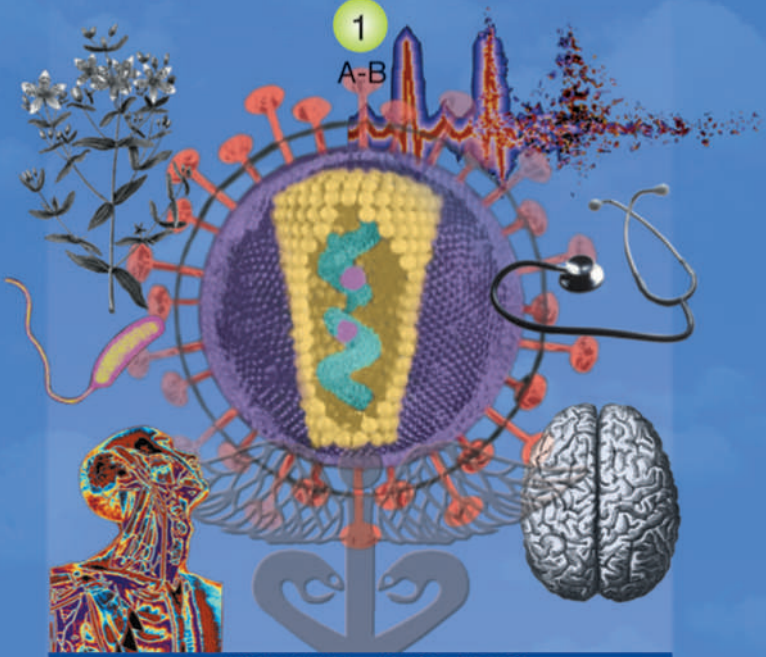
The GALE ENCYCLOPEDIA of MEDICINE

SECOND EDITION

VOLUME 1 A-B



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VOLUME

A-B

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CONTENTS

PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Medicine 2* is a medical reference product designed to inform and educate readers about a wide variety of disorders, conditions, treatments, and diagnostic tests. The Gale Group believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioner. While the Gale Group has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, the Gale Group makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of medical opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their health care provider.

INTRODUCTION

The *Gale Encyclopedia of Medicine 2 (GEM2)* is a one-stop source for medical information on nearly 1,700 common medical disorders, conditions, tests, and treatments, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart attack. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 2* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

SCOPE

Almost 1,700 full-length articles are included in the *Gale Encyclopedia of Medicine 2*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses, eg. acetaminophen (Tylenol). Throughout the *Gale Encyclopedia of Medicine 2*, many prominent individuals are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Description	Purpose
Causes and symptoms	Precautions
Diagnosis	Description
Treatment	Preparation
Alternative treatment	Aftercare
Prognosis	Risks
Prevention	Normal/Abnormal results
Resources	Resources
Key terms	Key terms

In recent years there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 2* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies.

INCLUSION CRITERIA

A preliminary list of diseases, disorders, tests and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM2* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale Group editor.

ABOUT THE CONTRIBUTORS

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM2* medical advisors reviewed the completed essays to insure that they are appropriate, up-to-date, and medically accurate.

HOW TO USE THIS BOOK

The *Gale Encyclopedia of Medicine 2* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.

- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms are also cross-referenced.
- A list of **key terms** are provided where appropriate to define unfamiliar terms or concepts.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix contains an extensive list of organizations arranged in alphabetical order.
- **Resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

GRAPHICS

The *Gale Encyclopedia of Medicine 2* is enhanced with over 675 color images, including photos, charts, tables, and customized line drawings.

ADVISORY BOARD

A number of experts in the library and medical communities provided invaluable assistance in the formulation of this encyclopedia. Our advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. The editor would like to express her appreciation to them.

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Abdominal aorta ultrasound *see* **Abdominal ultrasound**

Abdominal aortic aneurysm *see* **Aortic aneurysm**

Abdominal hernia *see* **Hernia**

Abdominal thrust *see* **Heimlich maneuver**

Abdominal ultrasound

Definition

Ultrasound technology allows doctors to "see" inside a patient without resorting to surgery. A transmitter sends high frequency sound waves into the body, where they bounce off the different tissues and organs to produce a distinctive pattern of echoes. A receiver "hears" the returning echo pattern and forwards it to a computer, which translates the data into an image on a television screen. Because ultrasound can distinguish subtle variations between soft, fluid-filled tissues, it is particularly useful in providing diagnostic images of the abdomen. Ultrasound can also be used in treatment.

Purpose

The potential medical applications of ultrasound were first recognized in the 1940s as an outgrowth of the sonar technology developed to detect submarines during World War II. The first useful medical images were produced in the early 1950s, and, by 1965, ultrasound quality had improved to the point that it came into general medical use. Improvements in the technology, application, and interpretation of ultrasound continue. Its low cost, versatility, safety and speed have brought it into the top drawer of medical imaging techniques.

While **pelvic ultrasound** is widely known and commonly used for fetal monitoring during **pregnancy**, ultrasound is also routinely used for general abdominal imaging. It has great advantage over x-ray imaging technologies in that it does not damage tissues with ionizing radiation. Ultrasound is also generally far better than plain x rays at distinguishing the subtle variations of soft tissue structures, and can be used in any of several modes, depending on the need at hand.

As an imaging tool, abdominal ultrasound generally is warranted for patients afflicted with: chronic or acute abdominal **pain**; abdominal trauma; an obvious or suspected abdominal mass; symptoms of liver disease, pancreatic disease, **gallstones**, spleen disease, kidney disease and urinary blockage; or symptoms of an abdominal **aortic aneurysm**. Specifically:

- Abdominal pain. Whether acute or chronic, pain can signal a serious problem—from organ malfunction or injury to the presence of malignant growths. Ultrasound scanning can help doctors quickly sort through potential causes when presented with general or ambiguous symptoms. All of the major abdominal organs can be studied for signs of disease that appear as changes in size, shape and internal structure.
- Abdominal trauma. After a serious accident, such as a car crash or a fall, internal bleeding from injured abdominal organs is often the most serious threat to survival. Neither the injuries nor the bleeding are immediately apparent. Ultrasound is very useful as an initial scan when abdominal trauma is suspected, and it can be used to pinpoint the location, cause, and severity of hemorrhaging. In the case of puncture **wounds**, from a bullet for example, ultrasound can locate the foreign object and provide a preliminary survey of the damage. The easy portability and versatility of ultrasound technology has brought it into common emergency room use, and even into limited ambulance service.
- Abdominal mass. Abnormal growths—tumors, cysts, abscesses, scar tissue and accessory organs—can be

located and tentatively identified with ultrasound. In particular, potentially malignant solid tumors can be distinguished from benign fluid-filled cysts and abscesses. Masses and malformations in any organ or part of the abdomen can be found.

- Liver disease. The types and underlying causes of liver disease are numerous, though **jaundice** tends to be a general symptom. Ultrasound can differentiate between many of the types and causes of liver malfunction, and is particularly good at identifying obstruction of the bile ducts and **cirrhosis**, which is characterized by abnormal fibrous growths and reduced blood flow.
- Pancreatic disease. Inflammation and malformation of the pancreas are readily identified by ultrasound, as are pancreatic stones (calculi), which can disrupt proper functioning.
- Gallstones. Gallstones cause more hospital admissions than any other digestive malady. These calculi can cause painful inflammation of the gallbladder and also obstruct the bile ducts that carry digestive enzymes from the gallbladder and liver to the intestines. Gallstones are readily identifiable with ultrasound.
- Spleen disease. The spleen is particularly prone to injury during abdominal trauma. It may also become painfully inflamed when beset with infection or **cancer**. These conditions also lend themselves well to ultrasonic inspection and diagnosis.
- Kidney disease. The kidneys are also prone to traumatic injury and are the organs most likely to form calculi, which can block the flow of urine and cause blood **poisoning** (uremia). A variety of diseases causing distinct changes in kidney morphology can also lead to complete kidney failure. Ultrasound imaging has proven extremely useful in diagnosing kidney disorders.
- Abdominal aortic aneurysm. This is a bulging weak spot in the abdominal aorta, which supplies blood directly from the heart to the entire lower body. These aneurysms are relatively common and increase in prevalence with age. A burst aortic aneurysm is imminently life-threatening. However, they can be readily identified and monitored with ultrasound before acute complications result.

Ultrasound technology can also be used for treatment purposes, most frequently as a visual aid during surgical procedures—such as guiding needle placement to drain fluid from a cyst, or to extract tumor cells for biopsy. Increasingly, direct therapeutic applications for ultrasound are being developed.

The direct therapeutic value of ultrasonic waves lies in their mechanical nature. They are shock waves, just like audible sound, and vibrate the materials through which they pass. These vibrations are mild, virtually unnoticeable at the frequencies and intensities used for imaging. Properly focused however, high-intensity ultrasound can be used to heat and physically agitate targeted tissues.

High-intensity ultrasound is used routinely to treat soft tissue injuries, such as strains, tears and associated scarring. The heating and agitation are believed to promote rapid healing through increased circulation. Strongly focused, high-intensity, high-frequency ultrasound can also be used to physically destroy certain types of tumors, as well as gallstones and other types of calculi. Developing new treatment applications for ultrasound is an active area of medical research.

Precautions

Properly performed, ultrasound imaging is virtually without risk or side effects. Some patients report feeling a slight tingling and/or warmth while being scanned, but most feel nothing at all. Ultrasound waves of appropriate frequency and intensity are not known to cause or aggravate any medical condition, though any woman who thinks she might be pregnant should raise the issue with her doctor before undergoing an abdominal ultrasound.

The value of ultrasound imaging as a medical tool, however, depends greatly on the quality of the equipment used and the skill of the medical personnel operating it. Improperly performed and/or interpreted, ultrasound can be worse than useless if it indicates that a problem exists where there is none, or fails to detect a significant condition. Basic ultrasound equipment is relatively inexpensive to obtain, and any doctor with the equipment can perform the procedure whether qualified or not. Patients should not hesitate to verify the credentials of technicians and doctors performing ultrasounds, as well as the quality of the equipment used and the benefits of the proposed procedure.

In cases where ultrasound is used as a treatment tool, patients should educate themselves about the proposed procedure with the help of their doctors—as is appropriate before any surgical procedure. Also, any abdominal ultrasound procedure, diagnostic or therapeutic, may be hampered by a patient's body type or other factors, such as the presence of excessive bowel gas (which is opaque to ultrasound). In particular, very obese people are often not good candidates for abdominal ultrasound.

Description

Ultrasound includes all sound waves above the frequency of human hearing—about 20 thousand hertz, or cycles per second. Medical ultrasound generally uses frequencies between one and 10 million hertz (1-10 MHz).

KEY TERMS

Accessory organ—A lump of tissue adjacent to an organ that is similar to it, but which serves no important purpose, if functional at all. While not necessarily harmful, such organs can cause problems if they grow too large or become cancerous. In any case, their presence points to an underlying abnormality in the parent organ.

Benign—In medical usage, benign is the opposite of malignant. It describes an abnormal growth that is stable, treatable and generally not life-threatening.

Biopsy—The surgical removal and analysis of a tissue sample for diagnostic purposes. Usually, the term refers to the collection and analysis of tissue from a suspected tumor to establish malignancy.

Calculus—Any type of hard concretion (stone) in the body, but usually found in the gallbladder, pancreas and kidneys. They are formed by the accumulation of excess mineral salts and other organic material such as blood or mucous. Calculi (pl.) can cause problems by lodging in and obstructing the proper flow of fluids, such as bile to the intestines or urine to the bladder.

Cirrhosis—A chronic liver disease characterized by the invasion of connective tissue and the degeneration of proper functioning—jaundice is often an accompanying symptom. Causes of cirrhosis include alcoholism, metabolic diseases, syphilis and congestive heart disease.

Common bile duct—The branching passage through which bile—a necessary digestive enzyme—travels from the liver and gallbladder into the small intestine. Digestive enzymes from the pancreas also enter the intestines through the common bile duct.

Computed tomography scan (CT scan)—A specialized type of x-ray imaging that uses highly focused and relatively low energy radiation to produce detailed two-dimensional images of soft tissue structures, particularly the brain. CT scans are the chief competitor to ultrasound and can yield higher quality images not disrupted by bone or gas. They are, however, more cumbersome, time consuming and expensive to perform, and they use ionizing electromagnetic radiation.

Doppler—The Doppler effect refers to the apparent change in frequency of sound wave echoes returning to a stationary source from a moving target. If the object is moving toward the source, the frequency increases; if the object is moving away, the frequency decreases. The size of this frequency shift can be used to compute the object's speed—be it a car on the road or blood in an artery. The Doppler effect holds true for all types of radiation, not just sound.

Frequency—Sound, whether traveling through air or the human body, produces vibrations—molecules bouncing into each other—as the shock wave travels along. The frequency of a sound is the number of vibrations per second. Within the audible range, frequency means pitch—the higher the frequency, the higher a sound's pitch.

Ionizing radiation—Radiation that can damage living tissue by disrupting and destroying individual cells at the molecular level. All types of nuclear radiation—x rays, gamma rays and beta rays—are potentially ionizing. Sound waves physically vibrate the material through which they pass, but do not ionize it.

Jaundice—A condition that results in a yellow tint to the skin, eyes and body fluids. Bile retention in the liver, gallbladder and pancreas is the immediate cause, but the underlying cause could be as simple as obstruction of the common bile duct by a gallstone or as serious as pancreatic cancer. Ultrasound can distinguish between these conditions.

Malignant—The term literally means growing worse and resisting treatment. It is used as a synonym for cancerous and connotes a harmful condition that generally is life-threatening.

Morphology—Literally, the study of form. In medicine, morphology refers to the size, shape and structure rather than the function of a given organ. As a diagnostic imaging technique, ultrasound facilitates the recognition of abnormal morphologies as symptoms of underlying conditions.

Higher frequency ultrasound waves produce more detailed images, but are also more readily absorbed and so cannot penetrate as deeply into the body. Abdominal ultrasound imaging is generally performed at frequencies between 2-5 MHz.

An ultrasound machine consists of two parts: the transducer and the analyzer. The transducer both produces the sound waves that penetrate the body and receives the reflected echoes. Transducers are built around piezoelectric ceramic chips. (Piezoelectric refers to electricity that is produced when you put pressure on certain crystals such as quartz). These ceramic chips react to electric pulses by producing sound waves (they are transmitting waves) and react to sound waves by producing electric pulses (receiving). Bursts of high frequency electric pulses supplied to the transducer causes it to produce the scanning sound waves. The transducer then receives the returning echoes, translates them back into electric pulses and sends them to the analyzer—a computer that organizes the data into an image on a television screen.

Because sound waves travel through all the body's tissues at nearly the same speed—about 3,400 miles per hour—the microseconds it takes for each echo to be received can be plotted on the screen as a distance into the body. The relative strength of each echo, a function of the specific tissue or organ boundary that produced it, can be plotted as a point of varying brightness. In this way, the echoes are translated into a picture. Tissues surrounded by bone or filled with gas (the stomach, intestines and bowel) cannot be imaged using ultrasound, because the waves are blocked or become randomly scattered.

Four different modes of ultrasound are used in medical imaging:

- A-mode. This is the simplest type of ultrasound in which a single transducer scans a line through the body with the echoes plotted on screen as a function of depth. This method is used to measure distances within the body and the size of internal organs. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy.
- B-mode. In B-mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen. Ultrasound probes containing more than 100 transducers in sequence form the basis for these most commonly used scanners, which cost about $50,000.
- M-Mode. The M stands for motion. A rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe. M-mode ultrasound has been put to particular use in studying heart motion.
- Doppler mode. **Doppler ultrasonography** includes the capability of accurately measuring velocities of moving material, such as blood in arteries and veins. The principle is the same as that used in radar guns that measure the speed of a car on the highway. Doppler capability is most often combined with B-mode scanning to produce images of blood vessels from which blood flow can be directly measured. This technique is used extensively to investigate valve defects, arteriosclerosis and **hypertension**, particularly in the heart, but also in the abdominal aorta and the portal vein of the liver. These machines cost about $250,000.

The actual procedure for a patient undergoing an abdominal ultrasound is relatively simple, regardless of the type of scan or its purpose. **Fasting** for at least eight hours prior to the procedure ensures that the stomach is empty and as small as possible, and that the intestines and bowels are relatively inactive. Fasting also allows the gall bladder to be seen, as it contracts after eating and may not be seen if the stomach is full. In some cases, a full bladder helps to push intestinal folds out of the way so that the gas they contain does not disrupt the image. The patient's abdomen is then greased with a special gel that allows the ultrasound probe to glide easily across the skin while transmitting and receiving ultrasonic pulses.

This procedure is conducted by a doctor with the assistance of a technologist skilled in operating the equipment. The probe is moved around the abdomen to obtain different views of the target areas. The patient will likely be asked to change positions from side to side and to hold their breath as necessary to obtain the desired views. Discomfort during the procedure is minimal.

The many types and uses of ultrasound technology makes it difficult to generalize about the time and costs involved. Relatively simple imaging—scanning a suspicious abdominal mass or a suspected abdominal aortic aneurysm—will take about half an hour to perform and will cost a few hundred dollars or more, depending on the quality of the equipment, the operator and other factors. More involved techniques such as multiple M-mode and Doppler-enhanced scans, or cases where the targets not well defined in advance, generally take more time and are more expensive.

Regardless of the type of scan used and the potential difficulties encountered, ultrasound remains faster and less expensive than **computed tomography scans** (CT), its primary rival in abdominal imaging. Furthermore, as abdominal ultrasounds are generally undertaken as "medically necessary" procedures designed to detect the presence of suspected abnormalities, they are covered

under most types of major medical insurance. As always, though, the patient would be wise to confirm that their coverage extends to the specific procedure proposed. For nonemergency situations, most underwriters stipulate prior approval as a condition of coverage.

Specific conditions for which ultrasound may be selected as a treatment option—certain types of tumors, lesions, **kidney stones** and other calculi, muscle and ligament injuries, etc.—are described in detail under the appropriate entries in this encyclopedia.

Preparation

A patient undergoing abdominal ultrasound will be advised by their physician about what to expect and how to prepare. As mentioned above, preparations generally include fasting and arriving for the procedure with a full bladder, if necessary. This preparation is particularly useful if the gallbladder, ovaries or veins are to be examined.

Aftercare

In general, no aftercare related to the abdominal ultrasound procedure itself is required.

Risks

Abdominal ultrasound carries with it no recognized risks or side effects, if properly performed using appropriate frequency and intensity ranges. Sensitive tissues, particularly those of the reproductive organs, could possibly sustain damage if violently vibrated by overly intense ultrasound waves. In general though, such damage would only result from improper use of the equipment.

Any woman who thinks she might be pregnant should raise this issue with her doctor before undergoing an abdominal ultrasound, as a fetus in the early stages of development could be injured by ultrasound meant to probe deeply recessed abdominal organs.

Normal results

As a diagnostic imaging technique, a normal abdominal ultrasound is one that indicates the absence of the suspected condition that prompted the scan. For example, symptoms such as a persistent **cough**, labored breathing, and upper abdominal pain suggest the possibility of, among other things, an abdominal aortic aneurysm. An ultrasound scan that indicates the absence of an aneurysm would rule out this life-threatening condition and point to other, less serious causes.

Abnormal results

Because abdominal ultrasound imaging is generally undertaken to confirm a suspected condition, the results of a scan often will prove abnormal—that is they will confirm the diagnosis, be it kidney stones, cirrhosis of the liver or an aortic aneurysm. At that point, appropriate medical treatment as prescribed by a patient's doctor is in order. See the relevant disease and disorder entries in this encyclopedia for more information.

Resources

BOOKS

Hall, Rebecca. *The Ultrasonic Handbook: Clinical, Etiologic and Pathologic Implications of Sonographic Findings.* Philadelphia: Lippincott, 1993.

Kevles, Bettyann Holtzmann. *Naked to the Bone: Medical Imaging in the Twentieth Century.* New Brunswick, NJ: Rutgers University Press, 1997.

Kremkau, Frederick W. *Diagnostic Ultrasound: Principles and Instruments.* Philadelphia: W. B. Saunders Co., 1993.

Shtasel, Philip. *Medical Tests and Diagnostic Procedures: A Patient's Guide to Just What the Doctor Ordered.* New York: Harper & Row, 1991.

Tempkin, Betty Bates. *Ultrasound Scanning: Principles and Protocols.* Philadelphia: W. B. Saunders Co., 1993.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

"Ultrasound Detects Stomach Problems." *USA Today Magazine* (October 1992): 5.

Freundlich, Naomi. "Ultrasound: What's Wrong with this Picture?" *Business Week* (15 September 1997): 84-5.

McDonagh, D. Brian. "Ultrasound: Unsung Medical Hero." *USA Today Magazine* (September 1996): 66-7.

Murray, Maxine. "Basics of Ultrasonography." *Student British Medical Journal* (August 1996): 269-72.

Tait, N., and J. M. Little. "The Treatment of Gallstones." *British Medical Journal* (8 July 1995): 99-105.

ORGANIZATIONS

American College of Gastroenterology. 4900 B South 31st St., Arlington, VA 22206-1656. (703) 820-7400. <http://www.acg.gi.org>.

American Institute of Ultrasound in Medicine. 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707-5906. (800) 638-5352. <http://www.aium.org>.

American Society of Radiologic Technologists. 15000 Central Ave., SE, Albuquerque, NM 87123-3917. (505) 298-4500. <http://www.asrt.org>.

Kurt Richard Sternlof

Abdominal wall defects

Definition

Abdominal wall defects are birth (congenital) defects that allow the stomach or intestines to protrude.

KEY TERMS

Hernia—Movement of a structure into a place it does not belong.

Umbilical—Referring to the opening in the abdominal wall where the blood vessels from the placenta enter.

Viscera—Any of the body's organs located in the chest or abdomen.

Description

Many unexpected and fascinating events occur during the development of a fetus inside the womb. The stomach and intestines begin development outside the baby's abdomen and only later does the abdominal wall enclose them. Occasionally, either the umbilical opening is too large, or it develops improperly, allowing the bowels or stomach to remain outside or squeeze through the abdominal wall.

Causes and symptoms

There are many causes for **birth defects** that still remain unclear. Presently, the cause(s) of abdominal wall defects is unknown, and any symptoms the mother may have to indicate that the defects are present in the fetus are nondescript.

Diagnosis

At birth, the problem is obvious, because the base of the umbilical cord at the navel will bulge or, in worse cases, contain viscera (internal organs). Before birth, an ultrasound examination may detect the problem. It is always necessary in children with one birth defect to look for others, because birth defects are usually multiple.

Treatment

Abdominal wall defects are effectively treated with surgical repair. Unless there are accompanying anomalies, the surgical procedure is not overly complicated. The organs are normal, just misplaced. However, if the defect is large, it may be difficult to fit all the viscera into the small abdominal cavity.

Prognosis

If there are no other defects, the prognosis after surgical repair of this condition is relatively good. However, 10% of those with more severe or additional abnormalities die from it. The organs themselves are fully functional; the difficulty lies in fitting them inside the abdomen. The condition is, in fact, a **hernia** requiring only replacement and strengthening of the passageway through which it occurred. After surgery, increased pressure in the stretched abdomen can compromise the function of the organs inside.

Prevention

Some, but by no means all, birth defects are preventable by early and attentive prenatal care, good **nutrition**, supplemental **vitamins**, diligent avoidance of all unnecessary drugs and chemicals—especially tobacco—and other elements of a healthy lifestyle.

Resources

PERIODICALS

Dunn, J. C., and E. W. Fonkalsrud. "Improved Survival of Infants with Omphalocele." *American Journal of Surgery* 173 (April 1997): 284-7.

Langer, J. C. "Gastroschisis and Omphalocele." *Seminars in Pediatric Surgery* 5 (May 1996): 124-8.

J. Ricker Polsdorfer, MD

Abnormal heart rhythms *see* **Arrhythmias**

ABO blood typing *see* **Blood typing and crossmatching**

ABO incompatibility *see* **Erythroblastosis fetalis**

Abortion, habitual *see* **Recurrent miscarriage**

Abortion, partial birth

Definition

Partial birth abortion is a method of late-term abortion that terminates a **pregnancy** and results in the **death** and intact removal of a fetus. This procedure is most commonly referred to as intact dilatation and extraction (D & X).

Purpose

Partial birth abortion, or D&X, is performed to end a pregnancy and results in the death of a fetus, typically in

the late second or third trimester. Although D&X is highly controversial, some physicians argue that it has advantages that make it a preferable procedure in some circumstances. One perceived advantage is that the fetus is removed largely intact, allowing for better evaluation and **autopsy** of the fetus in cases of known fetal anomalies. Intact removal of the fetus may also confer a lower risk of puncturing the uterus or damaging the cervix. Another perceived advantage is that D&X ends the pregnancy without requiring the woman to go through labor, which may be less emotionally traumatic than other methods of late-term abortion. In addition, D&X may offer a lower cost and shorter procedure time.

Precautions

Women considering D&X should be aware of the highly controversial nature of this procedure. A controversy common to all late-term abortions is whether the fetus is viable, or able to survive outside of the woman's body. A specific area of controversy with D&X is that fetal death does not occur until after most of the fetal body has exited the uterus. Several states have taken legal action to limit or ban D&X and many physicians who perform abortions do not perform D&X. This may restrict the availability of this procedure to women seeking late-term abortion.

Description

Intact D&X, or partial birth abortion first involves administration of medications to cause the cervix to dilate, usually over the course of several days. Next, the physician rotates the fetus to a footling breech position. The body of the fetus is then drawn out of the uterus feet first, until only the head remains inside the uterus. Then, the physician uses an instrument to puncture the base of the skull, which collapses the fetal head. Typically, the contents of the fetal head are then partially suctioned out, which results in the death of the fetus, and reduces the sizes of the fetal head enough to allow it to pass through the cervix. The dead and otherwise intact fetus is then removed from the woman's body.

Preparation

Medical preparation for D&X involves an outpatient visit to administer medications, such as *laminaria*, to cause the cervix to begin dilating.

In addition, preparation may involve fulfilling local legal requirements, such as a mandatory waiting period, counseling, or an informed consent procedure reviewing stages of fetal development, **childbirth**, alternative abortion methods, and adoption.

KEY TERMS

Cervix—The narrow outer end of the uterus that separates the uterus from the vaginal canal.

Footling breech—A position of the fetus while in the uterus where the feet of the fetus are nearest the cervix would be the first part of the fetus to exit the uterus, with the head of the fetus being the last part to exit the uterus.

Laminaria—A medical product made from a certain type of seaweed that is physically placed near the cervix to cause it to dilate.

Aftercare

D&X typically does not require an overnight hospital stay, so a follow up appointment may be scheduled to monitor the woman for any complications.

Risks

With all abortion, the later in pregnancy an abortion is performed, the more complicated the procedure and the greater the risk of injury to the woman. In addition to associated emotion reactions, D&X carries the risk of injury to the woman, including heavy bleeding, blood clots, damage to the cervix or uterus, pelvic infection, and anesthesia-related complications. There is also a risk of incomplete abortion, meaning that the fetus is not dead when removed from the woman's body. Possible long-term risks include difficulty becoming pregnant or carrying a future pregnancy to term.

Normal results

The expected outcome of D&X is the termination of a pregnancy with removal of a dead fetus from the woman's body.

Resources

PERIODICALS

Epner, Janet E., et al. "Late-term Abortion." *JAMA* 280, no. 8 (26 August 1998): 724-729.

Sprang, M. LeRoy, and Neerhof, Mark G. "Rationale for Banning Abortions Late in Pregnancy." *JAMA* (26 August 1998): 744-747.

Swomley, John M. "The 'Partial-birth' Debate in 1998." *Humanist* (March/April 1998): 5-7.

Grimes, David A. "The Continuing Need for Late Abortion." *JAMA* (26 August 1998): 747-750.

ORGANIZATIONS

Planned Parenthood Federation of America. 810 Seventh Ave., New York, NY 10019. (212) 541-7800. FAX: (212) 245-1845.

OTHER

Status of partial-birth abortion laws in the states. Othmer Institute at Planned Parenthood of NYC. 2000.

Stefanie B. N. Dugan, M.S.

Abortion, selective

Definition

Selective abortion, also known as selective reduction, refers to choosing to abort a fetus, typically in a multi-fetal **pregnancy**, to decrease the health risks to the mother in carrying and giving birth to more than one or two babies, and also to decrease the risk of complications to the remaining fetus(es). The term selective abortion also refers to choosing to abort a fetus for reasons such as the woman is carrying a fetus which likely will be born with some birth defect or impairment, or because the sex of the fetus is not preferred by the individual.

Purpose

A woman may decide to abort for health reasons, for example, she is at higher risk for complications during pregnancy because of a disorder or disease such as diabetes.

However, selective reduction is recommended often in cases of multi-fetal pregnancy, or the presence of more than one fetus, typically, at least three or more fetuses. In the general population, multi-fetal pregnancy happens in only about 1-2% of pregnant women. But multi-fetal pregnancies occur far more often in women using fertility drugs.

Precautions

Because women or couples who use fertility drugs have made an extra effort to become pregnant, it is possible that the individuals may be unwilling or uncomfortable with the decision to abort a fetus in cases of multi-fetal pregnancy. Individuals engaging in fertility treatment should be made aware of the risk of multi-fetal pregnancy and consider the prospect of recommended reduction before undergoing fertility treatment.

Description

Selective reduction is usually performed between nine and 12 weeks of pregnancy and is most successful when performed in early pregnancy. It is a simple procedure and can be performed on an outpatient basis. A needle is inserted into the woman's stomach or vagina and potassium chloride is injected into the fetus.

Preparation

Individuals who have chosen selective reduction to safeguard the remaining fetuses should be counseled prior to the procedure. Individuals should receive information regarding the risks of a multi-fetal pregnancy to both the fetuses and the mother compared with the risks after the reduction.

Individuals seeking an abortion for any reason should consider the ethical implications whether it be because the fetus is not the preferred sex or because the fetus would be born with a severe birth defect.

Aftercare

Counseling should continue after the abortion because it is a traumatic event. Individuals may feel guilty about choosing one fetus over another. Mental health professionals should be consulted throughout the process.

Risks

About 75% of women who undergo selective reduction will go into **premature labor**. About 4-5% of women undergoing selective reduction also miscarry one or more of the remaining fetuses. The risks associated with multi-fetal pregnancy is considered higher.

Normal results

In cases where a multi-fetal pregnancy, three or more fetuses, is reduced to two, the twin fetuses typically develop as they would as if they were conceived as twins.

Resources

BOOKS

Knobil, Ernst and Jimmy D. Neill, editors. "Abortion." In *Encyclopedia of Reproduction*. San Diego: Adademic Press, 1998, pp.1-5.

Scott, James R., editor. "Induced Abortion." In *Danforth's Obstetrics and Gynecology.* Philadelphia: Lippincott Williams & Wilkins, 1999, pp.567-578.

PERIODICALS

Author unspecified. "Multiple Pregnancy Associated With Infertility Therapy." *American Society for Reproductive Medicine, A Practice Committee Report* (November 2000): 1-8.

KEY TERMS

Multi-fetal pregnancy—A pregnancy of two or more fetuses.

Selective reduction—Typically referred to in cases of multifetal pregnancy, when one or more fetuses are aborted to preserve the viability of the remaining fetuses and decrease health risks to the mother.

ORGANIZATIONS

The American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216-2809. (205) 978-5000. <http://www.asrm.org>.

The Alan Guttmacher Institute. 120 Wall Street, New York, NY 10005. (212) 248-1111. <http://www.agi-usa.org>.

Meghan M. Gourley

Abortion, spontaneous *see* **Miscarriage**

Abortion, therapeutic

Definition

Therapeutic abortion is the intentional termination of a **pregnancy** before the fetus can live independently. Abortion has been a legal procedure in the United States since 1973.

Purpose

An abortion may be performed whenever there is some compelling reason to end a pregnancy. Women have abortions because continuing the pregnancy would cause them hardship, endanger their life or health, or because prenatal testing has shown that the fetus will be born with severe abnormalities.

Abortions are safest when performed within the first six to 10 weeks after the last menstrual period. The calculation of this date is referred to as the gestational age and is used in determining the stage of pregnancy. For example, a woman who is two weeks late having her period is said to be six weeks pregnant, because it is six weeks since she last menstruated.

About 90% of women who have abortions do so before 13 weeks and experience few complications. Abortions performed between 13-24 weeks have a higher rate of complications. Abortions after 24 weeks are extremely rare and are usually limited to situations where the life of the mother is in danger.

Precautions

Most women are able to have abortions at clinics or outpatient facilities if the procedure is performed early in pregnancy. Women who have stable diabetes, controlled epilepsy, mild to moderate high blood pressure, or who are HIV positive can often have abortions as outpatients if precautions are taken. Women with heart disease, previous **endocarditis**, **asthma**, lupus erythematosus, uterine fibroid tumors, blood clotting disorders, poorly controlled epilepsy, or some psychological disorders usually need to be hospitalized in order to receive special monitoring and medications during the procedure.

Description

Very early abortions

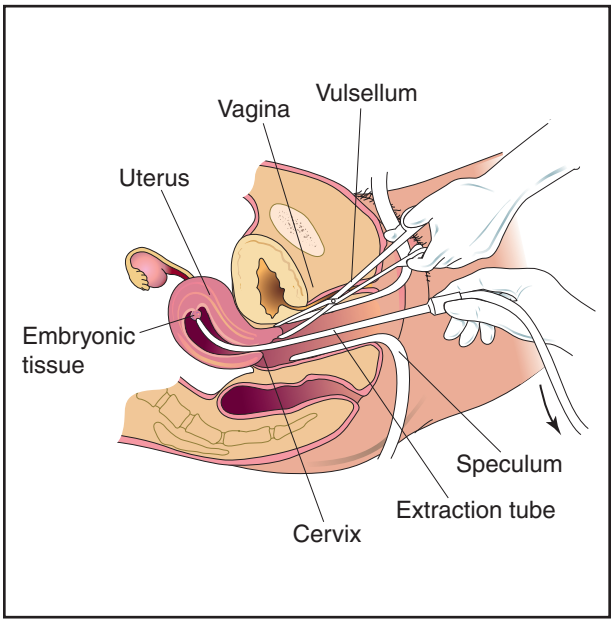
Between five and seven weeks, a pregnancy can be ended by a procedure called menstrual extraction. This procedure is also sometimes called menstrual regulation, mini-suction, or preemptive abortion. The contents of the uterus are suctioned out through a thin (3-4 mm) plastic tube that is inserted through the undilated cervix. Suction is applied either by a bulb syringe or a small pump.

Another method is called the "morning after" pill, or emergency **contraception**. Basically, it involves taking high doses of birth control pills within 24 to 48 hours of having unprotected sex. The high doses of hormones causes the uterine lining to change so that it will not support a pregnancy. Thus, if the egg has been fertilized, it is simply expelled from the body.

There are two types of emergency contraception. One type is identical to ordinary birth control pills, and uses the hormones estrogen and progestin). This type is available with a prescription under the brand name Preven. But women can even use their regular birth control pills for emergency contraception, after they check with their doctor about the proper dose. About half of women who use birth control pills for emergency contraception get nauseated and 20 percent vomit. This method cuts the risk of pregnancy 75 percent.

The other type of morning-after pill contains only one hormone: progestin, and is available under the brand name Plan B. It is more effective than the first type with a lower risk of **nausea and vomiting**. It reduces the risk of pregnancy 89 percent.

Women should check with their physicians regarding the proper dose of pills to take, as it depends on the



Between 5 and 7 weeks, a pregnancy can be ended by a procedure called menstrual extraction. The contents of the uterus are suctioned out through a thin extraction tube that is inserted through the undilated cervix. *(Illustration by Electronic Illustrators Group.)*

brand of birth control pill. Not all birth control pills will work for emergency contraception.

Menstrual extractions are safe, but because the amount of fetal material is so small at this stage of development, it is easy to miss. This results in an incomplete abortion that means the pregnancy continues.

First trimester abortions

The first trimester of pregnancy includes the first 13 weeks after the last menstrual period. In the United States, about 90% of abortions are performed during this period. It is the safest time in which to have an abortion, and the time in which women have the most choice of how the procedure is performed.

MEDICAL ABORTIONS. Medical abortions are brought about by taking medications that end the pregnancy. The advantages of a first trimester medical abortion are:

- The procedure is non-invasive; no surgical instruments are used.
- Anesthesia is not required.
- Drugs are administered either orally or by injection.
- The procedure resembles a natural **miscarriage**.

Disadvantages of a medical abortion are:

- The effectiveness decreases after the seventh week.
- The procedure may require multiple visits to the doctor.
- Bleeding after the abortion lasts longer than after a surgical abortion.
- The woman may see the contents of her womb as it is expelled.

Two different medications can be used to bring about an abortion. Methotrexate (Rheumatrex) works by stopping fetal cells from dividing which causes the fetus to die.

On the first visit to the doctor, the woman receives an injection of methotrexate. On the second visit, about a week later, she is given misoprostol (Cytotec), an oxygenated unsaturated cyclic fatty acid responsible for various hormonal reactions such as muscle contraction (prostaglandin), that stimulates contractions of the uterus. Within two weeks, the woman will expel the contents of her uterus, ending the pregnancy. A follow-up visit to the doctor is necessary to assure that the abortion is complete.

With this procedure, a woman will feel cramping and may feel nauseated from the misoprostol. This combination of drugs is 90-96% effective in ending pregnancy.

Mifepristone (RU-486), which goes by the brand name Mifeprex, works by blocking the action of progesterone, a hormone needed for pregnancy to continue, then stimulates uterine contractions thus ending the pregnancy. It can be taken a much as 49 days after the first day of a woman's last period. On the first visit to the doctor, a woman takes a mifepristone pill. Two days later she returns and, if the miscarriage has not occurred, takes two misoprostol pills, which causes the uterus to contract. Five percent of women won't need to take misoprostol. After an observation period, she returns home.

Within four days, 90% of women have expelled the contents of their uterus and completed the abortion. Within 14 days, 95-97% of women have completed the abortion. A third follow-up visit to the doctor is necessary to confirm through observation or ultrasound that the procedure is complete. In the event that it is not, a surgical abortion is performed. Studies show that 4.5 to 8 percent of women need surgery or a blood **transfusion** after taking mifepristone, and the pregnancy persists in about 1 percent of women. In this case, surgical abortion is recommended because the fetus may be damanged. Side effects include nausea, vaginal bleeding and heavy cramping. The bleeding is typically heavier than a normal period and may last up to 16 days.

Mifepristone is not recommended for women with **ectopic pregnancy**, an **IUD**, who have been taking long-

term steroidal therapy, have bleeding abnormalities or on blood-thinners such as Coumadin.

Surgical abortions

First trimester surgical abortions are performed using vacuum aspiration. The procedure is also called dilation and evacuation (D & E), suction dilation, vacuum curettage, or suction curettage.

Advantages of a vacuum aspiration abortion are:

- It is usually done as a one-day outpatient procedure.
- The procedure takes only 10-15 minutes.
- Bleeding after the abortion lasts five days or less.
- The woman does not see the products of her womb being removed.

Disadvantages include:

- The procedure is invasive; surgical instruments are used.
- Infection may occur.

During a vacuum aspiration, the woman's cervix is gradually dilated by expanding rods inserted into the cervical opening. Once dilated, a tube attached to a suction pump is inserted through the cervix and the contents of the uterus are suctioned out. The procedure is 97-99% effective. The amount of discomfort a woman feels varies considerably. Local anesthesia is often given to numb the cervix, but it does not mask uterine cramping. After a few hours of rest, the woman may return home.

KEY TERMS

Endocarditis—An infection of the inner membrane lining of the heart.

Fibroid tumors—Fibroid tumors are non-cancerous (benign) growths in the uterus. They occur in 30-40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Lupus erythematosus—A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

Prostaglandin—Oxygenated unsaturated cyclic fatty acids responsible for various hormonal reactions such as muscle contraction.

Rh negative—Lacking the Rh factor, genetically determined antigens in red blood cells that produce immune responses. If an Rh negative woman is pregnant with an Rh positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the women's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

Second trimester abortions

Although it is better to have an abortion during the first trimester, some second trimester abortions may be inevitable. The results of **genetic testing** are often not available until 16 weeks. In addition, women, especially teens, may not have recognized the pregnancy or come to terms with it emotionally soon enough to have a first trimester abortion. Teens make up the largest group having second trimester abortions.

Some second trimester abortions are performed as a D & E. The procedures are similar to those used in the first trimester, but a larger suction tube must be used because more material must be removed. This increases the amount of cervical dilation necessary and increases the risk of the procedure. Many physicians are reluctant to perform a D & E this late in pregnancy, and for some women is it not a medically safe option.

The alternative to a D & E in the second trimester is an abortion by induced labor. Induced labor may require an overnight stay in a hospital. The day before the procedure, the woman visits the doctor for tests, and to either have rods inserted in her cervix to help dilate it or to receive medication that will soften the cervix and speed up labor.

On the day of the abortion, drugs, usually prostaglandins to induce contractions, and a salt water solution, are injected into the uterus. Contractions begin, and within eight to 72 hours the woman delivers the fetus.

Side effects of this procedure include nausea, vomiting, and **diarrhea** from the prostaglandins, and **pain** from uterine cramps. Anesthesia of the sort used in **childbirth** can be given to mask the pain. Many women are able to go home a few hours after the procedure.

Very early abortions cost between $200-$400. Later abortions cost more. The cost increases about $100 per week between the thirteenth and sixteenth week. Second trimester abortions are much more costly because they often involve more risk, more services, anesthesia, and sometimes a hospital stay. Insurance carriers and HMOs may or may not cover the procedure. Federal law pro-

hibits federal funds including Medicaid funds, from being used to pay for an elective abortion.

Preparation

The doctor must know accurately the stage of a woman's pregnancy before an abortion is performed. The doctor will ask the woman questions about her menstrual cycle and also do a **physical examination** to confirm the stage of pregnancy. This may be done at an office visit before the abortion or on the day of the abortion. Some states require a waiting period before an abortion can be performed. Others require parental or court consent for a child under age 18 to receive an abortion.

Despite the fact that almost half of all women in the United States have had at least one abortion by the time they reach age 45, abortion is surrounded by controversy. Women often find themselves in emotional turmoil when deciding if an abortion is a procedure they wish to undergo. Pre-abortion counseling is important in helping a woman resolve any questions she may have about having the procedure.

Aftercare

Regardless of the method used to perform the abortion, a woman will be observed for a period of time to make sure her blood pressure is stable and that bleeding is controlled. The doctor may prescribe **antibiotics** to reduce the chance of infection. Women who are Rh negative (lacking genetically determined antigens in their red blood cells that produce immune responses) should be given a human Rh immune globulin (RhoGAM) after the procedure unless the father of the fetus is also Rh negative. This prevents blood incompatibility complications in future pregnancies.

Bleeding will continue for about five days in a surgical abortion and longer in a medical abortion. To decrease the risk of infection, a woman should avoid intercourse and not use tampons and douches for two weeks after the abortion.

A follow-up visit is a necessary part of the woman's aftercare. Contraception will be offered to women who wish to avoid future pregnancies, because menstrual periods normally resume within a few weeks.

Risks

Serious complications resulting from abortions performed before 13 weeks are rare. Of the 90% of women who have abortions in this time period, 2.5% have minor complications that can be handled without hospitalization. Less than 0.5% have complications that require a hospital stay. The rate of complications increases as the pregnancy progresses.

Complications from abortions can include:

- uncontrolled bleeding
- infection
- blood clots accumulating in the uterus
- a tear in the cervix or uterus
- missed abortion where the pregnancy continues
- incomplete abortion where some material from the pregnancy remains in the uterus

Women who experience any of the following symptoms of post-abortion complications should call the clinic or doctor who performed the abortion immediately.

- severe pain
- fever over 100.4°F (38.2°C)
- heavy bleeding that soaks through more than one sanitary pad per hour
- foul-smelling discharge from the vagina
- continuing symptoms of pregnancy

Normal results

Usually the pregnancy is ended without complication and without altering future fertility.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Abortion." In *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

DeCherney, Alan H., and Martin L. Peroll. "Contraception and Family Planning." In *Current Obstetric and Gynecologic Diagnosis and Treatment*. Norwalk, CT: Appleton & Lange, 1994.

ORGANIZATION

National Abortion Federation. (800) 772-9100. <http://www.prochoice.org>.

Debra Gordon

Abrasions *see* **Wounds**

Abruptio placentae *see* **Placental abruption**

Abscess

Definition

An abscess is an enclosed collection of liquefied tissue, known as pus, somewhere in the body. It is the result of the body's defensive reaction to foreign material.

Description

There are two types of abscesses, septic and sterile. Most abscesses are septic, which means that they are the result of an infection. Septic abscesses can occur anywhere in the body. Only a germ and the body's immune response are required. In response to the invading germ, white blood cells gather at the infected site and begin producing chemicals called enzymes that attack the germ by digesting it. These enzymes act like acid, killing the germs and breaking them down into small pieces that can be picked up by the circulation and eliminated from the body. Unfortunately, these chemicals also digest body tissues. In most cases, the germ produces similar chemicals. The result is a thick, yellow liquid—pus—containing digested germs, digested tissue, white blood cells, and enzymes.

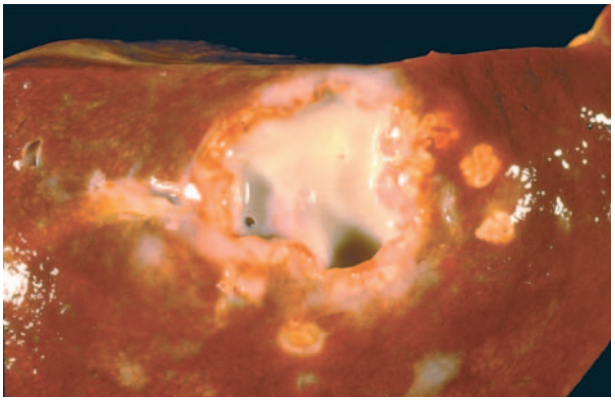
An abscess is the last stage of a tissue infection that begins with a process called inflammation. Initially, as the invading germ activates the body's immune system, several events occur:

- Blood flow to the area increases.
- The temperature of the area increases due to the increased blood supply.
- The area swells due to the accumulation of water, blood, and other liquids.
- It turns red.
- It hurts, because of the irritation from the swelling and the chemical activity.

These four signs—heat, swelling, redness, and pain—characterize inflammation.

As the process progresses, the tissue begins to turn to liquid, and an abscess forms. It is the nature of an abscess to spread as the chemical digestion liquefies more and more tissue. Furthermore, the spreading follows the path of least resistance—the tissues most easily digested. A good example is an abscess just beneath the skin. It most easily continues along beneath the skin rather than working its way through the skin where it could drain its toxic contents. The contents of the abscess also leak into the general circulation and produce symptoms just like any other infection. These include chills, **fever**, aching, and general discomfort.

Sterile abscesses are sometimes a milder form of the same process caused not by germs but by non-living irritants such as drugs. If an injected drug like penicillin is not absorbed, it stays where it was injected and may cause enough irritation to generate a sterile abscess—sterile because there is no infection involved. Sterile abscesses are quite likely to turn into hard, solid lumps as they scar, rather than remaining pockets of pus.



An amoebic abscess caused by *Entameoba histolytica.* *(Phototake NYC. Reproduced by permission.)*

Causes and symptoms

Many different agents cause abscesses. The most common are the pus-forming (pyogenic) bacteria like *Staphylococcus aureus*, which is nearly always the cause of abscesses under the skin. Abscesses near the large bowel, particularly around the anus, may be caused by any of the numerous bacteria found within the large bowel. Brain abscesses and liver abscesses can be caused by any organism that can travel there through the circulation. Bacteria, amoeba, and certain fungi can travel in this fashion. Abscesses in other parts of the body are caused by organisms that normally inhabit nearby structures or that infect them. Some common causes of specific abscesses are:

- skin abscesses by normal skin flora
- dental and throat abscesses by mouth flora
- lung abscesses by normal airway flora, **pneumonia** germs, or **tuberculosis**
- abdominal and anal abscesses by normal bowel flora

Specific types of abscesses

Listed below are some of the more common and important abscesses.

- Carbuncles and other **boils**. Skin oil glands (sebaceous glands) on the back or the back of the neck are the ones usually infected. The most common germ involved is *Staphylococcus aureus*. **Acne** is a similar condition of sebaceous glands on the face and back.
- Pilonidal abscess. Many people have as a birth defect a tiny opening in the skin just above the anus. Fecal bacteria can enter this opening, causing an infection and subsequent abscess.

KEY TERMS

Cellulitis—Inflammation of tissue due to infection.

Enzyme—Any of a number of protein chemicals that can change other chemicals.

Fallopian tubes—Part of the internal female anatomy that carries eggs from the ovaries to the uterus.

Flora—Living inhabitants of a region or area.

Pyogenic—Capable of generating pus. *Streptococcus, Staphocococcus,* and bowel bacteria are the primary pyogenic organisms.

Sebaceous glands—Tiny structures in the skin that produce oil (sebum). If they become plugged, sebum collects inside and forms a nurturing place for germs to grow.

Septicemia—The spread of an infectious agent throughout the body by means of the blood stream.

Sinus—A tubular channel connecting one body part with another or with the outside.

- Retropharyngeal, parapharyngeal, peritonsillar abscess. As a result of throat infections like **strep throat** and **tonsillitis**, bacteria can invade the deeper tissues of the throat and cause an abscess. These abscesses can compromise swallowing and even breathing.
- Lung abscess. During or after pneumonia, whether it's due to bacteria [common pneumonia], tuberculosis, fungi, parasites, or other germs, abscesses can develop as a complication.
- Liver abscess. Bacteria or amoeba from the intestines can spread through the blood to the liver and cause abscesses.
- Psoas abscess. Deep in the back of the abdomen on either side of the lumbar spine lie the psoas muscles. They flex the hips. An abscess can develop in one of these muscles, usually when it spreads from the appendix, the large bowel, or the fallopian tubes.

Diagnosis

The common findings of inflammation—heat, redness, swelling, and pain—easily identify superficial abscesses. Abscesses in other places may produce only generalized symptoms such as fever and discomfort. If the patient's symptoms and **physical examination** do not help, a physician may have to resort to a battery of tests to locate the site of an abscess, but usually something in the initial evaluation directs the search. Recent or chronic disease in an organ suggests it may be the site of an abscess. Dysfunction of an organ or system—for instance, seizures or altered bowel function—may provide the clue. **Pain** and tenderness on physical examination are common findings. Sometimes a deep abscess will eat a small channel (sinus) to the surface and begin leaking pus. A sterile abscess may cause only a painful lump deep in the buttock where a shot was given.

Treatment

Since skin is very resistant to the spread of infection, it acts as a barrier, often keeping the toxic chemicals of an abscess from escaping the body on their own. Thus, the pus must be drained from the abscess by a physician. The surgeon determines when the abscess is ready for drainage and opens a path to the outside, allowing the pus to escape. Ordinarily, the body handles the remaining infection, sometimes with the help of **antibiotics** or other drugs. The surgeon may leave a drain (a piece of cloth or rubber) in the abscess cavity to prevent it from closing before all the pus has drained out.

Alternative treatment

If an abscess is directly beneath the skin, it will be slowly working its way through the skin as it is more rapidly working its way elsewhere. Since chemicals work faster at higher temperatures, applications of hot compresses to the skin over the abscess will hasten the digestion of the skin and eventually result in its breaking down, releasing the pus spontaneously. This treatment is best reserved for smaller abscesses in relatively less dangerous areas of the body—limbs, trunk, back of the neck. It is also useful for all superficial abscesses in their very early stages. It will "ripen" them.

Contrast **hydrotherapy**, alternating hot and cold compresses, can also help assist the body in resorption of the abscess. There are two homeopathic remedies that work to rebalance the body in relation to abscess formation, *Silica* and *Hepar sulphuris*. In cases of septic abscesses, bentonite clay packs (bentonite clay and a small amount of *Hydrastis* powder) can be used to draw the infection from the area.

Prognosis

Once the abscess is properly drained, the prognosis is excellent for the condition itself. The reason for the abscess (other diseases the patient has) will determine the overall outcome. If, on the other hand, the abscess ruptures into neighboring areas or permits the infectious

agent to spill into the bloodstream, serious or fatal consequences are likely. Abscesses in and around the nasal sinuses, face, ears, and scalp may work their way into the brain. Abscesses within an abdominal organ such as the liver may rupture into the abdominal cavity. In either case, the result is life threatening. Blood **poisoning** is a term commonly used to describe an infection that has spilled into the blood stream and spread throughout the body from a localized origin. Blood poisoning, known to physicians as septicemia, is also life threatening.

Of special note, abscesses in the hand are more serious than they might appear. Due to the intricate structure and the overriding importance of the hand, any hand infection must be treated promptly and competently.

Prevention

Infections that are treated early with heat (if superficial) or antibiotics will often resolve without the formation of an abscess. It is even better to avoid infections altogether by taking prompt care of open injuries, particularly puncture **wounds**. Bites are the most dangerous of all, even more so because they often occur on the hand.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Abscess drainage *see* **Abscess incision and drainage**

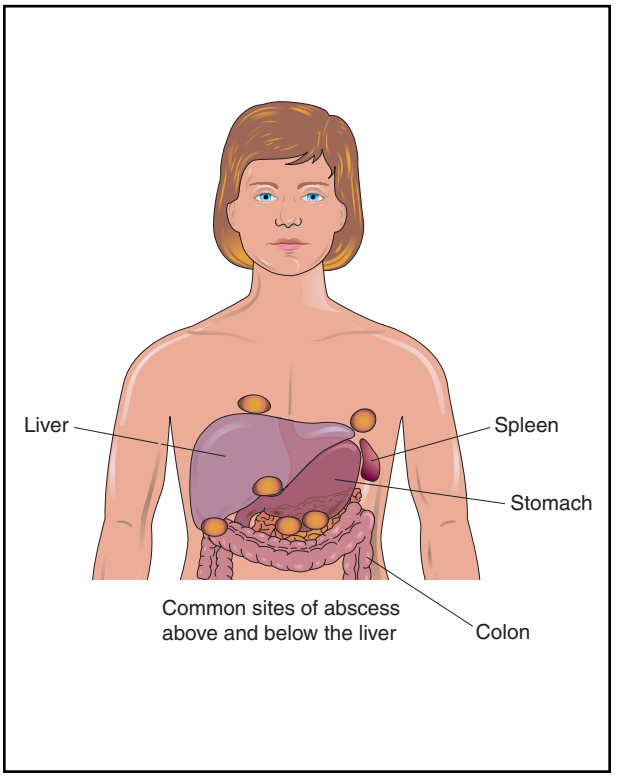
Abscess incision & drainage

Definition

An infected skin nodule that contains pus may need to be drained via a cut if it does not respond to **antibiotics**. This allows the pus to escape, and the infection to heal.

Purpose

An **abscess** is a pus-filled sore, usually caused by a bacterial infection. The pus is made up of both live and dead organisms and destroyed tissue from the white blood cells that were carried to the area to fight the infection. Abscesses are often found in the soft tissue under the skin, such as the armpit or the groin. However, they may develop in any organ, and are commonly found in the breast and gums. Abscesses are far more serious and call for more specific treatment if they are located in deep organs such as the lung, liver or brain.



Although abscesses are often found in the soft tissue under the skin, such as the armpit or the groin, they may develop in any organ, such as the liver. *(Illustration by Electronic Illustrators Group.)*

Because the lining of the abscess cavity tends to interfere with the amount of the drug that can penetrate the source of infection from the blood, the cavity itself may require draining. Once an abscess has fully formed, it often does not respond to antibiotics. Even if the antibiotic does penetrate into the abscess, it doesn't function as well in that environment.

Precautions

An abscess can usually be diagnosed visually, although an imaging technique such as a computed tomography scan may be used to confirm the extent of the abscess before drainage. Such procedures may also be needed to localize internal abscesses, such as those in the abdominal cavity or brain.

KEY TERMS

White blood cells—Cells that protect the body against infection.

Description

A doctor will cut into the lining of the abscess, allowing the pus to escape either through a drainage tube or by leaving the cavity open to the skin. How big the incision is depends on how quickly the pus is encountered.

Once the abscess is opened, the doctor will clean and irrigate the wound thoroughly with saline. If it is not too large or deep, the doctor may simply pack the abscess wound with gauze for 24–48 hours to absorb the pus and discharge.

If it is a deeper abscess, the doctor may insert a drainage tube after cleaning out the wound. Once the tube is in place, the surgeon closes the incision with simple stitches, and applies a sterile dressing. Drainage is maintained for several days to help prevent the abscess from reforming.

Preparation

The skin over the abscess will be cleansed by swabbing gently with an antiseptic solution.

Aftercare

Much of the **pain** around the abscess will be gone after the surgery. Healing is usually very fast. After the tube is taken out, antibiotics may be continued for several days. Applying heat and keeping the affected area elevated may help relieve inflammation.

Risks

If there is any scarring, it is likely to become much less noticeable as time goes on, and eventually almost invisible. Occasionally, an abscess within a vital organ (such as the brain) damages enough surrounding tissue that there is some permanent loss of normal function.

Normal results

Most abscesses heal after drainage alone; others require drainage and antibiotic drug treatment.

Resources

BOOKS

Turkington, Carol A., and Jeffrey S. Dover. *Skin Deep*. New York: Facts on File, 1998.

ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases. 9000 Rockville Pike, Bldg. 31, Rm 9A04, Bethesda, MD 20892.

Carol A. Turkington

Abuse

Definition

Abuse is defined as any thing that is harmful, injurious, or offensive. Abuse also includes excessive and wrongful misuse of anything. There are several major types of abuse: physical and sexual abuse of a child or an adult, substance abuse, elderly abuse, and emotional abuse.

Description

Physical abuse of a child is the infliction of injury by an other person. The injuries can include punching, kicking, biting, burning, beating, or pulling the victim's hair. The physical abuse inflicted on a child can result in **bruises**, **burns**, **poisoning**, broken bones, and internal hemorrhages. Physical assault against an adult primarily occurs with women, usually in the form of domestic violence. It is estimated that approximately three million children witness domestic violence every year.

Sexual abuse of a child refers to sexual behavior between an adult and child or between two children, one of whom is dominant or significantly older. The sexual behaviors can include touching breasts, genitals, and buttocks; either dressed or undressed. The behavior can also include exhibitionism, cunnilingus, fellatio, or penetration of the vagina or anus with sexual organs or objects.

Pornographic photography is also used in sexual abuse with children. Reported sex offenders are 97% male. Females are more often perpetrators in child-care settings, since children may confuse sexual abuse by a female with normal hygiene care. Sexual abuse by stepfathers is five times more common than with biological fathers. Sexual abuse of daughters by stepfathers or fathers is the most common form of incest.

Sexual abuse can also take the form of rape. The legal definition of rape includes only slight penile penetration in the victim's outer vulva area. Complete erection and ejaculation are not necessary. Rape is the perpetration of an act of sexual intercourse whether:

- will is overcome by force or fear (from threats or by use of drugs).

- mental impairment renders the victim incapable of rational judgment.
- if the victim is below the legal age established for consent.

Substance abuse is an abnormal pattern of substance usage leading to significant distress or impairment. The criteria include one or more of the following occurring within a 12-month period:

- recurrent substance use resulting in failure to fulfill obligations at home, work, or school.
- using substance in situations that are physically dangerous (i.e., while driving).
- recurrent substance-related legal problems.
- continued usage despite recurrent social and interpersonal problems (i.e., arguments and fights with significant other).

Abuse in the elderly is common and occurs mostly as a result of caretaker burnout, due to the high level of dependency frail, elderly patients usually require. Abuse can be manifested by physical signs, fear, and delaying or not reporting the need for advanced medical care. Elderly patients may also exhibit financial abuse (money or possessions taken away) and abandonment.

Emotional abuse generally continues even after physical assaults have stopped. In most cases it is a personally tailored form of verbal or gesture abuse expressed to illicit a provoked response.

Causes and symptoms

Children who have been abused usually have a variety of symptoms that encompass behavioral, emotional, and psychosomatic problems. Children who have been physically abused tend to be more aggressive, angry, hostile, depressed, and have low self-esteem. Additionally, they exhibit fear, **anxiety**, and nightmares. Severe psychological problems may result in suicidal behavior or posttraumatic **stress** disorder. Physically abused children may complain of physical illness even in the absence of a cause. They may also suffer from eating disorders and encopresis. Children who are sexually abused may exhibit abnormal sexual behavior in the form of aggressiveness and hyperarousal. Adolescents may display promiscuity, sexual acting out, and—in some situations—homosexual contact.

Physical abuse directed towards adults can ultimately lead to **death**. Approximately 50% of women murdered in the United States were killed by a former or current male partner. Approximately one-third of emergency room consultations by women were prompted due to domestic violence. Female victims who are married also have a higher rate of internal injuries and unconsciousness than victims of stranger assault (mugging, robbery). Physical abuse or rape can also occur between married persons and persons of the same gender. Perpetrators usually sexually assault their victims to dominate, hurt, and debase them. It is common for physical and sexual violence to occur at the same time. A large percentage of sexually assaulted persons were also physically abused in the form of punching, beating, or threatening the victim with a weapon such as a gun or knife. Usually males who are hurt and humiliated tend to physical assault persons whom they are intimately involved with, such as spouses and/or children. Males who assault a female tend to have experienced or witnessed violence during childhood. They also tend to abuse alcohol, to be sexually assaultive, and are at increased risk for assaultive behavior directed against children. Jealous males tend to monitor the women's movements and whereabouts and to isolate other sources of protection and support. They interpret their behavior as betrayal of trust and this causes resentment and explosive anger outbursts during periods of losing control. Males may also use aggression against females in an effort to control and intimidate partners.

Abuse in the elderly usually occurs in the frail, elderly community. The caretaker is usually the perpetrator. Caretaker abuse can be suspected if there is evidence suggesting behavioral changes in the elderly person when the caretaker is present. Additionally, elderly abuse can be possible if there are delays between injuries and treatment, inconsistencies between injury and explanations, lack of hygiene or clothing, and prescriptions no being filled.

Diagnosis

Children who are victims of domestic violence are frequently injured attempting to protect their mother from an abusive partner. Injuries are visible by inspection or self-report. Physical abuse of an adult may be also be evident by inspection with visible cuts and/or bruises or self report.

Sexual abuse of both a child and an adult can be diagnosed with a history from the victim. Victims can be assessed for ejaculatory evidence from the perpetrator. Ejaculatory specimens can be retrieved from the mouth, rectum, and clothing. Tests for **sexually transmitted diseases** may be performed.

KEY TERMS

Encopresis—Abnormalities relating to bowel movements that can occur as a result of stress or fear.

Elderly abuse can be suspected if the elderly patient demonstrates a fear from the caretaker. Additionally, elderly abuse can be suspected if there are signs indicating intentional delay of required medical care or a change in medical status.

Substance abuse can be suspected in a person who continues to indulge in their drug of choice despite recurrent negative consequences. The diagnosis can be made after administration of a comprehensive bio-psychosocial exam and standardized chemical abuse assessments by a therapist.

Treatment

Children who are victims of physical or sexual abuse typically require psychological support and medical attention. A complaint may be filed with the local family social services that will initiate investigations. The authorities will usually follow up the allegation or offense. Children may also be referred for psychological evaluation and/or treatment. The victim may be placed in foster care pending the investigation outcome. The police may also investigate physical and sexual abuse of an adult. The victim may require immediate medical care and long-term psychological treatment. It is common for children to be adversely affected by domestic violence situations and the local family services agency may be involved.

Substance abusers should elect treatment, either inpatient or outpatient, depending on severity of **addiction**. Long term treatment and/or medications may be utilized to assist in abstinence. The patient should be encouraged to participate in community centered support groups.

Prognosis

The prognosis depends on the diagnosis. Usually victims of physical and sexual abuse require therapy to deal with emotional distress associated with the incident. Perpetrators require further psychological evaluation and treatment. Victims of abuse may have a variety of emotional problems including depression, acts of suicide, or anxiety. Children of sexual abuse may as adults enter abusive relationships or have problems with intimacy. The substance abuser may experience relapses, since the cardinal feature of all addictive disorders is a tendency to return to symptoms. Elderly patients may suffer from further medical problems and/or anxiety, and in some cases neglect may precipitate death.

Prevention

Prevention programs are geared to education and awareness. Detection of initial symptoms or characteristic behaviors may assist in some situations. In some cases treatment may be sought before incident. The professional treating the abused persons must develop a clear sense of the relationship dynamics and the chances for continued harm.

Resources

BOOKS

Behrman, Richard E., et al, eds. *Nelson Textbook of Pediatrics.* 16th ed. W. B. Saunders Company, 2000.

Duthie, Edmund H., et al, eds. *Practice of Geriatrics.* 3rd ed. W. B. Saunders Company, 1998.

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice.* 4th ed. Mosby-Year Book, Inc., 1998.

PERIODICALS

Narendra, K., and S. Lazoritz. "Physical Assessment: Evaluation for Possible Physical and Sexual Abuse." *Pediatric Clinics of North America* 45 (Feb. 1998).

Stringham, P. "Mental Health: Domestic Violence." *Primary Care; Clinics in Office Practice* 26 (June 1999).

ORGANIZATIONS

National Clearinghouse on Child Abuse and Neglect Information. 330 C Street SW, Washington, DC 20447. (800) 392-3366.

OTHER

Elder Abuse Prevention. <http://www.oaktrees.org/elder>.

National Institute on Drug Abuse. <http://www.nida.nih.gov>.

Laith Farid Gulli, M.D.
Bilal Nasser, M.Sc.

Acceleration-deceleration cervical injury *see* **Whiplash**

ACE inhibitors *see* **Angiotensin-converting enzyme inhibitors**

Acetaminophen

Definition

Acetaminophen is a medicine used to relieve **pain** and reduce **fever**.

Purpose

Acetaminophen is used to relieve many kinds of minor aches and pains—headaches, muscle aches, backaches, toothaches, menstrual cramps, arthritis, and the aches and pains that often accompany colds.

Description

This drug is available without a prescription. Acetaminophen—or APAP—is sold under various brand names, including Tylenol, Panadol, **Aspirin** Free Anacin, and Bayer Select Maximum Strength **Headache** Pain Relief Formula. Many multi-symptom cold, flu, and sinus medicines also contain acetaminophen. Check the ingredients listed on the container to see if acetaminophen is included in the product.

Studies have shown that acetaminophen relieves pain and reduces fever about as well as aspirin. But differences between these two common drugs exist. Acetaminophen is less likely than aspirin to irritate the stomach. However, unlike aspirin, acetaminophen does not reduce the redness, stiffness, or swelling that accompany arthritis.

Recommended dosage

The usual dosage for adults and children age 12 and over is 325-650 mg every 4- 6 hours as needed. No more than 4 grams (4000 mg) should be taken in 24 hours. Because the drug can potentially harm the liver, people who drink alcohol in large quantities should take considerably less acetaminophen and possibly should avoid the drug completely.

For children ages 6-11 years, the usual dose is 150-300 mg, three to four times a day. Check with a physician for dosages for children under age 6 years.

Precautions

Never take more than the recommended dosage of acetaminophen unless told to do so by a physician or dentist.

Patients should not use acetaminophen for more than 10 days to relieve pain (5 days for children) or for more than 3 days to reduce fever, unless directed to do so by a physician. If symptoms do not go away—or if they get worse—contact a physician. Anyone who drinks three or more alcoholic beverages a day should check with a physician before using this drug and should never take more than the recommended dosage. A risk of liver damage exists from combining large amounts of alcohol and acetaminophen. People who already have kidney or liver disease or liver infections should also consult with a physician before using the drug. So should women who are pregnant or breastfeeding.

Smoking cigarettes may interfere with the effectiveness of acetaminophen. Smokers may need to take higher doses of the medicine, but should not take more than the recommended daily dosage unless told by a physician to do so.

KEY TERMS

Arthritis—Inflammation of the joints. The condition causes pain and swelling.

Fatigue—Physical or mental weariness.

Inflammation—A response to irritation, infection, or injury, resulting in pain, redness, and swelling.

Many drugs can interact with one another. Consult a physician or pharmacist before combining acetaminophen with any other medicine. Do not use two different acetaminophen-containing products at the same time.

Acetaminophen interferes with the results of some medical tests. Before having medical tests done, check to see whether taking acetaminophen will affect the results. Avoiding the drug for a few days before the tests may be necessary.

Side effects

Acetaminophen causes few side effects. The most common one is lightheadedness. Some people may experience trembling and pain in the side or the lower back. Allergic reactions do occur in some people, but they are rare. Anyone who develops symptoms such as a rash, swelling, or difficulty breathing after taking acetaminophen should stop taking the drug and get immediate medical attention. Other rare side effects include yellow skin or eyes, unusual bleeding or bruising, weakness, **fatigue**, bloody or black stools, bloody or cloudy urine, and a sudden decrease in the amount of urine.

Overdoses of acetaminophen may cause nausea, vomiting, sweating, and exhaustion. Very large overdoses can cause liver damage. In case of an overdose, get immediate medical attention.

Interactions

Acetaminophen may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with acetaminophen are alcohol, **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as Motrin, **oral contraceptives**, the antiseizure drug phenytoin (Dilantin), the blood-thinning drug warfarin (Coumadin), the cholesterol-lowering drug cholestyramine (Questran), the antibiotic Isoniazid, and zidovudine (Retrovir, AZT).

Check with a physician or pharmacist before combining acetaminophen with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Acetylsalicylic acid *see* **Aspirin**

Achalasia

Definition

Achalasia is a disorder of the esophagus that prevents normal swallowing.

Description

Achalasia affects the esophagus, the tube that carries swallowed food from the back of the throat down into the stomach. A ring of muscle called the lower esophageal sphincter encircles the esophagus just above the entrance to the stomach. This sphincter muscle is normally contracted to close the esophagus. When the sphincter is closed, the contents of the stomach cannot flow back into the esophagus. Backward flow of stomach contents (reflux) can irritate and inflame the esophagus, causing symptoms such as **heartburn**. The act of swallowing causes a wave of esophageal contraction called peristalsis. Peristalsis pushes food along the esophagus. Normally, peristalsis causes the esophageal sphincter to relax and allow food into the stomach. In achalasia, which means "failure to relax," the esophageal sphincter remains contracted. Normal peristalsis is interrupted and food cannot enter the stomach.

Causes and symptoms

Causes

Achalasia is caused by degeneration of the nerve cells that normally signal the brain to relax the esophageal sphincter. The ultimate cause of this degeneration is unknown. Autoimmune disease or hidden infection is suspected.

Symptoms

Dysphagia, or difficulty swallowing, is the most common symptom of achalasia. The person with achalasia usually has trouble swallowing both liquid and solid foods, often feeling that food "gets stuck" on the way down. The person has chest **pain** that is often mistaken for **angina** pectoris (cardiac pain). Heartburn and difficulty belching are common. Symptoms usually get steadily worse. Other symptoms may include nighttime **cough** or recurrent **pneumonia** caused by food passing into the lower airways.

Diagnosis

Diagnosis of achalasia begins with a careful medical history. The history should focus on the timing of symptoms and on eliminating other medical conditions that may cause similar symptoms. Tests used to diagnose achalasia include:

- Esophageal manometry. In this test, a thin tube is passed into the esophagus to measure the pressure exerted by the esophageal sphincter.
- X ray of the esophagus. Barium may be swallowed to act as a contrast agent. Barium reveals the outlines of the esophagus in greater detail and makes it easier to see its constriction at the sphincter.
- Endoscopy. In this test, a tube containing a lens and a light source is passed into the esophagus. Endoscopy is used to look directly at the surface of the esophagus. This test can also detect tumors that cause symptoms like those of achalasia. **Cancer** of the esophagus occurs as a complication of achalasia in 2-7% of patients.

Treatment

The first-line treatment for achalasia is balloon dilation. In this procedure, an inflatable membrane or balloon is passed down the esophagus to the sphincter and inflated to force the sphincter open. Dilation is effective in about 70% of patients.

Three other treatments are used for achalasia when balloon dilation is inappropriate or unacceptable.

- Botulinum toxin injection. Injected into the sphincter, botulinum toxin paralyzes the muscle and allows it to relax. Symptoms usually return within one to two years.
- Esophagomyotomy. This surgical procedure cuts the sphincter muscle to allow the esophagus to open. Esophagomyotomy is becoming more popular with the development of techniques allowing very small abdominal incisions.
- Drug therapy. Nifedipine, a calcium-channel blocker, reduces muscle contraction. Taken daily, this drug provides relief for about two-thirds of patients for as long as two years.

Prognosis

Most patients with achalasia can be treated effectively. Achalasia does not reduce life expectancy unless esophageal carcinoma develops.

KEY TERMS

Botulinum toxin—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*. The toxins cause muscle paralysis.

Dysphagia—Difficulty in swallowing.

Endoscopy—A test in which a viewing device and a light source are introduced into the esophagus by means of a flexible tube. Endoscopy permits visual inspection of the esophagus for abnormalities.

Esophageal manometry—A test in which a thin tube is passed into the esophagus to measure the degree of pressure exerted by the muscles of the esophageal wall.

Esophageal sphincter—A circular band of muscle that closes the last few centimeters of the esophagus and prevents the backward flow of stomach contents.

Esophagomyotomy—A surgical incision through the muscular tissue of the esophagus.

Esophagus—The muscular tube that leads from the back of the throat to the entrance of the stomach.

Peristalsis—The coordinated, rhythmic wave of smooth muscle contraction that forces food through the digestive tract.

Reflux—An abnormal backward or return flow of a fluid.

Prevention

There is no known way to prevent achalasia.

Resources

BOOKS

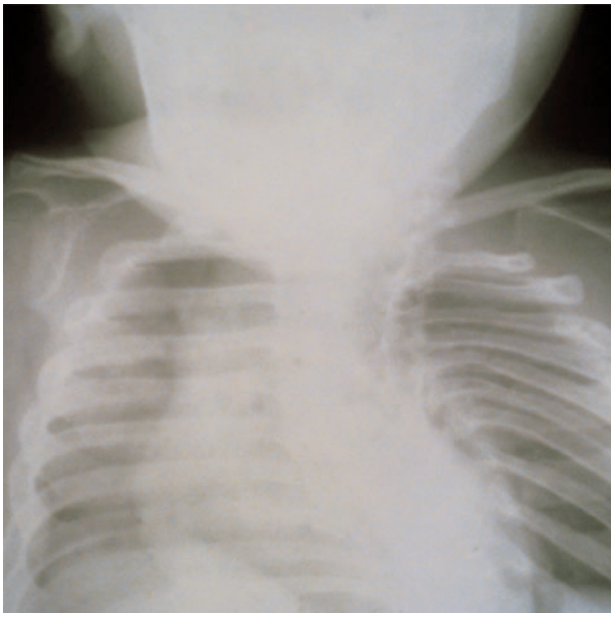
Grendell, James H., Kenneth R. McQuaid, and Scott L. Friedman, eds. *Current Diagnosis and Treatment in Gastroenterology.* Stamford: Appleton & Lange, 1996.

Richard Robinson

Achondroplasia

Definition

Achondroplasia is the most common cause of dwarfism, or significantly abnormal short stature.



An x-ray image of an achondroplastic person's head and chest. *(Custom Medical Stock Photo. Reproduced by permission.)*

Description

Achondroplasia is one of a number of chondodystrophies, in which the development of cartilage, and therefore, bone is disturbed. The disorder appears in approximately one in every 10,000 births. Achondroplasia is usually diagnosed at birth, owing to the characteristic appearance of the newborn.

Normal bone growth depends on the production of cartilage (a fibrous connective tissue). Over time, calcium is deposited within the cartilage, causing it to harden and become bone. In achondroplasia, abnormalities of this process prevent the bones (especially those in the limbs) from growing as long as they normally should, at the same time allowing the bones to become abnormally thickened. The bones in the trunk of the body and the skull are mostly not affected, although the opening from the skull through which the spinal cord passes (foramen magnum) is often narrower than normal, and the opening (spinal canal) through which the spinal cord runs in the back bones (vertebrae) becomes increasingly and abnormally small down the length of the spine.

Causes and symptoms

Achondroplasia is caused by a genetic defect. It is a dominant trait, meaning that anybody with the genetic defect will display all the symptoms of the disorder. A parent with the disorder has a 50% chance of passing it

KEY TERMS

Cartilage—A flexible, fibrous type of connective tissue which serves as a base on which bone is built.

Foramen magnum—The opening at the base of the skull, through which the spinal cord and the brainstem pass.

Hydrocephalus—An abnormal accumulation of fluid within the brain. This accumulation can be destructive by pressing on brain structures, and damaging them.

Mutation—A new, permanent change in the structure of a gene, which can result in abnormal structure or function somewhere in the body.

Spinal canal—The opening that runs through the center of the column of spinal bones (vertebrae), and through which the spinal cord passes.

Vertebrae—The individual bones of the spinal column which are stacked on top of each other. There is a hole in the center of each bone, through which the spinal cord passes.

on to the offspring. Although achondroplasia can be passed on to subsequent offspring, the majority of cases occur due to a new mutation (change) in a gene. Interestingly enough, the defect seen in achondroplasia is one of only a few defects known to increase in frequency with increasing age of the father (many genetic defects are linked to increased age of the mother).

People with achondroplasia have abnormally short arms and legs. Their trunk is usually of normal size, as is their head. The appearance of short limbs and normal head size actually makes the head appear to be oversized. The bridge of the nose often has a scooped out appearance termed "saddle nose." The lower back has an abnormal curvature, or sway back. The face often displays an overly prominent forehead, and a relative lack of development of the face in the area of the upper jaw. Because the foramen magnum and spinal canal are abnormally narrowed, nerve damage may occur if the spinal cord or nerves become compressed. The narrowed foramen magnum may disrupt the normal flow of fluid between the brain and the spinal cord, resulting in the accumulation of too much fluid in the brain (**hydrocephalus**). Children with achondroplasia have a very high risk of serious and repeated middle ear infections, which can result in **hearing loss**. The disease does not affect either mental capacity, or reproductive ability.

Diagnosis

Diagnosis is often made at birth due to the characteristically short limbs, and the appearance of a large head. X-ray examination will reveal a characteristic appearance to the bones, with the bones of the limbs appearing short in length, yet broad in width. A number of measurements of the bones in x-ray images will reveal abnormal proportions.

Treatment

No treatment will reverse the defect present in achondroplasia. All patients with the disease will be short, with abnormally proportioned limbs, trunk, and head. Treatment of achondroplasia primarily addresses some of the complications of the disorder, including problems due to nerve compression, hydrocephalus, bowed legs, and abnormal curves in the spine. Children with achondroplasia who develop middle ear infections (acute **otitis media**) will require quick treatment with **antibiotics** and careful monitoring in order to avoid hearing loss.

Prognosis

Achondroplasia is a disease which causes considerable deformity. However, with careful attention paid to the development of dangerous complications (nerve compression, hydrocephalus), most people are in good health, and can live a normal lifespan.

Prevention

The only form of prevention is through **genetic counseling**, which could help parents assess their risk of having a child with achondroplasia.

Resources

BOOKS

Hall, Bryan D. "Achondroplasia." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Horton, W. A., and J. T. Hecht. "The Chondrodysplasias." In *Connective Tissue and Its Heritable Disorders*, ed. R. M. Royce and B. Steinmann. Somerset, NJ: Wiley-Liss, 1993.

Krane, Stephen M., and Alan L. Schiller. "Achondroplasia." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Whyte, Michael, P. "Achondroplasia." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

ORGANIZATIONS

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Rosalyn Carson-DeWitt, MD

Achromatopsia *see* **Color blindness**

Acid indigestion *see* **Heartburn**

Acid phosphatase test

Definition

Acid phosphatase is an enzyme found throughout the body, but primarily in the prostate gland. Like all enzymes, it is needed to trigger specific chemical reactions. Acid phosphatase testing is done to diagnose whether **prostate cancer** has spread to other parts of the body (metastasized), and to check the effectiveness of treatment. The test has been largely supplanted by the prostate specific antigen test (PSA).

KEY TERMS

Enzyme—A substance needed to trigger specific chemical reactions.

Metastasize—Spread to other parts of the body; usually refers to cancer.

Prostate gland—A gland of the male reproductive system.

Purpose

The male prostate gland has 100 times more acid phosphatase than any other body tissue. When prostate **cancer** spreads to other parts of the body, acid phosphatase levels rise, particularly if the cancer spreads to the bone. One-half to three-fourths of persons who have metastasized prostate cancer have high acid phosphatase levels. Levels fall after the tumor is removed or reduced through treatment.

Tissues other than prostate have small amounts of acid phosphatase, including bone, liver, spleen, kidney, and red blood cells and platelets. Damage to these tissues causes a moderate increase in acid phosphatase levels.

Acid phosphatase is very concentrated in semen. Rape investigations will often include testing for the presence of acid phosphatase in vaginal fluid.

Precautions

This is not a screening test for prostate cancer. Acid phosphatase levels rise only after prostate cancer has metastasized.

Description

Laboratory testing measures the amount of acid phosphatase in a person's blood, and can determine from what tissue the enzyme is coming. For example, it is important to know if the increased acid phosphatase is from the prostate or red blood cells. Acid phosphatase from the prostate, called prostatic acid phosphatase (PAP), is the most medically significant type of acid phosphatase.

Subtle differences between prostatic acid phosphatase and acid phosphatases from other tissues cause them to react differently in the laboratory when mixed with certain chemicals. For example, adding the chemical tartrate to the test mixture inhibits the activity of prostatic acid phosphatase but not red blood cell acid phosphatase. Laboratory test methods based on these differences reveal how much of a person's total acid phosphatase is derived from the prostate. Results are usually available the next day.

Preparation

This test requires drawing about 5-10 mL of blood. The patient should not have a rectal exam or prostate massage for two to three days prior to the test.

Aftercare

Discomfort or bruising may occur at the puncture site, and the person may feel dizzy or faint. Applying pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Normal results vary based on the laboratory and the method used.

Abnormal results

The highest levels of acid phosphatase are found in metastasized prostate cancer. Diseases of the bone, such as Paget's disease or **hyperparathyroidism**; diseases of blood cells, such as **sickle cell disease** or **multiple myeloma**; or lysosomal disorders, such as Gaucher's disease, will show moderately increased levels.

Certain medications can cause temporary increases or decreases in acid phosphatase levels. Manipulation of the prostate gland through massage, biopsy, or rectal exam before a test can increase the level.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Garza, Diana, and Kathleen Becan-McBride. *Phlebotomy Handbook*. 4th ed. Stamford: Appleton & Lange, 1996.

PERIODICALS

Moul, Judd W., et al. "The Contemporary Value of Pretreatment Prostatic Acid Phosphatase to Predict Pathological Stage and Recurrence in Radical Prostatectomy Cases." *Journal of Urology* (Mar. 1998): 935-940.

Nancy J. Nordenson

Acid reflux *see* **Heartburn**

Acidosis *see* **Respiratory acidosis; Renal tubular acidosis; Metabolic acidosis**

Acne

Definition

Acne is a common skin disease characterized by pimples on the face, chest, and back. It occurs when the pores of the skin become clogged with oil, dead skin cells, and bacteria.

Description

Acne vulgaris, the medical term for common acne, is the most common skin disease. It affects nearly 17 million people in the United States. While acne can arise at any age, it usually begins at **puberty** and worsens during adolescence. Nearly 85% of people develop acne at some time between the ages of 12-25 years. Up to 20% of women develop mild acne. It is also found in some newborns.

The sebaceous glands lie just beneath the skin's surface. They produce an oil called sebum, the skin's natural moisturizer. These glands and the hair follicles within which they are found are called sebaceous follicles. These follicles open onto the skin through pores. At puberty, increased levels of androgens (male hormones) cause the glands to produce too much sebum. When excess sebum combines with dead, sticky skin cells, a hard plug, or comedo, forms that blocks the pore. Mild noninflammatory acne consists of the two types of comedones, whiteheads and blackheads.

Moderate and severe inflammatory types of acne result after the plugged follicle is invaded by *Propionibacterium acnes*, a bacteria that normally lives on the skin. A pimple forms when the damaged follicle weakens and bursts open, releasing sebum, bacteria, and skin and white blood cells into the surrounding tissues. Inflamed pimples near the skin's surface are called papules; when deeper, they are called pustules. The most severe type of acne consists of cysts (closed sacs) and nodules (hard swellings). Scarring occurs when new skin cells are laid down to replace damaged cells.

The most common sites of acne are the face, chest, shoulders, and back since these are the parts of the body where the most sebaceous follicles are found.

Causes and symptoms

The exact cause of acne is unknown. Several risk factors have been identified:

- Age. Due to the hormonal changes they experience, teenagers are more likely to develop acne.
- Gender. Boys have more severe acne and develop it more often than girls.
- Disease. Hormonal disorders can complicate acne in girls.
- Heredity. Individuals with a family history of acne have greater susceptibility to the disease.
- Hormonal changes. Acne can flare up before menstruation, during **pregnancy**, and **menopause**.
- Diet. No foods cause acne, but certain foods may cause flare-ups.
- Drugs. Acne can be a side effect of drugs including tranquilizers, antidepressants, **antibiotics**, **oral contraceptives**, and anabolic steroids.
- Personal hygiene. Abrasive soaps, hard scrubbing, or picking at pimples will make them worse.
- Cosmetics. Oil-based makeup and hair sprays worsen acne.
- Environment. Exposure to oils and greases, polluted air, and sweating in hot weather aggravate acne.
- **Stress**. Emotional stress may contribute to acne.

Acne is usually not conspicuous, although inflamed lesions may cause **pain**, tenderness, **itching**, or swelling. The most troubling aspects of these lesions are the negative cosmetic effects and potential for scarring. Some people, especially teenagers, become emotionally upset about their condition, and have problems forming relationships or keeping jobs.

Diagnosis

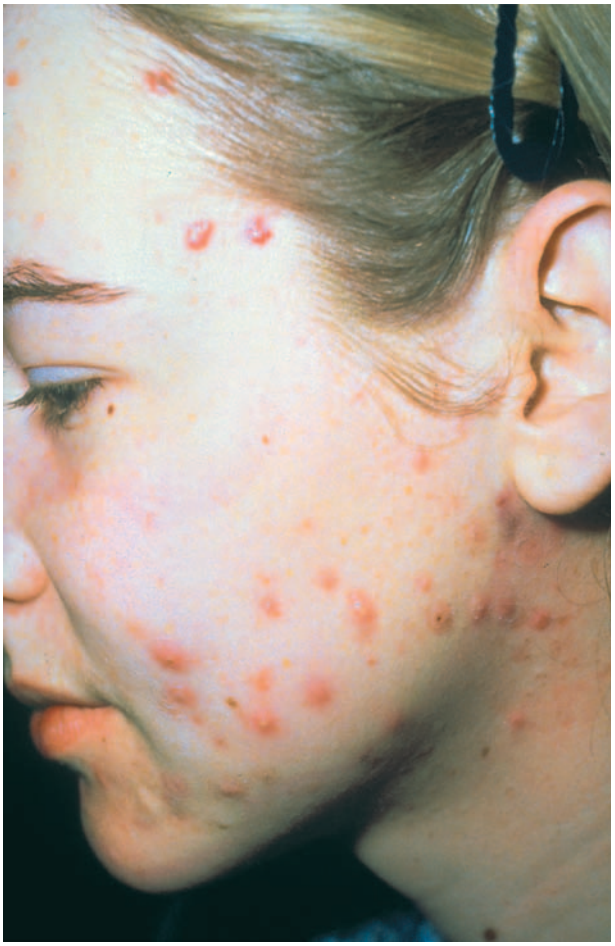
Acne patients are often treated by family doctors. Complicated cases are referred to a dermatologist, a skin

disease specialist, or an endocrinologist, a specialist who treats diseases of the body's endocrine (hormones and glands) system.

Acne has a characteristic appearance and is not difficult to diagnose. The doctor takes a complete medical history, including questions about skin care, diet, factors causing flare-ups, medication use, and prior treatment. **Physical examination** includes the face, upper neck, chest, shoulders, back, and other affected areas. Under good lighting, the doctor determines what types and how many blemishes are present, whether they are inflamed, whether they are deep or superficial, and whether there is scarring or skin discoloration.

In teenagers, acne is often found on the forehead, nose, and chin. As people get older, acne tends to appear towards the outer part of the face. Adult women may have acne on their chins and around their mouths. The elderly may develop whiteheads and blackheads on the upper cheeks and skin around the eyes.

Laboratory tests are not done unless the patient appears to have a hormonal disorder or other medical problem. In this case, blood analyses or other tests may be ordered. Most insurance plans cover the costs of diagnosing and treating acne.



Acne vulgaris affecting a woman's face. Acne is the general name given to a skin disorder in which the sebaceous glands become inflamed. *(Photograph by Biophoto Associates, Photo Researchers, Inc. Reproduced by permission.)*

Treatment

Acne treatment consists of reducing sebum production, removing dead skin cells, and killing bacteria with topical drugs and oral medications. Treatment choice depends upon whether the acne is mild, moderate, or severe.

Drugs

TOPICAL DRUGS. Treatment for mild noninflammatory acne consists of reducing the formation of new comedones with topical tretinoin, benzoyl peroxide, adapalene, or salicylic acid. Tretinoin is especially effective because it increases turnover (**death** and replacement) of skin cells. When complicated by inflammation, topical antibiotics may be added to the treatment regimen. Improvement is usually seen in two to four weeks.

Topical medications are available as cream, gel, lotion, or pad preparations of varying strengths. They include antibiotics (agents that kill bacteria), such as erythromycin, clindamycin (Cleocin-T), and meclocycline (Meclan); comedolytics (agents that loosen hard plugs and open pores) such as the vitamin A acid tretinoin (Retin-A), salicylic acid, adapalene (Differin), resorcinol, and sulfur. Drugs that act as both comedolytics and antibiotics, such as benzoyl peroxide, azelaic acid (Azelex), or benzoyl peroxide plus erythromycin (Benzamycin), are also used. These drugs may be used for months to years to achieve disease control.

After washing with mild soap, the drugs are applied alone or in combination, once or twice a day over the entire affected area of skin. Possible side effects include mild redness, peeling, irritation, dryness, and an increased sensitivity to sunlight that requires use of a sunscreen.

ORAL DRUGS. Oral antibiotics are taken daily for two to four months. The drugs used include tetracycline, erythromycin, minocycline (Minocin), doxycycline, clindamycin (Cleocin), and trimethoprim- sulfamethoxazole (Bactrim, Septra). Possible side effects include allergic reactions, stomach upset, vaginal yeast infections, **dizziness**, and tooth discoloration.

The goal of treating moderate acne is to decrease inflammation and prevent new comedone formation. One effective treatment is topical tretinoin along with a topical

KEY TERMS

Androgens—Male sex hormones that are linked with the development of acne.

Antiandrogens—Drugs that inhibit the production of androgens.

Antibiotics—Medicines that kill bacteria.

Comedo—A hard plug composed of sebum and dead skin cells. The mildest type of acne.

Comedolytic—Drugs that break up comedones and open clogged pores.

Corticosteroids—A group of hormones produced by the adrenal glands with different functions, including regulation of fluid balance, androgen activity, and reaction to inflammation.

Estrogens—Hormones produced by the ovaries, the female sex glands.

Isotretinoin—A drug that decreases sebum production and dries up acne pimples.

Sebaceous follicles—A structure found within the skin that houses the oil-producing glands and hair follicles, where pimples form.

Sebum—An oily skin moisturizer produced by sebaceous glands.

Tretinoin—A drug that works by increasing the turnover (death and replacement) of skin cells.

or oral antibiotic. A combination of topical benzoyl peroxide and erythromycin is also very effective. Improvement is normally seen within four to six weeks, but treatment is maintained for at least two to four months.

A drug reserved for the treatment of severe acne, oral isotretinoin (Accutane), reduces sebum production and cell stickiness. It is the treatment of choice for severe acne with cysts and nodules, and is used with or without topical or oral antibiotics. Taken for four to five months, it provides long-term disease control in up to 60% of patients. If the acne reappears, another course of isotretinoin may be needed by about 20% of patients, while another 20% may do well with topical drugs or oral antibiotics. Side effects include temporary worsening of the acne, dry skin, nosebleeds, vision disorders, and elevated liver enzymes, blood fats and cholesterol. This drug must not be taken during pregnancy since it causes **birth defects**.

Anti-androgens, drugs that inhibit androgen production, are used to treat women who are unresponsive to other therapies. Certain types of oral contraceptives (for example, Ortho-Tri-Cyclen) and female sex hormones (estrogens) reduce hormone activity in the ovaries. Other drugs, for example, spironolactone and **corticosteroids**, reduce hormone activity in the adrenal glands. Improvement may take up to four months.

Oral corticosteroids, or anti-inflammatory drugs, are the treatment of choice for an extremely severe, but rare type of destructive inflammatory acne called acne fulminans, found mostly in adolescent males. Acne conglobata, a more common form of severe inflammation, is characterized by numerous, deep, inflammatory nodules that heal with scarring. It is treated with oral isotretinoin and corticosteroids.

Other treatments

Several surgical or medical treatments are available to alleviate acne or the resulting scars:

- Comedone extraction. The comedo is removed from the pore with a special tool.
- Chemical peels. Glycolic acid is applied to peel off the top layer of skin to reduce scarring.
- Dermabrasion. The affected skin is frozen with a chemical spray, and removed by brushing or planing.
- Punch grafting. Deep scars are excised and the area repaired with small skin grafts.
- Intralesional injection. Corticosteroids are injected directly into inflamed pimples.
- Collagen injection. Shallow scars are elevated by collagen (protein) injections.

Alternative treatment

Alternative treatments for acne focus on proper cleansing to keep the skin oil-free; eating a well-balanced diet high in fiber, zinc, and raw foods; and avoiding alcohol, dairy products, **smoking**, **caffeine**, sugar,processed foods, and foods high in iodine, such as salt. Supplementation with herbs such as burdock root (*Arctium lappa*), red clover (*Trifolium pratense*), and milk thistle (*Silybum marianum*), and with nutrients such as essential fatty acids, vitamin B complex, zinc, vitamin A, and chromium is also recommended. Chinese herbal remedies used for acne include cnidium seed (*Cnidium monnieri*) and honeysuckle flower (*Lonicera japonica*). Wholistic physicians or nutritionists can recommend the proper amounts of these herbs.

Prognosis

Acne is not curable, although long-term control is achieved in up to 60% of patients treated with

isotretinoin. It can be controlled by proper treatment, with improvement taking two or more months. Acne tends to reappear when treatment stops, but spontaneously improves over time. Inflammatory acne may leave scars that require further treatment.

Prevention

There are no sure ways to prevent acne, but the following steps may be taken to minimize flare-ups:

- gentle washing of affected areas once or twice every day
- avoid abrasive cleansers
- use noncomedogenic makeup and moisturizers
- shampoo often and wear hair off face
- eat a well-balanced diet, avoiding foods that trigger flare-ups
- unless told otherwise, give dry pimples a limited amount of sun exposur
- do not pick or squeeze blemishes
- reduce stress

Resources

BOOKS

Balch, James F., and Phyllis A. Balch. "The Disorders: Acne." In *Prescription for Nutritional Healing*, ed. Amy C. Tecklenburg, et al. New York: Avery Publishing Group, 1997.

Bark, Joseph P. *Your Skin: An Owner's Guide*. Englewood Cliffs, NJ: Prentice Hall, 1995.

Goldstein, Sanford M., and Richard B. Odom. "Skin & Appendages: Pustular Disorders." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Kaptchuk, Ted J., Z'ev Rosenberg, and K'an Herb Co., Inc. *K'an Herbals: Formulas by Ted Kaptchuk, O.M.D*. San Francisco: Andrew Miller, 1996.

PERIODICALS

"Adult Acne." *Harvard Women's Health Watch* (Mar. 1995): 4-5.

Bergfeld, Wilma F. "The Evaluation and Management of Acne: Economic Considerations." *Journal of the American Academy of Dermatology* 32 (1995): S52-6.

Billings, Laura. "Getting Clear." *Health Magazine*, Apr. 1997, 48-52.

Christiano, Donna. "Acne Treatment Meant for Grown- Ups." *American Health* (Oct. 1994): 23-4.

"Clearly Better New Treatments Help Adult Acne." *Prevention Magazine*, Aug. 1997, 50-51.

Leyden, James J. "Therapy For Acne Vulgaris." *New England Journal of Medicine* 17 (Apr. 1997): 1156-1162.

Nguyen, Quan H., Y. Alyssa Kim, and Robert A. Schwartz. "Management of Acne Vulgaris." *American Family Physician* (July 1994): 89-96.

"Pimple Control Pill?" *Prevention Magazine*, May 1997, 132.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

Mercedes McLaughlin

Acne rosacea *see* **Rosacea**

Acoustic neurinoma *see* **Acoustic neuroma**

Acoustic neuroma

Definition

An acoustic neuroma is a benign tumor involving cells of the myelin sheath that surrounds the vestibulocochlear nerve (eighth cranial nerve).

Description

The vestibulocochlear nerve extends from the inner ear to the brain and is made up of a vestibular branch, often called the vestibular nerve, and a cochlear branch, called the cochlear nerve. The vestibular and cochlear nerves lie next to one another. They also run along side other cranial nerves. People possess two of each type of vestibulocochlear nerve, one that extends from the left ear and one that extends from the right ear.

The vestibular nerve transmits information concerning balance from the inner ear to the brain and the cochlear nerve transmits information about hearing. The vestibular nerve, like many nerves, is surrounded by a cover called a myelin sheath. A tumor, called a schwannoma, can sometimes develop from the cells of the myelin sheath. A tumor is an abnormal growth of tissue that results from the uncontrolled growth of cells. Acoustic neuromas are often called vestibular schwannomas because they are tumors that arise from the myelin sheath that surrounds the vestibular nerve. Acoustic neuromas are considered benign (non-cancerous) tumors since they do not spread to other parts of the body. They can occur anywhere along the vestibular nerve but are most likely to occur where the vestibulocochlear nerve passes through the tiny bony canal that connects the brain and the inner ear.

An acoustic neuroma can arise from the left vestibular nerve or the right vestibular nerve. A unilateral tumor is a tumor arising from one nerve and a bilateral tumor arises from both vestibular nerves. Unilateral acoustic neuromas usually occur spontaneously (by chance). Bilateral acoustic neuromas occur as part of a hereditary con-

dition called **Neurofibromatosis** Type 2 (NF2). A person with NF2 has inherited a predisposition for developing acoustic neuromas and other tumors of the nerve cells.

Acoustic neuromas usually grow slowly and can take years to develop. Some acoustic neuromas remain so small that they do not cause any symptoms. As the acoustic neuroma grows it can interfere with the functioning of the vestibular nerve and can cause vertigo and balance difficulties. If the acoustic nerve grows large enough to press against the cochlear nerve, then **hearing loss** and a ringing (**tinnitus**) in the affected ear will usually occur. If untreated and the acoustic neuroma continues to grow it can press against other nerves in the region and cause other symptoms. This tumor can be life threatening if it becomes large enough to press against and interfere with the functioning of the brain.

Causes and symptoms

Causes

An acoustic neuroma is caused by a change or absence of both of the NF2 tumor suppressor genes in a nerve cell. Every person possesses a pair of NF2 genes in every cell of their body including their nerve cells. One NF2 gene is inherited from the egg cell of the mother and one NF2 gene is inherited from the sperm cell of the father. The NF2 gene is responsible for helping to prevent the formation of tumors in the nerve cells. In particular the NF2 gene helps to prevent acoustic neuromas.

Only one unchanged and functioning NF2 gene is necessary to prevent the formation of an acoustic neuroma. If both NF2 genes become changed or missing in one of the myelin sheath cells of the vestibular nerve then an acoustic neuroma will usually develop. Most unilateral acoustic neuromas result when the NF2 genes become spontaneously changed or missing. Someone with a unilateral acoustic neuroma that has developed spontaneously is not at increased risk for having children with an acoustic neuroma. Some unilateral acoustic neuromas result from the hereditary condition NF2. It is also possible that some unilateral acoustic neuromas may be caused by changes in other genes responsible for preventing the formation of tumors.

Bilateral acoustic neuromas result when someone is affected with the hereditary condition NF2. A person with NF2 is typically born with one unchanged and one changed or missing NF2 gene in every cell of their body. Sometimes they inherit this change from their mother or father. Sometimes the change occurs spontaneously when the egg and sperm come together to form the first cell of the baby. The children of a person with NF2 have a 50% chance of inheriting the changed or missing NF2 gene.

A person with NF2 will develop an acoustic neuroma if the remaining unchanged NF2 gene becomes spontaneously changed or missing in one of the myelin sheath cells of their vestibular nerve. People with NF2 often develop acoustic neuromas at a younger age. The mean age of onset of acoustic neuroma in NF2 is 31 years of age versus 50 years of age for sporadic acoustic neuromas. Not all people with NF2, however, develop acoustic neuromas. People with NF2 are at increased risk for developing **cataracts** and tumors in other nerve cells.

Most people with a unilateral acoustic neuroma are not affected with NF2. Some people with NF2, however, only develop a tumor in one of the vestibulocochlear nerves. Others may initially be diagnosed with a unilateral tumor but may develop a tumor in the other nerve a number of years later. NF2 should be considered in someone under the age of 40 who has a unilateral acoustic neuroma. Someone with a unilateral acoustic neuroma and other family members diagnosed with NF2 probably is affected with NF2. Someone with a unilateral acoustic neuroma and other symptoms of NF2 such as cataracts and other tumors may also be affected with NF2. On the other hand, someone over the age of 50 with a unilateral acoustic neuroma, no other tumors and no family history of NF2 is very unlikely to be affected with NF2.

Symptoms

Small acoustic neuromas usually only interfere with the functioning of the vestibulocochlear nerve. The most common first symptom of an acoustic neuroma is hearing loss, which is often accompanied by a ringing sound (tinnitis). People with acoustic neuromas sometimes report difficulties in using the phone and difficulties in perceiving the tone of a musical instrument or sound even when their hearing appears to be otherwise normal. In most cases the hearing loss is initially subtle and worsens gradually over time until deafness occurs in the affected ear. In approximately 10% of cases the hearing loss is sudden and severe.

Acoustic neuromas can also affect the functioning of the vestibular branch of the vestibulocochlear nerve and van cause vertigo and dysequilibrium. Twenty percent of small tumors are associated with periodic vertigo, which is characterized by **dizziness** or a whirling sensation. Larger acoustic neuromas are less likely to cause vertigo but more likely to cause dysequilibrium. Dysequilibrium, which is characterized by minor clumsiness and a general feeling of instability, occurs in nearly 50% of people with an acoustic neuroma.

As the tumor grows larger it can press on the surrounding cranial nerves. Compression of the fifth cranial nerve can result in facial **pain** and or numbness. Compression of the seventh cranial nerve can cause spasms, weakness or

KEY TERMS

Benign tumor—A localized overgrowth of cells that does not spread to other parts of the body.

Chromosome—A microscopic structure, made of a complex of proteins and DNA, that is found within each cell of the body.

Computed tomography (CT)—An examination that uses a computer to compile and analyze the images produced by x rays projected at a particular part of the body.

Cranial nerves—The set of twelve nerves found on each side of the head and neck that control the sensory and muscle functions of a number of organs such as the eyes, nose, tongue face and throat.

DNA testing—Testing for a change or changes in a gene or genes.

Gene—A building block of inheritance, made up of a compound called DNA (deoxyribonucleic acid) and containing the instructions for the production of a particular protein. Each gene is found on a specific location on a chromosome.

Magnetic resonance imaging (MRI)—A test which uses an external magnetic field instead of x rays to visualize different tissues of the body.

Myelin sheath—The cover that surrounds many nerve cells and helps to increase the speed by which information travels along the nerve.

Neurofibromatosis type 2 (NF2)—A hereditary condition associated with an increased risk of bilateral acoustic neuromas, other nerve cell tumors and cataracts.

Protein—A substance produced by a gene that is involved in creating the traits of the human body such as hair and eye color or is involved in controlling the basic functions of the human body.

Schwannoma—A tumor derived from the cells of the myelin sheath that surrounds many nerve cells.

Tinnitus—A ringing sound or other noise in the ear.

Vertigo—A feeling of spinning or whirling.

Vestibulocochlear nerve (Eighth cranial nerve)—Nerve that transmits information, about hearing and balance from the ear to the brain.

paralysis of the facial muscles. Double vision is a rare symptom but can result when the 6th cranial nerve is affected. Swallowing and/or speaking difficulties can occur if the tumor presses against the 9th, 10th, or 12th cranial nerves.

If left untreated, the tumor can become large enough to press against and affect the functioning of the brain stem. The brain stem is the stalk like portion of the brain that joins the spinal cord to the cerebrum, the thinking and reasoning part of the brain. Different parts of the brainstem have different functions such as the control of breathing and muscle coordination. Large tumors that impact the brain stem can result in headaches, walking difficulties (gait ataxia) and involuntary shaking movements of the muscles (**tremors**). In rare cases when an acoustic neuroma remains undiagnosed and untreated it can cause nausea, vomiting, lethargy and eventually **coma**, respiratory difficulties and **death**. In the vast majority of cases, however, the tumor is discovered and treated long before it is large enough to cause such serious manifestations.

Diagnosis

Anyone with symptoms of hearing loss should undergo hearing evaluations. Pure tone and speech **audiometry** are two screening tests that are often used to evaluate hearing. Pure tone audiometry tests to see how well someone can hear tones of different volume and pitch and speech audiometry tests to see how well someone can hear and recognize speech. An acoustic neuroma is suspected in someone with unilateral hearing loss or hearing loss that is less severe in one ear than the other ear(asymmetrical).

Sometimes an auditory brainstem response (ABR, BAER) test is performed to help establish whether someone is likely to have an acoustic neuroma. During the ABR examination, a harmless electrical impulse is passed from the inner ear to the brainstem. An acoustic neuroma can interfere with the passage of this electrical impulse and this interference can, sometimes be identified through the ABR evaluation. A normal ABR examination does not rule out the possibility of an acoustic neuroma. An abnormal ABR examination increases the likelihood that an acoustic neuroma is present but other tests are necessary to confirm the presence of a tumor.

If an acoustic neuroma is strongly suspected then **magnetic resonance imaging** (MRI) is usually performed. The MRI is a very accurate evaluation that is

able to detect nearly 100% of acoustic neuromas. Computerized tomography (CT scan, CAT scan)is unable to identify smaller tumors; but it can be used when an acoustic neuroma is suspected and an MRI evaluation cannot be performed.

Once an acoustic neuroma is diagnosed, an evaluation by genetic specialists such as a geneticist and genetic counselor may be recommended. The purpose of this evaluation is to obtain a detailed family history and check for signs of NF2. If NF2 is strongly suspected then DNA testing may be recommended. DNA testing involves checking the blood cells obtained from a routine blood draw for the common gene changes associated with NF2.

Treatment

The three treatment options for acoustic neuroma are surgery, radiation, and observation. The physician and patient should discuss the pros and cons of the different options prior to making a decision about treatment. The patient's, physical health, age, symptoms, tumor size, and tumor location should be considered.

Microsurgery

The surgical removal of the tumor or tumors is the most common treatment for acoustic neuroma. In most cases the entire tumor is removed during the surgery. If the tumor is large and causing significant symptoms, yet there is a need to preserve hearing in that ear, then only part of the tumor may be removed. During the procedure the tumor is removed under microscopic guidance and general anesthetic. Monitoring of the neighboring cranial nerves is done during the procedure so that damage to these nerves can be prevented. If preservation of hearing is a possibility, then monitoring of hearing will also take place during the surgery.

Most people stay in the hospital four to seven days following the surgery. Total recovery usually takes four to six weeks. Most people experience **fatigue** and head discomfort following the surgery. Problems with balance and head and neck stiffness are also common. The mortality rate of this type of surgery is less than 2% at most major centers. Approximately 20% of patients experience some degree of post-surgical complications. In most cases these complications can be managed successfully and do not result in long term medical problems. Surgery brings with it a risk of **stroke**, damage to the brain stem, infection, leakage of spinal fluid and damage to the cranial nerves. Hearing loss and/or tinnitis often result from the surgery. A follow-up MRI is recommended one to five years following the surgery because of possible regrowth of the tumor.

Stereotactic Radiation therapy

During stereotactic **radiation therapy**, also called radiosurgery or radiotherapy, many small beams of radiation are aimed directly at the acoustic neuroma. The radiation is administered in a single large dose, under local anesthetic and is performed on an outpatient basis. This results in a high dose of radiation to the tumor but little radiation exposure to the surrounding area. This treatment approach is limited to small or medium tumors. The goal of the surgery is to cause tumor shrinkage or at least limit the growth of the tumor. The long term efficacy and risks of this treatment approach are not known. Periodic MRI monitoring throughout the life of the patient is therefore recommended.

Radiation therapy can cause hearing loss which can sometimes occurs even years later. Radiation therapy can also cause damage to neighboring cranial nerves, which can result in symptoms such as numbness, pain or paralysis of the facial muscles. In many cases these symptoms are temporary. Radiation treatment can also induce the formation of other benign or malignant schwannomas. This type of treatment may therefore be contraindicated in the treatment of acoustic neuromas in those with NF2 who are predisposed to developing schwannomas and other tumors.

Observation

Acoustic neuromas are usually slow growing and in some cases they will stop growing and even become smaller or disappear entirely. It may therefore be appropriate in some cases to hold off on treatment and to periodically monitor the tumor through MRI evaluations. Long-term observation may be appropriate for example in an elderly person with a small acoustic neuroma and few symptoms. Periodic observation may also be indicated for someone with a small and asymptomatic acoustic neuroma that was detected through an evaluation for another medical problem. Observation may also be suggested for someone with an acoustic neuroma in the only hearing ear or in the ear that has better hearing. The danger of an observational approach is that as the tumor grows larger it can become more difficult to treat.

Prognosis

The prognosis for someone with a unilateral acoustic neuroma is usually quite good provided the tumor is diagnosed early and appropriate treatment is instituted. Long term hearing loss and tinnitis in the affected ear are common, even if appropriate treatment is provided. Regrowth of the tumor is also a possibility following surgery or radiation therapy and repeat treatment may be necessary. The prognosis can be poorer for those with NF2 who have an increased risk of bilateral acoustic neuromas and other tumors.

Resources

BOOKS

Filipo, R., and Barbara Maurizio *Acoustic neuroma: trends and controversies: proceedings of the Symposium Acoustic Neuroma: Trends and Controversies, Rome, Italy, November 13–15, 1997*. The Hague, Netherlands: Kugler,1999.

Malis, Leonard *Acoustic Neuroma* New York: Elsevier, 1998.

Roland, Peter, and Bradley Marple. *Diagnosis and Management of Acoustic Neuroma (Sipac)*. Alexandria, VA: American Academy of Otolaryngology—Head and Neck Survey Foundation, 1998.

PERIODICALS

Broad, R. W. "Management of Acoustic Neuroma." In *New England Journal of Medicine*. 340(14) (8 April 1999):1119.

Lederman G, E. Arbit, and J. Lowry. "Management of Acoustic Neuroma." *New England Journal of Medicine*. 340(14) (8 April 1999):1119–1120.

Levo H., I. Pyykko, and G. Blomstedt. "Non-surgical Treatment of Vestibular Schwannoma Patients." *Acta Oto-Laryngologica* 529 (1997): 56–8.

O'Donoghue G.M., T. Nikolopoulos and J. Thomsen. "Management of Acoustic Neuroma." In *New England Journal of Medicine* 340(14) (8 April 1999):1120–1121.

Rigby, P. L., et al. "Acoustic Neuroma Surgery: Outcome Analysis of Patient-Perceived Disability." In *American Journal of Otology* 18 (July 1997): 427–35.

van Roijen, L., et al. "Costs and Effects of Microsurgery versus Radiosurgery in Treating Acoustic Neuroma." In *Acta Neurochirurgica* 139 (1997): 942–48.

ORGANIZATIONS

Acoustic Neuroma Association. 600 Peachtree Pkwy, Suite 108, Cumming, GA 30041-6899. Phone:(770) 205-8211. Fax: (770) 205-0239. ANAusa@aol.com <http://anausa.org>. 28 June 2001.

Acoustic Neuroma Association of Canada Box 369, Edmonton, AB T5J 2J6. 1-800-561-ANAC(2622). (780)428-3384. anac@compusmart.ab.ca. <http://www.anac.ca>. 28 June 2001.

British Acoustic Neuroma Association. Oak House, Ransom Wood Business Park, Southwell Road West, Mansfield, Nottingham, NG21 0HJ. Tel: 01623 632143. Fax: 01623 635313. bana@btclick.com. <http://www.ukan.co.uk/bana>. 28 June 2001.

Seattle Acoustic Neuroma Group. Emcityland@aol.com <http://acousticneuromaseattle.org/entryenglish.html>. 28 June 2001.

OTHER

National Institute of Health Consensus Statement Online. *Acoustic Neuroma* 9(4)(11-13 December 1991). <http://text.nlm.nih.gov/nih/cdc/www/87txt.html>. (28 June 2001).

University of California at San Francisco (UCSF). *Information on Acoustic Neuromas* (28 June 2001). <http://itsa.ucsf.edu/~rkj/IndexAN. html>.

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Acquired hypogammaglobulinemia *see* **Common variable immunodeficiency**

Acquired immunodeficiency syndrome *see* **AIDS**

Acrocyanosis

Definition

Acrocyanosis is a decrease in the amount of oxygen delivered to the extremities. The hands and feet turn blue because of the lack of oxygen. Decreased blood supply to the affected areas is caused by constriction or spasm of small blood vessels.

Description

Acrocyanosis is a painless disorder caused by constriction or narrowing of small blood vessels in the skin of affected patients. The spasm of the blood vessels decreases the amount of blood that passes through them, resulting in less blood being delivered to the hands and feet. The hands may be the main area affected. The affected areas turn blue and become cold and sweaty. Localized swelling may also occur. Emotion and cold temperatures can worsen the symptoms, while warmth can decrease symptoms. The disease is seen mainly in women and the effect of the disorder is mainly cosmetic. People with the disease tend to be uncomfortable, with sweaty, cold, bluish colored hands and feet.

Causes and symptoms

The sympathetic nerves cause constriction or spasms in the peripheral blood vessels that supply blood to the extremities. The spasms are a contraction of the muscles in the walls of the blood vessels. The contraction decreases the internal diameter of the blood vessels, thereby decreasing the amount of blood flow through the affected area. The spasms occur on a persistent basis, resulting in long term reduction of blood supply to the hands and feet. Sufficient blood still passes through the blood vessels so that the tissue in the affected areas does not starve for oxygen or die. Mainly, blood vessels near the surface of the skin are affected.

Diagnosis

Diagnosis is made by observation of the main clinical symptoms, including persistently blue and sweaty hands and/or feet and a lack of **pain**. Cooling the hands increases the blueness, while warming the hands decreas-

KEY TERMS

Sympathetic nerve—A nerve of the autonomic nervous system that regulates involuntary and automatic reactions, especially to stress.

es the blue color. The acrocyanosis patient's pulse is normal, which rules out obstructive diseases. **Raynaud's disease** differs from acrocyanosis in that it causes white and red skin coloration phases, not just bluish discoloration.

Treatment

Acrocyanosis usually isn't treated. Drugs that block the uptake of calcium (**calcium channel blockers**) and alpha-one antagonists reduce the symptoms in most cases. Drugs that dilate blood vessels are only effective some of the time. Sweating from the affected areas can be profuse and require treatment. Surgery to cut the sympathetic nerves is performed rarely.

Prognosis

Acrocyanosis is a benign and persistent disease. The main concern of patients is cosmetic. Left untreated, the disease does not worsen.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Larsen, D. E., ed. *Mayo Clinic Family Health Book.* New York: William Morrow and Co., Inc., 1996.

John T. Lohr, PhD

Acromegaly and gigantism

Definition

Acromegaly is a disorder in which the abnormal release of a particular chemical from the pituitary gland in the brain causes increased growth in bone and soft tissue, as well as a variety of other disturbances throughout the body. This chemical released from the pituitary gland is called growth hormone (GH). The body's ability to process and use nutrients like fats and sugars is also altered. In children whose bony growth plates have not closed, the chemical changes of acromegaly result in exceptional growth of long bones. This variant is called gigantism, with the additional bone growth causing unusual height. When the abnormality occurs after bone growth stops, the disorder is called acromegaly.

Description

Acromegaly is a relatively rare disorder, occurring in approximately 50 out of every one million people (50/1,000,000). Both men and women are affected. Because the symptoms of acromegaly occur so gradually, diagnosis is often delayed. The majority of patients are not identified until they are middle aged.

Causes and symptoms

The pituitary is a small gland located at the base of the brain. A gland is a collection of cells that releases certain chemicals, or hormones, which are important to the functioning of other organs or body systems. The pituitary hormones travel throughout the body and are involved in a large number of activities, including the regulation of growth and reproductive functions. The cause of acromegaly can be traced to the pituitary's production of GH.

Under normal conditions, the pituitary receives input from another brain structure, the hypothalamus, located at the base of the brain. This input from the hypothalamus regulates the pituitary's release of hormones. For example, the hypothalamus produces growth hormone-releasing hormone (GHRH), which directs the pituitary to release GH. Input from the hypothalamus should also direct the pituitary to stop releasing hormones.

In acromegaly, the pituitary continues to release GH and ignores signals from the hypothalamus. In the liver, GH causes production of a hormone called insulin-like growth factor 1 (IGF-1), which is responsible for growth throughout the body. When the pituitary refuses to stop producing GH, the levels of IGF-1 also reach abnormal peaks. Bones, soft tissue, and organs throughout the body begin to enlarge, and the body changes its ability to process and use nutrients like sugars and fats.

In acromegaly, an individual's hands and feet begin to grow, becoming thick and doughy. The jaw line, nose, and forehead also grow, and facial features are described as "coarsening". The tongue grows larger, and because the jaw is larger, the teeth become more widely spaced. Due to swelling within the structures of the throat and sinuses, the voice becomes deeper and sounds more hollow, and patients may develop loud **snoring**. Various hormonal changes cause symptoms such as:

- heavy sweating
- oily skin
- increased coarse body hair
- improper processing of sugars in the diet (and sometimes actual diabetes)
- high blood pressure
- increased calcium in the urine (sometimes leading to kidney stones)
- increased risk of **gallstones**; and
- swelling of the thyroid gland

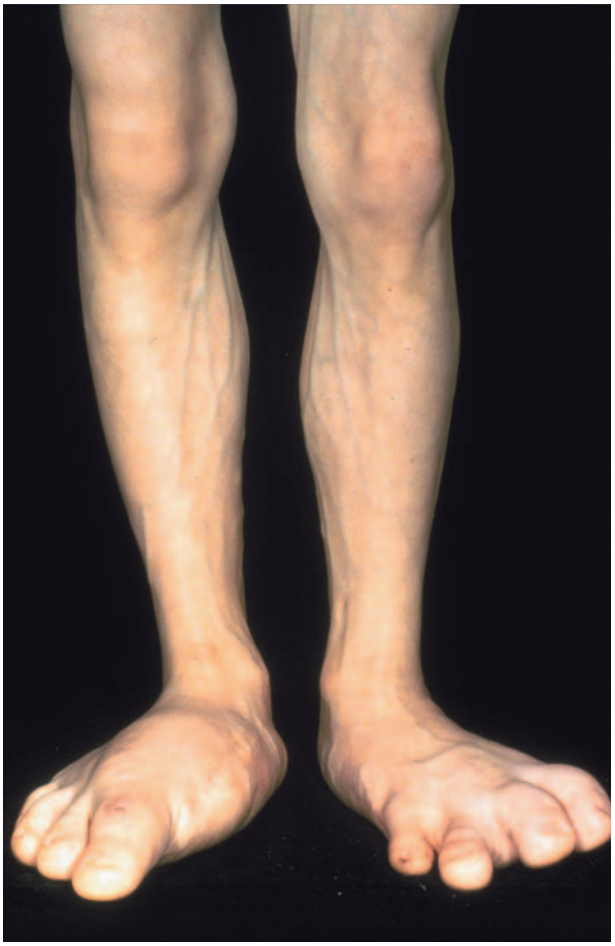
People with acromegaly have more skin tags, or outgrowths of tissue, than normal. This increase in skin tags is also associated with the development of growths, called polyps, within the large intestine that may eventually become cancerous. Patients with acromegaly often suffer from headaches and arthritis. The various swellings and enlargements throughout the body may press on nerves, causing sensations of local tingling or burning, and sometimes result in muscle weakness.

The most common cause of this disorder (in 90% of patients) is the development of a noncancerous tumor within the pituitary, called a pituitary adenoma. These tumors are the source of the abnormal release of GH. As these tumors grow, they may press on nearby structures within the brain, causing headaches and changes in vision. As the adenoma grows, it may disrupt other pituitary tissue, interfering with the release of other hormones. These disruptions may be responsible for changes in the menstrual cycle of women, decreases in the sexual drive in men and women, and the abnormal production of breast milk in women. In rare cases, acromegaly is caused by the abnormal production of GHRH, which leads to the increased production of GH. Certain tumors in the pancreas, lungs, adrenal glands, thyroid, and intestine produce GHRH, which in turn triggers production of an abnormal quantity of GH.

Diagnosis

Because acromegaly produces slow changes over time, diagnosis is often significantly delayed. In fact, the characteristic coarsening of the facial features is often not recognized by family members, friends, or long-time family physicians. Often, the diagnosis is suspected by a new physician who sees the patient for the first time and is struck by the patient's characteristic facial appearance. Comparing old photographs from a number of different time periods will often increase suspicion of the disease.

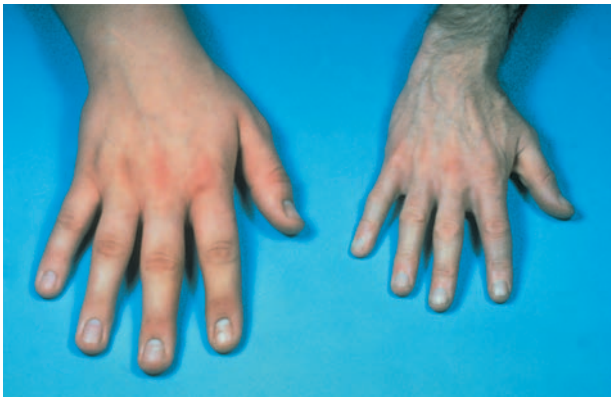
Because the quantity of GH produced varies widely under normal conditions, demonstrating high levels of GH in the blood is not sufficient to merit a diagnosis of acromegaly. Instead, laboratory tests measuring an increase of IGF-1 (3-10 times above the normal level) are useful. These results, however, must be carefully interpreted because normal laboratory values for IGF-1 vary when the patient is pregnant, undergoing **puberty**, elderly, or severely malnourished. Normal patients will show a decrease in GH production when given a large dose of sugar (glucose). Patients with acromegaly will not show this decrease, and will often show an increase in GH production. **Magnetic resonance imaging** (MRI) is useful for viewing the pituitary, and for identifying and locating an adenoma. When no adenoma can be located, the search for a GHRH-producing tumor in another location begins.



Enlarged feet is one deformity caused by acromegaly. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

The first step in treatment of acromegaly is removal of all or part of the pituitary adenoma. Removal requires surgery, usually performed by entering the skull through the nose. While this surgery can cause rapid improvement of many acromegaly symptoms, most patients will also



A comparison of the right hand of a person afflicted with acromegaly (left) and the hand of a normal sized person. *(Custom Medical Stock Photo. Reproduced by permission.)*

require additional treatment with medication. Bromocriptine (Parlodel) is a medication that can be taken by mouth, while octreotide (Sandostatin) must be injected every eight hours. Both of these medications are helpful in reducing GH production, but must often be taken for life and produce their own unique side effects. Some patients who cannot undergo surgery are treated with **radiation therapy** to the pituitary in an attempt to shrink the adenoma. Radiating the pituitary may take up to 10 years, however, and may also injure/destroy other normal parts of the pituitary.

Prognosis

Without treatment, patients with acromegaly will most likely die early because of the disease's effects on the heart, lungs, brain, or due to the development of **cancer** in the large intestine. With treatment, however, a patient with acromegaly may be able to live a normal lifespan.

Resources

BOOKS

Biller, Beverly M. K., and Gilbert H. Daniels. "Growth Hormone Excess: Acromegaly and Gigantism." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Jameson, J. Larry. "Growth Hormone Excess: Acromegaly and Gigantism." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Jaffe, C. A. "Acromegaly: Recognition and Treatment." *Drugs* 47, no. 3 (1994): 425+.

Krishna, A. Y. "Management of Acromegaly: A Review." *American Journal of Medical Science* 308, no. 6 (1994): 370+.

Maugans, Todd, and Michael L. Coates. "Diagnosis and Treatment of Acromegaly." *American Family Physician* 52, no. 1 (July 1995): 207+.

KEY TERMS

Adenoma—A type of noncancerous (benign) tumor that often involves the overgrowth of certain cells found in glands.

Gland—A collection of cells that releases certain chemicals, or hormones, that are important to the functioning of other organs or body systems.

Hormone—A chemical produced in one part of the body that travels to another part of the body in order to exert an effect.

Hypothalamus—A structure within the brain responsible for a large number of normal functions throughout the body, including regulating sleep, temperature, eating, and sexual development. The hypothalamus also regulates the functions of the pituitary gland by directing the pituitary to stop or start production of its hormones.

Pituitary—A gland located at the base of the brain that produces a number of hormones, including those that regulate growth and reproductive functions. Overproduction of the pituitary hormone called growth hormone (GH) is responsible for the condition known as acromegaly.

ORGANIZATIONS

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ACT *see* **Alanine aminotransferase test**

ACTH test *see* **Adrenocorticotropic hormone test**

Actinomyces israelii infection *see* **Actinomycosis**

Actinomycosis

Definition

Actinomycosis is an infection primarily caused by the bacterium *Actinomyces israelii*. Infection most often occurs in the face and neck region and is characterized by the presence of a slowly enlarging, hard, red lump.

Description

Actinomycosis is a relatively rare infection occurring in one out of 300,000(1/300,000) people per year. It is characterized by the presence of a lump or mass that often forms, draining sinus tracts to the skin surface. Fifty percent of actinomycosis cases are of the head and neck region (also called "lumpy jaw" and "cervicofacial actinomycosis"), 15% are in the chest, 20% are in the abdomen, and the rest are in the pelvis, heart, and brain. Men are three times more likely to develop actinomycosis than women.

Causes and symptoms

Actinomycosis is usually caused by the bacterium *Actinomyces israelii*. This bacterium is normally present in the mouth but can cause disease if it enters tissues following an injury. *Actinomyces israelii* is an anaerobic bacterium which means it dislikes oxygen but grows very well in deep tissues where oxygen levels are low. **Tooth extraction**, tooth disease, **root canal treatment**, jaw surgery, or poor dental hygiene can allow *Actinomyces israelii* to cause an infection in the head and neck region.

The main symptom of cervicofacial actinomycosis is the presence of a hard lump on the face or neck. The lump may or may not be red. **Fever** occurs in some cases.

Diagnosis

Cervicofacial actinomycosis can be diagnosed by a family doctor or dentist and the patient may be referred to an oral surgeon or infectious disease specialist. The diagnosis of actinomycosis is based upon several things. The presence of a red lump with draining sinuses on the head or neck is strongly suggestive of cervicofacial actinomycosis. A recent history of tooth extraction or signs of **tooth decay** or poor dental hygiene aid in the diagnosis. Microscopic examination of the fluid draining from the sinuses shows the characteristic "sulfur granules" (small yellow colored material in the fluid) produced by *Actinomyces israelii*. A biopsy may be performed to remove a sample of the infected tissue. This procedure can be performed under local anesthesia in the doctor's office. Occasionally the bacteria can be cultured from the sinus tract fluid or from samples of the infected tissue.

Actinomycosis in the lungs, abdomen, pelvis, or brain can be very hard to diagnose since the symptoms often mimic those of other diseases. Actinomycosis of the lungs or abdomen can resemble **tuberculosis** or **cancer**. x-ray results, the presence of draining sinus tracts, and microscopic analysis and culturing of infected tissue assist in the diagnosis.

Treatment

Actinomycosis is difficult to treat because of its dense tissue location. Surgery is often required to drain the lesion and/or to remove the site of infection. To kill the bacteria, large doses of penicillin are given through a vein daily for two to six weeks followed by six to twelve months of penicillin taken by mouth. Tetracycline, clindamycin, or erythromycin may be used instead of penicillin. The antibiotic therapy must be completed to insure that the infection does not return. Hyperbaric oxygen (oxygen under high pressure) therapy in combination with the antibiotic therapy has been successful.

KEY TERMS

Biopsy—The process which removes a sample of tissue for microscopic examination to aid in the diagnosis of a disease.

Sinus tract—A narrow, elongated channel in the body which allows the escape of fluid.

Prognosis

Complete recovery is achieved following treatment. If left untreated, the infection may cause localized bone destruction.

Prevention

The best prevention is to maintain good dental hygiene.

Resources

OTHER

"Actinomycosis." HealthAnswers.com. 6 Feb. 1998. <http://www.healthanswers.com/database/ami/converted/000599.html>.

Belinda Rowland, PhD

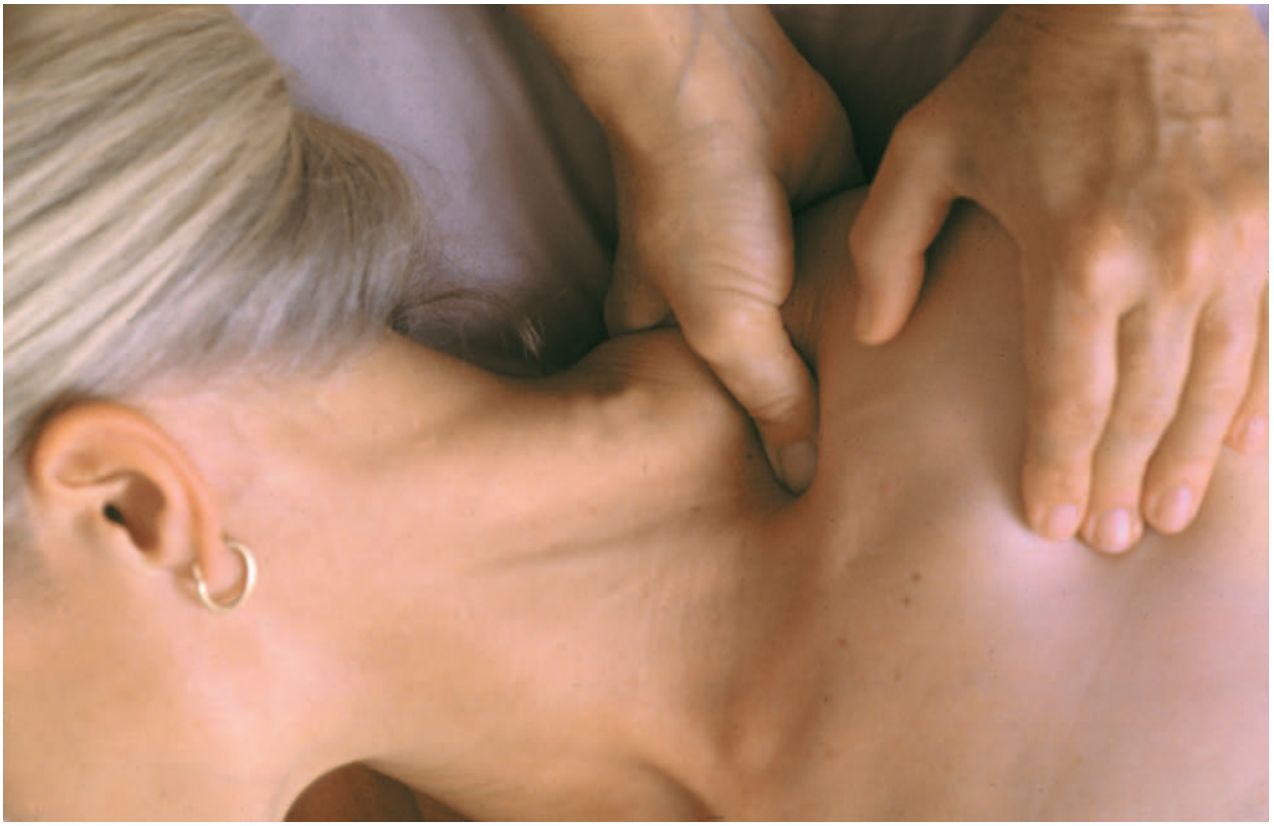
Activated charcoal *see* **Charcoal, activated**

Activated partial thromboplastin time *see* **Partial thromboplastin time**

Acupressure

Definition

Acupressure is a form of touch therapy that utilizes the principles of **acupuncture** and Chinese medicine. In acupressure, the same points on the body are used as in acupuncture, but are stimulated with finger pressure



Therapist working acupressure points on a woman's shoulder. *(Photo Researchers, Inc. Reproduced by permission.)*

instead of with the insertion of needles. Acupressure is used to relieve a variety of symptoms and **pain**.

Purpose

Acupressure massage performed by a therapist can be very effective both as prevention and as a treatment for many health conditions, including headaches, general aches and pains, colds and flu, arthritis, **allergies**, **asthma**, nervous tension, menstrual cramps, sinus problems, sprains, **tennis elbow**, and toothaches, among others. Unlike acupuncture which requires a visit to a professional, acupressure can be performed by a layperson. Acupressure techniques are fairly easy to learn, and have been used to provide quick, cost-free, and effective relief from many symptoms. Acupressure points can also be stimulated to increase energy and feelings of well-being, reduce **stress**, stimulate the immune system, and alleviate **sexual dysfunction**.

Description

Origins

One of the oldest text of Chinese medicine is the *Huang Di*, The Yellow Emperor's Classic of Internal Medicine, which may be at least 2,000 years old. Chinese medicine has developed acupuncture, acupressure, herbal remedies, diet, **exercise**, lifestyle changes, and other remedies as part of its healing methods. Nearly all of the forms of Oriental medicine that are used in the West today, including acupuncture, acupressure, **shiatsu**, and Chinese herbal medicine, have their roots in Chinese medicine. One legend has it that acupuncture and acupressure evolved as early Chinese healers studied the puncture **wounds** of Chinese warriors, noting that certain points on the body created interesting results when stimulated. The oldest known text specifically on acupuncture points, the *Systematic Classic of Acupuncture*, dates back to 282 A.D. Acupressure is the non-invasive form of acupuncture, as Chinese physicians determined that stimulating points on the body with massage and pressure could be effective for treating certain problems.

Outside of Asian-American communities, Chinese medicine remained virtually unknown in the United States until the 1970s, when Richard Nixon became the first U.S. president to visit China. On Nixon's trip, journalists were amazed to observe major operations being performed on patients without the use of anesthetics. Instead, wide-awake patients were being operated on,

with only acupuncture needles inserted into them to control pain. At that time, a famous columnist for the *New York Times*, James Reston, had to undergo surgery and elected to use acupuncture for anesthesia. Later, he wrote some convincing stories on its effectiveness. Despite being neglected by mainstream medicine and the American Medical Association (AMA), acupuncture and Chinese medicine became a central to alternative medicine practitioners in the United States. Today, there are millions of patients who attest to its effectiveness, and nearly 9,000 practitioners in all 50 states.

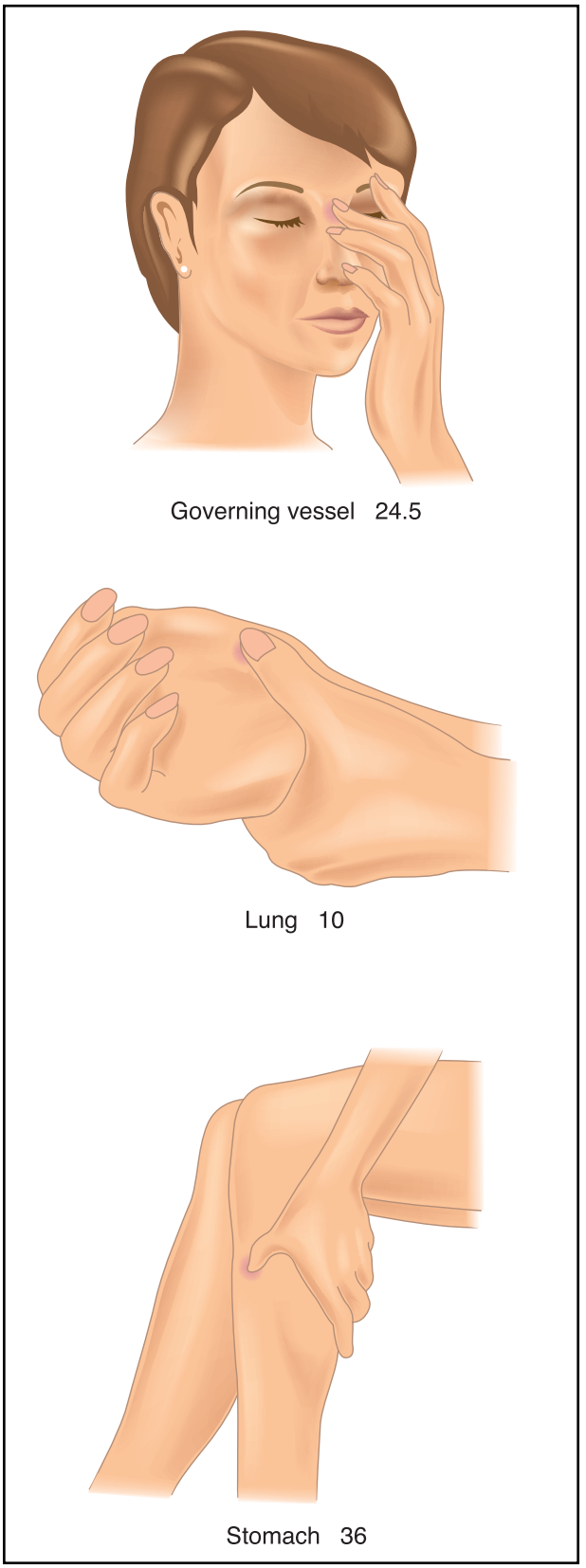
Acupressure is practiced as a treatment by Chinese medicine practitioners and acupuncturists, as well as by massage therapists. Most massage schools in American include acupressure techniques as part of their bodywork programs. Shiatsu massage is very closely related to acupressure, working with the same points on the body and the same general principles, although it was developed over centuries in Japan rather than in China. **Reflexology** is a form of bodywork based on acupressure concepts. Jin Shin Do is a bodywork technique with an increasing number of practitioners in America that combines acupressure and shiatsu principles with **qigong**, Reichian theory, and **meditation**.

Acupressure and Chinese medicine

Chinese medicine views the body as a small part of the universe, subject to laws and principles of harmony and balance. Chinese medicine does not make as sharp a destinction as Western medicine does between mind and body. The Chinese system believes that emotions and mental states are every bit as influential on disease as purely physical mechanisms, and considers factors like work, environment, and relationships as fundamental to a patient's health. Chinese medicine also uses very different symbols and ideas to discuss the body and health. While Western medicine typically describes health as mainly physical processes composed of chemical equations and reactions, the Chinese use ideas like yin and yang, chi, and the organ system to describe health and the body.

Everything in the universe has properties of yin and yang. Yin is associated with cold, female, passive, downward, inward, dark, wet. Yang can be described as hot, male, active, upward, outward, light, dry, and so on. Nothing is either completely yin or yang. These two principles always interact and affect each other, although the body and its organs can become imbalanced by having either too much or too little of either.

Chi (pronounced *chee*, also spelled *qi* or *ki* in Japanese shiatsu) is the fundamental life energy. It is found in food, air, water, and sunlight, and it travels through the body in channels called *meridians*. There are 12 major



Acupressure points to relieve hay fever, sore throat, and heartburn. *(Illustration by Electronic Illustrators Group.)*

KEY TERMS

Acupoint—A pressure point stimulated in acupressure.

Chi—Basic life energy.

Meridian—A channel through which chi travels in the body.

Moxibustion—An acupuncture technique that burns the herb moxa or mugwort.

Shiatsu—Japanese form of acupressure massage.

Yin/yang—Universal characteristics used to describe aspects of the natural world.

meridians in the body that transport chi, corresponding to the 12 main organs categorized by Chinese medicine.

Disease is viewed as an imbalance of the organs and chi in the body. Chinese medicine has developed intricate systems of how organs are related to physical and mental symptoms, and it has devised corresponding treatments using the meridian and pressure point networks that are classified and numbered. The goal of acupressure, and acupuncture, is to stimulate and unblock the circulation of chi, by activating very specific points, called pressure points or *acupoints*. Acupressure seeks to stimulate the points on the chi meridians that pass close to the skin, as these are easiest to unblock and manipulate with finger pressure.

Acupressure can be used as part of a Chinese physician's prescription, as a session of **massage therapy**, or as a self-treatment for common aches and illnesses. A Chinese medicine practitioner examines a patient very thoroughly, looking at physical, mental and emotional activity, taking the pulse usually at the wrists, examining the tongue and complexion, and observing the patient's demeanor and attitude, to get a complete diagnosis of which organs and meridian points are out of balance. When the imbalance is located, the physician will recommend specific pressure points for acupuncture or acupressure. If acupressure is recommended, the patient might opt for a series of treatments from a massage therapist.

In massage therapy, acupressurists will evaluate a patient's symptoms and overall health, but a massage therapist's diagnostic training isn't as extensive as a Chinese physician's. In a massage therapy treatment, a person usually lies down on a table or mat, with thin clothing on. The acupressurist will gently feel and palpate the abdomen and other parts of the body to determine energy imbalances. Then, the therapist will work with different meridians throughout the body, depending on which organs are imbalanced in the abdomen. The therapist will use different types of finger movements and pressure on different acupoints, depending on whether the chi needs to be increased or dispersed at different points. The therapist observes and guides the energy flow through the patient's body throughout the session. Sometimes, special herbs (*Artemesia vulgaris* or moxa) may be placed on a point to warm it, a process called *moxibustion*. A session of acupressure is generally a very pleasant experience, and some people experience great benefit immediately. For more chronic conditions, several sessions may be necessary to relieve and improve conditions.

Acupressure massage usually costs from $30–70 per hour session. A visit to a Chinese medicine physician or acupuncturist can be more expensive, comparable to a visit to an allopathic physician if the practitioner is an MD. Insurance reimbursement varies widely, and consumers should be aware if their policies cover alternative treatment, acupuncture, or massage therapy.

Self-treatment

Acupressure is easy to learn, and there are many good books that illustrate the position of acupoints and meridians on the body. It is also very versatile, as it can be done anywhere, and it's a good form of treatment for spouses and partners to give to each other and for parents to perform on children for minor conditions.

While giving self-treatment or performing acupressure on another, a mental attitude of calmness and attention is important, as one person's energy can be used to help another's. Loose, thin clothing is recommended. There are three general techniques for stimulating a pressure point.

- Tonifying is meant to strengthen weak chi, and is done by pressing the thumb or finger into an acupoint with a firm, steady pressure, holding it for up to two minutes.
- Dispersing is meant to move stagnant or blocked chi, and the finger or thumb is moved in a circular motion or slightly in and out of the point for two minutes.
- Calming the chi in a pressure point utilizes the palm to cover the point and gently stroke the area for about two minutes.

There are many pressure points that are easily found and memorized to treat common ailments from headaches to colds.

- For headaches, toothaches, sinus problems, and pain in the upper body, the "LI4" point is recommended. It is located in the web between the thumb and index finger, on the back of the hand. Using the thumb and index finger of the other hand, apply a pinching pressure until

the point is felt, and hold it for two minutes. Pregnant women should never press this point.

- To calm the nerves and stimulate digestion, find the "CV12" point that is four thumb widths above the navel in the center of the abdomen. Calm the point with the palm, using gentle stroking for several minutes.
- To stimulate the immune system, find the "TH5" point on the back of the forearm two thumb widths above the wrist. Use a dispersing technique, or circular pressure with the thumb or finger, for two minutes on each arm.
- For headaches, sinus congestion, and tension, locate the "GB20" points at the base of the skull in the back of the head, just behind the bones in back of the ears. Disperse these points for two minutes with the fingers or thumbs. Also find the "yintang" point, which is in the middle of the forehead between the eyebrows. Disperse it with gentle pressure for two minutes to clear the mind and to relieve headaches.

Precautions

Acupressure is a safe technique, but it is not meant to replace professional health care. A physician should always be consulted when there are doubts about medical conditions. If a condition is chronic, a professional should be consulted; purely symptomatic treatment can exacerbate chronic conditions. Acupressure should not be applied to open wounds, or where there is swelling and inflammation. Areas of scar tissue, blisters, **boils**, **rashes**, or **varicose veins** should be avoided. Finally, certain acupressure points should not be stimulated on people with high or low blood pressure and on pregnant women.

Research and general acceptance

In general, Chinese medicine has been slow to gain acceptance in the West, mainly because it rests on ideas very foreign to the scientific model. For instance, Western scientists have trouble with the idea of chi, the invisible energy of the body, and the idea that pressing on certain points can alleviate certain conditions seems sometimes too simple for scientists to believe.

Western scientists, in trying to account for the action of acupressure, have theorized that chi is actually part of the neuroendocrine system of the body. Celebrated orthopedic surgeon Robert O. Becker, who was twice nominated for the Nobel Prize, wrote a book on the subject called *Cross Currents: The Promise of Electromedicine; The Perils of Electropollution*. By using precise electrical measuring devices, Becker and his colleagues showed that the body has a complex web of electromagnetic energy, and that traditional acupressure meridians and points contained amounts of energy that non-acupressure points did not.

The mechanisms of acupuncture and acupressure remain difficult to document in terms of the biochemical processes involved; numerous testimonials are the primary evidence backing up the effectiveness of acupressure and acupuncture. However, a body of research is growing that verifies the effectiveness in acupressure and acupuncture techniques in treating many problems and in controlling pain.

Resources

BOOKS

Jarmey, Chris and John Tindall. *Acupressure for Common Ailments*. London: Gaia, 1991.

Kakptchuk, Ted. *The Web That Has No Weaver: Understanding Chinese Medicine*. New York: Congdon and Weed, 1983.

Warren, Frank Z., MD. *Freedom From Pain Through Acupressure*. New York: Fell, 1976.

PERIODICALS

Massage Therapy Journal. 820 Davis Street, Suite 100, Evanston, IL 60201-4444.

OTHER

American Association of Oriental Medicine. <http://www.aaom.org/> (December 28, 2000).

National Acupuncture and Oriental Medicine Alliance. <http://www.acuall.org/> (December 28, 2000).

Douglas Dupler

Acupressure, foot *see* **Reflexology**

Acupuncture

Definition

Acupuncture is one of the main forms of treatment in **traditional Chinese medicine**. It involves the use of sharp, thin needles that are inserted in the body at very specific points. This process is believed to adjust and alter the body's energy flow into healthier patterns, and is used to treat a wide variety of illnesses and health conditions.

Purpose

The World Health Organization (WHO) recommends acupuncture as an effective treatment for over forty medical problems, including **allergies**, respiratory conditions, gastrointestinal disorders, gynecological problems, nervous conditions, and disorders of the eyes, nose and throat, and childhood illnesses, among others. Acupuncture has been used in the treatment of **alcoholism** and substance abuse. It is an effective and low-cost treatment

Woman undergoing facial acupuncture. *(Photograph by Yoav Levy. Phototake NYC. Reproduced by permission.)*

for headaches and chronic **pain**, associated with problems like back injuries and arthritis. It has also been used to supplement invasive Western treatments like **chemotherapy** and surgery. Acupuncture is generally most effective when used as prevention or before a health condition becomes acute, but it has been used to help patients suffering from **cancer** and **AIDS**. Acupuncture is limited in treating conditions or traumas that require surgery or emergency care (such as for broken bones).

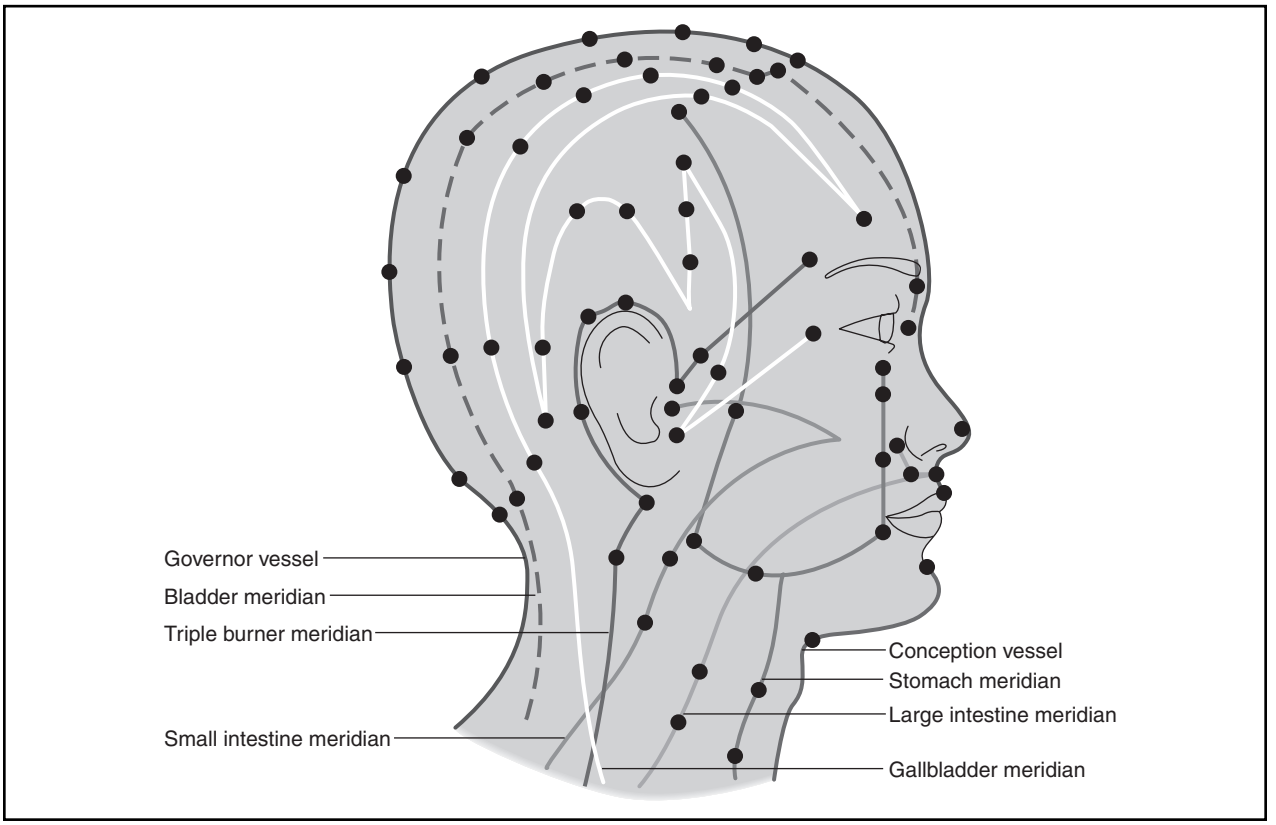
Description

Origins

The original text of Chinese medicine is the *Nei Ching, The Yellow Emperor's Classic of Internal Medicine*, which is estimated to be at least 2,500 years old. Thousands of books since then have been written on the subject of Chinese healing, and its basic philosophies spread long ago to other Asian civilizations. Nearly all of the forms of Oriental medicine which are used in the West today, including acupuncture, **shiatsu**, **acupressure** massage, and macrobiotics, are part of or have their roots in Chinese medicine. Legend has it that acupuncture developed when early Chinese physicians observed unpredicted effects of puncture **wounds** in Chinese warriors. The oldest known text on acupuncture, the *Systematic Classic of Acupuncture*, dates back to 282 A.D. Although acupuncture is its best known technique, Chinese medicine traditionally utilizes herbal remedies, dietary therapy, lifestyle changes and other means to treat patients.

In the early 1900s, only a few Western physicians who had visited China were fascinated by acupuncture, but outside of Asian-American communities it remained virtually unknown until the 1970s, when Richard Nixon became the first U.S. president to visit China. On Nixon's trip, journalists were amazed to observe major operations being performed on patients without the use of anesthetics. Instead, wide-awake patients were being operated on with only acupuncture needles inserted into them to control pain. During that time, a famous columnist for the *New York Times*, James Reston, had to undergo surgery and elected to use acupuncture instead of pain medication, and he wrote some convincing stories on its effectiveness.

Today acupuncture is being practiced in all 50 states by over 9,000 practitioners, with over 4,000 MDs including it in their practices. Acupuncture has shown notable success in treating many conditions, and over 15 million Americans have used it as a therapy. Acupuncture, how-



Acupuncture sites and meridians on the face and neck. *(Illustration by Hans & Cassady.)*

ever, remains largely unsupported by the medical establishment. The American Medical Association has been resistant to researching it, as it is based on concepts very different from the Western scientific model.

Several forms of acupuncture are being used today in America. Japanese acupuncture uses extremely thin needles and does not incorporate herbal medicine in its practice. Auricular acupuncture uses acupuncture points only on the ear, which are believed to stimulate and balance internal organs. In France, where acupuncture is very popular and more accepted by the medical establishment, neurologist Paul Nogier developed a system of acupuncture based on neuroendocrine theory rather than on traditional Chinese concepts, which is gaining some use in America.

Basic ideas of Chinese medicine

Chinese medicine views the body as a small part of the universe, and subject to universal laws and principles of harmony and balance. Chinese medicine does not draw a sharp line, as Western medicine does, between mind and body. The Chinese system believes that emotions and mental states are every bit as influential on disease as purely physical mechanisms, and considers factors like work, environment, lifestyle and relationships as fundamental to the overall picture of a patient's health. Chinese medicine also uses very different symbols and ideas to discuss the body and health. While Western medicine typically describes health in terms of measurable physical processes made up of chemical reactions, the Chinese use ideas like yin and yang, chi, the organ system, and the five elements to describe health and the body. To understand the ideas behind acupuncture, it is worthwhile to introduce some of these basic terms.

YIN AND YANG. According to Chinese philosophy, the universe and the body can be described by two separate but complementary principles, that of yin and yang. For example, in temperature, yin is cold and yang is hot. In gender, yin is female and yang is male. In activity, yin is passive and yang is active. In light, yin is dark and yang is bright; in direction yin is inward and downward and yang is outward and up, and so on. Nothing is ever completely yin or yang, but a combination of the two. These two principles are always interacting, opposing, and influencing each other. The goal of Chinese medicine is not to eliminate either yin or yang, but to allow the two to balance each other and exist harmoniously together. For instance, if a person suffers from symptoms

KEY TERMS

Acupressure—Form of massage using acupuncture points.

Auricular acupuncture—Acupuncture using only points found on the ears.

Chi—Basic life energy.

Meridian—Channel through which chi travels in the body.

Moxibustion—Acupuncture technique which burns the herb moxa or mugwort.

Tonification—Acupuncture technique for strengthening the body.

Yin/Yang—Universal characteristics used to describe aspects of the natural world.

of high blood pressure, the Chinese system would say that the heart organ might have too much yang, and would recommend methods either to reduce the yang or to increase the yin of the heart, depending on the other symptoms and organs in the body. Thus, acupuncture therapies seek to either increase or reduce yang, or increase or reduce yin in particular regions of the body.

CHI. Another fundamental concept of Chinese medicine is that of chi (pronounced *chee*, also spelled *qi*). Chi is the fundamental life energy of the universe. It is invisible and is found in the environment in the air, water, food and sunlight. In the body, it is the invisible vital force that creates and animates life. We are all born with inherited amounts of chi, and we also get acquired chi from the food we eat and the air we breathe. The level and quality of a person's chi also depends on the state of physical, mental and emotional balance. Chi travels through the body along channels called *meridians*.

THE ORGAN SYSTEM. In the Chinese system, there are twelve main organs: the lung, large intestine, stomach, spleen, heart, small intestine, urinary bladder, kidney, liver, gallbladder, pericardium, and the "triple warmer," which represents the entire torso region. Each organ has chi energy associated with it, and each organ interacts with particular emotions on the mental level. As there are twelve organs, there are twelve types of chi which can move through the body, and these move through twelve main channels or meridians. Chinese doctors connect symptoms to organs. That is, symptoms are caused by yin/yang imbalances in one or more organs, or by an unhealthy flow of chi to or from one organ to another. Each organ has a different profile of symptoms it can manifest.

THE FIVE ELEMENTS. Another basis of Chinese theory is that the world and body are made up of five main elements: wood, fire, earth, metal, and water. These elements are all interconnected, and each element either generates or controls another element. For instance, water controls fire and earth generates metal. Each organ is associated with one of the five elements. The Chinese system uses elements and organs to describe and treat conditions. For instance, the kidney is associated with water and the heart is associated with fire, and the two organs are related as water and fire are related. If the kidney is weak, then there might be a corresponding fire problem in the heart, so treatment might be made by acupuncture or herbs to cool the heart system and/or increase energy in the kidney system.

The Chinese have developed an intricate system of how organs and elements are related to physical and mental symptoms, and the above example is a very simple one. Although this system sounds suspect to Western scientists, some interesting parallels have been observed. For instance, Western medicine has observed that with severe heart problems, kidney failure often follows, but it still does not know exactly why. In Chinese medicine, this connection between the two organs has long been established.

MEDICAL PROBLEMS AND ACUPUNCTURE. In Chinese medicine, disease as seen as imbalances in the organ system or chi meridians, and the goal of any remedy or treatment is to assist the body in reestablishing its innate harmony. Disease can be caused by internal factors like emotions, external factors like the environment and weather, and other factors like injuries, trauma, diet, and germs. However, infection is seen not as primarily a problem with germs and viruses, but as a weakness in the energy of the body which is allowing a sickness to occur. In Chinese medicine, no two illnesses are ever the same, as each body has its own characteristics of symptoms and balance. Acupuncture is used to open or adjust the flow of chi throughout the organ system, which will strengthen the body and prompt it to heal itself.

A VISIT TO THE ACUPUNCTURIST. The first thing an acupuncturist will do is get a thorough idea of a patient's medical history and symptoms, both physical and emotional. This is done with a long questionnaire and interview. Then the acupuncturist will examine the patient to find further symptoms, looking closely at the tongue, the pulse at various points in the body, the complexion, general behavior, and other signs like coughs or pains. From this, the practitioner will be able to determine patterns of symptoms which indicate which organs and areas are

imbalanced. Depending on the problem, the acupuncturist will insert needles to manipulate chi on one or more of the twelve organ meridians. On these twelve meridians, there are nearly 2,000 points which can be used in acupuncture, with around 200 points being most frequently used by traditional acupuncturists. During an individual treatment, one to twenty needles may be used, depending on which meridian points are chosen.

Acupuncture needles are always sterilized and acupuncture is a very safe procedure. The depth of insertion of needles varies, depending on which chi channels are being treated. Some points barely go beyond superficial layers of skin, while some acupuncture points require a depth of 1-3 in (2.5-7.5 cm) of needle. The needles generally do not cause pain. Patients sometimes report pinching sensations and often pleasant sensations, as the body experiences healing. Depending on the problem, the acupuncturist might spin or move the needles, or even pass a slight electrical current through some of them. *Moxibustion* may be sometimes used, in which an herbal mixture (moxa or mugwort) is either burned like incense on the acupuncture point or on the end of the needle, which is believed to stimulate chi in a particular way. Also, acupuncturists sometimes use *cupping*, during which small suction cups are placed on meridian points to stimulate them.

How long the needles are inserted also varies. Some patients only require a quick in and out insertion to clear problems and provide *tonification* (strengthening of health), while some other conditions might require needles inserted up to an hour or more. The average visit to an acupuncturist takes about thirty minutes. The number of visits to the acupuncturist varies as well, with some conditions improved in one or two sessions and others requiring a series of six or more visits over the course of weeks or months.

Costs for acupuncture can vary, depending on whether the practitioner is an MD. Initial visits with non-MD acupuncturists can run from $50-$100, with follow-up visits usually costing less. Insurance reimbursement also varies widely, depending on the company and state. Regulations have been changing often. Some states authorize Medicaid to cover acupuncture for certain conditions, and some states have mandated that general coverage pay for acupuncture. Consumers should be aware of the provisions for acupuncture in their individual policies.

Precautions

Acupuncture is generally a very safe procedure. If a patient is in doubt about a medical condition, more than one physician should be consulted. Also, a patient should always feel comfortable and confident that their acupuncturist is knowledgable and properly trained.

Research and general acceptance

Mainstream medicine has been slow to accept acupuncture; although more MDs are using it, the American Medical Association does not recognize it as a specialty. The reason for this is that the mechanism of acupuncture is difficult to scientifically understand or measure, such as the invisible energy of chi in the body. Western medicine, admitting that acupuncture works in many cases, has theorized that the energy meridians are actually part of the nervous system and that acupuncture relieves pain by releasing endorphins, or natural pain killers, into the bloodstream. Despite the ambiguity in the biochemistry involved, acupuncture continues to show effectiveness in clinical tests, from reducing pain to alleviating the symptoms of chronic illnesses, and research in acupuncture is currently growing. The Office of Alternative Medicine of the National Institute of Health is currently funding research in the use of acupuncture for treating depression and attention-deficit disorder.

Resources

BOOKS

Fleischman, Dr. Gary F. *Acupuncture: Everything You Ever Wanted To Know.* New York: Barrytown, 1998.

Kakptchuk, Ted. *The Web That Has No Weaver: Understanding Chinese Medicine*. New York: Congdon and Weed, 1983.

Requena, Yves, MD. *Terrains and Pathology in Acupuncture*. Massachusetts: Paradigm, 1986.

PERIODICALS

American Journal of Acupuncture. 1840 41st Ave., Suite 102, P.O. Box 610, Capitola, CA 95010.

OTHER

American Association of Oriental Medicine. <http://www.aaom.org/> (December 28, 2000).

North American Society of Acupuncture and Alternative Medicine. <http://www.nasa-altmed.com/> (December 28, 2000).

Douglas Dupler

Acute glomerulonephritis *see* **Acute poststreptococcal glomerulonephritis**

Acute homeopathic remedies *see* **Homeopathic remedies, acute prescribing**

Acute kidney failure

Definition

Acute kidney failure occurs when illness, infection, or injury damages the kidneys. Temporarily, the kidneys

cannot adequately remove fluids and wastes from the body or maintain the proper level of certain kidney-regulated chemicals in the bloodstream.

Description

The kidneys are the body's natural filtration system. They perform the critical task of processing approximately 200 quarts of fluid in the bloodstream every 24 hours. Waste products like urea and toxins, along with excess fluids, are removed from the bloodstream in the form of urine. Kidney (or renal) failure occurs when kidney functioning becomes impaired. Fluids and toxins begin to accumulate in the bloodstream. As fluids build up in the bloodstream, the patient with acute kidney failure may become puffy and swollen (edematous) in the face, hands, and feet. Their blood pressure typically begins to rise, and they may experience **fatigue** and nausea.

Unlike **chronic kidney failure**, which is long term and irreversible, acute kidney failure is a temporary condition. With proper and timely treatment, it can typically be reversed. Often there is no permanent damage to the kidneys. Acute kidney failure appears most frequently as a complication of serious illness, like **heart failure**, liver failure, **dehydration**, severe **burns**, and excessive bleeding (hemorrhage). It may also be caused by an obstruction to the urinary tract or as a direct result of kidney disease, injury, or an adverse reaction to a medicine.

Causes and symptoms

Acute kidney failure can be caused by many different illnesses, injuries, and infections. These conditions fall into three main categories: *prerenal*, *postrenal*, and *intrarenal* conditions.

Prerenal conditions do not damage the kidney, but can cause diminished kidney function. They are the most common cause of acute renal failure, and include:

- dehydration
- hemorrhage
- septicemia, or **sepsis**
- heart failure
- liver failure
- burns

Postrenal conditions cause kidney failure by obstructing the urinary tract. These conditions include:

- inflammation of the prostate gland in men (prostatitis)
- enlargement of the prostate gland (benign prostatic hypertrophy)
- bladder or pelvic tumors
- **kidney stones** (calculi)

Intrarenal conditions involve kidney disease or direct injury to the kidneys. These conditions include:

- lack of blood supply to the kidneys (ischemia)
- use of radiocontrast agents in patients with kidney problems
- drug abuse or overdose
- long-term use of nephrotoxic medications, like certain **pain** medicines
- acute inflammation of the glomeruli, or filters, of the kidney (**glomerulonephritis**)
- kidney infections (pyelitis or pyelonephritis)

Common symptoms of acute kidney failure include:

- anemia. The kidneys are responsible for producing erythropoietin (EPO), a hormone that stimulates red blood cell production. If kidney disease causes shrinking of the kidney, red blood cell production is reduced, leading to anemia.
- bad breath or bad taste in mouth. Urea in the saliva may cause an ammonia-like taste in the mouth.
- bone and joint problems. The kidneys produce vitamin D, which helps the body absorb calcium and keeps bones strong. For patients with kidney failure, bones may become brittle. In children, normal growth may be stunted. Joint pain may also occur as a result of high phosphate levels in the blood. Retention of uric acid may cause **gout**.
- edema. Puffiness or swelling in the arms, hands, feet, and around the eyes.
- frequent urination.
- foamy or bloody urine. Protein in the urine may cause it to foam significantly. Blood in the urine may indicate bleeding from diseased or obstructed kidneys, bladder, or ureters.
- headaches. High blood pressure may trigger headaches.
- hypertension, or high blood pressure. The retention of fluids and wastes causes blood volume to increase. This makes blood pressure rise.
- increased fatigue. Toxic substances in the blood and the presence of anemia may cause the patient to feel exhausted.
- itching. Phosphorus, normally eliminated in the urine, accumulates in the blood of patients with kidney failure. An increased phosphorus level may cause the skin to itch.
- lower back pain. Patients suffering from certain kidney problems (like kidney stones and other obstructions) may have pain where the kidneys are located, in the small of the back below the ribs.
- nausea. Urea in the gastric juices may cause upset stomach.

Diagnosis

Kidney failure is diagnosed by a doctor. A nephrologist, a doctor that specializes in the kidney, may be consulted to confirm the diagnosis and recommend treatment options. The patient that is suspected of having acute kidney failure will have blood and urine tests to determine the level of kidney function. A blood test will assess the levels of creatinine, blood urea nitrogen (BUN), uric acid, phosphate, sodium, and potassium. The kidney regulates these agents in the blood. Urine samples will also be collected, usually over a 24-hour period, to assess protein loss and/or creatinine clearance.

Determining the cause of kidney failure is critical to proper treatment. A full assessment of the kidneys is necessary to determine if the underlying disease is treatable and if the kidney failure is chronic or acute. X rays, **magnetic resonance imaging** (MRI), computed tomography scan (CT), ultrasound, renal biopsy, and/or arteriogram of the kidneys may be used to determine the cause of kidney failure and level of remaining kidney function. X rays and ultrasound of the bladder and/or ureters may also be needed.

KEY TERMS

Blood urea nitrogen (BUN)—A waste product that is formed in the liver and collects in the bloodstream; patients with kidney failure have high BUN levels.

Creatinine—A protein produced by muscle that healthy kidneys filter out.

Extracorporeal—Outside of, or unrelated to, the body.

Ischemia—A lack of blood supply to an organ or tissue.

Nephrotoxic—Toxic, or damaging, to the kidney.

Radiocontrast agents—Dyes administered to a patient for the purposes of a radiologic study.

Sepsis—A bacterial infection of the bloodstream.

Vasopressors—Medications that constrict the blood vessels.

Treatment

Treatment for acute kidney failure varies. Treatment is directed to the underlying, primary medical condition that has triggered kidney failure. Prerenal conditions may be treated with replacement fluids given through a vein, **diuretics**, blood **transfusion**, or medications. Postrenal conditions and intrarenal conditions may require surgery and/or medication.

Frequently, patients in acute kidney failure require *hemodialysis*, *hemofiltration*, or *peritoneal dialysis* to filter fluids and wastes from the bloodstream until the primary medical condition can be controlled.

Hemodialysis

Hemodialysis involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. The ECC is made up of plastic blood tubing, a filter known as a dialyzer (or artificial kidney), and a dialysis machine that monitors and maintains blood flow and administers dialysate. Dialysate is a sterile chemical solution that is used to draw waste products out of the blood. The patient's blood leaves the body through the vein and travels through the ECC and the dialyzer, where fluid removal takes place.

During dialysis, waste products in the bloodstream are carried out of the body. At the same time, electrolytes and other chemicals are added to the blood. The purified, chemically-balanced blood is then returned to the body.

A dialysis "run" typically lasts three to four hours, depending on the type of dialyzer used and the physical condition of the patient. Dialysis is used several times a week until acute kidney failure is reversed.

Blood pressure changes associated with hemodialysis may pose a risk for patients with heart problems. Peritoneal dialysis may be the preferred treatment option in these cases.

Hemofiltration

Hemofiltration, also called continuous renal replacement therapy (CRRT), is a slow, continuous blood filtration therapy used to control acute kidney failure in critically ill patients. These patients are typically very sick and may have heart problems or circulatory problems. They cannot handle the rapid filtration rates of hemodialysis. They also frequently need **antibiotics**, **nutrition**, vasopressors, and other fluids given through a vein to treat their primary condition. Because hemofiltration is continuous, prescription fluids can be given to patients in kidney failure without the risk of fluid overload.

Like hemodialysis, hemofiltration uses an ECC. A hollow fiber hemofilter is used instead of a dialyzer to remove fluids and toxins. Instead of a dialysis machine, a blood pump makes the blood flow through the ECC. The volume of blood circulating through the ECC in hemofiltration is less than that in hemodialysis. Filtration rates are slower and gentler on the circulatory system.

Hemofiltration treatment will generally be used until kidney failure is reversed.

Peritoneal dialysis

Peritoneal dialysis may be used if an acute kidney failure patient is stable and not in immediate crisis. In peritoneal dialysis (PD), the lining of the patient's abdomen, the peritoneum, acts as a blood filter. A flexible tube-like instrument (catheter) is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a certain time period, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate. There are three type of peritoneal dialysis, which vary according to treatment time and administration method.

Peritoneal dialysis is often the best treatment option for infants and children. Their small size can make vein access difficult to maintain. It is not recommended for patients with abdominal adhesions or other abdominal defects (like a **hernia**) that might reduce the efficiency of the treatment. It is also not recommended for patients who suffer frequent bouts of an inflammation of the small pouches in the intestinal tract (diverticulitis).

Prognosis

Because many of the illnesses and underlying conditions that often trigger acute kidney failure are critical, the prognosis for these patients many times is not good. Studies have estimated overall **death** rates for acute kidney failure at 42-88%. Many people, however, die because of the primary disease that has caused the kidney failure. These figures may also be misleading because patients who experience kidney failure as a result of less serious illnesses (like kidney stones or dehydration) have an excellent chance of complete recovery. Early recognition and prompt, appropriate treatment are key to patient recovery.

Up to 10% of patients who experience acute kidney failure will suffer irreversible kidney damage. They will eventually go on to develop chronic kidney failure or end-stage renal disease. These patients will require long-term dialysis or **kidney transplantation** to replace their lost renal functioning.

Prevention

Since acute kidney failure can be caused by many things, prevention is difficult. Medications that may impair kidney function should be given cautiously. Patients with pre-existing kidney conditions who are hospitalized for other illnesses or injuries should be carefully monitored for kidney failure complications. Treatments and procedures that may put them at risk for kidney failure (like diagnostic tests requiring radiocontrast agents or dyes) should be used with extreme caution.

Resources

BOOKS

Bock, G. H., E. J. Ruley, and M. P. Moore. *A Parent's Guide to Kidney Disorders.* Minneapolis: University of Minnesota Press, 1993.

Brenner, Barry M., and Floyd C. Rector Jr., eds. *The Kidney.* Philadelphia: W. B. Saunders Co., 1991.

Cameron, J. Stewart. *Kidney Failure: The Facts.* New York: Oxford University Press, 1996.

Ross, Linda M., ed. *Kidney and Urinary Tract Diseases and Disorders Sourcebook.* Vol. 21. Detroit: Omnigraphics, Inc., 1997.

PERIODICALS

Stark, June. "Dialysis Choices: Turning the Tide in Acute Renal Failure." *Nursing* 27, no. 2 (Feb. 1997): 41-8.

ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

Paula Anne Ford-Martin

Acute leukemias *see* **Leukemias, acute**

Acute lymphangitis

Definition

Acute lymphangitis is a bacterial infection in the lymphatic vessels which is characterized by painful, red streaks below the skin surface. This is a potentially serious infection which can rapidly spread to the bloodstream and be fatal.

Description

Acute lymphangitis affects a critical member of the immune system—the lymphatic system. Waste materials from nearly every organ in the body drain into the lymphatic vessels and are filtered in small organs called lymph nodes. Foreign bodies, such as bacteria or viruses, are processed in the lymph nodes to generate an immune response to fight an infection.

In acute lymphangitis, bacteria enter the body through a cut, scratch, insect bite, surgical wound, or other skin injury. Once the bacteria enter the lymphatic system, they multiply rapidly and follow the lymphatic vessel like a highway. The infected lymphatic vessel becomes inflamed, causing red streaks that are visible below the skin surface. The growth of the bacteria occurs so rapidly that the immune system does not respond fast enough to stop the infection.

If left untreated, the bacteria can cause tissue destruction in the area of the infection. A pus-filled, painful lump called an **abscess** may be formed in the infected area. **Cellulitis**, a generalized infection of the lower skin layers, may also occur. In addition, the bacteria may invade the bloodstream and cause septicemia. Lay people, for that reason, often call the red streaks seen in the skin "blood poisoning." Septicemia is a very serious illness and may be fatal.

KEY TERMS

Biopsy—The process which removes a sample of diseased or infected tissue for microscopic examination to aid in diagnosis.

Lymphatic system—A component of the immune system consisting of vessels and nodes. Waste materials from organs drain into the lymphatic vessels and are filtered by the lymph nodes.

Septicemia—Disease caused by the presence and growth of bacteria in the bloodstream.

Causes and symptoms

Acute lymphangitis is most often caused by the bacterium *Streptococcus pyogenes*. This potentially dangerous bacterium also causes **strep throat**, infections of the heart, spinal cord, and lungs, and in the 1990s has been called the "flesh-eating bacterium." Staphylococci bacteria may also cause lymphangitis.

Although anyone can develop lymphangitis, some people are more at risk. People who have had radical **mastectomy** (removal of a breast and nearby lymph nodes), a leg vein removed for coronary bypass surgery, or recurrent lymphangitis caused by tinea pedis (a fungal infection on the foot) are at an increased risk for lymphangitis.

The characteristic symptoms of acute lymphangitis are the wide, red streaks which travel from the site of infection to the armpit or groin. The affected areas are red, swollen, and painful. Blistering of the affected skin may occur. The bacterial infection causes a **fever** of 100-104°F (38°–40°C). In addition, a general ill feeling, muscle aches, **headache**, chills, and loss of appetite may be felt.

Diagnosis

If lymphangitis is suspected, the person should call his or her doctor immediately or go to an emergency room. Acute lymphangitis could be diagnosed by the family doctor, infectious disease specialist, or an emergency room doctor. The painful, red streaks just below the skin surface and the high fever are diagnostic of acute lymphangitis. A sample of blood would be taken for culture to determine whether the bacteria have entered the bloodstream. A biopsy (removal of a piece of infected tissue) sample may be taken for culture to identify which type of bacteria is causing the infection. Diagnosis is immediate because it is based primarily on the symptoms. Most insurance policies should cover the expenses for the diagnosis and treatment of acute lymphangitis.

Treatment

Because of the serious nature of this infection, treatment would begin immediately even before the bacterial culture results were available. The only treatment for acute lymphangitis is to give very large doses of an antibiotic, usually penicillin, through the vein. Growing streptococcal bacteria are usually eliminated rapidly and easily by penicillin. The antibiotic clindamycin may be included in the treatment to kill any streptococci which are not growing and are in a resting state. Alternatively, a "broad spectrum" antibiotic may be used which would kill many different kinds of bacteria.

Aspirin or other medications which reduce the **pain** and the fever may also be given. Medications which reduce any inflammation of the infected region may also be provided. The patient is likely to be hospitalized to administer the antibiotic and other medications and to closely monitor his or her condition. Surgical drainage of an abscess may be necessary.

Prognosis

Complete recovery is expected if antibiotic treatment is begun at an early stage of the infection. However, if untreated, acute lymphangitis can be a very serious and even deadly disease. Acute lymphangitis that goes untreated can spread, causing tissue damage. Extensive tissue damage would need to be repaired by plastic surgery. Spread of the infection into the bloodstream could be fatal.

Prevention

Although acute lymphangitis can occur in anyone, good hygiene and general health may help to prevent infections.

Resources

PERIODICALS

Dajer, Tony. "A Lethal Scratch." *Discover* (Feb. 1998): 34-7.

Belinda Rowland, PhD

Acute pericarditis *see* **Pericarditis**

Acute poststreptococcal glomerulonephritis

Definition

Acute poststreptococcal **glomerulonephritis** (APSGN) is an inflammation of the kidney tubules (glomeruli) that filter waste products from the blood, following a streptococcal infection such as **strep throat**. APSGN is also called postinfectious glomerulonephritis.

Description

APSGN develops after certain streptococcal bacteria (group A beta-hemolytic streptococci) have infected the skin or throat. Antigens from the dead streptococci clump together with the antibodies that killed them. These clumps are trapped in the kidney tubules, cause the tubules to become inflamed, and impair that organs' ability to filter and eliminate body wastes. The onset of APSGN usually occurs one to six weeks (average two weeks) after the streptococcal infection.

APSGN is a relatively uncommon disease affecting about one of every 10,000 people, although four or five times that many may actually be affected by it but show no symptoms. APSGN is most prevalent among boys between the ages of 3 and 7, but it can occur at any age.

Causes and symptoms

Frequent sore throats and a history of streptococcal infection increase the risk of acquiring APSGN. Symptoms of APSGN include:

- fluid accumulation and tissue swelling (**edema**) initially in the face and around the eyes, later in the legs
- low urine output (oliguria)
- blood in the urine (hematuria)
- protein in the urine (proteinuria)
- high blood pressure
- joint **pain** or stiffness

KEY TERMS

Streptococcus—A gram-positive, round or oval bacteria in the genus *Streptococcus*. Group A streptococci cause a number of human diseases including strep throat, impetigo, and ASPGN.

Diagnosis

Diagnosis of APSGN is made by taking the patient's history, assessing his/her symptoms, and performing certain laboratory tests. **Urinalysis** usually shows blood and protein in the urine. Concentrations of urea and creatinine (two waste products normally filtered out of the blood by the kidneys) in the blood are often high, indicating impaired kidney function. A reliable, inexpensive blood test called the anti-streptolysin-O test can confirm that a patient has or has had a streptococcal infection. A **throat culture** may also show the presence of group A beta-hemolytic streptococci.

Treatment

Treatment of ASPGN is designed to relieve the symptoms and prevent complications. Some patients are advised to stay in bed until they feel better and to restrict fluid and salt intake. **Antibiotics** may be prescribed to kill any lingering streptococcal bacteria, if their presence is confirmed. Antihypertensives may be given to help control high blood pressure and **diuretics** may be used to reduce fluid retention and swelling. **Kidney dialysis** is rarely needed.

Prognosis

Most children (up to 95%) fully recover from APSGN in a matter of weeks or months. Most adults (up to 70%) also recover fully. In those who do not recover fully, chronic or progressive problems of kidney function may occur. Kidney failure may result in some patients.

Prevention

Receiving prompt treatment for **streptococcal infections** may prevent APSGN.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

ORGANIZATIONS

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

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Acute respiratory distress syndrome *see* **Adult respiratory distress syndrome**

Acute stress disorder

KEY TERMS

Depersonalization—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

Derealization—A dissociative symptom in which the external environment is perceived as unreal.

Dissociation—A reaction to trauma in which the mind splits off certain aspects of the trauma from conscious awareness. Dissociation can affect the patient's memory, sense of reality, and sense of identity.

Trauma—In the context of ASD, a disastrous or life-threatening event.

Definition

Acute **stress** disorder (ASD) is an **anxiety** disorder characterized by a cluster of dissociative and anxiety symptoms occurring within one month of a traumatic event. (Dissociation is a psychological reaction to trauma in which the mind tries to cope by "sealing off" some features of the trauma from conscious awareness).

Description

Acute stress disorder is a new diagnostic category that was introduced in 1994 to differentiate time-limited reactions to trauma from **post-traumatic stress disorder** (PTSD).

Causes and symptoms

Acute stress disorder is caused by exposure to trauma, which is defined as a stressor that causes intense fear and, usually, involves threats to life or serious injury to oneself or others. Examples are rape, mugging, combat, natural disasters, etc.

The symptoms of stress disorder include a combining of one or more dissociative and anxiety symptoms with the avoidance of reminders of the traumatic event. Dissociative symptoms include emotional detachment, temporary loss of memory, depersonalization, and derealization.

Anxiety symptoms connected with acute stress disorder include irritability, physical restlessness, sleep problems, inability to concentrate, and being easily startled.

Diagnosis

Diagnosis of acute stress disorder is based on a combination of the patient's history and a **physical examination** to rule out diseases that can cause anxiety. The essential feature is a traumatic event within one month of the onset of symptoms. Other diagnostic criteria include:

- The symptoms significantly interfere with normal social or vocational functioning
- The symptoms last between two days and four weeks.

Treatment

Treatment for acute stress disorder usually includes a combination of antidepressant medications and short-term psychotherapy.

Alternative treatment

Acupuncture has been recommended as a treatment for acute stress disorder. Some other alternative approaches, including **meditation**, breathing exercises, and **yoga**, may be helpful when combined with short-term psychotherapy. Homeopathic treatment and the use of herbal medicine and flower essences also can help the person with acute stress disorder rebalance on the physical, mental, and emotional levels.

Prognosis

The prognosis for recovery is influenced by the severity and duration of the trauma, the patient's closeness to it, and the patient's previous level of functioning. Favorable signs include a short time period between the trauma and onset of symptoms, immediate treatment, and appropriate social support. If the patient's symptoms are severe enough to interfere with normal life and have lasted longer than one month, the diagnosis may be changed to PTSD. If the symptoms have lasted longer than one month but are

not severe enough to meet the definition of PTSD, the diagnosis may be changed to adjustment disorder.

Patients who do not receive treatment for acute stress disorder are at increased risk for substance abuse or major **depressive disorders**.

Prevention

Traumatic events cannot usually be foreseen and, thus, cannot be prevented. However, in theory, professional intervention soon after a major trauma might reduce the likelihood or severity of ASD. In addition, some symptoms of acute stress disorder result from biochemical changes in the central nervous system, muscles, and digestive tract that are not subject to conscious control.

Resources

BOOKS

"Acute Stress Disorder." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Corbman, Gene R. "Anxiety Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Kabat-Zinn, Jon. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness*. New York: Bantam Doubleday Dell Publishing Group, Inc., 1990.

"On-Call Problems: Insomnia." In *Surgery On Call*, ed. Leonard G. Gomella and Alan T. Lefor. Stamford: Appleton & Lange, 1996.

Rebecca J. Frey

Acute stress gastritis *see* **Gastritis**

Acute transverse myelitis *see* **Transverse myelitis**

Acyclovir *see* **Antiviral drugs**

Addiction

Definition

Addiction is a dependence on a behavior or substance that a person is powerless to stop. The term has been partially replaced by the word *dependence* for substance abuse. Addiction has been extended, however, to include mood-altering behaviors or activities. Some researchers speak of two types of addictions: substance addictions (for example, **alcoholism**, drug abuse, and **smoking**); and process addictions (for example, gambling, spending, shopping, eating, and sexual activity). There is a growing recognition that many addicts, such as polydrug abusers, are addicted to more than one substance or process.

Description

Addiction is one of the most costly public health problems in the United States. It is a progressive syndrome, which means that it increases in severity over time unless it is treated. Substance abuse is characterized by frequent relapse, or return to the abused substance. Substance abusers often make repeated attempts to quit before they are successful.

In 1995 the economic cost of substance abuse in the United States exceeded $414 billion, with health care costs attributed to substance abuse estimated at more than $114 billion.

By eighth grade, 52% of adolescents have consumed alcohol, 41% have smoked tobacco, and 20% have smoked marijuana. Compared to females, males are almost four times as likely to be heavy drinkers, nearly one and a half more likely to smoke a pack or more of cigarettes daily, and twice as likely to smoke marijuana weekly. However, among adolescents these gender differences are decreasing. Although frequent use of tobacco, **cocaine** and heavy drinking appears to have remained stable in the 1990s, marijuana use increased.

In 1999, an estimated four million Americans over the age of 12 used prescription **pain** relievers, sedatives, and stimulants for "nonmedical" reasons during one month.

In the United States, 25% of the population regularly uses tobacco. Tobacco use reportedly kills 2.5 times as many people each year as alcohol and drug abuse combined. According to 1998 data from the World Health Organization, there were 1.1 billion smokers worldwide and 10,000 tobacco-related deaths per day. Furthermore, in the United States, 43% of children aged 2-11 years are exposed to environmental tobacco smoke, which has been implicated in **sudden infant death syndrome**, low birth weight, **asthma**, middle ear disease, **pneumonia**, **cough**, and upper respiratory infection.

Eating disorders, such as **anorexia nervosa**, **bulimia nervosa**, and binge eating, affect over five million American women and men. Fifteen percent of young women have substantially disordered attitudes toward eating and eating behaviors. More than 1,000 women die each year from anorexia nervosa.

A 1997 Harvard study found that an estimated 15.4 million Americans suffered from a gambling addiction. Over half that number (7.9 million) were adolescents.

Causes and symptoms

Addiction to substances results from the interaction of several factors:

Drug chemistry

Some substances are more addictive than others, either because they produce a rapid and intense change in mood; or because they produce painful withdrawal symptoms when stopped suddenly.

Genetic factor

Some people appear to be more vulnerable to addiction because their body chemistry increases their sensitivity to drugs. Some forms of **substance abuse and dependence** seem to run in families; and this may be the result of a genetic predisposition, environmental influences, or a combination of both.

Brain structure and function

Using drugs repeatedly over time changes brain structure and function in fundamental and long-lasting ways. Addiction comes about through an array of changes in the brain and the strengthening of new memory connections. Evidence suggests that those long-lasting brain changes are responsible for the distortions of cognitive and emotional functioning that characterize addicts, particularly the compulsion to use drugs. Although the causes of addiction remain the subject of ongoing debate and research, many experts now consider addiction to be a brain disease: a condition caused by persistent changes in brain structure and function. However, having this brain disease does not absolve the addict of responsibility for his or her behavior, but it does explain why many addicts cannot stop using drugs by sheer force of will alone.

Social learning

Social learning is considered the most important single factor. It includes patterns of use in the addict's family or subculture, peer pressure, and advertising or media influence.

Availability

Inexpensive or readily available tobacco, alcohol, or drugs produce marked increases in rates of addiction.

Crack users. Crack, a form of cocaine, is one of the most addictive drugs. *(Photograph by Roy Marsch, The Stock Market. Reproduced by permission.)*

Individual development

Before the 1980s, the so-called addictive personality was used to explain the development of addiction. The addictive personality was described as escapist, impulsive, dependent, devious, manipulative, and self-centered. Many doctors now believe that these character traits develop in addicts as a result of the addiction, rather than the traits being a cause of the addiction.

Diagnosis

In addition to a preoccupation with using and acquiring the abused substance, the diagnosis of addiction is based on five criteria:

- loss of willpower
- harmful consequences
- unmanageable lifestyle
- tolerance or escalation of use
- withdrawal symptoms upon quitting

Treatment

Treatment requires both medical and social approaches. Substance addicts may need hospital treatment to manage withdrawal symptoms. Individual or group psychotherapy is often helpful, but only after substance use has stopped. Anti-addiction medications, such as **methadone** and naltrexone, are also commonly used.

The most frequently recommended social form of outpatient treatment is the twelve-step program. Such programs are also frequently combined with psychotherapy. According to a recent study reported by the American Psychological Association (APA), anyone, regardless of his or her religious beliefs or lack of religious beliefs, can benefit from participation in 12-step programs such as Alcoholics Anonymous (AA) or Narcotics Anonymous (NA). The number of visits to 12-step self-help groups exceeds the number of visits to all mental health professionals combined. There are twelve-step groups for all major substance and process addictions.

The Twelve Steps are:

- Admit powerlessness over the addiction.
- Believe that a Power greater than oneself could restore sanity.
- Make a decision to turn your will and your life over to the care of God, as you understand him.
- Make a searching and fearless moral inventory of self.
- Admit to God, yourself, and another human being the exact nature of your wrongs.
- Become willing to have God remove all these defects from your character.
- Humbly ask God to remove shortcomings.
- Make a list of all persons harmed by your wrongs and become willing to make amends to them all.
- Make direct amends to such people, whenever possible except when to do so would injure them or others.
- Continue to take personal inventory and promptly admit any future wrongdoings.
- Seek to improve contact with a God of the individual's understanding through **meditation** and prayer.
- Carry the message of spiritual awakening to others and practice these principles in all your affairs.

Alternative treatment

Acupuncture and **homeopathy** have been used to treat withdrawal symptoms. Meditation, **yoga**, and **reiki** healing have been recommended for process addictions, however, the success of these programs has not been well documented through controlled studies.

KEY TERMS

Addiction—Dependence on a habit-forming substance or behavior that the person is powerless to stop.

Addictive personality—A concept that was formerly used to explain addiction as the result of pre-existing character defects in individuals.

Process addiction—Addiction to certain mood-altering behaviors, such as eating disorders, gambling, sexual activity, overwork, and shopping.

Tolerance—A condition in which an addict needs higher doses of a substance to achieve the same effect previously achieved with a lower dose.

Withdrawal—The unpleasant, sometimes life-threatening physiological changes that occur, due to the discontinuation of use of some drugs after prolonged, regular use.

Prognosis

The prognosis for recovery from any addiction depends on the substance or process, the individual's circumstances, and underlying personality structure. Polydrug users have the worst prognosis for recovery.

Prevention

The most effective form of prevention appears to be a stable family that models responsible attitudes toward mood-altering substances and behaviors. Prevention education programs are also widely used to inform the public of the harmfulness of substance abuse.

Resources

BOOKS

"Psychiatric Disorders: Drug Dependence." In *The Merck Manual of Diagnosis and Therapy.* Vol. 1. Ed. Robert Berkow, et al. Rahway, N.J.: Merck Research Laboratories, 1992.

Robert Wood Johnson Foundation. *Substance Abuse: The Nation's #1 Problem.* Princeton, N.J., 2001.

PERIODICALS

Kalivas, Peter. "Drug Addiction: To the Cortex..and beyond" *The American Journal of Psychiatry* volume 158, issue 3, (March 2001).

Kelly, Timothy. "Addiction: A Booming $800 Billion Industry. *The World and I* (July 1, 2000).

Leshner, Alan. "Addiction is a Brain Disease" *Issues in Science and Technology* volume 17, issue 3, (April 1, 2001).

Mattas-Curry, L. "12-step self-help programs proved successful regardless of participants' religious background, study

suggests." *APA Monitor Online*. volume 30, number 11, (December 1999). <http://www.apa.org/monitor/>.

ORGANIZATIONS

Al-Anon Family Groups. Box 182, Madison Square Station, New York, NY 10159. <http://www.Al-Anon Alateen.org>.
Alcoholics Anonymous World Services, Inc. Box 459, Grand Central Station, New York, NY 10163. <http://www.alcoholics-anonymous.org>.
American Anorexia Bulimina Association. <http://www.aabainc.org/>.
American Psychiatric Association. <http://www.pscyh.org>.
Center for On-Line Addiction. <http://www.netaddiction.com/>.
eGambling: Electronic Joural of Gambling Issues. <http://www.camh.net/egambling/main.html>.
National Center on Addiction and Substance Abuse at Columbia University. <http://www.casacolumbia.org/>.
National Alliance on Alcoholism and Drug Dependence, Inc. 12 West 21st St., New York, NY 10010. (212)206-6770.
National Clearinghouse for Alcohol and Drug Information. <http://www.health.org>.
National Institute on Alcohol Abuse and Alcoholism (NIAAA) 6000 Executive Boulevard, Bethesda, Maryland 20892-7003. <http://www.niaaa.nih.gov>.

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Addison's disease

Definition

Addison's disease is a disorder involving disrupted functioning of the part of the adrenal gland called the cortex. This results in decreased production of two important chemicals (hormones) normally released by the adrenal cortex: cortisol and aldosterone.

Description

The adrenals are two glands, each perched on the upper part of the two kidneys. The outer part of the gland is known as the cortex; the inner part is known as the medulla. Each of these parts of the adrenal gland is responsible for producing different types of hormones.

Cortisol is a very potent hormone produced by the adrenal cortex. It is involved in regulating the functioning of nearly every type of organ and tissue throughout the body, and is considered to be one of the few hormones absolutely necessary for life. Cortisol is involved in:

- the very complex processing and utilization of many nutrients, including sugars (carbohydrates), fats, and proteins
- the normal functioning of the circulatory system and the heart

KEY TERMS

Gland—A collection of cells whose function is to release certain chemicals, or hormones, which are important to the functioning of other, sometimes distantly located, organs or body systems.

Hormone—A chemical produced in one part of the body, which travels to another part of the body in order to exert its effect.

- the functioning of muscles
- normal kidney function
- production of blood cells
- the normal processes involved in maintaining the skeletal system
- proper functioning of the brain and nerves
- the normal responses of the immune system

Aldosterone, also produced by the adrenal cortex, plays a central role in maintaining the appropriate proportions of water and salts in the body. When this balance is upset, the volume of blood circulating throughout the body will fall dangerously low, accompanied by a drop in blood pressure.

Addison's disease is also called primary adrenocortical insufficiency. In other words, some process interferes directly with the ability of the adrenal cortex to produce its hormones. Levels of both cortisol and aldosterone drop, and numerous functions throughout the body are disrupted.

Addison's disease occurs in about four in every 100,000 people. It strikes both men and women of all ages.

Causes and symptoms

The most common cause of Addison's disease is the destruction and/or shrinking (atrophy) of the adrenal cortex. In about 70% of all cases, this atrophy is believed to occur due to an autoimmune disorder. In an autoimmune disorder, the immune system of the body, responsible for identifying foreign invaders such as viruses or bacteria and killing them, accidentally begins to identify the cells of the adrenal cortex as foreign, and destroy them. In about 20% of all cases, destruction of the adrenal cortex is caused by **tuberculosis**. The remaining cases of Addison's disease may be caused by fungal infections, such as **histoplasmosis**, coccidiomycosis, and **cryptococcosis**, which affect the adrenal gland by producing destructive, tumor-like masses

called granulomas; a disease called **amyloidosis**, in which a starchy substance called amyloid is deposited in abnormal places throughout the body, interfering with the function of whatever structure it is present within; or invasion of the adrenal glands by **cancer**.

In about 75% of all patients, Addison's disease tends to be a very gradual, slowly developing disease. Significant symptoms are not noted until about 90% of the adrenal cortex has been destroyed. The most common symptoms include **fatigue** and loss of energy, decreased appetite, nausea, vomiting, **diarrhea**, abdominal **pain**, weight loss, muscle weakness, **dizziness** when standing, **dehydration**, unusual areas of darkened (pigmented) skin, and dark freckling. As the disease progresses, the patient may appear to have very tanned, or bronzed skin, with darkening of the lining of the mouth, vagina, and rectum, and dark pigmentation of the area around the nipples (aereola). As dehydration becomes more severe, the blood pressure will continue to drop and the patient will feel increasingly weak and light-headed. Some patients have psychiatric symptoms, including depression and irritability. Women lose pubic and underarm hair, and stop having normal menstrual periods.

When a patient becomes ill with an infection, or stressed by an injury, the disease may suddenly and rapidly progress, becoming life-threatening. Symptoms of this "Addisonian crisis" include abnormal heart rhythms, severe pain in the back and abdomen, uncontrollable **nausea and vomiting**, a drastic drop in blood pressure, kidney failure, and unconsciousness. About 25% of all Addison's disease patients are identified due to the development of Addisonian crisis.

Diagnosis

Many patients do not recognize the slow progression of symptoms and the disease is ultimately identified when a physician notices the areas of increased pigmentation of the skin. Once suspected, a number of blood tests can lead to the diagnosis of Addison's disease. It is not sufficient to demonstrate low blood cortisol levels, as normal levels of cortisol vary quite widely. Instead, patients are given a testing dose of another hormone called corticotropin (ACTH). ACTH is produced in the body by the pituitary gland, and normally acts by promoting growth within the adrenal cortex and stimulating the production and release of cortisol. In Addison's disease, even a dose of synthetic ACTH does not increase cortisol levels.

To distinguish between primary adrenocortical insufficiency (Addison's disease) and secondary adrenocortical insufficiency (caused by failure of the pituitary to produce enough ACTH), levels of ACTH in the blood are examined. Normal or high levels of ACTH indicate that the pituitary is working properly, but the adrenal cortex is not responding normally to the presence of ACTH. This confirms the diagnosis of Addison's disease.

Treatment

Treatment of Addison's disease involves replacing the missing or low levels of cortisol. In the case of Addisonian crisis, this will be achieved by injecting a potent form of steroid preparation through a needle placed in a vein (intravenous or IV). Dehydration and salt loss will also be treated by administering carefully balanced solutions through the IV. Dangerously low blood pressure may require special medications to safely elevate it until the steroids take effect.

Patients with Addison's disease will need to take a steroid preparation (hydrocortisone) and a replacement for aldosterone (fludrocortisone) by mouth for the rest of their lives. When a patient has an illness which causes nausea and vomiting (such that they cannot hold down their medications), he or she will need to enter a medical facility where IV medications can be administered. When a patient has any kind of infection or injury, the normal dose of hydrocortisone will need to be doubled.

Prognosis

Prognosis for patients appropriately treated with hydrocortisone and aldosterone is excellent. These patients can expect to enjoy a normal lifespan. Without treatment, or with substandard treatment, patients are always at risk of developing Addisonian crisis.

Resources

BOOKS

Williams, Gordon H., and Robert G. Dluhy. "Hypofunction of the Adrenal Cortex." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Brosnan, C. M., and N. F. C. Gowing. "Addison's Disease." *British Medical Journal* 312, no. 7038 (27 Apr. 1996): 1085+.

Oelkers, Wolfgang. "Adrenal Insufficiency." *New England Journal of Medicine* 335, no. 16 (17 Oct. 1996): 1206+.

ORGANIZATIONS

National Adrenal Disease Foundation. 505 Northern Boulevard, Suite 200, Great Neck, NY 11021. (516) 487-4992.

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Adenoid hyperplasia

Definition

Adenoid hyperplasia is the overenlargement of the lymph glands located above the back of the mouth.

Description

Located at the back of the mouth above and below the soft palate are two pairs of lymph glands. The tonsils below are clearly visible behind the back teeth; the adenoids lie just above them and are hidden from view by the palate. Together these four arsenals of immune defense guard the major entrance to the body from foreign invaders—the germs we breathe and eat. In contrast to the rest of the body's tissues, lymphoid tissue reaches its greatest size in mid-childhood and recedes thereafter. In this way children are best able to develop the immunities they need to survive in a world full of infectious diseases.

Beyond its normal growth pattern, lymphoid tissue grows excessively (hypertrophies) during an acute infection, as it suddenly increases its immune activity to fight off the invaders. Often it does not completely return to its former size. Each subsequent infection leaves behind a larger set of tonsils and adenoids. To make matters worse, the sponge-like structure of these hypertrophied glands can produce safe havens for germs where the body cannot reach and eliminate them. Before **antibiotics** and the reduction in infectious childhood diseases over the past few generations, tonsils and adenoids caused greater health problems.

Causes and symptoms

Most tonsil and adenoid hypertrophy is simply caused by the normal growth pattern for that type of tissue. Less often, the hypertrophy is due to repeated throat infections by cold viruses, **strep throat**, mononucleosis, and in times gone by, **diphtheria**. The acute infections are usually referred to as **tonsillitis**, the adenoids getting little recognition because they cannot be seen without special instruments. Symptoms include painful, bright red, often ulcerated tonsils, enlargement of lymph nodes (glands) beneath the jaw, **fever**, and general discomfort.

After the acute infection subsides, symptoms are generated simply by the size of the glands. Extremely large tonsils can impair breathing and swallowing, although that is quite rare. Large adenoids can impair nose breathing and require a child to breathe through the mouth. Because they encircle the only connection between the middle ear and the eustachian tube, hypertrophied adenoids can also obstruct it and cause middle ear infections.

KEY TERMS

Eustacian tube—A tube connecting the middle ear with the back of the nose, allowing air pressure to equalize within the ear whenever it opens, such as with yawning.

Hyperplastic—Overgrown.

Hypertrophy—Overgrowth.

Strep throat—An infection of the throat caused by bacteria of the *Streptococcus* family, which causes tonsillitis.

Ulcerated—Damaged so that the surface tissue is lost and/or necrotic (dead).

Diagnosis

A simple tongue blade depressing the tongue allows an adequate view of the tonsils. Enlarged tonsils may have deep pockets (crypts) containing dead tissue (necrotic debris). Viewing adenoids requires a small mirror or fiberoptic scope. A child with recurring middle ear infections may well have large adenoids. A **throat culture** or mononucleosis test will usually reveal the identity of the germ.

Treatment

It used to be standard practice to remove tonsils and/or adenoids after a few episodes of acute throat or ear infection. The surgery is called **tonsillectomy and adenoidectomy** (T and A). Opinion changed as it was realized that this tissue is beneficial to the development of immunity. For instance, children without tonsils and adenoids produce only half the immunity to oral **polio** vaccine. In addition, treatment of ear and throat infections with antibiotics and of recurring ear infections with surgical drainage through the ear drum (tympanostomy) has greatly reduced the incidence of surgical removal of these lymph glands.

Alternative treatment

There are many botanical/herbal remedies that can be used alone or in formulas to locally assist the tonsils and adenoids in their immune function at the opening of the oral cavity and to tone these glands. Keeping the Eustachian tubes open is an important contribution to optimal function in the tonsils and adenoids. Food **allergies** are often the culprits for recurring ear infections, as well as tonsilitis and adenoiditis. Identification and removal of the allergic food(s) can greatly assist in alle-

viating the cause of the problem. Acute tonsillitis also benefits from warm saline gargles.

Prognosis

Hypertrophied adenoids are a normal part of growing up and should be respected for their important role in the development of immunity. Only when their size causes problems by obstructing breathing or middle ear drainage do they demand intervention.

Prevention

Prevention can be directed toward prompt evaluation and appropriate treatment of sore throats to prevent overgrowth of adenoid tissue. Avoiding other children with acute respiratory illness will also reduce the spread of these common illnesses.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of the Nose, Throat, Ear, Head, and Neck.* Philadelphia: Lea & Febiger, 1991.

"Otitis Media with Effusion." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

"Tonsils and Adenoids." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Weil, Andrew. *Natural Health, Natural Medicine.* Boston: Houghton Mifflin Co., 1995.

PERIODICALS

Laliberte, Richard. "The Tonsils Controversy." *Parents Magazine*, (Dec. 1995): 38.

J. Ricker Polsdorfer, MD

Adenoid hypertrophy *see* **Adenoid hyperplasia**

Adenoid removal *see* **Tonsillectomy and adenoidectomy**

Adenoidectomy *see* **Tonsillectomy and adenoidectomy**

Adenovirus infections

Definition

Adenoviruses are DNA viruses (small infectious agents) that cause upper respiratory tract infections, **conjunctivitis**, and other infections in humans.

Description

Adenoviruses were discovered in 1953. About 47 different types have been identified since then, and about half of them are believed to cause human diseases. Infants and children are most commonly affected by adenoviruses. Adenovirus infections can occur throughout the year, but seem to be most common from fall to spring.

Adenoviruses are responsible for 3-5% of acute respiratory infections in children and 2% of respiratory illnesses in civilian adults. They are more apt to cause infection among military recruits and other young people who live in institutional environments. Outbreaks among children are frequently reported at boarding schools and summer camps.

Acquired immunity

Most children have been infected by at least one adenovirus by the time they reach school age. Most adults have acquired immunity to multiple adenovirus types due to infections they had as children.

In one mode of adenovirus infection (called lytic infection because it destroys large numbers of cells), adenoviruses kill healthy cells and replicate up to one million new viruses per cell killed (of which 1-5% are infectious). People with this kind of infection feel sick. In chronic or latent infection, a much smaller number of viruses are released and healthy cells can multiply more rapidly than they are destroyed. People who have this kind of infection don't seem to be sick. This is probably why many adults have immunity to adenoviruses without realizing they have been infected.

Childhood infections

In children, adenoviruses most often cause acute upper respiratory infections with **fever** and runny nose. Adenovirus types 1, 2, 3,5, and 6 are responsible for most of these infections. Occasionally more serious lower respiratory diseases, such as **pneumonia**, may occur.

Adenoviruses also cause acute pharyngoconjunctival fever in children. This disease is most often caused by types 3 and 7. Symptoms, which appear suddenly and usually disappear in less than a week, include:

- inflammation of the lining of the eyelid (conjunctivitis)
- fever
- **sore throat** (pharyngitis)
- runny nose
- inflammation of lymph glands in the neck (cervical adenitis)

Adenoviruses also cause acute **diarrhea** in young children, characterized by fever and watery stools. This condition is caused by adenovirus types 40 and 41 and can last as long as two weeks.

As much as 51% of all hemorrhagic **cystitis** (inflammation of the bladder and of the tubes that carry urine to the bladder from the kidneys) in American and Japanese children can be attributed to adenovirus infection. A child who has hemorrhagic cystitis has bloody urine for about three days, and invisible traces of blood can be found in the urine a few days longer. The child will feel the urge to urinate frequently—but find it difficult to do so—for about the same length of time.

Adult infections

In adults, the most frequently reported adenovirus infection is acute respiratory disease (ARD, caused by types 4 and 7) in military recruits. Influenza-like symptoms including fever, sore throat, runny nose, and **cough** are almost always present; weakness, chills, **headache**, and swollen lymph glands in the neck may also occur. The symptoms typically last three to five days.

Epidemic keratoconjunctivitis (EKC, caused by adenovirus types 8, 19, and 37) was first seen in shipyard workers whose eyes had been slightly injured by chips of rust or paint. This inflammation of tissues lining the eyelid and covering the front of the eyeball can also be caused by using contaminated contact lens solutions or by drying the hands or face with a towel used by someone who has this infection.

The inflamed, sticky eyelids characteristic of conjunctivitis develop 4-24 days after exposure and last between one and four weeks. Only 5-8% of patients with epidemic keratoconjunctivitis experience respiratory symptoms. One or both eyes may be affected. As symptoms of conjunctivitis subside, eye **pain** and watering and blurred vision develop. These symptoms of **keratitis** may last for several months, and about 10% of these infections spread to at least one other member of the patient's household.

Other illnesses associated with adenovirus include:

- encephalitis (inflammation of the brain) and other infections of the central nervous system (CNS)
- gastroenteritis (inflammation of the stomach and intestines)
- acute mesenteric **lymphadenitis** (inflammation of lymph glands in the abdomen)
- chronic interstitial fibrosis (abnormal growth of connective tissue between cells)
- intussusception (a type of intestinal obstruction)

KEY TERMS

Conjunctivitis—Inflammation of the conjunctiva, the mucous membrane lining the inner surfaces of the eyelid and the front of the eyeball.

Virus—A small infectious agent consisting of a core of genetic material (DNA or RNA) surrounded by a shell of protein.

- pneumonia that doesn't respond to antibiotic therapy
- **whooping cough** syndrome when *Bordetella pertussis* (the bacterium that causes classic whooping cough) is not found

Causes and symptoms

Specific adenovirus infections can be traced to particular sources and produce distinctive symptoms. In general, however, adenovirus infection is caused by:

- inhaling airborne viruses
- getting the virus in the eyes by swimming in contaminated water, using contaminated eye solutions or instruments, wiping the eyes with contaminated towels, or rubbing the eyes with contaminated fingers.
- not washing the hands after using the bathroom, and then touching the mouth or eyes

Symptoms common to most types of adenovirus infections include:

- cough
- fever
- runny nose
- sore throat
- watery eyes

Diagnosis

Although symptoms may suggest the presence of adenovirus, distinguishing these infections from other viruses can be difficult. A definitive diagnosis is based on culture or detection of the virus in eye secretions, sputum, urine, or stool.

The extent of infection can be estimated from the results of blood tests that measure increases in the quantity of antibodies the immune system produces to fight it. Antibody levels begin to rise about a week after infection occurs and remain elevated for about a year.

Treatment

Treatment of adenovirus infections is usually supportive and aimed at relieving symptoms of the illness. Bed rest may be recommended along with medications to reduce fever and/or pain. (**Aspirin** should not be given to children because of concerns about Reye's syndrome.) Eye infections may benefit from topical **corticosteroids** to relieve symptoms and shorten the course of the disease. Hospitalization is usually required for severe pneumonia in infants and for EKC (to prevent blindness). No effective **antiviral drugs** have been developed.

Prognosis

Adenovirus infections are rarely fatal. Most patients recover fully.

Prevention

Practicing good personal hygiene and avoiding people with infectious illnesses can reduce the risk of developing adenovirus infection. Proper handwashing can prevent the spread of the virus by oral-fecal transmission. Sterilization of instruments and solutions used in the eye can prevent the spread of EKC, as can adequate chlorination of swimming pools.

A vaccine containing live adenovirus types 4 and 7 is used to control disease in military recruits, but it is not recommended or available for civilian use. Vaccines prepared from purified subunits of adenovirus are under investigation.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Mandell, Gerald L., ed., et al. *Principles and Practices of Infectious Diseases*. New York: Churchill Livingstone, 1995.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Maureen Haggerty

Adjustment disorders

Definition

An adjustment disorder is a debilitating reaction, usually lasting less than six months, to a stressful event or situation. It is not the same thing as **post-traumatic stress disorder** (PTSD), which usually occurs in reaction to a life-threatening event and can be longer lasting.

Description

An adjustment disorder usually begins within three months of a stressful event, and ends within six months after the stressor stops. There are many different subtypes of adjustment disorders, including adjustment disorder with:

- depression
- **anxiety**
- mixed anxiety and depression
- conduct disturbances
- mixed disturbance of emotions and conduct
- unspecified

Adjustment disorders are very common and can affect anyone, regardless of gender, age, race, or lifestyle. By definition, an adjustment disorder is short-lived, unless a person is faced with a chronic recurring crisis (such as a child who is repeatedly abused). In such cases, the adjustment disorder may last more than six months.

Causes and symptoms

An adjustment disorder occurs when a person can't cope with a stressful event and develops emotional or behavioral symptoms. The stressful event can be anything: it might be just one isolated incident, or a string of problems that wears the person down. The **stress** might be anything from a car accident or illness, to a divorce, or even a certain time of year (such as Christmas or summer).

People with adjustment disorder may have a wide variety of symptoms. How those symptoms combine depend on the particular subtype of adjustment disorder and on the individual's personality and psychological defenses. Symptoms normally include some (but not all) of the following:

- hopelessness
- sadness
- crying
- anxiety
- worry
- headaches or stomachaches
- withdrawal
- inhibition
- truancy
- vandalism
- reckless driving
- fighting
- other destructive acts

Diagnosis

It is extremely important that a thorough evaluation rule out other more serious mental disorders, since the treatment for adjustment disorder may be very different than for other mental problems.

In order to be diagnosed as a true adjustment disorder, the level of distress must be more severe than what would normally be expected in response to the stressor, or the symptoms must significantly interfere with a person's social, job, or school functioning. Normal expression of grief, in bereavement for instance, is not considered an adjustment disorder.

Treatment

Psychotherapy (counseling) is the treatment of choice for adjustment disorders, since the symptoms are an understandable reaction to a specific stress. The type of therapy depends on the mental health expert, but it usually is short-term treatment that focuses on resolving the immediate problem.

Therapy usually will help clients:

- develop coping skills
- understand how the stressor has affected their lives
- develop alternate social or recreational activities

Family or couples therapy may be helpful in some cases. Medications are not usually used to treat adjustment disorders, although sometimes a few days or weeks of an anti-anxiety drug can control anxiety or sleeping problems.

Self-help groups aimed at a specific problem (such as recovering from divorce or job loss) can be extremely helpful to people suffering from an adjustment disorder. Social support, which is usually an important part of self-help groups, can lead to a quicker recovery.

Prognosis

Most people recover completely from adjustment disorders, especially if they had no previous history of mental problems, and have a stable home life with strong social support. People with progressive or cyclic disorders (such as **multiple sclerosis**) may experience an adjustment disorder with each exacerbation period.

Resources

BOOKS

Horowitz, Mardi J. *Stress Response Syndromes: PTSD, Grief and Adjustment Disorders*. Northvale, NJ: Jason Aronson, 1997.

Luther, Suniya G., Jacob A. Burack, and Dante Cicchetti. *Developmental Psychopathology: Perspectives on Adjustment, Risk, and Disorder*. London: Cambridge University Press, 1997.

KEY TERMS

Multiple sclerosis—A progressive disorder of the central nervous system in which scattered patches of the protective sheath covering the nerves is destroyed. The disease, which causes progressive paralysis, is marked by periods of exacerbation and remission. There is no cure.

Post-traumatic stress disorder (PTSD)—A specific form of anxiety that begins after a life-threatening event, such as rape, a natural disaster, or combat-related trauma.

PERIODICALS

Newcorn, Jeffrey H., and James Strain. "Adjustment Disorder in Children and Adolescents." *Journal of the American Academy of Child and Adolescent Psychiatry* 31 (Mar. 1992): 318-27.

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Adrenal gland cancer

Definition

Adrenal gland cancers are rare cancers occuring in the endocrine tissue of the adrenals. They are characterized by overproduction of adrenal gland hormones.

Description

Cancers of the adrenal gland are very rare. The adrenal gland is a hormone producing endocrine gland with two main parts, the cortex and the medulla. The main hormone of the adrenal cortex is cortisol and the main hormone of the adrenal medulla is epinephrine. When tumors develop in the adrenal gland, they secrete excess amounts of these hormones. A **cancer** that arises in the adrenal cortex is called an adrenocortical carcinoma and can produce high blood pressure, weight gain, excess body hair, weakening of the bones and diabetes. A cancer in the adrenal medulla is called a **pheochromocytoma** and can cause high blood pressure, **headache**, **palpitations**, and excessive perspiration. Although these cancers can happen at any age, most occur in young adults.

Causes and symptoms

It is not known what causes adrenal gland cancer, but some cases are associated with hereditary diseases.

KEY TERMS

Cortisol—A hormone produced by the adrenal cortex. It is partially responsible for regulating blood sugar levels.

Diabetes—A disease characterized by low blood sugar.

Epinephrine—A hormone produced by the adrenal medulla. It is important in the response to stress and partially regulates heart rate and metabolism. It is also called adrenaline.

Laparoscopy—The insertion of a tube through the abdominal wall. It can be used to visualize the inside of the abdomen and for surgical procedures.

Symptoms of adrenal cancer are related to the specific hormones produced by that tumor. An adrenocortical carcinoma typically secretes high amounts of cortisol, producing **Cushing's Syndrome**. This syndrome produces progressive weight gain, rounding of the face, and increased blood pressure. Women can experience menstrual cycle alterations and men can experience feminization. The symptoms for pheochromocytoma include **hypertension**, acidosis, unexplained **fever** and weight loss. Because of the hormones produced by this type of tumor, **anxiety** is often a feature also.

Diagnosis

Diagnosis for adrenal cancer usually begins with blood tests to evaluate the hormone levels. These hormones include epinephrine, cortisol, and testosterone. It also includes **magnetic resonance imaging**, and **computed tomography scans** to determine the extent of the disease. Urine and blood tests can be done to detect the high levels of hormone secreted by the tumor.

Treatment

Treatment is aimed at removing the tumor by surgery. In some cases, this can be done by **laparoscopy**. Surgery is sometimes followed by **chemotherapy** and/or **radiation therapy**. Because the surgery removes the source of many important hormones, hormones must be supplemented following surgery. If adrenocortical cancer recurs or has spread to other parts of the body (metastasized), additional surgery may be done followed by chemotherapy using the drug mitotane.

Alternative treatment

As with any form of cancer, all conventional treatment options should be considered and applied as appropriate. Nutritional support, as well as supporting the functioning of the entire person diagnosed with adrenal gland cancer through homeopathic medicine, **acupuncture**, vitamin and mineral supplementation, and herbal medicine, can benefit recovery and enhance quality of life.

Prognosis

The prognosis for adrenal gland cancer is variable. For localized pheochromocytomas the 5-year survival rate is 95%. This rate decreases with aggressive tumors that have metastasized. The prognosis for adrenal cortical cancer is not as good with a 5-year survival rate of 10-35%.

Prevention

Since so little is known about the cause of adrenal gland cancer, it is not known if it can be prevented.

Resources

BOOKS

Norton, J. A. "Adrenal Tumors." In *Cancer, Principles and Practice of Oncology.* Ed. V. T. DeVita, S. Hellman, and S. A. Rosenberg. Philadelphia: Lippincott-Raven, 1997.

OTHER

Endocrine Web. <http://www.endocrineweb.com>.

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Adrenal gland removal *see* **Adrenalectomy**

Adrenal gland scan

Definition

The adrenal gland scan is a nuclear medicine evaluation of the medulla (inner tissue) of the adrenal gland.

Purpose

The adrenal glands are a pair of small organs located just above the kidney, which contain two types of tissue. The adrenal cortex produces hormones that affect water balance and metabolism in the body. The adrenal medulla produces adrenaline and noradrenaline (also called epinepherine and norepinepherine).

An adrenal gland scan is done when too much adrenaline and noradrenaline is produced in the body and

a tumor in the adrenal gland is suspected. One such situation in which a tumor might be suspected is when high blood pressure (**hypertension**) does not respond to medication. Tumors that secrete adrenaline and noradrenaline can also be found outside the adrenal gland. An adrenal gland scan usually covers the abdomen, chest, and head.

Precautions

Adrenal gland scans are not recommended for pregnant women because of the potential harm to the developing fetus. A pregnant woman should discuss with her doctor the risks of the procedure against the benefits of the information it can provide in evaluating her individual medical situation.

People who have recently undergone tests that use barium must wait until the barium has been eliminated from their system in order to obtain accurate results from the adrenal gland scan.

Description

The adrenal gland scan takes several days. On the first day, a radiopharmaceutical is injected intravenously into the patient. On the second, third, and fourth day the patient is positioned under the camera for imaging. The scanning time each day takes approximately 30 minutes. It is essential that the patient remain still during imaging.

Occasionally, the scanning process may involve fewer than three days, or it may continue several days longer. The area scanned extends from the pelvis and lower abdomen to the lower chest. Sometimes the upper legs, thighs, and head are also included.

Preparation

For two days before and ten days after the injection of the radiopharmaceutical, patients are given either Lugol's solution or potassium iodine. This prevents the thyroid from taking up radioactive iodine and interfering with the scan.

Aftercare

The patient should not feel any adverse effects of the test and can resume normal activity immediately. Follow-up tests that might be ordered include a nuclear scan of the bones or kidney, a computed tomography scan (CT) of the adrenals, or an ultrasound of the pelvic area.

Risks

The main risk associated with this test is to the fetus of a pregnant woman.

KEY TERMS

Adrenal cortex—The outer tissue of the adrenal gland. It produces a group of chemically related hormones called corticosteroids that control mineral and water balance in the body and include aldosterone and cortisol.

Adrenal medulla—The inner tissue of the adrenal gland. It produces the hormones adrenaline and noradrenaline.

Lugol's solution—A strong iodine solution.

Normal results

Normal results will show no unusual areas of hormone secretion and no tumors.

Abnormal results

Abnormal results will show evidence of a tumor where there is excessive secretion of adrenaline or noradrenaline. Over 90% of these tumors are in the abdomen.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Tish Davidson

Adrenal hypofunction *see* **Addison's disease**

Adrenal insufficiency *see* **Addison's disease**

Adrenal virilism

Definition

Adrenal virilism is the development or premature development of male secondary sexual characteristics caused by male sex hormones (androgens) excessively produced by the adrenal gland. This disorder can occur before birth and can lead to sexual abnormalities in newborns. It can also occur in girls and women later in life.

Description

In the normal human body, there are two adrenal glands. They are small structures that lie on top of the

KEY TERMS

Glucocorticoid—A hormone produced by the adrenal gland; this hormone leads to an increase in blood sugar and creation of sugar molecules by the liver.

Hydrocortisone—A hormone in the group of glucocorticoid hormones.

Prednisone—A drug that functions as a glucocorticoid hormone.

kidneys. The adrenal glands produce many hormones that regulate body functions. These hormones include androgens, or male hormones. Androgens are produced in normal girls and women. Sometimes, one or both of the adrenal glands becomes enlarged or overactive, producing more than the usual amount of androgens. The excess androgens create masculine characteristics.

Causes and symptoms

In infants and children, adrenal virilism is usually the result of adrenal gland enlargement that is present at birth. This is called **congenital adrenal hyperplasia**. The cause is usually a genetic problem that leads to severe enzyme deficiencies. In rare cases, adrenal virilism is caused by an adrenal gland tumor. The tumor can be benign (adrenal adenoma) or cancerous (adrenal carcinoma). Sometimes virilism is caused by a type of tumor on a woman's ovary (arrhenoblastoma).

Newborn girls with adrenal virilism have external sex organs that seem to be a mixture of male and female organs (called female pseudohermaphrodism). Newborn boys with the disorder have enlarged external sex organs, and these organs develop at an abnormally rapid pace.

Children with congenital adrenal hyperplasia begin growing abnormally fast, but they stop growing earlier than normal. Later in childhood, they are typically shorter than normal but have well-developed trunks.

Women with adrenal virilization may develop facial hair. Typically, their menstrual cycles are infrequent or absent. They may also develop a deeper voice, a more prominent Adam's apple, and other masculine signs.

Diagnosis

Endocrinologists, doctors who specialize in the diagnosis and treatment of glandular disorders, have the most expertise to deal with adrenal virilization. Some doctors who treat disorders of the internal organs (internists) and doctors who specialize in treating the reproductive system of women (gynecologists) may also be able to help patients with this disorder.

Diagnosis involves performing many laboratory tests on blood samples from the patient. These tests measure the concentration of different hormones. Different abnormalities of the adrenal gland produce a different pattern of hormonal abnormalities. These tests can also help determine if the problem is adrenal or ovarian. If a tumor is suspected, special x rays may be done to visualize the tumor in the body. Final diagnosis may depend on obtaining a tissue sample from the tumor (biopsy), and examining it under a microscope in order to verify its characteristics.

Treatment

Adrenal virilism caused by adrenal hyperplasia is treated with daily doses of a glucocorticoid. Usually prednisone is the drug of choice, but in infants hydrocortisone is usually given. Laboratory tests are usually needed from time to time to adjust the dosage. Girls with pseudohermaphrodism may require surgery to make their external sex organs appear more normal. If a tumor is causing the disorder, the treatment will depend on the type and location of the tumor. Information about the tumor cell type and the spread of the tumor is used to decide the best kind of treatment for a particular patient. If the tumor is cancerous, the patient will require special treatment depending on how far the **cancer** has advanced. Treatment can be a combination of surgery, medications used to kill cancer cells (**chemotherapy**), and x rays or other high energy rays used to kill cancer cells (**radiation therapy**). Sometimes the doctor must remove the adrenal gland and the surrounding tissues. If the tumor is benign, then surgically removing the tumor may be the best option.

Prognosis

Ongoing glucocorticoid treatment usually controls adrenal virilism in cases of adrenal hyperplasia, but there is no cure. If a cancerous tumor has caused the disorder, patients have a better prognosis if they have an early stage of cancer that is diagnosed quickly and has not spread.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Little, M., and D. C. Garrell. *Encyclopedia of Health; The Endocrine System: The Healthy Body.* Chelsea House, 1990.

PERIODICALS

Willensy, D. "The Endocrine System." *American Health* (Apr. 1996): 92-3.

Richard H. Lampert

Adrenalectomy

Definition

Adrenalectomy is the surgical removal of one or both of the adrenal glands. The adrenal glands are paired endocrine glands, one located above each kidney, that produce hormones such as epinephrine, norepinephrine, androgens, estrogens, aldosterone, and cortisol. Adrenalectomy is usually performed by conventional (open) surgery, but in selected patients surgeons may use **laparoscopy**. With laparoscopy, adrenalectomy can be accomplished through four very small incisions.

Purpose

Adrenalectomy is usually advised for patients with tumors of the adrenal glands. Adrenal gland tumors may be malignant or benign, but all typically excrete excessive amounts of one or more hormones. A successful procedure will aid in correcting hormone imbalances, and may also remove cancerous tumors that can invade other parts of the body. Occasionally, adrenalectomy may be recommended when hormones produced by the adrenal glands aggravate another condition such as **breast cancer**.

Precautions

The adrenal glands are fed by numerous blood vessels, so surgeons need to be alert to extensive bleeding during surgery. In addition, the adrenal glands lie close to one of the body's major blood vessels (the vena cava), and to the spleen and the pancreas. The surgeon needs to remove the gland(s) without damaging any of these important and delicate organs.

Description

Open adrenalectomy

The surgeon may operate from any of four directions, depending on the exact problem and the patient's body type.

In the anterior approach, the surgeon cuts into the abdominal wall. Usually the incision will be horizontal, just under the rib cage. If the surgeon intends to operate on only one of the adrenal glands, the incision will run under just the right or the left side of the rib cage. Sometimes a vertical incision in the middle of the abdomen provides a better approach, especially if both adrenal glands are involved.

In the posterior approach, the surgeon cuts into the back, just beneath the rib cage. If both glands are to be removed, an incision is made on each side of the body. This approach is the most direct route to the adrenal glands, but it does not provide quite as clear a view of the surrounding structures as the anterior approach.

In the flank approach, the surgeon cuts into the patient's side. This is particularly useful in massively obese patients. If both glands need to be removed, the surgeon must remove one gland, repair the surgical wound, turn the patient onto the other side, and repeat the entire process.

The last approach involves an incision into the chest cavity, either with or without part of the incision into the abdominal cavity. It is used when the surgeon anticipates a very large tumor, or if the surgeon needs to examine or remove nearby structures as well.

Laparoscopic adrenalectomy

This technique does not require the surgeon to open the body cavity. Instead, four small incisions (about 1/2 in diameter each) are made into a patient's flank, just under the rib cage. A laparoscope, which enables the surgeon to visualize the inside of the abdominal cavity on a television monitor, is placed through one of the incisions. The other incisions are for tubes that carry miniaturized versions of surgical tools. These tools are designed to be operated by manipulations that the surgeon makes outside the body.

Preparation

Most aspects of preparation are the same as in other major operations. In addition, hormone imbalances are often a major challenge. Whenever possible, physicians will try to correct hormone imbalances through medication in the days or weeks before surgery. Adrenal tumors may cause other problems such as **hypertension** or inadequate potassium in the blood, and these problems also should be resolved if possible before surgery is performed. Therefore, a patient may take specific medicines for days or weeks before surgery.

Most adrenal tumors can be imaged very well with a CT scan or MRI, and benign tumors tend to look different on these tests than do cancerous tumors. Surgeons may order a CT scan, MRI, or scintigraphy (viewing of the location of a tiny amount of radioactive agent) to help locate exactly where the tumor is.

KEY TERMS

Laparoscope—An instrument that enables the surgeon to see inside the abdominal cavity by means of a thin tube that carries an image to a television monitor.

Pancreas—An organ that secretes a number of digestive hormones and also secretes insulin to regulate blood sugar.

Pheochromocytoma—A tumor of specialized cells of the adrenal gland.

Spleen—An organ that traps and breaks down red blood cells at the end of their useful life and manufactures some key substances used by the immune system.

Vena cava—The large vein that drains directly into the heart after gathering incoming blood from the entire body.

The day before surgery, patients will probably have an enema to clear the bowels. In patients with lung problems or clotting problems, physicians may advise special preparations.

Aftercare

Patients stay in the hospital for various lengths of time after adrenalectomy. The longest hospital stays are required for open surgery using an anterior approach; hospital stays of about three days are indicated for open surgery using the posterior approach or for laparoscopic adrenalectomy.

The special concern after adrenalectomy is the patient's hormone balance. There may be several sets of lab tests to define hormone problems and monitor the results of drug treatment. In addition, blood pressure problems and infections are more common after removal of certain types of adrenal tumors.

As with most open surgery, surgeons are also concerned about blood clots forming in the legs and traveling to the lungs (venous thromboembolism), bowel problems, and postoperative **pain**. With laparoscopic adrenalectomy, these problems are somewhat less difficult, but they are still present.

Risks

The special risks of adrenalectomy involve major hormone imbalances, caused by the underlying disease, the surgery, or both.These can include problems with wound healing itself, blood pressure fluctuations, and other metabolic problems.

Other risks are typical of many operations.These include:

- bleeding
- damage to adjacent organs (spleen, pancreas)
- loss of bowel function
- blood clots in the lungs
- lung problems
- surgical infections
- pain
- extensive scarring

Resources

BOOKS

Bradley, Edward L., III. *The Patient's Guide to Surgery.* Philadelphia: University of Pennsylvania Press, 1994.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Little, M., and D. C. Garrell. *The Endocrine System: The Healthy Body.* Chelsea House, 1990.

Richard H. Lampert
Janis O. Flores

Adrenocortical insufficiency *see* **Addison's disease**

Adrenocorticotropic hormone test

Definition

Adrenocorticotropic hormone test (also known as an ACTH test or a corticotropin test) measures pituitary gland function.

Purpose

The pituitary gland produces the hormone ACTH, which stimulates the outer layer of the adrenal gland (the adrenal cortex). ACTH causes the release of the hormones hydrocortisone (cortisol), aldosterone, and androgen. The most important of these hormones released is cortisol. The ACTH test is used to determine if too much cortisol is being produced (**Cushing's syndrome**) or if not enough cortisol is being produced (**Addison's disease**).

Precautions

ACTH has diurnal variation, meaning that the levels of this hormone vary according to the time of day. The highest levels occur in the morning hours. Testing for normal secretion, as well as for Cushing's disease, may require multiple samples. For sequential follow-up, a blood sample analyzed for ACTH should always be drawn at the same time each day.

ACTH can be directly measured by an analyzing method (immunoassay) in many large laboratories. However, smaller laboratories are usually not equipped to perform this test and they may need to send the blood sample to a larger laboratory. Because of this delay, results may take several days to obtain.

Description

ACTH production is partly controlled by an area in the center of the brain (the hypothalamus) and partly controlled by the level of cortisol in the blood. When ACTH levels are too high, cortisol production increases to suppress ACTH release from the pituitary gland. If ACTH levels are too low, the hypothalamus produces corticotropin-releasing hormone (CRH) to stimulate the pituitary gland to make more ACTH. ACTH levels rise in response to **stress**, emotions, injury, infection, **burns**, surgery, and decreased blood pressure.

Cushing's syndrome

Cushing's syndrome is caused by an abnormally high level of circulating hydrocortisone. The high level may be the result of an adrenal gland tumor or enlargement of both adrenal glands due to a pituitary tumor. The high level of hydrocortisone may be the result of taking corticosteroid drugs for a long time. Corticosteroid drugs are widely used for inflammation in disorders like **rheumatoid arthritis**, inflammatory bowel disease, and **asthma**.

Addison's disease

Addison's disease is a rare disorder in which symptoms are caused by a deficiency of hydrocortisone and aldosterone. The most common cause of this disease is an autoimmune disorder. The immune system normally fights foreign invaders in the body like bacteria. In an autoimmune disorder, the immune systems attacks the body. In this case, the immune system produces antibodies that attack the adrenal glands. Addison's disease generally progresses slowly, with symptoms developing gradually over months or years. However, acute episodes, called Addisonian crises, are brought on by infection, injury, or other stresses. Diagnosis is generally made if the patient fails to respond to an injection of ACTH, which normally stimulates the secretion of hydrocortisone.

KEY TERMS

Adrenal glands—A pair of endocrine glands that lie on top of the kidneys.

Pituitary gland—The most important of the endocrine glands, glands that release hormones directly into the bloodstream; sometimes called the master gland.

Preparation

A person's ACTH level is determined from a blood sample. The patient must fast from midnight until the test the next morning. This means that the patient cannot eat or drink anything after midnight except water. The patient must also avoid radioisotope scanning tests or recently administered radioisotopes prior to the blood test.

Risks

The risks associated with this test are minimal. They may include slight bleeding from the location where the blood was drawn. The patient may feel faint or lightheaded after the blood is drawn. Sometimes the patient may have an accumulation of blood under the puncture site (hematoma) after the test.

Normal results

Each laboratory will have its own set of normal values for this test. The normal values can range from: Morning (4-8 A.M.) 8-100 pg/mL or 10-80 ng/L (SI units) Evening (8-10 P.M.) less than 50 pg/mL or less than 50 ng/L (SI units)

Abnormal results

In Cushing's syndrome, high levels of ACTH may be caused by ACTH-producing tumors. These tumors may be either in the pituitary or in another area (like tumors from lung **cancer** or **ovarian cancer**). Low ACTH levels may be caused by adrenal enlargement due to high levels of cortisol and feedback to the pituitary.

In Addison's disease, high levels of ACTH may be caused by adrenal gland diseases. These diseases decrease adrenal hormones and the pituitary attempts to increase functioning. Low levels of ACTH may occur because of decreased pituitary function.

Resources

BOOKS

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Adrenogenital syndrome *see* **Adrenal virilism**

Adrenoleukodystrophy

Definition

Adrenoleukodystrophy is a rare genetic disease characterized by a loss of myelin surrounding nerve cells in the brain and progressive adrenal gland dysfunction.

Description

Adrenoleukodystrophy (ALD) is a member of a group of diseases, leukodystrophies, that cause damage to the myelin sheath of nerve cells. Approximately one in 100,000 people is affected by ALD. There are three basic forms of ALD: childhood, adult-onset, and neonatal. The childhood form of the disease is the classical form and is the most severe. Childhood ALD is progressive and usually leads to total disability or **death**. It affects only boys because the genetic defect is sex-linked (carried on the X chromosome). Onset usually occurs between ages four and ten and can include many different symptoms, not all of which appear together. The most common symptoms are behavioral problems and poor memory. Other symptoms frequently seen are loss of vision, seizures, poorly articulated speech, difficulty swallowing, deafness, problems with gait and coordination, **fatigue**, increased skin pigmentation, and progressive **dementia**.

The adult-onset form of the disease, also called adrenomyeloneuropathy, is milder, progresses slowly, is usually associated with a normal life span, and usually appears between ages 21-35. Symptoms may include progressive stiffness, weakness, or **paralysis** of the lower limbs and loss of coordination. Brain function deterioration may also been seen. Women who are carriers of the disease occasionally experience the same symptoms, as well as others, including ataxia, hypertonia (excessive muscle tone), mild **peripheral neuropathy**, and urinary problems. The neonatal form affects both male and female infants and may produce **mental retardation**, facial abnormalities, seizures, retinal degeneration, poor muscle tone, enlarged liver, and adrenal dysfunction. Neonatal ALD usually progresses rapidly.

KEY TERMS

Amniocentesis—The collection of amniotic fluid through a needle inserted through the abdomen. Used to collect fetal cells for genetic analysis.

Ataxia—Loss of coordination of muscular movement.

Hypertonia—Having excessive muscular tone.

Myelin—A layer that encloses nerve cells and some axons and is made largely of lipids and lipoproteins.

Neuropathy—A disease or abnormality of the peripheral nerves.

Causes and symptoms

The genetic defect in ALD causes a decrease in the ability to degrade very long chain fatty acids. These build up in the adrenal glands, brain, plasma, and fibroblasts. The build-up of very long chain fatty acids interferes with the ability of the adrenal gland to convert cholesterol into steroids and causes demyelination of nerves in the white matter of the brain. Demyelinated nerve cells are unable to function properly.

Diagnosis

Diagnosis is made based on observed symptoms, a biochemical test, and a family history. The biochemical test detects elevated levels of very long chain fatty acids in samples from **amniocentesis**, chorionic villi, plasma, red blood cells, or fibroblasts. A family history may indicate the likelihood of ALD because the disease is carried on the X-chromosome by the female lineage of families.

Treatment

Treatment for all forms of ALD consists of treating the symptoms and supporting the patient with physical therapy, psychological counseling, and special education in some cases. There is no cure for this disease, and there are no drugs that can reverse demyelination of nerve and brain cells. Dietary measures consist of reducing the intake of foods high in fat, which are a source of very long chain fatty acids. A mixture called Lorenzo's Oil has been shown to reduce the level of long chain fatty acids if used long term; however, the rate of myelin loss

is unaffected. Experimental **bone marrow transplantation** has not been very effective.

Prognosis

Prognosis for childhood and neonatal ALD patients is poor because of the progressive myelin degeneration. Death usually occurs between one and ten years after onset of symptoms.

Prevention

Since ALD is a genetic disease, prevention is largely limited to **genetic counseling** and fetal monitoring through amniocentesis or **chorionic villus sampling**.

Resources

BOOKS

Berkow, Robert. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

John T. Lohr, PhD

Adrenomyeloneuropathy *see* **Adrenoleukodystrophy**

Adult respiratory distress syndrome

Definition

Adult **respiratory distress syndrome** (ARDS), also called acute respiratory distress syndrome, is a type of lung (pulmonary) failure that may result from any disease that causes large amounts of fluid to collect in the lungs. ARDS is not itself a specific disease, but a syndrome, a group of symptoms and signs that make up one of the most important forms of lung or **respiratory failure**. It can develop quite suddenly in persons whose lungs have been perfectly normal. Very often ARDS is a true medical emergency. The basic fault is a breakdown of the barrier, or membrane, that normally keeps fluid from leaking out of the small blood vessels of the lung into the breathing sacs (the alveoli).

Description

Another name for ARDS is shock lung. Its formal name is misleading, because children, as well as adults, may be affected. In the lungs the smallest blood vessels, or capillaries, make contact with the alveoli, tiny air sacs at the tips of the smallest breathing tubes (the bronchi). This is the all-important site where oxygen passes from air that is inhaled to the blood, which carries it to all parts of the body. Any form of lung injury that damages this point of contact, called the alveolo-capillary junction, will allow blood and tissue fluid to leak into the alveoli, eventually filling them so that air cannot enter. The result is the type of breathing distress called ARDS. ARDS is one of the major causes of excess fluid in the lungs, the other being **heart failure**.

Along with fluid there is a marked increase in inflamed cells in the lungs. There also is debris left over from damaged lung cells, and fibrin, a semi-solid material derived from blood in the tissues. Typically these materials join together with large molecules in the blood (proteins), to form hyaline membranes. (These membranes are very prominent in premature infants who develop respiratory distress syndrome; it is often called hyaline membrane disease.) If ARDS is very severe or lasts a long time, the lungs do not heal, but rather become scarred, a process known as fibrosis. The lack of a normal amount of oxygen causes the blood vessels of the lung to become narrower, and in time they, too, may become scarred and filled with clotted blood. The lungs as a whole become very "stiff," and it becomes much harder for the patient to breathe.

Causes and symptoms

A very wide range of diseases or toxic substances, including some drugs, can cause ARDS. They include:

- Breathing in (aspiration) of the stomach contents when regurgitated, or salt water or fresh water from nearly drowning.
- Inhaling smoke, as in a fire; toxic materials in the air, such as ammonia or hydrocarbons; or too much oxygen, which itself can injure the lungs.
- Infection by a virus or bacterium, or **sepsis**, a widespread infection that gets into the blood.
- Massive trauma, with severe injury to any part of the body.
- Shock with persistently low blood pressure may not in itself cause ARDS, but it can be an important factor.
- A blood clotting disorder called disseminated intravascular coagulation, in which blood clots form in vessels throughout the body, including the lungs.
- A large amount of fat entering the circulation and traveling to the lungs, where it lodges in small blood vessels, injuring the cells lining the vessel walls.
- An overdose of a narcotic drug, a sedative, or, rarely, **aspirin**.

KEY TERMS

Alveoli—The tiny air sacs at the ends of the breathing tubes of the lung where oxygen normally is taken up by the capillaries to enter the circulation.

Aspiration—The process in which solid food, liquids, or secretions that normally are swallowed are, instead, breathed into the lungs.

Capillaries—The smallest arteries which, in the lung, are located next to the alveoli so that they can pick up oxygen from inhaled air.

Face mask—The simplest way of delivering a high level of oxygen to patients with ARDS or other low-oxygen conditions.

Steroids—A class of drugs resembling normal body substances that often help control inflammation in the body tissues.

Ventilator—A mechanical device that can take over the work of breathing for a patient whose lungs are injured or are starting to heal.

- Inflammation of the pancreas (**pancreatitis**), when blood proteins, called enzymes, pass to the lungs and injure lung cells.
- Severe burn injury.
- Injury of the brain, or bleeding into the brain, from any cause may be a factor in ARDS for reasons that are not clear. Convulsions also may cause some cases.

Usually ARDS develops within one to two days of the original illness or injury. The person begins to take rapid but shallow breaths. The doctor who listens to the patient's chest with a stethoscope may hear "crackling" or **wheezing** sounds. The low blood oxygen content may cause the skin to appear mottled or even blue. As fluid continues to fill the breathing sacs, the patient may have great trouble breathing, take very rapid breaths, and gasp for air.

Diagnosis

A simple test using a device applied to the ear will show whether the blood is carrying too little oxygen, and this can be confirmed by analyzing blood taken from an artery. The **chest x ray** may be normal in the early stages, but, in a short time, fluid will be seen where it does not belong. The two lungs are about equally affected. A heart of normal size indicates that the problem actually is ARDS and not heart failure. Another way a physician can distinguish between these two possibilities is to place a catheter into a vein and advance it into the main artery of the lung. In this way, the pressure within the pulmonary capillaries can be measured. Pressure within the pulmonary capillaries is elevated in heart failure, but normal in ARDS.

Treatment

The three main goals in treating patients with ARDS are:

- To treat whatever injury or disease has caused ARDS. Examples are: to treat septic infection with the proper **antibiotics**, and to reduce the level of oxygen therapy if ARDS has resulted from a toxic level of oxygen.
- To control the process in the lungs that allows fluid to leak out of the blood vessels. At present there is no certain way to achieve this. Certain steroid hormones have been tried because they can combat inflammation, but the actual results have been disappointing.
- To make sure the patient gets enough oxygen until the lung injury has had time to heal. If oxygen delivered by a face mask is not enough, the patient is placed on a ventilator, which takes over breathing, and, through a tube placed in the nose or mouth (or an incision in the windpipe), forces oxygen into the lungs. This treatment must be closely supervised, and the pressure adjusted so that too much oxygen is not delivered.

Patients with ARDS should be cared for in an intensive care unit, where experienced staff and all needed equipment are available. Enough fluid must be provided, by vein if necessary, to prevent **dehydration**. Also, the patient's nutritional state must be maintained, again by vein, if oral intake is not sufficient.

Prognosis

If the patient's lung injury does not soon begin to heal, the lack of sufficient oxygen can injure other organs, such as the kidneys. There always is a risk that bacterial **pneumonia** will develop at some point. Without prompt treatment, as many as 90% of patients with ARDS can be expected to die. With modern treatment, however, about half of all patients will survive. Those who do live usually recover completely, with little or no long-term breathing difficulty. Lung scarring is a risk after a long period on a ventilator, but it may improve in the months after the patient is taken off ventilation. Whether a particular patient will recover depends to a great extent on whether the primary disease that caused ARDS to develop in the first place can be effectively treated.

Prevention

The only way to prevent ARDS is to avoid those diseases and harmful conditions that damage the lung. For

instance, the danger of aspirating stomach contents into the lungs can be avoided by making sure a patient does not eat shortly before receiving general anesthesia. If a patient needs oxygen therapy, as low a level as possible should be given. Any form of lung infection, or infection anywhere in the body that gets into the blood, must be treated promptly to avoid the lung injury that causes ARDS.

Resources

BOOKS

Smolley, Lawrence A., and Debra F. Bryse. *Breathe Right Now: A Comprehensive Guide to Understanding and Treating the Most Common Breathing Disorders*. New York: W. W. Norton & Co., 1998.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Respiratory Distress Syndrome Foundation. P.O. Box 723, Montgomeryville, PA 18936.

OTHER

"Pulmonary Medicine." HealthWeb.com. 5 Jan. 1998. <http://healthweb.org>.

David A. Cramer, MD

AFP test *see* **Alpha-fetoprotein test**

African American health *see* **Minority health**

African sleeping sickness *see* **Sleeping sickness**

African trypanosomiasis *see* **Sleeping sickness**

Agammaglobulinemia *see* **Common variable immunodeficiency**

Aggression *see* **Conduct disorder**

Aging

Definition

Starting at what is commonly called middle age, operations of the human body begin to be more vulnerable to daily wear and tear; there is a general decline in physical, and possibly mental, functioning. In the Western countries, the length of life is often into the 70s. The upward limit of the life span, however, can be as high as 120 years. During the latter half of life, an individual is more prone to have problems with the various functions of the body and to develop any number of chronic or fatal diseases. The cardiovascular, digestive, excretory, nervous, reproductive and urinary systems are particularly affected. The most common diseases of aging include Alzheimer's, arthritis, **cancer**, diabetes, depression, and heart disease.

Description

Human beings reach a peak of growth and development around the time of their mid 20s. Aging is the normal transition time after that flurry of activity. Although there are quite a few age-related changes that tax the body, disability is not necessarily a part of aging. Health and lifestyle factors together with the genetic makeup of the individual, and determines the response to these changes. Body functions that are most often affected by age include:

- Hearing, which declines especially in relation to the highest pitched tones.
- The proportion of fat to muscle, which may increase by as much as 30%. Typically, the total padding of body fat directly under the skin thins out and accumulates around the stomach. The ability to excrete fats is impaired, and therefore the storage of fats increases, including cholesterol and fat-soluble nutrients.
- The amount of water in the body decreases, which therefore decreases the absorption of water-soluble nutrients. Also, there is less saliva and other lubricating fluids.
- The liver and the kidneys cannot function as efficiently, thus affecting the elimination of wastes.
- A decrease in the ease of digestion, with a decrease in stomach acid production.
- A loss of muscle strength and coordination, with an accompanying loss of mobility, agility, and flexibility.
- A decline in sexual hormones and sexual functioning.
- A decrease in the sensations of taste and smell.
- Changes in the cardiovascular and respiratory systems, leading to decreased oxygen and nutrients throughout the body.
- Decreased functioning of the nervous system so that nerve impulses are not transmitted as efficiently, reflexes are not as sharp, and memory and learning are diminished.
- A decrease in bone strength and density.
- Hormone levels, which gradually decline. The thyroid and sexual hormones are particularly affected.
- Declining visual abilities. Age-related changes may lead to diseases such as **macular degeneration**.

- A compromised ability to produce vitamin D from sunlight.
- A reduction in protein formation leading to shrinkage in muscle mass and decreased bone formation, possibly leading to osteoporosis.

Causes and symptoms

There are several theories as to why the aging body loses functioning. It may be that several factors work together or that one particular factor is at work more than others in a given individual.

- Programmed senescence, or aging clock, theory. The aging of the cells of each individual is programmed into the genes, and there is a preset number of possible rejuvenations in the life of a given cell. When cells die at a rate faster than they are replaced, organs do not function properly, and they are soon unable to maintain the functions necessary for life.
- Genetic theory. Human cells maintain their own seed of destruction at the level of the chromosomes.
- Connective tissue, or cross-linking theory. Changes in the make-up of the connective tissue alter the stability of body structures, causing a loss of elasticity and functioning, and leading to symptoms of aging.
- Free-radical theory. The most commonly held theory of aging, it is based on the fact that ongoing chemical reactions of the cells produce free radicals. In the presence of oxygen, these free radicals cause the cells of the body to break down. As time goes on, more cells die or lose the ability to function, and the body soon ceases to function as a whole.
- Immunological theory. There are changes in the immune system as it begins to wear out, and the body is more prone to infections and tissue damage, which may finally cause **death**. Also, as the system breaks down, the body is more apt to have autoimmune reactions, in which the body's own cells are mistaken for foreign material and are destroyed or damaged by the immune system.

Diagnosis

Many problems can arise due to age-related changes in the body. Although there is no one test to be given, a thorough physical exam and a basic blood screening and blood chemistry panel can point to areas in need of further attention. When older people become ill, the first signs of disease are often nonspecific. Further exams should be conducted if any of the following occur:

- diminished or lack of desire for food
- increasing confusion
- failure to thrive
- urinary incontinence
- dizziness
- weight loss
- falling

Treatment

For the most part, doctors prescribe medications to control the symptoms and diseases of aging. In the United States, about two-thirds of people 65 and over take medications for various complaints. More women than men use these medications. The most common drugs used by the elderly are painkillers, **diuretics** or water pills, sedatives, cardiac drugs, **antibiotics**, and mental health drugs.

Estrogen replacement therapy (ERT) is commonly prescribed to postmenopausal women for symptoms of aging. It is often used in conjunction with progesterone. ERT functions to help keep bones strong, reduce risk of heart disease, restore vaginal lubrication, and to improve skin elasticity. Evidence suggests that it may also help maintain mental functions.

Expected results

Aging is unavoidable, but major physical impairment is not. People can lead a healthy, disability-free life well through their later years. A well established support system of family, friends, and health care providers, together with focus on good **nutrition** and lifestyle habits and good **stress** management, can prevent disease and lessen the impact of chronic conditions.

Alternative treatment

Nutritional supplements

Consumption of a high–quality multivitamin is recommended. Common nutritional deficiencies connected with aging include B **vitamins**, vitamins A and C, **folic acid**, calcium, magnesium, zinc, iron, chromium, and trace **minerals**. Since stomach acids may be decreased, it is suggested that the use of a powdered multivitamin formula in gelatin capsules be used, as this form is the easiest to digest. Such formulas may also contain enzymes for further help with digestion.

Antioxidants can help to neutralize damage by the free radical actions thought to contribute to problems of aging. They are also helpful in preventing and treating cancer and in treating **cataracts** and **glaucoma**. Supplements that serve as antioxidants include:

- Vitamin E, 400–1,000 IUs daily. Protects cell membranes against damage. It shows promise in prevention against heart disease, and Alzheimer's and Parkinson's diseases.
- Selenium, 50 mg taken twice daily. Research suggests that selenium may play a role in reducing the risk of cancer.
- Beta-carotene, 25,000–40,000 IUs daily. May help in treating cancer, colds and flu, arthritis, and immune support.
- Vitamin C, 1,000–2,000 mg per day. It may cause **diarrhea** in large doses. If this occurs, however, all that is needed is a decrease in the dosage.

Other supplements that are helpful in treating age-related problems including:

- B_{12}/B-complex vitamins, studies show that B_{12} may help reduce mental symptoms, such as confusion, memory loss, and depression.
- Coenzyme Q10 may be helpful in treating heart disease, as up to three-quarters cardiac patients have been found to be lacking in this heart enzyme.

Hormones

The following hormone supplements may be taken to prevent or to treat various age-related problems. However, caution should be taken before beginning treatment, and the patient should consult his or her health care professional.

DHEA improves brain functioning and serves as a building block for many other important hormones in the body. It may be helpful in restoring declining hormone levels and in building up muscle mass, strengthening the bones, and maintaining a healthy heart.

Melatonin may be helpful for **insomnia**. It has also been used to help fight viruses and bacterial infections, reduce the risk of heart disease, improve sexual functioning, and to protect against cancer.

Human growth hormone (hGH) has been shown to regulate blood sugar levels and to stimulate bone, cartilage, and muscle growth while reducing fat.

Herbs

Garlic (*Allium sativa*) is helpful in preventing heart disease, as well as improving the tone and texture of skin. Garlic stimulates liver and digestive system functions, and also helps in dealing with heart disease and high blood pressure.

Siberian ginseng (*Eleutherococcus senticosus*) supports the adrenal glands and immune functions. It is believed to be helpful in treating problems related to stress. Siberian ginseng also increases mental and physical performance, and may be useful in treating memory loss, chronic **fatigue**, and immune dysfunction.

Ginkgo biloba works particularly well on the brain and nervous system. It is effective in reducing the symptoms of conditions, such as Alzheimer's, depression, visual problems, and problems of blood circulation. It may also help treat heart disease, strokes, **dementia**, **Raynaud's disease**, head injuries, leg cramps, macular degeneration, **tinnitus**, **impotence** due to poor blood flow, and diabetes-related nerve damage.

Proanthocyanidins, or PCO, are Pycnogenol, derived from grape seeds and skin, and from pine tree bark, and may help in the prevention of cancer and poor vision.

In **Ayurvedic medicine**, aging is described as a process of increased vata, in which there is a tendency to become thinner, drier, more nervous, more restless, and more fearful, while having a loss of appetite as well as sleep. Bananas, almonds, avocados, and coconuts are some of the foods used in correcting such conditions. One of the main herbs used for such conditions is gotu kola (*Centella asiatica*), which is used to revitalize the nervous system and brain cells and to fortify the immune system. Gotu kola is also used to treat memory loss, **anxiety**, and insomnia.

In Chinese medicine, most symptoms of aging are regarded as symptoms of a yin deficiency. Moistening foods such as millet, barley soup, tofu, mung beans, wheat germ, spirulina, potatoes, black sesame seeds, walnuts, and flax seeds are recommended. Jing tonics may also be used. These include deer antler, dodder seeds, processed rehmannia, longevity soup, mussels, and chicken.

KEY TERMS

Antioxidants—Substances that reduce the damage of the highly reactive free radicals that are the byproducts of the cells.

Alzheimer's disease—A condition causing a decline in brain function that interferes with the ability to reason and to perform daily activities.

Senescence—Aging.

Vata—One of the three main constitutional types found under Ayurvedic principles. Keeping one's particular constitution in balance is considered important in maintaining health.

Prevention

Preventive health practices such as healthy diet, daily **exercise**, stress management, and control of lifestyle habits such as **smoking** and drinking, can lengthen the life span and improve the quality of life as people age. Exercise can improve the appetite, the health of the bones, the emotional and mental outlook, and the digestion and circulation.

Drinking plenty of fluids aids in maintaining healthy skin, good digestion, and proper elimination of wastes. Up to eight glasses of water should be consumed daily, along with plenty of herbal teas, diluted fruit and vegetable juices, and fresh fruits and vegetables with high water content.

Because of a decrease in the sense of taste, older people often increase their intake of salt, which can contribute to high blood pressure and nutrient loss. Use of sugar is also increased. Seaweeds and small amounts of honey can be used as replacements.

Alcohol, nicotine, and **caffeine** all have potential damaging effects, and should be limited or completely eliminated from consumption.

A diet high in fiber and low in fat is recommended. Processed foods should be replaced by complex carbohydrates, such as whole grains. If chewing becomes a problem, there should be an increased intake of protein drinks, freshly juiced fruits and vegetables, and creamed cereals.

Resources

BOOKS

Darden Ph.D., Ellington. *Living Longer Stronger.* New York: A Perigee Book, The Berkeley Publishing Group, 1995.

Pitchford, Paul. *Healing with Whole Foods.* Berkeley, CA: North Atlantic Books, 1993.

OTHER

"Anti-Aging-Nutritional Program." <http://www.healthy.net/hwlibrarybooks/haas/perform/antiagin.htm/> (December 28, 2000).

"Effects of Hormone in the Body." <http://www.anti-aging.org/Effects_hGH.html/> (December 28, 2000).

"The Elderly-Nutritional Programs." <http://www.healthy.net/hwlibrarybooks/haas/lifestage/elderly.htm/> (December 28, 2000).

"Evaluating the Elderly Patient: the Case for Assessment Technology." <http://text.nlm.nih.gov/nih/ta/www/01.html/> (December 28, 2000).

"Herbal Phytotherapy and the Elderly." <http://www.healthy.net/hwlibrarybooks/hoffman/elders/elders.htm/> (December 28, 2000).

"Pharmacokinetics." Merck & Co., Inc. (1995-2000). <http://www.merck.com/pubs/mmanual/section22/chapter304/304a.htm/> (December 28, 2000).

"To a Long and Healthy Life." <http://www.healthy.net/hwlibraryarticles/aesoph/longandhealthy.htm/> (December 28, 2000).

Patience Paradox

Agoraphobia

Definition

The word agoraphobia is derived from Greek words literally meaning "fear of the marketplace." The term is used to describe an irrational and often disabling fear of being out in public.

Description

Agoraphobia is just one type of phobia, or irrational fear. People with **phobias** feel dread or panic when they face certain objects, situations, or activities. People with agoraphobia frequently also experience panic attacks, but panic attacks, or **panic disorder**, are not a requirement for a diagnosis of agoraphobia. The defining feature of agoraphobia is **anxiety** about being in places from which escape might be embarrasing or difficult, or in which help might be unavailable. The person suffering from agoraphobia usually avoids the anxiety-provoking situation and may become totally housebound.

Causes and symptoms

Agoraphobia is the most common type of phobia, and it is estimated to affect between 5-12% of Americans within their lifetime. Agoraphobia is twice as common in women as in men and usually strikes between the ages of 15-35.

The symptoms of the panic attacks which may accompany agoraphobia vary from person to person, and may include trembling, sweating, heart **palpitations** (a feeling of the heart pounding against the chest), jitters, **fatigue**, tingling in the hands and feet, nausea, a rapid pulse or breathing rate, and a sense of impending doom.

Agoraphobia and other phobias are thought to be the result of a number of physical and environmental factors. For instance, they have been associated with biochemical imbalances, especially related to certain neurotransmitters (chemical nerve messengers) in the brain. People who have a panic attack in a given situation (e.g., a shopping mall) may begin to associate the panic with that situation and learn to avoid it. According to some theories, irrational anxiety results from unresolved emotional conflicts. All of these factors may play a role to varying extents in different cases of agoraphobia.

Diagnosis

People who suffer from panic attacks should discuss the problem with a physician. The doctor can diagnose the underlying panic or anxiety disorder and make sure the symptoms aren't related to some other underlying medical condition.

The doctor makes the diagnosis of agoraphobia based primarily on the patient's description of his or her symptoms. The person with agoraphobia experiences anxiety in situations where escape is difficult or help is unavailable—or in certain situations, such as being alone. While many people are somewhat apprehensive in these situations, the hallmark of agoraphobia is that a person's active avoidance of the feared situation impairs his or her ability to work, socialize, or otherwise function.

Treatment

Treatment for agoraphobia usually consists of both medication and psychotherapy. Usually, patients can benefit from certain antidepressants, such as amitriptyline (Elavil), or **selective serotonin reuptake inhibitors**, such as paroxetine (Paxil), fluoxetine (Prozac), or sertraline (Zoloft). In addition, patients may manage panic attacks in progress with certain tranquilizers called **benzodiazepines**, such as alprazolam (Xanax) or clonazepam (Klonipin).

The mainstay of treatment for agoraphobia and other phobias is cognitive behavioral therapy. A specific technique that is often employed is called desensitization. The patient is gradually exposed to the situation that usually triggers fear and avoidance, and, with the help of breathing or relaxation techniques, learns to cope with the situation. This helps break the mental connection between the situation and the fear, anxiety, or panic. Patients may also benefit from psychodynamically oriented psychotherapy, discussing underlying emotional conflicts with a therapist or support group.

Prognosis

With proper medication and psychotherapy, 90% of patients will find significant improvement in their symptoms.

Resources

BOOKS

Hallowell, Edward M. *Worry: Controlling It and Using It Wisely.* New York: Pantheon Books, 1997.

PERIODICALS

Forsyth, Sondra. "I Panic When I'm Alone." *Mademoiselle*, Apr. 1998, 119-24.

Hale, Anthony S. "ABC of Mental Health: Anxiety." *British Medical Journal* 314 (28 June 1997): 1886-9.

"Panic Disorder—Panic Attacks and Agoraphobia." *American Family Physician* 52, no. 7 (15 Nov. 1995): 2067-8.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

Anxiety Disorders Association of America. 11900 Park Lawn Drive, Ste. 100, Rockville, MD 20852. (800) 545-7367. <http://www.adaa.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Robert Scott Dinsmoor

KEY TERMS

Benzodiazepines—A group of tranquilizers often used to treat anxiety.

Desensitization—A treatment for phobias which involves exposing the phobic person to the feared situation. It is often used in conjunction with relaxation techniques.

Phobia—An intense and irrational fear of a specific object, activity, or situation.

Agranulocytosis *see* **Neutropenia**

AIDS

Definition

Acquired immune deficiency syndrome (AIDS) is an infectious disease caused by the human **immunodeficiency** virus (HIV). It was first recognized in the United States in 1981. AIDS is the advanced form of infection with the HIV virus, which may not cause recognizable disease for a long period after the initial exposure (latency). No vaccine is currently available to prevent HIV infection. At present, all forms of AIDS therapy are focused on improving the quality and length of life for AIDS patients by slowing or halting the replication of the virus and treating or preventing infections and cancers that take advantage of a person's weakened immune system.

Description

AIDS is considered one of the most devastating public health problems in recent history. In June 2000, the Centers

Risk of acquiring HIV infection by entry site

	Entry site	Risk virus reaches entry site	Risk virus enters	Risk inoculated
	Conjuntiva	Moderate	Moderate	Very low
	Oral mucosa	Moderate	Moderate	Low
	Nasal mucosa	Low	Low	Very low
	Lower respiratory	Very low	Very low	Very low
	Anus	Very high	Very high	Very high
	Skin, intact	Very low	Very low	Very low
	Skin, broken	Low	High	High
Sexual:				
	Vagina	Low	High	High
	Penis	Low	Low	High
	Ulcers (STD)	Medium	Low	Very high
Blood:				
	Products	High	High	Low
	Shared needles	High	High	High
	Accidental needle	High	Very High	Low
	Traumatic wound	Modest	High	High
	Perinatal	High	High	High

for Disease Control and Prevention (CDC) reported that 120,223 (includes only those cases in areas that have confidential HIV reporting) in the United States are HIV-positive, and 311,701 are living with AIDS (includes only those cases where vital status is known). Of these patients, 44% are gay or bisexual men, 20% are heterosexual intravenous drug users, and 17% are women. In addition, approximately 1,000-2,000 children are born each year with HIV infection. The World Health Organization (WHO) estimates that 33 million adults and 1.3 million children worldwide were living with HIV/AIDS as of 1999 with 5.4 million being newly infected that year. Most of these cases are in the developing countries of Asia and Africa.

Risk factors

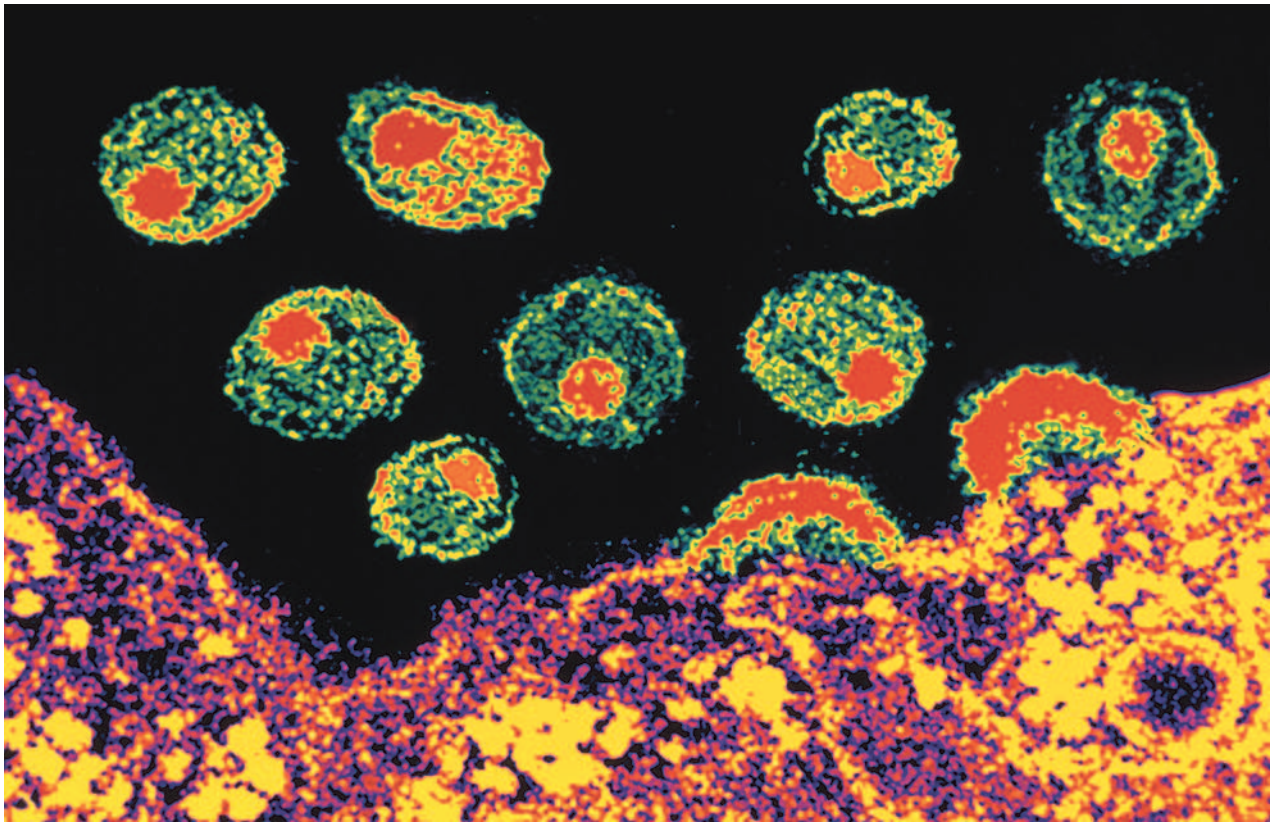
AIDS can be transmitted in several ways. The risk factors for HIV transmission vary according to category:

- Sexual contact. Persons at greatest risk are those who do not practice safe sex, those who are not monogamous, those who participate in anal intercourse, and those who have sex with a partner with symptoms of advanced HIV infection and/or other **sexually transmitted diseases** (STDs). In the United States and Europe, most cases of sexually transmitted HIV infection have resulted from homosexual contact, whereas in Africa, the disease is spread primarily through sexual intercourse among heterosexuals.
- Transmission in **pregnancy**. High-risk mothers include women married to bisexual men or men who have an abnormal blood condition called **hemophilia** and require blood transfusions, intravenous drug users, and women living in neighborhoods with a high rate of HIV infection among heterosexuals. The chances of transmitting the disease to the child are higher in women in advanced stages of the disease. Breast feeding increases the risk of transmission by 10-20%. The use of zidovudine (AZT) during pregnancy, however, can decrease the risk of transmission to the baby.
- Exposure to contaminated blood or blood products. With the introduction of blood product screening in the mid-1980s, the incidence of HIV transmission in blood transfusions has dropped to one in every 100,000 transfused. With respect to HIV transmission among drug abusers, risk increases with the duration of using injections, the frequency of needle sharing, the number of persons who share a needle, and the number of AIDS cases in the local population.
- Needle sticks among health care professionals. Present studies indicate that the risk of HIV transmission by a needle stick is about one in 250. This rate can be decreased if the injured worker is given AZT, an anti-retroviral medication, in combination with other medication.

HIV is not transmitted by handshakes or other casual non-sexual contact, coughing or sneezing, or by blood-sucking insects such as mosquitoes.

AIDS in women

AIDS in women is a serious public health concern. Women exposed to HIV infection through heterosexual contact are the most rapidly growing risk group in the United States population. The percentage of AIDS cases diagnosed in women has risen from 7% in 1985 to 23% in 1999. Women diagnosed with AIDS may not live as long as men, although the reasons for this finding are unclear.



Mature HIV-1 viruses (above) and the lymphocyte from which they emerged (below). Two immature viruses can be seen budding on the surface of the lymphocyte (right of center). *(Photograph by Scott Camazir, Photo Researchers, Inc. Reproduced by permission.)*

AIDS in children

Since AIDS can be transmitted from an infected mother to the child during pregnancy, during the birth process, or through breast milk, all infants born to HIV-positive mothers are a high-risk group. As of 2000, it was estimated that 87% of HIV-positive women are of childbearing age; 41% of them are drug abusers. Between 15-30% of children born to HIV-positive women will be infected with the virus.

AIDS is one of the 10 leading causes of **death** in children between one and four years of age. The interval between exposure to HIV and the development of AIDS is shorter in children than in adults. Infants infected with HIV have a 20-30% chance of developing AIDS within a year and dying before age three. In the remainder, AIDS progresses more slowly; the average child patient survives to seven years of age. Some survive into early adolescence.

Causes and symptoms

Because HIV destroys immune system cells, AIDS is a disease that can affect any of the body's major organ systems. HIV attacks the body through three disease processes: immunodeficiency, autoimmunity, and nervous system dysfunction.

Immunodeficiency describes the condition in which the body's immune response is damaged, weakened, or is not functioning properly. In AIDS, immunodeficiency results from the way that the virus binds to a protein called CD4, which is primarily found on the surface of certain subtypes of white blood cells called helper T cells or CD4 cells. After the virus has attached to the CD4 receptor, the virus-CD4 complex refolds to uncover another receptor called a chemokine receptor that helps to mediate entry of the virus into the cell. One chemokine receptor in particular, CCR5, has gotten recent attention after studies showed that defects in its structure (caused by genetic mutations) cause the progression of AIDS to be prevented or slowed. Scientists hope that this discovery will lead to the development of drugs that trigger an artificial mutation of the CCR5 gene or target the CCR5 receptor.

Once HIV has entered the cell, it can replicate intracellularly and kill the cell in ways that are still not completely understood. In addition to killing some lymphocytes directly, the AIDS virus disrupts the functioning of

the remaining CD4 cells. Because the immune system cells are destroyed, many different types of infections and cancers that take advantage of a person's weakened immune system (opportunistic) can develop.

Autoimmunity is a condition in which the body's immune system produces antibodies that work against its own cells. Antibodies are specific proteins produced in response to exposure to a specific, usually foreign, protein or particle called an antigen. In this case, the body produces antibodies that bind to blood platelets that are necessary for proper blood clotting and tissue repair. Once bound, the antibodies mark the platelets for removal from the body, and they are filtered out by the spleen. Some AIDS patients develop a disorder, called immune-related **thrombocytopenia** purpura (ITP), in which the number of blood platelets drops to abnormally low levels.

As of 2000, researchers do not know precisely how HIV attacks the nervous system since the virus can cause damage without infecting nerve cells directly. One theory is that, once infected with HIV, one type of immune system cell, called a macrophage, begins to release a toxin that harms the nervous system.

The course of AIDS generally progresses through three stages, although not all patients will follow this progression precisely:

Acute retroviral syndrome

Acute retroviral syndrome is a term used to describe a group of symptoms that can resemble mononucleosis and that may be the first sign of HIV infection in 50-70% of all patients and 45-90% of women. Most patients are not recognized as infected during this phase and may not seek medical attention. The symptoms may include **fever**, **fatigue**, muscle aches, loss of appetite, digestive disturbances, weight loss, skin **rashes**, **headache**, and chronically swollen lymph nodes (lymphadenopathy). Approximately 25-33% of patients will experience a form of **meningitis** during this phase in which the membranes that cover the brain and spinal cord become inflamed. Acute retroviral syndrome develops between one and six weeks after infection and lasts for two to three weeks. Blood tests during this period will indicate the presence of virus (viremia) and the appearance of the viral p24 antigen in the blood.

Latency period

After the HIV virus enters a patient's lymph nodes during the acute retroviral syndrome stage, the disease becomes latent for as many as 10 years or more before symptoms of advanced disease develop. During latency, the virus continues to replicate in the lymph nodes, where it may cause one or more of the following conditions:

PERSISTENT GENERALIZED LYMPHADENOPATHY (PGL). Persistent generalized lymphadenopathy, or PGL, is a condition in which HIV continues to produce chronic painless swellings in the lymph nodes during the latency period. The lymph nodes that are most frequently affected by PGL are those in the areas of the neck, jaw, groin, and armpits. PGL affects between 50-70% of patients during latency.

CONSTITUTIONAL SYMPTOMS. Many patients will develop low-grade fevers, chronic fatigue, and general weakness. HIV may also cause a combination of food malabsorption, loss of appetite, and increased metabolism that contribute to the so-called AIDS wasting or wasting syndrome.

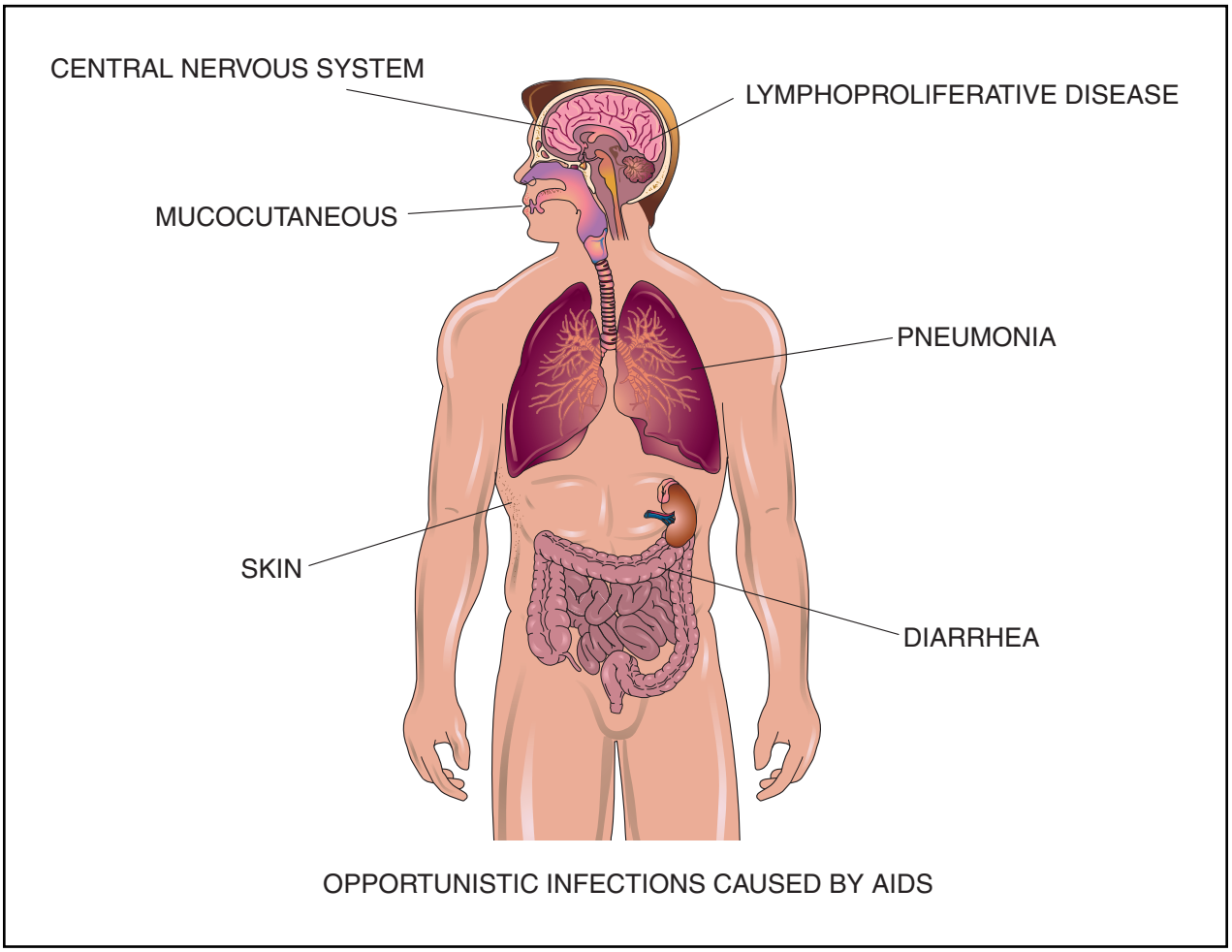
OTHER ORGAN SYSTEMS. At any time during the course of HIV infection, patients may suffer from a yeast infection in the mouth called thrush, open sores or ulcers, or other infections of the mouth; **diarrhea** and other gastrointestinal symptoms that cause **malnutrition** and weight loss; diseases of the lungs and kidneys; and degeneration of the nerve fibers in the arms and legs. HIV infection of the nervous system leads to general loss of strength, loss of reflexes, and feelings of numbness or burning sensations in the feet or lower legs.

Late-stage disease (AIDS)

AIDS is usually marked by a very low number of CD4+ lymphocytes, followed by a rise in the frequency of opportunistic infections and cancers. Doctors monitor the number and proportion of CD4+ lymphocytes in the patient's blood in order to assess the progression of the disease and the effectiveness of different medications. About 10% of infected individuals never progress to this overt stage of the disease and are referred to as nonprogressors.

OPPORTUNISTIC INFECTIONS. Once the patient's CD4+ lymphocyte count falls below 200 cells/mm^3, he or she is at risk for a variety of opportunistic infections. The infectious organisms may include the following:

- Fungi. The most common fungal disease associated with AIDS is *Pneumocystis carinii* **pneumonia** (PCP). PCP is the immediate cause of death in 15-20% of AIDS patients. It is an important measure of a patient's prognosis. Other fungal infections include a yeast infection of the mouth (**candidiasis** or thrush) and cryptococcal meningitis.
- Protozoa. **Toxoplasmosis** is a common opportunistic infection in AIDS patients that is caused by a protozoan. Other diseases in this category include isoporiasis and cryptosporidiosis.
- Mycobacteria. AIDS patients may develop **tuberculosis** or MAC infections. MAC infections are caused by



Because the immune system cells are destroyed by the AIDS virus, many different types of infections and cancers can develop, taking advantage of a person's weakened immune system. *(Illustration by Electronic Illustrators Group.)*

Mycobacterium avium-intracellulare, and occur in about 40% of AIDS patients. It is rare until CD4+ counts falls below 50 cells/mm^3.

- Bacteria. AIDS patients are likely to develop bacterial infections of the skin and digestive tract.
- Viruses. AIDS patients are highly vulnerable to cytomegalovirus (CMV), herpes simplex virus (HSV), varicella zoster virus (VZV), and Epstein-Barr virus (EBV) infections. Another virus, JC virus, causes progressive destruction of brain tissue in the brain stem, cerebrum, and cerebellum (multifocal leukoencephalopathy or PML), which is regarded as an AIDS-defining illness by the Centers for Disease Control and Prevention.

AIDS DEMENTIA COMPLEX AND NEUROLOGIC COMPLICATIONS. AIDS **dementia** complex is usually a late complication of the disease. It is unclear whether it is caused by the direct effects of the virus on the brain or by intermediate causes. AIDS dementia complex is marked by loss of reasoning ability, loss of memory, inability to concentrate, apathy and loss of initiative, and unsteadiness or weakness in walking. Some patients also develop seizures. There are no specific treatments for AIDS dementia complex.

MUSCULOSKELETAL COMPLICATIONS. Patients in late-stage AIDS may develop inflammations of the muscles, particularly in the hip area, and may have arthritis-like pains in the joints.

ORAL SYMPTOMS. In addition to thrush and painful ulcers in the mouth, patients may develop a condition called hairy leukoplakia of the tongue. This condition is also regarded by the CDC as an indicator of AIDS. Hairy leukoplakia is a white area of diseased tissue on the tongue that may be flat or slightly raised. It is caused by the Epstein-Barr virus.

KEY TERMS

Acute retroviral syndrome—A group of symptoms resembling mononucleosis that often are the first sign of HIV infection in 50-70% of all patients and 45-90% of women.

AIDS dementia complex—A type of brain dysfunction caused by HIV infection that causes difficulty thinking, confusion, and loss of muscular coordination.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—Any substance that stimulates the body to produce antibody.

Autoimmunity—A condition in which the body's immune system produces antibodies in response to its own tissues or blood components instead of foreign particles or microorganisms.

CCR5—A chemokine receptor; defects in its structure caused by genetic mutation cause the progression of AIDS to be prevented or slowed.

CD4—A type of protein molecule in human blood, sometimes called the T4 antigen, that is present on the surface of 65% of immune cells. The HIV virus infects cells with CD4 surface proteins, and as a result, depletes the number of T cells, B cells, natural killer cells, and monocytes in the patient's blood. Most of the damage to an AIDS patient's immune system is done by the virus' destruction of CD4+ lymphocytes.

Chemokine receptor—A receptor on the surface of some types of immune cells that helps to mediate entry of HIV into the cell.

Hairy leukoplakia of the tongue—A white area of diseased tissue on the tongue that may be flat or slightly raised. It is caused by the Epstein-Barr virus and is an important diagnostic sign of AIDS.

Hemophilia—Any of several hereditary blood coagulation disorders occurring almost exclusively in males. Because blood does not clot properly, even minor injuries can cause significant blood loss that may require a blood transfusion, with its associated minor risk of infection.

Human immunodeficiency virus (HIV)—A transmissible retrovirus that causes AIDS in humans. Two forms of HIV are now recognized: HIV-1, which causes most cases of AIDS in Europe, North and South America, and most parts of Africa; and HIV-2, which is chiefly found in West African patients. HIV-2, discovered in 1986, appears to be less virulent than HIV-1 and may also have a longer latency period.

Immunodeficient—A condition in which the body's immune response is damaged, weakened, or is not functioning properly.

Kaposi's sarcoma—A cancer of the connective tissue that produces painless purplish red (in people with light skin) or brown (in people with dark skin) blotches on the skin. It is a major diagnostic marker of AIDS.

Latent period—Also called incubation period, the time between infection with a disease-causing agent and the development of disease.

Lymphocyte—A type of white blood cell that is important in the formation of antibodies and that can be used to monitor the health of AIDS patients.

AIDS-RELATED CANCERS. Patients with late-stage AIDS may develop **Kaposi's sarcoma** (KS), a skin tumor that primarily affects homosexual men. KS is the most common AIDS-related malignancy. It is characterized by reddish-purple blotches or patches (brownish in African-Americans) on the skin or in the mouth. About 40% of patients with KS develop symptoms in the digestive tract or lungs. KS may be caused by a herpes virus-like sexually transmitted disease agent rather than HIV.

The second most common form of **cancer** in AIDS patients is a tumor of the lymphatic system (lymphoma). AIDS-related lymphomas often affect the central nervous system and develop very aggressively.

Invasive cancer of the cervix (related to certain types of human papilloma virus [HPV]) is an important diagnostic marker of AIDS in women.

Diagnosis

Because HIV infection produces such a wide range of symptoms, the CDC has drawn up a list of 34 conditions regarded as defining AIDS. The physician will use the CDC list to decide whether the patient falls into one of these three groups:

- definitive diagnoses with or without laboratory evidence of HIV infection

KEY TERMS

Lymphoma—A cancerous tumor in the lymphatic system that is associated with a poor prognosis in AIDS patients.

Macrophage—A large white blood cell, found primarily in the bloodstream and connective tissue, that helps the body fight off infections by ingesting the disease-causing organism. HIV can infect and kill macrophages.

Monocyte—A large white blood cell that is formed in the bone marrow and spleen. About 4% of the white blood cells in normal adults are monocytes.

***Mycobacterium avium* (MAC) infection**—A type of opportunistic infection that occurs in about 40% of AIDS patients and is regarded as an AIDS-defining disease.

Non-nucleoside reverse transcriptase inhibitors—The newest class of antiretroviral drugs that work by inhibiting the reverse transcriptase enzyme necessary for HIV replication.

Nucleoside analogues—The first group of effective anti-retroviral medications. They work by interfering with the AIDS virus' synthesis of DNA.

Opportunistic infection—An infection by organisms that usually don't cause infection in people whose immune systems are working normally.

Persistent generalized lymphadenopathy (PGL)—A condition in which HIV continues to produce chronic painless swellings in the lymph nodes during the latency period.

***Pneumocystis carinii* pneumonia (PCP)**—An opportunistic infection caused by a fungus that is a major cause of death in patients with late-stage AIDS.

Progressive multifocal leukoencephalopathy (PML)—A disease caused by a virus that destroys white matter in localized areas of the brain. It is regarded as an AIDS-defining illness.

Protease inhibitors—The second major category of drug used to treat AIDS that works by suppressing the replication of the HIV virus.

Protozoan—A single-celled, usually microscopic organism that is eukaryotic and, therefore, different from bacteria (prokaryotic).

Retrovirus—A virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells.

T cells—Lymphocytes that originate in the thymus gland. T cells regulate the immune system's response to infections, including HIV. CD4 lymphocytes are a subset of T lymphocytes.

Thrush—A yeast infection of the mouth characterized by white patches on the inside of the mouth and cheeks.

Viremia—The measurable presence of virus in the bloodstream that is a characteristic of acute retroviral syndrome.

Wasting syndrome—A progressive loss of weight and muscle tissue caused by the AIDS virus.

- definitive diagnoses with laboratory evidence of HIV infection
- presumptive diagnoses with laboratory evidence of HIV infection

Physical findings

Almost all the symptoms of AIDS can occur with other diseases. The general **physical examination** may range from normal findings to symptoms that are closely associated with AIDS. These symptoms are hairy leukoplakia of the tongue and Kaposi's sarcoma. When the doctor examines the patient, he or she will look for the overall pattern of symptoms rather than any one finding.

Laboratory tests for HIV infection

BLOOD TESTS (SEROLOGY). The first blood test for AIDS was developed in 1985. At present, patients who are being tested for HIV infection are usually given an enzyme-linked immunosorbent assay (ELISA) test for the presence of HIV antibody in their blood. Positive ELISA results are then tested with a Western blot or immunofluorescence (IFA) assay for confirmation. The combination of the ELISA and Western blot tests is more than 99.9%

accurate in detecting HIV infection within four to eight weeks following exposure. The polymerase chain reaction (PCR) test can be used to detect the presence of viral nucleic acids in the very small number of HIV patients who have false-negative results on the ELISA and Western blot tests. These tests are also used to detect viruses and bacterium other than HIV and AIDS.

OTHER LABORATORY TESTS. In addition to diagnostic blood tests, there are other blood tests that are used to track the course of AIDS in patients that have already been diagnosed. These include blood counts, viral load tests, p24 antigen assays, and measurements of β_2-microglobulin (β_2M).

Doctors will use a wide variety of tests to diagnose the presence of opportunistic infections, cancers, or other disease conditions in AIDS patients. Tissue biopsies, samples of cerebrospinal fluid, and sophisticated imaging techniques, such as **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT) are used to diagnose AIDS-related cancers, some opportunistic infections, damage to the central nervous system, and wasting of the muscles. Urine and stool samples are used to diagnose infections caused by parasites. AIDS patients are also given blood tests for **syphilis** and other sexually transmitted diseases.

Diagnosis in children

Diagnostic blood testing in children older than 18 months is similar to adult testing, with ELISA screening confirmed by Western blot. Younger infants can be diagnosed by direct culture of the HIV virus, PCR testing, and p24 antigen testing.

In terms of symptoms, children are less likely than adults to have an early acute syndrome. They are, however, likely to have delayed growth, a history of frequent illness, recurrent ear infections, a low blood cell count, failure to gain weight, and unexplained fevers. Children with AIDS are more likely to develop bacterial infections, inflammation of the lungs, and AIDS-related brain disorders than are HIV-positive adults.

Treatment

Treatment for AIDS covers four considerations:

TREATMENT OF OPPORTUNISTIC INFECTIONS AND MALIGNANCIES. Most AIDS patients require complex long-term treatment with medications for infectious diseases. This treatment is often complicated by the development of resistance in the disease organisms. AIDS-related malignancies in the central nervous system are usually treated with **radiation therapy**. Cancers elsewhere in the body are treated with **chemotherapy**.

PROPHYLACTIC TREATMENT FOR OPPORTUNISTIC INFECTIONS. Prophylactic treatment is treatment that is given to prevent disease. AIDS patients with a history of *Pneumocystis* pneumonia; with CD4+ counts below 200 cells/mm^3 or 14% of lymphocytes; weight loss; or thrush should be given prophylactic medications. The three drugs given are trimethoprim-sulfamethoxazole, dapsone, or pentamidine in aerosol form.

ANTI-RETROVIRAL TREATMENT. In recent years researchers have developed drugs that suppress HIV replication, as distinct from treating its effects on the body. These drugs fall into three classes:

- Nucleoside analogues. These drugs work by interfering with the action of HIV reverse transcriptase inside infected cells, thus ending the virus' replication process. These drugs include zidovudine (sometimes called azidothymidine or AZT), didanosine (ddI), zalcitabine (ddC), stavudine (d4T), lamivudine (3TC), and abacavir (ABC).
- **Protease inhibitors**. Protease inhibitors can be effective against HIV strains that have developed resistance to nucleoside analogues, and are often used in combination with them. These compounds include saquinavir, ritonavir, indinavir, nelfinavir, amprenavir, and lopinavir.
- Non-nucleoside reverse transcriptase inhibitors. This is a new class of antiretroviral agents. Three are available, nevirapine, which was approved first, delavirdine and efavirin.

Treatment guidelines for these agents are in constant change as new medications are developed and introduced. Two principles currently guide doctors in working out drug regimens for AIDS patients: using combinations of drugs rather than one medication alone; and basing treatment decisions on the results of the patient's viral load tests.

STIMULATION OF BLOOD CELL PRODUCTION. Because many patients with AIDS suffer from abnormally low levels of both red and white blood cells, they may be given medications to stimulate blood cell production. Epoetin alfa (erythropoietin) may be given to anemic patients. Patients with low white blood cell counts may be given filgrastim or sargramostim.

Treatment in women

Treatment of pregnant women with HIV is particularly important in that anti-retroviral therapy has been shown to reduce transmission to the infant by 65%.

Alternative treatment

Alternative treatments for AIDS can be grouped into two categories: those intended to help the immune sys-

tem and those aimed at **pain** control. Treatments that may enhance the function of the immune system include Chinese herbal medicine and western herbal medicine, macrobiotic and other special **diets**, **guided imagery** and creative visualization, **homeopathy**, and vitamin therapy. Pain control therapies include **hydrotherapy**, **reiki**, **acupuncture**, **meditation**, **chiropractic** treatments, and therapeutic massage. Alternative therapies can also be used to help with side effects of the medications used in the treatment of AIDS.

Prognosis

At the present time, there is no cure for AIDS.

Treatment stresses aggressive combination drug therapy for those patients with access to the expensive medications and who tolerate them adequately. The use of these multi-drug therapies has significantly reduced the numbers of deaths, in this country, resulting from AIDS. The data is still inconclusive, but the potential exists to possibly prolong life indefinitely using these and other drug therapies to boost the immune system, keep the virus from replicating, and ward off opportunistic infections and malignancies.

Prognosis after the latency period depends on the patient's specific symptoms and the organ systems affected by the disease. Patients with AIDS-related lymphomas of the central nervous system die within two to three months of diagnosis; those with systemic lymphomas may survive for eight to ten months.

Prevention

As of 2001, there is no vaccine effective against AIDS. Several vaccines are currently being investigated, however, both to prevent initial HIV infection and as a therapeutic treatment to prevent HIV from progressing to full-blown AIDS.

In the meantime, there are many things that can be done to prevent the spread of AIDS:

- Be monogamous and practice safe sex. Individuals must be instructed in the proper use of condoms and urged to practice safe sex. Besides avoiding the risk of HIV infection, condoms are successful in preventing other sexually transmitted diseases and unwanted pregnancies. Before engaging in a sexual relationship with someone, get tested for HIV infection.
- Avoid needle sharing among intravenous drug users.
- Although blood and blood products are carefully monitored, those individuals who are planning to undergo major surgery may wish to donate blood ahead of time to prevent a risk of infection from a blood **transfusion**.
- Healthcare professionals must taken all necessary precautions by wearing gloves and masks when handling body fluids and preventing needle-stick injuries.
- If you suspect that you may have become infected, get tested for HIV infection. If treated aggressively early on, the development of AIDS may be postponed indefinitely. If HIV infection is confirmed, it is also vital to let your sexual partners know so that they can be tested and, if necessary, receive medical attention.

Resources

BOOKS

Early HIV Infection Guideline Panel. *Evaluation and Management of Early HIV Infection*. Rockville, MD: U.S. Department of Health and Human Services, Agency for Health Care Policy and Research, 1994.

Huber, Jeffrey T. *Dictionary of AIDS-Related Terminology.* New York and London: Neal-Schuman Publishers, Inc., 1993.

"Infectious Diseases: Human Immunodeficiency Virus (HIV)." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*. Ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

Katz, Mitchell H., and Harry Hollander. "HIV Infection." In *Current Medical Diagnosis & Treatment*. Ed. Lawrence M. Tierney Jr., et al. Stamford, CT: Appleton & Lange, 1998.

McFarland, Elizabeth J. "Human Immunodeficiency Virus (HIV) Infections: Acquired Immunodeficiency Syndrome (AIDS)." In *Current Pediatric Diagnosis & Treatment*. Ed. William W. Hay Jr., et al. Stamford, CT: Appleton & Lange, 1997.

So, Peter, and Livette Johnson. "Acquired Immune Deficiency Syndrome (AIDS)." In *Conn's Current Therapy.* Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Company, 1997.

PERIODICALS

Xiao, X., L. Wu, T. S. Stantchev, Y. R. Feng, S. Ugolini, H. Chen, Z. Shen, J. L. Riley, C. C. Broder, Q. J. Sattentau, and D. S. Dimitrov. "Constitutive cell surface association between CD4 and CCR5." *Proceedings of the National Academy of Sciences of the United States of America*. (June 1999): 7496-7501.

ORGANIZATIONS

Gay Men's Health Crisis, Inc., 129 West 20th Street, New York, NY 10011-0022. (212) 807-6655.

National AIDS Hot Line. (800) 342-AIDS (English). (800) 344-SIDA (Spanish). (800) AIDS-TTY (hearing-impaired).

OTHER

"FDA Approved Drugs for HIV Infection and AIDS-Related Conditions." *HIV/AIDS Treatment Information Service website.* January 2001. <http://hivatis.org>.

Rebecca J. Frey

AIDS serology *see* **AIDS tests**

AIDS tests

Definition

AIDS tests, short for acquired **immunodeficiency** syndrome tests, cover a number of different procedures used in the diagnosis and treatment of HIV patients. These tests are sometimes called AIDS serology tests. Serology is the branch of immunology that deals with the contents and characteristics of blood serum. Serum is the clear light yellow part of blood that remains liquid when blood cells form a clot. AIDS serology evaluates the presence of human immunodeficiency virus (HIV) infection in blood serum and its effects on each patient's immune system.

Purpose

AIDS serology serves several different purposes. Some AIDS tests are used to diagnose patients or confirm a diagnosis; others are used to measure the progression of the disease or the effectiveness of specific treatment regimens. Some AIDS tests can also be used to screen blood donations for safe use in transfusions.

In order to understand the different purposes of the blood tests used with AIDS patients, it is helpful to understand how HIV infection affects human blood and the immune system. HIV is a retrovirus that enters the blood stream of a new host in the following ways:

- by sexual contact
- by contact with infected body fluids (such as blood and urine)
- by transmission during **pregnancy**, or
- through **transfusion** of infected blood products

A retrovirus is a virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells. The virus binds to a protein called CD4, which is found on the surface of certain subtypes of white blood cells, including helper T cells, macrophages, and monocytes. Once HIV enters the cell, it can replicate and kill the cell in ways that are still not completely understood. In addition to killing some lymphocytes directly, the AIDS virus disrupts the functioning of the remaining CD4 cells. CD4 cells ordinarily produce a substance called interleukin-2 (IL-2), which stimulates other cells (T cells and B cells) in the human immune system to respond to infections. Without the IL-2, T cells do not reproduce as they normally would in response to the HIV virus, and B cells are not stimulated to respond to the infection.

Precautions

In some states such as New York, a signed consent form is needed in order to administer an AIDS test. As with all blood tests, healthcare professionals should always wear latex gloves and to avoid being pricked by the needle used in drawing blood for the tests. Also, it may be difficult to get blood from a habitual intravenous drug user due to collapsed veins.

Description

Diagnostic tests

Diagnostic blood tests for AIDS are usually given to persons in high-risk populations who may have been exposed to HIV or who have the early symptoms of AIDS. Most persons infected with HIV will develop a detectable level of antibody within three months of infection. The condition of testing positive for HIV antibody in the blood is called seroconversion, and persons who have become HIV-positive are called seroconverters.

It is possible to diagnose HIV infection by isolating the virus itself from a blood sample or by demonstrating the presence of HIV antigen in the blood. Viral culture, however, is expensive, not widely available, and slow—it takes 28 days to complete the viral culture test. More common are blood tests that work by detecting the presence of antibodies to the HIV virus. These tests are inexpensive, widely available, and accurate in detecting 99.9% of AIDS infections when used in combination to screen patients and confirm diagnoses.

ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA). This type of blood test is used to screen blood for transfusions as well as diagnose patients. An ELISA test for HIV works by attaching HIV antigens to a plastic well or beads. A sample of the patient's blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by addition of a substance that will cause the enzyme to react by forming a color. An instrument called a spectrophotometer can measure the color. The name of the test is derived from the use of the enzyme that is coupled or linked to the second antibody.

The latest generation of ELISA tests are 99.5% sensitive to HIV. Occasionally, the ELISA test will be positive for a patient without symptoms of AIDS from a low-risk group. Because this result is likely to be a false-positive, the ELISA must be repeated *on the same sample of the patient's blood*. If the second ELISA is positive, the result should be confirmed by the Western blot test.

WESTERN BLOT (IMMUNOBLOT). The Western blot or immunoblot test is used as a reference procedure to confirm the diagnosis of AIDS. In Western blot testing, HIV antigen is purified by electrophoresis (large protein molecules are suspended in a gel and separated from one another by running an electric current through the gel).

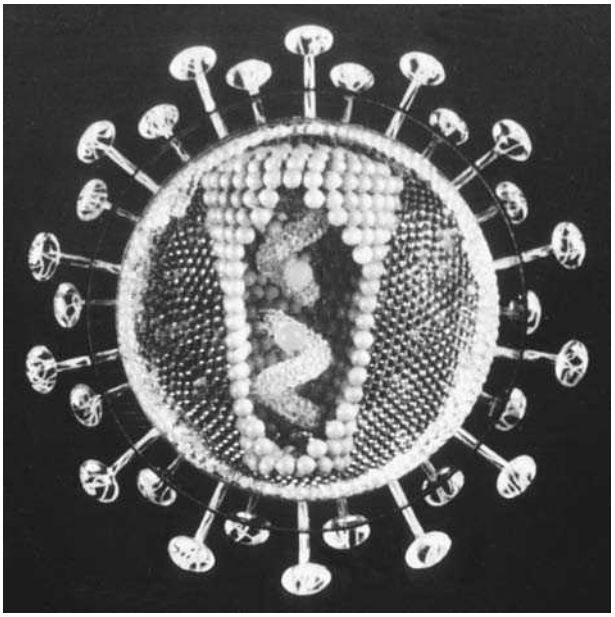
The HIV antigens are attached by blotting to a nylon or nitrocellulose filter. The patient's serum is reacted against the filter, followed by treatment with developing chemicals that allow HIV antibody to show up as a colored patch or blot. A commercially produced Western blot test for HIV-1 is now available. It consists of a prefabricated strip that is incubated with a sample of the patient's blood serum and the developing chemicals. About nine different HIV-1 proteins can be detected in the blots.

When used in combination with ELISA testing, Western blot testing is 99.9% specific. It can, however, yield false negatives in patients with very early HIV infection and in those infected by HIV-2. In some patients the Western blot yields indeterminate results.

IMMUNOFLUORESCENCE ASSAY (IFA). This method is sometimes used to confirm ELISA results instead of Western blotting. An IFA test detects the presence of HIV antibody in a sample of the patient's serum by mixing HIV antigen with a fluorescent chemical, adding the blood sample, and observing the reaction under a microscope with ultraviolet light.

POLYMERASE CHAIN REACTION (PCR). This test is used to evaluate the very small number of AIDS patients with false-negative ELISA and Western blot tests. These patients are sometimes called antibody-negative asymptomatic (without symptoms) carriers, because they do not have any symptoms of AIDS and there is no detectable quantity of antibody in the blood serum. Antibody-negative asymptomatic carriers may be responsible for the very low ongoing risk of HIV infection transmitted by blood transfusions. It is estimated that the risk is between 1 in 10,000 and 1 in 100,000 units of transfused blood.

The polymerase chain reaction (PCR) test can measure the presence of viral nucleic acids in the patient's blood even when there is no detectable antibody to HIV. This test works by amplifying the presence of HIV nucleic acids in a blood sample. Numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. It is questionable whether PCR will replace Western blotting as the method of confirming AIDS diagnoses. Although PCR can detect the low number of persons (1%) with HIV infections that have not yet generated an antibody response to the virus, the overwhelming majority of infected persons will be detected by ELISA screening within one to three months of infection. In addition, PCR testing is based on present knowledge of the genetic sequences in HIV. Since the virus is continually generating new variants, PCR testing could yield a false negative in patients with these new variants.



A three-dimensional model of the HIV virus. *(Corbis Corporation (New York). Reproduced by permission.)*

In 1999, the U.S. Food and Drug Administration (FDA) approved an HIV home testing kit. The kit contains multiple components, including material for specimen collection, a mailing envelope to send the specimen to a laboratory for analysis, and provides pre- and post-test counseling. It uses a finger prick process for blood collection. The results are obtained by the purchaser through a toll free telephone number using a personal identification number (PIN). Post test counseling is provided over the telephone by a licensed counselor. The only kit approved by the FDA as of 2001 was the Home Access test system.

Prognostic tests

Blood tests to evaluate patients already diagnosed with HIV infection are as important as the diagnostic tests. Because AIDS has a long latency period, some persons may be infected with the virus for 10 years or longer before they develop symptoms of AIDS. These patients are sometimes called antibody-positive asymptomatic carriers. Prognostic tests also help drug researchers evaluate the usefulness of new medications in treating AIDS.

BLOOD CELL COUNTS. Doctors can measure the number or proportion of certain types of cells in an AIDS patient's blood to see whether and how rapidly the disease is progressing, or whether certain treatments are helping the patient. These cell count tests include:

- Complete **blood count** (CBC). A CBC is a routine analysis performed on a sample of blood taken from the patient's vein with a needle and vacuum tube. The mea-

KEY TERMS

Antibody—A protein in the blood that identifies and helps remove disease organisms or their toxins. Antibodies are secreted by B cells. AIDS diagnostic tests work by demonstrating the presence of HIV antibody in the patient's blood.

Antigen—Any substance that stimulates the body to produce antibodies.

B cell—A type of white blood cell derived from bone marrow. B cells are sometimes called B lymphocytes. They secrete antibody and have a number of other complex functions within the human immune system.

CD4—A type of protein molecule in human blood that is present on the surface of 65% of human T cells. CD4 is a receptor for the HIV virus. When the HIV virus infects cells with CD4 surface proteins, it depletes the number of T cells, B cells, natural killer cells, and monocytes in the patient's blood. Most of the damage to an AIDS patient's immune system is done by the virus' destruction of CD4+ lymphocytes. CD4 is sometimes called the T4 antigen.

Complete blood count (CBC)—A routine analysis performed on a sample of blood taken from the patient's vein with a needle and vacuum tube. The measurements taken in a CBC include a white blood cell count, a red blood cell count, the red cell distribution width, the hematocrit (ratio of the volume of the red blood cells to the blood volume), and the amount of hemoglobin (the blood protein that carries oxygen). CBCs are a routine blood test used for many medical reasons and are not used only for AIDS patients. They can help the doctor determine if a patient is in advanced stages of the disease.

Electrophoresis—A method of separating complex protein molecules suspended in a gel by running an electric current through the gel.

Enzyme-linked immunosorbent assay (ELISA)—A diagnostic blood test used to screen patients for AIDS or other viruses. The patient's blood is mixed with antigen attached to a plastic tube or bead surface. A sample of the patient's blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by a chemical that will cause a color reaction that can be measured by a special instrument.

Human immunodeficiency virus (HIV)—A transmissible retrovirus that causes AIDS in humans. Two forms of HIV are now recognized: HIV-1, which causes most cases of AIDS in Europe, North and South America, and most parts of Africa; and HIV-2, which is chiefly found in West African patients. HIV-2, discovered in 1986, appears to be less virulent than HIV-1, but may also have a longer latency period.

Immunofluorescent assay (IFA)—A blood test sometimes used to confirm ELISA results instead of using the Western blotting. In an IFA test, HIV antigen is mixed with a fluorescent compound and then with a sample of the patient's blood. If HIV antibody is present, the mixture will fluoresce when examined under ultraviolet light.

Lymphocyte—A type of white blood cell that is important in the formation of antibodies. Doctors

surements taken in a CBC include a white blood cell count (WBC), a red blood cell count (RBC), the red cell distribution width, the **hematocrit** (ratio of the volume of the red blood cells to the blood volume), and the amount of hemoglobin (the blood protein that carries oxygen). Although CBCs are used on more than just AIDS patients, they can help the doctor determine if an AIDS patient has an advanced form of the disease. Specific AIDS-related signs in a CBC include a low hematocrit, a sharp decrease in the number of blood platelets, and a low level of a certain type of white blood cell called neutrophils.

- Absolute CD4+ lymphocytes. A lymphocyte is a type of white blood cell that is important in the formation of an immune response. Because HIV targets CD4+ lymphocytes, their number in the patient's blood can be used to track the course of the infection. This blood cell count is considered the most accurate indicator for the presence of an opportunistic infection in an AIDS patient. The absolute CD4+ lymphocyte count is obtained by multiplying the patient's white blood cell count (WBC) by the percentage of lymphocytes among the white blood cells, and multiplying the result by the percentage of lymphocytes bearing the CD4+ marker. An absolute count below 200-300 CD+4 lymphocytes in 1 cubic millimeter (mm^3) of blood indicates that the patient is vulnerable to some opportunistic infections.

KEY TERMS

can monitor the health of AIDS patients by measuring the number or proportion of certain types of lymphocytes in the patient's blood.

Macrophage—A large white blood cell, found primarily in the bloodstream and connective tissue, that helps the body fight off infections by ingesting the disease organism. HIV can infect and kill macrophages.

Monocyte—A large white blood cell that is formed in the bone marrow and spleen. About 4% of the white blood cells in normal adults are monocytes.

Opportunistic infection—An infection that develops only when a person's immune system is weakened, as happens to AIDS patients.

Polymerase chain reaction (PCR)—A test performed to evaluate false-negative results to the ELISA and Western blot tests. In PCR testing, numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. The amplification of gene sequences that are associated with HIV allows for detection of the virus by this method.

Retrovirus—A virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells.

Seroconversion—The change from HIV- negative to HIV-positive status during blood testing. Persons who are HIV-positive are called seroconverters.

Serology—The analysis of the contents and properties of blood serum.

Serum—The part of human blood that remains liquid when blood cells form a clot. Human blood serum is clear light yellow in color.

T cells—Lymphocytes that originate in the thymus gland. T cells regulate the immune system's response to infections, including HIV. CD4 lymphocytes are a subset of T lymphocytes.

Viral load test—A new blood test for monitoring the speed of HIV replication in AIDS patients. The viral load test is based on PCR techniques and supplements the CD4+ cell count tests.

Western blot—A technique developed in 1979 that is used to confirm ELISA results. HIV antigen is purified by electrophoresis and attached by blotting to a nylon or nitrocellulose filter. The patient's serum is reacted against the filter, followed by treatment with developing chemicals that allow HIV antibody to show up as a colored patch or blot. If the patient is HIV-positive, there will be stripes at specific locations for two or more viral proteins. A negative result is blank.

WBC differential—A white blood cell count in which the technician classifies the different white blood cells by type as well as calculating the number of each type. A WBC differential is necessary to calculate the absolute CD4+ lymphocyte count.

- CD4+ lymphocyte percentage. Some doctors think that this is a more accurate test than the absolute count because the percentage does not depend on a manual calculation of the number of types of different white blood cells. A white blood cell count that is broken down into categories in this way is called a WBC differential.

It is important for doctors treating AIDS patients to measure the lymphocyte count on a regular basis. Experts consulted by the United States Public Health Service recommend the following frequency of serum testing based on the patient's CD4+ level:

- CD4+ count more than 600 cells/mm^3: Every six months.
- CD4+ count between 200-600 cells/mm^3: Every three months.
- CD4+ count less than 200 cells/mm^3: Every three months.

When the CD4+ count falls below 200 cells/mm^3, the doctor will put the patient on a medication regimen to protect him or her against opportunistic infections.

HIV VIRAL LOAD TESTS. Another type of blood test for monitoring AIDS patients is the viral load test. It supplements the CD4+ count, which can tell the doctor the extent of the patient's loss of immune function, but not the speed of HIV replication in the body. The viral load test is based on PCR techniques and can measure the

number of copies of HIV nucleic acids. Successive test results for a given patient's viral load are calculated on a base 10 logarithmic scale.

BETA$_2$-MICROGLOBULIN (β_2M). Beta$_2$-microglobulin is a protein found on the surface of all human cells with a nucleus. It is released into the blood when a cell dies. Although rising blood levels of β_2M are found in patients with **cancer** and other serious diseases, a rising β_2M blood level can be used to measure the progression of AIDS.

P24 ANTIGEN CAPTURE ASSAY. Found in the viral core of HIV, p24 is a protein that can be measured by the ELISA technique. Doctors can use p24 assays to measure the antiviral activity of the patient's medications. In addition, the p24 assay is sometimes useful in detecting HIV infection before seroconversion. However, p24 is consistently present in only 25% of persons infected with HIV.

GENOTYPIC DRUG RESISTANCE TEST. Genotypic testing can help determine whether specific gene mutations, common in people with HIV, are causing drug resistance and drug failure. The test looks for specific genetic mutations of within the virus that are known to cause resistance to certain drugs used in HIV treatment. For example the drug 3TC, also known as lamivudine (Epivir), is not effective against strains of HIV that have a mutation at a particular position on the reverse transcriptase protein—amino acid 184—known as M184V (M→V, methionine to valine). So if the genotypic resistance test shows a mutation at position M184V, it is likely that person is resistant to 3TC and not likely to respond to 3TC treatment. Genotypic tests are only effective if the person is already taking antiviral medication and if the viral load is greater than 1,000 copies per milliliter (mL) of blood. The cost of the test, usually between $300 and $500, is usually now covered by many insurance plans.

PHENOTYPIC DRUG RESISTANCE TESTING. Phenotypic testing directly measures the sensitivity of a patient's HIV to particular drugs and drug combinations. To do this, it measures the concentration of a drug required to inhibit viral replication in the test tube. This is the same method used by researchers to determine whether a drug might be effective against HIV before using it in human clinical trials. Phenotypic testing is a more direct measurement of resistance than genotypic testing. Also, unlike genotypic testing, phenotypic testing does not require a high viral load but it is recommended that persons already be taking **antiretroviral drugs**. The cost is between $700 and $900 and is now covered by many insurance plans.

AIDS serology in children

Children born to HIV-infected mothers may acquire the infection through the mother's placenta or during the birth process. Public health experts recommend the testing and monitoring of all children born to mothers with HIV. Diagnostic testing in children older than 18 months is similar to adult testing, with ELISA screening confirmed by Western blot. Younger infants can be diagnosed by direct culture of the HIV virus, PCR testing, and p24 antigen testing. These techniques allow a pediatrician to identify 50% of infected children at or near birth, and 95% of cases in infants three to six months of age.

Preparation

Preparation and aftercare are important parts of AIDS diagnostic testing. Doctors are now advised to take the patient's emotional, social, economic, and other circumstances into account and to provide counseling before and after testing. Patients are generally better able to cope with the results if the doctor has spent some time with them before the blood test explaining the basic facts about HIV infection and testing. Many doctors now offer this type of informational counseling before performing the tests.

Aftercare

If the test results indicate that the patient is HIV- positive, he or she will need counseling, information, referral for treatment, and support. Doctors can either counsel the patient themselves or invite an experienced HIV counselor to discuss the results of the blood tests with the patient. They will also assess the patient's emotional and psychological status, including the possibility of violent behavior and the availability of a support network.

Risks

The risks of AIDS testing are primarily related to disclosure of the patient's HIV status rather than to any physical risks connected with blood testing. Some patients are better prepared to cope with a positive diagnosis than others, depending on their age, sex, health, resources, belief system, and similar factors.

Normal results

Normal results for ELISA, Western blot, IFA, and PCR testing are negative for HIV antibody.

Normal results for blood cell counts:

- WBC differential: Total lymphocytes 24-44% of the white blood cells.
- Hematocrit: 40-54% in men; 37-47% in women.

- T cell lymphocytes: 644-2200/mm^3, 60-88% of all lymphocytes.
- B cell lymphocytes: 82-392/mm^3, 3-20% of all lymphocytes.
- CD4+ lymphocytes: 500-1200/mm^3, 34-67% of all lymphocytes.

Abnormal results

The following results in AIDS tests indicate progression of the disease:

- Percentage of CD4+ lymphocytes: less than 20% of all lymphocytes.
- CD4+ lymphocyte count: less than 200 cells/mm^3.
- Viral load test: Levels more than 5000 copies/mL.
- β-2-microglobulin: Levels more than 3.5 mg/dL.
- P24 antigen: Measurable amounts in blood serum.

Resources

BOOKS

Avrameas, Stratis, and Therese Ternynck. "Enzyme Linked Immunosorbent Assay (ELISA)." In *Encyclopedia of Immunology.* Vol. 1. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Bennett, Rebecca, and Erin, Charles A. (Editors). *HIV and AIDS Testing, Screening, and Confidentiality: Ethics, Law, and Social Policy.* Oxford, England: Oxford University Press, 2001.

Early HIV Infection Guideline Panel. *Evaluation and Management of Early HIV Infection.* Rockville, MD: U.S. Department of Health and Human Services, Agency for Health Care Policy and Research, 1994.

Huber, Jeffrey T. *Dictionary of AIDS- Related Terminology.* New York: Neal-Schuman Publishers, Inc., 1993.

"Infectious Diseases: Human Immunodeficiency Virus (HIV)." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs.* Ed. Tricia Lacy Gomella et al. Norwalk, CT: Appleton & Lange, 1994.

Katz, Mitchell H., and Harry Hollander. "HIV Infection." In *Current Medical Diagnosis & Treatment.* Ed. Lawrence M. Tierney et al. Stamford, CT: Appleton & Lange, 1998.

McClure, Myra. "Human Immunodeficiency Viruses." In *Encyclopedia of Immunology.* Vol. 2. Ed. by Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

McFarland, Elizabeth J. "Human Immunodeficiency Virus (HIV) Infections: Acquired Immunodeficiency Syndrome (AIDS)." In *Current Pediatric Diagnosis & Treatment.* Ed. William W. Hay et al. Stamford, CT: Appleton & Lange, 1997.

So, Peter, and Livette Johnson. "Acquired Immune Deficiency Syndrome (AIDS)." In *Conn's Current Therapy.* Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Company, 1997.

Springhouse Publishing. *Handbook of Diagnostic Tests.* Springhouse, PA: Springhouse Publishing Co., 1999.

Towbin, Harry. "Western Blotting." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

PERIODICALS

Freedberg, Kenneth A., and Samet, Jeffrey H. "Think HIV (HIV Testing)." *Archives of Internal Medicine* (September 27, 1999): 1994

Kaplan, Edward H., and Satten, Glen A. "Repeat Screening for HIV: When to Test and Why." *The Journal of the American Medical Association.* (July 19, 2000): 285.

Sieff, Elaine M., et al. "Anticipated Versus Actual Reaction to HIV Test Results." *American Journal of Psychology.* (Summer 1999): 297-298.

Weinhardt, Lance S., et al. "Human Immunodeficiency Virus Testing and Behavior Change." *Archives of Internal Medicine.* (May 22, 2000): 1538.

Woehrle, Theresa A., and Branson, Bernard. "New Tests for Detecting HIV Infection." *The Western Journal of Medicine.* (December 1998): 371-372.

ORGANIZATION

National Association of People with Aids. 1413 K St.N.W., Washington, DC 20005-3442. (202) 898-0414.

National Institute of Health. Office of Aids Research. (301) 496-0357. <http://www.nih.gov/od/oar/index.htm>.

Centers for Disease Control and Prevention (CDC). 1600 Clifton Rd., Atlanta, GA 30337. (404) 639-3311. <http://www.cdc.gov>.

OTHER

Food and Drug Administration (FDA). "Testing Yourself for HIV-1, the Virus that Causes AIDS." 1999. Available at FDA Website: <http://www.fda.gov>. or by calling (301) 827-4460.

Ken R. Wells

Air embolism *see* **Gas embolism**

Alanine aminotransferase test

Definition

The alanine aminotransferase test, also known as ALT, is one of a group of tests known as **liver function tests** (or LFTs) and is used to monitor damage to the liver.

Purpose

ALT levels are used to detect liver abnormalities. Since the alanine aminotransferase enzyme is also found in muscle, tests indicating elevated AST levels might also indicate muscle damage. However, other tests, such as

the levels of the MB fraction of creatine kinase should indicate whether the abnormal test levels are because of muscle or liver damage.

Description

The alanine aminotransferase test (ALT) can reveal liver damage. It is probably the most specific test for liver damage. However, the severity of the liver damage is not necessarily shown by the ALT test, since the amount of dead liver tissue does not correspond to higher ALT levels. Also, patients with normal, or declining, ALT levels may experience serious liver damage without an increase in ALT.

Nevertheless, ALT is widely used, and useful, because ALT levels are elevated in most patients with liver disease. Although ALT levels do not necessarily indicate the severity of the damage to the liver, they may indicate how much of the liver has been damaged. ALT levels, when compared to the levels of a similar enzyme, aspartate aminotransferase (AST), may provide important clues to the nature of the liver disease. For example, within a certain range of values, a ratio of 2:1 or greater for AST: ALT might indicate that a patient suffers from alcoholic liver disease. Other diagnostic data may be gleaned from ALT tests to indicate abnormal results.

Preparation

No special preparations are necessary for this test.

Aftercare

This test involves blood being drawn, probably from a vein in the patient's elbow. The patient should keep the wound from the needle puncture covered (with a bandage) until the bleeding stops. Patients should report any unusual symptoms to their physician.

Normal results

Normal values vary from laboratory to laboratory, and should be available to your physician at the time of the test. An informal survey of some laboratories indicates many laboratories find values from approximately seven to 50 IU/L to be normal.

Abnormal results

Low levels of ALT (generally below 300 IU/L) may indicate any kind of liver disease. Levels above 1,000 IU/L generally indicate extensive liver damage from toxins or drugs, viral hepatitis, or a lack of oxygen (usually resulting from very low blood pressure or a **heart attack**). A briefly elevated ALT above 1,000 IU/L that resolves in 24-48 hours may indicate a blockage of the bile duct. More moderate levels of ALT (300-1,000IU/L) may support a diagnosis of acute or chronic hepatitis.

It is important to note that persons with normal livers may have slightly elevated levels of ALT. This is a normal finding.

Michael V. Zuck, PhD

Alanine aminotransferase test *see* **Liver function tests**

Albers-Schönberg disease *see* **Osteopetroses**

Albinism

Definition

Albinism is an inherited condition present at birth, characterized by a lack of pigment that normally gives color to the skin, hair, and eyes. Many types of albinism exist, all of which involve lack of pigment in varying degrees. The condition, which is found in all races, may be accompanied by eye problems and may lead to skin **cancer** later in life.

Description

Albinism is a rare disorder found in fewer than five people per 100,000 in the United States and Europe. Other parts of the world have a much higher rate; for example, albinism is found in about 20 out of every 100,000 people in southern Nigeria.

There are 10 types of the most common form of the condition, known as "oculocutaneous albinism," which affects the eyes, hair, and skin. In its most severe form, hair and skin remain pure white throughout life. People with a less severe form are born with white hair and skin, which turn slightly darker as they age. Everyone with oculocutaneous albinism experiences abnormal flickering eye movements (**nystagmus**) and sensitivity to bright light. There may be other eye problems as well, including poor vision and crossed or "lazy" eyes (**strabismus**).

The second most common type of the condition is known as "ocular" albinism, in which only the eyes lack color; skin and hair are normal. There are five forms of ocular albinism; some types cause more problems—especially eye problems—than others.

KEY TERMS

Amino acids—Natural substances that are the building blocks of protein. The body breaks down the protein in food into amino acids, and then uses these amino acids to create other proteins. The body also changes amino acids into melanin pigment.

Astigmatism—An eye condition in which the lens doesn't focus light evenly on the retina, leading to problems with visual sharpness.

Carrier—A person with one normal gene and one faulty gene, who can pass on a condition to others without actually having symptoms.

DNA—The abbreviation for "deoxyribonucleic acid," the primary carrier of genetic information found in the chromosomes of almost all organisms. The entwined double structure allows the chromosomes to be copied exactly during cell division.

DOPA—The common name for a natural chemical (3,4-dihydroxyphenylalanine) made by the body during the process of making melanin.

Enzyme—A protein that helps the body convert one chemical substance to another.

Gene—The basic unit of genetic material carried in a particular place on a chromosome. Genes are passed on from parents to child when the sperm and egg unite during conception.

Hairbulb—The root of a strand of hair from which the color develops.

Hermansky-Pudlak Syndrome (HPS)—A rare type of albinism characterized by a problem with blood clotting and a buildup of waxy material in lungs and intestines.

Melanin—Pigment made in the hair, skin and eyes.

Nystagmus—An involuntary back-and-forth movement of the eyes that is often found in albinism.

Strabismus—Crossed or "lazy" eyes, often found in albinism.

Tyrosine—A protein building block found in a wide variety of foods that is used by the body to make melanin.

Tyrosinase—An enzyme in a pigment cell which helps change tyrosine to DOPA during the process of making melanin.

Causes and symptoms

Every cell in the body contains a matched pair of genes, one inherited from each parent. These genes act as a sort of "blueprint" that guides the development of a fetus.

Albinism is an inherited problem caused by a flaw in one or more of the genes that are responsible for directing the eyes and skin to make melanin (pigment). As a result, little or no pigment is made, and the child's skin, eyes and hair may be colorless.

In most types of albinism, a recessive trait, the child inherits flawed genes for making melanin from both parents. Because the task of making melanin is complex, there are many different types of albinism, involving a number of different genes.

It's also possible to inherit one normal gene and one albinism gene. In this case, the one normal gene provides enough information in its cellular blueprint to make some pigment, and the child will have normal skin and eye color. They "carry" one gene for albinism. About one in 70 people are albinism carriers, with one flawed gene but no symptoms; they have a 50% chance of passing the albinism gene to their child. However, if both parents are carriers with one flawed gene each, they have a 1 in 4 chance of passing on both copies of the flawed gene to the child, who will have albinism. (There is also a type of ocular albinism that is carried on the X chromosome and occurs almost exclusively in males because they have only one X chromosome and, therefore, no other gene for the trait to override the flawed one.)

Symptoms of albinism can involve the skin, hair, and eyes. The skin, because it contains little pigment, appears very light, as does the hair.

Although people with albinism may experience a variety of eye problems, one of the myths about albinism is that it causes people to have pink or red eyes. In fact, people with albinism can have irises varying from light gray or blue to brown. (The iris is the colored portion of the eye that controls the size of the pupil, the opening that lets light into the eye.) If people with albinism seem to have reddish eyes, it's because light is being reflected from the back of the eye (retina) in much the same way as happens when people are photographed with an electronic flash.

People with albinism may have one or more of the following eye problems:

A man with albinism stands with his normally pigmented father. *(Photograph by Norman Lightfoot, Photo Researchers, Inc. Reproduced by permission.)*

- They may be very far-sighted or near-sighted, and may have other defects in the curvature of the lens of the eye (**astigmatism**) that cause images to appear unfocused.
- They may have a constant, involuntary movement of the eyeball called nystagmus.
- They may have problems in coordinating the eyes in fixing and tracking objects (strabismus), which may lead to an appearance of having "crossed eyes" at times. Strabismus may cause some problems with depth perception, especially at close distances.
- They may be very sensitive to light (photophobia) because their irises allow "stray" light to enter their eyes. It's a common misconception that people with albinism shouldn't go out on sunny days, but wearing sunglasses can make it possible to go outside quite comfortably.

In addition to the characteristically light skin and eye problems, people with a rare form of albinism called Hermansky-Pudlak Syndrome (HPS) also have a greater tendency to have bleeding disorders, inflammation of the large bowel (colitis), lung (pulmonary) disease, and kidney (renal) problems.

Diagnosis

It's not always easy to diagnose the exact type of albinism a person has; there are two tests available that can identify only two types of the condition. Recently, a blood test has been developed that can identify carriers of the gene for some types of albinism; a similar test during **amniocentesis** can diagnose some types of albinism in an unborn child. A **chorionic villus sampling** test during the fifth week of **pregnancy** may also reveal some types of albinism.

The specific type of albinism a person has can be determined by taking a good family history and examining the patient and several close relatives.

The "hairbulb pigmentation test" is used to identify carriers by incubating a piece of the person's hair in a solution of tyrosine, a substance in food which the body uses to make melanin. If the hair turns dark, it means the hair is making melanin (a "positive" test); light hair means there is no melanin. This test is the source of the names of two types of albinism: "ty-pos" and "ty-neg."

The tyrosinase test is more precise than the hairbulb pigmentation test. It measures the rate at which hair con-

verts tyrosine into another chemical (DOPA), which is then made into pigment. The hair converts tyrosine with the help of a substance called "tyrosinase." In some types of albinism, tyrosinase doesn't do its job, and melanin production breaks down.

Treatment

There is no treatment that can replace the lack of melanin that causes the symptoms of albinism. Doctors can only treat, not cure, the eye problems that often accompany the lack of skin color. Glasses are usually needed and can be tinted to ease **pain** from too much sunlight. There is no cure for involuntary eye movements (nystagmus), and treatments for focusing problems (surgery or contact lenses) are not effective in all cases.

Crossed eyes (strabismus) can be treated during infancy, using eye patches, surgery or medicine injections. Treatment may improve the appearance of the eye, but it can do nothing to cure the underlying condition.

Patients with albinism should avoid excessive exposure to the sun, especially between 10 A.M. and 2 P.M. If exposure can't be avoided, they should use UVA-UVB sunblocks with an SPF of at least 20. Taking beta-carotene may help provide some skin color, although it doesn't protect against sun exposure.

Prognosis

In the United States, people with this condition can expect to have a normal lifespan. People with albinism may experience some social problems because of a lack of understanding on the part of others. When a member of a normally dark-skinned ethnic group has albinism, he or she may face some very complex social challenges.

One of the greatest health hazards for people with albinism is excessive exposure to sun without protection, which could lead to skin cancer. Wearing opaque clothes and sunscreen rated SPF 20, people with albinism can safely work and play outdoors safely even during the summer.

Prevention

Genetic counseling is very important to prevent further occurrences of the condition.

Resources

BOOKS

National Association for the Visually Handicapped. *Larry: A Book for Children with Albinism Going to School*. New York: National Association for the Visually Handicapped.

Witkop Jr., C. J., W. C. Quevedo Jr., T. B. Fitzpatrick, and R. A King. "Albinism." In *The Metabolic Basis of Inherited Disease*. 6th ed. Ed. C. R. Scriver, et al. New York: McGraw-Hill, 1989.

PERIODICALS

Campbell, Maude. "Gene Found for Albinism, Other Pigment Disorders." *Dermatology Times* (1 Apr. 1995): 1.

Siegel-Itzkovich, Judy. "Early-warning Test for Albinism." *Jerusalem Post* (4 Dec. 1994).

ORGANIZATIONS

Albinism World Alliance. <http://www.albinism.org/awa.html>.

American Foundation for the Blind. 15 W. 16th St., New York, NY 10011. (800) AFB-LIND.

Hermansky-Pudlak Syndrome Network, Inc. One South Road, Oyster Bay, NY 11771-1905. (800) 789-9477. <appell@theonramp.net>.

National Organization for Albinism and Hypopigmentation (NOAH). 1530 Locust St., #29, Philadelphia, PA 19102-4415. (800) 473-2310. <http://www.albinism.org>.

Carol A. Turkington

Albuterol *see* **Bronchodilators**

Alcohol-related neurologic disease

Definition

Alcohol, or ethanol, is a poison with direct toxic effects on nerve and muscle cells. Depending on which nerve and muscle pathways are involved, alcohol can have far-reaching effects on different parts of the brain, peripheral nerves, and muscles, with symptoms of memory loss, incoordination, seizures, weakness, and sensory deficits. These different effects can be grouped in three main categories: (1) intoxication due to the acute effects of ethanol, (2) withdrawal syndrome from suddenly stopping drinking, and (3) disorders related to long-term or chronic alcohol abuse. Alcohol-related neurologic disease includes Wernicke-Korsakoff disease, alcoholic cerebellar degeneration, alcoholic myopathy, alcoholic neuropathy, alcohol withdrawal syndrome with seizures and **delirium** tremens, and **fetal alcohol syndrome**.

Description

Acute excess intake of alcohol can cause drunkenness (intoxication) or even **death**, and chronic or long-term abuse leads to potentially irreversible damage to virtually any level of the nervous system. Any given

patient with long-term alcohol abuse may have no neurologic complications, a single alcohol-related disease, or multiple conditions, depending on the genes they have inherited, how well nourished they are, and other environmental factors, such as exposure to other drugs or toxins.

Neurologic complications of alcohol abuse may also result from nutritional deficiency, because alcoholics tend to eat poorly and may become depleted of thiamine or other **vitamins** important for nervous system function. Persons who are intoxicated are also at higher risk for **head injury** or for compression injuries of the peripheral nerves. Sudden changes in blood chemistry, especially sodium, related to alcohol abuse may cause central pontine myelinolysis, a condition of the brainstem in which nerves lose their myelin coating. Liver disease complicating alcoholic **cirrhosis** may cause **dementia**, delirium, and movement disorder.

Causes and symptoms

When a person drinks alcohol, it is absorbed by blood vessels in the stomach lining and flows rapidly throughout the body and brain, as ethanol freely crosses the blood-brain barrier that ordinarily keeps large molecules from escaping from the blood vessel to the brain tissue. Drunkenness, or intoxication, may occur at blood ethanol concentrations of as low as 50-150 mg per dL in people who don't drink. Sleepiness, stupor, **coma**, or even death from respiratory depression and low blood pressure occur at progressively higher concentrations.

Although alcohol is broken down by the liver, the toxic effects from a high dose of alcohol are most likely a direct result of alcohol itself rather than of its breakdown products. The fatal dose varies widely because people who drink heavily develop a tolerance to the effects of alcohol with repeated use. In addition, alcohol tolerance results in the need for higher levels of blood alcohol to achieve intoxicating effects, which increases the likelihood that habitual drinkers will be exposed to high and potentially toxic levels of ethanol. This is particularly true when binge drinkers fail to eat, because **fasting** decreases the rate of alcohol clearance and causes even higher blood alcohol levels.

When a chronic alcoholic suddenly stops drinking, withdrawal of alcohol leads to a syndrome of increased excitability of the central nervous system, called delirium tremens or "DTs." Symptoms begin six to eight hours after abstinence, and are most pronounced 24-72 hours after abstinence. They include body shaking (tremulousness), **insomnia**, agitation, confusion, hearing voices or seeing images that are not really there (such as crawling bugs), seizures, rapid heart beat, profuse sweating, high blood pressure, and **fever**. Alcohol-related seizures may also occur without withdrawal, such as during active heavy drinking or after more than a week without alcohol.

Wernicke-Korsakoff syndrome is caused by deficiency of the B-vitamin thiamine, and can also be seen in people who don't drink but have some other cause of thiamine deficiency, such as chronic vomiting that prevents the absorption of this vitamin. Patients with this condition have the sudden onset of Wernicke encephalopathy; the symptoms include marked confusion, delirium, disorientation, inattention, memory loss, and drowsiness. Examination reveals abnormalities of eye movement, including jerking of the eyes (**nystagmus**) and double vision. Problems with balance make walking difficult. People may have trouble coordinating their leg movements, but usually not their arms. If thiamine is not given promptly, Wernicke encephalopathy may progress to stupor, coma, and death.

If thiamine is given and death averted, **Korsakoff's syndrome** may develop in some patients, who suffer from memory impairment that leaves them unable to remember events for a period of a few years before the onset of illness (retrograde **amnesia**) and unable to learn new information (anterograde amnesia). Most patients have very limited insight into their memory dysfunction and have a tendency to make up explanations for events they have forgotten (confabulation).

Severe **alcoholism** can cause cerebellar degeneration, a slowly progressive condition affecting portions of the brain called the anterior and superior cerebellar vermis, causing a wide-based gait, leg incoordination, and an inability to walk heel-to-toe in tightrope fashion. The gait disturbance usually develops over several weeks, but may be relatively mild for some time, and then suddenly worsen after binge drinking or an unrelated illness.

Fetal alcohol syndrome occurs in infants born to alcoholic mothers when prenatal exposure to ethanol retards fetal growth and development. Affected infants often have a distinctive appearance with a thin upper lip, flat nose and mid-face, short stature and small head size. Almost half are mentally retarded, and most others are mildly impaired intellectually or have problems with speech, learning, and behavior.

Alcoholic myopathy, or weakness secondary to breakdown of muscle tissue, is also known as alcoholic rhabdomyolysis or alcoholic myoglobinuria. Males are affected by acute (sudden onset) alcoholic myopathy four times as often as females. Breakdown of muscle tissue (myonecrosis), can come on suddenly during binge drinking or in the first days of alcohol withdrawal. In its mildest form, this breakdown may cause no noticeable

symptoms, but may be detected by a temporary elevation in blood levels of an enzyme found predominantly in muscle, the MM fraction of creatine kinase.

The severe form of acute alcoholic myopathy is associated with the sudden onset of muscle **pain**, swelling, and weakness; a reddish tinge in the urine caused by myoglobin, a breakdown product of muscle excreted in the urine; and a rapid rise in muscle enzymes in the blood. Symptoms usually worsen over hours to a few days, and then improve over the next week to 10 days as the patient is withdrawn from alcohol. Muscle symptoms are usually generalized, but pain and swelling may selectively involve the calves or other muscle groups. The muscle breakdown of acute alcoholic myopathy may be worsened by crush injuries, which may occur when people drink so much that they compress a muscle group with their body weight for a long time without moving, or by withdrawal seizures with generalized muscle activity.

In patients who abuse alcohol over many years, chronic alcoholic myopathy may develop. Males and females are equally affected. Symptoms include painless weakness of the limb muscles closest to the trunk and the girdle muscles, including the thighs, hips, shoulders, and upper arms. This weakness develops gradually, over weeks or months, without symptoms of acute muscle injury. Muscle atrophy, or decreased bulk, may be striking. The nerves of the extremities may also begin to break down, a condition known as alcoholic **peripheral neuropathy**, which can add to the person's difficulty in moving.

The way in which alcohol destroys muscle tissue is still not well understood. Proposed mechanisms include muscle membrane changes affecting the transport of calcium, potassium, or other **minerals**; impaired muscle energy metabolism; and impaired protein synthesis. Alcohol is metabolized or broken down primarily by the liver, with a series of chemical reactions in which ethanol is converted to acetate. Acetate is metabolized by skeletal muscle, and alcohol-related changes in liver function may affect skeletal muscle metabolism, decreasing the amount of blood sugar available to muscles during prolonged activity. Because not enough sugar is available to supply needed energy, muscle protein may be broken down as an alternate energy source. However, toxic effects on muscle may be a direct result of alcohol itself rather than of its breakdown products.

Although alcoholic peripheral neuropathy may contribute to muscle weakness and atrophy by injuring the motor nerves controlling muscle movement, alcoholic neuropathy more commonly affects sensory fibers. Injury to these fibers can cause tingling or burning pain in the feet, which may be severe enough to interfere with walking. As the condition worsens, pain decreases but numbness increases.

Diagnosis

The diagnosis of alcohol-related neurologic disease depends largely on finding characteristic symptoms and signs in patients who abuse alcohol. Other possible causes should be excluded by the appropriate tests, which may include blood chemistry, **thyroid function tests**, brain MRI (**magnetic resonance imaging**) or CT (computed tomography scan), and/or cerebrospinal fluid analysis.

Acute alcoholic myopathy can be diagnosed by finding myoglobin in the urine and increased creatine kinase and other blood enzymes released from injured muscle. The surgical removal of a small piece of muscle for microscopic analysis (muscle biopsy) shows the scattered breakdown and repair of muscle fibers. Doctors must rule out other acquired causes of muscle breakdown, which include the abuse of drugs such as heroin, **cocaine**, or amphetamines; trauma with crush injury; the depletion of phosphate or potassium; or an underlying defect in the metabolism of carbohydrates or lipids. In chronic alcoholic myopathy, serum creatine kinase often is normal, and muscle biopsy shows atrophy, or loss of muscle fibers. **Electromyography** (EMG) may show features characteristic of alcoholic myopathy or neuropathy.

Treatment

Acute management of alcohol intoxication, delirium tremens, and withdrawal is primarily supportive, to monitor and treat any cardiovascular or **respiratory failure** that may develop. In delirium tremens, fever and sweating may necessitate treatment of fluid loss and secondary low blood pressure. Agitation may be treated with **benzodiazepines** such as chlordiazepoxide, beta-adrenergic antagonists such as atenolol, or alpha 2-adrenergic agonists such as clonidine. Because Wernicke's syndrome is rapidly reversible with thiamine, and because death may intervene if thiamine is not given promptly, all patients admitted for acute complications of alcohol, as well as all patients with unexplained encephalopathy, should be given intravenous thiamine.

Withdrawal seizures typically resolve without specific anti-epileptic drug treatment, although status epilepticus (continual seizures occurring without interruption) should be treated vigorously. Acute alcoholic myopathy with myoglobinuria requires monitoring and maintenance of kidney function, and correction of imbalances

KEY TERMS

Abstinence—Refraining from the use of alcoholic beverages.

Atrophy—A wasting or decrease in size of a muscle or other tissue.

Cerebellum—The part of the brain involved in coordination of movement, walking, and balance.

Degeneration—Gradual, progressive loss of nerve cells.

Delirium—Sudden confusion with decreased or fluctuating level of consciousness.

Delirium tremens—A complication that may accompany alcohol withdrawal. The symptoms include body shaking (tremulousness), insomnia, agitation, confusion, hearing voices or seeing images that are not really there (hallucinations), seizures, rapid heart beat, profuse sweating, high blood pressure, and fever.

Dementia—Loss of memory and other higher functions, such as thinking or speech, lasting six months or more.

Myoglobinuria—Reddish urine caused by excretion of myoglobin, a breakdown product of muscle.

Myopathy—A disorder that causes weakening of muscles.

Neuropathy—A condition affecting the nerves supplying the arms and legs. Typically, the feet and hands are involved first. If sensory nerves are involved, numbness, tingling, and pain are prominent, and if motor nerves are involved, the patient experiences weakness.

Thiamine—A B vitamin essential for the body to process carbohydrates and fats. Alcoholics may suffer complications (including Wernike-Korsakoff syndrome) from a deficiency of this vitamin.

Wernicke-Korsakoff syndrome—A combination of symptoms, including eye-movement problems, tremors, and confusion, that is caused by a lack of the B vitamin thiamine and may be seen in alcoholics.

in blood chemistry including potassium, phosphate, and magnesium levels.

Chronic alcoholic myopathy and other chronic conditions are treated by correcting associated nutritional deficiencies and maintaining a diet adequate in protein and carbohydrate. The key to treating any alcohol-related disease is helping the patient overcome alcohol **addiction**. Behavioral measures and social supports may be needed in patients who develop broad problems in their thinking abilities (dementia) or remain in a state of confusion and disorientation (delirium). People with walking disturbances may benefit from physical therapy and assistive devices. Doctors may also prescribe drugs to treat the pain associated with peripheral neuropathy.

Prognosis

Complete recovery from Wernicke's syndrome may follow prompt administration of thiamine. However, repeated episodes of encephalopathy or prolonged alcohol abuse may cause persistent dementia or Korsakoff **psychosis**. Most patients recover fully from acute alcoholic myopathy within days to weeks, but severe cases may be fatal from **acute kidney failure** and disturbances in heart rhythm secondary to increased potassium levels. Recovery from chronic alcoholic myopathy may occur over weeks to months of abstinence from alcohol and correction of **malnutrition**. Cerebellar degeneration and alcoholic neuropathy may also improve to some extent with abstinence and balanced diet, depending on the severity and duration of the condition.

Prevention

Prevention requires abstinence from alcohol. Persons who consume small or moderate amounts of alcohol might theoretically help prevent nutritional complications of alcohol use with dietary supplements including B vitamins. However, proper **nutrition** cannot protect against the direct toxic effect of alcohol or of its breakdown products. Patients with any alcohol-related symptoms or conditions, pregnant women, and patients with liver or neurologic disease should abstain completely. Persons with family history of alcoholism or alcohol-related conditions may also be at increased risk for neurologic complications of alcohol use.

Resources

PERIODICALS

Diamond, I., and R. O. Messing. "Neurologic Effects of Alcoholism." *Western Journal of Medicine* 161 (1994): 279-87.

Neiman, J., et al. "Movement Disorders in Alcoholism: A Review." *Neurology* 40 (1990): 741-6.
Saitz, R. "Individualized Treatment for Alcohol Withdrawal. A Randomized Double-Blind Controlled Trial." *Journal of the American Medical Association* 272 (1994): 557-8.
Victor, M. "Alcoholic Dementia." *Candian Journal of Neurological Science* 21 (1994): 88-99.

ORGANIZATIONS

National Institute on Alcohol Abuse and Alcoholism. 6000 Executive Boulevard, Willco Building, Bethesda, MD 20892-7003. <http://silk.nih.gov/silk/niaaa1>.

Laurie Barclay, MD

Alcohol abuse *see* **Alcoholism**

Alcohol dependence *see* **Alcoholism**

Alcohol withdrawal *see* **Withdrawal syndromes**

Alcoholic cerebellar disease *see* **Alcohol-related neurologic disease**

Alcoholic hepatitis *see* **Hepatitis, alcoholic**

Alcoholic rose gardener's disease *see* **Sporotrichosis**

Alcoholism

Definition

The essential feature of alcohol abuse is the maladaptive use of alcohol with recurrent and significant adverse consequences related to its repeated use. Alcoholism is the popular term for two disorders, alcohol abuse and alcohol dependence. The hallmarks of both these disorders involve repeated life problems that can be directly attributed to the use of alcohol. Both these disorders can have serious consequences, affecting an individual's health and personal life, as well as having an impact on society at large.

Description

The effects of alcoholism are quite far-reaching. Alcohol affects every body system, causing a wide range of health problems. Some such problems include poor **nutrition**, memory disorders, difficulty with balance and walking, liver disease (including **cirrhosis** and hepatitis), high blood pressure, muscle weakness (including the heart), heart rhythm disturbances, anemia, clotting disorders, decreased immunity to infections, gastrointestinal inflammation and irritation, acute and chronic problems with the pancreas, low blood sugar, high blood fat content, interference with reproductive fertility, and weakened bones.

On a personal level, alcoholism results in marital and other relationship difficulties, depression, unemployment, **child abuse**, and general family dysfunction.

Alcoholism causes or contributes to a variety of severe social problems including homelessness, murder, suicide, injury, and violent crime. Alcohol is a contributing factor in at least 50% of all deaths from motor vehicle accidents. In fact, about 100,000 deaths occur each year due to the effects of alcohol, of which 50% are due to injuries of some sort. According to a recent special report prepared for the U.S. Congress by the National Institute on Alcohol Abuse and Alcoholism, the impact of alcohol on society, including violence, traffic accidents, lost work productivity, and premature **death**, costs our nation an estimated $185 billion annually. In addition, it is estimated that approximately one in four children (19 million children or 29 percent of children up to 17 years of age) is exposed at some time to familial alcohol abuse, alcohol dependence, or both. Furthermore, it has been estimated that approximately 18 percent of adults experience an episode of alcohol abuse or dependence a some time during their lives.

Causes and symptoms

There are probably a number of factors that work together to cause a person to become an alcoholic. Recent genetic studies have demonstrated that close relatives of an alcoholic are four times more likely to become alcoholics themselves. Furthermore, this risk holds true even for children who were adopted away from their biological families at birth and raised in a non-alcoholic adoptive family, with no knowledge of their biological family's difficulties with alcohol. More research is being conducted to determine if genetic factors could account for differences in alcohol metabolism that may increase the risk of an individual becoming an alcoholic.

The symptoms of alcoholism can be broken down into two major categories: symptoms of acute alcohol use and symptoms of long-term alcohol use.

Immediate (acute) effects of alcohol use

Alcohol exerts a depressive effect on the brain. The blood-brain barrier does not prevent alcohol from entering the brain, so the brain alcohol level will quickly become equivalent to the blood alcohol level. Alcohol's depressive effects result in difficulty walking, poor balance, slurring of speech, and generally poor coordination

(accounting in part for the increased likelihood of injury). The affected person may also have impairment of peripheral vision. At higher alcohol levels, a person's breathing and heart rates will be slowed, and vomiting may occur (with a high risk of the vomit being breathed into the lungs, resulting in severe problems, including the possibility of **pneumonia**). Still higher alcohol levels may result in **coma** and death.

Effects of long-term (chronic) alcoholism

Long-term use of alcohol affects virtually every organ system of the body:

- Nervous system. An estimated 30-40% of all men in their teens and twenties have experienced alcoholic blackout, which occurs when drinking a large quantity of alcohol results in the loss of memory of the time surrounding the episode of drinking. Alcohol is well-known to cause sleep disturbances, so that overall sleep quality is affected. **Numbness and tingling** may occur in the arms and legs. Two syndromes, which can occur together or separately, are known as Wernicke's and Korsakoff's syndromes. Both are due to the low thiamine (a form of vitamin B complex) levels found in alcoholics. Wernicke's syndrome results in disordered eye movements, very poor balance and difficulty walking, while **Korsakoff's syndrome** severely affects one's memory, preventing new learning from taking place.
- Gastrointestinal system. Alcohol causes loosening of the muscular ring that prevents the stomach's contents from re-entering the esophagus. Therefore, the acid from the stomach flows backwards into the esophagus, burning those tissues, and causing **pain** and bleeding. Inflammation of the stomach can also result in bleeding and pain, and decreased desire to eat. A major cause of severe, uncontrollable bleeding (hemorrhage) in an alcoholic is the development of enlarged (dilated) blood vessels within the esophagus, which are called esophageal varices. These varices are actually developed in response to liver disease, and are extremely prone to bursting and hemorrhaging. **Diarrhea** is a common symptom, due to alcohol's effect on the pancreas. In addition, inflammation of the pancreas (**pancreatitis**) is a serious and painful problem in alcoholics. Throughout the intestinal tract, alcohol interferes with the absorption of nutrients, creating a malnourished state. Because alcohol is broken down (metabolized) within the liver, that organ is severely affected by constant levels of alcohol. Alcohol interferes with a number of important chemical processes that also occur in the liver. The liver begins to enlarge and fill with fat (**fatty liver**), fibrous scar tissue interferes with the liver's normal structure and function (cirrhosis), and the liver may become inflamed (hepatitis).
- Blood. Alcohol can cause changes to all the types of blood cells. Red blood cells become abnormally large. White blood cells (important for fighting infections) decrease in number, resulting in a weakened immune system. This places alcoholics at increased risk for infections, and is thought to account in part for the increased risk of **cancer** faced by alcoholics (ten times increased over normal). Platelets and blood clotting factors are affected, causing an increased risk of bleeding.
- Heart. Small amounts of alcohol cause a drop in blood pressure, but with increased use, alcohol begins to increase blood pressure into a dangerous range. High levels of fats circulating in the bloodstream increase the risk of heart disease. Heavy drinking results in an increase in heart size, weakening of the heart muscle, abnormal heart rhythms, a risk of blood clots forming within the chambers of the heart, and a greatly increased risk of **stroke** (due to a blood clot from the heart entering the circulatory system, going to the brain, and blocking a brain blood vessel).
- Reproductive system. Heavy drinking has a negative effect on fertility in both men and women, by decreasing testicle and ovary size, and interfering with both sperm and egg production. When **pregnancy** is achieved in an alcoholic woman, the baby has a great risk of being born with **fetal alcohol syndrome**, which causes distinctive facial defects, lowered IQ, and behavioral problems.

Diagnosis

Two different types of alcohol-related difficulties have been identified. The first is called *alcohol dependence*, which refers to a person who literally depends on the use of alcohol. Three of the following traits must be present to diagnose alcohol dependence:

- tolerance, meaning that a person becomes accustomed to a particular dose of alcohol, and must increase the dose in order to obtain the desired effect
- withdrawal, meaning that a person experiences unpleasant physical and psychological symptoms when he or she does not drink alcohol
- the tendency to drink more alcohol than one intends (once an alcoholic starts to drink, he or she finds it difficult to stop)
- being unable to avoid drinking or stop drinking once started

Symptoms Of Co-Alcohol Dependence

Psychological distress manifested in symptoms such as anxiety, aggression, anorexia nervosa, bulimia, depression, insomnia, hyperactivity, and suicidal tendency
Psychosomatic illness (ailments that have no biological basis and clear up after the co-alcoholism clears up)
Family violence or neglect
Alcoholism or other drug abuse

- having large blocks of time taken up by alcohol use
- choosing to drink at the expense of other important tasks or activities
- drinking despite evidence of negative effects on one's health, relationships, education, or job

Alcohol abuse requires that one of the following four criteria is met. Because of drinking, a person repeatedly:

- fails to live up to his or her most important responsibilities
- physically endangers him or herself, or others (for example, by drinking when driving)
- gets into trouble with the law
- experiences difficulties in relationships or jobs

Diagnosis is sometimes brought about when family members call an alcoholic's difficulties to the attention of a physician. A clinician may begin to be suspicious when a patient suffers repeated injuries or begins to experience medical problems related to the use of alcohol. In fact, some estimates suggest that about 20% of a physician's patients will be alcoholics.

Diagnosis is aided by administering specific psychological assessments that try to determine what aspects of a person's life may be affected by his or her use of alcohol. Determining the exact quantity of alcohol that a person drinks is of much less importance than determining how his or her drinking affects relationships, jobs, educational goals, and family life. In fact, because the metabolism of alcohol (how the body breaks down and processes alcohol) is so individual, the quantity of alcohol consumed is not part of the criteria list for diagnosing either alcohol dependence or alcohol abuse.

One very simple tool for beginning the diagnosis of alcoholism is called the CAGE questionnaire. It consists of four questions, with the first letters of each key word spelling out the word CAGE:

- Have you ever tried to *Cut* down on your drinking?
- Have you ever been *Annoyed* by anyone's comments about your drinking?
- Have you ever felt *Guilty* about your drinking?
- Do you ever need an *Eye-opener* (a morning drink of alcohol) to start the day)?

Other, longer lists of questions exist to help determine the severity and effects of a person's alcohol use. Given the recent research pointing to a genetic basis for alcoholism, it is important to ascertain whether anyone else in the person's family has ever suffered from alcoholism.

Physical examination may reveal signs suggestive of alcoholism: evidence of old injuries; a visible network of enlarged veins just under the skin around the navel (called caput medusae); fluid in the abdomen (**ascites**); yellowish-tone to the skin; decreased testicular size in men; and poor nutritional status. Lab work may reveal an increase in the size of the red blood cells; abnormalities in the white blood cells (cells responsible for fighting infection) and platelets (particles responsible for clotting); and an increase in certain liver enzymes.

Treatment

Treatment of alcoholism has two parts. The first step in the treatment of alcoholism, called **detoxification**, involves helping the person stop drinking and ridding his or her body of the harmful (toxic) effects of alcohol. Because the person's body has become accustomed to alcohol, the person will need to be supported through withdrawal. Withdrawal will be different for different patients, depending on the severity of the alcoholism, as measured by the quantity of alcohol ingested daily and the length of time the patient has been an alcoholic. Withdrawal symptoms can range from mild to life-threatening. Mild withdrawal symptoms include nausea, achiness, diarrhea, difficulty sleeping, sweatiness, **anxiety**, and trembling. This phase is usually over in about three to five days. More severe effects of withdrawal can include **hallucinations** (in which a patient sees, hears, or feels something that is not actually real), seizures, an unbearable craving for more alcohol, confusion, **fever**, fast heart rate, high blood pressure, and **delirium** (a fluctuating level of consciousness). Patients at highest risk for the most severe symptoms of withdrawal (referred to as delirium tremens) are those with other medical problems, including **malnutrition**, liver disease, or Wernicke's syndrome. Delirium

tremens usually begin about three to five days after the patient's last drink, progressing from the more mild symptoms to the more severe, and may last a number of days.

Patients going through only mild withdrawal are simply monitored carefully to make sure that more severe symptoms do not develop. No medications are necessary, however. Treatment of a patient suffering the more severe effects of withdrawal may require the use of sedative medications to relieve the discomfort of withdrawal and to avoid the potentially life-threatening complications of high blood pressure, fast heart rate, and seizures. Drugs called benzodiazapines are helpful in those patients suffering from hallucinations. Because of the patient's nausea, fluids may need to be given through a vein (intravenously), along with some necessary sugars and salts. It is crucial that thiamine be included in the fluids, because thiamine is usually quite low in alcoholic patients, and deficiency of thiamine is responsible for the Wernicke-Korsakoff syndrome.

After cessation of drinking has been accomplished, the next steps involve helping the patient avoid ever taking another drink. This phase of treatment is referred to as **rehabilitation**. The best programs incorporate the family into the therapy, because the family has undoubtedly been severely affected by the patient's drinking. Some therapists believe that family members, in an effort to deal with their loved one's drinking problem, sometimes develop patterns of behavior that accidentally support or "enable" the patient's drinking. This situation is referred to as "co-dependence," and must be addressed in order to successfully treat a person's alcoholism.

Sessions led by peers, where recovering alcoholics meet regularly and provide support for each other's recoveries, are considered some of the best methods of preventing a return to drinking (relapse). Perhaps the most well-known such group is called Alcoholics Anonymous, which uses a "12-step" model to help people avoid drinking. These steps involve recognizing the destructive power that alcohol has held over the alcoholic's life, looking to a higher power for help in overcoming the problem, and reflecting on the ways in which the use of alcohol has hurt others and, if possible, making amends to those people. According to a recent study reported by the American Psychological Association (APA), anyone, regardless of his or her religious beliefs or lack of religious beliefs, can benefit from participation in 12-step programs such as Alcoholics Anonymous (AA) or Narcotics Anonymous (NA). The number of visits to 12-step self-help groups exceeds the number of visits to all mental health professionals combined.

There are also medications that may help an alcoholic avoid returning to drinking. These have been used with variable success. Disulfiram (Antabuse) is a drug which, when mixed with alcohol, causes unpleasant reactions including nausea, vomiting, diarrhea, and trembling. Naltrexone, along with a similar compound, Nalmefene, can be helpful in limiting the effects of a relapse. Acamprosate is helpful in preventing relapse. None of these medications would be helpful unless the patient was also willing to work very hard to change his or her behavior.

Alternative treatment

Alternative treatments can be a helpful adjunct for the alcoholic patient, once the medical danger of withdrawal has passed. Because many alcoholics have very stressful lives (whether because of or leading to the alcoholism is sometimes a matter of debate), many of the treatments for alcoholism involve dealing with and relieving **stress**. These include massage, **meditation**, and **hypnotherapy**. The malnutrition of long-term alcohol use is addressed by nutrition-oriented practitioners with careful attention to a healthy diet and the use of nutritional supplements such as **vitamins** A, B complex, and C, as well as certain fatty acids, amino acids, zinc, magnesium, and selenium. Herbal treatments include milk thistle(*Silybum marianum*), which is thought to protect the liver against damage. Other herbs are thought to be helpful for the patient suffering through withdrawal. Some of these include lavender (*Lavandula officinalis*), skullcap (*Scutellaria lateriflora*), chamomile (*Matricaria recutita*), peppermint (*Mentha piperita*) yarrow (*Achillea millefolium*), and valerian (*Valeriana officinalis*). **Acupuncture** is believed to both decrease withdrawal symptoms and to help improve a patient's chances for continued recovery from alcoholism.

Prognosis

Recovery from alcoholism is a life-long process. In fact, people who have suffered from alcoholism are encouraged to refer to themselves ever after as "a recovering alcoholic," never a recovered alcoholic. This is because most researchers in the field believe that since the potential for alcoholism is still part of the individual's biological and psychological makeup, one can never fully recover from alcoholism. The potential for relapse (returning to illness) is always there, and must be acknowledged and respected. Statistics suggest that, among middle-class alcoholics in stable financial and family situations who have undergone treatment, 60% or more can be successful at an attempt to stop drinking for at least a year, and many for a lifetime.

Prevention

Prevention must begin at a relatively young age since the first instance of intoxication (drunkenness) usu-

KEY TERMS

Blood-brain barrier—A network of blood vessels characterized by closely spaced cells that prevents many potentially toxic substances from penetrating the blood vessel walls to enter the brain. Alcohol is able to cross this barrier.

Detoxification—The phase of treatment during which a patient stops drinking and is monitored and cared for while he or she experiences withdrawal from alcohol.

Relapse—A return to a disease state, after recovery appeared to be occurring; in alcoholism, relapse refers to a patient beginning to drink alcohol again after a period of avoiding alcohol.

Tolerance—A phenomenon during which a drinker becomes physically accustomed to a particular quantity of alcohol, and requires ever-increasing quantities in order to obtain the same effects.

Withdrawal—Those signs and symptoms experienced by a person who has become physically dependent on a drug, experienced upon decreasing the drug's dosage or discontinuing its use.

ally occurs during the teenage years. It is particularly important that teenagers who are at high risk for alcoholism—those with a family history of alcoholism, an early or frequent use of alcohol, a tendency to drink to drunkenness, alcohol use that interferes with school work, a poor family environment, or a history of domestic violence—receive education about alcohol and its long-term effects. How this is best achieved, without irritating the youngsters and thus losing their attention, is the subject of continuing debate and study.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders. 4th ed.* Washington, D.C.: American Psychiatric Association, 1994.

National Institute on Alcohol Abuse and Alcoholism. *10th Special Report to the U.S. Congress on Alcohol and Health.* National Institute of Health, 2000.

Schuckit, Marc A. "Alcohol and Alcoholism." In *Harrison's Principles of Internal Medicine.* Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

PERIODICALS

Mattas-Curry, L. "12-step self-help programs proved successful regardless of participants' religious background, study suggests." *APA Monitor Online.* volume 30, number 11, December 1999. <http://www.apa.org/monitor/>.

ORGANIZATIONS

Al-Anon, Alanon Family Group, Inc. P.O. Box 862, Midtown Station, New York, NY 10018-0862. (800)356-9996. <http://www.recovery.org/aa>.

Alcoholics Anonymous. Grand Central Station, Box 459, New York, NY 10163. <http://www.alcoholics-anonymous.org/>.

National Alliance on Alcoholism and Drug Dependence, Inc. 12 West 21st St., New York, NY 10010. (212)206-6770.

National Clearinghouse for Alcohol and Drug Information. <http://www.health.org>.

National Institute on Alcohol Abuse and Alcoholism (NIAAA) 6000 Executive Boulevard, Bethesda, Maryland 20892-7003. <http://www.niaaa.nih.gov>.

Bill Asenjo, MS, CRC

ALD *see* **Adrenoleukodystrophy**

Aldolase test

Definition

Aldolase is an enzyme found throughout the body, particularly in muscles. Like all enzymes, it is needed to trigger specific chemical reactions. Aldolase helps muscle turn sugar into energy. Testing for aldolase is done to diagnose and monitor skeletal muscle diseases.

Purpose

Skeletal muscle diseases increase the aldolase level found in a person's blood. Skeletal muscles are those muscles attached to bones and whose contractions make those bones move. When the muscles are diseased or damaged, such as in **muscular dystrophy**, the cells deteriorate and break open. The contents of the cells, including aldolase, spill into the bloodstream. Measuring the amount of aldolase in the blood indicates the degree of muscle damage.

As muscles continue to deteriorate, aldolase levels decrease and eventually fall below normal. Less muscle means fewer cells and less aldolase.

Muscle weakness may be caused by neurologic as well as muscular problems. The measurement of aldolase levels can help pinpoint the cause. Aldolase levels will be normal where muscle weakness is caused by neurological disease, such as poliomyelitis or **multiple sclerosis**, but aldolase levels will be elevated in cases of muscular disease, such as muscular dystrophy.

Aldolase is also found in the liver and cardiac muscle of the heart. Damage or disease to these organs, such as chronic hepatitis or a **heart attack**, will also increase aldolase levels in the blood, but to a lesser degree.

Description

Aldolase is measured by mixing a person's serum with a substance with which aldolase is known to trigger a reaction. The end product of this reaction is measured, and, from that measurement, the amount of aldolase in the person's serum is determined.

The test is covered by insurance when medically necessary. Results are usually available the next day.

Preparation

To collect the 5-10 ml of blood needed for this test, a healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

The patient should avoid strenuous **exercise** and have nothing to eat or drink, except water, for eight to ten hours before this test.

Aftercare

Discomfort or bruising may occur at the puncture site and the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Newborns have the highest normal aldolase levels and adults the lowest. Normal values will vary based on the laboratory and the method used.

Abnormal results

As noted, aldolase is elevated in skeletal muscle diseases, such as muscular dystrophies. Duchenne's muscular dystrophy, the most common type of muscular dystrophy, will increase the aldolase level more than any other disease.

Nondisease conditions that affect the muscle, such as injury, **gangrene**, or an infection, can also increase the aldolase level. Also, strenuous exercise can temporarily increase a person's aldolase level.

KEY TERMS

Aldolase—An enzyme, found primarily in the muscle, that helps convert sugar into energy.

Enzyme—A substance needed to trigger specific chemical reactions.

Neurologic—Having to do with the nervous system.

Skeletal muscle—Muscle connected to, and necessary for the movement of, bones.

Certain medications can increase the aldolase level, while others can decrease it. To interpret what the results of the aldolase test mean, a physician will evaluate the result, the person's clinical symptoms, and other tests that are more specific for muscle damage and disease.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Garza Diana, and Kathleen Becan-McBride. *Phlebotomy Handbook*. 4th ed. Stamford: Appleton & Lange, 1996.

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Philadelphia: W. B. Saunders Co., 1996.

Mayo Medical Laboratories. *Interpretive Handbook*. Rochester, MN: Mayo Medical Laboratories, 1997.

Nancy J. Nordenson

Aldosterone assay

Definition

This test measures the levels of aldosterone, a hormone produced by the outer part (cortex) of the two adrenal glands, organs which sit one on top of each of the kidneys. Aldosterone regulates the amounts of sodium and potassium in the blood. This helps maintain water balance and blood volume, which, in turn, affects blood pressure.

Purpose

Aldosterone measurement is useful in detecting a condition called aldosteronism, which is caused by excess secretion of the hormone from the adrenal glands.

There are two types of aldosteronism: primary and secondary. Primary aldosteronism is most commonly caused by an adrenal tumor, as in Conn's syndrome. Idiopathic (of unknown cause) **hyperaldosteronism** is another type of primary aldosteronism. Secondary aldosteronism is more common and may occur with congestive **heart failure**, **cirrhosis** with fluid in the abdominal cavity (**ascites**), certain kidney diseases, excess potassium, sodium-depleted diet, and toxemia of **pregnancy**.

To differentiate primary aldosteronism from secondary aldosteronism, a plasma renin test should be performed at the same time as the aldosterone assay. Renin, an enzyme produced in the kidneys, is high in secondary aldosteronism and low in primary aldosteronism.

Description

Aldosterone testing can be performed on a blood sample or on a 24-hour urine specimen. Several factors, including diet, posture (upright or lying down), and time of day that the sample is obtained can cause aldosterone levels to fluctuate. Blood samples are affected by short-term fluctuations. A urine specimen collected over an entire 24-hour period lessens the effects of those interfering factors and provides a more reliable aldosterone measurement.

Preparation

Fasting is not required for either the blood sample or urine collection, but the patient should maintain a normal sodium diet (approximately 0.1 oz [3 g] /day) for at least two weeks before either test. The doctor should decide if drugs that alter sodium, potassium, and fluid balance (e.g., **diuretics**, antihypertensives, steroids, **oral contraceptives**) should be withheld. The test will be more accurate if these are suspended at least two weeks before the test. Renin inhibitors (e.g., propranolol) should not be taken one week before the test, unless permitted by the physician. The patient should avoid licorice for at least two weeks before the test, because of its aldosterone-like effect. Strenuous **exercise** and **stress** can increase aldosterone levels as well. Because the test is usually performed by a method called radioimmunoassay, recently administered radioactive medications will affect test results.

Since posture and body position affect aldosterone, hospitalized patients should remain in an upright position (at least sitting) for two hours before blood is drawn. Occasionally blood will be drawn again before the patient gets out of bed. Nonhospitalized patients should arrive at the laboratory in time to maintain an upright position for at least two hours.

KEY TERMS

Aldosteronism—A condition in which the adrenal glands secrete excessive levels of the hormone aldosterone.

Renin—An enzyme produced in the kidneys that controls the activation of the hormone angiotensin, which stimulates the adrenal glands to produce aldosterone.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal results are laboratory-specific and also vary with sodium intake, with time of day, source of specimen (e.g., peripheral vein, adrenal vein, 24-hour urine), age, sex, and posture.

Reference ranges for blood include:

- supine (lying down): 3-10 ng/dL
- upright (sitting for at least two hours): Female: 5-30ng/dL; Male: 6-22 ng/dL

Reference ranges for urine: 2-80 mg/24 hr.

Abnormal results

Increased levels of aldosterone are found in Conn's disease (aldosterone-producing adrenal tumor), and in cases of Bartter's syndrome (a condition in which the kidneys overexcrete potassium, sodium and chloride, resulting in low blood levels of potassium and high blood levels of aldosterone and renin). Among other conditions, elevated levels are also seen in secondary aldosteronism, stress, and malignant **hypertension**.

Decreased levels of aldosterone are found in aldosterone deficiency, steroid therapy, high-sodium **diets**, certain antihypertensive therapies, and **Addison's disease** (an autoimmune disorder).

Resources

BOOKS

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

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Alemtuzumab

Definition

Alemtuzumab is sold as Campath in the United States. Alemtuzumab is a humanized monoclonal antibody that selectively binds to CD52, a protein found on the surface of normal and malignant B and T cells, that is used to reduce the numbers of circulating malignant cells of patients who have B-cell chronic lymphocytic leukemia (B-CLL).

Purpose

Alemtuzumab is a monoclonal antibody used to treat B-CLL, one of the most prevalent forms of adult chronic leukemia. It specifically binds CD52, a protein found on the surface of essentially all B and T cells of the immune system. By binding the CD52 protein on the malignant B cells, the antibody targets it for removal from the circulation. Scientists believe that alemtuzumab triggers antibody-mediated lysis of the B cells, a method that the immune system uses to eliminate foreign cells.

Alemtuzumab has been approved by the FDA for treatment of refractory B-CLL. For a patient's disease to be classified as refractory, both alkylating agents and fludarabine treatment must have been tried and failed. Thus, this drug gives patients who have tried all approved treatments for B-CLL another option. As most patients with B-CLL are in stage III or IV by the time both alkylating agents and fludarabine have been tried, the experience with alemtuzumab treatment are primarily with those stages of the disease. In clinical trials, about 30% of patients had a partial response to the drug, with 2% of these being complete responses.

This antibody has been tested with limited success in the treatment of non-Hodgkin's lymphoma (NHL) and for the preparation of patients with various immune cell malignancies for bone marrow transplantation. There is also a clinical trial ongoing to test the ability of this antibody to prevent rejection in kidney transplantation.

Description

Alemtuzumab is produced in the laboratory using genetically engineered single clones of B-cells. Like all antibodies, it is a Y-shaped molecule can bind one particular substance, the antigen for that monoclonal antibody. For alemtuzumab, the antigen is CD52, a protein found on the surface of normal and malignant B and T cells as well as other cells of the immune and male reproductive systems. Alemtuzumab is a humanized antibody, meaning that the regions that bind CD52, located on the tips of the Y branches, are derived from rat antibodies, but the rest of the antibody is human sequence. The presence of the human sequences helps to reduce the immune response by the patient against the antibody itself, a problem seen when complete mouse antibodies are used for cancer therapies. The human sequences also help to ensure that the various cell-destroying mechanisms of the human immune system are properly triggered with binding of the antibody.

Alemtuzumab was approved in May of 2001 for the treatment of refractory B-CLL. It is approved for use alone but clinical trials have tested the ability of the antibody to be used in combination with the purine analogs pentostatin, fludarabine, and cladribine, and rituximab, a monoclonal antibody specific for the CD20 antigen, another protein found on the surface of B cells.

Recommended dosage

This antibody should be administered in a gradually escalating pattern at the start of treatment and any time administration is interrupted for seven or more days. The recommended beginning dosage for B-CLL patients is a daily dose of 3 mg of Campath administered as a two-hour IV infusion. Once this amount is tolerated, the dose is increased to 10 mg per day. After tolerating this dose, it can be increased to 30 mg, administered three days a week. Acetominophen and diphenhydramine hydrochoride are given thirty to sixty minutes before the infusion to help reduce side effects.

Additionally, patients generally receive anti-infective medication before treatment to help minimize the serious opportunistic infections that can result from this treatment. Specifically, trimethoprim/sulfamethoxazole (to prevent bacterial infections) and famciclovir (to prevent viral infections) were used during the clinical trial to decrease infections, although they were not eliminated.

Precautions

Blood studies should be done on a weekly basis while patients are receiving the alemtuzumab treatment. Vaccination during the treatment session is not recommended, given the T cell depletion that occurs during treatment. Furthermore, given that antibodies like alumtuzumab can pass through the placenta to the developing fetus and in breast milk, use during pregnancy and breastfeeding is not recommended unless clearly needed.

Side effects

A severe side effect of alemtuzumab treatment is the possible depletion of one or more types of blood cells.

KEY TERMS

Alkylating agent—A chemical that alters the composition of the genetic material of rapidly dividing cells, such as cancer cells, causing selective cell death; used as a chemotherapeutic agent to treat B-CLL.

Antibody—A protective protein made by the immune system in response to an antigen, also called an immunoglobulin.

Autoimmune—An immune reaction of a patient against their own cells.

Humanization—Fusing the constant and variable framework region of one or more human immunoglobulins with the binding region of an animal immunoglobulin, done to reduce human reaction against the fusion antibody.

Monoclonal—Genetically engineered antibodies specific for one antigen.

Tumor lysis syndrome—A side effect of some immunotherapies, like monoclonal antibodies, that lyse the tumor cells, due to the toxicity of flooding the bloodstream with such a quantity of cellular contents.

Because CD52 is expressed on a patient's normal B and T cells, as well as on the surface of the abnormal B cells, the treatment eliminates both normal and cancerous cells. The treatment also seems to trigger autoimmune reactions against various other blood cells. This results in severe reduction of the many circulating blood cells including red blood cells (anemia), white blood cells (neutropenia), and clotting cells (thrombopenia). These conditions are treated with blood transfusions. The great majority of patients treated exhibit some type of blood cell depletion.

A second serious side effect of this drug is the prevalence of opportunistic infections that occurs during the treatment. Serious, and sometimes fatal bacterial, viral, fungal, and protozoan infections have been reported. Treatments to prevent pneumonia and herpes infections reduce, but do not eliminate these infections.

The majority of other side effects occur after or during the first infusion of the drug. Some common side effects of this drug include fever and chills, nausea and vomiting, diarrhea, shortness of breath, skin rash, and unusual fatigue. This drug can also cause low blood pressure (hypotension).

In patients with high tumor burden (a large number of circulating malignant B cells) this drug can cause a side effect called tumor lysis syndrome. Thought to be due to the release of the lysed cells' contents into the blood stream, it can cause a misbalance of urea, uric acid, phosphate, potassium, and calcium in the urine and blood. Patients at risk for this side effect must keep hydrated and can be given allopurinol before infusion.

Interactions

There have been no formal drug interaction studies done for alemtuzumab.

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Alendronate *see* **Bone disorder drugs**

Alexander technique

Definition

The Alexander technique is a somatic method for improving physical and mental functioning. Excessive tension, which Frederick Alexander, the originator, recognized as both physical and mental, restricts movement and creates pressure in the joints, the spine, the breathing mechanism, and other organs. The goal of the technique is to restore freedom and expression to the body and clear thinking to the mind.

Purpose

Because the Alexander technique helps students improve overall functioning, both mental and physical, it offers a wide range of benefits. Nikolaas Tinbergen, in his 1973 Nobel lecture, hailed the "striking improvements in such diverse things as high blood pressure, breathing, depth of sleep, overall cheerfulness and mental alertness, resilience against outside pressures, and the refined skill of playing a musical instrument." He went on to quote a list of other conditions helped by the Alexander technique: "rheumatism, including various forms of arthritis, then respiratory troubles, and even potentially lethal **asthma**; following in their wake, circulation defects, which may lead to high blood pressure and also to some dangerous heart conditions; gastrointestinal disorders of many types, various gynecological conditions, sexual failures, migraines and depressive states."

Literature in the 1980s and 1990s went on to include improvements in back **pain**, chronic pain, postural prob-

lems, repetitive strain injury, benefits during **pregnancy** and **childbirth**, help in applying physical therapy and rehabilitative exercises, improvements in strain caused by computer use, improvements in the posture and performance of school children, and improvements in vocal and dramatic performance among the benefits offered by the technique.

Description

Origins

Frederick Matthias Alexander was born in 1869 in Tasmania, Australia. He became an actor and Shakespearean reciter, and early in his career he began to suffer from strain on his vocal chords. He sought medical attention for chronic hoarseness, but after treatment with a recommended prescription and extensive periods of rest, his problem persisted.

Alexander realized that his hoarseness began about an hour into a dramatic performance and reasoned that it was something he did in the process of reciting that caused him to lose his voice. Returning to his medical doctor, Alexander told him of his observation. When the doctor admitted that he didn't know what Alexander was doing to injure his vocal chords, Alexander decided to try and find out for himself.

Thus began a decade of self-observation and discovery. Using as many as three mirrors to observe himself in the act of reciting, normal speaking, and later standing, walking, and sitting, Alexander managed to improve his coordination and to overcome his vocal problems. One of his most startling discoveries was that in order to change the way he used his body he had to change the way he was thinking, redirecting his thoughts in such a way that he did not produce unnecessary tension when he attempted speech or movement. After making this discovery at the end of the nineteenth century, Alexander became a pioneer in body-mind medicine.

At first, performers and dancers sought guidance from Alexander to overcome physical complaints and to improve the expression and spontaneity of their performances. Soon a great number of people sought help from his teaching for a variety of physical and mental disorders.

The Alexander technique is primarily taught one-on-one in private lessons. Introductory workshops or workshops for special applications of the technique (e.g.,workshops for musicians) are also common. Private lessons range from a half-hour to an hour in length, and are taught in a series. The number of lessons varies according to the severity of the student's difficulties with coordination or to the extent of the student's interest in pursuing the improvements made possible by continued study. The cost of lessons ranges from $40-80 per hour. Insurance coverage is not widely available, but discounts are available for participants in some complementary care insurance plans. Pre-tax Flexible Spending Accounts for health care cover Alexander technique lessons if they are prescribed by a physician.

In lessons teachers guide students through simple movements (while students are dressed in comfortable clothing) and use their hands to help students identify and stop destructive patterns of tension. Tensing arises from mental processes as well as physical, so discussions of personal reactions or behavior are likely to arise in the course of a lesson.

The technique helps students move with ease and improved coordination. At the beginning of a movement (the lessons are a series of movements), most people pull back their heads, raise their shoulders toward their ears, over-arch their lower backs, tighten their legs, and otherwise produce excessive tension in their bodies. Alexander referred to this as misuse of the body.

At any point in a movement, proper use can be established. If the neck muscles are not over-tensed, the head will carry slightly forward of the spine, simply because it is heavier in the front. When the head is out of balance in the forward direction, it sets off a series of stretch reflexes in the extensor muscles of the back. It is skillful use of these reflexes, along with reflex activity in the feet and legs, the arms and hands, the breathing mechanism, and other parts of the body, that lessons in the technique aim to develop.

Alexander found that optimal functioning of the body was very hard to maintain, even for the short period of time it took to complete a single movement. People, especially adults, have very strong tension habits associated with movement. Chronic misuse of the muscles is common. It may be caused by slouching in front of televisions or video monitors, too much sitting or driving and too little walking, or by tension associated with past traumas and injuries. Stiffening the neck after a **whiplash** injury or favoring a broken or sprained leg long after it has healed are examples of habitual tension caused by injury.

The first thing a teacher of the Alexander technique does is to increase a student's sensory awareness of this excessive habitual tension, particularly that in the neck and spine. Next the student is taught to inhibit the tension. If the student prepares to sit down, for example, he will tense his muscles in his habitual way. If he is asked to put aside the intention to sit and instead to free his neck and allow less constriction in

his muscles, he can begin to change his tense habitual response to sitting.

By leaving the head resting on the spine in its natural free balance, by keeping eyes open and focused, not held in a tense stare, by allowing the shoulders to release, the knees to unlock and the back to lengthen and widen, a student greatly reduces strain. In Alexander lessons students learn to direct themselves this way in activity and become skilled in fluid, coordinated movement.

Precautions

Side effects

The focus of the Alexander technique is educational. Teachers use their hands simply to gently guide students in movement. Therefore, both contraindications and potential physiological side effects are kept to a minimum. No forceful treatment of soft tissue or bony structure is attempted, so damage to tissues, even in the case of errors in teaching, is unlikely.

As students' sensory awareness develops in the course of Alexander lessons, they become more acutely aware of chronic tension patterns. As students learn to release excessive tension in their muscles and to sustain this release in daily activity, they may experience tightness or soreness in the connective tissue. This is caused by the connective tissue adapting to the lengthened and released muscles and the expanded range of movement in the joints.

Occasionally students may get light-headed during a lesson as contracted muscles release and effect the circulatory or respiratory functioning.

Forceful contraction of muscles and rigid postures often indicate suppression of emotion. As muscles release during or after an Alexander lesson, students may experience strong surges of emotion or sudden changes in mood. In some cases, somatic memories surface, bringing to consciousness past injury or trauma. This can cause extreme **anxiety**, and referrals may be made by the teacher for counseling.

Research and general acceptance

Alexander became well known among the intellectual, artistic, and medical communities in London, England, during the first half of the twentieth century. Among Alexander's supporters were John Dewey, Aldous Huxley, Bernard Shaw, and renowned scientists Raymond Dart, G.E. Coghill, Charles Sherrington, and Nikolaas Tinbergen.

Researchers continue to study the effects and applications of the technique in the fields of education, preventive medicine, and **rehabilitation**. The Alexander technique has proven an effective treatment for reducing **stress**, for improving posture and performance in schoolchildren, for relieving chronic pain, and for improving psychological functioning. The technique has been found to be as effective as beta-blocker medications in controlling stress responses in professional musicians, to enhance respiratory function in normal adults, and to mediate the effects of **scoliosis** in adolescents and adults.

KEY TERMS

Direction—Bringing about the free balance of the head on the spine and the resulting release of the erector muscles of the back and legs which establish improved coordination.

Habit—Referring to the particular set of physical and mental tensions present in any individual.

Inhibition—Referring to the moment in an Alexander lesson when the student refrains from beginning a movement in order to avoid tensing of the muscles.

Sensory awareness—Bringing attention to the sensations of tension and/or release in the muscles.

Resources

BOOKS

Caplan, Deborah. *Back Trouble - A new approach to prevention and recovery based on the Alexander Technique*. Triad Communications: 1987.

Dimon, Theodore. *THE UNDIVIDED SELF: Alexander Technique and the Control of Stress*. North Atlantic Books: 1999.

Jones, Frank Pierce. *Freedom To Change - The Development and Science of the Alexander Technique*. Mouritz: 1997, imported (First published 1976 as *Body Awareness in Action*.)

PERIODICALS

Stern, Judith C. "The Alexander Technique:An Approach to Pain Control." *Lifeline* (Summer 1992).

Tinbergen, Nikolaas. "Ethology and Stress Diseases." *England Science* 185:20-27,(1974).

ORGANIZATIONS

American Society for the Alexander Technique, 401 East Market Street (P.O. Box 835) Charlottesville, VA 22902 USA. (800) 473-0620; or (804) 295-2840. Fax: 804-295-3947. alexandertec@earthlink.net. <http://www.alexandertech.org>.

Alexander Technique International, 1692 Massachusetts Ave.,3rd Floor, Cambridge, MA 02138 USA. (888) 321-0856. Fax: 617-497-2615. ati@ati-net.com. <http://www.ati-net.com>.

OTHER

Alexander Technique Resource Guide. (includes list of teachers) AmSAT Books, (800) 473-0620 or (804) 295-2840.

Nielsen, Michael. "A Study of Stress Amongst Professional Musicians." *STAT Books* London, 1994.

Reiser, Samuel. "Stress Reduction and Optimal Psychological Functioning." Lecture given at Sixth International Montreaus Congress on Stress, 1994.

Sandra Bain Cushman

Alkali-resistant hemoglobin test *see* **Fetal hemoglobin test**

Alkaline phosphatase test

Definition

Alkaline phosphatase is an enzyme found throughout the body. Like all enzymes, it is needed, in small amounts, to trigger specific chemical reactions. When it is present in large amounts, it may signify bone or liver disease or a tumor.

Purpose

Medical testing of alkaline phosphatase is concerned with the enzyme that is found in liver, bone, placenta, and intestine. In a healthy liver, fluid containing alkaline phosphate and other substances is continually drained away through the bile duct. In a diseased liver, this bile duct is often blocked, keeping fluid within the liver. Alkaline phosphatase accumulates and eventually escapes into the bloodstream.

The alkaline phosphatase of the liver is produced by the cells lining the small bile ducts (ductoles) in the liver. Its origin differs from that of other enzymes called aminotransferases. If the liver disease is primarily of an obstructive nature (cholestatic), i.e. involving the biliary drainage system, the alkaline phosphatase will be the first and foremost enzyme elevation. If, on the other hand, the disease is primarily of the liver cells (hepatocytes), the aminotransferases will rise prominently.Thus, these enzymes are very useful in distinguishing the type of liver disease—cholestatic or hepatocellular.

Growing bones need alkaline phosphatase. Any condition of bone growth will cause alkaline phosphatase levels to rise. The condition may be normal, such as a childhood growth spurt or the healing of a broken bone; or the condition may be a disease, such as bone **cancer**, Paget's disease, or rickets.

During **pregnancy**, alkaline phosphatase is made by the placenta and leaks into the mother's bloodstream. This is normal. Some tumors, however, start production of the same kind of alkaline phosphatase produced by the placenta. These tumors are called germ cell tumors and include **testicular cancer** and certain brain tumors.

Alkaline phosphatase from the intestine is increased in a person with inflammatory bowel disease, such as **ulcerative colitis**.

Description

Alkaline phosphatase is measured by combining the person's serum with specific substances with which alkaline phosphatase is known to react. The end product of this reaction is measured; and from that measurement, the amount of alkaline phosphatase in the person's serum is determined.

Each tissue—liver, bone, placenta, and intestine—produces a slightly different alkaline phosphatase. These variations are called isoenzymes. In the laboratory, alkaline phosphatase is measured as the total amount or the amount of each of the the four isoenzymes. The isoenzymes react differently to heat, certain chemicals, and other processes in the laboratory. Methods to measure them separately are based on these differences.

The test is covered by insurance when medically necessary. Results are usually available the next day.

Preparation

To collect the 5-10 ml blood needed for this test, a healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

A person being tested for alkaline phosphatase shouldn't have anything to eat or drink, except water, for eight to ten hours before the test. Some people release alkaline phosphatase from the intestine into the bloodstream after eating. This will temporarily increase the result of the test.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the

KEY TERMS

Alkaline phosphatase—An enzyme found throughout the body, primarily in liver, bone, placenta, and intestine.

Cholestatis—Stoppage or suppression of the flow of bile.

Enzyme—A substance needed to trigger specific chemical reactions.

Hepatocellular—Of or pertaining to liver cells.

Hepatocyte—A liver cell.

Isoenzyme—A variation of an enzyme.

puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Normal results vary by age and by sex. They also vary based on the laboratory and the method used.

Abnormal results

Bone and liver disease increase alkaline phosphatase more than any other disease, up to five times the normal level. Irritable bowel disease, germ cell tumors, and infections involving the liver, such as viral hepatitis and **infectious mononucleosis**, increase the enzyme also, but to a lesser degree. Healing bones, pregnancy, and normal growth in children also increase levels.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Garza, Diana, and Kathleen Becan-MacBride. *Phlebotomy Handbook*. 4th ed. Stamford: Appleton & Lange, 1996.

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Philadephia: W. B. Saunders Co., 1996.

Lehmann, Craig A., ed. *Saunders Manual of Clinical Laboratory Science*. Philadelphia: W. B. Saunders Co., 1998.

Sacher, Ronald A., Richard A. McPherson, and J. M. Campos. "Transfusion Medicine." In *Widmann's Clinical Interpretation of Laboratory Tests*. 10th ed. Philadelphia: F. A. Davis, 1991.

Nancy J. Nordenson

Alkalosis *see* **Metabolic alkalosis; Respiratory alkalosis**

Allergic alveolitis *see* **Hypersensitivity pneumonitis**

Allergic bronchopulmonary aspergillosis

Definition

Allergic bronchopulmonary **aspergillosis**, or ABPA, is one of four major types of infections in humans caused by *Aspergillus* fungi. ABPA is a hypersensitivity reaction that occurs in **asthma** patients who are allergic to this specific fungus.

Description

ABPA is an allergic reaction to a species of *Aspergillus* called *Aspergillus fumigatus*. It is sometimes grouped together with other lung disorders characterized by eosinophilia—an abnormal increase of a certain type of white blood cell in the blood—under the heading of **eosinophilic pneumonia**. These disorders are also called hypersensitivity lung diseases.

ABPA appears to be increasing in frequency in the United States, although the reasons for the increase are not clear. The disorder is most likely to occur in adult asthmatics aged 20-40. It affects males and females equally.

Causes and symptoms

ABPA develops when the patient breathes air containing *Aspergillus* spores. These spores are found worldwide, especially around riverbanks, marshes, bogs, forests, and wherever there is wet or decaying vegetation. They are also found on wet paint, construction materials, and in air conditioning systems. ABPA is a nosocomial infection, which means that a patient can get it in a hospital. When *Aspergillus* spores reach the bronchi, which are the branches of the windpipe that lead into the lungs, the bronchi react by contracting spasmodically. So the patient has difficulty breathing and usually wheezes or coughs. Many patients with ABPA also run a low-grade **fever** and lose their appetites.

Complications

Patients with ABPA sometimes **cough** up large amounts of blood, a condition that is called **hemoptysis**. They may also develop a serious long-term form of **bronchiectasis**, the formation of fibrous tissue in the lungs. Bronchiectasis is a chronic bronchial disorder

caused by repeated inflammation of the airway, and marked by the abnormal enlargement of, or damage to, the bronchial walls. ABPA sometimes occurs as a complication of **cystic fibrosis**.

Diagnosis

The diagnosis of ABPA is based on a combination of the patient's history and the results of blood tests, sputum tests, skin tests, and diagnostic imaging. The doctor will be concerned to distinguish between ABPA and a worsening of the patient's asthma, cystic fibrosis, or other lung disorders. There are seven major criteria for a diagnosis of allergic bronchopulmonary aspergillosis:

- a history of asthma.
- an accumulation of fluid in the lung that is visible on a **chest x ray**.
- bronchiectasis (abnormal stretching, enlarging, or destruction of the walls of the bronchial tubes).
- skin reaction to *Aspergillus* antigen.
- eosinophilia in the patient's blood and sputum.
- *Aspergillus* precipitins in the patient's blood. Precipitins are antibodies that react with the antigen to form a solid that separates from the rest of the solution in the test tube.
- a high level of IgE in the patient's blood. IgE refers to a class of antibodies in blood plasma that activate allergic reactions to foreign particles.

Other criteria that may be used to support the diagnosis include the presence of *Aspergillus* in samples of the patient's sputum, the coughing up of plugs of brown mucus, or a late skin reaction to the *Aspergillus* antigen.

Laboratory tests

The laboratory tests that are done to obtain this information include a complete **blood count** (CBC), a **sputum culture**, a blood serum test of IgE levels, and a skin test for the *Aspergillus* antigen. In the skin test, a small amount of antigen is injected into the upper layer of skin on the patient's forearm about four inches below the elbow. If the patient has a high level of IgE antibodies in the tissue, he or she will develop what is called a "wheal and flare" reaction in about 15-20 minutes. A "wheal and flare" reaction is characterized by the eruption of a reddened, **itching** spot on the skin. Some patients with ABPA will develop the so-called late reaction to the skin test, in which a red, sore, swollen area develops about six to eight hours after the initial reaction.

Aspergillus can sometimes be seen under a microscope slide made from the patient's sputum, but the diagnosis is considered definite only when the fungus is cultured in the laboratory. *Aspergillus* is easy to culture, and can be identified when it is stained with periodic acid-Schiff (PAS), Calcofluor, or potassium hydroxide (KOH) preparations.

Diagnostic imaging

Chest x rays and CT scans are used to check for the presence of fluid accumulation in the lungs and signs of bronchiectasis.

Treatment

ABPA is usually treated with prednisone (Meticorten) or other **corticosteroids** taken by mouth, and with **bronchodilators**.

Antifungal drugs are *not* used to treat ABPA because it is caused by an allergic reaction to *Aspergillus* rather than by direct infection of tissue.

Follow-up care

Patients with ABPA should be given periodic checkups with chest x rays and a spirometer test. A spirometer is an instrument that evaluates the patient's lung capacity.

Prognosis

Most patients with ABPA respond well to corticosteroid treatment. Others have a chronic course with gradual improvement over time. The best indicator of a good prognosis is a long-term fall in the patient's IgE level. Patients with lung complications from ABPA may develop severe airway obstruction.

Prevention

ABPA is difficult to prevent because *Aspergillus* is a common fungus; it can be found in the saliva and sputum of most healthy individuals. Patients with ABPA can protect themselves somewhat by avoiding haystacks, compost piles, bogs, marshes, and other locations with wet or rotting vegetation; by avoiding construction sites or newly painted surfaces; and by having their air conditioners cleaned regularly. Some patients may be helped by air filtration systems for their bedrooms or offices.

Resources

BOOKS

"Aspergillosis." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Beavis, Kathleen G. "Systemic Mycoses." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

KEY TERMS

Antifungal—A medicine used to treat infections caused by a fungus.

Antigen—A substance that stimulates the production of antibodies.

Bronchiectasis—A disorder of the bronchial tubes marked by abnormal stretching, enlargement, or destruction of the walls. Bronchiectasis is usually caused by recurrent inflammation of the airway and is a diagnostic criterion of ABPA.

Bronchodilator—A medicine used to open up the bronchial tubes (air passages) of the lungs.

Eosinophil—A type of white blood cell containing granules that can be stained by eosin (a chemical that produces a red stain).

Eosinophilia—An abnormal increase in the number of eosinophils in the blood.

Hemoptysis—The coughing up of large amounts of blood. Hemoptysis can occur as a complication of ABPA.

Hypersensitivity—An excessive response by the body to a foreign substance.

Immunoglobulin E (IgE)—A type of protein in blood plasma that acts as an antibody to activate allergic reactions. About 50% of patients with allergic disorders have increased IgE levels in their blood serum.

Nosocomial infection—An infection that can be acquired in a hospital. ABPA is a nosocomial infection.

Precipitin—An antibody in blood that combines with an antigen to form a solid that separates from the rest of the blood.

Spirometer—An instrument used to test a patient's lung capacity.

"Wheal and flare" reaction—A rapid response to a skin allergy test characterized by the development of a red, itching spot in the area where the allergen was injected.

Wheezing—A whistling or musical sound caused by tightening of the air passages inside the patient's chest.

Hamill, Richard J. "Infectious Diseases: Mycotic." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Larsen, Gary L., et al. "Respiratory Tract & Mediastinum." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Physicians' Guide to Rare Diseases. Ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Co., Inc., 1995.

"Pulmonary Disorders: Hypersensitivity Diseases of the Lungs." In *The Merck Manual of Diagnosis and Therapy*. 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

Stauffer, John L. "Lung." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

National Institute of Allergy and Infectious Disease. Building 31, Room 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892-2520. (301) 496-5717. <http://www.niaid.nih.gov/default.htm>.

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Allergic purpura

Definition

Allergic purpura (AP) is an allergic reaction of unknown origin causing red patches on the skin and other symptoms. AP is also called Henoch-Schonlein purpura, named after the two doctors who first described it.

Description

"Purpura" is a bleeding disorder that occurs when capillaries rupture, allowing small amounts of blood to accumulate in the surrounding tissues. In AP, this occurs because the capillaries are blocked by protein complexes

formed during an abnormal immune reaction. The skin is the most obvious site of reaction, but the joints, gastrointestinal tract, and kidneys are also often affected.

AP affects approximately 35,000 people in the United States each year. Most cases are children between the ages of two and seven. Boys are affected more often than girls, and most cases occur from late fall to winter.

Causes and symptoms

Causes

AP is caused by a reaction involving antibodies, special proteins of the immune system. Antibodies are designed to bind with foreign proteins, called antigens. In some situations, antigen-antibody complexes can become too large to remain suspended in the bloodstream. When this occurs, they precipitate out and become lodged in the capillaries. This can cause the capillary to burst, allowing a local hemorrhage.

The source of the antigen causing AP is unknown. Antigens may be introduced by bacterial or viral infection. More than 75% of patients report having had an infection of the throat, upper respiratory tract, or gastrointestinal system several weeks before the onset of AP. Other complex molecules can act as antigens as well, including drugs such as **antibiotics** or vaccines. Otherwise harmless substances that stimulate an immune reaction are known as allergens. Drug allergens that may cause AP include penicillin, ampicillin, erythromycin, and quinine. Vaccines possibly linked to AP include those for typhoid, **measles**, **cholera**, and **yellow fever**.

Symptoms

The onset of AP may be preceded by a **headache**, **fever**, and loss of appetite. Most patients first develop an itchy skin rash. The rash is red, either flat or raised, and may be small and freckle-like. The rash may also be larger, resembling a bruise. **Rashes** become purple and then rust colored over the course of a day, and fade after several weeks. Rashes are most common on the buttocks, abdomen, and lower extremities. Rashes higher on the body may also occur, especially in younger children.

Joint **pain** and swelling is common, especially in the knees and ankles. Abdominal pain occurs in almost all patients, along with blood in the body waste (feces). About half of all patients show blood in the urine, low urine volume, or other signs of kidney involvement. Kidney failure may occur due to widespread obstruction of the capillaries in the filtering structures called glomeruli. Kidney failure develops in about 5% of all patients, and in 15% of those with elevated blood or protein in the urine.

KEY TERMS

Glomeruli—Knots of capillaries in the kidneys responsible for filtering the blood (singular, glomerulus).

Less common symptoms include prolonged headache, fever, and pain and swelling of the scrotum. Involvement of other organ systems may lead to **heart attack** (myocardial infarction), inflammation of the pancreas (**pancreatitis**), intestinal obstruction, or bowel perforation.

Diagnosis

Diagnosis of AP is based on the symptoms and their development, a careful medical history, and blood and urine tests. X rays or **computed tomography scans** (CT) may be performed to assess complications in the bowel or other internal organs.

Treatment

Most cases of AP resolve completely without treatment. Nonetheless, a hospital stay is required because of the possibility of serious complications. Non-aspirin pain relievers may be given for joint pain. **Corticosteroids** (like prednisone) are sometimes used, although not all specialists agree on their utility. Kidney involvement requires monitoring and correction of blood fluids and electrolytes.

Patients with severe kidney complications may require a **kidney biopsy** so that tissue can be analyzed. Even after all other symptoms subside, elevated levels of blood or protein in the urine may persist for months and require regular monitoring. **Hypertension** or kidney failure may develop months or even years after the acute phase of the disease. Kidney failure requires dialysis or transplantation.

Plasmapheresis, which removes antibodies from the blood, has been tried for AP with mixed results.

Prognosis

Most people who develop AP become better on their own after several weeks. About half of all patients have at least one recurrence. Cases that do not have kidney complications usually have the best prognosis.

Resources

PERIODICALS

Andreoli, S. P. "Chronic Glomerulonephritis in Childhood. Membranoproliferative Glomerulonephritis, Henoch-

Schonlein PurpuraNnephritis, and IgA Nephropathy." *Pediatric Clinics of North America* 42, no. 6 (Dec. 1995): 1487-1503.

OTHER

"Henoch-Schonlein Purpura." Vanderbilt University Medical Center. <http://www.mc.vanderbilt.edu/peds/pidl/nephro/henoch.html>.

Richard Robinson

Allergic rhinitis

Definition

Allergic **rhinitis**, more commonly referred to as hay **fever**, is an inflammation of the nasal passages caused by allergic reaction to airborne substances.

Description

Allergic rhinitis (AR) is the most common allergic condition and one of the most common of all minor afflictions. It affects between 10-20% of all people in the United States, and is responsible for 2.5% of all doctor visits. **Antihistamines** and other drugs used to treat allergic rhinitis make up a significant fraction of both prescription and over-the-counter drug sales each year.

There are two types of allergic rhinitis: seasonal and perennial. Seasonal AR occurs in the spring, summer, and early fall, when airborne plant pollens are at their highest levels. In fact, the term hay fever is really a misnomer, since allergy to grass pollen is only one cause of symptoms for most people. Perennial AR occurs all year and is usually caused by home or workplace airborne pollutants. A person can be affected by one or both types. Symptoms of seasonal AR are worst after being outdoors, while symptoms of perennial AR are worst after spending time indoors.

Both types of **allergies** can develop at any age, although onset in childhood through early adulthood is most common. Although allergy to a particular substance is not inherited, increased allergic sensitivity may "run in the family." While allergies can improve on their own over time, they can also become worse over time.

Causes and symptoms

Causes

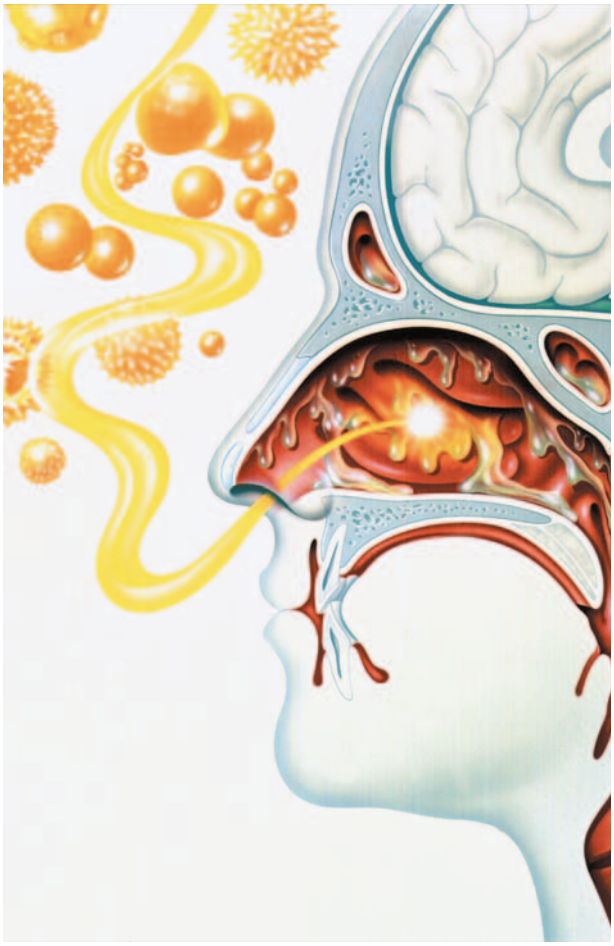
Allergic rhinitis is a type of immune reaction. Normally, the immune system responds to foreign microorganisms, or particles, like pollen or dust, by producing specific proteins, called antibodies, that are capable of binding to identifying molecules, or antigens, on the foreign particle. This reaction between antibody and antigen sets off a series of reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances. This is the condition known as allergy, and the offending substance is called an allergen.

Like all allergic reactions, AR involves a special set of cells in the immune system known as mast cells. Mast cells, found in the lining of the nasal passages and eyelids, display a special type of antibody, called immunoglobulin type E (IgE), on their surface. Inside, mast cells store reactive chemicals in small packets, called granules. When the antibodies encounter allergens, they trigger release of the granules, which spill out their chemicals onto neighboring cells, including blood vessels and nerve cells. One of these chemicals, histamine, binds to the surfaces of these other cells, through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes neighboring cells to become leaky, leading to the fluid collection, swelling, and increased redness characteristic of a runny nose and red, irritated eyes. Histamine also stimulates **pain** receptors, causing the itchy, scratchy nose, eyes, and throat common in allergic rhinitis.

The number of possible airborne allergens is enormous. Seasonal AR is most commonly caused by grass and tree pollens, since their pollen is produced in large amounts and is dispersed by the wind. Showy flowers, like roses or lilacs, that attract insects produce a sticky pollen which is less likely to become airborne. Different plants release their pollen at different times of the year, so seasonal AR sufferers may be most affected in spring, summer, or fall, depending on which plants provoke a response. The amount of pollen in the air is reflected in the pollen count, often broadcast on the daily news during allergy season. Pollen counts tend to be lower after a good rain that washes the pollen out of the air and higher on warm, dry, windy days.

Virtually any type of tree or grass may cause AR. A few types of weeds that tend to cause the most trouble for people include the following:

- ragweed
- sagebrush
- lamb's-quarters
- plantain
- pigweed
- dock/sorrel



This illustration depicts excessive mucus production in the nose after inhalation of airborne pollen. *(Photo Researchers, Inc. Reproduced by permission.)*

• tumbleweed

Perennial AR is often triggered by house dust, a complicated mixture of airborne particles, many of which are potent allergens. House dust contains some or all of the following:

• house mite body parts. All houses contain large numbers of microscopic insects called house mites. These harmless insects feed on fibers, fur, and skin shed by the house's larger occupants. Their tiny body parts easily become airborne.

• animal dander. Animals constantly shed fur, skin flakes, and dried saliva. Carried in the air, or transferred from pet to owner by direct contact, dander can cause allergy in many sensitive people.

• mold spores. Molds live in damp spots throughout the house, including basements, bathrooms, air ducts, air conditioners, refrigerator drains, damp windowsills, mattresses, and stuffed furniture. Mildew and other molds release airborne spores which circulate throughout the house.

Other potential causes of perennial allergic rhinitis include the following:

• cigarette smoke

• perfume

• cosmetics

• cleansers

• copier chemicals

• industrial chemicals

• construction material gases

Symptoms

Inflammation of the nose, or rhinitis, is the major symptom of AR. Inflammation causes **itching**, sneezing, runny nose, redness, and tenderness. Sinus swelling can constrict the eustachian tube that connects the inner ear to the throat, causing a congested feeling and "ear popping." The drip of mucus from the sinuses down the back of the throat, combined with increased sensitivity, can also lead to throat irritation and redness. AR usually also causes redness, itching, and watery eyes. **Fatigue** and **headache** are also common.

Diagnosis

Diagnosing seasonal AR is usually easy and can often be done without a medical specialist. When symptoms appear in spring or summer and disappear with the onset of cold weather, seasonal AR is almost certainly the culprit. Other causes of rhinitis, including infection, can usually be ruled out by a **physical examination** and a nasal smear, in which a sample of mucus is taken on a swab for examination.

Allergy tests, including skin testing and provocation testing, can help identify the precise culprit, but may not be done unless a single source is suspected and subsequent avoidance is possible. Skin testing involves placing a small amount of liquid containing a specific allergen on the skin and then either poking, scratching, or injecting it into the skin surface to observe whether redness and swelling occurs. Provocation testing involves challenging an individual with either a small amount of an inhalable or ingestable allergen to see if a response is elicited.

Perennial AR can also usually be diagnosed by careful questioning about the timing of exposure and the onset of symptoms. Specific allergens can be identified through allergy skin testing.

Treatment

Avoidance of the allergens is the best treatment, but this is often not possible. When it is not possible to avoid one or more allergens, there are two major forms of medical treatment, drugs and immunotherapy.

Drugs

ANTIHISTAMINES. Antihistamines block the histamine receptors on nasal tissue, decreasing the effect of histamine release by mast cells. They may be used after symptoms appear, though they may be even more effective when used preventively, before symptoms appear. A wide variety of antihistamines are available.

Older antihistamines often produce drowsiness as a major side effect. Such antihistamines include the following:

- diphenhydramine (Benadryl and generics)
- chlorpheniramine (Chlor-trimeton and generics)
- brompheniramine (Dimetane and generics)
- clemastine (Tavist and generics).

Newer antihistamines that do not cause drowsiness are available by prescription and include the following:

- astemizole (Hismanal)
- loratidine (Claritin)
- fexofenadine (Allegra)
- azelastin HCl (Astelin).

Hismanal has the potential to cause serious heart **arrhythmias** when taken with the antibiotic erythromycin, the antifungal drugs ketoconazole and itraconazole, or the antimalarial drug quinine. Taking more than the recommended dose of Hismanal can also cause arrhythimas. Seldane (terfenadine), the original nondrowsy antihistamine, was voluntarily withdrawn from the market by its manufacturers in early 1998 because of this potential and because of the availability of an equally effective, safer alternative drug, fexofenadine.

DECONGESTANTS. **Decongestants** constrict blood vessels to counteract the effects of histamine. Nasal sprays are available that can be applied directly to the nasal lining and oral systemic preparations are available. Decongestants are stimulants and may cause increased heart rate and blood pressure, headaches, and agitation. Use of topical decongestants for longer than several days can cause loss of effectiveness and rebound congestion, in which nasal passages become more severely swollen than before treatment.

TOPICAL CORTICOSTEROIDS. Topical **corticosteroids** reduce mucous membrane inflammation and are available by prescription. Allergies tend to become worse as the season progresses because the immune system becomes sensitized to particular antigens and can produce a faster, stronger response. Topical corticosteroids are especially effective at reducing this seasonal sensitization because they work more slowly and last longer than most other medication types. As a result, they are best started before allergy season begins. Side effects are usually mild, but may include headaches, nosebleeds, and unpleasant taste sensations.

MAST CELL STABILIZERS. Cromolyn sodium prevents the release of mast cell granules, thereby preventing release of histamine and the other chemicals contained in them. It acts as a preventive treatment if it is begun several weeks before the onset of the allergy season. It can be used for perennial AR as well.

Immunotherapy

Immunotherapy, also known as desensitization or allergy shots, alters the balance of antibody types in the body, thereby reducing the ability of IgE to cause allergic reactions. Immunotherapy is preceded by allergy testing to determine the precise allergens responsible. Injections involve very small but gradually increasing amounts of allergen, over several weeks or months, with periodic boosters. Full benefits may take up to several years to achieve and are not seen at all in about one in five patients. Individuals receiving all shots will be monitored closely following each shot because of the small risk of **anaphylaxis**, a condition that can result in difficulty breathing and a sharp drop in blood pressure.

Alternative treatment

Alternative treatments for AR often focus on modulation of the body's immune response, and frequently center around diet and lifestyle adjustments. Chinese herbal medicine can help rebalance a person's system, as can both acute and constitutional homeopathic treatment. Vitamin C in substantial amounts can help stabilize the mucous membrane response. For symptom relief, western herbal remedies including eyebright (*Euphrasia officinalis*) and nettle (*Urtica dioica*) may be helpful. Bee pollen may also be effective in alleviating or eliminating AR symptoms.

Prognosis

Most people with AR can achieve adequate relief with a combination of preventive strategies and treatment. While allergies may improve over time, they may also get worse or expand to include new allergens. Early treatment can help prevent an increased sensitization to other allergens.

KEY TERMS

Allergen—A substance that provokes an allergic response.

Anaphylaxis—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation (swelling) and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Granules—Small packets of reactive chemicals stored within cells.

Histamine—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

Mast cells—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

Prevention

Reducing exposure to pollen may improve symptoms of seasonal AR. Strategies include the following:

- stay indoors with windows closed during the morning hours, when pollen levels are highest
- keep car windows up while driving
- use a surgical face mask when outside
- avoid uncut fields
- learn which trees are producing pollen in which seasons, and avoid forests at the height of pollen season
- wash clothes and hair after being outside
- clean air conditioner filters in the home regularly
- use electrostatic filters for central air conditioning

Moving to a region with lower pollen levels is rarely effective, since new allergies often develop

Preventing perennial AR requires identification of the responsible allergens

Mold spores:

- keep the house dry through ventilation and use of dehumidifiers
- use a disinfectant such as dilute bleach to clean surfaces such as bathroom floors and walls
- have ducts cleaned and disinfected
- clean and disinfect air conditioners and coolers
- throw out moldy or mildewed books, shoes, pillows, or furniture

House dust:

- vacuum frequently, and change the bag regularly. Use a bag with small pores to catch extra-fine particles
- clean floors and walls with a damp mop
- install electrostatic filters in heating and cooling ducts, and change all filters regularly

Animal dander:

- avoid contact if possible
- wash hands after contact
- vacuum frequently
- keep pets out of the bedroom, and off furniture, rugs, and other dander-catching surfaces
- have your pets bathed and groomed frequently

Resources

BOOKS

Allergic and Non-Allergic Rhinitis: Clinical Aspects. Ed. N. Mygund and R. M. Naclerio. Philadelphia: W. B. Saunders Co., 1993.

Lawlor, G. J. Jr., T. J. Fischer, and D. C. Adelman. *Manual of Allergy and Immunology.* Boston: Little, Brown and Co., 1995.

Novick, N. L. *You Can Do Something About Your Allergies*. New York: Macmillan, 1994.

Weil, A. *Natural Health, Natural Medicine: A Comprehensive Manual for Wellness and Self-Care*. New York: Houghton Mifflin, 1995.

Richard Robinson

Allergies

Definition

Allergies are abnormal reactions of the immune system that occur in response to otherwise harmless substances.

Description

Allergies are among the most common of medical disorders. It is estimated that 60 million Americans, or more than one in every five people, suffer from some form of allergy, with similar proportions throughout much of the rest of the world. Allergy is the single largest reason for school absence and is a major source of lost productivity in the workplace.

An allergy is a type of immune reaction. Normally, the immune system responds to foreign microorganisms or particles by producing specific proteins called antibodies. These antibodies are capable of binding to identifying molecules, or antigens, on the foreign particle. This reaction between antibody and antigen sets off a series of chemical reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances such as pollen, dust, and animal danders. When this occurs, an allergy develops against the offending substance (an allergen.)

Mast cells, one of the major players in allergic reactions, capture and display a particular type of antibody, called immunoglobulin type E (IgE) that binds to allergens. Inside mast cells are small chemical-filled packets called granules. Granules contain a variety of potent chemicals, including histamine.

Immunologists separate allergic reactions into two main types: immediate hypersensitivity reactions, which are predominantly mast cell-mediated and occur within minutes of contact with allergen; and delayed hypersensitivity reactions, mediated by T cells (a type of white blood cells) and occurring hours to days after exposure.

Inhaled or ingested allergens usually cause immediate hypersensitivity reactions. Allergens bind to IgE antibodies on the surface of mast cells, which spill the contents of their granules out onto neighboring cells, including blood vessels and nerve cells. Histamine binds to the surfaces of these other cells through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes increased leakiness, leading to the fluid collection, swelling and increased redness. Histamine also stimulates **pain** receptors, making tissue more sensitive and irritable. Symptoms last from one to several hours following contact.

In the upper airways and eyes, immediate hypersensitivity reactions cause the runny nose and itchy, bloodshot eyes typical of **allergic rhinitis**. In the gastrointestinal tract, these reactions lead to swelling and irritation of the intestinal lining, which causes the cramping and **diarrhea** typical of food allergy. Allergens that enter the circulation may cause **hives**, angioedema, **anaphylaxis**, or **atopic dermatitis**.

Allergens on the skin usually cause delayed hypersensitivity reaction. Roving T cells contact the allergen, setting in motion a more prolonged immune response. This type of allergic response may develop over several days following contact with the allergen, and symptoms may persist for a week or more.

Causes and symptoms

Allergens enter the body through four main routes: the airways, the skin, the gastrointestinal tract, and the circulatory system.

- Airborne allergens cause the sneezing, runny nose, and itchy, bloodshot eyes of hay **fever** (allergic **rhinitis**). Airborne allergens can also affect the lining of the lungs, causing **asthma**, or the conjunctiva of the eyes, causing **conjunctivitis** (pink eye). Exposure to cockroach allergans have been associated with the development of asthma. Airborne allergans from household pets are another common source of environmental exposure.
- Allergens in food can cause **itching** and swelling of the lips and throat, cramps, and diarrhea. When absorbed into the bloodstream, they may cause hives (urticaria) or more severe reactions involving recurrent, noninflammatory swelling of the skin, mucous membranes, organs, and brain (angioedema). Some food allergens may cause anaphylaxis,a potentially life-threatening condition marked by tissue swelling, airwayconstriction, and drop in blood pressure. Allergies to foods such cow's milk, eggs, nuts, fish, and legumes (peanuts and soybeans) are common. Allergies to fruits and vegetables may also occur.
- In contact with the skin, allergens can cause reddening, itching, and blistering, called **contact dermatitis**. Skin reactions can also occur from allergens introduced through the airways or gastrointestinal tract. This type of reaction is known as atopic **dermatitis**. Dermatitis may arise from an allergic response (such as from poison ivy), or exposure to an irritant causing nonimmune damage to skin cells (such as soap, cold, and chemical agents).
- Injection of allergens, from insect **bites and stings** or drug administration, can introduce allergens directly into the circulation, where they may cause system-wide responses (including anaphylaxis), as well as the local ones of swelling and irritation at the injection site.

People with allergies are not equally sensitive to all allergens. Some may have severe allergic rhinitis but no food allergies, for instance, or be extremely sen-

sitive to nuts but not to any other food. Allergies may get worse over time. For example, childhood ragweed allergy may progress to year-round dust and pollen allergy. On the other hand, a person may lose allergic sensitivity. Infant or childhood atopic dermatitis disappears in almost all people. More commonly, what seems to be loss of sensitivity is instead a reduced exposure to allergens or an increased tolerance for the same level of symptoms.

While allergy to specific allergens is not inherited, the likelihood of developing some type of allergy seems to be, at least for many people. If neither parent has allergies, the chances of a child developing allergy is approximately 10-20%; if one parent has allergies, it is 30-50%; and if both have allergies, it is 40-75%.One source of this genetic predisposition is in the ability to produce higher levels of IgE in response to allergens. Those who produce more IgE will develop a stronger allergic sensitivity.

COMMON ALLERGENS. The most common airborne allergens are the following:

- plant pollens
- animal fur and dander
- body parts from house mites (microscopic creatures found in all houses)
- house dust
- mold spores
- cigarette smoke
- solvents
- cleaners

Common food allergens include the following:

- nuts, especially peanuts, walnuts, and brazil nuts
- fish, mollusks, and shellfish
- eggs
- wheat
- milk
- food additives and preservatives

The following types of drugs commonly cause allergic reactions:

- penicillin or other **antibiotics**
- flu vaccines
- tetanus toxoid vaccine
- gamma globulin

Common causes of contact dermatitis include the following:

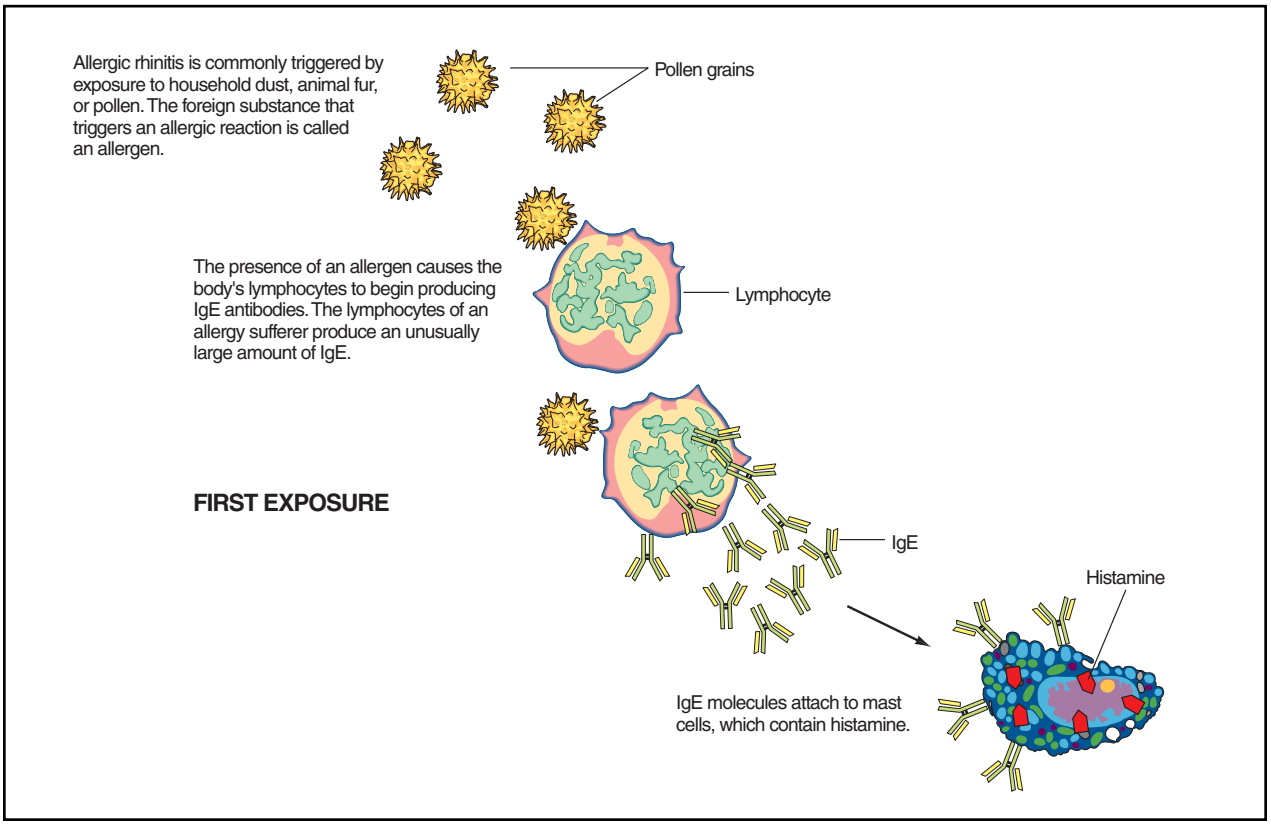
- poison ivy, oak, and sumac
- nickel or nickel alloys
- latex

Insects and other arthropods whose bites or stings typically cause allergy include the following:

- bees, wasps, and hornets
- mosquitoes
- fleas
- scabies

Symptoms depend on the specific type of allergic reaction. Allergic rhinitis is characterized by an itchy, runny nose, often with a scratchy or irritated throat due to post-nasal drip. Inflammation of the thin membrane covering the eye (allergic conjunctivitis) causes redness, irritation, and increased tearing in the eyes. Asthma causes **wheezing**, coughing, and **shortness of breath**. Symptoms of food allergies depend on the tissues most sensitive to the allergen and whether the allergen spread systemically by the circulatory system. Gastrointestinal symptoms may include swelling and tingling in the lips, tongue, palate or throat; nausea; cramping; diarrhea; and gas. Contact dermatitis is marked by reddened, itchy, weepy skin blisters, and an eczema that is slow to heal. It sometimes has a characteritic man-made pattern, such as a glove allergy with clear demarkation on the hands, wrist, and arms where the gloves are worn, or on the earlobes by wearing earrings.

Whole body or systemic reactions may occur from any type of allergen, but are more common following ingestion or injection of an allergen. Skin reactions include the raised, reddened, and itchy patches called hives that characteristically blanch with pressure and resolve within twenty-four hours. A deeper and more extensive skin reaction, involving more extensive fluid collection and pain, is called angioedema. This usually occurs on the extremities, fingers, toes, and parts of the head,neck,and face. Anaphylaxis is marked by airway constriction, blood pressure drop, widespread tissue swelling, heart rhythm abnormalities, and in some cases, loss of consciousness. Other syptoms may include, **dizziness**, weakness, seizures, coughing,flushing, or cramping. The symptoms may begin within five minutes after exposure to the allergan up to one hour or more later. Mast cells in the tissues and basophils in the blood release mediators that give rise to the clinical symptoms of this IgE-mediated hypersensitivity reaction. Commonly, this is associated with allergies to medications, foods, and insect venoms. In some individuals, anaphylaxis can occur with **exercise**, plasma exchange, hemodialysis, reaction to insulin, radocontrast media used in certain



The allergic response. *(Illustration by Hans & Cassady.)*

types of medical tests. and rarely during the administration of local anesthetics.

Diagnosis

Allergies can often be diagnosed by a careful medical history, matching the onset of symptoms to the exposure to possible allergens. Allergy is suspected if the symptoms presented are characteristic of an allergic reaction and this occurs repeatedly upon exposure to the suspected allergan. **Allergy tests** can be used to identify potential allergens, but these must be supported by eveidence of allergic responses in the patient's clinical history.

Skin tests

Skin tests are performed by administering a tiny dose of the suspected allergen by pricking, scratching, puncturing or injecting the skin. The allergen is applied to the skin as an auqeous extract, usually on the back, forearms, or top of the thighs. Once in the skin, the allergen may produce a classic immune wheal and flare response (a skin lesion with a raise, white, compressible area surrounded by a red flare). The tests usually begin with prick tests or patch tests that expose the skin to small amounts of allergen to observe the response. A positive reaction will occur on the skin even if the allergen is at levels normally encountered in food or in the airways. Reactions are usually evaluated approximately fifteen minutes after exposure. Intradermal skin tests involved injection of the allergan into the dermis of the skin. These tests are more sensitive and are used for allergies associated with risk of **death**, such as allergies to antibiotics.

Allergen-Specific IgE Measurement

Tests that measure allergen-specific IgE antibodies generally follow a basic method. The allergen is bound to a solid support, either in the form of a cellulose sponge, microtiter plate, or paper disk. The patient's serum is prepared from a blood sample and is incubated with the solid phase. If allergen specific IgE antibodies are present, they will bind to the solid phase and be retained there when the rest of the serum is washed away. Next, an labeled antibody against the IgE is added and will bind to any IgE on the solid phase. The excess is washed away and the levels of IgE are determined. The commonly used RAST test (radio allergo sorbent

test) employed radio-labeled Anti-IgE antibodies. Updated methods now incorporate the use of enyzme-labeled antibodies in ELISA assays (enzyme-linked immunosorbent assays).

Total Serum IgE

The total level of IgE in the serum is commonly measured with a two-site immunometric assay. Some research indicates that there is a higher level of total serum IgE in allergic as compared to non-allergic people. However, this may not always be the case as there is considerable overlap between the two groups.This test is useful for the diagnosis of allergic fungal **sinusitis** and bronchopulmonary **aspergillosis**. Other conditions that are not allergic in nature may give rise to higher IgE levels such as **smoking**, **AIDS**, infection with parasites, and IgE myeloma.

Provocation tests

These tests involve the administration of allergen to ellicit an immune response. Provocation tests, most commonly done with airborne allergens, present the allergen directly through the route normally involved. Delayed allergic contact dermatitis diagnosis involves similar methods by application of a skin patch with allergen to induce an allergic skin reaction. Food allergen provocation tests require abstinence from the suspect allergen for two weeks or more, followed by ingestion of a measured amount of the test substance administered as an opaque capsule along with a placebo control. Provocation tests are not used if anaphylaxis is is a concern due to the patient's medical history.

Future diagnostic methods

As of 2000, attempts have been made for direct measurement of immune mediators such as histamine, eosinophil cationic protein (ECP), and mast cell tryptase. Another, somewhat controversial,test is electrodermal testing or electro-acupuncture allergy testing. This test has been used in Europe and is under investigation in the United States, though not approved by the Food and Drug Administration. An electric potential is applied to the skin, the allergen presented, and the electrical resistance observed for changes. This method has not been verified.

Treatment

Avoiding allergens is the first line of defense to reduce the possibility of an allergic attack. It is helpful to avoid environmental irritants such as tobacco smoke, perfumes, household cleaning agents, paints, glues, air fresheners, and potpourri. Nitrogen dioxide from poorly vented gas stoves, woodburing stoves, and artificial fireplaces has also been linked to poor asthma control. Dust mite control is particularly important in the bedroom areas by use of allergen-impermeable covers on mattress and pillows, frequent washing of bedding in hot water,and removal of items that collect dust such as stuffed toys. Mold growth may be reduced by reducing indoor humidity, repair of house foundations to reduce indoor leaks and seepage, and installation of exhaust systems to ventilate areas where steam is generated such as the bathroom or kitchen. Allergic individuals should avoid pet allergens such as saliva, body excretions, pelts, urine, or feces. For those who insist on keeping a pet, restriction of the animal's activity to certain areas of the home may be beneficial.

Complete environmental control is often difficult to accomplish, hence therapuetic interventions may become necessary. A large number of prescription and over-the-counter drugs are available for treatment of immediate hypersensitivity reactions. Most of these work by decreasing the ability of histamine to provoke symptoms. Other drugs counteract the effects of histamine by stimulating other systems or reducing immune responses in general.

Antihistamines

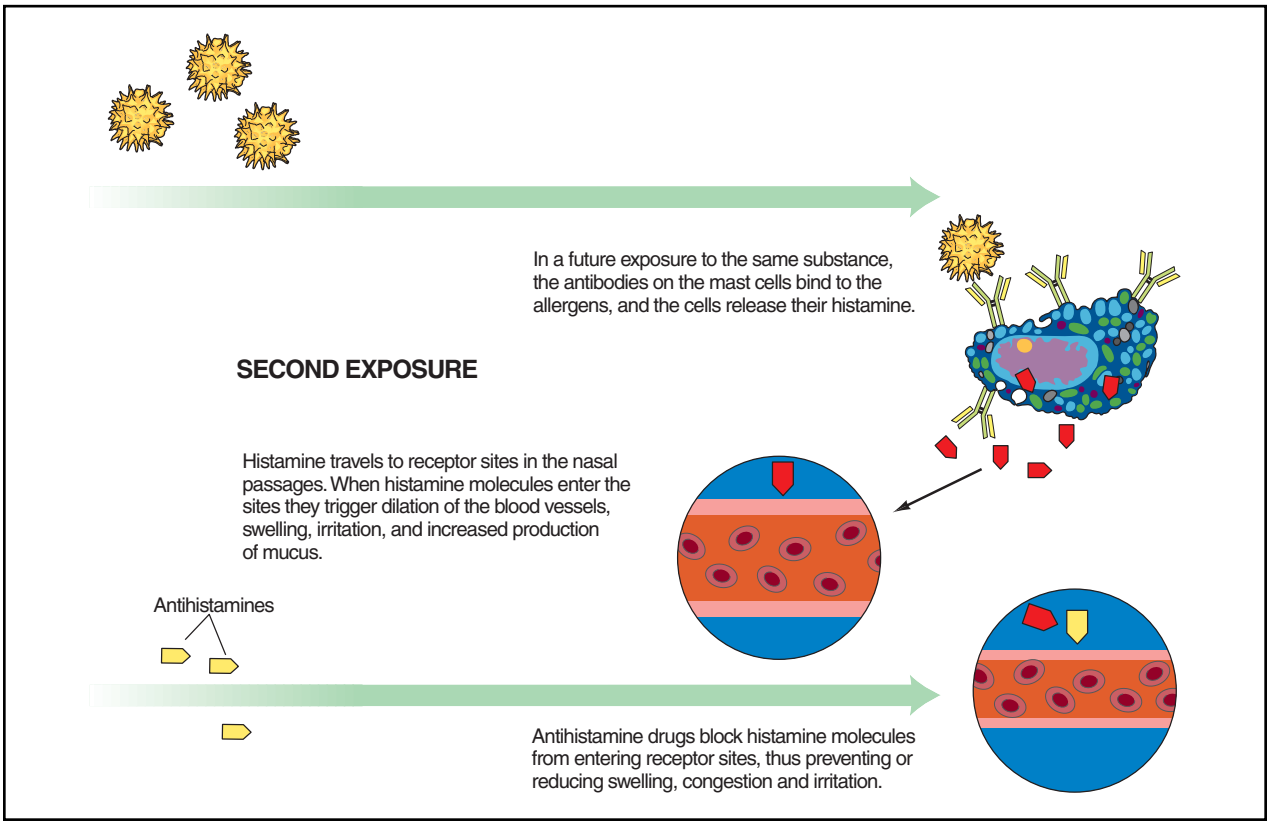
Antihistamines block the histamine receptors on nasal tissue, decreasing the effect of histamine released by mast cells. They may be used after symptoms appear, though they may be even more effective when used preventively, before symptoms appear. Antihistamines are help reduce sneezing, itching, and rhinorrhea. A wide variety of antihistamines are available.

Older, first generation antihistamines often produce drowsiness as a major side effect, as well as **dry mouth**, tachycardia, blurred vision, **constipation**, and lower the threshold for seizures. These medicatios also have similar effects to a alcohol and care should be taken when operating motor vehicles, as individuals may not be aware that they are impared. Such antihistamines include the following:

- diphenhydramine (Benadryl and generics)
- chlorpheniramine (Chlor-trimeton and generics)
- brompheniramine (Dimetane and generics)
- clemastine (Tavist and generics)

Newer antihistamines that do not cause drowsiness or pass the blood-brain barrier are available by prescription and include the following:

- loratidine (Claritin)



Second and subsequent exposure to allergen. *(Illustration by Hans & Cassady.)*

• fexofenadine (Allegra)

Hismanal has the potential to cause serious heart **arrhythmias** when taken with the antibiotic erythromycin,the antifungal drugs ketoconazole and itraconazole, or the antimalarial drug quinine. Taking more than the recommended dose of Hismanal can also cause arrhythimas. Seldane (terfenadine), the original non-drowsy antihistamine, was voluntarily withdrawn from the market by its manufacturers in early 1998 because of this potential and because of the availability of an equally effective, safer alternative drug, fexofenadine.

Decongestants

Decongestants constrict blood vessels to the mucosa to counteract the effects of histamine. This decreases the amount of blood in the nasopahryngeal and sinus mucosa and reduces swelling. Nasal sprays are available that can be applied directly to the nasal lining and oral systemicpreparations are available. Decongestants are stimulants and may cause increased heart rate and blood pressure, headaches,insomnia,agitation, and difficulty emptying the bladder. Use of topical decongestants for longer than several days can cause loss of effectiveness and rebound congestion, in which nasal passages become more severely swollen than before treatment.

Topical corticosteroids

Topical **corticosteroids** reduce mucous membrane inflammationas by decreasing the amount of fluid moved from the vascular spaces into the tissues. These medications reduce the recruitment of inflammatory cells as well as the synthesis of cytokines. They are available by prescription. Allergies tend to become worse as the season progresses because the immune system becomes sensitized to particular antigens and can produce a faster, stronger response. Topical corticosteroids are especially effective at reducing this seasonal sensitization because they work more slowly and last longer than most other medication types. As a result, they are best started before allergy season begins. Side effects are usually mild, but may include headaches, nosebleeds, and unpleasant taste sensations.

Bronchodilators or metered-dose inhalers (MDI)

Because allergic reactions involving the lungs cause the airways or bronchial tubes to narrow, as in asthma,

KEY TERMS

Allergen—A substance that provokes an allergic response.

Allergic rhinitis—Inflammation of the mucous membranes of the nose and eyes in response to an allergen.

Anaphylaxis—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

Angioedema—Severe non-inflammatory swelling of the skin, organs, and brain that can also be accompanied by fever and muscle pain.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Asthma—A lung condition in which the airways become narrow due to smooth muscle contraction, causing wheezing, coughing, and shortness of breath.

Atopic dermatitis—Infection of the skin as a result of exposure to airborne or food allergens.

Conjunctivitis—Inflammation of the thin lining of the eye called the conjunctiva.

Contact dermatitis—Inflammation of the skin as a result of contact with a substance.

Delayed hypersensitivity reactions—Allergic reactions mediated by T cells that occur hours to days after exposure.

Granules—Small packets of reactive chemicals stored within cells.

Histamine—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

Immune hypersensitivity reaction—Allergic reactions that are mediated by mast cells and occur within minutes of allergen contact.

Mast cells—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

T cells—Immune system cells or more specifically, white blood cells, that stimulate cells to create and release antibodies.

bronchodilators, which cause the smooth muscle lining the airways to open or dilate, can be very effective. When inahlers are used, it is important that the patient be educated in the proper use of these medications.The inhaler should be shaken, and the patient should breathe out to expel air from the lungs. The inhaler should be place at least two fingerbreadths in front of the mouth. The medication should be aimed at the back of the throat, and the inhaler activated while breathing in quite slowly 3-4 seconds. The breath should be held for at least ten seconds, and then expelled. At least thirty to sixty seconds should pass before the inhaler is used again. Care should be taken to properly wash out the mouth and brush the teeth following use, as residual medication remains in this area with only a small amount actually reaching the lungs. Some bronchodilators used to treat acute asthma attacks include adrenaline, albuterol, or other "adrenoceptor stimulants," most often administered as aerosols. Futicasone (Flovent) is another commonly prescribed inhaler. Some bronchodilators used to treat acute asthma attacks include adrenaline, albuterol, Maxair, Proventil, or other "adrenoceptor stimulants," most often administered as aerosols. Another group of medications, the long-acting beta agonists, are proving useful to reduce the use of inhalers.and include salmeterol xinafoate (Serevent). Theophylline,naturally present in coffee and tea, is another drug that produces brochodilation.It is usually taken orally, but in a severe asthma attack is may be given intravenously. Side effects include gastrointestinal disturbances, **insomnia**, headaches, and seizures.

Anticholinergics

Ipratropium bromide (atrovent) and atropine sulfate are achticholinergic drugs used for the treatment of asthma. Ipratropium is used for treating asthmatics in emergency situations with a nebulizer.

Nonsteroidal drugs

MAST CELL STABILIZERS. Cromolyn sodium prevents the release of mast cell granules, thereby prevent-

ing the release of histamine and other chemicals contained in them. It acts as a preventive treatment if it is begun several weeks before the onset of the allergy season. It can also be used for year round allergy prevention. Cromolyn sodium is available as a nasal spray for allergic rhinitis and in aerosol (a suspension of particles in gas) form for asthma.

LEUKOTRIENE MODIFIERS. These medications are useful for individuals with **aspirin** sensitivity,sinusitis, polposis, urticaria. Examples include zafirlukast (Accolate),montelukast (Singulair), and zileuton (Zyflo). When zileuton is used, care must be taken to measure liver enzymes.

Immunotherapy

In this form of therapy, allergen is injected into the skin in increasing doses over a specific period of time. This may be helpful for patients who do not respond to medications or avoidance of allergens in the environment. This type of therapy may reduce the need for medications.

Treatment of contact dermatitis

An individual suffering from contact dermatitis should initially take steps to avoid possible wources of exposure to the offending agent. Calamine lotion applied to affected skin can reduce irritation somewhat, as can cold water compresses. Side effects of topical agents may include over-drying of the skin.In the case of acute contact dermatitis, short-term oral corticosteroid therapy may be appropriate. Moderately strong coricosteroids can also be applied as a wrap for twenty-four hours. Health care workers are especially at risk for hand eruptions due to glove use.

Treatment of anaphylaxis

The emergency condition of anaphylaxis is treated with injection of adrenaline, also known as epinephrine. People who are prone to anaphylaxis because of food or insect allergies often carry an "Epi-pen" containing adrenaline in a hypodermic needle. Other medications may be given to aid the action of the epi-pen. Prompt injection can prevent a more serious reaction from developing. Paticular care should be taken to assess the affected individual's airway status, and he or she should be placed in a recumbent pose and vital signs determined. If a reaction resulted from insect sting or an injection, a tourniquet may need to be placed proximal to the area where the agent penetrated the skin. This should then be released at intervals of ten minutes at a time, for one to two minutes duration. If the individual does not respond to such interventions, then emergency treatment is appropriate.

Alternative treatment

Any alternative treatment for allergies begins with finding the cause and then helping the patient to avoid or eliminate the allergen, although this is not always possible. As with any alternative therapy, a physician should be consulted before initiating a new form of treatment. Education on the use of alternative agents is critical, as they are still "drugs" even though they are derived from natural sources.Various categories of alternative remedies may be helpful in allergy treatment, including:

- antihistamines: vitamin C and the bioflavonoid hesperidin act as natural anithistamines.
- decongestants: vitamin C, the homeopathic remedies *Ferrum phosphoricum* and *Kali muriaticum* (used alternately), and the dietary supplement N-acetylcysteine are believed to have decongestant effects.
- mast cell stabilizers: the bioflavonoids quercetin and hesperidin may help stabilize mast cells.
- immunotherapy: the herbs **echinacea** (*Echinacea* spp.) and astragalus or milk-vetch root (*Astragalus membranaceus*) may possibly help to strengthen the immune system.
- bronchodilators: the herbal remedies ephedra (*Ephedra sinica*, also known as ma huang in **traditional Chinese medicine**), khellin (*Ammi visnaga*) and cramp bark (*Viburnum opulus*) are believed to help open the airways.

Treatment of contact dermatitis

A variety of herbal remedies, either applied topically or taken internally, may possibly assist in the treatment of contact dermatitis. A poultice (crushed herbs applied directly to the affected area) made of jewelweed (*Impatiens* spp.) or chickweed (*Stellaria media*) may soothe the skin. A cream or wash containing calendula (*Calendula officinalis*), a natural antiseptic and anti-inflammatory agent, may help heal the rash when applied topically. Homeopathic treatment may include such remedies as *Rhus toxicodendron*, *Apis mellifica*, or *Anacardium* taken internally. A qualified homeopathic practitioner should be consulted to match the symptoms with the correct remedy. Care should be taken with any agent taken internally.

Prognosis

Allergies can improve over time, although they often worsen. While anaphylaxis and severe asthma are life-

threatening, other allergic reactions are not. Learning to recognize and avoid allergy-provoking situations allows most people with allergies to lead normal lives.

Prevention

Avoiding allergens is the best means of limiting allergic reactions. For food allergies, there is no effective treatment except avoidance. By determining the allergens that are causing reactions, most people can learn to avoid allergic reactions from food, drugs, and contact allergens such as poison ivy or latex. Airborne allergens are more difficult to avoid, although keeping dust and animal dander from collecting in the house may limit exposure. Cromolyn sodium can prevent mast cell degranulation, thereby limiting the allergic response.

Immunotherapy, also known as desensitization or allergy shots, alters the balance of antibody types in the body, thereby reducing the ability of IgE to cause allergic reactions. Immunotherapy is preceded by allergy testing to determine the precise allergens responsible. Injections involve very small but gradually increasing amounts of allergen, over several weeks or months, with periodic boosters. Full benefits may take up to several years to achieve and are not seen at all in about one in five patients. Individuals receiving all shots will be monitored closely following each shot because of the small risk of anaphylaxis, a condition that can result in difficulty breathing and a sharp drop in blood pressure.

Other drugs, including steroids, are used to prevent asthma attacks and in the long-term management of asthma.

Resources

BOOKS

Kemp, Stephen F. and Richard Lockey, editors. *Diagnostic Testing of Allergic Disease*. New York: Marcel Dekker, Inc., 2000.

Lawlor, G. J., T. J. Fischer, and D. C. Adelman. *Manual of Allergy and Immunology.* Boston: Little, Brown and Co., 1995.

Lieberman, Phil, and Johh Anderson, editors. *Allergic Diseases: Diagnosis and Treatment, 2nd edition*. Totowa: Humana Press, Inc., 2000.

Novick, N. L. *You Can Do Something About Your Allergies*. New York: Macmillan, 1994.

Hans-Uwe, Simon, editor. *CRC Desk Reference for Allergy and Asthma*. Boca Raton: CRC Press, 2000.

Weil, A. *Natural Health, Natural Medicine: A Comprehensive Manual for Wellness and Self-Care*. Boston: Houghton Mifflin, 1995.

Richard Robinson
Jill Granger, MS

Allergy tests

Definition

Allergy tests indicate a person's allergic sensitivity to commonly encountered environmental substances.

Purpose

Allergy is a reaction of the immune system. Normally, the immune system responds to foreign microorganisms and particles, like pollen or dust, by producing specific proteins called antibodies that are capable of binding to identifying molecules, or antigens, on the foreign organisms. This reaction between antibody and antigen sets off a series of reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances. This is the condition known as allergy, and the offending substance is called an allergen. Common inhaled allergens include pollen, dust, and insect parts from tiny house mites. Common food allergens include nuts, fish, and milk.

Allergic reactions involve a special set of cells in the immune system known as mast cells. Mast cells serve as guards in the tissues where the body meets the outside world: the skin, the mucous membranes of the eyes and other areas, and the linings of the respiratory and digestive systems. Mast cells display a special type of antibody, called immunoglobulin type E (IgE), on their surface. Inside, mast cells store reactive chemicals in small packets, called granules. When the antibodies encounter allergens, they trigger the release of granules, which spill out their chemicals onto neighboring cells, including blood vessels and nerve cells. One of these chemicals, histamine, binds to the surfaces of these other cells, through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes neighboring cells to become leaky, leading to the fluid collection, swelling, and increased redness characteristic of a runny nose and red, irritated eyes. Histamine also stimulates **pain** receptors, causing the itchy, scratchy nose, eyes, and throat common in **allergic rhinitis**.

The particular allergens to which a person is sensitive can be determined through allergy testing. Allergy tests may be performed on the skin or using blood serum in a test tube. During skin tests, potential allergens are placed on the skin and the reaction is observed. In radioallergosorbent allergy testing (RAST), a patient's blood serum is combined with allergen in a test tube to determine if serum antibodies react with the allergen. Provocation testing involves direct exposure to a likely aller-

gen, either through inhalation or ingestion. Positive reactions from any of these tests may be used to narrow the candidates for the actual allergen causing the allergy.

Identification of the allergenic substance may allow the patient to avoid the substance and reduce allergic reactions. In addition, allergy testing may be done in those with **asthma** that is difficult to manage, eczema, or skin **rashes** to determine if an allergy is causing the condition or making it worse. Allergy tests may also be done before allergen desensitization to ensure the safety of more extensive exposure.

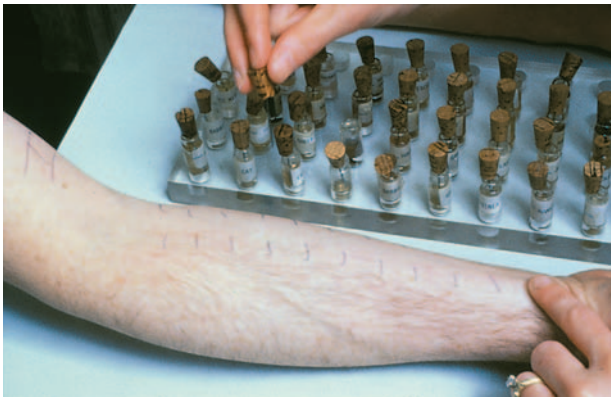
Skin testing is the most common type of allergy test. There are two forms: percutaneous and intradermal. In percutaneous or prick testing, allergen solutions are placed on the skin, and the skin is then pricked with a needle, allowing the allergen to enter the skin and become exposed to mast cells. Scratch testing, in which the skin is scratched instead of punctured, is used less often. Intradermal testing involves directly injecting allergen solutions into the skin. In both tests, a reddened, swollen spot develops at the injection site for each substance to which the person is sensitive. Skin reactivity is seen for allergens regardless of whether they usually affect the skin. In other words, airborne and food allergens cause skin reactions equally well.

The range of allergens used for testing is chosen to reflect possible sources in the environment and may include the following:

- pollen from a variety of trees, common grasses, and weeds
- mold and fungus spores
- house dust
- house mites
- animal skin cells (dander) and saliva
- food extracts
- antibiotics
- insect venoms

Radio-allergosorbent testing (RAST) is a laboratory test performed when a person may be too sensitive to risk skin testing or when medications or skin conditions prevent it.

Provocation testing is done to positively identify suspected allergens after preliminary skin testing. A purified preparation of the allergen is inhaled or ingested in increasing concentrations to determine if it will provoke a response. Food testing is much more tedious than inhalation testing, since full passage through the digestive system may take a day or more.



This patient is being exposed to certain allergens as part of an allergy test. *(Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

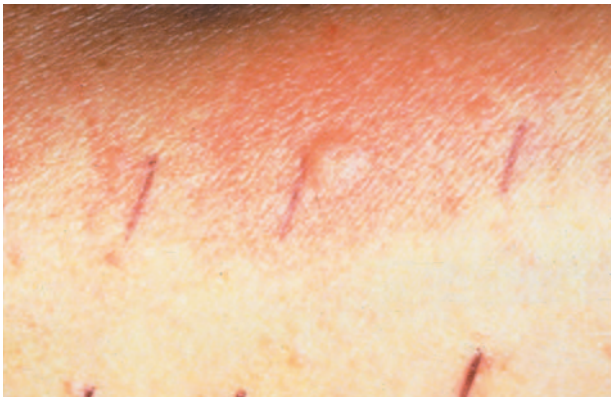
While allergy tests are quite safe for most people, the possibility of a condition known as **anaphylaxis** does exist. Anaphylaxis is a potentially dangerous condition that can result in difficulty breathing and a sharp drop in blood pressure. People with a known history of anaphylaxis should inform the testing clinician. Skin tests should never include a substance known to cause anaphylaxis in the person being tested.

Provocation tests may cause an allergic reaction. Therefore, treatment medications should be available following the tests, to be administered, if needed.

Description

In prick testing, a drop of each allergen to be tested is placed on the skin, usually on the forearm or the back. A typical battery of tests may involve two dozen allergen drops, including a drop of saline solution that should not provoke a reaction (negative control) and a drop of histamine that should provoke a reaction (positive control). A small needle is inserted through the drop, and used to prick the skin below. A new needle is used for each prick. The sites are examined over the next twenty minutes for evidence of swelling and redness, indicating a positive reaction. In some instances, a tracing of the set of reactions may be made by placing paper over the tested area. Similarly, in intradermal testing, separate injections are made for each allergen tested. Observations are made over the next twenty minutes.

In RAST testing, a blood sample is taken for use in the laboratory, where the antibody- containing serum is separated from the blood cells. The serum is then exposed to allergens bound to a solid medium. If a person has antibodies to a particular allergen, those antibod-



A close-up of a patient's arm after allergy testing. *(Custom Medical Stock Photo. Reproduced by permission.)*

ies will bind to the solid medium and remain behind after a rinse. Location of allergen-antibody combinations is done by adding antibody-reactive antibodies, so called anti-antibodies, that are chemically linked with a radioactive dye. By locating radioactive spots on the solid medium, the reactive allergens are discovered.

Provocation testing may be performed to identify airborne or food allergens. Inhalation testing is performed only after a patient's lung capacity and response to the medium used to dilute the allergen has been determined. Once this has been determined, the patient inhales increasingly concentrated samples of a particular allergen, followed each time by measurement of the exhalation capacity. Only one allergen is tested per day. Testing for food **allergies** is usually done by removing the suspect food from the diet for two weeks, followed by eating a single portion of the suspect food and follow-up monitoring.

Preparation

Skin testing is preceded by a brief examination of the skin. The patient should refrain from using anti-allergy drugs for at least 48 hours before testing. Prior to inhalation testing, patients with asthma who can tolerate it may be asked to stop any asthma medications. Testing for food allergies requires the person to avoid all suspect food for at least two weeks before testing.

Aftercare

Skin testing does not usually require any aftercare. A generalized redness and swelling may occur in the test area, but it will usually resolve within a day or two.

Inhalation tests may cause delayed asthma attacks, even if the antigen administered in the test initially produced no response. Severe initial reactions may justify close professional observation for at least 12 hours after testing.

KEY TERMS

Allergen—A substance that provokes an allergic response.

Anaphylaxis—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation (swelling) and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Histamine—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

Mast cells—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

Risks

Intradermal testing may inadvertently result in the injection of the allergen into the circulation, with an increased risk of adverse reactions. Inhalation tests may provoke an asthma attack. Exposure to new or unsuspected allergens in any test carries the risk of anaphylaxis. Because patients are monitored following allergy testing, an anaphylactic reaction is usually recognized and treated promptly. Occasionally, a delayed anaphylactic response can occur that will require immediate care. Proper patient education regarding how to recognize anaphylaxis is vital.

Normal results

Lack of redness or swelling on a skin test indicates no allergic response. In an inhalation test, the exhalation capacity should remain unchanged. In a food challenge, no symptoms should occur.

Abnormal results

Presence of redness or swelling, especially over 5 mm (1/4 inch) in diameter, indicates an allergic response.

This does not mean the substance actually causes the patient's symptoms, however, since he or she may have no regular exposure to the allergen. In fact, the actual allergen may not have been included in the test array.

Following allergen inhalation, reduction in exhalation capacity of more than 20%, and for at least 10-20 minutes, indicates a positive reaction to the allergen.

Gastrointestinal symptoms within 24 hours following the ingestion of a suspected food allergen indicates a positive response.

Resources

BOOKS

Davies, R., and S. Ollier. *Allergy: The Facts*. Oxford, England: Oxford University Press, 1989.

Lawlor Jr., G. J., T. J. Fischer, and D. C. Adelman. *Manual of Allergy and Immunology*. Boston: Little, Brown and Co., 1995.

Richard Robinson

Allogenic transplant *see* **Bone marrow transplantation**

Allopurino *see* **Gout drugs**

Alopecia

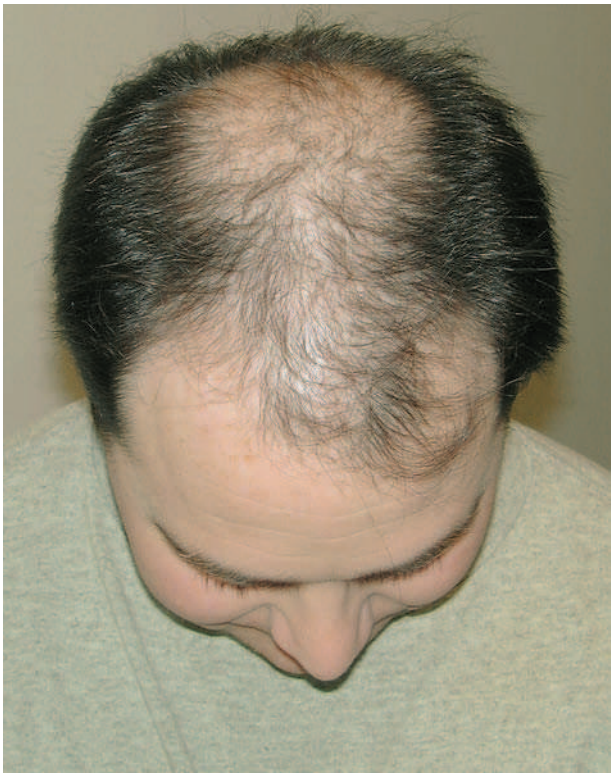
Definition

Alopecia simply means hair loss (baldness).

Description

Hair loss occurs for a great many reasons—from pulling it out to having it killed off by **cancer chemotherapy**. Some causes are considered natural, while others signal serious health problems. Some conditions are confined to the scalp. Others reflect disease throughout the body. Being plainly visible, the skin and its components can provide early signs of disease elsewhere in the body.

Oftentimes, conditions affecting the skin of the scalp will result in hair loss. The first clue to the specific cause is the pattern of hair loss, whether it be complete baldness (alopecia totalis), patchy bald spots, thinning, or hair loss confined to certain areas. Also a factor is the condition of the hair and the scalp beneath it. Sometimes only the hair is affected; sometimes the skin is visibly diseased as well.



Top of balding male's head. *(Photograph by Kelly A. Quin. Reproduced by permission.)*

Causes and symptoms

- Male pattern baldness (androgenic alopecia) is considered normal in adult males. It is easily recognized by the distribution of hair loss over the top and front of the head and by the healthy condition of the scalp.
- Alopecia areata is a hair loss condition of unknown cause that can be patchy or extend to complete baldness.
- Fungal infections of the scalp usually cause patchy hair loss. The fungus, similar to the ones that cause **athlete's foot** and **ringworm**, often glows under ultraviolet light.
- Trichotillomania is the name of a mental disorder that causes a person to pull out his/her own hair.
- Complete hair loss is a common result of cancer chemotherapy, due to the toxicity of the drugs used. Placing a tourniquet around the skull just above the ears during the intravenous infusion of the drugs may reduce or eliminate hair loss by preventing the drugs from reaching the scalp.
- Systemic diseases often affect hair growth either selectively or by altering the skin of the scalp. One example is thyroid disorders. **Hyperthyroidism** (too much thyroid hormone) causes hair to become thin and fine.

KEY TERMS

Athlete's foot—A fungal infection between the toes, officially known as tinea pedis.

Autoimmune disease—Certain diseases caused by the body's development of an immune reaction to its own tissues.

Chemotherapy—The treatment of diseases, usually cancer, with drugs (chemicals).

Hair follicles—Tiny organs in the skin, each one of which grows a single hair.

Lupus erythematosus—An autoimmune disease that can damage skin, joints, kidneys, and other organs.

Ringworm—A fungal infection of the skin, usually known as tinea corporis.

Systemic—Affecting all or most parts of the body.

Hypothyroidism (too little thyroid hormone) thickens both hair and skin.

- Several autoimmune diseases (when protective cells begin to attack self cells within the body) affect the skin, notably lupus erythematosus.

Diagnosis

Dermatologists are skilled in diagnosis by sight alone. For more obscure diseases, they may have to resort to a **skin biopsy**, removing a tiny bit of skin using a local anesthetic so that it can examined under a microscope. Systemic diseases will require a complete evaluation by a physician, including specific tests to identify and characterize the problem.

Treatment

Successful treatment of underlying causes is most likely to restore hair growth, be it the completion of chemotherapy, effective cure of a scalp fungus, or control of a systemic disease. Two relatively new drugs—minoxidil (Rogaine) and finasteride (Proscar)—promote hair growth in a significant minority of patients, especially those with male pattern baldness and alopecia areata. While both drugs have so far proved to be quite safe when used for this purpose, **minoxidil** is a liquid that is applied to the scalp and finasteride is the first and only approved treatment in a pill form.

Minoxidil was approved for over-the-counter sales in 1996. When used continuously for long periods of time, minoxidil produces satisfactory results in about one quarter of patients with androgenic alopecia and as many as half the patients with alopecia areata. There is also an over-the-counter extra-strength version of minoxidil (5% concentration) approved for use by men only. The treatment often results in new hair that is thinner and lighter in color. It is important to note that new hair stops growing soon after the use of minoxidil is discontinued.

Over the past few decades there have appeared a multitude of hair replacement methods performed by both physicians and non-physicians. They range from simply weaving someone else's hair in with the remains of your own to surgically transplanting thousands of hair follicles one at a time.

Hair transplantation is completed by taking tiny plugs of skin, each containing one to several hairs, from the back side of the scalp. The bald sections are then implanted with the plugs. Research completed in 2000 looked at the new technique of hair grafting, and found that micrografts (one to two hairs transplanted per follicle) resulted in fewer complications and the best results

Another surgical procedure used to treat androgenic alopecia is scalp reduction. By stretching skin the hairless scalp can be removed and the area of bald skin decreased by closing the space with hair-covered scalp. Hair-bearing skin can also be folded over an area of bald skin with a technique called a flap.

Prognosis

The prognosis varies with the cause. It is generally much easier to lose hair than to regrow it. Even when it returns, it is often thin and less attractive than the original.

Resources

BOOKS

American Society of Health-System Pharmacists Inc. *American Hospital Formulary Service Drug Information*. Bethesda, MD: American Society of Health-System Pharmacists Inc., 1998.

Bennett, J. Claude, and Fred Plum, ed. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders, 1996.

The Burton Goldberg Group. "Hair loss." In *Alternate Medicine: The Definitive Guide*. Puyallup, WA: Future Medicine Publishing, 1993.

Isselbacher, Kurt, et al., ed. *Harrison's Principles of Internal Medicine*. New York: McGraw-Hill, 1994.

PERIODICALS

Amichai B., M. H. Grunwald, and R. Sobel. "5 Alpha-reductase Inhibitors—A New Hope in Dermatology?" *International Journal of Dermatology*, March 1997, 182-4.

Nielsen, Timothy A., and Martin Reichel. "Alopecia: Diagnosis and Management." *American Family Physician*.

OTHER

Androgenetic Alopecia.com. "How can minoxidil be used to treat baldness?". <http://androgenetic-alopecia.com/baldnesstreatments/minoxidil/002minoxidilbaldnessusee.shtml> (1 May 2001).

Hairloss Information Center. "Rogaine: Does It Really Work?" 1997. <http://www.hairloss.com/rogaine.htm> (19 April 1998).

Houston Academy of Medicine. "Propecia: Male Baldness Pill." December 30, 1997. <http://library.tmc.edu/t-prop.html> (19 April 1998).

Mayo Clinic. "Alopecia" January 26, 2001. <http://www.mayohealth.org> (1 May 2001).

WebMD Medical News. "Hair Today, Gone Tomorrow, Hair Again" 2000. <http://my.webmd.com/content/article/1728.53923> (1 May 2001).

Beth Kapes

Alpha-fetoprotein test

Definition

The alpha-fetoprotein (AFP) test is a blood test that is performed during **pregnancy**. This screening test measures the level of AFP in the mother's blood and indicates the probability that the fetus has one of several serious **birth defects**. The level of AFP can also be determined by analyzing a sample of amniotic fluid. This screening test cannot diagnose a specific condition; it only indicates the increase of risk for several birth defects. Outside pregnancy, the AFP test is used to detect liver disease, certain cancerous tumors, and to monitor the progress of **cancer** treatment.

Purpose

Alpha-fetoprotein is a substance produced by the liver of a fetus. The exact function of this protein is unknown. After birth, the infant's liver stops producing AFP, and an adult liver contains only trace amounts. During pregnancy, the fetus excretes AFP in urine and some of the protein crosses the fetal membranes to enter the mother's blood. The level of AFP can then be determined by analyzing a sample of the mother's blood. By analyzing the amount of AFP found in a blood or amniotic fluid sample, doctors can determine the probability that the fetus is at risk for certain birth defects. It is very important that the doctor know precisely how old the fetus is when the test is performed since the AFP level changes over the length of the pregnancy. Alone, AFP screening cannot diagnose a birth defect. The test is used as an indicator of risk and then an appropriate line of testing (like **amniocentesis** or ultrasound) follows, based on the results.

Abnormally high AFP may indicate that the fetus has an increased risk of a neural tube defect, the most common and severe type of disorder associated with increased AFP. These types of defects include spinal column defects (**spina bifida**) and anencephaly (a severe and usually fatal brain abnormality). If the tube that becomes the brain and spinal cord does not close correctly during fetal development, AFP may leak through this abnormal opening and enter the amniotic fluid. This leakage creates abnormally high levels of AFP in amniotic fluid and in maternal blood. If the screening test indicates abnormally high AFP, ultrasound is used to diagnosis the problem.

Other fetal conditions that can raise AFP levels above normal include:

- cysts at the end of the spine
- blockage in the esophagus or intestines
- liver disease causing liver cells to die
- defects in the abdominal wall
- kidney or urinary tract defects or disease
- brittle bone disease

Levels may also be high if there is too little fluid in the amniotic sac around the fetus, more than one developing fetus, or a pregnancy that is farther along than estimated.

For unknown reasons, abnormally low AFP may indicate that the fetus has an increased risk of **Down syndrome**. Down syndrome is a condition that includes **mental retardation** and a distinctive physical appearance linked to an abnormality of chromosome 21 (called trisomy 21). If the screening test indicates an abnormally low AFP, amniocentesis is used to diagnosis the problem. Abnormally low levels of AFP can also occur when the fetus has died or when the mother is overweight.

AFP is often part of a "triple check" blood test that analyzes three substances as risk indicators of possible birth defects: AFP, estriol, and human chorionic gonadotropin (HCG). When all three substances are measured in the mother's blood, the accuracy of the test results increases.

Although AFP in human blood gradually disappears after birth, it never disappears entirely. It may reappear in liver disease, or tumors of the liver, ovaries, or testicles. The AFP test is used to screen people at high risk for these conditions. After a cancerous tumor is removed, an

KEY TERMS

Amniotic fluid—Fluid within the uterine sac in which the fetus lives until born.

Fetus—The stage in human development from the second month of pregnancy until birth.

AFP test can monitor the progress of treatment. Continued high AFP levels suggest the cancer is growing.

Precautions

It is very important that the doctor know precisely how old the fetus is when the test is performed since the AFP level considered normal changes over the length of the pregnancy. Errors in determining the age of the fetus lead to errors when interpreting the test results. Since an AFP test is only a screening tool, more specific tests must follow to make an accurate diagnosis. An abnormal test result does not necessarily mean that the fetus has a birth defect. The test has a high rate of abnormal results (either high or low) in order to prevent missing a fetus that has a serious condition.

Description

The AFP test is usually performed at week 16 of pregnancy. Blood is drawn from a vein, usually on the inside of the elbow. AFP can also be measured in the sample of amniotic fluid taken at the time of amniocentesis. Test results are usually available after about one week.

Preparation

There is no specific physical preparation for the AFP test.

Aftercare

There is no specific aftercare involved with this screening test.

Risks

The risks associated with drawing blood are minimal, but may include bleeding from the puncture site, feeling faint or lightheaded after the blood is drawn, or blood accumulating under the puncture site (hematoma).

Normal results

Alpha-fetoprotein is measured in nanograms per milliliter (ng/mL) and is expressed as a probability. The probability (1:100, for example) translates into the chance that the fetus has a defect (a one in 100 chance, for example).

When testing for cancer or liver diseases, AFP results are reported as nanograms per milliliter. An AFP level less than or equal to 50 ng/mL is considered normal.

Abnormal results

The doctor will inform the woman of her specific increased risk as compared to the "normal" risk of a standard case. If the risk of Down syndrome is greater than the standard risk for women who are 35 years old or older (one in 270), then amniocentesis is recommended. Again, the test has a high rate of showing an abnormal AFP level in order to prevent missing a fetus that has Down's syndrome. This screening test only predicts risk; appropriate diagnostic testing will follow after an abnormal screening result.

In tumor or liver disease testing, an AFP level greater than 50 ng/mL is considered abnormal.

Resources

BOOKS

Cunningham, Gary, et al. *Williams Obstetrics*. 20th ed. Stamford: Appleton & Lange, 1997.

Eisenberg, Arlene, et al. *What To Expect When You're Expecting*. 2nd ed. New York: Workman Publishing, 1996.

Johnson, Robert, ed. *Mayo Clinic Complete Book of Pregnancy and Baby's First Year.* New York: William Morrow and Co., 1997.

PERIODICALS

Haddow, James, et al. "Reducing the Need for Amniocentesis in Women 35 Years of Age or Older with Serum Markers for Screening." *The New England Journal Of Medicine* 330, no. 16 (21 Apr. 1994): 1114-8.

Kase, Lori. "Do Pregnant Women Need All Those Tests?" *American Baby* (Aug. 1994): 42-3.

Lieberman, Adrienne. "AFP Screening: A Test for Birth Defects." *American Baby* (Nov. 1993): 6.

McCabe, Edward, et al. "Maternal Serum Alpha-fetoprotein Screening." *Pediatrics* 88, no. 6 (Dec. 1991): 1282-3.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Adrienne Massel, RN

Alpha-thalassemia *see* **Thalassemia**

Alpha$_1$-adrenergic blockers

Definition

Alpha$_1$-adrenergic blockers are drugs that work by blocking the alpha$_1$-receptors of vascular smooth muscle, thus preventing the uptake of catecholamines by the smooth muscle cells. This causes vasodilation and allows blood to flow more easily.

Purpose

These drugs, called alpha blockers for short, are used for two main purposes: to treat high blood pressure (**hypertension**) and to treat benign prostatic hyperplasia (BPH), a condition that affects men and is characterized by an **enlarged prostate** gland.

High blood pressure

High blood pressure puts a strain on the heart and the arteries. Over time, hypertension can damage the blood vessels to the point of causing **stroke**, **heart failure** or kidney failure. People with high blood pressure may also be at higher risk for heart attacks. Controlling high blood pressure makes these problems less likely. Alpha blockers help lower blood pressure by causing vasodilation, meaning an increase in the diameter of the blood vessels, which allows blood to flow more easily.

Benign prostatic hyperplasia (BPH)

This condition particularly affects older men. Over time, the prostate, a donut-shaped gland below the bladder, enlarges. When this happens, it may interfere with the passage of urine from the bladder out of the body. Men who are diagnosed with BPH may have to urinate more often. Or they may feel that they can not completely empty their bladders. Alpha blockers inhibit the contraction of prostatic smooth muscle and thus relax muscles in the prostate and the bladder, allowing urine to flow more freely.

Description

Commonly prescribed alpha blockers for hypertension and BPH include doxazosin (Cardura, prazosin (Minipress) and terazosin (Hytrin). Prazosin is also used in the treatment of heart failure. All are available only with a physician's prescription and are sold in tablet form.

Recommended dosage

The recommended dose depends on the patient and the type of alpha blocker and may change over the course of treatment. The prescribing physician will gradually increase the dosage, if necessary. Some patients may need as much as 15-20 mg per day of terazosin, 16 mg per day of doxazosin, or as much as 40 mg per day of prazosin, but most people benefit from lower doses. As the dosage increases, so does the possibility of unwanted side effects.

Alpha blockers should be taken exactly as directed, even if the medication does not seem to be working at first. It should not be stopped even if symptoms improve because it needs to be taken regularly to be effective. Patients should avoid missing any doses, and should not take larger or more frequent doses to make up for missed doses.

Precautions

Alpha blockers may lower blood pressure to a greater extent than desired. This can cause **dizziness**, lightheadedness, heart **palpitations**, and **fainting**. Activities such as driving, using machines, or doing anything else that might be dangerous for 24 hours after taking the first dose should be avoided. Patients should be reminded to be especially careful not to fall when getting up in the middle of the night. The same precautions are recommended if the dosage is increased or if the drug has been stopped and then started again. Anyone whose safety on the job could be affected by taking alpha blockers should inform his or her physician, so that the physician can take this factor into account when increasing dosage.

Dizziness, lightheadedness, and fainting are more likely to occur when people taking alpha blockers also drink alcohol, **exercise**, stand for a long time, or are exposed to hot weather. Extra care should be used under these conditions and alcohol consumption should be limited.

Some people may feel drowsy or less alert when using these drugs. They should accordingly avoid driving or performing activities that require full attention.

People diagnosed with kidney disease or liver disease may also be more sensitive to alpha blockers. They should inform their physicians about these conditions if alpha blockers are prescribed. Older people may also be more sensitive and may be more likely to have unwanted side effects, such as fainting, dizziness, and lightheadedness.

It should be noted that alpha blockers do not cure high blood pressure. They simply help to keep the condition under control. Similarly, these drugs will not shrink an enlarged prostate gland. Although they will help relieve the symptoms of prostate enlargement, the prostate may continue to grow, and it eventually may be necessary to have prostate surgery.

Alpha blockers may lower blood counts. Patients may need to have their blood checked regularly while taking this medicine.

KEY TERMS

Adrenergic—Refers to neurons (nerve cells) that use catecholamines as neurotransmitters at a synapse.

Adrenergic receptor—There are three families of adrenergic receptors, alpha$_1$, alpha$_2$ and beta, and each family contains three distinct subtypes. Each of the nine subtypes are coded by separate genes, and display specific drug specificities and regulatory properties.

Alpha blockers—Medications that bind alpha adrenergic receptors and decrease the workload of the heart and lower blood pressure. They are commonly used to treat hypertension, peripheral vascular disease, and hyperplasia.

Arteries—Blood vessels that carry oxygenated blood away from the heart to the cells, tissues, and organs of the body.

Catecholamines—Family of neurotransmitters containing dopamine, norepinephrine and epinephrine, produced and secreted by cells of the adrenal medulla in the brain. Catecholamines have excitatory effects on smooth muscle cells of the vessels that supply blood to the skin and mucous membranes and have inhibitory effects on smooth muscle cells located in the wall of the gut, the bronchial tree of the lungs, and the vessels that supply blood to skeletal muscle. There are two different main types of receptors for these neurotransmitters, called alpha and beta adrenergic receptors. The catecholamines are therefore are also known as adrenergic neurotransmitters.

Hyperplasia—The abnormal increase in the number of normal cells in a given tissue.

Hypertension—Persistently high arterial blood pressure.

Neurotransmitter—Substance released from neurons of the peripheral nervous system that travels across the synaptic clefts (gaps) of other neurons to excite or inhibit the target cell.

Palpitation—Rapid, forceful, throbbing, or fluttering heartbeat.

Receptor—A molecular structure in a cell or on the surface of a cell that allows binding of a specific substance that causes a specific physiologic response.

Synapse—A connection between nerve cells, by which nervous excitation is transferred from one cell to the other.

Vasodilation—The increase in the internal diameter of a blood vessel that results from relaxation of smooth muscle within the wall of the vessel thus causing an increase in blood flow.

Anyone who has had unusual reactions to alpha blockers in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

The effects of taking alpha blockers during **pregnancy** are not fully understood. Women who are pregnant or planning to become pregnant should inform their physicians. Breastfeeding mothers who need to take alpha blockers should also talk to their physicians. These drugs can pass into breast milk and may affect nursing babies. It may be necessary to stop breastfeeding while being treated with alpha blockers.

Side effects

The most common side effects are dizziness, drowsiness, tiredness, **headache**, nervousness, irritability, stuffy or runny nose, nausea, **pain** in the arms and legs, and weakness. These problems usually go away as the body adjusts to the drug and do not require medical treatment. If they do not subside or if they interfere with normal activities, the physician should be informed.

If any of the following side effects occur, the prescribing physician should be notified as soon as possible:

- fainting
- shortness of breath or difficulty breathing
- fast, pounding, or irregular heartbeat
- swollen feet, ankles, wrists

Other side effects may occur. Anyone who has unusual symptoms after taking alpha blockers should contact his or her physician.

Interactions

Doxazosin (Cardura) is not known to interact with any other drugs. Terazosin (Hytrin) may interact with **nonsteroidal anti-inflammatory drugs**, such as ibupro-

fen (Motrin), and with other blood pressure drugs, such as enalapril (Vasotec), and verapamil (Calan,Verelan). Prazosin (Minipress) may interact with beta adrenergic blocking agents such as propranolol (Inderal) and others, and with verapamil (Calan, Isoptin.) When drugs interact, the effects of one or both of the drugs may change or the risk of side effects may be greater.

Nancy Ross-Flanigan

Alport syndrome

Definition

A hereditary disease of the kidneys that primarily affects men, causing blood in the urine, **hearing loss** and eye problems. Eventually, **kidney dialysis** or transplant may be necessary.

KEY TERMS

Albumin—A protein that is important in maintaining blood volume. Low albumin levels is one sign of Alport syndrome.

Dialysis—A technique of removing waste material from the blood. It is used with patients whose kidneys have stopped functioning and can no longer cleanse the blood on their own.

Diuretic—A drug that increases the amount of urine a person produces.

Hematuria—Blood in the urine, Hematuria is a hallmark of Alport syndrome.

Pulmonary edema—Excess fluid in the air spaces of the lungs.

Uremia—The presence of excessive amounts of urea and other waste products in the blood.

Description

Alport syndrome affects about one in 5,000 Americans, striking men more often and severely than women. There are several varieties of the syndrome, some occurring in childhood and others not causing symptoms until men reach their 20s or 30s. All varieties of the syndrome are characterized by kidney disease that usually progresses to **chronic kidney failure** and by uremia (the presence of excessive amounts of urea and other waste products in the blood).

Causes and symptoms

Alport syndrome in most cases is caused by a defect in one or more genes located on the X chromosome. It is usually inherited from the mother, who is a normal carrier. However, in up to 20% of cases there is no family history of the disorder. In these cases, there appears to be a spontaneous genetic mutation causing Alport syndrome.

Blood in the urine (hematuria) is a hallmark of Alport syndrome. Other symptoms that may appear in varying combinations include:

- protein in the urine (proteinuria)
- sensorineural hearing loss
- eye problems [involuntary, rhythmic eye movements (**nystagmus**), **cataracts**, or cornea problems]
- skin problems
- platelet disorders
- abnormal white blood cells
- smooth muscle tumors

Not all patients with Alport syndrome have hearing problems. In general, those with normal hearing have less severe cases of Alport syndrome.

Diagnosis

Alport syndrome is diagnosed with a medical evaluation and family history, together with a **kidney biopsy** that can detect changes in the kidney typical of the condition. **Urinalysis** may reveal blood or protein in the urine. Blood tests can reveal a low platelet level.

In addition, tests for the Alport gene are now available. Although testing is fairly expensive, it is covered by many types of health insurance. DNA tests can diagnose affected children even before birth, and genetic linkage tests tracing all family members at risk for Alport syndrome are also available.

Treatment

There is no specific treatment that can "cure" Alport syndrome. Instead, care is aimed at easing the problems related to kidney failure, such as the presence of too many waste products in the blood (uremia).

To control kidney inflammation (**nephritis**), patients should:

- restrict fluids
- control high blood pressure
- manage **pulmonary edema**

• control high blood levels of potassium

Rarely patients with Alport syndrome may develop **nephrotic syndrome**, a group of symptoms including too much protein in the urine, low albumin levels, and swelling. To ease these symptoms, patients should:

• drink less

• eat a salt-free diet

• use **diuretics**

• have albumin transfusions

The treatment for chronic kidney failure is dialysis or a kidney transplant.

Prognosis

Women with this condition can lead a normal life, although they may have slight hearing loss. An affected woman may notice blood in her urine only when under **stress** or pregnant.

Men generally have a much more serious problem with the disease. Most will experience kidney disease in their 20s or 30s, which may eventually require dialysis or transplantation, and many develop significant hearing loss. Men with Alport syndrome often die of complications by middle age.

Prevention

Alport syndrome is a genetic disease and prevention efforts are aimed at providing affected individuals and their families with information concerning the genetic mechanisms responsible for the disease. Since it is possible to determine if a woman is a carrier, or if an unborn child has the condition, **genetic counseling** can provide helpful information and support for the decisions that affected individuals and their families may have to make.

Resources

BOOKS

Schrier, R. W., and C. W. Gottschalk, eds. *Diseases of the Kidney.* 6th ed. Boston: Little, Brown, 1996.

ORGANIZATIONS

American Association of Kidney Patients. 100 S. Ashley Dr., #280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney and Urologic Disease Information Clearinghouse. 3 Information Way, Bethesda, MD 20892. (301) 654-4415. <http://www.niddk.nih.gov>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.

National Organization for Rare Diseases. P.O. Box 8923, Fairfield, CT 06812. (213) 745-6518. <http://www.w2.com>.

OTHER

"Alport Syndrome." Pediatric Database Home Page. <http://www.icondata.com/health/pedbase/files/ALPORTSY.HTM>.

Alport Syndrome Home Page. <http://www.cc.utah.edu/~cla6202/ASHP.htm>.

The Hereditary Nephritis Foundation (HNF) Home Page. <http://www.cc.utah.edu/~cla6202/HNF.htm>.

Carol A. Turkington

Alprazolam *see* **Benzodiazepines**

ALS *see* **Amyotrophic lateral sclerosis**

Alteplase *see* **Thrombolytic therapy**

Altitude sickness

Definition

Altitude sickness is a general term encompassing a spectrum of disorders that occur at higher altitudes. Since the severity of symptoms varies with altitude, it is important to understand the range of the different altitudes that may be involved. High altitude is defined as height greater than 8,000 feet (2,438 m); medium altitude is defined as height between 5,000 and 8,000 feet (1,524–2,438 m); and extreme altitude is defined as height greater than 19,000 feet (5,791 m). The majority of healthy individuals suffer from altitude sickness when they reach very high altitudes. In addition, about 20% of people ascending above 9,000 (2,743 m) feet in one day will develop altitude sickness. Children under six years and women in the premenstrual part of their cycles may be more vulnerable. Individuals with preexisting medical conditions—even a minor respiratory infection—may become sick at more moderate altitudes.

Description

There are three major clinical syndromes that fall under the heading of altitude sickness: acute mountain sickness (AMS), high-altitude **pulmonary edema** (HAPE), and high-altitude cerebral **edema** (HACE). These syndromes are not separate, individual syndromes as much as they are a continuum of severity, all resulting from a decrease in oxygen in the air. AMS is the mildest, and the other two represent severe, life-threatening forms of altitude sickness.

Altitude sickness occurs because the partial pressure of oxygen decreases with altitude. (Partial pressure is a term applied to gases that is similar to the way the term concentration is applied to liquid solutions.) For instance, at 18,000 feet (5,486 m) the partial pressure of oxygen drops to one-half its value at sea level and, therefore, there is a substantially lower amount of oxygen available for the individual to inhale. This is known as hypoxia. Furthermore, since there is less oxygen to inhale, less oxygen reaches the blood. This is known as hypoxemia. These two conditions are the major factors that form the basis for all the medical problems associated with altitude sickness.

As a person becomes hypoxemic, his natural response is to breathe more rapidly (hyperventilate). This is the body's attempt to bring in more oxygen at a rapid rate. This attempt at alleviating the effects of the hypoxia at higher altitudes is known as acclimatization, and it occurs during the first few days. Acclimatization is a response that occurs in individuals who travel from lower to higher altitudes. There are groups of people who have lived at high altitudes (for example, in the Himalayan and Andes mountains) for generations, and they are simply accustomed to living at such altitudes, perhaps through a genetic ability.

KEY TERMS

Cerebral—Pertaining to the brain.

Edema—Accumulation of excess fluid in the tissues of the body.

Hypoxemia—Insufficient oxygenation of the blood.

Hypoxia—A deficiency in the amount of oxygen required for effective ventilation.

Pulmonary—Pertaining to the lungs.

Causes and symptoms

Acute mountain sickness (AMS) is a mild form of altitude sickness that results from ascent to altitudes higher greater than 8,000 feet (2,438 m)—even 6,500 feet (1,981 m) in some susceptible individuals. Although hypoxia is associated with the development of AMS, the exact mechanism by which this condition develops has yet to be confirmed. It is important to realize that some individuals acclimatize to higher altitudes more efficiently than others. As a result, under similar conditions some will suffer from AMS while others will not. At present, the susceptibility of otherwise healthy individuals to contracting AMS cannot be accurately predicted. Of those who do suffer from AMS, the condition tends to be most severe on the second or third day after reaching the high altitude, and it usually abates after three to five days if they remain at the same altitude. However, it can recur if the individuals travel to an even higher altitude. Symptoms usually appear a few hours to a few days following ascent, and they include **dizziness**, **headache**, **shortness of breath**, nausea, vomiting, loss of appetite, and **insomnia**.

High-altitude pulmonary edema (HAPE) is a life-threatening condition that afflicts a small percentage of those who suffer from AMS. In this condition, fluid leaks from within the pulmonary blood vessels into the lung tissue. As this fluid begins to accumulate within the lung tissue (pulmonary edema), the individual begins to become more and more short of breath. HAPE is known to afflict all types of individuals, regardless of their level of physical fitness.

Typically, the individual who suffers from HAPE ascends quickly to a high altitude and almost immediately develops shortness of breath, a rapid heart rate, a **cough** productive of a large amount of sometimes bloody sputum, and a rapid rate of breathing. If no medical assistance is provided by this point, the patient goes into a **coma** and dies within a few hours.

High-altitude cerebral edema (HACE), the rarest and most severe form of altitude sickness, involves cerebral edema, and its mechanism of development is also poorly understood. The symptoms often begin with those of AMS, but neurologic symptoms such as an altered level of consciousness, speech abnormalities, severe headache, loss of coordination, **hallucinations**, and even seizures. If no intervention is implemented, **death** is the result.

Diagnosis

The diagnosis for altitude sickness may be made from the observation of the individual's symptoms during travel to higher altitudes.

Treatment

Mild AMS requires no treatment other than an **aspirin** or ibuprofen for headache, and avoidance of further ascent. Narcotics should be avoided because they may blunt the respiratory response, making it even more difficult for the person to breathe deeply and rapidly enough to compensate for the lower levels of oxygen in the environment. Oxygen may also be used to alleviate symptoms of mild AMS.

As for HAPE and HACE, the most important course of action is descent to a lower altitude as soon as possible. Even a 1,000-2,000 -foot (305–610 m) descent can

dramatically improve one's symptoms. If descent is not possible, oxygen therapy should be started. In addition, dexamethasone (a steroid) has been suggested in order to reduce cerebral edema.

Prognosis

The prognosis for mild AMS is good, if appropriate measures are taken. As for HAPE and HACE, the prognosis depends upon the rapidity and distance of descent and the availability of medical intervention. Descent often leads to improvement of symptoms, however, recovery times vary among individuals.

Prevention

When individuals ascend from sea level, it is recommended that they spend at least one night at an intermediate altitude prior to ascending to higher elevations. In general, climbers should take at least two days to go from sea level to 8,000 feet (2,438 m). After reaching that point, healthy climbers should generally allow one day for each additional 2,000 feet (610 m), and one day of rest should be taken every two or three days. Should mild symptoms begin to surface, further ascent should be avoided. If the symptoms are severe, the individual should return to a lower altitude. Some reports indicate that acetazolamide (a diuretic) may be taken before ascent as a preventative measure for AMS.

Paying attention to diet can also help prevent altitude sickness. Water loss is a problem at higher altitudes, so climbers should drink ample water (enough to produce copious amounts of relatively light-colored or clear urine). Alcohol and large amounts of salt should be avoided. Eating frequent small, high-carbohydrate snacks (for example, fruits, jams and starchy foods) can help, especially in the first few days of climbing.

Resources

BOOKS

Crystal, R. G., ed., et al. *The Lung: Scientific Foundations*. Lippincott-Raven Publishers, 1997.

Kravis, T. C., C. G. Warner, and L. M. Jacobs Jr., eds. *Emergency Medicine*. Raven Press, 1993.

Rosen, Peter, ed., et al. *Emergency Medicine: Concepts and Clinical Practice*. Mosby Year Book, 1992.

PERIODICALS

Coote, J. H. "Medicine and Mechanisms in Altitude Sickness." *Sports Medicine* 20 (Sept. 1995): 148-159.

Kapil Gupta, MD

Aluminum hydroxide *see* **Antacids**

Alzheimer's disease

Definition

Alzheimer's disease (AD) is the most common form of **dementia**, a neurologic disease characterized by loss of mental ability severe enough to interfere with normal activities of daily living, lasting at least six months, and not present from birth. AD usually occurs in old age, and is marked by a decline in cognitive functions such as remembering, reasoning, and planning.

Description

A person with AD usually has a gradual decline in mental functions, often beginning with slight memory loss, followed by losses in the ability to maintain employment, to plan and execute familiar tasks, and to reason and **exercise** judgment. Communication ability, mood, and personality may also be affected. Most people who have AD die within eight years of their diagnosis, although that interval may be as short as one year or as long as 20 years. AD is the fourth leading cause of **death** in adults after heart disease, **cancer**, and **stroke**.

Between two and four million Americans have AD; that number is expected to grow to as many as 14 million by the middle of the 21st century as the population as a whole ages. While a small number of people in their 40s and 50s develop the disease (called early-onset AD), AD predominantly affects the elderly. AD affects about 3% of all people between ages 65 and 74, about 19% of those between 75 and 84, and about 47% of those over 85. Slightly more women than men are affected with AD, but this may be because women tend to live longer, and so there is a higher proportion of women in the most affected age groups.

The costs for caring for a person with AD is considerable. The annual cost of caring for one AD patient in 1998 was estimated as about $18,400 for a patient with mild AD, $30,100 for a patient with moderate AD, and $36,100 for a patient with severe AD. The annual direct and indirect costs of caring for AD patients in the United States was estimated to be as much as $100 billion. Slightly more than half of AD patients are cared for at home, while the remainder are cared for in a variety of health care institutions.

Causes and symptoms

Causes

The cause or causes of Alzheimer's disease are unknown. Some strong leads have been found through recent research, however, and these have also given some theoretical support to several new experimental treatments.

At first AD destroys neurons (nerve cells) in parts of the brain that control memory, including the hippocampus, which is a structure deep in the deep that controls short-term memory. As these neurons in the hippocampus stop functioning, the short-term memory of the person fails, and the ability to perform familiar tasks decreases. Later AD affects the cerebral cortex, particularly the areas responsible for language and reasoning; this language skills are lost and the ability to make judgments is changed. Personality changes occur, which may include emotional outbursts, wandering, and agitation. The severity of these changes increases with the progression of the disease. Eventually many other areas of the brain become involved, the brain regions affected atrophy (shrink and lose function), and the person with AD becomes bedridden, incontinent, helpless, and non-responsive.

Autopsy of a person with AD shows that the regions of the brain affected by the disease become clogged with two abnormal structures, called neurofibrillary tangles and amyloid plaques. Neurofibrillary tangles are twisted masses of protein fibers inside nerve cells, or neurons. In AD, tau proteins, which normally help bind and stabilize parts of neurons, is changed chemically, become twisted and tangled, and no longer can stabilize the neurons. Amyloid plaques consist of insoluble deposits of beta-amyloid (a protein fragment from a larger protein called amyloid precursor protein (APP) mixed with parts of neurons and non-nerve cells. Plaques are found in the spaces between the nerve cells of the brain. While it is not clear exactly how these structures cause problems, many researchers believe that their formation is responsible for the mental changes of AD, presumably by interfering with the normal communication between neurons in the brain and later leading to the death of neurons. As of 2000, three drugs for the treatment of AD symptoms have been approved by the United States Food and Drug Administration (FDA). They act by increasing the level of chemical signaling molecules in the brain, known as neurotransmitters, to make up for this decreased communication ability. All act by inhibiting the activity of acetylcholinesterase, which is an enzyme that breaks down acetylcholine, an important neurotransmitter released by neurons that is necessary for cognitive function. These drugs modestly increase cognition and improve one's ability to perform normal activities of daily living.

What triggers the formation of plaques and tangles and the development of AD are unknown. AD likely results from many interrelated factors, including genetic, environmental, and others not yet identified. Two types of AD exist: familial AD (FAD), which is a rare autosomal dominant inherited disease, and sporadic AD, with no obvious inheritance pattern. AD is also described in terms of age at onset, with early on-set AD occurring in people younger than 65, and late-onset occurring in those 65 and older. Early on-set AD comprises about 5-10 of AD cases and affects people aged 30 to 60. Some cases of early on-set AD are inherited and are common in some families. Early-onset AD often progresses faster than the more common late-on-set type.

All FAD, which are relatively uncommon, that have been identified so far are the early on-set type. As many as 50% of the FAD cases are known to be caused by three genes located on three different chromosomes. Some families have mutations in the APP gene located on chromosome 21, which causes the production of abnormal APP protein. Others have mutations in a gene called presenilin 1 located on chromosome 14, which causes the production of abnormal presenilin 1 protein, and others have mutations in a similar gene called presenilin 2 located on chromosome 1, which causes production of abnormal presenilin 2. Presenilin 1 may be one of the enzymes that clips APP into beta-amyloid; it may also be important in the synaptic connections between brain cells.

There is no evidence that the mutated genes that cause early on-set FAD also cause late on-set AD, but genetics does appear to play a role in this more common form of AD. Discovered by researchers at Duke University in the early 1990s, potentially the most important genetic link to AD was on chromosome 19. A gene on this chromosome, called APOE (apolipoprotein E), codes for a protein involved in transporting lipids into neurons. APOE occurs in at least three forms (alleles), called APOE e2, APOE e3, and APOE e4. Each person inherits one APOE from each parent, and therefore can either have one copy of two different forms, or two copies of one. The relatively rare APOE e2 appears to protect some people from AD, as it seems to be associated with a lower risk of AD and a later age of onset if AD does develop. APOE e3 is the most common version found in the general population, and only appears to have a neutral role in AD. However, APOE e4 appears to increase the risk of developing late onset AD with the inheritance of one or two copies of APOE e4. Compared to those without APOE e4, people with one copy are about three times as likely to develop late-onset AD, and those with two copies are almost four times as likely to do so. Having APOE e4 can also lower the age of onset by as much as 17 years. However, APOE e4 only increases the risk of developing AD and does not cause it, as not everyone with APOE e4 develops AD, and people without it can still have the disease. Why APOE e4 increases the chances of developing AD is not known with certainty. However, one theory is that APOE e4 facilitates beta-amyloid buildup in plaques, thus contributing to the lowering of the age of onset of AD; other theories involve interactions with cholesterol levels and effects on nerve

cell death independent of its effects on plaque buildup. In 2000, four new AD-related regions in the human genome were identified, where one out of several hundred genes in each of these regions may be a risk factor gene for AD. These genes, which are not yet identified, appear to make a contribution to the risk of developing late-onset AD that is at least as important as APOE e4.

Other non-genetic factors have also been studied in relation to the causes of AD. Inflammation of the brain may play a role in development of AD, and use of **nonsteroidal anti-inflammatory drugs** (NSAIDs) seems to reduce the risk of developing AD. Restriction of blood flow may be part of the problem, perhaps accounting for the beneficial effects of estrogen, which increases blood flow in the brain, among its other effects. Highly reactive molecular fragments called free radicals damage cells of all kinds, especially brain cells, which have smaller supplies of protective antioxidants thought to protect against free radical damage. Vitamin E is one such antioxidant, and its use in AD may be of possible theoretical benefit.

While the ultimate cause or causes of Alzheimer's disease are still unknown, there are several risk factors that increase a person's likelihood of developing the disease. The most significant one is, of course, age; older people develop AD at much higher rates than younger ones. There is some evidence that strokes and AD may be linked, with small strokes that go undetected clinically contributing to the injury of neurons. Blood cholesterol levels may also be important. Scientists have shown that high blood cholesterol levels in special breeds of genetically engineered (transgenic) mice may increase the rate of plaque deposition. There are also parallels between AD and other progressive neurodegenerative disorders that cause dementia, including prion diseases, Parkinson's disease, and Huntington's disease.

Numerous epidemiological studies of populations are also being conducted to learn more about whether and to what extent early life events, socioeconomic factors, and ethnicity have an impact on the development of AD. For example, results from one study indicated that rural residence in childhood, along with fewer than six years of schooling, was associated with increased AD risk. However, the low educational attainment that was identified as a risk factor might be a marker or surrogate for other deleterious socioeconomic or environmental influences in childhood, thus illustrating the difficulties in interpreting epidemiological findings, due to the complexity of the issues and the large number of variables involved.

Many environmental factors have been suspected of contributing to AD, but epidemiological population studies have not borne out these links. Among these have been pollutants in drinking water, aluminum from commercial products, and metal dental fillings. To date, none of these factors has been shown to cause AD or increase its likelihood. Further research may yet turn up links to other environmental factors.

Symptoms

The symptoms of Alzheimer's disease begin gradually, usually with memory lapses. Occasional memory lapses are of course common to everyone, and do not by themselves signify any change in cognitive function. The person with AD may begin with only the routine sort of memory lapse—forgetting where the car keys are—but progress to more profound or disturbing losses, such as forgetting that he or she can even drive a car. Becoming lost or disoriented on a walk around the neighborhood becomes more likely as the disease progresses. A person with AD may forget the names of family members, or forget what was said at the beginning of a sentence by the time he hears the end.

As AD progresses, other symptoms appear, including inability to perform routine tasks, loss of judgment, and personality or behavior changes. Some patients have trouble sleeping and may suffer from confusion or agitation in the evening ("sunsetting" or Sundowner's Syndrome). In some cases, people with AD repeat the same ideas, movements, words, or thoughts, a behavior known as perseveration. In the final stages people may have severe problems with eating, communicating, and controlling their bladder and bowel functions.

The Alzheimer's Association has developed a list of ten warning signs of AD. A person with several of these symptoms should see a physician for a thorough evaluation:

- memory loss that affects job skills
- difficulty performing familiar tasks
- problems with language
- disorientation of time and place
- poor or decreased judgment
- problems with abstract thinking
- misplacing things
- changes in mood or behavior
- changes in personality
- loss of initiative

Other types of dementia, including some that are reversible, can cause similar symptoms. It is important for the person with these symptoms to be evaluated by a professional who can weigh the possibility that his or her symptoms may have another cause. Approximately 20% of those originally suspected of having AD turn out to have some other disorder; about half of these cases are treatable.

Diagnosis

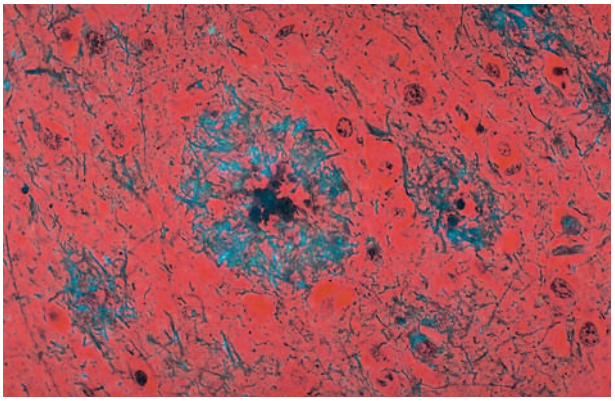
Diagnosis of Alzheimer's disease is complex, and may require office visits to several different specialists over several months before a diagnosis can be made. While a confident provisional diagnosis may be made in most cases after thorough testing, AD cannot be definitively diagnosed until autopsy examination of the brain for plaques and neurofibrillary tangles.

The diagnosis of AD begins with a thorough physical exam and complete medical history. Except in the disease's earliest stages, accurate history from family members or caregivers is essential. Since there are both prescription and over-the-counter drugs that can cause the same mental changes as AD, a careful review of the patient's drug, medicine, and alcohol use is important. AD-like symptoms can also be provoked by other medical conditions, including tumors, infection, and dementia caused by mild strokes (multi-infarct dementia). These possibilities must be ruled out as well through appropriate blood and urine tests, brain **magnetic resonance imaging** (MRI), **positron emission tomography** (**PET**) or single photon emission computed tomography (SPECT) scans, tests of the brain's electrical activity (electroencephalographs or EEGs), or other tests. Several types of oral and written tests are used to aid in the AD diagnosis and to follow its progression, including tests of mental status, functional abilities, memory, and concentration. Still, the **neurologic exam** is normal in most patients in early stages.

One of the most important parts of the diagnostic process is to evaluate the patient for depression and **delirium**, since each of these can be present with AD, or may be mistaken for it. (Delirium involves a decreased consciousness or awareness of one's environment.) Depression and memory loss are both common in the elderly, and the combination of the two can often be mistaken for AD. Depression can be treated with drugs, although some antidepressants can worsen dementia if it is present, further complicating both diagnosis and treatment.

An early and accurate diagnosis of AD is important in developing strategies for managing symptoms and for helping patients and their families planning for the future and pursuing care options while the patient can still take part in the decision-making process.

A genetic test for the APOE e4 gene is available, but is not used for diagnosis, since possessing even two copies does not ensure that a person will develop AD. In addition, access to genetic information could affect the insurability of a patient if disclosed, and also affect employment status and legal rights.



Diseased tissue from the brain of an Alzheimer's patient showing senile plaques within the brain's gray matter. *(Photograph by Cecil Fox, Photo Researchers, Inc. Reproduced by permission.)*

Treatment

Alzheimer's disease is presently incurable, so therefore the mainstay of treatment for a person with AD is good nursing care, providing both physical and emotional support for a person who is gradually able to do less and less for himself, and whose behavior is becoming more and more erratic. Modifications of the home to increase safety and security are often necessary. The caregiver also needs support to prevent anger, despair, and burnout from becoming overwhelming. Becoming familiar with the issues likely to lie ahead, and considering the appropriate financial and legal issues early on, can help both the patient and family cope with the difficult process of the disease. Regular medical care by a practitioner with a non-defeatist attitude toward AD is important so that illnesses such as urinary or respiratory infections can be diagnosed and treated properly, rather than being incorrectly attributed to the inevitable decline seen in AD.

People with AD are also often depressed or anxious, and may suffer from sleeplessness, poor **nutrition**, and general poor health. Each of these conditions is treatable to some degree. It is important for the person with AD to eat well and continue to exercise. Professional advice from a nutritionist may be useful to provide healthy, easy-to-prepare meals. Finger foods may be preferable to those requiring utensils to be eaten. Regular exercise (supervised if necessary for safety) promotes overall health. A calm, structured environment with simple orientation aids (such as calendars and clocks) may reduce **anxiety** and increase safety. Other psychiatric symptoms, such as depression, anxiety, **hallucinations** (seeing or hearing things that aren't there), and **delusions** (false beliefs) may be treated with drugs if necessary.

Drugs

As of 2000, only three drugs—tacrine (Cognex), donepezil hydrochloride (Aricept), and rivastigmine (Exelon)—have been approved by the FDA for its treatment. Tacrine has been shown to be effective for improving memory skills, but only in patients with mild-to-moderate AD, and even then in less than half of those who take it. Its beneficial effects are usually mild and temporary, but it may delay the need for nursing home admission. The most significant side effect is an increase in a liver enzyme known as alanine aminotransferase, or ALT. Patients taking tacrine must have a weekly blood test to monitor their ALT levels. Other frequent side effects include nausea, vomiting, **diarrhea**, abdominal **pain**, **indigestion**, and skin rash. The cost of tacrine was about $125 per month in early 1998, with additional costs for the weekly blood monitoring. Despite its high cost, tacrine appears to be cost-effective for those who respond to it, since it may decrease the number of months a patient needs nursing care. Donepezil is the drug most commonly used to treat mild to moderate symptoms of AD, although it only helps some patients for periods of time ranging from months to about two years. Donepezil has two advantages over tacrine: it has fewer side effects, and it can be given once daily rather than three times daily. Donepezil does not appear to affect liver enzymes, and therefore does not require weekly blood tests. The frequency of abdominal side effects is also lower. The monthly cost is approximately the same. Rivastigmine, approved for use in April of 2000, has been shown to improve the ability of patients to carry out daily activities, such as eating and dressing, decrease behavioral symptoms such as delusions and agitation, and improve cognitive functions such as thinking, memory, and speaking. The cost is similar to those of the other two drugs. However, none of these three drugs stops or reverses the progression of AD.

Estrogen, the female sex hormone, is widely prescribed for post-menopausal women to prevent **osteoporosis**. Several preliminary studies have shown that women taking estrogen have lower rates of AD, and those who develop AD have a slower progression and less severe symptoms.However, estrogen does not appear to have a beneficial effect on women who already have AD.

Preliminary studies have also suggested a reduced risk for developing AD in older people who regularly use nonsteroidal anti-inflammatory drugs (NSAIDs), including **aspirin**, ibuprofen, and naproxen, although not acetaminophen.Inflammation of the brain is a distinctive characteristic of AD, but whether it is a cause or an effect of the disease is not yet known.

Antioxidants, which act to inhibit and protect against oxidative damage caused by free radicals, have been shown to inhibit toxic effects of beta-amyloid in tissue culture. Therefore, research is being conducted to see whether antioxidants may delay or prevent AD.

Another antioxidant, vitamin E, is also thought to delay AD onset. It is not yet clear whether this is due to the specific action of vitamin E on brain cells, or to an increase in the overall health of those taking it.

Drugs such as antidepressants, anti-psychotics, and sedatives are used to treat the behavioral symptoms (agitation, aggression, wandering, and **sleep disorders**) of AD. Research is being conducted to search for better treatments, including non-drug approaches for AD patients.

Nursing care and safety

The person with Alzheimer's disease will gradually lose the ability to dress, groom, feed, bathe, or use the toilet by himself; in the later stages of the disease, he may be unable to move or speak. In addition, the person's behavior becomes increasing erratic. A tendency to wander may make it difficult to leave him unattended for even a few minutes and make even the home a potentially dangerous place. In addition, some patients may exhibit inappropriate sexual behaviors.

The nursing care required for a person with AD is well within the abilities of most people to learn. The difficulty for many caregivers comes in the constant but unpredictable nature of the demands put on them. In addition, the personality changes undergone by a person with AD can be heartbreaking for family members, as a loved one deteriorates, seeming to become a different person. Not all AD patients develop negative behaviors: some become quite gentle, and spend increasing amounts of time in dreamlike states.

A loss of good grooming may be one of the early symptoms of AD. Mismatched clothing, unkempt hair, and decreased interest in personal hygiene become more common. Caregivers, especially spouses, may find these changes socially embarrassing and difficult to cope with. The caregiver will usually need to spend increasing amounts of time for grooming to compensate for the loss of attention from the patient, although some adjustment of expectations (while maintaining cleanliness) is often needed as the disease progresses.

Proper nutrition is important for a person with AD, and may require assisted feeding early on, to make sure the person is taking in enough nutrients. Later on, as movement and swallowing become difficult, a feeding tube may be placed into the stomach through the abdominal wall. A feeding tube requires more attention, but is generally easy to care for if the patient is not resistant to its use.

For many caregivers, incontinence becomes the most difficult problem to deal with at home, and is a principal reason for pursuing nursing home care. In the early stages, limiting fluid intake and increasing the frequency of toileting can help. Careful attention to hygiene is important to prevent skin irritation and infection from soiled clothing.

Persons with dementia must deal with six basic safety concerns: injury from falls, injury from ingesting dangerous substances, leaving the home and getting lost, injury to self or others from sharp objects, fire or **burns**, and the inability to respond rapidly to crisis situations. In all cases, a person diagnosed with AD should no longer be allowed to drive, because of the increased potential for accidents and the increased likelihood of wandering very far from home while disoriented. In the home, simple measures such as grab bars in the bathroom, bed rails on the bed, and easily negotiable passageways can greatly increase safety. Electrical appliances should be unplugged and put away when not in use, and matches, lighters, knives, or weapons should be stored safely out of reach. The hot water heater temperature may be set lower to prevent accidental scalding. A list of emergency numbers, including the poison control center and the hospital emergency room, should be posted by the phone. As the disease progresses, caregivers need to periodically reevaluate the physical safety of the home and introduce new strategies for continued safety.

Care for the caregiver

Family members or others caring for a person with AD have an extremely difficult and stressful job, which becomes harder as the disease progresses. Dementia caregivers spend significantly more time on caregiving than do people providing care for those with other types of illnesses. This type of caregiving also has a greater impact in terms of employment complications, caregiver strain, mental and physical health problems, time for leisure and other family members, and family conflict than do other types of caregiving. It is common for AD caregivers to develop feelings of anger, resentment, guilt, and hopelessness, in addition to the sorrow they feel for their loved one and for themselves. Depression is an extremely common consequence of being a full-time caregiver for a person with AD. Support groups are an important way to deal with the **stress** of caregiving. Becoming a member of an AD caregivers' support group can be one of the most important things a family member does, not only for him or herself, but for the person with AD as well. The location and contact numbers for AD caregiver support groups are available from the Alzheimer's Association; they may also be available through a local social service agency, the patient's physician, or pharmaceutical companies that manufacture the drugs used to treat AD. Medical treatment for depression may be an important adjunct to group support.

Outside help, nursing homes, and governmental assistance

Most families eventually need outside help to relieve some of the burden of around-the-clock care for a person with AD. Personal care assistants, either volunteer or paid, may be available through local social service agencies. Adult daycare facilities are becoming increasingly common. Meal delivery, shopping assistance, or respite care may be available as well.

Providing the total care required by a person with late-stage AD can become an overwhelming burden for a family, even with outside help. At this stage, many families consider nursing home care. This decision is often one of the most difficult for the family, since it is often seen as an abandonment of the loved one and a failure of the family. Careful counseling with a sympathetic physician, clergy, or other trusted adviser may ease the difficulties of this transition. Selecting a nursing home may require a difficult balancing of cost, services, location, and availability. Keeping the entire family involved in the decision may help prevent further stress from developing later on.

Several federal government programs may ease the cost of caring for a person with AD, including Social Security Disability, Medicare, and Supplemental Security Income. Each of these programs may provide some assistance for care, medication, or other costs, but none of them will pay for nursing home care indefinitely. Medicaid is a state-funded program that may provide for some or all of the cost of nursing home care, although there are important restrictions. Details of the benefits and eligibility requirements of these programs are available through the local Social Security or Medicaid office, or from local social service agencies.

Private long-term care insurance, special "reverse mortgages," viatical insurance, and other financial devices are other ways of paying for care for those with the appropriate financial situations. Further information on these options may be available through resources listed below.

Alternative treatment

Several substances are currently being tested for their ability to slow the progress of Alzheimer's disease. These include acetylcarnitine, a supplement that acts on the cellular energy structures known as mitochondria. Ginkgo extract, derived from the leaves of the *Ginkgo biloba* tree, appears to have antioxidant as well as anti-inflammatory and anticoagulant properties. Ginkgo

KEY TERMS

Acetylcholine—One of the substances in the body that helps transmit nerve impulses.

Dementia—Impaired intellectual function that interferes with normal social and work activities.

Ginkgo—An herb from the *Ginkgo biloba* tree that some alternative practitioners recommend for the prevention and treatment of AD.

Neurofibrillary tangle—Twisted masses of protein inside nerve cells that develop in the brains of people with AD.

Senile plaque—Structures composed of parts of neurons surrounding brain proteins called beta-amyloid deposits and found in the brains of people with AD.

extract has been used for many years in China and is widely prescribed in Europe for treatment of circulatory problems. A 1997 study of patients with dementia seemed to show that ginkgo extract could improve their symptoms, though the study was criticized for certain flaws in its method.Large scale follow-up studies are being conducted to determine whether Ginkgo extract can prevent or delay the development of AD. Ginkgo extract is available in many health food or nutritional supplement stores. Some alternative practitioners also advise people with AD to take supplements of phosphatidylcholine, vitamin B_{12}, gotu kola, ginseng, St. John's Wort, rosemary, saiko-keishi-to-shakuyaku (A Japanese herbal mixture), and **folic acid**.

Prognosis

While Alzheimer's disease may not be the direct cause of death, the generally poorer health of a person with AD increases the risk of life-threatening infection, including **pneumonia**. In addition, other diseases common in old age—cancer, stroke, and heart disease—may lead to more severe consequences in a person with AD. On average, people with AD live eight years past their diagnosis, with a range from one to 20 years.

Prevention

There is currently no sure way to prevent Alzheimer's disease, although some of the drug treatments discussed above may eventually be proven to reduce the risk of developing the disease. The most likely current candidates are estrogen, NSAIDs, vitamin E, and **ginkgo biloba**, although this list may grow or shrink with further research.

Research on the prevention of AD is focusing on blocking the production of amyloid in the brain as well as breaking down beta-amyloid once it is released from cells but before it has a chance to aggregate into insoluble plaques. There are also promising studies being conducted to develop an AD vaccine, where immune responses may result in the elimination of the formation of amyloid plaques.

The Alzheimer's Disease Research Centers (ADCs) program promotes research, training and education, technology transfer, and multicenter and cooperative studies in AD, other dementias, and normal brain **aging**. Each ADC enrolls and performs studies on AD patients and healthy older people. Persons can participate in research protocols and clinical drug trials at these centers. Data from the ADCs as well as from other sources are coordinated and made available for use by researchers at the National Alzheimer's Coordinating Center, established in 1999.

Resources

BOOKS

Cohen, Donna, and Carl Eisdorfer. *The Loss of Self: A Family Resource for the Care of Alzheimer's Disease and Related Disorders, Revised Edition*. New York: W.W. Norton & Company, 2001.

Cohen, Elwood. *Alzheimer's Disease: Prevention, Intervention, and Treatment*. Los Angeles: Keats Publishing, 1999.

Geldmacher, David S. *Contemporary Diagnosis and Management of Alzheimer's Disease*. Newtown, PA: Associates in Medical Marketing Co., Inc., 2001.

Gruetzner, Howard. *Alzheimer's: A Caregiver's Guide and Sourcebook, 3rd Edition*. New York: John Wiley & Sons, 2001.

Mace, Nancy L., and Peter V. Rabins. *The 36-Hour Day: A Family Guide for Caring with Persons with Alzheimer Disease, Related Dementing Illnesses, and Memory Loss in Later Life*. New York: Warner Books, 2001.

Teitel, Rosette, and Marc L. Gordon. *The Handholder's Handbook: A Guide for Caregivers of Alzheimer's and other Dementias*. New Brunswick, NJ: Rutgers University Press, 2001.

PERIODICALS

Gitlin, L.N., and M. Corcoran. "Making Homes Safer: Environmental Adaptations for People with Dementia." *Alzheimer's Care Quarterly* 1 (2000): 50-58.

Helmuth, L. "Alzheimer's Congress: Further Progress on a B-Amyloid Vaccine." *Science* 289, No. 5476 (2000): 375.

ORGANIZATIONS

Alzheimer's Association. 919 North Michigan Ave., Suite 1000 Chicago, IL 60611. (800) 272-3900. <http://www.alz.org>.

Alzheimer's Disease Education and Referral Center. P.O. Box 8250, Silver Spring, MD. (800) 438-4380.Fax: (301) 495-3334. adear@alzheimers.org. <http://www.alzheimers.org>.

Alzheimer's Research Foundation. <http:// www. alzheimers-research.org>.

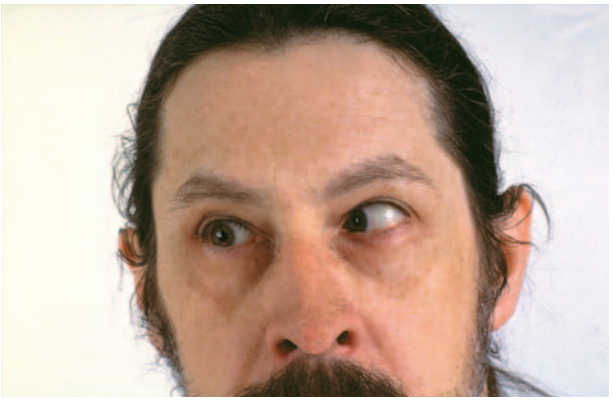
OTHER

National Institute on Aging, National Institutes of Health. *2000: Progress Report on Alzheimer's Disease - Taking the Next Steps*. NIH Publication No. 4859 (2000). <http://www.alzheimers.org/pubs/prog00.htm#References>.

Alzheimer's Disease Books and Videotapes. <http://www.alzheimersbooks.com>.

Judith Sims

Ambiguous genitals *see* **Intersex states**



Man with a lazy eye. *(Custom Medical Stock Photo. Reproduced by permission.)*

Amblyopia

Definition

Amblyopia is an uncorrectable decrease in vision in one or both eyes with no apparent structural abnormality seen to explain it. It is a diagnosis of exclusion, meaning that when a decrease in vision is detected, other causes must be ruled out. Once no other cause is found, amblyopia is the diagnosis. Generally, a difference of two lines or more (on an eye-chart test of visual acuity) between the two eyes or a best corrected vision of 20/30 or worse would be defined as amblyopia. For example, if someone has 20/20 vision with the right eye and only 20/40 with the left, and the left eye cannot achieve better vision with corrective lenses, the left eye is said to be amblyopic.

Description

Lazy eye is a common non-medical term used to describe amblyopia because the eye with poorer vision doesn't seem to be doing its job of seeing. Amblyopia is the most common cause of impaired vision in children, affecting nearly three out of every 100 people or 2-4% of the population. Vision is a combination of the clarity of the images of the eyes (visual acuity) and the processing of those images by the brain. If the images produced by the two eyes are substantially different, the brain may not be able to fuse the images. Instead of seeing two different images or double vision (diplopia), the brain suppresses the blurrier image. This suppression can lead to amblyopia. During the first few years of life, preferring one eye over the other may lead to poor visual development in the blurrier eye.

Causes and symptoms

Some of the major causes of amblyopia are as follows:

- **Strabismus**. A misalignment of the eyes (strabismus) is the most common cause of functional amblyopia. The two eyes are looking in two different directions at the same time. The brain is sent two different images and this causes confusion. Images from the misaligned or "crossed" eye are turned off to avoid double vision.
- Anisometropia. This is another type of functional amblyopia. In this case, there is a difference of refractive states between the two eyes (in other words, a difference of prescriptions between the two eyes). For example, one eye may be more nearsighted than the other eye, or one eye may be farsighted and the other eye nearsighted. Because the brain cannot fuse the two dissimilar images, the brain will suppress the blurrier image, causing the eye to become amblyopic.
- Cataract. Clouding of the lens of the eye will cause the image to be blurrier than the other eye. The brain "prefers" the clearer image. The eye with the cataract may become amblyopic.
- **Ptosis**. This is the drooping of the upper eyelid. If light cannot enter the eye because of the drooping lid, the eye is essentially not being used. This can lead to amblyopia.
- **Nutrition**. A type of organic amblyopia in which nutritional deficiencies or chemical toxicity may result in amblyopia. Alcohol, tobacco, or a deficiency in the B **vitamins** may result in toxic amblyopia.
- Heredity. Amblyopia can run in families.

Barring the presence of strabismus or ptosis, children may or may not show signs of amblyopia. Children may hold their heads at an angle while trying to favor the eye with normal vision. They may have trouble seeing or reaching for things when approached from the side of the amblyopic eye. Parents should see if one side of

KEY TERMS

Anisometropia—An eye condition in which there is an inequality of vision between the two eyes. There may be unequal amounts of nearsightedness, farsightedness, or astigmatism, so that one eye will be in focus while the other will not.

Cataract—Cloudiness of the eye's natural lens.

Occulsion therapy—A type of treatment for amblyopia in which the good eye is patched for a period of time. This forces the weaker eye to be used.

Strabismus—A condition in which the eyes are misaligned and point in different directions. One eye may look straight ahead, while the other turns inward, outward, upward, or downward. This is also called crossed-eyes.

Visual acuity—Acuity is the acuteness or sharpness of vision.

approach is preferred by the child or infant. If an infant's good eye is covered, the child may cry.

Diagnosis

Because children with outwardly normal eyes may have amblyopia, it is important to have regular vision screenings performed for all children. While there is some controversy regarding the age children should have their first vision examination, their eyes can, in actuality, be examined at any age, even at one day of life.

Some recommend that children have their vision checked by their pediatrician, family physician, ophthalmologist, or optometrist at or before six months of age. Others recommend testing by at least the child's fourth birthday. There may be a "critical period" in the development of vision, and amblyopia may not be treatable after age eight or nine. The earlier amblyopia is found, the better the possible outcome. Most physicians test vision as part of a child's medical examination. If there is any sign of an eye problem, they may refer a child to an eye specialist.

There are objective methods, such as retinoscopy, to measure the refractive status of the eyes. This can help determine anisometropia. In retinoscopy, a hand-held instrument is used to shine a light in the child's (or infant's) eyes. Using hand-held lenses, a rough prescription can be obtained. Visual acuity can be determined using a variety of methods. Many different eye charts are available (e.g., tumbling E, pictures, or letters). In amblyopia, single letters are easier to recognize than when a whole line is shown. This is called the "crowding effect" and helps in diagnosing amblyopia. Neutral density filters may also be held over the eye to aid in the diagnosis. Sometimes visual fields to determine defects in the area of vision will be performed. Color vision testing may also be performed. Again, it must be emphasized that amblyopia is a diagnosis of exclusion. Visual or life-threatening problems can also cause a decrease in vision. An examination of the eyes and visual system is very important when there is an unexplained decrease in vision.

Treatment

The primary treatment for amblyopia is occlusion therapy. It is important to alternate patching the good eye (forcing the amblyopic eye to work) and the amblyopic eye. If the good eye is constantly patched, it too may become amblyopic because of disuse. The treatment plan should be discussed with the doctor to fully understand how long the patch will be on. When patched, eye exercises may be prescribed to force the amblyopic eye to focus and work. This is called vision therapy or **vision training** (eye exercises). Even after vision has been restored in the weak eye, part-time patching may be required over a period of years to maintain the improvement.

While patching is necessary to get the amblyopic eye to work, it is just as important to correct the reason for the amblyopia. Glasses may also be worn if there are errors in refraction. Surgery or vision training may be necessary in the case of strabismus. Better nutrition is indicated in some toxic amblyopias. Occasionally, amblyopia is treated by blurring the vision in the good eye with eye drops or lenses to force the child to use the amblyopic eye.

Prognosis

The younger the person, the better the chance for improvement with occlusion and vision therapy. However, treatment may be successful in older children—even adults. Success in the treatment of amblyopia also depends upon how severe the amblyopia is, the specific type of amblyopia, and patient compliance. It is important to diagnose and treat amblyopia early because significant vision loss can occur if left untreated. The best outcomes result from early diagnosis and treatment.

Prevention

To protect their child's vision, parents must be aware of amblyopia as a potential problem. This awareness may encourage parents to take young children for vision exams early on in life—certainly before school age. Proper nutrition is important in the avoidance of toxic amblyopia.

Resources

BOOKS

D'Alonzo, T. L., O.D. *Your Eyes! A Comprehensive Look at the Understanding and Treatment of Vision Problems*. Clifton Heights, PA: Avanti, 1992.

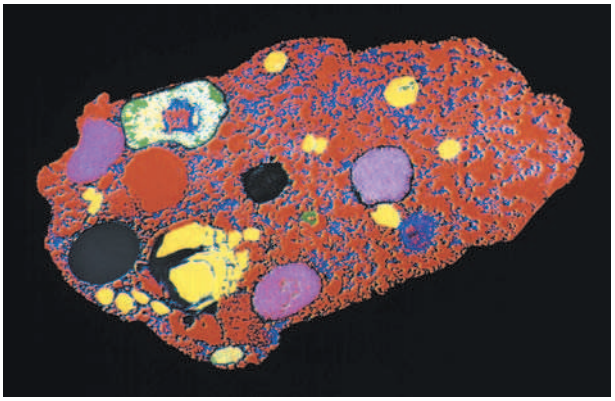
Newell, Frank W. *Ophthalmology: Principles and Concepts*. 8th ed. St. Louis: Mosby, 1996.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Lorraine Steefel, RN



A micrograph of *Entameoba histolytica,* a parasitic amoeba which invades and destroys the tissues of the intestines, causing amebiasis and ulceration to the intestinal wall. *(Photo Researchers, Inc. Reproduced by permission.)*

Amebiasis

Definition

Amebiasis is an infectious disease caused by a parasitic one-celled microorganism (protozoan) called *Entamoeba histolytica*. Persons with amebiasis may experience a wide range of symptoms, including **diarrhea**, **fever**, and cramps. The disease may also affect the intestines, liver, or other parts of the body.

Description

Amebiasis, also known as amebic dysentery, is one of the most common parasitic diseases occurring in humans, with an estimated 500 million new cases each year. It occurs most frequently in tropical and subtropical areas where living conditions are crowded, with inadequate sanitation. Although most cases of amebiasis occur in persons who carry the disease but do not exhibit any symptoms (asymptomatic), as many as 100,000 people die of amebiasis each year. In the United States, between 1 and 5% of the general population will develop amebiasis in any given year, while male homosexuals, migrant workers, institutionalized people, and recent immigrants develop amebiasis at a higher rate.

Human beings are the only known host of the amebiasis organism, and all groups of people, regardless of age or sex, can become affected. Amebiasis is primarily spread in food and water that has been contaminated by human feces but is also spread by person-to-person contact. The number of cases is typically limited, but regional outbreaks can occur in areas where human feces are used as fertilizer for crops, or in cities with water supplies contaminated with human feces.

Causes and symptoms

Recently, it has been discovered that persons with symptom-causing amebiasis are infected with *Entamoeba histolytica*, and those individuals who exhibit no symptoms are actually infected with an almost identical-looking ameba called *Entamoeba dispar*. During their life cycles, the amebas exist in two very different forms: the infective cyst or capsuled form, which cannot move but can survive outside the human body because of its protective covering, and the disease-producing form, the trophozoite, which although capable of moving, cannot survive once excreted in the feces and, therefore, cannot infect others. The disease is most commonly transmitted when a person eats food or drinks water containing *E. histolytica* cysts from human feces. In the digestive tract the cysts are transported to the intestine where the walls of the cysts are broken open by digestive secretions, releasing the mobile trophozoites. Once released within the intestine, the trophozoites multiply by feeding on intestinal bacteria or by invading the lining of the large intestine. Within the lining of the large intestine, the trophozoites secrete a substance that destroys intestinal tissue and creates a distinctive bottle-shaped sore (ulcer). The trophozoites may remain inside the intestine, in the intestinal wall, or may break through the intestinal wall and be carried by the blood to the liver, lungs, brain, or other organs. Trophozoites that remain in the intestines eventually form new cysts that are carried through the digestive tract and excreted in the feces. Under favorable temperature and humidity conditions, the cysts can survive in soil or water for weeks to months, ready to begin the cycle again.

Although 90% of cases of amebiasis in the United States are mild, pregnant women, children under two years of age, the elderly, malnourished individuals, and

people whose immune systems may be compressed, such as **cancer** or **AIDS** patients and those individuals taking prescription medications that suppress the immune system, are at a greater risk for developing a severe infection.

The signs and symptoms of amebiasis vary according to the location and severity of the infection and are classified as follows:

Intestinal amebiasis

Intestinal amebiasis can be subdivided into several categories:

ASYMPTOMATIC INFECTION. Most persons with amebiasis have no noticeable symptoms. Even though these individuals may not feel ill, they are still capable of infecting others by person-to-person contact or by contaminating food or water with cysts that others may ingest, for example, by preparing food with unwashed hands.

CHRONIC NON-DYSENTERIC INFECTION. Individuals may experience symptoms over a long period of time during a chronic amebiasis infection and experience recurrent episodes of diarrhea that last from one to four weeks and recur over a period of years. These patients may also suffer from abdominal cramps, **fatigue**, and weight loss.

AMEBIC DYSENTERY. In severe cases of intestinal amebiasis, the organism invades the lining of the intestine, producing sores (ulcers), bloody diarrhea, severe abdominal cramps, vomiting, chills, and fevers as high as 104-105°F (40-40.6°C). In addition, a case of acute amebic dysentery may cause complications, including inflammation of the appendix (**appendicitis**), a tear in the intestinal wall (perforation), or a sudden, severe inflammation of the colon (fulminating colitis).

AMEBOMA. An ameboma is a mass of tissue in the bowel that is formed by the amebiasis organism. It can result from either chronic intestinal infection or acute amebic dysentery. Amebomas may produce symptoms that mimic cancer or other intestinal diseases.

PERIANAL ULCERS. Intestinal amebiasis may produce skin infections in the area around the patient's anus (perianal). These ulcerated areas have a "punched-out" appearance and are painful to the touch.

Extraintestinal amebiasis

Extraintestinal amebiasis accounts for approximately 10% of all reported amebiasis cases and includes all forms of the disease that affect other organs.

The most common form of extraintestinal amebiasis is amebic **abscess** of the liver. In the United States, amebic liver abscesses occur most frequently in young Hispanic adults. An amebic liver abscess can result from direct infection of the liver by *E. histolytica* or as a complication of intestinal amebiasis. Patients with an amebic abscess of the liver complain of **pain** in the chest or abdomen, fever, nausea, and tenderness on the right side directly above the liver.

Other forms of extraintestinal amebiasis, though rare, include infections of the lungs, chest cavity, brain, or genitals. These are extremely serious and have a relatively high mortality rate.

Diagnosis

Diagnosis of amebiasis is complicated, partly because the disease can affect several areas of the body and can range from exhibiting few, if any, symptoms to being severe, or even life-threatening. In most cases, a physician will consider a diagnosis of amebiasis when a patient has a combination of symptoms, in particular, diarrhea and a possible history of recent exposure to amebiasis through travel, contact with infected persons, or anal intercourse.

It is vital to distinguish between amebiasis and another disease, inflammatory bowel disease (IBD) that produces similar symptoms because, if diagnosed incorrectly, drugs that are given to treat IBD can encourage the growth and spread of the amebiasis organism. Because of the serious consequences of misdiagnosis, potential cases of IBD must be confirmed with multiple stool samples and blood tests, and a procedure involving a visual inspection of the intestinal wall using a thin lighted, tubular instrument (**sigmoidoscopy**) to rule out amebiasis.

A diagnosis of amebiasis may be confirmed by one or more tests, depending on the location of the disease.

Stool examination

This test involves microscopically examining a stool sample for the presence of cysts and/or trophozoites of *E. histolytica* and not one of the many other intestinal amebas that are often found but that do not cause disease. A series of three stool tests is approximately 90% accurate in confirming a diagnosis of amebic dysentery. Unfortunately, however, the stool test is not useful in diagnosing amebomas or extraintestinal infections.

Sigmoidoscopy

Sigmoidoscopy is a useful diagnostic procedure in which a thin, flexible, lighted instrument, called a sigmoidoscope, is used to visually examine the lower part of the large intestine for amebic ulcers and take tissue or fluid samples from the intestinal lining.

Blood tests

Although tests designed to detect a specific protein produced in response to amebiasis infection (antibody) are capable of detecting only about 10% of cases of mild amebiasis, these tests are extremely useful in confirming 95% of dysentery diagnoses and 98% of liver abscess diagnoses. Blood serum will usually test positive for antibody within a week of symptom onset. Blood testing, however, cannot always distinguish between a current or past infection since the antibodies may be detectable in the blood for as long as 10 years following initial infection.

Imaging studies

A number of sophisticated imaging techniques, such as **computed tomography scans** (CT), **magnetic resonance imaging** (MRI), and ultrasound, can be used to determine whether a liver abscess is present. Once located, a physician may then use a fine needle to withdraw a sample of tissue to determine whether the abscess is indeed caused by an amebic infection.

Treatment

Asymptomatic or mild cases of amebiasis may require no treatment. However, because of the potential for disease spread, amebiasis is generally treated with a medication to kill the disease-causing amebas. More severe cases of amebic dysentery are additionally treated by replacing lost fluid and blood. Patients with an amebic liver abscess will also require hospitalization and bed rest. For those cases of extraintestinal amebiasis, treatment can be complicated because different drugs may be required to eliminate the parasite, based on the location of the infection within the body. Drugs used to treat amebiasis, called amebicides, are divided into two categories:

Luminal amebicides

These drugs get their name because they act on organisms within the inner cavity (lumen) of the bowel. They include diloxanide furoate, iodoquinol, metronidazole, and paromomycin.

Tissue amebicides

Tissue amebicides are used to treat infections in the liver and other body tissues and include emetine, dehydroemetine, metronidazole, and chloroquine. Because these drugs have potentially serious side effects, patients given emetine or dehydroemetine require bed rest and heart monitoring. Chloroquine has been found to be the most useful drug for treating amebic liver abscess. Patients taking metronidazole must avoid alcohol because the drug-alcohol combination causes nausea, vomiting, and **headache**.

KEY TERMS

Ameboma—A mass of tissue that can develop on the wall of the colon in response to amebic infection.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Appendicitis—Condition characterized by the rapid inflammation of the appendix, a part of the intestine.

Asymptomatic—Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Dysentery—Intestinal infection marked by diarrhea containing blood and mucus.

Fulminating colitis—A potentially fatal complication of amebic dysentery marked by sudden and severe inflammation of the intestinal lining, severe bleeding or hemorrhaging, and massive shedding of dead tissue.

Inflammatory bowel disease (IBD)—Disease in which the lining of the intestine becomes inflamed.

Lumen—The inner cavity or canal of a tube-shaped organ, such as the bowel.

Protozoan—A single-celled, usually microscopic organism that is eukaryotic and, therefore, different from bacteria (prokaryotic).

Most patients are given a combination of luminal and tissue amebicides over a treatment period of seven to ten days. Follow-up care includes periodic stool examinations beginning two to four weeks after the end of medication treatment to check the effectiveness of drug therapy.

Prognosis

The prognosis depends on the location of the infection and the patient's general health prior to infection. The prognosis is generally good, although the mortality rate is higher for patients with ameboma, perforation of the bowel, and liver infection. Patients who develop fulminant colitis have the most serious prognosis, with over 50% mortality.

Prevention

There are no immunization procedures or medications that can be taken prior to potential exposure to pre-

vent amebiasis. Moreover, people who have had the disease can become reinfected. Prevention requires effective personal and community hygiene.

Specific safeguards include the following:

- Purification of drinking water. Water can be purified by filtering, boiling, or treatment with iodine.
- Proper food handling. Measures include protecting food from contamination by flies, cooking food properly, washing one's hands after using the bathroom and before cooking or eating, and avoiding foods that cannot be cooked or peeled when traveling in countries with high rates of amebiasis.
- Careful disposal of human feces.
- Monitoring the contacts of amebiasis patients. The stools of family members and sexual partners of infected persons should be tested for the presence of cysts or trophozoites.

Resources

BOOKS

Ackers, John P. "Amebiasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Friedman, Lawrence S. "Liver, Biliary Tract, & Pancreas." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Goldsmith, Robert S. "Infectious Diseases: Protozoal & Helminthic." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Hasbun, Rodrigo, and Frank J. Bia. "Amebiasis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Infectious Disease: Parasitic Infections." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Weinberg, Adriana, and Myron J. Levin. "Infections: Parasitic & Mycotic." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Amebic dysentery *see* **Amebiasis**

Amenorrhea

Definition

The absence of menstrual periods is called amenorrhea. Primary amenorrhea is the failure to start having a period by the age of 16. Secondary amenorrhea is more common and refers to either the temporary or permanent ending of periods in a woman who has menstruated normally in the past. Many women miss a period occasionally. Amenorrhea occurs if a woman misses three or more periods in a row.

Description

The absence of menstrual periods is a symptom, not a disease. While the average age that menstruation begins is 12, the range varies. The incidence of primary amenorrhea in the United States is just 2.5%.

Some female athletes who participate in rowing, long distance running, and cycling, may notice a few missed periods. Women athletes at a particular risk for developing amenorrhea include ballerinas and gymnasts, who typically **exercise** strenuously and eat poorly.

Causes and symptoms

Amenorrhea can have many causes. Primary amenorrhea can be the result of hormonal imbalances, psychiatric disorders, eating disorders, **malnutrition**, excessive thinness or fatness, rapid weight loss, body fat content too low, and excessive physical conditioning. Intense physical training prior to **puberty** can delay menarche (the onset of menstruation). Every year of training can delay menarche for up to five months. Some medications such as antidepressants, tranquilizers, steroids, and heroin can induce amenorrhea.

Primary amenorrhea

However, the main cause is a delay in the beginning of puberty either from natural reasons (such as heredity or poor **nutrition**) or because of a problem in the endocrine system, such as a pituitary tumor or **hypothyroidism**. An obstructed flow tract or inflammation in the uterus may be the presenting indications of an underlying metabolic, endocrine, congenital or gynecological disorder.

Typical causes of primary amenorrhea include:

- excessive physical activity
- drastic weight loss (such as occurs in anorexia or bulimia)
- extreme **obesity**
- drugs (antidepressants or tranquilizers)
- chronic illness
- turner's syndrome. (A chromosomal problem in place at birth, relevant only in cases of primary amenorrhea)
- the absence of a vagina or a uterus

- imperforate hymen (lack of an opening to allow the menstrual blood through)

Secondary amenorrhea

Some of the causes of primary amenorrhea can also cause secondary amenorrhea—strenuous physical activity, excessive weight loss, use of antidepressants or tranquilizers, in particular. In adolescents, **pregnancy** and **stress** are two major causes. Missed periods are usually caused in adolescents by stress and changes in environment. Adolescents are especially prone to irregular periods with fevers, weight loss, changes in environment, or increased physical or athletic activity. However, any cessation of periods for four months should be evaluated.

The most common cause of seconardy amenorrhea is pregnancy. Also, a woman's periods may halt temporarily after she stops taking birth control pills. This temporary halt usually lasts only for a month or two, though in some cases it can last for a year or more. Secondary amenorrhea may also be related to hormonal problems related to stress, depression, **anorexia nervosa** or drugs, or it may be caused by any condition affecting the ovaries, such as a tumor. The cessation of menstruation also occurs permanently after **menopause** or a **hysterectomy**.

Polycystic ovary syndrome is another common cause of secondary amenorrhea. It is caused by ovaries containing many fluid filled sacs (cysts) with abnormal levels of male hormones (androgens). This condition is related to improper functioning of the pituitary gland, as it releases hormones necessary for pregnancy (leuteinizing hormones), and can cause women to develop male characteristics, such as **acne** and coarse body hair. If the condition is not treated, some of the androgens may convert to estrogen, and chronically high levels of estrogen may increase the chance of developing **cancer** of the uterine lining.

Diagnosis

It may be difficult to find the cause of amenorrhea, but the exam should start with a pregnancy test; pregnancy needs to be ruled out whenever a woman's period is two to three weeks overdue. Androgen excess, estrogen deficiency, or other problems with the endocrine system need to be checked. Prolactin in the blood and the thyroid stimulating hormone (TSH) should also be checked.

The diagnosis usually includes a patient history and a physical exam (including a **pelvic exam**). If a woman has missed three or more periods in a row, a physician may recommend blood tests to measure hormone levels, a scan of the skull to rule out the possibility of a pituitary tumor, and ultrasound scans of the abdomen and pelvis to rule out a tumor of the adrenal gland or ovary.

Treatment

Treatment of amenorrhea depends on the cause. Primary amenorrhea often requires no treatment, but it's always important to discover the cause of the problem in any case. Not all conditions can be treated, but any underlying condition that is treatable should be treated.

If a hormonal imbalance is the problem, progesterone for one to two weeks every month or two may correct the problem. With polycystic ovary syndrome, birth control pills are often prescribed. A pituitary tumor is treated with bromocriptine, a drug that reduces certain hormone (prolactin) secretions. Weight loss may bring on a period in an obese woman. Easing up on excessive exercise and eating a proper diet may bring on periods in teen athletes. In very rare cases, surgery may be needed for women with ovarian or uterine cysts.

Prognosis

Prolonged amenorrhea can lead to **infertility** and other medical problems such as **osteoporosis** (thinning of the bones). If the halt in the normal period is caused by stress or illness, periods should begin again when the stress passes or the illness is treated. Amenorrhea that occurs with discontinuing birth control pills usually go away within six to eight weeks, although it may take up to a year.

The prognosis for polycystic ovary disease depends on the severity of the symptoms and the treatment plan. Spironolactone, a drug that blocks the production of male hormones, can help in reducing body hair. If a woman wishes to become pregnant, treatment with clomiphene may be required or, on rare occasions, surgery on the ovaries.

Prevention

Primary amenorrhea caused by a congenital condition cannot be prevented. In general, however, women should maintain a healthy diet, with plenty of exercise, rest, and not too much stress, avoiding **smoking** and substance abuse. Female athletes should be sure to eat a balanced diet and rest and exercise normally. However, many cases of amenorrhea cannot be prevented.

Resources

BOOKS

Carlson, Karen J., Stephanie Eisenstat, and Ziporyn Eisenstat. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

PERIODICALS

Hogg, Anne Cahill. "Breaking the Cycle: Often Confused and Frustrated, Sufferers of Amenorrhea Now have Better

KEY TERMS

Hymen—Membrane that stretches across the opening of the vagina.

Hypothyroidism—Underactive thyroid gland.

Hysterectomy—Surgical removal of the uterus.

Turner's syndrome—A condition in which one female sex chromosome is missing.

Treatment Options." *American Fitness* 15, no. 4 (July-Aug. 1997): 30-4.

Kiningham, Robert B., Barbara Apgar, and Thomas Schwenk. "Evaluation of Amenorrhea." *American Family Physician* 53, no. 3 (Mar. 1996): 1185-95.

Mayo editors. "Amenorrhea: Can Athletics Disrupt a Girl's Menstrual Cycle During the Growing Years?" *Mayo Clinic Nutrition Letter* 2, no. 9 (Sept. 1989): 4-5.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

Federation of Feminist Women's Health Centers.1469 Humboldt Rd, Suite 200, Chico, CA 96928. (530) 891-1911.

National Women's Health Network. 514 10th St. NW, Suite 400, Washington, DC 20004. (202) 628-7814. <http://www.womenshealthnetwork.org>.

Carol A. Turkington

Amikiacin *see* **Aminoglycosides**

Amiloride *see* **Diuretics**

Amino acid disorders screening

Definition

Amino acid disorder screening checks for inherited disorders in amino acid metabolism. Tests are most commonly done on newborns. Two tests are available, one using a blood sample and the other a urine sample.

Purpose

Amino acid disorder screening is done in newborns, and sometimes children and adults, to detect inborn errors in metabolism of amino acids. Twenty of the 100 known amino acids are the main building blocks for human proteins. Proteins regulate every aspect of cellular function. Of these 20 amino acids, ten are not made by the body and must be acquired through diet. Congenital (present at birth) enzyme deficiencies that affect amino acid metabolism or congenital abnormalities in the amino acid transport system of the kidneys creates a condition called aminoaciduria.

Screening is especially important in newborns. Some congenital amino acid metabolic defects cause **mental retardation** that can prevented with prompt treatment of the newborn. One of the best known examples of this is **phenylketonuria** (PKU). This is an genetic error in metabolism of phenylalanine, an amino acid found in milk. Individuals with PKU do not produce the enzyme necessary to break down phenylalanine.

PKU occurs in about one out of 16,000 live births in the United States, but is more prevalent in caucasians and less prevalent in Ashkenazi Jews and African Americans. Newborns in the United States are routinely screened for PKU by a blood test.

There are two types of aminoacidurias. Primary or overflow aminoaciduria results from deficiencies in the enzymes necessary to metabolize amino acids. Overflow aminoaciduria is best detected by a blood plasma test.

Secondary or renal aminoaciduria occurs because of a congenital defect in the amino acid transport system in the tubules of the kidneys. This produces increased amino acids in the urine. Blood and urine test in combination are used to determine if the aminoaciduria is of the overflow or renal type. Urine tests are also used to monitor specific amino acid disorders.

Newborns are screened for amino acid disorders. Young children with acidosis (accumulation of acid in the body), severe vomiting and **diarrhea**, or urine with an abnormal color or odor, are also screened with a urine test for specific amino acid levels.

Precautions

Both blood and urine tests are simple tests that can be done in a doctor's office or clinic. These tests can be done on even the youngest patients.

Description

Two types of amino acid screening tests are used together to diagnose amino acid disorders.

Blood plasma screening

In the blood test, a medical technician draws a small amount of blood from a baby's heel. The procedure is rapid and relatively painless. Total time for the test is less than ten minutes. The blood is sent to a laboratory where results will be available in about two days.

Urine test

In the urine test, the patient is asked to urinate into a collecting cup. For an infant, the urine is collected in a pediatric urine collector. The process is painless. The length of time the test takes is determined by how long it takes the patient to urinate. Results also take about two days.

Both these tests use thin layer chromatography to separate the amino acids present. Using this technique, the amino acids form a characteristic patterns on a glass plate coated with a thin layer of silica gel. This pattern is then compared to the normal pattern to determine if there are abnormalities.

Preparation

Before the blood test, the patient must not eat or drink for four hours. Failure to fast will alter the results of the test.

The patient should eat and drink normally before the urine test. Some drugs may affect the results of the urine test. The technician handling the urine sample should be informed of any medications the patient is taking. Mothers of breastfeeding infants should report any medications they are taking, since these can pass from mother to child in breast milk.

Aftercare

The blood screening is normally done first. Depending on the results, it is followed by the urine test. It takes both tests to distinguish between overflow and renal aminoaciduria. Also, if the results are abnormal, a 24-hour urine test is performed along with other tests to determine the levels of specific amino acids. In the event of abnormal results, there are many other tests that will be performed to determine the specific amino acid involved in the abnormality.

Risks

There are no particular risks associated with either of these tests. Occasionally minor bruising may occur at the site where the blood was taken.

Normal results

The pattern of amino acid banding on the thin layer chromatography plates will be normal.

Abnormal results

The blood plasma amino acid pattern is abnormal in overflow aminoaciduria and is normal in renal aminoaciduria. The pattern is abnormal in the urine test, suggesting additional tests need to be done to determine which amino acids are involved. In addition to PKU, a variety of other amino acid metabolism disorders can be detected by these tests, including tyrosinosis, histidinemia, maple syrup urine disease, hypervalinemia, hyperprolinemia, and homocystinuria.

KEY TERMS

Amino acid—An organic compound composed of both an amino group and an acidic carboxyl group; amino acids are the basic building blocks of proteins.

Aminoaciduria—The abnormal presence of amino acids in the urine.

Chromatography—A family of laboratory techniques that separate mixtures of chemicals into their individual components.

Enzyme—A biological catalyst that increases the rate of a chemical reaction without being used up in the reaction.

Metabolism—The sum of all the chemical and energy reactions that take place in the human body.

Resources

BOOKS

Everything You Need to Know About Medical Tests. Ed. Michael Shaw, et al. Springhouse, PA: Springhouse Corporation, 1996.

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

ORGANIZATIONS

Association for Neuro-Metabolic Disorders. 5223 Brookfield Lane, Sylvania, OH 43560-1809. (419) 885-1497.

Children's PKU Network (CPN). 3790 Via De La Valle, Ste 120, Del Mar, CA 92014. (800) 377-6677. <http://www.pkunetwork.org/>.

National Phenylketonuria Foundation. 6301 Tejas Drive, Pasadena, TX 77503. (713) 487-4802.

Tish Davidson

Aminoglycosides

Definition

Aminoglycosides are a group of **antibiotics** that are used to treat certain bacterial infections. This group of

antibiotics includes at least eight drugs: amikacin, gentamicin, kanamycin, neomycin, netilmicin, paromomycin, streptomycin, and tobramycin. All of these drugs have the same basic chemical structure.

Purpose

Aminoglycosides are primarily used to combat infections due to aerobic, Gram-negative bacteria. These bacteria can be identified by their reaction to Gram's stain. In Gram's staining, a film of material containing the possible bacteria is placed on a glass slide and dried. The slide is stained with crystal violet for one minute, cleaned off with water and then placed into a solution of Gram's iodine solution for one minute. The iodine solution is rinsed off and the slide is immersed in 95% ethyl alcohol. The slide is then stained again with reddish carbolfuchsin or safranine for 30 seconds, rinsed in water, dried and examined. Gram-positive bacteria retain the violet purple stain. Gram-negative bacteria accept the red stain. Bacteria that can successfully be combated with aminoglycosides include *Pseudomonas*, *Acinetobacter*, and *Enterobacter* species, among others. Aminoglycosides are also effective against mycobacteria, the bacteria responsible for **tuberculosis**.

The aminoglycosides can be used against certain Gram-positive bacteria, but are not typically employed because other antibiotics are more effective and have fewer side effects. Aminoglycosides are ineffective against anaerobic bacteria (bacteria that cannot grow in the presence of oxygen), viruses, and fungi. And only one aminoglycoside, paromomycin, is used against parasitic infection.

Like all other antibiotics, aminoglycosides are not effective against **influenza**, the **common cold**, or other viral infections.

Precautions

Pre-existing medical conditions—such as kidney disease, eighth cranial nerve disease, **myasthenia gravis**, and Parkinson's disease—should be discussed prior to taking any aminoglycosides. Pregnant women are usually advised against taking aminoglycosides, because their infants may suffer damage to their hearing, kidneys, or sense of balance. However, those factors need to be considered alongside the threat to the mother's health and life in cases of serious infection. Aminoglycosides do not pass into breast milk to any great extent, so nursing mothers may be prescribed aminoglycosides without injuring their infants.

Description

Streptomycin, the first aminoglycoside, was isolated from *Streptomyces griseus* in the mid-1940s. This antibiotic was very effective against tuberculosis. One of the main drawbacks to streptomycin is its toxicity, especially to cells in the inner and middle ear and the kidney. Furthermore, some strains of tuberculosis are resistant to treatment with streptomycin. Therefore, medical researchers have put considerable effort into identifying other antibiotics with streptomycin's efficacy, but without its toxicity.

Aminoglycosides are absorbed very poorly from the gastrointestinal tract; in fact, aminoglycosides taken orally are excreted virtually unchanged and undiminished in quantity. The route of drug administration depends on the type and location of the infection being treated. The typical routes of administration are by intramuscular (injection into a muscle) or intravenous injection (injection into a vein), irrigation, topical skin application, or inhalation. If the infection being treated involves the central nervous system, the drug can be injected into the spinal canal.

The bactericidal ability of aminoglycosides has not been fully explained. It is known that the drug attaches to a bacterial cell wall and is drawn into the cell via channels made up of the protein, porin. Once inside the cell, the aminoglycoside attaches to the cell's ribosomes. Ribosomes are the intracellular structures responsible for manufacturing proteins. This attachment either shuts down protein production or causes the cell to produce abnormal, ineffective proteins. The bacterial cell cannot survive with this impediment.

Antibiotic treatment using aminoglycosides may pair the drug with a second type of antibiotic, usually a beta-lactam or vancomycin, administered separately. Beta-lactams disrupt the integrity of the bacteria cell wall, making it more porous. The increased porosity allows more of the aminoglycoside into the bacteria cell.

Traditionally, aminoglycosides were administered at even doses given throughout the day. It was thought that a steady plasma concentration was necessary to combat infection. However, this administration schedule is time and labor intensive. Furthermore, administering a single daily dose can be as effective, or more effective, than several doses throughout the day.

Dosage depends on the patient's age, weight, gender, and general health. Since the drug is cleared by the kidneys, it is important to assess any underlying problems with kidney function. Kidney function is assessed by measuring the blood levels of creatinine, a protein normally found in the body. If these levels are high, it is an indication that the kidneys may not be functioning at an optimal rate and dosage will be lowered accordingly.

Risks

Aminoglycosides have been shown to be toxic to certain cells in the ears and in the kidneys. Approximately 5-

10% of the people who are treated with aminoglycosides experience some side effect, affecting their hearing, sense of balance, or kidneys. However, in most cases the damage is minor and reversible once medication is stopped.

If cells in the inner ear are damaged or destroyed, an individual may experience a loss of balance and feelings of **dizziness**. Damage to the middle ear may result in **hearing loss** or **tinnitus**. Neomycin, kanamycin, and amikacin are the most likely to cause problems with hearing, and streptomycin and gentamicin carry the greatest risk of causing vertigo and loss of balance. Kidney damage, apparent with changes in urination frequency or urine production, is most likely precipitated by neomycin, tobramycin, and gentamicin.

Young children and the elderly are at the greatest risk of suffering side effects. Excessive dosage or poor clearance of the drug from the body can be injurious at any age.

Less common side effects include skin **rashes** and **itching**. Very rarely, certain aminoglycosides may cause difficulty in breathing, weakness, or drowsiness. Gentamicin, when injected, may cause leg cramps, skin rash, **fever**, or seizures.

If side effects linger or become worse after medication is stopped, it is advisable to seek medical advice. Side effects that may be of concern include tinnitus or loss of hearing, dizziness or loss of balance, changes in urination frequency or urine production, increased thirst, appetite loss, and nausea or vomiting.

Normal results

At the proper dosage and in the presence of gram-negative enteric (intestinal) bacteria, aminoglycosides are very effective in treating an infection.

Abnormal results

In some cases, bacteria are resistant to antibiotics that would normally kill them. This resistance becomes apparent after repeated exposure to the antibiotic and arises from a mutation that alters the bacteria's susceptibility to the drug. Various degrees of resistance have been observed in bacteria that normally would be destroyed by aminoglycosides. In general, though, aminoglycoside effectiveness has held up well over time.

Resources

BOOKS

Chambers, Henry F., W. Keith Hadley, and Ernest Jawetz. "Aminoglycosides & Spectinomycin." In *Basic and Clinical Pharmacology.* 7th ed. Ed. Bertram G. Katzung. Stamford: Appleton & Lange, 1998.

KEY TERMS

Aerobic bacteria—Bacteria which require oxygen in order to grow and survive.

Anaerobic bacteria—Bacteria which cannot grow or reproduce in the presence of oxygen.

Eighth cranial nerve disease—A disorder affecting the eighth cranial nerve, characterized by a loss of hearing and/or balance.

Gram-negative—Referring to a bacteria that take on a pink color when exposed to Gram's stain.

Gram-positive—Referring to a bacteria that takes on a purplish- black color when exposed to Gram's stain.

Gram's stain—A stain used in microbiology to classify bacteria and help identify the species to which they belong. This identification aids in determining treatment.

Kidney disease—Any disorder which impairs the kidney's ability to remove waste and toxins from the body.

Myasthenis gravis—A neuromuscular disease characterized by muscle weakness in the limbs and face.

Parkinson's disease—A neurological disorder caused by deficiency of dopamine, a neurotransmitter, that is a chemical that assists in transmitting messages between the nerves within the brain. It is characterized by muscle tremor or palsy and rigid movements.

Lerner, Stephen A., Robert P. Gaynes, and Lisbeth Nördstrom-Lerner. "Aminoglycosides." In *Infectious Diseases.* 2nd ed. Ed. Sherwood L. Gorbach, John G. Bartlett, and Neil R. Blacklow. Philadelphia: W. B. Saunders Co., 1998.

Julia Barrett

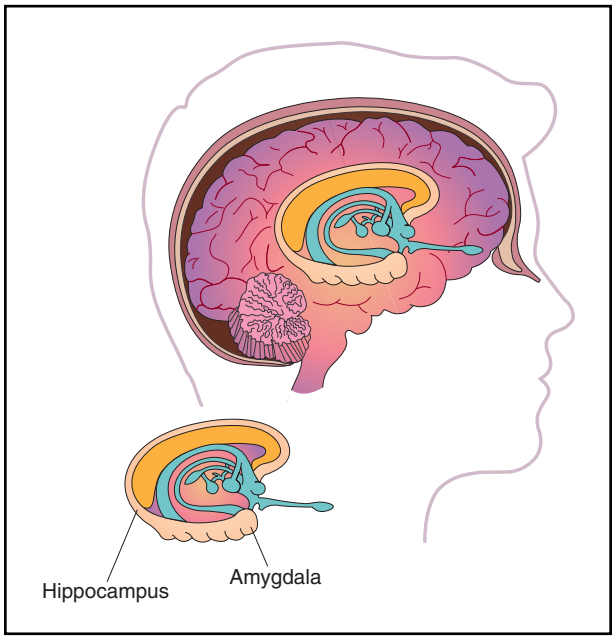
Amitriptyline *see* **Antidepressants, tricyclic**

Amlodipine *see* **Calcium channel blockers**

Amnesia

Definition

Amnesia refers to the loss of memory. Memory loss may result from two-sided (bilateral) damage to parts of



Memory loss may result from bilateral damage to the limbic system of the brain responsible for memory storage, processing, and recall. *(Illustration by Electronic Illustrators Group).*

the brain vital for memory storage, processing, or recall (the limbic system, including the hippocampus in the medial temporal lobe).

Description

Amnesia can be a symptom of several neurodegenerative diseases; however, people whose primary symptom is memory loss (amnesiacs), typically remain lucid and retain their sense of self. They may even be aware that they suffer from a memory disorder.

People who experience amnesia have been instrumental in helping brain researchers determine how the brain processes memory. Until the early 1970s, researchers viewed memory as a single entity. Memory of new experiences, motor skills, past events, and previous conditioning were grouped together in one system that relied on a specific area of the brain.

If all memory were stored in the same way, it would be reasonable to deduce that damage to the specific brain area would cause complete memory loss. However, studies of amnesiacs counter that theory. Such research demonstrates that the brain has multiple systems for processing, storing, and drawing on memory.

Causes and symptoms

Amnesia has several root causes. Most are traceable to brain injury related to physical trauma, disease, infection, drug and alcohol abuse, or reduced blood flow to the brain (vascular insufficiency). In Wernicke-Korsakoff syndrome, for example, damage to the memory centers of the brain results from the use of alcohol or **malnutrition**. Infections that damage brain tissue, including **encephalitis** and herpes, can also cause amnesia. If the amnesia is thought to be of psychological origin, it is termed psychogenic.

There are at least three general types of amnesia:

- Anterograde. This form of amnesia follows brain trauma and is characterized by the inability to remember new information. Recent experiences and short-term memory disappear, but victims can recall events prior to the trauma with clarity.
- Retrograde. In some ways, this form of amnesia is the opposite of anterograde amnesia: the victim can recall events that occurred after a trauma, but cannot remember previously familiar information or the events preceding the trauma.
- Transient global amnesia. This type of amnesia has no consistently identifiable cause, but researchers have suggested that migraines or transient ischemic attacks may be the trigger. (A **transient ischemic attack**, sometimes called "a small stroke," occurs when a blockage in an artery temporarily blocks off blood supply to part of the brain.) A victim experiences sudden confusion and forgetfulness. Attacks can be as brief as 30-60 minutes or can last up to 24 hours. In severe attacks, a person is completely disoriented and may experience retrograde amnesia that extends back several years. While very frightening for the patient, transient global amnesia generally has an excellent prognosis for recovery.

Diagnosis

In diagnosing amnesia and its cause, doctors look at several factors. During a **physical examination**, the doctor inquires about recent traumas or illnesses, drug and medication history, and checks the patient's general health. Psychological exams may be ordered to determine the extent of amnesia and the memory system affected. The doctor may also order imaging tests such as **magnetic resonance imaging** (MRI) to reveal whether the brain has been damaged, and blood work to exclude treatable metabolic causes or chemical imbalances.

Treatment

Treatment depends on the root cause of amnesia and is handled on an individual basis. Regardless of cause, cognitive **rehabilitation** may be helpful in learning strategies to cope with memory impairment.

KEY TERMS

Classical conditioning—The memory system that links perceptual information to the proper motor response. For example, Ivan Pavlov conditioned a dog to salivate when a bell was rung.

Emotional conditioning—The memory system that links perceptual information to an emotional response. For example, spotting a friend in a crowd causes a person to feel happy.

Explicit memory—Conscious recall of facts and events that is classified into episodic memory (involves time and place) and semantic memory (does not involve time and place). For example, an amnesiac may remember he has a wife (semantic memory), but cannot recall his last conversation with her (episodic memory).

Limbic system—The brain structures involved in memory.

Magnetic resonance imaging (MRI)—MRI uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Motor skill learning—This memory system is associated with physical movement and activity. For example, learning to swim is initially difficult, but once an efficient stroke is learned, it requires little conscious effort.

Neurodegenerative disease—A disease in which the nervous system progressively and irreversibly deteriorates.

Priming memory—The memory system that joins perceptual and conceptual representations.

Transient ischemic attack—A sudden and brief blockage of blood flow in the brain.

Working memory—The memory system that relates to the task at hand and coordinates recall of memories necessary to complete it.

Prognosis

Some types of amnesia, such as transient global amnesia, are completely resolved and there is no permanent loss of memory. Others, such as Korsakoff syndrome, associated with prolonged alcohol abuse or amnesias caused by severe brain injury, may be permanent. Depending on the degree of amnesia and its cause, victims may be able to lead relatively normal lives. Amnesiacs can learn through therapy to rely on other memory systems to compensate for what is lost.

Prevention

Amnesia is only preventable in so far as brain injury can be prevented or minimized. Common sense approaches include wearing a helmet when bicycling or participating in potentially dangerous sports, using automobile seat belts, and avoiding excessive alcohol or drug use. Brain infections should be treated swiftly and aggressively to minimize the damage due to swelling. Victims of strokes, brain aneurysms, and transient ischemic attacks should seek immediate medical treatment.

Resources

BOOKS

Cohen, Neal J., and Howard Eichenbaum. *Memory, Amnesia, and the Hippocampal System*. Cambridge, MA: MIT Press, 1993.

PERIODICALS

Kaufman, Leslie. "The Forgetting People: Amnesiacs." *Health* 9, no. 6 (Oct. 1995): 86.

Squire, Larry R., and Stuart M. Zola. "Amnesia, Memory and Brain Systems." *Philosophical Transactions of the Royal Society of London, Series B* 352 (1997): 1663.

"The Man Who Lost Himself." *World Press Review* 44, no. 6 (June 1997): 36. (Reprinted from *Der Spiegel* 17 Mar. 1997.)

Julia Barrett

Amniocentesis

Definition

Amniocentesis is a procedure used to diagnose fetal defects in the early second trimester of **pregnancy**. A sample of the amniotic fluid, which surrounds a fetus in the womb, is collected through a pregnant woman's abdomen using a needle and syringe. Tests performed on fetal cells found in the sample can reveal the presence of many types of genetic disorders, thus allowing doctors and prospective parents to make important decisions about early treatment and intervention.

Purpose

Since the mid-1970s, amniocentesis has been used routinely to test for **Down syndrome**, by far the most common, nonhereditary, genetic birth defect, afflicting about one in every 1,000 babies. By 1997, approximately 800 different diagnostic tests were available, most of them for hereditary genetic disorders such as **Tay-Sachs disease**, sickle cell anemia, **hemophilia**, **muscular dystrophy** and **cystic fibrosis**.

Amniocentesis, often called amnio, is recommended for women who will be older than 35 on their due-date. It is also recommended for women who have already borne children with **birth defects**, or when either of the parents has a family history of a birth defect for which a diagnostic test is available. Another reason for the procedure is to confirm indications of Down syndrome and certain other defects which may have shown up previously during routine maternal blood screening.

The risk of bearing a child with a nonhereditary genetic defect such as Down syndrome is directly related to a woman's age—the older the woman, the greater the risk. Thirty-five is the recommended age to begin amnio testing because that is the age at which the risk of carrying a fetus with such a defect roughly equals the risk of **miscarriage** caused by the procedure—about one in 200. At age 25, the risk of giving birth to a child with this type of defect is about one in 1,400; by age 45 it increases to about one in 20. Nearly half of all pregnant women over 35 in the United States undergo amniocentesis and many younger women also decide to have the procedure. Notably, some 75% of all Down syndrome infants born in the United States each year are to women younger than 35.

One of the most common reasons for performing amniocentesis is an abnormal alpha-fetoprotein (AFP) test. Alpha-fetoprotein is a protein produced by the fetus and present in the mother's blood. A simple blood screening, usually conducted around the 15th week of pregnancy, can determine the AFP levels in the mother's blood. Levels that are too high or too low may signal possible fetal defects. Because this test has a high false-positive rate, another test such as amnio is recommended whenever the AFP levels fall outside the normal range.

Amniocentesis is generally performed during the 16th week of pregnancy, with results usually available within three weeks. It is possible to perform an amnio as early as the 11th week but this is not usually recommended because there appears to be an increased risk of miscarriage when done at this time. The advantage of early amnio and speedy results lies in the extra time for decision making if a problem is detected. Potential treatment of the fetus can begin earlier. Important, also, is the fact that elective abortions are safer and less controversial the earlier they are performed.

Precautions

As an invasive surgical procedure, amnio poses a real, although small, risk to the health of a fetus. Parents must weigh the potential value of the knowledge gained, or indeed the reassurance that all is well, against the small risk of damaging what is in all probability a normal fetus. The serious emotional and ethical dilemmas that adverse test results can bring must also be considered. The decision to undergo amnio is always a matter of personal choice.

Description

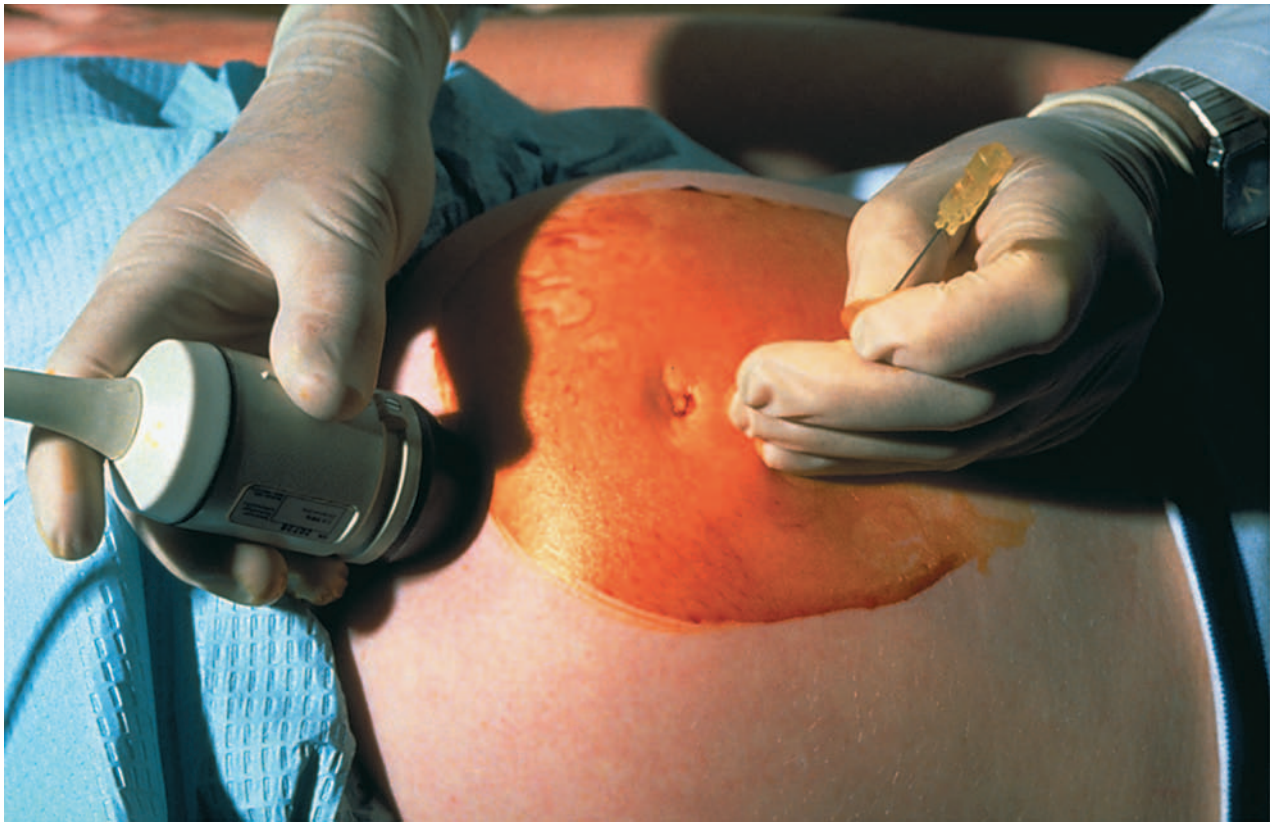
The word amniocentesis literally means "puncture of the amnion," the thin-walled sac of fluid in which a developing fetus is suspended during pregnancy. During the sampling procedure, the obstetrician inserts a very fine needle through the woman's abdomen into the uterus and amniotic sac and withdraws approximately one ounce of amniotic fluid for testing. The relatively painless procedure is performed on an outpatient basis, sometimes using local anesthesia.

The physician uses ultrasound images to guide needle placement and collect the sample, thereby minimizing the risk of fetal injury and the need for repeated needle insertions. Once the sample is collected, the woman can return home after a brief observation period. She may be instructed to rest for the first 24 hours and to avoid heavy lifting for two days.

The sample of amniotic fluid is sent to a laboratory where fetal cells contained in the fluid are isolated and grown in order to provide enough genetic material for testing. This takes about seven to 14 days. The material is then extracted and treated so that visual examination for defects can be made. For some disorders, like Tay-Sachs, the simple presence of a telltale chemical compound in the amniotic fluid is enough to confirm a diagnosis. Depending on the specific tests ordered, and the skill of the lab conducting them, all the results are available between one and four weeks after the sample is taken.

Cost of the procedure depends on the doctor, the lab, and the tests ordered. Most insurers provide coverage for women over 35, as a follow-up to positive maternal blood screening results, and when genetic disorders run in the family.

An alternative to amnio, now in general use, is **chorionic villus sampling**, or CVS, which can be performed as early as the eighth week of pregnancy. While this allows for the possibility of a first trimester abortion, if warranted, CVS is apparently also riskier and is more expensive.



A physician uses an ultrasound monitor (left) to position the needle for insertion into the amnion when performing amniocentesis. *(Photograph by Will and Deni McIntyre, Photo Researchers, Inc. Reproduced by permission.)*

The most promising area of new research in prenatal testing involves expanding the scope and accuracy of maternal blood screening as this poses no risk to the fetus.

Preparation

It is important for a woman to fully understand the procedure and to feel confident in the obstetrician performing it. Evidence suggests that a physician's experience with the procedure reduces the chance of mishap. Almost all obstetricians are experienced in performing amniocentesis. The patient should feel free to ask questions and seek emotional support before, during and after the amnio is performed.

Aftercare

Necessary aftercare falls into two categories, physical and emotional.

Physical aftercare

During and immediately following the sampling procedure, a woman may experience **dizziness**, nausea, a rapid heartbeat, and cramping. Once past these immediate hurdles, the physician will send the woman home with instructions to rest and to report any complications requiring immediate treatment, including:

- vaginal bleeding. The appearance of blood could signal a problem.
- **premature labor**. Unusual abdominal **pain** and/or cramping may indicate the onset of premature labor. Mild cramping for the first day or two following the procedure is normal.
- signs of infection. Leaking of amniotic fluid or unusual vaginal discharge, and **fever** could signal the onset of infection.

Emotional aftercare

Once the procedure has been safely completed, the **anxiety** of waiting for the test results can prove to be the worst part of the process. A woman should seek and receive emotional support from family and friends, as well as from her obstetrician and family doctor. Professional counseling may also prove necessary, particularly if a fetal defect is discovered.

KEY TERMS

Alpha-fetoprotein (AFP)—A protein normally produced by the liver of a fetus and detectable in maternal blood samples. AFP screening measures the amount of alpha-fetoprotein in the blood. Levels outside the norm may indicate fetal defects.

Anencephaly—A hereditary defect resulting in the partial to complete absence of a brain and spinal cord. It is fatal.

Chorionic villus sampling (CVS)—A procedure similar to amniocentesis, except that cells are taken from the chorionic membrane for testing. These cells, called chorionic villus cells, eventually become the placenta. The samples are collected either through the abdomen, as in amnio, or through the vagina. CVS can be done earlier in the pregnancy than amnio, but carries a somewhat higher risk.

Chromosome—Chromosomes are the strands of genetic material in a cell that occur in nearly identical pairs. Normal human cells contain 23 chromosome pairs—one in each pair inherited from the mother, and one from the father. Every human cell contains the exact same set of chromosomes.

Down syndrome—The most prevalent of a class of genetic defects known as trisomies, in which cells contain three copies of certain chromosomes rather than the usual two. Down syndrome, or trisomy 21, usually results from three copies of chromosome 21.

Genetic—The term refers to genes, the basic units of biological heredity, which are contained on the chromosomes, and contain chemical instructions which direct the development and functioning of an individual.

Hereditary—Something which is inherited—passed down from parents to offspring. In biology and medicine, the word pertains to inherited genetic characteristics.

Maternal blood screening—Maternal blood screening is normally done early in pregnancy to test for a variety of conditions. Abnormal amounts of certain proteins in a pregnant woman's blood raise the probability of fetal defects. Amniocentesis is recommended if such a probability occurs.

Tay-Sachs disease—An inherited disease prevalent among the Ashkenazi Jewish population of the United States. Infants with the disease are unable to process a certain type of fat which accumulates in nerve and brain cells, causing mental and physical retardation, and death by age four.

Ultrasound—A technique which uses high-frequency sound waves to create a visual image (a sonogram) of soft tissues. The technique is routinely used in prenatal care and diagnosis.

Risks

Most of the risks and short-term side effects associated with amniocentesis relate to the sampling procedure and have been discussed above. A successful amnio sampling results in no long-term side effects. Risks include:

- maternal/fetal hemorrhaging. While spotting in pregnancy is fairly common, bleeding following amnio should always be investigated.
- infection. Infection, although rare, can occur after amniocentesis. An unchecked infection can lead to severe complications.
- fetal injury. A very slight risk of injury to the fetus resulting from contact with the amnio needle does exist.
- miscarriage. The rate of miscarriage occurring during standard, second trimester amnio appears to be approximately 0.5%. This compares to a miscarriage rate of 1% for CVS. Many fetuses with severe genetic defects miscarry naturally during the first trimester.
- the trauma of difficult family-planning decisions. The threat posed to parental and family mental health from the trauma accompanying an abnormal test result can not be underestimated.

Normal results

Negative results from an amnio analysis indicate that everything about the fetus appears normal and the pregnancy can continue without undue concern. A negative result for Down syndrome means that it is 99% certain that the disease does not exist.

An overall "normal" result does not, however, guarantee that the pregnancy will come to term, or that the fetus does not suffer from some other defect. Laboratory tests are not 100% accurate at detecting targeted conditions, nor can every possible fetal condition be tested for.

Abnormal results

Positive results on an amnio analysis indicate the presence of the fetal defect being tested for, with an accuracy approaching 100%. Prospective parents are then faced with emotionally and ethically difficult choices regarding treatment options, the prospect of dealing with a severely affected newborn, and the option of elective abortion. At this point, the parents need expert medical advice and counseling.

Resources

BOOKS

Elias, Sherman, and Joe Leigh Simpson. "Techniques for Prenatal Diagnosis—Amniocentesis." In *Essentials of Prenatal Diagnosis*. Ed. Joe Leigh Simpson and Sherman Elias. New York: Churchill Livingstone, 1993.

Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment. Ed. Aubrey Milunsky. Baltimore: Johns Hopkins University Press, 1992.

Kolker, Aliza. *Prenatal Testing: A Sociological Perspective.* Westport, CT: Bergin & Garvey, 1994.

Rapp, Rayna. "The Power of Positive Diagnosis: Medical and Maternal Discourses on Amniocentesis." In *Repre-sentations of Motherhood*, ed. Donna Bassin, et al. New Haven, CT: Yale University Press, 1994.

Women and Prenatal Testing: Facing the Challenges of Genetic Technology. Ed. Karen H. Rothenberg and Elizabeth J. Thomson. Columbus, OH: Ohio State University Press, 1994.

PERIODICALS

Bonner, John. "Simple Blood Test May Replace Amniocentesis." *New Scientist* (5 Oct. 1996): 26.

Boss, Judith A. "First Trimester Prenatal Diagnosis: Earlier is Not Necessarily Better." *Journal of Medical Ethics* 20 (Sept. 1994): 146-151.

"Complications Associated with Early Amniocentesis." *American Family Physician* 54 (1 Oct. 1996): 1716.

Dreisbach, Shaun. "Amnio Alternative." *Working Mother*, Mar. 1997, 11.

Josephson, N. F. "What You May Not Know About Pregnancy Tests and What They Tell Your Doctor About Your Baby's Health." *Parents*, Apr. 1996, 77-8.

Marble, Michelle. "Testing During First Trimester Proves Risky." *Women's Health Weekly*, 8 July 1996, 12.

Sher, Emil. "Everything is Perfectly Normal." *Chatelaine*, June 1996, 22.

Stranc, Leonie C., et al. "Chorionic Villus Sampling and Amniocentesis for Prenatal Diagnosis." *The Lancet* (8 Mar. 1997): 711-4.

Sundberg, K., et al. "Randomized Study of Risk of Fetal Loss Related to Early Amniocentesis versus Chorionic Villus Sampling." *The Lancet* (6 Sept. 1997): 697-703.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

OTHER

Holbrook Jr., Harold R. Stanford University School of Medicine Web Home Page. Feb. 2001 <http://www.stanford.edu/~holbrook>.

Kurt Richard Sternlof

Amniotic fluid analysis *see* **Amniocentesis**

Amoxicillin *see* **Penicillins**

Amphetamines *see* **Central nervous system stimulants**

Amphotericin B *see* **Antifungal drugs, systemic**

Amputation

Definition

Amputation is the intentional surgical removal of a limb or body part. It is performed to remove diseased tissue or relieve **pain**.

Purpose

Arms, legs, hands, feet, fingers, and toes can all be amputated. Most amputations involve small body parts such as a finger, rather than an entire limb. About 65,000 amputations are performed in the United States each year.

Amputation is performed for the following reasons:

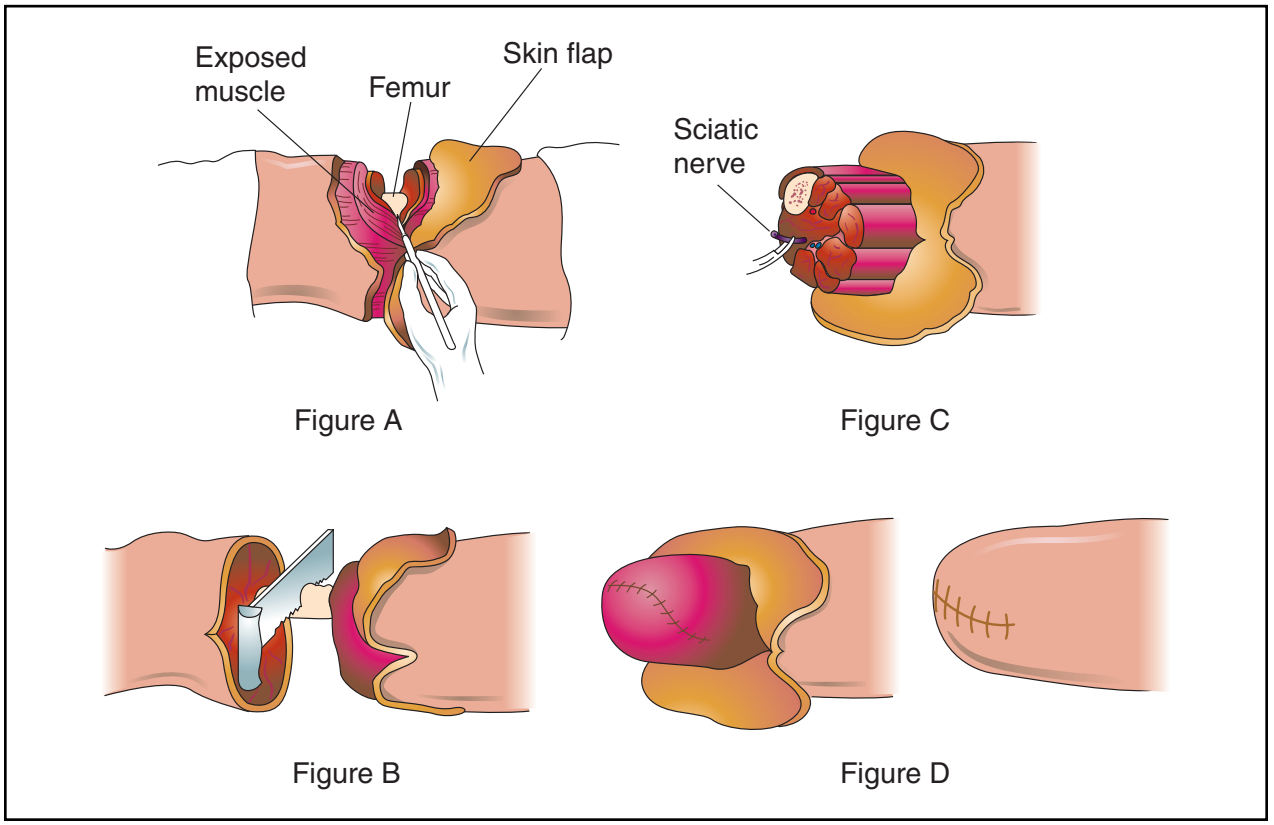
- to remove tissue that no longer has an adequate blood supply
- to remove malignant tumors
- because of severe trauma to the body part

The blood supply to an extremity can be cut off because of injury to the blood vessel, hardening of the arteries, **arterial embolism**, impaired circulation as a complication of **diabetes mellitus**, repeated severe infection that leads to **gangrene**, severe frostbite, **Raynaud's disease**, or **Buerger's disease**.

More than 90% of amputations performed in the United States are due to circulatory complications of diabetes. Sixty to eighty percent of these operations involve the legs.

Precautions

Amputations cannot be performed on patients with uncontrolled diabetes mellitus, **heart failure**, or infec-



Amputation of leg. Figure A: After the surgeon creates two flaps of skin and tissue, the muscle is cut and the main artery and veins of the femur bone are exposed. Figure B: The surgeon severs the main artery and veins. New connections are formed between them, restoring blood circulation. The sciatic nerve is then pulled down, clamped and tied, and severed. Figure C: The surgeon saws through the exposed femur bone. Figure D: The muscles are closed and sutured over the bone. The remaining skin flaps are then sutured together, creating a stump. *(Illustration by Electronic Illustrators Group.)*

tion. Patients with blood clotting disorders are also not good candidates for amputation.

Description

Amputations can be either planned or emergency procedures. Injury and arterial embolisms are the main reasons for emergency amputations. The operation is performed under regional or general anesthesia by a general or orthopedic surgeon in a hospital operating room.

Details of the operation vary slightly depending on what part is to be removed. The goal of all amputations is twofold: to remove diseased tissue so that the wound will heal cleanly, and to construct a stump that will allow the attachment of a prosthesis or artificial replacement part.

The surgeon makes an incision around the part to be amputated. The part is removed, and the bone is smoothed. A flap is constructed of muscle, connective tissue, and skin to cover the raw end of the bone. The flap is closed over the bone with sutures (surgical stitches) that remain in place for about one month. Often, a rigid dressing or cast is applied that stays in place for about two weeks.

Preparation

Before an amputation is performed, extensive testing is done to determine the proper level of amputation. The goal of the surgeon is to find the place where healing is most likely to be complete, while allowing the maximum amount of limb to remain for effective **rehabilitation**.

The greater the blood flow through an area, the more likely healing is to occur. These tests are designed to measure blood flow through the limb. Several or all of them can be done to help choose the proper level of amputation.

- measurement of blood pressure in different parts of the limb
- xenon 133 studies, which use a radiopharmaceutical to measure blood flow
- oxygen tension measurements in which an oxygen electrode is used to measure oxygen pressure under the skin

If the pressure is 0, the healing will not occur. If the pressure reads higher than 40mm Hg (40 milliliters of mercury), healing of the area is likely to be satisfactory.

- laser Doppler measurements of the microcirculation of the skin
- skin fluorescent studies that also measure skin microcirculation
- skin perfusion measurements using a blood pressure cuff and photoelectric detector
- infrared measurements of skin temperature

No one test is highly predictive of healing, but taken together, the results give the surgeon an excellent idea of the best place to amputate.

Aftercare

After amputation, medication is prescribed for pain, and patients are treated with **antibiotics** to discourage infection. The stump is moved often to encourage good circulation. Physical therapy and rehabilitation are started as soon as possible, usually within 48 hours. Studies have shown that there is a positive relationship between early rehabilitation and effective functioning of the stump and prosthesis. Length of stay in the hospital depends on the severity of the amputation and the general health of the amputee, but ranges from several days to two weeks.

Rehabilitation is a long, arduous process, especially for above the knee amputees. Twice daily physical therapy is not uncommon. In addition, psychological counseling is an important part of rehabilitation. Many people feel a sense of loss and grief when they lose a body part. Others are bothered by phantom limb syndrome, where they feel as if the amputated part is still in place. They may even feel pain in this limb that does not exist. Many amputees benefit from joining self-help groups and meeting others who are also living with amputation. Addressing the emotional aspects of amputation often speeds the physical rehabilitation process.

Risks

Amputation is major surgery. All the risks associated with the administration of anesthesia exist, along with the possibility of heavy blood loss and the development of blood clots. Infection is of special concern to amputees. Infection rates in amputations average 15%. If the stump becomes infected, it is necessary to remove the prosthesis and sometimes to amputate a second time at a higher level.

Failure of the stump to heal is another major complication. Nonhealing is usually due to an inadequate blood supply. The rate of nonhealing varies from 5-30% depending on the facility. Centers that specialize in amputation usually have the lowest rates of complication.

Persistent pain in the stump or pain in the phantom limb is experienced by most amputees to some degree. Treatment of phantom limb pain is difficult. One final complication is that many amputees give up on the rehabilitation process and discard their prosthesis. Better fitting prosthetics and earlier rehabilitation have decreased the incidence of this problem.

KEY TERMS

Arterial embolism—A blood clot arising from another location that blocks an artery.

Buerger's disease—An episodic disease that causes inflammation and blockage of the veins and arteries of the limbs. It tends to be present almost exclusively on men under age 40 who smoke, and may require amputation of the hand or foot.

Diabetes mellitus—A disease in which insufficient insulin is made by the body to metabolize sugars.

Raynaud's disease—A disease found mainly in young women that causes decreased circulation to the hands and feet. Its cause is unknown.

Normal results

The five year survival rate for all lower extremity amputees is less than 50%. For diabetic amputees, the rate is less than 40%. Up to 50% of people who have one leg amputated because of diabetes will lose the other within five years. Amputees who walk using a prosthesis have a less stable gait. Three to five percent of these people fall and break bones because of this instability. Although the **fractures** can be treated, about half the amputees who suffer them then remain wheelchair bound.

Resources

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

OTHER

Amputation Prevention Global Resource Center Page. Feb. 2001. <http://www.diabetesresource.com>.

Tish Davidson

Amylase tests

Definition

Amylase is a digestive enzyme made primarily by the pancreas and salivary glands. Enzymes are substances made and used by the body to trigger specific chemical reactions. The primary function of the enzyme amylase is to break down starches in food so that they can be used by the body. Amylase testing is usually done to determine the cause of sudden abdominal **pain**.

Purpose

Amylase testing is performed to diagnose a number of diseases that elevate amylase levels. **Pancreatitis**, for example, is the most common reason for a high amylase level. When the pancreas is inflamed, amylase escapes from the pancreas into the blood. Within six to 48 hours after the pain begins, amylase levels in the blood start to rise. Levels will stay high for several days before gradually returning to normal.

There are other causes of increased amylase. An ulcer that erodes tissue from the stomach and goes into the pancreas will cause amylase to spill into the blood. During a **mumps** infection, amylase from the inflamed salivary glands increases. Amylase is also found in the liver, fallopian tubes, and small intestine; inflammation of these tissues also increases levels. Gall bladder disease, tumors of the lung or ovaries, alcohol **poisoning**, ruptured **aortic aneurysm**, and intestinal strangulation or perforation can also cause unusually high amylase levels.

Precautions

This is not a screening test for future pancreatic disease.

Description

Amylase testing is done on both blood and urine. The laboratory may use any of several testing methods that involve mixing the blood or urine sample with a substance with which amylase is known to react. By measuring the end-product or the reaction time, technicians can calculate the amount of amylase present in the sample. More sophisticated methods separately measure the amylase made by the pancreas and the amylase made by the salivary glands.

Urine testing is a better long-term monitor of amylase levels. The kidneys quickly move extra amylase from the blood into the urine. Urine levels rise six to 10 hours after blood levels and stay high longer. Urine is usually collected throughout a 2- or 24-hour time period. Results are usually available the same day.

Preparation

In most cases, no special preparation is necessary for a person undergoing an amylase blood test. Patients taking longer term urine amylase tests will be given a container and instructions for collecting the urine at home. The urine should be refrigerated until it is brought to the laboratory.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Applying warm packs to the puncture site relieves discomfort.

Normal results

Normal results vary based on the laboratory and the method used.

Abnormal results

Eight out of ten persons with acute pancreatitis will have high amylase levels, up to four times the normal level. Other causes of increased amylase, such as mumps, kidney failure, **pregnancy** occurring in the abdomen but outside the uterus (**ectopic pregnancy**), certain tumors, a penetrating ulcer, certain complications of diabetes, and advanced pancreatic **cancer**, are further investigated based on the person's symptoms, medical history, and the results of other tests.

In kidney disease, the kidneys are not as efficient at removing amylase from the blood. Amylase rises in the blood, but stays at normal levels in the urine.

People with macroamylasia have large clumps of amylase in their blood. These clumps are too large to move through the kidney, so they stay in the blood. Amylase levels in the blood will be high; levels in the urine will be low.

Amylase levels may be low in severe liver disease (including hepatitis), conditions in which the pancreas fails to secrete enough enzyme for proper digestions (pancreatic insufficiency), when toxic materials build up in the blood during pregnancy (pre-eclampsia), following **burns**, in thyroid disorders, and in advanced **cystic fibrosis**. Some medications can raise or lower levels.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

KEY TERMS

Amylase—A digestive enzyme made primarily by the pancreas and salivary glands.

Enzyme—A substance made and used by the body to trigger specific chemical reactions.

Pancreatitis—Inflammation of the pancreas.

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods.* 19th ed. Philadelphia: W. B. Saunders Co., 1996.

Lehman, Craig A. *Saunders Manual of Clinical Laboratory Science.* Philadelphia: W. B. Saunders Co., 1998.

Mayo Medical Laboratories. *Interpretive Handbook.* Rochester, MN: Mayo Medical Laboratories, 1997.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

Nancy J. Nordenson

Amyloidosis

Definition

Amyloidosis is a progressive, incurable, metabolic disease characterized by abnormal deposits of protein in one or more organs or body systems.

Description

Amyloid proteins are manufactured by malfunctioning bone marrow. Amyloidosis, which occurs when accumulated amyloid deposits impair normal body function, can cause organ failure or **death**. It is a rare disease, occurring in about eight of every 1,000,000 people. It affects males and females equally and usually develops after the age of 40. At least 15 types of amyloidosis have been identified. Each one is associated with deposits of a different kind of protein.

Types of amyloidosis

The major forms of this disease are primary systemic, secondary, and familial or hereditary amyloidosis. There is also another form of amyloidosis associated with **Alzheimer's disease**.

Primary systemic amyloidosis usually develops between the ages of 50 and 60. With about 2,000 new cases diagnosed annually, primary systemic amyloidosis is the most common form of this disease in the United States. Also known as light-chain-related amyloidosis, it may also occur in association with **multiple myeloma** (bone marrow **cancer**).

Secondary amyloidosis is a result of chronic infection or inflammatory disease. It is often associated with:

- **familial Mediterranean fever** (a bacterial infection characterized by chills, weakness, **headache**, and recurring **fever**)
- granulomatous ileitis (inflammation of the small intestine)
- Hodgkin's disease (cancer of the lymphatic system)
- leprosy
- osteomyelitits (bacterial infection of bone and bone marrow)
- rheumatoid arthritis

Familial or hereditary amyloidosis is the only inherited form of the disease. It occurs in members of most ethnic groups, and each family has a distinctive pattern of symptoms and organ involvement. Hereditary amyloidosis is though to be autosomal dominant, which means that only one copy of the defective gene is necessary to cause the disease. A child of a parent with familial amyloidosis has a 50-50 chance of developing the disease.

Amyloidosis can involve any organ or system in the body. The heart, kidneys, gastrointestinal system, and nervous system are affected most often. Other common sites of amyloid accumulation include the brain, joints, liver, spleen, pancreas, respiratory system, and skin.

Causes and symptoms

The cause of amyloidosis is unknown. Most patients have gastrointestinal abnormalities, but other symptoms vary according to the organ(s) or system(s) affected by the disease. Usually the affected organs are rubbery, firm, and enlarged.

Heart

Because amyloid protein deposits can limit the heart's ability to fill with blood between beats, even the slightest exertion can cause **shortness of breath**. If the heart's electrical system is affected, the heart's rhythm may become erratic. The heart may also be enlarged and **heart murmurs** may be present. Congestive **heart failure** may result.

Kidneys

The feet, ankles, and calves swell when amyloidosis damages the kidneys. The kidneys become small and

KEY TERMS

Amyloid—A waxy, starch-like protein.

Peripheral nerves—Nerves that carry information to and from the spinal cord.

Stem cells—Parent cells from which other cells are made.

hard, and kidney failure may result. It is not unusual for a patient to lose 20-25 pounds and develop a distaste for meat, eggs, and other protein-rich foods. Cholesterol elevations that don't respond to medication and protein in the urine (proteinuria) are common.

Nervous system

Nervous system symptoms often appear in patients with familial amyloidosis. Inflammation and degeneration of the peripheral nerves (**peripheral neuropathy**) may be present. One of four patients with amyloidosis has **carpal tunnel syndrome**, a painful disorder that causes numbness or tingling in response to pressure on nerves around the wrist. Amyloidosis that affects nerves to the feet can cause burning or numbness in the toes and soles and eventually weaken the legs. If nerves controlling bowel function are involved, bouts of **diarrhea** alternate with periods of **constipation**. If the disease affects nerves that regulate blood pressure, patients may feel dizzy or faint when they stand up suddenly.

Liver and spleen

The most common symptoms are enlargement of these organs. Liver function is not usually affected until quite late in the course of the disease. Protein accumulation in the spleen can increase the risk of rupture of this organ due to trauma.

Gastrointestinal system

The tongue may be inflammed, enlarged, and stiff. Intestinal movement (motility) may be reduced. Absorption of food and other nutrients may be impaired (and may lead to **malnutrition**), and there may also be bleeding, abdominal **pain**, constipation, and diarrhea.

Skin

Skin symptoms occur in about half of all cases of primary and secondary amyloidosis and in all cases where there is inflammation or degeneration of the peripheral nerves. Waxy-looking raised bumps (papules) may appear on the face and neck, in the groin, armpits, or anal area, and on the tongue or in the ear canals. Swelling, hemorrhage beneath the skin (purpura), hair loss, and **dry mouth** may also occur.

Respiratory system

Airways may be obstructed by amyloid deposits in the nasal sinus, larynx and traches (windpipe).

Diagnosis

Blood and urine tests can reveal the presence of amyloid protein, but tissue or bone-marrow biopsy is necessary to positively diagnose amyloidosis. Once the diagnosis has been confirmed, additional laboratory tests and imaging procedures are performed to determine:

- which type of amyloid protein is involved
- which organ(s) or system(s) have been affected
- how far the disease has progressed

Treatment

The goal of treatment is to slow down or stop production of amyloid protein, eliminate existing amyloid deposits, alleviate underlying disorders (that give rise to secondary amyloidosis), and relieve symptoms caused by heart or kidney damage. Specialists in cardiology, hematology (the study of blood and the tissues that form it), nephrology (the study of kidney function and abnormalities), neurology (the study of the nervous system), and rheumatology (the study of disorders characterized by inflammation or degeneration of connective tissue) work together to assess a patient's medical status and evaluate the effects of amyloidosis on every part of the body.

Colchicine (Colebenemid, Probeneaid), prednisone, (Prodium), and other anti-inflammatory drugs can slow or stop disease progression. Bone-marrow and stem-cell transplants can enable patients to tolerate higher and more effective doses of melphalan (Alkeran) and other **chemotherapy** drugs prescribed to combat this non-malignant disease. Surgery can relieve nerve pressure and may be performed to correct other symptom-producing conditions. Localized amyloid deposits can also be removed surgically. Dialysis or **kidney transplantation** can lengthen and improve the quality of life for patients whose amyloidosis results in kidney failure. Heart transplants are rarely performed.

Supportive measures

Although no link has been established between diet and development of amyloid proteins, a patient whose heart or kidneys have been affected by the disease may be advised to use a diuretic or follow a low-salt diet.

Prognosis

Most cases of amyloidosis are diagnosed after the disease has reached an advanced stage. The course of each patient's illness is unique but death, usually a result of heart disease or kidney failure, generally occurs within a few years. Amyloidosis associated by multiple myeloma usually has a poor prognosis. Most patients with both diseases die within one to two years.

Prevention

Genetic counseling may be helpful for patients with hereditary amyloidosis and their families. Use of cholchicine in patients with familial Mediterranean fever has successfully prevented amyloidosis.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Amyloidosis Network International. 7118 Cole Creek Drive, Houston, TX 77092-1421. (888) 1AMYLOID. <http://www.health.gov/nhic/Scripts/Entry.cfm?HRCode=HR2397>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

OTHER

Mayo Clinic Online. 5 March 1998. <http://www.mayohealth.org>.

Maureen Haggerty

Amyotrophic lateral sclerosis

Definition

Amyotrophic lateral sclerosis (ALS) is a disease that breaks down tissues in the nervous system (a neurodegenerative disease) of unknown cause that affects the nerves responsible for movement. It is also known as motor neuron disease and Lou Gehrig's disease, after the baseball player whose career it ended.

Description

ALS is a disease of the motor neurons, those nerve cells reaching from the brain to the spinal cord (upper motor neurons) and the spinal cord to the peripheral nerves (lower motor neurons) that control muscle movement. In ALS, for unknown reasons, these neurons die, leading to a progressive loss of the ability to move virtually any of the muscles in the body. ALS affects "voluntary" muscles, those controlled by conscious thought, such as the arm, leg, and trunk muscles. ALS, in and of itself, does not affect sensation, thought processes, the heart muscle, or the "smooth" muscle of the digestive system, bladder, and other internal organs. Most people with ALS retain function of their eye muscles as well. However, various forms of ALS may be associated with a loss of intellectual function (**dementia**) or sensory symptoms.

"Amyotrophic" refers to the loss of muscle bulk, a cardinal sign of ALS. "Lateral" indicates one of the regions of the spinal cord affected, and "sclerosis" describes the hardened tissue that develops in place of healthy nerves. ALS affects approximately 30,000 people in the United States, with about 5,000 new cases each year. It usually begins between the ages of 40 and 70, although younger onset is possible. Men are slightly more likely to develop ALS than women.

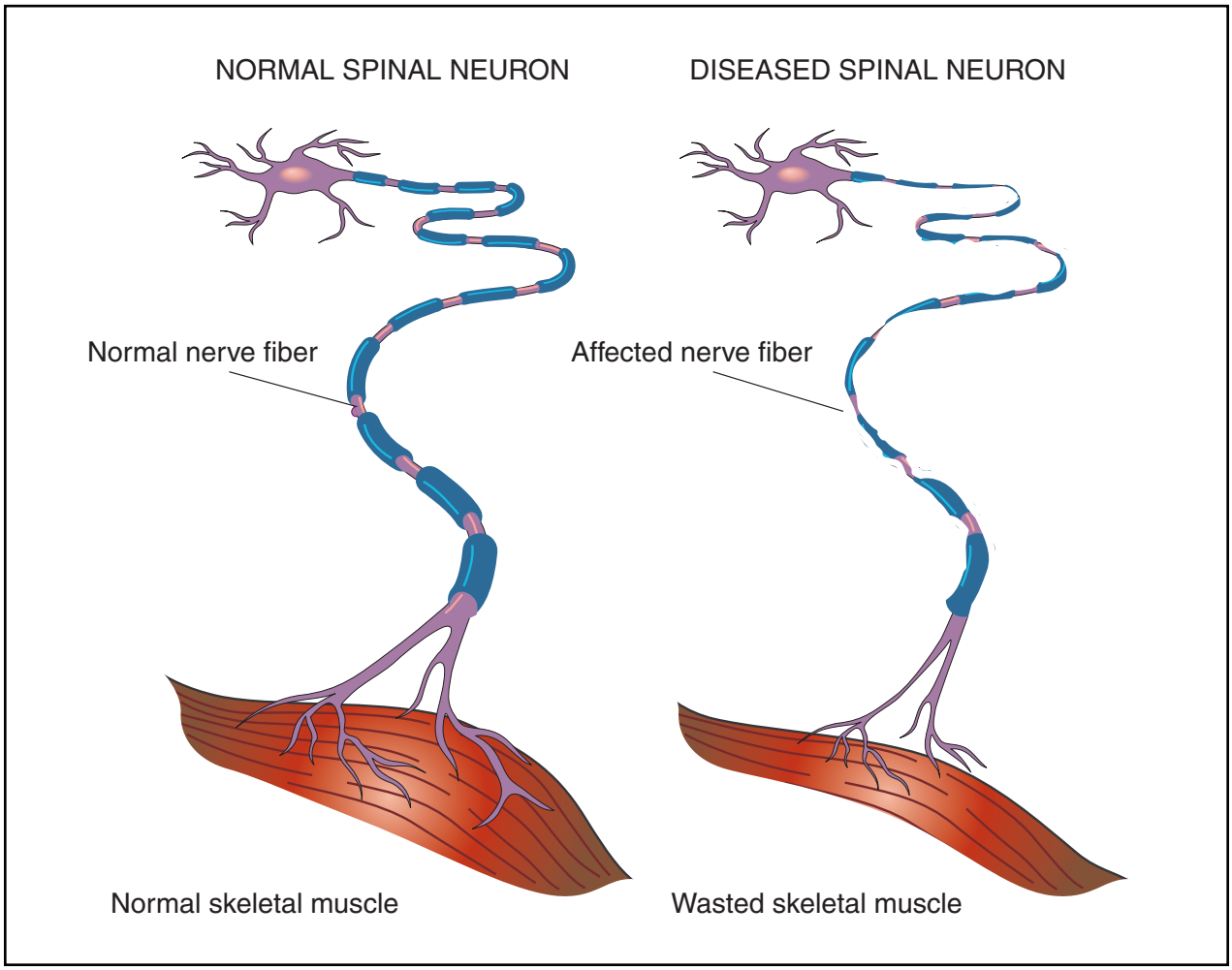
ALS progresses rapidly in most cases. It is fatal within three years for 50% of all people affected, and within five years for 80%. Ten percent of people with ALS live beyond eight years.

Causes and symptoms

Causes

The symptoms of ALS are caused by the **death** of motor neurons in the spinal cord and brain. Normally, these neurons convey electrical messages from the brain to the muscles to stimulate movement in the arms, legs, trunk, neck, and head. As motor neurons die, the muscles they enervate cannot be moved as effectively, and weakness results. In addition, lack of stimulation leads to muscle wasting, or loss of bulk. Involvement of the upper motor neurons causes spasms and increased tone in the limbs, and abnormal reflexes. Involvement of the lower motor neurons causes muscle wasting and twitching (fasciculations).

Although many causes of motor neuron degeneration have been suggested for ALS, none has yet been proven responsible. Results of recent research have implicated toxic molecular fragments known as free radicals. Some evidence suggests that a cascade of events leads to excess free radical production inside motor neurons, leading to their death. Why free radicals should be produced in excess amounts is unclear, as is whether this excess is the cause or the effect of other degenerative processes. Additional agents within this toxic cascade may include excessive levels of a neurotransmitter known as glutamate, which may over-stimulate motor neurons, thereby increasing free-radical production, and a faulty **detoxification** enzyme known as SOD-1, for



Amyotrophic lateral sclerosis (ALS) is caused by the degeneration and death of motor neurons in the spinal cord and brain. These neurons convey electrical messages from the brain to the muscles to stimulate movement in the arms, legs, trunk, neck, and head. As motor neurons degenerate, the muscles are weakened and cannot move as effectively, leading to muscle wasting. *(Illustration by Electronic Illustrators Group.)*

superoxide dismutase type 1. The actual pathway of destruction is not known, however, nor is the trigger for the rapid degeneration that marks ALS. Further research may show that other pathways are involved, perhaps ones even more important than this one. Autoimmune factors or premature **aging** may play some role, as could viral agents or environmental toxins.

Two major forms of ALS are known: familial and sporadic. Familial ALS accounts for about 10% of all ALS cases. As the name suggests, familial ALS is believed to be caused by the inheritance of one or more faulty genes. About 15% of families with this type of ALS have mutations in the gene for SOD-1. SOD-1 gene defects are dominant, meaning only one gene copy is needed to develop the disease. Therefore, a parent with the faulty gene has a 50% chance of passing the gene along to a child.

Sporadic ALS has no known cause. While many environmental toxins have been suggested as causes, to date no research has confirmed any of the candidates investigated, including aluminum and mercury and lead from dental fillings. As research progresses, it is likely that many cases of sporadic ALS will be shown to have a genetic basis as well.

A third type, called Western Pacific ALS, occurs in Guam and other Pacific islands. This form combines symptoms of both ALS and **Parkinson's disease**.

Symptoms

The earliest sign of ALS is most often weakness in the arms or legs, usually more pronounced on one side than the other at first. Loss of function is usually more

rapid in the legs among people with familial ALS and in the arms among those with sporadic ALS. Leg weakness may first become apparent by an increased frequency of stumbling on uneven pavement, or an unexplained difficulty climbing stairs. Arm weakness may lead to difficulty grasping and holding a cup, for instance, or loss of dexterity in the fingers.

Less often, the earliest sign of ALS is weakness in the *bulbar* muscles, those muscles in the mouth and throat that control chewing, swallowing, and speaking. A person with bulbar weakness may become hoarse or tired after speaking at length, or speech may become slurred.

In addition to weakness, the other cardinal signs of ALS are muscle wasting and persistent twitching (fasciculation). These are usually seen after weakness becomes obvious. Fasciculation is quite common in people without the disease, and is virtually never the first sign of ALS.

While initial weakness may be limited to one region, ALS almost always progresses rapidly to involve virtually all the voluntary muscle groups in the body. Later symptoms include loss of the ability to walk, to use the arms and hands, to speak clearly or at all, to swallow, and to hold the head up. Weakness of the respiratory muscles makes breathing and coughing difficult, and poor swallowing control increases the likelihood of inhaling food or saliva (aspiration). Aspiration increases the likelihood of lung infection, which is often the cause of death. With a ventilator and scrupulous bronchial hygiene, a person with ALS may live much longer than the average, although weakness and wasting will continue to erode any remaining functional abilities. Most people with ALS continue to retain function of the extraocular muscles that move their eyes, allowing some communication to take place with simple blinks or through use of a computer-assisted device.

Diagnosis

The diagnosis of ALS begins with a complete medical history and physical exam, plus a neurological examination to determine the distribution and extent of weakness. An electrical test of muscle function, called an electromyogram, or EMG, is an important part of the diagnostic process. Various other tests, including blood and urine tests, x rays, and CT scans, may be done to rule out other possible causes of the symptoms, such as tumors of the skull base or high cervical spinal cord, thyroid disease, spinal arthritis, **lead poisoning**, or severe vitamin deficiency. ALS is rarely misdiagnosed following a careful review of all these factors.

Treatment

There is no cure for ALS, and no treatment that can significantly alter its course. There are many things which can be done, however, to help maintain quality of life and to retain functional ability even in the face of progressive weakness.

KEY TERMS

Aspiration—Inhalation of food or liquids into the lungs.

Bulbar muscles—Muscles of the mouth and throat responsible for speech and swallowing.

Fasciculations—Involuntary twitching of muscles.

Motor neuron—A nerve cell that controls a muscle.

Riluzole (Rilutek)—The first drug approved in the United States for the treatment of ALS.

Voluntary muscle—A muscle under conscious control; contrasted with smooth muscle and heart muscle which are not under voluntary control.

As of early 1998, only one drug had been approved for treatment of ALS. Riluzole (Rilutek) appears to provide on average a three-month increase in life expectancy when taken regularly early in the disease, and shows a significant slowing of the loss of muscle strength. Riluzole acts by decreasing glutamate release from nerve terminals. Experimental trials of nerve growth factor have not demonstrated any benefit. No other drug or vitamin currently available has been shown to have any effect on the course of ALS.

A physical therapist works with an affected person and family to implement **exercise** and stretching programs to maintain strength and range of motion, and to promote general health. Swimming may be a good choice for people with ALS, as it provides a low-impact workout to most muscle groups. One result of chronic inactivity is contracture, or muscle shortening. **Contractures** limit a person's range of motion, and are often painful. Regular stretching can prevent contracture. Several drugs are available to reduce cramping, a common complaint in ALS.

An occupational therapist can help design solutions to movement and coordination problems, and provide advice on adaptive devices and home modifications.

Speech and swallowing difficulties can be minimized or delayed through training provided by a speech-language pathologist. This specialist can also provide advice on communication aids, including computer-assisted devices and simpler word boards.

Nutritional advice can be provided by a nutritionist. A person with ALS often needs softer foods to prevent jaw exhaustion or **choking**. Later in the disease, **nutrition** may be provided by a **gastrostomy** tube inserted into the stomach.

Mechanical ventilation may be used when breathing becomes too difficult. Modern mechanical ventilators are small and portable, allowing a person with ALS to maintain the maximum level of function and mobility. Ventilation may be administered through a mouth or nose piece, or through a tracheostomy tube. This tube is inserted through a small hole made in the windpipe. In addition to providing direct access to the airway, the tube also decreases the risk aspiration. While many people with rapidly progressing ALS choose not to use ventilators for lengthy periods, they are increasingly being used to prolong life for a short time.

The progressive nature of ALS means that most persons will eventually require full-time nursing care. This care is often provided by a spouse or other family member. While the skills involved are not difficult to learn, the physical and emotional burden of care can be overwhelming. Caregivers need to recognize and provide for their own needs as well as those of people with ALS, to prevent depression, burnout, and bitterness.

Throughout the disease, a support group can provide important psychological aid to affected persons and their caregivers as they come to terms with the losses ALS inflicts. Support groups are sponsored by both the ALS Society and the **Muscular Dystrophy** Association.

Alternative treatment

Given the grave prognosis and absence of traditional medical treatments, it is not surprising that a large number of alternative treatments have been tried for ALS. Two studies published in 1988 suggested that amino-acid therapies may provide some improvement for some people with ALS. While individual reports claim benefits for megavitamin therapy, herbal medicine, and removal of dental fillings, for instance, no evidence suggests that these offer any more than a brief psychological boost, often followed by a more severe letdown when it becomes apparent the disease has continued unabated. However, once the causes of ALS are better understood, alternative therapies may be more intensively studied. For example, if damage by free radicals turns out to be the root of most of the symptoms, antioxidant **vitamins** and supplements may be used more routinely to slow the progression of ALS. Or, if environmental toxins are implicated, alternative therapies with the goal of detoxifying the body may be of some use.

Prognosis

ALS usually progresses rapidly, and leads to death from respiratory infection within three to five years in most cases. The slowest disease progression is seen in those who are young and have their first symptoms in the limbs. About 10% of people with ALS live longer than eight years.

Prevention

There is no known way to prevent ALS or to alter its course.

Resources

BOOKS

Adams, Raymond D, Victor, Maurice and Ropper, Allan H. *Adam's & Victor's Principles of Neurology, 6th ed.* New York, McGraw Hill, 1997.

Brown, Robert H. "The motor neuron diseases." In *Harrison's Principles of Internal Medicine, 14th ed.,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998, 2368-2372.

Feldman, Eva L. "Motor neuron diseases." In *Cecil Textbook of Medicine, 21st ed.,* edited by Goldman, Lee and Bennett, J. Claude. Philadelphia: W.B. Saunders, 2000, 2089-2092.

Kimura, Jun and Kaji, Ryuji. *Physiology of ALS and Related Diseases*. Amsterdam, Elsevier Science, 1997.

Mitsumoto, Hiroshi, Chad, David A, Pioro, Erik and Gilman, Sid. *Amyotrophic Lateral Sclerosis*. New York, Oxford University Press, 1997.

PERIODICALS

Ansevin CF. *Treatment of ALS with pleconaril*. Neurology, 56(5): 691-692, 2001.

Eisen A, Weber M. *The motor cortex and amyotrophic lateral sclerosis*. Muscle and Nerve, 24(4): 564-573, 2001.

Gelanis DF. *Respiratory Failure or Impairment in Amyotrophic Lateral Sclerosis*. Current treatment options in neurology, 3(2): 133-138, 2001.

Ludolph AC. *Treatment of amyotrophic lateral sclerosis—what is the next step?* Journal of Neurology, 246 Suppl 6:13-18, 2000.

Pasetti C, Zanini G. *The physician-patient relationship in amyotrophic lateral sclerosis*. Neurological Science, 21(5): 318-323, 2000.

Robberecht W. *Genetics of amyotrophic lateral sclerosis*. Journal of Neurology, 246 Suppl 6: 2-6, 2000.

Robbins RA, Simmons Z, Bremer BA, Walsh SM, Fischer S. *Quality of life in ALS is maintained as physical function declines*. Neurology, 56(4): 442-444, 2001.

ORGANIZATIONS

ALS Association of America. 27001 Agoura Road, Suite 150, Calabasas Hills, CA 91301-5104. (800) 782-4747 (Information and Referral Service) or (818) 880-9007. Fax: (818) 880-9006. <http://www.alsa.org/als/>.

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000, <http://www.aafp.org/>. fp@aafp.org.
American Academy of Neurology. 1080 Montreal Avenue, St. Paul, Minnesota 55116. (651) 695-1940. Fax: (651) 695-2791. <http://www.aan.com/>. info@aan.org.
American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http:// www.ama-assn.org/>.
Centers for Disease Control and Prevention. 1600 Clifton Road, Atlanta, GA 30333. (404) 639-3534 or (800) 311-3435. <http://www.cdc.gov/ncidod/ eid/vol7no1/brown.htm>. http://www.cdc.gov/ netinfo.htm.
Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson AZ 85718-3208. (520) 529-2000 or (800) 572-1717. Fax: (520) 529-5300. <http://www.mdausa.org>.

OTHER

*A*LS Society of Canada: <http://www.als.ca/>.
ALS Survival Guide: <http://www.lougehrigsdisease.net/>.
American Academy of Family Physicians: <http://www.aafp.org/afp/990315ap/1489.html>.
National Institute of Neurological Disorders and Stroke: <http://www.ninds.nih.gov/health_and_medical/disorders/amyotrophiclateralsclerosis_doc.htm>.
National Library of Medicine: <http://www.nlm.nih.gov/medlineplus/amyotrophiclateralsclerosis.html>.
National Organization for Rare Diseases: <http://www.stepstn.com/cgi-win/nord.exe?proc=Redirect&type=rdb_sum&id=57.htm>.
World Federation of Neurology: <http://www.wfnals.org/>.

L. Fleming Fallon, Jr., MD, DrPH

Anaerobic infections

Definition

An anaerobic infection is an infection caused by bacteria (called anaerobes) which cannot grow in the presence of oxygen. Anaerobic bacteria can infect deep **wounds**, deep tissues, and internal organs where there is little oxygen. These infections are characterized by **abscess** formation, foul-smelling pus, and tissue destruction.

Description

Anaerobic means "life without air." Anaerobic bacteria grow in places which completely, or almost completely, lack oxygen. They are normally found in the mouth, gastrointestinal tract, and vagina, and on the skin. Commonly known diseases caused by anaerobic bacteria include gas **gangrene**, **tetanus**, and **botulism**. Nearly all dental infections are caused by anaerobic bacteria.

Anaerobic bacteria can cause an infection when a normal barrier (such as skin, gums, or intestinal wall) is damaged due to surgery, injury, or disease. Usually, the immune system kills any invading bacteria, but sometimes the bacteria are able to grow and cause an infection. Body sites that have tissue destruction (necrosis) or a poor blood supply are low in oxygen and favor the growth of anaerobic bacteria. The low oxygen condition can result from blood vessel disease, **shock**, injury, and surgery.

Anaerobic bacteria can cause infection practically anywhere in the body. For example:

- Mouth, head, and neck. Infections can occur in the root canals, gums (gingivitis), jaw, tonsils, throat, sinuses, and ears.
- Lung. Anaerobic bacteria can cause **pneumonia**, lung abscesses, infecton of the lining of the lung (**empyema**), and dilated lung bronchi (**bronchiectasis**).
- Intraabdominal. Anaerobic infections within the abdomen include abscess formation, **peritonitis**, and **appendicitis**.
- Female genital tract. Anaerobic bacteria can cause pelvic abscesses, **pelvic inflammatory disease**, inflammation of the uterine lining (endometritis), and pelvic infections following abortion, **childbirth**, and surgery.
- Skin and soft tissue. Anaerobic bacteria are common causes of diabetic skin ulcers, gangrene, destructive infection of the deep skin and tissues (necrotizing fasciitis), and bite wound infections.
- Central nervous system. Anaerobic bacteria can cause brain and spinal cord abscesses.
- Bloodstream. Anaerobic bacteria can be found in the bloodstream of ill patients (a condition called bacteremia).

Causes and symptoms

People who have experienced shock, injury, or surgery, and those with blood vessel disease or tumors are at an increased risk for infection by anaerobic bacteria. There are many different kinds of anaerobic bacteria which can cause an infection. Indeed, most anaerobic infections are "mixed infections" which means that there is a mixture of different bacteria growing. The anaerobic bacteria that most frequently cause infections are *Bacteroides fragilis*, *Peptostreptococcus*, and *Clostridium* species.

The signs and symptoms of anaerobic infection can vary depending on the location of the infection. In general, anaerobic infections result in tissue destruc-

KEY TERMS

Abscess—A lump filled with pus resulting from an infection.

Anaerobic—Living and growing in the absence of oxygen.

Necrosis—Tissue death and destruction resulting from infection or disease.

tion, an abscess which drains foul-smelling pus, and possibly **fever**. Symptoms for specific infections are as follows:

- Tooth and gum infections. Swollen, tender bleeding gums, **bad breath**, and **pain**. Severe infections may produce oozing sores.
- Throat infection. An extremely **sore throat**, bad breath, a bad taste in the mouth, fever, and a sense of **choking**.
- Lung infection. Chest pain, coughing, difficulty breathing, fever, foul-smelling sputum, and weight loss.
- Intraabdominal infection. Pain, fever, and possibly, if following surgery, foul- smelling drainage from the wound.
- Pelvic infection. Foul-smelling pus or blood draining from the uterus, general or localized pelvic pain, fever, and chills.
- Skin and soft tissue infection. Infected wounds are red, painful, swollen, and may drain a foul-smelling pus. Skin infection causes localized swelling, pain, redness, and possibly a painful, open sore (ulcer) which drains foul-smelling pus. Severe skin infections may cause extensive tissue destruction (necrosis).
- Bloodstream. Bloodstream invasion causes high fever (up to 105°F [40.6°C]), chills, a general ill feeling, and is potentially fatal.

Diagnosis

The diagnosis of anaerobic infection is based primarily on symptoms, the patient's medical history, and location of the infection. A foul-smelling infection or drainage from an abscess is diagnostic of anaerobic infection. This foul smell is produced by anaerobic bacteria and occurs in one third to one half of patients late in the infection. Other clues to anaerobic infection include tissue necrosis and gas production at the infection site. A sample from the infected site may be obtained, using a swab or a needle and syringe, to determine which bacteria is (are) causing the infection. Because these bacteria can be easily killed by oxygen, they rarely grow in the laboratory cultures of tissue or pus samples.

The recent medical history of the patient is helpful in diagnosing anaerobic infection. A patient who has or recently had surgery, dental work, tumors, blood vessel disease, or injury are susceptible to this infection. The failure to improve following treatment with **antibiotics** that aren't able to kill anaerobes is another clue that the infection is caused by anaerobes. The location and type of infection also help in the diagnosis.

Diagnostic tests may include blood tests to see if bacteria are in the bloodstream and x rays to look at internal infections.

Treatment

Serious infections may require hospitalization for treatment. Immediate antibiotic treatment of anaerobic infections is necessary. Laboratory testing may identify the bacteria causing the infection and also which antibiotic will work best. Every antibiotic does not work against all anaerobic bacteria but nearly all anaerobes are killed by chloramphenicol (Chloromycetin), metronidazole (Flagyl or Protostat), and imipenem (Primaxin). Other antibiotics which may be used are clindamycin (Cleocin) or cefoxitin (Mefoxin).

Surgical removal or drainage of the abscess is almost always required. This may involve drainage by needle and syringe to remove the pus from a skin abscess (called "aspiration"). The area would be numbed prior to the aspiration procedure. Also, some internal abscesses can be drained using this procedure with the help of ultrasound (a device which uses sound waves to visualize internal organs). This type of abscess drainage may be performed in the doctor's office.

Prognosis

Complete recovery should be achieved with the appropriate surgery and antibiotic treatment. Untreated or uncontrolled infections can cause severe tissue and bone destruction, which would require plastic surgery to repair. Serious infections can be life threatening.

Prevention

Although anaerobic infections can occur in anyone, good hygiene and general health may help to prevent infections.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Belinda Rowland, PhD

Anaerobic myositis *see* **Gangrene**

Anal atresia

Definition

The anus is either not present or it is in the wrong place.

Description

There are basically two kinds of anal atresia. In boys with high anal atresia, there may be a channel (fistula) connecting the large intestine to either the urethra (which delivers urine from the bladder) or the bladder itself. In girls, the channel may connect with the vagina. Sixty percent of children with high anal atresia have other defects, including problems with the esophagus, urinary tract, and bones. In low anal atresia, the channel may open in front of the circular mass of muscles that constrict to close the anal opening (anal sphincter) or, in boys, below the scrotum. Occasionally, the intestine ends just under the skin. It is estimated that overall abnormalities of the anus and rectum occur in about one in every 5,000 births and are slightly more common among boys. A mother who has one child with these kind of conditions has a 1% chance of having another child who suffers from this ailment.

Cause and symptoms

Anal atresia is a defect in the development of the fetus. The cause is unknown, but genetics seem to play a minor role.

Diagnosis

Usually a physician can make an obvious visual diagnosis of anal atesia right after birth. Occasionally, however, anal atresia is missed until the baby is fed and signs of intestinal obstruction appear. At the end of the first or second day, the abdomen swells and there is vomiting of fecal material. To determine the type of anal atresia and the exact position, x rays will be taken which include injecting opaque dye into the opening. **Magnetic resonance imaging** (MRI) or **computed tomography scans** (CT), as well as ultrasound, are the imaging techniques used to determine the type and size of the anal atresia. Ultrasound uses sound waves, CT scans pass x rays through the body at different angles, and an MRI uses a magnetic field and radio waves.

KEY TERMS

Anus—The canal at the end of the large intestine through which waste is excreted to the outside of the body.

Bowel obstruction—Anything that prevents waste from moving normally to the anal opening.

Colostomy—An operation where the large intestine is diverted through an opening in the abdomen and waste is excreted.

Feces—Bodily waste material that normally passes through the anus.

Fistula—An abnormal channel that connects two organs or connects an organ to the skin.

Treatment

Surgery is the only treatment for anal atresia. For high anal atresia, immediately after the diagnosis is made, a surgical incision is made in the large intestine to make a temporary opening (**colostomy**) in the abdomen where waste is excreted. Several months later, the intestine is moved into the ring of muscle (sphincter) that is part of the anus and a hole is made in the skin. The colostomy is closed several weeks later. In low anal atresia, immediately after diagnosis, a hole is made in the skin to open the area where the anus should be. If the channel is in the wrong place, the intestine is moved into the correct position sometime during the child's first year. After surgery, the pediatric surgeon uses an instrument to dilate or widen the rectum and teaches the parents how to do this daily at home to prevent scar tissue from contracting.

Prognosis

With high anal atresia, many children have problems controlling bowel function. Most also become constipated. With low anal atresia, children generally have good bowel control, but they may still become constipated.

Prevention

There is no known way to prevent anal atresia.

Resources

BOOKS

Freeman, Neill V. "Anorectal Malformations." In *Surgery of the Newborn*. Edinburgh: Churchill Livingstone, 1994.

Paidas, Charles N., and Alberto Pena. "Rectum and Anus." In *Surgery of Infants and Children*. Philadelphia: Lippincott-Raven, 1997.

Jeanine Barone, Physiologist

Anal cancer

Definition

Anal **cancer** is an uncommon form of cancer affecting the anus. The anus is the inch-and-a-half-long end portion of the large intestine, which opens to allow solid wastes to exit the body. Other parts of the large intestine include the colon and the rectum.

Description

Different cancers can develop in different parts of the anus, part of which is inside the body and part of which is outside. Sometimes abnormal changes of the anus are harmless in their early stages but may later develop into cancer. Some **anal warts**, for example, contain precancerous areas and can develop into cancer. Types of anal cancer include:

- Squamous Cell Carcinomas. Approximately half of anal cancers are squamous cell carcinomas, which arise from the cells lining the anal margin and the anal canal. The anal margin is the part of the anus that is half inside and half outside the body, and the anal canal is the part of the anus that is inside the body. The earliest form of squamous cell carcinoma is known as carcinoma in situ, or Bowen's disease.
- Cloacogenic Carcinomas. Approximately one-fourth to one-third of anal tumors are cloacogenic carcinomas. These tumors develop in the transitional zone, or cloaca, which is a ring of tissue between the anal canal and the rectum.
- Adenocarcinomas. About 15% of anal cancers are adenocarcinomas, which affect glands in the anal area. One type of adenocarcinoma that can occur in the anal area is called Paget's disease, which can also affect the vulva, breasts, and other areas of the body.
- Skin cancers. A small percentage of anal cancers are either basal cell carcinomas, or malignant melanomas, two types of skin cancer. Malignant melanomas, which develop from skin cells that produce the brown pigment called melanin, are far more common on areas of the body exposed to the sun.

Approximately 3,500 Americans will be diagnosed with anal cancer in 2001, and an estimated 500 individuals will die of the disease during this same interval, according to the American Cancer Society. Anal cancers are fairly rare: they make up only 1% to 2% of cancers affecting the digestive system. The disease affects women somewhat more often than men, although the number of cases among men, particularly homosexual men, seems to be increasing.

Causes and symptoms

The exact cause of most anal cancers is unknown, although certain individuals appear to have a higher risk of developing the disease. Smokers are at higher risk, as are individuals with certain types of the human papillomavirus (HPV), and those with long-term problems in the anal area, such as abnormal openings known as fistulas. Since it increases the risk of HPV infection, the practice of anal sex appears to increase the risk of anal cancer—male homosexuals who practice anal sex are about 33 times more likely to have anal cancers than heterosexual men. Those with weakened immune systems, such individuals with HIV, or transplant patients taking **immunosuppressant drugs**, are also at higher risk. Most individuals with anal cancer are over the age of 50.

Symptoms of anal cancer resemble those found in other harmless conditions. They include **pain**, **itching** and bleeding, straining during a bowel movement, change in bowel habits, change in the diameter of the stool, discharge from the anus, and swollen lymph nodes in the anal or groin area.

Diagnosis

Anal cancer is sometimes diagnosed during routine physicals, or during minor procedures such as hemorrhoid removal. It may also be diagnosed during a digital **rectal examination** (DRE), when a physician inserts a gloved, lubricated finger into the anus to feel for unusual growths. Individuals over the age of 50 who have no symptoms should have a digital rectal examination (DRE) every five to 10 years, according to American Cancer Society (ACS) guidelines for early detection of colorectal cancer.

Other diagnostic procedures for anal cancer include: **Anoscopy**. A procedure that involves use of a special device to examine the anus. Proctoscopy. A procedure that involves use of a lighted scope to see the anal canal. Transrectal ultrasound. A procedure in which sound waves are used to create an image of the anus and nearby tissues.

A biopsy is performed on any suspicious growths; that is, a tiny piece of the growth is examined under a microscope for cancer cells. The physician may also perform a procedure called a fine needle aspiration biopsy, in which a needle is used to withdraw fluid from lymph nodes located near the growth, to make sure the cancer hasn't spread to these nodes.

Anal cancer severity is categorized by the following stages:

- Stage 0 anal cancer is found only in the top layer of anal tissue.
- Stage I anal cancer has spread beyond the top layer of anal tissue, but is less than 1 inch in diameter.

- Stage II anal cancer has spread beyond the top layer of anal tissue and is larger than 1 inch in diameter, but has not spread to nearby organs or lymph nodes.
- Stage IIIA anal cancer has spread to the lymph nodes around the rectum or to nearby organs such as the vagina or bladder.
- Stage IIIB anal cancer has spread to lymph nodes in the mid-abdomen or groin, or to nearby organs and the lymph nodes around the rectum.
- Stage IV anal cancer has spread to distant lymph nodes within the abdomen or to distant organs.

Treatment

Anal cancer is treated using three methods, used either in concert or individually: surgery, **radiation therapy**, and **chemotherapy**.

Two types of surgery may be performed. A local resection, performed if the cancer has not spread, removes the tumor and an area of tissue around the tumor. An abdominoperineal resection is a more complex procedure in which the anus and the lower rectum are removed, and an opening called a **colostomy** is created for body wastes to exit. This procedure is fairly uncommon today because radiation and chemotherapy are just as effective.

Radiation therapy uses high-energy rays to fight cancer cells. It is usually delivered via a machine outside the body, but may also be delivered via surgically implanted radioactive pellets. This latter method is called internal radiation, brachytherapy, or interstitial radiation. Side effects of radiation may include tiredness, skin damage resembling **sunburn**, and damage to anal tissues.

Chemotherapy fights cancer using drugs, which may be delivered via pill or needle. Some chemotherapy types kill cancer cells directly, while others act indirectly by making cancer cells more vulnerable to radiation. The main drugs used to treat anal cancer are 5-fluorouracil (5-FU) and mitomycin or 5-FU and cisplatin. Side effects of chemotherapy, which damages normal cells in addition to cancer cells, may include **nausea and vomiting**, hair loss, loss of appetite, **diarrhea**, mouth sores, **fatigue**, **shortness of breath**, and a weakened immune system.

Alternative treatment

Research suggests **acupuncture** can help manage chemotherapy-related nausea and vomiting and control pain associated with surgery.

Prognosis

Anal cancer is often curable. The chance of recovery depends on the cancer stage and the patient's general health.

KEY TERMS

Biopsy—A procedure in which a small piece of body tissue is removed and examined under a microscope for cancer.

Chemotherapy—A cancer treatment in which drugs delivered into the blood stream kill cancer cells or make them more vulnerable to radiation therapy.

Human papillomavirus (HPV)—A virus with many subtypes, some of which cause cell changes that increase the risk of certain cancers.

Human immunodeficiency virus (HIV)—The virus that causes acquired immune deficiency syndrome (AIDS).

Lymph nodes—Bean-shaped structures found throughout the body that produce and store infection-fighting cells.

Radiation therapy—A cancer treatment that uses high-energy rays to kill or weaken cancer cells. Radiation may be delivered externally or internally via surgically implanted pellets.

Prevention

Reducing the risks of the **sexually transmitted diseases** HPV and HIV also reduces the risk of anal cancer. In addition, quitting **smoking** lowers the risk of anal cancer.

Resources

BOOKS

American Joint Committee on Cancer: AJCC Cancer Staging Manual. Philadelphia, Pa: Lippincott-Raven Publishers, 1997.

PERIODICALS

Murakami, M, KJ Gurski and MA Steller. "Human Papillomavirus Vaccines For Cervical Cancer." *Journal of Immunotherapy* 1999, 22(3):212-8.

ORGANIZATIONS

American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.

American College of Gastroenterology. <http://www.acg.gi.org/>.

American Gastroenterological Association. 7910 Woodmont Ave., Seventh Floor, Bethesda, MD 20814. (301) 654-2055. <http://www.gastro.org>.

American Society of Colon and Rectal Surgeons. 85 W. Algonquin Road, Suite 550, Arlington Heights, IL 60005. (847)290-9184.

The NCI Office of Cancer Complementary and Alternative Medicine. <http://occam.nci.nih.gov>.

National Cancer Institute. 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 4-CANCER. <http://www.nci.nih.gov>.
National Coalition for Cancer Survivorship. 1010 Wayne Avenue, 5th Floor, Suite 300, Silver Spring, MD 20910. (888) 650-9127.
The NIH National Center for Complementary and Alternative Medicine. Post Office Box 8218, Silver Spring, MD 20907-8218. (888) 644-6226. <http://nccam.nih.gov>.
United Ostomy Association. (800) 826-0826. <http://www.uoa.org>.

Ann Quigley

Anal fissure *see* **Anorectal disorders**

Anal warts

Definition

Anal **warts**, also known as condyloma acuminata, are small warts that can occur in the rectum.

Description

Initially appear as tiny blemishes that can be as small as the head of a pin or grow into larger cauliflower-like protuberances. They can be yellow, pink, or light brown in color, and only rarely are painful or uncomfortable. In fact, infected individuals often are unaware that they exist. Most cases are caused by sexual transmission.

Most individuals have between one to 10 **genital warts** thtat range in size from roughly 0.5–1.9 cm^2. Some will complain of painless bumps or **itching**, but often, these warts can remain completely unnoticed.

Causes and symptoms

Condyloma acuminatum is one of the most common sexually transmitted disease (STD) in the United States. Young adults aged 17 to 33 years are at greatest risk. Risk factors include **smoking**, using **oral contraceptives**, having multiple sexual partners, and an early coital age. In addition, individuals who have a history of immunosuppression or anal intercourse are also at risk.

Roughly 90% of all anal warts are caused by the human papilloma virus (HPV) types 6 and 11, which are the least likely of over 60 types of HPV to become cancerous. Anal warts are usually transmitted through direct sexual contact with someone who is infected with condyloma acuminata anywhere in the genital area, including the penis and vagina. Studies have shown that roughly 75% of those who engage in sexual contact with someone infected with condyloma acuminata will develop these warts within three months.

Treatment

According to guidelines from the Centers for Disease Control (CDC), the treatment of all genital warts, including anal warts, should be conducted according to the methods preferred by the patient, the medications or procedures most readily available, and the experience of the patient's physician in removing anal warts.

Treatment options include electrical cautery, surgical removal, or both. Warts that appear inside the anal canal will almost always be treated with cauterization or surgical removal. Surgical removal, also known as excision, has the highest success rates and lowest recurrence rates. Indeed, studies have shown that initial cure rates range from 63–91%.

Unfortunately, most cases require numerous treatments because the virus that causes the warts can live in the surrounding tissue. The area may seem normal and wart-free for six months or longer before another wart develops.

Laser surgery is another possibility, but requires local, general, or spinal anesthesia, depending on the number warts and where they are.

Electrocoagulation, a technique that uses electrical energy to destroy the warts, is usually the most painful of the procedures done to eliminate condyloma acuminata of the anus, and is usually reserved for larger warts. It is done with local anesthesia, and may cause discharge or bleeding from the anus.

Follow-up visits to the physician are necessary to make sure that the warts have not recurred. It is recommended that these patients see their physicians every three to six months for up to 1.5 years, which is how long the incubation period is for the HPV virus.

Carbon dioxide laser treatment and electrodesiccation are other options, but these are usually reserved for extensive warts or those that continue to recur despite numerous treatments. However, because HPV virus can be transmitted via the smoke caused by these procedures, they are usually reserved for the worst infections.

For small warts that affect only the skin around the anus, several medications are available, which can be applied directly to the surface of the warts by a physician or by the patients themselves.

Such medications include podophyllum resin (Podocon-25, Pod-Ben-25), a substance made from the cytotoxic extracts of several plants. This agent offers a

cure rate of 20–50% when used alone, and is applied by the physician weekly and then washed off 6 hours later by the patient.

Podofilox (Condylox) is another agent, and is available for patients to use at home. It can be applied twice daily for up to 4 weeks. Podofilox offers a slightly higher cure rate than podophyllin, and can also be used to prevent warts.

Trichloroacetic and bichloroacetic acids are available in several concentrations up to 80% for the treatment of condyloma acuminata. These acids work to cauterize the skin, and are quite caustic. Nevertheless, they cause less irritation and overall body effects than the other agents mentioned above. Recurrence, however, is higher with these acids.

Bleomycin (Blenoxane) is another treatment option, but it has several drawbacks. First, it must be administered by a physician into each lesion via injection, but is can have a host of side effects, and patients must be followed carefully by their physician.

Imiquimod 5% cream is also available for patients to apply themselves. It is to be applied three times weekly, for up to 16 weeks, and has been shown to clear warts within eight to 10 weeks.

Finally, the interferon drugs, which are naturally occurring proteins that have antiviral and antitumor effects, are available. These include interferon alfa 2a and 2b (Roferon, Intron A), which are to be injected into each lesion twice a week for up to eight weeks.

Prognosis

Once a diagnosis of anal warts has been made, further outbreaks can be controlled or sometimes prevented with proper care. Unfortunately, many cases of anal warts either fail to respond to treatment or recur. Patients have to undergo roughly six to nine treatments over several months to assure that the warts are completely eradicated.

Recurrence rates have been estimated to be over 50% after one year and may be due to the long incubation of HPV (up to 1.5 years), deep lesions, undetected lesions, virus present in surrounding skin that is not treated.

Prevention

Sexual abstinence and monogamous relationships can be the most effective form of prevention, and condoms may also decrease the chances of transmission of condyloma acuminata. Abstinence from sexual relations with people who have anal or genital warts can prevent infection. Unfortunately, since many people may not be aware that they have this condition, this is not always possible.

KEY TERMS

Electrocoagulation—a technique using electrical energy to destroy the warts. Usually done for warts within the anus with a local anesthesia, electrocoagulation is most painful form of therapy, and can cause both bleeding and discharge from the anus.

Individuals infected with anal warts should have follow-up checkups every few weeks after their initial treatment, after which self-exams can be done.

Sexual partners of people who have anal warts should also be examined, as a precautionary preventive measure.

Finally, 5-flourouracil (Adrucil, Efudex, Fluoroplex) may be useful to prevent recurrence once the warts have been removed. Treatment must, however, be initiated within 1 month of wart removal.

Resources

PERIODICALS

Maw, Raymond, and Geo von Krogh. "The Management of Anal Warts." *British Medical Journal*, no. 321 (October 14, 2000):910-11.

ORGANIZATIONS

Centers for Disease Control and Prevention, Sexually Transmitted Diseases Hotline: (800) 227-8922.

OTHER

<http://www.arthritis-baldness-impotency- obesity.com/medcenter/NF009.html>.
<http://www.emedicine.com>.
<http://wwwmedlineplus.adam.com>.
<http://www.mayohealth.org>.

Liz Meszaros

Analgesics

Definition

Analgesics are medicines that relieve **pain**.

Purpose

Analgesics are those drugs whose primary purpose is pain relief. The primary classes of analgesics are the narcotics, including additional agents that are chemically

based on the morphine molecule but have minimal abuse potential; **nonsteroidal anti-inflammatory drugs** (NSAIDs) including the salicylates; and **acetaminophen**. Other drugs, notably the tricyclic antidepressants and anti-epileptic agents such as gabapentin, have been used to relieve pain, particularly neurologic pain, but are not routinely classified as analgesics. Analgesics provide symptomatic relief, but have no effect on causation, although clearly the NSAIDs, by virtue of their dual activity, may be beneficial in both regards.

Description

Pain has been classified as "productive" pain and "non-productive" pain. While this distinction has no physiologic meaning, it may serve as a guide to treatment. "Productive" pain has been described as a warning of injury, and so may be both an indication of need for treatment and a guide to diagnosis. "Non-productive" pain by definition serves no purpose either as a warning or diagnostic tool.

Although pain syndromes may be dissimilar, the common factor is a sensory pathway from the affected organ to the brain. Analgesics work at the level of the nerves, either by blocking the signal from the peripheral nervous system, or by distorting the interpretation by the central nervous system. Selection of an appropriate analgesic is based on consideration of the risk-benefit factors of each class of drugs, based on type of pain, severity of pain, and risk of adverse effects. Traditionally, pain has been divided into two classes, acute and chronic, although severity and projected patient survival are other factors that must be considered in drug selection.

Acute pain

Acute pain is self limiting in duration, and includes post-operative pain, pain of injury, and **childbirth**. Because pain of these types is expected to be short term, the long-term side effects of analgesic therapy may routinely be ignored. Thus, these patients may safely be treated with narcotic analgesics without concern for their addictive potential, or NSAIDs with only limited concern for their ulcerogenic risks. Drugs and doses should be adjusted based on observation of healing rate, switching patients from high to low doses, and from narcotic analgesics to non-narcotics when circumstances permit.

An important consideration of **pain management** in severe pain is that patients should not be subject to the return of pain. Analgesics should be dosed adequately to assure that the pain is at least tolerable, and frequently enough to avoid the **anxiety** that accompanies the anticipated return of pain. Analgesics should never be dosed on a "prn" (as needed) basis, but should be administered often enough to assure constant blood levels of analgesic. This applies to both the narcotic and non-narcotic analgesics.

Chronic pain

Chronic pain, pain lasting over three months and severe enough to impair function, is more difficult to treat, since the anticipated side effects of the analgesics are more difficult to manage. In the case of narcotic analgesics this means the **addiction** potential, as well as respiratory depression and **constipation**. For the NSAIDs, the risk of gastric ulcers may be dose limiting. While some classes of drugs, such as the narcotic agonist/antagonist drugs bupronophine, nalbuphine and pentazocine, and the selective COX-2 inhibitors celecoxib and rofecoxib represent advances in reduction of adverse effects, they are still not fully suitable for long-term management of severe pain. Generally, chronic pain management requires a combination of drug therapy, life-style modification, and other treatment modalities.

Narcotic analgesics

The narcotic analgesics, also termed opioids, are all derived from opium. The class includes morphine, codeine, and a number of semi-synthetics including meperidine (Demerol), propoxyphen (Darvon) and others. The narcotic analgesics vary in potency, but all are effective in treatment of visceral pain when used in adequate doses. Adverse effects are dose related. Because these drugs are all addictive, they are controlled under federal and state laws. A variety of dosage forms are available, including oral solids, liquids, intravenous and intrathecal injections, and transcutaneous patches.

NSAIDs, non-steroidal anti-inflammatory drugs, are effective analgesics even at doses too low to have any anti-inflammatory effects. There are a number of chemical classes, but all have similar therapeutic effects and side effects. Most are appropriate only for oral administration; however ketorolac (Toradol) is appropriate for injection and may be used in moderate to severe pain for short periods.

Acetaminophen is a non-narcotic analgesic with no anti-inflammatory properties. It is appropriate for mild to moderate pain. Although the drug is well tolerated in normal doses, it may have significant toxicity at high doses. Because acetaminophen is largely free of side effects at therapeutic doses, it has been considered the first choice for mild pain, including that of **osteoarthritis**.

Recommended dosage

Appropriate dosage varies by drug, and should consider the type of pain, as well as other risks associated

KEY TERMS

Acute pain—Pain that is usually temporary and results from something specific, such as a surgery, an injury, or an infection.

Analgesic—Medicine used to relieve pain.

Chronic pain—Pain that lasts more than three months and threatens to disrupt daily life.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Osteoarthritis—Joint pain resulting from damage to the cartilage.

with patient age and condition. For example, narcotic analgesics should usually be avoided in patients with a history of substance abuse, but may be fully appropriate in patients with **cancer** pain. Similarly, because narcotics are more rapidly metabolized in patients who have used these drugs for a long period, higher than normal doses may be needed to provide adequate pain management. NSAIDs, although comparatively safe in adults, represent an increased risk of gastrointestinal bleeding in patients over the age of 60.

Precautions

Narcotic analgesics may be contraindicated in patients with respiratory depression. NSAIDS may be hazardous to patients with ulcers or an ulcer history. They should be used with care in patients with renal insufficiency or **coagulation disorders**. NSAIDs are contraindicated in patients allergic to **aspirin**.

Side effects

Review adverse effects of each drug individually. Drugs within a class may vary in their frequency and severity of adverse effects.

The primary adverse effects of the narcotic analgesics are addiction, constipation, and respiratory depression. Because narcotic analgesics stimulate the production of enzymes that cause the metabolism of these drugs, patients on narcotics for a prolonged period may require increasing doses. This is not the same thing as addiction, and is not a reason for withholding medication from patients in severe pain.

NSAIDs are ulcerogenic and may cause kidney problems. Gastrointestinal discomfort is common, although in some cases, these drugs may cause ulcers without the prior warning of gastrointestinal distress. Platelet aggregation problems may occur, although not to the same extent as if seen with aspirin.

Interactions

Interactions depend on the specific type of analgesic. See specific references.

Samuel Uretsky, PharmD

Analgesics, opioid

Definition

Opioid **analgesics**, also known as narcotic analgesics, are **pain** relievers that act on the central nervous system. Like all narcotics, they may become habit-forming if used over long periods.

Purpose

Opioid analgesics are used to relieve pain from a variety of conditions. Some are used before or during surgery (including dental surgery) both to relieve pain and to make anesthetics work more effectively. They may also be used for the same purposes during labor and delivery.

Description

Opioid analgesics relieve pain by acting directly on the central nervous system. However, this can also lead to unwanted side effects, such as drowsiness, **dizziness**, breathing problems, and physical or mental dependence.

Among the drugs in this category are codeine, propoxyphene (Darvon), propoxyphene and **acetaminophen** (Darvocet N), meperidine (Demerol), hydromorphone (Dilaudid), morphine, oxycodone, oxycodone and acetaminophen (Percocet, Roxicet), and hydrocodone and acetaminophen (Lortab, Anexsia). These drugs come in many forms—tablets, syrups, suppositories, and injections, and are sold only by prescription. For some, a new prescription is required for each new supply—refills are prohibited according to federal regulations.

Recommended dosage

Recommended doses vary, depending on the type of opioid analgesic and the form in which it is being used. Doses may be different for different patients. Check with the physician who prescribed the drug or the pharmacist

Opioid analgesics

Drug	Route of administration	Onset of action (min)	Time to peak effect (min)	Duration of action (h)
Strong agonists				
Fentanyl (Sublimaze)	IM	7–15	20–30	1–2
	IV	1–2	3–5	0.5–1
Hydromorphone (Dilaudid)	Oral	30	90–120	4
	IM	15		
	IV	10–15	30–60	2–3
	Sub-Q	30		15–30
Levorphanol (Levo-Dromoran)	Oral	10–60	90–120	4–5
	IM			
	IV	—	60	4–5
	Sub-Q	10–60	within 20	
Meperidine (Demerol)	Oral	15	60–90	2–4
	IM	10–15		
	IV		30–50	2–4
	Sub-Q	1		
Methadone (Dolophine)	Oral	30–60	90–120	4–6
	IM			
	IV	10–20	60–120	4–5
Morphine (many trade names)	Oral	—	60–120	4–5
	IM	10–30		
	IV		30–60	4–5
	Sub-Q	—		
	Epidural	10–30	20	4–5
Oxymorphone (Numorphan)	IM	10–15	30–90	3–6
	IV			
	Sub-Q	5–10	15–30	3–4
	Rectal			
Mild-to-moderate agonists				
Codiene (many trade names)	Oral	30–40	60–120	4
	Im	10–30	30–60	4
	Sub-Q	10–30		4
Hydrocodone (Hycodan)	Oral	10–30	30–60	4–6
Oxycodone (Percodan)	Oral	—	60	3–4
Propoxyphene (Darvon, Dolene)	Oral	15–60	120	4–6
Butophanol (Stadol)	IM	10–30	30–60	3–4
	IV	2–3	30	2–4
Nalbuphine (Nubian)	IM	within 15	60	3–6
	IV	2–3	30	3–4
	Sub-Q	within 15	—	3–6
Pentazocine (Talwin)	Oral	15–30	60–90	3
	IM	15–20	30–60	2–3
	IV	2–3	15–30	2–3
	Sub-Q	15–20	30–60	2–3

who filled the prescription for correct dosages, and make sure to understand how to take the drug.

Always take opioid analgesics exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. Do not stop taking the drug suddenly without checking with the physician or dentist who prescribed it. Gradually tapering the dose may the chance of withdrawal symptoms.

Precautions

Anyone who uses opioid analgesics—or any narcotic—over a long time may become physically or mentally dependent on the drug. Physical dependence may lead to withdrawal symptoms when the person stops taking the medicine. Building tolerance to these drugs is also possible when they are used for a long period. Over time, the body needs larger and larger doses to relieve pain.

Take these drugs exactly as directed. Never take more than the recommended dose, and do not take the drugs more often than directed. If the drugs do not seem to be working, consult your physician. Do not share these or any other prescription drugs with others because the drug may have a completely different effect on the person for whom it was not prescribed.

Children and older people are especially sensitive to opioid analgesics and may have serious breathing prob-

lems after taking them. Children may also become unusually restless or agitated when given these drugs.

Opioid analgesics increase the effects of alcohol. Anyone taking these drugs should not drink alcoholic beverages.

Some of these drugs may also contain **aspirin**, **caffeine**, or acetaminophen. Refer to the entries on each of these drugs for additional precautions.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take opioid analgesics. Before taking these drugs, be sure to let the physician know about any of these conditions.

ALLERGIES. Let the physician know about any **allergies** to foods, dyes, preservatives, or other substances and about any previous reactions to opioid analgesics.

PREGNANCY. Women who are pregnant or plan to become pregnant while taking opioid analgesics should let their physicians know. No evidence exists that these drugs cause **birth defects** in people, but some do cause birth defects and other problems when given to pregnant animals in experiments. Babies can become dependent on opioid analgesics if their mothers use too much during **pregnancy**. This can cause the baby to go through withdrawal symptoms after birth. If taken just before delivery, some opioid analgesics may cause serious breathing problems in the newborn.

BREAST FEEDING. Some opioid analgesics can pass into breast milk. Women who are breast feeding should check with their physicians about the safety of taking these drugs.

OTHER MEDICAL CONDITIONS. These conditions may influence the effects of opioid analgesics:

- head injury. The effects of some opioid analgesics may be stronger and may interfere with recovery in people with head injuries.
- history of convulsions. Some of these drugs may trigger convulsions.
- asthma, **emphysema**, or any chronic lung disease
- heart disease
- kidney disease
- liver disease
- underactive thyroid. The chance of side effects may be greater.
- addison's disease (a disease of the adrenal glands)
- colitis
- gallbladder disease or **gallstones**. Side effects can be dangerous in people with these conditions.
- enlarged prostate or other urinary problems
- current or past alcohol abuse
- current or past drug abuse, especially narcotic abuse
- current or past emotional problems. The chance of side effects may be greater.

USE OF CERTAIN MEDICINES. Taking opioid narcotics with certain other drugs may increase the chances of serious side effects.

Side effects

Some people experience drowsiness, dizziness, lightheadedness, or a false sense of well-being after taking opioid analgesics. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they know how the drug affects them. **Nausea and vomiting** are common side effects, especially when first beginning to take the medicine. If these symptoms do not go away after the first few doses, check with the physician or dentist who prescribed the medicine.

Dry mouth is another common side effect. Dry mouth can be relieved by sucking on sugarless hard candy or ice chips or by chewing sugarless gum. Saliva substitutes, which come in liquid or tablet forms, also may help. Patients who must use opioid analgesics over long periods and who have dry mouth should see their dentists, as the problem can lead to **tooth decay** and other dental problems.

The following side effects are less common. They usually do not need medical attention and will go away after the first few doses. If they continue or interfere with normal activity, check with the physician who prescribed the medicine.

- headache
- loss of appetite
- restlessness or nervousness
- nightmares, unusual dreams, or problems sleeping
- weakness or tiredness
- mental sluggishness
- stomach pain or cramps
- blurred or double vision or other vision problems
- problems urinating, such as pain, difficulty urinating, frequent urge to urinate, or decreased amount of urine
- constipation.

Other side effects may be more serious and may require quick medical attention. These symptoms could

be signs of an overdose. Get emergency medical care immediately.

- cold, clammy skin
- bluish discoloration of the skin
- extremely small pupils
- serious difficulty breathing or extremely slow breathing
- extreme sleepiness or unresponsiveness
- severe weakness
- confusion
- severe dizziness
- severe drowsiness
- slow heartbeat
- low blood pressure
- severe nervousness or restlessness

In addition, these less common side effects do not require emergency medical care, but should have medical attention as soon as possible:

- **hallucinations** or a sense of unreality
- depression or other mood changes
- ringing or buzzing in the ears
- pounding or unusually fast heartbeat
- itching, **hives**, or rash
- facial swelling
- trembling or twitching
- dark urine, pale stools, or yellow eyes or skin (after taking propoxyphene)
- increased sweating, red or flushed face (more common after taking hydrocodone and meperidine)

Interactions

Anyone taking these drugs should notify his or her physician before taking opioid analgesics:

- Central nervous system (CNS) depressants, such as **antihistamines** and other medicines for allergies, hay **fever**, or colds; tranquilizers; some other prescription pain relievers; seizure medicines; **muscle relaxants**; sleeping pills; some anesthetics (including dental anesthetics).
- Monoamine oxidase (MAO) inhibitors, such as phenelzine (Nardil) and tranylcypromine (Parnate). The combination of the opioid analgesic meperidine (Demerol) and MAO inhibitors is especially dangerous.
- Tricyclic antidepressants, such as amitriptyline (Elavil).
- Anti-seizure medicines, such as carbamazepine (Tegretol). May lead to serious side effects, including **coma**, when combined with propoxyphene and acetaminophen (Darvocet-N) or propoxyphene (Darvon).

KEY TERMS

Analgesic—Medicine used to relieve pain.

Central nervous system—The brain, spinal cord and nerves throughout the body.

Colitis—Inflammation of the colon (large bowel)

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Narcotic—A drug derived from opium or compounds similar to opium. Such drugs are potent pain relievers and can affect mood and behavior. Long-term use of narcotics can lead to dependence and tolerance.

Tolerance—A decrease in sensitivity to a drug. When tolerance occurs, a person must take more and more of the drug to get the same effect.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

- Muscle relaxants, such as cyclobenzaprine (Flexeril).
- Sleeping pills, such as triazolam (Halcion).
- Blood-thinning drugs, such as warfarin (Coumadin).
- Naltrexone (Trexan, Revia). Cancels the effects of opioid analgesics.
- Rifampin (Rifadin).
- Zidovudine (AZT, Retrovir). Serious side effects when combined with morphine.

Nancy Ross-Flanigan

Anaphylactic shock *see* **Anaphylaxis**

Anaphylactoid purpura *see* **Allergic purpura**

Anaphylaxis

Definition

Anaphylaxis is a rapidly progressing, life-threatening allergic reaction.

Description

Anaphylaxis is a type of allergic reaction, in which the immune system responds to otherwise harmless substances from the environment. Unlike other allergic reactions, however, anaphylaxis can kill. Reaction may begin within minutes or even seconds of exposure, and rapidly progress to cause airway constriction, skin and intestinal irritation, and altered heart rhythms. In severe cases, it can result in complete airway obstruction, **shock**, and **death**.

Causes and symptoms

Causes

Like the majority of other allergic reactions, anaphylaxis is caused by the release of histamine and other chemicals from mast cells. Mast cells are a type of white blood cell and they are found in large numbers in the tissues that regulate exchange with the environment: the airways, digestive system, and skin.

On their surfaces, mast cells display antibodies called IgE (immunoglobulin type E). These antibodies are designed to detect environmental substances to which the immune system is sensitive. Substances from a genuinely threatening source, such as bacteria or viruses, are called antigens. A substance that most people tolerate well, but to which others have an allergic response, is called an allergen. When IgE antibodies bind with allergens, they cause the mast cell to release histamine and other chemicals, which spill out onto neighboring cells.

The interaction of these chemicals with receptors on the surface of blood vessels causes the vessels to leak fluid into surrounding tissues, causing fluid accumulation, redness, and swelling. On the smooth muscle cells of the airways and digestive system, they cause constriction. On nerve endings, they increase sensitivity and cause **itching**.

In anaphylaxis, the dramatic response is due both to extreme hypersensivity to the allergen and its usually systemic distribution. Allergens are more likely to cause anaphylaxis if they are introduced directly into the circulatory system by injection. However, exposure by ingestion, inhalation, or skin contact can also cause anaphylaxis. In some cases, anaphylaxis may develop over time from less severe **allergies**.

Anaphylaxis is most often due to allergens in foods, drugs, and insect venom. Specific causes include:

- fish, shellfish, and mollusks
- nuts and seeds
- stings of bees, wasps, or hornets
- papain from meat tenderizers
- vaccines, including flu and **measles** vaccines
- penicillin
- cephalosporins
- streptomycin
- gamma globulin
- insulin
- hormones (ACTH, thyroid-stimulating hormone)
- **aspirin** and other NSAIDs
- latex, from exam gloves or condoms, for example

Exposure to cold or **exercise** can trigger anaphylaxis in some individuals.

Symptoms

Symptoms may include:

- urticaria (**hives**)
- swelling and irritation of the tongue or mouth
- swelling of the sinuses
- difficulty breathing
- wheezing
- cramping, vomiting, or **diarrhea**
- anxiety or confusion
- strong, very rapid heartbeat (**palpitations**)
- loss of consciousness

Not all symptoms may be present.

Diagnosis

Anaphylaxis is diagnosed based on the rapid development of symptoms in response to a suspect allergen. Identification of the culprit may be done with RAST testing, a blood test that identifies IgE reactions to specific allergens. Skin testing may be done for less severe anaphylactic reactions.

Treatment

Emergency treatment of anaphylaxis involves injection of adrenaline (epinephrine) which constricts blood vessels and counteracts the effects of histamine. Oxygen may be given, as well as intravenous replacement fluids. **Antihistamines** may be used for skin rash, and aminophylline for bronchial constriction. If the upper airway is obstructed, placement of a breathing tube or tracheostomy tube may be needed.

KEY TERMS

ACTH—Adrenocorticotropic hormone, a hormone normally produced by the pituitary gland, sometimes taken as a treatment for arthritis and other disorders.

Antibody—An immune system protein which binds to a substance from the environment.

NSAIDs—Non-steroidal antiinflammatory drugs, including aspirin and ibuprofen.

Tracheostomy tube—A tube which is inserted into an incision in the trachea (tracheostomy) to relieve upper airway obstruction.

Prognosis

The rapidity of symptom development is an indication of the likely severity of reaction: the faster symptoms develop, the more severe the ultimate reaction. Prompt emergency medical attention and close monitoring reduces the likelihood of death. Nonetheless, death is possible from severe anaphylaxis. For most people who receive rapid treatment, recovery is complete.

Prevention

Avoidance of the allergic trigger is the only reliable method of preventing anaphylaxis. For insect allergies, this requires recognizing likely nest sites. Preventing food allergies requires knowledge of the prepared foods or dishes in which the allergen is likely to occur, and careful questioning about ingredients when dining out. Use of a Medic-Alert tag detailing drug allergies is vital to prevent inadvertent administration during a medical emergency.

People prone to anaphylaxis should carry an "Epipen" or "Ana-kit," which contain an adrenaline dose ready for injection.

Resources

BOOKS

Holgate, Stephen T., and Martin K. Church. *Allergy.* New York: Gower Medical Publishing, 1993.

Lawlor Jr., G. J., T. J. Fischer, and D. C. Adelman. *Manual of Allergy and Immunology.* Boston: Little, Brown and Co., 1995.

Novick, N. L. *You Can Do Something About Your Allergies.* New York: Macmillan, 1994.

OTHER

The Merck Page. 20 Feb. 1998. <http://www.merck.com>.

Richard Robinson

Anemias

Definition

Anemia is a condition characterized by abnormally low levels of healthy red blood cells or hemoglobin (the component of red blood cells that delivers oxygen to tissues throughout the body).

Description

The tissues of the human body need a regular supply of oxygen to stay healthy. Red blood cells, which contain hemoglobin that allows them to deliver oxygen throughout the body, live for only about 120 days. When they die, the iron they contain is returned to the bone marrow and used to create new red blood cells. Anemia develops when heavy bleeding causes significant iron loss or when something happens to slow down the production of red blood cells or to increase the rate at which they are destroyed.

Types of anemia

Anemia can be mild, moderate, or severe enough to lead to life-threatening complications. More than 400 different types of anemia have been identified. Many of them are rare.

IRON DEFICIENCY ANEMIA. Iron deficiency anemia is the most common form of anemia in the world. In the United States, iron deficiency anemia affects about 240,000 toddlers between one and two years of age and 3.3 million women of childbearing age. This condition is less common in older children and in adults over 50 and rarely occurs in teenage boys and young men.

The onset of iron deficiency anemia is gradual and, at first, there may not be any symptoms. The deficiency begins when the body loses more iron than it derives from food and other sources. Because depleted iron stores cannot meet the red blood cell's needs, fewer red blood cells develop. In this early stage of anemia, the red blood cells look normal, but they are reduced in number. Then the body tries to compensate for the iron deficiency by producing more red blood cells, which are characteristically small in size. Symptoms develop at this stage.

FOLIC ACID DEFICIENCY ANEMIA. Folic acid deficiency anemia is the most common type of megaloblastic anemia (in which red blood cells are bigger than normal). It is caused by a deficiency of **folic acid**, a vitamin that the body needs to produce normal cells.

Folic acid anemia is especially common in infants and teenagers. Although this condition usually results from a dietary deficiency, it is sometimes due to inability to absorb enough folic acid from such foods as:

• cheese

• eggs

• fish

• green vegetables

• meat

• milk

• mushrooms

• yeast

Smoking raises the risk of developing this condition by interfering with the absorption of Vitamin C, which the body needs to absorb folic acid. Folic acid anemia can be a complication of **pregnancy**, when a woman's body needs eight times more folic acid than it does otherwise.

VITAMIN B_{12} DEFICIENCY ANEMIA. Less common in this country than folic acid anemia, vitamin B_{12} deficiency anemia is another type of megaloblastic anemia that develops when the body doesn't absorb enough of this nutrient. Necessary for the creation of red blood cells, B_{12} is found in meat and vegetables.

Large amounts of B_{12} are stored in the body, so this condition may not become apparent until as much as four years after B_{12} absorption stops or slows down. The resulting drop in red blood cell production can cause:

• loss of muscle control

• loss of sensation in the legs, hands, and feet

• soreness or burning of the tongue

• weight loss

• yellow-blue color blindness

The most common form of B_{12} deficiency is **pernicious anemia**. Since most people who eat meat or eggs get enough B_{12} in their **diets**, a deficiency of this vitamin usually means that the body is not absorbing it properly. This can occur among people who have had intestinal surgery or among those who do not produce adequate amounts of intrinsic factor, a chemical secreted by the stomach lining that combines with B_{12} to help its absorption in the small intestine.

Pernicious anemia usually strikes between the ages of 50–60. Eating disorders or an unbalanced diet increases the risk of developing pernicious anemia. So do:

• diabetes mellitus

• **gastritis**, **stomach cancer**, or stomach surgery

• thyroid disease

• family history of pernicious anemia

VITAMIN C DEFICIENCY ANEMIA. A rare disorder that causes the bone marrow to manufacture abnormally small red blood cells, Vitamin C deficiency anemia results from a severe, long-standing dietary deficiency.

HEMOLYTIC ANEMIA. Some people are born with **hemolytic anemia**. Some acquire this condition, in which infection or antibodies destroy red blood cells more rapidly than bone marrow can replace them.

Hemolytic anemia can enlarge the spleen, accelerating the destruction of red blood cells (hemolysis). Other complications of hemolytic anemia include:

• **pain**

• shock

• gallstones and other serious health problems

THALASSEMIAS. An inherited form of hemolytic anemia, **thalassemia** stems from the body's inability to manufacture as much normal hemoglobin as it needs. There are two categories of thalassemia, depending on which of the amino acid chains is affected. (Hemoglobin is composed of four chains of amino acids.) In alpha-thalassemia, there is an imbalance in the production of the alpha chain of amino acids; in beta-thalassemia, there is an imbalance in the beta chain. Alpha-thalassemias most commonly affect blacks (25% have at least one gene); beta-thalassemias most commonly affect people of Mediterranean ancestry and Southeast Asians.

Characterized by production of red blood cells that are unusually small and fragile, thalassemia only affects people who inherit the gene for it from each parent (autosomal recessive inheritance).

AUTOIMMUNE HEMOLYTIC ANEMIAS. Warm antibody hemolytic anemia is the most common type of this disorder. This condition occurs when the body produces autoantibodies that coat red blood cells. The coated cells are destroyed by the spleen, liver, or bone marrow.

Warm antibody hemolytic anemia is more common in women than in men. About one-third of patients who have warm antibody hemolytic anemia also have lymphoma, leukemia, lupus, or connective tissue disease.

In cold antibody hemolytic anemia, the body attacks red blood cells at or below normal body temperature. The acute form of this condition frequently develops in people who have had **pneumonia**, mononeucleosis, or other acute infections. It tends to be mild and short-lived, and disappears without treatment.

Chronic cold antibody hemolytic anemia is most common in women and most often affects those who are over 40 and who have arthritis. This condition usually lasts for a lifetime, generally causing few symptoms. However, exposure to cold temperatures can accelerate

red blood cell destruction, causing **fatigue**, joint aches, and discoloration of the arms and hands.

SICKLE CELL ANEMIA. Sickle cell anemia is a chronic, incurable condition that causes the body to produce defective hemoglobin, which forces red blood cells to assume an abnormal crescent shape. Unlike normal oval cells, fragile sickle cells can't hold enough hemoglobin to nourish body tissues. The deformed shape makes it hard for sickle cells to pass through narrow blood vessels. When capillaries become obstructed, a life-threatening condition called sickle cell crisis is likely to occur.

Sickle cell anemia is hereditary. It almost always affects blacks and people of Mediterranean descent. A child who inherits the sickle cell gene from each parent will have the disease. A child who inherits the sickle cell gene from only one parent carries the sickle cell trait, but does not have the disease.

APLASTIC ANEMIA. Sometimes curable by bone marrow transplant, but potentially fatal, **aplastic anemia** is characterized by decreased production of red and white blood cells and platelets (disc-shaped cells that allow the blood to clot). This disorder may be inherited or acquired as a result of:

- recent severe illness
- long-term exposure to industrial chemicals
- use of **anticancer drugs** and certain other medications

ANEMIA OF CHRONIC DISEASE. **Cancer**, chronic infection or inflammation, and kidney and liver disease often cause mild or moderate anemia. Chronic liver failure generally produces the most severe symptoms.

Causes and symptoms

Anemia is caused by bleeding, decreased red blood cell production, or increased red blood cell destruction. Poor diet can contribute to vitamin deficiency and iron deficiency anemias in which fewer red blood cells are produced. Hereditary disorders and certain diseases can cause increased blood cell destruction. However, excessive bleeding is the most common cause of anemia, and the speed with which blood loss occurs has a significant effect on the severity of symptoms. Chronic blood loss is usually a consequence of:

- cancer
- gastrointestinal tumors
- diverticulosis
- polyposis
- heavy menstrual flow
- hemorrhoids
- nosebleeds
- stomach ulcers
- long-standing alcohol abuse

Acute blood loss is usually the result of:

- childbirth
- injury
- a ruptured blood vessel
- surgery

When a lot of blood is lost within a short time, blood pressure and the amount of oxygen in the body drop suddenly. **Heart failure** and **death** can follow.

Loss of even one-third of the body's blood volume in the space of several hours can be fatal. More gradual blood loss is less serious, because the body has time to create new red blood cells to replace those that have been lost.

Symptoms

Weakness, fatigue, and a run-down feeling may be signs of mild anemia. Skin that is pasty or sallow, or lack of color in the creases of the palm, gums, nail beds, or lining of the eyelids are other signs of anemia. Someone who is weak, tires easily, is often out of breath, and feels faint or dizzy may be severely anemic.

Other symptoms of anemia are:

- angina pectoris (chest pain, often accompanied by a **choking** sensation that provokes severe **anxiety**)
- cravings for ice, paint, or dirt
- headache
- inability to concentrate, memory loss
- inflammation of the mouth (**stomatitis**) or tongue (glossitis)
- insomnia
- irregular heartbeat
- loss of appetite
- nails that are dry, brittle, or ridged
- rapid breathing
- sores in the mouth, throat, or rectum
- sweating
- swelling of the hands and feet
- thirst
- tinnitus (ringing in the ears)
- unexplained bleeding or bruising

In pernicious anemia, the tongue feels unusually slick. A patient with pernicious anemia may have:

• problems with movement or balance

• tingling in the hands and feet

• confusion, depression, and memory loss

Pernicious anemia can damage the spinal cord. A doctor should be notified whenever symptoms of this condition occur.

A doctor should also be notified if a patient who has been taking iron supplements develops:

• diarrhea

• cramps

• vomiting

Diagnosis

Personal and family health history may suggest the presence of certain types of anemia. Laboratory tests that measure the percentage of red blood cells or the amount of hemoglobin in the blood are used to confirm diagnosis and determine which type of anemia is responsible for a patient's symptoms. X rays and examinations of bone marrow may be used to identify the source of bleeding.

Treatment

Anemia due to nutritional deficiencies can usually be treated at home with iron supplements or self administered injections of vitamin B_{12}. People with folic acid anemia should take oral folic acid replacements. Vitamin C deficiency anemia can be cured by taking one vitamin C tablet a day.

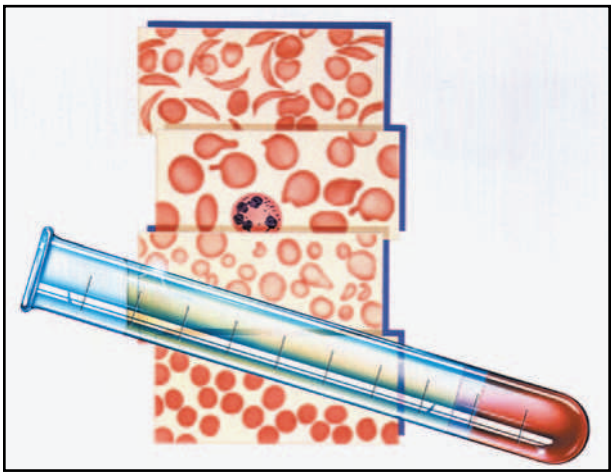
Surgery may be necessary to treat anemia caused by excessive loss of blood. Transfusions of red blood cells may be used to accelerate production of red blood cells.

Medication or surgery may also be necessary to control heavy menstrual flow, repair a bleeding ulcer, or remove polyps (growths or nodules) from the bowels.

Patients with thalassemia usually do not require treatment. However people with a severe form may require periodic hospitalization for blood transfusions and/or **bone marrow transplantation**.

SICKLE CELL ANEMIA. Treatment for sickle cell anemia involves regular eye examinations, immunizations for pneumonia and infectious diseases, and prompt treatment for sickle cell crises and infections of any kind. Psychotherapy or counseling may help patients deal with the emotional impact of this condition.

VITAMIN B_{12} DEFICIENCY ANEMIA. A life-long regimen of B_{12} shots is necessary to control symptoms of pernicious anemia. The patient may be advised to limit physical activity until treatment restores strength and balance.



An illustration of normal red blood cells (left) and those in three different types of anemia (from left), iron-deficiency anemia, megaloblastic anemia, and sickle cell anemia. *(Illustration by John Bavosi, Custom Medical Stock Photo. Reproduced by permission.)*

APLASTIC ANEMIA. People who have aplastic anemia are especially susceptible to infection. Treatment for aplastic anemia may involve blood transfusions and bone marrow transplant to replace malfunctioning cells with healthy ones.

ANEMIA OF CHRONIC DISEASE. There is no specific treatment for anemia associated with chronic disease, but treating the underlying illness may alleviate this condition. This type of anemia rarely becomes severe. If it does, transfusions or hormone treatments to stimulate red blood cell production may be prescribed.

HEMOLYTIC ANEMIA. There is no specific treatment for cold-antibody hemolytic anemia. About one-third of patients with warm-antibody hemolytic anemia respond well to large doses of intravenous and oral **corticosteroids**, which are gradually discontinued as the patient's condition improves. Patients with this condition who don't respond to medical therapy must have the spleen surgically removed. This operation controls anemia in about half of the patients on whom it's performed. Immune-system suppressants are prescribed for patients whose surgery is not successful.

Self-care

Anyone who has anemia caused by poor **nutrition** should modify his or her diet to include more **vitamins**, **minerals**, and iron. Vitamin C can stimulate iron absorption. The following foods are also good sources of iron:

• almonds

• broccoli

- dried beans
- dried fruits
- enriched breads and cereals
- lean red meat
- liver
- potatoes
- poultry
- rice
- shellfish
- tomatoes

Because light and heat destroy folic acid, fruits and vegetables should be eaten raw or cooked as little as possible.

Alternative treatment

As is the case in standard medical treatment, the cause of the specific anemia will determine the alternative treatment recommended. If the cause is a deficiency, for example iron deficiency, folic acid deficiency, B_{12} deficiency, or vitamin C deficiency, supplementation is the treatment. For extensive blood loss, the cause should be identified and corrected. Other types of anemias should be addressed on a deep healing level with crisis intervention when necessary.

Many alternative therapies for iron-deficiency anemia focus on adding iron-rich foods to the diet or on techniques to improve circulation and digestion. Iron supplementation, especially with iron citrate (less likely to cause **constipation**), is used by alternative practitioners. This can be given in combination with herbs that are rich in iron. Some examples of iron-rich herbs are dandelion (*Taraxacum officinale*), parsley (*Petroselinum crispum*), and nettle (*Urtica dioica*). The homeopathic remedy ferrum phosphoricum can also be helpful.

An iron-rich herbal tonic can also me made using the following recipe:

- soak 1/2 oz of yellow dock root and 1/2 oz dandelion root in 1 qt of boiled water for four to 8 hours
- strain and simmer until the amount of liquid is reduced to 1 cup
- remove from heat and add 1/2 cup black strap molasses, mixing well
- store in refrigerator; take 1 tsp-2 Tbsp daily

Other herbal remedies used to treat iron-deficiency anemia aim to improve the digestion. Gentian (*Gentiana lutea*) is widely used in Europe to treat anemia and other nutritionally based disorders. The bitter qualities of gentian help stimulate the digestive system, making iron and other nutrients more available for absorption. This bitter herb can be brewed into tea or purchased as an alcoholic extract (tincture).

Other herbs recommended to promote digestion include:

- anise (*Pimpinella anisum*)
- caraway (*Carum carvi*)
- cumin (*Cuminum cyminum*)
- linden (*Tilia* spp.)
- licorice (*Glycyrrhiza glabra*)

Traditional Chinese treatments for anemia include:

- acupuncture to stimulate a weakened spleen
- asian ginseng (*Panax ginseng*) to restore energy
- dong quai (*Angelica sinensis*) to control heavy menstrual bleeding
- a mixture of dong quai and Chinese foxglove(*Rehmannia glutinosa*) to clear a sallow complexion

Prognosis

Folic-acid and iron-deficiency anemias

It usually takes three to six weeks to correct folic acid or iron deficiency anemia. Patients should continue taking supplements for another six months to replenish iron reserves and should have periodic blood tests to make sure the bleeding has stopped and the anemia has not recurred.

Pernicious anemia

Although pernicious anemia is considered incurable, regular B_{12} shots will alleviate symptoms and reverse complications. Some symptoms will disappear almost as soon as treatment begins.

Aplastic anemia

Aplastic anemia can sometimes be cured by bone marrow transplantation. If the condition is due to immunosuppressive drugs, symptoms may disappear after the drugs are discontinued.

Sickle cell anemia

Although sickle cell anemia cannot be cured, effective treatments enable patients with this disease to enjoy longer, more productive lives.

Thalassemia

People with mild thalassemia (alpha thalassemia trait or beta thalassemia minor) lead normal lives and do

KEY TERMS

Aplastic—Exhibiting incomplete or faulty development.

Diabetes mellitus—A disorder of carbohydrate metabolism brought on by a combination of hereditary and enviornmental factors.

Hemoglobin—An iron-containing pigment of red blood cells composed of four amino acid chains (alpha, beta, gamma, delta) that delivers oxygen from the lungs to the tissues of the body.

Megaloblast—A large erythroblast (a red marrow cell that synthesizes hemoglobin).

not require treatment. Those with severe thalassemia may require bone marrow transplantation. Genetic therapy is is being investigated and may soon be available.

Hemolytic anemia

Acquired hemolytic anemia can generally be cured when the cause is removed.

Prevention

Inherited anemias cannot be prevented. **Genetic counseling** can help parents cope with questions and concerns about transmitting disease-causing genes to their children.

Avoiding excessive use of alcohol, eating a balanced diet that contains plenty of iron-rich foods, and taking a daily multivitamin can help prevent anemia.

Methods of preventing specific types of anemia include:

- avoiding lengthy exposure to industrial chemicals and drugs known to cause aplastic anemia
- not taking medication that has triggered hemolytic anemia and not eating foods that have caused hemolysis (breakdown of red blood cells)
- receiving regular B_{12} shots to prevent pernicious anemia resulting from gastritis or stomach surgery

Resources

BOOKS

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck & Co., Inc., 1997.

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

OTHER

"Aplastic Anemia." ThriveOnline. 2 June 1998 <http://thriveonline.oxygen.com>.

"Folic Acid Deficiency Anemia." ThriveOnline. 2 June 1998 <http://thriveonline.oxygen.com>.

"Hemolytic Anemia." ThriveOnline. 2 June 1998 <http://thriveonline.oxygen.com>.

"Iron Deficiency Anemia." ThriveOnline. 2 June 1998 <http://thriveonline.oxygen.com>.

"Pernicious Anemia." ThriveOnline. 3 June 1998 <http://thriveonline.oxygen.com>.

"Prevalence of Iron Deficiency in the United States." ThriveOnline. 2 June 1998 <http://thriveonline.oxygen.com>.

"Sickle Cell Anemia & Sickle Cell Trait." ThriveOnline. 2 June 1995 <http://thriveonline.oxygen.com>.

"Thalassemia." ThriveOnline. 2 June 1998 <http://thriveonline.oxygen.com>.

Maureen Haggerty

Anencephaly *see* **Congenital brain defects**

Anesthesia, general

Definition

General anesthesia is the induction of a state of unconsciousness with the absence of **pain** sensation over the entire body, through the administration of anesthetic drugs. It is used during certain medical and surgical procedures.

Purpose

General anesthesia has many purposes including:

- pain relief (analgesia)
- blocking memory of the procedure (**amnesia**)
- producing unconsciousness
- inhibiting normal body reflexes to make surgery safe and easier to perform
- relaxing the muscles of the body

Description

Anesthesia performed with general anesthetics occurs in four stages which may or may not be observable because they can occur very rapidly:

- Stage One: Analgesia. The patient experiences analgesia or a loss of pain sensation but remains conscious and can carry on a conversation.
- Stage Two: Excitement. The patient may experience **delirium** or become violent. Blood pressure rises and becomes irregular, and breathing rate increases. This stage is typically bypassed by administering a barbiturate, such as sodium pentothal, before the anesthesia.
- Stage Three: Surgical Anesthesia. During this stage, the skeletal muscles relax, and the patient's breathing becomes regular. Eye movements slow, then stop, and surgery can begin.
- Stage Four: Medullary **Paralysis**. This stage occurs if the respiratory centers in the medulla oblongata of the brain that control breathing and other vital functions cease to function. **Death** can result if the patient cannot be revived quickly. This stage should never be reached. Careful control of the amounts of anesthetics administered prevent this occurrence.

Agents used for general anesthesia may be either gases or volatile liquids that are vaporized and inhaled with oxygen, or drugs delivered intravenously. A combination of inhaled anesthetic gases and intravenous drugs are usually delivered during general anesthesia; this practice is called balanced anesthesia and is used because it takes advantage of the beneficial effects of each anesthetic agent to reach surgical anesthesia. If necessary, the extent of the anesthesia produced by inhaling a general anesthetic can be rapidly modified by adjusting the concentration of the anesthetic in the oxygen that is breathed by the patient. The degree of anesthesia produced by an intravenously injected anesthesic is fixed and cannot be changed as rapidly. Most commonly, intravenous anesthetic agents are used for induction of anesthesia and then followed by inhaled anesthetic agents.

General anesthesia works by altering the flow of sodium molecules into nerve cells (neurons) through the cell membrane. Exactly how the anesthetic does this is not understood since the drug apparently does not bind to any receptor on the cell surface and does not seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. It is known, however, that when the sodium molecules do not get into the neurons, nerve impulses are not generated and the brain becomes unconscious, does not store memories, does not register pain impulses from other areas of the body, and does not control involuntary reflexes. Although anesthesia may feel like deep sleep, it is not the same. In sleep, some parts of the brain speed up while others slow down. Under anesthesia, the loss of consciousness is more widespread.

When general anesthesia was first introduced in medical practice, ether and chloroform were inhaled with the physician manually covering the patient's mouth. Since then, general anesthesia has become much more sophisticated. During most surgical procedures, anesthetic agents are now delivered and controlled by computerized equipment that includes anesthetic gas monitoring as well as patient monitoring equipment. Anesthesiologists are the physicians that specialize in the delivery of anesthetic agents. Currently used inhaled general anesthetics include halothane, enflurane, isoflurane, desfluorane, sevofluorane, and nitrous oxide.

- Halothane (Fluothane) is a powerful anesthetic and can easily be overadministered. This drug causes unconsciousness but little pain relief so it is often used with other agents to control pain. Very rarely, it can be toxic to the liver in adults, causing death. It also has the potential for causing serious cardiac dysrhythmias. Halothane has a pleasant odor, and was frequently the anesthetic of choice for use with children, but since the introduction of sevofluorane in the 1990s, halothane use has declined.
- Enflurane (Ethrane) is less potent and results in a more rapid onset of anesthesia and faster awakening than halothane. In addition, it acts as an enhancer of paralyzing agents. Enflurane has been found to increase intracranial pressure and the risk of seizures; therefore, its use is contraindicated in patients with seizure disorders.
- Isoflurane (Forane) is not toxic to the liver but can cause some cardiac irregularities. Isofluorane is often used in combination with intravenous anesthetics for anesthesia induction. Awakening from anesthesia is faster than it is with halothane and enfluorane.
- Desfluorane (Suprane) may increase the heart rate and should not be used in patients with **aortic valve stenosis**; however, it does not usually cause heart **arrhythmias**. Desflurane may cause coughing and excitation during induction and is therefore used with intravenous anesthetics for induction. Desflurane is rapidly eliminated and awakening is therefore faster than with other inhaled agents.
- Sevofluorane (Ultane) may also cause increased heart rate and should not be used in patients with narrowed aortic valve (stenosis); however, it does not usually cause heart arrhythmias. Unlike desfluorane, sevofluorane does not cause any coughing or other related side effects, and can therefore be used without intravenous agents for rapid induction. For this reason, sevofluorane is replacing halothane for induction in pediatric patients. Like desfluorane, this agent is rapidly eliminated and allows rapid awakening.

- Nitrous oxide (laughing gas) is a weak anesthetic and is used with other agents, such as thiopental, to produce surgical anesthesia. It has the fastest induction and recovery and is the safest because it does not slow breathing or blood flow to the brain. However, it diffuses rapidly into air-containing cavities and can result in a collapsed lung (**pneumothorax**) or lower the oxygen contents of tissues (hypoxia).

Commonly administered intravenous anesthetic agents include ketamine, thiopental, opioids, and propofol.

- Ketamine (Ketalar) affects the senses, and produces a dissociative anesthesia (**catatonia**, amnesia, analgesia) in which the patient may appear awake and reactive, but cannot respond to sensory stimuli. These properties make it especially useful for use in developing countries and during warfare medical treatment. Ketamine is frequently used in pediatric patients because anesthesia and analgesia can be achieved with an intramuscular injection. It is also used in high-risk geriatric patients and in **shock** cases, because it also provides cardiac stimulation.
- Thiopental (Pentothal) is a barbiturate that induces a rapid hypnotic state of short duration. Because thiopental is slowly metabolized by the liver, toxic accumulation can occur; therefore, it should not be continuously infused. Side effects include **nausea and vomiting** upon awakening.
- Opioids include fentanyl, sufentanil, and alfentanil, and are frequently used prior to anesthesia and surgery as a sedative and analgesic, as well as a continuous infusion for primary anesthesia. Because opioids rarely affect the cardiovascular system, they are particularly useful for cardiac surgery and other high-risk cases. Opioids act directly on spinal cord receptors, and are freqently used in epidurals for spinal anesthesia. Side effects may include nausea and vomiting, **itching**, and respiratory depression.
- Propofol (Diprivan) is a nonbarbiturate hypnotic agent and the most recently developed intravenous anesthetic. Its rapid induction and short duration of action are identical to thiopental, but recovery occurs more quickly and with much less nausea and vomiting. Also, propofol is rapidly metabolized in the liver and excreted in the urine, so it can be used for long durations of anesthesia, unlike thiopental. Hence, propofol is rapidly replacing thiopental as an intravenous induction agent. It is used for **general surgery**, cardiac surgery, neurosurgery, and pediatric surgery.

General anesthetics are given only by anesthesiologists, the medical professionals trained to use them. These specialists consider many factors, including a patient's age, weight, medication **allergies**, medical history, and general health, when deciding which anesthetic or combination of anesthetics to use. General anesthetics are usually inhaled through a mask or a breathing tube or injected into a vein, but are also sometimes given rectally.

General anesthesia is much safer today than it was in the past. This progress is due to faster-acting anesthetics, improved safety standards in the equipment used to deliver the drugs, and better devices to monitor breathing, heart rate, blood pressure, and brain activity during surgery. Unpleasant side effects are also less common.

Recommended dosage

The dosage depends on the type of anesthetic, the patient's age and physical condition, the type of surgery or medical procedure being done, and other medication the patient takes before, during, or after surgery.

Precautions

Although the risks of serious complications from general anesthesia are very low, they can include **heart attack**, **stroke**, brain damage, and death. Anyone scheduled to undergo general anesthesia should thoroughly discuss the benefits and risks with a physician. The risks of complications depend, in part, on a patient's age, sex, weight, allergies, general health, and history of **smoking**, drinking alcohol, or drug use. Some of these risks can be minimized by ensuring that the physician and anesthesiologist are fully informed of the detailed health condition of the patient, including any drugs that he or she may be using. Older people are especially sensitive to the effects of certain anesthetics and may be more likely to experience side effects from these drugs.

Patients who have had general anesthesia should not drink alcoholic beverages or take medication that slow down the central nervous system (such as **antihistamines**, sedatives, tranquilizers, sleep aids, certain pain relievers, **muscle relaxants**, and anti-seizure medication) for at least 24 hours, except under a doctor's care.

Special conditions

People with certain medical conditions are at greater risk of developing problems with anesthetics. Before undergoing general anesthesia, anyone with the following conditions should absolutely inform their doctor.

ALLERGIES. Anyone who has had allergic or other unusual reactions to **barbiturates** or general anesthetics in the past should notify the doctor before having general anesthesia. In particular, people who have had malignant hyperthermia or whose family members have had malignant hyperthermia during or after being given an anes-

Anesthetics: How They Work

Type	Name(s)	Administered	Affect
General	Halothane, Enflurane Isoflurane, Ketamine, Nitrous Oxide, Thiopental	Intravenously, Inhalation	Produces total unconsciousness affecting the entire body
Regional	Mepivacaine, Chloroprocaine, Lidocaine	Intravenously	Temporarily interrupts transmission of nerve impulses (temperature, touch, pain) and motor functions in a large area to be treated; does not produce unconsciousness
Local	Procaine, Lidocaine, Tetracaine, Bupivacaine	Intravenously	Temporarily blocks transmission of nerve impulses and motor functions in a specific area; does not produce unconsciousness
Topical	Benzocaine, Lidocaine Dibucaine, Pramoxine, Butamben, Tetracaine	Demal (Sprays, Drope, Ointments, Creams, Gels)	Temporarily blocks nerve endings in skin and mucous membranes; does not produce unconsciousness

thetic should inform the physician. Signs of malignant hyperthermia include rapid, irregular heartbeat, breathing problems, very high **fever**, and muscle tightness or spasms. These symptoms can occur following the administration of general anesthesia using inhaled agents, especially halothane. In addition, the doctor should also be told about any allergies to foods, dyes, preservatives, or other substances.

PREGNANCY. The effects of anesthetics on pregnant women and fetuses vary, depending on the type of drug. In general, giving large amounts of general anesthetics to the mother during labor and delivery may make the baby sluggish after delivery. Pregnant women should discuss the use of anesthetics during labor and delivery with their doctors. Pregnant women who may be given general anesthesia for other medical procedures should ensure that the treating physician is informed about the **pregnancy**.

BREASTFEEDING. Some general anesthetics pass into breast milk, but they have not been reported to cause problems in nursing babies whose mothers were given the drugs.

OTHER MEDICAL CONDITIONS. Before being given a general anesthetic, a patient who has any of the following conditions should inform his or her doctor:

- neurological conditions, such as epilepsy or stroke
- problems with the stomach or esophagus, such as ulcers or **heartburn**
- eating disorders
- loose teeth, dentures, bridgework
- heart disease or family history of heart problems
- lung diseases, such as **emphysema** or **asthma**
- history of smoking
- immune system diseases
- arthritis or any other conditions that affect movement
- diseases of the endocrine system, such as diabetes or thyroid problems

Side effects

Because general anesthetics affect the central nervous system, patients may feel drowsy, weak, or tired for as long as a few days after having general anesthesia. Fuzzy thinking, blurred vision, and coordination problems are also possible. For these reasons, anyone who has had general anesthesia should not drive, operate machinery, or perform other activities that could endanger themselves or others for at least 24 hours, or longer if necessary.

Most side effects usually disappear as the anesthetic wears off. A nurse or doctor should be notified if these or other side effects persist or cause problems, such as:

- **Headache**
- vision problems, including blurred or double vision
- shivering or trembling
- muscle pain
- dizziness, lightheadedness, or faintness
- drowsiness
- mood or mental changes
- nausea or vomiting
- sore throat
- nightmares or unusual dreams

A doctor should be notified as soon as possible if any of the following side effects occur within two weeks of having general anesthesia:

- severe headache
- pain in the stomach or abdomen
- back or leg pain
- severe nausea
- black or bloody vomit
- unusual tiredness or weakness
- weakness in the wrist and fingers
- weight loss or loss of appetite

KEY TERMS

Amnesia—The loss of memory.

Analgesia—A state of insensitivity to pain even though the person remains fully conscious.

Anesthesiologist—A medical specialist who administers an anesthetic to a patient before he is treated.

Anesthetic—A drug that causes unconsciousness or a loss of general sensation.

Arrhythmia—Abnormal heart beat.

Barbiturate—A drug with hypnotic and sedative effects.

Catatonia—Psychomotor disturbance characterized by muscular rigidity, excitement or stupor.

Hypnotic agent—A drug capable of inducing a hypnotic state.

Hypnotic state—A state of heightened awareness that can be used to modulate the perception of pain.

Hypoxia—Reduction of oxygen supply to the tissues.

Malignant hyperthermia—A type of reaction (probably with a genetic origin) that can occur during general anesthesia and in which the patient experiences a high fever, muscle rigidity, and irregular heart rate and blood pressure.

Medulla oblongata—The lowest section of the brainstem, located next to the spinal cord. The medulla is the site of important cardiac and respiratory regulatory centers.

Opioid—Any morphine-like synthetic narcotic that produces the same effects as drugs derived from the opium poppy (opiates), such as pain relief, sedation, constipation and respiratory depression.

Pneumothorax—A collapse of the lung.

Stenosis—A narrowing or constriction of the diameter of a passage or orifice, such as a blood vessel.

- increase or decrease in amount of urine
- pale skin
- yellow eyes or skin

Interactions

General anesthetics may interact with other medicines. When this happens, the effects of one or both of the drugs may be altered or the risk of side effects may be greater. Anyone scheduled to undergo general anesthesia should inform the doctor about all other medication that he or she is taking. This includes prescription drugs, nonprescription medicines, and street drugs. Serious and possibly life-threatening reactions may occur when general anesthetics are given to people who use street drugs, such as **cocaine**, marijuana, phencyclidine (PCP or angel dust), amphetamines (uppers), barbiturates (downers), heroin, or other narcotics. Anyone who uses these drugs should make sure their doctor or dentist knows what they have taken.

Resources

BOOKS

Dobson, Michael B. *Anaesthesia at the District Hospital*. 2nd ed. World Health Organization, 2000.

U.S. Pharmacopeia Staff. *Complete Drug Reference*. 1997 ed. Yonkers, NY: Consumer Reports Books, 1997.

PERIODICALS

Adachi, Y.U. K. Watanabe, H. Higuchi, and T. Satoh. "The Determinants of Propofol Induction of Anesthesia Dose. *Anesthesia and Analgesia*, 92 (2001): 656-661.

Marcus, Mary Brophy. "How Does Anesthesia Work? A State That Is Nothing Like Sleep: No Memory, No Fight-or-Flight Response, No Pain." *U.S. News & World Report* 123 (August 18, 1997): 66.

ORGANIZATION

American Society of Anesthesiologists. "Anesthesia and You." 1999. <http://www.asahq.org/PublicEducation/anesth. and_you.html>.

OTHER

Wenker, O. "Review of Currently Used Inhalation Anesthetics Part I."(1999) The Internet Journal of Anesthesiology <http://www.ispub.com/journals/IJA/Vol3N2/ inhal1.htm. April 1, 1999.

Jennifer Sisk

Anesthesia, local

Definition

Local or regional anesthesia involves the injection or application of an anesthetic drug to a specific area of the body, as opposed to the entire body and brain as occurs during general anesthesia.

Purpose

Local anesthetics are used to prevent patients from feeling **pain** during medical, surgical, or dental procedures. Over-the-counter local anesthetics are also available to provide temporary relief from pain, irritation, and **itching** caused by various conditions, such as cold sores, **canker sores**, sore throats, **sunburn**, insect bites, poison ivy, and minor cuts and scratches.

Types of surgery or medical procedures that regularly make use of local or regional anesthesia include the following:

- biopsies in which skin or tissue samples are taken for diagnostic procedures
- childbirth
- surgeries on the arms, hands, legs, or feet
- eye surgery
- surgeries involving the urinary tract or sexual organs

Surgeries involving the chest and abdomen are usually performed under general anesthesia.

Local and regional anesthesia have advantages over general anesthesia in that patients can avoid some unpleasant side effects, can receive longer lasting pain relief, have reduced blood loss, and maintain a sense of psychological comfort by not losing consciousness.

Description

Regional anesthesia typically affects a larger area than local anesthesia, for example, everything below the waist. As a result, regional anesthesia may be used for more involved or complicated surgical or medical procedures. Regional anesthetics are injected. Local anesthesia involves the injection into the skin or muscle or application to the skin of an anesthetic directly where pain will occur. Local anesthesia can be divided into four groups: injectable, topical, dental (non-injectable), and ophthalmic.

Local and regional anesthesia work by altering the flow of sodium molecules into nerve cells or neurons through the cell membrane. Exactly how the anesthetic does this is not understood, since the drug apparently does not bind to any receptor on the cell surface and does not seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. It is known, however, that when the sodium molecules do not get into the neurons, nerve impulses are not generated and pain impulses are not transmitted to the brain. The duration of action of an anesthetic depends on the type and amount of anesthetic administered.

Regional anesthesia

Types of regional anesthesia include:

- Spinal anesthesia. Spinal anesthesia involves the injection of a small amount of local anesthetic directly into the cerebrospinal fluid surrounding the spinal cord (the subarachnoid space). Blood pressure drops are common but are easily treated.
- Epidural anesthesia. Epidural anesthesia involves the injection of a large volume of local anesthetic directly into the space surrounding the spinal fluid sac (the epidural space), not into the spinal fluid. Pain relief occurs more slowly but is less likely to produce blood pressure drops. Also, the block can be maintained for long periods, even days.
- Nerve blocks. Nerve blocks involve the injection of an anesthetic into the area around a nerve that supplies a particular region of the body, preventing the nerve from carrying nerve impulses to the brain.

Anesthetics may be administered with another drug, such as epinephrine (adrenaline), which decreases bleeding, and sodium bicarbonate to decrease the acidity of a drug so that it will work faster. In addition, drugs may be administered to help a patient remain calm and more comfortable or to make them sleepy.

Local anesthesia

INJECTABLE LOCAL ANESTHETICS. These medicines are given by injection to numb and provide pain relief to some part of the body during surgery, dental procedures, or other medical procedures. They are given only by a trained health care professional and only in a doctor's office or a hospital. Some commonly used injectable local anesthetics are procaine (Novocain), lidocaine (Dalcaine, Dilocaine, L-Caine, Nervocaine, Xylocaine, and other brands), and tetracaine (Pontocaine).

TOPICAL ANESTHETICS. Topical anesthetics, such as benzocaine, lidocaine, dibucaine, pramoxine, butamben, and tetracaine, relieve pain and itching by deadening the nerve endings in the skin. They are ingredients in a variety of nonprescription products that are applied to the skin to relieve the discomfort of sunburn, insect bites or stings, poison ivy, and minor cuts, scratches, and **burns**. These products are sold as creams, ointments, sprays, lotions, and gels.

DENTAL ANESTHETICS (NON-INJECTABLE). Some local anesthetics are intended for pain relief in the mouth or throat. They may be used to relieve throat pain, teething pain, painful canker sores, toothaches, or discomfort from dentures, braces, or bridgework. Some dental anesthetics are available only with a doctor's prescription. Others may be purchased without a prescription, including products such as Num-Zit, Orajel, Chloraseptic lozenges, and Xylocaine.

OPHTHALMIC ANESTHETICS. Other local anesthetics are designed for use in the eye. The ophthalmic anesthetics proparacaine and tetracaine are used to numb the eye before certain eye examinations. Eye doctors may also use these medicines before measuring eye pressure or removing stitches or **foreign objects** from the eye. These drugs are to be given only by a trained health care professional.

Recommended dosage

The recommended dosage depends on the type of local anesthetic and the purpose for which it is being used. When using a nonprescription local anesthetic, follow the directions on the package. Questions concerning how to use a product should be referred to a medical doctor, dentist, or pharmacist.

Precautions

People who strongly feel that they cannot psychologically cope with being awake and alert during certain procedures may not be good candidates for local or regional anesthesia. Other medications may be given in conjunction with the anesthetic, however, to relieve **anxiety** and help the patient relax.

Local anesthetics should be used only for the conditions for which they are intended. For example, a topical anesthetic meant to relieve sunburn pain should not be used on cold sores. Anyone who has had an unusual reaction to any local anesthetic in the past should check with a doctor before using any type of local anesthetic again. The doctor should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Older people may be more sensitive to the effects of local anesthetics, especially lidocaine. This increased sensitivity may increase the risk of side effects. Older people who use nonprescription local anesthetics should be especially careful not to use more than the recommended amount. Children also may be especially sensitive to the effects of some local anesthetics, which may increase the chance of side effects. Anyone using these medicines on a child should be careful not to use more than the amount that is recommended for children. Certain types of local anesthetics should not be used at all young children. Follow package directions carefully and check with a doctor of pharmacist if there are any questions.

Regional anesthetics

Serious, possibly life-threatening, side effects may occur when anesthetics are given to people who use street drugs. Anyone who uses **cocaine**, **marijuana**, amphetamines, **barbiturates**, phencyclidine (PCP, or angel dust), heroin, or other street drugs should make sure their doctor or dentist knows what they have used.

Patients who have had a particular kind of reaction called malignant hyperthermia (or who have one or more family members who have had this problem) during or just after receiving a general anesthetic should inform their doctors before receiving any kind of anesthetic. Signs of malignant hyperthermia include fast and irregular heartbeat, very high **fever**, breathing problems, and muscle spasms or tightness.

Although problems are rare, some unwanted side effects may occur when regional anesthetics are used during labor and delivery. These anesthetics can prolong labor and increase the risk of **Cesarean section**. Pregnant women should discuss with their doctors the risks and benefits of being given these drugs.

Patients should not drive or operate other machinery immediately following a procedure involving regional anesthesia, due to numbness and weakness, or if local anesthesia also included drugs to make the patient sleep or strong pain medications. Injection sites should be kept clean, dry, and uncovered to prevent infection.

Injectable local anesthetics

Until the anesthetic wears off, patients should be careful not to injure the numbed area. If the anesthetic was used in the mouth, do not eat or chew gum until feeling returns.

Topical anesthetics

Unless advised by a doctor, topical anesthetics should not be used on or near any part of the body with large sores, broken or scraped skin, severe injury, or infection. They should also not be used on large areas of skin. Some topical anesthetics contain alcohol and should not be used near an open flame, or while **smoking**.

Anyone using a topical anesthetic should be careful not to get this medication in the eyes, nose, or mouth. When using a spray form of this medication, do not spray it directly on the face, but apply it to the face with a cotton swab or sterile gauze pad. After using a topical anesthetic on a child, make sure the child does not get the medicine in his or her mouth.

Topical anesthetics are intended for the temporary relief of pain and itching. They should not be used for more than a few days at a time. Check with a doctor if:

- the discomfort continues for more than seven days
- the problem gets worse
- the treated area becomes infected
- new signs of irritation, such as skin rash, burning, stinging, or swelling appear

Dental anesthetics (non-injectable)

Dental anesthetics should not be used if certain kinds of infections are present. Check package directions or check with a dentist or medical doctor if uncertain. Dental anesthetics should be used only for temporary pain relief. If problems such as **toothache**, mouth sores, or pain from dentures or braces continue, check with a dentist. Check with a doctor if **sore throat** pain is severe, lasts more than two days, or is accompanied by other symptoms such as fever, **headache**, skin rash, swelling, nausea, or vomiting.

Patients should not eat or chew gum while the mouth is numb from a dental anesthetic. There is a risk of accidently biting the tongue or the inside of the mouth. Also nothing should be eaten or drunk for one hour after applying a dental anesthetic to the back of the mouth or throat, since the medicine may interfere with swallowing and may cause **choking**. If normal feeling does not return to the mouth within a few hours after receiving a dental anesthetic or if it is difficult to open the mouth, check with a dentist.

Ophthalmic anesthetics

When anesthetics are used in the eye, it is important not to rub or wipe the eye until the effect of the anesthetic has worn off and feeling has returned. Rubbing the eye while it is numb could cause injury.

Side effects

Side effects of regional or local anesthetics vary depending on the type of anesthetic used and the way it is administered. Anyone who has unusual symptoms following the use of an anesthetic should get in touch with his or her doctor immediately.

Paralysis after regional anesthesia, for example an epidural or spinal block, is extremely rare, but can occur. Paralysis reportedly occurs even less frequently than deaths due to general anesthesia.

There is a small risk of developing a severe headache called a spinal headache following a spinal or epidural block. This headache is severe when the patient is upright and hardly felt when the patient lies down. Though rare, it can occur and can be treated by performing a blood patch, in which a small amount of the patient's own blood is injected into the area in the back where the anesthetic was injected. The blood clots and closes up any area that may have been leaking spinal fluid. Relief is almost immediate. Finally, blood clots or **abscess** can form in the back, but these are also readily treatable and so pose little risk.

KEY TERMS

Canker sore—A painful sore inside the mouth.

Cold sore—A small blister on the lips or face, caused by a virus. Also called a fever blister.

Epidural space—The space surrounding the spinal fluid sac.

Malignant hyperthermia—A type of reaction (probably with a genetic basis) that can occur during general anesthesia in which the patient experiences a high fever, the muscles become rigid, and the heart rate and blood pressure fluctuate.

Subarachnoid space—The space surrounding the spinal cord that is filled with cerebrospinal fluid.

Topical—Not ingested; applied to the outside of the body, for example to the skin, eye, or mouth.

A physician should be notified immediately if any of these symptoms occur:

- large swellings that look like **hives** on the skin, in the mouth, or in the throat
- severe headache
- blurred or double vision
- dizziness or lightheadedness
- drowsiness
- confusion
- anxiety, excitement, nervousness, or restlessness
- convulsions (seizures)
- feeling hot, cold, or numb
- ringing or buzzing in the ears
- shivering or trembling
- sweating
- pale skin
- slow or irregular heartbeat
- breathing problems
- unusual weakness or tiredness

Interactions

Some anesthetic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who receives a regional or local anesthetic should let the doctor know all other drugs he or she is tak-

ing including prescription drugs, nonprescription drugs, and street drugs (such as cocaine, marijuana, and heroin).

Resources

BOOKS

"Anesthetics." In *Lippincott's Illustrated Reviews: Pharmacology*, ed. Richard A. Harvey, et al. Philadelphia: J.B. Lippincott & Co., 1992.

Nancy Ross-Flanigan

Aneurysmectomy

Definition

Aneurysmectomy is a surgical procedure performed to repair a weak area in the aorta. The aorta is the largest artery in the body and the main blood vessel leading away from the heart.

Purpose

The purpose of aneurysmectomy is to repair an **aortic aneurysm** that is likely to rupture if left in place. Aneurysmectomy is indicated for an aortic aneurysm that grows to at least 2 in (5 cm) or for an aortic aneurysm of any size that is symptomatic, tender, or enlarging rapidly.

Precautions

Aneurysmectomy may not be appropriate for patients with severely debilitating diseases such as **cancer**, **emphysema**, and **heart failure**.

Description

An aortic aneurysm is a bulge in the wall of the aorta that is usually due to arteriosclerosis or **atherosclerosis**. People who are 50-80 years old are most likely to develop an aortic aneurysm, with men four times more likely to develop one than women.

An aortic aneurysm develops and grows slowly. It rarely produces symptoms and is usually only diagnosed by accident during a routine physical exam or on an x ray or ultrasound done for another reason. As the aneurysm grows larger, the risk of bursting with no warning, which causes catastrophic bleeding, rises. A ruptured aortic aneurysm can cause sudden loss of a fatal amount of blood within minutes or it can leak in a series of small bleeds that lead within hours or days to massive bleeding. A leaking aortic aneurysm that is not treated is always fatal.

Aneurysmectomy is performed to repair the two most common types of aortic aneurysms: abdominal aortic aneurysms that occur in the abdomen below the kidneys, and thoracic aortic aneurysms that occur in the chest. It is major surgery performed in a hospital under general anesthesia and involves removing debris and then implanting a flexible tube (graft) to replace the enlarged artery. Aneurysmectomy for an aneurysm of the ascending aorta (the first part of the aorta that travels upward from the heart) requires the use of a heart-lung machine that temporarily stops the heart while the aneurysm is repaired. Aneurysmectomy requires a one-week hospital stay; the recovery period is five weeks.

During surgery, the site of the aneurysm (either the abdomen or the chest) is opened with an incision to expose the aneurysm. The aorta is clamped above and below the aneurysm to stop the flow of blood. Then, an incision is made in the aneurysm. An artificial Dacron tube is sewn in place above and below the opened aneurysm, but the aneurysm is not removed. Plaque or clotted blood are cleaned from the diseased tissue. The clamps are removed and blood flow is re-established through the graft. The wall of the aneurysm is wrapped around the graft to protect it and the skin of the abdomen or chest is sewn up.

Aneurysmectomy can be performed as elective or emergency surgery. Elective aneurysmectomy takes about an hour and is far safer than emergency aneurysmectomy, with a mortality rate of 3-5% for elective abdominal aneurysmectomy and 5-10% for elective thoracic aneurysmectomy. When an aneurysm ruptures, 62% of patients die before they reach the hospital. Of those who make it into emergency aneurysmectromy, 50% die. After a successful aneurysmectomy, the patient has nearly the same life expectancy as other people of the same age.

Preparation

Before elective aneurysmectomy, blood studies, a **chest x ray**, cardiac catherization, electrocardiogram (ECG), and ultrasound are performed.

Aftercare

After aneurysmectomy, the patient is monitored in an Intensive Care Unit for the first 24–48 hours. Follow-up tests include ECG, chest x ray, and ultrasound.

Risks

Elective aneurysmectomy has a 5-10% rate of complications, such as bleeding, kidney failure, respiratory complications, **heart attack**, **stroke**, infection, limb loss, bowel **ischemia**, and **impotence**. These complications are many times more common in emergency aneurysmectomy.

KEY TERMS

Aneurysm—A weakening in the muscular walls of a part of the artery which causes the damaged section to enlarge or sag, giving it a balloon-like appearance.

Aorta—The main blood vessel that leads away from the heart and the body's largest artery. The aorta carries blood from the heart through the chest and abdomen, providing major branches to all of the organs in the body.

Arteriosclerosis—Hardening of the arteries that occurs as part of the aging process.

Artery—A blood vessel that carries blood from the heart to the body's tissues.

Atherosclerosis—A form of arteriosclerosis in which cholesterol-containing fatty deposits accumulate in the inner most walls of the heart's arteries.

Thoracic—Relating to the chest.

Resources

BOOKS

"Aneurysmectomy." *In Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

DeBakey, Michael E., and Antonio M. Gotto Jr. "Aneurysms." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

"Diseases of the Aorta." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

PERIODICALS

"Aortic Aneurysm: Stopping a Silent Killer." *Johns Hopkins Medical Letter* 7 (Aug. 1995): 4-5.

Donaldson, M. C., M. Belkin, and A. D. Whittemore. "Mesenteric Revascularization During Aneurysmectomy." *Surgery Clinic of North America* 77 (Apr. 1997): 443-459.

OTHER

"Aortic Aneurysm." *American Heart Association*. 28 May 1998 <http://www.americanheart.org>.

"Aneurysm" and "Aneurysm Removal." *ThriveOnline*. 28 May 1998. <http://thriveonline.oxygen.com>.

"Aortic Aneurysm: Surgery Can Stop This Silent Danger." *Mayo Clinic Online*. 28 May 1998. <http://www.mayohealth.org/mayo/9403/htm/aneurysm.htm>.

"Aneurysm, Diagnosis & Treatment." *Mid Atlantic Surgical Associates Page*. 28 May 1998. <http://www.heartsurgeons.com>.

Lori De Milto

Aneurysms *see* **Aneurysmectomy; Cerebral aneurysm; Ventricular aneurysm**

Angina

Definition

Angina is **pain**, "discomfort," or pressure localized in the chest that is caused by an insufficient supply of blood (**ischemia**) to the heart muscle. It is also sometimes characterized by a feeling of **choking**, suffocation, or crushing heaviness. This condition is also called angina pectoris.

Description

Often described as a muscle spasm and choking sensation, the term "angina" is used primarily to describe chest (thoracic) pain originating from insufficient oxygen to the heart muscle. An episode of angina is not an actual **heart attack**, but rather pain that results from the heart muscle temporarily receiving too little blood. This temporary condition may be the result of demanding activities such as **exercise** and does not necessarily indicate that the heart muscle is experiencing permanent damage. In fact, episodes of angina seldom cause permanent damage to heart muscle.

Angina can be subdivided further into two categories: angina of effort and variant angina.

Angina of effort

Angina of effort is a common disorder caused by the narrowing of the arteries (**atherosclerosis**) that supply oxygen-rich blood to the heart muscle. In the case of angina of effort, the heart (coronary) arteries can provide the heart muscle (myocardium) adequate blood during rest but not during periods of exercise, **stress**, or excitement—any of which may precipitate pain. The pain is relieved by resting or by administering nitroglycerin, a medication that reduces ischemia of the heart. Patients with angina of effort have an increased risk of heart attack (myocardial infarction).

Variant angina

Variant angina is uncommon and occurs independently of atherosclerosis which may, however, be present as an incidental finding. Variant angina occurs at rest and is not related to excessive work by the heart muscle. Research indicates that variant angina is caused by coro-

nary artery muscle spasm of insufficient duration or intensity to cause an actual heart attack.

Causes and symptoms

Angina causes a pressing pain or sensation of heaviness, usually in the chest area under the breast bone (sternum). It occasionally is experienced in the shoulder, arm, neck, or jaw regions. Because episodes of angina occur when the heart's need for oxygen increases beyond the oxygen available from the blood nourishing the heart, the condition is often precipitated by physical exertion. In most cases, the symptoms are relieved within a few minutes by resting or by taking prescribed angina medications. Emotional stress, extreme temperatures, heavy meals, cigarette **smoking**, and alcohol can also cause or contribute to an episode of angina.

Diagnosis

Physicians can usually diagnose angina based on the patient's symptoms and the precipitating factors. However, other diagnostic testing is often required to confirm or rule out angina, or to determine the severity of the underlying heart disease.

Electrocardiogram (ECG)

An electrocardiogram is a test that records electrical impulses from the heart. The resulting graph of electrical activity can show if the heart muscle isn't functioning properly as a result of a lack of oxygen. Electrocardiograms are also useful in investigating other possible abnormal features of the heart.

Stress test

For many individuals with angina, the results of an electrocardiogram while at rest will not show any abnormalities. Because the symptoms of angina occur during stress, the functioning of the heart may need to be evaluated under the physical stress of exercise. The **stress test** records information from the electrocardiogram before, during, and after exercise in search of stress-related abnormalities. Blood pressure is also measured during the stress test and symptoms are noted. A more involved and complex stress test (for example, thallium scanning) may be used in some cases to picture the blood flow in the heart muscle during the most intense time of exercise and after rest.

Angiogram

The angiogram, which is basically an x ray of the coronary artery, has been noted to be the most accurate diagnostic test to indicate the presence and extent of coronary disease. In this procedure, a long, thin, flexible tube (catheter) is maneuvered into an artery located in the forearm or groin. This catheter is passed further through the artery into one of the two major coronary arteries. A dye is injected at that time to help the x rays "see" the heart and arteries more clearly. Many brief x rays are made to create a "movie" of blood flowing through the coronary arteries, which will reveal any possible narrowing that causes a decrease in blood flow to the heart muscle and associated symptoms of angina.

Treatment

Conservative treatment

Artery disease causing angina is addressed initially by controlling existing factors placing the individual at risk. These risk factors include cigarette smoking, high blood pressure, **high cholesterol** levels, and **obesity**. Angina is often controlled by medication, most commonly with nitroglycerin. This drug relieves symptoms of angina by increasing the diameter of the blood vessels carrying blood to the heart muscle. Nitroglycerin is taken whenever discomfort occurs or is expected. It may be taken by mouth by placing the tablet under the tongue or transdermally by placing a medicated patch directly on the skin. In addition, **beta blockers** or **calcium channel blockers** may be prescribed to also decrease the demand on the heart by decreasing the rate and workload of the heart.

Surgical treatment

When conservative treatments are not effective in the reduction of angina pain and the risk of heart attack remains high, physicians may recommend **angioplasty** or surgery. Coronary artery bypass surgery is an operation in which a blood vessel (often a long vein surgically removed from the leg) is grafted onto the blocked artery to bypass the blocked portion. This newly formed pathway allows blood to flow adequately to the heart muscle.

Another procedure used to improve blood flow to the heart is balloon angioplasty. In this procedure, the physician inserts a catheter with a tiny balloon at the end into a forearm or groin artery. The catheter is then threaded up into the coronary arteries and the balloon is inflated to open the vessel in narrowed sections. Other techniques using laser and mechanical devices are being developed and applied, also by means of catheters.

Alternative treatment

During an angina episode, relief has been noted by applying massage or kinesiological methods, but these techniques are not standard recommendations by physi-

cians. For example, one technique places the palm and fingers of either hand on the forehead while simultaneously firmly massaging the sternum (breast bone) up and down its entire length using the other hand. This is followed by additional massaging by the fingertip and thumb next to the sternum, on each side.

Once the angina has subsided, the cause should be determined and treated. Atherosclerosis, a major associated cause, requires diet and lifestyle adjustments, primarily including regular exercise, reduction of dietary sugar and saturated fats, and increase of dietary fiber. Both conventional and alternative medicine agree that increasing exercise and improving diet are important steps to reduce high cholesterol levels. Alternative medicine has proposed specific cholesterol-lowering treatments, with several gaining the attention and interest of the public. One of the most recent popular treatments is garlic (*Allium sativum*). Some studies have shown that adequate dosages of garlic can reduce total cholesterol by about 10%, LDL (bad) cholesterol by 15%, and raise HDL (good) cholesterol by 10%. Other studies have not shown significant benefit. Although its effect on cholesterol is not as great as that achieved by medications, garlic may possibly be of benefit in relatively mild cases of high cholesterol, without causing the side effects associated with **cholesterol-reducing drugs**. Other herbal remedies that may help lower cholesterol include alfalfa (*Medicago sativa*), fenugreek (*Trigonella foenum-graecum*), Asian ginseng (*Panax ginseng*), and tumeric (*Curcuma longa*).

Antioxidants, including vitamin A (beta carotene), vitamin C, vitamin E, and selenium, can limit the oxidative damage to the walls of blood vessels that may be a precursor of atherosclerotic plaque formation.

Prognosis

The prognosis for a patient with angina depends on its origin, type, severity, and the general health of the individual. A person who has angina has the best prognosis if he or she seeks prompt medical attention and learns the pattern of his or her angina, such as what causes the attacks, what they feel like, how long episodes usually last, and whether medication relieves the attacks. If patterns of the symptoms change significantly, or if symptoms resemble those of a heart attack, medical help should be sought immediately.

Prevention

In most cases, the best prevention involves changing one's habits to avoid bringing on attacks of angina. If blood pressure medication has been prescribed, compliance is a necessity and should be a priority as well. Many healthcare professionals—including physicians, dietitians, and nurses—can provide valuable advice on proper diet, weight control, blood cholesterol levels, and blood pressure. These professionals also offer suggestions about current treatments and information to help stop smoking. In general, the majority of those with angina adjust their lives to minimize episodes of angina, by taking necessary precautions and using medications if recommended and necessary. **Coronary artery disease** is the underlying problem that should be addressed.

KEY TERMS

Ischemia—Decreased blood supply to an organ or body part, often resulting in pain.

Myocardial infarction—A blockage of a coronary artery that cuts off the blood supply to part of the heart. In most cases, the blockage is caused by fatty deposits.

Myocardium—The thick middle layer of the heart that forms the bulk of the heart wall and contracts as the organ beats.

Resources

BOOKS

Banasik, Jacquelyn L. "Alterations in Cardiac Function." In *Perspectives on Pathophysiology*, ed. Lee-Ellen C. Copstead. Philadelphia: W. B. Saunders Co., 1994.

Chandrasoma, Parakrama, and Clive R. Taylor. *Concise Pathology.* East Norwalk, CT: Appleton & Lange, 1991.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

OTHER

"Angina." Healthtouch Online Page. Sept. 1997. 21 May 1998. <http://www.healthtouch.com>.

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Angioedema *see* **Hives**

Angiogram *see* **Angiography**

Angiography

Definition

Angiography is the x-ray study of the blood vessels. An angiogram uses a radiopaque substance, or dye, to

make the blood vessels visible under x ray. Arteriography is a type of angiography that involves the study of the arteries.

Purpose

Angiography is used to detect abnormalities or blockages in the blood vessels (called occlusions) throughout the circulatory system and in some organs. The procedure is commonly used to identify **atherosclerosis**; to diagnose heart disease; to evaluate kidney function and detect kidney cysts or tumors; to detect an aneurysm (an abnormal bulge of an artery that can rupture leading to hemorrhage), tumor, blood clot, or **arteriovenous malformations** (abnormals tangles of arteries and veins) in the brain; and to diagnose problems with the retina of the eye. It is also used to give surgeons an accurate "map" of the heart prior to open-heart surgery, or of the brain prior to neurosurgery.

Precautions

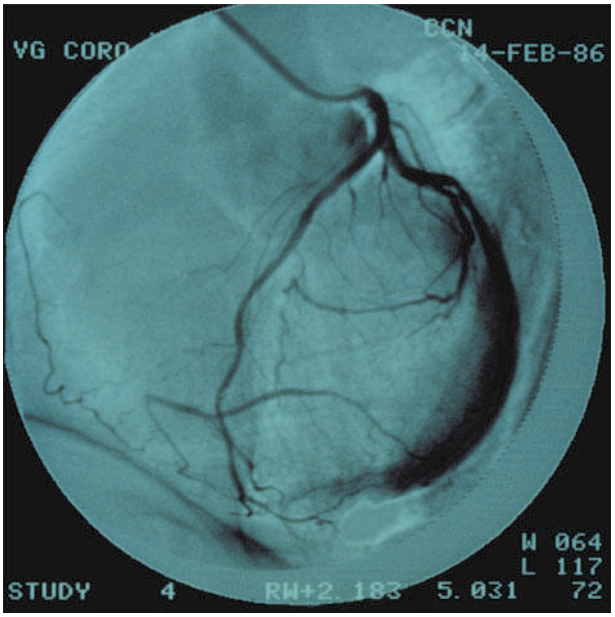
Patients with kidney disease or injury may suffer further kidney damage from the contrast mediums used for angiography. Patients who have blood clotting problems, have a known allergy to contrast mediums, or are allergic to iodine, a component of some contrast mediums, may also not be suitable candidates for an angiography procedure. Because x rays carry risks of ionizing radiation exposure to the fetus, pregnant women are also advised to avoid this procedure.

Description

Angiography is usually performed at a hospital by a trained radiologist and assisting technician or nurse. It takes place in an x-ray or fluoroscopy suite, and for most types of angiograms, the patient's vital signs will be monitored throughout the procedure.

Angiography requires the injection of a contrast dye that makes the blood vessels visible to x ray. The dye is injected through a procedure known as *arterial puncture*. The puncture is usually made in the groin area, armpit, inside elbow, or neck. The site is cleaned with an antiseptic agent and injected with a local anesthetic. First, a small incision is made in the skin to help the needle pass. A needle containing an inner wire called a stylet is inserted through the skin into the artery. When the radiologist has punctured the artery with the needle, the stylet is removed and replaced with another long wire called a guide wire. It is normal for blood to spout out of the needle before the guide wire is inserted.

The guide wire is fed through the outer needle into the artery and to the area that requires angiographic



An angiogram of a coronary artery. *(Phototake NYC. Reproduced by permission.)*

study. A fluoroscopic screen that displays a view of the patient's vascular system is used to pilot the wire to the correct location. Once it is in position, the needle is removed and a catheter is slid over the length of the guide wire until it to reaches the area of study. The guide wire is removed and the catheter is left in place in preparation for the injection of the contrast medium, or dye.

Depending on the type of angiography procedure being performed, the contrast medium is either injected by hand with a syringe or is mechanically injected with an automatic injector connected to the catheter. An automatic injector is used frequently because it is able to propel a large volume of dye very quickly to the angiogram site. The patient is warned that the injection will start, and instructed to remain very still. The injection causes some mild to moderate discomfort. Possible side effects or reactions include **headache**, **dizziness**, irregular heartbeat, nausea, warmth, burning sensation, and chest **pain**, but they usually last only momentarily. To view the area of study from different angles or perspectives, the patient may be asked to change positions several times, and subsequent dye injections may be administered. During any injection, the patient or the camera may move.

Throughout the dye injection procedure, x-ray pictures and/or fluoroscopic pictures (or moving x rays) will be taken. Because of the high pressure of arterial blood flow, the dye will dissipate through the patient's system quickly, so pictures must be taken in rapid succession.

An automatic film changer is used because the manual changing of x-ray plates can eat up valuable time.

Once the x rays are complete, the catheter is slowly and carefully removed from the patient. Pressure is applied to the site with a sandbag or other weight for 10-20 minutes in order for clotting to take place and the arterial puncture to reseal itself. A pressure bandage is then applied.

Most angiograms follow the general procedures outlined above, but vary slightly depending on the area of the vascular system being studied. A variety of common angiography procedures are outlined below:

Cerebral angiography

Cerebral angiography is used to detect aneurysms, blood clots, and other vascular irregularities in the brain. The catheter is inserted into the femoral or carotid artery and the injected contrast medium travels through the blood vessels on the brain. Patients frequently experience headache, warmth, or a burning sensation in the head or neck during the injection portion of the procedure. A cerebral angiogram takes two to four hours to complete.

Coronary angiography

Coronary angiography is administered by a cardiologist with training in radiology or, occasionally, by a radiologist. The arterial puncture is typically given in the femoral artery, and the cardiologist uses a guide wire and catheter to perform a contrast injection and x-ray series on the coronary arteries. The catheter may also be placed in the left ventricle to examine the mitral and aortic valves of the heart. If the cardiologist requires a view of the right ventricle of the heart or of the tricuspid or pulmonic valves, the catheter will be inserted through a large vein and guided into the right ventricle. The catheter also serves the purpose of monitoring blood pressures in these different locations inside the heart. The angiogram procedure takes several hours, depending on the complexity of the procedure.

Pulmonary angiography

Pulmonary, or lung, angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a **pulmonary embolism**. The procedure differs from cerebral and coronary angiograms in that the guide wire and catheter are inserted into a vein instead of an artery, and are guided up through the chambers of the heart and into the pulmonary artery. Throughout the procedure, the patient's vital signs are monitored to ensure that the catheter doesn't cause **arrhythmias**, or irregular heartbeats. The contrast medium is then injected into the pulmonary artery where it circulates through the lung capillaries. The test typically takes up to 90 minutes.

Kidney angiography

Patients with chronic renal disease or injury can suffer further damage to their kidneys from the contrast medium used in a kidney angiogram, yet they often require the test to evaluate kidney function. These patients should be well-hydrated with a intravenous saline drip before the procedure, and may benefit from available medications (e.g., dopamine) that help to protect the kidney from further injury due to contrast agents. During a kidney angiogram, the guide wire and catheter are inserted into the femoral artery in the groin area and advanced through the abdominal aorta, the main artery in the abdomen, and into the renal arteries. The procedure will take approximately one hour.

Fluorescein angiography

Fluorescein angiography is used to diagnose retinal problems and circulatory disorders. It is typically conducted as an outpatient procedure. The patient's pupils are dilated with eye drops and he rests his chin and forehead against a bracing apparatus to keep it still. Sodium fluorescein dye is then injected with a syringe into a vein in the patient's arm. The dye will travel through the patient's body and into the blood vessels of the eye. The procedure does not require x rays. Instead, a rapid series of close-up photographs of the patient's eyes are taken, one set immediately after the dye is injected, and a second set approximately 20 minutes later once the dye has moved through the patient's vascular system. The entire procedure takes up to one hour.

Celiac and mesenteric angiography

Celiac and mesenteric angiography involves x-ray exploration of the celiac and mesenteric arteries, arterial branches of the abdominal aorta that supply blood to the abdomen and digestive system. The test is commonly used to detect aneurysm, thrombosis, and signs of **ischemia** in the celiac and mesenteric arteries, and to locate the source of gastrointestinal bleeding. It is also used in the diagnosis of a number of conditions, including portal **hypertension**, and **cirrhosis**. The procedure can take up to three hours, depending on the number of blood vessels studied.

Splenoportography

A splenoportograph is a variation of an angiogram that involves the injection of contrast medium directly into the spleen to view the splenic and portal veins. It is used to diagnose blockages in the splenic vein and portal

KEY TERMS

Arteriosclerosis—A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

Carotid artery—An artery located in the neck.

Catheter—A long, thin, flexible tube used in angiography to inject contrast material into the arteries.

Cirrhosis—A condition characterized by the destruction of healthy liver tissue. A cirrhotic liver is scarred and cannot break down the proteins in the bloodstream. Cirrhosis is associated with portal hypertension.

Embolism—A blood clot, air bubble, or clot of foreign material that travels and blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction, or death of the tissue the artery feeds, occurs. Without immediate and appropriate treatment, an embolism can be fatal.

Femoral artery—An artery located in the groin area that is the most frequently accessed site for arterial puncture in angiography.

Fluorescein dye—An orange dye used to illuminate the blood vessels of the retina in fluorescein angiography.

Fluoroscopic screen—A fluorescent screen which displays "moving x-rays" of the body. Fluoroscopy allows the radiologist to visualize the guide wire and catheter he is moving through the patient's artery.

Guide wire—A wire that is inserted into an artery to guides a catheter to a certain location in the body.

Iscehmia—A lack of normal blood supply to a organ or body part because of blockages or constriction of the blood vessels.

Necrosis—Cellular or tissue death; skin necrosis may be caused by multiple, consecutive doses of radiation from fluoroscopic or x-ray procedures.

Plaque—Fatty material that is deposited on the inside of the arterial wall.

Portal hypertension—A condition caused by cirrhosis of the liver. It is characterized by impaired or reversed blood flow from the portal vein to the liver, an enlarged spleen, and dilated veins in the esophagus and stomach.

Portal vein thrombosis—The development of a blood clot in the vein that brings blood into the liver. Untreated portal vein thrombosis causes portal hypertension.

vein thrombosis and to assess the strength and location of the vascular system prior to **liver transplantation**.

Most angiography procedures are typically paid for by major medical insurance. Patients should check with their individual insurance plans to determine their coverage.

Preparation

Patients undergoing an angiogram are advised to stop eating and drinking eight hours prior to the procedure. They must remove all jewelry before the procedure and change into a hospital gown. If the arterial puncture is to be made in the armpit or groin area, shaving may be required. A sedative may be administered to relax the patient for the procedure. An IV line will also be inserted into a vein in the patient's arm before the procedure begins in case medication or blood products are required during the angiogram.

Prior to the angiography procedure, patients will be briefed on the details of the test, the benefits and risks, and the possible complications involved, and asked to sign an informed consent form.

Aftercare

Because life-threatening internal bleeding is a possible complication of an arterial puncture, an overnight stay in the hospital is sometimes recommended following an angiography procedure, particularly with cerebral and coronary angiograms. If the procedure is performed on an outpatient basis, the patient is typically kept under close observation for a period of at six to 12 hours before being released. If the arterial puncture was performed in the femoral artery, the patient will be instructed to keep his leg straight and relatively immobile during the observation period. The patient's blood pressure and vital signs will be monitored and the puncture site observed closely. Pain medication may be prescribed if the patient is experiencing discomfort from the puncture, and a cold pack is applied to the site to reduce swelling. It is normal for the puncture site to be sore and bruised for several weeks.

The patient may also develop a hematoma, a hard mass created by the blood vessels broken during the procedure. Hematomas should be watched carefully, as they may indicate continued bleeding of the arterial puncture site.

Angiography patients are also advised to enjoy two to three days of rest and relaxation after the procedure in order to avoid placing any undue **stress** on the arterial puncture. Patients who experience continued bleeding or abnormal swelling of the puncture site, sudden dizziness, or chest pains in the days following an angiography procedure should seek medical attention immediately.

Patients undergoing a fluorescein angiography should not drive or expose their eyes to direct sunlight for 12 hours following the procedure.

Risks

Because angiography involves puncturing an artery, internal bleeding or hemorrhage are possible complications of the test. As with any invasive procedure, infection of the puncture site or bloodstream is also a risk, but this is rare.

A **stroke** or **heart attack** may be triggered by an angiogram if blood clots or plaque on the inside of the arterial wall are dislodged by the catheter and form a blockage in the blood vessels or artery. The heart may also become irritated by the movement of the catheter through its chambers during pulmonary and coronary angiography procedures, and arrhythmias may develop.

Patients who develop an allergic reaction to the contrast medium used in angiography may experience a variety of symptoms, including swelling, difficulty breathing, **heart failure**, or a sudden drop in blood pressure. If the patient is aware of the allergy before the test is administered, certain medications can be administered at that time to counteract the reaction.

Angiography involves minor exposure to radiation through the x rays and fluoroscopic guidance used in the procedure. Unless the patient is pregnant, or multiple radiological or fluoroscopic studies are required, the small dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known to cause skin necrosis in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses administered to these patients.

Normal results

The results of an angiogram or arteriogram depend on the artery or organ system being examined. Generally, test results should display a normal and unimpeded flow of blood through the vascular system. Fluorescein angiography should result in no leakage of fluorescein dye through the retinal blood vessels.

Abnormal results

Abnormal results of an angiography may display a restricted blood vessel or arterial blood flow (ischemia) or an irregular placement or location of blood vessels. The results of an angiography vary widely by the type of procedure performed, and should be interpreted and explained to the patient by a trained radiologist.

Resources

BOOKS

Baum, Stanley, and Michael J. Pentecost, eds. *Abrams' Angiography.* 4th ed. Philadelphia: Lippincott-Raven, 1996.

Paula Anne Ford-Martin

Angiomas *see* **Birthmarks**

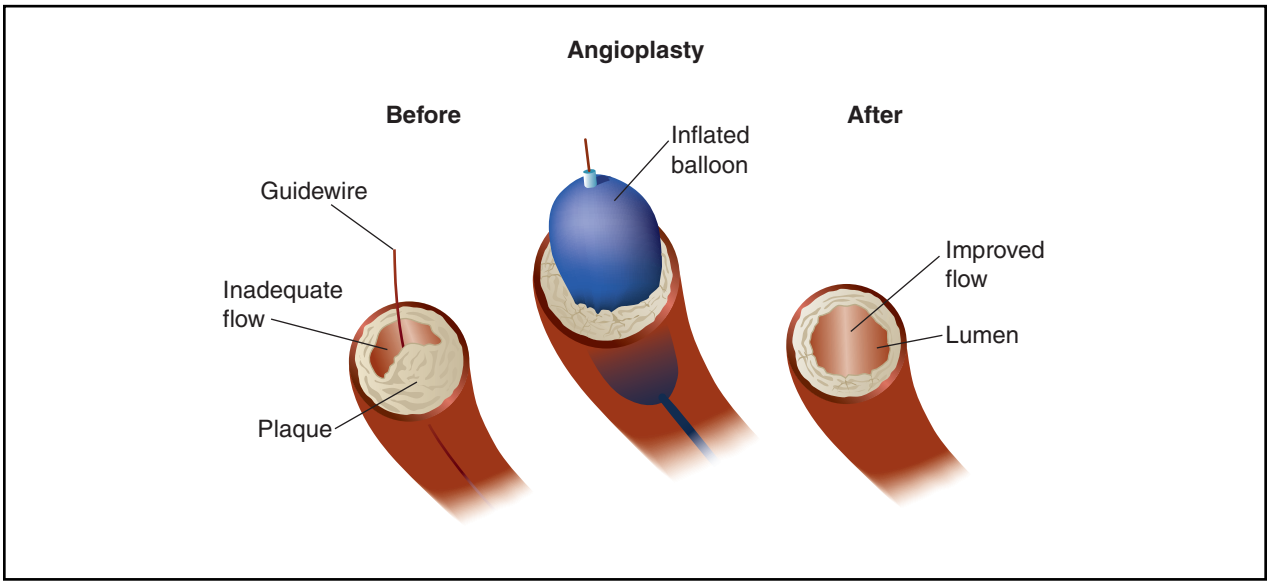
Angioplasty

Definition

Angioplasty is a term describing a procedure used to widen vessels narrowed by stenoses or occlusions. There are various types of these procedures and their names are associated with the type of vessel entry and equipment used. For example, percutaneous transluminal angioplasty (PTA) describes entry through the skin (percutaneous) and navigates to the area of the vessel of interest through the same vessel or one that communicates with it (transluminal). In the case of a procedure involving the coronary arteries, the point of entry could be the femoral artery in the groin and the catheter/guidewire system is passed through the aorta to the heart and the origin of the coronary arteries at the base of the aorta just outside the aortic valve.

Purpose

In individuals with an occulsive vascular disease such as **atherosclerosis**, blood flow is impaired to an organ (such as the heart) or to a distal body part (such as the lower leg) by the narrowing of the vessel's lumen due to fatty deposits or calcium accumulation. This narrowing may occur in any vessel but may occur anywhere. Once the vessel has been widened, adequate blood flow is returned. The vessel may narrow again over time at the same location and the procedure could be repeated.



In balloon angioplasty, plaque is pushed out of the clogged artery by the inflation of the balloon device. *(Illustration by Argosy Inc.)*

Precautions

Angioplasty procedures are performed on hospital inpatients in facilities for proper monitoring and recovery. If the procedure is to be performed in a coronary artery, the patient's care is likely to be provided by specially trained physicians, nurses, and vascular specialists. Typically, patients are given anticoagulants prior to the procedure to assist in the prevention of thromboses (blood clots). Administration of anticoagulants, however, may impede the sealing of the vascular entry point. The procedure will be performed using fluoroscopic guidance and contrast media. Since the decision to perform angioplasty may have been made following a diagnostic angiogram, the patient's sensitivity to iodinated contrast media is likely to known. The procedure may then require the use of non-ionic contrast agents.

Description

Angioplasty was originally performed by dilating the vessel with the introduction of larger and larger stiff catheters through the narrowed space. Complications of this procedure caused researchers to develop means of widening the vessel using a minimally sized device. Today, catheters contain balloons that are inflated to widen the vessel and stents to provide structural support for the vessel. Lasers may be used to assist in the break up of the fat or calcium plaque. Catheters may also be equipped with spinning wires or drill tips to clean out the plaque.

Angioplasty may be performed while the patient is sedated or anesthetized, depending on the vessels involved. If a percutaneous transluminal coronary angioplasty (PTCA) is to be performed, the patient will be kept awake to report on discomfort and **cough** if required. PTCA procedures are performed in **cardiac catheterization** labs with sophisticated monitoring devices. If angioplasty is performed in the radiology department's angiographic suite, the patient may be sedated for the procedure and a nurse will monitor the patient's vital signs during the procedure. If performed by a vascular surgeon, the angioplasty procedure will be performed in an operating room or specially designed vascular procedure suite.

The site of the introduction of the angioplasty equipment is prepared as a sterile surgical site. Although many procedures are performed by puncturing the vessel through skin, many procedures are also performed by surgically exposing the site of entry. Direct view of the vessel's puncture site aids in monitoring damage to the vessel or excessive bleeding at the site. Once the vessel is punctured and the guidewire is introduced, fluoroscopy is used to monitor small injections of contrast media used to visualize the path through the vessel. If the fluoroscopy system has a feature called 'roadmap', the amount of contrast media injected will be greater in order to define the full route the guidewire will take. The fluoroscopy system will then superimpose subsequent images over the roadmap while the vessel is traversed, that is, the physician moves the guidewire along the map to the destination.

Having reached the area of stenosis, the physician will inflate the balloon on the catheter that has been

passed along the guidewire. Balloons are inflated in size and duration depending on the size and location of the vessel. In some cases, the use of a stent (a mesh of wire that resembles a Chinese finger puzzle) may also be used. The vessel may be widened before, during, or after the deployment of the stent. Procedures for deploying stents are dependent on the type of stent used. In cases where the vessel is tortuous or at intersections of vessels, the use of a graph may be necessary to provide structural strength to the vessel. Stents, graphs, and balloon dilation may all be used together or separately.

The procedure is verified using fluoroscopy and contrast media to produce an angiogram or by using intravascular ultrasound or both. All equipment is withdrawn from the vessel and the puncture site repaired.

Risks

During the procedure there is a danger of puncturing the vessel with the guidewire. This is a very small risk. Patients must be monitored for hematoma or hemorrhage at the puncture site. There is also a small risk of **heart attack**, emboli, and although unlikely **death**. Hospitalization will vary in length by the patient's overall condition, any complications, and availability of home care.

Resources

BOOKS

Thomas MD MPH, Clayton L. editor. *Taber's Cyclopedic Medical Dictionary.* Philadelphia, PA: F.A. Davis Company, 1985.

Schneider MD, Peter A. *Endovascular Skills: Guidewires, Catheters, Arteriography, Balloon Angioplasty, Stents.* St. Louis, MO: Quality Medical Publishing, Inc., 1998.

Wojtowycz MD, Mryon. *Handbooks in Radiology-Interventional Radiology and Agiography.* Chicago, IL: Year Book Medical Publishers, Inc., 1990.

PERIODICALS

Carnall, Douglas. "Angioplasty." *The Western Journal of Medicine* (September 2000):v173 i3 p201

"New Imaging Technique Could Improve Outcome of Popular Heart Procedure." *Heart Disease Weekly* (May 13, 2001):3

"Success clearing clogged arteries." *Science News* (February 3, 2001):v159 i5 p72

"The angioplasty correct follow up strategy after stent implantation." *Heart* (April, 2001):v85 i4 p363.

OTHER

"Cardiovascular System" Miami Heart Research Institute. 2001. <http://www.miamiheartresearch.org/LearningCenter/YourCardiovascular/Cardiovascular.htm (July 5, 2001).

"Coronary angioplasty: Opening clogged arteries" MayoClinic.com, Condition Centers, Treatments and tests. 2000. <http://www.mayoclinic.com> (July 5, 2001).

KEY TERMS

Plaque—In atherosclerosis, a swollen area in the lining of an artery formed by fatty deposits.

Cardiac catheterization—A procedure to pass a catheter to the heart and its vessels for the purpose of diagnosing coronary artery disease, assessing injury or disease of the aorta, or evaluating cardiac function.

EKG—Electrocardiogram, used to study and record the electrical activity of the heart.

"Heart & Stroke Guide: Laser Angioplasty." *American Heart Association online.* 2000. <http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/angiol.html> (July 5, 2001).

"STS Patient Information: What to Expect after your Heart Surgery." Society of Thoracic Surgeons online. 2000. <http://www.sts.org/doc/3563> (July 5, 2001).

"When you need to have Angioplast: A patient guide" Heart Information Network. 2000. <http://www.heartinfo.org/news97/gdangio111897.htm> (July 5, 2001).

Elaine R. Proseus, MBA/TM, BSRT, RT(R)

Angiotensin-converting enzyme inhibitors

Definition

Angiotensin-converting enzyme inhibitors (also called ACE inhibitors) are medicines that block the conversion of the chemical angiotensin I to a substance that increases salt and water retention in the body.

Purpose

ACE inhibitors are used in the treatment of high blood pressure. They may be used alone or in combination with other medicines for high blood pressure. They work by preventing a chemical in the blood, angiotensin I, from being converted into a substance that increases salt and water retention in the body. Increased salt and water retention lead to high blood pressure. ACE inhibitors also make blood vessels relax, which helps lower blood pressure and allows more oxygen-rich blood to reach the heart.

Treating high blood pressure is important because the condition puts a burden on the heart and the arteries, which can lead to permanent damage over time. If untreated, high blood pressure increases the risk of heart attacks, **heart failure**, **stroke**, or kidney failure.

ACE inhibitors may also be prescribed for other conditions. For example, captopril (Capoten) is used to treat kidney problems in people who take insulin to control diabetes. Captopril and lisinopril are also given to some patients after a **heart attack**. Heart attacks damage and weaken the heart muscle, and the damage continues even after a person recovers from the attack. This medicine helps slow down further damage to the heart. ACE inhibitors also may be used to treat congestive heart failure.

Description

ACE inhibitors are available only with a physician's prescription and come in tablet, capsule, and injectable forms. Some commonly used ACE inhibitors are benazepril (Lotensin), captopril (Capoten), enalapril (Vasotec), fosinopril (Monopril), lisinopril (Prinivil, Zestril), moexipril (Univasc), perindopril (Aceon), quinapril (Accupril), ramipril (Altace) and trandolapril (Mavik).

Recommended dosage

The recommended dosage depends on the type of ACE inhibitor and the medical condition for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

This medicine may take weeks to noticeably lower blood pressure. Take it exactly as directed.

Do not stop taking this medicine without checking with the physician who prescribed it.

Precautions

A person taking an ACE inhibitor should see a physician regularly. The physician will check the blood pressure to make sure the medicine is working as it should and will note any unwanted side effects. People who have high blood pressure often feel perfectly fine. However, they should continue to see their physicians even when they feel well so that the physician can keep a close watch on their condition. It is also important for patients to keep taking their medicine even when they feel fine.

ACE inhibitors will not cure high blood pressure, but will help control the condition. To avoid the serious health problems that high blood pressure can cause, patients may have to take medicine for the rest of their lives. Furthermore, medicine alone may not be enough. Patients with high blood pressure may also need to avoid certain foods, such as salty snacks, and keep their weight under control. The health care professional who is treating the condition can offer advice on what measures may be necessary. Patients being treated for high blood pressure should not change their **diets** without consulting their physicians.

Anyone taking this medicine for high blood pressure should not take any other prescription or over-the-counter (OTC) medicine without first checking with his or her physician. Some medicines, such as certain cold remedies, may increase blood pressure.

Some people feel dizzy or lightheaded after taking the first dose of an ACE inhibitor, especially if they have been taking a water pill (diuretic). Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them. Such symptoms should be reported to the physician or pharmacist if they do not subside within a day or so. For the first one or two days of taking an ACE inhibitor, patients may become lightheaded when arising from bed in the morning. Patienst should rise slowly to a sitting position before standing up.

While a goal of treatment with an ACE inhibitor is to lower the blood pressure, patients must be careful not to let their blood pressure get too low. Low blood pressure can lead to **dizziness**, lightheadedness and **fainting**. To prevent the blood pressure from getting too low, observe these precautions:

- Do not drink alcohol without checking with the physician who prescribed this medicine.
- Captopril and moexipril should be taken one hour before meals. Other ACE inhinbitors may be taken with or without meals.
- Avoid overheating when exercising or in hot weather. The loss of water from the body through heavy sweating can cause low blood pressure.
- Check with a physician right away if illness occurs while taking an ACE inhibitor. This is especially true if the illness involves severe nausea, vomiting, or **diarrhea**. Vomiting and diarrhea can cause the loss of too much water from the body, which can lead to low blood pressure.

Anyone who is taking ACE inhibitors should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some ACE inhibitors may change the results of certain medical tests, such as blood or urine tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Do not use a potassium supplement or a salt substitute that contains potassium without first checking with the physician who prescribed the ACE inhibitor.

Patients who are being treated with bee or wasp venom to prevent allergic reactions to stings may have a severe allergic reaction to certain ACE inhibitors.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take ACE inhibitors. Before taking these drugs, be sure to let the physician know about any of these conditions.

ALLERGIES. Anyone who has had unusual reactions to an ACE inhibitor in the past should let his or her physician know before taking this type of medicine again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. The use of ACE inhibitors in **pregnancy** can cause serious problems and even **death** in the fetus or newborn. Women who are pregnant or who may become pregnant should check with their physicians before using this medicine. Women who become pregnant while taking this medicine should check with their physicians immediately.

BREASTFEEDING. Some ACE inhibitors pass into breast milk. Women who are breastfeeding should check with their physicians before using ACE inhibitors.

OTHER MEDICAL CONDITIONS. Before using ACE inhibitors, people with any of these medical problems should make sure their physicians are aware of their conditions:

- diabetes
- heart or blood vessel disease
- recent heart attack or stroke
- liver disease
- kidney disease
- kidney transplant
- scleroderma
- systemic lupus erythematosus (SLE)

USE OF CERTAIN MEDICINES. Taking ACE inhibitors with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effect is a dry, continuing **cough**. This usually does not subside unless the medication is stopped. Ask the physician if the cough can be treated. Less common side effects, such as **headache**, loss of taste, unusual tiredness, and nausea or diarrhea also may occur and do not need medical attention unless they are severe or they interfere with normal activities.

More serious side effects are rare, but may occur. If any of the following side effects occur, check with a physician immediately:

- swelling of the face, lips, tongue, throat, arms, legs, hands, or feet
- itchy skin
- sudden breathing or swallowing problems
- chest pain
- hoarseness
- sore throat
- fever and chills
- stomach pain
- yellow eyes or skin

In addition, anyone who has any of the following symptoms while taking an ACE inhibitor should check with his or her physician as soon as possible:

- dizziness, lightheadedness, fainting
- confusion
- nervousness
- fever
- joint pain
- numbness or tingling in hands, feet, or lips
- weak or heavy feeling in the legs
- skin rash
- irregular heartbeat
- shortness of breath or other breathing problems

Other side effects may occur. Anyone who has unusual symptoms after taking an ACE inhibitor should get in touch with his or her physician.

Interactions

ACE inhibitors may interact with certain foods and other medicines. For example, captopril (Capoten) interacts with food and should be taken one hour before meals. Anyone who takes ACE inhibitors should let the physician know all other medicines he or she is taking and should ask about foods that should be avoided.

KEY TERMS

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Fetus—A developing baby inside the womb.

Scleroderma—A disease that first affects the skin and later affects certain internal organs. The first symptoms are the hardening, thickening, and shrinking of the skin.

Systemic lupus erythematosus (SLE)—A chronic disease that affects the skin, joints, and certain internal organs.

Venom—A poisonous substance secreted by an animal, usually delivered through a bite or a sting.

Among the foods and drugs that may interact with ACE inhibitors are:

- water pills (diuretics)
- lithium, used to treat bipolar disorder
- tetracycline, an antibiotic
- medicines or supplements that contain potassium
- salt substitutes that contain potassium

The list above may not include everything that interacts with ACE inhibitors. Be sure to check with a physician or pharmacist before combining ACE inhibitors with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Angiotensin-converting enzyme test

Definition

This test measures blood levels of angiotensin-converting enzyme (ACE), also known as Serum Angiotensin-Converting Enzyme (SASE). The primary function of ACE is to help regulate arterial pressure by converting angiotensin I to angiotensin II.

Purpose

The ACE test is used primarily to detect and monitor the clinical course of **sarcoidosis** (a disease that affects many organs, especially the lungs), to differentiate between sarcoidosis and similar diseases, and to delineate between active and inactive sarcoid disease. Elevated ACE levels are also found in a number of other conditions, including Gaucher's disease (a rare familial disorder of fat metabolism) and **leprosy**.

Precautions

It should be noted that people under 20 years of age normally have very high ACE levels. Decreased levels may be seen in the condition of excess fat in the blood (hyperlipidemia). Drugs that may cause decreased ACE levels include ACE inhibitor antihypertensives and steroids.

Description

ACE plays an important role in the renin/aldosterone mechanism which controls blood pressure by converting angiotensin I to angiotensin II, two proteins involved in regulating blood pressure. Angiotensin I by itself is inactive, but when converted by ACE to the active form, angiotensin II, it causes narrowing of the small blood vessels in tissues, resulting in an increase in blood pressure. Angiotensin II also stimulates the hormone aldosterone, which causes an increase in blood pressure. Certain kidney disorders increase the production of angiotensin II, another cause of **hypertension**. Despite the action of ACE on blood pressure regulation, determination of this enzyme is not very helpful in the evaluation of hypertension (high blood pressure).

Preparation

Determination of ACE levels requires a blood sample. The patient need not be **fasting**.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal ranges for this test are laboratory-specific but can range from 8-57 U/ml for patients over 20 years of age.

KEY TERMS

Sarcoidosis—Sarcoidosis is a rare disease of unknown cause in which inflammation occurs in lymph nodes and other tissues throughout the body, usually the lungs, skin, liver, and eyes.

Abnormal results

Serum ACE levels are elevated in approximately 80-90% of patients with active sarcoidosis. Thyroid hormone may have an effect on ACE activity, as hypothyroid (low thyroid) patients, as well as patients with **anorexia nervosa** with associated findings of **hypothyroidism**, may have low serum ACE activity. ACE can also be decreased in lung **cancer** (bronchogenic carcinoma).

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Animal bite infections

Definition

The most common problem following an animal bite is simple infection. The saliva of dogs and cats is known to contain a wide variety of bacteria. According to one recent study, bacteria or other pathogens show up in about 85 percent of bites. When an animal bites, it can then transmit pathogens into the wound. These microorganisms may grow within the wound and cause an infection. The consequences of infection range from mild discomfort to life-threatening complications.

Description

Two to 4.5 million animal bites occur each year in the United States and about 1% of bites require hospitalization. Animal bites result in 334,000 emergency room visits per year, which represents approximately 1% of all emergency hospital visits, at an annual cost of $100 million dollars in health care expenses and lost income. Children are the most frequent victims of dog bites, with 5-9 year-old boys having the highest incidence. Men are more often bitten by dogs than are women (3:1), whereas women are more often bitten by cats (3:1).

Dog bites make up 80-85% of all reported incidents. Cats account for about 10% of reported bites, and other animals (including rodents, rabbits, horses, raccoons, bats, skunks, and monkeys) make up the remaining 5-10%. Cat bites become infected more frequently than dog bites. A dog's mouth is rich in bacteria, but only 15-20% of dog bites become infected. In contrast, approximately 30-50% of cat bites become infected.

Many factors contribute to the infection rates, such as, for example, the type of wound inflicted, the location of the wound, pre-existing health conditions in the bitten person, the extent of delay before treatment, patient compliance and the presence of a foreign body in the wound. Dogs usually inflict crush injuries because they have rounded teeth and strong jaws; thus, the bite of an adult dog can exert up to 200 pounds per square inch of pressure. This pressure usually results in a crushing injury, causing damage to deep structures such as bones, blood vessels, tendons, muscles, and nerves. Dog canine teeth are also sharp and strong and also inflict lacerations. Cats, with their needle-like fangs, typically cause puncture **wounds**. Puncture wounds appear innocuous on the surface, but the underlying injury goes deep. Cat teeth essentially inject bacteria into the bite, and the deep, narrow wound is difficult to clean. Persons with impaired immunocompetence—for example, individuals with HIV infection—are especially vulnerable to infection.

The bacterial species most commonly found in bite wounds include *Pasteurella multocida*, *Staphylococcus aureus*, *Pseudomonas sp*, and *Streptococcus sp*. *P. multocida*, the root cause of pasteurellosis, is especially prominent in cat bite infections. Other infectious diseases from animal bites include **cat-scratch disease**, **tetanus** and **rabies**.

Causes and symptoms

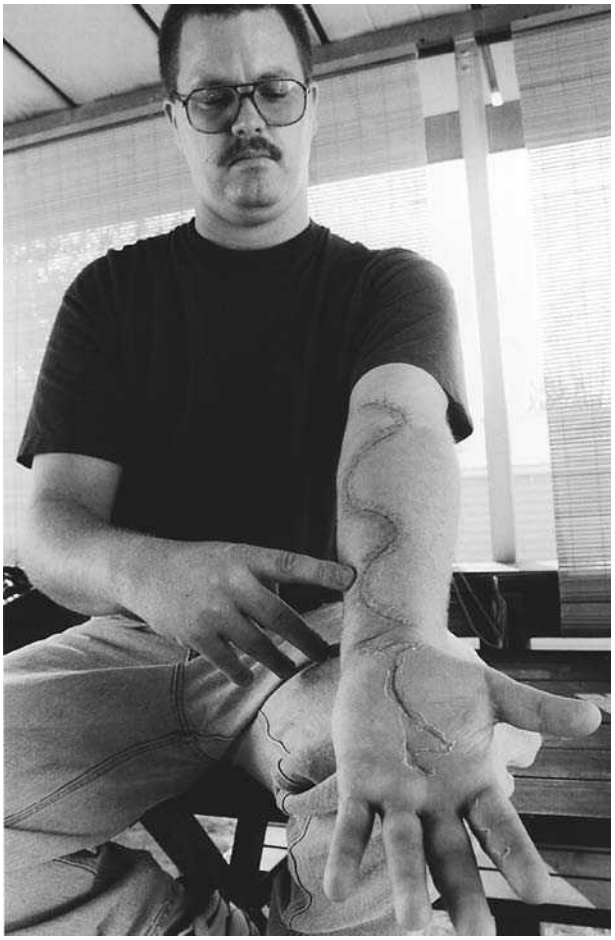
The most common sign of infection from an animal bite is inflammation. The skin around the wound is red and feels warm, and the wound may exude pus. Nearby lymph glands may be swollen. Complications can arise if the infection is not treated and spreads into deeper structures or into the bloodstream. If the bite is deep or occurs on the hand or at a joint, complications are more likely.

Live, disease-causing bacteria within the bloodstream and tissues cause complications far from the wound site. Such complications include **meningitis**, brain abscesses, **pneumonia** and lung abscesses, and heart infections, among others. These complications can be fatal. Deep bites or bites near joints can damage joints

and bones, causing inflammation of the bone and bone marrow or septic arthritis.

Cat-scratch disease is caused by *Bartonella henselae*, a bacterium that is carried in cat saliva; infection may be transmitted by a bite or scratch. Approximately 22,000 cases are reported each year in the United States; worldwide, nine out of every 100,000 individuals become infected. More than 80% of reported cases occur in persons under the age of 21. The disease is not normally severe in individuals with healthy immune systems. Symptoms may become serious, however, in immunocompromised individuals, such as those with acquired immune deficiency syndrome (**AIDS**) or those undergoing **chemotherapy**. Common symptoms include an inflamed sore in the area of the bite or scratch, swollen lymph nodes, **fever**, **fatigue**, and rash.

Rabies is caused by a virus that is transmitted through the bite of an animal that is already infected. More than 90% of animal rabies cases occur in wild animals such as skunks, bats, and raccoons, with domestic animals such as dogs and cats accounting for less than 10%. The World Health Organization (WHO) estimates that between 35,000 and 50,000 individuals worldwide die each year as a result of rabies. The highest incidence of rabies occurs in Asia where, in 1997, over 33,000 deaths were noted, most occurring in India. Rabies is nowadays rare in the U.S. due to good animal control practice. The delay of onset is usually weeks to months after being bitten. Early symptoms of rabies include fever, **headache**, and flu-like symptoms. These progress to **anxiety**, **hallucinations**, muscle spasms, partial **paralysis**, fear of water (hydrophobia), and other neurological symptoms as the virus spreads to the central nervous system. Medical treatment must be sought soon after exposure because **death** invariably follows once the infection becomes established.



This snake breeder shows the scar from his surgery after he was bitten by a venomous West African Gabon viper. His arm was cut open in order to relieve swelling from the snake bite in his middle finger. *(Photograph by Joe Crocetta, AP/Wide World Photo. Reproduced by permission.)*

Diagnosis

A medical examination involves taking the history of the injury and assessing the wound type and damage. Tetanus immunization and general health status are checked. An x ray may be ordered to assess bone damage and to check for **foreign objects** in the wound. Wound cultures are done for infected bites if the victim is at high risk for complications or if the infection does not respond to treatment. Evaluation of possible exposure to rabies is also important. A biting animal suspected of having rabies is usually apprehended, tested, and observed for a period of time for evidence of pre-existing infection.

Treatment

Treatment depends on the wound type, its site, and risk factors for infection. All wounds are cleaned and disinfected as thoroughly as possible. Bites to the head and face usually receive sutures, as do severe lacerations elsewhere. Puncture wounds are left open. If **abscess** formation occurs, the physician may perform an incision so as to drain the abscess.

If infection occurs, **antibiotics** are prescribed. Antibiotics may also be used for infection prevention. Since a single bite wound may contain many different types of bacteria, no single antibiotic is always effective. Commonly prescribed antibiotics are penicillin or a combination of amoxicillin and clavulanate potassium.

Because rabies is caused by a virus, antibiotics are not effective. In addition, as of 2001, there is no known cure for the disease once symptoms become apparent. It is therefore recommended that individuals with a high risk of contracting the disease (veterinarians, animal handlers, some laboratory workers) receive preexposure **vac-**

KEY TERMS

Canines—The two sharp teeth located next to the front incisor teeth in mammals that are used to grip and tear.

Culture—A laboratory procedure in which a sample from a wound, the blood or other body fluid is taken from an infected person. The sample is placed in conditions under which bacteria can grow. If bacteria grow, identification tests are done to determine the bacteria species causing the infection.

Immunocompetence—An individual's ability to fight off infection.

Microorganisms—Microscopic organisms, such as bacteria, viruses, algae and fungi.

Pasteurellosis—A bacterial infection caused by *Pasteurella multocida*. Pasteurellosis is characterized by inflammation around the wound site and may be accompanied by bacteria in the bloodstream and infection in tissues and organs.

Pathogen—Any disease producing microorganism.

Postexposure prophylaxis (PEP)—Any treatment given after exposure to a disease to try to prevent the disease from occurring. In the case of rabies, PEP involves a series of vaccines given to an individual who has been bitten by an unknown animal or one that is potentially infected with the rabies virus.

cination. Individuals bitten by an unknown or potentially rapid animal should receive postexposure vaccination, also called postexposure **prophylaxis** (PEP). The PEP regimen consists of one vaccine given at the initial visit as well as one dose of human immune globulin. Additional vaccines given on days 3, 7, 14, and 28.

Prognosis

Once a bacterial infection is halted, the bite victim usually recovers fully. There is no known cure for rabies once symptoms become evident and death is almost certain. WHO reports that 114 rabies deaths occurred in the Americas in 1997, with only four deaths occurring that year in the United States, thus emphasizing the importance of good animal control practice and postexposure prophylaxis.

Prevention

Preventing bites obviously prevents subsequent infections. Children under 12 years of age are at a higher risk for bites due to their small size and their inexperience with animals; therefore, they should be supervised with animals and taught to act appropriately around them. An animal that is unusually aggressive or behaving strangely (e.g. a raccoon that is active during the daytime) should be avoided and reported to the local animal control authorities; it may be infected with the rabies virus. All pets should be vaccinated against rabies and wild animals should not be taken in as pets. People should also avoid trying to break up fights between animals and should as a rule approach unknown cats and dogs very cautiously, especially on their territory. Finally, animals should not be trained to fight.

Resources

BOOKS

Kizer, Kenneth W. "Animal Bites." In *Infectious Diseases.* 2nd ed. Ed. Sherwood L. Gorbach, John G. Bartlett, and Neil R. Blacklow. Philadelphia: W. B. Saunders, 1998.

PERIODICALS

Dumyati, Ghinwa K., Nayef El-Daher, and C. Richard Magnussen. "Animal and Human Bite Wounds: Immunization, Prophylaxis, and Treatment." *Consultant* 37 (June 1997): 1501.

Lewis, Katherine T., and Melissa Stiles. "Management of Cat and Dog Bites." *American Family Physician* 52 (August 1995): 479.

Presutti, R. John. "Bite Wounds: Early Treatment and Prophylaxis Against Infectious Complications." *Postgraduate Medicine* 101 (April 1997): 243-54.

OTHER

"Farm Animal Zoonotic and Reportable Diseases." University of Arizona, University Animal Care. 2000. <http://www.ahsc.arizona.edu/uac/notes/classes/farmzoodisease 00/farmzoo2000.html>.

"Rabies Situation and Trends." World Health Organization. 2001. <http://www.who.int/emc/diseases/zoo/ rabies.html>.

Julia Barrett

Ankylosing spondylitis

Definition

Ankylosing spondylitis (AS) refers to inflammation of the joints in the spine. AS is also known as rheumatoid spondylitis or Marie-Strümpell disease (among other names).

Description

A form of arthritis, AS is characterized by chronic inflammation, causing **pain** and stiffness of the back,

progressing to the chest and neck. Eventually, the whole back may become curved and inflexible if the bones fuse (this is known as "bamboo spine"). AS is a systemic disorder that may involve multiple organs, such as the:

- eye (causing an inflammation of the iris, or iritis)
- heart (causing aortic valve disease)
- lungs
- skin (causing a scaly skin condition, or psoriasis)
- gastrointestinal tract (causing inflammation within the small intestine, called ileitis, or inflammation of the large intestine, called colitis)

Less than 1% of the population has AS; however, 20% of AS sufferers have a relative with the disorder.

Causes and symptoms

Genetics play an important role in the disease, but the cause of AS is still unknown. More than 90% of patients have a gene called HLA-B27, but only 10-15% of those who inherit the gene develop the disease. Symptoms of AS include:

- low back and hip pain and stiffness
- difficulty expanding the chest
- pain in the neck, shoulders, knees, and ankles
- low-grade fever
- fatigue
- weight loss

AS is seen most commonly in males 30 years old and older. Initial symptoms are uncommon after the age of 30, although the diagnosis may not be established until after that age. The incidence of AS in Afro-Americans is about 25% of the incidence in Caucasians.

Diagnosis

Doctors usually diagnose the disease simply by the patient's report of pain and stiffness. Doctors also review spinal and pelvic x rays since involvement of the hip and pelvic joints is common and may be the first abnormality seen on the x ray. The doctor may also order a blood test to determine the presence of HLA-B27 antigen. When a diagnosis is made, patients may be referred to a rheumatologist, a doctor who specializes in treating arthritis. Patients may also be referred to an orthopedic surgeon, a doctor who can surgically correct joint or bone disorders.

Treatment

Nonsteroidal anti-inflammatory drugs (NSAIDs), like naproxen (Naprosyn) or indomethacin (Indocin) are used to relieve pain and stiffness. In severe cases, sulfasalazine (Azulfidine), another drug to reduce inflammation, or methotrexate (Rheumatrex), an immune-suppressing drug, is recommended. In cases where chronic therapy is needed, potential drug side effects must be taken into consideration. Corticosteroid drugs are effective in relieving symptoms, but are usually reserved for severe cases that do not improve when NSAIDs are used. To avoid potential side effects, treatment with **corticosteroids** is usually limited to a short amount of time with a gradual weaning from the drug.

Physical therapists prescribe exercises to prevent a stooped posture and breathing problems when the spine starts to fuse and ribs are affected. Back braces may be used to prevent continued deformity of the spine and ribs. Only in severe cases of deformity is surgery performed to straighten and realign the spine, or to replace knee, shoulder, or hip joints.

Alternative treatment

To reduce inflammation various herbal remedies, including white willow (*Salix alba*), yarrow (*Achillea millefolium*), and lobelia (*Lobelia inflata*), may be helpful. **Acupuncture**, performed by a trained professional, has helped some patients manage their pain. Homeopathic practitioners may prescribe such remedies as *Bryonia* and *Rhus toxicodendron* for pain relief.

Prognosis

There is no cure for AS, and the course of the disease is unpredictable. Generally, AS progresses for about 10 years and then its progression levels off. Most patients can lead normal lives with treatment to control symptoms.

Prevention

There is no known way to prevent AS.

Resources

BOOKS

Brewer Jr., Earl J., and Kathy Cochran Angel. *The Arthritis Sourcebook*. Los Angeles: Lowell House, 1993.

Swezey, Robert L. *Straight Talk on Spondylitis*. Spondylitis Association of America, 1994.

Taurog, Joel D., and Peter E. Lipsky. "Ankylosing Spondylitis, Reactive Arthritis, and Undifferentiated Spondyloarthropathy." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Arthritis Foundation.1300 W. Peachtree St., Atlanta, GA 30309. (800) 283-7800. <http://www.arthritis.org>.

KEY TERMS

Ankylosing—When bones of a joint are fused, stiff, or rigid.

HLA-B27—An antigen or protein marker on cells that may indicate ankylosing spondylitis.

Immune suppressing—Anything that reduces the activity of the immune system.

Inflammation—A reaction of tissues to disease or injury, often associated with pain and swelling.

Spondylitis—An inflammation of the spine.

National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse. 1 AMS Circle, Bethesda, MD 29892-3675. (301) 495-4484.

Spondylitis Association of America. P.O. Box 5872, Sherman Oaks, CA 91413. (800) 777-8189.

OTHER

Matsen III, Frederick, ed. "Ankylosing Spondylitis." University of Washington Orthopaedics and Sports Medicine. <http://www.orthop.washington.edu/arthritis/types/ankylosingspondylitis>.

Jeanine Barone, Physiologist

Anorectal abscess *see* **Anorectal disorders**

Anorectal disorders

Definition

Anorectal disorders are a group of medical disorders that occur at the junction of the anal canal and the rectum.

Description

The anal canal, also called the anus, is the opening at the bottom end of the digestive tract and is a combination of external skin and tissue from the digestive tract. It has many sensory nerves and is sensitive to **pain**. The rectum is the last section of the digestive tract and has a mucus layer as its inside surface. It has very few sensory nerves and is, therefore, relatively insensitive to pain. The anal canal has a ring of muscle, called the anal sphincter, which keeps the anus closed. There are a number of different anorectal disorders.

Causes and symptoms

Hemorrhoids are swollen or **varicose veins** in the anal canal and rectum. They may become inflamed, enlarged, or protrude from the anorectal area. Hemorrhoids may bleed when passing a bowel movement. The amount of bleeding is typically small. Frequently, hemorrhoids develop because of straining during bowel movements, especially if the person has **constipation**.

An anal fissure is a tear in the lining of the anus that is usually caused by a hard bowel movement. Fissures are painful and bleed when the tissue is stressed during bowel movements.

Anorectal abscesses are characterized by pus-forming infections in the anorectal region. Painful abscesses form under the skin.

An anorectal fistula is an abnormal opening or channel from the anorectal area to another part of the body. Typically, the channel leads to pockets of skin near the anus. When seen in infants, anorectal fistulas are considered **birth defects**. These are seen more frequently in boys than in girls. Fistulas are also seen more frequently in people who have other diseases, including **Crohn's disease**, **tuberculosis**, **cancer**, and diverticulitis. Anorectal fistulas also occur following anorectal abscesses or other injury to the anal area. Fistulas are usually painful and discharge pus.

Proctitis is an inflammation of the internal mucosal lining of the rectum. Ulcers of the lining may form and develop into **ulcerative colitis**. There are many causes of proctitis, including the **sexually transmitted diseases** chlamydia and herpes simplex infections. Proctitis is frequently seen in homosexual males as a consequence of anorectal infection. Proctitis itself is not painful, but pain may be caused by the infectious agent.

Diagnosis

Diagnosis is made by visual inspection of the skin around the anus. Also, the doctor may probe the rectum with a gloved finger. An anoscope is a short instrument that allows the physician to view the inside of the anus. A proctoscope is a longer, rigid viewing tube of approximately six to ten inches in length, which may be used to look for anorectal disorders. A sigmoidoscope is a longer, flexible tube, that allows the physician to view up to about two feet of the inside of the large intestine. Tissue samples and material for microbial culture may be obtained during the examination.

Treatment

Treatment usually isn't required for hemorrhoids. Most hemorrhoids will heal if the patient takes stool soft-

eners to relieve the constipation. Enlarged blood vessels can be eliminated by surgery if they are considered a severe problem. In the case of fissures, treatment involves stool softeners that eliminate **stress** on the fissure during bowel movements, which allows the fissure to heal. If the fissure doesn't heal, surgery is required. Treatment for anorectal abscesses consists of cutting the **abscess** and draining the pus. Fistulas are treated by surgery.The usual treatment for proctitis is **antibiotics**.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Edwards, C. R. W., I. A. D. Bouchier, and C. Haslett. *Davidson's Principles and Practices of Medicine*. Edinburgh: Churchill Livingstone, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

John T. Lohr, PhD

Anorectal fistula *see* **Anorectal disorders**

Anorexia nervosa

Definition

Anorexia nervosa is an eating disorder characterized by unrealistic fear of weight gain, self-starvation, and conspicuous distortion of body image. The name comes from two Latin words that mean nervous inability to eat. In females who have begun to menstruate, anorexia nervosa is usually marked by **amenorrhea**, or skipping at least three menstrual periods in a row. The fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders*, or *DSM-IV* (1994), defines two subtypes of anorexia nervosa—a restricting type, characterized by strict dieting and **exercise** without binge eating; and a binge-eating/purging type, marked by episodes of compulsive eating with or without self-induced vomiting and the use of **laxatives** or **enemas**. *DSM-IV* defines a binge as a time-limited (usually under two hours) episode of compulsive eating in which the individual consumes a significantly larger amount of food than most people would eat in similar circumstances.

Description

Anorexia nervosa was not officially classified as a psychiatric disorder until the third edition of *DSM* in 1980. It is, however, a growing problem among adolescent females. Its incidence in the United States has doubled since 1970. The rise in the number of reported cases reflects a genuine increase in the number of persons affected by the disorder, and not simply earlier or more accurate diagnosis. Estimates of the incidence of anorexia range between 0.5–1% of caucasian female adolescents. Over 90% of patients diagnosed with the disorder as of 1998 are female. It was originally thought that only 5% of anorexics are male, but that estimate is being revised upward. The peak age range for onset of the disorder is 14-18 years, although there are patients who develop anorexia as late as their 40s. In the 1970s and 1980s, anorexia was regarded as a disorder of upper- and middle-class women, but that generalization is also changing. More recent studies indicate that anorexia is increasingly common among women of all races and social classes in the United States.

Anorexia nervosa is a serious public health problem not only because of its rising incidence, but also because it has one of the highest mortality rates of any psychiatric disorder. Moreover, the disorder may cause serious long-term health complications, including congestive **heart failure**, sudden **death**, growth retardation, dental problems, **constipation**, stomach rupture, swelling of the salivary glands, anemia and other abnormalities of the blood, loss of kidney function, and **osteoporosis**.

Causes and symptoms

Anorexia is a disorder that results from the interaction of cultural and interpersonal as well as biological factors. While the precise cause of the disease is not known, it has been linked to the following:

Social influences

The rising incidence of anorexia is thought to reflect the present idealization of thinness as a badge of upper-class status as well as of female beauty. In addition, the increase in cases of anorexia includes "copycat" behavior, with some patients developing the disorder from imitating other girls.

The onset of anorexia in adolescence is attributed to a developmental crisis caused by girls' changing bodies coupled with society's overemphasis on women's looks. The increasing influence of the mass media in spreading and reinforcing gender stereotypes has also been noted.

Occupational goals

The risk of developing anorexia is higher among adolescents preparing for careers that require attention to weight and/or appearance. These high-risk groups

include dancers, fashion models, professional athletes (including gymnasts, skaters, long-distance runners, and jockeys), and actresses.

Genetic and biological influences

Women whose biological mothers or sisters have the disorder appear to be at increased risk.

Psychological factors

A number of theories have been advanced to explain the psychological aspects of the disorder. No single explanation covers all cases. Anorexia nervosa has been interpreted as:

- A rejection of female sexual maturity. This rejection is variously interpreted as a desire to remain a child, or as a desire to resemble men as closely as possible.
- A reaction to sexual **abuse** or assault.
- A desire to appear as fragile and nonthreatening as possible. This hypothesis reflects the idea that female passivity and weakness are attractive to men.
- Overemphasis on control, autonomy, and independence. Some anorexics come from achievement-oriented families that **stress** physical fitness and dieting. Many anorexics are perfectionistic and "driven" about schoolwork and other matters in addition to weight control.
- Evidence of family dysfunction. In some families, a daughter's eating disorder serves as a distraction from marital discord or other family tensions.
- Inability to interpret the body's hunger signals accurately due to early experiences of inappropriate feeding.

Male anorexics

Although anorexia nervosa is still considered a disorder that largely affects women, its incidence in the male population is rising. Less is known about the causes of anorexia in males, but some risk factors are the same as for females. These include certain occupational goals and increasing media emphasis on external appearance in men. Moreover, homosexual males are under pressure to conform to an ideal body weight that is about 20 pounds lighter than the standard "attractive" weight for heterosexual males.

Diagnosis

Diagnosis of anorexia nervosa is complicated by a number of factors. One is that the disorder varies somewhat in severity from patient to patient. A second factor is denial, which is regarded as an early sign of the disorder. Most anorexics deny that they are ill and are usually brought to treatment by a family member.

Most anorexics are diagnosed by pediatricians or family practitioners. Anorexics develop emaciated bodies, dry or yellowish skin, and abnormally low blood pressure. There is usually a history of amenorrhea (failure to menstruate) in females, and sometimes of abdominal **pain**, constipation, or lack of energy. The patient may feel chilly or have developed lanugo, a growth of downy body hair. If the patient has been vomiting, she may have eroded tooth enamel or Russell's sign (scars on the back of the hand). The second step in diagnosis is measurement of the patient's weight loss. *DSM-IV* specifies a weight loss leading to a body weight 15% below normal, with some allowance for body build and weight history.

The doctor will need to rule out other physical conditions that can cause weight loss or vomiting after eating, including metabolic disorders, brain tumors (especially hypothalamus and pituitary gland lesions), diseases of the digestive tract, and a condition called superior mesenteric artery syndrome. Persons with this condition sometimes vomit after meals because the blood supply to the intestine is blocked. The doctor will usually order blood tests, an electrocardiogram, **urinalysis**, and bone densitometry (**bone density test**) in order to exclude other diseases and to assess the patient's nutritional status.

The doctor will also need to distinguish between anorexia and other psychiatric disorders, including depression, **schizophrenia**, social phobia, **obsessive-compulsive disorder**, and body dysmorphic disorder. Two diagnostic tests that are often used are the Eating Attitudes Test (EAT) and the Eating Disorder Inventory (EDI).

Treatment

Treatment of anorexia nervosa includes both short- and long-term measures, and requires assessment by dietitians and psychiatrists as well as medical specialists. Therapy is often complicated by the patient's resistance or failure to carry out treatment plan.

Hospital treatment

Hospitalization is recommended for anorexics with any of the following characteristics:

- weight of 40% or more below normal; or weight loss over a three-month period of more than 30 pounds
- severely disturbed metabolism
- severe binging and purging
- signs of **psychosis**
- severe depression or risk of suicide
- family in crisis

Hospital treatment includes individual and **group therapy** as well as refeeding and monitoring of the patient's physical condition. Treatment usually requires two to four months in the hospital. In extreme cases, hospitalized patients may be force-fed through a tube inserted in the nose (nasogastric tube) or by over-feeding (hyperalimentation techniques).

Outpatient treatment

Anorexics who are not severely malnourished can be treated by outpatient psychotherapy. The types of treatment recommended are supportive rather than insight-oriented, and include behavioral approaches as well as individual or group therapy. **Family therapy** is often recommended when the patient's eating disorder is closely tied to family dysfunction. Self-help groups are often useful in helping anorexics find social support and encouragement. Psychotherapy with anorexics is a slow and difficult process; about 50% of patients continue to have serious psychiatric problems after their weight has stabilized.

Medications

Anorexics have been treated with a variety of medications, including antidepressants, **antianxiety drugs**, **selective serotonin reuptake inhibitors**, and lithium carbonate. The effectiveness of medications in treatment regimens is still debated. However, at least one study of Prozac showed it helped the patient maintain weight gained while in the hospital.

Prognosis

Figures for long-term recovery vary from study to study, but the most reliable estimates are that 40-60% of anorexics will make a good physical and social recovery, and 75% will gain weight. The long-term mortality rate for anorexia is estimated at around 10%, although some studies give a lower figure of 3-4%. The most frequent causes of death associated with anorexia are **starvation**, electrolyte imbalance, heart failure, and suicide.

Prevention

Short of major long-term changes in the larger society, the best strategy for prevention of anorexia is the cultivation of healthy attitudes toward food, weight control, and beauty (or body image) within families.

KEY TERMS

Amenorrhea—Absence of the menses in a female who has begun to have menstrual periods.

Binge eating—A pattern of eating marked by episodes of rapid consumption of large amounts of food; usually food that is high in calories.

Body dysmorphic disorder—A psychiatric disorder marked by preoccupation with an imagined physical defect.

Hyperalimentation—A method of refeeding anorexics by infusing liquid nutrients and electrolytes directly into central veins through a catheter.

Lanugo—A soft, downy body hair that develops on the chest and arms of anorexic women.

Purging—The use of vomiting, diuretics, or laxatives to clear the stomach and intestines after a binge.

Russell's sign—Scraped or raw areas on the patient's knuckles, caused by self-induced vomiting.

Superior mesenteric artery syndrome—A condition in which a person vomits after meals due to blockage of the blood supply to the intestine.

Resources

BOOKS

"Anorexia Nervosa." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Baron, Robert B. "Nutrition." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Cassell, Dana K., with Felix E. F. Larocca. *The Encyclopedia of Obesity and Eating Disorders*. New York: Facts on File, Inc., 1994.

Herzog, David B. "Eating Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

Kaplan, David W., and Kathleen A. Mammel. "Adolescence." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Mitchell, James E. "Anorexia Nervosa: Medical and Physiological Aspects." In *Handbook of Eating Disorders*, ed. Kelly D. Brownell and John P. Foreyt. New York: Basic Books, Inc., 1986.

"Physical Conditions in Adolescence: Anorexia Nervosa." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Pipher, Mary. *Reviving Ophelia: Saving the Selves of Adolescent Girls*. New York: Ballantine Books, 1994.

ORGANIZATIONS

American Anorexia/Bulimia Association. 418 East 76th St., New York, NY 10021. (212) 734-1114.

National Institute of Mental Health Eating Disorders Program, Building 10, Room 3S231. 9000 Rockville Pike, Bethesda, MD 20892. (301) 496-1891.

Rebecca J. Frey

Anoscopy

Definition

An anoscopy is an examination of the rectum in which a small tube is inserted into the anus to screen, diagnose, and evaluate problems of the anus and anal canal.

KEY TERMS

Anal fissure—An ulcer on the margin of the anus.

Digital rectal examination—An examination where a gloved, lubricated index finger is inserted into the rectum to check for any abnormalities.

Polyps—A tumor with a small flap that attaches itself to the wall of various vascular organs such as the nose, uterus and rectum. Polyps bleed easily, and if they are suspected to be cancerous they should be surgically removed.

Vasovagal reaction—Regarding the action of stimuli from the vagus nerve on blood vessels.

Purpose

This test may be ordered for the evaluation of perianal or anal **pain**, **hemorrhoids**, **rectal prolapse**, digital **rectal examination** that shows a mass, perianal **abscess** and condyloma (a wart-like growth). An anascopy may be performed to check for abnormal openings between the anus and the skin, or anal fissures. The test is also used to diagnose **rectal cancer**.

Precautions

Anoscopy should not be performed on patients with acute cardiovascular problems due to the vasovagal reaction it may cause. This test is also not recommended for patients with acute abdominal problems and those with a constricted or narrowed anal canal.

Description

Anoscopy views the anus and anal canal by using an anoscope. An anoscope is a plastic, tube-shaped speculum that is a smaller version of a sigmoidscope. Before the anoscope is used, the doctor completes a digital rectal examination with a lubricated, gloved index finger. The anoscope is then lubricated and gently inserted a few inches into the rectum. This procedure enlarges the rectum to allow the doctor to view the entire anal canal with a light. If any suspicious areas are noticed, a piece of tissue can be biopsied.

During the anoscopy procedure there may be a feeling of pressure or the need to go to the bathroom. If a biopsy is taken, the patient may feel a slight pinch. The procedure is performed on an out-patient basis, and takes approximately an hour to complete.

Preparation

The patient will be instructed to clear their rectum of stool before the procedure. This may be done by taking a laxative, enema, or other preparation that may help with the evacuation.

Aftercare

If a biopsy is needed during an anoscopy, there may be slight anal bleeding for less than two days following the procedure. The patient may be instructed to sit in a bathtub of warm water for 10 to 15 minutes, three times a day, to help decrease the pain and swelling.

Risks

A simple anoscopy procedure offers minimal risks. There is a limited risk of bleeding and mild pain is a biopsy is performed.

Normal results

Normal values to look for during an anoscopy include an anal canal that appears healthy in size, color, and shape. The test also looks for no evidence of bleeding, polyps, hemorrhoids or other abnormalities.

Abnormal results

While an anoscopy is typically performed to determine is hemorrhoids are present, other abnormal finding could include polyps, abscesses, inflammation, fissures, colorectal polyps, or **cancer**.

Resources

BOOKS

Altman, Roberta; Sarg, Michael J. "Anoscopy." *The Cancer Dictionary.* Checkmark Books, 2000. 18

PERIODICALS

Colyar, Margaret. "Anascopy Basics." *The Nurse Practitioner* (October 2000): 91.

OTHER

Discovery Health. "Medical Tests: Anoscopy." <http://health.discover.com/diseasesandcond/encyclopedia/1038.html> (5 May 2001)

Lycos Health with WebMD. "Anoscopy." <http://webmd.lycos.com/content/asset/adam_test_anoscopy> (5 May 2001).

Beth A. Kapes

Anosmia

Definition

The term anosmia means lack of the sense of smell. It may also refer to a decreased sense of smell. Ageusia, a companion word, refers to a lack of taste sensation. Patients who actually have anosmia may complain wrongly of ageusia, although they retain the ability to distinguish salt, sweet, sour, and bitter—humans' only taste sensations.

Description

Of the five senses, smell ranks fourth in importance for humans, although it is much more pronounced in other animals. Bloodhounds, for example, can smell an odor a thousand times weaker than humans. Taste, considered the fifth sense, is mostly the smell of food in the mouth. The sense of smell originates from the first cranial nerves (the olfactory nerves), which sit at the base of the brain's frontal lobes, right behind the eyes and above the nose. Inhaled airborne chemicals stimulate these nerves.

There are other aberrations of smell beside a decrease. Smells can be distorted, intensified, or hallucinated. These changes usually indicate a malfunction of the brain.

Causes and symptoms

The most common cause of anosmia is nasal occlusion caused by **rhinitis** (inflammation of the nasal membranes). If no air gets to the olfactory nerves, smell will not happen. In turn, rhinitis and **nasal polyps** (growths on nasal membranes) are caused by irritants such as allergens, infections, cigarette smoke, and other air pollutants. Tumors such as nasal polyps can also block the nasal passages and the olfactory nerves and cause anosmia. **Head injury** or, rarely, certain viral infections can damage or destroy the olfactory nerves.

Diagnosis

It is difficult to measure a loss of smell, and no one complains of loss of smell in just one nostril. So a physician usually begins by testing each nostril separately with a common, non-irritating odor such as perfume, lemon, vanilla, or coffee. Polyps and rhinitis are obvious causal agents a physician looks for. Imaging studies of the head may be necessary in order to detect brain injury, sinus infection, or tumor.

Treatment

Cessation of **smoking** is the first step. Many smokers who quit discover new tastes so enthusiastically that they immediately gain weight. Attention to reducing exposure to other nasal irritants and treatment of respiratory **allergies** or chronic upper respiratory infections will be beneficial. **Corticosteroids** are particularly helpful.

Alternative treatment

Finding and treating the cause of the loss of smell is the first approach in **naturopathic medicine**. If rhinitis is the cause, treating acute rhinitis with herbal mast cell stabilizers and herbal **decongestants** can offer some relief as the body heals. If chronic rhinitis is present, this is often related to an environmental irritant or to food allergies. Removal of the causative factors is the first step to healing. Nasal steams with essential oils offer relief of the blockage and tonification of the membranes. Blockages can sometimes be resolved through naso-specific therapy—a way of realigning the nasal cavities. Polyp blockage can be addressed through botanical medicine treatment as well as **hydrotherapy**. Olfactory nerve damage may not be regenerable. Some olfactory aberrations, like intensified sense of smell, can be resolved using homeopathic medicine.

Prognosis

If nasal inflammation is the cause of anosmia, the chances of recovery are excellent. However, if nerve damage is the cause of the problem, the recovery of smell is much more difficult.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Olfactory Dysfunction." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

KEY TERMS

Allergen—Any substance that irritates only those who are sensitive (allergic) to it.

Corticosteroids—Cortisone, prednisone, and related drugs that reduce inflammation.

Rhinitis—Inflammation and swelling of the nasal membranes.

Nasal polyps—Drop-shaped overgrowths of the nasal membranes.

PERIODICALS

Davidson, T. M., C. Murphy, and A. A. Jalowayski. "Smell Impairment. Can It Be Reversed?" *Postgraduate Medicine* 98 (July 1995): 107-109, 112.

J. Ricker Polsdorfer, MD

Anoxemia *see* **Anoxia**

Anoxia

Definition

Anoxia is a condition characterized by an absence of oxygen supply to an organ or a tissue.

Description

Anoxia results when oxygen is not being delivered to a part of the body. If the condition does not involve total oxygen deprivation, it is often called hypoxia, although the two terms have been used interchangeably. A related condition, anoxemia, occurs when the blood circulates but contains a below normal amount of oxygen.

The five types of anoxia or hypoxia include hypoxemic, anemic, affinity, stagnant, and histotoxic. Hypoxemic anoxia happens when the oxygen pressure outside the body is so low that the hemoglobin, the chemical which carries oxygen in the red blood cells (RBCs), is unable to become fully loaded with the gas. This results in too little oxygen reaching the tissues and can occur in suffocation when a person is at high altitude, where the pressure of oxygen in the air is much less than at sea level.

Anemic anoxia results from a decrease in the amount of hemoglobin or RBCs in the blood, which reduces the ability to get oxygen to the tissues. Anemia may result from lack of production of red blood cells (iron deficiency), blood loss (hemorrhage), or shortened lifespan of red blood cells (autoimmune disease).

Affinity anoxia involves a defect in the chemistry of the blood such that the hemoglobin can no longer pick up as much oxygen from the air, even though the quantities are normal, reducing how much is delivered to the tissues.

Stagnant anoxia occurs when there is interference with the blood flow, although the blood and its oxygen-carrying abilities are normal. A common cause of general stagnant anoxia is heart disease or interference with the return of blood flow through the veins. Examples of local stagnant anoxia include exposure to cold, diseases that restrict circulation to the extremities, and ergot **poisoning**. When the tissue or organ itself has a reduced ability to accept and use the oxygen, it is called histotoxic anoxia. The classic example is cyanide poisoning, where the chemical inactivates a cellular enzyme necessary for the cell to use oxygen. Thus, tissue exposed to cyanide cannot use the oxygen even though it is in normal amounts in the bloodstream. Histotoxic anoxia can also be caused by exposure to narcotics, alcohol, formaldehyde, acetone, toluene, and certain anesthetic agents.

Causes and symptoms

Anoxia and hypoxia can be caused by any number of disease states of the blood, lungs, heart and circulation including **heart attack**, severe **asthma**, or **emphysema**. It can also result from smoke or carbon monoxide inhalation, improper exposure to anesthesia, poisoning, strangulation, **near-drowning**, or high altitude exposure through mountain climbing or travel in an insufficiently pressurized airplane. Anoxia, and the resultant brain damage, is a particular problem with newborns during difficult births.

No matter what the cause of anoxia, the symptoms are similar. In severe cases, the patient is often confused and commonly stuperous or comatose (in a state of unconsciousness). Depending on the severity of the injury to the brain, the organ most sensitive to reduced oxygen intake, this condition can persist for hours, days, weeks, or even months or years. Seizures, myoclonic jerks (involuntary muscle spasms or twitches), and neck stiffness are some other symptoms of the anoxic condition.

Symptoms of more localized or less complete oxygen deprivation (hypoxia) include increased breathing rate, lightheadedness, **dizziness**, tingling or warm sensation, sweating, reduced field of vision, sleepiness, a bluish tint to skin, particularly the fingertips and lips, and behavior changes, often an inappropriate sense of euphoria.

Diagnosis

Diagnosis of anoxia and hypoxia is commonly made through the appearance of clinical symptoms. However,

suspected reduction in oxygen reaching the tissues can be confirmed using laboratory tests. The exact test that is performed is dependent on the suspected cause of the anoxia. One systemic measure of tissue anoxia is the serum lactate (lactic acid) test. When cells are forced to produce energy without oxygen, as would happen during anoxia, lactic acid is one of the byproducts. Thus, an increase in lactic acid in the blood would indicate that tissues were starved for oxygen and are using non-oxygen pathways to produce energy. Normally, the blood contains less than 2mmol/L of lactic acid. However, some forms of anoxia do not increase lactic acid concentrations in the blood and some increases in lactic acid levels are not associated with anoxia, so an elevated value for this test is only suggestive of an anoxic or hypoxic condition.

Treatment

The exact treatment for anoxia is dependent on the cause of the reduced oxygen reaching the tissues. However, immediate restoration of tissue oxygen levels through supplementing the patient's air supply with 100% oxygen is a common first step. Secondary steps often include support of the cardiovascular system through drugs or other treatment, treatment of lung disease, transfusions, or administration of anecdotes for poisoning, as appropriate.

Prognosis

A good prognosis is dependent on the ability to treat the underlying cause of the low oxygen levels. If cardiovascular and respiratory systems can be supported adequately, recovery from the injury to the tissue is possible, although extent of injury to the brain can be difficult to assess. The exact amount of recovery varies with the amount of injury sustained, where significant injury brings a poorer prognosis. As recovery occurs, both psychological and neurological abnormalities may appear, persist, and can improve. Some problems seen after anoxia include mental confusion, personality changes, **amnesia** or other types of memory loss, **hallucinations**, and persistent myoclonus (involuntary contractions of the muscles).

Prevention

Hypoxemic anoxia can be avoided by utilizing supplemental oxygen when in high altitudes and being aware of the early symptoms of **altitude sickness** and reducing altitude once recognized. Iron supplements can avoid anemic hypoxia, although more severe anemic states are usually caused by disease or bleeding. Maintaining good cardiovascular health through proper diet and **exercise** is a good first step to avoiding the most common cause of stagnant anoxia. Avoiding exposure to the toxic chemicals that cause the condition can prevent histotoxic anoxia.

KEY TERMS

Amnesia—Loss of memory often traceable to brain tissue damage.

Anoxemia—An extreme lack of oxygen in the blood.

Hemoglobin—A chemical found in red blood cells that transports oxygen.

Myoclonus—Involuntary contractions of a muscle or group of muscles.

Resources

BOOKS

Gutierrez, Guillermo. "Metabolic Assessement of Tissue Oxygenation" *Seminars in Respiratory and Critical Care Medicine* 20 (January 1999):11–15.

ORGANIZATIONS

Brain Injury Association. 105 N. Alfred St. Alexandria, VA 22314. (800)444-6443. <http://www.biausa.org>.

Phoenix Project/Head Injury Hotline. Box 84151, Seattle, WA 98124. (206)621-8558. <http://www.headinjury.com>.

OTHER

Borron, Stephen W. "Lactic Acidosis." *eMedicine* (February 7, 2001). <http://www.emedicine.com/emerg/topic291.htm>. (May 13, 2001).

NINDS Anoxia/Hypoxia Information Page.The National Institute of Neurological Disorders and Stroke (NINDS). January 22, 2001. <http://www.ninds.nih.gov/health_and_medical/disorders/anoxia_doc.htm>. (May 13, 2001).

Michelle Johnson, MS, JD

Antacids

Definition

Antacids are medicines that neutralize stomach acid.

Purpose

Antacids are used to relieve acid **indigestion**, upset stomach, sour stomach, and **heartburn**. Additional components of some formulations include dimethicone, to

reduce gas pains (flatulence) and alginic acid, which, in combination with antacids, may help manage GERD (gastro-esophageal reflux disease). Antacids should not be confused with gastric acid inhibitors, such as the H-2 receptor blockers (cimetidine, ranitide and others) or the proton pump inhibitors (lansoprazole, omeprazole and others). Although all three classes of drugs act to reduce the levels of gastric acid, their mechanisms are different, and this affects the appropriate use of the drug. Antacids have a rapid onset and short duration of action, and are most appropriate for rapid relief of gastric discomfort for a short period of time.

Antacids may be divided into two classes, those that work by chemical neutralization of gastric acid, most notably sodium bicarbonate; and those that act by adsorption of the acid (non-absorbable antacids), such as calcium and magnesium salts.

The chemical antacids show the most rapid onset of action, but may cause "acid rebound," a condition in which the gastric acid returns in greater concentration after the drug effect has stopped. Also, since these antacids may contain high concentrations of sodium, they may be inappropriate in patients with **hypertension**.

Calcium and magnesium salts act by adsorption of the acid, and are less prone to the rebound effect, but may have other significant disadvantages. These antacids are particularly prone to drug interactions, and patients taking other medications must often avoid simultaneous administration of the medications. These antacids are more effective in liquid formulations than in tablet or capsule form, and so may be inconvenient for routine dosing.

The non-absorbable antacids may have additional uses beyond control of hyperacidity. Calcium salts may be used as diet supplements in prevention of **osteoporosis**. Aluminum carbonate is useful for binding phosphate, and has been effective in treatment and control of hyperphosphatemia or for use with a low phosphate diet to prevent formation of phosphate urinary stones. This application is particularly valuable in patients with chronic renal failure. Antacids with aluminum and magnesium hydroxides or aluminum hydroxide alone effectively prevent significant **stress** ulcer bleeding in post-operative patients or those with severe **burns**.

Recommended dosage

The dose depends on the type of antacid. Consult specific references.

When using antacids in chewable tablet form, chew the tablet well before swallowing. Drink a glass of water after taking chewable aluminum hydroxide. Lozenges should be allowed to dissolve completely in the mouth. Liquid antacids should be shaken well before using.

Precautions

Antacids should be avoided if any signs of **appendicitis** or inflamed bowel are present. These include cramping, **pain**, and soreness in the lower abdomen, bloating, and **nausea and vomiting**.

Antacids may affect the results of some medical tests, such as those that measure how much acid the stomach produces. Health care providers and patients should keep this in mind when scheduling a medical test.

Antacids that contain magnesium may cause **diarrhea**. Other types of antacids may cause **constipation**.

Avoid taking antacids containing sodium bicarbonate when the stomach is uncomfortably full from eating or drinking.

Antacids should not be given to children under six years of age.

Antacids that contain calcium or sodium bicarbonate may cause side effects, such as **dizziness**, nausea, and vomiting, in people who consume large amounts of calcium (from dairy products or calcium supplements). In some cases, this can lead to permanent kidney damage. Before combining antacids with extra calcium, check with a physician.

Some antacids contain large amounts of sodium, particularly sodium bicarbonate (baking soda). Anyone who is on a low-sodium diet should check the list of ingredients or check with a physician or pharmacist before taking an antacid product.

Excessive use of antacids may cause or increase the severity or kidney problems. Calcium based antacids may lead to renal stone formation.

ALLERGIES. **Allergies** to antacids are extremely rare, however the inactive ingredients in some formulations may include dyes or other products with allergic potential.

PREGNANCY. Antacids are not classified under the **pregnancy** safety categories A, B, C, D and X. Occasional use of antacids in small amounts during pregnancy is considered safe. However, pregnant women should check with their physicians before using antacids or any other medicines. Pregnant women who are consuming extra calcium should be aware that using antacids that contain sodium bicarbonate or calcium can lead to serious side effects.

BREASTFEEDING. Some antacids may pass into breast milk. However, no evidence exists that the inges-

KEY TERMS

Acid indigestion—Indigestion that results from too much acid in the stomach.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Heartburn—A burning sensation, usually in the center of the chest, near the breastbone.

Indigestion—A feeling of discomfort or illness that results from the inability to properly digest food.

Inflamed bowel—Irritation of the intestinal tract.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Pregnancy safety categories—A system for reporting the known safety issues of drugs for use during pregnancy, The ratings range from A, proven safe by well controlled studies, to X, proven harmful.

tion of antacids through breast milk causes problems for nursing babies whose mothers use antacids occasionally.

Side effects

Side effects are very rare when antacids are taken as directed. They are more likely when the medicine is taken in large doses or over a long time. Minor side effects include a chalky taste, mild constipation or diarrhea, thirst, stomach cramps, and whitish or speckled stools. These symptoms do not need medical attention unless they do not go away or they interfere with normal activities.

Other uncommon side effects may occur. Anyone who has unusual symptoms after taking antacids should get in touch with his or her health care provider.

Interactions

Antacids have multiple drug interactions, usually due to inhibition of absorption of other medications. In rare cases, the absorbable antacids may alter the pH of the stomach contents or urine sufficiently to alter drug absoprtion or excretion. Consult specific references.

Samuel Uretsky, PharmD

Antegrade pyelography *see* **Intravenous urography**

Antenatal testing

Definition

Antenatal testing includes any diagnostic procedures performed before the birth of a baby.

Purpose

These tests and exams are essential for protecting the health of a pregnant woman and her developing child.

Precautions

Some tests, such as amniocentisis, carry a small risk of a **miscarriage** or other complications that could harm the mother or baby.

Description

Women who become pregnant undergo a wide variety of tests throughout the nine months before delivery. In the early stages, physicians order blood tests to screen for possible disorders or infections, such as human **immunodeficiency** virus (HIV), which can pass from the mother to the fetus. Later, the focus shifts to checking on fetal well-being with a variety of technological tools such as ultrasound scans. Descriptions of the most common tests and procedures used during **pregnancy** are listed below.

When a woman first learns she is pregnant, her physician will run a series of routine urine and blood tests to determine her blood type, check for anemia and **gestational diabetes**, make sure she is immune to **rubella** (German **measles**) and check for infectious diseases like HIV, hepatitis, chlamydia or **syphilis**. Physicians also usually do **pelvic exam** to screen for **cervical cancer** and check the patient's blood pressure. As the pregnancy progresses, more tests will follow.

Ultrasound

Ultrasound is a device that records sound waves as they bounce off the developing fetus to create an image, which is projected onto a large computer screen. Physicians order an ultrasound scan to listen for a fetal heartbeat, determine a woman's precise due date and check for twins, among other uses. An ultrasound scan also is known as a sonogram. The procedure takes a few minutes, is painless and usually is covered by health insurance.

The ultrasound technician will ask the pregnant woman to remove her clothes and change into a gown. The technician may rub some gel on the woman's stomach, which helps the hand-held device pick up sound

waves better. In certain cases, the technician may insert a plastic probe into the woman's vaginal canal to get a clearer picture of the fetus. Early in pregnancy, the test may need to be done with a full bladder.

Unlike x rays, ultrasound is safe to use during pregnancy. It does not cause any known side-effects that would harm the mother or baby.

Pregnant women usually will have their first ultrasound anytime between 8 and 12 weeks of gestation. In normal cases, the technician is able to identify a fetal heartbeat, which appears as a flashing light on the screen. Closer to the due date, physicians use ultrasound to make sure the fetus is in the correct position to exit the birth canal head first.

Sometimes an ultrasound will show that a fetus has stopped growing, or a gestational sac has formed without a fetus, and a miscarriage has occurred. Later in pregnancy, it also may show that the child is in a breech position, oriented feet first, which can cause a difficult labor.

Tests for birth defects

Most obstetricians offer parents a variety of ways to find out if their developing child might have **birth defects** such as **spina bifida** and **Down Syndrome**. An alpha fetoprotein screen can be done through a simple blood test in the doctor's office between the 16th and 18th week of gestation. It tells the odds that their child will have a severe congenital anomaly. The test works by measuring the level of alpha fetoprotein, a substance produced by a fetus with birth defects. Low levels of alpha fetoprotein in the mother's blood may indicate Down's Syndrome. In that case, the next step for most couples is **amniocentesis** because the alpha fetoprotein test can give false-positive results. Amniocentesis is a more accurate test, but it also has higher risks of complications.

This procedure typically is used to diagnose Down syndrome while a developing child is still in the womb, at 15-28 weeks.

During amniocentesis, a doctor inserts a needle through a woman's vaginal canal and inside her cervix. Using ultrasound as a guide, the doctor pierces the uterus to withdraw a sample of fluid from the amniotic sac. Afterwards, tiny cells shed by the fetus can be studied in the laboratory. Scientists can analyze DNA samples to determine if the fetus has Down syndrome or other genetic conditions. Amniocentesis also can determine the sex of the fetus.

Women who have a history of recurring miscarriages may not want to have this procedure.

Amniocentesis is usually performed in a doctor's office on an outpatient basis.

Common side effects include cramping and bleeding.

In about one out of every 1,000 cases, amniocentesis causes a needle to puncture the uterine wall, which could result in miscarriage.

In most cases, couples find out their baby does not have a birth defect.

If the results come back positive for Down's Syndrome or other serious conditions, the couple must decide if they want to end the pregnancy. Others use the knowledge to plan and prepare any special care needed for their future child.

Group B Strep

This test is for Group B streptococci (GBS) infection.

By testing for GBS, physicians can determine if a woman is at risk of passing this infection along to her child.

Women who have had a prior child with GBS, or who have a **fever** or prolonged or premature rupture of the amniotic sac may be at higher risk for this type of infection.

GBS is a type of bacteria commonly found in the vagina and rectum. Unlike regular **strep throat**, GBS can be present in a person's body without causing any symptoms, so many women do not realize they are infected with it.

To test for the presence of GBS, doctors may take a urine sample. They also may collect samples from the vagina or rectum, which are then analyzed in a lab. This test is usually performed late in pregnancy, at 35-37 weeks of gestation.

This is a routine urine test or pelvic exam with no side effects.

In many cases, doctors do not find any evidence of this type of infection.

If a woman is found to be infected with Group B strep, physicians usually wait to treat it until just before labor begins. At that time, they may give the mother **antibiotics** so the baby is not born with the infection. Newborns who are exposed to Group B strep can have inflammation of the brain, spinal cord, blood or lungs. In some cases, this serious complication can result in infant **death**.

Resources

BOOKS

Eisenberg, Arlene, et al. *What to Expect When You're Expecting* New York: Workman Publishing Company Inc, 1996.

Planning your Pregnancy and Birth Washington, DC: The American College of Obstetricians and Gynecologists, 2000.

KEY TERMS

Ultrasound—A device that records sound waves as they bounce off a developing fetus to create an image, which is projected onto a large computer screen

Breech position—When a child is oriented feet first in the mother's uterus just before delivery.

Alpha fetoprotein screen—A test that measures the level of alpha fetoprotein, a substance produced by a fetus with birth defects, in the mother's blood.

Amniocentesis—An invasive procedure that allows physicians to check for birth defects by collecting a sample of fetal cells from inside the amniotic sac.

GBS—Group B streptococci are a type of bacteria that, if passed to a can cause inflammation of the brain, spinal cord, blood or lungs. In some cases, it can result in infant death

PERIODICALS

Parkey, Paula. "Birth Defects: Is Prenatal Screening Advisable?" *CBS HealthWatch* (April, 2000). <http://www.cbshealthwatch.com/cx/viewarticle/214798>.

ORGANIZATIONS

American College of Obstetricians and Gynecologists.409 12th Street SW, Washington, DC 20024-2188. (202) 638-5577. <http://www.acog.org>.

March of Dimes Birth Defects Foundation. P.O. Box 1657, Wilkes-Barre, PA 18703. 1-800-367-6630. <http://www.modimes.org>.

Melissa Knopper

Antepartum testing

Definition

Antepartum testing consists of a variety of tests performed late in **pregnancy** to verify fetal well-being, as judged by the baby's heart rate and other characteristics. Antepartum tests include the nonstress test (NST), biophysical profile, and contraction **stress test** (CST).

Purpose

Antepartum testing is performed after 32 weeks of pregnancy so that the couple and the doctor can be warned of any problems that may necessitate further testing or immediate delivery. The results reflect the adequacy of blood flow (and oxygen delivery) to the fetus from the placenta.

Antepartum tests are usually done in pregnancies at high risk for fetal complications. Various reasons include:

- any chronic illness in the mother, such as high blood pressure or diabetes
- problems with previous pregnancies, such as **stillbirth**
- fetal complications, such as **intrauterine growth retardation** (a slowing of growth of the fetus) or **birth defects**
- problems in the current pregnancy, including preeclampsia (serious pregnancy-induced high blood pressure), gestational (pregnancy-related) diabetes, premature rupture of the membranes, excessive amniotic fluid (the liquid that surrounds the fetus), vaginal bleeding, or **placenta previa** (a condition in which the placenta is positioned over the cervix instead of near the top of the uterus)
- twins or other multiple fetuses

One of the most common indications for antepartum testing is post-term pregnancy. A pregnancy should not be allowed to continue past 42 weeks. (The usual pregnancy is 40 weeks in duration). Babies should be monitored with antepartum testing starting at 41 weeks. After 41 weeks, there is an increasing risk that the placenta cannot meet the growing baby's needs for oxygen and **nutrition**. This may be reflected in decreased movements of the baby, decreased amniotic fluid, and changes in the heart rate pattern of the baby.

Description

Technology

The NST and CST use a technique called **electronic fetal monitoring** to evaluate the heartbeat of the fetus. The biophysical profile is an ultrasound examination.

NST

The NST is usually the first antepartum test used to verify fetal well-being. It is based on the principle that when the fetus moves, its heartbeat normally speeds up. The NST assesses fetal health through monitoring accelerations of the heart rate in response to the baby's own movements, i.e., in the absence of **stress**.

The mother lays down or sits, and an electronic fetal monitor is placed on her abdomen to monitor the fetal heart rate. The doctor records the baby's heartbeat on a graph or "tracing" to determine whether it demonstrates

correct reactivity, or acceleration of the heart rate. To record fetal movements on the tracing, the mother presses a button every time she feels the baby move. If the baby is inactive, the mother may be asked to rub her abdomen to "awaken" it. Sometimes an instrument is used to produce a loud noise to arouse the fetus (vibroacoustic stimulation). The test usually takes between 20–45 minutes.

A baby who is receiving enough oxygen should move at least twice in a 20 minute period. The baby's heart rate should increase at least 20 beats per minute for at least 20 seconds during these movements. The NST is the simplest and cheapest antepartum test.

Biophysical profile

The biophysical profile is an ultrasound exam that can add additional information to the NST. During the biophysical profile, the examiner checks for various characteristics of the baby to evaluate its overall health. These include: fetal movement, fetal tone, breathing movements, and the amniotic fluid volume. Amniotic fluid volume is important because a decreased amount raises the possibility that the baby may be under stress. The five components of the test (NST is also included) are each given a score of 2 for normal (or present), 1 if decreased, and 0 for abnormal. The highest possible score is 10. The "modified" biophysical profile is another option; this includes only the NST and amniotic fluid volume.

CST

The CST is like the NST, except that the fetus is evaluated in response to contractions of the mother's uterus. Because it is a more complicated test, it is often used after an abnormal NST to confirm the results. Uterine contractions produce "stress" in the fetus because they temporarily stop the flow of blood and oxygen. The CST is used to confirm that the fetus does not respond to this stress by a decrease in the heart rate.

The CST is performed with the same equipment as the NST. Maternal blood pressure and fetal heart rate are recorded along with the onset, relative intensity, and duration of any spontaneous contractions. For an accurate test, the contractions should be of sufficient duration and frequency. If uterine activity does not occur naturally, a drug called oxytocin may be given to the mother intravenously (hence the test's alternate name, the oxytocin challenge test) to provoke contractions. Another option is self-stimulation of the mother's nipples, because this releases natural oxytocin. The fetal heart rate is observed until, ideally, three moderate contractions occur within 10 minutes.

Preparation

The mother should eat just before the antepartum tests to help stimulate fetal activity.

Risks

There are no appreciable risks from the NST or the biophysical profile. Ultrasound used for the biophysical profile is painless and safe because it uses no harmful radiation, and no evidence has been found that sound waves cause any adverse effects on the mother or fetus.

The frequency of antepartum testing depends on the reason for its use. All of the tests occasionally give incorrect results, which may prompt an unnecessary early delivery or cesarean. Repeat testing is important to double-check any abnormal findings.

Normal results

In general, "negative" or normal results on antepartum testing provide reassurance that the baby is healthy and should remain so for perhaps a week, with no need for immediate delivery. Unfortunately, the tests cannot guarantee that there are no problems, because falsely normal results can occur, though this is unusual. Even if all test results are normal, it is important to realize that this does not guarantee a "perfect" baby.

The NST is normal ("reactive") if two or more distinct fetal movements occur in association with appropriate accelerations of the fetal heart rate within 20 minutes. A biophysical profile score of 8-10 is considered reassuring. The CST is normal if the fetus shows no decelerations in heart rate in response to three uterine contractions within 10 minutes.

Abnormal results

A "positive" result suggests that the baby is not receiving enough oxygen for some reason. However, it is quite possible that the test result was falsely abnormal. To confirm or monitor a suspected disorder, follow-up testing with the same or an alternate test will probably be performed at least weekly.

The NST is abnormal ("nonreactive") if the fetal heart rate fails to speed up by at least 20 beats per minute at least two times during a 20-minute period. Abnormal decreases in the heart rate (decelerations) are also a cause for concern.

A biophysical profile score of 6 is considered a cause for concern and should be followed by further testing. Scores of 4 or less may require immediate delivery of the fetus.

KEY TERMS

Amniotic fluid—The liquid that surrounds the baby within the amniotic sac. Because it is composed mostly of fetal urine, a low amount of fluid can indicate inadequate placental blood flow to the fetus.

Deceleration—A decrease in the fetal heart rate that can indicate inadequate blood flow through the placenta.

Oxytocin—A natural hormone that produces uterine contractions.

Ultrasound—A procedure in which high-frequency sound waves are used to create a picture of the baby, used alone or with antepartum tests.

Vibroacoustic stimulation—In the biophysical profile, use of an artificial larynx to produce a loud noise to "awaken" the fetus.

Abnormal results on the CST include late decelerations, or abnormal slowing of the fetal heart rate after the uterine contractions. This can suggest that the baby is not receiving enough oxygen and may have difficulty withstanding the stress of labor and vaginal delivery. **Cesarean section** might be necessary so the baby can be spared the stress of labor. With either NST or CST, a severe deceleration (a period of very slow heartbeat) can also suggest fetal distress.

The ultimate outcome will depend on the woman's individual situation. In some cases, delivery can be postponed while medication is given to the mother (e.g., for high blood pressure) or the fetus (e.g., to speed up lung maturity before delivery). Depending upon the readiness of the mother's cervix, the doctor may decide to induce labor. The extra-large fetus of a diabetic woman may require cesarean delivery; severe preeclampsia also may necessitate **induction of labor** or cesarean section. The doctor will determine the most prudent course of action.

Resources

BOOKS

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

Johnson, Robert V. *Mayo Clinic Complete Book of Pregnancy & Baby's First Year.* New York: William Morrow and Co., Inc., 1994.

Slupik, Ramona I. *American Medical Association Complete Guide to Women's Health.* New York: Random House, 1996.

PERIODICALS

McMahon, Michael J., and Jeffrey A. Kuller. "Assessment of the Post-term Pregnancy." *American Family Physician* 54 (Aug. 1996): 631-636.

"Pregnancy—What to Expect When It's Past Your Due Date." *American Family Physician* 54 (Aug. 1996): 641-642.

Smith-Levitin, Michelle, Boris Petrikovsky, and Elizabeth P. Schneider. "Practical Guidelines for Antepartum Fetal Surveillance." *American Family Physician* 56 (15 Nov. 1997): 1981-1988.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920, Washington, DC 20090-6920. (202) 638-5577. <http://www.acog.com>.

National Institute of Child Health and Human Development. Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD 20892-2425. (800) 505-2742. <http://www.nichd.nih.gov/sids/sids.htm>.

Laura J. Ninger

Anthrax

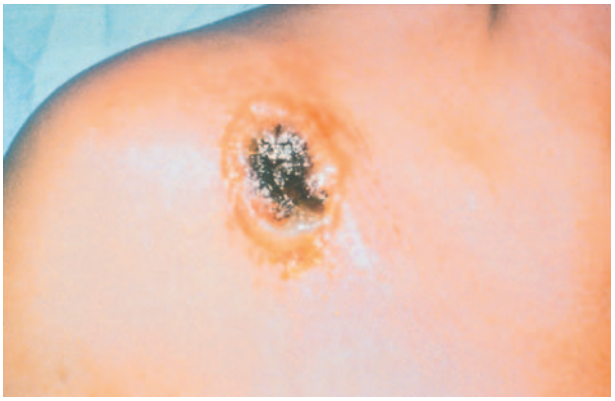
Definition

Anthrax is a bacterial infection caused by *Bacillus anthracis* that primarily affects livestock but that can occasionally spread to humans, affecting either the skin, intestines, or lungs. In humans, the infection can often be treated, but it is almost always fatal in animals.

Description

Anthrax is most often found in the agricultural areas of South and Central America, southern and eastern Europe, Asia, Africa, the Caribbean, and the Middle East. In the United States, anthrax is rarely reported, however, cases of animal infection with anthrax are most often reported in Texas, Louisiana, Mississippi, Oklahoma, and South Dakota. The bacterium and its associated disease get their name from the Greek word meaning "coal" because of the characteristic coal-black sore that is the hallmark of the most common form of the disease.

During the 1800s, in England and Germany, anthrax was known either as "wool-sorter's" or "ragpicker's" disease because workers contracted the disease from bacterial spores present on hides and in wool or fabric fibers. Spores are the small, thick-walled dormant stage of some bacteria that enable them to survive for long periods of time under adverse conditions. The first anthrax vaccine was perfected in 1881 by Louis Pasteur.



Humans suffering from anthrax often develop ulcerating nodules on the body. *Custom Medical Stock Photo. Reproduced by permission.)*

The largest outbreak ever recorded in the United States occurred in 1957 when nine employees of a goat hair processing plant became ill after handling a contaminated shipment from Pakistan. Four of the five patients with the pulmonary form of the disease died. Other cases appeared in the 1970s when contaminated goatskin drumheads from Haiti were brought into this country as souvenirs. Today, anthrax is rare, even among cattle, largely because of widespread animal **vaccination**. However, some serious epidemics continue to occur among animal herds and in human settlements in developing countries due to ineffective control programs.

There has been a great deal of recent concern that the bacteria that causes anthrax may be used by some countries as a type of biological warfare, since it is possible to become infected simply by breathing in the spores. The largest-ever documented outbreak of human anthrax contracted through spore inhalation occurred in Russia in 1979, when anthrax spores were released from a military laboratory, causing a regional epidemic that killed 69 of its 77 victims. Because the United States government considers anthrax to be of potential risk to soldiers, the Department of Defense has begun systematic vaccination of all military personnel against anthrax, and other nations, such as Britain, are rapidly following suit.

Causes and symptoms

Anthrax is caused by the bacterium *Bacillus anthracis*, which produces spores that can remain dormant for years in soil and on animal products, such as hides, wool, hair, or bones. The disease is often fatal to cattle, sheep, and goats, and their hides, wool, and bones are often heavily contaminated.

Today, in humans, the disease is almost always an occupational hazard, contracted by those who handle animal hides (farmers, butchers, and veterinarians) or sort wool. It is also possible to become infected with anthrax by eating meat from contaminated animals. There are no reports of the disease spreading from one person to another.

Symptoms vary depending on how the disease was contracted, but the symptoms usually appear within one week of exposure.

Cutaneous anthrax

In humans, anthrax usually occurs when the bacteria enter a cut or abrasion, causing a skin (cutaneous) infection at the site. Cutaneous anthrax, as this infection is called, is the mildest form of the disease. At first, the bacteria cause an itchy, raised area like an insect bite. Within one to two days, inflammation occurs around the raised area, and a blister forms around an area of dying tissue that becomes black in the center. Other symptoms may include shivering and chills. In most cases the bacteria remain within the sore. If, however, they spread to the nearest lymph node (or, in rare cases, escape into the bloodstream), the bacteria can cause a form of blood **poisoning** that rapidly proves fatal.

Inhalation anthrax

Inhaling the bacteria or bacterial spores can lead to a rare, fatal form of anthrax known as pulmonary or inhalation anthrax that attacks the lungs and sometimes spreads to the brain. Inhalation anthrax begins with flu-like symptoms, namely **fever**, **fatigue**, **headache**, and **shortness of breath**, but progresses to **bronchitis**, during which time it becomes difficult to breathe, and finally, the patient enters a state of **shock**. This rare form of anthrax is usually fatal, even if treated within one or two days after the symptoms appear.

Intestinal anthrax

Intestinal anthrax is a rare, often-fatal form of the disease, caused by eating meat from an animal that died of anthrax. Intestinal anthrax causes stomach and intestinal inflammation and sores or lesions (ulcers), much like the sores that appear on the skin in the cutaneous form of anthrax. The first signs of the disease are **nausea and vomiting**, loss of appetite, and fever, followed by abdominal **pain**, vomiting of blood, and severe bloody **diarrhea**.

Diagnosis

Anthrax is diagnosed by detecting *B. anthracis* in samples taken from blood, **skin lesions**, or respiratory secretions. The bacteria may be positively identified using biochemical methods or using a technique where-

by, if present in the sample, the anthrax bacterium is made to fluoresce. Blood samples will also indicate elevated antibody levels or increased amounts of a protein produced directly in response to infection with the anthrax bacterium. Additional DNA-based tests are also currently being perfected.

Treatment

In the early stages, anthrax is curable by administering high doses of penicillin, but in the advanced stages, it can be fatal. Other commonly used **antibiotics**, such as erythromycin, tetracycline, or chloramphenicol, are also effective, particularly for those individuals who are allergic to penicillin. Although not proven, it is thought that newer antibiotics, like ciprofloxacin and some **cephalosporins**, may also prove effective. Although cutaneous anthrax may be cured following a single dose of antibiotic, it is important to continue treatment so as to avoid potential serious complications, such as inflammation of the membranes covering the brain and spinal cord (**meningitis**).

Prognosis

Untreated anthrax is often fatal, but **death** is far less likely with appropriate care. Ten to twenty percent of patients will die from anthrax of the skin (cutaneous anthrax) if it is not properly treated. All patients with inhalation (pulmonary) anthrax will die if untreated. Intestinal anthrax is fatal 25-75% of the time.

Prevention

Anthrax is relatively rare in the United States because of widespread animal vaccination and practices used to disinfect hides or other animal products. For those in high-risk professions, an anthrax vaccine is available that is 93% effective in protecting against infection. To provide this immunity, an individual must be given an initial course of three injections, given two weeks apart, followed by booster injections at 6, 12, and 18 months and an annual immunization thereafter.

Approximately 30% of those who have been vaccinated against anthrax may notice mild local reactions, such as a slight tenderness at the injection site. Someone who has already had anthrax might have a more severe local reaction upon vaccination. Infrequently, there may be a severe local reaction with extensive swelling of the forearm, and only a very few vaccine recipients may have a more general flu-like reaction to the shot.

Other means of preventing the spread of infection include carefully handling dead animals suspected of having the disease and providing good ventilation when processing hides, fur, wool, or hair. Whether this vaccine would protect against anthrax used as a biological weapon is, as yet, unclear.

Anyone visiting a country where anthrax is common or where herd animals are not often vaccinated should avoid contact with livestock or animal products and avoid eating meat that has not been properly prepared and cooked.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Bronchitis—Inflammation of the mucous membrane of the bronchial tubes of the lung that can make it difficult to breathe.

Cutaneous—Pertaining to the skin

Meningitis—Inflammation of the membranes covering the brain and spinal cord called the meninges.

Pulmonary—Having to do with the lungs or respiratory system.

Spore—A dormant form assumed by some bacteria, such as anthrax, that enable the bacterium to survive high temperatures, dryness, and lack of nourishment for long periods of time. Under proper conditions, the spore may revert to the actively multiplying form of the bacteria.

Resources

BOOKS

Infectious Disease. Ed. Barbara A. Bannister, et al. Oxford, England: Blackwell Scientific, Inc., 1996.

Van De Graaff, Kent. *Survey of Infectious and Parasitic Diseases*. New York: McGraw Hill, 1996.

Wilks, David, et. al. *The Infectious Diseases Manual*. Oxford, England: Blackwell Scientific, Inc., 1995.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Institute of Allergies and Infectious Diseases, Division of Microbiology and Infectious Diseases. Building 31, Room. 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892. <http://www.niaid.nih.gov>.

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

OTHER

"Anthrax." *New York State Department of Health communicable Disease Fact Sheet*. <http://www.health.state.ny.us/nysdoh/consumer/anthrax.htm>.

"Anthrax: Memo From a WHO Meeting." *World Health Organization*. Bulletin of the World Health Organization, 74 (5)(Sept.-Oct. 1996):456-61.

"Bacterial Diseases." *Healthtouch Online Page*. <http:www.healthtouch.com>.

"Bacillus anthracis (Anthrax)." <http://web.bu.edu/COHIS/infxns/bacteria/anthrax.htm>.

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

Carol A. Turkington

Antiacne drugs

Definition

Antiacne drugs are medicines that help clear up pimples, blackheads, whiteheads, and more severe forms of **acne**.

Purpose

Different types of antiacne drugs are used for different purposes. For example, lotions, soaps, gels, and creams containing benzoyl peroxide or tretinoin may be used to clear up mild to moderately severe acne. Isotretinoin (Accutane) is prescribed only for very severe, disfiguring acne.

Acne is a skin condition that occurs when pores or hair follicles become blocked. This allows a waxy material, sebum, to collect inside the pores or follicles. Normally, sebum flows out onto the skin and hair to form a protective coating, but when it cannot get out, small swellings develop on the skin surface. Bacteria and dead skin cells can also collect that can cause inflammation. Swellings that are small and not inflamed are whiteheads or blackheads. When they become inflamed, they turn into pimples. Pimples that fill with pus are called pustules.

Acne cannot be cured, but acne drugs can help clear the skin. Benzoyl peroxide and tretinoin work by mildly irritating the skin. This encourages skin cells to slough off, which helps open blocked pores. Benzoyl peroxide also kills bacteria, which helps prevent whiteheads and blackheads from turning into pimples. Isotretinoin shrinks the glands that produce sebum.

Description

Benzoyl peroxide is found in many over-the-counter acne products that are applied to the skin, such as Benoxyl, Clear By Design, Neutrogena Acne, PanOxyl, and some formulations of Clean & Clear, Clearasil, and Oxy. Some benzoyl peroxide products are available without a physician's prescription; others require a prescription. Tretinoin (Retin-A) is available only with a physician's prescription and comes in liquid, cream, and gel forms, which are applied to the skin. Isotretinoin (Accutane), which is taken by mouth in capsule form, is available only with a physician's prescription. Only physicians who have experience in diagnosing and treating severe acne, such as dermatologists, should prescribe isotretinoin.

Recommended dosage

The recommended dosage depends on the type of anti-acne drug. These drugs usually come with written directions for patients and should be used only as directed. Patients who have questions about how to use the medicine should check with a physician or pharmacist.

Patients who use isotretinoin usually take the medicine for a few months, then stop for at least two months. Their acne may continue to improve even after they stop taking the medicine. If the condition is still severe after several months of treatment and a two-month break, the physician may prescribe a second course of treatment.

Precautions

Isotretinoin

Isotretinoin can cause serious **birth defects**, including **mental retardation** and physical deformities. This medicine should not be used during **pregnancy**. Women who are able to bear children should not use isotretinoin unless they have very severe acne that has not cleared up with the use of other anti-acne drugs. In that case, a woman who uses this drug must have a pregnancy test two weeks before beginning treatment and each month they are taking the drug. Another pregnancy test must be done one month after treatment ends. The woman must use an effective birth control method for one month before treatment begins and must continue using it throughout treatment and for one month after treatment ends. Women who are able to bear children and who want to use this medicine should discuss this information with their health care providers. Before using the medicine, they will be asked to sign a consent form stating that they understand the danger of taking isotretinoin during pregnancy and that they agree to use effective birth control.

Do not donate blood to a blood bank while taking isotretinoin or for 30 days after treatment with the drug

Antiacne Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Accutane (isotretinoin)	Dry skin, dry mouth, conjunctivitis
Benzamycin	Dry and itchy skin
Cleocin T (clindamycin phosphate)	Dry skin
Desquam-E (benzoyl peroxide)	Itching, red and peeling skin
Erythromycin topical (A/T/S, erycette, t-stat)	Burning, dry skin, hives, red and peeling skin
Minocin (minocycline hydrochloride)	Headache, hives, diarrhea, peeling skin, vomiting
Retin-A (tretinoin)	Darkening of the skin, blistering, crusted, or puffy skin

ends. This will help reduce the chance of a pregnant woman receiving blood containing isotretinoin, which could cause birth defects.

Isotretinoin may cause a sudden decrease in night vision. If this happens, do not drive or do anything else that could be dangerous until vision returns to normal. Let the physician know about the problem.

This medicine may also make the eyes, nose, and mouth dry. Ask the physician about using special eye drops to relieve eye dryness. To temporarily relieve the **dry mouth**, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than two weeks, check with a physician or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

Isotretinoin may increase sensitivity to sunlight. Patients being treated with this medicine should avoid exposure to the sun and should not use tanning beds, tanning booths, or sunlamps until they know how the drug affects them.

In the early stages of treatment with isotretinoin, some people's acne seems to get worse before it starts getting better. If the condition becomes much worse or if the skin is very irritated, check with the physician who prescribed the medicine.

Benzoyl peroxide and tretinoin

When applying antiacne drugs to the skin, be careful not to get the medicine in the eyes, mouth, or inside of the nose. Do not put the medicine on skin that is wind burned, sunburned, or irritated, and do not apply it to open **wounds**.

Because antiacne drugs such as benzoyl peroxide and tretinoin irritate the skin slightly, avoid doing anything that might cause further irritation. Wash the face with mild soap and water only two or three times a day, unless the physician says to wash it more often. Avoid using abrasive soaps or cleansers and products that might dry the skin or make it peel, such as medicated cosmetics, cleansers that contain alcohol, or other acne products that contain resorcinol, sulfur or salicylic acid.

If benzoyl peroxide or tretinoin make the skin too red or too dry or cause too much peeling, check with a physician. Using the medicine less often or using a weaker strength may be necessary.

Tretinoin may increase sensitivity to sunlight. While being treated with this medicine, avoid exposure to the sun and do not use tanning beds, tanning booths, or sunlamps. If it is not possible to avoid being in the sun, use a sunscreen with a skin protection factor (SPF) of at least 15 or wear protective clothing over the treated areas. The skin may also become more sensitive to cold and wind. People who use this medicine should protect their skin from cold and wind until they know how the medicine affects them.

Benzoyl peroxide may discolor hair or colored fabrics.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they use antiacne drugs. Before using these products, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to etretinate, isotretinoin, tretinoin, vitamin A preparations, or benzoyl peroxide in the past should let his or her physician know before using an antiacne drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who are pregnant or who may become pregnant should check with a physician before using tretinoin or benzoyl peroxide. *Isotretinoin causes birth defects in humans and must not be used during pregnancy.*

BREASTFEEDING. No problems have been reported in nursing babies whose mothers used tretinoin or benzoyl peroxide. Women who are breastfeeding babies should not take isotretinoin, however, as it may cause problems in nursing babies.

OTHER MEDICAL CONDITIONS. Before using anti-acne drugs applied to the skin, people with any of these medical problems should make sure their physicians are aware of their conditions:

- eczema. Anti-acne drugs that are applied to the skin may make this condition worse.
- sunburn or raw skin. Anti-acne drugs that are applied to the skin may increase the **pain** and irritation of these conditions.

In people with certain medical conditions, isotretinoin may increase the amount of triglyceride (a fatty-substance) in the blood. This may lead to heart or blood vessel problems. Before using isotretinoin, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcoholism or heavy drinking, now or in the past
- diabetes (or family history of diabetes). Isotretinoin may also change blood sugar levels.
- family history of high triglyceride levels in the blood
- severe weight problems

USE OF CERTAIN MEDICINES. Using antiacne drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

KEY TERMS

Acne—A skin condition in which raised bumps, pimples, and cysts form on the face, neck, shoulders and upper back.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Bowel—The intestine; a tube-like structure that extends from the stomach to the anus. Some digestive processes are carried out in the bowel before food passes out of the body as waste.

Cyst—An abnormal sac or enclosed cavity in the body, filled with liquid or partially solid material.

Eczema—Inflammation of the skin with itching and a rash. The rash may have blisters that ooze and form crusts.

Pimple—A small, red swelling of the skin.

Psoriasis—A skin disease in which people have itchy, scaly, red patches on the skin.

Pus—Thick, whitish or yellowish fluid that forms in infected tissue.

Triglyceride—A substance formed in the body from fat in the diet.

Side effects

Isotretinoin

Minor discomforts such as dry mouth or nose, dry eyes, dry skin, or **itching** usually go away as the body adjusts to the drug and do not require medical attention unless they continue or are bothersome.

Other side effects should be brought to a physicians attention. These include:

- burning, redness, or itching of the eyes
- nosebleeds
- signs of inflammation of the lips, such as peeling, burning, redness or pain

Bowel inflammation is not a common side effect, but it may occur. If any of the following signs of bowel inflammation occur, stop taking isotretinoin immediately and check with a physician:

- pain in the abdomen
- bleeding from the rectum
- severe **diarrhea**

Benzoyl peroxide and tretinoin

The most common side effects of antiacne drugs applied to the skin are slight redness, dryness, peeling, and stinging, and a warm feeling to the skin. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

Other side effects should be brought to a physician's attention. Check with a physician as soon as possible if any of the following side effects occur:

- blistering, crusting or swelling of the skin
- severe burning or redness of the skin
- darkening or lightening of the skin. (This effect will eventually go away after treatment with an anti-acne drug ends.)
- skin rash

Other side effects are possible with any type of anti-acne drug. Anyone who has unusual symptoms while using anti-acne drugs should get in touch with his or her physician.

Interactions

Patients using antiacne drugs on their skin should tell their physicians if they are using any other prescription or nonprescription (over-the-counter) medicine that they apply to the skin in the same area.

KEY TERMS

Acne—A skin condition in which raised bumps, pimples, and cysts form on the face, neck, shoulders and upper back.

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Pus—Thick, whitish or yellowish fluid that forms in infected tissue.

Triglyceride—A substance formed in the body from fat in the diet.

Isotretinoin may interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be greater. Anyone who takes isotretinoin should let the physician know about all other medicines he or she is taking and should ask whether the possible interactions can interfere with drug therapy. Among the drugs that may interact with isotretinoin are:

- etretinate (Tegison), used to treat severe **psoriasis**. Using this medicine with isotretinoin increases side effects.
- tretinoin (Retin-A, Renova). Using this medicine with isotretinoin increases side effects.
- vitamin A or any medicine containing vitamin A. Using any vitamin A preparations with isotretinoin increases side effects. Do not take vitamin supplements containing vitamin A while taking isotretinoin.
- tetracyclines (used to treat infections). Using these medicines with isotretinoin increases the chance of swelling of the brain. Make sure the physician knows if tetracycline is being used to treat acne or another infection.

Nancy Ross-Flanigan

Antiangina drugs

Definition

Antiangina drugs are medicines that relieve the symptoms of **angina** pectoris (severe chest **pain**).

Purpose

The dull, tight chest pain of angina occurs when the heart's muscular wall is not getting enough oxygen. By relaxing the blood vessels, antiangina drugs reduce the heart's work load and increase the amount of oxygen-rich blood that reaches the heart. These drugs come in different forms, and are used in three main ways:

- taken regularly over a long period, they reduce the number of angina attacks.
- taken just before some activity that usually brings on an attack, such as climbing stairs, they prevent attacks.
- taken when an attack begins, they relieve the pain and pressure.

Not every form of antiangina drug can be used in every way. Some work too slowly to prevent attacks that are about to begin or to relieve attacks that have already started. These forms can be used only to reduce the number of attacks. Be sure to understand how and when to use the type of antiangina drug that has been prescribed.

Description

Antiangina drugs, also known as nitrates, come in many different forms: tablets and capsules that are swallowed; tablets that are held under the tongue, inside the lip, or in the cheek until they dissolve; stick-on patches; ointment; and in-the-mouth sprays. Commonly used antiangina drugs include isosorbide dinitrate (Isordil, Sorbitrate, and other brands) and nitroglycerin (Nitro-Bid, Nitro-Dur, Nitrolingual Spray, Nitrostat Tablets, Transderm-Nitro, and other brands). These medicines are available only with a physician's prescription.

Recommended dosage

The recommended dosage depends on the type and form of antiangina drug and may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take antiangina drugs exactly as directed. The medicine will not work if it is not taken correctly.

Do not stop taking this medicine suddenly after taking it for several weeks or more, as this could cause angi-

Antiangina Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Calan (calan SR, isoptin, isoptin SR, verelan)	Constipation, dizziness, fatigue, headache, fluid retention, low blood pressure, nausea
Cardene (nicardipine hydrochloride)	Dizziness, headache, indigestion, nausea, rapid heartbeat, sleepiness, swelling of feet, flushing
Cardizem (diltiazem hydrochloride)	Dizziness, fluid retention, headache, nausea, rash
Corgard (nadolol)	Behaviorial changes, dizziness, drowsiness, tiredness
Imdur, Ismo, Monoket (isosorbide mononitrate)	Headache
Isordil (isosorbide dinitrate)	Headache, dizziness, low blood pressure
Lopressor (metroprolol tartrate)	Depression, diarrhea, itching, rash, tiredness
Nitro-Bid, Nitro-Dur, Nitrolingual Spray, Nitrostat Tables, Transderm-Nitro (nitroglycerin)	Dizziness, flushing, headache
Norvasc (amlodipine besylate)	Dizziness, fatigue, fluid retention, headache, palpitations
Procardia, Procardia XL, Adalat (nifedipine)	Constipation, dizziness, hearburn, low blood pressure, moodiness, nausea, swelling
Tenormin (atenolol)	Dizziness, fatigue, nausea, slowed heartbeat

na attacks to return. If it is necessary to stop taking the drug, check with the physician who prescribed it for instructions on how to taper down gradually.

Precautions

Remember that some forms of antiangina drugs work too slowly to relieve attacks that have already started. Check with the physician who prescribed the medicine for instructions on how to use the type that has been prescribed. Patients who are using slower-acting forms to make attacks less frequent may want to ask their physicians to prescribe a fast-acting type to relieve attacks. Another method of treating the frequency of attacks is to increase the dosage of the long-acting antiangina drug. Do this only with the approval of a physician.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible. Antiangina drugs may also cause **dizziness**, lightheadedness, or **fainting** in hot weather or when people stand for a long time or **exercise**. Use caution in all these situations. Drinking alcohol while taking antiangina drugs may cause the same problems. Anyone who takes this medicine should limit the amount of alcohol consumed.

Because these drugs may cause dizziness, be careful when driving, using machines, or doing anything else that could be dangerous.

If the person is taking the form of nitroglycerin that is placed under the tongue and symptoms are not relieved within three doses taken about 5 minutes apart, the person should go to the hospital emergency room as soon as possible. A **heart attack** may be in progress.

Some people develop tolerance to antiangina drugs over time. That is, the drug no longer produces the desired effects. Anyone who seems to be developing a tolerance to this medicine should check with his or her physician.

Anyone who has had unusual reactions to antiangina drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant or breastfeeding or who may become pregnant should check with their physicians before using antiangina drugs.

Older people may be especially sensitive to the effects of antiangina drugs and thus more likely to have side effects such as dizziness and lightheadedness.

Before using antiangina drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- recent heart attack or **stroke**
- kidney disease
- liver disease
- severe anemia
- overactive thyroid
- glaucoma
- recent head injury

Side effects

A common side effect is a **headache** just after taking a dose of the medicine. These headaches usually become less noticeable as the body adjusts to the drug. Check with a physician if they are severe or they continue even after taking the medicine for a few weeks. Unless a physician says to do so, do not change the dose to avoid

KEY TERMS

Angina pectoris—A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

headaches. Other common side effects include dizziness, lightheadedness, fast pulse, flushed face and neck, nausea or vomiting, and restlessness. These problems do not need medical attention unless they do not go away or they interfere with normal activities.

Other side effects may occur. Anyone who has unusual symptoms after taking an antiangina drug should get in touch with his or her physician.

Interactions

Antiangina drugs may interact with other medicines. This may increase the risk of side effects or change the effects of one or both drugs. Anyone who takes antiangina drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antiangina drugs are:

- other heart medicines
- blood pressure medicines
- aspirin
- alcohol
- ergot alkaloids used in migraine headaches

Nancy Ross-Flanigan

Antianxiety drugs

Definition

Antianxiety drugs are medicines that calm and relax people with excessive **anxiety**, nervousness, or tension, or for short term control of social phobia disorder or specific phobia disorder.

Purpose

Antianxiety agents, or anxiolytics, may be used to treat mild transient bouts of anxiety as well as more pronounced episodes of social phobia and specific phobia. Clinically significant anxiety is marked by several symptoms. The patient experiences marked or persistent fear of one or more social or performance situations in which he or she is exposed to unfamiliar people or possible scrutiny by others, and may react in a humiliating or embarrassing way. The exposure to the feared situation produces an anxiety attack. Fear of these episodes of anxiety leads to avoidance behavior, which impairs normal social functioning, including working or attending classes. The patient is aware that these fears are unjustified.

Description

In psychiatric practice, treatment of anxiety has largely turned from traditional antianxiety agents, anxiolytics, to antidepressant therapies. In current use, the **benzodiazepines**, the best known class of anxiolytics, have been largely supplanted by serotonin-specific reuptake inhibitors (SSRIs, citalopram, fluoxetine, fluvoxamine and others) which have a milder side effect profile and less risk of dependency. However, traditional anxiolytics remain useful for patients who need a rapid onset of action, or whose frequency of exposure to anxiety provoking stimuli is low enough to eliminate the need for continued treatment. While SSRIs may require three to five weeks to show any effects, and must be taken continuously, benzodiazepines may produce a response within 30 minutes, and may be dosed on an as-needed basis.

The intermediate action benzodiazepines, alprazolam (Xanax), and lorazepam (Ativan) are the appropriate choice for treatment of mild anxiety and social phobia. Diazepam (Valium) is still widely used for anxiety, but its active metabolite, desmethyldiazepam, which has a long half-life, may make this a poorer choice than other drugs in its class. Note that there is considerable variation between individuals in metabolism of benzodiazepines, so patient response may not be predictable. As a class, benzodiazepines are used not only as anxiolytics, but also as sedatives, **muscle relaxants**, and in treatment of epilepsy and **alcoholism**. The distinctions between these uses are largely determined by onset and duration of action, and route of administration.

Buspirone (BuSpar), which is not chemically related to other classes of central nervous system drugs, is also a traditional anxiolytic, although it is now considered either a third line or adjunctive agent for use after trials of SSRIs and benzodiazepines. It is appropriate for use in patients who have either failed trials of other treatments, or who should not receive benzodiazepines because of a history of substance abuse problems. Buspirone, in common with antidepressants, requires a two to three week period before there is clinical evidence of improvement, and must be continuously dosed to maintain its effects.

Antianxiety Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Atarax (hydroxyzine hydrochloride)	Drowsiness, dry mouth
Ativan (lorazepam)	Dizziness, excessive calm, weakness
BuSpar, Buspirone (buspirone hydrochloride)	Dry mouth, dizziness, headache, fatigue, nausea
Centrax (pazepam)	Decreased coordination, dizziness, drowsiness, fatigue, weakness
Librium, Libritabs (chlordiazepoxide)	Constipation, drowsiness, nausea, swelling
Miltown, Equanil (meprobamate)	Diarrhea, bruising, fever, headache, nausea, rash, slurred speech
Serax (oxazepam)	Dizziness, fainting, headache, liver problems, decreased coordination, nausea, swelling, vertigo
Stelazine (trifluoperazine hydrochloride)	Abnormal glucose in urine, allergic reactions, blurred vision, constipation, eye spasms, fluid retention and swelling
Tranxene, Tranxene-SD (clorazepate dipotassium)	Drowsiness
Valium (diazepam)	Decreased coordination, drowsiness, light-headedness

Benzodiazepines are controlled drugs under federal law. Buspirone is not a controlled substance and has no established abuse potential.

Recommended dosage

Benzodiazepines should be administered 30 to 60 minutes before exposure to the anticipated **stress**. Dosage should be individualized to minimize **sedation**. The normal dose of alprazolam is 0.25–0.5 mg. The usual dose of lorazepam is 2–3 mg. Doses may be repeated if necessary.

Buspirone is initially dosed at 5 mg t.i.d. (3 times a day.) Increase the dosage 5 mg/day, at intervals of two to three days, as needed. Do not exceed 60 mg/day. Two to three weeks may be required before a satisfactory response is seen.

Precautions

Benzodiazepines should not be used in patients with **psychosis**, acute narrow angle **glaucoma**, or liver disease. The drugs can act as respiratory depressants and should be avoided in patients with respiratory conditions. Benzodiazepines are potentially addictive and should not be administered to patients with substance abuse disorders. Because benzodiazepines are sedative, they should be avoided in patients who must remain alert. Their use for periods over four months has not been documented. These drugs should not be used during the second and third trimester of **pregnancy**, although use during the first trimester appears to be safe. They should not be taken while breastfeeding. Consult specialized references for use in children.

Buspirone is metabolized by the liver and excreted by the kidney, and should be used with care in patients with hepatic or renal disease. The drug is classified as schedule B during pregnancy, but should not be taken during breastfeeding. Its use in children under the age of 18 years has not been studied.

Side effects

The most common side effects of benzodiazepines are secondary to their CNS effects and include sedation and sleepiness; depression; lethargy; apathy; **fatigue**; hypoactivity; lightheadedness; memory impairment; disorientation; anterograde **amnesia**; restlessness; confusion; crying or sobbing; **delirium**; **headache**; slurred speech; aphonia; dysarthria; stupor; seizures; **coma**; syncope; rigidity; tremor; dystonia; vertigo; **dizziness**; euphoria; nervousness; irritability; difficulty in concentration; agitation; inability to perform complex mental functions; akathisia; hemiparesis; hypotonia; unsteadiness; ataxia; incoordination; weakness; vivid dreams; psychomotor retardation; "glassy-eyed" appearance; extrapyramidal symptoms; paradoxical reactions. Other reactions include changes in heart rate and blood pressure, changes in bowel function, severe skin rash and changes in genitourinary function. Other adverse effects have been reported.

Buspirone has a low incidence of side effects. Dizziness and drowsiness are the most commonly reported adverse effects. Other CNS effects include dream disturbances; depersonalization, dysphoria, noise intolerance, euphoria, akathisia, fearfulness, loss of interest, disassociative reaction, **hallucinations**, suicidal ideation, seizures; feelings of claustrophobia, cold intolerance, stupor and slurred speech, psychosis. Rarely, heart problems, including congestive **heart failure** and myocardial infarction, have been reported. Other adverse effects have been reported.

Interactions

The metabolism of alprazolam may be increased by: cimetidine, **oral contraceptives**, disulfiram, fluoxetine,

KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Epilepsy—A brain disorder with symptoms that include seizures.

Panic disorder—An disorder in which people have sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

Phobia—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

Pregnancy category B—Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies.

Pregnancy category C—No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data.

Seizure—A sudden attack, spasm, or convulsion.

isoniazid, ketoconazole, metoprolol, propoxyphene, propranolol and valproic acid. The absorption of all benzodiazepines is inhibited by concomitant use of **antacids**. Benzodiazepines may increase blood devels of digoxin, and reduce the efficacy of levodopa. Other drug interactions have been reported.

Buspirone levels will be increased by concomitant use of erythromycin, itraconazole, and nefazadone. Doses should be adjusted based on clinical response. Use of buspirone at the same time as mono-amine oxidase inhibitors (MAOIs, phenelzine, tranycypromine) may cause severe blood pressure elevations. Use of buspirone with MAOIs should be avoided.

Samuel Uretsky, PharmD

Antiarrhythmic drugs

Definition

Antiarrhythmic drugs are medicines that correct irregular heartbeats and slow down hearts that beat too fast.

Purpose

Normally, the heart beats at a steady, even pace. The pace is controlled by electrical signals that begin in one part of the heart and quickly spread through the whole heart. If something goes wrong with this control system, the result may be an irregular heartbeat, or an arrhythmia. Antiarrhythmic drugs correct irregular heartbeats, restoring the normal rhythm. If the heart is beating too fast, these drugs will slow it down. By correcting these problems, antiarrhythmic drugs help the heart work more efficiently.

Description

Antiarrhythmic drugs are available only with a physician's prescription and are sold in capsule (regular and extended release), tablet (regular and extended-release), and injectable forms. Commonly used antiarrhythmic drugs are disopyramide (Norpace, Norpace CR), procainamide (Procan SR, Pronestyl, Pronestyl-SR), and quinidine (Cardioquin, Duraquin, Quinidex, and other brands). *Do not confuse quinidine with quinine, which is a related medicine with different uses, such as relieving leg cramps.*

Recommended dosage

The recommended dosage depends on the type of antiarrhythmic drug and other factors. Doses may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take antiarrhythmic drugs exactly as directed. Never take larger or more frequent doses.

Do not stop taking this medicine without checking with the physician who prescribed it. Stopping it suddenly could lead to a serious change in heart function.

Antiarrhythmic drugs work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. If taking medicine at night interferes with sleep, or if it is difficult to remember to take the medicine during the day, check with a health care professional for suggestions.

Precautions

Persons who take these drugs should see their physician regularly. The physician will check to make sure the medicine is working as it should and will note any unwanted side effects.

Some people feel dizzy, lightheaded, or faint when using these drugs. This medicine may cause blurred

vision or other vision problems. Because of these possible problems, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them. If the medicine does cause vision problems, wait until vision is clear before driving or engaging in other activities that require normal vision.

Antiarrhythmic drugs make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible.

Anyone taking this medicine should not drink alcohol without his or her physician's approval.

Some antiarrhythmic drugs may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Anyone who is taking antiarrhythmic drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Antiarrhythmic drugs may cause low blood sugar in some people. Anyone who experiences symptoms of low blood sugar should eat or drink a food that contains sugar and call a physician immediately. Signs of low blood sugar are:

- anxiety
- confusion
- nervousness
- shakiness
- unsteady walk
- extreme hunger
- headache
- nausea
- drowsiness
- unusual tiredness or weakness
- fast heartbeat
- pale, cool skin
- chills
- cold sweats

Antiarrhythmic drugs may cause **dry mouth**. To temporarily relieve the discomfort, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than 2 weeks, check with a physician or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

People taking antiarrhythmic drugs may sweat less, which can cause the body temperature to rise. Anyone who takes this medicine should be careful not to become overheated during **exercise** or hot weather and should avoid hot baths, hot tubs, and saunas. Overheating could lead to heat stroke.

Older people may be especially sensitive to the effects of antiarrhythmic drugs. This may increase the risk of certain side effects, such as dry mouth, difficult urination, and **dizziness** or lightheadedness.

The antiarrhythmic drug procainamide can cause serious blood disorders. Anyone taking this medicine should have regular blood counts and should check with a physician if any of the following symptoms occur:

- joint or muscle **pain**
- muscle weakness
- pain in the chest or abdomen
- tremors
- wheezing
- cough
- palpitations
- rash, sores, or pain in the mouth
- sore throat
- fever and chills
- loss of appetite
- **diarrhea**
- dark urine
- yellow skin or eyes
- unusual bleeding or bruising
- dizziness
- **hallucinations**
- depression

Special conditions

People with certain medical conditions or who are taking certain other medicines may have problems if they take antiarrhythmic drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to an antiarrhythmic drug in the past should let his or her physician know before taking this type of medicine again. Patients taking procainamide should let their physicians know if they have ever had an unusual or allergic reaction to procaine or any other "caine-type" medicine, such as xylocaine or lidocaine. Patients taking quinidine should mention any previous reactions to qui-

KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Arrhythmia—Abnormal heart rhythm.

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Emphysema—A lung disease in which breathing becomes difficult.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Heat stroke—A severe condition caused by prolonged exposure to high heat. Heat stroke interferes with the body's temperature regulating abilities and can lead to collapse and coma.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Myasthenia gravis—A chronic disease with symptoms that include muscle weakness and sometimes paralysis.

Palpitation—Rapid, forceful, throbbing, or fluttering heartbeat.

Prostate—A donut-shaped gland below the bladder in men that contributes to the production of semen.

Psoriasis—A skin disease in which people have itchy, scaly, red patches on the skin.

Systemic lupus erythematosus (SLE)—A chronic disease that affects the skin, joints, and certain internal organs.

Tourette syndrome—A condition in which a person has tics and other involuntary behavior, such as barking, sniffing, swearing, grunting, and making uncontrollable movements.

Tremor—Shakiness or trembling.

nine. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

CONGESTIVE HEART DISEASE. Antiarrhythmic drugs may cause low blood sugar, which can be a particular problem for people with congestive heart disease. Anyone with congestive heart disease should be familiar with the signs of low blood sugar (listed above) and should check with his or her physician about what to do if such symptoms occur.

DIABETES. Antiarrhythmic drugs may cause low blood sugar, which can be a particular problem for people with diabetes. Anyone with diabetes should be familiar with the signs of low blood sugar (listed above) and should check with his or her physician about what to do if such symptoms occur.

PREGNANCY. The effects of taking antiarrhythmic drugs in **pregnancy** have not been studied in humans. In studies of laboratory animals, this medicine increased the risk of **miscarriage**. In addition, some women who have taken these drugs while pregnant have had contractions of the uterus (womb). Women who are pregnant or who may become pregnant should check with their physicians before taking this medicine. Women who become pregnant while taking this medicine should let their physicians know right away.

BREASTFEEDING. Antiarrhythmic drugs pass into breast milk. Women who are breastfeeding should check with their physicians before taking this medicine.

OTHER MEDICAL CONDITIONS. Before using antiarrhythmic drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart disorders such as structural heart disease or inflammation of the heart muscle
- congestive **heart failure**
- kidney disease
- liver disease
- diseases of the blood
- asthma or **emphysema**
- enlarged prostate or difficulty urinating
- overactive thyroid
- low blood sugar
- psoriasis
- **glaucoma**

- myasthenia gravis
- systemic lupus erythematosus

USE OF CERTAIN MEDICINES. Taking antiarrhythmic drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are dry mouth and throat, diarrhea, and loss of appetite. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as dizziness, lightheadedness, blurred vision, dry eyes and nose, frequent urge to urinate, bloating, **constipation**, stomach pain, and decreased sexual ability, also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- fever and chills
- difficult urination
- swollen or painful joints
- pain when breathing
- skin rash or itching

People who are especially sensitive to quinidine may have a reaction to the first dose or doses. If any of these side effects occur after taking quinidine, check with a physician immediately:

- dizziness
- ringing in the ears
- breathing problems
- vision changes
- fever
- headache
- skin rash

Other rare side effects may occur with any antiarrhythmic drug. Anyone who has unusual symptoms after taking antiarrhythmic drugs should get in touch with his or her physician.

Interactions

Antiarrhythmic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antiarrhythmic drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antiarrhythmic drugs are:

- other heart medicines, including other antiarrhythmic drugs
- blood pressure medicine
- blood thinners
- pimozide (Orap), used to treat Tourette's syndrome

The list above does not include every drug that may interact with antiarrhythmic drugs. Be sure to check with a physician or pharmacist before combining antiarrhythmic drugs with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antiasthmatic drugs

Definition

Antiasthmatic drugs are medicines that treat or prevent **asthma** attacks.

Purpose

For people with asthma, the simple act of breathing can be a struggle. Their airways become inflamed and blocked with mucus during asthma attacks, narrowing the opening through which air passes. This is not such a problem when the person breathes in, because the airways naturally expand when a person takes a breath. The real problem arises when the person with asthma tries to breathe out. The air cannot get out through the blocked airways, so it stays trapped in the lungs. With each new breath, the person can take in only a little more air, so breathing becomes shallow and takes more and more effort.

Asthma attacks can be caused by **allergies** to pollen, dust, pets or other things, but people without known allergies may also have asthma. **Exercise**, **stress**, intense emotions, exposure to cold, certain medicines and some medical conditions also can bring on attacks.

The two main approaches to dealing with asthma are avoiding substances and situations that trigger attacks and using medicines that treat or prevent the symptoms. With a combination of the two, most people with asthma can find relief and live normal lives.

Description

Three types of drugs are used in treating and preventing asthma attacks:

Antiasthmatic Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
AeroBid (aerobid-m, nasalide)	Diarrhea, headache, nausea, sore throat
Alupent (metaproterenol sulfate)	Cough, increased blood pressure and heart rate, nausea, upset stomach
Atrovent (ipratropium bromide)	Blurred vision, dry mouth, rash, headache
Azmacort (triamcinolone acetonide)	Dry mouth, dry and irritated throat
Beclovent Inhalation Aerosol, Beconase AQ Nasal Spray, Beconase Inhalation Aerosol (beclomethasone dipropionate)	Dry mouth, fluid retention, rash, headache, nasal irritation and burning, watery eyes
Brethine (terbutaline sulate)	Difficulty in breathing, drowsiness, headache, increased heartbeat, vomiting
Decadron Tables (dexamethasone)	Blood clots, bruising, fluid retention, increased blood pressure, hives
Decadron Turbinaire/Respihaler (dexamethasone sodium phosphate)	Headache, nausea, coughing, irritated throat
Deltasone (orasone)	Changes in behavior, mood and personality, may cause depression, fluid retention, increased blood pressure
Intal (cromolyn sodium)	Nausea, coughing and sneezing, irritated throat
Medrol (methylprednisolone)	Bruising, cataracts, increased blood pressure, stomach ulcer, rash, vertigo
Pediapred (prednisolone sodium phosphate)	Loss of bone and muscle mass, dizziness, fluid retention, diabetes, peptic ulcer
Provential (albuterol sulfate)	Diarrhea, headache, heartburn, muscle cramps, nausea, ringing in the ears
Theo-Dur (theophylline)	Nausea, diarrhea, hair loss, decreased blood pressure, rash, sleepiness
Tilade (neodocromil sodium)	Chest pain, headache, nausea, sore throat

- **Bronchodilators** relax the smooth muscles that line the airway. This makes the airways open wider, letting more air pass through them. These drugs are used mainly to relieve sudden asthma attacks or to prevent attacks that might come on after exercise. They may be taken by mouth, injected or inhaled.
- **Corticosteroids** block the inflammation that narrows the airways. Used regularly, these drugs will help prevent asthma attacks. Those attacks that do occur will be less severe. However, corticosteroids cannot stop an attack that is already underway. These drugs may be taken by mouth, injected or inhaled.
- Cromolyn also is taken regularly to prevent asthma attacks and may be used alone or with other asthma medicines. It cannot stop an attack that already has started. The drug works by preventing certain cells in the body from releasing substances that cause allergic reactions or asthma symptoms. One brand of this drug, Nasalcrom, comes in capsule and nasal spray forms and is used to treat hay **fever** and other allergies. The inhalation form of the drug, Intal, is used for asthma. It comes in aerosol canisters, in capsules that are inserted into an inhaler, and in liquid form that is used in a nebulizer.

Precautions

Using antiasthmatic drugs properly is important. Because bronchodilators provide quick relief, some people may be tempted to overuse them. However, with some kinds of bronchodilators, this can lead to serious and possibly life-threatening complications. In the long run, patients are better off using bronchodilators only as directed and also using corticosteroids, which eventually will reduce their need for bronchodilators.

Patients who are using their antiasthmatic drugs correctly but feel their asthma is not under control should see their physicians. The physician can either increase the dose, switch to another medicine or add another medicine to the regimen.

Corticosteroids are powerful drugs that may cause serious side effects when used over a long time. However, these problems are much less likely with the inhalant forms than with the oral and injected forms. While the oral and injected forms generally should be used only for one to two weeks, the inhalant forms may be used for long periods.

When used to prevent asthma attacks, cromolyn must be taken as directed every day. The drug may take as long as four weeks to start working. Unless told to do so by a physician, patients should not stop taking the drug just because it does not seem to be working. When symptoms do begin to improve, patients should continue taking all medicines that have been prescribed, unless a physician directs otherwise.

Side effects

Inhalant forms of antiasthmatic drugs may cause dryness or irritation in the throat, **dry mouth**, or an unpleasant taste in the mouth. To help prevent these problems, gargle and rinse the mouth or take a sip of water after each dose.

More serious side effects are not common when these medicines are used properly. However, anyone who

KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Inhalant—Medicine that is breathed into the lungs.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Nebulizer—A device that turns liquid forms of medicine into a fine spray that can be inhaled.

has unusual or bothersome symptoms after taking an antiasthmatic drug should get in touch with a physician.

Interactions

Check with a physician or pharmacist before combining antiasthmatic drugs with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antibacterial bath *see* **Therapeutic baths**

Antibiotic-associated colitis

Definition

Antibiotic-associated colitis is an inflammation of the intestines that sometimes occurs following antibiotic treatment and is caused by toxins produced by the bacterium *Clostridium difficile*.

Description

Antibiotic-associated colitis, also called antibiotic-associated enterocolitis, can occur following antibiotic treatment. The bacteria *Clostridia difficile* are normally found in the intestines of 5% of healthy adults, but people can also pick up the bacteria while they are in a hospital or nursing home. In a healthy person, harmless resident intestinal bacteria compete with each other for food and places to "sit" along the inner intestinal wall. When **antibiotics** are given, most of the resident bacteria are killed. With fewer bacteria to compete with, the normally harmless *Clostridia difficile* grow rapidly and produce toxins. These toxins damage the inner wall of the intestines and cause inflammation and **diarrhea**.

Although all antibiotics can cause this disease, it is most commonly caused by clindamycin (Cleocin), ampicillin (Omnipen), amoxicillin (Amoxil, Augmentin, or Wymox), and any in the cephalosporin class (such as cefazolin or cephalexin). Symptoms of the condition can occur during antibiotic treatment or within four weeks after the treatment has stopped.

In approximately half of cases of antibiotic-associated colitis, the condition progresses to a more severe form of colitis called pseudomembranous enterocolitis in which pseudomembranes are excreted in the stools. Pseudomembranes are membrane-like collections of white blood cells, mucus, and the protein that causes blood to clot (fibrin) that are released by the damaged intestinal wall.

Causes and symptoms

Antibiotic-associated colitis is caused by toxins produced by the bacterium *Clostridium difficile* after treatment with antibiotics. When most of the other intestinal bacteria have been killed, *Clostridium difficile* grows rapidly and releases toxins that damage the intestinal wall. The disease and symptoms are caused by these toxins, not by the bacterium itself.

Symptoms of antibiotic-associated colitis usually begin four to ten days after antibiotic treatment has begun. The early signs and symptoms of this disease include lower abdominal cramps, an increased need to pass stool, and watery diarrhea. As the disease progresses, the patient may experience a general ill feeling, **fatigue**, abdominal **pain**, and **fever**. If the disease proceeds to pseudomembranous enterocolitis, the patient may also experience nausea, vomiting, large amounts of watery diarrhea, and a very high fever (104-105°F/40-40.5°C). Complications of antibiotic-associated colitis include severe **dehydration**, imbalances in blood **minerals**, low blood pressure, fluid accumulation in deep skin (**edema**), enlargement of the large intestine (toxic megacolon), and the formation of a tear (perforation) in the wall of the large intestine.

Clostridium difficile is easily spread from person to person in hospitals and nursing homes. The following individuals are most at-risk for developing this disease:

- the elderly
- severely ill individuals
- individuals with weakened or suppressed immune systems (immunocompromised)

- individuals with poor hygiene
- individuals who have been hospitalized for a long period of time

The *Clostridium difficile* toxin is found in the stools of persons older than 60 years of age 20-100 times more frequently than in the stools of persons who are 10-20 years old. As a result, the elderly are much more prone to developing antibiotic-associated colitis than younger individuals.

Diagnosis

Antibiotic-associated colitis can be diagnosed by the symptoms and recent medical history of the patient, by a laboratory test for the bacterial toxin, and/or by using a procedure called endoscopy.

If the diarrhea and related symptoms occurred after the patient received antibiotics, antibiotic-associated colitis may be suspected. A stool sample may be analyzed for the presence of the *Clostridium difficile* toxin. This toxin test is the preferred diagnostic test for antibiotic-associated colitis. One frequently used test for the toxin involves adding the processed stool sample to a human cell culture. If the toxin is present in the stool sample, the cells die. It may take up to two days to get the results from this test. A simpler test, which provides results in two to three hours, is also available. Symptoms and toxin test results are usually enough to diagnose the disease.

Another tool that may be useful in the diagnosis of antibiotic-associated colitis, however, is a procedure called an endoscopy that involves inserting a thin, lighted tube into the rectum to visually inspect the intestinal lining. Two different types of endoscopy procedures, the **sigmoidoscopy** and the **colonoscopy**, are used to view different parts of the large intestine. These procedures are performed in a hospital or doctor's office. Patients are sedated during the procedure to make them more comfortable and are allowed to go home after recovering from the **sedation**.

Treatment

Diarrhea, regardless of the cause, is always treated by encouraging the individual to replace lost fluids and prevent dehydration. One method to treat antibiotic-associated colitis is to simply stop taking the antibiotic that caused the disease. This allows the normal intestinal bacteria to repopulate the intestines and inhibits the overgrowth of *Clostridium difficile*. Many patients with mild disease respond well to this and are free from diarrhea within two weeks. It is important, however, to make sure that the original disease for which the antibiotics were prescribed is treated.

KEY TERMS

Colitis—Inflammation of the colon.

Edema—Fluid accumulation in a tissue.

Endoscopy—A procedure in which a thin, lighted instrument is inserted into the interior of a hollow organ, such as the rectum and used to visually inspect the inner intestinal lining.

Fibrin—A fibrous blood protein vital to coagulation and blood clot formation.

Rectum—The last part of the intestine. Stool passes through the rectum and out through the anal opening.

Toxic megacolon—Acute enlargement or dilation of the large intestine.

Because of the potential seriousness of this disease, most patients are given another antibiotic to control the growth of the *Clostridium difficile*, usually vancomycin (Vancocin) or metronidazole (Flagyl or Protostat). Both are designed to be taken orally four times a day for 10-14 days. Upon finishing antibiotic treatment, approximately 15-20% of patients will experience a relapse of diarrhea within one to five weeks. Mild relapses can go untreated with great success, however, severe relapses of diarrhea require another round of antibiotic treatment. Instead of further antibiotic treatment, a cholestyramine resin (Questran or Prevalite) may be given. The bacterial toxins produced in the intestine stick to the resin and are passed out with the resin in the stool. Unfortunately, however, vancomycin also sticks to the resin, so these two drugs cannot be taken at the same time. Serious disease may require hospitalization so that the patient can be monitored, treated, and rehydrated.

Alternative treatment

The goal of alternative treatment for antibiotic-associated enterocolitis is to repopulate the intestinal environment with microorganisms that are normal and healthy for the intestinal tract. These microorgansisms then compete for space and keep the *Clostridium difficile* from over-populating.

Several types of supplements can be used. Supplements containing *Lactobacillus acidophilus*, the bacteria commonly found in yogurt and some types of milk, *Lactobacillus bifidus*, and *Streptococcus faecium*, are available in many stores in powder, capsule, tablet, and liquid form. *Acidophilus* also acts as a mild antibiotic, which helps it to

KEY TERMS

Colitis—Inflammation of the colon.

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reestablish itself in the intestine, and all may aid in the production of some B **vitamins** and vitamin K. These supplements can be taken individually and alternated weekly or together following one or more courses of antibiotics.

Prognosis

With appropriate treatment and replenishment of fluids, the prognosis is generally excellent. One or more relapses can occur. Very severe colitis can cause a tear (perforation) in the wall of the large intestine that would require major surgery. Perforation of the intestine can cause a serious abdominal infection. Antibiotic-associated colitis can be fatal in people who are elderly and/or have a serious underlying illness, such as **cancer**.

Prevention

There are no specific preventative measures for this disease. Good general health can reduce the chance of developing a bacterial infection that would require antibiotic treatment and the chance of picking up the *Clostridia* bacteria. Maintaining good general health can also reduce the seriousness and length of the condition, should it develop following antibiotic therapy.

Resources

PERIODICALS

Fekety, R., and A. B. Shah. "Diagnosis and Treatment of Clostridium difficile Colitis." *Journal of the American Medical Association* 269 (1993): 71+.

Kelly, Ciaran P., Charalabos Pothoulakis, and J. Thomas LaMont. "Clostridium difficile Colitis." *The New England Journal of Medicine* 330 (27 Jan. 1994): 257+.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Antibiotic prophylaxis *see* **Prophylaxis**

Antibiotics

Definition

Antibiotics may be informally defined as the subgroup of anti-infectives that are derived from bacterial sources and are used to treat bacterial infections. Other classes of drugs, most notably the **sulfonamides**, may be effective antibacterials. Similarly, some antibiotics may have secondary uses, such as the use of demeclocycline (Declomycin, a tetracycline derivative) to treat the syndrome of inappropriate antidiuretic hormone (SIADH) secretion. Other antibiotics may be useful in treating protozoal infections.

Purpose

Antibiotics are used for treatment or prevention of bacterial infection.

Description

Classifications

Although there are several classification schemes for antibiotics, based on bacterial spectrum (broad versus narrow) or route of administration (injectable versus oral versus topical), or type of activity (bactericidal vs. bacteriostatic), the most useful is based on chemical structure. Antibiotics within a structural class will generally show similar patterns of effectiveness, toxicity, and allergic potential.

PENICILLINS. The **penicillins** are the oldest class of antibiotics, and have a common chemical structure which they share with the cephalopsorins. The two groups are classed as the beta-lactam antibiotics, and are generally bacteriocidal—that is, they kill bacteria rather than inhibiting growth. The penicillins can be further subdivided. The natural pencillins are based on the original penicillin G structure; penicillinase-resistant penicillins, notably methicillin and oxacillin, are active even in the presence of the bacterial enzyme that inactivates most natural penicillins. Aminopenicillins such as ampicillin and amoxicillin have an extended spectrum of action compared with the natural penicillins; extended spectrum

penicillins are effective against a wider range of bacteria. These generally include coverage for *Pseudomonas aeruginaosa* and may provide the penicillin in combination with a penicillinase inhibitor.

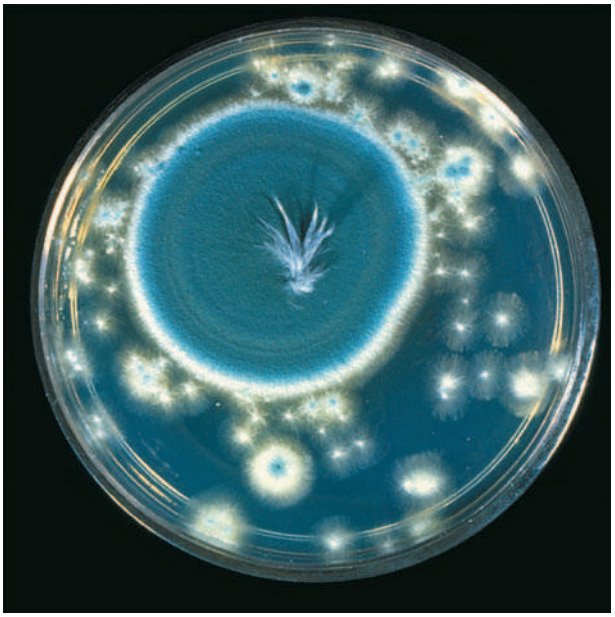
CEPHALOSPORINS. **Cephalosporins** and the closely related cephamycins and carbapenems, like the pencillins, contain a beta-lactam chemical structure. Consequently, there are patterns of cross-resistance and cross-allergenicity among the drugs in these classes. The "cepha" drugs are among the most diverse classes of antibiotics, and are themselves subgrouped into 1st, 2nd and 3rd generations. Each generation has a broader spectrum of activity than the one before. In addition, cefoxitin, a cephamycin, is highly active against anaerobic bacteria, which offers utility in treatment of abdominal infections. The 3rd generation drugs, cefotaxime, ceftizoxime, ceftriaxone and others, cross the blood-brain barrier and may be used to treat **meningitis** and **encephalitis**. Cephalopsorins are the usually preferred agents for surgical **prophylaxis**.

FLUROQUINOLONES. The fluroquinolones are synthetic antibacterial agents, and not derived from bacteria. They are included here because they can be readily interchanged with traditional antibiotics. An earlier, related class of antibacterial agents, the quinolones, were not well absorbed, and could be used only to treat urinary tract infections. The fluroquinolones, which are based on the older group, are broad-spectrum bacteriocidal drugs that are chemically unrelated to the penicillins or the cephaloprosins. They are well distributed into bone tissue, and so well absorbed that in general they are as effective by the oral route as by intravenous infusion.

TETRACYCLINES. **Tetracyclines** got their name because they share a chemical structure that has four rings. They are derived from a species of *Streptomyces* bacteria. Broad-spectrum bacteriostatic agents, the tetracyclines may be effective against a wide variety of microorganisms, including rickettsia and amebic parasites.

MACROLIDES. The macrolide antibiotics are derived from *Streptomyces* bacteria, and got their name because they all have a macrocyclic lactone chemical structure. Erythromycin, the prototype of this class, has a spectrum and use similar to penicillin. Newer members of the group, azithromycin and clarithyromycin, are particularly useful for their high level of lung penetration. Clarithromycin has been widely used to treat *Helicobacter pylori* infections, the cause of stomach ulcers.

OTHERS. Other classes of antibiotics include the **aminoglycosides**, which are particularly useful for their effectiveness in treating *Pseudomonas aeruginosa* infections; the lincosamindes, clindamycin and lincomycin, which are highly active against anaerobic pathogens. There are other, individual drugs which may have utility in specific infections.



A penicillin culture. *(Photograph by P. Barber, Custom Medical Stock Photo. Reproduced by permission.)*

Recommended dosage

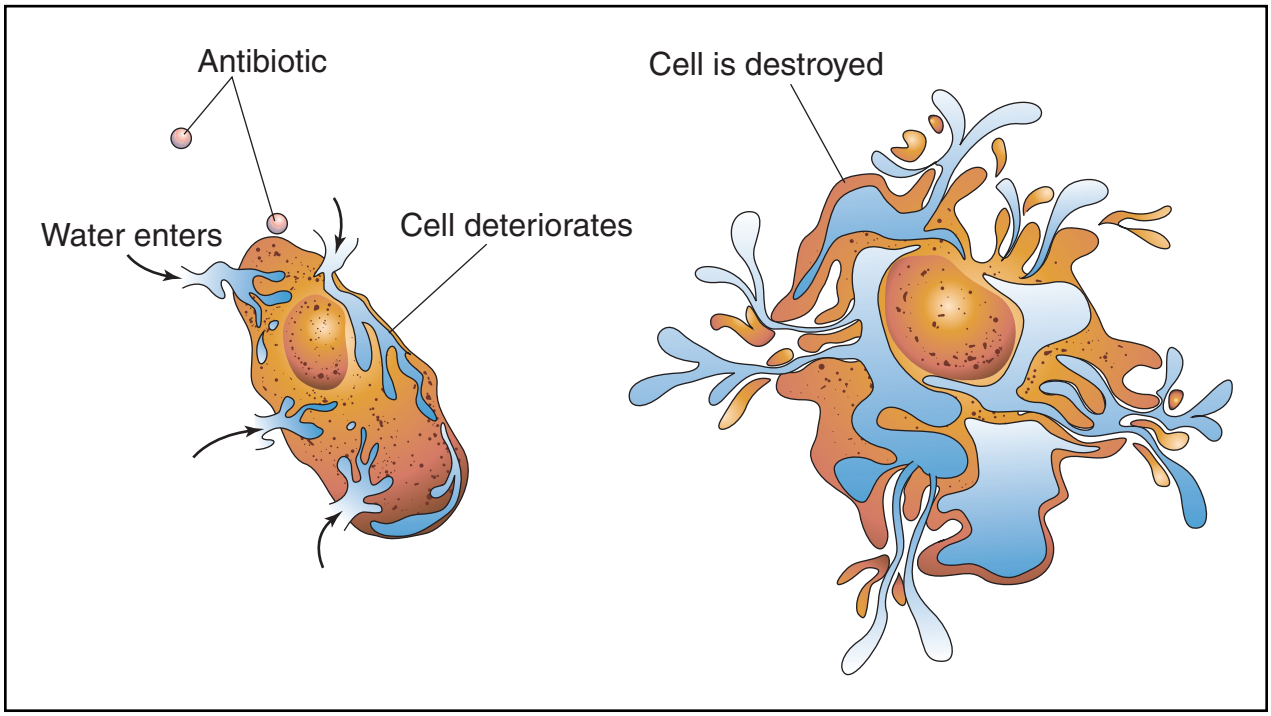
Dosage varies with drug, route of administration, pathogen, site of infection, and severity. Additional considerations include renal function, age of patient, and other factors. Consult manufacturers' recommendations for dose and route.

Side effects

All antibiotics cause risk of overgrowth by non-susceptible bacteria. Manufacturers list other major hazards by class; however, the health care provider should review each drug individually to assess the degree of risk. Generally, breastfeeding is not recommended while taking antibiotics because of risk of alteration to infant's intestinal flora, and risk of masking infection in the infant. Excessive or inappropriate use may promote growth of resistant pathogens.

Penicillins: Hypersensitivity may be common, and cross allergenicity with cephalosporins has been reported. Penicillins are classed as category B during **pregnancy**.

Cephalopsorins: Several cephalopsorins and related compounds have been associated with seizures. Cefmetazole, cefoperazone, cefotetan and ceftriaxone may be



Different antibiotics destroy bacteria in different ways. Some short-circuit the processes by which bacteria receive energy. Others disturb the structure of the bacterial cell wall, as shown in the illustration above. Still others interfere with the production of essential proteins. *(Illustration by Electronic Illustrators Group.)*

associated with a fall in prothrombin activity and coagulation abnormalities. Pseudomembranous colitis has been reported with cephalosporins and other broad spectrum antibiotics. Some drugs in this class may cause renal toxicity. Pregnancy category B.

Fluroquinolones: Lomefloxacin has been associated with increased **photosensitivity**. All drugs in this class have been associated with convulsions. Pregnancy category C.

Tetracyclines: Demeclocycline may cause increased photosensitivity. Minocycline may cause **dizziness**. Do not use tetracyclines in children under the age of eight, and specifically avoid during periods of tooth development. Oral tetracyclines bind to anions such as calcium and iron. Although doxycycline and minocycline may be taken with meals, patients must be advised to take other tetracycline antibiotics on an empty stomach, and not to take the drugs with milk or other calcium-rich foods. Expired tetracycline should never be administered. Pregnancy category D. Use during pregnancy may cause alterations in bone development.

Macrolides: Erythromycin may aggravate the weakness of patients with **myasthenia gravis**. Azithromycin has, rarely, been associated with allergic reactions, including angioedema, **anaphylaxis**, and dermatologic reactions, including Stevens-Johnson syndrome and **toxic epidermal necrolysis**. Oral erythromycin may be highly irritating to the stomach and when given by injection may cause severe phlebitis. These drugs should be used with caution in patients with liver dysfunction. Pregnancy category B: Azithromycin, erythromycin. Pregnancy category C: Clarithromycin, dirithromycin, troleandomycin.

Aminoglycosides: This class of drugs causes kidney and **ototoxicity**. These problems can occur even with normal doses. Dosing should be based on renal function, with periodic testing of both kidney function and hearing. Pregnancy category D.

Recommended usage

To minimize risk of adverse reactions and development of resistant strains of bacteria, antibiotics should be restricted to use in cases where there is either known or a reasonable presumption of bacterial infection. The use of antibiotics in viral infections is to be avoided. Avoid use of fluroquinolones for trivial infections.

In severe infections, presumptive therapy with a broad-spectrum antibiotic such as a 3rd generation cephalosporin may be appropriate. Treatment should be changed to a narrow spectrum agent as soon as the

KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Meningitis—Inflammation of tissues that surround the brain and spinal cord.

Microorganism—An organism that is too small to be seen with the naked eye.

Organism—A single, independent unit of life, such as a bacterium, a plant or an animal.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

pathogen has been identified. After 48 hours of treatment, if there is clinical improvement, an oral antibiotic should be considered.

Resources

PERIODICALS

Braffman-Miller, Judith. "Beware the Rise of Antibiotic-Resistant Microbes." *USA Today (Magazine)* 125 (March 1997): 56.

"Consumer Alert: Antibiotic Resistance Is Growing!" *People's Medical Society Newsletter* 16 (August 1997): 1.

Swartz, Morton N. "The Path of Least Resistance." *Harvard Health Letter* 20 (April 1995): 6.

Samuel Uretsky, PharmD

Antibiotics, ophthalmic

Definition

Ophthalmic **antibiotics** are medicines that kill bacteria that cause eye infections.

Purpose

Ophthalmic antibiotics are applied to the eye, or under the eyelid, to treat eye infections caused by bacteria.

Description

The medicine described here, tobramycin (Tobrex), comes in the form of eye drops or ointment. It is available only with a physician's prescription.

Recommended dosage

The dosages given here are typical doses. Physicians may adjust the number of doses per day, the time between doses, and the length of treatment with the medicine, depending on the patient's particular medical problem. If the physician's directions are different from those given here, follow the physician's directions.

Be sure to follow package directions for applying drops or ointment properly.

Adults

EYE DROPS. For mild to moderate infections, use one to two drops in the affected eye or eyes every four hours.

For severe infections, use two drops in the affected eye or eyes every two hours until the condition improves. At that time, the physician will determine how much to use until the infection is completely cleared up.

OINTMENT. For mild to moderate infections, squeeze a half-inch ribbon of ointment into the affected eye or eyes two or three times a day. Do not let the tip of the ointment tube touch the eye.

For severe infections, squeeze a half-inch ribbon of ointment into the affected eye or eyes every three to four hours until the condition improves. At that time, the physician will determine how much to use until the infection is completely cleared up.

Children

The child's physician should determine the proper dose.

Precautions

Use this drug as often as directed, for as long as directed. Although the symptoms may have disappeared, the infection may not clear up completely if the drug is stopped too soon. Therefore, the medication may be prescribed for several days after the infection appears to have cleared. However, it is just as important to use the drug for *only* as long as directed. Using it for

KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Ointment—A thick, spreadable substance that contains medicine and is meant to be used on the skin, or, if it is specifically an ophthalmic, or "eye" ointment, in the eye

too long may lead to the growth of bacteria that do not respond to the drug. These bacteria may then cause infections that can be very difficult to treat. Make sure the physician or pharmacist specifies how long the medication is to be used.

Anyone who has had an allergic reaction to tobramycin or any other ingredients of Tobrex should not use this medicine. Be sure to tell the physician about any past reactions to the drug or its ingredients.

Anyone who has an allergic reaction to tobramycin should stop using it immediately and call a physician.

Women who are pregnant or breastfeeding or who plan to become pregnant should check with their physicians before using tobramycin.

Side effects

The main side effects of this medicine are **itching**, redness, and swelling of the eye or eyelid. Allergic reactions also are possible. If any of these symptoms occur, call the physician who prescribed the medicine.

Interactions

Patients who are using any other prescription or nonprescription (over-the-counter) medicines in their eyes should check with their physicians before using tobramycin.

Nancy Ross-Flanigan

Antibiotics, topical

Definition

Topical **antibiotics** are medicines applied to the skin to kill bacteria.

Purpose

Topical antibiotics help prevent infections caused by bacteria that get into minor cuts, scrapes, and **burns**. Treating minor **wounds** with antibiotics allows quicker healing. If the wounds are left untreated, the bacteria will multiply, causing **pain**, redness, swelling, **itching**, and oozing. Untreated infections can eventually spread and become much more serious.

Different kinds of topical antibiotics kill different kinds of bacteria. Many antibiotic first-aid products contain combinations of antibiotics to make them effective against a broad range of bacteria.

When treating a wound, it is not enough to simply apply a topical antibiotic. The wound must first be cleaned with soap and water and patted dry. After the antibiotic is applied, the wound should be covered with a dressing, such as a bandage or a protective gel or spray. For many years, it was thought that wounds heal best when exposed to the air. But now most experts say it is best to keep wounds clean and moist while they heal. The covering should still allow some air to reach the wound, however.

Description

Some topical antibiotics are available without a prescription and are sold in many forms, including creams, ointments, powders, and sprays. Some widely used topical antibiotics are bacitracin, neomycin, mupirocin, and polymyxin B. Among the products that contain one or more of these ingredients are Bactroban (a prescription item), Neosporin, Polysporin, and Triple Antibiotic Ointment or Cream.

Recommended dosage

The recommended dosage depends on the type of topical antibiotic. Follow the directions on the package label or ask a pharmacist for directions.

In general, topical antibiotics should be applied within four hours after injury. Do not use more than the recommended amount and do not apply it more often than three times a day. Do not apply the medicine over large areas of skin or on open wounds.

Precautions

Many public health experts are concerned about antibiotic resistance, a problem that can develop when antibiotics are overused. Over time, bacteria develop new defenses against antibiotics that once were effective against them. Because bacteria reproduce so quickly, these defenses can be rapidly passed on through generations of bacteria until almost all are immune to the

effects of a particular antibiotic. The process happens faster than new antibiotics can be developed. To help control the problem, many experts advise people to use topical antibiotics only for short periods, that is, until the wound heals, and only as directed. For the topical antibiotic to work best, it should be used only to prevent infection in a fresh wound, not to treat an infection that has already started. Wounds that are not fresh may need the attention of a physician to prevent complications such as blood **poisoning**.

Topical antibiotics are meant to be used only on the skin and only for only a few days at a time. If the wound has not healed in five days, stop using the antibiotic and call a doctor.

Do not use topical antibiotics on large areas of skin or on open wounds. These products should not be used to treat **diaper rash** in infants or incontinence rash in adults.

Only minor cuts, scrapes, and burns should be treated with topical antibiotics. Certain kinds of injuries may need medical care and should not be self-treated with topical antibiotics. These include:

- large wounds
- deep cuts
- cuts that continue bleeding
- cuts that may need stitches
- burns any larger than a few inches in diameter
- scrapes imbedded with particles that won't wash away
- animal bites
- deep puncture wounds
- eye injuries

Never use regular topical antibiotics in the eyes. Special antibiotic products are available for treating eye infections.

Although topical antibiotics control infections caused by bacteria, they may allow fungal infections to develop. The use of other medicines to treat the fungal infections may be necessary. Check with the physician or pharmacist.

Some people may be allergic to one or more ingredients in a topical antibiotic product. If an allergic reaction develops, stop using the product immediately and call a physician.

No harmful or abnormal effects have been reported in babies whose mothers used topical antibiotics while pregnant or nursing. However, pregnant women generally are advised not to use any drugs during the first 3 months after conception. A woman who is pregnant or breastfeeding or who plans to become pregnant should check with her physician before using a topical antibiotic.

Unless a physician says to do so, do not use topical antibiotics on children under two years of age.

KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Conception—The union of egg and sperm to form a fetus.

Fungal—Caused by a fungus.

Fungus—A member of a group of simple organisms that are related to yeast and molds.

Incontinence—The inability to control the bladder or bowel.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Side effects

The most common minor side effects are itching or burning. These problems usually do not require medical treatment unless they do not go away or they interfere with normal activities.

If any of the following side effects occur, check with a doctor as soon as possible:

- rash
- swelling of the lips and face
- sweating
- tightness or discomfort in the chest
- breathing problems
- fainting or **dizziness**
- low blood pressure
- nausea
- diarrhea
- hearing loss or ringing in the ears

Other rare side effects may occur. Anyone who has unusual symptoms after using a topical antibiotic should get in touch with the physician who prescribed or the pharmacist who recommedned the medication.

Interactions

Using certain topical antibiotics at the same time as hydrocortisone (a topical corticosteroid used to treat

inflammation) may hide signs of infection or allergic reaction. Do not use these two medicines at the same time unless told to do so by a health care provider.

Anyone who is using any other type of prescription or nonprescription (over-the-counter) medicine on the skin should check with a doctor before using a topical antibiotic.

Resources

PERIODICALS

Farley, Dixie. "Help for Cuts, Scrapes and Burns." *FDA Consumer* (May 1996):12.

Nancy Ross-Flanigan

Antibody screening *see* **Blood typing and crossmatching**

Anticancer drugs

Definition

Anticancer, or antineoplastic, drugs are used to treat malignancies, cancerous growths. Drug therapy may be used alone, or in combination with other treatments such as surgery or **radiation therapy**.

Purpose

Anticancer drugs are used to control the growth of cancerous cells. **Cancer** is commonly defined as the uncontrolled growth of cells, with loss of differentiation and commonly, with metastasis, spread of the cancer to other tissues and organs. Cancers are malignant growths. In contrast, benign growths remain encapsulated and grow within a well-defined area. Although benign tumors may be fatal if untreated, due to pressure on essential organs, as in the case of a benign **brain tumor**, surgery or radiation are the preferred methods of treating growths which have a well defined location. Drug therapy is used when the tumor has spread, or may spread, to all areas of the body.

Description

Several classes of drugs may be used in cancer treatment, depending on the nature of the organ involved. For example, breast cancers are commonly stimulated by estrogens, and may be treated with drugs which inactive the sex hormones. Similarly, **prostate cancer** may be treated with drugs that inactivate androgens, the male sex hormone. However, the majority of antineoplastic drugs act by interfering with cell growth. Since cancerous cells grow more rapidly than other cells, the drugs target those cells which are in the process of reproducing themselves. As a result, antineoplastic drugs will commonly affect not only the cancerous cells, but others cells that commonly reproduce quickly, including hair follicles, ovaries and testis, and the blood-forming organs.

KEY TERMS

Cataract—Clouding of the lens of the eye, leading to poor vision or blindness.

Impotent—Unable to achieve or maintain an erection of the penis.

Newer approaches to antineoplastic drug therapy have taken different approaches, including angigenesis—the inhibition of formation of blood vessels feeding the tumor and contributing to tumor growth. Although these approaches hold promise, they are not yet in common use.

Antineoplastic drugs may be divided into two classes: cycle specific and non-cycle specific. Cycle specific drugs act only at specific points of the cell's duplication cycle, such as anaphase or metaphase, while non-cycle specific drugs may act at any point in the cell cycle. In order to gain maximum effect, antineoplastic drugs are commonly used in combinations.

Precautions

Because antineoplastic agents do not target specific cell types, they have a number of common adverse side effects. Hair loss is common due to the effects on hair follicles, and anemia, immune system impairment, and clotting problems are caused by destruction of the blood forming organs, leading to reduction in the number of red cells, white cells, and platelets. Because of the frequency and severity of these side effects, it is common to administer **chemotherapy** in cycles, allowing time for recovery from the drug effects before administering the next dose. Doses are often calculated, not on the basis of weight, but rather based on blood counts, in order to avoid dangerous levels of anemia (red cell depletion), **neutropenia** (white cell deficiency), or **thrombocytopenia** (platelet deficiency.)

Nausea and vomiting are among the most common adverse effects of cancer chemotherapy, and in some cases may be severe enough to cause dose reduction or discontinuation of treatment.

The health professional has many responsibilities in dealing with patients undergoing chemotherapy. The

Anti Cancer Drugs

Generic (Brand Name)	Clinical Uses	Common Side Effects To Drug
Altretamine (Hexalen)	Treatment of advanced ovarian cancer	Bone marrow depression, nausea and vomiting
Asparaginase (Elspar)	Commonly used in combination with other drugs; refractory acute lymphocytic leukemia	Liver, kidney, pancreas, CNS abnormalities
Bleomycin (Blenoxane)	Lymphomas, Hodgkin's disease, testicular cancer	Hair loss, stomatitis, pulmonary toxicity, hyperpigmentation of skin
Busulfan (Myleran)	Chronic granulocytic leukemia	Bone marrow depression, pulmonary toxicity
Carboplatin (Paraplatin)	Pallilation of ovarian cancer	Bone marrow depression, nausea and vomiting
Carmustine	Hodgkin's disease, brain tumors, multiple myeloma, malignant melonoma	Bone marrow depression, nausea and vomiting, toxic damage to liver
Chlorambucil (Leukeran)	Chronic lymphocytic leukemia, non-Hodgkin's lymphomas, breast and ovarian cancer	Bone marrow depression, excess uric acid in blood
Cisplatin (Platinol)	Treatment of bladder, ovarian, uterine, testicular, head and neck cancers	Renal toxicity and ototoxicity
Cladribine (Leustatin)	Hairy cell leukemia	Bone marrow depression, nausea and vomiting, fever
Cyclophosphamide (Cytoxan)	Hodgkin's disease, non-Hodgkin's lymphomas, neuroblastoma. Often used with other drugs for breast, ovarian, and lung cancers; acute lymphoblastic leukemia in children; multiple myeloma	Bone marrow depression, hair loss, nausea and vomiting, inflammation of the bladder
Cytarabine (Cytosar-U)	Leukemias occurring in adults and children	Bone marrow depression, nausea and vomiting, diarrhea, stomatitis
Dacarbazine (DTIC-Dome)	Hodgkin's disease, malignant melanoma	Bone marrow depression, nausea and vomiting
Diethylstilbestrol (DES) (Stilbestrol)	Breast cancer in post-menopausal women, prostate cancer	Hair loss, nausea and vomiting, edema, excess calcium in blood; feminizing effects in men
Ethinyl estradiol (Estinyl)	Advanced breast cancer in post-menopausal women, prostate cancer	Excess calcium in blood, anorexia, edema, nausea and vomiting; feminizing effects in men
Etoposide (VePesid)	Acute leukemias, lymphomas, testicular cancer	Bone marrow depression, nausea and vomiting, hair loss

patient must be well informed of the risks and benefits of chemotherapy, and must be emotionally prepared for the side effects. These may be permanent, and younger patients should be aware of the high risk of sterility after chemotherapy.

The patient must also know which side effects should be reported to the practitioner, since many adverse effects do not appear until several days after a dose of chemotherapy. When chemotherapy is self-administered, the patient must be familiar with proper use of the drugs, including dose scheduling and avoidance of drug-drug and food-drug interactions.

Appropriate steps should be taken to minimize side effects. These may include administration of antinauseant medications to reduce nausea and vomiting, maintaining fluid levels to reduce drug toxicity, particularly to the kidneys, or application of a scalp tourniquet to reduce blood flow to the scalp and minimize hair loss due to drug therapy.

Patients receiving chemotherapy are also at risk of infections due to reduced white blood counts. While prophylactic **antibiotics** may be useful, the health care professional should also be sure to use standard precautions, including gowns and gloves when appropriate. Patients should be alerted to avoid risks of viral contamination, and live virus immunizations are contraindicated until the patient has fully recovered from the effects of chemotherapy. Similarly, the patient should avoid contact with other people who have recently had live virus immunizations.

Other precautions which should be emphasized are the risks to pregnant or nursing women. Because antineoplastic drugs are commonly harmful to the fetus, women of childbearing potential should be cautioned to use two effective methods of birth control while receiving cancer chemotherapy. This also applies if the woman's male partner is receiving chemotherapy. Breastfeeding should be avoided while the mother is being treated.

Before prescribing or administering anticancer drugs, health care providers should inquire whether the patient has any of the following conditions:

- **chickenpox** or recent exposure to someone with chickenpox
- shingles (Herpes zoster)
- mouth sores
- current or past seizures

Anti Cancer Drugs (continued)

Generic (Brand Name)	Clinical Uses	Common Side Effects To Drug
Floxuridine (FUDR)	Cancers of the liver, pancreas, GI and biliary tract, head and neck tumors	See Cytarabine
Fludarabine (Fludara)	Chronic lymphocytic leukemia	Bone marrow depression, nausea and vomiting, fever
Fluorouracil (5–FU)(Adrucil)	Breast, colon, pancreatic cancer, cancer of the rectum and stomach	See Cytarabine
Flutamide (Eulexin)	Advanced prostate cancer	Nausea and vomiting, hot flashes, diarrhea, impotence, decreased libido, gynecomastia
Goserelin (Zoladex)	Advanced prostate cancer	Pain in bones
Hydroxyurea (Hydrea)	Chronic granulocytic leukemia, malignant melanoma	Bone marrow depression, gastrointestinal irritation
Idarubicin (Idamycin)	Used in combination with other antileukemic drugs, acute myelogenous leukemia	See Doxorubicin
Ifosfamide (Ifex)	Germ cell testicular cancer	Bone marrow depression, nausea and vomiting, inflammation of the bladder
Leuprolide (Lupron)	Advanced prostate cancer	See Goserelin
Levamisole (Ergamisol)	Used in conjunction with Fluorouracil to treat colon cancer	Diarrhea, dermatitis, nausea and vomiting
Lomustine	Brain tumors, Hodgkin's disease	Bone marrow depression, nausea and vomiting, toxic damage to liver
Mechlorethamine (Mustargen)	Lung cancer, Hodgkin's disease and non-Hodgkin's lymphomas	Bone marrow depression, nausea and vomiting
Medroxyprogesterone (Depo-Provera)	Advanced uterine cancer	May cause edema
Megestrol (Megace)	Advanced uterine cancer, breast cancer	Masculinizing effects
Melphalan (Alkeran)	Multiple myeloma	Bone marrow depression, nausea and vomiting
Mercaptopurine (Purinethol)	Acute and chronic leukemias	Bone marrow depression, nausea, excess uric acid in blood
Methotrexate (Mexate)	Acute lymphoblastic leukemias in children, bone cancer, choriocaricinoma of the testes	Bone marrow depression, diarrhea, nausea, stomatitis

- head injury
- nerve or muscle disease
- hearing problems
- infection of any kind
- gout
- colitis
- intestine blockage
- stomach ulcer
- kidney stones
- kidney disease
- liver disease
- current or past alcohol abuse
- immune system disease
- **cataracts** or other eye problems
- high cholesterol

Other precautions

The anticancer drug methotrexate has additional precautions. Patients should be given advice on the effects of sun exposure and the use of alcohol and **pain** relievers.

Side effects

Tamoxifen

The anticancer drug tamoxifen (Nolvadex) increases the risk of cancer of the uterus in some women. It also causes cataracts and other eye problems. Women taking this drug may have hot flashes, menstrual changes, genital **itching**, vaginal discharge, and weight gain. Men who take tamoxifen may lose interest in sex or become impotent. Health care providers should keep in close contact with patients to assess the individual risks associated with taking this powerful drug.

Other anticancer drugs

These side effects are not common, but could be a sign of a serious problem. Health care providers should immediately be consulted if any of the following occur:

- black, tarry, or bloody stools
- blood in the urine
- diarrhea
- fever or chills
- cough or hoarseness
- wheezing or **shortness of breath**

Anti Cancer Drugs (continued)

Generic (Brand Name)	Clinical Uses	Common Side Effects To Drug
Mitomycin (Mutamycin)	Bladder, breast, colon, lung, pancreas, rectum cancers, head and neck cancer, malignant melanoma	Bone marrow depression, nausea and vomiting, diarrhea, stomatitis, possible tissue damage
Mitotane (Lysodren)	Cancer of the adrenal cortex (inoperable)	Damage to adrenal cortex, nausea, anorexia
Mitoxantrone (Novantrone)	Acute nonlymphocytic leukemia	Cardiac arrhythmias, labored breating, nausea and vomiting, diarrhea, fever, congestive heart failure
Paclitaxel (Taxol)	Advanced ovarian cancer	Bone marrow depression, hair loss, nausea and vomiting, hypotension, allergic reactions, slow heart action, muscle and joint pain
Pentastatin (Nipent)	Hairy cell leukemia unresponsive to alpha-interferon	Bone marrow depression, fever, skin rash, liver damage, nausea and vomiting
Pipobroman (Vercyte)	Chronic granulocytic leukemia	Bone marrow depression
Plicamycin (Mithracin)	Testucular tumors	Toxicity/damage to bone marrow, kidneys, and liver
Prednisone (Meticorten)	Used in adjunct therapy for palliation of symptoms in lymphomas, acute leukemia Hodgkin's disease	May be toxic to all body systems
Procarbazine (Matulane)	Hodgkin's disease	Bone marrow depression, nausea and vomiting
Streptozocin (Zanosar)	Islet cell carcinoma of pancreas	Nausea and vomiting, toxicity to kidneys
Tamoxifen (Nolvadex)	Advanced breast cancer in post menopausal	Nausea and vomiting, ocular toxicity, hot flashes
Teniposide (Vumon)	Acute lymphocytic leukemia in children	See Etoposide
Vinblastine (Velban)	Breast cancer, Hodgkin's disease, metastatic testicular cancer	Bone marrow depression, neurotoxicity
Vincristine (Oncovin)	Acute leukemia, Hodgkin's disease, lymphomas	Constipation, neurotoxicity, possible tissue necrosis

- sores in the mouth or on the lips
- unusual bleeding or bruising
- swelling of the face
- red "pinpoint" spots on the skin
- redness, pain, or swelling at the place on the body where an injectable anticancer drug is given
- pain in the side or lower back
- problems urinating or painful urination
- dizziness or faintness
- fast or irregular heartbeat

Other side effects do not need immediate care, but should have medical attention. They are:

- joint pain
- skin rash
- hearing problems or ringing in the ears
- numbness or tingling in the fingers or toes
- trouble walking or balance problems
- swelling of the feet or lower legs
- unusual tiredness or weakness
- loss of taste
- seizures
- dizziness
- confusion
- agitation
- headache
- dark urine
- yellow eyes or skin
- flushing of the face

In addition, there are other possible side effects that do not need medical attention unless they persist or interfere with normal activities. These include changes in menstrual period, itchy skin, nausea and vomiting, and loss of appetite.

Other rare side effects may occur. Anyone who has unusual symptoms after taking anticancer drugs should contact the physician who prescribed the medication.

Interactions

Anticancer drugs may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. The health care provider should be aware of all other prescription or non-prescription (over-the-counter) medicines a patient is taking. The primary care provider should also be told if the patient has been treated with radiation or has taken other anticancer drugs.

Samuel Uretsky, PharmD

Anticholinergic drugs *see* **Antiparkinson drugs**

Anticlotting drugs *see* **Anticoagulant and antiplatelet drugs**

Anticoagulant and antiplatelet drugs

Definition

Anticoagulants are drugs used to prevent clot formation or to prevent a clot that has formed from enlarging. They inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into three categories: inhibitors of clotting factor synthesis, inhibitors of thrombin and antiplatelet drugs.

Purpose

Anticoagulant drugs reduce the ability of the blood to form clots. Although blood clotting is essential to prevent serious bleeding in the case of skin cuts, clots inside the blood vessels block the flow of blood to major organs and cause heart attacks and strokes. Although these drugs are sometimes called blood thinners, they do not actually thin the blood. Furthermore, this type of medication will not dissolve clots that already have formed, although the drug stops an existing clot from worsening. However, another type of drug, used in **thrombolytic therapy**, will dissolve existing clots.

Anticoagulant drugs are used for a number of conditions. For example, they may be given to prevent blood clots from forming after the replacement of a heart valve or to reduce the risk of a **stroke** or another **heart attack** after a first heart attack. They are also used to reduce the chance of blood clots forming during open heart surgery or bypass surgery. Low doses of these drugs may be given to prevent blood clots in patients who must stay in bed for a long time after certain types of surgery.

Because anticoagulants affect the blood's ability to clot, they can increase the risk of severe bleeding and heavy blood loss. It is thus essential to take these drugs exactly as directed and to see a physician regularly as long as they are prescribed.

Description

Anticoagulant drugs, also called anticlotting drugs or blood thinners, are available only with a physician's prescription. They come in tablet and injectable forms. They fall into three groups:

- Inhibitors of clotting factor synthesis. These anticoagulants inhibit the production of certain clotting factors in the liver. One example is warfarin (brand name: coumadin).
- Inhibitors of thrombin. Thrombin inhibitors interfere with blood clotting by blocking the activity of thrombin. They include heparin, lepirudin (Refludan).
- Antiplatelet drugs. Antiplatelet drugs interact with platelets, which is a type of blood cell, to block platelets from aggregating into harmful clots. They include: **aspirin**, ticlopidine (Ticlid), clopidogrel (Plavix), tirofiban (Aggrastat), and eptifibatide (Integrilin).

Recommended dosage

The recommended dosage depends on the type of anticoagulant drug and the medical condition for which it is prescribed. The prescribing physician or the pharmacist who filled the prescription can provide information concerning the correct dosage. Usually, the physician will adjust the dose after checking the patient's clotting time.

Anticoagulant drugs must be taken exactly as directed by the physician. Larger or more frequent doses should not be taken, and the drug should also not be taken for longer than prescribed. *Taking too much of this medication can cause severe bleeding*. Anticoagulants should also be taken on schedule. A record of each dose should be kept as it is taken. If a dose is missed, it should be taken as soon as possible followed by the regular dose schedule. However, a patient who forgets to take a missed dose until the next day should not take the missed dose at all and should not double the next dose, as this could lead to bleeding. A record of all missed doses should be kept for the prescribing physician who should be informed at the scheduled visits.

Precautions

Persons who take anticoagulants should see a physician regularly while taking these drugs, particularly at the beginning of therapy. The physician will order periodic blood tests to check the blood's clotting ability. The results of these tests will help the physician determine the proper amount of medication to be taken each day.

Time is required for normal clotting ability to return after anticoagulant treatment. During this period, patients must observe the same precautions they observed while taking the drug. The length of time needed for the blood to return to normal depends on the type of anticoagulant drug that was taken. The prescribing physician will advise as to how long the precautions should be observed.

People who are taking anticoagulant drugs should tell all physicians, dentists, pharmacists, and other medical professionals who provide medical treatments or services to them that they are taking such a medication.

They should also carry identification stating that they are using an anticoagulant drug.

Other prescription drugs or over-the-counter medicine—especially aspirin—should be not be taken without the prescribing physician being informed.

Because of the risk of heavy bleeding, anyone who takes an anticoagulant drug must take care to avoid injuries. Sports and other potentially hazardous activities should be avoided. Any falls, blows to the body or head, or other injuries should be reported to a physician, as internal bleeding may occur without any obvious symptoms. Special care should be taken in shaving and in brushing and flossing the teeth. Soft toothbrushes should be used and the flossing should be very gentle. Electric razors should be used instead of a blade.

Alcohol can change the way anticoagulant drugs affect the body. Anyone who takes this medicine should not have more than one to two drinks at any time and should not drink alcohol every day.

Special conditions

People with specific medical conditions or who are taking certain other medicines can have problems if they take anticoagulant drugs. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to anticoagulants in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to beef, pork, or other foods; dyes; preservatives; or other substances.

PREGNANCY. Anticoagulants may cause many serious problems if taken during **pregnancy**. **Birth defects**, severe bleeding in the fetus, and other problems that affect the physical or mental development of the fetus or newborn are possible. The mother may also experience severe bleeding if she takes anticoagulants during pregnancy, during delivery, or even shortly after delivery. *Women should not take start taking anticoagulants during pregnancy and should not become pregnant while taking it. Any woman who becomes pregnant or suspects that she has become pregnant while taking an anticoagulant should check with her physician immediately.*

BREASTFEEDING. Some anticoagulant drugs may pass into breast milk. Blood tests can be done on nursing babies to see whether the drug is causing any problems. If it is, other medication may be prescribed to counteract the effects of the anticoagulant drug.

OTHER MEDICAL CONDITIONS. Before using anticoagulant drugs, people should inform their physician about *any* medical problems they have. They should also let the physician who prescribed the medicine know if they are being treated by any other medical physician or dentist. In addition, people who will be taking anticoagulant drugs should let their physician know if they have recently had any of the following:

- **fever** lasting more than one to two days
- severe or continuing **diarrhea**
- childbirth
- heavy or unusual menstrual bleeding
- insertion of an intrauterine contraceptive device (**IUD**)
- falls, injuries, or blows to the body or head
- any type of surgery, including dental surgery
- spinal anesthesia
- radiation treatment

USE OF CERTAIN FOODS AND MEDICINES. Many foods and drugs may affect the way the anticoagulant drugs work or may increase the risk of side effects.

Side effects

The most common minor side effects are bloating or gas. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects may occur, especially if excessive anticoagulant is taken. If any of the following side effects occur, a physician should be notified immediately:

- bleeding gums
- sores or white spots in the mouth or throat
- unusual **bruises** or purplish areas on the skin
- unexplained nosebleeds
- unusually heavy bleeding or oozing from **wounds**
- unexpected or unusually menstrual bleeding
- blood in the urine
- cloudy or dark urine
- painful or difficult urination or sudden decrease in amount of urine
- black, tarry, or bloody stools
- coughing up blood
- vomiting blood or something that looks like coffee grounds
- constipation
- **pain** or swelling in the stomach or abdomen
- back pain
- stiff, swollen, or painful joints

KEY TERMS

Anticoagulant—Drug used to prevent clot formation or to prevent a clot that has formed from enlarging. Anticoagulant drugs inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into three groups: inhibitors of clotting factor synthesis, inhibitors of thrombin and antiplatelet drugs.

Antiplatelet drug—Drug that inhibits platelets from aggregating to form a plug. They are used to prevent clotting and alter the natural course of atherosclerosis.

Atherosclerosis—Condition characterized by deposits of fatty plaque in the arteries.

Clot—A soft, semi-solid mass that forms when blood gels.

Platelet—A small, disk-shaped body in the blood that has an important role in blood clotting: they form the initial plug at the rupture site of a blood vessel.

Thrombin—Thrombin is a protein produced by the body. It is a specific clotting factor that plays an important role in the blood clotting process.

Thrombin inhibitor—Thrombin inhibitors are one type of anticoagulant medication, used to help prevent formation of harmful blood clots in the body by blocking the activity of thrombin.

- painful, bluish or purplish fingers or toes
- puffy or swollen eyelids, face, feet, or lower legs
- changes in the color of the face
- skin rash, **itching**, or **hives**
- yellow eyes or skin
- severe or continuing **headache**
- sore throat and fever, with or without chills
- breathing problems or **wheezing**
- tightness in the chest
- dizziness
- unusual tiredness or weakness
- weight gain

In addition, patients taking anticoagulant drugs should check with their physicians as soon as possible if any of these side effects occur:

- nausea or vomiting
- diarrhea
- stomach pain or cramps

Other side effects may occur. Anyone who has unusual symptoms while taking anticoagulant drugs should get in touch with his or her physician.

Interactions

Anticoagulants may interact with many other medications. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be increased. *Anyone who takes anticoagulants should inform the prescribing physician about other prescription or nonprescription (over-the-counter medicines) he or she is taking—even aspirin, laxatives, vitamins, and antacids.*

Diet also affects the way anticoagulant drugs work in the body. A normal, balanced diet should be followed every day while taking such medication. No dietary changes should be made without informing first the prescribing physician, who should also be told of any illness or other condition interfering with the ability to eat normally. Diet is a very important consideration because the amount of vitamin K in the body affects how anticoagulant drugs work. Dicoumarol and warfarin act by reducing the effects of vitamin K. Vitamin K is found in meats, dairy products, leafy, green vegetables, and some multiple **vitamins** and nutritional supplements. For the drugs to work properly, it is best to have the same amount of vitamin K in the body all the time. Foods containing vitamin K in the diet should not be increased or decreased without consulting with the prescribing physician. If the patient takes vitamin supplements, he should check the label to see if it contains vitamin K. Because vitamin K is also produced by intestinal bacteria, a severe case of diarrhea or the use of **laxatives** may also alter a person's vitamin K levels.

Nancy Ross-Flanigan

Anticonvulsant drugs

Definition

Anticonvulsant drugs are medicines used to prevent or treat convulsions (seizures).

Purpose

Anticonvulsant drugs are used to control seizures in people with epilepsy. Epilepsy is not a single disease—it is a set of symptoms that may have different causes in different people. The common thread is an imbalance in the brain's electrical activity. This imbalance causes seizures that may affect part or all of the body and may or may not cause a loss of consciousness. Anticonvulsant drugs act on the brain to reduce the frequency and severity of seizures.

Some cases of epilepsy are brought on by head injuries, brain tumors or infections, or metabolic problems such as low blood sugar. But in some people with epilepsy, the cause is not clear.

Anticonvulsant drugs are an important part of the treatment program for epilepsy. Different kinds of drugs may be prescribed for different types of seizures. In addition to taking medicine, patients with epilepsy should get enough rest, avoid **stress**, and practice good health habits.

Some physicians believe that giving the drugs to children with epilepsy may prevent the condition from getting worse in later life. However, others say the effects are the same, whether treatment is started early or later in life. Determining when treatment begins depends on the physician and his assessment of the patient's symptoms.

Physicians also prescribe certain anticonvulsant drugs for other conditions, including **bipolar disorder** and migraine headaches.

Description

Anticonvulsant drugs may be divided into several classes. The hydantoins include pheytoin (Dilantin) and mephenytoin (Mesantoin.) Ther succimides include ethosuximide (Zarontin)and methsuccimide (Celontin.) The **benzodiazepines**, which are better known for their use as tranquilizers and sedatives, include clonazepam (Klonopin), clorazepate (Tranxene) and diazepam (Valium.) There are also a large number of other drugs which are not related to larger groups. These include carbamazepine (Tegretol), valproic acid (Depakote, Depakene) gabapentin (Neurontin), topiramate (Topamax), felbamate (Felbatol) and several others. Phenobarbital has been used as an anticonvulsant, and is still useful for some patients. The drugs are available only with a physician's prescription and come in tablet, capsule, liquid, and "sprinkle" forms.

Recommended dosage

The recommended dosage depends on the type of anticonvulsant, its strength, and the type of seizures for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Do not stop taking this medicine suddenly after taking it for several weeks or more. Gradually tapering the dose may reduce the chance of withdrawal effects.

Do not change brands or dosage forms of this medicine without checking with a pharmacist or physician. If a prescription refill does not look like the original medicine, check with the pharmacist who filled the prescription.

Precautions

Patients on anticonvulsant drugs should see a physician regularly while on therapy, especially during the first few months. The physician will check to make sure the medicine is working as it should and will note unwanted side effects. The physician may also need to adjust the dosage during this period.

Valproic acid can cause serious liver damage, especially in the first 6 months of treatment. Children are particularly at risk, but anyone taking this medicine should see their physician regularly for tests of liver function and should be alert to symptoms of liver damage, such as yellow skin and eyes, facial swelling, loss of appetite, general feeling of illness, loss of appetite, and vomiting. If liver problems are suspected, call a physician immediately.

Felbatol has caused serious liver damage and **aplastic anemia**, a condition in which the bone marrow stops producing blood cells. Patients taking this drug should have regular blood counts, and should stop taking the drug if there are too few red blood cells.

While taking anticonvulsant drugs, do not start or stop taking any other medicines without checking with a physician. The other medicines may affect the way the anticonvulsant medicine works.

Because anticonvulsant drugs work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, other medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking anticonvulsant drugs should check with his or her physician before drinking alcohol or taking any medicines that slow the central nervous system.

Anticonvulsant drugs may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking anticonvulsant drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some people feel drowsy, dizzy, lightheaded, or less alert when using these drugs, especially when they first begin taking them or when their dosage is increased. Anyone who takes anticonvulsant drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Anticonvulsant drugs may affect the results of certain medical tests. Before having medical tests, people who take anticonvulsant drugs should make sure that the medical professional in charge knows what they are taking.

Children may be more likely to have certain side effects from anticonvulsant drugs, such as behavior changes; tender, bleeding, or swollen gums; enlarged facial features; and excessive hair growth. Problems with the gums may be prevented by regularly brushing and flossing, massaging the gums, and having the teeth cleaned every 3 months whether the patient is a child or an adult.

Children who take high doses of this medicine for a long time may have problems in school.

Older people may be more sensitive to the effects of anticonvulsant drugs. This may increase the chance of side effects and overdoses.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take anticonvulsant drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to anticonvulsant drugs or to tricyclic antidepressants such as imipramine (Tofranil) or desipramine (Norpramin) in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. **Birth defects** have been reported in babies born to mothers who took anticonvulsant drugs during **pregnancy**. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using anticonvulsant drugs during pregnancy.

Some anticonvulsant drugs taken during pregnancy may cause bleeding problems in the mother during delivery and in the baby after delivery. This problem can be avoided by giving vitamin K to the mother during delivery and to the baby after birth.

Pregnancy may affect the way the body absorbs anticonvulsant drugs. Women who are prone to seizures may have more seizures during pregnancy, even though they are taking their medicine regularly. If this happens, they should check with their physicians about whether the dose needs to be increased.

BREASTFEEDING. Some anticonvulsant drugs pass into breast milk and may cause unwanted effects in babies whose mothers take the medicine. Women who are breastfeeding should check with their physicians about the benefits and risks of using anticonvulsant drugs.

DIABETES. Anticonvulsant drugs may affect blood sugar levels. Patients with diabetes who notice changes in the results of their urine or blood tests should check with their physicians.

OTHER MEDICAL CONDITIONS. Before using anticonvulsant drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- liver disease
- kidney disease
- thyroid disease
- heart or blood vessel disease
- blood disease
- brain disease
- problems with urination
- current or past alcohol abuse
- behavior problems
- diabetes mellitus
- **glaucoma**
- porphyria
- systemic lupus erythematosus
- **fever** higher than 101°F (38.3°C) for more than 24 hours

USE OF CERTAIN MEDICINES. Taking anticonvulsant drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **constipation**, mild nausea or vomiting, and mild **dizziness**, drowsiness, or lightheadedness. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, sleep problems, aching joints or muscles, increased sensitivity to sunlight, increased sweating, hair loss, enlargement of facial features, excessive hair growth, muscle twitching, and breast enlargement in males also may

occur and do not need medical attention unless they persist or are troublesome.

Other side effects may need medical attention. If any of these side effects occur, check with a physician as soon as possible:

- clumsiness or unsteadiness
- slurred speech or stuttering
- trembling
- unusual excitement, irritability, or nervousness
- uncontrolled eye movements
- blurred or double vision
- mood or mental changes
- confusion
- increase in seizures
- bleeding, tender, or swollen gums
- skin rash or itching
- enlarged glands in neck or armpits
- muscle weakness or pain
- fever

Other side effects are possible. Anyone who has unusual symptoms after taking anticonvulsant drugs should get in touch with his or her physician.

KEY TERMS

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Epilepsy—A brain disorder with symptoms that include seizures.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things, such as chlorophyll which makes plants green or hemoglobin which makes blood red.

Seizure—A sudden attack, spasm, or convulsion.

Systemic lupus erythematosus (SLE)—A chronic disease with many symptoms, including weakness, fatigue, joint pain, sores on the skin, and problems with the kidneys, spleen, and other organs.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

Interactions

Some anticonvulsant drugs should not be taken within two to three hours of taking **antacids** or medicine for diarrhea. These medicines may make the anticonvulsant drugs less effective. Ask the pharmacist or physician for more information.

Birth control pills may not work properly when anticonvulsant drugs are being taken. To prevent pregnancy, ask the physician or pharmacist if additional methods of birth control should be used while taking anticonvulsant drugs.

Anticonvulsant drugs may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes anticonvulsant drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with certain anticonvulsant drugs are:

- airway opening drugs (**bronchodilators**) such as aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (Choledyl and other brands)
- medicines that contain calcium, such as antacids and calcium supplements
- blood thinning drugs
- caffeine
- antibiotics such as clarithromycin (Biaxin), **erythromycins**, and **sulfonamides** (sulfa drugs)
- disulfiram (Antabuse), used to treat alcohol abuse
- fluoxetine (Prozac)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and **Parkinson's disease**
- tricyclic antidepressants such as imipramine (Tofranil) or desipramine (Norpramin)
- corticosteroids
- acetaminophen (Tylenol)
- aspirin
- female hormones (estrogens)
- male hormones (androgens)
- cimetidine (Tagamet)

- central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and **asthma**; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; **barbiturates**; and anesthetics
- alcohol
- other anticonvulsant drugs

The list above does not include every drug that may interact with anticonvulsant drugs. Be sure to check with a physician or pharmacist before combining anticonvulsant drugs with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Chadwick, David and Peter C. Rubin. "Case for Early Treatment Is Not Established." *British Medical Journal* 310 (January 21, 1995): 177.

Reynolds, E.H. "Do Anticonvulsant Drugs Alter the Natural Course of Epilepsy? Treatment Should Be Started as Early as Possible." *British Medical Journal* 310 (January 21, 1995): 176.

ORGANIZATIONS

American Epilepsy Society. 638 Prospect Avenue, Hartford, CT 06105. (203) 232-4825.

Epilepsy Foundation of America. 4351 Garden City Drive, #406, Landover, MD 20785. (800) 332-1000.

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (301) 496-5751.

Nancy Ross-Flanigan

Antidepressant drugs

Definition

Antidepressant drugs are medicines that relieve symptoms of **depressive disorders**.

Purpose

Depressive disorders may be either unipolar (depression alone) or bipolar (depression alternating with periods of extreme excitation). The formal diagnosis requires a cluster of symptoms, lasting at least two weeks. These symptoms include, but are not limited to mood changes, **insomnia** or hypersomnia, and diminished interest in daily activities. The symptoms are not caused by any medical condition, drug side effect, or adverse life event. The condition is severe enough to cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Secondary depression, depression caused by unfavorable life events, is normally self limiting, and may be best treated with cognitive/behavioral therapy rather than drugs.

Description

Antidepressant agents act by increasing the levels of excitatory neurostransmitters. The main types of antidepressant drugs in use today are:

- tricyclic antidepressants, such as amitriptyline (Elavil), imipramine (Tofranil), nortriptyline (Pamelor)
- **selective serotonin reuptake inhibitors** (SSRIs or serotonin boosters), such as fluoxetine (Prozac), paroxetine (Paxil), and sertraline (Zoloft)
- **monoamine oxidase inhibitors** (MAO inhibitors), such as phenelzine (Nardil), and tranylcypromine (Parnate)
- tetracyclic compounds and atypical antidepressants which do not fall into any of the above categories

Selective serotonin reuptake inhibitors maintain levels of the excitatory neurohormone serotonin in the brain. They do not alter levels of norepinephrine. These have become the drugs of choice for a variety of psychiatric disorders, primarily because of their low incidence of severe side effects as compared with other drugs in this therapeutic class. SSRIs show similar actions and side effect profiles, but may vary in duration of action.

Tricyclic compounds, identified by their chemical structure containing three carbon rings, are an older class of antidepressants. Although generally effective, they have a high incidence of anticholinergic effects, notably **dry mouth** and dry eyes, which can cause discomfort. They also cause cardiac arrythmias. Because tricyclics act on both serotonin and norepinephrine, they may have some value in treatment of patients who fail to respond to SSRIs. Drugs in this class are often available at low prices, which may be significant when cost is a major factor in treatment. They have also been found useful in control of some neurologic **pain** syndromes.

Tricyclic antidepressants are similar, but may vary in severity of side effects, most notably the degree of **sedation** and the extent of the anticholinergic effects.

Tetracyclic compounds and atypical antidepressants are chemically distinct from both the major groups and each other. Although maprotilene (no brand name, marketed in generic form only) and mirtazepine (Remeron) are similar in chemical structures, they differ in their balance of activity on serotonine and norepinephrine levels.

Monoamine oxidase inhibitors (phenelzine [Nardil], tranylcypromine [Parnate]) have largely been supplanted

Antidepressant Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Desyrel (trazodone hydrochloride)	Allergic skin reactions, blurred vision, decreased appetite, fluid retention, headache
Effexor (venlafaxine hydrochloride)	Diarrhea, dizziness, gas, headache, insommia, rash, vomiting
Elavil (amitriptyline hydrochloride)	Constipation, idzziness, high blood pressure, fever, nausea, rash, weight gain or loss
Nardil (phenelzine sulfate)	Dry mouth, fatigue, headache, muscle spasms, tremors
Norpramin (desipramine hydrochloride)	Blurred vision, cramps, hallucinations, hair loss, vomiting
Pamelor (nortriptyline hydrochloride)	Diarrhea, fatigue, headache, decreased coordination
Paxil (paroxetine hydrochloride)	Cold symptoms, drowsiness, nervousness, stomach pain
Prozac (fluoxetine hydrochloride)	Bronchitis, drowsiness, fatigue, nausea, tremors
Sinequan (doxepin hydrochloride)	Bruising, constipation, fluid retention, itching, increased heartbeat
Surmontil (trimipramine maleate)	Disorientation, flushing, headache, nausea, vomiting
Tofranil (imipramine hydrochloride)	Bleeding sores, fever, hives, decreased coordination
Travil	Asthma, diarrhea, dizziness, fatigue, seizures
Wellbutrin (bupropion hydrochloride)	Agitation, dry mouth, headache, nausea, rash
Zoloft (sertraline)	Diarrhea, fainting, gas, headache, nervousness

in therapy because of their high risk of severe adverse effects, most notably severe **hypertension**. They act by inhibiting the enzyme monoamine oxidase, which is responsible for the metabolism of the stimulatory neurohormones norepinephrine, epinephrine, dopamine, and serotonin. The MAOIs are normally reserved for patients who are resistant to safer drugs. Two drugs, eldepryl (Carbex, used in treatment of **Parkinson's disease**) and the herb, **St. John's wort**, have some action against monoamine oxidase B, and have shown some value as anti-depressants. They do not share the same risks as the non-selective MAO inhibitors.

All antidepressant agents, regardless of their structure, have a slow onset of action, typically three to five weeks. Although adverse effects may be seen as early as the first dose, significant therapeutic improvement is always delayed. Similarly, the effects of antidepressants will continue for a similar length of time after the drugs have been discontinued.

Recommended dosage

Dose varies with the specific drug and patient. Consult specialized references.

Precautions

Antidepressants have many significant cautions and adverse effects. Although a few are listed here, specific references should be consulted for more complete information.

SSRIs. The most common side effect of SSRIs is excitation and insomnia. Excitation has been reported in over 20% of patients, and insomnia in 33%. Significant weight loss has been frequently reported, but most commonly in patients who are already underweight. SSRIs may cause some sedation, and patients should be cautioned not to perform tasks requiring alertness until they have evaluated the effects of these drugs. SSRIs are **pregnancy** category C drugs. Most SSRIs are excreted in breast milk, and there have been anecdotal reports of somnolence in infants whose mothers were taking SSRIs while breastfeeding.

Tricyclic antidepressants. Amoxepine (not marketed by brand, generic available), although a tricyclic antidepressant rather than a neuroleptic (major tranquilizer), displays some of the more serious effects of the neuroleptics, including tardive dyskinesias (drug induced involuntary movements) and neuroleptic malignant syndrome, a potentially fatal syndrome whose symptoms include high **fever**, altered mental status, irregular pulse or blood pressure, and changes in heart rate. These adverse effects have not been reported with other tricyclic antidepressants.

The most common adverse effects of tricyclic antidepressants are sedation and the anticholinergic effects, such as dry mouth, dry eyes, and difficult urination. Alterations in heartbeat are also common, and may progress to congestive **heart failure**, **stroke**, and sudden **death**.

Tricyclic antidepressants are in pregnancy categories C or D, although there have been no formal studies of the drugs on fetal development. There are no studies of effects on newborns, but some anecdotal reports of malformations have resulted from animal studies. The drugs are excreted in breast milk.

Monoamine oxidase inhibitors. The greatest risk associated with these drugs is a hypertensive crisis which may be fatal and most often occurs when the drugs are taken with interacting foods or drugs. More common adverse reactions may include low blood pressure and slowing of heartbeat. Sedation and gastrointestinal disturbances are also common. MAOIs are in pregnancy category C. Safety in breast feeding has not been established.

KEY TERMS

Cognitive behavioral therapy—A type of psychotherapy in which people learn to recognize and change negative and self-defeating patterns of thinking and behavior.

Depression—A mental condition in which people feel extremely sad and lose interest in life. People with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk,

Tetracyclics and atypicals. Because these drugs are individual, there are no group patterns of adverse reactions. Consult specific references.

Interactions

The antidepressants have many drug interactions, some severe. Although a few are listed here, specific references should be consulted for more complete information.

SSRIs should not be administered with MAOIs. Allow a wash-out period of about four weeks before switching from one class of drugs to the other. Allow five weeks if switching from fluoxetine (Prozac) to an MAOI.

MAOIs have many interactions; however the best known are those with foods containing the amino acid tyramine. These include aged cheese, chianti wine, and many others. Patients and providers should review the MAOI diet restrictions before using or prescribing these drugs. Because of the severity of MAOI interactions, all additions to the patient's drug regimen should be reviewed with care.

Tricyclic compounds have many interactions, and specialized references should be consulted. Specifically avoid other drugs with anticholinergic effects. Tricyclics should not be taken with the **antibiotics** grepafloxacin and sprafloxacin, since the combination may cause serious heart arrythmias.

Tricyclic compounds should not be taken with the gastric acid inhibitor cimetidine (Tagamet), since this increases the blood levels of the tricyclic compound. Other acid inhibiting drugs do not share this interaction.

SSRIs interact with a number of other drugs which act on the central nervous system. Use care in combining these drugs with major or minor tranquilizers, or with anti-epileptic agents such as phenytoin (Dilantin) or carbamazepine (Tegretol).

Resources

PERIODICALS

"Treatment of Depression: Drugs Alone Are Not Enough." *HealthFacts* 20 (February 1995): 189.

Samuel Uretsky, PharmD

Antidepressants, tricyclic

Definition

Tricyclic antidepressants are medicines that relieve mental depression.

Purpose

Since their discovery in the 1950s, tricyclic antidepressants have been used to treat mental depression. Like other **antidepressant drugs**, they reduce symptoms such as extreme sadness, hopelessness, and lack of energy. Some tricyclic antidepressants are also used to treat bulimia, **cocaine** withdrawal, **panic disorder**, obsessive-compulsive disorders, certain types of chronic **pain**, and **bed-wetting** in children.

Description

Named for their three-ring chemical structure, tricyclic antidepressants work by correcting chemical imbalances in the brain. But because they also affect other chemicals throughout the body, these drugs may produce many unwanted side effects.

Tricyclic antidepressants are available only with a physician's prescription and are sold in tablet, capsule, liquid, and injectable forms. Some commonly used tricyclic antidepressants are amitriptyline (Elavil), desipramine (Norpramin), imipramine (Tofranil), nortriptyline (Pamelor), and protriptyline (Vivactil). Different drugs in this family have different effects, and physicians can choose the drug that best fits the patient's symptoms. For example, a physician might prescribe Elavil for

a person with depression who has trouble sleeping, because this drug is more likely to make people feel calm and sleepy. Other tricyclic antidepressants might be more appropriate for depressed people with low energy.

Recommended dosage

The recommended dosage depends on many factors, including the patient's age, weight, general health and symptoms. The type of tricyclic antidepressant and its strength also must be considered. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take tricyclic antidepressants exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. Do not stop taking the medicine just because it does not seem to be working. Several weeks may be needed for its effects to be felt. Visit the physician as often as recommended so that the physician can check to see if the drug is working and to note for side effects.

Do not stop taking this medicine suddenly after taking it for several weeks or more. Gradually tapering the dose may be necessary to reduce the chance of withdrawal symptoms.

Taking this medicine with food may prevent upset stomach.

Precautions

The effects of this medicine may continue for three to seven days after patients stop taking it. All precautions should be observed during this period, as well as throughout treatment with tricyclic antidepressants.

Some people feel drowsy, dizzy, or lightheaded, when taking these drugs. The drugs may also cause blurred vision. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Because tricyclic antidepressants work on the central nervous system, they may add to the effects of alcohol and other drugs that cause drowsiness, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. Anyone taking tricyclic antidepressants should check with his or her physician before drinking alcohol or taking any drugs that cause drowsiness.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible.

Tricyclic antidepressants may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking tricyclic antidepressants should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

These drugs may also change the results of medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this tricyclic antidepressants, avoid being in direct sunlight, especially between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use tanning beds, tanning booths, or sunlamps.

Tricyclic antidepressants may cause **dry mouth**. To temporarily relieve the discomfort, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription.

Children and older people are especially sensitive to the effects of tricyclic antidepressants. This increased sensitivity may increase the chance of side effects.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take tricyclic antidepressants. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to tricyclic antidepressants or to carbamazepine (Tegretol), maprotiline (Ludiomil), or trazodone (Desyrel) in the past should let his or her physician know before taking tricyclic antidepressants. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Problems have been reported in babies whose mothers took tricyclic antidepressants just before delivery. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using tricyclic antidepressants.

BREASTFEEDING. Tricyclic antidepressants pass into breast milk and may cause drowsiness in nursing babies whose mothers take the drugs. Women who are breast-

feeding should check with their physicians before using tricyclic antidepressants.

DIABETES. Tricyclic antidepressants may affect blood sugar levels. Diabetic patients who notice changes in blood or urine test results while taking this medicine should check with their physicians.

OTHER MEDICAL CONDITIONS. Before using tricyclic antidepressants, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past alcohol or drug abuse
- bipolar disorder (manic-depressive illness)
- schizophrenia
- seizures (convulsions)
- heart disease
- high blood pressure
- kidney disease
- liver disease
- overactive thyroid
- stomach or intestinal problems
- enlarged prostate
- problems urinating
- **glaucoma**
- **asthma**

USE OF CERTAIN MEDICINES. Taking tricyclic antidepressants with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **dizziness**, drowsiness, dry mouth, unpleasant taste, **headache**, nausea, mild tiredness or weakness, increased appetite or craving for sweets, and weight gain. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, vomiting, sleep problems, sweating, and **heartburn** also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- blurred vision
- eye pain
- confusion
- **hallucinations**
- fainting
- loss of balance
- swallowing problems
- difficulty speaking
- mask-like face
- shakiness or trembling
- nervousness or restlessness
- movement problems, such as shuffling walk, stiff arms and legs, or slow movement
- decreased sexual ability
- fast or irregular heartbeat
- constipation
- problems urinating

Some side effects may continue after treatment with tricyclic antidepressants has ended. Check with a physician if these symptoms occur:

- headache
- nausea, vomiting, or diarrhea
- sleep problems, including vivid dreams
- unusual excitement, restlessness, or irritability

Interactions

Life-threatening reactions, such as extrememly high blood pressure, may occur when tricyclic antidepressants are taken with other antidepressants called monoamine oxidase (MAO) inhibitors (such as Nardil and Parnate). *Do not take tricyclic antidepressants within 2 weeks of taking a MAO inhibitor. However, a patient can take an MAO inhibitor immediately after tricyclic antidepressant therapy is stopped by the physician.*

Tricyclic antidepressants may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes tricyclic antidepressants should let the physician know all other medicines he or she is taking. Among the drugs that may interact with tricyclic antidepressants are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay **fever**, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; **barbiturates**; and anesthetics.
- Diet pills

KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bulimia—An eating disorder in which a person binges on food and then induces vomiting, uses laxatives, or goes without food for some time.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Delusion—An abnormal mental state characterized by the acceptance of something as true that is actually false or unreal, such as the belief that one is Jesus Christ.

Depression—A mental condition in which a person feels extremely sad and loses interest in life. A person with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Obsessive-compulsive disorder—An anxiety disorder in which a person cannot prevent himself from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing his hands or checking to make sure he turned off the lights.

Panic disorder—An disorder in which a person has sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

Prostate—A donut-shaped gland in males below the bladder that contributes to the production of semen.

Schizophrenia—A severe mental disorder in which a person loses touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems and other disturbances.

Seizure—A sudden attack, spasm, or convulsion.

Serotonin—A natural chemical found in the brain and other parts of the body, that carries signals between nerve cells.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

- amphetamines
- blood thinning drugs
- medicine for overactive thyroid
- cimetidine (Tagamet)
- other antidepressant drugs, including MAO inhibitors (such as Nardil and Parnate) and antidepressants that raise serotonin levels (such as Prozac and Zoloft)
- blood pressure medicines such as clonidine (Catapres) and guanethidine monosulfate (Ismelin)
- disulfiram (Antabuse), used to treat alcohol abuse
- major tranquilizers such as thioridazine (Mellaril) and chlorpromazine (Thorazine)
- antianxiety drugs such as chlordiazepoxide (Librium) and alprazolam (Xanax)
- antiseizure medicines such as carbamazaepine (Tegretol) and phenytoin (Dilantin)

The list above does not include every drug that may interact with tricyclic antidepressants. Be sure to check with a physician or pharmacist before combining tricyclic antidepressants with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antidiabetic drugs

Definition

Antidiabetic drugs are medicines that help control blood sugar levels in people with **diabetes mellitus** (sugar diabetes).

Purpose

Diabetes may be divided into type I and type II, formerly termed juvenile onset or insulin-dependent, and

maturity onset or non insulin-dependent. Type I is caused by a deficiency of insulin production, while type II is characterized by insulin resistance.

Treatment of type I diabetes is limited to insulin replacement, while type II diabetes is treatable by a number of therapeutic approaches. Many cases of insulin resistance are asymptomatic due to normal increases in insulin secretion, and others may be controlled by diet and **exercise**. Drug therapy may be directed towards increasing insulin secretion, increasing insulin sensitivity, or increasing insulin penetration of the cells.

Description

Antidiabetic drugs may be subdivided into six groups: insulin, sufonylureas, alpha-glucosidase inhibitors, biguanides, meglitinides, and thiazolidinediones.

Insulin (Humulin, Novolin) is the hormone responsible for glucose utilization. It is effective in both types of diabetes, since, even in insulin resistance, some sensitivity remains and the condition can be treated with larger doses of insulin. Most insulins are now produced by recombinant DNA techniques, and are chemically identical to natural human insulin. Isophane insulin suspension, insulin zinc suspension, and other formulations are intended to extend the duration of action of insulin, and permit glucose control over longer periods of time.

Sulfonylureas (chlorpropamide [Diabinese], tolazamide [Tolinase], glipizide [Glucotrol] and others) act by increasing insulin release from the beta cells of the pancrease. Glimepiride (Amaryl), a member of this class, appears to have a useful secondary action in increasing insulin sensitivity in peripheral cells.

Alpha-glucosidase inhibitors (acarbose [Precose], miglitol [Glyset]) do not enhance insulin secretion. Rather, they inhibit the conversion of disaccharides and complex carbohydrates to glucose. This mechanism does not prevent conversion, but only delays it, reducing the peak blood glucose levels. Alpha-glucosidase inhibitors are useful for either monotherapy or in combination therapy with sulfonylureas or other hypoglycemic agents.

Metformin (Glucophage) is the only available member of the biguanide class. Metformin decreases hepatic glucose production, decreases intestinal absorption of glucose and increases peripheral glucose uptake and utilization. Metformin may be used as monotherapy, or in combination therapy with a sulfonylurea.

There are two members of the meglitinide class: repaglinide (Prandin) and nateglitinide (Starlix). The mechanism of action of the meglitinides is to stimulate insulin production. This activity is both dose dependent and dependent on the presence of glucose, so that the drugs have reduced effectiveness in the presence of low blood glucose levels. The meglitinides may be used alone, or in combination with metformin. The manufacturer warns that nateglitinide should not be used in combination with other drugs which enhance insulin secretion.

Rosiglitazone (Avandia) and pioglitazone (Actos) and the members of the thiazolidinedione class. They act by both reducing glucose production in the liver, and increasing insulin dependent glucose uptake in muscle cells. They do not increase insulin production. These drugs may be used in combination with metoformin or a sulfonylurea.

Recommended dosage

Dosage must be highly individualized for all antidiabetic agents and is based on blood glucose levels which must be taken regularly. Review specific literature.

Precautions

Insulin. The greatest short term risk of insulin is **hypoglycemia**, which may be the result of either a direct overdose or an imbalance between insulin injection and level of exercise and diet. This may also occur in the presence of other conditions which reduce the glucose load, such as illness with vomiting and **diarrhea**. Treatment is with glucose in the form of glucose tablets or liquid, although severe cases may require intravenous therapy. Allergic reactions and skin reactions may also occur. Insulin is classified as category B in **pregnancy**, and is considered the drug of choice for glucose control during pregnancy. Insulin glargine (Lantus), an insulin analog which is suitable for once-daily dosing, is classified as category C, because there have been reported changes in the hearts of newborns in animal studies of this drug. The reports are essentially anecdotal, and no cause and effect relationship has been determined. Insulin is not recommended during breast feeding because either low of high doses of insulin may inhibit milk production. Insulin administered orally is destroyed in the GI tract, and represents no risk to the newborn.

Sulonylureas. All sulfonylurea drugs may cause hypoglycemia. Most patients become resistant to these drugs over time, and may require either dose adjustments or a switch to insulin. The list of adverse reactions is extensive, and includes central nervous system problems and skin reactions, among others. Hematologic reactions, although rare, may be severe and include **aplastic anemia** and **hemolytic anemia**. The administration of oral hypoglycemic drugs has been associated with increased cardiovascular mortality as compared with treatment with diet alone or diet plus insulin. The sulfonylureas are classified as category C during pregnancy, based on ani-

Antidiabetic Drugs

Brand Name(Generic Name)	Possible Common Side Effects Include:
Diabinese (chlorpropamide)	Diarrhea, nausea, loss of appetite
Glucotrol (glipizide)	Dizziness, fatigue, headache, nervousness
*Insulin	Mild allergic reactions, decreased blood pressure, rash, shortness of breath
Micronase (glyburide)	Nausea, heartburn, bloating
orinase (tolbutamide)	Nausea, heartburn, bloating

*Insulin is the generic name for several brands which may be animal-based, human-based, or synthetic.

mal studies, although glyburide has not shown any harm to the fetus and is classified as category B. Because there may be significant alterations in blood glucose levels during pregnancy, it is recommended that patients be switch to insulin. These drugs have not been fully studied during breast feeding, but it is recommended that because their presence in breast milk might cause hypoglycemia in the newborn, breastfeeding be avoided while taking sulfonylureas.

Alpha-glucosidase inhibitors are generally well tolerated, and do not cause hypoglycemia. The most common adverse effects are gastrointestinal problems, including flatulence, diarrhea, and abdominal **pain**. These drugs are classified as category B in pregnancy. Although there is no evidence that the drugs are harmful to the fetus, it is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. Alpha-glucosidase inhibitors may be excreted in small amounts in breast milk, and it is recommended that the drugs not be administered to nursing mothers.

Metformin causes gastrointestinal reactions in about a third of patients. A rare, but very serious, reaction to metformin is lactic acidosis, which is fatal in about 50% of cases. Lactic acidosis occurs in patients with multiple medical problems, including renal insufficiency. The risk may be reduced with careful renal monitoring, and careful dose adjustments to metformin. Metformin is category B during pregnancy. There have been no carefully controlled studies of the drug during pregnancy, but there is no evidence of fetal harm from animal studies. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. Animal studies show that metformin is excreted in milk. It is recommended that metformin not be administered to nursing mothers.

Meglitinides. These drugs are generally well tolerated, with an adverse event profile similar to placebo. The drugs are classified as category C during pregnancy, based on fetal abnormalities in rabbits given about 40 times the normal human dose. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. It is not known whether the meglitinides are excreted in human milk, but it is recommended that these drugs not be given to nursing mothers.

Thiazolidinediones. These drugs are generally well tolerated, however they are structurally related to an earlier drug, troglitazone, which was associated with liver function problems. It is strongly recommended that all patients treated with pioglitazone or rosiglitazone have regular liver function monitoring. The drugs are classified as pregnancy category C, based on evidence of inhibition of fetal growth in rats given more than four times the normal human dose. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. It is not known whether the thiazolidinediones are excreted in human milk, however they have been identified in the milk of lactating rats. It is recommended that these drugs not be administered to nursing mothers.

Interactions

The sulfonylureas have a particularly long list of drug interactions, several of which may be severe. Review specific literature for these drugs.

The actions of oral hypoglycemic agents may be strengthened by highly protein bound drugs, including NSAIDs, salicylates, **sulfonamides**, chloramphenicol, coumarins, probenecid, MAOIs, and **beta blockers**.

Review the specific literature of each drugs for possible drug-drug or food-drug interactions.

Resources

PERIODICALS

Hingley, Audrey. "Diabetes Demands a Trial of Treatments." *FDA Consumer* 31 (May-June 1997): 33.

ORGANIZATIONS

American Diabetes Association. ADA National Service Center, 1660 Duke Street, Alexandria, VA 22314. (800)232-3472. <http://www.diabetes.org>.

KEY TERMS

Blood sugar—The concentration of glucose in the blood.

Glucose—A simple sugar that serves as the body's main source of energy.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Metabolism—All the physical and chemical changes that occur in cells to allow growth and maintain body functions. These include processes that break down substances to yield energy and processes that build up other substances necessary for life.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

Seizure—A sudden attack, spasm, or convulsion.

National Diabetes Information Clearinghouse. 1 Information Way, Bethesda, MD 20892-3560. (301)654-3327. ndic @info.niddk.nih.gov.

OTHER

National Institute of Diabetes and Digestive and Kidney Diseases. <http://www.niddk.nih.gov>.

Samuel Uretsky, PharmD

Antidiarrheal drugs

Definition

Antidiarrheal drugs are medicines that relieve **diarrhea**.

Purpose

Antidiarrheal drugs help control diarrhea and some of the symptoms that go along with it. An average, healthy person has anywhere from three bowel movements a day to three a week, depending on that person's diet. Normally the stool (the material that is passed in a bowel movement) has a texture something like clay. With diarrhea, bowel movements may be more frequent, and the texture of the stool is thin and sometimes watery.

Diarrhea is not a disease, but a symptom of some other problem. The symptom may be caused by eating or drinking food or water that is contaminated with bacteria, viruses, or parasites, or by eating something that is difficult to digest. People who have trouble digesting lactose (milk sugar), for example, may get diarrhea if they eat dairy products. Some cases of diarrhea are caused by **stress**, while others are brought on by taking certain medicines.

Description

Antidiarrheal drugs work in several ways. The drug loperamide, found in Imodium A-D, for example, slows the passage of stools through the intestines. This allows more time for water and salts in the stools to be absorbed back into the body. Adsorbents, such as attapulgite (found in Kaopectate) pull diarrhea-causing substances from the digestive tract. However, they may also pull out substances that the body needs, such as enzymes and nutrients. Bismuth subsalicylate, the ingredient in Pepto-Bismol, decreases the secretion of fluid into the intestine and inhibits the activity of bacteria. It not only controls diarrhea, but relieves the cramps that often accompany diarrhea.

These medicines come in liquid, tablet, caplet, and chewable tablet forms and can be bought without a physician's prescription.

Recommended dosage

The dose depends on the type of antidiarrheal drug. Read and follow the directions on the product label. For questions about dosage, check with a physician or pharmacist. Never take larger or more frequent doses, and do not take the drug for longer than directed.

Precautions

Diarrhea usually improves within 24-48 hours. If the problem lasts longer or if it keeps coming back, diarrhea could be a sign of a more serious problem. Anyone who has any of the symptoms listed below should get medical attention as soon as possible:

• diarrhea that lasts more than two days or gets worse

- fever
- blood in the stool
- vomiting
- cramps or tenderness in the abdomen
- Signs of **dehydration**, such as decreased urination, **dizziness** or lightheadedness, **dry mouth**, increased thirst, or wrinkled skin

Do not use antidiarrheal drugs for more than two days unless told to do so by a physician.

Severe, long-lasting diarrhea can lead to dehydration. In such cases, lost fluids and salts, such as calcium, sodium, and potassium, must be replaced.

People older than 60 should not use attapulgite (Kaopectate, Donnagel, Parepectolin), but may use other kinds of antidiarrheal drugs. However, people in this age group may be more likely to have side effects, such as severe **constipation**, from bismuth subsalicylate. Ask the pharmacist for more information.

Bismuth subsalicylate may cause the tongue or the stool to temporarily darken. This is harmless. However, do not confuse this harmless darkening of the stool with the black, tarry stools that are a sign of bleeding in the intestinal tract.

Children with flu or chicken pox should not be given bismuth subsalicylate. It can lead to **Reye's syndrome**, a life-threatening condition that affects the liver and central nervous system. To be safe, never give bismuth subsalicylate to a child under 16 years without consulting a physician. Children may have unpredictable reactions to other antidiarrheal drugs. Loperamide should not be given to children under six years and attapulgite should not be given to children under three years unless directed by a physician.

Anyone who has a history of liver disease or who has been taking **antibiotics** should check with his or her physician before taking the antidiarrheal drug loperamide. A physician should also be consulted before anyone with acute **ulcerative colitis** or anyone who has been advised to avoid constipation uses the drug.

Loperamide should not be used by people whose diarrhea is caused by certain infections, such as salmonella or shigella. To be safe, check with a physician before using this drug.

Anyone who has a medical condition that causes weakness should check with a physician about the best way to treat diarrhea.

Special conditions

Before taking antidiarrheal drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to **aspirin** or other drugs containing salicylates should check with a physician before taking bismuth subsalicylate. Anyone who has developed a rash or other unusual reactions after taking loperamide should not take that drug again without checking with a physician. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY AND BREASTFEEDING. Women who are pregnant or breastfeeding should check with their physicians before using antidiarrheal drugs. They should also ask advice on how to replace lost fluids and salts.

OTHER MEDICAL CONDITIONS. Before using antidiarrheal drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- dysentery
- gout
- hemophilia or other bleeding problems
- kidney disease
- stomach ulcer
- severe colitis
- liver disease

USE OF CERTAIN MEDICINES. Taking antidiarrheal drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects of attapulgite are constipation, bloating, and fullness. Bismuth subsalicylate may cause ringing in the ears, but that side effect is rare. Possible side effects from loperamide include skin rash, constipation, drowsiness, dizziness, tiredness, dry mouth, nausea, vomiting, and swelling, **pain**, and discomfort in the abdomen. Some of these symptoms are the same as those that occur with diarrhea, so it may be difficult to tell if the medicine is causing the problems. Children may be more sensitive than adults to certain side effects of loperamide, such as drowsiness and dizziness.

Other rare side effects may occur with any antidiarrheal medicine. Anyone who has unusual symptoms after taking an antidiarrhea drug should get in touch with his or her physician.

Interactions

Attapulgite can decrease the effectiveness of other medicines taken at the same time. Changing the times at which the other medicines are taken may be necessary.

KEY TERMS

Colitis—Inflammation of the colon (large bowel).

Dehydration—Excessive loss of water from the body.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Nutrient—A food substance that provides energy or is necessary for growth and repair. Examples of nutrients are vitamins, minerals, carbohydrates, fats, and proteins.

Check with a physician or pharmacist to work out the proper dose schedule.

Bismuth subsalicylate should not be taken with aspirin or any other medicine that contains salicylate. This drug may also interact with other drugs, such as blood thinners (warfarin, for example), methotrexate, the antigout medicine probenecid, and the antidiabetes drug tolbutamide. In addition, bismuth subsalicylate may interact with any drug that interacts with aspirin. Anyone taking these drugs should check with a physician or pharmacist before taking bismuth subsalicylate.

Nancy Ross-Flanigan

Antidiuretic hormone (ADH) test

Definition

Antidiuretic hormone (ADH) test, also called the Vasopressin test, is a test for the antidiuretic hormone, which is released from the pituitary gland and acts on the kidneys to increase their reabsorption of water into the blood.

Purpose

An ADH test is used to aid in the diagnosis of **diabetes insipidus** or the syndrome of inappropriate ADH called SIADH.

Precautions

Certain drugs can either increase or decrease ADH levels. Drugs that increase ADH levels include **acetaminophen**, **barbiturates**, cholinergic agents, estrogen, nicotine, oral **hypoglycemia** agents, some **diuretics** (e.g., thiazides), cyclophosphamide, narcotics, and tricyclic antidepressants. Drugs that decrease ADH levels include alcohol, beta-adrenergic agents, morphine antagonists, and phenytoin (Dilantin).

Description

The purpose of ADH is to control the amount of water reabsorbed by the kidneys. Water is continually being taken into the body in food and drink, as well as being produced by chemical reactions in cells. Water is also continually lost in urine, sweat, feces, and in the breath as water vapor. ADH release helps maintain the optimum amount of water in the body when there is an increase in the concentration of the blood serum or a decrease in blood volume. Physical **stress**, surgery, and high levels of **anxiety** can also stimulate ADH.

Various factors can affect ADH production, thereby disturbing the body's water balance. For example, alcohol consumption reduces ADH production by direct action on the brain, resulting in a temporarily increased production of urine. This may also occur in diabetes insipidus, when the pituitary gland produces insufficient ADH, or rarely, when the kidneys fail to respond to ADH. The reverse effect of water retention can result from temporarily increased ADH production after a major operation or accident. Water retention may also be caused by the secretion of ADH by some tumors, especially of the lung.

Preparation

The test requires collection of a blood sample. The patient must be **fasting** (nothing to eat or drink) for 12 hours, be adequately hydrated, and limit physical activity for 10-12 hours before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

ADH normal ranges are laboratory-specific but can range from 1-5 pg/ml or 1.5 ng/L (SI units).

Abnormal results

Patients who are dehydrated, who have a decreased amount of blood in the body (hypovolemia), or who are undergoing severe physical stress (e.g., trauma, **pain** or

KEY TERMS

Diabetes insipidus—A metabolic disorder in which the pituitary gland produces inadequate amounts of antidiuretic hormone (ADH) or the kidneys are unable to respond to release of the hormone. Primary symptoms are excessive urination and constant thirst.

Pituitary gland—The pituitary gland is sometimes referred to as the "master gland." As the most important of the endocrine glands (glands which release hormones directly into the bloodstream), it regulates and controls not only the activities of other endocrine glands but also many body processes.

prolonged mechanical ventilation) may exhibit increased ADH levels. Patients who are overly hydrated or who have an increased amount of blood in the body (hypervolemia) may have decreased ADH levels.

Other conditions that cause increased levels include SIADH, central nervous system tumors or infection, or **pneumonia**.

Resources

BOOKS

Jacobs, David S., et al. *Laboratory Test Handbook.* 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Antiemetic drugs *see* **Antinausea drugs**

Antiepileptic drugs *see* **Anticonvulsant drugs**

Antifungal drugs, systemic

Definition

Systemic antifungal drugs are medicines taken by mouth or by injection to treat deep infections caused by a fungus.

Purpose

Systemic antifungal drugs are used to treat infections in various parts of the body that are caused by a fungus. A fungus is an organism that can be either one-celled or filamentous. Unlike a plant, which makes its own food, or an animal, which eats plants or other animals, a fungus survives by invading and living off other living things. Fungi thrive in moist, dark places, including some parts of the body.

Fungal infections can either be systemic, meaning that the infection is deep, or topical (dermatophytic), meaning that the infection is superficial and occurs on the skin. Additionally, yeast infections can affect the mucous membranes of the body. Fungal infections on the skin are usually treated with creams or ointments (topical antifungal drugs). However, systemic infections, yeast infections or topical infections that do not clear up after treatment with creams or ointments may need to be treated with systemic antifungal drugs. These drugs are used, for example, to treat common fungal infections such as tinea (**ringworm**), which occurs on the skin or **candidiasis** (a yeast infection, also known as trush), which can occur in the throat, in the vagina, or in other parts of the body. They are also used to treat other deep fungal infections such as **histoplasmosis**, **blastomycosis**, and **aspergillosis**, which can affect the lungs and other organs. They are sometimes used to prevent or treat fungal infections in people whose immune systems are weakened, such as bone marrow or organ transplant patients and people with **AIDS**.

Description

Antifungal drugs are categorized depending on their route or site of action, their mechanism of action and their chemical nature.

Systemic antifungal drugs, such as capsofungin (Cancidas), flucytosine, fluconazole (Diflucan), itraconazole (Sporanox), ketoconazole (Nizoral), and miconazole (Monistat I.V.) are available only by prescription. They are available in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of antifungal drug and the nature and extent of fungal infection being treated. Doses may also be different for different patients. The prescribing physician or the pharmacist can provide dosage information. Systemic antifungal drugs must be taken exactly as directed. Itraconazole and ketoconazole should be taken with food.

Fungal infections can take a long time to clear up, so it may be necessary to take the medication for several months, or even for a year or longer. It is very important to keep taking the medicine for as long as the physician says to take it, even if symptoms seem to improve. If the drug is stopped too soon, the symptoms may return.

Systemic antifungal drugs work best when their amount is kept constant in the body, meaning that they have to be taken regularly, at the same time every day, and without missing any doses.

Patients taking the liquid form of ketoconazole should use a specially marked medicine spoon or other medicine measuring device to make sure they take the correct amount. A regular household teaspoon may not hold the right amount of medicine. Ask the pharmacists about ways to accurately measure the dose of these drugs.

Precautions

If symptoms do not improve within a few weeks, the prescribing physician should be informed.

While taking this medicine, regular medical visits should be scheduled. The physician needs to keep checking for side effects throughout the antifungal therapy.

Some people feel drowsy or dizzy while taking systemic antifungal drugs. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Liver problems, stomach problems and other problems may occur in people who drink alcohol while taking systemic antifungal drugs. Alcohol and prescription or nonprescription (over-the-counter) drugs that contain alcohol should be avoided while taking antifungal drugs. (Medicines that may contain alcohol include some **cough** syrups, tonics, and elixirs.) Alcohol should be avoided for at least a day after taking an antifungal drug.

The antifungal drug ketoconazole may make the eyes unusually sensitive to light. Wearing sunglasses and avoiding exposure to bright light may help.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take systemic antifungal drugs. Before taking these drugs, the prescribing physician should be informed about any of the following conditions:

ALLERGIES. Anyone who has had unusual reactions to systemic antifungal drugs in the past should let his or her physician know about the problem before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. In laboratory studies of animals, systemic antifungal drugs have caused **birth defects** and other problems in the mother and fetus. Studies have not been done on pregnant women, so it is not known whether these drugs cause similar effects in people. Women who are pregnant or who plan to become pregnant should check with their physicians before taking systemic antifungal drugs. Any woman who becomes pregnant while taking these drugs should let her physician know immediately.

BREASTFEEDING. Systemic antifungal drugs pass into breast milk. Women who are breastfeeding should check with their physicians before using systemic antifungal drugs.

OTHER MEDICAL CONDITIONS. People who have medical conditions that deplete stomach acid (achlorhydria) or decrease stomach acid (hypochlorhydria) should be sure to inform their physicians about their condition before they use a systemic antifungal drug. These drugs are not active in their natural form, but must be converted to the active form by an acid. If these is not enough stomach acid, the drugs will be ineffective. For people with insufficient stomach acid, it may help to take the medicine with an acidic drink, such as a cola. The patient's health care provider can suggest the best way to take the medicine.

Before using systemic antifungal drugs, people with any of these medical problems should also make sure their physicians are aware of their conditions:

- current or past alcohol abuse
- liver disease
- kidney disease

USE OF CERTAIN MEDICINES. Taking systemic antifungal drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Fluconazole

Although rare, severe allergic reactions to this medicine have been reported. Call a physician immediately if any of these symptoms develop after taking fluconazole (Diflucan):

- hives, **itching**, or swelling
- breathing or swallowing problems
- sudden drop in blood pressure
- **diarrhea**
- abdominal pain

Ketoconazole

Ketoconazole has caused **anaphylaxis** (a life-threatening allergic reaction) in some people after their first dose. This is a rare reaction.

Antifungal Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Diflucan (fluconazole)	Nausea, diarrhea, headache, vomiting
Femstat (butoconazole nitrate)	Vaginal discharge or burning, soreness, swelling
Gris-PEG, Grisactin, Fulvicin P/G (griseofulvin)	Rash, hives, diarrhea, fatigue, oral thrush
Gyne-Lotrimin, Mycelex-7 (clotrimazole)	Burning sensation, hives, itching/irritated skin, swelling
Loprox (ciclopiroz olamine)	This drug rarely causes side effects
Lotrisone	Blistering, hives, itching/irritated skin, swelling
Monistat (miconazole nitrate)	Burning sensation, headaches, hives, rash, vaginal itching
Mycolog-II	Burning, blistering, rash, itching/peeling of skin
Nizoral (ketoconazole)	Nausea, vomiting
Oxistat (oxiconazole nitrate)	Burning, cracked skin, rash, itching
Spectazole Cream (econazole nitrate)	Burning, itching
Sporanox (itraconazole)	Headache, diarrhea, increased blood pressure, fever

Systemic antifungal drugs in general

Systemic antifungal drugs may cause serious and possibly life-threatening liver damage. Patients who take these drugs should have **liver function tests** before they start taking the medicine and as often as their physician recommends while they are taking it. The physician should be notified immediately if any of these symptoms develop:

- loss of appetite
- nausea or vomiting
- yellow skin or eyes
- unusual **fatigue**
- dark urine
- pale stools

The most common minor side effects of systemic antifungal drugs are **constipation**, diarrhea, nausea, vomiting, **headache**, drowsiness, **dizziness**, and flushing of the face or skin. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as menstrual problems in women, breast enlargement in men, and decreased sexual ability in men also may occur and do not need medical attention unless they do not improve in a reasonable amount of time.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine immediately:

- fever and chills
- skin rash or itching
- high blood pressure
- pain, redness, or swelling at site of injection (for injectable miconazole)

Other rare side effects are possible. Anyone who has unusual symptoms after taking systemic antifungal drugs should get in touch with his or her physician.

Interactions

Serious and possibly life-threatening side effects can result if the oral forms of itraconazole or ketoconazole or the injectable form of miconazole are taken with certain drugs. Do not take those types of systemic antifungal drugs with any of the following drugs unless the physician approves of the therapy:

- astemizole (Hismanal)
- cisapride (Propulsid)
- antacids
- theophylline-containing anti-wheezing medications

Taking an acid blocker such as cimetidine (Tagamet), famotidine (Pepcid), nizatidine (Axid), omeprazole (Prilosec), or ranitidine (Zantac) at the same time as a systemic antifungal drug may prevent the antifungal drug from working properly. For best results, take the acid blocker at least 2 hours after taking the antifungal drug.

In addition, systemic antifungal drugs may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. *Anyone who takes systemic antifungal drugs should inform the prescribing physician about all other prescription and nonprescription (over-the-counter) medicines he or she is taking.* Among the drugs that may interact with systemic antifungal drugs are:

- acetaminophen (Tylenol)
- birth control pills
- male hormones (androgens)
- female hormones (estrogens)

KEY TERMS

Elixir—A sweetened liquid that contains alcohol, water, and medicine.

Fetus—A developing baby inside the womb.

Fungus—A unicellular to filamentous organism that causes parasitic infections.

Ointment—A thick substance that contains medicine and is meant to be spread on the skin, or if an ophthalmic ointment, in the eye.

Systemic—A term used to describe a medicine that has effects throughout the body, as opposed to topical drugs that work on the skin. Most medicines that are taken by mouth or by injection are systemic drugs.

- medicine for other types of infections
- antidepressants
- antihistamines
- muscle relaxants
- medicine for diabetes, such as tolbutamide (Orinase), glyburide (DiaBeta), and glipizide (Glucotrol)
- blood-thinning medicine, such as warfarin (Coumadin)

The list above does not include every drug that may interact with systemic antifungal drugs. Be sure to check with a physician or pharmacist before combining systemic antifungal drugs with any other medicine.

Nancy Ross-Flanigan

Antifungal drugs, topical

Definition

Topical antifungal drugs are medicines applied to the skin to treat skin infections caused by a fungus.

Purpose

Dermatologic fungal infections are usually described by their location on the body: tinea pedis (infection of the foot), tinea unguium (infection of the nails), tinia capitis (infection of the scalp.) Three types of fungus are involved in most skin infections: *Trichophyton, Epidermophyton,* and *Microsporum.* Mild infections are usually susceptible to topical therapy, however severe or resistant infections may require systemic treatment.

Description

There are a large number of drugs currently available in topical form for fungal infections. Other than the imidazoles, (miconazole [Micatin, Miconazole], clotrimazole [Lotrimin], econazole [Spectazole], ketoconazole [Nizoral], oxiconazole [Oxistat], sulconazole [Exelderm]) and the allylamine derivatives (butenafine [Mentax], naftifine [Naftin], terbinafine [Lamisil]), the drugs in this therapeutic class are chemically distinct from each other. All drugs when applied topically have a good margin of safety, and most show a high degree of effectiveness. There are no studies comparing drugs on which to base a recommendation for drugs of choice. Although some of the topical antifungals are available over-the-counter, they may be as effective as prescription drugs for this purpose.

Traditional antifungal drugs such as undecylinic acid (Cruex, Desenex) and gentian violet (also known as crystal violet) remain available, but have a lower cure rate (complete eradication of fungus) than the newer agents and are not recommended. Tolnaftate (Tinactin) has a lower cure rate than the newer drugs, but may be used prophylactically to prevent infection.

Recommended dosage

All drugs are applied topically. Consult individual product information for specific application recommendations.

As with all topical products, selection of the dosage form may be as important as proper drug selection. Consider factors such as presence or absence of hair on the affected area, and type of skin to which the medication is to be applied. Thin liquids may preferable for application to hairy areas, creams for the hands and face, and ointments may be preferable for the trunk and legs. Other dosage forms available include shampoos and sprays. Ciclopirox and triacetin are available in formulations for topical treatment of nail fungus as well as skin infections (ciclopirox as Penlac Nail Lacquer and triacetin as Ony-Clear Nail).

Most topical antifungal drugs require four weeks of treatment. Infections in some areas, particularly the spaces between toes, may take up to six weeks for cure.

Precautions

Most topical antifungal agents are well tolerated. The most common adverse effects are localized irritation caused by the vehicle or its components. This may

KEY TERMS

Cream—A spreadable substance, similar to an ointment, but not as thick. Creams may be more appropriate than ointments for application to exposed skin areas such as the face and hands.

Ointment—A thick, spreadable substance that contains medicine and is meant to be used on the skin, or if a vaginal preparation, in the vagina.

Opthalmic—Pertaining to the eye.

Otic—Pertaining to the ear.

Topical—A term used to describe medicine that has effects only in a specific area, not throughout the body, particularly medicine that is put directly on the skin.

include redness, itch, and a burning sensation. Some direct allergic reactions are possible.

Topical antifungal drugs should only be applied in accordance with labeled uses. They are not intended or ophthalmic (eye) or otic (ear) use. Application to mucous membranes should be limited to appropriate formulations.

The antifungal drugs have not been evaluated for safety in **pregnancy** and **lactation** on topical application under the pregnancy risk category system. Although systemic absorption is probably low, review specific references. Gentian violet is labeled with a warning against use in pregnancy.

Interactions

Topical antifungal drugs have no recognized drug-drug or food-drug interactions.

Samuel Uretsky, PharmD

Antigas agents

Definition

Antigas agents are medicines that relieve the uncomfortable symptoms of too much gas in the stomach and intestines.

Purpose

Excess gas can build up in the stomach and intestines for a number of reasons. Eating high-fiber foods, such as beans, grains, and vegetables is one cause. Some people unconsciously swallow air when they eat, drink, chew gum, or smoke cigarettes, which can lead to uncomfortable amounts of gas in the digestive system. Surgery and certain medical conditions, such as irritable colon, peptic ulcer, and diverticulosis, can also lead to gas build-up. Certain intestinal parasites can contribute to the production of severe gas - these parasites need to be treated separately with special drugs. Abdominal **pain**, pressure, bloating, and flatulence are signs of too much gas. Antigas agents help relieve the symptoms by preventing the formation of gas pockets and breaking up gas that already is trapped in the stomach and intestines.

Description

Antigas agents are sold as capsules, liquids, and tablets (regular and chewable) and can be bought without a physician's prescription. Some commonly used brands are Gas-X, Flatulex, Mylanta Gas Relief, Di-Gel, and Phazyme. The ingredient that helps relieve excess gas is simethicone. Simethicone does not relieve acid **indigestion**, but some products also contain **antacids** for that purpose. Check the label of the product or ask the pharmacist for more information.

Recommended dosage

Check the product container for dosing information. Typically, the doses should be taken after meals and at bedtime. Chewable forms should be chewed thoroughly.

Check with a physician before giving this medicine to children under age 12 years.

Precautions

Some anti-gas medicines may contain sugar, sodium, or other ingredients. Anyone who is on a special diet or is allergic to any foods, dyes, preservatives, or other substances should check with his or her physician or pharmacist before using any of these products.

Anyone who has had unusual reactions to simethicone—the active ingredient in antigas medicines—should check with his or her physician before taking these drugs.

Side effects

No common or serious side effects have been reported in people who use this medicine. However, anyone who has unusual symptoms after taking an antigas agent should get in touch with his or her physician.

KEY TERMS

Digestive tract—The stomach, intestines, and other parts of the body through which food passes.

Diverticulosis—A condition in which the colon (large intestine) develops a number of outpouchings or sacs.

Flatulence—Excess gas in the digestive tract.

Irritable colon—An intestinal disorder often accompanied by abdominal pain and diarrhea.

Interactions

Antigas agents are not known to interact with any other drugs.

Nancy Ross-Flanigan

Antigastroesophageal reflux drugs

Definition

These drugs are used to treat gastroesophageal reflux, the backward flow of stomach contents into the esophagus.

Purpose

The drug discussed here, cisapride (Propulsid), is used to treat nighttime **heartburn** resulting from gastroesophageal reflux disease (GERD). In this condition, food and stomach juices flow backward from the stomach into the esophagus, the part of the digestive tract through which food passes on its way from the mouth to the stomach. Normally, a muscular ring called the lower esophageal sphincter (LES) opens to allow food into the stomach and then closes to prevent the stomach's contents from flowing back into the esophagus. In people with GERD, this muscular ring is either weak or it relaxes at the wrong times. The main symptom is heartburn—a burning sensation centered behind the breastbone and spreading upward toward the neck and throat.

Cisapride works by strengthening the lower esophageal sphincter and making the stomach empty more quickly. This shortens the amount of time that the esophagus comes in contact with the stomach contents. Other drugs, such as H2-blockers are sometimes prescribed to reduce the amount of acid in the stomach.

Description

Cisapride is available only with a physician's prescription. Cisapride is sold in tablet and liquid forms.

Recommended dosage

The dose depends on the patient. The average dose for adults and children age 12 and over is 5-20 mg taken two to four times a day. The medicine should be taken 15 minutes before meals and at bedtime. For children under 12, the dose is based on body weight and should be determined by the child's physician.

Precautions

This medicine is effective in treating only nighttime heartburn, not daytime heartburn.

Cisapride may increase the effects of alcohol and tranquilizers.

Cisapride has caused dangerous irregular heartbeats in a few people who took it with other medicines. Anyone who takes this drug should let the physician know all other medicines he or she is taking. Patients with heart problems should check with their physicians before taking cisapride.

Anyone who has bleeding, blockage, or leakage in the stomach or intestines should not take cisapride. Cisapride should not be used by anyone who has had an unusual reaction to the drug in the past. In addition, people with any of the following medical problems should make sure their physicians are aware of their conditions:

- epilepsy or history of seizures
- kidney disease
- liver disease

The effects of taking cisapride during **pregnancy** have not been fully studied. Women who are pregnant or plan to become pregnant should check with their physicians before taking Cisapride. The drug passes into breast milk and may affect nursing babies. Women who are breastfeeding and need to take this medicine should check with their physicians. Avoiding breastfeeding while taking the drug may be necessary.

Side effects

The most common side effects are abdominal **pain**, bloating, gas, **diarrhea**, **constipation**, nausea, upper respiratory infections, inflammation of the nasal passages

KEY TERMS

Esophagus—The part of the digestive tract between the pharynx and the stomach. (The pharynx is the space just behind the mouth.)

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

and sinuses, **headache**, and viral infections. Other side effects may occur. Anyone who has unusual or troublesome symptoms after taking this drug should get in touch with his or her physician.

Interactions

Cisapride may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes Cisapride should let the physician know all other medicines he or she is taking. Among the drugs that may interact with cisapride are:

- antifungal drugs such as ketoconazole (Nizoral), miconazole (Monistat), and fluconazole (Diflucan)
- antibiotics such as clarithromycin (Biaxin) and erythromycin (E-Mycin, ERYC)
- blood-thinners such as warfarin (Coumadin)
- H2-blockers such as cimetidine (Tagamet) and ranitidine (Zantac)
- tranquilizers such as chlordiazepoxide (Librium), diazepam (Valium), and alprazolam (Xanax)

The list above does not include every drug that may interact with cisapride. Be sure to check with a physician or pharmacist before combining cisapride with any other prescription or nonprescription (over-the-counter) medicine.

Resources

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Pediatric/Adolescent Gastroesophageal Reflux Association, Inc. P.O. Box 1153, Germantown, MD 20875-1153. (301) 601-9541. <http://www.reflux.org>.

OTHER

GERD Information Resource Center. <http://www.gerd.com>.

Pharmaceutical Information Network. GERD Information Center. <http://pharminfo.com/disease/gerd/gerd_info.html>.

Nancy Ross-Flanigan

Antihelminthic drugs

Definition

Antihelminthic drugs are used to treat parasitic infestations.

Purpose

Parasitic infestations are caused by protozoa or worms gaining entry into the body. Most of these organisms cause infections by being ingested in the form of eggs or larvae, usually present on contaminated food or clothing, while others gain entry through skin abrasions. Common parasitic infestations include **amebiasis**, **malaria**, **giardiasis**, hookworm, pinworm, threadworm, whipworm and tapeworm infestations. Once in the body, parasitic worms may go unnoticed if they cause no severe symptoms. However, if they multiply rapidly and spread to a major organ, they can cause very serious and even life-threatening conditions. Antihelminthic drugs are prescribed to treat these infestations. They function either by destroying the worms on contact or by paralyzing them, or by altering the permeability of their plasma membranes. The dead worms then pass out of the body in the feces.

Description

Antihelminthic drugs are available only with a prescription and are available as liquids, tablets or capsules. Some commonly used antihelminthics include: albendazole (Albenza), mebendazole (Vermox), niclosamide (Niclocide), oxamniquine (Vansil), praziquantel (Biltricide), pyrantel (Antiminth), pyantel pamoate (Antiminth) and thiabendazole (Mintezol). Some types of parasitic infestations are rarely seen in the United States, thus, the corresponding antihelminthic drugs are not widely distributed and need to be obtained from the United States Center for Disease Control (CDC) when required. These include for example bitional and ivermectin, used to treat onchocerciasis infestations. Other antihelminthic drugs, such as diethylcarbamazepine citrate (Hetrezan), used for treatment of roundworms and other parasites, is supplied directly by its manufacturer when needed.

Most antihelminthic drugs are only active against specific parasites, some are also toxic. Before treatment, the parasites must therefore be identified using tests that look for parasites, eggs or larvae in feces, urine, blood, sputum, or tissues. Thus, niclosamide is used against tapeworms, but will not be effective for the treatment of pinworm or roundworm infestations, because it acts by inhibiting ATP production in tapeworm cells. Thiabendazole (Mintezole) is the drug usually prescribed for treatment of threadworm, but a similar drug, mebendazole (Vermox) works

KEY TERMS

Amebiasis—Parasitic infestation caused by amebas, especially by Entamoeba histolytica.

Colitis—Inflammation of the colon (large intestine).

Feces—The solid waste that is left after digestion. Feces form in the intestines and leave the body through the anus.

Flukes—Parasite worms that look like leeches. They usually have one or more suckers for attaching to the digestive mucosa of the host. Liver flukes infest the liver, destroying liver tissue and impairing bile production and drainage.

Giardiasis—Parasitic infestation caused by a flagellate protozoan of the genus Giardia, especially by G. lamblia.

Hallucination—A false or distorted perception of objective reality. Imaginary objects, sounds, and events are perceived as real.

Hookworm—Parasitic intestinal infestation caused by any of several parasitic nematode worms of the family Ancylostomatidae. These worms have strong buccal hooks that attach to the host's intestinal lining.

Larva—The immature, early form of an organism that at birth or hatching is not like its parent and has to undergo metamorphosis before assuming adult features.

Malaria—Disease caused by the presence of sporozoan parasites of the genus Plasmodium in the red blood cells, transmitted by the bite of anopheline mosquitoes, and characterized by severe and recurring attacks of chills and fever).

Microtubules—Slender, elongated anatomical channels in worms.

Nematode—Roundworm.

Organism—A single, independent life form, such as a bacterium, a plant or an animal.

Parasite—An organism that lives in or with another organism, called the host, in parasitism, a type of association characterized by the parasite obtaining benefits from the host, such as food, and the host being injured as a result.

Parasitic—Of, or relating to a parasite.

Pinworm—Enterobius vermicularis, a nematode worm of the family Oxyuridae that causes parasitic infestation of the intestines and cecum. Pinworm is endemic in both temperate and tropical regions and common especially in school age children.

Onchocerciasis—Parasitic infestation caused by filamentous worms of the genus Onchocerca, especially O. volvulus, that is found in tropical America and is transmitted by several types of blackflies.

Protozoan—Any unicellular or multicellular organism containing nuclei and organelles (eukaryotic) of the subkingdom Protozoa.

Roundworm—Any round-bodied unsegmented worm as distinguished from a flatworm. Also called a nematode, they look similar to the common earthworm.

Tapeworm—Flat and very long (up to 30 meters) intestinal parasitic worms, similar to a long piece of tape. Common tapeworms include: T. saginata (beef tapeworm), T. solium (pork tapeworm) D. latum (fish tapeworm), H. Nana (dwarf tapeworm) and E. granulosus (dog tapeworm). General symptoms are vague abdominal discomfort, nausea, vomiting, diarrhea and weight loss.

Threadworm—Any long, thin nematode worm.

Trematode—Any parasitic flatworm of the class Trematoda, as the liver fluke.

Whipworm—A nematode worm of the family Trichuridae with a body that is thick at one end and very long and slender at the other end.

better on whipworm by disrupting the microtubules of this worm. Praziquantel is another drug that acts by altering the membrane permeability of the worms.

Preparation

Dosage is established depending on the patient's general health status and age, the type of antihelminthic drug used, and the type of parasitic infestation being treated. The number of doses per day, the time between doses, and the length of treatment will also depend on these factors.

Antihelminthic drugs must be taken exactly as directed to completely rid the body of the parasitic infestation, and for as long as directed. A second round of treatment may be required to ensure that the infection has completely cleared.

Precautions

Some antihelminthic drugs work best when ingested along with fatty foods, such as milk or ice cream. Oral drugs should be taken with water during or after meals. The prescribing physician should be informed if the patient has a low-fat or other special diet.

Some antihelminthic drugs, such as praziquantel, come in chewable form. These tablets should not be chewed or kept in the mouth, but should swallowed whole because their bitter taste may cause gagging or vomiting.

Antihelminthic drugs sometimes need to be taken with other medications. For example, steroids such as prednisone are also prescribed together with the antihelminthic drug for tapeworm to reduce the inflammation that the worm may cause.

When required, pre- or post-treatment purges are also performed with magnesium or sodium sulfate.

Regular medical visits are recommended for people affected by parasitic infestations. The physician monitors whether the infection is clearing or not and also keeps track of unwanted side effects. The prescribing physician should be informed if symptoms do not disappear or if they get worse.

Hookworm or whipworm infections are also treated with iron supplements along with the antihelminthic prescription.

Some types of parasitic infestations (e.g. pinworms) can be passed from one person to another. It is then often recommended that everyone in the household of an infected person be asked to also take the prescribed antihelminthic drug.

Risks

People with the following medical conditions may have adverse reactions to antihelminthic drugs. The prescribing physician should accordingly be informed if any of these conditions are present:

- **Allergies**. Anyone who has had adverse reactions to antihelminthic drugs should inform the prescribing physician before taking the drugs again. The physician should also be informed about any other pre-existing allergies.
- Ulcers. Antihelminthic drugs are also contraindicated for persons diagnosed with ulcers of the digestive tract, especially **ulcerative colitis**.
- **Pregnancy**. There is research evidence reporting that some antihelminthic drugs cause **birth defects** or **miscarriage** in animal studies. No human birth defects have been reported, but antihelminthic drugs are usually not recommended for use during pregnancy. Pregnant women should accordingly inform the prescribing physician.
- Breastfeeding. Some antihelminthic drugs can pass into breast milk. Breastfeeding may have to be discontinued until the antihelminthic treatment has ended and breastfeeding mothers must also inform the prescribing physician.
- Other risk conditions. Any of the following medical conditions should also be reported to the prescribing physician: **Crohn's disease**, liver disease, kidney disease and worm cysts in the eyes.

Common side effects of antihelminthic drugs include **dizziness**, drowsiness, **headache**, sweating, dryness of the mouth and eyes, and ringing in the ears. Anyone taking these drugs should accordingly avoid driving, operating machines or other activities that may be dangerous until they know how they are affected by the drugs. Side effects usually wear off as the body adjusts to the drug and do not usually require medical treatment. Thiabendazole may cause the urine to have an unusual odor that can last for a day after the last dose. Other side effects of antihelminthic drugs, such as loss of appetite, **diarrhea**, nausea, vomiting, or abdominal cramps are less common. If they occur, they are usually mild and do not require medical attention.

More serious side effects, such as **fever**, chills, confusion, extreme weakness, **hallucinations**, severe diarrhea, nausea or vomiting, skin **rashes**, **low back pain**, dark urine, blurred vision, seizures, and **jaundice** have been reported in some cases. The patient's physician should be informed immediately if any should develop. As a rule, anyone who has unusual symptoms after starting treatment with antihelminthic drugs should notify the prescribing physician.

Antihelminthic drugs may interact with each other or with other drugs, whether prescribed or not. For example, it has been reported that use of the antihelminthic drugs pyrantel and piperazine together lowers the efficiency of pyrantel. Similarly, combining a given antihelminthic drug with another medication may increase the risk of side effects from either drug.

Nancy Ross-Flanigan

Antihemorrhoid drugs

Definition

Antihemorrhoid drugs are medicines that reduce the swelling and relieve the discomfort of **hemorrhoids** (swellings in the area around the anus).

Purpose

Hemorrhoids are bulges in the veins that supply blood to the skin and membranes of the area around the anus. They may form for various reasons. Frequent heavy lifting, sitting for long periods, or straining to have bowel movements may put **stress** on anal tissues, which can lead to hemorrhoids. Some women develop hemorrhoids during **pregnancy** as the expanding uterus puts pressure on the anal tissues. The strain of labor and delivery can also cause hemorrhoids or make existing hemorrhoids worse. Hemorrhoids sometimes result from certain medical problems, such as tumors pressing on the lower bowel.

The main symptoms of hemorrhoids are bleeding from the rectum, especially after a bowel movement, and **itching**, burning, **pain**, and general discomfort in the anal area. Over-the-counter antihemorrhoid products can relieve many of these symptoms. The products contain combinations of four main types of ingredients:

- local anesthetics, such as benzocaine, lidocaine and tetracaine, to temporarily relieve the pain
- vasoconstrictors, such as epinephrine base, epinephrine hydrochloride, ephedrine sulfate and phenylephrine hydrochloride that reduce swelling and relieve itching and discomfort by tightening blood vessels
- astringents (drying agents), such as witch hazel, calamine, and zinc oxide. These help shrink hemorrhoids by pulling water out of the swollen tissue. This, in turn, helps relieve itching, burning, and irritation.
- protectants, such as cocoa butter, lanolin, glycerin, mineral oil, and shark liver oil which soothe irritated tissues and form a protective barrier to prevent further irritation

Description

Antihemorrhoid drugs are available as creams, ointments and suppositories. Most can be bought without a physician's prescription.

Recommended dosage

Follow package instructions for using these products. Do not use more than the recommended amount of this medicine every day. For explanations or further information about how to use antihemorrhoid drugs, check with a physician or pharmacist.

Precautions

Do not use antihemorrhoid drugs for more than seven days in a row. If the problem gets worse or does not improve, check with a physician.

KEY TERMS

Anus—The opening at the end of the intestine through which solid waste (stool) passes as it leaves the body.

Rectum—The end of the intestine closest to the anus.

Uterus—A hollow organ in a female in which a fetus develops until birth.

If rectal bleeding continues, check with a physician. This could be a sign of a condition that needs medical attention.

Side effects

Side effects are rare, however, if a rash or any other sign of an allergic reaction occurs, stop using the medicine.

Interactions

Some antihemorrhoid drugs should not be used by people who are taking or have recently taken **monoamine oxidase inhibitors** (MAO inhibitors), such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and **Parkinson's disease**. Anyone who is not sure if he or she has taken this type of drug should check with a physician or pharmacist before using an antihemorrhoid drug. People who are taking antidepressants or medicine for high blood pressure also should not use certain antihemorrhoid drugs. Check with a pharmacist for a list of drugs that may interact with specific antihemorrhoid drugs.

Nancy Ross-Flanigan

Antihistamines

Definition

Antihistamines are drugs that block the action of histamine (a compound released in allergic inflammatory reactions) at the H_1 receptor sites, responsible for immediate hypersensitivity reactions such as sneezing and **itching**. Members of this class of drugs may also be used for their side effects, including **sedation** and antiemesis (prevention of **nausea and vomiting**).

DANIELE BOVET (1907–1992)

A gifted researcher in therapeutic chemistry, Daniele Bovet was born in Neuchatel, Switzerland, one of four children of a professor of experimental education. Bovet studied zoology and comparative anatomy at the University of Geneva, receiving his doctor of science degree in 1929. He then joined the Pasteur Institute in Paris, becoming director of the Laboratory of Therapeutic Chemistry in 1936.

Bovet investigated histamine, thought to cause allergy symptoms. No antagonist of histamine was known, so Bovet—with his research student Anne-Marie Staub—began studying substances that blocked hormones similar to histamine. By 1937 he had produced the first antihistamine, thymoxydiethylamine. Since this substance was too toxic for human use, Bovet and Staub performed thousands more experiments seeking less toxic antihistamines. This work formed the basis for the development of subsequent clinically useful antihistamines.

KEY TERMS

Allergen—A substance that causes an allergy.

Anaphylaxis—A sudden, life-threatening allergic reaction.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Histamine—A chemical released from cells in the immune system as part of an allergic reaction.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Purpose

Antihistamines provide their primary action by blocking histamine H_1 at the receptor site. They have no effect on rate of histamine release, nor do they inactivate histamine. By inhibiting the activity of histamine, they can reduce capillary fragility, which produces the erythema, or redness, associated with allergic reactions. They will also reduce histamine-induced secretions, including excessive tears and salivation. Additional effects vary with the individual drug used. Several of the older drugs, called first-generation antihistamines, bind non-selectively to H_1 receptors in the central nervous system as well as to peripheral receptors, and can produce sedation, inhibition of nausea and vomiting, and reduction of **motion sickness**. The second-generation antihistamines bind only to peripheral H_1 receptors, and reduce allergic response with little or no sedation.

The first-generation antihistamines may be divided into several chemical classes. The side effect profile, which also determines the uses of the drugs, will vary by chemical class. The alkylamines include brompheniramine (Dimetapp) and chlorpheniramine (Chlor-Trimeton.) These agents cause relatively little sedation, and are used primarily for treatment of allergic reactions. Promethazine (Phenergan), in contrast, is a phenothiazine, chemically related to the major tranquilizers, and while it is used for treatment of **allergies**, may also be used as a sedative, the relieve **anxiety** prior to surgery, as an antinauseant, and for control of motion sickness. Diphenhydramine (Benadryl) is chemically an ethanolamine, and in addition to its role in reducing allergic reactions, may be used as a nighttime sedative, for control of drug-induced Parkinsonism, and, in liquid form, for control of coughs. Consult more detailed references for further information.

The second generation antihistamines have no central action, and are used only for treatment of allergic reactions. These are divided into two chemical classes. Cetirizine (Zyrtec) is a piperazine derivative, and has a slight sedative effect. Loratidine (Claritin) and fexofenadine (Allegra) are members of the piperadine class and are essentially non-sedating.

Recommended dosage

Dosage varies with drug, patient and intended use. Consult more detailed references for further information.

When used for control of allergic reactions, antihistamines should be taken on a regular schedule, rather than on an as-needed basis, since they have no effect on histamine itself, nor on histamine already bound to the receptor site.

Efficacy is highly variable from patient to patient. If an antihistamine fails to provide adequate relief, switch to a drug from a different chemical class. Individual drugs may be effective in no more than 40% of patients, and provide 50% relief of allergic symptoms.

Antihistamines

Brand Name (Generic Name)	Possible Common Side Effects Include:
*Atarax (hydroxyzine hydrochloride)	Drowsiness, dry mouth
Benadryl (diphenhydramine hydrochloride)	Dizziness, sleepiness, upset stomach, decreased coordination
Hismanal (astemiozole)	Drowsiness, dry mouth, fatigue, weight gain
PBZ-SR (tripelennamine hydrochloride)	Dizziness, drowsiness, dry mouth and throat, chest congestion, decreased coordination, upset stomach
Periactin (cyproheptadine hydrochloride)	Chest congestion, dizziness, fluttery heartbeat, loss of appetite, hives, sleepiness, vision problems
Phenergan (promethazine hydrochloride)	Changes in blood pressure, dizziness, blurred vision, nausea, rash
Polaramine (dexchlorpheniramine maleate)	Drowiness
Seldane, Seldane-D (terfenadine)	Upset stomach, nausea, drowiness, headache, fatigue
Tavist (clemastine fumarate)	Decreased coordination, dizziness, upset stomach
Trinalin Repetabs (azatadine maleate, pseudoephedrine sulfate)	Abdominal cramps, chest pain, dry mouth, headache

*Also used in the treatment of anxiety

Side effects

The frequency and severity of adverse effects will vary between drugs. Not all adverse reactions will apply to every member of this class.

Central nervous system reactions include drowsiness, sedation, **dizziness**, faintness, disturbed coordination, lassitude, confusion, restlessness, excitation, tremor, seizures, **headache**, **insomnia**, euphoria, blurred vision, **hallucinations**, disorientation, disturbing dreams/nightmares, schizophrenic-like reactions, weakness, vertigo, **hysteria**, nerve **pain**, and convulsions. Overdoses may cause involuntary movements. Other problems have been reported.

Gastrointestinal problems include increased appetite, decreased appetite, nausea, vomiting, **diarrhea**, and **constipation**.

Hematologic reactions are rare, but may be severe. These include anemia, or breakdown of red blood cells; reduced platelets; reduced white cells; and bone marrow failure.

A large number of additional reactions have been reported. Not all apply to every drug, and some reactions may not be drug related. Some of the other adverse effects are chest tightness; **wheezing**; nasal stuffiness; **dry mouth**, nose and throat; **sore throat**; respiratory depression; sneezing; and a burning sensation in the nose.

When taking antihistamines during **pregnancy**, Chlorpheniramine (Chlor-Trimeton), dexchlorpheniramine (Polaramine), diphenhydramine (Benadryl), brompheniramine (Dimetapp), cetirizine (Zyrtec), cyproheptadine (Periactin), clemastine (Tavist), azatadine (Optimine), loratadine (Claritin) are all listed as category B. Azelastine (Astelin), hydroxyzine (Atarax), promethazine (Phenergan) are category C.

Regardless of chemical class of the drug, it is recommended that mothers not breast feed while taking antihistamines.

Contraindications

The following are absolute or relative contraindications to use of antihistamines. The significance of the contraindication will vary with the drug and dose.

- glaucoma
- hyperthyroidism (overactive thyroid)
- high blood pressure
- enlarged prostate
- heart disease
- ulcers or other stomach problems
- stomach or intestinal blockage
- liver disease
- kidney disease
- bladder obstruction
- diabetes

Interactions

Drug interactions will vary with the chemical class of antihistamine. In general, antihistamines will increase the effects of other sedatives, including alcohol.

Monoamine oxidase inhibitor antidepressants (phenelzine [Nardil], tranylcypromine [Parnate]) may prolong and increase the effects of some antihistamines. When used with promethazine (Phenergan) this may cause reduced blood pressure and involuntary movements.

Resources

ORGANIZATIONS

Allergy and Asthma Network. 3554 Chain Bridge Road, Suite 200. (800) 878-4403.

American Academy of Allergy and Immunology. 611 East Wells Street, Milwaukee, WI 53202. (800)822-2762.
Asthma and Allergy Foundation of America. 1125 15th Street NW, Suite 502, Washington, DC 20005. (800)727-8462.

Samuel Uretsky, PharmD

Antihyperlipidemic drugs *see* **Cholesterol-reducing drugs**

Antihypertensive drugs

Definition

Antihypertensive drugs are medicines that help lower blood pressure.

Purpose

The overall class of antihypertensive agents lowers blood pressure, although the mechanisms of action vary greatly. Within this therapeutic class, there are several subgroups. There are a very large number of drugs used to control **hypertension**, and the drugs listed below are representatives, but not the only members of their classes.

The calcium channel blocking agents, also called slow channel blockers or calcium antagonists, inhibit the movement of ionic calcium across the cell membrane. This reduces the force of contraction of muscles of the heart and arteries. Although the **calcium channel blockers** are treated as a group, there are four different chemical classes, leading to significant variations in the activity of individual drugs. Nifedipine (Adalat, Procardia) has the greatest effect on the blood vessels, while verapamil (Calan, Isoptin) and diltiazem (Cardizem) have a greater effect on the heart muscle itself.

Peripheral **vasodilators** such as hydralazine (Apresoline), isoxuprine (Vasodilan), and **minoxidil** (Loniten) act by relaxing blood vessels.

There are several groups of drugs which act by reducing adrenergic nerve stimulation, the excitatory nerve stimulation that causes contraction of the muscles in the arteries, veins, and heart. These drugs include the beta-adrenergic blockers and alpha/beta adrenergic blockers. There are also non-specific adrenergic blocking agents.

Beta-adrenergic blocking agents include propranolol (Inderal), atenolol (Tenormin), and pindolol (Visken). Propranolol acts on the beta-adrenergic receptors anywhere in the body, and has been used as a treatment for emotional **anxiety** and rapid heart beat. Atenolol and acebutolol (Sectral) act specifically on the nerves of the heart and circulation.

There are two alpha/beta adrenergic blockers, labetolol (Normodyne, Trandate) and carvedilol (Coreg). These work similarly to the **beta blockers**.

Angiotensin-converting enzyme inhibitors (ACE inhibitors) act by inhibiting the production of angiotensin II, a substance that both induces constriction of blood vessels and retention of sodium, which leads to water retention and increased blood volume. There are 10 ACE inhibitors currently marketed in the United States, including captopril (Capoten), benazepril (Lotensin), enalapril (Vasotec), and quinapril (Acupril). The primary difference between these drugs is their onset and duration of action.

The ACE II inhibitors, losartan (Cozaar), candesartan (Atacand), irbesartan (Avapro), telmisartan (Micardis), valsartan (Diovan) and eprosartan (Teveten) directly inhibit the effects of ACE II rather than blocking its production. Their actions are similar to the ACE inhibitors, but they appear to have a more favorable side effect and safety profile.

In addition to these drugs, other classes of drugs have been used to lower blood pressure, most notably the thiazide **diuretics**. There are 12 thiazide diuretics marketed in the United States, including hydrochlorothiazide (Hydrodiuril, Esidrex), indapamide (Lozol), polythiazide (Renese), and hydroflumethiazide (Diucardin). The drugs in this class appear to lower blood pressure through several mechanisms. By promoting sodium loss they lower blood volume. At the same time, the pressure of the walls of blood vessels, the peripheral vascular resistance, is lowered. Thiazide diuretics are commonly used as the first choice for reduction of mild hypertension, and may be used in combination with other antihypertensive drugs.

Recommended dosage

Recommended dosage varies with patient, drug, severity of hypertension, and whether the drug is being used alone or in combination with other drugs. Consult specialized references for further information.

Precautions

Because of the large number of classes and individual drugs in this group, consult specialized references for complete information.

Peripheral vasodilators may cause **dizziness** and orthostatic hypotension—a rapid lowering of blood pressure when the patient stands up in the morning. Patients

Antihypertensive Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Accupril (quinapril hydrochloride)	Headache, dizziness
Aldatazide	Diarrhea, fever, headache, decreased coordination
Aldactone (spironolactone)	Cramps, drowsiness, stomach disorders
Aldomet (methyldopa)	Fluid retention, headache, weak feeling
Altace (ramipril)	Headache, cough
Calan, Calan SR (verapamil hydrochloride)	Constipation, fatigue, decreased blood pressure
Capoten (captopril)	Decreased sense of taste, decreased blood pressure tiching, rash
Cardene (nicardipine Hydrochloride)	Dizziness, headache, indigestion and nausea, increased heartbeat
Cardizem (diltiazem hydrochloride)	Dizziness, fluid retention, headache, nausea, skin rash
Cardura (doxazosin mesylate)	Dizziness, fatigue, drowsiness, headache
Catapres	Dry mouth, drowsiness, dizziness, constipation
Corgard (nadolol)	Behaviorial changes, dizziness, decreased heartbeat, tiredness
Corzide	Dizziness, decreased heartbeat, fatigue, cold hands and feet
Diuril (chlorothiazide)	Cramps, constipation or diarrhea, dizziness, fever, increased glocose level in urine
Dyazide	Blurred vision, muscle and abdominal pain, fatigue
DynaCirc (isradipine)	Chest pain, fluid retention, headache, fatigue
HydroDIURIL (hydrochlorothiazide)	Upset stomach, headache, cramps, loss of appetite
Hygroton (chlorthalidone)	Anemia, constipation or diarrhea, cramps, itching
Hytrin (terazosin hydrochloride)	Dizziness, labored breathing, nausea, swelling
Inderal (propranolol hydrochloride)	Constipation or diarrhea, tingling sensation, nausea and vomiting
Inderide	Blurred vision, cramps, fatigue, loss of appetite
Lasix (furosemide)	Back and muscle pain, indigestion, nausea
Lopressor (metoprolol tartrate)	Diarrhea, itching/rash, tiredness
Lotensin (benazepril hydrochloride)	Nausea, dizziness, fatigue, headache
Alozol (indapamide)	Anxiety, headache, loss of energy, muscle cramps
Maxzide	Cramps, labored breathing, drowsiness, irritated stomach
Minipress (prazosin hdrochloride)	Headache, nausea, weakness, dizziness
Moduretic	Diarrhea, fatigue, itching, loss of appetite
Monopril (fosinopril sodium)	Nausea and vomiting, headache, cough
Normodyne (labetalol hydrochloride)	Fatigue, nausea, stuffy nose
Plendil (felodipine)	Pain in back, chest, muscles, joints, and abdomen, itching, dry mouth, respiratory problems
Procardia, Procardia X (nifedipine)	Swelling, constipation, decreased blood pressure, nausea, fatigue
Sectral (acebutolol hydrochloride)	Constipation or diarrhea, gas, chest and joint pain
Ser-Ap-Es	Blurred vision, cramps, muscle pain, dizziness
Tenex (guanfacine hydrochloride)	Headache, constipation, dry mouth, weakness
Tenoretic	Decreased heartbeat, fatigue, nausea
Tenormin (atenolol)	Nausea, fatigue, dizziness
Veseretic	Diarrhea, muscle cramps, rash
Vasotec (enalapril maleate)	Chest pain, blurred vision, constipation or diarrhea, hives, nausea
Visken (pindolol)	Muscle cramps, labored breathing, nausea, fluid retention
Wytensin (guanabenz acetate)	Headache, drowsiness, dizziness
Zaroxolyn (metolazone)	Constipation or diarrhea, chest pain, spasms, nausea
Zestoretic (lisinopril hydrochlorothiazide)	Fatigue, headache, dizziness
Zestril (lisinopril)	Labored breathing, abdominal and chest pain, nausea, decreased blood pressure

taking these drugs must be instructed to rise from bed slowly. **Pregnancy** risk factors for this group are generally category C. Hydralazine has been shown to cause cleft palate in animal studies, but there is no human data available. Breastfeeding is not recommended.

ACE inhibitors are generally well tolerated, but may rarely cause dangerous reactions including laryngospasm and angioedema. Persistent **cough** is a common side effect. ACE inhibitors should not be used in pregnancy. When used in pregnancy during the second and third trimesters, angiotension-converting inhibitors (ACEIs) can cause injury to and even **death** in the developing fetus. When pregnancy is detected, discontinue the ACE inhibitor as soon as possible. Breastfeeding is not recommended.

ACE II inhibitors are generally well tolerated and do not cause cough. Pregnancy risk factor is category C during the first trimester and category D during the second and third trimesters. Drugs that act directly on the renin-angiotensin system can cause fetal and neonatal morbidity and death when administered to pregnant women. Several dozen cases have been reported in patients who were taking ACE inhibitors. When pregnancy is detected, discontinue AIIRAs as soon as possible. Breast feeding is not recommended.

Thiazide diuretics commonly cause potassium depletion. Patients should have potassium supplementation either through diet, or potassium supplements. Pregnancy risk factor is category B (chlorothiazide, chlorthalidone, hydrochlorothiazide, indapamide, metolazone) or catego-

KEY TERMS

Adrenergic—Activated by adrenalin (norepinephrine), loosely applied to the sympathetic nervous system responses.

Angioedema—An allergic skin disease characterized by patches of circumscribed swelling involving the skin and its subcutaneous layers, the mucous membranes, and sometimes the viscera—called also angioneurotic edema, giant urticaria, Quincke's disease, or Quincke's edema.

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Laryngospasm—Spasmodic closure of the larynx.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Sympathetic nervous system—The part of the autonomic nervous system that is concerned especially with preparing the body to react to situations of stress or emergency; it contains chiefly adrenergic fibers and tends to depress secretion, decrease the tone and contractility of smooth muscle, and increase heart rate.

ry C (bendroflumethiazide, benzthiazide, hydroflumethiazide, methyclothiazide, trichlormethiazide). Routine use during normal pregnancy is inappropriate. Thiazides are found in breast milk. Breastfeeding is not recommended.

Beta blockers may cause a large number of adverse reactions including dangerous heart rate abnormalities. Pregnancy risk factor is category B (acebutolol, pindolol, sotalol) or category C (atenolol, labetalol, esmolol, metoprolol, nadolol, timolol, propranolol, penbutolol, carteolol, bisoprolol). Breastfeeding is not recommended.

Interactions

Consult specific drug references.

Samuel Uretsky, PharmD

Anti-hyperuricemic drugs

Definition

Anti-hyperuricemic drugs are used to treat hyperuricemia, the state of having too much uric acid in the blood.

Purpose

Anti-hyperuricemic drugs decrease the levels of uric acid in the blood, either by increasing the rate at which uric acid is excreted in the urine, or by preventing the formation of excess uric acid.

Precautions

Before taking any medication, patients should notify their physician of all other medications that they are currently taking. Patients should also notify their physician of any health problems they are currently experiencing. Patients must notify physicians if they have kidney problems, since this might affect the type of drug administered. Patients must also notify their physician if they are allergic to any of the medications used to treat acute or long-term **gout**. Since all of these factors contribute to the disease, patients suffering from gout should attempt to lose weight, avoid excess alcohol consumption, and avoid foods high in purines, such as asparagus, sardines, lobster, avocado, and peas.

Description

Gout and hyperuricemia

Persons with high levels of uric acid (hyperuricemia) may experience gout. Commonly gout occurs in males in their 40s and 50s. Gout is defined by the attacks of (arthritic) painful, reddened joints, and is often accompanied by hard lumps in the painful joints. The most common joint affected is the big toe. **Kidney stones**, and/or poor kidney function may also be associated with hyperuricemia, but may not be considered gout if the patient does not have painful joints. In persons with gout (and associated symptoms), uric acid forms crystals, which then cause the aforementioned symptoms. Although uric acid levels must be high in order for patients to have crystals form, and therefore have gout, most persons with high uric acid levels don't ever have symptoms. Thus, recent criteria for use of anti-hyperuricemic agents suggest that patients who have never experienced symptoms of gout should not receive drug therapy, unless their hyperuricemia is associated with **cancer** (may lead to kidney damage) or certain rare

genetic disorders (McGill, Rheumatologist, University of Sydney, Australia, 2000).

Acute gout attacks

When patients experience acute attacks of gout, drugs that lower the levels of uric acid can cause an acute gout attack or cause an attack to become more severe. Thus, drugs that lower uric acid levels and are used to treat gout in the long term are not used in the short term. Medications used in acute gout attacks include non-steroidal anti-inflammatory drugs (such as indomethacin), colchicine, and **corticosteroids**. Colchicine causes side effects in a large number of individuals (usually diarhhea). The most important factor in the effective treatment of gout may not be the drug used, but how quickly it is administered after an acute attack has begun.

Long-term treatment

Long-term treatment of gout or hyperuricemia usually involves one of four drugs: allopurinol, probenicid, sulphinpyrazone, or benzbromarone (as of this printing in 2001, benzbromarone is not available for use in the United States). While allopurinol decreases the amount of uric acid that is produced (and may help prevent acute attacks of gout), the other drugs all increase the rate at which uric acid is excreted in the urine. As previously mentioned, lowering the concentration of uric acid can cause gout attacks. Thus, patients taking these medications should have the dose slowly increased (and uric acid levels slowly lowered) to prevent acute attacks of gout. Patients may also be treated with colchicine or non-steroidal anti-inflammatory drugs to prevent acute attacks of gout (corticosteroids are not used in this scenario because over the long term corticosteroids have deleterious side effects).

Michael V Zuck, PhD

Anti-insomnia drugs

Definition

Anti-insomnia drugs are medicines that help people fall asleep or stay asleep.

Purpose

Physicians prescribe anti-insomnia drugs for short-term treatment of insomnia—a sleep problem in which people have trouble falling asleep or staying asleep or wake up too early and can't go back to sleep. These drugs should be used only for occasional treatment of temporary sleep problems and should not be taken for more than a week or two at a time. People whose sleep problems last longer than this should see a physician. Their sleep problems could be a sign of another medical problem.

Description

The anti-insomnia drug described here, zolpidem (Ambien), is a classified as a central nervous system (CNS) depressant. CNS depressants are medicines that slow the nervous system. Physicians also prescribe medicines in the benzodiazepine family, such as flurazepam (Dalmane), quazepam (Doral), triazolam (Halcion), estazolam (ProSom), and temazepam (Restoril), for **insomnia**. Benzodiazepine drugs are described in the essay on **antianxiety drugs**. Zaleplon (Sonata) is another anti-insomnia drug that is not related to other drugs with the same effect. The **barbiturates**, such as pentobarbital (Nembutal) and secobarbital (Seconal) are no longer commonly used to treat insomnia because they are too dangerous if they are taken in overdoses. For patients with mild insomnia, some **antihistamines**, such as diphenhydramine (Benadryl) or hydroxyzine (Atarax) may be used, since these also cause sleepiness.

Zolpidem is available only with a physician's prescription and comes in tablet form.

Recommended dosage

The recommended dose for adults is 5-10 mg just before bedtime. The medicine works quickly, often within 20 minutes, so it should be taken right before going to bed.

For older people and others who may be more sensitive to the drug's effects, the recommended starting dosage is 5 mg just before bedtime.

Never take more than 10 mg of zolpidem in one 24-hour period. Overdoses can lead to excessive sleepiness or coma.

Zolpidem may be taken with food or on an empty stomach, but it may work faster when taken on an empty stomach. Check with a physician or pharmacists for instructions on how to take the medicine.

Precautions

Zolpidem is meant only for short-term treatment of insomnia. If sleep problems last more than seven to 10 days, check with a physician. Longer-lasting sleep problems could be a sign of another medical problem. Also, this drug may lose its effectiveness when taken every night for more than a few weeks.

Anti-Insomnia Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Ambien (zolpidem tartrate)	Daytime drowsiness, dizziness, headache
Dalmane (flurazepam hydrochloride)	Decreased coordination, lightheadedness, dizziness
Doral (quazepam)	Daytime drowsiness, headache, dry mouth, fatigue
Halcion (triazolam)	Decreased coordination, chest pain, memory impairment
ProSom (estazolam)	Dizziness, headache, nausea, weakness
Restoril (temazepam)	Dizziness, fatigue, nausea, headache, sluggishness

Some people feel drowsy, dizzy, confused, lightheaded, or less alert the morning after they have taken zolpidem. The medicine may also cause clumsiness, unsteadiness, double vision, or other vision problems the next day. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how zolpidem affects them.

This medicine has caused cause behavior changes in some people, similar to those seen in people whose behavior changes when they drink alcohol. Examples include giddiness and rage. More extreme changes, such as confusion, agitation, and **hallucinations**, also are possible. Anyone who starts having strange or unusual thoughts or behavior while taking this medicine should get in touch with his or her physician.

Zolpidem and other sleep medicines may cause a special type of temporary memory loss, in which the person does not remember what happens between the time they take the medicine and the time its effects wear off. This is usually not a problem, because people go to sleep right after taking the medicine and stay asleep until its effects wear off. But it could be a problem for anyone who has to wake up before getting a full night's sleep (seven to eight hours). In particular, travelers should not take this medicine on airplane flights of less than seven to eight hours.

Because zolpidem works work on the central nervous system, it may add to the effects of alcohol and other drugs that slow down the central nervous system, such as antihistamines, cold medicine, allergy medicine, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Zolpidem may also add to the effects of anesthetics, including those used for dental procedures. The combined effects of zolpidem and alcohol or other CNS depressants (drugs that slow the central nervous system) can be very dangerous, leading to unconsciousness or even **death**. People who take zolpidem should not drink alcohol and should check with their physicians before taking any other CNS depressant. Anyone who shows signs of an overdose or of the effects of combining zolpidem drugs with alcohol or other drugs should have immediate emergency help. Warning signs include severe drowsiness, severe nausea or vomiting, breathing problems, and staggering.

Anyone who takes zolpidem for more than one to two weeks should not stop taking it without first checking with a physician. Stopping the drug abruptly may cause rebound insomnia; increased difficulty falling asleep for the first one of two nights after the drug has been discontinued. In rare cases, withdrawal symptoms, such as vomiting, cramps, and unpleasant feelings may occur. Gradual tapering may be necessary.

Older people may be more sensitive to the effects of zolpidem. This may increase the chance of side effects, such as confusion, and may also increase the risk of falling.

In people with breathing problems, zolpidem may worsen the symptoms.

Special conditions

People with certain other medical conditions or who are taking certain other medicines can have problems if they take zolpidem. Before taking this medicine, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to zolpidem in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using zolpidem during **pregnancy**.

BREASTFEEDING. Women who are breastfeeding should check with their physicians before using zolpidem.

OTHER MEDICAL CONDITIONS. Before using zolpidem, people with any of these medical problems should make sure their physicians are aware of their conditions:

- chronic lung diseases (**emphysema**, **asthma**, or chronic bronchitis)

- liver disease
- kidney disease
- current or past alcohol or drug abuse
- depression
- sleep apnea

USE OF CERTAIN MEDICINES. Taking zolpidem with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common minor side effects are daytime drowsiness or a "drugged" feeling, vision problems, memory problems, nightmares or unusual dreams, vomiting, nausea, abdominal or stomach pain, **diarrhea**, **dry mouth**, **headache**, and general feeling of discomfort or illness. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- confusion
- depression
- clumsiness or unsteadiness

Patients who take zolpidem may notice side effects for several weeks after they stop taking the drug. They should check with their physicians if these or other troublesome symptoms occur:

- agitation, nervousness, feelings of panic
- uncontrolled crying
- worsening of mental or emotional problems
- seizures
- tremors
- lightheadedness
- sweating
- flushing
- nausea or abdominal or stomach cramps
- muscle cramps
- unusual tiredness or weakness

Other rare side effects may occur. Anyone who has unusual symptoms after taking zolpidem should get in touch with his or her physician.

Interactions

Zolpidem may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes zolpidem should let the physician know all other medicines he or she is taking. Among the drugs that may interact with zolpidem are:

- other central nervous system (CNS) depressants such as medicine for allergies, colds, hay **fever**, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; barbiturates; and anesthetics.
- the major tranquilizer chlorpromazine (Thorazine).
- tricyclic antidepressants such as imipramine (Tofranil) and amitriptyline (Elavil)

Nancy Ross-Flanigan

KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bronchitis—Inflammation of the air passages of the lungs.

Emphysema—A lung disease in which breathing becomes difficult.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Sleep apnea—A condition in which a person temporarily stops breathing during sleep.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

Anti-itch drugs

Definition

Anti-itch drugs are medicines taken by mouth or by injection to relieve **itching**.

Purpose

The medicine described here, hydroxyzine, is a type of antihistamine used to relieve itching caused by allergic

reactions. An allergic reaction occurs when the body is unusually sensitive to some substance, such as pollen, dust, mold, or certain foods or medicine. The body reacts by releasing a chemical called histamine that causes itching and other symptoms, such as sneezing and watery eyes. **Antihistamines** reduce the symptoms by blocking the effects of histamine.

Hydroxyzine is also prescribed for **anxiety** and to help people relax before or after having general anesthesia.

KEY TERMS

Anesthesia—Treatment with medicine that causes a loss of feeling, especially pain. Local anesthesia numbs only part of the body; general anesthesia causes loss of consciousness.

Antihistamine—Medicine that prevents or relieves allergy symptoms.

Description

Anti-itch drugs, also called antipruritic drugs, are available only with a physician's prescription and come in tablet and injectable forms. Some commonly used brands of the anti-itch drug hydroxyzine are Atarax and Vistaril.

Recommended dosage

When prescribed for itching, the usual dosage for adults is 25 mg, three to four times a day. For children over six years of age, the usual dosage 50-100 mg per day, divided into several small doses. The usual dosage for children under six years of age is 50 mg per day, divided into several small doses.

The dosage may be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and take the medicine exactly as directed.

Precautions

This medicine should not be used for more than four months at a time because its effects can wear off. See a physician regularly while taking the medicine to determine whether it is still needed.

Hydroxyzine may add to the effects of alcohol and other drugs that slow down the central nervous system, such as other antihistamines, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking hydroxyzine should not drink alcohol and should check with his or her physician before taking any of the above.

Some people feel drowsy or less alert when using this medicine. Anyone who takes it should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

Anyone who has had unusual reactions to hydroxyzine in the past should let his or her physician know before taking the medicine again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

A woman who is pregnant or who may become pregnant should check with her physician before taking this medicine. In studies of laboratory animals, hydroxyzine has caused **birth defects** when taken during **pregnancy**. Although the drug's effects on pregnant women have not been fully studied, physicians advise against taking it in early pregnancy.

BREASTFEEDING. Women who are breastfeeding should also check with their physicians before using hydroxyzine. The medicine may pass into breast milk and may cause problems in nursing babies whose mothers take it.

Side effects

The most common side effect, drowsiness, usually goes away as the body adjusts to the drug. If it does not, reducing the dosage may be necessary. Other side effects, such as **dry mouth**, also may occur and do not need medical attention unless they continue.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- twitches or **tremors**
- convulsions (seizures)

Interactions

Hydroxyzine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes hydroxyzine should let the physician know all other medicines he or she is taking. Among the drugs that may interact with hydroxyzine are:

- barbiturates such as phenobarbital and secobarbital (Seconal)
- opioid (narcotic) pain medicines such as meperidine (Demerol) and oxycodone (Percocet)

• non-narcotic pain medicines such as **acetaminophen** (Tylenol) and ibuprofen (Motrin, Advil)

The list above may not include every drug that interacts with hydroxyzine. Be sure to check with a physician or pharmacist before combining hydroxyzine with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antimalarial drugs

Definition

Antimalarial drugs are medicines that prevent or treat **malaria**.

Purpose

Antimalarial drugs treat or prevent malaria, a disease that occurs in tropical, subtropical, and some temperate regions of the world. The disease is caused by a parasite, *Plasmodium*, which belongs to a group of one-celled organisms known as protozoa. The only way to get malaria is to be bitten by a certain type of mosquito that has bitten someone who has the disease.Thanks to mosquito control programs, malaria has been eliminated in the United States, almost all of Europe, and large parts of Central and South America. However, mosquito control has not worked well in other parts of the world, and malaria continues to be a major health problem in parts of Africa, Southeast Asia, Latin America, Haiti, the Dominican Republic, and some Pacific Islands. Every year, some 30,000 Americans and Europeans who travel to these areas get malaria. People planning to travel to the tropics are often advised to take antimalarial drugs before, during, and after their trips, to help them avoid getting the disease and bringing it home with them. These drugs kill *Plasmodium* or prevent its growth.

In recent years, some strains of *Plasmodium* have become resistant to antimalarial drugs, and medical researchers have stepped up efforts to develop a malaria vaccine. In early1997, researchers reported encouraging results from a small study of one vaccine and planned to test the vaccine in Africa.

Description

Antimalarial drugs are available only with a physician's prescription. They come in tablet, capsule, and injectable forms. Among the commonly used antimalarial drugs are chloroquine (Aralen), mefloquine (Lariam), primaquine, pyrimethamine (Daraprim), and quinine.

Recommended dosage

Recommended dosage depends on the type of antimalarial drug, its strength, and the form in which it is being used (such as tablet or injection). The dosage may also be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage. Always take this medicine exactly as directed, and keep taking it for the full time of treatment. If the drug is being taken to treat malaria, do not stop taking it just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon. Never take larger or more frequent doses than the physician has ordered, and do not take the drug for longer than directed.

Travelers taking this medicine to prevent malaria may be told to take it for one to two weeks before their trip and for 4 weeks afterward, as well as for the whole time they are away. It is important to follow these directions.

Antimalarial drugs work best when they are taken on a regular schedule. When taken once a week to prevent malaria, they should be taken on the same day every week. When taken daily or several times a day to treat malaria, they should be taken at the same time every day. Doses should not be missed or skipped.

Some antimalarial drugs should be taken with meals or with milk to prevent upset stomach. Others must be taken with a full glass of water. Be sure to follow directions for the best way to take the drug that is prescribed.

Precautions

Antimalarial drugs may cause lightheadedness, **dizziness**, blurred vision and other vision changes. Anyone who takes these drugs should not drive, use machines or do anything else thatmight be dangerous until they have found out how the drugs affect them.

The antimalarial drug mefloquine (Lariam) has received attention because of reports that it causes panic attacks, **hallucinations**, **anxiety**, depression, **paranoia**, and other mental and mood changes, sometimes lasting for months after the last dose. A study published in 1996 in the *British Medical Journal* noted that about one in 140 travelers who take the drug may have mental or mood changes severe enough to interfere with normal activities. This compares to about one in 1,100 patients who have such reactions to the antimalarial drug chloroquine. Anyone who has unexplained anxiety, depression, restlessness, confusion, or other troubling mental or mood changes after taking mefloquine should call a physician

right away. Switching to a different antimalarial drug may be an alternative and can allow the side effects to stop.

Anyone taking antimalarial drugs to prevent malaria who develops a **fever** or flu-like symptoms while taking the medicine or within two to three months after traveling to an area where malaria is common should call a physician immediately.

If the medicine is being taken to treat malaria, and symptoms stay the same or get worse, check with the physician who prescribed the medicine.

Patients who take this medicine over a long time need to have a physician check them periodically for unwanted side effects.

Babies and children are especially sensitive to the antimalarial drug chloroquine. Not only are they more likely to have side effects from the medicine, but they are also at greater risk of being harmed by an overdose. A single 300-mg tablet could kill a small child. *Keep this medicine out of the reach of children. Use safety vials.*

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take antimalarial drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to antimalarial drugs or related medicines in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. In laboratory animal studies, some antimalarial drugs cause **birth defects**. But it is also risky for a pregnant woman to get malaria. Untreated malaria can cause premature birth, **stillbirth**, and **miscarriage**. When given in low doses to prevent malaria, antimalarial drugs have not been reported to cause birth defects in humans. If possible, pregnant women should avoid traveling to areas where they could get malaria. If travel is necessary, women who are pregnant or who may become pregnant should check with their physicians about the use of antimalarial drugs.

BREASTFEEDING. Some antimalarial drugs pass into breast milk. Although no problems have been reported in nursing babies whose mothers took antimalarial drugs, babies and young children are particularly sensitive to some of these drugs. Women who are breastfeeding should check with their physicians before using antimalarial drugs.

OTHER MEDICAL CONDITIONS. Before using antimalarial drugs, people who have any of these medical problems (or have had them in the past) should make sure their physicians are aware of their conditions:

- blood disease
- liver disease
- nerve or brain disease or disorder, including seizures (convulsions)
- past or current mental disorder
- stomach or intestinal disease
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD), which is important in the breakdown of sugar in the body
- deficiency of the enzyme nicotinamide adenine dinucleotide (NADH) methemoglobin reductase
- psoriasis
- heart disease
- family or personal history of the genetic condition favism (a hereditary allergic condition)
- family or personal history of **hemolytic anemia**, a condition in which red blood cells are destroyed
- purpura
- hypoglycemia (low blood sugar)
- blackwater fever (a serious complication of one type of malaria)
- myasthenia gravis (a disease of the nerves and muscles)

USE OF CERTAIN MEDICINES. Taking antimalarial drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

High doses of the antimalarial drug pyrimethamine may cause blood problems that caninterfere with healing and increase the risk of infection. People taking this drug should be careful not to injure their gums when brushing or flossing their teeth or using toothpicks. If possible, dental work should be postponed until treatment is complete and the blood has returned to normal.

The most common side effects of antimalarial drugs are **diarrhea**, nausea or vomiting, stomach cramps or **pain**, loss of appetite, **headache**, **itching**, difficulty concentrating, dizziness, lightheadedness, and sleep problems. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as hair loss or loss of color in the hair; skin rash; or blue-black discoloration of the skin, fingernails, or inside of the mouth also may

occur and do not need medical attention unless they are long-lasting.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine immediately:

- blurred vision or any other vision changes
- convulsions (seizures)
- mood or mental changes
- hallucinations
- anxiety
- confusion
- weakness or unusual tiredness
- unusual bruising or bleeding
- hearing loss or ringing or buzzing in the ears
- fever, with or without **sore throat**
- slow heartbeat
- pain in the back or legs
- dark urine
- pale skin
- taste changes
- soreness, swelling, or burning sensation in the tongue

Other rare side effects may occur. Anyone who has unusual symptoms after taking anantimalarial drug should get in touch with his or her physician.

Interactions

Some antimalarial drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antimalarial drugs should let the physician know all other medicines he or she is taking. Among the drugs that interact with some antimalarial drugs are:

- beta blockers such as atenolol (Tenormin), propranolol (Inderal), and metoprolol (Lopressor)
- calcium channel blockers such as diltiazem (Cardizem), nicardipene (Cardene), and nifedipine (Procardia)
- other antimalarial drugs
- quinidine, used to treat abnormal heart rhythms
- antiseizure medicines such as vaproic acid derivatives (Depakote or Depakene)
- oral typhoid vaccine
- diabetes medicines taken by mouth
- sulfonamides (sulfa drugs)
- vitamin K

KEY TERMS

Glucose—A simple sugar that serves as the body's main source of energy.

Hypoglycemia—Abnormally low levels of glucose in the blood.

Organism—An individual of some type of life form, such as a plant or an animal.

Parasite—An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

Protozoa—Animal-like, one-celled organisms, some of which cause diseases in people.

Psoriasis—A skin disease in which people have itchy, scaly, red patches on the skin.

Purpura—A spotty or patchy purplish rash caused by bleeding under the surface of the skin.

- anticancer drugs
- medicine for overactive thyroid
- antiviral drugs such as zidovudine (Retrovir)

The list above does not include every medicine that may interact with every antimalarial drug. Be sure to check with a physician or pharmacist before combining an antimalarial drug with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Schmidt, Elizabeth B. "The Road to Illville." *Harvard Health Letter* 19 (Nov. 1993): 6.

OTHER

"Should You Take Lariam?" Travel Health Information Page. <http://travelhealth.com/lariam.htm>.

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Antimicrobial agents *see* **Antibiotics**

Antimigraine drugs

Definition

Antimigraine drugs are medicines used to prevent or reduce the severity of migraine headaches.

Purpose

Migraine headaches usually cause a throbbing **pain** on one side of the head. Nausea, vomiting, **dizziness**, increased sensitivity to light and sound, and other symptoms may accompany the pain. The attacks may last for several hours or for a day or more and may come as often as several times a week. Some people who get migraine headaches have warning signals before the headaches begin, such as restlessness, tingling in an arm or leg, or seeing patterns of flashing lights. This set of signals is called an aura. The antimigraine drugs discussed in this section are meant to be taken as soon as the pain begins, to relieve the pain and other symptoms. Other types of drugs, such as antiseizure medicines, antidepressants, **calcium channel blockers** and **beta blockers**, are sometimes prescribed to prevent attacks in people with very severe or frequent migraines.

Description

Migraine is thought to be caused by electrical and chemical imbalances in certain parts of the brain. These imbalances affect the blood vessels in the brain—first tightening them up, then widening them. As the blood vessels widen, they stimulate the release of chemicals that increase sensitivity to pain and cause inflammation and swelling. Antimigraine drugs are believed to work by correcting the imbalances and by tightening the blood vessels.

Examples of drugs in this group are ergotamine (Cafergot), naratriptan (Amerge), sumatriptan (Imitrex), rizatriptan (Maxalt) and zolmitriptan (Zomig). Methysergide maleate (Sansert) may be used by patients whose headaches are not controlled by other drugs, while some patients do well on other drugs. For example, combinations or ergotamine and **caffeine** may be very effective. The caffeine acts by constricting blood vessels to relieve the **headache**. Sometimes, an analgesic such as **acetaminophen**, caffeine, and a barbiturate which acts as a sedative, are combined, as in Fioricet and similar compounds. These medicines are available only with a physician's prescription and come in several forms. Ergotamine is available as tablets and rectal suppositories; sumatriptan as tablets, injections, and nasal spray; and zolmitriptan as tablets.

Antimigraine drugs are used to treat headaches once they have started. These drugs should not be taken to prevent headaches.

Recommended dosage

Recommended dosage depends on the type of drug. Typical recommended dosages for adults are given below for each type of drug.

Ergotamine

Take at the first sign of a migraine attack. Patients who get warning signals (aura) may take the drug as soon as they know a headache is coming.

TABLETS. No more than six tablets for any single attack.

No more than 10 tablets per week.

SUPPOSITORIES. No more than two suppositories for any single attack.

No more than five suppositories per week.

Naratriptan

Take as soon as pain or other migraine symptoms begin. Also effective if taken any time during an attack. Do not take the drug until the pain actually starts as not all auras result in a migraine.

TABLETS. Usual dose is one 1-mg tablet taken with water or other liquid.

Doses of 2.5-mg may be used, but they may cause more side effects.

If the headache returns or if there is only partial response, the dose may be repeated once after four hours, for a maximum dose of 5 mg in a 24-hour period. Larger doses do not seem to offer any benefit.

Sumatriptan

Take as soon as pain or other migraine symptoms begin. Also effective if taken any time during an attack. Do not take the drug until the pain actually starts as not all auras result in a migraine.

TABLETS. Usual dose is one 25-mg tablet, taken with water or other liquid.

Doses should be spaced at least two hours apart.

Anyone with liver disease should consult with a physician for proper dosing.

INJECTIONS. No more than 6 mg per dose, injected under the skin.

No more than two 6-mg injections per day. These doses should be taken at least 1 hour apart.

Zolmitriptan

Take as soon as symptoms begin.

TABLETS. Usual dose is 1-5 mg. Additional doses may be taken at two-hour intervals.

No more than 10 mg per 24-hour period.

Antimigraine Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Cafergot	Nausea, increased blood pressure, fluid retention, numbness, increased heart rate, tingling sensation
Imitrex (sumatriptan succinate)	Burning, flushing, neck pain, inflammation at injection site, sore throat, tingling sensation
Inderal (propranolol hydrochloride)	Constipation or diarrhea, headache, nausea, rash
Midrin	Dizziness, rash

General dosage advice

Always take antimigraine drugs exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed.

If possible, lie down and relax in a dark, quiet room for a few hours after taking the medicine.

Precautions

These drugs should be used only to treat the type of headache for which they were prescribed. Patients should not use them for other headaches, such as those caused by **stress** or too much alcohol, unless directed to do so by a physician.

Anyone whose headache is unlike any previous headache should check with a physician before taking these drugs. If the headache is far worse than any other, emergency medical treatment should be sought immediately.

Taking too much of the antimigraine drug ergotamine (Cafergot), can lead to ergot **poisoning**. Symptoms include headache, muscle pain, numbness, coldness, and unusually pale fingers and toes. If not treated, the condition can lead to **gangrene** (tissue **death**).

Sumatriptan (Imitrex), naratriptan (Amerge), rizatriptan (Maxalt) and zolmitriptan (Zomig) may interact with ergotamine. These drugs should not be taken within 24 hours of taking any drug containing ergotamine.

Some antimigraine drugs work by tightening blood vessels in the brain. Because these drugs also affect blood vessels in other parts of the body, people with coronary heart disease, circulatory problems, or high blood pressure should not take these medicines unless directed to do so by their physicians.

Special conditions

People with certain other medical conditions or who are taking certain other medicines can have problems if they take antimigraine drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to ergotamine, caffeine, sumatriptan, zolmitriptan, or other antimigraine drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who are pregnant should not take ergotamine (Cafergot). The effects of other antimigraine drugs during **pregnancy** have not been well studied. Any woman who is pregnant or plans to become pregnant should let her physician know before an antimigraine drug is prescribed.

BREASTFEEDING. Some antimigraine drugs can pass into breast milk and may cause serious problems in nursing babies. Women who are breastfeeding should check with their physicians about whether to stop breastfeeding while taking the medicine.

OTHER MEDICAL CONDITIONS. Before using antimigraine drugs, people with any of these medical problems should make sure their physicians know about their conditions:

- coronary heart disease
- angina (crushing chest pain)
- circulatory problems or blood vessel disease
- high blood pressure
- liver problems
- kidney problems
- any infection
- eye problems

USE OF CERTAIN MEDICINES. Taking antimigraine drugs certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are fluid retention, flushing; high blood pressure; unusually fast or slow heart rate; numbness; tingling; **itching**; nausea; vomiting; weakness; neck or jaw pain and stiffness; feelings of tightness, heaviness, warmth, or coldness; **sore throat**; and discomfort of the mouth and tongue.

More serious side effects are not common, but they may occur. If any of the following side effects occur, call a physician immediately:

- tightness in the chest
- bluish tinge to the skin
- cold arms and legs
- signs of gangrene, such as coldness, dryness, and a shriveled or black appearance of a body part
- dizziness
- drowsiness
- shortness of breath or **wheezing**
- skin rash
- swelling of the eyelids or face

Other side effects may occur with any antimigraine drug. Anyone who has unusual symptoms after taking this medicine should get in touch with his or her physician.

Interactions

Antimigraine drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antimigraine drugs are:

- beta blockers such as atenolol (Tenormin) and propranolol (Inderal)
- drugs that tighten blood vessels such as epinephrine (EpiPen) and pseudoephedrine (Sudafed)
- nicotine such as cigarettes or Nicoderm, Habitrol, and other **smoking-cessation drugs**
- certain **antibiotics**, such as erythromycin and clarithromycin (Biaxin)
- monoamine oxidase inhibitors such as phenelzine (Nardil) and tranylcypromine (Parnate)
- certain antidepressants, such as sertraline (Zoloft), fluoxetine (Prozac), and paroxetine (Paxil)
- fluvoxamine (Luvox), prescribed for obsessive compulsive disorder or chronic pain

Remember naratriptan, sumatriptan, rizatriptan and zolmitriptan may interact with ergotamine. These drugs should not be taken within 24 hours of taking any drug containing ergotamine.

Resources

BOOKS

Duckro, Paul N., William D. Richardson, and Janet E. Marshall. *Taking Control of Your Headaches: How to Get the Treatment You Need*. New York, NY: The Guilford Press, 1995.

ORGANIZATIONS

American Council for Headache Education (ACHE). 19 Mantua Road, Mt. Royal, NJ 08061. (800) 255-2243. <http://www.achenet.org>.

National Headache Foundation. 428 W. St. James Place, Chicago, IL 60614. (800) 843-2256. <http://www.headaches.org>.

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov>.

Nancy Ross-Flanigan

KEY TERMS

Aura—A set of warning symptoms, such as seeing flashing lights, that some people have 10-30 minutes before a migraine attack.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Antimyocardial antibody test

Definition

Testing for antimyocardial antibodies is done when evaluating a person for heart damage or heart disease.

Purpose

Antimyocardial antibodies are autoantibodies. Normal antibodies are special proteins built by the body as a defense against foreign material entering the body. Autoantibodies are also proteins built by the body, but instead of attacking foreign material, they inappropriately attack the body's own cells. Antimyocardial antibodies attack a person's heart muscle, or myocardium.

This test may be done on a person who recently had trauma to the heart, such as heart surgery or a myocardial infarction (**heart attack**). It also may be done on someone with heart disease, such as cardiomyopathy or **rheumatic fever**.

Although the presence of antimyocardial antibodies does not diagnose heart damage or disease, there is a connection between the presence of these antibodies and damage to the heart. The amount of damage, however, cannot be predicted by the amount of antibodies.

These antibodies usually appear after heart surgery or the beginning of disease, but they may be present before surgery or the onset of disease. In 30% of people with myocardial infarction and 70% of people having heart surgery, antimyocardial antibodies will appear within two to three weeks and stay for three to eight weeks.

Description

A 5-10 mL sample of venous blood is drawn from the patient's arm in the region of the inner elbow. Antimyocardial antibodies are detected by combining a patient's serum (clear, thin, sticky fluid in blood) with cells from animal heart tissue, usually that of a monkey. Antimyocardial antibodies in the serum bind to the heart tissue cells. A fluorescent dye is then added to the mixture. This dye will attach to any antibodies and heart tissue cells bound together. The final mixture is studied under a microscope that is designed to show fluorescence. If fluorescent cells are seen under the microscope, the test is positive.

When the test is positive, the next step is to find out how much antibody is present. The patient's serum is diluted, or titered, and the test is done again. The serum is then further diluted and the test repeated until the serum is so dilute that fluorescence is no longer seen. The last dilution that showed fluorescence is the titer reported.

Preparation

No **fasting** or special prepartion is needed. Before the test is done it should be explained to the patient.

Aftercare

Discomfort or bruising may occur at the puncture site after the blood is drawn or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs on the puncture site relieve discomfort.

Normal results

Antimyocardial antibodies are not normally seen in healthy individuals.

Abnormal results

A positive result means that antimyocardial antibodies are present and that heart disease or damage is likely. Further testing may be needed as other autoantibodies could also be present, causing a false abnormal test.

Resources

BOOKS

Clinical Diagnosis and Management by Laboratory Methods. 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Mayo Medical Laboratories. *Interpretive Handbook.* Rochester, MN: Mayo Medical Laboratories, 1997.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

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KEY TERMS

Antibody—A special protein built by the body as a defense against foreign material entering the body.

Antimyocardial antibody—An autoantibody that attacks a person's own heart muscle, or myocardium.

Autoantibody—An antibody that attacks the body's own cells or tissues.

Myocardial infarction—A block in the blood supply to the heart, resulting in what is commonly called a heart attack.

Myocardium—The muscular middle layer of the heart.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

Antinausea drugs

Definition

Antinausea drugs are medicines that control nausea—a feeling of sickness or queasiness in the stomach with an urge to vomit. These drugs also prevent or stop vomiting. Drugs that control vomiting are called antiemetic drugs.

Purpose

The drug described here, prochlorperazine (Compazine), controls both **nausea and vomiting**. Prochlorperazine is also sometimes prescribed for symptoms of mental disorders, such as **schizophrenia**.

Description

Prochlorperazine is available only with a physician's prescription. It is sold in syrup, capsule, tablet, injection, and suppository forms.

Antinausea Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Compazine (phochlorperazine)	Involuntary muscle spasms, dizziness, jitteriness, puckering of the mouth
Phenergan (promethazine hydrochloride)	Dizziness, dry mouth, nausea and vomiting, rash
Reglan (metoclopramide hydrochloride)	Fatigue, drowsiness, restlessness
Tigan (trimethobenzamide hydrochloride)	Blurred vision, diarrhea, cramps, headache
Zofan (ondansetron hydrochloride)	Constipation, headache, fatigue, abdominal pain

Recommended dosage

To control nausea and vomiting in adults, the usual dose is:

- tablets: one 5-mg or 10-mg tablet three to four times a day
- extended-release capsules: one 15-mg capsule first thing in the morning or one 10-mg capsule every 12 hours
- suppository: 25 mg, twice a day
- syrup: 5-10 mg three to four times a day
- injection: 5-10 mg injected into a muscle three to four times a day

Doses for children must be determined by a physician.

Precautions

Prochlorperazine may cause a movement disorder called **tardive dyskinesia**. Signs of this disorder are involuntary twitches and muscle spasms in the face and body and jutting or rolling movements of the tongue. The condition may be permanent. Older people, especially women, are particularly at risk of developing this problem when they take prochlorperazine.

Some people feel drowsy, dizzy, lightheaded, or less alert when using this medicine. The drug may also cause blurred vision, and movement problems. For these reasons, anyone who takes this drug should not drive, use machines or do anything else that might be dangerous until they have found out how the drug affects them.

Prochlorperazine makes some people sweat less, which can allow the body to overheat. The drug may also make the skin and eyes more sensitive to the sun. People who are taking prochlorperazine should try to avoid extreme heat and exposure to the sun. When going outdoors, they should wear protective clothing, a hat, a sunscreen with a skin protection factor (SPF) of at least 15, and sunglasses that block ultraviolet (UV) light. Saunas, sunlamps, tanning booths, tanning beds, hot baths, and hot tubs should be avoided while taking this medicine. Anyone who must be exposed to extreme heat while taking the drug should check with his or her physician.

This medicine adds to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold and flu medicines, tranquilizers, sleep aids, anesthetics, some **pain** medicines, and **muscle relaxants**. Do not drink alcohol while taking prochlorperazine, and check with the physician who prescribed the drug before combining it with any other medicines.

Do not stop taking this medicine without checking with the physician who prescribed it. Stopping the drug suddenly can **dizziness**, nausea, vomiting, **tremors**, and other side effects. When stopping the medicine, it may be necessary to taper down the dose gradually.

Prochlorperazine may cause false **pregnancy** tests.

Women who are pregnant (or planning to become pregnant) or breast feeding should check with their physicians before using this medicine.

Before using prochlorperazine, people with any of these medical problems should make sure their physicians are aware of their conditions:

- previous sensitivity or allergic reaction to prochlorperazine
- heart disease
- glaucoma
- brain tumor
- intestinal blockage
- abnormal blood conditions, such as leukemia
- exposure to pesticides.

Side effects

Many side effects are possible with this drug, including, but not limited to, **constipation**, dizziness, drowsiness, decreased sweating, **dry mouth**, stuffy nose, movement problems, changes in menstrual period, increased sensitivity to sun, and swelling or pain in breasts. Anyone who has unusual or troublesome symptoms after taking prochlorperazine should get in touch with his or her physician.

KEY TERMS

Anesthetic—Medicine that causes a loss of feeling, especially pain. Some anesthetics also cause a loss of consciousness.

Antihistamine—Medicine that prevents or relieves allergy symptoms.

Central nervous system—The brain, spinal cord and the nerves throughout the body.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles.

Tranquilizer—Medicine that has a calming effect and is used to treat anxiety and mental tension.

Interactions

Prochlorperazine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with prochlorperazine are antiseizure drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol), anticoagulants such as warfarin (Coumadin), and drugs that slow the central nervous system such as alprazolam (Xanax), diazepam (Valium), and secobarbital (Seconal). Not every drug that interacts with prochlorperazine is listed here. Be sure to check with a physician or pharmacist before taking any other prescription or nonprescription (over-the-counter) drug with Prochlorperazine.

Nancy Ross-Flanigan

Antinuclear antibody test

Definition

The antinuclear antibody (ANA) test is a test done early in the evaluation of a person for autoimmune or rheumatic disease, particularly **systemic lupus erythematosus** (SLE).

Purpose

In autoimmune diseases, the body makes antibodies that work against its own cells or tissues. Rheumatic diseases (diseases that affect connective tissue, including the joints, bone, and muscle) are also associated with these antibodies. Autoantibodies are proteins built by the body, but instead of guarding against foreign material (including bacteria, viruses, and fungi) as normal antibodies do, they attack the body's own cells.

Autoimmune and rheumatic diseases can be difficult to diagnose. People with the same disease can have very different symptoms. A helpful strategy in the diagnosis of these diseases is to find and identify an autoantibody in the person's blood.

The antinuclear antibody test looks for a group of autoantibodies that attack substances found in the center (nucleus) of all cells. It is useful as a screen for many autoantibodies associated with diseases that affect the entire body (systemic diseases).

This test is particularly useful when diagnosing a person with symptoms of SLE, an illness that affects many body organs and tissues. If the test is negative, it is unlikely that the person has SLE; if the test is positive, more tests are done to confirm whether the person has SLE or another related disease. Other diseases, such as **scleroderma**, **Sjögren's syndrome**, **Raynaud's disease**, **rheumatoid arthritis**, and autoimmune hepatitis, often have a positive test for antinuclear antibodies.

Description

Five to 10 mL of blood is needed for this test. The antinuclear antibody test is done by adding a person's serum to commercial cells mounted on a microscope slide. If antinuclear antibodies are in the serum, they bind to the nuclei of cells on the slide. Next, a second antibody is added to the mixture. This antibody is "tagged" with a fluorescent dye so that it can be seen. The second antibody attaches to any antibodies and cells bound together and, because of the fluorescent "tag," the areas with antinuclear antibodies seem to glow, or fluoresce, when the slide is viewed under an ultraviolet microscope.

If fluorescent cells are seen, the test is positive. When positive, the serum is diluted, or titered, and the test done again. These steps are repeated until the serum is so dilute it no longer gives a positive result. The last dilution that shows fluorescence is the titer reported.

The pattern of fluorescence within the cells gives the physician clues as to what the disease might be. The test result includes the titer and the pattern.

This test is also called the fluorescent antinuclear antibody test or FANA. Results are available within one to three days.

Preparation

No special preparations or diet changes are required before a person undergoes an antinuclear antibody test.

KEY TERMS

Antibody—A special protein built by the immune system as a defense against foreign material entering the body.

Autoantibody—An antibody that attacks the body's own cells or tissues.

Antinuclear antibodies—Autoantibodies that attack substances found in the center, or nucleus, of all cells.

Autoimmune disease—Disease in which the body makes antibodies against its own cells or tissues.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

Normal results

Normal results will be negative, showing no antinuclear antibodies.

Abnormal results

A positive test in a person with symptoms of an autoimmune or rheumatic disease helps the physician make a diagnosis. More than 95% of people with SLE have a positive ANA test. Scleroderma has a 60-71% positive rate; Sjögren's disease, 50-60%, and rheumatoid arthritis, 25-30%.

Several factors must be considered when interpreting a positive test. Diseases other than autoimmune diseases can cause autoantibodies. Some healthy people have a positive test. More testing is done after a positive test to identify individual autoantibodies associated with the various diseases.

Resources

BOOKS

Clinical Diagnosis and Management by Laboratory Methods. 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

Lehman, Craig A. *Saunders Manual of Clinical Laboratory Science.* Philadelphia: W. B. Saunders Co., 1998.

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Mayo Medical Laboratories. *Interpretive Handbook.* Rochester, MN: Mayo Medical Laboratories, 1997.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

PERIODICALS

Slater, Cindi S., Roger B. Davis, and Robert H. Shmerling. "Antinuclear Antibody Testing. A Study of Clinical Utility." *Archives of Internal Medicine* (July 1996): 1421-1425.

Ward, Michael M. "Laboratory Testing for Systemic Rheumatic Diseases." *Postgraduate Medicine* (Feb. 1998): 93-100.

Nancy J. Nordenson

Antiparkinson drugs

Definition

Antiparkinson drugs are medicines that relieve the symptoms of **Parkinson's disease** and other forms of parkinsonism.

Purpose

Antiparkinson drugs are used to treat symptoms of parkinsonism, a group of disorders that share four main symptoms: tremor or trembling in the hands, arms, legs, jaw, and face; stiffness or rigidity of the arms, legs, and trunk; slowness of movement (bradykinesia); and poor balance and coordination. Parkinson's disease is the most common form of parkinsonism and is seen more frequently with advancing age. Other forms of the disorder may result from viral infections, environmental toxins, **carbon monoxide poisoning**, and the effects of treatment with **antipsychotic drugs**.

The immediate cause of Parkinson's disease or Parkinsonian-like syndrome is the lack of the neurotransmitter dopamine in the brain. Drug therapy may take several forms, including replacement of dopamine, inhibition of dopamine metabolism to increase the effects of the dopamine already present, or sensitization of dopamine receptors. Drugs may be used singly or in combination.

Description

Levodopa (Larodopa) is the mainstay of Parkinson's treatment. The drug crosses the blood-brain barrier, and is converted to dopamine. The drug may be administered alone, or in combination with carbidopa (Lodosyn) which

Antiparkinson Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Artane (trihexyphenidyl hydrochloride)	Dry mouth, nervousness, blurred vision, nausea
Benadryl (diephenhydramine hydrochloride)	Dizziness, sleepiness, upset stomach, decreased coordination
Cogentin (benztropine mesylate)	Constipation, dry mouth, nausea and vomiting, rash
Eldepryl (selegiline hydrochloride)	Abdominal and back pain, drowsiness, decreased coordination
Parlodel (bromocriptine mesylate)	Constipation, decreased blood pressure, abdominal cramps
Sinemet CR	Involuntary body movements, confusion, nausea, hallucinations

inhibits the enzyme responsible for the destruction of levodopa. The limitation of levodopa or levodopa-carbidopa therapy is that after approximately two years of treatment, the drugs cease to work reliably. This has been termed the "on-off phenomenon." Additional treatment strategies have been developed to retard the progression of Parkinsonism, or to find alternative approaches to treatment.

Anticholinergic drugs reduce some of the symptoms of Parkinsonism, and reduce the reuptake of dopamine, thereby sustaining the activity of the natural neurohormone. They may be effective in all stages of the disease. All drugs with anticholinergic properties, the naturally occurring belladonna alkaloids (atropine, scopolamine, hyoscyamine), some **antihistamines** with anticholinergic properties, and synthetics such as benztropin (Cogentin), procyclidine (Kemadrin) and biperiden (Akineton) are members of this group. Although the anticholinergic drugs have only limited activity against Parkinson's disease, they are useful in the early stages, and may be adjuncts to levodopa as the disease progresses.

Amantadine (Symmetrel), was developed for prevention of **influenza** virus infection, but has anti-Parkinsonian properties. Its mechanism of action is not known.

Bromocriptine (Parlodel) is a prolactin inhibitor, which is used for a variety of indications including amenorrhea/galactorrhea, female **infertility**, and acromegaly. It appears to work by direct stimulation of the dopamine receptors. Bromocriptine is used as a late adjunct to levodopa therapy, and may permit reduction in levodopa dosage. Pergolide (Permax) is similar to bromocriptine, but has not been studied as extensively in Parkinson's disease.

Entacapone (Comtan) appears to act by maintaining levels of dopamine through enzyme inhibition. It is used as an adjunct to levodopa was the patient is beginning to experience the on-off effect. Tolcapone (Tasmar) is a similar agent, but has demonstrated the potential for inducing severe liver failure. As such, tolcapone is reserved for cases where all other adjunctive therapies have failed or are contraindicated.

Selegeline (Carbex, Eldepryl) is a selective monoamine oxidase B (MAO-B) inhibitor, however its mechanism of action in Parkinsonism is unclear, since other drugs with MAO-B inhibition have failed to show similar anti-Parkinsonian effects. Selegeline is used primarily as an adjunct to levodopa, although some studies have indicated that the drug may be useful in the early stages of Parkinsonism, and may delay the progression of the disease.

Pramipexole (Mirapex) and ropinirole (Requip) are believed to act by direct stimulation of the dopamine receptors in the brain. They may be used alone in early Parkison's disease, or as adjuncts to levodopa in advanced stages.

Recommended dosage

Dosages of anti-Parkinsonian medications must be highly individualized. All doses must be carefully titrated. Consult specific references.

Precautions

There are a large number of drugs and drug classes used to treat Parkinson's disease, and individual references should be consulted.

The anticholinergics have a large number of adverse effects, all related to their primary mode of activity. Their cardiovascular effects include tachycardia, **palpitations**, **hypotension**, postural hypotension, and mild bradycardia. They may also cause a wide range of central nervous system effects, including disorientation, confusion, memory loss, **hallucinations**, psychoses, agitation, nervousness, **delusions**, **delirium**, **paranoia**, euphoria, excitement, lightheadedness, **dizziness**, **headache**, listlessness, depression, drowsiness, weakness, and giddiness. **Dry mouth**, dry eyes and gastrointestinal distress are common problems. **Sedation** has been reported with some drugs in this group, but this may be beneficial in patients who suffer from **insomnia**. **Pregnancy** risk factor is C. Because anticholinergic drugs may inhibit milk production, their use during breastfeeding is not recommended. Patients should be warned that anticholinergic

KEY TERMS

Anorexia—Lack or loss of appetite.

Anticholigerginc—An agent that blocks the parasympathetic nerves and their actions.

Bradykinesia—Extremely slow movement.

Bruxism—Compulsive grinding or clenching of the teeth, especially at night.

Carbon monoxide—A colorless, odorless, highly poisonous gas.

Central nervous system—The brain, spinal cord and nerves throughout the body.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Heat stroke—A severe condition caused by prolonged exposure to high heat. Heat stroke interferes with the body's temperature regulating abilities and can lead to collapse and coma.

Parkinsonism—A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Seizure—A sudden attack, spasm, or convulsion.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles.

Tremor—Shakiness or trembling.

medications will inhibit perspiration, and so **exercise** during periods of high temperature should be avoided.

Levodopa has a large number of adverse effects. Anorexia, loss of appetite, occurs in roughly half the patients using this drug. Symptoms of gastrointestinal upset, such as **nausea and vomiting**, have been reported in 80% of cases. Other reported effects include increased hand tremor; headache; dizziness; numbness; weakness and faintness; **bruxism**; confusion; insomnia; nightmares; hallucinations and delusions; agitation and **anxiety**; malaise; **fatigue** and euphoria. Levodopa has not been listed under the pregnancy risk factor schedules, but should be used with caution. Breastfeeding is not recommended.

Amantadine is generally well tolerated, but may cause dizziness and nausea. It is classified as pregnancy schedule C. Since amantadine is excreted in breast milk, breastfeeding while taking amantidine is not recommended.

Pergolide and bromocriptine have been generally well tolerated. **Orthostatic hypotension** are common problems, and patients must be instructed to risk slowly from bed. This problem can be minimized by low initial doses with small dose increments. Hallucinations may be a problem. Bromocriptine has not been evaluated for pregnancy risk, while pergolide is category B. Since both drugs may inhibit **lactation**, breastfeeding while taking these drugs is not recommended.

Pramipexole and ropinirole cause orthostatic hypotension, hallucinations and dizziness. The two drugs are in pregnancy category C. In animals, ropinirole has been shown to have adverse effects on embryo-fetal development, including teratogenic effects, decreased fetal body weight, increased fetal **death** and digital malformation. Because these drugs inhibit prolactin secretion, they should not be taken while breastfeeding.

Side effects

The most common side effects are associated with the central nervous system, and include dizziness, lightheadedness, mood changes and hallucinations. Gastrointestinal problems, including nausea and vomiting, are also common.

Interactions

All anti-Parkinsonian regimens should be carefully reviewed for possible drug interactions. Note that combination therapy with anti-Parkinsonian drugs is, in itself, use of additive and potentiating interactions between

drugs, and so careful dose adjustment is needed whenever a drug is added or withdrawn.

Resources

ORGANIZATIONS

American Parkinson Disease Association. 60 Bay Street, Suite 401, Staten Island, NY 10301. (800) 223-2732.

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (800) 352-9424.

National Parkinson Foundation, Inc. 1501 N.W. 9th Avenue, Miami, FL 33136-1494. (800) 327-4545.

Samuel Uretsky, PharmD

Antiplatelet drugs *see* **Anticoagulant and antiplatelet drugs**

Antiprotozoal drugs

Definition

Antiprotozoal drugs are medicines that treat infections caused by protozoa.

Purpose

Antiprotozoal drugs are used to treat a variety of diseases caused by protozoa. Protozoa are animal-like, one-celled animals, such as amoebas. Some are parasites that cause infections in the body. African **sleeping sickness**, **giardiasis**, **amebiasis**, *Pneumocystis carinii* **pneumonia** (PCP), and **malaria** are examples of diseases caused by protozoa.

Description

Antiprotozoal drugs come in liquid, tablet, and injectable forms and are available only with a doctor's prescription. Some commonly used antiprotozoal drugs are metronidazole (Flagyl), eflornithine (Ornidyl), furazolidone (Furoxone), hydroxychloroquine (Plaquenil), iodoquinol (Diquinol, Yodoquinol, Yodoxin), and pentamidine (Pentam 300).

Recommended dosage

The recommended dosage depends on the type of antiprotozoal drug, its strength, and the medical problem for which it is being used. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage. Always take antiprotozoal drugs exactly as directed.

Precautions

Some people feel dizzy, confused, lightheaded, or less alert when using these drugs. The drugs may also cause blurred vision and other vision problems. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

The antiprotozoal drug furazolidone may cause very dangerous side effects when taken with certain foods or beverages. Likewise, metronidazole (Flagyl) can cause serious liver damage if taken with alcohol. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for a list of products to avoid while taking these medicines.

Anyone who has ever had unusual reactions to antiprotozoal drugs or related medicines should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Some antiprotozoal drugs may cause problems with the blood. This can increase the risk of infection or excessive bleeding. Patients taking these drugs shouldbe careful not to injure their gums when brushing or flossing their teeth or using a toothpick. They shouldcheck with the physician before having any dentalwork done. Care should also be taken to avoidcuts from razors, nail clippers, or kitchen knives, orhousehold tools. Anyone who has any of these symptoms while taking antiprotozoal drugs should call the physician immediately:

- fever or chills
- signs of cold or flu
- signs of infection, such as redness, swelling, or inflammation
- unusual bruising or bleeding
- black, tarry stools
- blood in urine or stools
- pinpoint red spots on the skin
- unusual tiredness or weakness.

Anyone taking this medicine should also check with a physician immediately if any of these symptoms occur:

- blurred vision or other vision changes
- skin rash, **hives**, or **itching**
- swelling of the neck
- clumsiness or unsteadiness
- numbness, tingling, **pain**, or weakness in the hands or feet
- decrease in urination

Children are especially sensitive to the effects of some antiprotozoal drugs. *Never give this medicine to a child unless directed to do so by a physician, and always keep this medicine out of the reach of children. Use safety vials.*

The effects of antiprotozoal drugs on pregnant women have not been studied. However, in experiments with pregnant laboratory animals, some antiprotozoal drugs cause **birth defects** or **death** of the fetus. Women who are pregnant or who plan to become pregnant should check with their physicians before taking antiprotozoal drugs. Mothers who are breastfeeding should also check with their physicians about the safety of taking these drugs.

Before using antiprotozoal drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- anemia or other blood problems
- kidney disease
- heart disease
- low blood pressure
- diabetes
- hypoglycemia (low blood sugar)
- liver disease
- stomach or intestinal disease
- nerve or brain disease or disorder, including convulsions (seizures)
- psoriasis (a skin condition)
- hearing loss
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD)
- eye or vision problems
- thyroid disease

Side effects

The most common side effects are **diarrhea**, nausea, vomiting, and stomach pain. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

Other rare side effects may occur. Anyone who has unusual symptoms after taking an antiprotozoal drug should get in touch with his or her physician.

Interactions

Antiprotozoal drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antiprotozoal drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antiprotozoal drugs are:

- alcohol
- anticancer drugs
- medicine for overactive thyroid
- antiviral drugs such as zidovudine (Retrovir)
- antibiotics
- medicine used to relieve pain or inflammation
- amphetamine
- diet pills (appetite suppressants)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate), used to treat conditions including depression and **Parkinson's disease**
- tricyclic antidepressants such as amitriptyline (Elavil) and imipramine (Tofranil)
- decongestants such as phenylephrine (Neo-Synephrine) and pseudoephedrine (Sudafed)
- other antiprotozoal drugs

The list above does not include every medicine that may interact with an antifungal drug. Be sure to check with a physician or pharmacist before combining antifungal drugs with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

KEY TERMS

Amebiasis—An infection caused by an ameba, which is a type of protozoan.

Fetus—A developing baby inside the womb.

Giardiasis—A condition in which the intestines are infected with *Giardia lamblia*, a type of protozoan.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Parasite—An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

***Pneumocystis carinii* pneumonia**—A severe lung infection caused by a parasitic protozoan. The disease mainly affects people with weakened immune systems, such as people with AIDS.

Antipruritic drugs *see* **Anti-itch drugs**

Antipsychotic drugs

Definition

Antipsychotic drugs are a class of medicines used to treat **psychosis** and other mental and emotional conditions.

Purpose

Psychosis is defined as "a serious mental disorder (as **schizophrenia**) characterized by defective or lost contact with reality often with **hallucinations** or delusions." Psychosis is an end-stage condition arising from a variety of possible causes. Anti-psychotic drugs control the symptoms of psychosis, and in many cases are effective in controlling the symptoms of other disorders that may lead to psychosis, including bipolar mood disorder (formerly termed manic-depressive), in which the patient cycles from severe depression to feelings of extreme excitation. This class of drugs is primarily composed of the major tranquilizers; however, lithium carbonate, a drug that is largely specific to bipolar mood disorder, is commonly classified among the antipsychotic agents.

Description

The antipsychotic agents may be divided by chemical class. The phenothiazines are the oldest group, and include chlorpromazine (Thorazine), mesoridazine (Serentil), prochlorperazine (Compazine), and thioridazine (Mellaril). These drugs are essentially similar in action and adverse effects. They may also be used as anti-emetics, although prochlorperazine is the drug most often used for this indication.

The phenylbutylpiperadines are haloperidol (Haldol) and pimozide (Orap). They find primary use in control of Tourette's syndrome. Haloperidol has been extremely useful in controlling aggressive behavior.

The debenzapine derivatives, clozapine (Clozaril), loxapine (Loxitane), olanzapine (Zyprexa) and quetiapine (Seroquel), have been effective in controlling psychotic symptoms that have not been responsive to other classes of drugs.

The benzisoxidil group is composed of resperidone (Resperidal) and ziprasidone (Geodon). Resperidone has been found useful for controlling bipolar mood disorder, while ziprasidone is used primarily as second-line treatment for schizophrenia.

In addition to these drugs, the class of antipsychotic agents includes lithium carbonate (Eskalith, Lithonate), which is used for control of bipolar mood disorder, and thiothixene (Navane), which is used in the treatment of psychosis.

Recommended dosage

Dose varies with the drug, condition being treated, and patient response. See specific references.

Precautions

Neuroleptic malignant syndrome (NMS). NMS is a rare, idiosyncratic combination of extra-pyramidal symptoms (EPS), hyperthermia, and autonomic disturbance. Onset may be hours to months after drug initiation, but once started, proceeds rapidly over 24 to 72 hours. It is most commonly associated with haloperidol, long-acting fluphenazine, but has occurred with thiothixene, thioridazine, and clozapine, and may occur with other agents. NMS is potentially fatal, and requires intensive symptomatic treatment and immediate discontinuation of neuroleptic treatment. There is no established treatment. Most patients who develop NMS will have the same problem if the drug is restarted.

Tardive dyskinesia (TD). Tardive dyskinesia is a syndrome of involuntary movements that may appear in patients treated with neuroleptic drugs. Although prevalence of TD appears highest among the elderly, especially women, it is impossible to predict which patients are likely to develop the syndrome. Both the risk of developing TD and the likelihood that it will become irreversible are increased with higher doses and longer periods of treatment. The syndrome can develop after short treatment periods at low doses. Anticholinergic agents may worsen these effects. Clozapine has occasionally been useful in controlling the TD caused by other antipsychotic drugs.

Agranulocytosis has been associated with clozapine. This is a potentially fatal reaction, but can be prevented with careful monitoring of the white **blood count**. There are no well-established risk factors for developing agranulocytosis, and so all patients treated with this drug must follow the clozapine Patient Management System. For more information, call 1-800-448-5938.

Anticholinergic effects, particularly **dry mouth**, have been reported with all of the phenothiazines, and can be severe enough to cause patients to discontinue their medication.

Photosensitization is a common reaction to chlorpromazine. Patients must be instructed to use precautions when exposed to sunlight.

Antipsychotic Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Clozaril (clozapine)	Seizures, agranulocytosis, dizziness, increased blood pressure
Compazine (prochlorperazine)	Involuntary muscle spasms, dizziness, jitteriness, puckering of the mouth
Haldol (haloperidol)	Involuntary muscle spasms, blurred vision, dehydration, headache, puckering of the mouth
Mellaril (thioridazine)	Involuntary muscle spasms, constipation and diarrhea, sensitivity to light
Navane (thiothixene)	Involuntary muscle spasms, dry mouth, rash, hives
Risperdal (risperidone)	Involuntary muscle spasms, abdominal and chest pain, fever, headache
Stelazine (trifluoperazine hydrochloride)	Involuntary muscle spasms, drowsiness, fatigue
Thorazine (chlorpromazine)	Involuntary muscle spasms, labored breathing, fever, puckering of the mouth
Triavil	Involuntary muscle spasms, disorientation, excitability, lightheadedness

Lithium carbonate commonly causes increased frequency of urination.

Antipsychotic drugs are **pregnancy** category C. (Clozapine is category B.) The drugs in this class appear to be generally safe for occasional use at low doses during pregnancy, but should be avoided near time of delivery. Although the drugs do not appear to be teratogenic, when used near term, they may cross the placenta and have adverse effects on the newborn infant, including causing involuntary movements. There is no information about safety in breast feeding.

As a class, the antipsychotic drugs have a large number of potential side effects, many of them serious. Specific references should be consulted.

Interactions

Because the phenothiazines have anticholinergic effects, they should not be used in combination with other drugs that may have similar effects.

Because the drugs in this group may cause **hypotension**, or low blood pressure, they should be used with extreme care in combination with blood pressure-lowering drugs.

The antipsychotic drugs have a large number of drug interactions. Consult specific references.

Samuel D. Uretsky, PharmD

Antipsychotic drugs, atypical

Definition

The atypical antipsychotic agents, sometimes called the "novel" antipsychotic agents are a group of drugs which are different chemically from the older drugs used to treat **psychosis**. The "conventional" **antipsychotic drugs** are classified by their chemical structures as the phenothiazines, thioxanthines (which are chemically very similar to the phenothiazines), butyrophenones, diphenylbutylpiperadines and the indolones. All of the atypical antipsychotic agents are chemically classified as dibenzepines. They are considered *atypical* or *novel* because they have different side effects from the conventional antipsychotic agents. The atypical drugs are far less likely to cause extra-pyrammidal side-effects(EPS), drug induced involuntary movements, than are the older drugs. The atypical antipsychotic drugs may also be effective in some cases that are resistant to older drugs.

The drugs in this group are clozapine (Clozaril), loxapine (Loxitane), olanzapine (Zyprexa), and quetiapine (Seroquel).

Purpose

The antipsychotic drugs are used to treat severe emotional disorders. Although there may be different names for these disorders, depending on severity and how long the symptoms last, psychotic disorders all cause at least one of the following symptoms:

- delusions
- **hallucinations**
- disorganized speech
- grossly disorganized or catatonic behavior

Loxapine has also been used to treat **anxiety** with mental depression.

Recommended dosage

The recommended dose depends on the drug, the patient, and the condition being treated. The normal practice is to start each patient at a low dose, and gradually increase the dose until a satisfactory response is achieved. The odse should be held at the lowest level that gives satisfactory results.

Clozapine usually requires doses between 300 and 600 milligrams a day, but some people require as much as 900 milligrams/day. Doses higher than 900 millgrams/day are not recommended.

Loxapine is usually effective at doses of 60-100 milligrams/day, but may be used in doses as high as 250 mg/day if needed.

Olanzapine doses vary with the condition being treated. The usual maximum dose is 20 milligrams/day.

Quetiapine may be dosed anywhere from 150-750 milligrams/day, depending on how well the patient responds.

Precautions

Although the atypical antipsychotics are generally safe, clozapine has been associated with severe agranulocytosis, a shortage of white blood cells. For this reason, people who may be treated with clozapine should have blood counts before starting the drug, blood counts every week for as long as they are using clozapine, and blood counts every week for the first four weeks after they stop taking clozapine. If there is any evidence of a drop in the white **blood count** while using clozapine, the drug should be stopped.

Atypical antipsychotics should not be used in patients with liver damage, brain or circulatory problems, or some types of blood problems.

Allergies

People who have had an allergic reaction to one of the atypical antipsychotics should not use that medication again. However, sometimes it is possible to use a different drug from the same group safely.

Pregnancy

The atypical antipsychotics have not been proved safe in **pregnancy**. They should be used only when clearly needed and when potential benefits outweigh potential hazards to the fetus. These drugs have not been reported in human milk.

Side effects

Although the atypical antipsychotics are less likely to cause involuntary movements than the older antipsychotic drugs, they still have a large number of adverse effects. The following list is not complete. Review each drug individually for a full list of possible adverse effects.

- chest pain
- high blood pressure
- low blood pressure
- fast heart beat
- aggitation
- memory loss
- confusion
- dizziness
- tiredness
- headache
- sleep disturbances
- stuttering
- dry skin
- nausea
- constipation
- fever
- weight gain
- visual disturbances

KEY TERMS

Anxiety—An abnormal and overwhelming sense of apprehension and fear often marked by physiological signs (as sweating, tension, and increased pulse), by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope with it.

Delusions—A false belief regarding the self or persons or objects outside the self that persists despite the facts.

Depression—A state of being depressed marked especially by sadness, inactivity, difficulty with thinking and concentration, a significant increase or decrease in appetite and time spent sleeping, feelings of dejection and hopelessness, and sometimes suicidal thoughts or an attempt to commit suicide.

Glucocorticoid—Any of a group of corticosteroids (as hydrocortisone or dexamethasone) that are anti-inflammatory and immunosuppressive, and that are used widely in medicine (as in the alleviation of the symptoms of rheumatoid arthritis).

Psychosis—A serious mental disorder characterized by defective or lost contact with reality often with hallucinations or delusions.

Interactions

Taking atypical antipsychotic medications with certain other drugs may affect the way the drugs work or may increase the chance of side effects. While taking antipsychotic drugs, do not take any other prescription or

nonprescription (over-the-counter) drugs without first checking with a physician.

Because the atypical antipsychotics may cause lowering of blood pressure, care should be used when these drugs are taken at the same time as other drugs which lower blood pressure.

Quetiapine has many interactions. Doses should be carefully adjusted when quetiapine is used with ketoconazole, itraconazole, fluconazole, erythromycin, carbamazepine, **barbiturates**, rifampin or glucocorticoids including prednisone, dexamethasone and methylprednisolone.

These drugs will also require dose adjustments when used with **antiparkinson drugs**.

Resources

BOOKS

Brain Basics: An Integrated Biological Approach to Understanding and Assessing Human Behavior. Phoenix: Biological-Psychiatry-Institute, June 1999.

Contemporary Treatment of Psychosis: Healing Relationships in the "Decade of the Brain." Northvale: Jason-Aronson-Publishers, May 1996.

PERIODICALS

McDougle, C. J. "A double-blind, placebo-controlled study of risperidone addition in serotonin reuptake inhibitor-refractory obsessive-compulsive disorder." *Archives of General Psychiatry* (August 2000): 794.

Samuel David Uretsky, PharmD

Antiretroviral drugs

Definition

Antiretroviral drugs inhibit the reproduction of retroviruses—viruses composed of RNA rather than DNA. The best known of this group is HIV, human **immunodeficiency** virus, the causative agent of **AIDS**.

Purpose

Antiretroviral agents are virustatic agents which block steps in the replication of the virus. The drugs are not curative; however continued use of drugs, particularly in multi-drug regimens, significantly slows disease progression.

Description

There are three main types of antiretroviral drugs, although only two steps in the viral replications process are blocked. Nucleoside analogs, or nucleoside reverse transcriptase inhibitors (NRTIs), such as didanosine (ddI, Videx), lamivudine (3TC, Epivir), stavudine (d4T, Zerit), zalcitabine (ddC, Hivid), and zidovudine (AZT, Retrovir), act by inhibiting the enzyme reverse transcriptase. Because a retrovirus is composed of RNA, the virus must make a DNA strand in order to replicate itself. Reverse transcriptase is an enzyme that is essential to making the DNA copy. The nucleoside reverse transcriptase inhibitors are incorporated into the DNA strand. This is a faulty DNA molecule which is incapable of reproducing.

The **non-nucleoside reverse transcriptase inhibitors** (NNRTIs), such as delavirdine (Rescriptor), loviride, and nevirapine (Viramune) act by binding directly to the reverse transcriptase molecule, inhibiting its activity.

Protease inhibitors, such as indinavir (Crixivan), nelfinavir (Viracept), ritonavir (Norvir), and saquinavir (Invirase) act on the enzyme protease, which is essential for the virus to break down the proteins in infected cells. Without this essential step, the virus produces immature copies of itself, which are non-infectious.

Because HIV mutates readily, the virus can develop resistance to single drug therapy. However, treatment with drug combinations appears to produce a durable response. Proper treatment appears to slow the progression of HIV infections and reduce the frequency of opportunistic infections.

Recommended dosage

Doses must be individualized based on the patient, and use of interacting drugs. The optimum combinations of antiretroviral drugs have not been determined, nor is there agreement on the stage of infection at which to start treatment.

Precautions

Although the antiretroviral drugs fall into three groups, each drug has a unique pattern of adverse effects and drug interactions. Since the drugs are used in various combinations, the frequency and severity of adverse effects will vary with the combination. Although most drug combinations show a higher rate of adverse events that single drug therapy, some patterns are not predictable. For example, indinavir has been reported to cause **insomnia** in 3% of patients, however, when used in combination with zidovudine, only 1.5% of patients complained of sleep difficulties.

The most severe adverse effects associated with the protease inhibitors are renal and hepatic toxicity. Patients have also reported a syndrome of abdominal distention

KEY TERMS

Antiviral drugs—Medicines that cure or control virus infections.

Bioavailability—A measure of the amount of drug that is actually absorbed from a given dose.

Immune system—The body's natural defenses against disease and infection.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Insomnia—A sleep disorder characterized by inability to either fall asleep or to stay asleep.

Mutates—Undergoes a spontaneous change in the make-up of genes or chromosomes.

Pancreas—A gland located beneath the stomach. The pancreas produces juices that help break down food and secretes insulin that helps the body use sugar for energy.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Retrovirus—A virus composed of ribonucleic acid (RNA) instead of deoxynucleic acid (DNA).

Virus—A tiny, disease-causing particle that can reproduce only in living cells.

and increased body odor, which may be socially limiting. Hemophilic patients have reported increased bleeding tendencies while taking protease inhibitors. The drugs are **pregnancy** category B. There have been no controlled studies of safety in pregnancy. HIV-infected mothers are advised not to breast feed in order to prevent transmission of the virus to the newborn.

The nucleoside reverse transcriptase inhibitors have significant levels of toxicity. Lactic acidosis in the absence of hypoxemia and severe hepatomegaly with steatosis have been reported with zidovudine and zalcitabine, and are potentially fatal. Rare cases of hepatic failure, considered possibly related to underlying **hepatitis B** and zalcitabine monotherapy, have been reported.

Abacavir has been associated with fatal hypersensitivity reactions. Didanosine has been associated with severe **pancreatitis**. Nucleoside reverse transcriptase inhibitors are pregnancy category C. There is limited information regarding safety during pregnancy. Zidovudine has been used during pregnancy to reduce the risk of HIV infection to the infant. HIV-infected mothers are advised not to breastfeed in order to prevent transmission of the virus to the newborn.

Efavirenz has been associated with a high frequency of skin rash, 27% in adults and 40% in children. Nevirapine has been associated with severe liver damage and skin reactions. All of the non-nucleoside reverse transcriptase inhibitors are pregnancy category C, based on animal studies.

Because of the high risk of viral resistance development, antiretroviral agents should be used in combination. If one drug in the group must be discontinued, it is recommended that all antiretroviral therapy be discontinued until a multi-drug regimen can be resumed. The non-nucleoside reverse transcriptase inhibitors particularly should not be used alone.

Interactions

Because of the high frequency of drug interactions associated with AIDS therapy, specialized references should be consulted.

Saquinavir is marketed in both hard and soft gelatin capsules. Because saquinavir in the hard gelatin capsule formulation (Invirase) has poor bioavailability, it is recommended that this formulation only be used in combination with other drugs which interact to raise saquinavir blood levels. Saquinavir soft gelatin capsules (Fortovase) are the preferred dosage form of this drug.

Resources

PERIODICALS

Lipsky, James J. "Antiretroviral Drugs for AIDS." *The Lancet* 348 (September 21, 1996): 800.

Williams, Ann B. "New Horizons: Antiretroviral Therapy in 1997." *Journal of the Association of Nurses in AIDS Care* 8 (July-August 1997): 26.

ORGANIZATIONS

Project Inform. 205 13th Street, #2001, San Francisco, CA 94103. (415) 558-8669. <http://www.projinf.org>.

OTHER

AIDS Clinical Trials Information Service website and telephone information line. Sponsored by Centers for Disease Control and Prevention, Food and Drug Administration, National Institute of Allergy and Infectious Diseases, and National Library of Medicine. 800-TRIALS-A (800-874-2572). <http://actis.org>.

HIV/AIDS Treatment Information Service website and telephone information line. Sponsored by Agency for Health Care Policy and Research, Centers for Disease Control and Prevention, Health Resources and Services Administration, Indian Health Service, National Institutes of Health, and Substance Abuse and Mental Health Services Administration. 800-HIV-0440 (800-448-0440). <http://www.hivatis.org>.

Project Inform National HIV/AIDS Treatment Hotline. 800-822-7422.

Samuel Uretsky, PharmD

Antirheumatic drugs

Definition

Antirheumatic drugs are drugs used to treat **rheumatoid arthritis**.

Purpose

Rheumatoid arthritis is a progressive form of arthritis that has devastating effects on joints and general health. It is classified as an auto-immune disease, because the disease is caused by the body's own immune system acting against the body itself. Symptoms include painful, stiff, swollen joints, **fever**, **fatigue**, and loss of appetite.

In recent years, there has been a change in attitude concerning the treatment of rheumatoid arthritis. Physicians now use Disease Modifying Anti-Rheumatic Drugs (DMARDs) early in the history of the disease and are less inclined to wait for crippling stages before resorting to the more potent drugs. Fuller understanding of the side-effects of non-steroidal anti-inflammatory drugs (NSAIDs) has also stimulated reliance on other types of antirheumatic drugs.

Description

The major classes of antirheumatic drugs include:

- Nonsteroidal Anti-Inflammatory Drugs (NSAIDs. Drugs belonging to this class bring symptomatic relief of both inflammation and **pain**, but have a limited effect on the progressive bone and cartilage loss associated with rheumatoid arthritis. They act by slowing the body's production of prostaglandins. Common NSAIDs include: ibuprofen (Motrin, Nuprin or Advil), naproxen (Naprosyn, Aleve) and indomethacin(Indocin).
- **Corticosteroids**. These drugs are very powerful anti-inflammatory agents. They are the synthetic analogs of cortisone, produced by the body. Corticosteroids are used to reduce inflammation and suppress activity of the immune system. The most commonly prescribed are prednisone and dexamethasone.
- Disease Modifying Anti-Rheumatic Drugs (DMARDs). DMARDs influence the disease process itself and do not only treat symptoms, hence their name. DMARDs also have anti-inflammatory effects, and most were borrowed from the treatment of other diseases, such as **cancer** and **malaria**. Antimalarials DMARDs include chloroquine (Aralen) and hydroxychloroquine (Plaquenil). Powerful DMARDs include: methotrexate (Rheumatrex), sulfasalazine, cyclosporine, azathioprine (Imuran) and cyclophosphamide (Cytoxan), azathioprine, sulfasalazine, penicillamine, and organic gold compounds such as aurothioglucose (Solganol), gold sodium thiomalate (Aurolate) and auranofin (Ridaura).
- Slow-Acting Antirheumatic Drugs (SAARDs). SAARDs are a special class of DMARDs and the effect of these drugs is slow acting and not so quickly apparent as that of the NSAIDs. Examples are hydroxychloroquine and aurothioglucose.
- Immunosuppresive cytotoxic drugs. This class of drugs is used if treatment with NSAIDs and SAARDs have no effect. Immunosuppresive drugs have a stabilizing effect on the immune system. Since the inflammation associated with chronic arthritis is due to malfunctions of the immune system, use of this class of drugs has been shown to be beneficial for the treatment of rheumatoid arthritis as well. Examples are: methotrexate, mechlorethamine, cyclophosphamide, chlorambucil, and azathioprine.

Recommended dosage

Recommended dosage depends on the type of drug. The prescribing physician or the pharmacist provide information for the correct dosage. The drugs must be taken exactly as directed.

When taking methotrexate for rheumatoid arthritis, it should be taken only *once or twice a week as prescribed,* not every day. Taking it every day can lead to a fatal overdose.

Precautions

Many antirheumatic drugs such as, for example, azathioprine (Imuran) and methotrexate (Rheumatrex), are very

KEY TERMS

Anti-inflammatory drugs—A class of drugs that lower inflammation and that includes NSAIDs and corticosteroids.

Arthritis—A painful condition that involves inflammation of one or more joints.

Conception—The union of egg and sperm to form a fetus.

Corticosteroids—A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

Cortisone—Glucocorticoid produced by the adrenal cortex in response to stress. Cortisone is a steroid and has anti-inflammatory and immunosuppressive properties.

Cytotoxic drugs—Drugs that function by destroying cells.

Disease Modifying Anti-Rheumatic Drugs (DMARDs)—A class of drugs that function by.

Inflammation—A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in disorders such as arthritis and causes harmful effects.

Inflammatory—Pertaining to inflammation.

Immune response—Physiological response of the body controlled by the immune system that involves the production of antibodies to fight off specific foreign substances or agents (antigens).

Immune system—The sum of the defence mechanisms of the body that protects it against foreign substances and organisms causing infection.

Immunosuppressive—Any agent that suppresses the immune response of an individual.

Immunosuppresive cytotoxic drugs—A class of drugs that function by destroying cells and suppressing the immune response.

Methotrexate—A drug that interferes with cell growth and is used to treat rheumatoid arthritis as well as various types of cancer. Side-effects may include mouth sores, digestive upsets, skin rashes, and hair loss.

Non steroidal—Not containing steroids or cortisone. Usually refers to a class of drugs called Non Steroidal Anti-Inflammatory Drugs (NSAID).

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs)—A class of drugs that is used to relieve pain, and symptoms of inflammation, such as ibuprofen and ketoprofen.

Osteoarthritis—A form of arthritis that occurs mainly in older people and involves the gradual degeneration of the cartilage of the joints.

Prostaglandins—Prostaglandins are produced by the body and are responsible for inflammation features, such as swelling, pain, stiffness, redness and warmth.

powerful drugs. They are usually prescribed in severe cases, when all other treatments have failed. Thus, they may have serious side effects, so it is important to be monitored closely by a physician while taking any of these drugs.

Side effects

Hydroxychloroquine (Plaquenil) may cause vision problems. Anyone taking it should see an ophthalmologist (a physician who specializes in treating eyes) for a thorough **eye examination** every six months.

Methotrexate and penicillamine may cause **birth defects**. Women taking these drugs must stop taking them during **pregnancy** and for several months before a planned pregnancy. Methotrexate may also cause lung damage or fertility problems and should not be taken by anyone with serious kidney or liver disease or by anyone who drinks alcohol.

Azathioprine may cause birth defects if either the man or woman is using it at the time of conception. Anyone who uses this drug and is sexually active should consult with a physician about an effective birth control method.

Other common side effects of antirheumatic drugs include abdominal cramps, **diarrhea**, **dizziness**, loss of appetite, **headache**, nausea, vomiting, fever and chills, and mouth sores. A variety of other side effects may occur. Anyone who has unusual symptoms while taking antirheumatic drugs should notify the treating physician.

The gold compounds may cause serious blood problems by reducing the ability of the blood forming organs to produce blood cells. These drugs may decrease the number

of white blood cells, red blood cells, or both. Patients taking these drugs should have regular blood counts.

Entanercept (Enbrel) may also cause blood problems, and some patients who received this drug have developed eye problems and **multiple sclerosis**. It is not certain whether these reactions were caused by entanercept, but multiple sclerosis has been seen in patients taking other drugs which act against tumor necrosis factor.

Interactions

Antirheumatic drugs may interact with a variety of other medicines or other antirheumatic drugs. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. Anyone who takes this type of drug should inform the prescribing physician about any other medication he or she is taking. Among the drugs that may interact with antirheumatic drugs are phenytoin (Dilantin), **aspirin**, sulfa drugs such as Bactrim and Gantrisin, tetracycline and some other **antibiotics** and cimetidine (Tagamet). NSAIDs such as ibuprofen (Motrin, Advil) are also known to interact with other classes of antirheumatic drugs.

Resources

ORGANIZATION

Arthritis Foundation. 1300 W. Peachtree St., Atlanta, GA 30309. (800) 283-7800. <http://www.arthritis.org>.

Nancy Ross-Flanigan

Antiseptics

Definition

An antiseptic is a substance which inhibits the growth and development of microorganisms. For practical purposes, antiseptics are routinely thought of as topical agents, for application to skin, mucous membranes, and inanimate objects, although a formal definition includes agents which are used internally, such as the urinary tract antiseptics.

Purpose

Antiseptics are a diverse class of drugs which are applied to skin surfaces or mucous membranes for their anti-infective effects. This may be either bacteriocidal or bacteriostatic. Their uses include cleansing of skin and wound surfaces after injury, preparation of skin surfaces prior to injections or surgical procedures, and routine disinfection of the oral cavity as part of a program of **oral hygiene**. Antiseptics are also used for disinfection of inanimate objects, including instruments and furniture surfaces.

Commonly used antiseptics for skin cleaning include benzalkonium chloride, chlorhexidine, hexachlorophine, iodine compounds, mercury compounds, alcohol and hydrogen peroxide. Other agents which have been used for this purpose, but have largely been supplanted by more effective or safer agents, include boric acid and volatile oils such as methyl salicylate (oil of wintergreen.)

Chlorhexidine shows a high margin of safety when applied to mucous membranes, and has been used in oral rinses and preoperative total body washes.

Benzalkonium chloride and hexachlorophine are used primarily as hand scrubs or face washes. Benzalkonium may also find application is a disinfecting agent for instruments, and in low concentration as a preservative for drugs including ophthalmic solutions. Benzalkonium chloride is inactivated by organic compounds, including soap, and must not be applied to areas which have not been fully rinsed.

Iodine compounds include tincture of iodine and povidone iodine compounds. Iodine compounds have the broadest spectrum of all topical anti-infectives, with action against bacteria, fungi, viruses, spores, protozoa, and yeasts. Iodine tincture is highly effective, but its alcoholic component is drying and extremely irritating when applied to abraided (scraped or rubbed) skin. Povidone iodine, an organic compound, is less irritating and less toxic, but not as effective. Povidone iodine has been used for hand scrubs and disinfection of surgical sites. Aqueous solutions of iodine have also been used as antiseptic agents, but are less effective than alcoholic solutions and less convenient to use that the povidone iodine compounds.

Hydrogen peroxide acts through the liberation of oxygen gas. Although the antibacterial activity of hydrogen peroxide is relatively weak, the liberation of oxygen bubbles produces an effervescent action, which may be useful for wound cleansing through removal of tissue debris. The activity of hydrogen peroxide may be reduced by the presence of blood and pus. The appropriate concentration of hydrogen peroxide for antiseptic use is 3%, although higher concentrations are available.

Thimerosol (Mersol) is a mercury compound with activity against bacteria and yeasts. Prolonged use may result in mercury toxicity.

Recommended dosage

Dosage varies with product and intended use. Consult individualized references.

Precautions

Precautions vary with individual product and use. Consult individualized references.

KEY TERMS

Antibiotic—A medicine used to treat infections.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Mucous membrane—The moist lining of a body cavity or structure, such as the mouth or nose.

Residue—Traces that remain after most of the rest of the material is gone.

Hypersensitivity reactions should be considered with organic compounds such as chlorhexidine, benzalkonium and hexachlorophine.

Skin dryness and irritation should be considered with all products, but particularly with those containing alcohol.

Systemic toxicity may result from ingestion of iodine containing compounds or mercury compounds.

Chlorhexidine should not be instilled into the ear. There is one anecdotal report of deafness following use of chlorhexidine in a patient with a **perforated eardrum**. Safety in **pregnancy** and breastfeeding have not been reported, however there is one anecdotal report of an infant developing slowed heartbeat apparently related to maternal use of chlorhexidine.

Iodine compounds should be used sparingly during pregnancy and **lactation** due to risk of infant absorption of iodine with alterations in thyroid function.

Interactions

Antiseptics are not known to interact with any other medicines. However, they should not be used together with any other topical cream, solution, or ointment.

Resources

PERIODICALS

Farley, Dixie. "Help for Cuts, Scrapes and Burns." *FDA Consumer* (May 1996):12.

Samuel Uretsky, PharmD

Antispasmodic drugs

Definition

Antispasmodic drugs relieve cramps or spasms of the stomach, intestines, and bladder.

Purpose

Antispasmodic drugs have been used to treat stomach cramps. Traditionally, they were used to treat stomach ulcers, but for this purpose they have largely been replaced by the acid inhibiting compoundsa, the H-2 receptor blockers such as cimetidine and ranitidine and the proton pump inhibtors such as omeprazole, lansoprazole and rabetazole.

Most of the drugs used for this purpose as "anticholinergics", since they counteract the effects of the neurohormone acetylcholine. Some of these drugs are derived from the plant belladonna, also known as Deadly Nightshade. There is also a group of drugs with similar activity, but not taken from plant sources. The anticholingergics decrease both the movements of the stomach and intestine, and also the secretions of stomach acid and digestive enzymes. They may be used for other purposes including treatment of **Parkinson's Disease**, and bladder urgency. Because these drugs inhibit secretions, they cause **dry mouth** and dry eyes because of reduced salivation and tearing. Dicyclomine is an antispasmodic with very lettle effect on secretions. It is used to treat **irritable bowel syndrome**.

Description

Dicyclomine is available only with a prescription and is sold as capsules, tablets (regular and extended-release forms), and syrup.

Recommended dosage

The usual dosage for adults is 20 mg, four times a day. However, the physician may recommend starting at a lower dosage and gradually increasing the dose to reduce the chance of unwanted side effects.

The dosage for children depends on the child's age. Check with the child's physician for the correct dosage.

Precautions

Dicyclomine makes some people sweat less, which allows the body to overheat and may lead to heat prostration (**fever** and heat **stroke**). Anyone taking this drug should try to avoid extreme heat. If that is not possible, check with the physician who prescribed the drug. If heat prostration occurs, stop taking the medicine and call a physician immediately.

This medicine can cause drowsiness and blurred or double vision. People who take this drug should not drive, use machines, or do anything else that might be dangerous until they have found out how the medicine affects them.

Dicyclomine should not be given to infants or children unless the physician decides the use of this drug is necessary. Diclyclomine should not be used by women who are breast feeding. Women who are pregnant or plan to become pregnant should check with their physicians before using this drug.

Anyone with the following medical conditions should not take dicyclomine unless directed to do so by a physician:

- previous sensitivity or allergic reaction to dicyclomine
- glaucoma
- myasthenia gravis
- blockage of the urinary tract, stomach, or intestines
- severe **ulcerative colitis**
- reflux esophagitis

In addition, patients with these conditions should check with their physicians before using dicyclomine:

- liver disease
- kidney disease
- high blood pressure
- heart problems
- enlarged prostate gland
- hiatal **hernia**
- autonomic neuropathy (a nerve disorder)
- hyperthyroidism

Side effects

The most common side effects are **dizziness**, drowsiness, lightheadedness, nausea, nervousness, blurred vision, dry mouth, and weakness. Other side effects may occur. Anyone who has unusual symptoms after taking dicyclomine should get in touch with his or her physician.

Interactions

Dicyclomine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with Dicyclomine are:

- antacids such as Maalox
- antihistamines such as clemastine fumarate (Tavist)
- bronchodilators (airway opening drugs) such as albuterol (Proventil, Ventolin)
- corticosteroids such as prednisone (Deltasone)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate)
- tranquilizers such as diazepam (Valium) and alprazolam (Xanax)

KEY TERMS

Heat stroke—A serious condition that results from exposure to extreme heat. The body loses its ability to cool itself. Severe headache, high fever, and hot, dry skin may result. In severe cases, a person with heat stroke may collapse or go into a coma.

Hiatal hernia—A condition in which part of the stomach protrudes through the diaphragm.

Hyperthyroidism—Secretion of excess thyroid hormones by the thyroid gland.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Myasthenia gravis—A condition in which certain muscles weaken and may become paralyzed.

Reflux esophagitis—Inflammation of the lower esophagus caused by the backflow of stomach contents.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles

Ulcerative colitis—Long-lasting and repeated inflammation of the colon with the development of sores.

The list above does not include every drug that may interact with dicyclomine. Be sure to check with a physician or pharmacist before combining dicyclomine with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antistreptolysin O titer (ASO) *see* **Streptococcal antibody tests**

Antithrombin III deficiency *see* **Hypercoagulation disorders**

Antituberculosis drugs

Definition

Antituberculosis drugs are medicines used to treat **tuberculosis**, an infectious disease that can affect the lungs and other organs.

Purpose

Tuberculosis is a disease caused by Mycobacterium tuberculae, a bacteria that is passed between people through the air. The disease can be cured with proper drug therapy, but because the bacteria may become resistant to any single drug, combinations of antituberculosis drugs are used to treat tuberculosis (TB) are normally required for effective treatment. At the start of the 20th Century, tuberculosis was the most common cause of **death** in the United States, but was laregly eliminated with better living conditions. It is most common in areas of crowding and poor ventilation, suich as crowded urban areas and prisons. In some areas, the **AIDS** epidemic has been accompanied by an increase in the prevalence of tuberculosis.

Some antituberculosis drugs also are used to treat or prevent other infections such as *Mycobacterium avium* complex (MAC), which causes disease throughout the bodies of people with AIDS or other diseases of the immune system.

Description

Antituberculosis drugs are available only with a physician's prescription and come in tablet, capsule, liquid and injectable forms. Some commonly used antituberculosis drugs are cycloserine (Seromycin), ethambutol (Myambutol), ethionamide (Trecator-SC), isoniazid (Nydrazid, Laniazid), pyrazinamide, rifabutin (Mycobutin), and rifampin (Rifadin, Rimactane).

Recommended dosage

The recommended dosage depends on the type of antituberculosis drug and may be different for different patients. Check with the physician who prescribed the medicine or the pharmacist who filled the prescription for the proper dosage. The physician may gradually increase the dosage during treatment. Be sure to follow the physician's orders. Patients who are infected with HIV must usually take larger combinations of drugs for a longer period of time than is needed for patients with an unimpaired immune system.

Some antituberculosis drugs must be taken with other drugs. If they are taken alone, they may encourage the bacteria that cause tuberculosis to become resistant to drugs used to treat the disease. When the bacteria become resistant, treating the disease becomes more difficult.

To clear up tuberculosis completely, antituberculosis drugs must be taken for as long as directed. This may mean taking the medicine every day for a year or two or even longer. Symptoms may improve very quickly after treatment with this medicine begins. However, they may come back if the medicine is stopped too quickly. Do not stop taking the medicine just because symptoms improve.

Because people may neglect to take their medication for tuberculosis, it is common to have tuberculosis centers develop a program of Directly Observed Therapy (DOT.) In these programs, patients come to the hospital or clinic, and take their medication in front of an observer. These programs may be annoying to the patients, but are justified by the risks to public health if tuberculosis germs which have become resistant to drugs were to be spread.

Cycloserine works best when it is at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. If taking medicine at night interferes with sleep, or if it is difficult to remember to take the medicine during the day, check with a health care professional for suggestions.

Do not take **antacids** that contain aluminum, such as Maalox, within 1 hour of taking isoniazid, as this may keep the medicine from working.

Precautions

Seeing a physician regularly while taking antituberculosis drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. These visits also will help the physician know if the dosage needs to be changed.

Symptoms should begin to improve within a few weeks after treatment begins with antituberculosis drugs. If they do not, or if they become worse, check with a physician.

Some people feel drowsy, dizzy, confused, or less alert when using these drugs. Some may also cause vision changes, clumsiness, or unsteadiness. Because of these possible problems, anyone who takes antituberculosis drugs should not drive, use machines, or do anything else that might be dangerous until they have found out how the medicine affects them.

Daily doses of pyridoxine (vitamin B_6) may lessen or prevent some side effects of ethionamide or isoniazid. If the physician who prescribed the medicine recommends this, be sure to take the pyridoxine every day.

Certain kinds of cheese (such as Swiss and Cheshire) and fish (such as tuna and skipjack) may cause an unusual reaction in people taking isoniazid. Symptoms of this reaction include fast or pounding heartbeat, sweating or a hot feeling, chills or a clammy feeling, **headache**, lightheadedness, and red or itchy skin. This reaction is very

rare. However, if any of these symptoms occur, check with a physician as soon as possible.

Rifabutin and rifampin will make saliva, sweat, tears, urine, feces, and skin turn reddish orange to reddish brown. This is nothing to worry about. However, the discolored tears may permanently stain soft contact lenses (but not hard contact lenses). To avoid ruining contact lenses, do not wear soft contacts while taking these medicines.

Rifampin may temporarily lower the number of white blood cells. Because the white blood cells are important in fighting infection, this effect increases the chance of getting an infection. This drug also may lower the number of platelets that play an important role in clotting. To reduce the risk of bleeding and infection in the mouth while taking this medicine, be especially careful when brushing and flossing the teeth. Check with a physician or dentist for suggestions on how to keep the teeth and mouth clean without causing injuries. Put off any dental work until blood counts return to normal.

Rifampin may affect the results of some medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

People who have certain medical conditions may have problems if they take antituberculosis drugs. For example:

- cycloserine or isoniazid may increase the risk of seizures (convulsions) in people with a history of seizures.
- the dosage of cycloserine may need to be adjusted for people with kidney disease.
- ethambutol or pyrazinamide may cause or worsen attacks of **gout** in people who are prone to having them.
- ethambutol may cause or worsen eye damage.
- diabetes may be harder to control in patients who take ethionamide.
- isoniazid may cause false results on some urine sugar tests, and pyrazinamide may cause false results on urine ketone tests. Diabetic patients who either of these medicines should discuss the possibility of false test results with their physicians.
- people with liver disease or a history of alcohol abuse may be more likely to develop hepatitis when taking isoniazid and are more likely to have side effects that affect the liver when taking rifampin.
- in people with kidney disease, ethambutol, ethionamide, or isoniazid may be more likely to cause side effects.
- side effects are also more likely in people with liver disease who take pyrazinamide.

Before taking antituberculosis drugs, be sure to let the physician know about these or any other medical problems.

In laboratory tests of pregnant animals, high doses of some antituberculosis drugs have caused **birth defects** and other problems in the fetus or newborn. However, pregnant women with tuberculosis need to take antituberculosis drugs to clear up their disease. Knowing that many women have had healthy babies after taking these drugs during **pregnancy** may be reassuring. Pregnant women who need to take this medicine and are worried about birth defects or other problems should talk to their physicians.

Anyone who has had unusual reactions to antituberculosis drugs or to niacin should let his or her physician know before taking any antituberculosis drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Patients who are on special **diets**, such as low-sodium or low-sugar diets, should make sure their physicians know. Some antituberculosis medicines may contain sodium, sugar, or alcohol.

Side effects

Cycloserine

In some people, this medicine causes depression and thoughts of suicide. If this happens, check with a physician immediately. Switching to another medicine will usually stop these troubling thoughts and feelings. Also let the physician know immediately about any other mood or mental changes; such as nervousness, nightmares, **anxiety**, confusion, or irritability; and about symptoms such as muscle twitches, convulsions, or speech problems.

Headache is a common side effect that usually goes away as the body adjusts to this medicine. This problem does not need medical attention unless it continues or it interferes with everyday life.

Ethambutol

This medicine may cause eye **pain** or vision changes, including loss of vision or changes in color vision. Check with a physician immediately if any of these problems develop.

In addition, anyone who has any of these symptoms while taking ethambutol should check with a physician immediately:

- painful or swollen joints, especially in the knee, ankle, or big toe
- a tight, hot sensation in the skin over painful or swollen joints

• chills

Other side effects may occur but do not need medical attention unless they are bothersome or they do not go away as the body adjusts to the medicine. These include: headache, confusion, **nausea and vomiting**, stomach pain, and loss of appetite.

Ethionamide

Check with a physician immediately if eye pain, blurred vision, or other vision changes occur while taking this medicine.

Symptoms such as unsteadiness, clumsiness and pain, numbness, tingling, or burning in the hands or feet could be the first signs of nerve problems that may become more serious. If any of these symptoms occur, check with a physician immediately. Other side effects that should be brought to a physician's attention immediately include yellow eyes or skin and mood or mental changes such as depression or confusion.

Less serious side effects such as **dizziness**, nausea or vomiting, appetite loss, sore mouth, or metallic taste may also occur. These problems usually go away as the body adjusts to the medicine. They do not need medical attention unless they continue or they interfere with normal activities.

Isoniazid

This medicine may cause serious liver damage, especially in people over 40 years of age. However, taking medicine for tuberculosis is very important for people with the disease. Anyone who has tuberculosis and has been advised to take this drug should thoroughly discuss treatment options with his or her physician.

Recognizing the early signs of liver and nerve damage can help prevent the problems from getting worse. If any of these symptoms occur, check with a physician immediately:

• unusual tiredness or weakness

• clumsiness or unsteadiness

• pain, numbness, tingling, or burning in the hands and feet

• loss of appetite

• vomiting

This medicine may also cause less serious side effects such as **diarrhea** and stomach pain. These usually go away as the body adjusts to the medicine and do not need medical attention unless they continue.

If eye pain, blurred vision, or other vision changes occur while taking this medicine, check with a physician immediately.

Pyrazinamide

Check with a physician immediately if pain in the joints occurs.

Rifabutin

Check with a physician immediately if a skin rash occurs.

Nausea and vomiting are other possible side effects of this medicine. These problems usually go away as the body adjusts to the medicine. If they do not, check with a physician.

Rifampin

Stop taking rifampin and check with a physician immediately if any of the following symptoms occur. These symptoms could be early signs of problems that may become more serious. Getting prompt medical attention could prevent them from getting worse.

• unusual tiredness or weakness

• nausea or vomiting

• loss of appetite

In addition, anyone who has any of these symptoms while taking rifampin should check with a physician immediately:

• breathing problems

• fever

• chills

• shivering

• headache

• dizziness

• itching

• skin rash or redness

• muscle and bone pain

Other side effects, such as diarrhea and stomach pain, may occur with this medicine, but should go away as the body adjusts to the drug. Medical treatment is not necessary unless these problems continue.

Other side effects may occur with any antituberculosis drug. Anyone who has unusual symptoms while taking an antituberculosis drug should get in touch with his or her physician.

Interactions

Taking cycloserine and ethionamide together may increase the risk of seizures and other nervous system problems. These and other side effects also are more

KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Feces—(Also called stool.) The solid waste that is left after food is digested. Feces form in the intestines and pass out of the body through the anus.

Fetus—A developing baby inside the womb.

Gout—A disease in which uric acid, a waste product that normally passes out of the body in urine, collects in the joints and the kidneys. This causes arthritis and kidney stones.

Immune system—The body's natural defenses against disease and infection.

Microorganism—An organism (life form) that is too small to be seen with the naked eye.

Platelets—Disk-shaped bodies in the blood that are important in clotting.

Seizure—A sudden attack, spasm, or convulsion.

likely in people who drink alcohol while taking cycloserine. To avoid these problems, *do not drink alcohol while taking cycloserine* and check with a physician before combining cycloserine and ethionamide.

Drinking alcohol regularly may prevent isoniazid from working properly and may increase the chance of liver damage. Anyone taking this medicine should strictly limit the use of alcohol. Check with a health care professional for advice on the amount of alcohol that may safely be used.

Many drugs may interact with isoniazid or rifampin, increasing the chance of liver damage or other side effects. Among these drugs are **acetaminophen** (Tylenol), birth control pills and other drugs that contain female hormones, and the antiseizure drugs divalproex (Depakote) and valproic acid (Depakene). For a complete list of drugs that may have this effect, check with a pharmacist.

Isoniazid may also decrease the effects of the antifungal drug ketoconazole (Nizoral) and the antituberculosis drug rifampin (Rifadin).

Rifampin may make many drugs less effective. Among the drugs that may be affected are diabetes medicines taken by mouth (oral hypoglycemics), digitalis heart drugs, many antifungal drugs, and birth control pills. Because it makes birth control pills less effective, taking rifampin may increase the chance of becoming pregnant. Women who take this medicine along with birth control pills should use an additional form of birth control. For a complete list of drugs that may be affected by rifampin, check with a pharmacist.

Using rifabutin with the antiretroviral drug zidovudine (AZT, Retrovir) may make the zidovudine less effective. Consult with a physician if both drugs are prescribed.

Not every drug that may interact with an antituberculosis drug is listed here. Be sure to check with a physician or pharmacist before combining an antituberculosis drug with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Cornwall, Janet. "Tuberculosis: A Clinical Problem of International Importance." *The Lancet* (August 30, 1997): 660.

Nancy Ross-Flanigan

Antiulcer drugs

Definition

Antiulcer drugs are a class of drugs, exclusive of the antibacterial agents, used to treat ulcers in the stomach and the upper part of the small intestine.

Purpose

Recurrent gastric and duodenal ulcers are caused by *Helicobacter pylori* infections, and are treated with combination treatments that incorporate antibiotic therapy with gastric acid suppression. Additionally, bismuth compounds have been used. The primary class of drugs used for gastric acid suppression are the proton pump inhibitors, omeprazole, lansoprazole, pantoprazole and rabeprazole. The H-2 receptor blocking agents, cimetidine, famotidine, nizatidine, and ranitidine have been used for this purpose, but are now more widely used for maintenance therapy after treatment with the proton pump inhibitors. Sucralfate, which acts by forming a protective coating over the ulcerate lesion, is also used in ulcer treatment and may be appropriate for patients in whom other classes of drugs are not indicated, or those whose gastric ulcers are caused by non-steroidal anti-inflammatory drugs (NSAIDs) rather than *H. pylori* infections.

Description

The proton pump inhibitors block the secretion of gastric acid by the gastric parietal cells. The extent of inhi-

Antiulcer Drugs

Brand Name (Generic Name)	Possible Common Side Effects Include:
Axid (nitzatidine)	Diarrhea, headache, nausea and vomiting, sore throat
Carafate (sucralfate)	Constipation, insomnia, hives, upset stomach, vomiting
Cytotec (misoprostol)	Cramps, diarrhea, nausea, gas, headache, menstrual disorders (including heavy bleeding and severe cramping)
Pepcid (famotidine)	Constipation or diarrhea, dizziness, fatigue, fever
Prilosec (omeprazole)	Nausea and vomiting, headache, diarrhea, abdominal pain
Tagamet (cimetidine)	Headache, breast development in men, depression and disorientation
Zantac (ranitidine hydrochloride)	Headache, constipation or diarrhea, joint pain

bition of acid secretion is dose related. In some cases, gastric acid secretion is completely blocked for over 24 hours on a single dose. In addition to their role in treatment of gastric ulcers, the proton pump inhibitors are used to treat syndromes of excessive acid secretion (Zollinger-Ellison Syndrome) and gastroesophageal reflux disease (GERD).

Histamine H-2 receptor blockers stop the action of histamine on the gastric parietal cells, inhibiting the secretion of gastric acid. These drugs are less effective than the proton pump inhibitors, but may achieve a 75–79% reduction in acid secretion. Higher rates of acid inhibition may be achieved when the drug is administered by the intravenous route. The H-2 receptor blockers may also be used to treat **heartburn** and hypersecretory syndromes. When given before surgery, the H-2 receptor blockers are useful in prevention of aspiration **pneumonia**.

Sucralfate (Carafate), a substituted sugar molecule with no nutritional value, does not inhibit gastric acid, but rather, reacts with existing stomach acid to form a thick coating that covers the surface of an ulcer, protecting the open area from further damage. A secondary effect is to act as an inhibitor of the digestive enzyme pepsin. Sucralfate does not bind to the normal stomach lining. The drug has been used for prevention of **stress** ulcers, the type seen in patients exposed to physical stress such as **burns** and surgery. It has no systemic effects.

Recommended dosage

The doses of the proton pump inhibitors and H-2 receptor blockers vary depending on the drug and condition being treated. Consult individual references.

The dose of sucralfate for acute ulcer therapy is 1 gram four times a day. After the ulcer has healed, maintenance treatment may continue at 1 gram two times daily.

Precautions

The proton pump inhibitors are generally well tolerated, and the most common adverse effects are **diarrhea**, **itching**, skin rash, **dizziness** and **headache**. Muscle aches and a higher than normal rate of respiratory infections are among the other adverse reactions reported. Omeprazole has an increased rate of fetal deaths in animal studies. It is not known if these drugs are excreted in human milk, but because of reported adverse effects to infants in animal studies, it is recommended that proton pump inhibitors not be used by nursing mothers.

The H-2 receptor blockers vary widely in their adverse effects. Although they are generally well tolerated, cimetidine may cause confusion in elderly patients, and has an antiandrogenic effect that may cause **sexual dysfunction** in males. Famotidine has been reported to cause headache in 4.7% of patients. It is advisable that mothers not take H-2 receptor blockers while nursing.

Sucralfate is well tolerated. It is poorly absorbed, and its most common side effect is **constipation** in 2% of patients. Diarrhea, nausea, vomiting, gastric discomfort, **indigestion**, flatulence, **dry mouth**, rash, pruritus (itching), back **pain**, headache, dizziness, sleepiness, and vertigo have been reported, as well as rare allergic responses. Because sucralfate releases small amounts of aluminum into the system, it should be used with caution in patients with renal insufficiency. There is no information available about sucralfate's safety in breastfeeding.

Interactions

Proton pump inhibitors may increase the pH of the stomach. This will inactivate some antifungal drugs that require an acid medium for effectiveness, notable itraconazole and ketoconazole.

H-2 receptor blocking agents have a large number of drug interactions. Consult individualized references.

Sucralfate should not be used with aluminum containing **antacids**, because of the risk of increased aluminum absorption. Sucralfate may inhibit absorption and reduce blood levels of anticoagulants, digoxin, quinidine, ketoconazole, quinolones and phenytoin.

KEY TERMS

Antibiotic—Medicine used to treat infections.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Gastrointestinal tract—The stomach, small intestine and large intestine.

Hypersecretory—Excessive production of a bodily secretion. The most common hypersecretory syndrome of the stomach is Zollinger-Ellison Syndrome, a syndrome consisting of fulminating intractable peptic ulcers, gastric hypersecretion and hyperacidity, and the occurrence of gastrinomas of the pancreatic cells of the islets of Langerhans.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Mucous—Thick fluid produced by the moist membranes that line many body cavities and structures.

Nonsteroidal anti-inflammatory drug (NSAID)—A type of medicine used to relieve pain, swelling, and other symptoms of inflammation, such as ibuprofen or ketoprofen.

Resources

ORGANIZATIONS

Digestive Disease National Coalition. 507 Capitol Court NE, Suite 200, Washington, DC 20003. (202) 544-7497.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. nddic@aerie.com. <http://www.niddk.nih.gov/Brochures/NDDIC.htm>.

OTHER

Duodenal Ulcer Fact sheet. Johns Hopkins Health Information Adult Health Advisor. Available at <http://csi.intelihealth.com>.

National Institute of Diabetes and Digestive and Kidney Diseases. <http://www.niddk.nih.gov>.

PharmInfoNet's Digestive Disease Center. <http://pharminfo.com/disease.gastro.html>.

Stomach and Duodenal Ulcers. Fact sheet. National Institute of Diabetes and Digestive and Kidney Diseases, January 1995 (NIH Publication No. 95-38).

Stomach Ulcer (Gastric Ulcer). Fact sheet. Johns Hopkins Health Information Adult Health Advisor. Available on website at <http://csi.intelihealth.com>.

Samuel Uretsky, PharmD

Antiviral drugs

Definition

Antiviral drugs are medicines that cure or control virus infections.

Purpose

Antivirals are used to treat infections caused by viruses. Unlike antibacterial drugs, which may cover a wide range of pathogens, antiviral agents tend to be narrow in spectrum, and have limited efficacy.

Description

Exclusive of the antiretroviral agents used in HIV (**AIDS**) therapy, there are currently only 11 antiviral drugs available, covering four types of virus. Acyclovir (Zovirax), famciclovir (Famvir), and valacyclovir (Valtrex) are effective against herpesvirus, including herpes zoster and herpes genitalis. They may also be of value in either conditions caused by herpes, such as **chickenpox** and **shingles**. These drugs are not curative, but may reduce the **pain** of a herpes outbreak and shorten the period of viral shedding.

Amantadine (Symmetrel), oseltamivir (Tamiflu), rimantidine (Flumadine), and zanamivir (Relenza) are useful in treatment of **influenza** virus. Amantadine, rimantadine, and oseltamivir may be administered throughout the flu season as preventatives for patients who cannot take influenza virus vaccine.

Cidofovir (Vistide), foscarnet (Foscavir), and ganciclovir (Cytovene) have been beneficial in treatment of cytomegalovirus in immunosupressed patients, primarily HIV-positive patients and transplant recipients. Ribavirin (Virazole) is used to treat respiratory syncytial virus. In combination with interferons, ribavirin has shown some efficacy against **hepatitis C**, and there have been anecdotal reports of utility against other types of viral infections.

As a class, the antivirals are not curative, and must be used either prophylactically or early in the development of an infection. Their mechanism of action is typically to inactivate the enzymes needed for viral replication. This will reduce the rate of viral growth, but will not inactive the virus already present. Antiviral therapy must normally be initiated within 48 hours of the onset of an infection to provide any benefit. Drugs used for influenza may be used throughout the influenza season in high risk patients, or within 48 hours of exposure to a known carrier. Antiherpetic agents should be used at the first signs of an outbreak. Anti-cytomegaloviral drugs must routinely be used as part of a program of secondary **prophylaxis** (mainte-

nance therapy following an initial response) in order to prevent reinfection in immunocompromised patients.

Recommended dosage

Dosage varies with the drug, patient age and condition, route of administration, and other factors. See specific references.

Precautions

Ganciclovir is available in intravenous injection, oral capsules, and intraoccular inserts. The capsules should be reserved for prophylactic use in organ transplant patients, or for HIV infected patients who cannot be treated with the intravenous drug. The toxicity profile of this drug when administered systemically includes granulocytopenia, anemia and **thrombocytopenia**. The drug is in **pregnancy** category C, but has caused significant fetal abnormalities in animal studies including cleft palate and organ defects. Breast feeding is not recommended.

Cidofovir causes renal toxicity in 53% of patients. Patients should be well hydrated, and renal function should be checked regularly. Other common adverse effects are **nausea and vomiting** in 65% or patients, asthenia in 46% and **headache** and **diarrhea**, both reported in 27% of cases. The drug is category C in pregnancy, due to fetal abnormalities in animal studies. Breast feeding is not recommended.

Foscarnet is used in treatment of immunocompromised patients with cytomegalovirus infections and in acyclovir-resistant herpes simples virus. The primary hazard is renal toxicity. Alterations in electrolyte levels may cause seizures. Foscarnet is category C during pregnancy. The drug has caused skeletal abnormailities in developing fetuses. It is not known whether foscarnet is excreted in breast milk, however the drug does appear in breast milk in animal studies.

Valaciclovir is metabolized to acyclovir, so that the hazards of the two drugs are very similar. They are generally well tolerated, but nausea and headache are common adverse effects. They are both pregnancy category B. Although there have been no reports of fetal abnormalities attributable to either drug, the small number of reported cases makes it impossible to draw conclusions regarding safety in pregnancy. Acyclovir is found in breast milk, but no adverse effects have been reported in the newborn. Famciclovir is similar in actions and adverse effects.

Ribavirin is used by aerosol for treatment of hospitalized infants and young children with severe lower respiratory tract infections due to respiratory syncytial virus (RSV). When administered orally, the drug has been used in adultys to treat other viral diseases including acute and chronic hepatitis, herpes genitalis, **measles**, and Lassa **fever**, however there is relatively little information about these uses. In rare cases, initiation of ribavirin therapy has led to deterioration of respiratory function in infants. Careful monitoring is essential for safe use.

The anti-influenza drugs are generally well tolerated. Amantadine, which is also used for treatment of

KEY TERMS

Asthenia—Muscle weakness.

Cytomegalovirus (CMV)—A type of virus that attacks and enlarges certain cells in the body. The virus also causes a disease in infants.

Herpes simplex—A virus that causes sores on the lips (cold sores) or on the genitals (genital herpes).

HIV—Acronym for human immunodeficiency virus, the virus that causes AIDS.

Parkinsonism—A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Prophylactic—Guarding from or preventing the spread or occurrence of disease or infection.

Retrovirus—A group of viruses that contain RNA and the enzyme reverse transcriptase. Many viruses in this family cause tumors. The virus that causes AIDS is a retrovirus.

Shingles—An disease caused by an infection with the Herpes zoster virus, the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

Virus—A tiny, disease-causing structure that can reproduce only in living cells and causes a variety of infectious diseases.

Parkinsonism, may show more frequent CNS effects, including **sedation** and **dizziness**. Rapid discontinuation of amantidine may cause an increase in Parkinsonian symptoms in patients using the drug for that purpose. All are schedule C for pregnancy. In animal studies, they have caused fetal malformations in doses several times higher than the normal human dose. Use caution in breast feeding.

Interactions

Consult specific references for information on drug interactions.

Use particular caution in HIV-positive patients, since these patients are commonly on multi-drug regimens with a high frequency of interactions. Ganciclovir should not be used with other drugs which cause hematologic toxicity, and cidofovir should not be used with other drugs that may cause kidney damage.

Resources

PERIODICALS

Gray, Mary Ann. "Antiviral Medications." *Orthopaedic Nursing* 15 (November-December 1996): 82.

Samuel D. Uretsky, PharmD

Anxiety

Definition

Anxiety is a multisystem response to a perceived threat or danger. It reflects a combination of biochemical changes in the body, the patient's personal history and memory, and the social situation. As far as we know, anxiety is a uniquely human experience. Other animals clearly know fear, but human anxiety involves an ability, to use memory and imagination to move backward and forward in time, that animals do not appear to have. The anxiety that occurs in post-traumatic syndromes indicates that human memory is a much more complicated mental function than animal memory. Moreover, a large portion of human anxiety is produced by anticipation of future events. Without a sense of personal continuity over time, people would not have the "raw materials" of anxiety.

It is important to distinguish between anxiety as a feeling or experience, and an anxiety disorder as a psychiatric diagnosis. A person may feel anxious without having an anxiety disorder. Also a person facing a clear and present danger or a realistic fear is not usually considered to be in a state of anxiety. In addition, anxiety frequently occurs as a symptom in other categories of psychiatric disturbance.

Description

Although anxiety is a commonplace experience that everyone has from time to time, it is difficult to describe concretely because it has so many different potential causes and degrees of intensity. Doctors sometimes categorize anxiety as an emotion or an affect depending on whether it is being described by the person having it (emotion) or by an outside observer (affect). The word *emotion* is generally used for the biochemical changes and feeling state that underlie a person's internal sense of anxiety. *Affect* is used to describe the person's emotional state from an observer's perspective. If a doctor says that a patient has an anxious affect, he or she means that the patient appears nervous or anxious, or responds to others in an anxious way (for example, the individual is shaky, tremulous, etc.).

Although anxiety is related to fear, it is not the same thing. Fear is a direct, focused response to a specific event or object, and the person is consciously aware of it. Most people will feel fear if someone points a loaded gun at them or if they see a tornado forming on the horizon. They also will recognize that they are afraid. Anxiety, on the other hand, is often unfocused, vague, and hard to pin down to a specific cause. In this form it is called free-floating anxiety. Sometimes anxiety being experienced in the present may stem from an event or person that produced **pain** and fear in the past, but the anxious individual is not consciously aware of the original source of the feeling. It is anxiety's aspect of remoteness that makes it hard for people to compare their experiences of it. Whereas most people will be fearful in physically dangerous situations, and can agree that fear is an appropriate response in the presence of danger, anxiety is often triggered by objects or events that are unique and specific to an individual. An individual might be anxious because of a unique meaning or memory being stimulated by present circumstances, not because of some immediate danger. Another individual looking at the anxious person from the outside may be truly puzzled as to the reason for the person's anxiety.

Causes and symptoms

Anxiety can have a number of different causes. It is a multidimensional response to stimuli in the person's environment, or a response to an internal stimulus (for example, a hypochondriac's reaction to a stomach rumbling) resulting from a combination of general biological and individual psychological processes.

Physical

In some cases, anxiety is produced by physical responses to **stress**, or by certain disease processes or medications.

THE AUTONOMIC NERVOUS SYSTEM (ANS). The nervous system of human beings is "hard-wired" to respond to dangers or threats. These responses are not subject to conscious control, and are the same in humans as in lower animals. They represent an evolutionary adaptation to the animal predators and other dangers with which all animals, including primitive humans, had to cope. The most familiar reaction of this type is the so-called "fight-or-flight" reaction. This response is the human organism's automatic "red alert" in a life-threatening situation. It is a state of physiological and emotional hyperarousal marked by high muscle tension and strong feelings of fear or anger. When a person has a fight-or-flight reaction, the level of stress hormones in their blood rises. They become more alert and attentive, their eyes dilate, their heartbeat increases, their breathing rate increases, and their digestion slows down, allowing more energy to be available to the muscles.

This emergency reaction is regulated by a part of the nervous system called the autonomic nervous system, or ANS. The ANS is controlled by the hypothalamus, a specialized part of the brainstem that is among a group of structures called the limbic system. The limbic system controls human emotions through its connections to glands and muscles; it also connects to the ANS and "higher" brain centers, such as parts of the cerebral cortex. One problem with this arrangement is that the limbic system cannot tell the difference between a realistic physical threat and an anxiety-producing thought or idea. The hypothalamus may trigger the release of stress hormones by the pituitary gland, even when there is no external and objective danger. A second problem is caused by the biochemical side effects of too many "false alarms" in the ANS. When a person responds to a real danger, his or her body gets rid of the stress hormones by running away or by fighting. In modern life, however, people often have fight-or-flight reactions in situations in which they can neither run away nor lash out physically. As a result, their bodies have to absorb all the biochemical changes of hyperarousal, rather than release them. These biochemical changes can produce anxious feelings, as well as muscle tension and other physical symptoms associated with anxiety. They may even produce permanent changes in the brain, if the process occurs repeatedly. Moreover, chronic physical disorders, such as **coronary artery disease**, may be worsened by anxiety, as chronic hyperarousal puts undue stress on the heart, stomach, and other organs.

DISEASES AND DISORDERS. Anxiety can be a symptom of certain medical conditions. Some of these diseases are disorders of the endocrine system, such as **Cushing's syndrome** (overproduction of cortisol by the adrenal cortex), and include over- or underactivity of the thyroid gland. Other medical conditions that can produce anxiety include **respiratory distress syndrome**, **mitral valve prolapse**, porphyria, and chest pain caused by inadequate blood supply to the heart (**angina** pectoris).

MEDICATIONS AND SUBSTANCE USE. Numerous medications may cause anxiety-like symptoms as a side effect. They include birth control pills; some thyroid or **asthma** drugs; some psychotropic agents; occasionally, local anesthetics; **corticosteroids**; **antihypertensive drugs**; and **nonsteroidal anti-inflammatory drugs** (like flurbiprofen and ibuprofen).

Although people do not usually think of **caffeine** as a drug, it can cause anxiety-like symptoms when consumed in sufficient quantity. Patients who consume caffeine rich foods and beverages, such as chocolate, cocoa, coffee, tea, or carbonated soft drinks (especially cola beverages), can sometimes lower their anxiety symptoms simply by reducing their intake of these substances.

Withdrawal from certain prescription drugs, primarily **beta blockers** and corticosteroids, can cause anxiety. Withdrawal from drugs of abuse, including **LSD**, **cocaine**, alcohol, and opiates, can also cause anxiety.

Learned associations

Some aspects of anxiety appear to be unavoidable byproducts of the human developmental process. Humans are unique among animals in that they spend an unusually long period of early life in a relatively helpless condition, and a sense of helplessness can lead to anxiety. The extended period of human dependency on adults means that people may remember, and learn to anticipate, frightening or upsetting experiences long before they are capable enough to feel a sense of mastery over their environment. In addition, the fact that **anxiety disorders** often run in families indicates that children can learn unhealthy attitudes and behaviors from parents, as well as healthy ones. Also, recurrent disorders in families may indicate that there is a genetic or inherited component in some anxiety disorders. For example, there has been found to be a higher rate of anxiety disorders (panic) in identical twins than in fraternal twins.

CHILDHOOD DEVELOPMENT AND ANXIETY. Researchers in early childhood development regard anxiety in adult life as a residue of childhood memories of dependency. Humans learn during the first year of life that they are not self-sufficient and that their basic survival depends on the care of others. It is thought that this early experience of helplessness underlies the most common anxieties of adult life, including fear of powerlessness and fear of being unloved. Thus, adults can be made anxious by symbolic threats to their sense of competence

and/or significant relationships, even though they are no longer helpless children.

SYMBOLIZATION. The psychoanalytic model gives considerable weight to the symbolic aspect of human anxiety; examples include phobic disorders, obsessions, compulsions, and other forms of anxiety that are highly individualized. The length of the human maturation process allows many opportunities for children and adolescents to connect their experiences with certain objects or events that can bring back feelings in later life. For example, a person who was frightened as a child by a tall man wearing glasses may feel panicky years later by something that reminds him of that person or experience without consciously knowing why.

Freud thought that anxiety results from a person's internal conflicts. According to his theory, people feel anxious when they feel torn between desires or urges toward certain actions, on the one hand, and moral restrictions, on the other. In some cases, the person's anxiety may attach itself to an object that represents the inner conflict. For example, someone who feels anxious around money may be pulled between a desire to steal and the belief that stealing is wrong. Money becomes a symbol for the inner conflict between doing what is considered right and doing what one wants.

PHOBIAS. **Phobias** are a special type of anxiety reaction in which the person's anxiety is concentrated on a specific object or situation that the person then tries to avoid. In most cases, the person's fear is out of all proportion to its "cause." Prior to the *Diagnostic and Statistical Manual of Mental Disorders,* 4th edition *(DSM-IV),* these specific phobias were called simple phobias. It is estimated that 10-11% of the population will develop a phobia in the course of their lives. Some phobias, such as **agoraphobia** (fear of open spaces), claustrophobia (fear of small or confined spaces), and social phobia, are shared by large numbers of people. Others are less common or unique to the patient.

Social and environmental stressors

Anxiety often has a social dimension because humans are social creatures. People frequently report feelings of high anxiety when they anticipate and, therefore, fear the loss of social approval or love. Social phobia is a specific anxiety disorder that is marked by high levels of anxiety or fear of embarrassment in social situations.

Another social stressor is prejudice. People who belong to groups that are targets of bias are at higher risk for developing anxiety disorders. Some experts think, for example, that the higher rates of phobias and **panic disorder** among women reflects their greater social and economic vulnerability.

Some controversial studies indicate that the increase in violent or upsetting pictures and stories in news reports and entertainment may raise the anxiety level of many people. Stress and anxiety management programs often suggest that patients cut down their exposure to upsetting stimuli.

Anxiety may also be caused by environmental or occupational factors. People who must live or work around sudden or loud noises, bright or flashing lights, chemical vapors, or similar nuisances, which they cannot avoid or control, may develop heightened anxiety levels.

Existential anxiety

Another factor that shapes human experiences of anxiety is knowledge of personal mortality. Humans are the only animals that appear to be aware of their limited life span. Some researchers think that awareness of **death** influences experiences of anxiety from the time that a person is old enough to understand death.

Symptoms of anxiety

In order to understand the diagnosis and treatment of anxiety, it is helpful to have a basic understanding of its symptoms.

SOMATIC. The somatic or physical symptoms of anxiety include headaches, **dizziness** or lightheadedness, nausea and/or vomiting, **diarrhea**, tingling, pale complexion, sweating, numbness, difficulty in breathing, and sensations of tightness in the chest, neck, shoulders, or hands. These symptoms are produced by the hormonal, muscular, and cardiovascular reactions involved in the fight-or-flight reaction.

BEHAVIORAL. Behavioral symptoms of anxiety include pacing, trembling, general restlessness, hyperventilation, pressured speech, hand wringing, or finger tapping.

COGNITIVE. Cognitive symptoms of anxiety include recurrent or obsessive thoughts, feelings of doom, morbid or fear-inducing thoughts or ideas, and confusion, or inability to concentrate.

EMOTIONAL. Feeling states associated with anxiety include tension or nervousness, feeling "hyper" or "keyed up," and feelings of unreality, panic, or terror.

DEFENSE MECHANISMS. In psychoanalytic theory, the symptoms of anxiety in humans may arise from or activate a number of unconscious defense mechanisms. Because of these defenses, it is possible for a person to be anxious without being consciously aware of it or appearing anxious to others. These psychological defenses include:

- Repression. The person pushes anxious thoughts or ideas out of conscious awareness.
- Displacement. Anxiety from one source is attached to a different object or event. Phobias are an example of the mechanism of displacement in psychoanalytic theory.
- Rationalization. The person justifies the anxious feelings by saying that any normal person would feel anxious in their situation.
- Somatization. The anxiety emerges in the form of physical complaints and illnesses, such as recurrent headaches, stomach upsets, or muscle and joint pain.
- Delusion formation. The person converts anxious feelings into conspiracy theories or similar ideas without reality testing. Delusion formation can involve groups as well as individuals.

Other theorists attribute some drug **addiction** to the desire to relieve symptoms of anxiety. Most addictions, they argue, originate in the use of mood-altering substances or behaviors to "medicate" anxious feelings.

Diagnosis

The diagnosis of anxiety is difficult and complex because of the variety of its causes and the highly personalized and individualized nature of its symptom formation. There are no medical tests that can be used to diagnose anxiety by itself. When a doctor examines an anxious patient, he or she will first rule out physical conditions and diseases that have anxiety as a symptom. Apart from these exclusions, the **physical examination** is usually inconclusive. Some anxious patients may have their blood pressure or pulse rate affected by anxiety, or may look pale or perspire heavily, but others may appear physically completely normal. The doctor will then take the patient's medication, dietary, and occupational history to see if they are taking prescription drugs that might cause anxiety, if they are abusing alcohol or mood-altering drugs, if they are consuming large amounts of caffeine, or if their workplace is noisy or dangerous. In most cases, the most important source of diagnostic information is the patient's psychological and social history. The doctor may administer a brief psychological test to help evaluate the intensity of the patient's anxiety and some of its features. Some tests that are often given include the Hamilton Anxiety Scale and the Anxiety Disorders Interview Schedule (ADIS). Many doctors will check a number of chemical factors in the blood, such as the level of thyroid hormone and blood sugar.

Treatment

Not all patients with anxiety require treatment, but for more severe cases, treatment is recommended. Because anxiety often has more than one cause and is experienced in highly individual ways, its treatment usually requires more than one type of therapy. In addition, there is no way to tell in advance how patients will respond to a specific drug or therapy. Sometimes the doctor will need to try different medications or methods of treatment before finding the best combination for the particular patient. It usually takes about six to eight weeks for the doctor to evaluate the effectiveness of a treatment regimen.

Medications

Medications are often prescribed to relieve the physical and psychological symptoms of anxiety. Most agents work by counteracting the biochemical and muscular changes involved in the fight-or-flight reaction. Some work directly on the chemicals in the brain that are thought to underlie the anxiety.

ANXIOLYTICS. Anxiolytics are sometimes called tranquilizers. Most anxiolytic drugs are either **benzodiazepines** or **barbiturates**. Barbiturates, once commonly used, are now rarely used in clinical practice. Barbiturates work by slowing down the transmission of nerve impulses from the brain to other parts of the body. They include such drugs as phenobarbital (Luminal) and pentobarbital (Nembutal). Benzodiazepines work by relaxing the skeletal muscles and calming the limbic system. They include such drugs as chlordiazepoxide (Librium) and diazepam (Valium). Both barbiturates and benzodiazepines are potentially habit-forming and may cause withdrawal symptoms, but benzodiazepines are far less likely than barbiturates to cause physical dependency. Both drugs also increase the effects of alcohol and should never be taken in combination with it.

Two other types of anxiolytic medications include meprobamate (Equanil), which is now rarely used, and buspirone (BuSpar), a new type of anxiolytic that appears to work by increasing the efficiency of the body's own emotion-regulating brain chemicals. Buspirone has several advantages over other anxiolytics. It does not cause dependence problems, does not interact with alcohol, and does not affect the patient's ability to drive or operate machinery. However, buspirone is not effective against certain types of anxiety, such as panic disorder.

ANTIDEPRESSANTS AND BETA-BLOCKERS. For some anxiety disorders, such as **obsessive-compulsive disorder** and panic type anxiety, a type of drugs used to treat depression, **selective serotonin reuptake inhibitors** (SSRIs; such as Prozac and Paxil), are the treatment of choice. Because anxiety often coexists with symptoms of depression, many doctors prescribe antidepressant medications for anxious/depressed patients. While SSRIs are

more common, antidepressants are sometimes prescribed, including tricyclic antidepressants such as imipramine (Tofranil) or **monoamine oxidase inhibitors** (MAO inhibitors) such as phenelzine (Nardil).

Beta-blockers are medications that work by blocking the body's reaction to the stress hormones that are released during the fight-or-flight reaction. They include drugs like propranolol (Inderal) or atenolol (Tenormin). Beta-blockers are sometimes given to patients with post-traumatic anxiety symptoms. More commonly, the beta-blockers are given to patients with a mild form of social phobic anxiety, such as fear of public speaking.

Psychotherapy

Most patients with anxiety will be given some form of psychotherapy along with medications. Many patients benefit from insight-oriented therapies, which are designed to help them uncover unconscious conflicts and defense mechanisms in order to understand how their symptoms developed. Patients who are extremely anxious may benefit from supportive psychotherapy, which aims at symptom reduction rather than personality restructuring.

Two newer approaches that work well with anxious patients are **cognitive-behavioral therapy** (CBT), and relaxation training. In CBT, the patient is taught to identify the thoughts and situations that stimulate his or her anxiety, and to view them more realistically. In the behavioral part of the program, the patient is exposed to the anxiety-provoking object, situation, or internal stimulus (like a rapid heart beat) in gradual stages until he or she is desensitized to it. Relaxation training, which is sometimes called anxiety management training, includes breathing exercises and similar techniques intended to help the patient prevent hyperventilation and relieve the muscle tension associated with the fight-or-flight reaction. Both CBT and relaxation training can be used in **group therapy** as well as individual treatment. In addition to CBT, support groups are often helpful to anxious patients, because they provide a social network and lessen the embarrassment that often accompanies anxiety symptoms.

Psychosurgery

Surgery on the brain is very rarely recommended for patients with anxiety; however, some patients with severe cases of obsessive- compulsive disorder (OCD) have been helped by an operation on a part of the brain that is involved in OCD. Normally, this operation is attempted after all other treatments have failed.

Alternative treatment

Alternative treatments for anxiety cover a variety of approaches. **Meditation** and mindfulness training are thought beneficial to patients with phobias and panic disorder. **Hydrotherapy** is useful to some anxious patients because it promotes general relaxation of the nervous system. **Yoga**, aikido, **t'ai chi**, and dance therapy help patients work with the physical, as well as the emotional, tensions that either promote anxiety or are created by the anxiety.

Homeopathy and **traditional Chinese medicine** approach anxiety as a symptom of a systemic disorder. Homeopathic practitioners select a remedy based on other associated symptoms and the patient's general constitution. Chinese medicine regards anxiety as a blockage of *qi*, or vital force, inside the patient's body that is most likely to affect the lung and large intestine meridian flow. The practitioner of Chinese medicine chooses **acupuncture** point locations and/or herbal therapy to move the qi and rebalance the entire system in relation to the lung and large intestine.

Aromatherapy using essential oils can also be beneficial in treating patients with anxiety. The oils go directly to the brain via the olfactory nerve (which controls smell) and can have direct affect on calming the nervous system.

Prognosis

The prognosis for resolution of anxiety depends on the specific disorder and a wide variety of factors, including the patient's age, sex, general health, living situation, belief system, social support network, and responses to different anxiolytic medications and forms of therapy.

Prevention

Humans have significant control over thoughts, and, therefore, may learn ways of preventing anxiety by changing irrational ideas and beliefs. Humans also have some power over anxiety arising from social and environmental conditions. Other forms of anxiety, however, are built into the human organism and its life cycle, and cannot be prevented or eliminated.

Resources

BOOKS

"Anxiety Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics & Psychiatric Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Corbman, Gene R. "Anxiety Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

KEY TERMS

Affect—An observed emotional expression or response. In some situations, anxiety would be considered an inappropriate affect.

Anxiolytic—A type of medication that helps to relieve anxiety.

Autonomic nervous system (ANS)—The part of the nervous system that supplies nerve endings in the blood vessels, heart, intestines, glands, and smooth muscles, and governs their involuntary functioning. The autonomic nervous system is responsible for the biochemical changes involved in experiences of anxiety.

Endocrine gland—A ductless gland, such as the pituitary, thyroid, or adrenal gland, that secretes its products directly into the blood or lymph.

Free-floating anxiety—Anxiety that lacks a definite focus or content.

Hyperarousal—A state or condition of muscular and emotional tension produced by hormones released during the fight-or-flight reaction.

Hypothalamus—A portion of the brain that regulates the autonomic nervous system, the release of hormones from the pituitary gland, sleep cycles, and body temperature.

Limbic system—A group of structures in the brain that includes the hypothalamus, amygdala, and hippocampus. The limbic system plays an important part in regulation of human moods and emotions. Many psychiatric disorders are related to malfunctioning of the limbic system.

Phobia—In psychoanalytic theory, a psychological defense against anxiety in which the patient displaces anxious feelings onto an external object, activity, or situation.

Doctor, Ronald M., and Ada P. Kahn. *The Encyclopedia of Phobias, Fears, and Anxieties.* New York: Facts On File, 1989.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Gaylin, Willard. *Feelings: Our Vital Signs.* New York: Ballantine Books, 1979.

Kabat-Zinn, Jon. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness.* New York: Bantam Doubleday Dell Publishing Group, Inc., 1990.

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Anxiety disorders

Definition

The **anxiety** disorders are a group of mental disturbances characterized by anxiety as a central or core symptom. Although anxiety is a commonplace experience, not everyone who experiences it has an anxiety disorder. Anxiety is associated with a wide range of physical illnesses, medication side effects, and other psychiatric disorders.

The revisions of the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* that took place after 1980 brought major changes in the classification of the anxiety disorders. Prior to 1980, psychiatrists classified patients on the basis of a theory of causality that defined anxiety as the outcome of unconscious conflicts in the patient's mind. *DSM-III* (1980), *DSM-III-R* (1987), and *DSM-IV* (1994) introduced and refined a new classification that took into consideration recent discoveries about the biochemical and post-traumatic origins of some types of anxiety. The present definitions are based on the external and reported symptom patterns of the disorders rather than on theories about their origins.

Description

Anxiety disorders are the most common form of mental disturbance in the United States population. It is estimated that 28 million persons suffer from an anxiety disorder every year. These disorders are a serious problem for the entire society because of their interference with patients' work, schooling, and family life. They also contribute to the high rates of alcohol and substance abuse in the United States. Anxiety disorders are an additional problem for health professionals because the physical symptoms of anxiety frequently bring people to primary care doctors or emergency rooms.

DSM-IV defines twelve types of anxiety disorders in the adult population. They can be grouped under seven headings:

- Panic disorders with or without **agoraphobia**. The chief characteristic of **panic disorder** is the occurrence of panic attacks coupled with fear of their recurrence. In clinical settings, agoraphobia is usually not a disorder by itself, but is typically associated with some form of panic disorder. Patients with agoraphobia are afraid of places or situations in which they might have a panic attack and be unable to leave or to find help. About 25% of patients with panic disorder develop **obsessive-compulsive disorder** (OCD).
- **Phobias**. These include specific phobias and social phobia. A phobia is an intense irrational fear of a spe-

cific object or situation that compels the patient to avoid it. Some phobias concern activities or objects that involve some risk (for example, flying or driving) but many are focused on harmless animals or other objects. Social phobia involves a fear of being humiliated, judged, or scrutinized. It manifests itself as a fear of performing certain functions in the presence of others, such as public speaking or using public lavatories.

- Obsessive-compulsive disorder (OCD). This disorder is marked by unwanted, intrusive, persistent thoughts or repetitive behaviors that reflect the patient's anxiety or attempts to control it. It affects between 2-3% of the population and is much more common than was previously thought.
- **Stress** disorders. These include **post-traumatic stress disorder** (PTSD) and **acute stress disorder**. Stress disorders are symptomatic reactions to traumatic events in the patient's life.
- **Generalized anxiety disorder** (GAD). GAD is the most commonly diagnosed anxiety disorder and occurs most frequently in young adults.
- Anxiety disorders due to known physical causes. These include general medical conditions or substance abuse.
- Anxiety disorder not otherwise specified. This last category is not a separate type of disorder, but is included to cover symptoms that do not meet the specific *DSM-IV* criteria for other anxiety disorders.

All *DSM-IV* anxiety disorder diagnoses include a criterion of severity. The anxiety must be severe enough to interfere significantly with the patient's occupational or educational functioning, social activities or close relationships, and other customary activities.

The anxiety disorders vary widely in their frequency of occurrence in the general population, age of onset, family patterns, and gender distribution. The stress disorders and anxiety disorders caused by medical conditions or substance abuse are less age- and gender-specific. Whereas OCD affects males and females equally, GAD, panic disorder, and specific phobias all affect women more frequently than men. GAD and panic disorders are more likely to develop in young adults, while phobias and OCD can begin in childhood.

Anxiety disorders in children and adolescents

DSM-IV defines one anxiety disorder as specific to children, namely, separation anxiety disorder. This disorder is defined as anxiety regarding separation from home or family that is excessive or inappropriate for the child's age. In some children, separation anxiety takes the form of school avoidance.

Children and adolescents can also be diagnosed with panic disorder, phobias, generalized anxiety disorder, and the post- traumatic stress syndromes.

Causes and symptoms

The causes of anxiety include a variety of individual and general social factors, and may produce physical, cognitive, emotional, or behavioral symptoms. The patient's ethnic or cultural background may also influence his or her vulnerability to certain forms of anxiety. Genetic factors that lead to biochemical abnormalities may also play a role.

Anxiety in children may be caused by suffering from abuse, as well as by the factors that cause anxiety in adults.

Diagnosis

The diagnosis of anxiety disorders is complicated by the variety of causes of anxiety and the range of disorders that may include anxiety as a symptom. Many patients who suffer from anxiety disorders have features or symptoms of more than one disorder. Patients whose anxiety is accounted for by another psychic disorder, such as **schizophrenia** or major depression, are not diagnosed with an anxiety disorder. A doctor examining an anxious patient will usually begin by ruling out diseases that are known to cause anxiety and then proceed to take the patient's medication history, in order to exclude side effects of prescription drugs. Most doctors will ask about **caffeine** consumption to see if the patient's dietary habits are a factor. The patient's work and family situation will also be discussed. Laboratory tests for blood sugar and thyroid function are also common

Diagnostic testing for anxiety

There are no laboratory tests that can diagnose anxiety, although the doctor may order some specific tests to rule out disease conditions. Although there is no psychiatric test that can provide definite diagnoses of anxiety disorders, there are several short-answer interviews or symptom inventories that doctors can use to evaluate the intensity of a patient's anxiety and some of its associated features. These measures include the Hamilton Anxiety Scale and the Anxiety Disorders Interview Schedule (ADIS).

Treatment

For relatively mild anxiety disorders, psychotherapy alone may suffice. In general, doctors prefer to use a combination of medications and psychotherapy with more severely anxious patients. Most patients respond better to a combination of treatment methods than to either med-

ications or psychotherapy in **isolation**. Because of the variety of medications and treatment approaches that are used to treat anxiety disorders, the doctor cannot predict in advance which combination will be most helpful to a specific patient. In many cases the doctor will need to try a new medication or treatment over a six- to eight-week period in order to assess its effectiveness. Treatment trials do not necessarily mean that the patient cannot be helped or that the doctor is incompetent.

Although anxiety disorders are not always easy to diagnose, there are several reasons why it is important for patients with severe anxiety symptoms to get help. Anxiety doesn't always go away by itself; it often progresses to panic attacks, phobias, and episodes of depression. Untreated anxiety disorders may eventually lead to a diagnosis of major depression, or interfere with the patient's education or ability to keep a job. In addition, many anxious patients develop addictions to drugs or alcohol when they try to "medicate" their symptoms. Moreover, since children learn ways of coping with anxiety from their parents, adults who get help for anxiety disorders are in a better position to help their families cope with factors that lead to anxiety than those who remain untreated.

Alternative treatment

Alternative treatments for anxiety cover a variety of approaches. **Meditation** and mindfulness training are thought beneficial to patients with phobias and panic disorder. **Hydrotherapy** is useful to some anxious patients because it promotes general relaxation of the nervous system. **Yoga**, aikido, **t'ai chi**, and dance therapy help patients work with the physical, as well as the emotional, tensions that either promote anxiety or are created by the anxiety.

Homeopathy and **traditional Chinese medicine** approach anxiety as a symptom of a systemic disorder. Homeopathic practitioners select a remedy based on other associated symptoms and the patient's general constitution. Chinese medicine regards anxiety as a blockage of *qi*, or vital force, inside the patient's body that is most likely to affect the lung and large intestine meridian flow. The practitioner of Chinese medicine chooses **acupuncture** point locations and/or herbal therapy to move the qi and rebalance the entire system in relation to the lung and large intestine.

Aromatherapy using essential oils can also be beneficial in treating patients with anxiety. The oils go directly to the brain via the olfactory nerve (which controls smell) and can have direct affect on calming the nervous system.

Prognosis

The prognosis for recovery depends on the specific disorder, the severity of the patient's symptoms, the specific causes of the anxiety, and the patient's degree of control over these causes.

KEY TERMS

Agoraphobia—Abnormal anxiety regarding public places or situations from which the patient may wish to flee or in which he or she would be helpless in the event of a panic attack.

Compulsion—A repetitive or ritualistic behavior that a person performs to reduce anxiety. Compulsions often develop as a way of controlling or "undoing" obsessive thoughts.

Obsession—A repetitive or persistent thought, idea, or impulse that is perceived as inappropriate and distressing.

Panic attack—A time-limited period of intense fear accompanied by physical and cognitive symptoms. Panic attacks may be unexpected or triggered by specific cues.

Prevention

Anxiety is an unavoidable feature of human existence. However, humans do have some power over their reactions to anxiety- provoking events and situations. Cognitive therapy and meditation or mindfulness training appear to be beneficial in helping people lower their long-term anxiety levels.

Resources

BOOKS

"Anxiety Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics & Psychiatric Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Corbman, Gene R. "Anxiety Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Doctor, Ronald M., and Ada P. Kahn. *The Encyclopedia of Phobias, Fears, and Anxieties*. New York: Facts On File, 1989.

Gaylin, Willard. *Feelings: Our Vital Signs*. New York: Ballantine Books, 1979.

Nemiah, John C. "Psychoneurotic Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

"Psychiatric Disorders: Anxiety Neurosis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

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Anxiolytics *see* **Antianxiety drugs**

Aortic aneurysm

Definition

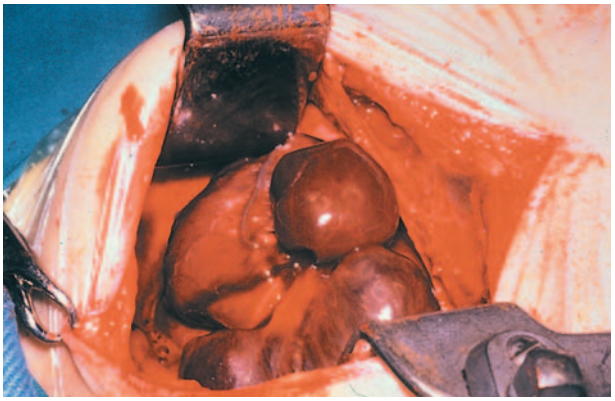
An aneurysm is an abnormal bulging or swelling of a portion of a blood vessel. The aorta, which can develop these abnormal bulges, is the large blood vessel that carries oxygen-rich blood away from the heart to the rest of the body.

Description

The aorta carries oxygen-rich blood to the body, and is therefore called an artery. Because the aorta is an artery, its walls are made of up three layers; a thin inner layer, a muscular middle layer (that gives the vessel its flexibility under pressure from the filling blood), and a fiber-like outer layer that gives the vessel strength to not burst when the heart pumps blood to the body.

Aortic aneurysms occur when a weakness develops in part of the wall of the aorta; three basic types are usually found. If all three layers of the vessel are affected and weakness develops along an extended area of the vessel, the weakened area will appear as a large, bulging region of blood vessel; this is called a fusiform aneurysm. If weakness develops between the inner and outer layers of the aortic wall, a bulge results as blood from the interior of the vessel is pushed around the damaged region in the wall and collects between these layers. This is called a dissecting aneurysm because one layer is "dissected" or separated from another. If damage occurs to only the middle (muscular) layer of the vessel, a sack-like bulge can form; therefore, this is a saccular aneurysm.

An aneurysm in progress. An aneurysm is an abnormal bulging or swelling of a portion of a blood vessel. *(Custom Medical Stock Photo. Reproduced by permission.)*



Surgery being performed to correct aortic aneurysm. *(Custom Medical Stock Photo. Reproduced by permission.)*

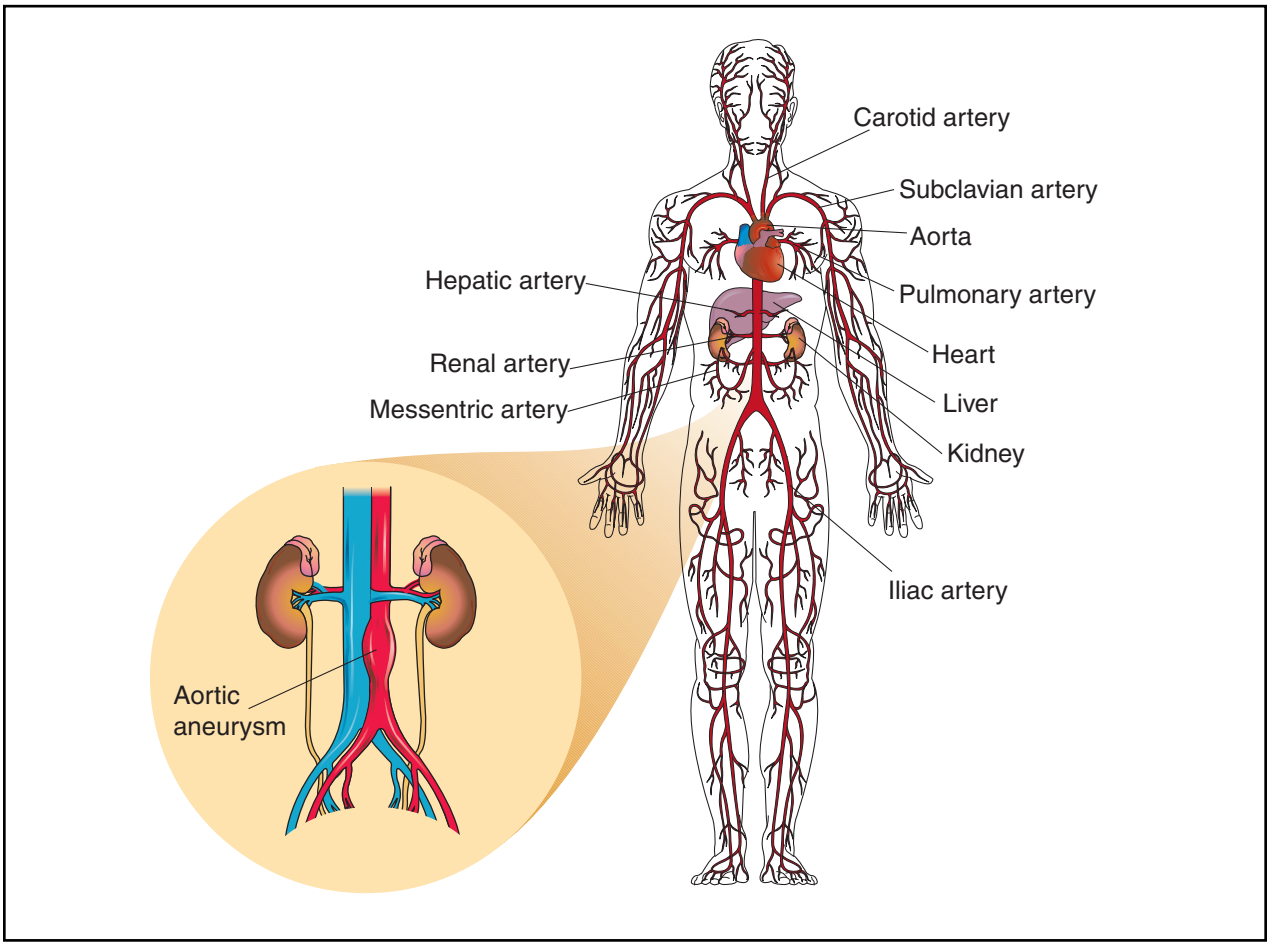
Causes and symptoms

Aortic aneurysms occur in different portions of the aorta, which begins in the chest (at the heart) and travels downward through the abdomen. Aneurysms found in the region of the aorta within the chest are called thoracic aortic aneurysms. Aneurysms that occur in the part of the aorta within the abdomen are called abdominal aortic aneurysms.

Thoracic aortic aneurysms do not usually produce any noticeable symptoms. However, as the aneurysm becomes larger, chest, shoulder, neck, lower back, or abdominal **pain** can result. Abdominal aortic aneurysms occur more often in men, and these aneurysms can cause pain in the lower back, hips, and abdomen. A painful abdominal aortic aneurysm usually means that the aneurysm could burst very soon.

Most abdominal aortic aneurysms are caused by **atherosclerosis**, a condition caused when fat (mostly cholesterol) carried in the blood builds up in the inner wall of the aorta. As more and more fat attaches to the aortic wall, the wall itself becomes abnormally weak and often results in an aneurysm or bulge.

Aortic aneurysms are also caused by a breakdown of the muscular middle layer of the artery wall, by high blood pressure, by direct injury to the chest, and although rare, by bacteria that can infect the aorta.



Aortic aneurysms occur when a weakness develops in a part of the wall of the aorta. The aorta is the large blood vessel that carries oxygen-rich blood away from the heart to the rest of the body. *(Illustration by Electronic Illustrators Group.)*

Diagnosis

Silent, stable aneurysms are often detected when a person has an x ray as part of a routine examination or for other medical reasons. Otherwise, when chest, abdominal, or back pain is severe, aortic aneurysm is suspected and x-ray (radiographic) studies can confirm or rule out that condition.

Treatment

Aortic aneurysms are potentially life-threatening conditions. Small aneurysms should be monitored for their rate of growth and large aneurysms require consideration for a surgical repair. The most common method of surgical repair is to cut out the bulging section of artery wall and sew a Dacron fiber material into its place in the vessel wall.

Prognosis

Only 1-2% of people die from having surgical repair of an aortic aneurysm. However, if the aneurysm is untreated and eventually ruptures, less than half of the people with ruptured aneurysms will survive. The challenge for the physician is to decide when or if to do the preventive surgery.

Prevention

Aneuryms can develop in people with atherosclerosis. High blood pressure can also lead to this condition. Although no definite prevention exists, lifestyle and dietary changes that help lower blood pressure and the amount of fat in the blood stream may slow the development of aneurysms.

Resources

BOOKS

"Aneurysms and Other Vascular Disorders." In *Cardiovascular Diseases and Disorders Sourcebook*, ed. Karen Bellenir and Peter D. Dresser. Detroit: Omnigraphics, Inc., 1995.

Dzau, Victor J., and Mark A.Creager. "Diseases of the Aorta." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw Hill, 1997.

KEY TERMS

Atherosclerosis—The accumulation of fat on the inner wall of an artery. This fat is largely made up of cholesterol being carried in the blood.

Dacron—A synthetic polyester fiber used to surgically repair damaged sections of blood vessel walls.

Lindsay, Joseph L., Michael E. DeBakey, and Arthur C. Beall. "Diagnosis and Treatment of Diseases of the Aorta." In *Hurst's The Heart*, ed. Robert C. Schlant, et al. New York: McGraw Hill, 1994.

PERIODICALS

van der Vleit, J. Adam, and Albert P. M. Boll. "Abdominal Aortic Aneurysm." *The Lancet* 349 (22 Mar. 1997): 863.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Dominic De Bellis, PhD

Aortic dissection

Definition

Aortic dissection is a rare, but potentially fatal, condition in which blood passes through the inner lining and between the layers of the aorta. The dissecting aorta usually does not burst, but has an abnormal second channel within it.

Description

A defect in the inner lining of the aorta allows an opening or tear to develop. The aorta is the main artery of the body and is an area of high blood pressure. When a defect develops, blood pressure can force the tear to open and allow blood to pass through. Since the blood is under pressure, it eventually splits (dissecting) the middle layer of the blood vessel, creating a new channel for blood. The length of the channel grows over time and can result in the closing off of connection points to other arteries. This can lead to **heart attack**, strokes, abdominal **pain**, and nerve damage. Blood may leak from the dissection and collect in the chest an around the heart.

A second mechanism leading to aortic dissection is medial hemorrhage. A medial hemorrhage occurs in the middle layer of the blood vessel and spills through the inner lining of the aorta wall. This opening then allows blood from the aorta to enter the vessel wall and begin a dissection. Approximately 2,000 cases of aortic dissection occur yearly in the United States.

Causes and symptoms

Aortic dissection is caused by a deterioration of the inner lining of the aorta. There are a number of conditions that predispose a person to develop defects of the inner lining, including high blood pressure, Marfan's disease, **Ehlers-Danlos syndrome**, connective tissue diseases, and defects of heart development which begin during fetal development. A dissection can also occur accidentally following insertion of a catheter, trauma, or surgery. The main symptom is sudden, intense pain. The pain can be so intense as to immobilize the patient and cause him to fall to the ground. The pain is frequently felt in both the chest and in the back, between the shoulder blades. The extent of the pain is proportional to the length of the dissection.

Diagnosis

The pain experienced by the patient is the first symptom of aortic dissection and is unique. The pain is usually described by the patient as "tearing, ripping, or stabbing." This is in contrast to the pain associated with heart attacks. The patient frequently has a reduced or absent pulse in the extremities. A murmur may be heard if the dissection is close to the heart. An enlarged aorta will usually appear in the chest x rays and ultrasound exams of most patients. The use of a blood dye in angiograms and/or CT scans (**computed tomography scans**) will aid in diagnosing and visualizing the dissection.

Treatment

Because of the potentially fatal nature of aortic dissection, patients are treated immediately. Drugs are administered to reduce the blood pressure and heart rate. If the dissection is small, drug therapy alone may be used. In other cases, surgery is performed. In surgery, damaged sections of the aorta are removed and a synthetic graft is often used to reconstruct the damaged vessel.

Prognosis

Depending on the nature and extent of the dissection, **death** can occur within a few hours of the start of a dissection. Approximately 75% of untreated people die with-

KEY TERMS

Dissection—A cut or divide.

Hemorrhage—A large discharge of blood, profuse bleeding.

in two weeks of the start of a dissection. Of those who are treated, 40% survive more than 10 years. Patients are usually given long term treatment with drugs to reduce their blood pressure, even if they have had surgery.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Braunwald, E. *Heart Disease*. Philadelphia: W. B. Saunders Co., 1997.

John T. Lohr, PhD

Aortic incompetence *see* **Aortic valve insufficiency**

Aortic regurgitation *see* **Aortic valve insufficiency**

Aortic stenosis *see* **Aortic valve stenosis**

Aortic valve insufficiency

Definition

The aortic valve separates the left ventricle of the heart (the heart's largest pumping chamber) from the aorta, the large artery that carries oxygen-rich blood out of the left ventricle to the rest of the body. In aortic valve insufficiency, the aortic valve becomes leaky, causing blood to flow backwards into the left ventricle.

Description

Aortic valve insufficiency occurs when this valve cannot properly close after blood that is leaving the heart's left ventricle enters the aorta. With each contraction of the heart more and more blood flows back into the left ventricle, causing the ventricle to become overfilled. This larger-than-normal amount of blood that collects in the left ventricle puts pressure on the walls of the heart, causing the heart muscle to increase in thickness (hypertrophy). If this thickening continues, the heart can be permanently damaged.

Aortic valve insufficiency is also know as aortic valve regurgitation because of the abnormal reversed flow of blood leaking through the poorly functioning valve.

Causes and symptoms

The faulty working of the aortic valve can be caused by a birth defect; by abnormal widening of the aorta (which can be caused by very high blood pressure and a variety of other less common conditions); by various diseases that cause large amounts of swelling (inflammation) in different areas of the body, like **rheumatic fever**; and, although rarely, by the sexually transmitted disease, **syphilis**.

About 75% of people with aortic valve insufficiency are men. Rheumatic (inflammatory) diseases have been the main cause of this condition in both men and women.

Aortic valve insufficiency can remain unnoticed for 10 to 15 years. In cases of severe insufficiency a person may notice a variety of symptoms, including an uncomfortable pounding of the heart when lying down, a very rapid or hard heart beat (**palpitations**), **shortness of breath**, chest **pain**, and if untreated for very long times, swelling of the liver, ankles, and belly.

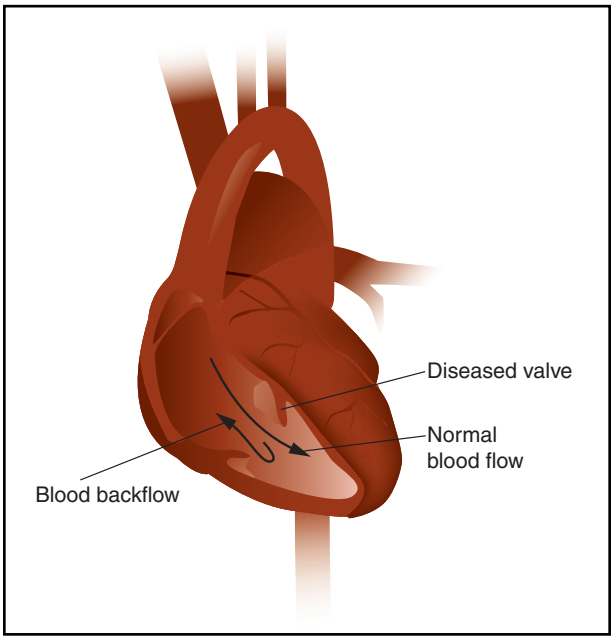
Diagnosis

A poorly functioning or insufficient aortic valve can be identified when a doctor listens to the heart during a **physical examination**. A **chest x ray**, an electrocardiogram (ECG, an electrical printout of the heart beats), as well as an echocardiogram (a test that uses sound waves to create an image of the heart and its valves), can further evaluate or confirm the condition.

Treatment

Aortic insufficiency is usually corrected by having the defective valve surgically replaced. However, such an operation is done in severe cases. Before the condition worsens, certain drugs can be used to help manage this condition.

Drugs that remove water from the body, drugs that lower blood pressure, and drugs that help the heart beat more effectively can each be used for this condition. Reducing the amount of salt in the diet also helps lower the amount of fluid the body holds and can help the heart to work more efficiently as well.



A human heart with a diseased valve that doesn't open and close properly, allowing blood to backflow to the heart. *(Illustration by Argosy, Inc.)*

In cases of a severely malfunctioning valve that has been untreated for a long time, surgery is the treatment of choice, especially if the heart is not functioning normally. Human heart valves can be replaced with man-made valves or with valves taken from pig hearts.

Prognosis

Although drug treatment can help put off the need for surgical valve replacement, it is important to replace the faulty valve before the heart muscle itself is damaged beyond recovery.

Resources

BOOKS

Braunwald, Eugene. "Valvular Heart Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw Hill, 1997.

"Heart Valve Surgery." In *Cardiovascular Diseases and Disorders Sourcebook*, ed. Karen Bellenir and Peter D. Dresser. Detroit: Omnigraphics, Inc., 1995.

PERIODICALS

Carabello, Blase A., and Fred A. Crawford Jr. "Valvular Heart Disease." *New England Journal of Medicine* 337 (3 July 1997): 32-41.

Condos Jr., William R. "Decade-old Heart Drug May Have a New Use." *San Diego Business Journal* 18 (21 July 1997): 24.

KEY TERMS

Rheumatic fever—A disease believed to be caused by a bacterium named group A streptococcus. This bacterium causes a sore "strep throat" and can also result in fever. Infection by this bacterium can also damage the heart and its valves, but how this takes place is not clearly understood.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Dominic De Bellis, PhD

Aortic valve stenosis

Definition

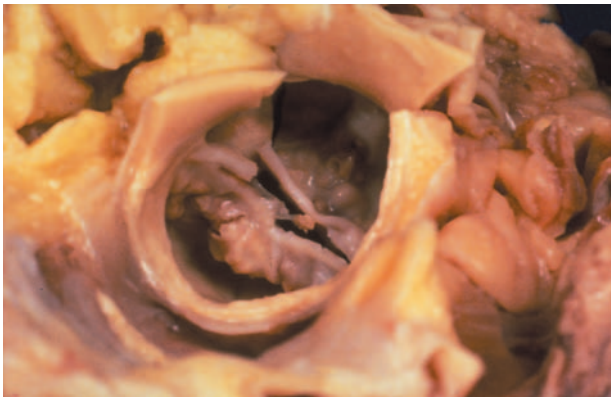
When aortic valve stenosis occurs, the aortic valve, located between the aorta and left ventricle of the heart, is narrower than normal size.

Description

A normal aortic valve, when open, allows the free flow of blood from the left ventricle to the aorta. When the valve narrows, as it does with stenosis, blood flow is impeded. Because it is more difficult for blood to flow through the valve, there is increased strain on the heart. This can cause the left ventricle to enlarge and malfunction, resulting in reduced blood supply to the heart muscle and body, as well as fluid build up in the lungs.

Cause and symptoms

Aortic valve stenosis can occur because of a birth defect in the formation of the valve. Calcium deposits may form on the valve with **aging**, causing the valve to become stiff and narrow. Stenosis can also occur as a result of **rheumatic fever**. Mild aortic stenosis may produce no symptoms at all. The most common symptoms, depending on the severity of the disease, are chest **pain**, blackouts, and difficulty breathing.



A close-up view of a calcified stenosis of the aortic valve. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Aorta—The largest artery in the body, which moves blood from the left ventricle to the rest of the body.

ECG—Also called an electrocardiogram, it records the electrical activity of the heart.

Echocardiogram—A procedure in which high frequency sound waves harmlessly bounce off organs in the body providing an image so one can determine their structure and function.

Cardiac catheterization—A procedure in which dye is injected through a tube or catheter into an artery to more easily observe valves or blood vessels seen on an x ray.

Left ventricle—One of the lower chambers of the heart, which pumps blood to the aorta.

Murmur—An abnormal heart sound that can reflect a valve dysfunction.

Rheumatic fever—A bacterial infection that often causes heart inflammation.

Pulmonary valve—The valve located between the pulmonary artery and the right ventricle, which brings blood to the lungs.

Diagnosis

Using a stethoscope, a physician may hear a murmur and other abnormal heart sounds. An ECG, also called an electrocardiogram, records the electrical activity of the heart. This technique and **chest x ray** can show evidence that the left ventricle is enlarged. An x ray can also reveal calcium deposits on the valve, as well as congestion in the lungs. **Echocardiography** can pick up thickening of the valve, heart size, and whether or not the valve is working properly. This is a procedure in which high frequency sound waves harmlessly bounce off organs in the body. **Cardiac catheterization**, in which a contrast dye is injected in an artery using a catheter, is the key tool to confirm stenosis and gauge its severity.

Treatment

Treatment depends on the symptoms and how the heart's function is affected. The valve can be opened without surgery by using a balloon catheter, but this is often a temporary solution. The procedure involves inserting a deflated balloon at the end of a catheter through the arteries to the valve. Inflating the balloon should widen the valve. In severe stenosis, **heart valve replacement** is recommended, most often involving open-heart surgery. The valve can be replaced with a mechanical valve, a valve from a pig, or by moving the patient's other heart valve (pulmonary) into the position of the aortic valve and then replacing the pulmonary valve with an mechanical one. Anyone with aortic stenosis needs to take **antibiotics** (amoxicillin, erythromycin, or clindamycin) before dental and some other surgical procedures, to prevent a heart valve infection.

Prognosis

The prognosis for aortic valve stenosis depends on the severity of the disease. With surgical repair, the disease is curable. Patients suffering mild stenosis can usually lead a normal life; a minority of the patients progress to severe disease. Anyone with moderate stenosis should avoid vigorous physical activity. Most of these patients end up suffering some kind of coronary heart disease over a 10 year period. Because it is a progressive disease, moderate and severe stenosis will be treated ultimately with surgery. Severe disease, if left untreated, leads to **death** within 2 to 4 years once the symptoms start.

Prevention

There is no way to prevent aortic stenosis.

Resources

BOOKS

Bender, Jeffrey R. "Heart Valve Disease." In *Yale University School of Medicine Heart Book*, ed. Barry L. Zaret, et al. New York: Hearst Books, 1992.

Braunwald, E. "Aortic Stenosis." In *Heart Disease: A Textbook of Cardiovascular Medicine.* Philadelphia: W. B. Saunders Co., 1997.

McGoon, Michael D. "Aortic Stenosis." In *Mayo Clinic Heart Book.* New York: William Morrow and Co., 1993.

OTHER

"Aortic Stenosis." *Ochsner Heart and Vascular Institute*. <http://www.ochsner.org/pedcard/as.htm>.

Rahimtoola, Aly. "Aortic Stenosis." *Loyola University Health System Page*. <http://www.luhs.org>.

Jeanine Barone, Physiologist

KEY TERMS

Acrocyanosis—A slight cyanosis, or blueness of the hands and feet of the neonate is considered normal. This impaired ability to fully oxygenate the extremities is due to an immature circulatory system which is still in flux.

Amniotic fluid—The protective bag of fluid that surrounds the fetus while growing in the uterus.

Neonate—A term referring to the newborn infant, from birth until one month of age.

Neonatologist—A physician who specializes in problems of newborn infants.

Pallor—Extreme paleness in the color of the skin.

Apgar testing

Definition

Apgar testing is the assessment of the newborn rating color, heart rate, stimulus response, muscle tone, and respirations on a scale of zero to two, for a maximum possible score of 10. It is performed twice, first at one minute and then again at five minutes after birth.

Purpose

Apgar scoring was originally developed in the 1950s by the anesthesiologist Virginia Apgar to assist practitioners attending a birth in deciding whether or not a newborn was in need of resuscitation. Using a scoring method fosters consistency and standardization among different practitioners. A February 2001 study published in the *New England Journal of Medicine* investigated whether Apgar scoring continues to be relevant. Researchers concluded that "The Apgar scoring system remains as relevant for the prediction of neonatal survival today as it was almost 50 years ago".

Description

The five areas are scored as follows:

- Appearance, or color: 2 if the skin is pink all over; 1 for **acrocyanosis**, where the trunk and head are pink, but the arms and legs are blue; and 0 if the whole body is blue. Newborns with naturally darker skin color will not be pink. However, pallor is still noticeable, especially in the soles and palms. Color is related to the neonate's ability to oxygenate its body and extremities, and is dependent on heart rate and respirations. A perfectly healthy newborn will often receive a score of 9 because of some blueness in the hands and feet.
- Pulse (heart rate): 2 for a pulse of 100+ beats per minute (bpm); 1 for a pulse below 100 bpm; 0 for no pulse. Heart rate is assessed by listening with a stethoscope to the newborn's heart and counting the number of beats.
- Grimace, or reflex irritability: 2 if the neonate coughs, sneezes, or vigorously cries in response to a stimulus (such as the use of nasal suctioning, stroking the back to assess for spinal abnormalities, or having the foot tapped); 1 for a slight cry or grimace in response to the stimulus; 0 for no response.
- Activity, or muscle tone: 2 for vigorous movements of arms and legs; 1 for some movement; 0 for no movement, limpness.
- Respirations: 2 for visible breathing and crying; 1 for slow, weak, irregular breathing; 0 for apnea, or no breathing. A crying newborn can adequately oxygenate its lungs. Respirations are best assessed by watching the rise and fall of the neonate's abdomen, as infants are diaphragmatic breathers.

The combined first letters in these five areas spell Apgar.

Preparation

No preparation is needed to perform the test. However, while being born the neonate may receive nasal and oral suctioning to remove mucus and amniotic fluid. This may be done when the head of the newborn is safely out, while the mother rests before she continues to push.

Aftercare

Since the test is primarily observational in nature, no aftercare is needed. However, the test may flag the need for immediate intervention or prolonged observation.

Normal results

The maximum possible score is 10, the minimum is zero. It is rare to receive a true 10, as some acrocyanosis in

DR. VIRGINIA APGAR (1909–1974)

(AP/Wide World Photos. Reproduced by permission.)

As one of very few female medical students at Columbia University College of Physicians and Surgeons in New York during the early 1930s and one of the first women to graduate from its medical school, Apgar knew that her goal of becoming a surgeon would not be achieved easily in a male-dominated profession. Reluctantly, she switched her medical specialty to anesthesiology, she embraced her new field with typical intelligence and energy. At this time, anesthesiology was a relatively new field, having been left by the doctors mostly to the attention of nurses. Apgar realized immediately how much in need of scientifically trained personnel was this significant part of surgery, and she set out to make anesthesiology a separate medical discipline. By 1937, she had become the fiftieth physician to be certified as an anesthesiologist in the United States. The following year she was appointed director of anesthesiology at the Columbia-Presbyterian Medical Center, becoming the first woman to head a department at that institution.

As the attending anesthesiologist who assisted in the delivery of thousands of babies during these years, Apgar realized that infants had died from respiratory or circulatory complications that early treatment could have prevented. Apgar decided to bring her considerable research skills to this childbirth dilemma, and her careful study resulted in her publication of the Apgar Score System in 1952.

the newborn is considered normal, and therefore not a cause for concern. Most infants score between 7 and 10. These infants are expected to have an excellent outcome. A score of 4, 5, or 6 requires immediate intervention, usually in the form of oxygen and respiratory assistance, or perhaps just suctioning if breathing has been obstructed by mucus. While suctioning is being done, a source of oxygen may be placed near, but not over the newborn's nose and mouth. This form of oxygen is referred to as *blow-by*. A score in the 4-6 range indicates that the neonate is having some difficulty adapting to extrauterine life. This may be due to medications given to the mother during a difficult labor, or at the very end of labor, when these medications have an exaggerated effect on the neonate.

Abnormal results

With a score of 0-3, the newborn is unresponsive, apneic, pale, limp and may not have a pulse. Interventions to resuscitate will begin immediately. The test is repeated at five minutes after birth and both scores are documented. Should the resuscitation effort continue into the five-minute time period, interventions will not stop in order to perform the test. The one-minute score indicates the need for intervention at birth. It addresses survival and prevention of birth-related complications resulting from inadequate oxygen supply. Poor oxygenation may be due to inadequate neurological and/or chemical control of respiration. The five-minute score appears to have a more predictive value for morbidity and normal development, although research studies on this are inconsistent in their conclusions.

Resources

BOOKS

Doenges, Marilynn E., and Mary Frances Moorhouse.

Feinbloom, Richard I. *Pregnancy, Birth and the Early Months.* Cambridge, MA: Perseus Publishing, 2000.

Pillitteri, Adele. *Maternal & Child Nursing; Care of the Childbearing and Childrearing Family.* 3rd Edition. Philadelphia: Lippincott, 1999.

Spencer, Paula. *Parenting: Guide to Pregnancy and Childbirth.* New York: Ballantine Books, 1998.

PERIODICALS

Casey, B. M., D. D. McIntire, and K. J. Leveno. "The Continuing Value of Apgar Score for the Assessment of Newborn Infants". *New England Journal of Medicine* 344(February 15, 2000): 467-71.

OTHER

Apgar, Virginia. *A Proposal for a New Method of Evaluation of the Newborn Infant*. <http://www.apgarfamily.com/Apgar_Paper.html>.

The National Childbirth Trust. <http://www.nctpregnancyandbabycare.com>.

PregnancyWeekly.com <http://www.pregnancyweekly.com>.

Esther Csapo Rastegari, RN, BSN, EdM

Aphasia

Definition

Aphasia is condition characterized by either partial or total loss of the ability to communicate verbally or using written words. A person with aphasia may have difficulty speaking, reading, writing, recognizing the names of objects, or understanding what other people have said. Aphasia is caused by a brain injury, as may occur during a traumatic accident or when the brain is deprived of oxygen during a **stroke**. It may also be caused by a **brain tumor**, a disease such as Alzheimer's, or an infection, like **encephalitis**. Aphasia may be temporary or permanent. Aphasia does not include speech impediments caused by loss of muscle control.

Description

To understand and use language effectively, an individual draws upon word memory—stored information on what certain words mean, how to put them together, and how and when to use them properly. For a majority of people, these and other language functions are located in the left side (hemisphere) of the brain. Damage to this side of the brain is most commonly linked to the development of aphasia. Interestingly, however, left-handed people appear to have language areas in both the left and right hemispheres of the brain and, as a result, may develop aphasia from damage to either side of the brain.

Stroke is the most common cause of aphasia in the United States. Approximately 500,000 individuals suffer strokes each year, and 20% of these individuals develop some type of aphasia. Other causes of brain damage include head injuries, brain tumors, and infection. About half of the people who show signs of aphasia have what is called temporary or transient aphasia and recover completely within a few days. An estimated one million Americans suffer from some form of permanent aphasia. As yet, no connection between aphasia and age, gender, or race has been found.

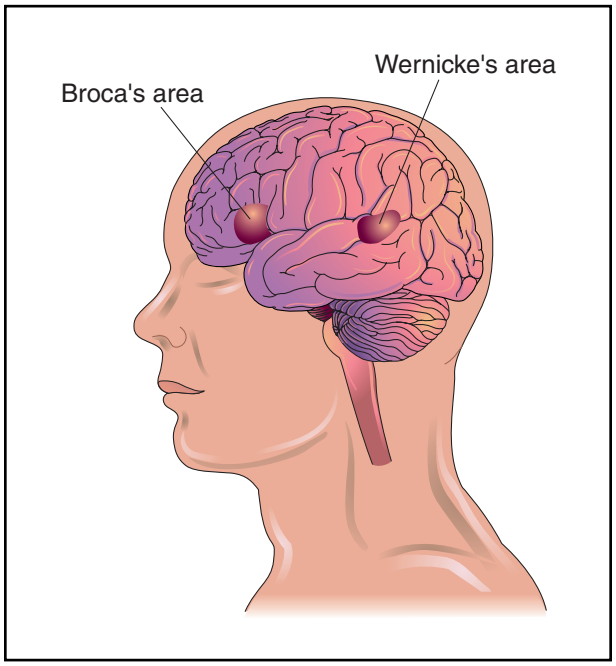
Aphasia is sometimes confused with other conditions that affect speech, such as dysarthria and apraxia. These condition affect the muscles used in speaking rather than language function itself. Dysarthria is a speech disturbance caused by lack of control over the muscles used in speaking, perhaps due to nerve damage. Speech apraxia is a speech disturbance in which language comprehension and muscle control are retained, but the memory of how to use the muscles to form words is not.

Causes and symptoms

Aphasia can develop after an individual sustains a brain injury from a stroke, head trauma, tumor, or infection, such as herpes encephalitis. As a result of this injury, the pathways for language comprehension or production are disrupted or destroyed. For most people, this means damage to the left hemisphere of the brain. (In 95 to 99% of right-handed people, language centers are in the left hemisphere, and up to 70% of left-handed people also have left-hemisphere language dominance.) According to the traditional classification scheme, each form of aphasia is caused by damage to a different part of the left hemisphere of the brain. This damage affects one or more of the basic language functions: speech, naming (the ability to identify an object, color, or other item with an appropriate word or term), repetition (the ability to repeat words, phrases, and sentences), hearing comprehension (the ability to understand spoken language), reading (the ability to understand written words and their meaning), and writing (the ability to communicate and record events with text).

The traditional classification scheme includes eight types of aphasia:

- Broca's aphasia, also called motor aphasia, results from damage to the front portion or frontal lobe of the language-dominant area of the brain. Individuals with Broca's aphasia may be completely unable to use speech (**mutism**) or may be able to use single-word statements or even full sentences, though these sentences may require a great deal of effort to construct. Small words, such as conjunctions (and, or, but) and articles (the, an, a), may be omitted, leading to a "telegraph" quality in their speech. Hearing comprehension is usually not affected, so they are able to understand other people's speech and conversation and can follow commands. Often, they may experience weakness on the right side of their bodies, which can make it difficult to write. Reading ability is impaired, and they may have difficulty finding the right word when speaking. Individuals with Broca's aphasia may become frustrated and depressed because they are aware of their language difficulties.
- Wernicke's aphasia is caused by damage to the side portion or temporal lobe of the language-dominant area



Broca's aphasia results from damage to the frontal lobe of the language-dominant area of the brain. Individuals with Broca's aphasia may become mute or may be able to use single-word statements or full sentences, although it may require great effort. Wernicke's aphasia is caused by damage to the temporal lobe of the language-dominant area of the brain. People with this condition speak in long, uninterrupted sentences, but the words used are often unnecessary and unintelligible. *(Illustration by Electronic Illustrators Group.)*

of the brain. Individuals with Wernicke's aphasia speak in long, uninterrupted sentences; however, the words used are frequently unnecessary or even made-up. They have a great deal of difficulty understanding other people's speech, sometimes to the point of being unable to understand spoken language at all. Reading ability is diminished, and although writing ability is retained, what is written may be abnormal. No physical symptoms, such as the right-sided weakness seen with Broca's aphasia, are typically observed. Also, in contrast to Broca's aphasia, individuals with Wernicke's aphasia are not aware of their language errors.

- Global aphasia is caused by widespread damage to the language areas of the left hemisphere. As a result, all basic language functions are affected, but some areas may be more affected than others. For example, an individual may have difficulty speaking but may be able to write well. The individual may experience weakness and loss of feeling on the right side of their body.
- Conduction aphasia, also called associative aphasia, is rather uncommon. Individuals with conduction aphasia are unable to repeat words, sentences, and phrases. Speech is fairly unbroken, although individuals may frequently correct themselves and words may be skipped or repeated. Although able to understand spoken language, it may also be difficult for the individual with conduction aphasia to find the right word to describe a person or object. The impact of this condition on reading and writing ability varies. As with other types of aphasia, right-sided weakness or sensory loss may be present.
- Anomic or nominal aphasia primarily influences an individual's ability to find the right name for a person or object. As a result, an object may be described rather than named. Hearing comprehension, repetition, reading, and writing are not affected, other than by this inability to find the right name. Speech is fluent, except for pauses as the individual tries to recall the right name. Physical symptoms are variable, and some individuals have no symptoms of one-sided weakness or sensory loss.
- Transcortical aphasia is caused by damage to the language areas of the left hemisphere outside the primary language areas. There are three types of aphasia: transcortical motor aphasia, transcortical sensory aphasia, and mixed transcortical aphasia. All of the transcortical aphasias are distinguished from other types by the individual's ability to repeat words, phrases, or sentences. Other language functions may also be impaired to varying degrees, depending on the extent and particular location of brain damage.

As researchers continue to learn more about the brain's structure and function, new types of aphasia are being recognized. One newly recognized type of aphasia, subcortical aphasia, mimics the symptoms of other traditional types of aphasia but involves language disorders that are not typical. This type of aphasia is associated with injuries to areas of the brain typically not identified with language and language processing.

Diagnosis

Following brain injury, an initial bedside assessment is made to determine whether language function has been affected. If the individual experiences difficulty communicating, attempts are made to determine whether this difficulty arises from impaired language comprehension or an impaired ability to speak. A typical examination involves listening to spontaneous speech and evaluating the individual's ability to recognize and name objects, comprehend what is heard, and repeat sample words and phrases. The individual may also be asked to read text aloud and explain what the passage means. In addition, writing ability is evaluated by having the individual copy text, transcribe dictated text, and write something without prompting.

KEY TERMS

Anomic aphasia—A condition characterized by either partial or total loss of the ability to recall the names of persons or things as a result of a stroke, head injury, brain tumor, or infection.

Broca's aphasia—A condition characterized by either partial or total loss of the ability to express oneself, either through speech or writing. Hearing comprehension is not affected. This condition may result from a stroke, head injury, brain tumor, or infection.

Computed tomography (CT)—An imaging technique that uses cross-sectional x rays of the body to create a three-dimensional image of the body's internal structures.

Conduction aphasia—A condition characterized by the inability to repeat words, sentences, or phrases as a result of a stroke, head injury, brain tumor, or infection.

Frontal lobe—The largest, most forward-facing part of each side or hemisphere of the brain.

Global aphasia—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of widespread injury to the language areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection. The exact language abilities affected vary depending on the location and extent of injury.

Hemisphere—One of the two halves or sides-the left and the right-of the brain.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Subcortical aphasia—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of damage to non language-dominated areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection.

Temporal lobe—The part of each side or hemisphere of the brain that is on the side of the head, nearest the ears.

Transcortical aphasia—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words that does not affect an individual's ability to repeat words, phrases, and sentences.

Wernicke's aphasia—A condition characterized by either partial or total loss of the ability to understand what is being said or read. The individual maintains the ability to speak, but speech may contain unnecessary or made-up words.

A speech pathologist or neuropsychologist may be asked to conduct more extensive examinations using in-depth, standardized tests. Commonly used tests include the Boston Diagnostic Aphasia Examination, the Western Aphasia Battery, and possibly, the Porch Index of Speech Ability.

The results of these tests indicate the severity of the aphasia and may also provide information regarding the exact location of the brain damage. This more extensive testing is also designed to provide the information necessary to design an individualized speech therapy program. Further information about the location of the damage is gained through the use of imaging technology, such as **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT).

Treatment

Initially, the underlying cause of aphasia must be treated or stabilized. To regain language function, therapy must begin as soon as possible following the injury. Although there are no medical or surgical procedures currently available to treat this condition, aphasia resulting from stroke or **head injury** may improve through the use of speech therapy. For most individuals, however, the primary emphasis is placed on making the most of retained language abilities and learning to use other means of communication to compensate for lost language abilities.

Speech therapy is tailored to meet individual needs, but activities and tools that are frequently used include the following:

- **Exercise** and practice. Weakened muscles are exercised by repetitively speaking certain words or making facial expressions, such as smiling.
- Picture cards. Pictures of everyday objects are used to improve word recall and increase vocabulary. The

names of the objects may also be repetitively spoken aloud as part of an exercise and practice routine.

- Picture boards. Pictures of everyday objects and activities are placed together, and the individual points to certain pictures to convey ideas and communicate with others.
- Workbooks. Reading and writing exercises are used to sharpen word recall and regain reading and writing abilities. Hearing comprehension is also redeveloped using these exercises.
- Computers. Computer software can be used to improve speech, reading, recall, and hearing comprehension by, for example, displaying pictures and having the individual find the right word.

Prognosis

The degree to which an individual can recover language abilities is highly dependent on how much brain damage occurred and the location and cause of the original brain injury. Other factors include the individual's age, general health, motivation and willingness to participate in speech therapy, and whether the individual is left or right handed. Language areas may be located in both the left and right hemispheres in left-handed individuals. Left-handed individuals are, therefore, more likely to develop aphasia following brain injury, but because they have two language centers, may recover more fully because language abilities can be recovered from either side of the brain. The intensity of therapy and the time between diagnosis and the start of therapy may also affect the eventual outcome.

Prevention

Because there is no way of knowing when a stroke, traumatic head injury, or disease will occur, very little can be done to prevent aphasia. The extent of recovery, however, in some cases, can be affected by an individual's willingness to cooperate and participate in speech therapy directly following the injury.

Resources

BOOKS

Goodglass, Harold. *Understanding Aphasia.* San Diego: Academic Press, 1993.

Kirshner, Howard S., ed. *Handbook of Neurological Speech and Language Disorders.* New York: Marcel Dekker, Inc., 1995.

LaPointe, Leonard L., ed. *Aphasia and Related Neurogenic Language Disorders.* 2nd ed. New York: Thieme, 1997.

Lyon, Jon G., and Marianne B. Simpson. *Coping with Aphasia.* San Diego: Singular Publishing Group, 1998.

ORGANIZATIONS

National Aphasia Association. 156 5th Ave., Suite 707, New York, NY 10010. (800) 922-4622. <http://www.aphasia.org>.

National Institute on Deafness and Other Communication Disorders. National Institutes of Health, 31 Center Drive, MSC 2320, Bethesda, MD USA 20892-2320. (800) 241-1044. <http://www.nidcd.nih.gov>.

Julia Barrett

Apheres *see* **Transfusion**

Aplastic anemia

Definition

Aplastic anemia is a disorder in which the bone marrow greatly decreases or stops production of blood cells.

Description

The bone marrow (soft tissue which is located within the hard outer shell of the bones) is responsible for the production of all the types of blood cells. The mature forms of these cells include red blood cells, which carry oxygen throughout the body; white blood cells, which fight infection; and platelets, which are involved in clotting. In aplastic anemia, the basic structure of the marrow becomes abnormal, and those cells responsible for generating blood cells (hematopoietic cells) are greatly decreased in number or absent. These hematopoietic cells are replaced by large quantities of fat.

Yearly, aplastic anemia strikes about 5-10 people in every one million. Although aplastic anemia strikes both males and females of all ages, there are two age groups that have an increased risk. Both young adults (between 15-30 years of age) and the elderly (over the age of 60) have higher rates of aplastic anemia than the general population. While the disorder occurs worldwide, young adults in Asia have a higher disease rate than do populations in North America and Europe.

Causes and symptoms

Aplastic anemia falls into three basic categories, based on the origin of its cause: idiopathic, acquired, and hereditary.

In about 60% of cases, aplastic anemia is considered to be idiopathic, meaning that the cause of the disorder is unknown.

Acquired aplastic anemia refers to those cases where certain environmental factors and physical conditions seem to be associated with development of the disease. Acquired aplastic anemia can be associated with:

- exposure to drugs, especially anti-cancer agents, **antibiotics**, anti-inflammatory agents, seizure medications, and antithyroid drugs (drugs given to stop the functioning of an overactive thyroid)
- exposure to radiation
- chemical exposure (especially to the organic solvent benzene and certain insecticides)
- infection with certain viruses (especially those causing viral hepatitis, as well as Epstein-Barr virus, parvovirus, and HIV, the virus which can cause **AIDS**)
- pregnancy
- certain other disorders, including a disease called paroxysmal nocturnal hemoglobinuria, an autoimmune reaction called graft-vs-host disease (which occurs when the body's immune system attacks and destroys the body's own cells), and certain connective tissue diseases

Hereditary aplastic anemia is relatively rare, but does occur in Fanconi's anemia, Shwachman-Diamond syndrome, and dyskeratosis congenita.

Symptoms of aplastic anemia tend to be those of other **anemias**, including **fatigue**, weakness, tiny reddish-purple marks (petechiae) on the skin (evidence of pinpoint hemorrhages into the skin), evidence of abnormal bruising, and bleeding from the gums, nose, intestine, or vagina. The patient is likely to appear pale. If the anemia progresses, decreased oxygen circulating in the blood may lead to an increase in heart rate and the sudden appearance of a new heart murmur.

Diagnosis

The **blood count** in aplastic anemia will reveal low numbers of all formed blood cells. Red blood cells will appear normal in size and coloration, but greatly decreased in number. Cells called reticulocytes (very young red blood cells, which are usually produced in great numbers by the bone marrow in order to compensate for a severe anemia) will be very low in number. Platelets and white blood cells will also be decreased in number, though normal in structure.

A sample of the patient's bone marrow will need to be removed by needle (usually from the hip bone) and examined under a microscope. If aplastic anemia is present, this examination will reveal very few or no hematopoietic cells, and replacement with fat.

Treatment

The first step in the treatment of aplastic anemia involves discontinuing exposure to any substance that may be causing the disorder. Although it would seem that blood transfusions would be helpful in this disease, in fact, they only serve as a temporary help, and may complicate future attempts at **bone marrow transplantation**.

The most successful treatment for aplastic anemia is bone marrow transplantation. To do this, a marrow donor (often a sibling) must be identified. There are a number of tissue markers which must be examined to determine whether a bone marrow donation is likely to be compatible with the patient's immune system. Compatibility is necessary to avoid complications, including the destruction of the donor marrow by the patient's own immune system.

Patients who cannot undergo bone marrow transplant can be treated with a number of agents, including antithymocyte globulin (ATG), cyclophosphamide, steroids, and cyclosporine. These agents all have the potential to cause a number of troublesome side-effects. Furthermore, not all patients respond fully to these agents. Still, even among those patients who do have a good response, many later suffer a relapse (return) of aplastic anemia.

Prognosis

Aplastic anemia is a life-threatening illness. Without treatment, it will almost surely progress to **death**. Survival depends on how severe the disease is at diagnosis, which type of treatment a patient is eligible for, and what kind of response their body has to that treatment. The worst-prognosis type of aplastic anemia is one associated with very low numbers of a particular type of white blood cell. These patients have a high chance of dying from overwhelming bacterial infections. In fact, 80% of all patients treated with blood transfusions alone die within 18 months to two years. Patients who undergo bone marrow transplantation have a 60-90% chance of being cured of the disease.

Resources

BOOKS

Castro-Malaspina, Hugo, and Richard J. O'Reilly. "Aplastic Anemia and Myelodysplastic Syndromes." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Doney, Kristine, et al. "Primary Treatment of Acquired Aplastic Anemia: Outcomes with Bone Marrow Transplantation and Immunosuppressive Therapy." *Annals of Internal Medicine* 126 (15 Jan. 1997): 107+.

KEY TERMS

Bone marrow—A substance found in the cavities of bones, especially the long bones and the sternum (breast bone). The bone marrow contains those cells which are responsible for the production of the blood cells (red blood cells, white blood cells, and platelets).

Bone marrow transplant—A procedure in which a quantity of bone marrow is extracted through a needle from a donor, and then passed into a patient to replace the patient's diseased or absent bone marrow.

Hematopoietic cells—Those cells which are lodged within the bone marrow, and which are responsible for producing the cells which circulate in the blood (red blood cells, white blood cells, and platelets).

Young, Neal. "Aplastic Anaemia." *The Lancet* 346 (22 July 1995): 228+.

Young, Neal, and Jaroslaw Maciejewski. "The Pathophysiology of Acquired Aplastic Anemia." *The New England Journal of Medicine* 336 (8 May 1997): 1365+.

ORGANIZATIONS

Aplastic Anemia Foundation of America. P.O. Box 613, Annapolis, MD 21404. (800) 747-2820. <http://www.aplastic.org>.

Rosalyn Carson-DeWitt, MD

Aplastic crisis *see* **Fifth disease**

Appendectomy

Definition

Appendectomy is the surgical removal of the appendix. The appendix is a worm-shaped hollow pouch attached to the cecum, the beginning of the large intestine.

Purpose

Appendectomies are performed to treat **appendicitis**, an inflamed and infected appendix.

Precautions

Since appendicitis occurs most commonly in males between the ages of 10-14 and in females between the ages of 15-19, appendectomy is most often performed during this time. The diagnosis of appendicitis is most difficult in the very young (less than two years of age) and in the elderly.

Description

Appendectomy is considered a major surgical operation. Therefore, a general surgeon must perform this operation in the operating room of a hospital. An anesthesiologist is also present during the operation to administer an anesthetic. Most often the anesthesiologist uses a general anesthetic technique whereby patients are put to sleep and made **pain** free by administering drugs in the vein or by agents inhaled through a tube placed in the windpipe. Occasionally a spinal anesthetic may be used.

After the patient is anesthetized, the general surgeon can remove the appendix either by using the traditional open procedure (in which a 2-3 [5-7.6 cm] in incision is made in the abdomen) or via **laparoscopy** (in which four 1 in [2.5 cm] incisions are made in the abdomen).

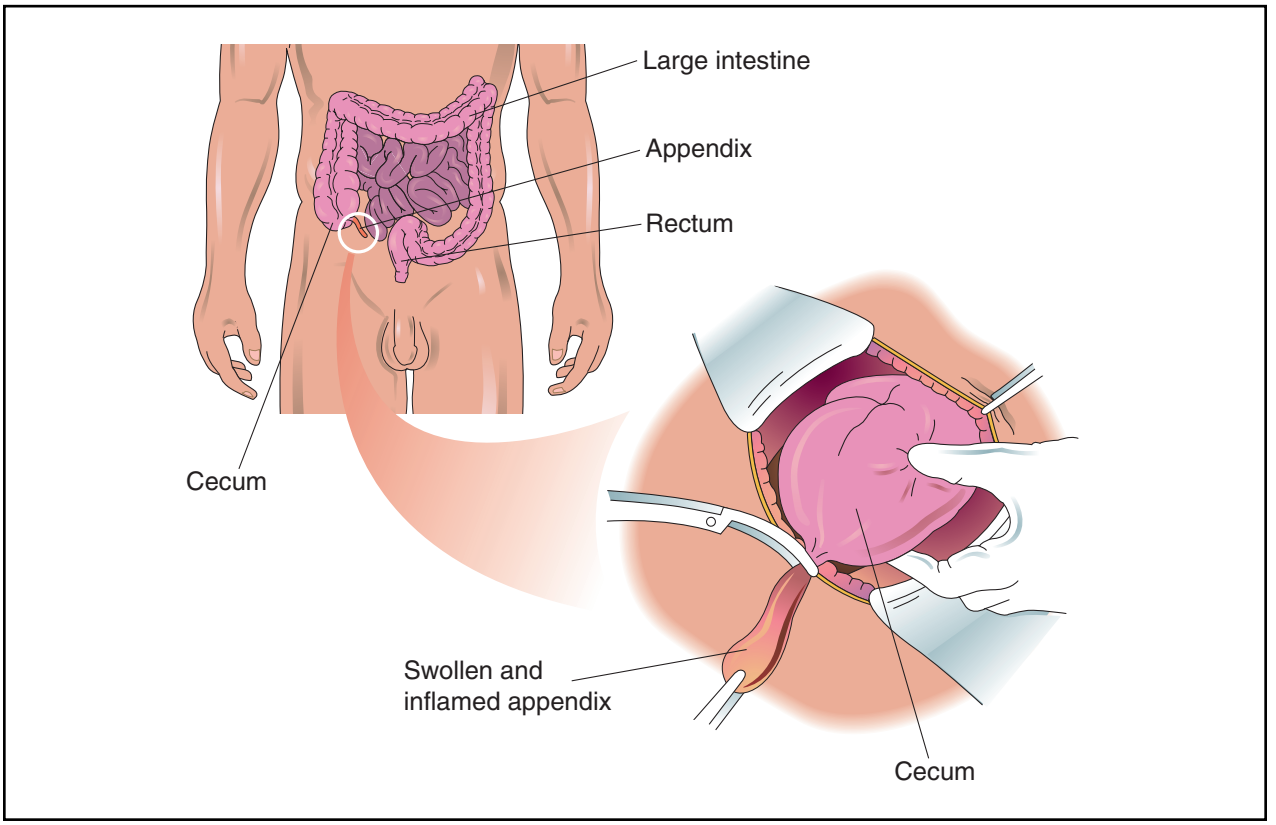
Traditional open appendectomy

When the surgeon uses the open approach, he makes an incision in the lower right section of the abdomen. Most incisions are less than 3 in (7.6 cm) in length. The surgeon then identifies all of the organs in the abdomen and examines them for other disease or abnormalities. The appendix is located and brought up into the **wounds**. The surgeon separates the appendix from all the surrounding tissue and its attachment to the cecum and then removes it. The site where the appendix was previously attached, the cecum, is closed and returned to the abdomen. The muscle layers and then the skin are sewn together.

Laproscopic appendectomy

When the surgeon conducts a laproscopic appendectomy, four incisions, each about 1 in (2.5 cm) in length, are made. One incision is near the umbilicus, or navel, and one is between the umbilicus and the pubis. Two other incisions are smaller and are in the right side of the lower abdomen. The surgeon then passes a camera and special instruments through these incisions. With the aid of this equipment, the surgeon visually examines the abdominal organs and identifies the appendix. Similarly, the appendix is freed from all of its attachments and removed. The place where the appendix was formerly attached, the cecum, is stitched. The appendix is removed through one of the incisions. The instruments are removed and then all of the incisions are closed.

Studies and opinions about the relative advantages and disadvantages of each method are divided. A skilled surgeon can perform either one of these procedures in



A traditional open appendectomy. After the surgeon makes an incision in the lower right section of the abdomen, he/she pulls the appendix up, separates it from the surrounding tissue and its attachment to the cecum, and then removes it. *(Illustration by Electronic Illustrators Group.)*

less than one hour. However, laproscopic appendectomy (LA) always takes longer than traditional appendectomy (TA). The increased time required to do a LA increases the patient's exposure to anesthetics, which increases the risk of complications. The increased time requirement also escalates fees charged by the hospital for operating room time and by the anesthesiologist. Since LA also requires specialized equipment, the fees for its use also increases the hospital charges. Patients with either operation have similar pain medication needs, begin eating **diets** at comparable times, and stay in the hospital equivalent amounts of time. LA is of special benefit in women in whom the diagnosis is difficult and gynecological disease (such as **endometriosis**, **pelvic inflammatory disease**, ruptured ovarian follicles, ruptured **ovarian cysts**, and tubal pregnancies) may be the source of pain and not appendicitis. If LA is done in these patients, the pelvic organs can be more thoroughly examined and a definitive diagnosis made prior to removal of the appendix. Most surgeons select either TA or LA based on the individual needs and circumstances of the patient.

Insurance plans do cover the costs of appendectomy. Fees are charged independently by the hospital and the physicians. Hospital charges include fees for operating and recovery room use, diagnostic and laboratory testing, as well as the normal hospital room charges. Surgical fees vary from region to region and range between $250-$750. The anesthesiologist's fee depends upon the health of the patient and the length of the operation.

Preparation

Once the diagnosis of appendicitis is made and the decision has been made to perform an appendectomy, the patient undergoes the standard preparation for an operation. This usually takes only one to two hours and includes signing the operative consents, patient identification procedures, evaluation by the anesthesiologist, and moving the patient to the operating suites of the hospital. Occasionally, if the patient has been ill for a prolonged period of time or has had protracted vomiting, a delay of few to several hours may be necessary to give the patient fluids and **antibiotics**.

Aftercare

Recovery from an appendectomy is similar to other operations. Patients are allowed to eat when the stomach

and intestines begin to function again. Usually the first meal is a clear liquid diet—broth, juice, soda pop, and gelatin. If patients tolerate this meal, the next meal usually is a regular diet. Patients are asked to walk and resume their normal physical activities as soon as possible. If TA was done, work and physical education classes may be restricted for a full three weeks after the operation. If a LA was done, most patients are able to return to work and strenuous activity within one to three weeks after the operation.

Risks

Certain risks are present when any operation requires a general anesthetic and the abdominal cavity is opened. **Pneumonia** and collapse of the small airways (**atelectasis**) often occurs. Patients who smoke are at a greater risk for developing these complications. **Thrombophlebitis**, or inflammation of the veins, is rare but can occur if the patient requires prolonged bed rest. Bleeding can occur but rarely is a blood **transfusion** required. Adhesions (abnormal connections to abdominal organs by thin fibrous tissue) is a known complication of any abdominal procedure such as appendectomy. These adhesions can lead to intestinal obstruction which prevents the normal flow of intestinal contents. **Hernia** is a complication of any incision, However, they are rarely seen after appendectomy because the abdominal wall is very strong in the area of the standard appendectomy incision.

The overall complication rate of appendectomy depends upon the status of the appendix at the time it is removed. If the appendix has not ruptured the complication rate is only about 3%. However, if the appendix has ruptured the complication rate rises to almost 59%. Wound infections do occur and are more common if the appendicitis was severe, far advanced, or ruptured. An **abscess** may form in the abdomen as a complication of appendicitis.

Occasionally, an appendix will rupture prior to its removal, spilling its contents into the abdominal cavity. **Peritonitis** or a generalized infection in the abdomen will occur. Treatment of peritonitis as a result of a ruptured appendix includes removal of what remains of the appendix, insertion of drains (rubber tubes that promote the flow of infection inside the abdomen to outside of the body), and antibiotics. Fistula formation (an abnormal connection between the cecum and the skin) rarely occurs. It is only seen if the appendix has a broad attachment to the cecum and the appendicitis is far advanced causing destruction of the cecum itself.

Normal results

Most patients feel better immediately after an operation for appendicitis. Many patients are discharged from the hospital within 24 hours after the appendectomy. Others may require a longer stay—three to five days. Almost all patients are back to their normal activities within three weeks.

The mortality rate of appendicitis has dramatically decreased over time. Currently, the mortality rate is estimated at one to two per 1,000,000 cases of appendicitis. **Death** is usually due to peritonitis, intra abdominal abscess or severe infection following rupture.

The complications associated with undiagnosed, misdiagnosised, or delayed diagnosis of appendectomy are very significant. The diagnosis is of appendicitis is difficult and never certain. This has led surgeons to perform an appendectomy any time that they feel appendicitis is the diagnosis. Most surgeons feel that in approximately 20% of their patients, a normal appendix will be removed. Rates much lower than this would seem to indicate that the diagnosis of appendicitis was being frequently missed.

KEY TERMS

Abscess—A collection of pus buried deep in the tissues or in a body cavity.

Anesthesiologist—A physician who has special training and expertise in the delivery of anesthetics.

Anesthetics—Drugs or methodologies used to make a body area free of sensation or pain.

Cecum—The beginning of the large intestine and the place where the appendix attaches to the intestinal tract.

General surgeon—A physician who has special training and expertise in performing a variety of operations.

Pelvic organs—The organs inside of the body that are located within the confines of the pelvis. This includes the bladder and rectum in both sexes and the uterus, ovaries, and fallopian tubes in females.

Pubis—The anterior portion of the pelvis located in the anterior abdomen.

Thrombophlebitis—Inflammation of the veins, usually in the legs, which causes swelling and tenderness in the affected area.

Umbilicus—The navel.

Resources

BOOKS

Schwartz, Seymour I. "Appendix." In *Principles of Surgery*, ed. Seymour Schwartz, et al. New York: McGraw-Hill, 1994.

Silen, William. "Acute Appendicitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

McCall, J. L., K. Sharples, and F. Jafallah. "Systematic Review of Randomized Controlled Trial Comparing Laproscopic with Open Appendectomy." *British Journal of Surgery* 84, no. 8 (Aug. 1997): 1045-1950.

Minne, L., et al. "Laproscopic Vs Open Appendectomy. Prospective Randomized Study of Outcomes." *Archives of Surgery* 132 (July 1997): 708-711.

OTHER

"Appendectomy." ThriveOnline. <http://thriveonline.oxygen.com>.

"The Appendix." Mayo Clinic Online. <http://www.mayohealth.org>.

Mary Jeanne Krob, MD, FACS

Appendicitis

Definition

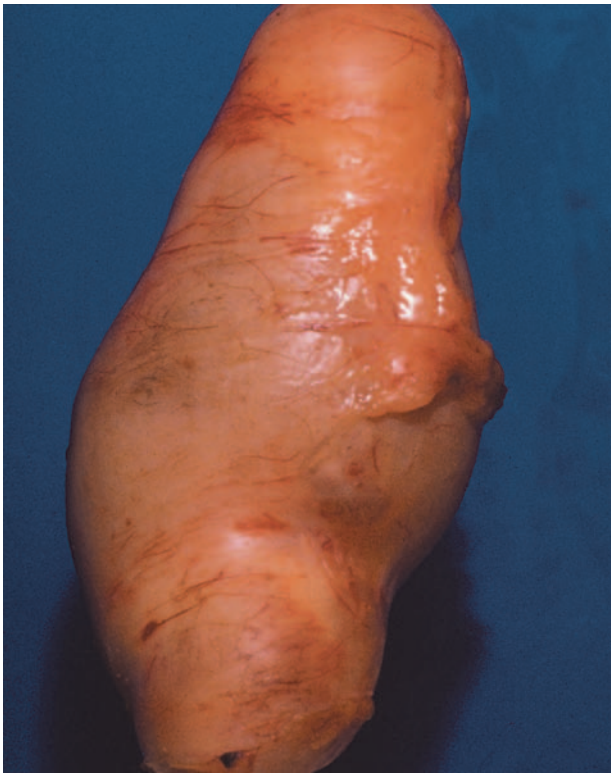
Appendicitis is an inflammation of the appendix, which is the worm-shaped pouch attached to the cecum, the beginning of the large intestine. The appendix has no known function in the body, but it can become diseased. Appendicitis is a medical emergency, and if it is left untreated the appendix may rupture and cause a potentially fatal infection.

Description

Appendicitis is the most common abdominal emergency found in children and young adults. One person in 15 develops appendicitis in his or her lifetime. The incidence is highest among males aged 10-14, and among females aged 15-19. More males than females develop appendicitis between **puberty** and age 25. It is rare in the elderly and in children under the age of two.

The hallmark symptom of appendicitis is increasingly severe abdominal **pain**. Since many different conditions can cause abdominal pain, an accurate diagnosis of appendicitis can be difficult. A timely diagnosis is important, however, because a delay can result in perforation, or rupture, of the appendix. When this happens, the infected contents of the appendix spill into the abdomen, potentially causing a serious infection of the abdomen called **peritonitis**.

Other conditions can have similar symptoms, especially in women. These include **pelvic inflammatory disease**, ruptured ovarian follicles, ruptured **ovarian cysts**, tubal pregnancies, and **endometriosis**. Various forms of stomach upset and bowel inflammation may also mimic appendicitis.



An extracted appendix. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission.)*

The treatment for acute (sudden, severe) appendicitis is an **appendectomy**, surgery to remove the appendix. Because of the potential for a life-threatening ruptured appendix, persons suspected of having appendicitis are often taken to surgery before the diagnosis is certain.

Causes and symptoms

The causes of appendicitis are not well understood, but it is believed to occur as a result of one or more of these factors: an obstruction within the appendix, the development of an ulceration (an abnormal change in tissue accompanied by the **death** of cells) within the appendix, and the invasion of bacteria.

Under these conditions, bacteria may multiply within the appendix. The appendix may become swollen and filled with pus (a fluid formed in infected tissue, consisting of while blood cells and cellular debris), and may eventually rupture. Signs of rupture include the presence of symptoms for more than 24 hours, a **fever**, a high white blood cell count, and a fast heart rate. Very rarely,

the inflammation and symptoms of appendicitis may disappear but recur again later.

The distinguishing symptom of appendicitis is pain beginning around or above the navel. The pain, which may be severe or only achy and uncomfortable, eventually moves into the right lower corner of the abdomen. There, it becomes more steady and more severe, and often increases with movement, coughing, and so forth. The abdomen often becomes rigid and tender to the touch. Increasing rigidity and tenderness indicates an increased likelihood of perforation and peritonitis.

Loss of appetite is very common. **Nausea and vomiting** may occur in about half of the cases and occasionally there may be **constipation** or **diarrhea**. The temperature may be normal or slightly elevated. The presence of a fever may indicate that the appendix has ruptured.

Diagnosis

A careful examination is the best way to diagnose appendicitis. It is often difficult even for experienced physicians to distinguish the symptoms of appendicitis from those of other abdominal disorders. Therefore, very specific questioning and a thorough **physical examination** are crucial. The physician should ask questions, such as where the pain is centered, whether the pain has shifted, and where the pain began. The physician should press on the abdomen to judge the location of the pain and the degree of tenderness.

The typical sequence of symptoms is present in about 50% of cases. In the other half of cases, less typical patterns may be seen, especially in pregnant women, older patients, and infants. In pregnant women, appendicitis is easily masked by the frequent occurrence of mild abdominal pain and nausea from other causes. Elderly patients may feel less pain and tenderness than most patients, thereby delaying diagnosis and treatment, and leading to rupture in 30% of cases. Infants and young children often have diarrhea, vomiting, and fever in addition to pain.

While laboratory tests cannot establish the diagnosis, an increased white cell count may point to appendicitis. **Urinalysis** may help to rule out a urinary tract infection that can mimic appendicitis.

Patients whose symptoms and physical examination are compatible with a diagnosis of appendicitis are usually taken immediately to surgery, where a laparotomy (surgical exploration of the abdomen) is done to confirm the diagnosis. In cases with a questionable diagnosis, other tests, such as a computed tomography scan (CT) may be performed to avoid unnecessary surgery. An ultrasound examination of the abdomen may help to identify an inflamed appendix or other condition that would explain the symptoms. Abdominal x-rays are not of much value except when the appendix has ruptured.

Often, the diagnosis is not certain until an operation is done. To avoid a ruptured appendix, surgery may be recommended without delay if the symptoms point clearly to appendicitis. If the symptoms are not clear, surgery may be postponed until they progress enough to confirm a diagnosis.

When appendicitis is strongly suspected in a woman of child-bearing age, a diagnostic **laparoscopy** (an examination of the interior of the abdomen) is sometimes recommended before the appendectomy in order to be sure that a gynecological problem, such as a ruptured ovarian cyst, is not causing the pain. In this procedure, a lighted viewing tube is inserted into the abdomen through a small incision around the navel.

A normal appendix is discovered in about 10-20% of patients who undergo laparotomy, because of suspected appendicitis. Sometimes the surgeon will remove a normal appendix as a safeguard against appendicitis in the future. During the surgery, another specific cause for the pain and symptoms of appendicitis is found for about 30% of these patients.

Treatment

The treatment of appendicitis is an immediate appendectomy. This may be done by opening the abdomen in the standard open appendectomy technique, or through laparoscopy. In laparoscopy, a smaller incision is made through the navel. Both methods can successfully accomplish the removal of the appendix. It is not certain that laparoscopy holds any advantage over open appendectomy. When the appendix has ruptured, patients undergoing a laparoscopic appendectomy may have to be switched to the open appendectomy procedure for the successful management of the rupture. If a ruptured appendix is left untreated, the condition is fatal.

Prognosis

Appendicitis is usually treated successfully by appendectomy. Unless there are complications, the patient should recover without further problems. The mortality rate in cases without complications is less than 0.1%. When an appendix has ruptured, or a severe infection has developed, the likelihood is higher for complications, with slower recovery, or death from disease. There are higher rates of perforation and mortality among children and the elderly.

Prevention

Appendicitis is probably not preventable, although there is some indication that a diet high in green vegetables and tomatoes may help prevent appendicitis.

KEY TERMS

Appendectomy (or appendicectomy)—Surgical removal of the appendix.

Appendix—The worm-shaped pouch attached to the cecum, the beginning of the large intestine.

Laparotomy—Surgical incision into the loin, between the ribs and the pelvis, which offers surgeons a view inside the abdominal cavity.

Peritonitis—Inflammation of the peritoneum, membranes lining the abdominal pelvic wall.

Resources

BOOKS

Carter, David C. "The Acute Abdomen." In *Diseases of the Gastrointestinal Tract and Liver*, ed. David J.C. Shearman, et al. New York: Churchill Livingstone, 1997.

Mulholland, Michael W. "Approach to the Patient with Acute Abdomen." In *Textbook of Gastroenterology*, ed. Tadataka Yamada, et al. Philadelphia: J. B. Lippincott, 1995.

Silen, William. "Acute Appendicitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Van Der Meer, Antonia. "Do You Know the Warning Signs of Appendicitis?" *Parents Magazine*, Apr. 1997, 49.

Wagner J. M., et al. "Does This Patient Have Appendicitis?" *The Journal of the American Medical Association* 276 (1996): 1589-1594.

Caroline Andrews Helwick

Appendix removal *see* **Appendectomy**

Applied kinesiology

Definition

Applied kinesiology (AK) is the study of muscles and the relationship of muscle strength to health. It incorporates a system of manual muscle testing and therapy. AK is based on the theory that an organ dysfunction is accompanied by a specific muscle weakness. Diseases are diagnosed through muscle-testing procedures and then treated. AK is not the same as kinesiology, or biomechanics, which is the scientific study of movement.

Purpose

AK is not designed for crisis medicine. For example, an AK practitioner cannot cure **cancer**, arthritis, diabetes, heart disease, or infections. This therapy is designed to be a part of a holistic approach to preventive medicine. The goals of AK are to (1) restore normal nerve function, (2) achieve normal endocrine, immune, digestive, and other internal organ functions, (3) intervene early in degenerative processes to prevent or delay pathological conditions, and to (4) restore postural balance, correct gait (walking) impairment, and improve range of motion.

Description

Origins

AK is based on principles of functional neurology, anatomy, physiology, biomechanics, and biochemistry as well as principles from Chinese medicine, **acupuncture**, and massage. It was developed from traditional kinesiology in 1964 by George G. Goodheart, a chiropractor from Detroit, Michigan. He observed that each large muscle relates to a body organ. A weakness in a muscle may mean that there is a problem in the associated organ. Goodheart found that by treating the muscle and making it strong again, he was able to improve the function of the organ as well. For example, if a particular nutritional supplement was given to a patient, and the muscle tested strong, it was the correct supplement for the patient. If the muscle remained weak, it was not. Other methods of treatment can be evaluated in a similar manner. Goodheart also found that painful nodules (small bumps) may be associated with a weak muscle. By deeply massaging the muscle, he was able to improve its strength. Goodheart's findings in 1964 led to the origin and insertion treatment, the first method developed in AK. Other diagnostic and therapeutic procedures were developed for various reflexes described by other chiropractors and doctors. Goodheart incorporated acupuncture meridian therapy into AK after reading the writings of Felix Mann, M.D.

Goodheart considered AK to be a therapeutic tool that incorporates feedback from the body. He said that "applied kinesiology is based on the fact that the body language never lies." He felt that the body's muscles were indicators of disharmony. Once muscle weakness has been ascertained, the problem may be solved in a variety of ways. If a practitioner approaches the problem correctly, he believed, making the proper and adequate diagnosis and treatment, the outcome is satisfactory both to the doctor and to the patient.

According to AK, each muscle in the body relates to a specific meridian or energy pathway (acupuncture

GEORGE GOODHEART (1918–)

Dr. George Goodheart was born in Detroit, Michigan, in 1918 and became a second-generation doctor of chiropractic. He graduated from the National College of Chiropractic in 1939 and is recognized as the founder and developer of Applied Kinesiology. After he joined the U.S. Air Force as an aviation cadet in World War II, he received a promotion to major at the age of 22. He was the youngest ever to attain that rank. He served in active duty from 1941-1946 and continued as a member of the Air Force Reserve until the mid-1950s.

Dr. Goodheart held numerous positions of distinction during his career, including director of the National Chiropractic Mutual Insurance Company and director for the International College of Applied Kinesiology-U.S.A. He also lectured and taught throughout the United States, Japan, Europe, and Australia; and he was the official doctor of chiropractic for the Lake Placed Winter Olympic Games in 1980. He contributes to a variety of trade publications on a regular basis.

In 1998 Dr. Goodheart received a Lifetime Achievement Award from the International College of Kinesiology. Earlier, in 1987 he was honored with the Leonardo da Vinci Award from the Institute for the Achievement of Human Potential, and he was cited for his research by Logan and Palmer Colleges of Chiropractic. He represented the State of Michigan as a delegate to the American Chiropractic Association and was a fellow at the International College of Chiropractic. He resides with his wife, JoAnn in Grosse Pointe Woods, Michigan, where he enjoys skiing and tennis.

lines) in the body. These meridians also relate to organs or glands, allowing the muscles to provide information about organ or gland function and energy. The five areas of diagnosis and therapy for the applied kinesiologist are (1) the nervous system, (2) the lymphatic system, (3) the vascular (blood vessel) system, (4) the cerebrospinal system, and (5) the meridian system.

The first part of AK is muscle testing, which is used to help diagnose what part of the body is functioning abnormally. Muscle testing involves putting the body into a position that requires a certain muscle to remain contracted, and then applying pressure against the muscle. The testing does not measure strength but is meant to reveal stresses and imbalances in the body through the tension in the muscle. The test evaluates the ability of a controlling system (like the nervous system) to adapt the muscle to meet the changing pressure of the examiner's test. AK practitioners also examine structural factors such as posture, gait, and range of motion. Some chiropractors use AK to help them evaluate the success of spinal adjustment. A leg muscle is tested for strength or weakness to determine whether the adjustments made are appropriate.

According to AK, common internal causes of muscle weakness include:

- dysfunction of nerve supply (nerve interference between spine and muscles)
- impairment of lymphatic drainage
- reduction of blood supply
- abnormal pressure in cerebral fluid affecting nerve-to-muscle relationships
- blockage of an acupuncture meridian
- imbalance of chemicals
- dysfunction of organs or glands
- excesses or deficiencies in **nutrition**

Physiological reactions to chemicals, including those associated with nutrition and **allergies**, may also be evaluated using AK. The AK protocol for testing chemical compounds is to place the substance on the patient's tongue so that he tastes the material, and the normal chemical reactions of ingestion begin. In some cases, the substances are inhaled through the nose. The AK practitioner then tests the associated muscle-organ pattern to determine where or if there is a strength or weakness. The patient does not need to swallow the substance for a change in strength or weakness to be identified. David S. Walther, a diplomate of the International College of Applied Kinesiology, has indicated that "it is possible that the central nervous system, recognizing the compound being ingested, relays information to the organs and glands preparing for use of the compound. If the compound is recognized as beneficial, the energy pattern is immediately enhanced, influencing not only the organ or gland, but also the associated muscle."

AK has been used as a diagnostic health tool for a variety of conditions.

Bone health

- neck/low back **pain** and sciatica
- whiplash
- frozen shoulder

Joint health

- carpal tunnel syndrome
- arthritis (including rheumatoid arthritis)
- sports injuries

Muscle health

- tennis elbow

- heel spurs
- wound healing
- intermittent claudication (pain on walking)
- restless legs
- cramps

Vascular system health

- aching varicose veins
- palpitations
- high blood pressure

Nervous system health

- migraine and other headaches
- trigeminal **neuralgia** and other face pains
- Bell's palsy
- anxiety
- depression
- fears
- addictions (like smoking)
- claustrophobia
- Meniere's disorder
- neuralgia (severe, throbbing pain)
- travel sickness
- fatigue
- phantom limb pain
- paralysis of leg or arm after a stroke

Respiratory system health

- hay fever
- rhinitis (inflammed nasal passages)
- **asthma**
- bronchitis
- emphysema (lung disease)

Urinary system health

- cystitis (bladder inflammation), especially in the elderly
- early prostate enlargement
- non-specific **urethritis** (inflammation of tube from the bladder)
- bedwetting

Reproductive organ health

- menstrual pains
- irregular or excessive menstrual activity
- pelvic pains and endometriosis
- menopausal flushes
- painful, nodular breasts
- preparation for childbirth
- vaginal pain
- post herpetic (**shingles**) pain
- impotence and infertility

Skin health

- pain after operations
- painful, prominent scars
- wrinkles or bagginess of face
- acne
- psoriasis and eczema (skin diseases)
- boils
- excessive perspiration
- hemorrhoids
- canker sores
- itching

Immune system health

- recurring **tonsillitis** (inflammed tonsils)
- persisting weakness after a severe illness

Sensory organ health

- tinnitus (ringing ears)
- tired eyes
- retinitis pigmentosa and pterygium retinitis (diseases of the retina)

Digestive system health

- constipation
- colitis or other bowel inflammations
- ulcers
- diarrhea
- obesity

The second part of AK involves the treatment phase. Goodheart and other practitioners of AK have adapted many treatment methods for the problems that are diagnosed with muscle testing. Examples of treatment methods include special **diets**, dietary supplements, **chiropractic** manipulation, osteopathic cranial techniques, acupuncture/meridian therapies, **acupressure**, deep muscle massage, and nervous system coordination procedures. For example, an AK practitioner might treat asthma by looking for weaknesses in specific lower back and leg muscles that share a connection with the adrenal glands. The practitioner will strengthen these muscles and help the adrenal gland produce **bronchodilators**, chemicals that relax or open air passages in the lungs.

The practice of kinesiology requires that it be used in conjunction with other standard diagnostic methods by professionals trained in clinical diagnosis. Most practitioners of AK are chiropractors, but naturopaths, medical doctors, dentists, osteopaths, nutritionists, physical therapists, massage therapists, podiatrists, psychiatrists, and nurse practitioners are also involved. In 1991, 37.2% of 4,835 full-time chiropractors in the United States who responded to a survey by the National Board of Chiropractic Examiners (NBCE) said they used AK in their practice. Subsequent NBCE surveys indicated that 31% of chiropractors in Canada, 60% in Australia, and 72% in New Zealand use AK.

Most practitioners of AK utilize a holistic approach and evaluate a person from a triad-based health perspective. Generally, chiropractors approach health and healing from a structural basis, medical doctors generally from a chemical basis, and psychiatrists and psychologists from a mental or emotional basis. Applied kinesiologists attempt to work with all three areas of health, and in some cases, include a spiritual dimension.

The use of AK is often included in insurance coverage if the policy covers chiropractor benefits. The cost of the AK examination is similar to the costs of other chiropractic practices.

Precautions

AK should only by used by trained professionals with the necessary expertise to perform specific and accurate tests. The AK examination should be combined with a standard physical diagnosis, which often includes laboratory tests, x rays, health and dietary history, and other special tests. An AK examination should enhance a standard diagnosis, not replace it. The total diagnostic work-up should be used to determine the final diagnosis.

The use of manual muscle testing to evaluate nutrition is particularly a problem if it is done by a lay nutrition sales person as a tool to sell his/her product. The person should have the educational background to evaluate nutritional needs as well as have a high level of knowledge in the use of proper muscle testing techniques.

Side effects

If AK is performed by a trained practitioner with the appropriate educational background, side effects from the muscle-testing procedures should be minimal.

Research and general acceptance

AK is a tool that is used by many health care professionals, and especially by chiropractors. A literature review published in 1999 by researchers from the School of Medicine at the University of North Carolina at Chapel Hill and the Foundation for Allied Conservative Therapies Research in Chapel Hill stated that, although AK appears to be a promising methodology, there is a lack of research results relevant to clinical practice and outcomes of AK care. They found this lack of results surprising, since cost, satisfaction, utilization, and changes in symptoms are the important results of clinical practice. In addition, they determined that some studies that were supposed to be an evaluation of AK procedures did not actually use clinical practices and principles of AK. However, from studies adhering to AK principles and employing standardized training by well-trained practitioners, they did state there was some evidence that AK is an objectively verifiable phenomenon. They suggested that "future studies of AK should focus on outcomes of care, including symptoms, function, costs, and safety. Only well-designed studies that account for the individual nature of AK diagnosis and treatment and preserve the proper clinical context of AK treatment will be informative. Understanding the individual components of the process of AK treatment remains important. Studies addressing validation of isolated AK procedures need to meet the methodological challenges of studying appropriate subjects that reflects the current recognized practice and understanding of AK. Further evaluation of the basic physiologic phenomena involved and correlation of AK manual muscle test results will also advance understanding of this diagnostic and therapeutic system."

Resources

BOOKS

Holdway, Anne. *Kinesiology: Muscle Testing and Energy Balancing for Health and Well-Being.* Rockport, MA: Element, 1997.

Valentine, Tom, Carol Valentine, and D.P. Hetrick. *Applied Kinesiology.* Rochester, VT: Healing Arts Press, 1989.

ORGANIZATIONS

International College of Applied Kinesiology. 6405 Metcalf Ave., Suite 503, Shawnee Mission, KS 66202. 913-384-5336. <http://www.icakusa.com and <http://www.icak.com>.

Judith Sims

APSGN *see* **Acute poststreptococcal glomerulonephritis**

APTT *see* **Partial thromboplastin time**

Arachnodactyly *see* **Marfan syndrome**

Arbovirus encephalitis

Definition

Encephalitis is a serious inflammation of the brain. Arbovirus encephalitis is caused by a virus from the Arbovirus group. The term *arbovirus* stands for *Arthropod-borne virus* because these viruses are passed to humans by members of the phylum Arthropoda (which includes insects and spiders).

Description

Of the huge number of arboviruses known to exist, about 80 types are responsible for human disease. In addition to the virus, there are usually two other types of living creatures involved in the cycle leading to human disease. When large quantities of virus are present in an arthropod (often a tick or mosquito), the viruses are passed to a bird or small mammal when the arthropod attempts to feed on the blood of that creature. The virus thrives within the new host, sometimes causing illness, sometimes not. More ticks or mosquitoes are infected with the virus when they feed on the host's blood. Eventually, a tick or mosquito bites a human, and the virus is passed along. Just a few types of arboviruses cycle only between arthropods and humans, with no intermediate stop in a bird or small mammal.

Because the arboviruses require an arthropod to pass them along to humans, the most common times of year for these illnesses include summer and fall, when mosquitoes and ticks are most prevalent. Damp environments favor large populations of mosquitoes, and thus also increase the risk of arbovirus infections.

The major causes of arbovirus encephalitis include the members of the viral families alphavirus (causing Eastern equine encephalitis, Western equine encephalitis, and Venezuelan equine encephalitis), flavivirus (responsible for St. Louis encephalitis, **Japanese encephalitis**, Tick-borne encephalitis, Murray Valley encephalitis, Russian spring-summer encephalitis, and Powassan), and bunyavirus (causing California encephalitis).

In the United States, the most important types of arbovirus encephalitis include Western equine encephalitis (WEE), Eastern equine encephalitis (EEE), St. Louis encephalitis, and California encephalitis. WEE strikes young infants in particular, with a 5% chance of **death** from the illness. Of those who survive, about 60% suffer permanent brain damage. EEE strikes infants and children, with a 20% chance of death, and a high rate of permanent brain damage among survivors. St. Louis encephalitis tends to strike adults older than 40 years of age, and older patients tend to have higher rates of death and long-term disability from the infection. California virus primarily strikes 5-18 year olds, with a lower degree of permanent brain damage.

Causes and symptoms

Encephalitis occurs because specific arboviruses have biochemical characteristics which cause them to be particularly attracted to the cells of the brain and the nerves. The virus causes cell death and inflammation, with **fever** and swelling within the brain and nerves. The membranous coverings of the brain and spinal cord (the meninges) may also become inflamed, a condition called **meningitis**. The brain is swollen, and patches of bleeding occur throughout the brain and spinal cord.

Patients with encephalitis suffer from headaches, fever, **nausea and vomiting**, stiff neck, and sleepiness. As the disease progresses, more severe symptoms develop, including **tremors**, confusion, seizures, **coma**, and **paralysis**. Loss of function occurs when specific nerve areas are damaged and/or killed.

Diagnosis

Early in the disease, laboratory testing of blood may reveal the presence of the arbovirus. The usual technique used to verify the presence of arbovirus involves injecting the patient's blood into the brain of a newborn mouse, then waiting to see if the mouse develops encephalitis. Diagnosis is usually based on the patient's symptoms, history of tick or mosquito bites, and knowledge that the patient has been in an area known to harbor the arbovirus.

Treatment

Treatment is mostly supportive, meaning it is directed at improving the symptoms, but does not shorten the course of the illness. The main concerns of treatment involve lowering fever, treating **pain**, avoiding **dehydration** or other chemical imbalances, and decreasing swelling in the brain with steroids.

Prognosis

Prognosis depends on the particular type of arbovirus causing disease, and on the age and prior health status of the patient. Death rates range all the way up to 20% for arbovirus encephalitis, and the rates of lifelong effects due to brain damage reach 60% for some types of arboviruses.

Prevention

Prevention involves avoiding contact with arthropods which carry these viruses. This means wearing

KEY TERMS

Arthropods—A phylum name referring to certain insects (including mosquitoes and ticks) and spiders.

Encephalitis—A condition in which the brain swells.

appropriate insect repellents, and dressing properly in areas known to be infested. Insecticides and the avoidance of collections of standing water (which are good breeding ground for arthropods) is also effective at decreasing arthropod populations.

There are immunizations available against EEE and WEE. These have primarily been used to safeguard laboratory workers who have regular exposure to these viruses.

Resources

BOOKS

Ray, C. George. "Arthropod-Borne and Other Zoonotic Viruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley & Sons, 1995.

Rosalyn Carson-DeWitt, MD

ARDS *see* **Adult respiratory distress syndrome**

Aromatherapy

Definition

Aromatherapy is the therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being. It is sometimes used in combination with massage and other therapeutic techniques as part of a holistic treatment approach.

Purpose

Aromatherapy offers diverse physical and psychological benefits, depending on the essential oil or oil combination and method of application used. Some common medicinal properties of essential oils used in aromatherapy include: analgesic, antimicrobial, antiseptic, anti-inflammatory, astringent, sedative, antispasmodic, expectorant, diuretic, and sedative. Essential oils are used to treat a wide range of symptoms and conditions, including, but not limited to, gastrointestinal discomfort, skin conditions, menstrual **pain** and irregularities, stress-related conditions, **mood disorders**, circulatory problems, respiratory infections, and **wounds**.

Description

Origins

Aromatic plants have been employed for their healing, preservative, and pleasurable qualities throughout recorded history in both the East and West. As early as 1500 B.C. the ancient Egyptians used waters, oils, incense, resins, and ointments scented with botanicals for their religious ceremonies.

There is evidence that the Chinese may have recognized the benefits of herbal and aromatic remedies much earlier than this. The oldest known herbal text, Shen Nung's *Pen Ts'ao* (c. 2700-3000 B.C.) catalogs over 200 botanicals. Ayurveda, a practice of traditional Indian medicine that dates back over 2,500 years, also used aromatic herbs for treatment.

The Romans were well-known for their use of fragrances. They bathed with botanicals and integrated them into their state and religious rituals. So did the Greeks, with a growing awareness of the medicinal properties of herbs, as well. Greek physician and surgeon Pedanios Dioscorides, whose renown herbal text *De Materia Medica* (60 A.D.) was the standard textbook for Western medicine for 1,500 years, wrote extensively on the medicinal value of botanical aromatics. The *Medica* contained detailed information on over 500 plants and 4,740 separate medicinal uses for them, including an entire section on aromatics.

Written records of herbal distillation are found as early as the first century A.D., and around 1000 A.D., the noted Arab physician and naturalist Avicenna described the distillation of rose oil from rose petals, and the medicinal properties of essential oils in his writings. However, it wasn't until 1937, when French chemist René-Maurice Gattefossé published *Aromatherapie: Les Huiles essentielles, hormones végé tales*, that aromatherapie, or aromatherapy, was introduced in Europe as a medical discipline. Gattefossé, who was employed by a French perfumeur, discovered the healing properties of lavender oil quite by accident when he suffered a severe burn while working and used the closest available liquid, lavender oil, to soak it in.

In the late 20th century, French physician Jean Valnet used botanical aromatics as a front line treatment for wounded soldiers in World War II. He wrote about his use

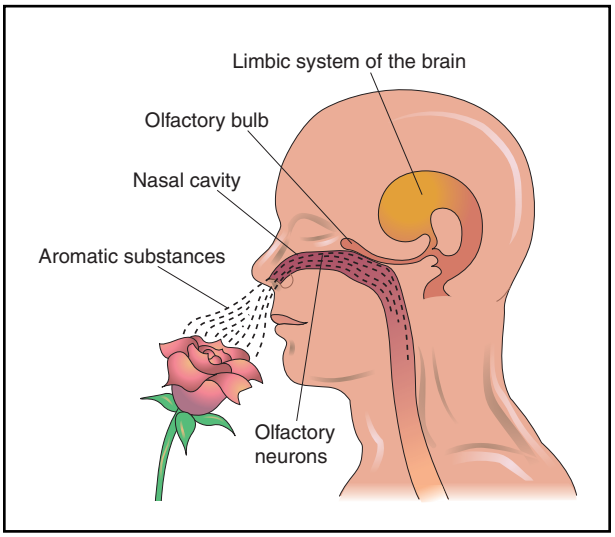
of essential oils and their healing and antiseptic properties, in his 1964 book *Aromatherapie, traitement des maladies par les essences des plantes*, which popularized the use of essential oils for medical and psychiatric treatment throughout France. Later, French biochemist Mauguerite Maury popularized the cosmetic benefits of essential oils, and in 1977 Robert Tisserand wrote the first English language book on the subject, *The Art of Aromatherapy*, which introduced massage as an adjunct treatment to aromatherapy and sparked its popularity in the United Kingdom.

In aromatherapy, essential oils are carefully selected for their medicinal properties. As essential oils are absorbed into the bloodstream through application to the skin or inhalation, their active components trigger certain pharmalogical effects (e.g., pain relief).

In addition to physical benefits, aromatherapy has strong psychological benefits. The volatility of an oil, or the speed at which it evaporates in open air, is thought to be linked to the specific psychological effect of an oil. As a rule of thumb, oils that evaporate quickly are considered emotionally uplifting, while slowly-evaporating oils are thought to have a calming effect.

Essential oils commonly used in aromatherapy treatment include:

- Roman chamomile (*Chamaemelum nobilis*). An anti-inflammatory and analgesic. Useful in treating **otitis media** (earache), skin conditions, menstrual pains, and depression.
- Clary sage (*Salvia sclarea*). This natural astringent is not only used to treat oily hair and skin, but is also said to be useful in regulating the menstrual cycle, improving mood, and controlling high blood pressure. Clary sage should not be used by pregnant women.
- Lavender (*Lavandula officinalis*). A popular aromatherapy oil which mixes well with most essential oils, lavender has a wide range of medicinal and cosmetic applications, including treatment of insect bites, **burns**, respiratory infections, intestinal discomfort, nausea, migraine, **insomnia**, depression, and **stress**.
- Myrtle (*Myrtus communis*). Myrtle is a fungicide, disinfectant, and antibacterial. It is often used in steam aromatherapy treatments to alleviate the symptoms of **whooping cough**, **bronchitis**, and other respiratory infections.
- Neroli (bitter orange), (*Citrus aurantium*). Citrus oil extracted from bitter orange flower and peel and used to treat **sore throat**, insomnia, and stress and anxiety-related conditions.
- Sweet orange (*Citrus sinensis*). An essential oil used to treat stomach complaints and known for its reported ability to lift the mood while relieving stress.



As a holistic therapy, aromatherapy is believed to benefit both the mind and body. Here, the aromatic substances from a flower stimulates the olfactory bulb and neurons. The desired emotional response (such as relaxation) is activated from the limbic system of the brain. *(Illustration by Electronic Illustrators Group.)*

- Peppermint (*Mentha piperita*). Relaxes and soothes the stomach muscles and gastrointestinal tract. Peppermint's actions as an anti-inflammatory, antiseptic, and antimicrobial also make it an effective skin treatment, and useful in fighting cold and flu symptoms.
- Rosemary (*Rosmarinus officinalis*). Stimulating essential oil used to treat muscular and rheumatic complaints, as well as low blood pressure, gastrointestinal problems, and headaches.
- Tea tree (*Melaleuca alternifolia*). Has bactericidal, virucidal, fungicidal, and anti-inflammatory properties that make it a good choice for fighting infection. Recommended for treating sore throat and respiratory infections, vaginal and bladder infections, wounds, and a variety of skin conditions.
- Ylang ylang (*Cananga odorata*). A sedative essential oil sometimes used to treat **hypertension** and tachycardia.

Essential oils contain active agents that can have potent physical effects. While some basic aromatherapy home treatments can be self-administered, medical aromatherapy should always be performed under the guidance of an aromatherapist, herbalist, massage therapist, nurse, or physician.

Inhalation

The most basic method of administering aromatherapy is direct or indirect inhalation of essential oils. Several drops of an essential oil can be applied to a tissue or

Aromatherapy Oils

Name	Description	Conditions treated
Bay laurel	Antiseptic, diuretic,sedative, etc.	Digestive problems, bronchitis, common cold, influenza, and scabies and lice. CAUTION: Don't use if pregnant.
Clary sage	Relaxant, anticonvulsive, antiinflammatory, and antiseptic	Menstrual and menopausal symptoms, burns, eczema, and anxiety. CAUTION: Don't use if pregnant.
Eucalyptus	Antiseptic, antibacterial, astringent, expectorant, and analgesic	Boils, breakouts, cough, common cold, influenza, and sinusitis. CAUTION: Not to be taken orally.
Chamomile	Sedative, antiinflammatory, antiseptic, and pain reliever	Hay fever, burns, acne, arthritis, digestive problems, sunburn, and menstrual an menopausal symptoms.
Lavender	Analgesic, antiseptic, calming/soothing	Headache, depression, insomnia, stress, sprains, and nausea.
Peppermint	Pain reliever	Indigestion, nausea, headache, motion sickness, and muscle pain.
Rosemary	Antiseptic, stimulant, and diuretic	Indigestion, gas, bronchitis, fluid retention, and influenza. CAUTION: Don't use if pregnant or have epilepsy or hypertension.
Tarragon	Diuretic, laxative, antispasmodic, and stimulant	Menstrual and menopausal symptoms, gas, and indigestion. CAUTION: Don't use if pregnant.
Tea tree	Antiseptic and soothing	Common cold, bronchitis, abscesses, acne, vaginitis, and burns.
Thyme	Stimulant, antiseptic, antibacterial, and antispasmodic	Cough, laryngitis, diarrhea, gas, and intestinal worms. CAUTION: Don't use if pregnant or have hypertension.

handkerchief and gently inhaled. A small amount of essential oil can also be added to a bowl of hot water and used as a steam treatment. This technique is recommended when aromatherapy is used to treat respiratory and/or skin conditions. Aromatherapy steam devices are also available commercially. A warm bath containing essential oils can have the same effect as steam aromatherapy, with the added benefit of promoting relaxation. When used in a bath, water should be lukewarm rather than hot to slow the evaporation of the oil.

Essential oil diffusers, vaporizers, and light bulb rings can be used to disperse essential oils over a large area. These devices can be particularly effective in aromatherapy that uses essential oils to promote a healthier home environment. For example, eucalyptus and tea tree oil are known for their antiseptic qualities and are frequently used to disinfect sickrooms, and citronella and geranium can be useful in repelling insects.

Direct application

Because of their potency, essential oils are diluted in a carrier oil or lotion before being applied to the skin to prevent an allergic skin reaction. The carrier oil can be a vegetable or olive based one, such as wheat germ or avocado. Light oils, such as safflower, sweet almond, grapeseed, hazelnut, apricot seed, or peach kernel, may be absorbed more easily by the skin. Standard dilutions of essential oils in carrier oils range from 2–10%. However, some oils can be used at higher concentrations, and others should be diluted further for safe and effective use. The type of carrier oil used and the therapeutic use of the application may also influence how the essential oil is mixed. Individuals should seek guidance from a healthcare professional and/or aromatherapist when diluting essential oils.

Massage is a common therapeutic technique used in conjunction with aromatherapy to both relax the body and thoroughly administer the essential oil treatment. Essential oils can also be used in hot or cold compresses and soaks to treat muscle aches and pains (e.g., lavender and ginger). As a sore throat remedy, antiseptic and soothing essential oils (e.g., tea tree and sage) can be thoroughly mixed with water and used as a gargle or mouthwash.

Internal use

Some essential oils can be administered internally in tincture, infusion, or suppository form to treat certain symptoms or conditions; however, this treatment should never be self-administered. Essential oils should only be taken internally under the supervision of a qualified healthcare professional.

As non-prescription botanical preparations, the essential oils used in aromatherapy are typically not paid for by health insurance. The self-administered nature of the therapy controls costs to some degree. Aromatherapy treatment sessions from a professional aromatherapist are not covered by health insurance in most cases, although aromatherapy performed in conjunction with physical therapy, nursing, therapeutic massage, or other covered medical services may be. Individuals should check with their insurance provider to find out about their specific coverage.

The adage "You get what you pay for" usually applies when purchasing essential oils, as bargain oils are

KEY TERMS

Antiseptic—Inhibits the growth of microorganisms.

Bactericidal—An agent that destroys bacteria (e.g., Staphylococci aureus, Streptococci pneumoniae, Escherichia coli, Salmonella enteritidis).

Carrier oil—An oil used to dilute essential oils for use in massage and other skin care applications.

Contact dermatitis—Skin irritation as a result of contact with a foreign substance.

Essential oil—A volatile oil extracted from the leaves, fruit, flowers, roots, or other components of a plant and used in aromatherapy, perfumes, and foods and beverages.

Holistic—A practice of medicine that focuses on the whole patient, and addresses the social, emotional, and spiritual needs of a patient as well as their physical treatment.

Phototoxic—Causes a harmful skin reaction when exposed to sunlight.

Remedy antidote—Certain foods, beverages, prescription medications, aromatic compounds, and other environmental elements that counteract the efficacy of homeopathic remedies.

Steam distillation—A process of extracting essential oils from plant products through a heating and evaporation process.

Volatile—Something that vaporizes or evaporates quickly when exposed to air.

often adulterated, diluted, or synthetic. Pure essential oils can be expensive; and the cost of an oil will vary depending on its quality and availability.

Preparations

The method of extracting an essential oil varies by plant type. Common methods include water or steam distillation and cold pressing. Quality essential oils should be unadulterated and extracted from pure botanicals. Many aromatherapy oils on the market are synthetic and/or diluted, contain solvents, or are extracted from botanicals grown with pesticides or herbicides. To ensure best results, essential oils should be made from pure organic botanicals and labeled by their full botanical name. Oils should always be stored dark bottles out of direct light.

Before using essential oils on the skin, individuals should perform a skin patch test by applying a small amount of the diluted oil behind the wrist and covering it with a bandage or cloth for up to 12 hours. If redness or irritation occurs, the oil should be diluted further and a second skin test performed, or it should be avoided altogether. Individuals should never apply undiluted essential oils to the skin unless advised to do so by a trained healthcare professional.

Precautions

Individuals should only take essential oils internally under the guidance and close supervision of a health-care professional. Some oils, such as eucalyptus, wormwood, and sage, should never be taken internally. Many essential oils are highly toxic and should never be used at all in aromatherapy. These include (but are not limited to) bitter almond, pennyroyal, mustard, sassafras, rue, and mugwort.

Citrus-based essential oils, including bitter and sweet orange, lime, lemon, grapefruit, and tangerine, are phototoxic, and exposure to direct sunlight should be avoided for at least four hours after their application.

Other essential oils, such as cinnamon leaf, black pepper, juniper, lemon, white camphor, eucalyptus blue gum, ginger, peppermint, pine needle, and thyme can be extremely irritating to the skin if applied in high enough concentration or without a carrier oil or lotion. Caution should always be exercised when applying essential oils topically. Individuals should never apply undiluted essential oils to the skin unless directed to do so by a trained healthcare professional and/or aromatherapist.

Individuals taking homeopathic remedies should avoid black pepper, camphor, eucalyptus, and peppermint essential oils. These oils may act as a remedy antidote to the homeopathic treatment.

Children should only receive aromatherapy treatment under the guidance of a trained aromatherapist or healthcare professional. Some essential oils may not be appropriate for treating children, or may require additional dilution before use on children.

Certain essential oils should not be used by pregnant or nursing women or by people with specific illnesses or physical conditions. Individuals suffering from any

chronic or acute health condition should inform their healthcare provider before starting treatment with any essential oil.

Asthmatic individuals should not use steam inhalation for aromatherapy, as it can aggravate their condition.

Essential oils are flammable, and should be kept away from heat sources.

Side effects

Side effects vary by the type of essential oil used. Citrus-based essential oils can cause heightened sensitivity to sunlight. Essential oils may also cause **contact dermatitis**, an allergic reaction characterized by redness and irritation. Anyone experiencing an allergic reaction to an essential oil should discontinue its use and contact their healthcare professional for further guidance. Individuals should do a small skin patch test with new essential oils before using them extensively (see "Preparations" above).

Research and general acceptance

The antiseptic and bactericidal qualities of some essential oils (such as tea tree and peppermint) and their value in fighting infection has been detailed extensively in both ancient and modern medical literature.

Recent research in mainstream medical literature has also shown that aromatherapy has a positive psychological impact on patients, as well. Several clinical studies involving both post-operative and chronically ill subjects showed that massage with essential oils can be helpful in improving emotional well-being, and consequently, promoting the healing process.

Today, the use of holistic aromatherapy is widely accepted in Europe, particularly in Great Britain, where it is commonly used in conjunction with massage as both a psychological and physiological healing tool. In the United States, where aromatherapy is often misunderstood as solely a cosmetic treatment, the mainstream medical community has been slower to accept it.

Resources

BOOKS

Lawless, Julia. *The Complete Illustrated Guide To Aromatherapy.* Rockport, MA: Element Books Ltd, 1997.

Schnaubelt, Kurt. *Medical Aromatherapy: Healing With Essential Oils.* Berkeley, CA: Frog Ltd, 1999.

ORGANIZATIONS

National Association of Holistic Aromatherapy. 836 Hanley Industrial Court, St. Louis, MO 63144. 888-ASK-NAHA. <http://www.naha.org>.

Paula Ford-Martin

Arrhythmias

Definition

An arrhythmia is an abnormality in the heart's rhythm, or heartbeat pattern. The heartbeat can be too slow, too fast, have extra beats, skip a beat, or otherwise beat irregularly.

Description

Arrhythmias are deviations from the normal cadence of the heartbeat, which cause the heart to pump improperly. The normal heartbeat starts in the right atrium, where the heart's natural pacemaker (the sinus node) sends an electrical signal to the center of the heart to the atrioventricular node. The atrioventricular node then sends signals into the main pumping chamber to make the ventricle contract. Arrhythmias occur when the heartbeat starts in a part of the heart other than the sinus node, an abnormal rate or rhythm develops in the sinus node, or a heart conduction "block" prevents the electrical signal from traveling down the normal pathway.

More than four million Americans have arrhythmias, most of which are harmless. Middle-aged adults commonly experience arrhythmias. As people age, the probability of experiencing an arrhythmia increases. Arrhythmias often occur in people who do not have heart disease. In people with heart disease, it is usually the heart disease which is dangerous, not the arrhythmia. Arrhythmias often occur during and after heart attacks. Some types of arrhythmias, such as **ventricular tachycardia**, are serious and even life threatening. In the United States, arrhythmias are the primary cause of **sudden cardiac death**, accounting for more than 350,000 deaths each year.

Slow heart rates (less than 60 beats per minute) are called bradycardias, while fast heart rates (more than 100 beats per minute) are called tachycardias. Bradycardia can result in poor circulation of blood, and, hence, a lack of oxygen throughout the body, especially the brain. Tachycardias also can compromise the heart's ability to pump effectively because the ventricles do not have enough time to completely fill.

Arrhythmias are characterized by their site of origin: the atria or the ventricles. Supraventricular arrhythmias occur in the upper areas of the heart and are less serious than ventricular arrhythmias. **Ventricular fibrillation** is the most serious arrhythmia and is fatal unless medical help is immediate.

Causes and symptoms

In many cases, the cause of an arrhythmia is unknown. Known causes of arrhythmias include heart

disease, **stress**, **caffeine**, tobacco, alcohol, diet pills, and **decongestants** in **cough** and cold medicines.

Symptoms of an arrhythmia include a fast heartbeat, pounding or fluttering chest sensations, skipping a heartbeat, "flip-flops," **dizziness**, faintness, **shortness of breath**, and chest pains.

Diagnosis

Examination with a stethoscope, electrocardiograms, and electrophysiologic studies is used to diagnose arrhythmias. Sometimes arrhythmias can be identified by listening to the patient's heart through a stethoscope, but, since arrhythmias are not always present, they may not occur during the physical exam.

An electrocardiogram (ECG) shows the heart's activity and may reveal a lack of oxygen from poor circulation (**ischemia**). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through an electrical activity monitor (oscilloscope) to a recorder that traces them on paper. The test takes about 10 minutes and is performed in a physician's office. Another type of ECG, commonly known as the **exercisestress test**, measures how the heart and blood vessels respond to exertion while the patient is exercising on a treadmill or a stationary bike. This test is performed in a physician's office or an exercise laboratory and takes 15-30 minutes. Other types of ECGs include 24-hour ECG monitoring and transtelephonic monitoring. In 24-hour ECG (Holter) monitoring, the patient wears a small, portable tape recorder connected to disks on his/her chest that record the heart's rhythm during daily activities. Transtelephonic monitoring can identify arrhythmias that occur infrequently. Similar to **Holter monitoring**, transtelephonic monitoring can continue for days or weeks, and it enables patients to send the ECG via telephone to a monitoring station when an arrhythmia is felt, or the patient can store the information in the recorder and transmit it later.

Electrophysiologic studies are invasive procedures performed in a hospital to identify the origin of serious arrhythmias and responses to various treatments. They involve **cardiac catheterization**, in which catheters tipped with electrodes are passed from a vein in the arm or leg through the blood vessels into the heart. The electrodes record impulses in the heart, highlighting where the arrhythmia starts. During the procedure, physicians can test the effects of various drugs by provoking an arrhythmia through the electrodes and trying different drugs. The procedure takes one to three hours, during which the patient is awake but mildly sedated. Local anesthetic is injected at the catheter insertion sites.

Treatment

Many arrhythmias do not require any treatment. For serious arrhythmias, treating the underlying heart disease sometimes controls the arrhythmia. In some cases, the arrhythmia itself is treated with drugs, electrical shock (**cardioversion**), automatic implantable defibrillators, artificial **pacemakers**, **catheter ablation**, or surgery. Supraventricular arrhythmias often can be treated with drug therapy. Ventricular arrhythmias are more complex to treat.

Drug therapy can manage many arrhythmias, but finding the right drug and dose requires care and can take some time. Common drugs for suppressing arrhythmias include beta-blockers, **calcium channel blockers**, quinidine, digitalis preparations, and procainamide. Because of their potential serious side effects, stronger, desensitizing drugs are used only to treat life-threatening arrhythmias. All of the drugs used to treat arrhythmias have possible side effects, ranging from mild complications with beta-blockers and calcium channel blockers to more serious effects of desensitizing drugs that can, paradoxically, cause arrhythmias or make them worse. Response to drugs is usually measured by ECG, Holter monitor, or electrophysiologic study.

In emergency situations, cardioversion or **defibrillation** (the application of an electrical shock to the chest wall) is used. Cardioversion restores the heart to its normal rhythm. It is followed by drug therapy to prevent recurrence of the arrhythmia.

Artificial pacemakers that send electrical signals to make the heart beat properly can be implanted under the skin during a simple operation. Leads from the pacemaker are anchored to the right side of the heart. Pacemakers are used to correct bradycardia and are sometimes used after surgical or catheter ablation.

Automatic implantable defibrillators correct life-threatening ventricular arrhythmias by recognizing them and then restoring a normal heart rhythm by pacing the heart or giving it an electric shock. They are implanted within the chest wall without major surgery and store information for future evaluation by physicians. Automatic implantable defibrillators have proven to be more effective in saving lives than drugs alone. They often are used in conjunction with drug therapy.

Ablation, a procedure to alter or remove the heart tissue causing the arrhythmia in order to prevent a recurrence, can be performed through a catheter or surgery. Supraventricular tachycardia can be treated successfully with ablation. Catheter ablation is performed in a catheterization laboratory with the patient under **sedation**. A catheter equipped with a device that maps the heart's electrical pathways is inserted into a vein and is

threaded into the heart. High-frequency radio waves are then used to remove the pathway(s) causing the arrhythmia. Surgical ablation is similar in principle but it is performed in a hospital, using a cold probe instead of radio waves to destroy tissue. Ablation treatments are used when medications fail.

Maze surgery treats atrial fibrillation by making multiple incisions through the atrium to allow electrical impulses to move effectively. This is often recommended for patients who have not responded to drugs or cardioversion.

Alternative treatment

Since some arrhythmias can be life threatening, a conventional medical doctor should always be consulted first. **Acupuncture** can correct an insignificant number (1.5%) of atrial fibrillation cases. For new, minor arrhythmias, acupuncture may be effective in up to 70% of cases, but this figure may not differ much from placebo therapy. Both western and Chinese herbal remedies are also used in the treatment of arrhythmias. Since hawthorn (*Crataegus laevigata*) dilates the blood vessels and stimulates the heart muscle, it may help to stabilize arrhythmias. It is gentle and appropriate for home use, unlike foxglove (*Digitalis purpurea*), an herb whose action on the heart is too potent for use without supervision by a qualified practitioner. Homeopathic practitioners may prescribe remedies such as *Lachesis* and aconite or monkshood (*Aconitum napellus*) to treat mild arrhythmias.

Prognosis

Advances in diagnostic techniques, new drugs, and medical technology have extended the lives of many patients with serious arrhythmias. Diagnostic techniques enable physicians to accurately identify arrhythmias, while new drugs, advances in pacemaker technology, the development of implantable defibrillators, and progress in ablative techniques offer effective treatments for many types of arrhythmia.

Prevention

Some arrhythmias can be prevented by managing stress, controlling **anxiety**, and avoiding caffeine, alcohol, decongestants, **cocaine**, and cigarettes.

Resources

BOOKS

American Heart Association. *American Heart Association Guide to Heart Attack Treatment, Recovery, and Prevention.* New York: Time Books, 1996.

DeBakey, Michael E., and Antonio M. Gotto Jr. "Arrhythmias" and "Controlling Arrhythmias: Pacemakers, Ablation, and Surgery." In *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Notelovitz, Morris, and Diane Tonnessen. "Other Cardiovascular Conditions." In *The Essential Heart Book for Women.* New York: St. Martin's Press, 1996.

Texas Heart Institute. "Arrhythmias." In *Texas Heart Institute Heart Owner's Handbook.* New York: John Wiley & Sons, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"The Correction of Abnormal Heart Rhythms." *Health World Online.* 3 Mar. 1998 <http://www.health.net/library/books>.

"Implanted Defibrillators Save More Lives Than Drugs." *Mayo Clinic Online.* 26 Feb. 1998. 3 Mar. 1998 <http://www.mayohealth.org>.

Lori De Milto

KEY TERMS

Bradycardia—A slow heart rate. Bradycardia is one of the two types of arrhythmia

Electrocardiogram—A test which uses electric sensors placed on the body to monitor the heartbeat.

Electrophysiology study—A test using cardiac catheterization to stimulate an electrical current to provoke an arrhythmia. The test identifies the origin of arrhythmias and is used to test the effectiveness of antiarrhythmic drugs.

Tachycardia—A fast heart rate. Tachycardia is one of the two types of arrhythmia.

Arterial blood gas analysis *see* **Blood gas analysis**

Arterial embolism

Definition

An embolus is a blood clot, bit of tissue or tumor, gas bubble, or other foreign body that circulates in the blood stream until it becomes stuck in a blood vessel.

Description

When a blood clot develops in an artery and remains in place, it is called a thrombosis. If all or part of the blockage breaks away and lodges in another part of the artery, it is called an **embolism**. Blockage of an artery in this manner can be the result of a blood clot, fat cells, or an air bubble.

When an embolus blocks the flow of blood in an artery, the tissues beyond the plug are deprived of normal blood flow and oxygen. This can cause severe damage and even **death** of the tissues involved.

Emboli can affect any part of the body. The most common sites are the legs and feet. When the brain is affected, it is called a **stroke**. When the heart is involved, it is called a **heart attack** or myocardial infarction (MI).

Causes and symptoms

A common cause of embolus is when an artery whose lining has become thickened or damaged, usually with age, allows cholesterol to build up more easily than normal on the artery wall. If some of the cholesterol breaks off, it forms an embolus. Emboli also commonly form from blood clots in a heart that has been damaged from heart attack or when the heart contracts abnormally from arterial fibrillation.

Other known causes are fat cells that enter the blood after a major bone fracture, infected blood cells, **cancer** cells that enter the blood stream, and small gas bubbles.

Symptoms of an embolus can begin suddenly or build slowly over time, depending on the amount of blocked blood flow.

If the embolus is in an arm or leg, there will be muscle **pain**, numbness or tingling, pale skin color, lower temperature in the limb, and weakness or loss of muscle function. If it occurs in an internal organ, there is usually pain and/or loss of the organ's function.

Diagnosis

The following tests can be used to confirm the presence of an arterial embolism:

- Electrocardiogram, also known as an EKG or ECG. For this test, patches that detect electrical impulses from the heart are attached to the chest and extremities. The information is displayed on a monitor screen or a paper tape in the form of waves. Reduced blood and oxygen supply to the heart shows as a change in the shape of the waves.
- Noninvasive vascular tests. These involve measuring blood pressure in various parts of the body and comparing the results from each location. When there is a decrease in blood pressure beyond what is normal between two points, a blockage is presumed to be present.
- **Angiography**. In this procedure, a colored liquid material (a dye, or contrast material) that can be seen with x rays is injected into the blood stream through a small tube called a catheter. As the dye fills the arteries, they are easily seen on x ray motion pictures. If there is a blockage in the artery, it shows up as a sudden cut off in the movement of contrast material. Angiography is an expensive procedure and does carry some risk. The catheter may cause a blood clot to form, blocking blood flow. There is also the risk of poking the catheter through the artery or heart muscle. Some people may be allergic to the dye. The risk of any of these injuries occurring is small.

KEY TERMS

Arterial fibrillation—An arrhythmia; chaotic quivering of the arteries.

Thrombosis—A blockage in a blood vessel that builds and remains in one place.

Treatment

Arterial embolism can be treated with medication or surgery, depending on the extent and location of the blockage.

Medication to dissolve the clot is usually given through a catheter directly into the affected artery. If the embolus was caused by a blood clot, medications that thin the blood will help reduce the risk of another embolism.

A surgeon can remove an embolus by making an incision in the artery above the blockage and, using a catheter inserted past the embolus, drag it out through the incision.

If the condition is severe, a surgeon may elect to bypass the blocked vessel by grafting a new vessel in its place.

Prognosis

An arterial embolism is serious and should be treated promptly to avoid permanent damage to the affected area. The outcome of any treatment depends on the location and seriousness of the embolism. New arterial emboli can form even after successful treatment of the first event.

Prevention

Prevention may include diet changes to reduce cholesterol levels, medications to thin the blood, and practicing an active, healthy lifestyle.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

OTHER

"Arterial Embolism." HealthAnswers.com. <http://www.healthanswers.com>.

Dorothy Elinor Stonely

Arteriogram *see* **Angiography**

Arteriography *see* **Angiography**

Arteriosclerosis *see* **Atherosclerosis**

Arteriovenous fistula

Definition

An arteriovenous fistula is an abnormal channel or passage between an artery and a vein.

Description

An arteriovenous fistula is a disruption of the normal blood flow pattern. Normally, oxygenated blood flows to the tissue through arteries and capillaries. Following the release of oxygen in the tissues, the blood returns to the heart in veins. An arteriovenous fistula is an abnormal connection of an artery and a vein. The blood bypasses the capillaries and tissues, and returns to the heart. Arterial blood has a higher blood pressure than veins and causes swelling of veins involved in a fistula. Although both the artery and the vein retain their normal connections, the new opening between the two will cause some arterial blood to shunt into the vein because of the blood pressure difference.

Causes and symptoms

There are two types of arteriovenous fistulas, congenital and acquired. A congenital arteriovenous fistula is one that formed during fetal development. It is a birth defect.

KEY TERMS

Congenital—Present at the time of birth.

In congenital fistulas, blood vessels of the lower extremity are more frequently involved than other areas of the body. Congenital fistulas are not common. An acquired arteriovenous fistula is one that develops after a person is born. It usually occurs when an artery and vein that are side-by-side are damaged and the healing process results in the two becoming linked. After catheterizations, arteriovenous fistulas may occur as a complication of the arterial puncture in the leg or arm. Fistulas also form without apparent cause. In the case of patients on hemodialysis, physicians perform surgery to create a fistula. These patients receive many needle sticks to flush their blood through dialysis machines and for routine blood analysis testing. The veins used may scar and become difficult to use. Surgery is used to connect an artery and vein so that arterial blood pressure and flow rate widens the vein and decreases the chance of blood clots forming inside the vein.

The main symptoms of arteriovenous fistulas near the surface of the skin are bulging and discolored veins. In some cases, the bulging veins can be mistaken for **varicose veins**. Other fistulas can cause more serious problems depending on their location and the blood vessels involved.

Diagnosis

Using a stethoscope, a physician can detect the sound of a pulse in the affected vein (bruit). The sound is a distinctive to-and-fro sound. Dye into the blood can be tracked by x ray to confirm the presence of a fistula.

Treatment

Small arteriovenous fistulas can be corrected by surgery. Fistulas in the brain or eye are very difficult to treat. If surgery is not possible or very difficult, injection therapy may be used. Injection therapy is the injection of substances that cause the blood to clot at the site of the injection. In the case of an arteriovenous fistula, the blood clot should stop the passage of blood from the artery to the vein. Surgery is usually used to correct acquired fistulas once they are diagnosed.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Braunwald, E. *Heart Disease*. Philadelphia: W. B. Saunders Co., 1997.

John T. Lohr, PhD

Arteriovenous malformations

Definition

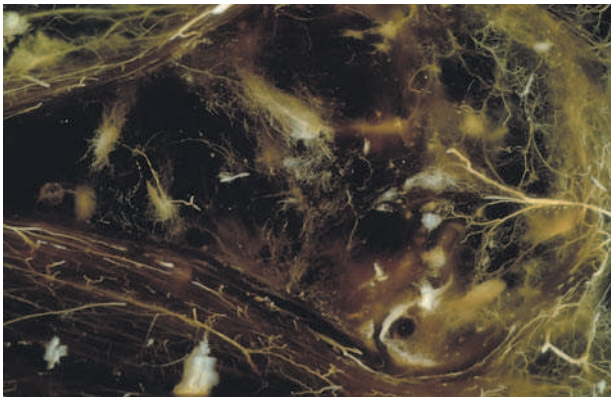
Arteriovenous malformations are blood vessel defects that occur before birth when the fetus is growing in the uterus (prenatal development). The blood vessels appear as a tangled mass of arteries and veins. They do not possess the capillary (very fine blood vessels) bed which normally exists in the common area where the arteries and veins lie in close proximity (artery-vein interface). An arteriovenous malformation (AVM) may hemorrhage, or bleed, leading to serious complications that can be life-threatening.

Description

AVMs represent an abnormal interface between arteries and veins. Normally, arteries carry oxygenated blood to the body's tissues through progressively smaller blood vessels. The smallest are capillaries, which form a web of blood vessels (the capillary bed) through the body's tissues. The arterial blood moves through tissues by these tiny pathways, exchanging its load of oxygen and nutrients for carbon dioxide and other waste products produced by the body cells (cellular wastes). The blood is carried away by progressively larger blood vessels, the veins. AVMs lack a capillary bed and arterial blood is moved (shunted) directly from the arteries into the veins.

AVMs can occur anywhere in the body and have been found in the arms, hands, legs, feet, lungs, heart, liver, and kidneys. However, 50% of these malformations are located in the brain, brainstem, and spinal cord. Owing to the possibility of hemorrhaging, such AVMs carry the risk of **stroke**, **paralysis**, and the loss of speech, memory, or vision. An AVM that hemorrhages can be fatal.

Approximately three of every 100,000 people have a cerebral AVM and roughly 40-80% of them will experience some bleeding from the abnormal blood vessels at some point. The annual risk of an AVM bleeding is estimated at about 1-4%. After age 55, the risk of bleeding decreases. Pre-existing high blood pressure or intense physical activity do not seem to be associated with AVM hemorrhage, but **pregnancy** and labor could cause a rupture or breaking open of a blood vessel. An AVM hemorrhage is not as dangerous as an aneurysmal rupture. (An aneurysm is a swollen, blood filled vessel where the pressure of the blood causes the wall to bulge outward.) There is an approximate 10% fatality rate associated with AVM hemorrhage, compared to a 50% fatality rate for ruptured aneurysms.



Arteriovenous malformations. *(Custom Medical Stock Photo. Reproduced by permission.)*

Although AVMs are congenital defects, meaning a person is born with them, they are rarely discovered before age 20. A genetic link has been proposed for some AVMs, but studies are only suggestive, not positive. The majority of AVMs are discovered in people age 20-40. Medical researchers estimate that the malformations are created during days 45-60 of fetal development. A second theory suggests that AVMs are primitive structures that are left over from the period when fetal blood circulating systems began to develop.

However they form, AVMs have blood vessels that are abnormally fragile. The arteries that feed into the malformation are unusually swollen and thin walled. They lack the usual amount of smooth muscle tissue and elastin, a fibrous connective tissue. These blood vessels commonly accumulate deposits of calcium salts and hyalin. The venous part of the malformation receives blood directly from the artery. Without the intervening capillary bed, the veins receive blood at a higher pressure than they were designed to handle. This part of the malformation is also swollen (dilated) and thin walled. There is a measurable risk of an aneurysm forming near an AVM, increasing the threat of hemorrhage, brain damage, and **death**. Approximately 10-15% of AVMs are accompanied by saccular aneurysms, a type of aneurysm that looks like a small sac attached to the outer wall of the blood vessel.

Although the malformation itself lacks capillaries, there is often an abnormal proliferation of capillaries next to the defect. These blood vessels feed into the malformation, causing it to grow larger in some cases. As the AVM receives more blood through this "steal," adjacent brain tissue does not receive enough. These areas show abnormal nerve cell growth, cell death, and deposits of calcium in that area (calcification). Nerve cells within the malformation may demonstrate abnormal growth and are believed to be nonfunctional.

Causes and symptoms

Most people do not realize that they have an AVM unless it hemorrhages enough to produce symptoms. Small AVMs are more likely to hemorrhage. If a hemorrhage occurs, it produces a sudden, severe **headache**. The headache may be focused in one specific area or it may be more general. It can be mistaken for a migraine in some cases. The headache is accompanied by other symptoms, such as vomiting, a stiff neck, sleepiness, lethargy, confusion, irritability, or weakness anywhere in the body. Seizures occur in about a quarter of AVM cases. A person may experience decreased, double, or blurred vision. Hemorrhaging from an AVM is generally less dangerous than hemorrhaging from an aneurysm, with a survival rate of 80-90%.

Other symptoms occur less frequently, but sometimes appear alongside major symptoms such as the sudden severe headache. Additional warning signs of a bleeding AVM are impaired speech or smell, **fainting**, facial paralysis, a drooping eyelid, **dizziness**, and ringing or buzzing in the ears.

Although large AVMs are less likely to hemorrhage, they can induce symptoms based on their mass alone. Large AVMs exert pressure against brain tissue, cause abnormal development in the surrounding brain tissue, and slow down or block blood flow. **Hydrocephalus**, a swelling of brain tissue caused by accumulated fluids, may develop. The warning signs associated with a large non-bleeding AVM are similar to the symptoms of a small malformation that is bleeding. Unexplained headaches, seizures, dizziness, and neurological symptoms, such as sensory changes, are signals that demand medical attention.

Diagnosis

Based on the clinical symptoms such as severe headache and neurological problems, and after a complete **neurologic exam**, a computed tomography scan (CT) of the head will be done. In some cases, a whooshing sound from arteries in the neck or over the eye or jaw (called a bruit), can be heard with a stethoscope. The CT scan will reveal whether there has been bleeding in the brain and can identify AVMs larger than 1 inch (2.5 cm). **Magnetic resonance imaging** (MRI) is also used to identify an AVM. A lumbar puncture, or spinal tap, may follow the MRI or CT scan. A lumbar puncture involves removing a small amount of cerebrospinal fluid from the lower part of the spine. Blood cells or blood breakdown products in the cerebrospinal fluid indicate bleeding.

To pinpoint where the blood is coming from, a cerebral **angiography** is done. This procedure uses x rays to map out the blood vessels in the brain, including the vessels that feed into the malformation. The information gained from angiography complements the MRI and helps distinguish the precise location of the AVM.

Treatment

Neurosurgeons consider several factors before deciding on a treatment option. There is some debate over whether or not to treat AVMs that have not ruptured and are not causing any symptoms. The risks and benefits of proceeding with treatment need to be measured on an individual basis, taking into account factors such as the person's age and general health, as well as the AVM's size and location. Several treatment options are available, both for symptomatic or asymptomatic AVMs. These treatment options may be used alone or in combination.

Surgery

Removing the AVM is the surest way of preventing it from causing future problems. Both small and large AVMs can be handled in surgery. Surgery is recommended for superficial AVMs, but may be too dangerous for deep or very large AVMs. Unless it is an emergency situation, an AVM that has hemorrhaged is treated conservatively for several weeks. Conservative treatment consists of managing the immediate symptoms and allowing the patient's condition to stabilize. Surgery requires general anesthesia and a longer period of recuperation than any other treatment option.

Radiation

Radiation is particularly useful to treat small (under 1 in) malformations that are deep within the brain. Ionizing radiation is directed at the malformation, destroying the AVM without damaging the surrounding tissue. Radiation treatment is accomplished in a single session and it is not necessary to open the skull. However, success can only be measured over the course of the following two years. A year after the procedure, 50-75% of treated AVMs are completely blocked; two years after radiation treatment, the percentage increases to 85-95%.

KEY TERMS

Aneurysm—A weak point in a blood vessel where the pressure of the blood causes the vessel wall to bulge outwards.

Angiography—A mapping of the brain's blood vessels, using x-ray imaging.

Capillary bed—A dense network of tiny blood vessels that enables blood to fill a tissue or organ.

Hydrocephalus—Swelling of the brain caused by an accumulation of fluid.

Lumbar puncture—A diagnostic procedure in which a needle is inserted into the lower spine to withdraw a small amount of cerebrospinal fluid. This fluid is examined to assess trauma to the brain.

Saccular aneurysm—A type of aneurysm that resembles a small sack of blood attached to the outer surface of a blood vessel by a thin neck.

Embolization

Embolization involves plugging up access to the malformation. This technique does not require opening the skull to expose the brain and can be used to treat deep AVMs. Using x-ray images as a guide, a catheter is threaded through the artery in the thigh (femoral artery) to the affected area. The patient remains awake during the procedure and medications can be administered to prevent discomfort. The blood vessel leading into the AVM is assessed for its importance to the rest of the brain before a balloon or other blocking agent is inserted via the catheter. The block chokes off the blood supply to the malformation. There may be a mild headache or nausea associated with the procedure, but patients may resume normal activities after leaving the hospital. At least two to three embolization procedures are usually necessary at intervals of two to six weeks. At least a three-day hospital stay is associated with each embolization.

Prognosis

Approximately 10% of AVM cases are fatal. Seizures and neurological changes may be permanent in another 10-30% cases of AVM rupture. If an AVM bleeds once, it is about 20% likely to bleed again in the next year. As time passes from the initial hemorrhage, the risk for further bleeding drops to about 3-4%. If the AVM has not bled, it is possible, but not guaranteed, that it never will. Untreated AVMs can grow larger over time and rarely go away by themselves. Once an AVM is removed and a person has recovered from the procedure, there should be no further symptoms associated with that malformation.

Resources

BOOKS

Camarate, P. J., and R. C. Heros. "Arteriovenous Malformations of the Brain." In *Neurological Surgery.* Vol. 2. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Henning, Mast. "Risk of Spontaneous Hemorrhage after Diagnosis of Cerebral Arteriovenous Malformation." *The Lancet* 350 (11 Oct. 1997): 1065.

ORGANIZATIONS

American Chronic Pain Association. PO Box 850, Rocklin, CA 95677-0850. (916) 632-0922. <http://members.tripod.com/~widdy/ACPA.html>.

Arteriovenous Malformation Support Group. 168 Six Mile Canyon Road, Dayton, NV 89403. (702) 246-0682.

National Chronic Pain Outreach Association, Inc. P.O. Box 274, Millboro, VA 24460. (540) 997-5004.

Julia Barrett

Arthritis *see* **Juvenile arthritis; Osteoarthritis; Psoriatic arthritis; Rheumatoid arthritis**

Arthrocentesis *see* **Joint fluid analysis**

Arthrogram *see* **Arthrography**

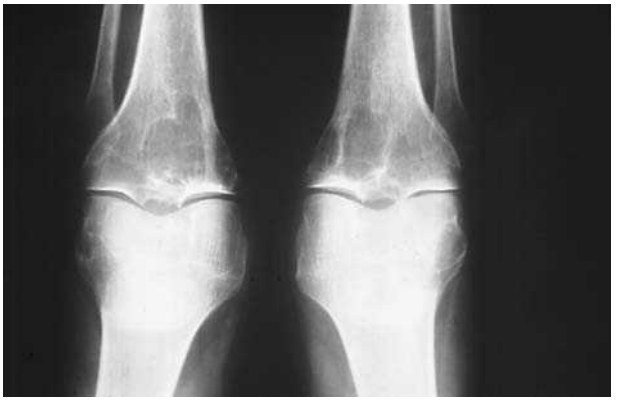
Arthrography

Definition

Arthrograpy is a procedure involving multiple x rays of a joint using a fluoroscope, or a special piece of x-ray equipment which shows an immediate x-ray image. A contrast medium (in this case, a contrast iodine solution) injected into the joint area helps highlight structures of the joint.

Purpose

Frequently, arthrography is ordered to determine the cause of unexplained joint **pain**. This fluoroscopic procedure can show the internal workings of specific joints and outline soft tissue structures. The procedure may also be conducted to identify problems with the ligaments, cartilage, tendons, or the joint capsule of the hip, shoulder, knee, ankle or wrist. An arthrography procedure may locate cysts in the joint area, evaluate problems with the joint's arrangement and function, or indicate the



An x-ray image of the knees of a patient with cysts caused by rheumatoid arthritis. The cysts appear as dark areas just below the knee joints. *(Custom Medical Stock Photo. Reproduced by permission.)*

need for **joint replacement** (prostheses). The most commonly studied joints are the knee and shoulder.

Precautions

Patients who are pregnant or may be pregnant should not have this procedure unless the benefits of the findings outweigh the risk of radiation exposure. Patients who are known to be allergic to iodine need to discuss this complication with their physician. Patients who have a known allergy to shellfish are more likely to be allergic to iodine contrast.

Description

Arthrograpy may be referred to as "joint radiography" or "x rays of the joint." The term arthrogram may be used interchangeably with arthrography. The joint area will be cleaned and a local anesthetic will be injected into the tissues around the joint to reduce pain. Next, if fluids are present in the joint, the physician may suction them out (aspirate) with a needle. These fluids may be sent to a laboratory for further study. Contrast agents are then injected into the joint through the same location by attaching the aspirating needle to a syringe containing the contrast medium. The purpose of contrast agents in x-ray procedures is to help highlight details of areas under study by making them opaque. Agents for arthrography are generally air and water-soluble dyes, the most common containing iodine. Air and iodine may be used together or independently. After the contrast agent is administered, the site of injection will be sealed and the patient may be asked to move the joint around to distribute the contrast.

Before the contrast medium can be absorbed by the joint itself, several films will be quickly taken under the guidance of the fluoroscope. The patient will be asked to move the joint into a series of positions, keeping still between positioning. Sometimes, the patient will experience some tingling or discomfort during the procedure, which is normal and due to the contrast. Following fluoroscopic tracking of the contrast, standard x rays of the area may also be taken. The entire procedure will last about one hour.

Preparation

It is important to discuss any known sensitivity to local anesthetics or iodine prior to this procedure. A physician should explain the procedure and the risks associated with contrast agents and ask the patient to sign an informed consent. If iodine contrast will be administered, the patient may be instructed not to eat before the exam. The timeframe of **fasting** may extend from only 90 minutes prior to the exam up to the night before. There is no other preparation necessary.

Aftercare

The affected joint should be rested for approximately 12 hours following the procedure. The joint may be wrapped in an elastic bandage and the patient should receive instructions on the care and changing of the bandage. Noises in the joint such as cracking or clicking are normal for a few days following arthrography. These noises are the result of liquid in the joints. Swelling may also occur and can be treated with application of ice or cold packs. A mild pain reliever can be used to lessen pain in the first few days. However, if any of these symptoms persist for more than a few days, patients are advised to contact their physician.

Risks

In some patients iodine can cause allergic reactions, ranging from mild nausea to severe cardiovascular or nervous system complications. Since the contrast dye is put into a joint, rather than into a vein, allergic reactions are rare. Facilities licensed to perform contrast exams should meet requirements for equipment, supplies and staff training to handle a possible severe reaction. Infection or joint damage are possible, although not frequent, complications of arthrography.

Normal results

A normal arthrography exam will show proper placement of the dye or contrast medium throughout the joint structures, joint space, cartilage and ligaments.

Abnormal results

The abnormal placement of dye may indicate **rheumatoid arthritis**, cysts, joint dislocation, rupture of

KEY TERMS

Aspirate—Remove fluids by suction, often through a needle.

Contrast (agent, medium)—A substance injected into the body that illuminates certain structures that would otherwise be hard to see on the radiograph(film).

Fluoroscope—A device used in some radiology procedures that provides immediate images and motion on a screen much like those seen at airport baggage security stations.

Radiologist—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

the rotator cuff, tears in the ligament and other conditions. The entire lining of the joint becomes opaque from the technique, which allows the radiologist to see abnormalities in the intricate workings of the joint. In the case of recurrent shoulder dislocations, arthrography results can be used to evaluate damage. Patients with hip prostheses may receive arthrography to evaluate proper placement or function of their prostheses.

Resources

BOOKS

Juhl, John H., and Andrew B. Crummy. *Paul and Juhl's Essentials of Radiologic Imaging*. Philadelphia: J. B. Lippincott Co., 1993.

ORGANIZATIONS

American College of Radiology. 1891 Preston White Drive, Reston, VA 22091. (800) 227-5463. <http://www.acr.org>.

Arthritis Foundation.1300 W. Peachtree St., Atlanta, GA 30309. (800) 283-7800. <http://www.arthritis.org>.

Teresa Norris, RN

Arthroplasty

Definition

Arthroplasty is surgery to relieve **pain** and restore range of motion by realigning or reconstructing a joint.

Purpose

The goal of arthroplasty is to restore the function of a stiffened joint and relieve pain. Two types of arthroplastic surgery exist. Joint resection involves removing a portion of the bone from a stiffened joint, creating a gap between the bone and the socket, to improve the range of motion. Scar tissue eventually fills the gap. Pain is relieved and motion is restored, but the joint is less stable.

Interpositional reconstruction is surgery to reshape the joint and add a prosthetic disk between the two bones forming the joint. The prosthesis can be made of plastic and metal or from body tissue such as fascia and skin. When interpositional reconstruction fails, total **joint replacement** may be necessary. Joint replacement is also called total joint arthroplasty.

In recent years, joint replacement has become the operation of choice for most knee and hip problems. Elbow, shoulder, ankle, and finger joints are more likely to be treated with joint resection or interpositional reconstruction.

Arthroplasty is performed on people suffering from severe pain and disabling joint stiffness that result from **osteoarthritis** or **rheumatoid arthritis**. Joint resection, rather than joint replacement, is more likely to be performed on people with rheumatoid arthritis, especially when the elbow joint is involved. Total joint replacement is usually reserved for people over the age of 60.

Precautions

If both the bone and socket of a joint are damaged, joint replacement is usually the preferred treatment.

Description

Arthroplasty is performed under general or regional anesthesia in a hospital, by an orthopedic surgeon. Certain medical centers specialize in joint surgery and tend to have higher success rates than less specialized centers.

In joint resection, the surgeon makes an incision at the joint, then carefully removes minimum amount of bone necessary to allow free motion. The more bone that remains, the more stable the joint. Ligament attachments are preserved as much as possible. In interpositional reconstruction, both bones of the joint are reshaped, and a disk of material is placed between the bones to prevent their rubbing together. Length of hospital stay depends on which joint is treated, but is normally only a few days.

Preparation

Prior to arthroplasty, all the standard preoperative blood and urine tests are performed. The patient meets

KEY TERMS

Fascia—Thin connective tissue covering or separating the muscles and internal organs of the body.

Rheumatoid arthritis—A joint disease of unknown origins that may begin at an early age, causing deformity and loss of function in the joints.

with the anesthesiologist to discuss any special conditions that affect the administration of anesthesia.

Aftercare

Patients who have undergone arthroplasty must be careful not to over **stress** or destabilize the joint. Physical therapy is begun immediately. **Antibiotics** are given to prevent infection.

Risks

Joint resection and interpositional reconstruction do not always produce successful results, especially in patients with rheumatoid arthritis. Repeat surgery or total joint replacement may be necessary. As with any major surgery, there is always a risk of an allergic reaction to anesthesia or that blood clots will break loose and obstruct the arteries.

Normal results

Most patients recover with improved range of motion in the joint and relief from pain.

Resources

BOOKS

"Joint Replacement." In *Everything You Need to Know About Medical Treatments.* Springhouse, PA: Springhouse Corp., 1996.

OTHER

"Darrach's Procedure." *Wheeless' Textbook of Orthopaedics Page.* <http://www.medmedia.com/ooa1/119.htm>.

Tish Davidson

Arthroscopic surgery

Definition

Arthroscopic surgery is a procedure to visualize, diagnose, and treat joint problems. The name is derived from the Greek words *arthron,* which means *joint,* and *skopein,* which means *to look at.*

Purpose

Arthroscopic surgery is used to identify, monitor, and diagnose joint injuries and disease; or to remove bone or cartilage or repair tendons or ligaments. Diagnostic arthroscopic surgery is performed when medical history, physical exam, x rays, and other tests such as MRIs or CTs don't provide a definitive diagnosis.

Precautions

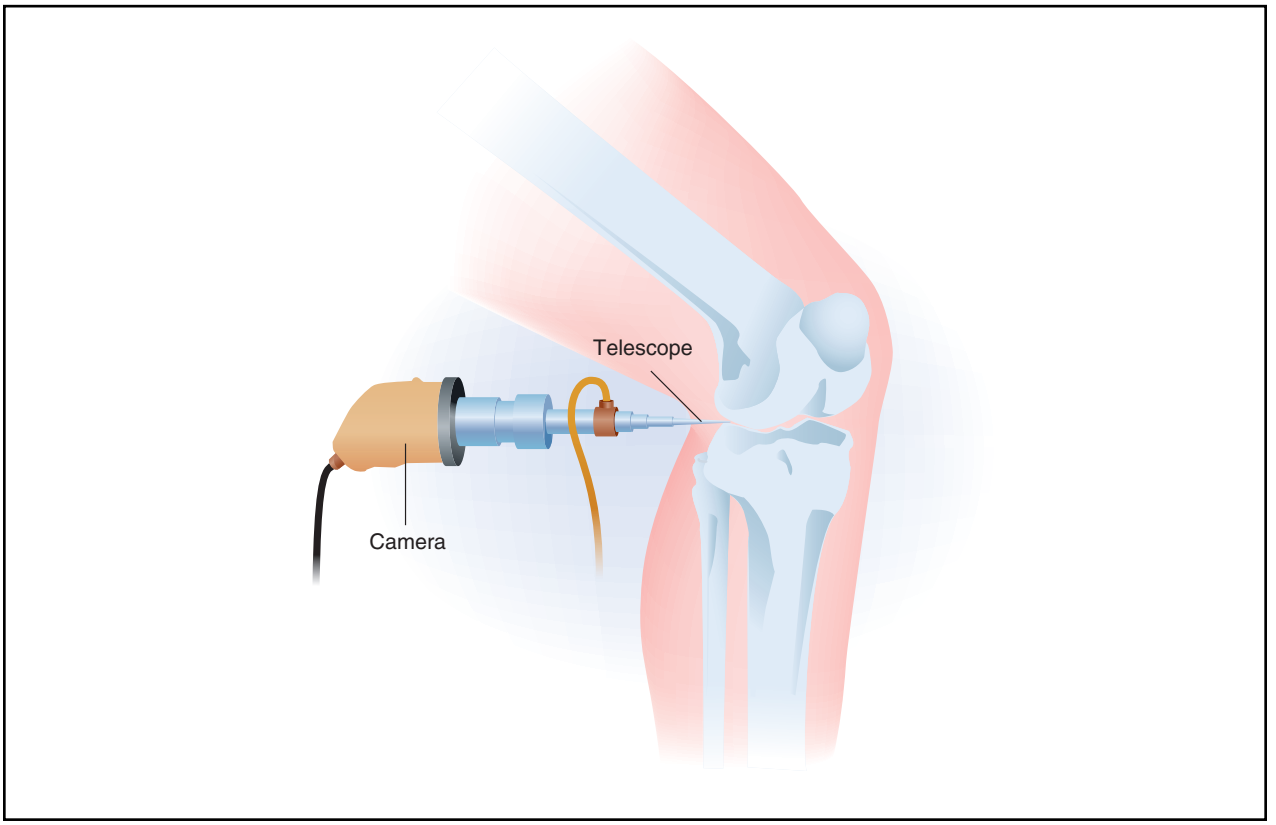
Diagnostic arthroscopic surgery should not be performed unless conservative treatment does not fix the problem.

Description

In arthroscopic surgery, an orthopedic surgeon uses an arthroscope, a fiber-optic instrument, to see the inside of a joint. After making an incision about the size of a buttonhole in the patient's skin, a sterile sodium chloride solution is injected to distend the joint. The arthroscope, an instrument the size of a pencil, is then inserted into the joint. The arthroscope has a lens and a lighting system through which the structures inside the joint are transmitted to a miniature television camera attached to the end of the arthroscope. The surgeon uses irrigation and suction to remove blood and debris from the joint before examining it. Other incisions may be made in order to see other parts of the joint or to insert additional instruments. Looking at the interior of the joint on the television screen, the surgeon can then determine the amount or type of injury and, if necessary, take a biopsy specimen or repair or correct the problem. Arthroscopic surgery can be used to remove floating bits of cartilage and treat minor tears and other disorders. When the procedure is finished, the arthroscope is removed and the joint is irrigated. The site of the incision is bandaged.

Arthroscopic surgery is used to diagnose and treat joint problems, most commonly in the knee, but also in the shoulder, elbow, ankle, wrist, and hip. Some of the most common joint problems seen with an arthroscope are:

- inflammation in the knee, shoulder, elbow, wrist, or ankle
- injuries to the shoulder (rotator cuff tendon tears, impingement syndrome, and recurrent dislocations), knee (cartilage tears, wearing down of or injury to the cartilage cushion, and anterior cruciate ligament tears with instability), and wrist (**carpal tunnel syndrome**)
- loose bodies of bone and/or cartilage in the knee, shoulder, elbow, ankle, or wrist



An arthroscope uses optical fibers to form an image of the damged cartilage, which it sends to a television monitor that helps the surgeon perform surgery. *(Illustration by Argosy Inc.)*

Corrective arthroscopic surgery is performed with instruments that are inserted through additional incisions. Arthritis can sometimes be treated with arthroscopic surgery. Some problems are treated with a combination of arthroscopic and standard surgery.

Also called **arthroscopy**, the procedure is performed in a hospital or outpatient surgical facility. The type of anesthesia (local, spinal, or general) and the length of the procedure depends on the joint operated on and the complexity of the suspected problem. Arthroscopic surgery rarely takes more than an hour. Most patients who have arthroscopic surgery are released that same day; some patients stay in the hospital overnight.

Considered the most important orthopedic development in the 20th century, arthroscopic surgery is widely used. The use of arthroscopic surgery on famous athletes has been well publicized. It is estimated that 80% of orthopedic surgeons practice arthroscopic surgery. Arthroscopic surgery was initially a diagnostic tool used prior to open surgery, but as better instruments and techniques were developed, it began to be used to actually treat a variety of joint problems. New techniques currently under development are likely to lead to other joints being treated with arthroscopic surgery in the future. Recently, lasers were introduced in arthroscopic surgery and other new energy sources are being explored. Lasers and electromagnetic radiation can repair rather than resect injuries and may be more cost effective than instruments.

Preparation

Before the procedure, blood and urine studies and x rays of the joint will be conducted.

Aftercare

Immediately after the procedure, the patient will spend several hours in the recovery room. An ice pack will be put on the joint that was operated on for up to 48 hours after the procedure. **Pain** medicine, prescription or non-prescription, will be given. The morning after the surgery, the dressing can be removed and replaced by adhesive strips. The patient should call his/her doctor upon experiencing an increase in pain, swelling, redness, drainage or bleeding at the site of the surgery, signs of infection (**headache**, muscle aches, **dizziness**, **fever**), or nausea or vomiting.

KEY TERMS

Joint—The point where bones meet. Arthroscopic surgery is used on joint problems.

Laser—A device that concentrates electromagnetic radiation into a narrow beam and treats tissue quickly without heating surrounding areas.

Orthopedics—The medical specialty that deals with preserving, restoring, and developing form and function in the extremities, spine, and other structures using medical, surgical, and physical methods. Arthroscopic surgery is performed by orthopedic surgeons.

It takes several days for the puncture **wounds** to heal, and several weeks for the joint to fully recover. Many patients can resume their daily activities, including going back to work, within a few days of the procedure. A **rehabilitation** program, including physical therapy, may be suggested to speed recovery and improve the future functioning of the joint.

Risks

Complications are rare in arthroscopic surgery, occurring in less than 1% of patients. These include infection and inflammation, blood vessel clots, damage to blood vessels or nerves, and instrument breakage.

Resources

BOOKS

Andrews, James R, and Laura A. Timmerman. *Diagnostic and Operative Arthroscopy.* Philadelphia: W. B. Saunders Co., 1997.

Brillhart, Allen T., ed. *Arthroscoic Laser Surgery: Clinical Applications.* New York: Springer-Verlag, 1995.

Oxford Medical Publications. *Oxford Textbook of Sports Medicine.* New York: Oxford Medical Publications, 1994.

PERIODICALS

"Arthroscopic Knee Surgery." *Harvard Women's Health Watch* 4 (Dec. 1996): 4.

Pierce, Michael W. "Arthroscopic Surgery." *Scientific American* 276 (Feb. 1997): 108.

"Should You Be Scoped?" *Prevention* (Aug. 1997): 82.

Wilkinson, Todd. "Pop, Crackle, Snap." *Women's Sports & Fitness* (Apr. 1998): 68.

OTHER

"Arthroscopy." American Academy of Orthopaedic Surgeons. 15 Apr. 1998. <http://www.aos.org/ wordhtml/pat_educ/ arthrosc.htm>.

"Arthroscopy." *ThriveOnline.* 15 Apr. 1998. <http://thrive online.oxygen.com>.

"Knee Arthroscopy." The Center for Orthopaedics and Sports Medicine. 15 Apr. 1998. <http://www.arthro scopy.com/ spo4002.htm>.

Lori De Milto

Arthroscopy

Definition

Arthroscopy is the examination of a joint, specifically, the inside structures. The procedure is performed by inserting a specifically designed illuminated device into the joint through a small incision. This instrument is called an arthroscope. The procedure of arthroscopy is primarily associated with the process of diagnosis. However, when actual repair is performed, the procedure is called **arthroscopic surgery**.

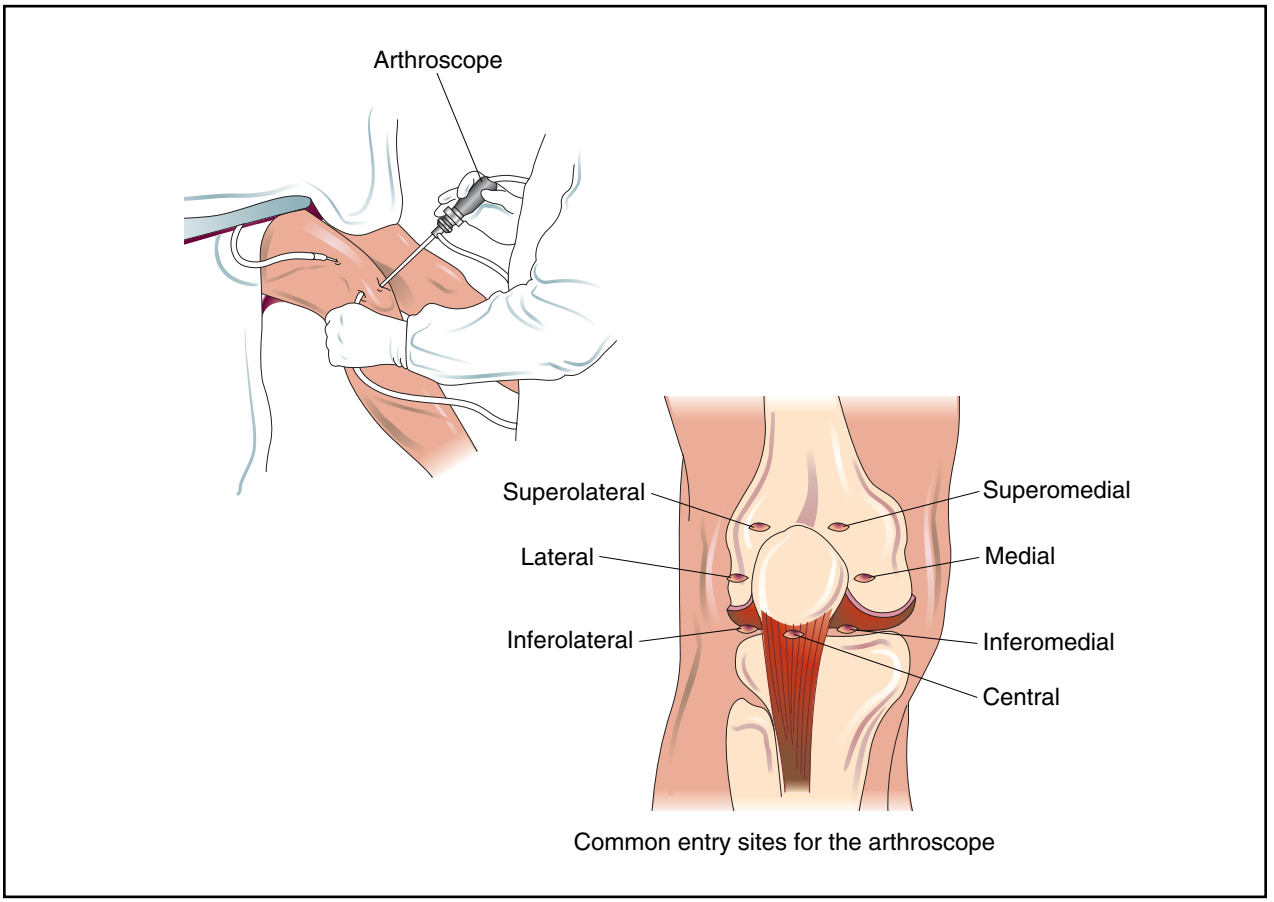
Purpose

Arthroscopy is used primarily by doctors who specialize in treating disorders of the bones and related structures (orthopedics) to help diagnose joint problems. Once described as essential for those who primarily care for athletic injuries, arthroscopy is now a technique commonly used by orthopedic surgeons for the treatment of patients of all ages. This procedure is most commonly used to diagnose knee and shoulder problems, although the elbow, hip, wrist, and ankle may also be examined with an arthroscope.

A joint is a complex system. Within a joint, ligaments attach bones to other bones, tendons attach muscles to bones, cartilage lines and helps protect the ends of bones, and a special fluid (synovial fluid) cushions and lubricates the structures. Looking inside the joint allows the doctors to see exactly which structures are damaged. Arthroscopy also permits earlier diagnosis of many types of joint problems which had been difficult to detect in previous years.

Precautions

Most arthroscopic procedures today are performed in same-day surgery centers where the patient is admitted just before surgery. A few hours following the procedure, the patient is allowed to return home, although usually someone else must drive. Depending on the type of anesthesia used, the patient may be told not to eat for several hours before arriving. Before the procedure, the anesthesiologist will ask if the patient has any known **allergies** to local or general anesthetics. Airway obstruction is always possible in any patient who receives a general



Arthroscopy is primarily used to help diagnose joint problems. This procedure, most commonly associated with knee and shoulder problems, allows accurate examination and diagnosis of damaged joint ligaments, surfaces, and other related joint structures. The illustration above indicates the most common entry sites, or portals, in knee arthroscopy. *(Illustration by Electronic Illustrators Group.)*

anesthesia. Because of this, oxygen, suction, and monitoring equipment must be available. The patient's cardiac status should always be monitored in the event that any cardiac abnormalities arise during the arthroscopy.

Description

The arthroscope is an instrument used to look directly into the joint. It contains magnifying lenses and glass-coated fibers that send concentrated light into the joint. A camera attached to the arthroscope allows the surgeon to see a clear image of the joint. This image is then transferred to a monitor located in the operating room at the time of the arthroscopy. This video technology is also important for documentation of the arthroscopic procedure. For example, if the surgeon decides after the arthroscopic examination that a conventional approach to surgically expose or "open" the joint (arthrotomy) must be used, a good photographic record will be useful when the surgeon returns to execute the final surgical plan.

The procedure requires the surgeon to make several small incisions (portals) through the skin's surface into the joint. Through one or two of the portals, a large-bore needle, called a cannula, is attached to tubing and inserted into the joint. The joint is inflated with a sterile saline solution to expand the joint and ensure clear arthroscopic viewing. Often, following a recent traumatic injury to a joint, the joint's natural fluid may be cloudy, making interior viewing of the joint difficult. In this condition, a constant flow of the saline solution is necessary. This inflow of saline solution may be through the cannula with the outflow through the arthroscope, or the positions may be reversed. The arthroscope is placed through one of the portals to view and evaluate the condition of the joint.

Preparation

Before an arthroscopy can take place, the surgeon completes a thorough medical history and evaluation. Important for the accuracy of this diagnostic procedure, a

medical history and evaluation may discover other disorders of the joint or body parts, proving the procedure unnecessary. This is always an important preliminary step, because **pain** can often be referred to a joint from another area of the body. Anatomical models and pictures are useful aids to explain to the patient the proposed arthroscopy and what the surgeon may be looking at specifically.

Proper draping of the body part is important to prevent contamination from instruments used in arthroscopy, such as the camera, light cords, and inflow and outflow drains placed in the portals. Draping packs used in arthroscopy include disposable paper gowns and drapes with adhesive backing. The surgeon may also place a tourniquet above the joint to temporarily block blood flow to the area during the arthroscopic exam.

General or local anesthesia may be used during arthroscopy. Local anesthesia is usually used because it reduces the risk of lung and heart complications and allows the patient to go home sooner. The local anesthetic may be injected in small amounts in multiple locations in skin and joint tissues in a process called infiltration. In other cases, the anesthetic is injected into the spinal cord or a main nerve supplying the area. This process is called a "block," and it blocks all sensation below the main trunk of the nerve. For example, a femoral block anesthetizes the leg from the thigh down (its name comes from femur, the thighbone). Most patients are comfortable once the skin, muscles, and other tissues around the joint are numbed by the anesthetic; however, some patients are also given a sedative if they express **anxiety** about the procedure. (It's important for the patient to remain still during the arthroscopic examination.)

General anesthesia, in which the patient becomes unconcious, may be used if the procedure may be unusually complicated or painful. For example, people who have relatively "tight" joints may be candidates for general anesthesia because the procedure may take longer and cause more discomfort.

Aftercare

The portals are closed by small tape strips or stitches and covered with dressings and a bandage. The patient spends a short amount of time in the recovery room after arthroscopy. Most patients can go home after about an hour in the recovery room. Pain medication may be prescribed for a short period; however, many patients find various over-the-counter pain relievers sufficient.

Following the surgical procedure, the patient needs to be aware of the signs of infection, which include redness, warmth, excessive pain, and swelling. The risk of infection increases if the incisions become wet too early following surgery. Because of this, it is good practice to cover the joint with plastic (for example, a plastic bag) while showering after arthroscopy.

The use of crutches is commonplace after arthroscopy, with progression to independent walking on an "as tolerated" basis by the patient. Generally, a **rehabilitation** program, supervised by a physical therapist, follows shortly after the arthroscopy to help the patient regain mobility and strength of the affected joint and limb.

Risks

The incidence of complications is low compared to the high number of arthroscopic procedures performed every year. Possible complications include infection, swelling, damage to the tissues in the joint, blood clots in the leg veins (**thrombophlebitis**), leakage of blood into the joint (hemarthrosis), blood clots that move to the lung (pulmonary embolus), and injury to the nerves around the joint.

Normal results

The goal of arthroscopy is to diagnose a joint problem causing pain and/or restrictions in normal joint function. For example, arthroscopy can be a useful tool in locating a tear in the joint surface of the knee or locating a torn ligament of the shoulder. Arthroscopic examination is often followed by arthroscopic surgery performed to repair the problem with appropriate arthroscopic tools. The final result is to decrease pain, increase joint mobility, and thereby improve the overall quality of the patient's activities of daily living.

Abnormal results

Less optimal results that may require further treatment include adhesive capsulitis. In this condition, the joint capsule that naturally forms around the joint becomes thickened, forming adhesions. This results in a stiff and less mobile joint. This problem is frequently corrected by manipulation and mobilization of the joint with the patient placed under general anesthesia.

Resources

BOOKS

Casscells, Ward S. *Arthroscopy: Diagnostic and Surgical Practice*. Philadelphia: Lea and Febiger, 1984.

McGinty, John B. "Complications of Arthroscopy and Arthroscopic Surgery." In *Arthroscopic Surgery*, ed. Serge J. Parisien. New York: McGraw Hill, 1988.

Parisien, Serge J., and Dzenis Peteris. "Development of Modern Arthroscopic Techniques, Fundamentals of Endoscopes, Basic Equipment for Diagnosis of Surgery." In

KEY TERMS

Hemarthrosis—A condition of blood within a joint.

Pulmonary embolus—Blockage of an artery of the lung by foreign matter such as fat, tumor, tissue, or a clot originating from a vein.

Thrombophlebitis—Inflamation of a vein with the formation of a thrombus or clot.

Arthroscopic Surgery, ed. Serge J. Parisien. New York: McGraw Hill, 1988.

Scott, Norman W. *Arthroscopy of the Knee*. Philadelphia: W. B. Saunders Co., 1990.

Smith, Genevieve L., and Phyllis E. Davis. *Medical Terminology: A Programmed Text*. New York: John Wiley and Sons, Inc., 1988.

PERIODICALS

Glassman, Scott. "Advances in Treating Shoulder Injuries." *Advanced Magazine for Physical Therapists*, Dec. 1997, 10-12.

Mattson, Patricia, and Thomas Moore. "Preoperative and Postoperative Management of Lower Extremity Surgery." *Orthopaedic Physical Therapy Clinics of North America* (Mar. 1993): 87-92.

Jeffrey P. Larson, RPT

Artificial insemination *see* **Infertility therapies**

Art therapy

Definition

Art therapy, sometimes called creative arts therapy or expressive arts therapy, encourages people to express and understand emotions through artistic expression and through the creative process.

Purpose

Art therapy provides the client-artist with critical insight into emotions, thoughts, and feelings. Key benefits of the art therapy process include:

- Self-discovery. At its most successful, art therapy triggers an emotional catharsis.
- Personal fulfillment. The creation of a tangible reward can build confidence and nurture feelings of self-worth. Personal fulfillment comes from both the creative and the analytical components of the artistic process.
- Empowerment. Art therapy can help people visually express emotions and fears that they cannot express through conventional means, and can give them some sense of control over these feelings.
- Relaxation and **stress** relief. Chronic stress can be harmful to both mind and body. Stress can weaken and damage the immune system, can cause **insomnia** and depression, and can trigger circulatory problems (like high blood pressure and irregular heartbeats). When used alone or in combination with other relaxation techniques such as **guided imagery**, art therapy can effectively relieve stress.
- Symptom relief and physical **rehabilitation**. Art therapy can also help patients cope with **pain**. This therapy can promote physiological healing when patients identify and work through anger, resentment, and other emotional stressors. It is often prescribed to accompany pain control therapy for chronically and terminally ill patients.

Description

Origins

Humans have expressed themselves with symbols throughout history. Masks, ritual pottery, costumes, other objects used in rituals, cave drawings, Egyptian hieroglyphics, and Celtic art and symbols are all visual records of self-expression and communication through art. Art has also been associated spiritual power, and artistic forms such as the Hindu and Buddhist mandala and Native American sand painting are considered powerful healing tools.

In the late nineteenth century, French psychiatrists Ambrose Tardieu and Paul-Max Simon both published studies on the similar characteristics of and symbolism in the artwork of the mentally ill. Tardieu and Simon viewed art therapy as an effective diagnostic tool to identify specific types of mental illness or traumatic events. Later, psychologists would use this diagnostic aspect to develop psychological drawing tests (the Draw-A-Man test, the Draw-A-Person Questionnaire [DAP.Q]) and projective personality tests involving visual symbol recognition (e.g., the Rorschach Inkblot Test, the **Thematic Apperception Test** [TAT], and the Holtzman Inkblot Test [HIT]).

The growing popularity of milieu therapies at psychiatric institutions in the twentieth century was an important factor in the development of art therapy in the

United States. Milieu therapies (or environmental therapy) focus on putting the patient in a controlled therapeutic social setting that provides the patient with opportunities to gain self-confidence and interact with peers in a positive way. Activities that encourage self-discovery and empowerment such as art, music, dance, and writing are important components of this approach.

Educator and therapist Margaret Naumburg was a follower of both Freud and Jung, and incorporated art into psychotherapy as a means for her patients to visualize and recognize the unconscious. She founded the Walden School in 1915, where she used students' artworks in psychological counseling. She published extensively on the subject and taught seminars on the technique at New York University in the 1950s. Today, she is considered the founder of art therapy in the United States.

In the 1930s, Karl, William, and Charles Menninger introduced an art therapy program at their Kansas-based psychiatric hospital, the Menninger Clinic. The Menninger Clinic employed a number of artists in residence in the following years, and the facility was also considered a leader in the art therapy movement through the 1950s and 60s. Other noted art therapy pioneers who emerged in the 50s and 60s include Edith Kramer, Hanna Yaxa Kwiatkowska (National Institute of Mental Health), and Janie Rhyne.

Art therapy, sometimes called expressive art or art psychology, encourages self-discovery and emotional growth. It is a two part process, involving both the creation of art and the discovery of its meaning. Rooted in Freud and Jung's theories of the subconscious and unconscious, art therapy is based on the assumption that visual symbols and images are the most accessible and natural form of communication to the human experience. Patients are encouraged to visualize, and then create, the thoughts and emotions that they cannot talk about. The resulting artwork is then reviewed and its meaning interpreted by the patient.

The "analysis" of the artwork produced in art therapy typically allows patients to gain some level of insight into their feelings and lets them to work through these issues in a constructive manner. Art therapy is typically practiced with individual, group, or family psychotherapy (talk therapy). While a therapist may provide critical guidance for these activities, a key feature of effective art therapy is that the patient/artist, not the therapist, directs the interpretation of the artwork.

Art therapy can be a particularly useful treatment tool for children, who frequently have limited language skills. By drawing or using other visual means to express troublesome feelings, younger patients can begin to address these issues, even if they cannot identify or label these emotions with words. Art therapy is also valuable for adolescents and adults who are unable or unwilling to talk about thoughts and feelings.

Beyond its use in mental health treatment, art therapy is also used with traditional medicine to treat organic diseases and conditions. The connection between mental and physical health is well documented, and art therapy can promote healing by relieving stress and allowing the patient to develop coping skills.

Art therapy has traditionally centered on visual mediums, like paintings, sculptures, and drawings. Some mental healthcare providers have now broadened the definition to include music, film, dance, writing, and other types of artistic expression.

Art therapy is often one part of a psychiatric inpatient or outpatient treatment program, and can take place in individual or **group therapy** sessions. Group art therapy sessions often take place in hospital, clinic, shelter, and community program settings. These group therapy sessions can have the added benefits of positive social interaction, empathy, and support from peers. The client-artist can learn that others have similar concerns and issues.

Preparations

Before starting art therapy, the therapist may have an introductory session with the client-artist to discuss art therapy techniques and give the client the opportunity to ask questions about the process. The client-artist's comfort with the artistic process is critical to successful art therapy.

The therapist ensures that appropriate materials and space are available for the client-artist, as well as an adequate amount of time for the session. If the individual artist is exploring art as therapy without the guidance of a trained therapist, adequate materials, space, and time are still important factors in a successful creative experience.

The supplies used in art therapy are limited only by the artist's (and/or therapist's) imagination. Some of the materials often used include paper, canvas, poster board, assorted paints, inks, markers, pencils, charcoals, chalks, fabrics, string, adhesives, clay, wood, glazes, wire, bendable metals, and natural items (like shells, leaves, etc.). Providing artists with a variety of materials in assorted colors and textures can enhance their interest in the process and may result in a richer, more diverse exploration of their emotions in the resulting artwork. Appropriate tools such as scissors, brushes, erasers, easels, supply trays, glue guns, smocks or aprons, and cleaning materials are also essential.

An appropriate workspace should be available for the creation of art. Ideally, this should be a bright, quiet, comfortable place, with large tables, counters, or other

suitable surfaces. The space can be as simple as a kitchen or office table, or as fancy as a specialized artist's studio.

The artist should have adequate time to become comfortable with and explore the creative process. This is especially true for people who do not consider themselves "artists" and may be uncomfortable with the concept. If performed in a therapy group or one-on-one session, the art therapist should be available to answer general questions about materials and/or the creative process. However, the therapist should be careful not to influence the creation or interpretation of the work.

Precautions

Art materials and techniques should match the age and ability of the client. People with impairments, such as traumatic brain injury or an organic neurological condition, may have difficulties with the self-discovery portion of the art therapy process depending on their level of functioning. However, they may still benefit from art therapy through the sensory stimulation it provides and the pleasure they get from artistic creation.

While art is accessible to all (with or without a therapist to guide the process), it may be difficult to tap the full potential of the interpretive part of art therapy without a therapist to guide the process. When art therapy is chosen as a therapeutic tool to cope with a physical condition, it should be treated as a supplemental therapy and not as a substitute for conventional medical treatments.

Research and general acceptance

A wide body of literature supports the use of art therapy in a mental health capacity. And as the mind-body connection between psychological well-being and physical health is further documented by studies in the field, art therapy gains greater acceptance by mainstream medicine as a therapeutic technique for organic illness.

Resources

BOOKS

Fausek, Diane. *A Practical Guide to Art Therapy.* Binghamton, New York: Haworth Press, 1997.

Ganim, Barbara. *Art and Healing: Using expressive art to heal your body, mind, and spirit.* New York: Three Rivers Press, 1999.

Malchiodi, Cathy A. *The Art Therapy Sourcebook.* Los Angeles: Lowell House, 1998.

McNiff, Shaun. *Art as Medicine: Creating a Therapy of the Imagination.* Boston: Shambhala, 1992.

ORGANIZATIONS

American Art Therapy Association.1202 Allanson Rd., Mundelein, IL 60060-3808. 888-290-0878 or 847-949-6064. Fax: 847-566-4580. arttherapy@ntr.net. <http://www.arttherapy.org>.

Paula Ford-Martin

KEY TERMS

Catharsis—Therapeutic discharge of emotional tension by recalling past events.

Mandala—A design, usually circular, that appears in religion and art. In Buddhism and Hinduism, the mandala has religious ritual purposes and serves as a yantra (a geometric emblem or instrument of contemplation).

Organic illness—A physically, biologically based illness.

Asbestosis

Definition

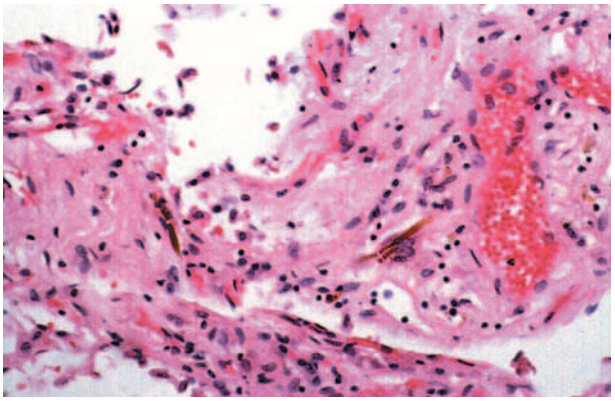
Asbestosis is chronic, progressive inflammation of the lung. It is not contagious.

Description

Asbestosis is a consequence of prolonged exposure to large quantities of asbestos, a material once widely used in construction, insulation, and manufacturing. When asbestos is inhaled, fibers penetrate the breathing passages and irritate, fill, inflame, and scar lung tissue. In advanced asbestosis,, the lungs shrink, stiffen, and become honeycombed (riddled with tiny holes).

Legislation has reduced use of asbestos in the United States, but workers who handle automobile brake shoe linings, boiler insulation, ceiling acoustic tiles, electrical equipment, and fire-resistant materials are still exposed to the substance. Asbestos is used in the production of paints and plastics. Significant amounts can be released into the atmosphere when old buildings or boats are razed or remodeled.

Asbestosis is most common in men over 40 who have worked in asbestos-related occupations. Smokers or heavy drinkers have the greatest risk of developing this disease. Between 1968 and 1992, more than 10,000 Americans over the age of 15 died as a result of asbestosis. Nearly 25% of those who died lived in California or



Micrograph of asbestos fibers embedded in lung tissue. *(Photograph by Dr. E. Walker, Custom Medical Stock Photo. Reproduced by permission.)*

New Jersey, and most of them had worked in the construction or shipbuilding trades.

Causes and symptoms

Occupational exposure is the most common cause of asbestosis, but the condition also strikes people who inhale asbestos fiber or who are exposed to waste products from plants near their homes. Family members can develop the disease as a result of inhaling particles of asbestos dust that cling to workers' clothes.

It is rare for asbestosis to develop in anyone who hasn't been exposed to large amounts of asbestos on a regular basis for at least 10 years. Symptoms of the disease do not usually appear until 15–20 years after initial exposure to asbestos.

The first symptom of asbestosis is usually **shortness of breath** following **exercise** or other physical activity. The early stages of the disease are also characterized by a dry **cough** and a generalized feeling of illness.

As the disease progresses and lung damage increases, shortness of breath occurs even when the patient is at rest. Recurrent respiratory infections and coughing up blood are common. So is swelling of the feet, ankles, or hands. Other symptoms of advanced asbestosis include chest **pain**, hoarseness, and restless sleep. Patients who have asbestosis often have clubbed (widened and thickened) fingers. Other potential complications include **heart failure**, collapsed (deflated) lung, and **pleurisy** (inflammation of the membrane that protects the lung).

Diagnosis

Screening of at-risk workers can reveal lung inflammation and lesions characteristic of asbestosis. Patients' medical histories can identify occupations, hobbies, or other situations likely to involve exposure to asbestos fibers.

X rays can show shadows or spots on the lungs or an indistinct or shaggy outline of the heart that suggests the presence of asbestosis. Blood tests are used to measure concentrations of oxygen and carbon dioxide. Pulmonary function tests can be used to assess a patient's ability to inhale and exhale, and a computed tomography scan (CT) of the lungs can show flat, raised patches associated with advanced asbestosis.

Treatment

The goal of treatment is to help patients breathe more easily, prevent colds and other respiratory infections, and control complications associated with advanced disease. Ultrasonic, cool-mist humidifiers or controlled coughing can loosen bronchial secretions.

Regular exercise helps maintain and improve lung capacity. Although temporary bed rest may be recommended, patients are encouraged to resume their regular activities as soon as they can.

Antibiotics may be prescribed to combat infection. **Aspirin** or acetominophen (Tylenol) can relieve minor discomfort and **bronchodilators** that are swallowed or inhaled can relax and widen breathing passages.

Diuretics (drugs that increase urine production and excretion) or digitalis glycoside (*Digitalis purpurea*) are prescribed for some patients. Others may need to use supplemental oxygen or use less salt.

Anyone who develops symptoms of asbestosis should see a family physician or lung disease specialist. A doctor should be notified if someone who has been diagnosed with asbestosis:

- coughs up blood
- continues to lose weight
- is short of breath
- has chest pain
- develops a sudden **fever** of 101°F (38.3°C) or higher
- develops unfamiliar, unexplained symptoms

Prognosis

Asbestosis can't be cured, but its symptoms can be controlled. Doctors don't know why the health of some patients deteriorates and the condition of others remain the same, but believe the difference may be due to varying exposures of asbestos. People with asbestosis who smoke, particularly those who smoke more than one pack of cigarettes each day, are at increased risk for

KEY TERMS

Asbestos—A silicate (containing silica) mineral that occurs in a variety of forms; it is characterized by a fibrous structure and resistance to fire.

developing lung **cancer** and should be strongly advised to quit **smoking**.

Prevention

Workers in asbestosis-related industries should have regular x rays to determine whether their lungs are healthy. A person whose lung x ray shows a shadow should eliminate asbestos exposure even if no symptoms of the condition have appeared.

Anyone who works with asbestos should wear a protective mask or a hood with a clean-air supply and obey recommended procedures to control asbestos dust. Anyone who is at risk of developing asbestosis should:

- not smoke
- be vaccinated against **influenza** and **pneumonia**
- exercise regularly to maintain cardiopulmonary fitness
- avoid crowds and people who have respiratory infections

A person who has asbestosis should exercise regularly, relax, and conserve energy whenever necessary.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Burton, George G., John E. Hodgkin, and Jeffrey J. Ward, eds. *Respiratory Care: A Guide to Clinical Practice*. 4th ed. Philadelphia: Lippincott, 1997.

Farzan, Sattar. *A Concise Handbook of Respiratory Diseases*. 4th ed. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

OTHER

"Asbestosis." ThriveOnline. 1 May 1998. <http://thriveonline.oxygen.com>.

"1996 World Report: Asbestosis Mortality." Centers for Disease Control. 1 May 1998. <http://www.cdc.gov/hiosh/w7asbt9.html>.

Maureen Haggerty

Ascariasis *see* **Roundworm infections**

Ascending cholangitis *see* **Cholangitis**

Ascending contrast phlebography *see* **Venography**

Ascites

Definition

Ascites is an abnormal accumulation of fluid in the abdomen.

Description

Rapidly developing (acute) ascites can occur as a complication of trauma, perforated ulcer, **appendicitis**, or inflammation of the colon or other tube-shaped organ (diverticulitis). This condition can also develop when intestinal fluids, bile, pancreatic juices, or bacteria invade or inflame the smooth, transparent membrane that lines the inside of the abdomen (peritoneum). However, ascites is more often associated with liver disease and other long-lasting (chronic) conditions.

Types of ascites

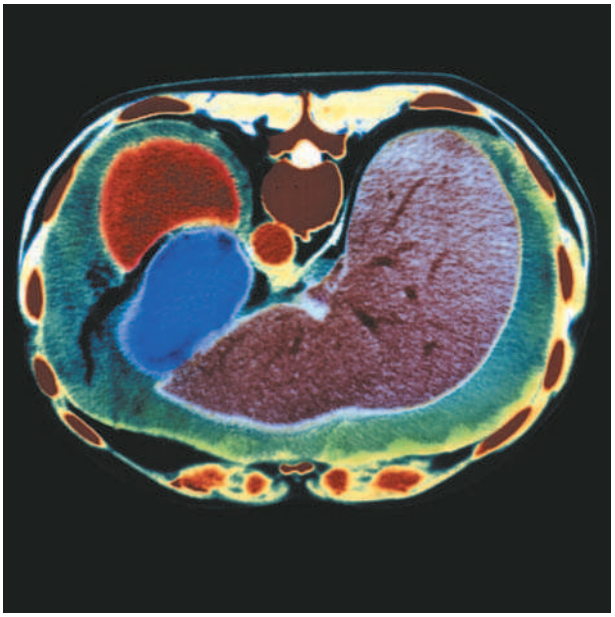
Cirrhosis, which is responsible for 80% of all instances of ascites in the United States, triggers a series of disease-producing changes that weaken the kidney's ability to excrete sodium in the urine.

Pancreatic ascites develops when a cyst that has thick, fibrous walls (pseudocyst) bursts and permits pancreatic juices to enter the abdominal cavity.

Chylous ascites has a milky appearance caused by lymph that has leaked into the abdominal cavity. Although chylous ascites is sometimes caused by trauma, abdominal surgery, **tuberculosis**, or another peritoneal infection, it is usually a symptom of lymphoma or some other **cancer**.

Cancer causes 10% of all instances of ascites in the United States. It is most commonly a consequence of disease that originates in the peritoneum (peritoneal carcinomatosis) or of cancer that spreads (metastasizes) from another part of the body.

Endocrine and renal ascites are rare disorders. Endocrine ascites, sometimes a symptom of an endocrine system disorder, also affects women who are taking fertility drugs. Renal ascites develops when blood levels of albumin dip below normal. Albumin is the major protein



A computed tomography (CT) scan of an axial section through the abdomen, showing ascites. At right is the liver occupying much of the abdomen; the stomach and spleen are also seen. Around these organs is fluid giving rise to this condition. *(Custom Medical Stock Photo. Reproduced by permission.)*

in blood plasma. It functions to keep fluid inside the blood vessels.

Causes and symptoms

Causes

The two most important factors in the production of ascites due to chronic liver disease are:

- Low levels of albumin in the blood that cause a change in the pressure necessary to prevent fluid exchange (osmotic pressure). This change in pressure allows fluid to seep out of the blood vessels.
- An increase in the pressure within the branches of the portal vein that run through liver (portal **hypertension**). Portal hypertension is caused by the scarring that occurs in cirrhosis. Blood that cannot flow through the liver because of the increased pressure leaks into the abdomen and causes ascites.

Other conditions that contribute to ascites development include:

- hepatitis
- heart or kidney failure
- inflammation and fibrous hardening of the sac that contains the heart (constrictive **pericarditis**)

Persons who have **systemic lupus erythematosus** but do not have liver disease or portal hypertension occasionally develop ascites. Depressed thyroid activity sometimes causes pronounced ascites, but inflammation of the pancreas (**pancreatitis**) rarely causes significant accumulations of fluid.

Symptoms

Small amounts of fluid in the abdomen do not usually produce symptoms. Massive accumulations may cause:

- rapid weight gain
- abdominal discomfort and distention
- shortness of breath
- swollen ankles

Diagnosis

Skin stretches tightly across an abdomen that contains large amounts of fluid. The navel bulges or lies flat, and the fluid makes a dull sound when the doctor taps the abdomen. Ascitic fluid may cause the flanks to bulge.

Physical examination generally enables doctors to distinguish ascites from **pregnancy**, intestinal gas, **obesity**, or ovarian tumors. Ultrasound or **computed tomography scans** (CT) can detect even small amounts of fluid. Laboratory analysis of fluid extracted by inserting a needle through the abdominal wall (diagnostic **paracentesis**) can help identify the cause of the accumulation.

Treatment

Reclining minimizes the amount of salt the kidneys absorb, so treatment generally starts with bed rest and a low-salt diet. Urine-producing drugs (**diuretics**) may be prescribed if initial treatment is ineffective. The weight and urinary output of patients using diuretics must be carefully monitored for signs of :

- hypovolemia (massive loss of blood or fluid)
- azotemia (abnormally high blood levels of nitrogen-bearing materials)
- potassium imbalance
- high sodium concentration. If the patient consumes more salt than the kidneys excrete, increased doses of diuretics should be prescribed

Moderate-to-severe accumulations of fluid are treated by draining large amounts of fluid (large-volume paracentesis) from the patient's abdomen. This procedure is safer than diuretic therapy. It causes fewer complications and requires a shorter hospital stay.

Large-volume paracentesis is also the preferred treatment for massive ascites. Diuretics are sometimes

KEY TERMS

Computed tomography scan (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Interferon—A protein formed when cells are exposed to a virus. Interferon causes other noninfected cells to develop translation inhibitory protein (TIP). TIP blocks viruses from infecting new cells.

Paracentesis—A procedure in which fluid is drained from a body cavity by means of a catheter placed through an incision in the skin.

Systemic lupus erythematosus—An inflammatory disease that affects many body systems, including the skin, blood vessels, kidneys, and nervous system. It is characterized, in part, by arthritis, skin rash, weakness, and fatigue.

Ultrasonography—A test using sound waves to measure blood flow. Gel is applied to a hand-held transducer that is pressed against the patient's body. Images are displayed on a monitor.

used to prevent new fluid accumulations, and the procedure may be repeated periodically.

Alternative treatment

Dietary alterations, focused on reducing salt intake, should be a part of the treatment. In less severe cases, herbal diuretics like dandelion (*Taraxacum officinale*) can help eliminate excess fluid and provide potassium. Potassium-rich foods like low-fat yogurt, mackerel, cantaloupe, and baked potatoes help balance excess sodium intake.

Prognosis

The prognosis depends upon the condition that is causing the ascites. Carcinomatous ascites has a very bad prognosis. However, salt restriction and diuretics can control ascites caused by liver disease in many cases.

Therapy should also be directed towards the underlying disease that produces the ascites. Cirrhosis should be treated by abstinence from alcohol and appropriate diet. The new interferon agents maybe helpful in treating chronic hepatitis.

Prevention

Modifying or restricting use of salt can prevent most cases of recurrent ascites.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Berkow, Robert, ed. *The Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

New Choices in Natural Healing. Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

PERIODICALS

Jaffe, D. L., R. T. Chung, and L. S. Friedman. "Management of portal hypertension and its complications." *The Medical Clinics of North America* 80 (1996): 1021-34.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

OTHER

"Hepatic and Liver Disorders." *The Meck Page*. 20 Apr. 1998. <http://www.merck.com>.

Maureen Haggerty

Ascorbic acid deficiency *see* **Scurvy**

ASD *see* **Atrial septal defect**

Asian American health *see* **Minority health**

Asian flu *see* **Influenza**

Aspartate aminotransferase test

Definition

The Aspartate aminotransferase test measures levels of AST, an enzyme released into the blood when certain organs or tissues, particularly the liver and heart, are injured. Aspartate aminotransferase (AST) is also known as serum glutamic oxaloacetic transaminase (SGOT).

Purpose

The determination of AST levels aids primarily in the diagnosis of liver disease. In the past, the AST test was used to diagnose **heart attack** (myocardial infarction or MI) but more accurate blood tests have largely replaced it for cardiac purposes.

Description

AST is determined by analysis of a blood sample, usually from taken from a venipuncture site at the bend of the elbow.

AST is found in the heart, liver, skeletal muscle, kidney, pancreas, spleen, lung, red blood cells, and brain tissue. When disease or injury affects these tissues, the cells are destroyed and AST is released into the bloodstream. The amount of AST is directly related to the number of cells affected by the disease or injury, but the level of elevation depends on the length of time that the blood is tested after the injury. Serum AST levels become elevated eight hours after cell injury, peak at 24-36 hours, and return to normal in three to seven days. If the cellular injury is chronic (ongoing), AST levels will remain elevated.

One of the most important uses for AST determination has formerly been in the diagnosis of a heart attack, or MI. AST can assist in determining the timing and extent of a recent MI, although it is less specific than creatine phosphokinase (CPK), CKMB, myglobin, troponins, and lactic dehydrogenase (LDH). Assuming no further cardiac injury occurs, the AST level rises within 6-10 hours after an acute attack, peaks at 12-48 hours, and returns to normal in three to four days. Myocardial injuries such as **angina** (chest **pain**) or **pericarditis** (inflammation of the pericardium, the membrane around the heart) do not increase AST levels.

AST is also a valuable aid in the diagnosis of liver disease. Although not specific for liver disease, it can be used in combination with other enzymes to monitor the course of various liver disorders. Chronic, silent hepatitis (**hepatitis C**) is sometimes the cause of elevated AST. In alcoholic hepatitis, caused by excessive alcohol ingestion, AST values are usually moderately elevated; in acute viral hepatitis, AST levels can rise to over 20 times normal. Acute extrahepatic (outside the liver) obstruction (e.g. gallstone), produces AST levels that can quickly rise to 10 times normal, and then rapidly fall. In cases of **cirrhosis**, the AST level is related to the amount of active inflammation of the liver. Determination of AST also assists in early recognition of toxic hepatitis that results from exposure to drugs toxic to the liver, like **acetaminophen** and cholesterol lowering medications.

Other disorders or diseases in which the AST determination can be valuable include acute **pancreatitis**, muscle disease, trauma, severe burn, and **infectious mononucleosis**.

KEY TERMS

Cirrhosis—Disease of the liver caused by chronic damage to its cells.

Myocardial infarction—Commonly known as a heart attack. Sudden death of part of the heart muscle, characterized, in most cases, by severe, unremitting chest pain.

Preparation

The physician may require discontinuation of any drugs that might affect the test. These types include such drugs as antihypertensives (for treatment of high blood pressure), coumarin-type anticoagulants (blood-thinning drugs), digitalis, erythromycin (an antibiotic), **oral contraceptives**, and opiates, among others. The patient may also need to cut back on strenuous activities temporarily, because **exercise** can also elevate AST for a day or two.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal ranges for the AST are laboratory-specific, but can range from 3-45 units/L (units per liter).

Abnormal results

Striking elevations of AST (400-4000 units/L) are found in almost all forms of acute hepatic necrosis, such as viral hepatitis and carbon tetrachloride **poisoning**. In alcoholics, even moderate doses of the analgesic acetaminophen have caused extreme elevations (1,960-29,700 units/L). Moderate rises of AST are seen in **jaundice**, cirrhosis, and metastatic carcinoma. Approximately 80% of patients with infectious mononucleosis show elevations in the range of 100-600 units/L.

Resources

BOOKS

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Asperger's syndrome *see* **Pervasive developmental disorders**

Aspergilloma *see* **Aspergillosis**

Aspergillosis

Definition

Aspergillosis refers to several forms of disease caused by a fungus in the genus *Aspergillus*. Aspergillosis fungal infections can occur in the ear canal, eyes, nose, sinus cavities, and lungs. In some individuals, the infection can even invade bone and the membranes that enclose the brain and spinal cord (**meningitis**).

Description

Aspergillosis is primarily an infection of the lungs caused by the inhalation of airborne spores of the fungus *Aspergillus*. Spores are the small particles that most fungi use to reproduce. Although virtually everyone is exposed to this fungus in their daily environment, it rarely causes disease. When *Aspergillus* does cause disease, however, it usually occurs in those individuals with weakened immune systems (immunocompromised) or who have a history of respiratory ailments. Because it does not present distinctive symptoms, aspergillosis is generally thought to be underdiagnosed and underreported. Furthermore, many patients with the more severe forms of aspergillosis tend to have multiple, complex health problems, such as **AIDS** or a blood disorder like leukemia, which can further complicate diagnosis and treatment.

Once considered particularly rare, the incidence of reported aspergillosis has risen somewhat with the development of more sophisticated methods of diagnosis and advances made in other areas of medicine, such as with the increased use of certain chemotherapeutic and corticosteroid drugs that are extremely useful in treating various types of **cancer** but that decrease the individual's immune response, making them more susceptible to other diseases like aspergillosis.

Our advanced ability to perform tissue and organ transplants has also increased the number of people vulnerable to fungal infections. Transplant recipients, particularly those receiving bone marrow or heart transplants, are highly susceptible to *Aspergillus*, which may be circulating in the hospital air.

Aspergillosis can be a serious, potentially deadly threat for two primary reasons:

- Aspergillosis usually occurs in those individuals who are already ill or have weakened immune systems, such as patients who have undergone **chemotherapy** for cancer.
- None of the currently available antifungal drugs are reliably effective against *Aspergillus*.

Causes and symptoms

Aspergillus is a fungus that is found almost everywhere, but particularly in soil, water, decaying vegetation, and stored grain. The fungus has also been cultured from ventilation systems and may be stirred up during building renovations. The species most commonly identified in patients with confirmed disease are *A. fumigatus* and *A. flavus*.

Airborne *Aspergillus* spores enter the body primarily through inhalation but can also lodge in the ear or eye. Normally functioning immune systems are generally able to cope without consequent development of aspergillosis.

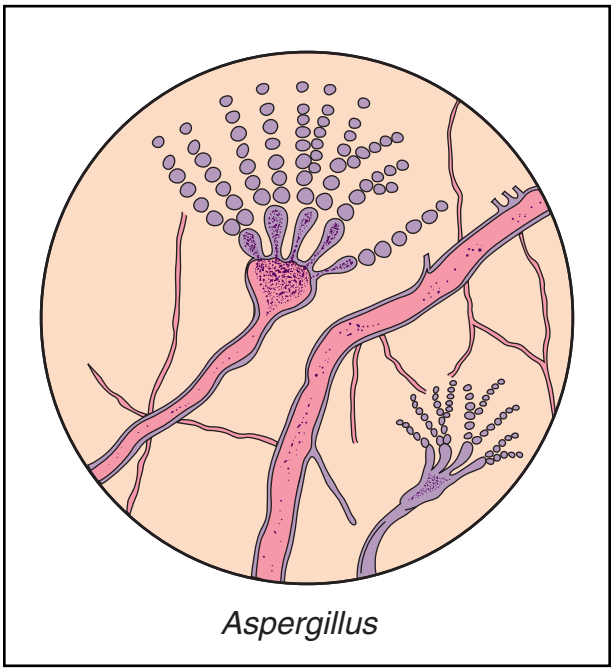
It is important to make distinctions between the various forms of aspergillosis, as the treatment and prognosis varies considerably among types. Aspergillosis as a diagnosis refers to three general forms:

- Allergic bronchopulmonary aspergillosis (ABPA) is seen in patients with long-standing **asthma**, particularly in patients taking oral **corticosteroids** for a long period of time. This is usually the least serious and most treatable form.
- Aspergilloma refers to the mass formed when fungal spores settle into or colonize areas of the lung that have been pitted and scarred as a result of **tuberculosis** or prior **pneumonia**. There are several available treatments, although the success rate varies with each treatment.
- Invasive fungal infection refers to rare cases in which the fungus spreads throughout the body via the blood stream and invades other organ systems. Once established, invasive fungal infections are extremely difficult to cure and, as a result, the associated **death** rate is extremely high.

Aspergillus infection of the ear (called otomycosis), can produce **itching** and a discharge, sometimes noticed as a spot on the pillow. Fungal infection of the cornea of the eye in a susceptible person can result in blindness, if not diagnosed and treated promptly.

Diagnosis

Aspergillosis can be quite difficult to diagnose because the symptoms, such as coughing and **wheezing**, if present at all, are common to many respiratory disorders. Furthermore, blood and sputum cultures are not very helpful. The presence of *Aspergillus* is so common, even in asthmatics, that a positive culture alone is insufficient for a diagnosis. Other, potentially more useful, screening tools include examining the sample obtained after repeatedly washing the bronchial tubes of the lung with water (bronchial lavage), but examining a tissue sample (biopsy) is the most reliable diagnostic tool. Researchers are currently attempting to develop a practi-



Aspergillosis is an infection of the lungs caused by inhalation of airborne spores of the fungus *Aspergillus*. *(Illustration by Electronic Illustrators Group).*

cal, specific, and rapid blood test that would confirm *Aspergillus* infection.

Signs of ABPA include a worsening of bronchial asthma accompanied by a low-grade **fever**. Brown flecks or clumps may be seen in the sputum. Pulmonary function tests may show decreased blood flow, suggesting an obstruction within the lungs. Elevated blood levels of an antibody produced in response to *Aspergillus* and of certain immune system cells may indicate a specific allergic-type immune system response.

A fungal mass (aspergilloma) in the lung usually does not produce clear symptoms and is generally diagnosed when seen on chest x rays. However, 70% or more of patients spit up blood from the lungs (**hemoptysis**) at least once, and this may become repetitive and serious. Hemoptysis, then, is another indication that the patient may be suffering from an aspergilloma.

In patients with lowered immune systems who are at risk for developing invasive aspergillosis, the physician may use a combination of **blood culture** with visual diagnostic techniques, such as **computed tomography scans** (CT) and radiography, to arrive at a likely diagnosis.

Treatment

The treatment method selected depends on the form of aspergillosis. ABPA can usually be treated with many of the same drugs used to treat asthma, such as systemic steroids. Long-term therapy may be required, however, to prevent recurrence. Antifungal agents are not recommended in the treatment of ABPA. In cases of aspergilloma, it may become necessary to surgically remove or reduce the size of a fungal mass, especially if the patient continues to spit up blood. In aspergillosis cases affecting the nose and nasal sinuses, surgery may also be required.

In non-ABPA cases, the use of antifungal drugs may be indicated. In such cases, amphotericin B (Fungizone) is the first-line therapy. The prescribed dose will depend on the patient's condition but usually begins with a small test dose and then escalates. Less than one-third of patients are likely to respond to amphotericin B, and its side effects often limit its use. For patients who do not respond to oral amphotericin B, another option is a different formulation of the same drug called liposomal amphotericin B.

For patients who fail to respond or who cannot tolerate amphotericin B, another drug called itraconazole (Sporanox), given 400-600 mg daily, has also been approved. Treatment generally lasts about 3 months. Giving itraconazole can produce adverse reactions if prescribed in combination with certain other drugs by increasing the concentrations of both drugs in the blood and creating a potentially life-threatening situation. Even **antacids** can significantly affect itraconazole levels. As a result, drug levels must be continually monitored to ensure that absorption is occurring at acceptable levels.

Two other methods of treatment are being studied: direct instillation of an antifungal agent into the lungs and administration of antifungals using a nebulizer. Instilling or injecting amphotericin B or itraconazole directly into the lung cavity or into the fungal ball (aspergilloma) itself has been helpful in stopping episodes of hemoptysis, but not in preventing future recurrences. Furthermore, many patients with aspergillomas are poor risks for surgery because their lung function is already compromised. As a result, instillation of a fungal agent should only be considered in those who have significant hempotysis.

A popular method of treating some respiratory disorders is to add a liquid drug to another carrier liquid and aerosolize or produce a fine mist that can be inhaled into the lungs through a device called a nebulizer. However, this has not yet been shown to improve the patient's condition in cases of aspergillosis, possibly because the drug is not reaching the aspergilloma.

At this point, preventative therapy for aspergillosis is not suggested for susceptible individuals, primarily because overuse of the drugs used to fight fungal infections may lead to the development of drug-resistant

aspergillosis against which current antifungal drugs are no longer effective.

Prognosis

The likelihood of recovery from aspergillosis depends on any underlying medical conditions, the patient's general health, and the specific type of aspergillosis. If the problem is based on an allergic response, as in ABPA, the patient will likely respond well to systemic steroids.

Patients who require **lung surgery**, especially those who have problems with coughing up blood, have a mortality rate of about 7-14%, and complications or recurrence may result in a higher overall death rate. However, by treating aspergilloma with other, non-surgical methods, that risk rises to 26%, making surgery a better option in some cases.

Unfortunately, the prognosis for the most serious form, invasive aspergillosis, is quite poor, largely because these patients have little resilience due to their underlying disorders. Death rates have ranged from about 50% in some studies to as high as 95% for bone-marrow recipients and patients with AIDS. The course of the illness can be rapid, resulting in death within a few months of diagnosis.

Prevention

Fungal infection by *Aspergillus* presents a major challenge, particularly in the patient with a suppressed immune system (immunocompromised). Hospitals and government health agencies continually seek ways to minimize exposure for hospitalized patients. Practical suggestions are minimal but include moving leaf piles away from the house. Unfortunately, overall avoidance of this fungus is all but impossible because it is present in the environment virtually everywhere. Research efforts are being directed at enhancing patients' resistance to *Aspergillus* rather than trying to eliminate exposure to the fungus. Given the growing number of people with immune disorders or whose immune systems have been suppressed in the course of treating another disease, research and clinical trials for new antifungal agents will be increasingly important in the future.

Resources

BOOKS

Bonadio, G. R. *Air Pollution of Humans With Bacteria, Fungus, and Molds in Homes, Offices, and Hospitals: Index of New Information With Author & Subjects*. ABBE Publishers Association of Washington, DC, 1995.

PERIODICALS

Greenberger, P. A. "Immunologic Aspects of Lung Diseases and Cystic Fibrosis." *The Journal of the American Medical Association* 278 (10 Dec. 1997):1924-1930.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Aspergilloma—A ball or mass made of *Aspergillus* fungi that can form in the lungs of patients with suppressed immune systems.

Bronchial lavage—A procedure that involves repeatedly washing the inside of the bronchial tubes of the lung.

Hemoptysis—Spitting up blood from the lungs or sputum stained with blood.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Meningitis—Inflammation of the membranes covering the brain and spinal cord, called the meninges.

Nebulizer—A device that produces an extremely fine mist that is readily inhalable.

Spores—The small, thick-walled reproductive structures of fungi.

Sputum—Mucus and other matter coughed up from the airways.

ORGANIZATIONS

American College of Allergy, Asthma, and Immunology. 85 West Algonquin Road, Suite 550, Arlington Heights, IL 60005. <http://allergy.mcg.edu>.

OTHER

"Lung, Allergic and Immune Diseases: Mold Allergy: Prevention Techniques." National Jewish Medical and Research. <http://nationaljewish.org/main.html>.

Office of Rare Diseases (ORD) at National Institutes of Health, Bldg. 31,1BO3, Bethesda, MD 20892-2082. (301) 402-4336 <http://rarediseases.info.nih.gov/ord>.

Jill S. Lasker

Aspirin

Definition

Aspirin is a medicine that relieves **pain** and reduces **fever**.

Purpose

Aspirin is used to relieve many kinds of minor aches and pains—headaches, toothaches, muscle pain, menstrual cramps, the joint pain from arthritis, and aches associated with colds and flu. Some people take aspirin daily to reduce the risk of **stroke**, **heart attack**, or other heart problems.

Description

Aspirin—also known as acetylsalicylic acid—is sold over the counter and comes in many forms, from the familiar white tablets to chewing gum and rectal suppositories. Coated, chewable, buffered, and extended release forms are available. Many other over-the-counter medicine contain aspirin. Alka-Seltzer Original Effervescent Antacid Pain Reliever, for example, contains aspirin for pain relief and sodium bicarbonate to relieve acid **indigestion**, **heartburn**, and sour stomach.

Aspirin belongs to a group of drugs called salicylates. Other members of this group include sodium salicylate, choline salicylate, and magnesium salicylate. These drugs are more expensive and no more effective than aspirin. However, they are a little easier on the stomach. Aspirin is quickly absorbed into the bloodstream and provides quick and relatively long-lasting pain relief. Aspirin also reduces inflammation. Researchers believe these effects come about because aspirin blocks the production of pain-producing chemicals called prostaglandins.

In addition to relieving pain and reducing inflammation, aspirin also lowers fever by acting on the part of the brain that regulates temperature. The brain then signals the blood vessels to widen, which allows heat to leave the body more quickly.

Recommended dosage

Adults

TO RELIEVE PAIN OR REDUCE FEVER. one to two tablets every three to four hours, up to six times per day.

TO REDUCE THE RISK OF STROKE. one tablet four times a day or two tablets twice a day.

TO REDUCE THE RISK OF HEART ATTACK. Check with a physician for the proper dose and number of times per week aspirin should, if at all, be taken.

Children

Check with a physician.

Precautions

Aspirin—even children's aspirin—should never be given to children or teenagers with flu-like symptoms or **chickenpox**. Aspirin can cause **Reye's syndrome**, a life-threatening condition that affects the nervous system and liver. As many as 30% of children and teenagers who develop Reye's syndrome die. Those who survive may have permanent brain damage.

Check with a physician before giving aspirin to a child under 12 years for arthritis, rheumatism, or any condition that requires long-term use of the drug.

No one should take aspirin for more than 10 days in a row unless told to do so by a physician. Anyone with fever should not take aspirin for more than 3 days without a physician's consent. Do not to take more than the recommended daily dosage.

People in the following categories should not use aspirin without first checking with their physician:

- Pregnant women. Aspirin can cause bleeding problems in both the mother and the developing fetus. Aspirin can also cause the infant's weight to be too low at birth.
- Women who are breastfeeding. Aspirin can pass into breast milk and may affect the baby.
- People with a history of bleeding problems.
- People who are taking blood-thinning drugs, such as warfarin (Coumadin).
- People with a history of ulcers.
- People with a history of **asthma**, **nasal polyps**, or both. These people are more likely to be allergic to aspirin.
- People who are allergic to fenoprofen, ibuprofen, indomethacin, ketoprofen, meclofenamate sodium, naproxen, sulindac, tolmetin, or the orange food-coloring tartrazine. They may also be allergic to aspirin.
- People with **AIDS** or AIDS-related complex who are taking AZT (zidovudine). Aspirin can increase the risk of bleeding in these patients.
- People taking certain other drugs (discussed in Interactions).
- People with liver damage or severe kidney failure.

Aspirin should not be taken before surgery, as it can increase the risk of excessive bleeding. Anyone who is scheduled for surgery should check with his or her surgeon to find out how long before surgery to avoid taking aspirin.

Aspirin can cause stomach irritation. To reduce the likelihood of that problem, take aspirin with food or milk or drink a full 8-oz glass of water with it. Taking coated or buffered aspirin can also help. Be aware that drinking alcohol can make the stomach irritation worse.

Stop taking aspirin immediately and call a physician if any of these symptoms develop:

- ringing or buzzing in the ears

KEY TERMS

Diuretic—Medicine that increases the amount of urine produced and relieves excess fluid buildup in body tissues. Diuretics may be used in treating high blood pressure, lung disease, premenstrual syndrome, and other conditions.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

NSAIDs—Nonsteroidal anti-inflammatory drugs. Drugs such as ketoprofen and ibuprofen which relieve pain and reduce inflammation.

Polyp—A lump of tissue protruding from the lining of an organ, such as the nose, bladder, or intestine. Polyps can sometimes block the passages in which they are found.

Prostaglandin—A hormonelike chemical produced in the body. Prostaglandins have a wide variety of effects, and may be responsible for the production of some types of pain and inflammation.

Reye's syndrome—A life-threatening disease that affects the liver and the brain and sometimes occurs after a viral infection, such as flu or chickenpox. Children or teenagers who are given aspirin for flu or chickenpox are at increased risk of developing Reye's syndrome.

Rhinitis—Inflammation of the membranes inside the nose.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

- hearing loss
- **dizziness**
- stomach pain that does not go away

Do not take aspirin that has a vinegary smell. That is a sign that the aspirin is too old and ineffective. Flush such aspirin down the toilet.

Because aspirin can increase the risk of excessive bleeding, do not take aspirin daily over long periods—to reduce the risk of stroke or heart attack, for example—unless advised to do so by a physician.

Side effects

The most common side effects include stomachache, heartburn, loss of appetite, and small amounts of blood in stools. Less common side effects are **rashes**, **hives**, fever, vision problems, liver damage, thirst, stomach ulcers, and bleeding. People who are allergic to aspirin or those who have asthma, **rhinitis**, or polyps in the nose may have trouble breathing after taking aspirin.

Interactions

Aspirin may increase, decrease, or change the effects of many drugs. Aspirin can make drugs such as methotrexate (Rheumatrex) and valproic acid (Depakote, Depakene) more toxic. If taken with blood-thinning drugs, such as warfarin (Coumadin) and dicumarol, aspirin can increase the risk of excessive bleeding. Aspirin counteracts the effects of other drugs, such as angiotensin-converting enzyme (ACE) inhibitors and **beta blockers**, which lower blood pressure, and medicines used to treat **gout** (probenecid and sulfinpyrazone). Blood pressure may drop unexpectedly and cause **fainting** or dizziness if aspirin is taken along with nitroglycerin tablets. Aspirin may also interact with **diuretics**, diabetes medicines, other **nonsteroidal anti-inflammatory drugs** (NSAIDs), seizure medications, and steroids. Anyone who is taking these drugs should ask his or her physician whether they can safely take aspirin.

Resources

PERIODICALS

"How to Give Medicine to Children" (Includes related article on health risks of aspirin for children). *FDA Consumer* (Jan./Feb. 1996): 6.

"The Miracle Drug in Your Medicine Cabinet." *American Health* (Jan./Feb. 1996): 67.

"No Aspirin, Please." *Current Health* (Dec. 1992): 12.

"What's the Best Pain Reliever? Depends on Your Pain." *Consumer Reports*, May 1996, 62.

Nancy Ross-Flanigan

AST *see* **Aspartate aminotransferase test**

Astemizole *see* **Antihistamines**

Asthma

Definition

Today asthma is viewed as a chronic (long-lasting) inflammatory disease of the airways. In those susceptible to asthma, this inflammation causes the airways to narrow periodically. This, in turn, produces **wheezing** and breathlessness, sometimes to the point where the patient

gasps for air. Obstruction to air flow either stops spontaneously or responds to a wide range of treatments, but continuing inflammation makes the airways hyperresponsive to stimuli such as cold air, **exercise**, dust mites, pollutants in the air, and even **stress** and **anxiety**.

Description

About 10 million Americans have asthma, and the number seems to be increasing. Between 1982-92, the rate actually rose by 42%. Not only is asthma becoming more frequent, but it also is a more severe disease than before, despite modern drug treatments. In the same 10-year period, the **death** rate from asthma in the United States increased by 35%.

The changes that take place in the lungs of asthmatic persons makes the airways (the "breathing tubes," or *bronchi* and the smaller *bronchioles*) hyper-reactive to many different types of stimuli that don't affect healthy lungs. In an asthma attack, the muscle tissue in the walls of bronchi go into spasm, and the cells lining the airways swell and secrete mucus into the air spaces. Both these actions cause the bronchi to become narrowed (bronchoconstriction). As a result, an asthmatic person has to make a much greater effort to breathe in air and to expel it.

Cells in the bronchial walls, called mast cells, release certain substances that cause the bronchial muscle to contract and stimulate mucus formation. These substances, which include histamine and a group of chemicals called leukotrienes, also bring white blood cells into the area, which is a key part of the inflammatory response. Many patients with asthma are prone to react to such "foreign" substances as pollen, house dust mites, or animal dander; these are called allergens. On the other hand, asthma affects many patients who are not "allergic" in this way.

Asthma usually begins in childhood or adolescence, but it also may first appear during adult years. While the symptoms may be similar, certain important aspects of asthma are different in children and adults.

Child-onset asthma

When asthma does begin in childhood, it often does so in a child who is likely, for genetic reasons, to become sensitized to common "allergens" in the environment (atopic person). When these children are exposed to house-dust mites, animal proteins, fungi, or other potential allergens, they produce a type of antibody that is intended to engulf and destroy the foreign materials. This has the effect of making the airway cells sensitive to particular materials. Further exposure can lead rapidly to an asthmatic response. This condition of atopy is present in at least one-third and as many as half of the general population. When an infant or young child wheezes during viral infections, the presence of allergy (in the child itself or a close relative) is a clue that asthma may well continue throughout childhood.

Adult-onset asthma

Allergenic materials may also play a role when adults become asthmatic. Asthma can actually start at any age and in a wide variety of situations. Many adults who are not allergic do have such conditions as **sinusitis** or **nasal polyps**, or they may be sensitive to **aspirin** and related drugs. Another major source of adult asthma is exposure at work to animal products, certain forms of plastic, wood dust, or metals.

Causes and symptoms

In most cases, asthma is caused by inhaling an allergen that sets off the chain of biochemical and tissue changes leading to airway inflammation, bronchoconstriction, and wheezing. Because avoiding (or at least minimizing) exposure is the most effective way of treating asthma, it is vital to identify which allergen or irritant is causing symptoms in a particular patient. Once asthma is present, symptoms can be set off or made worse if the patient also has **rhinitis** (inflammation of the lining of the nose) or sinusitis. When, for some reason, stomach acid passes back up the esophagus (acid reflux), this can also make asthma worse. A viral infection of the respiratory tract can also inflame an asthmatic reaction. Aspirin and a type of drug called beta-blockers, often used to treat high blood pressure, can also worsen the symptoms of asthma.

The most important inhaled allergens giving rise to attacks of asthma are:

- animal dander
- mites in house dust
- fungi (molds) that grow indoors
- cockroach allergens
- pollen
- occupational exposure to chemicals, fumes, or particles of industrial materials in the air

Inhaling tobacco smoke, either by **smoking** or being near people who are smoking, can irritate the airways and trigger an asthmatic attack. Air pollutants can have a similar effect. In addition, there are three important factors that regularly produce attacks in certain asthmatic patients, and they may sometimes be the sole cause of symptoms. They are:

- inhaling cold air (cold-induced asthma)
- exercise-induced asthma (in certain children, asthma is caused simply by exercising)
- stress or a high level of anxiety

Wheezing is often very obvious, but mild asthmatic attacks may be confirmed when the physician listens to the patient's chest with a stethoscope. Besides wheezing and being short of breath, the patient may **cough** and may report a feeling of "tightness" in the chest. Children may have **itching** on their back or neck at the start of an attack. Wheezing is often loudest when the patient breathes out, in an attempt to expel used air through the narrowed airways. Some asthmatics are free of symptoms most of the time but may occasionally be short of breath for a brief time. Others spend much of their days (and nights) coughing and wheezing, until properly treated. Crying or even laughing may bring on an attack. Severe episodes are often seen when the patient gets a viral respiratory tract infection or is exposed to a heavy load of an allergen or irritant. Asthmatic attacks may last only a few minutes or can go on for hours or even days (a condition called status asthmaticus).

Being short of breath may cause a patient to become very anxious, sit upright, lean forward, and use the muscles of the neck and chest wall to help breathe. The patient may be able to say only a few words at a time before stopping to take a breath. Confusion and a bluish tint to the skin are clues that the oxygen supply is much too low, and that emergency treatment is needed. In a severe attack that lasts for some time, some of the air sacs in the lung may rupture so that air collects within the chest. This makes it even harder to breathe in enough air. Almost always, even patients with the most severe attacks will recover completely.

Diagnosis

Apart from listening to the patient's chest, the examiner should look for maximum chest expansion while taking in air. Hunched shoulders and contracting neck muscles are other signs of narrowed airways. Nasal polyps or increased amounts of nasal secretions are often noted in asthmatic patients. Skin changes, like **atopic dermatitis** or eczema, are a tipoff that the patient has allergic problems.

Inquiring about a family history of asthma or **allergies** can be a valuable indicator of asthma. The diagnosis may be strongly suggested when typical symptoms and signs are present. A test called spirometry measures how rapidly air is exhaled and how much is retained in the lungs. Repeating the test after the patient inhales a drug that widens the air passages (a bronchodilator) will show whether the airway narrowing is reversible, which is a very typical finding in asthma. Often patients use a related instrument, called a peak flow meter, to keep track of asthma severity when at home.

Often, it is difficult to determine what is triggering asthma attacks. Allergy skin testing may be used, although an allergic skin response does not always mean that the allergen being tested is causing the asthma. Also, the body's immune system produces antibody to fight off the allergen, and the amount of antibody can be measured by a blood test. This will show how sensitive the patient is to a particular allergen. If the diagnosis is still in doubt, the patient can inhale a suspect allergen while using a spirometer to detect airway narrowing. Spirometry can also be repeated after a bout of exercise if exercise-induced asthma is a possibility. A **chest x ray** will help rule out other disorders.

Treatment

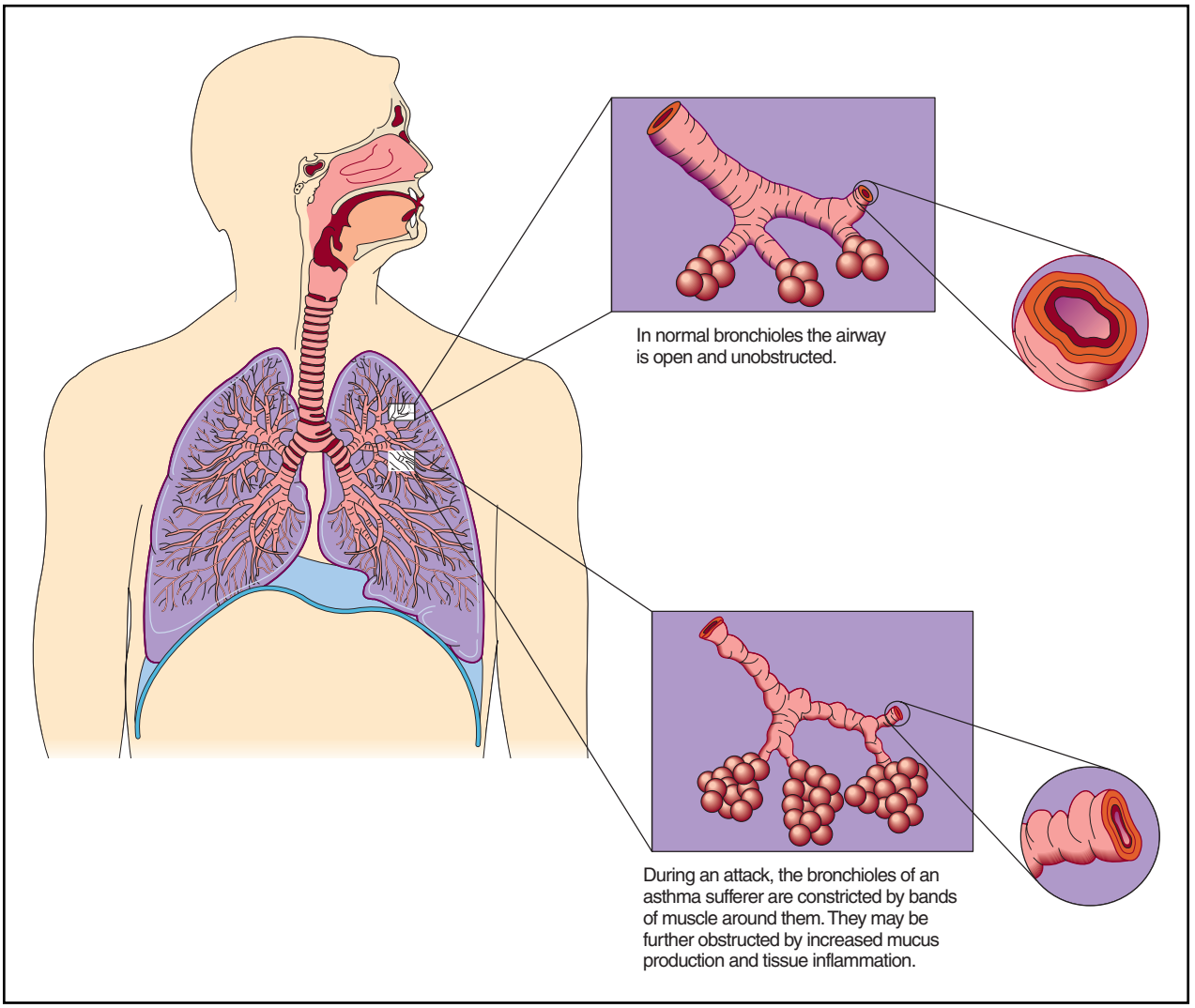
Patients should be periodically examined and have their lung function measured by spirometry to make sure that treatment goals are being met. These goals are to prevent troublesome symptoms, to maintain lung function as close to normal as possible, and to allow patients to pursue their normal activities including those requiring exertion. The best drug therapy is that which controls asthmatic symptoms while causing few or no side-effects.

Drugs

METHYLXANTHINES. The chief methylxanthine drug is theophylline. It may exert some anti-inflammatory effect, and is especially helpful in controlling nighttime symptoms of asthma. When, for some reason, a patient cannot use an inhaler to maintain long-term control, sustained-release theophylline is a good alternative. The blood levels of the drug must be measured periodically, as too high a dose can cause an abnormal heart rhythm or convulsions.

BETA-RECEPTOR AGONISTS. These drugs, which are **bronchodilators**, are the best choice for relieving sudden attacks of asthma and for preventing attacks from being triggered by exercise. Some agonists, such as albuterol, act mainly in lung cells and have little effect on other organs, such as the heart. These drugs generally start acting within minutes, but their effects last only four to six hours (although longer-acting forms are being developed). They may be taken by mouth, inhaled, or injected.

STEROIDS. These drugs, which resemble natural body hormones, block inflammation and are extremely effective in relieving symptoms of asthma. When steroids are taken by inhalation for a long period, asthma



A comparison of normal bronchioles and those of an asthma sufferer. *(Illustration by Hans & Cassady.)*

attacks become less frequent as the airways become less sensitive to allergens. This is the strongest medicine for asthma, and can control even severe cases over the long term and maintain good lung function. Steroids can cause numerous side-effects, however, including bleeding from the stomach, loss of calcium from bones, **cataracts** in the eye, and a diabetes-like state. Patients using steroids for lengthy periods may also have problems with wound healing, may gain weight, and may suffer mental problems. In children, growth may be slowed. Besides being inhaled, steroids may be taken by mouth or injected, to rapidly control severe asthma.

LEUKOTRIENE MODIFIERS. Leukotriene modifiers are a new type of drug that can be used in place of steroids, for older children or adults who have a mild degree of asthma that persists. They work by counteracting leukotrienes, which are substances released by white blood cells in the lung that cause the air passages to constrict and promote mucus secretion.

OTHER DRUGS. Cromolyn and nedocromil are anti-inflammatory drugs that are often used as initial treatment to prevent asthmatic attacks over the long term in children. They can also prevent attacks when given before exercise or when exposure to an allergen cannot be avoided. These are safe drugs but are expensive, and must be taken regularly even if there are no symptoms. Anti-cholinergic drugs, such as atropine, are useful in controlling severe attacks when added to an inhaled beta-receptor agonist. They help widen the airways and suppress mucus production.

If a patient's asthma is caused by an allergen that cannot be avoided and it has been difficult to control symptoms by drugs, immunotherapy may be worth try-

ing. Typically, increasing amounts of the allergen are injected over a period of three to five years, so that the body can build up an effective immune response. There is a risk that this treatment may itself cause the airways to become narrowed and bring on an asthmatic attack. Not all experts are enthusiastic about immunotherapy, although some studies have shown that it does reduce asthmatic symptoms caused by exposure to house-dust mites, ragweed pollen, and cats.

Managing asthmatic attacks

A severe asthma attack should be treated as quickly as possible. It is most important for a patient suffering an acute attack to be given extra oxygen. Rarely, it may be necessary to use a mechanical ventilator to help the patient breathe. A beta-receptor agonist is inhaled repeatedly or continuously. If the patient does not respond promptly and completely, a steroid is given. A course of steroid therapy, given after the attack is over, will make a recurrence less likely.

Maintaining control

Long-term asthma treatment is based on inhaling a beta-receptor agonist using a special inhaler that meters the dose. Patients must be instructed in proper use of an inhaler to be sure that it will deliver the right amount of drug. Once asthma has been controlled for several weeks or months, it is worth trying to cut down on drug treatment, but this must be done gradually. The last drug added should be the first to be reduced. Patients should be seen every one to six months, depending on the frequency of attacks.

Starting treatment at home, rather than in hospital, makes for minimal delay and helps the patient to gain a sense of control over the disease. All patients should be taught how to monitor their symptoms so that they will know when an attack is starting, and those with moderate or severe asthma should know how to use a flow meter. They should also have a written "action plan" to follow if symptoms suddenly become worse, including how to adjust their medication and when to seek medical help. If more intense treatment is necessary, it should be continued for several days. Over-the-counter "remedies" should be avoided. When deciding whether a patient should be hospitalized, the past history of acute attacks, severity of symptoms, current medication, and whether good support is available at home all must be taken into account.

Referral to an asthma specialist should be considered if:

- there has been a life-threatening asthma attack or severe, persistent asthma
- treatment for three to six months has not met its goals
- some other condition, such as nasal polyps or chronic lung disease, is complicating asthma
- special tests, such as allergy skin testing or an allergen challenge, are needed
- intensive steroid therapy has been necessary

Special populations

INFANTS AND YOUNG CHILDREN. It is especially important to closely watch the course of asthma in young patients. Treatment is cut down when possible and if there is no clear improvement, some other treatment should be tried. If a viral infection leads to severe asthmatic symptoms, steroids may help. The health care provider should write out an asthma treatment plan for the child's school. Asthmatic children often need medication at school to control acute symptoms or to prevent exercise- induced attacks. Proper management will usually allow a child to take part in play activities. Only as a last resort should activities be limited.

THE ELDERLY. Older persons often have other types of obstructive lung disease, such as chronic **bronchitis** or **emphysema**. This makes it important to know to what extent the symptoms are caused by asthma. Giving steroids for two to three weeks can help determine this. Side-effects from beta-receptor agonist drugs (including a speeding heart and tremor) may be more common in older patients. These patients may benefit from receiving an anti-cholinergic drug, along with the beta-receptor agonist. If theophylline is given, the dose should be limited, as older patients are less able to clear this drug from their blood. Steroids should be avoided, as they often make elderly patients confused and agitated. Steroids may also further weaken the bones.

Prognosis

Most patients with asthma respond well when the best drug or combination of drugs is found, and they are able to lead relatively normal lives. More than half of affected children stop having attacks by the time they reach 21 years of age. Many others have less frequent and less severe attacks as they grow older. Urgent measures to control asthma attacks and ongoing treatment to prevent attacks are equally important. A small minority of patients will have progressively more trouble breathing and they run a risk of going into **respiratory failure** and they must receive intensive treatment.

Prevention

Minimizing exposure to allergens

There are a number of ways to cut down exposure to the common allergens and irritants that provoke asthmatic attacks, or to avoid them altogether:

KEY TERMS

Allergen—A foreign substance, such as mites in house dust or animal dander which, when inhaled, causes the airways to narrow and produces symptoms of asthma.

Atopy—A state that makes persons more likely to develop allergic reactions of any type, including the inflammation and airway narrowing typical of asthma.

Hypersensitivity—The state where even a tiny amount of allergen can cause the airways to constrict and bring on an asthmatic attack.

Spirometry—A test using an instrument called a spirometer that shows how difficult it is for an asthmatic patient to breathe. Used to determine the severity of asthma and to see how well it is responding to treatment.

- If the patient is sensitive to a family pet, remove the animal or at least keep it out of the bedroom (with the bedroom door closed). Keep the pet away from carpets and upholstered furniture. Remove all feathers.
- To reduce exposure to house dust mites, remove wall-to-wall carpeting, keep the humidity down, and use special pillow and mattress covers. Cut down on stuffed toys, and wash them each week in hot water.
- If cockroach allergen is causing asthma attacks, kill the roaches (using poison, traps, or boric acid rather than chemicals). Take care not to leave food or garbage exposed.
- Keep indoor air clean by vacuuming carpets once or twice a week (with the patient absent), avoid using humidifiers, and do use air conditioning during warm weather (so that the windows can be closed).
- Avoid exposure to tobacco smoke.
- Do not exercise outside when air pollution levels are high.
- When asthma is related to exposure at work, take all precautions, including wearing a mask and, if necessary, arrange to work in a safer area.

Resources

BOOKS

Gershwin, M. Eric, E. L. Klinglhofer. *Asthma: Stop Suffering, Start Living.* 2nd ed. Reading, MA: Addison-Wessey Publishing Co., l992.

Haas, Francois, and Sheila S Haas. *The Essential Asthma Book: A Manual for Asthmatics of All Ages.* New York: Ivy Books, 1987.

ORGANIZATIONS

Asthma and Allergy Foundation of America. 1233 20th Street, NW, Suite 402, Washington, DC 20036. (800) 727-8462. <http://www.aafa.org>.

Mothers of Asthmatics, Inc. 3554 Chain Bridge Road, Suite 200, Fairfax, VA 22030. (800) 878-4403.

National Asthma Education Program. 4733 Bethesda Ave., Suite 350, Bethesda, MD 20814. 301-495-4484.

National Jewish Medical and Research Center. 1400 Jackson St., Denver, CO 80206. 800-222-LUNG.

David A. Cramer, MD

Astigmatism

Definition

Astigmatism is the result of an inability of the cornea to properly focus an image onto the retina. The result is a blurred image.

Description

The cornea is the outermost part of the eye. It is a transparent layer that covers the colored part of the eye (iris), pupil, and lens. The cornea bends light and helps to focus it onto the retina where specialized cells (photo receptors) detect light and transmit nerve impulses via the optic nerve to the brain where the image is formed. The cornea is dome shaped. Any incorrect shaping of the cornea results in an incorrect focusing of the light that passes through that part of the cornea. The bending of light is called refraction and focusing problems with the cornea are called diseases of refraction or refractive disorders. Astigmatism is an image distortion that results from an improperly shaped cornea. Usually the cornea is spherically shaped, like a baseball. However, in astigmatism the cornea is elliptically shaped, more like a football. There is a long meridian and a short meridian. These two meridians generally have a constant curvature and are generally perpendicular to each other (regular astigmatism). Irregular astigmatism may have more than two meridians of focus and they may not be 90° apart. A point of light, therefore, going through an astigmatic cornea will have two points of focus, instead of one nice sharp image on the retina. This will cause the person to have blurry vision. What the blur looks like will depend upon the amount and the direction of the astigmatism. A person with nearsightedness (**myopia**) or farsightedness

(**hyperopia**) may see a dot as a blurred circle. A person with astigmatism may see the same dot as a blurred oval or frankfurter-shaped blur.

Some cases of astigmatism are caused by problems in the lens of the eye. Minor variations in the curvature of the lens can produce minor degrees of astigmatism (lenticular astigmatism). In these patients, the cornea is usually normal in shape. Infants, as a group, have the least amount of astigmatism. Astigmatism may increase during childhood, as the eye is developing.

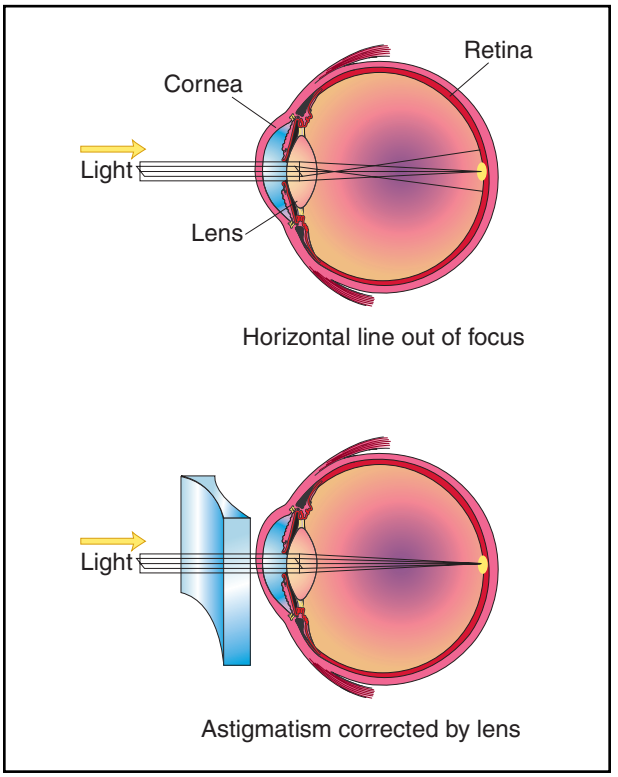
Causes and symptoms

The main symptom of astigmatism is blurring. People can also experience headaches and eyestrain. Parents can notice that a child may have astigmatism when the child can see some part of a pattern or picture more clearly than others. For example, lines going across may seem clearer than lines going up and down.

Regular astigmatism can be caused by the weight of the upper eyelid resting on the eyeball creating distortion, surgical incisions in the cornea, trauma or scarring to the cornea, the presence of tumors in the eyelid, or a developmental factor. Irregular astigmatism can be caused by scarring or keratoconus. Keratoconus is a condition in which the cornea thins and becomes cone shaped. It usually occurs around **puberty** and is more common in women. Although the causes of keratoconus are unknown, it may be hereditary or a result of chronic eye rubbing, as in people with **allergies**. The center of the cone may not be in line with the center of the cornea. Diabetes can play a role in the development of astigmatism. High blood sugar levels can cause shape changes in the lens of the eye. This process usually occurs slowly and, often, is only noticed when the diabetic has started treatment to control their blood sugar. The return to a more normal blood sugar allows the lens to return to normal and this change is sometimes noticed by the patient as farsightedness. Because of this, diabetics should wait until their blood sugar is under control for at least one month to allow vision to stabilize before being measured for eyeglasses.

Diagnosis

Patients seek treatment because of blurred vision. A variety of tests can be used to detect astigmatism during the eye exam. The patient may be asked to describe the astigmatic dial, a series of lines that radiate outward from a center. People with astigmatism will see some of the lines more clearly than others. One diagnostic instrument used is the keratometer. This measures the curvature of the central cornea. It measures the amount and direction of the curvature. A corneal topographer can measure a larger area of the cornea. It can measure the central area and mid-periphery of the cornea. A keratoscope projects a series of concentric light rings onto the cornea. Misshapen areas of the cornea are revealed by noting areas of the light pattern that do not appear concentric on the cornea. Because these instruments are measuring the cornea, it is also important to have a refraction in case the lens is also contributing to the astigmatism. The refraction measures the optics or visual status of the eye and the result is the eyeglass prescription. The refraction is when the patient is looking at an eye chart and the doctor is putting different lenses in front of the patient's eyes and asks which one looks better.



Astigmatism can be treated by the use of cylindrical lenses. The lenses are shaped to counteract the shape of the sections of the cornea that are causing the difficulty. *(Illustration by Electronic Illustrators Group.)*

Treatment

Astigmatism can be treated by the use of cylindrical lenses. They can be in eyeglasses or contact lenses. The unit of measure describing the power of the lens system or lens is called the diopter (D). The lenses are shaped to counteract the shape of the sections of cornea that are causing the difficulty. Because the correction is in one direction, it is written in terms of the axis the correction is in. On a prescription, for example, it may say -1.00D × 180°.

KEY TERMS

Meridian—A section of a sphere. For example, longitude or latitude on the globe. Or, on a clock, a section going through 12:00-6:00 or 3:00-9:00, etc.

Refraction—The turning or bending of light waves as the light passes from one medium or layer to another. In the eye it means the ability of the eye to bend light so that an image is focused onto the retina.

Cylinders correct astigmatism, minus spheres correct myopia, and plus spheres correct hyperopia.

There is some debate as to whether people with very small amounts of astigmatism should be treated. Generally, if visual acuity is good and the patient experiences no overt symptoms, treatment is not necessary. When treating larger amounts of astigmatism, or astigmatism for the first time, the doctor may not totally correct the astigmatism. The cylindrical correction in the eyeglasses may make the floor appear to tilt, thus making it difficult for the patient at first. Generally, the doctor will place lenses in a trial frame to allow the patient to try the prescription at the exam. It may take a week or so to get used to the glasses, however, if the patient is having a problem they should contact their doctor, who might want to recheck the prescription.

Contact lenses that are used to correct astigmatism are called toric lenses. When a person blinks, the contact lens rotates. In toric lenses, it is important for the lens to return to the same position each time. Lenses have thin zones, or cut-off areas (truncated), or have other ways to rotate and return to the correct position. Soft toric lenses are available in a variety of prescriptions, materials, and even in tints. Patients should ask their doctors about the possibility of toric lenses.

In 1997, the Food and Drug Administration (FDA) approved laser treatment of astigmatism. Patients considering this should make sure the surgeon has a lot of experience in the procedure and discuss the possible side effects or risks with the doctor. In the case of keratoconus, a corneal transplant is performed if the astigmatism can not be corrected with hard contact lenses.

Prognosis

Astigmatism is a condition that may be present at birth. It may also be acquired if something is distorting the cornea. Vision can generally be corrected with eyeglasses or contact lenses. The major risks of surgery (aside from the surgical risks) are over and under correction of the astigmatism. There is no cure for over correction. Under correction can be solved by repeating the operation.

Resources

BOOKS

Albert, D. M., and F. A. Jakobiec. *Principles and Practice of Ophthalmology.* New York: W. B. Saunders Co., 1994.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Newell, Frank W. *Ophthalmology: Principles and Concepts.* 8th ed. St. Louis: Mosby, 1996.

John T. Lohr, PhD

Aston-Patterning

Definition

Aston-Patterning is an integrated system of movement education, bodywork, ergonomic adjustments, and fitness training that recognizes the relationship between the body and mind for well being. It helps people who seek a remedy from acute or chronic **pain** by teaching them to improve postural and movement patterns.

Purpose

Aston-Patterning assists people in finding more efficient and less stressful ways of performing the simple movements of everyday life to dissipate tension in the body. This is done through massage, alteration of the environment, and fitness training.

Description

Seeking to solve movement problems, Aston-Patterning helps make the most of their own unique body types rather than trying to force them to conform to an ideal. Unlike **Rolfing**, it doesn't strive for linear symmetry. Rather it works with asymmetry in the human body to develop patterns of alignment and movement that feel right to the individual. Aston also introduced the idea of working in a three-dimensional spinal pattern.

Aston-Patterning sessions have four general components. They are:

- A personal history that helps the practitioner assess the client's needs.
- Pre-testing, in which the practitioner and the client explore patterns of movement and potential for improvement.

JUDITH ASTON

Judith Aston was born in Long Beach, California. She graduated from University of California at Los Angeles with a B.A. and a M.F.A. in dance. Her interest in movement arose from working as a dancer. In 1963 Aston established her first movement education program for dancers, actors, and athletes at Long Beach City College.

Five years later, while recovering from injuries sustained during two consecutive automobile accidents, Aston met Ida Rolf, the developer of Rolfing. Aston began working for Rolf, teaching a movement education program called Rolf-Aston Structural Patterning that emphasized using the body with minimum effort and maximum precision.

In time, Rolf and Aston's views on movement diverged, and the partnership was dissolved in 1977. Aston formed her own company called the Aston Paradigm Corporation in Lake Tahoe, California. This company provides training and certification for Aston practitioners. She also began exploring how environmental conditions affect body movement, foreshadowing the ergonomic movement in the workplace that developed in the 1990s. Over time, Aston has expanded her movement work to include a fitness program for older adults. Today, Judith Aston serves as director of Aston Paradigm Corporation.

- Movement education and bodywork, including massage, myofacial release, and arthrokinetics, to help release tension and make new movement patterns easier.
- Post-testing, when pre-testing movements are repeated, allowing the client to feel the changes that have taken place and integrate them into daily life.

Aston-Patterning requires more participation from the client than many bodywork techniques. The massage aspect of Aston-Patterning is designed around a three-dimensional, non-compressive touch that releases patterns of tension in the body. It is gentler than Rolfing. Myokinetics uses touch to release tension in the face and neck. Arthrokinetics addresses tension at bones and joints. This massage is accompanied by education about how new movement patterns may be established.

In addition to Aston-Patterning sessions, clients are also helped to examine their environment for factors, such as seating or sleeping arrangements, that may limit their body function and introduce tension. Finally, they may choose to participate in the Aston fitness training program that includes loosening techniques based on self-massage, toning, stretching, and cardiovascular fitness.

KEY TERMS

Rolfing—Developed by Dr. Ida Rolf (1896–1979), rolfing is a systematic approach to relieving stress patterns and dysfunctions in the body's structure through the manipulation of the highly pliant myofacial (connective) tissue. It assists the body in reorganizing its major segments into vertical alignment.

Preparations

No special preparation need be taken.

Precautions

No special precautions are necessary when participating.

Side effects

No undesirable side effects are reported. Usually clients report a diminution of tension, improved body movement, and an enhanced feeling of well being.

Research and general acceptance

Aston-Patterning is an outgrowth of Rolfing, which has been shown to be of benefit in a limited number of controlled studies. Little controlled research has been done on the either benefits or limitations of Aston-Patterning. Its claims have been neither proven nor disproved, although anecdotally many clients report relief from pain and tension and also improved body movement.

Resources

ORGANIZATIONS

The Aston Training Center. P. O. Box 3568, Incline Village, NV 89450. 775-831-8228. Astonpat@aol.com <http://www.aston-patterning.com>.

Tish Davidson

Astrocytoma *see* **Brain tumor**

Ataxia-telangiectasia

Definition

Ataxia-telangiectasia (A-T), also called Louis-Bar syndrome, is a rare, genetic neurological disorder of child-

hood that progressively destroys part of the motor control area of the brain, leading to a lack of balance and coordination. A-T also affects the immune system and increases the risk of leukemia and lymphoma in affected individuals.

Description

The disorder first appeared in the medical literature in the mid-1920s, but was not named specifically until 1957. The name is a combination of two recognized abnormalities: ataxia (lack of muscle control) and telangiectasia (abnormal dilatation of capillary vessels that often result in tumors and red **skin lesions**). However, A-T involves more than just the sum of these two findings. Other associated A-T problems include immune system deficiencies, extreme sensitivity to radiation, and blood cancers.

Medical researchers initially suspected that multiple genes (the units responsible for inherited features) were involved. However, in 1995, mutations in a single large gene were identified as causing A-T. Researchers named the gene ATM for A-T, mutated. Subsequent research revealed that ATM has a significant role in regulating cell division. The symptoms associated with A-T reflect the main role of the AT gene, which is to induce several cellular responses to DNA damage, such as preventing damaged DNA from being reproduced. When the AT gene is mutated into ATM, the signaling networks are affected and the cell no longer responds correctly to minimize the damage.

A-T is very rare, but it occurs in every population world wide, with an estimated frequency of between 1/40,000 and 1/100,000 live births. But it is believed that many A-T cases, particularly those who die at a young age, are never properly diagnosed. Therefore, this disease may actually be much more prevalent. According to the A-T Project Foundation, an estimated 1% (2.5 million in the United States) of the general population carries defective A-T genes. Carriers of one copy of this gene do not develop A-T, but have a significantly increased risk of **cancer**. This makes the A-T gene one of the most important cancer-related genes identified to date.

Causes and symptoms

The ATM gene is autosomal recessive, meaning the disease occurs only if a defective gene is inherited from both parents. Infants with A-T initially often appear very healthy. At around age two, ataxia and nervous system abnormalities becomes apparent. The root cause of A-T-associated ataxia is cell **death** in the brain, specifically the large branching cells of the nervous system (Purkinje's cells) which are located in the cerebellum. A toddler becomes clumsy, loses balance easily and lacks muscle control. Speech becomes slurred and more difficult, and the symptoms progressively worsen. Between ages two and eight, telangiectases, or tiny, red "spider" veins, appear on the cheeks and ears and in the eyes.

By age 10-12, children with A-T can no longer control their muscles. Immune system deficiencies become common, and affected individuals are extremely sensitive to radiation. Immune system deficiencies vary between individuals but include lower-than-normal levels of proteins that function as antibodies (immunoglobulins) and white blood cells (blood cells not containing "iron" proteins). The thymus gland, which aids in development of the body's immune system, is either missing or has developed abnormally. Intelligence is normal, but growth may be retarded owing to immune system or hormonal deficiencies. Individuals with A-T are also sometimes afflicted with diabetes, prematurely graying hair, and difficulty swallowing. As the children grow older, the immune system becomes weaker and less capable of fighting infection. In the later stages, recurrent respiratory infections and blood cancers, such as leukemia or lymphoma, are common.

Diagnosis

Diagnosis relies on recognizing the hallmarks of A-T: progressive ataxia and telangiectasia. However, this may be difficult as ataxia symptoms do appear prior to telangiectasia symptoms by several years. Other symptoms can vary between individuals; for example, 70% of individuals with A-T have a high incidence of respiratory infection, 30% do not. The identification of the ATM gene raises hopes that screening, and perhaps treatment, may be possible.

Treatment

There is currently no cure for A-T, and treatment focuses on managing the individual's multiple symptoms. Physical therapy and speech therapy can help the patient adjust to ataxia. Injections of gamma globulin, or extracts of human blood that contain antibodies, are used to strengthen the weakened immune system. High-dose vitamin administrations may also be prescribed. Research continues in many countries to find effective treatments. Individuals and families living with this disorder may benefit from attending support groups.

Prognosis

A-T is a fatal condition. Children with A-T become physically disabled by their early teens and typically die by their early 20s, usually from the associated blood cancers and malignancies. In very rare cases, individuals with A-T may experience slower progression and a slightly longer life span, surviving into their 30s. A-T carriers have a five-fold higher risk than non-carriers of developing certain cancers, especially **breast cancer**.

KEY TERMS

Angioma—A tumor (such as a hemangioma or lymphangioma) that mainly consists of blood vessels or lymphatic vessels.

Antibody—Any of a large number of proteins produced by specialized blood cells after stimulation by an antigen and that act specifically against the antigen in an immune response.

Antigen—Any substance (such as a toxin or enzyme) capable of stimulating an immune response in the body.

Ataxia—The inability to control voluntary muscle movement, most frequently resulting from disorders in the brain or spinal cord.

Autosomal—Relating to any of the chromosomes except for X and Y, the sex chromosomes.

Cerebellum—The part of the brain responsible for coordination of voluntary movements.

Gamma-globulin—An extract of human blood that contains antibodies.

Immune response—A response from the body to an antigen that occurs when the antigen is identified as foreign and that induces the production of antibodies and lymphocytes capable of destroying the antigen or making it harmless.

Immunoglobulin—A protein in the blood that is the component part of an antibody.

Leukemia—A cancer of blood cells characterized by the abnormal increase in the number of white blood cells in the tissues. There are many types of leukemias and they are classified according to the type of white blood cell involved.

Lymphoma—A blood cancer in which lymphocytes, a variety of white blood cells, grow at an unusually rapid rate.

Mutation—Any change in the hereditary material of genes.

Purkinje's cells—Large branching cells of the nervous system.

Recessive—Producing little or no phenotypic effect when occurring in heterozygous condition with a contrasting allele.

Telangiectases—Spidery red skin lesions caused by dilated blood vessels.

Telangiectasia—Abnormal dilation of capillary blood vessels leading to the formation of telangiectases or angiomas.

Thymus—A gland located in the front of the neck that coordinates the development of the immune system.

Prevention

Medical researchers are investigating methods for screening individuals who may be carriers of the defective gene. Prenatal testing for A-T is possible but not done routinely, because commercial screening tests have yet to be developed.

Resources

PERIODICALS

Lavin, Martin F., and Yosef Shiloh. "The Genetic Defect in Ataxia-Telangiectasia." *Annual Review of Immunology* 15 (1997): 177.

ORGANIZATION

A-T Children's Project. 1 W. Camino Real, Suite 212, Boca Raton, FL 33432-5966. (561) 395-2621 or (800) 543-5728. <http://www.med.jhu.edu/ataxia/.

A-T Medical Research Foundation. 5241 Round Meadow Rd., Hidden Hills, CA 91302. (818) 704-8146.

A-T Project. 3002 Enfield Rd., Austin, TX 78703. (512) 472-3417.

The Ataxia-Telangiectasia Society of the United Kingdom, <http://www.atsociety.org.uk>.

National Ataxia Foundation. 2600 Fernbrook Ln., Suite 119, Minneapolis, MN 55447- 4752. (61) 553-0020. <http://www.ataxia.org/>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812- 1783. (203) 746-6518 or (800) 999-6673.

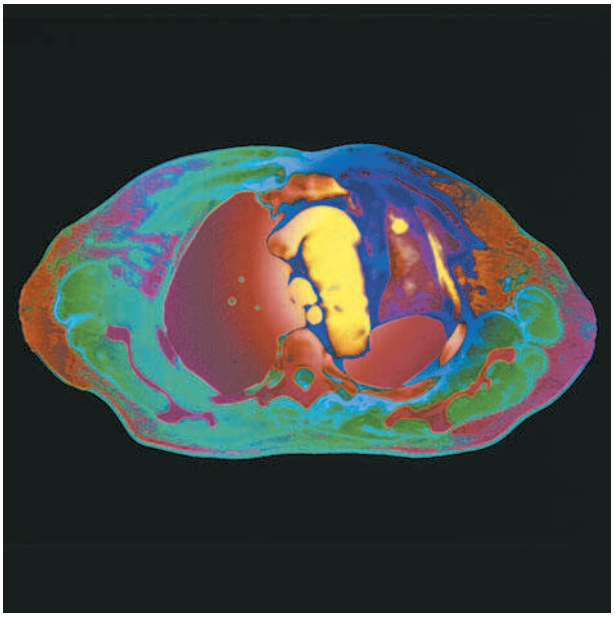
Bethanne Black

Ataxia *see* **Movement disorders**

Atelectasis

Definition

Atelectasis is a collapse of lung tissue affecting part or all of one lung. This condition prevents normal oxygen absoption to healthy tissues.



A computed tomography (CT) scan through a patient's chest. The collapsed lung appears at the right of the image. *(Photo Researchers, Inc. Reproduced by permission.)*

Description

Atelectasis can result from an obstruction (blockage) of the airways that affects tiny air scas called alveoli. Alveoli are very thin-walled and contain a rich blood supply. They are important for lung function, since their purpose is the exchange of oxygen and carbon dioxide. When the airways are blocked by a mucous "plug," foreign object, or tumor, the alveoli are unable to fill with air and collapse of lung tissue can occur in the affected area. Atelectasis is a potential complication following surgery, especially in individuals who have undergone chest or abdominal operations resulting in associated abdominal or chest **pain** during breathing. Congenital atelectasis can result from a failure of the lungs to expand at birth. This congenital condition may be localized or may affect all of both lungs.

Causes and symptoms

Causes of atelectasis include insufficient attemps at respiration by the newborn, bronchial obstruction, or absence of surfactant (a substance secreted by alveoli that maintains the stability of lung tissue by reducing the surface tension of fluids that coat the lung). This lack of surfactant reduces the surface area available for effective gas exchange causing it to collapse if severe. Pressure on the lung from fluid or air can cause atelectasis as well as obstruction of lung air passages by thick mucus resulting from various infections and lung diseases. Tumors and inhaled objects can also cause obstruction of the airway, leading to atelectasis.

Anyone undergoing chest or abdominal surgery using general anesthesia is at risk to develop atelectasis, since breathing is often shallow after surgery to avoid pain from the surgical incision. Any significant decrease in airflow to the alveoli contributes to pooling of secretions, which in turn can cause infection. Chest injuries causing shallow breathing, including fractured ribs, can cause atelectasis. Common symptoms of atelectasis include **shortness of breath** and decreased chest wall expansion. If atelectasis only afects a small area of the lung, symptoms are ususally minimal. If the condition affects a large area of the lung and develops quickly, the individual may turn blue (cyanotic) or pale, have extreme shortness of breath, and feel a stabbing pain on the affected side. **Fever** and increased heart rate may be present if infection accompanies atelectasis.

Diagnosis

To diagnose atelectasis, a doctor starts by recording the patient's symptoms and performing a thorough **physical examination**. When the doctor listens to the lungs through a stethoscope (ausculation), diminished or bronchial breath sounds may be heard. By tapping on the chest (percussion) while listening through the stethoscope, the doctor can often tell if the lung is collapsed. A **chest x ray** that shows an airless area in the lung confirms the diagnosis of atelectasis. If an obstruction of the airways is suspected, a computed tomography scan (CT) or **bronchoscopy** may be performed to locate the cause of the blockage.

Treatment

If atelectasis is due to obstruction of the airway, the first step in treatment is to remove the cause of the blockage. This may be done by coughing, suctioning, or bronchoscopy. If a tumor is the cause of atelectasis, surgery may be necessary to remove it. **Antibiotics** are commonly used to fight the infection that often accompanies atelectasis. In cases where recurrent or long-lasting infection is disabling or where significant bleeding occurs, the affected section of the lung may be surgically removed.

Prognosis

If atelectasis is caused by a thick mucus "plug" or inhaled foreign object, the patient usually recovers completely when the blockage is removed. If it is caused by a tumor, the outcome depends on the nature of the tumor involved. If atelectasis is a result of surgery, other post-operative conditions and/or complications affect the prognosis.

KEY TERMS

Alveoli—Tiny air sacs in the lungs where gas exchange takes place between alveolar air and pulmonary blood within the capillaries

Bronchial—Relating to the air passages to and from the lungs including the bronchi and the bronchioles.

Bronchoscopy—A procedure in which a hollow, flexible tube is inserted into the airway to allow visual examination of the larynx, trachea, bronchi, and bronchioles. It is also used to collect specimens for biopsy or culturing and to remove airway obstructions.

Incentive spirometer—A breathing device that provides feedback on performance to encourage deep breathing.

Mucus—A thin, slippery film secreted by the mucous membranes and glands.

Postural drainage—Techniques to help expel excess mucus by specific poistions of the body (that decrease the effects of gravity) combined with manual percussion and vibration over various parts of the lung.

Surfactant—A substance secreted by the alveoli in the lungs that reduces the surface tension of lung fluids, allowing gas exchange and helping maintain the elasticity of lung tissue.

Tumor—An abnormal growth of tissue resulting from uncontrolled, progressive multiplication of cells.

Prevention

When recovering from surgery, frequent repositioning in bed along with coughing and deep breathing are important. Coughing and breathing deeply every one to two hours after any surgical operation with general anesthesia is recommended. Breathing exercises and the use of breathing devices, such as an incentive spirometer, may also help prevent atelectasis. Although smokers have a higher risk of developing atelectasis following surgery, stopping **smoking** six to eight weeks before surgery can help reduce the risk. Increasing fluid intake during respiratory illness or after surgery (by mouth or intravenously) helps lung secretions to remain loose. Increasing humidity may also be beneficial.

Postural drainage techniques can be learned from a respiratory therapist or physical therapist and are a useful tool for anyone affected with a respiratiory illness that could cause atelectasis. Because **foreign objects** blocking the airway can cause atelectasis, it is very important to keep small objects that might be inhaled away from young children.

Resources

BOOKS

Banasik, Jacquelyn L. "Restrictive Pulmonary Disorders." In *Perspectives on Pathophysiology.* Ed. Lee-Ellen C. Copstead. Philadelphia: W. B. Saunders Co., 1994.

Chandrasoma, Parakrama, and Clive R. Taylor. *Concise Pathology.* East Norwalk, CT: Appleton & Lange, 1991.

ORGANIZATIONS

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Jeffrey P. Larson, RPT

Atenolol *see* **Beta blockers**

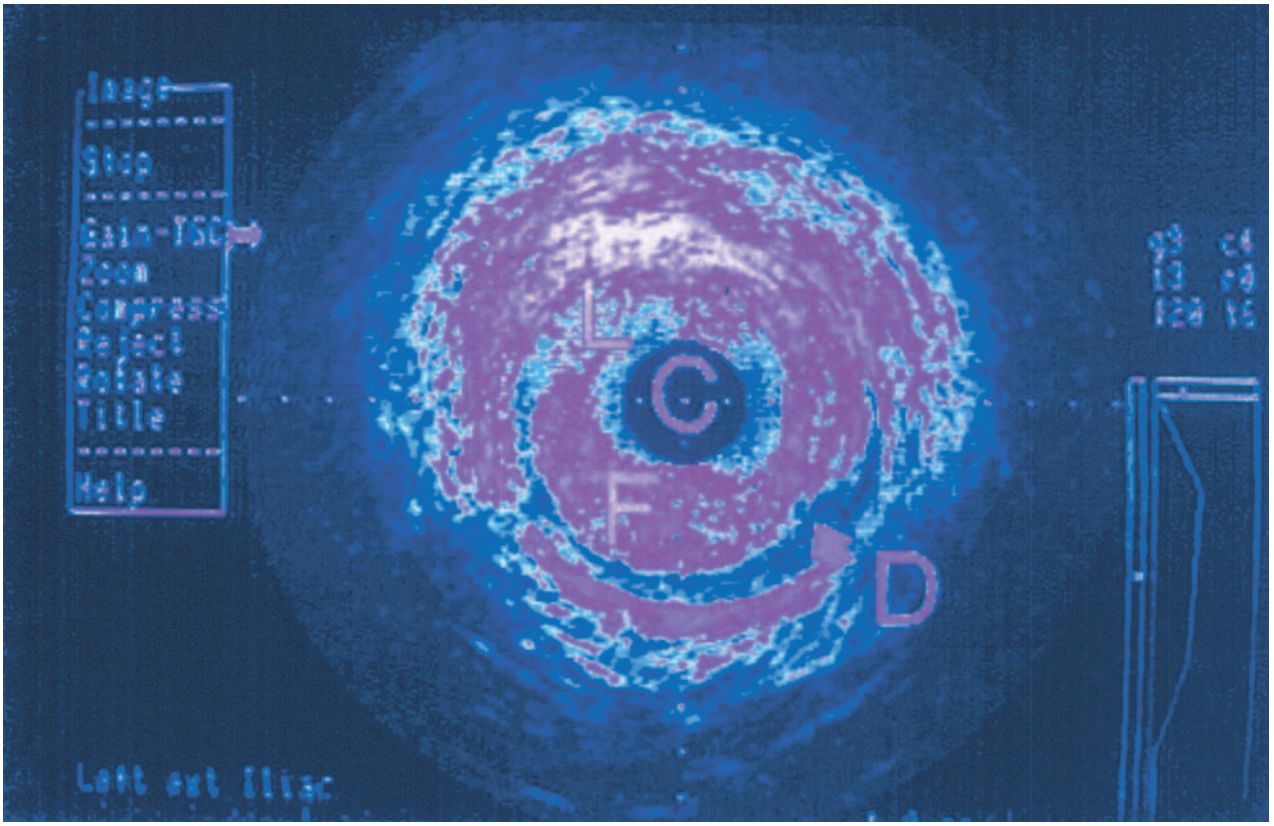
Atherectomy

Definition

Atherectomy is a non-surgical procedure to open blocked coronary arteries or vein grafts by using a device on the end of a catheter to cut or shave away atherosclerotic plaque (a deposit of fat and other substances that accumulate in the lining of the artery wall).

Purpose

Atherectomy is performed to restore the flow of oxygen-rich blood to the heart, to relieve chest **pain**, and to prevent heart attacks. It may be done on patients with chest pain who have not responded to other medical therapy and on certain of those who are candidates for balloon **angioplasty** (a surgical procedure in which a balloon catheter is used to flatten plaque against an artery wall) or **coronary artery bypass graft surgery**. It is



In this digitized ultrasound of a blood vessel, C is the catheter, D is the dissection, and F is the artherosclerotic flap. *(Custom Medical Stock Photo. Reproduced by permission.)*

sometimes performed to remove plaque that has built up after a coronary artery bypass graft surgery.

Precautions

Atherectomy should not be performed when the plaque is located where blood vessels divide into branches, when plaque is angular or inside an angle of a blood vessel, on patients with weak vessel walls, on ulcerated or calcium-hardened lesions, or on blockages through which a guide wire won't pass.

Description

Atherectomy uses a rotating shaver or other device placed on the end of a catheter to slice away or destroy plaque. At the beginning of the procedure, medications to control blood pressure, dilate the coronary arteries, and prevent blood clots are administered. The patient is awake but sedated. The catheter is inserted into an artery in the groin, leg, or arm, and threaded through the blood vessels into the blocked coronary artery. The cutting head is positioned against the plaque and activated, and the plaque is ground up or suctioned out.

The types of atherectomy are rotational, directional, and transluminal extraction. Rotational atherectomy uses a high speed rotating shaver to grind up plaque. Directional atherectomy was the first type approved, but is no longer commonly used; it scrapes plaque into an opening in one side of the catheter. Transluminal extraction coronary atherectomy uses a device that cuts plaque off vessel walls and vacuums it into a bottle. It is used to clear bypass grafts.

Performed in a **cardiac catheterization** lab, atherectomy is also called removal of plaque from the coronary arteries. It can be used instead of, or along with, balloon angioplasty. Atherectomy is successful about 95% of the time. Plaque forms again in 20-30% of patients.

Preparation

The day before atherectomy, the patient takes medication to prevent blood clots and may be asked to bathe and shampoo with an antiseptic skin cleaner.

Aftercare

After the procedure, the patient spends several days in the hospital's cardiac monitoring area. For at least 20

KEY TERMS

Atherosclerotic plaque—A deposit of fat and other substances that accumulate in the lining of the artery wall.

Balloon angioplasty—A surgical procedure in which a balloon catheter is used to flatten plaque against an artery wall.

Coronary arteries—The two main arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into two branches. These are the arteries where coronary artery disease occurs.

Hematoma—A localized collection of blood, usually clotted, due to a break in the wall of blood vessel.

minutes, pressure is applied to a dressing on the insertion site. For the first hour, an electrocardiogram and close monitoring are conducted; vital signs are checked every 15 minutes. Pain medication is then administered. The puncture site is checked once an hour or more. For most of the first 24 hours, the patient remains in bed.

Risks

Chest pain is the most common complication of atherectomy. Other common complications are injury to the blood vessel lining, plaque that re-forms, blood clots (hematoma), and bleeding at the site of insertion. More serious but less frequent complications are blood vessel holes, blood vessel wall tears, or reduced blood flow to the heart.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

DeBakey Michael E, and Antonio M. Gotto Jr. "Therapeutic Procedures." In *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Texas Heart Institute. "Coronary Artery Disease, Angina, and Heart Attacks." In *Texas Heart Institute Heart Owner's Handbook.* New York: John Wiley & Sons, 1996.

PERIODICALS

Bittl, John A., and Patricia Thomas. "Beyond the Balloon." *Harvard Health Letter* 21, no. 3 (Jan. 1996): 4.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Atherectomy." American Heart Association. 1997. 30 Mar. 1998 <http://www.americanheart.org>.

Lori De Milto

Atherectomy *see* **Angioplasty**

Atherosclerosis

Definition

Atherosclerosis is the build up of a waxy plaque on the inside of blood vessels. In Greek, *athere* means *gruel*, and *skleros* means *hard*. Atherosclerosis is often called arteriosclerosis. Arteriosclerosis (from the Greek *arteria,* meaning *artery*) is a general term for hardening of the arteries. Arteriosclerosis can occur in several forms, including atherosclerosis.

Description

Atherosclerosis, a progressive process responsible for most heart disease, is a type of arteriosclerosis or hardening of the arteries. An artery is made up of several layers: an inner lining called the endothelium, an elastic membrane that allows the artery to expand and contract, a layer of smooth muscle, and a layer of connective tissue. Arteriosclerosis is a broad term that includes a hardening of the inner and middle layers of the artery. It can be caused by normal **aging**, by high blood pressure, and by diseases such as diabetes. Atherosclerosis is a type of arteriosclerosis that affects only the inner lining of an artery. It is characterized by plaque deposits that block the flow of blood.

Plaque is made of fatty substances, cholesterol, waste products from the cells, calcium, and fibrin, a stringy material that helps clot blood. The plaque formation process stimulates the cells of the artery wall to produce substances that accumulate in the inner layer. Fat builds up within these cells and around them, and they form connective tissue and calcium. The inner layer of the artery wall thickens, the artery's diameter is reduced, and blood flow and oxygen delivery are decreased. Plaques can rupture or crack open, causing the sudden formation of a blood clot (thrombosis). Atherosclerosis

can cause a **heart attack** if it completely blocks the blood flow in the heart (coronary) arteries. It can cause a **stroke** if it completely blocks the brain (carotid) arteries. Atherosclerosis can also occur in the arteries of the neck, kidneys, thighs, and arms, causing kidney failure or **gangrene** and **amputation**.

Causes and symptoms

Atherosclerosis can begin in the late teens, but it usually takes decades to cause symptoms. Some people experience rapidly progressing atherosclerosis during their thirties, others during their fifties or sixties. Atherosclerosis is complex. Its exact cause is still unknown. It is thought that atherosclerosis is caused by a response to damage to the endothelium from **high cholesterol**, high blood pressure, and cigarette **smoking**. A person who has all three of these risk factors is eight times more likely to develop atherosclerosis than is a person who has none. Physical inactivity, diabetes, and **obesity** are also risk factors for atherosclerosis. High levels of the amino acid homocysteine and abnormal levels of protein-coated fats called lipoproteins also raise the risk of **coronary artery disease**. These substances are the targets of much current research. The role of triglycerides, another fat that circulates in the blood, in forming atherosclerotic plaques is unclear. High levels of triglycerides are often associated with diabetes, obesity, and low levels of high-density lipoproteins (HDL cholesterol). The more HDL ("good") cholesterol, in the blood, the less likely is coronary artery disease. These risk factors are all modifiable. Non-modifiable risk factors are heredity, sex, and age.

Risk factors that can be changed:

- Cigarette/tobacco smoke—Smoking increases both the chance of developing atherosclerosis and the chance of dying from coronary heart disease. Second hand smoke may also increase risk.
- High blood cholesterol—Cholesterol, a soft, waxy substance, comes from foods such as meat, eggs, and other animal products and is produced in the liver. Age, sex, heredity, and diet affect cholesterol. Total blood cholesterol is considered high at levels above 240 mg/dL and borderline at 200-239 mg/dL. High-risk levels of low-density lipoprotein (LDL cholesterol) begin at 130-159 mg/dL.
- High triglycerides—Most fat in food and in the body takes the form of triglycerides. Blood triglyceride levels above 400 mg/dL have been linked to coronary artery disease in some people. Triglycerides, however, are not nearly as harmful as LDL cholesterol.
- High blood pressure—Blood pressure of 140 over 90 or higher makes the heart work harder, and over time, both weakens the heart and harms the arteries.
- Physical inactivity—Lack of **exercise** increases the risk of atherosclerosis.
- Diabetes mellitus—The risk of developing atherosclerosis is seriously increased for diabetics and can be lowered by keeping diabetes under control. Most diabetics die from heart attacks caused by atherosclerosis.
- Obesity—Excess weight increases the strain on the heart and increases the risk of developing atherosclerosis even if no other risk factors are present.

Risk factors that cannot be changed:

- Heredity—People whose parents have coronary artery disease, atherosclerosis, or stroke at an early age are at increased risk. The high rate of severe **hypertension** among African-Americans puts them at increased risk.
- Sex—Before age 60, men are more likely to have heart attacks than women are. After age 60, the risk is equal among men and women.
- Age—Risk is higher in men who are 45 years of age and older and women who are 55 years of age and older.

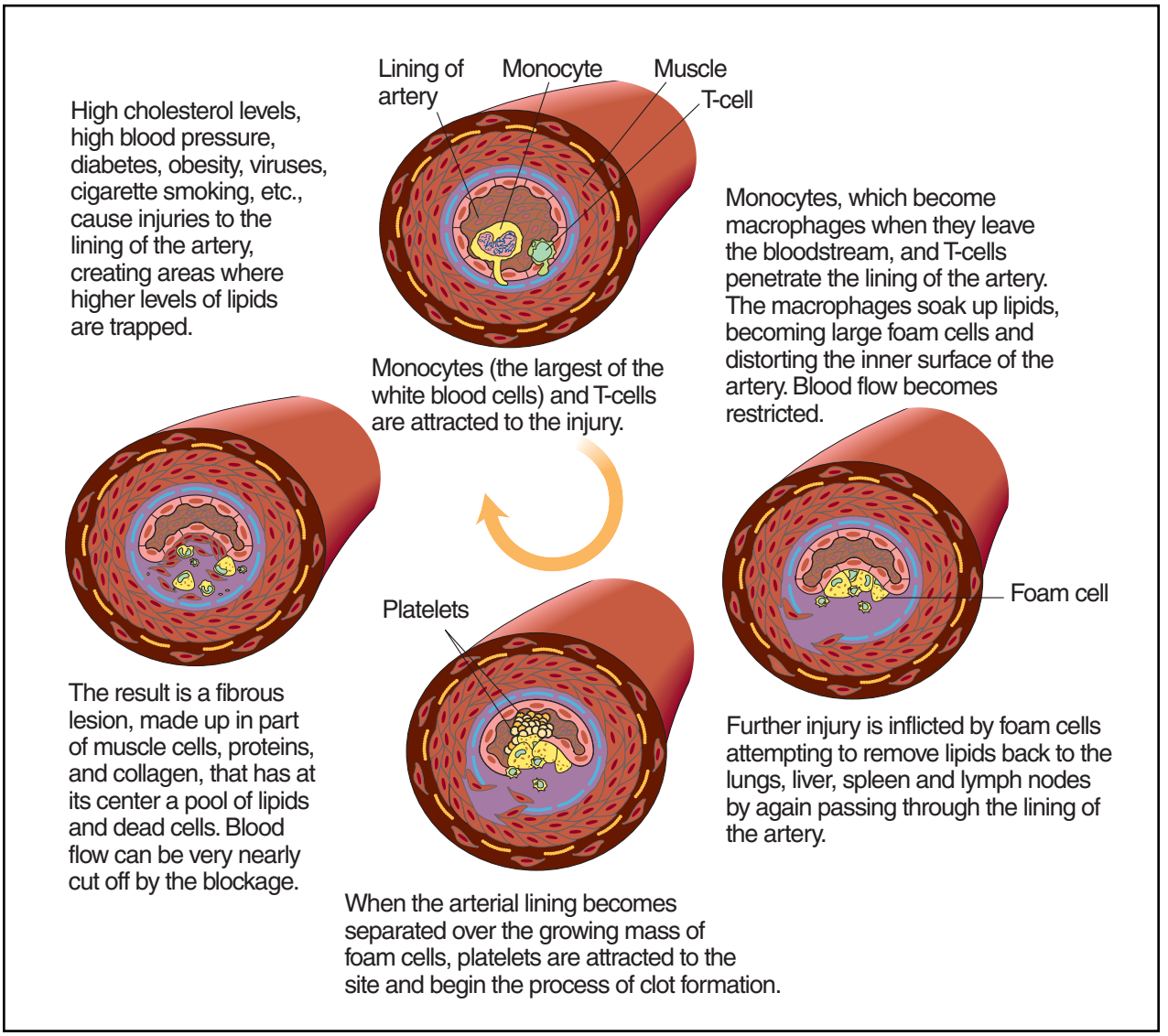
Symptoms differ depending upon the location of the atherosclerosis.

- In the coronary (heart) arteries: Chest **pain**, heart attack, or sudden **death**.
- In the carotid (brain) arteries: Sudden **dizziness**, weakness, loss of speech, or blindness.
- In the femoral (leg) arteries: Disease of the blood vessels in the outer parts of the body (**peripheral vascular disease**) causes cramping and **fatigue** in the calves when walking.
- In the renal (kidney) arteries: High blood pressure that is difficult to treat.

Diagnosis

Physicians may be able to make a diagnosis of atherosclerosis during a physical exam by means of a stethoscope and gentle probing of the arteries with the hand (palpation). More definite tests are **electrocardiography**, **echocardiography** or ultrasonography of the arteries (for example, the carotids), radionuclide scans, and **angiography**.

An electrocardiogram shows the heart's activity. Electrodes covered with conducting jelly are placed on the patient's body. They send impulses of the heart to a recorder. The test takes about 10 minutes and is performed in a physician's office. Exercise electrocardiography (**stress test**) is conducted while the patient exercises on a treadmill



The progression of atherosclerosis. *(Illustration by Hans & Cassady.)*

or a stationary bike. It is performed in a physician's office or an exercise laboratory and takes 15-30 minutes.

Echocardiography, cardiac ultrasound, uses sound waves to create an image of the heart's chambers and valves. A technician applies gel to a hand-held transducer, presses it against the patient's chest, and images are displayed on a monitor. This technique cannot evaluate the coronary arteries directly. They are too small and are in motion with the heart. Severe coronary artery disease, however, may cause abnormal heart motion that is detected by echocardiography. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30-60 minutes. Ultrasonography is also used to assess arteries of the neck and thighs.

Radionuclide angiography and thallium (or sestamibi) scanning enable physicians to see the blood flow through the coronary arteries and the heart chambers. Radioactive material is injected into the bloodstream. A device that uses gamma rays to produce an image of the radioactive material (gamma camera) records pictures of the heart. Radionuclide angiography is usually performed in a hospital's nuclear medicine department and takes 30-60 minutes. Thallium scanning is usually done after an exercise **stress** test or after injection of a vasodilator, a drug to enlarge the blood vessels, like dipyridamole (Persantine). Thallium is injected, and the scan is done then and again four hours (and possibly 24 hours) later. Thallium scanning is usually performed in a hospital's nuclear medicine department. Each scan takes 30-60 minutes.

Coronary angiography is the most accurate diagnostic method and the only one that requires entering the body (invasive procedure). A cardiologist inserts a catheter equipped with a viewing device into a blood vessel in the leg or arm and guides it into the heart. The patient has been given a contrast dye that makes the heart visible to x rays. Motion pictures are taken of the contrast dye flowing though the arteries. Plaques and blockages, if present, are well defined. The patient is awake but has been given a sedative. Coronary angiography is performed in a **cardiac catheterization** laboratory and takes from 30 minutes to two hours.

Treatment

Treatment includes lifestyle changes, lipid-lowering drugs, percutaneous transluminal coronary **angioplasty**, and coronary artery bypass surgery. Atherosclerosis requires lifelong care.

Patients who have less severe atherosclerosis may achieve adequate control through lifestyle changes and drug therapy. Many of the lifestyle changes that prevent disease progression—a low-fat, low-cholesterol diet, losing weight (if necessary), exercise, controlling blood pressure, and not smoking—also help prevent the disease.

Most of the drugs prescribed for atherosclerosis seek to lower cholesterol. Many popular lipid-lowering drugs can reduce LDL-cholesterol by an average of 25-30% when combined with a low-fat, low-cholesterol diet. Lipid-lowering drugs include bile acid resins, "statins" (drugs that effect HMG-CoA reductase, an enzyme that controls the processing of cholesterol), niacin, and fibric acid derivatives such as gemfibrozil (Lobid). **Aspirin** helps prevent thrombosis and a variety of other medications can be used to treat the effects of atherosclerosis.

Percutaneous transluminal coronary angioplasty and bypass surgery are invasive procedures that improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty (coronary angioplasty) is a non-surgical procedure in which a catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compresses the plaque to enlarge the blood vessel, and opens the blocked artery. Coronary angioplasty is performed by a cardiologist in a hospital and generally requires a hospital stay of one or two days. It is successful about 90% of the time, but for one-third of patients the artery narrows again within six months. It can be repeated and a "stent" may be placed in the artery to help keep it open (see below).

In coronary artery bypass surgery (bypass surgery), a detour is built around the blockage with a healthy vein or artery, which then supplies oxygen-rich blood to the heart. It is major surgery appropriate for patients with blockages in two or three major coronary arteries or severely narrowed left main coronary arteries, and for those who have not responded to other treatments. It is performed in a hospital under general anesthesia and uses a heart-lung machine. About 70% of patients experience full relief; about 20% partial relief.

Three other semi-experimental surgical procedures may be used to treat atherosclerosis. In **atherectomy**, a cardiologist shaves off and removes strips of plaque from the blocked artery. In laser angioplasty, a catheter with a laser tip is inserted to burn or break down the plaque. A metal coil called a stent may be permanently implanted to keep a blocked artery open.

Alternative treatment

Alternative therapies that focus on diet and lifestyle can help prevent, retard, or reverse atherosclerosis. Herbal therapies that may be helpful include: hawthorn (*Crataegus laevigata*), notoginseng root (*Panax notoginseng*), garlic (*Allium sativum*), ginger (*Zingiber officinale*), hot red or chili peppers, yarrow (*Achillea millefolium*), and alfalfa (*Medicago sativum*). Relaxation techniques including **yoga**, **meditation**, **guided imagery**, **biofeedback**, and counseling and other "talking" therapies may also be useful to prevent or slow the progress of the disease. Dietary modifications focus on eating foods that are low in fats (especially saturated fats), cholesterol, sugar, and animal proteins and high in fiber and antioxidants (found in fresh fruits and vegetables). Liberal use of onions and garlic is recommended, as is eating raw and cooked fish, especially cold-water fish like salmon. Smoking, alcohol, and stimulants like coffee should be avoided. **Chelation therapy**, which uses anticoagulant drugs and nutrients to dissolve plaque and flush it through the kidneys, is controversial. Long-term remedies can be prescribed by specialists in **ayurvedic medicine**, which combines diet, herbal remedies, relaxation and exercise, and **homeopathy**, which treats a disease with small doses of a drug that causes the symptoms of the disease.

Prognosis

Atherosclerosis can be successfully treated but not cured. Recent clinical studies have shown that atherosclerosis can be delayed, stopped, and even reversed by aggressively lowering LDL cholesterol. New diagnostic techniques enable physicians to identify and treat atherosclerosis in its earliest stages. New technologies and surgical procedures have extended the lives of many patients who would otherwise have died. Research continues.

Prevention

A healthy lifestyle—eating right, regular exercise, maintaining a healthy weight, not smoking, and controlling hypertension—can reduce the risk of developing atherosclerosis, help keep the disease from progressing, and sometimes cause it to regress.

- Eat right-A healthy diet reduces excess levels of LDL cholesterol and triglycerides. It includes a variety of foods that are low in fat and cholesterol and high in fiber; plenty of fruits and vegetables; and limited sodium. Fat should comprise no more than 30%, and saturated fat no more than 8-10%, of total daily calories according to the American Heart Association. Cholesterol should be limited to about 300 milligrams per day and sodium to about 2,400 milligrams. The "Food Guide" Pyramid developed by the U.S. Departments of Agriculture and Health and Human Services provides daily guidelines: 6-11 servings of bread, cereal, rice, and pasta; 3-5 servings of vegetables; 2-4 servings of fruit; 2-3 servings of milk, yogurt, and cheese; and 2-3 servings of meat, poultry, fish, dry beans, eggs, and nuts. Fats, oils, and sweets should be used sparingly. Monounsaturated oils, like olive and rapeseed (Canola) are good alternatives to use for cooking.
- Exercise regularly—Aerobic exercise can lower blood pressure, help control weight, and increase HDL ("good") cholesterol. It may keep the blood vessels more flexible. Moderate to intense aerobic exercise lasting about 30 minutes (or three 10-minute exercise periods) four or more times per week is recommended, according to the Centers for Disease Control and Prevention and the American College of Sports Medicine. Aerobic exercise includes walking, jogging, and cycling, active gardening, climbing stairs, or brisk housework. A physician should be consulted before exercise if a person has atherosclerosis or is at increased risk for it.
- Maintain a desirable body weight—Losing weight can help reduce total and LDL cholesterol, reduce triglycerides, and boost HDL cholesterol. It may also reduce blood pressure. Eating right and exercising are two key components in maintaining a desirable body weight.
- Do not smoke or use tobacco—Smoking has many adverse effects on the heart but quitting can repair damage. Ex-smokers face the same risk of heart disease as non-smokers within five to 10 years of quitting. Smoking is the worst thing a person can do to their heart and lungs.
- Seek treatment for hypertension—High blood pressure can be controlled through lifestyle changes—reducing sodium and fat, exercising, managing stress, quitting smoking, and drinking alcohol in moderation—and medication. Drugs that provide effective treatment are: **diuretics**, beta-blockers, sympathetic nerve inhibitors, **vasodilators**, angiotensin converting enzyme inhibitors, and calcium antagonists. Hypertension usually has no symptoms so it must be checked to be known. Like cholesterol, hypertension is called a "silent killer".

KEY TERMS

Arteriosclerosis—Hardening of the arteries. It includes atherosclerosis, but the two terms are often used synonymously.

Cholesterol—A fat-like substance that is made by the human body and eaten in animal products. Cholesterol is used to form cell membranes and process hormones and vitamin D. High cholesterol levels contribute to the development of atherosclerosis.

HDL Cholesterol—About one-third or one-fourth of all cholesterol is high-density lipoprotein cholesterol. High levels of HDL, nicknamed "good" cholesterol, decrease the risk of atherosclerosis.

LDL Cholesterol—Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL, nicknamed "bad" cholesterol, increase the risk of atherosclerosis

Plaque—A deposit of fatty and other substances that accumulates in the lining of the artery wall.

Triglyceride—A fat that comes from food or is made from other energy sources in the body. Elevated triglyceride levels contribute to the development of atherosclerosis.

Resources

BOOKS

American Heart Association. "The Power of Prevention." In *Guide to Heart Attack Treatment, Recovery, and Prevention.* New York: Time Books, 1996.

American Heart Association and American Cancer Society. *Living Well, Staying Well.* New York: American Heart Association and American Cancer Society, 1996.

"Atherosclerosis." In *The Complete Family Guide to Alternative Medicine*, ed. C. Norman Shealy. New York: Barnes & Noble Books, 1996.

"Basic Mechanisms of Atherosclerosis." In *Cardiovascular Medicine*, ed. J. T. Willerson and J. Cohn. New York: Churchill Livingstone, 1995.

DeBakey Michael E., and Antonio M. Gotto Jr. "Atherosclerosis." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

The Editors of Time-Life Books. "Atherosclerosis." In *The Alternative Advisor: The Complete Guide to Natural Therapies and Alternative Treatments*. Alexandria, VA: Time-Life Books, 1997.

Texas Heart Institute. "Coronary Artery Disease, Angina, and Heart Attacks" and "Diseases of the Peripheral Arteries and Veins." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

"Landmark Study Shows Heart Disease Prevention Must Start Early." *The Nation's Health* (Mar. 1997): 13.

Morgan, Peggy. "What Your Heart Wishes You Knew About Cholesterol." *Prevention*, Sept. 1997, 96.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Lori De Milto

Athetosis *see* **Movement disorders**

Athlete's foot

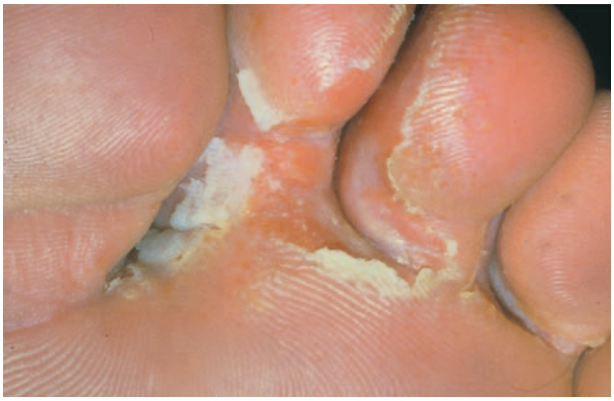
Definition

A common fungus infection between the toes in which the skin becomes itchy and sore, cracking and peeling away. Athlete's foot (also known as tinea pedis or foot **ringworm**) can be treated, but it can be tenacious and difficult to clear up completely.

Description

Athlete's foot is a very common condition of itchy, peeling skin on the feet. In fact, it's so common that most people will have at least one episode at least once in their lives. It's less often found in women and children under age 12. (Symptoms that look like athlete's foot in young children most probably are caused by some other skin condition).

Because the fungi grow well in warm, damp areas, they flourish in and around swimming pools, showers, and locker rooms. Tinea pedis got its common name because the infection was common among athletes who often used these areas.



Athlete's foot fungus on bottom of patient's foot. *(Custom Medical Stock Photo. Reproduced by permission.)*

Causes and symptoms

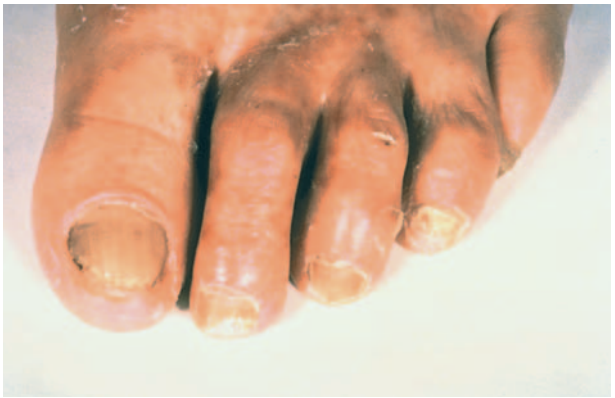
Athlete's foot is caused by a fungal infection that most often affects the fourth and fifth toe webs. *Trichophyton rubrum*, *T. mentagrophytes*, and *Epidermophyton floccosum*, the fungi that cause athlete's foot, are unusual in that they live exclusively on dead body tissue (hair, the outer layer of skin, and nails). The fungus grows best in moist, damp, dark places with poor ventilation. The problem doesn't occur among people who usually go barefoot.

Many people carry the fungus on their skin. However, it will only flourish to the point of causing athlete's foot if conditions are right. Many people believe athlete's foot is highly contagious, especially in public swimming pools and shower rooms. Research has shown, however, that it is difficult to pick up the infection simply by walking barefoot over a contaminated damp floor. Exactly why some people develop the condition and others don't is not well understood.

Sweaty feet, tight shoes, synthetic socks that don't absorb moisture well, a warm climate, and not drying the feet well after swimming or bathing, all contribute to the overgrowth of the fungus.

Symptoms of athlete's foot include itchy, sore skin on the toes, with scaling, cracking, inflammation, and blisters. Blisters that break, exposing raw patches of tissue, can cause **pain** and swelling. As the infection spreads, **itching** and burning may get worse.

If it's not treated, athlete's foot can spread to the soles of the feet and toenails. Stubborn toenail infections may appear at the same time, with crumbling, scaling and thickened nails, and nail loss. The infection can spread further if patients scratch and then touch themselves else-



Athlete's foot fungus on toes of patient. *(Custom Medical Stock Photo. Reproduced by permission.)*

where (especially in the groin or under the arms). It's also possible to spread the infection to other parts of the body via contaminated bed sheets or clothing.

Diagnosis

Not all foot **rashes** are athlete's foot, which is why a physician should diagnose the condition before any remedies are used. Using nonprescription products on a rash that is not athlete's foot could make the rash worse.

A dermatologist can diagnose the condition by **physical examination** and by examining a preparation of skin scrapings under a microscope. This test, called a KOH preparation, treats a sample of tissue scraped from the infected area with heat and potassium hydroxide (KOH). This treatment dissolves certain substances in the tissue sample, making it possible to see the fungi under the microscope.

Treatment

Athlete's foot may be resistant to medication and should not be ignored. Simple cases usually respond well to antifungal creams or sprays (clotrimazole, ketoconazole, miconazole nitrate, sulconazole nitrate, or tolnaftate). If the infection is resistant to topical treatment, the doctor may prescribe an oral antifungal drug.

Untreated athlete's foot may lead to a secondary bacterial infection in the skin cracks.

Alternative treatment

A footbath containing cinnamon has been shown to slow down the growth of certain molds and fungi, and is said to be very effective in clearing up athlete's foot. To make the bath:

- heat four cups of water to a boil
- add eight to 10 broken cinnamon sticks
- reduce heat and simmer five minutes
- remove and let the mixture steep for 45 minutes until lukewarm
- soak feet

Other herbal remedies used externally to treat athlete's foot include: a foot soak or powder containing goldenseal (*Hydrastis canadensis*); tea tree oil (*Melaleuca* spp.); or calendula (*Calendula officinalis*) cream to help heal cracked skin.

Prognosis

Athlete's foot usually responds well to treatment, but it is important to take all medication as directed by a dermatologist, even if the skin appears to be free of fungus. Otherwise, the infection could return. The toenail infections that may accompany athlete's foot, however, are typically very hard to treat effectively

Prevention

Good personal hygiene and a few simple precautions can help prevent athlete's foot. To prevent spread of athlete's foot:

- wash feet daily
- dry feet thoroughly (especially between toes)
- avoid tight shoes (especially in summer)
- wear sandals during warm weather
- wear cotton socks and change them often if they get damp
- don't wear socks made of synthetic material
- go barefoot outdoors when possible
- wear bathing shoes in public bathing or showering areas
- use a good quality foot powder
- don't wear sneakers without socks
- wash towels, contaminated floors, and shower stalls well with hot soapy water if anyone in the family has athlete's foot

Resources

BOOKS

Donahue, Peggy Jo. *Relief from Chronic Skin Problems*. New York: Dell Publishing, 1992.

Orkin, Milton, Howard Maibach, and Mark Dahl. *Dermatology*. Norwalk, CT: Appleton & Lange, 1991.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Illnesses*. New York: John Wiley & Sons, 1995.

Thompson, June, et al. *Mosby's Clinical Nursing*. St. Louis: Mosby, 1998.

ORGANIZATIONS

American Podiatric Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814-1698. (301) 571-9200. <http://www.apma.org>.

Carol A. Turkington

Athletic heart syndrome

Definition

Athletic heart syndrome is the adaptation of an athlete's heart in response the physiologic stresses of strenuous physical training. It can be difficult to distinguish a significant medical condition from an athletic heart.

Description

The heart adapts to physical demands by enlarging, especially the left ventricle. Enlargement increases the cardiac output, the amount of blood pumped with each beat of the heart. The exact type of adaptation depends on the nature of the physical demand. There are two types of demand, static and dynamic. Static demand involves smaller groups of muscles under extreme resistance for brief period. An example is weight lifting. Dynamic training involves larger groups of muscles at lower resistance for extended periods of time. Examples are aerobic training and tennis. Cardiac enlargement is associated with dynamic training. The heart's response to static training is hypertrophy, thickening of the muscle walls of the heart. As the wall of the heart adapts, there are changes in the electrical conducting system of the heart. Because of the larger volume of blood being pumped with each heart beat, the heart rate when at rest decreases below the normal level for nonathletes.

Sudden unexpected **death** (SUD) is the death of an athlete, usually during or shortly after physical activity. Often, there is no warning that the person will experience SUD, although in some cases, warning signs appear which cause the person to seek medical advice. Importantly, cases of death occurring during physical activity are not caused by athletic heart syndrome, but by undiagnosed heart disorders.

Causes and symptoms

Athletic heart syndrome is the consequence of a normal adaptation by the heart to increased physical activity. The changes in the electrical conduction system of the heart may be pronounced and diagnostic, but should not cause problems. In the case of SUD, other heart problems are involved. In 85-97% of the cases of SUD, an underlying structural defect of the heart has been noted.

Diagnosis

The changes in the heart beat caused by the electrical conduction system of the heart are detectable on an electrocardiogram. Many of the changes seen in athletic heart syndrome mimic those of various heart diseases. Careful examination must be made to distinguish heart disease from athletic heart syndrome.

Prognosis

The yearly rate for occurrence of SUD in people less than 35 years of age is less than seven incidents per 100,000. Of all SUD cases, only about 8% are **exercise** related. On a national basis, this means that each year approximately 25 athletes experience SUD. In persons over age 35, the incidence of SUD is approximately 55 in 100,000, with only 3% of the cases occurring during exercise.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill, 1998.

Braunwald, E. *Heart Disease*. Philadelphia: W. B. Saunders Co., 1997.

Gibler, W. B., and T. P. Aufderheide. *Emergency Cardiac Care*. St. Louis: Mosby, 1994.

John T. Lohr, PhD

Atkins diet

Definition

The Atkins diet is a high-protein, high-fat, and very low-carbohydrate regimen. It emphasizes meat, cheese, and eggs, while discouraging foods such as bread, pasta, fruit, and sugar. It is a form of ketogenic diet.

Purpose

The primary benefit of the diet is rapid and substantial weight loss. By restricting carbohydrate intake, the body will burn more fat stored in the body. Since there are no limits on the amount of calories or quantities of foods allowed on the diet, there is little hunger between meals. According to Atkins, the diet can alleviate symptoms of

DR. ROBERT C. ATKINS (1930–)

(AP/Wide World Photos. Reproduced by permission.)

Dr. Robert C. Atkins graduated from the University of Michigan in 1951 and received his medical degree from Cornell University Medical School in 1955 with a specialty in cardiology. As an internist and cardiologist he developed the Atkins Diet in the early 1970s. The diet is a ketogenic diet—a high protein, high fat, and very low carbohydrate regimen resulting in ketosis. It emphasizes meat, cheese, and eggs, while discouraging foods such as bread, pasta, fruit, and sugar. It first came to public attention in 1972 with the publication of *Dr. Atkins' Diet Revolution*. The book quickly became a bestseller but unlike most other fad diet books, this one has remained popular. At last count, it had been reprinted 28 times and sold more than 10 million copies worldwide. Since then, Atkins has authored a number of other books on his diet theme, including *Dr. Atkins' New Diet Revolution* (1992), *Dr. Atkins' Quick and Easy New Diet Cookbook* (1997), and *The Vita-Nutrient Solution: Nature's Answer to Drugs* (1998).

Atkins has seen about 60,000 patients in his more than 30 years of practice. He has also appeared on numerous radio and television talk shows, has his own syndicated radio program, *Your Health Choices*, and authors the monthly newsletter *Dr. Atkins' Health Revelations*. Atkins has received the World Organization of Alternative Medicine's Recognition of Achievement Award and been named the National Health Federation's Man of the Year. He is director of the Atkins Center for Complementary Medicine which he founded in the early 1980s. The center is located at 152 E. 55th St., New York, NY 10022.

conditions such as **fatigue**, irritability, headaches, depression, and some types of joint and muscle **pain**.

Description

The regimen is a low-carbohydrate, or ketogenic diet, characterized by initial rapid weight loss, usually due to water loss. Drastically reducing the amount of carbohydrate intake causes liver and muscle glycogen loss, which has a strong but temporary diuretic effect. Long-term weight loss occurs because with a low amount of carbohydrate intake, the body burns stored fat for energy.

The four-step diet starts with a two-week induction program designed to rebalance an individual's metabolism. Unlimited amounts of fat and protein are allowed but carbohydrate intake is restricted to 15-20 grams per day. Foods allowed include butter, oil, meat, poultry, fish, eggs, cheese, and cream. The daily amount of carbohydrates allowed equals about three cups of salad vegetables, such as lettuce, cucumbers, and celery.

The second stage is for ongoing weight loss. It allows 15-40 grams of carbohydrates a day. When the individual is about 10 pounds from their desired weight, they begin the pre-maintenance phase. This gradually adds one to three servings a week of high carbohydrate foods, such as a piece of fruit or slice of whole-wheat bread. When the desired weight is reached, the maintenance stage begins. It allows 40-60 grams of carbohydrates per day.

Opinion from the general medical community remains mixed on the Atkins diet, but is generally unfavorable. There have been no significant long-term scientific studies on the diet. A number of leading medical and health organizations, including the American Medical Association, American Dietetic Association (ADA), and the American Heart Association oppose it. It is drastically different than the dietary intakes recommended by the U.S. Department of Agriculture and the National Institutes of Health. Much of the opposition is because the diet is lacking in some **vitamins** and nutrients, and because it is high in fat. In a hearing before the U.S. Congress on February 24, 2000, an ADA representative called the Atkins diet "hazardous" and said it lacked scientific credibility.

Preparations

No advance preparation is needed to go on the diet. However, as with most **diets**, it is generally considered appropriate to consult with a physician and to have a physical evaluation before starting such a nutritional regimen. The evaluation should include blood tests to determine levels of cholesterol, triglycerides, glucose, insulin, and uric acid. A glucose tolerance test is also recommended.

Precautions

Adherence to the Atkins diet can result in vitamin and mineral deficiencies. In his books, Atkins recommends a wide-range of nutritional supplements, including a multi-vitamin. Among his recommendations, Atkins suggests the following daily dosages: 300-600 micrograms (mcg) of chromium picolinate, 100-400 milligrams (mg) of pantetheine, 200 mcg of selenium, and 450-675 mcg of biotin.

The diet is not recommended for lacto-ovo vegetarians, since it cannot be done as successfully without protein derived from animal products. Also, vegans cannot follow this diet, since a vegan diet is too high in carbohydrates, according to Atkins. Instead, he recommends vegetarians with a serious weight problem give up **vegetarianism**, or at least include fish in their diet.

Side effects

According to Atkins, the diet causes no adverse side effects. Many health care professionals disagree. In a fact sheet for the Healthcare Reality Check Web site (http://www.hcrc.org), Ellen Coleman, a registered dietician and author, said the diet may have serious side effects for some people. She said complications associated with the diet include ketosis, **dehydration**, electrolyte loss, calcium depletion, weakness, nausea, and kidney problems. "It is certainly riskier for overweight individuals with medical problems such as heart disease, **hypertension**, kidney disease, and diabetes than it is for overweight people with no health problems," she said.

People with diabetes taking insulin are at risk of becoming hypoglycemic if they do not eat appropriate carbohydrates. Also, persons who **exercise** regularly may experience low energy levels and muscle fatigue from low carbohydrate intake.

KEY TERMS

Biotin—A B complex vitamin, found naturally in yeast, liver, and egg yolks.

Carbohydrates—Neutral compounds of carbon, hydrogen, and oxygen found in sugar, starches, and cellulose.

Hypertension—Abnormally high arterial blood pressure, which if left untreated can lead to heart disease and stroke.

Ketogenic diet—A diet that supplies an abnormally high amount of fat, and small amounts of carbohydrates and protein.

Ketosis—An abnormal increase in ketones in the body, usually found in people with uncontrolled diabetes mellitus.

Pantetheine—A growth factor substance essential in humans, and a constituent of coenzyme A.

Triglycerides—A blood fat lipid that increases the risk for heart disease.

Resources

BOOKS

Atkins, Dr. Robert C. *Dr. Atkins' New Diet Revolution*. New York City: Avon Books. 1992.

Atkins, Dr. Robert C. *Dr. Atkins' Vita-Nutrient Solution: Nature's Answer to Drugs*. New York: Simon & Schuster. 1998.

Atkins, Dr. Robert C. *Dr. Atkins' Health Revolution: How Complementary Medicine Can Extend Your Life*. New York: Bantam Books. 1990.

Atkins, Dr. Robert C. *Dr. Atkins' Age-Defying Diet Revolution*. New York: St. Martin's Press. 1999.

Atkins, Dr. Robert C. *Dr. Atkins' Diet Revolution: The High Calorie Way to Stay Thin Forever*. New York: Bantam Books. 1989.

PERIODICALS

Alger, Alexandra. "Meat's Neat." *Forbes* (Aug. 11, 1997): 129.

Carroll, Joanne. "The Ketogenic Diet: A Practical Guide for Caregivers." *Journal of the American Dietetic Association* (March 1998): 316-321.

Cray, Dan, et al. "The Low-Carb Diet Craze." *Time* (Nov. 1, 1999): 72-79.

Gotthardt, Melissa Meyers. "The New Low-Carb Diet Craze." *Cosmopolitan* (Feb. 2000): 148.

Hammock, Delia. "Dr. Atkins' New Diet Revolution." *Good Housekeeping* (June 1997): 127.

Howe, Maggy. "Excess Pounds." *Country Living* (Nov. 1995): 60-61.

Merrell, Woodson. "How I Became a Low-Carb Believer." *Time* (Nov. 1, 1999): 80.

Turner, Richard. "The Trendy Diet That Sizzles." *Newsweek* Sept. 6, 1999): 60.

OTHER

Atkins Center for Complementary Medicine. 152 E. 55th St., New York, NY 10022. 212-758-2110. <http://www.atkinscenter.com>.

Ken R. Wells

Atopic dermatitis

Definition

Eczema is a general term used to describe a variety of conditions that cause an itchy, inflamed skin rash. Atopic **dermatitis**, a form of eczema, is a non-contagious disorder characterized by chronically inflamed skin and sometimes intolerable **itching**.

Description

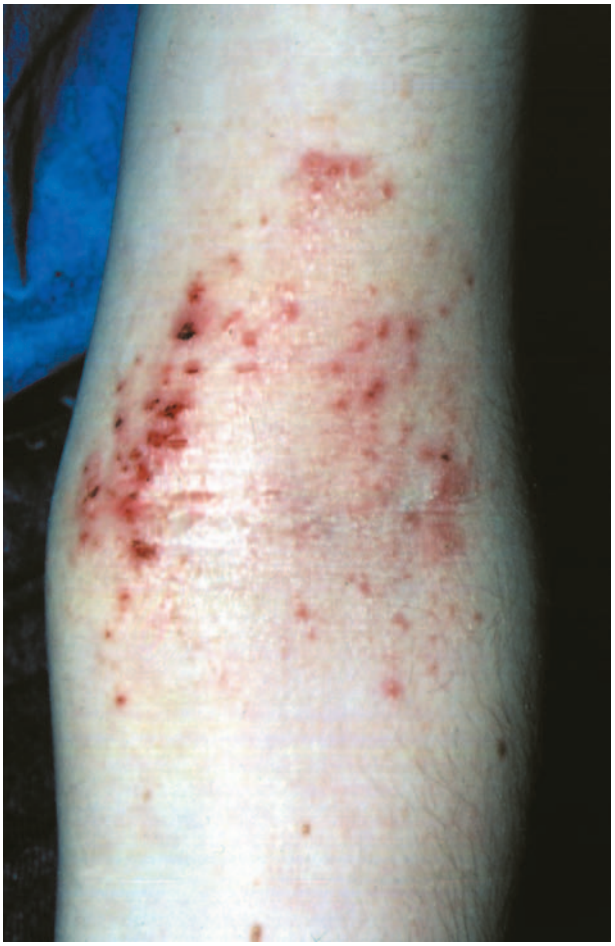
Atopic dermatitis refers to a wide range of diseases that are often associated with **stress** and allergic disorders that involve the respiratory system, like **asthma** and hay **fever**. Although atopic dermatitis can appear at any age, it is most common in children and young adults. Symptoms usually abate before the age of 25 and do not affect the patient's general health.

About one in ten babies develop a form of atopic dermatitis called infantile eczema. Characterized by skin that oozes and becomes encrusted, infantile eczema most often occurs on the face and scalp. The condition usually improves before the child's second birthday, and medical attention can keep symptoms in check until that time.

When atopic dermatitis develops after infancy, inflammation, blistering, oozing, and crusting are less pronounced. The patient's sores become dry, turn from red to brownish-gray, and skin may thicken and become scaly. In dark-skinned individuals, this condition can cause the complexion to lighten or darken. Itching associated with this condition is usually worst at night. It can be so intense that patients scratch until their sores bleed, sometimes causing scarring and infection.

Atopic dermatitis affects about 3% of the population of the United States, and about 80% of the people who have the condition have one or more relatives with the same condition or a similar one. Symptoms tend to be most severe in females. Atopic dermatitis can erupt on any part of the skin, and crusted, thickened patches on the fingers, palms, or the soles of the feet can last for years. In teenagers and young adults, atopic dermatitis often appears on one or more of the following areas:

- elbow creases
- backs of the knees

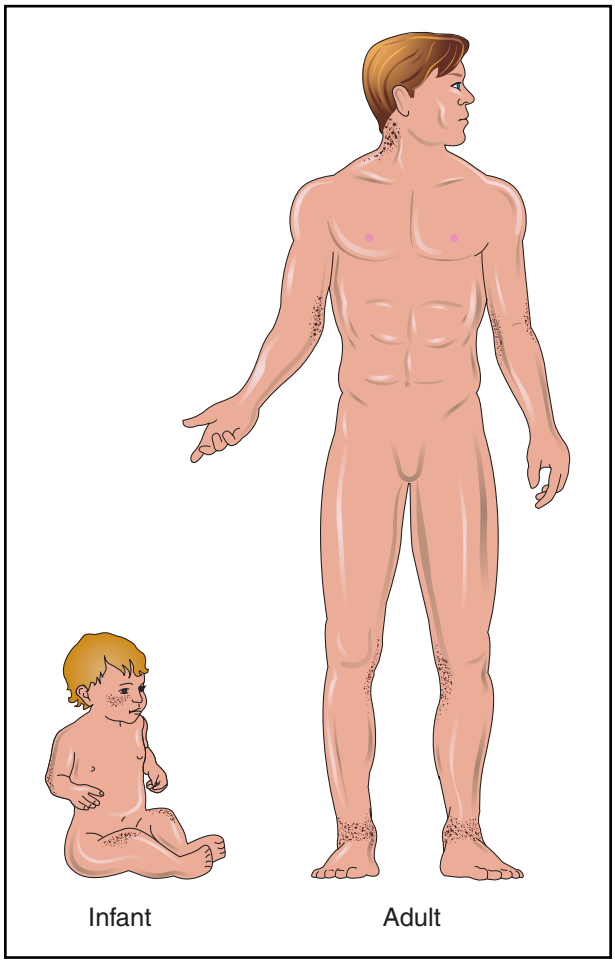


A close-up view of atopic dermatitis in the crook of the elbow of a 12-year-old patient. *(Custom Medical Stock Photo. Reproduced by permission.)*

- ankles
- wrists
- face
- neck
- upper chest
- palms and between the fingers

Causes and symptoms

While allergic reactions often trigger atopic dermatitis, the condition is thought to be the result of an inherited over-active immune system or a genetic defect that causes the skin to lose abnormally large amounts of moisture. The condition can be aggravated by a cycle that develops in which the skin itches, the patient scratches, the condition worsens, the itching worsens, the patient scratches, etc. This cycle must be broken by relieving the itching to allow the skin time to heal. If the skin becomes



Atopic dermatitis can erupt on any part of the skin. In infants, it often appears on the face, scalp, and knees, while it develops on the elbows, neck, back of the knees, and ankles in adults. *(Illustration by Electronic Illustrators Group.)*

broken, there is also a risk of developing skin infections which, if not recognized and treated promptly, can become more serious.

Symptoms of atopic dermatitis include the following:

- an itchy rash and dry, thickened skin on areas of the body where moisture can be trapped
- continual scratching
- chronic **fatigue**, caused when itching disrupts sleep

An individual is more at-risk for developing the condition if there is a personal or family history of atopic dermatitis, hay fever, asthma, or other **allergies**. Exposure to any of the following can cause a flare-up:

- hot or cold temperatures
- wool and synthetic fabrics
- detergents, fabric softeners, and chemicals
- use of drugs that suppress immune-system activity

Certain foods, such as peanuts, cow's milk, eggs, and fish, can trigger symptoms of atopic dermatitis. A small percentage of patients with atopic dermatitis find that their symptoms worsen after having been exposed to dust, feather pillows, rough-textured fabrics, or other materials to which dust adheres.

Diagnosis

Diagnosis of atopic dermatitis is usually based on the patient's symptoms and personal and family health history. Skin tests do not generally provide reliable information about this condition.

Treatment

Atopic dermatitis cannot be cured, but the severity and duration of symptoms can be controlled. A dermatologist should be consulted when symptoms first appear, and is likely to recommend warm baths to loosen encrusted skin, followed by applications of petroleum jelly or vegetable shortening to prevent the skin's natural moisture from escaping.

Externally applied (topical) steroids or preparations containing coal tar can relieve minor itching, but coal tar has an unpleasant odor, stains clothes, and may increase skin-cancer risk. Excessive use of steroid creams in young children can alter growth. Pregnant women should not use products that contain coal tar. Topical steroids can cause itching, burning, **acne**, permanent stretch marks, and thinning and spotting of the skin. Applying topical steroids to the area around the eyes can cause **glaucoma**.

Oral **antihistamines**, such as diphenhydramine (Benadryl), can relieve symptoms of allergy-related atopic dermatitis. More concentrated topical steroids are recommended for persistent symptoms. A mild tranquilizer may be prescribed to reduce stress and help the patient sleep, and **antibiotics** are used to treat secondary infections.

Cortisone ointments should be used sparingly, and strong preparations should never be applied to the face, groin, armpits, or rectal area. Regular medical monitoring is recommended for patients who use cortisone salves or lotions to control wide-spread symptoms. Oral cortisone may be prescribed if the patient does not respond to other treatments, but patients who take the medication for more than two weeks have a greater-than-average risk of developing severe symptoms when the treatment is discontinued.

Allergy shots rarely improve atopic dermatitis and sometimes aggravate the symptoms. Since food allergies may trigger atopic dermatitis, the doctor may suggest

eliminating certain foods from the diet if other treatments prove ineffective.

If symptoms are extremely severe, ultraviolet light therapy may be prescribed, and a wet body wrap recommended to help the skin retain moisture. This technique, used most often with children, involves sleeping in a warm room while wearing wet pajamas under dry clothing, rain gear, or a nylon sweatsuit. The patient's face may be covered with wet gauze covered by elastic bandages, and his hands encased in wet socks covered by dry ones.

A physician should be notified if the condition is widespread or resists treatment, or the skin oozes, becomes encrusted, or smells, as this may indicate an infection.

Alternative treatment

Alternative therapies can sometimes bring relief or resolution of atopic dermatitis when conventional therapies are not helping. If the condition becomes increasingly widespread or infected, a physician should be consulted.

Helpful alternative treatments for atopic dermatitis may include:

- Taking regular brisk walks, followed by bathing in warm water sprinkled with essential oil of lavender (*Lavandula officinalis*); lavender oil acts as a nerve relaxant for the whole body including the skin
- Supplementing the diet daily with zinc, fish oils, vitamin A, vitamin E, and evening primrose oil (*Oenothera biennis*)—all good sources of nutrients for the skin
- Reducing or eliminating red meat from the diet
- Eliminating or rotating potentially allergic foods such as cow's milk, peanuts, wheat, eggs, and soy
- Implementing **stress reduction** techniques in daily life.

Herbal therapies also can be helpful in treating atopic dermatitis. Western herbal remedies used in the treatment of this condition include burdock (*Arctium lappa*) and *Ruta* (*Ruta graveolens*). Long-term herbal therapy requires monitoring and should be guided by an experienced practitioner.

Other alternative techniques that may be useful in the treatment of atopic dermatitis include:

- Acupressure (**acupuncture** without needles) to relieve tension that may trigger a flare
- Aromatherapy, using essential oils like lavender, thyme (*Thymus vulgaris*), jasmine (*Jasminum officinale*) and chamomile (*Matricaria recutita*) in hot water, to add a soothing fragrance to the air

KEY TERMS

Corticosteroid—A steroid hormone produced by the adrenal gland or as a synthetic compound that reduces inflammation, redness, rashes, and irritation.

Dermatitis—Inflammation of the skin.

- Shiatsu massage and **reflexology**, performed by licensed practitioners, to alleviate symptoms by restoring the body's natural balance
- Homeopathy, which may temporarily worsen symptoms before relieving them, and should be supervised by a trained alternative healthcare professional
- Hydrotherapy, which uses water, ice, liquid, and steam, to stimulate the immune system
- Juice therapy to purify the liver and relieve bowel congestion
- Yoga to induce a sense of serenity.

Prognosis

Atopic dermatitis is unpredictable. Although symptoms occur less often with age and sometimes disappear altogether, they can recur without warning. Atopic dermatitis lowers resistance to infection and increases the risk of developing **cataracts**. Sixty percent of patients with atopic dermatitis will experience flares and remissions throughout their lives.

Prevention

Research has shown that babies weaned from breast milk before they are four months old are almost three times more likely than other babies to develop recurrent eczema. Feeding eggs or fish to a baby less than one year old can activate symptoms, and babies should be shielded from such irritants as mites, molds, pet hair, and smoke.

Possible ways to prevent flare-ups include the following:

- eliminate activities that cause sweating
- lubricate the skin frequently
- avoid wool, perfumes, fabric softeners, soaps that dry the skin, and other irritants
- avoid sudden temperature changes.

A doctor should be notified whenever any of the following occurs:

- fever or relentless itching develop during a flare

- an unexplained rash develops in someone who has a personal or family history of eczema or asthma
- inflammation does not decrease after seven days of treatment with an over-the-counter preparation containing coal tar or steroids
- a yellow, tan, or brown crust or pus-filled blisters appear on top of an existing rash
- a person with active atopic dermatitis comes into contact with someone who has cold sores, **genital herpes**, or another viral skin disease

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

Maureen Haggerty

Atrial ectopic beats

Definition

Atrial ectopic beats (AEB) refers to a contraction of the upper heart chamber which occurs before it would be expected. Atrial ectopic beats are also known as premature atrial beats, premature atrial complex (PAC), or atrial extrasystole.

Description

An AEB is usually a harmless disturbance in the normal rhythm of the heart. It can occur only occasionally, in a regular pattern, or several may occur in sequence and then disappear. Most often, the person is unaware of the event.

Causes and symptoms

As people age, extra beats tend to happen more frequently even in perfectly healthy individuals. AEB may be triggered or increased by **stress**, **caffeine**, **smoking**, and some medicines. Cold remedies containing ephedrine or pseudoephedrine have been known to increase the incidence of atrial ectopic beats. AEB may also be the result of an enlarged atria, lung disease, or the result of reduced blood supply to that area of the heart.

If a person is aware of the event, the first symptom of AEB is usually a feeling that the heart has skipped or missed a beat. This is often accompanied by a feeling that the heart is thumping or pounding in the chest. The thumping or pounding is caused by the fact that when there is an AEB, the pause before the next beat is usually longer than normal. The next beat must be stronger than usual to pump the accumulated blood out of the chamber.

Diagnosis

Diagnosis of AEB is often suspected on the basis of the patient's description of the occurrence. An electrocardiogram (ECG) can confirm the diagnosis. An ECG shows the heart beat as three wave forms. The first wave is called P, the second is called QRS, and the last is T. An atrial ectopic beat will show up on the ECG as a P wave that occurs closer than usual to the preceding T wave.

Treatment

Atrial ectopic beats do not usually require treatment. If treatment is necessary because the beats occur frequently and cause intolerable discomfort, the doctor may prescribe medication.

Prognosis

Occasional AEB usually have no significance. If they increase in frequency, they can lead to atrial tachycardia or fibrillation and to a decrease in cardiac output.

Prevention

AEB cannot usually be prevented. Aggravating factors can be addressed, like excessive stimulants, and uncontrolled pulmonary disorders.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Atrial extrasystole *see* **Atrial ectopic beats**

Atrial fibrillation and flutter

Definition

Atrial fibrillation and flutter are abnormal heart rhythms in which the atria, or upper chambers of the heart, are out of sync with the ventricles, or lower chambers of the heart. In atrial fibrillation, the atria "quiver" chaotically and the ventricles beat irregularly. In atrial flutter, the atria beat regularly and faster than the ventricles.

Description

Atrial fibrillation and flutter are two types of cardiac **arrhythmias**, irregularities in the heart's rhythm. Nearly 2 million Americans have atrial fibrillation, according to the American Heart Association. It is the most common chronic arrhythmia. Atrial flutter is less common, but both of these arrhythmias can cause a blood clot to form in the heart. This can lead to a **stroke** or a blockage carried by the blood flow (an **embolism**) anywhere in the body's arteries. Atrial fibrillation is responsible for about 15% of strokes.

The atria are the heart's two small upper chambers. In atrial fibrillation, the heart beat is completely irregular. The atrial muscles contract very quickly and irregularly; the ventricles, the heart's two large lower chambers, beat irregularly but not as fast as the atria. When the atria fibrillate, blood that is not completely pumped out can pool and form a clot. In atrial flutter, the heart beat is usually very fast but steady. The atria beat faster than the ventricles.

Atrial fibrillation often occurs in people with various types of heart disease. Atrial fibrillation may also result from an inflammation of the heart's covering (**pericarditis**), chest trauma or surgery, pulmonary disease, and certain medications. Atrial fibrillation is more common in older people; about 10% of people over the age of 75 have it. Atrial flutter and fibrillation usually occur in people with hypertensive or coronary heart disease and other types of heart disorders.

Causes and symptoms

In most cases, the cause of atrial fibrillation and flutter can be found, but often it cannot. Causes of these heart beat abnormalities include:

- many types of heart disease
- **stress** and anxiety
- **caffeine**
- alcohol
- tobacco
- diet pills
- some prescription and over-the-counter medications
- open heart surgery

Symptoms, when present, include:

- a fluttering feeling in the chest
- a pulse that feels like the heart is skipping, racing, jumping, or is irregular
- low energy
- a faint or dizzy feeling
- pressure or discomfort in the chest
- shortness of breath
- anxiety.

Diagnosis

A doctor can sometimes hear these arrhythmias using an instrument (a stethoscope) to listen to the sounds within the chest. Atrial fibrillation and flutter are usually diagnosed through **electrocardiography** (EKGs), an **exercisestress test**, a 24-hour Holter EKG monitor, or a telephone cardiac monitor. An EKG shows the heart's activity and may reveal a lack of oxygen (**ischemia**). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. The electrodes send impulses of the heart's activity through a monitor (called an oscilloscope) to a recorder that traces the pattern of the impulses onto paper. The test takes about 10 minutes and is performed in a doctor's office. The exercise stress test measures how the heart and blood vessels respond to work when the patient is exercising on a treadmill or a stationary bike. This test is performed in a doctor's office within an exercise laboratory and takes 15-30 minutes.

In 24-hour EKG (Holter) monitoring, the patient wears a small, portable tape recorder connected to disks on his/her chest that record the heart's rhythm during normal activities. An EKG called transtelephonic monitoring identifies arrhythmias that occur infrequently. Like **Holter monitoring**, transtelephonic monitoring continues for days or weeks and enables patients to send the EKG via telephone to a monitoring station when an arrhythmia is felt, or to store the information in the recorder and transmit it later. Doctors can also use high-frequency sound waves (**echocardiography**) to determine the structure and function of the heart. This diagnostic method is often helpful to evaluate for underlying heart disease.

Treatment

Atrial fibrillation and flutter are usually treated with medications and/or electrical shock (**cardioversion**). In

some cases, removal of a small portion of the heart (ablation), implantation of a pacemaker or a cardioverter defibrillator, or maze surgery is needed.

If the heart rate cannot be quickly controlled, electrical cardioversion may be used. Cardioversion, the electric shock to the chest wall, is usually performed emergencies. This device briefly suspends the heart's activity and allows it to return to a normal rhythm.

Ablation destroys the heart tissue that causes the arrhythmia. The tissue can be destroyed by catheterization or surgery. Radiofrequency **catheter ablation**, performed in a **cardiac catheterization** laboratory, can cure atrial flutter and control the heart rate in atrial fibrillation. The patient is awake but sedated. A thin tube called a catheter is inserted into a vein and is threaded into the heart. At the end of the catheter, a device maps the electrical pathways of the heart. A cardiologist, a doctor specializing in the heart, uses this map to identify the pathway(s) causing the arrhythmia, and then eliminates it (them) with bursts of high-frequency radio waves. Surgical ablation is performed in an operating room under general anesthesia. Computerized mapping techniques are combined with a cold probe to destroy arrhythmia-causing tissue. Ablation is generally successful. When ablation is used for atrial fibrillation, it is usually followed by implantation of a pacemaker as well as drug therapy.

A pacemaker is a battery-powered device about the size of a matchbox that is surgically implanted near the collarbone to regulate the heart beat. Lead wires threaded to the right side of the heart supply electrical energy to pace the atria and ventricles. The implantable cardioverter defibrillator is a treatment for serious arrhythmias. The battery-powered device senses an abnormal heart rhythm and automatically provides electrical shock(s). The shock(s) suspends heart activity and then allows the heart to initiate a normal rhythm. Wire electrodes on the device are attached to the heart. Some of the electrodes are attached to the outside of the heart and some are attached to the inside of the heart through veins. The newest implantable cardioverter defibrillators can be implanted in the chest wall and do not require open chest surgery. These devices weigh less than 10 oz and generally last seven or eight years. An implantable cardioverter defibrillator is usually used with drug therapy, but the amount medication is reduced. In maze surgery, often the last resort, surgeons create a maze of stitches (sutures) that help the heart's electrical impulses travel effectively.

Most of the drugs used for treatment have potential side effects and should be carefully monitored by a doctor. The goal of treatment is to control the rate and rhythm of the heart and to prevent the formation of blood clots. If the arrhythmia is caused by heart disease, the heart disease will also be treated. The American Heart Association recommends aggressive treatment.

A digitalis drug, most commonly digoxin, is usually prescribed to control the heart rate. **Digitalis drugs** slow the heart's electrical impulses, helping to restore the normal rate and rhythm. These drugs also increase the ability of the heart's muscular layer to contract and pump properly. Beta-blockers and **calcium channel blockers** can also be used for this purpose. Beta-blockers slow the speed of electrical impulses through the heart. Some calcium channel blockers dampen the heart's response to erratic electrical impulses.

To prevent blood clots, **aspirin** or warfarin (Coumadin) is administered. Warfarin, however, has potential bleeding side effects, especially in older patients. Amiodarone is fairly efffective for atrial flutter. This drug is often able to maintain the heart's proper rhythm and can also help control the heart rate when the flutter occurs.

Prognosis

Patients with atrial fibrillation and flutter can live a normal life for many years as long as the arrhythmia is controlled and serious blood clots are prevented.

Prevention

Atrial fibrillation and flutter can sometimes be prevented when the cause can be identified and controlled. Depending on the cause, prevention could include:

- treating the underlying heart disease
- reducing stress and anxiety
- reducing or stopping consumption of caffeine, alcohol, or tobacco; and/or
- discontinuing diet pills or other medications (over-the-counter or prescription)

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

DeBakey, Michael E., and Antonio M. Gotto Jr. *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Falk, Rodney H., and Philip J. Podrid, eds. *Atrial Fibrillation: Mechanisms and Management.* 2nd ed. New York: Lippincott-Raven, 1997.

KEY TERMS

Arrhythmia—A variation in the normal rhythm of the heart beat. Atrial fibrillation and flutter are two types of arrhythmia.

Atria—The two small upper chambers of the heart that receive blood from the lungs and the body.

Stroke—A brain attack caused by a sudden disruption of blood flow to the brain, in this case because of a blood clot.

Ventricles—The two large lower chambers of the heart that pump blood to the lungs and to the rest of the body.

Texas Heart Institute. "Arrhythmias." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

Waldo, Albert L., and Paul Touboul, eds. *Atrial Flutter: Advances in Mechanisms and Management*. Armonk, NY: Futura Publishing Co., Inc., 1996.

PERIODICALS

Kosinski, Daniel, et al. "Catheter Ablation for Atrial Flutter and Fibrillation: An Effective Alternative to Medical Therapy." *Postgraduate Medicine* 103, no. 1 (Jan. 1998): 103-110.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Atrial Fibrillation" and "Management of Patients with Atrial Fibrillation." American Heart Association. 1997. 30 Mar. 1998 <http://www.americanheart.org>.

"Facts About Arrhythmias/Rhythm Disorders." National Institutes of Health. 30 Mar. 1998 <http://www.nhlbi.nih.gov/nhlbi/cardio/other/gp/arrhyth.htm>.

"Understanding Your Arrythmia." Deborah Heart and Lung Center. 30 Mar. 1998 <http://www/deborah.org/consumer/arr_atrial.html>.

Lori De Milto

Atrial flutter *see* **Atrial fibrillation and flutter**

Atrial septal defect

Definition

An atrial septal defect is an abnormal opening in the wall separating the left and right upper chambers (atria) of the heart.

Description

During the normal development of the fetal heart, there is an opening in the wall (the septum) separating the left and right upper chambers of the heart. Normally, this opening closes before birth, but if it does not, the child is born with a hole between the left and right atria. This abnormal opening is called an atrial septal defect and causes blood from the left atrium to flow into the right atrium.

Different types of atrial septal defects can occur, and they are classified according to where in the separating wall they are found. The most commonly found atrial septal defect occurs in the middle of the atrial septum and accounts for about 70% of all atrial septal defects. Abnormal openings can form in the upper and lower parts of the atrial septum as well.

Causes and symptoms

Abnormal openings in the atrial septum occur during fetal development and are twice as common in females as in males. These abnormalities can go unnoticed if the opening is small, producing no abnormal symptoms. If the defect is big, large amounts of blood flowing from the left to the right atrium will cause the right atrium to swell to hold the extra blood.

People born with an atrial septal defect can have no symptoms through their twenties, but by age 40, most people with this condition have symptoms that can include **shortness of breath**, rapid abnormal beating of the atria (atrial fibrillation), and eventually **heart failure**.

Diagnosis

Atrial septal defects can be identified by various methods. Abnormal changes in the sound of the heart beats can be heard when a doctor listens to the heart with a stethoscope. In addition, a **chest x ray**, an electrocardiogram (ECG, an electrical printout of the heartbeats), and an echocardiogram (a test that uses sound waves to form a detailed image of the heart) can also be used to identify this condition.

An atrial septal defect can also be diagnosed by using a test called **cardiac catheterization**. This test involves

KEY TERMS

Cardiac catheterization—A test that involves having a tiny tube inserted into the heart through a blood vessel.

Dacron—A synthetic polyester fiber used to surgically repair damaged sections of heart muscle and blood vessel walls.

Echocardiogram—A test that uses sound waves to generate an image of the heart, its valves, and chambers.

inserting a very thin tube (catheter) into the heart's chambers to measure the amount of oxygen present in the blood within the heart. If the heart has an opening between the atria, oxygen-rich blood from the left atrium enters the right atrium. Through cardiac catheterization, doctors can detect the higher-than-normal amount of oxygen in the heart's right atrium, right ventricle, and the large blood vessels that carry blood to the lungs, where the blood would normally subsequently get its oxygen.

Treatment

Atrial septal defects often correct themselves without medical treatments by the age of two. If this dose not happen, surgery is done by sewing the hole closed, or by sewing a patch of Dacron material or a piece of the sac that surrounds the heart (the pericardium), over the opening.

Some patients can have the defect fixed by having an clam-shaped plug placed over the opening. This plug is a man-made device that is put in place through a catheter inserted into the heart.

Prognosis

Individuals with small defects can live a normal life, but larger defects require surgical correction. Less than 1% of people younger than 45 years of age die from corrective surgery. Five to ten percent of patients can die from the surgery if they are older than 40 and have other heart-related problems. When an atrial septal defect is corrected within the first 20 years of life, there is an excellent chance for the individual to live normally.

Resources

BOOKS

"Congenital Heart Disease." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, Inc., 1996.

"If Your Child Has A Congenital Heart Defect." In *Cardiovascular Diseases and Disorders Sourcebook*, ed. Karen Bellenir and Peter D. Dresser. Detroit: Omnigraphics, Inc., 1995.

Friedman, William F., and John S. Child. "Congenital Heart Disease in the Adult." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw Hill, 1997.

Nugent, Elizabeth W., et al. "The Pathology, Pathophysiology, Recognition, and Treatment of Congenital Heart Disease." In *Hurst's The Heart*, ed. Robert C. Schlant, et al. New York: McGraw Hill, 1994.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dominic De Bellis, PhD

Atrioventricular block *see* **Heart block**

Attapulgite *see* **Antidiarrheal drugs**

Attention-deficit/hyperactivity disorder (ADHD)

Definition

Attention-deficit/hyperactivity disorder (ADHD) is a developmental disorder characterized by distractibility, hyperactivity, impulsive behaviors, and the inability to remain focused on tasks or activities.

Description

ADHD, also known as hyperkinetic disorder (HKD) outside of the United States, is estimated to affect 3-9% of children, and afflicts boys more often than girls. Although difficult to assess in infancy and toddlerhood, signs of ADHD may begin to appear as early as age two or three, but the symptom picture changes as adolescence approaches. Many symptoms, particularly hyperactivity, diminish in early adulthood, but impulsivity and inattention problems remain with up to 50% of ADHD individuals throughout their adult life.

Children with ADHD have short attention spans, becoming easily bored and/or frustrated with tasks. Although they may be quite intelligent, their lack of focus frequently results in poor grades and difficulties in school. ADHD children act impulsively, taking action first and thinking later. They are constantly moving, running, climbing, squirming, and fidgeting, but often have trouble with gross and fine motor skills and, as a result, may be

physically clumsy and awkward. Their clumsiness may extend to the social arena, where they are sometimes shunned due to their impulsive and intrusive behavior.

Causes and symptoms

The causes of ADHD are not known. However, it appears that heredity plays a major role in the development of ADHD. Children with an ADHD parent or sibling are more likely to develop the disorder themselves. Before birth, ADHD children may have been exposed to poor maternal **nutrition**, viral infections, or maternal substance abuse. In early childhood, exposure to lead or other toxins can cause ADHD-like symptoms. Traumatic brain injury or neurological disorders may also trigger ADHD symptoms. Although the exact cause of ADHD is not known, an imbalance of certain neurotransmitters, the chemicals in the brain that transmit messages between nerve cells, is believed to be the mechanism behind ADHD symptoms.

A widely publicized study conducted by Dr. Ben Feingold in the early 1970s suggested that **allergies** to certain foods and food additives caused the characteristic hyperactivity of ADHD children. Although some children may have adverse reactions to certain foods that can affect their behavior (for example, a rash might temporarily cause a child to be distracted from other tasks), carefully controlled follow-up studies have uncovered no link between food allergies and ADHD. Another popularly held misconception about food and ADHD is that the consumption of sugar causes hyperactive behavior. Again, studies have shown no link between sugar intake and ADHD. It is important to note, however, that a nutritionally balanced diet is important for normal development in *all* children.

Psychologists and other mental health professionals typically use the criteria listed in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)* as a guideline for determining the presence of ADHD. For a diagnosis of ADHD, *DSM-IV* requires the presence of at least six of the following symptoms of inattention, or six or more symptoms of hyperactivity and impulsivity combined:

Inattention:

- fails to pay close attention to detail or makes careless mistakes in schoolwork or other activities
- has difficulty sustaining attention in tasks or activities
- does not appear to listen when spoken to
- does not follow through on instructions and does not finish tasks
- has difficulty organizing tasks and activities
- avoids or dislikes tasks that require sustained mental effort (e.g., homework)
- is easily distracted
- is forgetful in daily activities

Hyperactivity:

- fidgets with hands or feet or squirms in seat
- does not remain seated when expected to
- runs or climbs excessively when inappropriate (in adolescence and adults, feelings of restlessness)
- has difficulty playing quietly
- is constantly on the move
- talks excessively

Impulsivity:

- blurts out answers before the question has been completed
- has difficulty waiting for his or her turn
- interrupts and/or intrudes on others

DSM-IV also requires that some symptoms develop before age seven, and that they significantly impair functioning in two or more settings (e.g., home and school) for a period of at least six months. Children who meet the symptom criteria for inattention, but not for hyperactivity/impulsivity are diagnosed with Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type, commonly called ADD. (Young girls with ADHD may not be diagnosed because they have mainly this subtype of the disorder.)

Diagnosis

The first step in determining if a child has ADHD is to consult with a pediatrician. The pediatrician can make an initial evaluation of the child's developmental maturity compared to other children in his or her age group. The physician should also perform a comprehensive **physical examination** to rule out any organic causes of ADHD symptoms, such as an overactive thyroid or vision or hearing problems.

If no organic problem can be found, a psychologist, psychiatrist, neurologist, neuropsychologist, or learning specialist is typically consulted to perform a comprehensive ADHD assessment. A complete medical, family, social, psychiatric, and educational history is compiled from existing medical and school records and from interviews with parents and teachers. Interviews may also be conducted with the child, depending on his or her age. Along with these interviews, several clinical inventories may also be used, such as the Conners Rating Scales (Teacher's Questionnaire and Parent's Ques-

Drugs Used To Treat ADHD

Brand Name (Generic Name)	Possible Common Side Effects Include:
Cylert (pemoline)	Insomnia
Dexedrine (dextroamphetamine sulfate)	Excessive stimulation, restlessness
Ritalin (methylphenidate hydrochloride)	Insomnia, nervousness, loss of appetite

tionnaire), Child Behavior Checklist (CBCL), and the Achenbach Child Behavior Rating Scales. These inventories provide valuable information on the child's behavior in different settings and situations. In addition, the Wender Utah Rating Scale has been adapted for use in diagnosing ADHD in adults.

It is important to note that mental disorders such as depression and **anxiety** disorder can cause symptoms similar to ADHD. A complete and comprehensive psychiatric assessment is critical to differentiate ADHD from other possible mood and behavioral disorders. **Bipolar disorder**, for example, may be misdiagnosed, as ADHD.

Public schools are required by federal law to offer free ADHD testing upon request. A pediatrician can also provide a referral to a psychologist or pediatric specialist for ADHD assessment. Parents should check with their insurance plans to see if these services are covered.

Treatment

Psychosocial therapy, usually combined with medications, is the treatment approach of choice to alleviate ADHD symptoms. Psychostimulants, such as dextroamphetamine (Dexedrine), pemoline (Cylert), and methylphenidate (Ritalin) are commonly prescribed to control hyperactive and impulsive behavior and increase attention span. They work by stimulating the production of certain neurotransmitters in the brain. Possible side effects of stimulants include nervous tics, irregular heartbeat, loss of appetite, and **insomnia**. However, the medications are usually well-tolerated and safe in most cases.

In children who don't respond well to stimulant therapy, tricyclic antidepressants such as desipramine (Norpramin, Pertofane) and amitriptyline (Elavil) are frequently recommended. Reported side effects of these drugs include persistent **dry mouth**, **sedation**, disorientation, and cardiac arrhythmia (particularly with desipramine). Other medications prescribed for ADHD therapy include buproprion (Wellbutrin), an antidepressant; fluoxetine (Prozac), an SSRI antidepressant; and carbamazepine (Tegretol, Atretol), an anticonvulsant drug. Clonidine (Catapres), an antihypertensive medication, has also been used to control aggression and hyperactivity in some ADHD children, although it should not be used with Ritalin. A child's response to medication will change with age and maturation, so ADHD symptoms should be monitored closely and prescriptions adjusted accordingly.

Behavior modification therapy uses a reward system to reinforce good behavior and task completion and can be implemented both in the classroom and at home. A tangible reward such as a sticker may be given to the child every time he completes a task or behaves in an acceptable manner. A chart system may be used to display the stickers and visually illustrate the child's progress. When a certain number of stickers are collected, the child may trade them in for a bigger reward such as a trip to the zoo or a day at the beach. The reward system stays in place until the good behavior becomes ingrained.

A variation of this technique, **cognitive-behavioral therapy**, works to decrease impulsive behavior by getting the child to recognize the connection between thoughts and behavior, and to change behavior by changing negative thinking patterns.

Individual psychotherapy can help an ADHD child build self-esteem, give them a place to discuss their worries and anxieties, and help them gain insight into their behavior and feelings. **Family therapy** may also be beneficial in helping family members develop coping skills and in working through feelings of guilt or anger parents may be experiencing.

ADHD children perform better within a familiar, consistent, and structured routine with positive reinforcements for good behavior and real consequences for bad. Family, friends, and caretakers should all be educated on the special needs and behaviors of the ADHD child. Communication between parents and teachers is especially critical to ensuring an ADHD child has an appropriate learning environment.

Alternative treatment

A number of alternative treatments exist for ADHD. Although there is a lack of controlled studies to prove their efficacy, proponents report that they are successful in controlling symptoms in some ADHD patients. Some of the more popular alternative treatments include:

KEY TERMS

Conduct disorder—A behavioral and emotional disorder of childhood and adolescence. Children with a conduct disorder act inappropriately, infringe on the rights of others, and violate societal norms.

Nervous tic—A repetitive, involuntary action, such as the twitching of a muscle or repeated blinking.

Oppositional defiant disorder—A disorder characterized by hostile, deliberately argumentative, and defiant behavior towards authority figures.

- EEG (electroencephalograph) **biofeedback**. By measuring brainwave activity and teaching the ADHD patient which type of brainwave is associated with attention, EEG biofeedback attempts to train patients to generate the desired brainwave activity.
- Dietary therapy. Based in part on the Feingold food allergy diet, dietary therapy focuses on a nutritional plan that is high in protein and complex carbohydrates and free of white sugar and salicylate-containing foods such as strawberries, tomatoes, and grapes.
- Herbal therapy. Herbal therapy uses a variety of natural remedies to address the symptoms of ADHD, such as ginkgo (*Gingko biloba*) for memory and mental sharpness and chamomile (*Matricaria recutita*) extract for calming. The safety of herbal remedies has not been demonstrated in controlled studies. For example, it is known that gingko may affect blood coagulation, but controlled studies have not yet evaluated the risk of the effect.
- Homeopathic medicine. This is probably the most effective alternative therapy for ADD and ADHD because it treats the whole person at a core level. Constitutional homeopathic care is most appropriate and requires consulting with a well-trained homeopath who has experience working with ADD and ADHD individuals.

Prognosis

Untreated, ADHD negatively affects a child's social and educational performance and can seriously damage his or her sense of self-esteem. ADHD children have impaired relationships with their peers, and may be looked upon as social outcasts. They may be perceived as slow learners or troublemakers in the classroom. Siblings and even parents may develop resentful feelings towards the ADHD child.

Some ADHD children also develop a **conduct disorder** problem. For those adolescents who have both ADHD and a conduct disorder, up to 25% go on to develop antisocial personality disorder and the criminal behavior, substance abuse, and high rate of suicide attempts that are symptomatic of it. Children diagnosed with ADHD are also more likely to have a learning disorder, a mood disorder such as depression, or an anxiety disorder.

Approximately 70-80% of ADHD patients treated with stimulant medication experience significant relief from symptoms, at least in the short-term. Approximately half of ADHD children seem to "outgrow" the disorder in adolescence or early adulthood; the other half will retain some or all symptoms of ADHD as adults. With early identification and intervention, careful compliance with a treatment program, and a supportive and nurturing home and school environment, ADHD children can flourish socially and academically.

Resources

BOOKS

Alexander-Roberts, Colleen. *The ADHD Parenting Handbook: Practical Advice for Parents from Parents*. Dallas: Taylor Publishing Co., 1994.

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Hallowell, Edward M., and John J. Ratey. *Driven to Distraction*. New York: Pantheon Books, 1994.

Kennedy, Patricia, Leif Terdal, and Lydia Fusetti. *The Hyperactive Child Book*. New York: St. Martin's Press, 1993.

Maxmen, Jerrold S., and Nicholas G. Ward. "Disorders Usually First Diagnosed in Infancy, Childhood, or Adolescence." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Osman, Betty B. *Learning Disabilities and ADHD: A Family Guide to Living and Learning Together.* New York: John Wiley & Sons, 1997.

PERIODICALS

Glicken, Anita D. "Attention Deficit Disorder and the Pediatric Patient: A Review." *Physician Assistant* 21, no. 4 (Apr. 1997):101-11.

Hallowell, Edward M. "What I've Learned from A.D.D." *Psychology Today* 30, no. 3 (May/June 1997): 40-6.

Swanson, J. M., et al. "Attention-deficit Hyperactivity Disorder and Hyperkinetic Disorder." *The Lancet* 351 (7 Feb. 1997): 429-33.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry. (AACAP). 3615 Wisconsin Ave. NW, Washington, DC 20016. (202) 966-7300. <http://www.aacap.org>.

Children and Adults with Attention Deficit Disorder (CH.A.D.D.). 8181 Professional Place, Suite 201, Plantation, FL 33317. (800) 233-4050. <http://www.chadd.org>.

An audiologist conducting a hearing test. *(Custom Medical Stock Photo. Reproduced by permission.)*

The National Attention Deficit Disorder Association. (ADDA). 9930 Johnnycake Ridge Road, Suite 3E, Mentor, OH 44060. (800) 487-2282. <http://www.add.org>.

Paula Anne Ford-Martin

Attention deficit disorder *see* **Attention-deficit/Hyperactivity disorder (ADHD)**

Atypical mycobacterial infections *see* **Mycobacterial infections, atypical**

Atypical pneumonia *see* **Mycoplasma infections**

Audiometry

Definition

Audiometry is the testing of a person's ability to hear various sound frequencies. The test is performed with the use of electronic equipment called an audiometer. This testing is usually administered by a trained technician called an audiologist.

Purpose

Audiometry testing is used to identify and diagnose **hearing loss**. The equipment is used in health screening programs, for example in grade schools, to detect hearing problems in children. It is also used in the doctor's office or hospital audiology department to diagnose hearing problems in children, adults, and the elderly. With correct diagnosis of a person's specific pattern of hearing impairment, the right type of therapy, which might include **hearing aids**, corrective surgery, or speech therapy, can be prescribed.

Precautions

Testing with audiometry equipment is simple and painless. No special precautions are required.

Description

A trained audiologist (a specialist in detecting hearing loss) uses an audiometer to conduct audiometry testing. This equipment emits sounds or tones, like musical notes, at various frequencies, or pitches, and at differing volumes or levels of loudness. Testing is usually done in a soundproof testing room.

The person being tested wears a set of headphones that blocks out other distracting sounds and delivers a test tone to one ear at a time. At the sound of a tone, the patient holds up a hand or finger to indicate that the sound is detected. The audiologist lowers the volume and repeats the sound until the patient can no longer detect it. This process is repeated over a wide range of tones or frequencies from very deep, low sounds, like the lowest note played on a tuba, to very high sounds, like the pinging of a triangle. Each ear is tested separately. It is not unusual for levels of sensitivity to sound to differ from one ear to the other.

A second type of audiometry testing uses a headband rather than headphones. The headband is worn with small plastic rectangles that fit behind the ears to conduct sound through the bones of the skull. The patient being tested senses the tones that are transmitted as vibrations through the bones to the inner ear. As with the headphones, the tones are repeated at various frequencies and volumes.

The results of the audiometry test may be recorded on a grid or graph called an audiogram. This graph is generally set up with low frequencies or tones at one end and high ones at the other end, much like a piano keyboard. Low notes are graphed on the left and high notes on the right. The graph also charts the volume of the tones used; from soft, quiet sounds at the top of the chart to loud sounds at the bottom. Hearing is measured in units called decibels. Most of the sounds associated with normal speech patterns are generally spoken in the range of 20-50 decibels. An adult with normal hearing can detect tones between 0-20 decibels.

Speech audiometry is another type of testing that uses a series of simple recorded words spoken at various volumes into headphones worn by the patient being tested. The patient repeats each word back to the audiologist as it is heard. An adult with normal hearing will be able to recognize and repeat 90-100% of the words.

KEY TERMS

Audiogram—A chart or graph of the results of a hearing test conducted with audiographic equipment. The chart reflects the softest (lowest volume) sounds that can be heard at various frequencies or pitches.

Decibel—A unit of measure for expressing the loudness of a sound. Normal speech is typically spoken in the range of about 20-50 decibels.

Otoscope—A hand-held instrument with a tiny light and a funnel-shaped attachment called an ear speculum, which is used to examine the ear canal and eardrum.

Preparation

The ears may be examined with an otoscope prior to audiometry testing to determine if there are any blockages in the ear canal due to ear wax or other material.

Normal results

A person with normal hearing will be able to recognize and respond to all of the tone frequencies administered at various volumes in both ears by the audiometry test. An adult with normal hearing can detect a range of low and high pitched sounds that are played as softly as between nearly 0-20 decibels. Normal speech is generally spoken in the range of 20-50 decibels.

Abnormal results

Audiometry test results are considered abnormal if there is a significant or unexplained difference between the levels of sound heard between the two ears, or if the person being tested is unable to hear in the normal range of frequencies and volume. The pattern of responses displayed on the audiogram can be used by the audiologist to identify if a significant hearing loss is present and if the patient might benefit from hearing aids or corrective surgery.

Resources

BOOKS

"Clinical Evaluation of Complaints Referable to the Ears." In *The Merck Manual*. 17th ed. Ed. Robert Berkow. Rahway NJ: Merck & Co., Inc., 1996.

"Pure-Tone Audiometry." In *The Yale University Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin Co., 1997.

ORGANIZATIONS

American Academy of Audiology. 8201 Greensboro Drive, Suite 300, McLean, VA 22102. (703) 610-9022. <http://audiology.org>.

Audiology Awareness Campaign. 3008 Millwood Ave., Columbia, SC 29205. (800) 445-8629.

OTHER

"How to Read Your Hearing Test." *Hearing Alliance of America*. <http://www.earinfo.com>.

"Understanding Your Audiogram." *The League for the Hard of Hearing*. <http://www.lhh.org>.

Altha Roberts Edgren

Auditory integration training

Definition

Auditory integration training, or AIT, is one specific type of music/auditory therapy based upon the work of French otolaryngologists Dr. Alfred Tomatis and Dr. Guy Berard.

Origins

The premise upon which most auditory integration programs are based is that distortion in how things are heard contributes to commonly seen behavioral or learning disorders in children. Some of these disorders include **attention deficit/hyperactive disorder** (ADHD), **autism**, dyslexia, and central auditory processing disorders (CAPD). Training the patient to listen can stimulate central and cortical organization.

Auditory integration is one facet of what audiologists call central auditory processing. The simplest definition of central auditory processing, or CAP, is University of Buffalo Professor of Audiology Jack Katz's, which is: "What we do with what we hear." Central auditory integration is actually the perception of sound, including the ability to attend to sound, to remember it, retaining it in both the long- and short-term memory, to be able to listen to sound selectively, and to localize it.

Guy Berard developed one of the programs commonly used. Berard's auditory integration training consists of twenty half-hour sessions spent listening to musical sounds via a stereophonic system. The music is random, with filtered frequencies, and the person listens through earphones. These sound waves vibrate and exercise structures in the middle ear. This is normally done in sessions twice a day for 10 days.

ALFRED TOMATIS (1920–)

(Photograph by V. Brynner. Gamma Liaison. Reproduced by permission.)

Internationally renowned French otolaryngologist, psychologist, educator and inventor Alfred Tomatis perceived the importance of sound and hearing early in his career. He took his degree as a Doctor of Medicine from the University of Paris and specialized in ear, nose and throat medicine. The son of two opera singers, Tomatis early in his career treated some of his parents' fellow opera singers. From these experiences with the sound of music, he developed the principle that has come to be known as the Tomatis Effect, i.e. that the human voice can only sing what it hears.

Tomatis has been called the Einstein of the ear. It was his research that made the world aware that the ears of an infant in utero are already functioning at four and half months of age. Just as the umbilical cord provides nourishment to the unborn infant's body, Tomatis postulated that the sound of the mother's voice is also a nutrient heard by the fetus. This sound literally charges and stimulates the growth of the brain.

Tomatis took this further, into the realm of language. Tomatis concluded that the need to communicate and to be understood are among our most basic needs. He was a pioneer in perceiving that language problems convert into social problems for people. "Language is what characterizes man and makes him different from other creatures," Tomatis is quoted as saying. The techniques he developed to teach people how to listen effectively are internationally respected tools used in the treatment of autism, attention-deficit disorder, and other learning disabilities.

His listening program, the invention of the Electronic Ear, and his work with the therapeutic use of sound and music for the past fifty years have made Tomatis arguably the best known and most successful ear specialist in the world. There are more than two hundred Tomatis Centers worldwide, treating a vast variety of problems related to the ability to hear.

Alfred Tomatis is also the inventor of the Electronic Ear. This device operates through a series of filters, and reestablishes the dominance of the right ear in hearing. The basis of Tomatis' work is a series of principles that follow:

- The most important purpose of the ear is to adapt sound waves into signals that charge the brain.
- Sound is conducted via both air and bone. It can be considered something that nourishes the nervous system, either stimulating or destimulating it.
- Just as seeing is not the same as looking, hearing is not the same as listening. Hearing is passive. Listening is active.
- A person's ability to listen affects all language development for that person. This process influences every aspect of self-image and social development.
- The capacity to listen can be changed or improved through auditory stimulation using musical and vocal sounds at high frequencies.
- Communication begins in the womb. As early as the beginning of the second trimester, fetuses can hear sounds. These sounds literally cause the brain and nervous system of the baby to develop.

Description

A quartet of CAP defects have been identified that can unfavorably alter how each person processes sound. Among these are:

- Phonetic decoding, a problem that occurs when the brain incorrectly decodes what is being heard. Sounds are unrecognizable, often because the person speaking talks too fast.
- Tolerance-fading memory, a condition with little or poor tolerance for background sounds.
- Auditory integration involves a person's ability to put together things heard with things seen. Characteristical-

ly there are long response delays and trouble with phonics, or recognizing the symbols for sounds.

- The fourth problem area, often called auditory organization, overlaps the previous three. It is characterized by disorganization in handling auditory and other information.

Certain audiological tests are carried out to see if the person has a CAP problem, and if so, how severe it is. Other tests give more specific information regarding the nature of the CAP problem. They include:

- Puretone air-conduction threshold testing, which measures peripheral hearing loss. If loss is found, then bone-conduction testing, or evaluation of the vibration of small bones in the inner ear, is also carried out.
- Word discrimination scores (WDS) determines a person's clarity in hearing ideal speech. This is done by presenting 25–50 words at 40 decibels above the person's average sound threshold in each ear. Test scores equal the percentage of words heard correctly.
- Immittance testing is made up of two parts, assessing the status of, and the protective mechanisms of the middle ear.
- Staggered sporadic word (SSW) testing delivers 40 compound words in an overlapping way at 50 decibels above threshold to each ear of the person being tested. This test provides expanded information that makes it possible to break down CAP problems into the four basic types.
- Speech in noise discrimination (SN) testing is similar to Staggered Sporadic Word testing except that other noise is also added and the percentage correct in quiet is compared with that correct when there is added noise.
- Phonemic synthesis (PS) determines serious learning problems. The types of errors made in sounding out written words or associating written letters with the sounds they represent help in determining the type and severity of CAP problems.

Purpose

Upon completion of an auditory integration training program, the person's hearing should be capable of perceiving all frequencies at, or near, the same level. Total improvement from this therapy, in both hearing and behavior, can take up to one year.

Research and general acceptance

Auditory integration training is based upon newly learned information about the brain. Though brain structures and connections are predetermined, probably by heredity, another factor called *plasticity* also comes into play. Learning, we now know, continues from birth to death. Plasticity is the ability of the brain to actually change its structuring and connections through the process of learning.

Problems with auditory processing are now viewed as having a wide–reaching ripple effect on our society. It is estimated that 30–40% of children starting school have language-learning skills that can be described as poor. CAP difficulties are a factor in several different learning disabilities. They affect not only academic success, but also nearly every aspect of societal difficulties. One example to illustrate this is a 1989 University of Buffalo study where CAP problems were found to be present in a surprising 97% of youth inmates in an upstate New York corrections facility.

Resources

BOOKS

Katz, Jack, Ph.D., Wilma Laufer Gabbay, M.S., Deborah S. Ungerleider, M.A., and Lorin Wilde, M.S. *Handbook of Clinical Audiology.* Waverly Press, Inc., 1985.

PERIODICALS

Katz, Jack, Ph.D. "Central Auditory Processing Evaluation." (1996).

Masters, M. Gay. "Speech and Language Management of CAPD." (1996).

Musiek, Frank, Ph.D. "Auditory Training: An Eclectic Approach." *American Journal of Audiology* (1995).

OTHER

Cooper, Rachel. "What is Auditory Integration Training?" <http://www.vision3d.com/adhd/>. (December 2000).

Dejean, Valerie. *About the Tomatis Method,1997.* Tomatis Auditory Training Spectrum Center, Bethseda, MD.

Masters, M. Gay and Jack Stecker Katz, N.A. *Central Auditory Processing Disorders: Characteristic Difficulties.* Miniseminar, 1994.

The Spectrum Center. "Auditory Integration and Alfred Tomatis." <http://listeningtraining.com/>. (December 2000).

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Australia antigen-associated hepatitis *see* **Hepatitis B**

Autism

Definition

Autism is a severe disorder of brain function marked by problems with social contact, intelligence and lan-

guage, together with ritualistic or compulsive behavior and bizarre responses to the environment.

Description

Autism is a lifelong disorder that interferes with the ability to understand what is seen, heard, and touched. This can cause profound problems in personal behavior and in the ability to relate to others. A person with autism must learn how to communicate normally and how to relate to people, objects and events. However, not all patients suffer the same degree of impairment. There is a full spectrum of symptoms, which can range from mild to severe.

Autism occurs in as many as one or two per 1,000 children. It is found four times more often in boys (usually the first-born) and occurs around the world in all races and social backgrounds. Autism usually is evident in the first three years of life, although in some children it's hard to tell when the problem develops. Sometimes the condition isn't diagnosed until the child enters school.

While a person with autism can have symptoms ranging from mild to severe, about 10% have an extraordinary ability in one area, such as in mathematics, memory, music, or art. Such children are known as "autistic savants" (formerly known as "idiot savants.").

Causes and symptoms

Autism is a brain disorder that affects the way the brain uses or transmits information. Studies have found abnormalities in several parts of the brain that almost certainly occurred during fetal development. The problem may be centered in the parts of the brain responsible for processing language and information from the senses.

There appears to be a strong genetic basis for autism. Identical twins are more likely to both be affected than twins who are fraternal (not genetically identical). In a family with one autistic child, the chance of having another child with autism is about 1 in 20, much higher than in the normal population. Sometimes, relatives of an autistic child have mild behaviors that look very much like autism, such as repetitive behaviors and social or communication problems. Research also has found that some emotional disorders (such as manic depression) occur more often in families of a child with autism.

At least one group of researchers has found a link between an abnormal gene and autism. The gene may be just one of at least three to five genes that interact in some way to cause the condition. Scientists suspect that a faulty gene or genes might make a person vulnerable to develop autism in the presence of other factors, such as a chemical imbalance, viruses or chemicals, or a lack of oxygen at birth.

In a few cases, autistic behavior is caused by a disease such as:

- **rubella** in the pregnant mother
- tuberous sclerosis
- **fragile X syndrome**
- encephalitis
- untreated **phenylketonuria**.

The severity of the condition varies between individuals, ranging from the most severe (extremely unusual, repetitive, self- injurious, and aggressive behavior) to very mild, resembling a personality disorder with some learning disability.

Profound problems with social interaction are the most common symptoms of autism. Infants with the disorder won't cuddle; they avoid eye contact and don't seem to want or need physical contact or affection. They may become rigid or flaccid when they are held, cry when picked up, and show little interest in human contact. Such a child doesn't smile or lift his arms in anticipation of being picked up. He forms no attachment to parents nor shows any normal **anxiety** toward strangers. He doesn't learn typical games of childhood, such as peek-a-boo.

Language problems

The child with autism may not speak at all; if he does, it is often in single words. He may endlessly repeat words or phrases that are addressed to him and may reverse pronouns ("You go sleep" instead of "I want to go to sleep").

Restricted interests and activity

Usually a child with autism has many problems playing normally. He probably won't act out adultroles during play time, and instead of enjoying fantasy play, he may simply repeatedly mimic the actions of someone else. Bizarre behavior patterns are very common among autistic children and may include complex rituals, screaming fits, rhythmic rocking, arm flapping, finger twiddling, and crying without tears. Autistic children may play with their own saliva, feces or urine.They may be self-destructive, biting their own hands, gouging at their eyes, pulling their hair, or banging their head.

Sensory problems

The sensory world poses a real problem to many autistic children, who seem overwhelmed by their own senses. A child with autism may ignore objects or

This autistic child is encouraged to interact with the guinea pig in an effort to improve his social interaction. *(Helen B. Senisi. Photo Researchers, Inc. Reproduced by permission.)*

become obsessed with them, continually watching the object or the movement of his fingers over it. Many of these children may react to sounds by banging their head or flapping fingers. Some high-functioning autistic adults who have written books about their childhood experiences report that sounds were often excruciatingly painful to them, forcing them to withdraw from their environment or try to cope by withdrawing into their own world of sensation and movement.

Intellectual problems

Most autistic children appear to be moderately mentally retarded. They may giggle or cry for no reason, have no fear of real danger, but exhibit terror of harmless objects.

Diagnosis

There is no medical test for autism. Because the symptoms of autism are so varied, the condition may go undiagnosed for some time (especially in those with mild cases or if other handicaps are also present). It may be confused with other diseases, such as fragile X syndrome, tuberous sclerosis, and untreated phenylketonuria.

Autism is diagnosed by observing the child's behavior, communication skills, and social interactions. Medical tests should rule out other possible causes of autistic symptoms. Criteria that mental health experts use to diagnose autism include:

- problems with developing friendships
- problems with make-believe or social play
- endlessly repeated words or strings of words
- difficulty in carrying on a conversation
- obsessions with rituals or restricted patterns
- preoccupation with parts of objects

Some children have a few of the symptoms of autism, but not enough to be diagnosed with the "classical" form of the condition. Children who have autistic behavior but no problems with language may be diagnosed with "Asperger syndrome." Children who seem normal at first but who begin to show autistic behavior as they get older might be diagnosed with "childhood disintegrative disorder" (CDD). These problems are sometimes called "autistic spectrum disorders." It is also important to rule out other problems that seem similar to autism.

KEY TERMS

Antidepressants—A type of medication that is used to treat depression; it is also sometimes used to treat autism.

Asperger syndrome—Children who have autistic behavior but no problems with language.

Encephalitis—A rare inflammation of the brain caused by a viral infection. It has been linked to the develoment of autism.

Fragile X syndrome—A genetic condition related to the X chromosome that affects mental, physical and sensory development.

Major tranquilizers—The family of drugs that includes the psychotropic or neuroleptic drugs, sometimes used to help autistic people. They carry significant risk of side effects, including Parkinsonism and movement disorders, and should be prescribed with caution.

Opiate blockers—A type of drug that blocks the effects of natural opiates in the system. This makes some people, including some people with autism, appear more responsive to their environment.

Phenylketonuria (PKU)—An enzyme deficiency present at birth that disrupts metabolism and causes brain damage. This rare inherited defect may be linked to the development of autism.

Rubella—Also known as German measles. When a woman contracts rubella during pregnancy, her developing infant may be damaged. One of the problems that may result is autism.

Stimulants—A class of drugs, including Ritalin, used to treat people with autism. They may make children calmer and better able to concentrate, but they also may limit growth or have other side effects.

Tuberous sclerosis—A genetic disease that causes skin problems, seizures, and mental retardation. It may be confused with autism.

Treatment

There is no cure for autism. Treatments are aimed at reducing specific symptoms. Because the symptoms vary so widely from one person to the next, there is not a single approach that works for every person. A spectrum of interventions include training in music, listening, vision, speech and language, and senses. Special **diets** and medications may also be prescribed.

Studies show that people with autism can improve significantly with proper treatment. A child with autism can learn best with special teachers in a structured program that emphasizes individual instruction. The two most-often studied types of treatment are:

Educational or behavioral treatment

Typically, behavioral techniques are used to help the child respond and decrease symptoms. This might include positive reinforcement (food and rewards) to boost language and social skills. This training includes structured, skill-oriented instruction designed to boost social and language abilities. Training needs to begin as early as possible, since early intervention appears to influence brain development.

Most experts believe that modern treatment is most effective when carried out at home, although treatment may also take place in a psychiatric hospital, specialized school, or day care program.

Medication

No single medication has yet proved highly effective for the major features of autism. However, a variety of drugs can control self-injurious, aggressive, and other of the more difficult behaviors. Drugs also can control epilepsy, which afflicts up to 20% of people with autism.

Five types of drugs are sometimes prescribed to help the behavior problems of people with autism:

- stimulants, such as methylphenidate (Ritalin)
- antidepressants, such as fluroxamine (Luvox)
- opiate blockers, such as naltrexone (ReVia)
- antipsychotics
- tranquilizers

Today, most experts recommend a complex treatment regimen that begins early and continues through the teenage years. Behavioral therapies are used in conjunction with medications.

Alternative treatment

Many parents report success with megavitamin therapy. Some studies have shown that vitamin B_6 improves

eye contact and speech and lessens tantrum behavior. Vitamin B_6 causes fewer side effects than other medications and is considered safe when used in appropriate doses. However, not many health practitioners advocate its use in the treatment of autism, citing that the studies showing its benefit were flawed.

DMG (dimethylglycine)

This compound, available in many health food stores, is legally classified as a food, not a vitamin or drug. Some researchers claim that it improves speech in children with autism. Those who respond to this treatment will usually do so within a week. Again, many doctors do not feel that the studies are adequate to promote this treatment.

Exercise

One researcher found that vigorous **exercise** (20 minutes or longer, three or four days a week) seems to decrease hyperactivity, aggression, self-injury and other autistic symptoms.

Prognosis

While there is no cure, with appropriate treatment the negative behaviors of autism may improve. Earlier generations placed autistic children in institutions; today, even severely disabled children can be helped in a less restrictive environment to develop to their highest potential. Many can eventually become more responsive to others as they learn to understand the world around them, and some can lead nearly normal lives.

People with autism have a normal life expectancy. Some people with autism can handle a job; they do best with structured jobs that involve a degree of repetition.

Prevention

Until the cause of autism is discovered, prevention is not possible.

Resources

BOOKS

Barron, Sean, and Judy Barron. *There's a Boy in Here*. New York: Simon & Schuster, 1992.

Bratt, Berneen. *No Time for Jello*. Cambridge, MA: Brookline Books, 1989.

Cohen, Donald J., and Fred R. Volkmar. *Handbook of Autism and Pervasive Developmental Disorders*. John Wiley & Sons, 1997.

Cohen, Shirley. *Targeting Autism: What We Know, Don't Know, and Can Do to Help Young Children with Autism and Related Disorders*. Berkeley: University of California Press, 1998.

Grandin, Temple. *Emergence: Labeled Autistic*. Novato, Ca: Arena Press, 1986.

Greenfield, Josh. *A Child Called Noah*. New York: Holt, Rinehart and Winston, 1971.

Hart, Charles. *A Parent's Guide to Autism: Answers to the Most Common Questions*. New York: Pocket Books, 1993.

Kaufman, Barry Neil. *Son-Rise*. New York: Harper & Row, 1976.

Williams, Donna. *Nobody Nowhere*. New York: Times Books/Random House, 1992.

PERIODICALS

Cook, E. H., et. al. "Fluoxetine Treatment in Children and Adults with Autistic Disorder and Mental Retardation." *Journal of the American Academy of Child and Adolescent Psychiatry* 31 (1992): 739-45.

"How to Tell Asperger's from Autism." *Brown University Child and Adolescent Behavior Letter* 12/1 (Jan. 1996): 1-2.

Rimland, Bernard. "DMG, A Nontoxic Metabolite, and Autism." *Autism Research Review International* 4/2 (1996).

Roeder, Jason. "Can Medication Change Behavior in Autism?" *The Exceptional Parent* 25/11 (Nov. 1995): 50-54.

Shapiro, Joseph. "Beyond the Rain Main: A Singular Woman Changes the Cattle Industry and Our Image of Autism." *U.S. News & World Report* 120/21 (27 May 1996): 78-79.

Wing, Lorna. "Autism spectrum." *The Lancet* 350/9093 (13 Dec. 1997): 1761-1767.

ORGANIZATIONS

Autism Society of America. 7910 Woodmont Avenue, Suite 300, Bethesda, Maryland 20814-3067. (800) 328-8476. <http://www.autism-society.org>.

Autism Network International. PO Box 448, Syracuse, NY 13210.

Autism Research Institute. 4182 Adams Ave., San Diego, CA 92116. (619) 281-7165.

National Autism Hotline. c/o Autism Services Center, PO Box 507, 605 Ninth St., Huntington, WV 25710. (304) 525-8014.

National Fragile X Foundation. PO Box 190488, San Francisco, CA 94119. (800) 688-8765. <http://www.nfxf.org>.

National Institute of Neurological Disorders and Stroke. PO Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

National Alliance for Autism Research. <naar@naar.org>.

OTHER

Autism Society of America. 7910 Woodmont Avenue. <http://www.autism-society.org>.

National Alliance for Autism Research (NAAR). <http://www.naar.org>.

National Information Center for Children and Youth with Disabilities. <http://www.nichcy.org/transitn.htm>.

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Autograft *see* **Skin grafting**

Autoimmune disorders

Definition

Autoimmune disorders are conditions in which a person's immune system attacks the body's own cells, causing tissue destruction.

Description

Autoimmunity is accepted as the cause of a wide range of disorders, and it is suspected to be responsible for many more. Autoimmune diseases are classified as either general, in which the autoimmune reaction takes place simultaneously in a number of tissues, or organ specific, in which the autoimmune reaction targets a single organ.

Autoimmune disorders include the following:

- **Systemic lupus erythematosus**. A general autoimmune disease in which antibodies attack a number of different tissues. The disease recurs periodically and is seen mainly in young and middle-aged women.
- **Rheumatoid arthritis**. Occurs when the immune system attacks and destroys the tissues that line bone joints and cartilage. The disease occurs throughout the body, although some joints may be more affected than others.
- Goodpasture's syndrome. Occurs when antibodies are deposited in the membranes of both the lung and kidneys, causing both inflammation of kidney glomerulus (**glomerulonephritis**) and lung bleeding. It is typically a disease of young males.
- Grave's disease. Caused by an antibody that binds to specific cells in the thyroid gland, causing them to make excessive amounts of thyroid hormone.
- Hashimoto's **thyroiditis**. Caused by an antibody that binds to cells in the thyroid gland. Unlike in Grave's disease, however, this antibody's action results in less thyroid hormone being made.
- Pemphigus vulgaris. A group of autoimmune disorders that affect the skin.
- **Myasthenia gravis**. A condition in which the immune system attacks a receptor on the surface of muscle cells, preventing the muscle from receiving nerve impulses and resulting in severe muscle weakness.
- **Scleroderma**. Also called CREST syndrome or progressive systemic sclerosis, scleroderma affects the connective tissue.
- Autoimmune **hemolytic anemia**. Occurs when the body produces antibodies that coat red blood cells.
- Autoimmune thrombocytopenic purpura. Disorder in which the immune system targets and destroys blood platelets.
- **Polymyositis** and Dermatomyositis. Immune disorders that affect the neuromuscular system.
- **Pernicious anemia**. Disorder in which the immune system attacks the lining of the stomach in such a way that the body cannot metabolize vitamin B_{12}.
- Sjögren's syndrome. Occurs when the exocrine glands are attacked by the immune system, resulting in excessive dryness.
- **Ankylosing spondylitis**. Immune system induced degeneration of the joints and soft tissue of the spine.
- **Vasculitis**. A group of autoimmune disorders in which the immune system attacks and destroys blood vessels.
- Type I **diabetes mellitus**. May be caused by an antibody that attacks and destroys the islet cells of the pancreas, which produce insulin.
- Amyotrophic lateral schlerosis. Also called Lou Gehrig's disease. An immune disorder that causes the **death** of neurons which leads to progressive loss of muscular control.
- Guillain-Barre syndrome. Also called infectious polyneuritis. Often occurring after an infection or an immunization (specifically Swine flu), the disease affects the myelin sheath, which coats nerve cells. It causes progressive muscle weakness and **paralysis**.
- **Multiple sclerosis**. An autoimmune disorder that may involve a virus affects the central nervous system, causing loss of coordination and muscle control.

Causes and symptoms

To further understand autoimmune disorders, it is helpful to understand the workings of the immune system. The purpose of the immune system is to defend the body against attack by infectious microbes (germs) and **foreign objects**. When the immune system attacks an invader, it is very specific—a particular immune system cell will only recognize and target one type of invader. To function properly, the immune system must not only develop this specialized knowledge of individual invaders, but it must also learn how to recognize and not destroy cells that belong to the body itself. Every cell carries protein markers on its surface that identifies it in one of two ways: what kind of cell it is (e.g. nerve cell, muscle cell, blood cell, etc.) and to whom that cell belongs. These markers are called major histocompatability complexes (MHCs). When functioning properly, cells of the immune system will not attack any other cell with markers identifying it as belonging to the

body. Conversely, if the immune system cells do not recognize the cell as "self," they attach themselves to it and put out a signal that the body has been invaded, which in turn stimulates the production of substances such as antibodies that engulf and destroy the foreign particles. In case of autoimmune disorders, the immune system cannot distinguish between "self" cells and invader cells. As a result, the same destructive operation is carried out on the body's own cells that would normally be carried out on bacteria, viruses, and other such harmful entities.

The reasons why immune systems become dysfunctional in this way is not well understood. However, most researchers agree that a combination of genetic, environmental, and hormonal factors play into autoimmunity. Researchers also speculate that certain mechanisms may trigger autoimmunity. First, a substance that is normally restricted to one part of the body, and therefore not usually exposed to the immune system, is released into other areas where it is attacked. Second, the immune system may mistake a component of the body for a similar foreign component. Third, cells of the body may be altered in some way, either by drugs, infection, or some other environmental factor, so that they are no longer recognizable as "self" to the immune system. Fourth, the immune system itself may be damaged, such as by a genetic mutation, and therefore cannot function properly.

Symptoms

The symptoms of the above disorders include:

- Systemic lupus erythematosus. Symptoms include **fever**, chills, **fatigue**, weight loss, skin **rashes** (particularly the classic "butterfly" rash on the face), vasculitis, polyarthralgia, patchy hair loss, sores in the mouth or nose, lymph-node enlargement, gastric problems, and, in women, irregular periods. About half of those who suffer from lupus develop cardiopulmonary problems, and some may also develop urinary problems. Lupus can also effect the central nervous system, causing seizures, depression, and psychosis.
- Rheumatoid arthritis. Initially may be characterized by a low-grade fever, loss of appetite, weight loss, and a generalized **pain** in the joints. The joint pain then becomes more specific, usually beginning in the fingers, then spreading to other areas, such as the wrists, elbows, knees, and ankles. As the disease progresses, joint function diminishes sharply and deformities occur, particularly the characteristic "swan's neck" curling of the fingers.
- Goodpasture's syndrome. Symptoms are similar to that of **iron deficiency anemia**, including fatigue and pallor. Symptoms involving the lungs may range from a **cough** that produces bloody sputum to outright hemorrhaging. Symptoms involving the urinary system include blood in the urine and/or swelling.
- Grave's disease. This disease is characterized by an enlarged thyroid gland, weight loss without loss of appetite, sweating, heart **palpitations**, nervousness, and an inability to tolerate heat.
- Hashimoto's thyroiditis. This disorder generally displays no symptoms.
- Pemphigus vulgaris. This disease is characterized by blisters and deep lesions on the skin.
- Myasthenia gravis. Characterized by fatigue and muscle weakness that at first may be confined to certain muscle groups, but then may progress to the point of paralysis. Myasthenia gravis patients often have expressionless faces as well as difficulty chewing and swallowing. If the disease progresses to the respiratory system, artificial respiration may be required.
- Scleroderma. Disorder is usually preceded by Raynaud's phenomenon. Symptoms that follow include pain, swelling, and stiffness of the joints, and the skin takes on a tight, shiny appearance. The digestive system also becomes involved, resulting in weight loss, appetite loss, **diarrhea**, **constipation**, and distention of the abdomen. As the disease progresses, the heart, lungs, and kidneys become involved, and malignant **hypertension** causes death in approximately 30% of cases.
- Autoimmune hemolytic anemia. May be acute or chronic. Symptoms include fatigue and abdominal tenderness due to an enlarged spleen.
- Autoimmune thrombocytopenic purpura. Characterized by pinhead-size red dots on the skin, unexplained **bruises**, bleeding from the nose and gums, and blood in the stool.
- Polymyositis and Dermatomyositis. In polymyositis, symptoms include muscle weakness, particularly in the shoulders or pelvis, that prevents the patient from performing everyday activities. In dermatomyositis, the same muscle weakness is accompanied by a rash that appears on the upper body, arms, and fingertips. A rash may also appear on the eyelids, and the area around the eyes may become swollen.
- Pernicious anemia. Signs of pernicious anemia include weakness, sore tongue, bleeding gums, and tingling in the extremities. Because the disease causes a decrease in stomach acid, nausea, vomiting, loss of appetite, weight loss, diarrhea, and constipation are possible. Also, because Vitamin B_{12} is essential for the nervous system function, the deficiency of it brought on by the disease can result in a host of neu-

rological problems, including weakness, lack of coordination, blurred vision, loss of fine motor skills, loss of the sense of taste, ringing in the ears, and loss of bladder control.

- Sjögren's syndrome. Characterized by excessive dryness of the mouth and eyes.
- Ankylosing spondylitis. Generally begins with lower back pain that progresses up the spine. The pain may eventually become crippling.
- Vasculitis. Symptoms depend upon the group of veins affected and can range greatly.
- Type I diabetes mellitus. Characterized by fatigue and an abnormally high level of glucose in the blood (hyperglycemia).
- Amyotrophic lateral schlerosis. First signs are stumbling and difficulty climbing stairs. Later, muscle cramps and twitching may be observed as well as weakness in the hands making fastening buttons or turning a key difficult. Speech may become slowed or slurred. There may also be diffic luty swallowing. As respiratory muscles atrophy, there is increased danger of aspiration or lung infection.
- Guillain-Barre syndrome. Muscle weakness in the legs occurs first, then the arms and face. Paresthesias (a prickly, tingling sensation) is also felt. This disorder affects both sides of the body and may involve paralysis and the muscles that control breathing.
- Multiple sclerosis. Like Lou Gehrig's disease, the first symptom may be clumsiness. Weakness or exhaustion is often reported, as well as blurry or double vision. There may be **dizziness**, depression, loss of bladder control, and muscle weakness so severe that the patient is confined to a wheelchair.

Diagnosis

A number of tests are involved in the diagnosis of autoimmune diseases, depending on the particular disease; e.g. blood tests, cerebrospinal fluid analysis, electromylogram (measures muscle function), and **magnetic resonance imaging** of the brain. Usually, these tests determine the location and extent of damage or involvement. They are useful in charting progress of the disease and as baselines for treatment.

The principle tool, however, for authenticating autoimmune disease is antibody testing. Such tests involve measuring the level of antibodies found in the blood and determining if they react with specific antigens that would give rise to an autoimmune reaction. An elevated amount of antibodies indicates that a humoral immune reaction is occurring. Since elevated antibody levels are also seen in common infections, they must be ruled out as the cause for the increased antibody levels.

Antibodies can also be typed by class. There are five classes of antibodies, and they can be separated in the laboratory. The class IgG is usually associated with autoimmune diseases. Unfortunately, IgG class antibodies are also the main class of antibody seen in normal immune responses.

The most useful antibody tests involve introducing the patient's antibodies to samples of his or her own tissue, usually thyroid, stomach, liver, and kidney tissue. If antibodies bind to the "self" tissue, it is diagnostic for an autoimmune disorder. Antibodies from a person without an autoimmune disorder would not react to "self" tissue.

Treatment

Treatment of autoimmune diseases is specific to the disease, and usually concentrates on alleviating or preventing symptoms rather than correcting the underlying cause. For example, if a gland involved in an autoimmune reaction is not producing a hormone such as insulin, administration of that hormone is required. Administration of a hormone, however, will restore the function of the gland damaged by the autoimmune disease.

The other aspect of treatment is controlling the inflammatory and proliferative nature of the immune response. This is generally accomplished with two types of drugs. Steroid compounds are used to control inflammation. There are many different steroids, each having side effects. The proliferative nature of the immune response is controlled with immunosuppressive drugs. These drugs work by inhibiting the replication of cells and, therefore, also suppress non-immune cells leading to side effects such as anemia.

Systemic **enzyme therapy** is a new treatment that is showing results for rheumatoid arthritis, multiple sclerosis, ankylosing spondylitis, and other inflammatory diseases. Enzymes combinations of pancreatin, trypsin, chymotrypsin, bromelain, and papain help stimulate the body's own defenses, accelerate inflammation in order to reduce swelling and improve circulation, and break up the immune complexes within the bloodstream. Symptoms have been reduced using this treatment.

Other treatments that hold some promise are irradiation of the spleen and **gene therapy**. Splenic irradiation is touted to be a safe, alternative for patients with autoimmune blood diseases, especially autoimmune hemolytic anemia, or others with compromised immune systems, such as HIV patients and the elderly. It is reported to have few side effects and seems to be working. Cytokine

KEY TERMS

Autoantibody—An antibody made by a person that reacts with their own tissues.

Paresthesias—A prickly, tingling sensation.

and cytokine inhibitor genes injected directly into muscle tissue also appear to be effective in treating Type I diabetes mellitus, systemic lupus erythematosus, thyroditis, and arthritis.

Prognosis

Prognosis depends upon the pathology of each autoimmune disease.

Prevention

Most autoimmune diseases cannot be prevented. Though the mechanisms involved in how these diseases affect the body are known, it is still unclear why the body turns on itself. Since more women than men seem to be affected by some of these disorders (e.g. lupus), some researchers are looking into hormones as a factor. This, and gene therapy, may be the preventatives of the future.

Resources

BOOKS

Abbas, A.K., A.H. Lichtman, and J.S. Pober. *Cellular and Molecular Immunology.* Philadelphia: W.B. Saunders Company, 1997.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Roit, I. M. *Roitt's Essential Immunolgy.* Oxford: Blackwell Science Ltd., 1997.

PERIODICALS

Cichoke, Anthony J. "Natural Relief for Autoimmune Disorders." *Better Nutrition.* (June 2000)62(6): 24.

Henderson, Charles W. "Gene Therapy Uses Vectors Encoding Cytokines or Cytokine Inhibitors (for treatment of autoimmune disorders)." *Immunotherapy Weekly.* (September 27, 2000): pNA.

Riccio, Nina M. "Autoimmune Disorder: When the Body Attacks Itself." *Current Health 2.* (January 2000)26(5): 13.

"Splenic Irradiation Is an Option for Patients with Autoimmune Disorders and Those with HIV." *AIDS Weekly.* (April 9, 2001): pNA.

Janie F. Franz

Autoimmune hepatitis *see* **Hepatitis, autoimmune**

Autologous transfusion *see* **Transfusion**

Autologous transplant *see* **Bone marrow transplantation**

Automatic implantable cardioverter-defibrillator *see* **Implantable cardioverter-defibrillator**

Autopsy

Definition

An autopsy is a postmortem assessment or examination of a body to determine the cause of **death**. An autopsy is performed by a physician trained in pathology.

Purpose

Most autopsies advance medical knowledge and provide evidence for legal action. Medically, autopsies determine the exact cause and circumstances of death, discover the pathway of a disease, and provide valuable information to be used in the care of the living. When foul play is suspected, a government coroner or medical examiner performs autopsies for legal use. This branch of medical study is called forensic medicine. Forensic specialists investigate deaths resulting from violence or occurring under suspicious circumstances.

Benefits of research from autopsies include the production of new medical information on diseases such as **toxic shock syndrome**, acquired **immunodeficiency** syndrome (**AIDS**). Organ donation, which can potentially save the lives of other patients, is also another benefit of autopsies.

Precautions

When performed for medical reasons, autopsies require formal permission from family members or the legal guardian. (Autopsies required for legal reasons when foul play is suspected do not need the consent of next of kin.) During the autopsy, very concise notes and documentation must be made for both medical and legal reasons. Some religious groups prohibit autopsies.

KEY TERMS

Acquired immunodeficiency syndrome (AIDS)— A group of diseases resulting from infection with the human immunodeficiency virus (HIV). A person infected with HIV gradually loses immune function, becoming less able to resist aliments and cancers, resulting in eventual death.

Computed tomography scan (CT scan)—The technique used in diagnostic studies of internal bodily structures in the detection of tumors or brain aneurysms. This diagnostic test consists of a computer analysis of a series of cross-sectional scans made along a single axis of a bodily structure or tissue that is used to construct a three-dimensional image of that structure

Creutzfeld-Jakob disease—A rare, often fatal disease of the brain, characterized by gradual dementia and loss of muscle control that occurs most often in middle age and is caused by a slow virus.

Hepatitis—Inflammation of the liver, caused by infectious or toxic agents and characterized by jaundice, fever, liver enlargement, and abdominal pain.

Magnetic resonance imaging (MRI)—A diagnostic tool that utilizes nuclear magnetic energy in the production of images of specific atoms and molecular structures in solids, especially human cells, tissues, and organs.

Postmortem—After death.

Description

An autopsy can be described as the examination of a deceased human body with a detailed exam of the person's remains. This procedure dates back to the Roman era when few human dissections were performed; autopsies were utilized, however, to determine the cause of death in criminal cases. At the beginning of the procedure the exterior body is examined and then the internal organs are removed and studied. Some pathologists argue that more autopsies are performed than necessary. However, recent studies show that autopsies can detect major findings about a person's condition that were not suspected when the person was alive. And the growing awareness of the influence of genetic factors in disease has also emphasized the importance of autopsies.

Despite the usefulness of autopsies, fewer autopsies have been performed in the United States during the past 10-20 years. A possible reason for this decline is concern about malpractice suits on the part of the treating physician. Other possible reasons are that hospitals are performing fewer autopsies because of the expense or because modern technology, such as CT scans and **magnetic resonance imaging**, can often provide sufficient diagnostic information. Nonetheless, federal regulators and pathology groups have begun to establish new guidelines designed to increase the number and quality of autopsies being performed.

Many experts are concerned that if the number of autopsies increases, hospitals may be forced to charge families a fee for the procedure as autopies are not normally covered by insurance companies or Medicare. Yet, according to several pathologists, the benefit of the procedure for families and doctors does justify the cost. In medical autopsies, physicians remain cautious to examine only as much of the body as permitted according to the wishes of the family. It is important to note that autopsies can also provide peace of mind for the bereaved family in certain situations.

Preparation

If a medical autopsy is being performed, written permission is secured from the family of the deceased

Aftercare

Once the autopsy has been completed, the body is prepared for final arrangements according to the family's wishes

Risks

There are some risks of disease transmission from the deceased. In fact, some physicans may refuse to do autopsies on specific patients because of a fear of contracting diseases such as AIDS, hepatitis, or Creutzfeld-Jakob disease.

Normal results

In most situations the cause of death is determined from the procedure of an autopsy without any transmission of disease.

Abnormal results

Abnormal results would include inconclusive results from the autopsy and transmission of infectious disease during the autopsy.

Resources

BOOKS

Van de Graff, Kent M., and Stuart I. Fox. *Concepts of Human Anatomy and Physiology.* Dubuque, IA: Wm. C. Brown Publishers 1986.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

OTHER

"When and Why an Autopsy is Ordered After Death." *University of Texas Lifetime Health Letter* 9, no.5 (May 1997): 4-5.

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Aviation medicine

Definition

Also known as aerospace medicine, flight medicine, or space medicine, aviation medicine is a medical specialty that focuses on the physical and psychological conditions associated with flying and space travel.

Purpose

Since flying airplanes and spacecraft involves great risk and physical demands, such as changes in gravity and oxygen, pilots and astronauts need medical experts to protect their safety and the public's safety.

Description

Pressure changes

In the United States, the Federal Aviation Administration (FAA) requires all pilots who fly above 14,500 ft (4,420 m) to be prepared for pressure changes caused by lower oxygen levels at high altitude. Pilots must either have a pressurized cabin or access to an oxygen mask. Without these protections, they could experience hypoxia, or **altitude sickness**. Hypoxia reduces the amount of oxygen in the brain, causing such symptoms as **dizziness**, **shortness of breath**, and mental confusion. These symptoms could cause the pilot to lose control of the plane. Hypoxia can be treated with oxygen therapy.

Rapid altitude increases and decreases can cause **pain** because there is an air pocket in the middle portion of the ear. To equalize pressure in the ear, physicians typically advise pilots and passengers to clear their sinuses by plugging their nose and blowing until the eardrums "pop." Other options include yawning, swallowing or chewing gum. For people with a cold or a severely blocked middle ear, the use of **decongestants**, **antihistamines**, or nasal sprays may help. Without taking steps to equalize pressure, the tympanic membrane could rupture, causing **hearing loss**, vertigo, dizziness, and nausea.

Gravity's impact

Fighter pilots who fly high-performance jets can experience health problems during rapid acceleration and when executing tight turns at high speed. During these moves, a pilot experiences extreme gravity conditions that can pull blood away from the brain and heart and into the lower body. This can cause the pilot to have tunnel vision or pass out. To prevent these potentially deadly situations, the military requires fighter pilots to wear special flight suits, or G suits, which have compartments that fill with air or fluid to keep blood from pooling in the lower body.

Some pilots, like the Blue Angels, use a technique called the **Valsalva Maneuver** instead of G suits to prevent black outs during high-performance flying. The Valsalva Maneuver involves grunting and tightening the abdominal muscles to stop blood from collecting in the wrong parts of the body.

PREVENTIVE CARE. Since any routine health problem that affects a pilot could mean the loss of hundreds of lives, aviation medicine specialists who work for commercial airlines and the military take special care to educate pilots about proper diet, **exercise** and preventive health tools. For example, physicians may frequently screen pilots for vision changes caused by **glaucoma** or **cataracts**. They also will check for hearing loss and encourage the pilot to wear earplugs or headphones to buffer engine noise. To monitor for heart disease, physicians will check blood pressure and may order diagnostic tests such as an ECG or **stress test**.

Motion sickness

Many people experience nausea, vertigo, and disorientation when they first arrive in space. This is caused by changes in the fluid in the inner ear, which is sensitive to gravity and affects our sense of spatial orientation. The symptoms typically ease after several days, but often recur when the astronaut returns to Earth. To treat this condition, physicians give astronauts **motion sickness** medication, such as lorazepam.

Bone and muscle loss

In zero-gravity conditions, astronauts lose bone and muscle mass. On earth, the natural resistance of gravity helps build stronger muscles and bones during normal

KEY TERMS

G suits—Special flight suits, worn by fighter pilots, which have compartments that fill with air or fluid to keep blood from pooling in the lower body during rapid acceleration and tight turns.

Hypoxia—Hypoxia, or altitude sickness, reduces the amount of oxygen in the brain causing such symptoms as dizziness, shortness of breath, and mental confusion.

Tympanic membrane—A structure in the middle ear that can rupture if pressure in the ear is not equalized during airplane ascents and descents.

Valsalva Maneuver—Pilots grunt and tighten their abdominal muscles to prevent black outs during high-performance flying.

weight-bearing activities like walking or even sitting at a desk. In space, however, astronauts must work harder to prevent bone and muscle loss. Exercise is an important treatment. Crew members may use an exercise cycle or resistive rubber bands to stay in shape. Physicians also may give them medication to prevent bone loss and prescribe nutritional supplements, such as a mixture of essential amino acids and carbohydrates, to limit muscle atrophy.

Radiation

Another health threat to space travelers is radiation. Harmful rays can alter the DNA in human cells and cause **cancer**. Excess radiation also can weaken the immune system. To prevent these problems, physicians may give astronauts nutritional supplements. For example, research has show that n-3 fatty acids found in fish oil reduce DNA damage.

Cardiovascular issues

When astronauts return to earth after a long mission, they tend to feel dizzy and black out. Scientists are concerned about this dilemma because it could be dangerous if the crew members need to make an emergency exit. One way to prevent this problem, which is caused by a drop in blood pressure, is to have the astronauts drink extra fluids and increase salt intake to increase blood volume. Physicians also may prescribe medication that causes blood vessels to contract. As another precaution, astronauts also put on protective flight suits, or G suits, before they re-enter the earth's atmosphere.

Resources

BOOKS

Dehart, Roy L. *Fundamentals of Aerospace Medicine*. Philadelphia: Lippincott, Williams & Wilkins, 1996.

PERIODICALS

Aviation, Space and Environmental Medicine. Monthly peer-reviewed journal published by the Aerospace Medical Association. Contact the editor: 3212 Swandale Dr., San Antonio, TX 78230-4404. (210) 342-5670. ASEMJournal@worldnet.att.net.

ORGANIZATIONS

Aerospace Medical Association. 320 S. Henry St., Alexandria, VA 22314-3579. (703) 739-2240. <http://www.asma.org>.(
National Space Biomedical Research Institute. One Baylor Plaza, NA-425, Houston, TX 77030. (713) 798-7412. info@www.nsbri.org. <http://www.nsbri.org>.
Wright State University Aerospace Medicine Program. P.O. Box 92, Dayton, Ohio 45401-0927. (937) 276-8338. <http://www.med.wright.edu>.

OTHER

Society of USAF Flight Surgeons Online Catalog. <http://www.sam.brooks.af.mil/ram/rammain.htm>.
Federal Aviation Administration Office of Aviation Medicine. <http://www.faa.gov/avr/aamhome.htm>.
National Aeronautics and Space Administration Aerospace Medicine. <http://spacelink.msfc.nasa.gov>.

Melissa Knopper

AVM *see* **Arteriovenous malformations**

Avoidant personality disorder *see* **Personality disorders**

Avulsions *see* **Wounds**

Ayurvedic medicine

Definition

Ayurvedic medicine is a system of healing that originated in ancient India. In Sanskrit, *ayur* means life or living, and *veda* means knowledge, so Ayurveda has been defined as the "knowledge of living" or the "science of longevity." Ayurvedic medicine utilizes diet, **detoxification** and purification techniques, herbal and mineral remedies, **yoga**, breathing exercises, **meditation**, and **massage therapy** as holistic healing methods. Ayurvedic medicine is widely practiced in modern India and has been steadily gaining followers in the West.

DEEPAK CHOPRA (1946–)

(AP/Wide World Photos. Reproduced by permission.)

Deepak Chopra was born in India and studied medicine at the All India Institute of Medical Science. He left his home for the United States in 1970 and completed residencies in internal medicine and endocrinology. He went on to teaching posts at major medical institutions—Tufts University and Boston University schools of medicine—while establishing a very successful private practice. By the time he was thirty-five, Chopra had become chief of staff at New England Memorial Hospital.

Disturbed by Western medicine's reliance on medication, he began a search for alternatives and discovered one in the teachings of the Maharishi Mahesh Yogi, an Indian spiritualist who had gained a cult following in the late sixties teaching Transcendental Meditation (TM). Chopra began practicing TM fervently and eventually met the Maharishi. In 1985 Chopra established the Ayurvedic Health Center for Stress Management and Behavioral Medicine in Lancaster, Massachusetts, where he began his practice of integrating the best aspects of Eastern and Western medicine.

In 1993, he published *Creating Affluence: Wealth Consciousness in the Field of All Possibilities*, and the enormously successful best seller, *Ageless Body, Timeless Mind*. In the latter he presents his most radical thesis: that aging is not the inevitable deterioration of organs and mind that we have been traditionally taught to think of it as. It is a process that can be influenced, slowed down, and even reversed with the correct kinds of therapies, almost all of which are self-administered or self-taught. He teaches that applying a regimen of nutritional balance, meditation, and emotional clarity characterized by such factors as learning to easily and quickly express anger, for instance, can lead to increased lifespans of up to 120 years.

Purpose

According to the original texts, the goal of Ayurveda is prevention as well as promotion of the body's own capacity for maintenance and balance. Ayurvedic treatment is non-invasive and non-toxic, so it can be used safely as an alternative therapy or alongside conventional therapies. Ayurvedic physicians claim that their methods can also help stress-related, metabolic, and chronic conditions. Ayurveda has been used to treat **acne**, **allergies**, **asthma**, **anxiety**, arthritis, **chronic fatigue syndrome**, colds, colitis, **constipation**, depression, diabetes, flu, heart disease, **hypertension**, immune problems, inflammation, **insomnia**, nervous disorders, **obesity**, skin problems, and ulcers.

Ayurvedic physicians seek to discover the roots of a disease before it gets so advanced that more radical treatments are necessary. Thus, Ayurveda seems to be limited in treating severely advanced conditions, traumatic injuries, acute **pain**, and conditions and injuries requiring invasive surgery. Ayurvedic techniques have also been used alongside **chemotherapy** and surgery to assist patients in recovery and healing.

Description

Origins

Ayurvedic medicine originated in the early civilizations of India some 3,000-5,000 years ago. It is mentioned in the *Vedas*, the ancient religious and philosophical texts that are the oldest surviving literature in the world, which makes Ayurvedic medicine the oldest surviving healing system. According to the texts, Ayurveda was conceived by enlightened wise men as a system of living harmoniously and maintaining the body so that mental and spiritual awareness could be possible. Medical historians believe that Ayurvedic ideas were transported from ancient India to China and were instrumental in the development of Chinese medicine.

Ayurvedic Body Types

	Vata	Pitta	Kapha
Physical characteristics	Thin	Average build	Large build
	Prominent features	Fair, thin hair	Wavy, thick hair
	Cool, dry skin	Warm, moist skin	Pale, cool, oily skin
	Constipation	Ulcers, heartburn, and hemorrhoids	Obesity, allergies, and sinus problems
	Cramps	Acne	High cholesterol
Emotional characteristics	Moody	Intense	Relaxed
	Vivacious	Quick tempered	Not easily angered
	Imaginative	Intelligent	Affectionate
	Enthusiastic	Loving	Tolerant
	Intuitive	Articulate	Compassionate
Behavioral characteristics	Unscheduled sleep and meal times	Orderly	Slow, graceful
	Nervous disorders	Structured sleep and meal times	Long sleeper and slow eater
	Anxiety	Perfectionist	Procrastination

Today, Ayurvedic medicine is used by 80% of the population in India. Aided by the efforts of Deepak Chopra and the Maharishi, it has become an increasingly accepted alternative medical treatment in America during the last two decades. Chopra is an M.D. who has written several bestsellers based on Ayurvedic ideas. He also helped develop the Center for Mind/Body Medicine in La Jolla, California, a major Ayurvedic center that trains physicians in Ayurvedic principles, produces herbal remedies, and conducts research and documentation of its healing techniques.

Key ideas

To understand Ayurvedic treatment, it is necessary to have an idea how the Ayurvedic system views the body. The basic life force in the body is *prana*, which is also found in the elements and is similar to the Chinese notion of *chi*. As Swami Vishnudevananda, a yogi and expert, put it, "Prana is in the air, but is not the oxygen, nor any of its chemical constituents. It is in food, water, and in the sunlight, yet it is not vitamin, heat, or light-rays. Food, water, air, etc., are only the media through which the prana is carried."

In Ayurveda, there are five basic elements that contain prana: earth, water, fire, air, and ether. These elements interact and are further organized in the human body as three main categories or basic physiological principles in the body that govern all bodily functions known as the *doshas*. The three doshas are *vata, pitta, and kapha*. Each person has a unique blend of the three doshas, known as the person's *prakriti*, which is why Ayurvedic treatment is always individualized. In Ayurveda, disease is viewed as a state of imbalance in one or more of a person's doshas, and an Ayurvedic physician strives to adjust and balance them, using a variety of techniques.

The vata dosha is associated with air and ether, and in the body promotes movement and lightness. Vata people are generally thin and light physically, dry-skinned, and very energetic and mentally restless. When vata is out of balance, there are often nervous problems, hyperactivity, sleeplessness, lower back pains, and headaches.

Pitta is associated with fire and water. In the body, it is responsible for metabolism and digestion. Pitta characteristics are medium-built bodies, fair skin, strong digestion, and good mental concentration. Pitta imbalances show up as anger and aggression and stress-related conditions like **gastritis**, ulcers, liver problems, and hypertension.

The kapha dosha is associated with water and earth. People characterized as kapha are generally large or heavy with more oily complexions. They tend to be slow, calm, and peaceful. Kapha disorders manifest emotionally as greed and possessiveness, and physically as obesity, **fatigue**, **bronchitis**, and sinus problems.

Diagnosis

In Ayurvedic medicine, disease is always seen as an imbalance in the dosha system, so the diagnostic process strives to determine which doshas are underactive or overactive in a body. Diagnosis is often taken over a course of days in order for the Ayurvedic physician to most accurately determine what parts of the body are being affected. To diagnose problems, Ayurvedic physicians often use long questionnaires and interviews to determine a person's dosha patterns and physical and psychological histories. Ayurvedic physicians also intricately observe the pulse, tongue, face, lips, eyes, and fingernails for abnormalities or patterns that they believe can indicate deeper problems in the internal systems. Some Ayurvedic physicians also use laboratory tests to assist in diagnosis.

Treatment

Ayurvedic treatment seeks to re-establish balance and harmony in the body's systems. Usually the first method of treatment involves some sort of detoxification and cleansing of the body, in the belief that accumulated toxins must be removed before any other methods of treatment will be effective. Methods of detoxification include therapeutic vomiting, **laxatives**, medicated **enemas**, **fasting**, and cleansing of the sinuses. Many Ayurvedic clinics combine all of these cleansing methods into intensive sessions known as *panchakarma*. Panchakarma can take several days or even weeks and they are more than elimination therapies. They also include herbalized oil massage and herbalized **heat treatments**. After purification, Ayurvedic physicians use herbal and mineral remedies to balance the body as well. Ayurvedic medicine contains a vast knowledge of the use of herbs for specific health problems.

Ayurvedic medicine also emphasizes how people live their lives from day to day, believing that proper lifestyles and routines accentuate balance, rest, diet, and prevention. Ayurveda recommends yoga as a form of **exercise** to build strength and health, and also advises massage therapy and self-massage as ways of increasing circulation and reducing **stress**. Yogic breathing techniques and meditation are also part of a healthy Ayurvedic regimen, to reduce stress and improve mental energy.

Of all treatments, though, diet is one of the most basic and widely used therapy in the Ayurvedic system. An Ayurvedic diet can be a very well planned and individualized regimen. According to Ayurveda, there are six basic tastes: sweet, sour, salty, pungent, bitter, and astringent. Certain tastes and foods can either calm or aggravate a particular dosha. For instance, sweet, sour, and salty decrease vata problems and increase kapha. Sour, salty, and pungent can increase pitta. After an Ayurvedic physician determines a person's dosha profile, they will recommend a specific diet to correct imbalances and increase health. The Ayurvedic diet emphasizes primarily vegetarian foods of high quality and freshness, tailored to the season and time of day. Cooling foods are eaten in the summer and heating ones in the winter, always within a person's dosha requirements. In daily routine, the heaviest meal of the day should be lunch, and dinner should eaten well before bedtime, to allow for complete digestion. Also, eating meals in a calm manner with proper chewing and state of mind is important, as is combining foods properly and avoiding overeating.

Cost

Costs of Ayurvedic treatments can vary, with initial consultations running anywhere from $40 to over $100, with follow-up visits costing less. Herbal treatments may cost from $10 to $50 per month, and are often available from health food or bulk herb stores. Some clinics offer panchakarma, the intensive Ayurvedic detoxification treatment, which can include overnight stays for up to several weeks. The prices for these programs can vary significantly, depending on the services and length of stay. Insurance reimbursement may depend on whether the primary physician is a licensed M.D.

KEY TERMS

Dosha—One of three constitutional types, either vata, pitta, or kapha, found in Ayurvedic medicine.

Meditation—Technique of calming the mind.

Panchakarma—Intensive Ayurvedic cleansing and detoxification program.

Prakriti—An individual's unique dosha pattern.

Prana—Basic life energy found in the elements.

Yoga—System of body and breathing exercises.

Preparations

Ayurveda is a mind/body system of health that contains some ideas foreign to the Western scientific model. Those people considering Ayurveda should approach it with an open mind and willingness to experiment. Also, because Ayurveda is a whole-body system of healing and health, patience and discipline are helpful, as some conditions and diseases are believed to be brought on by years of bad health habits and require time and effort to correct. Finally, the Ayurvedic philosophy believes that each person has the ability to heal themselves, so those considering Ayurveda should be prepared to bring responsibility and participation into the treatment.

Precautions

An Ayurvedic practitioner should always be consulted.

Side effects

During Ayurvedic detoxification programs, some people report fatigue, muscle soreness, and general sickness. Also, as Ayurveda seeks to release mental stresses and psychological problems from the patient, some people can experience mental disturbances and depression during treatment, and psychological counseling may be part of a sound program.

Research and general acceptance

Because Ayurveda had been outside the Western scientific system for years, research in the United States is new. Another difficulty in documentation arises because Ayurvedic treatment is very individualized; two people with the same disease but different dosha patterns might be treated differently. Much more scientific research has been conducted over the past several decades in India. Much research in the United States is being supported by the Maharishi Ayur-Ved organization, which studies the Ayurvedic products it sells and its clinical practices.

Some Ayurvedic herbal mixtures have been proven to have high antioxidant properties, much stronger than **vitamins** A, C, and E, and some have also been shown in laboratory tests to reduce or eliminate tumors in mice and to inhibit **cancer** growth in human lung tumor cells. In a 1987 study at MIT, an Ayurvedic herbal remedy was shown to significantly reduce **colon cancer** in rats. Another study was performed in the Netherlands with Maharishi Ayur-Ved products. A group of patients with chronic illnesses, including asthma, chronic bronchitis, hypertension, eczema, **psoriasis**, constipation, **rheumatoid arthritis**, headaches, and non-insulin dependent **diabetes mellitus**, were given Ayurvedic treatment. Strong results were observed, with nearly 80% of the patients improving and some chronic conditions being completely cured.

Other studies have shown that Ayurvedic therapies can significantly lower cholesterol and blood pressure in stress-related problems. Diabetes, acne, and allergies have also been successfully treated with Ayurvedic remedies. Ayurvedic products have been shown to increase short-term memory and reduce headaches. Also, Ayurvedic remedies have been used successfully to support the healing process of patients undergoing chemotherapy, as these remedies have been demonstrated to increase immune system activity.

Resources

BOOKS

Gerson, Scott M.D. *Ayurveda: The Ancient Indian Healing Art*. Boston: Element Books, 1993.

Lad, Dr. Vasant. *Ayurveda: The Science of Self-Healing*. Wisconsin: Lotus Press, 1984.

Lad, Dr. Vasant. *The Complete Book of Ayurvedic Home Remedies*. Minneapolis: Three Rivers Press, 1999.

Tiwari, Maya. *Ayurveda: A Life of Balance*. Vermont: Healing Arts Press, 1995.

ORGANIZATIONS

American Institute of Vedic Studiess. P.O. Box 8357, Santa Fe, NM 87504. (505) 983-9385

Ayurveda Holistic Center. Bayville, Long Island, NY. (516)759-7731 mail@Ayurvedahc.com <http://www.Ayurvedahc.com>.

The Ayurvedic Institute. 11311 Menaul, NE Albuquerque, New Mexico 87112. (505)291-9698. info@Ayurveda.com <http://www.Ayurveda.com>.

Ayurvedic and Naturopathic Medical Clinic. 10025 NE 4th Street, Bellevue, WA 98004. (206)453-8022.

Bastyr University of Natural Health Sciences. 144 N.E. 54th Street, Seattle, WA 98105. (206)523-9585.

Center for Mind/Body Medicine. P.O. Box 1048, La Jolla, CA 92038. (619)794-2425.

The College of Maharishi Ayur-Ved, Maharishi International University. 1000 4th Street, Fairfield, IA 52557. (515)472-7000.

National Institute of Ayurvedic Medicine. (914)278-8700. drgerson@erols.com <http://www.niam.com>.

The Rocky Mountain Institute of Yoga and Ayurveda. P.O. Box 1091, Boulder, CO 80306. (303)443-6923.

OTHER

"Inside Ayurveda: An Independent Journal of Ayurvedic Health Care." P.O. Box 3021, Quincy, CA 95971. <http://www.insideayurveda.com>.

Douglas Dupler

Azithromycin *see* **Erythromycins**

AZT *see* **Antiretroviral drugs**

B

B-cell count *see* **Lymphocyte typing**

Babesiosis

Definition

Babesiosis is an infection of red blood cells caused by the single-celled parasite, *Babesia microti*, which is spread to humans by a tick bite.

Description

Babesiosis is a rare, tick-transmitted disease that is caused most often by the single-celled parasite *Babesia microti*. By 1995, fewer than 500 cases of babesiosis had been reported in the United States. The disease occurs primarily in New England and New York, especially on the coastal islands. However, cases have occurred in other parts of the United States. Because of tick activity, the risk for babesiosis is highest during June and July.

Ticks are small, blood-sucking arachnids. Although some ticks carry disease-causing organisms, most do not. *Babesia microti* is spread to humans through the bite of the tick *Ixodes scapularis* (also called *Ixodes dammini*). *Ixodes scapularis*, called the "blacklegged deer tick," usually feeds on deer and mice. A tick picks up the parasites by feeding on an infected mouse and then passes them on by biting a new host, possibly a human. To pass on the parasites, the tick must be attached to the skin for 36-48 hours. Once in the bloodstream, *Babesia microti* enters a red blood cell, reproduces by cell division, and destroys the cell. Humans infected with *Babesia microti* produce antibodies that can be helpful in diagnosing the infection.

Causes and symptoms

Babesia microti live and divide within red blood cells, destroying the cells and causing anemia. The majority of people who are infected have no visible symptoms. In those who become ill, symptoms appear one to six weeks following the tick bite. Because the ticks are small, many patients have no recollection of a tick bite. The symptoms are flu-like and include tiredness, loss of appetite, **fever**, drenching sweats, and muscle **pain**. Nausea, vomiting, **headache**, shaking chills, blood in the urine, and depression can occur.

Persons who are over 40 years old, have had their spleen removed (splenectomized), and/or have a serious disease (**cancer**, **AIDS**, etc.) are at a greater risk for severe babesiosis. In severe cases of babesiosis, up to 85% of the blood cells can be infected. This causes a serious, possibly fatal, blood deficiency.

Diagnosis

Babesiosis can be diagnosed by examining a blood sample microscopically and detecting the presence of *Babesia microti* within the blood cells. The blood can also be checked for the presence of antibodies to the parasite.

Treatment

In serious cases, babesiosis is treated with a combination of clindamycin (Cleocin) and quinine. Clindamycin is given by injection and quinine is given orally three to four times a day for four to seven days. To reduce the number of parasites in the blood, severely ill patients have been treated with blood transfusions.

Prognosis

Otherwise healthy patients will recover completely. Babesiosis may last several months without treatment and is a severe, potentially fatal disease in splenectomized patients.

Prevention

The only prevention for babesiosis is to minimize exposure to ticks by staying on trails when walking

KEY TERMS

Anemia—A below normal number of red blood cells in the bloodstream.

Parasite—An organism that lives upon or within another organism.

through the woods, avoiding tall grasses, wearing long sleeves and tucking pant legs into socks, wearing insect repellent, and checking for ticks after an outing. Remove a tick as soon as possible by grasping the tick with tweezers and gently pulling. Splenectomized people should avoid northeastern coastal regions during the tick season.

Resources

BOOKS

Blood: Textbook of Hematology. 2nd ed. Ed. James H. Jandl. Boston: Little, Brown and Co., 1996.

Chiodini, Peter L. "Babesiosis." In *Manson's Tropical Diseases.* 20th ed. Philadelphia: W. B. Saunders Co., 1996.

Infections and Diseases. 2nd ed. Ed. Sherood L. Gorbach, John G. Bartlett, and Neil R. Blacklow. Philadelphia: W. B. Saunders Co., 1997.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Bach flower remedies *see* **Flower remedies**

Bacillary angiomatosis

Definition

A life-threatening but curable infection that causes an eruption of purple lesions on or under the skin that resemble **Kaposi's sarcoma**. The infection, which occurs almost exclusively in patients with **AIDS**, can be a complication of **cat-scratch disease**.

Description

Bacillary angiomatosis is a re-emerging bacterial infection that is identical or closely related to one which commonly afflicted thousands of soldiers during World War I. Today, the disease, caused by two versions of the same bacteria, is linked to homeless AIDS patients and to those afflicted with cat-scratch disease.

The infection is rarely seen today in patients who don't have HIV. According to the U.S. Centers for Disease Control and Prevention (CDC), an HIV patient diagnosed with bacillary angiomatosis is considered to have progressed to full-blown AIDS.

Causes and symptoms

Scientists have recently isolated two varieties of the Bartonella bacteria as the cause of bacillary angiomatosis: *Bartonella* (formerly *Rochalimaeaquintana*) and *B. henselae* (cause of cat-scratch disease).

B. quintana infection is known popularly as **trench fever**, and is the infection associated with body lice that sickened European troops during World War I. Lice carry the bacteria, and can transmit the infection to humans. The incidence of trench **fever** was believed to have faded away with the end of World War I. It was not diagnosed in the United States until 1992, when 10 cases were reported among homeless Seattle men.

The related bacteria *B. henselae* was first identified several years ago as the cause of cat-scratch fever. It also can lead to bacillary angiomatosis in AIDS patients. Bacillary angiomatosis caused by this bacteria is transmitted to AIDS patients from cat fleas.

These two different types of bacteria both cause bacillary angiomatosis, a disease which is characterized by wildly proliferating blood vessels that form tumor-like masses in the skin and organs. The nodules that appear in bacillary angiomatosis are firm and don't turn white when pressed. The lesions can occur anywhere on the body, in numbers ranging from one to 100. They are rarely found on palms of the hands, soles of the feet, or in the mouth. As the number of lesions increase, the patient may develop a high fever, sweats, chills, poor appetite, vomiting, and weight loss. If untreated, infection may be fatal.

In addition to the basic disease process, the two different types of bacteria cause some slightly different symptoms. Patients infected with *B. henselae* also experience blood-filled cysts within the liver and abnormal liver function, whereas *B. quintana* patients may have tumor growths in the bone.

Diagnosis

This life-threatening but curable infection is often misdiagnosed, because it may be mistaken for other conditions (such as Kaposi's sarcoma). A blood test developed in 1992 by the CDC detects antibodies to the bacteria. It can be confirmed by reviewing symptoms, history

KEY TERMS

Cat-scratch disease—An infectious disease caused by bacteria transmitted by the common cat flea that causes a self-limiting, mild infection in healthy people.

Kaposi's sarcoma—A malignant condition that begins as soft brown or purple lesions on the skin that occurs most often in men with AIDS.

and negative tests for other diseases that cause swollen lymph glands. It isn't necessary to biopsy a small sample of the lymph node unless there is a question of **cancer** of the lymph node or some other disease.

Treatment

Recent research indicates that **antibiotics** used to treat other HIV opportunistic infections can both prevent and treat bacillary angiomatosis. Treatment is usually given until the lesions disappear, which typically takes three or four weeks. A severely affected lymph node or blister may have to be drained, and a heating pad may help swollen, tender lymph glands. **Acetaminophen** (Tylenol) may relieve **pain**, aches, and fever over 101°F (38.3°C).

Prognosis

In most cases, prompt antibiotic treatment in patients with AIDS cured the infection caused by either variety of the bacteria, and patients may resume normal life. Early diagnosis is crucial to a cure.

Prevention

Studies suggest that antibiotics may prevent the disease. Patients also should be sure to treat cats for fleas.

Resources

PERIODICALS

Koehler, J. E. "Zoonoses: Cats, Fleas and Bacteria." *Journal of the American Medical Association* 271 (1994): 531-535.

Tsang, W. Y., and J. K. Chan. "Bacillary Angiomatosis: A "New" Disease With a Broadening Clinicopathologic Spectrum." *Histology and Histopathology* 7 (Jan. 1992): 143-52.

Carol A. Turkington

Bacillary dysentery *see* **Shigellosis**

Bacitracin *see* **Antibiotics, topical**

Bacteremia

Definition

Bacteremia is an invasion of the bloodstream by bacteria.

Description

Bacteremia occurs when bacteria enter the bloodstream. This may occur through a wound or infection, or through a surgical procedure or injection. Bacteremia may cause no symptoms and resolve without treatment, or it may produce **fever** and other symptoms of infection. In some cases, bacteremia leads to **septic shock**, a potentially life-threatening condition.

Causes and symptoms

Causes

Several types of bacteria live on the surface of the skin or colonize the moist linings of the urinary tract, lower digestive tract, and other internal surfaces. These bacteria are normally harmless as long as they are kept in check by the body's natural barriers and the immune system. People in good health with strong immune systems rarely develop bacteremia. However, when bacteria are introduced directly into the circulatory system, especially in a person who is ill or undergoing aggressive medical treatment, the immune system may not be able to cope with the invasion, and symptoms of bacteremia may develop. For this reason, bacteremia is most common in people who are already affected by or being treated for some other medical problem. In addition, medical treatment may bring a person in contact with new types of bacteria that are more invasive than those already residing in that person's body, further increasing the likelihood of bacterial infection.

Conditions which increase the chances of developing bacteremia include:

- immune suppression, either due to HIV infection or drug therapy
- antibiotic therapy which changes the balance of bacterial types in the body
- prolonged or severe illness
- alcoholism or other drug abuse
- malnutrition
- diseases or drug therapy that cause ulcers in the intestines, e.g. **chemotherapy** for cancer

Common immediate causes of bacteremia include:

- drainage of an **abscess**, including an abscessed tooth.
- urinary tract infection, especially in the presence of a bladder catheter.
- decubitus ulcers (pressure sores).
- intravenous procedures using unsterilized needles, including IV drug use.
- prolonged IV needle placement.
- use of **ostomy** tubes, including **gastrostomy** (surgically making a new opening into the stomach), jejunostomy (surgically making an opening from the abdominal wall into the jejunum), and **colostomy** (surgically creating an articifical opening into the colon).

The bacteria most likely to cause bacteremia include members of the *Staphylococcus, Streptococcus, Pseudomonas, Haemophilus,* and *Esherichia coli* (*E. coli*) genera.

Symptoms

Symptoms of bacteremia may include:

- fever over 101°F (38.3°C)
- chills
- malaise
- abdominal **pain**
- nausea
- vomiting
- diarrhea
- anxiety
- shortness of breath
- confusion

Not all of these symptoms are usually present. In the elderly, confusion may be the only prominent symptom. Bacteremia may lead to septic **shock**, whose symptoms include decreased consciousness, rapid heart and breathing rates and multiple organ failures.

Diagnosis

Bacteremia is diagnosed by culturing the blood for bacteria. Samples may need to be tested several times over several hours. Blood analysis may also reveal an elevated number of white blood cells. Blood pressure is monitored closely; a decline in blood pressure may indicate the onset of septic shock.

Treatment

Antibiotics are the mainstay of treatment, and are often begun before positive identification of the bacteria is made. Close observation is required to guard against septic shock. Since bacteremia is usually associated with an existing infection elsewhere in the body, finding and treating this infection is an important part of treatment.

Bacteremia may cause no symptoms, but may be discovered through a blood test for another condition. In this situation, it may not need to be treated, except in patients especially at risk for infection, such as those with heart valve defects or whose immune systems are suppressed.

KEY TERMS

Colostomy—Surgical creation of an artificial anus on the abdominal wall by cutting into the colon and bringing it up to the surface.

Gastrostomy—Surgical creation of an artificial opening into the stomach through the abdominal wall to allow tube feeding.

Jejunostomy—Surgical creation of an opening to the middle portion of the small intestine (jejunum), through the abdominal wall.

Septic shock—A life-threatening drop in blood pressure caused by bacterial infection.

Prognosis

Prompt antibiotic therapy usually succeeds in clearing bacteria from the bloodstream. Recurrence may indicate an undiscovered site of infection. Untreated bacteria in the blood may spread, causing infection of the heart (**endocarditis** or **pericarditis**) or infection of the covering of the central nervous system (**meningitis**).

Prevention

Bacteremia can be prevented by preventing the infections which often precede it. Good personal hygiene, especially during viral illness, may reduce the risk of developing bacterial infection. Treating bacterial infections quickly and thoroughly can minimize the risk of spreading infection. During medical procedures, the burden falls on medical professionals to minimize the number and duration of invasive procedures, to reduce patients' exposure to sources of bacteria when being treated, and to use scrupulous technique.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

OTHER
The Meck Page. 13 Apr. 1998 <http://www.merck.com>.

Richard Robinson

Bacterial meningitis *see* **Meningitis**

Bacterial vaginosis *see* **Vulvovaginitis**

Bacteroides infection *see* **Anaerobic infections**

Bad breath

Definition

Bad breath, sometimes called halitosis, is an unpleasant odor of the breath.

Description

Bad breath is likely to be experienced by most adults at least occasionally. Bad breath, either real or imagined, can have a significant impact on a person's social and professional life.

Causes and symptoms

Bad breath can be caused by a number of problems. Oral diseases, fermentation of food particles in the mouth, sinus infections, and unclean dentures can all contribute to mouth odor. Many non-oral diseases, such as lung infections, kidney failure, or severe liver disease, can also cause bad breath, though rarely. Many people think that bad breath can originate in the stomach or intestines; this is extremely rare. The esophagus is usually collapsed and closed, and, although a belch may carry odor up from the stomach, the chance of bad breath being caused from air continually escaping from the stomach is remote. Cigarette smoke can cause bad breath, not only in the cigarette smoker, but also in one who is constantly exposed to second-hand smoke.

Diagnosis

The easiest way to determine if one has bad breath is to ask someone who is trustworthy and discrete. This is usually not too difficult. Another, more private, method of determining if one has bad breath is to lick one's wrist, wait until it dries, then smell the area. Scraping the rear area of the tongue with a plastic spoon, then smelling the spoon, is another method one can use to assess bad breath.

KEY TERMS

Halitosis—The medical term for bad breath.

Treatment

The most effective treatment of bad breath is to treat the cause. Poor **oral hygiene** can be improved by regular brushing and flossing, as well as regular dental checkups. Gentle brushing of the tongue should be part of daily oral hygiene. In addition to good oral hygiene, the judicious use of mouthwashes is helpful. Mouth dryness, experienced at night or during **fasting**, or due to certain medications and medical conditions, can contribute to bad breath. Dryness can be avoided by drinking adequate amounts of water. Chewing gum may be beneficial.

As mentioned, some medications, such as some high blood pressure medications, can cause **dry mouth**. If this problem is significant, a medication change, under the supervision of one's health care provider, may improve the dry-mouth condition. Oral or sinus infections, once diagnosed, can be treated medically, usually with **antibiotics**. Lung infections and kidney or liver problems will, of course, need medical treatment

Alternative treatment

Depending on the cause, a multitude of alternative therapeutic remedies can be used. For example, **sinusitis** can be treated with steam inhalation of essential oils and/or herbs.

Prognosis

Most bad breath can be treated successfully with good oral hygiene and/or medical care. Occasionally, for patients who feel that these therapies are unsuccessful, some delusional or obsessive behavior pattern might pertain, and mental health counseling may be appropriate.

Resources

BOOKS
Berkow, Robert, ed. *The Merck Manual*. 16th ed. Rahway, NJ: Merck Sharp & Dohme Research Laboratories, 1992.

PERIODICALS
Rosenberg, M. "Clinical Assessment of Bad Breath." *Journal of the American Dental Association* (Apr. 1996): 475-481.

ORGANIZATIONS
American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Joseph Knight, PA

Balance and coordination tests

Definition

Balance is the ability to maintain a position. Coordination is the capacity to move through a complex set of movements. Balance and coordination depend on the interaction of multiple body organs and systems including the eyes, ears, brain and nervous system, cardiovascular system, and muscles. Tests or examination of any or all of these organs or systems may be necessary to determine the causes of loss of balance, **dizziness**, or the inability to coordinate movement or activities.

Purpose

Tests of balance and coordination, and the examination of the organs and systems that influence balance and coordination, can help to identify causes of dizziness, **fainting**, falling, or incoordination.

Precautions

Tests for balance and coordination should be conducted in a safe and controlled area where patients will not experience injury if they become dizzy or fall.

Description

Assessment of balance and coordination can include discussion of the patient's medical history and a complete **physical examination** including evaluation of the heart, head, eyes, and ears. A slow pulse or heart rate, or very low blood pressure may indicate a circulatory system problem, which can cause dizziness or fainting. During the examination, the patient may be asked to rotate the head from side to side while sitting up or while lying down with the head and neck extended over the edge of the examination table. If these tests produce dizziness or a rapid twitching of the eyeballs (**nystagmus**), the patient may have a disorder of the inner ear, which is responsible for maintaining balance.

An examination of the eyes and ears may also give clues to episodes of dizziness or incoordination. The patient may be asked to focus on a light or on a distant point or object, and to look up, down, left, and right moving only the eyes while the eyes are examined. Problems with vision may, in themselves, contribute to balance and coordination disturbances, or may indicate more serious problems of the nervous system or brain function. **Hearing loss**, fluid in the inner ear, or ear infection might indicate the cause of balance and coordination problems.

A patient sits on a ball, working on his balance. He wears a belt so that the physical therapist can catch him if he loses balance. *(Custom Medical Stock Photo. Reproduced by permission.)*

Various physical tests may also be used. A patient may be asked to walk a straight line, stand on one foot, or touch a finger to the nose to help assess balance. The patient may be asked to squeeze or push against the doctor's hands, to squat down, to bend over, stand on tiptoes or stand on their heels. Important aspects of these tests include holding positions for a certain number of seconds, successfully repeating movements a certain number of times, and repeating the test accurately with eyes closed. The patient's reflexes may also be tested. For example, the doctor may tap on the knees, ankles, and elbows with a small rubber mallet to test nervous system functioning. These tests may reveal

KEY TERMS

Meniere's disease—An abnormality of the inner ear that causes dizziness, ringing in the ears, and hearing loss.

muscle weakness or nervous system problems that could contribute to incoordination.

Preparation

No special preparation is required prior to administration of balance and coordination tests. The patient may be asked to disrobe and put on an examination gown to make it easier for the doctor to observe muscles and reflex responses.

Aftercare

No special aftercare is generally required, however, some of the tests may cause episodes of dizziness or incoordination. Patients may need to use caution in returning to normal activities if they are experiencing any symptoms of dizziness, lightheadedness, or weakness.

Risks

These simple tests of balance and coordination are generally harmless.

Normal results

Under normal conditions, these test will not cause dizziness, loss of balance, or incoordination.

Abnormal results

The presence of dizziness, lightheadedness, loss of coordination, unusual eye movements, muscle weakness, or impaired reflexes are abnormal results and may indicate the problem causing the loss of balance or incoordination. In some cases, additional testing may be needed to diagnose the cause of balance or coordination problems.

Resources

BOOKS

Blakley, B. W., and M. E. Siegel. "Finding the Cause of Dizziness and Vertigo." In *Feeling Dizzy: Understanding and Treating Dizziness, Vertigo, and Other Balancing Disorders*. New York: Macmillan Publishing, 1995.

"Clinical Evaluation of Complaints Referable to the Ears." In *The Merck Manual*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck & Co., Inc., 1992.

Shaw, Michael, ed. *Everything You Need to Know About Diseases*. Springhouse, PA: Springhouse Corporation, 1996.

PERIODICALS

Bowen, J. "Dizziness: A Diagnostic Puzzle." *Hospital Medicine* 34, no. 1 (1998): 39-44.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Ear Foundation. 1817 Patterson St., Nashville, TN 37203. (800) 545-4327. <http://www.earfoundation.org>.

Vestibular Disorders Association (VEDA). P.O. Box 4467, Portland, OR 97208-4467. (800) 837-8428 or (503) 229-7705 (phone); (503) 229-8064 (FAX).

Altha Roberts Edgren

Balanitis

Definition

Balanitis is an inflammation of the head and foreskin of the penis.

Description

Balanitis generally affects uncircumcised males. These are men who have a foreskin, which is the "hood" of soft skin that partially covers the head of the penis. In balanitis, the head and foreskin become red and inflamed. (In circumcised men, who lack a foreskin, these symptoms only affect the tip of the penis.) The condition often occurs due to the fungus *Candida albicans*, the same organism that causes vaginal yeast infections in women. Balanitis (which is also referred to as balanoposthitis) can be caused by a variety of other fungal or bacterial infections, or may occur due to a sensitivity reaction to common chemical agents.

Uncircumcised men are more at risk for balanitis due to the presence of the foreskin. The snug fit of the foreskin around the top of the penis tends to create a damp, warm environment that encourages the growth of microorganisms. Most of the organisms associated with balanitis are already present on the penis, but in very small numbers. However, if the area between the head and foreskin is not cleansed thoroughly on a regular basis, these organisms can multiply and lead to infection.

Diabetes can increase the risk of developing the condition.

Causes and symptoms

Balanitis is usually a result of poor hygiene—for example, neglecting to bathe for several days. A failure

to properly wash (or rinse) the area between the head and foreskin can lead to the development of fungal or bacterial infections that cause the condition. In other cases, balanitis may occur due to an allergic reaction: Some men may be sensitive to chemicals found in harsh soaps, laundry detergents, or contraceptive creams. Men who contract a **sexually transmitted disease** (STD) such as trichimoniasis may also develop symptoms.

The symptoms of balanitis are limited to the foreskin and head of the penis (in circumcised men, only the head is affected). These include redness, inflammation, **pain**, discharge, sore or itchy skin, and difficulty retracting the foreskin.

Diagnosis

Balanitis is usually diagnosed based on a brief **physical examination**. This may be conducted by your regular health care provider or by a urologist, the type of doctor who specializes in such disorders. The doctor may take a sample of the discharge (if any) to determine the nature of the possible infection. A urine test may be recommended to evaluate glucose (sugar) levels in the urine. Balanitis treatment is typically covered by medical insurance.

Treatment

The treatment of balanitis depends on the specific cause, which can vary from case to case. **Antibiotics** are used to treat bacterial infections, while topical antifungals such as clotrimazole can combat balanitis caused by *Candida*. If an allergic reaction is causing symptoms, the goal is to identify the chemical agent responsible. Ointments or creams may be used to ease skin irritation.

No matter what the cause, it is important to thoroughly clean the penis on a daily basis in order to alleviate symptoms. If the condition keeps occurring, or if the inflammation is interfering with urination, **circumcision** may be advised.

Alternative treatment

According to practitioners of alternative medicine, certain herbs may be effective in controlling or preventing yeast infections—a common cause of balanitis. These remedies include garlic, calendula, and goldenseal. Eating yogurt that contains acidophilus may also help to clear up a *Candida* infection.

Prognosis

Most cases go away quickly once the cause is identified and treated. However, regular bouts of balanitis can result in urethral stricture.

KEY TERMS

Acidophilus—A bacteria believed to combat yeast infections.

Circumcision—The surgical removal of the foreskin.

Urethral stricture—A narrowing of the urethra (urine tube).

Prevention

Proper hygiene is the best way to avoid balanitis. Circumcision is sometimes performed to prevent repeated cases.

Resources

BOOKS

Smith, Donald R. *Smith's General Urology. 14th ed.* Norwalk, CT: Appleton & Lange, 1995.

Tierney, Lawrence M., et al. *Current Medical Diagnosis and Treatment* McGraw-Hill, 2000.

PERIODICALS

Edwards S. "Balanitis and balanoposthitis: a review." *Genitourinary Medicine* 72 (June 1996): 155-9.

Mayser, P. "Mycotic infections of the penis." *Andrologia* 31 Suppl 1 (1999): 13-6.

ORGANIZATIONS

U.S. National Library of Medicine. 8600 Rockville Pike, Bethesda, MD 20894. (888) 346-3656. <http://www.nlm.nih.gov>.

Greg Annussek

Balantidiasis

Definition

Balantidiasis is an infectious disease produced by a single-celled microorganism (protozoan) called *Balantidium coli* that infects the digestive tract. It is primarily a disease of the tropics, although it is also found in cooler, temperate climates. Most persons with balantidiasis do not exhibit any noticeable symptoms (asymptomatic), but a few individuals will develop **diarrhea** with blood and mucus and an inflamed colon (colitis).

Description

Balantidiasis is caused by *Balantidium coli*, a parasitic protozoan that infects the large intestine. *B. coli* is

the largest and only protozoan, having cilia or hair-like structures, that is capable of causing disease in humans. Balantidiasis occurs most commonly in areas with poor sanitation and in settings where humans live in close contact with pigs, sheep, or goats.

Causes and symptoms

Balantidiasis is transmitted primarily by eating food or drinking water that has been contaminated by human or animal feces containing *B. coli* cysts. During its life cycle, this organism exists in two very different forms: the infective cyst or capsuled form, which cannot move but can survive outside the human body because of its thick, protective covering; and the disease-producing form, the trophozoite, which although capable of moving, cannot survive once excreted in the feces and, therefore, cannot infect others. In the digestive tract, the cysts are transported to the intestine where the walls of the cysts are broken open by digestive secretions, releasing the mobile trophozoites. Once released within the intestine, the trophozoites multiply by feeding on intestinal bacteria or by invading the lining of the large intestine. Within the lining of the large intestine, the trophozoites secrete a substance that destroys intestinal tissue and creates sores (ulcers) or abscesses. Trophozoites eventually form new cysts that are carried through the digestive tract and excreted in the feces. Under favorable temperature and humidity conditions, the cysts can survive in soil or water for weeks to months, ready to begin the cycle again.

Most individuals with balantidiasis have no noticeable symptoms. Even though these individuals may not feel ill, they are still capable of infecting others by person-to-person contact or by contaminating food or water with cysts that others may ingest, for example, by preparing food with unwashed hands.

The most common symptoms of balantidiasis are chronic diarrhea or severe colitis with abdominal cramps, **pain**, and bloody stools. Complications may include intestinal perforation in which the intestinal wall becomes torn, but the organisms do not spread to other parts of the body in the blood stream.

Diagnosis

Diagnosis of balantidiasis, as with other similar diseases, can be complicated, partly because symptoms may or may not be present. A diagnosis of balantidiasis may be considered when a patient has diarrhea combined with a possible history of recent exposure to **amebiasis** through travel, contact with infected persons, or anal intercourse.

Specifically, a diagnosis of balantidiasis is made by finding *B. coli* cysts or trophozoites in the patient's stools or by finding trophozoites in tissue samples (biopsy) taken from the large bowel. A diagnostic blood test has not yet been developed.

Stool examination

This test involves microscopically examining a stool sample for the presence of cysts and/or trophozoites of *B. coli*.

Sigmoidoscopy

To take a tissue sample from the large intestine, a procedure called a **sigmoidoscopy** is performed. During a sigmoidoscopy, a thin, flexible instrument is used to visually examine the intestinal lining and obtain small tissue specimens.

Treatment

Patients with balantidiasis are treated with prescription medication, typically consisting of a ten day course of either tetracycline or metronidazole. Alternative drugs that have proven effective in treating balantidiasis include iodoquinol or paromomycin.

Prognosis

Although somewhat dependent on the patient's overall health, in general, the prognosis for most patients with balantidiasis is good. Severely infected patients occasionally die as a result of a tear in the intestinal wall (intestinal perforation) and consequent loss of blood.

Prevention

There are no immunization procedures or medications that can be taken prior to potential exposure to prevent balantidiasis. Moreover, people who have had the disease can become reinfected. Prevention requires effective personal and community hygiene. Specific safeguards include the following:

- Purification of drinking water. Water can be purified by filtering, boiling, or treatment with iodine.
- Proper food handling. Measures include protecting food from contamination by flies, cooking food properly, washing one's hands after using the bathroom and before cooking or eating, and avoiding foods that cannot be cooked or peeled when traveling in countries with high rates of balantidiasis.
- Careful disposal of human feces.
- Monitoring the contacts of balantidiasis patients. The stools of family members and sexual partners of infected persons should be tested for the presence of cysts or trophozoites.

KEY TERMS

Asymptomatic—Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Biopsy—The removal of a tissue sample for diagnostic purposes.

Ciliated—Covered with short, hair-like protrusions, like *B. coli* and certain other protozoa. The cilia or hairs help the organism to move.

Colitis—An inflammation of the large intestine that occurs in some cases of balantidiasis. It is marked by cramping pain and the passing of bloody mucus.

Protozoan—A single-celled, usually microscopic organism, such as *B. coli*, that is eukaryotic and, therefore, different from bacteria (prokaryotic).

Sigmoidoscopy—A procedure in which a thin, flexible, lighted instrument, called a sigmoidoscope, is used to visually examine the lower part of the large intestine.

Resources

BOOKS

Goldsmith, Robert S. "Infectious Diseases: Protozoal & Helminthic." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Gumprecht, Jeffrey P., and Murray Wittner. "Other Intestinal Parasites." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Weinberg, Adriana, and Myron J. Levin. "Infections: Parasitic & Mycotic." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Baldness *see* **Alopecia**

Balloon angioplasty *see* **Angioplasty**

Balloon valvuloplasty

Definition

Balloon valvuloplasty is a procedure in which a narrowed heart valve is stretched open using a procedure that does not require open heart surgery.

Purpose

There are four valves in the heart, which are located at the exit of each of the four chambers of the heart. They are called aortic valve, pulmonary valve, mitral valve, and tricuspid valve. The valves open and close to regulate the blood flow from one chamber to the next. They are vital to the efficient functioning of the heart.

In some people the valves are too narrow (a condition called stenosis). Balloon valvuloplasty is performed on children and adults to improve valve function and blood flow by enlarging the valve opening. It is a treatment for aortic, mitral, and pulmonary stenosis. Balloon valvuloplasty has the best results as a treatment for narrowed pulmonary valves. Results in treating narrowing of the mitral valve are generally good. It is more difficult to perform and less successful in treating narrowing of the aortic valve.

Description

Balloon valvuloplasty is a procedure in which a thin tube (catheter) that has a small deflated balloon at the tip is inserted through the skin in the groin area into a blood vessel, and then is threaded up to the opening of the narrowed heart valve. The balloon is inflated, which stretches the valve open. This procedure cures many valve obstructions. It is also called balloon enlargement of a narrowed heart valve.

The procedure is performed in a **cardiac catheterization** laboratory and takes up to four hours. The patient is usually awake, but is given local anesthesia to make the area where the catheter is inserted numb. After the site where the catheter will be inserted is prepared and anesthetized, the cardiologist inserts a catheter into the appropriate blood vessel, then passes a balloon-tipped catheter through the first catheter. Guided by a video monitor and an x ray, the physician slowly threads the catheter into the heart. The deflated balloon is positioned in the valve opening, then is inflated repeatedly. The inflated balloon widens the valve's opening by splitting the valve leaflets apart. Once the valve is widened, the balloon-tipped catheter is removed. The other catheter remains in place for 6 to 12 hours because in some cases the procedure must be repeated.

Preparation

For at least six hours before balloon valvuloplasty, the patient will have to avoid eating or drinking anything. An intravenous line is inserted so that medications can be administered. The patient's groin area is shaved and cleaned with an antiseptic. About an hour before the procedure, the patient is given an oral sedative such as diazepam (Valium).

Aftercare

After balloon valvuloplasty, the patient is sent to the recovery room for several hours, where he or she is monitored for vital signs (such as pulse and breathing) and heart sounds. An electrocardiogram, which is a record of the electrical impulses in the heart, is done. The leg in which the catheter was inserted is temporarily prevented from moving. The skin condition is monitored. The insertion site, which will be covered by a sandbag, is observed for bleeding until the catheter is removed. Intravenous fluids will be given to help eliminate the x-ray dye; intravenous blood thinners or other medications to dilate the coronary arteries may be given. **Pain** medication is available.

For at least 30 minutes after removal of the catheter, direct pressure is applied to the site of insertion; after this a pressure dressing will be applied. Following discharge from the hospital, the patient can usually resume normal activities. After balloon valvuloplasty lifelong follow-up is necessary because valves sometimes degenerate or narrowing recurs, making surgery necessary.

Risks

Balloon valvuloplasty can have serious complications. For example, the valve can become misshapen so that it doesn't close completely, which makes the condition worse. **Embolism**, where pieces of the valve break off and travel to the brain or the lungs, is another possible risk. If the procedure causes severe damage to the valve leaflets, immediate surgery is required. Less frequent complications are bleeding and hematoma (a local collection of clotted blood) at the puncture site, abnormal heart rhythms, reduced blood flow, **heart attack**, heart puncture, infection, and circulatory problems.

Resources

BOOKS

"Balloon Valvuloplasty." In *Mayo Clinic Practice of Cardiology.* 3rd ed. Ed. Emilio R. Giuliani, et al. St. Louis: Mosby, 1996.

Texas Heart Institute. "Congenital Heart Disease" and "Diseases of the Heart Valves." In *Texas Heart Institute's Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

"Valvular Heart Disease" and "Pulmonary Stenosis." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

PERIODICALS

Latson, Larry A. "Interventional Catheterization for Congenital Heart Disease-Limited 'Surgery' Without the Chest Scar." *Clinical Pediatrics* 36 (Mar. 1997): 125.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

KEY TERMS

Cardiac catheterization—A technique used to evaluate the heart and fix certain problems. Catheterization is far less invasive than traditional surgery.

Stenosis—The narrowing of any valve, especially one of the heart valves or the opening into the pulmonary artery from the right ventricle.

Valve—Tissue in the passageways between the heart's upper and lower chambers that controls passage of blood and prevents regurgitation.

OTHER

"Congenital Heart Disease Treatments." American Heart Association. 1997. 9 Apr. 1998 <http://www.americanheart.org>.

Lori De Milto

Bancroftian filariasis *see* **Elephantiasis**

Bang's disease *see* **Brucellosis**

Barbiturate-induced coma

Definition

A barbiturate-induced **coma**, or barb coma, is a temporary state of unconsciousness brought on by a controlled dose of a barbiturate drug, usually pentobarbital or thiopental.

Purpose

Barbiturate comas are used to protect the brain during major brain surgery, such as the removal of **arteriovenous malformations** or aneurysms. Coma may also be induced to control intracranial **hypertension** caused by brain injury.

Precautions

Barbiturate-induced comas are used when conventional therapy to reduce intracranial hypertension has failed. Barbiturate dosing is geared toward burst suppression—that is, reducing brain activity as measured by **electroencephalography**. This reduction in brain activity has to be balanced against the potential side effects of **barbiturates**, which include allergic reactions and effects on the cardiovascular system.

KEY TERMS

Aneurysm—A bulge or sack-like projection from a blood vessel.

Arteriovenous malformation—An abnormal tangle of arteries and veins in which the arteries feed directly into the veins without a normal intervening capillary bed.

Diuretic agent—A drug which increases urine output.

Electroencephalography—The recording of electrical potentials produced by the brain. These potentials indicate brain activity.

Hyperventilation—A respiratory therapy involving deeper and/or faster breathing to keep the carbon dioxide pressure in the blood below normal.

Intracranial hypertension—Abnormally high blood pressure within the skull.

Osmotherapy—Intravenous injection or oral administration of an agent that induces dehydration. The goal of dehydration is to reduce the amount of accumulated fluid in the brain.

Steroid—A type of drug used to reduce swelling.

Description

One of the greatest hazards associated with brain injury is intracranial hypertension. Brain injury may be caused by an accidental **head injury** or a medical condition, such as **stroke**, tumor, or infection. When the brain is injured, fluids accumulate in the brain, causing it to swell. The skull does not allow for the expansion of the brain; in effect, the brain becomes compressed.

If the pressure does not abate, oxygenated blood may not reach all areas of the brain. Also, the brain tissue may be forced against hard, bony edges on the interior of the skull. In either case, the brain tissue may die, causing permanent brain damage or **death**.

Barbiturates reduce the metabolic rate of brain tissue, as well as the cerebral blood flow. With these reductions, the blood vessels in the brain narrow, decreasing the amount of swelling in the brain. With the swelling relieved, the pressure decreases and some or all brain damage may be averted.

Controversy exists, however, over the benefits of using barbiturates to control intracranial hypertension. Some studies have shown that barbiturate-induced coma can reduce intracranial hypertension but does not necessarily prevent brain damage. Furthermore, the reduction in intracranial hypertension may not be sustained.

Preparation

Inducing a barbiturate coma is usually kept in reserve for cases in which conventional treatments for controlling intracranial hypertension have failed. Before coma is induced, intracranial hypertension may be treated by hyperventilation; by facilitation of blood flow from the brain; by decompressive surgical procedures, such as draining excess fluids from under the skull or from the chambers within the brain (ventricles); or by drug therapy, including osmotherapy, diuretic agents, or steroids.

Risks

An estimated 25% of barbiturate-induced comas are accompanied by severe side effects. The side effects of barbiturates, especially the depressive effect on the cardiovascular system, can be too risky for some patients. Other side effects include impaired gastrointestinal motility and impaired immune response and infection. Since barbiturates depress activity in the brain, measurements of brain activity may be unreliable. Careful monitoring of the patient is required to ensure nutritional needs are being met and to guard against complications, such as lung infection, fevers, or deep vein blood clots.

Normal results

In many patients who do not respond to conventional therapy, barbiturate-induced coma can achieve the necessary control of intracranial hypertension.

Resources

PERIODICALS

Lee, Michael W., et al. "The Efficacy of Barbiturate Coma in the Management of Uncontrolled Intracranial Hypertension Following Neurosurgical Trauma." *Journal of Neurotrauma* 11, no. 3 (1994): 325.

Myles, Geraldine L., et al. "Quantifying Nursing Care in Barbiturate-Induced Coma with the Therapeutic Intervention Scoring System." *Journal of Neuroscience Nursing* 27, no. 1 (1995): 35.

Schwab, Stefan, et al. "Barbiturate Coma in Severe Hemispheric Stroke: Useful or Obsolete?" *Neurology* 48 (1997): 1608.

Julia Barrett

Barbiturate withdrawal *see* **Withdrawal syndromes**

Barbiturates

Definition

Barbiturates are medicines that act on the central nervous system and cause drowsiness and can control seizures.

Purpose

Barbiturates are in the group of medicines known as **central nervous system depressants** (CNS). Also known as sedative-hypnotic drugs, barbiturates make people very relaxed, calm, and sleepy. These drugs are sometimes used to help patients relax before surgery. Some may also be used to control seizures (convulsions). Although barbiturates have been used to treat nervousness and sleep problems, they have generally been replaced by other medicines for these purposes.

These medicines may become habit forming and should not be used to relieve everyday **anxiety** and tension or to treat sleeplessness over long periods.

Description

Barbiturates are available only with a physician's prescription and are sold in capsule, tablet, liquid, and injectable forms. Some commonly used barbiturates are phenobarbital (Barbita) and secobarbital (Seconal).

Recommended dosage

Recommended dosage depends on the type of barbiturate and other factors such as the patient's age and the condition for which the medicine is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take barbiturates exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. If the medicine does not seem to be working, even after taking it for several weeks, do not increase the dosage. Instead, check with the physician who prescribed the medicine.

Do not stop taking this medicine suddenly without first checking with the physician who prescribed it. It may be necessary to taper down gradually to reduce the chance of withdrawal symptoms. If it is necessary to stop taking the drug, check with the physician for instructions on how to stop.

Precautions

See a physician regularly while taking barbiturates. The physician will check to make sure the medicine is working as it should and will note unwanted side effects.

Because barbiturates work on the central nervous system, they may add to the effects of alcohol and other drugs that slow the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. The combined effects of barbiturates and alcohol or other CNS depressants (drugs that slow the central nervous system) can be very dangerous, leading to unconsciousness or even **death**. Anyone taking barbiturates should not drink alcohol and should check with his or her physician before taking any medicines classified as CNS depressants.

Taking an overdose of barbiturates or combining barbiturates with alcohol or other central nervous system depressants can cause unconsciousness and even death. Anyone who shows signs of an overdose or a reaction to combining barbiturates with alcohol or other drugs should get emergency medical help immediately. Signs include:

- severe drowsiness
- breathing problems
- slurred speech
- staggering
- slow heartbeat
- severe confusion
- severe weakness

Barbiturates may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

People may feel drowsy, dizzy, lightheaded, or less alert when using these drugs. These effects may even occur the morning after taking a barbiturate at bedtime. Because of these possible effects, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Barbiturates may cause physical or mental dependence when taken over long periods. Anyone who shows these signs of dependence should check with his or her physician right away:

- the need to take larger and larger doses of the medicine to get the same effect
- a strong desire to keep taking the medicine
- withdrawal symptoms, such as anxiety, nausea or vomiting, convulsions, trembling, or sleep problems, when the medicine is stopped

Children may be especially sensitive to barbiturates. This may increase the chance of side effects such as unusual excitement.

Older people may also be more sensitive that others to the effects of this medicine. In older people, barbiturates may be more likely to cause confusion, depression, and unusual excitement. These effects are also more likely in people who are very ill.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take barbiturates. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to barbiturates in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Taking barbiturates during **pregnancy** increases the chance of **birth defects** and may cause other problems such as prolonged labor and withdrawal effects in the baby after birth. Pregnant women who must take barbiturates for serious or life-threatening conditions should thoroughly discuss with their physicians the benefits and risks of taking this medicine.

BREASTFEEDING. Barbiturates pass into breast milk and may cause problems such as drowsiness, breathing problems, or slow heartbeat in nursing babies whose mothers take the medicine. Women who are breastfeeding should check with their physicians before using barbiturates.

OTHER MEDICAL CONDITIONS. Before using barbiturates, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcohol or drug abuse
- depression
- hyperactivity (in children)
- pain
- kidney disease
- liver disease
- diabetes
- overactive thyroid
- underactive adrenal gland
- chronic lung diseases such as **asthma** or **emphysema**
- severe anemia
- porphyria

USE OF CERTAIN MEDICINES. Taking barbiturates with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **dizziness**, lightheadedness, drowsiness, and clumsiness or unsteadiness. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine immediately:

- **fever**
- muscle or joint pain
- sore throat
- chest pain or tightness in the chest
- wheezing
- skin problems, such as rash, **hives**, or red, thickened, or scaly skin
- bleeding sores on the lips
- sores or painful white spots in the mouth
- swollen eyelids, face, or lips

In addition, check with a physician as soon as possible if confusion, depression, or unusual excitement occur after taking barbiturates.

Patients who take barbiturates for a long time or at high doses may notice side effects for some time after they stop taking the drug. These effects usually appear within 8-16 hours after the patient stops taking the medicine. Check with a physician if these or other troublesome symptoms occur after stopping treatment with barbiturates:

- dizziness, lightheadedness or faintness
- anxiety or restlessness
- **hallucinations**
- vision problems
- nausea and vomiting
- seizures (convulsions)
- muscle twitches or trembling hands
- weakness
- sleep problems, nightmares, or increased dreaming

Other side effects may occur. Anyone who has unusual symptoms during or after treatment with barbiturates should get in touch with his or her physician.

KEY TERMS

Adrenal glands—Two glands located next to the kidneys. The adrenal glands produce the hormones epinephrine and norepinephrine and the corticosteroid (cortisone-like) hormones.

Anemia—A lack of hemoglobin—the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Central nervous system—The brain, spinal cord, and nerves throughout the body.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Hypnotic—A medicine that causes sleep.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things, such as chlorophyll which makes plants green and hemoglobin which makes blood red.

Sedative—Medicine that has a calming effect and may be used to treat nervousness or restlessness.

Seizure—A sudden attack, spasm, or convulsion.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

Interactions

Birth control pills may not work properly when taken while barbiturates are being taken. To prevent pregnancy, use additional or additional methods of birth control while taking barbiturates.

Barbiturates may also interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes barbiturates should let the physician know all other medicines he or she is taking. Among the drugs that may interact with barbiturates are:

- Other central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics.
- Blood thinners.
- Adrenocorticoids (cortisone-like medicines).
- Antiseizure medicines such as valproic acid (Depakote and Depakene), and carbamazepine (Tegretol).

The list above does not include every drug that may interact with barbiturates. Be sure to check with a physician or pharmacist before combining barbiturates with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Miller, Norman S. "Sedative-Hypnotics: Pharmacology and Use." *Journal of Family Practice* 29 (Dec. 1989): 665.

Nancy Ross-Flanigan

Barium enema

Definition

A barium enema, also known as a lower GI (gastrointestinal) exam, is a test that uses x-ray examination to view the large intestine. There are two types of this test: the single-contrast technique where barium sulfate is injected into the rectum in order to gain a profile view of the large intestine; and the double-contrast (or "air contrast") technique where air is inserted into the rectum.

Purpose

A barium enema may be performed for a variety of reasons, including to aid in the diagnosis of colon and **rectal cancer** (or colorectal **cancer**), and inflammatory disease. Detection of polyps (a benign growth in the tissue lining of the colon and rectum), diverticula (a pouch pushing out from the colon), and structural changes in the large intestine can also be established with this test. The double-contrast barium enema is the best method for detecting small tumors (such as polyps), early inflammatory disease, and bleeding caused by ulcers.

The decision to perform a barium enema is based on a person's history of altered bowel habits. These can include **diarrhea**, **constipation**, any lower abdominal **pain** they are currently exhibiting, blood, mucus, or pus in their stools. It is also recommended that this exam be used every five to 10 years to screen healthy people for colorectal cancer, the second most deadly type of tumor in the United States. Those who have a close relative with colorectal cancer or have had a precancerous polyp are considered to be

at an increased risk for the disease and should be screened more frequently to look for abnormalities.

Precautions

While barium enema is an effective screening method in the detection of symptoms and may lead to a timely diagnosis of several diseases, it is not the only method to do this. As of 1997, some studies have shown that the **colonoscopy** procedure performed by experienced gastroenterologists is a more accurate initial diagnostic tool for detecting early signs of colorectal cancer. A colonoscopy is the most accurate way for the physician to examine the entire colon and rectum for polyps. If abnormalities are seen at this time the procedure is accompanied by a biopsy. Some physicians use **sigmoidoscopy** plus a barium enema instead of colonoscopy.

Description

To begin a barium enema, the patient will lie with their back down on a tilting radiographic table in order to have x rays of the abdomen taken. After being assisted to a different position, a well-lubricated rectal tube is inserted through the anus. This tube allows the physician or assistant to slowly administer the barium into the intestine. While this filling process is closely monitored, it is important for the patient to keep the anus tightly contracted against the rectal tube to help maintain its position and prevent the barium from leaking. This step is emphasized to the patient due to the inaccuracy that may be caused if the barium leaks. A rectal balloon may also be inflated to help retain the barium. The table may be tilted or the patient moved to a different position to aid in the filling process.

As the barium fills the intestine, x rays of the abdomen are taken to distinguish significant findings.There are many ways to perform a barium enema. One way is that shortly after filling, the rectal tube is removed and the patient expels as much of the barium as possible. Upon completing this, an additional x ray is taken, and a double-contrast enema may follow. If this is done immediately, a thin film of barium will remain in the intestine, and air is then slowly injected to expand the bowel lumen. Sometimes no x rays will be taken until after the air is injected.

Preparation

In order to conduct the most accurate barium enema test, the patient must follow a prescribed diet and bowel preparation instructions prior to the test. This preparation commonly includes restricted intake of diary products and a liquid diet for 24 hours prior to the test, in addition to drinking large amounts of water or clear liquids 12–24 hours before the test. Patients may also be given **laxatives**, and asked to give themselves a cleansing enema.

In addition to the prescribed diet and bowel preparation prior to the test, the patient can expect the following during a barium enema:

- They will be well draped with a gown as they are secured to a tilting x-ray table.
- As the barium or air is injected into the intestine, they may experience cramping pains or the urge to defecate.
- The patient will be instructed to take slow, deep breaths through the mouth to ease any discomfort.

Aftercare

Patients should follow several steps immediately after undergoing a barium enema, including:

- Drink plenty of fluids to help counteract the dehydrating effects of bowel preparation and the test.
- Take time to rest. A barium enema and the bowel preparation taken before it can be exhausting.
- A cleansing enema may be given to eliminate any remaining barium. Lightly colored stools will be prevalent for the next 24-72 hours following the test.

Risks

While a barium enema is considered a safe screening test used on a routine basis, it can cause complications in certain people. The following indications should be kept in mind before a barium enema is performed:

- Those who have a rapid heart rate, severe **ulcerative colitis**, toxic megacolon, or a presumed perforation in the intestine should not undergo a barium enema.
- The test can be cautiously performed if the patient has a blocked intestine, ulcerative colitis, diverticulitis, or severe bloody diarrhea.
- Complications that may be caused by the test include perforation of the colon, water intoxication, barium granulomas (inflamed nodules), and allergic reaction. These are all very rare.

Normal results

When the patient undergoes a single-contrast enema, their intestine is steadily filled with barium to differentiate the colon's markings. A normal result displays uniform filling of the colon. As the barium is expelled, the intestinal walls collapse. A normal result on the x ray after defecation will show the intestinal lining as having a standard, feathery appearance.

KEY TERMS

Barium sulfate—A barium compound used during a barium enema to block the passage of x rays during the exam.

Bowel lumen—The space within the intestine.

Colonoscopy—An examination of the upper portion of the rectum performed with a colonoscope or elongated speculum.

Diverticula—A diverticulum of the colon is a sac or pouch in the colon walls which is usually asymptomatic (without symptoms) but may cause difficulty if it becomes inflamed.

Diverticulitis—A condition of the diverticulum of the intestinal tract, especially in the colon, where inflammation may cause distended sacs extending from the colon and pain.

Ulcerative colitis—An ulceration or erosion of the mucosa of the colon.

Proctosigmoidoscopy—A visual examination of the rectum and sigmoid colon using a sigmoidoscope.

Accordingly, the double-contrast enema expands the intestine which is already lined with a thin layer of barium, but with air to display a detailed image of the mucosal pattern. Varying positions taken by the patient allow the barium to collect on the dependent walls of the intestine by way of gravity.

Abnormal results

A barium enema allows abnormalities to appear on an x ray that may aid in the diagnosis of several different conditions. Although most colon cancers occur in the rectosigmoid region, or upper part of the rectum and adjoining portion of the sigmoid colon, and are better detected with a different test called a proctosigmoidoscopy, an enema can identify other early signs of cancer.

Identification of polyps, diverticulosis, inflammatory disease, such as diverticulitis and ulcerative colitis is attainable through a barium x ray. Structural changes in the intestine, **gastroenteritis**, and some cases of acute **appendicitis** may also be apparent by viewing this x ray.

Resources

BOOKS

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

"Detecting Colon Cancer: Colonoscopy Superior To Barium Enema." *Geriatrics* (Apr. 1997): 101.

"Screening Tests." *US News & World Report* 10 (Feb. 1997): 64.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Beth A. Kapes

Barium swallow *see* **Upper GI exam**

Barlow's syndrome *see* **Mitral valve prolapse**

Bartholin's gland cyst

Definition

A Bartholin's gland cyst is a swollen fluid-filled lump that develops from a blockage of one of the Bartholin's glands, which are small glands located on each side of the opening to the vagina. Bartholin's gland cysts and abscesses are commonly found in women of reproductive age, developing in approximately 2% of all women.

Description

The Bartholin's glands are located in the lips of the labia that cover the vaginal opening. The glands (normally the size of a pea) provide moisture for the vulva area. A Bartholin's gland cyst may form in the gland itself or in the duct draining the gland. A cyst normally does not cause **pain**, grows slowly, and may go away without treatment. It usually ranges in size from 0.4-1.2 in (1–3 cm), although some may grow much larger.

If infected, a Bartholin's gland cyst can form an **abscess** that will increase in size over several days and is very painful. In order to heal, a Bartholin's gland cyst usually must be drained.

Causes and symptoms

A Bartholin's gland cyst occurs if the duct becomes blocked for any reason, such as infection, injury, or chronic inflammation. Very rarely a cyst is caused by **cancer**, which usually occurs only in women over the age of 40. In many cases, the cause of a Bartholin's gland cyst is unknown.

Symptoms of an uninfected Bartholin's gland cyst include a painless lump on one side of the vulva area (most common symptom) and redness or swelling in the vulva area.

KEY TERMS

Marsupialization—Cutting out a wedge of the cyst wall and putting in stitches so the cyst cannot reoccur.

Sitz bath—A warm bath in which just the buttocks and genital area soak in water; used to reduce pain and aid healing in the genital area.

Window operation—Cutting out a large oval-shaped piece of the cyst wall and putting in stitches to create a window so the cyst cannot reoccur.

Word catheter—A small rubber catheter with an inflatable balloon tip that is inserted into a stab incision in the cyst, after the contents of the cyst have been drained.

Symptoms of an abscessed Bartholin's gland include:

- pain that occurs with walking, sitting, physical activity, or sexual intercourse
- fever and chills
- increased swelling in the vulva area over a two- to four-day period
- drainage from the cyst, normally occurring four to five days after the swelling starts

Abscesses may be caused by sexually transmitted bacteria, such as those causing chlamydial or gonococcal infections, while others are caused by bacteria normally occurring in the vagina. Over 60 types of bacteria have been found in Bartholin's gland abscesses.

Diagnosis

A Bartholin's gland cyst or abscess is diagnosed by a gynecological **pelvic exam**. If the cyst appears to be infected, a culture is often performed to identify the type of bacteria causing the abscess.

Treatment

Treatment for this condition depends on the size of the cyst, whether it is painful, and whether the cyst is infected.

If the cyst is not infected, treatment options include:

- watchful waiting by the woman and her health care professional
- soaking of the genital area with warm towel compresses
- soaking of the genital area in a sitz bath
- use of non-prescription pain medication to relieve mild discomfort

If the Bartholin's gland is infected, there are several treatments available to treat the abscess, including:

- soaking of the genital area in a sitz bath
- treatment with **antibiotics**
- use of prescription or non-prescription pain medication
- incision and drainage, i.e., cutting into the cyst and draining the fluid (not usually successful, as the cyst often reoccurs)
- placement of a drain (Word catheter) in the cyst for two to four weeks so fluid can drain and prevent reoccurrence of the cyst
- marsupialization
- window operation
- use of a carbon dioxide laser to open the cyst and heat the cyst wall tissue so that the cyst cannot form a sac and reoccur
- incision and drainage, followed by treatment with silver nitrate to burn the cyst wall so the cyst cannot form a sac and reoccur
- removal of the entire Bartholin's gland cyst, if the cyst has reoccurred several times after use of other treatment methods

During surgical treatment, the area will be numbed with a local anesthetic to reduce pain. General anesthesia may be used for treatment of an abscess, as the procedure can be painful.

In a pregnant woman, surgical treatment of cysts that are asymptomatic should be delayed until after delivery to avoid the possibility of excessive bleeding. However, if the Bartholin's gland is infected and must be drained, antibiotics and local anesthesia are generally considered safe.

If the cyst is caused by cancer, the gland must be excised, and the woman should be under the care of a gynecologist familiar with the treatment of this type of cancer.

Alternative treatment

If a Bartholin's gland cyst has no or mild symptoms, or has opened on its own to drain, a woman may decide to use watchful waiting, warm sitz baths, and non-prescription pain medication. If symptoms become worse or do not improve, a health care professional should then be consulted.

Infected Bartholin's glands should be evaluated and treated by a health care professional.

Prognosis

A Bartholin's gland cyst should respond to treatment in a few days. If an abscess requires surgery, healing may take days to weeks, depending on the size of the abscess and the type of surgical procedure used. Most of the surgical procedures, except for incision and drainage, should be effective in preventing recurring infections.

Prevention

There are few ways to prevent the formation of Bartholin's gland cysts or abscesses. However, as a Bartholin's gland abscess may be caused by a sexually transmitted disease, the practice of safe sex is recommended. Using good hygiene, i.e., wiping front to back after a bowel movement, is also recommended to prevent bacteria from the bowels from contaminating the vaginal area.

Resources

BOOKS

Toth, P. P. "Management of Bartholin's Gland Duct Cysts and Abscesses." In *Saunders Manual of Medical Practice*. Philadelphia: W.B. Saunders, 2000.

PERIODICALS

Hill, D. A., and J. J. Lense. "Office Management of Bartholin Gland Cysts and Abscesses." *American Family Physician* 57, no. 7 (1998): 1611-1616.

Judith Sims

Bartonella bacilliformis infection *see* **Bartonellosis**

Bartonellosis

Definition

Bartonellosis is an infectious bacterial disease with an acute form (which has a sudden onset and short course) and a chronic form (which has more gradual onset and longer duration). The disease is transmitted by sandflies and occurs in western South America. Characterized by a form of red blood cell deficiency (**hemolytic anemia**) and **fever**, the potentially fatal acute form is called Oroya fever or Carrion's disease. The chronic form is identified by painful **skin lesions**.

Description

The acute form of the disease gets its name from an outbreak that occurred in 1871 near La Oroya, Peru. More than 7,000 people perished. Some survivors later developed a skin disease, called verruga peruana (Peruvian **warts**). These skin lesions were observed prior to the 1871 outbreak—perhaps as far back as the pre-Columbian era—but a connection to Oroya fever was unknown. In 1885, a young medical researcher, Daniel Carrion, inoculated himself with blood from a lesion to study the course of the skin disease. When he became ill with Oroya fever, the connection became apparent. Oroya fever is often called Carrion's disease in honor of his fatal experiment.

The bacteria, *Bartonella bacilliformis*, was isolated by Alberto Barton in 1909, but wasn't identified as the cause of the fever until 1940. The *Bartonella* genus includes at least 11 bacteria species, four of which cause human diseases, including **cat-scratch disease** and **bacillary angiomatosis**. However, bartonellosis refers exclusively to the disease caused by *B. bacilliformis*. The disease is limited to a small area of the Andes Mountains in western South America; nearly all cases have been in Peru, Colombia, and Ecuador. A large outbreak involving thousands of people occurred in 1940–41, but bartonellosis has since occurred sporadically. Control of sandflies, the only known disease carrier (vector), has been credited with managing the disease.

KEY TERMS

Acute—Referring to the course of a disease, or a phase of a disease, the short-term experience of prominent symptoms.

Chronic—Referring to the course of a disease, or a phase of a disease, the long-term experience of prominent symptoms.

Erythrocytes—Red blood cells.

Hemolytic anemia—A form of erythrocyte deficiency caused by the destruction of the red blood cells.

Host—The organism that harbors or nourishes another organism (parasite). In bartonellosis, the person infected with *Bartonella basilliformis*.

Vector—An organism, such as insects or rodents, that can transmit disease to humans.

Causes and symptoms

Bartonellosis is transmitted by the nocturnal sandfly and arises from infection with *B. bacilliformis*. The sandfly, *Lutzomyia verrucarum*, dines on human blood and, in so doing, can inject bacteria into the bloodstream. The

sandfly is found only in certain areas of the Peruvian Andes; other, as-yet-unidentified vectors are suspected in Ecuador and Colombia.

Once in the bloodstream, the bacteria latch onto red blood cells (erythrocytes), burrow into the cells, and reproduce. In the process, up to 90% of the host's erythrocytes are destroyed, causing severe hemolytic anemia. The anemia is accompanied by high fever, muscle and joint **pain**, **delirium**, and possibly **coma**.

Two to eight weeks after the acute phase, an infected individual develops verruga peruana. However, individuals may exhibit the characteristic lesions without ever experiencing the acute phase. Left untreated, the lesions may last months or years. These lesions resemble blood-filled blisters, up to 1.6 in (4 cm) in diameter, and appear primarily on the head and limbs. They can be painful to the touch and may bleed or ulcerate.

Diagnosis

Bartonellosis is identified by symptoms and the patient's history, such as recent travel in areas where bartonellosis occurs. **Isolation** of *B. bacilliformis* from the bloodstream or lesions can confirm the diagnosis.

Treatment

Antibiotics are the mainstay of bartonellosis treatment. The bacteria are susceptible to several antibiotics, including chloramphenicol, **penicillins**, and **aminoglycosides**. Blood transfusions may be necessary to treat the anemia caused by bartonellosis.

Prognosis

Antibiotics have dramatically decreased the fatality associated with bartonellosis. Prior to the development of antibiotics, the fever was fatal in 40% of cases. With antibiotic treatment, that rate has dropped to 8%. Fatalities can result from complications associated with severe anemia and secondary infections. Once the infection is halted, an individual can recover fully.

Prevention

Avoiding sandfly bites is the primary means of prevention. Sandfly eradication programs have been helpful in decreasing the sandfly population, and insect repellant can be effective in preventing sandfly bites.

Resources

BOOKS

Daly, Jennifer S. "Bartonella Species." In *Infectious Diseases*. 2nd ed. Ed. Sherwood F. Gorbach, John S. Bartlett, and Neil R. Blacklow. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Alexander, Bruce. "A Review of Bartonellosis in Ecuador and Colombia." *American Journal of Tropical Medicine and Hygiene* 52, no. 4 (1995): 354.

Maurin, M., R. Birtles, and D. Raoult. "Current Knowledge of Bartonella Species." *European Journal of Clinical Microbiology and Infectious Disease* 16, no. 7 (1997): 487.

Nosal, Jane M. "Bacillary Angiomatosis, Cat-Scratch Disease, and Bartonellosis: What's the Connection?" *International Journal of Dermatology* 36 (1997): 405.

Julia Barrett

Basal cell cancer *see* **Skin cancer, non-melanoma**

Basal gastric secretion test *see* **Gastric acid determination**

Battered child syndrome

Definition

Battered child syndrome refers to injuries sustained by a child as a result of physical **abuse**, usually inflicted by an adult caregiver. Alternative terms include: shaken baby; **shaken baby syndrome**; **child abuse**; and non-accidental trauma (NAT).

Description

Internal injuries, cuts, **burns**, **bruises** and broken or fractured bones are all possible signs of battered child syndrome. Emotional damage to a child is also often the by-product of child abuse, which can result in serious behavioral problems such as substance abuse or the physical abuse of others. Approximately 14% of children in the United States are physically abused each year, and an estimated 2,000 of those children die as a result of the abuse. Between 1994–1995, 1.1 million cases of child abuse were recorded in the United States; of that number, 55% of the victims were less than a year old.

Causes and symptoms

Battered child syndrome (BCS) is found at every level of society, although the incidence may be higher in low-income households where adult caregivers suffer greater **stress** and social difficulties, without having had the benefit of higher education. The child abuser most often injures a child in the heat of anger, and was often abused as a child himself. The incessant crying of an

infant or child may trigger abuse. Symptoms may include a delayed visit to the emergency room with an injured child; an implausible explanation of the cause of a child's injury; bruises that match the shape of a hand, fist or belt; cigarette burns; scald marks; bite marks; black eyes; unconsciousness; bruises around the neck; and a bulging fontanel in infants.

Diagnosis

Battered child syndrome is most often diagnosed by an emergency room physician or pediatrician, or by teachers or social workers. **Physical examination** will detect bruises, burns, swelling, retinal hemorrhages. X rays, and other imaging techniques, such as MRI or scans may confirm **fractures** or other internal injuries. The presence of injuries at different stages of healing (i.e. having occurred at different times)is nearly always indicative of BCS. Establishing the diagnosis is often hindered by the excessive cautiousness of caregivers or by actual concealment of the true origin of the child¸s injuries, as a result of fear, shame and avoidance or denial mechanisms.

Treatment

Medical treatment for battered child syndrome will vary according to the type of injury incurred. Counseling and the implementation of an intervention plan for the child's parents or guardians is necessary. The child abuser may be incarcerated, and/or the abused child removed from the home to prevent further harm. Reporting child abuse to authorities is mandatory for doctors, teachers, and childcare workers in most states as a way to prevent continued abuse. Both physical and psychological therapy are often recommended as treatment for the abused child.

Prognosis

The prognosis for battered child syndrome will depend on the severity of injury, actions taken by the authorities to ensure the future safety of the injured child, and the willingness of parents or guardians to seek counseling for themselves as well as for the child.

Prevention

Recognizing the potential for child abuse in a situation, and the seeking or offering of intervention and counseling before battered child syndrome occurs is the best way to prevent it. Signs that physical abuse may be forthcoming include parental alcohol or substance abuse; previous abuse of the child or the child's siblings; history of mental or emotional problems in parents; parents abused as children; absence of visible parental love or concern for the child; child's hygiene neglected.

KEY TERMS

Fontanel—Soft spot on top of an infant's skull.

Subdural hematoma—Bleeding over the brain.

Multiple retinal hemorrhages—Bleeding in the back of the eye.

Resources

BOOKS

Lukefahr, James L. *"Treatment of Child Abuse."* Baltimore, MD: Johns Hopkins University Press, 2000.

Helfer, Mary Edna, Kempe, Ruth S., and Krugman, Richard D. *The Battered Child, 5th ed."* Chicago, IL, and London, England: University of Chicago Press, 1997.

PERIODICALS

Mulryan, Kathleen, "Protecting the Child." *Nursing (July, 2000)*

ORGANIZATIONS

Childhelp National Abuse Hotline. (800)422-4453.

Mary Jane Tenerelli

Becker muscular dystrophy *see* **Muscular dystrophy**

Bed-wetting

Definition

Bed-wetting is the unintentional (involuntary) discharge of urine during the night. Although most children between the ages of three and five begin to stay dry at night, the age at which children are physically and emotionally ready to maintain complete bladder control varies. Enuresis is a technical term that refers to the continued, usually involuntary, passage of urine during the night or the day after the age at which control is expected.

Description

Most children wet the bed occasionally, and definitions of the age and frequency at which bed-wetting becomes a medical problem vary somewhat. Many researchers consider bed-wetting normal until age 6.

About 10% of 6-year-old children wet the bed about once a month. More boys than girls have this problem. The American Psychiatric Association, however, defines enuresis as repeated voiding of urine into the bed or clothes at age five or older. The wetting is usually involuntary but in some cases it is intentional. For a diagnosis of enuresis, wetting must occur twice a week for at least three months with no underlying physiological cause. Enuresis, both nighttime (nocturnal) and daytime (diurnal), at age five affects 7% of boys and 3% of girls. By age 10, it affects 3% of boys and 2% of girls; only 1% of adolescents experience enuresis.

Enuresis is divided into two classes. A child with primary enuresis has never established bladder control. A child with secondary enuresis begins to wet after a prolonged dry period. Some children have both nocturnal and diurnal enuresis.

Causes and symptoms

The causes of bed-wetting are not entirely known. It tends to run in families. Most children with primary enuresis have a close relative—a parent, aunt, or uncle—who also had the disorder. About 70% of children with two parents who wet the bed will also wet the bed. Twin studies have shown that both of a pair of identical twins experience enuresis more often than both of a pair of fraternal twins.

Sometimes bed-wetting can be caused by a serious medical problem like diabetes, sickle-cell anemia, or epilepsy. **Snoring** and episodes of interrupted breathing during sleep (**sleep apnea**) occasionally contribute to bed-wetting problems. Enlarged adenoids can cause these conditions. Other physiological problems, such as urinary tract infection, severe **constipation**, or **spinal cord injury**, can cause bed-wetting.

Children who wet the bed frequently may have a smaller than normal functional bladder capacity. Functional bladder capacity is the amount of urine a person can hold in the bladder before feeling a strong urge to urinate. When functional capacity is small, the bladder will not hold all the urine produced during the night. Tests have shown that bladder size in these children is normal. Nevertheless, they experience frequent strong urges to urinate. Such children urinate often during the daytime and may wet several times at night. Although a small functional bladder capacity may be caused by a developmental delay, it may also be that the child's habit of voiding frequently slows bladder development.

Parents often report that their bed-wetting child is an extremely sound sleeper and difficult to wake. However, several research studies found that bed-wetting children have normal sleep patterns and that bed-wetting can occur in any stage of sleep.

Recent medical research has found that many children who wet the bed may have a deficiency of an important hormone known as antidiuretic hormone (ADH). ADH helps to concentrate urine during sleep hours, meaning that the urine contains less water and therefore takes up less space. This decreased volume of water usually prevents the child's bladder from overfilling during the night, unless the child drank a lot just before going to bed. Testing of many bed-wetting children has shown that these children do not have the usual increase in ADH during sleep. Children who wet the bed, therefore, often produce more urine during the hours of sleep than their bladders can hold. If they do not wake up, the bladder releases the excess urine and the child wets the bed.

Research demonstrates that in most cases bed-wetting does not indicate that the child has a physical or psychological problem. Children who wet the bed usually have normal-sized bladders and have sleep patterns that are no different from those of non-bed-wetting children. Sometimes emotional **stress**, such as the birth of a sibling, a **death** in the family, or separation from the family, may be associated with the onset of bed-wetting in a previously toilet-trained child. Daytime wetting, however, may indicate that the problem has a physical cause.

While most children have no long-term problems as a result of bed-wetting, some children may develop psychological problems. Low self-esteem may occur when these children, who already feel embarrassed, are further humiliated by angry or frustrated parents who punish them or who are overly aggressive about toilet training. The problem can by aggravated when playmates tease or when social activities such as sleep-away camp are avoided for fear of teasing.

Diagnosis

If a child continues to wet the bed after the age of six, parents may feel the need to seek evaluation and diagnosis by the family doctor or a children's specialist (pediatrician). Typically, before the doctor can make a diagnosis, a thorough medical history is obtained. Then the child receives a **physical examination**, appropriate laboratory tests, including a urine test (**urinalysis**), and, if necessary, radiologic studies (such as x rays).

If the child is healthy and no physical problem is found, which is the case 90% of the time, the doctor may not recommend treatment but rather may provide the parents and the child with reassurance, information, and advice.

Treatment

Occasionally a doctor will determine that the problem is serious enough to require treatment. Standard

treatments for bed-wetting include **bladder training** exercises, motivational therapy, drug therapy, psychotherapy, and diet therapy.

Bladder training exercises are based on the theory that those who wet the bed have small functional bladder capacity. Children are told to drink a large quantity of water and to try to prolong the periods between urinations. These exercises are designed to increase bladder capacity but are only successful in resolving bed-wetting in a small number of patients.

In motivational therapy, parents attempt to encourage the child to combat bed-wetting, but the child must want to achieve success. Positive reinforcement, such as praise or rewards for staying dry, can help improve self-image and resolve the condition. Punishment for "wet" nights will hamper the child's self-esteem and compound the problem.

The following motivational techniques are commonly used:

- Behavior modification. This method of therapy is aimed at helping children take responsibility for their nighttime bladder control by teaching new behaviors. For example, children are taught to use the bathroom before bedtime and to avoid drinking fluids after dinner. While behavior modification generally produces good results, it is long-term treatment.
- Alarms. This form of therapy uses a sensor placed in the child's pajamas or in a bed pad. This sensor triggers an alarm that wakes the child at the first sign of wetness. If the child is awakened, he or she can then go to the bathroom and finish urinating. The intention is to condition a response to awaken when the bladder is full. Bed-wetting alarms require the motivation of both parents and children. They are considered the most effective form of treatment now available.

A number of drugs are also used to treat bed-wetting. These medications are usually fast acting; children often respond to them within the first week of treatment. Among the drugs commonly used are a nasal spray of desmopressin acetate (DDAVP), a substance similar to the hormone that helps regulate urine production; and imipramine hydrochloride, a drug that helps to increase bladder capacity. Studies show that imipramine is effective for as many as 50% of patients. However, children often wet the bed again after the drug is discontinued, and it has some side effects. Some bed-wetting with an underlying physical cause can be treated by surgical procedures. These causes include enlarged adenoids that cause sleep apnea, physical defects in the urinary system, or a spinal tumor.

Psychotherapy is indicated when the child exhibits signs of severe emotional distress in response to events such as a death in the family, the birth of a new child, a change in schools, or divorce. Psychotherapy is also indicated if a child shows signs of persistently low self-esteem or depression.

In rare cases, **allergies** or intolerances to certain foods—such as dairy products, citrus products, or chocolate—can cause bed-wetting. When children have food sensitivities, bed-wetting may be helped by discovering the substances that trigger the allergic response and eliminating these substances from the child's diet.

Alternative treatment

A number of alternative treatments are available for bed-wetting.

Massage

According to practitioners of this technique, pressure applied to various points on the body may help alleviate the condition. **Acupressure** or massage, when done by a trained therapist, may also be helpful in bed-wetting caused by a neurologic problem.

Herbal and homeopathic remedies

Some herbal remedies, such as horsetail (*Equisetum arvense*) have also been used to treat bed-wetting. A trained homeopathic practitioner, working at the constitutional level, will seek to rebalance the child's vital force, eliminating the imbalanced behavior of bed-wetting. Common homeopathic remedies used in this treatment include *Causticum, Lycopodium,* and *Pulsatilla.*

Hypnosis

Hypnosis is another approach that is being used successfully by practitioners trained in this therapy. It trains the child to awaken and go to the bathroom when his or her bladder feels full. Hypnosis is less expensive, less time-consuming, and less dangerous than most approaches; it has virtually no side effects. Recent medical studies show that **hypnotherapy** can work quickly—within four to six sessions.

Prognosis

Occasional bed-wetting is not a disease and it does not have a "cure." If the child has no underlying physical or psychological problem that is causing the bed-wetting, in most cases he or she will outgrow the condition without treatment. About 15% of bedwetters become dry each year after age 6. If bed-wetting is frequent, accompanied by daytime wetting, or falls into the American Psychiatric Association's diagnostic definition of enuresis, a doctor

KEY TERMS

Acupressure—A technique using pressure to various points on the body to alleviate health problems.

ADH—Antidiuretic hormone, or the hormone that helps to concentrate urine during the night.

Behavior modification—Techniques used to change harmful behavior patterns.

Bladder—The muscular sac or container that stores urine until it is released from the body through the tube that carries urine from the bladder to the outside of the body (urethra).

DDAVP—Desmopressin acetate, a drug used to regulate urine production.

Hypnosis—The technique by which a trained professional relaxes the subject and then asks questions or gives suggestions.

Imipramine hydrochloride—A drug used to increase bladder capacity.

Kidneys—A pair of organs located on each side of the spine in the lower back area. They excrete, or get rid of, urine.

Nocturnal enuresis—Involuntary discharge of urine during the night.

Urinalysis—A urine test.

Urine—The fluid excreted by the kidneys, stored in the bladder, then discharged from the body through the tube that carries urine from the bladder to the outside of the body (urethra).

Void—To empty the bladder.

should be consulted. If treatment is indicated, it usually successfully resolves the problem. Marked improvement is seen in about 75% of cases treated with wetness alarms.

Prevention

Although preventing a child from wetting the bed is not always possible, parents can take steps to help the child keep the bed dry at night. These steps include:

- Encouraging and praising the child for staying dry instead of punishing when the child wets.
- Reminding the child to urinate before going to bed, if he or she feels the need.
- Limiting liquid intake at least two hours before bedtime.

Resources

BOOKS

American Psychiatric Association *Diagnostic and Statistical Manual of Mental Disorders. DSM-IV.* 4th ed. Washington, DC: American Psychiatric Association, 1994.

Arnold, Samuel J. *No More Bedwetting: How to Help Your Child Stay Dry.* New York: John Wiley & Sons, Inc., 1997.

Kagan, Jerome, ed. *The Gale Encyclopedia of Childhood and Adolescence.* Detroit: Gale Research, 1998.

PERIODICALS

Gosnell, John. "Enuresis—The Cause That Dares Not Speak Its Name." *British Medical Journal* 315 (16 Aug. 1997): 435.

Schmitt, Barton D. "Nocturnal Enuresis." *Pediatrics in Review* 18 (June 1997): 6.

Ullom-Minnich, Marla R. "Diagnosis and Management of Nocturnal Enuresis." *American Family Physician* 54 (15 Nov. 1996): 2259-2267.

White, Kevin, and Ray D. Wallace. "The Challenge of Incontinence." *Exceptional Parent* 27 (Aug. 1997): 361-363.

ORGANIZATIONS

Association for the Care of Children's Health (ACCH). 7910 Woodmont Ave., Suite 300, Bethesda, MD 20814. 800-808-2224.

National Association of Continence. P.O. Box 8310, Spartenburg, SC 29305. (800) 252-3337. <http://www.nafc.org>.

National Enuresis Society. 7777 Forest Lane, Suite C-737, Dallas, TX 75230-2518. (800) 697-8080. <http://www.peds.umn.edu/Centers/NES>.

Genevieve Slomski, PhD

Beclomethasone *see* **Corticosteroids**

Bedsores

Definition

Bedsores are also called decubitus ulcers, pressure ulcers, or pressure sores. These tender or inflamed patches develop when skin covering a weight-bearing part of the body is squeezed between bone and another body part, or a bed, chair, splint, or other hard object.

Description

Each year, about one million people in the United States develop bedsores ranging from mild inflammation to deep **wounds** that involve muscle and bone. This often painful condition usually starts with shiny red skin that quickly blisters and deteriorates into open sores that can harbor life-threatening infection.

Bedsores are not cancerous or contagious. They are most likely to occur in people who must use wheelchairs or who are confined to bed. In 1992, the federal Agency for Health Care Policy and Research reported that bedsores afflict:

- 10% of hospital patients
- 25% of nursing home residents
- 60% of quadriplegics

The Agency also noted that 65% of elderly people hospitalized with broken hips develop bedsores and that doctors fees for treatment of bedsores amounted to $2,900 per person.

Bedsores are most apt to develop on the:

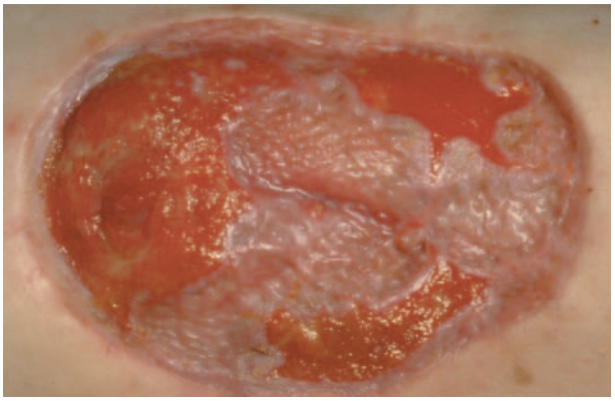
- ankles
- back of the head
- heels
- hips
- knees
- lower back
- shoulder blades
- spine

People over the age of 60 are more likely than younger people to develop bedsores. Risk is also increased by:

- atherosclerosis (hardening of arteries)
- diabetes or other conditions that make skin more susceptible to infection
- diminished sensation or lack of feeling
- heart problems
- incontinence (inability to control bladder or bowel movements)
- malnutrition
- obesity
- paralysis or immobility
- poor circulation
- prolonged bed rest, especially in unsanitary conditions or with wet or wrinkled sheets
- spinal cord injury

Causes and symptoms

Bedsores most often develop when constant pressure pinches tiny blood vessels that deliver oxygen and nutrients to the skin. When skin is deprived of oxygen and nutrients for as little as an hour, areas of tissue can die and bedsores can form.



Bedsore. *(Photograph by Michael English, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

Slight rubbing or friction against the skin can cause minor pressure ulcers. They can also develop when a patient stretches or bends blood vessels by slipping into a different position in a bed or chair.

Urine, feces, or other moisture increases the risk of skin infection, and people who are unable to move or recognize internal cues to shift position have a greater than average risk of developing bedsores.

Other risk factors include:

- malnutrition
- anemia (lack of red blood cells)
- diuse atrophy (muscle loss or weakness from lack of use)
- infection

Diagnosis

Physical examination, medical history, and patient and caregiver observations are the basis of diagnosis. Special attention must be paid to physical or mental problems, like incontinence or confusion, that could complicate a patient's recovery.

Bedsores usually follow six stages:

- redness of skin
- redness, swelling, and possible peeling of outer layer of skin
- dead skin, draining wound, and exposed layer of fat
- tissue **death** through skin and fat, to muscle
- inner fat and muscle death
- destruction of bone, bone, infection, fracture, and blood infection

Treatment

Prompt medical attention can prevent surface pressure sores from deepening into more serious infections. For mild bedsores, treatment involves relieving pressure, keeping the wound clean and moist, and keeping the area around the ulcer clean and dry. **Antiseptics**, harsh soaps, and other skin cleansers can damage new tissue, so a saline solution should be used to cleanse the wound whenever a fresh non-stick dressing is applied.

The patient's doctor may prescribe infection-fighting **antibiotics**, special dressings or drying agents, or lotions or ointments to be applied to the wound in a thin film three or four times a day. Warm whirlpool treatments are sometimes recommended for sores on the arm, hand, foot, or leg.

In a procedure called debriding, a scalpel may be used to remove dead tissue or other debris from the wound. Deep, ulcerated sores that don't respond to other therapy may require skin grafts or plastic surgery.

A doctor should be notified whenever a person:

- will be bedridden or immobilized for an extended time
- is very weak or unable to move
- develops bedsores

Immediate medical attention is required whenever:

- skin turns black or becomes inflamed, tender, swollen, or warm to the touch.
- the patient develops a **fever** during treatment.
- the sore contains pus or has a foul-smelling discharge.

With proper treatment, bedsores should begin to heal two to four weeks after treatment begins.

Alternative treatment

Zinc and **vitamins** A, C, E, and B complex help skin repair injuries and stay healthy, but large doses of vitamins or **minerals** should never be used without a doctor's approval.

A poultice made of equal parts of powdered slippery elm (*Ulmus fulva*), marsh mallow (*Althaea officinalis*), and **echinacea** (*Echinacea* spp.) blended with a small amount of hot water can relieve minor inflammation. An infection-fighting rinse can be made by diluting two drops of essential tea tree oil (*Melaleuca* spp.) in eight ounces of water. An herbal tea made from the calendula (*Calendula officinalis*) can act as an antiseptic and wound healing agent. Calendula cream can also be used.

Contrasting hot and cold local applications can increase circulation to the area and help flush out waste products, speeding the healing process. The temperatures should be extreme (hot hot and ice cold), yet tolerable to the skin. Hot compresses should be applied for three minutes, followed by 30 seconds of cold compress application, repeating the cycle three times. The cycle should always end with the cold compress.

Prevention

It is usually possible to prevent bedsores from developing or worsening. The patient should be inspected regularly; should bathe or shower every day, using warm water and mild soap; and should avoid cold or dry air. A bedridden patient should be repositioned at least once every two hours while awake. A person who uses a wheelchair should shift his weight every 10 or 15 minutes, or be helped to reposition himself at least once an hour. It is important to lift, rather than drag, a person being repositioned. Bony parts of the body should not be massaged. Even slight friction can remove the top layer of skin and damage blood vessels beneath it.

If the patient is bedridden, sensitive body parts can be protected by:

- sheepskin pads
- special cushions placed on top of a mattress
- a water-filled mattress
- a variable-pressure mattress whose sections can be individually inflated or deflated to redistribute pressure

Pillows or foam wedges can prevent a bedridden patient's ankles from irritating each other, and pillows placed under the legs from mid-calf to ankle can raise the heels off the bed. Raising the head of the bed slightly and briefly can provide relief, but raising the head of the bed more than 30 degrees can cause the patient to slide, thereby causing damage to skin and tiny blood vessels.

A person who uses a wheelchair should be encouraged to sit up as straight as possible. Pillows behind the head and between the legs can help prevent bedsores, as can a special cushion placed on the chair seat. Donut-shaped cushions should not be used because they restrict blood flow and cause tissues to swell.

Prognosis

Bedsores can usually be cured, but about 60,000 deaths a year are attributed to complications caused by bedsores. Bedsores can be slow to heal. Without proper treatment, they can lead to:

- gangrene (tissue death)
- osteomyelitis (infection of the bone beneath the bedsore)
- sepsis (tissue-destroying bacterial infection)

• other localized or systemic infections that slow the healing process, increase the cost of treatment, lengthen hospital or nursing home stays, or cause death

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

ORGANIZATIONS

International Association of Enterstomal Therapy. 27241 La Paz Road, Suite 121, Laguna Niguel, CA 92656. (714) 476-0268.

National Pressure Ulcer Advisory Panel. SUNY at Buffalo, Beck Hall, 3435 Main St., Buffalo, NY 14214. (716) 881-3558. <http://www.npuap.org>.

OTHER

"Bed Sores." American Health and Herbs Ministry. 15 Mar. 1998 <http://www.healthherbs.com>.

"Break the Connection Between the O.R. and Pressure Ulcers." SpringNet Page. 16 Mar. 1998 <http://www.springnet.com/top.shtml>.

"Pressure Sores." ThriveOnline. 14 Mar. 1998 <http://thriveonline.oxygen.com>.

"Preventing Pressure Ulcers." Health Pages.org. 15 Mar. 1998 <http://www.healthpages.org/AHP/LIBRARY/HLTHTOP/MISC/bedsore.htm>.

"Treatment of Bed Sores." U. S. Department of Health and Human Services. 15 Mar. 1998 <http://www.os.dhhs.gov>.

Maureen Haggerty

Beef tapeworm infection *see* **Tapeworm diseases**

Behavior therapy *see* **Cognitive-behavioral therapy**

Behcet's syndrome

Definition

A group of symptoms that affect a variety of body systems, including musculoskeletal, gastrointestinal, and the central nervous system. These symptoms include ulceration of the mouth or the genital area, **skin lesions**, and inflammation of the uvea (an area around the pupil of the eye).

Description

Behcet's syndrome is a chronic disease that involves multiple body systems. The disease is named for a Turkish dermatologist, Hulusi Behcet, who first reported a patient with recurrent mouth and genital ulcers along with **uveitis** in 1937. The disease occurs worldwide, but is most prevalent in Japan, the Middle East, and in the Mediterranean region. There is a wider prevalence among males than females in a ratio of two to one.

Causes and symptoms

The cause of Behcet's syndrome is unknown. Symptoms include recurring ulcers in the mouth or the genital area, skin lesions, arthritis that affects mainly the knees and ankles, **pain** and irritation in the eyes, and **fever**. The mouth and genital ulcers tend to occur in multiples and can be quite painful. In the mouth, these ulcers are generally found on the tongue, gums, and the inside of the lips or jaws. In the genital area, the ulcers usually occur on the penis and scrotum in males and on the vulva of women. The eye inflammation can lead to blindness.

Diagnosis

Because Behcet's syndrome is a multisystem disease, it is difficult to diagnose. International criteria have been proposed to assist in classifying this disease. There is no one diagnostic feature of this disease, so diagnosis depends on grouping together enough symptoms in order to identify the disease. Symptoms of Behcet's syndrome also occur in other diseases, so it is often necessary to rule out the other diseases before a definitive diagnosis can be reached.

Treatment

Some of the current drugs used to treat Behcet's syndrome include:

• corticosteroids
• cyclosporin
• azathioprine
• chlorambucil
• interferon alpha
• thalidomide
• levamisole
• pulse cyclophosphamide
• cyclosporine

Prognosis

The prognosis for Behcet's syndrome is generally poor. There has been a documented case of Behcet's lasting for 17 years. Although the disease is considered painful but not fatal, when the central nervous system is involved there is usually severe disability and **death** often occurs. The condition is usually chronic, although there can be remissions during the course of the disease.

KEY TERMS

Remission—When active symptoms of a chronic disease are absent.

Uveitis—Inflammation of the area of the eye around the pupil.

There is no predictable method to determine which patients will progress into the more serious symptoms, and which might move into remission.

Prevention

There is no known prevention for Behcet's syndrome.

Resources

BOOKS

Berkow, Robert. *The Merck Manual of Medical Information.* Whitehouse Station: Merck Research Laboratories, 1997.

Ruddy, Shaun. *Kelley's Textbook of Rheumatology.* Philadelphia: W.B. Saunders Company, 2001.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment*. Los Altos: Lange Medical Publications, 2001.

PERIODICALS

Okada, A. A. "Drug Therapy in Behcet's Disease." *Ocular Immunology and Inflammation* (June 2000): 85-91.

Shed, L. P. "Thalomide Responsiveness in an Infant with Behcet's Syndrome." *Pediatrics* (June 1999): 1295-1297.

ORGANIZATIONS

American Behcet's Disease Association. P.O. Box 280240, Memphis, TN 38168-0240. <http://www.behcets.com>.

Behcet's Organization Worldwide, Head Office. P.O. Box 27, Watchet, Somerset TA23 OYJ, United Kingdom. <http://www.behcets.org>.

National Eye Institute. National Institute of Health. Bldg. 31, Rm. 6A32, Bethesda, MD 30892-2510. (800) 869-2020. <http://www.nei.nih.gov>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseaes.org>.

Kim Sharp, M.Ln.

Bejel

Definition

Bejel, also known as endemic **syphilis**, is a chronic but curable disease, seen mostly in children in arid regions. Unlike the better-known venereal syphilis, endemic syphilis is not a **sexually transmitted disease**.

Description

Bejel has many other names depending on the locality: siti, dichuchwa, njovera, belesh, and skerljevo are some of the names. It is most commonly found in the Middle East (Syria, Saudi Arabia, Iraq), Africa, central Asia, and Australia. Bejel is related to **yaws** and **pinta**, but has different symptoms.

Causes and symptoms

Treponema pallidum, the bacteria that causes bejel, is very closely related to the one that causes the sexually transmitted form of syphilis, but transmission is very different. In bejel, transmission is by direct contact, with broken skin or contaminated hands, or indirectly by sharing drinking vessels and eating utensils. *T. pallidum* is passed on mostly between children living in poverty in very unsanitary environments and with poor hygiene.

The skin, bones, and mucous membranes are affected by bejel. Patches and ulcerated sores are common in the mouth, throat, and nasal passages. Gummy lesions may form, even breaking through the palate. Other findings may include a region of swollen lymph nodes and deep bone **pain** in the legs. Eventually, bones may become deformed.

Diagnosis

T. pallidum can be detected by microscopic study of samples taken from the sores or lymph fluid. However, since antibody tests don't distinguish between the types of syphilis, specific diagnosis of the type of syphilis depends on the patient's history, symptoms, and environment.

Treatment

Large doses of benzathine penicillin G given by injection into the muscle can cure this disease in any stage, although it may take longer and require additional doses in later stages. If penicillin cannot be given, the alternative is tetracycline. Since tetracycline can permanently discolor new teeth still forming, it is usually not prescribed for children unless no viable alternative is available.

Prognosis

Bejel is completely curable with antibiotic treatment.

Prevention

The World Health Organization (WHO) has worked with many countries to prevent this and other diseases, and

KEY TERMS

Endemic disease—An infectious disease that occurs frequently in a specific geographical locale. The disease often occurs in cycles. Influenza is an example of an endemic disease.

Lymph—This is a clear, colorless fluid found in lymph vessels and nodes. The lymph nodes contain organisms that destroy bacteria and other disease causing organisms (also called pathogens).

Syphilis—This disease occurs in two forms. One is a sexually transmitted disease caused by a bacteria. The second form is not sexually transmitted, but passed on by direct contact with the patient or through use of shared food dishes and utensils.

the number of cases has been reduced somewhat. Widespread use of penicillin has been responsible for reducing the number of existing cases, but the only way to eliminate bejel is by improving living and sanitation conditions.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Jill S Lasker

Bell's palsy

Definition

Bell's palsy describes an unexplained weakness or **paralysis** of the muscles on one side of the face. Afflicted individuals may be unable to close the eye on the affected side of the face, and may also experience tearing, drooling, and hypersensitive hearing. The onset can be quite sudden, sometimes occurring overnight. Although Bell's palsy is unsettling and inconvenient, it is typically not indicative of a serious health problem. The weakness and paralysis resolve completely in the majority of cases.

Description

Bell's palsy has been described as a diagnosis of exclusion because several other disorders present similar symptoms. Facial palsies have been linked to conditions such as **Lyme disease**, ear infection, **meningitis**, **syphilis**, German **measles** (**rubella**), **mumps**, **chickenpox** (varicella), and infection with Epstein-Barr virus (e.g., **infectious mononucleosis**). True Bell's palsy is an idiopathic facial palsy, meaning the root cause cannot be identified. Although Bell's palsy is not life-threatening, it can present symptoms similar to truly serious conditions, such as a **stroke**, ruptured aneurysm, or tumors.

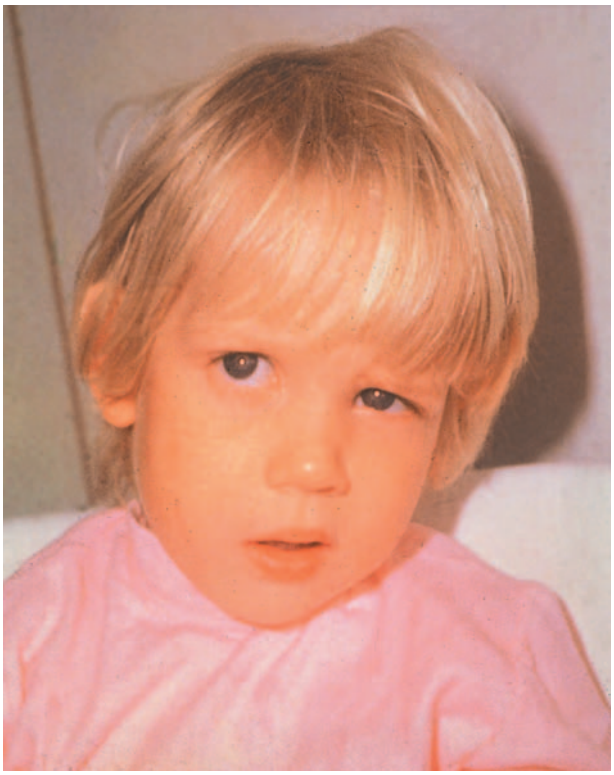
Every year, approximately 40,000-65,000 Americans are stricken with Bell's palsy. Worldwide, there is an annual incidence of 20-30 cases per 100,000 individuals. An individual can be affected at any age, but young and middle-aged adults are the most likely to be affected. It is unusual to see Bell's palsy in people less than 10 years old. Bell's palsy can affect either side of the face, and neither gender seems to be at a greater risk. Pregnant women and individuals with diabetes, **influenza**, a cold, or an upper respiratory infection seem to be at a greater risk. Although it cannot be considered a serious condition from a health standpoint, it can cause extreme **stress**, embarrassment, and inconvenience for those affected.

In the large majority of cases (80-85%), the facial weakness or paralysis is temporary. However, individuals who experience complete paralysis seem to have a poorer recovery rate with only 60% returning to normal. Approximately 4-6% of all Bell's palsy cases result in permanent facial deformity, and another 10-15% experience permanent problems with spasms, twitching, or contracted muscles. Between 2% and 7.3% of individuals who have experienced Bell's palsy will have a recurrence. On average, the first recurrence happens 9.8 years after the first episode; the second, 6.7 years later. One recurrence is very infrequent, and a second is extremely rare.

Causes and symptoms

The symptoms of Bell's palsy arise from an inflammation or swelling of the seventh cranial nerve, otherwise called the facial nerve. Both sides of the face have a facial nerve which controls the muscles on that side of the face. The course of the facial nerve passes through a bony canal in the skull. When the nerve becomes swollen, it is compressed since the canal does not allow for any expansion. As further swelling increases the compression, nerve signal conduction is impeded or even prevented. The interference with the nerve signals is seen in the loss of muscle control and tone.

Why the facial nerve becomes inflamed in Bell's palsy is a matter of some debate, and medical researchers and doctors are not in complete agreement. The best-supported evidence implicates the herpes simplex virus (HSV), which is responsible for cold sores and **fever**



This boy's facial paralysis was caused by a tick-borne meningopadiculitis. *(Photo Researchers, Inc. Reproduced by permission.)*

blisters. HSV infection has been discovered in up to 70% of Bell's palsy cases. Most people harbor this virus, although they may not exhibit symptoms.

The major symptom of Bell's palsy is one-sided facial weakness or paralysis. Muscle control is either inadequate or completely missing. There may also be involuntary facial movements, such as twitches, that accompany certain facial expressions. Afflicted individuals frequently have difficulty shutting the affected eye and may not be able to close it at all.

Diagnosis

Although Bell's palsy is not life-threatening, it shares symptoms in common with serious conditions, such as stroke. Therefore, emergency medical attention is a wise and necessary precaution. Bell's palsy affects the facial nerve, unlike most strokes associated with facial weakness which affect higher nerve centers ultimately supplying the facial nerve. These two disorders can be distinquished clinically because most strokes do not cause weakness of the forehead or eyelid muscles.

The fact that Bell's palsy is a diagnosis of exclusion becomes apparent in the course of the medical examination—the usual mode of examination is to rule out other disorders until only Bell's palsy is left. Disorders that need to be excluded include demyelinating disease (e.g., **multiple sclerosis**), stroke, tumors, bacterial or viral infection, and bone fracture.

During the **physical examination**, the afflicted individual is asked about recent illnesses, accidents, infections, and any other symptoms. A visual exam of the ears, throat, and sinus is done, and hearing is tested. The extent of the symptoms is assessed by grading the symmetry of the face at rest and during voluntary movements, such as wrinkling the forehead, puckering the lips, and closing the affected eye. Involuntary movements are assessed in combination with the voluntary movements. **Neurologic exam** is done to rule out involvement of other parts of the nervous system except for the facial muscles, which would exclude the diagnosis of Bell's palsy.

In response to the individual's medical history, blood tests and possibly a **cerebrospinal fluid (CSF) analysis** are ordered. The results of these tests help determine the presence of a bacterial or viral infection or an inflammatory disease. Electrophysiological tests, in which a muscle or nerve is artificially stimulated, may be used to assess the condition of facial muscles and the facial nerve. Common tests include **electromyography**, which measures voluntary muscle movement, and nerve conduction velocity, which determines the extent of nerve degeneration. Radiological tests may also be included, such as an x ray, as well as imaging tests, such as **magnetic resonance imaging** (MRI) and computed tomography. These tests—especially MRI—allow an excellent view of the nerve itself.

Once all other possibilities are exhausted, a diagnosis of Bell's palsy is made. The following weeks are a period of watchful waiting. Further examinations are done to track recovery. Results from nerve conduction tests may be used to predict an outcome. However, this use is questioned by some doctors and medical researchers since evidence for their predictive value is inconclusive.

If facial movement, even a small amount, has not returned within 3-4 months, the diagnosis of Bell's palsy may need to be reevaluated.

Treatment

Many doctors prescribe an antiviral and/or a steroid for Bell's palsy, but there is some controversy about whether these drugs actually help. The consensus opinion seems to be that, although drugs might not be necessary, they are not dangerous, and they may help in some

cases, especially if there is complete paralysis. If drugs are used, they need to be taken as soon as possible following the onset of symptoms. **Antiviral drugs**, such as acyclovir, famciclovir, or valacyclovir, are prescribed to destroy actively replicating viruses and prevent further damage to the facial nerve. Steroids, such as prednisone, are thought to be useful in reducing swelling and, therefore, compression on the nerve.

In the past, surgery was performed to relieve the compression on the nerve. However, this treatment option is now used very infrequently because it does not guarantee recovery, and it carries the risk of permanent nerve damage.

The need to protect the affected eye is universally promoted. Since the individual may not be able to lower the affected eyelid, the eye may become dry, particularly at night. Excessive dryness can damage the cornea. Daytime treatment includes artificial tears and may include an eye patch or other protective measures. Nighttime treatment involves a more intense effort at keeping the eye protected. Eye lubricants or viscous ointments, along with taping the eye shut, are frequently recommended.

In cases of permanent nerve damage, cosmetic treatment options, such as therapeutic injections of **botulism** toxin or surgery, may be sought or suggested.

Alternative treatment

Practitioners of **traditional Chinese medicine** have historically used **acupuncture** to treat Bell's palsy. There are also some indications that facial massage and **chiropractic** manipulation may help treat the symptoms and improve the outcome. There are also claims of therapeutic value for local injections or ingestion of vitamin B_{12} supplements.

Prognosis

Most individuals with Bell's palsy begin to notice improvement in their condition within 2-3 weeks of the symptoms' onset. At least 80% of them will be fully recovered within three months. Among the other 20% of afflicted individuals, symptoms may take longer to resolve or they may be permanent. Individuals suffering permanent nerve damage may not regain control of the muscles on the affected side of the face. These muscles may remain weak or paralyzed. If the nerve recovers imperfectly, they may experience involuntary facial twitches or spasms that accompany normal facial expressions.

Prevention

Bell's palsy is not preventable.

KEY TERMS

Antiviral—A drug that prevents viruses from replicating and therefore spreading infection.

Computed tomography—Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Electromyography—A recording of the electrical activity generated in the muscle.

Facial nerve—A cranial nerve that controls the muscles in the face.

Magnetic resonance imaging (MRI)—This imaging technique uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Nerve conduction velocity—A recording of how well a nerve conducts electrical impulses.

Steroid—A drug used to reduce swelling and fluid accumulation.

Resources

PERIODICALS

Billue, Joyce S. "Bell's Palsy: An Update on Idiopathic Facial Palsy." *The Nurse Practitioner* 22, no. 8 (1997): 88.

Kakaiya, Ram. "Bell's Palsy: Update on Causes, Recognition, and Management." *Consultant* 37, no. 8 (1997): 2217.

ORGANIZATIONS

Bell's Palsy Research Foundation. 9121 E. Tanque Verde, Suite 105-286, Tucson, AZ 85749. (520) 749-4614.

Julia Barrett

Benazepril *see* **Angiotensin-converting enzyme inhibitors**

Bence Jones protein test

Definition

Bence Jones proteins are small proteins (light chains of immunoblobulin) found in the urine. Testing for these proteins is done to diagnose and monitor **multiple myeloma** and other similar diseases.

KEY TERMS

Bence Jones protein—Small protein, composed of a light chain of immunoglobulin, made by plasma cells.

Multiple myeloma—A tumor of the plasma cells.

Plasma cells—A type of white blood cell.

Purpose

Bence Jones proteins are considered the first tumor marker. A tumor marker is a substance, made by the body, that is linked to a certain **cancer**, or malignancy. Bence Jones proteins are made by plasma cells, a type of white blood cell. The presence of these proteins in a person's urine is associated with a malignancy of plasma cells.

Multiple myeloma, a tumor of plasma cells, is the disease most often linked with Bence Jones proteins. The amount of Bence Jones proteins in the urine indicates how much tumor is present. Physicians use Bence Jones proteins testing to diagnose the disease as well as to check how well the disease is responding to treatment.

Other diseases involving cancerous or excessive growth of plasma cells or cells similar to plasma cells can cause Bence Jones proteins in the urine. These diseases include: Waldenström's macroglobulinemia, some lymphomas and leukemias, osteogenic sarcoma, cryoglobulinemia, malignant B-cell disease, **amyloidosis**, light chain disease, and cancer that has spread to bone.

Description

Urine is the best specimen in which to look for Bence Jones proteins. Proteins are usually too large to move through a healthy kidney, from the blood into the urine. Bence Jones proteins are an exception. They are small enough to move quickly and easily through the kidney into the urine.

A routine **urinalysis** will not detect Bence Jones proteins. There are several methods used by laboratories to detect and measure these proteins. The classic Bence Jones reaction involves heating urine to 140°F (60°C). At this temperature, the Bence Jones proteins will clump. The clumping disappears if the urine is further heated to boiling and reappears when the urine is cooled. Other clumping procedures using salts, acids, and other chemicals are also used to detect these proteins. These types of test will reveal whether or not Bence Jones proteins are present, but not how much is present.

A more complex procedure is done to measure the exact amount of Bence Jones proteins. This procedure—immunoelectrophoresis—is usually done on urine that has been collected for 24-hours.

The test is covered by insurance when medically necessary. Results are usually available within several days.

Preparation

Urine is usually collected throughout a 24-hour time period. A person is given a large container in which to collect the urine. The urine should be refrigerated until it is brought to the laboratory or physician's office.

Normal results

Bence Jones proteins normally are not present in the urine.

Abnormal results

Bence Jones proteins are present in 50–80% of people with multiple myeloma. People with other malignancies also can have a positive Bence Jones proteins test, but less frequently.

Certain nonmalignant diseases, such as **rheumatoid arthritis**, **systemic lupus erythematosus**, and chronic renal insufficiency, can have Bence Jones proteins in the urine. High doses of penicillin or **aspirin** before collecting the urine can give a false positive result.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Philadelphia: W. B. Saunders Co., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Nancy J. Nordenson

Bender-Gestalt test

Definition

The Bender Visual Motor Gestalt test (or Bender-Gestalt test) is a psychological assessment used to evalu-

ate visual-motor functioning, visual-perceptual skills, neurological impairment, and emotional disturbances in children and adults ages three and older.

KEY TERMS

Neuropsychological test—A test or assessment given to diagnose a brain disorder or disease.

Perserveration—The persistence of a repetitive response after the cause of the response has been removed, or the response continues to different stimuli.

Visual-motor skills—Hand-eye coordination; in the Bender-Gestalt test, visual-motor skills are measured by the subject's ability to accurately perceive and then reproduce figures.

Visual-perceptual skills—The capacity of the mind and the eye to "see" something as it objectively exists.

Purpose

The Bender-Gestalt is used to evaluate visual-motor maturity and to screen children for developmental delays. The test is also used to assess brain damage and neurological deficits. Individuals who have suffered a traumatic brain injury may be given the Bender-Gestalt as part of a battery of neuropsychological measures, or tests.

The Bender-Gestalt is sometimes used in conjunction with other personality tests to determine the presence of emotional and psychiatric disturbances such as **schizophrenia**.

Precautions

Psychometric testing requires a clinically trained examiner. The Bender Visual Motor Gestalt Test should be administered and interpreted by a trained psychologist or psychiatrist. The Bender-Gestalt should always be employed as only one element of a complete battery of psychological or developmental tests, and should never be used alone as the sole basis for a diagnosis.

Description

The original Bender Visual Motor Gestalt test was developed in 1938 by psychiatrist Lauretta Bender. There are several different versions of the Bender-Gestalt available today (i.e., the Bender-Gestalt test; Modified Version of the Bender-Gestalt test for Preschool and Primary School Children; the Hutt Adaptation of the Bender-Gestalt test; the Bender Visual Motor Gestalt test for Children; the Bender-Gestalt test for Young Children; the Watkins Bender-Gestalt Scoring System; the Canter Background Interference Procedure for the Bender-Gestalt test). All use the same basic test materials, but vary in their scoring and interpretation methods.

The standard Bender Visual Motor Gestalt test consists of nine figures, each on its own 3 × 5 card. An examiner presents each figure to the test subject one at a time and asks the subject to copy it onto a single piece of blank paper. The only instruction given to the subject is that he or she should make the best reproduction of the figure possible. The test is not timed, although standard administration time is typically 10-20 minutes. After testing is complete, the results are scored based on accuracy and organization. Interpretation depends on the form of the test in use. Common features considered in evaluating the drawings are rotation, distortion, symmetry, and perseveration. As an example, a patient with frontal lobe injury may reproduce the same pattern over and over (perserveration)

The Bender-Gestalt can also be administered in a group setting. In group testing, the figures are shown to test subjects with a slide projector, in a test booklet, or on larger versions of the individual test cards. Both the individual and group- administered Bender-Gestalt evaluation may take place in either an outpatient or hospital setting. Patients should check with their insurance plans to determine if these or other mental health services are covered.

Normal results

Children normally improve in this test as they age, but, because of the complexity of the scoring process, results for the Bender-Gestalt should only be interpreted by a clinically trained psychologist or psychiatrist.

Resources

BOOKS

Maddox, Taddy. *Tests: A Comprehensive Reference for Assessments in Psychology, Education, and Busines*. 4th ed. Austin, TX: Pro-ed, 1997.

Shore, Milton F, et al. *When Your Child Needs Testing*. New York: Crossroad Publishing, 1992.

Wodrich, David L. *Children's Psychological Testing: A Guide for Nonpsychologists*. Baltimore: Paul H. Brookes Publishing, 1997.

PERIODICALS

Piotrowski, C. "A Review of the Clinical and Research Use of the Bender-Gestalt Test." *Perceptual Motor Skills* 81, no. 3, pt. 2 (Dec. 1995): 1271-74.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

Paula Anne Ford-Martin

Bends *see* **Decompression sickness**

Benign *see* **Uterine fibroids**

Benign prostatic hyperplasia *see* **Enlarged prostate**

Benign prostatic hypertrophy *see* **Enlarged prostate**

Benzocaine *see* **Antiseptics**

Benzodiazepines

Definition

Benzodiazepines are medicines that help relieve nervousness, tension, and other symptoms by slowing the central nervous system.

Purpose

Benzodiazepines are a type of **antianxiety drugs**. While **anxiety** is a normal response to stressful situations, some people have unusually high levels of anxiety that can interfere with everyday life. For these people, benzodiazepines can help bring their feelings under control. The medicine can also relieve troubling symptoms of anxiety, such as pounding heartbeat, breathing problems, irritability, nausea, and faintness.

Physicians may sometimes prescribe these drugs for other conditions, such as muscle spasms, epilepsy and other seizure disorders, **phobias**, **panic disorder**, withdrawal from alcohol, and sleeping problems. However, this medicine should not be used every day for sleep problems that last more than a few days. If used this way, the drug loses its effectiveness within a few weeks.

Benzodiazepines should not be used to relieve the nervousness and tension of normal everyday life.

Description

The family of antianxiety drugs known as benzodiazepines includes alprazolam (Xanax), chlordiazepoxide (Librium), diazepam (Valium), and lorazepam (Ativan). These medicines take effect fairly quickly, starting to work within an hour after they are taken. Benzodiazepines are available only with a physician's prescription and are available in tablet, capsule, liquid, or injectable forms.

Recommended dosage

The recommended dosage depends on the type of benzodiazepine, its strength, and the condition for which it is being taken. Doses may be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take benzodiazepines exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. If the medicine does not seem to be working, check with the physician who prescribed it. *Do not increase the dose or stop taking the medicine unless the physician says to do so.* Stopping the drug suddenly may cause withdrawal symptoms, especially if it has been taken in large doses or over a long period. People who are taking the medicine for seizure disorders may have seizures if they stop taking it suddenly. If it is necessary to stop taking the medicine, check with a physician for directions on how to stop. The physician may recommend tapering down gradually to reduce the chance of withdrawal symptoms or other problems.

Precautions

Seeing a physician regularly while taking benzodiazepines is important, especially during the first few months of treatment. The physician will check to make sure the medicine is working as it should and will note unwanted side effects.

People who take benzodiazepines to relieve nervousness, tension, or symptoms of panic disorder should check with their physicians every two to three months to make sure they still need to keep taking the medicine.

Patients who are taking benzodiazepines for sleep problems should check with their physicians if they are not sleeping better within 7-10 days. Sleep problems that last longer than this may be a sign of another medical problem.

People who take this medicine to help them sleep may have trouble sleeping when they stop taking the medicine. This effect should last only a few nights.

Some people, especially older people, feel drowsy, dizzy, lightheaded, or less alert when using benzodiazepines. The drugs may also cause clumsiness or unsteadiness. When the medicine is taken at bedtime, these effects may even occur the next morning. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Benzodiazepines may also cause behavior changes in some people, similar to those seen in people who act differently when they drink alcohol. More extreme changes, such as confusion, agitation, and **hallucinations**, also are possible. Anyone who starts having strange or unusual thoughts or behavior while taking this medicine should get in touch with his or her physician.

Because benzodiazepines work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. These effects may last several days after treatment with benzodiazepines ends. *The combined effects of benzodiazepines and alcohol or other CNS depressants (drugs that slow the central nervous system) can be very dangerous, leading to unconsciousness or, rarely, even death.* Anyone taking benzodiazepines should not drink alcohol and should check with his or her physician before using any CNS depressants. *Taking an overdose of benzodiazepines can also cause unconsciousness and possibly death. Anyone who shows signs of an overdose or of the effects of combining benzodiazepines with alcohol or other drugs should get immediate emergency help.* Warning signs include slurred speech or confusion, severe drowsiness, staggering, and profound weakness.

Some benzodiazepines may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Children are generally more sensitive than adults to the effects of benzodiazepines. This sensitivity may increase the chance of side effects.

Older people are more sensitive than younger adults to the effects of this medicine and may be at greater risk for side effects. Older people who take these drugs to help them sleep may be drowsy during the day. Older people also increase their risk of falling and injuring themselves when they take these drugs.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take benzodiazepines. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to benzodiazepines or other mood-altering drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Some benzodiazepines increase the likelihood of **birth defects**. Using these medicines during **pregnancy** may also cause the baby to become dependent on them and to have withdrawal symptoms after birth. When taken late in pregnancy or around the time of labor and delivery, these drugs can cause other problems in the newborn baby, such as weakness, breathing problems, slow heartbeat, and body temperature problems.

Women who are pregnant or who may become pregnant should not use benzodiazepines unless their anxiety is so severe that it threatens their pregnancy. Any woman who must take this medicine while pregnant should be sure to thoroughly discuss its risks and benefits with her physician.

BREASTFEEDING. Benzodiazepines may pass into breast milk and cause problems in babies whose mothers taken the medicine. These problems include drowsiness, breathing problems, and slow heartbeat. Women who are breastfeeding their babies should not use this medicine without checking with their physicians.

OTHER MEDICAL CONDITIONS. Before using benzodiazepines, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past drug or alcohol abuse
- depression
- severe mental illness
- epilepsy or other seizure disorders
- swallowing problems
- chronic lung disease such as **emphysema**, **asthma**, or chronic **bronchitis**
- kidney disease
- liver disease
- brain disease
- **glaucoma**
- hyperactivity
- myasthenia gravis
- porphyria
- sleep apnea

USE OF CERTAIN MEDICINES. Taking benzodiazepines with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **dizziness**, lightheadedness, drowsiness, clumsiness, unsteadiness, and

KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bronchitis—Inflammation of the air passages of the lungs.

Central nervous system—The brain, spinal cord and the nerves throughout the body.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Emphysema—An irreversible lung disease in which breathing becomes increasingly difficult.

Epilepsy—A brain disorder with symptoms that include seizures.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Myasthenia gravis—A chronic disease with symptoms that include muscle weakness and sometimes paralysis.

Panic disorder—A disorder in which people have sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

Phobia—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things.

Seizure—A sudden attack, spasm, or convulsion.

Sleep apnea—A condition in which a person temporarily stops breathing during sleep.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

slurred speech. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- behavior changes
- memory problems
- difficulty concentrating
- confusion
- depression
- seizures (convulsions)
- hallucinations
- sleep problems
- increased nervousness, excitability, or irritability
- involuntary movements of the body, including the eyes
- lLow blood pressure
- unusual weakness or tiredness
- skin rash or **itching**
- unusual bleeding or bruising
- yellow skin or eyes
- sore throat
- sores in the mouth or throat
- **fever** and chills

Patients who take benzodiazepines for a long time or at high doses may notice side effects for several weeks after they stop taking the drug. They should check with their physicians if these or other troublesome symptoms occur:

- irritability
- nervousness
- sleep problems

Other rare side effects may occur. Anyone who has unusual symptoms during or after treatment with benzodiazepines should get in touch with his or her physician.

Interactions

Benzodiazepines may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes benzodiazepines should let the physician know all other medicines he or she is taking. Among the drugs that may interact with benzodiazepines are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; **barbiturates**; and anesthetics.

Medicines other than those listed above may interact with benzodiazepines. Be sure to check with a physician or pharmacist before combining benzodiazepines with any other prescription or nonprescription (over-the-counter) medicine.

Resources

OTHER

"Medications." National Institute of Mental Health Page. 1995 <http://www.nimh.nih.gov>.

Nancy Ross-Flanigan

Benzoyl peroxide *see* **Antiacne drugs**

Benztropine *see* **Antiparkinson drugs**

Berger's disease *see* **Idiopathic primary renal hematuric/proteinuric syndrome**

Beriberi

Definition

Beriberi is a disease caused by a deficiency of thiamine (vitamin B_1) that affects many systems of the body, including the muscles, heart, nerves, and digestive system. Beriberi literally means "I can't, I can't" in Singhalese, which reflects the crippling effect it has on its victims. It is common in parts of southeast Asia, where white rice is the main food. In the United States, beriberi is primarily seen in people with chronic **alcoholism**.

Description

Beriberi puzzled medical experts for years as it ravaged people of all ages in Asia. Doctors thought it was caused by something in food. Not until the early 1900s did scientists discover that rice bran, the outer covering that was removed to create the polished white rice preferred by Asians, actually contained something that prevented the disease. Thiamine was the first vitamin identified. In the 1920s, extracts of rice polishings were used to treat the disease.

In adults, there are different forms of beriberi, classified according to the body systems most affected. Dry beriberi involves the nervous system; wet beriberi affects the heart and circulation. Both types usually occur in the same patient, with one set of symptoms predominating.

A less common form of cardiovascular, or wet beriberi, is known as "shoshin." This condition involves a rapid appearance of symptoms and acute **heart failure**. It is highly fatal and is known to cause sudden **death** in young migrant laborers in Asia whose diet consists of white rice.

Cerebral beriberi, also known as Wernicke-Korsakoff syndrome, usually occurs in chronic alcoholics and affects the central nervous system (brain and spinal cord). It can be caused by a situation that aggravates a chronic thiamine deficiency, like an alcoholic binge or severe vomiting.

Infantile beriberi is seen in breastfed infants of thiamine-deficient mothers, who live in developing nations.

Although severe beriberi is uncommon in the United States, less severe thiamine deficiencies do occur. About 25% of all alcoholics admitted to a hospital in the United States show some evidence of thiamine deficiency.

Causes and symptoms

Thiamine is one of the B **vitamins** and plays an important role in energy metabolism and tissue building. It combines with phosphate to form the coenzyme *thiamine pyrophosphate (TPP),* which is essential in reactions that produce energy from glucose or that convert glucose to fat for storage in the tissues. When there is not enough thiamine in the diet, these basic energy functions are disturbed, leading to problems throughout the body.

Special situations, such as an over-active metabolism, prolonged **fever**, **pregnancy**, and breastfeeding, can increase the body's thiamine requirements and lead to symptoms of deficiency. Extended periods of **diarrhea** or chronic liver disease can result in the body's inability to maintain normal levels of many nutrients, including thiamine. Other persons at risk are patients with kidney failure on dialysis and those with severe digestive problems who are unable to absorb nutrients. Alcoholics are susceptible because they may substitute alcohol for food and their frequent intake of alcohol decreases the body's ability to absorb thiamine.

The following systems are most affected by beriberi:

- Gastrointestinal system. When the cells of the smooth muscles in the digestive system and glands do not get enough energy from glucose, they are unable to produce more glucose from the normal digestion of food. There is a loss of appetite, **indigestion**, severe **constipation**, and a lack of hydrochloric acid in the stomach.
- Nervous System. Glucose is essential for the central nervous system to function normally. Early deficiency symptoms are **fatigue**, irritability, and poor memory. If the deficiency continues, there is damage to the peripheral nerves that causes loss of sensation and muscle weakness, which is called **peripheral neuropathy**. The legs are most affected. The toes feel numb and the feet have a burning sensation; the leg muscles become sore and the calf muscles cramp. The individual walks unsteadily and has difficulty getting up from a squatting position. Eventually, the muscles shrink (atrophy) and there is a loss of reflexes in the knees and feet; the feet may hang limp (footdrop).
- Cardiovascular system. There is a rapid heartbeat and sweating. Eventually the heart muscle weakens. Because the smooth muscle in the blood vessels is affected, the arteries and veins relax, causing swelling, known as **edema**, in the legs.
- Musculoskeletal system. There is widespread muscle **pain** caused by the lack of TPP in the muscle tissue.

Infants who are breastfed by a thiamine-deficient mother usually develop symptoms of deficiency between the second and fourth month of life. They are pale, restless, unable to sleep, prone to diarrhea, and have muscle wasting and edema in their arms and legs. They have a characteristic, sometimes silent, cry and develop heart failure and nerve damage.

Diagnosis

A **physical examination** will reveal many of the early symptoms of beriberi, such as fatigue, irritation, nausea, constipation, and poor memory, but the deficiency may be difficult to identify. Information about the individual's diet and general health is also needed.

There are many biochemical tests based on thiamine metabolism or the functions of TPP that can detect a thiamine deficiency. Levels of thiamine can be measured in the blood and urine and will be reduced if there is a deficiency. The urine can be collected for 24 hours to measure the level of thiamine excreted. Another reliable test measures the effect of TPP on red blood cell activity since all forms of beriberi affect the metabolism of red blood cells.

An electroencephalogram (EEG), which measures electrical activity in the brain, may be done to rule out other causes of neurologic changes. Observing improvements in the patient after giving thiamine supplements will also confirm the diagnosis.

Treatment

Treatment with thiamine reverses the deficiency in the body and relieves most of the symptoms. Severe thiamine deficiency is treated with high doses of thiamine given by injection into a muscle (intramuscular) or in a solution that goes into a vein (intravenously) for several days. Then smaller doses can be given either by injection or in pill form until the patient recovers. Usually there are other deficiencies in the B vitamins that will also need treatment.

The cardiovascular symptoms of wet beriberi can respond to treatment within a few hours if they are not too severe. Heart failure may require additional treatment with **diuretics** that help eliminate excess fluid and with heart-strengthening drugs like digitalis.

Recovery from peripheral neuropathy and other symptoms of dry beriberi may take longer and patients frequently become discouraged. They should stay active; physical therapy will also help in recovery.

Infantile beriberi is treated by giving thiamine to both the infant and the breast feeding mother until levels are normal.

In Wernicke-Korsakoff syndrome, thiamine should be given intravenously or by injection at first because the intestinal absorption of thiamine is probably impaired and the patient is very ill. Most of the symptoms will be relieved by treatment, though there may be residual memory loss.

Excess thiamine is excreted by the body in the urine, and negative reactions to too much thiamine are rare. Thiamine is unstable in alkali solutions, so it should not be taken with **antacids** or **barbiturates**.

Alternative treatment

Alternative treatments for beriberi deal first with correcting the thiamine deficiency. As in conventional treatments, alternative treatments for beriberi **stress** a diet rich in foods that provide thiamine and other B vitamins, such as brown rice, whole grains, raw fruits and vegetables, legumes, seeds, nuts, and yogurt. Drinking more than one glass of liquid with a meal should be avoided, since this may wash out the vitamins before they can be absorbed by the body. Thiamine should be taken daily, with the dose depending on the severity of

the disease. Additional supplements of B vitamins, a multivitamin and mineral complex, and Vitamin C are also recommended. Other alternative therapies may help relieve the person's symptoms after the thiamine deficiency is corrected.

Prognosis

Beriberi is fatal if not treated and the longer the deficiency exists, the sicker the person becomes. Most of the symptoms can be reversed and full recovery is possible when thiamine levels are returned to normal and maintained with a balanced diet and vitamin supplements as needed.

Prevention

A balanced diet containing all essential nutrients will prevent a thiamine deficiency and the development of beriberi. People who consume large quantities of junk food like soda, pretzels, chips, candy, and high carbohydrate foods made with unenriched flours may be deficient in thiamine and other vital nutrients. They may need to take vitamin supplements and should improve their **diets**.

Dietary Requirements

The body's requirements for thiamine are tied to carbohydrate metabolism and expressed in terms of total intake of calories. The current recommended dietary allowances (RDA) are 0.5 mg for every 1,000 calories, with a minimum daily intake of 1 mg even for those who eat fewer than 2,000 calories in a day. The RDA for children and teenagers is the same as for adults: 1.4 mg daily for males over age eleven, and 1.1 mg for females. During pregnancy, an increase to 1.5 mg daily is needed. Because of increased energy needs and the secretion of thiamine in breast milk, breast feeding mothers need 1.5 mg every day. In infants, 0.4 mg is advised.

Food Sources

The best food sources of thiamine are lean pork, beef, liver, brewer's yeast, peas and beans, whole or enriched grains, and breads. The more refined the food, as in white rice, white breads, and some cereals, the lower the thiamine. Many food products are enriched with thiamine, along with riboflavin, niacin, and iron, to prevent dietary deficiency.

During the milling process, rice is polished and all the vitamins in the exterior coating of bran are lost. Boiling the rice before husking preserves the vitamins by distributing them throughout the kernel. Food enrichment programs have eliminated beriberi in Japan and the Phillipines

KEY TERMS

B vitamins—This family of vitamins consists of thiamine (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6), biotin, folic acid (B_9), and cobalamin (B_{12}). They are interdependent and involved in converting glucose to energy.

Coenzyme—A substance needed by enzymes to produce many of the reactions in energy and protein metabolism in the body.

Edema—An excess accumulation of fluid in the cells and tissues.

Enzyme—A protein that acts as a catalyst to produce chemical changes in other substances without being changed themselves.

Metabolism—All the physical and chemical changes that take place within an organism.

Peripheral neuropathy—A disease affecting the portion of the nervous system outside the brain and spinal chord. One or more nerves can be involved, causing sensory loss, muscle weakness and shrinkage, and decreased reflexes.

Thiamine pyrophosphate (TPP)—The coenzyme containing thiamine that is essential in converting glucose to energy.

Like all B vitamins, thiamine is water soluble, which means it is easily dissolved in water. It will leach out during cooking in water and is destroyed by high heat and overcooking.

Resources

BOOKS

Anderson, Jean, and Barbara Deskins. *The Nutrition Bible.* New York: William Morrow, 1997.

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Fife, WA: Future Medicine Publishing, 1995.

Rivlin, Richard. "Vitamin Deficiency." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Williams, Sue Rodwell. *Essentials of Nutrition and Diet Therapy.* Philadelphia: Mosby, 1997.

PERIODICALS

Ryan, Ruth, et al. "Beriberi Unexpected." *Psychosomatics* (May/June 1997):191-294.

Karen Ericson, RN

Berry aneurysm *see* **Cerebral aneurysm**

Berylliosis

Definition

Berylliosis is lung inflammation caused by inhaling dust or fumes that contain the metallic element beryllium. Found in rocks, coal, soil, and volcanic dust, beryllium is used in the aerospace industry and in many types of manufacturing. Berylliosis occurs in both acute and chronic forms. In some cases, appearance of the disease may be delayed as much as 20 years after exposure to beryllium.

Description

In the 1930s, scientists discovered that beryllium could make fluorescent light bulbs last longer. During the following decade, the hard, grayish metal was identified as the cause of a potentially debilitating, sometimes deadly disease characterized by **shortness of breath** and inflammation, swelling, and scarring of the lungs.

The manufacture of fluorescent light bulbs is no longer a source of beryllium exposure, but serious health hazards are associated with any work environment or process in which beryllium fumes or particles become airborne. Working with pure beryllium, beryllium compounds (e.g. beryllium oxide), or beryllium alloys causes occupational exposure. So do jobs involving:

- electronics
- fiber optics
- manufacturing ceramics, bicycle frames, golf clubs, mirrors, and microwave ovens
- mining
- nuclear weapons and reactors
- reclaiming scrap metal
- space and atomic engineering.
- dental and laboratory technology

Beryllium dust and fumes are classified as toxic air pollutants by the Environmental Protection Agency (EPA). It is estimated that 2–6% of workers exposed to these contaminants eventually develop berylliosis.

Causes and symptoms

Coughing, shortness of breath, and weight loss that begin abruptly can be a symptom of acute berylliosis. This condition is caused by beryllium air pollution that inflames the lungs making them rigid; it can affect the eyes and skin as well. People who have acute berylliosis are usually very ill. Most recover, but some die of the disease.

Chronic berylliosis is an allergic reaction to long-term exposure to even low levels of beryllium dust or fumes. A systemic disease that causes formation of abnormal lung tissue and enlargement of the lymph nodes, chronic berylliosis also may affect other parts of the body. The symptoms of chronic berylliosis are largely the same as those seen in acute berylliosis, but they develop more slowly.

Diagnosis

Berylliosis is initially suspected if a patient with symptoms of the disease has a history of beryllium exposure. A **chest x ray** shows characteristic changes in the lungs. However, since these changes can resemble those caused by other lung diseases, further testing may be necessary.

The beryllium lymphocyte proliferation test (BeLPT), a blood test that can detect beryllium sensitivity (i.e. an allergic reaction to beryllium), is used to screen individuals at risk of developing berylliosis. When screening results reveal a high level of sensitivity, BeLPT is performed on cells washed from the lungs. This test is now considered the most definitive diagnostic test for berylliosis.

Treatment

Individuals with beryllium sensitivity or early-stage berylliosis should be transferred from tasks that involve beryllium exposure and regularly examined to determine whether the disease has progressed.

Acute berylliosis is a serious disease that occasionally may be fatal. Ventilators can help patients with acute berylliosis breathe. Prompt corticosteroid therapy is required to lessen lung inflammation.

Chronic beryllium disease is incurable. Corticosteroid therapy is often prescribed, but it is not certain that steroids can alter the progression of the disease, and they have no effect on scarring of lung tissue. Cleansing the lungs of beryllium is a slow process, so long-term therapy may be required. **Chelation therapy** is currently under investigation as a treatment for the disease.

Prognosis

Most patients with acute berylliosis recover fully 7–10 days after treatment begins, and the disease usually causes no after effects.

Patients whose lungs are severely damaged by chronic berylliosis may experience fatal **heart failure** because of the strain placed on the heart.

Prevention

Eliminating exposure to beryllium is the surest way to prevent berylliosis. Screening workers who are exposed to beryllium fumes or dust or who develop an allergic reaction to these substances is an effective way to control symptoms and prevent disease progression.

KEY TERMS

Beryllium—A steel-grey, metallic mineral used in the aerospace and nuclear industries and in a variety of manufacturing processes.

Chelation therapy—A treatment using chelating agents, compounds that surround and bind to target substances allowing them to be excreted from the body.

Corticosteroids—A group of anti-inflammatory drugs.

Resources

BOOKS

Thoene, Jess G., ed. *Physicians' Guide to Rare Diseases*. 2nd ed. Montvale, NJ: Dowden Publishing Co., 1995.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Beryllium Support Group. P.O. Box 2021, Broomfield, CO 80038-2021. (303) 412-7065. <http://www.dimensional.com/~mhj>.

Environmental Health Center. 1025 Connecticut Ave., NW, Washington, DC 20036 (202) 293-2270.

OTHER

"Beryllium Chemical Backgrounder." *Environmental Health Center Page*. 28 May 1998 <http://www.nsc.org/ehc/ew/chems/berylliu.htm>.

"Beryllium Disease: Reducing the Risks." *National Jewish Medical Research Center Page*. 28 May 1998 <http://www.nationaljewish.org/main.html>.

Epler, Gary R. Home Page. 29 May 1998. "Environmental and Occupational Lung Diseases." <http://www.epler.com/occu2.html>.

Maureen Haggerty

Beryllium pneumonosis *see* **Berylliosis**

Beryllium poisoning *see* **Berylliosis**

Beta-adrenergic blockers *see* **Beta blockers**

Beta-thalassemia *see* **Thalassemia**

Beta$_2$-microglobulin test

Definition

Beta$_2$-microglobulin is a protein found on the surface of many cells. Testing is done primarily when evaluating a person for certain kinds of **cancer** affecting white blood cells including chronic lymphocytic leukemia, non-Hodgkin's lymphoma, and **multiple myeloma** or kidney disease.

Purpose

Beta$_2$-microglobulin is plentiful on the surface of white blood cells. Increased production or destruction of these cells causes Beta$_2$-microglobulin levels in the blood to increase. This increase is seen in people with cancers involving white blood cells, but it is particularly meaningful in people newly diagnosed with multiple myeloma. Multiple myeloma is a malignancy (cancer) of a certain kind of white blood cell, called a plasma cell. At the time of diagnosis, the Beta$_2$-microglobulin levels reflect how advanced the disease is and the likely prognosis for that person.

When kidney disease is suspected, comparing blood and urine levels helps identify where the kidney is damaged. Beta$_2$-microglobulin normally is filtered out of the blood by the kidney's glomeruli (a round mass of capillary loops leading to each kidney tubule), only to be partially reabsorbed back into the blood when it reaches the kidney's tubules. In glomerular kidney disease, the glomeruli can't filter it out of the blood, so levels increase in the blood and decrease in the urine. In tubular kidney disease, the tubules can't reabsorb it back into the blood, so urine levels rise and blood levels fall. After a kidney transplant, increased blood levels may be an early sign of rejection.

Increased urinary levels are found in people with kidney damage caused by high exposure to the heavy metals cadmium and mercury. Periodic testing of workers exposed to these metals helps to detect beginning kidney damage.

Beta$_2$-microglobulin levels also rise during infection with some viruses, including cytomegalovirus and human **immunodeficiency** virus (HIV). Studies show that as HIV disease advances, beta$_2$-microglobulin levels rise.

Description

Testing methods vary, but most involve adding the person's serum—the yellow, liquid part of blood—or urine to one or more substances that bind to beta$_2$-microglobulin in the serum or urine. The amount of the substance(s) bound to beta$_2$-microglobulin is measured and the original amount of beta$_2$-microglobulin is determined.

The test is covered by insurance when medically necessary. Results are usually available the next day.

KEY TERMS

Beta$_2$-microglobulin—A protein found on the surface of many cells, particularly white blood cells.

Chronic lymphocytic leukemia—A cancer of the blood cells characterized by large numbers of cancerous, mature white blood cells and enlarged lymph nodes.

Glomerular kidney disease—Disease of the kidney that affects the glomeruli, the part of the kidney that filters certain substances out of the blood.

Muliple myeloma—A malignancy (cancer) of a certain kind of white blood cell, called a plasma cell.

Non-Hodgkin's lymphoma—Cancer that originates in the lymphatic system and typically spreads throughout the body.

Tubular kidney disease—Disease of the kidney that affect the tubules, the part of the kidney that allows certain substances to be reabsorbed back into the blood.

Preparation

The blood test requires 5 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Urine may be a single collection or collected throughout a 24-hour time period. The urine should be refrigerated until it is brought to the laboratory and must not become acidic.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs on the puncture site relieve discomfort.

Normal results

- Serum: less than or equal to 2.7 g/mL
- Urine: less than 1 mg/24 hours or 0-160 g/L

Abnormal results

The meaning of an abnormal result varies with the clinical condition of the person tested. In a person with multiple myeloma, a higher level means a poorer prognosis than a lower level. In a person with kidney disease, an increased blood level means the problem is tubular, not glomerular. In a kidney transplant patient, an increase may be a sign of rejection, toxic amounts of antirejection medication, or a viral infection. An increased level in a worker exposed to cadmium or mercury may signal beginning kidney damage and in a person with HIV, advancing disease.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Philadelphia: W. B. Saunders Co., 1996.

Lehmann, Craig A. *Saunders Manual of Clinical Laboratory Science*. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Bethea, Marc, and Donald R. Forman. "Beta$_2$-Microglobulin: Its Significance and Clinical Usefulness." *Annals of Clinical and Laboratory Science* (May/June 1990): 163–168.

Henne, V., P. Frei, and P. L. Burgisser. "Beta$_2$-microglobulin-A Rapid and Automated Determination for a Broad Range of Clinical Applications." *Anticancer Research* (July/Aug. 1997): 2915–2918.

Nancy J. Nordenson

Beta blockers

Definition

Beta blockers are medicines that affect the body's response to certain nerve impulses. This, in turn, decreases the force and rate of the heart's contractions, which lowers blood pressure and reduces the heart's demand for oxygen.

Purpose

The main use of beta blockers is to treat high blood pressure. Some also are used to relieve the type of chest **pain** called **angina** or to prevent heart attacks in people who already have had one **heart attack**. These drugs may also be prescribed for other conditions, such as migraine, **tremors**, and irregular heartbeat. In eye drop form, they are used to treat certain kinds of **glaucoma**.

Description

Beta blockers, also known as beta-adrenergic blockers, are available only with a physician's prescription.

The come in capsule, tablet, liquid, and injectable forms. Some common beta blockers are atenolol (Tenormin), metoprolol (Lopressor), nadolol (Corgard), propranolol (Inderal), and timolol (Blocadren). Timolol and certain other beta blockers are also sold in eye drop form for treating glaucoma. Eye drops that contain beta blockers include betaxolol (Betoptic), cartelol (Ocupress), and timolol (Timoptic).

Recommended dosage

The recommended dosage depends on the type, strength, and form of beta blocker and the condition for which it is prescribed. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

This medicine may take several weeks to noticeably lower blood pressure. Taking it exactly as directed is important.

Do not stop taking this medicine without checking with the physician who prescribed it. Some conditions may get worse when patients stop taking beta blockers abruptly. This may also increase the risk of heart attack in some people. Because of these possible effects, it is important to keep enough medicine on hand to get through weekends, holidays, and vacations.

Physicians may recommend that patients check their pulse before and after taking this medicine. If the pulse becomes too slow, circulation problems may result.

Precautions

Seeing a physician regularly while taking beta blockers is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. People who have high blood pressure often feel perfectly fine. However, they should continue to see their physicians even when they feel well so that the physician can keep a close watch on their condition. Patients also need to keep taking their medicine even when they feel fine.

Beta blockers will not cure high blood pressure, but will help control the condition. To avoid the serious health problems that high blood pressure can cause, patients may have to take medicine for the rest of their lives. Furthermore, medicine alone may not be enough. Patients with high blood pressure may also need to avoid certain foods and keep their weight under control. The health care professional who is treating the condition can offer advice on what measures may be necessary. Patients being treated for high blood pressure should not change their **diets** without consulting their physicians.

Anyone taking beta blockers for high blood pressure should not take any other prescription or over-the-counter medicine without first checking with his or her physician. Some medicines may increase blood pressure.

Anyone who is taking beta blockers should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some beta blockers may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Some people feel drowsy, dizzy, or lightheaded when taking beta blockers. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Beta blockers may increase sensitivity to cold, especially in older people or people who have poor circulation. Anyone who takes this medicine should dress warmly in cold weather and should be careful not to be exposed to the cold for too long.

People who usually have chest pain when they **exercise** or exert themselves may not have the pain when they are taking beta blockers. This could lead them to be more active than they should be. Anyone taking this medicine should ask his or her physician how much exercise and activity is safe.

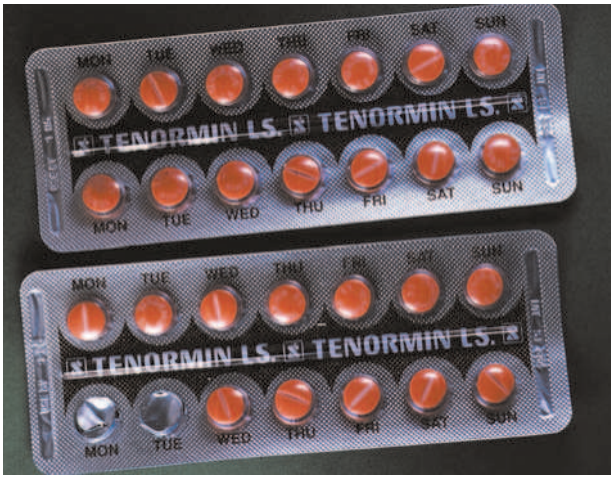
Older people may be unusually sensitive to the effects of beta blockers. This may increase the chance of side effects.

Physicians may advise people taking beta blockers to wear or carry medical identification indicating that they are taking this medicine.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take beta blockers. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to beta blockers in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to insect stings, medicines, foods, dyes, preservatives, or other substances. In people with allergies to medicines, foods, or insect stings, beta blockers may make the allergic reactions more severe and harder to treat. Anyone who has an allergic reaction while taking beta blockers should get medical attention right away and should make sure the



Blister packs of Tenormin LS (atenolol), a type of beta-receptor blocking drug or beta blocker. This type of drug is widely used to treat angina, to lower blood pressure, or to correct abnormal heart rhythms. *(Photograph by Adam Hart-Davis, Photo Researchers, Inc. Reproduced by permission.)*

physician in charge knows that he or she is taking this medicine.

Beta blockers may also cause serious reactions in people who take allergy shots. Anyone taking this medicine should be sure to alert the physician before having any allergy shots.

DIABETES. Beta blockers may make blood sugar levels rise and may hide some symptoms of low blood sugar. Diabetic patients should discuss these possible problems with their physicians.

PREGNANCY. Some studies of beta blockers show that these drugs cause problems in newborns whose mothers use them during **pregnancy**. Other studies do not show such effects. Women who are pregnant or who may become pregnant should check with their physicians about the use of beta blockers.

BREASTFEEDING. Some beta blockers pass into breast milk and may cause breathing problems, slow heartbeat, and low blood pressure in nursing babies whose mothers take the drugs. Women who need to take beta blockers and who want to breastfeed their babies should check with their physicians.

OTHER MEDICAL CONDITIONS. Beta blockers may increase breathing problems or make allergic reactions more severe in people who have allergies, **bronchitis**, or **emphysema**.

In people with an overactive thyroid, stopping beta blockers suddenly may cause an increase in symptoms. Also, taking this medicine may hide a fast heartbeat, which is one of the symptoms of overactive thyroid.

Effects of these drugs may be greater in people with kidney or liver disease because the medicine is cleared from the body more slowly.

Beta blockers may also make the following medical conditions worse:

- Heart or blood vessel disease
- Unusually slow heartbeat (bradycardia)
- Myasthenia gravis (chronic disease causing muscle weakness and possibly **paralysis**)
- Psoriasis (itchy, scaly, red patches of skin)
- Depression (now, or in the past).

Before using beta blockers, people with any of the medical problems listed in this section should make sure their physicians are aware of their conditions.

USE OF CERTAIN MEDICINES. Taking beta blockers with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **dizziness**, drowsiness, lightheadedness, sleep problems, unusual tiredness or weakness, and decreased sexual ability. In men, this can occur as **impotence** or delayed ejaculation. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they interfere with normal activities.

More serious side effects are possible. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- Breathing problems
- Slow heartbeat
- Cold hands and feet
- Swollen ankles, feet, or lower legs.
- Mental depression.

Other side effects may occur. Anyone who has unusual symptoms after taking beta blockers should get in touch with his or her physician.

Interactions

Beta blockers may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes beta blockers should let the physician know all other medicines he or she is taking. Among the drugs that may interact with beta blockers are:

KEY TERMS

Angina pectoris—A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Migraine—A throbbing headache that usually affects only one side of the head. Nausea, vomiting, increased sensitivity to light, and other symptoms often accompany migraine.

- Calcium channel blockers and other blood pressure drugs. Using these drugs with beta blockers may cause unwanted effects on the heart.
- Insulin and diabetes medicines taken by mouth. Beta blockers cause high blood sugar or hide the symptoms of low blood sugar.
- Monoamine oxidase inhibitors (MAO) such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and **Parkinson's disease**. Taking beta blockers at the same time or within two weeks of taking MAO inhibitors may cause severe high blood pressure.
- Airway-opening drugs (**bronchodilators**) such as aminophylline (Somophyllin), dyphylline (Lufyllin) oxtriphylline (Choledyl), or theophylline (Somophyllin-T). When combined with beta blockers, the effects of both the beta blockers and the airway-opening drugs may be lessened.
- **Cocaine**. High blood pressure, fast heartbeat, and heart problems are possible when cocaine and beta blockers are combined. Also, cocaine may interfere with the effects of beta blockers.
- Allergy shots or allergy skin tests. Beta blockers may increase the chance of serious reactions to these medicines.

The list above may not include every drug that interacts with beta blockers. Be sure to check with a physician or pharmacist before combining beta blockers with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Betamethasone *see* **Corticosteroids**

Bile duct atresia *see* **Biliary atresia**

Bile duct cancer

Definition

Bile duct **cancer**, or cholangiocarcinoma, is a malignant tumor of the bile ducts within the liver (intrahepatic), or leading from the liver to the small intestine (extrahepatic). It is a rare tumor with poor outcome for most patients.

Description

Bile is a substance manufactured by the liver that aids in the digestion of food. Bile ducts are channels that carry the bile from the liver to the small intestine. Like the tributaries of a river, the small bile ducts in the liver converge into two large bile ducts called the left and right hepatic ducts. These exit the liver and join to form the common hepatic duct. The gallbladder, which concentrates and stores the bile, empties into the common hepatic duct to form the common bile duct. Finally, this large duct connects to the small intestine where the bile can help digest food. Collectively, this network of bile ducts is called the biliary tract.

Bile duct cancer originates from the cells that line the inner surface of the bile ducts. A tumor may arise anywhere along the biliary tract, either within or outside of the liver. Bile duct tumors are typically slow-growing tumors that spread by local invasion of neighboring structures and by way of lymphatic channels.

Bile duct cancer is an uncommon malignancy. In the United States, approximately one case arises per 100,000 people per year, but it is more common in Southeast Asia. It occurs in men only slightly more often than in women, and it is most commonly diagnosed in people in their 50s and 60s.

Causes and symptoms

A number of risk factors are associated with the development of bile duct cancer:

- Primary sclerosing **cholangitis**. This disease is characterized by extensive scarring of the biliary tract, sometimes associated with inflammatory bowel disease.
- Choledochal cysts. These are abnormal dilatations of the biliary tract that usually form during fetal development. There is evidence that these cysts may rarely arise during adulthood.
- Hepatolithiasis. This is the condition of stone formation within the liver (not including gallbladder stones).
- Liver flukes. Parasitic infection with certain worms is thought to be at least partially responsible for the higher prevalence of bile duct cancer in Southeast Asia.

KEY TERMS

Angiography—Radiographic examination of blood vessels after injection with a special dye

Cholangiography—Radiographic examination of the bile ducts after injection with a special dye

Computed tomography—Radiographic examination by which images of cross-sectional planes of the body are obtained

Jaundice—Yellowish staining of the skin and eyes due to excess bilirubin in the bloodstream

Lymphatic—Pertaining to lymph, the clear fluid that is collected from tissues, flows through special vessels, and joins the venous circulation

Metastasis—The spread of tumor cells from one part of the body to another

Resection—To surgically remove a part of the body

Stent—Slender hollow catheter or rod placed within a vessels for duct to provide support or maintain patency

Ultrasound—Radiographic imaging technique utilizing high frequency sound waves

- Thorotrast. This is a chemical that was previously injected intravenously during certain types of x rays. It is not in use anymore. Exposure to Thorotrast has been implicated in the development of cancer of the liver as well as the bile ducts.

Symptoms

Jaundice is the first symptom in 90% of patients. This occurs when the bile duct tumor causes an obstruction in the normal flow of bile from the liver to the small intestine. Bilirubin, a component of bile, builds up within the liver and is absorbed into the bloodstream in excess amounts. This can be detected in a blood test, but it can also manifest as yellowish discoloring of the skin and eyes. The bilirubin in the bloodstream also makes the urine appear dark. Additionally, the patient may experience generalized **itching** due to the deposition of bile components in the skin. Normally, a portion of the bile is excreted in stool; bile actually gives stool its brown color. But when the biliary tract is obstructed by tumor, the stools may appear pale.

Abdominal **pain**, **fatigue**, weight loss, and poor appetite are less common symptoms. Occasionally, if obstruction of the biliary tract causes the gallbladder to swell enormously yet without causing pain, the physician may be able to feel the gallbladder during a **physical examination**. Sometimes the biliary tract can become infected, but this is normally a rare consequence of invasive tests. Infection causes **fever**, chills, and pain in the right upper portion of the abdomen.

Diagnosis

Certain laboratory tests of the blood may aid in the diagnosis. The most important one is the test for elevated bilirubin levels in the bloodstream. Levels of alkaline phosphatase and CA 19-9 may also be elevated.

When symptoms, physical signs, and blood tests poinmt toward an abnormality of the biliary tract, then the next step involves radiographic tests. Ultrasound and computed tomography (CT scan) are noninvasive and rapid. These tests can often detect the actual tumor as well as dilatation of the obstructed biliary tract. If these tests indicate the presence of a tumor, then cholangiography is required. This procedure involves injecting dye into the biliary tract to obtain anatomic images of the bile ducts and the tumor. The specialist that performs this test can also insert small tubes, or stents, into a partially obstructed portion of the bile duct to prevent further obstruction by growth of the tumor. This is vitally important since it may be the only intervention that is possible in certain patients. Cholangiography is an invasive test that carries a small risk of infection of the biliary tract. The objective of these radiological tests is to determine the size and location of the tumor, as well as the extent of spread to nearby structures.

The treatment of bile duct tumors is usually not affected by the specific type of cancer cells that comprise the tumor. For this reason, some physicians forego biopsy of the tumor.

Treatment

The treatment is with surgical resection (removal) of the tumor and all involved structures. Unfortunately, sometimes the cancer has already spread too far when the diagnosis is made. Thus, in the treatment of bile duct cancer, the first question to answer is if the tumor may be safely resected by surgery with reasonable benefit to the patient. If the cancer involves certain blood vessels or has spread widely throughout the liver, then resection may not be possible. Sometimes further invasive testing is required.

Angiography can determine if the blood vessels are involved. **Laparoscopy** is a surgical procedure that allows the surgeon to directly assess the tumor and nearby lymph nodes without making a large incision in the abdomen. Only about 45% of bile duct cancers are ultimately resectable.

If the tumor is resectable, and the patient is healthy enough to tolerate the operation, then the specific type of surgery performed depends on the location of the tumor. For tumors within the liver or high up in the biliary tract, resection of part of the liver may be required. Tumors in the middle portion of the biliary tract can be removed alone. Tumors of the lower end of the biliary tract may require extensive resection of part of the pancreas, small intestine, and stomach to ensure complete resection.

Unfortunately, sometimes the cancer appears resectable by all the radiological and invasive tests, but is found to be unresectable during surgery. In this scenario, a bypass operation can relieve the biliary tract obstruction, but does not remove the tumor itself. This does not produce a cure but it can offer a better quality of life for the patient.

Chemotherapy and **radiation therapy** have not been proven effective in the treatment of bile duct cancer.

Prognosis

Prognosis depends on the stage and resectability of the tumor. If the patient cannot undergo surgical resection, then the survival rate is commonly less than one year. If the tumor is resected, the survival rate improves, with 20% of these patients surviving past five years.

Clinical trials

Studies of new treatments in patients are known as clinical trials. These trials seek to compare the standard method of care with a new method, or the trials may be trying to establish whether one treatment is more beneficial for certain patients than others. Sometimes, a new treatment that is not being offered on a wide scale may be available to patients participating in clinical trials, but participating in the trials may involve some risk. To learn more about clinical trials, patients can call the National Cancer Institute (NCI) at 1-800-4-CANCER or visit the NCI web site for patients at <http://www.cancertrials.nci.nih.gov>.

Prevention

Other than the avoidance of infections caused by liver flukes, there are no known preventions for this cancer.

Resources

BOOKS

Ahrendt, Steven A. and Henry A. Pitt. "Biliary Tract." In *Sabiston Textbook of Surgery*, Edited by Courtney Townsend Jr., 16th ed. Philadelphia: W.B. Saunders Company, 2001, pp. 1076-1111.

Callery, Mark P. and William C. Meyers. "Bile Duct Cancer." In *Current Surgical Therapy*, Edited by John L. Cameron, sixth ed. St Louis: Mosby, 1998, pp.455-161.

"Cholangiocarcinoma." In *Clinical Oncology*, Edited by Abeloff, Martin D., second ed. New York: Churchill Livingstone, 2000, pp.1722-1723.

ORGANIZATIONS

The American Cancer Society. 1-800-ACS 2345. <http://www.cancer.org>.

National Cancer Institute Cancer Information Service. 1-800-4-CANCER. <http://www.nci.nih.gov>.

American Liver Foundation. 1-800-GO-LIVER (1-800-465-4837). <http://www.liverfoundation.org>.

Kevin O. Hwang, M.D.

Bile duct infection *see* **Cholangitis**

Bile flow obstruction *see* **Cholestasis**

Bilharziasis *see* **Schistosomiasis**

Biliary atresia

Definition

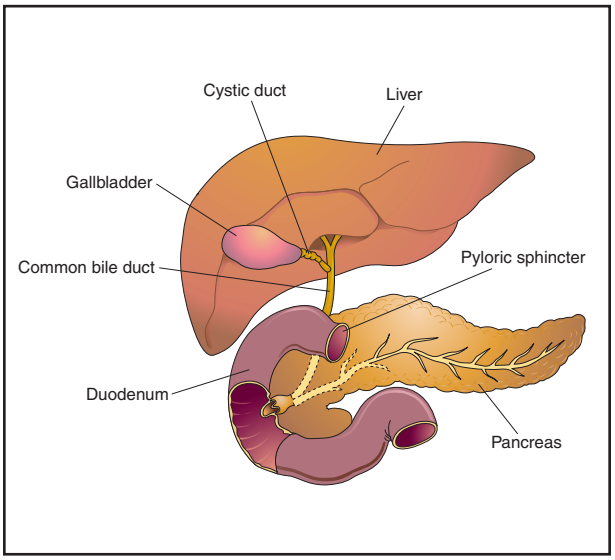
Biliary atresia is the failure of a fetus to develop an adequate pathway for bile to drain from the liver to the intestine.

Description

Biliary atresia is the most common lethal liver disease in children, occurring once every 10,000–15,000 live births. Half of all liver transplants are done for this reason.

The normal anatomy of the bile system begins within the liver, where thousands of tiny bile ducts collect bile from liver cells. These ducts merge into larger and larger channels, like streams flowing into rivers, until they all pour into a single duct that empties into the duodenum (first part of the small intestine). Between the liver and the duodenum this duct has a side channel connected to the gall bladder. The gall bladder stores bile and concentrates it, removing much of its water content. Then, when a meal hits the stomach, the gall bladder contracts and empties its contents.

Bile is a mixture of waste chemicals that the liver removes from the circulation and excretes through the biliary system into the intestine. On its way out, bile assists in the digestion of certain nutrients. If bile cannot get out because the channels are absent or blocked, it backs up into the liver and eventually into the rest of the body. The major pigment in bile is a chemical called bilirubin, which is yellow. Bilirubin is a breakdown product of hemoglobin (the red chemical in blood that carries oxygen). If the body accumulates an excess of bilirubin,



Biliary atresia is a congenital condition in which the pathway for bile to drain from the liver to the intestine is undeveloped. It is the most common lethal liver disease in children. *(Illustration by Electronic Illustrators Group).*

KEY TERMS

Duodenum—The first part of the small intestine, beginning at the outlet of the stomach.

Hemoglobin—The red, iron-containing chemical in the blood that carries oxygen to the tissues.

Jaundice—The yellow color taken on by a patient whose liver is unable to excrete bilirubin. A normal condition in the first week of life due to the infant's delayed ability to process certain waste products.

Kernicterus—A potentially lethal disease of newborns caused by excessive accumulation of the bile pigment bilirubin.

it turns yellow (jaundiced). Bile also turns the stool brown. Without it, stools are the color of clay.

Causes and symptoms

It is possible that a viral infection is responsible for this disease, but evidence is not yet convincing. The cause remains unknown.

The affected infant will appear normal at birth and during the newborn period. After two weeks the normal **jaundice** of the newborn will not disappear, and the stools will probably be clay-colored. At this point, the condition will come to the attention of a physician. If not, the child's abdomen will begin to swell, and the infant will get progressively more ill. Nearly all untreated children will die of liver failure within two years.

Diagnosis

The persistence of jaundice beyond the second week in a newborn with clay-colored stools is a sure sign of obstruction to the flow of bile. An immediate evaluation that includes blood tests and imaging of the biliary system will confirm the diagnosis.

Treatment

Surgery is the only treatment. Somehow the surgeon must create an adequate pathway for bile to escape the liver into the intestine. The altered anatomy of the biliary system is different in every case, calling upon the surgeon's skill and experience to select and execute the most effective among several options. If the obstruction is only between the gall bladder and the intestine, it is possible to attach a piece of intestine directly to the gall bladder. More likely, the upper biliary system will also be inadequate, and the surgeon will attach a piece of intestine directly to the liver—the Kasai procedure. In its wisdom, the body will discover that the tiny bile ducts in that part of the liver are discharging their bile directly into the intestine. Bile will begin to flow in that direction, and the channels will gradually enlarge. Survival rates for the Kasai procedure are commonly 50% at five years and 15% at 10 years. Persistent disease in the liver gradually destroys the organ.

Liver transplantation must be anticipated in all but the few patients who continue to do well after a Kasai procedure. Accumulating experience and newer techniques of liver transplantation are producing very gratifying early results.

Prognosis

Before liver transplants became available, even prompt and effective surgery did not cure the whole problem. Biliary drainage can usually be established, but the patients still have a defective biliary system that develops progressive disease and commonly leads to an early **death**. Transplantation now achieves up to 90% one-year survival rates and promises to prevent the chronic disease that used to accompany earlier procedures.

Prevention

The specific cause of this birth defect is unknown, so all that women can do is to practice the many general preventive measures, even before they conceive.

Resources

BOOKS

Balistreri, William F. "Cholestasis." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Feldman, Mark, et al. "Diseases of the Bile Ducts." *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Ryckman, F., R. Fisher, and S. Pedersen, et al. "Improved Survival in Biliary Atresia Patients in the Present Era of Liver Transplantation." *Journal of Pediatric Surgery* 28 (1993): 382.

J. Ricker Polsdorfer, MD

Biliary duct cancer *see* **Gallbladder cancer**

Biliary tract cancer *see* **Bile duct cancer**

Bilirubin test *see* **Liver function tests**

Binge-eating disorder

Definition

Binge eating disorder (BED) is characterized by a loss of control over eating behaviors. The binge eater consumes unnaturally large amounts of food in a short time period, but unlike a bulimic, does not regularly engage in any inappropriate weight-reducing behaviors (for example, excessive **exercise**, vomiting, taking **laxatives**) following the binge episodes.

Description

BED typically strikes individuals sometime between adolescence and the early twenties. Because of the nature of the disorder, most BED patients are overweight or obese. Studies of weight loss programs have shown that an average of 30% of individuals enrolling in these programs report binge eating behavior.

Causes and symptoms

Binge eating episodes may act as a psychological release for excessive emotional **stress**. Other circumstances that may predispose an individual to BED include heredity and affective disorders, such as major depression. BED patients are also more likely to have a comorbid, or co-existing, diagnosis of impulsive behaviors (for example, compulsive buying), **post-traumatic stress disorder** (PTSD), **panic disorder**, or **personality disorders**.

Individuals who develop BED often come from families who put an unnatural emphasis on the importance of food, for example, as a source of comfort in times of emotional distress. As children, BED patients may have been taught to clean their plate regardless of their appetite, or that finishing a meal made them a "good" girl or boy. Cultural attitudes towards beauty and thinness may also be a factor in the BED equation.

During binge episodes, BED patients experience a definite sense of lost control over their eating. They eat quickly and to the point of discomfort even if they aren't hungry. They typically binge alone two or more times a week, and often feel depressed and guilty once the episode has concluded.

Diagnosis

Binge eating disorder is usually diagnosed and treated by a psychiatrist and/or a psychologist. In addition to an interview with the patient, personality and behavioral inventories, such as the **Minnesota Multiphasic Personality Inventory** (MMPI), may be administered as part of the assessment process. One of several clinical inventories, or scales, may also be used to assess depressive symptoms, including the Hamilton Depression Scale (HAM-D) or Beck Depression Inventory (BDI). These tests may be administered in an outpatient or hospital setting.

Treatment

Many BED individuals binge after long intervals of excessive dietary restraint; therapy helps normalize this pattern. The initial goal of BED treatment is to teach the patient to gain control over his eating behavior by focusing on eating regular meals and avoiding snacking. **Cognitive-behavioral therapy**, **group therapy**, or interpersonal psychotherapy may be employed to uncover the emotional motives, distorted thinking, and behavioral patterns behind the binge eating.

Because the prevalence of depression in BED patients is high, psychopharmacological treatment with antidepressants may also be prescribed. Once the binge eating behavior is curbed and depressive symptoms are controlled, the physical symptoms of BED can be addressed. The overweight BED patient may be placed on a moderate exercise program and a nutritionist may be consulted to educate the patient on healthy food choices and strategies for weight loss.

Prognosis

The poor dietary habits and **obesity** that are symptomatic of BED can lead to serious health problems, such as high blood pressure, heart attacks, and diabetes, if left

KEY TERMS

Bulimia—An eating disorder characterized by binge eating and inappropriate compensatory behavior, such as vomiting, misusing laxatives, or excessive exercise.

Cognitive behavioral therapy—A therapy that pays particular attention to a patient's behavior and thinking processes rather than underlying psychological causes of an activity.

unchecked. BED is a chronic condition that requires ongoing medical and psychological management. To bring long-term relief to the BED patient, it is critical to address the underlying psychological causes behind binge eating behaviors. It appears that up to 50% of BED patients will stop bingeing with cognitive behavioral therapy (CBT).

Resources

BOOKS

Abraham, Suzanne, and Derek Llewellyn-Jones. *Eating Disorders: The Facts*. 4th ed. Oxford, England: Oxford University Press, 1997.

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Siegel, Michele, Judith Brisman, and Margot Weinshel. *Surviving an Eating Disorder: Strategies for Family and Friends*. 2nd ed. New York: Harper Perennial, 1997.

PERIODICALS

Brewerton, Timothy D. "Binge Eating Disorder: Recognition, Diagnosis, and Treatment." *Medscape Mental Health* 2, no. 5 (1997).

"Binge Eating Disorder Comes Out of the Closet: Experts Say Leading Obesity Factor Has Long Been Overlooked." *Tufts University Diet & Nutrition Letter*, 14, no. 11 (Jan. 1997): 4-5.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

Eating Disorders Awareness and Prevention. 603 Stewart St., Suite 803, Seattle, WA 98101. (206) 382-3587.

National Eating Disorders Organization (NEDO). 6655 South Yale Ave., Tulsa, OK 74136. (918) 481-4044.

Overeaters Anonymous World Service Office. 6075 Zenith Ct. NE, Rio Rancho, NM 87124. (505) 891-2664. <http://www.overeatersanonymous.org>.

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Biofeedback

Definition

Biofeedback, or applied psychophysiological feedback, is a patient-guided treatment that teaches an individual to control muscle tension, **pain**, body temperature, brain waves, and other bodily functions and processes through relaxation, visualization, and other cognitive control techniques. The name biofeedback refers to the biological signals that are fed back, or returned, to the patient in order for the patient to develop techniques of manipulating them.

Purpose

Biofeedback has been used to successfully treat a number of disorders and their symptoms, including **temporomandibular joint disorder** (TMJ), chronic pain, **irritable bowel syndrome** (IBS), Raynaud's syndrome, epilepsy, attention-deficit hyperactivity disorder (**ADHD**), migraine headaches, **anxiety**, depression, traumatic brain injury, and **sleep disorders**.

Illnesses that may be triggered at least in part by **stress** are also targeted by biofeedback therapy. Certain types of headaches, high blood pressure, **bruxism** (teeth grinding), **post-traumatic stress disorder**, eating disorders, substance abuse, and some **anxiety disorders** may be treated successfully by teaching patients the ability to relax and release both muscle and mental tension. Biofeedback is often just one part of a comprehensive treatment program for some of these disorders.

NASA has used biofeedback techniques to treat astronauts who suffer from severe space sickness, during which the autonomic nervous system is disrupted. Scientists at the University of Tennessee have adapted these techniques to treat individuals suffering from severe **nausea and vomiting** that is also rooted in autonomic nervous system dysfunction.

Recent research also indicates that biofeedback may be a useful tool in helping patients with **urinary incontinence** regain bladder control. Individuals learning pelvic-floor muscle strengthening exercises can gain better control over these muscles by using biofeedback. Sensors are placed on the muscles to train the patient where they are and when proper contractions are taking place.

Description

Origins

In 1961, Neal Miller, an experimental psychologist, suggested that autonomic nervous system responses (for

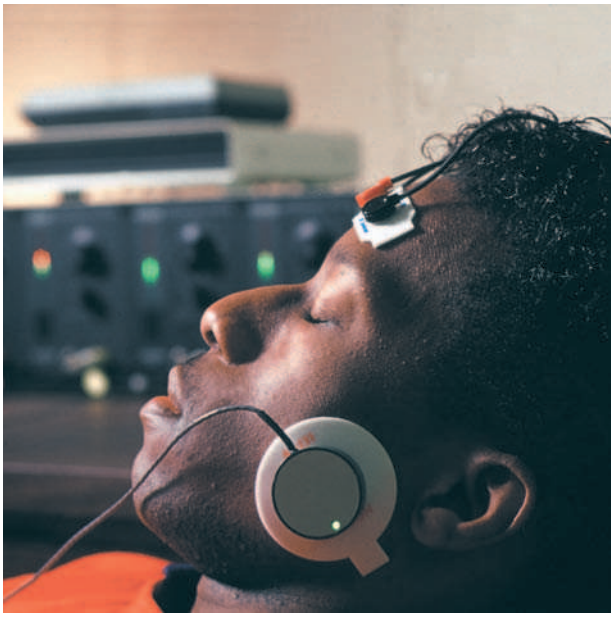
instance, heart rate, blood pressure, gastrointestinal activity, regional blood flow) could be under voluntary control. As a result of his experiments, he showed that such autonomic processes were controllable. This work led to the creation of biofeedback therapy. Willer's work was expanded by other researchers. Thereafter, research performed in the 1970s by UCLA researcher Dr. Barry Sterman established that both cats and monkeys could be trained to control their brain wave patterns. Sterman then used his research techniques on human patients with epilepsy, where he was able to reduce seizures by 60% with the use of biofeedback techniques. Throughout the 1970s, other researchers published reports of their use of biofeedback in the treatment of cardiac **arrhythmias**, headaches, Raynaud's syndrome, and excess stomach acid, and as a tool for teaching deep relaxation. Since the early work of Miller and Sterman, biofeedback has developed into a front-line behavioral treatment for an even wider range of disorders and symptoms.

During biofeedback, special sensors are placed on the body. These sensors measure the bodily function that is causing the patient problem symptoms, such as heart rate, blood pressure, muscle tension (EMG or electromyographic feedback), brain waves (EEC or electroencophalographic feedback), respiration, and body temperature (thermal feedback), and translates the information into a visual and/or audible readout, such as a paper tracing, a light display, or a series of beeps.

While the patient views the instantaneous feedback from the biofeedback monitors, he or she begins to recognize what thoughts, fears, and mental images influence his or her physical reactions. By monitoring this relationship between mind and body, the patient can then use these same thoughts and mental images as subtle cues, as these act as reminders to become deeply relaxed, instead of anxious. These reminders also work to manipulate heart beat, brain wave patterns, body temperature, and other bodily functions. This is achieved through relaxation exercises, mental imagery, and other cognitive therapy techniques.

As the biofeedback response takes place, patients can actually see or hear the results of their efforts instantly through the sensor readout on the biofeedback equipment. Once these techniques are learned and the patient is able to recognize the state of relaxation or visualization necessary to alleviate symptoms, the biofeedback equipment itself is no longer needed. The patient then has a powerful, portable, and self-administered treatment tool to deal with problem symptoms.

Biofeedback that specializes in reading and altering brain waves is sometimes called *neurofeedback*. The brain produces four distinct types of brain waves—delta, theta, alpha, and beta—that all operate at a different frequency. Delta, the slowest frequency wave, is the brain wave pattern associated with sleep. Beta waves, which occur in a normal, waking state, can range from 12-35 Hz. Problems begin to develop when beta wave averages fall in the low end (underarousal) or the high end (overarousal) of that spectrum. Underarousal might be present in conditions such as depression or attention-deficit disorder, and overarousal may be indicative of an anxiety disorder, obsessive compulsive disorder, or excessive stress. Beta wave neurofeedback focuses on normalizing that beta wave pattern to an optimum value of around 14 Hz. A second type of neurofeedback, alpha-theta, focuses on developing the more relaxing alpha (8-13 Hz) and theta waves (4-9 Hz) that are usually associated with deep, meditative states, and has been used with some success in substance abuse treatment.



A patient undergoing biofeedback therapy. *(Photo Researchers, Inc. Reproduced by permission.)*

Through brain wave manipulation, neurofeedback can be useful in treating a variety of disorders that are suspected or proven to impact brain wave patterns, such as epilepsy, attention-deficit disorder, migraine headaches, anxiety, depression, traumatic brain injury, and sleep disorders. The equipment used for neurofeedback usually uses a monitor as an output device. The monitor displays specific patterns that the patient attempts to change by producing the appropriate type of brain wave. Or, the monitor may reward the patient for producing the appropriate brain wave by producing a positive reinforcer, or reward. For example, children may be rewarded with a series of successful moves in a displayed video game.

Depending on the type of biofeedback, individuals may need up to 30 sessions with a trained professional to learn the techniques required to control their symptoms on a long-term basis. Therapists usually recommend that their patients practice both biofeedback and relaxation techniques on their own at home.

Preparations

Before initiating biofeedback treatment, the therapist and patient will have an initial consultation to record the patients medical history and treatment background and discuss goals for therapy.

Before a neurofeedback session, an EEG is taken from the patient to determine his or her baseline brainwave pattern.

Biofeedback typically is performed in a quiet and relaxed atmosphere with comfortable seating for the patient. Depending on the type and goals of biofeedback being performed, one or more sensors will be attached to the patient's body with conductive gel and/or adhesives. These may include:

- Electromyographic (EMG) sensors. EMG sensors measure electrical activity in the muscles, specifically muscle tension. In treating TMJ or bruxism, these sensors would be placed along the muscles of the jaw. Chronic pain might be treated by monitoring electrical energy in other muscle groups.
- Galvanic skin response (GSR) sensors. These are electrodes placed on the fingers that monitor perspiration, or sweat gland, activity. These may also be called skin conductance level (SCL).
- Temperature sensors. Temperature, or thermal, sensors measure body temperature and changes in blood flow.
- Electroencephalography (EEG) sensors. These electrodes are applied to the scalp to measure the electrical activity of the brain, or brain waves.
- Heart rate sensors. A pulse monitor placed on the finger tip can monitor pulse rate.
- Respiratory sensors. Respiratory sensors monitor oxygen intake and carbon dioxide output.

Precautions

Individuals who use a pacemaker or other implantable electrical devices should inform their biofeedback therapist before starting treatments, as certain types of biofeedback sensors have the potential to interfere with these devices.

Biofeedback may not be suitable for some patients. Patients must be willing to take a very active role in the treatment process. And because biofeedback focuses strictly on behavioral change, those patients who wish to gain insight into their symptoms by examining their past might be better served by psychodynamic therapy.

Biofeedback may also be inappropriate for cognitively impaired individuals, such as those patients with organic brain disease or a traumatic brain injury, depending on their levels of functioning.

Patients with specific pain symptoms of unknown origin should undergo a thorough medical examination before starting biofeedback treatments to rule out any serious underlying disease. Once a diagnosis has been made, biofeedback can be used concurrently with conventional treatment.

Biofeedback may only be one component of a comprehensive treatment plan. For illnesses and symptoms that are manifested from an organic disease process, such as **cancer** or diabetes, biofeedback should be an adjunct to (complementary to), and not a replacement for, conventional medical treatment.

Side effects

There are no known side effects to properly administered biofeedback or neurofeedback sessions.

Research and general acceptance

Preliminary research published in late 1999 indicated that neurofeedback may be a promising new tool in the treatment of **schizophrenia**. Researchers reported that schizophrenic patients had used neurofeedback to simulate brain wave patterns that antipsychotic medications produce in the brain. Further research is needed to determine what impact this may have on treatment for schizophrenia.

The use of biofeedback techniques to treat an array of disorders has been extensively described in the medical literature. Controlled studies for some applications are limited, such as for the treatment of menopausal symptoms and premenstrual disorder (PMS). There is also some debate over the effectiveness of biofeedback in ADHD treatment, and the lack of controlled studies on that application. While many therapists, counselors, and mental health professionals have reported great success with treating their ADHD patients with neurofeedback techniques, some critics attribute this positive therapeutic impact to a placebo effect.

There may also be some debate among mental health professionals as to whether biofeedback should be considered a first line treatment for some mental illnesses, and to what degree other treatments, such as medication, should be employed as an adjunct therapy.

KEY TERMS

Autonomic nervous system—The part of the nervous system that controls so-called involuntary functions, such as heart rate, salivary gland secretion, respiratory function, and pupil dilation.

Bruxism—Habitual, often unconscious, grinding of the teeth.

Epilepsy—A neurological disorder characterized by the sudden onset of seizures.

Placebo effect—Placebo effect occurs when a treatment or medication with no known therapeutic value (a placebo) is administered to a patient, and the patient's symptoms improve. The patient believes and expects that the treatment is going to work, so it does. The placebo effect is also a factor to some degree in clinically-effective therapies, and explains why patients respond better than others to treatment despite similar symptoms and illnesses.

Raynaud's syndrome—A vascular, or circulatory system, disorder which is characterized by abnormally cold hands and feet. This chilling effect is caused by constriction of the blood vessels in the extremities, and occurs when the hands and feet are exposed to cold weather. Emotional stress can also trigger the cold symptoms.

Schizophrenia—Schizophrenia is a psychotic disorder that causes distortions in perception (delusions and hallucinations), inappropriate moods and behaviors, and disorganized or incoherent speech and behavior.

Temporomandibular joint disorder—Inflammation, irritation, and pain of the jaw caused by improper opening and closing of the temporomandibular joint. Other symptoms include clicking of the jaw and a limited range of motion.

Resources

BOOKS

Robbins, Jim. *A Symphony in the Brain: The Evolution of the New Brain Wave Biofeedback.* Boston, MA: Atlantic Monthly Press, 2000.

PERIODICALS

Burgio, K.L. et al. "Behavioral vs. Drug Treatment for Urge Urinary Incontinence in Older Women: A randomized controlled trial." *Journal of the American Medical Association* 280 (Dec. 1998): 1995-2000.

Robbins, Jim. "On the Track with Neurofeedback." *Newsweek* 135, no. 25 (June 2000): 76.

ORGANIZATIONS

The Association for Applied Psychotherapy and Biofeedback. 10200 W. 44th Avenue, Suite 304, Wheat Ridge, CO 80033-2840. (303) 422-8436. <http://www.aapb.org

Biofeedback Certification Institute of America.10200 W. 44th Avenue, Suite 310, Wheat Ridge, CO 80033. (303) 420-2902.

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Biopsy *see* **Bone biopsy; Bone marrow aspiration and biopsy; Brain biopsy; Breast biopsy; Cervical conization; CT-guided biopsy; Endometrial biopsy; Joint biopsy; Kidney biopsy; Liver biopsy; Lung biopsy; Lymph node biopsy; Myocardial biopsy; Pleural biopsy; Prostate biopsy; Skin biopsy; Small intestine biopsy; Thyroid biopsy**

Bipolar disorder

Definition

Bipolar, or manic-depressive disorder, is a mood disorder that causes radical emotional changes and mood swings, from manic highs to depressive lows. The majority of bipolar individuals experience alternating episodes of **mania** and depression.

Description

In the United States alone, bipolar disorder afflicts almost two million people at an annual cost of over $45 billion, according to a report by the National Institutes of Mental Health. The average age of onset of bipolar disorder is from adolescence through the early twenties. However, because of the complexity of the disorder, a correct diagnosis can be delayed for several years or more. In a survey of bipolar patients conducted by the National Depressive and Manic Depressive Association (MDMDA), one-half of respondents reported visiting three or more professionals before receiving a correct diagnosis, and over one-third reported a wait of ten years or more before they were correctly diagnosed.

The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (*DSM-IV*), the diagnostic standard for mental health professionals in the United States, defines four separate categories of bipolar disorder: bipolar I, bipolar II, cyclothymia, and bipolar not-otherwise-specified (NOS).

Bipolar I disorder is characterized by manic episodes, the "high" of the manic-depressive cycle. A bipolar patient experiencing mania often has feelings of self-importance, elation, talkativeness, increased sociability, and a desire to embark on goal-oriented activities, coupled with the characteristics of irritability, impatience, impulsiveness, hyperactivity, and a decreased need for sleep. Usually this manic period is followed by a period of depression, although a few bipolar I individuals may not experience a major depressive episode. Mixed states, where both manic or hypomanic symptoms and depressive symptoms occur at the same time, also occur frequently with bipolar I patients (for example, depression with the racing thoughts of mania). Also, dysphoric mania is common (mania characterized by anger and irritability).

Bipolar II disorder is characterized by major depressive episodes alternating with episodes of hypomania, a milder form of mania. Bipolar depression may be difficult to distinguish from a unipolar major depressive episode. Patients with bipolar depression tend to have extremely low energy, retarded mental and physical processes, and more profound **fatigue** (for example, hypersomnia; a sleep disorder marked by a need for excessive sleep or sleepiness when awake) than unipolar depressives.

Cyclothymia refers to the cycling of hypomanic episodes with depression that does not reach major depressive proportions. A third of patients with cyclothymia will develop bipolar I or II disorder later in life.

A phenomenon known as rapid cycling occurs in up to 20% of bipolar I and II patients. In rapid cycling, manic and depressive episodes must alternate frequently; at least 4 times in 12 months; to meet the diagnostic definition. In some cases of "ultra-rapid cycling," the patient may bounce between manic and depressive states several times within a 24-hour period. This condition is very hard to distinguish from mixed states.

Bipolar NOS is a category for bipolar states that do not clearly fit into the bipolar I, II, or cyclothymia diagnoses.

Causes and symptoms

The source of bipolar disorder has not been clearly defined. Because two-thirds of bipolar patients have a family history of affective or emotional disorders, researchers have searched for a genetic link to the disorder. Several studies have uncovered a number of possible genetic connections to the predisposition for bipolar disorder. Another possible biological cause under investigation is the presence of an excessive calcium build-up in the cells of bipolar patients. Also, dopamine and other neurochemical transmitters appear to be implicated in bipolar disorder and these are under intense investigation.

Over half of patients diagnosed with bipolar disorder have a history of substance abuse. There is a high rate of association between **cocaine** abuse and bipolar disorder. Some studies have shown up to 30% of abusers meeting the criteria for bipolar disorder. The emotional and physical highs and lows of cocaine use correspond to the manic depression of the bipolar patient, making the disorder difficult to diagnosis.

For some bipolar patients, manic and depressive episodes coincide with seasonal changes. Depressive episodes are typical during winter and fall, and manic episodes are more probable in the spring and summer months.

Symptoms of bipolar depressive episodes include low energy levels, feelings of despair, difficulty concentrating, extreme fatigue, and psychomotor retardation (slowed mental and physical capabilities). Manic episodes are characterized by feelings of euphoria, lack of inhibitions, racing thoughts, diminished need for sleep, talkativeness, risk taking, and irritability. In extreme cases, mania can induce **hallucinations** and other psychotic symptoms such as grandiose illusions.

Diagnosis

Bipolar disorder is usually diagnosed and treated by a psychiatrist and/or a psychologist with medical assistance. In addition to an interview, several clinical inventories or scales may be used to assess the patient's mental status and determine the presence of bipolar symptoms. These include the Millon Clinical Multiaxial Inventory III (MCMI-III), **Minnesota Multiphasic Personality Inventory** II (**MMPI-2**), the Internal State Scale (ISS), the Self-Report Manic Inventory (SRMI), and the Young Mania Rating Scale (YMRS). The tests are verbal and/or written and are administered in both hospital and outpatient settings.

Psychologists and psychiatrists typically use the criteria listed in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*) as a guideline for diagnosis of bipolar disorder and other mental illnesses. *DSM-IV* describes a manic episode as an abnormally elevated or irritable mood lasting a period of at least one week that is distinguished by at least three of the mania symptoms: inflated self-esteem, decreased need for sleep, talkativeness, racing thoughts, distractibility, increase in goal-directed activity, or excessive involvement in pleasurable activities that have a high potential for painful consequences. If the mood of

the patient is irritable and not elevated, four of the symptoms are required.

Although many clinicians find the criteria too rigid, a hypomanic diagnosis requires a duration of at least four days with at least three of the symptoms indicated for manic episodes (four if mood is irritable and not elevated). *DSM-IV* notes that unlike manic episodes, hypomanic episodes do not cause a marked impairment in social or occupational functioning, do not require hospitalization, and do not have psychotic features. In addition, because hypomanic episodes are characterized by high energy and goal directed activities and often result in a positive outcome, or are perceived in a positive manner by the patient, bipolar II disorder can go undiagnosed.

Bipolar symptoms often present differently in children and adolescents. Manic episodes in these age groups are typically characterized by more psychotic features than in adults, which may lead to a misdiagnosis of **schizophrenia**. Children and adolescents also tend toward irritability and aggressiveness instead of elation. Further, symptoms tend to be chronic, or ongoing, rather than acute, or episodic. Bipolar children are easily distracted, impulsive, and hyperactive, which can lead to a misdiagnosis of attention deficit hyperactivity disorder (**ADHD**). Furthermore, their aggression often leads to violence, which may be misdiagnosed as a **conduct disorder**.

Substance abuse, thyroid disease, and use of prescription or over-the-counter medication can mask or mimic the presence of bipolar disorder. In cases of substance abuse, the patient must ordinarily undergo a period of **detoxification** and abstinence before a mood disorder is diagnosed and treatment begins.

Treatment

Treatment of bipolar disorder is usually by means of medication. A combination of mood stabilizing agents with antidepressants, antipsychotics, and anticonvulsants is used to regulate manic and depressive episodes.

Mood stabilizing agents such as lithium, carbamazepine, and valproate are prescribed to regulate the manic highs and lows of bipolar disorder:

- Lithium (Cibalith-S, Eskalith, Lithane, Lithobid, Lithonate, Lithotabs) is one of the oldest and most frequently prescribed drugs available for the treatment of bipolar mania and depression. Because the drug takes four to ten days to reach a therapeutic level in the bloodstream, it is sometimes prescribed in conjunction with neuroleptics and/or **benzodiazepines** to provide more immediate relief of a manic episode. Lithium has also been shown to be effective in regulating bipolar depression, but is not recommended for mixed mania. Lithium may not be an effective long-term treatment option for rapid cyclers, who typically develop a tolerance for it, or may not respond to it. Possible side effects of the drug include weight gain, thirst, nausea, and hand **tremors**. Prolonged lithium use may also cause **hyperthyroidism** (a disease of the thryoid that is marked by heart **palpitations**, nervousness, the presence of **goiter**, sweating, and a wide array of other symptoms.)
- Carbamazepine (Tegretol, Atretol) is an anticonvulsant drug usually prescribed in conjunction with other mood stabilizing agents. The drug is often used to treat bipolar patients who have not responded well to lithium therapy. Blurred vision and abnormal eye movement are two possible side effects of carbamazepine therapy. As of early 1998, carbamazepine did not have an FDA-cleared indication for mania.
- Valproate (divalproex sodium, or Depakote; valproic acid, or Depakene) is one of the few drugs available that has been proven effective in treating rapid cycling bipolar and mixed states patients. Valproate is prescribed alone or in combination with carbamazepine and/or lithium. Stomach cramps, **indigestion**, **diarrhea**, hair loss, appetite loss, nausea, and unusual weight loss or gain are some of the common side effects of valproate. Note: valproate is also approved for the treatment of mania.

Because antidepressants may stimulate manic episodes in some bipolar patients, their use is typically short-term. **Selective serotonin reuptake inhibitors** (SSRIs) or, less often, **monoamine oxidase inhibitors** (MAO inhibitors) are prescribed for episodes of bipolar depression. Tricyclic antidepressants used to treat unipolar depression may trigger rapid cycling in bipolar patients and are, therefore, not a preferred treatment option for bipolar depression.

- SSRIs, such as fluoxetine (Prozac), sertraline (Zoloft), and paroxetine (Paxil), regulate depression by regulating levels of serotonin, a neurotransmitter. **Anxiety**, diarrhea, drowsiness, **headache**, sweating, nausea, sexual problems, and **insomnia** are all possible side effects of SSRIs.
- MAOIs such as tranylcypromine (Parnate) and phenelzine (Nardil) block the action of monoamine oxidase (MAO), an enzyme in the central nervous system. Patients taking MAOIs must cut foods high in tyramine (found in aged cheeses and meats) out of their diet to avoid hypotensive side effects.
- Bupropion (Wellbutrin) is a heterocyclic antidepressant. The exact neurochemical mechanism of the drug is not known, but it has been effective in regulating bipolar depression in some patients. Side effects of bupropion include agitation, anxiety, confusion, tremor, **dry mouth**, fast or irregular heartbeat, headache, and insomnia.

- ECT, or **electroconvulsive therapy**, has a high success rate for treating both unipolar and bipolar depression, and mania. However, because of the convenience of drug treatment and the stigma sometimes attached to ECT therapy, ECT is usually employed after all pharmaceutical treatment options have been explored. ECT is given under anesthesia and patients are given a muscle relaxant medication to prevent convulsions. The treatment consists of a series of electrical pulses that move into the brain through electrodes on the patient's head. Although the exact mechanisms behind the success of ECT therapy are not known, it is believed that this electrical current alters the electrochemical processes of the brain, consequently relieving depression. Headaches, muscle soreness, nausea, and confusion are possible side effects immediately following an ECT procedure. Temporary memory loss has also been reported in ECT patients. In bipolar patients, ECT is often used in conjunction with drug therapy.

Adjunct treatments are used in conjunction with a long-term pharmaceutical treatment plan:

- Long-acting benzodiazepines such as clonazepam (Klonapin) and alprazolam (Xanax) are used for rapid treatment of manic symptoms to calm and sedate patients until mania or hypomania have waned and mood stabilizing agents can take effect. **Sedation** is a common effect, and clumsiness, lightheadedness, and slurred speech are other possible side effects of benzodiazepines.
- Neuroleptics such as chlorpromazine (Thorazine) and haloperidol (Haldol) are also used to control mania while a mood stabilizer such as lithium or valproate takes effect. Because neuroleptic side effects can be severe (difficulty in speaking or swallowing, **paralysis** of the eyes, loss of balance control, muscle spasms, severe restlessness, stiffness of arms and legs, tremors in fingers and hands, twisting movements of body, and weakness of arms and legs), benzodiazepines are generally preferred over neuroleptics.
- Psychotherapy and counseling. Because bipolar disorder is thought to be biological in nature, therapy is recommended as a companion to, but not a substitute for, pharmaceutical treatment of the disease. Psychotherapy, such as **cognitive-behavioral therapy**, can be a useful tool in helping patients and their families adjust to the disorder, in encouraging compliance to a medication regimen, and in reducing the risk of suicide. Also, educative counseling is recommended for the patient and family.

Calcium channel blockers (nimodipine, or Nimotop), typically used to treat **angina** and **hypotension**, have been found effective, in a few small studies, for treating rapid cyclers. Calcium channel blockers stop the excess calcium build up in cells that is thought to be a cause of bipolar disorder. They are usually used in conjunction with other drug therapies such as carbamazepine or lithium.

Clozapine (Clozaril) is an atypical antipsychotic medication used to control manic episodes in patients who have not responded to typical mood stabilizing agents. The drug has also been a useful prophylactic, or preventative treatment, in some bipolar patients. Common side effects of clozapine include tachycardia (rapid heart rate), hypotension, **constipation**, and weight gain. Agranulocytosis, a potentially serious but reversible condition in which the white blood cells that typically fight infection in the body are destroyed, is a possible side effect of clozapine. Patients treated with the drug should undergo weekly blood tests to monitor white blood cell counts.

Risperidone (Risperdal) is an atypical antipsychotic medication that has been successful in controlling mania in several clinical trials when low doses were administered. The side effects of risperidone are mild compared to many other antipsychotics (constipation, coughing, diarrhea, dry mouth, headache, **heartburn**, increased length of sleep and dream activity, nausea, runny nose, **sore throat**, fatigue, and weight gain).

Lamotrigine (Lamictal, or LTG), an anticonvulsant medication, was found to alleviate manic symptoms in a 1997 trial of 75 bipolar patients. The drug was used in conjunction with divalproex (divalproate) and/or lithium. Possible side effects of lamotrigine include skin rash, **dizziness**, drowsiness, headache, **nausea and vomiting**.

rTMS, or repeated transcranial magnetic stimulation is a new and still experimental treatment for the depressive phase of bipolar disorder. In rTMS, a large magnet is placed on the patient's head and magnetic fields of different frequency are generated to stimulate the left front cortex of the brain. Unlike ECT, rTMS requires no anesthesia and does not induce seizures.

Alternative treatment

General recommendations include maintaining a calm environment, avoiding over stimulation, getting plenty of rest, regular **exercise**, and proper diet. Chinese herbs may soften mood swings. **Biofeedback** is effective in helping some patients control symptoms such as irritability, poor self control, racing thoughts, and sleep problems. A diet low in vanadium (a mineral found in meats and other foods) and high in vitamin C may be helpful in reducing depression.

Prognosis

While most patients will show some positive response to treatment, response varies widely, from full recovery to a complete lack of response to all drug and/or ECT therapy.

KEY TERMS

Affective disorder—An emotional disorder involving abnormal highs and/or lows in mood. Now termed mood disorder.

Anticonvulsant medication—A drug used to prevent convulsions or seizures; often prescribed in the treatment of epilepsy. Several anticonvulsant medications have been found effective in the treatment of bipolar disorder.

Antipsychotic medication—A drug used to treat psychotic symptoms, such as delusions or hallucinations, in which patients are unable to distinguish fantasy from reality.

Benzodiazpines—A group of tranquilizers having sedative, hypnotic, antianxiety, amnestic, anticonvulsant, and muscle relaxant effects.

DSM-IV—Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV). This reference book, published by the American Psychiatric Association, is the diagnostic standard for most mental health professionals in the United States.

ECT—Electroconvulsive therapy is sometimes used to treat depression or mania when pharmaceutical treatment fails.

Hypomania—A milder form of mania which is characteristic of bipolar II disorder.

Mixed mania/mixed state—A mental state in which symptoms of both depression and mania occur simultaneously.

Mania—An elevated or euphoric mood or irritable state that is characteristic of bipolar I disorder.

Neurotransmitter—A chemical in the brain that transmits messages between neurons, or nerve cells. Changes in the levels of certain neurotransmitters, such as serotonin, norepinephrine, and dopamine, are thought to be related to bipolar disorder.

Psychomotor retardation—Slowed mental and physical processes characteristic of a bipolar depressive episode.

Drug therapies frequently need adjustment to achieve the maximum benefit for the patient. Bipolar disorder is a chronic recurrent illness in over 90% of those afflicted, and one that requires lifelong observation and treatment after diagnosis. Patients with untreated or inadequately treated bipolar disorder have a suicide rate of 15-25% and a nine-year decrease in life expectancy. With proper treatment, the life expectancy of the bipolar patient will increase by nearly seven years and work productivity increases by ten years.

Prevention

The ongoing medical management of bipolar disorder is critical to preventing relapse, or recurrence, of manic episodes. Even in carefully controlled treatment programs, bipolar patients may experience recurring episodes of the disorder. Patient education in the form of psychotherapy or self-help groups is crucial for training bipolar patients to recognize signs of mania and depression and to take an active part in their treatment program.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S. and Nicholas G. Ward. "Mood Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Whybrow, Peter C. *A Mood Apart*. New York: Harper Collins, 1997.

PERIODICALS

Biederman, Joseph A. "Is There a Childhood form of Bipolar Disorder?" *Harvard Mental Health Letter*, 13, no. 9 (Mar. 1997): 8.

Bowden, Charles L. "Choosing the Appropriate Therapy for Bipolar Disorder." *Medscape Mental Health*, 2, no. 8 (1997).

Bowden, Charles L. "Update on Bipolar Disorder: Epidemiology, Etiology, Diagnosis, and Prognosis." *Medscape Mental Health*, 2, no. 6 (1997).

Francis, A., J. P. Docherty, and D. A. Kahn. "The Expert Consensus Guideline Series: Treatment of Bipolar Disorder." *Journal of Clinical Psychiatry*, 57, supplement 12A (Nov. 1996): 1-89.

Hirschfeld, Robert "Recent Developments in Clinical Aspects of Bipolar Disorder." *The Decade of the Brain: A Publication of the National Alliance for the Mentally Ill* 6, no. 2 (Winter 1995).

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.
National Depressive and Manic-Depressive Association (NDMDA). 730 N. Franklin St., Suite 501, Chicago, IL 60610. (800) 826-3632. <http://www.ndmda.org>.
National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Paula Anne Ford-Martin

Birth control *see* **Condom; Contraception; Diaphragm (birth control)**

Birth control pills *see* **Oral contraceptives**

Birth defects

Definition

Birth defects are physical abnormalities that are present at birth; they are also called congenital abnormalities. More than 3,000 have been identified.

Description

Birth defects are found in 2-3% of all newborn infants. This rate doubles in the first year, and reaches 10% by age five, as more defects become evident and can be diagnosed. Almost 20% of deaths in newborns are caused by birth defects.

Abnormalities can occur in any major organ or part of the body. Major defects are structural abnormalities that affect the way a person looks and require medical and/or surgical treatment. Minor defects are abnormalities that do not cause serious health or social problems. When multiple birth defects occur together and have a similar cause, they are called syndromes. If two or more defects tend to appear together but do not share the same cause, they are called associations.

Causes and symptoms

The specific cause of many congenital abnormalities is unknown, but several factors associated with **pregnancy** and delivery can increase the risk of birth defects.

Teratogens

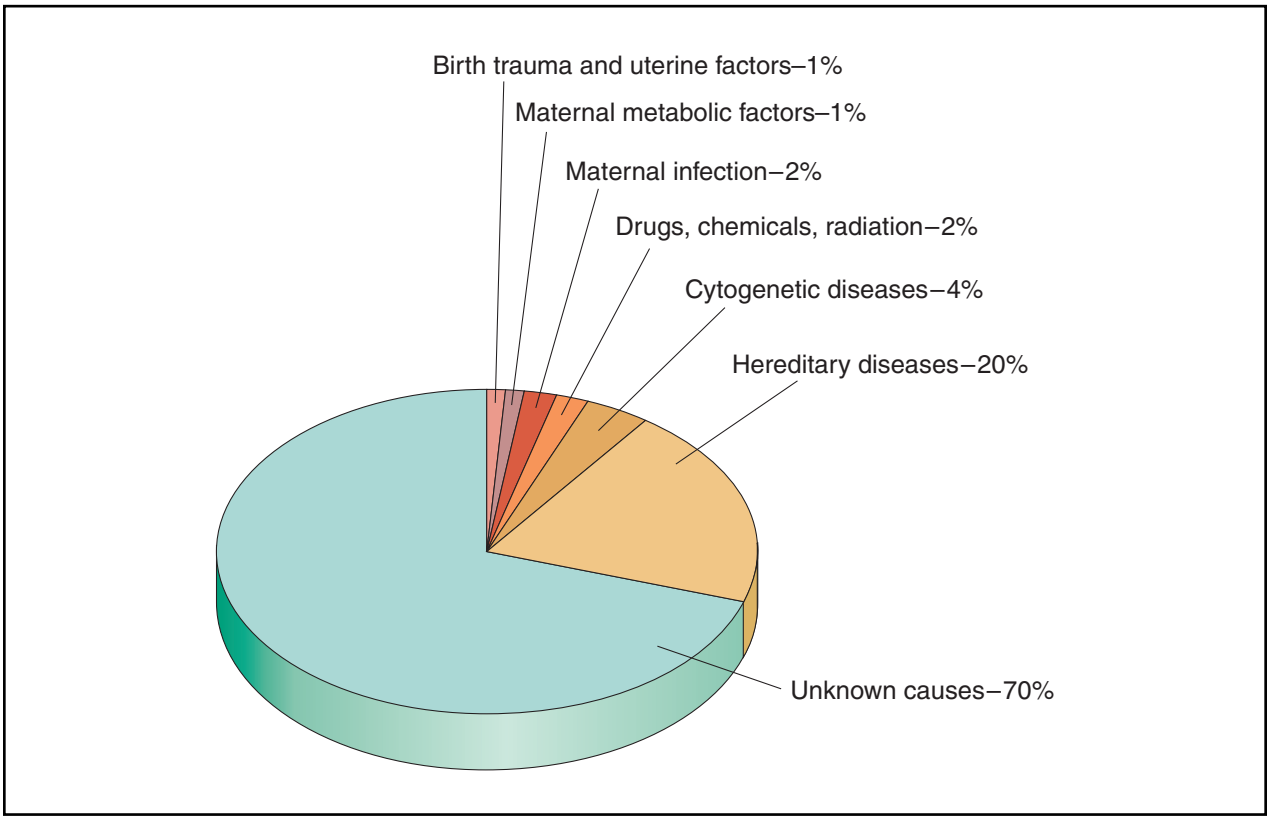
Any substance that can cause abnormal development of the egg in the mother's womb is called a teratogen. In the first two months after conception, the developing organism is called an embryo; developmental stages from two months to birth are called fetal. Growth is rapid, and each body organ has a critical period in which it is especially sensitive to outside influences. About 7% of all congenital defects are caused by exposure to teratogens.

DRUGS. Only a few drugs are known to cause birth defects, but all have the potential to cause harm. Thalidomide is known to cause defects of the arms and legs; several other types also cause problems.

- Alcohol. Drinking large amounts of alcohol while pregnant causes a cluster of defects called **fetal alcohol syndrome**, which include **mental retardation**, heart problems, and growth deficiency.
- **Antibiotics**. Certain antibiotics are known tetratogens. Tetracycline affects bone growth and discolors the teeth. Drugs used to treat **tuberculosis** can lead to hearing problems and damage to a nerve in the head (cranial). Sulfa drugs are associated with abnormally high levels of bilirubin in the newborn, which can cause **death**.
- Anticonvulsants. Drugs given to prevent seizures can cause serious problems in the developing fetus, including mental retardation and slow growth.
- Antipsychotic and antianxiety agents. Several drugs given for **anxiety** and mental illness are known to cause specific defects.
- Antineoplastic agents. Drugs given to treat **cancer** can cause major congenital malformations, especially central nervous system defects. They may also be harmful to the health care worker who is giving them while pregnant.
- Hormones. Male hormones may cause masculinization of a female fetus. A synthetic estrogen (DES) given in the 1940s and 1950s causes an increased risk of cancer in the adult female children of the mothers who received the drug.
- Recreational drugs. Drugs such as **LSD** have been associated with arm and leg abnormalities and central nervous system problems in infants. Crack **cocaine** has also been associated with birth defects. Since drug abusers tend to use many drugs and have poor **nutrition** and prenatal care, it is hard to determine the effects of individual drugs.

CHEMICALS. Environmental chemicals such as fungicides, food additives, and pollutants are suspected of causing birth defects, though this is difficult to prove.

RADIATION. Exposure of the mother to high levels of radiation can cause small skull size (microcephaly), blindness, **spina bifida**, and cleft palate. How severe the defect is depends on the duration and timing of the exposure.



The specific cause of many birth defects is unknown, but several factors associated with pregnancy and delivery can increase the risk of birth defects. These factors include exposure to teratogens, drugs and other chemicals, exposure to radiation, and infections present in the womb. *(Illustration by Electronic Illustrators Group.)*

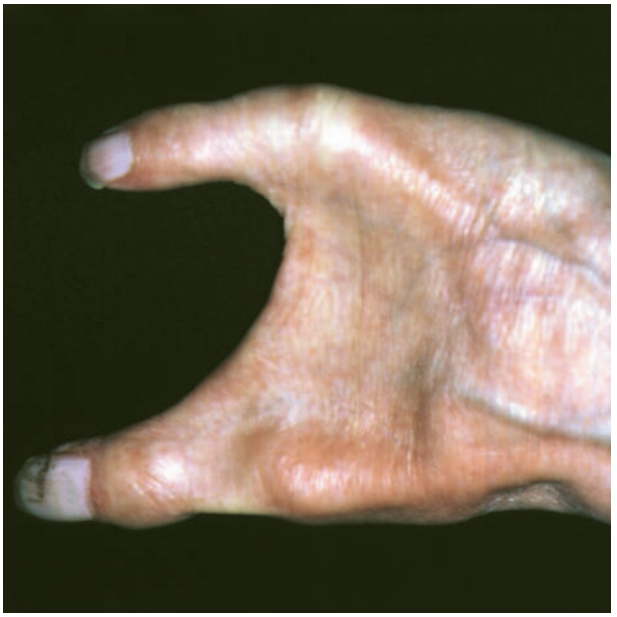
INFECTIONS. Three viruses are known to harm a developing baby: **rubella**, cytomegalovirus (CMV), and herpes simplex. *Toxoplasma gondii,* a parasite that can be contracted from undercooked meat, from dirt, or from handling the feces of infected cats, causes serious problems. Untreated **syphilis** in the mother is also harmful.

Genetic factors

A gene is a tiny, invisible unit containing information (DNA) that guides how the body forms and functions. Each individual inherits tens of thousands of genes from each parent, arranged on 46 chromosomes. Genes control all aspects of the body, how it works, and all its unique characteristics, including eye color and body size. Genes are influenced by chemicals and radiation, but sometimes changes in the genes are unexplained accidents. Each child gets half of its genes from each parent. In each pair of genes one will take precedence (dominant) over the other (recessive) in determining each trait, or characteristic. Birth defects caused by dominant inheritance include a form of dwarfism called **achondroplasia**; **high cholesterol**; Huntington's disease, a progressive nervous system disorder; **Marfan syndrome**, which affects connective tissue; some forms of **glaucoma**, and polydactyly (extra fingers or toes).

If both parents carry the same recessive gene, they have a one-in-four chance that the child will inherit the disease. Recessive diseases are severe and may lead to an early death. They include sickle cell anemia, a blood disorder that affects blacks, and **Tay-Sachs disease**, which causes mental retardation in people of eastern European Jewish heritage. Two recessive disorders that affect mostly whites are: **cystic fibrosis**, a lung and digestive disorder, and **phenylketonuria** (PKU), a metabolic disorder. If only one parent passes along the genes for the disorder, the normal gene received from the other parent will prevent the disease, but the child will be a carrier. Having the gene is not harmful to the carrier, but there is the 25% chance of the genetic disease showing up in the child of two carriers.

Some disorders are linked to the sex-determining chromosomes passed along by parents. **Hemophilia**, a condition that prevents blood from clotting, and Duchenne **muscular dystrophy**, which causes muscle weakness, are carried on the X chromosome. Genetic



Congenital absence of three fingers. Deformities such as this are usually caused by damage to the developing fetus *in utero.* *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

defects can also take place when the egg or sperm are forming if the mother or father passes along some faulty gene material. This is more common in older mothers. The most common defect of this kind is **Down syndrome**, a pattern of mental retardation and physical abnormalities, often including heart defects, caused by inheriting three copies of a chromosome rather than the normal pair.

A less understood cause of birth defects results from the interaction of genes from one or both parents plus environmental influences. These defects are thought to include:

- Cleft lip and palate, which are malformations of the mouth
- Clubfoot, ankle or foot deformities.
- Spina bifida, an open spine caused when the tube that forms the brain and spinal chord does not close properly.
- Water on the brain (**hydrocephalus**), which causes brain damage.
- **Diabetes mellitus**, an abnormality in sugar metabolism that appears later in life.
- Heart defects.
- Some forms of cancer.

A serious illness in the mother, such as an underactive thyroid, or diabetes mellitus, in which her body cannot process sugar, can also cause birth defects in the child. An abnormal amount of amniotic fluid may indicate or cause birth defects. Amniotic fluid is the liquid that surrounds and protects the unborn child in the uterus. Too little of this fluid can interfere with lung or limb development. Too much amniotic fluid can accumulate if the fetus has a disorder that interferes with swallowing.

Diagnosis

If there is a family history of birth defects or if the mother is over 35 years old, then screening tests can be done during pregnancy to gain information about the health of the baby.

- Alpha-fetoprotein test. This is a simple blood test that measure the level of a substance called alpha-fetoprotein that is associated with some major birth defects. An abnormally high or low level may indicate the need for further testing.
- Ultrasound. The use of sound waves to examine the shape, function, and age of the fetus is a common procedure. It can also detect many malformations, such as spina bifida, limb defects, and heart and kidney problems.
- Amniocentesis. This test is usually done between the 13th and 15th weeks of pregnancy. A small sample of amniotic fluid is withdrawn through a thin needle inserted into the mother's abdomen. Chromosomal analysis can rule out Down syndrome and other genetic conditions.
- Chorionic villus sampling (CVS). This test can be done as early as the ninth week of pregnancy to identify chromosome disorders and some genetic conditions. A thin needle is inserted through the abdomen or a slim tube is inserted through the vagina that takes a tiny tissue sample for testing.

If a birth defect is suspected after a baby is born, then confirmation of the diagnosis is very important. The patient's medical records and medical history may hold essential information. A careful **physical examination** and laboratory tests should be done. Special diagnostic tests can also provide genetic information in some cases.

Treatment

Treatment depends on the type of birth defect and how serious it is. When an abnormality has been identified before birth, then delivery can be planned at a health care facility that is prepared to offer any special care needed. Some abnormalities can be corrected with surgery. Experimental procedures have been used successfully in correcting some defects, like excessive fluid in the brain (hydrocephalus), even before the baby is

KEY TERMS

Chromosome—One of the bodies in the cell nucleus that carries genes. There are normally 46 chromosomes in humans.

Cleft lip and palate—An opening in the lip, the roof of the mouth (hard palate), or the soft tissue in the back of the mouth (soft palate).

Embryo—The developing baby from conception to the end of the second month.

Gene—The The functional unit of heredity that direct all growth and development of an organism. Each human being has over 100,000 genes that determine hair color, body build, and all other traits.

Fetus—In humans, the developing organism from the end of the eighth week to the moment of birth.

Neural tube defects—A group of birth defects that affect the backbone and sometimes the spinal chord.

Rubella—A mild, highly contagious childhood illness caused by a virus; it is also called German measles. It causes severe birth defects if a pregnant woman is not immune and gets the illness in the first three months of pregnancy.

Spina bifida—One of the more common birth defects in which the backbone never closes.

Trait—A distinguishing feature of an individual.

Virus—A very small organism that causes infection and needs a living cell to reproduce.

born. Patients with complicated conditions usually need the help of experienced medical and educational specialists with an understanding of the disorder.

Prognosis

The prognosis for a disorder varies with the specific condition.

Prevention

Pregnant women should eat a nutritious diet. Taking **folic acid** supplements before and during pregnancy reduces the risk of having a baby with serious problems of the brain or spinal chord (neural tube defects). It is important to avoid any teratogen that can harm the developing baby, including alcohol and drugs. When there is a family history of congenital defects in either parent, then **genetic counseling** and testing can help parents plan for future children. Often, counselors can determine the risk of a genetic condition occurring and the availability of tests for it. Talking to a genetic counselor after a child is born with a defect can provide parents with information about medical management and community resources that are available.

Resources

BOOKS

Jones, Kenneth Lyons. "Dysmorphology." In *Textbook of Pediatrics*, ed. Waldo E. Nelson, et al. Philadelphia: W. B. Saunders Co., 1996.

Lott, Judy Wright. "Fetal Development: Environmental Influences and Critical Periods." In *Comprehensive Neonatal Nursing*, ed. Carol Kenner, et al. Philadelphia: W. B. Saunders Co., 1998.

Van Allen, Margot I., and Judith G. Hall. "Congenital Anomalies." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

"Down Syndrome: New Trends in Testing." *Mayo Clinic Health Newsletter*, 15 Apr. 1997.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

OTHER

March of Dimes. *Public Health Education Information Sheets.*

Karen Ericson, RN

Birthmarks

Definition

Birthmarks, including angiomas and vascular malformations, are benign (noncancerous) skin growths composed of rapidly growing or poorly formed blood vessels or lymph vessels. Found at birth (congenital) or developing later in life (acquired) anywhere on the body, they range from faint spots to dark swellings covering wide areas.

Description

Skin angiomas, also called vascular (pertaining to vessel) nevi (marks), are composed of blood vessels (hemangiomas) or lymph vessels (lymphangiomas), that lie beneath the skin's surface. Hemangiomas, composed of clusters of cells that line the capillaries, the body's smallest blood vessels, are found on the face and neck

(60%), trunk (25%), or the arms and legs (15%). Congenital hemangiomas, 90% of which appear at birth or within the first month of life, grow quickly, and disappear over time. They are found in 1-10% of full-term infants, and 25% of premature infants. About 65% are capillary hemangiomas (strawberry marks), 15% are cavernous (deep) hemangiomas, and the rest are mixtures. Hemangiomas are three times more common in girls. Usually, only one hemangioma is found, in 20% two are found, while fewer than 5% have three or more. Lymphangiomas are skin bumps caused by enlarged lymph vessels anywhere on the body.

Vascular malformations are poorly formed blood or lymph vessels that appear at birth or later in life. One type, the salmon patch (nevus simplex), a pink mark composed of dilated capillaries, is found on the back of the neck (also called a stork bite) in 40% of newborns, and on the forehead and eyelids (also called an angel's kiss) in 20%. Stork bites are found in 70% of white and 60% of black newborns.

Found in fewer than 1% of newborns, port-wine stains (nevus flammeus), are vascular malformations composed of dilated capillaries in the upper and lower layers of the skin of the face, neck, arms, and legs. Often permanent, these flat pink to red marks develop into dark purple bumpy areas in later life; 85% appear on only one side of the body.

Acquired hemangiomas include spider angiomas (nevus araneus), commonly known as spider veins, and cherry angiomas (senile angiomas or Campbell de Morgan spots). Found around the eyes, cheekbones, arms, and legs, spider angiomas are red marks formed from dilated blood vessels. They occur during **pregnancy** in 70% of white women and 10% of black women, in alcoholics and liver disease patients, and in 50% of children. Cherry angiomas, dilated capillaries found mainly on the trunk, appear in the 30s, and multiply with **aging**.

Causes and symptoms

There are no known causes for congenital skin angiomas; they may be related to an inherited weakness of vessel walls. Exposure to estrogen causes spider angiomas in pregnant women or those taking **oral contraceptives**. Spider angiomas tend to run in families, and may be associated with liver disease, sun exposure, and trauma.

Hemangiomas

Hemangiomas first appear as single or multiple, white or pale pink marks, ranging from 2-20 cm (average 2-5 cm) in size. Some are symptomless while others cause **pain** or bleeding, or interfere with normal functioning when they are numerous, enlarged, infected, or ulcerated. Vision is affected by large marks on the eyelids. Spider and cherry angiomas are unsightly but symptomless.

Each type of hemangioma has a characteristic appearance:

- Capillary hemangiomas (strawberry marks). These round, raised marks are bright red and bumpy like a strawberry, and become white or gray when fading.
- Cavernous hemangiomas. These slightly raised, dome-shaped, blue or purple swellings are sometimes associated with lymphangiomas or involve the soft tissues, bone, or digestive tract.
- Spider angiomas. These are symptomless, reddish blue marks formed from blood-filled capillaries radiating around a central arteriole (small artery) in the shape of a spider web.
- Cherry angiomas. These harmless, dilated capillaries appear as tiny, bright red-to-violet colored bumps.
- Lymphangiomas. These dilated lymph vessels form light pink or yellow cysts (fluid- filled sacs) or swellings.

Vascular malformations

These are faint, flat, pink stains that grow as the child grows into larger dark red or purple marks. Some are symptomless but others bleed if enlarged or injured. Disfiguring port-wine stains can cause emotional and social problems. About 5% of port-wine stains on the forehead and eyelids increase eye pressure due to involvement of the eye and surrounding nerves. Abnormalities of the spinal cord, soft tissues, or bone may be associated with severe port-wine stains.

Each type has a characteristic appearance:

- Salmon patches. These symptomless, light red-to-pink marks usually fade with time.
- Port-wine stains. These flat, pink marks progress to raised, dark red-to-purple grape-like lumps distorting the facial features, arms, or legs.

Diagnosis

Patients are treated by pediatricians (doctors who specialize in the care of children), dermatologists (skin disease specialists), plastic surgeons (doctors who specialize in correcting abnormalities of the appearance), and ophthalmologists (eye disease specialists).

Angiomas and vascular malformations are not difficult to diagnose. The doctor takes a complete medical history and performs a **physical examination** including inspection and palpation of the marks. The skin is examined for discoloration, scarring, bleeding, infection, or

ulceration. The type, location, size, number, and severity of the marks are recorded. The doctor may empty the mark of blood by gentle pressure. Biopsies or specialized x rays or scans of the abnormal vessels and their surrounding areas may be performed. Patients with port-wine stains near the eye may require **skull x rays**, **computed tomography scans**, and vision and central nervous system tests. Most insurance plans pay for diagnosis and treatment of these conditions.

Treatment

Treatment choices for skin angiomas and vascular malformations depend on their type, location, and severity, and whether they cause symptoms, pain, or disfigurement.

Watchful waiting

No treatment is given, but the mark is regularly examined. This continues until the mark disappears, or requires treatment. This approach is particularly appropriate for the treatment of hemangiomas, which often do not require treatment, since they eventually shrink by themselves.

Drugs

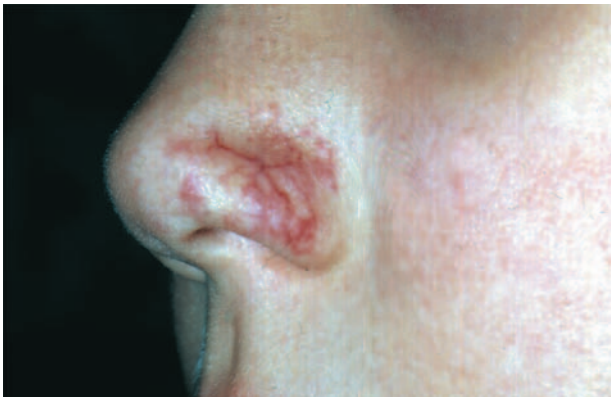
CORTICOSTEROIDS. Daily doses of the anti-inflammatory drugs prednisone or prednisolone are given for up to 2 months with gradual reduction of the dose. The marks begin to subside within 7-10 days, but may take up to 2 months to fully disappear. If no response is seen in 2 weeks, the drug is discontinued. Treatment may be repeated. Side effects include growth retardation, increased blood pressure and blood sugar, **cataracts**, glandular disorders, and infection. The **corticosteroids** triamcinolone acetate and betamethasone sodium phosphate or acetate are injected directly into the marks with a response usually achieved within a week; additional injections are given in 4-6 weeks. Side effects include tissue damage at the injection site.

INTERFERON ALPHA-2A. This drug reduces cell growth, and is used for vascular marks that affect vision, and that are unresponsive to corticosteroids. Given in daily injections under the skin, a response rate of 50% is achieved after about 7 months. Side effects include **fever**, chills, muscle and joint pain, vision disorders, low white and red blood cell counts, **fatigue**, elevated liver enzymes, nausea, blood clotting problems, and nerve damage.

ANTIBIOTICS. Oral or topical (applied to the skin) **antibiotics** are prescribed for infected marks.

Surgery

LASER SURGERY. Lasers create intense heat that destroys abnormal blood vessels beneath the skin, without damaging normal skin. Two types of lasers are used: the flashlamp-pulsed dye laser (FPDL) and the neodymium:YAG (Nd:YAG) laser. The FPDL, used mainly for strawberry marks and port-wine stains, penetrates to a depth of 1.8 mm and causes little scarring, while the Nd:YAG laser penetrates to a depth of 6 mm, and is used to treat deep hemangiomas. **Laser surgery** is not usually painful, but can be uncomfortable. Anesthetic cream is used for FPDL treatment. Treatment with the Nd:YAG laser requires local or general anesthesia. Children are usually sedated or anesthetized. Healing occurs within 2 weeks. Side effects include bruising, skin discoloration, swelling, crusting, and minor bleeding.



A fading capillary hemangioma on the nose of a child. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

SURGICAL EXCISION. Under local or general anesthesia, the skin is cut with a surgical instrument, and vascular marks or their scars are removed. The cut is repaired with stitches or skin clips.

CRYOSURGERY. Vascular marks are frozen with an extremely cold substance sprayed onto the skin. **Wounds** heal with minimal scarring.

ELECTRODESICCATION. Affected vessels are destroyed with the current from an electric needle.

Other treatments

These include:

- Sclerotherapy. Injection of a special solution causes blood clotting and shrinkage with little scarring. Side effects include stinging, swelling, bruising, scarring, muscle cramping, and allergic reactions. This treatment is used most commonly for spider angiomas.
- Embolization. Material injected into the vessel blocks blood flow which helps control blood loss during or reduces the size of inoperable growths. A serious side

KEY TERMS

Angioma—A benign skin tumor composed of rapidly growing, small blood or lymph vessels.

Capillaries—The smallest blood vessels, they connect the arteries and veins.

Corticosteroids—Drugs that fight inflammation.

Hemangioma—A benign skin tumor composed of abnormal blood vessels.

Lymph vessels—Part of the lymphatic system, these vessels connect lymph capillaries with the lymph nodes; they carry lymph, a thin, watery fluid resembling blood plasma and containing white blood cells.

Lymphangioma—A benign skin tumor composed of abnormal lymph vessels.

Nevus—A mark on the skin.

Ulcer—A red, shallow sore on the skin.

Vascular malformation—A poorly formed blood or lymph vessels.

effect, **stroke**, can occur if a major blood vessel becomes blocked.

- Make-up. Special brands are designed to cover birthmarks (Covermark or Dermablend).
- Cleaning and compression. Bleeding marks are cleaned with soap and water or hydrogen peroxide, and compressed with a sterile bandage for 5-10 minutes.

Alternative treatment

Alternative treatments for strengthening weak blood vessels include eating high-fiber foods and those containing bioflavonoids, including citrus fruit, blueberries, and cherries, supplementing the diet with vitamin C, and taking the herbs, ginkgo (*Ginkgo biloba*) and bilberry (*Vaccinium myrtillus*.)

Prognosis

The various types of birthmarks have different prognoses:

- Capillary hemangiomas. Fewer than 10% require treatment. Without treatment, 50% disappear by age 5, 70% by age 7, and 90% by age 9. No skin changes are found in half while others have some discoloration, scarring, or wrinkling. From 30-90% respond to oral corticosteroids, and 45% respond to injected corticosteroids; 50% respond to interferon Alpha-2a. About 60% improve after laser surgery.
- Cavernous hemangiomas. Some do not disappear and some are complicated by ulceration or infection. About 75% respond to Nd:YAG laser surgery but have scarring. Severe marks respond to oral corticosteroids, but some require excision.
- Spider angiomas. These fade following **childbirth** and in children, but may recur. About 90% respond to sclerotherapy, electrodesiccation, or laser therapy.
- Cherry angiomas. These are easily removed by electrodesiccation.
- Lymphangiomas. These require surgery.
- Salmon patches. Eyelid marks disappear by 6-12 months of age, and forehead marks fade by age 6; however, 50% of stork bites on the neck persist into adulthood.
- Port-wine stains. Some flat birthmarks are easily covered with make-up. Treatment during infancy or childhood improves results. About 95% of the stains respond to FPDL surgery with minimal scarring; 25% will completely and 70% will partially disappear. For unknown reasons, 5% show no improvement.

Prevention

Congenital hemangiomas or vascular malformations cannot be prevented, but spider angiomas may be prevented by **exercise**, weight control, and a high-fiber diet, as well as avoidance of sun exposure, alcohol drinking, or wearing tight hosiery.

Resources

BOOKS

Bark, Joseph P. *Your Skin: An Owner's Guide*. Englewood Cliffs, NJ: Prentice Hall, 1995.

Fitzpatrick, Thomas B., et al. "Benign Neoplasms and Hyperplasias. Disorders of the Blood Vessels." In *Color Atlas and Synopsis of Clinical Dermatology. Common and Serious Diseases*, ed. Martin J. Wonsiewicz, et al. New York: McGraw-Hill, 1997.

Lookingbill, Donald P., and James G. Marks. "Dermal and Subcutaneous Growths." In *Principles of Dermatology.* Philadelphia: W. B. Saunders Co., 1993.

PERIODICALS

Errickson, Carla V., and Nancy R. Matus. "Skin Disorders of Pregnancy." *American Family Physician* 15 (Feb. 1994): 605-610.

Morelli, Joseph G., et al. "Initial Lesion Size as a Predictive Factor in Determining the Response of Port-Wine Stains in Children Treated with the Pulse Dye Laser." *Archives of Pediatrics and Adolescent Medicine* (Oct. 1995): 1142-1145.

Nanda, Vandana, S. "Management of Capillary Hemangiomas." *The Western Journal of Medicine* (Apr. 1994): 364.

Tanner, J. Lane, Martha P. Dechert, and Ilona J. Frieden. "Growing Up With a Facial Hemangioma: Parent and Child Coping and Adaptation." *Pediatrics* (Mar. 1998): 446-452.

Vander Schaff, Rachelle. "Lasers Zap Strawberry Birthmarks." *Parents*, Oct. 1997, 37.

Wirth Fern A., and Mark H. Lowitt. "Diagnosis and Treatment of Cutaneous Vascular Lesions." *American Family Physician* 15 (Feb. 1998): 765-773.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000. <http://www.aap.org>.

Congenital Nevus Support Group. 1400 South Joyce St., Number C-1201, Arlington, VA 22202. (703) 920-3249.

National Congenital Port Wine Stain Foundation. 123 East 63rd St., New York, NY 10021. (516) 867-5137.

Mercedes McLaughlin

Bismuth subsalicylate *see* **Antidiarrheal drugs**

Bites and stings

Definition

Humans can be injured by the bites or stings of many kinds of animals, including mammals such as dogs, cats, and fellow humans; arthropods such as spiders, bees, and wasps; snakes; and marine animals such as jellyfish and stingrays.

Description

Mammals

DOGS. In the United States, where the dog population exceeds 50 million, dogs surpass all other mammals in the number of bites inflicted on humans. However, most dog-bite injuries are minor. A telephone survey of U.S. households conducted in 1994 led researchers to estimate that 3,737,000 dog bites not requiring medical attention occurred in the United States that year, versus 757,000 that did require medical treatment. Studies also show that most dog bites are from pets or other dogs known to the bitten person, that males are more likely than females to be bitten, and that children face a greater risk than adults. Each year, about 10-20 Americans, mostly children under 10 years of age, are killed by dogs.

Dog bites result in an estimated 340,000 emergency-room visits annually throughout the United States. More than half of the bites seen by emergency departments occur at home. Children under 10 years old, especially boys between 5 and 9 years of age, are more likely than older people to visit an emergency room for bite treatment. Children under 10 years old were also much more liable to be bitten on the face, neck, and head. Nearly all of the injuries suffered by people seeking treatment in emergency rooms were of "low severity," and most were treated and released without being admitted to hospital or sent to another facility. Many of the bites resulted from people attempting to break up fights between animals.

CATS. Although cats are found in nearly a third of U.S. households, cat bites are far less common than dog bites. According to one study, cats inflict perhaps 400,000 harmful bites in the United States each year. The tissue damage caused by cat bites is usually limited, but they carry a high risk of infection. Whereas the infection rate for dog bite injuries is 15-20%, the infection rate for cat bites is 30-40%. A typical person who has been bitten is a young girl playing with a pet.

HUMANS. Bites from mammals other than dogs and cats are uncommon, with one exception—human bites. There are approximately 70,000 human bites each year in the United States. Because the human mouth contains a multitude of potentially harmful microorganisms, human bites are more infectious than those of most other animals.

Arthropods

Arthropods are invertebrates belonging to the phylum Arthropoda, which includes insects, arachnids, crustaceans, and other subgroups. There are more than 700,000 species in all. The list of arthropods that bite or sting humans is extensive and includes lice, bedbugs, fleas, mosquitoes, black flies, ants, chiggers, ticks, centipedes, scorpions, and other species. Spiders, bees, and wasps are the three kinds of arthropod that most often bite people.

SPIDERS. In the United States, only two kinds of venomous spider are truly dangerous: widow spiders and brown (violin or fiddle) spiders. The black widow, which is found in every state but Alaska, is probably the most notorious widow spider. It prefers dark, dry places such as barns, garages, and outhouses, and also lives under rocks and logs. Disturbing a female black widow or its web may provoke a bite. Brown spiders also prefer sheltered places, including clothing, and may bite if disturbed.

BEES AND WASPS. Bees and wasps will sting to defend their nests or if they are disturbed. Species common to the United States include honeybees, bumblebees, yellow jackets, bald-faced hornets, brown hornets, and paper wasps. Of note are also Africanized bee species, also called "killer bees" that are now found in the United States since 1990. More than fifty Americans die each year after being stung by a bee, wasp, or ant. Almost all of those deaths are the result of allergic reactions, and not of exposure to the venom itself.

Snakes

There are 20 species of venomous snakes in the United States. These snakes are found in every state except Maine, Alaska, and Hawaii. Each year about 8,000 Americans receive a venomous snakebite, but no more than about 15 die, mostly from rattlesnake bites.

The venomous snakes of the United States are divided into two families, the Crotalidae (pit vipers) and the Elapidae. Pit vipers, named after the small heat-sensing pit that lies between each eye and nostril, are responsible for about 99% of the venomous snakebites suffered by Americans. Rattlesnakes, copperheads, and cottonmouths (also called water moccasins) are pit vipers. This family of snakes delivers its venom through two long, hinged fangs in the upper jaw. Some pit vipers carry a potent venom that can threaten the brain and spinal cord. The venom of others, such as the copperheads, is less harmful.

The Elapidae family includes two kinds of venomous coral snakes indigenous to the southern and western states. Because coral snakes are bashful creatures that come out only at night, they almost never bite humans, and are responsible for approximately 25 bites a year in the United States. Coral snakes also have short fangs and a small mouth, which lowers the risk of a bite actually forcing venom into a person's body. However, their venom is quite poisonous.

Marine animals

Several varieties of marine animal may bite or sting. Jellyfish and stingrays are two kinds that pose a threat to people who live or vacation in coastal communities.

Causes and symptoms

Mammals

DOGS. A typical dog bite results in a laceration, tear, puncture, or crush injury. Bites from large, powerful dogs may even cause **fractures** and dangerous internal injuries. Also, dogs trained to attack may bite repeatedly during a single episode. Infected bites usually cause **pain**, **cellulitis** (inflammation of the connective tissues), and a pus-filled discharge at the wound site within 8-24 hours. Most infections are confined to the wound site, but many of the microorganisms in the mouths of dogs can cause systemic and possibly life-threatening infections. Examples are **bacteremia** and **meningitis**, especially severe in people diagnosed with acquired **immunodeficiency** syndrome (**AIDS**) or other health condition that increases their susceptibility to infection. **Rabies** is rare among pet dogs in the United States, most of which have been vaccinated against the disease. **Tetanus** is also rare but can be transmitted by a dog bite if the victim is not immunized.

CATS. The mouths of cats and dogs contain many of the same microorganisms. Cat scratches and bites are also capable of transmitting the *Bartonella henselae* bacterium, which can lead to **cat-scratch disease**, an unpleasant but usually not life-threatening illness.

Cat bites are mostly found on the arms and hands. Sharp cat teeth typically leave behind a deep puncture wound that can reach muscles, tendons, and bones, which are vulnerable to infection because of their comparatively poor blood supply. This is why cat bites are much more likely to become infected than dog bites. Also, people are less inclined to view cat bites as dangerous requiring immediate attention; the risk that infection has set in by the time a medical professional is consulted is thus greater.

HUMANS. Humans bites result from fights, sexual activity, medical and dental treatment, and seizures. Bites also raise the possibility of spousal or **child abuse**. Children often bite other children, but those bites are hardly ever severe. Human bites are capable of transmitting a wide range of dangerous diseases, including **hepatitis B**, **syphilis**, and **tuberculosis**.

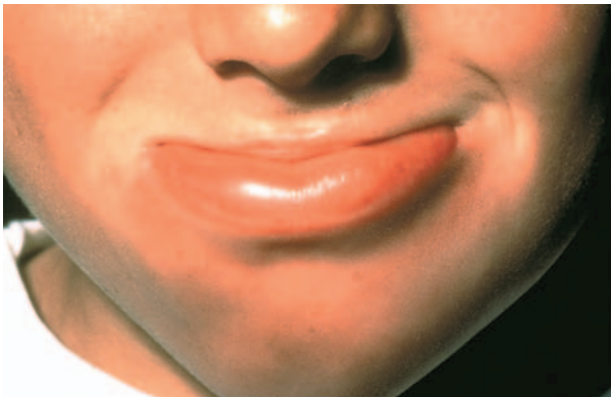
Human bites fall into two categories: occlusional (true) bites and clenched-fist injuries. The former present a lower risk of infection. The latter, which are very infectious and can permanently damage the hand, usually result from a fist hitting teeth during a fight. People often wait before seeking treatment for a clenched-fist injury, with the result that about half of such injuries are infected by the time they are seen by a medical professional.

Arthropods

SPIDERS. As a rule, people rarely see a black widow bite, nor do they feel the bite as it occurs. The first (and possibly only) evidence that a person has been bitten may be a mild swelling of the injured area and two red puncture marks. Within a short time, however, some victims begin to experience severe muscle cramps and rigidity of the abdominal muscles. Other possible symptoms include excessive sweating, nausea, vomiting, headaches, and vertigo as well as breathing, vision, and speech problems.

A brown spider's bite can lead to necrotic arachnidism, in which the tissue in an area of up to several inches around the bite becomes necrotic (dies), producing an open sore that can take months or years to disappear. In most cases, however, the bite simply produces a hard, painful, itchy, and discolored area that heals without treatment in 2-3 days. The bite may also be accompanied by a **fever**, chills, **edema** (an accumulation of excess tissue fluid), **nausea and vomiting**, **dizziness**, muscle and joint pain, and a rash.

BEES AND WASPS. The familiar symptoms of bee and wasp stings include pain, redness, swelling, and itchiness in the area of the sting. Multiple stings can have much more severe consequences, such as **anaphylaxis**, a life-threatening allergic reaction that occurs in hypersensitive persons.



An insect bite caused this person's lower lip to swell. *(Custom Medical Stock Photo. Reproduced by permission.)*

Snakes

Venomous pit viper bites usually begin to swell within 10 minutes and sometimes are painful. Other symptoms include skin blisters and discoloration, weakness, sweating, nausea, faintness, dizziness, bruising, and tender lymph nodes. Severe **poisoning** can also lead to tingling in the scalp, fingers, and toes, muscle contractions, an elevated heart rate, rapid breathing, large drops in body temperature and blood pressure, vomiting of blood, and **coma**.

Many pit viper and coral snake bites (20-60%) fail to poison (envenomate) their victim, or introduce only a small amount of venom into the victim's body. The **wounds**, however, can still become infected by the harmful microorganisms that snakes carry in their mouths.

Coral snake bites are painful but may be hard to see. One to seven hours after the bite, a bitten person begins to experience the effects of the venom, which include tingling at the wound site, weakness, nausea, vomiting, excessive salivation, and irrational behavior. Major nerves of the body can become paralyzed for 6-14 days, causing double vision, difficulty swallowing and speaking, **respiratory failure**, and other problems. Six to eight weeks may be needed before normal muscular strength is regained.

Marine animals

JELLYFISH. Jellyfish venom is delivered by barbs called nematocysts, which are located on the creature's tentacles and penetrate the skin of people who brush up against them. Instantly painful and itchy red lesions usually result. The pain can continue up to 48 hours. Severe cases may lead to skin necrosis, **muscle spasms and cramps**, vomiting, nausea, **diarrhea**, headaches, excessive sweating, and other symptoms. In rare instances, cardiorespiratory failure may also occur.

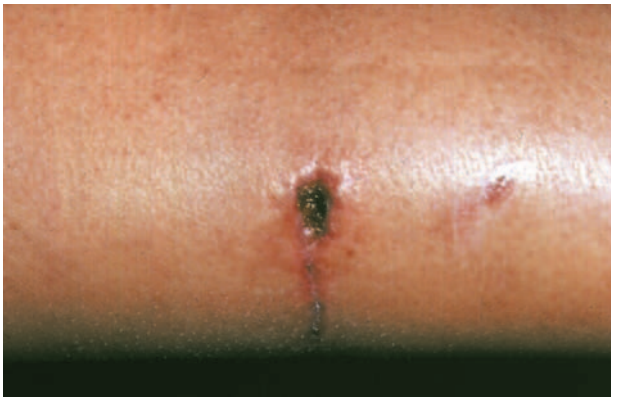
STINGRAYS. Tail spines are the delivery mechanism for stingray venom. Deep puncture wounds result that can cause an infection if pieces of spine become embedded in the wound. A typical stingray injury scenario involves a person who inadvertently steps on a resting stingray and is lashed in the ankle by its tail. Stingray venom produces immediate, excruciating pain that lasts several hours. Sometimes the victim suffers a severe reaction, including vomiting, diarrhea, hemorrhage (bleeding), a drop in blood pressure, and cardiac arrhythmia (disordered heart beat).

Diagnosis

Mammals

DOGS. Gathering information on the circumstances of a dog attack is a crucial part of treatment. Medical professionals need to know when the attack occurred (the chances of infection increase dramatically if the wound has been left untreated for more than eight hours) and what led to the attack (unprovoked attacks are more likely to be associated with rabies). A person's general health must also be assessed, including the tetanus immunization history if any, as well as information concerning possible **allergies** to medication and pre-existing health problems that may increase the risk of infection.

A **physical examination** requires careful scrutiny of the wound, with special attention to possible bone, joint, ligament, muscle, tendon, nerve, or blood-vessel damage caused by deep punctures or severe crush injuries. Serious hand injuries should be evaluated by a specialized surgeon. Most of the time, laboratory tests for identifying the microorganisms in bite wounds are performed if infection is present. X rays and other diagnostic procedures may also be necessary.



A close-up view of lacerations on the shin of an adult woman inflicted by a Rottweiler dog. *(Custom Medical Stock Photo. Reproduced by permission.)*

CATS. The diagnostic procedures used for dog bites also apply to cat bites.

HUMANS. Testing the blood of a person who has been bitten for immunity to hepatitis B and other diseases is always necessary after a human bite. Ideally, the biter should be tested as well for the presence of transmissible disease. Clenched-fist injuries often require evaluation by a hand surgeon or orthopedist. Because many people will deny having been in a fight, medical professionals usually consider lacerations over the fourth and fifth knuckles—the typical result of a clenched-fist injury—to be evidence of a bite wound. Medical professionals also look for indications of spousal or child **abuse** when evaluating human bites.

Arthropods

SPIDERS. Because bites from widow spiders and brown spiders require different treatments, capturing and identifying the spider helps to establish diagnosis.

Snakes

Diagnosis relies on a physical examination of the victim, information about the circumstances of the bite, and a look at the snake itself (if it can safely be killed and brought in for identification). Blood tests and **urinalysis** supply important data on the victim's condition. Chest x-rays and **electrocardiography** (a procedure for measuring heart activity) may also be necessary.

Treatment

Mammals

DOGS. Minor dog bites can be treated at home. The American Academy of Family Physicians recommends gently washing the wound with soap and water and then applying pressure to the injured area with a clean towel to stop the bleeding. The next step is to apply antibiotic ointment and a sterile bandage to the wound. To reduce swelling and fend off infection, ice should be applied and the injured area kept elevated above the level of the heart. The wound should be cleaned and covered with ointment twice a day until it heals.

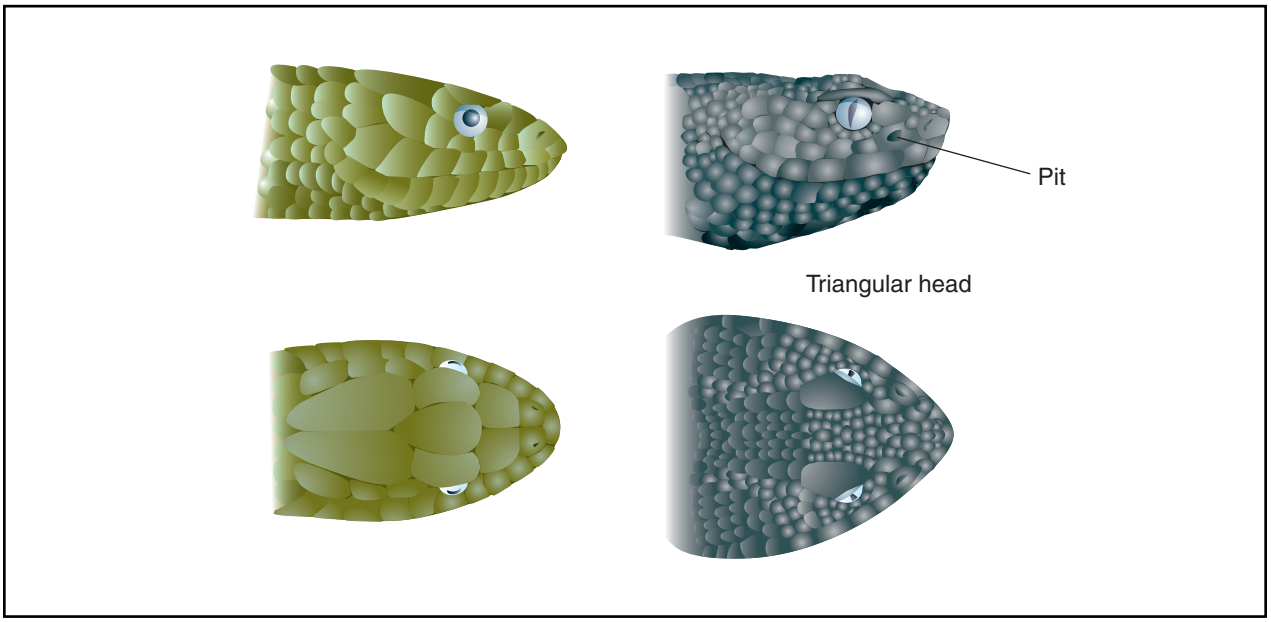
Any dog bite that does not stop bleeding after 15 minutes of pressure must be seen by a medical professional. The same is true for bites that are deep or gaping; for bites to the head, hands, or feet; and for bites that may have broken a bone, damaged nerves, or caused a major injury of another kind. Bite victims must also watch for infection. A fever is one sign of infection, as are redness, swelling, warmth, increased tenderness, and pus at the wound site. Diabetics, people with AIDS or **cancer**, individuals who have not had a tetanus shot in five years, and anyone else who has a medical problem that can increase susceptibility to infection should seek medical treatment no matter how minor the bite appears.

Medical treatment of dog bites involves washing the wound with an anti-infective solution. Removal of dead and damaged tissue (under local, regional, or general anesthetic) may be required after the wound has been washed, and any person whose tetanus shots are not up to date should receive a booster injection. Some wounds are left open and allowed to heal on their own, while others require stitches (stitching may be delayed a few days if infection is a concern). Many emergency departments prescribe **antibiotics** for all people with dog bites, but some researchers suggest that antibiotics are usually unnecessary and should be limited to those whose injuries or other health problems make them likely candidates for infection. A follow-up visit after one or two days is generally required for anyone who has received bite treatment.

CATS. Because of the high risk of infection, people who are bitten by a cat should always see a doctor. Cat scratches do not require professional medical treatment unless the wound appears infected or the scratched person has a weakened immune system.

Medical treatment for cat bites generally follows the procedures used for dog bites. Experts advise, however, that cat-bite wounds should always be left open to prevent infection. Persons who have been bitten by cats generally receive antibiotics as a preventive measure.

HUMANS. Human bites should always be examined by a doctor. Such bites are usually treated with antibiotics and left open because of the high risk of infection. A person who has been bitten may also require immunization against hepatitis B and other diseases. Persons



Profile and top views of typically nonpoisonous and poisonous snakes. Characteristic triangular head and pits on the side of the head are indicative of poisonous pit vipers found in the United States. *(Illustration by Argosy Inc.)*

who are being treated for a clenched-fist injury will require a daily follow-up examination for 3-5 days.

Arthropods

SPIDERS. No spider bite should be ignored. The antidote for severe widow spider bites is a substance called antivenin, which contains antibodies taken from the blood serum of horses injected with spider venom. Doctors **exercise** caution in using antivenin, however, because it can trigger anaphylactic **shock**, a potentially deadly (though treatable) allergic reaction, and **serum sickness**, an inflammatory response that can give rise to joint pain, a fever, **rashes**, and other unpleasant, though rarely serious, consequences.

An antivenin for brown spider bites exists as well, but it is not yet available in the United States. The drug dapsone, used to treat **leprosy**, can sometimes stop the tissue **death** associated with a brown spider bite. Necrotic areas may need **debridement** (removal of dead and damaged tissue) and skin grafts. Pain medications, **antihistamines**, antibiotics, and tetanus shots are a few of the other treatments that are sometimes necessary after a bite from a brown spider or widow spider.

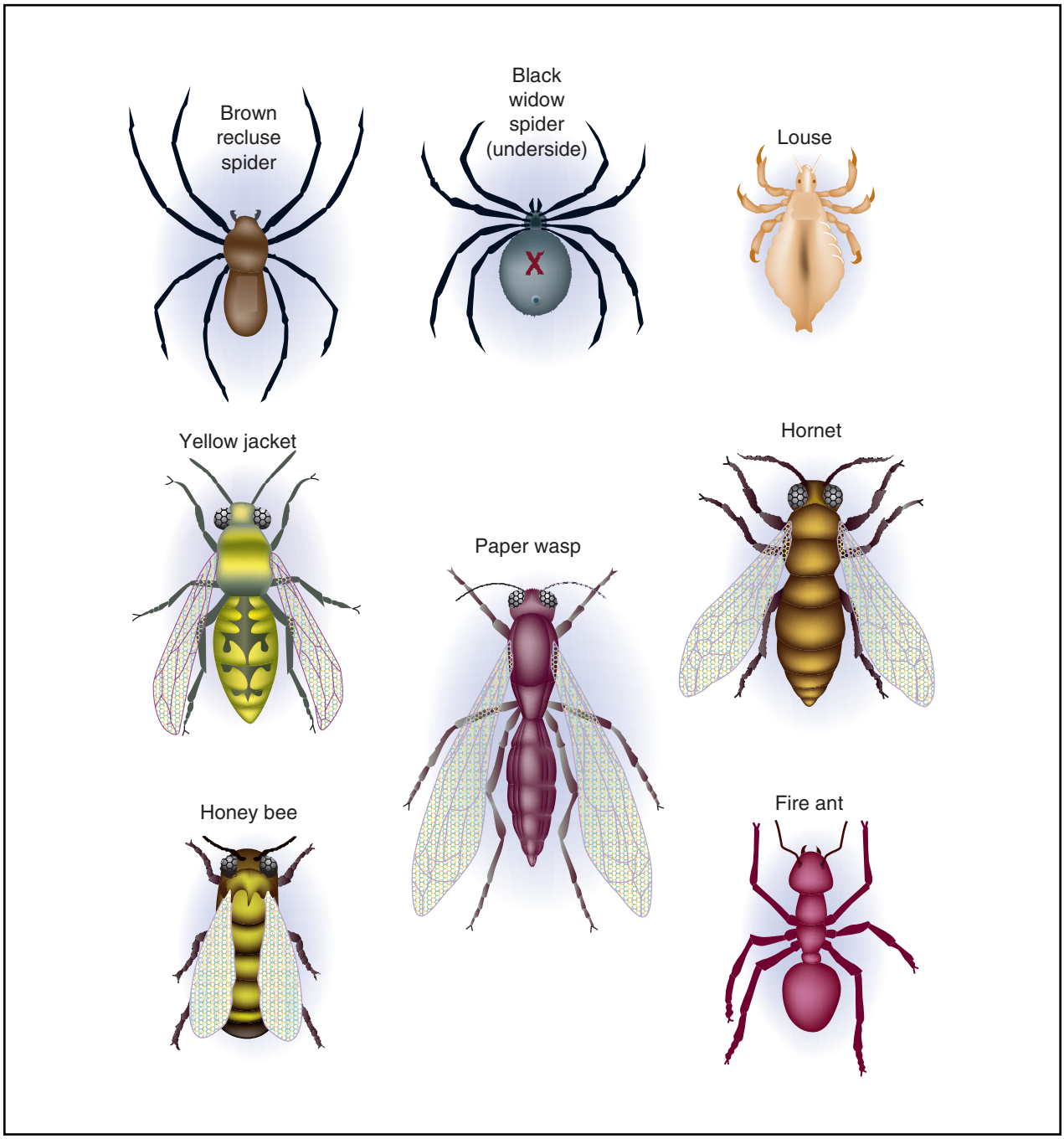
BEES AND WASPS. Most stings can be treated at home. A stinger that is stuck in the skin can be scraped off with a blade, fingernail, credit card, or piece of paper (using tweezers may push more venom out of the venom sac and into the wound). The area should be cleaned and covered with an ice pack. **Aspirin** and other pain medications, oral antihistamines, and calamine lotion are good for treating minor symptoms. Putting meat tenderizer on the wound has no effect.

Persons who have been stung and experience an allergic reaction, or who are at risk due to their medical history, require immediate medical attention. The danger signs, which usually begin 10 minutes after an individual is stung (though possibly not for several hours), include nausea, faintness, chest pain, abdominal cramps, diarrhea, and difficulty swallowing or breathing.

Snakes

Although most snakes are not venomous, any snakebite should immediately be examined at a hospital. While waiting for emergency help to arrive, the victim should wash the wound site with soap and water, and then keep the injured area still and at a level lower than the heart. Ice should never be used on the wound site nor should attempts be made to suck out the venom. Making a cut at the wound site is also dangerous. It is important to stay calm and wait for emergency medical aid if it can arrive quickly. Otherwise, the victim should proceed directly to a hospital.

When the victim arrives at a hospital, the medical staff must determine whether the bite was inflicted by a venomous snake and, if so, whether envenomation occurred and how much venom the person has received.



Types of spiders and insects that bite and sting. *(Illustration by Argosy Inc.)*

Patients may develop low blood pressure, abnormal blood clotting, or severe pain, all of which require aggressive treatment. Fortunately, the effects of some snakebites can be counteracted with antivenin. Minor rattlesnake envenomations can be successfully treated without antivenin, as can copperhead and water-moccasin bites. However, coral snake envenomations and the more dangerous rattlesnake envenomations require antivenin, sometimes in large amounts. Other treatment measures include antibiotics to prevent infection and a tetanus booster injection.

Marine animals

JELLYFISH. Vinegar and other acidic substances are used to neutralize jellyfish nematocysts still clinging to

the skin, which are then scraped off. Anesthetic ointments, antihistamine creams, and steroid lotions applied to the skin are sometimes beneficial. Other measures may be necessary to counter the many harmful effects of jellyfish stings, which, if severe, require emergency medical care.

STINGRAYS. Stingray wounds should be washed with saltwater and then soaked in very hot water for 30-90 minutes to neutralize the venom. Afterwards, the wound should be examined by a doctor to ensure that no pieces of spine remain.

Alternative treatment

Arthropods

Several alternative self-care approaches are used to treat minor bee, wasp, and other arthropod stings, including **aromatherapy**, **ayurvedic medicine**, **flower remedies**, herbs, **homeopathy**, and nutritional therapy.

Prognosis

Mammals

Prompt treatment and recognizing that even apparently minor bites can have serious consequences are the keys to a good outcome after a mammal bite. Infected bites can be fatal if neglected. Surgery and hospitalization may be needed for severe bites.

Arthropods

SPIDERS. Even without treatment, adults usually recover from black widow bites after 2-3 days. Those most at risk of dying are very young children, the elderly, and people with high blood pressure. In the case of brown spider bites, the risk of death is greatest for children, though rare.

BEES AND WASPS. The pain and other symptoms of a bee or wasp sting normally fade away after a few hours. People who are allergic to such stings, however, can experience severe and occasionally fatal anaphylaxis.

Snakes

A snakebite victim's chances of survival are excellent if medical aid is obtained in time. Some bites, however, result in **amputation**, permanent deformity, or loss of function in the injured area.

Marine animals

STINGRAYS. Stingray venom kills its human victims on rare occasions.

Prevention

Mammals

DOGS. The risk of a dog bite injury can be reduced by avoiding sick or stray dogs, staying away from dogfights (people often get bitten when they try to separate the animals), and not behaving in ways that might provoke or upset dogs, such as wrestling with them or bothering them while they are sleeping, eating, or looking after their puppies. Special precautions need to be taken around infants and young children, who must never be left alone with a dog. Pit bulls, rottweilers, and German shepherds (responsible for nearly half of all fatal dog attacks in the United States in 1997-2000) are potentially dangerous pets in households where children live or visit. For all breeds of dog, obedience training as well as spaying or neutering lessen the chances of aggressive behavior.

CATS. Prevention involves warning children to stay away from strange cats and to avoid rough play and other behavior that can anger cats and cause them to bite.

Arthropods

SPIDERS. Common-sense precautions include clearing webs out of garages, outhouses, and other places favored by venomous spiders; keeping one's hands away from places where spiders may be lurking; and, when camping or vacationing, checking clothing, shoes, and sleeping areas.

BEES AND WASPS. When possible, avoid the nests of bees and wasps and do not eat sweet food or wear bright clothing, perfumes, or cosmetics that attract bees and wasps.

Emergency medical kits containing self-administrable epinephrine to counter anaphylactic shock are available for allergic people and should be carried by them at all times. People who suspect they are allergic should consult an allergist about shots that can reduce reactions to bee and wasp venom.

Snakes

Snakes should not be kept as pets. Measures such as mowing the lawn, keeping hedges trimmed, and removing brush from the yard also discourages snakes from living close to human dwellings. Tongs should be used to move brush, lumber, and firewood, to avoid exposing one's hands to snakes that might be lying underneath. Similarly, golfers should never use their hands to retrieve golf balls from a water hole, since snakes can be hiding in the rocks and weeds. Caution is also necessary when walking through weedy or grassy areas, and children should be prevented from playing in weedy, vacant lots

KEY TERMS

Anaphylaxis—A life-threatening allergic reaction occurring in persons hypersensitive to bites and stings.

Antibiotics—Substances used against bacteria that cause infection.

Antibodies—Substances created by the body to combat infection.

Antihistamines—Drugs used to treat allergic reactions by acting against a substance called histamine.

Arachnid—Large class of arthropods that include spiders, scorpions, mites, and ticks. Arachnids have a segmented body divided into two parts, one of which has four pairs of legs but no antennae.

Arachnidism—Poisoning resulting from the bite or sting of an arachnid.

Bacteremia—Bacteria in the blood.

Blood serum—A component of blood.

Immune system—The body system that fights infection and protects the body against foreign invaders and disease.

Killer bees—Hybrids of African bees accidentally introduced into the wild in South and North America in 1956 and first reported in Texas in 1990. They were first imported by Brazilian scientists attempting to create a new hybrid bee to improve honey production.

Lymph nodes—Small, kidney-shaped organs that filter a fluid called lymph and that are part of the body's immune system.

Pus—A thick yellowish or greenish fluid composed of the remains of dead white blood cells, pathogens and decomposed cellular debris.

and other places where snakes may live. Leather boots and long pants offer hikers and campers some protection from bites. Approaching a snake, even a dead one, can be dangerous, for the venom of recently killed snakes may still be active.

Marine animals

JELLYFISH. Prevention of jellyfish stings includes obeying posted warning signs at the beach. Also, jellyfish tentacles may be transparent and up to 120 ft (36.5 m) long, therefore great caution must be exercised whenever a jellyfish is sighted nearby.

STINGRAYS. Shuffling while walking through shallow areas that may be inhabited by stingrays will disturb the water, causing the animal to move before it can be stepped on.

Resources

BOOKS

Holve, Steve. "Envenomations." In *Cecil Textbook of Medicine, 21st ed.,* edited by Goldman, Lee and Bennett, J. Claude. Philadelphia: W.B. Saunders, 2000, 2174-2178.

Linden, Christopher H and Lovejoy, Frederick H. " Disorders caused by reptile bites and marine animal evenomations." In *Harrison's Principles of Internal Medicine, 14th ed.* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998, 2544-2548.

Norris, Robert L, Oslund, Scott and Auerbach, Paul S. "Ectoparasite infestations and arthropod bites and stings." In *Harrison's Principles of Internal Medicine, 14th ed.,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998, 2548-2554.

Sutherland, Struan and Tibballs, James. *Australian Animal Toxins, 2nd ed.* New York, Oxford Univ Press, 2001.

PERIODICALS

Graudins A, Padula M, Broady K, Nicholson GM. "Red-back spider (Latrodectus hasselti) antivenom prevents the toxicity of widow spider venoms." *Annals of Emergency Medicine* 37(2): 154-160, 2001.

Jarvis RM, Neufeld MV, Westfall CT. "Brown recluse spider bite to the eyelid." *Ophthalmology* 107(8): 1492-1496, 2000.

Kasdan ML, Kasdan AS, Hamilton DL. "Lionfish envenomation." *Plastic and Reconstructive Surgery* 80(4): 613-614, 1987.

Metry DW, Hebert AA. "Insect and arachnid stings, bites, infestations, and repellents." *Pediatric Annals* 29(1): 39-48, 2000.

Sams HH, Dunnick CA, Smith ML, King LE. "Necrotic arachnidism." *Journal of the American Academy of Dermatology* 44(4): 561-573, 2001.

Sams HH. "Nineteen documented cases of Loxosceles reclusa envenomation." *Journal of the American Academy of Dermatology* 44(4): 603-608, 2001.

ORGANIZATIONS

American Academy of Clinical Toxicology. 777 East Park Drive, PO Box 8820, Harrisburg, PA 17105-8820. (717) 558-7750, Fax: (717) 558-7845. <http://www.clintox.org/index.html>. hmiller@pamedsoc.org.

American Academy of Emergency Medicine. 611 East Wells Street, Milwaukee, WI 53202. (800) 884-2236, Fax: (414) 276-3349. <http://www.aaem.org/>.

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000. <http://www.aafp.org/>. fp@aafp.org.
American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000, Fax: (847) 434-8000. <http://www. aap.org/default.htm>. kidsdoc@aap.org.
American Association of Poison Control Centers, 3201 New Mexico Avenue NW, Washington, DC 20016. (202) 362-7217. Fax: (202) 362-8377. <http://www. aapcc.org/>.
American College of Occupational and Environmental Medicine. 55 West Seegers Road, Arlington Heights, IL 60005. (708) 228-6850. Fax: (708) 228-1856. <http://www.acoem.org/>.
American Medical Association, 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http://www.ama-assn.org/>.

OTHER

City of Phoenix, Arizona. <http://www.ci.phoenix.az.us/FIRE/bitessna.html>.
Southwestern University School of Medicine. <http://www.swmed.edu/toxicology/toxlinks.htm>
Toxicology Professional Groups. <http://www.pitt.edu/~martint/pages/motoxorg.htm#AAPCC>.
University of Sydney, Australia. <http://www.usyd.edu.au/su/anaes/spiders.html>.
Vanderbilt University. <http://www.mc.vanderbilt.edu/clintox/>.

L. Fleming Fallon, Jr., MD, PhD

Black death *see* **Plague**

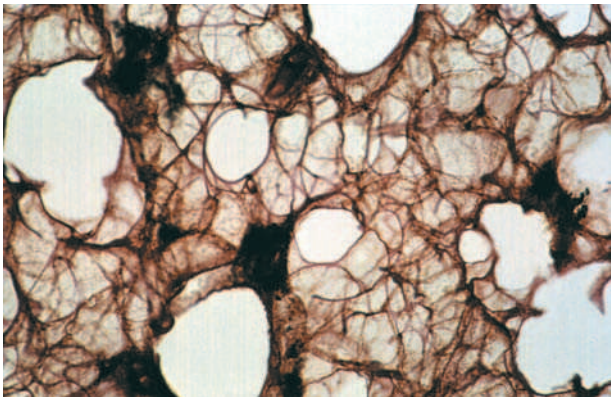
Black lung disease

Definition

Black lung disease is the common name for coal workers' pneumoconiosis (CWP) or anthracosis, a lung disease of older workers in the coal industry, caused by inhalation, over many years, of small amounts of coal dust.

Description

The risk of having black lung disease is directly related to the amount of dust inhaled over the years; the disease typically affects workers over age 50. Its common name comes from the fact that the inhalation of heavy deposits of coal dust makes miners lungs look black instead of a healthy pink. Although people who live in cities often have some black deposits in their lungs from polluted air, coal miners have much more extensive deposits.



A light micrograph of a human lung containing particles of inspired coal dust (anthracosis). The black masses shown are groups of coal dust particles. *(Photograph by Astrid & Hanns-Frieder Michler, Photo Researchers, Inc. Reproduced by permission.)*

In the years since the federal government has regulated dust levels in coal mines, the number of cases of black lung disease has fallen sharply. Since the Federal Coal Mine Health and Safety Act of 1969, average dust levels have fallen from 8.0 mg. per cubic meter to the current standard of 2.0 mg. per cubic meter. The 1969 law also set up a black lung disability benefits program to compensate coal miners who have been disabled by on-the-job dust exposure.

Despite the technology available to control the hazard, however, miners still run the risk of developing this lung disease. The risk is much lower today, however; fewer than 10% of coal miners have any x ray evidence of coal dust deposits. When there is such evidence, it often shows up as only small black spots less than 0.4 in (1 cm). in diameter, and may have been caused by **smoking** rather than coal dust. This condition is called "simple CWP" and does not lead to symptoms or disability.

Causes and symptoms

Since the particles of fine coal dust, which a miner breathes when he is in the mines, cannot be destroyed within the lungs or removed from them, builds up. Eventually, this build-up causes thickening and scarring, making the lungs less efficient in supplying oxygen to the blood.

The primary symptom of the disease is **shortness of breath**, which gradually gets worse as the disease progresses. In severe cases, the patient may develop **cor pulmonale**, an enlargement and strain of the right side of the heart caused by chronic lung disease. This may eventually cause right-sided **heart failure**.

KEY TERMS

Emphysema—A disease in which the tiny air sacs in the lungs become damaged, leading to shortness of breath, and respiratory and heart failure.

Fibrosis—The growth of scar tissue, often as a response to injury, infection, or inflammation.

Pulmonary function test—A group of procedures used to evaluate the function of the lungs and confirm the presence of certain lung disorders.

Silica dust—A type of dust from silica (crystalline quartz) which causes breathing problems in workers in the fields of mining, stone cutting, quarrying (especially granite), blasting, road and building construction industries that manufacture abrasives, and farming. Breathing the dust causes silicosis, a severe disease that can scar the lungs.

Some patients develop **emphysema** (a disease in which the tiny air sacs in the lungs become damaged, leading to shortness of breath, and respiratory and heart failure) as a complication of black lung disease. Others develop a severe type of black lung disease called progressive massive fibrosis, in which damage continues in the upper parts of the lungs even after exposure to the dust has ended. Scientists aren't sure what causes this serious complication. Some think that it may be due to the breathing of a mixture of coal and silica dust that is found in certain mines. Silica is far more likely to lead to scarring than coal dust alone.

Diagnosis

Black lung disease can be diagnosed by checking a patient's history for exposure to coal dust, followed by a chest x-ray to discover if the characteristic spots in the lungs caused by coal dust are present. A **pulmonary function test** may aid in diagnosis.

X rays can detect black lung disease before it causes any symptoms. If exposure to the dust is stopped at that point, progression of the disease may be prevented.

Treatment

There is no treatment or cure for this condition, although it is possible to treat complications such as lung infections and cor pulmonale. Further exposure to coal dust must be stopped.

Prognosis

Those miners with simple CWP can lead a normal life. However, patients who develop black lung disease at an early age, or who have progressive massive fibrosis, have a higher risk of premature **death**.

Prevention

The only way to prevent black lung disease is to avoid long-term exposure to coal dust. Coal mines may help prevent the condition by lowering coal dust levels and providing protective clothes to coal miners.

Resources

BOOKS

The Merck Manual. 6th ed. Ed. Robert Berkow, et. al. Rahway, NJ: Merck and Co., Inc., 1992.

ORGANIZATIONS

Mine Safety and Health Administration. 4015 Wilson Blvd. Arlington, VA 22203. (703) 235-1910. <http://www.msha.gov>.

Carol A. Turkington

Bladder calculi *see* **Bladder stones**

Bladder cancer

Definition

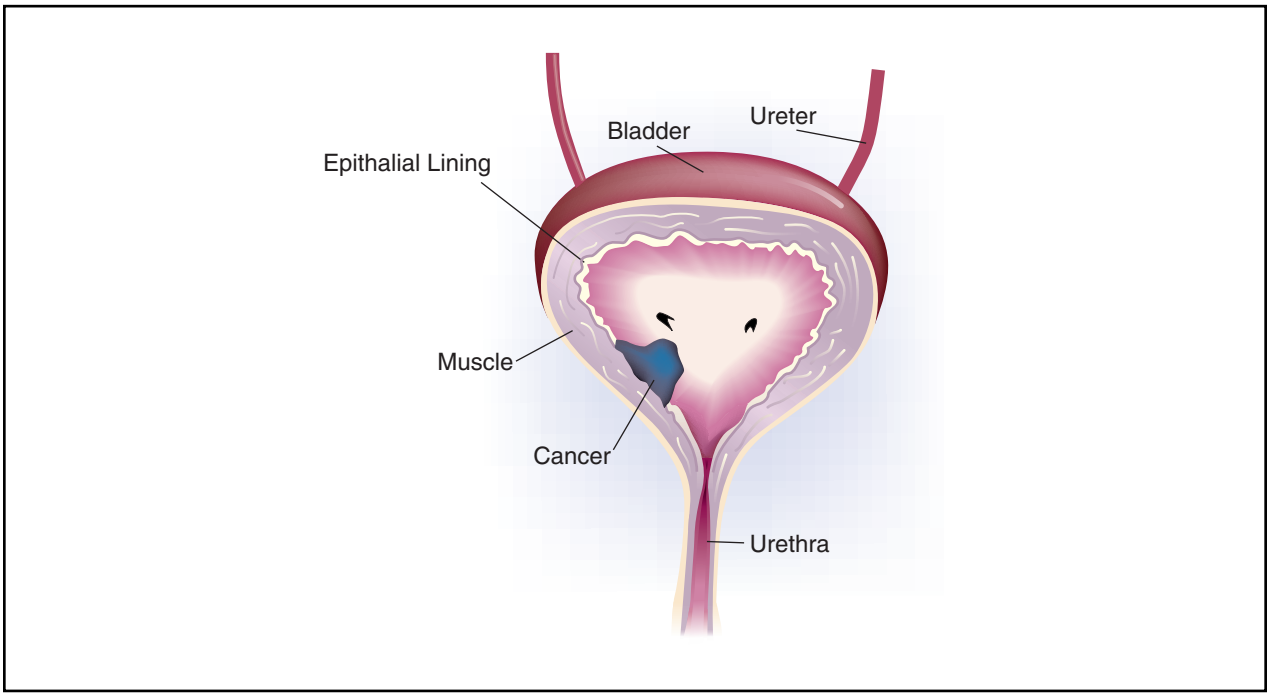
Bladder **cancer** is a disease in which the cells lining the urinary bladder lose the ability to regulate their growth and start dividing uncontrollably. This abnormal growth results in a mass of cells that form a tumor.

Description

Bladder cancer is the fifth most common cancer in the United States. The American Cancer Society (ACS) estimates that in 1998, approximately 55,000 new cases of bladder cancer will be diagnosed, and it will cause at least 12,500 deaths. The disease is three times more common among men than women, and the incidence is also higher in caucasians.

The urinary bladder is a hollow muscular organ that stores urine from the kidneys until it is excreted out of the body. Two tubes called the ureters bring the urine from the kidneys to the bladder. The urethra carries the urine from the bladder to the outside of the body.

Bladder cancer has a very high rate of recurrence. Even after superficial tumors are completely removed,



Bladder cancer on the inner lining of the bladder. *(Illustration by Argosy Inc.)*

there is a 75% chance that new tumors will develop in other areas of the bladder. Hence, patients need very frequent and thorough follow-up care.

Causes and symptoms

Although the exact cause of bladder cancer is not known, smokers are twice as likely as nonsmokers to get the disease. Hence, **smoking** is considered the greatest risk factor for bladder cancer. Workers who are exposed to certain chemicals that are used in the dye industry and in the rubber, leather, textile, and paint industries are believed to be at a higher risk for bladder cancer. The disease is also three times more common in men than in women; caucasians also are at an increased risk. The risk of bladder cancer increases with age. Most cases are found in people who are 50–70 years old.

Frequent urinary infections, kidney and **bladder stones**, and other conditions that cause long-term irritation to the bladder may increase the risk of getting bladder cancer. A past history of tumors in the bladder could also increase one's risk of getting other tumors.

One of the first warning signals of bladder cancer is blood in the urine. Sometimes, there is enough blood in the urine to change the color of the urine to a yellow-red or a dark red. At other times, the color of the urine appears normal but chemical testing of the urine reveals the presence of blood cells. A change in bladder habits such as painful urination, increased frequency of urination and a feeling of needing to urinate but not being able to do so are some of the signs of possible bladder cancer. All of these symptoms may also be caused by conditions other than cancer, but it is important to see a doctor and have the symptoms evaluated. When detected early and treated appropriately, patients have a very good chance of being cured completely.

Diagnosis

If a doctor has any reason to suspect bladder cancer, he may use several tests to find out if the disease is present. As a first step, a complete medical history will be taken to check for any risk factors. A thorough **physical examination** will be conducted to assess all the signs and symptoms. Laboratory testing of a urine sample will help to rule out the presence of a bacterial infection. In a urine cytology test, the urine is examined under a microscope to look for any abnormal or cancerous cells. A catheter (tube) can be advanced into the bladder through the urethra, and a salt solution is passed through it to wash the bladder. The solution can then be collected and examined under a microscope to check for the presence of any cancerous cells.

A test known as the intravenous pyelogram (IVP) is an x-ray examination that is done after a dye is injected into the blood stream through a vein in the arm. The dye travels through the blood stream and then reaches the kidneys to be excreted. It clearly outlines the kidneys,

ureters, bladder, and urethra. Multiple x rays are taken to detect any abnormality in the lining of these organs.

The physician may use a procedure known as a **cystoscopy** to view the inside of the bladder. A thin hollow lighted tube is introduced into the bladder through the urethra. If any suspicious looking masses are seen, a small piece of the tissue can be removed from it using a pair of biopsy forceps. The tissue is then examined microscopically to verify if cancer is present, and if so, to identify the type of cancer.

If cancer is detected and there is evidence to indicate that it has metastasized (spread) to distant sites in the body, imaging tests such as chest x rays, **computed tomography scans** (CT), and **magnetic resonance imaging** (MRI) may be done to determine which organs are affected. Bladder cancer generally tends to spread to the lungs, liver, and bone.

Treatment

Treatment for bladder cancer depends on the stage of the tumor. The patient's medical history, overall health status, and personal preferences are also taken into account when deciding on an appropriate treatment plan. The three standard modes of treatment that are available for bladder cancer are surgery, **radiation therapy**, and **chemotherapy**. In addition, newer treatment methods such as photodynamic therapy and immunotherapy are also being investigated in clinical trials.

Surgery is considered an option only when the disease is in its early stages. If the tumor is localized to a small area and has not spread to the inner layers of the bladder, then the surgery is done without cutting open the abdomen. A cytoscope is introduced into the bladder through the urethra, and the tumor is removed through it. This procedure is called a transurethral resection (TUR). Passing a high-energy laser beam through the cytoscope and burning the cancer may treat any remaining cancer. This procedure is known as electrofulguration. If the cancer has invaded the walls of the bladder, surgery will be done through an incision in the abdomen. Cancer that is not very large can be removed by partial **cystectomy**, a procedure where a part of the bladder is removed. If the cancer is large or is present in more than one area of the bladder, a radical cystectomy is done. In this operation, besides the entire bladder, the adjoining organs may also be removed. In men, the prostate is removed, while in women, the uterus, ovaries, and fallopian tubes are removed.

If the entire urinary bladder is removed, then an alternate storage place must be created for the urine to be stored before it is excreted out of the body. To do this, a piece of intestine is converted into a small bag and attached to the ureters. This is then connected to an opening (stoma) that is made in the abdominal wall. The procedure is called a urostomy. In some urostomy procedures, the urine from the intestinal sac is routed into a bag that is placed over the stoma in the abdominal wall. The bag is hidden by the clothing and has to be emptied occasionally by the patient. In a different procedure, the urine is collected in the intestinal sac, but there is no bag on the outside of the abdomen. The intestinal sac has to be emptied by the patient, by placing a drainage tube through the stoma.

Radiation therapy that uses high-energy rays to kill cancer cells is generally used after surgery to destroy any remaining cancer cells that may not have been removed during surgery. If the tumor is in a location that makes surgery difficult, or if it is large, radiation may be used before surgery to shrink the tumor. In cases of advanced bladder cancer, radiation therapy is used to ease the symptoms such as **pain**, bleeding, or blockage. Radiation can be delivered by external beam radiation where a source of radiation that is outside the body focuses the radiation on the area of the tumor. Occasionally, a small pellet of radioactive material may be placed directly into the cancer. This is known as interstitial radiation therapy.

Chemotherapy uses **anticancer drugs** to destroy the cancer cells that may have migrated to distant sites. The drugs are introduced into the bloodstream by injecting them into a vein in the arm or taking them orally in pill form. Generally a combination of drugs is more effective than any single drug in treating bladder cancer. Chemotherapy may be given following surgery to kill any remaining cancer cells. It may also be given even when no remaining cancer cells can be seen. This is called adjuvant chemotherapy. Anticancer drugs, including thiotepa, doxorubicin, and mitomycin, may also be instilled directly into the bladder (intravesicular chemotherapy) to treat superficial tumors.

Immunotherapy or biological therapy, uses the body's own immune cells to fight the disease. To treat superficial bladder cancer, bacille Calmette-Guerin (BCG) may be instilled directly into the bladder. BCG is a weakened (attenuated) strain of the **tuberculosis** bacillus that stimulates the body's immune system to fight the cancer. This therapy has been shown to be effective in controlling superficial bladder cancer.

Photodynamic treatment is a novel mode of treatment that uses special chemicals and light to kill the cancerous cells. First, a drug is introduced into the bladder that makes the cancer cells more susceptible to light. Following that, a special light is shone on the bladder in an attempt to destroy the cancerous cells.

Prognosis

When detected at the early stages, the prognosis for bladder cancer is excellent. At least 94% of the people

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Chemotherapy—Treatment with drugs that are anti cancer.

Computed tomography (CT) scan—A medical procedure where a series of X-rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Cystoscopy—A diagnostic procedure where a hollow lighted tube, (cystoscope) is used to look inside the bladder and the urethra.

Electrofulguration—A procedure where a high-energy laser beam is used to burn the cancerous tissue.

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Intravenous pyelogram (IVP)—A procedure where a dye is injected into a vein in the arm. The dye travels through the body and then concentrates in the urine to be excreted. It outlines the kidneys, ureters, and the urinary bladder. An x-ray of the pelvic region is then taken and any abnormalities of the urinary tract are revealed.

Magnetic Resonance Imaging (MRI)—A medical procedure used for diagnostic purposes where pictures of areas inside the body can be created using a magnet linked to a computer.

Partial cystectomy—A surgical procedure where the cancerous tissue is removed by cutting out a small piece of the bladder.

Photodynamic therapy—A novel mode of treatment where a combination of special light rays and drugs are used to destroy the cancerous cells. First, the drugs, which make the cancerous cells more susceptible to the light rays, are introduced into the bladder. Then the light is shone on the bladder to kill the cells.

Radiation therapy—Treatment using high- energy radiation from X-ray machines, cobalt, radium, or other sources.

Radical cystectomy—A surgical procedure that is used when the cancer is in more than one area of the bladder. Along with the bladder, the adjoining organs are also removed. In men, the prostate is removed, while in women, the ovaries, fallopian tubes and uterus may be removed.

Stoma—An artificial opening between two cavities or between a cavity and the surface of the body.

Transurethral resection—A surgical procedure to remove abnormal tissue from the bladder. The technique involves the insertion of an instrument called a cytoscope into the bladder through the urethra, and the tumor is removed through it.

Urostomy—A surgical procedure consisting of cutting the ureters from the bladder and connecting them to an opening (see Stoma) on the abdomen, allowing urine to flow into a collection bag.

survive five years or more after initial diagnosis. However, if the disease has spread to the nearby tissues, the survival rates drop to 49%. If it has metastasized to distant organs such as the lung, and the liver, commonly only 6% of the patients will survive five years or more.

Prevention

Since we do not know what exactly causes bladder cancer, there is no certain way to prevent it. Avoiding risk factors whenever possible is the best alternative.

Since smoking doubles one's risk of getting bladder cancer, avoiding tobacco may prevent at least half the deaths that result from bladder cancer. Taking appropriate safety precautions when working with organic cancer-causing chemicals is another way of preventing the disease.

If a person has had a history of bladder cancer, or has been exposed to cancer-causing chemicals, then he or she is considered to be at an increased risk of getting bladder cancer. Similarly, **kidney stones**, frequent urinary infections, and other conditions that cause long-term irritation to the bladder also increases the chance of getting the disease. In such cases, it is advisable to undergo regularscreening tests such as urine cytology, cystoscopy and x rays of the urinary tract, so that bladder cancer can be detected at its early stages and treated appropriately.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Diagnosis and Therapy.* 16th ed. Rahway, NJ: Merck Research Laboratories, 1992.

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Morra, Marion E., and Eve Potts. *Choices: The New, Most Up-To-Date Sourcebook for Cancer Information.* New York: Avon Books, 1994.

Murphy, Gerald P., Lois B. Morris, and Dianne Lange. *Informed Decisions: The Complete Book of Cancer Diagnosis, Treatment and Recovery.* New York: Viking, 1997.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

American Foundation for Urologic Disease. 300 W. Pratt St., Suite 401. Baltimore, MD 21201. Phone: (800)-828-7866.

Cancer Research Institute. 681 Fifth Ave., New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

Oncolink. University of Pennsylvania Cancer Center. <http://cancer.med.upenn.edu>.

OTHER

"Bladder Cancer." National Cancer Institute Page. <http://www.nci.nih.gov>.

"1998 Cancer Facts and Figures." American Cancer Society Page. <http://www.cancer.orgl>.

Lata Cherath, PhD

Bladder removal *see* **Cystectomy**

Bladder resection *see* **Transurethral bladder resection**

Bladder stones

Definition

Bladder stones are crystalline masses that form from the **minerals** and proteins, which naturally occur in urine. These types of stones are much less common than **kidney stones**.

Description

Bladder stones can form anywhere in the urinary tract before depositing in the bladder. They begin as tiny granules about the size of a grain of sand, but they can grow to more than an inch in diameter. These stones can block the flow of urine causing **pain** and difficulty with urination. They can also scratch the bladder wall, which may lead to bleeding or infection.

Causes and symptoms

While the exact causes of the formation of bladder stones are not completely understood, bladder stones usually occur because of urinary tract infection (UTI), obstruction of the urinary tract, enlargement of the prostate gland in men, or the presence of foreign bodies in the urinary tract. Diet and the amount of fluid intake also appear to be important factors in the development of bladder stones.

Ninety-five percent of all bladder stones occur in men, most of who have an **enlarged prostate** gland or a UTI. These stones are rarely seen in children or in African Americans. People with **gout** may develop bladder stones composed almost entirely of uric acid.

The symptoms of bladder stones may become evident when the wall of the bladder is scratched or when the urinary tract becomes obstructed by the stone. These symptoms include:

- abnormally dark colored urine
- blood in the urine
- difficulty urinating
- frequent urge to urinate
- lower abdominal pain
- pain or discomfort in the penis

Some people with bladder stones also may experience an inability to control urination (**urinary incontinence**).

Diagnosis

The diagnosis of bladder stones is usually made after a **physical examination**, which may include a **rectal examination** to check for enlargement of the prostate gland. Urine tests are then used to determine if there is blood or indications of an UTI in the urine. If bladder stones are suspected, bladder or pelvic x rays may be ordered. Stones that are large enough to cause problems with urinary function are almost always detectable by x ray.

Treatment

Many bladder stones can be passed out of the body in the urine. People with small bladder stones will be asked to increase their fluid intakes to at least six to eight eight-ounce glasses of water per day to increase urinary output. If the stones do not pass after two weeks, or if the

patient's symptoms become worse, further medical treatment may be required.

A large bladder stone, or small stone that the patient cannot pass in the urine, may be broken up into smaller stones using ultrasound (shock waves). These smaller stones may then pass in the urine. Stones that cannot be broken into pieces by these methods, or that the patient cannot pass, may have to be surgically removed.

Alternative treatment

Traditional herbal remedies for bladder stones include celery seed and horsetail. Also, because incomplete bladder emptying may cause bladder stones, many patients may benefit from methods and remedies aimed at improving overall bladder function. These include Kegel exercises, which are used to strengthen the muscles involved in urination; herbal supplements (cornsilk, hydrangea, juniper berries, parsley, and uva ursi) used to increase urine flow and flush out sediment from the bladder; and, the consumption of cranberry juice and/or fresh, unsweetened, lemon juice. Cranberry juice helps to control urinary tract infection and contains a chemical that coats the walls of the bladder, making them more resistant to infection. Lemon juice helps to flush out the urinary system.

Prognosis

Most bladder stones can be, and are, passed out of the body in the urine without any permanent damage to the bladder or the rest of the urinary tract. However, most bladder stones arise from an underlying medical condition. Therefore, if this medical condition is not corrected approximately half of all patients will experience a recurrence of bladder stones within five years.

Prevention

Bladder stones may, in some cases, be prevented by the patient receiving prompt medical treatment for an enlarged prostate gland or UTI. The consumption of at least six to eight eight-ounce glasses of water per day and/or the regular consumption of cranberry juice may help to prevent recurrences of bladder stones.

Resources

BOOKS

Ross, Linda M. and Peter Dresser, eds. *Kidney and Urinary Tract Diseases and Disorders Sourcebook.* Detroit, MI: Omnigraphics, Inc., 1997.

PERIODICALS

Schwartz, B.F. and M.L. Stoller. "The vesical calculus." *Urologic Clinics of North America* 27 (May 2000): 333-46.

KEY TERMS

Bladder—A small organ that serves as the reservoir for urine prior to its passing from the body during urination.

Prostate gland—A small gland in the male genitals that contributes to the production of seminal fluid.

Urinary tract—The system of organs that produces and expels urine from the body. This system begins at the kidneys, where the urine is formed; passes through the bladder; and, ends at the urethra, where urine is expelled.

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 North Charles Street, Baltimore, Maryland 21201. (410) 468-1800. Fax: (410) 468-1808. <http://www.afud.org/>.

OTHER

"Bladder Stones." MEDLINEplus Health Information. <http://medlineplus.adam.com/ency/article/001275.htm>. (12 May 2001).

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Bladder training

Definition

Bladder training is a behavioral modification treatment technique for **urinary incontinence** that involves placing a patient on a toileting schedule. The time interval between urination is gradually increased in order to train the patient to remain continent.

Purpose

Bladder training is used to treat urinary urge incontinence. Urge incontinence occurs when an individual feels a sudden need to urinate and cannot control the urge to do so and, as a consequence, involuntarily loses urine before making it to the toilet.

Precautions

Incontinence may be controlled through a number of invasive and non-invasive treatment options, including Kegel exercises, **biofeedback**, bladder training, medication, insertable incontinence devices, and surgery. Each patient should undergo a full diagnostic work-up to

KEY TERMS

Biofeedback—Biofeedback training monitors temperature and muscle contractions in the vagina to help incontinent patients control their pelvic muscles.

Pelvic muscle exercises—Exercises that tighten and tone the pelvic floor, or perineal, muscles. Also known as Kegel and PC muscle exercises.

determine the type and cause of the incontinence in order to determine the best course of treatment.

Description

Bladder training may be prescribed and implemented by a general physician, urologist, or urogynecologist. A urination schedule is created for the patient. The schedule typically starts out with fairly short intervals between bathroom breaks (e.g., an hour). As soon as the patient is able to consistently remain continent for several days at a certain toileting time interval, the time span is increased. Bladder training continues until the patient regularly achieves continence at a time interval he/she feels comfortable with.

Preparation

A complete evaluation to determine the cause of urinary incontinence is critical to proper treatment. A thorough medical history and **physical examination** should be performed on patients considering bladder training. Diagnostic testing may include x rays, ultrasound, urine tests, and a physical examination of the pelvis. It may include a series of exams called urodynamic testing that measure bladder pressure and capacity and the urinary flow. The patient may also be asked to keep a diary of their urination output and frequency and episodes of incontinence over a period of several days or a week.

Risks

Bladder training may not be successful in all patients with urge incontinence. Patients who demonstrate a strong desire to control their continence and are committed to sticking with a training program tend to have the most success with bladder training.

Normal results

Patients who undergo successful bladder training gain complete or improved control over their urination. In some cases, additional alternate treatment such as biofeedback or pelvic muscle exercises may be recommended to supplement the progress made with bladder training.

Resources

BOOKS

Blaivas, Jerry. *Conquering Bladder and Prostate Problems: The Authoritative Guide for Men and Women.* New York: Plenum, 1998.

King, Barbara, and Judy Harke. *Coping With Bowel and Bladder Problems.* San Diego: Singular Publishing Group, 1994.

PERIODICALS

Strange, Carolyn J. "Incontinence Can Be Controlled." *FDA Consumer* 31 (July/Aug. 1997): 28-31.

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 North Charles St., Baltimore, MD 21201. (800) 242-2383. <http://www.afud.org>.

National Association for Continence. P.O. Box 8310, Spartanburg, SC 29305-8310. (800) 252-3337. <http://www.nafc.org>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

Paula Anne Ford-Martin

Blastomyces dermatitidis see **Blastomycosis**

Blastomycosis

Definition

Blastomycosis is an infection caused by inhaling microscopic particles (spores) produced by the fungus *Blastomyces dermatitidis*. Blastomycosis may be limited to the lungs or also involve the skin and bones. In its most severe form, the infection can spread throughout the body and involve many organ systems (systemic).

Description

Blastomycosis is a fungal infection caused by *Blastomyces dermatitidis*. Although primarily an airborne disease, farmers and gardeners may become infected from contact with spores in the soil through cuts and scrapes. The fungus that causes the disease is found in moist soil and wood in the southeastern United States, the Mississippi River valley, southern Canada, and Central America. Blastomycosis is also called Gilchrist's dis-

ease, Chicago disease, or North American blastomycosis. Another South and Central American disease, paracoccidioidomycosis, is sometimes called **South American blastomycosis**, but despite the similar name, this disease is substantially different from North American blastomycosis. Canine blastomycosis, a common dog disease, is caused by the same fungus that infects humans. However, people do not get this disease from their dogs except only very rarely through dog bites.

Blastomycosis is a rare disease infecting only about 4 in every 100,000 people. It is at least six times more common in men than in women and tends to more often infect children and individuals in the 30–50 year old age group. People who have **diabetes mellitus** or who are taking drugs that suppress the immune system (immunocompromised) are more likely to develop blastomycosis. Although people with **AIDS** can get blastomycosis because of their weakened immune system, blastomycosis has not been one of the more common fungal infections associated with AIDS.

Causes and symptoms

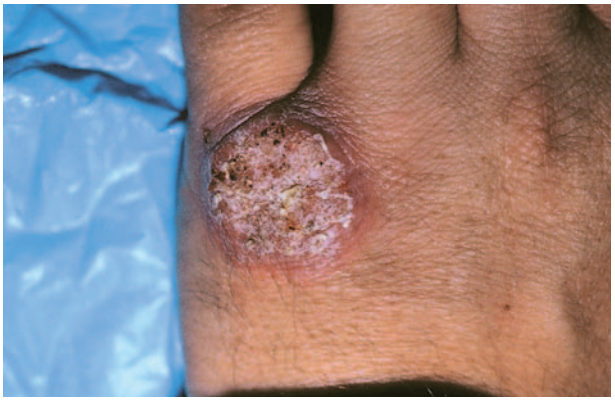
Once inhaled, the spores of *B. dermatitidis* can lodge in the lungs and cause a localized inflammation. This is known as primary pulmonary blastomycosis. The disease does not spread from one person to another. In the early stages, symptoms may include a dry **cough**, **fever**, heavy sweating, **fatigue**, and a general feeling of ill health. In approximately 25% of blastomycosis cases, only the lungs are affected. As the disease progresses, small lesions form in the lungs causing the air sacs deep within the lungs (alveoli) to break down and form small cavities.

In another 35%, the disease involves both the lungs and the skin. Bumps develop on the skin, gradually becoming small, white, crusted blisters filled with pus. The blisters break open, creating abscesses that do not heal. Approximately 19% of infected people have skin sores without infection in the lungs.

The remaining approximately 20% of the infected population has blastomycosis that has spread or disseminated to other systems of the body. Symptoms may include **pain** and lesions on one or more bones, the male genitalia, and/or parts of the central nervous system. The liver, spleen, lymph nodes, heart, adrenal glands, and digestive system may also be infected.

Diagnosis

A positive diagnosis of blastomycosis is made when the fungus *B. dermatitidis* is identified by direct microscopic examination of body fluids such as sputum and prostate fluid or in tissue samples (biopsies) from the lung or skin. Another way to diagnose blastomycosis is to culture and isolate the fungus from a sample of sputum. Chest x rays are used to assess lung damage, but alone cannot lead to a definitive diagnosis of blastomycosis because any damage caused by other diseases, such as by **pneumonia** or **tuberculosis**, may appear look on the x ray. Because its symptoms vary widely, blastomycosis is often misdiagnosed.



Blastomycosis is usually attributed to contact with yeast-like fungi. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Blastomycosis must be treated or it will gradually lead to **death**. Treatment with the fungicidal drug ketoconazole (Nizoral) taken orally is effective in about 75% of patients. Amphotericin B (Fungizone) given intravenously is also very effective, but it has more toxic side effects than ketoconazole. Treatment with amphotericin B usually requires hospitalization, and the patient may also receive other drugs to minimize the its side effects.

Alternative treatment

Alternative treatment for fungal infections focuses on creating an internal environment where the fungus cannot survive. This is accomplished by eating a diet low in dairy products, sugars, including honey and fruit juice, and foods like beer that contain yeast. This is complemented by a diet consisting, in large part, of uncooked and unprocessed foods. Supplements of **vitamins** C, E, A-plus, and B complex may also be useful. *Lactobacillus acidophilus* and *Bifidobacterium* will replenish the good bacteria in the intestines. Some antifungal herbs, like garlic (*Allium sativum*), can be consumed in relatively large doses and for an extended period of time in order to increase effectiveness. A variety of antifungal herbs, such as myrrh (*Commiphora molmol*), tea tree oil (*Melaleuca* spp.), citrus seed extract, pau d'arco tea

KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Acidophilus—The bacteria called *Lactobacillus acidophilus* that is usually found in yogurt.

Alveoli—Small air pockets in the lungs that increase the surface area for oxygen absorption.

Bifidobacteria—A group of bacteria normally present in the intestine. Commercial supplements containing these bacteria are available.

Biopsy—The removal of a tissue sample for diagnostic purposes.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Spores—The small, thick-walled reproductive structures of fungi.

Sputum—Mucus and other matter coughed up from airways.

Systemic—Not localized to a single area of the body but, instead, involving one or more body systems.

(*Tabebuia impetiginosa*), and garlic may also be applied directly to the infected skin.

Prognosis

Left untreated, blastomycosis gradually leads to death. When treated, however, patients begin to improve within one week and, with intensive treatment, may be cured within several weeks. The highest rate of recovery is among patients who only have **skin lesions**. People with the disseminated form of the disease are least likely to be cured and and most likely to suffer a relapse.

Prevention

Because the fungus that causes blastomycosis is airborne and microscopic, the only form of prevention is to avoid visiting areas where it is found in the soil. For many people this is impractical. Since the disease is rare, people who maintain general good health do not need to worry much about infection.

Resources

ORGANIZATIONS

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

OTHER

McGinnis, Michael R. "Blastomycosis." Medical Mycology Research Center Page. University of Texas Medical Branch. Apr. 1997 <http://www.fungus.utmb.edu/f-atlas/blastom.htm.>.

"Blastomycosis." Vanderbilt University Medical Center. <http://www.mc.vanterbilt.edu/peds/pid/infect/blastomy.html>.

Tish Davidson

Bleeding disorders *see* **Coagulation disorders**

Bleeding time

Definition

Bleeding time is a crude test of hemostasis (the arrest or stopping of bleeding). It indicates how well platelets interact with blood vessel walls to form blood clots.

Purpose

Bleeding time is used most often to detect qualitative defects of platelets, such as Von Willebrand's disease. The test helps identify people who have defects in their platelet function. This is the ability of blood to clot following a wound or trauma. Normally, platelets interact with the walls of blood vessels to cause a blood clot. There are many factors in the clotting mechanism, and they are initiated by platelets. The bleeding time test is usually used on patients who have a history of prolonged bleeding after cuts, or who have a family history of bleeding disorders. Also, the bleeding time test is sometimes performed as a preoperative test to determine a patient's likely bleeding response during and after surgery. However, in patients with no history of bleeding problems, or who are not taking anti-inflammatory drugs, the bleeding time test is not usually necessary.

Precautions

Before administering the test, patients should be questioned about what medications they may be taking. Some medications will adversely affect the results of the bleeding time test. These medications include anticoagulants, **diuretics**, **anticancer drugs**, **sulfonamides**, thiazide, **aspirin** and aspirin-containing preparations, and **nonsteroidal anti-inflammatory drugs**. The test may also be affected by anemia (a deficiency in red blood cells). Since the taking of aspirin or related drugs are the most common cause of prolonged bleeding time, no aspirin should be taken two weeks prior to the test.

Description

There are four methods to perform the bleeding test. The Ivy method is the traditional format for this test. In the Ivy method, a blood pressure cuff is placed on the upper arm and inflated to 40 mM Hg. A lancet or scalpel blade is used to make a stab wound on the underside of the forearm. An automatic, spring-loaded blade device is most commonly used to make a standard-sized cut. The area stabbed is selected so that no superficial or visible veins are cut. These veins, because of their size, may have longer bleeding times, especially in people with bleeding defects. The time from when the stab wound is made until all bleeding has stopped is measured and is called the bleeding time. Every 30 seconds, filter paper or a paper towel is used to draw off the blood. The test is finished when bleeding has stopped completely.

The three other methods of performing the bleeding test are the template, modified template, and Duke methods. The template and modified template methods are variations of the Ivy method. A blood pressure cuff is used and the skin on the forearm prepared as in the Ivy method. A template is placed over the area to be stabbed and two incisions are made in the forearm using the template as a location guide. The main difference between the template and the modified method is the length of the cut made.

For the Duke method, a nick is made in an ear lobe or a fingertip is pricked to cause bleeding. As in the Ivy method, the test is timed from the start of bleeding until bleeding is completely stopped. The disadvantage to the Duke method is that the pressure on the blood veins in the stab area is not constant and the results achieved are less reliable. The advantage to the Duke method is that no scar remains after the test. The other methods may result in a tiny, hairline scar where the wound was made. However, this is largely a cosmetic concern.

Preparation

There is no special preparation required of the patient for this test. The area to be stabbed should be wiped clean with an alcohol pad. The alcohol should be left on the skin long enough for it to kill bacteria at the wound site. The alcohol must be removed before stabbing the arm because alcohol will adversely affect the tests results by inhibiting clotting.

Aftercare

If a prolonged bleeding time is caused by unknown factors or diseases, further testing is required to identify the exact cause of the bleeding problem.

KEY TERMS

Hemostasis—The stopping of bleeding or blood flow through a blood vessel or organ.

Normal results

A normal bleeding time for the Ivy method is less than five minutes from the time of the stab until all bleeding from the wound stops. Some texts extend the normal range to eight minutes. Normal values for the template method range up to eight minutes, while for the modified template methods, up to 10 minutes is considered normal. Normal for the Duke method is three minutes.

Abnormal results

A bleeding time that is longer than normal is an abnormal result. The test should be stopped if the patient hasn't stopped bleeding by 20-30 minutes. Bleeding time is longer when the normal function of platelets is impaired, or there are a lower-than-normal number of platelets in the blood.

A longer-than-normal bleeding time can indicate that one of several defects in hemostasis is present, including severe **thrombocytopenia**, platelet dysfunction, vascular defects, Von Willebrand's disease, or other abnormalities.

Resources

BOOKS

Henry, J. B. *Clinical Diagnosis and Management by Laboratory Methods.* Philadelphia: W. B. Saunders Co., 1996.

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

Jandl, J. H. *Blood, Textbook of Hematology.* New York: Little, Brown and Co., 1996.

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Bleeding varices

Definition

Bleeding varices are bleeding, dilated (swollen) veins in the esophagus (gullet), or the upper part of the stomach, caused by liver disease.

KEY TERMS

Cirrhosis of the liver—A type of liver disease, most often caused by chronic alcohol abuse. It is characterized by scarring of the liver, which leads to an increase in the blood pressure in the portal veins.

Endoscopy—Medical imaging technique for visualizing the interior of a hollow organ.

Esophagus—The tube in the body which takes food from the mouth to the stomach.

Esophagogastroduodenoscopy (EGD)—An imaging test that involves visually examining the lining of the esophagus, stomach, and upper duodenum with a flexible fiberoptic endoscope.

Portal hypertension—Portal hypertension forces the blood flow backward, causing the portal veins to enlarge and the emergence of bleeding varices across the esophagus and stomach from the pressure in the portal vein. Portal hypertension is most commonly caused by cirrhosis, but can also be seen in portal vein obstruction from unknown causes.

Portal veins—The main veins that carry blood from the stomach and intestines to the liver.

Shock—A state of depression of the vital processes of the body characterized by pallor, a rapid and weak pulse, rapid and shallow respiration, and lowered blood pressure. Shock results from severe trauma, such as crushing injuries, hemorrhage, burns, or major surgery.

Transjugular intrahepatic portosystemic shunt (TIPS)—A transjugular intrahepatic portosystemic shunt (TIPS) is a radiology procedure in which a tubular device is inserted in the middle of the liver to redirect the blood flow.

Varices—A type of varicose vein that develops in veins in the linings of the esophagus and upper stomach when these veins fill with blood and swell due to an increase in blood pressure in the portal veins.

Description

Engorged veins are called varices (plural of varix). Varices may occur in the lining of the esophagus, the tube that connects the mouth to the stomach, or in the upper part of the stomach. Such varices are called esophageal varices. These varices are fragile and can bleed easily because veins are not designed to handle high internal pressures.

Causes and symptoms

Liver disease often causes an increase in the blood pressure in the main veins that carry blood from the stomach and intestines to the liver (portal veins). As the pressure in the portal veins increases, the veins of the stomach and esophagus swell, until they eventually become varices. Bleeding varices are a life-threatening complication of this increase in blood pressure (portal **hypertension**). The most common cause of bleeding varices is **cirrhosis** of the liver caused by chronic alcohol abuse or hepatitis. Bleeding varices occur in approximately one in every 10,000 people.

Symptoms of bleeding varices include

- vomiting blood, sometimes in massive amounts
- black, tarry stools
- decreased urine output
- excessive thirst
- nausea
- vomiting
- and blood in the vomit

If bleeding from the varices is severe, a patient may go into **shock** from the loss of blood, characterized by pallor, a rapid and weak pulse, rapid and shallow respiration, and lowered systemic blood pressure.

Diagnosis

Bleeding varices may be suspected in a patient who has any of the above-mentioned symptoms, and who has either been diagnosed with cirrhosis of the liver or who has a history of prolonged alcohol abuse. The definitive diagnosis is established via a specialized type of endoscopy, namely, **esophagogastroduodenoscopy** (EGD), a procedure that involves the visual examination of the lining of the esophagus, stomach, and upper duodenum with a flexible fiberoptic endoscope.

Treatment

The objective during treatment of bleeding varices is to stop and/or prevent bleeding and to restore/maintain normal blood circulation throughout the body. Patients with severe bleeding should be treated in intensive care since uncontrolled bleeding can lead to **death**.

Initial treatment of bleeding varices begins with standard resuscitation, including intravenous fluids and blood transfusions as needed. Definitive treatment is usually endoscopic, with the endoscope used to locate the sites of the bleeding. An instrument, inserted along with the endoscope, is used either to inject these sites with a clotting agent or to tie off the bleeding sites with tiny rubber bands.

Repeated endoscopic treatments (usually four to six) are generally required to eliminate the varices and to prevent the recurrence of bleeding. These endoscopic techniques are successful in about 90 percent of cases.

Patients who cannot be treated endoscopically may be considered for an alternative procedure called TIPS (transjugular intrahepatic portosystemic shunt). This procedure involves placing a hollow metal tube (shunt) in the liver connecting the portal veins with the hepatic veins (veins that leave the liver and drain to the heart). This shunt lowers the pressure in the portal veins and prevents bleeding and portal hypertension. The TIPS procedure is performed by a radiologist and has become an accepted method for reducing portal vein pressure since 1992. Although the procedure continues to evolve, TIPS can routinely be created in more than 93% of patients.

Medications aimed at controlling bleeding may also be prescribed. These include propanolol, vasopressin, octreotide acetate, and isosorbide mononitrate.

Alternative treatment

Some alternative treatments are aimed at preventing the cirrhosis of the liver that often causes bleeding varices and most are effective. However, once a patient has reached the bleeding varice stage, standard intervention to stop the bleeding is required or the patient may die.

Prognosis

Bleeding varices represent one of the most feared complications of portal hypertension. They contribute to the estimated 32,000 deaths per year attributed to cirrhosis. Half or more of patients who survive episodes of bleeding varices are at risk of renewed esophageal bleeding during the first one to two years. The risk of recurrence can be lowered by endoscopic and drug treatment. Prognosis is usually more related to the underlying liver disease. Approximately 30 to 50 percent of people with bleeding varices will die from this condition within the six weeks of the first bleeding episode.

Prevention

The best way to possibly prevent the development or recurrence of bleeding varices is to eliminate the risk factors for cirrhosis of the liver. The most common cause of cirrhosis is prolonged alcohol abuse, and alcohol consumption must be completely eliminated. People with **hepatitis B** or **hepatitis C** also have an increased risk of developing cirrhosis of the liver. **Vaccination** against hepatitis B and avoidance of intravenous drug usage reduce the risk of contracting hepatitis.

Resources

BOOKS

Shannon, Joyce Brennfleck, ed. *Liver Disorders Sourcebook.* Detroit, MI: Omnigraphics, Inc., 2000.

PERIODICALS

Burroughs, Andrew K. and David Patch. "Primary prevention of bleeding from esophageal varices." *New England Journal of Medicine* 340 (April 1, 1999): 1033-5.

Hegab, Ahmed M. and Velimir A. Luketic. "Bleeding esophageal varices: How to treat this dreaded complication of portal hypertension." *Postgraduate Medicine* 109 (February 2001): 75-89.

ORGANIZATIONS

American Liver Foundation. 75 Maiden Lane, Suite 603, New York, NY 10038. (800) 465-4837. <http://www.liverfoundation.org/>.

OTHER

Goff, John. "Portal hypertensive bleeding." <http://www.nysge.org/PostGrad1999/Goff_VaricealBleeding.htm> (12 May 2001).

Paul A. Johnson

Blepharitis *see* **Eyelid disorders**

Blepharoplasty

Definition

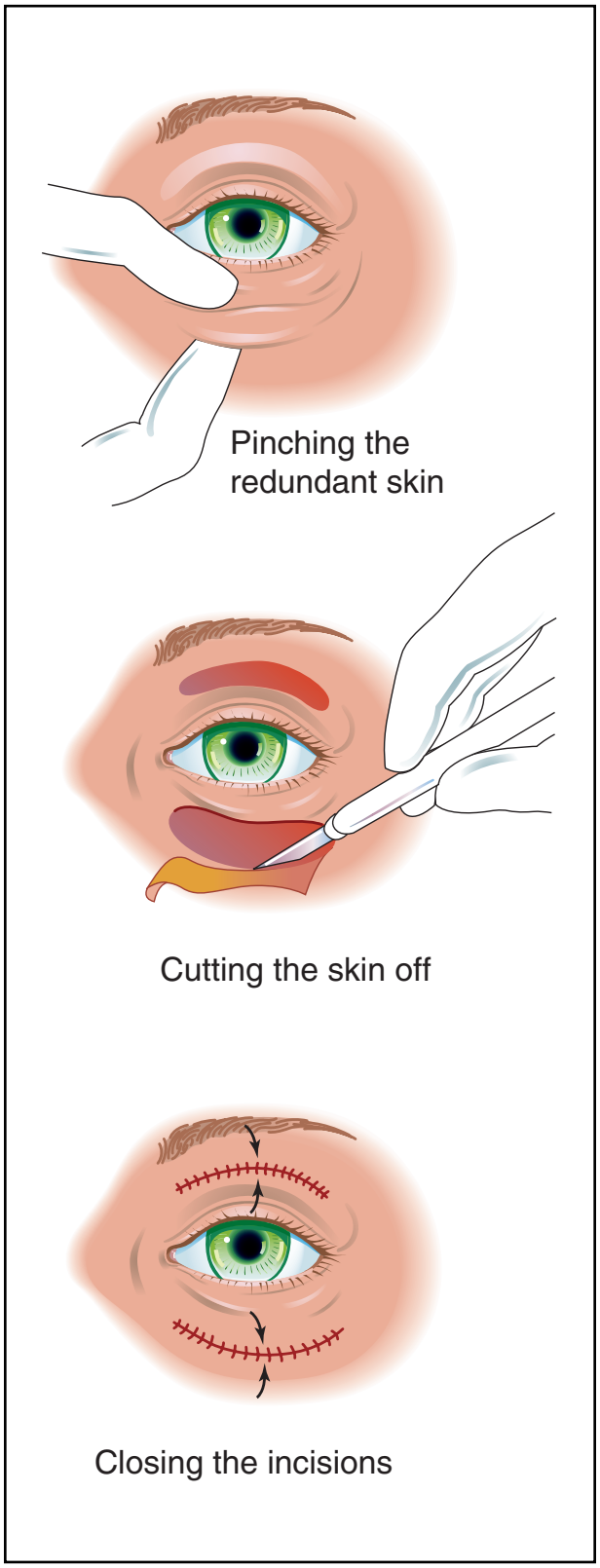
Blepharoplasty is a cosmetic surgical procedure that removes fat deposits, excess tissue, or muscle from the eyelids to improve the appearance of the eyes.

Purpose

The primary use of blepharoplasty is for improving the cosmetic appearance of the eyes. In some older patients, however, sagging and excess skin surrounding the eyes can be so extensive that it limits the range of vision. In those cases, blepharoplasty serves a more functional purpose.

Precautions

Before performing blepharoplasty, the surgeon will assess whether the patient is a good candidate for the



The illustration above depicts a procedure to eliminate dermochalasia, or baggy skin around the eyes. *(Illustration by Electronic Illustrators Group.)*

treatment. A good medical history is important. The surgeon will want to know about any history of thyroid disease, **hypertension**, or eye problems, which may increase the risk of complications.

Description

Blepharoplasty can be performed on the upper or lower eyelid; it can involve the removal of excess skin and fat deposits and the tightening of selected muscles surrounding the eyelids. The goal is to provide a more youthful appearance.

The surgeon will begin by deciding whether excess skin, fat deposits, or muscle looseness are at fault. While the patient is sitting upright, the surgeon will mark on the skin where incisions will be made. Care will be taken to hide the incision lines in the natural skin folds above and below the eye. The patient then receives injections of a local anesthetic to numb the **pain**. Many surgeons also give the patient a sedative intravenously during the procedure.

After a small, crescent-shaped section of eyelid skin is removed, the surgeon will work to tease out small pockets of fat that have collected in the lids. If muscle looseness is also a problem, the surgeon may trim tissue or add a stitch to pull it tighter. Then the incision is closed with stitches.

In some patients, fat deposits in the lower eyelid may be the only or primary problem. Such patients may be good candidates for transconjunctival blepharoplasty. In this procedure the surgeon makes no incision on the surface of the eyelid, but instead enters from behind to tease out the fat deposits from a small incision. The advantage of this procedure is that there is no visible scar.

Preparation

Prior to surgery, patients meet with their surgeon to discuss the procedure, clarify the results that can be achieved, and discuss the potential problems that might occur. Having realistic expectations is important in any cosmetic procedure. Patients will learn, for example, that although blepharoplasty can improve the appearance of the eyelid, other procedures, such as a chemical peel, will be necessary to reduce the appearance of wrinkles around the eye. Some surgeons prescribe vitamin C and vitamin K for 10 days prior to surgery in the belief that this helps the healing process. Patients are also told to stop **smoking** in the weeks before and after the procedure, and to refrain from alcohol and **aspirin**.

Aftercare

An antibiotic ointment is applied to the line of stitches for several days after surgery. Patients also take an

antibiotic several times a day to prevent infection. Ice-cold compresses are applied to the eyes continuously for the first day following surgery, and several times a day for the next week or so, to reduce swelling. Some swelling and discoloration around the eyes is expected with the procedure. Patients should avoid aspirin or alcoholic beverages for one week and should limit their activities, including bending, straining, and lifting. The stitches are removed a few days after surgery. Patients can generally return to their usual activities within a week to 10 days.

Risks

As with any surgical procedure, blepharoplasty can lead to infection and scarring. Good care of the wound following surgery can minimize these risks. In cases where too much skin is removed from the eyelids, the patient may have difficulty closing his eyes. Dry eye syndrome may develop, requiring the use of artificial tears to lubricate the eye. In a rare complication, called retrobulbar hematoma, a pocket of blood forms behind the eyeball.

Normal results

Most patients can expect good results from blepharoplasty, with the removal of excess eyelid skin and fat producing a more youthful appearance. Some swelling and discoloration is expected immediately following the procedure, but this clears in time. Small scars will be left where the surgeon has made incisions; but these generally lighten in appearance over several months, and, if placed correctly, will not be readily noticeable.

Abnormal results

As noted, if too much excess skin is removed from the upper eyelid, the patient may be unable to close his eyes completely; another surgery to correct the defect may be required. Similarly, too much skin can be removed from the lower eyelid, allowing too much of the white of the eye (the sclera) to show. In extreme cases, the lower lid may be pulled down too far, revealing the underlying tissue. Called an ectropion, this, too, may require a second, corrective surgery. The eye's ability to make tears may also be compromised, leading to dry eye syndrome. Dry eye syndrome is potentially dangerous; in rare cases it leads to damage to the cornea of the eye and vision loss.

Resources

BOOKS

Asken, Saul. "Blepharoplasty." In *Cosmetic Surgery of the Skin: Principles and Techniques*, ed. William P. Coleman. St. Louis: Mosby, 1997.

Flowers, Robert S. "Blepharoplasty and Brow Lifting." In *Roenigk and Roenigk's Dermatologic Surgery: Principles and Practice*, ed. Randall K. Roenigk and Henry H. Roenigk. New York: Marcel Dekker, 1996.

PERIODICALS

Baylis, Henry I., et al. "Blepharoplasty and Periorbital Surgery." *Dermatologic Clinics* 15 (Oct. 1997): 635-647.

ORGANIZATIONS

American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asds-net.org>.

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

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KEY TERMS

Ectropion—A complication of blepharoplasty, in which the lower lid is pulled downward, exposing the surface below.

Intravenous sedation—A method of injecting a fluid sedative into the blood through the vein

Retrobulbar hematoma—A rare complication of blepharoplasty, in which a pocket of blood forms behind the eyeball.

Transconjuctival blepharoplasty—A type of blepharoplasty in which the surgeon makes no incision on the surface of the eyelid, but, instead, enters from behind to tease out the fat deposits.

Blindness *see* **Visual impairment**

Blood-viscosity reducing drugs

Definition

Blood-viscosity reducing drugs are medicines that improve blood flow by making the blood less viscous (sticky).

Purpose

The main use of blood-viscosity reducing drugs is to relieve painful leg cramps caused by poor circulation, a condition called intermittent claudication. Physicians

KEY TERMS

Raynaud's disease—A blood vessel disorder in which the fingers and toes become numb and turn white when exposed to cold.

also may prescribe this medicine for other conditions, including **stroke**, **impotence**, male **infertility**, **Raynaud's disease**, and nerve and circulation problems caused by diabetes.

Description

Blood-viscosity reducing drugs are available only with a physician's prescription and come in extended-release tablet form. Examples of blood-viscosity reducing drugs are pentoxifylline (Trental) and oxypentifylline.

Recommended dosage

The usual dosage for adults is 400 mg, two to three times a day, with meals. However, the dose may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage. Dosages for children must be determined by a physician.

Taking an antacid with this medicine may help prevent upset stomach.

Precautions

This medicine may relieve leg **pain** that results from poor circulation, but it should not be considered a substitute for other treatments the physician recommends, such as physical therapy or surgery.

This medicine may take several weeks to produce noticeable results. Be sure to keep taking it as directed, even if it doesn't seem to be helping.

Patients being treated with this medicine should not smoke, as **smoking** may worsen the conditions for which the medicine is prescribed.

Anyone who has had unusual reactions to pentoxifylline, aminophylline, **caffeine**, dyphylline, ethylenediamine (contained in aminophylline), oxtriphylline, theobromine, or theophylline in the past should let his or her physician know before taking a blood-viscosity reducing drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant or breastfeeding or who may become pregnant should check with their physicians before using a blood-viscosity reducing drug.

Older people may be especially sensitive to the effects of this medicine, which may increase the chance of side effects.

Before using blood-viscosity reducing drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- recent stroke
- any condition in which there is an increased chance of bleeding
- kidney disease
- liver disease

Side effects

Minor discomforts, such as **dizziness**, **headache**, upset stomach, nausea, or vomiting usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they interfere with normal activities.

More serious side effects are rare. However, if these or any other unusual or troublesome symptoms occur, check with the physician who prescribed the medicine as soon as possible:

- chest pain
- irregular heartbeat

Interactions

Blood-viscosity reducing drugs may interact with a other medicines, changing the effects of one or both of the drugs or increasing the risk of side effects. Anyone who takes blood-viscosity reducing drugs should let the physician know all other prescription or nonprescription (over-the-counter) medicines he or she is taking. Among the drugs that may interact with blood-viscosity reducing drugs are:

- anticoagulants such as warfarin (Coumadin)(also called blood thinners or clot inhibitors)
- calcium channel blockers such as diltiazem (Cardizem), used to treat high blood pressure
- angiotensin-converting enzyme (ACE) inhibitors such as enalapril (Vasotec), used to treat high blood pressure
- theophylline (Theo-Dur)
- medicines such as cimetidine (Tagamet), taken for ulcers or heartburn

Nancy Ross-Flanigan

Blood count

Definition

One of the most commonly ordered clinical laboratory tests, a blood count, also called a complete blood count (CBC), is a basic evaluation of the cells (red blood cells, white blood cells, and platelets) suspended in the liquid part of the blood (plasma). It involves determining the numbers, concentrations, and conditions of the different types of blood cells.

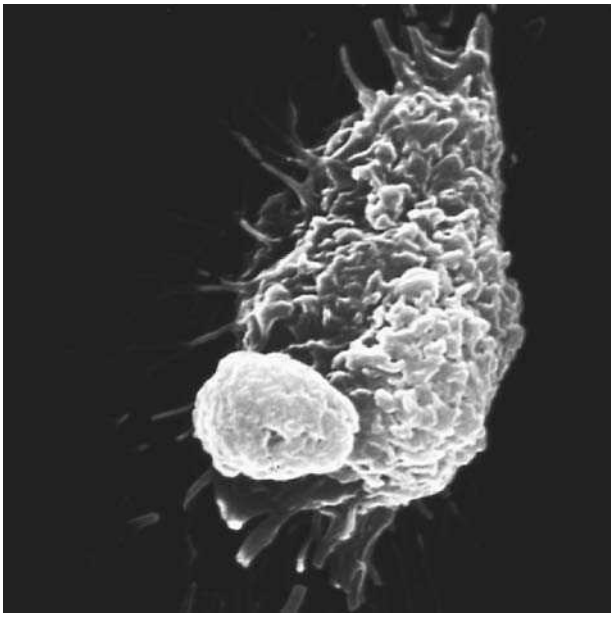
Purpose

The CBC is a useful screening and diagnostic test that is often done as part of a routine **physical examination**. It can provide valuable information about the blood and blood-forming tissues (especially the bone marrow), as well as other body systems. Abnormal results can indicate the presence of a variety of conditions—including **anemias**, leukemias, and infections—sometimes before the patient experiences symptoms of the disease.

Description

A complete blood count is actually a series of tests in which the numbers of red blood cells, white blood cells, and platelets in a given volume of blood are counted. The CBC also measures the hemoglobin content and the packed cell volume (**hematocrit**) of the red blood cells, assesses the size and shape of the red blood cells, and determines the types and percentages of white blood cells. Components of the complete blood count (hemoglobin, hematocrit, white blood cells, platelets, etc.) can also be tested separately, and are sometimes done that way when a doctor wants to monitor a specific condition, such as the white cell count of a patient diagnosed with leukemia, or the hemoglobin of a patient who has recently received a blood **transfusion**. Because of its value, though, as an indicator of a person's overall health, the CBC package is most frequently ordered.

The blood count is performed relatively inexpensively and quickly. Most laboratories routinely use some type of automated equipment to dilute the blood, sample a measured volume of the diluted suspension, and count the cells in that volume. In addition to counting actual numbers of red cells, white cells, and platelets, the automated cell counters also measure the hemoglobin and calculate the hematocrit and the **red blood cell indices** (measures of the size and hemoglobin content of the red blood cells). Technologists then examine a stained blood smear under the microscope to identify any abnormalities in the appearance of the red blood cells and to report the types and percentages of white blood cells observed.



A white blood cell. *(Photograph by Institut Pasteur, Phototake NYC. Reproduced by permission.)*

The red blood cell (RBC) count determines the total number of red cells (erythrocytes) in a sample of blood. The red cells, the most numerous of the cellular elements, carry oxygen from the lungs to the body's tissues. Hemoglobin (Hgb) is the protein-iron compound in the red blood cells that enables them to transport oxygen. Its concentration corresponds closely to the RBC count. Also closely tied to the RBC and hemoglobin values is the hematocrit (Hct), which measures the percentage of red blood cells in the total blood volume. The hematocrit (expressed as percentage points) is normally about three times the hemoglobin concentration (reported as grams per deciliter).

Red blood cell indices provide information about the size and hemoglobin content of the red cells. They are useful in differentiating types of anemias. The indices include four measurements that are calculated using the RBC count, hemoglobin, and hematocrit results. Mean corpuscular volume (MCV) is a measurement of the average size of the red blood cells and indicates whether that is small, large or normal. The red blood cell distribution width (RDW) is an indication of the variation in RBC size. Mean corpuscular hemoglobin (MCH) measures the average amount (weight) of hemoglobin within a red blood cell. A similar measurement, mean corpuscular hemoglobin concentration (MCHC), expresses the average concentration of hemoglobin in the red blood cells.

The white blood cell (WBC) count determines the total number of white cells (leukocytes) in the blood

sample. Fewer in number than the red cells, WBCs are the body's primary means of fighting infection. There are five main types of white cells (neutrophils, lymphocytes, monocytes, eosinophils, and basophils), each of which plays a different role in responding to the presence of foreign organisms in the body. A differential white cell count is done by staining a smear of the patient's blood with a Wright's stain, allowing the different types of white cells to be clearly seen under the microscope. A technologist then counts a minimum of 100 WBCs and reports each type of white cell as a percentage of the total white blood cells counted.

The **platelet count** is an actual count of the number of platelets (thrombocytes) in a given volume of blood. Platelets, the smallest of the cellular elements of blood, are involved in blood clotting. Because platelets can clump together, the automated counting method is subject to a certain level of error and may not be accurate enough for low platelet counts. For this reason, very low platelet levels are often counted manually.

Normal results

Blood count values can vary by age and sex. The normal red blood cell count ranges from 4.2–5.4 million RBCs per microliter of blood for men and 3.6–5.0 million for women. Hemoglobin values range from 14–18 grams per deciliter of blood for men and 12–16 grams for women. The normal hematocrit is 42–54% for men and 36–48% for women. The normal number of white blood cells for both men and women is approximately 4,000–10,000 WBCs per microliter of blood.

Abnormal results

Abnormal blood count results are seen in a variety of conditions. One of the most common is anemias, which are characterized by low RBC counts, hemoglobins, and hematocrits. Infections and leukemias are associated with increased numbers of WBCs.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Henry, J. B. *Clinical Diagnosis and Management by Laboratory Methods.* New York: W. B. Saunders Co., 1996.

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Blood crossmatching *see* **Blood typing and crossmatching**

Blood culture

Definition

A blood culture is done when a person has symptoms of a blood infection, also called **bacteremia**. Blood is drawn from the person one or more times and is tested in a laboratory to find and identify any microorganism present and growing in the blood. If a microorganism is found, more testing is done to determine the **antibiotics** that will be effective in treating the infection.

Purpose

Bacteremia is a serious clinical condition and can lead to **death**. To give the best chance for effective treatment and survival, a blood culture is done as soon as an infection is suspected.

Symptoms of bacteremia are **fever**, chills, mental confusion, **anxiety**, rapid heart beat, hyperventilation, blood clotting problems, and **shock**. These symptoms are especially significant in a person who already has another illness or infection, is hospitalized, or has trouble fighting infections because of a weak immune system. Often, the blood infection results from an infection somewhere else in the body that has now spread.

Additionally, blood cultures are done to find the causes of other infections. These include bacterial **pneumonia** (an infection of the lung), and infectious **endocarditis** (an infection of the inner layer of the heart). Both of these infections leak bacteria into the blood.

After a blood infection has been diagnosed, confirmed by culture, and treated, an additional blood culture may be done to make sure the infection is gone.

Description

Culture strategies

There are many variables involved in performing a blood culture. Before the person's blood is drawn, the physician must make several decisions based on a knowledge of infections and the person's clinical condition and medical history.

Several groups of microorganisms, including bacteria, viruses, mold, and yeast, can cause blood infections. The bacteria group can be further broken down into aerobes and anaerobes. Most aerobes do not need oxygen to live. They can grow with oxygen (aerobic microbes) or without oxygen (anaerobic microbes).

Based on the clinical condition of the patient, the physician determines what group of microorganisms is likely to be causing the infection and then orders one or

more specific types of blood culture, including aerobic, anaerobic, viral, or fungal (for yeasts and molds). Each specific type of culture is handled differently by the laboratory. Most blood cultures test for both aerobic and anaerobic microbes. Fungal, viral, and mycobacterial blood cultures can also be done, but are less common.

The physician must also decide how many blood cultures should be done. One culture is rarely enough, but two to three are usually adequate. Four cultures are occasionally required. Some factors influencing this decision are the specific microorganisms the physician expects to find based on the person's symptoms or previous culture results, and whether or not the person has had recent antibiotic therapy.

The time at which the cultures are to be drawn is another decision made by the physician. During most blood infections (called intermittent bacteremia) microorganisms enter the blood at various time intervals. Blood drawn randomly may miss the microorganisms. Since microorganisms enter the blood 30–90 minutes before the person's fever spikes, collecting the culture just after the fever spike offers the best likelihood of finding the microorganism. The second and third cultures may be collected at the same time, but from different places on the person, or spaced at 30-minute or one-hour intervals, as the physician chooses. During continuous bacteremia, such as infective endocarditis, microorganisms are always in the blood and the timing of culture collection is less important. Blood cultures should always be collected before antibiotic treatment has begun.

Laboratory analysis

Bacteria are the most common microorganisms found in blood infections. Laboratory analysis of a bacterial blood culture differs slightly from that of a fungal culture and significantly from that of a viral culture.

Blood is drawn from a person and put directly into a blood culture bottle containing a nutritional broth. After the laboratory receives the blood culture bottle, several processes must be completed:

- provide an environment for the bacteria to grow
- detect the growth when it occurs
- identify the bacteria that grow
- test the bacteria against certain antibiotics to determine which antibiotic will be effective

There are several types of systems, both manual and automated, available to laboratories to carry out these processes.

The broth in the blood culture bottle is the first step in creating an environment in which bacteria will grow. It contains all the nutrients that bacteria need to grow. If the physician expects anaerobic bacteria to grow, oxygen will be kept out of the blood culture bottle; if aerobes are expected, oxygen will be allowed in the bottle.

The bottles are placed in an incubator and kept at body temperature. They are watched daily for signs of growth, including cloudiness or a color change in the broth, gas bubbles, or clumps of bacteria. When there is evidence of growth, the laboratory does a gram stain and a subculture. To do the gram stain, a drop of blood is removed from the bottle and placed on a microscope slide. The blood is allowed to dry and then is stained with purple and red stains and examined under the microscope. If bacteria are seen, the color of stain they picked up (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to what type of microorganism they are and what antibiotics might work best. To do the subculture, a drop of blood is placed on a culture plate, spread over the surface, and placed in an incubator.

If there is no immediate visible evidence of growth in the bottles, the laboratory looks for bacteria by doing gram stains and subcultures. These steps are repeated daily for the first several days and periodically after that.

When bacteria grows, the laboratory identifies it using biochemical tests and the gram stain. Sensitivity testing, also called antibiotic susceptibility testing, is also done. The bacteria are tested against many different antibiotics to see which antibiotics can effectively kill it.

All information is passed on to the physician as soon as it is known. An early report, known as a preliminary report, is usually available after one day. This report will tell if any bacteria have been found yet, and if so, the results of the gram stain. The next preliminary report may include a description of the bacteria growing on the subculture. The laboratory notifies the physician immediately when an organism is found and as soon as sensitivity tests are complete. Sensitivity tests may be complete before the bacteria is completely identified. The final report may not be available for five to seven days. If bacteria was found, the report will include its complete identification and a list of the antibiotics to which the bacteria is sensitive.

One automated system is considered one of the most important recent technical advances in blood cultures. It is called continuous-monitoring blood culture systems (CMCCS). The instruments automatically monitor the bottles containing the patient blood for evidence of microorganisms, usually every 10 minutes. Many data points are collected daily for each bottle, and fed into a computer for analysis. Sophisticated mathematical calculations can determine when microorganisms have grown. This, combined with more frequent blood tests, make it

KEY TERMS

Aerobe—Bacteria that require oxygen to live.

Anaerobe—Bacteria that live where there is no oxygen.

Bacteremia—Bacteria in the blood.

Continuous bacteremia—A kind of bacteremia where bacteria is always in the blood.

Intermittent bacteremia—A kind of bacteremia where the bacteria enter the blood at various time intervals.

possible to detect microbial growth earlier. In addition, all CMBCS instruments have the detection system, incubator, and agitation unit in one unit.

Preparation

Ten ml (milliliter) of blood is usually needed for each blood culture bottle. First a healthcare worker locates a vein in the inner elbow region. The area of skin where the blood will be drawn must be disinfected to prevent any microorganisms on a person's skin from entering the blood culture bottle and contaminating it. The area is disinfected by wiping the area with alcohol in a circular fashion, starting with tiny circles at the spot where the needle will puncture the skin and enlarging the size of the circles while wiping away from the puncture site. The same pattern of wiping is repeated using an iodine or iodophor solution. The top of the bottle is disinfected using alcohol. After the person's skin has been disinfected, the healthcare worker draws the blood and about 10 ml of blood is injected into each blood culture bottle. The type of bottles used will vary based on whether the physician is looking for bacteria (aerobes or anaerobes), yeast, mold, or viruses.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

Normal results

Normal results will be negative. A single negative culture does not rule out a blood infection. False negatives can occur if the person was started on antibiotics before the blood was drawn, if the environment for growth was not right, the timing was off, or for some unknown reason the microorganism just didn't grow. Three negative cultures may be enough to rule out bacteremia in the case of endocarditis.

Abnormal results

The physician's skill in interpreting the culture results and assessing the person's clinical condition is essential in distinguishing a blood culture that is positive because of a true infection from a culture that is positive because it became contaminated. In true bacteremia, the patient's clinical condition should be consistent with a blood infection caused by the microorganism that was found. The microorganism is usually found in more than one culture, it usually grows soon after the bottles are incubated, and it is often the cause of an infection somewhere else in the person's body.

When the culture is positive because of contamination, the patient's clinical condition usually is not consistent with an infection from the identified microorganism. In addition, the microorganism is often one commonly found on skin, it rarely causes infection, it is found in only one bottle, and it may appear after several days of incubation. More than one microorganism often grow in contaminated cultures.

Resources

BOOKS

Warren, John R. "Sepsis." In *The Biologic and Clinical Basis of Infectious Diseases* Ed. Standford T. Shulman, et.al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Reimer, L. G., M. L. Wilson, and M. P. Weinstein. "Update on Detection of Bacteremia and Fungemia." *Clinical Microbiology Review* (July 1997): 444-465.

ORGANIZATIONS

American Society of Microbiology. 1752 N Street N.W., Washington, D.C. 20036. (202) 737-3600. <http://www.asmusa.org>.

Nancy J. Nordenson

Blood donation and registry

Definition

Blood donation refers to the process of collecting, testing, preparing, and storing blood and blood components. Donors are most commonly unpaid volunteers, but they may also be paid by commercial enterprises. Blood

registry refers to the collection and sharing of data about donated blood and ineligible donors.

Purpose

The purpose of the blood collection and distribution system is to help ensure an adequate supply of blood for accident victims, people needing surgery, and people suffering from certain diseases, as well as for medical research.

Sometimes, donors give blood specifically to benefit a particular person. People preparing for elective surgery may donate their own blood to be held and then returned to them during surgery. This is known as autologous blood donation. Directed donor blood has been donated by someone known to the intended recipient, such as a family member or friend.

Each year, more than four million Americans receive blood transfusions involving more than 26 million units of blood (one unit equals 450 milliliters, or about one pint), or an average of about 32,000 units per day. All of that blood must be collected, tested, prepared, stored, and delivered to the appropriate sites. Roughly eight million people in the United States donate blood each year; about half of the total amount needed is provided by the 36 regional blood centers of the American Red Cross.

Whole blood and the various blood components have many uses. Red blood cells, which carry oxygen, are used to treat anemia. Platelets, which play a role in controlling bleeding, are commonly used in the treatment of leukemia and other cancers. Fresh frozen plasma is also used to control bleeding in people deficient in certain clotting factors. Cryoprecipitated AHF, made from fresh frozen plasma, contains a few specific clotting factors.

Precautions

To ensure the safety of the blood supply, a multi-tiered process of donor screening and deferral is employed. This involves donor education, taking a detailed health history of each prospective donor, and giving potential donors a simple **physical examination** (which includes taking a few drops of blood to test for anemia). At any point in the process, a potential donor may be "deferred," or judged ineligible to donate blood. This deferral may be temporary or permanent, depending on the reason. Potential donors are also encouraged to "self-defer," or voluntarily decline to donate, rather than put future blood recipients at risk.

All donated blood is extensively tested before being used. The first step is determining the blood type, which indicates who can receive the blood. Receiving the wrong type of blood can cause **death**. Blood is also screened for any antibodies that could cause complications for recipients. In addition, blood is tested to screen out donors infected with the following diseases: **Hepatitis B** surface antigen ADD, hepatitis B core antibody, **hepatitis C** virus antibody, HIV-1 and HIV-2 antibody, HIV p24 antigen, HTLV-I and HTLV-II antibodies, and **syphilis**. Nucleic Acid Amplification testing is also performed, and other tests may be done if a doctor requests them.

In order to detect the greatest possible number of infections, these screening tests are extremely sensitive. For this reason, however, donors sometimes receive false positive test results. In these cases, more specific confirmatory tests are performed, to help rule out false positive results. Blood found to be abnormal is discarded, and all items coming into direct contact with donors are used only once and then discarded. Donors of infected blood are entered into the Donor Deferral Register, a confidential national data base used to prevent deferred people from donating blood.

In general, blood donors must be at least 17 years old (some states allow younger people to donate blood with their parents' consent), must weigh at least 110 pounds (50 kg), and must be in good health.

Many factors can temporarily or permanently disqualify potential donors. Most of them have to do with having engaged in behaviors that put them at risk of infection or having spent time in certain specified areas. Among these factors are having had a tattoo, having had sex with people in high-risk groups, having had certain diseases, and having been raped.

Description

There are eight different blood types in all—four ABO groups, each of which may be either Rh positive or Rh negative. These types, and their approximate distribution in the U.S. population, are as follows: O+ (38%), O- (7%), A+ (34%), A- (6%), B+ (9%), B- (2%), AB+ (3%), AB- (1%). In an emergency, anyone can safely receive type O red blood cells, and people with this blood type are known as "universal donors. " People with type AB blood, known as "universal recipients," can receive any type of red blood cells and can give plasma to all blood types.

Blood donations can be made in community blood centers, at hospitals or in bloodmobiles, which visit schools, churches and workplaces. The actual process of donating whole blood takes about 20 minutes. A sterile needle is inserted into a vein in the donor's arm. The blood flows through plastic tubing into a blood bag. Donors may be asked to clench their fist to encourage blood to flow. Usually, one unit of blood is collected. Afterward, donors are escorted to an observation area, given light refreshments, and allowed to rest.

KEY TERMS

Apheresis—Extraction of a specific component from donated blood, with the remainder returned to the donor.

Autologous donation—Blood donated for the donor's own use.

Granulocytes—White blood cells.

Plasma—The liquid part of blood.

Platelets—Tiny, disklike elements of plasma that promote clotting.

Plasma, the liquid portion of the blood in which red blood cells, platelets and other elements are suspended, is also collected, often by commercial enterprises that sell it to companies manufacturing clotting factors and other blood products. This is done using a process known as apheresis, in which whole blood is collected, the desired blood component is removed, and the remainder is returned to the donor. Collecting plasma generally takes one to two hours. Apheresis may also be used to collect other blood components, such as platelets and granulocytes.

Preparation

Once whole blood has been collected, it is sent to a lab for testing and processing. Most donated blood is separated into its constituent components, such as red blood cells, platelets, and cryoprecipitate. This enables more than one person to benefit from the same unit of donated blood.

Different blood components vary in how long they can be stored. Red blood cells can be refrigerated for up to 42 days or frozen for as much as 10 years. Platelets, stored at room temperature, may be kept for up to five days. Fresh frozen plasma and cryoprecipitated AHF can be kept for as much as one year.

Aftercare

It generally takes about 24 hours for the donor's body to replenish the lost fluid. Replacing the lost red blood cells, however, may take as much as two months. Whole blood donors must wait a minimum of eight weeks before donating again. Some states place further limits on the frequency and/or total number of times an individual may donate blood within a 12-month period.

Risks

Thanks to the use of a multi-tiered screening system and advances in the effectiveness of screening tests, the transmission of infectious diseases via **transfusion** has been significantly diminished. Nonetheless, there is still a minuscule risk that blood recipients could contract HIV, Hepatitis C, or other infections via transfusion. Other diseases that could conceivably be contracted in this way, or that are of particular concern to blood-collection agencies, include **babesiosis**, Chagas disease, HTLV-I and -II, **Creutzfeldt-Jakob disease**, cytomegalovirus, **Lyme disease**, **malaria**, and new variant Creutzfeldt-Jakob disease.

Autologous blood donors run a tiny risk of having the wrong blood returned to them due to clerical error. There is also a faint possibility of bacterial contamination of the autologous blood.

Normal results

For most donors, the process is quick and painless and they leave feeling fine. They may also find satisfaction in knowing that they have contributed to the nation's blood supply and may even have helped save lives.

Abnormal results

Most blood donors suffer no significant aftereffects. Occasionally, however, donors feel faint or dizzy, nauseous, and/or have **pain**, redness, or a bruise where the blood was taken. More serious complications, which rarely occur, include **fainting**, muscle spasms, and nerve damage.

Resources

BOOKS

Starr, Douglass. *Blood: An Epic History of Medicine and Commerce*. New York: Alfred A Knopf, 1998.

PERIODICALS

McKenna, C. "Blood Minded" *Nursing Times* (6 April 2000) : 27-28.

Wagner, H. "Umbilical Cord Blood Banking: Insurance Against Future Diseases?" *USA Today Magazine* (March 2000) : 59-61.

ORGANIZATIONS

American Association of Blood Banks. 8101 Glenbrook Road, Bethesda, MD 20814-2749. (301) 907-6977. <http://www.aabb.org>.

American Red Cross. 430 17th Street NW, Washington, D.C. 20006. <http://www.redcross.org>.

National Blood Data Resource Center. (301) 215-6506. <http://www.nbdrc.org>.

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Blood fluke infection *see* **Schistosomiasis**

Blood gas analysis

Definition

Blood gas analysis, also called arterial blood gas (ABG) analysis, is a test which measures the amounts of oxygen and carbon dioxide in the blood, as well as the acidity (pH) of the blood.

Purpose

An ABG analysis evaluates how effectively the lungs are delivering oxygen to the blood and how efficiently they are eliminating carbon dioxide from it. The test also indicates how well the lungs and kidneys are interacting to maintain normal blood pH (acid-base balance). Blood gas studies are usually done to assess respiratory disease and other conditions that may affect the lungs, and to manage patients receiving oxygen therapy (respiratory therapy). In addition, the acid-base component of the test provides information on kidney function.

Description

Blood gas analysis is performed on blood from an artery. It measures the partial pressures of oxygen and carbon dioxide in the blood, as well as oxygen content, oxygen saturation, bicarbonate content, and blood pH.

Oxygen in the lungs is carried to the tissues through the bloodstream, but only a small amount of this oxygen can actually dissolve in arterial blood. How much dissolves depends on the partial pressure of the oxygen (the pressure that the gas exerts on the walls of the arteries). Therefore, testing the partial pressure of oxygen is actually measuring how much oxygen the lungs are delivering to the blood. Carbon dioxide is released into the blood as a by-product of cell metabolism. The partial carbon dioxide pressure indicates how well the lungs are eliminating this carbon dioxide.

The remainder of oxygen that is not dissolved in the blood combines with hemoglobin, a protein—iron compound found in the red blood cells. The oxygen content measurement in an ABG analysis indicates how much oxygen is combined with the hemoglobin. A related value is the oxygen saturation, which compares the amount of oxygen actually combined with hemoglobin to the total amount of oxygen that the hemoglobin is capable of combining with.

Carbon dioxide dissolves more readily in the blood than oxygen does, primarily forming bicarbonate and smaller amounts of carbonic acid. When present in normal amounts, the ratio of carbonic acid to bicarbonate creates an acid-base balance in the blood, helping to keep the pH at a level where the body's cellular functions are most efficient. The lungs and kidneys both participate in maintaining the carbonic acid-bicarbonate balance. The lungs control the carbonic acid level and the kidneys regulate the bicarbonate. If either organ is not functioning properly, an acid-base imbalance can result. Determination of bicarbonate and pH levels, then, aids in diagnosing the cause of abnormal blood gas values.

A blood gas analyzer from Corning Corporation. *(Photograph by Hank Morgan, Photo Researchers, Inc. Reproduced by permission.)*

The procedure

The blood sample is obtained by arterial puncture (usually in the wrist, although it could be in the groin or arm) or from an arterial line already in place. If a puncture is needed, the skin over the artery is cleaned with an antiseptic. A technician then collects the blood with a small sterile needle attached to a disposable syringe. The patient may feel a brief throbbing or cramping at the site of the puncture. After the blood is drawn, the sample must be transported to the laboratory as soon as possible for analysis.

KEY TERMS

Acid-base balance—The condition that exists when the body's carbonic acid-bicarbonate buffer system is in equilibrium, helping to maintain the blood pH at a normal level of 7.35–7.45.

Hemoglobin—A protein-iron compound in red blood cells that functions primarily in carrying oxygen from the lungs to the tissues of the body.

pH—A measure of the acidity of a solution. Normal blood pH ranges from 7.35–7.45.

Preparation

There are no special preparations. Patients have no restrictions on drinking or eating before the test. If the patient is receiving oxygen, the oxygen concentration must remain the same for 20 minutes before the test; if the test is to be taken without oxygen, the gas must be turned off for 20 minutes before the test is taken. The patient should breathe normally during the test.

Aftercare

After the blood has been taken, the technician or the patient applies pressure to the puncture site for 10–15 minutes to stop the bleeding, and then places a dressing over the puncture.The patient should rest quietly while applying the pressure to the puncture site. Health care workers will observe the patient for signs of bleeding or circulation problems

Risks

Risks are very low when the test is done correctly. Risks include bleeding or bruising at the site, or delayed bleeding from the site. Very rarely, there may be a problem with circulation in the puncture area.

Normal results

Normal blood gas values are as follows:

- partial pressure of oxygen (PaO_2): 75–100 mm Hg
- partial pressure of carbon dioxide ($PaCO_2$): 35–45 mm Hg
- oxygen content (O_2CT): 15–23%
- oxygen saturation (SaO_2): 94–100%
- bicarbonate (HCO_3): 22–26 mEq/liter
- pH: 7.35–7.45

Abnormal results

Values that differ from those listed above may indicate respiratory, metabolic, or kidney disease. These results also may be abnormal if the patient has experienced trauma that may affect breathing (especially head and neck injuries). Disorders, such as anemia, that affect the oxygen-carrying capacity of blood, can produce an abnormally low oxygen content value.

Resources

BOOKS

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

Thompson, June, et al. *Mosby's Clinical Nursing*. 4th ed. St. Louis: Mosby, 1997.

Carol A. Turkington

Blood poisoning *see* **Acute lymphangitis**

Blood registry *see* **Blood donation and registry**

Blood removal *see* **Phlebotomy**

Blood sugar tests

Definition

Blood sugar tests include several different tests that measure the amount of sugar (glucose) in a person's blood. These tests are done either on an empty stomach, or after consuming a meal or premeasured glucose drink. Blood sugar tests are done primarily to diagnose and evaluate a person with **diabetes mellitus**.

Purpose

The body uses sugar, also called glucose, to supply the energy it needs to function. People get sugar from their diet and from their body tissues. Insulin is made by the pancreas and affects the outer membrane of cells, making it easy for glucose to move from the blood into the cells. When insulin is active, blood glucose levels fall. Sugar from body tissues is stored in the form of glycogen. When glycogen is active, blood glucose levels rise.

After a meal, blood glucose levels rise sharply. The pancreas responds by releasing enough insulin to take care of all the newly added sugar found in the body. The insulin moves the sugar out of the blood and into the cells. Only then does the blood sugar start to level off and

begin to fall. A person with diabetes mellitus either does not make enough insulin, or makes insulin that does not work properly. The result is blood sugar that remains high, a condition called hyperglycemia.

Diabetes must be diagnosed as early as possible. If left untreated, it can damage or cause failure of the eyes, kidneys, nerves, heart, blood vessels, and other body organs. **Hypoglycemia**, or low blood sugar, may also be discovered through blood sugar testing. Hypoglycemia is caused by various hormone disorders and liver disease, as well as by too much insulin.

Description

There are a variety of ways to measure a person's blood sugar.

Whole blood glucose test

Whole blood glucose testing can be performed by a person in his or her home, and kits are available for this purpose. The person pricks his or her finger (a finger stick) with a sterile sharp blade from the kit. A single drop of blood is placed on a strip in a portable instrument called a glucometer. The glucometer quickly determines the blood sugar and shows the results on a small screen in usually a few seconds.

Fasting plasma glucose test

The fasting plasma glucose test is done on an empty stomach. For the eight hours before the test, the person must fast (nothing to eat or drink, except water). The person's blood is drawn from a vein by a healthcare worker. The blood sample is collected into a tube containing an anticoagulant. Anticoagulants stop the blood from clotting. In the laboratory, the tube of blood spins at high speed within a machine called a centrifuge. The blood cells sink to the bottom and the liquid stays on the top. This straw-colored liquid on the top is the plasma. To measure the glucose, a person's plasma is combined with other substances. From the resulting reaction, the amount of glucose in the plasma is determined.

Oral glucose tolerance test

The oral glucose tolerance test is done to see how well the body handles a standard amount of glucose. This test measures the amount of glucose in a person's plasma before and two hours after drinking a large premeasured beverage containing glucose. The person must eat a consistent diet, containing at least 5.25oz (150 g) of carbohydrates each day, for three days before this test. For eight hours before the test, the person must fast. A healthcare provider draws the first sample of blood at the end of the fast to determine the glucose level at the start of the test. The healthcare provider then gives the person a beverage containing 2.6 oz (75 g) of glucose. Two hours later, the person's blood is drawn again. These blood samples are centrifuged and processed in the laboratory. A doctor can then compare the before and after glucose levels to see how well the body processed the sugar.

Two-hour postprandial blood glucose test

The two-hour postprandial blood glucose test measures the amount of glucose in plasma after a person eats a specific meal containing a certain amount of sugar. Although the meal follows a predetermined menu, it is difficult to control many factors associated with this testing method.

Blood sugar tests can be used in a variety of situations including:

- Testing people suspected for diabetes. The American Diabetic Association (ADA) recommends that either a fasting plasma glucose test or an oral glucose tolerance test be used to diagnose diabetes. If the person already has symptoms of diabetes, a blood glucose test without fasting (called a casual plasma glucose test) may be done. If the test result is abnormal, it must be confirmed with another test performed on another day. The two tests can be different or they can be the same, but they must be done on different days. If the second test is also abnormal, the person has diabetes. A two-hour postprandial test is not recommended by the ADA as a test to use for the diagnosis of diabetes. A doctor may order this test, and follow it with the oral glucose tolerance test or the fasting plasma glucose test if the results are abnormal.
- Testing pregnant women. Diabetes that occurs during **pregnancy** (**gestational diabetes**) is dangerous for both the mother and the baby. Women who may be at risk are screened when they are 24-28 weeks pregnant. A woman is considered at risk if she is older than 25 years, is not at her normal body weight, has a parent or sibling with diabetes, or if she is in an ethnic group that has a high rate of diabetes (Hispanics, Native Americans, Asians, African Americans). The blood sugar test to screen for gestational diabetes is a variation of the oral glucose tolerance test. Fasting is not required. If the result is abnormal, a more complete test is done on another day.
- Testing healthy people. Healthy people without symptoms of diabetes should be screened for diabetes when they are 45 years old and again every three years. Either the fasting plasma glucose or oral glucose tolerance test is used for screening. People in high risk groups should be tested before the age of 45 and tested more frequently.

- Testing of people already diagnosed with diabetes. The ADA recommends that a person with diabetes keep the amount of glucose in the blood at a normal level as much as possible. This can be done by the diabetic person testing his or her own blood at home one or more times a day.

Preparation

Each blood sugar test that uses plasma requires a 5 mL blood sample. A healthcare worker ties a tight band (tourniquet) on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

When fasting is required, the person should have nothing to eat or drink (except water) for eight hours before the test and until the test or series of tests is completed. The person should not smoke before or during the testing period because this can temporarily increase the amount of glucose in the blood. Other factors that can cause inaccurate results are a change in diet before the test, illness or surgery two weeks before the test, certain drugs, and extended bed rest. The doctor may tell a person on insulin or taking pills for diabetes to stop the medication until after the test.

Aftercare

After the test or series of tests is completed (and with the approval of his or her doctor), the person should eat, drink, and take any medications that were stopped for the test.

The patient may feel discomfort when blood is drawn from a vein. Bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Risks

If the person experiences any weakness, **fainting**, sweating, or any other unusual reaction while fasting or during the test, he or she should immediately tell the person giving the test.

Normal results

Normal results are:

- fasting plasma glucose test less than 120 mg/dL
- oral glucose tolerance test, 2 hours less than 140 mg/dL

For the diabetic person, the ADA recommends an ongoing blood sugar goal of less than or equal to 120 mg/dL.

Abnormal results

These abnormal results indicate diabetes and must be confirmed with repeat testing:

- fasting plasma glucose test less than or equal to 126 mg/dL
- oral glucose tolerance test, 2 hours less than or equal to 200 mg/dL
- casual plasma glucose test (nonfasting, with symptoms) less than or equal to 200 mg/dL
- gestational oral glucose tolerance test, 1 hour less than or equal to 140 mg/dL

Brain damage can occur from glucose levels below 40 mg/dL and **coma** from levels above 470 mg/dL.

Other hormone disorders can cause both hyperglycemia and hypoglycemia. Abnormal results must be interpreted by a doctor who is aware of the person's medical condition and medical history.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

American Diabetes Association. "Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus." *Diabetes Care* 20, no, 7(July 997): 1183-1197.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Diabetes Information Clearinghouse. 1 Information Way, Bethesda, MD 20892-3560. (800) 860-8747. <http://www.niddk.nih.gov/health/diabetes/ndic.htm>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

Nancy J. Nordenson

Blood thinners *see* **Anticoagulant and antiplatelet drugs**

Blood transfusion *see* **Transfusion**

Blood typing and crossmatching

Definition

Blood typing is a laboratory test done to determine a person's blood type. If the person needs a blood **transfusion**, another test called crossmatching is done after the blood is typed to find blood from a donor that the person's body will accept.

Purpose

Blood typing and crossmatching are most commonly done to make certain that a person who needs a transfusion will receive blood that matches (is compatible with) his own. People must receive blood of the same blood type, otherwise, a serious, even fatal, transfusion reaction can occur.

Parents who are expecting a baby have their blood typed to diagnose and prevent hemolytic disease of the newborn (HDN), a type of anemia also known as **erythroblastosis fetalis**. Babies who have a blood type different from their mothers are at risk for developing this disease. The disease is serious with certain blood type differences, but is milder with others.

A child inherits factors or genes from each parent that determine his blood type. This fact makes blood typing useful in paternity testing. To determine whether or not the alleged father could be the true father, the blood types of the child, mother, and alleged father are compared.

Legal investigations may require typing of blood or other body fluids, such as semen or saliva, to identify persons involved in crimes or other legal matters.

Description

Blood typing and crossmatching tests are performed in a blood bank laboratory by technologists trained in blood bank and transfusion services. The tests are done on blood, after it has separated into cells and serum (serum is the yellow liquid left after the blood clots.) Costs for both tests are covered by insurance when the tests are determined to be medically necessary.

Blood bank laboratories are usually located in facilities, such as those operated by the American Red Cross, that collect, process, and supply blood that is donated, as well as in facilities, such as most hospitals, that prepare blood for transfusion. These laboratories are regulated by the United States Food and Drug Administration (FDA) and are often inspected and accredited by a professional association such as the American Association of Blood Banks (AABB).

Blood typing and crossmatching tests are based on the reaction between antigens and antibodies. An antigen can be anything that causes the body to launch an attack, known as an immune response, against it. The attack begins when the body builds a special protein, called an antibody, that is uniquely designed to attack and make ineffective (neutralize) the specific antigen that caused the attack. A person's body normally doesn't make antibodies against its own antigens, only against antigens that are foreign to it.

A person's body contains many antigens. The antigens found on the surface of red blood cells are important because they determine a person's blood type. When red blood cells having a certain blood type antigen are mixed with serum containing antibodies against that antigen, the antibodies attack and stick to the antigen. In a test tube, this reaction is observed as the formation of clumps of cells (clumping).

When blood is typed, a person's cells and serum are mixed in a test tube with commercially-prepared serum and cells. Clumping tells which antigens or antibodies are present and reveals the person's blood type. When blood is crossmatched, patient serum is mixed with cells from donated blood that might be used for transfusion. Clumping or lack of clumping in the test tube tells whether or not the blood is compatible.

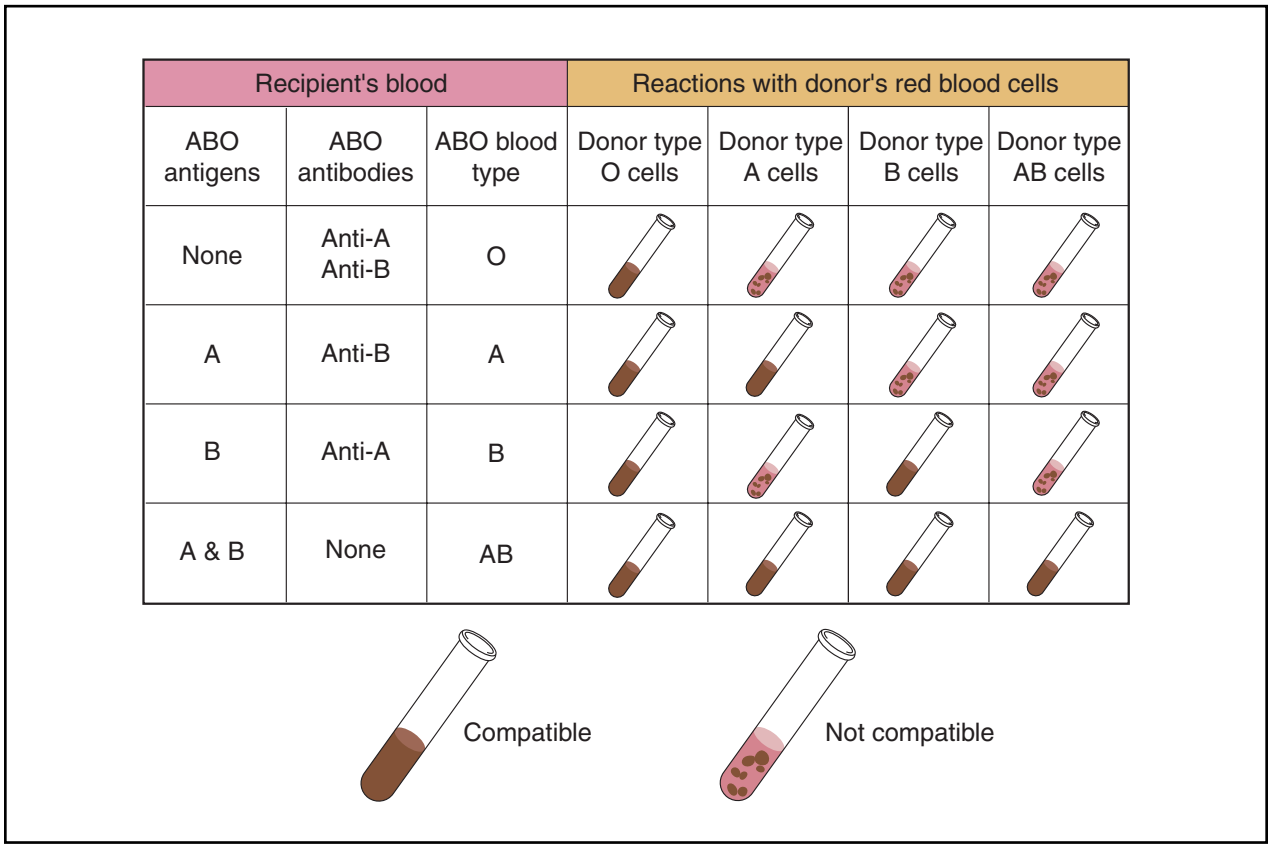
Although there are over 600 known red blood cell antigens, organized into 22 blood group systems, routine blood typing and crossmatching is usually concerned with only two systems: the ABO and Rh blood group systems.

Blood typing

ABO BLOOD GROUP SYSTEM. In 1901, Karl Landsteiner, an Austrian pathologist, randomly combined the serum and red blood cells of his colleagues. From the reactions he observed in test tubes, he discovered the ABO blood group system. This discovery earned him the 1930 Nobel Prize in Medicine.

A person's ABO blood type—A, B, AB, or O—is based on the presence or absence of the A and B antigens on his red blood cells. The A blood type has only the A antigen and the B blood type has only the B antigen. The AB blood type has both A and B antigens, and the O blood type has neither A nor B antigen.

By the time a person is six months old, he naturally will have developed antibodies against the antigens his red blood cells lack. That is, a person with A blood type will have anti-B antibodies, and a person with B blood



Blood typing is a laboratory test done to discover a person's blood type. If the person needs a blood transfusion, crossmatching is done following blood typing to locate donor blood that the person's body will accept. *(Illustration by Electronic Illustrators Group.)*

type will have anti-A antibodies. A person with AB blood type will have neither antibody, but a person with O blood type will have both anti-A and anti-B antibodies. Although the distribution of each of the four ABO blood types varies between racial groups, O is the most common and AB is the least common.

ABO typing is the first test done on blood when it is tested for transfusion. A person must receive ABO-matched blood. ABO incompatibilities are the major cause of fatal transfusion reactions. ABO antigens are also found on most body organs, so ABO compatibility is also important for organ transplants.

An ABO incompatibility between a pregnant woman and her baby is a minor cause of HDN and usually causes no problem for the baby. The structure of ABO antibodies makes it unlikely they will cross the placenta to attack the baby's red blood cells.

Paternity testing compares the ABO blood types of the child, mother, and alleged father. The alleged father can't be the true father if the child's blood type requires a gene that neither he nor the mother have. For example, a child with blood type B whose mother has blood type O, requires a father with either AB or B blood type; a man with blood type O cannot be the true father.

In some people, ABO antigens can be found in body fluids other than blood, such as saliva and semen. ABO typing of these fluids provides clues in legal investigations.

RH BLOOD GROUP SYSTEM. The Rh, or Rhesus, system was first detected in 1940 by Landsteiner and Wiener when they injected blood from rhesus monkeys into guinea pigs and rabbits. More than 50 antigens have since been discovered belonging to this system, making it the most complex red blood cell antigen system.

In routine blood typing and crossmatching tests, only one of these 50 antigens, the D antigen, also known as the Rh factor or Rh_o[D], is tested for. If the D antigen is present, that person is Rh-positive; if the D antigen is absent, that person is Rh-negative.

Other important antigens in the Rh system are C, c, E, and e. These antigens are not usually tested for in routine blood typing tests. However, testing for the presence of these antigens is useful in paternity testing, and when a technologist tries to identify unexpected Rh antibodies

KEY TERMS

ABO blood type—Blood type based on the presence or absence of the A and B antigens on the red blood cells.

Antibody—A special protein made by the body as a defense against foreign material that enters the body. It is uniquely designed to attack and neutralize the specific antigen that triggered the immune response.

Antigen—Anything that causes the body to launch an immune response against that antigen through the production of antibodies.

Blood bank—A laboratory that specializes in blood typing, antibody identification, and transfusion services.

Blood type—Blood categories based on the presence or absence of certain antigens on the red blood cells.

Crossmatch—A laboratory test done to confirm that blood from a donor and blood from the recipient are compatible.

Gene—A piece of DNA, located on a chromosome, that determines how traits such as blood type are inherited and expressed.

Immune response—The body's attack against an antigen that it considers foreign to itself. The attack begins with the production of antibodies against the antigen.

Rh blood type—Blood type based on the presence or absence of the D antigen on the red blood cells.

Transfusion—The therapeutic introduction of blood or a blood component into a patient's bloodstream.

or find matching blood for a person with antibodies to one or more of these antigens.

Unlike the ABO system, antibodies to Rh antigens don't develop naturally. They develop only as an immune response after a transfusion or during **pregnancy**.

The incidence of the Rh blood types varies between racial groups, but not as widely as the ABO blood types: 85% of whites and 90% of blacks are Rh-positive; 15% of whites and 10% of blacks are Rh-negative.

In transfusions, the Rh system is next in importance after the ABO system. Most Rh-negative people who receive Rh-positive blood will develop anti-D antibodies. A later transfusion of Rh-positive blood could result in a severe or fatal transfusion reaction.

Rh incompatibility is the most common and severe cause of HDN. This incompatibility can happen when an Rh-negative woman and an Rh-positive man produce an Rh-positive baby. Cells from the baby can cross the placenta and enter the mother's bloodstream, causing the mother to make anti-D antibodies. Unlike ABO antibodies, the structure of anti-D antibodies makes it likely that they will cross the placenta and enter the baby's bloodstream. There, they can destroy the baby's red blood cells, causing severe or fatal anemia.

The first step in preventing HDN is to find out the Rh types of the expectant parents. If the mother is Rh-negative and the father is Rh-positive, the baby is at risk for developing HDN. The next step is to test the mother's serum to make sure she doesn't already have anti-D antibodies from a previous pregnancy or transfusion. This procedure is similar to blood typing. Finally, the Rh-negative mother is given an injection of Rh Immunoglobulin (RhIg) at 28 weeks of gestation and again after delivery, if the baby is Rh positive. The RhIg attaches to any Rh-positive cells from the baby in the mother's bloodstream, preventing them from triggering anti-D antibody production in the mother. An Rh-negative woman should also receive RhIg following a **miscarriage**, abortion, or **ectopic pregnancy**.

OTHER BLOOD GROUP SYSTEMS. Several other blood group systems may be involved in HDN and transfusion reactions, although they are much less frequent than ABO and Rh. They are the Duffy, Kell, Kidd, MNS, and P systems. Tests for antigens from these systems are not included in routine blood typing, but they are commonly used in paternity testing.

Like Rh antibodies, antibodies in these systems do not develop naturally, but as an immune response after transfusion or during pregnancy. An antibody screening test is done before a crossmatch to check for unexpected antibodies to antigens in these systems. A person's serum is mixed in a test tube with commercially-prepared cells containing antigens from these systems. If clumping occurs, the antibody is identified.

Crossmatching

Crossmatching is the final step in pretransfusion testing. It is commonly referred to as compatibility testing, or "Type and Cross."

Before blood from a donor and the recipient are crossmatched, both are ABO and Rh typed. In addition, antibody screening is done to look for antibodies to certain Rh, Duffy, MNS, Kell, Kidd, and P system antigens. If an antibody to one of these antigens is found, only blood without that antigen will be compatible in a crossmatch. This sequence must be repeated before each transfusion a person receives.

To begin the crossmatch, blood from a donor with the same ABO and Rh type as the rcipient is selected. In a test tube, serum from the patient is mixed with red blood cells from the donor. If clumping occurs, the blood is not compatible; if clumping does not occur, the blood is compatible. If an unexpected antibody is found in either the patient or the donor, the blood bank does further testing to make sure the blood is compatible.

In an emergency, when there is not enough time for blood typing and crossmatching, O red blood cells may be given, preferably Rh-negative. O blood type is called the universal donor because it has no ABO antigens for a patient's antibodies to attack. In contrast, AB blood type is called the universal recipient because it has no ABO antibodies to attack the antigens on transfused red blood cells. If there is time for blood typing, red blood cells of the recipient type (type specific cells) are given. In either case, the crossmatch is continued, even though the transfusion has begun.

Preparation

To collect the 10 mL blood needed for these tests, a healthcare worker ties a tourniquet above the patient's elbow, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Blood typing and crossmatching must be done three days or less before a transfusion. A person doesn't need to change diet, medications, or activities before these tests. He should tell his healthcare provider if, during the last three months, he has received a blood transfusion or a plasma substitute, or has had a radiology procedure using intravenous contrast media. These can give false clumping reactions in both typing and crossmatching tests.

Aftercare

The possible side effects of any blood collection are discomfort or bruising at the site where the needle punctured the skin, as well as **dizziness** or **fainting**. Bruising is reduced if pressure is applied with a finger to the puncture site until the bleeding stops. Discomfort is treated with warm packs to the puncture site.

Risks

There are no risks from the blood collection or test procedures. Blood transfusions always have the risk of an unexpected transfusion reaction. A nurse watches a patient for signs of a reaction during the entire transfusion.

Normal results

There is no normal blood type. The desired result of a crossmatch is that compatible donor blood is found. Compatibility testing procedures are designed to provide the safest blood product possible for the recipient, but a compatible crossmatch is no guarantee that an unexpected adverse reaction will not appear during the transfusion.

Abnormal results

Except in an emergency, a person cannot receive a transfusion without a compatible crossmatch result.

Resources

BOOKS

American Association of Blood Banks. *Technical Manual.* 12th ed. Bethesda: American Association of Blood Banks, 1996.

Boral, Leonard I., and John B. Henry. "Transfusion Medicine." In *Clinical Diagnosis and Management by Laboratory Methods.* 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

Daniels, Geoff. *Human Blood Groups.* Oxford: Blackwell, 1995.

Harmening, Denise M. *Modern Blood Banking and Transfusion Practices.* 3rd ed. Philadelphia: F. A. Davis, 1994.

Henry, John B., and Wendy V. Beadling. "Immunohematology." In *Clinical Diagnosis and Management by Laboratory Methods.* 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

Silberstein, Leslie E., ed. *Molecular and Functional Aspects of Blood Group Antigens.* Bethesda: American Association of Blood Banks, 1995.

PERIODICALS

Beck, Malcolm L., and Lowell L. Tilzer. "Red Cell Compatibility Testing: A Perspective for the Future." *Transfusion Medical Reviews* (Apr. 1996): 118-130.

Widman, Frances. "Early Observations about the ABO Blood Groups." *Transfusion* (June 1997): 665-667.

ORGANIZATIONS

American Association of Blood Banks. 8101 Glenbrook Road, Bethesda, MD 20814. (301) 907-6977. <http://www.aabb.org>.

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

American Red Cross Blood Services. 430 17th Street NW, Washington, DC 20006. (202) 737-8300. <http://www.redcross.org>.

Nancy J. Nordenson

Blood urea nitrogen test

Definition

The blood urea nitrogen (BUN) test measures the level of urea nitrogen in a sample of the patient's blood. Urea is a substance that is formed in the liver when the body breaks down protein. Urea then circulates in the blood in the form of urea nitrogen. In healthy people, most urea nitrogen is filtered out by the kidneys and leaves the body in the urine. If the patient's kidneys are not functioning properly or if the body is using large amounts of protein, the BUN level will rise. If the patient has severe liver disease, the BUN will drop.

Purpose

The BUN level may be checked in order to assess or monitor:

- the presence or progression of kidney or liver disease.
- blockage of urine flow.
- mental confusion. Patients with kidney failure are sometimes disoriented and confused.
- abnormal loss of water from the body (**dehydration**).
- recovery from severe **burns**. The body uses larger than normal amounts of protein following serious burns.

Description

The BUN test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

Preparation

The doctor should check to make sure that the patient is not taking any medications that can affect BUN results. These drugs include the **antibiotics** chloramphenicol, streptomycin, amphotericin B, methicillin, gentamicin, tobramycin, and kanamycin, as well as **diuretics** and **corticosteroids**.

The patient should be advised not to eat large amounts of meat the day before the test.

Aftercare

Aftercare consists of routine care of the area around the venipuncture.

Risks

The primary risk is the possibility of a bruise or swelling in the area of the venipuncture. The patient can apply moist warm compresses.

KEY TERMS

Urea—A compound containing nitrogen that occurs in the urine and other body fluids as a result of protein metabolism.

Normal results

Normal BUN levels are 5-18 mg/dL for children; 7-18 mg/dL for adults; and 8-20 mg/dL in the elderly.

Abnormal results

BUN levels can be too low as well as too high.

Abnormally low BUN

Low levels of BUN may indicate **overhydration**, **malnutrition**, **celiac disease** [a disease characterized by the inability ot tolerate foods containing wheat protein (gluten)], liver damage or disease, or use of corticosteroids. Low BUN may also occur in early **pregnancy**.

Abnormally high BUN

High levels of BUN may indicate kidney disease or failure; blockage of the urinary tract by a kidney stone or tumor; a **heart attack** or congestive **heart failure**; dehydration; **fever**; **shock**; or bleeding in the digestive tract. High BUN levels can sometimes occur during late pregnancy or result from eating large amounts of protein-rich foods. A BUN level higher than 100 mg/dL points to severe kidney damage.

Resources

BOOKS

Everything You Need to Know About Medical Tests. Ed. Michael Shaw, et al. Springhouse, PA: Springhouse Corporation, 1996.

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Sobel, David S., and Tom Ferguson. *The People's Book of Medical Tests*. New York: Summit Books, 1985.

Rebecca J. Frey

Blood vessel scan *see* **Doppler ultrasonography**

Body lice *see* **Lice infestation**

Boils

Definition

Boils and carbuncles are bacterial infections of hair follicles and surrounding skin that form pustules (small blister-like swellings containing pus) around the follicle. Boils are sometimes called furuncles. A carbuncle is formed when several furuncles merge to form a single deep **abscess** with several heads or drainage points.

Description

Boils and carbuncles are firm reddish swellings about 0.2-0.4 in (5-10 mm) across that are slightly raised above the skin surface. They are sore to the touch. A boil usually has a visible central core of pus; a carbuncle is larger and has several visible heads. Boils occur most commonly on the face, back of the neck, buttocks, upper legs and groin area, armpits, and upper torso. Carbuncles are less common than single boils; they are most likely to form at the back of the neck. Males are more likely to develop carbuncles.

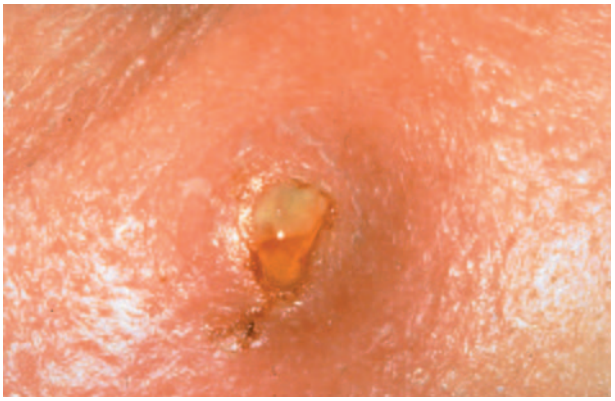
Boils and carbuncles are common problems in the general population, particularly among adolescents and adults. People who are more likely to develop these skin infections include those with:

- diabetes, especially when treated by injected insulin
- alcoholism or drug abuse
- poor personal hygiene
- crowded living arrangements
- jobs or hobbies that expose them to greasy or oily substances, especially petroleum products
- allergies or immune system disorders, including HIV infection.
- family members with recurrent skin infections

Causes and symptoms

Boils and carbuncles are caused by *Staphylococcus aureus*, a bacterium that causes an infection in an oil gland or hair follicle. Although the surface of human skin is usually resistant to bacterial infection, *S. aureus* can enter through a break in the skin surface—including breaks caused by needle punctures for insulin or drug injections. Hair follicles that are blocked by greasy creams, petroleum jelly, or similar products are more vulnerable to infection. Bacterial skin infections can be spread by shared cosmetics or washcloths, close human contact, or by contact with pus from a boil or carbuncle.

As the infection develops, an area of inflamed tissue gradually forms a pus-filled swelling or pimple that is painful to touch. As the boil matures, it forms a yellowish head or point. It may either continue to swell until the point bursts open and allows the pus to drain, or it may be gradually reabsorbed into the skin. It takes between one and two weeks for a boil to heal completely after it comes to a head and discharges pus. The bacteria that cause the boil can spread into other areas of the skin or even into the bloodstream if the skin around the boil is injured by squeezing. If the infection spreads, the patient will usually develop chills and **fever**, swollen lymph nodes (**lymphadenitis**), and red lines in the skin running outward from the boil.



Boils often occur from a bacterial infection in a hair follicle or skin gland. *(Custom Medical Stock Photo. Reproduced by permission.)*

Furunculosis is a word that is sometimes used to refer to recurrent boils. Many patients have repeated episodes of furunculosis that are difficult to treat because their nasal passages carry colonies of *S. aureus*. These bacterial colonies make it easy for the patient's skin to be reinfected. They are most likely to develop in patients with diabetes, HIV infection, or other immune system disorders.

Carbuncles are formed when the bacteria infect several hair follicles that are close together. Carbunculosis is a word that is sometimes used to refer to the development of carbuncles. The abscesses spread until they merge with each other to form a single large area of infected skin with several pus-filled heads. Patients with carbuncles may also have a low-grade fever or feel generally unwell.

Diagnosis

The diagnosis of boils and carbuncles is usually made by the patient's primary care doctor on the basis of visual examination of the skin. In some cases involving recurrent boils on the face, the doctor may need to consider **acne** as a possible diagnosis, but for the most part

boils and carbuncles are not difficult to distinguish from other skin disorders.

S. aureus can easily be cultured in the laboratory if the doctor needs to rule out inclusion cysts or deep fungal infections that gardeners sometimes get. The doctor can make a culture from pus taken from the boil or carbuncle to confirm the diagnosis of a staphylococcal infection. He or she can also culture the patient's nasal discharge to test for the presence of a *S. aureus* colony.

Treatment

Patient and family education

Patient education is an important part of the treatment of boils and carbuncles. Patients need to be warned against picking at or squeezing boils because of the danger of spreading the infection into other parts of the skin or bloodstream. It is especially important to avoid squeezing boils around the mouth or nose because infections in these areas can be carried to the brain. Patients should also be advised about keeping the skin clean, washing their hands carefully before and after touching the boil or carbuncle, avoiding the use of greasy cosmetics or creams, and keeping their towels and washcloths separate from those of other family members. Some doctors may recommend an antiseptic soap or gel for washing the infected areas.

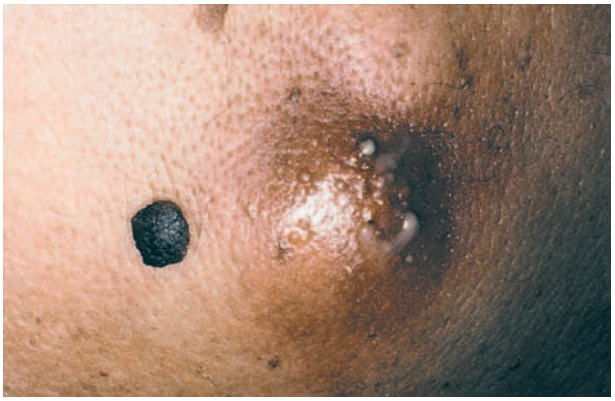
If the patient has had several episodes of furunculosis, the doctor may examine family members or close contacts to see if they are carriers of *S. aureus*. In many cases they also need treatment for boils or carbuncles. Skin infections and reinfections involving small groups or clusters of people are being reported more frequently in the United States.

Medications

Boils are usually treated with application of antibiotic creams—usually clindamycin or polymyxin—following the application of hot compresses. The compresses help the infection to come to a head and drain.

Carbuncles and furunculosis are usually treated with oral **antibiotics** as well as antibiotic creams or ointments. The specific medications that are given are usually dicloxacillin (Dynapen) or cephalexin (Keflex). Erythromycin may be given to patients who are allergic to penicillin. The usual course of oral antibiotics is 5-10 days; however, patients with recurrent furunculosis may be given oral antibiotics for longer periods. Furunculosis is treated with a combination of dicloxacillin and rifampin (Rifadin).

Patients with bacterial colonies in their nasal passages are often given mupirocin (Bactroban) to apply directly to the lining of the nose.



A close-up view of a carbuncle on person's back. *(Photograph by John Watney, Photo Researchers, Inc. Reproduced by permission.)*

Surgical treatment

Boils and carbuncles that are very large, or that are not draining, may be opened with a sterile needle or surgical knife to allow the pus to drain. The doctor will usually give the patient a local anesthetic if a knife is used; surgical treatment of boils is painful and usually leaves noticeable scars.

Alternative treatment

Naturopathic therapy

Naturopathic practitioners usually recommend changes in the patient's diet as well as applying herbal poultices to the infected area. The addition of zinc supplements and vitamin A to the diet is reported to be effective in treating boils. The application of a paste or poultice containing goldenseal (*Hydrastis canadensis*) root is recommended by naturopaths on the grounds that goldenseal helps to kill bacteria and reduce inflammation.

Homeopathy

Homeopaths maintain that taking the proper homeopathic medication in the first stages of a boil or carbuncle will bring about early resolution of the infection and prevent pus formation. The most likely choices are *Belladonna* or *Hepar sulphuris*. If the boil has already formed, *Mercurius vivus* or *Silica* may be recommended to bring the pus to a head.

Western herbal therapies

A variety of herbal remedies can be applied topically to boils to fight infection. These include essential oils of bergamot (*Citrus bergamia*), chamomile (*Matri-*

KEY TERMS

Abscess—A localized collection of pus in the skin or other body tissue.

Carbuncle—A large, deep skin abscess formed by a group or cluster of boils.

Follicle—The small sac at the base of a hair shaft. The follicle lies below the skin surface.

Furunculosis—A condition in which the patient suffers from recurrent episodes of boils.

Pustule—A small raised pimple or blister-like swelling of the skin that contains pus.

caria recutita), lavender (*Lavandula officinalis*), and sage (*Salvia officinalis*), as well as tea tree oil (*Melaleuca* spp.). Herbalists also recommend washing the skin with a mixture of goldenseal and witch hazel. To fight the inflammation associated with boils, herbalists suggest marsh mallow (*Althaea officinalis*) ointment, tinctures (herbal solutions made with alcohol) of blue flag (*Iris versicolor*) or myrrh (*Commiphora molmol*), and slippery elm (*Ulmus fulva*) made into a poultice.

Prognosis

The prognosis for most boils is excellent. Some patients, however, suffer from recurrent carbuncles or furunculosis. In addition, although the spread of infection from boils is relatively unusual, there have been deaths reported from brain infections caused by squeezing boils on the upper lip or in the tissue folds at the base of the nose.

Prevention

There are some precautions that people can take to minimize the risk of developing bacterial skin infections:

- cleanse skin properly with soap and water, and take showers rather than tub baths
- do not share washcloths, towels, or facial cosmetics with others
- cut down on greasy or fatty foods and snacks
- always wash hands before touching the face
- consider using antiseptic soaps and shower gels
- consult a doctor if furunculosis is a persistent problem—it may indicate an underlying disease such as diabetes

Resources

BOOKS

Berger, Timothy G. "Skin and Appendages." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

"Folliculitis, Furunculosis, and Carbunculosis." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Hacker, Steven M. "Common Bacterial and Fungal Infections of the Integument." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Rasmussen, James E. "Bacterial Infections of the Skin." In *Conn's Current Therapy, 1996*, Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Turkington, Carol A., and Jeffrey S. Dover. *Skin Deep: An A-Z of Skin Disorders, Treatments, and Health*. New York: Facts On File, 1996.

Rebecca J. Frey

Bone biopsy

Definition

Bone biopsy is the removal of a piece of bone for laboratory examination and analysis.

Purpose

Bone biopsy is used to distinguish between malignant tumors and benign bone disease such as **osteoporosis** and **osteomyelitis**. This test may be ordered to determine why a patient's bones ache or feel sore, or when a mass or deformity is found on an x ray, CT scan, bone scan, or other diagnostic imaging procedure.

Precautions

The patient's doctor and the surgeon who performs the bone biopsy must be told about any prescription and over-the-counter medications the patient is taking, and about **allergies** or reactions the patient has had to anesthetics or **pain** relievers. Special care must be taken with patients who have experienced bleeding problems.

Description

A bone biopsy involves using a special drill or other surgical instruments to remove bone from the patient's body. The procedure usually lasts about 30 minutes and may be performed in the hospital, a doctor's office, or a surgical center.

A drill biopsy is generally used to obtain a small specimen. After the skin covering the bone has been cleansed with an antiseptic and shaved, the patient is given a local anesthetic. The doctor will not begin the procedure until the anesthetic has numbed the area from which the bone is to be removed, but the patient may feel pressure or mild pain when the needle pierces the bone. The surgeon turns the needle in a half-circle to extract a sample from the core, or innermost part, of the bone. The sample is drawn into the hollow stem of the biopsy needle. The sample is then sent to a laboratory, where it is examined under a microscope.

An open biopsy is used when a larger specimen is needed. After the area covering the bone has been cleansed with an antiseptic and shaved, the patient is given a general anesthetic. After the anesthetic takes effect and the patient is unconscious, the surgeon makes an incision and removes a bone specimen. The specimen is sent to the laboratory for immediate analysis. Results of that analysis may indicate that additional surgery should be performed right away.

Preparation

No special preparation is needed for a drill biopsy, but a patient must fast for at least 12 hours before an open biopsy.

Aftercare

Pain medication will be prescribed after a biopsy, and vital signs will be monitored until they return to normal. Most patients can go home in about an hour. If bone was removed from the spine, the patient may stay in the hospital overnight. The surgical site must be kept clean and dry for 48 hours, and the patient's doctor should be notified if any of these symptoms appear:

- fever
- headache
- pain on movement
- inflammation or pus near the biopsy site
- bleeding through the bandage at the biopsy site

Risks

Risks include bone fracture, injury to nearby tissue, and infection. Bleeding is a rare complication. Factors that increase risk include:

- stress
- obesity
- poor **nutrition**
- chronic illness
- some medications
- mind-altering drugs

KEY TERMS

Biopsy—Removal and examination of tissue to determine if cancer is present.

Osteomyelitis—An infection of the bone that is usually treated with antibiotics but sometimes requires surgery.

Osteoporosis—Thinning and loss of bone tissue.

Normal results

Normal bone is made up of collagen fibers and bone tissue.

Abnormal results

Bone biopsy can reveal the presence of benign disease, infection, or malignant tumors that have spread to the bone from other parts of the body.

Results of this test are considered reliable, but may be affected by:

- failure to fast before open biopsy
- failure to obtain an adequate specimen
- delayed microscopic examination or laboratory analysis

Resources

BOOKS

Everything You Need to Know About Medical Tests. Ed. Michael Shaw, et al. Springhouse, PA: Springhouse Corporation, 1996.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

ORGANIZATIONS

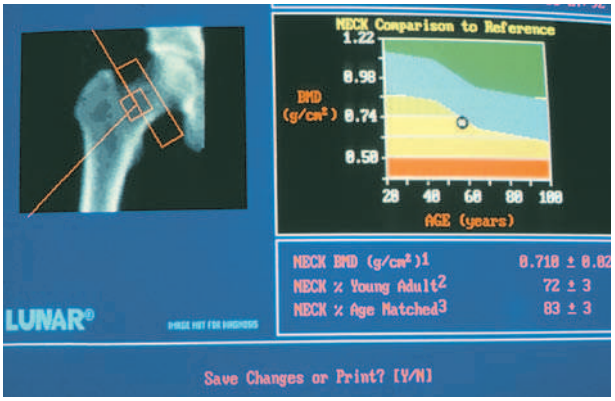
Cancer Group Institute. 1814 N.E. Miami Gardens Drive, North Miami Beach, FL 33179. (305) 651-5070. <http://www.cancergroup.com/em19.html>.

National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse. National Institutes of Health. 1 AMS Circle, Bethesda, MD 20892-3695. (301) 495-3675.

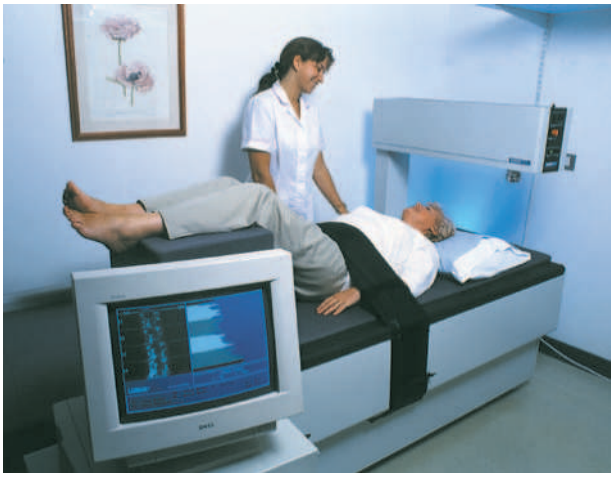
OTHER

ThriveOnline. 17 Feb. 1998 <http://thriveonline.oxygen.com>.

Maureen Haggerty



Computer read-out of a bone density scan. *(Photo Researchers. Reproduced by permission.)*



Patient undergoing a bone density scan. *(Photo Researchers. Reproduced by permission.)*

Bone break fever *see* **Dengue fever**

Bone cancer *see* **Sarcomas**

Bone densitometry *see* **Bone density test**

Bone density test

Definition

A bone density test, or scan, is designed to check for **osteoporosis**, a disease that occurs when the bones become thin and weak. Osteoporosis happens when the bones lose calcium and other **minerals** that keep them strong. Osteoporosis begins after **menopause** in many women, and worsens after age 65, often resulting in serious **fractures**. These fractures may not only bring disability, but may affect longevity. As many as one-fourth of women who fracture their hip after age 50 die within one year.

Most people today will get a bone density scan from a machine using a technology called Dual Energy X-ray Absorptiometry or DEXA for short. This machine takes a picture of the bones in the spine, hip, total body and wrist, and calculates their density. If a DEXA machine is not available, bone density scans can also be done with dual photon absorptiometry (measuring the spine, hip and total body) and quantitative **computed tomography scans** (measuring the spine). Bone density scanners that use DEXA technology to just measure bone density in the wrist (called pDEXA scans) provide scans at some drugstores. Yet these tests are not as accurate as those that measure density in the total body, spine or hip—where most fractures occur.

Purpose

A bone density scan measures the strength of an individual's bones and determines the risk of fracture. An observation of any osteoporosis present can be made.

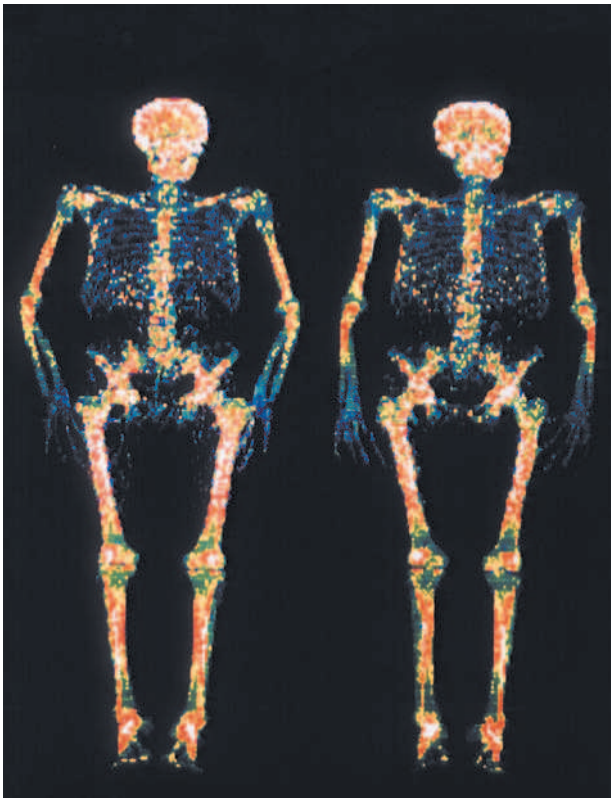
Description

To take a DEXA bone density scan, the patient lies on a bed underneath the scanner, a curving plastic arm that emits x rays. These low-dose x rays form a fan beam that rotates around the patient. During the test, the scanner moves to capture images of the patient's spine, hip or entire body. A computer then compares the patient's bone strength and risk of fracture to that of other people in the United States at the same age and to young people at peak bone density. Bones reach peak density at age 30 and then start to lose mass. The test takes about 20 minutes to do and is painless. The DEXA bone scan costs about $250. Some insurance companies and Medicare cover the cost. pDEXA wrist bone scans in drugstores are available for about $30.

Preparation

The patient puts on a hospital gown and lies on the bed underneath the scanner. Not all doctors routinely schedule this test. If the following factors apply to a patient, they may need a bone density scan and can discuss this with their doctor. The patient:

- is at risk for osteoporosis
- is near menopause
- has broken a bone after a modest trauma
- has a family history of osteoporosis
- uses steroid or antiseizure medications



A bone densitometry scan of identical twins. Their bone density is normal and identical to one another. *(Photo Researchers. Reproduced by permission.)*

- has had a period of restricted mobility for more than six months

Risks

The DEXA bone scan exposes the patient to only a small amount of radiation—about one-fiftieth that of a **chest x ray**, or about the amount you get from taking a cross-country airplane flight.

Normal results

The patient, when compared with people at "young normal bone density" (called the T-score) has the same or denser bones than a healthy 30-year-old. T scores above 1 mean that a patient has a healthy bone mass. Scores from 0 to −1 mean that the patient has borderline bone mass and should repeat the test in two to five years.

Abnormal results

The patient has two to four times the risk of a broken bone as other people in the United States at the same age and those at peak bone density. If a patient's T score ranges from −1 to −2.5 they have low bone mass and are at risk for osteoporosis. A T score below −2.5 means osteoporosis is already evident. These patients should have a repeat bone density scan every year or two.

KEY TERMS

Calcium—A mineral that helps build bone. After menopause, when women start making less of the bone-protecting hormone estrogen, they may need to increase their intake of calcium.

DEXA bone density scan—A bone density scan that uses a rotating x-ray beam to measure the strength of an individual's bones and his or her fracture risk.

Osteoporosis—A disease that occurs when the bones lose the calcium and structure that keep them strong. It often occurs after menopause (around age 50) in women and in old age in men.

Resources

BOOKS

Bonnick, Sydney Lou. *The Osteoporosis Handbook.* Taylor Publishing, 1994.

Brown, Susan E. *Better Bones, Better Body: A Comprehensive Self-Help Program for Preventing, Halting and Overcoming Osteoporosis.* New Canaan, CT: Keats Publishing, 1996.

PERIODICALS

Bilger, Burkhard. "Bone Medicine." *Health*, May/June 1996, 125-128.

"Bone Density Testing: Should You Be Checked?" *Mayo Clinic Health Newsletter* 15 (June 1997): 6

Hanlon, Toby, et al. "Size Up Your Bones Now." *Prevention*, Feb. 1996, 75.

ORGANIZATIONS

National Osteoporosis Foundation. 1150 17th St., NW, Suite 500, Washington, DC 20036-4603. (800) 223-9994. <http://www.nof.org>.

Barbara Boughton

Bone disorder drugs

Definition

Bone disorder drugs are medicines used to treat diseases that weaken the bones.

Purpose

The drugs described here are used to treat or prevent **osteoporosis** (brittle bone disease) in women past **menopause** as well as older men. They also are used prescribed for Paget's disease, a painful condition that weakens and deforms bones, and they are used to control calcium levels in the blood.

Bone is living tissue. Like other tissue, bone is constantly being broken down and replaced with new material. Normally, there is a balance between the breakdown of old bone and its replacement with new bone. But when something goes wrong with the process, bone disorders may result.

Osteoporosis is a particular concern for women after menopause, as well as for older men. In osteoporosis, the inside of the bones become porous and thin. Over time, this condition weakens the bones and makes them more likely to break. Osteoporosis is four times more common in women than in men. This is because women have less bone mass than men, tend to live longer and take in less calcium, and need the female hormone estrogen to keep their bones strong. If men live long enough, they are also at risk of getting osteoporosis later in life. Once total bone mass has peaked—around age 35—all adults start to lose it. In women, the rate of bone loss speeds up during menopause, when estrogen levels fall. Bone loss may also occur if both ovaries are removed by surgery. Ovaries make estrogen. **Hormone replacement therapy** is one approach to preventing osteoporosis. However, not all people can use hormone replacement therapy. Bone disorder drugs are a good alternative for people who already have osteoporosis or who are at risk of developing it. Risk factors include lack of regular **exercise**, early menopause, being underweight, and a strong family history of osteoporosis.

Description

Bone disorder drugs are available only with a physician's prescription and come in tablet, nasal spray, and injectable forms. Commonly used bone disorder drugs are alendronate (Fosamax), calcitonin (Miacalcin, Calcimar), and raloxifene (Evista). Raloxifene belongs to a group of drugs known as selective estrogen receptor modulators (SERMs), which act like estrogen in some parts of the body but not in others. This makes the drugs less likely to cause some of the harmful effects that estrogen may cause. Unlike estrogen, raloxifene does not increase the risk of **breast cancer**. In fact, research suggests that raloxifene may even reduce that risk.

Recommended dosage

Alendronate

FOR OSTEOPOROSIS. The usual dose is 10 mg once a day. Treatment usually continues over many years.

FOR PAGET'S DISEASE. The usual dose is 40 mg once a day for six months.

This medicine works only when it is taken with a full glass of water first thing in the morning, at least 30 minutes before eating or drinking anything or taking any other medicine. Do not lie down for at least 30 minutes after taking it because the drug can irritate the esophagus, the tube that delivers food form the mouth to the stomach.

Calcitonin

NASAL SPRAY. The usual dose is one spray into the nose once a day. Alternate nostrils, spraying the right nostril one day, the left nostril the next day, and so on.

INJECTABLE. The recommended dosage depends on the condition for which the medicine is prescribed and may be different for different people. Check with the physician who prescribed the medicine or the pharmacist who filled the prescription for the proper dosage.

Raloxifene

The usual dose is one 60-mg tablet daily.

Precautions

Aldendronate

People with low levels of calcium in their blood should not take this medicine. It also is not recommended for women on hormone replacement therapy or for anyone with kidney problems. Before using alendronate, anyone who has digestive or swallowing problems should make sure that his or her physician knows about the condition.

Calcitonin

Calcitonin nasal spray may cause irritation or small sores in the nose. Check with a physician if this becomes very uncomfortable or if there is bleeding from the nose.

The injectable form of calcitonin has caused serious allergic reactions in a few people. The nasal spray is not known to cause such reactions, but the possibility exists. Before starting treatment with calcitonin, the physician who prescribes the drug may order an allergy test to make sure there will not be a problem.

Raloxifene

A rare, but serious side effect of raloxifene is an increased risk of blood clots that form in the veins and

may break away and travel to the lungs. This is about as likely in women who take raloxifene as it is in women who take estrogen. Because of this possible problem, women with a history of blood clots in their veins should not take raloxifene.

Women who have had breast **cancer** or cancer of the uterus should check with their physicians about whether they can safely use raloxifene.

General precautions for bone disorder drugs

To keep bones strong, the body needs calcium and vitamin D. Dairy products and fish such as salmon, sardines and tuna are good sources of both calcium and vitamin D. People who are taking bone disorder drugs for osteoporosis and who do not get enough of these nutrients in their **diets** should check with their physicians about taking supplements. Other important bone-saving steps are avoiding **smoking** and alcohol and getting enough of the kind of exercise that puts weight on the bones (such as walking or lifting weights).

People who are taking these drugs because they have too much calcium in their blood may need to *limit* the amount of calcium in their diets. Too much calcium may prevent the medicine from working properly. Discuss the proper diet with the physician who prescribed the drug, and do not make any diet changes without the physician's approval.

Anyone who has had unusual reactions to bone disorder drugs in the past should let his or her physician know before taking the drugs again. The physician also should be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant or who may become pregnant and women who are breastfeeding should check with their physicians before using this alendronate or calcitonin. Raloxifene should not be used by women who are pregnant or who may become pregnant. In laboratory studies of rats, raloxifene caused **birth defects**.

Side effects

Aldendronate

Common side effects include **constipation**, **diarrhea**, **indigestion**, nausea, **pain** in the abdomen, and pain in the muscles and bones. These problems usually go away as the body adjusts to the medicine and do not need medical attention unless they continue or they interfere with normal activities.

Calcitonin

The most common side effects of calcitonin nasal spray are nose problems, such as dryness, redness, **itching**, sores, bleeding and general discomfort. These problems should go away as the body adjusts to the medicine, but if they do not or if they are very uncomfortable, check with a physician. Other side effects that should be brought to a physician's attention include **headache**, back pain and joint pain.

Injectable calcitonin may cause minor side effects such as nausea or vomiting; diarrhea; stomach pain; loss of appetite; flushing of the face, ears, hands or feet; and discomfort or redness at the place on the body where it is injected. Medical attention is not necessary unless these problems persist or cause unusual discomfort.

Anyone who has a skin rash or **hives** after taking injectable calcitonin should check with a physician as soon as possible.

Raloxifene

Common side effects include hot flashes, leg cramps, **nausea and vomiting**. Women who have these problems while taking raloxifene should check with their physicians.

Interactions

Aldendronate

Taking **aspirin** with alendronate may increase the chance of upset stomach, especially if the dose of alendronate is more than 10 mg per day. If an analgesic is

KEY TERMS

Estrogen—The main sex hormone that controls normal sexual development in females. During the menstrual cycle, estrogen helps prepare the body for possible pregnancy.

Fracture—A break or crack in a bone.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Menopause—The stage in a woman's life when the ovaries stop producing egg cells at regular times and menstruation stops.

Osteoporosis—A disease in which bones become very porous and weak. The bones are then more likely to fracture and take longer to heal. The condition is most common in women after menopause but can also occur in older men.

necessary, switch to another drug, such as **acetaminophen** (Tylenol) or use buffered aspirin. Ask a physician or pharmacist for the correct medication to use.

Some calcium supplements, **antacids** and other medicines keep the body from absorbing alendronate. To prevent this problem, do not take any other medicine within 30 minutes of taking alendronate.

Calcitonin

Calcitonin may keep certain other drugs for Paget's disease, such as etidronate (Didronel), from working as they should.

Raloxifene

Raloxifene may affect blood clotting. Patients who are taking other drugs that affect blood clotting, such as warfarin (Coumadin), should check with their physicians before using raloxifene.

Resources

ORGANIZATIONS

Foundation For Osteoporosis Research & Education. (888) 266-3015. <http://www.fore.org>.

National Association for the Relief of Paget's Disease. <http://www.demon.co.uk/narpd>.

National Osteoporosis Foundation 1150 17th Street NW Suite 500 Washington, D.C. 20036-4603. <http://www.nof.org>.

Nancy Ross-Flanigan

Bone grafting

Definition

Bone grafting is a surgical procedure by which new bone or a replacement material is placed into spaces between or around broken bone (**fractures**) or holes in bone (defects) to aid in healing.

Purpose

Bone grafting is used to repair bone fractures that are extremely complex, pose a significant risk to the patient, or fail to heal properly. Bone graft is also used to help fusion between vertebrae, correct deformities, or provide structural support for fractures of the spine. In addition to **fracture repair**, bone graft is used to repair defects in bone caused by **birth defects**, traumatic injury, or surgery for bone **cancer**.

Description

Bone is composed of a matrix, mainly made up of a protein called collagen. It is strengthened by deposits of calcium and phosphate salts, called hydroxyapatite. Within and around this matrix are located the cells of the bones, which are of four types. Osteoblasts produce the bone matrix. Osteocytes are mature osteoblasts and serve to maintain the bone. Osteoclasts break down and remove bone tissue. Bone lining cells cover bone surfaces. Together, these four types of cells are responsible for building the bone matrix, maintaining it, and remodeling the bone as needed.

There are three ways in which a bone graft can help repair a defect. The first is called osteogenesis, the formation of new bone by the cells contained within the graft. The second is osteoinduction, a chemical process in which molecules contained within the graft (bone morphogenetic proteins) convert the patient's cells into cells that are capable of forming bone. The third is osteoconduction, a physical effect by which the matrix of the graft forms a scaffold on which cells in the recipient are able to form new bone.

New bone for grafting can be obtained from other bones in the patient's own body (e.g., hip bones or ribs), called autograft, or from bone taken from other people that is frozen and stored in tissue banks, called allograft. A variety of natural and synthetic replacement materials are also used instead of bone, including collagen (the protein substance of the white fibers of the skin, bone, and connective tissues); polymers, such as silicone and some acrylics; hydroxyapatite; calcium sulfate; and ceramics. A new material, called resorbable polymeric grafts, is also being studied. These resorbable grafts provide a structure for new bone to grow on; the grafts then slowly dissolve, leaving only the new bone behind.

To place the graft, the surgeon makes an incision in the skin over the bone defect and shapes the bone graft or replacement material to fit into the defect. After the graft is placed into the defect, it is held in place with pins, plates, or screws. The incision is closed with stitches and a splint or cast is used to prevent movement of the bones while healing.

The costs associated with a bone graft vary. These costs include: the surgeon's fee (variable); anesthesiologist's fees (averaging $350 to $400 per hour); hospital charges (averaging $1,500 to $1,800 per day, more for intensive care or private rooms); medication charges ($200 to $400); and additional charges, including an assisting surgeon, treatment of complications, diagnostic procedures (e.g., blood work or x rays), medical supplies, and equipment use. The cost for the graft itself can range from $250 to $900.

This procedure is covered by many third-party insurers; insurance coverage should be explored for each individual case.

Aftercare

The time required for convalescence for fractures or spinal fusion may vary from one to 10 days, and vigorous **exercise** may be limited for up to three months.

Most bone grafts are successful in helping the bone defect to heal. The extent of recovery will depend on the size of the defect and the condition of the bone surrounding the graft at the time of surgery. Severe defects may take some time to heal and may require further attention after the initial graft. In one study of over 1,000 patients who received very large allografts after surgery for bone cancer, researchers found that approximately 85% of the patients were able to return to work or normal physical activities without using crutches. However, about 25% of these patients required a second operation, because the first did not heal properly. Less severe bone defects, though, should heal completely without serious complications.

Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and breathing problems. The risks for any surgical procedure include bleeding and infection.

The drawbacks of autografts include: the additional surgical and anesthesia time (typically 30 minutes per procedure) to obtain, or harvest, the bone for grafting; added costs of the additional surgery; **pain** and infection that might occur at the site from which the graft is taken; and the relatively small amount of bone that is available for grafting.

The drawbacks of allografts include: variability between lots, since the bone is harvested from a variety of donors; the bone may take longer to incorporate with the host bone than an autograft would; the graft may be less effective than an autograft; and the possibility of transferring diseases to the patient. Other complications may result from the immune response mounted by the patient's immune system against the grafted bone tissue. With the use anti-rejection agents (drugs to combat rejection of grafted bone tissue) immune rejection is less of a problem.

Resources

PERIODICALS

Brown, Edwin H. "New Bones from the Sea: Tropical Coral." *Medical Update* 20 (Jan. 1997): 2.

Cowley, Geoffrey. "Replacement Parts." *Newsweek* 129 (27 Jan. 1997): 66.

DeLacure, Mark D. "Physiology and Healing of Bone Grafts." *Otolaryngologic Clinics of North America* 27, no. 5 (1994): 859.

Farley, Dixie. "New Ways to Heal Broken Bones." *FDA Consumer* 30 (Apr. 1996): 14.

Hayes, Ketra Marie, and Nancy L. Combs. "Perioperative Nursing Care of Patients with Craniofacial Injuries." *ADRN Journal* 64 (Sept. 1996): 383.

Hotter, David S. "Band-Aids for Broken Bones." *Machine Design* 68 (4 Apr. 1996): 39.

Kopp, Marleen. "Caring for the Adult Patient Undergoing Anterior/Posterior Spinal Fusion." *Orthopedic Nursing* 16, no. 2 (1997): 55.

Larkin, Brenda G. "Understanding Bone Banking." *Orthopedic Nursing* 16, NO. 4, 1997: 49.

Morgan, Peggy, and Toby Hanlon. "Power Medicine in 2000: Breakthrough Treatments for a New Millennium." *Medical Update* 20 (Jan. 1997): 2.

"New Ways to Fix Bone Fractures." *USA Today Magazine* 124 (Feb. 1996): 4.

Oseph, Lou. "The New World of Dental Care." *Consumers Digest* 35 (May 1996): 59.

"Restoring Severely Disfigured Faces." *USA Today Magazine*, 125 (Oct. 1996): 8.

Scaggs, David L., and George S. Bassett. "Adolescent Idiopathic Scoliosis: An Update." *American Family Physician* 53 (15 May 1996): 2327.

Vangsness, C. Thomas, et al. "Soft Tissue for Allograft Reconstruction of the Human Knee: A Survey of the American Association of Tissue Banks." *American Journal of Sports Medicine* 24 (Mar. 1996): 230.

KEY TERMS

Allograft—Tissue for transplantation that is taken from another person.

Autograft—Tissue for transplantation that is taken from the patient.

Hydroxyapatite—A calcium phosphate complex that is the primary mineral component of bone.

Osteoblasts—Bone cells that build new bone tissue.

Osteoclasts—Bone cells that break down and remove bone tissue.

Osteoconduction—Provision of a scaffold for the growth of new bone.

Osteocytes—Bone cells that maintain bone tissue.

Osteogenesis—Growth of new bone.

Osteoinduction—Acceleration of new bone formation by chemical means.

ORGANIZATIONS

American Association of Tissue Banks. 1350 Beverly Road, Suite 220-A, McLean, VA 22101. (703) 827-9582.

Lisa Christenson, PhD

Bone growth stimulation

Definition

Bone growth stimulation is the technique of promoting bone growth in difficult to heal **fractures** by applying a low electrical current or ultrasound to the fracture.

Purpose

Bone growth stimulation is done when satisfactory healing is not occurring naturally or when the pace of healing is too slow. This condition is called fracture nonunion, and it occurs more frequently among adults than children, in people with severe or complex fractures, and in people who smoke.

The theory behind applying an electric current to fractures to stimulate healing is based on the fact that the concave side of the bone becomes negatively charged and the convex side is positively charged. It is believed that artificially encouraging this charging with an electric current will speed healing. In 1996, the Food and Drug Administration (FDA) also approved the application of low intensity ultrasound pulses as a treatment for fracture nonunion.

Ultrasound and electromagnetic stimulation are expensive and are used only when healing problems exist for a substantial length of time. Each method must be used for at least three to six months to be effective.

Precautions

Bone growth stimulation cannot be used if the gap between the ends of the fracture is too large.

Description

Electric stimulation can be applied either from the inside of the body (invasively) or from the outside the body (noninvasively). Ultrasound is a noninvasive procedure. The type of stimulation selected depends on the doctor's preference, the type and location of the fracture, and the patient's motivation to comply with the treatment schedule. Treatment can take anywhere from three to six months.

Invasive stimulators

Invasive electric stimulators are either fully or partially implantable. The advantage of these devices is that they apply a direct electric current to the fracture 24 hours a day. The fully implantable stimulator requires little daily attention from the patient. Patients using a semi-implanted stimulator must regulate their own treatment schedule and have to care for the external power pack. The disadvantage of implantable and semi-implantable stimulators is that their implantation is a surgical procedure.

Fully implantable direct current stimulators are installed in a hospital under general or regional anesthesia. Both the stimulator and the power source are implanted. The surgeon makes an incision and places a spiral shaped cathode inside the bone. A wire leads to the power source and a small anode. The power source is a battery pack that is implanted in the nearby muscle. The body transmits electrical current to close the circuit. The incision is then closed. Once in place, the device provides continuous direct electric current for bone growth stimulation.

Partially implanted stimulators use cathode pins that are implanted at the edge of each bone that is fractured. Wires lead to the surface of the skin where a power source and the anode are located. Wires complete the circuit. The external portion of the device is held in place by a cast. This source of stimulation also runs continuously.

Noninvasive stimulators

In the noninvasive stimulator, external electromagnetic coils are placed on either side of the fracture and are held in place by a strap or cuff. Locating the coils correctly is important, and their location relative to the fracture is usually confirmed by x rays.

The coils produce a pulsating electromagnetic field. It is up to the patient to maintain the prescribed treatment schedule. Effective treatment requires stimulation anywhere from three to ten hours each day in periods of no less than one hour.

Ultrasound stimulation is the most recent treatment for stimulating bone growth. A device that generates low intensity pulses of sound is applied to the skin over the fracture. The advantage of this technique is that it is noninvasive and the period of application of the sound pulses can be as short as 20-30 minutes each day. The results of this treatment have been studied less than the effect of electromagnetic stimulation.

Preparation

Bone growth stimulation is done only when healing has failed to occur for many months. Before it is started,

x rays are done of the fracture area. If the device is to be implanted, standard preoperative blood and urine tests are done. The patient may meet with an anesthesiologist to discuss any conditions that might affect the administration of anesthesia.

Aftercare

If a noninvasive, pulsating, electromagnetic field device is used, the patient must not put any **stress** or weight on the fracture until it is healed, which is a matter of months in most cases. In all lower limb fractures, regardless of the stimulation method used, the patient can not bear weight on the limb with the fracture until healing is complete. This limits the patient's mobility for many months. Patients have the responsibility for regularly making sure that the unit works and caring for external devices and the casts that hold them in place.

Risks

Noninvasive devices have few risks associated with them. The main risk associated with implantable devices is the development of infection at the site of implantation.

Normal results

Success in healing a fracture nonunion using bone growth stimulation depends on the type, location, and severity of the fracture and the age and general health of the patient.

Resources

PERIODICALS

Mayo Clinic. "Fractures - Treatment Methods are Tailored to the Break." *Mayo Clinic Health Letter* 14, no. 4 (Apr.1996):1-3.

Tish Davidson

Bone infection *see* **Osteomyelitis**

Bone marrow aspiration and biopsy

Definition

Bone marrow aspiration, also called bone marrow sampling, is the removal by suction of fluid from the soft, spongy material that lines the inside of most bones. Bone marrow biopsy, or needle biopsy, is the removal of a small piece of bone marrow.

KEY TERMS

Anode—The positive electrode to which an electromagnetic current flows.

Cathode—The negative electrode from which an electromagnetic current flows.

Purpose

Bone marrow aspiration is used to:

- pinpoint the cause of abnormal blood test results
- confirm a diagnosis or check the status of severe anemia (abnormally low numbers of red blood cells in the bloodstream) of unknown cause, or other irregularities in the way blood cells are produced or become mature
- evaluate abnormalities in the blood's ability to store iron
- diagnose infection

Bone marrow biopsy is used to:

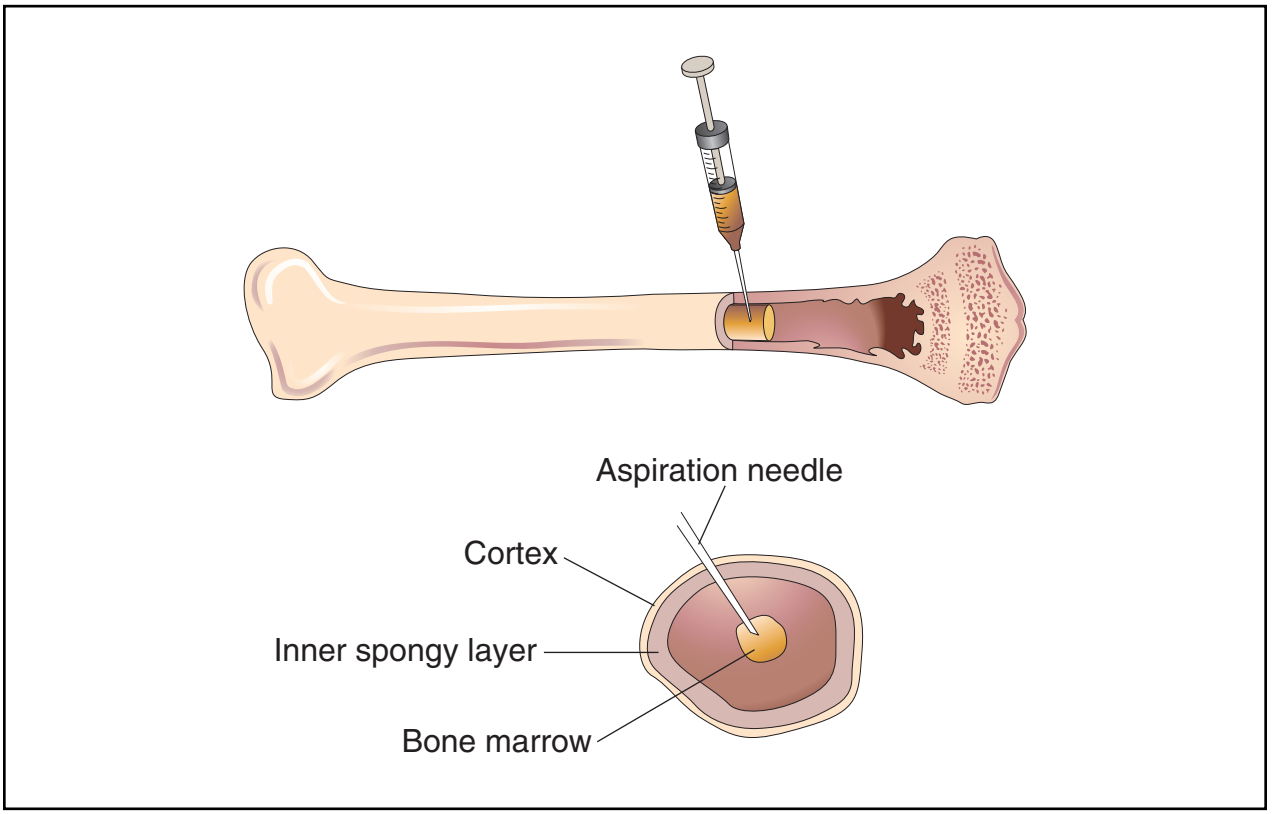
- obtain intact bone marrow for laboratory analysis
- diagnose and stage some types of **cancer** or anemia and other blood disorders
- identify the source of an unexplained fever
- diagnose fibrosis of bone marrow or myeloma (a tumor composed of cells normally found in the bone marrow) when bone marrow aspiration has failed to provide an appropriate specimen

Bone marrow aspiration and bone marrow biopsy are also used to gauge the effectiveness of **chemotherapy** and other medical treatments. These procedures are often used together to ensure the availability of the best possible bone marrow specimen.

Precautions

Allergies or previous adverse reactions to medications should be discussed with the doctor. Any current medications, including herbal or nutritional supplements, should be evaluated for the potential to interfere with proper coagulation (clot formation). These would include coumadin, **aspirin**, and other agents used as blood thinners. Caution should be used when the herbs gingko, ginger, garlic, or ginseng have been utilized as supplements, due to a risk of bleeding.

Pregnancy, **lactation** (production and secretion of milk), and preexisting platelet or bleeding disorders should be evaluated before either procedure is undertaken.



In a bone marrow aspiration, a needle is inserted beneath the skin and rotated until it penetrates the cortex, or outer covering of the bone. A small amount of marrow is suctioned out of the bone by a syringe attached to the needle. *(Illustration by Electronic Illustrators Group.)*

Description

Bone marrow aspiration and biopsy should be performed by a physician or nurse clinician. Each procedure takes about 20 to 30 minutes and is usually performed on an outpatient basis, but can be done in a hospital if necessary.

The skin covering the biopsy site is cleansed with an antiseptic, and the patient may be given a mild sedative. A local anesthetic is administered. The hematologist or nurse clinician performing the procedure will not begin until the anesthetic has numbed the area from which the specimen is to be extracted. In both adults and children, aspiration and biopsy are most commonly performed on the rear bone of the hip (posterior iliac crest). In adults, sampling from the sternum (breastbone) is sometimes done. The latter location is technically easier, but is somewhat more painful for the patient and presents the risk of heart injury. On rare occasions, a long bone of the leg (tibia) may be used as a sample site for an infant.

In a bone marrow aspiration, a special needle is inserted beneath the skin and rotated until it penetrates the cortex, or outer covering of the bone. At least half a teaspoon of marrow is withdrawn from the bone by a syringe attached to the needle. The patient may experience discomfort when the needle is inserted or when the marrow is aspirated. If more marrow is needed, the needle is repositioned slightly, a new syringe is attached, and a second sample is taken. The samples are transferred from the syringes to slides and vials, then sent to a laboratory for analysis.

Bone marrow biopsy may be performed immediately before or after bone marrow aspiration. The procedure utilizes a special large-bore needle that is used to drill out a core of marrow. In bone marrow biopsy, the needle is inserted, rotated from side to side, withdrawn, and reinserted at a different angle. This procedure is repeated if needed until a small core, about 0.4 inches (1 cm) long, is separated from the bone marrow. The needle is again removed, and a piece of fine wire threaded through its tip transfers the specimen onto sterile gauze. The patient may feel discomfort or pressure when the needle is inserted and experience a brief, pulling sensation when the marrow is withdrawn. Unlike aspiration specimens, which are smeared, these samples contain structurally intact bone marrow. Microscopic examination can show what material its cells

contain and how they are alike or different from one another. The bone may either be embedded intact in paraffin (a type of wax), or be decalcified (a process which takes place overnight) for a different type of staining and examination. Each type of preparation has certain advantages.

Preparation

A current history and physical are obtained from the patient, along with proper consent. The patient is generally placed in a prone position (lying face down) for preparation, and local anesthetic, with or without **sedation**, is administered.

Aftercare

After the needle is removed, the biopsy site will be covered with a clean, dry bandage. Pressure is applied to control bleeding. The patient's pulse, breathing, blood pressure, and temperature are monitored until they return to normal, and the patient may be instructed to remain in a supine position (lying face up) for half an hour before getting dressed.

The patient should be able to leave the clinic and resume normal activities immediately. Patients who have received a sedative often feel sleepy for the rest of the day; driving, cooking, and other activities that require clear thinking and quick reactions should therefore be avoided.

The biopsy site should be kept covered and dry for several hours. Walking or taking prescribed **pain** medications usually ease any discomfort felt at the biopsy site, and ice can be used to reduce swelling.

A doctor should be notified if the patient:

- feels severe pain more than 24 hours after the procedure.
- experiences persistent bleeding or notices more than a few drops of blood on the wound dressing.
- has a temperature above 101°F (38.3°C). Inflammation and pus at the biopsy site and other signs of infection should also be reported to a doctor without delay

Risks

Bleeding and discomfort often occur at the biopsy site. Infection and hematoma may also develop. In rare instances, the heart or a major blood vessel is pierced when marrow is extracted from the sternum during bone marrow biopsy. This can lead to severe hemorrhage.

Normal results

Healthy adult bone marrow contains yellow fat cells, connective tissue, and red marrow that produces blood.

KEY TERMS

Aspiration—A procedure to withdraw fluid from the body.

Connective tissue—Material that links one part of the body with another.

Fibrosis—A condition characterized by the presence of scar tissue or fiber-containing tissues that replace normal tissues.

Hematologist—A medical specialist who treats diseases and disorders of the blood and blood-forming organs.

Hematoma—Blood that collects under the skin and causes swelling.

Hemorrhage—Heavy bleeding.

Myeloma—A tumor that originates in bone marrow and usually spreads to more than one bone.

Nurse practitioner—A registered nurse who is qualified to perform some specialized duties.

The bone marrow of a healthy infant is primarily red due to active production of red cells necessary for growth.

Abnormal results

Culture of bone marrow aspirate may yield information about an infectious agent. Microscopic examination of bone marrow can reveal granulomas, **myelofibrosis**, lymphomas, leukemias, or other cancers. Analyzing specimens can help doctors diagnose iron deficiency, vitamin B_{12}deficiency, and folate deficiency, as well as anemia.

Obesity can affect the ease with which a bone marrow biopsy can be done, and the results of either procedure can be affected if the patient has had **radiation therapy** at the biopsy site.

Resources

BOOKS

Bain, Barbara, et al. *Bone Marrow Pathology.* Oxford, UK: Blackwell Science, Ltd., 1996.

Gatter, Kevin, and David Brown. *An Illustrated Guide to Bone Marrow Diagnosis*. Oxford, UK: Blackwell Science, Ltd., 1997.

Zaret, Barry L., et al. *The Yale University Patient's Guide to Medical Tests*. Boston: Houghton Mifflin Company, 1997.

ORGANIZATION

Leukemia Society of America. 600 Third Ave., New York, NY 10016. (800) 955-4572. <http://www.leukemia.org>.

National Cancer Institute Cancer Information Service. 9000 Rockville Pike, Bethesda, MD 20892. (800) 422-6237. <http://cis.nci.nih.gov>.

National Marrow Donor Program. 3433 Broadway St. NE, #400, Minneapolis, MN 55413. (800) 627-7692. <http://www.marrow.org>.

The Wellness Community. 35 E. Seventh St., Suite 412, Cincinnati, OH 45202. (888) 793-WELL. <http://www.wellness-community.org>.

OTHER

"Bone Marrow Biopsy." CanCareSA Website. 2 July 1998. 25 June 2001 <http://www.health.sa.gov.au/cancare/Treatment/PROCEDURES-TESTS/BMBiopsy.htm>.

Maureen Haggerty

Bone marrow transplantation

Definition

The bone marrow—the sponge-like tissue found in the center of certain bones—contains stem cells that are the precursors of white blood cells, red blood cells, and platelets. These blood cells are vital for normal body functions, such as oxygen transport, defense against infection and disease, and clotting. Blood cells have a limited lifespan and are constantly being replaced; therefore, healthy stem cells are vital.

In association with certain diseases, stem cells may produce too many, too few, or otherwise abnormal blood cells. Also, medical treatments may destroy stem cells or alter blood cell production. The resultant blood cell abnormalities can be life threatening.

Bone marrow transplantation involves extracting bone marrow containing normal stem cells from a healthy donor, and transferring it to a recipient whose body cannot manufacture proper quantities of normal blood cells. The goal of the transplant is to rebuild the recipient's blood cells and immune system and hopefully cure the underlying ailment.

Purpose

A person's red blood cells, white blood cells, and platelets may be destroyed or may be abnormal due to disease. Also, certain medical therapies, particularly **chemotherapy** or radiation treatment, may destroy a person's stem cells. The consequence to a person's health is severe. Under normal circumstances, red blood cells carry oxygen throughout the body and remove carbon dioxide from the body's tissues. White blood cells form the cornerstone of the body's immune system and defend it against infection. Platelets limit bleeding by enabling the blood to clot if a blood vessel is damaged.

A bone marrow transplant is used to rebuild the body's capacity to produce these blood cells and bring their numbers to normal levels. Illnesses that may be treated with a bone marrow transplant include both cancerous and noncancerous diseases.

Cancerous diseases may or may not specifically involve blood cells; but, **cancer** treatment can destroy the body's ability to manufacture new blood cells. Bone marrow transplantation may be used in conjunction with additional treatments, such as chemotherapy, for various types of leukemia, **Hodgkin's disease**, lymphoma, breast and **ovarian cancer**, and other cancers. Noncancerous diseases for which bone marrow transplantation can be a treatment option include **aplastic anemia**, **sickle cell disease**, **thalassemia**, and severe **immunodeficiency**.

Precautions

Bone marrow transplants are not for everyone. Transplants are accompanied by a risk of infection, transplant rejection by the recipient's immune system, and other complications. The procedure has a lower success rate the greater the recipient's age. Complications are exacerbated for people whose health is already seriously impaired as in late-stage cancers. Therefore, a person's age or state of health may prohibit use of a bone marrow transplant. The typical cut-off age for a transplant ranges from 40 to 55 years; however, a person's general health is usually the more important factor.

Even in the absence of complications, the transplant and associated treatments are hard on the recipient. Bone marrow transplants are debilitating. A person's ability to withstand the rigors of the transplant is a key consideration in deciding to use this treatment.

Description

Autologous and allogeneic transplants

Two important requirements for a bone marrow transplant are the donor and the recipient. Sometimes, the donor and the recipient may be the same person. This type of transplant is called an autologous transplant. It is typically used in cases in which a person's bone marrow is generally healthy but will be destroyed due to medical treatment for diseases such as **breast cancer** and Hodgkin's disease. Most bone marrow transplants are autologous. If a person's bone marrow is unsuitable for an autologous transplant, the bone marrow must be derived from another person in an allogeneic transplant.

Allogeneic transplants are more complicated because of proteins called human lymphocyte antigens

(HLA) that are on the surface of bone marrow cells. If the donor and the recipient have very dissimilar antigens, the recipient's immune system regards the donor's bone marrow cells as invaders and launches a destructive attack against them. Such an attack negates any benefits offered by the transplant.

HLA matching

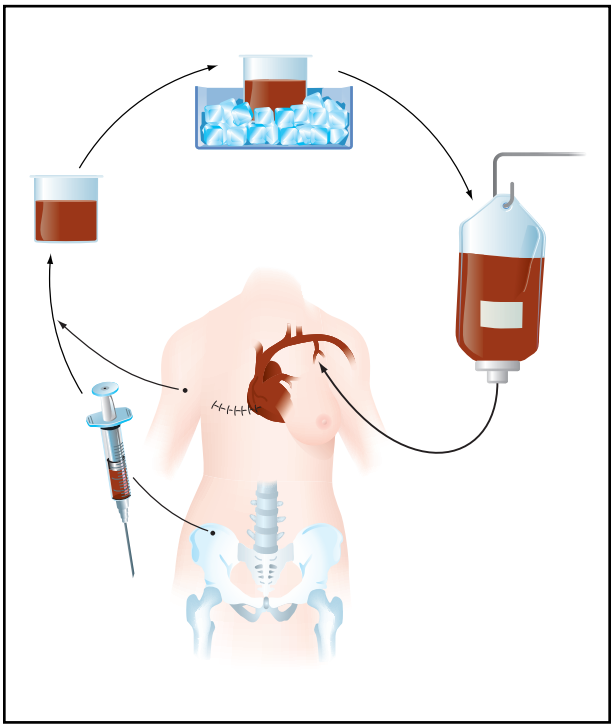
There are only five major HLA classes or types—designated HLA–A,–B, –C,–D, and class III—but much variation within the groupings. For example, HLA–A from one individual may be similar to, but not the same as, HLA–A in another individual; such a situation can render a transplant from one to the other impossible.

HLA matching is more likely if the donor and recipient are related, particularly if they are siblings; however, an unrelated donor may be a potential match. Only in rare cases is matching HLA types between two people not an issue: if the recipient has an identical twin. Identical twins carry the same genes; therefore, the same antigens. A bone marrow transplant between identical twins is called a syngeneic transplant.

Peripheral blood stem cell transplants

A relatively recent development in stem cell transplantation is the use of peripheral blood cells instead of stem cells from bone marrow. Peripheral blood stem cells (PBSCs) are obtained from circulating blood rather than from bone marrow, but the amount of stem cells found in the peripheral blood is much smaller than the amount of stem cells found in the bone marrow. Peripheral blood stem cells can be used in either autologous or allogeneic transplants. The majority of PBSC transplants are autologous. However, recent clinical studies indicate that PBSCs are being used more frequently than bone marrow for allogeneic bone marrow transplantation.

The advantages of PBSC transplants when compared to bone marrow transplants are: in allogeneic transplantation, haematopoietic and immune recovery are faster with PBSCs which reduces the potential for disease recurrence, primarily graft-versus-host-disease. In autologous transplantation, the use of PBSCs can result in faster **blood count** recoveries. Also, some medical conditions exist in which the recipient cannot accept bone marrow stem cell transplants, but can accept PBSC transplants. Some possible disadvantages to PBSC transplant versus bone marrow transplantation are: so much more fluid volume is necessary to collect enough PBSCs that, at the time of infusing the new stem cells into the recipient, the fluid can collect in the lungs or cause temporary kidney problems. Also, the time commitment for the donor for a PBSC transplant is considerable. When the PBSCs are being collected, several outpatient sessions are needed and each session lasts approximately two–four hours.



In autologous bone marrow transplantation, stem cells are collected from the patient. Once the patient has undergone chemotherapy, the cells are replaced in the blood via an intravenous catheter. The cells return to the bone marrow and begin producing healthy new cells. *(Illustration by Argosy Inc.)*

The transplant procedure

BONE MARROW TRANSPLANTATION. The bone marrow extraction, or harvest, is the same whether for an autologous or allogeneic transplant. Harvesting is done under general anesthesia (i.e., the donor sleeps through the procedure), and discomfort is usually minimal afterwards. Bone marrow is drawn from the iliac crest (the part of the hip bone to either side of the lower back) with a special needle and a syringe. Several punctures are usually necessary to collect the needed amount of bone marrow, approximately 1–2 quarts (0.9-1.91). (This amount is only a small percentage of the total bone marrow and is typically replaced within four weeks.) The donor remains at the hospital for 24–48 hours and can resume normal activities within a few days.

If the bone marrow is meant for an autologous transplant, it is stored at –112 to –320°F (–80 to –196°C) until it is needed. Bone marrow for an allogeneic transplant is sometimes treated to remove the donor's T cells (a type of white blood cell) or to remove ABO (blood type) antigens; otherwise, it is transplanted without modification.

KEY TERMS

ABO antigen—Protein molecules located on the surfaces of red blood cells that determine a person's blood type: A, B, or O.

AML—Acute myelogenous leukemia, also called acute myelocytic leukemia. Malignant disorder where myeloid blast cells accumulate in the marrow and bloodstream.

Allogeneic—Referring to bone marrow transplants between two different, genetically dissimilar people.

Anemia—Decreased red cell production which results in deficiency in oxygen-carrying capacity of the blood.

Antigen—A molecule that is capable of provoking an immune response.

Aplastic anemia—A disorder in which the body produces inadequate amounts of red blood cells and hemoglobin due to underdeveloped or missing bone marrow.

Autologous—Referring to bone marrow transplants in which recipients serve as their own donors.

Blank—If an individual has inherited same HLA antigen from both parents, the HLA typing is designated by the shared HLA antigen followed by a "blank"(–).

Blast cells—Blood cells in early stage of cellular development.

Blast crisis—Stage of chronic myelogenous leukemia where large quantities of immature cells are produced by the marrow and is not responsive to treatment.

Bone marrow—A spongy tissue located within flat bones, including the hip and breast bones and the skull. This tissue contains stem cells, the precursors of platelets, red blood cells, and white blood cells.

Bone marrow transplant—Healthy marrow is infused into people who have had high-dose chemotherapy for one of the many forms of leukemias, immunodeficiencies, lymphomas, anemias, metabolic disorders, and sometimes solid tumors.

Chemotherapy—Medical treatment of a disease, particularly cancer, with drugs or other chemicals.

Chronic myelogenous leukemia (CML)—Also called chronic myelocytic leukemia, malignant disorder that involves abnormal accumulation of white cells in the marrow and bloodstream.

Cytomegalovirus (CMV)—Virus that can cause pneumonia in post bone marrow transplant patients.

Conditioning—Process of preparing patient to receive marrow donation, often through the use of chemotherapy and radiation therapy.

Confirmatory typing—Repeat tissue typing to confirm the compatibility of the donor and patient before transplant.

Donor—A healthy person who contributes bone marrow for transplantation.

Graft versus host disease—A life-threatening complication of bone marrow transplants in which the donated marrow causes an immune reaction against the recipient's body.

Histocompatibility—The major histocompatibility determinants are the human leukocyte antigens

The bone marrow is administered to the recipient via a catheter (a narrow, flexible tube) inserted into a large vein in the chest. From the bloodstream, it migrates to the cavities within the bones where bone marrow is normally stored. If the transplant is successful, the bone marrow begins to produce normal blood cells once it is in place, or engrafted.

PERIPHERAL BLOOD STEM CELL TRANSPLANTATION. Before collection for a PBSC transplant, donors receive daily four injections of the drug G-CSF, or filgrastim. (Patients can give it to themselves at home if need be.) These pretreatments stimulate the body to release stem cells into the blood. After these pretreatments, the donors' experience is similar to that of a whole blood donor's experience—PBSC donors' blood is collected at a clinic or hospital as an outpatient procedure. The differences are that several sessions will be needed over days or weeks and the blood is collected in a process called apheresis. The blood travels from one arm into a blood cell separator that removes only the stem cells, and the rest of the blood is returned back to the donor, in the other arm. The cells are then frozen for later use.

The PBSCs are administered to the recipient using the same methods as those used in bone marrow transplantation. As stated, the amount of fluid with PBSCs infused into the recipient's body can be an issue.

KEY TERMS

(HLA) and characterize how well the patient and donor are matched.

HLA (human leuckocyte antigen)—A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

Hodgkin's disease—A type of cancer involving the lymph nodes and potentially affecting nonlymphatic organs in the later stage.

Immunodeficiency—A disorder in which the immune system is ineffective or disabled either due to acquired or inherited disease.

Leukemia—A type of cancer that affects leukocytes, a particular type of white blood cell. A characteristic symptom is excessive production of immature or otherwise abnormal leukocytes.

Lymphoma—A type of cancer that affects lymph cells and tissues, including certain white blood cells (T cells and B cells), lymph nodes, bone marrow, and the spleen. Abnormal cells (lymphocyte/leukocyte) multiply uncontrollably.

Match—How similar the HLA typing, out of a possible six antigens, is between the donor and the recipient.

Mixed lymphocyte culture (MLC)—Test that measures level of reactivity between donor and recipient lymphocytes.

Neuroblastoma—Solid tumor in children, may be treated by BMT.

Platelets—Fragments of a large precursor cell, a megakaryocyte found in the bone marrow. These fragments adhere to areas of blood vessel damage and release chemical signals that direct the formation of a blood clot.

Recipient—The person who receives the donated blood marrow.

Red blood cells—Cells that carry hemoglobin (the molecule that transports oxygen) and help remove wastes from tissues throughout the body.

Sickle cell disease—An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

Syngeneic—Referring to a bone marrow transplant from one identical twin to the other.

Thalassemia—A group of inherited disorders that affects hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) Because hemoglobin production is impaired, a person with this disorder may suffer mild to severe anemia. Certain types of thalassemia can be fatal.

White blood cells—A group of several cell types that occur in the bloodstream and are essential for a properly functioning immune system.

Costs

Bone marrow transplantation is an expensive procedure. (Bone marrow donors are volunteers and do not pay for any part of the procedure.) Insurance companies and health maintenance organizations (HMOs) may not cover the costs.

Preparation

A bone marrow transplant recipient can expect to spend four to eight weeks in the hospital. In preparation for receiving the transplant, the recipient undergoes "conditioning"—a preparative regimen in which the bone marrow and abnormal cells are destroyed. Conditioning rids the body of diseased cells and makes room for the marrow to be transplanted. It typically involves chemotherapy and/or radiation treatment, depending on the disease being treated. Unfortunately, this treatment also destroys healthy cells and has many side effects such as extreme weakness, nausea, vomiting, and **diarrhea**. These side effects may continue for several weeks.

Aftercare

A two– to four–week waiting period follows the marrow transplant before its success can begin to be judged. The marrow recipient is kept in **isolation** during this time to minimize potential infections. The recipient also

receives antibiotic medications and blood and platelet transfusions to help fight off infection and prevent excessive bleeding. Further side effects, such as **nausea and vomiting**, can be treated with other medications. Once blood counts are normal and the side effects of the transplant abate, the recipient is taken off **antibiotics** and usually no longer needs blood and platelet transfusions.

Following discharge from the hospital, the recipient is monitored through home visits by nurses or out-patient visits for up to a year. For the first several months out of the hospital, the recipient needs to be careful in avoiding potential infections. For example, contact with other people who may be ill should be avoided or kept to a minimum. Further blood transfusions and medications may be necessary, but barring complications, the recipient can return to normal activities about 6–8 months after the transplant.

Risks

Bone marrow transplants are accompanied by serious and life-threatening risks. Furthermore, they are not always an absolute assurance of a cure for the underlying ailment; a disease may recur in the future. Approximately 30% of people receiving allogeneic transplants do not survive. Autologous transplants have a much better survival rate—nearly 90%—but are not appropriate for all types of ailments requiring a bone marrow transplant. Furthermore, they have a higher failure rate with certain diseases, specifically leukemia.

In the short term, there is the danger of **pneumonia** or other infectious disease, excessive bleeding, or liver disorder caused by blocked blood vessels. The transplant may be rejected by the recipient's immune system, or the donor bone marrow may launch an immune-mediated attack against the recipient's tissues. This complication is called acute graft versus host disease, and it can be a life-threatening condition. Characteristic signs of the disease include **fever**, rash, diarrhea, liver problems, and a compromised immune system.

Approximately 25–50% of bone marrow transplant recipients develop long-term complications. Chronic graft versus host disease symptoms include skin changes such as dryness, altered pigmentation, and thickening; abnormal **liver function tests**; **dry mouth** and eyes; infections; and weight loss. Other long-term complications include **cataracts** (due to radiation treatment), abnormal lung function, hormonal abnormalities resulting in reduced growth or **hypothyroidism**, secondary cancers, and **infertility**.

Normal results

In a successful bone marrow transplant, the donor's marrow migrates to the cavities in the recipient's bones and produces normal numbers of healthy blood cells. Bone marrow transplants can extend a person's life, improve quality of life, and may aid in curing the underlying ailment.

Resources

BOOKS

Armitage, J. O. "Bone Marrow Transplantation." *Harrison's Principles of Internal Medicine* 14th Ed. New York, NY: McGraw Hill, Inc., 1998: 724-730.

Lonergan, Jean Nelson, et al. *Homecare Management of the Bone Marrow Transplant Patient*. 2nd ed. Boston: Jones and Bartlett Publishers, 1996.

Treleaven, Jennifer, and Peter Wiernik, ed. *Color Atlas and Text of Bone Marrow Transplantation*. St. Louis: Mosby-Wolfe, 1995.

PERIODICALS

Dreger, P. and N. Schmitz. "Allogeneic transplantation of blood stem cells: coming of age?" *Annals of Hematology* (March, 2001) 80(3):127-36.

Nuzhat, Iqbal, Donna Salzman, Audrey J. Lazenby, et al. "Diagnosis of Gastrointestinal Graft-Versus-Host Disease." *The American Journal of Gastroenterology* (November, 2000) 95:3034- 3038.

ORGANIZATIONS

American Society for Blood and Marrow Transplantation (ASBMT) 85 W. Algonquin Road, Suite 550 Arlington Heights, IL 60005. (847) 427-0224. mail@asbmt.org. Founded in 1990, a national professional association that promotes advancement of the field of blood and bone marrow transplantation in clinical practice and research.

Blood & Marrow Transplant Newsletter (Formerly BMT Newsletter). 2900 Skokie Valley Road, Suite B, Highland Park, IL 60035 (847) 433-3313. 1-888-597-7674. help@bmtinfonet.org. <http://www2.bmtnews.org>. Blood & Marrow Transplant Newsletter is a not-for-profit organization that provides publications and support services to bone marrow, peripheral blood stem cell, and cord blood transplant patients and survivors.

International Bone Marrow Transplant Registry/Autologous Blood and Marrow Transplant Registry N. America, Health Policy Institute, Medical College of Wisconsin, 8701 Watertown Plank Road, P.O. Box 26509, Milwaukee, WI 53226 USA, 414-456-8325, ibmtr@mcw.edu. Voluntary organizations of more than 400 institutions in 47 countries that submit data on their allogeneic and autologous blood and marrow transplant recipients to the IBMTR/ABMTR Statistical Center at the Medical College of Wisconsin in Milwaukee.

Health Resources and Services Administration. 5600 Fishers Lane, Rm. 14-45, Rockville, MD 20857, 301-443-3376, comments@hrsa.gov. <http://www.hrsa.gov>. HRSA manages contracts for the Organ Procurement and Transplantation Network, Scientific Registry of Transplant Recipients and National Marrow Donor Program and provides public education and technical assistance to increase

donation. HRSA also monitors the performance of the nation's transplant centers and provides potential transplant recipients with survival rates and other vital information.

Leukemia & Lymphoma Society, Inc. 1311 Mamaroneck Avenue White Plains, NY 10605, 914-949-5213 <http://www.leukemia-lymphoma.org/>. National voluntary health agency dedicated to curing leukemia, lymphoma, Hodgkin's disease and myeloma, and to improving the quality of life of patients and their families.

National Marrow Donor Program. Suite 500, 3001 Broadway Street Northeast, Minneapolis, MN 55413-1753. (800) MARROW-2. <http://www.marrow.org>. Founded in 1986, The National Marrow Donor Program (NMDP) is a non-profit international leader in the facilitation of unrelated marrow and blood stem cell transplantation.

BMT Information <http://www.bmtinfo.org/>. Web site, sponsored by a variety of other bone marrow transplant organizations, lists basic information and resources about bone marrow transplants.

National Organ and Tissue Donation Initiative <http://www.organdonor.gov/>. Created by Health Resources and Services Administration (HRSA) Department of Health and Human Services (DHHS) <http://www.os.dhhs.gov/>. Provides information and resources on organ donation and transplantation issues.

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Bone nuclear medicine scan

Definition

A bone scan is a diagnostic procedure used to evaluate abnormalities involving bones and joints. A radioactive substance is injected intravenously, and the image of its distribution in the skeletal system is analyzed to detect certain diseases or conditions.

Purpose

Bone scans are most frequently ordered to check whether a **cancer** that originated elsewhere has spread to the bones. Cancers which begin in the breasts, kidneys, lungs, prostate, thyroid, or urinary bladder are most likely to spread, or metastasize, to the bones. If metastases are found, periodic bone scans may be ordered to see if therapy is effective against a cancer.

Some cancers arise in bone. These are called primary bone cancers. When an abnormality is found on an x ray of a bone, a bone scan may be helpful in deciding if it is a primary bone cancer, or a non-cancerous (benign) condition.

Infection in the bone (**osteomyelitis**) can be detected or confirmed by a bone scan, often days or weeks before an x ray would reveal it. Bone scans are useful in diagnosing early arthritic changes, and monitoring both the progression of the disease and the effectiveness of treatment. Unexplained **pain** may be evaluated with a bone scan, because it can demonstrate **fractures** which are difficult to detect on x ray. Bone scans can be used to see if artificial joints have loosened or become infected. Suspected **child abuse** may be evaluated with a bone scan, due to its ability to see an overall pattern of repeated trauma. Abnormalities caused by altered circulation to the bone may be diagnosed with a bone scan.

Precautions

Women who are pregnant or breastfeeding should not have this test. A patient who is unable to remain still for an extended period of time may require **sedation** for a bone scan.

Description

This test is performed in a radiology facility, either in a hospital department or an outpatient x-ray center. The patient usually sits or lies down while a radioactive substance is injected through a vein in the arm. For a bone scan, the radionuclide used is specifically chosen to accumulate in the bone. The patient then waits from three to four hours, for the substance to collect within the skeletal system. During this time, he or she will be instructed to drink several glasses of water. Patients are free to get up and move around as they desire during this waiting time, and should urinate frequently. Just before the scanning begins, the patient should empty his or her bladder again. This ensures that a lot of radioactive material is not concentrated in the urinary bladder, which could obscure part of the pelvic bones.

During the scan, the patient lies on his or her back on a table, but may be repositioned to the stomach or side during the study. It is important for the patient not to move, except when directed to by the technologist.

The radionuclide scanner, sometimes called a gamma camera, or scintillation camera, is positioned against the body part to be examined. Either the camera, the table, or both, may change position during the study. For a total body bone scan, the patient is scanned from head to foot, over a period of 30-60 minutes. Patients should experience no discomfort from this examination.

A special kind of bone scan, called a SPECT (Single Photon Emission Computed Tomography) scan may be added, to study a particular part of the body in more detail. Suspected diseases of the hips, lower back, or jaw

KEY TERMS

Radioisotope—A radioactive, or radiation-emitting form, of an element.

Radionuclide—A substance which emits radiation as it disintegrates.

are often evaluated using this study. It usually takes an additional 30-45 minutes. The camera circles completely around the area in question or multiple cameras are used to create a cross-sectional image. This helps pinpoint the location of the abnormality being evaluated.

Another variation is called a three-phase, or three-stage, bone scan. The procedure is the same, except the scanning takes place immediately after the radioactive substance is injected, approximately 20 minutes after the injection, then two to four hours later.

Preparation

Some specialized blood studies should be drawn before this study is begun. Jewelry or metallic objects need to be removed. No other special physical preparation is required.

The patient should understand that there is no danger of radioactive exposure to themselves or others, as only small amounts of the radioisotope are used. The total dose of radiation absorbed is minimal, often less than the amount received from ordinary x rays. The radionuclide scanner does not emit any radiation at all, but detects and records it from the patient.

Aftercare

Fluids are encouraged after the scan to aid in the excretion of the radioisotope. It is almost completely eliminated from the body within 24 hours.

Normal results

The normal appearance of the scan will vary according to the patient's age. In general, a uniform concentration of radionuclide uptake is present in all bones in a normal scan.

Abnormal results

A high concentration of radionuclide occurs in areas of increased bone activity. These regions appear brighter and may be referred to as "hot spots". They may indicate healing fractures, tumors, infections, or other processes which trigger new bone formation. Lower concentrations of radionuclide may be called "cold spots". Poor blood flow to an area of bone, or bone destruction from tumor may produce a cold spot.

The bone scan is a very sensitive test and can detect subtle conditions more readily than other studies. However, it is not a very specific examination, and often cannot distinguish exactly what disease process is causing an abnormality. Results need to be correlated with the patient's medical history, and other radiologic and laboratory studies to make a definite diagnosis.

Resources

BOOKS

Christian, Paul E., and R. Edward Coleman. "Skeletal System." In *Nuclear Medicine*, Ed. Donald R. Bernier, et al. St. Louis: Mosby, 1997.

PERIODICALS

Sutter, Charles W., and David K. Shelton "Three-Phase Bone Scan in Osteomyelitis and Other Musculoskeletal Disorders." *American Family Physician* 54 (Oct. 1996): 1639-1648.

Ellen S. Weber, MSN

Bone tumor *see* **Sarcomas**

Bone x rays

Definition

Bone x rays are a diagnostic test in which ionizing radiation passing through the bones being examined enables an image to be produced on film.

Purpose

Bone x rays are ordered to detect disease or injury to the bone such as broken bones, tumors, and other problems. They can determine bone density, texture, erosion, and changes in bone relationships. Bone x rays also evaluate the joints for diseases such as **osteoarthritis**.

Precautions

Precautions should be taken to protect patients from unnecessary exposure to radiation. Patients should be shielded with lead aprons as much as possible. Women of childbearing age who could be pregnant should not have x rays of their trunk or pelvic regions. The fetus is espe-

cially at risk during the first trimester of **pregnancy**. Women who are pregnant should not have x rays of their pelvic region, lumbar spine, and abdomen unless absolutely necessary. If other types of x rays are necessary, a lead apron should be used to shield the abdominal and pelvic regions.

Description

X rays are a common diagnostic test in which a form of energy called x-ray radiation penetrates the patient's body. In bone x rays, electrical current passes through an x-ray tube and produces a beam of ionizing radiation that passes through the bone(s) being examined. This produces a picture of the inside of the body on film. The physician reads the developed x ray on a wall-mounted light box.

Digital x rays are a new type of x ray in which conventional equipment is used to take the x ray but the image is produced via computer. In a digital x ray, the image is created on a reusable plate. After being read by a laser reader, the information is sent in digital form to a storage unit connected to a computer network from which the radiologist reads the x ray. An electronic report can then be sent to the patient's physician.

Problems with bones that x rays can detect result from injury or from disease caused by a malfunction in the patient's bone chemistry. Bone injuries, especially broken bones (**fractures**), are common and can be accurately diagnosed by bone x rays. X rays are especially helpful in diagnosing simple and incomplete fractures which can't be detected during a **physical examination**. X rays can also be used to check for bone position in a fracture. Some bone diseases can be definitively diagnosed with bone x rays while others require additional tests.

Osteoporosis, a common bone disease, can be detected in bone x rays but other tests are then ordered to determine the extent of the disease. For osteomalacia and rickets, a blood test and x rays of the affected bone are usually definitive; in some cases a **bone biopsy** (microscopic analysis of a small ammount of tissue) is also done. In a rare bone disease called Paget's disease, x rays may be used in conjunction with bone, blood, and urine tests to make a diagnosis. In another rare bone disease, fibrous dysplasia, bone x rays or a bone biopsy (microscopic analysis of a small amount of tissue) are used to confirm the diagnosis. Bone x rays are definitive in diagnosing **osteogenesis imperfecta**. For **osteomyelitis**, bone x rays are used in conjunction with a blood test, bone scan, or needle biopsy to make the diagnosis. For arthritis, x rays of the bone are occasionally used in conjunction with blood tests. In bone tumors, bone x rays are helpful but they may not be definitive.

Bone x rays are performed by a technician or radiologist, and interpreted by a radiologist. They are taken in a physician's office, radiology unit, outpatient clinic, or diagnostic clinic. Bone x rays generally take less than 10 minutes. There is no **pain** or discomfort associated with the test, but some people find it difficult to remain still. The results are often available in minutes.

During the test, the patient lies on a table. The technician taking the x ray will check the patient's positioning and place the x-ray machine over the part of the body being examined. After asking the patient to remain motionless, he or she steps out of the area and presses a button to take the picture.

Preparation

The patient is asked to remove clothing, jewelry, and any other metal objects from the area being x rayed. If appropriate, a lead shield will be placed over other body parts to minimize exposure to radiation.

Aftercare

The patient can immediately resume normal activities.

Risks

The human body contains some natural radiation and is also exposed to radiation in the environment. There is a slight risk from exposure to radiation during bone x rays, however, the amount of radiation is small and the risk of harm is very low. If reproductive organs are exposed to radiation, genetic alterations may occur. Excessive or repeated doses of radiation can cause changes in other types of body tissue. No radiation remains in the body after the x ray.

Normal results

Normal bones show no fractures, dislocations, or other abnormalities.

Abnormal results

Results that indicate the presence of bone injury or disease differ in appearance according to the nature of the injury/disease. For example, fractures show up as clear breaks in the bones, while osteoporotic bone has the same shape as a normal bone on an x ray but is less dense.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

KEY TERMS

Arthritis—A disease of the joints that arises from wear and tear, age and less often from inflammation.

Osteogenesis imperfecta—Also called brittle bones, this is a condition present at birth in which bones are abnormally fragile, brittle and break easily.

Osteomalacia—A disease in which bones gradually soften and bend.

Osteomyelitis—An infection of the bone marrow and the bone.

Osteoporosis—A disease which occurs primarily in post-menopausal women in which the amount of bone is reduced or skeletal tissue wastes away.

Paget's disease—A disease, whose cause is unknown, which is generally found in older people. Symptoms include bone pain, bowed legs, curves spine, and broken bones. Another name for this disease is osteitis deformans.

"Tumors and Tumor-Like Lesions of the Bone." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

PERIODICALS

"FDA Approves Bone Density Measurement Device." *Women's Health Weekly* 23 (Mar. 1998), 13.

Tanner, Lisa. "New Radiology Saving Money-And Maybe Lives." *Dallas Business Journal*, 20 (25 July 1997): 23.

Wu, C. "Nylon May Take X Rays into Digital Age." *Science News*, 150 (3 Aug. 1996): 70.

OTHER

"Bone Fracture," and "Osteporosis: Improved Detection and Treatment." ThriveOnline. 15 Apr. 1998 <http://thriveonline.oxygen.com>.

Lori De Milto

Borderline personality disorder *see* **Personality disorders**

Bordetella pertussis infection *see* **Whooping cough**

Borrelia burgdorferi infection *see* **Lyme disease**

Botanical medicine *see* **Herbalism, western**

Botox injections *see* **Botulinum toxin injections**

Botulinum toxin injections

Definition

Botulinum is a bacterium (*Clostridium botulinum*) that produces seven different toxins that can cause **botulism** and is also medically used to block muscle contractions.

Purpose

Botulinum toxin (Botox) injection is used in conditions of excessive and inappropriate muscle contraction, hyperhidiosis (excess sweating) in armpits and palms, spasticity (persistent states of muscle contraction), sphincter contraction, eye-movement disorders, tics and **tremors**, and cosmetically to treat facial lines and wrinkles.

Botox has also been explored in the treatment of chronic muscle tension and migraine headaches. The relief is likely due to the decrease in localized muscle spasms, as no direct effect of Botox on the sensory nerves has been established.

Precautions

Botulinum toxin is produced from the bacterium that causes **food poisoning** in humans. High doses of the toxin can be fatal; however, doses administered therapeutically are so small that harmful effects are uncommon.

Description

The number of potential applications for botulinum toxin extends to every muscle group. The first therapeutic use of Botox was in the treatment of **strabismus** (eyes are unable to direct towards the same object) and since then it has been used to treat a variety of involuntary muscle contractions or disorders. Its cosmetic use is the result of treatment for facial spasms where smoothing of facial lines was reported by patients. In general, 90% of injections for facial spasms are resolved satisfactorily.

Toxin type A has a duration of effect that lasts approximately three months and is the therapeutic agent of choice for most conditions.

Preparation

The dosage of Botox must be monitored and adjusted, with multiple injections showing a lower incidence of complications versus administration by one larger dose.

Risks

In over 30 years of therapeutic use in humans, botulinum toxin has proven to be remarkably safe. Difficul-

KEY TERMS

Antibodies—A protein developed in response to the presence of a foreign substance.

Immunoresistance—The presence of circulating antibodies.

Neuromuscular junction—Interface between motor nerve ending and muscle tissue.

Serotype—Microorganisms differing in the type of surface antigens.

Antigen—A foreign substance inducing an antibody response within the body.

ties associated with administration of toxin are: different patients may experience different effects at the same dose, patients new to the treatment may experience exaggerated effects at subsequent visits and/or neighboring muscles may become activated at subsequent treatments.

Additional side effects may include excessive muscle weakness at the injection site or adjacent muscles. These effects typically resolve quickly. Occasionally, patients report flu-like symptoms but they are usually self-limited.

A certain percentage of patients may also experience resistance to the toxin. The presence of circulating antibodies to the toxin is presumed to be the primary reason for resistance to Botox injections. Patients who have little reaction to Botox 'A' may benefit from injections using one of the other six serotypes. Using the smallest effective dose limits the likelihood of immunoresistance in unresponsive patients.

Normal results

The anticipated outcome of Botox injections is relaxation of the target muscle tissue. The pharmacological effects of botulinum toxin are typically isolated to local areas and do not result in tissue destruction or prolonged **paralysis**. Varying the dose can deliver a precise amount of toxin to achieve graded degrees of paralysis for the desired level of response.

Resources

BOOKS

Brin M.F. *Botulinum Toxin Therapy: Basic Science and Overview of Other Therapeutic Applications* Department of Neurology, Movement Disorders Program, The Mount Sinai Medical Center, New York, New York 10029.

Blitzer, A., W. J. Binder, J. Brian Boyd, and Alastair Carruthers. *Management of Facial Lines and Wrinkles*. Philadelphia: Lippincott Williams & Wilkins, 1999.

OTHER

Blitzer A and L. Sulica. "Botulinum toxin: basic science and clinical uses in otolaryngology." New York Center for Voice and Swallowing Disorders, St. Luke's Roosevelt Hospital Center.

Bonny McClain, DC

Botulism

Definition

Botulism is caused by botulinum toxin, a natural poison produced by certain bacteria in the *Clostridium* genus. Exposure to the botulinum toxin occurs mostly from eating contaminated food, or in infants, from certain clostridia growing in the intestine. Botulinum toxin blocks motor nerves' ability to release acetylcholine, the neurotransmitter that relays nerve signals to muscles, and flaccid **paralysis** occurs. As botulism progresses, the muscles that control the airway and breathing fail.

Description

Botulism occurs rarely, but it incites concern because of its high fatality rate. Clinical descriptions of botulism possibly reach as far back in history as ancient Rome and Greece. However, the relationship between contaminated food and botulism wasn't defined until the late 1700s. In 1793 the German physician, Justinius Kerner, deduced that a substance in spoiled sausages, which he called *wurstgift* (German for sausage poison), caused botulism. The toxin's origin and identity remained elusive until Emile von Ermengem, a Belgian professor, isolated *Clostridium botulinum* in 1895 and identified it as the poison source.

Three types of botulism have been identified: food-borne, wound, and infant botulism. The main difference between types hinges on the route of exposure to the toxin. In the United States, there are approximately 110 cases of botulism reported annually. Food-borne botulism accounts for 25% of all botulism cases and can be traced to eating contaminated home-preserved food. Infant botulism accounts for 72% of all cases, but the recovery rate is good (about 98%) with proper treatment.

Though domestic **food poisoning** is a problem world-wide, there has been a growing concern regarding the use of botulism toxin in biological warfare and terror-

ist acts. The Iraqi government admitted in 1995 that it had loaded 11,200 liters of botulinum toxin into SCUD missiles during the Gulf War. Luckily, these special missiles were never used. As of 1999, there were 17 countries known to be developing biological weapons, including the culture of botulism toxins.

Causes and symptoms

Causes

Toxin produced by the bacterium *Clostridium botulinum* is the main culprit in botulism. Other members of the *clostridium* genus can produce botulinum toxin, namely *C. argentinense*, *C. butyricum*, and *C. baratii*, but they are minor sources. To grow, these bacteria require a low-acid, oxygen-free environment that is warm (40-120°F or 4.4-48.8°C) and moist. Lacking these conditions, the bacteria transform themselves into spores that, like plant seeds, can remain dormant for years. Clostridia and their spores exist all over the world, especially in soil and aquatic sediments. They do not threaten human or animal health until the spores encounter an environment that favors growth. The spores then germinate, and the growing bacteria produce the deadly botulism toxin.

Scientists have discovered that clostridia can produce at least seven types of botulism toxin, identified as A, B, C, D, E, F, and G. Humans are usually affected by A, B, E, and very rarely F. Domesticated animals such as dogs, cattle, and mink are affected by botulism C toxin, which also affects birds and has caused massive die-offs in domestic bird flocks and wild waterfowl. Botulism D toxin can cause illness in cattle, and horses succumb to botulism A, B, and C toxin. There have been no confirmed human or animal botulism cases linked to the G toxin.

In humans, botulinum toxin latches onto specific proteins in nerve endings and irreversibly destroys them. These proteins control the release of acetylcholine, a neurotransmitter that stimulates muscle cells. With acetylcholine release blocked, nerves are not able to stimulate muscles. Ironically, botulinum toxin has found a beneficial niche in the world of medicine due to this action. Certain medical disorders are characterized by involuntary and uncontrollable muscle contractions. Medical researchers have discovered that injecting a strictly controlled dose of botulinum toxin into affected muscles inhibits excessive muscle contractions. The muscle is partially paralyzed and normal movement is retained.

Symptoms

The three types of human botulism include the following symptoms:

- Food-borne. Food that has been improperly preserved or stored can harbor botulinum toxin-producing clostridia. Botulism symptoms typically appear within 18-36 hours of eating contaminated food, with extremes of four hours to eight days. Initial symptoms include blurred or double vision and difficulty swallowing and speaking. Possible gastrointestinal problems include **constipation**, nausea, and vomiting. As botulism progresses, the victim experiences weakness or paralysis, starting with the head muscles and progressing down the body. Breathing becomes increasingly difficult. Without medical care, **respiratory failure** and **death** are very likely.
- Infant. Infant botulism was first described in 1976. Unlike adults, infants younger than 12 months are vulnerable to *C. botulinum* colonizing the intestine. Infants ingest spores in honey or simply by swallowing spore-containing dust. The spores germinate in the large intestine and, as the bacteria grow, they produce botulinum toxin that is absorbed into the infant's body. The first symptoms include constipation, lethargy, and poor feeding. As infant botulism progresses, sucking and swallowing (thus eating) become difficult. A nursing mother will often notice breast engorgement as the first sign of her infant's illness. The baby suffers overall weakness and cannot control head movements. Because of the flaccid paralysis of the muscles, the baby appears "floppy." Breathing is impaired, and death from respiratory failure is a very real danger.
- Wound. Confirmed cases of wound botulism have been linked to trauma such as severe crush injuries to the extremities, surgery, and illegal drug use. Wound botulism occurs when clostridia colonize an infected wound and produce botulinum toxin. The symptoms usually appear four to 18 days after an injury occurs and are similar to food-borne botulism, although gastrointestinal symptoms may be absent.

Diagnosis

Diagnosis of botulism can be tricky because symptoms mimic those presented by other diseases. Botulism may be confused with Guillain-Barre syndrome, **myasthenia gravis**, drug reactions, **stroke**, or nervous system infection, intoxications (e.g. carbon monoxide or atropine), or shellfish **poisoning**. **Sepsis** is the most common initial diagnosis for infant botulism. **Failure to thrive** may also be suspected. Some reports have linked infant botulism to 5-15% of **sudden infant death syndrome** (SIDS, crib death) cases. Laboratory tests are used for definitive diagnosis, but if botulism seems likely, treatment starts immediately.

While waiting for laboratory results, doctors ask about recently consumed food and work to dismiss other

KEY TERMS

Acetylcholine—A chemical released by nerve cells to signal other cells.

Antitoxin—A substance that inactivates a poison (e.g., toxin) and protects the body from being injured by it.

CT scan—The abbreviated term for computed or computerized axial tomography. The test involves injecting a radioactive substance into the body. Computers are used to scan for radiation and create three-dimensional images of internal organs.

Electromyographic test—A medical test which determines if a muscle's response to electrical stimuli. The test results allow medical personnel to assess how nerves to the muscle are functioning.

Flaccid paralysis—Paralysis characterized by limp, unresponsive muscles.

Lumbar puncture—A procedure in which a small amount of cerebrospinal fluid is removed from the lower spine. Examination of this fluid helps diagnose certain illnesses.

MRI—The abbreviated term for magnetic resonance imaging. MRI uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Neurotransmitter—A chemical found in nerves which relays nerve signals to other cells. Acetylcholine is a neurotransmitter.

Sepsis—The presence of infection-causing organisms or associated toxins in the blood or within body tissues.

Spores—A state of "suspended animation" that some bacteria can adopt when conditions are not ideal for growth. Spores are analogous to plant seeds and can germinate into growing bacteria when conditions are right.

Toxin—A poisonous substance produced by a microorganism, plant, or animal.

Tracheostomy—The procedure used to open a hole in the neck to the trachea, or windpipe. It is sometimes used in conjunction with a respirator.

disease possibilities. A **physical examination** is done with an emphasis on the nervous system. As part of this examination, CT scans, MRIs, electromyographic tests, or lumbar punctures may be ordered. Laboratory tests involve testing a suspected food and/or the patient's serum, feces, or other specimens for traces of botulinum toxin or clostridia.

Treatment

Drugs

Adults with botulism are treated with an antitoxin derived from horse serum that is distributed by the Centers for Disease Control and Prevention. The antitoxin (effective against toxin types A, B, and E) inactivates only the botulinum toxin that is unattached to nerve endings. Early injection of antitoxin (usually within 24 hours of onset of symptoms) can preserve nerve endings, prevent progression of the disease, and reduce mortality.

Infants, however, cannot receive the antitoxin used for adults. For them, human botulism immune globulin (BIG) is available in the United States through the Infant Botulism Treatment and Prevention Program in Berkeley, California. BIG neutralizes toxin types A, B, C, D, and E before they can bind to nerves. This antitoxin can provide protection against A and B toxins for approximately four months. Though many infants recover with supportive care, BIG cuts hospital stay in half, and therefore reduces hospital costs by 50% as well.

Aside from antitoxin, no drugs are used to treat botulism. **Antibiotics** are not effective for preventing or treating botulism. In fact, antibiotic use is discouraged for infants because dying bacteria could potentially release more toxin into a baby's system. Antibiotics can be used, however, to treat secondary respiratory tract and other infections.

Respiratory support

Treatment for infants usually involves intensive respiratory support and tube feeding for weeks or even months. Once an infant can breathe unaided, physical therapy is initiated to help the child relearn how to suck and swallow. A respirator is often required to help adult patients breathe, and a tracheostomy may also be necessary.

Surgery

Surgery may be necessary to clean an infected wound and remove the source of the bacteria that is producing the toxin. Antimicrobial therapy may be necessary.

Gastric lavage

When botulism is caused by food, it often is necessary to flush the gastrointestinal tract (gastric lavage). Often cathartic agents or **enemas** are used. It is important to avoid products that contain magnesium, since magnesium enhances the effect of the toxin.

Prognosis

With medical intervention, botulism victims can recover completely, albeit slowly. It takes weeks to months to recover from botulism, and severe cases can take years before a total recovery is attained. Recovery depends on the nerve endings building new proteins to replace those destroyed by botulinum toxin.

Prevention

Vaccines against botulism do not exist to prevent infant botulism or other forms of the disease. Food safety is the surest prevention for botulism. Botulinum toxin cannot be seen, smelled, or tasted, so the wisest course is to discard any food that seems spoiled *without tasting it*. Home canners must be diligent about using sterile equipment and following U.S. Department of Agriculture canning guidelines. If any part of a canned food container is rusty or bulging, the food should not be eaten. Infant botulism is difficult to prevent, because controlling what goes into an infant's mouth is often beyond control, especially in regard to spores in the air. One concrete preventative is to never feed honey to infants younger than 12 months since it is one known source of botulism spores. As infants begin eating solid foods, the same food precautions should be followed as for adults.

Resources

BOOKS

Arnon, Stephen S. "Infant Botulism." In *Textbook of Pediatric Infectious Diseases, 4th edition,* edited by R.D. Feigen and J.D. Cherry, Philidelphia: W.B. Saunders, 1998.

Arnon, Stephen S. "Botulism as an Intestinal Toxemia." In *Infections of the Gastrointestinal Tract,* edited by M.J. Blaser et al., New York: Raven Press, 1995.

PERIODICALS

Cadou, Stephanie G. "Diagnosing Infant Botulism." *The Nurse Practitioner.* (March 2001) 26(3): 76.

Kessler, Kirn R., and Reiner Benecke. "Botulinum Toxin: From Poison to Remedy." *NeuroToxicology* 18(1997): 761.

Shapiro, Roger L. and David L. Swerdlow. "Botulism: Keys to Prompt Recognition and Therapy." *Consultant.* (April 1999): 1021- 1024.

Janie Franz

Bovine spongiform encephalopathy *see* **Creutzfeldt-Jakob disease**

Bowel incontinence *see* **Fecal incontinence**

Bowel preparation

Definition

Bowel preparation is a procedure usually undertaken before a diagnosis and /or treatment can be initiated for certain colon and rectum diseases. Bowel preparation is a cleansing of the intestines from fecal matter and secretions.

Purpose

The ultimate goal of bowel preparation is priming the bowel for a diagnosis procedure (using x rays to detect a disease process in the intestines) or for surgical intervention (such as removal of polyps, **cancer**, or narrowing of the intestinal diameter). **Colonoscopy** is an effective treatment procedure for polyps (a growing mass of tissue). This procedure enables visualization of the entire large bowel. During a colonoscopy, polyps can be cauterized (applying an electric current which incinerates the polyp). The procedure can be both diagnostic and therapeutic. A **sigmoidoscopy** scope is a flexible tube that allows clinicians to view the sigmoid colon (the part of the large intestine before the rectum). This procedure is important for detection of colon/rectal cancer. It is safe, quick to perform (usually 30–45 minutes in about 90% of cases), and an effective diagnostic tool for evaluation of:

- rectal bleeding
- other studies that showed an abnormality
- removal of polyps
- biopsy
- evaluation of chronic **diarrhea** or inflammatory bowel disease
- to detect recurrences for colon/rectal cancer or polyps
- relieving a twisted bowel
- foreign body removal
- treating bleeding lesions
- preventive surveillance of cancer in patients with a positive family history of colon cancer

Precautions

Antibiotic **prophylaxis** is not routinely recommended. In some cases of prosthetic heart valves, **antibiotics** can be prescribed. Evidence exists that evacuation of intestinal waste products in conjunction with antibiotics

before (prophylactic) the procedure reduces the possibility of **sepsis** (infection which spreads from the primary site to blood).

Description

The bowel is emptied of any contents for procedures such as **barium enema** (introducing a barium containing chemical to promote better visualization of intestines during x rays) or colonoscopy. Preparation of the bowel distally—from the rectum—is necessary for diagnostic procedures such as sigmoidoscopy. Prior to surgical procedures bowel preparation is recommended to decrease the possibility of developing more medical problems. Patients may also be given a course of antibiotics to prevent the possibility of infection.

Preparation

Bowel preparation for visualization of the colon is performed to ensure the procedure will be accurate and complete. There are several effective cleansing preparations that include: Polyethylene glycol solution, Magnesium citrate with bisacodyl tablets, and Castor oil with bisacodyl tablets. One of these preparations should be administered starting at 4:00 P.M. the day before the procedure.

Aftercare

After the preparation has been ingested the patient is advised to only ingest clear liquids until midnight.

Risks

The current standard of care dictates that patients receive antibiotic prophylaxis if they are high risk for developing an infection. High-risk patients include those with cardiac diseases or patients who have a prostheses.

Normal results

Absence of anatomical changes or abnormalities in the intestines would result in normal diagnosis.

Abnormal results

Polyps can be treated with electrocautery. A biopsy is taken of any suspicious polyps and further analyzed. Sigmoidoscopy can detect masses, bleeding, and ulcerative disease.

Resources

BOOKS

Pfenninger, John L., et al. *Procedures for Primary Care Physicians.* 1994.

Tierney, Lawrence M., et al, eds. *Current Medical Diagnosis and Treatment 2001.* 40th ed. MCGraw-Hill, 2001.

KEY TERMS

Lesion—An abnormal change in tissues.

Polyp—A growing mass of tissue.

PERIODICALS

Sturmann, K. "Neurologic Emergencies: The Neurologic Examination." *Emergency Medicine Clinics of North America* 15 (Aug. 1997).

ORGANIZATIONS

American College of Gastroenterology. 4900 B South 31st Street, Arlington, VA 22206. (703) 820-7400. <http://www.acg.gi.org/ct_html>.

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Bowel resection

Definition

A bowel resection is a surgical procedure in which a part of the large or small intestine is removed.

Purpose

Bowel resection may be performed to treat various disorders of the intestine, including **cancer**, obstruction, inflammatory bowel disease, ruptured diverticulum, **ischemia** (compromised blood supply), or traumatic injury.

Description

The preferred type of bowel resection involves removal of the diseased portion of intestine, and surgically re-joining the remaining ends. In this procedure, the continuity of the bowel is maintained and normal passage of stool is preserved. When deemed necessary by the surgeon, the diseased portion of the bowel may be removed, and the functioning end of the intestine may be brought out onto the surface of the abdomen, forming an temporary or permanent **ostomy**. Use of the large intestine to form the ostomy results in a **colostomy**; use of small intestine to form the ostomy results in an ileostomy.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is

KEY TERMS

Diverticulum—Small tubes or pouches that project off the wall of the intestine, visible as opaque on an x ray after the patient has swallowed a contrast (dye) substance.

Embolism—Blockage of a blood vessel by any small piece of material traveling in the blood. The emboli may be caused by germs, air, blood clots, or fat.

Ischemia—A compromise in blood supply to body tissues that causes tissue damage or death.

Ostomy—A surgically-created opening in the abdomen for elimination of waste products (urine or stool).

explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiogram (EKG) may be ordered as the doctor deems necessary. In order to empty and cleanse the bowel, the patient may be placed on a low residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing taken by mouth after midnight. A series of **enemas** and/or oral preparations (GoLytely or Colyte), may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent post-operative infection. A nasogastric tube is inserted through the nose into the stomach on the day of surgery or during surgery. This removes the gastric secretions and prevents **nausea and vomiting**. A urinary catheter (thin tube inserted into the bladder) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

Aftercare

Post-operative care for the patient who has had a bowel resection, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience **pain** that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and is given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids and advancing to a regular diet as tolerated. The patient is generally out of bed approximately eight to 24 hours after surgery. Postoperative weight loss follows almost all bowel resections. Weight and strength are slowly regained over a period of months.

Risks

Potential complications of this abdominal surgery include:

- excessive bleeding
- surgical wound infection
- incisional **hernia** (An organ projects through the muscle wall that surrounds it. The hernia occurs through the surgical scar.)
- thrombophlebitis (inflammation and blood clot to veins in the legs)
- pneumonia
- pulmonary **embolism** (blood clot or air bubble in the lungs' blood supply)

Normal results

Complete healing is expected without complications after bowel resection. The period of time required for recovery from the surgery may vary depending of the patient's overall health status prior to surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, **dizziness**, fever
- increased abdominal pain or swelling, **constipation**, nausea or vomiting, rectal bleeding, or black, tarry stools

Resources

BOOKS

Doughty, Dorothy. *Urinary and Fecal Incontinence*. St. Louis: Mosby-Year Book, Inc., 1991.

Hampton, Beverly, and Ruth Bryant. *Ostomies and Continent Diversions*. St. Louis: Mosby-Year Book, Inc., 1992.

Monahan, Frances. *Medical-Surgical Nursing*. Philadelphia: W. B. Saunders Co., 1998.

Suddarth, Doris. *The Lippincott Manual of Nursing*. Philadelphia: J. B. Lippincott, 1991.

ORGANIZATIONS

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. <http://www.uoa.org>.

Wound Ostomy and Continence Nurses Society. 1550 South Coast Highway, Suite #201, Laguna Beach, CA 92651. (888) 224-WOCN. Fax: (949) 376-3456. <http://www.wocn.org>.

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Bowel surgery with ostomy *see* **Colostomy**

Bowel training

Definition

Bowel training helps to reestablish normal bowel movements in persons who suffer from **constipation**, **diarrhea**, incontinence, or irregularity. Healthy bowel activity is considered one or two movements of moderate size every day.

Purpose

Many people for many reasons have irregular bowel function. In some cases, the irregularity lasts beyond the condition that caused it. The bowels by themselves develop bad habits that can be retrained with suitable exercises and education. Normal bowel habits not only improve the quality of life, they help prevent several common diseases—for example, diverticulitis and fecal impaction. Gall stones, **appendicitis**, **colon cancer**, hiatal **hernia**, diabetes, and heart disease have also been related to the quality of bowel movements and the foods that affect them.

- One of the most common causes of constipation is the laxative habit. Repeated artificial stimulation of the bowels destroys their natural emptying reflex, so that they will no longer move without artificial stimulants. The laxative habit begins innocently enough with the correct belief that bowels should move every day, however, **laxatives** will cause the evacuation of several days worth of stool in a single movement. Impatient for stool to reaccumulate for the necessary few days, the patient takes another laxative, and the cycle begins.
- The other major cause of constipation is a diet with insufficient bulk or roughage. The bowel works more smoothly the more contents it has. Western **diets** of highly refined foods have eliminated most of the residue from food. The result is that most food is absorbed, leaving little to pass through and be excreted as feces.
- Constipation occurs acutely with impaction—the presence in the rectum of a mass of feces too large to pass. Fecal impaction is usually the result of poor bowel habits, a diet with too little liquid and roughage, and inadequate physical activity.
- Diarrhea, whether acute or chronic, can disrupt the bowel's normal rhythm and lead to irregularity.
- Several diseases of the nervous system affect bowel reflexes.

Description

Bowel training reestablishes the bowel's normal reflexes by repeating a routine until it becomes a habit. Naturally the patient must be able and willing to cooperate. Some patients are so convinced they need daily laxatives that they are afraid to do without them. It takes time for a changed diet to effect the bowels and for the bowel to regain its normal rhythm. Trust and patience are necessary.

After gaining the patient's cooperation, the next step is to optimize the diet. Healthy bowel movements require ingestion of a large amount of liquids and bulk foods. The patient should drink two to three quarts of liquids every day, with liberal inclusion of prune juice and perhaps coffee for their natural laxative effect. Bulk comes from unrefined foods. Oat bran, wheat bran, brown rice, green vegetables, apples, and pears are a few examples of high residue foods. Many patients will benefit from adding bulk preparations of psyllium. Constipating foods like bananas and cheese should be avoided until a natural rhythm is well established.

To assure that stools are soft enough to pass easily, it is a good idea to add a pure stool softener like DOSS (dioctyl sodium sulfosuccinate), two to four per day as needed. DOSS also helps prevent impaction.

There is usually a time of day when bowel movements are more likely to occur. In anticipation of this time, the patient should participate in activities that stimulate a normal bowel movement. Walking, eating unrefined foods, and drinking prune juice or coffee, encourage natural evacuation. It is acceptable to use lubricants such as glycerine suppositories or oil **enemas** at this time. For severe constipation, water enemas may be needed to initiate a movement.

It is also important for the patient to recognize the urge to defecate and to respond right away to that urge. The longer stool sits in the rectum, the more water the rectum will absorb from it, making it harder and more difficult to pass.

Normal results

With patience and diligence, normal bowel habits and the health that comes with them will return in most patients.

KEY TERMS

Defecate—To pass feces (stool) out of the rectum through the anus.

Diverticulitis—Infection of outpouchings in the large bowel.

Fecal impaction—Obstruction of the rectum by a large mass of feces (stool).

Hiatal hernia—Part of the stomach displaced through the diaphragm into the chest.

Resources

BOOKS

"Bowel Training." *Mosby's Medical, Nursing, and Allied Health Dictionary.* Mosby-Year Book, Inc., 1994.

Burkitt, D. P., and H. C. Trowell, ed. *Refined Carbohydrate Foods and Disease: Some Implications of Dietary Fibre.* New York: Academic Press, 1975.

Barker, L. Randol, et al., eds. *Principles of Ambulatory Medicine.* Baltimore: William & Wilkins, 1994.

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Braces *see* **Immobilization**

Brachytherapy *see* **Radioactive implants**

Brain abscess

Definition

Brain **abscess** is a bacterial infection within the brain.

Description

The brain is usually well insulated from infection by bacteria, protected by the skull, the meninges (tissue layers surrounding the brain), the immune system, and the highly regulated barrier between the bloodstream and the brain. Under certain circumstances, however, bacteria can invade the brain and cause a localized infection called an abscess. Brain abscess is relatively rare, accounting for 1 in 10,000 hospital admissions. Single abscess occurs in 75% of cases, and the remainder of cases involve multiple abscesses. If not treated, brain abscess is almost always fatal.

Causes and symptoms

One-half of all brain abscesses are caused by the spread of bacteria from a nearby infection. Sources of bacteria include:

- middle ear infections (**otitis media**) or infections in the bony spaces in front of the middle ear (**mastoiditis**)
- sinus infections
- an abscessed tooth.

Other sources of bacteria include:

- lung infections
- abdominal infection
- infection of the heart's lining (**endocarditis**)
- penetrating head **wounds**
- neurosurgery

Acquired Immune Deficiency Syndrome (**AIDS**) or the presence of another immune deficiency greatly increases the risk of brain abscess. Approximately 25% of cases have no detectable cause of infection.

Brain abscess can be caused by a variety of organisms, many of them related to ear and sinus infections. Many times brain abscess cases are caused by two or more bacteria. In 30–60% of cases, the bacteria combination includes streptococci, microorganisms that can live without oxygen (anaerobes), and enterobacteria. A small number of cases are caused by yeast, fungi, and single-cell organisms (protozoa).

The symptoms of brain abscess often develop slowly, usually within a period of about two weeks. The most common symptoms are:

- headache
- neurologic symptoms related to the specific part of the brain that is infected
- altered mental status
- seizures

Fever and stiff neck occur in less than one-third of cases. Additional symptoms may include vomiting, eye tremor (**nystagmus**), poor balance, and uncoordinated movements.

Diagnosis

Diagnosis of brain abscess is performed by using a computed tomography scan (CT) or a **magnetic resonance imaging** (MRI) scan to determine the site of infection. Tissue removal (biopsy) is usually performed as well. A biopsy is performed to determine the type of bacterium involved. Biopsies can also be used to rule out

tumor or other noninfectious localized lesions, which may look the same on the scans.

Other tests are performed to determine the source of the infection. These tests include blood cultures, x rays of the chest, and a physical exam of the ears, sinuses, and teeth. A test for human **immunodeficiency** virus (HIV) is usually also performed.

Treatment

Treatment for brain abscess begins with intravenous **antibiotics**, chosen to match the infecting bacterium if known, or to cover a wide spectrum of possibilities if not. Treatment usually continues for six to eight weeks.

Aspiration surgery is almost always done to drain the abscess. In this procedure, a needle is guided to the infected site by CT scan, and fluid is removed (aspirated) from the abscess. Aspiration may be repeated several times until the bacteria are completely killed or removed. Surgical removal of infected or dead tissue may be needed in some cases. For patients with many sites of infection, aspiration or surgical removal is not done because of the increased difficulty and risk of the procedure. For these patients, antibiotic therapy alone is used. Steroid treatment is controversial, but may be indicated in some cases.

Prognosis

Even with prompt treatment, brain abscess is fatal in about 20% of cases. About half of those who survive have some residual neurological problems, including seizures in many patients.

There are several reasons why patients with brain abscess can have a poor prognosis. The illness may not be diagnosed correctly or an accurate diagnosis may take additional time. The patient may receive an antibiotic that does not match the infecting organism. Sometimes the infection may not be limited to a definite area in the brain, making diagnosis and treatment difficult. The small number of cases caused by fungal infection may take additional time to diagnose. A patient may also have a poor prognosis because there is more than one abscess, the location of the abscess may be deep within the brain, or the infection may have moved into many locations within the brain. Severe complications can result from brain abscess, including comma and brain rupture. In 80-100% of cases involving brain rupture, the patient dies.

Prevention

Brain abscess may be preventable by prompt and aggressive treatment of the infections which give rise to it, especially sinus and ear infections.

KEY TERMS

Biopsy—The removal of a tissue sample for examination.

Aspiration—Removal of fluid from a closed space through a needle.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Rolak, Loren A. "Brain and Spinal Abscesses." In *Office Practice of Neurology*, Ed. Martin Samuels and Steven Feske. New York: Churchill Livingstone, 1996.

Wispelwey, Brian, and Carole A. Sable. "Intracranial Suppuration." In *Current Therapy of Infectious Disease*, Ed. David Schlossberg. St. Louis: Mosby-Year Book, 1996.

Richard Robinson

Brain aneurysm *see* **Cerebral aneurysm**

Brain biopsy

Definition

A brain biopsy is the removal of a small piece of brain tissue for the diagnosis of abnormalities of the brain, such as **Alzheimer's disease**, tumors, infection, or inflammation.

Purpose

By examining the tissue sample under a microscope, the biopsy sample provides doctors with the information necessary to guide diagnosis and treatment.

Precautions

Imaging of the brain is performed to determine the precise positioning of the needle to enter the brain.

Description

When an abnormality of the brain is suspected, Stereotactic (probing in three dimensions) brain needle biopsy is performed and guided precisely by a computer system to avoid serious complications. A small hole is

KEY TERMS

Alzheimer's disease—A progressive, neurodegenerative disease characterized by loss of function and death of nerve cells in several areas of the brain, leading to loss of mental functions such as memory and learning.

Computed axial tomography (CT)—Computed axial tomography (CT) is a x-ray technique that has the ability to image soft tissue, bone, and blood vessels.

Cortex—The thin convoluted surface of the brain comprised primarilyof cell bodies of neurons.

MRI—Magnetic resonance imaging is an imaging technique that uses radiowaves, magnetic fields, and computer analysis to visualize body tissue and structures.

Stereotactic brain needle biopsy—In this procedure a computer uses information from a CT or MRI to create a three-dimensional map of the operation site to better guide the needle to perform the biopsy.

drilled into the skull, and a needle is inserted into the brain tissue guided by computer-assisted imaging techniques (CT or MRI scans). Historically, the patient's head was held in a rigid frame to direct the probe into the brain; however since the early nineties, it has been possible to perform these biopsies without the frame. Since the frame was attached to the skull with screws, this advancement is less invasive and better tolerated by the patient. The doctor (pathologist) prepares the sample for analysis and studies it further under a microscope.

Preparation

A CT or MRI brain scan is done to find the position where the biopsy will be performed. Prior to the biopsy, the patient is placed under general anesthesia.

Aftercare

The patient is monitored in the recovery room for several hours and is usually required to spend a few days in the hospital since general anesthesia is required.

Risks

The procedure is invasive and includes risks associated with anesthesia and surgery. Brain injury may occur due to removal of brain tissue. The resulting scar, left on the brain has the potential to trigger seizures.

Normal results

After examining the brain tissue directly, no abnormalities are detected.

Abnormal results

Various brain abnormalities can be diagnosed by microscopic analysis of the tissue sample. The pathologist (a physician trained in how disease affects the body's tissues) looks for abnormal growth, changes in cell membranes, and/or abnormal collections of cells. In Alzheimer's disease, the cortex of the brain contains abnormal collections of plaques. If infection is suspected, the infectious organism can be cultured from the tissue and identified. Classification of tumors is also possible after biopsy.

Resources

BOOKS

Zaret, B. L. *The Yale University School of Medicine Patient's Guide to Medical Tests*. Yale University School of Medicine and G.S. Sharpe Communications Inc., 1997.

ORGANIZATIONS

Alzheimer's Association. 919 North Michigan Avenue, Suite 1100 Chicago, IL 60611-1676.(800) 272-3900 <http://www.alz.org/chapter/>.

American Brain Tumor Association. 2720 River Road, Suite 146, Des Plaines, IL 60018-4110. (800) 886-2282. <http://www.abta.org>.

National Institute of Neurological Disorders and Stroke, NIH Neurological Institute. P.O. Box 5801 Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

Bonny McClain, MS

Brain circulation scan *see* **Transcranial Doppler ultrasonography**

Brain infection *see* **Encephalitis**

Brain injury *see* **Head injury**

Brain surgery *see* **Craniotomy**

Brain tumor

Definition

A brain tumor is an abnormal growth of tissue in the brain. Unlike other tumors, brain tumors spread by local

extension and rarely metastasize (spread) outside the brain. A benign brain tumor is composed of non-cancerous cells and does not metastasize beyond the part of the brain where it originates. A brain tumor is considered malignant if it contains **cancer** cells, or if it is composed of harmless cells located in an area where it suppresses one or more vital functions.

Description

Each year, more than 17,000 brain tumors are diagnosed in the United States. About half of all primary brain tumors are benign, but in life-threatening locations. The rest are malignant and invasive.

Benign brain tumors

Benign brain tumors, composed of harmless cells, have clearly defined borders, can usually be completely removed, and are unlikely to recur. Benign brain tumors do not infiltrate nearby tissues but can cause severe **pain**, permanent brain damage, and **death**. Benign brain tumors sometimes become malignant.

Malignant brain tumors

Malignant brain tumors do not have distinct borders. They tend to grow rapidly, increasing pressure within the brain (IICP) and can spread in the brain or spinal cord beyond the point where they originate. It is highly unusual for malignant brain tumors to spread beyond the central nervous system (CNS).

Primary brain tumors

Primary brain tumors originate in the brain. They represent about 1% of all cancers and 2.5% of all cancer deaths.

Metastatic or secondary brain tumors

Approximately 25% of all cancer patients develop secondary or metastatic brain tumors when cancer cells spread from another part of the body to the brain. Secondary brain tumors are most apt to occur in patients who have:

- breast cancer.
- colon cancer.
- kidney cancer.
- lung cancer.
- melanoma (cancer) of the skin. These metastatic brain tumors can develop on any part of the brain or spinal cord.
- cancer within the nasal passages and/or throat that follow the nerve pathways into the skull, and metastasize to the brain.

Who gets brain tumors

Brain tumors can develop at any age, but are most common in children between the ages of 3-12, and in adults aged 55-65. Primary brain cancer is the second most common cause of cancer death between birth and the age of 34, and the fourth most common cause of cancer death in men aged 35-54. Primary tumors of the brain and central nervous system are often associated with HIV infection. Men and caucasians have a higher risk of developing brain tumors. Other risk factors being studied include children with a history of previous radiation treatment to the head for cancer; parents with certain cancers (nervous system, salivary gland, colon); having an older father; having well-educated parents; occupational exposure to vinyl chloride, lead, and pesticides; history of epilepsy; history of certain genetic conditions (tuberous sclerosis, **neurofibromatosis**, von Hippel Lindau, **familial polyposis**, Osler-Weber-Rendu, Li-Fraumeni).

Naming and grading brain tumors

The name of a brain tumor describes where it originates, how it grows, and what kind of cells it contains. A tumor in an adult is also graded or staged according to:

- how malignant it is
- how rapidly it is growing and how likely it is to invade other tissues
- how closely its cells resemble normal cells. (The more abnormal a tumor cell looks, the faster it is likely to grow)

Low-grade brain tumors usually have well-defined borders. Some low-grade brain tumors form or are enclosed (encapsulated) in cysts. Low-grade brain tumors grow slowly, if at all. They may spread throughout the brain, but rarely metastasize to other parts of the body.

Mid-grade and high-grade tumors grow more rapidly than low-grade tumors. Described as "truly malignant," these tumors usually infiltrate healthy tissue. The growth pattern makes it difficult to remove the entire tumor, and these tumors recur more often than low-grade tumors.

A single brain tumor can contain several different types of cells. The tumor's grade is determined by the highest-grade (most malignant) cell detected under a microscope, even if most of the cells in the tumor are less malignant. An infiltrating tumor is a tumor of any grade that grows into surrounding tissue.

Types of brain tumors

Glioma is the term used to refer to the most prevalent primary brain tumors. Gliomas arise from glial tissue, which supports and nourishes cells that send messages from the brain to other parts of the body. These tumors may be either malignant or benign. Astrocytomas, ependymomas, and mixed gliomas are three of the most common gliomas.

ASTROCYTOMAS. Named for the star-like shape of their cells, astrocytomas can develop on any part of the brain or spinal cord. Non-infiltrating astrocytomas grow slowly, and rarely spread to nearby tissue. Mild-to-moderately anaplastic astrocytomas with well-differentiated borders do not grow as slowly as non-infiltrating astrocytomas, and they do spread to surrounding tissues.

Anaplastic astrocytomas, which are also called Grade III astrocytomas, look more abnormal and grow more rapidly than non-infiltrating or mild-to-moderately anaplastic tumors.

Grade IV astrocytomas are also called glioblastoma multiforme (GBM) tumors. Accounting for 30% of all primary brain tumors, GBMs are the most common brain tumors in middle-aged adults. GBMs are the most malignant of all brain tumors. Because they contain a greater mixture of cells than any other brain tumor, they are the most difficult to treat.

EPENDYMOMAS. Also called ependymal tumors, ependymomas account for 9% of all gliomas, and 5% of all intracranial tumors. These tumors, which are most common in children and adolescents, begin in the very thin membranes that help form cerebrospinal fluid (CSF) and line the brain cavities (ventricles) that contain it.

Ependymomas are usually benign, have well-differentiated borders, resemble normal cells, and grow very slowly. The cells of anaplastic (malignant) ependymomas look abnormal and grow more rapidly than the cells of benign tumors.

MIXED GLIOMAS. These heterogeneous tumors contain elements of astrocytomas and ependymomas and/or oligodendrogliomas. These are rare tumors that usually occur in middle-aged adults, grow slowly, and do not usually spread beyond the part of the brain where they originate. Mixed gliomas behave like tumors composed of the highest-grade cells they contain.

Non-glial brain tumors

The most common brain tumors that do not develop from glial cells are medulloblastomas, meningiomas, and Schwannomas.

MEDULLOBLASTOMAS. Scientists once thought medulloblastomas (MDLs) developed from glial cells. These fast-growing, malignant tumors are now believed to originate in developing cells not normally present in the body after birth. They are sometimes called primitive neurodectal tumors (PNET).

MDL tumors are most common in children and are more common in boys than in girls. Only 30% of MDL tumors occur in adults. MDL tumors usually originate in the cerebellum (the part of the brain that controls coordination and some muscle activity), and are often carried to other parts of the brain by cerebrospinal fluid. MDL tumors rarely metastasize beyond the brain and spinal cord.

MENINGIOMAS. Meningiomas, which represent more than 20% of all primary brain tumors, originate in the membranes that enclose the brain and spinal cord (meninges). These tumors are usually benign and most often occur in women aged 30-50 years old. Meningiomas grow so slowly that the brain can sometimes become accustomed to their presence. Meningiomas compress, rather than invade, brain tissue and may grow to be quite large before any symptoms appear.

SCHWANNOMAS. Schwannomas originate in the Schwann cells. These cells produce myelin, material that protects the acoustic nerve, which controls hearing. These benign tumors are twice as common in women as in men, and are most often diagnosed in patients between the ages 30-60.

Schwannomas grow very slowly, and many people adapt to the slight **hearing loss** and balance problems that are the tumors' earliest symptoms. A pear-shaped Schwannoma can cause sudden or gradual loss of hearing in an ear. As the tumor progresses, it can press on the nerves that control movement and feeling in the face, and cause headaches and facial numbness or tingling. The patient may have trouble walking, swallowing, or controlling eye movements, and the sense of taste can be affected. A Schwannoma that grows large enough to press on the brainstem can be deadly.

CHILDHOOD BRAIN TUMORS. Brain tumors that occur in children are described as supratentorial (in the upper part of the brain) or infratentorial (in the lowest part of the brain). Astrocytomas and ependymomas are common supratentorial tumors. Infratentorial tumors include medulloblastomas, astrocytomas, and ependymomas.

Causes and symptoms

The cause of primary brain tumors is unknown, but people who work with rubber and certain chemicals have a greater-than-average risk of developing them. There is

no evidence that **head injury** causes brain tumors, but researchers are trying to determine the relationship, if any, between brain tumors and viruses, family history, and long-term exposure to electromagnetic fields.

Symptoms do not usually appear until the tumor grows large enough to displace, damage, or destroy delicate brain tissue. When that happens, the patient may experience:

- headaches that become increasingly painful and are most painful when lying down
- nausea and vomiting or sudden attacks of vomiting not accompanied by nausea
- seizures
- dizziness, loss of coordination or balance
- personality changes
- sudden loss of vision
- memory loss
- speech problems
- sensory changes
- mental impairment
- weakness or **paralysis** on one side of the body

A doctor should be notified whenever a patient experiences one or more of the symptoms.

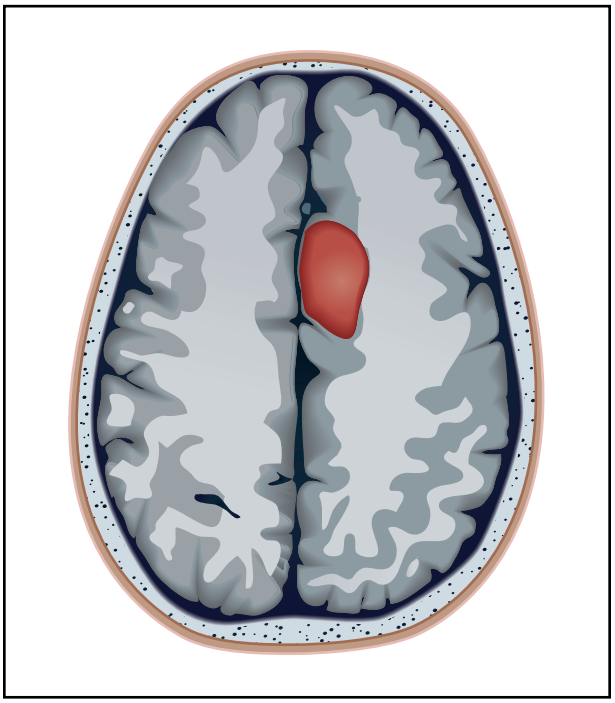
Diagnosis

Although brain tumor symptoms resemble those of many other illnesses, the presence of a brain tumor may be indicated by:

- persistent headaches with vomiting or convulsions
- progressive deterioration of sight, speech, hearing, touch; or deterioration in the ability to use an arm, hand, foot, or leg

When a patient experiences one or more of the above symptoms, a primary care physician will perform a complete **physical examination**, take a detailed medical history, and conduct a basic neurologic examination to evaluate:

- balance and coordination
- abstract thinking and memory
- eye movements
- hearing, touch, and sense of smell
- reflexes
- control of facial muscles and movements of the head and tongue
- awareness



A scan of a brain with a tumor located in the central right portion of the brain. *(Illustration by Argosy Inc.)*

If the results of these examinations suggest a patient may have a brain tumor, a neurologist recommends some or all of these additional diagnostic tests:

- computed tomography scan (CT scan) to reveal brain abnormalities
- magnetic resonance imaging (MRI) to detect tumors beneath the bones of the skull
- complex imaging techniques such as **Positron emission tomography** (**PET** scan), Single photon emission tomography (SPECT scan)
- electroencephalography (EEG) to measure electrical activity in the brain
- magnetoencephalography (MEG scan) to measure the magnetic fields produced by nerve cells and their electric currents
- x rays to reveal any distortion in the bones of the skull
- angiography to outline a tumor and the blood vessels that lead to it
- a brain scan to identify and record the location of abnormal cells in the brain
- radionuclide brain scintigraphy to view the capillaries feeding the tumor after highlighting them with a radioactive substance

- myelography (x ray of the spine) to detect a spinal cord tumor
- a lumbar puncture (spinal tap) to obtain spinal fluid, which may contain tumor cells.
- digital holography to view a complete three-dimensional map of the tumor and surrounding brain structures

Interpreting these images and results of laboratory analysis allows neurologists to determine whether a tumor is present, but microscopic examination of tumor tissue (biopsy) is the only way to identify the kind of cells it contains.

Treatment

Brain tumors are treated by multidisciplinary teams of highly skilled specialists whose decisions are based on:

- results of diagnostic tests
- tumor size, position, and growth pattern
- the patient's health history and current medical status
- the wishes of the patient and his family

Surgery

Surgery is the treatment of choice for accessible brain tumors, which can be removed without causing serious neurologic damage. The procedure most often performed is a **craniotomy**, but the goals of any type of brain tumor surgery include:

- removing as much of the tumor as possible (called debulking the tumor)
- removing tumor tissue for microscopic analysis
- allowing neurosurgeons to see exactly how the tumor is situated and how it is growing
- creating an entry channel for **chemotherapy** drugs and forms of radiation that are implanted in the brain

Depending on the type of brain tumor, its location, and its size, a number of different techniques may be used to surgically remove it. Surgical techniques include:

- classic operation
- laser microsurgery (uses high temperatures to vaporize tumor cells
- ultrasonic aspiration (uses ultrasound waves to break up the tumor into smaller bits which can be "vacuumed" out

Before undergoing brain surgery, patients are often given:

- steroids to reduce swelling of brain tissue
- snticonvulsant medications to prevent or control seizures
- radiation treatments to reduce tumor size

Patients whose benign brain tumors can be completely removed may not require any additional treatment, but periodic physical and neurologic examinations and CT or MRI scans are sometimes recommended to determine whether the tumor has returned. Because surgeons cannot be sure that every bit of an infiltrating or metastasizing tumor has been removed, radiation and chemotherapy are used to eradicate cells that may have escaped the scalpel.

If a tumor cannot be completely removed, removing a portion of it (debulking) can alleviate the patient's symptoms, enhance the sense of well-being, and increase the effectiveness of other treatments.

Radiation therapy

External radiotherapy, generally delivered on an outpatient basis, directs radiation to the tumor and the area around it. Implant **radiation therapy** involves placing tiny pieces of radioactive material in the brain. Left in place permanently, or for a short time, these radioactive pellets release measured doses of radiation each day. This technique is called brachytherapy. Patients are usually hospitalized during the several days the pellets are most active.

Stereoactic radiosurgery involves fitting the patient with a frame to stabilize the head, using imaging techniques to determine the exact location of tumor cells, and using a sophisticated instrument to administer radiation precisely to that point. Instruments used for delivery of radiation include the gamma knife, adapted linear accelerator (LINAC), and cyclotron.

A variety of drugs may also be given during radiation therapy, to protect brain cells from the effects of radiation (radioprotective drugs), to increase the sensitivity of tumor cells to radiation (radiosensitizers), or to boost radiation's effects (radioenhancers).

Chemotherapy

One or more cancer-killing drugs may be taken by mouth or injected into a blood vessel, muscle, or the cerebrospinal fluid. Chemotherapy may be used with radiation and surgery as part of a patient's initial treatment, or used alone to treat tumors that recur in the same place or in another part of the body. The usual chemotherapy regimen for a brain tumor is a combination approach, most commonly using procarbazine, CCNU, and vincristine.

New methods of delivering chemotherapy are being used as well. These include:

- interstitial chemotherapy is performed at the time of surgery. A chemotherapy-soaked wafer is placed in the cavity left after tumor removal.

- Intrathecal chemotherapy instills the medications right into the spinal fluid.
- Intraarterial chemotherapy uses tiny catheter tubes to delivery high-dose chemotherapy directly into the arteries of the brain.
- Potentially toxic chemotherapy drugs can be wrapped in special biologic envelopes called liposomes, to allow the drugs to be delivered to the tumor without adversely affecting other healthy tissues along the way.
- Electrochemotherapy uses electric voltage to transport chemotherapy agents into the brain.

When a young child has a brain tumor, chemotherapy is often used to eliminate or delay the need for radiation.

Other treatments

If a brain tumor cannot be cured, treatment is designed to make the patient as comfortable as possible and preserve as much of his neurologic functioning as possible. The patient's doctor may prescribe:

- analgesics to relieve pain
- anticancer drugs to limit tumor growth
- anticonvulsants to control seizures
- steroids to reduce swelling of brain tissue

Potential therapies

Scientists are studying ways to empower chemotherapy drugs to penetrate the blood-brain barrier (which protects the CNS by separating the brain from blood circulating throughout the body), and attack cancer cells that have infiltrated tissue inside it. Agents under investigation include both mannitol and substances called receptor-mediated permeabilizers

Brain tumor researchers are also investigating:

- Less invasive surgical procedures.
- Monoclonal antibodies, which pair antibodies with radioactive substances. The antibodies are directed to find and attach to tumor cells, at which time the radioactive substance kills the tumor cell.
- Interleukin and interferon, which are substances produced naturally by the human immune system which seem to kill tumor cells. Scientists seek to produce these substances in the laboratory and incorporate their use in brain tumor treatment.
- T-lymphocytes, which are also produced normally by the human immune system, and are being used to inject directly into the tumor location during surgery and to infuse into the bloodstream after surgery, in the hopes that they will boost the immune system's ability to fight tumor cells.
- Tumor vaccines, which use elements of tumor cells to stimulate the patient's immune system.
- Methods of incorporating chemotherapy drugs into tumor cells to reduce the need for radiation.
- Laboratory techniques that enable physicians to select the chemotherapy drugs most likely to kill particular types of tumors.
- Gene therapy in which genetically engineered material is transported to tumor cells by viruses that infect tumor cells and convert them to normal cells, stop their growth, or kill them.

Alternative treatment

Alternative treatments have not been shown to cure brain tumors and should never be substituted for conventional therapy. However, complementary therapies (used with, not instead of, standard treatments) can help some patients cope with the **stress** of their illness and side effects of their treatment.

Biofeedback can teach patients to influence and control heart rate, muscle tension, and other stress-related body functions. Some patients claim that **guided imagery** (visualization) helps them feel healthier and more in control of their disease.

Massage, **meditation**, and **reflexology** help some patients relax; while **yoga** is said to soothe the body, spirit, and mind. **Hydrotherapy** uses ice, liquid, and steam to improve circulation and relieve pain. **Therapeutic touch** practitioners say they can relieve pain and other symptoms by moving their hands in slow, rhythmic motions several inches above the patient's body.

Botanical therapies, homeopathic treatment, **traditional Chinese medicine** treatments, nutritional focuses on diet and supplements, and **detoxification** can also be incorporated as complementary therapies.

Prognosis

The patient's prognosis depends on where the tumor is located, what type of cells it contains, the size of the tumor, and the effect its already had on adjacent brain structures. A patient whose tumor is discovered early and removed completely may make a full recovery, but the surgery itself can harm or destroy normal brain tissue and cause:

- problems with thought, speech, and coordination
- seizures
- weakness
- personality changes

KEY TERMS

Central nervous system (CNS)—The division of the nervous system that consists of the brain and spinal cord.

Cerebrospinal fluid (CSF)—Clear liquid that fills brain cavities and protects the brain and spinal cord.

Gamma knife—High-dose radiation treatment for intracranial tumors.

Intracranial—Located within or on the surface of the brain.

Although these post-operative problems may initially be more severe than the symptoms produced by the tumor, they will probably diminish or disappear in time.

Occupational therapy can teach patients and their families new ways to approach daily tasks. Physical therapy can benefit patients who have difficulty keeping their balance, expressing their thoughts, speaking, or swallowing. Children may need special tutors before and after returning to school. For patients who have incurable brain tumors, hospice care may be available. Hospices provide a supportive environment and help patients manage pain and remain comfortable.

Consequences of radiation therapy

Cells killed by radiation can cluster in the brain, resembling tumors. They can cause headaches, seizures, and memory loss. Children treated with radiation may lose some of their eyesight and develop learning problems. Radiation damage to the pituitary gland can hinder normal growth and development.

Consequences of chemotherapy

Some drugs used to treat brain tumors can cause kidney damage and temporary or permanent tingling in the fingers and ringing in the ears.

Inoperable tumors

Brain tumors that cannot be removed may cause irreversible brain damage and death.

Prevention

The cause of primary brain tumors has not been determined, so there is no known way to prevent them.

The best way to prevent secondary or metastatic brain tumors is to eliminate such risk factors as:

- poor **nutrition** and a low-fiber diet; since these contribute to development of intestinal cancers
- smoking, which causes lung cancer
- excessive use of alcohol, which is associated with liver cancer
- excessive exposure to the sun, which can cause melanoma (a deadly form of skin cancer).

Monthly self-examinations of the breasts and testicles can detect breast and **testicular cancer** at their earliest, most curable stages.

Resources

BOOKS

The Editors of Time-Life Books, Inc. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatment*. Alexandria, VA: Time-Life, Inc., 1996.

PERIODICALS

Moulignier, Antoine, et al., "Cerebral Glial Tumors and Human Immunodeficiency Virus-1 Infection: More Than a Coincidental Association." *Cancer* 74, no. 2 (July 15, 1994): 686-87.

ORGANIZATIONS

American Brain Tumor Association. 2770 River Road, Des Plaines, IL 60018. (847) 827-9918, (800) 886-2289. <http:/www.abta.org>.

Brain Tumor Foundation for Children, Inc. 2231 Perimeter Park Drive, Suite 9, Atlanta, GA 30341. (404) 454-5554.

Brain Tumor Information Services. Box 405, Room J341, University of Chicago Hospitals, 5841 S. Maryland Avenue, Chicago, IL 60637. (312) 684-1400.

MedHelp International. 6300 N. Wickham, Suite 130, Box 188, Melbourne, FL 32940. (407) 253-9048. <http://www.medhlp.netusa.net/

National Brain Tumor Foundation. 785 Market Street, #1600, San Francisco, CA 94103. <http://www.oncolink.penn.edu/psychosocial.

OTHER

Adult Brain Tumor. <http://cancernet.nci.nih.gov/clinpdq/pif/Adult_brain_tumor_Patient.html (May 2001).

Brain Tumor, Primary. Nidus Information Services,Well Connected,2001.

"Brain Tumors," Goldman: Cecil Textbook of Medicine, 21st Ed., Copyright (c) 2000 W. B. Saunders Company

"Brain Tumors," Abeloff: Clinical Oncology, 2nd Ed., Copyright (c) 2000 Churchill Livingstone, Inc.

Childhood Brain Tumor. <http://cancernet.nci.nih.gov/clinpdq/pif/Childhood_brain_tumor_Patient.html (May 2001).

A Primer on Brain Tumors. <http://neurosurgery.mgh.harvard.edu/abta/primer.htm (12 March 1998).

Question: What is a Gamma Knife? <http://oncolink.upenn.edu/specialty/med_phys/gamma.html (13 April 2001).

What You Need to Know About Brain Tumors. <http://rex.nci.nih.gov/WTNK_PUBS/brain/index.htm (28 September 1998).

Rosalyn Carson-DeWitt, M.D.

Breast biopsy

Definition

A breast biopsy is removal of breast tissue for examination by a pathologist. This can be accomplished surgically, or by withdrawing tissue through a needle.

Purpose

A biopsy is recommended when a significant abnormality is found, either on **physical examination** and/or by an imaging test. Examples of abnormality can include a breast lump felt during physical self examination or tissue changes noticed from a mammogram test. Before a biopsy is performed, it is important to make sure that the threat of **cancer** cannot be disproved or ruled out by a simpler, less invasive examination. A lump may be obviously harmless when examined by ultrasound. If this is not decisive, the presence of cancer or a variety of benign breast conditions can be determined using a biopsy.

Precautions

The type of biopsy recommended should be considered. This will depend on whether the area can be felt, how well it can be seen on mammogram or ultrasound, and how suspicious it feels or appears. Specialized equipment is needed for different types of biopsy and availability may vary. Generally, needle biopsy is less invasive than surgical biopsy. It is appropriate for most, but not all situations. However, some surgeons feel it is far less accurate.

Description

Surgical biopsy

If an abnormality is not felt during a self examination, there are signs that indicate the need for medical attention. These include:

- severe breast **pain**
- changes in the size of a breast or the nipple
- changes in the shape of both breast or nipple
- pitting, dumpling or redness of the breast skin
- nipple redness, irritation, or inversion
- changes in the pattern of veins visible on the surface of the breast
- some types of nipple discharge

If the abnormality is not felt, a needle localization must be done before the actual surgery. After local anesthetic is administered, a fine wire is placed in the area of concern. Either x ray or ultrasound guidance is used. The patient is awake and usually sitting up.

There are two types of breast biopsy considered here, excisional and incisional. An excisional biopsy is a surgical procedure, where the entire area of concern and some surrounding tissue is removed. It is usually done as an outpatient procedure, in a hospital or free standing surgery center. The patient may be awake, and is sometimes given medication to make her drowsy. The area to be operated on is numbed with local anesthetic. Infrequently, general anesthesia is used.

An excisional biopsy itself usually takes under one hour. The total amount of time spent at the facility depends on the type of anesthesia used, whether a needle localization was done, and the extent of the surgery.

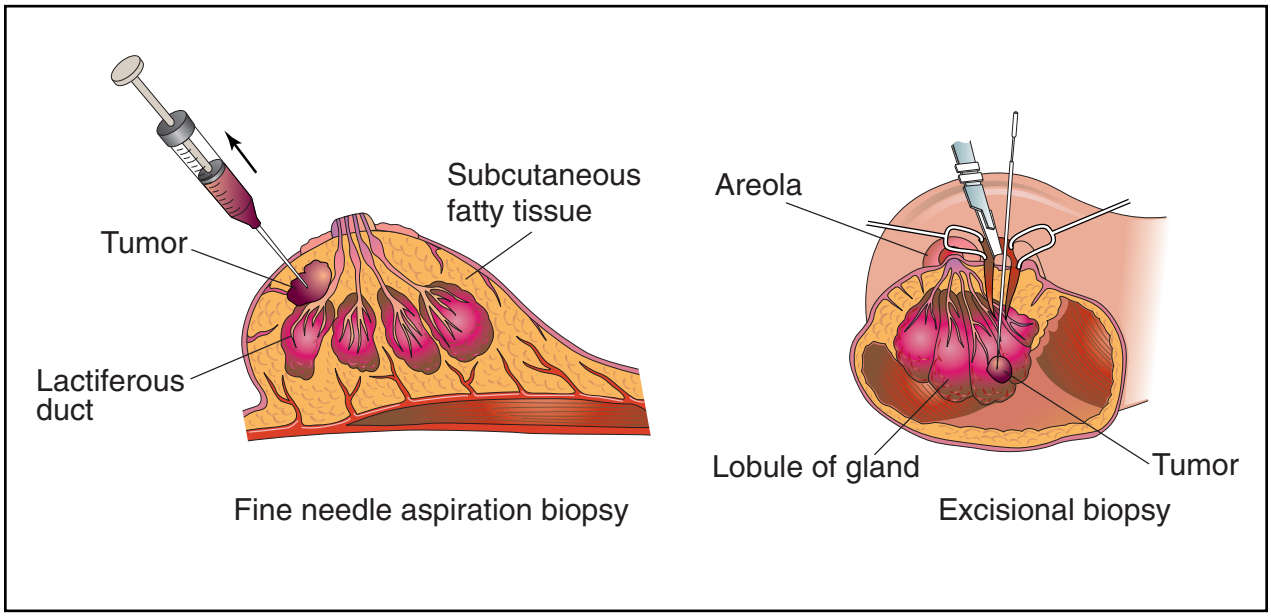
If a mass is very large, an incisional biopsy may be performed. In this case only a portion of the area is removed and sent for analysis. The procedure is the same as an excisional biopsy in other respects.

Needle biopsy

A needle biopsy removes part of the suspicious area for examination. There are two types, aspiration biopsy (using a fine needle), and large core needle biopsy. Either of these may be called a percutaneous needle biopsy. Percutaneous refers to a procedure done through the skin.

A fine needle aspiration biopsy uses a very thin needle to withdraw fluid and cells that can be studied. It can be done in a doctor's office, clinic, or hospital. Local anesthetic may be used, but is sometimes withheld, as it may be more painful than the biopsy needle. The area to place the needle may be located by touch. No specialized equipment is needed. However, using ultrasound guidance enables the physician to feel and see the lesion at the same time. The actual withdrawing of fluid and cells can be visualized as it occurs. This helps ensure that the specimen is taken from the right place.

A large core needle biopsy uses a larger diameter needle to remove small pieces of tissue, about the size of a grain of rice. It can be done in a clinic or hospital that has the appropriate facilities. Local anesthetic is routine-



A fine needle aspiration biopsy uses a very thin needle to withdraw fluid and cells from the breast to be examined. An excisional biopsy is a surgical procedure in which the entire area of concern and some surrounding tissue is removed for analysis. *(Illustration by Electronic Illustrators Group.)*

ly used. Ultrasound or x ray is used for guidance of a large core needle biopsy.

If the suspicious area is seen best with x ray, a stereotactic device is used. This means that x rays are taken from several angles. This information is fed into a computer, which analyzes the data and guides the needle to the correct place. The patient may be sitting up, or she may be lying on her stomach, with her breast positioned through an opening in the table. The breast is held firmly, but comfortably between a plastic paddle and a metal plate, similar to those used for mammograms (a set of x rays taken of the front and side of the breast). X rays may be taken before, during, and after the tissue is drawn into the needle, to confirm that the correct spot is biopsied. This procedure may also be referred to as a stereotactic core biopsy, or a mammotomy.

Ultrasound is used to guide needle placement for some lesions. The patient lies on her back or side. After the area is numbed, sterile gel is applied. The physician places a transducer, an instrument about the size of an electric shaver, over the skin. This produces an image from the reflection of sound waves. A special needle, usually in a spring loaded device, is used to obtain the tissue. The procedure is observed on a monitor as it is happening.

Preparation

A surgical breast biopsy may require the patient to have nothing to eat or drink for a period of time before the operation. This will typically be from midnight the night before, if general anesthesia is planned. No food restrictions are necessary for needle biopsy. It is advisable to eat lightly before the procedure. This is especially important if the patient will be lying on her stomach for a stereotactic biopsy.

Aftercare

After a surgical biopsy, the incision will be closed with stitches, and covered with a bandage. The bandage can usually be removed in one or two days. Stitches are taken out approximately one week afterward. Depending on the extent of the operation, normal activities can be resumed in approximately one to three days. Vigorous **exercise** may be limited for one to three weeks.

The skin opening for a needle biopsy is minimal. It may be closed with thin, clear tape, called a steri strip, or covered with a bandaid and a small gauze bandage. The patient can return to her usual routine immediately after the biopsy. Strenuous activity or heavy lifting is not recommended for 24 hours. Any bandages can be removed one or two days after the biopsy.

Risks

Infection is always a possibility when the skin is broken, although this rarely occurs. Redness, swelling, or severe pain at the biopsy site would indicate a possible

infection. Another possible consequence of a breast biopsy is a hematoma. This is a collection of blood at the biopsy site. It is usually absorbed naturally by the body. If it is very large and uncomfortable, it may need to be drained. A surgical breast biopsy may produce a visible scar on the breast. Sometimes this may make future mammograms harder to interpret accurately.

A false negative pathology report is another risk. This means that no cancer was found when a cancer was present. The incidence of this varies with the biopsy technique. In general, fine needle aspiration biopsies have the highest rate of false negative results, but there may be variation in results between facilities.

Normal results

A normal pathology report indicates no malignancy is present. The tissue sample may be further classified as a benign breast condition, such as tumor of the breast (**fibroadenoma**) or connective tissue that resembles fiber (fibrosis). Studies have demonstrated that approximately 80% of all breast biopsies result in a benign pathology report.

Abnormal results

An abnormal pathology report indicates a cancer is present. If a fine needle aspiration biopsy was performed, the pathologist has viewed individual cells under a microscope to see if they appear cancerous. Large core needle biopsy and surgical biopsy will be able to give more information. This includes the type of cancer, whether it has invaded surrounding tissue, and how likely it is to spread quickly. There are some conditions which are not malignant but indicate high risk for future development of **breast cancer**. If these are identified, more frequent monitoring of the area may be recommended.

Resources

BOOKS

Baron-Faust, Rita. *Breast Cancer: What Every Woman Should Know.* New York: Hearst Books, 1995.

Love, Susan and Karen Lindsey. *Dr. Susan Love's Breast Book.* 2nd ed. Reading, MA: Addison-Wesley, 1995.

PERIODICALS

Bassett, Lawrence, et al. "Stereotactic Core-Needle Biopsy of the Breast." *CA: A Journal for Clinicians* 47 (May/June 1997): 171-190.

Cady, Blake, et al. "Evaluation of Common Breast Problems: Guidance for Primary Care Providers." *CA:A Journal for Clinicians* 48 (Jan./Feb. 1998): 49-63.

Castleman, Michael. "News About Breast Cancer That Could Save Your Life." *Family Circle*, 11 (13 May 1997): 60-65.

KEY TERMS

Fine needle aspiration biopsy—A procedure using a thin needle to remove fluid and cells from a lump in the breast.

Large core needle biopsy—A procedure using a thicker needle to remove a core of tissue, about the size of a grain of rice, from the breast.

Weber, Ellen. "Questions and Answers About Breast Cancer Diagnosis." *American Journal of Nursing* 97 (Oct. 1997): 34-38.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Ellen S. Weber, MSN

Breast cancer

Definition

Breast **cancer** is caused by the development of malignant cells in the breast. The malignant cells originate in the lining of the milk glands or ducts of the breast (ductal epithelium), defining this malignancy as a cancer. Cancer cells are characterized by uncontrolled division leading to abnormal growth and the ability of these cells to invade normal tissue locally or to spread throughout the body, in a process called metastasis.

Description

Breast cancer arises in the milk-producing glands of the breast tissue. Groups of glands in normal breast tissue are called lobules. The products of these glands are secreted into a ductal system that leads to the nipple. Depending on where in the glandular or ductal unit of the breast the cancer arises, it will develop certain characteristics that are used to sub-classify breast cancer into types. The pathologist will denote the subtype at the time of evaluation with the microscope. Ductal carcinoma begins in the ducts, lobular carcinoma has a pattern involving the lobules or glands. The more important classification is related to the evaluated tumor's capability to

invade, as this characteristic defines the disease as a true cancer. The stage before invasive cancer is called *in situ*, meaning that the early malignancy has not yet become capable of invasion. Thus, ductal carcinoma in situ is considered a minimal breast cancer.

How breast cancer spreads

The primary tumor begins in the breast itself but once it becomes invasive, it may progress beyond the breast to the regional lymph nodes or travel (metastasize) to other organ systems in the body and become systemic in nature. Lymph is the clear, protein-rich fluid that bathes the cells throughout the body. Lymph will work its way back to the bloodstream via small channels known as lymphatics. Along the way, the lymph is filtered through cellular stations known as nodes, thus they are called lymph nodes. Nearly all organs in the body have a primary lymph node group filtering the tissue fluid, or lymph, that comes from that organ. In the breast, the primary lymph nodes are under the armpit, or axilla. Classically, the primary tumor begins in the breast and the first place to which it is likely to spread is the regional lymph nodes. Cancer, as it invades in its place of origin, may also work its way into blood vessels. If cancer gets into the blood vessels, the blood vessels provide yet another route for the cancer to spread to other organs of the body.

Breast cancer follows this classic progression though it often becomes systemic or widespread early in the course of the disease. By the time one can feel a lump in the breast it is often 0.4 inches, or one centimeter, in size and contains roughly a million cells. It is estimated that a tumor of this size may take one to five years to develop. During that time, the cancer may metastasize, or spread by lymphatics or blood to areas elsewhere in the body.

When primary breast cancer spreads, it may first go to the regional lymph nodes under the armpit, the axillary nodes. If this occurs, regional metastasis exists. If it proceeds elsewhere either by lymphatic or blood-borne spread, the patient develops systemic metastasis that may involve a number of other organs in the body. Favorite sites of systemic involvement for breast cancer are the lung, bones, liver, and the skin and soft tissue. As it turns out, the presence of, and the actual number of, regional lymph nodes containing cancer remains the single best indicator of whether or not the cancer has become widely metastatic. Because tests to discover metastasis in other organs may not be sensitive enough to reveal minute deposits, the evaluation of the axilla for regional metastasis becomes very important in making treatment decisions for this disease.

If breast cancer spreads to other major organs of the body, its presence will compromise the function of those organs. **Death** is the result of extreme compromise of vital organ function.

Demographics

Every woman is at risk for breast cancer. If she lives to be 85, there is a one out of nine chance that she will develop the condition sometime during her life. As a woman ages, her risk of developing breast cancer rises dramatically regardless of her family history. The breast cancer risk of a 25-year-old woman is only one out of 19,608; by age 45, it is one in 93. In fact, less than 5% of cases are discovered before age 35 and the majority of all breast cancers are found in women over age 50.

In 1999, there were 180,000 new cases of breast cancer diagnosed. About 45,000 women die of breast cancer each year, accounting for 16% of deaths caused by cancer in women. For the first time ever, mortality rates decreased an average of 1.7% per year from 1995 through 1999, a reflection of earlier diagnosis and improving therapies.

Causes and symptoms

There are a number of risk factors for the development of breast cancer, including:

- family history of breast cancer in mother or sister
- early onset of menstruation and late **menopause**
- reproductive history: women who had no children or have children after age 30 and women who have never breastfed have increased risk
- history of abnormal breast biopsies

Though these are recognized risk factors, it is important to note that more than 70% of women who get breast cancer have no known risk factors. Having several risk factors may boost a woman's chances of developing breast cancer, but the interplay of predisposing factors is complex. In addition to those accepted factors listed above, some studies suggest that high-fat **diets**, **obesity**, or the use of alcohol may contribute to the risk profile. Another factor that may contribute to a woman's risk profile is **hormone replacement therapy** (HRT).

HRT provides significant relief of menopausal symptoms, prevention of **osteoporosis**, and possibly protection from cardiovascular disease and **stroke**. However, studies show that there is a small increased risk of developing breast cancer with HRT use. Thus, the use of hormone replacement therapy should be based on personal risk factors.

Of all the risk factors listed above, family history is the most important. In *The Biological Basis of Cancer*, the authors estimate that probably about half of all famil-

ial breast cancer cases (families in which there is a high breast cancer frequency) have mutations affecting the tumor suppressor gene BRCA-1. Another gene (BRCA-2) also appears to confer inherited vulnerability to early-onset breast cancers. However, breast cancer due to heredity is only a small proportion of breast cancer cases; only 5%–10% of all breast cancer cases will be women who inherited a susceptibility through their genes. Nevertheless, when the family history is strong for development of breast cancer, a woman's risk is increased.

Not all lumps detected in the breast are cancerous. Fibrocystic changes in the breast are extremely common. Also known as **fibrocystic condition of the breast**, fibrocystic changes are a leading cause of non-cancerous lumps in the breast. Fibrocystic changes also cause symptoms of **pain**, swelling, or discharge and may become evident to the patient or physician as a lump that is either solid or filled with fluid. Complete diagnostic evaluation of any significant breast abnormality is mandatory because though women commonly develop fibrocystic changes, breast cancer is common also, and the signs and symptoms of fibrocystic changes overlap with those of breast cancer.

Diagnosis

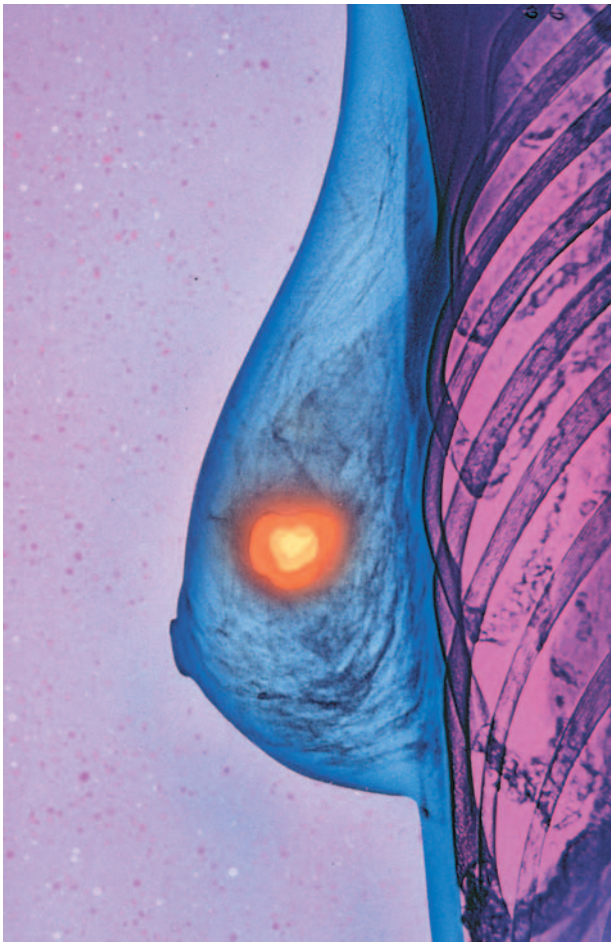
The diagnosis of breast cancer is accomplished by the biopsy of any suspicious lump or mammographic abnormality that has been identified. (A biopsy is the removal of tissue for examination by a pathologist. A mammogram is a low-dose, 2-view, x-ray examination of the breast.) The patient may be prompted to visit her doctor upon finding a lump in a breast, or she may have noticed skin dimpling, nipple retraction, or discharge from the nipple. Or, the patient may not have noticed anything abnormal, and a lump is detected by the mammogram.

When a patient has no signs or symptoms

Screening involves the evaluation of women who have no symptoms or signs of a breast problem, so when the screening mammogram leads to the evaluation, the patient has no symptoms and may not have any abnormality on examination of the breast. **Mammography** has been very helpful in detecting breast cancer that one cannot identify on **physical examination**. However, 10%–13% of breast cancer does not show up on mammography, and a similar number of patients with breast cancer have an abnormal mammogram and a normal physical examination. These figures emphasize the need for examination as part of the screening process.

Screening

It is recommended that women get into the habit of doing monthly breast self examinations to detect any lump at an early stage. If an uncertainty or a lump is found, evaluation by an experienced physician and mammography is recommended. The American Cancer Society (ACS) has made recommendations for the use of mammography on a screening basis. There has been controversy about the timing and appropriate frequency of mammography when used as a screening tool, but the ACS recommendations are as follows: Women should get annual mammograms after age 40. Those with a significant family history (one or more first-degree relatives who have been treated for breast cancer), should start annual mammograms 10 years younger than the youngest relative was when she was diagnosed, but not earlier than 35.



Mammogram indicating a tumor in the center of the breast. *(Chris Bjornberg, Photo Researchers. Reproduced by permission.)*

Because of the greater awareness of breast cancer in recent years, screening evaluations by examinations and mammography are performed much more frequently than in the past. The result is that the number of breast cancers diagnosed increased, but the disease is being diagnosed at an earlier stage than previously. The earlier the stage of

disease at the time of presentation, the better the long-term outcome after treatment, or prognosis, becomes.

When a patient has physical signs or symptoms

A very common finding that leads to diagnosis is the presence of a lump within the breast. Skin dimpling, nipple retraction, or discharge from the nipple are less frequent initial findings prompting biopsy. Though bloody nipple discharge is distressing, it is most often caused by benign disease. Skin dimpling or nipple retraction in the presence of an underlying breast mass on examination is a more advanced finding. Actual skin involvement, with **edema** or ulceration of the skin, are late findings.

A very common presenting sign is the presence of a breast lump. If the lump is suspicious and the patient has not had a mammogram by this point, a study should be done on both breasts prior to anything else so that the original characteristics of the lesion can be studied. The opposite breast should also be evaluated mammographically to determine if other problems exist that were undetected by physical examination.

Whether an abnormal screening mammogram or one of the signs mentioned above followed by a mammogram prompted suspicion, the diagnosis is established by obtaining tissue by biopsy of the area. There are different types of biopsy, each utilized with its own indication depending on the presentation of the patient. If signs of widespread metastasis are already present, biopsy of the metastasis itself may establish diagnosis.

Biopsy

Depending on the situation, different types of biopsy may be performed. The types include incisional and excisional biopsies. In an incisional biopsy, the physician takes a sample of tissue, and in excisional biopsy, the mass is removed. Fine needle aspiration biopsy and core needle biopsy are kinds of incisional biopsies.

FINE NEEDLE ASPIRATION BIOPSY. In a fine needle aspiration biopsy, a fine-gauge needle may be passed into the lesion and cells from the area suctioned into the needle can be quickly prepared for microscopic evaluation (cytology). (The patient experiencing nipple discharge can have a sample taken of the discharge for cytological evaluation, also.) Fine needle aspiration is a simple procedure that can be done under local anesthesia, and will tell if the lesion is a fluid-filled cyst or whether it is solid. The sample obtained will yield much diagnostic information. Fine needle aspiration biopsy is an excellent technique when the lump is palpable and the physician can easily hit the target with the needle. If the lesion is a simple cyst, the fluid will be evacuated and the mass will disappear. If it is solid, the diagnosis may be obtained. Care must be taken, however, because if the mass is solid and the specimen is non-malignant, a complete removal of the lesion may be appropriate to be sure.

CORE NEEDLE BIOPSY. Core needle biopsies are also obtained simply under local anesthesia. The larger piece of tissue obtained with its preserved architecture may be helpful in confirming the diagnosis short of open surgical removal. An open surgical incisional biopsy is rarely needed for diagnosis because of the needle techniques. If there remains question as to diagnosis, a complete open surgical biopsy may be required.

EXCISIONAL BIOPSY. When performed, the excisional, (complete removal) biopsy is a minimal outpatient procedure often done under local anesthesia.

NON-PALPABLE LESIONS. As screening increases, non-palpable lesions demonstrated only by mammography are becoming more common. The use of x rays and computers to guide the needle for biopsy or to place markers for the surgeon performing the excisional biopsy are commonly employed. Some benign lesions can be fully removed by multiple directed core biopsies. These techniques are very appealing because they are minimally invasive; however, the physician needs to be careful to obtain a good sample.

Other tests

If a lesion is not palpable and has simple cystic characteristics on mammography, ultrasound may be utilized both to determine that it is a cyst and to guide its evacuation. Ultrasound may also be used in some cases to guide fine needle or core biopsies of the breast.

Computed tomography (CT scan, CAT scans), and **magnetic resonance imaging**, (MRI), have only a very occasional use in the evaluation of breast lesions.

Treatment

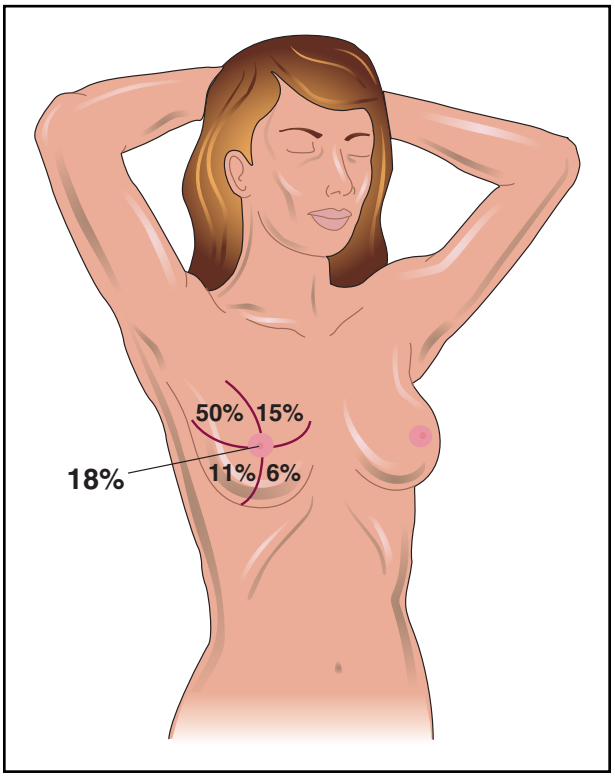
Staging

Once diagnosis is established, before treatment is rendered, more tests are done to determine if the cancer has spread beyond the breast. These tests include a **chest x ray** and **blood count** with **liver function tests**. Along with the liver function measured by the blood sample, the level of alkaline phosphatase, an enzyme from bone, is also determined. A radionuclear bone scan may be ordered. This test looks at the places in the body to which breast cancer usually metastasizes. A CT scan may also be ordered. The physician will do a careful examination of the axilla to assess likelihood of regional metastasis but unfortunately this exam is not very accurate. Since

the axillary node status is the best reflection of possible widespread disease, these nodes in part or all will be removed at the time of surgical treatment.

Using the results of these studies, clinical stage is defined for the patient. This helps define treatment protocol and prognosis. After surgical treatment, the final, or pathologic, stage is defined as the true axillary lymph node status is known. Detailed staging criteria are available from the American Joint Commission on Cancer Manual and are generalized here:

- Stage 1—The cancer is no larger than 2 cm (0.8 in) and no cancer cells are found in the lymph nodes.
- Stage 2—The cancer is between 2 cm and 5 cm, and the cancer has spread to the lymph nodes.
- Stage 3A—Tumor is larger than 5 cm (2 in) or is smaller than 5 cm, but has spread to the lymph nodes, which have grown into each other.
- Stage 3B—Cancer has spread to tissues near the breast, (local invasion), or to lymph nodes inside the chest wall, along the breastbone.
- Stage 4—Cancer has spread to skin and lymph nodes beyond the axilla or to other organs of the body.



This illustration shows the frequency of breast cancer developing in the four quadrants of the breast and the nipple. *(Illustration by Electronic Illustrators Group.)*

Treatment

Surgery, radiation, and **chemotherapy** are all utilized in the treatment of breast cancer. Depending on the stage, they will be used in different combinations or sequences to effect an appropriate strategy for the type and stage of the disease being treated.

SURGERY. Historically, surgical removal of the entire breast and axillary contents along with the muscles down to the chest wall was performed as the lone therapy, (radical **mastectomy**). In the last twenty-five years, as it has been appreciated that breast cancer is often systemic early in its course, the role of surgery is still primary but of less and less magnitude.

Today, surgical treatment is best thought of as a combination of removal of the primary tumor and staging of the axillary lymph nodes. If the whole breast is removed along with the entire axillary contents, but the muscles of the chest wall are not, the modified radical mastectomy has been performed.

If the tumor is less than 1.5 in (4 cm) in size and located so that it can be removed without destroying a reasonable cosmetic appearance of the residual breast, just the primary tumor and a rim of normal tissue will be removed. The axillary nodes will still be removed for staging purposes, usually through a separate incision. Because of the risk of recurrence in the remaining breast tissue, radiation is used to lessen the chance of local recurrence. This type of primary therapy is known as **lumpectomy**, (or segmental mastectomy), and axillary dissection.

Currently the necessary extent of the axillary dissection is being questioned. Sentinel **lymph node biopsy**, a technique for identifying which nodes in the axilla drain the tumor, has been developed to provide selective sampling and further lessen the degree of surgical trauma the patient experiences.

When patients are selected appropriately based on the preoperative clinical stage, all of these surgical approaches have been shown to produce similar results. In planning primary surgical therapy, it is imperative that the operation is tailored to fit the clinical circumstance of the patient.

The pathologic stage is determined after surgical treatment absolutely defines the local parameters. In addition to stage, there are other tests that are very necessary to aid in decisions regarding treatment. Handling of the surgical specimen is thus very important. The tissue needs to be analyzed for the presence or absence of hormone receptors and a receptor called HER-2. The presence of these receptors will influence additional thera-

pies. Microscopic evaluation may also include the assessment of lymphatic or blood vessel invasion as these predict a worse outcome. The DNA of the tumor cells is quantitatively analyzed to help decide the biologic aggressiveness of the tumor. These parameters will be utilized collectively along with the axillary lymph node status to define the anticipated aggressiveness of the cancer. This assessment, along with the age and general condition of the patient, will be considered when planning the adjuvant therapies. Adjuvant therapies are treatments utilized after the primary treatment to help ensure that no microscopic disease exists and to help prolong patients' survival time.

RADIATION. Like surgical therapy, **radiation therapy** is a local modality—it treats the tissue exposed to it and not the rest of the body. Radiation is usually given post-operatively after surgical **wounds** have healed. The pathologic stage of the primary tumor is now known and this aids in treatment planning. The extent of the local surgery also influences the planning. Radiation may not be needed at all after modified radical mastectomy for stage I disease, but is almost always utilized when breast-preserving surgery is performed. If the tumor was extensive or if multiple nodes were involved, the field of tissue exposed will vary accordingly. Radiation is utilized as an adjunct to surgical therapy and is considered an important modality in gaining local control of the tumor. The use of radiation therapy does not affect decisions for adjuvant treatment. In the past, radiation was used as an alternative to surgery on occasion. However, now that breast-preserving surgical protocols have been developed, primary radiation treatment of the tumor is no longer performed. Radiation also has an important role in the treatment of the patient with disseminated disease, particularly if it involves the skeleton. Radiation therapy can effect pain control and prevention of fracture in this circumstance.

DRUG THERAPY. Many breast cancers, particularly those originating in post-menopausal women, are responsive to hormones. These cancers have receptors on their cells for estrogen and progesterone. Part of primary tumor assessment after removal of the tumor is the evaluation for the presence of these estrogen and progesterone receptors. If they are present on the cancer cells, altering the hormone status of the patient will inhibit tumor growth and have a positive impact on survival. The drug tamoxifen binds up these receptors on the cancer cells so that the hormones can't have an effect and, in so doing, inhibits tumor growth. If the patient has these receptors present, tamoxifen is commonly prescribed for five years as an adjunct to primary treatment. Adjuvant hormonal therapy with tamoxifen has few side effects but they have to be kept in mind, particularly the need for yearly evaluation of the uterus. Other agents directed at altering hormone environment are under study. Because of these agents, there is rarely any need for surgical removal of hormone-producing glands, such as the ovary or adrenal, that was sometimes necessary in the past.

Shortly after the modified radical mastectomy replaced the radical mastectomy as primary surgical treatment, it was appreciated that survival after local treatment in stage II breast cancer was improved by the addition of chemotherapy. Adjuvant chemotherapy for an interval of four to six months is now standard treatment for patients with stage II disease. The addition of systemic therapy to local treatment in patients who have no evidence of disease is performed on the basis that some patients have metastasis that are not currently demonstrable because they are microscopic. By treating the whole patient early, before widespread disease is diagnosed, the adjuvant treatment improves survival rates from roughly 60% for stage II to about 75% at five years after treatment. The standard regimen of cytoxan, methotrexate, and 5-flourouracil, (CMF), is given for six months and is well tolerated. The regimen of cytoxan, adriamycin (doxorubicin), and 5-floururacil, (CAF), is a bit more toxic but only requires four months. (Adriamycin and cytoxin may also be used alone, without the fluorouracil.) The two methods are about equivalent in results. Adjuvant hormonal therapy may be added to the adjuvant chemotherapy as they work through different routes.

As one would expect, the encouraging results from adjuvant therapy in stage II disease have led to the study of similar therapy in stage I disease. The results are not as dramatic, but they are real. Currently, stage I disease is divided into categories a, b, and c on the basis of tumor size. Stage Ia is less than a centimeter in diameter. Adjuvant hormonal or chemotherapy is now commonly recommended for stage Ib and Ic patients. The toxicity of the treatment must be weighed individually for the patient as patients with stage I disease have a survivorship of over 80% without adjuvant chemotherapy.

If patients are diagnosed with stage IV disease or, in spite of treatment, progress to a state of widespread disease, systemic chemotherapy is utilized in a more aggressive fashion. In addition to the adriamycin-containing regimens, the taxols (docetaxel and paclitaxel) have been found to be effective in inducing remission.

On the basis of prognostic factors such as total number of involved nodes over 10, aneuploid DNA with a high synthesis value, or aggressive findings on microscopic evaluation, some patients with stage II or III disease can be predicted to do poorly. If their performance status allows, they can be considered for treatment with highly aggressive chemotherapy. The toxicity is such that bone marrow failure will result. To get around this antici-

KEY TERMS

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

Aneuploid—An abnormal number of chromosomes in a cell.

Aspiration biopsy—The removal of cells in fluid or tissue from a mass or cyst using a needle for microscopic examination and diagnosis.

Benign—Not malignant, noncancerous.

Biopsy—A procedure in which suspicious tissue is removed and examined by a pathologist for cancer or other disease. For breast biopsies, the tissue may be obtained by open surgery, or through a needle.

Estrogen-receptor assay—A test to see if a breast cancer needs estrogen to grow.

Hormones—Chemicals produced by glands in the body which circulate in the blood and control the actions of cells and organs. Estrogens are hormones which affect breast cancer growth.

Hormone therapy—Treating cancers by changing the hormone balance of the body, instead of by using cell-killing drugs.

Lumpectomy—A surgical procedure in which only the cancerous tumor in the breast is removed, together with a rim of normal tissue.

Lymph nodes—Small, bean-shaped masses of tissue scattered along the lymphatic system that act as filters and immune monitors, removing fluids, bacteria, or cancer cells that travel through the lymph system. Breast cancer cells in the lymph nodes under the arm or in the chest are a sign that the cancer has spread, and that it might recur.

Malignant—Cancerous.

Mammography—X-ray imaging of the breast that can often detect lesions in the tissue too small or too deep to be felt.

Oncogene—A gene that has to do with regulation of cancer growth. An abnormality can produce cancer.

pated side effect of the aggressive therapy, either the patients will be transplanted with their own stem cells, (the cells that will give rise to new marrow), or a traditional **bone marrow transplantation** will be required. This therapy can be a high-risk procedure for patients. It is given with known risk to patients predicted to do poorly and then only if it is felt they can tolerate it. Most patients who receive this therapy receive it as part of a clinical trial. At present, it is unclear that such aggressive therapy can be justified and it is under study.

For patients who are diagnosed with advanced local disease, surgery may be preceded with chemotherapy and radiation therapy. The disease locally regresses allowing traditional surgical treatment to those who could not receive it otherwise. Chemotherapy and sometimes radiation therapy will continue after the surgery. The regimens of this type are referred to as neo-adjuvant therapy. This has been proven to be effective in stage III disease. Neo-adjuvant therapy is now being studied in patients with large tumors that are stage II in an effort to be able to offer breast preservation to these patients.

A drug known as Herceptin (trastuzumab), a monoclonal antibody, is now being used in the treatment of those with systemic disease. The product of the Human Epidermal Growth Factor 2 gene, (HER-2) is overexpressed in 25%–30% of breast cancers. Herceptin binds to the HER-2 receptors on the cancer, resulting in the arrest of growth of these cells.

Prognosis

The prognosis for breast cancer depends on the type and stage of cancer. Over 80% of stage I patients are cured by current therapies. Stage II patients survive overall about 70% of the time, those with more extensive lymph nodal involvement doing worse than those with disease confined to the breast. About 40% of stage III patients survive five years, and about 20% of stage IV patients do so.

Coping with cancer treatment

Surgery for breast cancer is physically well-tolerated by the patient, especially those undergoing minimal surgery in the axilla. Most patients can return to a normal lifestyle within a month or so after surgery. Exercises can help the patient regain strength and flexibility. Arm, shoulder, and chest exercises help, and complete recovery of activity is to be expected.

About 5-7% of patients undergoing complete axillary lymph node resection as part of their therapy may develop clinically significant **lymphedema**, or swelling in the arm on the side of involvement. If present, elevation and massage may be needed intermittently. Though usually not serious, on occasion this complication may interfere with complete physical recovery. The incidence of lymphedema is less with less axillary surgery. This is the reason for the enthusiasm for sentinel node biopsy as the surgical staging procedure in the axilla.

It is common after breast cancer treatment to be depressed or moody, to cry, lose appetite, or feel unworthy or less interested in sex. The breast is involved with a woman's identity and loss of it may be disturbing. For some, counseling or a support group can help. Many women have found a support group of breast cancer survivors to be an invaluable help during this stage. Involvement with volunteers from the local chapter of the Reach to Recovery program may be very helpful.

Nearly all patients undergo some form of adjuvant therapy for breast cancer. The magnitude of the toxicity of these adjuvant therapies is usually small and many patients receiving chemotherapy on this basis are capable of normal activity during this time. Certainly, those who progress to advanced disease are treated with more toxic chemotherapeutic regimens in an attempt to induce remission.

Clinical trials

The use of tamoxifen and other agents which alter the hormone status of the patient are under study. The National Surgical Adjuvant Breast and Bowel Project (NSABP) with support from the National Cancer Institute began a study in 1992 (called the Breast Cancer Prevention Trial, or BCPT) studying the use of tamoxifen as a breast cancer preventative for high-risk women. The results yielded from the study showed that tamoxifen significantly reduced breast cancer risk, and the U.S. Food and Drug Administration approved the use of tamoxifen to reduce breast cancer risk for high-risk patients in 1998. Another NSABP study, known as STAR, is seeking to understand if another drug, raloxifene, is as effective as tamoxifen in reducing breast cancer risk in high-risk patients. That study was begun in 1999, and participants are to be monitored for five years.

Neo-adjuvant therapies to allow the use of breast preservation in those with more advanced local disease are under investigation.

Immune therapies have not been helpful to date though there are vaccines being developed against proteins such as that produced by HER-2 that may be beneficial in the future.

High-dose chemotherapy with bone marrow rescue remains controversial. Factors can be identified that predict certain patients will develop metastatic disease. This treatment has been offered to this select group of patients but the toxicity is such that defining a clear indication for this treatment remains under study.

Prevention

As mentioned above, because of the results yielded from the BCPT clinical trial, tamoxifen can now be prescribed to high-risk women to help prevent breast cancer.

And, while most breast cancer can't be prevented, it can be diagnosed from a mammogram at an early stage when it is most treatable. The results of awareness and routine screening have allowed earlier diagnosis, which results in a better prognosis for those discovered.

Special Concerns

Though breast-preserving therapy is being done more frequently than in years past, modified radical mastectomy remains an option when selecting therapy for the primary tumor. This option may allow treatment without radiation in earlier stage patients, or may be necessary if the presentation of the tumor does not allow breast preservation. Loss of the breast is disfiguring and many patients so treated desire reconstruction of the breast. **Breast reconstruction** is performed either at the time of initial surgery (immediate) or it may be delayed. Alternatives include placement of implants or the rotation of muscle flaps from the abdomen or back. Most agree that breast preservation gives superior results to any form of reconstruction. When the breast is removed as part of primary therapy, these reconstructions are available and do produce very reasonable results.

Resources

BOOKS

Abelhoff, Armitage, Lichter, Niederhuber. *Clinical Oncology Library.* Philadelphia: Churchill Livingstone 1999.

American Joint Committee on Cancer. *AJCC Clinical Staging Manual.* Philadelphia: Lippincott-Raven, 1997.

Love, Susan and Karen Lindsey. *Dr. Susan Love's Breast Book.* Reading, MA: Addison-Wesley, 1995.

Mayers, Musa. *Holding Tight, Letting Go: Living with Metastatic Breast Cancer.* Sebastopol, CA: O'Reilly & Associates, 1997.

McKinnell, Robert G., Ralph E. Parchment, Alan O. Perantoni, and G. Barry Pierce. *The Biological Basis of Cancer.* New York: Cambridge University Press, 1998.

Schwartz, Spencer, Galloway, Shires, Daly, Fischer. *Principles of Surgery.* New York: McGraw Hill, 1999.

PERIODICALS

Esteva and Hortobagyi. "Adjuvant Systemic Therapy for Primary Breast Cancer." *Surgical Clinics of North America* Volume 79 No. 5 (October 1999) p 1075-1090.

Krag, et al, "The Sentinel Node in Breast Cancer." *New England Journal of Medicine* Volume 339 No. 14 (October 1, 1998), p 941-946.
Margolese, R. G., M.D. "Surgical Considerations For Invasive Breast Cancer." *Surgical Clinics of North America* Volume 79 No. 5 (October 1999), p 1031-1046.
Munster and Hudis. "Adjuvant Therapy for Resectable Breast Cancer." *Hematology Oncology Clinics of North America* Volume 13 No. 2 (April 1999) p 391-413.
Shuster, et al. "Multidisciplinary Care For Patients With Breast Cancer." *Surgical Clinics of North America* Volume 80 No. 2 (April, 2000) p 505-533.

ORGANIZATIONS

American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.
American Cancer Society's Reach to Recovery Program: <http://www2.cancer.org/bcn/reach.html>.
Cancer Care, Inc. (800) 813-HOPE. <http://www.cancercare inc.org>.
Cancer Information Service of the NCI. 1-800-4-CANCER. <http://wwwicic.nci.nih.gov>.
National Alliance of Breast Cancer Organizations. 9 East 37th St., 10th floor, New York, NY 10016. (888) 80-NABCO.
National Coalition for Cancer Survivorship. 1010 Wayne Ave., 5th Floor, Silver Spring, MD 20910. (301) 650-8868.
National Women's Health Resource Center. 2425 L St. NW, 3rd floor, Washington, DC 20037. (202) 293-6045.

OTHER

Breast Cancer Online. <http://www.bco.org/>.
National Alliance of Breast Cancer Organizations. <http://www.nabco.org/>.
National Cancer Institute. <http://rex.nci.nih.gov/PATIENTS/INFO_PEOPL_DOC.html>.

Richard A. McCartney, M.D.

Breast enlargement *see* **Breast implants**
Breast-feeding *see* **Lactation**

Breast implants

Definition

Breast implantation is a surgical procedure for enlarging the breast. Breast-shaped sacks made of a silicone outer shell and filled with silicone gel or saline (salt water), called implants, are used.

Purpose

Breast implantation is usually performed to make normal breasts larger for cosmetic purposes. Sometimes a woman having a **breast reconstruction** after a **mastectomy** will need the opposite breast enlarged to make the breasts more symmetric. Breasts that are very unequal in size due to trauma or congenital deformity may also be corrected with an enlargement procedure.

A silicone breast implant. *(Photograph by Dale O'Dell, The Stock Market. Reproduced by permission.)*

Precautions

A woman in poor health or with a severe chronic disease is not a good candidate for this procedure.

Description

A cosmetic breast enlargement is usually an outpatient procedure. It may be done under local or general anesthesia, depending on patient and physician preference. The incision is made through the armpit, under the breast, or around the areola (the darkened area around the nipple). These techniques create the most inconspicuous scars. The implant is placed between the breast tissue and underlying chest muscle, or under the chest muscle. The operation takes approximately one to two hours. The cost of a cosmetic procedure is rarely covered by insur-

ance. However, if enlargement is part of breast reconstruction after a mastectomy, health plans may pay for some or all of it. The surgeon's fee ranges from $2,700-$4,200 and up. The procedure may also be called breast augmentation or augmentation mammaplasty.

Preparation

Before the surgery is performed, the woman should have a clear understanding of what her new breasts will look like. She and her physician should agree about the desired final result. Many surgeons find it helpful to have the patient review before and after pictures, to clarify expectations.

Aftercare

Driving and normal activities may be restricted for up to one week. Stitches are usually removed in seven to 10 days. Typically, a woman can resume all routines, including vigorous **exercise**, in about three weeks. The scars will be red for approximately one month, but will fade to their final appearance within one or two years.

Risks

Risks which are common to any surgical procedure include bleeding, infection, anesthesia reaction, or unexpected scarring. A breast enlargement may also result in decreased sensation in the breast, or interference with breast-feeding. Implants can also make it more difficult to read and interpret mammograms, possibly delaying **breast cancer** detection. Also, the implant itself can rupture and leak, or become displaced. A thick scar that normally forms around the implant, called a capsule, can become very hard. This is called capsular contracture, and may result in **pain** and/or an altered appearance of the breast. The older the implant, the greater the chances that these problems will occur.

There has been intermittent publicity about possible health risks from breast implants. Most concerns have focused on silicone gel-filled implants. As of 1992, the Food and Drug Administration (FDA) restricted the use of this type of implant, and ordered further studies. Today only saline-filled implants are used for cosmetic breast surgery. Recent studies have shown no evidence long-term health risks from silicone implants. However, research on the possible links between these implants and autoimmune or connective tissue diseases is continuing.

Normal results

Breasts of expected size and appearance would be the normal results of this surgery.

Ellen S. Weber, MSN

Resources

BOOKS

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book*. 2nd ed. Reading, MA: Addison-Wesley, 1995.

PERIODICALS

"Breast Implant Update." *Harvard Women's Health Watch* 5 (Sept. 1997): 7.

ORGANIZATIONS

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

Breast infection *see* **Mastitis**

Breast radiography *see* **Mammography**

Breast reconstruction

Definition

Breast reconstruction is a series of surgical procedures performed to recreate a breast. Reconstructions are commonly done after one or both breasts are removed as a treatment for **breast cancer**. Also, a breast may need to be refashioned for other reasons, such as trauma or abnormalities that occur during breast development.

Purpose

Many authorities consider reconstruction an integral part of the therapy for breast **cancer**. A breast that appears natural offers a sense of wholeness and normalcy, which can aid in the psychological recovery from breast cancer. It eliminates the need for an external prosthesis (false breast), which many women find physically uncomfortable as well as inconvenient.

Precautions

Not all women are good candidates for breast reconstruction. Overall poor physical health, or specific problems such as cigarette **smoking**, **obesity**, high blood pressure, or diabetes, will increase the chance of complications. Also, a difficult and/or prolonged recovery period or failure of the reconstruction may be a result. A woman's physical ability to cope with major surgery and recuperation also need to be considered.

Description

Breast reconstruction is done in two stages, with the ultimate goal of creating a breast which looks and feels as natural as possible. It is important to remember that

while a good result may mimic a normal breast closely, there will inevitably be scars and loss of sensation. The reconstructed breast cannot be exactly like the original.

The first step is to form a structure called a breast mound. This can be accomplished using artificial materials called **breast implants**, or by using tissues from other parts of the woman's body. The second step involves creating a balance between the newly constructed breast and the breast on the opposite side. The nipple and areolar complex (darker area around the nipple) are recreated. This is usually done several months after the mound is created, to allow swelling to go down. Other procedures may be necessary, such as lifting the opposite breast (mastopexy), or making it larger or smaller to match the reconstructed breast.

Timing, immediate or delayed reconstruction

While immediate reconstruction (IR) is not recommended for women with breast cancer who need to undergo other, more important treatments, breast reconstruction can be done almost anytime. It even can be done during the same procedure as the **mastectomy**, or it can be delayed. There are psychological benefits to IR. The ability to return to normal activities and routines is often enhanced when reconstruction follows immediately after mastectomy. A better appearance may result from IR. There is less skin removal, often resulting in a shorter scar. The surgeon is better able to preserve the normal boundaries of the breast, so it is easier to match the opposite breast more closely.

The cost of IR is generally lower than the cost of delayed reconstruction (DR). There is one fewer operation and hospital stay. Surgeon's fees may be lower for a combined procedure than for two separate surgeries.

There are disadvantages of IR as well. The surgery itself is longer, causing more time under anesthesia. Post-operative **pain** and recovery time will be greater than for mastectomy alone.

Other authorities contend that delayed reconstruction (DR) offers different physical and psychological advantages. The initial mastectomy procedure alone takes less time, and has a shorter recovery period and less pain than mastectomy and IR. The patient has more time to adjust to her diagnosis and recover from additional therapy. She is better able to research her options, and to formulate realistic goals for reconstruction. Some reconstructive surgery requires blood transfusions. With DR, the patient can donate her own blood ahead of time (autologous **transfusion**), and/or arrange to have family and friends donate blood for her use (directed donation).

The psychological **stress** of living without a breast is a disadvantage of DR. The extra procedure DR entails results in higher costs. Although initial recovery is faster, an additional recuperation period is required after the delayed operation.

Type of reconstruction

There are two basic choices for breast reconstruction. The breast tissue can be replaced with an implant or the breast is created using some of the woman's own tissues (autologous reconstruction).

ARTIFICIAL IMPLANTS. In general, implant procedures take less time, and are less expensive than autologous ones. Implants are breast shaped pouches. They are made of silicone outer shells, which may be smooth or textured. The inside may contain silicone gel, saline (salt water), or a combination of both.

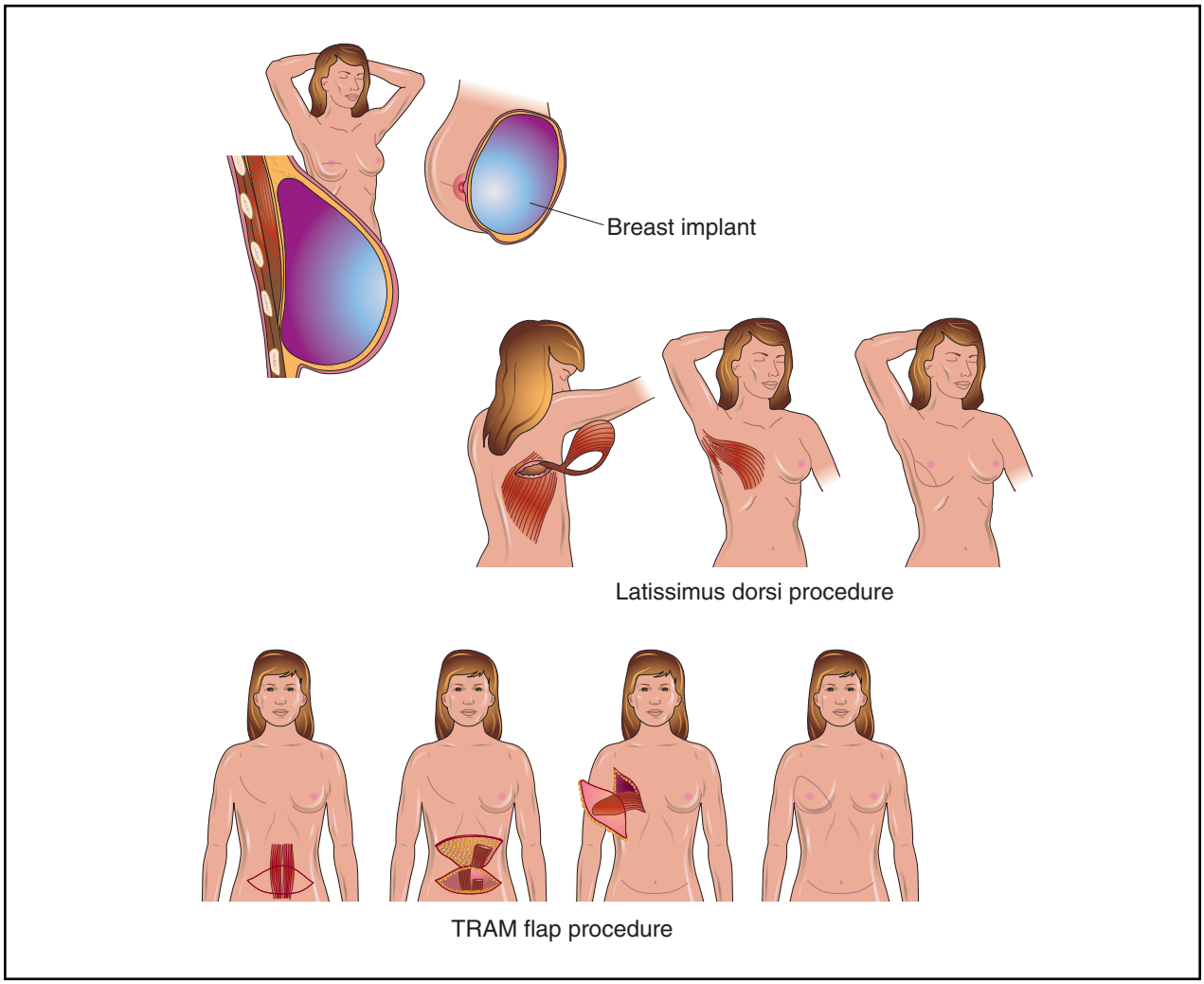
An implant may be a fixed volume type, which cannot change its size. Implants that have the capacity to be filled after insertion are called tissue expanders. These may be temporary or permanent.

The initial procedure for any implant insertion uses the mastectomy incision to make a pocket of tissue, usually underneath the chest wall muscle. In DR, the mastectomy scar may be re opened and used for this purpose, or a more cosmetic incision may be made. The implant is inserted into the pocket, the skin is stretched as needed and stitched closed.

If there is inadequate tissue to achieve the desired size, or a naturally sagging breast is desired, a tissue expander is used. It resembles a partially deflated balloon, with an attached valve or port through which saline can be injected. After the initial surgical incision is healed, the woman returns to the doctor's office, on a weekly or bi-weekly basis, to have small amounts of saline injected. Injections can continue for about six to eight weeks, until the preferred size is obtained. In some cases it may be overfilled, and later partially deflated to allow for a more pliable, natural result. A temporary tissue expander will be removed after several months and replaced with a permanent implant.

IR surgery using an implant takes approximately two to three hours, and usually requires up to a three day hospital stay. Implant insertion surgery, as part of DR, takes one to two hours and can sometimes be done as an outpatient, or it or it may entail overnight hospitalization.

AUTOLOGUS RECONSTRUCTION. Attached flap and free flap are two types of surgery where a woman's tissue is used in reconstruction. An attached flap uses skin, muscle, and fat, leaving blood vessels attached to their original source of blood. The flap is maneuvered to the reconstruction site, keeping its original blood supply for nourishment. This may also be known as a pedicle flap. The second kind of surgery is called a free flap. This also uses skin, muscle, and fat, but severs the blood vessels, and



Breast reconstruction surgery may be performed by inserting an artificial substance, or implant, to replace breast tissue. Autologous reconstruction, in which a woman's own tissues are used, includes the latissimus dorsi flap, where skin and muscle taken from the back is rotated around to the breast area, and the TRAM flap, in which abdominal fat and muscle are tunneled under the skin to the breast area. *(Illustration by Electronic Illustrators Group.)*

attaches them to other vessels where the new breast is to be created. The surgeon uses a microscope to accomplish this delicate task of sewing blood vessels together. Sometimes the term microsurgery is used to refer to free flap procedures. Either type of surgery may also be called a myocutaneous flap, referring to the skin and muscle used.

The skin and muscle used in autologous reconstruction can come from one of several possible places on the body, including the abdomen (TRAM flap or "tummy tuck"), the back (latissimus dorsi flap), or the buttocks (gluteus maximus free flap).

Finishing the reconstruction

Other procedures may be necessary to achieve the goal of symmetrical breasts. It may be necessary to make the opposite breast larger (augmentation), smaller (reduction), or higher (mastopexy). These, or any other refinements should be completed before the creation of a nipple and areola. Tissue to form the new nipple may come from the reconstructed breast itself, the opposite breast, or a more distant donor site, such as the inner thigh or behind the ear. The nipple and areolar construction is usually an outpatient procedure. A final step, often done in the doctor's office, is tattooing the new nipple and areola, to match the color of the opposite nipple and areola as closely as possible.

Insurance

Insurance coverage for breast reconstruction varies widely. Some policies will allow procedures on the affected breast, but refuse to pay for alterations to the opposite

breast. Other plans may cover the cost of an external prosthesis, or reconstructive surgery, but not both. As of January 1998, 25 states had different laws regarding required insurance coverage for post mastectomy reconstruction.

Implants may pose additional insurance concerns. Some companies will withdraw coverage for women with implants, or add a disclaimer for future implant-related problems. Careful reading of insurance policies, including checking on the need for pre-approval and/or a second opinion, is strongly recommended.

Preparation

Routine preoperative preparations, such as taking nothing to eat or drink the night before surgery are needed for reconstructive procedures. Blood transfusions are often necessary for autologous reconstructive surgeries. The patient may donate her own blood, and/or have family and friends donate several weeks before the surgery.

Emotional preparation is also important. Breast reconstruction will not resolve a psychological problem the woman had before mastectomy, nor make an unstable relationship strong. An expectation of physical perfection is unrealistic. A woman who cites any of these reasons for reconstruction shows that she has not been adequately informed or prepared. Complete understanding of the benefits and limitations of this surgery is necessary for a satisfactory result.

Aftercare

The length of the hospital stay, recovery period, and frequency of visits to the doctor after surgery varies considerably with the different kinds of reconstruction. In general, autologous procedures require longer hospitalization and recovery time than implant procedures. Bandages and drainage tubes remain in place for at least a day for all surgeries. Microsurgical or free flaps are most closely monitored in the first day or two after surgery. The circulation to the breast may be checked as often as every hour. Complete breast reconstruction requires at least one additional surgery to create a nipple and areola. Scars may remain red and raised for a month or longer. The true, final appearance of the breasts will not be visible for at least one year.

Risks

Some women have reported various types of autoimmune related connective-tissue disorders, which they attribute to their implants usually involving silicone gel implants. Lawsuits have been filed against the manufacturers of implants. Food and Drug Administration guidelines, issued in 1992, now limit their use to women who need to replace an existing silicone gel-filled implant, have had surgery for breast cancer, or have a medical condition which results in serious breast abnormality. In addition, patients must sign a consent form which details the potential risks of silicone gel-filled implants, and become enrolled in a long range study. Saline filled implants are permitted for all uses, although manufacturers must collect data on possible risks.

The FDA issued a status report on Breast Implant Safety in 1995, and revised it in March 1997. It noted that studies so far have not shown a serious increase in the risk of recognized autoimmune diseases in women with silicone gel-filled breast implants. It also addressed concerns about other complications and emphasized the need for further study of this issue.

There are a number of risks common to any surgical procedure such as bleeding, infection, anesthesia reaction, or unexpected scarring. Hematoma (accumulation of blood at the surgical site), or seroma (collection of fluid at the surgical site) can delay healing if not drained. Any breast reconstruction also poses a risk of asymmetry and/or the need for unplanned surgical revision. Persistent pain is another potential complication possible with all types of breast reconstruction.

Implants have some unique problems that may develop. A thick scar, also called a capsule, forms around

KEY TERMS

Autologous—From the same person. An autologous breast reconstruction uses the woman's own tissues. An autologous blood transfusion is blood removed then transfused back to the same person at a later time.

Capsular contracture—Thick scar tissue around a breast implant, which may tighten and cause discomfort and/or firmness.

Flap—A section of tissue moved from one area of the body to another.

Free flap—A section of tissue detached from its blood supply, moved to another part of the body, and reattached by microsurgery to a new blood supply.

Mastopexy—Surgical procedure to lift up a breast. May be used on opposite breast to achieve symmetrical appearance with a reconstructed breast.

Pedicle flap—Also called an attached flap. A section of tissue, with its blood supply intact, which is maneuvered to another part of the body.

the implant, as part of the body's normal reaction to a foreign substance. Capsular contracture occurs when the scar becomes firm or hardened. This may cause pain and/or change the texture and appearance of the breast. Implants can rupture and leak, deflate, or become displaced. The chances of capsular contracture or rupture increase with the age of the implant. These complications can usually be remedied with outpatient surgery to loosen the capsule or remove and/or replace the implant as needed. There is some evidence that using implants with textured surfaces may decrease the incidence of these problems. An implant tends to remain firm indefinitely. It will not grow larger or smaller as the woman's weight changes. Asymmetry can develop if a woman gains or loses a large amount of weight.

The autologous procedures all carry a risk of flap failure—loss of blood supply to the tissue forming the new breast. If a large portion of the flap develops inadequate blood supply, another reconstructive technique may be necessary. TRAM flap procedures can result in decreased muscle tone and weakness in the abdomen and/or abdominal **hernia**. Arm weakness may occur after latissimus dorsi flap surgery.

Normal results

A normal result of breast reconstruction depends on the woman's goals and expectations. It will not be the same as the breast it replaces. In general, it should be similar in size and shape to the opposite breast, but will have less sensation and be less mobile than a natural breast. A reconstruction using implants will usually be firmer and rounder than the other breast. It may feel cooler to touch, depending on the amount of tissue over it. Scars are unavoidable, but should be as unobtrusive as possible.

Resources

BOOKS

Berger, Karen, and John Bostwick III. *A Woman's Decision: Breast Care, Treatment and Reconstruction.* St. Louis: Quality Medical Publishing, Inc., 1994.

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book.* 2nd ed. Reading, MA: Addison-Wesley, 1995.

PERIODICALS

Bostwick III, John. "Breast Reconstruction Following Mastectomy." *CA: A Cancer Journal for Clinicians* 45 (Sept./Oct. 1995): 289-303.

"Breast Implant Update." *Harvard Women's Health Watch* 5 (Sept. 1997): 7.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

U.S. Department of Health and Human Services, U.S. Food and Drug Administration, Office of Consumer Affairs. 5600 Fishers Lane, Rockville, MD 20857. (800) 532-4440. <http://www.fda.gov/fdahomepage.html>.

Ellen S. Weber, MSN

Breast reduction

Definition

Breast reduction is a surgical procedure performed in order to decrease the size of the breasts.

Purpose

Women with very large breasts (macromastia or mammary hyperplasia) seek breast reduction for relief of **pain** in the back, shoulder, and neck. They may also feel uncomfortable about their breast size and have difficulty finding clothing that will fit properly. Additionally, breast reduction may be needed after reconstructive surgery following the surgical removal of cancerous breast tissue (**mastectomy**), to make the breasts more symmetric.

Men who have enlarged breasts (**gynecomastia**) may also be candidates for breast reduction. However, excessive alcohol intake, **smoking marijuana**, or using anabolic steroids may cause gynecomastia, and surgery is not recommended for men who continue to use these products.

Precautions

Breast reduction is not recommended for women whose breasts are not fully developed or who plan to breast feed.

Description

Breast reduction may also be called reduction mammaplasty. It is most often done in the hospital, under general anesthetic. However, studies have suggested that an outpatient procedure, using local anesthetic and mild **sedation** may be appropriate for some patients. The operation takes approximately two to four hours. The most commonly made incision encircles the areola (darkened area around the nipple) and extends downward and around the underside of the breast. This produces the least conspicuous scar. The excess tissue, fat, and skin are removed, and the nipple and areola are repositioned. In certain cases, **liposuction** (fat suctioning) is used to

KEY TERMS

Gynecomastia—Overly developed or enlarged breasts in a male.

Macromastia—Excessive size of the breasts.

Mammary hyperplasia—Increased size of the breast.

remove extra fat from the armpit area. A hospital stay of up to three days may be needed for recovery.

If deemed medically necessary, breast reduction is covered by some insurance plans. However, a specified amount of breast tissue may need to be removed in order to qualify for coverage. Surgeon's fees range from $4,800-$6,500 and up.

Preparation

Consultation between surgeon and patient is important to ensure that the woman understands and agrees with the expected final results of the procedure. Measurements and photographs may be taken. Many doctors also recommend a mammogram before the operation, to make sure there is no **cancer**.

Aftercare

After the surgery, an elastic bandage or special supportive bra is placed over gauze bandages and drainage tubes. The bandages and tubes are removed in a day or two. The bra will need to be worn around the clock for several weeks. Stitches are removed one to three weeks after the operation. Normal activities, including sexual relations may be restricted for several weeks. Scars will typically remain red, and perhaps lumpy for up to several months, but will gradually fade and become less noticeable. It may take up to a year before the breasts achieve their final position and size.

Risks

Risks common to any operation include bleeding, infection, anesthesia reactions, or unexpected scarring. Breast reduction may result in decreased feeling in the breasts or nipples and/or impaired ability to breastfeed. When healing is complete, the breasts may be slightly uneven, or the nipples may be asymmetric.

Normal results

Smaller breast size should be achieved, and with that, the accompanying pain and discomfort should be alleviated.

Resources

BOOKS

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book*. Reading, MA: Addison-Wesley, 1995.

ORGANIZATIONS

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

Ellen S. Weber, MSN

Breast self-examination

Definition

A breast self-examination (BSE) is an inspection by a woman of her breasts to detect **breast cancer**.

Purpose

A BSE is one of three tests the American **Cancer** Society recommends to help detect breast cancer in its earliest stages. By regularly examining her own breasts, a woman is more likely to find any changes that may have occurred. The best time to perform a BSE is about a week after a woman's period ends, when her breasts are not tender or swollen. If her periods are not regular, a BSE should be completed on the same day every month. A BSE should also be regularly completed by women who are pregnant, breastfeeding, or have **breast implants**. By combining a BSE with a **mammography** and clinical breast examination, a woman is offered the best opportunity for reducing chances of **death** from breast cancer through early detection. Close to 90% of breast cancers are found through a BSE. The American Cancer Society recommends that beginning at the age of 20, women complete a BSE each month by feeling for lumps or anything suspicious, as well as looking at their breasts carefully in a mirror for any changes in contour, swelling, dimpling, puckering of the skin, or changes in the nipple.

Description

To complete a monthly BSE:

- When lying down, place a pillow under the right shoulder and position the right arm behind the head. Using the finger pads of the three middle fingers on the left hand, check the entire breast area. Use small circles and follow an up-and-down pattern while pressing firmly enough to know how the breast feels from month to month. This exam should then be repeated on the left

breast using the finger pads of the right hand with the pillow under the left shoulder.

- When standing before a mirror, any changes in the shape or look of the breasts should be checked. In order to look for any skin or nipple changes such as dimpling or nipple discharge, the arms should first be placed at the sides and then overhead. Hands are then placed firmly on hips to flex chest muscles, and then the body should be bent forward.
- When taking a shower, the right arm should be raised. By using soapy hands and fingers flat the right breast and outer part of the breast can be examined. The same small circles and up-and-down pattern used when lying down should be used in an upright position. Repeat on the left breast.

Preparation

Before beginning a monthly BSE, a woman's breasts should be completely exposed.

Normal results

Each woman's breasts has their own normal look and feel. By completing a BSE each month, a woman can determine what is normal for her and check for changes that may arise. A regular pattern of lumpiness in the breasts is normal.

Abnormal results

If any changes are noticed during a monthly BSE, such as a new, hard lump in the breast or underarms, a doctor should examine the area immediately. Other trouble signs that should not be ignored include:

- change in breast size or shape
- dimpling or puckering of the skin
- redness, swelling, or warmth that does not go away
- a **pain** in one area that does not vary with a woman's monthly cycle
- a nipple that pulls in
- discharge from the nipple that begins suddenly and appears only in one breast
- one nipple that has an itchy, sore, or scaling area

Beth A. Kapes

Resources

BOOKS

Altman, Roberta and Michael J. Sarg. "Breast Self-examination." *The Cancer Dictionary.* Checkmark Books, 2000.

ORGANIZATIONS

American Cancer Society. (800) 227-2345. <http://www.cancer.org>.

The Komen Foundation. 5005 LBJ Freeway, Suite 250, Dallas, Texas 75244. (972) 855-1600. <http://www.komen.org>.

OTHER

"How to do a Breast Self-Exam." Women.com. 5 May 2001. <http://www.women.com>.

Breast sonogram *see* **Breast ultrasound**

Breast ultrasound

Definition

Breast ultrasound (or sonography) is an imaging technique for diagnosing breast disease, such as **cancer**. It uses harmless, high frequency sound waves to form an image (sonogram). The sound waves pass through the breast and bounce back or echo from various tissues to form a picture of the internal structures. It is not invasive and involves no radiation.

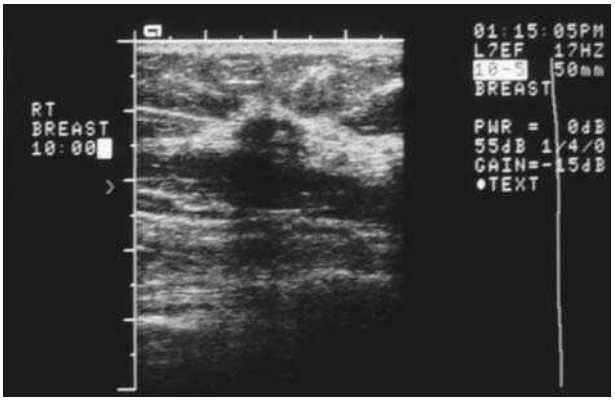
Purpose

Breast ultrasound may be used in several ways. The most common application is to investigate a specific area of the breast where a problem is suspected. A palpable lump and/or a lump or density discovered by x ray (mammogram) can be further evaluated by ultrasound. It is especially helpful in distinguishing between a fluid-filled cyst and a solid mass. It can also identify small lesions that are too tiny to be felt.

Breast ultrasound is often the first study performed to evaluate masses in women under 35 whose mammograms can be difficult to interpret due to the density of their breast tissue. The lack of radiation used with ultrasound makes it ideal for studying breast abnormalities in women who are pregnant. Assessing **breast implants** for leakage or rupture is another way ultrasound is used. Breast inflammation, where pockets of infection or abscesses may form, can be diagnosed and monitored by ultrasound.

Thickened and swollen breast skin may be a sign of inflammatory **breast cancer**. Ultrasound can sometimes identify a cancerous growth within the breast causing the thickened skin. These cases are usually followed by a core biopsy guided by ultrasound (described below).

Breast ultrasound is employed to observe and guide a needle for several interventional procedures. These include cyst aspiration, fine needle aspiration, large core needle



A breast ultrasound image. *(Custom Medical Stock Photo. Reproduced by permission.)*

biopsy (as a first step in determining treatment for a lesion that is likely to be cancerous), and needle localization in surgical **breast biopsy**. Biopsies guided by ultrasound have distinct advantages. The ultrasound guides the needle so that a lesion can be removed for the biopsy. Patients usually find that the procedure is less traumatic and more comfortable than surgical biopsies. Ultrasound is known for its accuracy in determining how far a cancerous growth extends into the surrounding tissue in lesions that cannot be felt. Biopsies guided by ultrasound are generally less costly than surgical biopsies. Additionally, if the abnormality that requires biopsy can be seen on both a mammogram and ultrasound, an ultrasound-guided biopsy is often more comfortable for the patient as no compression is necessary.

Description

Ultrasound can be done in a doctor's office or another outpatient setting, such as a hospital or imaging center.

The patient removes her clothing from the waist up and puts on a hospital gown, open in the front. She lies on her back or side on an examining table. A gel that enhances sound transmission is spread over the area to be examined. The technologist then places a transducer, an instrument about the size of an electric shaver, against the skin. The images from reflected sound waves appear on a monitor screen.

A good ultrasound study is difficult to obtain if the patient is unable to remain quietly in one position. **Obesity** may hinder clear viewing of internal structures, and the accuracy of an ultrasound study is highly dependent on the skill of the person performing the examination. The images recorded vary with the angle and pressure of the transducer and the equipment settings. The examination may take from 30 to 45 minutes. Most insurance plans cover the cost of an ultrasound examination.

KEY TERMS

Cyst—A thin-walled, fluid-filled benign structure in the breast.

Ductal carcinoma—A type of cancer that accounts for as much as 80% of breast cancers. These tumors feel bigger than they look on ultrasound or mammogram.

Fibroadenoma—A benign breast growth made up of fibrous tissue. It is the most common mass in women under 35 years of age, and is found in both breasts in 3% of cases.

Infiltrating lobular carcinoma—A type of cancer that accounts for 8% to 10% of breast cancers. In breasts that are especially dense, ultrasound can be useful in identifying these masses.

Microcalcifications—Tiny flecks that are too small to be felt. They are important markers of cancer that show up on ultrasound and mammogram.

Mucinous (colloid) carcinoma—A type of cancer that accounts for 1% to 2% of breast cancers. Resembles medullary carcinoma in ultrasound and mammogram, but usually affects older women.

Nonpalpable—Cannot be felt by hand. In cancer, growths that are nonpalpable are too small to be felt, but may be seen on ultrasound or mammogram.

Papillary carcinoma—A type of breast cancer that primarily occurs in older women. On ultrasound, this type of tumor may look like a solid or complex mass, or it may show up as solid tissue protruding into a cyst.

Tubular carcinoma—A type of cancer that accounts for approximately 1% to 2% of breast cancers. Can appear small on ultrasound or mammogram.

Normal results

An ultrasound examination may reveal either normal tissue or a benign condition such as a cyst. Ultrasound can confidently diagnose a benign structure that has certain characteristics of a simple cyst. In the case of a simple cyst with no symptoms, additional treatment beyond continued observation is usually not needed.

Abnormal results

A potentially malignant mass can be identified by breast ultrasound. Abnormal results fall into the following

categories: benign fibrous nodule, complex cyst, suspicious lesion, and lesion highly suggestive of cancer. In cases where ultrasound shows the presence of a complex cyst or fibrous nodule, a biopsy is justified because 10% to 15% of these growths are malignant. Lesions falling into the last two categories (suspicious or highly suggestive of cancer) have a higher chance of being cancerous, and should be investigated further, either by biopsy or surgery.

Breast cancers such as the following may be identified on ultrasound: ductal carcinoma, infiltrating lobular carcinoma, medullary carcinoma, mucinous (colloid) carcinoma, tubular carcinoma, and papillary carcinoma. On ultrasound, the shape of a lesion and the type of edges it has can sometimes indicate if it is benign or cancerous, but there are exceptions. For example, benign fibroadenomas are usually oval, and some cancers can be similarly shaped. Cancerous tumors usually have jagged edges, but some benign growths can have these edges as well. Ultrasound is not a definitive test. Tissue diagnosis is often required.

Resources

BOOKS

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book.* 2nd ed. Reading, MA: Addison-Wesley, 1995.

Rumack, Carol M. et al., eds. *Diagnostic Ultrasound* St. Louis: Mosby–Year–Book, Inc., 1998.

PERIODICALS

Jackson, Valerie. "The Current Role of Ultrasonography in Breast Imaging." *Radiologic Clinics of North America* 33 (November 1995): 1161-70.

Rubin, Eva, et al. "Reducing the Cost of Diagnosis of Breast Carcinoma: Impact of Ultrasound and Imaging–Guided Biopsies on a Clinical Breast Practice." *Cancer* 91 (January 2001) 324-31.

Smith, LaNette F. et al. "Intraoperative Ultrasound–guided Breast Biopsy." *The American Journal of Surgery* 180 (December 2000): 419-23.

Velez, Nitzet et al. "Diagnostic and Interventional Ultrasound for Breast Disease." *The American Journal of Surgery* 180 (October 2000): 284-7.

Ellen S. Weber

Breast x ray *see* **Mammography**

Breech birth

Definition

Breech birth is the delivery of a fetus (unborn baby) hind end first. Between 3-4% of fetuses will start labor in the breech position, which is a potentially dangerous situation.

Description

Throughout most of **pregnancy**, the developing fetus is completely free to move around within the uterus. Between 32-36 weeks, it becomes so large that movement is restricted. It is much harder for the fetus to turn over, so whatever position it has assumed by this point is likely to be the same position that he or she will be in when labor begins.

For reasons that are not fully understood, almost all unborn babies settle into a head down position. The fetus is upside down in the uterus, and the head will lead the way during the birth process.

Unfortunately, some fetuses do not cooperate. Most of these are in the breech position. The buttocks lead the way out of the uterus, and the legs are folded in front of the body (frank breech). Delivery from the breech position poses far more risks than delivery head first (vertex position).

The biggest part of the fetus's body is usually its head. If the head fits through the mother's pelvis, then the rest of the fetus's body should slip out fairly easily. If the fetus is born bottom first, it is possible that the body will fit through the mother's pelvis, but the baby's head will get stuck at the level of the chin. This condition, known as a trapped head, is very dangerous.

When the baby's head comes first, it has a chance to "mold" during labor. The bones of the baby's skull are not yet fastened together the way they are in a child or adult's skull, meaning that the bones of the baby's skull can move. During the long hours of labor the skull can change shape to fit through the pelvis more easily, which is why many babies are born with a "cone head". If the baby is born from the breech position, the skull does not have a chance to change shape to fit the pelvis, and it is even more likely to get stuck.

If the baby's head gets trapped, the possibility of injury is high. Once the baby's body is born, the umbilical cord usually stops pulsating (just as it would during a normal delivery). This cuts off the oxygen supply from the mother to the baby. If the baby's head is still inside the uterus the baby cannot yet breathe on its own. Therefore, it is essential to deliver the baby as quickly as possible.

The life saving attempts to deliver the baby's head can cause injury to the baby's neck or head resulting in permanent handicaps. In extreme cases, if the baby cannot be delivered within a few minutes, the baby might die. Obviously, it is critical to avoid a breech delivery with a trapped head.

Of course, many babies are safely delivered from the breech position. There are certain factors that make a breech delivery more likely to be successful: if ultra-

sound (a technique that uses sound waves to visualize the fetus) shows that the fetus is in the frank breech position, the fetus's head is tucked on its chest, and the fetus is not big, it is less likely that its head will get stuck.

Among breech babies born after the full nine-month term, smaller babies usually do better. This is not true for premature babies. Premature babies are more likely to have a trapped head because the body of a premature baby is usually much smaller than his or her head. Premature babies are generally not delivered from the breech position.

The risks of vaginal breech delivery can be avoided by delivering the baby through a surgical procedure (**cesarean section**, also known as c-section). For the past twenty years, cesarean section has been recommended when the fetus is breech. More recently, many providers have offered the option of version, attempting to turn the fetus within the uterus to a head first position before labor begins.

Version is based on a very simple idea. If a fetus in the breech position does a somersault, it will end up head down. During a version, the obstetrician tries to make the fetus do a somersault.

A version should only be done in a hospital, with an ultrasound machine used to guide the obstetrician in turning the fetus. The fetus should be monitored with a fetal monitor before and after the version. Some obstetricians give the mother an injection of medication to relax the mother's uterus and prevent any contractions.

During the procedure, the obstetrician places his or her hands on the mother's abdomen to feel the location of the unborn baby's buttocks and head. The buttocks are lifted up slightly and the doctor pushes on the baby's head to encourage him to perform a somersault. It may take several tries before the fetus cooperates, but over half will eventually turn.

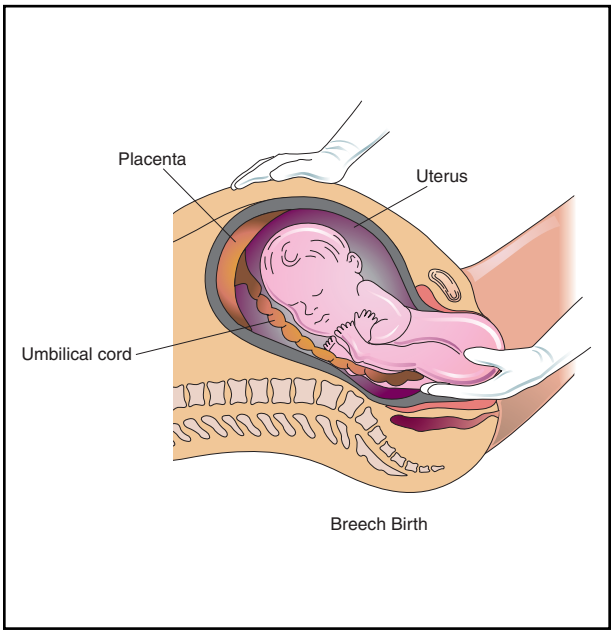
A version is not appropriate for every fetus who is in the breech position at the end of pregnancy. It can only be tried if there is one fetus in the uterus, if the placenta is not lying in front of the fetus, and if the umbilical cord does not appear to be wrapped around the fetus at any point.

Causes and symptoms

The cause of breech birth is not known. There are generally no identifiable symptoms. However, some women can tell the position of the fetus by where they feel the fetus kicking. Most women cannot tell what position the fetus is in at any given moment.

Diagnosis

A health care provider can often tell the position of the fetus by feeling it through the wall of the mother's abdomen. Another clue to the position is the location where the heartbeat is heard best. If the fetus's heartbeat is best heard below the level of the mother's navel, it is likely to be positioned head first. On the other hand, if the heartbeat is best heard above the level of the navel, it is likely to be breech.



Approximately 3-4% of babies will start labor in the breech (buttocks first) position. While this is a potentially dangerous situation, many full-term babies can be safely delivered from the breech position. *(Illustration by Electronic Illustrators Group.)*

The only way to really be sure, however, is to do an ultrasound exam. Using this technique it is very easy to tell the position of the fetus.

Treatment

If a fetus is in the breech position in the last weeks of pregnancy, there are three possible courses of action: Cesarean section, attempted version, or vaginal breech delivery.

Cesarean section is the most common way to deliver a breech baby. This surgical procedure carries more risk for the mother, but many women prefer to take the risk of surgery on themselves rather than let the baby face the risks of breech delivery.

Version is gaining in popularity. Version is a medical procedure in which the obstetrician tries to turn the breech fetus to the head first position. Version is successful more than 50% of the time. However, some babies who are successfully turned will turn back to the breech position after the procedure is done.

Some women choose breech vaginal delivery. This should only be attempted if ultrasound shows that the fetus is in a favorable breech position. Most babies will do very well during a breech delivery, but it is always possible that the fetus will be injured, perhaps seriously.

Prevention

There is no way to prevent a fetus from settling into the breech position at the end of pregnancy. A woman who has had one breech fetus is more likely than average to have another.

Amy B. Tuteur, MD

Resources

BOOKS

"Techniques for Breech Delivery." In *Williams Obstetrics*. 20th ed. Ed. F. Gary Cunningham, et al. Stamford: Appleton & Lange, 1997.

Breech presentation *see* **Breech birth**

Brill-Zinsser disease *see* **Typhus**

Brittle bone disease *see* **Osteogenesis imperfecta**

Broken nose *see* **Nasal trauma**

Bronchiectasis

Definition

Bronchiectasis is a condition in which an area of the bronchial tubes is permanently and abnormally widened (dilated), with accompanying infection.

Description

The bronchial tubes are the networks of branching tubes which deliver air to the tiny sacs of the lungs (alveoli). In bronchiectasis, the diameter of the bronchi is unusually large. Examination of the walls of the bronchial tubes reveals destruction of the normal structural elements, with replacement by scar tissue. Pus collects within the bronchi, and the normal flow of oxygen into the lungs, and carbon dioxide out of the lungs (air exchange) is impaired. The bronchi show signs of inflammation, with swelling and invasion by a variety of immune cells. The inflamed areas show signs of increased growth of blood vessels. The area of the lung which should be served by a diseased bronchial tube is also prone to inflammation and infection.

Causes and symptoms

Prior to the widespread use of immunizations, bronchiectasis was often the result of a serious infection with either **measles** or **whooping cough**. Currently, viruses that cause **influenza** (flu) or influenza-like syndromes, as well as a number of bacteria may precede the development of bronchiectasis. Patients who have been infected with **tuberculosis** or the virus which causes **AIDS** (HIV or human **immunodeficiency** virus) also have an increased chance of bronchiectasis.

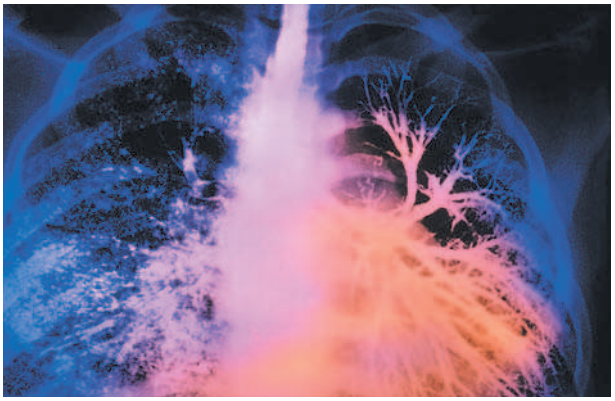
A number of pre-existing conditions may cause an individual to be more susceptible than normal to infection, with increased risk of bronchiectasis developing. These conditions include disorders of cilia, and immune disorders.

Cilia are the tiny hairs which usually line the bronchial tubes. Cilia wave constantly, sweeping the bronchial tubes clean of bacterial or viral invaders, and cleaning away excess secretions (mucus, sputum) which may be produced by the bronchi. When these cilia are abnormal or absent at birth, various bacterial or viral invaders may remain in the respiratory tract, multiply, and cause serious infections.

Immune disorders include decreased production of certain immune chemicals (immunoglobulins) which usually serve to fight off infection by bacterial or viral invasion. When these immunoglobulins are not produced in large enough quantity, bacterial and viral invaders are not effectively killed off, and infection occurs.

Other causes of bronchiectasis include an abnormally blocked (obstructed) airway. This can be due to tumor growth within the bronchial tube, or due to a child accidentally inhaling a small object which then blocks off the bronchial tube. People with the disease called **cystic fibrosis** (CF) often have their bronchial tubes obstructed by the thick, sticky mucus which is a hallmark of CF. Toxic exposures (breathing ammonia, for example) can harm the bronchi, and lead to bronchiectasis. An extreme allergic response of the immune system to the presence of certain fungi (especially one called *Aspergillus*) can also damage the bronchial tubes enough to result in bronchiectasis.

Symptoms of bronchiectasis include constant **cough** and the production of infected sputum (sputum is a mixture of mucus and pus), which may be bloody. In some cases, there may be **wheezing** and **shortness of breath**. The constant, low-level of infection may flare, resulting in increased production of sputum, worsening of the cough, and **fever**. The area of the lung served by the affected bronchial tube may become severely infected, resulting in **pneumonia**.



Colorized bronchogram of lungs—right tree has almost no structure caused by chronic inflammation. *(Mehau Kulyk, Photo Researchers. Reproduced by permission.)*

Diagnosis

Chest x ray may reveal evidence of bronchiectasis, and CT scans are particularly good at revealing the thick, dilated bronchial walls of bronchiectasis. Sputum will need to be collected and cultured (grown in a laboratory dish), in order to examine it microscopically for the specific type of organism responsible for infection. A careful search for other underlying diseases is important, looking in particular for ciliary abnormalities, cystic fibrosis, or immunoglobulin deficiencies.

Treatment

Treatment should involve efforts to resolve any underlying disorder. Infections will require **antibiotics**, obstruction may require the removal of a foreign object or tumor. Medications are available to help thin the sputum, so that it can be more effectively coughed up. Rhythmic clapping on the chest and back, while the patient assumes a number of positions (head down, primarily), may help the lungs to drain more effectively. This is called **chest physical therapy**, or percussion and postural drainage.

When a particular area of the lung is constantly and severely infected, surgery may be needed to remove it. When bleeding occurs from irritated bronchial tubes and overgrown bronchial blood vessels, surgery may be required either to remove an area of the bronchial tube, or to inject the bleeding blood vessel with a material to stop the bleeding.

In some patients, bronchiectasis eventually leads to a constantly low level of blood oxygen, despite other treatments. These patients usually have an associated increase in the size of the right side of their hearts, along with a decrease in the heart's ability to pump blood through the lungs. Some patients with extremely severe symptoms and disability have been treated with **lung transplantation**.

KEY TERMS

Bronchi—The network of tubular passages which carry air to the lung and allow air to be expelled from the lungs.

Cilia—Hair-like projections which line the bronchial tubes (also present in other areas of the body). Normal cilia beat consistently, sweeping the bronchi clean of bacteria, viruses, and mucus.

Prognosis

Prognosis varies widely, depending on how widespread or focal the bronchiectasis, and the presence of other underlying disorders.

Resources

BOOKS

Sherris Medical Microbiology: An Introduction to Infectious Diseases. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Weinberger, Steven. "Bronchiectasis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Marwah, Onkarjit S., and Om P. Sharma. "Bronchiectasis: How to Identify, Treat, and Prevent." *Postgraduate Medicine* 97 (Feb. 1995): 149+.

Nicotra, M. Brooke, et al. "Clinical, Pathophysiologic, and Microbiologic Characterization of Bronchiectasis in an Aging Cohort." *Chest* 108 (Oct. 1995): 955+.

Weinberger, Steven E., and Ann Giudici Fettner. "Disease in Disguise: Bronchiectasis." *Harvard Health Letter* 21 (Feb. 1996): 6+.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Rosalyn Carson-DeWitt, MD

Bronchiolitis *see* **Respiratory syncytial virus infection**

Bronchitis

Definition

Bronchitis is an inflammation of the air passages between the nose and the lungs, including the windpipe or

trachea and the larger air tubes of the lung that bring air in from the trachea (bronchi). Bronchitis can either be of brief duration (acute) or have a long course (chronic). Acute bronchitis is usually caused by a viral infection, but can also be caused by a bacterial infection and can heal without complications. Chronic bronchitis is a sign of serious lung disease that may be slowed but cannot be cured.

Description

Although acute and chronic bronchitis are both inflammations of the air passages, their causes and treatments are different. Acute bronchitis is most prevalent in winter. It usually follows a viral infection, such as a cold or the flu, and can be accompanied by a secondary bacterial infection. Acute bronchitis resolves within two weeks, although the **cough** may persist longer. Acute bronchitis, like any upper airway inflammatory process, can increase a person's likelihood of developing **pneumonia**.

Anyone can get acute bronchitis, but infants, young children, and the elderly are more likely to get the disease because people in these age groups generally have weaker immune systems. Smokers and people with heart or other lung diseases are also at higher risk of developing acute bronchitis. Individuals exposed to chemical fumes or high levels of air pollution also have a greater chance of developing acute bronchitis.

Chronic bronchitis is a major cause of disability and **death** in the United States. The American Lung Association estimates that about 14 million Americans suffer from the disease. Like acute bronchitis, chronic bronchitis is an inflammation of airways accompanied by coughing and spitting up of phlegm. In chronic bronchitis, these symptoms are present for at least three months in each of two consecutive years.

Chronic bronchitis is caused by inhaling bronchial irritants, especially cigarette smoke. Until recently, more men than women developed chronic bronchitis, but as the number of women who smoke has increased, so has their rate of chronic bronchitis. Because this disease progresses slowly, middle-aged and older people are more likely to be diagnosed with chronic bronchitis.

Chronic bronchitis is one of a group of diseases that fall under the name chronic obstructive pulmonary disease (COPD). Other diseases in this category include **emphysema** and chronic asthmatic bronchitis. Chronic bronchitis may progress to emphysema, or both diseases may be present together.

Causes and symptoms

Acute bronchitis

Acute bronchitis usually begins with the symptoms of a cold, such as a runny nose, sneezing, and dry cough. However, the cough soon becomes deep and painful. Coughing brings up a greenish yellow phlegm or sputum. These symptoms may be accompanied by a **fever** of up to 102°F (38.8°C). **Wheezing** after coughing is common.

In uncomplicated acute bronchitis, the fever and most other symptoms, except the cough, disappear after three to five days. Coughing may continue for several weeks. Acute bronchitis is often complicated by a bacterial infection, in which case the fever and a general feeling of illness persist. To be cured, the bacterial infection should be treated with **antibiotics**.

Chronic bronchitis

Chronic bronchitis is caused by inhaling respiratory tract irritants. The most common irritant is cigarette smoke. The American Lung Association estimates that 80-90% of COPD cases are caused by **smoking**. Other irritants include chemical fumes, air pollution, and environmental irritants, such as mold or dust.

Chronic bronchitis develops slowly over time. The cells that line the respiratory system contain fine, hairlike outgrowths from the cell called cilia. Normally, the cilia of many cells beat rhythmically to move mucus along the airways. When smoke or other irritants are inhaled, the cilia become paralyzed or snap off. When this occurs, the cilia are no longer able to move mucus, and the airways become inflamed, narrowed, and clogged. This leads to difficulty breathing and can progress to the life-threatening disease emphysema.

A mild cough, sometimes called smokers' cough, is usually the first visible sign of chronic bronchitis. Coughing brings up phlegm, although the amount varies considerably from person to person. Wheezing and **shortness of breath** may accompany the cough. Diagnostic tests show a decrease in lung function. As the disease advances, breathing becomes difficult and activity decreases. The body does not get enough oxygen, leading to changes in the composition of the blood.

Diagnosis

Initial diagnosis of bronchitis is based on observing the patient's symptoms and health history. The physician will listen to the patient's chest with a stethoscope for specific sounds that indicate lung inflammation, such as moist rales and crackling, and wheezing, that indicates airway narrowing. Moist rales is a bubbling sound heard with a stethoscope that is caused by fluid secretion in the bronchial tubes.

A **sputum culture** may be performed, particularly if the sputum is green or has blood in it, to determine whether a bacterial infection is present and to identify the disease-

causing organism so that an appropriate antibiotic can be selected. Normally, the patient will be asked to cough deeply, then spit the material that comes up from the lungs (sputum) into a cup. This sample is then grown in the laboratory to determine which organisms are present. The results are available in two to three days, except for tests for **tuberculosis**, which can take as long as two months.

Occasionally, in diagnosing a chronic lung disorder, the sample of sputum is collected using a procedure called a **bronchoscopy**. In this procedure, the patient is given a local anesthetic, and a tube is passed into the airways to collect a sputum sample.

A **pulmonary function test** is important in diagnosing chronic bronchitis and other variations of COPD. This test uses an instrument called a spirometer to measure the volume of air entering and leaving the lungs. The test is done in the doctor's office and is painless. It involves breathing into the spirometer mouthpiece either normally or forcefully. Volumes less than 80% of the normal values indicate an obstructive lung disease.

To better determine what type of obstructive lung disease a patient has, the doctor may do a **chest x ray**, electrocardiogram (ECG), and blood tests. An electrocardiogram is an instrument that is used to measure the electrical activity of the heart and is useful in the diagnosis of heart conditions. Other tests may be used to measure how effectively oxygen and carbon dioxide are exchanged in the lungs.

KEY TERMS

Acute—Disease or condition characterized by the rapid onset of severe symptoms.

Bronchi—The larger air tubes of the lung that bring air in from the trachea.

Chronic—Disease or condition characterized by slow onset over a long period of time.

Chronic obstructive pulmonary disease (COPD)—A term used to describe chronic lung diseases, like chronic bronchitis, emphysema, and asthma.

Emphysema—One of the several diseases called chronic obstructive pulmonary diseases, emphysema involves the destruction of air sac walls to form abnormally large air sacs that have reduced gas exchange ability and that tend to retain air within the lungs. Symptoms include labored breathing, the inability to forcefully blow air out of the lungs, and an increased susceptibility to respiratory tract infections.

Treatment

Acute bronchitis

When no secondary infection is present, acute bronchitis is treated in the same way as the **common cold**. Home care includes drinking plenty of fluids, resting, not smoking, increasing moisture in the air with a cool mist humidifier, and taking **acetaminophen** (Datril, Tylenol, Panadol) for fever and **pain**. **Aspirin** should not be given to children because of its association with the serious illness, **Reye's syndrome**.

Cough suppressants are used only when the cough is dry and produces no sputum. If the patient is coughing up phlegm, the cough should be allowed to continue. The purpose of the cough it to bring up extra mucus and irritants from the lungs. When coughing is suppressed, the mucus accumulates in the plugged airways and can become a breeding ground for pneumonia bacteria.

Expectorant cough medicines, unlike cough suppressants, do not stop the cough. Instead they are used to thin the mucus in the lungs, making it easier to cough up. This type of cough medicine may be helpful to individuals suffering from bronchitis. People who are unsure about what type of medications are in over-the-counter cough syrups should ask their pharmacist for an explanation.

If a secondary bacterial infection is present, the infection is treated with an antibiotic. Patients need to take the entire amount of antibiotic prescribed. Stopping the antibiotic early can lead to a return of the infection. Tetracycline or ampicillin are often used to treat adults. Other possibilities include trimethoprim/sulfamethoxazole (Bactrim or Septra) and the newer erythromycin-like drugs, such as azithromycin (Zithromax) and clarithromycin (Biaxin). Children under age eight are usually given amoxicillin (Amoxil, Pentamox, Sumox, Trimox), because tetracycline discolors permanent teeth that have not yet come in.

Chronic bronchitis

The treatment of chronic bronchitis is complex and depends on the stage of chronic bronchitis and whether other health problems are present. Lifestyle changes, such as quitting smoking and avoiding secondhand smoke or polluted air, are an important first step. Controlled exercise performed on a regular basis is also important.

Drug therapy begins with **bronchodilators**. These drugs relax the muscles of the bronchial tubes and allow increased air flow. They can be taken by mouth or inhaled using a nebulizer. A nebulizer is a device that delivers a regulated flow of medication into the airways.

Common bronchodilators include albuterol (Ventolin, Proventil, Apo-Salvent) and metaproterenol (Alupent, Orciprenaline, Metaprel, Dey-Dose).

Anti-inflammatory medications are added to reduce swelling of the airway tissue. **Corticosteroids**, such as prednisone, can be taken orally or intravenously. Other steroids are inhaled. Long-term steroid use can have serious side effects. Other drugs, such as ipratropium (Atrovent), are given to reduce the quantity of mucus produced.

As the disease progresses, the patient may need supplemental oxygen. Complications of COPD are many and often require hospitalization in the latter stages of the disease.

Alternative treatment

Alternative practitioners focus on prevention by eating a healthy diet that strengthens the immune system and practicing **stress** management. Bronchitis can become serious if it progresses to pneumonia, therefore, antibiotics may be required. In addition, however, there are a multitude of botanical and herbal medicines that can be formulated to treat bronchitis. Some examples include inhaling eucalyptus or other essential oils in warm steam. Herbalists recommend a tea made of mullein (*Verbascum thapsus*), coltsfoot (*Tussilago farfara*), and anise seed (*Pimpinella anisum*). Homeopathic medicine and **traditional Chinese medicine** may also be very useful for bronchitis, and **hydrotherapy** can contribute to cleaning the chest and stimulating immune response.

Prognosis

When treated, acute bronchitis normally resolves in one to two weeks without complications, although a cough may continue for several more weeks. The progression of chronic bronchitis, on the other hand, may be slowed, and an initial improvement in symptoms may be achieved. Unfortunately, however, there is no cure for chronic bronchitis, and the disease can often lead to or coexist with emphysema. Taken together, all forms of COPD are a leading cause of death.

Prevention

The best way to prevent bronchitis is not to begin smoking or to stop smoking. Smokers are ten times more likely to die of COPD than non-smokers. Smokers who stop show improvement in lung function. Other preventative steps include avoiding chemical and environmental irritants, such as air pollution, and maintaining good overall health. Immunizations against certain types of pneumonia (as well as **influenza**) are an important preventative measure for anyone with lung or immune system diseases.

Resources

BOOKS

Shayevits, Myra, Berton Shayevits, and the editors of Consumer Reports Books. *Living Well with Chronic Asthma, Bronchitis, and Emphysema.* Consumer Report Books, 1991.

PERIODICALS

Tiep, Brian L. "Disease Management of COPD with Pulmonary Rehabilitation." *Chest* 112, no. 6 (Dec. 1997): 1630-1657.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Jewish Center for Immunology and Respiratory Medicine. 1400 Jackson St., Denver, CO 80206. (800) 222-5864. <http://www.nationaljewish.org/main.html>.

Tish Davidson

Bronchodilators

Definition

Bronchodilators are medicines that help open the bronchial tubes (airways) of the lungs, allowing more air to flow through them.

Purpose

People with **asthma** have trouble breathing, because their airways are inflamed and become narrowed. Normally, air moves smoothly from the mouth and nose through the airways and into the tiny air sacs of the lungs as a person breathes in. Breathing out (exhaling) happens automatically when the person stops breathing in. In a person with asthma, breathing in (inhaling) is not a problem. Incoming air can slide around the blockage, because the act of breathing in makes the airways expand. The problem comes when the person with asthma tries to breathe out. The air can no longer get past the blockage, and it remains trapped in the lungs. The person can then only take shallow breaths. Bronchodilators work by relaxing the smooth muscles that line the airways. This makes the airways open wider and allows air to leave the lungs. These drugs also are used to relieve breathing problems associated with **emphysema**, chronic **bronchitis**, and other lung diseases.

Description

Some bronchodilators are inhaled, using a nebulizer or an inhalation aerosol. Others are taken as injections or by mouth. Most are available only by prescription, but a few, such as ephedrine, can be bought without a physician's prescription. Examples of bronchodilators are albuterol (Proventil, Ventolin), epinephrine (Primatene), ipratropium (Atrovent), metaproterenol (Alupent, Metaprel), and terbutaline (Brethine).

Recommended dosage

The recommended dosage depends on the type of bronchodilator and may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Precautions

Bronchodilators come with patient instructions. Be sure to carefully read them before using the medicine. If there is any confusion about how to use the medicine, check with the physician or pharmacist. Always use these medicines exactly as directed. Taking larger than recommended doses or using the medicine too often can lead to serious side effects and even **death**.

If symptoms do not improve or if they get worse after using a bronchodilator, call a physician right away.

Although some bronchodilators are available without a physician's prescription, these medicines should not be used unless a physician has diagnosed the patient's condition as asthma.

Some asthma experts believe that the overuse of bronchodilators can cause asthma to get worse. They advise patients and their physicians to consider controlling asthma with anti-inflammatory drugs including inhaled steroids such as beclomethasone dipropionate (Beclovent, Vanceril), flunisolide (AeroBid) or triamcinolone acetonide (Azmacort) Ideally, asthma should be controlled with an inhaled steroid that is used along with the bronchodilator. The more the inhaled steroid steroid controls the inflammation that causes the asthma, the less bronchodilator the patient needs to use because symptoms are under control.

Persons with diabetes should be aware that the bronchodilator epinephrine may raise their blood sugar levels.

Patients who are using an aerosol bronchodilator and an aerosol form of either ipratropium or a corticosteroid such as beclomethasone dipropionate (Beclovent, Vanceril) should use the bronchodilator first, then wait 5 minutes before using the other medicine. Check with a physician before using any other inhaled medications or other asthma medicines. The physician must determine the proper amount of time between doses.

Some bronchodilator products contain sulfites, that trigger an allergic reaction in certain people. Anyone who has a sulfite allergy should read the label carefully or check with a physician or pharmacist before using a bronchodilator. Call a physician immediately if any of these signs of an allergic reaction to sulfite occur:

- bluish coloration of the skin
- flushed or red face or skin
- faintness
- severe **dizziness**
- increased **wheezing** or other breathing problems
- skin rash, **hives**, or **itching**
- swelling of the face, lips, or eyelids

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they use bronchodilators. Before using these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to any bronchodilator or an inhaled form of any other drug in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Patients who are allergic to soybeans, soy lecithin, peanuts, or drugs based on atropine should not use the bronchodilator ipratropium (Atrovent).

PREGNANCY. In studies of laboratory animals, some bronchodilators cause **birth defects** or **miscarriage** when the animals are given doses many times the usual human dose. Whether these drugs cause such problems in humans in unknown. Any woman who is pregnant or plans to become pregnant should check with her physician before using a bronchodilator.

BREASTFEEDING. Some bronchodilators pass into breast milk. Breastfeeding mothers should check with their physicians before using bronchodilators.

OTHER MEDICAL CONDITIONS. Before using bronchodilators, people with any of these medical problems should make sure their physicians are aware of their conditions:

- glaucoma
- brain damage

KEY TERMS

Anti-inflammatory—Medicine used to relieve swelling, pain, and other symptoms of inflammation.

Bronchitis—Inflammation of the air passages of the lungs.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Emphysema—A lung disease in which breathing becomes difficult.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Nebulizer—A device that turns liquid forms of medicine into a fine spray that can be inhaled.

Sulfite—A type of preservative that causes allergic reactions in some people.

- convulsions (seizures)—recently or anytime in the past
- mental illness
- parkinson's disease
- diabetes
- heart or blood vessel diseases
- rapid or irregular heartbeat
- high blood pressure
- overactive thyroid
- enlarged prostate
- obstruction of the neck of the bladder

USE OF CERTAIN MEDICINES. Using bronchodilators with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Some patients have a dry or irritated throat or a **dry mouth** after using bronchodilators. To help prevent these problems, gargle and rinse the mouth or take a sip of water after each dose.

The most common side effects are nervousness or restlessness and trembling. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as bad taste in the mouth, coughing, dizziness or lightheadedness, drowsiness, **headache**, sweating, fast or pounding heartbeat, muscle cramps or twitches, nausea, vomiting, **diarrhea**, sleep problems and weakness also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- chest **pain** or discomfort
- irregular or fluttery heartbeat
- unusual bruising
- hives or rash
- swelling
- wheezing or other breathing problems
- numbness in the hands or feet
- blurred vision

Other side effects are possible. Anyone who has unusual symptoms after using a bronchodilator should get in touch with his or her physician.

Interactions

Bronchodilators may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with bronchodilators are:

- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate), used to treat depression
- other bronchodilators
- tricyclic antidepressants such as amitriptyline (Elavil) and imipramine (Tofranil)
- beta blockers such as propranolol (Inderal) and atenolol (Tenormin), used to control high blood pressure
- digitalis medicines, used to treat heart conditions, such as digoxin (Lanoxin)
- drugs, such as certain **diuretics** (water pills), that lower potassium levels
- ergoloid mesylates such as Hydergine, used to treat symptoms of **Alzheimer's disease** or multiple small stokes
- ergotamine (Cafergot, Ergostat, and other brands), used to treat migraine and cluster headaches
- the antidepressant maprotiline (Ludiomil)

The list above does not include every drug that may interact with bronchodilators. Be sure to check with a physician or pharmacist before combining bronchodilators with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Fackelmann, Kathy A. "Anti-inflammatory Drugs May Quell Asthma." *Science News* (26 Sept. 1992): 197.

ORGANIZATIONS

Asthma and Allergy Foundation of America. 1233 20th Street, NW, Suite 402, Washington, DC 20036. (800) 727-8462. <http://www.aafa.org>.

American Academy of Allergy, Asthma, and Immunology. 611 East Wells St., Milwaukee, WI 53202. (800) 822-2762. <http://www.aaaai.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Nancy Ross-Flanigan

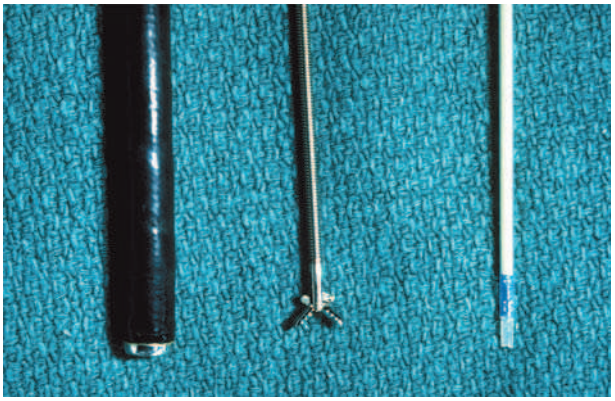
Bronchoscopy

Definition

Bronchoscopy is a procedure in which a cylindrical fiberoptic scope is inserted into the airways. This scope contains a viewing device that allows the visual examination of the lower airways.

Purpose

During a bronchoscopy, a physician can visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. The procedure is used to examine the mucosal surface of the airways for abnormalities that might be associated with a variety of lung diseases. Its use includes the visualization of airway obstructions such as a tumor, or the collection of specimens for the diagnosis of **cancer** originating in the bronchi of the lungs (bronchogenic cancer). It can also be used to collect specimens for culture to diagnose infectious diseases such as **tuberculosis**. The type of specimens collected can include sputum (composed of saliva and discharges from the respiratory passages), tissue samples from the bronchi or bronchioles, or cells collected from washing the lining of the bronchi or bronchioles. The instrument used in bronchoscopy, a bronchoscope, is a slender cylindrical instrument containing a light and an eyepiece. There are two types of bronchoscopes, a rigid tube that is sometimes referred to as an open-tube or ventilating bronchoscope, and a more flexible fiberoptic tube. This tube contains four smaller passages—two for light to pass through, one for seeing through and one that can accommodate medical instruments that may be used for biopsy or suctioning, or that medication can be passed through.



Instruments used in bronchoscopy procedures. *(Custom Medical Stock Photo. Reproduced by permission.)*

Bronchoscopy may be used for the following purposes:

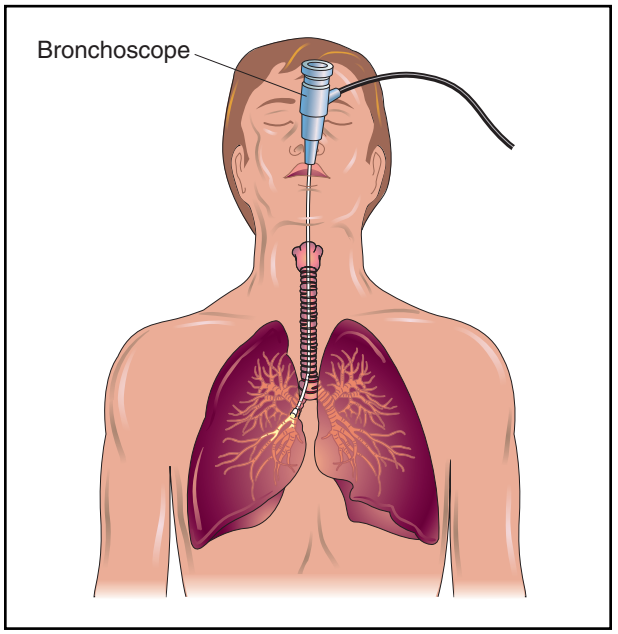
- to diagnose cancer, tuberculosis, lung infection, or other lung disease
- to examine an inherited deformity of the lungs
- to remove a foreign body in the lungs, such as a mucus plug, tumor, or excessive secretions
- to remove tissue samples, also known as biopsy, to test for cancer cells, help with staging the advancement of the lung cancer, or to treat a tumor with laser therapy
- to allow examination of a suspected tumor, obstruction, secretion, bleeding, or foreign body in the airways
- to determine the cause of a persistent **cough**, **wheezing**, or a cough that includes blood in the sputum
- to evaluate the effectiveness of lung cancer treatments

Precautions

Patients not breathing adequately on their own due to severe **respiratory failure** may require mechanical ventilation prior to bronchoscopy. It may not be appropriate to perform bronchoscopy on patients with an unstable heart condition. All patients must be constantly monitored while undergoing a bronchoscopy so that any abnormal reactions can be dealt with immediately.

Description

There are two types of bronchoscopes, a rigid tube and a fiberoptic tube. Because of its flexibility, the fiberop-



Bronchoscopy is a procedure in which a hollow, flexible tube is inserted into the airways, allowing the physician to visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. It can also be used to collect specimens for bacteriological culture to diagnose infectious diseases such as tuberculosis. *(Illustration by Electronic Illustrators Group.)*

tic tube is usually preferred. However, if the purpose of the procedure is to remove a foreign body caught in the windpipe or lungs of a child, the more rigid tube must be used because of its larger size. The patient will either lie face-up on his/her back or sit upright in a chair. Medication to decrease secretions, lessen **anxiety**, and relax the patient are often given prior to the procedure. While breathing through the nose, anesthesia is sprayed into the mouth or nose to numb it. It will take one to two minutes for the anesthesia to take effect. Once this happens, the bronchoscope will be put into the patient's mouth or nose and moved down into the throat. While the bronchoscope is moving down the throat, additional anesthesia is put into the bronchoscope to numb the lower parts of the airways. Using the eyepiece, the physician then observes the trachea and bronchi, and the mucosal lining of these passageways, looking for any abnormalities that may be present.

If the purpose of the bronchoscopy is to take tissue samples or biopsy, forceps or a bronchial brush are used to obtain cells. If the purpose is to identify an infectious agent, a bronchoalveolar lavage (BAL) can be used to gather fluid for culture purposes. Also, if any foreign matter is found in the airways, it can be removed.

Another procedure using bronchoscopy is called fluorescence bronchoscopy. This can be used to detect precancerous cells present in the airways. By using a fluorescent light in the bronchoscope, precancerous tissue will appear dark red, while healthy tissue will appear green. This technique can help detect lung cancer at an early stage, so that treatment can be started early.

Alternative procedures

Depending upon the purpose of the bronchoscopy, alternatives might include a computed tomography scan (CT) or no procedure at all. Bronchoscopy is often performed to investigate an abnormality that shows up on a **chest x ray** or CT scan. If the purpose is to obtain biopsy specimens, one option is to perform surgery, which carries greater risks. Another option is percutaneous (through the skin) biopsy guided by computed tomography.

Preparation

The doctor should be informed of any **allergies** and all the medications that the patient is currently taking. The doctor may instruct the patient not to take medications like **aspirin** or anti-inflammatory drugs, which interfere with clotting, for a period of time prior to the procedure. The patient needs to fast for 6 to 12 hours prior to the procedure and refrain from drinking any liquids the day of the procedure. The bronchoscopy takes about 45 to 60 minutes, with results usually available in one day. Prior to the bronchoscopy, several tests may be done, including a chest x ray and blood work. Sometimes a bronchoscopy is done under general anesthesia. Patients usually have an intravenous (IV) line in the arm. Most likely, the procedure will be done under local anesthesia, which is sprayed into the nose or mouth. This is necessary to decrease the gag reflex. A sedative may also be used to help the patient relax. It is important that the patient understands that at no time will the airway be blocked and that oxygen can be supplied through the bronchoscope. A signed consent form is necessary for this procedure.

Aftercare

After the bronchoscopy, the patient will be monitored for vital signs such as heart rate, blood pressure, and breathing, while resting in bed. Sometimes patients have an abnormal reaction to anesthesia. All saliva should be spit into a basin so that it can be examined for the presence of blood. If a biopsy was taken, the patient should not cough or clear the throat as this might dislodge any blood clot that has formed and cause bleeding. No food or drink should be consumed for about two hours after the procedure or until the anesthesia wears off. Diet is gradually progressed from ice chips and clear liquids to the patient's regular diet. There will also be a temporary **sore throat** and hoarseness that may last for a few days.

KEY TERMS

Anesthesia—A drug used to loss of sensation. It is used to lessen the pain of surgery and medical procedures.

Bronchi—The network of tubular passages that carry air to the lungs and allow air to be expelled from the lungs.

Bronchioles—Small airways extending from the bronchi into the lobes of the lungs.

Bronchoalveolar lavage—Washing cells from the air sacs at the end of the bronchioles.

Trachea—The windpipe.

Risks

Minor side effects arise from the bronchoscope causing abrasion of the lining of the airways. This results in some swelling and inflammation, as well as hoarseness caused from abrading the vocal cords. If this abrasion is more serious, it can lead to respiratory difficulty or bleeding of the airway lining. A more serious risk involved in having a bronchoscopy performed is the occurrence of a **pneumothorax**, due to puncturing of the lungs, which allows air to escape into the space between the lung and the chest wall. These risks are greater with the use of a rigid bronchoscope than with a fiberoptic bronchoscope. If a rigid tube is used, there is also a risk of chipped teeth.

Normal results

Normal tracheal appearance consists of smooth muscle with C-shaped rings of cartilage at regular intervals. The trachea and the bronchi are lined with a mucous membrane.

Abnormal results

Abnormal bronchoscopy findings may involve abnormalities of the bronchial wall such as inflammation, swelling, ulceration, or anatomical abnormalities. The bronchoscopy may also reveal the presence of abnormal substances in the trachea and bronchi. If samples are taken, the results could indicate cancer, disease-causing agents or other lung disease. Other abnormalities include constriction or narrowing (stenosis), compression, dilation of vessels, or abnormal branching of the bronchi. Abnormal substances that might be found in the airways include blood, secretions, or mucous plugs. Any abnormalities are discussed with the patient.

Resources

BOOKS

Bone, Roger C., ed. *Pulmonary & Critical Care Medicine.* St. Louis, MO: Mosby-Year Book, Inc., 1998.

Loeb, S., ed. *Illustrated Guide to Diagnostic Tests.* Springhouse, PA: Springhouse Corporation, 1994.

PERIODICALS

"Fluorescence Bronchoscopy Technology Used in Early Detection." *Cancer Weekly Plus* (Feb 3, 1997): 17.

ORGANIZATION

American College of Chest Physicians. 3300 Dundee Rd., Northbrook, IL 60062. (800) 343-2227. <www.chestnet.org>.

Cindy L. Jones, Ph.D.

Brucellosis

Definition

Brucellosis is a bacterial disease caused by members of the *Brucella* genus that can infect humans but primarily infects livestock. Symptoms of the disease include intermittent **fever**, sweating, chills, aches, and mental depression. The disease can become chronic and recur, particularly if untreated.

Description

Also known as undulant fever, Malta fever, Gibraltar fever, Bang's disease, or Mediterranean fever, brucellosis is most likely to occur among those individuals who regularly work with livestock. The disease originated in domestic livestock but was passed on to wild animal species, including the elk and buffalo of the western United States. In humans, brucellosis continues to be spread via unpasteurized milk obtained from infected cows or through contact with the discharges of cattle and goats during **miscarriage**. In areas of the world where milk is not pasteurized, for example in Latin America and the Mediterranean, the disease is still contracted by ingesting unpasteurized dairy products. However, in the United States, the widespread pasteurization of milk and nearly complete eradication of the infection from cattle has reduced the number of human cases from 6,500 in 1940 to about 70 in 1994.

Causes and symptoms

The disease is caused by several different species of parasitic bacteria of the genus Brucella. *B. abortus* is found in cattle and can cause cows to abort their fetuses.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Chronic—Disease or condition characterized by slow onset over a long period of time.

Parasite—An organism living in or on, and obtaining nourishment from, another organism.

Pasteurization—The process of applying heat, usually to milk or cheese, for the purpose of killing, or retarding the development of, pathogenic bacteria.

B. suis is most often found in hogs and is more deadly when contracted by humans than the organism found in cattle. *B. melitensis* is found in goats and sheep and causes the most severe illness in humans. *B. rangiferi* infects reindeer and caribou, and *B. canis* is found in dogs.

A human contracts the disease by coming into contact with an infected animal and either allowing the bacteria to enter a cut, breathing in the bacteria, or by consuming unpasteurized milk or fresh goat cheese obtained from a contaminated animal. In the United States, the disease is primarily confined to slaughterhouse workers.

Scientists do not agree about whether brucellosis can be transmitted from one person to another, although some people have been infected from a tainted blood **transfusion** or bone marrow transplant. Newborn babies have also contracted the illness from their mothers during birth. Currently, it is believed that brucellosis can also be transmitted sexually.

The disease is not usually fatal, but the intermittent fevers (a source of its nickname, "undulant fever") can be exhausting. Symptoms usually appear between five days and a month after exposure and begin with a single bout of high fever accompanied by shivering, aching, and drenching sweats that last for a few days. Other symptoms may include **headache**, poor appetite, backache, weakness, and depression. Mental depression can be so severe that the patient may become suicidal.

In rare, untreated cases, the disease can become so severe that it leads to fatal complications, such as **pneumonia** or bacterial **meningitis**. *B. melitensis* can cause miscarriages, especially during the first three months of **pregnancy**. The condition can also occur in a chronic form, in which symptoms recur over a period of months or years.

Diagnosis

Brucellosis is usually diagnosed by detecting one or more *Brucella* species in blood or urine samples. The bacteria may be positively identified using biochemical methods or using a technique whereby, if present in the sample, the brucellosis bacteria are made to fluoresce. Brucellosis may also be diagnosed by culturing and isolating the bacteria from one of the above samples. Blood samples will also indicate elevated antibody levels or increased amounts of a protein produced directly in response to infection with brucellosis bacteria.

Treatment

Prolonged treatment with **antibiotics**, including **tetracyclines** (with streptomycin), co-trimoxazole, and **sulfonamides**, is effective. Bed rest is also imperative. In the chronic form of brucellosis, the symptoms may recur, requiring a second course of treatment.

Prognosis

Early diagnosis and prompt treatment is essential to prevent chronic infection. Untreated, the disease may linger for years, but it is rarely fatal. Relapses may also occur.

Prevention

There is no human vaccine for brucellosis, but humans can be protected by controlling the disease in livestock. After checking to make sure an animal is not already infected, and destroying those that are, all livestock should be immunized. Butchers and those who work in slaughterhouses should wear protective glasses and clothing, and protect broken skin from infection.

Some experts suggest that a person with the disease refrain from engaging in unprotected sex until free of the disease. The sexual partners of an infected person should also be closely monitored for signs of infection.

Resources

BOOKS

Adams, L. Garry, ed. *Advances in Brucellosis Research*. Texas A & M University Press, 1990.

Infectious Disease. Ed. Barbara A. Bannister, et al. Oxford, England: Blackwell Scientific, Inc., 1996.

Madkour, M. Monir. *Brucellosis*. Butterworth-Heinemann, 1989.

Nielsen, Klaus, and Robert J. Duncan. *Animal Brucellosis*. CRC Press, 1990.

Van De Graaff, Kent. *Survey of Infectious and Parasitic Diseases*. New York: McGraw Hill, 1996.

Wilks, David, Mark Farrington, and David Rubenstein. *The Infectious Diseases Manual*. Oxford, England: Blackwell Scientific, Inc., 1995.

PERIODICALS

Ruben, Bruce, et al. "Person-to-Person Transmission of Brucella melitensis." *The Lancet* 337 (5 Jan. 1991): 8732.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Institute of Allergies and Infectious Diseases, Division of Microbiology and Infectious Diseases. Building 31, Room. 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892. <http://www.niaid.nih.gov>.

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

OTHER

"Bacterial Diseases." Healthtouch Online Page. <http:www.healthtouch.com>.

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

Carol A. Turkington

Brugian filariasis *see* **Elephantiasis**

Bruises

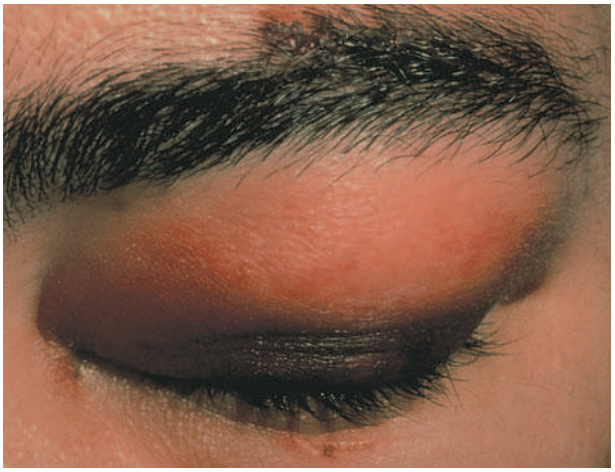
Definition

Bruises, or ecchymoses, are a discoloration and tenderness of the skin or mucous membranes due to the leakage of blood from an injured blood vessel into the tissues. Pupura refers to bruising as the result of a disease condition. A very small bruise is called a petechia. These often appear as many tiny red dots clustered together, and could indicate a serious problem.

Description

Bruises change colors over time in a predictable pattern, so that it is possible to estimate when an injury occurred by the color of the bruise. Initially, a bruise will be reddish, the color of the blood under the skin. After one to two days, the red blood cells begin to break down, and the bruise will darken to a blue or purplish color. This fades to green at about day six. Around the eighth or ninth day, the skin over the bruised area will have a brown or yellowish appearance, and it will gradually diminish back to its normal color.

Long periods of standing will cause the blood that collects in a bruise to seep through the tissues. Bruises



A close-up view of woman's bruised left eye. *(Custom Medical Stock Photo. Reproduced by permission.)*

are actually made of little pools of blood, so the blood in one place may flow downhill after awhile and appear in another. For instance, bruising in the back of the abdomen may eventually appear in the groin; bruising in the thigh or the knee will work its way down to the ankle.

Causes and symptoms

Healthy people may develop bruises from any injury that doesn't break through the skin. Vigorous **exercise** may also cause bruises due to bringing about small tears in blood vessels walls. In a condition known as purpura simplex, there is a tendency to bruise easily due to an increased fragility of the blood vessels. Bruises also develop easily in the elderly, because the skin and blood vessels have a tendency to become thinner and more fragile with **aging**, and there is an increased use of medications that interfere with the blood clotting system. In the condition known as purpura senilis, the elderly develop bruises from minimal contact that may take up to several months to completely heal.

The use of nonsteroidal anti-inflammatories such as ibuprofen (Advil) and naproxen (Aleve) may lead to increased bruising. **Aspirin**, antidepressants, **asthma** medications, and cortisone medications also have this effect. The anti-clotting medications also known as blood thinners, especially the drug Warfarin (Coumadin), may be the cause of particularly severe bruising.

Sometimes bruises are connected with more serious illnesses. There are a number of diseases that cause excessive bleeding or bleeding from injuries too slight to have consequences in healthy people. An abnormal tendency to bleed may be due to hereditary bleeding disorders, certain prescription medications, diseases of the

blood such as leukemia, and diseases that increase the fragility of blood vessels. If there are large areas of bruising or bruises develop very easily, this may herald a problem. Other causes that should be ruled out include liver disease, **alcoholism**, drug **addiction**, and acquired immune deficiency syndrome (**AIDS**). Bruising that occurs around the navel may indicate dangerous internal bleeding; bruising behind the ear, called Battle's sign, may be due to a skull fracture; and raised bruises may point to autoimmune disease.

Diagnosis

Bruising is usually a minor problem, which does not require a medical diagnosis. However, faced with extensive bruising, bruising with no apparent cause, or bruising in certain locations, a physician will pursue an evaluation that will include a number of blood tests. If the area of the bruise becomes hard, an x ray may be required.

Treatment

A bruise by itself needs no medical treatment. It is often recommended that ice packs be applied on and off during the first 24 hours of injury to reduce the bruising. After that, heat, especially moist heat, is recommended to increase the circulation and the healing of the injured tissues. Rest, elevation of the effected part, and compression with a bandage will also retard the accumulation of blood. Rarely, if a bruise is so large that the body cannot completely absorb it or if the site becomes infected, it may have to be surgically removed.

Alternative treatment

Several types of topical applications are usually recommend to speed healing and to reduce the **pain** associated with bruises. Vitamin K cream can be applied directly to the site of injury. Astringent herbs such as witch hazel, *Hamamelis virginiana*, can be used. This will tighten the tissues and therefore diminish the bruising. The homeopathic remedy, *Arnica montana*, can be applied as a cream or gel to unbroken skin.

Oral homeopathic remedies may reduce bruising, pain, and swelling as well. *Arnica montana*, at 30 ml (1 oz), taken one to two times per day is highly recommended. For ledum, 30 ml (1 oz) one to two times per day is also useful.

Prognosis

The blood under the skin which causes the discoloration of bruising should be totally reabsorbed by the body in three weeks or less. At that time, the skin color should completely return to normal.

Sometimes, a bruise may become solid and increase in size instead of dissolving. This may indicate blood trapped in the tissues, which may be need to be drained. This is referred to as a hematoma. Less commonly, the body may develop calcium deposits at the injury site in a process called heterotopic ossification.

Prevention

Vitamin K promotes normal clotting in the blood, and therefore may help reduce the tendency to bruise easily. Green leafy vegetables, alfalfa, broccoli, seaweed, and fish liver oils are dietary sources of vitamin K. Other good foods to eat would be those containing bioflavonoids, such as reddish-blue berries. These can assist in strengthening the connective tissue, which will decrease the spread of blood and bruising. Zinc and vitamin C supplements are also recommended for this.

Resources

BOOKS

Editors of Prevention Magazine Health Books, eds. *The Doctors Book of Home Remedies*. Prevention Health Books, 2000.

Williams,William J. *Williams' Hematology.* New York: McGraw-Hill, 1995.

Feinstein, Alice, ed. *Prevention's Healing With Vitamins: The Most Effective Vitamin and Mineral Treatments for Everyday Health Problems and Serious Disease*. Prevention Health Books, 1998.

Patience Paradox

Bruton's agammaglobulinemia *see* **X-linked agammaglobulinemia**

Bruxism

Definition

Bruxism is the habit of clenching and grinding the teeth. It most often occurs at night during sleep, but it may also occur during the day. It is an unconscious behavior, perhaps performed to release **anxiety**, aggression, or anger.

Description

Bruxism is one of the oldest disorders known, and approximately one in four adults experiences it. Most people are not aware of it before their teeth have been damaged.

Causes and symptoms

While bruxism is typically associated with **stress**, it may also be triggered by abnormal occlusion (the way the upper and lower teeth fit together), or crooked or missing teeth.

Symptoms of bruxism include: dull headaches; sore and tired facial muscles; earaches; sensitive teeth; and locking, popping, and clicking of the jaw.

During a dental examination, a dentist may recognize damage resulting from bruxism, including: enamel loss from the chewing surfaces of teeth; flattened tooth surfaces; loosened teeth; and fractured teeth and fillings. Left untreated, bruxism may lead to tooth loss and jaw dysfunction.

Diagnosis

Medical and dental histories and examinations are necessary to differentiate bruxism from other conditions that may cause similar **pain**, such as ear infections, dental infections, and temporomandibular joint (TMJ) dysfunction. However, uncommonly worn-down teeth strongly suggest a diagnosis of bruxism.

Treatment

To prevent further damage to the teeth, bruxism is treated by placing a removable, custom-fitted plastic appliance called a night guard between the upper and lower teeth. Although the clenching and grinding behavior may continue, the teeth wear away the plastic instead of each other.

In some cases, abnormal occlusion may be adjusted and high spots removed so that the teeth fit together in a more comfortable position. Missing teeth may be replaced and crooked teeth may be straightened with orthodontic treatment to eliminate possible underlying causes of bruxism. In cases where jaw muscles are very tight, a dentist may prescribe **muscle relaxants**.

Alternative treatment

Stress management and behavior modification techniques may be useful to break the habit of clenching and teeth grinding. Tight jaw muscles may be relaxed by applying warm compresses to the sides of the face. Herbal muscle relaxants also can be helpful. **Massage therapy** and deep tissue realignment, including **rolfing**, can assist in releasing the clenching pattern. This is a more permanent alternative treatment for bruxism.

Prognosis

Bruxism may cause permanent damage to teeth and chronic jaw pain unless properly diagnosed and promptly treated. The behavior may be eliminated if its underlying causes are found and addressed.

KEY TERMS

Enamel—The hard outermost surface of a tooth.

High spot—An area of a tooth or restoration that feels abnormal or uncomfortable because it hits its opposing tooth before other teeth meet.

Night guard—A removable, custom-fitted plastic appliance that fits between the upper and lower teeth to prevent them from grinding against each other.

Occlusion—The way upper and lower teeth fit together during biting and chewing.

Rolfing—Based on the belief that proper alignment of various parts of the body is necessary for physical and mental health, rolfing uses deep tissue massage and movement exercises in an attempt to bring the body into correct alignment.

Temporomandibular joint (TMJ)—The jaw joint formed by the mandible (lower jaw bone) moving against the temporal bone of the skull.

Prevention

Increased awareness in patients prone to anxiety, aggression, or anger may prevent the habit of bruxism from developing.

Resources

ORGANIZATIONS

Academy of General Dentistry. Suite 1200, 211 East Chicago Ave., Chicago, IL 60611.(312) 440-4300. <http://www.agd.org>.

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

Bethany Thivierge

Bubonic plague *see* **Plague**

Budd-Chiari syndrome

Definition

Budd-Chiari syndrome is a rare problem that results from blood clotting in the veins flowing out of the liver

KEY TERMS

Ascites—Accumulation of fluid in the abdomen.

Biopsy—Surgical removal of a tiny bit of tissue for examination under the microscope.

Catheter—A tubular surgical instrument.

Phlebitis—Inflammation of a vein.

Polycythemia rubra vera—An excess number of red blood cells in the blood.

Sickle cell disease—An inherited disease in which red blood cells take an unusual shape, leading to circulation problems.

(hepatic veins). The high pressure of blood in these veins leads to an enlarged liver, and to an accumulation of fluid in the abdomen, called **ascites**.

Description

The liver, the largest internal organ in the human body, is responsible for many vital physiologic processes. Blood flow through the liver nourishes the liver, carries in substances that the liver will process, and carries away substances that the liver has produced. When blood cannot flow out freely from the liver, blood pressure rises in the veins of the liver, leading to blood clots within the liver. Also, some of the blood plasma can leak through the walls of the veins and accumulate within the abdomen (ascites).

Causes and symptoms

The major symptoms include **pain** in the upper right-hand portion of the abdomen and a build-up of fluid in the abdomen. In the United States, blood disorders are the most common causes. Among these disorders are polycythemia rubra vera (an increase in the number of red blood cells), and **sickle cell disease**. In parts of the world where **liver cancer** is common, a form of liver **cancer** is the most frequent cause.

Other causes sometimes include:

- certain infections
- use of **oral contraceptives**
- body changes in **pregnancy** and the postpartum period
- phlebitis (inflammation of a vein)
- injury to the abdomen
- membranous webs (especially in Asia)

Diagnosis

Diagnosis of Budd-Chiari syndrome can be made by an internist (a specialist in diseases of the internal organs), a gastroenterologist (a specialist in the diseases of the digestive system), or a general surgeon. On **physical examination**, the doctor will note that the liver is larger than normal. Often an ultrasound scan of the liver will show abnormalities in the size of the liver, an abnormal pattern of the veins in the liver, and other abnormalities. A CT scan will often show similar abnormalities.

Once these abnormalities are confirmed, the key test is called hepatic vein catheterization. In this test, a narrow tube is snaked through the body until it reaches the hepatic veins. An instrument at the tip of the catheter can measure the pressure within each segment of the hepatic vein.

In some cases, a tiny amount of radioactive material is injected into a patient, and then an abnormal pattern of radioactivity in the liver can be revealed. In other cases, a **liver biopsy** enables a physician to examine cells from the liver itself. Cells damaged by Budd-Chiari syndrome have a characteristic appearance easily identifiable to a physician.

Treatment

Surgery

Most patients with Budd-Chiari syndrome must have surgery. A surgeon will re-route blood flow around the clotted hepatic vein into a large vein called the vena cava. The exact technique will depend on the specific location of the clots and other factors. In certain patients, other surgical techniques may be used. For patients who otherwise would have less than six months to live, **liver transplantation** is sometimes performed.

In a few patients, a "balloon catheter" can open the blocked blood vessels, without the need for major surgery.

Drugs

Sometimes, anti-clotting drugs such as urokinase can be used for patients with a sudden onset of clotting in the veins of the liver. These drugs do not seem to work when the clots have become established.

Prognosis

If surgery is done before permanent liver damage sets in, long-term survival is possible. In these cases, damaged liver cells can actually recover. If patients are already very sick with liver disease, the surgery may not be as helpful.

Prevention

The best approach to prevention is to carefully control the blood disorders that can lead to Budd-Chiari syndrome.

Resources

BOOKS

Gadacz, Thomas R., and John L. Cameron. "Budd-Chiari Syndrome and Surgery of the Hepatic Vasculature." In *Shackelford's Surgery of the Alimentary Tract*. 3rd ed. Vol. 3. Ed. J.G. Turcotte. Philadelphia: W. B. Saunders Co., 1991.

Richard H. Lampert

Buerger's disease

Definition

Buerger's disease is an inflammation of the arteries, veins, and nerves in the legs, principally, leading to restricted blood flow. Left untreated, Buerger's disease can lead to **gangrene** of the affected areas. Buerger's disease is also known as thromboangitis obliterans.

Causes and symptoms

The exact cause of Buerger's disease is not known. It is seen most often in young to middle-aged men (ages 20-40) who are heavy smokers of cigarettes. Cases of this disease in non-smokers are very rare, hence, cigarette **smoking** is considered a causative factor. Approximately 40% of the patients have a history of inflammation of a vein (phlebitis), which may play a role in the development of Buerger's disease. The disease is mainly seen in the legs of affected persons, but may also appear in their arms. Early symptoms include decrease in the blood supply (arterial **ischemia**) and superficial (near the skin surface) phlebitis. The main symptom is **pain** in the affected areas. Onset of the disease is gradual and first occurs in the feet or hands. Inflammation occurs in small and medium-sized arteries and veins near the surface of the limb. In advanced cases, blood vessels in other parts of the body may be affected. There is a progressive decrease in the blood flow to the affected areas. The pulse in arteries of the feet is weak or undetectable. The lack of blood flow can lead to gangrene, which is decay of tissue due to restricted blood supply. A cold sensitivity in the hands, similar to that seen in **Raynaud's disease**, can develop. In this case, the hands turn color—white, blue, and then red—when exposed to the cold.

Diagnosis

Diagnosis is usually made from the clinical symptoms. Patients frequently complain of numbness, tingling, or burning sensations in the affected area before evidence of vascular inflammation becomes apparent.

KEY TERMS

Gangrene—A decay of the tissue in a part of the body that experiences restricted blood flow.

Inflammation—A local reaction to irritation, injury, or infection characterized by pain, swelling, redness, and occasional loss of function.

Ischemia—A decrease in the blood supply to an area of the body caused by obstruction or constriction of blood vessels.

Phlebitis—Inflammation of a vein.

Treatment

There is no effective medication or surgery for this disease. Patients must stop smoking to halt further development of the symptoms. **Vasodilators**, drugs that increase the diameter of the blood vessels, can be administered, but may not be effective. Exposure of affected areas to heat or cold should be avoided. Trauma to the feet and other affected areas should be avoided and infections must be treated promptly.

Prognosis

The disease is progressive in patients who do not stop smoking. Areas with gangrene must be removed surgically.

Prevention

Smoking is the only known causative agent for this disease and should be avoided.

Resources

BOOKS

Berkow, R., ed. *The Merck Manual*. 17th ed. Rahway, NJ: Merck and Co., 1997.

John T. Lohr, PhD

Bulging eyes *see* **Exophthalmos**

Bulimia nervosa

Definition

Bulimia nervosa is a serious and sometimes life-threatening eating disorder affecting mainly young

women. People with bulimia, known as bulimics, consume large amounts of food (binge) and then try to rid themselves of the food and calories (purge) by **fasting**, excessive **exercise**, vomiting, or using **laxatives**. The behavior often serves to reduce **stress** and relieve **anxiety**. Because bulimia results from an excessive concern with weight control and self-image, and is often accompanied by depression, it is also considered a psychiatric illness.

Description

Bulimia nervosa is a serious health problem for over two million adolescent girls and young women in the United States. The bingeing and purging activity associated with this disorder can cause severe damage, even **death**, although the risk of death is not as high as for **anorexia nervosa**, an eating disorder that leads to excessive weight loss.

Binge eating may in rare instances cause the stomach to rupture. In the case of purging, **heart failure** can result due to loss of vital **minerals** such as potassium. Vomiting causes other serious problems, including acid-related scarring of the fingers (if used to induce vomiting) and damage to tooth enamel. In addition, the tube that brings food from the mouth to the stomach (the esophagus) often becomes inflamed and salivary glands can become swollen. Irregular menstrual periods can also result, and interest in sex may diminish.

Most bulimics find it difficult to stop their behavior without professional help. Many typically recognize that the behavior is not normal, but feel out of control. Some bulimics struggle with other compulsive, risky behaviors such as drug and alcohol abuse. Many also suffer from other psychiatric illnesses, including clinical depression, anxiety, and **obsessive-compulsive disorder** (OCD).

Most bulimics are females in their teens or early 20s. Males account for only 5-10% of all cases. People of all races develop the disorder, but most of those diagnosed are white.

Bulimic behavior is often carried out in secrecy, accompanied by feelings of guilt or shame. Outwardly, many people with bulimia appear healthy and successful, while inside they have feelings of helplessness and low self-esteem.

Causes and symptoms

Causes

The cause of bulimia is unknown. Researchers believe that it may be caused by a combination of genetic and environmental factors. Bulimia tends to run in families. Research shows that certain brain chemicals, known as neurotransmitters, may function abnormally in acutely ill bulimia patients. Scientists also believe there may be a link between bulimia and other psychiatric problems, such as depression and OCD. Environmental influences include participation in work or sports that emphasize thinness, such as modeling, dancing, or gymnastics. Family pressures also may play a role. One study found that mothers who are extremely concerned about their daughters' physical attractiveness and weight may help to cause bulimia. In addition, girls with eating disorders tend to have fathers and brothers who criticize their weight.

Symptoms

According to the American Anorexia/Bulimia Association, Inc., warning signs of bulimia include:

- eating large amounts of food uncontrollably (bingeing)
- vomiting, abusing laxatives or **diuretics**, or engaging in fasting, dieting, or vigorous exercise (purging)
- preoccupation with body weight
- using the bathroom frequently after meals
- depression or mood swings
- irregular menstrual periods
- onset of dental problems, swollen cheeks or glands, **heartburn** or bloating

Diagnosis

Bulimia is treated most successfully when diagnosed early. But because the bulimic may deny there is a problem, getting medical help is often delayed. A complete **physical examination** in order to rule out other illnesses is the first step to diagnosis.

According to the American Psychiatric Association, a diagnosis of bulimia requires that a person have all of the following symptoms:

- recurrent episodes of binge eating (minimum average of two binge-eating episodes a week for at least three months)
- a feeling of lack of control over eating during the binges
- regular use of one or more of the following to prevent weight gain: self-induced vomiting, use of laxatives or diuretics, strict dieting or fasting, or vigorous exercise
- persistent over-concern with body shape and weight

Treatment

Early treatment is important otherwise bulimia may become chronic, with serious health consequences. A comprehensive treatment plan is called for in order to address the complex interaction of physical and psycho-

logical problems in bulimia. A combination of drug and behavioral therapies is commonly used.

Behavioral approaches include individual psychotherapy, **group therapy**, and **family therapy**. **Cognitive-behavioral therapy**, which teaches patients how to change abnormal thoughts and behavior, is also used. **Nutrition** counseling and self-help groups are often helpful.

Antidepressants commonly used to treat bulimia include desipramine (Norpramin), imipramine (Tofranil), and fluoxetine (Prozac). These medications also may treat any co-existing depression.

In addition to professional treatment, family support plays an important role in helping the bulimic person. Encouragement and caring can provide the support needed to convince the sick person to get help, stay with treatment, or try again after a failure. Family members can help locate resources, such as eating disorder clinics in local hospitals or treatment programs in colleges designed for students.

Alternative treatment

Light therapy—exposure to bright, artificial light—may be useful in reducing bulimic episodes, especially during the dark winter months. Some feel that massage may prove helpful, putting people in touch with the reality of their own bodies and correcting misconceptions of body image. **Hypnotherapy** may help resolve unconscious issues that contribute to bulimic behavior.

Prognosis

Bulimia may become chronic and lead to serious health problems, including seizures, irregular heartbeat, and thin bones. In rare cases, it may be fatal.

Timely therapy and medication can effectively manage the disorder and help the bulimic look forward to a normal, productive, and fulfilling life.

Prevention

There is no known method to prevent bulimia.

Resources

BOOKS

Cassell, Dana K. *The Encyclopedia of Obesity and Eating Disorders*. New York: Facts on File, Inc., 1994.

Jablow, Martha M. *A Parent's Guide to Eating Disorders and Obesity.* New York: Dell Publishing, 1992.

Kubersky, Rachel. *Everything You Need to Know about Eating Disorders*. New York: The Rosen Publishing Group, Inc., 1992.

PERIODICALS

Berg, Frances M. "Eating Disorders Affect Both the Mind and Body." *Healthy Weight Journal* 9, no. 2 (1995): 27-31.

Cismoski, Janet, et al. "Teen Nutrition." *Whose Kids? Our Kids!* no. 6 (1995).

Levine, Michael P. "10 Things Men Can Do and Be to Help Prevent Eating Disorders." *Healthy Weight Journal* 9, no.1 (1995): 15.

ORGANIZATIONS

American Anorexia/Bulimia Association, Inc., 293 Central Park West, Suite IR, New York, NY 10024. (212) 501-8351.

Anorexia Nervosa and Related Eating Disorders, Inc., P.O. Box 5102, Eugene, OR 97405. (541) 344-1144.

Center for the Study of Anorexia and Bulimia, 1 W. 91st St., New York, NY 10024. (212) 595-3449.

Eating Disorder Awareness & Prevention, Inc., 603 Stewart St., Suite 803, Seattle, WA 98101. (206) 382-3587.

National Association of Anorexia Nervosa and Associated Disorders, Box 7, Highland Park, IL 60035. (708) 831-3438.

National Eating Disorders Organization, 6655 South Yale Ave, Tulsa, OK 74136. (918) 481-4044.

Jennifer Lamb

KEY TERMS

Binge—To consume large amounts of food uncontrollably within a short time period.

Diuretic—A drug that promotes the formation and excretion of urine.

Neurotransmitters—Certain brain chemicals that may function abnormally in acutely ill bulimic patients.

Obsessive-compulsive disorder (OCD)—A disorder that may accompany bulimia, characterized by the tendency to perform repetitive acts or rituals in order to relieve anxiety.

Purge—To rid the body of food and calories, commonly by vomiting or using laxatives.

Bulla *see* **Skin lesions**

Bumetanide *see* **Diuretics**

BUN *see* **Blood urea nitrogen test**

Bundle branch block

Definition

Bundle branch block (BBB) is a disruption in the normal flow of electrical pulses that drive the heart beat.

KEY TERMS

Electrocardiogram—The pattern of the heart's electrical impulses that indicate the order and condition of the heart's components.

QRS—A pattern seen in an electrocardiogram that indicates the pulses in a heart beat and their duration. Variations from a normal QRS pattern indicate heart disease.

Description

Bundle branch block belongs to a group of heart problems called intraventricular conduction defects (IVCD). There are two bundle branches, right and left. The right bundle carries nerve impulses that cause contraction of the right ventricle (the lower chamber of the heart) and the left bundle carries nerve impulses that cause contraction of the left ventricle. The two bundles initially are together at a junction called the bundle of His. Nerve impulses come through the sinus node of the heart to the bundle of His and then move into the right and left bundle branches. Bundle branch block is a slowing or interruption of nerve impulses. A problem may exist in any of the three bundles.

Patients with BBB are generally without symptoms unless the disease is severe enough to cause a complete infranodal A-V block and very slow heart rate. In patients with right bundle branch block (RBBB), the nerve impulse is conducted slowly or not at all. The right ventricle finally receives the impulse through muscle-to-muscle spread, outside the regular nerve pathway. This mechanism of impulse transmission is slow and results in a delayed contraction of the right ventricle. There are several types of left bundle branch block (LBBB), each producing its own characteristic mechanism of failure. In each case, the nerve impulse is blocked or delayed. Patients with LBBB may have left ventricular disease or cardiomyopathy.

Causes and symptoms

Left bundle branch block usually happens as a consequence of other diseases such as arteriosclerosis, **rheumatic fever**, **congenital heart disease**, **myocarditis**, myocardial infarction, metastatic heart tumors, or other invasions of the heart tissue. Right bundle branch block happens less often from underlying heart disease.

Diagnosis

Detection of BBB usually takes place during a normal **physical examination**. The block shows up as a widening of the second heart sound. Confirmation of BBB is obtained by electrocardiogram (ECG). The pattern seen in the electrocardiogram indicates pulses in a heart beat and their duration. A QRS duration of greater than 110 milliseconds is a diagnostic indication of BBB. There is a unique ECG pattern for blocks in each of the three bundles.

Treatment

There is no specific therapy for BBB. Patients are usually treated for associated heart diseases.

Prognosis

The prognosis of blockage in any of the three bundle branches depends on the prognosis of the associated heart disease. The associated diseases determine the outcome of the patient's health. Occasionally, disruptions in bundle branches lead to complete infranodal A-V block, a more serious blockage of nerve impulses. Approximately 2% of patients with BBB develop infranodal A-V blockage and these patients often require artificial **pacemakers**.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

John T. Lohr, PhD

Bunion

Definition

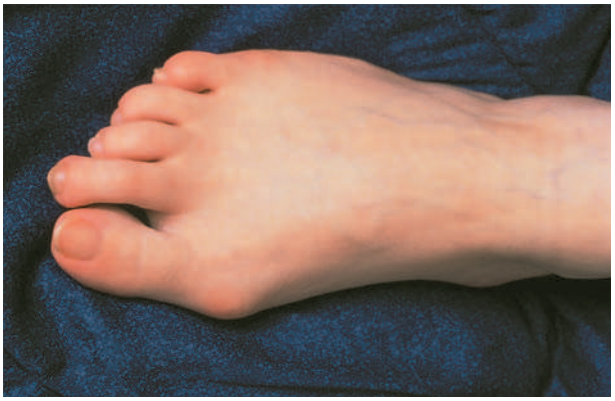
A bunion is an abnormal enlargement of the joint (the first metatarsophalangeal joint, or MTPJ) at the base of the great or big toe (hallux). It is caused by inflammation and usually results from chronic irritation and pressure from poorly fitting footwear.

Description

A displacement of two major bones of the foot (hallux valgus) causes bunions, although not everyone with this displacement will develop the joint swelling and bone overgrowth that characterize a bunion. One of the bones involved is called the first metatarsal bone. This bone is long and slender, with the big toe attached on one

end and the other end connected to foot bones closer to the ankle. This foot bone is displaced in the direction of the four other metatarsals connected with the toes. The other bone involved is the big toe itself, which is displaced toward the smaller toes. As the big toe continues to move toward the smaller toes, it may become displaced under or over the second toe. The displacement of these two foot bones causes a projection of bone on the inside portion of the forefoot. The skin over this projection often becomes inflamed from rubbing against the shoe, and a callus may form.

The joint contains a small sac (bursa) filled with fluid that cushions the bones and helps the joint to move smoothly. When a bunion forms, this sac becomes inflamed and thickened. The swelling in the joint causes additional **pain** and pressure in the toe.



Woman's right foot with bunion on big toe. *(Photograph by Wedgworth, Custom Medical Stock Photo. Reproduced by permission.)*

Causes and symptoms

Bunions may form as a result of abnormal motion of the foot during walking or running. One common example of an abnormal movement is an excessive amount of **stress** placed upon the inside of the foot. This leads to friction and irritation of the involved structures. Age has also been noted as a factor in developing bunions, in part because the underlying bone displacement worsens over time unless corrective measures are taken.

Wearing improperly fitting shoes, especially those with a narrow toe box and excessive heel height, often causes the formation of a bunion. This forefoot deformity is seen more often in women than men. The higher frequency in females may be related to the strong link between footwear fashion and bunions. In fact, in a recent survey of more than 350 women, nearly 90% wore shoes that were at least one size too small or too narrow.

Because genetic factors can predispose people to the hallux valgus bone displacement, a strong family history of bunions can increase the likelihood of developing this foot disorder. Various arthritic conditions and several genetic and neuromuscular diseases, such as **Down syndrome** and **Marfan syndrome**, cause muscle imbalances that can create bunions from displacement of the first metatarsal and big toe. Other possible causes of bunions are leg-length discrepancies, with the bunion present on the longer leg, and trauma occurring to the joint of the big toe.

Symptoms of bunions include the common signs of inflammation such as redness, swelling, and pain. The discomfort is primarily located along the inside of the foot just behind the big toe. Because of friction, a callus may develop over the bunion. If an overlapping of the toes is allowed, additional rubbing and pain occurs. Inflammation of this area causes a decrease in motion with associated discomfort in the joint between the big toe and the first metatarsal. If allowed to worsen, the skin over the bunion may break down causing an ulcer, which also presents a problem of potential infection. (Foot ulcers can be particularly dangerous for people with diabetes, who may have trouble feeling the ulcer forming and healing if it becomes infected.)

Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of bunions and other foot conditions. X rays can help confirm the diagnosis by showing the bone displacement, joint swelling, and, in some cases, the overgrowth of bone that characterizes bunions. Doctors will also consider the possibility that the joint pain is caused by or complicated by arthritis (which causes destruction of the cartilage of the joint), **gout** (which causes the accumulation of uric acid crystals in the joint), tiny **fractures** of a bone in the foot (stress fractures), or infection and may order additional tests to rule out these possibilities.

Treatment

Conservative

The first step in treating a bunion is to remove as much pressure from the area as possible. People with bunions should wear shoes that have enough room in the toe box to accommodate the bunion and avoid high-heeled shoes and tight-fitting socks or stockings. Dressings and pads help protect the bunion from additional shoe pressure. The application of splints or customized shoe inserts (orthotics) to correct the alignment of the big toe joint is effective for many bunions. Most patients are instructed to

KEY TERMS

Orthopedics—A medical specialty concerned with treating diseases, injuries, and malformations of the bones and supporting structures, such as tendons, ligaments, and muscles.

Orthotic—A device or brace to control, correct, or compensate for a bone deformity.

Podiatry—A medical specialty concerned with treating diseases, injuries, and malformations of the feet.

rest or choose exercises that put less stress on their feet, at least until the misalignment is corrected. In some cases, physicians also use steroid injections with local anesthetic around the bunion to reduce inflammation.

Surgery

If conservative treatment is not successful, surgical removal of the bunion may be necessary to correct the deformity. This procedure is called a bunionectomy, and there are many variations on the operation, which is usually performed by a surgeon who specializes in treating bone conditions (orthopedics) or by one who specializes in treating the foot (podiatry). Surgeons consider the angle of the bone misalignment, the condition of the bursa, and the strength of the bones when they choose which procedure to use. Most bunionectomies involve the removal of a section of bone and the insertion of pins to rejoin the bone. Sometimes the surgeons may move ligaments (which connect bone to bone in the joint) or tendons (which connect bone to muscle) in order to realign the bones. After this procedure, the bones and other tissues are held in place while they heal by compression dressings or a short cast. The individual must refrain from vigorous **exercise** for six weeks.

Alternative treatment

Deep friction massage techniques by a physical or massage therapist can be helpful to increase circulation, reduce inflammation, and prevent soft tissue build up. Physical therapy also provides useful approaches such as ultrasound to help retard or reverse the formation of the bunion. Various taping techniques can be useful to realign the toe and decrease friction and rubbing that may be present. The homeopathic tissue salt *Calcarea phosphorica* can be useful in balancing the bone formation/remodeling.

Prognosis

Often modifications in footwear allow a good prognosis without surgery. If surgery is necessary, complete healing without complications requires approximately four to six weeks. Even after surgery corrects the bone misalignment, patients are usually instructed to continue wearing low-heeled, roomy shoes to prevent the bunion from reforming.

Prevention

Prevention begins with proper foot wear. Shoes with a wide and deep toe box are best. High-heeled shoes should not be worn for long periods of time. If a bunion is present and becomes inflamed, the foot should be elevated with the application of an ice pack over the painful area for not more than 20 minutes every other hour. If pain and swelling continue, a podiatrist or physician should be contacted.

Resources

BOOKS

Common Foot Problems in Primary Care. 2nd ed. Ed. Richard B. Birrer, et al. Philadelphia: Hanley & Belfus, Inc., 1998.

Principles and Practice of Podiatric Medicine. Ed. Leonard A. Levy and Vincent J. Hetherington. New York: Churchill Livingstone, 1990.

ORGANIZATIONS

American Orthopedic Foot and Ankle Society. 222 South Prospect, Park Ridge, IL 60068.

American Podiatry Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814.

OTHER

Griffith, H. Winter. "Complete Guide to Symptoms, Illness & Surgery." ThriveOnline. <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Burkitt's lymphoma *see* **Malignant lymphomas**

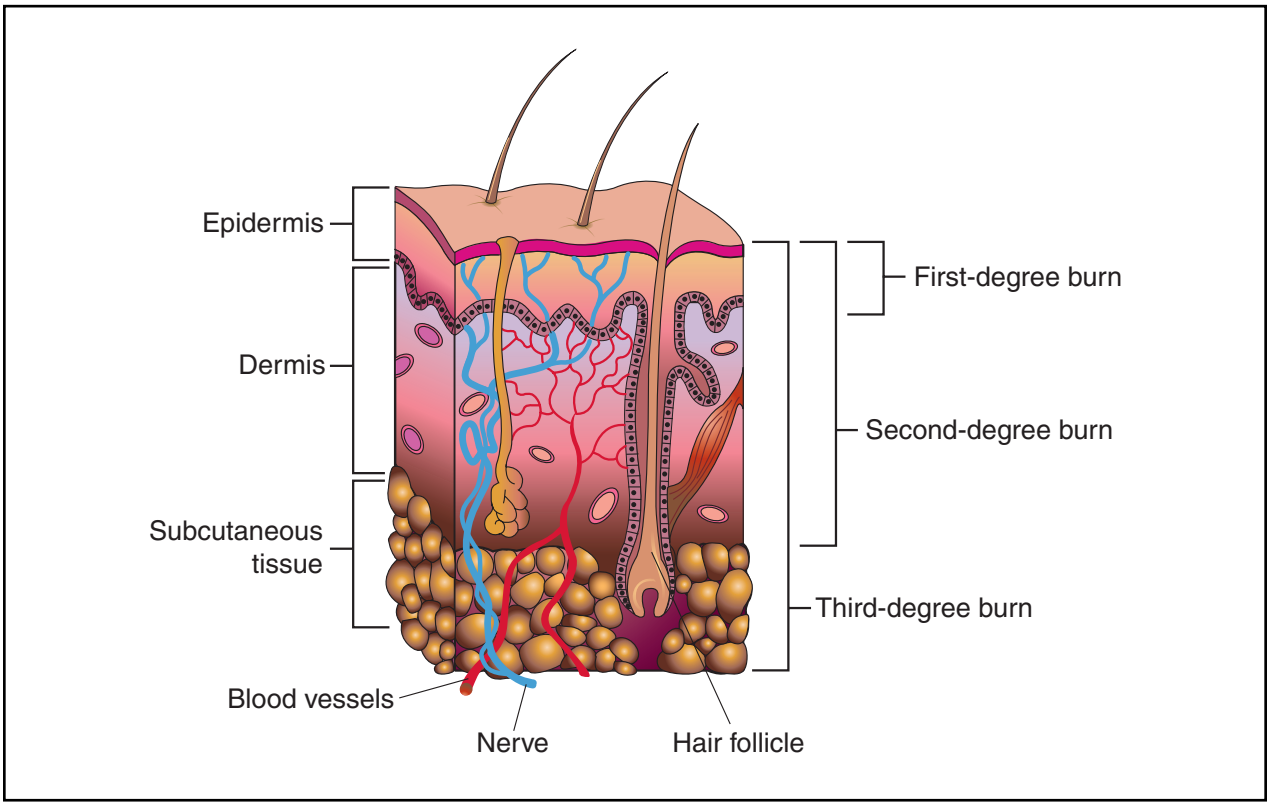
Burns

Definition

Burns are injuries to tissues caused by heat, friction, electricity, radiation, or chemicals.

Description

Burns are characterized by degree, based on the severity of the tissue damage. A first-degree burn causes



There are three classifications of burns: first-degree, second-degree, and third-degree burns. *(Illustration by Electronic Illustrators Group.)*

redness and swelling in the outermost layers of skin (epidermis). A second-degree burn involves redness, swelling and blistering, and the damage may extend beneath the epidermis to deeper layers of skin (dermis). A third-degree burn, also called a full-thickness burn, destroys the entire depth of skin, causing significant scarring. Damage also may extend to the underlying fat, muscle, or bone.

The severity of the burn is also judged by the amount of body surface area (BSA) involved. Health care workers use the "rule of nines" to determine the percentage of BSA affected in patients more than 9 years old: each arm with its hand is 9% of BSA; each leg with its foot is 18%; the front of the torso is 18%; the back of the torso, including the buttocks, is 18%; the head and neck are 9%; and the genital area (perineum) is 1%. This rule cannot be applied to a young child's body proportions, so BSA is estimated using the palm of the patient's hand as a measure of 1% area.

The severity of the burn will determine not only the type of treatment, but also where the burn patient should receive treatment. Minor burns may be treated at home or in a doctor's office. These are defined as first- or second-degree burns covering less than 15% of an adult's body or less than 10% of a child's body, or a third-degree burn on less than 2% BSA. Moderate burns should be treated at a hospital. These are defined as first- or second-degree burns covering 15%-25% of an adult's body or 10%-20% of a child's body, or a third-degree burn on 2%-10% BSA. Critical, or major, burns are the most serious and should be treated in a specialized burn unit of a hospital. These are defined as first- or second-degree burns covering more than 25% of an adult's body or more than 20% of a child's body, or a third-degree burn on more than 10% BSA. In addition, burns involving the hands, feet, face, eyes, ears, or genitals are considered critical. Other factors influence the level of treatment needed, including associated injuries such as bone **fractures** and **smoke inhalation**, presence of a chronic disease, or a history of being abused. Also, children and the elderly are more vulnerable to complications from burn injuries and require more intensive care.

Causes and symptoms

Burns may be caused by even a brief encounter with heat greater than 120°F (49°C). The source of this heat may be the sun (causing a **sunburn**), hot liquids, steam, fire, electricity, friction (causing rug burns and rope burns), and chemicals (causing a caustic burn upon contact).

Classification Of Burns

First-Degree (Minor)	The burned area is painful. The outer skin is reddened. Slight swelling is present.
Second-Degree (Moderate)	The burned area is painful. The underskin is affected. Blisters may form. The area may have a wet, shiny appearance because of exposed tissue.
Third-Degree (Critical)	The burned area is insensitive due to the destruction of nerve endings. Skin is destroyed.Muscle tissues and bone underneath may be damaged. The area may be charred, white, or grayish in color.

Signs of a burn are localized redness, swelling, and **pain**. A severe burn will also blister. The skin may also peel, appear white or charred, and feel numb. A burn may trigger a **headache** and **fever**. Extensive burns may induce **shock**, the symptoms of which are faintness, weakness, rapid pulse and breathing, pale and clammy skin, and bluish lips and fingernails.

Diagnosis

A physician will diagnose a burn based upon visual examination, and will also ask the patient or family members questions to determine the best treatment. He or she may also check for smoke inhalation, **carbon monoxide poisoning**, cyanide **poisoning**, other event-related trauma, or, if suspected, further evidence of **child abuse**.

Treatment

Burn treatment consists of relieving pain, preventing infection, and maintaining body fluids, electrolytes, and calorie intake while the body heals. Treatment of chemical or electrical burns is slightly different from the treatment of thermal burns but the objectives are the same.

Thermal burn treatment

The first act of thermal burn treatment is to stop the burning process. This may be accomplished by letting cool water run over the burned area or by soaking it in cool (not cold) water. Ice should never be applied to the burn. Cool (not cold) wet compresses may provide some pain relief when applied to small areas of first- and second-degree burns. Butter, shortening, or similar salve should never be applied to the burn since it prevents heat from escaping and drives the burning process deeper into the skin.

If the burn is minor, it may be cleaned gently with soap and water. Blisters should not be broken. If the skin of the burned area is unbroken and it is not likely to be further irritated by pressure or friction, the burn should be left exposed to the air to promote healing. If the skin is broken or apt to be disturbed, the burned area should be coated lightly with an antibacterial ointment and covered with a sterile bandage. **Aspirin**, **acetaminophen** (Tylenol), or ibuprofen (Advil) may be taken to ease pain and relieve inflammation. A doctor should be consulted if these signs of infection appear: increased warmth, redness, pain, or swelling; pus or similar drainage from the wound; swollen lymph nodes; or red streaks spreading away from the burn.

In situations where a person has received moderate or critical burns, lifesaving measures take precedence over burn treatment and emergency medical assistance must be called. A person with serious burns may stop breathing, and artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered immediately. Also, a person with burns covering more than 12% BSA is likely to go into shock; this condition may be prevented by laying the person flat and elevating the feet about 12 in (30 cm). Burned arms and hands should also be raised higher than the person's heart.

In rescues, a blanket may be used to smother any flames as the person is removed from danger. The person whose clothing is on fire should "stop, drop, and roll" or be assisted in lying flat on the ground and rolling to put out the fire. Afterwards, only burnt clothing that comes off easily should be removed; any clothing embedded in the burn should not be disturbed. Removing any smoldering apparel and covering the person with a light, cool, wet cloth, such as a sheet but not a blanket or towel, will stop the burning process.

At the hospital, the staff will provide further medical treatment. A tube to aid breathing may be inserted if the patient's airways or lungs have been damaged, as can happen during an explosion or a fire in a enclosed space. Also, because burns dramatically deplete the body of fluids, replacement fluids are administered intravenously. The patient is also given **antibiotics** intravenously to prevent infection, and he or she may also receive a **tetanus** shot, depending on his or her immunization history. Once the burned area is cleaned and treated with antibiotic cream or ointment, it is covered in sterile bandages, which are changed two to three times a day. Surgical removal of dead tissue (**debridement**) also takes place. As the burns heal, thick, taut scabs (eschar) form, which the doctor may have to cut to improve blood flow to the more elastic healthy tissue beneath. The patient will also undergo physical and

occupational therapy to keep the burned areas from becoming inflexible and to minimize scarring.

In cases where the skin has been so damaged that it cannot properly heal, a skin graft is usually performed. A skin graft involves taking a piece of skin from an unburned portion of the patient's body (autograft) and transplanting it to the burned area. When doctors cannot immediately use the patient's own skin, a temporary graft is performed using the skin of a human donor (allograft), either alive or dead, or the skin of an animal (xenograft), usually that of a pig.

The burn victim also may be placed in a hyperbaric chamber, if one is available. In a hyperbaric chamber (which can be a specialized room or enclosed space), the patient is exposed to pure oxygen under high pressure, which can aid in healing. However, for this therapy to be effective, the patient must be placed in a chamber within 24 hours of being burned.

Chemical burn treatment

Burns from liquid chemicals must be rinsed with cool water for at least 15 minutes to stop the burning process. Any burn to the eye must be similarly flushed with water. In cases of burns from dry chemicals such as lime, the powder should be completely brushed away before the area is washed. Any clothing which may have absorbed the chemical should be removed. The burn should then be loosely covered with a sterile gauze pad and the person taken to the hospital for further treatment. A physician may be able to neutralize the offending chemical with another before treating the burn like a thermal burn of similar severity.

Electrical burn treatment

Before electrical burns are treated at the site of the accident, the power source must be disconnected if possible and the victim moved away from it to keep the person giving aid from being electrocuted. Lifesaving measures again take priority over burn treatment, so breathing must be checked and assisted if necessary. Electrical burns should be loosely covered with sterile gauze pads and the person taken to the hospital for further treatment.

Alternative treatment

In addition to the excellent treatment of burns provided by traditional medicine, some alternative approaches may be helpful as well. (Major burns should always be treated by a medical practitioner.) The homeopathic remedies *Cantharis* and *Causticum* can assist in burn healing. A number of botanical remedies, applied topically, can also help burns heal. These include aloe (*Aloe barbadensis*), oil of St.-John's-wort (*Hypericum perforatum*), calendula (*Calendula officinalis*), comfrey (*Symphytum officinale*), and tea tree oil (*Melaleuca* spp.). Supplementing the diet with vitamin C, vitamin E, and zinc also is beneficial for wound healing.

KEY TERMS

Debridement—The surgical removal of dead tissue.

Dermis—The basal layer of skin; it contains blood and lymphatic vessels, nerves, glands, and hair follicles.

Epidermis—The outer portion of skin, made up of four or five superficial layers.

Shock—An abnormal condition resulting from low blood volume due to hemorrhage or dehydration. Signs of shock include rapid pulse and breathing, and cool, moist, pale skin.

Prognosis

The prognosis is dependent upon the degree of the burn, the amount of body surface covered, whether critical body parts were affected, any additional injuries or complications like infection, and the promptness of medical treatment. Minor burns may heal in five to 10 days with no scarring. Moderate burns may heal in 10-14 days and may leave scarring. Critical or major burns take more than 14 days to heal and will leave significant scarring. Scar tissue may limit mobility and functionality, but physical therapy may overcome these limitations. In some cases, additional surgery may be advisable to remove scar tissue and restore appearance.

Prevention

Burns are commonly received in residential fires. Properly placed and working smoke detectors in combination with rapid evacuation plans will minimize a person's exposure to smoke and flames in the event of a fire. Children must be taught never to play with matches, lighters, fireworks, gasoline, and cleaning fluids.

Burns by scalding with hot water or other liquids may be prevented by setting the water heater thermostat no higher than 120°F (49°C), checking the temperature of bath water before getting into the tub, and turning pot handles on the stove out of the reach of children. Care should be used when removing covers from pans of

steaming foods and when uncovering or opening foods heated in a microwave oven.

Thermal burns are often received from electrical appliances. Care should be exercised around stoves, space heaters, irons, and curling irons.

Sunburns may be avoided by the liberal use of a sunscreen containing either an opaque active ingredient such as zinc oxide or titanium dioxide or a nonopaque active ingredient such as PABA (para-aminobenzoic acid) or benzophenone. Hats, loose clothing, and umbrellas also provide protection, especially between 10 A.M. and 3 P.M. when the most damaging ultraviolet rays are present in direct sunlight.

Electrical burns may be prevented by covering unused electrical outlets with safety plugs and keeping electrical cords away from infants and toddlers who might chew on them. Persons should also seek shelter indoors during a thunderstorm to avoid being struck by lightning.

Chemical burns may be prevented by wearing protective clothing, including gloves and eyeshields. Chemical agents should always be used according to the manufacturer's instructions and properly stored when not in use.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

ORGANIZATIONS

Shriners Hospitals for Children. 2900 Rocky Point Drive, Tampa, FL 33607-1435. (813) 281-0300. <http://www.shrinershq.org>.

OTHER

HealthAnswers.com. <http://www.healthanswers.com>.

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Bursitis

Definition

Bursitis is the painful inflammation of the bursa, a padlike sac found in areas subject to friction. Bursae cushion the movement between the bones, tendons and muscles near the joints. Bursitis is most often caused by repetitive movement and is known by several common names including weaver's bottom, clergyman's knee, and miner's elbow, depending on the affected individual's occupation and area of injury.

Description

There are over 150 bursae in the human body. Usually bursae are present from birth, but they may form in response to repeated pressure. Each sac contains a small amount of *synovial fluid,* a clear liquid that acts as a lubricant. Inflammation causes **pain** on movement. The most common site for bursitis to occur is the shoulder (subdeltoid), but it also is seen in the elbows (olecranon), hips (trochanteric), knees, heels (Achilles), and toes. The affected area may be referred to as "frozen," because movement is so limited. In the knee there are four bursae, and all can become inflamed with overuse.

Causes and symptoms

The most common cause of bursitis is repeated physical activity, but it can flare up for no known reason. It can also be caused by trauma, **rheumatoid arthritis**, **gout**, and acute or chronic infection.

Pain and tenderness are common symptoms. If the affected joint is close to the skin, as with the shoulder, knee, elbow, or Achilles tendon, swelling and redness are seen and the area may feel warm to the touch. The bursae around the hip joint are deeper, and swelling is not obvious. Movement may be limited and is painful. In the shoulder, it may be difficult to raise the arm out from the side of the body. Putting on a jacket or combing the hair becomes a troublesome activity.

In acute bursitis symptoms appear suddenly; with chronic bursitis, pain, tenderness, and limited movement reappear after **exercise** or strain.

Diagnosis

When a patient has pain in a joint, a careful **physical examination** is needed to determine what type of movement is affected and if there is any swelling present. Bursitis will not show up on x-rays, although sometimes there are also calcium deposits in the joint that can be seen. Inserting a thin needle into the affected bursa and removing (aspirating) some of the synovial fluid for examination can confirm the diagnosis. In most cases, the fluid will not be clear. It can be tested for the presence of microorganisms, which would indicate an infection, and crystals, which could indicate gout. In instances where the diagnosis is difficult, a local anesthetic (a drug that numbs the area) is injected into the painful spot. If the discomfort stops temporarily, then bursitis is probably the correct diagnosis.

Treatment

Conservative treatment of bursitis is usually effective. The application of heat, rest, and **immobilization** of

the affected joint area is the first step. A sling can be used for a shoulder injury; a cane is helpful for hip problems. The patient can take **nonsteroidal anti-inflammatory drugs** (NSAIDs) like **aspirin**, ibuprofin, and naproxen. They can be obtained without a prescription and relieve the pain and inflammation. Once the pain decreases, exercises of the affected area can begin. If the nearby muscles have become weak because of the disease or prolonged immobility, then exercises to build strength and improve movement are best. A doctor or physical therapist can prescribe an effective regimen.

If the bursitis is related to an inflammatory condition like arthritis or gout, then management of that disease is needed to control the bursitis.

When bursitis does not respond to conservative treatment, an injection into the joint of a long-acting corticosteroid preparation, like prednisone, can bring immediate and lasting relief. A corticosteroid is a hormonal substance that is the most effective drug for reducing inflammation. The drug is mixed with a local anesthetic and works on the joint within five minutes. Usually one injection is all that is needed.

Surgery to remove the damaged bursa may be performed in extreme cases.

If the bursitis is caused by an infection, then additional treatment is needed. *Septic* bursitis is caused by the presence of a pus-forming organism, usually *staphylococcus aureus*. This is confirmed by examining a sample of the fluid in the bursa and requires treatment with **antibiotics** taken by mouth, injected into a muscle or into a vein (intravenously). The bursa will also need to be drained by needle two or three times over the first week of treatment. When a patient has such a serious infection, there may be underlying causes. There could be undiscovered diabetes, or an inefficient immune system caused by human **immunodeficiency** virus infection (HIV).

Alternative treatment

Alternative treatments take into consideration the role of diet in causing bursitis. The faulty use of calcium by the body, magnesium deficiency, and food **allergies** may have a role. Diet changes and vitamin supplements may be helpful. The use of herbs, **homeopathy**, **aromatherapy**, and **hydrotherapy** can help relieve symptoms. Ginger is useful in reducing inflammation. **Acupuncture** has been proven effective in treating hip and shoulder pain caused by bursitis and other conditions. Other therapies that deal effectively with musculoskeletal problems (relating to the muscles and skeleton), may also be helpful, such as body work, **magnetic field therapy**, **naturopathic medicine**, **chiropractic**, and **applied kinesiology**.

KEY TERMS

Arthritis—Inflammation of a joint that may lead to changes in the joint's structure. It causes pain and swelling. Rheumatoid arthritis is a chronic disease that leads to crippling deformities.

Diabetes mellitus—A metabolic disease caused by a deficiency of insulin, which is essential to process carbohydrates in the body.

Gout—A hereditary metabolic disease that is a form of arthritis and causes inflammation of the joints. It is more common in men.

Inflammation—The reaction of tissue to injury.

Kinesiology—The science or study of movement.

Prognosis

Bursitis usually responds well to treatment, but it may develop into a chronic condition if the underlying cause is not corrected.

Prevention

Aggravating factors should be eliminated to prevent bursitis. Overexercising or the repetition of a movement that triggers the condition should be avoided. Doing exercises to strengthen the muscles around the joint will also help. When doing repetitive tasks, frequent breaks should be taken and the activity should be alternated with others using different parts of the body. To cushion the joints, it is a good idea to use cushioned chairs when sitting and foam kneeling pads for the knees. Leaning on the elbows, kneeling or sitting on a hard surface for a long period of time should be avoided. Not wearing high heels can help prevent bursitis in the heel, as can changing to new running shoes as soon as the old ones are worn out.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Bennett, Robert M. "Bursitis, Tendinitis, Myofascial Pain, and Fibromyalgia." In *Conn's Current Therapy.* ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Fife, WA: Future Medicine Publishing, 1995.

PERIODICALS

"Bursitis." *Mayo Clinic Health Newsletter* (June 1995.)

"Bursitis of the Hip." *Mayo Clinic Health Newsletter* (Sept. 1997):

Munson, Marty. "Big bursa." *Prevention*(May 1996): 63-65.

OTHER
"Bursitis." HealthAnswers.com. 1998 <http://www.healthanswers.com>.

Karen Ericson, RN

Bypass surgery *see* **Coronary artery bypass graft surgery**

Byssinosis

Definition

Byssinosis is a chronic, asthma-like narrowing of the airways. Also called brown lung disease, byssinosis results from inhaling particles of cotton, flax, hemp, or jute.

Description

Although inhaling cotton dust was identified as a source of respiratory disease more than 300 years ago, byssinosis has been recognized as an occupational hazard for textile workers for less than 50 years. More than 800,000 workers in the cotton, flax, and rope-making industries are exposed in the workplace to airborne particles that can cause byssinosis. Only workers in mills that manufacture yarn, thread, or fabric have a significant risk of dying of this disease.

In the United States, byssinosis is almost completely limited to workers who handle unprocessed cotton. More than 35,000 textile workers have been disabled by byssinosis and 183 died between 1979 and 1992. Most of the people whose deaths were due to byssinosis lived in the textile-producing regions of North and South Carolina.

Causes and symptoms

Wheezing, **shortness of breath**, and a feeling of tightness in the chest occur occasionally during the early stages of the disease. Symptoms are usually more pronounced when returning to work after a weekend, holiday, or vacation and subside as the worker becomes reaccustomed to the environment.

As many as 25% of workers with byssinosis have symptoms that continue or recur throughout the workweek. More severe breathing problems seem to result both from exposure to high levels of dust and from longer dust exposure. Workers who also smoke cigarettes suffer the most severe impairment.

KEY TERMS

Wheeze—A whistling sound made by the flow of high-velocity air through narrowed airways. Wheezing is a symptom of several respiratory diseases including byssinosis and asthma.

Diagnosis

Tests that detect decreasing lung capacity during the workday are used to diagnose byssinosis. Obstructive patterns are likely in patients who have had recurrent symptoms for more than 10 years.

Treatment

Therapy for early-stage byssinosis focuses on reversing airway narrowing. **Antihistamines** may be prescribed to reduce tightness in the chest. **Bronchodilators** (drugs used to relax breathing passages and improve air flow) may be used with an inhaler or taken in tablet form. Reducing exposure is essential. Any worker who has symptoms of byssinosis or who has trouble breathing should transfer to a less-contaminated area.

Prognosis

Smoking, impaired lung function, and a history of respiratory allergy increase a textile worker's risk of developing byssinosis. Prolonged exposure makes patients wheeze more often and can cause chronic **bronchitis**. It does not lead to permanently disabling lung disease.

Prevention

Eliminating exposure to textile dust is the surest way to prevent byssinosis. Using exhaust hoods, improving ventilation, and employing wetting procedures are very successful methods of controlling dust levels to prevent byssinosis. Protective equipment required during certain procedures also prevents exposure to levels of contamination that exceed the current United States standard for cotton dust exposure.

Resources

BOOKS
Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.
Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Occupational Lung Disease." American Lung Association Page. 27 May 1998 <http://www.lungusa.org>.

"1996 World Surveillance Report: Selected Data Highlights." Centers for Disease Control. 27 May 1998. 27 May 1998 <http://www.cdc.gov/niosh/w7_high.html>.

Maureen Haggerty

The GALE ENCYCLOPEDIA *of* MEDICINE

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CONTENTS

PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Medicine 2* is a medical reference product designed to inform and educate readers about a wide variety of disorders, conditions, treatments, and diagnostic tests. The Gale Group believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioner. While the Gale Group has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, the Gale Group makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of medical opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their health care provider.

INTRODUCTION

The *Gale Encyclopedia of Medicine 2 (GEM2)* is a one-stop source for medical information on nearly 1,700 common medical disorders, conditions, tests, and treatments, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart attack. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 2* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

SCOPE

Almost 1,700 full-length articles are included in the *Gale Encyclopedia of Medicine 2*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses, eg. acetaminophen (Tylenol). Throughout the *Gale Encyclopedia of Medicine 2*, many prominent individuals are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Description	Purpose
Causes and symptoms	Precautions
Diagnosis	Description
Treatment	Preparation
Alternative treatment	Aftercare
Prognosis	Risks
Prevention	Normal/Abnormal results
Resources	Resources
Key terms	Key terms

In recent years there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 2* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies.

INCLUSION CRITERIA

A preliminary list of diseases, disorders, tests and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM2* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale Group editor.

ABOUT THE CONTRIBUTORS

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM2* medical advisors reviewed the completed essays to insure that they are appropriate, up-to-date, and medically accurate.

HOW TO USE THIS BOOK

The *Gale Encyclopedia of Medicine 2* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.

- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms are also cross-referenced.
- A list of **key terms** are provided where appropriate to define unfamiliar terms or concepts.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix contains an extensive list of organizations arranged in alphabetical order.
- **Resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

GRAPHICS

The *Gale Encyclopedia of Medicine 2* is enhanced with over 675 color images, including photos, charts, tables, and customized line drawings.

ADVISORY BOARD

A number of experts in the library and medical communities provided invaluable assistance in the formulation of this encyclopedia. Our advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. The editor would like to express her appreciation to them.

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C

CABG surgery *see* **Coronary artery bypass graft surgery**

CAD *see* **Coronary artery disease**

Caffeine

Definition

Caffeine is a drug that stimulates the central nervous system.

Purpose

Caffeine makes people more alert, less drowsy, and improves coordination. Combined with certain **pain** relievers or medicines for treating **migraine headache**, caffeine makes those drugs work more quickly and effectively. Caffeine alone can also help relieve headaches. **Antihistamines** are sometimes combined with caffeine to counteract the drowsiness that those drugs cause. Caffeine is also sometimes used to treat other conditions, including breathing problems in newborns and in young babies after surgery.

Description

Caffeine is found naturally in coffee, tea, and chocolate. Colas and some other soft drinks contain it. Caffeine also comes in tablet and capsule forms and can be bought without a prescription. Over-the-counter caffeine brands include No Doz, Overtime, Pep-Back, Quick-Pep, Caffedrine, and Vivarin. Some pain relievers, medicines for migraine headaches, and antihistamines also contain caffeine.

Recommended dosage

Adults and children age 12 years and over

100–200 mg no more than every 3–4 hours. In timed-release form, the dose is 200–250 mg once a day. Timed-release forms should not be taken less than six hours before bedtime.

Children under 12 years

Not recommended.

Other considerations

Avoid taking too much caffeine when it is being taken as an over-the-counter drug. Consider how much caffeine is being taken in from coffee, tea, chocolate, soft drinks, and other foods that contain caffeine. Check with a pharmacist or physician to find out how much caffeine is safe to use.

Precautions

Caffeine cannot replace sleep and should not be used regularly to stay awake as the drug can lead to more serious **sleep disorders**, like **insomnia**.

People who use large amounts of caffeine over long periods build up a tolerance to it. When that happens, they have to use more and more caffeine to get the same effects. Heavy caffeine use can also lead to dependence. If the person then stops using caffeine abruptly, withdrawal symptoms may occur. These can include throbbing headaches, **fatigue**, drowsiness, yawning, irritability, restlessness, vomiting, or runny nose. These symptoms can go on for as long as a week if caffeine is avoided. Then the symptoms usually disappear.

If taken too close to bedtime, caffeine can interfere with sleep. Even if it does not prevent a person from falling asleep, it may disturb sleep during the night.

The notion that caffeine helps people sober up after drinking too much alcohol is a myth. In fact, using caffeine and alcohol together is not a good idea. The combination can lead to an upset stomach, nausea, and vomiting.

Older people may be more sensitive to caffeine and thus more likely to have certain side effects, such as irritability, nervousness, **anxiety**, and sleep problems.

KEY TERMS

Arrhythmia—Abnormal heart rhythm.

Central nervous system—The brain, spinal cord and nerves throughout the body.

Fetus—A developing baby inside the womb.

Palpitation—Rapid, forceful, throbbing, or fluttering heartbeat.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

Special conditions

Caffeine may cause problems for people with certain medical conditions or who are taking certain medicines.

ALLERGIES. Anyone with **allergies** to foods, dyes, preservatives, or to the compounds aminophylline, dyphylline, oxtriphylline, theobromine, or theophylline should check with a physician before using caffeine. Anyone who has ever had an unusual reaction to caffeine should also check with a physician before using it again.

PREGNANCY. Caffeine can pass from a pregnant woman's body into the developing fetus. Although there is no evidence that caffeine causes **birth defects** in people, it does cause such effects in laboratory animals given very large doses (equal to human doses of 12–24 cups of coffee a day). In humans, evidence exists that doses of more than 300 mg of caffeine a day (about the amount of caffeine in 2–3 cups of coffee) may cause **miscarriage** or problems with the baby's heart rhythm. Women who take more than 300 mg of caffeine a day during **pregnancy** are also more likely to have babies with low birth weights. Any woman who is pregnant or planning to become pregnant should check with her physician before using caffeine.

BREASTFEEDING. Caffeine passes into breast milk and can affect the nursing baby. Nursing babies whose mothers use 600 mg or more of caffeine a day may be irritable and have trouble sleeping. Women who are breastfeeding should check with their physicians before using caffeine.

OTHER MEDICAL CONDITIONS. Caffeine may cause problems for people with these medical conditions:

- peptic ulcer
- heart **arrhythmias** or **palpitations**
- heart disease or recent **heart attack** (within a few weeks)
- high blood pressure
- liver disease
- insomnia (trouble sleeping)
- anxiety or panic attacks
- agoraphobia (fear of being in open places)
- premenstrual syndrome (PMS)

USE OF CERTAIN MEDICINES. Using caffeine with certain other drugs may interfere with the effects of the drugs or cause unwanted—and possibly serious—side effects.

Side effects

At recommended doses, caffeine can cause restlessness, irritability, nervousness, shakiness, **headache**, lightheadedness, sleeplessness, nausea, vomiting, and upset stomach. At higher than recommended doses, caffeine can cause excitement, agitation, anxiety, confusion, a sensation of light flashing before the eyes, unusual sensitivity to touch, unusual sensitivity of other senses, ringing in the ears, frequent urination, muscle twitches or **tremors**, heart arrhythmias, rapid heartbeat, flushing, and convulsions.

Interactions

Certain drugs interfere with the breakdown of caffeine in the body. These include **oral contraceptives** that contain estrogen, the antiarrhythmia drug mexiletine (Mexitil), the ulcer drug cimetidine (Tagamet), and the drug disulfiram (Antabuse), used to treat **alcoholism**.

Caffeine interferes with drugs that regulate heart rhythm, such as quinidine and propranolol (Inderal). Caffeine may also interfere with the body's absorption of iron. Anyone who takes iron supplements should take them at least an hour before or two hours after using caffeine.

Serious side effects are possible when caffeine is combined with certain drugs. For example, taking caffeine with the decongestant phenylpropanolamine can raise blood pressure. And very serious heart problems may occur if caffeine and **monoamine oxidase inhibitors** (MAO) are taken together. These drugs are used to treat **Parkinson's disease**, depression, and other psychiatric conditions. Consult with a pharmacist or physician about which drugs can interact with caffeine.

Because caffeine stimulates the nervous system, anyone taking other central nervous system (CNS) stimulants should be careful about using caffeine.

Nancy Ross-Flanigan

CAH *see* **Congenital adrenal hyperplasia**

Caisson disease *see* **Decompression sickness**

Calcaneal spurs *see* **Heel spurs**

Calcitonin *see* **Bone disorder drugs**

Calcium carbonate *see* **Antacids**

Calcium channel blockers

Definition

Calcium channel blockers are medicines that slow the movement of calcium into the cells of the heart and blood vessels. This, in turn, relaxes blood vessels, increases the supply of oxygen-rich blood to the heart, and reduces the heart's workload.

Purpose

Calcium channel blockers are used to treat high blood pressure, to correct abnormal heart rhythms, and to relieve the type of chest **pain** called **angina** pectoris. Physicians also prescribe calcium channel blockers to treat panic attacks and **bipolar disorder** (manic depressive illness) and to prevent **migraine headache**.

Precautions

Seeing a physician regularly while taking calcium channel blockers is important. The physician will check to make certain the medicine is working as it should and will watch for unwanted side effects. People who have high blood pressure often feel perfectly fine. However, they should continue to see their prescribing physician even when they feel well so that he can keep a close watch on their condition. They should also continue to take their medicine even when they feel fine.

Calcium channel blockers will not cure high blood pressure, but will help to control the condition. To avoid the serious health problems associated with high blood pressure, patients may have to take this type of medication for the rest of their lives. Furthermore, the blockers alone may not be enough. People with high blood pressure may also need to avoid certain foods and keep their weight under control. The health care professional who is treating the condition can offer advice as to what measures may be necessary. Patients being treated for high blood pressure should not change their **diets** without consulting their physicians.

Anyone taking calcium channel blockers for high blood pressure should not take any other prescription or over-the-counter medication without first checking with the prescribing physician, as some of these drugs may increase blood pressure.

Some people feel drowsy or less alert than usual when taking calcium channel blockers. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

People who normally have chest pain when they **exercise** or exert themselves may not have the pain when they are taking calcium channel blockers. This could lead them to be more active than they should be. Anyone taking calcium channel blockers should therefore consult with the prescribing physician concerning how much exercise and activity may be considered safe.

Some people get headaches that last for a short time after taking a dose of this medication. This problem usually goes away during the course of treatment. If it does not, or if the headaches are severe, the prescribing physician should be informed.

Patients taking certain calcium channel blockers may need to check their pulse regularly, as the drugs may slow the pulse too much. If the pulse is too slow, circulation problems may result. The prescribing physician can show patients the correct way to check their pulse.

This type of medication may cause the gums to swell, bleed, or become tender. If this problem occurs, a medical physician or dentist should be consulted. To help prevent the problem, care should be taken when brushing and flossing the teeth. Regular dental check-ups and cleanings are also recommended.

Older people may be unusually sensitive to the effects of calcium channel blockers. This may increase the chance of side effects.

Special conditions

People with certain medical conditions or who are taking certain other medicines may develop problems if they also take calcium channel blockers. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

ALLERGIES. Anyone who has had a previous unusual reaction to any calcium channel blocker should let his or her physician know before taking the drugs again. The physician should also be notified about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. The effects of taking calcium channel blockers during **pregnancy** have not been studied in

KEY TERMS

Angina pectoris—A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

Bipolar disorder—A severe mental illness, also known as manic depression, in which a person has extreme mood swings, ranging from a highly excited state—sometimes with a false sense of well-being—to depression.

Migraine—A throbbing headache that usually affects only one side of the head. Nausea, vomiting, increased sensitivity to light, and other symptoms often accompany migraine.

humans. However, in studies of laboratory animals, large doses of these drugs have been reported to cause **birth defects**, **stillbirth**, poor bone growth, and other problems when taken during pregnancy. Women who are pregnant or who may become pregnant should check with their physicians before using these drugs.

BREASTFEEDING. Some calcium channel blockers pass into breast milk, but there have been no reports of problems in nursing babies whose mothers were taking this type of medication. However, women who need to take this medicine and want to breastfeed their babies should check with their physicians.

OTHER MEDICAL CONDITIONS. Calcium channel blockers may worsen heart or blood vessel disorders.

The effects of calcium channel blockers may be greater in people with kidney or liver disease, as their bodies are slower to clear the drug from their systems.

Certain calcium channel blockers may also cause problems in people with a history of heart rhythm problems or with depression, **Parkinson's disease**, or other types of parkinsonism.

USE OF CERTAIN MEDICINES. Taking calcium channel blockers with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

As with most medications, certain side effects are possible and some interactions with other substances may occur.

Side effects

Side effects are not common with this medicine, but some may occur. Minor discomforts, such as **dizziness**, lightheadedness, flushing, **headache**, and nausea, usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they are bothersome.

If any of the following side effects occur, the prescribing physician should be notified as soon as possible:

- breathing problems, coughing or wheezing
- irregular, fast, or pounding heartbeat
- slow heartbeat (less than 50 beats per minute)
- skin rash
- swollen ankles, feet, or lower legs

Other side effects may occur. Anyone who has unusual symptoms after taking calcium blockers should contact the prescribing physician.

Interactions

Calcium channel blockers may interact with a number of other medications. When this happens, the effects of one or both of the drugs may change or the risk of side effects may increase. Anyone who takes calcium channel blockers should not take any other prescription or nonprescription (over-the-counter) medicines without first checking with the prescribing physician. Substances that may interact with calcium channel blockers include:

- Diuretics (water pills). This type of medicine may cause low levels of potassium in the body, which may increase the chance of unwanted effects from some calcium channel blockers.
- Beta-blockers, such as atenolol (Tenormin), propranolol (Inderal), and metoprolol (Lopressor), used to treat high blood pressure, angina, and other conditions. Also, eye drop forms of **beta blockers**, such as timolol (Timoptic), used to treat **glaucoma**. Taking any of these drugs with calcium channel blockers may increase the effects of both types of medicine and may cause problems if either drug is stopped suddenly.
- Digitalis heart medicines. Taking these medicines with calcium channel blockers may increase the action of the heart medication.
- Medicines used to correct irregular heart rhythms, such as quinidine (Quinidex), disopyramide (Norpace), and procainamide (Procan, Pronestyl). The effects of these drugs may increase if used with calcium channel blockers.
- Anti-seizure medications such as carbamazepine (Tegretol). Calcium channel drugs may increase the effects of these medicines.
- Cyclosporine (Sandimmune), a medicine that suppresses the immune system. Effects may increase if this drug is taken with calcium channel blockers.
- Grapefruit juice may increase the effects of some calcium channel blockers.

The above list does not include every drug that may interact with calcium channel blockers. The prescribing physician or pharmacist will advise as to whether combining calcium channel blockers with any other prescription or nonprescription (over-the-counter) medication is appropriate or not.

Description

Calcium channel blockers are available only with a physician's prescription and are sold in tablet, capsule, and injectable forms. Some commonly used calcium channel blockers include amlopidine (Norvasc), diltiazem (Cardizem), isradipine (DynaCirc), nifedipine (Adalat, Procardia), nicardipine (Cardene), and verapamil (Calan, Isoptin, Verelan).

The recommended dosage depends on the type, strength, and form of calcium channel blocker and the condition for which it is prescribed. Correct dosage is determined by the prescribing physician and further information can be obtained from the pharmacist.

Calcium channel blockers should be taken as directed. Larger or more frequent doses should not be taken, nor should doses be missed. This medicine may take several weeks to noticeably lower blood pressure. The patient taking calcium channel blockers should keep taking the medicine, to give it time to work. Once it begins to work and symptoms improve, it should continue to be taken as prescribed.

This medicine should not be discontinued without checking with the prescribing physician. Some conditions may worsen when patients stop taking calcium channel blockers abruptly. The prescribing physician will advise as to how to gradually taper down before stopping the medication completely.

Risks

A report from the European Cardiology Society in 2000 found that patients taking certain calcium channel blockers had a 27% greater risk of **heart attack**, and a 26% greater risk of **heart failure** than patients taking other high blood pressure medicines. However, there are many patients affected by conditions that still make calcium channel blockers the best choice for them. The patient should discuss this issue with the prescribing physician.

Normal results

The expected result of taking a calcium channel blocker is to either correct abnormal heart rhythms, return blood pressure to normal, or relieve chest pain.

Resources

BOOKS

Beers, Mark H. and Robert Berkow, eds. *The Merck Manual of Diagnosis and Therapy.* 17th ed. Whitehouse Station, NJ: Merck and Company, Inc., 1999.

PERIODICALS

Zoler, Mitchel L."Drug Update: Calcium Channel Blockers For Hypertension." *Family Practice News* (April 1, 2000): 53.

"The Pressure's On: A Hypertension Drug Taken by 28 Million People is Under Scrutiny. What Are the Other Options? (Calcium Channel Blockers)." *Time* (September 11, 2000): 126.

ORGANIZATION

National Heart, Lung and Blood Institute. <http://www.nhlbi.nih.gov>.

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Calcium imbalance *see* **Hypercalcemia; Hypocalcemia**

Calcium polycarbophil *see* **Laxatives**

California flower essences *see* **Flower remedies**

Calluses *see* **Corns and calluses**

Calorie-modified diet *see* **Diets**

Calymmatobacteriosis *see* **Granuloma inguinale**

Campylobacter jejuni infection *see* **Campylobacteriosis**

Campylobacteriosis

Definition

Campylobacteriosis refers to infection by the group of bacteria known as *Campylobacter*. The term comes from the Greek word meaning "curved rod" referring to the bacteria's curved shape. The most common disease caused by these organisms is **diarrhea**, which most often affects children and younger adults. *Campylobacter* infections account for a substantial percent of food-borne illness encountered each year.

Description

There are over 15 different subtypes, all of which are curved Gram-negative rods. *C. jeuni* is the subtype that

KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Anti-motility medications—Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing codeine or narcotics which decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Fluoroquinolones—A relatively new group of antibiotics that have had good success in treating infections with many Gram-negative bacteria. One drawback is that they should not be used in children under 17 years of age, because of possible effect on bone growth.

Food-borne illness—A disease that is transmitted by eating or handling contaminated food.

Gram-negative—Refers to the property of many bacteria that causes them to not take up color with Gram's stain, a method which is used to identify bacteria. Gram-positive bacteria which take up the stain turn purple, while Gram-negative bacteria which do not take up the stain turn red.

Guillain-Barré syndrome—Progressive and usually reversible paralysis or weakness of multiple muscles usually starting in the lower extremities and often ascending to the muscles involved in respiration. The syndrome is due to inflammation and loss of the myelin covering of the nerve fibers, often associated with an acute infection.

Meninges—Outer covering of the spinal cord and brain. Infection is called meningitis, which can lead to damage to the brain or spinal cord and even death.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Stool—Passage of fecal material; a bowel movement.

most often causes gastrointestinal disease. However, some species such as *C. fetus* produce disease outside the intestine, particularly in those with altered immune systems, such as people with **AIDS**, **cancer**, and liver disease.

Campylobacter are often found in the intestine of animals raised for food produce and pets. Infected animals often have no symptoms. Chickens are the most common source of human infection. It is estimated that 1% of the general population is infected each year.

Causes and symptoms

Improper or incomplete food preparation is the most common way the disease is spread, with poultry accounting for over half the cases. Untreated water and raw milk are also potential sources.

The incubation period after exposure is from one to 10 days. A day or two of mild **fever**, muscle aches, and **headache** occur before intestinal symptoms begin. Diarrhea with or without blood and severe abdominal cramps are the major intestinal symptoms. The severity of symptoms is variable, ranging from only mild fever to **dehydration** and rarely **death** (mainly in the very young or old). The disease usually lasts about one week, but persists longer in about 20% of cases. At least 10% will have a relapse, and some patients will continue to pass the bacteria for several weeks.

Complications

Dehydration is the most common complication. Especially at the extremes of age, this should be watched for and treated with either Oral Rehydration Solution or intravenous fluid replacement.

Infection may also involve areas outside the intestine. This is unusual, except for infections with *C. fetus*. *C. fetus* infections tend to occur in those who have diseases of decreased immunity such as AIDS, cancer, etc. This subtype is particularly adapted to protect itself from the body's defenses.

Areas outside the intestine that may be involved are:

- Nervous system involvement either by direct infection of the meninges (outer covering of the spinal and brain) or more commonly by producing the **Guillain-Barré syndrome** (progressive and reversible **paralysis** or weakness of many muscles). In fact, *Campylobacter* may be responsible for 40% of the reported cases of this syndrome.

- Joint inflammation can occur weeks later (leading to an unusual form of arthritis).
- Infection of vessels and heart valves is a special characteristic of *C. fetus*. Immunocompromised patients may develop repeated episodes of passage of bacteria into the bloodstream from these sites of infection.
- The gallbladder, pancreas, and bone may be affected.

Diagnosis

Campylobacter is only one of many causes of acute diarrhea. Culture (growing the bacteria in the laboratory) of freshly obtained diarrhea fluid is the only way to be certain of the diagnosis.

Treatment

The first aim of treatment is to keep up **nutrition** and avoid dehydration. Medications used to treat diarrhea by decreasing intestinal motility, such as Loperamide or Diphenoxylate are also useful, but should only be used with the advice of a physician. **Antibiotics** are of value, if started within three days of onset of symptoms. They are indicated for those with severe or persistent symptoms. Either an erythromycin type drug or one of the **fluoroquinolones** (such as ciprofloxacin) for five to seven days are the accepted therapies.

Prognosis

Most patients with *Campylobacter* infection rapidly recover without treatment. For certain groups of patients, infection becomes chronic and requires repeated courses of antibiotics.

Prevention

Good hand washing technique as well as proper preparation and cooking of food is the best way to prevent infection.

Resources

BOOKS

Blaser, Martin J. "Infections due to Campylobacter and Related Species." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hamer, Davidson H., and Sherwood L. Gorbach. "Campylobacter." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Thielman, Nathan M., and Richard L. Guerrant. "Food-Borne Illness." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Wolfe, Martin S. "Acute Infectious Diarrhea." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Lew, Edward A., Michael A. Poles, and Douglas T. Dieterich. "Diarrheal Disease Associated with HIV Infection." *Gastroenterology Clinics of North America* (June 1997): 259-290.

"Traveler's Diarrhea: Don't Let It Ruin Your Trip." *Mayo Clinic Health Letter* (Jan. 1997).

"When Microbes are on the Menu." *Harvard Health Letter* (Dec. 1994) : 4-5.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

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Cancer

Definition

Cancer is not just one disease, but a large group of almost one hundred diseases. Its two main characteristics are uncontrolled growth of the cells in the human body and the ability of these cells to migrate from the original site and spread to distant sites. If the spread is not controlled, cancer can result in **death**.

Description

One out of every four deaths in the United States is from cancer. It is second only to heart disease as a cause of death in the states. About 1.2 million Americans are diagnosed with cancer annually; more than 500,000 die of cancer annually.

Cancer can attack anyone. Since the occurrence of cancer increases as individuals age, most of the cases are seen in adults, middle-aged or older. Sixty percent of all cancers are diagnosed in people who are older than 65 years of age. The most common cancers are skin cancer, lung cancer, **colon cancer**, **breast cancer** (in women), and **prostate cancer** (in men). In addition, cancer of the kidneys, ovaries, uterus, pancreas, bladder, rectum, and blood and lymph node cancer (leukemias and lymphomas) are also included among the 12 major cancers that affect most Americans.

Cancer, by definition, is a disease of the genes. A gene is a small part of DNA, which is the master molecule of the cell. Genes make "proteins," which are the ultimate workhorses of the cells. It is these proteins that allow our bodies to carry out all the many processes that permit us to breathe, think, move, etc.

Throughout people's lives, the cells in their bodies are growing, dividing, and replacing themselves. Many genes produce proteins that are involved in controlling the processes of cell growth and division. An alteration (mutation) to the DNA molecule can disrupt the genes and produce faulty proteins. This causes the cell to become abnormal and lose its restraints on growth. The abnormal cell begins to divide uncontrollably and eventually forms a new growth known as a "tumor" or neoplasm (medical term for cancer meaning "new growth").

In a healthy individual, the immune system can recognize the neoplastic cells and destroy them before they get a chance to divide. However, some mutant cells may escape immune detection and survive to become tumors or cancers.

Tumors are of two types, benign or malignant. A benign tumor is not considered cancer. It is slow growing, does not spread or invade surrounding tissue, and once it is removed, it doesn't usually recur. A malignant tumor, on the other hand, is cancer. It invades surrounding tissue and spreads to other parts of the body. If the cancer cells have spread to the surrounding tissues, then, even after the malignant tumor is removed, it generally recurs.

A majority of cancers are caused by changes in the cell's DNA because of damage due to the environment. Environmental factors that are responsible for causing the initial mutation in the DNA are called carcinogens, and there are many types.

There are some cancers that have a genetic basis. In other words, an individual could inherit faulty DNA from his parents, which could predispose him to getting cancer. While there is scientific evidence that both factors (environmental and genetic) play a role, less than 10% of all cancers are purely hereditary. Cancers that are known to have a hereditary link are breast cancer, colon cancer, **ovarian cancer**, and uterine cancer. Besides genes, certain physiological traits could be inherited and could contribute to cancers. For example, inheriting fair skin makes a person more likely to develop skin cancer, but only if they also have prolonged exposure to intensive sunlight.

There are several different types of cancers:

- Carcinomas are cancers that arise in the epithelium (the layers of cells covering the body's surface and lining the internal organs and various glands). Ninety percent of human cancers fall into this category. Carcinomas can be subdivided into two types: adenocarcinomas and squamous cell carcinomas. Adenocarcinomas are cancers that develop in an organ or a gland, while squamous cell carcinomas refer to cancers that originate in the skin.
- Melanomas also originate in the skin, usually in the pigment cells (melanocytes).
- Sarcomas are cancers of the supporting tissues of the body, such as bone, muscle and blood vessels.
- Cancers of the blood and lymph glands are called leukemias and lymphomas respectively.
- Gliomas are cancers of the nerve tissue.

Causes and symptoms

The major risk factors for cancer are: tobacco, alcohol, diet, sexual and reproductive behavior, infectious agents, family history, occupation, environment and pollution.

According to the estimates of the American Cancer Society (ACS), approximately 40% of the cancer deaths in 1998 will be due to tobacco and excessive alcohol use. An additional one-third of the deaths will be related to diet and **nutrition**. Many of the one million skin cancers that are expected to be diagnosed in 1998 will be due to over-exposure to ultraviolet light from the sun's rays.

Tobacco

Eighty to ninety percent of the lung cancer cases occur in smokers. **Smoking** has also been shown to be a contributory factor in cancers of upper respiratory tract, esophagus, larynx, bladder, pancreas, and probably liver, stomach, and kidney as well. Recently, scientists have also shown that second-hand smoke (or passive smoking) can increase one's risk of developing cancer.

Alcohol

Excessive consumption of alcohol is a risk factor in certain cancers, such as **liver cancer**. Alcohol, in combination with tobacco, significantly increases the chances that an individual will develop mouth, pharynx, larynx and esophageal cancers.

Diet

Thirty-five percent of all cancers are due to dietary causes. Excessive intake of fat leading to **obesity** has been associated with cancers of the breast, colon, rectum, pancreas, prostate, gall bladder, ovaries and uterus.

Sexual and reproductive behavior

The human papilloma virus, which is sexually transmitted, has been shown to cause cancer of the cervix.

Having too many sex partners and becoming sexually active early has been shown to increase one's chances of contracting this disease. In addition, it has also been shown that women who don't have children or have children late in life have an increased risk for both ovarian and breast cancer.

Infectious agents

In the last 20 years, scientists have obtained evidence to show that approximately 15% of the world's cancer deaths can be traced to viruses, bacteria, or parasites. The most common cancer-causing pathogens and the cancers associated with them are shown in table form.

Family history

Certain cancers like breast, colon, ovarian and uterine cancer recur generation after generation in some families. A few cancers, such as the **eye cancer** "retinoblastoma," a type of colon cancer, and a type of breast cancer known as "early-onset breast cancer," have been shown to be linked to certain genes that can be tracked within a family. It is therefore possible that inheriting particular genes makes a person susceptible to certain cancers.

Occupational hazards

There is evidence to prove that certain occupational hazards account for 4% of all cancer deaths. For example, asbestos workers have an increased incidence of lung cancer. Similarly, a higher likelihood of getting **bladder cancer** is associated with dye, rubber and gas workers; skin and lung cancer with smelters, gold miners and arsenic workers; leukemia with glue and varnish workers; liver cancer with PVC manufacturers; and lung, bone and bone marrow cancer with radiologists and uranium miners.

Environment

Radiation is believed to cause 1–2% of all cancer deaths. Ultra-violet radiation from the sun accounts for a majority of melanoma deaths. Other sources of radiation are x rays, radon gas, and ionizing radiation from nuclear material.

Pollution

Several studies have shown that there is a well-established link between asbestos and cancer. Chlorination of water may account for a small rise in cancer risk. However, the main danger from pollution occurs when dangerous chemicals from the industries escape into the surrounding environment. It has been estimated that 1% of cancer deaths are due to air, land and water pollution.

Frequency Of Cancer-Related Death

Cancer Site	Number of Deaths Per Year
Lung	160,100
Colon and rectum	56,500
Breast	43,900
Prostate	39,200
Pancreas	28,900
Lymphoma	26,300
Leukemia	21,600
Brain	17,400
Stomach	13,700
Liver	13,000
Esophagus	11,900
Bladder	12,500
Kidney	11,600
Multiple myeloma	11,300

Cancer is a progressive disease, and goes through several stages. Each stage may produce a number of symptoms. Some symptoms are produced early and may occur due to a tumor that is growing within an organ or a gland. As the tumor grows, it may press on the nearby nerves, organs and blood vessels. This causes **pain** and some pressure which may be the earliest warning signs of cancer.

Despite the fact that there are several hundred different types of cancers, producing very different symptoms, the ACS has established the following seven symptoms as possible warning signals of cancer:

- changes in the size, color, or shape of a wart or a mole
- a sore that does not heal
- persistent **cough**, hoarseness, or **sore throat**
- a lump or thickening in the breast or elsewhere
- unusual bleeding or discharge
- chronic **indigestion** or difficulty in swallowing
- any change in bowel or bladder habits

Many other diseases, besides cancer, could produce the same symptoms. However, it is important to have these symptoms checked, as soon as possible, especially if they linger. The earlier a cancer is diagnosed and treated, the better the chance of it being cured. Many cancers such as breast cancer may not have any early symptoms. Therefore, it is important to undergo routine screening tests such as breast self-exams and mammograms.

Diagnosis

Diagnosis begins with a thorough **physical examination** and a complete medical history. The doctor will observe, feel and palpate (apply pressure by touch) different parts of the body in order to identify any variations from the normal size, feel and texture of the organ or tissue.

As part of the physical exam, the doctor will inspect the oral cavity or the mouth. By focusing a light into the mouth, he will look for abnormalities in color, moisture, surface texture, or presence of any thickening or sore in the lips, tongue, gums, the hard palate on the roof of the mouth, and the throat. To detect **thyroid cancer**, the doctor will observe the front of the neck for swelling. He may gently manipulate the neck and palpate the front and side surfaces of the thyroid gland (located at the base of the neck) to detect any nodules or tenderness. As part of the physical examination, the doctor will also palpate the lymph nodes in the neck, under the arms and in the groin. Many illnesses and cancers cause a swelling of the lymph nodes.

The doctor may conduct a thorough examination of the skin to look for sores that have been present for more than three weeks and that bleed, ooze, or crust; irritated patches that may itch or hurt, and any change in the size of a wart or a mole.

Examination of the female pelvis is used to detect cancers of the ovaries, uterus, cervix, and vagina. In the visual examination, the doctor looks for abnormal discharges or the presence of sores. Then, using gloved hands the physician palpates the internal pelvic organs such as the uterus and ovaries to detect any abnormal masses. Breast examination includes visual observation where the doctor looks for any discharge, unevenness, discoloration, or scaling. The doctor palpates both breasts to feel for masses or lumps.

For males, inspection of the rectum and the prostate is also included in the physical examination. The doctor inserts a gloved finger into the rectum and rotates it slowly to feel for any growths, tumors, or other abnormalities. The doctor also conducts an examination of the testes, where the doctor observes the genital area and looks for swelling or other abnormalities. The testicles are palpated to identify any lumps, thickening or differences in the size, weight and firmness.

If the doctor detects an abnormality on physical examination, or the patient has some symptom that could be indicative of cancer, the doctor may order diagnostic tests.

Laboratory studies of sputum (sputum cytology), blood, urine, and stool can detect abnormalities that may indicate cancer. Sputum cytology is a test where the phlegm that is coughed up from the lungs is microscopically examined. It is often used to detect lung cancer. A blood test for cancer is easy to perform, usually inexpensive and risk-free. The blood sample is obtained by a lab technician or a doctor by inserting a needle into a vein and is relatively painless. Blood tests can be either specific or non-specific. Often times, in certain cancers, the cancer cells release particular proteins (called **tumor markers**) and blood tests can be used to detect the presence of these tumor markers. However, with a few exceptions, tumor markers are not used for routine screening of cancers, because several non-cancerous conditions also produce positive results. Blood tests are generally more useful in monitoring the effectiveness of the treatment, or in following the course of the disease and detecting recurrent disease.

Imaging tests such as **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), ultrasound and fiberoptic scope examinations help the doctors determine the location of the tumor even if it is deep within the body. Conventional x rays are often used for initial evaluation, because they are relatively cheap, painless and easily accessible. In order to increase the information obtained from a conventional x ray, air or a dye (such as barium or iodine) may be used as a contrast medium to outline or highlight parts of the body.

The most definitive diagnostic test is the biopsy, wherein a piece of tissue is surgically removed for microscope examination. Besides confirming a cancer, the biopsy also provides information about the type of cancer, the stage it has reached, the aggressiveness of the cancer and the extent of its spread. Since a biopsy provides the most accurate analysis, it is considered the gold standard of diagnostic tests.

Screening examinations conducted regularly by healthcare professionals can result in the detection of cancers of the breast, colon, rectum, cervix, prostate, testis, tongue, mouth, and skin at early stages, when treatment is more likely to be successful. Some of the routine screening tests recommended by the ACS are **sigmoidoscopy** (for colorectal cancer), **mammography** (for breast cancer), pap smear (for **cervical cancer**), and the PSA test (for prostate cancer). Self-examinations for cancers of the breast, testes, mouth, and skin can also help in detecting the tumors before the symptoms become serious.

A recent revolution in molecular biology and cancer genetics has contributed a great deal to the development of several tests designed to assess one's risk of getting cancers. These new techniques include **genetic testing**, where molecular probes are used to identify mutations in certain genes that have been linked to particular cancers. At present, however, there are a lot of limitations to genetic testing and its utility appears ambiguous, emphasizing the need to develop better strategies for early detection.

Treatment

The aim of cancer treatment is to remove all or as much of the tumor as possible and to prevent the recurrence or spread of the primary tumor. While devising a treatment plan for cancer, the likelihood of curing the

Common Pathogens And The Cancers Associated With Them

Causative Angent	Type of Cancer
Viruses	
Papillomaviruses	Cancer of the cervix
Hepatitis B virus	Liver cancer
Hepatitis C virus	Liver cancer
Epstein-Barr virus	Burkitt's lymphoma
Cancers of the upper pharynx	Hodgkin's lymphoma, Non-Hodgkin's lymphoma, Gastric cancers
Human immunodeficiency virus (HIV)	Kaposi's sarcoma lymphoma
Bacteria	
Helicobacter pylori	Stomach cancer lymphomas

cancer has to be weighed against the side effects of the treatment. If the cancer is very aggressive and a cure is not possible, then the treatment should be aimed at relieving the symptoms and controlling the cancer for as long as possible.

Cancer treatment can take many different forms, and it is always tailored to the individual patient. The decision on which type of treatment is the most appropriate depends on the type and location of cancer, the extent to which it has already spread, the patient's age, sex, general health status and personal treatment preferences. The major types of treatment are: surgery, radiation, **chemotherapy**, immunotherapy, hormone therapy, and bone-marrow transplantation.

Surgery

Surgery is the removal of a visible tumor and is the most frequently used cancer treatment. It is most effective when a cancer is small and confined to one area of the body.

Surgery can be used for many purposes.

- Treatment. Treatment of cancer by surgery involves removal of the tumor to cure the disease. This is typically done when the cancer is localized to a discrete area. Along with the cancer, some part of the normal surrounding tissue is also removed to ensure that no cancer cells remain in the area. Since cancer usually spreads via the lymphatic system, adjoining lymph nodes may be examined and sometimes they are removed as well.
- Preventive surgery. Preventive or prophylactic surgery involves removal of an abnormal looking area that is likely to become malignant over time. For example, 40% of the people with a colon disease known as **ulcerative colitis**, ultimately die of colon cancer. Rather than live with the fear of developing colon cancer, these people may choose to have their colons removed and reduce the risk significantly.
- Diagnostic purposes. The most definitive tool for diagnosing cancer is a biopsy. Sometimes, a biopsy can be performed by inserting a needle through the skin. However, at other times, the only way to obtain some tissue sample for biopsy is by performing a surgical operation.
- Cytoreductive surgery is a procedure where the doctor removes as much of the cancer as possible, and then treats the remaining with **radiation therapy** or chemotherapy or both.
- Palliative surgery is aimed at curing the symptoms, not the cancer. Usually, in such cases, the tumor is so large or has spread so much that removing the entire tumor is not an option. For example, a tumor in the abdomen may be so large that it may press on and block a portion of the intestine, interfering with digestion and causing pain and vomiting. "Debulking surgery" may remove a part of the blockage and relieve the symptoms. In tumors that are dependent on hormones, removal of the organs that secrete the hormones is an option. For example, in prostate cancer, the release of testosterone by the testicles stimulates the growth of cancerous cells. Hence, a man may undergo an "orchiectomy" (removal of testicles) to slow the progress of the disease. Similarly, in a type of aggressive breast cancer, removal of the ovaries (**oophorectomy**) will stop the synthesis of hormones from the ovaries and slow the progression of the cancer.

Radiation

Radiation kills tumor cells. Radiation is used alone in cases where a tumor is unsuitable for surgery. More often, it is used in conjunction with surgery and chemotherapy. Radiation can be either external or internal. In the external form, the radiation is aimed at the tumor from outside the body. In internal radiation (also known as brachytherapy), a radioactive substance in the form of pellets or liquid is placed at the cancerous site by means of a pill, injection or insertion in a sealed container.

Chemotherapy

Chemotherapy is the use of drugs to kill cancer cells. It destroys the hard-to-detect cancer cells that have spread and are circulating in the body. Chemotherapeutic drugs can be taken either orally (by mouth) or intravenously, and may be given alone or in conjunction with surgery, radiation or both.

When chemotherapy is used before surgery or radiation, it is known as primary chemotherapy or "neoadjuvant chemotherapy." An advantage of neoadjuvant chemotherapy is that since the cancer cells have not been exposed to anti-cancer drugs, they are especially vulnerable. It can therefore be used effectively to reduce the size of the tumor for surgery or target it for radiation. However, the toxic effects of neoadjuvant chemotherapy are severe. In addition, it may make the body less tolerant to the side effects of other treatments that follow such as radiation therapy. The more common use of chemotherapy is adjuvant therapy, which is given to enhance the effectiveness of other treatments For example, after surgery, adjuvant chemotherapy is given to destroy any cancerous cells that still remain in the body.

Immunotherapy

Immunotherapy uses the body's own immune system to destroy cancer cells. This form of treatment is being intensively studied in clinical trials and is not yet widely available to most cancer patients. The various immunological agents being tested include substances produced by the body (such as the interferons, interleukins, and growth factors), monoclonal antibodies and vaccines. Unlike traditional vaccines, cancer vaccines do not prevent cancer. Instead, they are designed to treat people who already have the disease. Cancer vaccines work by boosting the body's immune system and training the immune cells to specifically destroy cancer cells.

Hormone therapy

Hormone therapy is standard treatment for some types of cancers that are hormone-dependent and grow faster in the presence of particular hormones. These include cancer of the prostate, breast, and uterus. Hormone therapy involves blocking the production or action of these hormones. As a result the growth of the tumor slows down and survival may be extended for several months or years.

Bone marrow transplantation

The bone marrow is the tissue within the bone cavities that contains blood-forming cells. Healthy bone marrow tissue constantly replenishes the blood supply and is essential to life. Sometimes, the amount of drugs or radiation needed to destroy cancer cells also destroys bone marrow. Replacing the bone marrow with healthy cells counteracts this adverse effect. A bone marrow transplant is the removal of marrow from one person and the transplant of the blood-forming cells either to the same person or to someone else. Bone-marrow transplantation, while not a therapy in itself, is often used to "rescue" a patient, by allowing those with cancer to undergo very aggressive therapy.

Many different specialists generally work together as a team to treat cancer patients. An oncologist is a physician who specializes in cancer care. The oncologist provides chemotherapy, hormone therapy, and any other non-surgical treatment that does not involve radiation. The oncologist often serves as the primary physician and coordinates the patient's treatment plan.

The radiation oncologist specializes in using radiation to treat cancer, while the surgical oncologist performs the operations needed to diagnose or treat cancer. Gynecologist-oncologists and pediatric-oncologists, as their titles suggest, are physicians involved with treating women's and children's cancers respectively. Many other specialists may also be involved in the care of a cancer patient. For example, radiologists specialize in the use of x rays, ultrasounds, computed tomography scans (CT scans), MRI imaging and other techniques that are used to diagnose cancer. Hematologists specialize in disorders of the blood and are consulted in case of blood cancers and bone marrow cancers. The samples that are removed for biopsy are sent to a laboratory, where a pathologist examines them to determine the type of cancer and extent of the disease. Only some of the specialists who are involved with cancer care have been mentioned above. There are many other specialties, and virtually any type of medical or surgical specialist may become involved with care of the cancer patient should it become necessary.

Alternative treatment

There are a multitude of alternative treatments available to help the person with cancer. They can be used in conjunction with, or separate from, surgery, chemotherapy, and radiation therapy. Alternative treatment of cancer is a complicated arena and a trained health practitioner should be consulted.

Although the effectiveness of complementary therapies such as **acupuncture** in alleviating cancer pain has not been clinically proven, many cancer patients find it safe and beneficial. Bodywork therapies such as massage and **reflexology** ease muscle tension and may alleviate the side effects such as **nausea and vomiting**. **Homeopathy** and herbal remedies used in Chinese traditional

herbal medicine have also been shown to alleviate some of the side effects of radiation and chemotherapy and are being recommended by many doctors.

Certain foods including many vegetables, fruits and grains are believed to offer protection against various cancers. However, isolation of the individual constituent of vegetables and fruits that are anti-cancer agents has proven difficult. In laboratory studies, **vitamins** such as A, C and E, as well as compounds such as isothiocyanates and dithiolthiones found in broccoli, cauliflower, and cabbage, and beta-carotene found in carrots have been shown to protect against cancer. Studies have shown that eating a diet rich in fiber as found in fruits and vegetables reduces the risk of colon cancer. **Exercise** and a low fat diet help control weight and reduce the risk of endometrial, breast, and colon cancer.

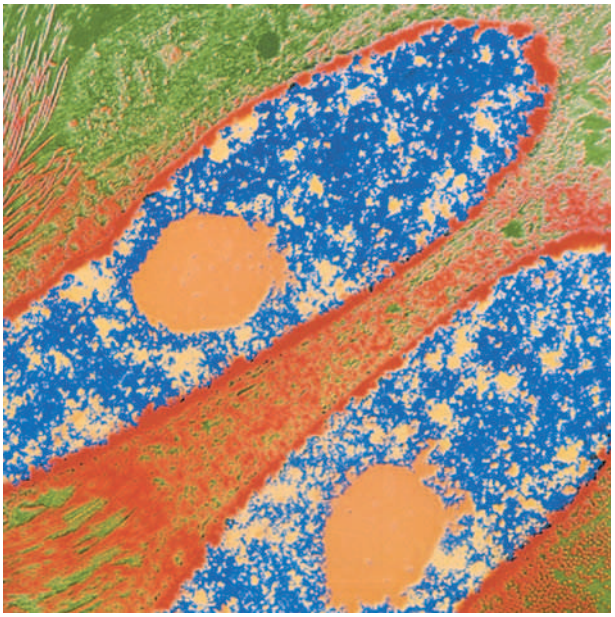
Certain drugs, which are currently being used for treatment, could also be suitable for prevention. For example, the drug tamoxifen (Nolvadex), which has been very effective against breast cancer, is currently being tested by the National Cancer Institute for its ability to prevent cancer. Similarly, retinoids derived from vitamin A are being tested for their ability to slow the progression or prevent head and neck cancers. Certain studies have suggested that cancer incidence is lower in areas where soil and foods are rich in the mineral selenium. More trials are needed to explain these intriguing connections.

Prognosis

"Lifetime risk" is the term that cancer researchers use to refer to the probability that an individual over the course of a lifetime will develop cancer or die from it. In the United States, men have a one in two lifetime risk of developing cancer, and for women the risk is one in three. Overall, African-Americans are more likely to develop cancer than whites. African-Americans are also 30% more likely to die of cancer than whites.

Most cancers are curable if detected and treated at their early stages. A cancer patient's prognosis is affected by many factors, particularly the type of cancer the patient has, the stage of the cancer, the extent to which it has metastasized and the aggressiveness of the cancer. In addition, the patient's age, general health status and the effectiveness of the treatment being pursued are also important factors.

To help predict the future course and outcome of the disease and the likelihood of recovery from the disease, doctors often use statistics. The five-year survival rates are the most common measures used. The number refers to the proportion of people with cancer who are expected to be alive, five years after initial diagnosis, compared with a similar population that is free of cancer. It is important to note that while statistics can give some information about the average survival experience of cancer patients in a given population, it cannot be used to indicate individual prognosis, because no two patients are exactly alike.



A transmission electron micrograph (TEM) of two spindle cell nuclei from a human sarcoma. Sarcomas are cancers of the connective tissue (bone, nerves, smooth muscle). *(Photograph by Dr. Brian Eyden, Photo Researchers, Inc. Reproduced by permission.)*

Prevention

According to nutritionists and epidemiologists from leading universities in the United States, a person can reduce the chances of getting cancer by following some simple guidelines:

- eating plenty of vegetables and fruits
- exercising vigorously for at least 20 minutes every day
- avoiding excessive weight gain
- avoiding tobacco (even second hand smoke)
- decreasing or avoiding consumption of animal fats and red meats
- avoiding excessive amounts of alcohol
- avoiding the midday sun (between 11 A.M. and 3 P.M.) when the suns rays are the strongest
- avoiding risky sexual practices
- avoiding known carcinogens in the environment or work place

KEY TERMS

Benign—A growth that does not spread to other parts of the body. Recovery is favorable with treatment.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Bone marrow—Spongy material that fills the inner cavities of the bones. The progenitors of all the blood cells are produced in this bone marrow.

Carcinogen—Any substance capable of causing cancer by mutating the cell's DNA.

Chemotherapy—Treatment with drugs that are anti cancer.

Epithelium—The layer of cells covering the body's surface and lining the internal organs and various glands.

Hormone therapy—Treatment of cancer by inhibiting the production of hormones such as testosterone and estrogen.

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Malignant—A general term for cells that can dislodge from the original tumor, invade and destroy other tissues and organs.

Metastasis—The spread of cancer from one part of the body to another.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Sore—An open wound or a bruise or lesion on the skin.

Tumor—An abnormal growth resulting from a cell that lost its normal growth control restraints and started multiplying uncontrollably.

X rays—High-energy radiation used in high doses, either to diagnose or treat disease.

Resources

BOOKS

Buckman, Robert. *What You Really Need to Know about Cancer: A Comprehensive Guide for Patients and Their Families*. Johns Hopkins University Press, 1997.

Morra, Marion E. *Choices*. Avon Books, October 1994.

Murphy, Gerald P. *American Cancer Textbook of Clinical Oncology.* American Cancer Society, 1995.

Murphy, Gerald P. *Informed Decisions: The Complete Book of Cancer Diagnosis, Treatment and Recovery.* American Cancer Society, 1997.

Simone, Joseph V. "Oncology: Introduction." In *Cecil Textbook of Medicine*, edited by Russel L. Cecil et al. Philadelphia: W.B. Saunders Company, 2000.

PERIODICALS

"What You Need to Know about Cancer." *Scientific American* (September 1996).

ORGANIZATIONS

American Cancer Society (National Headquarters). 1599 Clifton Road, N.E. Atlanta, GA 30329. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute (National Headquarters). 681 Fifth Avenue, New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

National Cancer Institute. 9000 Rockville Pike, Building 31, room 10A16, Bethesda, Maryland, 20892. (800) 422-6237. <http://wwwicic.nci.nih.gov>.

Rosalyn Carson-DeWitt

Cancer chemotherapy drugs *see* **Anticancer drugs**

Cancer therapy, definitive

Definition

Definitive **cancer** therapy is a treatment plan designed to potentially cure cancer using one or a combination of interventions including surgery, radiation, chemical agents, or biological therapies.

Purpose

The primary purpose of definitive care is to establish a cure and to destruct and remove all cancer cells from the infected person.

Surgery is not only a diagnostic tool, but also used for **tumor removal**. The surgeon usually identifies potential candidates for tumor removal and repairs intraoperatively (during the operation procedure). Surgery can be curative for some stomach, genital/urinary, thyroid, breast, skin, and central nervous system cancers. The best chance for a surgical cure is usually with the first opera-

tion. It is essential that the cancer surgeon (oncologic surgeon) be experienced in the specific procedure.

Radiation therapy is commonly administered to approximately 50% of cancer patients during the course of illness. It can be used as the sole method of cure for tumors in the mouth and neighboring structures in the oral cavity, vagina, prostate, cervix, esophagus, **Hodgkin's disease**, and certain types of cancer in the spinal cord and brain. Research and clinical trials have demonstrated that combination treatment is more effective than radiotherapy alone.

Chemotherapy is curative for only a small percentage of cancers. It is most effective for **choriocarcinoma**, cancer of the testis, some types of lymphomas, and cancer of skeletal muscles.

Biological therapies are a new and promising direction for cancer cures. Usually when cancer cells grow they manage to derive a blood supply that allows passage of nutrients promoting continuation of abnormal cancer growth. Research that focuses on destroying these blood vessels is called angiogenesis. Cutting off the blood supply has been shown to destroy tumors, since this stops the flow of essential nutrients required for cancer growth. Use of certain growth factors can also stimulate self-destructive pathways in cancer cells (apoptosis). **Gene therapy** is directed towards inhibiting specific cellular signals that promote cancer cell multiplication.

Precautions

Surgical resection requires an experienced surgeon, preoperative assessment, imaging studies, and delicate operative technique. Care should be taken during the procedure to avoid unnecessary tumor manipulation, which can cause cancer cells to infiltrate adjacent structures. If manipulation is excessive, cells can enter nearby areas for future re-growth. Accurate isolation of the tumor can also help to avoid contamination of the surgical area. Early ligation of the blood supply to the tumor is an essential component of a surgical cure.

Radiotherapy requires extensive treatment planning and imaging. Care must be taken to localize the cancer field while attempting to spare destruction of normal tissue. This requires image monitoring and exact positioning during radiation treatment sessions.

Chemotherapy usually causes destruction of normal cells, and cancer cells can become immune to chemical destruction. Side effects and patient tolerance issues are typically anticipated and dosages may have to be specifically altered. Very few chemotherapeutic agents offer curative responses.

Biological therapies may cause patient toxicity resulting in extensive side effects. This can occur since the optimal dose may be exceedingly elevated above patient tolerance.

Description

Surgery

Surgical removal of the tumor must be performed with care and accuracy. The surgeon must avoid over manipulation of the surgical field. Too much movement within the area can cause cancer cell displacement into surrounding tissue. If this occurs and no further treatment is indicated, the tumor may grow again. The surgeon should also perform an assessment concerning tissue removal around the cancer site. Tissue around the site may not by inspection seem cancerous, but adjacent structures may have cancer cells and surrounding tissue removal is usually part of the operative procedure. Pieces of tumor and the surrounding area are analyzed microscopically during the operation for cell type. An adequate resection (removal of tissue) will reveal normal cells in the specimens analyzed from areas bordering the cancerous growth. Surgery can also help to decrease the tumor bulk and, along with other treatment measures, may provide a cure for certain cancers.

Not only can surgery be curative for some cancers, but it is an essential diagnostic tool that must be assessed intraoperatively since microscopic analysis will guide the surgeon concerning tumor and surrounding tissue removal. These diagnostic procedures include an aspiration biopsy, which inserts a needle to extract (aspirate) fluid contained inside a cancerous growth; a needle biopsy uses a specialized needle to obtain a core tissue specimen; an incision biopsy removes a section from a large tumor; and an excision biopsy removes the entire tumor. The surgeon can also take samples of neighboring lymph nodes. Cancer in surrounding lymph nodes is an important avenue for distant spread of cancer to other areas. If microscopic analysis determines the presence of cancer cells in lymph nodes then the surgeon may decide to perform a more aggressive surgical approach.

Radiation therapy

Similar to surgical intervention, radiotherapy is a localized treatment. It involves the administration of ionizing radiation to a solid tumor location. This generates reactive oxygen molecules, causing the destruction of DNA in local cells. There are three commonly used radiotherapy beams: gamma rays from a linear accelerator machine produce a focused beam; orthovoltage rays are of less energy, thus penetrate less and typically deliver higher doses to superficial tissues (efficient for treating skin cancers); and megavoltage rays are high energy producing beams and can penetrate deeply situated inter-

KEY TERMS

Bone marrow suppression—A decrease in cells responsible for providing immunity, carrying oxygen and those responsible for normal blood clotting.

DNA—The molecule responsible for cell multiplication.

Titrate—To analyze the best end point (for dose) for a medication.

nal organs, while sparing extensive skin damage. Two common routes can deliver radiation. Brachytherapy delivers radiation to a local area by placing radioactive materials within close proximity to the cancerous site. Teletherapy delivers radiation to a specific area using an external beam machine.

Chemotherapy

Curative chemotherapy usually requires multiple administrations of the chemical agent. Chemotherapy or systemic therapy is administered in the blood and circulates through the entire body. The choice of chemotherapeutic agents depends on the specific type of cancer. Chemotherapy is more commonly used for metastatic (malignant cancer which has spread to other areas beyond the primary site of cancer growth) disease, since very few cancers are cured by systemic therapy.

Biologic therapy

Biologic therapies primarily function to alter the patient's response to cancer. These treatments are mostly investigations and there are numerous research protocols studying the effects of biologic treatments. These protocols usually have strict admission criteria that may exclude potential candidates who can benefit from treatment. These treatments tend to stimulate specific immune cells or immune chemicals to destroy cancer cells.

Preparation

For all treatment modalities imaging studies, biopsy, and constant blood analysis is essential before, during, and after treatments. Surgical candidates should undergo extensive pre-operative evaluation with imaging studies, blood chemistry analysis, stabilized health status, and readiness of staff for any potential complications and cell biopsy analysis. Patients with other pre-existing chronic disease may require intensive post-operative monitoring.

For radiotherapy, the patient undergoes extensive imaging studies. Additional planning strategies include beam localization to spare normal tissues, calibration of fractionated doses, and specific positioning during treatment sessions.

Patients who receive curative chemotherapy should be informed of possible side effects associated with the chemotherapeutic agent. Patients should also be informed of temporary lifestyle changes and medications that may offer some symptomatic relief.

Patients undergoing biologic therapies are usually advised of potential side effects, treatment cycles and specific tests for monitoring progress according to the specific research protocol.

Aftercare

Patients will typically be evaluated by imaging studies, blood analysis, **physical examination**, and health improvement. These follow-up visits usually occur at specific time intervals during the course of treatment. Surgical patients may require closer observation during the initial post-operative period to avoid potential complications. Reconstructive surgery can be considered to improve appearance and restore function. Certain surgical procedures (such as flaps and microsurgery of blood vessels) can restore new tissues to a previous surgery site.

Risks

Surgical risks

Surgical therapy can be both disfiguring and disabling. Many normal tissues can be adversely affected by radiotherapy. Side effects that commonly occur shortly after a treatment cycle include nausea, vomiting, **fatigue**, loss of appetite, and bone marrow suppression (a decrease in the cells that provide defense against infections and those which carry oxygen to cells).

Radiation risks

Radiotherapy can also cause difficulty swallowing, oral gum disease, and **dry mouth**. Additionally, radiation therapy can cause damage to local structures within the irradiated field.

Chemotherapy risks

Chemotherapy commonly causes bone marrow suppression. Additionally, a cell called platelets—important for normal blood clotting—may be significantly lowered, causing patients to bleed. This may be problematic enough to limit the treatment course. Bone marrow suppression can increase susceptibility to infection and also cause **infertility**. Patients commonly have bouts of **nausea and vomiting** shortly after a treatment session. Rapidly multiplying normal cells are also affected such as skin cells (causing blistering and ulceration) and hair cells (causing loss of hair, a condition called **alopecia**).

Biologic therapies risks

Biologic therapies can cause patients to develop suppression of cells that help the body fight against infection. Administration of certain chemicals that have anticancer effects can cause heart damage. Injection of killer immune cells (lymphokine-activated killer cells) may cause bone marrow suppression, and the host may reject the newly introduced cells.

Resources

BOOKS

Abeloff, Martin D., et al. *Clinical Oncology.* 2nd ed. Churchill Livingstone, Inc, 2000.

Fauci, Anthony S., et al, eds. *Harrison's Principles of Internal Medicine.* 14th ed. McGraw Hill, 1998.

Goroll, Allan H., et al, eds. *Primary Care Medicine.* 4th ed. Lippincott, Williams & Wilkins, 2000.

OTHER

American Cancer Society. <http://www.cancer.org>.

National Cancer Institute. <http://cnetdb.nci.nih.gov/cancerlit.shtml.>.

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Nicole Mallory, M.S.

Cancer therapy, palliative

Definition

Palliative **cancer** therapy is treatment specifically directed to help improve the symptoms associated with terminal cancer.

Purpose

Palliative care is directed to improving symptoms associated with incurable cancer. Care can include surgery, **radiation therapy**, **chemotherapy**, symptomatic treatments resulting from cancer, and side effects of treatment. The primary objective of palliative care is to improve the quality of remaining duration of life. Treatment usually involves a combination of modalities (multimodality approach) and numerous specialists are typically involved in the treatment planning process. Therapeutic planning usually involves meticulous coordination with the treatment team.

Surgery can be utilized for palliation after careful evaluation and planning. The use of surgery in these cases may reduce the tumor bulk and help improve the quality of life by relieving **pain**, alleviating obstruction, or controlling bleeding. Radiotherapy for terminal cancer patients can also alleviate pain, bleeding, and obstruction of neighboring areas. Chemotherapy may be helpful to reduce tumor size and provide some reduction to metastatic disease. Long-term chemotherapy patients develop drug resistance, a situation that renders chemotherapeutic treatments ineffective. If this occurs patients are usually given a second line medication or, if admission criteria are met, they may participate in an experimental research protocol. Palliative treatments and terminal cancer in combination can cause many symptoms that can become problematic. These symptoms commonly include pain, nausea, vomiting, difficulty in breathing, **constipation**, dehydration, agitation, and **delirium**. The palliative treatment-planning goal focuses to reduce these symptoms.

Precautions

Surgery for the purpose of **tumor removal**, biopsy, or size reduction is associated with postoperative pain and local nerve damage, which may be both severe and difficult to alleviate. Chemotherapy and radiation therapy can also produce nerve damage and severe pain. Additionally, patients with malignant cancer are susceptible to infections like herpes, **pneumonia**, urinary tract infections, and wound **abscess**, all of which can cause severe pain. Pain associated with cancer and/or treatments can significantly impair the patient's capabilities for performing daily tasks and hence impair quality of life. These complications may negatively impact the patient's psychological well being.

Description

Pain is one of the common symptoms associated with cancer. Approximately 75% of terminal cancer patients have pain. Pain is a subjective symptom and thus it cannot be measured using technological approaches. Pain can be assessed using numeric scales (from one to 10, one is rated as no pain while 10 is severe) or rating specific facial expressions associated with various levels of pain. The majority of cancer patients experience pain as a result of tumor mass that compresses neighboring nerves, bone, or soft tissues, or from direct nerve injury (neuropathic pain). Pain can occur from affected nerves in the ribs, muscles, and internal structures such as the abdomen (cramping type pain associated with obstruction). Many patients also experience various types of pain as a direct result of follow-up tests, treatments (surgery, radiation, and chemotherapy) and diagnostic procedures (i.e., biopsy).

Preparation

Patients are typically informed that their diagnosis is terminal and treatments are directed to improve quality of life for the remaining time and to minimize emotional suffering associated with pain.

KEY TERMS

Opioids—Narcotic pain killing medication.

World Health Organization (WHO)—An international organization concerned with world health and welfare.

A careful history is necessary to assess duration, severity, and location of pain. A **physical examination** may verify the presence of pain. Imaging analysis may further confirm the presence of potential causes of pain. The World Health Organization (WHO) recommends an analgesic ladder. This treatment approach provides medication selections based on previous analgesic use and severity of pain. The ladder starts with the use of non-opioid (non-morphine) drugs such as **aspirin**, acetaminophin, or non-steroidal anti-inflammatory medications for control of mild pain. Chronic pain must be treated with constant and consistently administered medication(s). The "take as needed" approach is not advised. Supplemental doses may be recommended in addition to the standard dose for circumstances that may worsen pain. Opioids (i.e., morphine and codeine) are the medications of choice for moderate to severe pain. Doses are adjusted to produce maximum pain relief while minimizing side effects. These medications are conveniently administered orally. Administering steroids can help reduce **nausea and vomiting**. Delirium and **anxiety** may be improved by psychoactive medications.

Aftercare

Care for palliation is continuous and consistent for the remainder of life. Patients who have less than six months of life remaining may choose a hospice to stop treatment and control pain.

Risks

Patients taking opioids for pain relief can develop tolerance and dependence. Tolerance develops when a patient requires increasing amounts of medication to produce pain reduction. Dependence shows characteristic withdrawal symptoms if medications are abruptly stopped. These symptoms can be avoided by tapering down doses in the event that these medications should be stopped.

Resources

BOOKS

Abeloff, Martin D., et al. *Clinical Oncology.* 2nd ed. Churchill Livingstone, Inc, 2000.

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine.* 14th ed. McGraw Hill, 1998.

Goroll, Allan H., et al., eds. *Primary Care Medicine.* 4th ed. Lippincott, Williams & Wilkins, 2000.

Washington Manual of Medical Therapeutics. 30th ed. Washington University School of Medicine, Department of Medicine, 2001.

PERIODICALS

Mercadante, S., F. Fulfaro, and A. Casuccio. "The Impact of Home Palliative Care on Symptoms in Advanced Cancer Patients." *Support Care Cancer* (July 2000).

ORGANIZATIONS

National Cancer Institute. <http://cnetdb.nci.nih.gov/cancerlit.shtml>.

American Cancer Society. <http://www.cancer.org>.

American Pain Society. <http://www.ampiansoc.org>.

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Cancer therapy, supportive

Definition

Supportive **cancer** therapy is the use of medicines to counteract unwanted effects of cancer treatment.

Purpose

Along with their beneficial effects, many cancer treatments produce uncomfortable and sometimes harmful side effects. For example, cancer drugs may cause nausea or vomiting. They may also destroy red or white blood cells, resulting in a low **blood count**. Fortunately, many of these side effects can be relieved with other medicines.

Description

Different kinds of drugs are used for different purposes in supportive cancer therapy. To relieve **nausea and vomiting**, a physician may prescribe dolasetron (Anzemet), granisetron (Kytril) or ondansetron (Zofran). Drugs called colony stimulating factors are used to help the bone marrow make new white blood cells to replace those destroyed by cancer treatment. Examples of colony stimulating factors are filgrastim (Neupogen) and sargramostim (Leukine). Another type of drug, epoetin (Epogen, Procrit), stimulates the bone marrow to make new red blood cells. It is a synthetically made version of human erythropoietin that is made naturally in the body and has the same effect on bone marrow.

Some physicians who treat cancer recommend that their patients use **marijuana** to relieve nausea and vomiting. This practice is controversial for several reasons. Using marijuana, even for medicinal purposes, is illegal in most states. Also, most of the evidence that marijuana effectively relieves nausea and vomiting comes from reports of people who have used it, not from carefully designed scientific studies. An oral medication that contains one of the active ingredients of marijuana is available with a physician's prescription and sometimes is used to treat nausea and vomiting in patients undergoing cancer treatment. However, the drug, dronabinol (Marinol), takes longer to work than smoked marijuana and may be difficult for patients with nausea and vomiting to swallow and keep down.

In 1997, the National Institutes of Health issued a report calling for more research into medical uses of marijuana. The panel of experts who wrote the report also recommended that researchers investigate other ways of getting the active ingredients of marijuana into the body, such as nasal sprays, skin patches and inhalers.

Patients who want to use marijuana to relieve side effects of cancer treatment should talk to their physicians and should carefully consider the benefits and risks, both medical and legal.

Recommended dosage

The recommended dosage depends on the type of supportive cancer therapy. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Precautions

Dolasetron, granisetron and ondansetron

If severe nausea and vomiting occur after taking this medicine, check with a physician.

The use of ondansetron after abdominal surgery may cover up symptoms of stomach problems.

People with liver disease may be more likely to have side effects from ondansetron.

Colony stimulating factors

Certain cancer drugs reduce the body's ability to fight infections. Although colony stimulating factors help restore the body's natural defenses, the process takes time. Getting prompt treatment for infections is important, even while taking this medicine. Call the physician at the first sign of illness or infection, such as a **sore throat**, **fever** or chills.

Seeing a physician regularly while taking this medicine is important. This will give the physician a chance to make sure the medicine is working and to check for unwanted side effects.

People with certain medical conditions may have problems if they take colony stimulating factors. In people who have kidney disease, liver disease, or conditions caused by inflammation or immune system problems, colony stimulating factors may make these problems worse. People with heart disease may be more likely to have side effects such as water retention and heart rhythm problems when they take these drugs. And people with lung disease may be more likely to have **shortness of breath**. Anyone who has any of these medical conditions should check with his or her physician before using colony stimulating factors.

Epoetin

This medicine may cause seizures (convulsions), especially in people with a history of seizures. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous if they have had a seizure.

Epoetin helps the body make new red blood cells, but it cannot do its job unless there is plenty of iron in the body. The physician may recommend taking iron supplements or certain **vitamins** that help get iron into the body. Follow the physician's orders to make sure the body has enough iron for this medicine to work. Do not take iron supplements unless they are prescribed by a physician.

In studies of laboratory animals, epoetin taken during **pregnancy** caused **birth defects**, including damage to the bones and spine. However, the drug has not been reported to cause problems in human babies whose mothers take it. Women who are pregnant or who may become pregnant should check with their physicians for the most up-to-date information on the safety of taking this medicine during pregnancy.

People with certain medical conditions may have problems if they take this medicine. For example, the chance of side effects may be greater in people with high blood pressure, heart or blood vessel disease or a history of blood clots. Epoetin may not work properly in people who have bone problems or sickle cell anemia.

Dronabinol

This medicine contains sesame oil and one of the active ingredients of marijuana. Anyone who has had allergic or unusual reactions to sesame oil or marijuana products should let his or her physician know before taking dronabinol.

KEY TERMS

Bipolar disorder—A severe mental illness in which a person has extreme mood swings, ranging from a highly excited state—sometimes with a false sense of well-being—to depression

Bone marrow—Soft tissue that fills the hollow centers of bones. Blood cells and platelets (disk-shaped bodies in the blood that are important in clotting) are produced in the bone marrow.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Immune system—The body's natural defenses against disease and infection.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Schizophrenia—A severe mental disorder in which people lose touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems and other disturbances.

Sickle cell anemia—An inherited disorder in which red blood cells contain an abnormal form of hemoglobin, a protein that carries oxygen. The abnormal form of hemoglobin causes the red cells to become sickle- or crescent-shaped. The misshapen cells may clog blood vessels, preventing oxygen from reaching tissues and leading to pain, blood clots and other problems. Sickle cell anemia is most common in people of African descent and in people from Italy, Greece, India, and the Middle East.

Because dronabinol works on the central nervous system, it may add to the effects of alcohol and other drugs that slow down the central nervous system. Examples of these drugs are **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Dronabinol may also add to the effects of anesthetics, including those used for dental procedures. Anyone taking dronabinol should not drink alcohol and should check with his or her physician before taking any of the drugs listed above.

This drug makes some people feel drowsy, dizzy, lightheaded or "high," with a sense of well-being. Because of these possible reactions, anyone who takes dronabinol should not drive, use machines or do anything else that might be dangerous until they have found out how the drug affects them. The **dizziness** and lightheadedness are especially likely when getting up after sitting or lying down. Getting up gradually and holding onto something for support should lessen the problem.

In laboratory studies, giving high doses of dronabinol to pregnant animals increased the risk of the unborn baby's **death**. The medicine's effects on pregnant women have not been studied. Women who are pregnant or who may become pregnant should check with their physicians before taking this medicine.

Dronabinol passes into breast milk and may affect nursing babies whose mothers take the medicine. Women who are breastfeeding their babies should check with their physicians before using dronabinol.

Because of its possible mind-altering effects, dronabinol should be used with care in children and older people. Both children and older people should be watched carefully when they are taking this medicine.

Using dronabinol may worsen some medical conditions, including high blood pressure, heart disease, **bipolar disorder** and **schizophrenia**.

General precautions for all types of supportive cancer therapy

Anyone who previously has had unusual reactions to drugs used in supportive cancer therapy should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Side effects

Dolasetron, granisetron and ondansetron

The most common minor side effects are **headache**, dizziness or lightheadedness, drowsiness, **dry mouth**, **diarrhea**, **constipation**, abdominal pain or stomach cramps and unusual tiredness or weakness. These problems usually do not require medical treatment.

Check with a physician as soon as possible if fever occurs after taking granisetron.

If any of these symptoms occur after taking ondansetron, check with a physician immediately:

- breathing problems or **wheezing**
- chest pain or tightness in chest
- skin rash, **hives** or **itching**

Colony stimulating factors

As this medicine starts to work, it may cause mild pain in the lower back or hips. This is nothing to worry about, and it will usually go away within a few days. If the pain is too uncomfortable, the physician may pre-

scribe a painkiller. Be sure to let the physician know if the painkiller does not help.

Other possible side effects include headache, joint or muscle pain, and skin rash or itching. These side effects usually go away as the body adjusts to the medicine and do not need medical treatment. If they continue or they interfere with normal activities, check with a physician.

Epoetin

This medicine may cause flu-like symptoms, such as muscle aches, bone pain, fever, chills, shivering, and sweating, within a few hours after it is taken. These symptoms usually go away within 12 hours. If they do not, or if they are troubling, check with a physician. Other possible side effects that do not need medical attention are diarrhea, nausea or vomiting, and tiredness or weakness.

Certain side effects should be brought to a physician's attention as soon as possible. These include headache, vision problems, increased blood pressure, fast heartbeat, weight gain, and swelling of the face, fingers, lower legs, ankles or feet.

Anyone who has chest pain or seizures after taking epoetin should check with a physician immediately.

Dronabinol

Side effects such as dizziness, drowsiness, confusion and clumsiness or unsteadiness usually do not need medical attention unless they are long-lasting or they interfere with normal activities.

Other side effects or signs of overdose should have immediate medical attention. These include:

- fast or pounding heartbeat
- constipation
- trouble urinating
- red eyes
- slurred speech
- mood changes, including depression, nervousness or **anxiety**
- confusion
- forgetfulness
- changes in sight, smell, taste, touch or hearing
- a sense that time is speeding up or slowing down
- **hallucinations**

General advice on side effects for all types of supportive cancer therapy

Other side effects are possible with any type of supportive cancer therapy. Anyone who has unusual symptoms during or after treatment with these drugs should get in touch with his or her physician.

Interactions

Anyone who has supportive cancer therapy should let the physician know all other medicines he or she is taking. Some combinations of drugs may interact, which may increase or decrease the effects of one or both drugs or may increase the risk of side effects. Ask the physician whether the possible interactions can interfere with drug therapy or cause harmful effects.

Resources

PERIODICALS

"Marijuana as Medicine: How Strong is the Science?" *Consumer Reports* 62 (May 1997): 62.

Morris, Kelly. "The Cannabis Remedy—Wonder Worker or Evil Weed?" *The Lancet* 350 (20 Dec.1997): 1828.

Nancy Ross-Flanigan

Candida albicans infection *see* **Candidiasis**

Candidiasis

Definition

Candidiasis is an infection caused by a species of the yeast *Candida*, usually *Candida albicans*. This is a common cause of vaginal infections in women. Also, *Candida* may cause mouth infections in people with reduced immune function, or in patients taking certain **antibiotics**. *Candida* can be found in virtually all normal people but causes problems in only a fraction. In recent years, however, several serious categories of candidiasis have become more common, due to overuse of antibiotics, the rise of **AIDS**, the increase in organ transplantations, and the use of invasive devices (catheters, artificial joints and valves)—all of which increase a patient's susceptibility to infection.

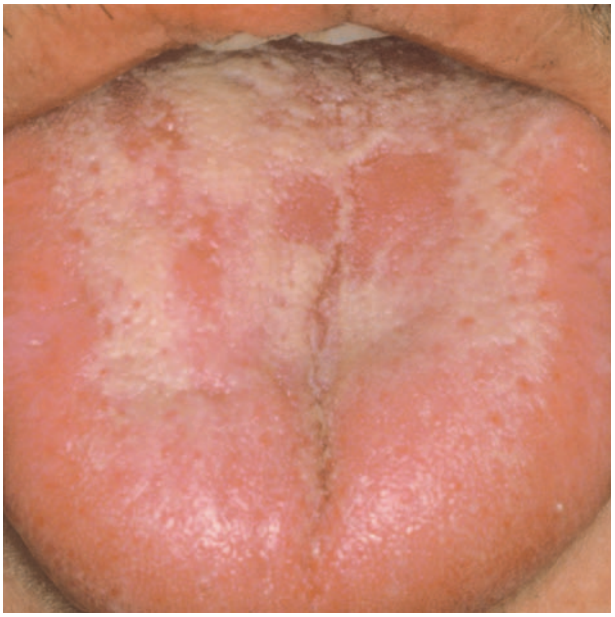
Description

Vaginal candidiasis

Over one million women in the United States develop vaginal yeast infections each year. It is not life-threatening, but it can be uncomfortable and frustrating.

Oral candidiasis

This disorder, also known as thrush, causes white, curd-like patches in the mouth or throat.



This patient's tongue is infected with candidiasis. *(Photograph by Edward H. Gill, Custom Medical Stock Photo. Reproduced by permission.)*

Deep organ candidiasis

Also known as invasive candidiasis, deep organ candidiasis is a serious systemic infection that can affect the esophagus, heart, blood, liver, spleen, kidneys, eyes, and skin. Like vaginal and oral candidiasis, it is an opportunistic disease that strikes when a person's resistance is lowered, often due to another illness. There are many diagnostic categories of deep organ candidiasis, depending on the tissues involved.

Causes and symptoms

Vaginal candidiasis

Most women with vaginal candidiasis experience severe vaginal **itching**. They also have a discharge that often looks like cottage cheese and has a sweet or bread-like odor. The vulva and vagina can be red, swollen, and painful. Sexual intercourse can also be painful.

Oral candidiasis

Whitish patches can appear on the tongue, inside of the cheeks, or the palate. Oral candidiasis typically occurs in people with abnormal immune systems. These can include people undergoing **chemotherapy** for **cancer**, people taking immunosuppressive drugs to protect transplanted organs, or people with HIV infection.

Deep organ candidiasis

Anything that weakens the body's natural barrier against colonizing organisms—including stomach surgery, **burns**, nasogastric tubes, and catheters—can predispose a person for deep organ candidiasis. Rising numbers of AIDS patients, organ transplant recipients, and other individuals whose immune systems are compromised help account for the dramatic increase in deep organ candidiasis in recent years. Patients with granulocytopenia (deficiency of white blood cells) are particularly at risk for deep organ candidiasis.

Diagnosis

Often clinical appearance gives a strong suggestion about the diagnosis. Generally, a clinician will take a sample of the vaginal discharge or swab an area of oral plaque, and then inspect this material under a microscope. Under the microscope, it is possible to see characteristic forms of yeasts at various stages in the lifecycle.

Fungal blood cultures should be taken for patients suspected of having deep organ candidiasis. Tissue biopsy may be needed for a definitive diagnosis.

Treatment

Vaginal candidiasis

In most cases, vaginal candidiasis can be treated successfully with a variety of over-the-counter antifungal creams or suppositories. These include Monistat, Gyne-Lotrimin, and Mycelex. However, infections often recur. If a women has frequent recurrences, she should consult her doctor about prescription drugs such as Vagistat-1, Diflucan, and others.

Oral candidiasis

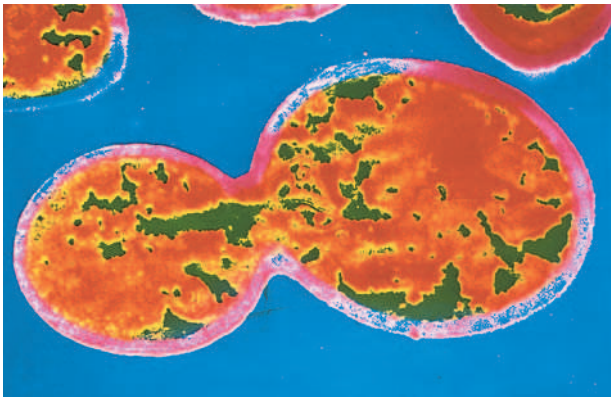
This is usually treated with prescription lozenges or mouthwashes. Some of the most-used prescriptions are nystatin mouthwashes (Nilstat or Nitrostat) and clotrimazole lozenges.

Deep organ candidiasis

The recent increase in deep organ candidiasis has led to the creation of treatment guidelines, including, but not limited to, the following: Catheters should be removed from patients in whom these devices are still present. Antifungal chemotherapy should be started to prevent the spread of the disease. Drugs should be prescribed based on a patient's specific history and defense status.

Alternative treatment

Home remedies for vaginal candidiasis include vinegar douches or insertion of a paste made from *Lactobacillus acidophilus* powder into the vagina. In theory,



A transmission electron microscopy (TEM) of *Candida albicans*. *(Custom Medical Stock Photo. Reproduced by permission.)*

these remedies will make the vagina more acidic and therefore less hospitable to the growth of *Candida*. Fresh garlic (*Allium sativum*) is believed to have antifungal action, so incorporating it into the diet or inserting a gauze-wrapped, peeled garlic clove into the vagina may be helpful. The insert should be changed twice daily. Some women report success with these remedies; they should try a conventional treatment if an alternative remedy isn't effective.

Prognosis

Vaginal candidiasis

Although most cases of vaginal candidiasis are cured reliably, these infections can recur. To limit recurrences, women may need to take a prescription anti-fungal drug such as terconazole (sold as Terazol) or take other anti-fungal drugs on a preventive basis.

Oral candidiasis

These infections can also recur, sometimes because the infecting *Candida* develops resistance to one drug. Therefore, a physician may need to prescribe a different drug.

Deep organ candidiasis

The prognosis depends on the category of disease as well as on the condition of the patient when the infection strikes. Patients who are already suffering from a serious underlying disease are more susceptible to deep organ candidiasis that speads throughout the body.

Prevention

Because *Candida* is part of the normal group of microorganisms that co-exist with all people, it is impossible to avoid contact with it. Good vaginal hygiene and good **oral hygiene** might reduce problems, but they are not guarantees against candidiasis.

Because hospital-acquired (nosocomial) deep organ candidiasis is on the rise, people need to be made aware of it. Patients should be sure that catheters are properly maintained and used for the shortest possible time length. The frequency, length, and scope of courses of antibiotic treatment should also be cut back.

KEY TERMS

Biopsy—The removal and examination of tissue from a live body.

Colonize—To become established in a host.

Granulocytopenia—A condition characterized by a deficiency of white blood cells.

Nasogastric—Tube inserted through the nasal passages into the stomach.

Opportunistic—Infection caused by microorganisms that are usually harmless, but which can cause disease when a host's resistance is lowered.

Systemic—Afflicting an entire body system or the body in general.

Resources

BOOKS

Carlson, K. J., S. A. Eisenstat, and T. Ziporyn. *The Harvard Guide to Women's Health*. Harvard University Press, 1996.

PERIODICALS

Greenspan, Deborah, and John S. Greenspan. "HIV-Related Oral Disease." *The Lancet* 348 (14 Sept. 1996): 729-734.

Tobin, Marla J. "Vulvovaginal candidiasis: Topical vs. Oral Therapy." *American Family Physician* 51 (15 May 1995): 1715-1723.

Richard H. Lampert

Candidosis *see* **Candidiasis**

Canker sores

Definition

Canker sores are small sores or ulcers that appear inside the mouth. They are painful, self-healing, and can recur.

KEY TERMS

Inflammation—A local reaction to tissue injury or damage, usually characterized by pain, swelling, and redness.

Sore—A wound, lesion, or ulcer on the skin.

Ulcer—A site of damage to the skin or mucous membrane that is characterized by the formation of pus, death of tissue, and is frequently accompanied by an inflammatory reaction.

Description

Canker sores occur on the inside of the mouth, usually on the inside of the lips, cheeks, and/or soft palate. They can also occur on the tongue and in the throat. Often, several canker sores will appear at the same time and may be grouped in clusters. Canker sores appear as a whitish, round area with a red border. The sores are painful and sensitive to touch. The average canker sore is about one-quarter inch in size, although they can occasionally be larger. Canker sores are not infectious.

Approximately 20% of the U.S. population is affected with recurring canker sores, and more women than men get them. Women are more likely to have canker sores during their premenstrual period.

Canker sores are sometimes confused with cold sores. Cold sores are caused by herpes simplex virus. This disease, also known as oral herpes or **fever** blisters, can occur anywhere on the body. Most commonly, herpes infection occurs on the outside of the lips and the gums, and much less frequently on the inside the mouth. Cold sores are infectious.

Causes and symptoms

The exact cause of canker sores is uncertain, however, they seem to be related to a localized immune reaction. Other proposed causes for this disease are trauma to the affected areas from toothbrush scrapes, **stress**, hormones, and food **allergies**. Canker sores tend to appear in response to stress. The initial symptom is a tingling or mildly painful **itching** sensation in the area where the sore will appear. After one to several days, a small red swelling appears. The sore is round, and is a whitish color with a grayish colored center. Usually, there is a red ring of inflammation surrounding the sore. The main symptom is **pain**. Canker sores can be very painful, especially if they are touched repeatedly, e.g., by the tongue. They last for one to two weeks.

Diagnosis

Canker sores are diagnosed by observation of the blister. A distinction between canker sores and cold sores must be made because cold sores are infectious and the herpes infection can be transmitted to other people. The two sores can usually be distinguished visually and there are specific diagnostic tests for herpes infection.

Treatment

Since canker sores heal by themselves, treatment is not usually necessary. Pain relief remedies, such as topical anesthetics, may be used to reduce the pain of the sores. The use of corticosteroid ointments sometimes speeds healing. Avoidance of spicy or acidic foods can help reduce the pain associated with canker sores.

Alternative treatment

Alternative therapies for canker sores are aimed at healing existing sores and preventing their recurrence. Several herbal remedies, including calendula (*Calendula officinalis*), myrrh (*Commiphora molmol*), and goldenseal (*Hydrastis canadensis*), may be helpful in the treatment of existing sores. Compresses soaked in teas made from these herbs are applied directly to the sores. The tannic acid in a tea bag can also help dry up the sores when the wet tea bag is used as a compress. Taking dandelion (*Taraxacum officinale*) tea or capsules may help heal sores and also prevent future outbreaks. Since canker sores are often brought on by stress, such stress-relieving techniques as **meditation**, **guided imagery**, and certain **acupressure** exercises may help prevent canker sores or lessen their severity.

Prognosis

There is no cure for canker sores. They do not get larger or occur more frequently with age.

Resources

BOOKS

Larsen, D. E., ed. *Mayo Clinic Family Health Book*. New York: William Morrow, 1996.

Schlossberg, D. *Current Therapy of Infectious Disease*. St. Louis: Mosby, 1996.

John T. Lohr, PhD

Captopril *see* **Angiotensin-converting enzyme inhibitors**

Carbamazepine *see* **Anticonvulsant drugs**

Carbidopa *see* **Antiparkinson drugs**

Carbohydrate intolerance

Definition

Carbohydrate intolerance is the inability of the body to completely process the nutrient carbohydrate (a classification that includes sugars and starches) into a source of energy for the body, usually because of the deficiency of an enzyme needed for digestion. **Lactose intolerance**, the inability to digest the sugar found in milk, is widespread and affects up to 70% of the world's adult population.

Description

Carbohydrates are the primary source of energy and, along with fats and proteins, one of the three major nutrients in the human diet. Carbohydrates are classified according to their structure based on the number of basic sugar, or *saccharide* units they contain.

A monosaccharide is the simplest carbohydrate and called a simple sugar. Simple sugars include glucose (the form in which sugar circulates in the blood), fructose (found in fruit and honey), and galactose (produced by the digestion of milk). These simple sugars are important because they can be absorbed by the small intestine. Two simple sugars linked together make a disaccharide. The disaccharide sugars present in the diet are maltose (a product of the digestion of starch), sucrose (table sugar), and lactose (the sugar in milk). These disaccharides must be broken down by enzymes into two simple sugars so that they can be absorbed by the intestine. Polysaccharides are much more complex carbohydrates made up of many simple sugars, the most important of which are glycogen, which is stored in the liver, and starch.

Digestion of sugars

Digestion of food begins in the mouth, moves on to the stomach, and then into the small intestine. Along the way, specific enzymes are needed to process different types of sugars. An enzyme is a substance that acts as a catalyst to produce chemical changes without being changed itself. The enzymes lactase, maltase, and isomaltase (or sucrase) are needed to break down the disaccharides; when one or more is inadequate, the result is carbohydrate intolerance.

Types of intolerance

Carbohydrate intolerance can be primary or secondary. Primary deficiency is caused by an enzyme defect present at birth or developed over time. The most common is lactose intolerance. Secondary deficiencies are caused by a disease or disorder of the intestinal tract, and disappear when the disease is treated. These include protein deficiency, **celiac disease**, and some intestinal infections.

Adult lactose intolerance is the most common of all enzyme deficiencies, and it is estimated that 30–50 million Americans have this condition. Some racial and ethnic populations are affected more than others. Lactose intolerance is found in as many as 75% of African Americans, Jewish Americans, Mexican Americans, and Native Americans, and in 90% of Asian Americans. Descendants of Northern Europeans and some Mediterranean peoples usually do not develop the condition. Deficiencies in enzymes other than lactase are extremely rare.

Causes and symptoms

Enzymes play an important role in breaking down carbohydrates into forms that can pass through the intestine and be used by the body. Usually they are named by adding *ase* to the name of the substance they act on, so lactase is the enzyme needed to process lactose. Cooked starch is broken down in the mouth to a disaccharide by amylase, an enzyme in the saliva. The disaccharides maltose, sucrose, and lactose cannot be absorbed until they have been separated into simple sugar molecules by their corresponding enzymes present in the cells lining the intestinal tract. If this process is not completed, digestion is interrupted.

Although not common, a deficiency in the enzymes needed to digest lactose, maltose, and sucrose is sometimes present at birth. Intestinal lactase enzymes usually decrease naturally with age, but this happens to varying degrees. Because of the uneven distribution of enzyme deficiency based on race and ethnic heritage, especially in lactose intolerance, genetics are believed to play a role in the cause of primary carbohydrate intolerance.

Digestive diseases such as celiac disease and tropical sprue (which affect absorption in the intestine), as well as intestinal infections and injuries, can reduce the amount of enzymes produced. In **cancer** patients, treatment with **radiation therapy** or **chemotherapy** may affect the cells in the intestine that normally secrete lactase, leading to intolerance.

The severity of the symptoms depends on the extent of the enzyme deficiency, and range from a feeling of mild bloating to severe **diarrhea**. In the case of a lactase deficiency, undigested milk sugar remains in the intestine, which is then fermented by the bacteria normally present in the intestine. These bacteria produce gas, cramping, bloating, a "gurgly" feeling in the abdomen, and flatulence. In a growing child, the main symptoms are diarrhea and a failure to gain weight. In an individual with lactase deficiency, gastrointestinal distress begins

KEY TERMS

Celiac disease—A disease, occurring in both children and adults, which is caused by a sensitivity to gluten, a protein found in grains. It results in chronic inflammation and shrinkage of the lining of the small intestine.

Digestion—The mechanical, chemical, and enzymatic process in which food is converted into the materials suitable for use by the body.

Enzyme—A substance produced by the body to assist in a chemical reaction. In carbohydrate intolerance, lack of an enzyme makes it impossible for one type of sugar to be broken down into a simpler form so that it can be absorbed by the intestines and used by the body.

Metabolism—All the physical and chemical changes that take place within an organism.

Nutrient—Food or another substance that supplies the body with the elements needed for metabolism.

Sugars—Those carbohydrates having the general composition of one part carbon, two parts hydrogen, and one part oxygen.

about 30 minutes to two hours after eating or drinking foods containing lactose. Food intolerances can be confused with food **allergies**, since the symptoms of nausea, cramps, bloating, and diarrhea are similar.

Sugars that aren't broken down into one of the simplest forms cause the body to push fluid into the intestines, which results in watery diarrhea (osmotic diarrhea). Diarrhea may sweep other nutrients out of the intestine before they can be absorbed, causing **malnutrition**.

Diagnosis

Carbohydrate intolerance can be diagnosed using oral tolerance tests. The carbohydrate being investigated is given by mouth in liquid form and several blood levels are measured and compared to normal values. This helps evaluate the individual's ability to digest the sugar.

To identify lactose intolerance in children and adults, the hydrogen breath test is used to measure the amount of hydrogen in the breath. The patient drinks a beverage containing lactose and the breath is analyzed at regular intervals. If undigested lactose in the large intestine (colon) is fermented by bacteria, various gases are produced. Hydrogen is absorbed from the intestines and carried by the bloodstream into the lungs where it is exhaled. Normally there is very little hydrogen detectable in the breath, so its presence indicates faulty digestion of lactose.

When lactose intolerance is suspected in infants and young children, many pediatricians recommend simply changing from cow's milk to soy formula and watching for improvement. If needed, a stool sample can be tested for acidity. The inadequate digestion of lactose will result in an increase of acid in the waste matter excreted by the bowels and the presence of glucose.

Treatment

Carbohydrate intolerance caused by temporary intestinal diseases disappears when the condition is successfully treated. In primary conditions, no treatment exists to improve the body's ability to produce the enzymes, but symptoms can be controlled by diet.

Because the degree of lactose intolerance varies so much, treatment should be tailored for the individual. Young children showing signs of intolerance should avoid milk products; infants should switch to soy-based formula. Older children and adults can adjust their intake of lactose depending on how much and what they can tolerate. For some, a small glass of milk will not cause problems, while others may be able to handle ice cream or aged cheeses such as cheddar or Swiss, but not other dairy products. Generally, small amounts of lactose-containing foods taken throughout the day are better tolerated than a large amount consumed all at once.

For those individuals who are sensitive to even very small amounts of lactose, the lactase enzyme is available without a prescription. It comes in liquid form for use with milk. The addition of a few drops to a quart of milk will reduce the lactose content by 70% after 24 hours in the refrigerator. Heating the milk speeds up the process, and doubling the amount of lactase liquid will result in milk that is 90% lactose free. Chewable lactase enzyme tablets are also available. Three to six tablets taken before a meal or snack will aid in the digestion of solid foods. Lactose-reduced milk and other products are also available in stores. The milk contains the same nutrients as regular milk.

Because dairy products are an important source of calcium, people who reduce or severely limit their intake of dairy products may need to consider other ways to consume an adequate amount of calcium in their **diets**.

Prognosis

With good dietary management, individuals with carbohydrate intolerance can lead normal lives.

Prevention

Since the cause of the enzyme deficiency leading to carbohydrate intolerance is unknown, there is no way to prevent this condition.

Resources

BOOKS

Macdonald, Ian. "Carbohydrates." In *Modern Nutrition in Health and Disease*, ed. Maurice E. Shils, et al. Philadelphia: Lea & Febiger, 1994.

Williams, Sue Rodwell. *Essentials of Nutrition and Diet Therapy.* Philadelphia: Mosby, 1997.

PERIODICALS

"If You Think You Can't Stomach Milk." *Tufts University Diet & Nutrition Letter*, 13 (Sept. 1995): 7.

"Lactose Intolerance." *Mayo Clinic Health Newsletter*, 15 (Feb. 1997): 7.

"Most Frequently Asked Questions About Lactose Intolerance." *Nutrition Today* (Mar./Apr. 1996): 78-79.

OTHER

National Institute of Diabetes and Digestive and Kidney Disease. <http://www.niddk.nih.gov>.

Karen Ericson, RN

Carbon monoxide poisoning

Definition

Carbon monoxide (CO) **poisoning** occurs when carbon monoxide gas is inhaled. CO is a colorless, odorless, highly poisonous gas that is produced by incomplete combustion. It is found in automobile exhaust fumes, faulty stoves and heating systems, fires, and cigarette smoke. Other sources include woodburning stoves, kerosene heaters, improperly ventilated water heaters and gas stoves, and blocked or poorly maintained chimney flues. CO interferes with the ability of the blood to carry oxygen. The result is **headache**, nausea, convulsions, and finally **death** by asphyxiation.

Description

Carbon monoxide, sometimes called coal gas, has been known as a toxic substance since the third century B.C. It was used for executions and suicides in early Rome. Today it is the leading cause of accidental poisoning in the United States. According to the *Journal of the American Medical Association*, 1,500 Americans die each year from accidental exposure to CO, and another 2,300 from intentional exposure (suicide). An additional 10,000 people seek medical attention after exposure to CO and recover.

Anyone who is exposed to CO will become sick, and the entire body is involved in CO poisoning. A developing fetus can also be poisoned if a pregnant woman breathes CO gas. Infants, people with heart or lung disease, or those with anemia may be more seriously affected. People such as underground parking garage attendants who are exposed to car exhausts in a confined area are more likely to be poisoned by CO. Firemen also run a higher risk of inhaling CO.

Causes and symptoms

Normally when a person breathes fresh air into the lungs, the oxygen in the air binds with a molecule called hemoglobin (Hb) that is found in red blood cells. This allows oxygen to be moved from the lungs to every part of the body. When the oxygen/hemoglobin complex reaches a muscle where it is needed, the oxygen is released. Because the oxygen binding process is reversible, hemoglobin can be used over and over again to pick up oxygen and move it throughout the body.

Inhaling carbon monoxide gas interferes with this oxygen transport system. In the lungs, CO competes with oxygen to bind with the hemoglobin molecule. Hemoglobin prefers CO to oxygen and accepts it more than 200 times more readily than it accepts oxygen. Not only does the hemoglobin prefer CO, it holds on to the CO much more tightly, forming a complex called carboxyhemoglobin (COHb). As a person breathes CO contaminated air, more and more oxygen transportation sites on the hemoglobin molecules become blocked by CO. Gradually, there are fewer and fewer sites available for oxygen. All cells need oxygen to live. When they don't get enough oxygen, cellular metabolism is disrupted and eventually cells begin to die.

The symptoms of CO poisoning and the speed with which they appear depend on the concentration of CO in the air and the rate and efficiency with which a person breathes. Heavy smokers can start off with up to 9% of their hemoglobin already bound to CO, which they regularly inhale in cigarette smoke. This makes them much more susceptible to environmental CO. The Occupational Safety and Health Administration (OSHA) has established a maximum permissible exposure level of 50 parts per million (ppm) over eight hours.

With exposure to 200 ppm for two to three hours, a person begins to experience headache, **fatigue**, nausea, and **dizziness**. These symptoms correspond to 15–25% COHb in the blood. When the concentration of COHb reaches 50% or more, death results in a very short time. Emergency room physicians have the most experience diagnosing and treating CO poisoning.

KEY TERMS

Carboxyhemoglobin (COHb)—Hemoglobin that is bound to carbon monoxide instead of oxygen.

Hemoglobin (Hb)—A molecule that normally binds to oxygen in order to carry it to our cells, where it is required for life.

Hypothermia—Development of a subnormal body temperature.

pH—A measurement of the acidity or alkalinity of a fluid. A neutral fluid, neither acid nor alkali, has a pH of 7.

The symptoms of CO poisoning in order of increasing severity include:

- headache
- shortness of breath
- dizziness
- fatigue
- mental confusion and difficulty thinking
- loss of fine hand-eye coordination
- nausea and vomiting
- rapid heart rate
- hallucinations
- inability to execute voluntary movements accurately
- collapse
- lowered body temperature (**hypothermia**)
- coma
- convulsions
- seriously low blood pressure
- cardiac and **respiratory failure**
- death

In some cases, the skin, mucous membranes, and nails of a person with CO poisoning are cherry red or bright pink. Because the color change doesn't always occur, it is an unreliable symptom to rely on for diagnosis.

Although most CO poisoning is acute, or sudden, it is possible to suffer from chronic CO poisoning. This condition exists when a person is exposed to low levels of the gas over a period of days to months. Symptoms are often vague and include (in order of frequency) fatigue, headache, dizziness, sleep disturbances, cardiac symptoms, apathy, nausea, and memory disturbances. Little is known about chronic CO poisoning, and it is often misdiagnosed.

Diagnosis

The main reason to suspect CO poisoning is evidence that fuel is being burned in a confined area, for example a car running inside a closed garage, a charcoal grill burning indoors, or an unvented kerosene heater in a workshop. Under these circumstances, one or more persons suffering from the symptoms listed above strongly suggests CO poisoning. In the absence of some concrete reason to suspect CO poisoning, the disorder is often misdiagnosed as **migraine headache**, **stroke**, psychiatric illness, **food poisoning**, alcohol poisoning, or heart disease.

Concrete confirmation of CO poisoning comes from a carboxyhemoglobin test. This blood test measures the amount of CO that is bound to hemoglobin in the body. Blood is drawn as soon after suspected exposure to CO as possible.

Other tests that are useful in determining the extent of CO poisoning include measurement of other arterial blood gases and pH; a complete **blood count**; measurement of other blood components such as sodium, potassium, bicarbonate, urea nitrogen, and lactic acid; an electrocardiogram (ECG); and a **chest x ray**.

Treatment

Immediate treatment for CO poisoning is to remove the victim from the source of carbon monoxide gas and get him or her into fresh air. If the victim is not breathing and has no pulse, **cardiopulmonary resuscitation** (**CPR**) should be started. Depending on the severity of the poisoning, 100% oxygen may be given with a tight fitting mask as soon as it is available.

Taken with other symptoms of CO poisoning, COHb levels of over 25% in healthy individuals, over 15% in patients with a history of heart or lung disease, and over 10% in pregnant women usually indicate the need for hospitalization. In the hospital, fluids and electrolytes are given to correct any imbalances that have arisen from the breakdown of cellular metabolism.

In severe cases of CO poisoning, patients are given hyperbaric oxygen therapy. This treatment involves placing the patient in a chamber breathing 100% oxygen at a pressure of more than one atmosphere (the normal pressure the atmosphere exerts at sea level). The increased pressure forces more oxygen into the blood. Hyperbaric facilities are specialized, and are usually available only at larger hospitals.

Prognosis

The speed and degree of recovery from CO poisoning depends on the length and duration of exposure to

the gas. The half-life of CO in normal room air is four to five hours. This means that, in four to five hours, half of the CO bound to hemoglobin will be replaced with oxygen. At normal atmospheric pressures, but breathing 100% oxygen, the half-life for the elimination of CO from the body is 50-70 minutes. In hyperbaric therapy at three atmospheres of pressure, the half-life is reduced to 20-25 minutes.

Although the symptoms of CO poisoning may subside in a few hours, some patients show memory problems, fatigue, confusion, and mood changes for two to four weeks after their exposure to the gas.

Prevention

Carbon monoxide poisoning is preventable. Particular care should be paid to situations where fuel is burned in a confined area. Portable and permanently installed carbon monoxide detectors that sound a warning similar to smoke detectors are available for under $50. Specific actions that will prevent CO poisoning include:

- stop **smoking**. Smokers have less tolerance to environmental CO
- have heating systems and appliances installed by a qualified contractor to assure that they are properly vented and meet local building codes
- inspect and properly maintain heating systems, chimneys, and appliances
- do not use a gas oven or stove to heat the home
- do not burn charcoal indoors
- make sure there is good ventilation if using a kerosene heater indoors
- do not leave cars or trucks running inside the garage
- keep car windows rolled up when stuck in heavy traffic, especially if inside a tunnel

Resources

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

OTHER

"Carbon Monoxide Headquarters." *Wayne State University School of Medicine.* <http://www.phypc.med.wayne.edu/>.

Tish Davidson

Carbunculosis *see* **Boils**

Carcinoembryonic antigen test

Definition

The carcinoembryonic antigen (CEA) test is a laboratory blood study. CEA is a substance which is normally found only during fetal development, but may reappear in adults who develop certain types of **cancer**.

Purpose

The CEA test is ordered for patients with known cancers. The CEA test is most commonly ordered when a patient has a cancer of the gastrointestinal system. These include cancer of the colon, rectum, stomach (gastric cancer), esophagus, liver, or pancreas. It is also used with cancers of the breast, lung, or prostate.

The CEA level in the blood is one of the factors that doctors consider when determining the prognosis, or most likely outcome of a cancer. In general, a higher CEA level predicts a more severe disease, one that is less likely to be curable. But it does not give clear-cut information. The results of a CEA test are usually considered along with other laboratory and/or imaging studies to follow the course of the disease.

Once treatment for the cancer has begun, CEA tests have a valuable role in monitoring the patient's progress. A decreasing CEA level means therapy is effective in fighting the cancer. A stable or increasing CEA level may mean the treatment is not working, and/or that the tumor is growing. It is important to understand that serial CEA measurements, which means several done over a period of time, are the most useful. A single test result is difficult to evaluate, but a number of tests, done weeks apart, shows trends in disease progression or regression.

Certain types of cancer treatments, such as hormone therapy for **breast cancer**, may actually cause the CEA level to go up. This elevation does not accurately reflect the state of the disease. It is sometimes referred to as a "flare response." Recognition that a rise in CEA may be temporary and due to therapy is significant. If this possibility is not taken into account, the patient may be unnecessarily discouraged. Further, treatment that is actually effective may be stopped or changed prematurely.

CEA tests are also used to help detect recurrence of a cancer after surgery and/or other treatment has been completed. A rising CEA level may be the first sign of cancer return, and may show up months before other studies or patient symptoms would raise concern. Unfortunately, this does not always mean the recurrent cancer can be cured. For example, only a small percentage of patients with colorectal cancers and rising CEA levels will benefit from

another surgical exploration. Those with recurrence in the same area as the original cancer, or with a single metastatic tumor in the liver or lung, have a chance that surgery will eliminate the disease. Patients with more widespread return of the cancer are generally not treatable with surgery. The CEA test will not separate the two groups.

Patients who are most likely to benefit from nonstandard treatments, such as bone marrow transplants, may be determined on the basis of CEA values, combined with other test results. CEA levels may be one of the criteria for determining whether the patient will benefit from more expensive studies, such as CT scan or MRI.

Precautions

The CEA test is not a screening test for cancer. It is not useful for detecting the presence of cancer. Many cancers do not produce an increased CEA level. Some noncancerous diseases, such as hepatitis, inflammatory bowel disease, **pancreatitis**, and obstructive pulmonary disease, may cause an elevated CEA level.

Description

Determination of the CEA level is a laboratory blood test. Obtaining a specimen of blood for the study takes only a few minutes. CEA testing should be covered by most insurance plans.

Preparation

No preparation is required.

Aftercare

None.

Risks

There are no complications or side effects of this test. However, the results of a CEA study should be interpreted with caution. A single test result may not yield clinically useful information. Several studies over a period of months may be needed.

Another concern is the potential for false positive as well as false negative results. A false positive result means the test shows an abnormal value when cancer is not present. A false negative means the test reveals a normal value when cancer actually is present.

Normal results

The absolute numbers which are considered normal vary from one laboratory to another. Any results reported should come with information regarding the testing facility's normal range.

Abnormal results

A single abnormal CEA value may be significant, but must be regarded cautiously. In general, very high CEA levels indicate more serious cancer, with a poorer chance for cure. But some benign diseases and certain cancer treatments may produce an elevated CEA test. Cigarette **smoking** will also cause the CEA level to be abnormally high.

Resources

BOOKS

Cooper, Dennis L. "Tumor Markers." In *Cecil Textbook of Medicine*, ed. J. Claude Bennet and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Ellen S. Weber, MSN

Carcinoid tumors *see* **Neuroendocrine tumors**

Cardiac arrest *see* **Sudden cardiac death**

Cardiac arrhythmias *see* **Arrhythmias**

Cardiac blood pool scan

Definition

A cardiac blood pool scan is a non-invasive test that uses a mildly radioactive marker to observe the functioning of the left ventricle of the heart.

Purpose

The left ventricle is the main pump for distributing blood through the body. A cardiac blood pool scan is used to determine how efficiently the left ventricle is working. The scan can detect aneurysms of the left ventricle, motion abnormalities caused by damage to the heart wall, cardiac shunts between the left and right ventricle, and coronary occlusive artery disease.

Precautions

Pregnant women are the only patients who should not participate in a cardiac blood pool scan. However, the accuracy of the results may be affected if the patient moves during imaging, has had other recent nuclear scans, or has an irregular heartbeat.

Description

A cardiac blood pool scan is sometimes called equilibrium radionuclide angiocardiography or gated (synchronized) cardiac blood pool imaging. A **multiple-gated acquisition (MUGA) scan** is a variation of this test.

To perform a cardiac blood pool scan, the patient lies under a special gamma scintillation camera that detects radiation. A protein tagged with a radioactive marker (usually technetium-99m) is injected into the patient's forearm.

The camera is synchronized with an electrocardiogram (ECG) to take a picture at specific times in the cycle of heart contraction and relaxation. When data from many sequential pictures is processed by a computer, a doctor can analyze whether the left ventricle is functioning normally.

The patient needs to remain silent and motionless during the test. Sometimes the patient is asked to **exercise**, then another set of pictures is taken for comparison. This test normally takes about 30 minutes.

Preparation

No changes in diet or medication are necessary. An ECG will probably be done before the test.

Aftercare

The patient may resume normal activities immediately.

Risks

Cardiac blood pool scans are a safe and effective way of measuring left ventricle function. The only risk is to the fetus of a pregnant woman.

Normal results

A computer is used to process the information from the test, then the results are analyzed by a doctor. A normally functioning left ventricle will contract symmetrically, show even distribution of the radioactively tagged protein, and eject about 55–65% of volume of blood it holds on each contraction.

Abnormal results

Patients with damage to the ventricle or heart wall will show an uneven distribution of the radiopharmaceutical. The volume of blood ejected in each contraction will be less than 55%.

KEY TERMS

Aneurysm—A sac or bulge that forms because of a weak spot in the wall of an artery or heart chamber.

Cardiac shunt—A defect in the wall of the heart that allows blood from different chambers to mix.

Coronary occlusive artery disease—Blockage of the arteries that supply blood to the heart; frequently a precursor to a heart attack.

Electrocardiogram (ECG)—A graph that shows the electrical charges that trigger the heart to contract. Heart abnormalities alter the graph, giving clues to the source of the abnormality.

Ventricle—One of the two bottom chambers of the heart (the heart has four chambers). The left ventricle acts as the body's main pump for blood.

Resources

BOOKS

"Cardiac Blood Pool Imaging." In *Illustrated Guide to Diagnostic Tests*, ed. J. A. Lewis. Springhouse, PA: Springhouse Corp., 1994.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Tish Davidson

Cardiac catheterization

Definition

Cardiac catheterization (also called heart catheterization) is a diagnostic procedure which does a comprehensive examination of how the heart and its blood vessels function. One or more catheters is inserted through a peripheral blood vessel in the arm (antecubital artery or vein) or leg (femoral artery or vein) with x-ray guidance. This procedure gathers information such as adequacy of blood supply through the coronary arteries, blood pressures, blood flow throughout chambers of the heart, collection of blood samples, and x rays of the heart's ventricles or arteries.

A test that can be performed on either side of the heart, cardiac catheterization checks for different functions in both the left and right sides. When testing the heart's right side, tricuspid and pulmonary valve function

are evaluated, in addition to measuring pressures of and collecting blood samples from the right atrium, ventricle, and pulmonary artery. Left-sided heart catheterization is performed by way of a catheter through an artery which tests the blood flow of the coronary arteries, function of the mitral and aortic valves, and left ventricle.

Purpose

The primary reason for conducting a cardiac catheterization is to diagnose and manage persons known or suspected to have heart disease, a frequently fatal condition that leads to 1.5 million heart attacks annually in the United States.

Symptoms and diagnoses that may lead to performing this procedure include:

- chest **pain**, characterized by prolonged heavy pressure or a squeezing pain
- abnormal treadmill **stress test**
- myocardial infarction, also known as a **heart attack**
- congenital heart defects, or heart problems that originated from birth
- a diagnosis of valvular-heart disease
- a need to measure the heart muscle's ability to pump blood

Typically performed along with **angiography**, a technique of injecting a dye into the vascular system to outline the heart and blood vessels, a catheterization can aid in the visualization of any blockages, narrowing, or abnormalities in the coronary arteries. If these signs are visible, the cardiologist may assess the patient's need and readiness for coronary bypass surgery, or perhaps a less invasive approach, such as dilation of a narrowed blood vessel either surgically or with the use of a balloon (**angioplasty**).

When looking at the left side of the heart, fluoroscopic guidance also allows the following diagnoses to be assessed:

- enlargement of the left ventricle
- ventricular aneurysms (abnormal dilation of a blood vessel)
- narrowing of the aortic valve
- insufficiency of the aortic or mitral valve
- the detour of blood from one side of the heart to the other due to septal defects (also known as shunting)

Precautions

Cardiac catheterization is categorized as an "invasive" procedure which involves the heart, its valves, and coronary arteries, in addition to a large artery in the arm or leg. Due to the nature of the test, it is important to evaluate for the following conditions before considering this procedure:

- A diagnosis of a bleeding disorder, poor kidney function, or debilitation. Any of these pre-existing conditions typically raises the risk of the catheterization procedure and may be reason to cancel the procedure.
- A diagnosis of heart valve disease. If this is detected, **antibiotics** may be given before the test to prevent inflammation of the membrane which lines the heart (endocarditis).

Description

To understand how a cardiac catheterization is able to diagnose and manage heart disease, the basic workings of the heart muscle must also be understood. Just as the body relies on a constant supply of blood to aid in its everyday functions, so does the heart. The heart is made up of an intricate web of blood vessels (coronary arteries) that ensure an adequate supply of blood rich in oxygen and nutrients. It is easy to see how an abnormality in any of these arteries can be detrimental to the heart's function. These abnormalities cause the heart's blood flow to decrease and result in the condition known as **coronary artery disease** or coronary insufficiency.

Catheterization is a valuable tool in detecting and treating abnormalities of the heart. Through the use of fluoroscopic (x ray) guidance, a catheter, which may resemble a balloon-tipped tube, is strung through the veins or arteries into the heart, so the cardiologist can monitor a body's various functions at each moment.

Generally a test that lasts two to three hours, a patient should expect the following prior to and during the catheterization procedure:

- A mild sedative may be given that will allow the patient to relax but remain conscious during the test.
- An intravenous needle will be inserted in the arm to administer medication. Electrodes will be attached to the chest to enable the painless procedure known as an electrocardiograph.
- Prior to inserting a catheter into an artery or vein in the arm or leg, the incision site will be made numb by injecting a local anesthetic. When the anesthetic is injected it may feel like a pin-prick followed by a quick stinging sensation. Pressure may also be experienced as the catheter travels through the blood vessel.
- After the catheter is guided into the coronary-artery system, a dye (also called a radiocontrast material) is injected to aid in the identification of any abnormalities

of the heart. During this time, the patient may experience a hot, flushed feeling or a quickly passing nausea. Coughing or breathing deeply aids in any discomfort.

- Medication may be given during the procedure if chest pain is experienced, and nitroglycerin may also be administered to allow expansion of the heart's blood vessels.
- When the test is complete, the physician will remove the catheter and close the skin with several sutures or tape.

Preparation

Prior to the cardiac catheterization procedure, it is important to relay information to the physician or nurse regarding **allergies** to shellfish (such as shrimp or scallops) which contain iodine, iodine itself, or the dyes that are commonly used in other diagnostic tests.

Because this procedure is categorized as a surgery, the patient will be instructed not to eat or drink anything for at least six hours prior to the test. Just before the test begins, the patient will urinate and change into a hospital gown, then lie flat on a padded table that may also be tilted in order for the heart to be examined from a variety of angles.

Aftercare

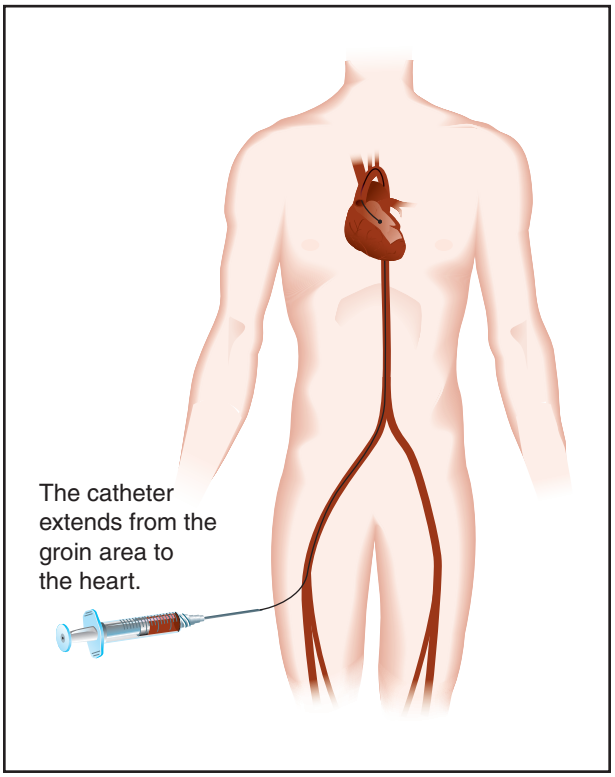
While cardiac catheterization may be performed on an outpatient basis, a patient may require close monitoring following the procedure while remaining in the hospital for at least 24 hours. The patient will be instructed to rest in bed for at least eight hours immediately after the test. If the catheter was inserted into a vein or artery in the leg or groin area, the leg will be kept extended for four to six hours. If a vein or artery in the arm was used to insert the catheter, the arm will need to remain extended for a minimum of three hours.

The patient should expect a hard ridge to form over the incision site that diminishes as the site heals. Bluish discoloration under the skin at the point of insertion should also be expected but fades in two weeks. It is also not uncommon for the incision site to bleed during the first 24 hours following surgery. If this should happen, the patient should apply pressure to the site with a clean tissue or cloth for 10–15 minutes.

Risks

Similar to all surgical procedures, the cardiac catheterization test does involve some risks. Complications that may occur during the procedure include

- cardiac **arrhythmias** (an irregular heart beat)
- pericardial tamponade (a condition that causes excess pressure in the pericardium which affects the heart due to accumulation of excess fluid)



The cardiac catheter runs from the groin to the heart. *(Illustration by Argosy Inc.)*

- the rare occurrence of myocardial infarction (heart attack) or **stroke** may also develop due to clotting or plaque rupture of one or more of the coronary or brain arteries.

Before left-side catheterization is performed, the anticoagulant medication heparin may be administered. This drug helps decrease the risk of the development of a blood clot in an artery (thrombosis) and blood clots traveling throughout the body (embolization).

The risks of the catheterization procedure increase in patients over the age of 60, those who have severe **heart failure**, or persons with serious **valvular heart disease**.

Normal results

Normal findings from a cardiac catheterization will indicate no abnormalities of heart chamber size or configuration, wall motion or thickness, the direction of blood flow, or motion of the valves. Smooth and regular outlines on the x ray indicate normal coronary arteries.

An essential part of the catheterization is measuring intracardiac pressures, or the pressure in the heart's chambers and vessels. Pressure readings that are higher

KEY TERMS

Aneurysm—An abnormal dilatation of a blood vessel, usually an artery. It can be caused by a congenital defect or weakness in the vessel's wall.

Angiography—In cardiac catheterization, a picture of the heart and coronary arteries is seen after injecting a radiopaque substance (often referred to as a dye) throughout the veins and arteries.

Angioplasty—An alternative to vascular surgery, a balloon catheter is used to mechanically dilate the affected area of the artery and enlarge the constricted or narrowed segment.

Aortic valve—The valve between the heart's left ventricle and ascending aorta that prevents regurgitation of blood back into the left ventricle.

Catheter—A tube made of elastic, elastic web, rubber, glass, metal, or plastic used to evacuate or inject fluids into the body. In cardiac catheterization, a long, fine catheter is used for passage through a blood vessel into the chambers of the heart.

Coronary bypass surgery—A surgical procedure which places a shunt to allow blood to travel from the aorta to a branch of the coronary artery at a point past an obstruction.

Left anterior descending coronary artery (LAD)—One of the heart's coronary artery branches from the left main coronary artery which supplies blood to the left ventricle.

Mitral valve—The bicuspid valve which is between the left atrium and left ventricle of the heart.

Pulmonary valve—The heart valve which is positioned between the right ventricle and the opening into the pulmonary artery.

Shunt—A passageway (or an artificially created passageway) that diverts blood flow from one main route to another.

Tricuspid valve—The right atrioventricular valve of the heart.

than normal are significant for a patient's overall diagnosis. The pressure readings that are lower, other than those which are produced as a result of **shock**, typically are not significant.

An ejection fraction, or a comparison of how much blood is ejected from the heart's left ventricle during its contraction phase with a measurement of blood remaining at the end of the left ventricle's relaxation phase, is also determined by performing a catheterization. The cardiologist will look for a normal ejection fraction reading of 60–70%.

Abnormal results

Cardiac catheterization provides valuable still and motion x-ray pictures of the coronary arteries that help in diagnosing coronary artery disease, poor heart function, disease of the heart valves, and septal defects (a defect in the septum, the wall that separates two heart chambers).

The most prominent sign of coronary artery disease is the narrowing or blockage in the coronary arteries, with narrowing that is greater than 70% considered significant. A clear indication for intervention (by angioplasty or surgery) is a finding of significant narrowing of the left main coronary artery and/or blockage or severe narrowing in the high, left anterior descending coronary artery.

A finding of impaired wall motion is an additional indicator of coronary artery disease, aneurysm, an enlarged heart, or a congenital heart problem. Using the findings from an ejection fraction test which measures wall motion, cardiologists look at an ejection fraction reading under 35% as increasing the risk of complications while also decreasing a successful long term or short term outcome with surgery.

Detecting the difference in pressure above and below the heart valve can verify heart valve disease. The greater narrowing correlates with the higher pressure difference.

To confirm septal defects, a catheterization measures oxygen content on both the left and right sides of the heart. The right heart pumps unoxygenated blood to the lungs, and the left heart pumps blood that contains oxygen from the lungs to the rest of the body. Right side elevated oxygen levels indicate left-to-right atrial or **ventricular shunt**. A left side that experiences decreased oxygen indicates a right-to-left shunt.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Everything You Need to Know About Medical Tests. Ed. Michael Shaw, et al. Springhouse, PA: Springhouse Corporation, 1996.
Griffith, H. Winter. "Cardiac Catheterization & Angiocardiography." In *Complete Guide To Symptoms, Illness and Surgery.* New York: The Berkley Publishing Group, 1995.
"Heart." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.
The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.
National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Beth A. Kapes

Cardiac compression *see* **Cardiac tamponade**

Cardiac conduction disorder *see* **Heart block**

Cardiac mapping *see* **Electrophysiology study of the heart**

Cardiac rehabilitation

Definition

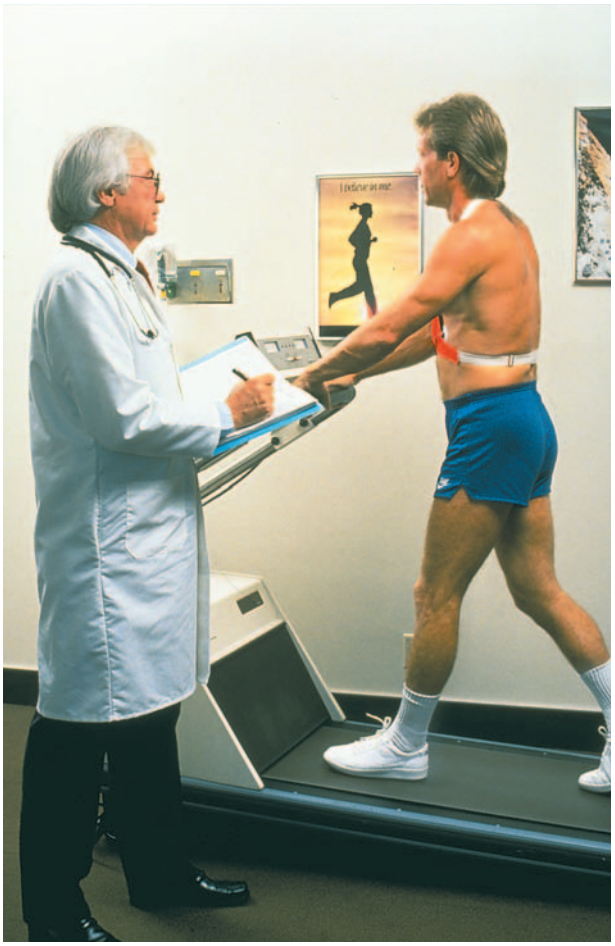
Cardiac **rehabilitation** is a comprehensive **exercise**, education, and behavioral modification program designed to improve the physical and emotional condition of patients with heart disease.

Purpose

Heart attack survivors, bypass and **angioplasty** patients, and individuals with **angina**, congestive **heart failure**, and heart transplants are all candidates for a cardiac rehabilitation program. Cardiac rehabilitation is prescribed to control symptoms, improve exercise tolerance, and improve the overall quality of life in these patients.

Precautions

A cardiac rehabilitation program should be implemented and closely monitored by a trained team of healthcare professionals.



This 40-year-old male is working out on a treadmill, monitored by his physician, following heart surgery. *(Custom Medical Stock Photo. Reproduced by permission.)*

Description

Cardiac rehabilitation is overseen by a specialized team of doctors, nurses, and other healthcare professionals. Members of the cardiac rehabilitation team may include a dietician or nutritionist, physical therapist, exercise physiologist, psychologist, vocational counselor, occupational therapist, and social worker. The program frequently begins in a hospital setting and continues on an outpatient basis after the patient is discharged over a period of six to 12 months.

Components of a cardiac rehabilitation program vary by individual clinical need, and each program will be carefully constructed for the patient by his or her rehabilitation team.

- Exercise. Exercise programs typically start out slowly, with simple range-of-motion arm and leg exercises. Walking and stair climbing soon follow. Blood pressure is carefully monitored before and after exercise ses-

KEY TERMS

Angina—Chest pain.

Bypass surgery—A surgical procedure that grafts blood vessels onto arteries to reroute the blood flow around blockages in the arteries (arteriosclerosis).

sions, and patients are taught how to measure their heart rate and evaluate any possible cardiac symptoms during each session. Patients with advanced coronary disease may require continuous ECG monitoring throughout their exercise sessions. Once discharged from the hospital, the patient works with his cardiac team to create an individual exercise plan.

- Diet. Cardiac patients will work with a nutritionist or dietician to develop a low-fat, low-cholesterol diet plan. Patients with high blood pressure may be put on a salt-restricted diet and instructed to limit alcohol intake. Weight loss may also be a goal with obese cardiac patients.
- Counseling. A psychologist or social worker can help cardiac patients with issues that may be contributing to their heart condition, such as **stress** and **anxiety**. Relaxation techniques may be taught to patients to help them deal with these feelings. Cardiac patients frequently experience a period of depression, and group or individual counseling can be beneficial in overcoming these feelings. Vocational counselors can assist cardiac patients in returning to the workforce.
- Education. The patient and family should be fully educated on the physical limitations of the patient, his recommended diet and exercise plan, his emotional status, and the lifestyle changes required to improve the patient's overall health.
- **Smoking** cessation. Cardiac patients who smoke are twice as likely to have a heart attack in the following five years than non-smoking patients. These patients are strongly encouraged to enroll in a smoking cessation program, which typically includes patient education and behavioral counseling. Nicotine replacement therapy, which uses nicotine patches, nose spray, or gum to wean patients off of cigarettes, may also be part of the program. Antidepressants and anti-anxiety medication may be helpful in some cases.

Aftercare

Long-term maintenance is a critical feature of cardiac rehabilitation. Patients require support from their healthcare team, family, and friends to continue the lifestyle changes they implemented during the rehabilitation period.

Risks

The risks of another heart attack during cardiac rehabilitation are slight, and greatly reduced by careful, continuous monitoring of the physical status of the patient.

Normal results

The outcome of the cardiac rehabilitation program depends on a number of variables, including patient follow-through, type and degree of heart disease, and the availability of an adequate support network for the patient. Patients who successfully complete the program will ideally reach an age-appropriate level of physical activity and be able to return to the workforce and/or other daily activities.

Resources

BOOKS

The American Heart Association. *American Heart Association Guide to Heart Attack Treatment, Recovery, and Prevention*. New York: Times Books, 1996.

DeBakey, Michael E., and Antonio Gotto Jr. *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

PERIODICALS

Harvard Medical School. "Cardiac Rehabilitation." *Harvard Health Letter*, 7 no. 5 (Jan. 1997): 3-7.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Paula Anne Ford-Martin

Cardiac tamponade

Definition

Cardiac tamponade occurs when the heart is squeezed by fluid that collects inside the sac that surrounds it.

Description

The heart is surrounded by a sac called the pericardium. When this sac becomes filled with fluid, the liquid presses on the heart, preventing the lower chambers of the heart from properly filling with blood.

Because the lower chambers (the ventricles) cannot fill with the correct amount of blood, less than normal amounts of blood reach the lungs and the rest of the body. This condition is very serious and can be fatal if not treated.

Causes and symptoms

Fluid can collect inside the pericardium and compress the heart when the kidneys do not properly remove waste from the blood, when the pericardium swells from unknown causes, from infection, or when the pericardium is damaged by **cancer**. Blunt or penetrating injury from trauma to the chest or heart can also result in cardiac tamponade when large amounts of blood fill the pericardium. Tamponade can also occur during heart surgery.

When the heart is compressed by the surrounding fluid, three conditions occur: a reduced amount of blood is pumped to the body by the heart, the lower chambers of the ventricles are filled with a less than normal amount of blood, and higher than normal blood pressures occur inside the heart, caused by the pressure of the fluid pushing in on the heart from the outside.

When tamponade occurs because of trauma, the sound of the heart beats can become faint, and the blood pressure in the arteries decreases, while the blood pressure in the veins increases.

In cases of tamponade caused by more slowly developing diseases, **shortness of breath**, a feeling of tightness in the chest, increased blood pressure in the large veins in the neck (the jugular veins), weight gain, and fluid retention by the body can occur.

Diagnosis

When cardiac tamponade is suspected, accurate diagnosis can be life-saving. The most accurate way to identify this condition is by using a test called an echocardiogram. This test uses sound waves to create an image of the heart and its surrounding sac, making it easy to visualize any fluid that has collected inside the sac.

Treatment

If the abnormal fluid buildup in the pericardial sac is caused by cancer or kidney disease, drugs used to treat these conditions can help lessen the amount of fluid collecting inside the sac. Drugs that help maintain normal blood pressure throughout the body can also help this condition; however, these drugs are only a temporary treatment. The fluid within the pericardium must be drained out to reduce the pressure on the heart and restore proper heart pumping.

The fluid inside the pericardium is drained by inserting a needle through the chest and into the sac itself. This allows the fluid to flow out of the sac, relieving the abnormal pressure on the heart. This procedure is called **pericardiocentesis**. In severe cases, a tube (catheter) can be inserted into the sac or a section of the sac can be surgically cut away to allow for more drainage.

KEY TERMS

Pericardiocentesis—A procedure used to drain fluid out of the sac surrounding the heart. This is done by inserting a needle through the chest and into the sac.

Prognosis

This condition is life-threatening. However, drug treatments can be helpful, and surgical treatments can successfully drain the trapped fluid, though it may reaccumulate. Some risk of **death** exists with surgical drainage of the accumulated fluid.

Resources

BOOKS

Braunwald, Eugene. "Pericardial Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Shabetai, Ralph. "Diseases of the Pericardium." In *Hurst's The Heart*, ed. Robert C. Schlant, et. al. New York: McGraw Hill, 1994.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dominic De Bellis, PhD

Cardiac tumors *see* **Myxoma**

Cardiogenic shock *see* **Shock**

Cardiomyopathy *see* **Congestive cardiomyopathy; Restrictive cardiomyopathy**

Cardiopulmonary resuscitation (CPR)

Definition

Cardiopulmonary resuscitation (CPR) is a procedure to support and maintain breathing and circulation for a

person who has stopped breathing (respiratory arrest) and/or whose heart has stopped (cardiac arrest).

Purpose

CPR is performed to restore and maintain breathing and circulation and to provide oxygen and blood flow to the heart, brain, and other vital organs. CPR should be performed if a person is unconscious and not breathing. Respiratory and cardiac arrest can be caused by allergic reactions, an ineffective heartbeat, asphyxiation, breathing passages that are blocked, **choking**, drowning, drug reactions or overdoses, electric shock, exposure to cold, severe shock, or trauma. CPR can be performed by trained bystanders or healthcare professionals on infants, children, and adults. It should always be performed by the person on the scene who is most experienced in CPR.

Precautions

CPR should never be performed on a healthy person because it can cause serious injury to a beating heart by interfering with normal heartbeats.

Description

CPR is part of the emergency cardiac care system designed to save lives. Many deaths can be prevented by prompt recognition of the problem and notification of the emergency medical system (EMS), followed by early CPR, **defibrillation** (which delivers a brief electric shock to the heart in attempt to get the heart to beat normally), and advanced cardiac **life support** measures.

CPR must be performed within four to six minutes after cessation of breathing so as to prevent brain damage or **death**. It is a two-part procedure that involves rescue breathing and external chest compressions. To provide oxygen to a person's lungs, the rescuer administers mouth-to-mouth breaths, then helps circulate blood through the heart to vital organs by external chest compressions. Mouth-to-mouth breathing and external chest compression should be performed together, but if the rescuer is not strong enough to do both, the external chest compressions should be done. This is more effective than no resuscitation attempt, as is CPR that is performed "poorly."

When performed by a bystander, CPR is designed to support and maintain breathing and circulation until emergency medical personnel arrive and take over. When performed by healthcare personnel, it is used in conjunction with other basic and advanced life support measures.

According to the American Heart Association, early CPR and defibrillation combined with early advanced emergency care can increase survival rates for people with a type of abnormal heart beat called **ventricular fibrillation** by as much as 40%. CPR by bystanders may prolong life during deadly ventricular fibrillation, giving emergency medical service personnel time to arrive.

However, many CPR attempts are not ultimately successful in restoring a person to a good quality of life. Often, there is brain damage even if the heart starts beating again. CPR is therefore not generally recommended for the chronically or terminally ill or frail elderly. For these people, it represents a traumatic and not a peaceful end of life.

Each year, CPR helps save thousands of lives in the United States. More than five million Americans annually receive training in CPR through American Heart Association and American Red Cross courses. In addition to courses taught by instructors, the American Heart Association also has an interactive video called Learning System, which is available at more than 500 healthcare institutions. Both organizations teach CPR the same way, but use different terms. These organizations recommend that family members or other people who live with people who are at risk for respiratory or cardiac arrest be trained in CPR. A hand-held device called a CPR Prompt is available to walk people trained in CPR through the procedure, using American Heart Association guidelines. CPR has been practiced for more than 40 years.

Performing CPR

The basic procedure for CPR is the same for all people, with a few modifications for infants and children to account for their smaller size.

PERFORMING CPR ON AN ADULT. The first step is to call the emergency medical system for help by telephoning 911; then to begin CPR, following these steps:

- The rescuer opens a person's airway by placing the head face up, with the forehead tilted back and the chin lifted. The rescuer checks again for breathing (three to five seconds), then begins rescue breathing (mouth-to-mouth artificial respiration), pinching the nostrils shut while holding the chin in the other hand. The rescuer's mouth is placed against the unconscious person's mouth with the lips making a tight seal, then gently exhales for about one to one and a half seconds. The rescuer breaks away for a moment and then repeats. The person's head is repositioned after each mouth-to-mouth breath.
- After two breaths, the rescuer checks the unconscious person's pulse by moving the hand that was under the person's chin to the artery in the neck (carotid artery). If the unconscious person has a heartbeat, the rescuer continues rescue breathing until help arrives or the per-

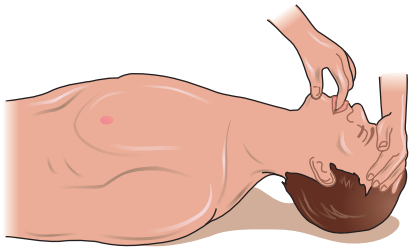


Figure A

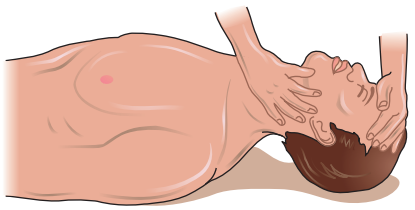


Figure B

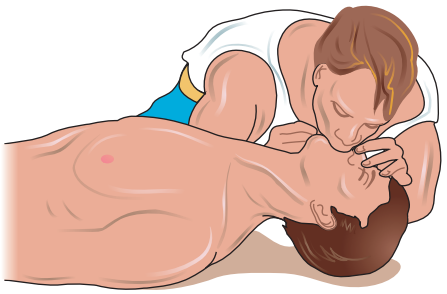


Figure C

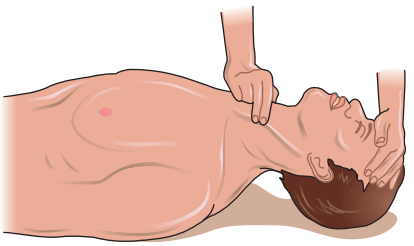


Figure D

Figure E

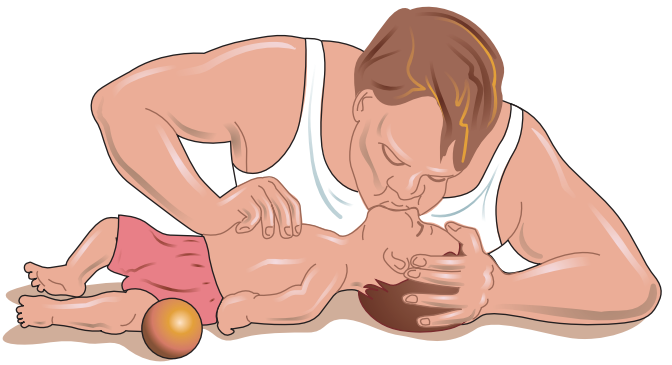


Figure F

CPR in basic life support. Figure A: The victim should be flat on his back and his mouth should be checked for debris. Figure B: If the victim is unconscious, open airway, lift neck, and tilt head back. Figure C: If victim is not breathing, begin artificial breathing with four quick full breaths. Figure D: Check for carotid pulse. Figure E: If pulse is absent, begin artificial circulation by depressing sternum. Figure F: Mouth-to-mouth resuscitation of an infant. *(Illustration by Electronic Illustrators Group.)*

son begins breathing without assistance. If the unconscious person is breathing, the rescuer turns the person onto his or her side.

- If there is no heartbeat, the rescuer performs chest compressions. The rescuer kneels next to the unconscious person, placing the heel of one hand in the spot on the lower chest where the two halves of the rib cage come together. The rescuer puts one hand on top of the other on the person's chest and interlocks the fingers. The arms are straightened, the rescuer's shoulders are positioned directly above the hands on the unconscious person's chest. The hands are pressed down, using only the palms, so that the person's breastbone sinks in about 1.5–2 inches. The rescuer releases pressure without removing the hands, then repeats about 15 times per 10–15 second intervals.
- The rescuer tilts the unconscious person's head and returns to rescue breathing for one or two quick breaths. Then breathing and chest compressions are alternated for one minute before checking for a pulse. If the rescuer finds signs of a heartbeat and breathing, CPR is stopped. If the unconscious person is breathing but has no pulse, the chest compressions are continued. If the unconscious person has a pulse but is not breathing, rescue breathing is continued.
- For children over the age of eight, the rescuer performs CPR exactly as for an adult.

PERFORMING CPR ON AN INFANT OR CHILD UNDER THE AGE OF EIGHT. The procedures outlined above are followed with these differences:

- The rescuer administers CPR for one minute, then calls for help.
- The rescuer makes a seal around the child's mouth or infant's nose and mouth to give gentle breaths. The rescuer delivers 20 rescue breaths per minute, taking 1.5–2 seconds for each breath.
- Chest compressions are given with only one hand for a child and with two or three fingers for an infant. The breastbone is depressed only 1–1.5 in (2.5–3.8 cm) for a child and 0.5–1 in (1.3–2.5 cm) for an infant, and the rescuer gives at least 100 chest compressions per minute.

New developments in CPR

Some new ways of performing CPR have been tried. Active compression-decompression resuscitation, abdominal compression done in between chest compressions, and chest compression using a pneumatic vest have all been tested but none are currently recommended for routine use.

The active compression-decompression device was developed to improve blood flow from the heart, but clinical studies have found no significant difference in survival between standard and active compression-decompression CPR. Interposed abdominal counterpulsation, which requires two or more rescuers, one compressing the chest and the other compressing the abdomen, was developed to improve pressure and therefore blood flow. It has been shown in a small study to improve survival but more data is needed. A pneumatic vest, which circles the chest of an unconscious person and compresses it, increases pressure within the chest during external chest compression. The vest has been shown to improve survival in a preliminary study but more data is necessary for a full assessment.

Preparation

If a person suddenly becomes unconscious, a rescuer should call out for help from other bystanders, and then determine if the unconscious person is responsive by gently shaking the shoulder and shouting a question. Upon receiving no answer, the rescuer should call the emergency medical system. The rescuer should check to see whether the unconscious person is breathing by kneeling near the person's shoulders, looking at the person's chest, and placing a cheek next to the unconscious person's mouth. The rescuer should look for signs of breathing in the chest and abdomen, and listen and feel for signs of breathing through the person's lips. If no signs of breathing are present after three to five seconds, CPR should be started.

Aftercare

Emergency medical care is always necessary after successful CPR. Once a person's breathing and heartbeat have been restored, the rescuer should make the person comfortable and stay there until emergency medical personnel arrive. The rescuer can continue to reassure the person that help is coming and talk positively until professionals arrive and take over.

Risks

CPR can cause injury to a person's ribs, liver, lungs, and heart. However, these risks must be accepted if CPR is necessary to save the person's life.

Normal results

In many cases, successful CPR results in restoration of consciousness and life. Barring other injuries, a revived person usually returns to normal functions within a few hours of being revived.

Abnormal results

These include injuries incurred during CPR and lack of success with CPR. Possible sites for injuries include a person's ribs, liver, lungs, and heart. Partially successful CPR may result in brain damage. Unsuccessful CPR results in death.

Resources

BOOKS

Alton, Thygerson. *First Aid and CPR*. 4th ed. Sudbury, Massachusetts: Jones & Bartlett Pub, 2001.

Knoop, Kevin J. and Lawrence B. Stack. *Atlas of Emergency Medicine*. 2nd ed. New York: McGraw Hill, 2001.

National Safety Council. *First Aid and CPR for Infants and Children*. 4th ed. Sudbury, Massachusetts: Jones & Bartlett Pub, 2001.

Skinner, David B. and Richard Vincent. *Cardiopulmonary Resuscitation*. 2nd ed. New York: Oxford University Press, 1996.

PERIODICALS

Davies, N. and D. Gould. "Updating cardiopulmonary resuscitation skills: a study to examine the efficacy of self-instruction on nurses' competence." *Journal of Clinical Nursing* 9 (2000): 400-410.

Eftestol T., K. Sunde, S. O. Aase, J. H. Husoy, and P. A. Steen. "'Probability of successful defibrillation' as a monitor during CPR in out-of-hospital cardiac arrested patients." *Resuscitation* 48 (2001): 245-254.

Kern, K. B., H. R. Halperin, and J. Field. "New guidelines for cardiopulmonary resuscitation and emergency cardiac care: changes in the management of cardiac arrest." *Journal of the American Medical Association* 285 (2001): 1267-1269.

Meyer W. and F. Balck. "Resuscitation decision index: a new approach to decision-making in prehospital CPR." *Resuscitation* 48 (2001): 255-263.

ORGANIZATIONS

American College of Emergency Physicians. P.O. Box 619911, Dallas, TX 75261-9911. (800) 798-1822 or (972) 550-0911. Fax: (972) 580-2816. <info@acep.org>. <http://www.acep.org/>.

American College of Osteopathic Emergency Physicians. 142 E. Ontario Street, Suite 550, Chicago, IL 60611. (312) 587-3709 or (800) 521-3709. Fax: (312) 587-9951. <http://www.acoep.org>.

American Heart Association, National Center. 7272 Greenville Avenue, Dallas, TX 75231. (877) 242-4277. <http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/heim.html>.

Heimlich Institute. PO Box 8858, Cincinnati, OH 45208. <heimlich@iglou.com>. <http://www.heimlichinstitute.org/index.htm>.

National Safe Kids Campaign. 1301 Pennsylvania Avenue, Suite 1000, Washington, DC 20004-1707. <http://pedsccm.wustl.edu/All-Net/english/neurpage/protect/drown.htm>.

KEY TERMS

Cardiac arrest—Temporary or permanent cessation of the heartbeat.

Cardiopulmonary—Relating to the heart and the lungs.

Defibrillation—A procedure to stop the type of irregular heart beat called ventricular fibrillation, usually by using electric shock.

Resuscitation—Bringing a person back to life after an apparent death or in cases of impending death.

Ventricular fibrillation—An irregular heartbeat where the heart beats very fast but ineffectively. Ventricular fibrillation is fatal if not quickly corrected.

OTHER

American Heart Association. <http://www.cpr-ecc.org/> and <http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/cprs.html>.

Columbia Presbyterian Medical Center. <http://cpmcnet.columbia.edu/texts/guide/hmg13_0001.html>.

Learn CPR. <http://www.learn-cpr.com>.

National Registry of Cardiopulmonary Resuscitation. <http://www.nrcpr.org/>.

University of Washington School of Medicine. <http://depts.washington.edu/learncpr/>.

L. Fleming Fallon, Jr., MD, DrPH

Cardioversion

Definition

Cardioversion refers to the process of restoring the heart's normal rhythm by applying a controlled electric shock to the exterior of the chest.

Purpose

When the heart beats too fast, blood no longer circulates effectively in the body. Cardioversion is used to stop this abnormal beating so that the heart can begin normal rhythm and pump more efficiently.

Precautions

Not all unusual heart rhythms (called **arrhythmias**) are dangerous or fatal. Atrial fibrillation and atrial flutter often revert to normal rhythms without the need for car-

KEY TERMS

Atrial fibrillation—A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

Atrial flutter—A rapid pulsation of the upper chamber of the heart that interferes with normal function.

Ventricular fibrillation—A condition in which the lower chamber of the heart quivers instead of pumping in an organized way.

Ventricular tachycardia—A rapid heart beat, usually over 100 beats per minute.

dioversion. Healthcare providers may also try to correct the heart rhythm with medication or recommend a lifestyle change before trying cardioversion. However, **ventricular tachycardia** lasting more than 30 seconds and **ventricular fibrillation** require immediate cardioversion.

Description

Elective cardioversion is usually scheduled ahead of time. After arriving at the hospital, an intravenous (IV) catheter will be placed in the arm and oxygen will be given through a face mask. A short-acting general anesthetic will be administered through the vein. During the two or three minutes of anesthesia, the doctor will apply two paddles to the exterior of the chest and administer the electric shock. It may be necessary to give the shock two or three times to obtain normal rhythm.

Preparation

Medication to thin the blood is usually given for at least three weeks before elective cardioversion. Food intake should be stopped eight hours before the procedure.

Aftercare

Medical personnel will monitor the heart rhythm for a few hours, after which the patient is usually sent home. It is advisable to arrange for transportation home, because drowsiness may last several hours. The doctor may prescribe anti-arrhythmic medication to prevent the abnormal rhythm from returning.

Risks

Cardioverters have been in use for many years and the risks are few. Those unlikely risks that remain include those instances when the device delivers greater or lesser power than expected or when power setting and control knobs are not set correctly. Unfortunately, in a number of cases, the heart prefers its abnormal rhythm and reverts to it despite cardioversion.

Normal results

Most cardioversions are successful and, at least for a time, restore the normal heart rhythm.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Carisoprodol *see* **Muscle relaxants**

Carotid artery surgery *see* **Endarterectomy**

Carotid Doppler ultrasound *see* **Doppler ultrasonography**

Carotid endarterectomy *see* **Endarterectomy**

Carotid sinus massage

Definition

Carotid sinus massage involves rubbing the large part of the arterial wall at the point where the common carotid artery, located in the neck, divides into its two main branches.

Purpose

Sinus, in this case, means an area in a blood vessel that is bigger than the rest of the vessel. This is a normal dilation of the vessel. Located in the neck just below the angle of the jaw, the carotid sinus sits above the point where the carotid artery divides into its two main branches. Rubbing the carotid sinus stimulates an area in the artery wall that contains nerve endings. These nerves respond to changes in blood pressure and are capable of slowing the heart rate. The response to this simple procedure often slows a rapid heart rate (for example, atrial

KEY TERMS

Angina pectoris—Chest pain usually caused by a lack of oxygen in the heart muscle.

Arrhythmia—Any deviation from a normal heart beat.

Atrial fibrillation—A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

Atrial flutter—Rapid, inefficient contraction of the upper chamber of the heart.

Carotid artery—One of the major arteries supplying blood to the head and neck.

Tachycardia—A rapid heart beat, usually over 100 beats per minute.

flutter or atrial tachycardia) and can provide important diagnostic information to the physician.

Description

The patient will be asked to lie down, with the neck fully extended and the head turned away from the side being massaged. While watching an electrocardiogram monitor, the doctor will gently touch the carotid sinus. If there is no change in the heart rate on the monitor, the pressure is applied more firmly with a gentle rotating motion. After massaging one side of the neck, the massage will be repeated on the other side. Both sides of the neck are never massaged at the same time.

Preparation

No special preparation is needed for carotid sinus massage.

Aftercare

No aftercare is required.

Risks

The physician must be sure there is no evidence of blockage in the carotid artery before performing the procedure. Massage in a blocked area might cause a clot to break loose and cause a **stroke**.

Normal results

Carotid sinus massage will slow the heart rate during episodes of atrial flutter, fibrillation, and some tachycardias. It has been known to stop the arrhythmia completely. If the procedure is being done to help diagnose **angina** pectoris, massaging the carotid sinus may make the discomfort go away.

Resources

BOOKS

McGood, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

Dorothy Elinor Stonely

Carpal tunnel syndrome

Definition

Carpal tunnel syndrome is a disorder caused by compression at the wrist of the median nerve supplying the hand, causing **numbness and tingling**.

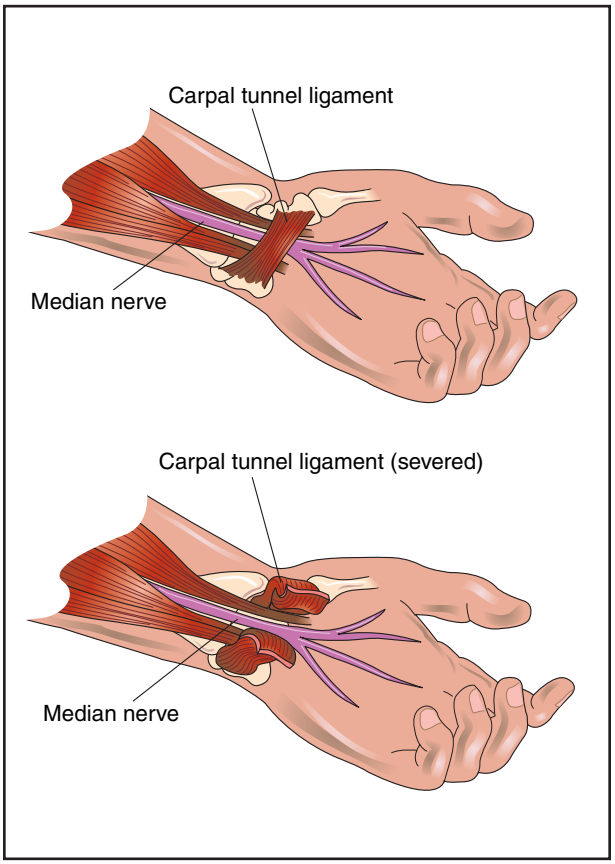
Description

The carpal tunnel is an area in the wrist where the bones and ligaments create a small passageway for the median nerve. The median nerve is responsible for both sensation and movement in the hand, in particular the thumb and first three fingers. When the median nerve is compressed, an individual's hand will feel as if it has "gone to sleep."

Women between the ages of 30 and 60 have the highest rates of carpal tunnel syndrome. Research has demonstrated that carpal tunnel syndrome is a very significant cause of missed work days due to **pain**. In 1995, about $270 million was spent on sick days taken for pain from repetitive motion injuries.

Causes and symptoms

Compression of the median nerve in the wrist can occur during a number of different conditions, particularly those conditions which lead to changes in fluid accumulation throughout the body. Because the area of the wrist through which the median nerve passes is very narrow, any swelling in the area will lead to pressure on the median nerve. This pressure will ultimately interfere with the nerve's ability to function normally. **Pregnancy**, **obesity**, arthritis, certain thyroid conditions, diabetes, and certain pituitary abnormalities all predispose to carpal tunnel syndrome. Other conditions which increase the risk for carpal tunnel syndrome include some forms



The most severe cases of carpal tunnel syndrome may require surgery to decrease the compression of the median nerve and restore its normal function. This procedure involves severing the ligament that crosses the wrist, thus allowing the median nerve more room and decreasing compression. *(Illustration by Electronic Illustrators Group.)*

of arthritis and various injuries to the arm and wrist (including **fractures**, sprains, and dislocations). Furthermore, activities which cause an individual to repeatedly bend the wrist inward toward the forearm can predispose to carpal tunnel syndrome. Certain jobs which require repeated strong wrist motions carry a relatively high risk of carpal tunnel syndrome. Injuries of this type are referred to as "repetitive motion" injuries, and are more frequent among secretaries doing a lot of typing, people working at computer keyboards or cash registers, factory workers, and some musicians.

Symptoms of carpal tunnel syndrome include numbness, burning, tingling, and a prickly pin-like sensation over the palm surface of the hand, and into the thumb, forefinger, middle finger, and half of the ring finger. Some individuals notice a shooting pain which goes from the wrist up the arm, or down into the hand and fingers. With continued median nerve compression, an individual may begin to experience muscle weakness, making it difficult to open jars and hold objects with the affected hand. Eventually, the muscles of the hand served by the median nerve may begin to grow noticeably smaller (atrophy), especially the fleshy part of the thumb. Untreated, carpal tunnel syndrome may eventually result in permanent weakness, loss of sensation, or even **paralysis** of the thumb and fingers of the affected hand.

Diagnosis

The diagnosis of carpal tunnel syndrome is made in part by checking to see whether the patient's symptoms can be brought on by holding his or her hand in position with wrist bent for about a minute. Wrist x rays are often taken to rule out the possibility of a tumor causing pressure on the median nerve. A physician examining a patient suspected of having carpal tunnel syndrome will perform a variety of simple tests to measure muscle strength and sensation in the affected hand and arm. Further testing might include electromyographic or nerve conduction velocity testing to determine the exact severity of nerve damage. These tests involve stimulating the median nerve with electricity and measuring the resulting speed and strength of the muscle response, as well as recording speed of nerve transmission across the carpel tunnel.

Treatment

Carpal tunnel syndrome is initially treated with splints, which support the wrist and prevent it from flexing inward into the position which exacerbates median nerve compression. Some people get significant relief by wearing such splints to sleep at night, while others will need to wear the splints all day, especially if they are performing jobs which **stress** the wrist. Ibuprofen or other **nonsteroidal anti-inflammatory drugs** may be prescribed to decrease pain and swelling. When carpal tunnel syndrome is more advanced, injection of steroids into the wrist to decrease inflammation may be necessary.

The most severe cases of carpal tunnel syndrome may require surgery to decrease the compression of the median nerve and restore its normal function. Such a repair involves cutting that ligament which crosses the wrist, thus allowing the median nerve more room and decreasing compression. This surgery is done almost exclusively on an outpatient basis and is often performed without the patient having to be made unconscious. Careful injection of numbing medicines (local anesthesia) or nerve blocks (the injection of anesthetics directly into the nerve) create sufficient numbness to allow the surgery to be performed painlessly, without the risks associated with general anesthesia. Recovery from this type of surgery is usually quick and without complications.

KEY TERMS

Carpal tunnel—A passageway in the wrist, created by the bones and ligaments of the wrist, through which the median nerve passes.

Electromyography—A type of test in which a nerve's function is tested by stimulating a nerve with electricity, and then measuring the speed and strength of the corresponding muscle's response.

Median nerve—A nerve which runs through the wrist and into the hand. It provides sensation and some movement to the hand, the thumb, the index finger, the middle finger, and half of the ring finger.

Prognosis

Without treatment, continued pressure on the median nerve puts an individual at risk for permanent disability in the affected hand. Most people are able to control the symptoms of carpal tunnel syndrome with splinting and anti-inflammatory agents. For those who go on to require surgery, about 95% will have complete cessation of symptoms.

Prevention

Prevention is generally aimed at becoming aware of the repetitive motions which one must make which could put the wrist into a bent position. People who must work long hours at a computer keyboard, for example, may need to take advantage of recent advances in "ergonomics," which try to position the keyboard and computer components in a way that increases efficiency and decreases stress. Early use of a splint may also be helpful for people whose jobs increase the risk of carpal tunnel syndrome.

Resources

BOOKS

Asbury, Arthur K. "Carpal Tunnel Syndrome." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Crouch, Tammy. *Carpal Tunnel Syndrome and Repetitive Stress Injuries*. Berkeley: Frog, 1995.

PERIODICALS

Brody, Jane E. "Experts on Carpal Tunnel Syndrome Say that Conservative Treatment is the Best First Approach." *The New York Times* 119 (28 Feb.1996): B9+.

"Carpal Tunnel Syndrome." *Postgraduate Medicine* 98 no. 3 (Sept. 1995): 216.

Glazer, Sarah. "Repetitive Stress Injury: A Modern Malady." *The Washington Post* 110 (12 Mar. 1996): WH12.

Seiler, John Gray. "Carpal Tunnel Syndrome: Update on Diagnostic Testing and Treatment Options." *Consultant* 37 no. 5 (May 1997): 1233+.

Rosalyn Carson-DeWitt, MD

Casts *see* **Immobilization**

CAT scan *see* **Computed tomography scans**

Cat-bite infection *see* **Animal bite infections**

Cat-scratch disease

Definition

Cat-scratch disease is an uncommon infection that typically results from a cat's scratch or bite. Most sufferers experience only moderate discomfort and find that their symptoms clear up without any lasting harm after a few weeks or months. Professional medical treatment is rarely needed.

Description

Cat-scratch disease (also called cat-scratch **fever**) is caused by the *Bartonella henselae* bacterium, which is found in cats around the world and is transmitted from cat to cat by fleas. Researchers have discovered that large numbers of North American cats carry antibodies for the disease (meaning that the cats have been infected at some point in their lives). Some parts of North America have much higher rates of cat infection than others, however. *Bartonella henselae* is uncommon or absent in cold climates, which fleas have difficulty tolerating, but prevalent in warm, humid places such as Memphis, Tennessee, where antibodies were found in 71% of the cats tested. The bacterium, which remains in a cat's bloodstream for several months after infection, seems to be harmless to most cats, and normally an infected cat will not display any symptoms. Kittens (cats less than one year old) are more likely than adult cats to be carrying the infection.

Bartonella henselae can infect people who are scratched or (more rarely) bitten or licked by a cat. It cannot be passed from person to person. Although cats are popular pets found in about 30% of American households, human infection appears to be rare. One study estimated that for every 100,000 Americans there are only 2.5 cases of cat-scratch disease each year (2.5/100,000). It is also unusual for more than one family member to become ill; a Florida investigation discovered multiple cases in only 3.5% of the families studied. Children and teenagers appear to be the most likely victims of cat-scratch disease, although the possibility exists that

KEY TERMS

Acetaminophen—A drug for relieving pain and fever.

AIDS—Acquired immunodeficiency syndrome. A disease that attacks the immune system.

Antibiotics—A category of manufactured substances used to combat infection.

Antibodies—Special substances created by the body to combat infection.

Bacterium—A tiny organism. Some bacteria cause disease.

Hepatitis—A disease that inflames the liver.

Immune system—A body system that combats disease.

Immunocompromised—Having a damaged immune system.

Lymph nodes—Small, kidney-shaped organs that filter a fluid called lymph.

Pneumonia—A disease that inflames the lungs.

Pus—A thick yellowish or greenish fluid.

the disease may be more common among adults than previously thought.

Causes and symptoms

The first sign of cat-scratch disease may be a small blister at the site of a scratch or bite three to 10 days after injury. The blister (which sometimes contains pus) often looks like an insect bite and is usually found on the hands, arms, or head. Within two weeks of the blister's appearance, lymph nodes near the site of injury become swollen. Often the infected person develops a fever or experiences **fatigue** or headaches. The symptoms usually disappear within a month, although the lymph nodes may remain swollen for several months. Hepatitis, **pneumonia**, and other dangerous complications can arise, but the likelihood of cat-scratch disease posing a serious threat to health is very small. **AIDS** patients and other immunocompromised people face the greatest risk of dangerous complications.

Occasionally, the symptoms of cat-scratch disease take the form of what is called Parinaud's oculoglandular syndrome. In such cases, a small sore develops on the palpebral conjunctiva (the membrane lining the inner eyelid), and is often accompanied by **conjunctivitis** (inflammation of the membrane) and swollen lymph nodes in front of the ear. Researchers suspect that the first step in the development of Parinaud's oculoglandular syndrome occurs when *Bartonella henselae* bacteria pass from a cat's saliva to its fur during grooming. Rubbing one's eyes after handling the cat then transmits the bacteria to the conjunctiva.

Diagnosis

A family doctor should be called whenever a cat scratch or bite fails to heal normally or is followed by a persistent fever or other unusual symptoms such as long-lasting bone or joint **pain**. The appearance of painful and swollen lymph nodes is another reason for consulting a doctor. When cat-scratch disease is suspected, the doctor will ask about a history of exposure to cats and look for evidence of a cat scratch or bite and swollen lymph nodes. A blood test for *Bartonella henselae* may be ordered to confirm the doctor's diagnosis.

Treatment

For otherwise healthy people, rest and over-the-counter medications for reducing fever and discomfort (such as **acetaminophen**) while waiting for the disease to run its course are usually all that is necessary. **Antibiotics** are prescribed in some cases, particularly when complications occur or the lymph nodes remain swollen and painful for more than two or three months, but there is no agreement among doctors about when and how they should be used. If a lymph node becomes very swollen and painful, the family doctor may decide to drain it.

Prognosis

Most people recover completely from a bout of cat-scratch disease. Further attacks are rare.

Prevention

Certain common-sense precautions can be taken to guard against the disease. Scratches and bites should be washed immediately with soap and water, and it is never a good idea to rub one's eyes after handling a cat without first washing one's hands. Children should be told not to play with stray cats or make cats angry. Immunocompromised people should avoid owning kittens, which are more likely than adult cats to be infectious. Because cat-scratch disease is usually not a life-threatening illness and people tend to form strong emotional bonds with their cats, doctors do not recommend getting rid of a cat suspected of carrying the disease.

Resources

BOOKS

Tompkins, Lucy Stuart. "Bartonella Infections, Including Cat-Scratch Disease." In *Harrison's Principles of Internal*

Medicine, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Smith, David L. "Cat-Scratch Disease and Related Clinical Syndromes." *American Family Physician* (Apr. 1997): 1783+.

Howard Baker

Cat-scratch fever *see* **Cat-scratch disease**

Cataract surgery

Definition

Cataract surgery is a procedure performed to remove a cloudy lens from the eye; usually an intraocular lens is implanted at the same time.

Purpose

The purpose of cataract surgery is to restore clear vision. It is indicated when cloudy vision due to **cataracts** has progressed to such an extent that it interferes with normal daily activities.

Precautions

Cataract surgery is not performed on both eyes at once. To avoid risking blindness in both eyes in the event of infection or other catastrophe, the first eye is allowed to heal before the cataract is removed from the second eye.

The presence of cataracts can mask additional eye problems, such as retinal damage, that neither doctors nor patients are aware of prior to surgery. Since such conditions will continue to impair sight after cataract removal if they are not identified and treated, the eventual outcome of cataract surgery will depend on the outcome of other problems.

In 1997 and 1998, evidence that cataract surgery can contribute to the progression of age-related **macular degeneration** (ARMD) was published. ARMD is the degeneration of the central part of the retina. Accordingly, ARMD patients with cataracts must weigh the risks of the loss of central vision, within four or five years, against short-term improvement. When an ARMD patient chooses cataract surgery, the surgeon should shield the retina against bright light to protect it from possible light-induced damage during surgery and install an intraocular lens capable of absorbing ultraviolet and blue light, which seem to do the most damage.

KEY TERMS

Age-related macular degeneration (ARMD)—Degeneration of the macula (the central part of the retina where the rods and cones are most dense) that leads to loss of central vision in people over 60.

Cataract—Progressive opacity or clouding of an eye lens, which obstructs the passage of light to the retina.

Cornea—Clear outer covering of the front of the eye.

Intraocular lens—Lens made of silicone or plastic placed within the eye; can be corrective.

Retina—Innermost layer at the back of the eye, which contains light receptors, the rods and cones.

Description

There are two types of cataract surgery: intracapsular and extracapsular. Intracapsular surgery is the removal of both the lens and the thin capsule that surround them. This type of surgery was common before 1980, but has since been displaced by extracapsular surgery. Removal of the capsule requires a large incision and doesn't allow comfortable intraocular lens implantation. Thus, people who undergo intracapsular cataract surgery have long recovery periods and have to wear very thick glasses.

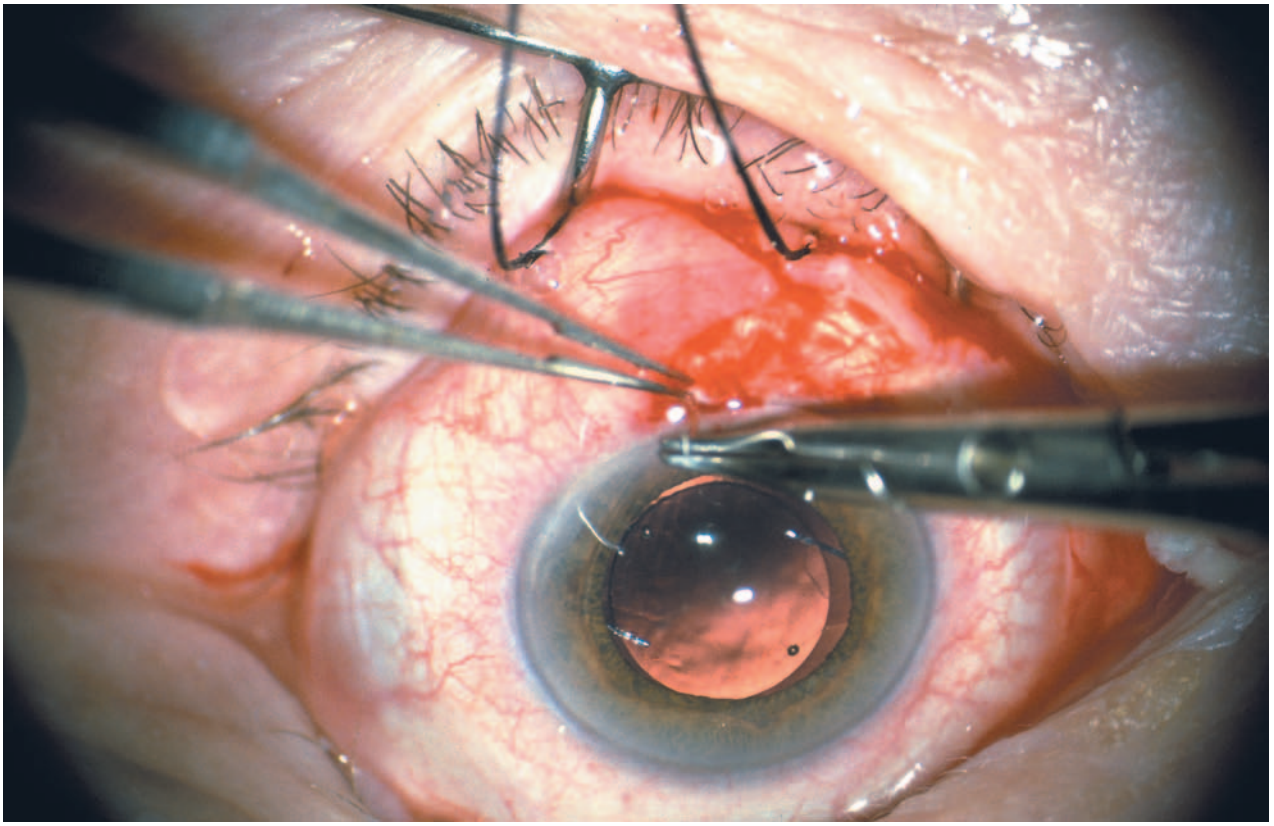
Extracapsular cataract surgery is the removal of the lens where the capsule is left in place. Each year in the United States, over a million cataracts are removed this way.

There are two methods for extracapsular cataract surgery. The usual technique is phacoemulsification. A tiny incision (about 0.12 in or 3 mm long) is made next to the cornea (the eye's outer covering), and an ultrasonic probe is used to break the cataract into minute pieces, which are then removed by suction. When the lens is too hard to be emulsified ultrasonically, the surgeon will use a different extracapsular technique requiring a larger incision. An incision about 0.37 in (9 mm) long is made, and the whole lens (without its capsule) is removed through the incision. Both kinds of extracapsular extraction leave the back of the capsule intact, so a silicone or plastic intraocular lens can be stably implanted in about the same location as the original lens.

The surgery takes about 30–60 minutes per eye.

Preparation

Patients must have a pre-operation **eye examination**, which will include ultrasound analysis to make sure the



Cataract surgery in progress. *(Photograph by David Sutton/Zuma Images, The Stock Market. Reproduced by permission.)*

retina (the innermost layer of the eye, containing the light receptors) is intact and also to measure eye curvature so that a lens with the proper correction can be implanted. The patient will also have a pre-operative **physical examination**. In addition, patients start a course of antibiotic eye drops or ointment the day before surgery.

Aftercare

Proper post-operative care is especially important after cataract surgery. Patients will need someone to drive them home after the surgery and should not bend over or do anything strenuous for about two weeks. They should refrain from rubbing the eye, should wear glasses to protect their eye, and should wear a shield while sleeping so the eye won't be rubbed or bumped accidentally. The patient will usually continue their antibiotic for two to three weeks and will also take anti-inflammatory medication for about the same length of time. If the patient experiences inflammation, redness, or **pain**, they should seek immediate medical treatment to avoid serious complications.

Risks

Cataract surgery itself is quite safe; over 90% of the time, there are no complications. Possible complications include intraocular infection (endophthalmitis), central retinal inflammation (macular **edema**), post-operative **glaucoma**, **retinal detachment**, bleeding under the retina (choroidal hemorrhage), and tiny lens fragments in the back (vitreous) cavity of the eye, all of which can lead to loss of sight.

Normal results

Ordinarily, patients experience improved visual acuity and improved perception of the vividness of colors, leading to increased abilities in many activities, including reading, needlework, driving, golf, and tennis, for example. In addition, sometimes implanted corrective lenses eliminate the need for eyeglasses or contact lenses.

Resources

BOOKS

Salmans, Sandra. *Your Eyes: Questions You Have. Answers You Need*. Allentown, PA: People's Medical Society, 1996.

Shulman, Julius. *Cataracts*. New York: St. Martin's Press, 1995.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Society of Cataract and Refractive Surgery. 4000 Legato Road, Suite 850, Fairfax, VA 22033-4055. (703) 591-2220. <http://www.ascrs.org>.

OTHER

"Cataract in Adults: A Patient's Guide." *National Library of Medicine Page*. <http://text.nlm.nih.gov>.

"Patient Information." *Digital Journal of Ophthalmology.* <http://www.djo.harvard.edu/meei/PI/PIhome.html>.

Lorraine Lica, PhD

Cataracts

Definition

A cataract is a cloudiness or opacity in the normally transparent crystalline lens of the eye. This cloudiness can cause a decrease in vision and may lead to eventual blindness.

Description

The human eye has several parts. The outer layer of the eyeball consists of a transparent dome-shaped cornea and an opaque, white sclera. The cornea and sclera help protect the eye. The next layer includes the iris, pupil, and ciliary body. The iris is the colored part of the eye and the pupil is the small dark round hole in the middle of the iris. The pupil and iris allow light into the eye. The ciliary body contains muscles that help in the eye's focusing ability. The lens lies behind the pupil and iris. It is covered by a cellophane-like capsule. The lens is normally transparent, elliptical in shape, and somewhat elastic. This elasticity allows the lens to focus on both near and far objects. The lens is attached to the ciliary body by fibers (zonules of Zinn). Muscles in the ciliary body act on the zonules, which then change the shape of the lens. This process is called accommodation—the lens focuses images to help make vision clear. As people age, the lens hardens and changes shape less easily. As a result, the accommodation process becomes more difficult, making it harder to see things up close. This generally occurs around the age of 40 and continues until about age 65. The condition is called **presbyopia**. It is a normal condition of **aging**, generally resulting in the need for reading glasses.

The lens is made up of approximately 35% protein and 65% water. As people age, degenerative changes in the lens' proteins occur. Changes in the proteins, water content, enzymes, and other chemicals are some of the reasons for the formation of a cataract.

The major areas of the lens are the nucleus, the cortex, and the capsule. The nucleus is in the center of the lens, the cortex surrounds the nucleus, and the capsule is the outer layer. Opacities can occur in any area of the lens. Cataracts, then, can be classified according to location (nuclear, cortical, or posterior subcapular cataracts). The density and location of the cataract determines the amount of vision affected. If the cataract forms in the area of the lens directly behind the pupil, vision may be significantly impaired. A cataract that occurs on the outer edges or side of the lens will create less of a visual problem.

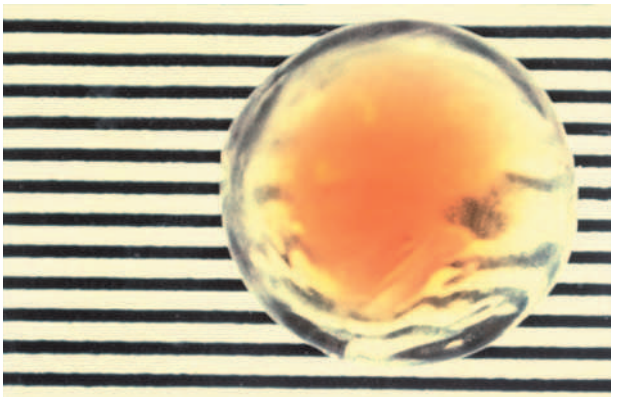
Cataracts in the elderly are so common that they are thought to be a normal part of the aging process. Between the ages of 52 and 64, there is a 50% chance of having a cataract, while at least 70% of those 70 and older are affected. Cataracts associated with aging (senile or age-related cataracts) most often occur in both eyes, with each cataract progressing at a different rate. Initially, cataracts may not affect vision. If the cataract remains small or at the periphery of the lens, the visual changes may be minor.

Cataracts that occur in people other than the elderly are much less common. Congenital cataracts occur very rarely in newborns. Genetic defects or an infection or disease in the mother during **pregnancy** are among the causes of congenital cataracts. Traumatic cataracts may develop after a foreign body or trauma injures the lens or eye. Systemic illnesses, such as diabetes, may result in cataracts. Cataracts can also occur secondary to other eye diseases—for example, an inflammation of the inner layer of the eye (**uveitis**) or **glaucoma**. Such cataracts are called complicated cataracts. Toxic cataracts result from chemical toxicity, such as steroid use. Cataracts can also result from exposure to the sun's ultraviolet (UV) rays.

Causes and symptoms

Recent studies have been conducted to try to determine whether diet or the use of **vitamins** might have an effect on the formation of cataracts in older people. The results have been mixed, with some studies finding that there is a connection and other studies finding none. Much interest has been focused on the use of antioxidant supplements as a protection against cataracts. Antioxidant vitamins such as vitamins A, C, E and beta-carotene help the body clean-up oxygen-free radicals. Some vitamins are marketed specifically for the eyes. Patients should speak to their doctors about the use of such vitamins.

Smoking and alcohol intake have been implicated in cataract formation. Some studies have determined that a diet high in fat will increase the likelihood of cataract formation, while an increase in foods rich in antioxidants will reduce the incidence. More research is needed to determine if diet, smoking, alcohol consumption, or vitamins have any connection to the formation of cataracts.



A dense cataract on lens of eye. *(Photograph by Margaret Cubberly, Phototake NYC. Reproduced by permission.)*

There are several common symptoms of cataracts:

- gradual, painless onset of blurry, filmy, or fuzzy vision
- poor central vision
- frequent changes in eyeglass prescription
- changes in color vision
- increased glare from lights, especially oncoming headlights when driving at night
- "second sight" improvement in near vision (no longer needing reading glasses), but a decrease in distance vision
- poor vision in sunlight
- presence of a milky whiteness in the pupil as the cataract progresses.

Diagnosis

Both ophthalmologists and optometrists may detect and monitor cataract growth and prescribe prescription lenses for visual deficits. However, only an ophthalmologist can perform cataract extraction.

Cataracts are easily diagnosed from the reporting of symptoms, a visual acuity exam using an eye chart, and by examination of the eye itself. Shining a penlight into the pupil may reveal opacities or a color change of the lens even before visual symptoms have developed. An instrument called a slit lamp is basically a large microscope. This lets the doctor examine the front of the eye and the lens. The slit lamp helps the doctor determine the location of the cataract.

Some other diagnostic tests may be used to determine if cataracts are present or how well the patient may potentially see after surgery. These include a glare test, potential vision test, and contrast sensitivity test.

Treatment

For cataracts that cause no symptoms or only minor visual changes, no treatment may be necessary. Continued monitoring and assessment of the cataract is needed by an ophthalmologist or optometrist at scheduled office visits. Increased strength in prescription eyeglasses or contact lenses may be helpful. This may be all that is required if the cataract does not reduce the patient's quality of life.

Cataract surgery—the only option for patients whose cataracts interfere with vision to the extent of affecting their daily lives—is the most frequently performed surgery in the United States. It generally improves vision in over 90% of patients. Some people have heard that a cataract should be "ripe" before being removed. A "ripe" or mature cataract is when the lens is completely opaque. Most cataracts are removed before they reach that stage. Sometimes cataracts need to be removed so that the doctor can examine the back of the eye more carefully. This is important in patients with diseases that may affect the eye. If cataracts are present in both eyes, only one eye at a time should be operated on. Healing occurs in the first eye before the second cataract is removed, sometimes as early as the following week. A final eyeglass prescription is usually given about four to six weeks after surgery. Patients will still need reading glasses. The overall health of the patient needs to be considered in making the decision to operate. However, age alone need not preclude effective surgical treatment of cataracts. People in their 90s can have successful return of vision after **cataract surgery**.

Surgery to remove cataracts is generally an outpatient procedure. A local anesthetic is used and the procedure lasts about an hour. Removal of the cloudy lens can be done by several different procedures. The three types of cataract surgery available are:

- Extracapsular cataract extraction. This type of cataract extraction is the most common. The lens and the front portion of the capsule are removed. The back part of the capsule remains, providing strength to the eye.
- Intracapsular cataract extraction. The lens and the entire capsule are removed. This method carries an increased risk for detachment of the retina and swelling after surgery. It is rarely used.
- Phacoemulsification. This type of extracapsular extraction needs a very small incision, resulting in faster healing. Ultrasonic vibration is applied to the lens to break it up into very small pieces which are then aspirated out of the eye with suction by the ophthalmologist.

A replacement lens is usually inserted at the time of the surgery. A plastic artificial lens called an intraocular lens (IOL) is placed in the remaining posterior lens capsule of the eye. When the intracapsular extraction

method is used, an IOL may be clipped onto the iris. Contact lenses and cataract glasses (aphakic lenses) are prescribed if an IOL was not inserted. A folding IOL is used when phacoemulsification is performed to accommodate the small incision.

Antibiotic drops to prevent infection and steroids to reduce inflammation are prescribed after surgery. An eye shield or glasses during the day will protect the eye from injury while it heals. During the night, an eye shield is worn. The patient returns to the doctor the day after surgery for assessment, with several follow-up visits over the next two months to monitor the healing process.

Prognosis

The success rate of cataract extraction is very high, with a good prognosis. A visual acuity of 20/40 or better may be achieved. If an extracapsular cataract extraction was performed, a secondary cataract may develop in the remaining back portion of the capsule. This can occur one to two years after surgery. YAG capsulotomy is most often used for this type of cataract. YAG stands for yttrium aluminum garnet, the name of the laser used for this procedure. This is a painless outpatient procedure and requires no incision. The laser beam makes a small opening in the remaining back part of the capsule, allowing light through.

In a very small percentage (3–5%) of surgical cataract extractions, complications occur. Infections, swelling of the cornea (**edema**), bleeding, **retinal detachment**, and the onset of glaucoma have been reported. Some problems may occur one to two days, or even several weeks, after surgery. Any haziness, redness, decrease in vision, nausea, or **pain** should be reported to the surgeon immediately.

Prevention

Preventive measures emphasize protecting the eyes from UV radiation by wearing glasses with a special coating to protect against UV rays. Dark lenses alone are not sufficient. The lenses must protect against UV light (specifically, UV-A and UV-B). Antioxidants may also provide some protection by reducing free radicals that can damage lens proteins. A healthy diet rich in sources of antioxidants, including citrus fruits, sweet potatoes, carrots, green leafy vegetables, and/or vitamin supplements may be helpful. When taking certain medications, such as steroids, more frequent eye exams may be necessary. Patients should speak to their doctors to see if medications may affect their eyes.

Resources

BOOKS

"Cataract." In *Medical-Surgical Nursing: Concepts and Clinical Practice*. 5th ed. Ed. Wilma J. Phipps, et al. St. Louis: Mosby-Year Book, Inc., 1995.

KEY TERMS

Aphakia—Absence of the lens of the eye.

Ciliary body—A structure in the eye that contains muscles which will affect the focusing of the lens.

Glaucoma—Disease of the eye characterized by increased pressure of the fluid inside the eye. Untreated, glaucoma can lead to blindness.

Phacoemulsification—Surgical procedure to remove a cataract using sound waves to disintegrate the lens which is then removed by suction.

Retina—The innermost layer of the eyeball. Images focused onto the retina are then sent to the brain.

Ultraviolet radiation (UV)—Invisible light rays which may be responsible for sunburns, skin cancers, and cataract formation.

Uveitis—Inflammation of the uvea. The uvea is a continuous layer of tissue which consists of the iris, the ciliary body, and the choroid. The uvea lies between the retina and sclera.

PERIODICALS

"Cataracts." *Well-Connected Health Report 26* (31 May 1997).

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

The Lighthouse. 111 East 59th St., New York, NY 10022. (800) 334-5497. <http://www.lighthouse.org>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

Cynthia L. Frozena, RN

Catatonia

Definition

Catatonia is a condition marked by changes in muscle tone or activity associated with a large number of serious mental and physical illnesses. There are two distinct sets of symptoms that are characteristic of this condition. In catatonic stupor the individual experiences a

deficit of motor (movement) activity that can render him/her motionless. Catatonic excitement, or excessive movement, is associated with violent behavior directed toward oneself or others.

Features of catatonia may also be seen in Neuroleptic Malignant Syndrome (NMS) which is an uncommon (but potentially lethal) reaction to some medications used to treat major mental illnesses. NMS is considered a medical emergency since 25% of untreated cases result in **death**. Catatonia can also be present in individuals suffering from a number of other physical and emotional conditions such as drug intoxication, depression, and **schizophrenia**. It is most commonly associated with **mood disorders**.

Description

In catatonic stupor, motor activity may be reduced to zero. Individuals avoid bathing and grooming, make little or no eye contact with others, may be mute and rigid, and initiate no social behaviors. In catatonic excitement the individual is extremely hyperactive although the activity seems to have no purpose. Violence toward him/herself or others may also be seen.

NMS is observed as a dangerous side effect associated with certain neuroleptic (antipsychotic) drugs such as haloperidol (Haldol). It comes on suddenly and is characterized by stiffening of the muscles, **fever**, confusion and heavy sweating.

Catatonia can also be categorized as intrinsic or extrinsic. If the condition has an identifiable cause, it is designated as extrinsic. If no cause can be determined following **physical examination**, laboratory testing, and history taking, the illness is considered to be intrinsic.

Causes and symptoms

The causes of catatonia are largely unknown although research indicates that brain structure and function are altered in this condition. While this and other information point to a physical cause, none has yet been proven. A variety of medical conditions also may lead to catatonia including head trauma, cerebrovascular disease, **encephalitis**, and certain metabolic disorders. NMS is an adverse side effect of certain **antipsychotic drugs**.

A variety of symptoms are associated with catatonia. Among the more common are echopraxia (imitation of the gestures of others) and echolalia (parrot-like repetition of words spoken by others). Other signs and symptoms include violence directed toward him/herself, the assumption of inappropriate posture, selective **mutism**, negativism, facial grimaces, and animal-like noises.

Catatonic stupor is marked by immobility and a behavior known as *cerea flexibilitas* (waxy flexibility) in which the individual can be made to assume bizarre (and sometimes painful) postures that they will maintain for extended periods of time. The individual may become dehydrated and malnourished because food and liquids are refused. In extreme situations such individuals must be fed through a tube. Catatonic excitement is characterized by hyperactivity and violence; the individual may harm him/herself or others. On rare occasions, **isolation** or restraint may be needed to ensure the individual's safety and the safety of others.

KEY TERMS

Barbiturates—A group of medicines that slow breathing and lower the body temperature and blood pressure. They can be habit forming and are now used chiefly for anesthesia.

Benzodiazipines—This group of medicines is used to help reduce anxiety (especially before surgery) and to help people sleep.

Electroconvulsive therapy—This type of therapy is used to treat major depression and severe mental illness that does not respond to medications. A measured dose of electricity is introduced into the brain in order to produce a convulsion. Electroconvulsive therapy is safe and effective.

Mutism—The inability or refusal to speak.

Negativism—Behavior characterized by resistance, opposition, and refusal to cooperate with requests, even the most reasonable ones.

Neuroleptic drugs—Antipsychotic drugs, including major tranquilizers, used in the treatment of psychoses like schizophrenia.

Diagnosis

Recognition of catatonia is made on the basis of specific movement symptoms. These include odd ways of walking such as walking on tiptoes or ritualistic pacing, and rarely, hopping and skipping. Repetitive odd movements of the fingers or hands, as well as imitating the speech or movements of others also may indicate that catatonia is present. There are no laboratory or other tests that can be used to positively diagnose this condition, but medical and neurological tests are necessary to rule out underlying lesions or disorders that may be causing the symptoms observed.

Treatment

Treatment of catatonia includes medications such as benzodiazipines (which are the preferred treatment) and rarely **barbiturates**. Antipsychotic drugs may be appropri-

ate in some cases, but often cause catatonia to worsen. **Electroconvulsive therapy** may prove beneficial for clients who do not respond to medication. If these approaches are unsuccessful, treatment will be redirected to attempts to control the signs and symptoms of the illness.

Prognosis

Catatonia usually responds quickly to medication interventions.

Prevention

There is currently no known way to prevent catatonia because the cause has not yet been identified. Research efforts continue to explore possible origins. Avoiding excessive use of neuroleptic drugs can help minimize the risk of developing catatonic-like symptoms.

Resources

BOOKS

Diagnostic and Statistical Manual for Mental Disorders. 4th edition. Washington, DC: American Psychiatric Association, 1994.

Frisch, Noreen Cavan, and Lawrence E. Frisch. *Psychiatric Mental Health Nursing*. Albany, NY: Delmar Publishers, 1998.

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Catecholamines tests

Definition

Catecholamines is a collective term for the hormones epinephrine, norepinephrine, and dopamine. Manufactured chiefly by the chromaffin cells of the adrenal glands, these hormones are involved in readying the body for the "fight-or-flight" response (also known as the alarm reaction). When these hormones are released, the heart beats stronger and faster, blood pressure rises, more blood flows to the brain and muscles, the liver releases stores of energy as a sugar the body can readily use (glucose), the rate of breathing increases and airways widen, and digestive activity slows. These reactions direct more oxygen and fuel to the organs most active in responding to stress—mainly the brain, heart, and skeletal muscles.

Purpose

Pheochromocytoma (a tumor of the chromaffin cells of the adrenal gland) and tumors of the nervous system (neuroblastomas, ganglioneuroblastomas, and ganglioneuromas) that affect hormone production can cause excessive levels of different catecholamines to be secreted. This results in constant or intermittent high blood pressure (**hypertension**). Episodes of high blood pressure may be accompanied by symptoms such as **headache**, sweating, **palpitations**, and **anxiety**. The catecholamines test can be ordered, then, to determine if high blood pressure and other symptoms are related to improper hormone secretion and to identify the type of tumor causing elevated catecholamine levels.

Description

The catecholamines test can be performed on either blood or urine. If performed on blood, the test may require one or two samples, depending on the physician's request. The first blood sample will be drawn after the patient has been lying down in a warm, comfortable environment for at least 30 minutes. If a second sample is needed, the patient will be asked to stand for 10 minutes before the blood is drawn. Instead of a venipuncture, which can be stressful for the patient, possibly increasing catecholamine levels in the blood, a plastic or rubber tube-like device called a catheter may be used to collect the blood samples. The catheter would be inserted in a vein 24 hours in advance, eliminating the need for needle punctures at the time of the test.

It may take up to a week for a lab to complete testing of the samples. Because blood levels of catecholamines commonly go up and down in response to such factors as temperature, **stress**, postural change, diet, **smoking**, **obesity**, and many drugs, abnormally high blood test results should be confirmed with a 24-hour urine test. In addition, catecholamine secretion from a tumor may not be steady, but may occur periodically during the day, and potentially could be missed when blood testing is used. The urine test provides the laboratory with a specimen that reflects catecholamine production over an entire 24-hour period. If urine is tested, the patient or a healthcare worker must collect all the urine passed over the 24-hour period.

Preparation

It is important that the patient refrain from using certain medications, especially cold or allergy remedies, for two weeks before the test. Certain foods—including bananas, avocados, cheese, coffee, tea, cocoa, beer, licorice, citrus fruit, vanilla, and Chianti—must be avoided for 48 hours prior to testing. However, people should be sure to get adequate amounts of vitamin C before the test, because this vitamin is necessary for catecholamine formation. The patient should be **fasting** (nothing to eat or drink) for 10 to 24 hours before the blood test and should not smoke for 24 hours beforehand. Some laboratories may call for additional restrictions. As much as possible, the patient should try to avoid excessive physi-

KEY TERMS

Dopamine—Dopamine is a precursor of epinephrine and norepinephrine.

Epinephrine—Epinephrine, also called adrenaline, is a naturally occurring hormone released by the adrenal glands in response to signals from the sympathetic nervous system. These signals are triggered by stress, exercise, or by emotions such as fear.

Ganglioneuroma—A ganglioneuroma is a tumor composed of mature nerve cells.

Neuroblastoma—Neuroblastoma is a tumor of the adrenal glands or sympathetic nervous system. Neuroblastomas can range from being relatively harmless to highly malignant.

Norepinephrine—Norepinephrine is a hormone secreted by certain nerve endings of the sympathetic nervous system, and by the medulla (center) of the adrenal glands. Its primary function is to help maintain a constant blood pressure by stimulating certain blood vessels to constrict when the blood pressure falls below normal.

Pheochromocytoma—A pheochromocytoma is a tumor that originates from the adrenal gland's chromaffin cells, causing overproduction of catecholamines, powerful hormones that induce high blood pressure and other symptoms.

cal **exercise** and emotional stress before the test, because either may alter test results by causing increased secretion of epinephrine and norepinephrine.

Patients collecting their own 24-hour urine samples will be given a container with special instructions. The urine samples must be refrigerated.

Risks

Risks for the blood test are minimal, but may include slight bleeding from the venipuncture site, **fainting** or feeling lightheaded after blood is drawn, or blood accumulating under the puncture site (hematoma). There are no risks for the urine test.

Normal results

Reference ranges are laboratory-specific, vary according to methodology of testing, and differ between blood and urine samples. If testing is done by the method called High Performance Liquid Chromatography (HPLC), typical values for blood and urine follow.

Reference ranges for blood catecholamines

Supine (lying down): Epinephrine less than 50 pg/mL, norepinephrine less than 410 pg/mL, and dopamine less than 90 pg/mL. Standing: Values for blood specimens taken when the subject is standing are higher than the ranges for supine posture for norepinephrine and epinephrine, but not for dopamine.

Reference ranges for urine catecholamines

Epinephrine 0–20 microgram per 24 hours; norepinephrine 15–80 microgram per 24 hours; dopamine 65–400 microgram per 24 hours.

Abnormal results

Depending on the results, high catecholamine levels can indicate different conditions and/or causes:

- High catecholamine levels can help to verify pheochromocytoma, **neuroblastoma**, or ganglioneuroma. An aid to diagnosis is the fact that an adrenal medullary tumor (pheochromocytoma) secretes epinephrine, whereas ganglioneuroma and neuroblastoma secrete norepinephrine.
- Elevations are possible with, but do not directly confirm, thyroid disorders, low blood sugar (**hypoglycemia**), or heart disease.
- Electroshock therapy, or **shock** resulting from hemorrhage or exposure to toxins, can raise catecholamine levels.
- In the patient with normal or low baseline catecholamine levels, failure to show an increase in the sample taken after standing suggests an autonomic nervous system dysfunction (the division of the nervous system responsible for the automatic or unconscious regulation of internal body functioning).

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

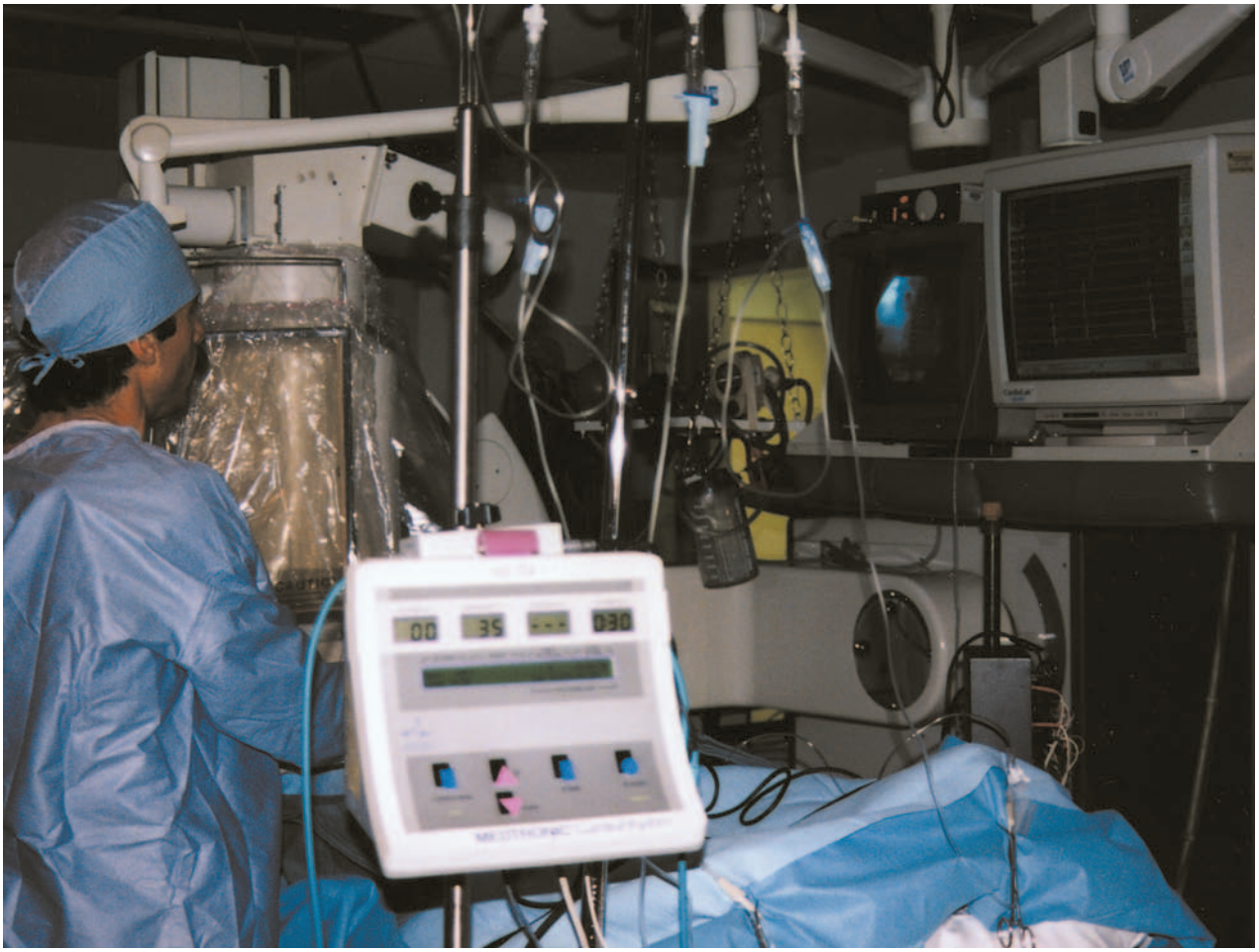
Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Catheter ablation

Definition

Catheter ablation of an irregular heartbeat involves having a tube (a catheter) inserted into the heart through



During catheter ablation, a long flexible tube called a catheter is inserted into a vein in the patient's groin and guided toward the heart. A special x-ray machine called a fluoroscope helps the electrophysiologist visualize correct placement. *(Photograph by Collette Placek. Reproduced by permission.)*

which electrical energy is sent to either reset the heartbeat or stop the heart from beating so a mechanical pacemaker can be put in place.

Purpose

Irregular heartbeats can occur in healthy people without causing any dangerous symptoms or requiring medical attention. Slight changes in the normal patterns of heartbeats often reset themselves without notice.

But when the heartbeat is greatly disrupted—either because of traumatic injury, disease, **hypertension**, surgery, or reduced blood flow to the heart caused by blockages in the blood vessels that nourish the heart—the condition must be recognized and treated immediately. Otherwise, it can be fatal.

Various drugs can be used to control and help reset these abnormal heart rhythms (**arrhythmias**). The technique of catheter ablation (meaning tube-guided removal) is used to interrupt the abnormal contractions in the heart, allowing normal heart beating to resume. **Atrial fibrillation and flutter** and **Wolff-Parkinson-White syndrome** are two of the most common disorders treated with catheter ablation.

Precautions

The improper correction of abnormal heartbeats can cause additional arrhythmias and can be fatal. Abnormalities in different areas of the heart cause different types of irregular heartbeats; the type of arrhythmia must be clearly defined before this procedure can be properly done.

Description

Catheter ablation involves delivering highly focused heat (or radio frequency energy) to specific areas of the

KEY TERMS

Fluoroscope—A specialized x-ray machine used to visualize the placement of the catheter when attempting to correct irregular heartbeats.

Pacemaker—An electrical device that has electrodes attached to the heart to electrically stimulate the heart to beat normally. Pacemakers can be internal (placed under the skin) or external, with the electrodes placed on the skin or threaded through a tube placed into the heart.

heart. Radio frequency energy is very rapidly alternating electrical current that is produced at the tip of the catheter that is placed inside the heart. At the same time as the catheter is inserted, a second electrode is placed on the patient's skin. When the catheter is energized, the body conducts the energy from the catheter's tip, through the heart and to the electrode on the skin's surface, completing the circuit.

Although very little electricity is given off by the catheter, the instrument does generate a large amount of heat. This heat is absorbed by the heart tissue, causing a small localized burn and destroying the tissue in contact with the catheter tip; in this way, small regions of heart tissue are burned in a controlled manner. This controlled destruction of small sections of heart muscle actually kills the nerve cells causing the irregular heartbeat, stopping the nerve signals that are passing through this section of the heart. This usually causes the irregular heartbeat to be reset into a normal heartbeat.

Preparation

People can undergo this procedure by having general anesthesia or by taking medicines to make them relaxed and sleepy (sedatives) along with painkillers. Once the type of irregular heartbeat is identified and these medicines are given, the catheter is inserted through a blood vessel and into the heart. Importantly, correct placement of the catheter is visualized by using a specialized type of x-ray machine called a fluoroscope.

Aftercare

Being sure the patient is comfortable during and after this procedure is very important. However, because each person may have a different arrhythmia and possibly other medical problems as well, each patient's needs must be evaluated individually.

Risks

Overall, fewer than 5% of people having this procedure experience complications. The most common complications are usually related to blood vessel injury when the catheter is inserted and to different heart-related problems due to the moving of the catheter within the heart. However, in general, this technique is safe and can control many different heart arrhythmias.

Normal results

Depending upon the type of irregular heartbeat being treated, either the normal heartbeat resumes after treatment or the ability of the heart to beat on its own is lost, requiring the insertion of a pacemaker to stimulate the heart to beat regularly.

Abnormal results

Additional irregular heartbeats can occur as a result of this procedure, as can damage to the blood vessels that feed the heart. Because this procedure requires the use of the x-ray machine called a fluoroscope, there is exposure to x-ray radiation, but it's doubtful that this is harmful in adult patients. The risk versus benefit is considered with pediatric patients.

Resources

BOOKS

Scheinman, Melvin M. "Treatment of Cardiac Arrhythmias with Catheter Ablative Techniques." In *Hurst's The Heart*, ed. Robert C. Schlant, et al. New York: McGraw Hill, 1994.

PERIODICALS

Lashus, Andrew G., Christopher L. Case, and Paul C. Gillette. "Catheter Ablation Treatment of Supraventricular Tachycardia-Induced Cardiomyopathy." *Archives of Pediatrics and Adolescent Medicine* 151 (Mar. 1997): 264.

Patlak, Margie. "When Heartbeats Go Haywire." *FDA Consumer* 31 (Apr. 1997): 12.

"Radiofrequency Catheter Ablation for Treatment of Cardiac Arrhythmias." *Medical Letter on Drugs and Therapeutics* 38 (26 Mar. 1996): 409.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dominic De Bellis, PhD

Cat's cry syndrome *see* **Cri du chat syndrome**

CBC *see* **Blood count**

CEA test *see* **Carcinoembryonic antigen test**
CEB *see* **Chronic fatigue syndrome**
Cefaclor *see* **Cephalosporins**
Cefadroxil *see* **Cephalosporins**
Cefixime *see* **Cephalosporins**
Cefprozil *see* **Cephalosporins**
Cefurox *see* **Cephalosporins**

Celiac disease

Definition

Celiac disease is a disease of the digestive system that damages the small intestine and interferes with the absorption of nutrients from food.

Description

Celiac disease occurs when the body reacts abnormally to gluten, a protein found in wheat, rye, barley, and possibly oats. When someone with celiac disease eats foods containing gluten, that person's immune system causes an inflammatory response in the small intestine, which damages the tissues and results in impaired ability to absorb nutrients from foods. The inflammation and malabsorption create wide-ranging problems in many systems of the body. Since the body's own immune system causes the damage, celiac disease is classified as an "autoimmune" disorder. Celiac disease may also be called sprue, nontropical sprue, gluten sensitive enteropathy, celiac sprue, and adult celiac disease.

Celiac disease may be discovered at any age, from infancy through adulthood. The disorder is more commonly found among white Europeans or in people of European descent. It is very unusual to find celiac disease in African or Asian people. The exact incidence of the disease is uncertain. Estimates vary from one in 5000, to as many as one in every 300 individuals with this background. The prevalence of celiac disease seems to be different from one European country to another, and between Europe and the United States. This may be due to differences in diet and/or unrecognized disease. A recent study of random blood samples tested for celiac disease in the US showed one in 250 testing positive. It is clearly underdiagnosed, probably due to the symptoms being attributed to another problem, or lack of knowledge about celiac disease by physicians and laboratories. Because of the known genetic component, relatives of patients with celiac disease are considered at higher risk for the disorder.

Because celiac disease has a hereditary influence, close relatives (especially first degree relatives, such as children, siblings, and parents) have a higher risk of being affected with the condition. The chance that a first degree relative of someone with celiac disease will have the disease is about 10%.

As more is learned about celiac disease, it becomes evident that it has many variations which may not produce typical symptoms. It may even be clinically "silent," where no obvious problems related to the disease are apparent.

Causes and symptoms

Celiac disease can run in families and has a genetic basis, although the pattern of inheritance is complicated. The type of inheritance pattern that celiac disease follows is called multifactorial (caused by many factors, both genetic and environmental). Researchers think that several factors must exist in order for the disease to occur. The patient must have a genetic predisposition to develop the disorder. Then, something in their environment acts as a stimulus, or "trigger," to their immune system, causing the disease to become active for the first time. For conditions with multifactorial inheritance, people without the genetic predisposition are less likely to develop the condition with exposure to the same triggers. Or, they may require more exposure to the stimulus before developing the disease than someone with a genetic predisposition. Some of the things which may provoke a reaction include surgery, especially gastrointestinal surgery; a change to a low fat diet, which has an increased number of wheat-based foods; **pregnancy**; **childbirth**; severe emotional **stress**; or a viral infection. This combination of genetic susceptibility and an outside agent leads to celiac disease.

Each person with celiac disease is affected differently. When food containing gluten reaches the small intestine, the immune system begins to attack a substance called gliadin, which is found in the gluten. The resulting inflammation causes damage to the delicate finger-like structures in the intestine, called villi, where food absorption actually takes place. The patient may experience a number of symptoms related to the inflammation and the chemicals it releases, and/or the lack of ability to absorb nutrients from food, which can cause **malnutrition**.

The most commonly recognized symptoms of celiac disease relate to the improper absorption of food in the gastrointestinal system. Many patients with gastrointestinal symptoms will have **diarrhea** and fatty, greasy,

unusually foul-smelling stools. The patient may complain of excessive gas (flatulence), distended abdomen, weight loss, and generalized weakness. Not all people have digestive system complications; some people only have irritability or depression. Irritability is one of the most common symptoms in children with celiac disease.

Not all patients have these problems. Unrecognized and therefore untreated celiac disease may cause or contribute to a variety of other conditions. The decreased ability to digest, absorb, and utilize food properly (malabsorption) may cause anemia (low red **blood count**) from iron deficiency or easy bruising from a lack of vitamin K. Poor mineral absorption may result in **osteoporosis**, or "brittle bones," which may lead to bone **fractures**. Vitamin D levels may be insufficient and bring about a "softening" of bones (osteomalacia), which produces **pain** and bony deformities, such as flattening or bending. Defects in the tooth enamel, characteristic of celiac disease, may be recognized by dentists. Celiac disease may be discovered during medical tests performed to investigate **failure to thrive** in infants, or lack of proper growth in children and adolescents. People with celiac disease may also experience **lactose intolerance** because they don't produce enough of the enzyme lactase, which breaks down the sugar in milk into a form the body can absorb. Other symptoms can include muscle cramps, **fatigue**, delayed growth, tingling or numbness in the legs (from nerve damage), pale sores in the mouth (called aphthus ulcers), tooth discoloration, or missed menstrual periods (due to severe weight loss).

A distinctive, painful skin rash, called **dermatitis** herpetiformis, may be the first sign of celiac disease. Approximately 10% of patients with celiac disease have this rash, but it is estimated that 85% or more of patients with the rash have the disease.

Many disorders are associated with celiac disease, though the nature of the connection is unclear. One type of epilepsy is linked to celiac disease. Once their celiac disease is successfully treated, a significant number of these patients have fewer or no seizures. Patients with **alopecia** areata, a condition where hair loss occurs in sharply defined areas, have been shown to have a higher risk of celiac disease than the general population. There appears to be a higher percentage of celiac disease among people with **Down syndrome**, but the link between the conditions is unknown.

Several conditions attributed to a disorder of the immune system have been associated with celiac disease. People with insulin dependent diabetes (type I) have a much higher incidence of celiac disease. One source estimates that as many as one in 20 insulin-dependent diabetics may have celiac disease. Patients with other conditions where celiac disease may be more commonly found include those with juvenile chronic arthritis, some thyroid diseases, and IgA deficiency.

There is an increased risk of intestinal lymphoma, a type of **cancer**, in individuals with celiac disease. Successful treatment of the celiac disease seems to decrease the chance of developing lymphoma.

Diagnosis

Because of the variety of ways celiac disease can manifest itself, it is often not discovered promptly. Its symptoms are similar to many other conditions including irritible bowel syndrome, **Crohn's disease**, **ulcerative colitis**, diverticulosis, intestinal infections, **chronic fatigue syndrome**, and depression. The condition may persist without diagnosis for so long that the patient accepts a general feeling of illness as normal. This leads to further delay in identifying and treating the disorder. It is not unusual for the disease to be identified in the course of medical investigations for seemingly unrelated problems. For example, celiac disease has been discovered during testing to find the cause of **infertility**.

If celiac disease is suspected, a blood test can be ordered. This test looks for the antibodies to gluten (called antigliadin, anti-endomysium, and antireticulin) that the immune system produces in celiac disease. Antibodies are chemicals produced by the immune system in response to substances that the body perceives to be threatening. Some experts advocate not just evaluating patients with symptoms, but using these blood studies as a screening test for high-risk individuals, such as those with relatives (especially first degree relatives) known to have the disorder. An abnormal result points towards celiac disease, but further tests are needed to confirm the diagnosis. Because celiac disease affects the ability of the body to absorb nutrients from food, several tests may be ordered to look for nutritional deficiencies. For example, doctors may order a test of iron levels in the blood because low levels of iron (anemia) may accompany celiac disease. Doctors may also order a test for fat in the stool, since celiac disease prevents the body from absorbing fat from food.

If these tests above are suspicious for celiac disease, the next step is a biopsy (removal of a tiny piece of tissue surgically) of the small intestine. This is usually done by a gastroenterologist, a physician who specializes in diagnosing and treating bowel disorders. It is generally performed in the office, or in a hospital's outpatient department. The patient remains awake, but is sedated. A narrow tube, called an endoscope, is passed through the mouth, down through the stomach, and into the small intestine. A small sample of tissue is taken and sent to the laboratory for analysis. If it shows a pattern of tissue damage characteristic of celiac disease, the diagnosis is established.

The patient is then placed on a gluten-free diet (GFD). The physician will periodically recheck the level of antibody in the patient's blood. After several months, the small intestine is biopsied again. If the diagnosis of celiac disease was correct (and the patient followed the rigorous diet), healing of the intestine will be apparent. Most experts agree that it is necessary to follow these steps in order to be sure of an accurate diagnosis.

Treatment

The only treatment for celiac disease is a gluten-free diet. This may be easy for the doctor to prescribe, but difficult for the patient to follow. For most people, adhering to this diet will stop symptoms and prevent damage to the intestines. Damaged villi can be functional again in three to six months. This diet must be followed for life. For people whose symptoms are cured by the gluten-free diet, this is further evidence that their diagnosis is correct.

Gluten is present in any product that contains wheat, rye, barley, or oats. It helps make bread rise, and gives many foods a smooth, pleasing texture. In addition to the many obvious places gluten can be found in a normal diet, such as breads, cereals, and pasta, there are many hidden sources of gluten. These include ingredients added to foods to improve texture or enhance flavor and products used in food packaging. Gluten may even be present on surfaces used for food preparation or cooking.

Fresh foods that have not been artificially processed, such as fruits, vegetables, and meats, are permitted as part of a GFD. Gluten-free foods can be found in health food stores and in some supermarkets. Mail-order food companies often have a selection of gluten-free products. Help in dietary planning is available from dieticians (healthcare professionals specializing in food and **nutrition**) or from support groups for individuals with celiac disease. There are many cookbooks on the market specifically for those on a GFD.

Treating celiac disease with a GFD is almost always completely effective. Gastrointestinal complaints and other symptoms are alleviated. Secondary complications, such as anemia and osteoporosis, resolve in almost all patients. People who have experienced lactose intolerance related to their celiac disease usually see those symptoms subside, as well. Although there is no risk and much potential benefit to this treatment, it is clear that avoiding all foods containing gluten can be difficult.

Experts emphasize the need for lifelong adherence to the GFD to avoid the long-term complications of this disorder. They point out that although the disease may have symptom-free periods if the diet is not followed, silent damage continues to occur. Celiac disease cannot be "outgrown" or cured, according to medical authorities.

KEY TERMS

Antibodies—Proteins that provoke the immune system to attack particular substances. In celiac disease, the immune system makes antibodies to a component of gluten.

Gluten—A protein found in wheat, rye, barley, and oats.

Villi—Tiny, finger-like projections that enable the small intestine to absorb nutrients from food.

Prognosis

Patients with celiac disease must adhere to a strict GFD throughout their lifetime. Once the diet has been followed for several years, individuals with celiac disease have similar mortality rates as the general population. However, about 10% of people with celiac disease develop a cancer involving the gastrointestinal tract (both carcinoma and lymphoma).

There are a small number of patients who develop a refractory type of celiac disease, where the GFD no longer seems effective. Once the diet has been thoroughly assessed to ensure no hidden sources of gluten are causing the problem, medications may be prescribed. Steroids or **immunosuppressant drugs** are often used to try to control the disease. It is unclear whether these efforts meet with much success.

Prevention

There is no way to prevent celiac disease. However, the key to decreasing its impact on overall health is early diagnosis and strict adherence to the prescribed gluten-free diet.

Resources

BOOKS

Lowell, Jax Peters. *Against the Grain: The Slightly Eccentric Guide to Living Well without Wheat or Gluten*. New York: Henry Holt, 1996.

PERIODICALS

Gluten-Free Living (bimonthly newsletter) PO Box 105, Hastings-on-Hudson, NY 10706.

Guest, Jean. "Wheat's Your Problem?" *Diabetes Forecast* 49 (August 1996): 44–51.

Pruessner, H. "Detecting Celiac Disease in Your Patients." *American Family Physician* 57 (March 1998): 1023–34.

ORGANIZATIONS

American Celiac Society. 58 Musano Court, West Orange, NJ, 7052. (201) 325-8837.

Celiac Disease Foundation. 13251 Ventura Blvd., Suite 1, Studio City, CA 91604-1838. (818) 990-2354.

Celiac Sprue Association/United States of America (CSA/USA). PO Box 31700, Omaha, NE 68131-0700. (402) 558-0600.

Gluten Intolerance Group. PO Box 23053, Seattle, WA, 98102-0353. (206) 325-6980.

National Center for Nutrition and Dietetics. American Dietetic Association, 216 West Jackson Boulevard, Suite 800, Chicago, IL, 60606-6995. (800) 366-1655.

OTHER

National Institute of Diabetes & Digestive & Kidney Diseases. <http://www.niddk.nih.gov/health/digest/pubs/celiac/index.htm>.

Amy Vance, MS, CGC

Cellulitis

Definition

Cellulitis is a spreading bacterial infection just below the skin surface. It is most commonly caused by *Streptococcus pyogenes* or *Staphylococcus aureus*.

Description

The word "cellulitis" actually means "inflammation of the cells." Specifically, cellulitis refers to an infection of the tissue just below the skin surface. In humans, the skin and the tissues under the skin are the most common locations for microbial infection. Skin is the first defense against invading bacteria and other microbes. An infection can occur when this normally strong barrier is damaged due to surgery, injury, or a burn. Even something as small as a scratch or an insect bite allows bacteria to enter the skin, which may lead to an infection. Usually, the immune system kills any invading bacteria, but sometimes the bacteria are able to grow and cause an infection.

Once past the skin surface, the warmth, moisture, and nutrients allow bacteria to grow rapidly. Disease-causing bacteria release proteins called enzymes which cause tissue damage. The body's reaction to damage is inflammation which is characterized by **pain**, redness, heat, and swelling. This red, painful region grows bigger as the infection and resulting tissue damage spread. An untreated infection may spread to the lymphatic system (**acute lymphangitis**), the lymph nodes (**lymphadenitis**), the bloodstream (**bacteremia**), or into deeper tissues. Cellulitis most often occurs on the face, neck, and legs.

Orbital cellulitis

A very serious infection, called orbital cellulitis, occurs when bacteria enter and infect the tissues surrounding the eye. In 50–70% of all cases of orbital cellulitis, the infection spreads to the eye(s) from the sinuses or the upper respiratory tract (nose and throat). Twenty-five percent of orbital infections occur after surgery on the face. Other sources of orbital infection include a direct infection from an eye injury, from a dental or throat infection, and through the bloodstream.

Infection of the tissues surrounding the eye causes redness, swollen eyelids, severe pain, and causes the eye to bulge out. This serious infection can lead to a temporary loss of vision, blindness, brain abscesses, inflammation of the brain and spinal tissues (**meningitis**), and other complications. Before the discovery of **antibiotics**, orbital cellulitis caused blindness in 20% of patients and **death** in 17% of patients. Antibiotic treatment has significantly reduced the incidence of blindness and death.

Causes and symptoms

Although other kinds of bacteria can cause cellulitis, it is most often caused by *Streptococcus pyogenes* (the bacteria which causes **strep throat**) and *Staphylococcus aureus*. *Streptococcus pyogenes* is the so-called "flesh-eating bacteria" and, in rare cases, can cause a dangerous, deep skin infection called necrotizing fasciitis. Orbital cellulitis may be caused by bacteria which cannot grow in the presence of oxygen (anaerobic bacteria). In children, *Haemophilus influenzae* type B frequently causes orbital cellulitis following a sinus infection.

Streptococcus pyogenes can be picked up from a person who has strep throat or an infected sore. Other cellulitis-causing bacteria can be acquired from direct contact with infected sores. Persons who are at a higher risk for cellulitis are those who have a severe underlying disease (such as **cancer**, diabetes, and kidney disease), are taking steroid medications, have a reduced immune system (because of **AIDS**, organ transplant, etc.), have been burned, have insect bites, have reduced blood circulation to limbs, or have had a leg vein removed for coronary bypass surgery. In addition, chicken pox, human or animal bite **wounds**, skin wounds, and recent surgery can put a person at a higher risk for cellulitis.

The characteristic symptoms of cellulitis are redness, warmth, pain, and swelling. The infected area appears as a red patch that gets larger rapidly within the first 24 hours. A thick red line which progresses towards the heart may appear indicating an infection of the lymph vessels (lymphangitis). Other symptoms which may occur include **fever**, chills, tiredness, muscle aches, and a

general ill feeling. Some people also experience nausea, vomiting, stiff joints, and hair loss at the infection site.

The characteristic symptoms of orbital cellulitis are eye pain, redness, swelling, warmth, and tenderness. The eye may bulge out and it may be difficult or impossible to move. Temporary loss of vision, pus drainage from the eye, chills, fever, headaches, vomiting, and a general ill feeling may occur.

Diagnosis

Cellulitis may be diagnosed and treated by a family doctor, an infectious disease specialist, a doctor who specializes in skin diseases (dermatologist), or in the case of orbital cellulitis, an eye doctor (ophthalmologist). The diagnosis of cellulitis is based mainly on the patient's symptoms. The patient's recent medical history is also used in the diagnosis.

Laboratory tests may be done to determine which kind of bacteria is causing the infection but these tests are not always successful. If the skin injury is visible, a sterile cotton swab is used to pick up a sample from the wound. If there is no obvious skin injury, a needle may be used to inject a small amount of sterile salt solution into the infected skin, and then the solution is withdrawn. The salt solution should pick up some of the bacteria causing the infection. A blood sample may be taken from the patient's arm to see if bacteria have entered the bloodstream. Also, a blood test may be done to count the number of white blood cells in the blood. High numbers of white blood cells suggest that the body is trying to fight a bacterial infection.

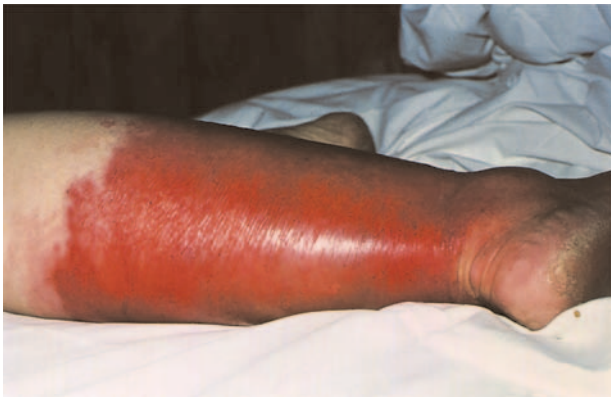
For orbital cellulitis, the doctor may often perform a special x-ray scan called **computed tomography scan** (CT). This scan enables the doctor to see the patient's head in cross-section to determine exactly where the infection is and see if any damage has occurred. A CT scan takes about 20 minutes.

Treatment

Antibiotic treatment is the only way to battle this potentially life-threatening infection. Mild to moderate cellulitis can be treated with the following antibiotics taken every four to eight hours by mouth:

- penicillins (Bicillin, Wycillin, Pen Vee, V-Cillin)
- erythromycin (E-Mycin, Ery-Tab)
- cephalexin (Biocef, Keflex)
- cloxacillin (Tegopen)

Other medications may be recommended, such as **acetaminophen** (Tylenol) or ibuprofen (Motrin, Advil) to relieve pain, and **aspirin** to decrease fever.



This person's lower leg is swollen and inflamed due to cellulitis. Cellulitis is a *Streptococcus* bacterial infection of the skin and the tissues beneath it. The face, neck, or legs are common sites of cellulitis. *(Custom Medical Stock Photo. Reproduced by permission.)*

A normally healthy person is usually not hospitalized for mild or moderate cellulitis. General treatment measures include elevation of the infected area, rest, and application of warm, moist compresses to the infected area. The doctor will want to see the patient again to make sure that the antibiotic treatment is effective in stopping the infection.

Persons at high risk for severe cellulitis will probably be hospitalized for treatment and monitoring. Antibiotics may be given intravenously to patients with severe cellulitis. Complications such as deep infection, or bone or joint infections, might require surgical drainage and a longer course of antibiotic treatment. Extensive tissue destruction may require plastic surgery to repair. In cases of orbital cellulitis caused by a sinus infection, surgery may be required to drain the sinuses.

Prognosis

Over 90% of all cellulitis cases are cured after seven to 10 days of antibiotic treatment. Persons with serious disease and/or those who are taking immunosuppressive drugs may experience a more severe form of cellulitis which can be life threatening. Serious complications include blood **poisoning** (bacteria growing in the blood stream), meningitis (brain and spinal cord infection), tissue death (necrosis), and/or lymphangitis (infection of the lymph vessels). Severe cellulitis caused by *Streptococcus pyogenes* can lead to destructive and life-threatening necrotizing fasciitis.

Prevention

Cellulitis may be prevented by wearing appropriate protective equipment during work and sports to avoid

KEY TERMS

Inflammation—A local, protective response to tissue injury. It is characterized by redness, warmth, swelling, and pain.

Necrotizing fasciitis—A destructive infection which follows severe cellulitis and involves the deep skin and underlying tissues.

Sinuses—Air cavities found in the bones of the head. The sinuses which are connected to the nose are prone to infection.

skin injury, cleaning cuts and skin injuries with antiseptic soap, keeping wounds clean and protected, watching wounds for signs of infection, taking the entire prescribed dose of antibiotic, and maintaining good general health. Persons with diabetes should try to maintain good blood sugar control.

Resources

BOOKS

Dermatology. 3rd ed. Ed. Peter J. Lynch. Baltimore: Williams and Wilkins, 1994.

Westfall, Christopher T., John W. Shore, and Ann Sullivan Baker. "Orbital Infections." In *Infectious Diseases.* 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Lewis, Ronald T. "Soft Tissue Infections." *World Journal of Surgery* 22, no. 2 (Feb. 1998): 146-51.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Cell therapy

Definition

Cell therapy is the transplantation of human or animal cells to replace or repair damaged tissue and/or cells.

Purpose

Cell therapy has been used successfully to rebuild damaged cartilage in joints, repair spinal cord injuries, strengthen a weakened immune system, treat autoimmune diseases such as **AIDS**, and help patients with neurological disorders such as **Alzheimer's disease**, **Parkinson's disease**, and epilepsy. Further uses have shown positive results in the treatment of a wide range of chronic conditions such as arteriosclerosis, congenital defects, and **sexual dysfunction**. The therapy has also been used to treat **cancer** patients at a number of clinics in Tijuana, Mexico, although this application has not been well supported with controlled clinical studies.

Description

Origins

The theory behind cell therapy has been in existence for several hundred years. The first recorded discussion of the concept of cell therapy can be traced to Phillippus Aureolus Paracelsus (1493–1541), a German-Swiss physician and alchemist who wrote in his *Der grossen Wundartzney* ("Great Surgery Book") in 1536 that "the heart heals the heart, lung heals the lung, spleen heals the spleen; like cures like." Paracelsus and many of his contemporaries agreed that the best way to treat an illness was to use living tissue to restore the ailing. In 1667, at a laboratory in the palace of Louis XIV, Jean-Baptiste Denis (1640–1704) attempted to transfuse blood from a calf into a mentally ill patient—and since blood **transfusion** is, in effect, a form of cell therapy, this could be the first documented case of this procedure. However, the first recorded attempt at non-blood cellular therapy occurred in 1912 when German physicians attempted to treat children with **hypothyroidism**, or an underactive thyroid, with thyroid cells.

In 1931, Dr. Paul Niehans (1882–1971), a Swiss physician, became known as "the father of cell therapy" quite by chance. After a surgical accident by a colleague, Niehans attempted to transplant a patient's severely damaged parathyroid glands with those of a steer. When the patient began to rapidly deteriorate before the transplant could take place, Niehans decided to dice the steer's parathyroid gland into fine pieces, mix the pieces in a saline solution, and inject them into the dying patient. Immediately, the patient began to improve and, in fact, lived for another 30 years.

Cell therapy is, in effect, a type of organ transplant which has also been referred to as "live cell therapy," "xenotransplant therapy," "cellular suspensions," "glandular therapy," or "fresh cell therapy." The procedure involves the injection of either whole fetal xenogenic (animal) cells (e.g., from sheep, cows, pigs, and sharks) or cell extracts from human tissue. The latter is known as autologous cell therapy if the cells are extracted from and transplanted back into the same patient. Several different types of cells can be administered simultaneously.

Just as Paracelsus' theory of "like cures like," the types of cells that are administered correspond in some

PAUL NIEHANS (1882–1971)

(AP/Wide World Photos. Reproduced by permission.)

Paul Niehans was born and raised in Switzerland. His father, a doctor, was dismayed when he entered the seminary, but Niehans quickly grew dissatisfied with religious life and took up medicine after all. He first studied at Bern, then completed an internship in Zurich.

Niehans enlisted in the Swiss Army in 1912. When war erupted in the Balkans, Niehans set up a hospital in Belgrade, Yugoslavia. The war provided him the opportunity to treat numerous patients, gaining a firsthand knowledge of the body and its workings.

Since 1913, Niehans had been intrigued with Alexis Carrel's experiments concerning the adaptive abilities of cells, though Niehans himself specialized in glandular transplants and by 1925 was one of the leading glandular surgeons in Europe.

Niehans referred to 1931 as the birth year of cellular therapy. That year, he treated a patient suffering from tetany whose parathyroid had been erroneously removed by another physician. Too weak for a glandular transplant, the patient was given injections of the parathyroid glands of an ox, and she soon recovered. Niehans made more injections, even experimenting on himself, and reported he could cure illnesses through injections of live cells extracted from healthy animal organs. He believed adding new tissue stimulated rejuvenation and recovery.

Niehans treated Pope Pious XII with his injections and was nominated to the Vatican Academy of Science following the pope's recovery.

Niehans remained a controversial figure throughout his life. As of 2000, the Clinique Paul Niehans in Switzerland, founded by his daughter, continues his work.

way with the organ or tissue in the patient that is failing. No one knows exactly how cell therapy works, but proponents claim that the injected cells travel to the similar organ from which they were taken to revitalize and stimulate that organ's function and regenerate its cellular structure. In other words, the cells are not species specific, but only organ specific. Supporters of cellular treatment believe that embryonic and fetal animal tissue contain active therapeutic agents distinct from **vitamins**, **minerals**, hormones, or enzymes.

Swedish researchers have successfully transplanted human fetal stem cells into human recipients, and the procedure is being investigated further as a possible treatment for repairing brain cells in Parkinson's patients. However, because the cells used in these applications must be harvested from aborted human fetuses, there is an ethical debate over their use.

Currently, applications of cell therapy in the United States is still in the research, experimental, and clinical trial stages. The U.S. Food and Drug Administration has approved the use of one cellular therapy technique for repairing damaged knee joints. The procedure involves removing healthy chondrocyte cells, the type of cell that forms cartilage, from the patient, culturing them in a laboratory for three to four weeks, and then transplanting them back into the damaged knee joint of the patient.

Preparations

There are several processes to prepare cells for use. One form involves extracting cells from the patient they are to be used on and then culturing them in a laboratory setting until they multiply to the level needed for transplant back into the patient. Another procedure uses freshly removed fetal animal tissue, which has been processed and suspended in a saline solution. The preparation of fresh cells then may be either injected immediately into the patient, or preserved by being freeze-dried or deep-frozen in liquid nitrogen before being injected. Cells may be tested for pathogens, such as bacteria, viruses, or parasites, before use.

KEY TERMS

Anaphylactic shock—A severe allergic reaction that causes blood pressure drop, racing heart, swelling of the airway, rash, and possibly convulsions.

Culturing—To grow cells in a special substance, or media, in the laboratory.

Encephalitis—Inflammation of the brain.

Precautions

Patients undergoing cell therapy treatments which use cells transplanted from animals or other humans run the risk of cell rejection, in which the body recognizes the cells as a foreign substance and uses the immune system's T-cells to attack and destroy them. Some forms of cell therapy use special coatings on the cells designed to trick the immune system into recognizing the new cells as native to the body.

There is also the chance of the cell solution transmitting bacterial or viral infection or other disease and parasites to the patient. Careful screening and testing of cells for pathogens can reduce this risk.

Many forms of cell therapy in the United States are still largely experimental procedures. Patients should approach these treatments with extreme caution, should inquire about their proven efficacy and legal use in the United States, and should only accept treatment from a licensed physician who should educate the patient completely on the risks and possible side effects involved with cell therapy. These same cautions apply for patients interested in participating in clinical trials of cell therapy treatments.

Side effects

Because cell therapy encompasses such a wide range of treatments and applications, and many of these treatments are still experimental, the full range of possible side effects of the treatments are not yet known. Anaphylactic **shock** (severe allergic reaction), immune system reactions, and **encephalitis** (inflammation of the brain) are just a few of the known reported side effects in some patients to date.

Side effects of the FDA-approved chondrocyte cell therapy used in knee joint repair may include tissue hypertrophy, a condition where too much cartilage grows in the joint where the cells were transplanted to and the knee joint begins to stiffen.

Research and general acceptance

There is a growing debate in the medical community over the efficacy and ethical implications of cell therapy. Much of the ethical debate revolves around the use of human fetal stem cells in treatment, and the fact that these cells must be harvested from aborted fetuses.

While some cell therapy procedures have had proven success in clinical studies, others are still largely unproven, including cell therapy for cancer treatment. Until more large, controlled clinical studies are performed on these procedures to either prove or disprove their efficacy, they will remain fringe treatments.

Resources

BOOKS

Sheridan, William, and George Morstyn. *Cell Therapy: Stem Cell Transplantation, Gene Therapy, and Cellular Immunotherapy.* Cambridge, UK: Cambridge University Press, 1996.

PERIODICALS

Sinha, Gunjan. "On the Road to Recovery: Fetal pig cell therapy has put Parkinson's patient Jim Finn back in the driver's seat." *Popular Science* 255, no. 4 (Oct 1999): 77.

ORGANIZATIONS

Center for Cell and Gene Therapy. Baylor College of Medicine. 1102 Bates St, Suite 1100, Houston, Texas 77030-2399. (713) 770-4663. <http://www.bcm.tmc.edu/genetherapy>.

Paula Ford-Martin

Central Mississippi Valley disease *see* **Histoplasmosis**

Central nervous system depressants

Definition

Central nervous system (CNS) depressants are drugs that can be used to slow down brain activity.

Purpose

CNS depressants may be prescribed by a physician to treat anxiety, muscle tension, pain, insomnia, acute stress reactions, panic attacks, and seizure disorders. In higher doses, some CNS depressants may be used as general anesthetics.

Description

Throughout history, humans have sought relief from anxiety and insomnia by using substances that depress brain activity and induce a drowsy or calming effect. CNS depressants include a wide range of drugs such as alcohol, narcotics, barbiturates (Amytal, Nembutal, Seconal), benzodiazepines (Ativan, Halcion, Librium, Valium, Xanax), chloral hydrate, and methaqualone (Quaaludes), as well as newer CNS depressants developed in the 1990s, such as Buspirone (Buspar) and Zolpidem (Ambien), which are thought to have the fewest sideeffects. Most CNS depressants activate a neurotransmitter called gamma-aminobutyric acid (GABA), which helps decrease brain activity. Street names for CNS depressants include Reds, Yellows, Blues, Ludes, Barbs, and Downers.

Precautions

Most CNS depressants have the potential to be physically and psychologically addictive. Alcohol is the most widely abused depressant. The body tends to develop tolerance for CNS depressants, and larger doses are needed to achieve the same effects. Withdrawal from some CNS depressants can be uncomfortable; for example, withdrawal from a depressant treating insomnia or anxiety can cause rebound insomnia or anxiety as the brain's activity bounces back after being suppressed. In some cases withdrawal can result in life-threatening seizures. Generally, depressant withdrawal should be undertaken under a physician's supervision. Many physicians will reduce the depressant dosage gradually, to give the body time to adjust. Certain CNS depressants such as barbiturates are easy to overdose on, since there is a relatively small difference between the optimal dose and an overdose. A small miscalculation can lead to coma, slowed breathing, and death. CNS depressants should be administered to elderly individuals with care, as these individuals have a reduced ability to metabolize CNS depressants.

Side Effects

Especially when taken in excess, CNS depressants can cause confusion and dizziness, and impair judgment, memory, intellectual performance, and motor coordination.

Interactions

CNS depressants should be used with other medications, such as antidepressant medications, only under a physician's supervision. Certain herbal remedies, such as Valerian and Kava, may dangerously exacerbate the effects of certain CNS depressants. Also, ingesting a combination of CNS depressants, such Valium and alcohol, for example, is not advised. When mixed together, CNS depressants tend to amplify each other's effects, which can cause severely reduced heart rate and even death.

KEY TERMS

GABA (gamma-aminobutyric acid)—A neurotransmitter that slows down the activity of nerve cells in the brain.

Neurotransmitter—A chemical compound in the brain that carries signals from one nerve cell to another.

Resources

BOOKS

Fontanarosa, P. *Alternative Medicine: An Objective Assessment*. American Medical Association, 2000.

ORGANIZATIONS

American Society of Addiction Medicine. 4601 North Park Avenue, Arcade Suite 101, Chevy Chase, MD 20815. (301) 656-3920. <http://www.asam.org>.

National Clearinghouse for Alcohol and Drug Abuse Information (NCADI) Center for Substance Abuse Prevention. 5600 Fishers Lane, Rockville, MD 20857. (301) 443-0365. <http://www.health.org>.

National Institute on Drug Abuse. 6001 Executive Blvd, Bethesda, MD 20892. (301) 443-1124 <http://www.nida.nih.gov>.

Ann Quigley

Central nervous system infections

Definition

The central nervous system, or CNS, comprises the brain, the spinal cord, and associated membranes. Under some circumstances, bacteria may enter areas of the CNS. If this occurs, abscesses or empyemas may be established.

Description

In general, the CNS is well defended against infection. The spine and brain are sheathed in tough, protective membranes. The outermost membrane, the dura mater, and the next layer, the arachnoid, entirely encase the brain and spinal cord. However, these defenses are not absolute. In rare cases, bacteria gain access to areas within the CNS.

KEY TERMS

Abscess—A pus-filled area with definite borders.

Arachnoid—One of the membranes that sheathes the spinal cord and brain; the arachnoid is the second-layer membrane.

Cerebrospinal fluid—Fluid that is normally found in the spinal cord and brain. Abnormal levels of certain molecules in this fluid can indicate the presence of infection or damage to the central nervous system.

CT scan (computed tomography)—Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Dura mater—One of the membranes that sheathes the spinal cord and brain; the dura mater is the outermost layer.

Empyema—A pus-filled area with indefinite borders.

Lumbar puncture—A procedure in which a needle is inserted into the lower spine to collect a sample of cerebrospinal fluid.

MRI (magnetic resonance imaging)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Bacterial infection of the CNS can result in abscesses and empyemas (accumulations of pus). Abscesses have fixed boundaries, but empyemas lack definable shape and size. CNS infections are classified according to the location where they occur. For example, a spinal epidural **abscess** is located above the dura mater, and a cranial subdural **empyema** occurs between the dura mater and the arachnoid.

As pus and other material from an infection accumulate, pressure is exerted on the brain or spinal cord. This pressure can damage the nervous system tissue, possibly permanently. Without treatment, a CNS infection is fatal.

Causes and symptoms

Typically, bacterial invasion results from the spread of a nearby infection; for example, a chronic sinus or middle ear infection can extend beyond its initial site. Bacteria may also be conveyed to the CNS from distant sites of infection by the bloodstream. In rare cases, head trauma or surgical procedures may introduce bacteria directly into the CNS. However, the source of infection cannot always be identified.

Specific symptoms of a CNS infection hinge on its exact location, but may include severe **headache** or back **pain**, weakness, sensory loss, and a **fever**. An individual may report a stiff neck, nausea or vomiting, and tiredness or disorientation. There is a potential for seizures, **paralysis**, or **coma**.

Diagnosis

Physical symptoms, such as a fever and intense backache or a fever, severe headache, and stiff neck, raise the suspicion of a CNS infection. Blood tests may indicate the presence of an infection but do not pinpoint its location. CT scans or MRI scans of the brain and spine can provide definitive diagnosis, with an MRI scan being the most sensitive. A lumbar puncture and analysis of the cerebrospinal fluid can help diagnose an epidural abscess; however, the procedure can be dangerous in cases of subdural empyema.

Treatment

A two-pronged approach is taken to treat CNS infections. First, antibiotic therapy against an array of potential infectious bacteria is begun. The second stage involves surgery to drain the infected site. Although some CNS infections have been resolved with **antibiotics** alone, the more aggressive approach is often preferred. Surgery allows immediate relief of pressure on the brain or spinal cord, as well as an opportunity to collect infectious material for bacterial identification. Once the bacterial species is identified, drug therapy can be altered to a more specific antibiotic. However, surgery may not be an option in some cases, such as when there are numerous sites of infection or when infection is located in an inaccessible area of the brain.

Prognosis

The fatality rate associated with CNS infections ranges from 10% to as high as 40%. Some survivors experience permanent CNS damage, resulting in partial paralysis, speech problems, or seizures. Rapid diagnosis and treatment are essential for a good prognosis. With prompt medical attention, an individual may recover completely.

Prevention

Treatment for pre-existing infections, such as sinus or middle ear infections, may prevent some cases of CNS infection. However, since some CNS infections are of unknown origin, not all are preventable.

Resources

BOOKS

Infections of the Central Nervous System. 2nd ed. Ed. W. M. Scheld, R. J. Whitley, and D. T. Durack. Philadelphia: Lippincott-Raven Publishers, 1997.

Infectious Diseases of the Central Nervous System. Ed. Kenneth L. Tyler and Joseph B. Martin. Philadelphia: F. A. Davis Co., 1993.

PERIODICALS

Brennan, Michael. "Subdural Empyema." *American Family Physician* 51, no. 1 (1995): 157.

Darouiche, Rabih O., et al. "Bacterial Spinal Epidural Abscess: Review of 43 Cases and Literature Survey." *Medicine* 71 no. 6 (1992): 369.

Julia Barrett

Central nervous system stimulants

Definition

Central nervous system (CNS) stimulants are medicines that speed up physical and mental processes.

Purpose

Central nervous system stimulants are used to treat conditions characterized by lack of adrenergic stimulation, including **narcolepsy** and neonatal apnea. Additionally, methylphenidate (Ritalin) and dextroamphetamine sulfate (Dexedrine) are used for their paradoxical effect in attention-deficit hyperactivity disorder (**ADHD**).

The anerexiants, benzphetamine (Didrex), diethylpropion (Tenuate), phendimetrazine (Bontril, Plegine), phentermine (Fastin, Ionamine), and sibutramine (Meridia) are CNS stimulants used for appetite reduction in severe **obesity**. Although these drugs are structurally similar to amphetamine, they cause less sensation of stimulation, and are less suited for use in conditions characterized by lack of adrenergic stimulation.

Phenylpropanolamine and ephedrine have been used both as diet aids and as vasoconstrictors.

Description

The majority of CNS stimulants are chemically similar to the neurohormone norepinephrine, and simulate the traditional "fight or flight" syndrome associated with sympathetic nervous system arousal. **Caffeine** is more closely related to the xanthines, such as theophylline. A small number of additional members of the CNS stimulant class do not fall into specific chemical groups.

Precautions

Amphetamines have a high potential for abuse. They should be used in weight reduction programs only when alternative therapies have been ineffective. Administration for prolonged periods may lead to drug dependence. These drugs are classified as schedule II under federal drug control regulations.

The amphetamines and their cogeners are contraindicated in advanced arteriosclerosis, symptomatic cardiovascular disease, and moderate to severe **hypertension** and **hyperthyroidism**. They should not be used to treat patients with hypersensitivity or idiosyncrasy to the sympathomimetic amines, or with **glaucoma**, a history of agitated states, a history of drug abuse, or during the 14 days following administration of monoamine oxidase (MAO) inhibitors.

Methylphenidate may lower the seizure threshold.

Benzphetamine is category X during **pregnancy**. Diethylpropion is category B. Other anorexiants have not been rated; however their use during pregnancy does not appear to be advisable. Safety for use of anorexiants has not been evaluated.

Amphetamines are all category C during pregnancy. Breastfeeding while receiving amphetamines is not recommended because the infant may experience withdrawal symptoms.

There have been reports that when used in children, methylphenidate and amphetamines may retard growth. Although these reports have been questioned, it may be suggested that the drugs not be administered outside of school hours (because most children have behavior problems in school), in order to permit full stature to be attained.

The most common adverse effects of CNS stimulants are associated with their primary action. Typical responses include overstimulation, **dizziness**, restlessness, and similar reactions. Rarely, hematologic reactions, including leukopenia, agranulocytosis, and bone marrow depression have been reported. Lowering of the seizure threshold has been noted with most drugs in this class.

Withdrawal syndrome

Abrupt discontinuation following prolonged high dosage results in extreme **fatigue**, mental depression and changes on the sleep EEG. This response is most evident with amphetamines, but may be observed with all CNS stimulants taken over a prolonged period of time.

KEY TERMS

Agranulocytosis—An acute febrile condition marked by severe depression of the granulocyte-producing bone marrow, and by prostration, chills, swollen neck, and sore throat sometimes with local ulceration.

Anorexiant—A drug that suppresses appetite.

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness, may accompany anxiety.

Attention-deficit hyperactivity disorder (ADHD)—A condition in which a person (usually a child) has an unusually high activity level and a short attention span. People with the disorder may act impulsively and may have learning and behavioral problems.

Central nervous system—The brain and spinal cord.

Depression—A mental condition in which people feel extremely sad and lose interest in life. People with depression may also have sleep problems and loss of appetite, and may have trouble concentrating and carrying out everyday activities.

Leucopenia—A condition in which the number of leukocytes circulating in the blood is abnormally low and which is most commonly due to a decreased production of new cells in conjunction with various infectious diseases or as a reaction to various drugs or other chemicals.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug on which he or she has become dependent.

Resources

PERIODICALS

"Are our children overmedicated?" *Parade*, (October 12, 1997): 4.
"Attention deficit hyperactivity disorder: not just for kids." *Mayo Clinic Health Letter,* 13 (September 1995): 6.
"Attention deficit hyperactivity disorder: there is no easy answer on whether to medicate or not." *British Medical Journal,* 315 (October 11, 1997): 894.
"The run on Ritalin: attention deficit disorder and stimulant treatment in the 1990s." *The Hastings Center Report,* 26 (March-April 1996): 12.

ORGANIZATION

Children and Adults with Attention Deficit Disorders (CH.A.D.D.). 499 N.W. 70th Avenue, Suite 109, Plantation, FL 33317. (305) 587-3700.

OTHER

Attention deficit hyperactivity disorder Pamphlet. National Institute of Mental Health, 1994.
Facts about childhood hyperactivity Pamphlet. National Institute of Child Health and Human Development, 1990.

Nancy Ross-Flanigan

Central retinal artery occlusion *see* **Retinopathies**

Central retinal vein occlusion *see* **Retinopathies**

Cephalosporins

Definition

Cephalosporins are medicines that kill bacteria or prevent their growth.

Purpose

Cephalosporins are used to treat infections in different parts of the body—the ears, nose, throat, lungs, sinuses, and skin, for example. Physicians may prescribe these drugs to treat **pneumonia**, **strep throat**, staph infections, **tonsillitis**, **bronchitis**, and **gonorrhea**. These drugs will *not* work for colds, flu, and other infections caused by viruses.

Description

Examples of cephalosporins are cefaclor (Ceclor), cefadroxil (Duricef), cefazolin (Ancef, Kefzol, Zolicef),

cefixime (Suprax), cefoxitin (Mefoxin), cefprozil (Cefzil), ceftazidime (Ceptaz, Fortaz, Tazicef, Tazideme), cefuroxime (Ceftin) and cephalexin (Keflex). These medicines are available only with a physician's prescription. They are sold in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of cephalosporin. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take cephalosporins exactly as directed by your physician. Never take larger, smaller, more frequent, or less frequent doses. Take the drug for exactly as long as directed—no more and no less. Do not save some doses of the drug to take for future infections. The medicine may not be right for other kinds of infections, even if the symptoms are the same. In addition, take all of the medicine to treat the infection for which it was prescribed. The infection may not clear up completely if too little medicine is taken. Taking this medicine for too long, on the other hand, may open the door to new infections that do not respond to the drug.

Some cephalosporins work best when taken on an empty stomach. Others should be taken after meals. Check with the physician who prescribed the medicine or the pharmacist who filled the prescription for instructions on how to take the medicine.

Precautions

Certain cephalosporins should not be combined with alcohol or with medicines that contain alcohol. Abdominal or stomach cramps, nausea, vomiting, facial flushing, and other symptoms may result within 15–30 minutes and may last for several hours. Do not drink alcoholic beverages or use other medicines that contain alcohol while being treated with cephalosporins and for several days after treatment ends.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take cephalosporins. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Severe allergic reactions to this medicine may occur. Anyone who is allergic to cephalosporins of any kind should not take other cephalosporins. Anyone who is allergic to penicillin should check with a physician before taking any cephalosporin. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

KEY TERMS

Bronchitis—Inflammation of the air passages of the lungs.

Colitis—Inflammation of the colon (large bowel).

Gonorrhea—A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Phenylketonuria—(PKU) A genetic disorder in which the body lacks an important enzyme. If untreated, the disorder can lead to brain damage and mental retardation.

Pneumonia—A disease in which the lungs become inflamed. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

Sexually transmitted disease—A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact. Also called STD.

Staph infection—Infection with *Staphylococcus* bacteria. These bacteria can infect any part of the body.

Strep throat—A sore throat caused by infection with *Streptococcus* bacteria. Symptoms include sore throat, chills, fever, and swollen lymph nodes in the neck.

Tonsillitis—Inflammation of a tonsil, a small mass of tissue in the throat.

DIABETES. Some cephalosporins may cause false positive results on urine sugar tests for diabetes. People with diabetes should check with their physicians to see if they need to adjust their medication or their **diets**.

PHENYLKETONURIA. Oral suspensions of cefprozil contain phenylalanine. People with **phenylketonuria** (PKU) should consult a physician before taking this medicine.

PREGNANCY. Women who are pregnant or who may become pregnant should check with their physicians before using cephalosporins.

BREASTFEEDING. Cephalosporins may pass into breast milk and may affect nursing babies. Women who are breastfeeding and who need to take this medicine

should check with their physicians. They may need to stop breastfeeding until treatment is finished.

OTHER MEDICAL CONDITIONS. Before using cephalosporins, people with any of these medical problems should make sure their physicians are aware of their conditions:

- History of stomach or intestinal problems, especially colitis. Cephalosporins may cause colitis in some people.
- Kidney problems. The dose of cephalosporin may need to be lower.
- Bleeding problems. Cephalosporins may increase the chance of bleeding in people with a history of bleeding problems.
- Liver disease. The dose of cephalosporin may need to be lower.

USE OF CERTAIN MEDICINES. Taking cephalosporins with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Get medical attention immediately if any of these symptoms develop while taking cephalosporins:

- shortness of breath
- Pounding heartbeat
- Skin rash or **hives**
- Severe cramps or **pain** in the stomach or abdomen
- **Fever**
- Severe watery or bloody **diarrhea** (may occur up to several weeks after stopping the drug)
- Unusual bleeding or bruising

Other rare side effects may occur. Anyone who has unusual symptoms during or after treatment with cephalosporins should get in touch with his or her physician.

Interactions

Some cephalosporins cause diarrhea. Certain diarrhea medicines, such as diphenoxylate-atropine (Lomotil), may make the problem worse. Check with a physician before taking any medicine for diarrhea caused by taking cephalosporins.

Birth control pills may not work properly when taken at the same time as cephalosporins. To prevent **pregnancy**, use other methods of birth control in addition to the pills while taking cephalosporins.

Taking cephalosporins with certain other drugs may increase the risk of excess bleeding. Among the drugs that may have this effect when taken with cephalosporins are:

- blood thinning drugs (anticoagulants) such as warfarin (Coumadin)
- blood viscosity reducing medicines such as pentoxifylline (Trental)
- the antiseizure medicines divalproex (Depakote) and valproic acid (Depakene)

Cephalosporins may also interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes cephalosporins should let the physician know all other medicines he or she is taking.

Nancy Ross-Flanigan

Cerebral abscess *see* **Brain abscess**

Cerebral amyloid angiopathy

Definition

Cerebral amyloid angiopathy (CAA) is also known as congophilic angiopathy or cerebrovascular **amyloidosis**. It is a disease of small blood vessels in the brain in which deposits of amyloid protein in the vessel walls may lead to **stroke**, brain hemorrhage, or **dementia**. Amyloid protein resembles a starch and is deposited in tissues during the course of certain chronic diseases.

Description

CAA may affect patients over age 45, but is most common in patients over age 65, and becomes more common with increasing age. Men and women are equally affected. In some cases, CAA is sporadic but it may also be inherited as an autosomal dominant condition (a form of inheritance in which only one copy of a gene coding for a disease need be present for that disease to be expressed; if either parent has the disease, a child has a 50% chance of inheriting the disease). CAA is responsible for 5–20% of brain hemorrhages and up to 30% of lobar hemorrhages localized to one lobe of the brain. CAA may be found during an **autopsy** in over one-third of persons over age 60, even though they may not have had brain hemorrhage, stroke, or other manifestations of the disease during life. In **Alzheimer's disease**, CAA is more common than in the general population, and may occur in more than 80% of patients over age 60.

Causes and symptoms

The cause of amyloid deposits in blood vessels in the brain in sporadic CAA is not known. In hereditary CAA,

genetic defects, typically on chromosome 21, allow accumulation of amyloid, a protein made up of units called beta-pleated sheet fibrils. The fibrils tend to clump together, so that the amyloid cannot be dissolved and builds up in the brain blood vessel walls. One form of amyloid fibril subunit proteins is the amyloid beta protein.

Different theories have been suggested for the source of amyloid beta protein in the brain. The systemic theory suggests that amyloid beta protein in the blood stream is deposited in blood vessels in the brain, causing weakness in the blood vessel wall and breakdown in the blood-brain barrier. Normally, the blood-brain barrier keeps proteins and other large molecules from escaping from the blood vessel to the brain tissue. When there is breakdown of the blood-brain barrier, amyloid beta protein leaks through the blood vessel wall, and is deposited in the brain substance, where it forms an abnormal structure called a neuritic plaque.

A second, more likely theory is that amyloid fibrils that form amyloid beta protein are produced by perivascular microglia, or support cells in contact with the brain blood vessel wall. The third theory is that the brain tissue gives rise to amyloid beta protein. Both the nerve cells and the glia are known to produce amyloid precursor protein, which increases with **aging** and with cell **stress**.

Bleeding into the brain may occur as tiny blood vessels carrying amyloid deposits become heavier and more brittle, and are therefore more likely to burst with minor trauma or with fluctuating blood pressure. Aneurysms, or ballooning of the blood vessel wall, may develop, and may also rupture as the stretched wall becomes thinner and is under more pressure. Amyloid deposits may destroy smooth muscle cells or cause inflammation in the blood vessel wall. This may also cause the blood vessel to break more easily.

The most common form of CAA is the sporadic form associated with aging. This type of CAA usually causes lobar hemorrhage, which may recur in different lobes of the brain. The frontal lobe (behind the forehead) and parietal lobe (behind the frontal lobe) are most often affected; the temporal lobe (near the temple) and occipital lobe (at the back of the brain) are affected less often; and the cerebellum (under the occipital lobe) is rarely affected. Approximately 10–50% of hemorrhages in sporadic CAA involve more than one lobe.

Symptoms of lobar hemorrhage in CAA include sudden onset of **headache**, neurologic symptoms such as weakness, sensory loss, visual changes, or speech problems, depending on which lobe is involved; and decreased level of consciousness (a patient who is difficult to arouse), nausea, and vomiting. Sporadic CAA may be associated with symptoms unrelated to lobar hemorrhage. Petechial hemorrhages (tiny hemorrhages involving many small vessels) may produce recurrent, brief neurologic symptoms secondary to seizures or decreased blood flow, or may produce rapidly progressive dementia (loss of memory and other brain functions) that worsens in distinct steps rather than gradually. Over 40% of patients with hemorrhage secondary to CAA also have dementia.

Genetic factors play a role in certain types of CAA and in diseases associated with CAA:

- Dutch type of hereditary cerebral hemorrhage with amyloidosis (build up of amyloid protein in blood vessels): autosomal dominant, with a genetic mutation involving the amyloid precursor protein. Onset is at age 40–60 with headaches, brain hemorrhage often in the parietal lobe, strokes, and dementia. More than half of patients die from their first hemorrhage. Patients with the Dutch type of CAA may produce an abnormal anti-

KEY TERMS

Amyloid—Amyloid protein resembles a starch and is deposited in tissues during the course of certain chronic diseases.

Ataxia—Problems with coordination and walking.

Autosomal dominant—A form of inheritance in which only one copy of a gene coding for a disease need be present for that disease to be expressed. If either parent has the disease, a child has a 50% chance of inheriting the disease.

Chromosome—A cellular structure containing genetic information in the form of DNA.

Dementia—Loss of memory and other higher functions, such as thinking or speech, lasting six months or more.

Hemorrhage—Bleeding, or escape of blood through ruptured or unruptured blood vessel walls.

Lobar hemorrhage—Bleeding into one of the lobes of the brain.

Seizure—Epileptic convulsion, fit, or attack.

Sporadic—A form of disease found in persons without a family history of the disease.

Spasticity—Limb stiffness related to disease of the brain or spinal cord.

Stroke—Sudden neurological deficit related to impaired blood supply to the brain.

coagulant, or blood thinner, which makes hemorrhage more likely.

- Flemish type of hereditary cerebral hemorrhage with amyloidosis: autosomal dominant, with a mutation involving the amyloid precursor protein. Symptoms include brain hemorrhage or dementia.
- Familial Alzheimer's disease: autosomal dominant, comprising 5–10% of all Alzheimer's disease cases (a brain disease in which **death** of nerve cells leads to progressive dementia).
- **Down Syndrome**: caused by trisomy 21 (three rather than two copies of chromosome 21), causing excess amyloid precursor protein gene. Children with Down syndrome are mentally handicapped and may have heart problems.
- Icelandic type of hereditary cerebral hemorrhage with amyloidosis: autosomal dominant, with mutation in the gene coding for cystatin C. Symptoms often begin at age 30–40 with multiple brain hemorrhages, dementia, **paralysis** (weakness), and death in 10–20 years. Headache occurs in more than half of patients, and seizures occur in one-quarter. Unlike most other forms of CAA, most hemorrhages involve the basal ganglia deep within the brain (Basal ganglia are islands of tissues in the cerebellum part of the brain.).
- Familial oculo-leptomeningeal amyloidosis: autosomal dominant with unknown gene defect(s), described in Japanese, Italian, and North American families. Symptoms can include dementia, ataxia (problems with coordination), spasticity (limb stiffness), strokes, seizures, **peripheral neuropathy** (disease affecting the nerves supplying the limbs), migraine, spinal cord problems, blindness, and deafness. Brain hemorrhage is rare as the amyloid protein is deposited in blood vessels in the eye and meninges (brain coverings), but not in the brain itself. In Italian families with the disease, patients may be affected as early as 20–30 years of age.
- British type of familial amyloidosis: autosomal dominant with unknown gene defect(s), associated with progressive dementia, spasticity, and ataxia. Brain stem, spinal cord, and cerebellum all exhibit amyloid deposits, but hemorrhage typically does not occur.

Diagnosis

As in most neurologic diseases, diagnosis is made most often from the patient's history, with careful inquiry into family history and the patient's onset and pattern of symptoms, as well as neurologic examination. Brain **computed tomography scan** (CT) or **magnetic resonance imaging** (MRI) may identify lobar hemorrhage, stroke, or petechial hemorrhages, and are important in excluding arteriovenous malformation, **brain tumor**, or other causes of hemorrhage. **Angiography** (x-ray study of the interior of blood vessels and the heart) is not helpful in diagnosis of CAA, but may be needed to exclude aneurysm. **Brain biopsy** (surgical removal of a small piece of brain tissue) may show characteristic amyloid deposits, but is rarely performed, as the risk may not be justifiable in the absence of effective treatment for CAA. If diagnosis is uncertain, biopsy may be needed to rule out conditions which are potentially treatable. Definite diagnosis requires microscopic examination of brain tissue, either at biopsy, at autopsy, or at surgery when brain hemorrhage is drained. Lumbar puncture to examine cerebrospinal fluid proteins may show characteristic abnormalities, but is not part of the routine exam. In familial forms, genetic analysis may be helpful.

CAA with hemorrhage must be distinguished from other types of brain hemorrhage. In CAA, hemorrhage typically occurs in the lobar region, often ruptures into the subarachnoid space between the brain and its coverings, and occurs at night. In hemorrhage related to high blood pressure, hemorrhage is usually deeper within the brain, ruptures into the ventricles or cavities deep inside the brain, and occurs during daytime activities. Other causes of brain hemorrhage are **arteriovenous malformations**, trauma, aneurysms, bleeding into a brain tumor, **vasculitis** (inflammation of blood vessels), or bleeding disorders.

Treatment

Although there is no effective treatment for the underlying disease process of CAA, measures can be taken to prevent brain hemorrhage in patients diagnosed with CAA. High blood pressure should be treated aggressively, and even normal blood pressure can be lowered as much as tolerated without side effects from medications. Blood thinners such as Coumadin, antiplatelet agents such as **aspirin**, or medications designed to dissolve blood clots may cause hemorrhage in patients with CAA, and should be avoided if possible. If these medications are required for other conditions, such as heart disease, the potential benefits must be carefully weighed against the increased risks.

Seizures, or recurrent neurologic symptoms thought to be seizures, should be treated with anti-epileptic drugs, although Depakote (sodium valproate) should be avoided because of its antiplatelet effect. Anti-epileptic drugs are sometimes given to patients with large lobar hemorrhage in an attempt to prevent seizures, although the benefit of this is unclear.

Once brain hemorrhage has occurred, the patient should be admitted to a hospital (ICU) for neurologic monitoring and control of increased pressure within the brain, blood pressure control, and supportive medical

care. Antiplatelet agents and blood thinners should be discontinued and their effects reversed, if possible. Surgery may be needed to remove brain hemorrhage, although bleeding during surgery may be difficult to control.

CAA may be rarely associated with cerebral vasculitis, or inflammation of the blood vessel walls. In these cases treatment with steroids or immune system suppressants may be helpful. Without tissue examination, vasculitis cannot be diagnosed reliably, and probably coexists with CAA too rarely to justify steroid treatment in most cases.

Prognosis

Since CAA is associated with progressive blood vessel degeneration, and since there is no effective treatment, most patients have a poor prognosis. Aggressive neurosurgical management allows increased survival following lobar hemorrhage, but as of 1998, 20–90% of patients die from the first hemorrhage or its complications, which include progression of hemorrhage, brain **edema** (swelling) with herniation (downward pressure on vital brain structures), seizures, and infections such as **pneumonia**. Many survivors have persistent neurologic deficits related to the brain lobe affected by hemorrhage, and are at risk for additional hemorrhages, seizures, and dementia. Prognosis is worse in patients who are older, or who have larger hemorrhages or recurrent hemorrhages within a short time.

Resources

PERIODICALS

Bornebroek, M., et.al. "White Matter Lesions and Cognitive Deterioration in Presymptomatic Carriers of the Amyloid Precursor Protein Gene Codon 693 Mutation." *Archives of Neurology* 53, no. 1 (1996): 43-48.

Itoh, Y., et.al. "Cerebral Amyloid Angiopathy: a Significant Cause of Cerebellar as well as Lobar Cerebral Hemorrhage in the Elderly." *Journal of Neurological Sciences* 116, no. 2 (1993):135-41.

Neau, J. P., et.al. "Recurrent Intracerebral Hemorrhage." *Neurology* 49, no. 1 (1997): 106-113.

Olichney, J. M., et.al. "Cerebral Infarction in Alzheimer's Disease Is Associated with Severe Amyloid Angiopathy and Hypertension." In *Archives of Neurology* 52, no. 7 (1995): 702-8.

Laurie Barclay, MD

Cerebral aneurysm

Definition

A cerebral aneurysm occurs at a weak point in the wall of a blood vessel (artery) that supplies blood to the brain. Because of the flaw, the artery wall bulges outward and fills with blood. This bulge is called an aneurysm. An aneurysm can rupture, spilling blood into the surrounding body tissue. A ruptured cerebral aneurysm can cause permanent brain damage, disability, or **death**.

Description

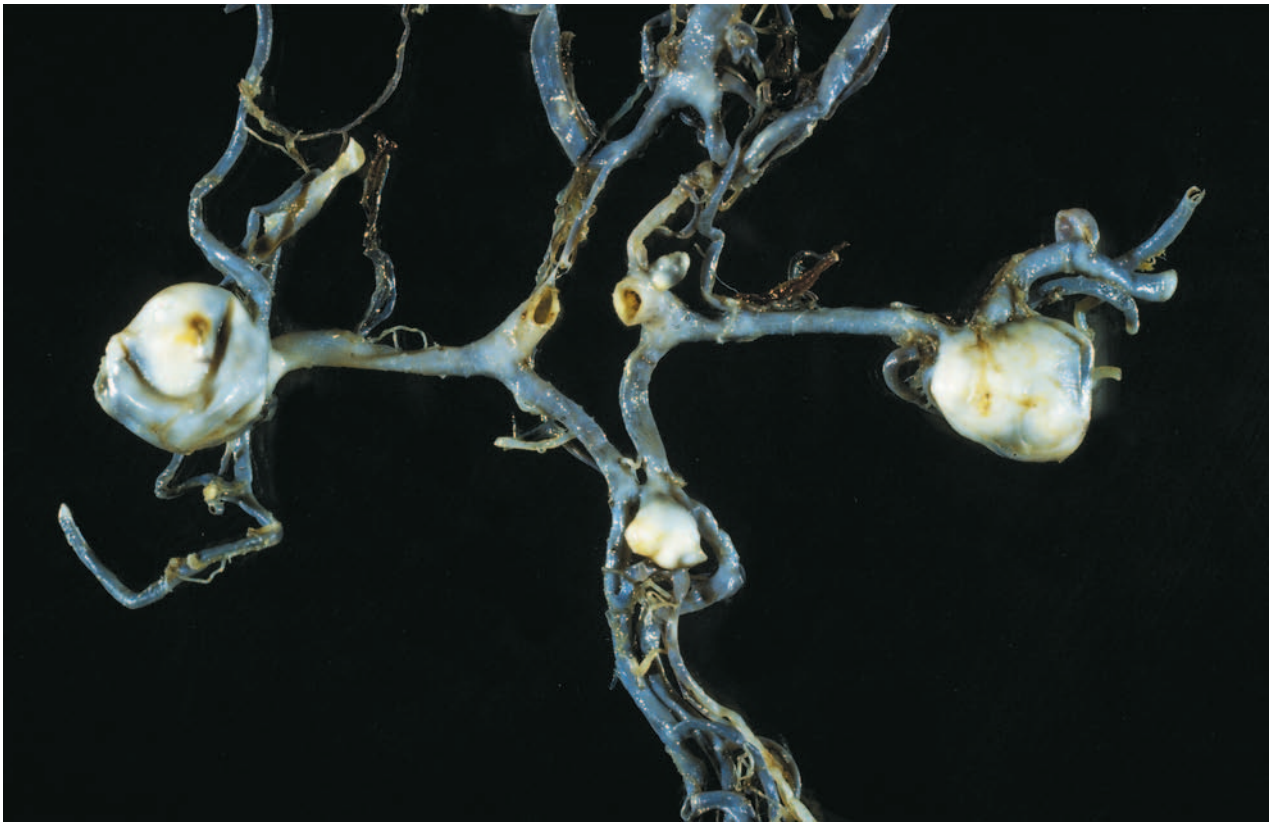
A cerebral aneurysm can occur anywhere in the brain. Aneurysms can have several shapes. The saccular aneurysm, once called a berry aneurysm, resembles a piece of fruit dangling from a branch. Saccular aneurysms are usually found at a branch in the blood vessel where they balloon out by a thin neck. Saccular cerebral aneurysms most often occur at the branch points of large arteries at the base of the brain. Aneurysms may also take the form of a bulge in one wall of the artery—a lateral aneurysm—or a widening of the entire artery—a fusiform aneurysm.

The greatest danger of aneurysms is rupture. Approximately 50–75% of stricken people survive an aneurysmal rupture. A ruptured aneurysm spills blood into the brain or into the fluid-filled area that surrounds the brain tissue. Bleeding into this area, called the subarachnoid space, is referred to as **subarachnoid hemorrhage** (SAH). About 25,000 people suffer a SAH each year. It is estimated that people with unruptured aneurysm have an annual 1–2% risk of hemorrhage. Under age 40, more men experience SAH. After age 40, more women than men are affected.

Most people who have suffered a SAH from a ruptured aneurysm did not know that the aneurysm even existed. Based on **autopsy** studies, medical researchers estimate that 1–5% of the population has some type of cerebral aneurysm. Aneurysms rarely occur in the very young or the very old; about 60% of aneurysms are diagnosed in people between ages 40 and 65.

Some aneurysms may have a genetic link and run in families. The genetic link has not been completely proven and a pattern of inheritance has not been determined. Some studies seem to show that first-degree relatives of people who suffered aneurysmal SAH are more likely to have aneurysms themselves. These studies reported that such immediate family members were four times more likely to have aneurysms than the general population. Other studies do not confirm these findings. Better evidence links aneurysms to certain rare diseases of the connective tissue. These diseases include **Marfan syndrome**, **pseudoxanthoma elasticum**, **Ehlers-Danlos syndrome**, and fibromuscular dysplasia. **Polycystic kidney disease** is also associated with cerebral aneurysms.

These diseases are also associated with an increased risk of aneurysmal rupture. Certain other conditions raise



Three aneurysms can be seen in this section of a cerebral artery removed from a human brain. *(Photograph by Martin Rotker, Phototake NYC. Reproduced by permission.)*

the risk of rupture, too. Most aneurysms that rupture are a half-inch or larger in diameter. Size is not the only factor, however, because smaller aneurysms also rupture. Cigarette **smoking**, excessive alcohol consumption, and recreational drug use (for example, use of **cocaine**) have been linked with an increased risk. The role, if any, of high blood pressure has not been determined. Some studies have implicated high blood pressure in aneurysm formation and rupture, but people with normal blood pressure also experience aneurysms and SAHs. High blood pressure may be a risk factor but not the most important one. **Pregnancy**, labor, and delivery also seem to increase the possibility that an aneurysm might rupture, but not all doctors agree. Physical exertion and use of oral contraceptives are not suspected causes for aneurysmal rupture.

Causes and symptoms

Cerebral aneurysms can be caused by brain trauma, infection, hardening of the arteries (**atherosclerosis**), or abnormal rapid cell growth (neoplastic disease), but most seem to arise from a congenital, or developmental, defect. These congenital aneurysms occur more frequently in women. Whatever the cause may be, the inner wall of the blood vessel is abnormally thin and the pressure of the blood flow causes an aneurysm to form.

Most aneurysms go unnoticed until they rupture. However, 10–15% of unruptured cerebral aneurysms are found because of their size or their location. Common warning signs include symptoms that affect only one eye, such as an enlarged pupil, a drooping eyelid, or **pain** above or behind the eye. Other symptoms are a localized **headache**, unsteady gait, a temporary problem with sight, double vision, or numbness in the face.

Some aneurysms bleed occasionally without rupturing. Symptoms of such an aneurysm develop gradually. The symptoms include headache, nausea, vomiting, neck pain, black-outs, ringing in the ears, **dizziness**, or seeing spots.

Eighty to ninety percent of aneurysms are not diagnosed until after they have ruptured. Rupture is not always a sudden event. Nearly 50% of patients who have aneurysmal SAHs also experience "the warning leak phenomenon." Persons with warning leak symptoms have sudden, atypical headaches that occur days or weeks before the actual rupture. These headaches are

KEY TERMS

Congenital—Existing at birth.

Ehlers-Danlos syndrome—A rare inheritable disease of the connective tissue marked by very elastic skin, very loose joints, and very fragile body tissue.

Embolization—A technique to stop or prevent hemorrhage by introducing a foreign mass, such as an air-filled membrane (balloon), into a blood vessel to block the flow of blood.

Fibromuscular dysplasia—A disorder that causes unexplained narrowing of arteries and high blood pressure.

Magnetic resonance angiography—A noninvasive diagnostic technique that uses radio waves to map the internal anatomy of the blood vessels.

Marfan syndrome—An inheritable disorder that affects the skeleton, joints, and blood vessels. Major indicators are excessively long arms and legs, lax joints, and vascular defects.

Nimodipine (Nimotop)—A calcium-channel blocker, that is, a drug that relaxes arterial smooth muscle by slowing the movement of calcium across cell walls.

Polycystic kidney disease—An abnormal condition in which the kidneys are enlarged and contain many cysts.

Pseudoxanthoma elasticum—A hereditary disorder of the connective, or elastic, tissue marked by premature aging and breakdown of the skin and degeneration of the arteries that leads to hemorrhages.

Subarachnoid hemorrhage (SAH)—Loss of blood into the subarachnoid space, the fluid-filled area that surrounds the brain tissue.

Vasospasm—Narrowing of a blood vessel caused by a spasm of the smooth muscle of the vessel wall.

referred to as sentinel headaches. Nausea, vomiting, and dizziness may accompany sentinel headaches. Unfortunately, these symptoms can be confused with tension headaches or migraines, and treatment can be delayed until rupture occurs.

When an aneurysm ruptures, most victims experience a sudden, extremely severe headache. This headache is typically described as the worst headache of the victim's life. **Nausea and vomiting** commonly accompany the headache. The person may experience a short loss of consciousness or prolonged **coma**. Other common signs of a SAH include a stiff neck, **fever**, and a sensitivity to light. About 25% of victims experience neurological problems linked to specific areas of the brain, swelling of the brain due to fluid accumulation (**hydrocephalus**), or seizure.

Diagnosis

Based on the clinical symptoms, a doctor will run several tests to confirm an aneurysm or an SAH. A **computed tomography** (CT) scan of the head is the initial procedure. A **magnetic resonance imaging** test (MRI) may be done instead of a CT scan. MRI, however, is not as sensitive as CT for detecting subarachnoid blood. A CT scan can determine whether there has been a hemorrhage and can assist in pinpointing the location of the aneurysm. The scan is most useful when it is done within 72 hours of the rupture. Later scans may miss the signs of hemorrhage.

If the CT scan is negative for a hemorrhage or provides an unclear diagnosis, the doctor will order a **cerebrospinal fluid (CSF) analysis**, also called a lumbar puncture. In this procedure, a small amount of cerebrospinal fluid is removed from the lower back and examined for traces of blood and blood-breakdown products. If this test is positive, cerebral **angiography** is used to map the brain's blood vessels and the damaged area. The angiography is done to pinpoint the aneurysm's location. About 15% of people who experience SAH have more than one aneurysm. For this reason, angiography should include both the common carotid artery that feeds the front of the brain and the vertebral artery that feeds the base of the brain. Occasionally, the angiography fails to find the aneurysm and must be repeated. If seizures occur, **electroencephalography** (EEG) may be used to measure the electrical activity of the brain.

Treatment

Unruptured aneurysm

If an aneurysm has not ruptured and is not causing any symptoms, it may be left untreated. Because there is a 1–2% chance of rupture per year, the cumulative risk over a number of years may justify surgical treatment.

However, if the aneurysm is small or in a place that would be difficult to reach, or if the person who has the aneurysm is in poor health, the surgical treatment may be a greater risk than the aneurysm. Risk of rupture is higher for people who have more than one aneurysm. Unruptured aneurysm would probably be treated with a surgical procedure called the clip ligation, as described below.

Ruptured aneurysm

The primary treatment for a ruptured aneurysm involves stabilizing the victim's condition, treating the immediate symptoms, and promptly assessing further treatment options, especially surgical procedures. The patient may require mechanical ventilation, oxygen, and fluids. Medications may be given to prevent major secondary complications such as seizures, rebleeding, and vasospasm (narrowing of the affected blood vessel). Vasospasm decreases blood flow to the brain and causes the death of nerve cells. A drug such as nimodipine (Nimotop) may help prevent vasospasm by relaxing the smooth muscle tissue of the arteries. Even with treatment, however, vasospasm may cause **stroke** or death.

To prevent further hemorrhage from the aneurysm, it must be removed from circulation. In general, surgical procedures should be performed as soon as possible to prevent rebleeding. The chances that aneurysm will rebleed are greatest in the first 24 hours, and vasospasm usually does not occur until 72 hours or more after rupture. If the patient is in poor condition or if there is vasospasm or other complication, surgical procedures may be delayed. The preferred surgical method is a clip ligation in which a clip is placed around the base of the aneurysm to block it off from circulation. Surgical coating, wrapping, or trapping of the aneurysm may also be performed. These procedures do not completely remove the aneurysm from circulation, however, and there is some risk that it may rebleed in the future. Newer techniques that look promising include balloon embolization, a procedure that blocks the aneurysm with an inflatable membrane introduced by means of a catheter inserted through the artery.

Prognosis

An unruptured aneurysm may not cause any symptoms over an entire lifetime. Surgical clip ligation will ensure that it won't rupture, but it may be better to leave the aneurysm alone in some cases. Familial cerebral aneurysms may rupture earlier than those without a genetic link.

The outlook is not as good for a person who suffers a ruptured aneurysm. Fifteen to twenty-five percent of people who experience a ruptured aneurysm do not survive. An additional 25–50% die as a result of complications associated with the hemorrhage. Of the survivors, 15–50% suffer permanent brain damage and disability. These conditions are caused by the death of nerve cells. Nerve cells can be destroyed by the hemorrhage itself or by complications from the hemorrhage, such as vasospasm or hydrocephalus. Hydrocephalus, a dilatation (expansion) of the fluid-filled cavity surrounding the brain, occurs in about 15% of cases. Immediate medical treatment is vital to prevent further complications and brain damage in those who survive the initial rupture. Patients who survive SAH and aneurysm clipping are unlikely to die from events related to SAH.

Prevention

There are no known methods to prevent an aneurysm from forming. If an aneurysm is discovered before it ruptures, it may be surgically removed. CT or MRI angiography may be recommended for relatives of patients with familial cerebral aneurysms.

Resources

BOOKS

Smith, Robert R., Yahgoub Tarassoli, and Yuri Zubkov. *Cerebral Aneurysms: Microvascular and Endovascular Management*. New York: Springer-Verlag, 1994.

PERIODICALS

Leblanc, Richard. "Familial Cerebral Aneurysms." *Canadian Journal of Neurological Sciences* 24, no. 3 (Aug. 1997): 191-199.

Olafsson, Elias, Allen Hauser, and Gunnar Gudmundsson. "A Population-Based Study of the Prognosis of Ruptured Cerebral Aneurysms: Mortality and Recurrence of Subarachnoid Hemorrhage." *Neurology* 48 (May 1997): 1191-1195.

Sawin, Paul D., and Christopher M. Loftus. "Diagnosis of Spontaneous Subarachnoid Hemorrhage." *American Family Physician* 55, no. 1 (Jan. 1997): 145.

Yasui, Nobuyuki, et al. "Long-term Follow-up Study of Unruptured Intracranial Aneurysms." *Neurosurgery* 40, no. 6 (June 1997): 1155-1160.

ORGANIZATIONS

The Brain Aneurysm Foundation, Inc. 66 Canal St., Boston, MA 02114. (617) 723-3870. <http://neurosurgery.mgh.harvard.edu/baf>.

OTHER

Bernadini, Gary L. "Intracerebral Aneurysms." *Columbia University Health Sciences Page*. <http://cpmcnet.columbia.edu>.

"The Brain Aneurysm Report." *Neurosurgical Sevice Page*. Harvard Medical School <http://neurosurgery.mgh.harvard.edu/abta/primer.htm>.

Julia Barrett

Cerebral angiography *see* **Angiography**

Cerebral palsy

Definition

Cerebral palsy (CP) is the term used for a group of nonprogressive disorders of movement and posture caused by abnormal development of, or damage to, motor control centers of the brain. CP is caused by events before, during, or after birth. The abnormalities of muscle control that define CP are often accompanied by other neurological and physical abnormalities.

Description

Voluntary movement (walking, grasping, chewing, etc.) is primarily accomplished using muscles that are attached to bones, known as the skeletal muscles. Control of the skeletal muscles originates in the cerebral cortex, the largest portion of the brain. Palsy means **paralysis**, but may also be used to describe uncontrolled muscle movement. Therefore, cerebral palsy encompasses any disorder of abnormal movement and paralysis caused by abnormal function of the cerebral cortex. In truth, however, CP does not include conditions due to progressive disease or degeneration of the brain. For this reason, CP is also referred to as static (nonprogressive) encephalopathy (disease of the brain). Also excluded from CP are any disorders of muscle control that arise in the muscles themselves and/or in the peripheral nervous system (nerves outside the brain and spinal cord).

CP is not a specific diagnosis, but is more accurately considered a description—a description of a broad but defined group of neurological and physical problems.

The symptoms of CP and their severity are quite variable. Those with CP may have only minor difficulty with fine motor skills, such as grasping and manipulating items with their hands. A severe form of CP could involve significant muscle problems in all four limbs, **mental retardation**, seizures, and difficulties with vision, speech, and hearing.

Muscles that receive defective messages from the brain may be constantly contracted and tight (spastic), exhibit involuntary writhing movements (athetosis), or have difficulty with voluntary movement (dyskinesia). There can also be a lack of balance and coordination with unsteady movements (ataxia). A combination of any of these problems may also occur. Spastic CP and mixed CP constitute the majority of cases. Effects on the muscles can range from mild weakness or partial paralysis (paresis), to complete loss of voluntary control of a muscle or group of muscles (plegia). CP is also designated by the number of limbs affected. For instance, affected muscles in one limb is monoplegia, both arms or both legs is diplegia, both limbs on one side of the body is hemiplegia, and in all four limbs is quadriplegia. Muscles of the trunk, neck, and head may be affected as well.

CP can be caused by a number of different mechanisms at various times—from several weeks after conception, through birth, to early childhood. For many years, it was accepted that most cases of CP were due to brain injuries received during a traumatic birth, known as birth asphyxia. However, extensive research in the 1980s showed that only 5–10% of CP can be attributed to birth trauma. Other possible causes include abnormal development of the brain, prenatal factors that directly or indirectly damage neurons in the developing brain, premature birth, and brain injuries that occur in the first few years of life.

Advances in the medical care of premature infants in the last 20 years have dramatically increased the rate of survival of these fragile newborns. However, as gestational age at delivery and birth weight of a baby decrease, the risk for CP dramatically increases. A term **pregnancy** is delivered at 37–41 weeks gestation. The risk for CP in a preterm infant (32–37 weeks) is increased about five-fold over the risk for an infant born at term. Survivors of extremely preterm births (less than 28 weeks) face as much as a 50-fold increase in risk. About 50% of all cases of CP now being diagnosed are in children who were born prematurely.

Two factors are involved in the risk for CP associated with **prematurity**. First, premature babies are at higher risk for various CP-associated medical complications, such as intracerebral hemorrhage, infection, and difficulty in breathing, to name a few. Second, the onset of **premature labor** may be induced, in part, by complications that have already caused neurologic damage in the fetus. A combination of both factors almost certainly plays a role in some cases of CP. The tendency toward premature delivery runs in families, but the genetic mechanisms are far from clear.

An increase in multiple pregnancies in recent years, especially in the United States, is blamed on the increased use of fertility drugs. As the number of fetuses in a pregnancy increases, the risks for abnormal development and premature delivery also increase. Children from twin pregnancies have four times the risk of developing CP as children from singleton pregnancies, owing to the fact that more twin pregnancies are delivered prematurely. The risk for CP in a child of triplets is up to 18 times greater. Furthermore, recent evidence suggests that a baby from a pregnancy in which its twin died before birth is at increased risk for CP.

Approximately 500,000 children and adults in the United States have CP, and it is newly diagnosed in about 6,000 infants and young children each year. The inci-

dence of CP has not changed much in the last 20–30 years. Ironically, advances in medicine have decreased the incidence from some causes, Rh disease for example, but increased it from others, notably, prematurity and multiple pregnancies. No particular ethnic groups seem to be at higher risk for CP. However, people of disadvantaged background are at higher risk due to poorer access to proper prenatal care and advanced medical services.

Causes and symptoms

As noted, CP has many causes, making a discussion of the genetics of CP complicated. A number of hereditary/genetic syndromes have signs and symptoms similar to CP, but usually also have problems not typical of CP. Put another way, some hereditary conditions "mimic" CP. Isolated CP, meaning CP that is not a part of some other syndrome or disorder, is usually not inherited.

It might be possible to group the causes of CP into those that are genetic and those that are non-genetic, but most would fall somewhere in between. Grouping causes into those that occur during pregnancy (prenatal), those that happen around the time of birth (perinatal), and those that occur after birth (postnatal), is preferable. CP related to premature birth and multiple pregnancies (twins, triplets, etc., not "many pregnancies") is somewhat different and considered separately.

Prenatal causes

Although much has been learned about human embryology in the last couple of decades, a great deal remains unknown. Studying prenatal human development is difficult because the embryo and fetus develop in a closed environment—the mother's womb. However, the relatively recent development of a number of prenatal tests has opened a window on the process. Add to that more accurate and complete evaluations of newborns, especially those with problems, and a clearer picture of what can go wrong before birth is possible.

The complicated process of brain development before birth is susceptible to many chance errors that can result in abnormalities of varying degrees. Some of these errors will result in structural anomalies of the brain, while others may cause undetectable, but significant, abnormalities in how the cerebral cortex is "wired." An abnormality in structure or wiring is sometimes hereditary, but is most often due to chance, or a cause unknown at this time. Whether and how much genetics played a role in a particular brain abnormality depends to some degree on the type of anomaly and the form of CP it causes.

Several maternal-fetal infections are known to increase the risk for CP, including **rubella** (German **measles**, now rare in the United States), cytomegalovirus (CMV), and **toxoplasmosis**. Each of these infections is considered a risk to the fetus only if the mother contracts it for the first time during that pregnancy. Even in those cases, though, most babies will be born normal. Most women are immune to all three infections by the time they reach childbearing age, but a woman's immune status can be determined using the so-called TORCH (for Toxoplasmosis, Rubella, Cytomegalovirus, and Herpes) test before or during pregnancy.

Just as a **stroke** can cause neurologic damage in an adult, so too can this type of event occur in the fetus. A burst blood vessel in the brain followed by uncontrolled bleeding (coagulopathy), known as intracerebral hemorrhage, could cause a fetal stroke, or a cerebral blood vessel could be obstructed by a clot (**embolism**). Infants who later develop CP, along with their mothers, are more likely than other mother-infant pairs to test positive for factors that put them at increased risk for bleeding episodes or blood clots. Some **coagulation disorders** are strictly hereditary, but most have a more complicated basis.

A teratogen is any substance to which a woman is exposed that has the potential to harm the embryo or fetus. Links between a drug or other chemical exposure during pregnancy and a risk for CP are difficult to prove. However, any substance that might affect fetal brain development, directly or indirectly, could increase the risk for CP. Furthermore, any substance that increases the risk for premature delivery and low birth weight, such as alcohol, tobacco, or **cocaine**, among others, might indirectly increase the risk for CP.

The fetus receives all nutrients and oxygen from blood that circulates through the placenta. Therefore, anything that interferes with normal placental function might adversely affect development of the fetus, including the brain, or might increase the risk for premature delivery. Structural abnormalities of the placenta, premature detachment of the placenta from the uterine wall (abruption), and placental infections (chorioamnionitis) are thought to pose some risk for CP.

Certain conditions in the mother during pregnancy might pose a risk to fetal development leading to CP. Women with autoimmune anti-thyroid or anti-phospholipid (APA) antibodies are at slightly increased risk for CP in their children. A potentially important clue uncovered recently points toward high levels of cytokines in the maternal and fetal circulation as a possible risk for CP. Cytokines are proteins associated with inflammation, such as from infection or **autoimmune disorders**, and they may be toxic to neurons in the fetal brain. More research is needed to determine the exact relationship, if any, between high levels of cytokines in pregnancy and

KEY TERMS

Asphyxia—Lack of oxygen. In the case of cerebral palsy, lack of oxygen to the brain.

Ataxia—A deficiency of muscular coordination, especially when voluntary movements are attempted, such as grasping or walking.

Athetosis—A condition marked by slow, writhing, involuntary muscle movements.

Cerebral palsy—Movement disability resulting from nonprogressive brain damage.

Coagulopathy—A disorder in which blood is either too slow or too quick to coagulate (clot).

Contracture—A tightening of muscles that prevents normal movement of the associated limb or other body part.

Cytokine—A protein associated with inflammation that, at high levels, may be toxic to nerve cells in the developing brain.

Diplegia—Paralysis affecting like parts on both sides the body, such as both arms or both legs.

Dorsal rhizotomy—A surgical procedure that cuts nerve roots to reduce spasticity in affected muscles.

Dyskinesia—Impaired ability to make voluntary movements.

Hemiplegia—Paralysis of one side of the body.

Hypotonia—Reduced or diminished muscle tone.

Quadriplegia—Paralysis of all four limbs.

Serial casting—A series of casts designed to gradually move a limb into a more functional position.

Spastic—A condition in which the muscles are rigid, posture may be abnormal, and fine motor control is impaired.

Spasticity—Increased mucle tone, or stiffness, which leads to uncontrolled, awkward movements.

Static encephalopathy—A disease of the brain that does not get better or worse.

Tenotomy—A surgical procedure that cuts the tendon of a contracted muscle to allow lengthening.

CP. A woman has some risk of developing the same complications in more than one pregnancy, slightly increasing the risk for more than one child with CP.

Serious physical trauma to the mother during pregnancy could result in direct trauma to the fetus as well, or injuries to the mother could compromise the availability of nutrients and oxygen to the developing fetal brain.

Perinatal causes

Birth asphyxia significant enough to result in CP is now uncommon in developed countries. Tight nuchal cord (umbilical cord around the baby's neck) and prolapsed cord (cord delivered before the baby) are possible causes of birth asphyxia, as are bleeding and other complications associated with **placental abruption** and **placenta previa** (placenta lying over the cervix).

Infection in the mother is sometimes not passed to the fetus through the placenta, but is transmitted to the baby during delivery. Any such infection that results in serious illness in the newborn has the potential to produce some neurological damage.

Postnatal causes

The remaining 15% of CP is due to neurologic injury sustained after birth. CP that has a postnatal cause is sometimes referred to as acquired CP, but this is only accurate for those cases caused by infection or trauma.

Incompatibility between the Rh blood types of mother and child (mother Rh negative, baby Rh positive) can result in severe anemia in the baby (**erythroblastosis fetalis**). This may lead to other complications, including severe **jaundice**, which can cause CP. Rh disease in the newborn is now rare in developed countries due to routine screening of maternal blood type and treatment of pregnancies at risk. The routine, effective treatment of jaundice due to other causes has also made it an infrequent cause of CP in developed countries. Rh blood type poses a risk for recurrence of Rh disease if treatment is not provided.

Serious infections that affect the brain directly, such as **meningitis** and **encephalitis**, may cause irreversible damage to the brain, leading to CP. A **seizure disorder** early in life may cause CP, or may be the product of a hidden problem that causes CP in addition to seizures. Unexplained (idiopathic) seizures are hereditary in only a small percentage of cases. Although rare in infants born healthy at or near term, intracerebral hemorrhage and brain embolism, like fetal stroke, are sometimes genetic.

Physical trauma to an infant or child resulting in brain injury, such as from abuse, accidents, or near

drowning/suffocation, might cause CP. Likewise, ingestion of a toxic substance such as lead, mercury, poisons, or certain chemicals could cause neurological damage. Accidental overdose of certain medications might also cause similar damage to the central nervous system.

By definition, the defect in cerebral function causing CP is nonprogressive. However, the symptoms of CP often change over time. Most of the symptoms of CP relate in some way to the aberrant control of muscles. To review, CP is categorized first by the type of movement/postural disturbance(s) present, then by a description of which limbs are affected, and finally by the severity of motor impairment. For example, spastic diplegia refers to continuously tight muscles that have no voluntary control in both legs, while athetoid quadraparesis describes uncontrolled writhing movements and muscle weakness in all four limbs. These three-part descriptions are helpful in providing a general picture, but cannot give a complete description of any one person with CP. In addition, the various "forms" of CP do not occur with equal frequency—spastic diplegia is seen in more individuals than is athetoid quadraparesis. CP can also be loosely categorized as mild, moderate, or severe, but these are very subjective terms with no firm boundaries between them.

A muscle that is tensed and contracted is hypertonic, while excessively loose muscles are hypotonic. Spastic, hypertonic muscles can cause serious orthopedic problems, including **scoliosis** (spine curvature), hip dislocation, or **contractures**. A contracture is shortening of a muscle, aided sometimes by a weak-opposing force from a neighboring muscle. Contractures may become permanent, or "fixed," without some sort of intervention. Fixed contractures may cause postural abnormalities in the affected limbs. Clenched fists and contracted feet (equinus or equinovarus) are common in people with CP. Spasticity in the thighs causes them to turn in and cross at the knees, resulting in an unusual method of walking known as a "scissors gait." Any of the joints in the limbs may be stiff (immobilized) due to spasticity of the attached muscles.

Athetosis and dyskinesia often occur with spasticity, but do not often occur alone. The same is true of ataxia. It is important to remember that "mild CP" or "severe CP" refers not only to the number of symptoms present, but also to the level of involvement of any particular class of symptoms.

Mechanisms that can cause CP are not always restricted to motor-control areas of the brain. Other neurologically based symptoms may include:

- mental retardation/learning disabilities
- behavioral disorders
- seizure disorders
- visual impairment
- hearing loss
- speech impairment (dysarthria)
- abnormal sensation and perception

These problems may have a greater impact on a child's life than the physical impairments of CP, although not all children with CP are affected by other problems. Many infants and children with CP have growth impairment. About one-third of individuals with CP have moderate-to-severe mental retardation, one-third have mild mental retardation, and one-third have normal intelligence.

Diagnosis

The signs of CP are not usually noticeable at birth. Children normally progress through a predictable set of developmental milestones through the first 18 months of life. Children with CP, however, tend to develop these skills more slowly because of their motor impairments, and delays in reaching milestones are usually the first symptoms of CP. Babies with more severe cases of CP are usually diagnosed earlier than others.

Selected developmental milestones, and the ages for normally acquiring them, are given below. If a child does not acquire the skill by the age shown in parentheses, there is some cause for concern.

- sits well unsupported—six months (eight–10 months)
- babbles—six months (eight months)
- crawls—nine months (12 months)
- finger feeds, holds bottle—nine months (12 months)
- walks alone—12 months (15–18 months)
- uses one or two words other than dada/mama—12 months (15 months)
- walks up and down steps—24 months (24–36 months)
- turns pages in books; removes shoes and socks—24 months (30 months)

Children do not consistently favor one hand over the other before 12–18 months, and doing so may be a sign that the child has difficulty using the other hand. This same preference for one side of the body may show up as asymmetric crawling or, later on, favoring one leg while climbing stairs.

It must be remembered that children normally progress at somewhat different rates, and slow beginning accomplishment is often followed by normal development. Other causes for developmental delay—some benign, some serious—should be excluded before con-

sidering CP as the answer. CP is nonprogressive, so continued loss of previously acquired milestones indicates that CP is not the cause of the problem.

No one test is diagnostic for CP, but certain factors increase suspicion. The Apgar score measures a baby's condition immediately after birth. Babies that have low Apgar scores are at increased risk for CP. Presence of abnormal muscle tone or movements may indicate CP, as may the persistence of infantile reflexes. Imaging of the brain using ultrasound, x rays, MRI, and/or CT scans may reveal a structural anomaly. Some brain lesions associated with CP include scarring, cysts, expansion of the cerebral ventricles (**hydrocephalus**), periventricular leukomalacia (an abnormality of the area surrounding the ventricles), areas of dead tissue (necrosis), and evidence of an intracerebral hemorrhage or blood clot. Blood and urine biochemical tests, as well as genetic tests, may be used to rule out other possible causes, including muscle and peripheral nerve diseases, mitochondrial and metabolic diseases, and other inherited disorders. Evaluations by a pediatric developmental specialist and a geneticist may be of benefit.

Treatment

Cerebral palsy cannot be cured, but many of the disabilities it causes can be managed through planning and timely care. Treatment for a child with CP depends on the severity, nature, and location of the primary muscular symptoms, as well as any associated problems that might be present. Optimal care of a child with mild CP may involve regular interaction with only a physical therapist and occupational therapist, whereas care for a more severely affected child may include visits to multiple medical specialists throughout life. With proper treatment and an effective plan, most people with CP can lead productive, happy lives.

Therapy

Spasticity, muscle weakness, coordination, ataxia, and scoliosis are all significant impairments that affect the posture and mobility of a person with CP. Physical and occupational therapists work with the patient, and the family, to maximize the ability to move affected limbs, develop normal motor patterns, and maintain posture. "Assistive technology," things such as wheelchairs, walkers, shoe inserts, crutches, and braces, are often required. A speech therapist, and high-tech aids such as computer-controlled communication devices, can make a tremendous difference in the life of those who have speech impairments.

Medications

Before fixed contractures develop, muscle-relaxant drugs such as diazepam (Valium), dantrolene (Dantrium), and baclofen (Lioresal) may be prescribed. Botulinum toxin (Botox), a newer and highly effective treatment, is injected directly into the affected muscles. Alcohol or phenol injections into the nerve controlling the muscle are another option. Multiple medications are available to control seizures, and athetosis can be treated using medications such as trihexyphenidyl HCl (Artane) and benztropine (Cogentin).

Surgery

Fixed contractures are usually treated with either serial casting or surgery. The most commonly used surgical procedures are tenotomy, tendon transfer, and dorsal rhizotomy. In tenotomy, tendons of the affected muscle are cut and the limb is cast in a more normal position while the tendon regrows. Alternatively, tendon transfer involves cutting and reattaching a tendon at a different point on the bone to enhance the length and function of the muscle. A neurosurgeon performing dorsal rhizotomy carefully cuts selected nerve roots in the spinal cord to prevent them from stimulating the spastic muscles. Neurosurgical techniques in the brain such as implanting tiny electrodes directly into the cerebellum, or cutting a portion of the hypothalamus, have very specific uses and have had mixed results.

Education

Parents of a child newly diagnosed with CP are not likely to have the necessary expertise to coordinate the full range of care their child will need. Although knowledgeable and caring medical professionals are indispensable for developing a care plan, a potentially more important source of information and advice is other parents who have dealt with the same set of difficulties. Support groups for parents of children with CP can be significant sources of both practical advice and emotional support. Many cities have support groups that can be located through the United Cerebral Palsy Association, and most large medical centers have special multidisciplinary clinics for children with developmental disorders.

Prognosis

Cerebral palsy can affect every stage of maturation, from childhood through adolescence to adulthood. At each stage, those with CP, along with their caregivers, must strive to achieve and maintain the fullest range of experiences and education consistent with their abilities. The advice and intervention of various professionals remains crucial for many people with CP. Although CP itself is not considered a terminal disorder, it can affect a person's lifespan by increasing the risk for certain med-

ical problems. People with mild cerebral palsy may have near-normal lifespans, but the lifespan of those with more severe forms may be shortened. However, over 90% of infants with CP survive into adulthood.

The cause of most cases of CP remains unknown, but it has become clear in recent years that birth difficulties are not to blame in most cases. Rather, developmental problems before birth, usually unknown and generally undiagnosable, are responsible for most cases. The rate of survival for preterm infants has leveled off in recent years, and methods to improve the long-term health of these at-risk babies are now being sought. Current research is also focusing on the possible benefits of recognizing and treating coagulopathies and inflammatory disorders in the prenatal and perinatal periods. The use of magnesium sulfate in pregnant women with preeclampsia or threatened preterm delivery may reduce the risk of CP in very preterm infants. Finally, the risk of CP can be decreased through good maternal **nutrition**, avoidance of drugs and alcohol during pregnancy, and prevention or prompt treatment of infections.

Resources

BOOKS

Miller, Freema, and Steven J. Bachrach. *Cerebral Palsy: A Complete Guide for Caregiving*. Baltimore: Johns Hopkins University Press, 1995.

Peacock, Judith. *Cerebral Palsy.* Mankato, MN: Capstone Press, 2000.

Pimm, Paul. *Living With Cerebral Palsy.* Austin, TX: Raintree Steck-Vaughn Publishers, 2000.

Pincus, Dion. *Everything You Need to Know About Cerebral Palsy.* New York: Rosen Publishing Group, Inc., 2000.

PERIODICALS

Chambers, Henry G. "Research in Cerebral Palsy." *The Exceptional Parent* 29 (July 1999): 50.

Myers, Scott M. and Bruce K. Shapiro. "Origins and Causes of Cerebral Palsy: Symptoms and Diagnosis." *The Exceptional Parent* 29 (April 1999): 28.

Seppa, Nathan. "Infections may underlie cerebral palsy." *Science News* 154 (October 17, 1998): 244.

Stephenson, Joan. "Cerebral Palsy Clues." *The Journal of the American Medical Association* 280 (21 October 1998): 1298.

ORGANIZATIONS

Epilepsy Foundation of America. 4351 Garden City Dr., Suite 406, Landover, MD 20785-2267. (301) 459-3700 or (800) 332-1000. <http://www.epilepsyfoundation.org>.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (888) 663-4637. resourcecenter@modimes.org. <http://www.modimes.org>.

National Easter Seal Society. 230 W. Monroe St., Suite 1800, Chicago, IL 60606-4802. (312) 726-6200 or (800) 221-6827. <http://www.easter-seals.org>.

National Institute of Neurological Disorders and Stroke. 31 Center Drive, MSC 2540, Bldg. 31, Room 8806, Bethesda, MD 20814. (301) 496-5751 or (800) 352-9424. <http://www.ninds.nih.gov>.

National Society of Genetic Counselors. 233 Canterbury Dr., Wallingford, PA 19086-6617. (610) 872-1192. <http://www.nsgc.org/GeneticCounselingYou.asp>.

United Cerebral Palsy Association, Inc. (UCP). 1660 L St. NW, Suite 700, Washington, DC 20036-5602. (202)776-0406 or (800)872-5827. <http://www.ucpa.org>.

OTHER

"Cerebral Palsy Information Page." *National Institute of Neurological Disorders and Stroke.* <http://www.ninds.nih.gov/health_and_medical/pubs/cerebral_palsy.htm>.

"Cerebral Palsy: Hope Through Research." *National Institute of Neurological Disorders and Stroke.* <http://www.ninds.nih.gov/health_and_medical/pubs/cerebral_palsyhtr.htm>.

Scott J. Polzin, MS

Cerebrospinal fluid (CSF) analysis

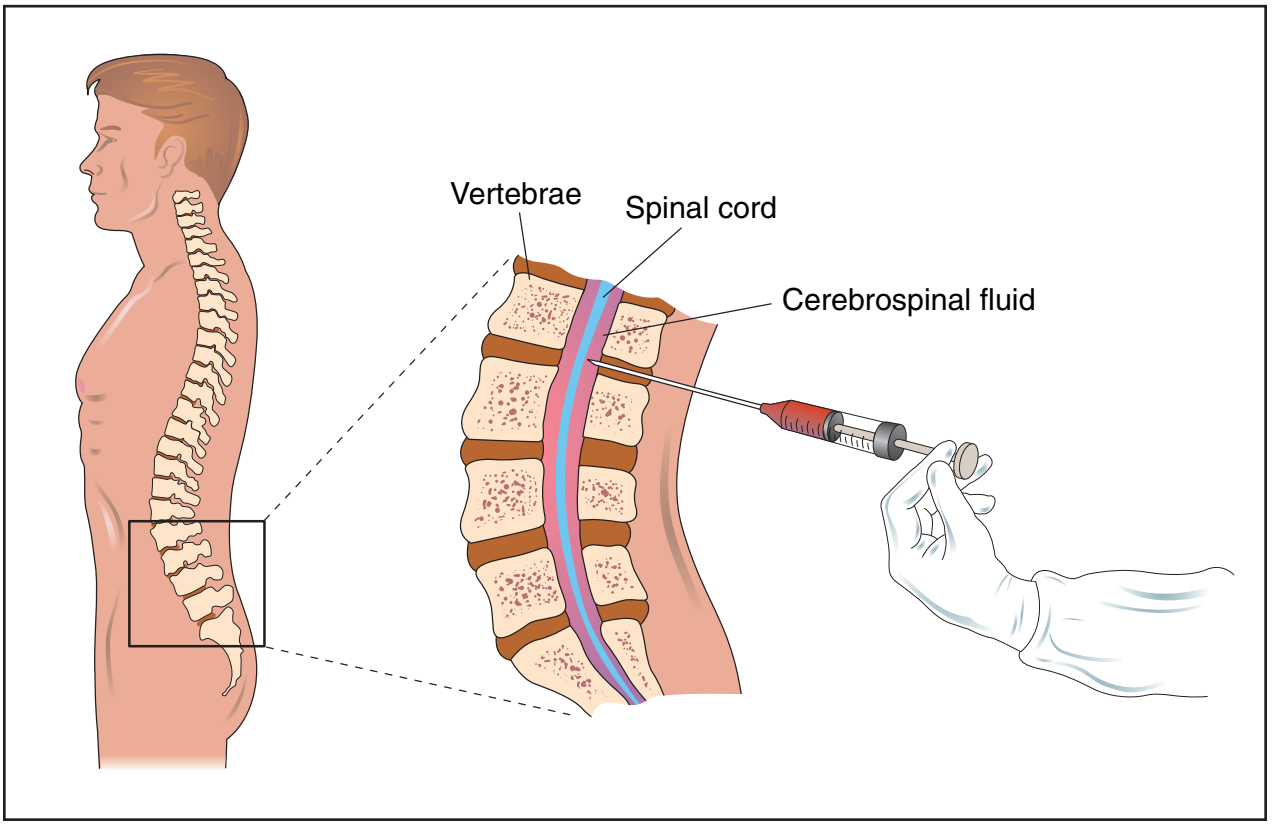
Definition

Cerebrospinal fluid (CSF) analysis is a laboratory test to examine a sample of the fluid surrounding the brain and spinal cord. This fluid is a clear, watery liquid that protects the central nervous system from injury and cushions it from the surrounding bone structure. It contains a variety of substances, particularly glucose (sugar), protein, and white blood cells from the immune system. The fluid is withdrawn through a needle in a procedure called a lumbar puncture.

Purpose

The purpose of a CSF analysis is to diagnose medical disorders that affect the central nervous system. Some of these conditions include:

- viral and bacterial infections, such as **meningitis** and **encephalitis**
- tumors or cancers of the nervous system
- syphilis, a sexually transmitted disease
- bleeding (hemorrhaging) around the brain and spinal cord
- multiple sclerosis, a disease that affects the myelin coating of the nerve fibers of the brain and spinal cord
- Guillain-Barré syndrome, an inflammation of the nerves.



During a lumbar puncture, or spinal tap, a procedure in which cerebrospinal fluid is aspirated, the physician inserts a hollow, thin needle in the space between two vertebrae of the lower back and slowly advances it toward the spine. The cerebrospinal fluid pressure is then measured and the fluid is withdrawn for laboratory analysis. *(Illustration by Electronic Illustrators Group.)*

Precautions

In some circumstances, a lumbar puncture to withdraw a small amount of CSF for analysis may lead to serious complications. Lumbar puncture should be performed only with extreme caution, and only if the benefits are thought to outweigh the risks, in certain conditions. For example, in people who have blood clotting (coagulation) or bleeding disorders, lumbar puncture can cause bleeding that can compress the spinal cord. If there is a large **brain tumor** or other mass, removal of CSF can cause the brain to droop down within the skull cavity (herniate), compressing the brain stem and other vital structures, and leading to irreversible brain damage or **death**. These problems are easily avoided by checking blood coagulation through a blood test and by doing a **computed tomography scan** (CT) or **magnetic resonance imaging** (MRI) scan before attempting the lumbar puncture. In addition, a lumbar puncture procedure should never be performed at the site of a localized skin infection on the lower back because the infection may be introduced into the CSF and may spread to the brain or spinal cord.

Description

The procedure to remove cerebrospinal fluid is called a lumbar puncture, or spinal tap, because the area of the spinal column used to obtain the sample is in the lumbar spine, or lower section of the back. In rare instances, such as a spinal fluid blockage in the middle of the back, a doctor may perform a spinal tap in the neck. The lower lumbar spine (usually between the vertebrae known as L4–5) is preferable because the spinal cord stops near L2, and a needle introduced below this level will miss the spinal cord and encounter only nerve roots, which are easily pushed aside.

A lumbar puncture takes about 30 minutes. Patients can undergo the test in a doctor's office, laboratory, or outpatient hospital setting. Sometimes it requires an inpatient hospital stay. If the patient has spinal arthritis, is extremely uncooperative, or obese, it may be necessary to introduce the spinal needle using x-ray guidance.

In order to get an accurate sample of cerebrospinal fluid, it is critical that a patient is in the proper position. The spine must be curved to allow as much space as possi-

KEY TERMS

Encephalitis—An inflammation or infection of the brain and spinal cord caused by a virus or as a complication of another infection.

Guillain-Barré syndrome—An inflammation involving nerves that affect the extremities. The inflammation may spread to the face, arms, and chest.

Immune system—Protects the body against infection.

Manometer—A device used to measure fluid pressure.

Meningitis—An infection or inflammation of the membranes or tissues that cover the brain and spinal cord, and caused by bacteria or a virus.

Multiple sclerosis—A disease that destroys the covering (myelin sheath) of nerve fibers of the brain and spinal cord.

Spinal canal—The cavity or hollow space within the spine that contains cerebrospinal fluid.

Vertebrae—The bones of the spinal column. There are 33 along the spine, with five (called L1-L5) making up the lower lumbar region.

ble between the lower vertebrae, or bones of the back, for the doctor to insert a lumbar puncture needle between the vertebrae and withdraw a small amount of fluid. The most common position is for the patient to lie on his or her side with the back at the edge of the exam table, head and chin bent down, knees drawn up to the chest, and arms clasped around the knees. (Small infants and people who are obese may need to curve their spines in a sitting position.) People should talk to their doctor if they have any questions about their position because it is important to be comfortable and to remain still during the entire procedure. In fact, the doctor will explain the procedure to the patient (or guardian) so that the patient can agree in writing to have it done (informed consent). If the patient is anxious or uncooperative, a short-acting sedative may be given.

During a lumbar puncture, the doctor drapes the back with a sterile covering that has an opening over the puncture site and cleans the skin surface with an antiseptic solution. Patients receive a local anesthetic to minimize any **pain** in the lower back.

The doctor inserts a hollow, thin needle in the space between two vertebrae of the lower back and slowly advances it toward the spine. A steady flow of clear cerebrospinal fluid, normally the color of water, will begin to fill the needle as soon as it enters the spinal canal. The doctor measures the cerebrospinal fluid pressure with a special instrument called a manometer and withdraws several vials of fluid for laboratory analysis. The amount of fluid collected depends on the type and number of tests needed to diagnose a particular medical disorder.

In some cases, the doctor must remove and reposition the needle. This occurs when there is not an even flow of fluid, the needle hits bone or a blood vessel, or the patient reports sharp, unusual pain.

Preparation

Patients can go about their normal activities before a lumbar puncture. Experts recommend that patients relax before the procedure to release any muscle tension, since the lumbar puncture needle must pass through muscle tissue before it reaches the spinal canal. A patient's level of relaxation before and during the procedure plays a critical role in the test's success.

Aftercare

After the procedure, the doctor covers the site of the puncture with a sterile bandage. Patients must avoid sitting or standing and remain lying down for as long as six hours after the lumbar puncture. They should also drink plenty of fluid to help prevent lumbar puncture **headache**, which is discussed in the next section.

Risks

For most people, the most common side effect after the removal of CSF is a headache. This occurs in 10–30% of adult patients and in up to 40% of children. It is caused by a decreased CSF pressure related to a small leak of CSF through the puncture site. These headaches usually are a dull pain, although some people report a throbbing sensation. A stiff neck and nausea may accompany the headache. Lumbar puncture headaches typically begin within two days after the procedure and persist from a few days to several weeks or months.

Since an upright position worsens the pain, patients with a lumbar puncture headache can control the pain by lying in a flat position and taking a prescription or nonprescription pain relief medication, preferably one containing **caffeine**. In rare cases, the puncture site leak is "patched" using the patient's own blood.

People should talk to their doctor about complications from a lumbar puncture. In most cases, this test to analyze CSF is a safe and effective procedure. Some patients experience pain, difficulty urinating, infection, or leakage of cerebrospinal fluid from the puncture site after the procedure.

Normal results

Normal CSF is clear and colorless. It may be cloudy in infections; straw- or yellow-colored if there is excess protein, as may occur with **cancer** or inflammation; blood-tinged if there was recent bleeding; or yellow to brown (xanthochromic) if caused by an older instance of bleeding.

A series of laboratory tests analyze the CSF for a variety of substances to rule out possible medical disorders of the central nervous system. The following are normal values for commonly tested substances:

- CSF pressure: 50–180 mmH_2O
- glucose: 40–85 mg/dL
- protein: 15–50 mg/dL
- leukocytes (white blood cells) total less than 5 per mL
- lymphocytes: 60–70%
- monocytes: 30–50%
- neutrophils: none

Normally, there are no red blood cells in the CSF unless the needle passes though a blood vessel on route to the CSF. If this is the case, there should be more red blood cells in the first tube collected than in the last.

Abnormal results

Abnormal test result values in the pressure or any of the substances found in the cerebrospinal fluid may suggest a number of medical problems including a tumor or spinal cord obstruction; hemorrhaging or bleeding in the central nervous system; infection from bacterial, viral, or fungal microorganisms; or an inflammation of the nerves. It is important for patients to review the results of a cerebrospinal fluid analysis with their doctor and to discuss any treatment plans.

Resources

BOOKS

Anderson, Kenneth, ed. *Mosby's Medical, Nursing and Allied Health Dictionary.* 4th ed. Chicago: Mosby Year-Book, Inc., 1994.

Conn's Current Therapy, 1996. Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"General Problems in Infectious Diseases." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

PERIODICALS

Lederman, Richard J. "Lumbar Puncture: Essential Steps to a Safe and Valid Procedure." *Geriatrics* (June 1996): 51-55.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Martha Floberg Robbins

Cerebrovascular accident *see* **Stroke**

Cerebrovascular amyloidosis *see* **Cerebral amyloid angiopathy**

Cerumen impaction

Definition

Cerumen impaction is a condition in which earwax has become tightly packed in the external ear canal to the point that the canal is blocked.

Description

Cerumen impaction develops when earwax accumulates in the inner part of the ear canal and blocks the eardrum. It affects between 2–6% of the general population in the United States. Impaction does not happen under normal circumstances because cerumen is produced by glands in the outer part of the ear canal; it is not produced in the inner part. The cerumen traps sand or dust particles before they reach the ear drum. It also protects the outer part of the ear canal because it repels water. The slow movement of the outer layer of skin of the ear canal carries cerumen toward the outer opening of the ear. As the older cerumen reaches the opening of the ear, it dries out and falls away.

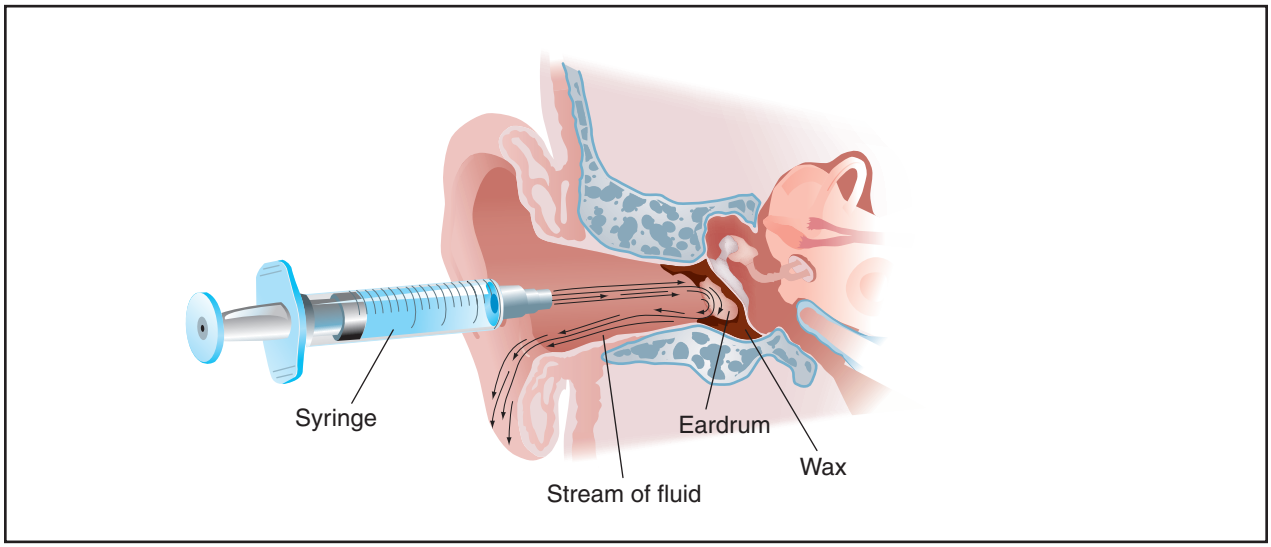
Causes and symptoms

Causes

Cerumen is most likely to become impacted when it is pushed against the eardrum by cotton-tipped applicators, hair pins, or other objects that people put in their ears; and when it is trapped against the eardrum by a hearing aid. Less common causes of cerumen impaction include overproduction of earwax by the glands in the ear canal, or an abnormally shaped ear canal.

Symptoms

The most important symptom of cerumen impaction is partial loss of hearing. Other symptoms are **itching**, **tinnitus** (noise or ringing in the ears), a sensation of fullness in the ear, and **pain**.



Ear wax is removed by flushing the ear canal with warm fluid. *(Illustration by Argosy, Inc.)*

Diagnosis

The diagnosis of impacted cerumen is usually made by examining the ear canal and eardrum with an otoscope, an instrument with a light attached that allows the doctor to look into the canal.

Treatment

Irrigation is the most common method of removing impacted cerumen. It involves washing out the ear canal with water from a commercial irrigator or a syringe with a catheter attached. Although some doctors use Water Piks to remove cerumen, most do not recommend them because the stream of water is too forceful and may damage the eardrum. The doctor may add a small amount of alcohol, hydrogen peroxide, or other antiseptic. The water must be close to body temperature; if it is too cold or too warm, the patient may feel dizzy or nauseated. After the ear has been irrigated, the doctor will apply antibiotic ear drops to protect the ear from infection.

Irrigation should not be used to remove cerumen if the patient's eardrum is ruptured or missing; if the patient has a history of chronic **otitis media** (inflammation of the middle ear) or a myringotomy (cutting the eardrum to allow fluid to escape from the middle ear); or if the patient has hearing in only one ear.

If irrigation cannot be used or fails to remove the cerumen, the patient is referred to an ear, nose, and throat (ENT) specialist. The specialist can remove the wax with a vacuum device or a curette, which is a small scoop-shaped surgical instrument.

Some doctors prescribe special ear drops, such as Cerumenex, to soften the wax. The most common side effect of Cerumenex is an allergic skin reaction. Over-the-counter wax removal products include Debrox or Murine Ear Drops. A 3% solution of hydrogen peroxide may also be used. These products are less likely to irritate the skin of the ear.

Prognosis

In most cases, impacted cerumen is successfully removed by irrigation with no lasting side effects. Irrigation can, however, lead to infection of the outer or the middle ear if the patient has a damaged or absent ear drum. Patients who try to remove earwax themselves with hair pins or similar objects run the risk of perforating the ear drum or damaging the fragile skin covering the ear canal, causing bleeding and the risk of infection.

Prevention

The best method of cleaning the external ear is to wipe the outer opening with a damp washcloth folded over the index finger, without going into the ear canal itself. Two techniques have been recommended to prevent cerumen from reaccumulating in the ear. The patient may place two or three drops of mineral oil into each ear once a week, allow it to remain for two or three minutes, and rinse it out with warm water; or place two drops of Domeboro otic solution in each ear once a week after showering.

Patients who wear **hearing aids** should have their ears examined periodically for signs of cerumen accumulation.

Resources

BOOKS

Jackler, Robert K., MD, and Michael J. Kaplan, MD. "Cerumen Impaction." In "Ear, Nose, & Throat," *Current Med-*

KEY TERMS

Cerumen—The medical term for earwax.

Curette—A small scoop-shaped surgical instrument that can be used to remove cerumen if irrigation does not work or cannot be used.

Impaction—A condition in which earwax has become tightly packed in the outer ear to the point that the external ear canal is blocked.

Irrigation—The technique of removing cerumen from the ear canal by flushing it with water.

Myringotomy—Surgical cutting of the ear drum to allow fluid to escape from the middle ear.

Otitis media—Inflammation of the middle ear. Patients who have had recurrent otitis media should not have cerumen removed by irrigation.

Tinnitus—A sensation of noise or ringing in the ears. Tinnitus may be a symptom of cerumen impaction.

ical Diagnosis & Treatment 2001. 40th ed. Ed. L. M. Tierney, Jr., MD, et al. New York: Lange Medical Books/McGraw-Hill, 2001.

"External Ear: Obstructions." In *The Merck Manual of Diagnosis and Therapy*, ed. Mark H. Beers, MD, and Robert Berkow, MD. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

PERIODICALS

Brownson, Paul J., MD. "Cerumen Management." *Update: The Newsletter of the Council for Accreditation in Occupational Hearing Conservation* 11, (no. 4), (Winter 2000-2001).

ORGANIZATIONS

American Academy of Otolaryngology, Head and Neck Surgery. 1 Prince Street, Alexandria, VA 22314. (703) 836-4444.

Rebecca J. Frey, PhD

Cervical biopsy *see* **Cervical conization**

Cervical cancer

Definition

Cervical **cancer** is a disease in which the cells of the cervix become abnormal and start to grow uncontrollably, forming tumors.

Description

In the United States, cervical cancer is the fifth most common cancer among women aged 35–54, and the third most common cancer of the female reproductive tract. In some developing countries, it is the most common type of cancer. It generally begins as an abnormality in the cells on the outside of the cervix. The cervix is the lower part or neck of the uterus (womb). It connects the body of the uterus to the vagina (birth canal).

Approximately 90% of cervical cancers are squamous cell carcinomas. This type of cancer originates in the thin, flat, squamous cells on the surface of the ectocervix, the part of the cervix that is next to the vagina. (Squamous cells are the thin, flat cells of the surfaces of the skin and cervix and linings of various organs.) Another 10% of cervical cancers are of the adenocarcinoma type. This cancer originates in the mucus-producing cells of the inner or endocervix, near the body of the uterus. Occasionally, the cancer may have characteristics of both types and is called adenosquamous carcinoma or mixed carcinoma.

The initial changes that may occur in some cervical cells are not cancerous. However, these precancerous cells form a lesion called dysplasia or a squamous intraepithelial lesion (SIL), since it occurs within the epithelial or outer layer of cells. These abnormal cells can also be described as cervical intraepithelial neoplasia (CIN). Moderate to severe dysplasia may be called carcinoma in situ or non-invasive cervical cancer.

Dysplasia is a common condition and the abnormal cells often disappear without treatment. However, these precancerous cells can become cancerous. This may take years, although it can happen in less than a year. Eventually, the abnormal cells start to grow uncontrollably into the deeper layers of the cervix, becoming an invasive cervical cancer.

Although cervical cancer used to be one of the most common causes of cancer **death** among American women, in the past 40 years there has been a 75% decrease in mortality. This is primarily due to routine screening with Pap tests (Pap smear), to identify precancerous and early-invasive stages of cervical cancer. With treatment, these conditions have a cure rate of nearly 100%.

Worldwide, there are more than 400,000 new cases of cervical cancer diagnosed each year. The American Cancer Society (ACS) estimates that there will be 12,900 new cases of invasive cervical cancer diagnosed in the United States in 2001. More than one million women will be diagnosed with a precancerous lesion or non-invasive cancer of the cervix.

Older women are at the highest risk for cervical cancer. Although girls under the age of 15 rarely develop this

cancer, the risk factor begins to increase in the late teens. Rates for carcinoma in situ peak between the ages of 20 and 30. In the United States, the incidence of invasive cervical cancer increases rapidly with age for African American women over the age of 25. The incidence rises more slowly for Caucasian women. However, women over age 65 account for more than 25% of all cases of invasive cervical cancer.

The incidence of cervical cancer is highest among poor women and among women in developing countries. In the United States, the death rates from cervical cancer are higher among Hispanic, Native American, and African American women than among Caucasian women. These groups of women are much less likely to receive regular Pap tests. Therefore, their cervical cancers usually are diagnosed at a much later stage, after the cancer has spread to other parts of the body.

Causes and symptoms

Human papilloma virus

Infection with the common human papilloma virus (HPV) is a cause of approximately 90% of all cervical cancers. There are more than 80 types of HPV. About 30 of these types can be transmitted sexually, including those that cause **genital warts** (papillomas). About half of the sexually transmitted HPVs are associated with cervical cancer. These "high-risk" HPVs produce a protein that can cause cervical epithelial cells to grow uncontrollably. The virus makes a second protein that interferes with tumor suppressors that are produced by the human immune system. The HPV-16 strain is thought to be a cause of about 50% of cervical cancers.

More than six million women in the United States have persistent HPV infections, for which there is no cure. Nevertheless, most women with HPV do not develop cervical cancer.

Symptoms of invasive cervical cancer

Most women do not have symptoms of cervical cancer until it has become invasive. At that point, the symptoms may include:

- unusual vaginal discharge
- light vaginal bleeding or spots of blood outside of normal menstruation
- **pain** or vaginal bleeding with sexual intercourse
- post-menopausal vaginal bleeding

Once the cancer has invaded the tissue surrounding the cervix, a woman may experience pain in the pelvic region and heavy bleeding from the vagina.

Diagnosis

The Pap test

Most often, cervical cancer is first detected with a **Pap test** that is performed as part of a regular pelvic examination. The vagina is spread with a metal or plastic instrument called a speculum. A swab is used to remove mucus and cells from the cervix. This sample is sent to a laboratory for microscopic examination.

The Pap test is a screening tool rather than a diagnostic tool. It is very efficient at detecting cervical abnormalities. The Bethesda System commonly is used to report Pap test results. A negative test means that no abnormalities are present in the cervical tissue. A positive Pap test describes abnormal cervical cells as low-grade or high-grade SIL, depending on the extent of dysplasia. About 5–10% of Pap tests show at least mild abnormalities. However, a number of factors other than cervical cancer can cause abnormalities, including inflammation from bacteria or yeast infections. A few months after the infection is treated, the Pap test is repeated.

Biopsy

Following an abnormal Pap test, a **colposcopy** is usually performed. The physician uses a magnifying scope to view the surface of the cervix. The cervix may be coated with an iodine solution that causes normal cells to turn brown and abnormal cells to turn white or yellow. This is called a Schiller test. If any abnormal areas are observed, a colposcopic biopsy may be performed. A biopsy is the removal of a small piece of tissue for microscopic examination by a pathologist.

Other types of cervical biopsies may be performed. An endocervical curettage is a biopsy in which a narrow instrument called a curette is used to scrape tissue from inside the opening of the cervix. A cone biopsy, or conization, is used to remove a cone-shaped piece of tissue from the cervix. In a cold knife cone biopsy, a surgical scalpel or laser is used to remove the tissue. A loop electrosurgical excision procedure (LEEP) is a cone biopsy using a wire that is heated by an electrical current. Cone biopsies can be used to determine whether abnormal cells have invaded below the surface of the cervix. They also can be used to treat many precancers and very early cancers. Biopsies may be performed with a local or general anesthetic. They may cause cramping and bleeding.

Diagnosing the stage

Following a diagnosis of cervical cancer, various procedures may be used to stage the disease (determine

how far the cancer has spread). For example, additional pelvic exams may be performed under anesthesia.

There are several procedures for determining if cervical cancer has invaded the urinary tract. With **cystoscopy**, a lighted tube with a lens is inserted through the urethra (the urine tube from the bladder to the exterior) and into the bladder to examine these organs for cancerous cells. Tissue samples may be removed for microscopic examination by a pathologist. **Intravenous urography** (intravenous pyelogram or IVP) is an x ray of the urinary system, following the injection of special dye. The kidneys remove the dye from the bloodstream and the dye passes into the ureters (the tubes from the kidneys to the bladder) and bladder. IVP can detect a blocked ureter, caused by the spread of cancer to the pelvic lymph nodes (small glands that are part of the immune system).

A procedure called proctoscopy or **sigmoidoscopy** is similar to cystoscopy. It is used to determine whether the cancer has spread to the rectum or lower large intestine.

Computed tomography (CT or CAT) scans, ultrasound, or other imaging techniques may be used to determine the spread of cancer to various parts of the body. With a CT scan, an x-ray beam rotates around the body, taking images from various angles. It is used to determine if the cancer has spread to the lymph nodes. **Magnetic resonance imaging** (MRI), which uses a magnetic field to image the body, sometimes is used for evaluating the spread of cervical cancer. Chest x rays may be used to detect cervical cancer that has spread to the lungs.

Treatment

Following a diagnosis of cervical cancer, the physician takes a medical history and performs a complete **physical examination**. This includes an evaluation of symptoms and risk factors for cervical cancer. The lymph nodes are examined for evidence that the cancer has spread from the cervix. The choice of treatment depends on the clinical stage of the disease.

The FIGO system of staging

The International Federation of Gynecologists and Obstetricians (FIGO) system usually is used to stage cervical cancer:

- Stage 0: Carcinoma in situ; non-invasive cancer that is confined to the layer of cells lining the cervix
- Stage I: Cancer that has spread into the connective tissue of the cervix but is confined to the uterus
- Stage IA: Very small cancerous area that is visible only with a microscope
- Stage IA1: Invasion area is less than 3 mm (0.13 in) deep and 7 mm (0.33 in) wide
- Stage IA2: Invasion area is 3–5 mm (0.13–0.2 in) deep and less than 7 mm (0.33 in) wide
- Stage IB: Cancer can be seen without a microscope or is deeper than 5 mm (0.2 in) or wider than 7 mm (0.33 in)
- Stage IB1: Cancer is no larger than 4 cm (1.6 in)
- Stage IB2: Stage IB cancer is larger than 4 cm (1.6 in)
- Stage II: Cancer has spread from the cervix but is confined to the pelvic region
- Stage IIA: Cancer has spread to the upper region of the vagina, but not to the lower one-third of the vagina
- Stage IIB: Cancer has spread to the parametrial tissue adjacent to the cervix
- Stage III: Cancer has spread to the lower one-third of the vagina or to the wall of the pelvis and may be blocking the ureters
- Stage IIIA: Cancer has spread to the lower vagina but not to the pelvic wall
- Stage IIIB: Cancer has spread to the pelvic wall and/or is blocking the flow of urine through the ureters to the bladder
- Stage IV: Cancer has spread to other parts of the body
- Stage IVA: Cancer has spread to the bladder or rectum
- Stage IVB: Cancer has spread to distant organs such as the lungs
- Recurrent: Following treatment, cancer has returned to the cervix or some other part of the body

In addition to the stage of the cancer, factors such as a woman's age, general health, and preferences may influence the choice of treatment. The exact location of the cancer within the cervix and the type of cervical cancer also are important considerations.

Treatment of precancer and carcinoma in situ

Most low-grade SILs that are detected with Pap tests revert to normal without treatment. Most high-grade SILs require treatment. Treatments to remove precancerous cells include:

- cold knife cone biopsy
- LEEP
- cryosurgery (freezing the cells with a metal probe)
- cauterization or diathermy (burning off the cells)
- laser surgery (burning off the cells with a laser beam)

These methods also may be used to treat cancer that is confined to the surface of the cervix (stage 0) and other

early-stage cervical cancers in women who may want to become pregnant. They may be used in conjunction with other treatments. These procedures may cause bleeding or cramping. All of these treatments require close follow-up to detect any recurrence of the cancer.

Surgery

A simple **hysterectomy** is used to treat some stages 0 and IA cervical cancers. Usually only the uterus is removed, although occasionally the fallopian tubes and ovaries are removed as well. The tissues adjoining the uterus, including the vagina, remain intact. The uterus may be removed either through the abdomen or the vagina.

In a radical hysterectomy, the uterus and adjoining tissues, including the ovaries, the upper region (1 in) of the vagina near the cervix, and the pelvic lymph nodes, are all removed. A radical hysterectomy usually involves abdominal surgery. However, it can be performed vaginally, in combination with a laparoscopic pelvic lymph node dissection. With **laparoscopy**, a tube is inserted through a very small surgical incision for the removal of the lymph nodes. These operations are used to treat stages IA2, IB, and IIA cervical cancers, particularly in young women. Following a hysterectomy, the tissue is examined to see if the cancer has spread and requires additional radiation treatment. Women who have had hysterectomies cannot become pregnant, but complications from a hysterectomy are rare.

If cervical cancer recurs following treatment, a pelvic exenteration (extensive surgery) may be performed. This includes a radical hysterectomy, with the additional removal of the bladder, rectum, part of the colon, and/or all of the vagina. Such operations require the creation of new openings for the urine and feces. A new vagina may be created surgically. Often the clitoris and other outer genitals are left intact.

Recovery from a pelvic exenteration may take six months to two years. This treatment is successful with 40–50% of recurrent cervical cancers that are confined to the pelvis. If the recurrent cancer has spread to other organs, radiation or **chemotherapy** may be used to alleviate some of the symptoms.

Radiation

Radiation therapy, which involves the use of high-dosage x rays or other high-energy waves to kill cancer cells, often is used for treating stages IB, IIA, and IIB cervical cancers, or in combination with surgery. With external-beam radiation therapy, the rays are focused on the pelvic area from a source outside the body. With implant or internal radiation therapy, a pellet of radioactive material is placed internally, near the tumor. Alternatively, thin needles may be used to insert the radioactive material directly into the tumor.

Radiation therapy to the pelvic region can have many side effects:

- skin reaction in the area of treatment
- fatigue
- upset stomach and loose bowels
- vaginal stenosis (narrowing of the vagina due to build-up of scar tissue) leading to painful sexual intercourse
- premature **menopause** in young women
- problems with urination

Chemotherapy

Chemotherapy, the use of one or more drugs to kill cancer cells, is used to treat disease that has spread beyond the cervix. Most often it is used following surgery or radiation treatment. Stages IIB, III, IV, and recurrent cervical cancers usually are treated with a combination of external and internal radiation and chemotherapy. The common drugs used for cervical cancer are cisplatin, ifosfamide, and fluorouracil. These may be injected or taken by mouth. The National Cancer Institute recommends that chemotherapy with cisplatin be considered for all women receiving radiation therapy for cervical cancer.

The side effects of chemotherapy depend on a number of factors, including the type of drug, the dosage, and the length of the treatment. Side effects may include:

- nausea and vomiting
- fatigue
- changes in appetite
- hair loss
- mouth or vaginal sores
- infections
- menstrual cycle changes
- premature menopause
- **infertility**
- bleeding or anemia (low red blood cell count)

With the exception of menopause and infertility, most of the side effects are temporary.

Alternative treatment

Biological therapy sometimes is used to treat cervical cancer, either alone or in combination with chemotherapy. Treatment with the immune-system pro-

KEY TERMS

Adenocarcinoma—Cervical cancer that originates in the mucus-producing cells of the inner or endocervix.

Biopsy—Removal of a small sample of tissue for examination under a microscope; used for the diagnosis and treatment of cervical cancer and precancerous conditions.

Carcinoma in situ—Cancer that is confined to the cells in which it originated and has not spread to other tissues.

Cervical intraepithelial neoplasia (CIN)—Abnormal cell growth on the surface of the cervix.

Cervix—Narrow, lower end of the uterus forming the opening to the vagina.

Colposcopy—Diagnostic procedure using a hollow, lighted tube (colposcope) to look inside the cervix and uterus.

Conization—Cone biopsy; removal of a cone-shaped section of tissue from the cervix for diagnosis or treatment.

Dysplasia—Abnormal cellular changes that may become cancerous.

Endocervical curettage—Biopsy performed with a curette to scrape the mucous membrane of the cervical canal.

Human papilloma virus (HPV)—Virus that causes abnormal cell growth (warts or papillomas); some types can cause cervical cancer.

Hysterectomy—Removal of the uterus.

Interferon—Potent immune-defense protein produced by viral-infected cells; used as an anti-cancer and anti-viral drug.

Laparoscopy—Laparoscopic pelvic lymph node dissection; insertion of a tube through a very small surgical incision to remove lymph nodes.

Loop electrosurgical excision procedure (LEEP)—Cone biopsy performed with a wire that is heated by electrical current.

Lymph nodes—Small round glands, located throughout the body, that filter the lymphatic fluid; part of the body's immune defense.

Pap test—Pap smear; removal of cervical cells to screen for cancer.

Pelvic exenteration—Extensive surgery to remove the uterus, ovaries, pelvic lymph nodes, part or all of the vagina, and the bladder, rectum, and/or part of the colon.

Squamous cells—Thin, flat cells on the surfaces of the skin and cervix and linings of various organs.

Squamous intraepithelial lesion (SIL)—Abnormal growth of squamous cells on the surface of the cervix.

Vaginal stenosis—Narrowing of the vagina due to a build-up of scar tissue.

tein interferon is used to boost the immune response. Biological therapy can cause temporary flu-like symptoms and other side effects.

Some research suggests that vitamin A (carotene) may help to prevent or stop cancerous changes in cells such as those on the surface of the cervix. Other studies suggest that **vitamins** C and E may reduce the risk of cervical cancer.

Prognosis

For cervical cancers that are diagnosed in the pre-invasive stage, the five-year-survival rate is almost 100%. When cervical cancer is detected in the early invasive stages, approximately 91% of women survive five years or more. Stage IVB cervical cancer is not considered to be curable. The five-year-survival rate for all cervical cancers combined is about 70%. The death rate from cervical cancer continues to decline by about 2% each year. Women over age 65 account for 40–50% of all deaths from cervical cancer.

Prevention

Viral infections

Most cervical cancers are preventable. More than 90% of women with cervical cancer are infected with HPV. HPV infection is the single most important risk factor. This is particularly true for young women because the cells lining the cervix do not fully mature until age 18. These immature cells are more susceptible to cancer-causing agents and viruses.

Since HPV is a sexually-transmitted infection, sexual behaviors can put women at risk for HPV infection and cervical cancer. These behaviors include:

- sexual intercourse at age 16 or younger
- partners who began having intercourse at a young age
- multiple sexual partners
- sexual partners who have had multiple partners ("high-risk males")
- a partner who has had a previous sexual partner with cervical cancer

HPV infection may not produce any symptoms, so sexual partners may not know that they are infected. However, Pap tests can detect the infection. Condoms do not necessarily prevent HPV infection.

Infection with the human **immunodeficiency** virus (HIV) that causes acquired immunodeficiency syndrome (**AIDS**) is a risk factor for cervical cancer. Women who test positive for HIV may have impaired immune systems that cannot correct precancerous conditions. Furthermore, sexual behavior that puts women at risk for HIV infection, also puts them at risk for HPV infection. There is some evidence suggesting that another sexually transmitted virus, the **genital herpes** virus, also may be involved in cervical cancer.

Smoking

Smoking may double the risk of cervical cancer. Chemicals produced by tobacco smoke can damage the DNA of cervical cells. The risk increases with the number of years a woman smokes and the amount she smokes.

Diet and drugs

Diets that are low in fruits and vegetables increase the risk of cervical cancer. Women also have an increased risk of cervical cancer if their mothers took the drug diethylstilbestrol (DES) while they were pregnant. This drug was given to women between 1940 and 1971 to prevent miscarriages. Some statistical studies have suggested that the long-term use of **oral contraceptives** may slightly increase the risk of cervical cancer.

Pap tests

Most cases of cervical cancers are preventable, since they start with easily detectable precancerous changes. Therefore, the best prevention for cervical cancer is a regular Pap test. When precancerous changes are detected, appropriate treatment can prevent the development of invasive cancer. The ACS recommends that women have annual Pap tests beginning when they first start having sex or at age 18. Women who are past menopause or some women with hysterectomies continue to require Pap tests.

The National Breast and Cervical Cancer Early Detection Program provides free or low-cost Pap tests and treatment for women without health insurance, for older women, and for members of racial and ethnic minorities. The program is administered through individual states, under the direction of the Centers for Disease Control and Prevention.

Special concerns

If a woman is diagnosed with very early-stage (IA) cervical cancer while pregnant, the physician usually will recommend a hysterectomy after the baby is born. For later-stage cancers, the **pregnancy** is terminated or the baby is removed by **cesarean section** as soon as it can survive outside the womb. This is followed by a hysterectomy and/or radiation treatment. For the most advanced stages of cervical cancer, treatment is initiated despite the pregnancy.

Many women with cervical cancer have hysterectomies, which are major surgeries. Although normal activities, including sexual intercourse, can be resumed in four-eight weeks, a woman may have emotional problems following a hysterectomy. A strong support system can help with these difficulties.

Resources

BOOKS

Falco, Kristine. *Reclaiming Our Lives After Breast and Gynecologic Cancer.* Northvale, NJ: Jason Aronson, Inc., 1998.

Holland, Jimmie C. and Sheldon Lewis. *The Human Side of Cancer: Living with Hope, Coping with Uncertainty.* New York: HarperCollins, 2000.

Runowicz, Carolyn D., Jeanne A. Petrek, and Ted S. Gansler. *Women and Cancer: A Thorough and Compassionate Resource for Patients and their Families*. New York: Villard Books, 1999.

Sweeney, Julia. *God Said "Ha!"* New York: Bantam Books, 1997.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Road, N.E., Atlanta, GA 30329. (800) ACS-2345. <http://www.cancer.org>.

Centers for Disease Control and Prevention. National Center for Chronic Disease Prevention and Health Promotion. Mail Stop K-64. 4770 Buford Highway NE, Atlanta, GA 30341-3717. (770) 488-4751. (888) 842-6355. <http://www.cdc.gov/cancer>.

EyesOnThePrize.Org. 446 S. Anaheim Hills Road, #108, Anaheim Hills, CA 92807. <http://www.eyesontheprize.org>.

Gynecologic Cancer Foundation. 401 North Michigan Avenue, Chicago, IL 60611. (800) 444-4441. (312) 644-6610. <http://www.wcn.org/gcf/>.

National Cancer Institute. Public Inquiries Office, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD

20892-2580. (800) 4-CANCER. <http://www.nci.nih.gov/>. <http://cancernet.nci.nih.gov>.
National Cervical Cancer Coalition. 16501 Sherman Way, Suite #110, Van Nuys, CA 91406. (800) 685-5531. (818) 909-3849. <http://www.nccc-online.org/>.

OTHER

"Cancer of the Cervix." *CancerNet*. 12 Dec. 2000. National Cancer Institute. NIH Publication No. 95-2047. 3 Apr. 2001. <http://cancernet.nci.nih.gov/wyntk_pubs/cervix.htm#2>.
"Cervical Cancer." *Cancer Resource Center.* American Cancer Society. 16 Mar. 2000. 3 Apr. 2001. <http://www3.cancer.org/cancerinfo/load_cont.asp?ct=8&doc=25&Language=English>.
"Cervical Cancer." *National Institutes of Health Consensus Development Conference Statement*. 1-3 Apr. 1996. 3 Apr. 2001. <http://text.nlm.nih.gov/nih/cdc/www/102txt.html>.
"Cervical Cytology: Evaluation and Management of Abnormalities." *American College of Obstetricians and Gynecologists (ACOG) Techincal Bulletin*. Number 183 (August 1993).

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Cervical conization

Definition

Cervical conization is both a diagnostic and treatment tool used to detect and treat abnormalities of the cervix. It is also known as a cone biopsy or cold knife cone biopsy.

Purpose

Cervical conization is performed if the results of a cervical biopsy have found a precancerous condition in the cervix. The cervix is the small cylindrical organ at the lower part of the uterus, which separates the uterus from the vagina. Cervical conization also may be performed if there is an abnormal cervical smear test (**PAP test**). A biopsy is a diagnostic test in which tissue or cells are removed from the body and examined under a microscope, primarily to look for **cancer** or other abnormalities.

Precautions

As with any operation that is performed under general anesthesia, the patient must not eat or drink anything for six to eight hours before surgery.

Description

The patient lies on the table with her legs raised in stirrups, similar to the position when having a PAP test.

KEY TERMS

Biopsy—The removal of a small piece of living tissue for examination under a microscope.

PAP test—The short term for Papanicolaou test, this procedure tests a smear of cellular material scraped from the cervix and examined under a microscope to detect abnormal cells.

The patient is given general anesthesia, and the vagina is held open with an instrument called a speculum. Using a scalpel or laser the doctor removes a cone-shaped piece of the cervix containing the area with abnormal cells. The resulting crater is repaired by stitching flaps of tissue over the wound. Alternatively, the wound may be left open, and heat or freezing is used to stop bleeding.

Once the tissue has been removed, it is examined under a microscope for signs of cancer. If cancer is present, other tests will be needed. Surgery will be performed to remove the cervix and uterus (**hysterectomy**) and other treatments may be used as well. If the abnormal cells are precancerous, a laser can be used to destroy them.

Cold knife cone biopsy used to be the preferred treatment for removing abnormal cells in the cervix. Now, most cone biopsies are performed using **laser surgery**. Cold knife cone biopsy is generally used only for special situations. For example, if a biopsy did not remove all the abnormal cells, the cold knife cone procedure allows the physician to remove what's left.

Aftercare

An overnight stay in the hospital may be required. After the test, the patient may feel some cramps or discomfort for about a week. Women should not have sex, use tampons, or douche until after seeing their physician for a follow up appointment (a week or more after the procedure).

Risks

Because cone biopsies carry risks such as bleeding and problems with subsequent pregnancies, they have been replaced with newer technologies except in a few circumstances.

About one in 10 women experience bleeding from the vagina about two weeks after the biopsy. There is also a slight risk of infection or perforation of the uterus. In a few women, the cervical canal becomes narrowed or

completely blocked, which can later interfere with the movement of sperm. This can impair a woman's fertility.

If too much muscle tissue has been removed, the procedure can lead to an **incompetent cervix**, which can be a problem with subsequent pregnancies. An incompetent cervix cannot seal properly to maintain a **pregnancy**. If untreated, the condition increases the odds of **miscarriage** or **premature labor**.

Cervical conization also may temporarily alter cervical cells, which can make a Pap smear test hard to interpret accurately for three or four months.

Normal results

This procedure is only performed if an abnormality is known or suspected.

Abnormal results

The presence of precancerous or cancerous cells in the cervix.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

PERIODICALS

Clifford, Catherine. "Cervical Cancer: Smart Way to Protect Yourself." *Redbook* 189 (Oct. 1997): 124-28.

Israeloff, Roberta. "Your Pap Test is Abnormal: What Does it Mean?" *Cosmopolitan*, Apr. 1995, 120-22.

ORGANIZATIONS

Cancer Information Service. (800) 4-CANCER. <http://www.rex.nci.nih.gov>.

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Cervical disk disease

Definition

Cervical disk disease refers to a gradual deterioration of the spongy disks in the top part of the spine.

Description

The spine is made up of 33 bones called vertebrae separated by spongy rings of elastic material. These rings, known as disks, are often compared to **shock** absorbers because they help to cushion the vertebrae. Just as importantly, they also make it possible to turn the head and neck. Over time, these disks slowly become flattened and less elastic due to everyday wear and tear. When this process occurs in the disks of the neck, it is referred to as cervical disk disease. Other general terms for this process include degenerative disk disease and intervertebral disk disease.

Cervical disk disease affects everyone to some degree, often without causing any bothersome symptoms. However, this condition can also lead to specific problems related to nerve functioning. For example, the outer edge of a disk may tear, allowing the gelatinous material inside to bulge outward (**herniated disk**). This can put pressure on nerves that exit the spine. Two adjacent vertebrae may rub together (sometimes resulting in bone spurs) that can also pinch these nerves. In other cases, the inner part of the ring may push on the spinal cord itself, which passes through the disk. Any of these situations can cause **pain** and limit movement. While symptoms primarily affect the neck, they can also occur in other parts of the body.

Causes and symptoms

Cervical disk disease is a gradual process that occurs with **aging**, though poor posture, repeated lifting, and tobacco use can hasten its course. Symptoms include pain when moving the neck and limited neck movement. The condition can also affect the hand, shoulder, and arm resulting in pain, numbness/tingling, and weakness. If the spinal cord itself is affected, these symptoms may occur in the legs. Loss of bowel or bladder control may also occur.

Diagnosis

Cervical disk disease is typically diagnosed by an orthopedist or a neurologist. After taking a medical history and conducting a **physical examination**, the doctor will recommend an imaging procedure to gather more information about the nature of the problem. This may include a CT scan, an MRI, or **myelography**. In addition, an electromyogram (EMG) may be used to evaluate the functioning of nerves in the arms, hands, or legs. Cervical disk disease is typically covered by medical insurance.

Treatment

Treatment usually involves physical therapy, several weeks of drug therapy with **nonsteroidal anti-inflammatory drugs** (NSAIDs), and limited use of a cervical collar (to reduce neck movement). Neck **traction** and **heat treatments** may also be recommended. In some

KEY TERMS

Bone spur—An overgrowth of bone.

Cervical—Relating to the top part of the spine that is composed of the seven vertebrae of the neck and the disks that separate them.

Computed tomography (CT) scan—An imaging procedure that produces a three-dimensional picture of organs or structures inside the body.

Myelography—An imaging procedure involving the injection of a radioactive dye into the fluid surrounding the spine. A myelography can be used to detect herniated disks, nerve root damage, and other problems affecting the cervical spine.

Neurologist—A doctor who specializes in disorders of the brain and central nervous system.

Orthopedist—A doctor who specializes in disorders of the musculoskeletal system.

Magnetic resonance imaging—A type of imaging that uses magnetic fields to generate a picture of internal structures.

cases, steroids or anesthetic drugs may be injected into the spinal canal to help alleviate symptoms. Aside from these measures, maintaining good posture and placing a pillow under the neck and head during sleep can be helpful. Treatment may last anywhere from several weeks to three months or more. Neck surgery is not usually advised unless other therapies have failed.

Alternative treatment

Acupuncture, therapeutic massage, and **yoga** are believed by some practitioners of alternative medicine to have generalized pain-relieving effects. However, any therapy that involves manipulating the neck is not recommended and should be approved by the primary doctor beforehand.

Prognosis

In most people symptoms go away within three months if not sooner. A smaller number may require surgery to correct the problem.

Prevention

While some degree of disk degeneration is inevitable, people can reduce their risk by practicing good posture (during sitting, standing, and lifting), performing neck-stretching exercises, maintaining an ideal weight, and quitting **smoking**.

Resources

BOOKS

Dee, Roger, et al. *Principles of Orthopaedic Practice*. New York: McGraw-Hill, 1997.

PERIODICALS

Heckmann, J. G., et al. "Herniated Cervical Intervertebral Discs with Radiculopathy: An Outcome Study of Conservatively or Surgically Treated Patients." *Journal of Spinal Disorders* 12 (Oct. 1999): 396-401.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018-4262. (800) 346-2267. <http://www.aaos.org>.

Greg Annussek

Cervical osteoarthritis *see* **Cervical spondylosis**

Cervical spondylosis

Definition

Cervical spondylosis refers to common age-related changes in the area of the spine at the back of the neck. With age, the vertebrae (the component bones of the spine) gradually form bone spurs, and their shock-absorbing disks slowly shrink. These changes can alter the alignment and stability of the spine. They may go unnoticed, or they may produce problems related to pressure on the spine and associated nerves and blood vessels. This pressure can cause weakness, numbness, and **pain** in various areas of the body. In severe cases, walking and other activities may be compromised.

Description

As it runs from the brain down the back, the spinal cord is protected by ringlike bones, called vertebrae, stacked one upon the other. The vertebrae are not in direct contact with one another, however. The intervening spaces are filled with structures called disks. The disks are made up of a tough, fibrous outer tissue with an inner core of elastic or gel-like tissue.

One of the most important functions of disks is protecting the vertebrae and the nerves and blood vessels between the vertebrae. The disks also lend flexibility to

the spinal cord, facilitating movements such as turning the head or bending the neck. As people age, disks gradually become tougher and more unyielding. Disks also shrink with age, which reduces the amount of padding between the vertebrae.

As the amount of padding shrinks, the spine loses stability. The vertebrae react by constructing osteophytes, commonly known as bone spurs. There are seven vertebrae in the neck; development of osteophytes on these bones is sometimes called cervical **osteoarthritis**. Osteophytes may help to stabilize the degenerating backbone and help protect the spinal cord.

By age 50, 25–50% of people develop cervical spondylosis; by 75 years of age, it is seen in at least 70% of people. Although shrunken vertebral disks, osteophyte growth, and other changes in their cervical spine may exist, many of these people never develop significant problems.

However, about 50% of people over age 50 experience neck pain and stiffness due to cervical spondylosis. Of these people, 25–40% have at least one episode of cervical radiculopathy, a condition that arises when osteophytes compress nerves between the vertebrae. Another potential problem occurs if osteophytes, degenerating disks, or shifting vertebrae narrow the spinal canal. This pressure compresses the spinal cord and its blood vessels, causing cervical spondylitic myelopathy, a disorder in which large segments of the spinal cord are damaged. This disorder affects fewer than 5% of people with cervical spondylosis. Symptoms of both cervical spondylitic myelopathy and cervical radiculopathy may be present in some people.

Causes and symptoms

As people age, shrinkage of the vertebral disks prompts the vertebrae to form osteophytes to stabilize the back bone. However, the position and alignment of the disks and vertebrae may shift despite the osteophytes. Symptoms may arise from problems with one or more disks or vertebrae.

Osteophyte formation and other changes do not necessarily lead to symptoms, but after age 50, half of the population experiences occasional neck pain and stiffness. As disks degenerate, the cervical spine becomes less stable, and the neck is more vulnerable to injuries, including muscle and ligament strains. Contact between the edges of the vertebrae can also cause pain. In some people, this pain may be referred—that is, perceived as occurring in the head, shoulders, or chest, rather than the neck. Other symptoms may include vertigo (a type of **dizziness**) or ringing in the ears.

The neck pain and stiffness can be intermittent, as can symptoms of radiculopathy. Radiculopathy refers to compression on the base, or root, of nerves that lead away from the spinal cord. Normally, these nerves fit comfortably through spaces between the vertebrae. These spaces are called intervertebral foramina. As the osteophytes form, they can impinge on this area and gradually make the fit between the vertebrae too snug.

The poor fit increases the chances that a minor incident, such as overdoing normal activities, may place excess pressure on the nerve root, sometimes referred to as a pinched nerve. Pressure may also accumulate as a direct consequence of osteophyte formation. The pressure on the nerve root causes severe shooting pain in the neck, arms, shoulder, and/or upper back, depending on which nerve roots of the cervical spine are affected. The pain is often aggravated by movement, but in most cases, symptoms resolve within four-six weeks.

Cervical spondylosis can cause cervical spondylitic myelopathy through stenosis- or osteophyte-related pressure on the spinal cord. **Spinal stenosis** is a narrowing of the spinal canal—the area through the center of the vertebral column occupied by the spinal cord. Stenosis occurs because of misaligned vertebrae and out-of-place or degenerating disks. The problems created by spondylosis can be exacerbated if a person has a naturally narrow spinal canal. Pressure against the spinal cord can also be created by osteophytes forming on the inner surface of vertebrae and pushing against the spinal cord. Stenosis or osteophytes can compress the spinal cord and its blood vessels, impeding or choking off needed nutrients to the spinal cord cells; in effect, the cells starve to **death**.

With the death of these cells, the functions that they once performed are impaired. These functions may include conveying sensory information to the brain or transmitting the brain's commands to voluntary muscles. Pain is usually absent, but a person may experience leg numbness and an inability to make the legs move properly. Other symptoms can include clumsiness and weakness in the hands, stiffness and weakness in the legs, and spontaneous twitches in the legs. A person's ability to walk is affected, and a wide-legged, shuffling gait is sometimes adopted to compensate for the lack of sensation in the legs and the accompanying, realistic fear of falling. In very few cases, bladder control becomes a problem.

Diagnosis

Cervical spondylosis is often suspected based on the symptoms and their history. Careful neurological examination can help determine which nerve roots are involved, based on the location of the pain and numbness, and the pattern of weakness and changes in reflex responses. To confirm the suspected diagnosis, and to rule out other possibilities, imaging tests are ordered. The first test is an x ray. X rays reveal the presence of osteophytes, stenosis,

KEY TERMS

Alexander technique—A technique developed by Frederick Alexander that focuses on the variations in body posture, muscles, and breathing. Defects in these functions can lead to stress, nervous tension or possible loss of function.

Bone spur—Also called an osteophyte, it is an outgrowth or ridge that forms on a bone.

Cervical—Referring to structures within the neck.

Computed tomography myelography—This medical procedure combines aspects of computed tomography scanning and plain-film myelography. A CT scan is an imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures. Myelography involves injecting a water-soluble substance into the area around the spine to make it visible on x rays. In computed tomography myelography or CT myelography, the water-soluble substance is injected, but the imaging is done with a CT scan.

Disk—A ringlike structure that fits between the vertebrae in the spine to protect the bones, nerves, and blood vessels. The outer layer is a tough, fibrous tissue, and the inner core is composed of more elastic tissue.

Feldenkrais method—A therapy based on creating a good self image by correction and improvements of body movements.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Myelopathy—A disorder in which the tissue of the spinal cord is diseased or damaged.

Orthosis—An external device, such as a splint or a brace, that prevents or assists movement.

Osteophyte—Also referred to as bone spur, it is an outgrowth or ridge that forms on a bone.

Radiculopathy—Sometimes referred to as a pinched nerve, it refers to compression of the nerve root—the part of a nerve between vertebrae. This compression causes pain to be perceived in areas to which the nerve leads.

Spine—A term for the backbone that includes the vertebrae, disks, and spinal cord as a whole.

Stenosis—A condition in which a canal or other passageway in the body is constricted.

Traction—A medical treatment that exerts a pulling or extending force. Used for cervical problems, it relieves pressure on structures between the vertebrae and muscular tension.

Vertebrae—The ringlike component bones of the spine.

constricted space between the vertebrae, and misalignment in the cervical spine—in short, an x ray confirms that a person has cervical spondylosis. To demonstrate that the condition is causing the symptoms, more details are needed. Other imaging tests, such as **magnetic resonance imaging** (MRI) and computed tomography **myelography**, help assess effects of cervical spondylosis on associated nerve tissue and blood vessels.

An MRI may be preferred, because it is a noninvasive procedure and does not require injecting a contrast medium as does computed tomography myelography. MRIs also have greater sensitivity for detecting disk problems and spinal cord involvement, and the test allows the physician to create images of a larger area from various angles. However, these images may not show enough detail about the vertebrae themselves. Computed tomography myelography yields a superior image of the bones involved in cervical spondylosis. Added benefits include that it takes less time to perform and tends to be less expensive than an MRI. A good diagnosis may be reached with either a computed tomography myelography or an MRI, but sometimes complementary information from both tests is necessary. Nerve conduction velocity, electromyogram (EMG), and/or somatosensory evoked potential testing may help to confirm which nerve roots are involved.

Treatment

When possible, conservative treatment of symptoms is preferred. Conservative treatment begins with rest—either restricting normal activities to a less strenuous level or bed rest for three to five days. If rest is not adequate to relieve symptoms, a cervical orthosis may be prescribed., such as a soft cervical collar or stiffer neck brace to restrict neck movement and shift some of the head's weight from the neck to the shoulders. Cervical

traction may also be suggested, either at home with the advice of a physical therapist or in a health-care setting.

Pain is treated with **nonsteroidal anti-inflammatory drugs**, such as **aspirin** or ibuprofen. If these drugs are ineffective, a short-term prescription for **corticosteroids** or **muscle relaxants** may be given. For chronic pain, tricyclic antidepressants can be prescribed. Although these drugs were developed to treat depression, they are also effective in treating pain. Once any pain is resolved, exercises to strengthen neck muscle and preserve flexibility are prescribed.

If the pain is severe, a short treatment of epidural corticosteroids may be prescribed with discretion. A corticosteroid such as prednisone can be combined with an anaesthetic and injected with a long needle into the space between the damaged disk and the covering of the nerve and spinal cord. Injection into the cervical epidural space relieves severe pain that is not managed with conventional treatment. Frequent use of this treatment is not medically recommended and is used only if the more conservative therapy is not effective.

If pain is continuous and does not respond to conservative treatment, surgery may be suggested. Surgery is usually not recommended for neck pain, but it may be necessary to address radiculopathy and myelopathy. Surgery is particularly recommended for people who have already developed moderate to severe symptoms of myelopathy, although age or poor health may prohibit that recommendation. The specific details of the surgery depend on the structures involved, but the overall goal is to relieve pressure on the nerve root, spinal cord, or blood vessels and to stabilize the spine.

Alternative treatment

Alternative therapy is not meant to replace conventional medical treatment, but it can be a useful adjunct. Its main roles are to relieve tension, manage pain, and strengthen neck and back muscles. Massage is one way to relieve tension, and **yoga** provides the additional benefit of strengthening muscles. **Chiropractic** and **acupuncture** have been reported to relieve the pain associated with disk problems, although great care needs to be taken to avoid exacerbating them. Practitioners of the **Alexander technique** or the **Feldenkrais method** can provide instruction on correct posture and **exercise** that may help prevent further symptoms. Vitamin and mineral supplementation along with herbal therapies and **homeopathy** can help build and rebalance the weakened structure.

Prognosis

The gradual progression of cervical spondylosis cannot be stopped; however, it doesn't always cause symptoms. For the individuals who do experience problems, conservative treatment is very effective in managing the symptoms. Nearly all people with neck pain, approximately 75% of persons with radiculopathy, and up to 50% of people with myelopathy find relief through therapy alone. For the remaining people with radiculopathy or myelopathy, surgery may be recommended. Surgery is deemed successful in 70–80% of cases.

Prevention

Since cervical spondylosis is part of the normal **aging** process, not much can be done to prevent it. It may be possible to ward off some or all of the symptoms by engaging in regular physical exercise and limiting occupational or recreational activities that place pressure on the head, neck, and shoulders. The best exercises for the health of the cervical spine are noncontact activities, such as swimming, walking, or yoga. Once symptoms have already developed, the emphasis is on symptom management rather than prevention.

Resources

BOOKS

Borenstein, David G., Sam W. Wiesel, and Scott D. Boden. "Mechanical Disorders of the Cervical Spine." In *Neck Pain: Medical Diagnosis and Comprehensive Management*. Philadelphia: W. B. Saunders Co., 1996.

Macnab, Ian, and John McCulloch. *Neck Ache and Shoulder Pain*. Baltimore: Williams & Wilkins, 1994.

PERIODICALS

Bohlman, Henry H. "Cervical Spondylosis and Myelopathy." *Instructional Course Lectures* 44 (1995): 81.

McCormack, Bruce M., and Phillip R. Weinstein. "Cervical Spondylosis: An Update." *Western Journal of Medicine* 165 (July/Aug. 1996): 43.

Neuwirth, Michael, and Joseph Marsicano. "Cervical Spondylosis: Diagnosis, Symptomatology, and Treatment." *Orthopaedic Nursing* 15, no. 1 (1996): 31.

Julia Barrett

Cervicitis

Definition

Cervicitis is an inflammation of the cervix.

Description

Cervicitis is a inflammation of the cervix (the opening into the uterus). This inflammation can be chronic and may or may not have an identified cause.

KEY TERMS

Cryotherapy—Freezing the affected tissue.

Electrocoagulation—Using electrical current to cauterize the affected tissue.

LEEP—Loop Electrosurgical Excision Procedure.

Causes and symptoms

The most common cause of cervicitis is infection, either local or as a result of various **sexually transmitted diseases**, such as chlamydia or **gonorrhea**. Cervicitis can also be caused by birth control devices such as a cervical cap or diaphragm, or chemical exposure. Other risk factors include multiple sexual partners or cervical trauma following birth. In postmenopausal women, cervicitis is sometimes related to a lack of estrogen.

Although a woman may not notice any signs of infection, symptoms of cervicitis include the following:

- persistent unusual vaginal discharge
- abnormal bleeding, either between periods or following sexual intercourse
- painful sexual intercourse
- vaginal pain
- frequent need to urinate
- burning or **itching** in the vaginal area

Diagnosis

The standard method of diagnosing cervicitis is through a pelvic examination or a Pap smear. During the **pelvic exam**, the physician usually swabs the affected area, and then sends the tissue sample to a laboratory. The laboratory tries to identify the specific organism responsible for causing the cervicitis. A biopsy to take a sample of tissue from the affected area is sometimes required in order to rule out **cancer**. **Colposcopy**, a procedure used to look at the cervix under a microscope, may also be used to rule out cancer.

Treatment

The first course of treatment for cervicitis is usually **antibiotics**. If these medicines do not cure the cervicitis, other treatment options include:

- Loop Electrosurgical Excision Procedure (LEEP)
- cryotherapy
- electrocoagulation
- laser treatment

Prognosis

Cervicitis will usually be cured when the course of therapy is complete. Severe cases, however, may last for a few months, even after the therapy is complete. If the cervicitis was caused by a sexually transmitted disease, both partners should be treated with medication.

Prevention

Practicing safe sexual behavior, such as monogamy, is one way of lowering the prevalence of cervicitis. In addition, women who began sexual activity at a later age have been shown to have a lower incidence of cervicitis. Another recommendation is to use a latex **condom** consistently during intercourse. If the cervicitis is caused by any sexually transmitted disease, the patient is advised to notify all sexual partners.

Resources

BOOKS

Berkow, Robert. *The Merck Manual of Medical Information.* Whitehouse Station: Merck Research Laboratories, 1997.

Dambro, Mark R. *The 5-Minute Clinical Consult.* Baltimore: Williams and Wilkins, 2001.

Larson, David E. *Mayo Clinic Family Health Book.* New York: William Morrow and Company, 1996.

Mandell, Gerald L. *Mandell, Douglas, and Bennet's Principles and Practice of Infectious Diseases.* Philadelphia: Churchill Livingstone, 2000.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment.* Los Altos: Lange Medical Publications, 2001.

PERIODICALS

Malik, S. N., et. al. "Benign Cellular Changes in Pap Smears. Causes and Significance." *Acta Cytologica* (Jan-Feb 2001): 5-8.

ORGANIZATIONS

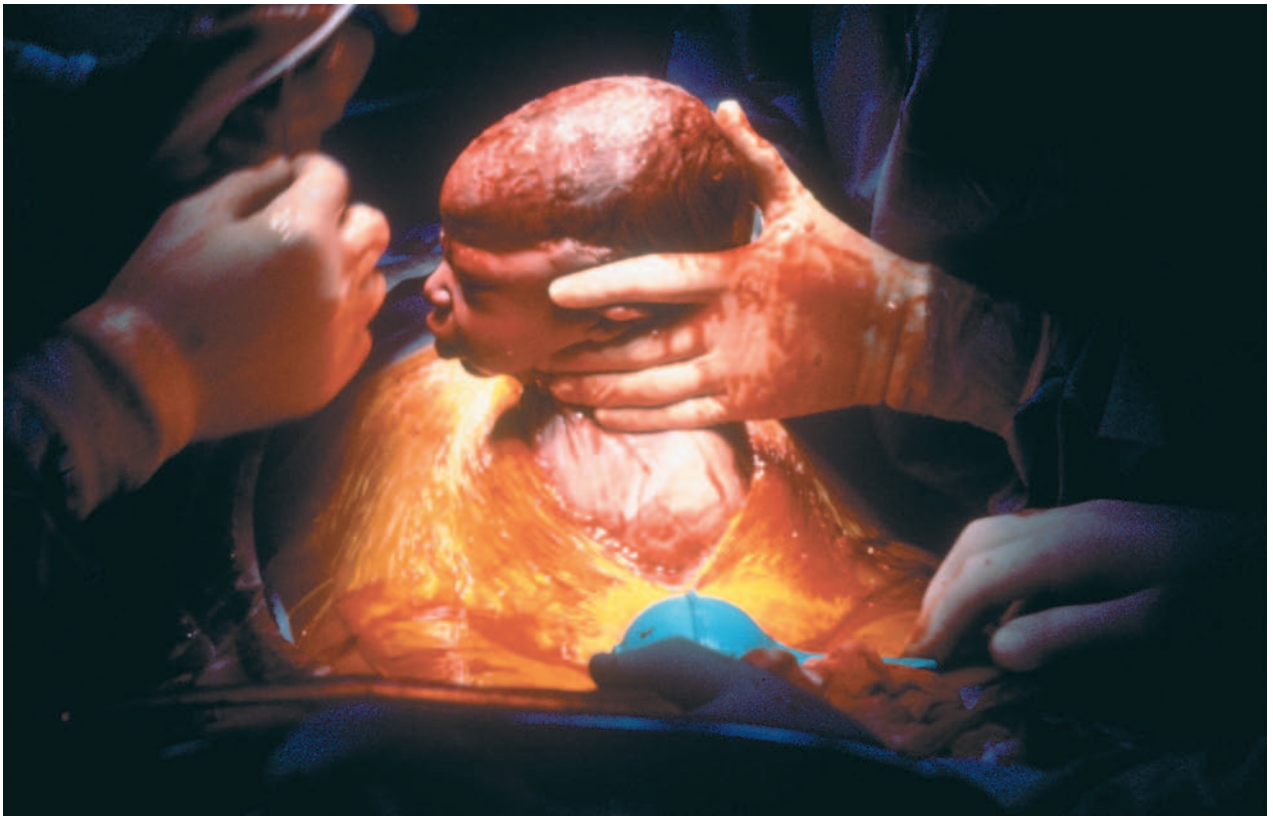
American College of Obstetricians and Gynecologists. 409 12th Street, SW P.O. Box 96920, Washington, DC 20090-6920. (202) 863-2518. <http://www.acog.org>.

Kim Sharp, M.Ln.

Cesarean section

Definition

A cesarean section is a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.



This baby is being delivered by cesarean section. *(Photograph by John Smith, Custom Medical Stock Photo.)*

Purpose

Cesarean sections, also called c-sections, are performed whenever abnormal conditions complicate labor and vaginal delivery, threatening the life or health of the mother or the baby. The procedure is performed in the United States on nearly one of every four babies delivered—more than 900,000 babies each year. The procedure is often used in cases where the mother has had a previous c-section. Dystocia, or difficult labor, is the other common cause of c-sections.

Difficult labor is commonly caused by one of the three following conditions: abnormalities in the mother's birth canal; abnormalities in the position of the fetus; or abnormalities in the labor, including weak or infrequent contractions.

Another major factor is fetal distress, a condition where the fetus is not getting enough oxygen. Fetal brain damage can result from oxygen deprivation. Fetal distress is often related to abnormalities in the position of the fetus or abnormalities in the birth canal, causing reduced blood flow through the placenta. Other conditions also can make c-section advisable, such as vaginal herpes, **hypertension,** and diabetes in the mother.

Precautions

There are several ways that obstetricians and other doctors diagnose conditions that may make a c-section necessary. Ultrasound testing reveals the positions of the baby and the placenta and may be used to estimate the baby's size and gestational age. Fetal heart monitors, in use since the 1970s, transmit any signals of fetal distress. Oxygen deprivation may be determined by checking the amniotic fluid for meconium (feces)—a lack of oxygen causes an unborn baby to defecate. Oxygen deprivation may also be determined by testing the pH of a blood sample taken from the baby's scalp; a pH of 7.25 or higher is normal, between 7.2 and 7.25 is suspicious, and below 7.2 is a sign of trouble.

When a c-section is being considered because labor is not progressing, the mother should first be encouraged to walk around to stimulate labor. Labor may also be stimulated with the drug oxytocin.

When a c-section is being considered because the baby is in a breech position, the doctor may first attempt to reposition the baby; this is called external cephalic version. The doctor may also try a vaginal breech delivery, depending on the size of the mother's pelvis, the size

KEY TERMS

Breech presentation—The condition in which the baby enters the birth canal with its buttocks or feet first.

Cephalopelvic disproportion (CPD)—The condition in which the baby's head is too large to fit through the mother's pelvis.

Classical incision—In a cesarean section, an incision made vertically along the uterus; this kind of incision makes a larger opening but also creates more bleeding, a greater chance of infection, and a weaker scar.

Dystocia—Failure to progress in labor, either because the cervix will not dilate (expand) further or (after full dilation) the head does not descend through the mother's pelvis.

Low transverse incision—Incision made horizontally across the lower end of the uterus; this kind of incision is preferred for less bleeding and stronger healing.

Placenta previa—The placenta totally or partially covers the cervix, preventing vaginal delivery.

Placental abruption—Separation of the placenta from the uterine wall before the baby is born, cutting off blood flow to the baby.

Prolapsed cord—The umbilical cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby.

Respiratory distress syndrome (RDS)—Difficulty breathing, found in infants with immature lungs.

Transverse presentation—The baby is laying sideways across the cervix instead of head first.

VBAC—Vaginal birth after cesarean.

of the baby, and the type of breech position the baby is in. However, a c-section is safer than a vaginal delivery when the baby is 8 lb (3.6 kg) or larger, in a breech position with the feet crossed, or in a breech position with the head hyperextended.

A woman should receive regular prenatal care and be able to alert her doctor to the first signs of trouble. Once labor begins, she should be encouraged to move around and to urinate. The doctor should be conservative in diagnosing dystocia (nonprogressive labor) and fetal distress, taking a position of "watchful waiting" before deciding to operate.

Description

The most common reason that a cesarean section is performed (in 35% of all cases, according to the United States Public Health Service) is that the woman has had a previous c-section. The "once a cesarean, always a cesarean" rule originated when the classical uterine incision was made vertically; the resulting scar was weak and had a risk of rupturing in subsequent deliveries. Today, the incision is almost always made horizontally across the lower end of the uterus (this is called a "low transverse incision"), resulting in reduced blood loss and a decreased chance of rupture. This kind of incision allows many women to have a vaginal birth after a cesarean (VBAC).

The second most common reason that a c-section is performed (in 30% of all cases) is difficult **childbirth** due to nonprogressive labor (dystocia). Uterine contractions may be weak or irregular, the cervix may not be dilating, or the mother's pelvic structure may not allow adequate passage for birth. When the baby's head is too large to fit through the pelvis, the condition is called cephalopelvic disproportion (CPD).

Another 12% of c-sections are performed to deliver a baby in a breech presentation: buttocks or feet first. Breech presentation is found in about 3% of all births.

In 9% of all cases, c-sections are performed in response to fetal distress. Fetal distress refers to any situation that threatens the baby, such as the umbilical cord getting wrapped around the baby's neck. This may appear on the fetal heart monitor as an abnormal heart rate or rhythm.

The remaining 14% of c-sections are indicated by other serious factors. One is prolapse of the umbilical cord: the cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby. Another is **placental abruption**: the placenta separates from the uterine wall before the baby is born, cutting off blood flow to the baby. The risk of this is especially high in multiple births (twins, triplets, or more). A third factor is **placenta previa**: the placenta covers the cervix partially or completely, making vaginal delivery impossible. In some cases requiring c-section, the baby is in a transverse position, lying horizontally across the pelvis, perhaps with a shoulder in the birth canal.

The mother's health may make delivery by c-section the safer choice, especially in cases of maternal diabetes,

hypertension, **genital herpes**, Rh blood incompatibility, and preeclampsia (high blood pressure related to **pregnancy**).

Preparation

When a c-section becomes necessary, the mother is prepped for surgery. A catheter is inserted into her bladder and an intravenous (IV) line is inserted into her arm. Leads for monitoring the mother's heart rate, rhythm, and blood pressure are attached. In the operating room, the mother is given anesthesia—usually a regional anesthetic (epidural or spinal), making her numb from below her breasts to her toes. In some cases, a general anesthetic will be administered. Surgical drapes are placed over the body, except the head; these drapes block the direct view of the procedure.

The abdomen is washed with an anti-bacterial solution and a portion of the pubic hair may be shaved. The first incision opens the abdomen. Infrequently, it will be vertical from just below the navel to the top of the pubic bone, or more commonly, it will be a horizontal incision across and above the pubic bone (informally called a "bikini cut").

The second incision opens the uterus. In most cases a transverse incision is made. This is the favored type because it heals well and makes it possible for a woman to attempt a vaginal delivery in the future. The classical incision is vertical. Because it provides a larger opening than a low transverse incision, it is used in the most critical situations, such as placenta previa. However, the classical incision causes more bleeding, a greater risk of abdominal infection, and a weaker scar, so the low transverse incision is preferred.

Once the uterus is opened, the amniotic sac is ruptured and the baby is delivered. The time from the initial incision to birth is typically five minutes.

Once the umbilical cord is clamped and cut, the newborn is evaluated. The placenta is removed from the mother, and her uterus and abdomen are stitched closed (surgical staples may be used instead in closing the outermost layer of the abdominal incision). From birth through suturing may take 30–40 minutes. Thus the entire surgical procedure may be performed in less than one hour.

Aftercare

A woman who undergoes a c-section requires both the care given to any new mother and the care given to any patient recovering from major surgery. She should be offered **pain** medication that does not interfere with breastfeeding. She should be encouraged to get out of bed and walk around eight to 24 hours after surgery to stimulate circulation (thus avoiding the formation of blood clots) and bowel movement. She should limit climbing stairs to once a day, and avoid lifting anything heavier than the baby. She should nap as often as the baby sleeps, and arrange for help with the housework, meals, and care of other children. She may resume driving after two weeks, although some doctors recommend waiting for six weeks, the typical recovery period from major surgery.

Risks

Because a c-section is a surgical procedure, it carries more risk to both the mother and the baby. The maternal **death** rate is less than 0.02%, but that is four times the maternal death rate associated with vaginal delivery. However, many women have a c-section for serious medical problems. The mother is at risk for increased bleeding (because a c-section may result in twice the blood loss of a vaginal delivery) from the two incisions, the placental attachment site, and possible damage to a uterine artery. Complications occur in less than 10% of cases. The mother may develop infection of either incision, the urinary tract, or the tissue lining the uterus (endometritis). Less commonly, she may receive injury to the surrounding organs, like the bladder and bowel. When a general anesthesia is used, she may experience complications from the anesthesia. Very rarely, she may develop a wound hematoma at the site of either incision or other blood clots leading to pelvic **thrombophlebitis** (inflammation of the major vein running from the pelvis into the leg) or a pulmonary embolus (a blood clot lodging in the lung).

Normal results

The after-effects of a c-section vary, depending on the woman's age, physical fitness, and overall health. Following this procedure, a woman commonly experiences gas pains, incision pain, and uterine contractions—which are also common in vaginal delivery. Her hospital stay may be two to four days. Breastfeeding the baby is encouraged, taking care that it is in a position that keeps the baby from resting on the mother's incision. As the woman heals, she may gradually increase appropriate exercises to regain abdominal tone. Full recovery may be seen in four to six weeks.

The prognosis for a successful vaginal birth after a cesarean (VBAC) may be at least 75%, especially when the c-section involved a low transverse incision in the uterus and there were no complications during or after delivery.

Abnormal results

Of the hundreds of thousands of women in the United States who undergo a c-section each year, about 500

die from serious infections, hemorrhaging, or other complications. These deaths may be related to the health conditions that made the operation necessary, and not simply to the operation itself.

Undergoing a c-section may also inflict psychological distress on the mother, beyond hormonal mood swings and **postpartum depression** ("baby blues"). The woman may feel disappointment and a sense of failure for not experiencing a vaginal delivery. She may feel isolated if the father or birthing coach is not with her in the operating room, or if she is treated by an unfamiliar doctor rather than by her own doctor or midwife. She may feel helpless from a loss of control over labor and delivery with no opportunity to actively participate. To overcome these feelings, the woman must understand why the c-section was necessary. She must accept that she couldn't control the unforeseen events that made the c-section the optimum means of delivery, and recognize that preserving the health and safety of both her and her child was more important than her delivering vaginally. Women who undergo a c-section should be encouraged to share their feelings with others. Hospitals can often recommend support groups for such mothers. Women should also be encouraged to seek professional help if negative emotions persist.

Resources

ORGANIZATIONS

American Academy of Family Physicians. 8880 Ward Parkway, Kansas City, MO 64114. (816) 333-9700. <http://www.aafp.org>.

Childbirth.Org. <http://www.childbirth.org>.

International Cesarean Awareness Network. 1304 Kingsdale Ave., Redondo Beach, CA 90278. (310) 542-6400.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

National Institute of Child Health and Human Development. Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD 20892-2425. (800) 505-2742. <http://www.nichd.nih.gov/sids/sids.htm>.

United States Department of Health and Human Services. 200 Independence Avenue SW, Washington DC 20201. (202) 619-0257. <http://www.hhs.gov>.

OTHER

"Cesarean Childbirth." *Perspectives: A Mental Health Magazine*. <http://mentalhelp.net/perspectives>.

"The Cesarean Section FAQ." *Childbirth.org*. 18 July 1998 <http://www.childbirth.org/section/CSFAQ.html>.

Bethany Thivierge

Cestodiasis *see* **Tapeworm diseases**

CFS *see* **Chronic fatigue syndrome**

CGD *see* **Chronic granulomatous disease**

Chagas' disease

Definition

Chagas' disease is named after Dr. Carlos Chagas who first found the organism in the early 1900s. It involves damage to the nerves that control the heart, digestive and other organs, and eventually leads to damage to these organs. Worldwide, Chagas' disease affects over 15 million persons, and kills 50,000 each year. Researchers believe that the parasite that causes the disease is only found in the Americas.

Description

When a person is infected with Chagas' disease, the parasite known as *Trypanosoma cruzi* first causes a mild, short-lived period of "acute" illness; then after a long period without symptoms, the effects of the infection begin to appear. The heart, esophagus, and colon are most frequently involved. These organs become unable to contract properly, and begin to stretch or dilate.

Causes and symptoms

T. cruzi is carried by insects or bugs known as reduviid or "kissing bugs." These insects are very common in Central and South America where they inhabit poorly constructed houses and huts. The insects deposit their waste material, exposing inhabitants to the parasites. The parasites then enter the body by way of a cut or via the eyes or mouth. *T. cruzi* can also be transmitted by blood **transfusion**. Eating uncooked, contaminated food or breastfeeding can also transmit the disease. The reduviids, in turn, become infected with the parasite by biting infected animals and humans.

There are three phases related to infection:

- Acute phase lasts about two months, with non-specific symptoms of low grade **fever**, **headache**, **fatigue**, and enlarged liver or spleen.
- Indeterminate phase lasts 10–20 years, during which time no symptoms occur, but the parasites are reproducing in various organs.
- Chronic phase is the stage when symptoms related to damage of major organs (heart, esophagus, colon) begin.

In the chronic phase, irregularities of heart rhythm, **heart failure**, and blood clots cause weakness, **fainting**, and even sudden **death**.

KEY TERMS

Achalasia—An esophageal disease of unknown cause, in which the lower sphincter or muscle is unable to relax normally, and leads to the accumulation of material within the esophagus.

Endoscopy—Exam using an endoscope (a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract). When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x ray.

Parasite—An organism that lives on or in another and takes nourishment (food and fluids) from that organism.

Regurgitation—Flow of material back up the esophagus and into the throat or lungs.

Esophageal symptoms are related to difficulty with swallowing and chest **pain**. Because the esophagus does not empty properly, food regurgitates into the lungs causing **cough**, **bronchitis**, and repeated bouts of **pneumonia**. Inability to eat, weight loss, and **malnutrition** become a significant factor in affecting survival.

Involvement of the large intestine (colon) causes **constipation**, distention, and abdominal pain.

Diagnosis

The best way to diagnose acute infection is to identify the parasites in tissue or blood. Occasionally it is possible to culture the organism from infected tissue, but this process usually requires too much time to be of value. In the chronic phase, antibody levels can be measured. Efforts to develop new, more accurate tests are ongoing.

Treatment

In most cases treatment of symptoms is all that is possible. Present medications can reduce the duration and severity of an acute infection, but are only 50% effective, at best, in eliminating the organisms.

Cardiac effects are managed with **pacemakers** and medications. Esophageal complications require either endoscopic or surgical methods to improve esophageal emptying, similar to those used to treat the disorder known as **achalasia**. Constipation is treated by increasing fiber and bulk **laxatives**, or removal of diseased portions of the colon.

Prognosis

Those patients with gastrointestinal complications often respond to some form of treatment. Cardiac problems are more difficult to treat, particularly since transplant would rekindle infection.

Prevention

Visitors traveling to areas of known infection should avoid staying in mud, adobe, or similar huts. Mosquito nets and insect repellents are useful in helping to avoid contact with the bugs. Blood screening is not always effective in many regions where infection is common. It is necessary to carefully screen people who have emigrated from Central and South America before they make blood donations.

Resources

BOOKS

Kirchoff, Louis V. "Trypanosomiasis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Owen, Robert L. "American Trypanosomiasis (Chagas' Disease)." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Kirchoff, Louis V. "American Trypanosomiasis (Chagas' Disease)." *Gastroenterology Clinics of North America* (Sept. 1996): 517-533.

Kirchoff, Louis V. "Current Concepts: American Trypanosomiasis (Chagas' Disease)-A Tropical Disease Now in the United States." *New England Journal of Medicine* 329, no. 9 (1993): 639.

OTHER

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

David Kaminstein, MD

Chalazion *see* **Eyelid disorders**

Chancroid

Definition

Chancroid is a sexually transmitted disease caused by a bacterial infection that is characterized by painful sores on the genitals.

Description

Chancroid is an infection of the genitals that is caused by the bacterium *Haemophilus ducreyi*. Chancroid is a sexually transmitted disease, which means that it is spread from person to person almost always by sexual contact. However, there have been a few cases in which healthcare providers have become infected through contact with infected patients.

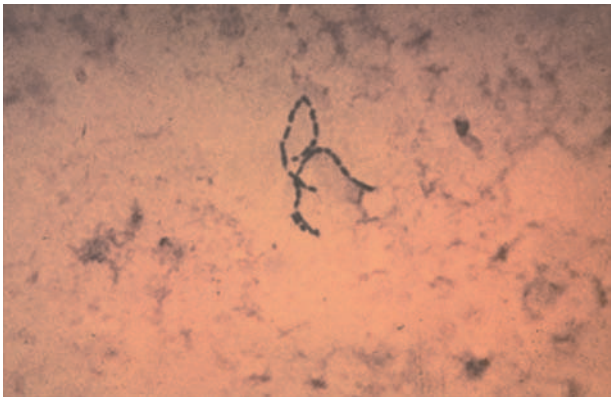
Common locations for chancroid sores (ulcers) in men are the shaft or head of the penis, foreskin, the groove behind the head of the penis, the opening of the penis, and the scrotum. In women, common locations are the labia majora (outer lips), labia minora (inner lips), perianal area (area around the anal opening), and inner thighs. It is rare for the ulcer(s) to be on the vaginal walls or cervix. In about 50% of the patients with chancroid, the infection spreads to either or both of the lymph nodes in the groin.

Chancroid is most commonly found in developing and third world countries. In the United States, the most common cause of genital ulcers is **genital herpes**, followed by **syphilis**, and then chancroid. As of 1997, there were fewer than 1,500 cases of chancroid in the United States per year and it occurred primarily in African Americans, Hispanic Americans, and Native Americans. There are occasional localized outbreaks of chancroid in the United States. In addition, the practice of exchanging sex for drugs has lead to a link between crack **cocaine** use and chancroid.

Even though the incidence of chancroid in the United States decreased in the 1990s, there is an alarming connection between chancroid and human **immunodeficiency** virus (HIV) infection. HIV causes **AIDS** (acquired immunodeficiency syndrome) and is easily spread from person to person through chancroid ulcers. Uncircumcised men with chancroid ulcers have a 48% risk of acquiring HIV from sexual contact. Women with chancroid ulcers are also at a greater risk of being infected with HIV during sexual contact. Genital ulcers seem to act as doorways for HIV to enter and exit.

Causes and symptoms

Haemophilus ducreyi is spread from person to person by vaginal, anal, and oral sexual contact. Uncircumcised men are about three times more likely than circumcised men to become infected following exposure to *Haemophilus ducreyi*. Having unprotected sex, exchanging sex for drugs, and having unprotected sex with a prostitute are other risk factors. Many cases of chancroid in the United States occur in persons who had traveled to countries where the disease is more common.



A close-up view of a chancroid specimen. *(Custom Medical Stock Photo. Reproduced by permission.)*

Chancroid occurs when *Haemophilus ducreyi* penetrates the skin through an injury, like a scratch or cut. Once past the skin surface, the warmth, moisture, and nutrients allow bacteria to grow rapidly. The first sign of chancroid is a small, red papule that occurs within three to seven days following exposure to the bacteria, but may take up to one month. Usually within one day, the papule becomes an ulcer. The chancroid ulcer is painful, bleeds easily, drains a grey or yellowish pus, and has sharply defined, ragged edges. They can vary in size from an eighth of an inch to two inches in diameter. Men usually have only one ulcer, but women often have four or more. Sometimes "kissing" ulcers occur when one ulcer spreads the bacterial infection to an opposite skin surface. For example, kissing ulcers can form on the lips of the labia majora. Alternatively, women may not have any external sores but may experience painful urination, intercourse, and/or bowel movements and may have a vaginal discharge or rectal bleeding.

Signs that the infection has spread to the lymph node appear about one week after the formation of the genital ulcer. Lymph nodes are small organs in the lymphatic system that filter waste materials from nearly every organ in the body. This lymph node infection is called "lymphadenitis" and the swollen, painful lymph node is called a "bubo." The bubo, which appears as a red, spherical lump, may burst through the skin, releasing a thick pus and forming another ulcer.

Diagnosis

Chancroid may be diagnosed and treated by urologists (urinary tract doctors for men), gynecologists (for women), and infectious disease specialists. Part of the diagnosis of chancroid involves ruling out genital herpes and syphilis because genital ulcers are also symptoms of these diseases. The appearance of these three diseases

KEY TERMS

Bubo—A tender, swollen lymph node in the groin that may follow a chancroid ulcer.

Groin—The region of the body that lies between the abdomen and the thighs.

can be close enough to be confusing. However, the presence of a pus-filled lump in the groin of a patient with a genital ulcer is highly specific for chancroid.

For a clear-cut diagnosis of chancroid, *Haemophilus ducreyi* must be isolated from the ulcer. To do this, a sterile cotton swab is wiped over the ulcer to obtain a pus sample. In the laboratory, the sample is put into special media and placed in an incubator. *Haemophilus ducreyi* takes from two to five days to grow in the laboratory. In addition, the pus may be examined under the microscope to see which bacteria are in the ulcer. A sample of the pus may also be tested to see if the herpes virus is present. A blood sample will probably be taken from the patient's arm to test for the presence of antibodies to the bacteria that causes syphilis.

Treatment

The only treatment for chancroid is **antibiotics** given either once or for several days. Antibiotics taken by mouth for one to two weeks include erythromycin (E-Mycin, Ery-Tab), amoxicillin plus clavulanic acid (Augmentin), co-trimoxazole (Bactrim, Septra), or ciprofloxacin (Cipro). Antibiotics given in one dose include ceftriaxone (Rocephin), spectinomycin (Trobicin), co-trimoxazole, or ofloxacin (Floxin).

The ulcer(s) may be cleaned and soaked to reduce the swelling. Salt solution dressings may be applied to the ulcer(s) to reduce the spread of the bacteria and prevent additional ulcers. A serious infection of the foreskin may require **circumcision**. Pus would be removed from infected lymph nodes by using a needle and syringe. Very large buboes may require surgical drainage.

Prognosis

Without treatment, chancroid may either go away quickly or patients may experience the painful ulcers for many months. A complete cure is obtained with antibiotic treatment. Severe ulcers may cause permanent scars. Severe scarring of the foreskin may require circumcision. Urethral fistulas (abnormal passageways from the urine tube to the skin) may occur and requires corrective surgery.

Prevention

The best prevention for chancroid is to use a **condom** during sexual intercourse. Chancroid can also be prevented by abstinence (avoidance of any sexual contact) and by being in a monogamous relationship with a disease-free partner. To prevent the spread of chancroid, it is important that all sexual contacts of the patient are identified and treated.

Resources

BOOKS

"Chancroid." In *The Skin and Infection: A Color Atlas and Text*, ed. Charles V. Sanders and Lee T. Nesbitt Jr. Baltimore: Williams and Wilkins, 1995.

Ronald, Allan Ross, and Michelle J. Alfa. "Chancroid, Lymphogranuloma Venerum, and Granuloma Inguinale." In *Infectious Diseases*. 2nd ed. Ed. Sherwood L. Gorbach, et al. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

DiCarlo, Richard P., and David H. Martin. "The Clinical Diagnosis of Genital Ulcer Disease in Men." *Clinical Infectious Diseases* 25 (Aug. 1997): 292-8.

ORGANIZATIONS

Planned Parenthood Federation of America, Inc. 810 Seventh Ave., New York, NY, 10019. (800) 669-0156. <http://www.plannedparenthood.org>.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Change of life *see* **Menopause**

Character disorders *see* **Personality disorders**

Charcoal, activated

Definition

Activated charcoal is a fine, black, odorless, and tasteless powder. It is made from wood or other materials that have been exposed to very high temperatures in an airless environment. It is then treated, or activated, to increase its ability to adsorb by reheating with oxidizing gas or other chemicals to break it into a very fine powder. Activated charcoal is pure carbon specially processed to make it highly adsorbent of particles and gases in the body's digestive system.

Activated charcoal has often been used since ancient times to cure a variety of ailments including **poisoning**.

Its healing effects have been well documented since as early as 1550 B.C. by the Egyptians. However, charcoal was almost forgotten until 15 years ago when it was rediscovered as a wonderful oral agent to treat most overdoses and toxins.

KEY TERMS

Antidote—A remedy to counteract a poison or injury.

Adsorption—The binding of a chemical (e.g., drug or poison) to a solid material such as activated charcoal or clay.

Description

Activated charcoal's most important use is for treatment of poisoning. It helps prevent the absorption of most poisons or drugs by the stomach and intestines. In addition to being used for most swallowed poisons in humans, charcoal has been effectively used in dogs, rabbits, rats, and other animals, as well. It can also adsorb gas in the bowels and has been used for the treatment of gas or **diarrhea**. Charcoal's other uses such as treatment of viruses, bacteria, bacterial toxic byproducts, snake venoms and other substances by adsorption have not been supported by clinical studies. By adding water to the powder to make a paste, activated charcoal can be used as an external application to alleviate **pain** and **itching** from **bites and stings**.

Poisons and drug overdoses

It is estimated that one million children accidentally overdose on drugs mistaken as candies or eat, drink, or inhale poisonous household products each year. Infants and toddlers are at the greatest risk for accidental poisoning. Activated charcoal is one of the agents most commonly used for these cases. It can absorb large amounts of poisons quickly. In addition, it is non-toxic, may be stored for a long time, and can be conveniently administered at home. Charcoal works by binding to irritating or toxic substances in the stomach and intestines. This prevents the toxic drug or chemical from spreading throughout the body. The activated charcoal with the toxic substance bound to it is then excreted in the stool without harm to the body. When poisoning is suspected the local poison control center should be contacted for instructions. They may recommend using activated charcoal, which should be available at home so that it can be given to the poisoned child or pet immediately. For severe poisoning, several doses of activated charcoal may be needed.

Intestinal disorders

In the past, activated charcoal was a popular remedy for gas. Even before the discovery of America by Europeans, Native Americans used powdered charcoal mixed with water to treat an upset stomach. Now charcoal is being rediscovered as an alternative treatment for this condition. Activated charcoal works like a sponge. Its huge surface area is ideal for soaking up different substances, including gas. In one study, people taking activated charcoal after eating a meal with high gas-producing foods did not produce more gas than those who did not have these foods. Charcoal has also been used to treat other intestinal disorders such as diarrhea, **constipation**, and cramps. There are few studies to support these uses and there are also concerns that frequent use of charcoal may decrease absorption of essential nutrients, especially in children.

Other uses

Besides being a general antidote for poisons or remedy for gas, activated charcoal has been used to treat other conditions as well. Based on its ability to adsorb or bind to other substances, charcoal has been effectively used to clean skin **wounds** and to adsorb waste materials from the gastrointestinal tract. In addition, it has been used to adsorb snake venoms, viruses, bacteria, and harmful materials excreted by bacteria or fungi. However, because of lack of scientific studies, these uses are not recommended. Activated charcoal, when used together with other remedies such as aloe vera, acidophilus, and psyllium, helps to keep symptoms of **ulcerative colitis** under control. While charcoal shows some anti-aging activity in rats, it is doubtful if it can do the same for humans.

Recommended dosage

For poisoning

Activated charcoal is available without prescription. However, in case of accidental poisoning or **drug overdose** an emergency poison control center, hospital emergency room, or doctor's office should be called for advice. In case that both syrup of **ipecac** and charcoal are recommended for treatment of the poison, ipecac should be given first. Charcoal should not be given for at least 30 minutes after ipecac or until vomiting from ipecac stops. Activated charcoal is often mixed with a liquid before being swallowed or put into the tube leading to the stomach. Activated charcoal is available as 1.1 oz (33 ml) liquid bottles. It is also available in 0.5 oz (15 ml) container sizes and as slurry of charcoal pre-mixed in water or as a container in which water or soda pop is added. Keeping activated charcoal at home is a

good idea so that it can be taken immediately when needed for treatment of poisoning.

For acute poisoning, the dosage is as follows:

- Infants (under 1 year of age): 1 g/kg.
- Children (1–12 years of age): 15–30 g or 1–2 g/kg with at least 8 oz of water.
- Adults: 30–100 g or 1–2 g/kg with at least 8 oz of water.

For diarrhea or gas

A person can take charcoal tablets or capsules with water or sprinkle the content onto foods. The dosage for treatment of gas or diarrhea in adults is 520–975 mg after each meal and up to 5 g per day.

Precautions

Parents should keep activated charcoal on hand in case of emergencies.

Do not give charcoal together with syrup of ipecac. The charcoal will adsorb the ipecac. Charcoal should be taken 30 minutes after ipecac or after the vomiting from ipecac stops.

Some activated charcoal products contain sorbitol. Sorbitol is a sweetener as well as a laxative, therefore, it may cause severe diarrhea and vomiting. These products should not be used in infants.

Charcoal may interfere with the absorption of medications and nutrients such as **vitamins** or **minerals**. For uses other than for treatment of poisoning, charcoal should be taken two hours after other medications.

Charcoal should not be used to treat poisoning caused by corrosive products such as lye or other strong acids or petroleum products such as gasoline, kerosene, or cleaning fluids. Charcoal may make the condition worse and delay diagnosis and treatment. In addition, charcoal is also not effective if the poison is lithium, cyanide, iron, ethanol, or methanol.

Parents should not mix charcoal with chocolate syrup, sherbet, or ice cream, even though it may make charcoal taste better. These foods may prevent charcoal from working properly.

Activated charcoal may cause swelling or pain in the stomach. A doctor should be notified immediately. It has been known to cause problems in people with intestinal bleeding, blockage or those people who have had recent surgery. These patients should talk to their doctor before using this product.

Charcoal may be less effective in people with slow digestion.

Charcoal should not be given for more than three or four days for treatment of diarrhea. Continuing for longer periods may interfere with normal **nutrition**.

Charcoal should not be used in children under three years of age to treat diarrhea or gas.

Activated charcoal should be kept out of reach of children.

Side effects

Charcoal may cause constipation when taken for overdose or accidental poisoning. A laxative should be taken after the crisis is over.

Activated charcoal may cause the stool to turn black. This is to be expected.

Pain or swelling of the stomach may occur. A doctor should be consulted.

Interactions

Activated charcoal should not be mixed together with chocolate syrup, ice cream or sherbet. These foods prevent charcoal from working properly.

Resources

BOOKS

Blumenthal, Mark. "Linden Charcoal." *The Complete German Commission E Monographs, Therapeutic Guide to Herbal Medicines*. American Botanical Council, Boston: Integrative Medicine Communications, 1998. <http://home.mdconsult.com>.

Cooney, David. Activated Charcoal: Antidote, Remedy, and Health Aid. Brushton, NY: TEACH Services, Inc., 1999.

Lacy Charles F., Lora L. Amstrong, Naomi B. Ingrim, and Leonard L. Lance. "Charcoal." *The Drug Information Handbook Pocket Version: 1998-1999*. Hudson, OH: Lexi-Comp Inc., 1998.

Roberts. "Activated Charcoal." *Clinical Procedures in Emergency Medicine*. Philadelphia, PA: W. B. Saunders Company, 1998: 726-8. <http://home.mdconsult.com>.

Wilson, Billie A., Margaret T. Shannon, and Carolyn L. Stang. "Charcoal, Activated (Liquid Antidote)." *Nurses Drug Guide 2000*. Stamford, CT: Appleton & Lange, 2000.

Mai Tran

Charcot Marie Tooth disease

Definition

Charcot Marie Tooth disease (CMT) is the name of a group of inherited disorders of the nerves in the peripheral nervous system (nerves throughout the body

that communicate motor and sensory information to and from the spinal cord) causing weakness and loss of sensation in the limbs.

Description

CMT is named for the three neurologists who first described the condition in the late 1800s. It is also known as hereditary motor and sensory neuropathy, and is sometimes called peroneal muscular atrophy, referring to the muscles in the leg that are often affected. The age of onset of CMT can vary anywhere from young childhood to the 50s or 60s. Symptoms typically begin by the age of 20. For reasons yet unknown, the severity in symptoms can also vary greatly, even among members of the same family.

Although CMT has been described for many years, it is only since the early 1990s that the genetic cause of many of the types of CMT have become known. Therefore, knowledge about CMT has increased dramatically within a short time.

The peripheral nerves

CMT affects the peripheral nerves, those groups of nerve cells carrying information to and from the spinal cord. CMT decreases the ability of these nerves to carry motor commands to muscles, especially those furthest from the spinal cord located in the feet and hands. As a result, the muscles connected to these nerves eventually weaken. CMT also affects the sensory nerves that carry information from the limbs to the brain. Therefore people with CMT also have sensory loss. This causes symptoms such as not being able to tell if something is hot or cold or difficulties with balance.

There are two parts of the nerve that can be affected in CMT. A nerve can be likened to an electrical wire, in which the wire part is the axon of the nerve and the insulation surrounding it is the myelin sheath. The job of the myelin is to help messages travel very fast through the nerves. CMT is usually classified depending on which part of the nerve is affected. People who have problems with the myelin have CMT type 1 and people who have abnormalities of the axon have CMT type 2.

Specialized testing of the nerves, called nerve conduction testing (NCV), can be performed to determine if a person has CMT1 or CMT2. These tests measure the speed at which messages travel through the nerves. In CMT1, the messages move too slowly, but in CMT2 the messages travel at the normal speed.

Demographics

CMT has been diagnosed in people from all over the world. It occurs in approximately one in 2,500 people, which is about the same incidence as **multiple sclerosis**. It is the most common type of inherited neurologic condition.

Signs and symptoms

CMT is caused by changes (mutations) in any one of a number of genes that carry the instructions to make the peripheral nerves. Genes contain the instructions for how the body grows and develops before and after a person is born. There are probably at least 15 different genes that can cause CMT. However, as of early 2001, many have not yet been identified.

CMT types 1 and 2 can be broken down into subtypes based upon the gene that is causing CMT. The subtypes are labeled by letters, so there is CMT1A, CMT1B, etc. Therefore, the gene with a mutation that causes CMT1A is different from that that causes CMT1B.

Types of CMT

CMT1A. The most common type of CMT is called CMT1A. It is caused by a mutation in a gene called peripheral myelin protein 22 (PMP22) located on chromosome 17. The job of this gene is to make a protein (PMP22) that makes up part of the myelin. In most people who have CMT, the mutation that causes the condition is a duplication (doubling) of the PMP22 gene. Instead of having two copies of the PMP22 gene (one on each chromosome) there are three copies. It is not known how this extra copy of the PMP22 gene causes the observed symptoms. A small percentage of people with CMT1A do not have a duplication of the PMP22 gene, but rather have a point mutation in the gene. A point mutation is like a typo in the gene that causes it to work incorrectly.

HEREDITARY NEUROPATHY WITH LIABILITY TO PRESSURE PALSIES (HNPP). HNPP is a condition that is also caused by a mutation in the PMP22 gene. The mutation is a deletion. Therefore, there is only one copy of the PMP22 gene instead of two. People who have HNPP may have some of the signs of CMT. However, they also have episodes where they develop weakness and problems with sensation after compression of certain pressure points such as the elbows or knee. Often these symptoms will resolve after a few days or weeks, but sometimes they are permanent.

CMT1B. Another type of CMT, called CMT1B, is caused by a mutation in a gene called myelin protein zero (MPZ) located on chromosome 1. The job of this gene is to make the layers of myelin stick together as they are wrapped around the axon. The mutations in this gene are point mutations because they involve a change (either deletion, substitution, or insertion) at one specific component of a gene.

CMTX. Another type of CMT, called CMTX, is usually considered a subtype of CMT1 because it affects the myelin, but it has a different type of inheritance than type 1 or type 2. In CMTX, the CMT-causing gene is located on the X chromosome and is called connexin 32 (Cx32). The job of this gene is to code for a class of protein called connexins that form tunnels between the layers of myelin.

CMT2. There are at least five different genes that can cause CMT type 2. Therefore, CMT2 has subtypes A, B, C, D and E. As of early 2001, scientists have narrowed in on the location of most of the CMT2 causing genes. However, the specific genes and the mutations have not yet been found for most types. Very recently, the gene for CMT2E has been found. The gene is called neurofilament-light (NF-L). Because it has just been discovered, not much is known about how mutations in this gene cause CMT.

CMT3. In the past a condition called Dejerine-Sottas disease was referred to as CMT3. This is a severe type of CMT in which symptoms begin in infancy or early childhood. It is now known that this is not a separate type of CMT and in fact people who have onset in infancy or early childhood often have mutations in the PMP22 or MPZ genes.

CMT4. CMT4 is a rare type of CMT in which the nerve conduction tests have slow response results. However, it is classified differently from CMT1 because it is passed through families by a different pattern of inheritance. There are five different subtypes and each has only been described in a few families. The symptoms in CMT4 are often severe and other symptoms such as deafness may be present. There are three different genes that have been associated with CMT4 as of early 2001. They are called MTMR2, EGR2, and NDRG1. More research is required to understand how mutations in these genes cause CMT.

Inheritance

CMT1A and 1B, HNPP, and all of the subtypes of CMT2 have autosomal dominant inheritance. Autosomal refers to the first 22 pairs of chromosomes that are the same in males and females. Therefore, males and females are affected equally in these types. In a dominant condition, only one gene of a pair needs to have a mutation in order for a person to have symptoms of the condition. Therefore, anyone who has these types has a 50%, or one in two, chance of passing CMT on to each of their children. This chance is the same for each **pregnancy** and does not change based on previous children.

CMTX has X-linked inheritance. Since males only have one X chromosome, they only have one copy of the Cx32 gene. Thus, when a male has a mutation in his Cx32 gene, he will have CMT. However, females have two X chromosomes and therefore have two copies of the Cx32 gene. If they have a mutation in one copy of their Cx32 genes, they will only have mild to moderate symptoms of CMT that may go unnoticed. This is because their normal copy of the Cx32 gene does make normal myelin.

Females pass on one or the other of their X chromosomes to their children—sons or daughters. If a woman with a Cx32 mutation passes her normal X chromosome, she will have an unaffected son or daughter who will not pass CMT on to his or her children. If the woman passes the chromosome with Cx32 mutation on she will have an affected son or daughter, although the daughter will be mildly affected or have no symptoms. Therefore, a woman with a Cx32 mutation has a 50%, or a one in two, chance of passing the mutation to her children: a son will be affected, and a daughter may only have mild symptoms.

When males pass on an X chromosome, they have a daughter. When they pass on a Y chromosome, they have a son. Since the Cx32 mutation is on the X chromosome, a man with CMTX will always pass the Cx32 mutation on to his daughters. However, when he has a son, he passes on the Y chromosome, and therefore the son will not be affected. Therefore, an affected male passes the Cx32 gene mutation on to all of his daughters, but to none of his sons.

CMT4 has autosomal recessive inheritance. Males and females are equally affected. In order for a person to have CMT4, they must have a mutation in both of their CMT-causing genes—one inherited from each parent. The parents of an affected person are called carriers. They have one normal copy of the gene and one copy with a mutation. Carriers do not have symptoms of CMT. Two carrier parents have a 25%, or one in four, chance of passing CMT on to *each* of their children.

The onset of symptoms is highly variable, even among members of the same family. Symptoms usually progress very slowly over a person's lifetime. The main problems caused by CMT are weakness and loss of sensation mainly in the feet and hands. The first symptoms are usually problems with the feet such as high arches and problems with walking and running. Tripping while walking and sprained ankles are common. Muscle loss in the feet and calves leads to "foot drop" where the foot does not lift high enough off the ground when walking. Complaints of cold legs are common, as are cramps in the legs, especially after **exercise**.

In many people, the fingers and hands eventually become affected. Muscle loss in the hands can make fine movements such as working buttons and zippers difficult. Some patients develop tremor in the upper limbs. Loss of sensation can cause problems such as numbness and the

inability to feel if something is hot or cold. Most people with CMT remain able to walk throughout their lives.

Diagnosis

Diagnosis of CMT begins with a careful neurological exam to determine the extent and distribution of weakness. A thorough family history should be taken at this time to determine if other people in the family are affected. Testing may also be performed to rule out other causes of neuropathy.

A nerve conduction velocity test should be performed to measure how fast impulses travel through the nerves. This test may show characteristic features of CMT, but it is not diagnostic of CMT. Nerve conduction testing may be combined with **electromyography** (EMG), an electrical test of the muscles.

A nerve biopsy (removal of a small piece of the nerve) may be performed to look for changes characteristic of CMT. However, this testing is not diagnostic of CMT and is usually not necessary for making a diagnosis.

Definitive diagnosis of CMT is made only by **genetic testing**, usually performed by drawing a small amount of blood. As of early 2001, testing is available to detect mutations in PMP22, MPZ, Cx32 and EGR2. However, research is progressing rapidly and new testing is often made available every few months. All affected members of a family have the same type of CMT. Therefore once a mutation is found in one affected member, it is possible to test other members who may have symptoms or are at risk of developing CMT.

Prenatal diagnosis

Testing during pregnancy to determine whether an unborn child is affected is possible if genetic testing in a family has identified a specific CMT-causing mutation. This can be done after 10–12 weeks of pregnancy using a procedure called **chorionic villus sampling** (CVS). CVS involves removing a tiny piece of the placenta and examining the cells. Testing can also be done by **amniocentesis** after 16 weeks gestation by removing a small amount of the amniotic fluid surrounding the baby and analyzing the cells in the fluid. Each of these procedures has a small risk of **miscarriage** associated with it, and those who are interested in learning more should check with their doctor or genetic counselor. Couples interested in these options should obtain **genetic counseling** to carefully explore all of the benefits and limitations of these procedures.

Treatment

There is no cure for CMT. However, physical and occupational therapy are an important part of CMT treatment. Physical therapy is used to preserve range of motion and minimize deformity caused by muscle shortening, or contracture. Braces are sometimes used to improve control of the lower extremities that can help tremendously with balance. After wearing braces, people often find that they have more energy because they are using less energy to focus on their walking. Occupational therapy is used to provide devices and techniques that can assist tasks such as dressing, feeding, writing, and other routine activities of daily life. Voice-activated software can also help people who have problems with fine motor control.

It is very important that people with CMT avoid injury that causes them to be immobile for long periods of time. It is often difficult for people with CMT to return to their original strength after injury.

There is a long list of medications that should be avoided if possible by people diagnosed with CMT such as hydralazine (Apresoline), megadoses of vitamin A, B_6, and D, Taxol, and large intravenous doses of penicillin. Complete lists are available from the CMT support groups. People considering taking any of these medications should weigh the risks and benefits with their physician.

Prognosis

The symptoms of CMT usually progress slowly over many years, but do not usually shorten life expectancy. The majority of people with CMT do not need to use a wheelchair during their lifetime. Most people with CMT are able to lead full and productive lives despite their physical challenges.

Resources

BOOKS

Parry, G. J., ed. *Charcot-Marie-Tooth Disorders: A Handbook for Primary Care Physicians*. Available from the CMT Association, 1995.

Shy, M. E., J. Kamholz, and R. E. Lovelace, eds. "Charcot-Marie-Tooth Disorders." *Annals of the New York Academy of Sciences*. 1999.

PERIODICALS

Keller. M. P., and P. F. Chance. "Inherited peripheral neuropathies." *Seminars in Neurology* 19, no. 4 (1999): 353–62.

Quest. A magazine for patients available from the Muscular Dystrophy Association.

ORGANIZATIONS

Charcot Marie Tooth Association (CMTA). 2700 Chestnut Parkway, Chester, PA 19013. (610) 499-9264 or (800) 606-CMTA. Fax: (610) 499-9267. <cmtassoc@aol.com>. <http://www.charcot-marie-tooth.org>.

CMT International. Attn: Linda Crabtree, 1 Springbank Dr. St. Catherine's, ONT L2S2K1. Canada (905) 687-3630. <http://www.cmtint.org>.

Muscular Dystrophy Association. 3300 East Sunrise Dr., Tucson, AZ 85718. (520) 529-2000 or (800) 572-1717. <http://www.mdausa.org>.

KEY TERMS

Axon—Skinny, wire-like extension of nerve cells.

Myelin—A fatty sheath surrounding nerves in the peripheral nervous system, which help them conduct impulses more quickly.

Nerve conduction testing—Procedure that measures the speed at which impulses move through the nerves.

Neuropathy—A condition caused by nerve damage. Major symptoms include weakness, numbness, paralysis, or pain in the affected area.

Peripheral nerves—Nerves throughout the body that carry information to and from the spinal cord.

Neuropathy Association. 60 E. 42nd St. Suite 942, New York, NY 10165. (212) 692-0662. <http://www.neuropathy.org>.

OTHER

HNPP—Hereditary Neuropathy with liability to Pressure Palsies. University of Washington, Seattle. <http://www.hnpp.org>.

"GeneClinics." <www.gene clinics.org>.

OMIM—Online Mendelian Inheritance in Man. <http://www.ncbi. nlm.nih.gov/Omim>.

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Charcot's joints

Definition

Charcot's joints is a progressive degenerative disease of the joints caused by nerve damage resulting in the loss of ability to feel **pain** in the joint and instability of the joint.

Description

Charcot's joints, also called neuropathic joint disease, is the result of two conditions present in the joint. The first factor is the inability to feel pain in the joint due to nerve damage. The second factor is that injuries to the joint go unnoticed leading to instability and making the joint more susceptible to further injury. Repeated small injuries, strains and even **fractures** can go unnoticed until finally the joint is permanently destroyed. Loss of the protective sensation of pain is what leads to the disintegration of the joint and often leads to deformity in the joint.

Although this condition can affect any joint, the knee is the joint most commonly involved. In individuals with **diabetes mellitus**, the foot is most commonly affected. The disease can involve only one joint or it may affect two or three joints. More than three affected joints is very rare. In all cases, the specific joint(s) affected depends on the location of the nerve damage.

Causes and symptoms

Many diseases and injuries can interfere with the ability to feel pain. Conditions such as diabetes mellitus, spinal injuries and diseases, **alcoholism**, and even **syphilis** can all lead to a loss of the ability to feel pain in some areas. Lack of pain sensation may also be congenital.

The symptoms of Charcot's joints can go unnoticed for some time and may be confused with **osteoarthritis** in the beginning. Swelling and stiffness in a joint without the expected pain, or with less pain than would be expected, are the primary symptoms of this condition. As the condition progresses, however, the joint can become very painful due to fluid build-up and bony growths.

Diagnosis

Charcot's joints is suspected when a person with a disease that impairs pain sensation exhibits painless swelling and/or stiffness in a joint. Standard x rays will show damage to the joint, and may also show abnormal bone growth and calcium deposits. Floating bone fragments from previous injuries may also be visible.

Treatment

In the early stages of Charcot's joints, braces to stabilize the joints can help stop or minimize the damage. When the disease has progressed beyond braces, surgery can sometimes repair the joint. If the damage is extensive, an artificial joint may be necessary.

Prognosis

Treatment of the disease causing loss of pain perception may help to slow the damage to the joints.

Prevention

Preventing or effectively managing the underlying disease can slow or in some cases reverse joint damage, but the condition cannot be prevented.

Resources

BOOKS

Resnick, Donald. *Diagnosis of Bone and Joint Disorders*. Philadelphia: W. B. Saunders Co., 1994.

Dorothy Elinor Stonely

Charley horse *see* **Muscle spasms and cramps**

Chelation therapy

Definition

Chelation therapy is an intravenous treatment designed to bind heavy metals in the body in order to treat heavy metal toxicity. Proponents claim it also treats **coronary artery disease** and other illnesses that may be linked to damage from free radicals (reactive molecules).

Purpose

The benefits of EDTA chelation for the treatment of **lead poisoning** and excessively high calcium levels are undisputed. The claims of benefits for those suffering from **atherosclerosis**, coronary artery disease, and other degenerative diseases are more difficult to prove. Reported uses for chelation therapy include treatment of **angina**, **gangrene**, arthritis, **multiple sclerosis**, **Parkinson's disease**, **psoriasis**, and **Alzheimer's disease**. Improvement is also claimed for people experiencing diminished sight, hearing, smell, coordination, and sexual potency.

Description

Origins

The term chelation is from the Greek root word "chele," meaning "claw." Chelating agents, most commonly diamine tetraacetic acid (EDTA), were originally designed for industrial applications in the early 1900s. It was not until the World War II era that the potential for medical therapy was realized. The initial intent was to develop antidotes to poison gas and radioactive contaminants. The need for widespread therapy of this nature did not materialize, but more practical uses were found for chelation. During the following decade, EDTA chelation therapy became standard treatment for people suffering from lead **poisoning**. Patients who had received this treatment claimed to have other health improvements that could not be attributed to the lead removal only. Especially notable were comments from those who had previously suffered from intermittent claudication and angina. They reported suffering less **pain** and **fatigue**, with improved endurance, after chelation therapy. These reports stimulated further interest in the potential benefits of chelation therapy for people suffering from atherosclerosis and coronary artery disease.

If the preparatory examination suggests that there is a condition that could be improved by chelation therapy, and there is no health reason why it shouldn't be used, then the treatment can begin. The patient is generally taken to a comfortable treatment area, sometimes in a group location, and an intravenous line is started. A solution of EDTA together with **vitamins** and **minerals** tailored for the individual patient is given. Most treatments take three to four hours, as the infusion must be given slowly in order to be safe. The number of recommended treatments is usually between 20 and 40. They are given one to three times a week. Maintenance treatments can then be given at the rate of once or twice a month. Maximum benefits are reportedly attained after approximately three months after a treatment series. The cost of therapy is considerable, but it is a fraction of the cost of an expensive medical procedure like cardiac bypass surgery. Intravenous vitamin C and mercury chelation therapies are also offered.

Preparations

A candidate for chelation therapy should initially have a thorough history and physical to define the type and extent of clinical problems. Laboratory tests will be done to determine whether there are any conditions present that would prevent the use of chelation. Patients who have preexisting **hypocalcemia**, poor liver or kidney function, congestive **heart failure**, **hypoglycemia**, **tuberculosis**, clotting problems, or potentially allergic conditions are at higher risk for complications from chelation therapy. A Doppler ultrasound may be performed to determine the adequacy of blood flow in different regions of the body.

Precautions

It is important for people who receive chelation therapy to work with medical personnel who are experienced in the use of this treatment. Treatment should not be undertaken before a good physical, lifestyle evaluation, history, and any laboratory tests necessary are performed. The staff must be forthcoming about test results and should answer any questions the patient may have. Evaluation and treatment should be individualized and involve assessment of kidney function before each treatment with chelation, since the metals bound by the EDTA are excreted through the kidneys.

Although EDTA binds harmful, toxic metals like mercury, lead, and cadmium, it also binds some essential nutrients of the body, such as copper, iron, calcium, zinc, and magnesium. Large amounts of zinc are lost during chelation. Zinc deficiency can cause impaired immune function and other harmful effects. Supplements of zinc are generally given to patients undergoing chelation, but it is not known whether this is adequate to prevent deficiency. Also, chelation therapy does not replace proper **nutrition**, **exercise**, and appropriate medications or surgery for specific diseases or conditions.

KEY TERMS

Angina—Chest pain caused by reduced oxygen to the heart.

Atherosclerosis—Arterial disease characterized by fatty deposits on inner arterial walls.

Hypocalcemia—Low blood calcium.

Hypoglycemia—Low blood sugar.

Intermittent claudication—Leg pain and weakness caused by walking.

Thrombophlebitis—Inflammation of a vein together with clot formation.

Side effects

Side effects of chelation therapy are reportedly unusual, but are occasionally serious. Mild reactions may include, but are not limited to, local irritation at the infusion site, skin reactions, nausea, **headache**, **dizziness**, hypoglycemia, **fever**, leg cramps, or loose bowel movements. Some of the more serious complications reported have included hypocalcemia, kidney damage, decreased clotting ability, anemia, bone marrow damage, insulin shock, **thrombophlebitis** with **embolism**, and even rare deaths. However, some doctors feel that the latter groups of complications occurred before the safer method currently used for chelation therapy was developed.

Research and general acceptance

EDTA chelation is a highly controversial therapy. The treatment is approved by the United States Food and Drug Administration (FDA) for lead poisoning and seriously high calcium levels. However, for the treatment of atherosclerotic heart disease, EDTA chelation therapy is not endorsed by the American Heart Association (AHA), the FDA, the National Institutes of Health (NIH), or the American College of Cardiology. The AHA reports that there are no adequate, controlled, published scientific studies using currently approved scientific methods to support this therapy for the treatment of coronary artery disease. However, a pooled analysis from the results of over 70 studies showed positive results in all but one.

Resources

BOOKS

Cassileth, Barrie. *The Alternative Medicine Handbook*. New York: W. W. Norton & Company, Inc., 1998.

Cranton, Elmer. *Bypassing Bypass*. Virginia: Medex Publishers, Inc., 1997.

PERIODICALS

Chappel, Stall. *Journal of the Advancement of Medicine* 6 (1993): 139-160.

ORGANIZATIONS

The American College for Advancement in Medicine (ACAM). 23121 Verdugo Dr., Suite 204, Laguna Hills, CA 92653. (714) 583-7666.

American Heart Association. <http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/chelat.html> (2000).

OTHER

Cranton, Elmer. *Chelation therapy.* <http://www.drcranton.com/chelation.html> (1999).

Green, Saul. *Quackwatch: Chelation therapy.* <http://www.quackwatch.com/01QuackeryRelatedTopics/chelation.html> (2000).

Judith Turner

Chemica *see* **Skin resurfacing**

Chemical debridement *see* **Debridement**

Chemobrasion *see* **Skin resurfacing**

Chemonucleolysis

Definition

Chemonucleolysis is a medical procedure that involves the dissolving of the gelatinous cushioning material in an intervertebral disk by the injection of an enzyme such as chymopapain.

Purpose

Between each vertebra lies a disk of cushioning material that keeps the spinal bones from rubbing together and absorbs some of the **shock** to the spine from body movements. In the center of the disk is soft, gelatinous material called the nucleus pulposus (NP). The NP is surrounded by a tough fibrous coating. Sometimes when the back is injured, this coating can weaken and bulge or tear to allow the NP to ooze out. When this happens, it is called a herniated nucleus pulposus (HNP), or—in common language—a **herniated disk**.

When the disk bulges or herniates, it can put pressure on nerves which originate in the spinal column, and go to other parts of the body. This causes lower back **pain**, and/or pain to the hips, legs, arms, shoulders, and neck, depending on the location of the herniated disk. Chemonucleolysis uses chymopapain, an enzyme derived from papyrus, to dissolve the disk material that has

KEY TERMS

Chymopapain—An enzyme from the milky white fluid of the papaya, used for medical purposes in chemonucleolysis.

Myelography—An x-ray test that evaluates the subarachnoid space of the spine.

Nucleus pulposus (NP)—an elastic, pulpy mass in the center of each vertebral disk.

been displaced because of injury. Herniated disks are the cause of only a small proportion of cases of lower back pain, and chemonucleolysis is appropriate for only some cases of HNP.

Chemonucleolysis is a conservative alternative to disk surgery. There are three types of disk injuries. A protruded disk is one that is intact but bulging. In an extruded disk, the fibrous wrapper has torn and the NP has oozed out, but is still connected to the disk. In a sequestered disk, a fragment of the NP has broken loose from the disk and is free in the spinal canal. Chemonucleolysis is effective on protruded and extruded disks, but not on sequestered disk injuries. In the United States, chymopapain chemonucleolysis is approved only for use in the lumbar (lower) spine. In other countries, it has also been used successfully to treat cervical (upper spine) hernias.

Other indications that a patient is a good candidate for chemonucleolysis instead of surgery include:

- the patient is 18–50 years of age
- leg pain is worse than lower back pain
- other conservative treatments have failed
- the spot where the herniated disk presses on the nerve has been pinpointed by **myelography**, computed tomography scan (CT scan), or **magnetic resonance imaging** (MRI)
- the patient wishes to avoid surgery

Precautions

There are some situations in which chemonucleolysis should not be performed. Chymopapain is derived from the papaya. About 0.3% of patients are allergic to chymopapain and go into life-threatening shock when exposed to the enzyme. Chemonucleolysis should not be performed on patients allergic to chymopapain or papaya. It also should not be done:

- when the patient is pregnant
- if the disk is sequestered
- if the patient has had several failed back operations
- if a spinal cord tumor is present
- if the patient has a neurological disease such as multiple sclerosis

Other conditions may affect the appropriateness of chemonucleolysis, including **hypertension**, **obesity**, diabetes, and a family history of stroke.

Description

A small gauge needle is placed in the center of the affected disk. Chymopapain is introduced into the disk. The patient needs to remain still.

Preparation

Patients will need tests such as a myelogram or CT scan to pinpoint the herniated disk. Some doctors medicate the patient 24 hours prior to the operation in order to decrease the chances of post-operative lower back stiffness.

Aftercare

Patients may feel lower back stiffness, which goes away in few weeks. Heavy lifting and sports activities should be avoided for at least three months.

Risks

The greatest risk is that the patient may be allergic to chymopapain. The **death** rate for chemonucleolysis is only 0.02%. Complications overall are five to 10 times less than with conventional surgery, and the failure rate is roughly comparable to the failure rate in conventional disk surgery.

Normal results

Many patients feel immediate relief from pain, but, in about 30% of patients, maximal relief takes six weeks. The long term (seven to 20 years) success rate averages about 75%, which is comparable to the success rate for conventional surgery.

Resources

PERIODICALS

Alexander, Herbert. "Chemonucleolysis for Lumbar Disc Herniation: How Does it Stack up to Other Minimally Invasive Approaches?" *Journal of Musculoskelatal Medicine* 12, no. 2 (1995): 13-24.

Tish Davidson

Chemotherapy

Definition

Chemotherapy is treatment of **cancer** with **anti-cancer drugs**.

Purpose

The main purpose of chemotherapy is to kill cancer cells. It is usually used to treat patients with cancer that has spread from the place in the body where it started (metastasized). Chemotherapy destroys cancer cells anywhere in the body. It even kills cells that have broken off from the main tumor and traveled through the blood or lymph systems to other parts of the body.

Chemotherapy can cure some types of cancer. In some cases, it is used to slow the growth of cancer cells or to keep the cancer from spreading to other parts of the body. When a cancer has been removed by surgery, chemotherapy may be used to keep the cancer from coming back (adjuvant therapy). Chemotherapy also can ease the symptoms of cancer, helping some patients to have a better quality of life.

Precautions

There are many different types of chemotherapy drugs. Oncologists, doctors who specialize in treating cancer, determine which drugs are best suited for each patient. This decision is based on the type of cancer, the patient's age and health, and other drugs the patient is taking. Some patients should not be treated with certain chemotherapy drugs. Age and other conditions may affect the drugs with which a person may be treated. Heart disease, kidney disease, and diabetes are conditions that may limit the choice of treatment drugs.

Description

More than 50 chemotherapy drugs are currently available to treat cancer and many more are being tested for their ability to destroy cancer cells. Most chemotherapy drugs interfere with the ability of cells to grow or multiply. Although these drugs affect all cells in the body, many useful treatments are most effective against rapidly growing cells. Cancer cells grow more quickly than most other body cells. Other cells that grow fast are cells of the bone marrow that produce blood cells, cells in the stomach and intestines, and cells of the hair follicles. Therefore, the most common side effects of chemotherapy are linked to their effects on other fast growing cells.

Types of chemotherapy drugs

Chemotherapy drugs are classified based on how they work. The main types of chemotherapy drugs are described below:

- Alkylating drugs kill cancer cells by directly attacking DNA, the genetic material of the genes. Cyclophosphamide is an alkylating drug.
- Antimetabolites interfere with the production of DNA and keep cells from growing and multiplying. An example of an antimetabolite is 5-fluorouracil (5-FU).
- Antitumor **antibiotics** are made from natural substances such as fungi in the soil. They interfere with important cell functions, including production of DNA and cell proteins. Doxorubicin and bleomycin belong to this group of chemotherapy drugs.
- Plant alkaloids prevent cells from dividing normally. Vinblastine and vincristine are plant alkaloids obtained from the periwinkle plant.
- Steroid hormones slow the growth of some cancers that depend on hormones. For example, tamoxifen is used to treat breast cancers that depend on the hormone estrogen for growth.

Combination chemotherapy

Chemotherapy is usually given in addition to other cancer treatments, such as surgery and **radiation therapy**. When given with other treatments, it is called adjuvant chemotherapy. An oncologist decides which chemotherapy drug or combination of drugs will work best for each patient. The use of two or more drugs together often works better than a single drug for treating cancer. This is called combination chemotherapy. Scientific studies of different drug combinations help doctors learn which combinations work best for each type of cancer.

How chemotherapy is given

Chemotherapy is administered in different ways, depending on the drugs to be given and the type of cancer. Doctors decide the dose of chemotherapy drugs considering many factors, among them being the patient's height and weight.

Chemotherapy may be given by one or more of the following methods:

- orally
- by injection
- through a catheter or port
- topically

Oral chemotherapy is given by mouth in the form a pill, capsule, or liquid. This is the easiest method and can usually be done at home.

Intravenous (IV) chemotherapy is injected into a vein. A small needle is inserted into a vein on the hand or lower arm. The needle is usually attached to a small tube called a catheter, which delivers the drug to the needle from an IV bag or bottle.

Intramuscular (IM) chemotherapy is injected into a muscle. Chemotherapy given by intramuscular injection is absorbed into the blood more slowly than IV chemotherapy. Because of this, the effects of IM chemotherapy may last longer than chemotherapy given intravenously. Chemotherapy may also be injected subcutaneously (SQ or SC), which means under the skin. Injection of chemotherapy directly into the cancer is called intralesional (IL) injection.

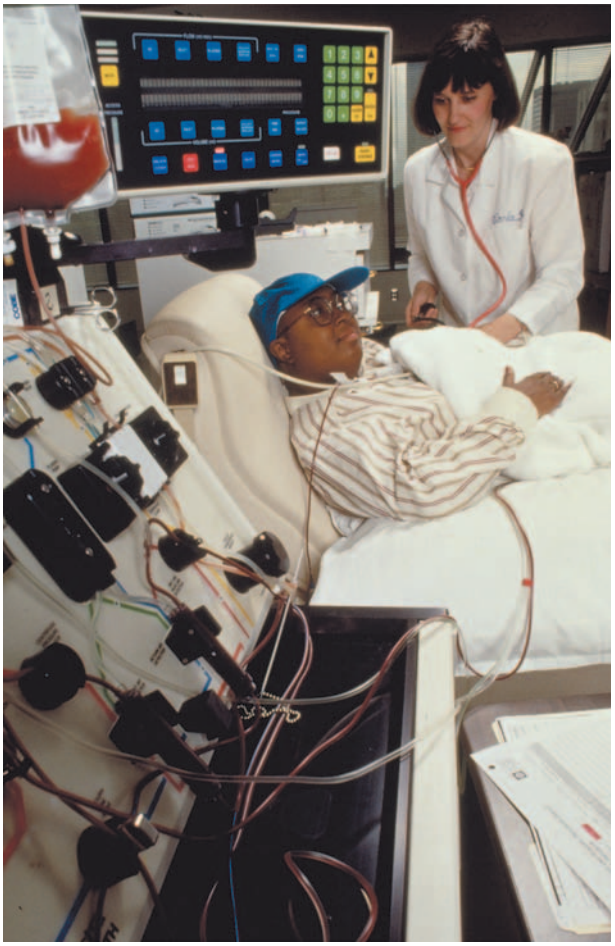
Chemotherapy may also be given by a catheter or port permanently inserted into a central vein or body cavity. A port is a small reservoir or container that is placed in a vein or under the skin in the area where the drug will be given. These methods eliminate the need for repeated injections and may allow patients to spend less time in the hospital while receiving chemotherapy. A common location for a permanent catheter is the external jugular vein in the neck. Intraperitoneal (IP) chemotherapy is administered into the abdominal cavity through a catheter or port. Chemotherapy given by catheter or port into the spinal fluid is called intrathecal (IT) administration. Catheters and ports may also be placed in the chest cavity, bladder, or pelvis, depending on the location of the cancer to be treated.

Topical chemotherapy is given as a cream or ointment applied directly to the cancer. This method is more common in treatment of certain types of skin cancer.

Treatment location and schedule

Patients may take chemotherapy at home, in the doctor's office, or as an inpatient or outpatient at the hospital. Most patients stay in the hospital when first beginning chemotherapy, so their doctor can check for any side effects and change the dose if needed.

How often and how long chemotherapy is given depends on the type of cancer, how patients respond to the drugs, patients' health and ability to tolerate the drugs, and the types of drugs given. Chemotherapy administration may take only a few minutes or may last as long as several hours. Chemotherapy may be given daily, weekly, or monthly. A rest period may follow a course of treatment before the next course begins. In combination chemotherapy, more than one drug may be given at a time, or they may be given alternately, one following the other.



Patient undergoing high dose stem cell chemotherapy. *(Custom Medical Stock Photo. Reproduced by permission.)*

Preparation

A number of medical tests are done before chemotherapy is started. The oncologist will determine how much the cancer has spread from the results of x rays and other imaging tests and from samples of the tumor taken during surgery.

Blood tests give the doctor important information about the function of the blood cells and levels of chemicals in the blood. A complete **blood count** (CBC) is commonly done before and regularly during treatment. The CBC shows the numbers of white blood cells, red blood cells, and platelets in the blood. Because chemotherapy affects the bone marrow, where blood cells are made, levels of these cells often drop during chemotherapy. The white blood cells and platelets are most likely to be affected by chemotherapy. A drop in the

white blood cell count means that the immune system cannot function properly. Low levels of platelets can cause a patient to bleed easily from a cut or other wound. A low red blood cell count can lead to anemia (deficiency of red blood cells) and **fatigue**.

When a chemotherapy treatment takes a long time, the patient may prepare for it by wearing comfortable clothes. Bringing a book to read or a tape to listen to may help pass the time and ease the **stress** of receiving chemotherapy. Some patients bring a friend or family member to provide company and support during treatment.

Sometimes, patients taking chemotherapy drugs known to cause nausea are given medications called anti-emetics before chemotherapy is administered. Anti-emetic drugs help to lessen feelings of nausea. Two anti-nausea medications that may be used are Kytril and Zofran.

Other ways to prepare for chemotherapy and help lessen nausea are:

- regularly eat nutritious foods and drink lots of fluids
- eat and drink normally until about two hours before chemotherapy
- eat high carbohydrate, low-fat foods and avoid spicy foods

Aftercare

Tips for helping to control side effects after chemotherapy include:

- follow any instructions given by the doctor or nurse
- take all prescribed medications
- eat small amounts of bland foods
- drink lots of fluids
- get plenty of rest

Some patients find it helps to breathe fresh air or get mild **exercise**, such as taking a walk.

Risks

Chemotherapy drugs are toxic to normal cells as well as cancer cells. A dose that will destroy cancer cells will probably cause damage to some normal cells. Doctors adjust doses to do the least amount of harm possible to normal cells. Some patients feel few or no side effects, and others may have more serious side effects. In some cases, a dose adjustment is all that is needed to reduce or stop a side effect.

Some chemotherapy drugs have more side effects than others. Some of the most common side effects are:

- **nausea and vomiting**
- loss of appetite
- hair loss
- anemia and fatigue
- infection
- easy bleeding or bruising
- sores in the mouth and throat
- neuropathy and other damage to the nervous system
- kidney damage

Nausea and vomiting are common, but can usually be controlled by taking **antinausea drugs**, drinking enough fluids, and avoiding spicy foods. Loss of appetite may be due to nausea or the stress of undergoing cancer treatment.

Some chemotherapy drugs cause hair loss, but it is almost always temporary.

Low blood cell counts caused by the effect of chemotherapy on the bone marrow can lead to anemia, infections, and easy bleeding and bruising. Patients with anemia have too few red blood cells to deliver oxygen and nutrients to the body's tissues. Anemic patients feel tired and weak. If red blood cell levels fall too low, a blood **transfusion** may be given.

Patients receiving chemotherapy are more likely to get infections. This happens because their infection-fighting white blood cells are reduced. It is important to take measures to avoid getting infections. When the white blood cell count drops too low, the doctor may prescribe medications called colony stimulating factors that help white blood cells grow. Neupogen and Leukine are two colony stimulants used as treatments to help fight infection.

Platelets are blood cells that make the blood clot. When patients do not have enough platelets, they may bleed or bruise easily, even from small injuries. Patients with low blood platelets should take precautions to avoid injuries. Medicines such as **aspirin** and other **pain** relievers can affect platelets and slow down the clotting process.

Chemotherapy can cause irritation and dryness in the mouth and throat. Painful sores may form that can bleed and become infected. Precautions to avoid this side effect include getting dental care before chemotherapy begins, brushing the teeth and gums regularly with a soft brush, and avoiding mouth washes that contain salt or alcohol.

Normal results

The main goal of chemotherapy is to cure cancer. Many cancers are cured by chemotherapy. It may be used in combination with surgery to keep a cancer from spread-

KEY TERMS

Adjuvant therapy—Treatment given after surgery or radiation therapy to prevent the cancer from coming back.

Alkaloid—A type of chemical commonly found in plants and often having medicinal properties.

Alykylating drug—A drug that kills cells by directly damaging DNA.

Antiemetic—A medicine that helps control nausea; also called an anti-nausea drug.

Antimetabolite—A drug that interferes with a cell's growth or ability to multiply.

Platelets—Blood cells that function in blood clotting.

ing to other parts of the body. Some widespread, fast-growing cancers are more difficult to treat. In these cases, chemotherapy may slow the growth of the cancer cells.

Doctors can tell if the chemotherapy is working by the results of medical tests. **Physical examination**, blood tests, and x rays are all used to check the effects of treatment on the cancer.

The possible outcomes of chemotherapy are:

- Complete remission or response. The cancer completely disappears. The course of chemotherapy is completed and the patient is tested regularly for a recurrence.
- Partial remission or response. The cancer shrinks in size but does not disappear. The same chemotherapy may be continued or a different combination of drugs may be tried.
- Stabilization. The cancer does not grow or shrink. Other therapy options may be explored. A tumor may stay stabilized for many years.
- Progression. The cancer continues to grow. Other therapy options may be explored.
- A secondary malignancy may develop from the one being treated, and that second cancer may need additional chemotherapy or other treatment.

Resources

BOOKS

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Drum, David. *Making the Chemotherapy Decision*. Los Angeles: Lowell House, 1996.

McKay, Judith, and Nancee Hirano. *The Chemotherapy Survival Guide*. Oakland, CA: New Harbinger Publications, 1993.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

OTHER

"Introduction to Chemotherapy." *OncoLink*. University of Pennsylvania Cancer Center. 1998 <http://www.oncolink.upenn.edu>.

"What is Chemotherapy?" *OncoLink*. University of Pennsylvania Cancer Center. 1998 <http://www.oncolink.upenn.edu>.

Toni Rizzo

Chest drainage therapy

Definition

Chest drainage therapy involves the removal of air, blood, pus, or other secretions from the chest cavity.

Purpose

Chest drainage therapy is done to relieve pressure on the lungs, and remove fluid that could promote infection. Installing a chest drainage tube can be either an emergency or a planned procedure.

Removing air or fluids from the chest involves the insertion of a tube through the skin and the muscles between the ribs, and into the chest cavity. This cavity is also called the pleural space. Insertion of this tube is called thoracostomy, and chest drainage therapy is sometimes called thoracostomy tube drainage.

Conditions that may need to be treated by chest drainage therapy include **emphysema** (air in the tissues of the lungs), **tuberculosis**, and spontaneous **pneumothorax** (air in the chest cavity) that causes more than a 25% collapse of the lung. Other conditions include **cancer** that causes excessive secretions, **empyema** (pus in the thoracic cavity), or hemothorax (blood in the thoracic cavity). Almost all chest drainage therapy is done to drain blood from the chest cavity after lung or heart surgery. In cases where the lung is collapsed, removing fluids by chest drainage therapy allows the lung to reinflate.

Oftentimes an x ray is performed prior to treatment to determine whether the problem is either fluid or air in

KEY TERMS

Empyema—Pus in the pleural cavity.

Hemothorax—Blood in the pleural cavity.

Pleural cavity—The area of the chest that includes the lining of the chest cavity, the space the lungs are located in, and the membrane covering of the lungs.

Spontaneous pneumothorax—Air in the chest cavity that occurs because of disease or other naturally occurring cause. Air and blood together in this space is called a pneumohemothorax.

the pleural space. Sometimes a procedure called **thoracentesis** is performed in an effort to avoid inserting a chest drainage tube. In this procedure a needle with a catheter is inserted into the pleural space and fluid is removed. When fluid continues to accumulate, chest drainage therapy is usually the next step. This is especially true when there is a lung infection underlying the fluid build-up.

Precautions

Chest drainage therapy is not done if a collapsed lung is not life-threatening. It also should be avoided for patients who have blood clotting problems.

Description

Most patients are awake when the chest drainage tube is inserted. They are given a sedative and a local anesthetic. Chest drainage tubes are usually inserted between the ribs. The exact location depends on the type of material to be drained and its location in the lungs.

An incision is made in the skin and through the muscles between the ribs. A chest tube is inserted and secured in place. The doctor connects one end of the tube to the chest drainage system.

The chest drainage system must remain sealed to prevent air from entering the chest cavity through the tube. One commonly used system is a water-seal drainage system, comprised of three compartments that collect and drain the fluid or air without allowing air to backflow into the tube. An alternative to this system is to connect the tube to a negative suction pump.

Once the tube and drainage system are in place, a chest x ray is done to confirm that the tube is in the right location, and that it is working. In some cases it may be necessary to insert more than one tube to drain localized pockets of fluid that have accumulated.

Preparation

A chest x ray is usually done before the chest drainage tube is inserted. Sometimes fluid becomes trapped in isolated spaces in the lung, and it is necessary to do an ultrasound to determine where to locate the drainage tube. **Computed tomography scans** (CT) are useful in locating small pockets of fluids caused by cancer or tuberculosis.

Aftercare

Normally after the material has been removed from the chest cavity and the situation is resolved, the chest drainage tube is removed. In cases where the reason for the tube was air in the pleural cavity, the tube is clamped and left in place several hours before it is removed to make sure no more air is leaking into the space. If the patient is on mechanical ventilation, the tube is often left in place until a respirator is no longer necessary. Chest drainage therapy is usually done in conjunction with treating the underlying cause of the fluid build-up.

The fluid that has been drained is examined for bacterial growth, cancer cells, pus, and blood—to determine the underlying cause of the condition and appropriate treatment.

Risks

Problems can arise in the insertion of the tube if the membrane lining the chest cavity is thick or if it has many adhesions. The tube will not drain correctly if the chest cavity contains blood clots or thick secretions that are often associated with infections. Excessive bleeding may occur during the insertion and positioning of the tube. Infection may result from the procedure. **Pain** is also a common complication.

Normal results

The gas, pus, or blood is drained from the chest cavity, and the lungs reinflate or begin to function more efficiently. The site at which the tube was inserted heals normally.

Resources

BOOKS

"Chest Drainage Therapy." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Thoracostomy Tube Drainage." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Tish Davidson

Chest pain *see* **Angina**

Chest physical therapy

Definition

Chest physical therapy is the term for a group of treatments designed to improve respiratory efficiency, promote expansion of the lungs, strengthen respiratory muscles, and eliminate secretions from the respiratory system.

Purpose

The purpose of chest physical therapy, also called chest physiotherapy, is to help patients breathe more freely and to get more oxygen into the body. Chest physical therapy includes postural drainage, chest percussion, chest vibration, turning, deep breathing exercises, and coughing. It is usually done in conjunction with other treatments to rid the airways of secretions. These other treatments include suctioning, nebulizer treatments, and the administration of expectorant drugs.

Chest physical therapy can be used with newborns, infants, children, and adults. People who benefit from chest physical therapy exhibit a wide range of problems that make it difficult to clear secretions from their lungs. Some people who may receive chest physical therapy include people with **cystic fibrosis** or neuromuscular diseases like **Guillain-Barré syndrome**, progressive muscle weakness (**myasthenia gravis**), or **tetanus**. People with lung diseases such as **bronchitis**, **pneumonia**, or chronic obstructive pulmonary disease (COPD) also benefit from chest physical therapy. People who are likely to aspirate their mucous secretions because of diseases such as **cerebral palsy** or **muscular dystrophy** also receive chest physical therapy, as do some people who are bedridden, confined to a wheelchair, or who cannot breathe deeply because of postoperative **pain**.

Precautions

Chest physical therapy should not be performed on people with

- bleeding from the lungs
- neck or head injuries
- fractured ribs
- collapsed lungs
- damaged chest walls
- tuberculosis
- acute asthma
- recent heart attack
- pulmonary embolism
- lung **abscess**
- active hemorrhage
- some spine injuries
- recent surgery, open **wounds**, or **burns**

Description

Chest physical therapy can be performed in a variety of settings including critical care units, hospitals, nursing homes, outpatient clinics, and at the patient's home. Depending on the circumstances, chest physical therapy may be performed by anyone from a respiratory care therapist to a trained member of the patient's family. Different patient conditions warrant different levels of training.

Chest physical therapy consists of a variety of procedures that are applied depending on the patient's health and condition. Hospitalized patients are reevaluated frequently to establish which procedures are most effective and best tolerated. Patients receiving long term chest physical therapy are reevaluated about every three months.

Turning

Turning from side to side permits lung expansion. Patients may turn themselves or be turned by a caregiver. The head of the bed is also elevated to promote drainage if the patient can tolerate this position. Critically ill patients and those dependent on mechanical respiration are turned once every one to two hours around the clock.

Coughing

Coughing helps break up secretions in the lungs so that the mucus can be suctioned out or expectorated. Patients sit upright and inhale deeply through the nose. They then exhale in short puffs or coughs. Coughing is repeated several times a day.

Deep breathing

Deep breathing helps expand the lungs and forces better distribution of the air into all sections of the lung. The patient either sits in a chair or sits upright in bed and inhales, pushing the abdomen out to force maximum amounts of air into the lung. The abdomen is then contracted, and the patient exhales. Deep breathing exercises are done several times each day for short periods.

KEY TERMS

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Percussion—This consists of rhythmically striking the chest wall with cupped hands. It is also called cupping, clapping, or tapotement. The purpose of percussion is to break up thick secretions in the lungs so that they can be more easily removed. Percussion is performed on each lung segment for one to two minutes at a time.

Postural drainage—This technique uses the force of gravity to assist in effectively draining secretions from the lungs and into the central airway where they can either be coughed up or suctioned out. The patient is placed in a head or chest down position and is kept in this position for up to 15 minutes. Critical care patients and those depending on mechanical ventilation receive postural draingage therapy four to six times daily. Percussion and vibration may be performed in conjunction with postural drainage.

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Vibration—The purpose of vibration is to help break up lung secretions. Vibration can be either mechanical or manual. It is performed as the patient breathes deeply. When done manually, the person performing the vibration places his or her hands against the patient's chest and creates vibrations by quickly contracting and relaxing arm and shoulder muscles while the patient exhales. The procedure is repeated several times each day for about five exhalations.

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Preparation

The only preparation needed for chest physical therapy is an evaluation of the patient's condition and determination of which chest physical therapy techniques would be most beneficial.

Aftercare

Patients practice **oral hygiene** procedures to lessen the bad taste or odor of the secretions they spit out.

Risks

Risks and complications associated with chest physical therapy depend on the health of the patient. Although

chest physical therapy usually poses few problems, in some patients it may cause

- oxygen deficiency if the head is kept lowered for drainage
- increased intracranial pressure
- temporary low blood pressure
- bleeding in the lungs
- pain or injury to the ribs, muscles, or spine
- vomiting
- inhaling secretions into the lungs
- heart irregularities

Normal results

The patient is considered to be responding positively to chest physical therapy if some, but not necessarily all, of these changes occur:

- increased volume of sputum secretions
- changes in breath sounds
- improved vital signs
- improved chest x ray
- increased oxygen in the blood as measured by arterial blood gas values
- patient reports of eased breathing

Resources

PERIODICALS

"AARC Clinical Practical Guideline: Postural Drainage." *Respiratory Care* 36 (1991): 1418-1426.

ORGANIZATIONS

Cystic Fibrosis Foundation. 6931 Arlington Road, Bethesda, MD 20814. (800) 344-4823. <http://www.cff.org>.

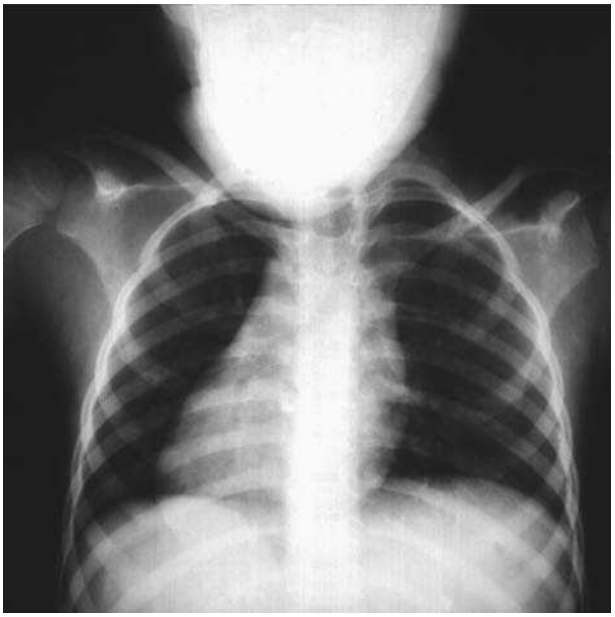
Tish Davidson

Chest radiography *see* **Chest x ray**

Chest x ray

Definition

A chest x ray is a procedure used to evaluate organs and structures within the chest for symptoms of disease. Chest x rays include views of the lungs, heart, small portions of the gastrointestinal tract, thyroid gland and the bones of the chest area. X rays are a form of radiation that can penetrate the body and produce an image on an x-ray film. Another name for x ray is radiograph.



A normal chest x ray of a child. (*Photograph by Peter Berndt, M.D., P.A, Custom Medical Stock Photo. Reproduced by permission.)*

Purpose

Chest x rays are ordered for a wide variety of diagnostic purposes. In fact, this is probably the most frequently performed x ray. In some cases, chest x rays are ordered for a single check of an organ's condition, and at other times, serial x rays are ordered to compare to previous studies. Some common reasons for chest x rays include:

Pulmonary disorders

Chest films are frequently ordered to diagnose or rule out **pneumonia**. Other pulmonary disorders such as **emphysema** or **pneumothorax** (presence of air or gas in the chest cavity outside the lungs) may be detected or evaluated through the use of chest x ray.

Cancer

A chest x ray may be ordered by a physician to check for possible tumors of the lungs, thyroid, lymphoid tissue, or bones of the thorax. These may be primary tumors. X rays also check for secondary spread of **cancer** from one organ to another.

Cardiac disorders

While less sensitive than **echocardiography**, chest x ray can be used to check for disorders such as congestive **heart failure** or **pulmonary edema**.

KEY TERMS

Bronchi—Plural of bronchus. The air passages in the lungs through which inhaled air passes on its way to the lungs.

Diaphragm—The large muscle that is located between the abdomen and the chest area. The diaphragm aids in breathing.

Gastrointestinal—The digestive organs and structures, including the stomach and intestines.

Interstitial lung disease—About 180 diseases fall into this category of breathing disorders. Injury or foreign substances in the lungs, (such as asbestos fibers) as well as infections, cancers, or inherited disorders may cause the diseases. They can lead to breathing or heart failure.

Lymphoid—Tissues relating to the lymphatic system. A thin, yellowish fluid, called lymph fluid, travels throughout the body. The lymphatic system helps control fluids in the body.

Portable chest x ray—An x ray procedure taken by equipment that can be brought to the patient. The resulting radiographs may not be as high in quality as stationary x ray radiographs, but allow a technologist to come to the bedridden patient.

Pulmonary—Refers to the lungs and the breathing system and function.

Serial x rays—A number of x rays performed at set times in the disease progression or treatment intervals. The radiographs will be compared to one another to track changes.

Sternum—Also referred to as the breast bone, this is the long flat bone in the middle of the chest.

Thorax—The chest area, which runs between the abdomen and neck and is encased in the ribs.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

Other

Tuberculosis can be observed on chest x rays, as can cardiac disease and damage to the ribs or lungs. Chest x rays are used to see foreign bodies that may have been swallowed or inhaled, and to evaluate response to treatment for various diseases. Often the chest x ray is also used to verify correct placement of chest tubes or catheters.

Precautions

Pregnant women, particularly those in the first or second trimester, should not have chest x rays unless absolutely necessary. If the exam is ordered, women who are, or could possibly be, pregnant must wear a protective lead apron. Because the procedure involves radiation, care should always be taken to avoid overexposure, particularly for children. However, the amount of radiation from one chest x ray procedure is minimal.

Description

Routine chest x rays consist of two views, the frontal view (referred to as posterioranterior or PA), and the lateral (side) view. It is preferred that the patient stand for this exam, particularly when studying collection of fluid in the lungs.

During the actual time of exposure, the technologist will ask the patient to hold his or her breath. It is very important in taking a chest x ray to ensure there is no motion that could detract from the quality and sharpness of the film image. The procedure will only take a few minutes and the time patients must hold their breaths is a matter of a few seconds.

The chest x ray may be performed in a physician's office or referred to an outpatient radiology facility or hospital radiology department. In some cases, particularly for bedridden patients, a portable chest x ray may be taken. Portable films are sometimes of poorer quality than those taken with permanent equipment, but are the best choice for some patients or situations. Bedridden patients may be placed in as upright a position as possible to get a clear picture, particularly of chest fluid.

Preparation

There is no advance preparation necessary for chest x rays. Once the patient arrives at the exam area, a hospital gown will replace all clothing on the upper body and all jewelry must be removed.

Aftercare

No aftercare is required by patients who have chest x rays.

Risks

The only risk associated with chest x ray is minimal exposure to radiation, particularly for pregnant women and children. Those patients should use protective lead aprons during the procedure. Technologists are cautioned to carefully check possible dislodging of any tubes or

monitors in the chest area from the patient's placement during the exam.

Normal results

A radiologist, or physician specially trained in the technique and interpretation of x rays, will evaluate the results. A normal chest x ray will show normal structures for the age and medical history or the patient. Findings, whether normal or abnormal, will be provided to the referring physician in the form of a written report.

Abnormal results

Abnormal findings on chest x rays are used in conjunction with a physician's physical exam findings, patient medical history and other diagnostic tests to reach a final diagnosis. For many diseases, chest x rays are more effective when compared to previous chest studies. The patient is asked to help the radiology facility in locating previous chest radiographs from other facilities.

Pulmonary disorders

Pneumonia shows up on radiographs as patches and irregular areas of density (from fluid in the lungs). If the bronchi, which are usually not visible, can be seen, a diagnosis of bronchial pneumonia may be made. Shifts or shadows in the hila (lung roots) may indicate emphysema or a pulmonary **abscess**. Widening of the spaces between ribs suggests emphysema. Other pulmonary diseases may also be detected or suspected through chest x ray.

Cancer

In nearly all patients with lung cancer, some sort of abnormality can be seen on a chest radiograph. Hilar masses (enlargements at that part of the lungs where vessels and nerves enter) are one of the more common symptoms as are abnormal masses and fluid buildup on the outside surface of the lungs or surrounding areas. Interstitial lung disease, which is a large category of disorders, many of which are related to exposure of substances (such as asbestos fibers), may be detected on a chest x ray as fiberlike deposits, often in the lower portions of the lungs.

Other

Congestive heart failure and other cardiac diseases may be indicated on the view of a heart and lung in a chest radiograph. **Fractures** of the sternum and ribs are usually easily detected as breaks on the chest x ray. In some instances, the radiologist's view of the diaphragm may indicate an abdominal problem. Tuberculosis can also be indicated by elevation of the diaphragm. Foreign bodies which may have been swallowed or inhaled can usually be located by the radiologist as they will look different from any other tissue or structure in the chest. Serial chest x rays may be ordered to track changes over a period of time.

Resources

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Emphysema Anonymous, Inc. P.O. Box 3224, Seminole, FL 34642. (813)391-9977.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris, RN

Chickenpox

Definition

Chickenpox (also called varicella) is a common and extremely infectious childhood disease that also affects adults on occasion. It produces an itchy, blistery rash that typically lasts about a week and is sometimes accompanied by a **fever** or other symptoms. A single attack of chickenpox almost always confers lifelong immunity against the disease. Because the symptoms of chickenpox are easily recognized and in most cases merely unpleasant rather than dangerous, treatment can almost always be carried out at home. Severe complications can develop, however, and professional medical attention is essential in some circumstances.

Description

Before the varicella vaccine (Varivax) was released for use in 1995, virtually all of the four million children born each year in the United States contracted chickenpox, resulting in hospitalization in five of every 1,000 cases and 100 deaths. Chickenpox is caused by the varicella-zoster virus (a member of the herpes virus family), which is spread through the air or by direct contact with an infected person. Once someone has been infected with the virus, an incubation period of about 10–21 days passes before symptoms begin. The period during which infected people are able to spread the disease is believed to start one or two days before the rash breaks out and to continue until all the blisters have formed scabs, which usually happens fout to seven days after the rash breaks

out but may be longer in adolescents and adults. For this reason, doctors recommend keeping children with chickenpox away from school for about a week. It is not necessary, however, to wait until all the scabs have fallen off.

Chickenpox has been a typical part of growing up for most children in the industrialized world (although this may change if the new varicella vaccine becomes more widely accepted). The disease can strike at any age, but by ages nine or 10 about 80–90% of American children have already been infected. U.S. children living in rural areas and many foreign-born children are less likely to be immune. Because almost every case of chickenpox, no matter how mild, leads to lifelong protection against further attacks, adults account for less than 5% of all cases in the United States. Study results reported by the Centers for Disease Control and Prevention (CDC) indicate that more than 90% of American adults are immune to the chickenpox virus. Adults, however, are much more likely than children to suffer dangerous complications. More than half of all chickenpox deaths occur among adults.

Causes and symptoms

A case of chickenpox usually starts without warning or with only a mild fever and a slight feeling of unwellness. Within a few hours or days small red spots begin to appear on the scalp, neck, or upper half of the trunk. After a further 12–24 hours the spots typically become itchy, fluid-filled bumps called vesicles, which continue to appear in crops for the next two to five days. In any area of skin, lesions of a variety of stages can be seen. These blisters can spread to cover much of the skin, and in some cases may also be found inside the mouth, nose, ears, vagina, or rectum. Some people develop only a few blisters, but in most cases the number reaches 250–500. The blisters soon begin to form scabs and fall off. Scarring usually does not occur unless the blisters have been scratched and become infected. Occasionally a minor and temporary darkening of the skin (called **hyperpigmentation**) is noticed around some of the blisters. The degree of itchiness can range from barely noticeable to extreme. Some chickenpox sufferers also have headaches, abdominal **pain**, or a fever. Full recovery usually takes five to 10 days after the first symptoms appear. Again, the most severe cases of the disease tend to be found among older children and adults.

Although for most people chickenpox is no more than a matter of a few days' discomfort, some groups are at risk for developing complications, the most common of which are bacterial infections of the blisters, **pneumonia**, **dehydration**, **encephalitis**, and hepatitis:

- Infants. Complications occur much more often among children less than one year old than among older children. The threat is greatest to newborns, who are more at risk of **death** from chickenpox than any other group. Under certain circumstances, children born to mothers who contract chickenpox just prior to delivery face an increased possibility of dangerous consequences, including brain damage and death. If the infection occurs during early **pregnancy**, there is a small (less than 5%) risk of congenital abnormalities.
- Immunocompromised children. Children whose immune systems have been weakened by a genetic disorder, disease, or medical treatment usually experience the most severe symptoms of any group. They have the second-highest rate of death from chickenpox.
- Adults and children 15 and older. Among this group, the typical symptoms of chickenpox tend to strike with greater force, and the risk of complications is much higher than among young children.

Immediate medical help should always be sought when anyone in these high-risk groups contracts the disease.

Diagnosis

Where children are concerned, especially those with recent exposure to the disease, diagnosis can usually be made at home, by a school nurse, or by a doctor over the telephone if the child's parent or caregiver is unsure that the disease is chickenpox.

A doctor should be called immediately if:

- The child's fever goes above 102°F (38.9°C) or takes more than four days to disappear.
- The child's blisters appear infected. Signs of infection include leakage of pus from the blisters or excessive redness, warmth, tenderness, or swelling around the blisters.
- The child seems nervous, confused, unresponsive, or unusually sleepy; complains of a stiff neck or severe **headache**; shows signs of poor balance or has trouble walking; finds bright lights hard to look at; is having breathing problems or is coughing a lot; is complaining of chest pain; is vomiting repeatedly; or is having convulsions. These may be signs of **Reye's syndrome** or encephalitis, two rare but potentially very dangerous conditions.

Treatment

With children, treatment usually takes place in the home and focuses on reducing discomfort and fever. Because chickenpox is a viral disease, **antibiotics** are ineffective against it.

Applying wet compresses or bathing the child in cool or lukewarm water once a day can help the itch. Adding

four to eight ounces of baking soda or one or two cups of oatmeal to the bath is a good idea (oatmeal bath packets are sold by pharmacies). Only mild soap should be used in the bath. Patting, not rubbing, is recommended for drying the child off, to prevent irritating the blisters. Calamine lotion (and some other kinds of lotions) also help to reduce itchiness. Because scratching can cause blisters to become infected and lead to scarring, the child's nails should be cut short. Of course, older children need to be warned not to scratch. For babies, light mittens or socks on the hands can help guard against scratching.

If mouth blisters make eating or drinking an unpleasant experience, cold drinks and soft, bland foods can ease the child's discomfort. Painful genital blisters can be treated with an anesthetic cream recommended by a doctor or pharmacist. Antibiotics are often prescribed if blisters become infected.

Fever and discomfort can be reduced by **acetaminophen** or another medication that does not contain **aspirin**. *Aspirin and any medications that contain aspirin or other salicylates must not be used with chickenpox, for they appear to increase the chances of developing Reye's syndrome.* The best idea is to consult a doctor or pharmacist if one is unsure about which medications are safe.

Immunocompromised chickenpox sufferers are sometimes given an antiviral drug called acyclovir (Zovirax). Studies have shown that Zovirax also lessens the symptoms of otherwise healthy children and adults who contract chickenpox, but the suggestion that it should be used to treat the disease among the general population, especially in children, is controversial.

A five-year-old girl with chickenpox. The first symptom of the disease is the rash that is evident on the girl's back and neck. The rash and the mild fever that accompanies it should disappear in a week or two. *(Photograph by Jim Selby, Photo Researchers, Inc. Reproduced by permission.)*

Alternative treatment

Alternative practitioners seek to lessen the discomfort and fever caused by chickenpox. Like other practitioners, they suggest cool or lukewarm baths. Rolled oats (*Avena sativa*) in the bath water help relieve **itching**. (Place oats in a sock, run the bath, turn the sock to release the milky anti-itch properties.) Other recommended remedies for itching include applying aloe vera, witch hazel, or herbal preparations of rosemary (*Rosmarinus officinalis*) and calendula (*Calendual officinalis*) to the blisters. Homeopathic remedies are selected on a case by case basis. Some common remedy choices are tartar emetic (antimonium tartaricum), windflower (pulsatilla), poison ivy (*Rhus toxicodendron*), and sulphur.

Prognosis

Most cases of chickenpox run their course within a week without causing lasting harm. However, there is one long-term consequence of chickenpox that strikes about 20% of the population, particularly people 50 and older. Like all herpes viruses, the varicella-zoster virus never leaves the body after an episode of chickenpox, but lies dormant in the nerve cells, where it may be reactivated years later by disease or age-related weakening of the immune system. The result is **shingles** (also called herpes zoster), a very painful nerve inflammation, accompanied by a rash, that usually affects the trunk or the face for 10 days or more. Especially in the elderly, pain, called postherpetic **neuralgia**, may persist at the site of the shingles for months or years. As of 1998, two newer drugs for treatment of shingles are available. Both valacyclovir (Valtrex) and famciclovir (Famvir) stop the replication of herpes zoster when administered within 72 hours of appearance of the rash. The effectiveness of these two drugs in immunocompromised patients has not

KEY TERMS

Acetaminophen—A drug for relieving pain and fever. Tylenol is the most common example.

Acyclovir—An antiviral drug used for combating chickenpox and other herpes viruses. Sold under the name Zovirax.

Dehydration—Excessive water loss by the body.

Encephalitis—A disease that inflames the brain.

Hepatitis—A disease that inflames the liver.

Immune system—A biochemical complex that protects the body against pathogenic organisms and other foreign bodies.

Immunocompromised—Having a damaged immune system.

Pneumonia—A disease that inflames the lungs.

Pus—A thick yellowish or greenish fluid containing inflammatory cells. Usually caused by bacterial infection.

Reye's syndrome—A rare but often fatal disease that involves the brain, liver, and kidneys.

Salicylates—Substances containing salicylic acid, which are used for relieving pain and fever. Aspirin is the most common example.

Shingles—A disease (also called herpes zoster) that causes a rash and a very painful nerve inflammation. An attack of chickenpox will eventually give rise to shingles in about 20% of the population.

Trunk—That part of the body that does not include the head, arms, and legs.

Varicella-zoster immune globulin (VZIG)—A substance that can reduce the severity of chickenpox symptoms.

Varicella-zoster virus—The virus that causes chickenpox and shingles.

Varivax—A vaccine for the prevention of chickenpox.

Virus—A tiny particle that can cause infections by duplicating itself inside a cell using the cell's own software. Antibiotics are ineffective against viruses, though antiviral drugs exist for some viruses, including chickenpox.

been established, and Famvir is not recommended for patients under 18 years, as of 1998.

Prevention

A substance known as varicella-zoster immune globulin (VZIG), which reduces the severity of chickenpox symptoms, is available to treat immunocompromised children and others at high risk of developing complications. It is administered by injection within 96 hours of known or suspected exposure to the disease and is not useful after that. VZIG is produced as a gamma globulin from blood of recently infected individuals.

A vaccine for chickenpox became available in the United States in 1995 under the name Varivax. Varivax is a live, attenuated (weakened) virus vaccine. It has been proven to be 85% effective for preventing all cases of chickenpox and close to 100% effective in preventing severe cases. Side effects are normally limited to occasional soreness or redness at the injection site. CDC guidelines state that the vaccine should be given to all children (with the exception of certain high-risk groups) at 12–18 months of age, preferably when they receive their measles-mumps-rubella vaccine. For older children, up to age 12, the CDC recommends **vaccination** when a reliable determination that the child in question has already had chickenpox cannot be made. Vaccination is also recommended for any older child or adult considered susceptible to the disease, particularly those, such as health care workers and women of childbearing age, who face a greater likelihood of severe illness or transmitting infection. A single dose of the vaccine is sufficient for children up to age 12; older children and adults receive a second dose four to eight weeks later. In 1997 the cost of two adult doses of the vaccine in the United States was about $80. Although this cost was not always covered by health insurance plans, children up to age 18 without access to the appropriate coverage could be vaccinated free of charge through the federal Vaccines for Children program. Varivax is not given to patients who already have overt signs of the disease. The vaccine is also not recommended for those women who are pregnant, or they should delay pregnancy for three months following a complete vaccination. The vaccine is useful when given early after exposure to chickenpox and, if given in the midst of the incubation period, it can be preventative. The Infectious Diseases Society of America stated in

2000 that immunization is recommended for all adults who have never had chickenpox.

While there was initial concern regarding the vaccine's safety and effectiveness when first released, the vaccination is gaining acceptance as numerous states require it for admittance into day care or public school. In 2000, 59% of toddlers in the United States were immunized; up from 43.2% in 1998. A study published in 2001 indicates that the varicella vaccine is highly effective when used in clinical practice. Although evidence has not ruled out a booster shot later in life, all research addressing the vaccine's effectiveness throughout its six-year use indicates that chickenpox may be the first human herpesvirus to be wiped out. Although initial concerns questioned if the vaccination might make shingles more likely, studies are beginning to show the effectiveness of the vaccine in reducing cases of that disease.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Puyallup, WA: Future Medicine Publishing, 1993.

Pattishall, Evan G., III. "Chickenpox." In *Primary Pediatric Care,* edited by Robert A. Hoekelman, et al. St. Louis: Mosby, 1997.

PERIODICALS

Arvin, Ann M. "Varicella Vaccine—The First Six Years." *New England Journal of Medicine* 344, no. 13 (March 2001).

Henderson, C. W. "Chickenpox Immunization Confirmed Effective in Adults." *Vaccine Weekly* (September 2000): 22.

Shapiro, Eugene D., and Phillip S. LaRussa. "Vaccination for Varicella—Just Do It!" *Journal of the American Medical Association* 278 (1997): 1529-1530.

ORGANIZATION

Centers for Disease Control and Prevention. National Immunization Hotline. 1600 Clifton Rd. NE, Atlanta, GA 30333. (800) 232-2522 (English). (800) 232-0233 (Spanish). <http://www.cdc.gov>.

OTHER

ABCNEWS.com. "Varicella Vaccine: States Mandate Chickenpox Immunization." 1 August 2000. <http://abcnews.go.com/sections/living/DailyNews/chickenpox_vaccine0802.html>. (3 May 2001).

Centers for Disease Control and Prevention. "Prevention of Varicella: Recommendations of the Advisory Committee on Immunization Practices (ACIP)." 12 July 1996. <http://aepo-xdv-www.epo.cdc.gov/wonder/prevguid/m0042990/entire.htm>. (12 December 1997).

Beth Kapes

Child abuse

Definition

Child **abuse** is the blanket term for four types of child mistreatment: physical abuse, sexual abuse, emotional abuse, and neglect. In many cases children are the victims of more than one type of abuse. The abusers can be parents or other family members, caretakers such as teachers and babysitters, acquaintances (including other children), and (in rare instances) strangers.

Description

Prevalence of abuse

Child abuse was once viewed as a minor social problem affecting only a handful of United States children. However, in recent years it has received close attention from the media, law enforcement, and the helping professions, and with increased public and professional awareness has come a sharp rise in the number of reported cases. But because abuse is often hidden from view and its victims too young or fearful to speak out, experts suggest that its true prevalence is possibly much greater than the official data indicate. In 1996, more than three million victims of alleged abuse were reported to child protective services (CPS) agencies in the United States, and the reports were substantiated in more than one million cases. Put another way, 1.5% of the country's children were confirmed victims of abuse in 1996. Parents were the abusers in 77% of the confirmed cases, other relatives in 11%. Sexual abuse was more likely to be committed by males, whereas females were responsible for the majority of neglect cases. More than 1,000 United States children died from abuse in 1996.

Although experts are quick to point out that abuse occurs among all social, ethnic, and income groups, reported cases usually involve poor families with little education. Young mothers, single-parent families, and parental alcohol or drug abuse are also common in reported cases. Charles F. Johnson remarks, "More than 90% of abusing parents have neither psychotic nor criminal personalities. Rather they tend to be lonely, unhappy, angry, young, and single parents who do not plan their pregnancies, have little or no knowledge of child development, and have unrealistic expectations for child behavior." About 10%, or perhaps as many as 40%, of abusive parents were themselves physically abused as children, but most abused children do not grow up to be abusive parents.

Types of abuse

PHYSICAL ABUSE. Physical abuse is the nonaccidental infliction of physical injury to a child. The abuser is

usually a family member or other caretaker, and is more likely to be male. In 1996, 24% of the confirmed cases of United States child abuse involved physical abuse.

A rare form of physical abuse is **Munchausen syndrome** by proxy, in which a caretaker (most often the mother) seeks attention by making the child sick or appear to be sick.

SEXUAL ABUSE. Charles F. Johnson defines child sexual abuse as "any activity with a child, before the age of legal consent, that is for the sexual gratification of an adult or a significantly older child." It includes, among other things, sexual touching and penetration, persuading a child to expose his or her sexual organs, and allowing a child to view pornography. In most cases the child is related to or knows the abuser, and about one in five abusers are themselves underage. Sexual abuse was present in 12% of the confirmed 1996 abuse cases. An estimated 20–25% of females and 10–15% of males report that they were sexually abused by age 18.

EMOTIONAL ABUSE. Emotional abuse, according to Richard D. Krugman, "has been defined as the rejection, ignoring, criticizing, **isolation**, or terrorizing of children, all of which have the effect of eroding their self-esteem." Emotional abuse usually expresses itself in verbal attacks involving rejection, scapegoating, belittlement, and so forth. Because it often accompanies other types of abuse and is difficult to prove, it is rarely reported, and accounted for only 6% of the confirmed 1996 cases.

NEGLECT. Neglect—failure to satisfy a child's basic needs—can assume many forms. Physical neglect is the failure (beyond the constraints imposed by poverty) to provide adequate food, clothing, shelter, or supervision. Emotional neglect is the failure to satisfy a child's normal emotional needs, or behavior that damages a child's normal emotional and psychological development (such as permitting drug abuse in the home). Failing to see that a child receives proper schooling or medical care is also considered neglect. In 1996 neglect was the finding in 52% of the confirmed abuse cases.

Causes and symptoms

Physical abuse

The usual physical abuse scenario involves a parent who loses control and lashes out at a child. The trigger may be normal child behavior such as crying or dirtying a diaper. Unlike nonabusive parents, who may become angry at or upset with their children from time to time but are genuinely loving, abusive parents tend to harbor deep-rooted negative feelings toward their children.

Unexplained or suspicious **bruises** or other marks on the skin are typical signs of physical abuse, as are **burns**. Skull and other bone **fractures** are often seen in young abused children, and in fact, head injuries are the leading cause of **death** from abuse. Children less than one year old are particularly vulnerable to injury from shaking. This is called **shaken baby syndrome** or shaken impact syndrome. Not surprisingly, physical abuse also causes a wide variety of behavioral changes in children.

Sexual abuse

John M. Leventhal observes, "The two prerequisites for this form of maltreatment include sexual arousal to children and the willingness to act on this arousal. Factors that may contribute to this willingness include alcohol or drug abuse, poor impulse control, and a belief that the sexual behaviors are acceptable and not harmful to the child." The chances of abuse are higher if the child is developmentally handicapped or vulnerable in some other way.

Genital or anal injuries or abnormalities (including the presence of **sexually transmitted diseases**) can be signs of sexual abuse, but often there is no physical evidence for a doctor to find. In fact, physical examinations of children in cases of suspected sexual abuse supply grounds for further suspicion only 15–20% of the time. **Anxiety**, poor academic performance, and suicidal conduct are some of the behavioral signs of sexual abuse, but are also found in children suffering other kinds of **stress**. Excessive masturbation and other unusually sexualized kinds of behavior are more closely associated with sexual abuse itself.

Emotional abuse

Emotional abuse can happen in many settings: at home, at school, on sports teams, and so on. Some of the possible symptoms include loss of self-esteem, sleep disturbances, headaches or stomachaches, school avoidance, and running away from home.

Neglect

Many cases of neglect occur because the parent experiences strong negative feelings toward the child. At other times, the parent may truly care about the child, but lack the ability or strength to adequately provide for the child's needs because he or she is handicapped by depression, drug abuse, **mental retardation**, or some other problem.

Neglected children often do not receive adequate nourishment or emotional and mental stimulation. As a result, their physical, social, emotional, and mental development is hindered. They may, for instance, be

Child Abuse: Signs And Symptoms

Although these signs do not necessarily indicate that a child has been abused, they may help adults recognize that something is wrong. The possibility of abuse should be investigated if a child shows a number of these symptoms, or any of them to a marked degree:

Sexual Abuse

Being overly affectionate or knowledgeable in a sexual way inappropriate to the child's age
Medical problems such as chronic itching, pain in the genitals, venereal diseases
Other extreme reactions, such as depression, self-mutilation, suicide attempts, running away, overdoses, anorexia
Personality changes such as becoming insecure or clinging
Regressing to younger behavior patterns such as thumb sucking or bringing out discarded cuddly toys
Sudden loss of appetite or compulsive eating
Being isolated or withdrawn
Inability to concentrate
Lack of trust or fear someone they know well, such as not wanting to be alone with a babysitter
Starting to wet again, day or night/nightmares
Become worried about clothing being removed
Suddenly drawing sexually explicit pictures
Trying to be "ultra-good" or perfect; overreacting to criticism

Physical Abuse

Unexplained recurrent injuries or burns
Improbable excuses or refusal to explain injuries
Wearing clothes to cover injuries, even in hot weather
Refusal to undress for gym
Bald patches
Chronic running away
Fear of medical help or examination
Self-destructive tendencies
Aggression towards others
Fear of physical contact—shrinking back if touched
Admitting that they are punished, but the punishment is excessive (such as a child being beaten every night to "make him/her study")
Fear of suspected abuser being contacted

Emotional Abuse

Physical, mental, and emotional development lags
Sudden speech disorders
Continual self-depreciation ("I'm stupid, ugly, worthless, etc.")
Overreaction to mistakes
Extreme fear of any new situation
Inappropriate response to pain ("I deserve this")
Neurotic behavior (rocking, hair twisting, self-mutilation)
Extremes of passivity or aggression

Neglect

Constant hunger
Poor personal hygiene
No social relationships
Constant tiredness
Poor state of clothing
Compulsive scavenging
Emaciation
Untreated medical problems
Destructive tendencies

A child may be subjected to a combination of different kinds of abuse. It is also possible that a child may show no outward signs and hide what is happening from everyone.

underweight, develop language skills less quickly than other children, and seem emotionally needy.

Diagnosis

Doctors and many other professionals who work with children are required by law to report suspected abuse to their state's Child Protective Services (CPS) agency. Abuse investigations are often a group effort involving medical personnel, social workers, police officers, and others. Some hospitals and communities maintain child protection teams that respond to cases of possible abuse. Careful questioning of the parents is crucial, as is interviewing the child (if he or she is capable of being interviewed). The investigators must ensure, however, that their questioning does not further traumatize the child. A **physical examination** for signs of abuse or neglect is, of course, always

necessary, and may include x rays, blood tests, and other procedures.

Treatment

Notification of the appropriate authorities, treatment of the child's injuries, and protecting the child from further harm are the immediate priorities in abuse cases. If the child does not require hospital treatment, protection often involves placing him or her with relatives or in foster care. Once the immediate concerns are dealt with, it becomes essential to determine how the child's long-term medical, psychological, educational, and other needs can best be met, a process that involves evaluating not only the child's needs but also the family's (such as for drug abuse counseling or parental skills training). If the child has brothers or sisters, the authorities must determine whether they have been abused as well. On investigation, signs of physical abuse are discovered in about 20% of the brothers and sisters of abused children.

Prognosis

Child abuse can have lifelong consequences. Research shows that abused children and adolescents are more likely, for instance, to do poorly in school, suffer emotional problems, develop an antisocial personality, become promiscuous, abuse drugs and alcohol, and attempt suicide. As adults they often have trouble establishing intimate relationships. Whether professional treatment is able to moderate the long-term psychological effects of abuse is a question that remains unanswered.

Prevention

Government efforts to prevent abuse include home-visitor programs aimed at high-risk families and school-based efforts to teach children how to respond to attempted sexual abuse. Emotional abuse prevention has been promoted through the media.

When children reach age three, parents should begin teaching them about "bad touches" and about confiding in a suitable adult if they are touched or treated in a way that makes them uneasy. Parents also need to exercise caution in hiring babysitters and other caretakers. Anyone who suspects abuse should immediately report those suspicions to the police or his or her local CPS agency, which will usually be listed in the blue pages of the telephone book under Rehabilitative Services or Child and Family Services, or in the yellow pages. Round-the-clock crisis counseling for children and adults is offered by the Childhelp USA/IOF Foresters National Child Abuse Hotline. The National Committee to Prevent Child Abuse is an excellent source of information on the many support groups and other organizations that help abused and at-risk children and their families. One of these organizations, National Parents Anonymous, sponsors 2,100 local self-help groups throughout the United States, Canada, and Europe. Telephone numbers for its local groups are listed in the white pages of the telephone book under Parents Anonymous or can be obtained by calling the national headquarters.

Resources

BOOKS

Johnson, Charles F. "Abuse and Neglect of Children." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Krugman, Richard D. "Child Abuse & Neglect." In *Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Leventhal, John M. "Child Maltreatment: Neglect to Abuse." In *Rudolph's Pediatric*, ed. Abraham M. Rudolph, et al. Stamford: Appleton & Lange, 1996.

ORGANIZATIONS

Childhelp USA/IOF Foresters National Child Abuse Hotline. (800) 422-4453.

National Clearinghouse on Child Abuse and Neglect Information. P.O. Box 1182, Washington, DC 20013-1182. (800) 394-3366. <http://www.calib.com/nccanch>.

National Committee to Prevent Child Abuse. 200 S. Michigan Ave., 17th Floor, Chicago, IL 60604. (312) 663-3520. <http://www.childabuse.org>.

National Parents Anonymous. 675 W. Foothill Blvd., Suite 220, Claremont, CA 91711. (909) 621-6184.

Howard Baker

Child development *see* **Children's health**

Child safety *see* **Children's health**

Childbirth

Definition

Childbirth includes both labor (the process of birth) and delivery (the birth itself); it refers to the entire process as an infant makes its way from the womb down the birth canal to the outside world.

Description

Childbirth usually begins spontaneously, following about 280 days after conception, but it may be started by artificial means if the **pregnancy** continues past 42

weeks gestation. The average length of labor is about 14 hours for a first pregnancy and about eight hours in subsequent pregnancies. However, many women experience a much longer or shorter labor.

Labor can be described in terms of a series of phases.

First stage of labor

During the first phase of labor, the cervix dilates (opens) from 0–10 cm. This phase has an early, or latent, phase and an active phase. During the latent phase, progress is usually very slow. It may take quite a while and many contractions before the cervix dilates the first few centimeters. Contractions increase in strength as labor progresses. Most women are relatively comfortable during the latent phase and walking around is encouraged, since it naturally stimulates the process.

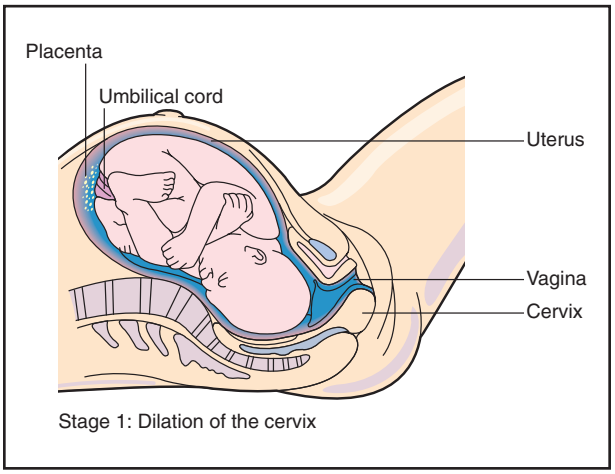
As labor begins, the muscular wall of the uterus begins to contract as the cervix relaxes and expands. As a portion of the amniotic sac surrounding the baby is pushed into the opening, it bursts under the pressure, releasing amniotic fluid. This is called "breaking the bag of waters."

During a contraction, the infant experiences intense pressure that pushes it against the cervix, eventually forcing the cervix to stretch open. At the same time, the contractions cause the cervix to thin. During this first stage, a woman's contractions occur more and more often and last longer and longer. The doctor or nurse will do a periodic **pelvic exam** to determine how the mother is progressing. If the contractions aren't forceful enough to open the cervix, a drug may be given to make the uterus contract.

As **pain** and discomfort increase, women may be tempted to request pain medication. If possible, though, administration of pain medication or anesthetics should be delayed until the active phase of labor begins—at which point the medication will not act to slow down or stop the labor.

The active stage of labor is faster and more efficient than the latent phase. In this phase, contractions are longer and more regular, usually occurring about every two minutes. These stronger contractions are also more painful. Women who use the breathing exercises learned in childbirth classes find that these can help cope with the pain experienced during this phase. Many women also receive some pain medication at this point—either a short-term medication, such as Nubain or Numorphan, or an epidural anesthesia.

As the cervix dilates to 8–9 cm, the phase called the transition begins. This refers to the transition from the first phase (during which the cervix dilates from 0–10 cm) and the second phase (during which the baby is pushed out through the birth canal). As the baby's head



Stage 1: Dilation of the cervix. *(Illustration by Hans & Cassady.)*

begins to descend, women begin to feel the urge to "push" or bear down. Active pushing by the mother should not begin until the second phase, since pushing too early can cause the cervix to swell or to tear and bleed. The attending healthcare practitioner should counsel the mother on when to begin to push.

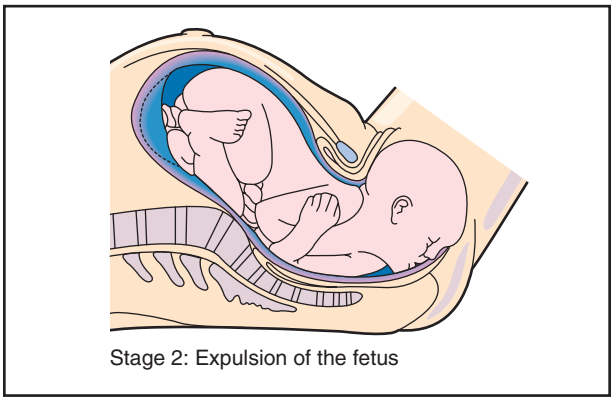
Second stage of labor

As the mother enters the second stage of labor, her baby's head appears at the top of the cervix. Uterine contractions get stronger. The infant passes down the vagina, helped along by contractions of the abdominal muscles and the mother's pushing. Active pushing by the mother is very important during this phase of labor. If an epidural anesthetic is being used, many practitioners recommend decreasing the amount administered during this phase of labor so that the mother has better control over her abdominal muscles.

When the top of the baby's head appears at the opening of the vagina, the birth is nearing completion. First the head passes under the pubic bone. It fills the lower vagina and stretches the perineum (the tissues between the vagina and the rectum). This position is called "crowning," since only the crown of the head is visible. When the entire head is out, the shoulders follow. The attending practitioner suctions the baby's mouth and nose to ease the baby's first breath. The rest of the baby usually slips out easily, and the umbilical cord is cut.

Episiotomy

As the baby's head appears, the perineum may stretch so tight that the baby's progress is slowed down. If there is risk of tearing the mother's skin, the doctor may choose to make a small incision into the perineum to



Stage 2: Expulsion of the fetus. *(Illustration by Hans & Cassady.)*

enlarge the vaginal opening. This is called an **episiotomy**. If the woman has not had an epidural or pudendal block, she will get a local anesthetic to numb the area. Once the episiotomy is made, the baby is born with a few pushes.

Third stage

In the final stage of labor, the placenta is pushed out of the vagina by the continuing uterine contractions. The placenta is pancake shaped and about 10 inches in diameter. It has been attached to the wall of the uterus and has served to convey nourishment from the mother to the fetus throughout the pregnancy. Continuing uterine contractions cause it to separate from the uterus at this point. It is important that all of the placenta be removed from the uterus. If it is not, the uterine bleeding that is normal after delivery may be much heavier.

Breech presentation

Approximately 4% of babies are in what is called the "breech" position when labor begins. In breech presentation, the baby's head is not the part pressing against the cervix. Instead the baby's bottom or legs are positioned to enter the birth canal instead of the head. An obstetrician may attempt to turn the baby to a head down position using a technique called version. This is only successful approximately half the time.

The risks of vaginal delivery with breech presentation are much higher than with a head-first presentation and the mother and attending practitioner will need to weigh the risks and make a decision on whether to deliver via a **cesarean section** or attempt a vaginal birth. The extent of the risk depends to a great extent on the type of breech presentation—of which there are three. Frank breech (the baby's legs are folded up against its body) is the most common and the safest for vaginal delivery. The other types are complete breech (in which the baby's legs are crossed under and in front of the body) and footling breech (in which one leg or both legs are positioned to enter the birth canal) are not considered safe to attempt vaginal delivery.

Even in complete breech, other factors should be met before considering a vaginal birth. An ultrasound examination should be done to be sure the baby does not have an unusually large head and that the head is tilted forward (flexed) rather than back (hyperextended). Fetal monitoring and close observation of the progress of labor are also important. A slowing of labor or any indication of difficulty in the body passing through the pelvis should be an indication that it is safer to consider a cesarean section.

Forceps delivery

If the labor is not progressing as it should or if the baby appears to be in distress, the doctor may opt for a forceps delivery. A forceps is a spoon-shaped device that resembles a set of salad tongs. It is placed around the baby's head so the doctor can pull the baby gently out of the vagina.

Forceps can be used after the cervix is fully dilated, and they might be required if:

- the umbilical cord has dropped down in front of the baby into the birth canal
- the baby is too large to pass through the birth canal unaided
- the baby shows signs of stress
- the mother is too exhausted to push

Before placing the forceps around the baby's head, pain medication or anesthesia may be given to the mother. The doctor may use a catheter to empty the mother's bladder, and may clean the perineal area with soapy water. Often an episiotomy is done before a forceps birth, although tears can still occur.

The obstetrician slides half of the forceps at a time into the vagina and around the side of the baby's head to gently grasp the head. When both "tongs" are in place, the doctor pulls on the forceps to help the baby through the birth canal as the uterus contracts. Sometimes the baby can be delivered this way after the very next contraction.

The frequency of forceps delivery varies from one hospital to the next, depending on the experience of staff and the types of anesthesia offered at the hospital. Some obstetricians accept the need for a forceps delivery as a way to avoid cesarean birth. However, other obstetrical services don't use forceps at all.

Complications from forceps deliveries can occur. Sometimes they may cause nerve damage or temporary

bruises to the baby's face. When used by an experienced physician, forceps can save the life of a baby in distress.

Vacuum-assisted birth

This method of helping a baby out of the birth canal was developed as a gentler alternative to forceps. Vacuum-assisted birth can only be used after the cervix is fully dilated (expanded), and the head of the fetus has begun to descend through the pelvis. In this procedure, the doctor uses a device called a vacuum extractor, placing a large rubber or plastic cup against the baby's head. A pump creates suction that gently pulls on the cup to ease the baby down the birth canal. The force of the suction may cause a bruise on the baby's head, but it fades away in a day or so.

The vacuum extractor is not as likely as forceps to injure the mother, and it leaves more room for the baby to pass through the pelvis. However, there may be problems in maintaining the suction during the vacuum-assisted birth, so forceps may be a better choice if it is important to remove the baby quickly.

Cesarean sections

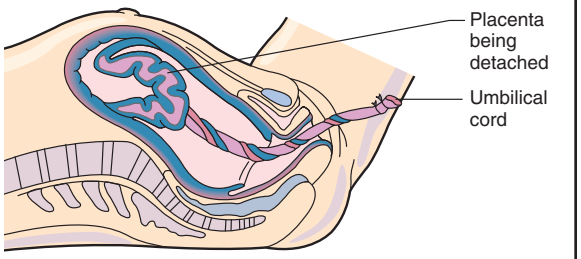
A cesarean section, also called a c-section, is a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

Cesarean sections are performed whenever abnormal conditions complicate labor and vaginal delivery, threatening the life or health of the mother or the baby. The procedure is performed in the United States on nearly one of every four babies delivered—more than 900,000 babies each year. The procedure is used in cases where the mother has had a previous c-section and the area of the incision has been weakened. Dystocia, or difficult labor, is the another common reason for performing a c-section.

Difficult labor is commonly caused by one of the three following conditions: abnormalities in the mother's birth canal; abnormalities in the position of the fetus; abnormalities in the labor, including weak or infrequent contractions.

Another major factor is fetal distress, a condition where the fetus is not getting enough oxygen. Fetal brain damage can result from oxygen deprivation. Fetal distress is often related to abnormalities in the position of the fetus, or abnormalities in the birth canal, causing reduced blood flow through the placenta.

Other conditions also can make c-section advisable, such as vaginal herpes, **hypertension** (high blood pressure) and diabetes in the mother.



Stage 3: Expulsion of the placenta

Stage 3: Expulsion of the placenta. *(Illustration by Hans & Cassady.)*

Causes and symptoms

One of the first signs of approaching childbirth may be a "bloody show," the appearance of a small amount of blood-tinged mucus released from the cervix as it begins to dilate. This is called the "mucus plug."

The most common sign of the onset of labor is contractions. Sometimes women have trouble telling the difference between true and false labor pains.

True labor pains:

- develop a regular pattern, with contractions coming closer together
- last from 15–30 seconds at the onset and get progressively stronger and longer (up to 60 seconds)
- may get stronger with physical activity
- occur high up on the abdomen, radiating throughout the abdomen and lower back

Another sign that labor is beginning is the breaking of the "bag of waters," the amniotic sac which had cushioned the baby during the pregnancy. When it breaks, it releases water in a trickle or a gush. Only about 10% of women actually experience this water flow in the beginning of labor, however. Most of the time, the rupture occurs sometime later in labor. If the amniotic sac doesn't rupture on its own, the doctor will break it during labor.

Some women have **diarrhea** or nausea as labor begins. Others notice a sudden surge of energy and the urge to clean or arrange things right before labor begins; this is known as "nesting."

Diagnosis

The onset of labor can be determined by measuring how much the cervix has dilated. The degree of dilation is estimated by feeling the opening cervix during a pelvic exam. Dilation is measured in centimeters, from zero to

KEY TERMS

Amniotic sac—The membranous sac that surrounds the embryo and fills with watery fluid as pregnancy advances.

Breech birth—Birth of a baby bottom-first, instead of the usual head first delivery. This can add to labor and delivery problems because the baby's bottom doesn't mold a passage through the birth canal as well as does the head.

Cervix—A small cylindrical organ about an inch or so long and less than an inch around that makes up the lower part and neck of the uterus. The cervix separates the body and cavity of the uterus from the vagina.

Embryo—The unborn child during the first eight weeks of its development following conception.

Gestation—The period from conception to birth, during which the developing fetus is carried in the uterus.

Perineum—The area between the thighs that lies behind the genital organs and in front of the anus.

Placenta—The organ that develops in the uterus during pregnancy and that links the blood supplies of mother and baby.

10. Contractions that cause the cervix to dilate are the sign of true labor.

Fetal monitoring

Fetal monitoring is a process in which the baby's heart rate is monitored for indicators of stress during labor and birth. There are several types of fetal monitoring.

A special stethoscope called a fetoscope may be used. This is a simple and non-invasive method.

The Doppler method uses ultrasound; it involves a handheld listening device that transmits the sounds of the heart rate through a speaker or into an attached ear piece. It can usually pick up the heart sounds 12 weeks after conception. This method offers intermittent monitoring. It allows the mother freedom to move about and is also useful during contractions.

Electronic fetal monitoring uses ultrasound and provides a view of the heartbeat in relationship to the mother's contractions. It can be used either continuously or intermittently. It is often used in high risk pregnancies, and is not often recommended for low risk ones because it renders the mother immobile and requires interpretation.

Internal monitoring does not use ultrasound, is more accurate than electronic monitoring and provides continuous monitoring for the high risk mother. This requires the mother's water to be broken and that she be two to three centimeters dilated. It is used in high-risk situations only.

Telemetry monitoring is the newest type of monitoring. It uses radio waves transmitted from an instrument on the mother's thigh. The mother is able to remain mobile. It provides continuous monitoring and is used in high-risk situations.

Treatment

Most women choose some type of pain relief during childbirth, ranging from relaxation and imagery to drugs. The specific choice may depend on what's available, the woman's preferences, her doctor's recommendations, and how the labor is proceeding. All drugs have some risks and some advantages.

Regional anesthetics

Regional anesthetics include epidurals and spinals. In this technique, medication is injected into the space around the spinal nerves. Depending on the type of medications used, this type of anesthesia can block nerve signals, causing temporary pain relief, or a loss of sensation from the waist down. An epidural or spinal block can provide complete pain relief during cesarean birth.

An epidural is placed with the woman lying on her side or sitting up in bed with the back rounded to allow more space between the vertebrae. Her back is scrubbed with antiseptic, and a local anesthetic is injected in the skin to numb the site. The needle is inserted between two vertebrae and through the tough tissue in front of the spinal column. A catheter is put in place that allows continuous doses of anesthetic to be given.

This type of anesthesia provides complete pain relief, and can help conserve a woman's energy, since she can relax or even sleep during labor. This type of anesthesia does require an IV and fetal monitor. It may be harder for a woman to bear down when it comes time to push, although the amount of anesthesia can be adjusted as this stage nears.

Spinal anesthesia operates on the same principle as epidural anesthesia, and is used primarily in cases of c-section delivery. It is administered in the same way as an epidural, but the catheter is not left in place. The amount of anesthetic injected is large, since it must be injected at one time. Because of the anesthetic's effect on motor nerves, most women using it cannot push during delivery.

This is a disadvantage in labor, but not an issue during a c-section. Spinals provide quick and strong anesthesia and allow for major abdominal surgery with almost no pain.

Narcotics

Short-acting narcotics can ease pain and don't interfere with a woman's ability to push. However, they can cause **sedation**, **dizziness**, nausea, and vomiting. Narcotics cross the placenta and may slow down a baby's breathing; they can't be given too close to the time of delivery.

Natural childbirth and preparation for childbirth

There are several methods to prepare for childbirth. The one selected often depends on what is available through the healthcare provider. Overall, family involvement is receiving increased attention by the healthcare systems, and many hospitals now offer birthing rooms and maternity centers to help the entire family. There are several choices available for childbirth preparation.

Lamaze, or Lamaze-Pavlov, is the most common in the United States today. It was the first popular natural childbirth method, becoming popular in the 1960s. Breathing exercises and concentration on a focal point are practiced to allow mothers to control pain while maintaining consciousness. This allows the flow of oxygen to the baby and to the muscles in the uterus to be maintained. A partner coaches the mother throughout the birthing process.

The Read method, named for Dick Read, is a technique of breathing that was originated in the 1930s to help mothers deal with apprehension and tension associated with childbirth. This natural childbirth method uses different breathing for the different stages of childbirth.

The LeBoyer method stresses a relaxed delivery in a quiet, dim room. It attempts to avoid overstimulation of the baby and to foster mother-child bonding by placing the baby on the mother's abdomen and having the mother massage him or her immediately after the birth. Then the father washes the baby in a warm bath.

The Bradley method is called father-coached childbirth, because it focuses on the father serving as coach throughout the process. It encourages normal activities during the first stages of labor.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

Cunningham, F. Gary, et.al. *Williams Obstetrics.* 20th ed. Stamford: Appleton & Lange, 1997.

Johnson, Robert V. *Mayo Clinic Complete Book of Pregnancy & Baby's First Year.* New York: William Morrow and Co., Inc., 1994.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1995.

Tuteur, Amy B. *How Your Baby is Born.* Emeryville, CA: Ziff-Davis Press, 1994.

ORGANIZATIONS

American Academy of Husband-Coached Childbirth. P.O. Box 5224, Sherman Oaks, CA 91413. (800) 423-2397; in California (800) 422-4784.

American Society for Prophylaxis in Obstetrics/LAMAZE (ASP.O. /LAMAZE). 1840 Wilson Blvd., Ste. 204, Arlington, VA 22201. (800) 368-4404.

Childbirth Education Foundation. P.O. Box 5, Richboro, PA 18954. (215) 357-2792.

International Association of Parents and Professionals for Safe Alternatives in Childbirth. Rte. 1, Box 646, Marble Hill, MO 63764. (314) 238-2010.

International Childbirth Education Association. P.O. Box 20048, Minneapolis, MN 55420. (612) 854-8660.

Postpartum Support International. 927 North Kellogg Ave., Santa Barbara, CA 93111. (805) 967-7636.

Carol A. Turkington

Childhood disintegrative disorder *see* **Pervasive developmental disorders**

Children's health

Definition

Children's health encompasses the physical, mental, emotional, and social well-being of children from infancy through adolescence.

Description

All children should have regular well-child check ups according to the schedule recommended by their physician or pediatrician. The American Academy of Pediatrics (AAP) advises that children be seen for well-baby check ups at two weeks, two months, four months, six months, nine months, twelve months, fifteen months, and eighteen months. Well-child visits are recommended at ages two, three, four, five, six, eight, ten, and annually thereafter through age 21.

In addition, an immunization schedule should be followed to protect against disease and infection. As of 2001, the AAP and the U.S. Centers for Disease Control (CDC) recommended that the following childhood immunizations be administered by age two:

KEY TERMS

Bipolar disorder—Manic depressive disorder. A mood disorder characterized by manic highs and depressive lows.

Child development—The process of physical, intellectual, emotional, and social growth that occurs from infancy through adolescence. Erik Erikson, Margaret Mahler, Sigmund Freud, and Jean Piaget are among the most well-known child development theorists.

CPR—Cardiopulmonary resuscitation. A first aid technique designed to stimulate breathing and blood flow through a combination of chest compressions and rescue breathing.

Immunization—Creating immunity to a disease through a vaccine injection that stimulates the production of antibodies.

Learning disabilities—An impairment of the cognitive processes of understanding and using spoken and written language that results in difficulties with one or more academic skill sets (e.g., reading, writing, mathematics).

Motor skills—Controlled movement of muscle groups. Fine motor skills involve tasks that require dexterity of small muscles, such as buttoning a shirt. Tasks such as walking or throwing a ball involve the use of gross motor skills.

Obsessive-compulsive disorder—Also known as OCD; a disorder characterized by obsessive thoughts (e.g., fear of contamination) and compulsive behaviors (e.g., repetitive hand washing) that cause distress and/or functional impairment.

Psychological tests—Written, verbal, or visual tasks that assess psychological functioning, intelligence, and/or personality traits.

Type 1 diabetes—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

- Hepatitis B. Three doses.
- Diphtheria, **Tetanus**, and Pertussis (DTaP). Four doses.
- H. influenzae type b (Hib). Four doses.
- Inactivated **Polio**. Three doses.
- Pneumococcal Conjugate. Three doses.
- Measles, **Mumps**, **Rubella** (MMR). One dose.
- Varicella (chickenpox). One dose.
- Hepatitis A. (In certain geographical areas and with certain high risk groups.)

Some immunizations may cause mild side effects, or more rarely, serious adverse reactions. However, the benefits of immunization greatly outweigh the incidence of health problems arising from them.

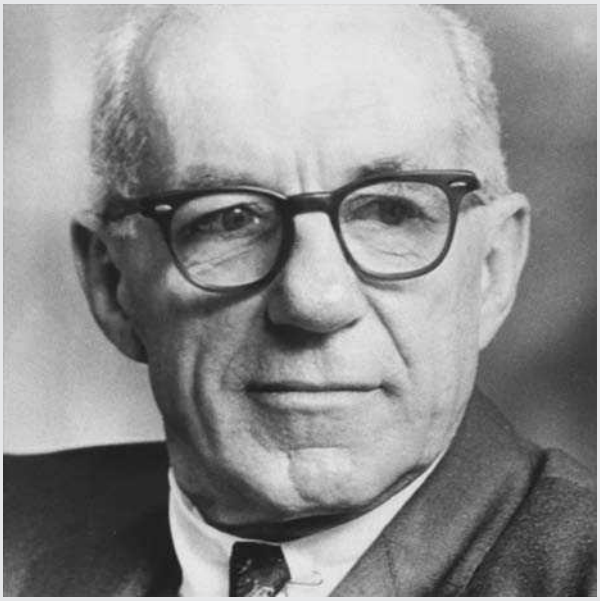
There are serious chronic diseases and health problems that are frequently diagnosed in childhood and cannot be vaccinated against. These include, but are not limited to, **asthma**, type I diabetes (juvenile diabetes), leukemia, **hemophilia**, and **cystic fibrosis**.

Mental health

Children who have difficulty in areas of language acquisition, cognitive development, and behavior control may be suffering from mental illness. Mental health problems that may afflict children include:

- Attention Deficit Hyperactivity Disorder (**ADHD**). According to the AAP, 4–12% of school-aged children have ADHD, a condition characterized by poor impulse control and excessive motor activity.
- **Learning disorders**. Learning disabilities affect one in 10 school children.
- Depression, **anxiety**, and **bipolar disorder**. Affective, or mood, disorders can affect kids as well as adults.
- Eating disorders. **Anorexia nervosa**, **bulimia nervosa**, and binge eating disorder (BED) frequently occur in adolescent girls.
- **Schizophrenia**. A disorder characterized by bizarre thoughts and behaviors, **paranoia**, impaired sense of reality, and **psychosis** may be diagnosed in childhood.
- Obsessive-compulsive disorder. Also called OCD, this anxiety disorder afflicts one in 200 children.
- **Autism** and pervasive developmental disorder. Severe developmental disabilities that cause a child to become withdrawn and unresponsive.
- **Mental retardation**. Children under age 18 with an IQ of 70 or below and impairments in adaptive functioning are considered mentally retarded.

DR. BENJAMIN SPOCK (1903–1998)



(Library of Congress.)

Benjamin Spock, pediatrician and political activist, was most noted for his authorship of *Baby and Child Care*, which significantly changed predominant attitudes toward the raising of infants and children. He began medical school at Yale University in 1925, and transferred to Columbia University's College of Physicians and Surgeons in 1927. Spock had decided well before starting his medical studies that he would "work with children, who have their whole lives ahead of them" and so, upon taking his M.D. degree in 1929 and serving his general internship at the prestigious Presbyterian Hospital, he specialized in pediatrics at a small hospital crowded with children in New York's Hell's Kitchen area.

On a summer vacation in 1943 he began to write his most famous book and he continued to work on it from 1944 to 1946 while serving as a medical officer in the Navy. The book sharply broke with the authoritarian tone and rigorous instructions found in earlier generations of baby-care books, most of which said to feed infants on a strict schedule and not to pick them up when they cried. Spock, who spent ten years trying to reconcile his psychoanalytic training with what mothers were telling him about their children, told his readers "You know more than you think you do. Don't be afraid to trust your own common sense. Take it easy, trust your own instincts, and follow the directions that your doctor gives you." The response was overwhelming. *Baby and Child Care* rapidly became America's all-time best-seller except for Shakespeare and the Bible; by 1976 it had also eclipsed Shakespeare.

Emotional and social health

Children take their first significant steps toward socialization and peer interaction when they begin to engage in cooperative play at around age four. Their social development will progress throughout childhood and adolescence as they develop friendships, start to be influenced by their peers, and begin to show interest in the opposite sex.

Factors which can have a negative impact on the emotional and social well-being of children include:

- Violence. Bullying can cause serious damage to a child's sense of self-esteem and personal safety, as can experiences with school violence.
- Family turmoil. Divorce, **death**, and other life-changing events that alter the family dynamic can have a serious impact on a child. Even a positive event such as the birth of a sibling or a move to a new city and school can put emotional strain on a child.
- **Stress**. The pressure to perform well academically and in extracurricular activities such as sports can be overwhelming to some children.
- Peer pressure. Although it can have a positive impact, peer pressure is often a source of significant stress for children. This is particularly true in adolescence when "fitting in" seems all-important.
- Drugs and alcohol. Curiosity is intrinsic to childhood, and over 30% of children have experimented with alcohol by age 13. Open communication with children that sets forth parental expectations about drug and alcohol use is essential.
- Negative sexual experiences. Sexual **abuse** and assault can emotionally scar a child and instill negative feelings about sexuality and relationships.

Causes and symptoms

Childhood health problems may be congenital (i.e., present at birth) or acquired through infection, immune system deficiency, or another disease process. They may also be caused by physical trauma (e.g., a car accident or a playground fall) or a toxic substance (e.g., an allergen, drug, or poisonous chemical), or triggered by genetic or environmental factors.

Physical and mental health problems in childhood can cause a wide spectrum of symptoms. However, the following behaviors frequently signify a larger emotional, social, or mental disturbance:

- signs of alcohol and drug use
- falling grades
- lack of interest in activities that were previously enjoyable to the child
- excessive anxiety
- persistent, prolonged depression
- withdrawal from friends and family
- violence
- temper tantrums or inappropriate displays of anger
- self-inflicted injury
- bizarre behavior and/or speech
- trouble with the police
- sexual promiscuity
- suicide attempts

The causes of developmental disorders and delays and learning disabilities are not always fully understood. Pervasive developmental disorder (PDD) and autistic spectrum disorder (more commonly known as autism) are characterized by unresponsiveness and severe impairments in one or more of the following areas:

- Social interaction. Autistic children are often unaware of acceptable social behavior and are withdrawn and socially isolated. They frequently do not like physical contact.
- Communication and language. A child with autism or PDD may not speak or may display limited or immature language skills.
- Behavior. Autistic or PDD children may have difficulty dealing with anger, can be self-injurious, and may display obsessive behavior.

Autism is associated with brain abnormalities, but the exact mechanisms that trigger the disorder are yet to be determined. It has been linked to certain congenital conditions such as **neurofibromatosis**, **fragile X syndrome**, and **phenylketonuria** (PKU).

Diagnosis

Physical, intellectual, emotional, and social maturation are all important markers of a child's overall health and well-being. When evaluating children, pediatricians and child-care specialists assess related skill sets, such as a child's acquisition and use of language, fine and gross motor skills, cognitive growth, and socialization, and achievement of certain milestones in these areas. A developmental milestone is a task or skill set that a child is expected to reach at a certain age or stage of life. For example, by age one, most children have achieved the physical milestone of walking with the assistance of an adult. Developmental disorders may be identified and/or diagnosed by physicians, teachers, child psychologists, therapists, counselors, and other professionals who interact with children on a regular basis.

It is important to remember that all children are unique, and develop at different paces within this broad framework. Reaching a milestone early or late does not necessarily indicate a developmental problem. However, if a child is consistently lagging on achieving milestones, or has a significant deficit in one developmental area, he or she may be experiencing developmental delays.

Pediatricians and other medical professionals typically diagnose physical illness and disease in children. In cases of illness and injury, children will undergo a thorough **physical examination** and patient history. Diagnostic tests may be performed as appropriate. In cases of mental or emotional disorders, a psychologist or other mental healthcare professional will meet with the patient to conduct an interview and take a detailed social and medical history. Interviews with a parent or guardian may also be part of the diagnostic process. The physician may also administer one or more **psychological tests** (also called clinical inventories, scales, or assessments).

Treatment

Medications may be prescribed to treat certain childhood illnesses. Proper dosage is particularly important with infants and children, as medications such as **acetaminophen** can be toxic in excessive amounts. Parents and caregivers should always follow the instructions for use that accompany medications, and inform the child's pediatrician if the child is taking any other drugs or **vitamins** to prevent potentially negative drug interactions. Any side effects or adverse reactions to medication should be reported to the child's physician. If **antibiotics** are prescribed, the full course should always be taken.

Other treatments for childhood illness and/or injuries include, but are not limited to, nutritional therapy, physical therapy, respiratory therapy, medical devices (e.g., **hearing aids**, glasses, braces), and in some cases, surgery.

Counseling is typically a front-line treatment for psychological disorders. Therapy approaches include psychotherapy, cognitive therapy, behavioral therapy, family counseling, and **group therapy**. Therapy or counseling may be administered by social workers, nurses, licensed counselors and therapists, psychologists, or psy-

Leading Causes Of Illness/Injury In Adolescents

Trauma (this could be anything from sports-related injuries to gunshot wounds; alcohol or other drug abuse is frequently a factor)
Mental health issues (substance abuse, depression, etc.)
Sexually transmitted infections
Acquired immunodeficiency syndrome (AIDS)
Eating disorders

chiatrists. Psychoactive medication may also be prescribed for symptom relief in children and adolescents with mental disorders.

Support groups may also provide emotional support for children with chronic illnesses or mental disorders. This approach, which allows individuals to seek advice and counsel from others in similar circumstances, can be extremely effective, especially in older children who look towards their peers for guidance and support.

Speech therapy may be helpful to children with developmental delays in language acquisition. Children with learning disorders can benefit from special education therapy.

Alternative treatment

Therapeutic approaches that encourage self-discovery and empowerment may be useful in treating some childhood emotional traumas and mental disorders. **Art therapy**, the use of the creative process to express and understand emotion, encompasses a broad range of humanistic disciplines, including visual arts, dance, drama, music, film, writing, literature, and other artistic genres. It can be particularly effective in children who may have difficulty gaining insight to emotions and thoughts they are otherwise incapable of expressing.

Certain mild herbal remedies may also be safely used with children, such as ginger (*Zingiber officinale*) tea for nausea and aloe vera salve for **burns**. Parents and caregivers should always consult their healthcare provider before administering herbs to children.

Prognosis

The prognosis for childhood health problems varies widely. In general, early detection and proper treatment can greatly improve the odds of recovery from many childhood ailments.

Some learning disabilities and mild developmental disorders can be overcome or greatly improved through the therapies discussed above. However, as of early 2001, there was no known medical treatment or pharmacological therapy that is capable of completely eliminating all of the symptoms associated with pervasive developmental disorder (PDD), autism spectrum disorder, and mental retardation. Mental illnesses such as schizophrenia and bipolar disorder are also chronic, lifelong disorders, although their symptoms can often be well-controlled with medication.

Prevention

Parents can take some precautions to ensure the safety of their children. Childproofing the home, following a recommended immunization schedule, educating kids on safety, learning **CPR**, and taking kids for regular well-child check-ups can help to protect against physical harm. In addition, encouraging open communication with children can help them grow both emotionally and socially. Providing a loving and supportive home environment can help to nurture an emotionally healthy child who is independent, self-confident, socially skilled, insightful, and empathetic towards others.

Because they are still developing motor skills, kids can be particularly accident prone. Observe the following safety rules to protect children from injury:

- Helmets and padding. Children should always wear a properly fitted helmet and appropriate protective gear when riding a bike, scooter, or similar equipment or participating in sports. They should also ride on designated bike paths whenever possible, and learn bicycle safety rules (i.e., ride with traffic, use hand signals).
- Playground safety. Swing sets and other outdoor play equipment should be well-maintained have at least 12 in (30 cm) of loose fill materials (e.g., sand, wood chips) underneath to cushion falls, and children should always be properly supervised at play.
- Stay apprised of recalls. Children's toys, play equipment, and care products are frequently involved in product recalls. The U.S. Consumer Safety Products Commission (CSPC) is the agency responsible for tracking these recalls (see *Resources* below).
- Stay safe in the car. Up to 85% of children's car seats are improperly installed and/or used. Infants should always be in a rear-facing car seat until they are over 12 months of age and weigh more than 20 lb (9 kg). Never

Leading Causes Of Death In Adolescents

Motor vehicle crashes
Suicide (numbers 2 and 3 are approximately equal)
Homicide
Poisoning (which includes accidental poisonings due to alcohol or other drug overdose)
Drowning

put an infant or car seat in a front passenger seat that has an air bag. Once they outgrow their forward facing car seats, children between the ages of four and eight who weigh between 40–80 lb (18–36 kg) should ride in a booster seat. Every child who rides in a car over this age and weight should buckle up with a properly fitted lap and shoulder belt.

- Teach children pedestrian safety. Younger children should never be allowed to cross the street by themselves, and older kids should know to follow traffic signs and signals, cross the street at the corner, and look both ways before stepping off the curb.
- Teach children about personal safety. Kids should know what to do in case they get lost or are approached by a stranger. It is also imperative that parents talk openly with their children about their body and sexuality, and what behavior is inappropriate, to protect them against sexual predators.

Child-proofing the household is also an important step towards keeping kids healthy. To make a house a safe home:

- Ban guns. Accidental shootings in the home injure an estimated 1,500 children under age 14 each year. If a gun must be in the home, it should be securely locked in a tamper proof box or safe.
- Keep all matches, lighters, and flammable materials properly stored and out of the reach of children.
- Make sure hot water heaters are set to 120 degrees or below to prevent scalding injuries.
- Equip the home with working fire extinguishers and smoke alarms, and teach children what to do in case of fire.
- Secure all medications (including vitamins, herbs, and supplements), hazardous chemicals, and poisonous substances (including alcohol and tobacco).
- Don't smoke. Aside from causing **cancer** and other health problems in smokers, second-hand smoke is hazardous to a child's health.
- Keep small children away from poisonous plants outdoors, and remove any indoor plants that are toxic.
- Post the phone numbers of poison control and the pediatrician near the phone, and teach children about dialing 9-1-1 for emergencies.
- Children under age five should never be left alone in the bathtub, wading pool, or near any standing water source (including an open toilet). Drowning is the leading cause of death by injury for children between the ages of one and four.
- Remove lead paint. Lead is a serious health hazard for children, and houses built before 1978 should be tested for lead paint. If lead is found, the paint should be removed using the appropriate safety precautions.

These safety guidelines are not all-inclusive, and there are many age-specific safety precautions that parents and guardians of children should observe. For example, infants should never be left with a propped-up bottle in their mouths or given small play items because of the **choking** hazards involved.

Resources

BOOKS

Holtzman, Debra Smiley. *The Panic Proof Parent.* Chicago: NTC/Contemporary, 2000.

Pasquariello Jr., Patrick S. ed. *The Children's Hospital of Philadelphia: Book of Pregnancy and Child Care.* New York: John Wiley & Sons, Inc., 1999.

White, Linda, and Sunny Mavor. *Kids, Herbs, and Health.* Loveland, CO: Interweave Press, 1998.

ORGANIZATIONS

National Institute of Mental Health. 6001 Executive Boulevard, Rm. 8184, MSC 9663, Bethesda, MD 20892-9663. (301) 443-4513.

National SAFE KIDS Campaign. Children's National Medical Center. (202) 662-0600. <http://www.safekids.org>.

U.S. Consumer Products Safety Commission (CPSC). 4330 East-West Highway, Bethesda, MD 20814-4408. (800) 638-2772. <http://www.cpsc.gov>.

Paula Ford-Martin

Chinese traditional herbal medicine *see* **Traditional Chinese herbalism**

Chinese traditional medicine *see* **Traditional Chinese medicine**

Chiropractic

Definition

Chiropractic is from Greek words meaning done by hand. It is grounded in the principle that the body can heal itself when the skeletal system is correctly aligned and the nervous system is functioning properly. To achieve this, the practitioner uses his or her hands or an adjusting tool to perform specific manipulations of the vertebrae. When these bones of the spine are not correctly articulated, resulting in a condition known as subluxation, the theory is that nerve transmission is disrupted and causes **pain** and illness manifested in the back as well as other areas of the body.

Chiropractic is one of the most popular alternative therapies currently available. Some would say it now qualifies as mainstream treatment as opposed to complementary medicine. Chiropractic treatment is covered by many insurance plans. It has become well-accepted treatment for acute pain and problems of the spine, including lower back pain and **whiplash**. Applications beyond that scope are not supported by current evidence, although there are ongoing studies into the usefulness of chiropractic for such problems as ear infections, **dysmenorrhea**, infant **colic**, migraine headaches, and other conditions.

Purpose

Most people will experience back pain at some time in their lives. Injuries due to overexertion and poor posture are among the most common. Depending on the cause and severity of the condition, options for treatment may include physical therapy, rest, medications, surgery, or chiropractic care. Chiropractic treatment carries none of the risks of surgical or pharmacologic treatment. Practitioners use a holistic approach to health, which is appreciated by most patients. The goal is not merely to relieve the present ailment, but to analyze the cause and recommend appropriate changes of lifestyle to prevent the problem from recurring again. They believe in a risk/benefit analysis before use of any intervention. The odds of an adverse outcome are extremely low. Chiropractic has proven in several studies to be less expensive than many more traditional routes such as outpatient physical therapy. Relief from some neuromuscular problems is immediate, although a series of treatments is likely to be required to maintain the improvement. Spinal manipulation is an excellent option for acute lower back pain, and may also relieve neck pain as well as other musculoskeletal pain. Although most back pain will subside eventually with no treatment at all, chiropractic treatment can significantly shorten the time it takes to get relief. Some types of **headache** can also be successfully treated by chiropractic.

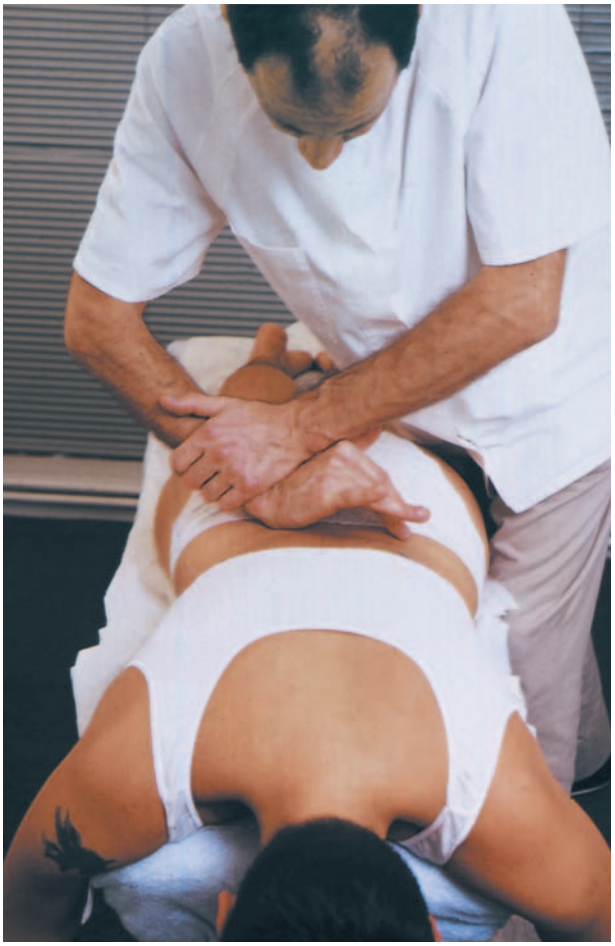
Description

Origins

Spinal manipulation has a long history in many cultures but Daniel D. Palmer is the founder of modern chiropractic theory, dating back to the 1890s. A grocer and magnetic healer, he applied his knowledge of the nervous system and manual therapies in an unusual situation. One renowned story concerns Harvey Lillard, a janitor in the office where Palmer worked. The man had been deaf for 17 years, ever since he had sustained an injury to his upper spine. Palmer performed an adjustment on a painful vertebra in the region of the injury and Lillard's hearing was reputedly restored. Palmer theorized that all communication from the brain to the rest of the body passes through the spinal canal, and areas that are poorly aligned or under **stress** can cause physical symptoms both in the spine and in other areas of the body. Thus the body has the innate intelligence to heal itself when unencumbered by spinal irregularities causing nerve interference. After his success with Lillard, other patients began coming to him for care, and responded well to adjustments. This resulted in Palmer's further study of the relationship between an optimally functional spine and normal health.

Palmer founded the first chiropractic college in 1897. His son, B. J. Palmer, continued to develop chiropractic philosophy and practice after his father's **death**. B. J. and other faculty members were divided over the role of subluxation in disease. B. J. saw it as the cause of all disease. The others disagreed and sought a more rational way of thinking, thus broadening the base of chiropractic education. From 1910–1920, many other chiropractic colleges were established. Other innovators, including John Howard, Carl Cleveland, Earl Homewood, Joseph Janse, Herbert Lee, and Claude Watkins, also helped to advance the profession.

The theories of the Palmers receive somewhat broader interpretation today. Many chiropractors believe that back pain can be relieved and health restored through chiropractic treatment even in patients who do not have demonstrable subluxations. Scientific development and research of chiropractic is gaining momentum. The twenty-first century will likely see the metaphysical concepts such as innate intelligence give way to more scientific proofs and reform.



An example of a McTimoney chiropractic technique on patient's lumbar vertebra. The McTimoney chiropractic is a system of adjustment by hand of displacements of the spinal column and bones. It can also be applied to animals. *(Photograph by Francoise Sauze, Custom Medical Stock Photo. Reproduced by permission.)*

Many people besides the Palmers have contributed to the development of chiropractic theory and technique. Some have gone on to create a variety of procedures and related types of therapy that have their roots in chiropractic, including McTimoney-Corley chiropractic, craniosacral manipulation, naprapathy, and **applied kinesiology**. **Osteopathy** is another related holistic discipline that utilizes spinal and musculoskeletal manipulation as a part of treatment, but osteopathic training is more similar in scope to that of an M.D.

Initial visit

An initial chiropractic exam will most often include a history and a physical. The patient should be asked about what the current complaint is, whether there are chronic health problems, family history of disease, dietary habits, medical care received, and any medications currently being taken. Further, the current complaint should be described in terms of how long it has been a problem, how it has progressed, and whether it is the result of an injury or occurred spontaneously. Details of how an injury occurred should be given. The physical exam should evaluate by observation and palpation whether the painful area has evidence of inflammation or poor alignment. Range of motion may also be assessed. In the spine, either hypomobility (fixation) or hypermobility may be a problem. Laboratory analysis is helpful in some cases to rule out serious infection or other health issues that may require referral for another type of treatment. Many practitioners also insist on x rays during the initial evaluation

Manipulation

When spinal manipulation is employed, it is generally done with the hands, although some practitioners may use an adjusting tool. A classic adjustment involves a high velocity, low amplitude thrust that produces a usually painless popping noise, and improves the range of motion of the joint that was treated. The patient may lie on a specially designed, padded table that helps the practitioner to achieve the proper positions for treatment. Some adjustments involve manipulating the entire spine, or large portions of it, as a unit; others are small movements designed to affect a single joint. Stretching, **traction**, and slow manipulation are other techniques that can be employed to restore structural integrity and relieve nerve interference.

Length of treatment

The number of chiropractic treatments required will vary depending on several factors. Generally longer-term treatment is needed for conditions that are chronic, severe, or occur in conjunction with another health problem. Patients who are not in overall good health may also have longer healing times. Some injuries will inherently require more treatments than others in order to get relief. Care is given in three stages. Initially appointments are more frequent with the goal of relieving immediate pain. Next, the patient moves into a rehabilitative stage to continue the healing process and help to prevent a relapse. Finally, the patient may elect periodic maintenance, or wellness treatments, along with lifestyle changes if needed in order to stay in good health.

Follow-up care

Discharge and follow-up therapy are important. If an injury occurred as a result of poor fitness or health, a program of **exercise** or **nutrition** should be prescribed. Home therapy may also be recommended, involving such things as anti-inflammatory medication and appli-

cations of heat or ice packs. Conscious attention to posture may help some patients avoid sustaining a similar injury in the future, and the chiropractor should be able to discern what poor postural habits require correction. A sedentary lifestyle, particularly with a lot of time spent sitting, is likely to contribute to poor posture and may predispose a person to back pain and injury.

Types of practitioners

Some practitioners use spinal manipulation to the exclusion of all other modalities, and are known as straight chiropractors. Others integrate various types of therapy such as massage, nutritional intervention, or treatment with **vitamins**, herbs, or homeopathic remedies. They also embrace ideas from other health care traditions. This group is known as mixers. The vast majority of chiropractors, perhaps 85%, fall in this latter category.

Preparations

Patients should enter the chiropractic clinic with an open mind. This will help to achieve maximum results.

Precautions

Chiropractic is not an appropriate therapy for diseases that are severely degenerative and may require medication or surgery. Many conditions of the spine are amenable to manipulative treatment, but that does not include **fractures**. The practitioner should be informed in advance if the patient is on anticoagulants, or has **osteoporosis** or any other condition that may weaken the bones. There are other circumstances that would contraindicate chiropractic care, and these should be detected in the history or physical exam. In addition to fractures, **Down syndrome**, some congenital defects, and some types of **cancer** are a few of the things that may preclude spinal manipulation. On rare occasions, a fracture or dislocation may occur. There is also a very slim possibility of experiencing a **stroke** as a result of spinal manipulation, but estimates are that it is no more frequent than 2.5 occurrences per one million treatments.

Be wary of chiropractors who insist on costly x rays and repeated visits with no end in sight. Extensive use is not scientifically justifiable, especially in most cases of lower back pain. There are some circumstances when x rays are indicated, including acute or possibly severe injuries such as those that might result from a car accident.

Side effects

It is not uncommon to have local discomfort in the form of aches, pains, or spasms for a few days following a chiropractic treatment. Some patients may also experience mild headache or **fatigue** that resolves quickly.

DANIEL PALMER (1845–1913)

Chiropractic inventor, Daniel David Palmer, was born on March 7, 1845, in Toronto, Ontario. He was one of five siblings, the children of a shoemaker and his wife, Thomas and Katherine Palmer. Daniel Palmer and his older brother fell victim to wanderlust and left Canada with a tiny cash reserve in April 1865. They immigrated to the United States on foot, walking for 30 days before arriving in Buffalo, New York. They traveled by boat through the St. Lawrence Seaway to Detroit, Michigan. There they survived by working odd jobs and sleeping on the dock. Daniel Palmer settled in What Cheer, Iowa, where he supported himself and his first wife as a grocer and fish peddler in the early 1880s. He later moved to Davenport, Iowa, where he raised three daughters and one son.

Palmer was a man of high curiosity. He investigated a variety of disciplines of medical science during his lifetime, many of which were in their infancy. He was intrigued by phrenology and assorted spiritual cults, and for nine years he investigated the relationship between magnetism and disease. Palmer felt that there was one thing that caused disease. He was intent upon discovering this one thing, or as he called it: the great secret.

In September 1895, Palmer purported to have cured a deaf man by placing pressure on the man's displaced vertebra. Shortly afterward Palmer claimed to cure another patient of heart trouble, again by adjusting a displaced vertebra. The double coincidence led Palmer to theorize that human disease might be the result of dislocated or luxated bones, as Palmer called them. That same year he established the Palmer School of Chiropractic where he taught a three-month course in the simple fundamentals of medicine and spinal adjustment.

Palmer, who was married six times during his life, died in California in 1913; he was destitute. His son, Bartlett Joshua Palmer, successfully commercialized the practice of chiropractic.

Research and general acceptance

As recently as the 1970s, the American Medical Association (a national group of medical doctors) was quite hostile to chiropractic, which it deemed a cult. AMA members were advised that it was unethical to be associated with chiropractors. Fortunately that has changed, and as of 2000, many allopathic or traditionally trained physicians enjoy cordial referral relationships with chiropractors. The public is certainly strongly in

KEY TERMS

Adjustment—A very specific type of manipulation of the spine designed to return it to proper structural and functional form.

Allopathic—Conventional practice of medicine generally associated with M.D. physicians.

Dysmenorrhea—Painful menstruation.

Osteoporosis—A condition of decreased bone density, causing increased bone fragility, that is most common in elderly women.

Subluxation—Misalignment between vertebrae that structurally and functionally impairs nerve function.

favor of chiropractic treatment. An estimated 15% of people in the United States used chiropractic care in 1997. Chiropractors see the lion's share of all patients who seek medical help for back problems.

Research has also supported the use of spinal manipulation for acute low back pain. There is some anecdotal evidence recommending chiropractic treatment for ailments unrelated to musculoskeletal problems, but there is not enough research-based data to support this. On the other hand, a chiropractor may be able to treat problems and diseases unrelated to the skeletal structure by employing therapies other than spinal manipulation.

Although many chiropractors limit their practice to spine and joint problems, others claim to treat disorders that are not closely related to the back or musculoskeletal system. These include **asthma**, **bed-wetting**, **bronchitis**, coughs, **dizziness**, dysmenorrhea, earache, **fainting**, headache, hyperactivity, **indigestion**, **infertility**, migraine, **pneumonia**, and issues related to **pregnancy**. There are at least three explanations for possible efficacy for these conditions. One is that the problem could be linked to a nerve impingement, as may be possible with bed-wetting, dizziness, fainting, and headache. In a second group, chiropractic treatment may offer some relief from complicating pain and spasms caused by the disease process, as with asthma, bronchitis, coughs, and pneumonia. The discomforts of pregnancy may also be relieved with gentle chiropractic therapy. A third possibility is that manipulation or use of soft-tissue techniques may directly promote improvement of some conditions. One particular procedure, known as the endonasal technique, is thought to help the eustachian tube to open and thus improve drainage of the middle ear. The tube is sometimes blocked off due to exudates or inflammatory processes. This can offer significant relief from earaches. Some headaches also fall in this category, as skilled use of soft tissue techniques and adjustment may relieve the muscle tension that may initiate some headaches.

Dysmenorrhea, hyperactivity, indigestion, and infertility are said to be relieved as a result of improved flow of blood and nerve energy following treatment. Evidence for this is anecdotal at best, but manipulation is unlikely to be harmful if causes treatable by other modalities have been ruled out.

For conditions such as cancer, fractures, infectious diseases, neurologic disease processes, and anything that may cause increased orthopedic fragility, chiropractic treatment alone is not an effective therapy, and may even be harmful in some cases. Those who have known circulatory problems, especially with a history of thrombosis, should not have spinal manipulation.

Resources

BOOKS

Cassileth, Barrie. *The Alternative Medicine Handbook*. New York: W. W. Norton & Co., Inc., 1998.

Dillard, James, and Terra Ziporyn. *Alternative Medicine for Dummies*. Indianapolis: IDG Bks. Worldwide, 1998.

Leach, Robert. *The Chiropractic Theories: Principles and Clinical Applications*. 3rd ed. Philadelphia: Lippincott Williams & Wilkins, 1994.

Rondberg, Terry. *Chiropractic First*. Chandler, AZ: The Chiropractic Journal, 1996.

Woodham, Anne, and David Peters. *Encyclopedia of Healing Therapies*. New York: DK Publishing, Inc., 1997.

ORGANIZATIONS

American Chiropractic Association. 1701 Clarendon Blvd., Arlington, VA 22209. (800)986-4636. <http://www.amerchiro.org/>.

Judith Turner

Chlamydial infections *see* **Chlamydial pneumonia; Epididymitis; Nongonococcal urethritis; Sexually transmitted diseases**

Chlamydial pneumonia

Definition

Chlamydial **pneumonia** refers to one of several types of pneumonia that can be caused by various types of the bacteria known as *Chlamydia*.

Description

Pneumonia is an infection of the lungs. The air sacs (alveoli) and/or the tissues of the lungs become swollen, and the alveoli may fill with pus or fluid. This prevents the lungs from taking in sufficient oxygen, which deprives the blood and the rest of the body's tissues of oxygen.

There are three major types of *Chlamydia*: *Chlamydia psittaci*, *Chlamydia pneumoniae*, and *Chlamydia trachomatis*. Each of these has the potential to cause a type of pneumonia.

Causes and symptoms

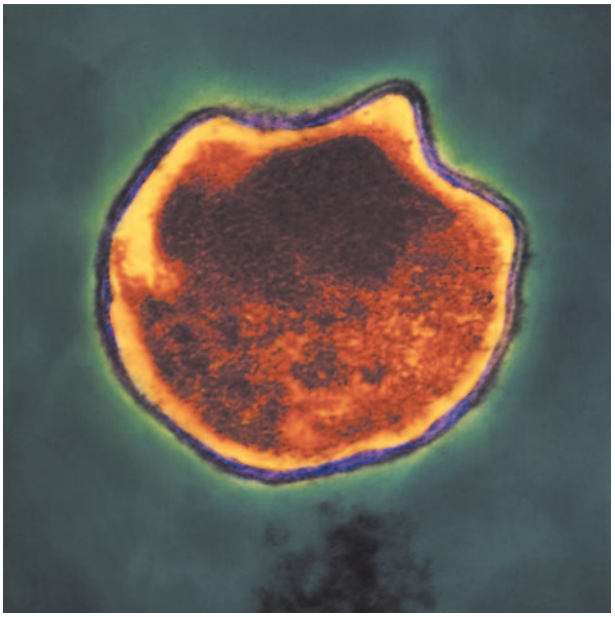
Chlamydia trachomatis is a major cause of **sexually transmitted diseases** (called **nongonococcal urethritis** and **pelvic inflammatory disease**). When a woman with an active chlamydial infection gives birth to a baby, the baby may aspirate (suck into his or her lungs) some of the mother's bacteria-laden secretions while passing through the birth canal. This can cause a form of relatively mild pneumonia in the newborn, occurring about two to six weeks after delivery.

Chlamydia psittaci is a bacteria carried by many types of birds, including pigeons, canaries, parakeets, parrots, and some gulls. Humans acquire the bacteria through contact with dust from bird feathers, bird droppings, or from the bite of a bird carrying the bacteria. People who keep birds as pets or who work where birds are kept have the highest risk for this type of pneumonia. This pneumonia, called psittacosis, causes **fever**, **cough**, and the production of sputum containing pus. This type of pneumonia may be quite severe, and is usually more serious in older patients. The illness can last several weeks.

Chlamydia pneumoniae usually causes a type of relatively mild "walking pneumonia." Patients experience fever and cough. This type of pneumonia is called a "community-acquired pneumonia" because it is easily passed from one member of the community to another.

Diagnosis

Laboratory tests indicating the presence of one of the strains of *Chlamydia* are sophisticated, expensive, and performed in only a few laboratories across the country. For this reason, doctors diagnose most cases of chlamydial pneumonia by performing a **physical examination** of the patient, and noting the presence of certain factors. For instance, if the mother of a baby sick with pneumonia is positive for a sexually transmitted disease caused by *Chlamydia trachomatis*, the diagnosis is obvious. History of exposure to birds in a patient sick with pneumonia suggests that *Chlamydia psittaci* may be the culprit. A mild pneumonia in an otherwise healthy person is likely to be a community-acquired walking pneumonia, such as that caused by *Chlamydia pneumoniae*.



A transmission electron microscopy (TEM) of a sectioned *Chlamydia pneumoniae* bacterium. *(Photograph by Dr. Kari Lounatmaa, Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Treatment varies depending on the specific type of *Chlamydia* causing the infection. A newborn with *Chlamydia trachomatis* improves rapidly with erythromycin. *Chlamydia psittaci* infection is treated with tetracycline, bed rest, oxygen supplementation, and codeine-containing cough preparations. *Chlamydia pneumoniae* infection is treated with erythromycin.

Prognosis

The prognosis is generally excellent for the newborn with *Chlamydia trachomatis* pneumonia. *Chlamydia psittaci* may linger, and severe cases have a **death** rate of as high as 30%. The elderly are hardest hit by this type of pneumonia. A young, healthy person with *Chlamydia pneumoniae* has an excellent prognosis. In the elderly, however, there is a 5–10% death rate from this infection.

Prevention

Prevention of *Chlamydia trachomatis* pneumonia involves recognizing the symptoms of genital infection in the mother and treating her prior to delivery of her baby.

KEY TERMS

Alveoli—The small air sacs clustered at the ends of the bronchioles in the lungs, in which oxygen-carbon dioxide exchange takes place.

Aspiration—When solids or liquids that should be swallowed into the stomach are instead breathed into the respiratory system, or when substances from the outside environment are accidentally breathed into the lungs.

Sputum—Material produced within the alveoli in response to an infectious or inflammatory process.

Chlamydia psittaci can be prevented by warning people who have birds as pets, or who work around birds, to be careful to avoid contact with the dust and droppings of these birds. Sick birds can be treated with an antibiotic in their feed. Because people can contract psittacosis from each other, a person sick with this infection should be kept in **isolation**, so as not to infect other people.

Chlamydia pneumoniae is difficult to prevent because it is spread by respiratory droplets from other sick people. Because people with this type of pneumonia do not always feel very sick, they often continue to attend school, go to work, and go to other public places. They then spread the bacteria in the tiny droplets that are released into the air during coughing. Therefore, this pneumonia is very difficult to prevent and often occurs in outbreaks within communities.

Resources

BOOKS

Drew, W. Lawrence. "Chlamydia." *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley & Sons, 1995.

PERIODICALS

Dalhoff, Klaus, and Matthias Maass. "Chlamydia Pneumoniae Pneumonia in Hospitalized Patients: Clinical Characteristics and Diagnosis." *Chest* 110, no. 2 (Aug. 1996): 351+.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Rosalyn Carson-DeWitt, MD

Chlorhexidine *see* **Antibiotics, topical**

Chloroquine *see* **Antimalarial drugs**

Chlorzoxazone *see* **Muscle relaxants**

Choking

Definition

Choking is the inability to breathe because the trachea is blocked, constricted, or swollen shut.

Description

Choking is a medical emergency. When a person is choking, air cannot reach the lungs. If the airways cannot be cleared, **death** follows rapidly.

Anyone can choke, but choking is more common in children than in adults. Choking is a common cause of accidental death in young children who are apt to put toys or coins in their mouths, then unintentionally inhale them. About 3,000 adults die each year from choking on food.

People also choke because infection causes the throat tissue to swell shut. It is believed that this is what caused George Washington's death. Allergic reactions can also cause the throat to swell shut. Acute allergic reactions are called anaphylactic reactions and may be fatal. Strangulation puts external pressure on the trachea causing another form of choking.

Finally, people can choke from obstructive **sleep apnea**. This is a condition where tissues of the body obstruct the airways during sleep. Sleep apnea is most common in obese men who sleep on their backs. **Smoking**, heavy alcohol use, lung diseases such as **emphysema**, and an inherited tendency toward a narrowed airway and throat all increase the risk of choking during sleep.

Causes and symptoms

There are three reasons why people choke. These are:

- mechanical obstruction
- tissue swelling
- crushing of the trachea

Regardless of the cause, choking cuts off the air supply to the lungs. Indications that a person's airway is blocked include:

- the person cannot speak or cry out
- the person's face turns blue from lack of oxygen
- the person desperately grabs at his or her throat

- the person has a weak **cough** and labored breathing that produces a high-pitched noise
- the person has all of the above symptoms, then becomes unconscious
- during sleep, the person has episodes of gasping, pauses in breathing, and sudden awakenings.

Diagnosis

Diagnosing choking due to mechanical obstruction is straightforward, since the symptoms are obvious even to an untrained person. In choking due to infection, the person, usually a child, will have a **fever** and signs of illness before labored breathing begins. If choking is due to an allergic reaction to medication or insect bites, the person's earlobes and face will swell, giving an external sign that internal swelling is also occurring.

Choking due to sleep apnea is usually diagnosed on reports of symptoms by the person's sleep partner. There are also alarm devices to detect the occurrence of sleep apnea. Eventually sleep may be interrupted so frequently that daytime drowsiness becomes a problem.

Treatment

Choking, except during sleep apnea, is a medical emergency. If choking is due to allergic reaction or infection, people should summon emergency help or go immediately to an emergency room. If choking is due to obstructed airways, the **Heimlich maneuver** (an emergency procedure in which a person is grasped from behind in order to forcefully expel the obstruction) should be performed immediately. In severe cases a **tracheotomy** (an incision into the trachea through the neck below the larynx) must be performed.

Patients who suffer airway obstruction during sleep can be treated with a device similar to an oxygen mask that creates positive airway pressure and delivers a mixture of oxygen and air.

Prognosis

Many people are treated successfully for choking with no permanent effects. However, if treatment is unsuccessful, the person dies from lack of oxygen. In cases where the ariway is restored after the critical period passes, there may be permanent brain damage.

Prevention

Watching children carefully to keep them from putting **foreign objects** in their mouth and avoiding giving young children food like raisins, round slices of hot dogs, and grapes can reduce the chance of choking in children. Adults should avoid heavy alcohol consumption when eating and avoid talking and laughing with food in their mouths. The risk of obstructive sleep apnea choking can be reduced by avoiding alcohol, tobacco smoking, tranquilizers, and sedatives before bed.

KEY TERMS

Trachea—The windpipe. A tube extending from below the voice box into the chest where it splits into two branches, the bronchi, that go to each lung.

Tracheotomy—The surgical creation of an opening in the trachea that functions as an alternative airway so that the patient may breathe.

Resources

BOOKS

Berkow, Robert, Mark Beers, and Andrew Fletcher, eds. "Sleep Apnea Syndromes." In *The Merck Manual of Medical Information. Home Edition*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Tish Davidson

Cholangitis

Definition

The term cholangitis means inflammation of the bile ducts. The term applies to inflammation of any portion of the bile ducts, which carry bile from the liver to the gallbladder and intestine. The inflammation is produced by bacterial infection or sometimes other causes.

Description

Bile, which is needed for digestion, is produced in the liver and then enters the common bile duct (CBD) through the hepatic ducts. Bile enters the gallbladder between meals, when the muscle or sphincter that controls flow of bile between the CBD and intestine is closed. During this period, bile accumulates in the CBD;

the pressure in the CBD rises, as would a pipe closed off at one end. The increase in pressure eventually causes the bile to flow into the gallbladder. During meals, the gallbladder contracts and the sphincter between the gallbladder and intestine relaxes, permitting bile to flow into the intestine and take part in digestion.

Bile that has just been produced by the liver is sterile (free of bacteria). This is partly due to its antibacterial properties; these are produced by the immunoglobulins (antibodies) secreted in bile, the bile acids which inhibit bacterial growth themselves, and mucus.

A small number of bacteria may be present in the bile ducts and gallbladder, getting there by moving backward from the intestine, which unlike the bile ducts, contains large numbers of bacteria. The normal flow of bile out of the ducts and into the intestine also helps keep too many organisms from multiplying. Bacteria also reach the bile ducts from the lymph tissue or from the blood stream.

When the passage of bile out of the ducts is blocked, the few bacteria that are there rapidly reproduce. A partial blockage to the flow of bile can occur when a stone from the gallbladder blocks the duct, and also allows bacteria to flow back into the CBD, and creates ideal conditions for their growth. Tumors, on the other hand, cause a more complete blockage of bile flow, both in and out, so fewer infections occur. The reproducing organisms are often able to enter the bloodstream and infect multiple organs such as the liver and heart valves.

Another source of inflammation of the bile ducts occurs in diseases of altered immunity, known as "autoimmune diseases." In these diseases, the body fails to recognize certain cells as part of its normal composition. The body thinks these cells are foreign and produces antibodies to fight them off, just as it fights against bacteria and viruses. Primary sclerosing cholangitis is a typical example of an autoimmune disease involving the bile ducts.

Causes and symptoms

As noted above, the two things that are needed for cholangitis to occur are: 1) obstruction to bile flow, and 2) presence of bacteria within the bile ducts. The most common cause of cholangitis is infection of the bile ducts due to blockage by a gallstone. Strictures (portions of ducts that have become narrow) also function in the same way. Strictures may be due to congenital (birth) abnormalities of the bile ducts, form as a result of injury to the bile duct (such as surgery, trauma), or result from inflammation that leads to scar tissue and narrowing.

The bacterium most commonly associated with infection of the bile ducts is *Escherichia coli (E. coli)* which is a normal inhabitant of the intestine. In some cases, more than one type of bacteria is involved. Patients with **AIDS** can develop infection of narrowed bile ducts with unusual organisms such as *Cryptosporidium* and others.

The three symptoms present in about 70% of patients with cholangitis are abdominal **pain**, **fever**, and **jaundice**. Some patients only have chills and fever with minimal abdominal symptoms. Jaundice or yellow discoloration of the skin and eyes occurs in about 80% of patients. The color change is due to bile pigments that accumulate in the blood and eventually in the skin and eyes.

Inflammation due to the autoimmune disease primary sclerosing cholangitis leads to multiple areas of narrowing and eventual infection. Tumors can block the bile duct and also cause cholangitis, but as noted, infection is relatively infrequent; in fact cholangitis occurs in only about one in six patients with tumors.

Another type of bile duct infection occurs mainly in Southeast Asia and is known as recurrent pyogenic cholangitis or Oriental cholangitis. It has also been identified in Asians immigrating to North America. Most patients have stones in the bile ducts and/or gallbladder, and many cases are associated with the presence of parasites within the ducts. The role of parasites in causing infection is not clear. Many researchers believe that they are just coincidental, and have nothing to do with the stones or infection.

Diagnosis

The above symptoms alone are very suggestive of cholangitis; however, it is important to determine the exact cause and site of possible obstruction. This is because attacks are likely to recur, and different causes require different treatments. For example, the treatment of cholangitis due to a stone in the CBD is different from that due to bile duct strictures. An elevated white **blood count** suggests infection, but may be normal in 20% of patients. Abnormal or elevated tests of liver function, such as bilirubin and others are also frequently present. The specific bacteria is sometimes identified from blood cultures.

X-ray techniques

A number of x-ray techniques can make the diagnosis of bile duct obstruction; these include ultrasound and **computed tomography scans** (CT scans). However, ultrasound often cannot tell if an obstruction is due to a stricture or stone, missing a stone in about half the cases. CT scans have an even poorer record of stone detection.

Another method of diagnosing and sometimes treating the cause of bile duct obstruction or narrowing is called **percutaneous transhepatic cholangiography**. In this procedure, dye is injected into the ducts by means of

KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Bilirubin—A pigment produced by the liver that is excreted in bile which causes a yellow discoloration of the skin and eyes when it accumulates in those organs. Bilirubin levels can be measured by blood tests, and are most often elevated in patients with liver disease or a blockage to bile flow.

Computed tomography scan (CT scan)—A specialized x-ray procedure in which cross-sections of the area in question can be examined in detail. In evaluating the bile ducts, iodine-based dye is often injected intravenously. The procedure is of greatest value in diagnosing the complications of gallstones (such as abscesses, pancreatitis) rather than documenting the presence of a stone.

Endoscope—An endoscope as used in the field of gastroenterology is a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x-ray dye into the bile duct.

Endoscopy—The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

Extracorporeal shock-wave lithotripsy (ESWL)—This is a technique that uses high-pressure waves similar to sound waves that can be "focused" on a very small area, thereby fracturing small solid objects such as gallstones, kidney stones, etc. The small fragments can pass more easily and harmlessly into the intestine or can be dissolved with medications.

Primary sclerosing cholangitis—A chronic disease in which it is believed that the immune system fails to recognize the cells that compose the bile ducts as part of the same body, and attempts to destroy them. It is not clear what exactly causes the disease, but it is frequently associated with another inflammatory disease of the digestive tract, ulcerative colitis. The inflammation of the ducts eventually produces formation of scar tissue, causing multiple areas of narrowing (strictures) that block bile flow and lead to bacterial infection. Liver transplant gives the best chance for long-term survival.

Ultrasound—A non-invasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition. It requires no preparation and no radiation occurs. It has become the "gold standard" for diagnosis of stones in the gallbladder, but is less accurate in diagnosing stones in the bile ducts. Gallstones as small as 2 mm can be identified. The procedure can now also be done through an endoscope, greatly improving investigation of the bile ducts.

a needle placed into the liver. It is also used to drain bile and relieve an obstruction.

ENDOSCOPIC TECHNIQUES. An endoscope is a thin flexible tube that uses a lens or mirror to look at various parts of the gastrointestinal tract. **Endoscopic retrograde cholangiopancreatography** (ERCP) can accurately determine the cause and site of blockage. It also has the advantage of being able to treat the cause of obstruction, by removing stones and dilating (stretching) strictures. ERCP involves the injection of x-ray dye into the bile ducts through an endoscope. Endoscopic ultrasound is another endoscopic alternative, but is not as available as ERCP and is not therapeutic.

Treatment

The first aim is to control the bacterial infection. Broad-spectrum **antibiotics** are usually used. If the infection does not come under control promptly, as noted by decrease in fever and pain, then other methods to relieve the obstruction and infection will be needed. Either way, definitive treatment of the cause of bile duct infection is the next step, and this has undergone revolutionary changes in the past decade. Endoscopic, radiographic and other techniques have made it possible to successfully remove stones and dilate strictures that previously required surgical intervention, often with high morbidity and mortality.

Radiologic and endoscopic techniques

Just as with diagnosis, treatment of cholangitis involves a number of similar procedures that differ mainly in the way the bile ducts are entered. The aims of these techniques are immediate relief of obstruction and infection as well as correction of any abnormalities that have

caused them. It is important to realize that even with endoscopy, x-ray dye is injected into the ducts and therefore the radiologist plays a role in both types of procedures. When endoscopy is used, the muscle between the intestine and bile duct is widened, to allow stones to pass. This is called a sphincterotomy and is often enough to relieve any obstruction and help clear infection. The widening of the muscle is needed if other procedures involving the bile duct are going to be performed.

The above techniques can be summarized as follows:

- Insertion of a catheter or thin flexible tube to drain bile and relieve obstruction. When performed by insertion of a needle into the liver the technique is called percutaneous transhepatic biliary drainage (PTBD); when performed endoscopically the catheter exits through the nose and is called a nasobiliary drain.
- Balloons can be inserted into the ducts with either method to dilate strictures.
- Insertion of a prosthesis which is a rigid or flexible tube designed to keep a narrowed area open; it is usually placed after a stricture is dilated with a balloon.
- Removal of stones can be accomplished most often by endoscopic techniques. A number of methods have been developed to perform this including laser and contact **lithotripsy** in which stones are fragmented by high-energy waves.

Surgical treatment

Fortunately, with recent advances in the above methods, this is a last option. Nonetheless, about 5–10% of patients will need to undergo surgical exploration of the bile ducts.

In some instances, the bile duct is so narrowed due to prior inflammation or tumor, that it needs connection to a different area of the intestinal tract to drain. This is rather complicated surgery and carries a mortality rate of 2%.

Other treatment

Extracorporeal shock-wave lithotripsy (ESWL) was first used to break up **kidney stones**. The technique has been extended to the treatment of **gallstones**, in both the gallbladder and bile ducts. It is often combined with endoscopic procedures to ease the passage of fragmented stones, or oral medications that can dissolve the fragments. Rarely, stones are also dissolved by instilling various chemicals such as ether directly into the bile ducts.

Prognosis

The outlook for those with cholangitis has markedly improved in the last several years due in large part to the development of the techniques described above. For those patients whose episode of infection is caused by something other than a simple stone, the future is not as bright, but still often responsive to treatment. Some patients with autoimmune disease will need **liver transplantation**.

Prevention

This involves eliminating those factors that increase the risk of infection of the bile ducts, mainly stones and strictures. If it is medically possible, patients who have their gallbladder and suffer a bout of cholangitis should undergo surgical removal of the gallbladder and removal of any stones.

For other patients, a variety of therapies as outlined above, including dissolving small stones with bile acids, are also available. A combination of several of these methods is needed in some patients. Patients should discuss the risks and alternatives of these treatments with their physicians.

Resources

BOOKS

Bilhartz, Lyman E., and Jay D. Horton. "Gallstone Disease and Its Complications." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Greenberger, Norton J., and Kurt J. Isselbacher. "Diseases of the Bile Ducts." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Mulvihill, Sean J. "Surgery for Choledocholithiasis." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Company. 1997.

Ostroff, James W., and Jeanne M. LaBerge. "Endoscopic and Radiologic Treatment of Biliary Disease." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Company. 1997.

Paumgartner, Gustav. "Nonsurgical Management of Gallstone Disease." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Company. 1997.

PERIODICALS

Cotton, Peter B., and Robert H. Hawes. "Therapeutic Biliary Endoscopy." *Gastrointestinal Endoscopy Clinics of North America* (Jan. 1996): 1-263.

Lee, Young-Mee, and Marshall M. Kaplan. "Primary Sclerosing Cholangitis." *New England Journal of Medicine* 332, no. 14 (1995): 924.

OTHER

"Endoscopic Retrograde Cholangiopancreatography (ERCP)." *American Society for Gastrointestinal Endoscopy.* <http://www.asge.org>.

"Gallstones." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.
Kaminstein, David S. "Gallstones." *A Healthy Me Page*. <http://www.ahealthyme.com/topic/cholangitis>.
"Primary Sclerosing Cholangitis." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.
Worman, Howard J. "Sclerosing Cholangitis." *Columbia University Health Sciences Page*. <http://cpmcnet.columbia.edu/dept/gi/PSC.html>.
"Your Digestive System and How It Works." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.

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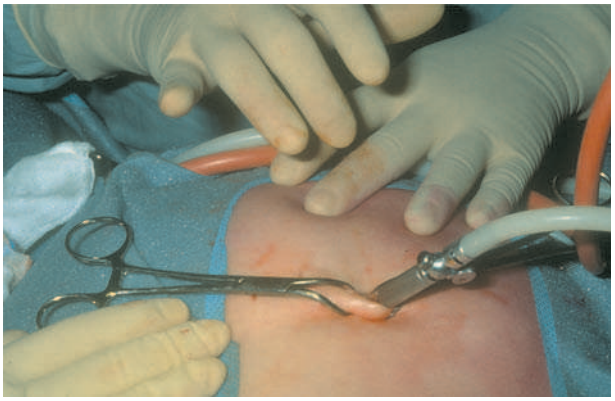

A surgeon performs a laparoscopic cholecystectomy on a patient. *(Custom Medical Stock Photo. Reproduced by permission.)*

Cholecystectomy

Definition

A cholecystectomy is the surgical removal of the gallbladder. The two basic types of this procedure are open cholecystectomy and the laparoscopic approach. It is estimated that the laparoscopic procedure is currently used for approximately 80% of cases.

Purpose

A cholecystectomy is performed to treat cholelithiasis and **cholecystitis**. In cholelithiasis, **gallstones** of varying shapes and sizes form from the solid components of bile. The presence of stones, often referred to as gallbladder disease, may produce symptoms of excruciating right upper abdominal **pain** radiating to the right shoulder. The gallbladder may become the site of acute infection and inflammation, resulting in symptoms of upper right abdominal pain, **nausea and vomiting**. This condition is referred to as cholecystitis. The surgical removal of the gallbladder can provide relief of these symptoms.

Precautions

Although the laparoscopic procedure requires general anesthesia for about the same length of time as the open procedure, **laparoscopy** generally produces less postoperative pain, and a shorter recovery period. The laparoscopic procedure would not be preferred in cases where the gallbladder is so inflamed that it could rupture, or when adhesions (additional fibrous bands of tissue) are present.

Description

The laparoscopic cholecystectomy involves the insertion of a long narrow cylindrical tube with a camera on the end, through an approximately 1 cm incision in the abdomen, which allows visualization of the internal organs and projection of this image onto a video monitor. Three smaller incisions allow for insertion of other instruments to perform the surgical procedure. A laser may be used for the incision and cautery (burning unwanted tissue to stop bleeding), in which case the procedure may be called laser laparoscopic cholecystectomy.

In a conventional or open cholecystectomy, the gallbladder is removed through a surgical incision high in the right abdomen, just beneath the ribs. A drain may be inserted to prevent accumulation of fluid at the surgical site.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Food and fluids will be prohibited after midnight before the procedure. **Enemas** may be ordered to clean out the bowel. If nausea or vomiting are present, a suction tube to empty the stomach may be used, and for laparoscopic procedures, a urinary drainage catheter will also be used to decrease the risk of accidental puncture of the stomach or bladder with insertion of the trocar (a sharp-pointed instrument).

Aftercare

Post-operative care for the patient who has had an open cholecystectomy, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respiration and temperature. Breathing tends to be shallow because of the effect of anesthesia, and the patient's reluctance to breathe deeply due to the pain caused by the proximity of the incision to the muscles used for respiration. The patient is shown how to support the operative site when breathing deeply and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the

KEY TERMS

Cholecystitis—Infection and inflammation of the gallbladder, causing severe pain and rigidity in the upper right abdomen.

Cholelithiasis—Also known as gallstones, these hard masses are formed in the gallbladder or passages, and can cause severe upper right abdominal pain radiating to the right shoulder, as a result of blocked bile flow.

Gallbladder—A hollow pear-shaped sac on the under surface of the right lobe of the liver. Bile comes to it from the liver, and passes from it to the intestine to aid in digestion.

operative site is observed for color and amount of wound drainage. Fluids are given intravenously for 24–48 hours, until the patient's diet is gradually advanced as bowel activity resumes. The patient is generally encouraged to walk 8 hours after surgery and is discharged from the hospital within three to five days, with return to work approximately four to six weeks after the procedure.

Care received immediately after laparoscopic cholecystectomy is similar to that of any patient undergoing surgery with general anesthesia. A unique post-operative pain may be experienced in the right shoulder related to pressure from carbon dioxide used through the laparoscopic tubes. This pain may be relieved by laying on the left side with right knee and thigh drawn up to the chest. Walking will also help increase the body's reabsorption of the gas. The patient is usually discharged the day after surgery, and allowed to shower on the second postoperative day. The patient is advised to gradually resume normal activities over a three day period, while avoiding heavy lifting for about 10 days.

Risks

Potential problems associated with open cholecystectomy include respiratory problems related to location of the incision, wound infection, or **abscess** formation. Possible complications of laparoscopic cholecystectomy include accidental puncture of the bowel or bladder and uncontrolled bleeding. Incomplete reabsorption of the carbon dioxide gas could irritate the muscles used in respiration and cause respiratory distress.

Resources

BOOKS

Monahan, Frances, and Marianne Neighbors. *Medical Surgical Nursing:Foundations in Clinical Practice*. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Wilson, R. G., et al. "Laparoscopic Cholecystectomy as a Safe and Effective Treatment for Severe Acute Cholecystitis." *British Medical Journal* (15 Aug. 1992): 394-6.

OTHER

"Gallstones and Laparoscopic Cholecystectomy." *Centers for Disease Control and Prevention*. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

"Patient Information Documents on Digestive Diseases." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.

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Cholecystitis

Definition

Cholecystitis refers to a painful inflammation of the gallbladder's wall. The disorder can occur a single time (acute), or can recur multiple times (chronic).

Description

The gallbladder is a small, pear-shaped organ in the upper right hand corner of the abdomen. It is connected by a series of ducts (tube-like channels) to the liver, pancreas, and duodenum (first part of the small intestine). To aid in digestion, the liver produces a substance called bile, which is passed into the gallbladder. The gallbladder concentrates this bile, meaning that it reabsorbs some of the fluid from the bile to make it more potent. After a meal, bile is squeezed out of the gallbladder by strong muscular contractions, and passes through a duct into the duodenum. Due to the chemical makeup of bile, the contents of the duodenum are kept at an optimal pH level for digestion. The bile also plays an important part in allowing fats within the small intestine to be absorbed.

Causes and symptoms

In about 95% of all cases of cholecystitis, the gallbladder contains **gallstones**. Gallstones are solid accumulations of the components of bile, particularly cholesterol, bile pigments, and calcium. These solids may occur when the components of bile are not in the correct proportion to each other. If the bile becomes overly concentrated, or if too much of one component is present, stones may form. When these stones block the duct leaving the gallbladder, bile accumulates within the gallbladder. The gallbladder continues to contract, but the bile

cannot pass out of the gallbladder in the normal way. Back pressure on the gallbladder, chemical changes from the stagnating bile trapped within the gallbladder, and occasionally bacterial infection, result in damage to the gallbladder wall. As the gallbladder becomes swollen, some areas of the wall do not receive adequate blood flow, and lack of oxygen causes cells to die.

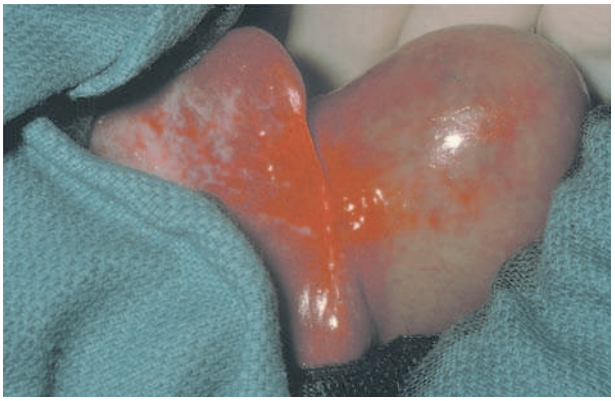
When the stone blocks the flow of bile from the liver, certain normal byproducts of the liver's processing of red blood cells (called bilirubin) build up. The bilirubin is reabsorbed into the bloodstream, and over time this bilirubin is deposited in the skin and in the whites of the eyes. Because bilirubin contains a yellowish color, it causes a yellowish cast to the skin and eyes that is called **jaundice**.

Gallstone formation is seen in twice as many women as men, particularly those between the ages of 20 and 60. Pregnant women, or those on birth control pills or estrogen replacement therapy have a greater risk of gallstones, as do Native Americans and Mexican Americans. People who are overweight, or who lose a large amount of weight quickly are also at greater risk for developing gallstones. Not all individuals with gallstones will go on to have cholecystitis, since many people never have any symptoms from their gallstones and never know they exist. However, the vast majority of people with cholecystitis will be found to have gallstones. Rare causes of cholecystitis include severe **burns** or injury, massive systemic infection, severe illness, diabetes, obstruction by a tumor of the duct leaving the gallbladder, and certain uncommon infections of the gallbladder (including bacteria and worms).

Although there are rare reports of patients with chronic cholecystitis who never experience any **pain**, nearly 100% of the time cholecystitis will be diagnosed after a patient has experienced a bout of severe pain in the region of the gallbladder and liver. The pain may be crampy and episodic, or it may be constant. The pain is often described as pushing through to the right upper back and shoulder. Because deep breathing increases the pain, breathing becomes shallow. **Fever** is often present, and **nausea and vomiting** are nearly universal. Jaundice occurs when the duct leaving the liver is also obstructed, although it may take a number of days for it to become apparent. When bacterial infection sets in, the patient may begin to experience higher fever and shaking chills.

Diagnosis

Diagnosis of cholecystitis involves a careful abdominal examination. The enlarged, tender gallbladder may be felt through the abdominal wall. Pressure in the upper right corner of the abdomen may cause the patient to stop breathing in, due to an increase in pain. This is called Murphy's sign. **Physical examination** may also reveal an increased heart rate and an increased rate of breathing.



A close-up view of an inflamed gallbladder. *(Custom Medical Stock Photo. Reproduced by permission.)*

Blood tests will show an increase in the white **blood count**, as well as an increase in bilirubin. Ultrasound is used to look for gallstones and to measure the thickness of the gallbladder wall (a marker of inflammation and scarring). A scan of the liver and gallbladder, with careful attention to the system of ducts throughout (called the biliary tree) is also used to demonstrate obstruction of ducts.

Rare complications of cholecystitis include:

- massive infection of the gallbladder, in which the gallbladder becomes filled with pus (called **empyema**)
- perforation of the gallbladder, in which the build-up of material within the gallbladder becomes so great that the wall of the organ bursts, with a resulting abdominal infection called **peritonitis**
- formation of abnormal connections between the gallbladder and other organs (the duodenum, large intestine, stomach), called fistulas
- obstruction of the intestine by a very large gallstone (called gallstone **ileus**)
- emphysema of the gallbladder, in which certain bacteria that produce gas infect the gallbladder, resulting in stretching of the gallbladder and disruption of its wall by gas

Treatment

Initial treatment of cholecystitis usually requires hospitalization. The patient is given fluids, salts, and sugars through a needle placed in a vein (intravenous or IV). No food or drink is given by mouth, and often a tube, called a nasogastric or NG tube, will need to be passed through the nose and down into the stomach to drain out

KEY TERMS

Bile—A substance produced by the liver, and concentrated and stored in the gallbladder. Bile contains many different substances, including bile salts, cholesterol, and bilirubin. After a meal, the gallbladder pumps bile into the duodenum (the first part of the small intestine) to keep the intestine's contents at the appropriate pH for digestion, and to help break down fats.

Bilirubin—Produced when red blood cells break down. It is a yellowish color and when levels are abnormally high, it causes the yellowish tint to eyes and skin known as jaundice.

Cholecystectomy—An operation to remove the gallbladder.

Cholecystotomy—An operation during which the gallbladder is opened, gallstones are removed, and excess bile is drained. The gallbladder is not removed.

Duct—A tube through which various substances can pass. These substances can travel through ducts to another organ or into the bloodstream.

the excess fluids. If infection is suspected, **antibiotics** are given.

Ultimately, treatment almost always involves removal of the gallbladder, a surgery called **cholecystectomy**. While this is not usually recommended while the patient is acutely ill, patients with complications usually do require emergency surgery (immediately following diagnosis) because the **death** rate increases in these cases. Similarly, those patients who have cholecystitis with no gallstones have about a 50% chance of death if the gallbladder is not quickly removed. Most patients, however, do best if surgery is performed after they have been stabilized with fluids, an NG tube, and antibiotics as necessary. When this is possible, gallbladder removal is done within five to six days of diagnosis. In patients who have other serious medical problems that may increase the risks of gallbladder removal surgery, the surgeon may decide to leave the gallbladder in place. In this case, the operation may involve removing obstructing gallstones and draining infected bile (called cholecystotomy).

Both cholecystectomy and cholecystotomy may be performed via the classical open abdominal operation (laparotomy). Tiny, "keyhole" incisions, a flexible scope, and a laser device that shatters the stones (a laparoscopic laser) can be used to destroy the gallstones. The laparoscopic procedure can also be used to remove the gallbladder through one of the small incisions. Because of the smaller incisions, laparoscopic cholecystectomy is a procedure that is less painful and promotes faster healing.

Prognosis

Hospital management of cholecystitis ends the symptoms for about 75% of all patients. Of these patients, however, 25% will go on to have another attack of cholecystitis within a year, and 60% will have another attack within six years. Each attack of cholecystitis increases a patient's risk of developing life-threatening complications, requiring risky emergency surgery. Therefore, early removal of the gallbladder, rather than a "wait-and-see" approach, is usually recommended. Cure is complete in those patients who undergo cholecystectomy.

Prevention

Prevention of cholecystitis is probably best attempted by maintaining a reasonably ideal weight. Some studies have suggested that eating a diet high in fiber, vegetables, and fruit is also protective.

Resources

BOOKS

Greenberger, Norton J., and Kirk J. Isselbacher. "Acute and Chronic Cholecystitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Chung, Shing C. "Acute Acalculous Cholecystitis." *Postgraduate Medicine* 98, no. 3 (Sept. 1995): 199+.

Lewis, R. "Gallbladder: An Organ You Can Live Without." *FDA Consumer* 25, no. 4 (1991): 13+.

Lo, Chung-Mau, et al. "Early Decision for Conversion of Laparoscopic Cholecystectomy for Treatment of Acute Cholecystitis." *American Journal of Surgery* 173, no. 6 (June 1997): 513+.

ORGANIZATIONS

Digestive Disease National Coalition. 507 Capitol Court NE, Suite 200, Washington, DC 20003. (202) 544-7497. <http://www.ddnc.org>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Rosalyn Carson-DeWitt, MD

Cholecystography *see* **Gallbladder x rays**

Choledocholithiasis *see* **Gallstones**

Cholelithiasis *see* **Gallstones**

Cholelithotomy *see* **Gallstone removal**

Cholera

Definition

Cholera is an acute illness characterized by watery **diarrhea** that is caused by the bacterium *Vibrio cholerae*. Cholera is spread by eating food or drinking water contaminated with the bacteria. Although cholera was a public health problem in the United States and Europe a hundred years ago, modern sanitation and the treatment of drinking water have virtually eliminated the disease in developed countries. In third world countries, however, cholera is still common.

Description

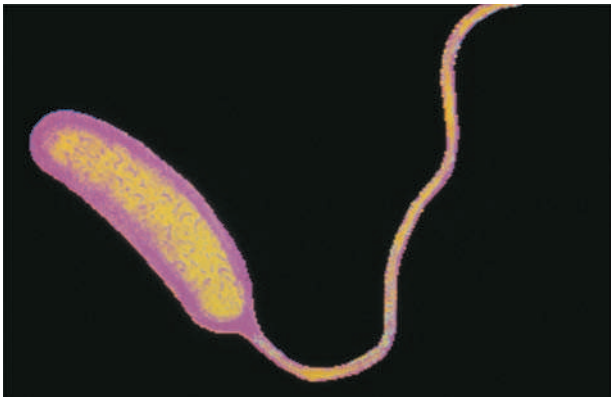
Cholera is spread by eating food or drinking water that has been contaminated with cholera bacteria. Contamination usually occurs when human feces from a person who has the disease seeps into a community water supply. Fruits and vegetables can also be contaminated in areas where crops are fertilized with human feces. Cholera bacteria also live in warm, brackish water and can infect persons who eat raw or undercooked seafood obtained from such waters. Cholera is rarely transmitted directly from one person to another.

Cholera often occurs in outbreaks or epidemics. The World Health Organization (WHO) estimates that during any cholera epidemic, approximately 0.2–1% of the local population will contract the disease. Anyone can get cholera, but infants, children, and the elderly are more likely to die from the disease because they become dehydrated faster than adults. There is no particular season in which cholera is more likely to occur.

Because of an extensive system of sewage and water treatment in the United States, Canada, Europe, Japan, and Australia, cholera is generally not a concern for visitors and residents of these countries. People visiting or living in other parts of the world, particularly on the Indian subcontinent and in parts of Africa and South America, should be aware of the potential for contracting cholera and practice prevention. Fortunately, the disease is both preventable and treatable.

Causes and symptoms

Because *V. cholerae* bacteria are sensitive to acid, most cholera-causing bacteria die in the acidic environment of the stomach. However, when a person has ingested food or water containing large amounts of cholera bacteria, some will survive to infect the intestines. As would be expected, antacid usage or the use of any medication that blocks acid production in the stomach would allow more bacteria to survive and cause infection.



A false color transmission electron micrograph (TEM) of *Vibrio cholerae* bacterium magnified 6,000 times its original size. *(Photography by T. McCarthy, Custom Medical Stock Photo. Reproduced by permission.)*

In the small intestine, the rapidly multiplying bacteria produce a toxin that causes a large volume of water and electrolytes to be secreted into the bowels and then to be abruptly eliminated as watery diarrhea. Vomiting may also occur. Symptoms begin to appear between one and three days after the contaminated food or water has been ingested.

Most cases of cholera are mild, but about one in 20 patients experience severe, potentially life-threatening symptoms. In severe cases, fluids can be lost through diarrhea and vomiting at the rate of one quart per hour. This can produce a dangerous state of **dehydration** unless the lost fluids and electrolytes are rapidly replaced.

Signs of dehydration include intense thirst, little or no urine output, dry skin and mouth, an absence of tears, glassy or sunken eyes, muscle cramps, weakness, and rapid heart rate. The soft spot on an infant's head will appear to be sunken or drawn in. Dehydration occurs most rapidly in the very young and the very old because they have fewer fluid reserves. A doctor should be consulted immediately any time signs of severe dehydration occur. Immediate replacement of the lost fluids and electrolytes is necessary to prevent kidney failure, **coma**, and **death**.

Diagnosis

Rapid diagnosis of cholera can be made by examining a fresh stool sample under the microscope for the

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Electrolytes—Salts and minerals that ionize in body fluids. Common human electrolytes are sodium, chloride, potassium, and calcium. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost all major biochemical reactions in the body.

Toxin—A poison. In the case of cholera, a poison secreted as a byproduct of the growth of the cholera bacteria in the small intestine.

presence of *V. cholerae* bacteria. Cholera can also be diagnosed by culturing a stool sample in the laboratory to isolate the cholera-causing bacteria. In addition, a blood test may reveal the presence of antibodies against the cholera bacteria. In areas where cholera occurs often, however, patients are usually treated for diarrhea and vomiting symptoms as if they had cholera without laboratory confirmation.

Treatment

The key to treating cholera lies in preventing dehydration by replacing the fluids and electrolytes lost through diarrhea and vomiting. The discovery that rehydration can be accomplished orally revolutionized the treatment of cholera and other, similar diseases by making this simple, cost-effective treatment widely available throughout the world. The World Health Organization has developed an inexpensive oral replacement fluid containing appropriate amounts of water, sugar, and salts that is used worldwide. In cases of severe dehydration, replacement fluids must be given intravenously. Patients should be encouraged to drink when they can keep liquids down and eat when their appetite returns. Recovery generally takes three to six days.

Adults may be given the antibiotic tetracycline to shorten the duration of the illness and reduce fluid loss. The World Health Organization recommends this antibiotic treatment only in cases of severe dehydration. If **antibiotics** are overused, the cholera bacteria organism may become resistant to the drug, making the antibiotic ineffective in treating even severe cases of cholera. Tetracycline is not given to children whose permanent teeth have not come in because it can cause the teeth to become permanently discolored.

Prognosis

Today, cholera is a very treatable disease. Patients with milder cases of cholera usually recover on their own in three to six days without additional complications. They may eliminate the bacteria in their feces for up to two weeks. Chronic carriers of the disease are rare. With prompt fluid and electrolyte replacement, the death rate in patients with severe cholera is less than 1%. Untreated, the death rate can be greater than 50%. The difficulty in treating severe cholera is not in knowing how to treat it, but in getting medical care to ill people in underdeveloped areas of the world where medical resources are limited.

Prevention

The best form of cholera prevention is to establish good sanitation and waste treatment systems. In the absence of adequate sewage treatment, the following guidelines should be followed to reduce the possibility of infection:

- Boil it. Drink and brush teeth only with water that has been boiled or treated with chlorine or iodine tablets. Safe drinks include coffee and tea made with boiling water or carbonated bottled water and carbonated soft drinks.
- Cook it. Eat only thoroughly cooked foods, and eat them while they are still hot. Avoid eating food from street vendors.
- Peel it. Eat only fruit or nuts with a thick, intact skin or shell that is removed immediately before eating.
- Forget it. Do not eat raw foods such as oysters or ceviche. Avoid salads and raw vegetables. Do not use untreated ice cubes in otherwise safe drinks.
- Stay out of it. Do not swim or fish in polluted water.

A cholera vaccine exists that can be given to travelers and residents of areas where cholera is known to be active, but the vaccine is not highly effective. It provides only 25–50% immunity, and then only for a period of about six months. The vaccine is never given to infants under six months of age. The United States Centers for Disease Control and Prevention do not currently recommend cholera **vaccination** for travelers. Residents of cholera-plagued areas should discuss the value of the vaccine with their doctor.

Resources

BOOKS

USP DI-Volume II, Advice for the Patient: Drug Information in Lay Language. 17th ed. 1997.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435. (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Cholera Prevention." *Centers for Disease Control and Prevention*. 9 Aug. 1996 <http://www.cdc.gov/ncidod/diseases/cholera/cholera.htm>.

Travel Health Information Page. 5 Mar. 1997 <http://www.travelhealth.com>.

Tish Davidson

Cholestasis

Definition

Cholestasis is a condition caused by rapidly developing (acute) or long-term (chronic) interruption in the excretion of bile (a digestive fluid that helps the body process fat). The term is taken from the Greek *chole*, bile, and *stasis*, standing still.

Description

Cholestasis is caused by obstruction within the liver (intrahepatic) or outside the liver (extrahepatic). The obstruction causes bile salts, the bile pigment bilirubin, and fats (lipids) to accumulate in the blood stream instead of being eliminated normally.

Intrahepatic cholestasis is characterized by widespread blockage of small ducts or by disorders, such as hepatitis, that impair the body's ability to eliminate bile. Extrahepatic cholestasis can occur as a side effect of many medications. It can also occur as a complication of surgery, serious injury, tissue-destroying infection, or intravenous feeding. Extrahepatic cholestasis can be caused by conditions such as tumors and **gallstones** that block the flow of bile from the gallbladder to the first part of the small intestine (duodenum).

Pregnancy increases the sensitivity of the bile ducts to estrogen, and cholestasis often develops during the second and third trimesters of pregnancy. This condition is the second most common cause of **jaundice** during pregnancy, but generalized **itching** (pruritus gravidarum) is the only symptom most women experience. Cholestasis of pregnancy tends to run in families. Symptoms usually disappear within two to four weeks after the baby's birth but may reappear if the woman becomes pregnant again.

A similar condition affects some women who take birth-control pills. Symptoms disappear after the woman stops using **oral contraceptives**. This condition does not lead to chronic liver disease. A woman who develops cholestasis from either of these causes (pregnancy or birth control hormones) has an increased risk of developing cholestasis from the other.

Benign familial recurrent cholestasis is a rare condition characterized by brief, repeated episodes of itching and jaundice. Symptoms often disappear. This condition does not cause **cirrhosis**.

Drug-induced cholestasis may be a complication of **chemotherapy** or other medications. The two major types of drug-induced cholestasis are direct toxic injury and reactions unique to an individual (idiosyncratic reactions). In direct toxic injury, the severity of symptoms parallels the amount of medication involved. This condition:

- develops a short time after treatment begins
- follows a predictable pattern
- usually causes liver damage

Direct toxic reactions develop in 1% of all patients who take chlorpromazine (Thorazine), a tranquilizer and antinausea drug. Idiosyncratic reactions may occur at the onset of treatment or at a later time. Allergic responses are varied and are not related to the amount of medication being taken.

Causes and symptoms

Intrahepatic cholestasis is usually caused by hepatitis or by medications that can produce symptoms resembling hepatitis. Phenothiazine-derivative drugs, including chlorpromazine, can cause sudden **fever** and inflammation. Symptoms usually disappear after use of the drug(s) is stopped. In rare cases, a condition resembling chronic biliary cirrhosis (a progressive disease characterized by destruction of small bile ducts) persists even after the medication is stopped. Some patients experience a similar reaction in response to tricyclic antidepressants (amitriptyline, imipramine), phenylbutazone (Butazolidin), erythromycin estolate (Estomycin, Purmycin), and other drugs. Intrahepatic cholestasis may also be caused by alcoholic liver disease, **primary biliary cirrhosis**, **cancer** that has spread (metastasized) from another part of the body, and a number of rare disorders.

Extrahepatic cholestasis is most often caused by a stone obstructing the passage through which bile travels from the gallbladder to the small intestine (common bile duct) or by pancreatic cancer. Less often, the condition occurs as a result of non-cancerous narrowing of the common duct (strictures), ductal carcinoma, or disorders of the pancreas.

Cholestasis caused by the use of steroids causes little, if any, inflammation. Symptoms develop gradually

KEY TERMS

Bile—A bitter yellow-green substance produced by the liver. Bile breaks down fats in the small intestine so that they can be used by the body. It is stored in the gallbladder and passes from the gallbladder through the common bile duct to the top of the small intestine (duodenum) as needed to digest fat.

Biliary—Of bile or of the gallbladder and bile ducts that transport bile and make up the biliary system or tract.

Endoscopic retrograde cholangiopancreatography—A diagnostic procedure for mapping the pancreatic and common bile ducts. A flexible tube with a light transmitter (fiberoptics) is placed in the duct. A contrast dye is instilled directly into the duct and a series of x-ray images are taken.

Computed tomography scans (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Hepatic—Of the liver, from the Greek *hepar*.

Liver function tests—Tests used to evaluate liver metabolism, storage, filtration, and excretion. The tests include alkaline phosphatase and serum alanine aminotransferase and aspartate aminotransferase.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Percutaneous transhepatic cholangiography—An x-ray examination of the bile ducts. A needle is passed through the skin (percutaneous) across or over the liver (transhepatic) and directly into a bile duct to inject a contrast dye. The dye enhances the x-ray image mapping the system of bile ducts (cholangiography).

Phenothiazine-derivative drugs—A large family of drugs derived from phenothiazine, a compound that in itself is too poisonous for human consumption. Phenothiazine derivatives include tranquilizers, medications that prevent vomiting, antihistamines, and drugs used to enhance the effectiveness of anesthesia.

Ultrasonography—A test using sound waves to measure blood flow. Gel is applied to a hand-held transducer that is pressed against the patient's body. Images are displayed on a monitor.

and usually disappear after the drug is discontinued. Other drugs that can cause cholestasis include:

- allopurinol (Zyloprim)
- amitriptyline (Elavil)
- azathioprine (Imuran)
- benoxaprofen (Oraflex)
- capotril (Capoten)
- carbamazepine (Tegretol)
- cimetidine (Tagamet)
- hydralazine hydrochloride (Apresoline Hydrochloride)
- imipramine (Tofranil)
- penicillin
- quinidine sulfate (Quinidex)
- ranitidine (Zantac)
- sulfonamides (Apo-Sulfatrim, sulfamethoxazole)
- sulindac (Clinoril, Saldac)

Symptoms of both intrahepatic and extrahepatic cholestasis include a yellow discoloration of the skin (jaundice), dark urine, and pale stools. Itching over the skin may be severe if the condition is advanced.

Symptoms of chronic cholestasis include:

- skin discoloration
- scars or skin injuries caused by scratching
- bone **pain**
- yellowish fat deposits beneath the surface of the skin (xanthoma) or around the eyes (xanthelasma)

Patients with advanced cholestasis feel ill, tire easily, and are often nauseated. Abdominal pain and such systemic symptoms as anorexia, vomiting, and fever are usually due to the underlying condition that causes cholestasis.

Diagnosis

Determining whether obstruction exists inside or outside the liver is the essential part of diagnosis. A his-

tory of hepatitis or heavy drinking, recent use of certain drugs, and symptoms like **ascites** (abnormal abdominal swelling) and splenomegaly (enlarged spleen) suggest intrahepatic cholestasis. Pain or rigidity in the gallbladder or pancreas suggest an extrahepatic form.

Blood tests and **liver function tests** can reveal the pattern and extent of liver injury, indicate functional abnormalities, and establish the cause of the condition. However, most misdiagnoses occur when physicians rely more on laboratory analysis than on detailed medical history and the results of a thorough **physical examination**. Special attention should be paid to three liver function tests. Levels of alkaline phosphatase (ALP), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) can indicate whether the patient's condition is caused by an obstructive condition like cholestasis or a disease of the liver cells (hepatocellular disease) like viral hepatitis or cancer. ALP levels more than three times greater than normal indicate cholestasis. High levels of AST and particularly of ALT, which is found predominantly in liver cells, indicate hepatocellular disease.

Once the disease pattern has been established, ultrasound may be performed to determine whether obstruction of the large duct has caused widening of small ducts located close to it. **Computed tomography scans** (CT) and **magnetic resonance imaging** (MRI) can provide more detailed information about the source of the obstruction. If these procedures that do not enter the patient's body (non-invasive procedures) do not provide the information a family physician, internist, or gastroenterologist needs to make a diagnosis of cholestasis, one of these procedures may be performed:

- direct cholangiography, an x-ray map of the bile ducts, enhanced by the use of contrast dye
- percutaneous transhepatic cholangiography, used to identify obstructions that impede the flow of bile from the liver to the digestive system, takes x-ray images of the bile ducts after a contrast dye has been injected by a needle passed directly into a hepatic duct
- endoscopic retrograde cholangiopancreatography (ERCP), which uses a special dye to outline the pancreatic and common bile ducts and highlight the position of any obstruction; a special tube with a light transmitter is inserted into the duct and a series of x-ray images is taken

A doctor who thinks a physical obstruction is responsible for progressive deterioration of a patient's condition may consider an exploratory surgical procedure (diagnostic laparotomy). **Liver biopsy** is sometimes performed if imaging tests do not indicate why a duct is enlarged, but results of a single biopsy may not represent the status of the entire organ.

Treatment

The goal of treatment is to eliminate or control the patient's symptoms. Discontinuing the use of certain drugs can restore normal liver function, but surgery may be needed to drain or remove obstructions or to widen affected ducts.

Rifampin (Rifadin, Rimactane), an antibacterial drug; phenobarbital, a barbiturate anticonvulsant; and other drugs are sometimes prescribed to cleanse the system and eliminate bile salts and other toxic compounds.

Patients who have chronic cholestasis and have trouble digesting fat may have to restrict the amount of fat in their diet and take calcium and water-soluble vitamin supplements. A liver transplant may become necessary if complications occur.

Prognosis

Symptoms almost always disappear after the underlying condition is controlled.

Some patients who have cholestasis experience symptoms only after infection develops, but chronic bile-duct obstruction always leads to cirrhosis. It may also cause **osteoporosis** (fragile bones) or osteomalacia (soft bones).

Emergency care is not required unless inflammation of the bile ducts (**cholangitis**) develops. Cancer should be considered when an adult suddenly develops cholestasis after the age of 50.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Pasha T. M., and K. D. Lindor. "Diagnosis and Therapy of Cholestatic Liver Disease." *Medical Clinics of North America* 80 (Sept. 1996): 995-1019.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

National Institute of Diabetes, Digestive, and Kidney Diseases of the National Institutes of Health. 31 Center Drive, Bethesda, MD 20892-2560. (301) 496-3583. <http://www.niddk.nih/gov>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

OTHER

"Hepatic and Biliary Disorders." *The Meck Page*. 13 Apr. 1998 <http://www.merck.com>.

Maureen Haggerty

Cholesterol, high

Definition

Cholesterol is a fatty substance found in animal tissue and is an important component to the human body. It is manufactured in the liver and carried throughout the body in the bloodstream. Problems can occur when too much cholesterol forms an accumulation of plaque on blood vessel walls, which impedes blood flow to the heart and other organs. The highest cholesterol content is found in meat, poultry, shellfish, and dairy products.

Description

Cholesterol is the Dr. Jekyll and Mr. Hyde of medicine, since it has both a good side and bad side. It is necessary to digest fats from food, make hormones, build cell walls, and participate in other processes for maintaining a healthy body. When people talk about cholesterol as a medical problem, they are usually referring to high cholesterol. This can be somewhat misleading, since there are four components to cholesterol. These are:

- LDL, the so-called bad cholesterol
- HDL, the so-called good cholesterol
- triglycerides, a blood fat lipid that increases the risk for heart disease
- total cholesterol

High LDL (low-density lipoprotein) is a major contributing factor of heart disease. The cholesterol forms plaque in the heart's blood vessels, which restricts or blocks the supply of blood to the heart, and causes a condition called **atherosclerosis**. This can lead to a "heart attack," resulting in damage to the heart and possibly **death**. The U.S. Food and Drug Administration (FDA) estimates that 90 million American adults, roughly half the adult population, have elevated cholesterol levels.

The population as a whole is at some risk of developing high LDL cholesterol in their lifetimes. Specific risk factors include a family history of high cholesterol, **obesity**, **heart attack** or **stroke**, **alcoholism**, and lack of regular **exercise**. The chances of developing high cholesterol increase after the age of 45. One of the primary causes of high LDL cholesterol is too much fat or sugar in the diet, a problem especially true in the United States. Cholesterol is also produced naturally in the liver and overproduction may occur even in people who limit their intake of high cholesterol food. Low HDL and high triglyceride levels are also risk factors for atherosclerosis.

Types Of Cholesterol

Types	Levels
Total cholesterol:	
Desirable	<200
Borderline	200 to 240
Undesirable	>240
HDL cholesterol:	
Desirable	>45
Borderline	35 to 45
Undesirable	<35
LDL cholesterol:	
Desirable	<130
Borderline	130 to 160
Undesirable	>160
Ratio of total cholesterol to HDL cholesterol:	
Desirable	<3
Borderline	3 to 4
Undesirable	>4

Causes and symptoms

There are no readily apparent symptoms that indicate high LDL or triglycerides, or low HDL. The only way to diagnose the problems is through a simple blood test. However, one general indication of high cholesterol is obesity. Another is a high-fat diet.

Diagnosis

High cholesterol is often diagnosed and treated by general practitioners or family practice physicians. In some cases, the condition is treated by an endocrinologist or cardiologist. Total cholesterol, LDL, HDL, and triglyceride levels as well as the cholesterol to HDL ratio are measured by a blood test called a lipid panel. The cost of a lipid panel is generally $40–100 and is covered by most health insurance and HMO plans, including Medicare, providing there is an appropriate reason for the test. Home cholesterol testing kits are available over the counter but test only for total cholesterol. The results should only be used as a guide and if the total cholesterol level is high or low, a lipid panel should be performed by a physician. In most adults the recommended levels, measured by milligrams per deciliter (mg/dL) of blood, are: total cholesterol, less than 200; LDL, less than 130; HDL, more than 35; triglycerides, 30–200; and cholesterol to HDL ratio, four to one. However, the recommended cholesterol levels may vary, depending on other risk factors such as **hypertension**, a family history of heart disease, diabetes, age, alcoholism, and **smoking**.

Doctors have always been puzzled by why some people develop heart disease while others with identical

HDL and LDL levels do not. New studies indicate it may be due to the size of the cholesterol particles in the bloodstream. A test called a nuclear magnetic resonance (NMR) LipoProfile exposes a blood sample to a magnetic field to determine the size of the cholesterol particles. Particle size can also be determined by a centrifugation test, where blood samples are spun very quickly to allow particles to separate and move at different distances. The smaller the particles, the greater the chance of developing heart disease. It allows physicians to treat patients who have normal or close to normal results from a lipid panel but abnormal particle size.

Treatment

A wide variety of prescription medicines are available to treat cholesterol problems. These include statins such as Mevacor (lovastatin), Lescol (fluvastatin), Pravachol (pravastatin), Zocor (simvastatin), Baycol (cervastatin), and Lipitor (atorvastatin) to lower LDL. A group of drugs called fibric acid derivatives are used to lower triglycerides and raise HDL. These include Lopid (gemfibrozil), Atromid-S (clofibrate), and Tricor (fenofibrate). Doctors decide which drug to use based on the severity of the cholesterol problem, side effects, and cost.

Alternative treatment

The primary goal of cholesterol treatment is to lower LDL to under 160 mg/dL in people without heart disease and who are at lower risk of developing it. The goal in people with higher risk factors for heart disease is less than 130 mg/dL. In patients who already have heart disease, the goal is under 100 mg/dL, according to FDA guidelines. Also, since low HDL levels increase the risks of heart disease, the goal of all patients is more than 35 mg/dL.

In both alternative and conventional treatment of high cholesterol, the first-line treatment options are exercise, diet, weight loss, and stopping smoking. Other alternative treatments include high doses of niacin, soy protein, garlic, algae, and the Chinese medicine supplement Cholestin (a red yeast fermented with rice).

Diet and exercise

Since a large number of people with high cholesterol are overweight, a healthy diet and regular exercise are probably the most beneficial natural ways to control cholesterol levels. In general, the goal is to substantially reduce or eliminate foods high in animal fat. These include meat, shellfish, eggs, and dairy products. Several specific diet options are beneficial. One is the vegetarian diet. Vegetarians typically get up to 100% more fiber and up to 50% less cholesterol from food than non-vegetarians. The vegetarian low-cholesterol diet consists of at least six servings of whole grain foods, three or more servings of green leafy vegetables, two to four servings of fruit, two to four servings of legumes, and one or two servings of non-fat dairy products daily.

A second diet is the Asian diet, with brown rice being the staple. Other allowable foods include fish, vegetables such as bok choy, bean sprouts, and black beans. It allows for one weekly serving of meat and very few dairy products. The food is flavored with traditional Asian spices and condiments, such as ginger, chilies, turmeric, and soy sauce.

Another regimen is the low glycemic or diabetic diet, which can raise the HDL (good cholesterol) level by as much as 20% in three weeks. Low glycemic foods promote a slow but steady rise in blood sugar levels following a meal, which increases the level of HDL. They also lower total cholesterol and triglycerides. Low glycemic foods include certain fruits, vegetables, beans, and whole grains. Processed and refined foods and sugars should be avoided.

Exercise is an extremely important part of lowering bad cholesterol and raising good cholesterol. It should consist of 20–30 minutes of vigorous aerobic exercise at least three times a week. Exercises that cause the heart to beat faster include fast walking, bicycling, jogging, roller skating, swimming, and walking up stairs. There are also a wide selection of aerobic programs available at gyms or on videocassette.

KEY TERMS

Atherosclerosis—A build-up of fatty substances in the inner layers of the arteries.

Estrogen—A hormone that stimulates development of female secondary sex characteristics.

Glycemic—The presence of glucose in the blood.

Hypertension—Abnormally high blood pressure in the arteries.

Legumes—A family of plants that bear edible seeds in pods, including beans and peas.

Lipid—Any of a variety of substances that, along with proteins and carbohydrates, make up the main structural components of living cells.

Polyunsaturated fats—A non-animal oil or fatty acid rich in unsaturated chemical bonds not associated with the formation of cholesterol in the blood.

Garlic

A number of clinical studies have indicated that garlic can offer modest reductions in cholesterol. A 1997 study by **nutrition** researchers at Pennsylvania State University found men who took garlic capsules for five months reduced their total cholesterol by 7% and LDL by 12%. Another study showed that seven cloves of fresh garlic a day significantly reduced LDL, as did a daily dose of four garlic extract pills. Other studies in 1997 and 1998 back up these results. However, two more recent studies have questioned the effectiveness of garlic in lowering "bad cholesterol."

Cholestin

Cholestin hit the over-the-counter market in 1997 as a cholesterol-lowering dietary supplement. It is a processed form of red yeast fermented with rice, a traditional herbal remedy used for centuries by the Chinese. Two studies released in 1998 showed Cholestin lowered LDL cholesterol by 20–30%. It also appeared to raise HDL and lower triglyceride levels. Although the supplement contains hundreds of compounds, the major active LDL-lowering ingredient is lovastatin, a chemical also found in the prescription drug Mevacor. The FDA banned Cholestin in early 1998 but a federal district court judge lifted the ban a year later, ruling the product was a dietary supplement, not a drug. It is not fully understood how the substance works and patients may want to consult with their physician before taking Cholestin. No serious side effects have been reported, but minor side effects, including bloating and **heartburn**, have been reported.

Other treatments

A study released in 1999 indicated that blue-green algae contains polyunsaturated fatty acids that lower cholesterol. The algae, known as alga *Aphanizomenon flos-aquae* (AFA) is available as an over-the-counter dietary supplement. Niacin, also known as nicotinic acid or vitamin B_3, has been shown to reduce LDL levels by 10–20%, and raise HDL levels by 15–35%. It also can reduce triglycerides. But because an extremely high dose of niacin (2–3 g) is needed to treat cholesterol problems, it should only be taken under a doctor's supervision to monitor possible toxic side effects. Niacin can also cause flushing when taken in high doses. Soy protein with high levels of isoflavones also have been shown to reduce bad cholesterol by up to 10%. A daily diet that contains 62 mg of isoflavones in soy protein is recommended, and can be incorporated into other diet regimens, including vegetarian, Asian, and low glycemic.

Prognosis

High cholesterol is one of the key risk factors for heart disease. Left untreated, too much bad cholesterol can clog the blood vessels, leading to chest **pain** (**angina**), blood clots, and heart attacks. Heart disease is the number one killer of men and women in the United States. By reducing LDL, people with heart disease may prevent further heart attacks and strokes, prolong and improve the quality of their lives, and slow or reverse cholesterol build-up in the arteries. In people without heart disease, lowering LDL can decrease the risk of a first heart attack or stroke.

Prevention

The best way to prevent cholesterol problems is through a combination of healthy lifestyle activities, a primarily low-fat and high-fiber diet, regular aerobic exercise, not smoking, and maintaining an optimal weight. But for people with high risk factors for heart disease, such as a family history of heart disease, diabetes, and being over the age of 45, these measures may not be enough to prevent the onset of high cholesterol. There are studies being done on the effectiveness of some existing anti-cholesterol drugs for controlling cholesterol levels in patients who do not meet the criteria for high cholesterol but no definitive results are available.

Resources

BOOKS

Bratman, Steven, and David Kroll. *Natural Pharmacist: Natural Treatments for High Cholesterol*. Roseville, CA: Prima Publishing, 2000.

Ingels, Darin. *The Natural Pharmacist: Your Complete Guide to Garlic and Cholesterol*. Roseville, CA: Prima Publishing, 1999.

Murray, Michael T. *Natural Alternatives to Over-the-Counter and Prescription Drugs*. New York: William Morrow & Co., 1999.

Trubo, Richard. *Cholesterol Cures: From Almonds and Antioxidants to Garlic, Golf, Wine and Yogurt*. Emmaus, PA: Rodale Press, 1996.

PERIODICALS

Carter, Ann. "Cholesterol in Your Diet." *Clinical Reference Systems* (July 1, 1999): 282.

Marandino, Cristin. "The Case for Cholesterol." *Vegetarian Times* (August 1999): 10.

Schmitt, B.D. "Treating High Cholesterol Levels." *Clinical Reference Systems* (July 1, 1999): 1551.

VanTyne, Julia, and Davis, Lori. "Drop Your Cholesterol 25 to 100 Points." *Prevention* (November 1999): 110.

ORGANIZATIONS

National Cholesterol Education Program. NHLBI Information Center, P.O. Box 30105, Bethesda, MD 20824-0105. <http://www.nhlbi.nih.gov>.

Ken R. Wells

Cholesterol-reducing drugs

Definition

Cholesterol-reducing drugs are medicines that lower the amount of cholesterol (a fat-like substance) in the blood.

Purpose

Cholesterol is a chemical that can both benefit and harm the body. On the good side, cholesterol plays important roles in the structure of cells and in the production of hormones. But too much cholesterol in the blood can lead to heart and blood vessel disease. To complicate matters, not all cholesterol contributes to heart and blood vessel problems. One type, called high-density lipoprotein (HDL) cholesterol, or "good cholesterol," actually lowers the risk of these problems. The other type, low-density lipoprotein (LDL) cholesterol, or "bad cholesterol," is the type that threatens people's health. The names reflect the way cholesterol moves through the body. To travel through the bloodstream, cholesterol must attach itself to a protein. The combination of a protein and a fatty substance like cholesterol is called a lipoprotein.

Many factors may contribute to the fact that some people have higher cholesterol levels than others. A diet high in certain types of fats is one factor. Medical problems such as poorly controlled diabetes, an underactive thyroid gland, an overactive pituitary gland, liver disease or kidney failure also may cause **high cholesterol** levels. And some people have inherited disorders that prevent their bodies from properly using and eliminating fats. This allows cholesterol to build up in the blood.

Treatment for high cholesterol levels usually begins with changes in daily habits. By losing weight, stopping **smoking**, exercising more and reducing the amount of fat and cholesterol in the diet, many people can bring their cholesterol levels down to acceptable levels. However, some may need to use cholesterol-reducing drugs to reduce their risk of health problems.

Description

There are four different classes of cholesterol lowering drugs:

Bile acid sequesterants are drugs that act by binding with the bile produced by the liver. Bile helps the digestion and absorption of fats in the intestine. By blocking the digestion of fats, bile acid sequesterants prevent the formation of cholesterol. Drugs in this class include: cholestyramine (Questran); colestipol (Colestid); and colesevalam (Welchol).

HMG-CoA inhibitors, often called "statins," are drugs that block an enzyme called "3-hydroxy-3-methyl-glutaryl-coenzyme A reductase." This blocks one of the steps in converting fat to cholesterol. These are the most effective cholesterol lowering agents available. Drugs in this group include: atorvastatin (Lipitor); cerivastatin (Baycol); fluvastatin (Lescol); lovastatin (Mevacor); pravastatin (Pravachol); and simvastatin (Zocor).

Fibric acid derivatives include clofibrate (Atromid-S); gemfibrozil (Lopid); and fenofibrate (Tricor). Although these drugs are less effective than the statins at lowering total cholesterol, they may be able to lower the low-density lipoprotein (LDL) cholesterol while raising the high-density lipoprotein (HDL) cholesterol. Their exact mechanism of action is believed to be associated with inhibition of lipoprotein lipase activity.

Niacin, vitamin B-3, is also effective in lowering cholesterol levels. Although the normal vitamin dose of niacin is only 20 mg, the dose required to reduce cholesterol levels is at least 500 mg each day. The mechanism of action of niacin in cholesterol reduction is associated with the inhibition of VLDL secretion in the bloodstream.

Recommended dosage

The recommended dosage depends on the type of cholesterol-reducing drug used. The prescribing physician or the pharmacist who filled the prescription can advise about the correct dosage.

Cholesterol-reducing drugs should be taken exactly as directed and doses should not be missed. Double doses should not be taken to make up for a missed dose.

Physicians may prescribe a combination of cholesterol-reducing drugs, such as pravastatin and colestipol. Following the directions for how and when to take the drugs is very important. The medicine may not work properly if both drugs are taken at the same time of day.

Niacin should not be taken at the same time as an HMG-CoA inhibitor, as this combination may cause severe muscle problems. If niacin is taken in an over-the-counter form, both the prescribing physician and pharmacist should be informed. There are no problems when the niacin is taken in normal doses as a vitamin.

The prescription should not be stopped without first checking with the physician who prescribed it. Cholesterol levels may increase when the medicine is stopped, and the physician may prescribe a special diet to make this less likely.

Precautions

Seeing a physician regularly while taking cholesterol-reducing drugs is important. The physician will check to

make sure the medicine is working as it should and will decide whether it is still needed. Blood tests and other medical tests may be ordered to help the physician monitor the drug's effectiveness and check for side effects.

For most people, cholesterol-reducing drugs are just one part of a whole program for lowering cholesterol levels. Other important elements of the program may include weight loss, **exercise**, special **diets** and changes in other habits. The medication should never be viewed as a substitute for other measures ordered by the physician. Cholesterol-reducing drugs will not cure problems that cause high cholesterol; they will only help control cholesterol levels.

People over 60 years of age may be unusually sensitive to the effects of some cholesterol-reducing drugs. This may increase the chance of side effects.

Anyone who is taking an HMG-CoA reductase inhibitor should notify the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Special conditions

People who have certain medical conditions or who are taking certain other medications may have problems if they take cholesterol-reducing drugs. Before taking these drugs, the prescribing physician should be informed of any of the following conditions:

ALLERGIES. Anyone who has had unusual reactions to cholesterol-reducing drugs in the past should inform the prescribing physician before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Studies of laboratory animals have shown that giving high doses of gemfibrozil during **pregnancy** increases the risk of **birth defects** and other problems, including **death** of the unborn baby. The effects of this drug have not been studied in pregnant women. Women who are pregnant or who may become pregnant should check with their physicians before using gemfibrozil.

Cholesterol-reducing drugs in the group known as HMG-CoA reductase inhibitors (such as lovastatin, fluvastatin, pravastatin and simvastatin) should not be taken by women who are pregnant or who plan to become pregnant soon. By blocking the production of cholesterol, these drugs prevent a fetus from developing properly. Women who are able to bear children should use an effective birth control method while taking these drugs. Any woman who becomes pregnant while taking these drugs should check with her physician immediately.

Cholestyramine and colestipol will not directly harm an unborn baby, because these drugs are not taken into the body. However, the drugs may keep the mother's body from absorbing **vitamins** that she and the baby need. Pregnant women who take these drugs should ask their physicians whether they need to take extra vitamins.

BREASTFEEDING. Because cholestyramine and colestipol interfere with the absorption of vitamins, women who use these drugs while breastfeeding should ask their physicians if they need to take extra vitamins.

Women who are breastfeeding should talk to their physicians before using gemfibrozil. Whether this drug passes into breast milk is not known. But because animal studies suggest that it may increase the risk of some types of **cancer**, women should carefully consider the safety of using it while breastfeeding.

HMG-CoA reductase inhibitors (such as lovastatin, pravastatin, fluvastatin and simvastatin) should not be used by women who are breastfeeding their babies.

OTHER MEDICAL CONDITIONS. Cholesterol-reducing drugs may make some medical problems worse. Before using these drugs, people with any of these medical conditions should make sure their physicians are aware of their conditions:

- stomach problems, including stomach ulcer
- **constipation**
- hemorrhoids
- **gallstones** or gallbladder disease
- bleeding problems
- underactive thyroid
- heart or blood vessel disease

In addition, people with kidney or liver disease may be more likely to have blood problems or other side effects when they take certain cholesterol-reducing drugs. And some drugs of this type may actually raise cholesterol levels in people with liver disease.

Patients with any of the following medical conditions may develop problems that could lead to kidney failure if they take HMG-CoA reductase inhibitors:

- treatments to prevent rejection after an organ transplant
- recent major surgery
- seizures (convulsions) that are not well controlled

People with **phenylketonuria** (PKU) should be aware that sugar-free formulations of some cholesterol-reducing drugs contain phenylalanine in aspartame. This ingredient can cause problems in people who have phenylketonuria.

USE OF CERTAIN MEDICINES. Cholesterol-reducing drugs may change the effects of other medicines. Patients should not take any other medicine that has not been prescribed or approved by a physician who knows they are taking cholesterol-reducing drugs.

Side effects

Gemfibrozil

Studies in animals and humans suggest that gemfibrozil increases the risk of some types of cancer. The drug may also cause gallstones or muscle problems. Patients who need to take this medicine should ask their physicians for the latest information on its benefits and risks.

Patients taking gemfibrozil should check with a physician immediately if any of these side effects occur:

- fever or chills
- severe stomach **pain** with nausea and vomiting
- pain in the lower back or side
- pain or difficulty when urinating
- cough or hoarseness

HMG-CoA reductase inhibitors

These drugs may damage the liver or muscles. Patients who take the drugs should have blood tests to check for liver damage as often as their physician recommends. Any unexplained pain, tenderness or weakness in the muscles should be reported to the physician at once.

All cholesterol-reducing drugs

Minor side effects such as **heartburn**, **indigestion**, belching, bloating, gas, nausea or vomiting, stomach pain, **dizziness** and **headache** usually go away as the body adjusts to the drug and do not require medical treatment unless they continue or they interfere with normal activities.

Patients who have constipation while taking cholesterol-reducing drugs should bring the problem to a physician's attention as soon as possible.

Additional side effects are possible. Anyone who has unusual symptoms while taking cholesterol-reducing drugs should get in touch with his or her physician.

Interactions

Cholesterol-reducing drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes cholesterol-reducing drugs should let the physician know all other medicines he or she is taking and should ask whether the possible interactions can interfere with drug therapy. Examples of possible interactions are listed below.

Some cholesterol-reducing drugs may prevent the following medicines from working properly:

- thyroid hormones
- water pills (diuretics)
- certain **antibiotics** taken by mouth, such as **tetracyclines**, penicillin G and vancomycin
- the beta-blocker Inderal, used to treat high blood pressure
- digitalis heart medicines
- phenylbutazone, a nonsteroidal anti-inflammatory drug

Taking some cholesterol-reducing drugs with blood thinners (anticoagulants) may increase the chance of bleeding.

Combining HMG-CoA reductase inhibitors with gemfibrozil, cyclosporine (Sandimmune) or niacin may cause or worsen problems with the kidneys or muscles.

KEY TERMS

Cell—The basic unit that makes up all living tissue.

Cholesterol—Fatty substance found in tissue. Necessary to maintain a healthy body.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Phenylketonuria—(PKU) A genetic disorder in which the body lacks an important enzyme. If untreated, the disorder can lead to brain damage and mental retardation.

Pituitary gland—A pea-sized gland at the base of the brain that produces many hormones that affect growth and body functions.

Resources

BOOKS

Nesto, R. W., and L. Christensen. *Cholesterol-Lowering Drugs: Everything You and Your Family Need to Know.* New York: Morrow, William & Co, 2000.

Parsons, W. B. *Cholesterol Control Without Diet! The Niacin Solution.* Scottsdale, AZ: Lilac Press, 1998.

Nancy Ross-Flanigan

Cholesterol test

Definition

The cholesterol test is a quantitative analysis of the cholesterol levels in a sample of the patient's blood. Total serum cholesterol (TC) is the measurement routinely taken. Doctors sometimes order a complete lipoprotein profile to better evaluate the risk for **atherosclerosis** (**coronary artery disease**, or CAD). The full lipoprotein profile also includes measurements of triglyceride levels (a chemical compound that forms 95% of the fats and oils stored in animal or vegetable cells) and lipoproteins (high density and low density). Blood fats are also called "lipids."

The type of cholesterol in the blood is as important as the total quantity. Cholesterol is a fatty substance and cannot be dissolved in water. It must combine with a protein molecule called a lipoprotein in order to be transported in the blood. There are five major types of lipoproteins in the human body; they differ in the amount of cholesterol that they carry in comparison to other fats and fatty acids, and in their functions in the body. Lipoproteins are classified, as follows, according to their density:

- Chylomicrons. These are normally found in the blood only after a person has eaten foods containing fats. They contain about 7% cholesterol. Chylomicrons transport fats and cholesterol from the intestine into the liver and then into the bloodstream. They are metabolized in the process of carrying food energy to muscle and fat cells.
- Very low-density lipoproteins (VLDL). These lipoproteins carry mostly triglycerides, but they also contain 16–22% cholesterol. VLDLs are made in the liver and eventually become IDL particles after they have lost their triglyceride content.
- Intermediate-density lipoproteins (IDL). IDLs are short-lived lipoproteins containing about 30% cholesterol that are converted in the liver to low-density lipoproteins (LDLs).
- Low-density lipoproteins (LDL). LDL molecules carry cholesterol from the liver to other body tissues. They contain about 50% cholesterol. Extra LDLs are absorbed by the liver and their cholesterol is excreted into the bile. LDL particles are involved in the formation of plaques (abnormal deposits of cholesterol) in the walls of the coronary arteries. LDL is known as "bad cholesterol."
- High-density lipoproteins (HDL). HDL molecules are made in the intestines and the liver. HDLs are about 50% protein and 19% cholesterol. They help to remove cholesterol from artery walls. Lifestyle changes, including exercising, keeping weight within recommended limits, and giving up **smoking** can increase the body's levels of HDL cholesterol. HDL is known as "good cholesterol."

Because of the difference in density and cholesterol content of lipoproteins, two patients with the same total cholesterol level can have very different lipid profiles and different risk for CAD. The critical factor is the level of HDL cholesterol in the blood serum. Some doctors use the ratio of the total cholesterol level to HDL cholesterol when assessing the patient's degree of risk. A low TC/HDL ratio is associated with a lower degree of risk.

Purpose

The purpose of the TC test is to measure the levels of cholesterol in the patient's blood. The patient's cholesterol can also be fractionated (separated into different portions) in order to determine the TC/HDL ratio. The results help the doctor to assess the patient's risk for coronary artery disease (CAD). High LDL levels are associated with increased risk of CAD whereas high HDL levels are associated with relatively lower risk.

In addition, the results of the cholesterol test can assist the doctor in evaluating the patient's metabolism of fat, or in diagnosing inflammation of the pancreas, liver disease, or disorders of the thyroid gland.

The frequency of cholesterol testing depends on the patient's degree of risk for CAD. People with low cholesterol levels may need to be tested once every five years. People with high levels of blood cholesterol should be tested more frequently, according to their doctor's advice. The doctor may recommend a detailed evaluation of the different types of lipids in the patient's blood. It is ideal to check the HDL and triglycerides as well as the cholesterol and LDL. In addition, the National Cholesterol Education Program (NCEP) suggests further evaluation if the patient has any of the symptoms of CAD or if she or he has two or more of the following risk factors for CAD:

- male sex
- high blood pressure
- smoking
- diabetes
- low HDL levels
- family history of CAD before age 55

Precautions

Patients who are seriously ill or hospitalized for surgery should not be given cholesterol tests because the results will not indicate the patient's normal cholesterol level. Acute illness, high **fever**, **starvation**, or recent surgery lowers blood cholesterol levels.

KEY TERMS

Atherosclerosis—A disease of the coronary arteries in which cholesterol is deposited in plaques on the arterial walls. The plaque narrows or blocks blood flow to the heart. Atherosclerosis is sometimes called coronary artery disease, or CAD.

Fractionation—A laboratory test or process in which blood or another fluid is broken down into its components. Fractionation can be used to assess the proportions of the different types of cholesterol in a blood sample.

High-density lipoprotein (HDL)—A type of lipoprotein that protects against CAD by removing cholesterol deposits from arteries or preventing their formation.

Hypercholesterolemia—The presence of excessively high levels of cholesterol in the blood.

Lipid—Any organic compound that is greasy, insoluble in water, but soluble in alcohol. Fats, waxes, and oils are examples of lipids.

Lipoprotein—A complex molecule that consists of a protein membrane surrounding a core of lipids. Lipoproteins carry cholesterol and other lipids from the digestive tract to the liver and other body tissues. There are five major types of lipoproteins.

Low-density lipoprotein (LDL)—A type of lipoprotein that consists of about 50% cholesterol and is associated with an increased risk of CAD.

Plaque—An abnormal deposit of hardened cholesterol on the wall of an artery.

Triglyceride—A chemical compound that forms about 95% of the fats and oils stored in animal and vegetable cells. Triglyceride levels are sometimes measured as well as cholesterol when a patient is screened for heart disease.

Description

The cholesterol test requires a sample of the patient's blood. **Fasting** before the test is required to get an accurate triglyceride and LDL level. The blood is withdrawn by the usual vacuum tube technique from one of the patient's veins. The blood test takes between three and five minutes.

Preparation

Patients who are scheduled for a lipid profile test should fast (except for water) for 12–14 hours before the blood sample is drawn. If the patient's cholesterol is to be fractionated, he or she should also avoid alcohol for 24 hours before the test.

Patients should also stop taking any medications that may affect the accuracy of the test results. These include **corticosteroids**, estrogen or androgens, **oral contraceptives**, some **diuretics**, haloperidol, some **antibiotics**, and niacin. Antilipemics are drugs that lower the concentration of fatty substances in the blood. When these are taken by the patient, blood testing may be done frequently to evaluate the liver function as well as lipids. The patient's doctor will give the patient a list of specific medications to be discontinued before the test.

Aftercare

Aftercare includes routine care of the skin around the needle puncture. Most patients have no aftereffects, but some may have a small bruise or swelling. A washcloth soaked in warm water usually relieves any discomfort. In addition, the patient should resume taking any prescription medications that were discontinued before the test.

Risks

The primary risk to the patient is a mild stinging or burning sensation during the venipuncture, with minor swelling or bruising afterward.

Normal results

The "normal" values for serum lipids depend on the patient's age, sex, and race. Normal values for people in Western countries are usually given as 140–220 mg/dL in adults, although as many as 5% of the population has TC higher than 300 mg/dL. Among Asians, the figures are about 20% lower. As a rule, both TC and LDL levels rise as people get older.

Some doctors prefer to speak of "desired" rather than "normal" cholesterol values, on the grounds that "normal" refers to statistically average levels that may still be too high for good health. Desirable values are as follows:

- Total cholesterol (TC): less than 200 mg/dL
- HDL cholesterol: 40–70 mg/dL in males, 40–80 mg/dL in females
- LDL cholesterol: less than 130 mg/dL
- TC/HDL ratio: under 4.0 in males, 3.8 in females.

Abnormal results

It is possible for blood cholesterol levels to be too low as well as too high.

Abnormally low levels

TC levels less than 160 mg/dL are associated with higher mortality rates from **cancer**, liver disease, respiratory disorders, and injuries. The connection between unusually low cholesterol and increased mortality is not clear, although some researchers think that the low level is a secondary sign of the underlying disease and not the cause of disease or **death**.

Low levels of serum cholesterol are also associated with **malnutrition** or **hyperthyroidism**. Further diagnostic testing may be necessary in order to locate the cause.

Abnormally high levels

Prior to 1980, **hypercholesterolemia** (an abnormally high TC level) was defined as any value above the 95th percentile for the population. These figures ranged from 210 mg/dL in persons younger than 20 to more than 280 mg/dL in persons older than 60. It is now known, however, that TC levels over 200 mg/dL are associated with significantly higher risk of CAD. Levels of 280 mg/dL or more are considered elevated. Treatment with diet and medication has proven to successfully lower risk of **heart attack** and **stroke**.

Elevated cholesterol levels may also result from hepatitis, blockage of the bile ducts, disorders of lipid metabolism, **nephrotic syndrome**, inflammation of the pancreas, or **hypothyroidism**.

Resources

BOOKS

Baron, Robert B., and Warren S. Browner. "Lipid Abnormalities." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Laboratory and Reference Guides." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Sobel, David S., and Tom Ferguson. *The People's Book of Medical Tests.* New York: Summit Books, 1985.

Rebecca J. Frey

Cholinergic drugs

Definition

Cholinergic drugs are medications that produce the same effects as the parasympathetic nervous system.

Purpose

Cholinergic drugs produce the same effects as acetylcholine. Acetylcholine is the most common neurohormone of the parasympathetic nervous system, the part of the peripheral nervous system responsible for the every day work of the body. While the sympathetic nervous system acts during times of excitation, the parasympathetic system deals with everyday activities such as salivation, digestion, and muscle relaxation.

The cholinergic drugs may be used in several ways. The cholinergic muscle stimulants are used to diagnose and treat myathenia gravis, a disease that causes severe muscle weakness. This class of drugs includes ambenonium chloride (Mytelase), edrophonium chloride (Tensilon), neostigmine (Prostigmine), and piridogstimina (Mestinón). These drugs are also widely used in surgery, both to reduce the risk of urinary retention, and to reverse the effects of the muscle relaxant drugs that are used in surgery.

Cholinergic drugs are also used in control of **glaucoma**, a disease that is caused by increased pressure inside the eye. The most common drugs used for this purpose are demecarium (Humorsol) and echthiophate (Phospholine iodide).

Description

Cholinergic drugs usually act in one of two ways. Some directly mimic the effect of acetylcholine, while others block the effects of acetylcholinesterase. Acetylcholinesterase is an enzyme that destroys naturally occurring acetylcholine. By blocking the enzyme, the naturally occurring acetylcholine has a longer action.

Recommended dosage

Cholinergic drugs are available only by prescription. They may be available as eye drops, capsules, tablets, or injections.

Precautions

Cholinergic drugs should be avoided when the patient has any sort of obstruction in the urinary or digestive tracts, such a a tumor, or severe inflammation which is causing blockage.

They should be used with caution in patients with **asthma**, epilepsy, slow heart beat, **hyperthyroidism**, or gastric ulcers.

The effects of the cholinergic drugs are to produce the same effects as stimulation of the parasympathetic nervous system. These effects include slowing of the heartbeat, increases in normal secretions including the

KEY TERMS

Cholinergic—Nerves that are stimulated by acetylcholine.

Glaucoma—a disease of the eye marked by increased pressure within the eyeball that can result in damage to the optic disk and gradual loss of vision.

Myasthenia gravis—a disease characterized by progressive weakness and exhaustibility of voluntary muscles without atrophy or sensory disturbance and caused by an autoimmune attack on acetylcholine receptors at neuromuscular junctions.

Parasympathetic nervous system—the part of the nervous system that contains chiefly cholinergic fibers, that tends to induce secretion, to increase the tone and contractility of smooth muscle, and to slow the heart rate.

digestive acids of the stomach, saliva and tears. For this reason, patients who already have a problem in one of these areas, such as a slow heartbeat or stomach ulcers should use these drugs with great caution, since the medication will make their conditions worse.

Side effects

When used properly, cholinergic drugs will increase muscle strength in patients with **myasthenia gravis**. In eye drop form, they can reduce the intraoccular pressure in glaucoma.

The possible adverse effects of cholinergic drugs are:

- slow heart beat, possibly leading to cardiac arrest
- muscle weakness, muscle cramps, and muscle pain
- convulsions
- weak breathing, inability to breath
- increased stomach acid and saliva
- nausea and vomiting
- dizziness, drowsiness, and headache

Resources

BOOKS

Beyond the Limits: A Self Portrait of Myasthenia Gravis. Susanville, CA: Palette-Publishing, March 1994.

PERIODICALS

"Classic Papers in Glaucoma." *Archives of Ophthalmology* (March 2001).

"Congenital myasthenic syndromes: recent advances." *Archives of Neurology* (February 1999).

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Chondromalacia patellae

Definition

Chondromalacia patellae refers to the progressive erosion of the articular cartilage of the knee joint, that is the cartilage underlying the kneecap (patella) that articulates with the knee joint.

Description

Chondromalacia patellae (CMP), also known as patello-femoral **pain** syndrome or patello-femoral **stress** syndrome, is a syndrome that causes pain/discomfort at the front of the knee. It is associated with irritation or wear on the underside of the kneecap, or patella. In a normal knee, the articular cartilage is smooth and elastic and glides smoothly over the surface of the thighbone, or femur when the knee is bent. Erosion of the cartilage roughens the surface and prevents this smooth action.

CMP is most common in adolescent females, although older people may also develop it. An average of two out of 10,000 people develop this condition, many of them runners or other athletes.

Causes and symptoms

CMP is the result of the normal **aging** process, overuse, injury, or uneven pressures exerted on the knee joint. In teens, CMP may be caused by uneven growth or uneven strength in the thigh muscles. Growth spurts, common in teens, may result in a mildly abnormal alignment of the patella, which increases the angle formed by the thigh and the patellar tendon (Q-angle). This condition adds to the damage. Symptoms include pain, normally around the kneecap, and a grinding sensation felt when extending the leg. The pain may radiate to the back of the knee, or it may be intermittent and brought on by squatting, kneeling, going up or down stairs, especially down, or by repeated bending of the joint.

Diagnosis

Diagnosis is established during a **physical examination** performed by a general practitioner or an orthopedist, and is based on frequency of symptoms and confirmed by x rays of the knee. The CMP erosion can also

KEY TERMS

Arthroscopic knee surgery—Surgery performed to examine or repair tissues inside the knee joint through a special scope (arthroscope).

Femur—The thigh bone.

Isometric exercises—Exercises which strengthen through muscle resistance.

Osteoarthritis—Degenerative joint disease.

Quadriceps, hip flexors, hamstrings—Major muscles in the thigh area which affect knee mechanics.

be seen on an MRI, although this type of scan is not routinely performed for this purpose. The patient should inform the doctor about any previous injuries to the joint.

Treatment

Initial treatment may consist of resting the knee using crutches, along with **aspirin**, Tylenol, or a nonsteroidal anti-inflammatory drug (NSAID) such as Motrin for seven to 10 days. The person should limit sports activity until the joint is healed and may use ice followed by heat to decrease inflammation. When the doctor allows the patient to resume sports, a knee brace may be prescribed in the form of a stabilizer with a hole at the kneecap.

Treatment also includes low impact exercises to strengthen the quadriceps muscles which help stabilize the knee joint. Physical therapy may be suggested at the start of this program so as to help the patient learn the correct method of performing the exercises.

Approximately 85% of people do well with conservative CMP treatment. The remainder still have severe pain and may require **arthroscopic surgery** to repair the tissues inside the knee joint. In more severe cases, open surgery may be required to realign the kneecap and perhaps other corrections.

Alternative treatments

Physical therapy offers treatments that may help CMP patients. Aqua therapy has the benefit of exercising the knee without putting stress on it and it also strengthens the thigh muscles. **Biofeedback** can be used to learn tensing and relaxing specific muscles to relieve pain. These techniques have the benefit of no side effects. **Massage therapy** might be beneficial as well. Calcium, **minerals**, and **vitamins** as part of a balanced diet will aid healing and help prevent further problems.

Prognosis

In most teens with CMP, the prognosis is excellent since the damage is reversible when treatment starts before the cartilage begins to break down. With proper treatment and preventive techniques, teenagers will complete their growth without permanent damage to the joint. Only about 15% of patients require surgical intervention. Older people may go on to develop **osteoarthritis** in the knee.

Prevention

Proper exercises are the best preventive measure. Since tightness of thigh muscles is a risk factor, warming up before athletic activities is recommended, as well as participating in a variety of sports rather than just one. Stretching exercises increase flexibility of the quadriceps, hip flexors, and hamstrings. Strengthening exercises such as short arc leg extensions, straight leg raises, quadriceps isometric exercises, and stationary bicycling are also recommended.

Resources

OTHER

Chondromalacia patellae. <http://my.webmd.com/content/asset/adam_disease_chondromalacia_patellae>.
Chondromalacia Patellae. <http://www.orthoseek.com/articles/chondromp.html>.
"Major Domains of Complementary & Alternative Medicine." <http://nccam.nih.gov/fcp/classify/>.
Questions and Answers About Knee Problems. <http://www.cbshealthwatch.com/cx/viewarticle/202777>.
Questions and Answers About Knee Problems. <http://www.nih.gov/niams/healthinfo/kneeprobs/kneeqa.htm>.

Barbara J. Mitchell

Chorea *see* **Movement disorders**

Choriocarcinoma

Definition

A choriocarcinoma is type of **cancer** germ cell containing trophoblast cells.

Description

Choriocarcinomas are cancers that develop from germ cells, cells that ordinarily turn into sperm or eggs. Choriocarcinomas resemble the cells that surround an

KEY TERMS

Biopsy—A sample of an organ taken to look for abnormalities. Also, the technique used to take such samples.

Chemotherapy—The treatment of cancer with drugs.

Computed tomography (CT)—A special x ray technique that produces a cross sectional image of the organs inside the body.

Extragonadal—In a location other than the reproductive organs.

Germ cell—One of the cells that ordinarily develop into eggs or sperm (also sperm and eggs).

Gonads—The ovaries or testes.

Klinefelter syndrome—A condition caused by extra X chromosome(s) in a male, that results in small testes and infertility together with increased height, decreased facial hair, and sometimes breast enlargement.

Magnetic resonance imaging—A type of study that uses changes induced by magnets to see cells and tissues inside the body.

Mole—A mass of abnormal, partially developed tissues inside the uterus (womb). Moles develop during a pregnancy that begins with an abnormal fertilization.

Ovaries—The female sex organs that make eggs and female hormones.

Remission—The disappearance of the symptoms of cancer, although all of the cancer cells may not be gone.

Reproductive organs—The group of organs (including the testes, ovaries, and uterus) whose purpose is to produce a new individual and continue the species.

Testes—The male sex organs that make sperm and male hormones.

Testicular cancer—A cancer that originates in the testes.

Trophoblast—The tissues that surround an embryo and attach it to the uterus.

Tumor—A lump made up of abnormal cells.

Uterus—The organ where a child develops (womb).

embryo in the uterus. Most of these cancers form inside the reproductive organs. Some originate in the testes or ovaries, especially in young adults. Others develop in the uterus after a **pregnancy** or miscarriage—particularly often after a mole. A few choriocarcinomas arise in sites outside the reproductive organs. Such "extragonadal" tumors are usually found in young adults and are more common in males.

Choriocarcinomas are one of the most dangerous germ cell cancers. Choriocarcinomas usually grow quickly and spread widely. Occasionally, this cancer grows so fast that the original tumor outgrows its blood supply and dies, leaving behind only a small scar.

Causes and symptoms

Choriocarcinomas result from genetic damage to a germ cell. Males with **Klinefelter syndrome** are especially likely to develop extragonadal germ cell tumors.

The symptoms of a choriocarcinoma vary, depending on where the tumor originates and where it spreads. In the uterus, the most common symptom is bleeding. Cancers in the ovary often have only subtle signs such as widening of the waistline or **pain**. In the testes, choriocarcinomas can often be felt as small painless lumps. Choriocarcinomas that spread to other organs may reveal their presence by bleeding. In the brain, this bleeding can cause a **stroke**.

Diagnosis

Choriocarcinomas are usually referred to an oncologist, a doctor who specializes in cancer treatment. To diagnose this tumor, the doctor will do a **physical examination** and examine the internal organs with x rays or ultrasound studies. Choriocarcinomas are not always biopsied before being treated, because they tend to bleed heavily. Spreading of the cancer is detected with x rays, ultrasound studies, computed tomography (CT), or **magnetic resonance imaging** (MRI) scans.

Most choriocarcinomas make human chorionic gonadotropin (hCG), a hormone normally found only during pregnancy. The presence of hCG in the blood can help diagnose this cancer and monitor the success of treatment.

Treatment

Choriocarcinomas are usually treated by surgical removal of the tumor and **chemotherapy**. Radiation is occasionally used, particularly for tumors in the brain.

Alternative treatment

Complementary treatments can decrease **stress**, reduce the side effects of cancer treatment, and help patients feel more in control. For instance, some people find activities such as **yoga**, massage, **music therapy**, **meditation**, prayer, or mild physical **exercise** helpful.

Prognosis

The prognosis for choriocarcinomas in the uterus is very good. Although these tumors have often spread throughout the body, chemotherapy results in a cure or remission in at least 80–90% of cases. Women who have had choriocarcinomas often go on to have normal pregnancies and deliveries.

Choriocarcinomas in other sites have a poorer prognosis. These tumors tend to spread quickly and don't always respond well to chemotherapy. Although treatment can be effective, the outcome usually depends on how widely the cancer is dispersed. Generally, the prognosis is worse if the cancer can be found in the liver or brain, if hCG levels are high, or if the original tumor developed outside the gonads. Five-year survival with testicular cancers can range from 92% for tumors that have spread only to the lungs to 48% to tumors that have spread to other internal organs.

Prevention

There is no known means of prevention. However, early detection of the symptoms and prompt medical treatment can improve the odds of survival.

Resources

BOOKS

Baker, Vicki V. "Gestational Trophoblastic Disease." In *Clinical Oncology*, 2nd ed. Ed. Martin D. Abeloff, et al. Philadelphia: Churchhill Livingstone, 2000.

Crum, Christopher P. "The Female Genital Tract." In *Robbins Pathologic Basis of Disease*, 6th ed. Ed. Ramzi S. Cotran, Vinay Kumar, and Tucker Collins. Philadelphia: W.B. Saunders, 1999.

Small, Eric J., and Frank M. Torti. "The Testes." In *Clinical Oncology*, 2nd ed. Ed. Martin D. Abeloff, et al. Philadelphia: Churchhill Livingstone, 2000.

Smithson, William A. "Gonadal and Germ Cell Neoplasms." In *Nelson Textbook of Pediatrics*, 16th ed. Ed. Richard E. Behrman, et al. Philadelphia: W.B. Saunders, 2000.

"The Male Genital Tract." In *Robbins Pathologic Basis of Disease*, 6th ed. Ed. Ramzi S. Cotran, Vinay Kumar, and Tucker Collins. Philadelphia: W.B. Saunders, 1999.

Thigpen, James Tate. "Ovaries and Fallopian Tubes." In *Clinical Oncology*, 2nd ed. Ed. Martin D. Abeloff, et al. Philadelphia: Churchill Livingstone, 2000.

PERIODICALS

Newlands, Edward S., Fernando J. Paradinas, and Rosemary A. Fisher. "Current Therapeutic Issues in Gynecologic Cancer. Recent Advances in Gestational Trophoblastic Disease." *Hematology/Oncology Clinics of North America* 13, no. 1 (Feb. 1999): 225-44.

OTHER

"Chemotherapy and You: A Guide to Self-help During Cancer Treatment." *CancerNet*. June 1999. 5 Apr. 2001 <http://cancernet.nci.nih.gov./peb/chemo_you/index.htm>.

"Extragonadal Germ Cell Tumors." *CancerNet*. Aug. 2000. 27 Apr. 2001 <http://cancernet.nci.nih.gov/pdq.html>.

"Ovarian Germ Cell Tumor." *CancerNet*. Feb. 2001. 27 Apr. 2001 <http://cancernet.nci.nih.gov/pdq.html>.

Anna Rovid Spickler, D.V.M., Ph.D.

Chorionic gonadotropin test *see* **Human chorionic gonadotropin pregnancy test**

Chorionic villus sampling

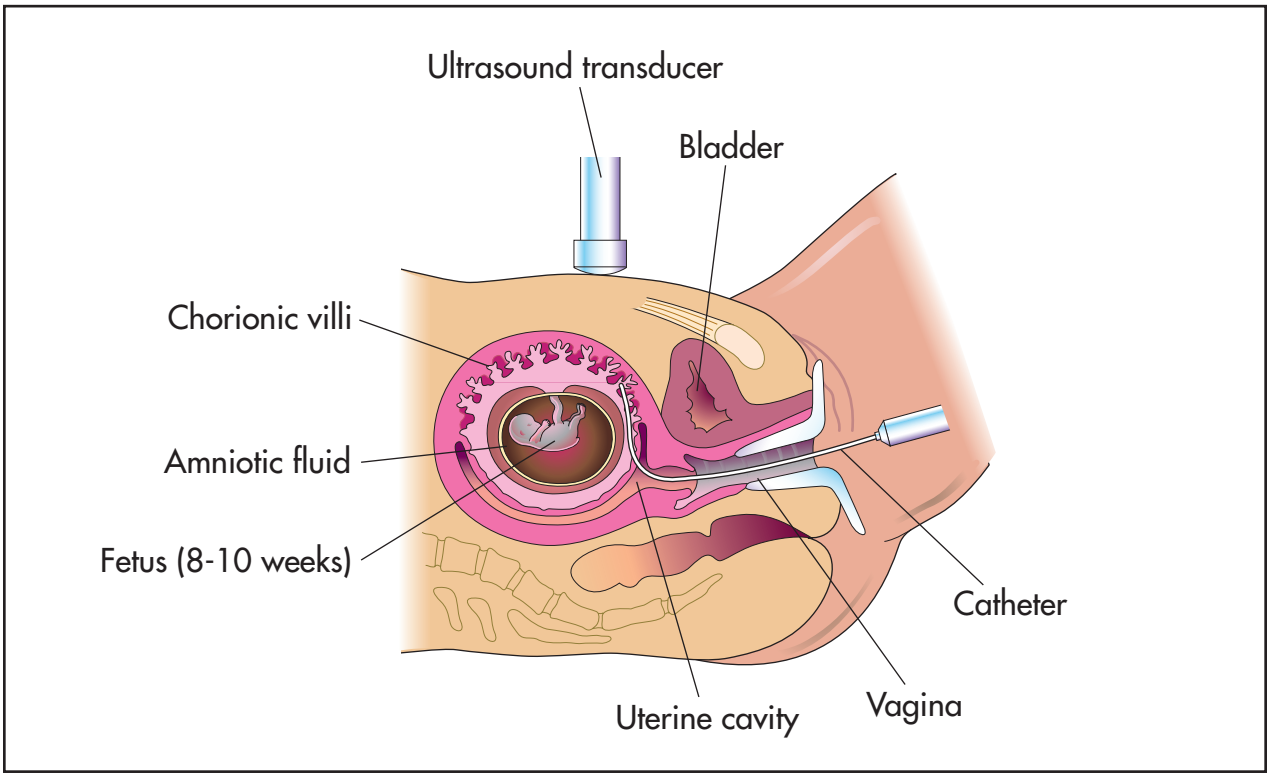
Definition

Chorionic villus sampling (CVS), also known as chorionic villus biopsy, is a prenatal test that can detect genetic and chromosomal abnormalities of an unborn baby.

Purpose

Chorionic villus sampling is performed on pregnant women who are at risk for carrying a fetus with a genetic or chromosomal defect. Although it carries a slightly higher risk, CVS may be used in place of **amniocentesis** for women who have one or more of the following risk factors:

- Women age 35 and older. The chance of having a child with **Down syndrome** increases with maternal age. For instance, the chance of having a baby with Down syndrome is one in 378 for a 35-year-old woman and increases to one in 30 for a 45-year-old woman.
- A history of miscarriages or children born with **birth defects**.
- A family history of genetic disease. Prenatal **genetic testing** is recommended if either the mother or father of



Chorionic villus sampling is performed on pregnant women who are at risk for carrying a fetus with a genetic or chromosomal defect. This procedure can be performed through the vagina and the cervix (transcervically) or through the abdomen (transabdominally). In the transcervical procedure, as depicted above, the physician uses ultrasound to help guide a catheter through the cervix into the uterus. By applying suction from the syringe attached to the other end of the catheter, a small sample of the chorionic villi are obtained. *(Illustration by Electronic Illustrators Group.)*

the unborn baby has a family history of genetic disease or is known to be a carrier of a genetic disease.

Precautions

Chorionic villus sampling is not recommended for women who have vaginal bleeding or spotting during the **pregnancy**. It is not typically recommended for women who have Rh sensitization from a previous pregnancy.

Description

Chorionic villus sampling has been in use since the 1980s. This prenatal testing procedure involves taking a sample of the chorion frondosum—that part of the chorionic membrane containing the villi—for laboratory analysis. The chorionic membrane is the outer sac which surrounds the developing fetus. Chorionic villi are microscopic, finger-like projections that emerge from the chorionic membrane and eventually form the placenta. The cells that make up the chorionic villi are of fetal origin so laboratory analysis can identify any genetic, chromosomal, or biochemical diseases of the fetus.

Chorionic villus sampling is best performed between 10 and 12 weeks of pregnancy. The procedure is performed either through the vagina and the cervix (transcervically) or through the abdomen (transabdominally) depending upon the preferences of the patient or the doctor. In some cases, the location of the placenta dictates which method the doctor uses. Both methods are equally safe and effective. Following the preparation time, both procedures take only about five minutes. Women undergoing chorionic villus sampling may experience no **pain** at all or feel cramping or pinching. Occasionally, a second sampling procedure must be performed if insufficient villus material was obtained.

For the transcervical procedure, the woman lies on an examining table on her back with her feet in stirrups. The woman's vaginal area is thoroughly cleansed with an antiseptic, a sterile speculum is inserted into her vagina and opened, and the cervix is cleansed with an antiseptic. Using ultrasound (a device which uses sound waves to visualize internal organs) as a guide, the doctor inserts a thin, plastic tube called a catheter through the cervix and into the uterus. The passage of the catheter through the

KEY TERMS

Chorionic villi—Microscopic, finger-like projections that emerge from the outer sac which surrounds the developing baby. Chorionic villi are of fetal origin and eventually form the placenta.

Chromosomes—Human cells carry DNA in tightly compressed rod-like structures called chromosomes. Humans have 23 pairs of chromosomes including the sex chromosomes.

Down syndrome—A chromosomal disorder caused by an extra copy or a rearrangement of chromosome 21. Children with Down syndrome have varying degrees of mental retardation and may have heart defects.

Fetus—Term for an unborn baby after the eighth week of pregnancy. Prior to seven weeks, it is called an embryo.

Rh sensitization—A woman with a negative blood type (Rh negative) who has produced antibodies against her fetus with a positive blood type (Rh positive). The mother's body considered the fetal blood cells a foreign object and mounted an immune attack on it.

Ultrasound—A safe, painless procedure which uses sound waves to visualize internal organs. A wand that transmits and receives the sound waves is moved over the woman's abdomen and internal organs can be seen on a video screen.

cervix may cause cramping. The doctor carefully watches the image produced by the ultrasound and advances the catheter to the chorionic villi. By applying suction from the syringe attached to the other end of the catheter, a small sample of the chorionic villi are obtained. A cramping or pinching feeling may be felt as the sample is being taken. The catheter is then easily withdrawn.

For the transabdominal method, the woman lies on her back on an examining table. Ultrasound enables the doctor to locate the placenta. The specific area on the woman's abdomen is cleansed thoroughly with an antiseptic and a local anesthetic may be injected to numb the area. With ultrasound guidance, a long needle is inserted through the woman's abdominal wall, through the uterine wall and to the chorionic villi. The sample is obtained by applying suction from the syringe.

The chorionic villus sample is immediately placed into nutrient medium and sent to the laboratory. At the laboratory, the sample is examined under the microscope and any contaminating cells or material is carefully removed. The villi can be analyzed immediately, or incubated for a day or more to allow for cell division. The cells are stopped in the midst of cell division and spread onto a microscope slide. Cells with clearly separated chromosomes are photographed so that the type and number of chromosomes can be analyzed. Chromosomes are strings of DNA which have been tightly compressed. Humans have 23 pairs of chromosomes including the sex chromosomes. Rearrangements of the chromosomes or the presence of additional or fewer chromosomes can be identified by examination of the photograph. Down syndrome, for instance, is caused by an extra copy of chromosome 21. In addition to the chromosomal analysis, specialized tests can be performed as needed to look for specific diseases such as **Tay-Sachs disease**. Depending upon which tests are performed, results may be available as early as two days or up to eight days after the procedure.

Chorionic villus sampling costs between $1,200 and $1,800. Insurance coverage for this test may vary.

Alternate procedures

There are alternate procedures for diagnosing genetic and chromosomal disorders of the fetus. Amniocentesis is commonly used and involves inserting a needle through the pregnant woman's abdomen to obtain a sample of amniotic fluid. Amniocentesis is usually performed in the second trimester at approximately 16 weeks gestation and the laboratory analysis may take two to three weeks. The two advantages of chorionic villus sampling are that it is performed during the first trimester and the results are available in about one week. However, as of 1997, amniocentesis is being performed in the first trimester, but this is still very rare. The risk of **miscarriage** after amniocentesis is 0.5–1% (one to two women out of 200) which is lower than that for chorionic villus sampling (1–3%).

A noninvasive alternative is the maternal blood test called triple marker screening or multiple marker screening. A sample of the pregnant woman's blood is analyzed for three different markers: alphafetoprotein (AFP), human chorionic gonadotropin, and unconjugated estriol. The levels of these three markers in the mother's blood can identify unborn babies who are at risk for certain genetic or chromosomal defects. This is a screening test which determines the chance that the fetus has the defect, but it can not diagnose defects. A negative test result does not necessarily mean the unborn baby does not have a birth defect. For instance, this screening test can only predict 60–70% of the fetuses with Down syndrome. Pregnant women who have a positive triple marker

screen are encouraged to undergo a diagnostic test, such as amniocentesis (by the time an AFP is done, it is too late to perform a CVS).

Preparation

Prior to the chorionic villus sampling procedure the woman needs to drink fluids and refrain from urinating to ensure her bladder is full. These preparations create a better ultrasound picture.

Aftercare

It is generally recommended that women undergoing chorionic villus sampling have someone drive them home and have no plans for the rest of the day. Women with Rh negative blood must receive a Rho (D) immune globulin injection following the procedure. Women should call their doctor if they experience excessive bleeding, vaginal discharge, **fever**, or abdominal pain after the procedure.

Risks

Of women who undergo transcervical chorionic villus sampling, one third experience minimal vaginal spotting and 7–10% experience vaginal bleeding. One out of five women experience cramping following the procedure. Two to three women out of 100 (or 2–3%) will miscarry following chorionic villus sampling. The risk of infection is very low. Rupture of the amniotic membranes is a rare complication. Women with Rh negative blood may be at an increased risk for developing Rh incompatibility following chorionic villus sampling.

There have been reports of limb defects in babies following chorionic villus sampling. However, in 1996 the World Health Organization reported that the incidence of babies born with limb defects from 138,966 women who had undergone chorionic villus sampling was the same as for women who had not. Therefore, this study found no connection between chorionic villus sampling and limb defects.

Normal results

No genetic, chromosomal, or biochemical abnormalities were found in the fetal cells. The gender of the fetus will be identified but will be made known to the parents only with their approval.

Abnormal results

Analysis of the cells from the chorionic villus enables the detection of over 200 diseases and disorders such as Down Syndrome, Tay-Sachs disease, and **cystic fibrosis**. Gross rearrangements of the chromosomes and chromosome additions or losses are detected.

Resources

BOOKS

Eisenberg, E., et. al. *What to Expect When You're Expecting*. New York: Workman Publishing, 1996.

PERIODICALS

Froster, U. G., et. al. "Limb Defects and Chorionic Villus Sampling: Results from an International Registry, 1992–94." *Lancet* 347 (1996): 489-94.

Sundberg, K., et. al. "Randomised Study of Risk of Fetal Loss Related to Early Amniocentesis Versus Chorionic Villus Sampling." *Lancet* 350 (1997): 697-703.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

OTHER

Family Internet Page. <http://www.familyinternet.com>.

Belinda Rowland, PhD

Choroiditis *see* **Uveitis**

Choroiretinitis *see* **Uveitis**

Chromosome studies *see* **Genetic testing**

Chronic arthritis of childhood *see* **Juvenile arthritis**

Chronic constrictive pericarditis *see* **Pericarditis**

Chronic Epstein-Barr virus *see* **Chronic fatigue syndrome**

Chronic fatigue syndrome

Definition

Chronic **fatigue** syndrome (CFS) is a condition that causes extreme tiredness. People with CFS have debilitating fatigue that lasts for six months or longer. They also have many other symptoms. Some of these are **pain** in the joints and muscles, **headache**, and **sore throat**. CFS does not have a known cause, but appears to result from a combination of factors.

Description

CFS is the most common name for this disorder, but it also has been called chronic fatigue and immune disor-

der (CFIDS), myalgic encephalomyelitis, low natural killer cell disease, post-viral syndrome, Epstein-Barr disease, and Yuppie flu. CFS has so many names because researchers have been unable to find out exactly what causes it and because there are many similar, overlapping conditions. Reports of a CFS-like syndrome called neurasthenia date back to 1869. Later, people with similar symptoms were said to have **fibromyalgia** because one of the main symptoms is myalgia, or muscle pain. Because of the similarity of symptoms, fibromyalgia and CFS are considered to be overlapping syndromes.

In the early to mid-1980s, there were outbreaks of CFS in some areas of the United States. Doctors found that many people with CFS had high levels of antibodies to the Epstein-Barr virus (EBV), which causes mononucleosis, in their blood. For a while they thought they had found the culprit, but it turned out that many healthy people also had high EBV antibodies. Scientists have also found high levels of other viral antibodies in the blood of people with CFS. These findings have led many scientists to believe that a virus or combination of viruses may trigger CFS.

CFS was sometimes referred to as Yuppie flu because it seemed to often affect young, middle-class professionals. In fact, CFS can affect people of any gender, age, race, or socioeconomic group. Although anyone can get CFS, most patients diagnosed with CFS are 25–45 years old, and about 80% of cases are in women. Estimates of how many people are afflicted with CFS vary due to the similarity of CFS symptoms to other diseases and the difficulty in identifying it. The Centers for Disease Control and Prevention (CDC) has estimated that four to 10 people per 100,000 in the United States have CFS. According to the CFIDS Foundation, about 500,000 adults in the United States (0.3% of the population) have CFS. This probably is a low estimate since these figures do not include children and are based on the CDC definition of CFS, which is very strict for research purposes.

Causes and symptoms

There is no single known cause for CFS. Studies have pointed to several different conditions that might be responsible. These include:

- viral infections
- chemical toxins
- **allergies**
- immune abnormalities
- psychological disorders

Although the cause is still controversial, many doctors and researchers now think that CFS may not be a single illness. Instead, they think CFS may be a group of symptoms caused by several conditions. One theory is that a microorganism, such as a virus, or a chemical injures the body and damages the immune system, allowing dormant viruses to become active. About 90% of all people have a virus in the herpes family dormant (not actively growing or reproducing) in their bodies since childhood. When these viruses start growing again, the immune system may overreact and produce chemicals called cytokines that can cause flu-like symptoms. Immune abnormalities have been found in studies of people with CFS, although the same abnormalities are also found in people with allergies, autoimmune diseases, **cancer**, and other disorders.

The role of psychological problems in CFS is very controversial. Because many people with CFS are diagnosed with depression and other psychiatric disorders, some experts conclude that the symptoms of CFS are psychological. However, many people with CFS did not have psychological disorders before getting the illness. Many doctors think that patients become depressed or anxious because of the effects of the symptoms of their CFS. One recent study concluded that depression was the result of CFS and was not its cause.

Having CFS is not just a matter of being tired. People with CFS have severe fatigue that keeps them from performing their normal daily activities. They find it difficult or impossible to work, attend school, or even to take part in social activities. They may have sleep disturbances that keep them from getting enough rest or they may sleep too much. Many people with CFS feel just as tired after a full night's sleep as before they went to bed. When they **exercise** or try to be active in spite of their fatigue, people with CFS experience what some patients call "payback"—debilitating exhaustion that can confine them to bed for days.

Other symptoms of CFS include:

- muscle pain (myalgia)
- joint pain (arthralgia)
- sore throat
- headache
- **fever** and chills
- tender lymph nodes
- trouble concentrating
- memory loss

A recent study at Johns Hopkins University found an abnormality in blood pressure regulation in 22 of 23 patients with CFS. This abnormality, called neurally mediated **hypotension**, causes a sudden drop in blood pressure when a person has been standing, exercising or exposed to heat for a while. When this occurs, patients

feel lightheaded and may faint. They often are exhausted for hours to days after one of these episodes. When treated with salt and medications to stabilize blood pressure, many patients in the study had marked improvements in their CFS symptoms.

Diagnosis

CFS is diagnosed by evaluating symptoms and eliminating other causes of fatigue. Doctors carefully question patients about their symptoms, any other illnesses they have had, and medications they are taking. They also conduct a **physical examination**, neurological examination, and laboratory tests to identify any underlying disorders or other diseases that cause fatigue. In the United States, many doctors use the CDC case definition to determine if a patient has CFS.

To be diagnosed with CFS, patients must meet both of the following criteria:

- Unexplained continuing or recurring chronic fatigue for at least six months that is of new or definite onset, is not the result of ongoing exertion, and is not mainly relieved by rest, and causes occupational, educational, social, or personal activities to be greatly reduced.
- Four or more of the following symptoms: loss of short-term memory or ability to concentrate; sore throat; tender lymph nodes; muscle pain; multi-joint pain without swelling or redness; headaches of a new type, pattern, or severity; unrefreshing sleep; and post-exertional malaise (a vague feeling of discomfort or tiredness following exercise or other physical or mental activity) lasting more than 24 hours. These symptoms must have continued or recurred during six or more consecutive months of illness and must not have started before the fatigue began.

Treatment

There is no cure for CFS, but many treatments are available to help relieve the symptoms. Treatments usually are individualized to each person's particular symptoms and needs. The first treatment most doctors recommend is a combination of rest, exercise, and a balanced diet. Prioritizing activities, avoiding overexertion, and resting when needed are key to maintaining existing energy reserves. A program of moderate exercise helps to keep patients from losing physical conditioning, but too much exercise can worsen fatigue and other CFS symptoms. Counseling and **stress reduction** techniques also may help some people with CFS.

Many medications, nutritional supplements, and herbal preparations have been used to treat CFS. While many of these are unproven, others seem to provide some people with relief. People with CFS should discuss their treatment plan with their doctors, and carefully weigh the benefits and risks of each therapy before making a decision.

KEY TERMS

Arthralgia—Joint pain.

Cytokines—Proteins produced by certain types of lymphocytes. They are important controllers of immune functions.

Depression—A psychological condition, with feelings of sadness, sleep disturbance, fatigue, and inability to concentrate.

Epstein-Barr virus (EBV)—A virus in the herpes family that causes mononucleosis.

Fibromyalgia—A disorder closely related to CFS. Symptoms include pain, tenderness, and muscle stiffness.

Lymph node—Small immune organs containing lymphocytes. They are found in the neck, armpits, groin, and other locations in the body.

Lymphocytes—White blood cells that are responsible for the actions of the immune system.

Mononucleosis—A flu-like illness caused by the Epstein-Barr virus.

Myalgia—Muscle pain.

Myalgic encephalomyelitis—An older name for chronic fatigue syndrome; encephalomyelitis refers to inflammation of the brain and spinal cord.

Natural killer (NK) cell—A lymphocyte that acts as a primary immune defense against infection.

Neurally mediated hypotension—A rapid fall in blood pressure that causes dizziness, blurred vision, and fainting, and is often followed by prolonged fatigue.

Neurasthenia—Nervous exhaustion—a disorder with symptoms of irritability and weakness, commonly diagnosed in the late 1800s.

Drugs

Nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen and naproxen, may be used to relieve pain and reduce fever. Another medication that is prescribed to relieve pain and muscle spasms is cyclobenzaprine (sold as Flexeril).

Many doctors prescribe low dosages of antidepressants for their sedative effects and to relieve symptoms of

depression. **Antianxiety drugs**, such as **benzodiazepines** or buspirone may be prescribed for excessive **anxiety** that has lasted for at least six months.

Other medications that have been tested or are being tested for treatment of CFS are:

- Fludrocortisone (Florinef), a synthetic steroid, which is currently being tested for treatment of people with CFS. It causes the body to retain salt, thereby increasing blood pressure. It has helped some people with CFS who have neurally mediated hypotension.
- Beta-adrenergic blocking drugs, often prescribed for high blood pressure. Such drugs, including atenolol (Tenoretic, Tenormin) and propranolol (Inderal), are sometimes prescribed for neurally mediated hypotension.
- Gamma globulin, which contains human antibodies to a variety of organisms that cause infection. It has been used experimentally to boost immune function in people with CFS.
- Ampligen, a drug which stimulates the immune system and has antiviral activity. In one small study, ampligen improved mental function in people with CFS.

Alternative treatment

A variety of nutritional supplements are used for treatment of CFS. Among these are vitamin C, vitamin B_{12}, vitamin A, vitamin E, and various dietary **minerals**. These supplements may help improve immune and mental functions. Several herbs have been shown to improve immune function and have other beneficial effects. Some that are used for CFS are astragalus (*Astragalus membranaceus*), **echinacea** (*Echinacea* spp.), garlic (*Allium sativum*), ginseng (*Panax ginseng*), gingko (*Gingko biloba*), evening primrose oil (*Oenothera biennis*), shiitake mushroom extract (*Lentinus edodes*), borage seed oil, and quercetin.

Many people have enhanced their healing process for CFS with the use of a treatment program inclusive of one or more alternative therapies. **Stress** reduction techniques such as **biofeedback**, **meditation**, **acupuncture**, and **yoga** may help people with sleep disturbances relax and get more rest. They also help some people reduce depression and anxiety caused by CFS.

Prognosis

The course of CFS varies widely for different people. Some people get progressively worse over time, while others gradually improve. Some individuals have periods of illness that alternate with periods of good health. While many people with CFS never fully regain their health, they find relief from symptoms and adapt to the demands of the disorder by carefully following a treatment plan combining adequate rest, **nutrition**, exercise, and other therapies.

Prevention

Because the cause of CFS is not known, there currently are no recommendations for preventing the disorder.

Resources

BOOKS

Demitrack, Mark A., and Susan E. Abbey. *Chronic Fatigue Syndrome: An Integrative Approach to Evaluation and Treatment*. New York: The Guilford Press, 1996.

Fisher, Gregg Charles. *Chronic Fatigue Syndrome: A Comprehensive Guide to Symptoms, Treatments, and Solving the Practical Problems of CFS*. New York: Warner Books, 1997.

Hoffman, Ronald L. *Tired All the Time: How to Regain Your Lost Energy.* New York: Poseidon Press, 1993.

Johnson, Hillary. *Osler's Web: Inside the Labyrinth of the Chronic Fatigue Syndrome Epidemic*. New York: Crown Publishers, 1996.

PERIODICALS

Cannon, J. G., et al. "Interleukin-1 beta, Interleukin-1 Receptor Antagonist, and Soluble Interleukin-1 Receptor Type II Secretion in Chronic Fatigue Syndrome." *Journal of Clinical Immunology* 17 (May 1997): 253-61.

Houde, Susan Crocker, and Renee Kampfe-Leacher. "Chronic Fatigue Syndrome: An Update for Clinicians in Primary Care." *The Nurse Practitioner* 22 (July 1997): 30-40.

Lerner, A. Martin, et al. "Hypothesis: A Unified Theory of the Cause of Chronic Fatigue Syndrome." *Infectious Diseases in Clinical Practice* 6 (1997): 239-243.

"New Treatment for Chronic Fatigue Syndrome." *Tufts University Diet & Nutrition Letter* 13 (Feb. 1996): 1-2.

Weiss, Rick. "A Cure for Chronic Fatigue? If New Research Proves Right, Some Sufferers Have Nothing More than an Easy-to-Fix Blood Pressure Problem." *The Nurse Practitioner* 22 (July 1997): 30-40.

ORGANIZATIONS

American Association for Chronic Fatigue Syndrome. 7 Van Buren St., Albany, NY 12206. (518) 435-1765. <http://weber.u.washington.edu/~dedra/aacfs1.html>.

The CFIDS Association. Community Health Services, P.O. Box 220398, Charlotte, NC 28222-0398. (704) 362-2343.

The National CFS Association. 919 Scott Ave., Kansas City, KS 66105. (913) 321-2278.

The National CFIDS Foundation. 103 Aletha Road, Needham, MA 02192. (781) 449-3535. <http://www.cfidsfoundation.org>.

OTHER

"The Facts about Chronic Fatigue Syndrome." *Centers for Disease Control*. <http://www.cdc.gov/ncidod/diseases/cfs/facts1.htm>.

"Chronic Fatigue Syndrome." *National Institutes of Health.* <http://www.nih.gov>.

Toni Rizzo

Chronic granulomatous disease

Definition

Chronic granulomatous disease (CGD) is an inherited disorder in which white blood cells lose their ability to destroy certain bacteria and fungi.

Description

CGD is an X-linked genetic disease, meaning the defective gene is carried on the X chromosome (one of the sex chromosomes). Females have two copies of the X chromosome, whereas males have one X and one Y. CGD also is a recessive defect meaning that both copies of the chromosome must have the defect before it can be expressed. Females who have one X chromosome without the defect do not get this disease. Males, since they only have one X chromosome, get the disease if the defect is present. Thus, CGD affects mostly males.

CGD is an **immunodeficiency** disorder. Patients with immunodeficiency disorders suffer frequent infections. This happens because part of their immune system isn't working properly and the infectious microorganisms are not killed as rapidly as is normal. In CGD there is a defect in the ability of the white blood cells to kill bacteria and fungi. The white blood cells affected are phagocytic cells. They are part of the non-specific immune system and move via the blood to all parts of the body where they ingest and destroy microbes. Phagocytic cells are the first line of defense against microorganisms. In this disease, the decreased ability to kill microbes that they have ingested leads to a failure to effectively combat infectious diseases. Patients with CGD are subject to certain types of recurring infection, especially those of the skin, lungs, mouth, nose, intestines, and lymph nodes. With the exception of the lymph nodes, all of these areas are considered external tissues that come into contact with microorganisms from the environment. The lymph system drains all areas of the body to eliminate destroyed microorganisms and to assist the immune system in attacking microorganisms. Infections occur in the lymph nodes as a consequence of the normal draining function.

KEY TERMS

Immunodeficiency—A weakening of the body's immune system.

Phagocytic cells—A cell that ingests microorganisms and foreign particles.

Causes and symptoms

The genetic defect that causes CGD reduces the amount of hydrogen peroxide and superoxide that white blood cells can make. These chemicals are important for killing bacteria and fungi. Without them the white blood cells ingest the microorganisms, but can't kill them. In some cases, the microbes then replicate inside the white blood cell eventually causing its **death**.

Symptoms of the disease usually appear by age two. Frequent, recurrent infections of the skin, lungs (e.g. **pneumonia**), mouth (e.g. gingivitis), nose, intestines and lymph nodes are a hallmark of this disease. Patients may also develop multiple, recurrent liver abscesses and bone infections (**osteomyelitis**).

Diagnosis

Diagnosis is made based on the observation of a pattern of recurrent infections. Blood tests of lymphocyte and antibody functions will be normal. Tests of phagocytic cells will show normal ingestion, but a greatly decreased ability to kill bacteria.

Treatment

Early, aggressive treatment of all infections is critical to the successful management of CGD. Patients are treated with **antibiotics** and immune serum. Antibiotics are used at the first sign of infection. Immune serum is a source of antibodies that help fight infections. Interferon gamma is an experimental treatment for CGD that has shown promising results. There is no cure for the underlying cause of chronic granulomatous disease

Prognosis

Although antibiotics can treat most infections and may help prevent others, premature death may result, typically due to repeated lung infections.

Prevention

Since CGD is a hereditary disorder, it cannot currently be prevented. Patients and their families may ben-

efit from **genetic counseling**. Preventive (prophylactic) antibiotics may help keep some infections from occurring, and good hygiene, especially rigorous skin and mouth care, can help prevent infections in these areas. Avoiding crowds or other people who have infections are also effective preventive measures.

Resources

BOOKS

Abbas, Abul K., Andrew H. Lichtman, and Jordan S. Pober. *Cellular and Molecular Immunology.* 3rd ed. Philadelphia. W. B. Saunders Co., 1997.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

ORGANIZATIONS

Chronic Granulomatous Disease Association. 2616 Monterey Road, San Marino, CA 91108-1646. (818) 441-4118.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

John T. Lohr, PhD

Chronic kidney failure

Definition

Chronic kidney failure occurs when disease or disorder damages the kidneys so that they are no longer capable of adequately removing fluids and wastes from the body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream.

Description

Chronic kidney failure, also known as chronic renal failure, affects over 250,000 Americans annually. It is caused by a number of diseases and inherited disorders, but the progression of chronic kidney failure is always the same. The kidneys, which serve as the body's natural filtration system, gradually lose their ability to remove fluids and waste products (urea) from the bloodstream. They also fail to regulate certain chemicals in the bloodstream, and deposit protein into the urine. Chronic kidney failure is irreversible, and will eventually lead to total kidney failure, also known as end-stage renal disease (ESRD). Without proper treatment intervention to remove wastes and fluids from the bloodstream, ESRD is fatal.

Causes and symptoms

Kidney failure is triggered by disease or a hereditary disorder in the kidneys. Both kidneys are typically affected. The four most common causes of chronic kidney failure include:

- Diabetes. **Diabetes mellitus** (DM), both insulin dependant (IDDM) and non-insulin dependant (NIDDM), occurs when the body cannot produce and/or use insulin, the hormone necessary for the body to process glucose. Long-term diabetes may cause the glomeruli, the filtering units located in the nephrons of the kidneys, to gradually lose functioning.
- **Glomerulonephritis**. Glomerulonephritis is a chronic inflammation of the glomeruli, or filtering units of the kidney. Certain types of glomerulonephritis are treatable, and may only cause a temporary disruption of kidney functioning.
- **Hypertension**. High blood pressure is unique in that it is both a cause and a major symptom of kidney failure. The kidneys can become stressed and ultimately sustain permanent damage from blood pushing through them at an excessive level of pressure over a long period of time.
- **Polycystic kidney disease**. Polycystic kidney disease is an inherited disorder that causes cysts to be formed on the nephrons, or functioning units, of the kidneys. The cysts hamper the regular functioning of the kidney.

Other possible causes of chronic kidney failure include **kidney cancer**, obstructions such as **kidney stones**, **pyelonephritis**, reflux nephropathy, **systemic lupus erythematosus**, **amyloidosis**, sickle cell anemia, **Alport syndrome**, and oxalosis.

Initially, symptoms of chronic kidney failure develop slowly. Even individuals with mild to moderate kidney failure may show few symptoms in spite of increased urea in their blood. Among the symptoms that may be present at this point are frequent urination during the night and high blood pressure.

Most symptoms of chronic kidney failure are not apparent until kidney disease has progressed significantly. Common symptoms include:

- Anemia. The kidneys are responsible for the production of erythropoietin (EPO), a hormone which stimulates red blood cell production. If kidney disease causes shrinking of the kidney, this red cell production is hampered.
- Bad breath or a bad taste in mouth. Urea, or waste products, in the saliva may cause an ammonia-like taste in the mouth.
- Bone and joint problems. The kidneys produce vitamin D, which aids in the absorption of calcium and keeps bones strong. For patients with kidney failure, bones may become brittle, and in the case of children, normal growth may be stunted. Joint **pain** may also occur as a result of unchecked phosphate levels in the blood.

- Edema. Puffiness or swelling around the eyes, arms, hands, and feet.
- Frequent urination.
- Foamy or bloody urine. Protein in the urine may cause it to foam significantly. Blood in the urine may indicate bleeding from diseased or obstructed kidneys, bladder, or ureters.
- Headaches. High blood pressure may trigger headaches.
- Hypertension, or high blood pressure. The retention of fluids and wastes causes blood volume to increase, which in turn, causes blood pressure to rise.
- Increased **fatigue**. Toxic substances in the blood and the presence of anemia may cause feelings of exhaustion.
- **Itching**. Phosphorus, which is typically eliminated in the urine, accumulates in the blood of patients with kidney failure. This heightened phosphorus level may cause itching of the skin.
- Lower back pain. Pain where the kidneys are located, in the small of the back below the ribs.
- Nausea, loss of appetite, and vomiting. Urea in the gastric juices may cause upset stomach. This can lead to **malnutrition** and weight loss.

Diagnosis

Kidney failure is typically diagnosed and treated by a nephrologist, a doctor that specializes in treating the kidneys. The patient that is suspected of having chronic kidney failure will undergo an extensive blood work-up. A blood test will assess the levels of creatinine, blood urea nitrogen (BUN), uric acid, phosphate, sodium, and potassium in the blood. Urine samples will also be collected, usually over a 24-hour period, to assess protein loss.

Uncovering the cause of kidney failure is critical to proper treatment. A full assessment of the kidneys is necessary to determine if the underlying disease is treatable and if the kidney failure is chronic or acute. An x ray, MRI, computed tomography scan, ultrasound, renal biopsy, and/or arteriogram of the kidneys may be employed to determine the cause of kidney failure and level of remaining kidney function. X rays and ultrasound of the bladder and/or ureters may also be taken.

Treatment

Chronic kidney failure is an irreversible condition. Hemodialysis, peritoneal dialysis, or **kidney transplantation** must be employed to replace the lost function of the kidneys. In addition, dietary changes and treatment to relieve specific symptoms such as anemia and high blood pressure are critical to the treatment process.

KEY TERMS

End-stage renal disease (ESRD)—Total kidney failure; chronic kidney failure is diagnosed as ESRD when kidney function falls to 5–10% of capacity.

Nephrotic syndrome—Characterized by protein loss in the urine, low protein levels in the blood, and fluid retention.

Ureters—The two ducts that pass urine from each kidney to the bladder.

Hemodialysis

Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. Most hemodialysis patients require treatment three times a week, for an average of three to four hours per dialysis "run" depending on the type of dialyzer used and their current physical condition. The treatment involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. The dialysis circuit consists of plastic blood tubing, a two-compartment filter known as a dialyzer, or artificial kidney, and a dialysis machine that monitors and maintains blood flow and administers dialysate, a chemical bath used to draw waste products out of the blood. The patient's blood leaves and enters the body through two needles inserted into the patient's vein, called an access site, and is pushed through the blood compartment of the dialyzer. Once inside of the dialyzer, excess fluids and toxins are pulled out of the bloodstream and into the dialysate compartment, where they are carried out of the body. At the same time, electrolytes and other chemicals in the dialysate solution move from the dialysate into the bloodstream. The purified, chemically-balanced blood is then returned to the body.

Peritoneal dialysis

In peritoneal dialysis (PD), the patient's peritoneum, or lining of the abdomen, acts as a blood filter. A catheter is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a waiting period of six to 24 hours, depending on the treatment method used, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate. There are three types of peritoneal dialysis, which vary by treatment time and administration method: Continuous Ambulatory Peritoneal Dialysis

(CAPD), Continuous Cyclic Peritoneal Dialysis (CCPD), and Intermittent Peritoneal Dialysis (IPD).

Kidney transplantation

Kidney transplantation involves surgically attaching a functioning kidney, or graft, from a brain dead organ donor (a cadaver transplant), or from a living donor, to a patient with ESRD. Patients with chronic renal disease who need a transplant and don't have a living donor register with UNOS (United Network for Organ Sharing), the federal organ procurement agency, to be placed on a waiting list for a cadaver kidney transplant. Kidney availability is based on the patient's health status. When the new kidney is transplanted, the patient's existing, diseased kidneys may or may not be removed, depending on the circumstances surrounding the kidney failure. A regimen of immunosuppressive, or anti-rejection medication, is required after transplantation surgery.

Dietary management

A diet low in sodium, potassium, and phosphorous, three substances that the kidneys regulate, is critical in managing kidney disease. Other dietary restrictions, such as a reduction in protein, may be prescribed depending on the cause of kidney failure and the type of dialysis treatment employed. Patients with chronic kidney failure also need to limit their fluid intake.

Medications and dietary supplements

Kidney failure patients with hypertension typically take medication to control their high blood pressure. Epoetin alfa, or EPO (Epogen), a hormone therapy, and intravenous or oral iron supplements are used to manage anemia. A multivitamin may be prescribed to replace **vitamins** lost during dialysis treatments. Vitamin D, which promotes the absorption of calcium, along with calcium supplements, may also be prescribed.

Since 1973, Medicare has picked up 80% of ESRD treatment costs, including the costs of dialysis and transplantation and of some medications. To qualify for benefits, a patient must be insured or eligible for benefits under Social Security, or be a spouse or child of an eligible American. Private insurance and state Medicaid programs often cover the remaining 20% of treatment costs.

Prognosis

Early diagnosis and treatment of kidney failure is critical to improving length and quality of life in chronic kidney failure patients. Patient outcome varies by the cause of chronic kidney failure and the method chosen to treat it. Overall, patients with chronic kidney disease leading to ESRD have a shortened lifespan. According to the United States Renal Data System (USRDS), the lifespan of an ESRD patient is 18–47% of the lifespan of the age-sex-race matched general population. ESRD patients on dialysis have a lifespan that is 16–37% of the general population.

The demand for kidneys to transplant continues to exceed supply. In 1996, over 34,000 Americans were on the UNOS waiting list for a kidney transplant, but only 11,330 living donor and cadaver transplants were actually performed. Cadaver kidney transplants have a 50% chance of functioning nine years, and living donor kidneys that have two matching antigen pairs have a 50% chance of functioning for 24 years. However, some transplant grafts have functioned for over 30 years.

Resources

BOOKS

Bock, G. H., E. J. Ruley, and M. P. Moore. *A Parent's Guide to Kidney Disorders.* Minneapolis: University of Minnesota Press, 1993.

Brenner, Barry M., and Floyd C. Rector Jr., eds. *The Kidney.* Philadelphia: W. B. Saunders Co., 1991.

Cameron, J. S. *Kidney Failure: The Facts.* New York: Oxford Univ. Press, 1996.

Ross, Linda M., ed. *Kidney and Urinary Tract Diseases and Disorders Sourcebook.* Vol. 21. Health Reference Series. Detroit: Omnigraphics, 1997.

U.S. Renal Data System. *USRDS 1997 Annual Data Report.* Bethesda, MD: The National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1996.

PERIODICALS

Friedman, Elia A. "End-stage Renal Disease Therapy: An American Success Story." *Journal of the American Medical Association* 275 (Apr. 1996): 1118-22.

Taylor, Judy H. "End-stage Renal Disease in Children: Diagnosis, Management, and Interventions." *Pediatric Nursing* 22 (Nov./Dec. 1996): 481-92.

ORGANIZATIONS

American Association of Kidney Patients (AAKP). 100 S. Ashley Drive, Suite 280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Fund (AKF). Suite 1010, 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://www.arbon.com/kidney>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

United States Renal Data System (USRDS). The University of Michigan, 315 W. Huron, Suite 240, Ann Arbor, MI 48103. (734) 998-6611. <http://www.med.umich.edu/usrds>.

Paula Anne Ford-Martin

Chronic leukemias *see* **Leukemias, chronic**

Chronic obstructive lung disease

Definition

Chronic obstructive lung disease, also known as chronic obstructive pulmonary disease (COPD), is a general term for a group of conditions in which there is persistent difficulty in expelling (or exhaling) air from the lungs. COPD commonly refers to two related, progressive diseases of the respiratory system, chronic **bronchitis** and **emphysema**. Because **smoking** is the major cause of both diseases, chronic bronchitis and emphysema often occur together in the same patient.

Description

COPD is one of the fastest-growing health problems. Nearly 16 million people in the United States, 14 million with chronic bronchitis and two million with emphysema, suffer from COPD. COPD is responsible for more than 96,000 deaths annually, making it the fourth leading cause of **death**. Although COPD is more common in men than women, the increase in incidence of smoking among women since World War II has produced an increase in deaths from COPD in women. COPD has a large economic impact on the healthcare system and a destructive impact on the lives of patients and their families. Quality of life for a person with COPD decreases as the disease progresses.

Chronic bronchitis

In chronic bronchitis, chronic inflammation caused by cigarette smoking results in a narrowing of the openings in the bronchi, the large air tubes of the respiratory system, and interferes with the flow of air. Inflammation also causes the glands that line the bronchi to produce excessive amounts of mucus, further narrowing the airways and blocking airflow. The result is often a chronic **cough** that produces sputum (mainly mucus) and **shortness of breath**. Cigarette smoke also damages the cilia, small hair-like projections that move bacteria and foreign particles out of the lungs, increasing the risk of infections.

Emphysema

Emphysema is a disease in which cigarette smoke causes an overproduction of the enzyme elastase, one of the immune system's infection-fighting biochemicals. This results in irreversible destruction of a protein in the lung called elastin which is important for maintaining the structure of the walls of the alveoli, the terminal small air sacs of the respiratory system. As the walls of the alveoli rupture, the number of alveoli is reduced and many of those remaining are enlarged, making the lungs of the patient with emphysema less elastic and overinflated. Due to the higher pressure inside the chest that must be developed to force air out of the less-elastic lungs, the bronchioles, small air tubes of the respiratory system, tend to collapse during exhalation. Stale air gets trapped in the air sacs and fresh air cannot be brought in.

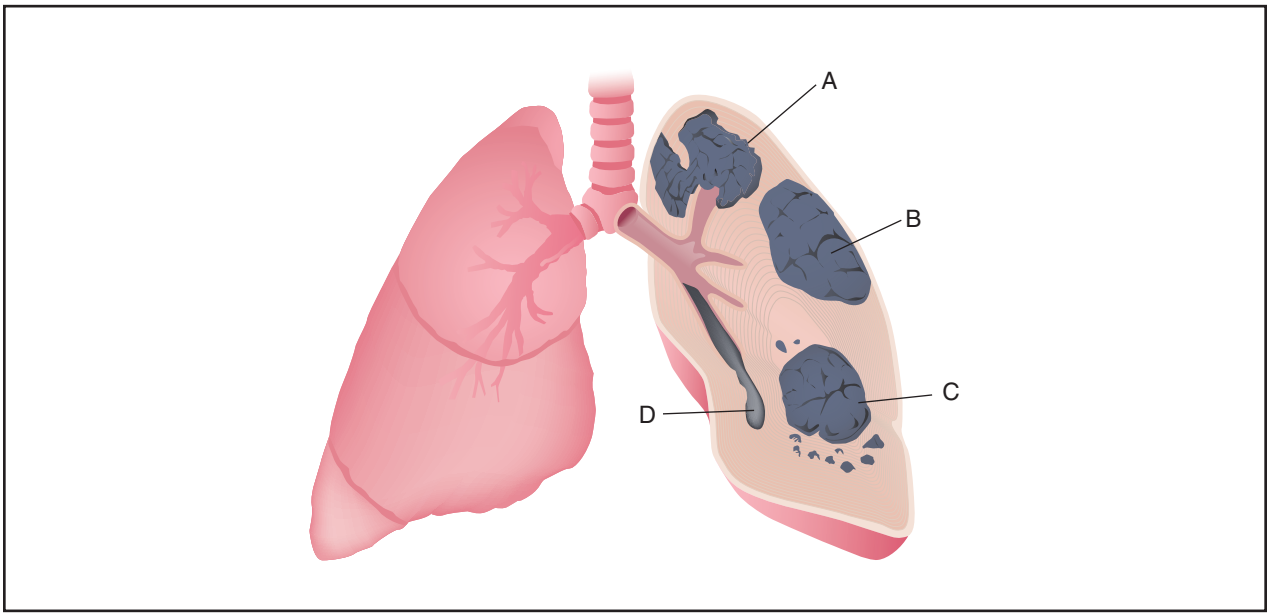
Causes and symptoms

There are several important risk factors for COPD:

- Lifestyle. Cigarette smoking is by far the most important risk factor for COPD (80% of all cases). Cigar and pipe smoking can also cause COPD. Air pollution and industrial dusts and fumes are other important risk factors.
- Age. Chronic bronchitis is more common in people over 40 years old; emphysema occurs more often in people 65 years of age and older.
- Socioeconomic class. COPD-related deaths are about twice as high among unskilled and semi-skilled laborers as among professionals.
- Family clustering. It is thought that heredity predisposes people in certain families to the development of COPD when other causes, such as smoking and air pollution, are present.
- Lung infections. Lung infections make all forms of COPD worse.

In the general population, emphysema usually develops in older individuals with a long smoking history. However, there is also a form of emphysema that runs in families. People with this type of emphysema have a hereditary deficiency of a blood component, an enzyme inhibitor called alpha-1-antitrypsin (AAT). This type of emphysema is sometimes called "early onset emphysema" because it can appear when a person is as young as 30 or 40 years old. It is estimated that there are between 75,000 and 150,000 Americans who were born with AAT-deficiency. Of this group, emphysema afflicts an estimated 20,000-40,000 people (1–3% of all cases of emphysema). The risk of developing emphysema for an AAT-deficient individual who also smokes is much greater than for others.

The first symptoms of chronic bronchitis are cough and mucus production. These symptoms resemble a chest cold that lingers on for weeks. Later, shortness of breath develops. Cough, sputum production, and shortness of breath may become worse if a person develops a lung infection. A person with chronic bronchitis may later



A. lung cancer. B. pneumonia. C. emphysema. D. phlegm from chronic bronchitis. *(Illustration by Argosy, Inc.)*

develop emphysema as well. In emphysema, shortness of breath on exertion is the predominant early symptom. Coughing is usually minor and there is little sputum. As the disease progresses, the shortness of breath occurs with less exertion, and eventually may be present even when at rest. At this point, a sputum-producing cough may also occur. Either chronic bronchitis or emphysema may lead to respiratory failure—a condition in which there occurs a dangerously low level of oxygen or a serious excess of carbon dioxide in the blood.

Diagnosis

The first step in diagnosing COPD is a good medical evaluation, including a medical history and a **physical examination** of the chest using a stethoscope. In addition, the doctor may request one or more of the following tests:

Pulmonary function test

Using a spirometer, an instrument that measures the air taken into and exhaled from the lungs, the doctor will determine two important values: (1) vital capacity (VC), the largest amount of air expelled after the deepest inhalation, and (2) forced expiratory volume (FEV1), the maximum amount of air expired in one second. The **pulmonary function test** can be performed in the doctor's office, but is expensive.

Chest x ray

Chest x rays can detect only about half of the cases of emphysema. Chest x rays are rarely useful for diagnosing chronic bronchitis.

Blood gas levels

Blood may be drawn from an artery (more painful than drawing blood from a vein) to determine the amount of oxygen and carbon dioxide present. Low oxygen and high carbon dioxide levels are often indicative of chronic bronchitis, but not always of emphysema.

Tests for cause of infection

If infection is present, blood and sputum tests may be done to determine the cause of infection.

Electrocardiogram (ECG)

Many patients with lung disease also develop heart problems. The ECG identifies signs of heart disease.

Treatment

The precise nature of the patient's condition will determine the type of treatment prescribed for COPD. With a program of complete respiratory care, disability can be minimized, acute episodes prevented, hospitalizations reduced, and some early deaths avoided. On the other hand, no treatment has been shown to slow the progress of the disease, and only oxygen therapy increases survival rate.

Drugs

Medications frequently prescribed for COPD patients include:

- **Bronchodilators**. These agents open narrowed airways and offer significant symptomatic relief for many, but not all, people with COPD. There are three types of bronchodilators: Beta2 agonists, anticholinergic agents, and theophylline and its derivatives. Depending on the specific drug, a bronchodilator may be inhaled, injected, or taken orally.
- **Corticosteroids**. Corticosteroids, usually inhaled, block inflammation and are most useful for patients with chronic bronchitis with or without emphysema. Steroids are generally not useful in patients who have emphysema.
- Oxygen replacement. Eventually, patients with low blood oxygen levels may need to rely on supplemental oxygen from portable or stationary tanks.
- **Antibiotics**. Antibiotics are frequently given at the first sign of a respiratory infection, such as increased sputum production or a change in color of sputum from clear to yellow or green.
- Vaccines. To prevent pulmonary infection from viruses and bacteria, people with COPD should be vaccinated against **influenza** each year at least six weeks before flu season and have a one-time pneumococcal (**pneumonia**) vaccine.
- Expectorants. These agents help loosen and expel mucus secretions from the airways.
- Diuretics. These drugs are given to prevent excess water retention in patients with associated right **heart failure**.
- Augmentation therapy (for emphysema due to AAT-deficiency only). Replacement AAT (Prolastin), derived from human blood which has been screened for viruses, is injected weekly or bimonthly for life.

KEY TERMS

Alpha-1-antitrypsin (AAT)—A blood component that breaks down infection-fighting enzymes such as elastase.

Alveoli—Terminal air sacs of the respiratory system, where gas (oxygen and carbon dioxide) exchange occurs.

Bronchi—Large air tubes of the respiratory system.

Bronchioles—Small air tubes of the respiratory system.

Bronchodilators—Drugs that open wider the bronchial tubes of the respiratory system.

Corticosteroids—A group of hormones that are used as drugs to block inflammation.

Forced expiratory volume (FEV1)—The maximum amount of air expired in one second.

Spirometer—An instrument used by a doctor to perform a breathing test.

Vital capacity (VC)—The largest amount of air expelled after one's deepest inhalation.

Surgery

Surgical procedures for emphysema are very rare. They are expensive and often not covered by insurance. The great majority of patients cannot be helped by surgery, and no single procedure is ideal for those who can be helped. In January of 1996, the government temporarily suspended Medicare payments for lung reduction surgery.

- **Lung transplantation**. Lung transplantation has been successfully employed in some patients with end-stage COPD. In the hands of an experienced team, the one-year survival rate is over 70%.
- Lung volume reduction. These procedures remove 20–30% of severely diseased lung tissue; the remaining parts of the lung are joined together. Mortality rates can be as high as 15% and complication rates are even higher. When the operation is successful, patients report significant improvement in symptoms.

Pulmonary rehabilitation

A structured, outpatient pulmonary **rehabilitation** program improves functional capacity in certain patients with COPD. Services may include general **exercise** training, administration of oxygen and nutritional supplements, intermittent mechanical ventilatory support, continuous positive airway pressure, relaxation techniques, breathing exercises and techniques (such as pursed lip breathing), and methods for mobilizing and removing secretions.

Alternative treatment

For both chronic bronchitis and emphysema, alternative practitioners recommend diet and nutritional supplements, a variety of herbal medicines, **hydrotherapy**, **acupressure** and **acupuncture**, **aromatherapy**, **homeopathy**, and **yoga**.

Prognosis

COPD is a disease that can be treated and controlled, but not cured. Survival of patients with COPD is clearly related to the degree of their lung function when they are

diagnosed and the rate at which they lose this function. Overall, the median survival is about 10 years for patients with COPD who have lost approximately two-thirds of their lung function at diagnosis.

Prevention

Lifestyle modifications that can help prevent COPD, or improve function in COPD patients, include: quitting smoking, avoiding respiratory irritants and infections, avoiding allergens, maintaining good **nutrition**, drinking lots of fluids, avoiding excessively low or high temperatures and very high altitudes, maintaining proper weight, and exercising to increase muscle tone.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Fife, WA: Future Medicine Publishing, 1995.

Honig, Eric G., and Ronald H. Ingram Jr. "Chronic Bronchitis, Emphysema, and Airways Obstruction." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Ries, Andrew L., et al. *Shortness of Breath.* St. Louis: Mosby, 1996.

PERIODICALS

Celli, Bartolome, et al. "The Challenge of COPD: Therapeutic Strategies That Work." *Patient Care* 31 (15 Mar. 1997): 101-118.

Cordova, Francis C., and Gerard J. Griner. "Management of Advanced Chronic Obstructive Pulmonary Disease." *Comprehensive Therapy* 23, no. 6: 413-424.

Lefrak, Stephen S., et al. "Recent Advances in Surgery for Emphysema." *Annual Review of Medicine* 48: 387-398.

Petty, Thomas L., and Gail G. Weinmann. "Building a National Strategy for the Prevention and Management of and Research in Chronic Obstructive Pulmonary Disease." *Journal of the American Medical Association* 277 (15 Jan. 1997): 246-253.

ORGANIZATIONS

American Association for Respiratory Care. 11030 Ables Lane, Dallas, TX 75229. (214) 243-2272. <http://www.aarc.org>.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Jewish Medical and Research Center. 1400 Jackson St., Denver, CO 80206. (800) 222-LUNG (Lung Line). <http://www.njc.org>.

Harry W. Golden

Chronic obstructive pulmonary disease *see* **Emphysema; Chronic obstructive lung disease**

Churg-Strauss syndrome *see* **Vasculitis**

Cingulotomy *see* **Psychosurgery**

Ciprofloxacin *see* **Fluoroquinolones**

Circadian rhythm sleep disorders *see* **Jet lag**

Circumcision

Definition

The surgical removal of the foreskin of the penis or prepuce.

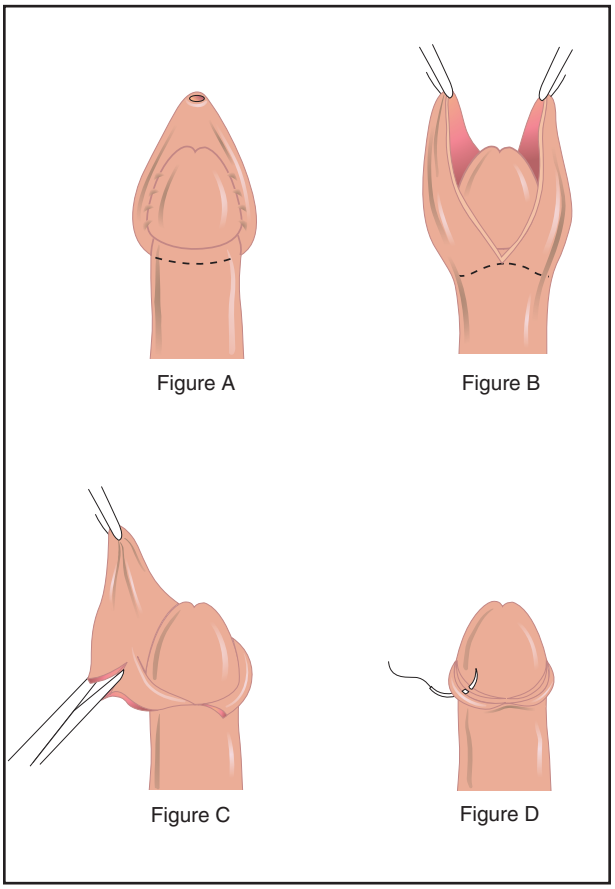
Purpose

In the United States, circumcision in infant boys is performed for social, medical, or cultural/religious reasons. Once a routine operation urged by pediatricians and obstetricians for newborns in the middle of the twentieth century, circumcision has become an elective option that parents make for their sons on an individual basis. Families who practice Judaism or Islam may select to have their sons circumcised as a religious practice. Others choose circumcision for medical benefits.

Female circumcision (also known as **female genital mutilation**) is usually performed for cultural and social reasons by family members and others who are not members of the medical profession, with no anesthesia. Not only is the prepuce removed but often the vaginal opening is sewn to make it smaller. This practice is supposed to ensure the virginity of a bride on her wedding day. It also prevents the woman from achieving sexual pleasure during coitus. This practice is not universally approved by the medical profession and is considered by some as a human rights violation.

Though the incidence of male circumcision has decreased from 90% in 1979 to 60% in 1996, it is still the most common surgical operation in the United States. Circumcision rates are much lower for the rest of the industrialized world. In Britain, it is only done for religious practices or to correct a specific medical condition of the penis.

Some of the medical reasons parents choose circumcision are to protect against infections of the urinary tract and the foreskin, prevent **cancer**, lower the risk of getting **sexually transmitted diseases**, and prevent phimosis (a tightening of the foreskin that may close the opening of the penis). Though studies indicate that uncircumcised boys under the age of five are 20 times more likely than circumcised boys to have



A typical circumcision procedure involves the following steps: Figure A: The surgeon makes an incision around the foreskin. Figure B: The foreskin is then freed from the skin covering the penile shaft. Figure C: The surgeon cuts the foreskin to the initial incision, lifting the foreskin from the mucous membrane. Figure D: The surgeon sutures the top edge of the skin that covers the penile shaft and the mucous membrane. *(Illustration by Electronic Illustrators Group.)*

urinary tract infections (UTIs), the rate of incidence of UTIs is quite low. There are also indications that circumcised men are less likely to suffer from **penile cancer**, inflammation of the penis, or have many sexually transmitted diseases. Here again, the rate of incidence is low. Good hygiene usually prevents most infections of the penis. Phimosis and penile cancer are very rare, even in men who have not been circumcised. Education and good safe sex practices can prevent sexually transmitted diseases in ways that a surgical procedure cannot because these are diseases acquired through risky behaviors.

With these factors in mind, the American Academy of Pediatrics has issued a policy statement that states though there is existing scientific evidence that indicates the medical benefits of circumcision, the benefits aren't strong enough to recommended circumcision as a routine practice.

KEY TERMS

Foreskin—A covering fold of skin over the tip of the penis.

Glans—The cone-shaped tip of the penis.

Hernia—Bulging of abdominal structures through an abnormal opening in the muscular wall.

Hydrocele—Collection of fluid in the scrotum.

Hypospadias—A congenital deformity of the penis where the urinary tract opening is not at the tip of the glans.

Phimosis—A tightening of the foreskin that may close the opening of the penis.

Prepuce—A fold like the foreskin that covers the clitoris; another name for foreskin.

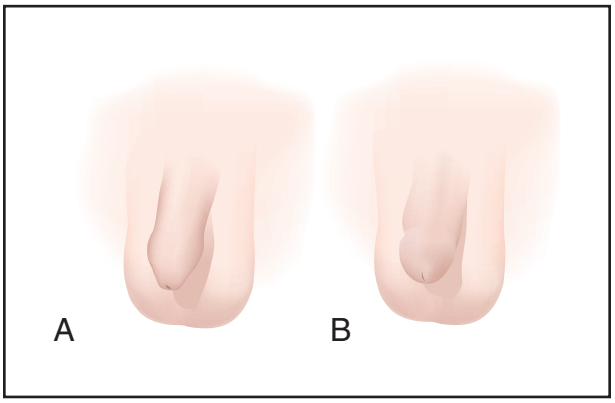
Precautions

Circumcision should not be performed on infants with certain deformities of the penis that may require a portion of the foreskin for repair. The most common condition for surgery using the foreskin is hypospadias, a congenital deformity of the penis where the urinary tract opening is not at the tip of the glans. Also, infants with a large hydrocoele or **hernia** may suffer important complications through circumcision. Premature infants and infants with serious infections are also poor candidates to be circumcised, as are infants with **hemophilia**, other bleeding disorders, or whose mothers had taken anticoagulant drugs. In older boys or men, circumcision is a minor procedure. Therefore, it can be performed in virtually anyone without a serious illness or unusual deformity.

Description

The foreskin of the penis protects the sensitivity of the glans and shields it from irritation by urine, feces, and foreign materials. It also protects the urinary opening against infection and incidental injury.

In circumcision of infants, the foreskin is pulled tightly into a specially designed clamp, and the foreskin pulls away from the broadened tip of the penis. Pressure from the clamp stops bleeding from blood vessels that supplied the foreskin. In older boys or adults, an incision is made around the base of the foreskin, the foreskin is



A. uncircumcised penis. B. circumcised penis. *(Illustration by Argosy Inc.)*

pulled back, and then it is cut away from the tip of the penis. Stitches are usually used to close the skin edges.

Preparation

Despite a long-standing belief that infants do not experience serious **pain** from circumcision, most authorities now believe that some form of local anesthesia is necessary. The physician injects local anesthesia at the base of the penis or under the skin around the penis (subcutaneous ring block). Both anesthetics block key nerves. EMLA cream, a topical formula of several anesthetics can also be used.

Aftercare

After circumcision, the wound should be washed daily. An antibiotic ointment or petroleum jelly may be applied to the site. If there is an incision, a wound dressing will be present and should be changed each time the diaper is changed. Sometimes a plastic ring is used instead of a bandage. The ring will usually fall off in five to eight days. The penis will heal in seven to 10 days.

Infants who undergo circumcision may be fussy for some hours afterward, so parents should be prepared for crying, feeding problems, and sleep problems. Generally these go away within a day. In older boys, the penis may be painful, but this will go away gradually. A topical anesthetic ointment or spray may be used to relieve this temporary discomfort. There may also be a "bruise" on the penis, which typically goes away with no particular attention.

Risks

Complications following newborn circumcision appear in one out of every 500 procedures. Most complications are minor. Bleeding occurs in half of the complications and is usually easy to control. Infections are rare and present with **fever** and signs of inflammation.

There may be injuries to the penis itself, and these may be difficult to repair. In 2000, there were reports that the surgical clamps used in circumcision were at fault in over 100 injuries reported between July 1996 and January 2000. In nearly all cases, the clamps were assumed to be in working order but had been repaired with replacement parts that were not of the manufacturer's specifications. Physicians were urged to inspect the clamps before use and ensure that their dimensions fit their infant patients.

Resources

BOOKS

Gollaher, David L. *Circumcision: A History of the World's Most Controversial Surgery.* Basic Books, 2000.

PERIODICALS

Imperio, Winnie Anne. "Circumcision Appears Safe, But Not Hugely Beneficial." *OB GYN News* 35, no. 7 (1 Apr. 2000): 9.

Schmitt, B. D. "The Circumcision Descision: Pros and Cons." *Clinical Reference Systems* (2000): 1579.

OTHER

American Academy of Pediatrics. *New AAP Circumcision Policy Released (Press Release).* 1 Mar. 1999. <http://www.aap.org/advocacy/archives/marcircum.htm>.

Janie F. Franz

Cirrhosis

Definition

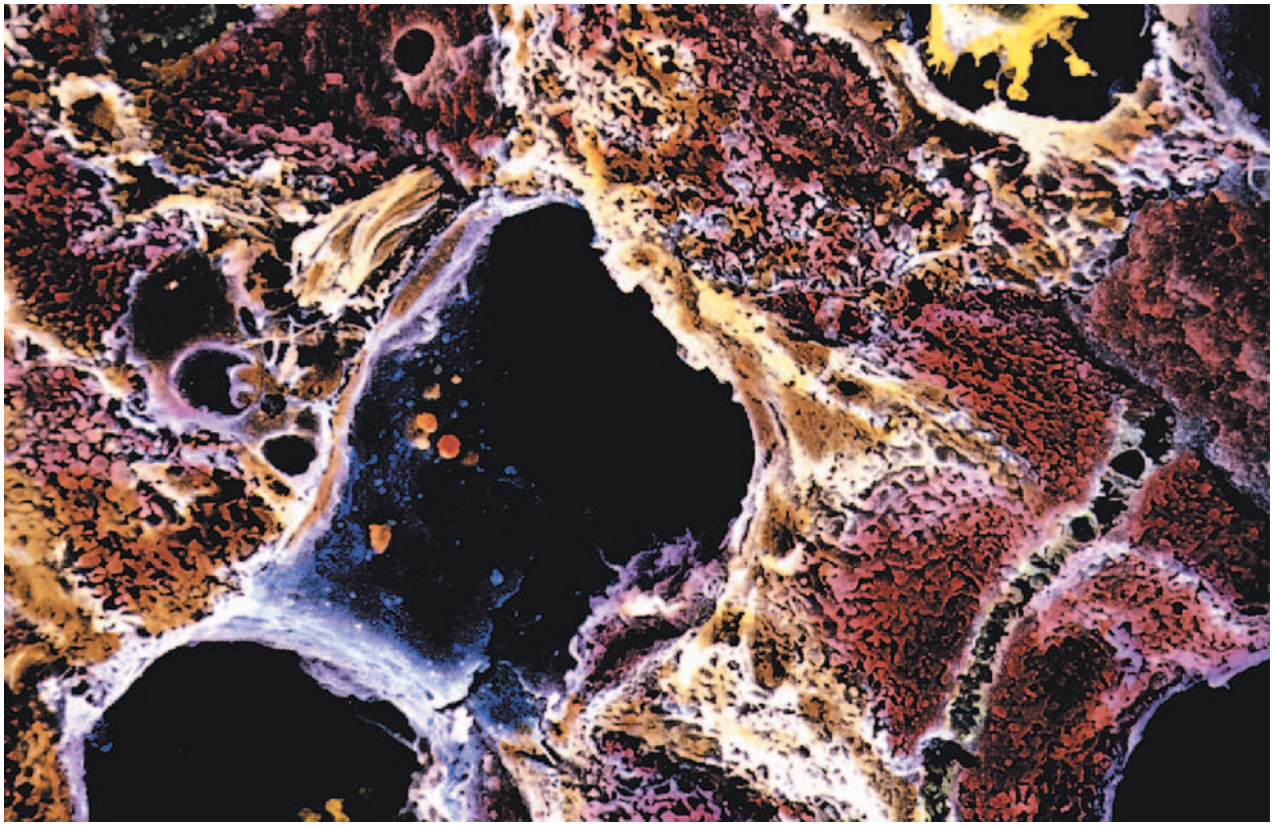
Cirrhosis is a chronic, degenerative disease in which normal liver cells are damaged and are then replaced by scar tissue.

Description

Cirrhosis changes the structure of the liver and the blood vessels that nourish it. The disease reduces the liver's ability to manufacture proteins and process hormones, nutrients, medications, and poisons.

Cirrhosis gets worse over time and can become potentially life threatening. This disease can cause:

- excessive bleeding (hemorrhage)
- impotence
- liver **cancer**
- coma due to accumulated ammonia and body wastes (liver failure)



A micrograph of a human liver showing tissue damaged by cirrhosis. *(Photograph by Professor P. Motta, Photo Researchers, Inc. Reproduced by permission.)*

• death

Cirrhosis is the seventh leading cause of disease-related death in the United States. It is twice as common in men as in women. The disease occurs in more than half of all malnourished chronic alcoholics and kills about 25,000 people a year. It is the third most common cause of death in adults between the ages of 45 and 65.

Types of cirrhosis

Portal or nutritional cirrhosis is the form of the disease most common in the United States. About 30–50% of all cases of cirrhosis are this type. Nine out of every 10 people who have nutritional cirrhosis have a history of **alcoholism**. Portal or nutritional cirrhosis is also called Laënnec's cirrhosis.

Biliary cirrhosis is caused by intrahepatic bile-duct diseases that impede bile flow. Bile is formed in the liver and is carried by ducts to the intestines. Bile then helps digest fats in the intestines. Biliary cirrhosis can scar or block these ducts. It represents 15–20% of all cirrhosis.

Various types of chronic hepatitis, especially **hepatitis B** and **hepatitis C**, can cause postnecrotic cirrhosis. This form of the disease affects up to 40% of all patients who have cirrhosis.

Disorders like the inability to metabolize iron and similar disorders may cause pigment cirrhosis (**hemochromatosis**), which accounts for 5–10% of all instances of the disease.

Causes and symptoms

Long-term alcoholism is the primary cause of cirrhosis in the United States. Men and women respond differently to alcohol. Although most men can safely consume two to five drinks a day, one or two drinks a day can cause liver damage in women. Individual tolerance to alcohol varies, but people who drink more and drink more often have a higher risk of developing cirrhosis. In some people, one drink a day can cause liver scarring.

Chronic liver infections like hepatitis B and particularly hepatitis C are commonly linked to cirrhosis. People at high risk of contracting hepatitis B include those exposed to the virus through contact with blood and body fluids. This includes healthcare workers and intraveneous

(IV) drug users. People in the past have contracted hepatitis C through blood transfusions.

Liver injury, reactions to prescription medications, exposure to toxic substances, and repeated episodes of **heart failure** with liver congestion can cause cirrhosis. The disorder can also be a result of diseases that run in families (inherited diseases) like:

- a lack of a specific liver enzyme ($alpha_1$-antitrypsin deficiency)
- the absence of a milk-digesting enzyme (galactosemia)
- an inability to convert sugars to energy (glycogen storage disease)
- an absorption deficit in which excess iron is deposited in the liver, pancreas, heart, and other organs (hemochromatosis)
- a disorder characterized by accumulations of copper in the liver, brain, kidneys, and corneas (Wilson's disease)

Poor **nutrition** increases a person's risk of developing cirrhosis. In about 10 out of every 100 patients, the cause of cirrhosis cannot be determined. Many people who have cirrhosis do not have any symptoms (often called compensated cirrhosis). Their disease is detected during a routine physical or when tests for an unrelated medical problem are performed. This type of cirrhosis can also be detected when complications occur (decompensated cirrhosis).

Symptoms of cirrhosis are usually caused by the loss of functioning liver cells or organ swelling due to scarring. The liver enlarges during the early stages of illness. The palms of the hands turn red and patients may experience:

- constipation
- diarrhea
- dull abdominal **pain**
- fatigue
- indigestion
- loss of appetite
- nausea
- vomiting
- weakness
- weight loss

As the disease progresses, the spleen enlarges and fluid collects in the abdomen (**ascites**) and legs (**edema**). Spider-like blood vessels appear on the chest and shoulders, and bruising becomes common. Men sometimes lose chest hair. Their breasts may grow and their testicles may shrink. Women may have menstrual irregularities.

Cirrhosis can cause extremely dry skin and intense **itching**. The whites of the eyes and the skin may turn yellow (**jaundice**), and urine may be dark yellow or brown. Stools may be black or bloody. Sometimes the patient develops persistent high blood pressure due to the scarring (portal **hypertension**). This type of hypertension can be life threatening. It can cause veins to enlarge in the stomach and in the tube leading from the mouth to the stomach (esophagus). These enlarged veins are called varices, and they can rupture and bleed massively.

Other symptoms of cirrhosis include:

- anemia
- bleeding gums
- decreased interest in sex
- fever
- fluid in the lungs
- hallucinations
- lethargy
- lightheadedness
- muscle weakness
- musty breath
- painful nerve inflammation (neuritis)
- slurred speech
- tremors

If the liver loses its ability to remove toxins from the brain, the patient may have additional symptoms. The patient may become forgetful and unresponsive, neglect personal care, have trouble concentrating, and acquire new sleeping habits. These symptoms are related to ammonia intoxication and the failure of the liver to convert ammonia to urea. High protein intake in these patients can also lead to these symptoms.

Diagnosis

A patient's medical history can reveal illnesses or lifestyles likely to lead to cirrhosis. Liver changes can be seen during a **physical examination**. A doctor who suspects cirrhosis may order blood and urine tests to measure liver function. Because only a small number of healthy cells are needed to carry out essential liver functions, test results may be normal even when cirrhosis is present.

Computed tomography scans (CT), ultrasound, and other imaging techniques can be used during diagnosis. They can help determine the size of the liver, indicate healthy and scarred areas of the organ, and detect **gallstones**. Cirrhosis is sometimes diagnosed during surgery or by examining the liver with a laparoscope. This view-

ing device is inserted into the patient's body through a tiny incision in the abdomen.

Liver biopsy is usually needed to confirm a diagnosis of cirrhosis. In this procedure, a tissue sample is removed from the liver and is examined under a microscope in order to learn more about the organ.

Treatment

The goal of treatment is to cure or reduce the condition causing cirrhosis, prevent or delay disease progression, and prevent or treat complications.

Salt and fluid intake are often limited, and activity is encouraged. A diet high in calories and moderately high in protein can benefit some patients. **Tube feedings** or vitamin supplements may be prescribed if the liver continues to deteriorate. Patients are asked not to consume alcohol.

Medication

Iron supplements, **diuretics**, and **antibiotics** may be used for anemia, fluid retention, and ammonia accumulation associated with cirrhosis. Vasoconstrictors are sometimes needed to stop internal bleeding and antiemetics may be prescribed to control nausea.

Laxatives help the body absorb toxins and accelerate their removal from the digestive tract. **Beta blockers** may be prescribed to control cirrhosis-induced portal hypertension. Because the diseased liver can no longer efficiently neutralize harmful substances, medications must be given with caution. Interferon medicines may be used by patients with chronic hepatitis B and hepatitis C to prevent post-hepatic cirrhosis.

Surgery

Medication that causes scarring can be injected directly into veins to control bleeding from varices in the stomach or esophagus. Varices may require a special surgical procedure called balloon tamponade ligation to stop the bleeding. Surgery may be required to repair disease-related throat damage. It is sometimes necessary to remove diseased portions of the spleen and other organs.

Liver transplants can benefit patients with advanced cirrhosis. However, the new liver will eventually become diseased unless the underlying cause of cirrhosis is removed. Patients with alcoholic cirrhosis must demonstrate a willingness to stop drinking before being considered suitable transplant candidates.

Supportive measures

A balanced diet promotes regeneration of healthy liver cells. Eating five or six small meals throughout the day should prevent the sick or bloated feeling patients with cirrhosis often have after eating. Alcohol and **caffeine**, which destroy liver cells, should be avoided. So should any foods that upset the stomach. Patients with brain disease associated with cirrhosis should avoid excessive amounts of protein in the diet.

A patient can keep a food diary that describes what was eaten, when it was eaten, and how the patient felt afterwards. This diary can be useful in identifying foods that are hard to digest and in scheduling meals to coincide with the times the patient is most hungry.

Patients who have cirrhosis should weigh themselves every day and notify their doctor of a sudden gain of five pounds or more. A doctor should also be notified if symptoms of cirrhosis appear in anyone who has not been diagnosed with the disease. A doctor should also be notified if a patient diagnosed with cirrhosis:

- vomits blood
- passes black stools
- seems confused or unresponsive
- shows signs of infection (redness, swelling, tenderness, pain)

Alternative treatment

Alternative treatments for cirrhosis are aimed at promoting the function of healthy liver cells and relieving the symptoms associated with the disease. Several herbal remedies may be helpful to cirrhosis patients. Dandelion (*Taraxacum officinale*) and rock-poppy (*Chelidonium majus*) may help improve the efficiency of liver cells. Milk thistle extract (*Silybum marianum*) may slow disease progression and significantly improve survival rates in alcoholics and other cirrhosis patients. Practitioners of **homeopathy** and **traditional Chinese medicine** can also prescribe treatments that support healthy liver function.

Prognosis

Cirrhosis-related liver damage cannot be reversed, but further damage can be prevented by patients who:

- eat properly
- get enough rest
- do not consume alcohol
- remain free of infection

If the underlying cause of cirrhosis cannot be corrected or removed, scarring will continue. The liver will fail, and the patient will probably die within five years. Patients who stop drinking after being diagnosed with cirrhosis can increase their likelihood of living more than a few years from 40% to 60–70%.

Prevention

Eliminating alcohol abuse could prevent 75–80% of all cases of cirrhosis.

Other preventive measures include:

- obtaining counseling or other treatment for alcoholism
- taking precautions (practicing safe sex, avoiding dirty needles) to prevent hepatitis
- getting immunizations against hepatitis if a person is in a high-risk group
- receiving appropriate medical treatment quickly when diagnosed with hepatitis B or hepatitis C
- having blood drawn at regular intervals to rid the body of excess iron from hemochromatosis
- using medicines (chelating agents) to rid the body of excess copper from Wilson's disease
- wearing protective clothing and following product directions when using toxic chemicals at work, at home, or in the garden

Resources

BOOKS

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

Springhouse Corporation. *Everything You Need to Know About Diseases*. Springhouse, PA: Springhouse Corporation, 1996.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

United Network for Organ Sharing. 1100 Boulders Parkway, Suite 500, P.O. Box 13770, Richmond, VA 23225-8770. (804) 330-8500.

OTHER

"Cirrhosis of the Liver." *ThriveOnline*. 8 May 1998 <http://thriveonline.oxygen.com>.

"Cirrhosis of the Liver." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.

Maureen Haggerty

Cisapride *see* **Antigastroesophageal reflux drugs**

CK test *see* **Creatine kinase test**

Clap *see* **Gonorrhea**

Clarithromycin *see* **Erythromycins**

Cleft lip and palate

Definition

A cleft is a birth defect that occurs when the tissues of the lip and/or palate of the fetus do not fuse very early in **pregnancy**. A cleft lip, sometimes referred to as a harelip, is an opening in the upper lip that can extend into the base of the nostril. A cleft palate is an opening in the roof of the mouth.

Description

Babies born with cleft lips will have an opening involving the upper lip. The length of the opening ranges from a small notch, to a cleft that extends into the base of the nostril. Cleft lips may involve one or both sides of the lip.

Babies born with cleft palates have openings in the palate, which is the roof of the mouth. The size and position of the opening varies. The cleft may be only in the hard palate, the bony portion of the roof of the mouth, opening into the floor of the nose. It may be only in the soft palate, the soft portion of the roof of the mouth. The cleft palate may involve both the hard and soft palate and may occur on both sides of the center of the palate.

Babies may have cleft lips with or without cleft palates. Cleft palates may also occur without cleft lips.

The incidence of cleft lip and palate not associated with a syndrome is one in 700 newborns. Native Americans have an incidence of 3.6 in 1,000 newborns. The incidence among Japanese newborns is 2.1 in 1,000. The incidence among whites is one in 1,000 newborns. African Americans have an incidence of 0.3 in 1,000 newborns.

Causes and symptoms

Cleft lips and palates not associated with a syndrome are caused by a combination of genetic and environmental factors. Inheritance caused by such a combination is called multifactorial. The embryo inherits genes that increase the risk for cleft lip and/or palate. When an embryo with such genes is exposed to certain environmental factors the embryo develops a cleft.

The risk of a baby being born with a cleft lip or palate increases with the number of affected relatives and increases with relatives that have more severe clefts.

Environmental factors that increase the risk of cleft lip and palate include cigarette and alcohol use during

pregnancy. Some drugs also increase the incidence of clefting, such as phenytoin, sodium valproate, and methotrexate. The pregnant mother's **nutrition** may affect the incidence of clefting as well.

Babies born with a cleft lip will be seen to have an elongated opening in the upper lip. The size of this opening may range from a small notch in the upper lip to an opening that extends into the base of the nostril. The cleft lip may be below the right or left nostril or below both nostrils.

Babies born with a cleft palate will be seen to have an opening into the roof of the mouth. The size and position of the cleft varies and it may involve only the hard palate, or only the soft palate and may occur on both sides of the center of the palate.

In some cases the cleft palate will be covered with the normal lining of the mouth and can only be felt by the examiner.

Babies with cleft lips and palates have feeding difficulties, which are more severe in babies with cleft palates. The difficulty in feeding is due to the baby being unable to achieve complete suction. In the case of clefts of the hard palate, liquids enter the nose from the mouth through the opening in the hard palate.

A cleft palate also affects a child's speech, since the palate is necessary for speech formation. The child's speech pattern may still be affected despite surgical repair.

Ear infections are more common in babies born with cleft palates. The infections occur because the muscles of the palate do not open the Eustachian tubes which drain the middle ear. This allows fluid to collect and increases the risk of infection and **hearing loss**.

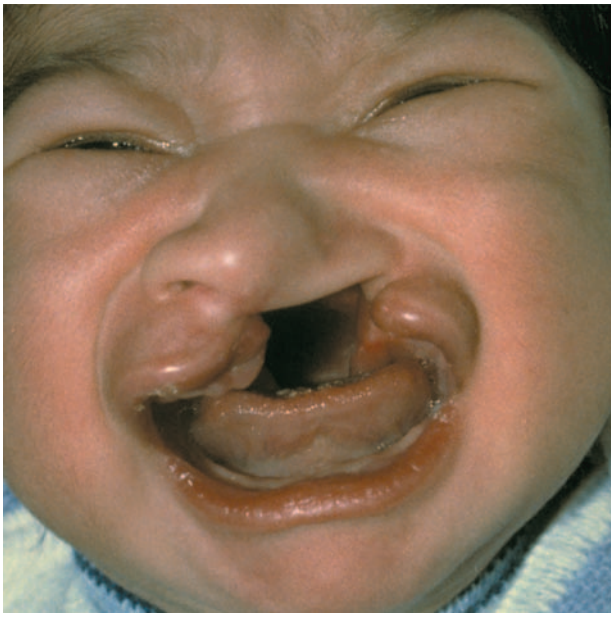
Teeth may also erupt misaligned.

Diagnosis

Cleft lip and palate can be diagnosed before birth by ultrasound. After birth, cleft lip and palate are diagnosed by physical exam.

Treatment

If cleft lip and/or palate are diagnosed by ultrasound before birth, further testing may be required to diagnose associated abnormalities if present. Referral to a cleft team is essential. A cleft team consists of specialists in the management of babies with clefts and includes surgeons as well as nurses and speech therapists. Members of the team inform the parents of all aspects of management. Feeding methods are also discussed, since feeding is the first problem that must be dealt with. It may be possible to breastfeed a baby born with only a cleft lip, but babies born with cleft palates usually have more problems with feeding and frequently require special bottles and teats. A palatal obturator is a device that fits into the roof of the mouth, thus blocking the cleft opening and allowing easier suckling.



This infant has an unilateral cleft lip and palate. *(Custom Medical Stock Photo. Reproduced by permission.)*

Surgery to repair cleft lips is sometimes performed after orthodontic treatment to narrow the gap in the upper lip. The orthodontic treatment can involve acrylic splints with or without screws or may involve the use of adhesive tape placed across the gap in the lip. The orthodontic treatment for cleft lip should be started within the first three weeks of life and continue until the cleft lip is repaired.

The timing of surgical cleft lip repair depends on the judgment of the surgeon who will perform the operation. The procedure is usually performed between one and three months of age. The goals of the operation are to close the gap in the upper lip, place scars in the natural skin curves and to repair muscle so that the lip appears normal during movement. The closure is done in the three layers (skin, muscle, and mucosa) that line the inside of the lip. At the time of the procedure, if the nose is shaped abnormally due to the cleft lip, it is also corrected. Sometimes further surgery may be needed on the lip and/or nose to refine the result.

The goals of the surgeon repairing a cleft palate are normal speech, normal facial growth, and hearing for the affected infant. The repair of the cleft palate is usually performed between three and 18 months of age. The timing may extend beyond this and varies with the type of cleft palate and center where the procedure is being performed.

Depending of the type of cleft palate, more than one operation may be needed to close the cleft and improve speech.

Nonsurgical treatment of a cleft palate is available for patients who are at high risk for surgery and consists of a prosthetic appliance worn to block the opening in the palate.

Babies born with cleft palates are vulnerable to ear infections. Their Eustachian tubes do not effectively drain fluid from the middle ear so fluid accumulates and infection sets in. This may lead to hearing loss. These children require drainage tubes to be inserted to prevent fluid accumulation.

Babies born with clefts usually require orthodontic treatment between 13 and 18 years of age. They also require speech therapy.

Prognosis

Babies born with cleft lip and palate have a good prognosis, and approximately 80% will develop normal speech. There is no known means of preventing clefting. Good prenatal care is essential and avoiding harmful substances appear to reduce the risk.

Resources

PERIODICALS

Litwak-Saleh, Kim. "Practical Points in the case of the Patient with post-Cleft lip repair." *Journal of Post Anesthesia Nursing* 8 (February 1993): 35–37.

Chung, Kevin C. "Maternal Cigarette Smoking during Pregnancy and the risk of having a child with Cleft Lip/Palate." *Plastic and Reconstructive Surgery* 105 (February 2000): 458–491.

Christensen, Karr. "The 20th Century Danish Facial Cleft Population—Epidemiological and Genetic-Epidemiolical Studies." *Cleft Palate—Craniofacial Journal* 36 (March 1999): 96–104.

Bender, Patricia L. "Genetics of Cleft Lip and Palate." *Journal of Pediatric Nursing* 15 (August 2000): 242–249.

Rohrich, Rod J. "Optimal Timing of Cleft Palate Closure." *Plastic and Reconstructive Surgery* 106 (August): 413–421.

Cockell, Anna. "Prenatal Diagnosis and Management of orofacial Clefts." *Prenatal Diagnosis* 20 (February 2000): 149–151.

Denk, Michael J. "Topics in Pediatric Plastic Surgery." *Pediatric Clinics of North America* 45 (December 1998).

ORGANIZATIONS

Cleft Palate Foundation. (800) 24-CLEFT. <http://www.cleftline.org>.

Farris F. Gulli, MD

Cleft palate *see* **Cleft lip and palate**

Climacteric *see* **Menopause**

Clenched fist injury

Definition

A clenched fist injury (CFI) is a bite wound on the hand, caused when a person's closed fist strikes the teeth of another person, usually in the course of a fight. CFIs are sometimes referred to as closed fist injuries or fight bites.

Description

Clenched fist injuries are most common over the metacarpo phalangeal joint. Their appearance is deceptive because they do not bleed heavily and the underlying injury is hidden by soft tissue when the patient opens his hand and straightens the injured finger. CFIs can, however, have serious consequences, including infection, **cellulitis**, inflammation of the bone or bone marrow (**osteomyelitis**), septic arthritis, and inflammation of the sheaths covering the tendons of the hand (tenosynovitis). These may lead to permanent loss of function or **amputation**.

Most CFIs result in tissue injury due to the force of impact, ragged-edged tears in the skin resulting from contact with the teeth, and contamination of the wound by the bacteria in human saliva. As the patient opens his hand, the skin of the finger is pulled backward over the deeper part of the wound, thus sealing bacteria within the injured tissue. This sealing of the wound by normal motions of the finger is the reason why clenched fist injuries have the highest rate of infection of any human bite. The rate of infection of clenched-fist injuries varies from 15–50%.

Causes and symptoms

The causes of CFIs include fighting and other forms of aggressive behavior, often combined with drug or alcohol consumption.

The symptoms of clenched fist injury include **pain** in the affected part of the hand and some stiffness of the injured finger with limitation of movement. If the patient has delayed getting medical treatment, there may be evidence of infection, including swelling, redness, and suppuration (a discharge of pus). The skin around the wound will be warm to the touch and **fever** may be present.

Diagnosis

Diagnosis of clenched fist injuries is usually made on the basis of the location of the injury and x-ray findings. The most common finding in CFI x rays is soft tissue swelling, but the x rays may also reveal air pockets in deep tissues or the joint spaces, fragments of teeth, frac-

ture lines in the bones, or small loose bone chips. Diagnosis is often complicated by the fact that the patient will be reluctant to admit how the injury happened. The treating physician must maintain a high level of suspicion and often ask directly.

Treatment

Treatment of clenched fist injuries is complicated by several factors. One factor is the anatomical structure of the human hand, which contains many small closed spaces that make it easy for infection to spread and persist. Another is the number of disease-causing bacteria transmitted by human bites; at least 42 different species have been identified. In addition, CFIs typically do not receive immediate treatment because the patient is concerned about legal consequences. The longer the delay, the higher the chances of infection and permanent damage to the hand. Patients who wait longer than 24 hours to seek treatment or have signs of infection or damage to the tendon, joint capsule, or bones are usually referred immediately to a doctor who specializes in hand surgery.

The first step in treatment of clenched fist injury is irrigation, a procedure by which the wound is flushed with a stream of water under high pressure or with an antiseptic solution. Incision and drainage of the wound (I&D) may be required as well as **debridement**, the surgical removal of dead tissue and **foreign objects** from a wound. Careful examination of the depth of the wound is essential to proper treatment. The surgeon may need to enlarge the sides of the wound in order to make an accurate evaluation. The patient will be asked to move the affected joint through its full range of motion so that the surgeon can determine whether the tendon or joint capsule has been damaged. Following these procedures, the surgeon will pack the wound and put the hand in a splint. Bite **wounds** are never sutured (sewn shut) because of the possibility of enclosing bacteria inside the injury. After 24 hours, the packing will be removed and the hand reexamined for signs of infection.

If the wound has become infected, the patient is usually hospitalized and given parenteral (injectable) **antibiotics**. The wound is irrigated and examined to determine the extent of the injury. Cultures are taken for both aerobic (requiring air or oxygen to live) and anaerobic (not requiring air or oxygen) species of bacteria. The cultures should be taken from areas deep in the wound rather than from the surface for greater accuracy. **Tetanus** toxoid should be given if the patient has not been immunized within the last 10 years. The patient should also receive treatment and follow-up for the rare possibility of HIV and hepatitis transmission. Although no well-documented cases of HIV transmission by human bites exist as of 2001, the potential for transmission by this route is still present.

KEY TERMS

Antibiotic—A chemical substance produced by a microorganism which can inhibit the growth of or kill other microorganisms.

Debridement—Surgical removal of damaged tissue and foreign objects from a wound.

I&D—Incision and drainage of a wound.

Irrigation—Cleansing a wound with large amounts of water and/or an antiseptic solution.

Parenteral—Administered inside the body but outside the digestive tract.

Tetanus toxoid—Tetanus toxoid is a vaccine used to prevent tetanus (also known as lockjaw).

Infected clenched fist injuries usually contain several disease-causing bacteria, the most common being *Streptococcus pyogenes*, *Staphylococcus aureus*, *Bacteroides sp*., *Peptostreptococcus sp*., and *Eikenella corrodens*. Broad-spectrum antibiotics are usually given. Uninfected and relatively superficial CFIs may be treated with oral penicillin plus dicloxacillin or Augmentin. For infected CFIs, parenteral penicillin G is usually given together with nafcillin or cefuroxime. CFIs infected by drug-resistant strains of *S. aureus* may require treatment with vancomycin.

Prognosis

The prognosis depends on the patient's underlying state of health and compliance with treatment; depth of the wound; the involvement of the joint capsule or tendon; and the length of time before the wound is treated. The more superficial the wound and the faster the treatment, the better the prognosis.

Prevention

The best way to prevent clenched fist injuries is to avoid fist fights, intoxication, and association with people who practice these forms of behavior. If involved in a fistfight, people should avoid directing punches at their opponent's mouth. The next best preventive measure is to get medical treatment at once for a clenched-fist injury.

Resources

BOOKS

Jacobs, Richard A., MD. "Animal & Human Bite Wounds." In "General Problems in Infectious Diseases." *Current Med-*

ical Diagnosis & Treatment 2001. 40th edition. Ed. L. M. Tierney, Jr., MD, et al. New York: Lange Medical Books/McGraw-Hill, 2001.

Taylor, Mark D., MD, and Samuel E. Wilson, MD. "Bacterial Diseases of the Skin." In *Conn's Current Therapy 2001*, ed. Robert E. Rakel, MD, and Edward T. Bope, MD. Philadelphia: W. B. Saunders Company, 2001.

PERIODICALS

Berlet, Greg, et al. "Clenched-fist injury complicated by methicillin-resistant *Staphylococcus aureus*." *Canadian Journal of Surgery/Journal canadien de chirurgie* 40 (4) (August 1997): 313-314.

ORGANIZATIONS

Massachusetts College of Emergency Physicians (MACEP). P. O. Box 296, Swansea, MA 02777. (508) 643-0117. Fax: (508) 643-0141.

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Clomiphene *see* **Infertility drugs**

Clonazepam *see* **Benzodiazepines**

Closed fracture reduction *see* **Fracture repair**

Clostridium difficile colitis *see* **Antibiotic-associated colitis**

Clotrimazole *see* **Antifungal drugs, topical**

Clotting disorders *see* **Coagulation disorders**

Clubfoot

Definition

Clubfoot is a condition in which one or both feet are twisted into an abnormal position at birth. The condition is also known as talipes.

Description

True clubfoot is characterized by abnormal bone formation in the foot. There are four variations of clubfoot, including talipes varus, talipes valgus, talipes equines, and talipes calcaneus. In talipes varus, the most common form of clubfoot, the foot generally turns inward so that the leg and foot look somewhat like the letter J. In talipes valgus, the foot rotates outward like the letter L. In talipes equinus, the foot points downward, similar to that of a toe dancer. In talipes calcaneus, the foot points upward, with the heel pointing down.

Clubfoot can affect one foot or both. Sometimes an infant's feet appear abnormal at birth because of the intrauterine position of the fetus birth. If there is no anatomic abnormality of the bone, this is not true clubfoot, and the problem can usually be corrected by applying special braces or casts to straighten the foot.

The ratio of males to females with clubfoot is 2.5 to 1. The incidence of clubfoot varies only slightly. In the United States, the incidence is approximately 1 in every 1,000 live births. A 1980 Danish study reported an overall incidence of 1.20 in every 1,000 children; by 1994, that number had doubled to 2.41 in every 1,000 live births. No reason was offered for the increase.

Causes and symptoms

Experts do not agree on the precise cause of clubfoot. The exact genetic mechanism of inheritance has been extensively investigated using family studies and other epidemiological methods. As of 1999, no definitive conclusions had been reached, although a Mendelian pattern of inheritance is suspected. This may be due to the interaction of several different inheritance patterns, different patterns of development appearing as the same condition, or a complex interaction between genetic and environmental factors. The MSX1 gene has been associated with clubfoot in animal studies. But, as of 2001, these findings have not been replicated in humans.

A family history of clubfoot has been reported in 24.4% of families in a single study. These findings suggest the potential role of one or more genes being responsible for clubfoot.

Several environmental causes have been proposed for clubfoot. Obstetricians feel that intrauterine crowding causes clubfoot. This theory is supported by a significantly higher incidence of clubfoot among twins compared to singleton births. Intrauterine exposure to the drug misoprostol has been linked with clubfoot. Misoprostol is commonly used when trying, usually unsuccessfully, to induce abortion in Brazil and in other countries in South and Central America. Researchers in Norway have reported that males who are in the printing trades have significantly more offspring with clubfoot than men in other occupations. For unknown reasons, **amniocentesis**, a prenatal test, has also been associated with clubfoot. The infants of mothers who smoke during **pregnancy** have a greater chance of being born with clubfoot than are offspring of women who do not smoke.

True clubfoot is usually obvious at birth. The four most common varieties have been described. A clubfoot has a typical appearance of pointing downward and

being twisted inwards. Since the condition starts in the first trimester of pregnancy, the abnormality is quite well established at birth, and the foot is often very rigid. Uncorrected clubfoot in an adult causes only part of the foot, usually the outer edge, or the heel or the toes, to touch the ground. For a person with clubfoot, walking becomes difficult or impossible.

Diagnosis

True clubfoot is usually recognizable and obvious on **physical examination**. A routine x ray of the foot that shows the bones to be malformed or misaligned supplies a confirmed diagnosis of clubfoot. Ultrasonography is not always useful in diagnosing the presence of clubfoot prior to the birth of a child.

Treatment

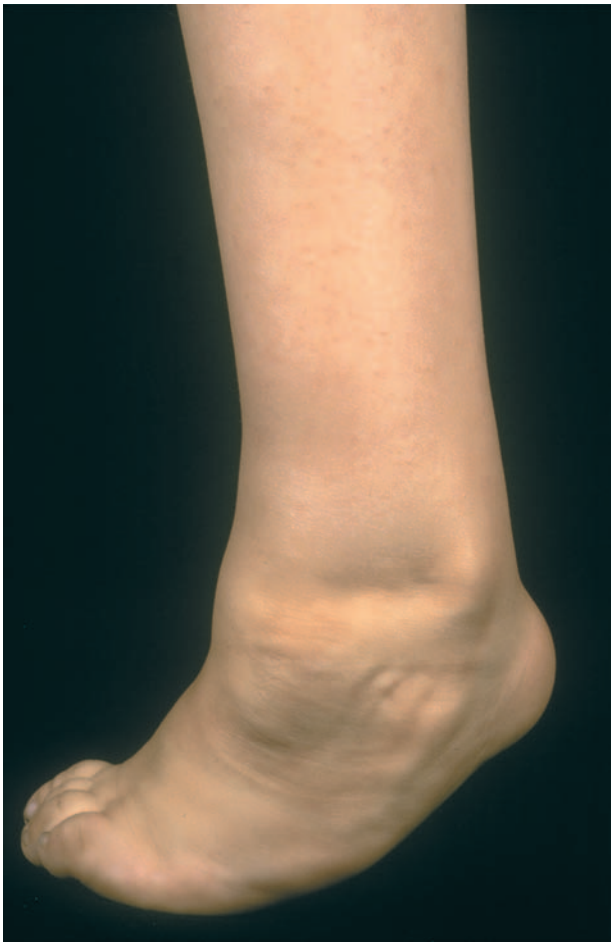
Most orthopedic surgeons agree that the initial treatment of congenital (present at birth) clubfoot should be non-operative. Non-surgical treatment should begin in the first days of life to take advantage of the favorable fibro-elastic properties of the foot's connective tissues, those forming the ligaments, joint capsules, and tendons. In a common treatment, a series of casts is applied over a period of months to reposition the foot into a normal alignment. In mild cases, splinting and wearing braces at night may correct the abnormality.

When clubfoot is severe enough to require surgery, the condition is usually not completely correctable, although significant improvement is possible. In the most severe cases, surgery may be required, especially when the Achilles tendon, which joins the muscles in the calf to the bone of the heel, needs to be lengthened. Because an early operation induces fibrosis, a scarring and stiffness of the tissue, surgery should be delayed until an affected child is at least three months old.

Much of a clubfoot abnormality can be corrected by the use of manipulation and casting during the first three months of life. Proper manipulative techniques must be followed by applications of appropriately molded plaster casts to provide effective and safe correction of most varieties of clubfoot. Long-term care by an orthopedist is required after initial treatment to ensure that the correction of the abnormality is maintained. Exercises, corrective shoes, or nighttime splints may be needed until the child stops growing.

Prognosis

With prompt, expert treatment, clubfoot is usually correctable. Most individuals are able to wear regular shoes and lead active lives. If clubfoot is not appropriately treated, the abnormality becomes fixed. This has an effect on the growth of the leg and foot, and some degree of permanent disability usually results.



Person suffering from clubfoot. About one of every 400 newborns has some form of this birth defect. *(Photo Researchers, Inc. Reproduced by permission.)*

Resources

BOOKS

Hall, Judith G. "Chromosomal Clinical Abnormalilties." In *Nelson Textbook of Pediatrics*. 16th ed. Ed. Richard E. Behrman et al. Philadelphia: Saunders, 2000, 325–34.

Jones, KL. "XO Syndrome." In *Smith's Recognizable Patterns of Human Malformation*. 5th ed. Ed. Kenneth L. Jones and Judy Fletcher Philadelphia: Saunders, 1997, pp. 81–7.

Thoene, Jess G., ed. *Physicians' Guide to Rare Diseases*. 2nd ed. Montvale, NJ: Dowden Publishing Co., 1995.

Van Allen, Margot I., and Judith G. Hall. "Congenital Anomalies." In *Cecil Textbook of Medicine*. 21st ed. Ed. Lee Goldman, et al. Philadelphia: Saunders, 2000, 150–52.

KEY TERMS

Enterovirus—Any of a group of viruses that primarily affect the gastrointestinal tract.

Intrauterine—Situated or occuring in the uterus.

Orthopedist—A doctor specializing in treatment of the skeletal system and its associated muscles and joints.

PERIODICALS

Chesney, D., et al. "Epidemiology and Genetic Theories in the Etiology of Congenital Talipes Equinovarus." *Bulletin of the Hospital for Joint Diseases* 58, no. 1 (1999): 59–64.

Gonzalez, C. H., et al. "Congenital Abnormalities in Brazilian Children Associated with Misoprostol Misuse in First Trimester of Pregnancy." *Lancet* 351, no. 9116 (May 30, 1998): 1624–27.

Honein, M. A., L. J. Paulozzi, and C. A. Moore. "Family History, Maternal Smoking, and Clubfoot: An Indication of a Gene-Environment Interaction." *American Journal of Epidemiology* 157, no. 7 (October 1, 2000): 658–65.

Lochmiller, C., et al. "Genetic Epidemiology Study of Idiopathic Talipes Equinovarus." *American Journal of Medical Genetics* 79, no. 2 (September 1, 1998): 90–6.

Rebbeck, T. R., et al. "A Single-Gene Explanation for the Probability of Having Idiopathic Talipes Equinovarus." *American Journal of Human Genetics* 53, no.5 (November 1993): 1051–63.

Robertson, W. W., and D. Corbett. "Congenital Clubfoot. Month of Conception." *Clinics in Orthopedics* 340, no. 338 (May 1997): 14–18.

ORGANIZATIONS

March of Dimes/Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (888) 663-4637. resourcecenter@modimes.org. <http://www.modimes.org>.

National Easter Seal Society. 230 W. Monroe St., Suite 1800, Chicago, IL 60606-4802. (312) 726-6200 or (800) 221-6827. <http://www.easter-seals.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

OTHER

"Clubfoot." *National Library of Medicine.* <http://www.nlm.nih.gov/medlineplus/ency/article/ 001228.htm>.

Clubfoot.net. <http://www.clubfoot.net/treatment.php3>.

Ponseti, Ignacio, MD. "Treatment of Congenital Clubfoot." Revised January 1998. *University of Iowa Health Care.* <http://www.vh.org/Providers/Textbooks/Clubfoot/Clubfoot.html>.

Schopler, Steven A., MD. "Clubfoot." *Southern California Orthopedic Institute.* <http://www.scoi.com/clubfoot.htm>.

L. Fleming Fallon, Jr., MD, DrPH

Cluster headache

Definition

Cluster headaches are characterized by an intense one-sided **pain** centered by the eye or temple. The pain lasts for one to two hours on average and may recur several times in a day.

Description

Cluster headaches have been known as histamine headaches, red migraines, and Horton's disease, among others. The constant factor is the pain, which transcends by far the distress of the more common tension-type **headache** or even that of a **migraine headache**.

Cluster headaches afflict less than 0.5% of the population and predominantly affect men; approximately 80% of sufferers are male. Onset typically occurs in the late 20s, but there is no absolute age restriction. Approximately 80% of cluster headaches are classified as episodic; the remaining 20% are considered chronic. Both display the same symptoms. However, episodic cluster headaches occur during one- to five-month periods followed by six- to 24-month attack-free, or remission, periods. There is no such reprieve for chronic cluster headache sufferers.

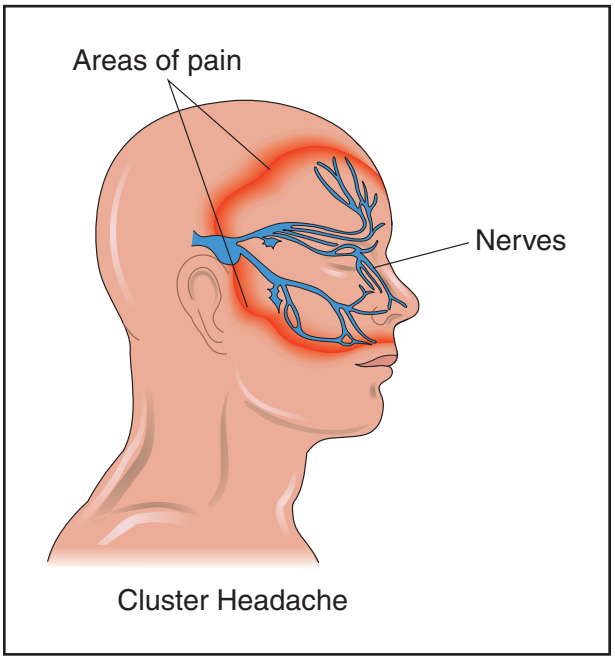
Causes and symptoms

Biochemical, hormonal, and vascular changes induce cluster headaches, but why these changes occur remains unclear. Episodic cluster headaches seem to be linked to changes in day length, possibly signaling a connection to the so-called biological clock. Alcohol, tobacco, histamine, or **stress** can trigger cluster headaches. Decreased blood oxygen levels (hypoxemia) can also act as a trigger, particularly during the night when an individual is sleeping. Interestingly, the triggers do not cause cluster headaches during remission periods.

The primary cluster headache symptom is excruciating one-sided head pain centered behind an eye or near the temple. This pain may radiate outward from the initial focus and encompass the mouth and teeth. For this reason, some cluster headache sufferers may mistakenly attribute their pain to a dental problem. Secondary symptoms, occurring on the same side as the pain, include eye tearing, nasal congestion followed by a runny nose, pupil contraction, and facial drooping or flushing.

Diagnosis

Cluster headache symptoms guide the diagnosis. A medical examination includes recording headache



The primary cluster headache symptom is excruciating one-sided head pain located behind an eye or near the temple. Secondary symptoms include eye tearing, nasal congestion, and a runny nose. *(Illustration by Electronic Illustrators Group.)*

details, such as frequency and duration, when it occurs, pain intensity and location, possible triggers, and any prior symptoms. This history allows other potential problems to be discounted.

Treatment

Treatment for cluster headaches is composed of induction, maintenance, and symptomatic therapies. The first two therapies are prophylactic treatments, geared toward preventing headaches. Symptomatic therapy is meant to stop or shorten a headache.

Induction and maintenance therapies begin together. Induction therapy is intended to break the headache cycle with drugs such as **corticosteroids** (for example, prednisone) or dihydroergotamine. These drugs are not meant for long-term therapy, but rather as a jump-start for maintenance therapy. Maintenance therapy drugs include verapamil, lithium carbonate, ergotamine, and methysergide. These drugs have long-term effectiveness, but must be taken for at least a week before a response is observed. With long-term treatment, methysergide must be stopped for one month each year to avoid dangerous side effects (formation of fibrous tissue inside the abdominal artery, lungs, and heart valves).

Despite prophylactic treatment, headaches may still occur. Symptomatic therapy includes oxygen inhalation, sumatriptan injection, and application of local anesthetics inside the nose. Surgery is a last resort for chronic cluster headaches that fail to respond to therapy.

KEY TERMS

Biological clock—A synonym for the body's circadian rhythm, the natural biological variations that occur over the course of a day.

Migraine headache—An intense throbbing pain that occurs on one or both sides of the head. The headache is usually accompanied by other symptoms, such as nausea, vomiting, and aversion to light.

Prophylactic—Referring to treatment that prevents symptoms from occurring.

Tension-type headache—A dull pain that seems to exert pressure on the head; the most common form of headache.

Alternative treatment

Since some cluster headaches are triggered by stress, **stress reduction** techniques, such as **yoga**, **meditation**, and regular **exercise**, may be effective. Some cluster headaches may be an allergic response triggered by food or environmental substances, therefore identifying and removing the allergen(s) may be key to resolution of the problem. Histamine is another suspected trigger of cluster headaches, and this response may be controlled with vitamin C and the bioflavonoids quercetin and bromelain (pineapple enzyme). Supplementation with essential fatty acids (EFA) will help decrease any inflammatory response.

Physical medicine therapies such as adjustments of the spine, craniosacral treatment, and massage at the temporomandibular joint (TMJ) can clear blockages, as can traditional Chinese medical therapies including **acupuncture**. Homeopathic treatment can also be beneficial. Nervous system relaxant herbs, used singly or in combination, can allow the central nervous system to relax as well as assist in peripheral nerve response. A few herbs to consider for relaxation are valerian (*Valeriana officinalis*), chamomile (*Matricaria recutita*), rosemary (*Rosemarinus officinalis*), and skullcap (*Scutellaria baicalensis*).

Prognosis

In general, drug therapy offers effective treatment.

Prevention

Avoiding triggers, adhering to medical treatment, and controlling stress can help ward off some cluster headaches.

Resources

PERIODICALS

Diamond, Seymour. "Cluster Headache: How to Distinguish from Migraine." *Consultant*, 36, no. 7 (1996): 1449.

Lewis, Todd A., and Glen D. Solomon. "Advances in Cluster Headache Management." *Cleveland Clinic Journal of Medicine* 63, no. 4 (1996): 237.

ORGANIZATIONS

American Council for Headache Education (ACHE). 19 Mantua Road, Mt. Royal, NJ 08061. (800) 255-2243. <http://www.achenet.org>.

National Headache Foundation. 428 W. St. James Place, Chicago, IL 60614. (800) 843-2256. <http://www.headaches.org>.

Julia Barrett

CMV *see* **Cytomegalovirus infection**

CNS depressants *see* **Central nervous system depressants**

CNS stimulants *see* **Central nervous system stimulants**

Coagulation disorders

Definition

Coagulation disorders deal with disruption of the body's ability to control blood clotting. The most commonly known coagulation disorder is **hemophilia**, a condition in which patients bleed for long periods of time before clotting. There are other coagulation disorders with a variety of causes.

Description

Coagulation, or clotting, occurs as a complex process involving several components of the blood. Plasma, the fluid component of the blood, carries a number of proteins and coagulation factors that regulate bleeding. Platelets, small colorless fragments in the blood, initiate contraction of damaged blood vessels so that less blood is lost. They also help plug damaged blood vessels and work with plasma to accelerate blood clotting. A disorder affecting platelet production or one of the many steps in the entire process can disrupt clotting.

Coagulation disorders arise from different causes and produce different complications. Some common coagulation disorders are:

- Hemophilia, or hemophilia A (Factor VIII deficiency), an inherited coagulation disorder, affects about 20,000 Americans. This genetic disorder is carried by females but most often affects males.
- Christmas disease, also known as hemophilia B or Factor IX deficiency, is less common than hemophilia A with similar in symptoms.
- Disseminated intravascular coagulation disorder, also known as consumption coagulopathy, occurs as a result of other diseases and conditions. This disease accelerates clotting, which can actually cause hemorrhage.
- **Thrombocytopenia** is the most common cause of coagulation disorder. It is characterized by a lack of circulating platelets in the blood. This disease also includes idiopathic thrombocytopenia.
- Von Willebrand's disease is a hereditary disorder with prolonged **bleeding time** due to a clotting factor deficiency and impaired platelet function. It is the most common hereditary coagulation disorder.
- Hypoprothrombinemia is a congenital deficiency of clotting factors that can lead to hemorrhage.
- Other coagulation disorders include Factor XI deficiency, also known as hemophilia C, and Factor VII deficiency. Hemophilia C afflicts one in 100,000 people and is the second most common bleeding disorder among women. Factor VII is also called serum prothrombin conversion accelerator (SPCA) deficiency. One in 500,000 people may be afflicted with this disorder that is often diagnosed in newborns because of bleeding into the brain as a result of traumatic delivery.

Causes and symptoms

Some coagulation disorders present symptoms such as severe bruising. Others will show no apparent symptoms, but carry the threat of severe internal bleeding.

Hemophilia

Because of its hereditary nature, hemophilia A may be suspected before symptoms occur. Some signs of hemophilia A are numerous large, deep **bruises** and **pain** and swelling of joints caused by internal bleeding. Patients with hemophilia do not bleed faster, just longer. A person with mild hemophilia may first discover the disorder with prolonged bleeding following a surgical procedure. If there is bleeding into the neck, head, or

digestive tract, or bleeding from an injury, emergency measures may be required.

Mild and severe hemophilia A are inherited through a complex genetic system that passes a recessive gene on the female chromosome. Women usually do not show signs of hemophilia but are carriers of the disease. Each male child of the carrier has a 50% chance of having hemophilia, and each female child has a 50% chance of passing the gene on.

Christmas disease

Christmas disease, or hemophilia B, is also hereditary but less common than hemophilia A. The severity of Christmas disease varies from mild to severe, although mild cases are more common. The severity depends on the degree of deficiency of the Factor IX (clotting factor). Hemophilia B symptoms are similar to those of hemophilia A, including numerous, large, and deep bruises and prolonged bleeding. The more dangerous symptoms are those that represent possible internal bleeding, such as swelling of joints, or bleeding into internal organs upon trauma. Hemophilia most often occurs in families with a known history of the disease, but occasionally, new cases will occur in families with no apparent history.

Disseminated intravascular coagulation

The name of this disorder arises from the fact that malfunction of clotting factors cause platelets to clot in small blood vessels throughout the body. This action leads to a lack of clotting factors and platelets at a site of injury that requires clotting. Patients with disseminated intravascular coagulation (DIC) will bleed abnormally even though there is no history of coagulation abnormality. Symptoms may include minute spots of hemorrhage on the skin, and purple patches or hematomas caused by bleeding in the skin. A patient may bleed from surgery or intravenous injection (IV) sites. Related symptoms include vomiting, seizures, **coma**, **shortness of breath**, **shock**, severe pain in the back, muscles, abdomen, or chest.

DIC is not a hereditary disorder or a common one. It is most commonly caused by complications during **pregnancy** or delivery, overwhelming infections, acute leukemia, metastatic **cancer**, extensive **burns** and trauma, and even snakebites. There are a number of other causes of DIC, and it is not commonly understood why or how these various disorders can lead to the coagulation problem. What the underlying causes of DIC have in common is some factor that affects proteins, platelets, or other clotting factors and processes. For example, uterine tissue can enter the mother's circulation during prolonged labor, introducing foreign proteins into the blood, or the venom of some exotic snakes can activate one of the clotting factors. Severe head trauma can expose blood to brain tissue. No matter the cause of DIC, the results are a malfunction of thrombin (an enzyme) and prothrombin (a glycoprotein), which activate the fibrinolytic system, releasing clotting factors in the blood. DIC can alternate from hemorrhage to thrombosis, and both can exist, which further complicates diagnosis and treatment.

KEY TERMS

Clotting factor—Also known as coagulation factors. Proteins in the plasma which serve to activate various parts of the blood clotting process by being transformed from inactive to active form.

Enzyme—A substance that causes a chemical reaction, usually a protein. Enzymes are secreted by cells.

Hemorrhage—Abnormal bleeding from the blood vessels.

Heparin—An anticoagulant, or blood clot "dissolver."

Idiopathic—Refers to a disease of unknown cause, and sometime to a primary disease.

Metastatic—The term used to describe a secondary cancer, or one that has spread from one area of the body to another.

Serum reagents—Serum is fluid, or the fluid portion of the blood retained after removal of the blood cells and fibrin clot. Reagents are substances added to the serum to produce a chemical reaction.

Thrombosis—Formation of a clot in the blood that either blocks, or partially blocks a blood vessel. The thrombus may lead to infarction, or death of tissue, due to a blocked blood supply.

Thrombocytopenia

Thrombocytopenia may be acquired or congenital. It represents a defective or decreased production of platelets. Symptoms include sudden onset of small spots of hemorrhage on the skin, or bleeding into mucous membranes (such as nosebleeds). The disorder may also be evident as blood in vomit or stools, bleeding during surgery, or heavy menstrual flow in women. Some patients show none of these symptoms, but complain of **fatigue** and general weakness. There are several causes of thrombocytopenia, which is more commonly acquired as a result of another disorder. Common underlying disorders include leukemia, drug toxicity, or **aplastic ane-**

mia, all of which lead to decreased or defective production of platelets in the bone marrow. Other diseases may destroy platelets outside the marrow. These include severe infection, disseminated intravascular coagulation, and **cirrhosis** of the liver. The idiopathic form most commonly occurs in children, and is most likely the result of production of antibodies that cause destruction of platelets in the spleen and to a lesser extent the liver.

Von Willebrand's disease is caused by a defect in the Von Willebrand clotting factor, often accompanied by a deficiency of Factor VIII as well. It is a hereditary disorder that affects both males and females. In rare cases, it may be acquired. Symptoms include easy bruising, bleeding in small cuts that stops and starts, abnormal bleeding after surgery, and abnormally heavy menstrual bleeding. Nosebleeds and blood in the stool with a black, tarlike appearance are also signs of Von Willebrand's disease.

Hypoprothrombinemia

This disorder is a deficiency in prothrombin, or Factor II, a glycoprotein formed and stored in the liver. Prothrombin, under the right conditions, is converted to thrombin, which activates fibrin and begins the process of coagulation. Some patients may show no symptoms, and others will suffer severe hemorrhaging. Patients may experience easy bruising, profuse nosebleeds, postpartum hemorrhage, excessively prolonged or heavy menstrual bleeding, and postsurgical hemorrhage. Hypoprothrombinemia may also be acquired rather than inherited, and usually results from a **Vitamin K deficiency** caused by liver diseases, newborn hemorrhagic disease, or a number of other factors.

Other coagulation disorders

Factor XI deficiency, or hemophilia C, occurs more frequently among certain ethnic groups, with an incidence of about one in 10,000 among Ashkenazi Jews. Nearly 50% of patients with this disorder experience no symptoms, but others may notice blood in their urine, nosebleeds, or bruising. Although joint bleeding seldom occurs, some factor XI patients will experience bleeding long after an injury occurs. Some women will experience prolonged bleeding after **childbirth**. Patients with factor VII deficiency vary greatly in their bleeding severity. Women may experience heavy menstrual bleeding, bleeding from the gums or nose, bleeding deep within the skin, and episodes of bleeding into the stomach, intestine, and urinary tract. Factor VII patients may also suffer bleeding into joints.

Diagnosis

Several blood tests can be used to detect various coagulation disorders. There are hundreds of different tests a doctor can order to look for indications of specific diseases. In addition to blood tests, physicians will complete a medical history and **physical examination**. In the case of acquired coagulation disorders, information such as prior or current diseases and medications will be important in determining the cause of the blood disorder.

- Hemohilia A will be diagnosed with laboratory tests detecting presence of clotting factor VIII, factor IX, and others, as well as the presence or absence of clotting factor inhibitors.
- Christmas disease will be checked against normal bleeding and clotting time, as well as for abnormal serum reagents in factor IX deficiency. Other tests of **prothrombin time** and thromboplastic generation may also be ordered.
- There is no one test or group of tests that can always make (or exclude) a diagnosis of DIC. DIC can be diagnosed through a number of laboratory tests which measure concentration of platelets and fibrinogen in the blood with normal counts and prolonged prothrombin time. Other supportive data include diminished levels of factors V, fibrinogen, and VIII, decreased hemoglobin, and others. Since many of the test results also indicate other disorders, the physician may have to put together several results to reach a diagnosis of DIC. Serial tests may also be recommended, because a single examine at one moment in time may not reveal the process that is occurring.
- Tests for thrombocytopenia include coagulation tests revealing a decreased **platelet count**, prolonged bleeding time, and other measurements. If these tests indicate that platelet destruction is causing the disorder, the physician may order bone marrow examination.
- Von Willebrand's disease will be diagnosed with the assistance of laboratory tests which show prolonged bleeding time, absent or reduced levels of factor VIII, normal platelet count, and others.
- Hypothrombinemia is diagnosed with history information and the use of tests that measure vitamin K deficiency, deficiency of prothrombin, and clotting factors V, VII, IX, and X.
- Factor XI deficiency is diagnosed most often after injury-related bleeding. Blood tests can help pinpoint factor VII deficiency.

Treatment

In mild cases, treatment may involve the use of drugs that stimulate the release of deficient clotting factors. In severe cases, bleeding may only stop if the clotting factor that is missing is replaced through infusion of donated human blood in the form of fresh frozen plasma or cryoprecipitate.

- Hemophilia A in mild episodes may require infusion of a drug called desmopressin or DDAVP. Severe bleeding episodes will require transfusions of human blood clotting factors. Hemophiliacs are encouraged to receive physical therapy to help damaged joints and to **exercise** in non-contact sports such as swimming, bicycle riding, or walking.
- Christmas disease patients are treated similarly to hemophilia A patients. There are commercial products and human blood products available to provide coagulation. Cryoprecipitate was invented in 1965 to replace the need for whole plasma transfusions, which introduced more volume than needed. By the 1970s, people were able to infuse themselves with freeze-dried clotting factor. Superficial **wounds** can be cleaned and bandaged. Parents of hemophiliac children receiving immunizations should inform the **vaccination** provider in advance to decrease the possibility of bleeding problems. These children should probably not receive injections which go into the muscle.
- Treatment for disseminated intravascular coagulation patients is complicated by the large variety of underlying causes of the disorder. If at all possible, the physician will first treat this underlying disorder. If the patient is not already bleeding, this supportive treatment may eliminate the DIC. However, if bleeding is occurring, the patient may need blood, platelets, fresh frozen plasma, or other blood products. Heparin has been controversial in treating DIC, but it is often used as a last resort to stop hemorrhage. Heparin has not proven useful in treating patients with DIC resulting from heat **stroke**, exotic snakebites, trauma, mismatched transfusions, and acute problems resulting from obstetrical complications.
- Secondary acquired thrombocytopenia is best alleviated by treating the underlying cause or disorder. The specific treatment may depend on the underlying cause. Sometimes, cortocoosterids or immune globulin may be given to improve platelet production.
- Von Willebrand's disease is treated by several methods to reduce bleeding time and to replace factor VIII, which consequently will replace the Von Willebrand factor. This may include infusion of cryoprecipitate or fresh frozen plasma. Desmopressin may also help raise levels of the Von Willebrand factor.
- Hypoprothrombinemia may be treated with concentrates of prothrombin. Vitamin K may also be produced, and in bleeding episodes, the patient may receive fresh plasma products.
- Factor XI (hemophilia C) is most often treated with plasma, since there are no commercially available concentrates of factor XI in the United States. Factor VII patients may be treated with prothrombin complex concentrates. As of early 1998, factor VII concentrate was not licensed in the United States and could only be used with special permission.

Alternative treatment

This can be a very severe condition and should be managed by a practitioner of alternative medicine in conjunction with a medical doctor; this condition should not be self managed. For patients known to suffer from hemophilia A or B and other bleeding disorders, avoidance of activities that can cause severe injury should be practiced. Comprehensive care addresses the whole person by helping to deal with the psychosocial aspects of the disease.

Prognosis

The prognosis for patients with mild forms of coagulation disorders is normally good. Many people can lead a normal life and maintain a normal life expectancy. Without treatment of bleeding episodes, severe muscle and joint pain, and eventually, damage, can occur. Any incident that causes blood to collect in the head, neck, or digestive system can be very serious and requires immediate attention. DIC can be severe enough to cause clots to form and a stroke could occur. DIC is also serious enough to cause **gangrene** in the fingers, nose, or genitals. The prognosis depends on early intervention and treatment of the underlying condition. Hemorrhage from a coagulation disorder, particularly into the brain or digestive track, can prove fatal. In the past, patients who received regular transfusions of human blood products were subject to increased risk of **AIDS** and other diseases. However, efforts have been made since the early 1990s to ensure the safety of the blood supply.

Prevention

Prevention of coagulation disorders varies. Acquired disorders may only be prevented by preventing onset of the underlying disorder (such as cirrhosis). Hereditary disorders can be predicted with prenatal testing and **genetic counseling**. Prevention of severe bleeding episodes may be accomplished by refraining from activities that could cause injury, such as contact sports. Open communication with healthcare providers prior to procedures or tests that could cause bleeding may prevent a severe bleeding incident.

Resources

BOOKS

Bellenir, Karen. *Genetic Disorders Sourcebook.* Omnigraphics, Inc., 1995.

PERIODICALS

Community Alert. New York: National Hemophilia Foundation.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Hemophilia Foundation. 116 West 32nd St., 11th Floor, New York, NY 10001. 800-424-2634. <http://www.hemophilia.org/home.htm>.

Teresa Norris, RN

Coagulopathies *see* **Coagulation disorders**

Coal miner's disease *see* **Black lung disease**

Coal worker's pneumoconiosis *see* **Black lung disease**

Coarctation of the aorta

Definition

A defect that develops in the fetus in which there is a narrowing of the aortic arch, the main blood artery that delivers blood from the left ventricle of the heart to the rest of the body. Coarctation of the aorta is diagnosed in both newborns and adults. Approximately 10% of newborns with **congenital heart disease** have coarctation of the aorta.

Description

Blood leaves the heart by way of the left ventricle and is distributed to the body by arteries. The aortic arch is the first artery to carry blood as it leaves the heart. Other arteries to the head and arms branch off the aortic arch. A narrowing of the aorta at any spot produces resistance to the flow of blood. This causes high blood pressure before the narrowing and low pressure below the narrowing (downstream). Parts of the body supplied by arteries that branch off the aortic arch before the narrowing have high blood pressure, while most of the lower body doesn't receive enough blood supply. To compensate for this, the heart works harder, and the blood pressure rises.

Approximately half of all infants with coarctation of the aorta are diagnosed within the first two months of life. Frequently, there are other congenital cardiac complications present. Infants with **Turner syndrome** have a 45% rate of also having coarctation. There is evidence that some cases of coarctation may be inherited.

Causes and symptoms

In newborns with congenital heart disease, coarctation of the aorta develops while the baby is in the womb. Among the consequences of coarctation of the aorta is ventricular hypertrophy, an enlarging of the left ventricle in response to the increased back pressure of the blood and the demand for more blood by the body. Symptoms in infants include **shortness of breath** (dyspnea), difficulty in feeding, and poor weight gain. Older children usually don't have symptoms, but may display **fatigue**, shortness of breath, or a feeling of lameness in their legs.

Diagnosis

Infants usually have an abnormal "gallop" heart rhythm and may also have **heart murmurs**. Sometimes excessive arterial pulses can be seen in the carotid and suprasternal notch arteries, indicating increased pressure in these arteries, while the femoral pulse is weak or can't be detected. The systolic pressure is higher in the arms than in the legs. Enlargement of the heart can be seen in x rays. Similar symptoms are seen in older children and adults. A 10 mm Hg (mercury) pressure difference between the upper and lower extremities is diagnostic for coarctation of the aorta. For some patients, the systolic pressure difference is observed only during **exercise**. Infants frequently have an abnormal electrocardiogram (ECG) that indicates that the right or both ventricles are enlarged, while in older children the ECG may be normal or show that the left ventricle is enlarged. The coarctation may be detected in echocardiographic examination.

Treatment

Drugs can be used to treat the **hypertension** and **heart failure**. Surgery is recommended for infants with other, associated cardiac defects and for those infants not responding to drug therapy. Surgery is indicated for infants that don't require immediate surgery, but who develop severe hypertension during the first several months of life. Patients are advised to avoid vigorous exercise prior to surgical correction of the coarctation. Recoarctation can occur in some patients, even if they have had surgery.

Prognosis

Approximately half of all infants diagnosed with coarctation of the aorta have no other cardiac defects and will respond well to medical management. Most of these children will eventually outgrow the condition after several years of life. Although their hypertension may increase for several months early in life, it will eventually decrease as the circulatory system develops. Surgery is required for infants that have severe coarctation of the aorta or have associated cardiac defects. The average life span of children who have coarctation of the aorta is 34

KEY TERMS

Dyspnea—Difficulty in breathing. Usually associated with heart or lung diseases.

Electrocardiogram—A graph of the heart's beating produced by an instrument that detects the electrical signals made by the heart.

years of age. The most common complications for children who have not had surgery are hypertension, aortic rupture, intracranial bleeding, and congestive heart failure. Women who have an uncorrected coarctation of the aorta have a mortality rate of 10% during **pregnancy** and a 90% rate of complications.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

John T. Lohr, PhD

Cocaine

Definition

Cocaine is a highly addictive central nervous system stimulant extracted from the leaves of the coca plant, *Erythroxylon coca*.

Description

In its most common form, cocaine is a whitish crystalline powder that produces feelings of euphoria when ingested.

Now classified as a Schedule II drug, cocaine has legitimate medical uses as well as a long history of recreational abuse. Administered by a licensed physician, the drug can be used as a local anesthetic for certain eye and ear problems and in some kinds of surgery.

Forms of the drug

In powder form, cocaine is known by such street names as "coke," "blow," "C," "flake," "snow" and "toot." It is most commonly inhaled or "snorted." It may also be dissolved in water and injected.

Crack is a smokable form of cocaine that produces an immediate and more intense high. It comes in off-white chunks or chips called "rocks." Little crumbs of crack are sometimes called "kibbles & bits."

In addition to their stand-alone use, both cocaine and crack are often mixed with other substances. Cocaine may be mixed with methcathinone (a more recent drug of abuse, known as "cat," that is similar to methamphetamine) to create a "wildcat." A hollowed-out cigar filled with a mixture of crack and marijuana is known as a "woolah." And either cocaine or crack used in conjunction with heroin is called a "speedball." Cocaine used together with alcohol represents the most common fatal two-drug combination.

History

Cocaine is one of the oldest known psychoactive drugs. Coca leaves, the source of cocaine, were used by the Incas and other inhabitants of the Andean region of South America for thousands of years, both as a stimulant and to depress appetite and combat apoxia (**altitude sickness**).

Despite the long history of coca leaf use, it was not until the latter part of the nineteenth century that the active ingredient of the plant, cocaine hydrochloride, was first extracted from those leaves. The new drug soon became a common ingredient in patent medicines and other popular products (including the original formula for Coca-Cola). This widespread use quickly raised concerns about the drug's negative effects. In the early 1900s, several legislative steps were taken to address those concerns; the Harrison Act of 1914 banned the use of cocaine and other substances in non-prescription products. In the wake of those actions, cocaine use declined substantially.

The drug culture of the 1960s sparked renewed interest in cocaine. With the advent of crack in the 1980s, use of the drug had once again become a national problem. Cocaine use declined significantly during the early 1990s, but it remains a significant problem and is on the increase in certain geographic areas and among certain age groups.

Causes and symptoms

As with other forms of **addiction**, cocaine abuse is the result of a complex combination of internal and external factors. Genetic predisposition, family history, and immediate environment can all affect a person's probability of becoming addicted.

As many as three to four million people are estimated to be chronic cocaine users. The 1997 National Household Survey on Drug Abuse reported an estimated 600,000 current crack users, showing no significant change since the late 1980s.

How cocaine affects the brain

Extensive research has been conducted to determine how cocaine works on the brain and why it is so addictive. Cocaine has been found to affect an area of the brain known as the ventral tegmental area (VTA), which connects with the nucleus accumbens, a major pleasure center. Like other commonly abused addictive drugs, cocaine's effects are related to the action of the neurotransmitter dopamine, which carries information between neurons. Cocaine interferes with the normal functioning of neurons by blocking the re-uptake of dopamine, which builds up in the synapses and is believed to cause the pleasurable feelings reported by cocaine users.

Short-term effects of use

The short-term effects of cocaine can include:

- rapid heartbeat
- constricted blood vessels
- dilated pupils
- increased temperature
- increased energy
- reduced appetite
- increased sense of alertness
- euphoria
- **death** due to overdose

Long-term effects of use

The long-term effects of cocaine and crack use include:

- dependence, addiction
- irritability
- mood swings
- restlessness
- weight loss
- auditory hallucinations
- paranoia

Cocaine use and pregnancy

The rise in cocaine use as well as the appearance of crack cocaine in the late 1980s spurred fears about its effects on the developing fetus and, since then, several research reports have suggested that prenatal cocaine use could be associated to a wide range of fetal, newborn, and child development problems. According to the The Lindesmith Center-Drug Policy Foundation, many of these early reports had methodological flaws, and most researchers nowadays propose more cautious conclusions concerning prenatal cocaine effects. Much evidence would seem to point to the lack of quality prenatal care and the use of alcohol and tobacco as primary factors in poor fetal development among pregnant cocaine users. Research sponsored by the National Institute on Drug Abuse (NIDA) and the Albert Einstein Medical Center in Philadelphia corroborate the Lindensmith Center findings in reporting that the lack of quality prenatal care is associated with undesirable effects often attributed to cocaine exposure such as **prematurity**, low birth weight, and fetal or infant death. The Center for Disease Control and Prevention (CDC) however, reports that mothers who use cocaine early in **pregnancy** are five times as likely to have a baby with a malformation of the urinary tract as mothers who do not use the drug. Thus, cocaine use during pregnancy is assuredly most inadvisable, especially since it is also often associated with the use of alcohol known to cause long-term developmental problems. Supporting the cocaine-exposed expecting mother so as to discourage cocaine use remains an important task for all health caregivers.

Diagnosis

Diagnosing cocaine addiction can be difficult. Many of the signs of short-term cocaine use are not obvious. Since cocaine users often also use other drugs, it may not be easy to distinguish the effects of one drug from another.

Cocaine use has been documented in significant numbers of eighth graders as well as older teens. Over all age groups, more men than women use the drug. The highest rate of cocaine use is found among adults 18 to 25 years old.

Medical complications

Cocaine has been linked to several serious health problems, including:

- arrhythmia
- heart attacks
- chest pain
- respiratory failure
- strokes
- seizures

Other complications may vary depending on how the drug is administered. Prolonged snorting, for example, can irritate the nasal septum, producing nosebleeds, chronic runny nose, and other problems. Intravenous users face an increased risk of infectious diseases such as HIV/AIDS and hepatitis.

Testing

Drug testing can be useful in diagnosing and treating cocaine abuse. Urine testing can detect cocaine; besides providing an objective alternative to reliance on what a patient says, such tests can also be used as a follow-up to treatment to confirm that the patient has remained drug-free.

Treatment

The last two decades have seen a dramatic rise in the number of cocaine addicts seeking treatment. But like all forms of drug abuse, cocaine abuse/addiction is a multifaceted phenomenon involving environmental, social, and familial as well as physiological factors. This greatly complicates the challenge of effectively treating cocaine addiction.

Pharmacological treatments

To date, no medications have been approved specifically for treating cocaine addiction. But several were under development at this writing. Selegeline, delivered either via a time-release pill or a transdermal patch, shows promise as a possible anti-cocaine medication. Clinical studies have shown the drug disulfiram (also used to treat alcoholics) to be effective in treating cocaine abusers. In addition, antidepressant medications are sometimes used to control the mood swings associated with the early stages of cocaine withdrawal.

Behavioral approaches

A wide range of behavioral interventions have been successfully used to treat cocaine addiction. The approach used must be tailored to the specific needs of each individual patient, however.

Contingency management rewards drug abstinence (confirmed by urine testing) with points or vouchers which patients can exchange for such things as an evening out or membership in a gym. **Cognitive-behavioral therapy** helps users learn to recognize and avoid situations most likely to lead to cocaine use and to develop healthier ways to cope with stressful situations. Residential programs/therapeutic communities may also be helpful, particularly in more severe cases. Patients typically spend six to 12 months in such programs, which may also include vocational training and other features.

KEY TERMS

Apoxia—Apoxia refers to altitude sickness.

Arrhythmia—Irregular heartbeat.

Central nervous system—Part of the nervous system consisting of the brain, cranial nerves and spinal cord. The brain is the center of higher processes, such as thought and emotion and is responsible for the coordination and control of bodily activities and the interpretation of information from the senses. The cranial nerves and spinal cord link the brain to the peripheral nervous system, that is the nerves present in the rest of body.

Nasal septum—The membrane that separates the nostrils.

Neurotransmitter—A chemical that carries nerve impulses across a synapse.

Synapse—The gap between two nerve cells.

Alternative treatment

Various alternative or complementary approaches have been used in treating cocaine addiction, often in combination with more conventional therapies. In Japan, the herb acorus has been traditionally used both to assist early-stage cocaine withdrawal and in later recovery stages. Other herbs sometimes used to treat drug addictions of various kinds include kola nut, guarana seed and yohimbe (to boost short-term energy), and valerian root, hops leaf, scullcap leaf, and chamomile (to calm the patient). The amino acids phenylalanine and tyrosine have been used to reduce cocaine addicts' craving for the drug, and vitamin therapy may be used to help strengthen the patient. Gentle massage has been used to help infants born with congenital cocaine addiction. Other techniques, such as **acupuncture**, EEG **biofeedback**, and visualization, may also be useful in treating addiction.

Prognosis

Because addiction involves so many different factors, prospects for individual addicts vary widely. However, research has consistently shown that treatment can significantly reduce both drug abuse and subsequent criminal activity. The comprehensive Services Research Outcomes Study (1998) found a 45% drop in cocaine use five years after treatment, compared to use during the five years before treatment. The study also found that females generally respond better to treatment than males, and older patients tend to reduce their drug use more than younger patients.

Some research also supports the idea that 12-step programs used in conjunction with other approaches can significantly enhance the prospects for a positive outcome. One study of people in outpatient drug-treatment programs found that participation in a 12-step program nearly doubled their chances of remaining drug-free.

Prevention

Despite significant variation over time, cocaine addiction has proven to be a persistent public health problem. Interdiction and source control are expensive and have failed to eliminate the problem, and some law enforcement officials are now recommending more emphasis on demand reduction through education and other measures to address the causes of cocaine addiction.

Resources

BOOKS

Gold, Mark S. *Cocaine (and Crack): Clinical Aspects (181-198), Substance Abuse: A Comprehensive Textbook*. Baltimore: Williams & Wilkins, 1997.

PERIODICALS

Avants, S. Kelly. "A Randomized Controlled Trial of Auricular Acupuncture for Cocaine Dependence." *JAMA* (22 November 2000).

Harvey, John A., and Barry Kosofsky, eds. "Cocaine: Effects on the Developing Brain." *Annals of the New York Academy of Sciences* 846 (1998).

LeDuff, Charlie. "Cocaine Quietly Reclaims Its Hold as Good Times Return." *New York Times* (21 August 2000): 2.

Goode, Erica. "Acupuncture Helps Some Quell Need for Cocaine." *New York Times* (15 August 2000): D7.

ORGANIZATIONS

Cocaine Anonymous. 6125 Washington Blvd. Suite 202, Culver City, CA 90232. (800) 347-8998.

Nar-Anon Family Group Headquarters, Inc. P.O. Box 2562, Palos Verdes Peninsula, CA 90274. (310) 547-5800.

Peter Gregutt

Coccidioidomycosis

Definition

Coccidioidomycosis is an infection caused by inhaling the microscopic spores of the fungus *Coccidioides immitis*. Spores are the tiny, thick-walled structures that fungi use to reproduce. Coccidioidomycosis exists in three forms. The acute form produces flu-like symptoms. The chronic form can develop as many as 20 years after initial infection and, in the lungs, can produce inflamed, injured areas that can fill with pus (abscesses). Disseminated coccidioidomycosis describes the type of coccidioidomycosis that spreads throughout the body affecting many organ systems and is often fatal.

Description

Coccidioidomycosis is an airborne infection. The fungus that causes the disease is found in the dry desert soil of the southwestern United States, Mexico, and Central and South America. Coccidioidomycosis is sometimes called San Joaquin **fever**, valley fever, or desert fever because of its prevalence in the farming valleys of California. Although commonly acquired, overt coccidioidomycosis is a rare disease. Chronic infections occur in only one out of every 100,000 people.

Although anyone can get coccidioidomycosis, farm laborers, construction workers, and archaeologists who work where it is dusty are at greater risk to become infected. People of any age can get coccidioidomycosis, but the disease most commonly occurs in the 25–55 age group. In its acute form, coccidioidomycosis infects men and women equally.

Chronic and disseminated forms of coccidioidomycosis occur more frequently in men and pregnant women. Although it is not clear why, people of color are 10-20 times more likely to develop the disseminated form of the disease than caucasians. People who have a weakened immune system (immunocompromised), either from diseases such as **AIDS** or leukemia, or as the result of medications that suppressed the immune system (**corticosteroids**, **chemotherapy**), are more likely to develop disseminated coccidioidomycosis.

Causes and symptoms

When the spores of *C. immitis* are inhaled, they can become lodged in the lungs, divide, and cause localized inflammation. This is known as acute or primary coccidioidomycosis. The disease is not spread from one person to another. Approximately 60% of people who are infected exhibit no symptoms (asymptomatic). In the other 40%, symptoms appear 10–30 days after exposure. These symptoms include a fever which can reach 104°F (39.5°C), dry **cough**, chest pains, joint and muscle aches, **headache**, and weight loss. About two weeks after the start of the fever, some people develop a painful red rash or lumps on the lower legs. Symptoms usually disappear without treatment in about one month. People who have been infected gain partial immunity to reinfection.

The chronic form of coccidioidomycosis normally occurs after a long latent period of 20 or more years during which the patient experiences no symptoms of the disease. In the chronic phase, coccidioidomycosis causes

lung abscesses that rupture, spilling pus and fluid into the lungs, and causing serious damage to the lungs. The patient experiences difficulty breathing and has a fever, chest **pain**, and other signs of **pneumonia**. Medical treatment is essential for recovery.

In its disseminated form, coccidioidomycosis spreads to other parts of the body including the liver, bones, skin, brain, heart, and lining around the heart (pericardium). Symptoms include fever, joint pain, loss of appetite, weight loss, night sweats, **skin lesions**, and difficulty breathing. Also, in 30–50% of patients with disseminated coccidioidomycosis, the tissue coverings of the brain and spinal cord become inflamed (**meningitis**).

Diagnosis

Many cases of coccidioidomycosis go undiagnosed because the symptoms resemble those of common viral diseases. However, a skin test similar to that for **tuberculosis** will determine whether a person has been infected. The test is simple and accurate, but it does not indicate whether the disease was limited to its acute form or if it has progressed to its chronic form.

Diagnosis of chronic or disseminated coccidioidomycosis is made by culturing a sample of sputum or other body fluids in the laboratory to isolate the fungus. A blood serum test is used to detect the presence of an antibody produced in response to *C. immitis* infection. Chest x rays are often used to assess lung damage, but alone cannot lead to a definitive diagnosis of coccidioidomycosis because other diseases can produce similar results on the x ray.

Treatment

In most cases of acute coccidioidomycosis, the body's own immune system is adequate to bring about recovery without medical intervention. Fever and pain can be treated with non-prescription drugs.

Chronic and disseminated coccidioidomycosis, however, are serious diseases that require treatment with prescription drugs. Patients with intact immune systems who develop chronic coccidiodomycosis are treated with the drug ketoconazole (Nizoral) or amphotericin B (Fungizone). Patients with suppressed immune systems are treated with amphotericin B (Fungizone). Amphotericin B is a powerful fungistatic drug with potentially toxic side effects. As a result, hospitalization is required in order to monitor patients. The patient may also receive other drugs to minimize the side effects of the amphotericin B.

Patients with AIDS must continue to take itraconazole (Sporonox) or fluconazole (Diflucan) orally or receive weekly intravenous doses of amphotericin B for the rest of their lives in order to prevent a relapse. Because of the high cost of fluconazole, Pfizer, the manufacturer of the drug, has established a financial assistance plan to make the drug available at lower cost to those who meet certain criteria. Patients needing this drug should ask their doctors about this program.

KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Acidophilus—The bacteria *Lactobacillus acidophilus* that usually found in yogurt.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Asymptomatic—Persons who carry a disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Bifidobacteria—A group of bacteria normally present in the intestine. Commercial supplements containing these bacteria are available.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Meningitis—An inflammation of the membranes surrounding the brain or spinal cord.

Pericardium—The tissue sac around the heart.

Alternative treatment

Alternative treatment for fungal infections focuses on creating an internal environment where the fungus cannot survive. This is accomplished by eating a diet low in dairy products, sugars, including honey and fruit juice, and foods like beer that contain yeast. This is complemented by a diet consisting, in large part, of uncooked and unprocessed foods. Supplements of **vitamins** C, E, A-plus, and B complex may also be useful. *Lactobacillus acidophilus* and *Bifidobacterium* will replenish the good bacteria in the intestines. Antifungal herbs, like garlic (*Allium sativum*), can be consumed in relatively large does and for an extended period of time in order to increase effectiveness.

Prognosis

Most people who are infected with coccidiodomycosis only suffer from the mild, acute form of the disease and recover without further complications. Patients who suffer from chronic coccidiodomycosis and who have no underlying lung or immune system diseases also stand a good change of recovery, although they must be alert to a relapse.

The picture for patients with the disseminated form of the disease, many of whom have AIDS, is less positive. Untreated disseminated coccidiodomycosis is almost always fatal within a short time. With treatment, chance of survival increases, but the **death** rate remains high when meningitis or diffuse lung (pulmonary) disease is present. AIDS patients must constantly guard against relapse.

Prevention

Because the fungus that causes coccidioidomycosis is airborne and microscopic, the only method of prevention is to avoid visiting areas where it is found in the soil. Unfortunately, for many people this is impractical. Maintaining general good health and avoiding HIV infection will limit coccidioidomycosis to the acute and relatively mild form in most people.

Resources

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Canadian HIV/AIDS Clearinghouse. 1565 Carling Avenue, Suite 400, Ottawa, ON K1Z 8R1. (877) 999-7740. <http://www.clearinghouse.cpha.ca/clearinghouse_e.htm>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Aids Hotline. (800) 342-2437.

Project Inform. 205 13th Street, #2001, San Francisco, CA 94103. (800) 822-7422. <http://www.projinf.org>.

OTHER

Powderly, William G. "Coccidioidomycosis." *Journal of the International Association of Physicians in AIDS Care*. Dec. 1996 <http://www.iapac.org>.

Tish Davidson

Coccyx injuries

Definition

The coccyx—or tailbone—is the last bone of the vertebral column, and usually consists of three to five fused vertebrae that connect with the sacrum, a part of the pelvis.

Description

The coccyx consists of fused vertebrae, which are not flexible like the other vertebrae of the vertebral column which are all interspaced by intervertebral disks and joined together by elastic ligaments. Since the spinal cord ends just before the coccyx begins, coccygeal vertebrae also lack a central foramen (hole). In the coccyx, the vertebrae generally fuse together in early adulthood and may also fuse with the sacrum, the bone located between the 5th lumbar vertebra and the coccyx, as a person ages. In males, the coccyx curves downward, and in females, it is straighter to allow a baby to pass through the birth canal without impediment.

Pain in or around the coccyx is called coccydynia or coccygodynia. Coccydynia presents a range of symptoms associated to a variety of underlying causes and conditions.

Causes and symptoms

Causes

Coccydynia can be caused by a number of factors. Usually, patients report pain after a fall onto their buttocks, as occurs when going down stairs or while skating. Others have pain during **pregnancy** or after **childbirth**. Some experience repetitive strain from rowing or cycling, and some cite anal intercourse as the cause of pain. In many cases, pain derives from a malformation of the coccyx itself. Sometimes bony spurs appear on the coccyx, but only seem to be painful in thin patients who do not have the padding to protect the region from the spur.

Other causes of coccydynia include **cancer** or damage to the sacrum that generates referred pain, meaning pain that appears in one region but originates from another. Muscle strain or tension, pinched nerves or damaged nerves, or dislocation of the coccyx due to gross **obesity** are other causes.

Symptoms

The most common symptom of coccydynia, irrespective of the cause of the condition, is pain when sitting, or when rising from a sitting position. If the condition lasts long enough, the patient may even experience pain when standing or lying down. Sometimes, numbness occurs in the lower part of the spine. Some patients will experience pain during bowel movements, sexual intercourse, or menstruation.

Secondary symptoms include back pain from sitting in odd positions in order to relieve pain, and painful feet from standing too much, because patients avoid sitting.

KEY TERMS

Coccyx—The last bone of the spinal column, consisting of three to five fused vertebrae that connect with the sacrum, a part of the pelvis.

Coccydynia—Also called coccygodynia. Pain in or around the coccyx.

Foramen—A small opening, perforation, or orifice.

Magnetic resonance imaging (MRI)—An imaging technique that produces pictures of the inside of the body.

Sacrum—The triangle-shaped bone located between the fifth lumbar vertebra and the coccyx that consists of five vertebrae fused together. The sacrum joins on each side with the bones of the pelvis.

Spinal cord—Elongated nerve bundles that lie in the vertebral canal and from which the spinal nerves emerge.

Vertebrae—Bones in the cervical, thoracic, and lumbar regions of the body that make up the vertebral column. Vertebrae have a central foramen (hole), and their superposition makes up the vertebral canal that encloses the spinal cord.

Vertebral column—The vertebral column, also called the spinal column or spine, consists of a series of vertebrae connected by ligaments. It provides a supporting axis for the body and protects the spinal cord. The vertebral column consists of seven cervical vertebrae in the neck, followed by 12 thoracic vertebrae that connect to the ribs, five lumbar vertebrae in the lower back, the sacrum, and the coccyx.

Sometimes the entire buttocks experience pain. Rarely, exhaustion, depression, and lack of sleep may occur.

Diagnosis

Diagnosis of fracture is usually made by inserting a gloved finger in the rectum and pressing on the coccyx. X rays and **magnetic resonance imaging** (MRI) are also often used. Since coccyx pain may be the result of other factors like cancer, these must be ruled out through a variety of tests before treatment can begin.

Treatment

Treatment exists to either control the pain or eliminate the cause. Pain control may be dangerous if an underlying condition exists of which the pain is a warning sign. Nerve blocks and a variety of drugs are other options to control pain.

Elimination of the root cause of the pain is ideal. This is done through careful diagnosis and the application of manual treatments, corticosteroid injections into the coccyx vertebrae, or surgery. Injections into the fourth and fifth sacral nerves and coccygeal nerves often bring relief, but are considered more as a pain control measure than as curative treatment. Manual treatments have not been found to be effective. Surgery is a radical procedure whose indications are inconsistent and dependent on the subjectivity of the physician.

Prognosis

With current treatment, prognosis is good and patients usually are able to live pain free.

Prevention

There probably is no real prevention, expect weight control. Some women may choose to give birth through ceasarian section instead of vaginally after an episode of coccyx pain from a previous delivery.

Resources

OTHER

Maigne, Jean-Yves. "Treatment Strategies for Coccydynia." May 7, 2001 <http://www.coccyx.org/whatisit.htm>.

"Treatments for Coccydynia." May 7, 2001 <http://www.coccyx.org/treatment.htm>.

"What is Coccydynia?" May 7, 2001 <http://www.coccyx.org/whatisit.htm>.

Janie Franz

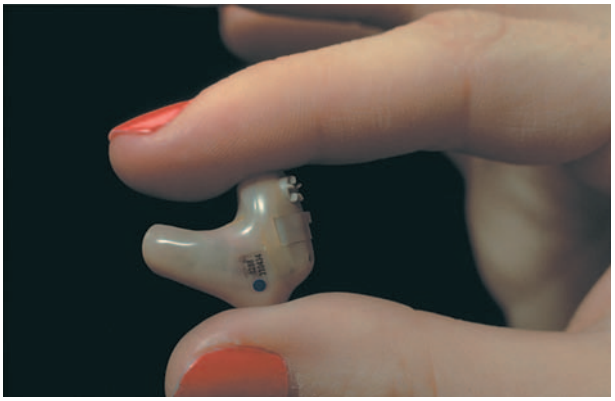
Cochlear implants

Definition

A cochlear implant is a surgical treatment for **hearing loss** that works like an artificial human cochlea in the inner ear, helping to send sound from the ear to the brain. It is different from a hearing aid, which simply amplifies sound.

Purpose

A cochlear implant bypasses damaged hair cells and helps establish some degree of hearing by stimulating the hearing (auditory) nerve directly.



A close-up view of a cochlear implant. *(Photograph by L. Steinmark, Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

Because the implants are controversial, very expensive, and have uncertain results, the U.S. Food and Drug Administration (FDA) has limited the implants to people:

- who get no significant benefit from **hearing aids**
- who are at least 2 years old (the age at which specialists can verify severity of deafness)
- with severe to profound hearing loss.

Description

Hearing loss is caused by a number of different problems that occur either in the hearing nerve or parts of the middle or inner ear. The most common type of deafness is caused by damaged hair cells in the cochlea, the hearing part of the inner ear. Normally, hair cells stimulate the hearing nerve, which transmits sound signals to the brain. When hair cells stop functioning, the hearing nerve remains unstimulated, and the person can't hear. Hair cells can be destroyed by many things, including infection, trauma, loud noise, **aging**, or **birth defects**.

All cochlear implants consist of a microphone worn behind the ear that picks up sound and sends it along a wire to a speech processor, which is worn in a small shoulder pouch, pocket, or belt. The processor boosts the sound, filters out background noise, and turns sound into digital signals before sending it to a transmitter worn behind the ear. A magnet holds the transmitter in place through its attraction to the receiver-stimulator, a part of the device that is surgically attached beneath the skin in the skull. The receiver picks up digital signs forwarded by the transmitter, and converts them into electrical impulses. These electrical impulses flow through electrodes contained in a narrow, flexible tube that has been threaded into the cochlea.

As many as 24 electrodes (depending on the type of implant) carry the impulses that stimulate the hearing nerve. The brain then interprets the signals as specific sounds.

Despite the benefits that the implant appears to offer, some hearing specialists and members of the deaf community still believe that the benefits may not outweigh the risks and limitations of the device. Because the device must be surgically implanted, it carries some surgical risk. Also, manufacturers can't promise how well a person will hear with an implant. Moreover, after getting an implant, some people say they feel alienated from the Deaf community, while at the same time not feeling fully a part of the hearing world.

The sounds heard through an implant are different from the normal hearing sounds, and have been described as artificial or "robotlike." This is because the implant's handful of electrodes cannot hope to match the complexity of a person's 15,000 hair cells.

Surgical procedure

During the procedure, the surgeon makes an incision behind the ear and opens the mastoid bone (the ridge on the skull behind the ear) leading into the middle ear. The surgeon then places the receiver-stimulator in the bone, and gently threads the electrodes into the cochlea. This operation takes between one and one-half to five hours.

Preparation

Before a person gets an implant, specialists at an implant clinic conduct a careful evaluation, including extensive hearing tests to determine how well the candidate can hear.

Unfortunately, it is not possible to predict who will benefit from an implant. In general, the later in life a person becomes deaf, and the shorter the duration of deafness, the better the person is likely to understand speech with an implant. Likewise,someone with a healthy hearing nerve will do better than someone with a damaged nerve.

First, candidates undergo a trial with a powerful hearing aid. If the aid can't improve hearing enough, a physician then performs a physical exam and orders a scan of the inner ear (some patients with a scarred cochlea aren't good candidates). A doctor may also order a psychological exam to better understand the person's expectations. Patients need to be highly motivated, and have a realistic understanding of what an implant can and cannot do.

Aftercare

The patient remains in the hospital for a day or two after the surgery. After a month, the surgical **wounds** will

have healed and the patient returns to the implant clinic to be fitted with the external parts of the device (the speech processor, microphone, and transmitter). A clinician tunes the speech processor and sets levels of stimulation for each electrode, from soft to loud.

The patient is then trained in how to interpret the sounds heard through the device. The length of the training varies from days to years, depending on how well the person can interpret the sounds heard through the device.

Risks

As with all operations, there are a few risks of surgery. These include:

- dizziness
- facial **paralysis** (rarely)
- infection at the incision site

Scientists aren't sure about the long-term effects of electrical stimulation on the nervous system. It is also possible to damage the implant's internal components by a blow to the head, which will render the device unworkable.

Normal results

Most profoundly, deaf patients who receive an implant are able to discern medium and loud sounds, including speech, at comfortable listening levels. Many use sound clues from the implant, together with speech reading and other facial cues. Almost all adults improve their communication skills when combining the implant with speech reading (lip reading), and some can understand spoken words without speech reading. More than half of adults who lost hearing after they learned to speak can understand some speech without speech reading. About 30% can understand spoken sounds well enough to use the phone.

Children who were born deaf or who lost their hearing before they could speak have the most difficulty in learning to use the implant. Research suggests, however, that most of these children are able to learn spoken language and understand speech using the implant.

Resources

BOOKS

Clark, Graeme M., Robert S. C. Cowan, and Richard Dowell. *Cochlear Implantation for Infants and Children*. New York: Singular Publishing Group, 1997.

Tye-Murray, Nancy. *Cochlear Implants and Children: A Handbook for Parents*. New York: Alexander Graham Bell Association for the Deaf, 1992.

KEY TERMS

Cochlea—The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies.

Hair cells—Sensory receptors in the inner ear that transform sound vibrations into messages that travel to the brain.

Inner ear—The interior section of the ear, where sound vibrations and information about balance are translated into nerve impulses.

Middle ear—The small cavity between the eardrum and the oval window that houses the three tiny bones of hearing.

PERIODICALS

Arana-Ward, Marie. "The Pros and Cons of Cochlear Implants." *Newsday*, 3 June 1997, B29.

Platman, Cheryl. "Hearing aids: A Link to the World." *FDA Consumer* 24 (1 Feb. 1990): 18-23.

Signor, Roger. "Sound Advice: Cochlear Implants Improve Learning for Deaf Children." *St. Louis Post-Dispatch*, 9 June 1995: 01C.

ORGANIZATIONS

Alexander Graham Bell Association for the Deaf. 3417 Volta Place NW, Washington, DC 20007. (202) 337-5220. <http://www.agbell.org>.

American Speech-Language-Hearing Association. 10801 Rockville Pike, Rockville, MD 20852. (800) 638-8255. <http://www.asha.org>.

Cochlear Implant Club International. 5335 Wisconsin Ave. NW, Suite 440, Washington, D.C. 20015-2052. (202) 895-2781. <http://www.cici.org>.

Hearing Loss Link. 2600 W. Peterson Ave., Ste. 202, Chicago, IL 60659. (312) 743-1032, (312) 743-1007 (TDD).

National Association for the Deaf. 814 Thayer Ave., Silver Spring, MD 20910. (301) 587-1788, (301) 587-1789 (TDD). <http://www.nad.org>.

Carol A. Turkington

Cognitive-behavioral therapy

Definition

Cognitive-behavioral therapy is an action-oriented form of psychosocial therapy that assumes that maladap-

tive, or faulty, thinking patterns cause maladaptive behavior and "negative" emotions. (Maladaptive behavior is behavior that is counter-productive or interferes with everyday living.) The treatment focuses on changing an individual's thoughts (cognitive patterns) in order to change his or her behavior and emotional state.

Purpose

Theoretically, cognitive-behavioral therapy can be employed in any situation in which there is a pattern of unwanted behavior accompanied by distress and impairment. It is a recommended treatment option for a number of mental disorders, including affective (mood) disorders, **personality disorders**, social phobia, **obsessive-compulsive disorder** (OCD), eating disorders, substance abuse, **anxiety** or **panic disorder**, **agoraphobia**, **post-traumatic stress disorder** (PTSD), and **attention-deficit/hyperactivity disorder** (ADHD). It is also frequently used as a tool to deal with chronic **pain** for patients with illnesses such as **rheumatoid arthritis**, back problems, and **cancer**. Patients with **sleep disorders** may also find cognitive-behavioral therapy a useful treatment for **insomnia**.

Precautions

Cognitive-behavioral therapy may not be suitable for some patients. Those who don't have a specific behavioral issue they wish to address and whose goals for therapy are to gain insight into the past may be better served by psychodynamic therapy. Patients must also be willing to take a very active role in the treatment process.

Cognitive-behavioral intervention may be inappropriate for some severely psychotic patients and for cognitively impaired patients (for example, patients with organic brain disease or a traumatic brain injury), depending on their level of functioning.

Description

Cognitive-behavioral therapy combines the individual goals of cognitive therapy and behavioral therapy.

Pioneered by psychologists Aaron Beck and Albert Ellis in the 1960s, cognitive therapy assumes that maladaptive behaviors and disturbed mood or emotions are the result of inappropriate or irrational thinking patterns, called *automatic thoughts*. Instead of reacting to the reality of a situation, an individual reacts to his or her own distorted viewpoint of the situation. For example, a person may conclude that he is "worthless" simply because he failed an exam or didn't get a date. Cognitive therapists attempt to make their patients aware of these distorted thinking patterns, or cognitive distortions, and change them (a process termed cognitive restructuring).

Behavioral therapy, or behavior modification, trains individuals to replace undesirable behaviors with healthier behavioral patterns. Unlike psychodynamic therapies, it does not focus on uncovering or understanding the unconscious motivations that may be behind the maladaptive behavior. In other words, strictly behavioral therapists don't try to find out why their patients behave the way they do, they just teach them to change the behavior.

Cognitive-behavioral therapy integrates the cognitive restructuring approach of cognitive therapy with the behavioral modification techniques of behavioral therapy. The therapist works with the patient to identify both the thoughts and the behaviors that are causing distress, and to change those thoughts in order to readjust the behavior. In some cases, the patient may have certain fundamental core beliefs, called schemas, which are flawed and require modification. For example, a patient suffering from depression may be avoiding social contact with others, and suffering considerable emotional distress because of his **isolation**. When questioned why, the patient reveals to his therapist that he is afraid of rejection, of what others may do or say to him. Upon further exploration with his therapist, they discover that his real fear is not rejection, but the belief that he is hopelessly uninteresting and unlovable. His therapist then tests the reality of that assertion by having the patient name friends and family who love him and enjoy his company. By showing the patient that others value him, the therapist both exposes the irrationality of the patient's belief and provides him with a new model of thought to change his old behavior pattern. In this case, the person learns to think, "I am an interesting and lovable person; therefore I should not have difficulty making new friends in social situations." If enough "irrational cognitions" are changed, this patient may experience considerable relief from his depression.

A number of different techniques may be employed in cognitive-behavioral therapy to help patients uncover and examine their thoughts and change their behaviors. They include:

- Behavioral homework assignments. Cognitive-behavioral therapists frequently request that their patients complete homework assignments between therapy sessions. These may consist of real-life "behavioral experiments" where patients are encouraged to try out new responses to situations discussed in therapy sessions.
- Cognitive rehearsal. The patient imagines a difficult situation and the therapist guides him through the step-by-step process of facing and successfully dealing with it. The patient then works on practicing, or rehearsing,

these steps mentally. Ideally, when the situation arises in real life, the patient will draw on the rehearsed behavior to address it.

- Journal. Patients are asked to keep a detailed diary recounting their thoughts, feelings, and actions when specific situations arise. The journal helps to make the patient aware of his or her maladaptive thoughts and to show their consequences on behavior. In later stages of therapy, it may serve to demonstrate and reinforce positive behaviors.
- Modeling. The therapist and patient engage in role-playing exercises in which the therapist acts out appropriate behaviors or responses to situations.
- Conditioning. The therapist uses reinforcement to encourage a particular behavior. For example, a child with ADHD gets a gold star every time he stays focused on tasks and accomplishes certain daily chores. The gold star reinforces and increases the desired behavior by identifying it with something positive. Reinforcement can also be used to extinguish unwanted behaviors by imposing negative consequences.
- Systematic desensitization. Patients imagine a situation they fear, while the therapist employs techniques to help the patient relax, helping the person cope with their fear reaction and eventually eliminate the anxiety altogether. For example, a patient in treatment for agoraphobia, or fear of open or public places, will relax and then picture herself on the sidewalk outside of her house. In her next session, she may relax herself and then imagine a visit to a crowded shopping mall. The imagery of the anxiety-producing situations gets progressively more intense until, eventually, the therapist and patient approach the anxiety-causing situation in real-life (a "graded exposure"), perhaps by visiting a mall. Exposure may be increased to the point of "flooding," providing maximum exposure to the real situation. By repeatedly pairing a desired response (relaxation) with a fear-producing situation (open, public spaces), the patient gradually becomes desensitized to the old response of fear and learns to react with feelings of relaxation.
- Validity testing. Patients are asked to test the validity of the automatic thoughts and schemas they encounter. The therapist may ask the patient to defend or produce evidence that a schema is true. If the patient is unable to meet the challenge, the faulty nature of the schema is exposed.

Initial treatment sessions are typically spent explaining the basic tenets of cognitive-behavioral therapy to the patient and establishing a positive working relationship between therapist and patient. Cognitive-behavioral therapy is a collaborative, action-oriented therapy effort. As such, it empowers the patient by giving him an active role in the therapy process and discourages any overdependence on the therapist that may occur in other therapeutic relationships. Therapy is typically administered in an outpatient setting in either an individual or group session. Therapists include psychologists (Ph.D., Psy.D., Ed.D. or M.A. degree), clinical social workers (M.S.W., D.S.W., or L.S.W. degree), counselors (M.A. or M.S. degree), or psychiatrists (M.D. with specialization in psychiatry) and should be trained in cognitive-behavioral techniques, although some brief cognitive-behavioral interventions may be suggested by a primary physician/caregiver. Treatment is relatively short in comparison to some other forms of psychotherapy, usually lasting no longer than 16 weeks. Many insurance plans provide reimbursement for cognitive-behavioral therapy services. Because coverage is dependent on the disorder or illness the therapy is treating, patients should check with their individual plans.

KEY TERMS

Automatic thoughts—Thoughts that automatically come to mind when a particular situation occurs. Cognitive-behavioral therapy seeks to challenge automatic thoughts.

Cognitive restructuring—The process of replacing maladaptive thought patterns with constructive thoughts and beliefs.

Maladaptive—Unsuitable or counterproductive; for example, maladaptive behavior is behavior that is inappropriate to a given situation.

Psychodynamic therapy—A therapeutic approach that assumes dysfunctional or unwanted behavior is caused by unconscious, internal conflicts and focuses on gaining insight into these motivations.

Relaxation technique—A technique used to relieve stress. Exercise, biofeedback, hypnosis, and meditation are all effective relaxation tools. Relaxation techniques are used in cognitive-behavioral therapy to teach patients new ways of coping with stressful situations.

Schemas—Fundamental core beliefs or assumptions that are part of the perceptual filter people use to view the world. Cognitive-behavioral therapy seeks to change maladaptive schemas.

Rational-emotive behavior therapy

Rational-emotive behavior therapy (REBT) is a popular variation of cognitive-behavioral therapy developed

in 1955 by psychologist Albert Ellis. REBT is based on the belief that a person's past experiences shape their belief system and thinking patterns. People form illogical, irrational thinking patterns that become the cause of both their negative emotions and of further irrational ideas. REBT focuses on helping patients discover these irrational beliefs that guide their behavior and replace them with rational beliefs and thoughts in order to relieve their emotional distress.

There are 10 basic irrational assumptions that trigger maladaptive emotions and behaviors:

- It is a necessity for an adult to be loved and approved of by almost everyone for virtually everything.
- A person must be thoroughly competent, adequate, and successful in all respects.
- Certain people are bad, wicked, or villainous and should be punished for their sins.
- It is catastrophic when things are not going the way one would like.
- Human unhappiness is externally caused. People have little or no ability to control their sorrows or to rid themselves of negative feelings.
- It is right to be terribly preoccupied with and upset about something that may be dangerous or fearsome.
- It is easier to avoid facing many of life's difficulties and responsibilities than it is to undertake more rewarding forms of self-discipline.
- The past is all-important. Because something once strongly affected someone's life, it should continue to do so indefinitely.
- People and things should be different from the way they are. It is catastrophic if perfect solutions to the grim realities of life are not immediately found.
- Maximal human happiness can be achieved by inertia and inaction or by passively and without commitment.

Meichenbaum's self-instructional approach

Psychologist Donald Meichenbaum pioneered the self-instructional, or "self-talk," approach to cognitive-behavioral therapy in the 1970s. This approach focuses on changing what people say to themselves, both internally and out loud. It is based on the belief that an individual's actions follow directly from this self-talk. This type of therapy emphasizes teaching patients coping skills that they can use in a variety of situations to help themselves. The technique used to accomplish this is self-instructional inner dialogue, a method of talking through a problem or situation as it occurs.

Preparation

Patients may seek therapy independently, or be referred for treatment by a primary physician, psychologist, or psychiatrist. Because the patient and therapist work closely together to achieve specific therapeutic objectives, it is important that their working relationship is comfortable and their goals are compatible. Prior to beginning treatment, the patient and therapist should meet for a consultation session, or mutual interview. The consultation gives the therapist the opportunity to make an initial assessment of the patient and recommend a course of treatment and goals for therapy. It also gives the patient an opportunity to find out important details about the therapist's approach to treatment, professional credentials, and any other issues of interest.

In some managed-care clinical settings, an intake interview or evaluation is required before a patient begins therapy. The intake interview is used to evaluate the patient and assign him or her to a therapist. It may be conducted by a psychiatric nurse, counselor, or social worker.

Normal results

Many patients who undergo cognitive-behavioral therapy successfully learn how to replace their maladaptive thoughts and behaviors with positive ones that facilitate individual growth and happiness. Cognitive-behavioral therapy may be used in conjunction with pharmaceutical and other treatment interventions, so overall success rates are difficult to gauge. However, success rates of 65% or more have been reported with cognitive-behavioral therapy alone as a treatment for panic attacks and agoraphobia. Relapse has been reported in some patient populations, perhaps due to the brief nature of the therapy, but follow-up sessions can put patients back on track.

Resources

BOOKS

Greenberger, Dennis, and Christine Padesky. *Mind over Mood: A Cognitive Therapy Treatment Manual for Clients.* New York: Guilford Press, 1995.

PERIODICALS

Enright, Simon. "Cognitive Behaviour Therapy." *British Medical Journal* 314, no. 7097 (June 1997): 1811-16.

Goisman, R. M. "Cognitive-Behavioral Therapy Today." *Harvard Mental Health Letter* 13, no. 11 (May 1997): 4-7.

ORGANIZATIONS

Albert Ellis Institute. 45 East 65th St., New York, NY 10021. (800) 323-4738. <http://www.rebt.org>.

Beck Institute. GSB Building, City Line and Belmont Avenues, Suite 700, Bala Cynwyd, PA 19004-1610. (610) 664-3020. <http://www.beckinstitute.org>.
The National Association of Cognitive-Behavioral Therapists. P.O. Box 2195, Weirton, WV 26062. (800) 853-1135. <http://www.nacbt.org>.

Paula Anne Ford-Martin

Colchicine *see* **Gout drugs**

COLD *see* **Chronic obstructive lung disease**

Cold agglutinins test

Definition

The cold agglutinins test is performed to detect the presence of antibodies in blood that are sensitive to temperature changes. Antibodies are proteins produced by the immune system in response to specific disease agents; autoantibodies are antibodies that the body produces against one of its own substances. Cold agglutinins are autoantibodies that cause red blood cells to clump, but only when the blood is cooled below the normal body temperature of 98.6°F (37°C). The clumping is most pronounced at temperatures below 78°F (25.6°C).

KEY TERMS

Agglutinin—An antibody that causes red blood cells to stick or clump together.

Antibody—A protein molecule produced by the immune system that is specific to a disease agent, such as *Mycoplasma pneumoniae*. The antibody combines with the organism and disables it.

Autoantibody—An antibody produced by the body in reaction to any of its own cells or cell products.

Cold agglutinins—Antibodies that cause clumping of red blood cells when the blood temperature falls below normal body temperature (98.6°F/37°C).

Hemolytic anemia—Oxygen deficiency in the blood, caused by shortened survival of red blood cells.

Mycoplasma—A type of free-living microorganism that has no cell wall. Mycoplasmas cause some varieties of pneumonia and urinary tract infections that stimulate the body to produce cold agglutinins.

Titer—The concentration of a substance in a given sample of blood or other tissue fluid.

Purpose

The cold agglutinins test is used to confirm the diagnosis of certain diseases that stimulate the body to produce cold agglutinins. The disease most commonly diagnosed by this test is mycoplasmal **pneumonia**, but mononucleosis, **mumps**, **measles**, **scarlet fever**, some parasitic infections, **cirrhosis** of the liver, and some types of **hemolytic anemia** can also cause the formation of cold agglutinins. Hemolytic **anemias** are conditions in which the blood is low in oxygen because the red blood cells are breaking down at a faster rate than their normal life expectancy of 120 days. In addition to these illnesses, some people have a benign condition called chronic cold agglutinin disease, in which exposure to cold causes temporary clumping of red blood cells and consequent numbness in ears, fingers, and toes.

Description

Since cold agglutinins cause red blood cells to clump only at temperatures lower than 98.6°F (37°C), the test consists of chilling a sample of the patient's blood. There is a bedside version of the test in which the doctor collects four or five drops of blood in a small tube, cools the tube in ice water for 30–60 seconds, and looks for clumping of red blood cells. If the cells clump after chilling and unclump as they rewarm, a cold agglutinin titer (concentration) greater than 1:64 is present. Bedside test results, however, should be confirmed by a laboratory. The laboratory test measures the clumping of red blood cells in different dilutions of the patient's blood serum at 39.2°F (4°C).

Normal results

The results of the cold agglutinins test require a doctor's interpretation. In general, however, a normal value is lower than 1:32.

Abnormal results

Any value higher than 1:32 suggests a diagnosis of mycoplasmal pneumonia or one of the other viral infections or disease conditions indicated by this test.

Resources

BOOKS

Dabrow, Michael B., and Thomas G. Gabuzda. "Acquired Hemolytic Anemia." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Feizi, Ten. "Cold Agglutinins." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Rebecca J. Frey

Cold sensitivity antibodies test *see* **Cryoglobulin test**

Cold sore

Definition

A cold sore is a fluid-filled blister which usually appears at the edge of the lips. Cold sores are caused by a herpes simplex virus infection.

Description

A cold sore is a fluid-filled, painful blister that is usually on or around the lips. Other names for a cold sore are **fever** blister, oral herpes, labial herpes, herpes labialis, and herpes febrilis. Cold sores most often occur on the lips which distinguishes them from the common canker sore, which is usually inside the mouth. Cold sores do not usually occur inside the mouth except during the initial episode. **Canker sores** usually form either on the tongue or inside the cheeks.

Cold sores are caused by a herpes virus. There are eight different kinds of human herpes viruses. Only two of these, herpes simplex types 1 and 2, can cause cold sores. It is commonly believed that herpes simplex virus type 1 infects above the waist and herpes simplex virus type 2 infects below the waist. This is not completely true. Both herpes virus type 1 and type 2 can cause herpes lesions on the lips or genitals, but recurrent cold sores are almost always type 1.

Oral herpes is very common. More than 60% of Americans have had a cold sore, and almost 25% of those infected experience recurrent outbreaks. Most of these persons became infected before age 10. Anyone can become infected by herpes virus and, once infected, the virus remains latent for life. Herpes viruses are spread from person to person by direct skin-to-skin contact. The highest risk for spreading the virus is the time period beginning with the appearance of blisters and ending with scab formation. However, infected persons need not have visible blisters to spread the infection to others since the virus may be present in the saliva without obvious oral lesions.

Viruses are different from bacteria. While bacteria are independent and can reproduce on their own, viruses enter human cells and force them to make more virus. The infected human cell is usually killed and releases thousands of new viruses. The cell **death** and resulting tissue damage causes the actual cold sores. In addition, the herpes virus can infect a cell and instead of making the cell produce new viruses, it hides inside the cell and waits. The herpes virus hides in the nervous system. This is called "latency." A latent virus can wait inside the nervous system for days, months, or even years. At some future time, the virus "awakens" and causes the cell to produce thousands of new viruses that cause an active infection.

This process of latency and active infection is best understood by considering the cold sore cycle. An active infection is obvious because cold sores are present. The first infection is called the "primary" infection. This active infection is then controlled by the body's immune system and the sores heal. In between active infections, the virus is latent. At some point in the future, latent viruses become activated and once again cause sores. These are called "recurrent" infections. Although it is unknown what triggers latent virus to activate, several conditions seem to bring on infections. These include **stress**, illness, tiredness, exposure to sunlight, menstruation, fever, and diet.

Causes and symptoms

While anyone can be infected by herpes virus, not everyone will show symptoms. The first symptoms of herpes occur within two-20 days after contact with an infected person. Symptoms of the primary infection are usually more severe than those of recurrent infections. The primary infection can cause symptoms like other viral infections including tiredness, **headache**, fever, and swollen lymph nodes in the neck.

Typically, 50-80% of persons with oral herpes experience a prodrome (symptoms of oncoming disease) of **pain**, burning, **itching**, or tingling at the site where blisters will form. This prodrome stage may last anywhere from a few hours to one to two days. The herpes infection prodrome occurs in both the primary infection and recurrent infections.

In 95% of the patients with cold sores, the blisters occur at the outer edge of the lips which is called the "vermilion border." Less often, blisters form on the nose, chin, or cheek. Following the prodrome, the disease process is rapid. First, small red bumps appear that quickly form fluid-filled blisters. The painful blisters may either burst and form a scab or dry up and form a scab. Within two days of the first red bumps, all the blisters have formed scabs. The skin heals completely and without scarring within six to ten days.

Some children have a very serious primary (first episode) herpes infection called "gingivostomatitis." This causes fever, swollen lymph glands, and numerous blisters inside the mouth and on the lips and tongue that may form large, open sores. These painful sores may last up to three weeks and can make eating and drinking difficult. Because of this, young children with gingivostomatitis are at risk for **dehydration** (excessive loss of water from the body).

Most people experience fewer than two recurrent outbreaks of cold sores each year. Some people never experience outbreaks, while some have very frequent outbreaks. In most people, the blisters form in the same area each time and are triggered by the same factors (such as stress, sun exposure, etc).

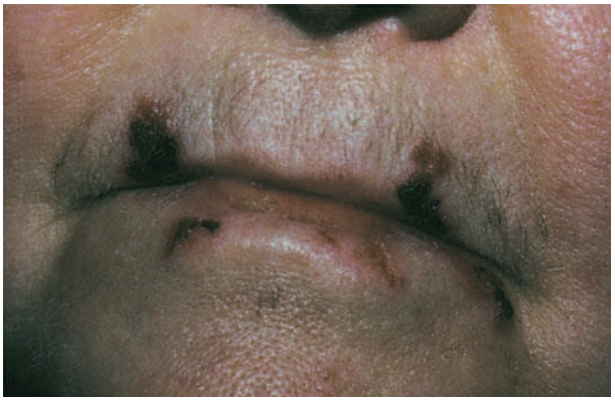
Diagnosis

Because oral herpes is so common, it is diagnosed primarily by symptoms. It can be diagnosed and treated by the family doctor, dermatologists (doctors who specialize in skin diseases) and infectious disease specialists. Laboratory tests may be performed to look for the virus. Because healing sores do not shed much virus, a sample from an open sore would be taken for viral culture. A sterile cotton swab would be wiped over open sores and the sample used to infect human cells in culture. Cells that are killed by the herpes virus have a certain appearance under microscopic examination. The results of this test are available within two to 10 days.

Oral herpes may resemble a bacterial infection called impetigo. This skin infection is most commonly seen in children and causes herpes-like blisters around the mouth and nose. Also, because oral herpes can occur inside the mouth, the blisters could be mistaken for common canker sores. Therefore, the doctor would need to determine whether the blisters are oral herpes, canker sores, or **impetigo**. The diagnosis and treatment of herpes infections should be covered by most insurance providers.

Treatment

There is no cure for herpes virus infections. There are **antiviral drugs** available that have some effect on lessening the symptoms and decreasing the length of herpes outbreaks. There is evidence that some may also prevent future outbreaks. These antiviral drugs work by interfering with the replication of the viruses, and are most effective when taken as early in the infection process as possible. For the best results, drug treatment should begin during the prodrome stage before blisters are visible. Depending on the length of the outbreak, drug treatment could continue for up to 10 days.



A close-up view of a patient's mouth with gingivostomatitis cold sores. *(Custom Medical Stock Photo. Reproduced by permission.)*

Acyclovir (Zovirax) is the drug of choice for herpes infection and can be given intravenously or taken by mouth. It can be applied directly to sores as an ointment but is not very useful in this form. A liquid form for children is also available. Acyclovir is effective in treating both the primary infection and recurrent outbreaks. When taken by mouth to prevent an outbreak, acyclovir reduces the frequency of herpes outbreaks.

During an outbreak of cold sores, salty foods, citrus foods (oranges etc.), and other foods that irritate the sores should be avoided. Wash the sores once or twice a day with warm, soapy water and pat gently to dry. Over-the-counter lip products that contain the chemical phenol (such as Blistex Medicated Lip Ointment) and numbing ointments (Anbesol) help to relieve cold sores. A bandage may be placed over the sores to protect them and prevent spreading the virus to other sites on the lips or face. **Acetaminophen** (Tylenol) or ibuprofen (Motrin, Advil) may be taken if necessary to reduce pain and fever.

Alternative treatment

Vitamin and mineral supplements and diet may have an effect on the recurrence and duration of cold sores. In general, cold sore sufferers should eat a healthy diet of unprocessed foods such as vegetables, fruits, and whole grains. Alcohol, **caffeine**, and sugar should be avoided.

An imbalance in the amino acids lysine and arginine is thought to be one contributing factor in herpes virus outbreaks. A diet that is rich in the amino acid lysine may help prevent recurrences of cold sores. Foods which contain high levels of lysine include most vegetables, legumes, fish, turkey, and chicken. In one study, patients taking lysine supplements had milder symptoms during an outbreak, a shorter healing time, and had fewer outbreaks

KEY TERMS

Latent—A nonactive virus which is in a dormant state within a cell. The herpes virus is latent in the nervous system.

Prodrome—The Symptoms that warn of the beginning of disease. The herpes prodrome consists of pain, burning, tingling, or itching at a site before blisters are visible.

Recurrence—The return of an active infection following a period of latency.

than patients who did not take lysine. Patients should take 1,000 mg of lysine three times a day during a cold sore outbreak and 500 mg daily on an ongoing basis to prevent recurrences. Intake of the amino acid arginine should be reduced. Foods rich in arginine that should be avoided are chocolate, peanuts, almonds, and other nuts and seeds.

Vitamin C and bioflavonoids (a substance in fruits that helps the body to absorb and use vitamin C) have been shown to reduce the duration of a cold sore outbreak and reduce the number of sores. The vitamin B complex includes important **vitamins** that support the nervous system where viruses can hide out. B complex vitamins can also help manage stress, an important contributing factor to the outbreak of herpes viruses. Applying the oil in vitamin E capsules directly to cold sores may provide relief. Zinc lozenges appear to affect the reproduction of viruses and also enhance the immune system. Ointments containing lemon balm (*Melissa officinalis*) or licorice (*Glycyrrhiza glabra*) and peppermint (*Mentha piperita*) have been shown to help cold sores heal.

Prognosis

Oral herpes can be painful and embarrassing, but it is not a serious infection. There is no cure for oral herpes, but outbreaks usually occur less frequently after age 35. The spread of the herpes virus to the eyes is very serious. The herpes virus can infect the cells in the cornea and cause scarring that may impair vision.

Prevention

The only way to prevent oral herpes is to avoid contact with infected persons. This is not an easy solution because many people aren't aware that they are infected and can easily infect others. Currently there are no herpes vaccines available, although herpes vaccines are being tested.

Several practices can reduce the occurrence of cold sores and the spread of virus to other body locations or people. These practices are:

- Avoidance of sun exposure to the face. Before getting prolonged exposure to the sun, apply sunscreen to the face and especially to the lips. Wearing a hat with a large brim is also helpful.
- Avoid touching cold sores. Squeezing, picking, or pinching blisters can allow the virus to spread to other parts of the lips or face and infect those sites.
- Wash hands frequently. Persons with oral herpes should wash their hands carefully before touching others. An infected person can spread the virus to others even when he or she has no obvious blisters.
- Avoid contact with others during active infection. Infected persons should avoid kissing or sexual contact with others until after the cold sores have healed.
- Wear gloves when applying ointment to a child's sore.
- Be especially careful with infants. Never kiss the eyes or lips of a baby who is under six months old.
- Be watchful of infected children. Do not allow infected children to share toys that may be put into the mouth. Toys that have been mouthed should be disinfected before other children play with them.
- Maintain good general health. A healthy diet, plenty of sleep, and **exercise** help to minimize the chance of getting a cold or the flu, which are known to bring on cold sores. Also, good general health keeps the immune system strong; this helps to keep the virus in check and prevents outbreaks.

Resources

BOOKS

Gorbach, Sherman, John Bartlett, and Neil Blacklow, eds. *Infectious Diseases*. Philadelphia: W. B.Saunders Co., 1998.

PERIODICALS

Kott, Andrea. "The Common Cold Sore." *Parents*, Nov. 1997, 101-105.

Murray, Michael T. "Natural Help for Herpes and Cold Sores." *Let's Live*, Apr. 1997, 68+.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Cold spot myocardial imaging *see* **Thallium heart scan**

Colds *see* **Common cold**

Colic

Definition

Colic is persistent, unexplained crying in a healthy baby between two weeks and five months of age.

Description

Colic, which is not a disease, affects 10–20% of all infants. It is more common in boys than in girls and most common in a family's first child. Symptoms of colic usually appear when a baby is 14–21 days old, reach a crescendo at the age of three months, and disappear within the next eight weeks. Episodes occur frequently but intermittently and usually begin with prolonged periods of crying in the late afternoon or evening. They can last for just a few minutes or continue for several hours. Some babies who have colic are simply fussy. Others cry so hard that their faces turn red, then pale.

Causes and symptoms

No one knows what causes colic. The condition may be the result of swallowing large amounts of air, which becomes trapped in the digestive tract and causes bloating and severe abdominal **pain**.

Other possible causes of colic include:

- digestive tract immaturity
- food intolerances
- hunger or overfeeding
- lack of sleep
- loneliness
- overheated milk or formula
- overstimulation resulting from noise, light, or activity
- tension

During a colicky episode, babies' bellies often look swollen, feel hard, and make a rumbling sound. Crying intensifies, tapers off, then gets louder. Many babies grow rigid, clench their fists, curl their toes, and draw their legs toward their body. A burp or a bowel movement can end an attack. Most babies who have colic don't seem to be in pain between attacks.

Diagnosis

Pediatricians and family physicians suspect colic in an infant who:

- has cried loudly for at least three hours a day at least three times a week for three weeks or longer
- is not hungry but cries for several hours between dinnertime and midnight
- demonstrates the clenched fists, rigidity, and other physical traits associated with colic

The baby's medical history and a parent's description of eating, sleeping, and crying patterns are used to confirm a diagnosis of colic. **Physical examination** and laboratory tests are used to rule out infection, intestinal blockage, and other conditions that can cause abdominal pain and other colic-like symptoms.

Treatment

Medications do not cure colic. Doctors sometimes recommend simethicone (Mylicon Drops) to relieve gas pain, but generally advise parents to take a practical approach to the problem.

Gently massaging the baby's back can release a trapped gas bubble, and holding the baby in a sitting position can help prevent air from being swallowed during feedings. Bottle-fed babies can swallow air if nipple holes are either too large or too small.

Nipple-hole size can be checked by filling a bottle with cold formula, turning it upside down, and counting the number of drops released when it is shaken or squeezed. A nipple hole that is the right size will release about one drop of formula every second.

Babies should not be fed every time they cry, but feeding and burping a baby more often may alleviate symptoms of colic. A bottle-fed baby should be burped after every ounce, and a baby who is breastfeeding should be burped every five minutes.

When cow's milk is the source of the symptoms, bottle-fed babies should be switched to a soy milk hydrolyzed protein formula. A woman whose baby is breastfeeding should eliminate dairy products from her diet for seven days, then gradually reintroduce them unless the baby's symptoms reappear.

Since intolerance to foods other than cow's milk may also lead to symptoms of colic, breastfeeding women may also relieve their babies' colic by eliminating from their diet:

- coffee
- tea
- cocoa
- citrus
- peanuts
- wheat
- broccoli and other vegetables belonging to the cabbage family

Rocking a baby in a quiet, darkened room can prevent overstimulation, and a baby usually calms down when cuddled in a warm, soft blanket.

Colicky babies cry less when they are soothed by the motion of a wind-up swing, a car ride, or being carried in a parent's arms. Pacifiers can soothe babies who are upset, but a pacifier should never be attached to a string.

A doctor should be notified if a baby who has been diagnosed with colic:

- develops a rectal **fever** higher than 101°F (38.3°C)
- cries for more than four hours
- vomits
- has **diarrhea** or stools that are black or bloody
- loses weight
- eats less than normal

Alternative treatment

Applying gentle pressure to the webbed area between the thumb and index finger of either hand can calm a crying child. So can gently massaging the area directly above the child's navel and the corresponding spot on the spine. Applying warm compresses or holding your hand firmly over the child's abdomen can relieve cramping.

Teas made with chamomile (*Matricaria recutita*), lemon balm (*Melissa officinalis*), peppermint (*Mentha piperita*), or dill (*Anethum graveolens*) can lessen bowel inflammation and reduce gas. A homeopathic combination called "colic" may be effective, and constitutional homeopathic treatment can help strenthen the child's entire constitution.

Prognosis

Colic is distressing, but it is not dangerous. Symptoms almost always disappear before a child is six months old.

Prevention

Many doctors believe that colic cannot be prevented. Some alternative practitioners, however, feel that colic can be prevented by an awareness of food intolerances and their impact.

Resources

BOOKS

Taylor, Robert, ed. *Family Medicine Principles and Practice.* New York: Springer-Verlag, 1994.

ORGANIZATIONS

American Academy of Family Physicians. 8880 Ward Parkway, Kansas City, MO 64114. (816) 333-9700. <http://www.aafp.org>.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000. <http://www.aap.org>.

OTHER

"Colic." *University of Michigan Health System Page*. 7 May 1998 <http://www.mcare.org/healthtips>.

"Colic." *WebMD Health*. 7 May 1998 <http://my.webmd.com>.

"Colic." *YourHealth.com Page*. 8 May 1998 <http://www.yourhealth.com>.

Maureen Haggerty

Collapsed lung *see* **Pneumothorax**

Colloidal bath *see* **Therapeutic baths**

Colon cancer

Definition

Cancer of the colon is the disease characterized by the development of malignant cells in the lining or epithelium of the first and longest portion of the large intestine. Malignant cells have lost normal control mechanisms governing growth. These cells may invade surrounding local tissue, or they may spread throughout the body and invade other organ systems.

Synonyms for the colon include the large bowel or the large intestine. The rectum is the continuation of the large intestine into the pelvis that terminates in the anus.

Description

The colon is a tubular organ beginning in the right lower aspect of the abdomen. Anatomically, it ascends on the right side of the abdomen, traverses from right to left in the upper abdomen, descends vertically down the left side, takes an S-shaped curve in the lower left abdomen, and then flows into the rectum as it leaves the abdomen for the pelvis. These portions of the colon are named separately though they are part of the same organ:

- cecum, the beginning of the colon
- ascending colon, the right vertical ascent of the colon
- transverse colon, the portion traversing from right to left
- descending colon, the left vertical descent of the colon
- sigmoid colon, the s-shaped segment of colon above the pelvis

These portions of the colon are recognized anatomically based on the arterial blood supply and venous and lymphatic drainage of these segments of the colon. Lymph, a protein-rich fluid that bathes the cells of the body, is transported in small channels known as lymphatics that run along side the veins of the colon. Lymph nodes are small filters through which the lymph travels on its way back to the blood stream. Cancer can spread elsewhere in the body by invading the lymph and vascular systems. Therefore, these anatomic considerations become very important in the treatment of colon cancer.

The small intestine is the continuation of the upper gastrointestinal tract that is responsible for the transport of ingested nutrients into the body. The waste left after the small intestine has completed absorption of nutrients amounts to a few liters (about the same as quart) of material per day and is directly delivered to the colon (at the cecum) for processing. Physiologically, the colon is responsible for the preservation of fluid and electrolytes as it propels the increasingly solid waste towards the rectum and anus for excretion.

When cells lining the colon become malignant, they first grow locally and may invade partially or totally through the wall of the bowel and even into adjacent structures and organs. In the process, the tumor can penetrate and invade the lymphatics or the capillaries locally and it gains access to the circulation. As the malignant cells work their way to other areas of the body, they again become locally invasive in the new area to which they have spread. These tumor deposits, originating in the colon primary tumor, are then known as metastases. If metastases are found in the regional lymph nodes from the primary, they are known as regional metastases or regional nodal metastases. If they are distant from the primary tumor, they are known as distant metastases. The patient with distant metastases has systemic disease. Thus the cancer originating in the colon begins locally and, given time, can become systemic in its extent.

By the time the primary is originally detected, it is usually larger than 0.4 in (1 cm) in size and has over a million cells. This amount of growth itself is estimated to take about three to seven years. Each time the cells double in number, the size of the tumor quadruples. Thus, like most cancers, the part that is identified clinically is later in the progression than would be desired and screening becomes a very important endeavor to aid in earlier detection of this disease.

There are about 94,000 cases of colon cancer diagnosed per year in the United States. Together, colon and rectal cancers account for 10% of cancers in men and 11% of cancers in women. It is the second most common site-specific cancer affecting both men and women. (Lung cancer is the first affecting both men and women, breast is the leader in women and prostate the leader in men.) Nearly 48,000 people died from colon cancer in the United States in 2000. In recent years the incidence of this disease is decreasing very slightly, as has the mortality rate. It is difficult to tell if the decrease in mortality reflects earlier diagnosis, less **death** related to the actual treatment of the disease, or a combination of both factors.

Cancer of the colon is thought to arise sporadically in about 80% of those who develop the disease. Twenty percent of cases are thought to have genetic predisposition that ranges from familial syndromes affecting 50% of the offspring of a mutation carrier, to a risk of 6% when there is just a family history of colon cancer occurring in a first degree relative. Development of colon cancer at an early age, or at multiple sites, or recurrent colon cancer suggests a genetically transmitted form of the disease as opposed to the sporadic form.

Causes and symptoms

Causes of colon cancer are probably environmental in the sporadic cases (80%) and genetic in the heredity predisposed cases (20%). Since malignant cells have a changed genetic makeup, this means that in 80% of cases, the environment spontaneously induces change, whereas in those born with a genetic predisposition, they are either destined to get the cancer or it will take less environmental exposure to induce the cancer. Exposure to agents in the environment that may induce mutation is the process of carcinogenesis and is caused by agents known as carcinogens (cancer-causing agents). Specific carcinogens have been difficult to identify; however, dietary factors seem to be involved.

Colon cancer is more common in industrialized nations and **diets** high in fat, red meat, total calories, and alcohol seem to predispose. Diets high in fiber are associated with a decreased risk. The mechanism for protection by high-fiber diets may be related to less exposure of the colon lining to carcinogens from the environment, as the transit time through the bowel is faster with a high-fiber diet than it is with a low-fiber diet.

Age plays a definite role in the predisposition to colon cancer. Colon cancer is uncommon before age 40. This incidence increases substantially after age 50 and doubles with each succeeding decade.

There is also a slight increase risk for colon cancer in the individual who smokes.

Patients who suffer from inflammatory diseases of the colon known as **ulcerative colitis** and Crohn's colitis are also at increased risk.

As for genetic predisposition, on chromosome 5, there is a gene called the APC gene associated with the familial adenomatous polyposis syndrome. There are multiple different mutations that occur at this site, yet they all cause a defect in tumor suppression that results in early and frequent development of colon cancer. This genetic aberration is transmitted to 50% of offspring and each of those affected will develop colon cancer, usually at an early age. There is another syndrome, hereditary non-polyposis colon cancer (also known as Lynch syndrome), related to mutations in any of four genes responsible for DNA mismatch repair. In patients with colon cancer, the p53 gene is mutated 70% of the time. When the p53 gene is mutated and ineffective, cells with damaged DNA escape repair or destruction. This allows for the damaged cell to perpetuate itself, and continued replication of the damaged DNA may lead to tumor development. Though these syndromes have a very high incidence of colon cancer, family history without the syndrome is also a substantial risk factor. When considering first-degree relatives, history of one with colon cancer raises the baseline risk of 2% to 6%. (Most physicians think that this baseline is about 4%.) The presence of a second raises the risk to 17%.

The development of polyps of the colon almost always precedes the development of colon cancer by five or more years. Polyps are benign growths of the colon lining. They can be unrelated to cancer, precancerous, or malignant. Polyps, when identified, are removed for diagnosis. If the polyps are benign, the patient should undergo careful surveillance for the development of more polyps or the development of colon cancer.

Colon cancer causes symptoms related to its local presence in the large bowel or by its effect on other organs if it has spread. These symptoms may occur alone or in combination:

- a change in bowel habit
- blood in the stool
- bloating, persistent abdominal distention
- constipation
- a feeling of fullness even after having a bowel movement
- narrowing of the stool—so-called ribbon stools
- persistent, chronic **fatigue**
- abdominal discomfort
- unexplained weight loss
- very rarely, nausea and vomiting

Most of these symptoms are caused by the physical presence of the tumor mass in the colon. Similar symptoms can be caused by other processes; these are not absolutely specific to colon cancer. The key is recognizing that the persistence of these types of symptoms without ready explanation should prompt the individual to seek medical evaluation.

Many of the symptoms are understood by remembering that the colon is a tubular conduit. If a tumor develops, as it reaches a certain size it will begin to cause symptoms related to the obstruction of that conduit. In addition, the tumor commonly oozes blood that is lost in the stool. (Often, this blood is not visible.) This phenomenon results in anemia and chronic fatigue. Weight loss is a late symptom, often implying substantial obstruction or the presence of systemic disease.

Diagnosis

Screening

Of all of the major cancers, only colorectal cancer can be prevented by screening. In all other cancers (breast and prostate, for example), screening tests look for small, malignant lesions. Screening for colorectal cancers, however, is the search for pre-malignant, benign polyps. This screening can be close to 100% effective in preventing cancer development, not just in detecting small cancers.

Screening involves physical exam, simple laboratory tests, and the visualization of the lining of the colon. The ways to visualize the colon epithelium are with x rays (indirect visualization), and endoscopy (direct visualization).

The **physical examination** involves the performance of a digital rectal exam (DRE). The DRE includes manual examination of the rectum, anus, and the prostate. During this examination, the physician examines the anus and the surrounding skin for **hemorrhoids**, abscesses, and other irregularities. After lubricating the gloved finger and anus, the examiner gently slides the finger into the anus and follows the contours of the rectum. The examiner notes the tone of the anus and feels the walls and the edges for texture, tenderness and masses as far as the examining finger can reach. At the time of this exam, the physician checks the stool on the examining glove with a chemical to see if any occult (invisible), blood is present. At home, after having a bowel movement, the patient is asked to swipe a sample of stool obtained with a small stick on a card. After 3 such specimens are on the card, the card is then easily chemically tested for occult blood also. (The stool analysis mentioned here is known as a **fecal occult blood test**, or FOBT, and, while it can be helpful, it is not 100% accurate—only about 50% of cancers are FOBT-positive.) These exams are accomplished as an easy part of a routine yearly physical exam.

Proteins are sometimes produced by cancers, and these may be elevated in the patient's blood. When this occurs, the protein produced is known as a tumor marker. There is a tumor marker for some cancers of the colon; it is known as carcinoembryonic antigen, or CEA. Unfortunately, this protein may be made by other adenocarcinomas as well, or it may not be produced by a particular colon cancer. Therefore, screening by chemical analysis for CEA has not been helpful. CEA has been helpful when used in a follow-up role for patients treated for colon cancer if their tumor makes the protein.

Indirect visualization of the colon may be accomplished by placing barium through the rectum and filling the colon with this compound. Barium produces a white contrast image of the lining of the colon on x ray and thus, the contour of the lining of the colon may be seen. Detail can be increased if the barium utilized is thinned and air also introduced. These studies are known as the **barium enema** (BE) and the double contrast barium enema (DCBE).

Direct visualization of the lining of the colon is accomplished using a scope or endoscope. The physician introduces the instrument through the rectum and passes it proximally, visualizing the colon epithelium in the process. Older, shorter scopes were rigid. Today, utilizing fiberoptic technology, the scopes are flexible and can reach much farther. If the left colon only is visualized, it is called flexible **sigmoidoscopy**. When the entire colon is visualized, the procedure is known as **colonoscopy**.

Unlike the indirect visualizations of the colon (the BE and the DCBE), the endoscopic screeenings allow the physician to remove polyps and biopsy suspicious tissue. (A biopsy is a removal of tissue for examination by a pthologist.) For this reason, many physicians prefer endoscopic screening. All of the visualizations, the BE, DCBE, and each type of endoscopy require pre-procedure preparation (evacuation) of the colon.

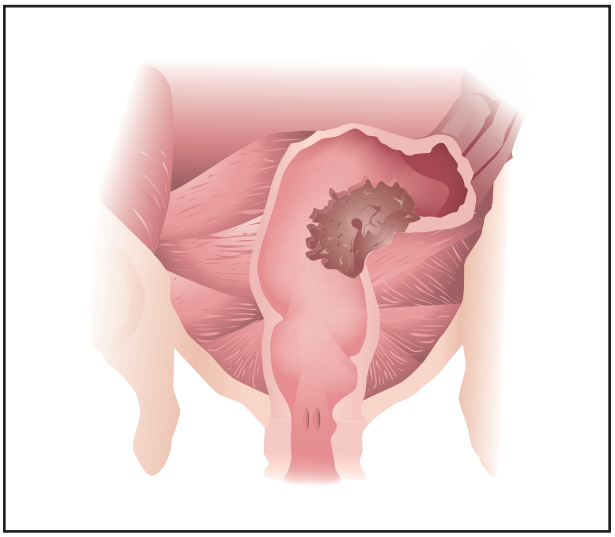
The American Cancer Society has recommended the following screening protocol for those of normal risk over 50 years of age:

- yearly DRE with occult blood in stool testing
- flexible sigmoidoscopy at age 50
- flexible sigmoidoscopy repeated every five years

Many physicians, however, recommend full colonoscopy every five to seven years. Screening evaluations should start sooner for patients who have predisposing factors, such as family history, history of polyps, or a familial syndrome.

Evaluation of patients with symptoms

For those whose symptoms prompt them to visit their physician, and if their symptoms could possibly be related to colon cancer, the entire colon will be inspected. The combination of a flexible sigmoidoscopy and DCBE may be performed but the preferred evaluation of the entire colon and rectum is that of complete colonoscopy. Colonoscopy allows direct visualization, photography, and the opportunity to obtain a biopsy of any abnormality visualized. If, for technical reasons, the entire colon is not visualized endoscopically, a DCBE should complement the colonoscopy.



A colon with a cancerous growth. *(Illustration by Argosy Inc.)*

The diagnosis of colon cancer is actually made by the performance of a biopsy of any abnormal lesion in the colon. When a tumor growth is identified, it could be either a benign polyp (or lesion) or a cancer; the biopsy resolves the issue. The endoscopist may take many samples so as to exclude any sampling errors.

If the patient presents with advanced disease, or has advanced disease at the time of diagnosis, areas where the tumor has spread (such as the liver) may be amenable to biopsy. Such biopsies are usually obtained using a special needle under local anesthesia.

Once a diagnosis of colon cancer has been established by biopsy, in addition to the physical exam, studies will be performed to assess the extent of the disease. Blood studies include a complete **blood count**, **liver function tests**, and a CEA. Imaging studies will include a **chest x ray** and a CAT scan (computed tomography scan) of the abdomen. The chest x ray will determine if there is spread to the lung, and the CAT scan will evaluate potential spread to the liver as well as any local invasive characteristics of the primary tumor. If the patient has any neurologic symptoms, a CAT scan of the brain will be performed, and if the

KEY TERMS

Adenocarcinoma—Type of cancer beginning in glandular epithelium.

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

Anastomosis—Surgical reconnection of the ends of the bowel after removal of a portion of the bowel.

Anemia—The condition caused by too few circulating red blood cells, often manifested in part by fatigue.

Carcinogens—Substances in the environment that cause cancer, presumably by inducing mutations, with prolonged exposure.

Electrolytes—Salts, such as sodium and chloride.

Epithelium—Cells composing the lining of an organ.

Lymphatics—Channels that are conduits for lymph.

Lymph nodes—Cellular filters through which lymphatics flow.

Malignant—Cells that have been altered such that they have lost normal control mechanisms and are capable of local invasion and spread to other areas of the body.

Metastasis—Site of invasive tumor growth that originated from a malignancy elsewhere in the body.

Mutation—A change in the genetic makeup of a cell that may occur spontaneously or be environmentally induced.

Occult blood—Presence of blood that cannot be seen with the naked eye.

Polyps—Localized growths of the epithelium that can be benign, precancerous, or harbor malignancy.

Radical resection—Surgical resection that takes the blood supply and lymph system supplying the organ along with the organ.

Resect—To remove surgically.

Sacrum—Posterior bony wall of the pelvis.

Systemic—Referring to throughout the body.

patient is experiencing bone **pain**, a bone scan will also be performed.

Treatment

Once the diagnosis has been confirmed by biopsy, the clinical stage of the cancer is assigned. Using the characteristics of the primary tumor, its depth of penetration through the bowel, and the presence or absence of regional or distant metastases, the stage of the cancer is derived. Often, the depth of penetration through the bowel or the presence of regional lymph nodes can't be assigned before surgery.

Colon cancer is assigned stages I through IV based on the following general criteria:

- Stage I: the tumor is confined to the epithelium or has not penetrated through the first layer of muscle in the bowel wall.
- Stage II: the tumor has penetrated through to the outer wall of the colon or has gone through it, possibly invading other local tissue.
- Stage III: any depth or size of tumor associated with regional lymph node involvement.
- Stage IV: any of previous criteria associated with distant metastasis.

With many cancers other than colon cancer, staging plays an important pre-treatment role to best determine treatment options. In colon cancer, almost all colon cancers are treated with surgery first, regardless of stage. Colon cancers through stage III, and even some stage IV colon cancers, are treated with surgery first before any other treatments are considered.

Surgery

Surgical removal of the involved anatomic segment of colon (colectomy) along with its blood supply and regional lymph nodes is the primary therapy for colon cancer. Usually, on the basis of the blood supply, the partial colectomies are separated into right, left, transverse, or sigmoid. The removal of the blood supply at its origin along with the regional lymph nodes that accompany it assures an adequate margin of normal colon on either side of the primary tumor. When the cancer lies in a position such that the blood supply and lymph drainage lies between two of the major vessels, both vessels are taken to assure complete radical resection or removal (extend-

ed radical right or left colectomy). If the primary tumor penetrates through the bowel wall, any tissue adjacent to the tumor extension is also taken if feasible.

Surgery is used as primary therapy for stages I through III colon cancer unless there are signs that local invasion will not permit complete removal of the tumor, as may occur in advanced stage III tumors. However, this circumstance is very rare, and occurs in less than 2% of all colon cancer cases.

After the resection is completed, the ends of the remaining colon are reconstructed; the hook-up is called an anastomosis. Once healing has occurred, there may be a slight increase in the frequency of bowel movements. This effect usually lasts only for several weeks. Most patients go on to develop completely normal bowel function.

Occasionally, the anastomosis would be risky and cannot be performed. (Most commonly, this occurs when the bowel could not be adequately evacuated in an emergency circumstance due to bowel obstruction.) When the anastomosis cannot be performed, a **colostomy** is performed instead. A colostomy is performed by bringing the end of the colon through the abdominal wall and sewing it to the skin. The patient will have to wear an appliance (a bag) to manage the stool. The colostomy may be temporary and the patient may undergo a hook-up at a later, safer date, or the colostomy may be permanent. In most cases, emergent colostomies are not reversed and are permanent.

Radiation

Radiation therapy is used as an adjunct to surgery if there is concern about potential for local recurrence post-operatively and the area of concern will tolerate the radiation. For instance, if the tumor invaded muscle of the abdominal wall but was not completely removed, this area would be considered for radiation. Radiation has significant dose limits when residual bowel is exposed to it because the small and large intestine do not tolerate radiation well.

Radiation is also used in the treatment of patients who present with or progress to having metastatic disease. It is particularly useful in shrinking metastatic colon cancer to the brain.

Chemotherapy

Chemotherapy is useful for patients who have had all identifiable tumor removed and are at risk for recurrence (adjuvant chemotherapy). Chemotherapy may also be used when the cancer is stage IV and is beyond the scope of regional therapy, but this use is rare.

Adjuvant therapy is considered in stage II disease with deep penetration or in stage III patients. Standard therapy is treatment with 5-fluorouracil, (5FU) combined with leucovorin for a period of six to 12 months. 5FU is an antimetabolite and leukovorin improves the response rate. (A response is a temporary regression of the cancer in response to the chemotherapy.) Another agent, levamisole, (which seems to stimulate the immune system), may be substituted for leucovorin. These protocols reduce rate of recurrence by about 15% and reduce mortality by about 10%. The regimens do have some toxicity, but usually are tolerated fairly well.

Similar chemotherapy may be administered for stage IV disease or if a patient progresses and develops metastases. Results show response rates of about 20%. Unfortunately, these patients eventually succumb to the disease, and this chemotherapy may not prolong survival or improve quality of life in Stage IV patients. Clinical trials have now shown that the results can be improved with the addition of another agent to this regimen. Irinotecan does not seem to increase toxicity but it improved response rates to 39%, added two to three months to disease-free survival, and prolonged overall survival by a little over two months.

Alternative treatment

Alternative therapies have not been studied in a large-scale, scientific way. Large doses of **vitamins**, fiber, and green tea are among therapies tried. Avoiding cigarettes and alcohol may be helpful. Before initiating any alternative therapies, the patient is wise to consult his/her physician to be sure that these therapies do not complicate or interfere with the established therapy.

Prognosis

Prognosis is the long-term outlook or survival after therapy. Overall, about 50% of patients treated for colon cancer survive the disease. As expected, the survival rates are dependent upon the stage of the cancer at the time of diagnosis, making early detection a very worthwhile endeavor.

About 15% of patients present with stage I disease and 85–90% survive. Stage II represents 20–30% of cases and 65–75% survive. Thirt to forty percent comprise the stage III presentation of which 55% survive. The remaining 20–25% present with stage IV disease and are very rarely cured.

Prevention

There is not an absolute way of preventing colon cancer. Still, there are steps an individual can take to dramatically lessen the risk or to identify the precursors of colon cancer so that it does not manifest itself. The patient with a familial history can enter screening and

surveillance programs earlier than the general population. High-fiber diets and vitamins, avoiding **obesity**, and staying active lessen the risk. Avoiding cigarettes and alcohol may be helpful. By controlling these environmental factors, an individual can lessen risk and to this degree prevent the disease.

By undergoing appropriate screening when uncontrollable genetic risk factors have been identified, an individual may be rewarded by the identification of benign polyps that can be treated as opposed to having these growths degenerate into a malignancy.

Resources

BOOKS

Abelhoff, Martin, James O. Armitage, Allen S. Lichter, and John E. Niederhuber. *Clinical Oncology Library.* Philadelphia: Churchill Livingstone, 1999.

Jorde, Lynn B., John C. Carey, Michael J. Bamshad, and Raymond L. White. *Medical Genetics,* Second Edition. St. Louis: Mosby, 1999.

Kirkwood, John M., Michael T. Lotze, and Joyce M. Yasko. *Current Cancer Therapeutics,* Third Edition. Philadelphia: Churchill Livingstone, 1998

PERIODICALS

Greenlee, Robert T., Mary Beth Hill-Harmon, Taylor Murray, and Michael Thun. "Cancer Statistics 2001." *CA: A Cancer Journal for Clinicians,* 51, no. 1 (Jan/Feb 2001).

Saltz, Leonard, et al. "Irinotecan plus Fluorouracil and Leucovorin for Metastatic Colorectal Cancer." *The New England Journal of Medicine* Volune 343, No. 13 (September 28, 2000).

ORGANIZATIONS

American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.

Cancer Information Service of the NCI. (1-800-4-CANCER). <http://wwwicic.nci.nih.gov>.

Colon Cancer Alliance. <http://www.ccalliance.org>.

National Cancer Institute Cancer Trials. <http://cancertrials.nci.nih.gov/system>. <http://www.cancertrials.com>.

Richard A. McCartney, MD

Colon therapy *see* **Colonic irrigation**

Colonic irrigation

Definition

Colonic irrigation is also known as **hydrotherapy** of the colon, high colonic, entero-lavage, or simply colonic. It is the process of cleansing the colon by passing several gallons of water through it with the use of special equipment. It is similar to an enema but treats the whole colon, not just the lower bowel. This has the effect of flushing out impacted fecal matter, toxins, mucous, and even parasites that often build up over the passage of time. It is a procedure that should only be undertaken by a qualified practitioner.

Purpose

Anyone suffering from gas, bloating, cramping pains, **acne** and other skin complaints, arthritis, and a list of bowel complaints such as diverticulitis and irritable bowel etc., may benefit from colonic irrigation. In particular, **cancer** patients are often advised to undertake a course of colonic irrigation sessions as an essential part of their treatment. When a biological cancer therapy begins to enable the body to breakdown a cancerous mass, it is essential that speedy and effective elimination of the resulting toxins is achieved.

Colon and bowel cancer is one of the leading causes of **death** in the United States, and alternative practitioners insist that it can be prevented by efficient hygiene procedures. Providing that care is taken to replace the natural organisms that flourish in the bowel, many health benefits can be expected from colonic irrigation. In general, alternative practitioners maintain that an ill-functioning bowel is the source of all disease, and therefore keeping it clean will be an effective protection against this.

Removing large amounts of toxic matter relieves the patient and can lead to the alleviation of symptoms such as arthritis, **chronic fatigue syndrome**, **candidiasis**, and a host of other illnesses. Properly executed, colonic irrigation can help restore normal peristaltic action to a sluggish bowel, thus reducing the need for more hydrotherapy treatments over time. In addition, removing the layer of fecal matter which coats the intestines in many individuals allows improved assimilation of the nutrients from foods and can alleviate symptoms of vitamin and other nutrient deficiencies. Many alternative health practitioners consider some form of hydrotherapy for the bowel to be essential in the treatment of degenerative diseases.

Description

Origins

Cleansing the colon with the use of hydrotherapy is not a new concept. Forms of colonic irrigation have been used successfully for decades to relieve chronic toxicity and even acute cases of toxemia.

Over time, many people develop a thick layer of fecal matter that coats their colon. It hardens and becomes impacted, reducing the efficiency of the bowel,

and in some cases, completely obstructing normal elimination of waste matter from the body. It is quite common for people to only have one bowel movement per day, and some as few as one or two per week.

Alternative practitioners advise that we probably should have one bowel movement for every meal that we eat. If not, then we are not eliminating wastes completely, and if input exceeds output, then we will surely suffer the consequences at some point.

Incomplete elimination of body wastes may result in the following, depending on where the deposits end up:

- sluggish system
- joint **pain** and arthritis
- irritable bowel syndrome
- diverticulitis
- **Crohn's disease**
- leaky gut syndrome
- heart problem
- migraine
- **allergies**
- bad breath
- acne and other skin problems such as psoriasis
- asthma
- early senility and **Alzheimer's disease**
- chronic **fatigue** syndrome
- cancer, particularly of the bowel
- multiple sclerosis

During colonic irrigation, a small speculum is passed into the patient's bowel through the rectum. This is attached to a tube, which leads to a machine that pumps temperature-controlled water into the colon at a controlled rate (to be controlled by either the practitioner or the patient). The temperature of the water should ideally be kept as close to body temperature as possible.

The patient will temporarily be filled with water up to the level of the entire colon. Patients say they can feel the water up under their ribs but that the process, although sometimes uncomfortable, is not painful. The amount of water will vary but will generally be in the region of between two and six liters (or quarts) at any one time. This triggers peristaltic action and the patient will begin to expel the water along with fecal matter back through the tube and into the machine.

The fecal matter is flushed out through a viewing tube, so that what is eliminated may be monitored. Quite often, unsuspected parasites are expelled, along with very old fecal material, very dark in color, which may have been in the colon for years. Some therapists comment that it looks like aging rubber.

KEY TERMS

Dysbiosis—The condition that results when the natural flora of the gut are thrown out of balance, such as when antibiotics are taken.

Peristalsis—The natural wave-like action of a healthy bowel that transports matter from one end of the bowel to the other.

Probiotics—Supplements of beneficial microorganisms that normally colonize the gut.

Toxemia—Poisoning of the blood.

During the treatment, the therapist will gently massage the patient's abdomen to help dislodge impacted fecal matter. In addition to massage, sometimes **acupressure**, **reflexology**, or lymphatic drainage techniques may be used to loosen deposits and stimulate the bowel. It is important that the right amount of water is used, as too much will cause discomfort and too little will be ineffective. If correctly done, colonic irrigation is not painful at all and some patients claim to sleep through their treatment.

Sanitation is vital to this process. The tubes and speculums used are generally disposable, but other parts of the machine, such as the viewing tube, must be sterilized after each patient.

Normally, a series of treatments will be required to achieve desired results regarding the elimination of impacted, decaying matter, and restoration of bowel regularity. Initially, only gas and recent fecal matter may be expelled. The residue attached to the colon wall is usually the result of years of neglect, and therapists say that one cannot expect complete relief in only one session.

Impacted fecal matter can cause an imbalance of the natural organisms that normally populate the bowel, causing what is known as dysbiosis. Under ideal conditions, the bowel is populated by a variety of naturally occurring organisms. It seems that the enzymes occurring in fresh fruit and vegetables encourage these beneficial organisms. One of the results of eating processed denatured foods is that this natural balance is upset, and food may begin to rot in the bowel instead of being processed.

Decomposing matter can cause a toxic condition and may lead to many health problems, as **constipation** causes backed up pollution of the body cells. The process of repair and elimination of wastes enters a downward spiral which at best will cause fatigue, lack of energy and

premature aging, and, at worst, can cause degenerative diseases, among them allergies, and even cancer and Alzheimer's disease.

The cost of colonic irrigation treatments varies, but is generally between $35–70 per session, which may last from 45 minutes to one hour. The cost of the machine itself ranges from $4,000–12,000, but again, it should be noted that only qualified therapists should conduct sessions.

Preparations

Most practitioners prefer that distilled or purified water is used for colonic irrigation, but others use sterilized tap water.

Precautions

It may be advisable to use a probiotic pessary after colonic irrigation, to ensure replacement of desirable natural flora. There are certain conditions that either partly or completely preclude the use of colonic irrigation, such as an active attack of Crohn's disease, bleeding ulcers, and hyperacidosis. If in doubt, a qualified practitioner should be consulted. Anyone suffering from these conditions should always notify the practitioner when receiving colonic irrigation treatments.

Side effects

Some allopathic practitioners claim that colonic irrigation flushes out essential electrolytes and friendly bacteria from the bowel and that it can be dangerous. Practitioners counter that this can easily be remedied with the use of probiotics, and that in any case, these possible disadvantages are easily offset by the benefits of having large amounts of putrefying matter, harmful organisms, and parasites removed from the system.

Research and general acceptance

Although many alternative health care practitioners swear by colonic irrigation, there is a large allopathic lobby that claims that there are no benefits to be had, and that there are dangers involved. However, there are many decades of records and research from the alternative health care community that indicate that this therapy may have a valuable place in the treatment of degenerative diseases and toxic conditions.

Resources

BOOKS

Bonk, Melinda, ed. *Alternative Medicine Yellow Pages.* Tiburon, CA: Future Medicine Publishing, Inc., 1994.

ORGANIZATIONS

California Colon Hygienist Society. 333 Miller Ave., Suite 1, Mill Valley, CA 94941. (415) 383-7224.

Intestinal Health Institute. 4427 East Fifth St., Tucson, AZ 85711. (520) 325-9686. info@sheilas.com. <http://www.sheilas.com>.

Patricia Skinner

Colonoscopy

Definition

Colonoscopy is a medical procedure where a long, flexible, tubular instrument called the colonoscope is used to view the entire inner lining of the colon (large intestine) and the rectum.

Purpose

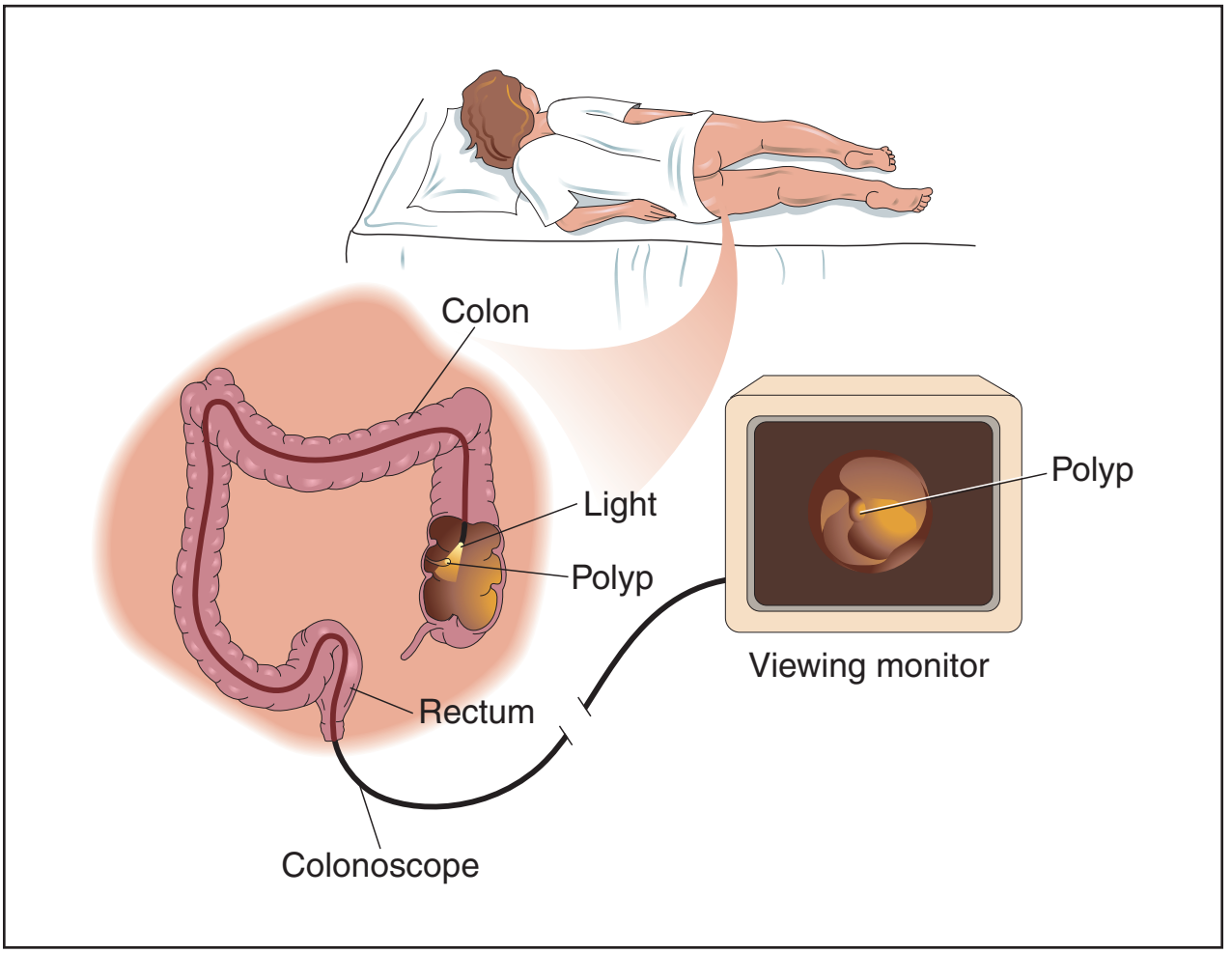
A colonoscopy is generally recommended when the patient complains of rectal bleeding or has a change in bowel habits and other unexplained abdominal symptoms. The test is frequently used to test for colorectal **cancer**, especially when polyps or tumor-like growths have been detected using the **barium enema** and other diagnostic tests. Polyps can be removed through the colonoscope and samples of tissue (biopsies) can be taken to test for the presence of cancerous cells.

The test also enables the physician to check for bowel diseases such as **ulcerative colitis** and **Crohn's disease**. It is a necessary tool in monitoring patients who have a past history of polyps or **colon cancer**.

Description

The procedure can be done either in the doctor's office or in a special procedure room of a local hospital. An intravenous (IV) line will be started in a vein in the arm. The patient is generally given a sedative and a painkiller through the IV line.

During the colonoscopy, the patient will be asked to lie on his/her left side with his/her knees drawn up towards the abdomen. The doctor begins the procedure by inserting a lubricated, gloved finger into the anus to check for any abnormal masses or blockage. A thin, well-lubricated colonoscope will then be inserted into the anus and it will be gently advanced through the colon. The lining of the intestine will be examined through the scope. Occasionally air may be pumped through the colonoscope to help clear the path or open the colon. If there are



Colonoscopy is a procedure where a long and flexible tubular instrument called a colonoscope is inserted into the patient's anus in order to view the lining of the colon and rectum. It is performed to test for colorectal cancer and other bowel diseases, and enables the physician to collect tissue samples for laboratory analysis. *(Illustration by Electronic Illustrators Group.)*

excessive secretions, stool, or blood that obstruct the viewing, they will be suctioned out through the scope. The doctor may press on the abdomen or ask the patient to change his/her position in order to advance the scope through the colon.

The entire length of the large intestine can be examined in this manner. If suspicious growths are observed, tiny biopsy forceps or brushes can be inserted through the colon and tissue samples can be obtained. Small polyps can also be removed through the colonoscope. After the procedure, the colonoscope is slowly withdrawn and the instilled air is allowed to escape. The anal area is then cleansed with tissues.

The procedure may take anywhere from 30 minutes to two hours depending on how easy it is to advance the scope through the colon. Colonoscopy can be a long and uncomfortable procedure, and the bowel cleaning preparation may be tiring and can produce **diarrhea** and cramping. During the colonoscopy, the sedative and the **pain** medications will keep the patient very drowsy and relaxed. Most patients complain of minor discomfort and pressure from the colonoscope moving inside. However, the procedure is not painful.

Preparation

The doctor should be notified if the patient has **allergies** to any medications or anesthetics; any bleeding problems; or if the woman is pregnant. The doctor should also be informed of all the medications that the person is currently on and if he or she has had a barium x-ray examination recently. If the patient has had heart valves replaced, the doctor should be informed so that appropriate **antibiotics** can be administered to prevent any chance of infection. The risks of the procedure will be

KEY TERMS

Barium enema—An x-ray test of the bowel after giving the patient an enema of a white chalky substance that outlines the colon and the rectum.

Biopsy—Removal of a tissue sample for examination under the microscope to check for cancer cells.

Colonoscope—A thin, flexible, hollow, lighted tube that in inserted through the rectum into the colon to enable the doctor to view the entire lining of the colon.

Crohn's disease—A chronic inflammatory disease where the immune system starts attacking one's own body. The disease generally starts in the gastrointestinal tract.

Diverticulosis—A pouchlike section that bulges through the large intestine's muscular walls but is not inflamed. It may cause bleeding, stomach distress and excess gas.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Polyps—An abnormal growth that develops on the inside of a hollow organ such as the colon.

Ulcerative colitis—A chronic condition where recurrent ulcers are found in the colon. It is manifested clinically by abdominal cramping, and rectal bleeding.

explained to the patient before performing the procedure and the patient will be asked to sign a consent form.

It is important that the colon be thoroughly cleaned before performing the examination. Hence, before the examination, considerable preparation is necessary to clear the colon of all stool. The patient will be asked to refrain from eating any solid food for 24–48 hours before the test. Only clear liquids such as juices, broth, and Jello are recommended. The patient is advised to drink plenty of water to avoid **dehydration**. The evening before the test, the patient will have to take a strong laxative that the doctor has prescribed. Several 1 qt **enemas** of warm tap water may have to be taken on the morning of the exam. Commercial enemas (e.g., Fleet) may be used.

The patient will be given specific instructions on how to use the enema and how many such enemas are necessary. Generally, the procedure has to be repeated until the return from the enema is clear of stool particles. On the morning of the examination, the patient is instructed not to eat or drink anything. The preparatory procedures are extremely important since, if the colon is not thoroughly clean, the exam cannot be done.

Aftercare

After the procedure, the patient is kept under observation until the effects of the medications wear off. The patient will have to be driven home by somebody and can generally resume a normal diet and usual activities unless otherwise instructed. The patient will be advised to drink lots of fluids to replace those lost by **laxatives** and **fasting**.

For a few hours after the procedure, the patient may feel groggy. There may be some abdominal cramping and considerable amount of gas may be passed. If a biopsy was performed or a polyp was removed, there may be small amounts of blood in the stool for a few days. If the patient experiences severe abdominal pain or has persistent and heavy bleeding, it should be brought to the doctor's attention immediately.

Risks

The procedure is virtually free of any complications and risks. Very rarely (two in 1000 cases) there may be a perforation (a hole) in the intestinal wall. Heavy bleeding due to the removal of the polyp or from the biopsy site occurs very infrequently (one in 1000 cases). Infections due to a colonoscopy are also extremely rare. Patients with artificial or abnormal heart valves are usually given antibiotics before and after the procedure to prevent an infection.

Normal results

The results are said to be normal if the lining of the colon is a pale reddish pink and there are no abnormal looking masses that are found in the lining of the colon.

Abnormal results

Abnormal results would imply that polyps or other suspicious-looking masses were detected in the lining of the intestine. Polyps can be removed during the procedure and tissue samples can be biopsied. If cancerous cells are detected in the tissue samples, then a diagnosis of colon cancer is made. The pathologist analyzes the tumor cells further to estimate the aggressiveness of the tumor and the extent of spread of the disease. This is crucial before deciding on the mode of treatment for the disease. Abnormal findings could also be due to inflam-

matory bowel diseases such as ulcerative colitis or Crohn's disease. A condition called diverticulosis, where many small fingerlike pouches protrude from the colon wall, may also contribute to an abnormal result in the colonoscopy.

Resources

BOOKS

Berkow, Robert, et al., eds. *Merck Manual of Diagnosis and Therapy.* 16th ed. Merck Research Laboratories, 1992.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Sobel, David S., and T. Ferguson. *The People's Book of Medical Tests*. Summit Books, 1985.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute. 681 Fifth Ave., New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. <http://www.uoa.org>.

Lata Cherath, PhD

Color blindness

Definition

Color blindness is an abnormal condition characterized by the inability to clearly distinguish different colors of the spectrum. The difficulties can be mild to severe. It is a misleading term because people with color blindness are not blind. Rather, they tend to see colors in a limited range of hues; a rare few may not see colors at all.

Description

Normal color vision requires the use of specialized receptor cells called cones, which are located in the retina of the eye. There are three types of cones, termed red, blue, and green, which enable people to see a wide spectrum of colors. An abnormality, or deficiency, of any of the types of cones will result in abnormal color vision.

There are three basic variants of color blindness. Red/green color blindness (deuteranopia) is the most common deficiency, affecting 8% of Caucasian males and 0.5% of Caucasian females. The prevalence varies with culture.

Blue color blindness (protanopia) is an inability to distinguish both blue and yellow, which are seen as white or gray. Protanopia is quite rare and has equal prevalence in males and females. It is common for young children to have blue/green confusion that becomes less pronounced in adulthood. Blue color deficiency often appears in people who have physical disorders such as liver disease or **diabetes mellitus**.

A total inability to distinguish colors (achromatopsia) is exceedingly rare. These affected individuals view the world in shades of gray. They frequently have poor visual acuity and are extremely sensitive to light (photophobia), which causes them to squint in ordinary light.

Researchers studying red/green color blindness in the United Kingdom reported an average prevalence of only 4.7% in one group. Only 1% of Eskimo males are color blind. Approximately 2.9% of boys from Saudi Arabia and 3.7% from India were found to have deficient color vision. Red/green color blindness may slightly increase an affected person's chances of contracting **leprosy**. Pre-term infants exhibit an increased prevalence of blue color blindness. Achromatopsia has a prevalence of about 1 in 33,000 in the United States and affects males and females equally.

Causes and symptoms

Red/green and blue color blindness appear to be located on at least two different gene locations. The majority of affected individuals are males. Females are carriers, but are not normally affected. This indicates that the X chromosome is one of the locations for color blindness. Male offspring of females who carry the altered gene have a 50-50 chance of being color-blind. The rare female that has red/green color blindness, or rarer still, blue color blindness, indicates there is an involvement of another gene. As of 2001, the location of this gene has not been identified.

Achromatopsia, the complete inability to distinguish color, is an autosomal recessive disease of the retina. This means that both parents have one copy of the altered gene but do not have the disease. Each of their children has a 25% chance of not having the gene, a 50% chance of having one altered gene (and, like the parents, being unaffected), and a 25% risk of having both the altered gene and the condition. In 1997, the achromatopsia gene was located on chromosome 2.

The inability to correctly identify colors is the only sign of color blindness. It is important to note that people with red/green or blue varieties of color blindness use other cues such as color saturation and object shape or location to distinguish colors. They can often distinguish

KEY TERMS

Achromatopsia—The inability to distinguish any colors.

Cones—Receptor cells that allow the perception of colors.

Deuteranopia—The inability or difficulty in distinguishing red/green colors.

Photophobia—An extreme sensitivity to light.

Protanopia—The inability of difficulty in distinguishing blue and yellow colors.

Retina—The light-sensitive layer of tissue in the back of the eye that receives and transmits visual signals to the brain through the optic nerve.

Rod—Photoreceptor that is highly sensitive to low levels of light and transmits images in shades of gray.

red or green if they can visually compare the colors. However, most have difficulty accurately identifying colors without any other references. Most people with any impairment in color vision learn colors, as do other young children. These individuals often reach adolescence before their visual deficiency is identified.

Color blindness is sometimes acquired. Chronic illnesses that can lead to color blindness include **Alzheimer's disease**, diabetes mellitus, **glaucoma**, leukemia, liver disease, chronic **alcoholism**, **macular degeneration**, **multiple sclerosis**, **Parkinson's disease**, sickle cell anemia, and **retinitis pigmentosa**. Accidents or strokes that damage the retina or affect particular areas of the brain eye can lead to color blindness. Some medications such as **antibiotics**, **barbiturates**, anti-tuberculosis drugs, high blood pressure medications, and several medications used to treat nervous disorders and psychological problems may cause color blindness. Industrial or environmental chemicals such as carbon monoxide, carbon disulfide, fertilizers, styrene, and some containing lead can cause loss of color vision. Occasionally, changes can occur in the affected person's capacity to see colors after age 60.

Diagnosis

There are several tests available to identify problems associated with color vision. The most commonly used is the American Optical/Hardy, Rand, and Ritter Pseudoisochromatic test. It is composed of several discs filled with colored dots of different sizes and colors. A person with normal color vision looking at a test item sees a number that is clearly located somewhere in the center of a circle of variously colored dots. A color-blind person is not able to distinguish the number.

The Ishihara test is comprised of eight plates that are similar to the American Optical Pseudoisochromatic test plates. The individual being tested looks for numbers among the various colored dots on each test plate. Some plates distinguish between red/green and blue color blindness. Individuals with normal color vision perceive one number. Those with red/green color deficiency see a different number. Those with blue color vision see yet a different number.

A third analytical tool is the Titmus II Vision Tester Color Perception test. The subject looks into a stereoscopic machine. The test stimulus most often used in professional offices contains six different designs or numbers on a black background, framed in a yellow border. Titmus II can test one eye at a time. However, its value is limited because it can only identify red/green deficiencies and is not highly accurate.

Treatment

There is no treatment or cure for color blindness. Most color vision deficient persons compensate well for their abnormality and usually rely on color cues and details that are not consciously evident to persons with typical color vision.

Inherited color blindness cannot be prevented. In the case of some types of acquired color deficiency, if the cause of the problem is removed, the condition may improve with time. But for most people with acquired color blindness, the damage is usually permanent.

Prognosis

Color blindness that is inherited is present in both eyes and remains constant over an individual's entire life. Some cases of acquired color vision loss are not severe, may appear in only one eye, and last for only a short time. Other cases tend to be progressive, becoming worse with time.

Resources

BOOKS

Rosenthal, Odeda, and Robert H. Phillips. *Coping with Color Blindness*. Garden City Park, NY: Avery Publishing Group, 1997.

Sacks, Oliver. *The Island of the Colorblind.* New York, Knopf, 1997.

Wiggs, Janey L. "Color Vision." In: *Ophthalmology,* ed. Myron Yanoff and Jay S. Duker. St. Louis, Mosby, 2000.

PERIODICALS

Arbour NC; Zlotogora J; Knowlton RG; Merin S; Rosenmann A; Kanis AB; Rokhlina T; Stone EM; Sheffield VC. "Homozygosity Mapping of Achromatopsia to Chromosome 2 Using DNA Pooling." *Human Molecular Genetics* 1997 May; 6(5): 689-694.

Dobson V; Quinn GE; Abramov I; Hardy RJ; Tung B; Siatkowski RM; Phelps DL. "Color Vision Measured with Pseudoisochromatic Plates at Five-and-a-Half Years in Eyes of Children from the CRYO-ROP Study." *Investigations in Ophthalmology and Visual Science (Nov 1996); 37(12): 2467-2474*.

Holroyd E; Hall DM. "A Re-Appraisal of Screening for Colour Vision Impairments." *Child Care Health Developments (Sep 1997); 23(5): 391-398*.

Osuobeni EP. "Prevalence of Congenital Red-Green Color Vision Defects in Arab Boys from Riyadh, Saudi Arabia." *Ophthalmic Epidemiology (Dec 1996); 3(3): 167-170*.

ORGANIZATIONS

Achromatopsia Network. C/O Frances Futterman, PO Box 214, Berkeley, CA 94701-0214. <http://www.achromat.org/how_to_join.html>.

American Academy of Ophthalmology. PO Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. <http://www.eyenet.org>.

International Colour Vision Society: Forschungsstelle fuer Experimentelle Ophthalmologie. Roentgenweg 11, Tuebingen, D-72076. Germany <http://orlab.optom.unsw.edu.au/ICVS>.

National Society to Prevent Blindness. 500 East Remington Rd., Schaumburg, IL 60173. (708) 843-2020 or (800) 331-2020. <http://www.preventblindness.org>.

OTHER

"Breaking the Code of Color." *Seeing, Hearing and Smelling the World*. <http://www.hhmi.org/senses/b/b130.htm>.

"Color Blindness." *Geocities*. <http://www.geocities.com/Heartland/8833/coloreye.html>.

"Medical Encyclopedia: Colorblind." *MEDLINEplus*. <http://medlineplus.adam.com/ency/article/001002sym.htm>.

University of Manchester. <http://www.umist.ac.uk/UMIST_OVS/welcome.html>.

University of Nevada–Reno. <http://www.delamare.unr.edu/cb/>.

L. Fleming Fallon, Jr., MD, MPH

Colorectal cancer *see* **Colon cancer; Rectal cancer**

Colostomy

Definition

Ostomy is a surgical procedure used to create an opening for urine and feces to be released from the body. Colostomy refers to a surgical procedure where a portion of the large intestine is brought through the abdominal wall to carry stool out of the body.

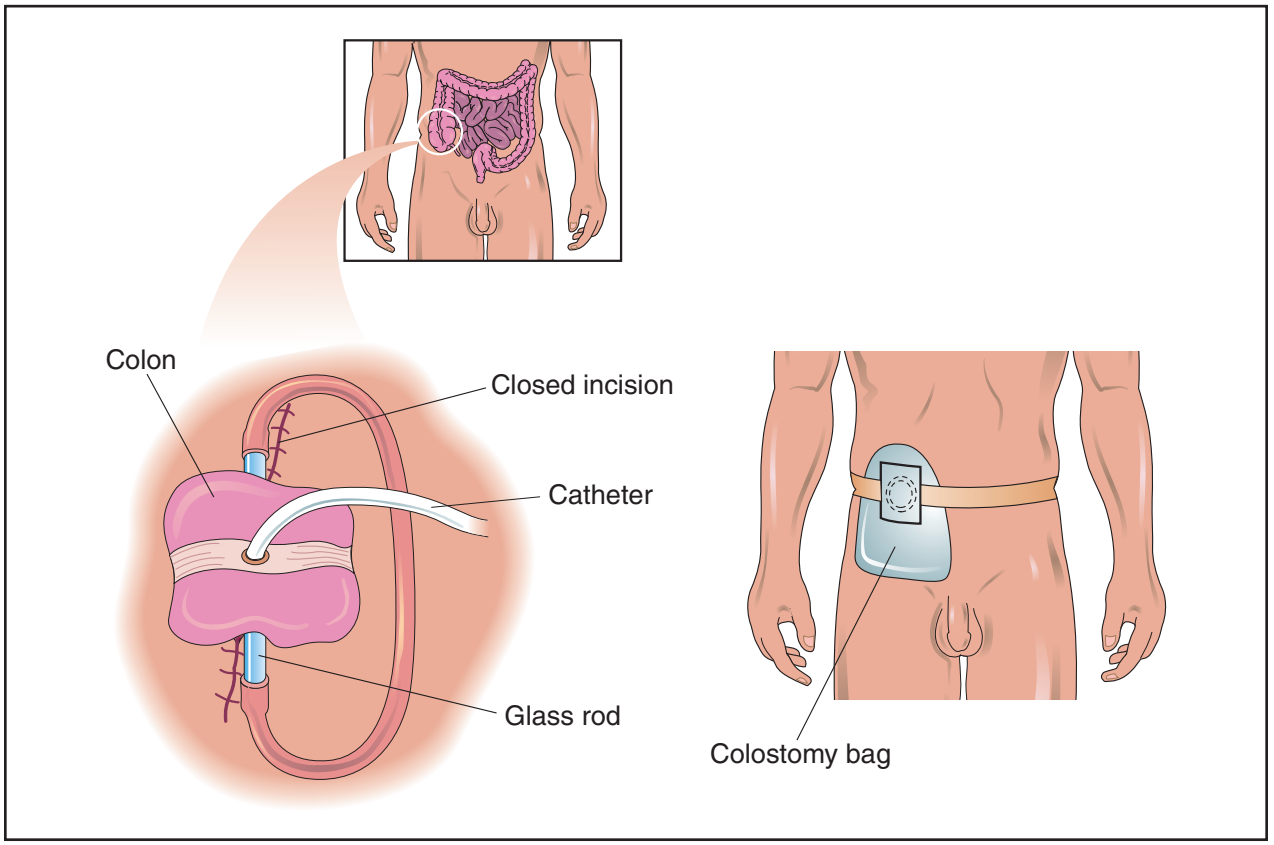
Purpose

A colostomy is created as a means to treat various disorders of the large intestine, including **cancer**, obstruction, inflammatory bowel disease, ruptured diverticulum, **ischemia** (compromised blood supply), or traumatic injury. Temporary colostomies are created to divert stool from injured or diseased portions of the large intestine, allowing rest and healing. Permanent colostomies are performed when the distal bowel (bowel at the farthest distance) must be removed or is blocked and inoperable. Although colorectal cancer is the most common indication for a permanent colostomy, only about 10–15% of patients with this diagnosis require a colostomy.

Description

Surgery will result in one of three types of colostomies:

- End colostomy. The functioning end of the intestine (the section of bowel that remains connected to the upper gastrointestinal tract) is brought out onto the surface of the abdomen, forming the stoma by cuffing the intestine back on itself and suturing the end to the skin. A stoma is an artificial opening created to the surface of the body. The surface of the stoma is actually the lining of the intestine, usually appearing moist and pink. The distal portion of bowel (now connected only to the rectum) may be removed, or sutured closed and left in the abdomen. An end colostomy is usually a permanent ostomy, resulting from trauma, cancer or another pathological condition.
- Double–barrel colostomy. This colsotomy involves the creation of two separate stomas on the abdominal wall. The proximal (nearest) stoma is the functional end that is connected to the upper gastrointestinal tract and will drain stool. The distal stoma, connected to the rectum and also called a mucous fistula, drains small amounts of mucus material. This is most often a temporary colostomy performed to rest an area of bowel, and to be later closed.
- Loop colostomy. This colostomy is created by bringing a loop of bowel through an incision in the abdominal wall. The loop is held in place outside the abdomen by a plastic rod slipped beneath it. An incision is made in the bowel to allow the passage of stool through the loop colostomy. The supporting rod is removed approximately 7-10 days after surgery, when healing has occurred that will prevent the loop of bowel from



A colostomy is a surgical procedure in which a portion of the large intestine, or colon, is brought through the abdominal wall to carry feces out of the body. There are three types of colostomies: end colostomy, double-barrel colostomy, and loop colostomy. The loop colostomy is featured in the illustration above. *(Illustration by Electronic Illustrators Group.)*

retracting into the abdomen. A loop colostomy is most often performed for creation of a temporary stoma to divert stool away from an area of intestine that has been blocked or ruptured.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiograph (EKG), may be ordered as the doctor deems necessary. If possible, the patient should visit an enterostomal therapist, who will mark an appropriate place on the abdomen for the stoma, and offer pre-operative education on ostomy management.

In order to empty and cleanse the bowel, the patient may be placed on a low residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing by mouth after midnight. A series of **enemas** and/or oral preparations (GoLytely or Colyte) may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent post-operative infection. A nasogastric tube is inserted from the nose to the stomach on the day of surgery or during surgery to remove gastric secretions and prevent **nausea and vomiting**. A urinary catheter (a thin plastic tube) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

Aftercare

Post-operative care for the patient with a new colostomy, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience **pain** that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed

for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction until bowel activity resumes. For the first 24–48 hours after surgery, the colostomy will drain bloody mucus. Fluids and electrolytes are infused intravenously until the patient's diet is can gradually be resumed, beginning with liquids. Usually within 72 hours, passage of gas and stool through the stoma begins. Initially the stool is liquid, gradually thickening as the patient begins to take solid foods. The patient is usually out of bed in 8–24 hours after surgery and discharged in 2–4 days.

A colostomy pouch will generally have been placed on the patient's abdomen, around the stoma, during surgery. During the hospital stay, the patient and his or her caregivers will be educated on how to care for the colostomy. Determination of appropriate pouching supplies and a schedule of how often to change the pouch should be established. Regular assessment and meticulous care of the skin surrounding the stoma is important to maintain an adequate surface on which to apply the pouch. Some patients with colostomies are able to routinely irrigate the stoma, resulting in regulation of bowel function; rather than needing to wear a pouch, these patients may need only a dressing or cap over their stoma. Often, an enterostomal therapist will visit the patient at home after discharge to help with the patient's resumption of normal daily activities.

KEY TERMS

Diverticulum—Pouches that project off the wall of the intestine, visible as opaque on an x ray after the patient has swallowed a contrast (dye) substance.

Embolism—Blockage of a blood vessel by any small piece of material traveling in the blood. The emboli may be caused by germs, air, blood clots, or fat.

Enema—Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

Intestine—Commonly called the bowels, divided into the small and large intestine. They extend from the stomach to the anus. The small intestine is about 20 ft (6 m) long. The large intestine is about 5 ft (1.5 m) long.

Ischemia—A compromise in blood supply delivered to body tissues that causes tissue damage or death.

Ostomy—A surgically created opening in the abdomen for elimination of waste products (urine or stool).

Risks

Potential complications of colostomy surgery include:

- excessive bleeding
- surgical wound infection
- thrombophlebitis (inflammation and blood clot to veins in the legs)
- pneumonia
- pulmonary **embolism** (blood clot or air bubble in the lungs' blood supply)

Normal results

Complete healing is expected without complications. The period of time required for recovery from the surgery may vary depending of the patient's overall health prior to surgery. The colostomy patient without other medical complications should be able to resume all daily activities once recovered from the surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, **dizziness,** or **fever**
- increased abdominal pain or swelling, **constipation**, nausea or vomiting or black, tarry stools

Stomal complications to be monitored include:

- Death (necrosis) of stomal tissue. Caused by inadequate blood supply, this complication is usually visible 12–24 hours after the operation and may require additional surgery.
- Retraction (stoma is flush with the abdomen surface or has moved below it). Caused by insufficient stomal length, this complication may be managed by use of special pouching supplies. Elective revision of the stoma is also an option.
- Prolapse (stoma increases length above the surface of the abdomen). Most often results from an overly large opening in the abdominal wall or inadequate fixation of the bowel to the abdominal wall. Surgical correction is required when blood supply is compromised.
- Stenosis (narrowing at the opening of the stoma). Often associated with infection around the stoma or scarring. Mild stenosis can be removed under local anesthesia.

Severe stenosis may require surgery for reshaping the stoma.

- Parastomal **hernia** (bowel causing bulge in the abdominal wall next to the stoma). This is due to placement of the stoma where the abdominal wall is weak or creation of an overly large opening in the abdominal wall. The use of an ostomy support belt and special pouching supplies may be adequate. If severe, the defect in the abdominal wall should be repaired and the stoma moved to another location.

Resources

BOOKS

Doughty, Dorothy. *Urinary and Fecal Incontinence*. St. Louis: Mosby-Year Book, Inc., 1991.

Hampton, Beverly, and Ruth Bryant. *Ostomies and Continent Diversions*. St. Louis: Mosby-Year Book, Inc., 1992.

Monahan, Frances. *Medical-Surgical Nursing*. Philadelphia: W. B. Saunders Co., 1998.

Suddarth, Doris. *The Lippincott Manual of Nursing*. Philadelphia: J. B. Lippincott, 1991.

ORGANIZATIONS

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. <http://www.uoa.org>.

Wound Ostomy and Continence Nurses Society. 1550 South Coast Highway, Suite #201 Laguna Beach, CA 92651.

OTHER

"Colostomy." *ThriveOnline*. 20 Apr. 1998 <http://thriveonline.oxygen.com>.

Kathleen D. Wright, RN

Colposcopy

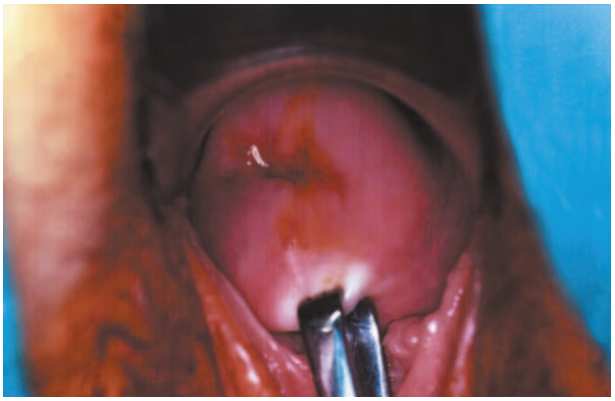
Definition

Colposcopy is a procedure that allows a physician to take a closer look at a woman's cervix and vagina using a special instrument called a colposcope. It is used to check for precancerous or abnormal areas. The colposcope can magnify the area between 10 and 40 times; some devices also can take photographs.

Purpose

The colposcope helps to identify abnormal areas of the cervix or vagina so that small pieces of tissue (biopsies) can be taken for further analysis.

Colposcopy is used to identify or rule out the existence of any precancerous conditions in the cervical tissue. If a **PAP test** shows abnormal cell growth, further testing, such as colposcopy, often is required. A PAP test is a screening test that involves scraping cells from the outside of the cervix. If abnormal cells are found, the physician will attempt to find the area that produced the abnormal cells and remove it for further study (biopsy). Only then can a diagnosis be made.



A colposcopy makes it possible for a physician to view this healthy cervix without surgery. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

Colposcopy may also be performed if the cervix looks abnormal during a routine examination. It may also be suggested for women with **genital warts** and for diethylstilbestrol (DES) daughters (women whose mothers took DES when pregnant with them).

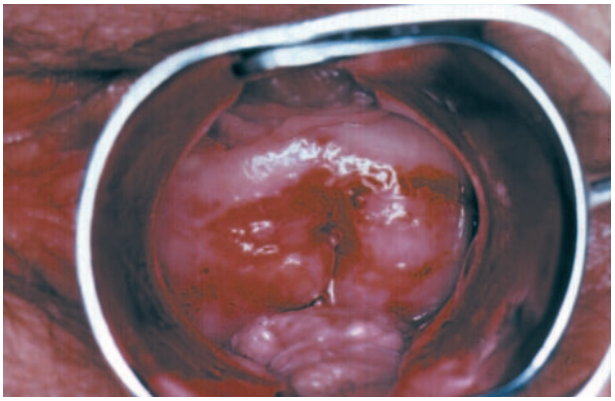
Precautions

Women who are pregnant, or who suspect that they are pregnant, must tell their doctor before the procedure begins. Pregnant women can, and should, have a colposcopy if they have an abnormal PAP test. However, special precautions must be taken during biopsy of the cervix.

Description

A colposcopy is performed in a physician's office and is similar to a regular gynecologic exam. An instrument called a speculum is used to hold the vagina open, and the gynecologist looks at the cervix and vagina through the colposcope instead simply by eye, as in a routine examination.

The colposcope is placed outside the patient's body and never touches the skin. The cervix and vagina are swabbed with dilute acetic acid (vinegar). The solution highlights abnormal areas by turning them white (instead of a normal pink color). Abnormal areas can also be identified by looking for a characteristic pattern made by abnormal blood vessels.



This colposcopic view of the cervix reveals CIN 2 dysplasia, or abnormal growth of cells. This is the second stage in the development of cervical cancer. *(Custom Medical Stock Photo. Reproduced by permission.)*

If any abnormal areas are seen, the doctor will take a biopsy of the tissue, a common procedure that takes about 15 minutes. Several samples might be taken, depending on the size of the abnormal area. A biopsy may cause temporary discomfort and cramping, which usually go away within a few minutes. If the abnormal area appears to extend inside the cervical canal, a scraping of the canal may be done. The biopsy results are usually available within a week.

If the tissue sample indicates abnormal growth (dysplasia) or precancer, and if the entire abnormal area can be seen, the doctor can destroy the tissue using one of several procedures, including ones that use high heat (diathermy), extreme cold (cryosurgery), or lasers. Another procedure, called a loop electrosurgical excision (LEEP), uses low-voltage high-frequency radio waves to excise tissue. If any of the abnormal tissue is within the cervical canal, a cone biopsy (removal of a conical section of the cervix for inspection) will be needed.

Preparation

Colposcopy is a painless procedure that does not require any anesthetic medication. If a biopsy is done, there may be mild cramps or a sharp pinching when the tissue is removed. To lessen this **pain**, your doctor may recommend 800 mg of ibuprofen (Motrin) taken the night before and the morning of the procedure (no later than 30 minutes before the appointment). Patients who are pregnant or allergic to **aspirin** or ibuprofen can take two tablets of **acetaminophen** (Tylenol) instead.

Aftercare

If a biopsy was done, there may be a dark vaginal discharge afterwards. After the sample is removed, the doctor applies Monsel's solution to the area to stop the bleeding. When this mixes with blood it creates a black fluid that looks like coffee grounds for a couple of days after the procedure. It is also normal to have some spotting after a colposcopy.

Patients should not use tampons or put anything else in the vagina for at least a week after the procedure, or until the doctor says it's safe. In addition, women should

KEY TERMS

Biopsy—Removal of sample of abnormal tissue for more extensive examination under a microscope.

Cervix—The neck of the uterus.

Cryosurgery—Freezing and destroying abnormal cells.

DES—The abbreviation for diethylstilbestrol, a synthetic form of estrogen that was widely prescribed to women from 1940 to 1970 to prevent complications. It was linked to several serious birth defects and disorders of the reproductive system in daughters of women who took DES. In 1971, the FDA suggested it not be used during pregnancy and banned its use in 1979 as a growth promoter in livestock.

Diathermy—Also called electrocautery, this is a procedure that heats and destroys abnormal cells. It is gradually being replaced by cryosurgery, lasers, or LEEP.

Human papilloma virus—A virus that causes common warts of the hands and feet, as well as lesions in the genital and vaginal area. More than 50 types of HPV have been identified, some of which are linked to cancerous and precancerous conditions, including cancer of the cervix.

Loop electrosurgical excision (LEEP)—A procedure that can help diagnose and treat cervical abnormalities, using a thin wire loop that emits a low-voltage high-frequency radio wave that can excise tissue. It is considered better than either lasers or electrocautery because it can both diagnose and treat precancerous cells or early stage cancer at the same time.

PAP test—The common term for the Papanicolaou test, a simple smear method of examining stained cells to detect cancer of the cervix.

Speculum—A retractor used to separate the walls of the vagina to make visual examination easier.

not have sex or douche for at least a week after the procedure because of the risk of infection.

Risks

Occasionally, patients may have bleeding or infection after biopsy. Bleeding is usually controlled with a topical medication.

A patient should call her doctor right away if she notices any of the following symptoms:

- heavy vaginal bleeding (more than one sanitary pad an hour)
- fever, chills, or an unpleasant vaginal odor
- lower abdominal pain.

Normal results

If visual inspection shows that the surface of the cervix is smooth and pink, this is considered normal. If abnormal areas are found and biopsied and the results show no indication of **cancer**, a precancerous condition, or other disease, this also is considered normal.

Abnormal results

Abnormal conditions that can be detected using colposcopy and biopsy include precancerous tissue changes (cervical dysplasia), cancer, and cervical **warts** (human papilloma virus).

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1995.

ORGANIZATIONS

American Society for Colposcopy and Cervical Pathology. 20 W. Washington St., Ste. #1, Hagerstown, MD 21740. (800) 787-7227. <http://www.asccp.org>.

Carol A. Turkington

Coma

Definition

Coma, from the Greek word "koma," meaning deep sleep, is a state of extreme unresponsiveness, in which an individual exhibits no voluntary movement or behavior. Furthermore, in a deep coma, even painful stimuli (actions which, when performed on a healthy individual, result in reactions) are unable to affect any response, and normal reflexes may be lost.

Description

Coma lies on a spectrum with other alterations in consciousness. The level of consciousness required by, for example, someone reading this passage lies at one extreme end of the spectrum, while complete brain **death** lies at the other end of the spectrum. In between are such states as obtundation, drowsiness, and stupor. All of these are conditions which, unlike coma, still allow the individual to respond to stimuli, although such a response may be brief and require stimulus of greater than normal intensity.

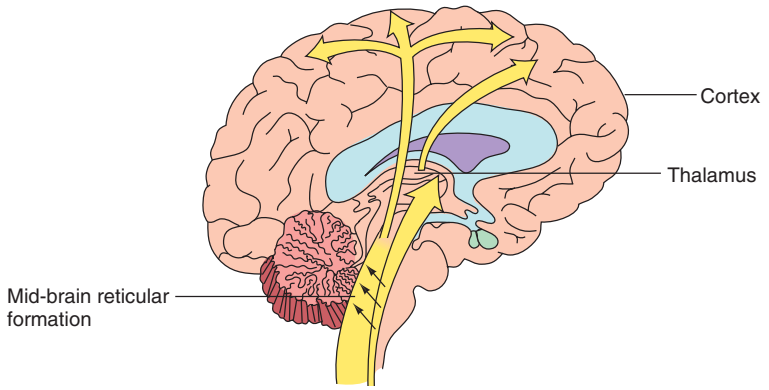
In order to understand the loss of function suffered by a comatose individual, it is necessary to first understand the important characteristics of the conscious state. Consciousness is defined by two fundamental elements: awareness and arousal.

Awareness allows one to receive and process all the information communicated by the five senses, and thus relate to oneself and to the outside world. Awareness has both psychological and physiological components. The psychological component is governed by an individual's mind and mental processes. The physiological component refers to the functioning of an individual's brain, and therefore that brain's physical and chemical condition. Awareness is regulated by cortical areas within the cerebral hemispheres, the outermost layer of the brain that separates humans from other animals by allowing for greater intellectual functioning.

Arousal is regulated solely by physiological functioning and consists of more primitive responsiveness to the world, as demonstrated by predictable reflex (involuntary) responses to stimuli. Arousal is maintained by the reticular activating system (RAS). This is not an anatomical area of the brain, but rather a network of structures (including the brainstem, the medulla, and the thalamus) and nerve pathways, which function together to produce and maintain arousal.

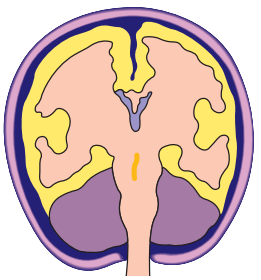
Causes and symptoms

Coma, then, is the result of something that interferes with the functioning of the cerebral cortex and/or the functioning of the structures which make up the RAS. In fact, a huge and varied number of conditions can result in coma. A good way of categorizing these conditions is to consider the anatomic and the metabolic causes of coma. Anatomic causes of coma are those conditions that disrupt the normal physical architecture of the brain structures responsible for consciousness, either at the level of



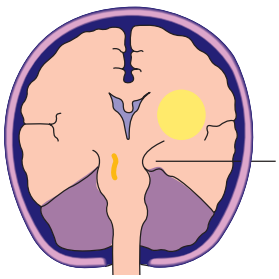
A side-view of the brain, showing movement of the reticular activating substance (RAS) essential to consciousness

Diffuse and bilateral damage to the cerebral cortex (relative preservation of brain-stem reflexes)

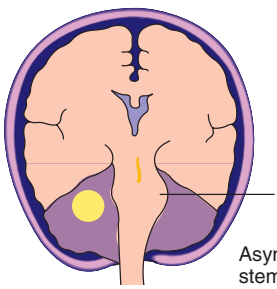


Possible causes
- Damage due to lack of oxygen or restricted blood flow, perhaps resulting from cardiac arrest, an anaesthetic accident, or shock
- Damage incurred from metabolic processes associated with kidney or liver failure, or with hypoglycemia
- Trauma damage
- Damage due to a bout with meningitis, encephalomyelitis, or a severe systemic infection

Mass lesions in this region resulting in compression of the brain-stem and damage to the reticular activating substance (RAS)

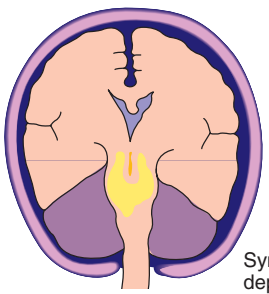


Structural lesions within this region also resulting in compression of the brain-stem and damage to the reticular activating substance (RAS)



Possible causes • Cerebellar tumors, abscesses, or hemorrhages

Lesions within the brain-stem directly suppressing the reticular activating substance (RAS)



Possible causes • Drug overdosage

The four brain conditions that result in coma. *(Illustration by Hans & Cassady.)*

KEY TERMS

Anatomic—Related to the physical structure of an organ or organism.

Metabolic—Refers to the chemical processes of an organ or organism.

Neuron—The cells within the body which make up the nervous system, specifically those along which information travels.

Physiological—Pertaining to the functioning of an organ, as governed by the interactions between its physical and chemical conditions.

Psychological—Pertaining to the mind, its mental processes, and its emotional makeup.

Stimulus/stimuli—Action or actions performed on an individual which predictably provoke(s) a reaction.

the cerebal cortex or the brainstem, while metabolic causes of coma consist of those conditions that change the chemical environment of the brain, thereby adversely affecting function.

There are many metabolic causes of coma, including:

- A decrease in the delivery to the brain of substances necessary for appropriate brain functioning, such as oxygen, glucose (sugar), and sodium.
- The presence of certain substances that disrupt the functioning of neurons. Drugs or alcohol in toxic quantities can result in neuronal dysfunction, as can substances normally found in the body, but that, due to some diseased state, accumulate at toxic levels. Accumulated substances that might cause coma include ammonia due to liver disease, ketones due to uncontrolled diabetes, or carbon dioxide due to a severe **asthma** attack.
- The changes in chemical levels in the brain due to the electrical derangements caused by seizures.

Diagnosis

As in any neurologic condition, history and examination form the cornerstone of diagnosis when the patient is in a coma; however, history must be obtained from family, friends, or EMS. The Glasgow Coma Scale is a system of examining a comatose patient. It is helpful for evaluating the depth of the coma, tracking the patient's progress, and predicting (somewhat) the ultimate outcome of the coma. The Glasgow Coma Scale assigns a different number of points for exam results in three different categories: opening the eyes, verbal response (using words or voice to respond), and motor response (moving a part of the body). Fifteen is the largest possible number of total points, indicating the highest level of functioning. The highest level of functioning would be demonstrated by an individual who spontaneously opens his/her eyes, gives appropriate answers to questions about his/her situation, and can carry out a command (such as "move your leg" or "nod your head"). Three is the least possible number of total points and would be given to a patient for whom not even a painful stimulus is sufficient to provoke a response. In the middle are those patients who may be able to respond, but who require an intense or painful stimulus, and whose response may demonstrate some degree of brain malfunctioning (such as a person whose only response to **pain** in a limb is to bend that limb in toward the body). When performed as part of the admission examination, a Glasgow score of three to five points often suggests that the patient has likely suffered fatal brain damage, while eight or more points indicates that the patient's chances for recovery are good. Expansion of the pupils and respiratory pattern are also important. Metabolic causes of coma are diagnosed from blood work and **urinalysis** to evaluate blood chemistry, drug screen, and blood cell abnormalities that may indicate infection. Anatomic causes of coma are diagnosed from **computed tomography scans** (CT) or **magnetic resonance imaging** (MRI) scans.

Treatment

Coma is a medical emergency, and attention must first be directed to maintaining the patient's respiration and circulation, using intubation aand ventilation, administration of intravenous fluids or blood as needed, and other supportive care. If head trama has not been excluded, the neck should be stablized in the event of fracture. It is obviously extremely important for a physician to determine quickly the cause of a coma, so that potentially reversible conditions are treated immediately. For example, an infection may be treated with **antibiotics**; a **brain tumor** may be removed; and brain swelling from an injury can be reduced with certain medications. Various metabolic disorders can be addressed by supplying the individual with the correct amount of oxygen, glucose, or sodium; by treating the underlying disease in liver disease, asthma, or diabetes; and by halting seizures with medication. Because of their low incidence of side effects and potential for prompt reversal of coma in certain conditions, glucose, the B-vitamin thiamine, and Narcan (to counteract any narcotic-type drugs) are routinely given.

Prognosis

Some conditions that cause coma can be completely reversed, restoring the individual to his or her original level of functioning. However, if areas of the brain have been sufficiently damaged due to the severity or duration of the condition which led to the coma, the individual may recover from the coma with permanent disabilities, or may even never regain consciousness. Take, for example, the situation of someone whose coma was caused by brain injury in a car accident. Such an injury can result in one of three outcomes. In the event of a less severe brain injury, with minimal swelling, an individual may indeed recover consciousness and regain all of his or her original abilities. In the event of a more severe brain injury, with swelling that resulted in further pressure on areas of the brain, an individual may regain consciousness, but may have some degree of impairment. The impairment may be physical (such as **paralysis** of a leg) or may even result in a change in the individual's intellectual functioning and/or personality. The most severe types of brain injury, short of death, result in states in which the individual loses all ability to function and remains deeply unresponsive. An individual who has suffered such a severe brain injury may remain in a coma indefinitely. This condition is termed persistent **vegetative state**.

Outcome from a coma is therefore quite variable and depends a great deal on the cause and duration of the coma. In the case of drug poisonings, extremely high rates of recovery can be expected following prompt medical attention. Patients who have suffered head injuries tend to do better than do patients whose coma was caused by other types of medical illnesses. Leaving out those people whose coma followed drug **poisoning**, only about 15% of patients who remain in a coma for more than just a few hours make a good recovery. Those adult patients who remain in a coma for greater than four weeks have almost no chance of eventually regaining their previous level of functioning. On the other hand, children and young adults have regained functioning even after two months in a coma.

Resources

BOOKS

Guberman, Alan. *An Introduction to Clinical Neurology.* Boston: Little, Brown and Co., 1994.

Liebman, Michael. *Neuroanatomy Made Easy and Understandable.* Baltimore: University Park Press, 1991.

Ropper, Allan H., and Joseph B. Martin. "Acute Confusional States and Coma." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Engeler, Amy. "A Life on Hold: What a Coma Really Looks Like." *Redbook*, July 1996, 72+.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Coma Recovery Association, Inc. 570 Elmont Rd., Suite 104, Elmont, NY 11003. (516) 355-0951.

Rosalyn Carson-DeWitt, MD

Combat neurosis *see* **Post-traumatic stress disorder**

Common cold

Definition

The common cold is a viral infection of the upper respiratory system, including the nose, throat, sinuses, eustachian tubes, trachea, larynx, and bronchial tubes. Although over 200 different viruses can cause a cold, 30–50% are caused by a group known as rhinoviruses. Almost all colds clear up in less than two weeks without complications.

Description

Colds, sometimes called rhinovirus or coronavirus infections, are the most common illness to strike any part of the body. It is estimated that the average person has more than 50 colds during a lifetime. Anyone can get a cold, although pre-school and grade school children catch them more frequently than adolescents and adults. Repeated exposure to viruses causing colds creates partial immunity.

Although most colds resolve on their own without complications, they are a leading cause of visits to the doctor and of time lost from work and school. Treating symptoms of the common cold has given rise to a multimillion dollar industry in over-the-counter medications.

Cold season in the United States begins in early autumn and extends through early spring. Although it is not true that getting wet or being in a draft causes a cold (a person has to come in contact with the virus to catch a cold), certain conditions may lead to increased susceptibility. These include:

- fatigue and overwork
- emotional **stress**
- poor **nutrition**
- **smoking**
- living or working in crowded conditions

Colds make the upper respiratory system less resistant to bacterial infection. Secondary bacterial infection may lead to middle ear infection, **bronchitis**, **pneumonia**, sinus infection, or **strep throat**. People with chronic lung disease, **asthma**, diabetes, or a weakened immune system are more likely to develop these complications.

Causes and symptoms

Colds are caused by more than 200 different viruses. The most common groups are rhinoviruses and coronaviruses. Different groups of viruses are more infectious at different seasons of the year, but knowing the exact virus causing the cold is not important in treatment.

People with colds are contagious during the first two to four days of the infection. Colds pass from person to person in several ways. When an infected person coughs, sneezes, or speaks, tiny fluid droplets containing the virus are expelled. If these are breathed in by other people, the virus may establish itself in their noses and airways.

Colds may also be passed through direct contact. If a person with a cold touches his runny nose or watery eyes, then shakes hands with another person some of the virus is transferred to the uninfected person. If that person then touches his mouth, nose, or eyes, the virus is transferred to an environment where it can reproduce and cause a cold.

Finally, cold viruses can be spread through inanimate objects (door knobs, telephones, toys) that become contaminated with the virus. This is a common method of transmission in child care centers. If a child with a cold touches his runny nose, then plays with a toy, some of the virus may be transferred to the toy. When another child plays with the toy a short time later, he may pick up some of the virus on his hands. The second child then touches his contaminated hands to his eyes, nose, or mouth and transfers some of the cold virus to himself.

Once acquired, the cold virus attaches itself to the lining of the nasal passages and sinuses. This causes the infected cells to release a chemical called histamine. Histamine increases the blood flow to the infected cells, causing swelling, congestion, and increased mucus production. Within one to three days the infected person begins to show cold symptoms.

The first cold symptoms are a tickle in the throat, runny nose, and sneezing. The initial discharge from the nose is clear and thin. Later it changes to a thick yellow or greenish discharge. Most adults do not develop a **fever** when they catch a cold. Young children may develop a low fever of up to 102°F (38.9°C).

In addition to a runny nose and fever, signs of a cold include coughing, sneezing, nasal congestion, **headache**, muscle ache, chills, **sore throat**, hoarseness, watery eyes, tiredness, and lack of appetite. The **cough** that accompanies a cold is usually intermittent and dry.

Most people begin to feel better four to five days after their cold symptoms become noticeable. All symptoms are generally gone within ten days, except for a dry cough that may linger for up to three weeks.

Colds make people more susceptible to bacterial infections such as strep throat, middle ear infections, and sinus infections. A person whose cold does not begin to improve within a week; or who experiences chest **pain**, fever for more than a few days, difficulty breathing, bluish lips or fingernails, a cough that brings up greenish-yellow or grayish sputum, skin rash, swollen glands, or whitish spots on the tonsils or throat should consult a doctor to see if they have acquired a secondary bacterial infection that needs to be treated with an antibiotic.

People who have **emphysema**, chronic lung disease, diabetes, or a weakened immune system—either from diseases such as **AIDS** or leukemia, or as the result of medications, (**corticosteroids**, **chemotherapy** drugs)—should consult their doctor if they get a cold. People with these health problems are more likely to get a secondary infection.

Diagnosis

Colds are diagnosed by observing a person's symptoms. There are no laboratory tests readily available to detect the cold virus. However, a doctor may do a **throat culture** or blood test to rule out a secondary infection.

Influenza is sometimes confused with a cold, but flu causes much more severe symptoms and generally a fever. **Allergies** to molds or pollens also can make the nose run. Allergies are usually more persistent than the common cold. An allergist can do tests to determine if the cold-like symptoms are being caused by an allergic reaction. Also, some people get a runny nose when they go outside in winter and breathe cold air. This type of runny nose is not a symptom of a cold.

Treatment

There are no medicines that will cure the common cold. Given time, the body's immune system will make antibodies to fight the infection, and the cold will be resolved without any intervention. **Antibiotics** are useless against a cold. However, a great deal of money is spent by pharmaceutical companies in the United States promoting products designed to relieve cold symptoms. These products usually contain **antihistamines**, **decongestants**, and/or pain relievers.

Antihistamines block the action of the chemical histamine that is produced when the cold virus invades the

cells lining the nasal passages. Histamine increases blood flow and causes the cells to swell. Antihistamines are taken to relieve the symptoms of sneezing, runny nose, itchy eyes, and congestion. Side effects are **dry mouth** and drowsiness, especially with the first few doses. Antihistamines should not be taken by people who are driving or operating dangerous equipment. Some people have allergic reactions to antihistamines. Common over-the-counter antihistamines include Chlor-Trimeton, Dimetapp, Tavist, and Actifed. The generic name for two common antihistamines are chlorpheniramine and diphenhydramine.

Decongestants work to constrict the blood flow to the vessels in the nose. This can shrink the tissue, reduce congestion, and open inflamed nasal passages, making breathing easier. Decongestants can make people feel jittery or keep them from sleeping. They should not be used by people with heart disease, high blood pressure, or **glaucoma**. Some common decongestants are Neo-Synepherine, Novafed, and Sudafed. The generic names of common decongestants include phenylephrine, phenylpropanolamine, pseudoephedrine, and in nasal sprays naphazoline, oxymetazoline and xylometazoline.

Many over the counter medications are combinations of both antihistamines and decongestants; an ache and pain reliever, such as **acetaminophen** (Datril, Tylenol, Panadol) or ibuprofen (Advil, Nuprin, Motrin, Medipren); and a cough suppressant (dextromethorphan). Common combination medications include Tylenol Cold and Flu, Triaminic, Sudafed Plus, and Tavist D. **Aspirin** should not be given to children with a cold because of its association with a risk of **Reye's syndrome**, a serious disease.

Nasal sprays and nose drops are other products promoted for reducing nasal congestion. These usually contain a decongestant, but the decongestant can act more quickly and strongly than ones found in pills or liquids because it is applied directly in the nose. Congestion returns after a few hours.

People can become dependent on nasal sprays and nose drops. If used for a long time, users may suffer withdrawal symptoms when these products are discontinued. Nasal sprays and nose drops should not be used for more than a few days. Check the label for recommendations on length and frequency of use.

People react differently to different cold medications and may find some more helpful than others. A medication may be effective initially, then lose some of its effectiveness. Children sometimes react differently than adults. Over-the-counter cold remedies should not be given to infants without consulting a doctor first.

Cold Remedies

	Symptoms	Side effects
Antihistamines	Congestion Itchy eyes Runny nose Sneezing Stuffy nose	Drowsiness Dry mouth and eyes
Decongestants	Congestion Stuffy nose	Insomnia Rapid heart beat Stimulation

Care should be taken not to exceed the recommended dosages, especially when combination medications or nasal sprays are taken. Individuals should determine whether they wish to use any of these drugs. None of them shorten or cure a cold. At best they help a person feel more comfortable. People who are confused about the drugs in any over-the-counter cold remedies should ask their pharmacist for an explanation.

In addition to the optional use of over the counter cold remedies, there are some self-care steps that people can take to ease their discomfort. These include:

- drinking plenty of fluids, but avoiding acidic juices, which may irritate the throat
- gargling with warm salt water—made by adding one teaspoon of salt to 8 oz of water—for a sore throat
- not smoking
- getting plenty of rest
- using a cool-mist room humidifier to ease congestion and sore throat
- rubbing Vaseline or other lubricant under the nose to prevent irritation from frequent nose blowing
- for babies too young to blow their noses, the mucus should be suctioned gently with an infant nasal aspirator, it may be necessary to soften the mucus first with a few drops of salt water

Alternative treatment

Alternative practitioners emphasize that people get colds because their immune systems are weak. They point out that everyone is exposed to cold viruses, but not everyone gets every cold. The difference seems to be in the ability of the immune system to fight infection. Prevention focuses on strengthening the immune system by eating a healthy diet low in sugars and high in fresh fruits and vegetables, practicing **meditation** to reduce stress, and getting regular moderate **exercise**.

Once cold symptoms appear, some naturopathic practitioners believe the symptoms should be allowed to

KEY TERMS

Bronchial tubes—The major airways to the lungs and their main branches.

Coronavirus—a genus of viruses that cause respiratory disease and gastroenteritis.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Eustachian tube—A thin tube between the middle ear and the pharnyx. Its purpose is to equalize pressure on either side of the ear drum.

Rhinovirus—A virus that infects the upper respiratory system and causes the common cold.

run their course without interference. Others suggest the following:

- Inhaling a steaming mixture of lemon oil, thyme oil, eucalyptus, and tea tree oil (*Melaleuca* spp.). (**Aromatherapy**)
- Gargling with a mixture of water, salt, and turmeric powder or astringents such as alum, sumac, sage, and bayberry to ease a sore throat. (**Ayurvedic medicine**)
- Taking coneflower (*Echinacea* spp.) or goldenseal (*Hydrastis canadensis*). Other useful herbs to reduce symptoms include yarrow (*Achillea millefolium*), eyebright (*Euphrasia officinalis*), garlic (*Allium sativum*), and onions (*Allium cepa*). (Herbal)
- Microdoses of *Viscue album*, *Natrum muriaticum*, *Allium cepa*, or *Nux vomica*. (**Homeopathy**)
- Taking yin chiao (sometimes transliterated as yinquiao) tablets that contain honeysuckle and forsythia when symptoms appear. Natural herb loquat syrup for cough and sinus congestion and Chinese ephedra (*ma-huang*) for runny nose. (Chinese traditional medicine)
- The use of zinc lozenges every two hours along with high doses of vitamin C is suggested. Some practitioners also suggest eliminating dairy products for the duration of the cold. (Nutritional therapy).

The use of zinc lozenges may be moving toward acceptance by practitioners of traditional medicine. In 1996 the Cleveland Clinic tested zinc gluconate lozenges and found using zinc in the first 24 hours after cold symptoms occurred shortened the duration of symptoms. The mechanism by which zinc worked was not clear, but additional studies are underway.

Prognosis

Given time, the body will make antibodies to cure itself of a cold. Most colds last a week to 10 days. Most people start feeling better within four or five days. Occasionally a cold will lead to a secondary bacterial infection that causes strep throat, bronchitis, pneumonia, sinus infection, or a middle ear infection. These conditions usually clear up rapidly when treated with an antibiotic.

Prevention

It is not possible to prevent colds because the viruses that cause colds are common and highly infectious. However, there are some steps individuals can take to reduce their spread. These include:

- washing hands well and frequently, especially after touching the nose or before handling food
- covering the mouth and nose when sneezing
- disposing of used tissues properly
- avoiding close contact with someone who has a cold during the first two to four days of their infection
- not sharing food, eating utensils, or cups with anyone
- avoiding crowded places where cold germs can spread
- eating a healthy diet and getting adequate sleep

Resources

BOOKS

Burton Goldberg Group. "Colds and Flu." In *Alternative Medicine: The Definitive Guide*, ed. James Strohecker. Puyallup, WA: Future Medicine Publishing, 1994.

Castleman, Michael. "Cold and Flu Therapy." In *Nature's Cures*. Emmaus, PA: Rodale Press, 1996.

Silverstein Alvin, et al. *Common Cold and Flu (Diseases and People)*. Springfield, MA: Enslow Publishers, 1996.

Tish Davidson

Common variable immunodeficiency

Definition

Common variable **immunodeficiency** is an immunodeficiency disorder characterized by a low level of antibodies. Patients with this disease are subject to recurring infections.

Description

Immunodeficiency means that the immune system is deficient in one or more of its components and is unable to respond effectively. Common variable immunodeficiency is the most common of the immunodeficiency disorders. Patients with this disease have frequent infections, especially those caused by the same microorganism. Recurring infections are an indication that the immune system is not responding normally and developing immunity to reinfection. Patients with common variable immunodeficiency have a normal number of B cells, the lymphocytes that make antibodies. In approximately one-third of these patients, the number of B cells in the blood that have IgG antibodies on their surface is lower than normal, but there are normal numbers of B cells in their bone marrow. B cells with IgG antibodies on their surface are capable of responding to microorganisms. The lack of IgG on the surface of the B cells means that they are not prepared to fight infection. The T-cell lymphocytes, those cells responsible for cellular immunity, are usually normal, although some cell signal components may be lacking.

Causes and symptoms

The cause of common variable immunodeficiency is not known, although some forms seem to be hereditary. The main symptom is recurring infections that tend to be chronic rather than acute. Patients may also develop **diarrhea** and, as a consequence of the diarrhea, do not absorb food efficiently. This can lead to malnourishment that can aggravate the disorder. Common variable immunodeficiency normally appears in children after the age of 10. **Autoimmune disorders** such as **rheumatoid arthritis**, **thyroiditis**, and **systemic lupus erythematosus** and certain cancers such as lymphomas and leukemias may be associated with common variable immunodeficiency.

Diagnosis

As is true of most immunodeficiency disorders, one of the first signs that the patient has the condition is recurrent infections. Patients with common variable immunodeficiency are subject to recurrent infections, especially those caused by microbes that don't normally cause disease in normal persons. The main diagnostic test that distinguishes common variable immunodeficiency from other immunodeficiency diseases is the low antibody level despite the normal number of B cells. Antibody levels are tested in the serum by a procedure called electrophoresis. This procedure both quantifies the amount of antibody present and identifies the various classes of antibodies. The main class of antibody for fighting infectious diseases is IgG.

Treatment

There is no treatment that will cure the disorder. Treatment for common variable immunodeficiency aims at boosting the body's immune response and preventing or controlling infections. Immune serum, obtained from donated blood, is given as a source of antibodies to boost the immune response. Immune serum is obtained from donated blood. It contains whatever antibodies the donors had in their blood. Consequently, it may not contain all the antibodies that the patient needs and may lack antibodies specific for some of the recurring infections that these patients suffer. **Antibiotics** are used routinely at the first sign of an infection to help the patient eliminate infectious microorganisms.

Prognosis

With good medical care, people with common variable immunodeficiency usually have a normal life span.

Prevention

The disease itself cannot be prevented, but patients and their families can take precautions to prevent the recurrent infections commonly associated with it. For example, good hygiene and **nutrition** are important, as is avoiding crowds or other people who have active infections.

Resources

BOOKS

Abbas, Abul K., Andrew H. Lichtman, and Jordan S. Pober. *Cellular and Molecular Immunology.* 3rd ed. Philadelphia: W. B. Saunders Co., 1997.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

John T. Lohr, PhD

Complement deficiencies

Definition

Complement deficiencies are a group of disorders in which there is a reduced level of specific proteins, complement, involved in proper immune functioning.

Description

Complement plays several functions in immunity. It can poke holes in bacteria, kill bacteria that are first targeted by antibodies, or, working with antibodies, point

KEY TERMS

Autoimmune diseases—A group of diseases, like rheumatoid arthritis and systemic lupus erythematosus, in which immune cells turn on the body, attacking various tissues and organs.

Hereditary angioedema—A complement deficiency characterized by lymphatic vessel blockages that cause temporary swelling (edema) of areas of the skin, mucous membranes, and, sometimes, internal organs.

Leucocyte adhesion deficiency syndrome—A complement deficiency syndrome characterized by recurrent infections of the skin, mucous membranes, and gastrointestinal tract and the absence of pus formation. This disorder is sometimes apparent at birth when separation of the umbilical cord takes longer than normal.

Meningitis—An inflammation of the lining surrounding the brain and spinal cord.

Paroxysmal nocturnal hemoglobinuria (PNH)—A rare complement disorder characterized by episodes of red blood cell destruction (hemolysis) and blood in the urine (hemoglobinuria) that is worse at night.

Systemic lupus erythematosus—An autoimmune disease in which the immune system attacks the body's connective tissue. A butterfly-shaped facial rash is characteristic.

White blood cells—Cells that are key in immune defense. There are various types, including those that engulf and kill invading bacteria.

out which bacteria need to be engulfed by white blood cells. Without sufficient complement, the body is prone to frequent infections, like **pneumonia** or **meningitis**, or other illnesses, including autoimmune diseases, like **systemic lupus erythematosus**. Since there are more than 20 different types of complement, the disease that results depends on the specific complement that is lacking.

Cause and symptoms

A defect in the complement system can be genetic, but a secondary complement deficiency can also result from ailments that involve a lot of protein loss, including serious **burns**, liver or kidney disease, and autoimmune diseases, like lupus. Symptoms vary depending on the specific complement deficiency and the disease that results. Some people remain healthy with no symptoms at all. Others, who suffer from frequent infections, may develop a high **fever**, **diarrhea**, headaches with a stiff neck, or a **cough** with chest **pain**. If an autoimmune disease develops, like lupus, the person may lose weight, suffer from a rash, and have joint pain. Other symptoms of complement deficiency diseases (like hereditary angioedema, paroxysmal nocturnal hemoglobinuria, or leukocyte adhesion deficiency syndrome) include abdominal and back pain, skin infections, **edema** or swelling of the face and red bumps on the skin.

Diagnosis

There are blood tests that determine the activity of the complement system. The two most common screening tests, CH50 and APH50, tell the physician which group of complement components have a defect. More specific blood tests for the individual complement components (e.g., C3 or C4 complement) are then performed. Other specialized blood tests, including C1 esterase level, Ham test, and a white **blood count**, may also be performed.

Treatment

There is no way to treat the actual complement deficiency. However, **antibiotics** are used to treat infections and vaccinations are given to reduce the risk of disease. Often, the person is vaccinated against infections that include **influenza**, pneumonia, and meningitis. In some cases, (e.g., a specific disease called paroxysmal nocturnal hemoglobinuria [PNH]), a bone marrow transplant may be recommended.

Alternative treatment

There is no alternative treatment for complement problems.

Prognosis

Since complement deficiencies include a wide range of disorders, the prognoses can also vary widely. Some patients remain healthy their entire life. Others are hospitalized frequently because of infections which, if not properly treated, can be fatal. Those with autoimmune diseases could have a normal life expectancy. There are some complement deficiencies, that have a high mortality rate. In those cases, **death** may occur within 10 years after diagnosis.

Prevention

There is currently no way to prevent complement deficiencies.

Resources

BOOKS

McLean, Robert H., and Thomas R. Welch. "Complement." In *Handbook of Human Immunology*, ed. Mary S. Leffell, et al. Boca Raton: CRC Press, 1997.

PERIODICALS

"Complement Deficiency States." *Immune Deficiency and Allied Disorders Newsletter* 2 (June 1996): 1-6.

ORGANIZATIONS

Immune Deficiency Foundation. 25 W. Chesapeake Ave., Suite 206, Towson, MD 21204. (800) 296-4433. <http://www.primaryimmune.org>.

OTHER

"The Clinical Presentation of the Primary Immunodeficiency Diseases." *International Patient Organization for Patient's with Primary Immunodeficiences*. <http://www.ipopi.org>.

Jeanine Barone, Physiologist

Complete blood count *see* **Blood count**

Computed tomography scans

Definition

Computed tomography (CT) scans are completed with the use of a 360-degree x-ray beam and computer production of images. These scans allow for cross-sectional views of body organs and tissues.

Purpose

CT scans are used to image a wide variety of body structures and internal organs. Since the 1990s, CT equipment has become more affordable and available. In some diagnoses, CT scans have become the first imaging exam of choice. Because the computerized image is so sharp, focused, and three-dimensional, many tissues can be better differentiated than on standard x rays. Common CT indications include:

- Sinus studies. The CT scan can show details of **sinusitis** and bone **fractures**. Physicians may order a CT of the sinuses to provide an accurate map for surgery.
- Brain studies. Brain scans can detect hematomas, tumors, and strokes. The introduction of CT scanning, especially spiral CT, has helped reduce the need for more invasive procedures such as cerebral **angiography**.
- Body scans. CT scans of the body will often be used to observe abdominal organs, such as the liver, kidneys, adrenal glands, spleen, and lymph nodes, and extremities.
- Aorta scans. CT scans can focus on the thoracic or abdominal aorta to locate aneurysms and other possible aortic diseases.
- Chest scans. CT scans of the chest are useful in distinguishing tumors and in detailing accumulation of fluid in chest infections.

Precautions

Pregnant women or those who could possibly be pregnant should not have a CT scan unless the diagnostic benefits outweigh the risks. Pregnant patients should particularly avoid full body or abdominal scans. If the exam is necessary for obstetrics purposes, technologists are instructed not to repeat films if there are errors. Pregnant patients receiving CT or any x-ray exam away from the abdominal area may be protected by a lead apron; most radiation, known as scatter, travels through the body and is not blocked by the apron.

Contrast agents are often used in CT exams and the use of these agents should be discussed with the medical professional prior to the procedure. Patients should be asked to sign a consent form concerning the administration of contrast. One of the common contrast agents, iodine, can cause allergic reactions. Patients who are known to be allergic to iodine (or shellfish) should inform the physician prior to the CT scan.

Description

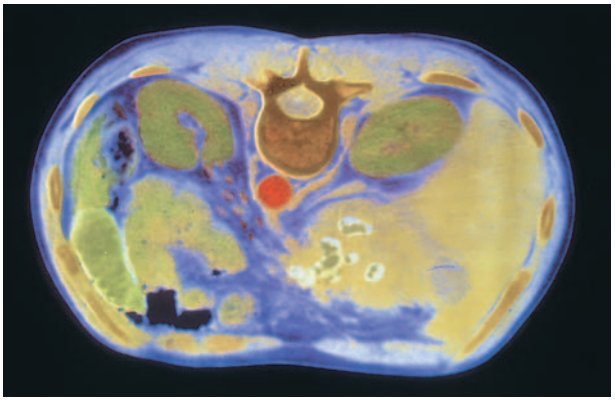
Computed tomography, also called CT scan, CAT scan, or computerized axial tomography, is a combination of focused x-ray beams and computerized production of an image. Introduced in the early 1970s, this radiologic procedure has advanced rapidly and is now widely used, sometimes in the place of standard x rays.

CT equipment

A CT scan may be performed in a hospital or outpatient imaging center. Although the equipment looks large and intimidating, it is very sophisticated and fairly comfortable. The patient is asked to lie on a gantry, or narrow table, that slides into the center of the scanner. The scanner looks like a doughnut and is round in the middle, which allows the x-ray beam to rotate around the patient. The scanner section may also be tilted slightly to allow for certain cross-sectional angles.

CT procedure

The patient will feel the gantry move very slightly as the precise adjustments for each sectional image are



Colorized CT scan of human abdomen—aorta is dead center/red *(Photo Researchers. Reproduced by permission.)*

made. A technologist watches the procedure from a window and views the images on a computer screen.

It is essential that the patient lie very still during the procedure to prevent motion blurring. In some studies, such as chest CTs, the patient will be asked to hold his or her breath during image capture.

Following the procedure, films of the images are usually printed for the radiologist and referring physician to review. A radiologist can also interpret CT exams on a special computer screen. The procedure time will vary in length depending on the area being imaged. Average study times are from 30 to 60 minutes. Some patients may be concerned about claustrophobia, but the width of the "doughnut" portion of the scanner is such that many patients can be reassured of openness.

The CT image

While traditional x rays image organs in two dimensions, with the possibility that organs in the front of the body are superimposed over those in the back, CT scans allow for a more three-dimensional effect. Some have compared CT images to slices in a loaf of bread. Precise sections of the body can be located and imaged as cross-sectional views. The screen before the technologist shows a computer's analysis of each section detected by the x-ray beam. Thus, various densities of tissue can be easily distinguished.

Contrast agents

Contrast agents are often used in CT exams and in other radiology procedures to illuminate certain details of anatomy which may not be easily seen. Some contrasts are natural, such as air or water. Other times, a water-based contrast agent is administered for specific diagnostic purposes. Barium sulfate is commonly used in gastroenterology procedures. The patient may drink this contrast, or receive it in an enema. Oral and rectal contrast are usually given when examining the abdomen or cells, and not given when scanning the brain or chest. Iodine is the most widely used intravenous contrast agent and is given through an intravenous needle.

If contrast agents are used in the CT exam, these will be administered several minutes before the study begins. Abdominal CT patients may be asked to drink a contrast medium. Some patients may experience a salty taste, flushing of the face, warmth or slight nausea, or **hives** from an intravenous contrast injection. Technologists and radiologists have equipment and training to help patients through these minor reactions and to handle more severe reactions. Severe reactions to contrast are rare, but do occur.

Spiral CT

Spiral CT, also called helical CT, is a newer version of CT scanning which is continuous in motion and allows for three-dimensional recreation of images. For example, traditional CT allows the technologist to take slices at very small and precise intervals one after the other. Spiral CT allows for a continuous flow of images, without stopping the scanner to move to the next image slice. A major advantage of spiral CT is the ability to reconstruct images anywhere along the length of the study area. The procedure also speeds up the imaging process, meaning less time for the patient to lie still. The ability to image contrast more rapidly after it is injected, when it is at its highest level, is another advantage of spiral CT's high speed.

Some facilities will have both spiral and conventional CT available. Although spiral is more advantageous for many applications, conventional CT is still a superior and precise method for imaging many tissues and structures. The physician will evaluate which type of CT works best for the specific exam purpose.

Preparation

If a contrast medium is administered, the patient may be asked to fast from about four to six hours prior to the procedure. Patients will usually be given a gown (like a typical hospital gown) to be worn during the procedure. All metal and jewelry should be removed to avoid artifacts on the film.

Aftercare

No aftercare is generally required following a CT scan. Immediately following the exam, the technologist will continue to watch the patient for possible adverse contrast reactions. Patients are instructed to advise the

technologist of any symptoms, particularly respiratory difficulty. The site of contrast injection will be bandaged and may feel tender following the exam. Hives may develop later and usually do not require treatment.

Risks

Radiation exposure from a CT scan is similar to, though higher than, that of a conventional x ray. Although this is a risk to pregnant women, the exposure to other adults is minimal and should produce no effects. Although severe contrast reactions are rare, they are a risk of many CT procedures.

Normal results

Normal findings on a CT exam show bone, the most dense tissue, as white areas. Tissues and fat will show as various shades of gray, and fluids will be gray or black. Air will also look black. Intravenous, oral, and rectal contrast appear as white areas. The radiologist can determine if tissues and organs appear normal by the sensitivity of the gray shadows. In CT, the images that can cut through a section of tissue or organ provide three-dimensional viewing for the radiologist and referring physician.

Abnormal results

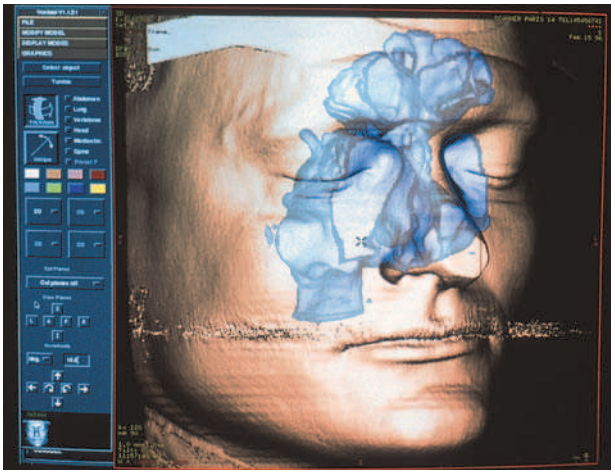
Abnormal results may show different characteristics of tissues within organs. Accumulations of blood or other fluids where they do not belong may be detected. Radiologists can differentiate among types of tumors throughout the body by viewing details of their makeup.

Sinus studies

The increasing availability and lowered cost of CT scanning has led to its increased use in sinus studies, either as a replacement for a sinus x ray or as a follow-up to an abnormal sinus radiograph. The sensitivity of CT allows for location of areas of sinus infection, particularly chronic infection. CT scans can show the extent and location of tiny fractures to the sinus and nasal bones. Foreign bodies in the sinus and nasal area are also easily detected by CT. CT imaging of the sinuses is important in evaluating trauma or disease of the sphenoid bone (the wedge shaped bone at the base of the skull). Sinus tumors will show as shades of gray indicating the difference in their density from that of normal tissues in the area.

Brain studies

The precise differences in density allowed by CT scan can clearly show tumors, strokes, or lesions in the brain area as altered densities. These lighter or darker areas on the image may indicate a tumor or hematoma within the brain and skull area. Different types of tumors can be identified by the presence of **edema**, by the tissue's density, or by studying blood vessel location and activity. The speed and convenience of CT often allows for detection of hemorrhage before symptoms even occur. Congenital abnormalities in children, such as **hydrocephalus**, may also be confirmed with CT. Hydrocephalus is suggested by enlargement of the fluid structures called ventricles of the brain.



Computerized CT scan of facial sinuses. *(Pascal Goetgheluck. Photo Researchers. Reproduced by permission.)*

Body scans

The body scan can identify abnormal body structures and organs. Throughout the body, a CT may indicate tumors or cysts, enlarged lymph nodes, abnormal collections of fluids, blood or fat, and metastasis of **cancer**. Tumors resulting from metastasis are different in makeup than primary tumors, or those that originate in the location of study. Fractures or damage to soft tissues and ligaments will be more easily seen on the sensitive images produced by CT scanning, though CT is not usually done for these. Liver conditions, such as **cirrhosis** or abscessed or **fatty liver**, may be observed on the body scan.

CT of the aorta

CT provides the ability to see and measure the thickness of the aortal wall, which is very helpful in diagnosing aortic aneurysms. The use of contrast will help see details within the aorta. In addition, density can identify calcification, and this helps differentiate between acute and chronic problems. An abnormal CT scan may indicate signs of aortic clots. Aortic rupture is suggested by signs such as a hematoma around the aorta or the escape of blood from its cavity.

KEY TERMS

Aneurysm—The bulging of the blood vessel wall. Aortic aneurysms are the most dangerous. Aneurysms can break and cause bleeding.

Contrast (agent, medium)—A substance injected into the body that illuminates certain structures that would otherwise be hard to see on the radiograph (film).

Gantry—A name for the couch or table used in a CT scan. The patient lies on the gantry while it slides into the x-ray scanner portion.

Hematoma—A collection of blood that has escaped from the vessels. It may clot and harden, causing pain to the patient.

Hydrocephalus—A collection of fluid on or around the brain. The pressure from the spinal fluid causes the ventricles to widen.

Metastasis—Secondary cancer, or cancer that has spread from one body organ or tissue to another.

Radiologist—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of disease and injury.

Spiral CT—Also referred to as helical CT, this method allows for continuous 360-degree x-ray image capture.

Thoracic—Refers to the chest area. The thorax runs between the abdomen and neck and is encased in the ribs.

Chest scans

In addition to those findings that may indicate aortic aneurysms, chest CT studies can show other problems in the heart and lungs, and distinguish between an **aortic aneurysm** and a tumor adjacent to the aorta. The computer will not only show differences between air, water, tissues, and bone, but will also assign numerical values to the various densities. Coin-sized lesions in the lungs may be indicative of **tuberculosis** or tumors. CT will help distinguish among the two. Enlarged lymph nodes in the chest area may indicate **Hodgkin's disease**. Spiral CT is particularly effective at identifying pulmonary emboli (clots in the lung's blood vessels).

Resources

BOOKS

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

PERIODICALS

Papatheofanis, Frank J. "Helical CT and Pulmonary Disease." *Decisions in Imaging Economics* (Jan./Feb. 1997): 61-63.

ORGANIZATIONS

American College of Radiology. 1891 Preston White Drive, Reston, VA 22091. (800) 227-5463. <http://www.acr.org>.

Teresa Norris, RN

Computerized axial tomography *see* **Computed tomography scans**

Concussion

Definition

Concussion is a trauma-induced change in mental status, with confusion and **amnesia**, and with or without a brief loss of consciousness.

Description

A concussion occurs when the head hits or is hit by an object, or when the brain is jarred against the skull, with sufficient force to cause temporary loss of function in the higher centers of the brain. The injured person may remain conscious or lose consciousness briefly, and is disoriented for some minutes after the blow. According to the Centers for Disease Control and Prevention, approximately 300,000 people sustain mild to moderate sports-related brain injuries each year, most of them young men between 16 and 25.

While concussion usually resolves on its own without lasting effect, it can set the stage for a much more serious condition. "Second impact syndrome" occurs when a person with a concussion, even a very mild one, suffers a second blow before fully recovering from the first. The brain swelling and increased intracranial pressure that can result is potentially fatal. More than 20 such cases have been reported since the syndrome was first described in 1984.

Causes and symptoms

Causes

Most concussions are caused by motor vehicle accidents and **sports injuries**. In motor vehicle accidents, concussion can occur without an actual blow to the head. Instead, concussion occurs because the skull suddenly decelerates or stops, which causes the brain to be jarred against the skull. Contact sports, especially football,

hockey, and boxing, are among those most likely to lead to concussion. Other significant causes include falls, collisions, or blows due to bicycling, horseback riding, skiing, and soccer.

The risk of concussion from football is extremely high, especially at the high school level. Studies show that approximately one in five players suffer concussion or more serious brain injury during their brief high-school careers. The rate at the collegiate level is approximately 1 in 20. Rates for hockey players are not known as certainly, but are believed to be similar.

Concussion and lasting brain damage is an especially significant risk for boxers, since the goal of the sport is, in fact, to deliver a concussion to the opponent. For this reason, the American Academy of Neurology has called for a ban on boxing. Repeated concussions over months or years can cause cumulative **head injury**. The cumulative brain injuries suffered by most boxers can lead to permanent brain damage. Multiple blows to the head can cause "punch-drunk" syndrome or **dementia** pugilistica, as evidenced by Muhammed Ali, whose parkinsonism is a result of his career in the ring.

Young children are likely to suffer concussions from falls or collisions on the playground or around the home. **Child abuse** is, unfortunately, another common cause of concussion.

Symptoms

Symptoms of concussion include:

- headache
- disorientation as to time, date, or place
- confusion
- dizziness
- vacant stare or confused expression
- incoherent or incomprehensible speech
- incoordination or weakness
- amnesia for the events immediately preceding the blow
- nausea or vomiting
- double vision
- ringing in the ears

These symptoms may last from several minutes to several hours. More severe or longer-lasting symptoms may indicate more severe brain injury. The person with a concussion may or may not lose consciousness from the blow; if so, it will be for several minutes at the most. More prolonged unconsciousness indicates more severe brain injury.

The severity of concussion is graded on a three-point scale, used as a basis for treatment decisions.

KEY TERMS

Amnesia—A loss of memory that may be caused by brain injury, such as concussion.

Parkinsonism—A neurological disorder that includes a fine tremor, muscular weakness and rigidity, and an altered way of walking.

- Grade 1: no loss of consciousness, transient confusion, and other symptoms that resolve within 15 minutes.
- Grade 2: no loss of consciousness, transient confusion, and other symptoms that require more than 15 minutes to resolve.
- Grade 3: loss of consciousness for any period.

Days or weeks after the accident, the person may show signs of:

- headache
- poor attention and concentration
- memory difficulties
- anxiety
- depression
- sleep disturbances
- light and noise intolerance

The occurrence of such symptoms is called "post-concussion syndrome."

Diagnosis

It is very important for those attending a person with concussion to pay close attention to the person's symptoms and progression immediately after the accident. The duration of unconsciousness and degree of confusion are very important indicators of the severity of the injury and help guide the diagnostic process and treatment decisions.

A doctor, nurse, or emergency medical technician may make an immediate assessment based on the severity of the symptoms; a **neurologic exam** of the pupils, coordination, and sensation; and brief tests of orientation, memory, and concentration. Those with very mild concussions may not need to be hospitalized or have expensive diagnostic tests. Questionable or more severe cases may require **computed tomography scan** (CT) or **magnetic resonance imaging** (MRI) scans to look for brain injury.

Treatment

The symptoms of concussion usually clear quickly and without lasting effect, if no further injury is sus-

tained during the healing process. Guidelines for returning to sports activities are based on the severity of the concussion.

A grade 1 concussion can usually be treated with rest and continued observation alone. The person may return to sports activities that same day, but only after examination by a trained professional, and after all symptoms have completely resolved. If the person sustains a second concussion of any severity that same day, he or she should not be allowed to continue contact sports until he or she has been symptom-free, during both rest and activity, for one week.

A person with a grade 2 concussion must discontinue sports activity for the day, should be evaluated by a trained professional, and should be observed closely throughout the day to make sure that all symptoms have completely cleared. Worsening of symptoms, or continuation of any symptoms beyond one week, indicates the need for a CT or MRI scan. Return to contact sports should only occur after one week with no symptoms, both at rest and during activity, and following examination by a physician. Following a second grade 2 concussion, the person should remain symptom-free for two weeks before resuming contact sports.

A person with a grade 3 concussion (involving any loss of consciousness, no matter how brief) should be examined by a medical professional either on the scene or in an emergency room. More severe symptoms may warrant a CT or MRI scan, along with a thorough neurological and physical exam. The person should be hospitalized if any abnormalities are found or if confusion persists. Prolonged unconsciousness and worsening symptoms require urgent neurosurgical evaluation or transfer to a trauma center. Following discharge from professional care, the patient is closely monitored for neurological symptoms which may arise or worsen. If headaches or other symptoms worsen or last longer than one week, a CT or MRI scan should be performed. Contact sports are avoided for one week following unconsciousness of only seconds, and for two weeks for unconsciousness of a minute or more. A person receiving a second grade 3 concussion should avoid contact sports for at least a month after all symptoms have cleared, and then only with the approval of a physician. If signs of brain swelling or bleeding are seen on a CT or MRI scan, the athlete should not return to the sport for the rest of the season, or even indefinitely.

For someone who has sustained a concussion of any severity, it is critically important that he or she avoid the possibility of another blow to the head until well after all symptoms have cleared to prevent second-impact syndrome. The guidelines above are designed to minimize the risk of this syndrome.

Prognosis

Concussion usually leaves no lasting neurological problems. Nonetheless, symptoms of **post-concussion syndrome** may last for weeks or even months.

Studies of concussion in contact sports have shown that the risk of sustaining a second concussion is even greater than it was for the first if the person continues to engage in the sport.

Prevention

Many cases of concussion can be prevented by using appropriate protective equipment. This includes seat belts and air bags in automobiles, and helmets in all contact sports. Helmets should also be worn when bicycling, skiing, or horseback riding. Soccer players should avoid heading the ball when it is kicked at high velocity from close range. Playground equipment should be underlaid with soft material, either sand or special matting.

The value of high-contact sports such as boxing, football, or hockey should be weighed against the high risk of brain injury during a young person's participation in the sport. Steering a child's general enthusiasm for sports into activities less apt to produce head impacts may reduce the likelihood of brain injury.

Resources

BOOKS

Evans, R. *Neurology and Trauma*. W. B. Saunders Co., 1996.

PERIODICALS

Quality Standards Subcommittee, American Academy of Neurology. "Practice Parameter: The Management of Concussion in Sports." *Neurology* 48 (Mar. 1997): 581-585.

"Sports-Related Recurrent Brain Injuries—United States." *Morbidity and Mortality Weekly Report*, 14 Mar. 1997, 224-227.

ORGANIZATIONS

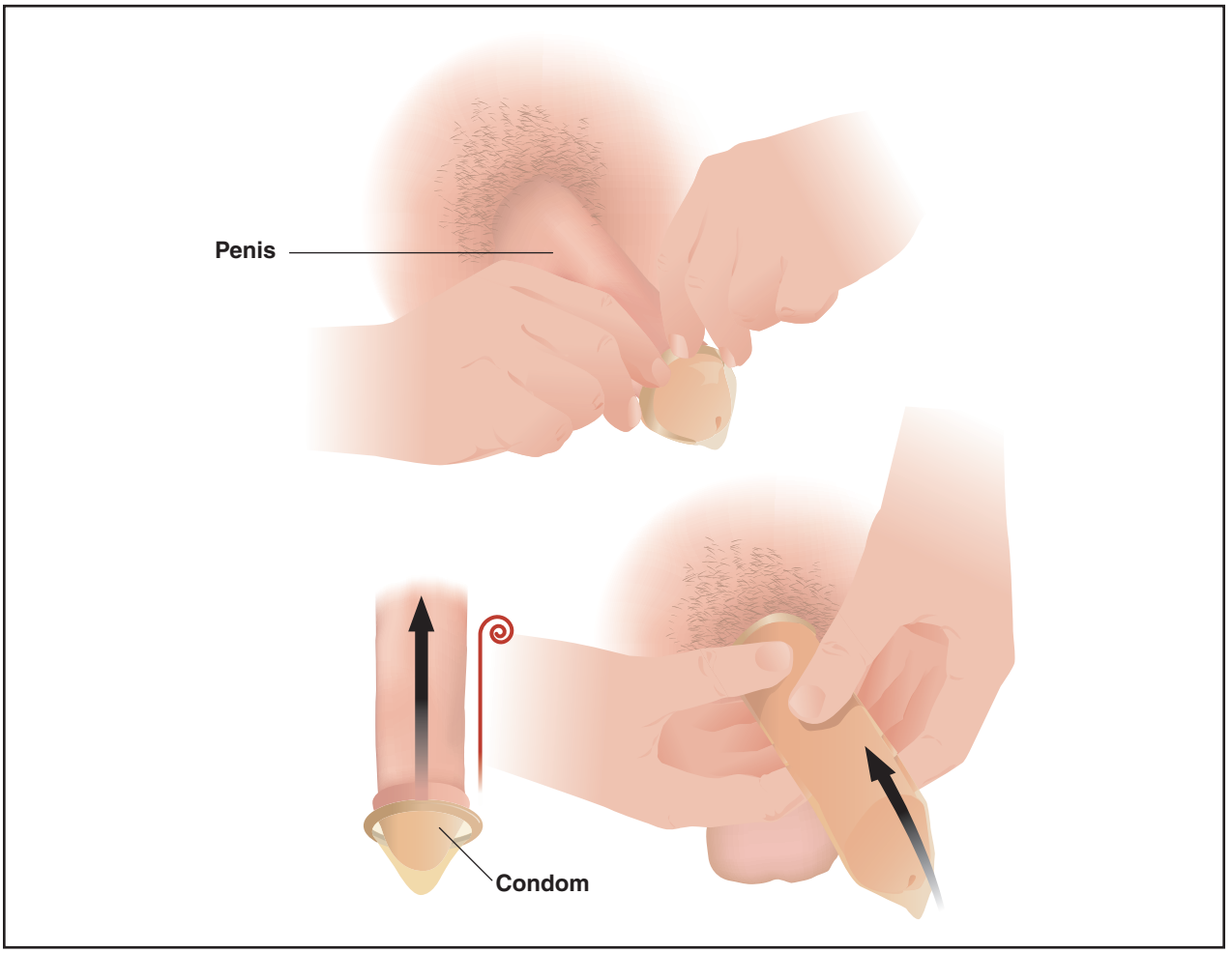
American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Richard Robinson

Condom

Definition

Male condoms are thin sheaths of latex (rubber), polyurethane (plastic), or animal tissue that are rolled onto an erect penis immediately prior to intercourse. They are commonly called "safes" or "rubbers." Female condoms are made of polyurethane and are inserted into the vaginal



A condom is most effective when it is placed on the penis correctly without trapping air between the penis and the condom. *(Illustration by Argosy, Inc.)*

canal before sexual relations. The open end covers the outside of the vagina, and the closed ring fits over the cervix (opening into the uterus). Both types of condoms collect the male semen at ejaculation, acting as a barrier to fertilization. Condoms also perform as barriers to the exchange of bodily fluids and are subsequently an important tool in the prevention of **sexually transmitted diseases** (STDs).

Purpose

Both male and female condoms are used to prevent **pregnancy** and to protect against STDs such as human **immunodeficiency** virus (HIV), **gonorrhea**, chlamydia, and **syphilis**. To accomplish these goals, the condom must be applied and removed correctly.

Precautions

Male and female condoms should not be used together as there is a risk that one of them may come off. The male condom should not be snug on the tip of the penis. A space of about 0.5 in should be left at the end to avoid the possibility of it breaking during sexual intercourse. The penis must be withdrawn quickly after ejaculation to prevent the condom from falling off as the penis softens. The condom should therefore always be removed while the penis is still erect to prevent the sperm from spilling into the vagina.

Description

Male condoms made from animal tissue and linen have been in use for centuries. Latex condoms were introduced in the late 1800s and gained immediate popularity because they were inexpensive and effective. At that time, they were primarily used to protect against STDs. A common complaint made by many consumers is that condoms reduce penis sensitivity and impair orgasm. Both men and women may develop **allergies** to

KEY TERMS

Ejaculate—To expel semen.

Semen—The thick whitish liquid released from the penis during sexual intercourse. It contains sperm and other secretions.

Sperm or spermatozoa—The part of the semen that is generative—can cause fertilization of the female ovum.

Spermicide—An agent that is destructive to sperm.

Vagina—The genital canal in the female, leading from the vulva to the uterus.

the latex. Consumer interest in female condoms has been slight.

Male condoms may be purchased lubricated, ribbed, or treated with spermicide (a chemical that kills sperm). To be effective, condoms must be removed carefully so as not to "spill" the contents into the vaginal canal. Condoms that leak or break do not provide protection against pregnancy or disease.

If used correctly, male condoms have an effectiveness rate of about 90% for preventing pregnancy, but this rate can be increased to about 99% if used with a spermicide. (Several types of spermicides are available; they can be purchased in the form of contraceptive creams and jellies, foams, or films.) Benefits associated with this type of contraceptive device include easy availability (no prescription is required), convenience of use, and lack of serious side effects. The primary disadvantage is that sexual activity must be interrupted in order to put the condom on.

Female condoms, when used correctly and at every instance of intercourse, were shown to prevent pregnancy in over 95% of women surveyed over the course of six months. When used inconsistently, the female condom was shown to have a failure rate of 21% in the same study. One benefit of the female condom is that it may be inserted immediately before sexual intercourse or up to eight hours prior, so that sexual activity does not need to be interrupted for its insertion. One study performed by a manufacturer of the female condom indicated that 50–75% of couples in numerous countries found the barrier acceptable for use.

Condoms provide better protection against STDs than any other contraceptive method. One study conducted in the 1990s indicated that out of 123 couples with one HIV-positive partner, not one healthy individual contracted the disease when condoms were used with every instance of sexual intercourse. A similar 1993 study showed that out of 171 couples with one HIV-positive partner, all but two individuals were protected against HIV transmission with condom use. In addition to HIV, condoms provide effective transmission against gonorrhea, chlamydia, syphilis, **chancroid**, and **trichomoniasis**. A measure of protection is also provided against **hepatitis B** virus (HBV), human papillomavirus (HPV), and herpes simplex virus (HSV).

Before purchasing a condom, check the expiration date. Prior to use, examine the condom for holes. If a lubricant is going to be used, it should be water soluble because petroleum jellies, such as Vaseline, and other oil based lubricants can weaken latex. It is also important to note that condoms made from animal tissue or plastic are not recommended as a protection against STDs.

Resources

OTHER

"The Condom." *Sexual Health InfoCenter.* <http:///www.sexhealth.org/infocenter/GuideSS/condoms.htm>.
"Condoms." *Planned Parenthood Page.* <http://www.plannedparenthood.org/condoms/index.html>.
"The Female Condom." *Frontsake Health Center.* 2001. <http://www.nau.edu/~fronske/fcondom.html>.
"Spermicides, Condoms and Other Barrier Methods." *Epigee Birth Control Guide.* <http://epigee.netministries.org/guide/barrier.html>.

Stephanie Dionne

Conduct disorder

Definition

Conduct disorder (CD) is a behavioral and emotional disorder of childhood and adolescence. Children with conduct disorder act inappropriately, infringe on the rights of others, and violate the behavioral expectations of others.

Description

CD is present in approximately 9% of boys and 2–9% of girls under the age of 18. Children with conduct disorder act out aggressively and express anger inappropriately. They engage in a variety of antisocial and destructive acts, including violence towards people and animals, destruction of property, lying, stealing,

truancy, and running away from home. They often begin using and abusing drugs and alcohol, and having sex at an early age. Irritability, temper tantrums, and low self-esteem are common personality traits of children with CD.

Causes and symptoms

There are two sub-types of CD, one beginning in childhood and the other in adolescence. There is no known cause. Researchers and physicians suggest that this disease may be caused by the following:

- poor parent-child relationships
- dysfunctional families
- drug abuse
- physical abuse
- poor relationships with other children
- cognitive problems leading to school failures
- brain damage
- biological defects

Difficulty in school is an early sign of potential conduct disorder problems. While the patient's IQ tends to be in the normal range, they can have trouble with verbal and abstract reasoning skills and may lag behind their classmates, and consequently, feel as if they don't "fit in." The frustration and loss of self-esteem resulting from this academic and social inadequacy can trigger the development of CD.

A dysfunctional home environment can be another major contributor to CD. An emotionally, physically, or sexually abusive home environment, a family history of antisocial personality disorder, or parental substance abuse can damage a child's perceptions of himself and put him on a path toward negative behavior. Other less obvious environmental factors can also play a part in the development of conduct disorder. Long-term studies have shown that maternal **smoking** during **pregnancy** may be linked to the development of CD in boys. Animal and human studies point out that nicotine can have undesirable effects on babies. These include altered structure and function of their nervous systems, learning deficits, and behavioral problems. In a study of 177 boys ages seven-12 years, those with mothers who smoked over one half a package of cigarettes daily while pregnant were more apt to have a CD than those with mothers who did not smoke.

Other conditions that may cause or co-exist with CD include **head injury**, substance abuse disorder, major depressive disorder, and attention deficit hyperactivity disorder (**ADHD**). Thirty to fifty percent of children diagnosed with ADHD, a disorder characterized by a persistent pattern of inattention and/or hyperactivity, also have CD.

CD is defined as a repetitive behavioral pattern of violating the rights of others or societal norms. Three of the following criteria, or symptoms, are required over the previous 12 months for a diagnosis of CD (one of the three must have occurred in the past six months):

- bullies, threatens, or intimidates others
- picks fights
- has used a dangerous weapon
- has been physically cruel to people
- has been physically cruel to animals
- has stolen while confronting a victim (for example, mugging or extortion)
- has forced someone into sexual activity
- has deliberately set a fire with the intention of causing damage
- has deliberately destroyed property of others
- has broken into someone else's house or car
- frequently lies to get something or to avoid obligations
- has stolen without confronting a victim or breaking and entering (e.g., shoplifting or forgery)
- stays out at night; breaks curfew (beginning before 13 years of age)
- has run away from home overnight at least twice (or once for a lengthy period)
- is often truant from school (beginning before 13 years of age).

Diagnosis

CD is diagnosed and treated by a number of social workers, school counselors, psychiatrists, and psychologists. Genuine diagnosis may require psychiatric expertise to rule out such conditions as **bipolar disorder** or ADHD. A comprehensive evaluation of the child should ideally include interviews with the child and parents, a full social and medical history, a cognitive evaluation, and a psychiatric exam. One or more clinical inventories or scales may be used to assess the child for conduct disorder—including the Youth Self-Report, the Overt Aggression Scale (OAS), Behavioral Assessment System for Children (BASC), Child Behavior Checklist (CBCL), and Diagnostic Interview Schedule for Children (DISC). The tests are verbal and/or written and are administered in both hospital and outpatient settings.

KEY TERMS

ADHD—Attention deficit hyperactivity disorder; a disorder characterized by a persistent pattern of inattention and/or hyperactivity.

Major depressive disorder—A mood disorder characterized by profound feelings of sadness or despair.

Treatment

Treating conduct disorder requires an approach that addresses both the child and his environment. Behavioral therapy and psychotherapy can help a child with CD to control his anger and develop new coping skills. Family **group therapy** may also be effective in some cases. Parents should be counseled on how to set appropriate limits with their child and be consistent and realistic when disciplining. If an abusive home life is at the root of the conduct problem, every effort should be made to move the child into a more supportive environment. Parent training programs are increasing in number.

For children with coexisting ADHD, substance abuse, depression, or **learning disorders**, treating these conditions first is preferred, and may result in a significant improvement to the CD condition. In all cases of CD, treatment should begin when symptoms first appear. Recent studies have shown Ritalin to be a useful drug for both ADHD and CD.

When aggressive behavior is severe, mood stabilizing medication, including lithium (Cibalith-S, Eskalith, Lithane, Lithobid, Lithonate, Lithotabs), carbamazepine (Tegretol, Atretol), and propranolol (Inderal), may be an appropriate option for treating the aggressive symptoms. However, placing the child into a structured setting or treatment program such as a psychiatric hospital may be just as beneficial for easing aggression as medication.

Prognosis

The prognosis for children with CD is not bright. Follow-up studies of conduct disordered children have shown a high incidence of antisocial personality disorder, affective illnesses, and chronic criminal behavior later in life. However, proper treatment of co-existing disorders, early identification and intervention, and long-term support may improve the outlook significantly.

Prevention

A supportive, nurturing, and structured home environment is believed to be the best defense against CD. Children with learning disabilities and/or difficulties in school should get immediate and appropriate academic assistance. Addressing these problems when they first appear helps to prevent the frustration and low self-esteem that may lead to CD later on.

Resources

BOOKS

Diagnostic and Statistical Manual of Mental Disorders. 4th ed. Washington, DC: American Psychiatric Association, 2000.

Maxmen, Jerrold S., and Nicholas G. Ward. "Disorders Usually First Diagnosed in Infancy, Childhood, or Adolescence." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Sholevar, Pirooz. *Conduct Disorders in Childhood and Adolescence*. Washington, DC: American Psychiatric Press, Inc., 1995.

PERIODICALS

Brodkin, Adele M., and Melba Coleman. "He's Trouble with a Capital T: What Can You Do for a Child with Conduct Disorder?" *Instructor*, Apr. 1996: 18-9.

Thompson, L. L., et al. "Contribution of ADHD Symptoms to Substance Problems and Delinquency in Conduct-Disordered Adolescents." *Journal of Abnormal Child Psychology* 24, no. 3 (June 1996): 325-47.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP). 3615 Wisconsin Ave. NW, Washington, DC 20016. (202) 966-7300. <http://www.aacap.org>.

Children and Adults with Attention Deficit Disorder (CH.A.D.D.). 8181 Professional Place, Suite 201

Paula Anne Ford-Martin

Conductive hearing loss *see* **Hearing loss**

Condylomata acuminata *see* **Genital warts**

Cone biopsy *see* **Cervical conization**

Congenital adrenal hyperplasia

Definition

Congenital adrenal hyperplasia is (CAH) a genetic disorder characterized by a deficiency in the hormones cortisol and aldosterone and an over-production of the

hormone androgen, which is present at birth and affects sexual development.

Description

CAH is a form of adrenal insufficiency in which the enzyme that produces two important adrenal steroid hormones, cortisol and aldosterone, is deficient. Because cortisol production is impeded, the adrenal gland instead overproduces androgens (male steroid hormones). Females with CAH are born with an enlarged clitoris and normal internal reproductive tract structures. Males have normal genitals at birth. CAH causes abnormal growth for both sexes; patients will be tall as children and short as adults. Females develop male characteristics, and males experience premature sexual development.

In its most severe form, called salt-wasting CAH, a life-threatening adrenal crisis can occur if the disorder is untreated. Adrenal crisis can cause **dehydration**, **shock**, and **death** within 14 days of birth. There is also a mild form of CAH that occurs later in childhood or young adult life in which patients have partial enzyme deficiency.

CAH, a genetic disorder, is the most common adrenal gland disorder in infants and children, occurring in one in 10,000 total births worldwide. It affects both females and males. It is also called adrenogenital syndrome.

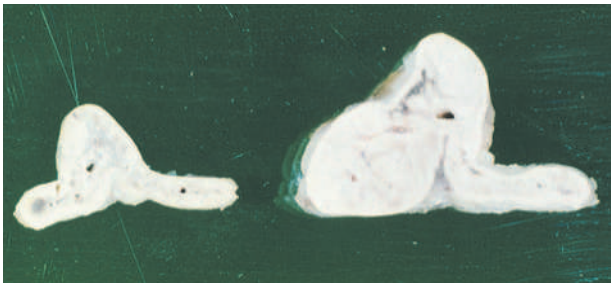
Causes and symptoms

CAH is an inherited disorder. It is a recessive disease, which means that a child must inherit one copy of the defective gene from each parent who is a carrier; when two carriers have children, each **pregnancy** carries a 25% risk of producing an affected child.

In females, CAH produces an enlarged clitoris at birth and masculinization of features as the child grows, such as deepening of the voice, facial hair, and failure to menstruate or abnormal periods at **puberty**. Females with severe CAH may be mistaken for males at birth. In males, the genitals are normal at birth, but the child becomes muscular, the penis enlarges, pubic hair appears, and the voice deepens long before normal puberty, sometimes as early as two to three years of age.

In the severe salt-wasting form of CAH, newborns may develop symptoms shortly after birth, including vomiting, dehydration, electrolyte (a compound such as sodium or calcium that separates to form ions when dissolved in water) changes, and cardiac arrhythmia.

In the mild form of CAH, which occurs in late childhood or early adulthood, symptoms include premature development of pubic hair, irregular menstrual periods, unwanted body hair, or severe **acne**. However, sometimes there are no symptoms.



Adrenal cortical hyperplasia. The adrenal on the right is normal, that on the left shows hyperplasia. *(Photo Researchers, Inc. Reproduced by permission.)*

Diagnosis

CAH is diagnosed by a careful examination of the genitals and blood and urine tests that measure the hormones produced by the adrenal gland. A number of states in the United States perform a hormonal test (a heel prick blood test) for CAH and other inherited diseases within a few days of birth. In questionable cases, **genetic testing** can provide a definitive diagnosis. For some forms of CAH, prenatal diagnosis is possible through chronic villus sampling in the first trimester and by measuring certain hormones in the amniotic fluid during the second trimester.

Treatment

The goal of treatment for CAH is to return the androgen levels to normal. This is usually accomplished through drug therapy, although surgery is an alternative. Lifelong treatment is required.

Drug therapy consists of a cortisol-like steroid medication called a glucocorticoid. Oral hydrocortisone is prescribed for children, and prednisone or dexamethasone is prescribed for older patients. For patients with salt-wasting CAH, fludrocortisone, which acts like aldosterone (the missing hormone), is also prescribed. Infants and small children may also receive salt tablets, while older patients are told to eat salty foods. Medical therapy achieves hormonal balance most of the time, but CAH patients can have periods of fluctuating hormonal control that lead to increases in the dose of steroids prescribed. Side effects of steroids include stunted growth. Steroid therapy should not be suddenly stopped, since adrenal insufficiency results.

Patients with CAH should see a pediatric endocrinologist frequently. The endocrinologist will assess height,

KEY TERMS

Adrenal glands—The two endocrine glands located above the kidney that secrete hormones and epinephrine.

Aldosterone—A hormone secreted by the adrenal glands that is important for maintaining salt and water balance in the body.

Androgens—Steroid hormones that cause masculinization.

Congenital—Present at birth.

Cortisol—A steroid hormone secreted by the adrenal cortex that is important for maintenance of body fluids, electrolytes, and blood sugar levels.

Hormone—A chemical messenger produced by the endocrine glands or certain other cells. Hormones are usually carried in the blood stream and regulate some metabolic activities.

Steroids—Hormones, including aldosterone, cortisol, and androgens, derived from cholesterol that share a four-ring structure.

weight, and blood pressure, and order an annual x ray of the wrist (to assess bone age), as well as assess blood hormone levels. CAH patients with the milder form of the disorder are usually effectively treated with hydrocortisone or prednisone, if they need medical treatment at all.

Females with CAH who have masculine external genitalia require surgery to reconstruct the clitoris and/or vagina. This is usually performed between the ages of one and three.

An experimental type of drug therapy—a three-drug combination, with an androgen blocking agent (flutamide), an aromatase inhibitor (testolactone), and low dose hydrocortisone—is currently being studied by physicians at the National Institutes of Health. Preliminary results are encouraging, but it will be many years before the safety and effectiveness of this therapy is fully known.

Adrenalectomy, a surgical procedure to remove the adrenal glands, is a more radical treatment for CAH. It was widely used before the advent of steroids. Today, it is recommended for CAH patients with little or no enzyme activity and can be accomplished by **laparoscopy**. This is a minimally invasive type of surgery done through one or more small 1 in (2.5 cm) incisions and a laparoscope, an instrument with a fiber-optic light containing a tube with openings for surgical instruments. Adrenalectomy is followed by hormone therapy, but in lower doses than CAH patients not treated surgically receive.

Prognosis

CAH can be controlled and successfully treated in most patients as long as they remain on drug therapy.

Prevention

Prenatal therapy, in which a pregnant woman at risk for a second CAH child is given dexamethasone to decrease secretion of androgens by the adrenal glands of the female fetus, has been in use for about 10 years. This therapy is started in the first trimester when fetal adrenal production of androgens begins, but before prenatal diagnosis is done that would provide definitive information about the sex of the fetus and its disease status. This means that a number of fetuses are exposed to unnecessary steroid treatment in order to prevent the development of male-like genitals in female fetuses with CAH. Several hundred children have undergone this treatment with no major adverse effects, but its long-term risks are unknown. Since there is very little data on the effectiveness and safety of prenatal therapy, it should only be offered to patients who clearly understand the risks and benefits and who are capable of complying with strict monitoring and follow-up throughout pregnancy and after the child is born.

Parents with a family history of CAH, including a child who has CAH, should seek **genetic counseling**. Genetic testing during pregnancy can provide information on the risk of having a child with CAH.

Resources

BOOKS

"Fetal Adrenal Development." In *Williams Obstetrics*, 20th ed. Stamford, CT: Appleton & Lange, 1997.

"Fetal Treatment." In *Medical Genetics*, ed. Lynn B. Jorde, et al. St. Louis: Mosby, 1995.

Hay Jr., William W., et al., eds. *Current Pediatric Diagnosis and Treatment*. Stamford, CT: Appleton & Lange, 1997.

PERIODICALS

Gussinye, Miquel, et al. "Bone Mineral Density in Prepubertal and in Adolescent and Young Adult Patients with the Salt-Wasting Form of Congenital Adrenal Hyperplasia." *Pediatrics* 100 (Oct. 1997): 671.

ORGANIZATIONS

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000.

National Adrenal Diseases Foundation. 510 Northern Boulevard, Great Neck, NY 11021. (516) 487-4992. <http://medhlp.netusa.net/www/nadf.htm>.

OTHER

The Johns Hopkins Children's Center. "Congenital Adrenal Hyperplasia Due to 21-Hydroxylase Deficiency." <http://www.med.jhu.edu/pedendo/cha/printable.html>.

Jennifer Sisk

Congenital amputation

Definition

Congenital **amputation** is the absence of a fetal limb or fetal part at birth. This condition may be the result of the constriction of fibrous bands within the membrane that surrounds the developing fetus (amniotic band syndrome) or the exposure to substances known to cause **birth defects** (teratogenic agents). Other factors, including genetics, may also play a role.

Description

An estimated one in 2,000 babies are born with all or part of a limb missing, ranging from a missing part of a finger to the absence of both arms and both legs. Congenital amputation is the least common reason for amputation. However, there are occasional periods in history where the number of congenital amputations increased. For example, the thalidomide tragedy of the early 1960s occurred after pregnant mothers in western Europe were given a tranquilizer containing the drug. The result was a drastic increase in the number of babies born with deformed limbs. In this example, the birth defect usually presented itself as very small, deformed versions of normal limbs. More recently, birth defects as a result of radiation exposure near the site of the Chernobyl disaster in Russia have left numerous children with malformed or absent limbs.

Causes and symptoms

The exact cause of congenital amputations is unknown. However, according to the March of Dimes, most birth defects have one or more genetic factors and one or more environmental factors. It is also known that most birth defects occur in the first three months of **pregnancy**, when the organs of the fetus are forming. Within these crucial first weeks, frequently prior to when a woman is aware of the pregnancy, the developing fetus is most susceptible to substances that can cause birth defects (teratogens). Exposure to teratogens can cause congenital amputation. In other cases, tight amniotic bands may constrict the developing fetus, preventing a limb from forming properly, if at all. It is estimated that this amniotic band syndrome occurs in between one in 12,000 and one in 15,000 live births.

An infant with congenital amputation may be missing an entire limb or just a portion of a limb. Congenital amputation resulting in the complete absence of a limb beyond a certain point (and leaving a stump) is called transverse deficiency or amelia. Longitudinal deficiencies occur when a specific part of a limb is missing; for example, when the fibula bone in the lower leg is missing, but the rest of the leg is intact. Phocomelia is the condition in which only a mid-portion of a limb is missing, as when the hands or feet are attached directly to the trunk.

Diagnosis

Many cases of congenital amputation are not diagnosed until the baby is born. Ultrasound examinations may reveal the absence of a limb in some developing fetuses, but routine ultrasounds may not pick up signs of more subtle defects. However, if a doctor suspects that the fetus is at risk for developing a limb deficiency (for example, if the mother has been exposed to radiation), a more detailed ultrasound examination may be performed.

Treatment

Successful treatment of a child with congenital amputation involves an entire medical team, including a pediatrician, an orthopedist, a psychiatrist or psychologist, a prosthetist (an expert in making prosthetics, or artificial limbs), a social worker, and occupational and physical therapists. The accepted method of treatment is to fit the child early with a functional prosthesis because this leads to normal development and less wasting away (atrophy) of the muscles of the limbs present. However, some parents and physicians believe that the child should be allowed to learn to play and perform tasks without a prosthesis, if possible. When the child is older, he or she can be involved in the decision of whether or not to be fitted for a prosthesis.

Recently, there have been cases in which physicians have detected amniotic band constriction interfering with limb development fairly early in its course. In 1997, doctors at the Florida Institute for Fetal Diagnosis and Therapy reported two cases in which minimally invasive surgery freed constricting amniotic bands and preserved the affected limbs.

Alternative treatment

Prevention of birth defects begins with building the well-being of the mother before pregnancy. Prenatal care

KEY TERMS

Prosthesis—An artificial replacement for a missing part of the body.

Teratogen—Any substance, agent, or process that interferes with normal prenatal development, causing the formation of one or more developmental abnormalities of the fetus.

should be strong and educational so that the mother understands both her genetic risks and her environmental risks. Several disciplines in alternative therapy also recommend various supplements and **vitamins** that may reduce the chances of birth defects. If a surgical procedure is planned, naturopathic and homeopathic pre- and post-surgical therapies can speed recovery.

Prognosis

A congenital limb deficiency has a profound effect on the life of the child and parents. However, occupational therapy can help the child learn to accomplish many tasks. In addition, some experts believe that early fitting of a prosthesis will enhance acceptance of the prosthesis by the child and parents.

Prevention

Studies have suggested that a multivitamin including **folic acid** may reduce birth defects, including congenital abnormalities. **Smoking**, drinking alcohol, and eating a poor diet while pregnant may increase the risk of congenital abnormalities. Daily, heavy exposure to chemicals may be dangerous while pregnant.

Resources

BOOKS

Banasik, Jacquelyn L. "Genetic and Developmental Disorders." In *Perspectives on Pathophysiology*, ed. Lee-Ellen C. Copstead. Philadelphia: W. B. Saunders Co., 1994.

ORGANIZATIONS

International Child Amputee Network. <http://www.amp-info.net/childamp.htm>.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

Jeffrey P. Larson, RPT

Congenital bladder diverticulum *see* **Congenital bladder anomalies**

Congenital bladder anomalies

Definition

The two most common congenital bladder abnormalities are exstrophy and congenital diverticula. An exstrophic bladder is one that is open to the outside and turned inside-out, so that its inside is visible at birth, protruding from the lower abdomen. A diverticulum is an extension of a hollow organ, usually shaped like a pouch with a narrow opening.

Description

During fetal development, folds enclose tissues and organs and eventually fuse at the edges to form sealed compartments. Both in the front and the back, folds eventually become major body structures. In the back, the entire spinal column folds in like a pipe wrapped in a pillow. In the front, the entire lower urinary system is folded in.

- Exstrophy of the bladder represents a failure of this folding process to complete itself, so the organs form with more or less of their front side missing and open to the outside. At the same time, the front of the pelvic bone is widely separated. The abdominal wall is open, too. In fact, the defect often extends all the way to the penis in the male or splits the clitoris in the female.
- A congenital bladder diverticulum represent an area of weakness in the bladder wall through which extrudes some of the lining of the bladder. (A small balloon squeezed in a fist will create diverticula-like effect between the fingers.) Bladder diverticula may be multiple, and they often occur at the ureterovesical junction—the entrance of the upper urinary system into the bladder. In this location, they may cause urine to reflux into the ureter and kidney, leading to infection and possible kidney damage.

Causes and symptoms

As with many **birth defects**, the causes are not well known. Lack of prenatal care and **nutrition** has been linked to many birth defects; however, beyond the avoidance of known teratogens (anything that can cause a birth defect), there is little prevention possible. Exstrophy is rare, occurring in about one in 40,000 births. Diverticula are more common, but less serious.

If left untreated, the patient with bladder exstrophy will have no control over urination and is more likely to develop **bladder cancer**. Diverticula, particularly if it causes urine reflux, may lead to chronic infection and its subsequent consequences.

Diagnosis

A major consideration with congenital abnormalities is that they tend to be multiple. Further, each one is unique in its extent and severity. Exstrophy can involve the rectum and large bowel and coexist with hernias. The obvious bladder exstrophy seen at birth will prompt immediate action and a search for other anomalies.

Diverticula are not visible and will be detected only if they cause trouble. They are usually found in an examination for the cause of recurring urinary infections. X rays of the urinary system or a **cystoscopy** (examination with a telescope-like instrument) will identify them. Often, the two procedures are done together: a urologist will perform the cystoscopy, then a radiologist will instill a contrast agent into the bladder and take x rays.

Treatment

Surgery is necessary and can usually produce successful results. If possible, the surgery must be done within 48 hours of birth. Prior to surgery, the exposed organs must be protected and all related defects identified and managed. Delay in the surgery leads to the frequent need to divert the urine into the bowel because the partially repaired bladder cannot control the flow. After surgery, the likelihood of infection requires monitoring.

Alternative treatment

After surgery ongoing precautions to reduce frequency of infection may need to be used. Cranberry juice has the ability to keep bacteria from adhering to the membranes and can help prevent infection whenever there is increased risk. There are botanical and homeopathic treatments available, however consultation by a trained practitioner is recommended before treatment.

Prognosis

With immediate surgery, three-quarters of patients can be successfully repaired. They will have control of their urine and no long-term consequences. The rate of infection is greater for those with congenital bladder anomalies, since any abnormality in the urinary system predisposes it to invasion by bacteria.

Prevention

Birth defects often have no precisely identified cause, therefore prevention is limited to general measures such as early and continuous prenatal care, appropriate nutrition, and a healthy lifestyle.

KEY TERMS

Congenital—Present at birth.

Cystoscopy—Examination of the urinary bladder with a thin telescope-like instrument.

Exstrophy—Being turned inside out combined with being outside the body.

Diverticulum—A pouch extending from a hollow organ.

Radiologist—A physician who specializes in creating images of the internal organs of the body.

Teratogen—Any agent that can cause birth defects.

Ureter—The tube that transports urine from the kidney to the bladder.

Ureterovesical junction—The joining of the ureter to the bladder.

Urologist—A surgeon who specializes in diseases of the urinary system.

Resources

BOOKS

"Anomalies of the Bladder." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Atala, Anthony, and Michael Keating. "Vesicoureteral Reflux and Megaureter." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Gearhart, John P., and Robert D. Jeffs. "Exstrophy-epispadias Complex and Bladder Anomalies." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

"Vesicoureteral Reflux." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Congenital brain defects

Definition

Congenital brain defects are a group of disorders of brain development.

Description

Brain development begins shortly after conception and continues throughout the growth of a fetus. A com-

plex genetic program coordinates the formation, growth, and migration of billions of neurons, or nerve cells, and their development into discrete, interacting brain regions. Interruption of this program, especially early in development, can cause structural defects in the brain. In addition, normal brain formation requires proper development of the surrounding skull, and skull defects may lead to brain malformation. Congenital brain defects may be caused by inherited genetic defects, spontaneous mutations within the genes of the embryo, or effects on the embryo due to the mother's infection, trauma, or drug use.

Early on in development, a flat strip of tissue along the back of the fetus rolls up to form a tube. This so-called "neural tube" develops into the spinal cord, and at one end, the brain. Closure of the tube is required for subsequent development of the tissue within. Anencephaly (literally "without brain"), results when the topmost portion of the tube fails to close. Anencephaly is the most common severe malformation seen in stillborn births. It is about four times more common in females than males. Anencephaly is sometimes seen to run in families, and for parents who have conceived one anencephalic fetus, the risk of a second is as high as 5%. Fewer than half of babies with anencephaly are born alive, and survival beyond the first month is rare.

Encephalocele is a protrusion of part of the brain through a defect in the skull. The most common site for encephalocele is along the front-to-back midline of the skull, usually at the rear, although frontal encephaloceles are more common among Asians. Pressure within the skull pushes out cranial tissue. The protective layer over the brain, the meninges, grows to cover the protrusion, as does skin in some cases. Defects in skull closure are thought to cause some cases of encephalocele, while defects in neural tube closure may cause others. Encephaloceles may be small and contain little or no brain tissue, or may be quite large and contain a significant fraction of the brain.

Failure of neural-tube closure below the level of the brain prevents full development of the surrounding vertebral bones and leads to **spina bifida**, or a divided spinal column. Incomplete closure causes protrusion of the spinal cord and meninges, called meningomyelocele. Some cases of spina bifida are accompanied by another defect at the base of the brain, known as the Arnold-Chiari malformation or Chiari II malformation. For reasons that are unclear, part of the cerebellum is displaced downward into the spinal column. Symptoms may be present at birth or delayed until early childhood.

The Dandy-Walker malformation is marked by incomplete formation, or absence of, the central section of the cerebellum, and the growth of cysts within the lowest of the brain's ventricles. The ventricles are fluid-filled cavities within the brain, through which cerebrospinal fluid (CSF) normally circulates. The cysts may block the exit of the fluid, causing **hydrocephalus**. Symptoms may be present at birth or delayed until early childhood.

Soon after closure of the neural tube, the brain divides into two halves, or hemispheres. Failure of division is termed holoprosencephaly (literally "whole forebrain"). Holoprosencephaly is almost always accompanied by facial and cranial deformities along the midline, including cleft lip, cleft palate, fused eye sockets and a single eye (cyclopia), and deformities of the limbs, heart, gastrointestinal tract, and other internal organs. Most infants are either stillborn or die soon after birth. Survivors suffer from severe neurological impairments.

The normal ridges and valleys of the mature brain are formed after cells from the inside of the developing brain migrate to the outside and multiply. When these cells fail to migrate, the surface remains smooth, a condition called lissencephaly ("smooth brain"). Lissencephaly is often associated with facial abnormalities including a small jaw, a high forehead, a short nose, and low-set ears.

If damaged during growth, especially within the first 20 weeks, brain tissue may stop growing, while tissue around it continues to form. This causes an abnormal cleft or groove to appear on the surface of the brain, called schizencephaly (literally "split brain"). This cleft should not be confused with the normal wrinkled brain surface, nor should the name be mistaken for **schizophrenia**, a mental disorder. Generalized destruction of tissue or lack of brain development may lead to hydranencephaly, in which cerebrospinal fluid fills much of the space normally occupied by the brain. Hydranencephaly is distinct from hydrocephalus, in which CSF accumulates within a normally-formed brain, putting pressure on it and possibly causing skull expansion.

Excessive brain size is termed megalencephaly (literally "big brain"). Megalencephaly is defined as any brain size above the 98th percentile within the population. Some cases are familial, and may be entirely benign. Others are due to metabolic or neurologic disease. The opposite condition, microcephaly, may be caused by failure of the brain to develop, or by intrauterine infection, drug toxicity, or brain trauma.

Causes and symptoms

Causes

Congenital brain defects may have genetic, infectious, toxic, or traumatic causes. In most cases, no certain cause can be identified.

GENETIC CAUSES. Some brain defects are caused by trisomy, the inclusion of a third copy of a chromosome normally occurring in pairs. Most trisomies occur because of improper division of the chromosomes during formation of eggs or sperm. Trisomy of chromosome 9 can cause some cases of Dandy-Walker and Chiari II malformation. Some cases of holoprosencephaly are caused by trisomy of chromosome 13, while others are due to abnormalities in chromosomes 7 or 18. Individual gene defects, either inherited or spontaneous, are responsible for other cases of congenital brain malformations.

DRUGS. Drugs known to cause congenital brain defects when used by the mother during critical developmental periods include:

- anticonvulsant drugs
- retinoic acid and tretinoin
- warfarin
- alcohol
- cocaine

OTHER. Other causes of congenital brain defects include:

- intrauterine infections, including cytomegalovirus, **rubella**, herpes simplex, and varicella zoster
- maternal **diabetes mellitus**
- maternal **phenylketonuria**
- fetal trauma

Symptoms

Besides the features listed above, symptoms of congenital brain defects may include:

- Chiari II malformation: impaired swallowing and gag reflex, loss of the breathing reflex, facial **paralysis**, uncontrolled eye movements (**nystagmus**), impaired balance and gait.
- Dandy-Walker malformation: symptoms of hydrocephalus, lack of muscle tone or "floppiness," seizures, spasticity, deafness, irritability, **visual impairment**, deterioration of consciousness, paralysis.
- Lissencephaly: lack of muscle tone, seizures, developmental delay, spasticity, **cerebral palsy**.
- Hydranencephaly: irritability, spasticity, seizures, temperature oscillations.
- megalencephaly due to neurological or metabolic disease: **mental retardation**, seizures.

KEY TERMS

Amniocentesis—Removal of fluid from the sac surrounding a fetus for purposes of diagnosis.

Cerebrospinal fluid—Fluid produced within the brain for nutrient transport and structural purposes. CSF circulates through the ventricles, open spaces within the brain, and drains through the membranes surrounding the brain.

Congenital—Defect present at birth.

Fetus—The unborn human, developing in a woman's uterus, from the eighth week after fertilization to birth.

Diagnosis

Congenital brain defects are diagnosed either from direct **physical examination** or imaging studies including **computed tomography scans** (CT) and **magnetic resonance imaging** (MRI) scans. **Electroencephalography** (EEG) may be used to reveal characteristic abnormalities.

Prenatal diagnosis of neural tube defects causing anencephaly or meningomyelocele is possible through ultrasound examination and maternal blood testing for alpha-fetoprotein, which is almost always elevated. Ultrasound can also be used to diagnose Dandy-Walker and Chiari II malformations. **Amniocentesis** may reveal trisomies or other chromosomal abnormalities.

Treatment

Meningomyelocele may be treated with surgery to close the open portion of the spinal cord. Surgery for encephalocele is possible only if there is a minimal amount of brain tissue protruding. Malformations associated with hydrocephalus (Dandy-Walker, Chiari II, and some cases of hydranencephaly) may be treated by installation of a drainage shunt for cerebrospinal fluid. Drugs may be used to treat some symptoms of brain defects, including seizures and spasticity.

Prognosis

Most congenital brain defects carry a very poor prognosis. Surgical treatment of meningomyelocele and encephalocele may be successful, with lasting neurologi-

cal deficiencies that vary in severity. Early treatment of hydrocephalus may prevent more severe brain damage.

Prevention

Some cases of congenital brain defects can be prevented with good maternal **nutrition**, including **folic acid** supplements. Folic acid is a vitamin that has been shown to reduce the incidence of neural tube defects. Pregnant women should avoid exposure to infection, especially during the first trimester. Abstention from drugs and alcohol during **pregnancy** may reduce risk. **Genetic counseling** is advisable for parents who have had one child with anencephaly, since the likelihood of having another is increased.

Resources

BOOKS

Bradley, W. G., et al. *Neurology in Clinical Practice*. 2nd ed. Butterworth-Heinemann, 1996.

Fenichel, G. M. *Clinical Pediatric Neurology.* 3rd ed. W. B. Saunders Co., 1997.

Norman, M. G., et al. *Congenital Malformations of the Brain.* Oxford University Press, 1995.

Richard Robinson

Congenital defects *see* **Birth defects**

Congenital hip dysplasia

Definition

A condition of abnormal development of the hip, resulting in hip joint instability and potential dislocation of the thigh bone from the socket in the pelvis. This condition has been more recently termed developmental hip dysplasia, as it often develops over the first few weeks, months, or years of life.

Description

Congenital hip dysplasia is a disorder in children that is either present at birth or shortly thereafter. During gestation, the infant's hip should be developing with the head of the thigh bone (femur) sitting perfectly centered in its shallow socket (acetabulum). The acetabulum should cover the head of the femur as if it were a ball sitting inside of a cup. In the event of congenital hip dysplasia, the development of the acetabulum in an infant allows the femoral head to ride upward out of the joint socket, especially when weight bearing begins.

Causes and symptoms

Clinical studies show a familial tendency toward hip dysplasia, with more females affected than males. This disorder is found in many cultures around the world. However, statistics show that the Native American population has a high incidence of hip dislocation. This has been documented to be due to the common practice of swaddling and using cradleboards for restraining the infants. This places the infant's hips into extreme adduction (brought together). The incidence of congenital hip dysplasia is also higher in infants born by caesarian and breech position births. Evidence also shows a greater chance of this hip abnormality in the first born compared to the second or third child. Hormonal changes within the mother during **pregnancy**, resulting in increased ligament laxity, is thought to possibly cross over to the placenta and cause the baby to have lax ligaments while still in the womb. Other symptoms of complete dislocation include a shortening of the leg and limited ability to abduct the leg.

Diagnosis

Because the abnormalities of this hip problem often vary, a thorough **physical examination** is necessary for an accurate diagnosis of congenital hip dysplasia. The hip disorder can be diagnosed by moving the hip to determine if the head of the femur is moving in and out of the hip joint. One specific method, called the Ortolani test, begins with each of the examiners' hands around the infant's knees, with the second and third fingers pointing down the child's thigh. With the legs abducted (moved apart), the examiner may be able to discern a distinct clicking sound with motion. If symptoms are present with a noted increase in abduction, the test is considered positive for hip joint instability. It is important to note this test is only valid a few weeks after birth.

The Barlow method is another test performed with the infant's hip brought together with knees in full bent position. The examiner's middle finger is placed over the outside of the hipbone while the thumb is placed on the inner side of the knee. The hip is abducted to where it can be felt if the hip is sliding out and then back in the joint. In older babies, if there is a lack of range of motion in one hip or even both hips, it is possible that the movement is blocked because the hip has dislocated and the muscles have contracted in that position. Also in older infants, hip dislocation is evident if one leg looks shorter than the other.

X-ray films can be helpful in detecting abnormal findings of the hip joint. X rays may also be helpful in finding the proper positioning of the hip joint for treatments of

casting. Ultrasound has been noted as a safe and effective tool for the diagnosis of congenital hip dysplasia. Ultrasound has advantages over x rays, as several positions are noted during the ultrasound procedure. This is in contrast to only one position observed during the x ray.

Treatment

The objective of treatment is to replace the head of the femur into the acetabulum and, by applying constant pressure, to enlarge and deepen the socket. In the past, stabilization was achieved by placing rolled cotton diapers or a pillow between the thighs, thereby keeping the knees in a frog like position. More recently, the Pavlik harness and von Rosen splint are commonly used in infants up to the age of six months. A stiff shell cast may be used, which achieves the same purpose, spreading the legs apart and forcing the head of the femur into the acetabulum. In some cases, in older children between six to 18 months, surgery may be necessary to reposition the joint. Also at this age, the use of closed manipulation may be applied successfully, by moving the leg around manually to replace joint. Operations are not only performed to reduce the dislocation of the hip, but also to repair a defect in the acetabulum. A cast is applied after the operation to hold the head of the femur in the correct position. The use of a home **traction** program is now more common. However, after the age of eight years, surgical procedures are primarily done for **pain** reduction measures only. Total hip surgeries may be inevitable later in adulthood.

Alternative treatment

Nonsurgical treatments include **exercise** programs, orthosis (a force system, often involving braces), and medications. A physical therapist may develop a program that includes strengthening, range-of-motion exercises, pain control, and functional activities. **Chiropractic** medicine may be helpful, especially the procedures of closed manipulations, to reduce the dislocated hip joint.

Prognosis

Unless corrected soon after birth, abnormal stresses cause malformation of the developing femur, with a characteristic limp or waddling gait. If cases of congenital hip dysplasia go untreated, the child will have difficulty walking, which could result in life-long pain. In addition, if this condition goes untreated, the abnormal hip positioning will force the acetabulum to locate to another position to accommodate the displaced femur.

Prevention

Prevention includes proper prenatal care to determine the position of the baby in the womb. This may be helpful in preparing for possible breech births associated with hip problems. Avoiding excessive and prolonged infant hip adduction may help prevent strain on the hip joints. Early diagnosis remains an important part of prevention of congenital hip dysplasia.

KEY TERMS

Acetabulum—The large cup-shaped cavity at the junction of pelvis and femur or thigh bone.

Orthosis—A force system designed to control or correct or compensate for a bone deformity, deforming forces, or forces absent from the body.

Resources

BOOKS

Chandrasoma, Parakrama, and Clive R. Taylor. *Concise Pathology.* East Norwalk, CT: Appleton & Lange, 1991.

PERIODICALS

Feeney, Tracy. "Early Intervention: Key to Success in Treatment of Infants with Hip Dysplasia." *Advance For Physical Therapy* (Nov. 1995).

Jamali, Mohammed and Kymberly McCoy. "Developmental Dysplasia of the Hip." *Advance For Physical Therapy* 8, no. 18 (May 1998).

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

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Congenital lobar emphysema

Definition

Congenital lobar **emphysema** is a chronic disease that causes respiratory distress in infants.

Description

Congenital lobar emphysema, also called infantile lobar emphysema, is a respiratory disease that occurs in infants when air enters the lungs but cannot leave easily. The lungs become over-inflated, causing respiratory function to decrease and air to leak out into the space around the lungs.

KEY TERMS

Congenital—A disease or condition that is present at birth.

Emphysema—A condition in which the air sacs in the lungs become overinflated, causing a decrease in respiratory function.

Lobar—Relating to a lobe, a rounded projecting part of the lungs.

Half of the cases of congenital lobar emphysema occur in the first four weeks of life, and three-quarters occur in infants less than six months old. Congenital lobar emphysema is more common in boys than in girls.

Each person has two lungs, right and left. The right lung is divided into three sections, called lobes, and the left lung into two lobes. Congenital lobar emphysema usually affects only one lobe, and this is usually an upper lobe. It occurs most frequently in the left upper lobe, followed by the right middle lobe.

Causes and symptoms

The cause of congenital lobar emphysema often cannot be identified. The airway may be obstructed or the infant's lungs may not have developed properly. Congenital lobar emphysema is almost never of genetic origin.

Symptoms of congenital lobar emphysema include:

- shortness of breath
- wheezing
- lips and fingernail beds that have a bluish tinge

Diagnosis

Congenital lobar emphysema is usually identified within the first two weeks of the infant's life. It is diagnosed by respiratory symptoms and a **chest x ray**, which shows the over-inflation of the affected lobe and may show a blocked air passage.

Treatment

For infants with no, mild, or intermittent symptoms, no treatment is necessary. For more serious cases of congenital lobar emphysema, surgery is necessary, usually a lobectomy to remove the affected lung lobe.

Alternative treatment

Alternative treatments that may be helpful for congenital lobar emphysema are aimed at supporting and strengthening the patient's respiratory function. Vitamin and mineral supplementation may be recommended as may herbal remedies such as lobelia (*Lobelia inflata*) that strengthen the lungs and enhance their elasticity. Homeopathic constitutional care may also be beneficial for this condition.

Prognosis

Surgery for congenital lobar emphysema has excellent results.

Prevention

Congenital lobar emphysema cannot be prevented.

Resources

BOOKS

Baum, Gerald L., et al., eds. *Textbook of Pulmonary Diseases*. Philadelphia: Lippincott-Raven, 1998.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Jewish Center for Immunology and Respiratory Medicine. 1400 Jackson St., Denver, CO 80206. (800) 222-5864. <http://www.nationaljewish.org/main.html>.

Lori De Milto

Congenital megacolon *see* **Hirschsprung's disease**

Congenital thymic hypoplasia *see* **DiGeorge syndrome**

Congenital ureter anomalies

Definition

The ureter drains urine from the kidney into the bladder. It is not simply a tube but an active organ that propels urine forward by muscular action. It has a valve at its bottom end that prevents urine from flowing backward into the kidney. Normally, there is one ureter on each side of the body for each kidney. However, among the many abnormalities of ureteral development, duplication is quite common. Ureters may also be malformed in a variety of ways—some harmful, others not.

Description

The urogenital system, for some reason, is more likely than any other to have **birth defects**, and they can occur in endless variety. Ureters can be duplicated completely or partially, they can be in the wrong place, they can be deformed, and they can end in the wrong place. The trouble these abnormalities bring is directly related to their effect on the flow of urine. As long as urine flows normally through them, and only in one direction, no harm is done.

- Duplication of ureters is quite common, either in part or completely. Kidneys are sometimes duplicated as well. Someone may have four kidneys and four ureters or two kidneys, half of each drained by a separate ureter, or a single kidney with two, three, or four ureters attached. As long as urine can flow easily in the correct direction, such malformations may never be detected. If, however, one of the ureters has a dead end, a stricture or stenosis (narrowing), or a leaky ureterovesical valve (valve between the ureter and bladder), infection is the likely result.
- Stricture or stenosis of a ureter prevents urine from flowing freely. Whenever flow is obstructed in the body—urine, bile, mucus, or any other liquid—infection follows. Ureters can be obstructed anywhere along their course, though the ureterovesical valve is the most common place.
- A ureter may have an ectopic (out of place) orifice (opening)—it may enter the bladder, or even another structure, where it does not belong and therefore without an adequate valve to control reflux.
- The primary ureter, or a duplicate, may not even reach the bladder, but rather terminate in a dead end. Urine will stagnate there and eventually cause infection.
- A ureter can be perfectly normal but in the wrong place, such as behind the vena cava (the large vein in the middle of the abdomen). A so-called retrocaval ureter may be pinched by the vena cava so that flow is hindered. Other aberrant locations may also lead to compression and impaired flow.

Besides infection, urine that backs up will cause the ureter and the kidney to dilate. Eventually, the kidney will stop functioning because of the back pressure. This condition is called hydronephrosis—a kidney swollen with urine.

Causes and symptoms

The causes of birth defects are multiple and often unknown. Furthermore, the precise cause of specific birth defects has only rarely been identified. Such is the case with congenital ureteral anomalies.

KEY TERMS

Congenital—Present at birth.

Contrast agent—A chemical or other substance placed in the body to show structures that would not otherwise be visible on x ray or other imaging studies.

Cystoscopy—Looking into the urinary bladder with a thin telescope-like instrument.

Ectopic—Out of place.

Septicemia—A serious whole body infection spreading through the blood stream.

Uretreovesical valve—A sphincter (an opening controlled by a circular muscle), located where the ureter enters the bladder, that keeps urine from flowing backward toward the kidney.

Urogenital—Both the urinary system and the sexual organs, which form together in the developing embryo.

Practically the only symptom generated by ureteral abnormalities is urinary tract infection. A lower tract infection—in the bladder—is called **cystitis**. In children, it may cause **fever** and systemic symptoms, but in adults it causes only cloudy, burning, and frequent urine. Upper tract infections, on the other hand, can be serious for both adults and children, causing high fevers, back **pain**, severe generalized discomfort, and even leading to kidney failure or septicemia (infection spreading throughout the body by way of the blood stream).

In rare cases, urine from an ectopic ureter will bypass the bladder and dribble out of the bottom somewhere, through a natural orifice like the vagina or a completely separate unnatural opening.

Diagnosis

Serious or recurrent urinary infections will prompt a search for underlying abnormalities. **Cystoscopy** (looking into the bladder with a thin telescope-like instrument) and x rays with a contrast agent to illuminate the urinary system will usually identify the defect. **Computed tomography scans** (CT) and **magnetic resonance imaging** (MRI) scans may provide additional information. Urine cultures to identify the infecting germs will be repeated frequently until the problem is corrected.

Treatment

Sometimes the recurring infections caused by flow abnormalities can be treated with repeated and changing

courses of **antibiotics**. Over time, the infecting germs develop resistance to most treatments, especially the safer ones. If it can be done with acceptable risk, it is better to repair the defect surgically. Urologists have an arsenal of approaches to urine drainage that range from simply reimplanting a ureter into the bladder, in such a way that an effective valve is created, to building a new bladder out of a piece of bowel.

Alternative treatment

There are botanical and homeopathic treatments available for urinary tract infection. None can take the place of correcting a problem that is occurring because of a malformed or dysfunctional organ system. Once correction of the cause is addressed and there is unimpeded flow of urine, adequate fluid intake can contribute to prevention of future infections.

Prognosis

As long as damage to the kidneys from infection or back pressure has not become significant, the surgical repair of troublesome ureteral defects produces excellent long-term results in the great majority of cases. Monitoring for recurrent infections is always a good idea, and occasional checking of kidney function will detect hidden ongoing damage.

Resources

BOOKS

Bauer, Stuart B. "Anomalies of the Kidney and Ureteropelvic Junction." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Vesicoureteral Reflux." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Schlussel, Richard N., and Alan B. Retik. "Anomalies of the Ureter." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

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Congestive cardiomyopathy

Definition

Cardiomyopathy is an ongoing disease process that damages the muscle wall of the lower chambers of the heart. Congestive cardiomyopathy is the most common form of cardiomyopathy. In congestive cardiomyopathy, also called dilated cardiomyopathy, the walls of the heart chambers stretch (dilate) to hold a greater volume of blood than normal. Congestive cardiomyopathy is the final stage of many heart diseases and the most common condition resulting in congestive **heart failure**.

Description

About 50,000 Americans develop cardiomyopathy each year. Of those, 87% have congestive cardiomyopathy. Primary cardiomyopathy accounts for only 1% of all deaths from heart disease.

When the heart muscle is damaged by a disease process, it cannot pump enough blood to meet the body's needs. Uninjured areas of the walls of the two lower heart chambers (called ventricles) stretch to make up for the lost pumping action. At first, the enlarged chambers allow more blood to be pumped with less force. The stretched muscle can also contract more forcefully. Over time, the heart muscle continues to stretch, ultimately becoming weaker. The heart is forced to work harder to pump blood by beating faster. Eventually it cannot keep up, and blood backs up into the veins, legs, and lungs. When this happens, the condition is called congestive heart failure.

Congestive cardiomyopathy usually affects both ventricles. Blood backed up into the lungs from the left ventricle causes fluid to congest the lung tissue. This is called **pulmonary edema**. When the right ventricle fails to pump enough blood, blood backs up into the veins causing **edema** in the legs, feet, ankles, and abdomen.

Causes and symptoms

Congestive cardiomyopathy may be caused by a number of conditions. Cardiomyopathy with a known cause is called secondary cardiomyopathy. When no cause can be identified, it is called primary cardiomyopathy or idiopathic cardiomyopathy. About 80% of all cases of cardiomyopathy do not have a known cause. Many heart specialists think that many cases of idiopathic congestive cardiomyopathy may be caused by a viral infection. Because cardiomyopathy may occur many years after a viral infection and viruses sometimes go undetected in laboratory tests, it is difficult to know if a virus is the cause. Some people have a weak heart from advanced **coronary artery disease** that causes heart muscle damage. This is sometimes called ischemic cardiomyopathy.

Conditions that can cause congestive cardiomyopathy are:

- Coronary artery disease
- Infections

KEY TERMS

Angiotensin-converting enzyme (ACE) inhibitor—A drug that relaxes blood vessel walls and lowers blood pressure.

Atherosclerosis—Buildup of a fatty substance called a plaque inside blood vessels.

Cardiac catheterization—A diagnostic test for evaluating heart disease; a catheter is inserted into an artery and passed into the heart.

Cardiomyopathy—Disease of the heart muscle.

Congestive cardiomyopathy—Also called dilated cardiomyopathy; cardiomyopathy in which the walls of the heart chambers stretch, enlarging the heart ventricles so they can hold a greater volume of blood than normal.

Coxsackievirus B—A type of virus in the group Enterovirus that causes an infection similar to polio, but without paralysis.

Digitalis—A drug that helps the heart muscle to have stronger pumping action.

Dilated cardiomyopathy—Also called congestive cardiomyopathy; cardiomyopathy in which the walls of the heart chambers stretch, enlarging the heart ventricles so they can hold a greater volume of blood than normal.

Diuretic—A type of drug that helps the kidneys eliminate excess salt and water.

Edema—Swelling caused by fluid buildup in tissues.

Granulomatous myocarditis—Also called giant cell myocarditis, this noninfectious inflammation of the heart causes large areas of tissue death in the heart muscle, ventricular enlargement, and clots inside the heart chambers.

Idiopathic cardiomyopathy—Cardiomyopathy without a known cause.

Sarcoidosis—A chronic disease that causes formation of abnormal areas containing inflammatory cells, called granulomas, in any organ or tissue; in the heart, large areas of the heart muscle can be involved, causing cardiomyopathy.

Vasodilator—Any drug that relaxes blood vessel walls.

Ventricle—One of the two lower chambers of the heart.

Wegener's granulomatosis—A disease usually affecting males that causes the infiltration of inflammatory cells and tissue death in the lungs, kidneys, blood vessels, heart, and other tissues.

- noninfectious inflammatory conditions
- alcohol and other drugs or toxins
- **hypertension**
- nutritional and metabolic disorders
- **pregnancy**.

Coronary artery disease is one of the most common causes of congestive cardiomyopathy. In coronary artery disease, the arteries supplying blood to the heart become narrowed or blocked. When blood flow to an area of the heart is completely blocked, the person has a **heart attack**. The heart muscle suffers damage when its blood supply is reduced or blocked. Significant recurrent muscle damage can occur silently. This damage can lead to congestive cardiomyopathy.

Infections caused by bacteria, viruses, and other microorganisms can involve the heart, causing inflammation of the heart muscle (**myocarditis**). The inflammation may damage the heart muscle and cause congestive cardiomyopathy. In the United States, the coxsackievirus B is the most common cause of viral congestive cardiomyopathy.

Myocarditis can also be caused by noninfectious disorders. For example, the conditions **sarcoidosis**, granulomatous myocarditis, and **Wegener's granulomatosis** cause inflammation and tissue **death** in the heart muscle.

Years of drinking excessive amounts of alcohol can weaken the heart muscle, leading to congestive cardiomyopathy. Other drugs and toxins, such as **cocaine**, pesticides, and other chemicals, may have the same effect.

High blood pressure (hypertension) puts extra pressure on blood vessels and the heart. This increased pressure makes the heart work harder to pump blood, which may thicken and damage the chamber walls.

Severe nutritional deficiencies can weaken the heart muscle and affect its pumping ability. Certain disorders of metabolism, including **diabetes mellitus** and thyroid disorders, can also lead to congestive cardiomyopathy.

Occasionally, inflammation of the heart muscle and congestive cardiomyopathy may develop late in pregnan-

cy or shortly after a woman gives birth. This type of congestive cardiomyopathy is called peripartum cardiomyopathy. The cause of congestive cardiomyopathy in pregnancy is not known.

Congestive cardiomyopathy usually is a chronic condition, developing gradually over time. Patients with early congestive cardiomyopathy may not have symptoms. The most common symptoms are **fatigue** and **shortness of breath** on exertion. Unfortunately, **sudden cardiac death** is not uncommon with this condition. It stems from irregular heart rhythms in the ventricles (ventricular **arrhythmias**).

Patients with more advanced congestive cardiomyopathy may also have chest or abdominal pains, extreme tiredness, **dizziness**, and swelling of the legs and ankles.

Diagnosis

Diagnosis of congestive cardiomyopathy is based on:

- symptoms
- medical history
- **physical examination**
- **chest x ray**
- electrocardiogram (ECG; also called EKG)
- echocardiogram
- **cardiac catheterization**

The diagnosis is based on the patient's symptoms, a complete physical examination, and tests that detect abnormalities of the heart chambers. The physician listens to the heart with a stethoscope to detect abnormal heart rhythms and heart sounds. A heart murmur might mean that the heart valves are not closing properly due to the ventricles being enlarged.

A chest x ray can show if the heart is enlarged and if there is fluid in the lungs. Abnormalities of heart valves and other structures may also be seen on a chest x ray.

An electrocardiogram provides a record of electrical changes in the heart muscle during the heartbeat. It gives information on the heart rhythm and can show if the heart chamber is enlarged. An ECG can detect damage to the heart muscle and the amount of damage.

Echocardiography uses sound waves to make images of the heart. These images can show if the heart wall or chambers are enlarged and if there are any abnormalities of the heart valves. Echocardiography can also evaluate the pumping efficiency of the ventricles.

Cardiac catheterization usually is only used if a diagnosis cannot be made with other methods. In cardiac catheterization, a small tube (called a catheter) is inserted into an artery and passed into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart. A small tissue sample of the heart muscle can be removed through the catheter for examination under a microscope (biopsy). This biopsy can show the type and amount of damage to the heart muscle.

Treatment

When a patient is diagnosed with congestive cardiomyopathy, physicians try to find out the cause. If coronary artery disease is not the culprit, in most other cases a cause is not identified. When a condition responsible for the congestive cardiomyopathy is diagnosed, treatment is aimed at correcting the underlying condition. Congestive cardiomyopathy caused by drinking excess alcohol or by drugs or toxins can be treated by eliminating the alcohol or toxin completely. In some cases, the heart may recover after the toxic substance is removed from the body. Bacterial myocarditis is treated with an antibiotic to eliminate the bacteria.

There is no cure for idiopathic congestive cardiomyopathy. Medicines are given to reduce the workload of the heart and to relieve the symptoms.

One or more of the following types of medicines may be prescribed for congestive cardiomyopathy:

- digitalis
- **diuretics**
- **vasodilators**
- **beta blockers**
- angiotensin converting enzyme inhibitors (ACE inhibitors)
- angiotensin receptor blockers

Digitalis helps the heart muscle to have stronger pumping action. Diuretics help eliminate excess salt and water from the kidneys by making patients urinate more often. This helps reduce the swelling caused by fluid buildup in the tissues. Vasodilators, beta blockers, and ACE inhibitors lower blood pressure and expand the blood vessels so blood can move more easily through them. This action makes it easier for the heart to pump blood through the vessels.

Patients may also be given anticoagulant medications to prevent clots from forming due to pooling of blood in the heart chambers. Medicines to prevent abnormal heart rhythms (arrhythmias) may be given, but some of these drugs can also reduce the force of heart contractions. Automatic implantable cardioverter defibrillators (AICDs) can treat life-threatening arrhythmias, which are relatively common in severe cardiomyopathy.

Certain lifestyle changes may help reduce the workload on the heart and relieve symptoms. Some patients may need to change their diet, stop drinking alcohol, begin a physician-supervised **exercise** program, and/or stop **smoking**.

Severe congestive cardiomyopathy usually causes heart failure. When the heart muscle is damaged so severely that medicines cannot help, a heart transplant may be the only remaining treatment to be considered.

Prognosis

The outlook for a patient with congestive cardiomyopathy depends on the severity of the disease and the person's health. Generally, congestive cardiomyopathy worsens over time and the prognosis is not good. About 50% of patients with congestive cardiomyopathy live for five years after the diagnosis. Twenty five percent of patients are alive 10 years after diagnosis. Women with congestive cardiomyopathy live twice as long as men with the disease. Many of the deaths are caused by sudden abnormal heart rhythms.

Prevention

Because idiopathic congestive cardiomyopathy does not have a known cause, there is no sure way to prevent it. The best way to prevent congestive cardiomyopathy is to avoid known causes such as drinking excess alcohol or taking toxic drugs. Eating a nutritious diet and getting regular exercise to improve overall fitness also can help the heart to stay healthy.

Congestive cardiomyopathy may also be prevented by identifying and treating any conditions that might damage the heart muscle. These include high blood pressure and coronary artery disease. Regular blood pressure checks and obtaining immediate medical care for hypertension and symptoms of coronary artery disease, such as chest **pain**, are important to keep the heart functioning properly.

Finally, diagnosing and treating congestive cardiomyopathy before the heart becomes severely damaged may improve the outlook.

Resources

BOOKS

Bellenir, Karen, and Peter D. Dresser, eds. *Cardiovascular Diseases and Disorders Sourcebook.* Detroit: Omnigraphics, 1995.

Texas Heart Institute. *Heart Owner's Handbook.* New York: John Wiley and Sons, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Toni Rizzo

Congestive heart failure *see* **Heart failure**

Congenital heart disease

Definition

Congenital heart disease, also called congenital heart defect, includes a variety of malformations of the heart or its major blood vessels that are present at birth.

Description

Congenital heart disease occurs when the heart or blood vessels near the heart do not develop properly before birth. Some infants are born with mild types of congenital heart disease, but most need surgery in order to survive. Patients who have had surgery are likely to experience other cardiac problems later in life.

Most types of congenital heart disease obstruct the flow of blood in the heart or the nearby vessels, or cause an abnormal flow of blood through the heart. Rarer types of congenital heart disease occur when the newborn has only one ventricle, or when the pulmonary artery and the aorta come out of the same ventricle, or when one side of the heart is not completely formed.

Patent ductus arteriosus

Patent ductus arteriosus refers to the opening of a passageway—or temporary blood vessel (ductus)—to carry the blood from the heart to the aorta before birth, allowing blood to bypass the lungs, which are not yet functional. The ductus should close spontaneously in the first few hours or days after birth. When it does not close in the newborn, some of the blood that should flow through the aorta then returns to the lungs. Patent ductus arteriosus is common in premature babies, but rare in full-term babies. It has also been associated with mothers who had German **measles** (**rubella**) while pregnant.

Hypoplastic left heart syndrome

Hypoplastic left heart syndrome, a condition in which the left side of the heart is underdeveloped, is rare, but it is the most serious type of congenital heart disease.

With this syndrome, blood reaches the aorta, which pumps blood to the entire body, only from the ductus, which then normally closes within a few days of birth. In hypoplastic left heart syndrome, the baby seems normal at birth, but as the ductus closes, blood cannot reach the aorta and circulation fails.

Obstruction defects

When heart valves, arteries, or veins are narrowed, they partly or completely block the flow of blood. The most common obstruction defects are **pulmonary valve stenosis**, **aortic valve stenosis**, and **coarctation of the aorta**. Bicuspid aortic valve and subaortic stenosis are less common.

Stenosis is a narrowing of the valves or arteries. In pulmonary stenosis, the pulmonary valve does not open properly, forcing the right ventricle to work harder. In aortic stenosis, the improperly formed aortic valve is narrowed. As the left ventricle works harder to pump blood through the body, it becomes enlarged. In coarctation of the aorta, the aorta is constricted, reducing the flow of blood to the lower part of the body and increasing blood pressure in the upper body.

A bicuspid aortic valve has only two flaps instead of three, which can lead to stenosis in adulthood. Subaortic stenosis is a narrowing of the left ventricle below the aortic valve, that limits the flow of blood from the left ventricle.

Septal defects

When a baby is born with a hole in the septum (the wall separating the right and left sides of the heart), blood leaks from the left side of the heart to the right, or from a higher pressure zone to a lower pressure zone. A major leakage can lead to enlargement of the heart and failing circulation. The most common types of septal defects are **atrial septal defect**, an opening between the two upper heart chambers, and **ventricular septal defect**, an opening between the two lower heart chambers. Ventricular septal defect accounts for about 15% of all cases of congenital heart disease in the United States.

Cyanotic defects

Heart disorders that cause a decreased, inadequate amount of oxygen in blood pumped to the body are called cyanotic defects. Cyanotic defects, including truncus arteriosus, total anomalous pulmonary venous return, **tetralogy of Fallot**, **transposition of the great arteries**, and tricuspid atresia, result in a blue discoloration of the skin due to low oxygen levels. About 10% of cases of congenital heart disease in the United States are tetralogy of Fallot, which includes four defects. The major defects are a large hole between the ventricles, which allows oxygen-poor blood to mix with oxygen-rich blood, and narrowing at or beneath the pulmonary valve. The other defects are an overly muscular right ventricle and an aorta that lies over the ventricular hole.

In transposition (reversal of position) of the great arteries, the pulmonary artery and the aorta are reversed, causing oxygen-rich blood to re-circulate to the lungs while oxygen-poor blood goes to the rest of the body. In tricuspid atresia, the baby lacks a triscupid valve and blood cannot flow properly from the right atrium to the right ventricle.

Other defects

Ebstein's anomaly is a rare congenital syndrome that causes malformed tricuspid valve leaflets, which allow blood to leak between the right ventricle and the right atrium. It also may cause a hole in the wall between the left and right atrium. Treatment often involves repairing the tricuspid valve. Ebstein's anomaly may be associated with maternal use of the psychiatric drug lithium during **pregnancy**.

Brugada syndrome is another rare congenital heart defect that appears in adulthood and may cause sudden **death** if untreated. Symptoms, which include rapid, uneven heart beat, often appear at night. Scientists believe that Brugada syndrome is caused by mutations in the gene SCN5A, which involves cardiac sodium channels.

Infants born with DiGeorge sequence can have heart defects such as a malformed aortic arch and tetralogy of Fallot. Researchers believe DiGeorge sequence is most often caused by mutations in genes in the region 22q11.

Marfan syndrome is a connective tissue disorder that causes tears in the aorta. Since the disease also causes excessive bone growth, most Marfan syndrome patients are over six feet tall. In athletes, and others, it can lead to sudden death. Researchers believe the defect responsible for Marfan's syndrome is found in gene FBN1, on chromosome 15.

About 32,000 infants are born every year with congenital heart disease, which is the most common birth defect. About half of these cases require medical treatment. More than one million people with heart defects are currently living in the United States.

Causes and symptoms

In most cases, the causes of congenital heart disease are unknown. Genetic and environmental factors and lifestyle habits can all be involved. The likelihood of hav-

ing a child with a congenital heart disease increases if the mother or father, another child, or another relative had congenital heart disease or a family history of sudden death. Viral infections, such as German measles, can produce congenital heart disease. Women with diabetes and **phenylketonuria** also are at higher risk of having children with congenital heart defects. Many cases of congenital heart disease result from the mother's excessive use of alcohol or taking illegal drugs, such as **cocaine**, while pregnant. The mother's exposure to certain anticonvulsant and dermatologic drugs during pregnancy can also cause congenital heart disease. There are many genetic conditions, such as **Down syndrome**, which affect multiple organs and can cause congenital heart disease.

Symptoms of congenital heart disease in general include: **shortness of breath**, difficulty feeding in infancy, sweating, **cyanosis** (bluish discoloration of the skin), heart murmur, respiratory infections that recur excessively, stunted growth, and limbs and muscles that are underdeveloped.

Symptoms of specific types of congenital heart disease are as follows:

- Patent ductus arteriosus: quick tiring, slow growth, susceptibility to **pneumonia**, rapid breathing. If the ductus is small, there are no symptoms.
- Hypoplastic left heart syndrome: ashen color, rapid and difficult breathing, inability to eat.
- Obstruction defects: cyanosis (skin that is discolored blue), chest **pain**, tiring easily, **dizziness** or **fainting**, congestive **heart failure**, and high blood pressure.
- Septal defects: difficulty breathing, stunted growth. Sometimes there are no symptoms.
- Cyanotic defects: cyanosis, sudden rapid breathing or unconsciousness, and shortness of breath and fainting during **exercise**.

KEY TERMS

Aorta—The main artery located above the heart that pumps oxygenated blood out into the body. Many congenital heart defects affect the aorta.

Congenital—Refers to a disorder that is present at birth.

Cyanotic—Marked by bluish discoloration of the skin due to a lack of oxygen in the blood. It is one of the types of congenital heart disease.

Ductus—The blood vessel that joins the pulmonary artery and the aorta. When the ductus does not close at birth, it causes a type of congenital heart disease called patent ductus arteriosus.

Electrocardiograph (ECG, EKG)—A test used to measure electrical impulses coming from the heart in order to gain information about its structure or function.

Hypoplastic—Incomplete or underdevelopment of a tissue or organ. Hypoplastic left heart syndrome is the most serious type of congenital heart disease.

Neuchal translucency—A pocket of fluid at the back of an embryo's neck visible via ultrasound that, when thickened, may indicate the infant will be born with a congenital heart defect.

Septal—Relating to the septum, the thin muscle wall dividing the right and left sides of the heart. Holes in the septum are called septal defects.

Stenosis—The constricting or narrowing of an opening or passageway.

Diagnosis

Echocardiography and cardiac **magnetic resonance imaging** (MRI) are used to confirm congenital heart disease when it is suggested by the symptoms and **physical examination**. An echocardiograph will display an image of the heart that is formed by sound waves. It detects valve and other heart problems. Fetal echocardiography is used to diagnose congenital heart disease in utero, usually after 20 weeks of pregnancy. Between 10 and 14 weeks of pregnancy, physicians also may use an ultrasound to look for a thickness at the nuchal translucency, a pocket of fluid in back of the embryo's neck, which may indicate a cardiac defect in 55% of cases. Cardiac MRI, a scanning method that uses magnetic fields and radio waves, can help physicians evaluate congenital heart disease, but is not always necessary. Physicians also may use a chest x ray to look at the size and location of the heart and lungs, or an electrocardiograph (ECG), which measures electrical impulses to create a graph of the heart beat.

Treatment

Congenital heart disease is treated with drugs and/or surgery. Drugs used include **diuretics**, which aid the baby in excreting water and salts, and digoxin, which strengthens the contraction of the heart, slows the heartbeat, and removes fluid from tissues.

Surgical procedures seek to repair the defect as much as possible and restore circulation to as close to

normal as possible. Sometimes, multiple surgical procedures are necessary. Surgical procedures include: arterial switch, balloon atrial septostomy, **balloon valvuloplasty**, Damus-Kaye-Stansel procedure, Fontan procedure, pulmonary artery banding, Ross procedure, shunt procedure, and venous switch or intra-atrial baffle.

Arterial switch, to correct transposition of the great arteries, involves connecting the aorta to the left ventricle and connecting the pulmonary artery to the right ventricle. Balloon atrial septostomy, also done to correct transposition of the great arteries, enlarges the atrial opening during heart catheterization. Balloon valvuloplasty uses a balloon-tipped catheter to open a narrowed heart valve, improving the flow of blood in pulmonary stenosis. It is sometimes used in aortic stenosis. Transposition of the great arteries can also be corrected by the Damus-Kaye-Stansel procedure, in which the pulmonary artery is cut in two and connected to the ascending aorta and the farthest section of the right ventricle.

For tricuspid atresia and pulmonary atresia, the Fontan procedure connects the right atrium to the pulmonary artery directly or with a conduit, and the atrial defect is closed. Pulmonary artery banding, narrowing the pulmonary artery with a band to reduce blood flow and pressure in the lungs, is used for ventricular septal defect, atrioventricular canal defect, and tricuspid atresia. Later, the band can be removed and the defect corrected with open-heart surgery.

To correct aortic stenosis, the Ross procedure grafts the pulmonary artery to the aorta. For tetralogy of Fallot, tricuspid atresia, or pulmonary atresia, the shunt procedure creates a passage between blood vessels, sending blood into parts of the body that need it. For transposition of the great arteries, venous switch creates a tunnel inside the atria to re-direct oxygen-rich blood to the right ventricle and aorta and venous blood to the left ventricle and pulmonary artery.

When all other options fail, some patients may need a heart transplant. Children with congenital heart disease require lifelong monitoring, even after successful surgery. The American Heart Association recommends regular dental check-ups and the preventive use of **antibiotics** to protect patients from heart infections, or **endocarditis**. Since children with congenital heart disease have slower growth, **nutrition** is important. Physicians may also limit their athletic activity.

Prognosis

The outlook for children with congenital heart disease has improved markedly in the past two decades. Many types of congenital heart disease that would have been fatal can now be treated successfully. Research on diagnosing heart defects when the fetus is in the womb may lead to future treatment to correct defects before birth. Promising new prevention methods and treatments include genetic screening and the cultivation of cardiac tissue in the laboratory that could be used to repair congenital heart defects.

Resources

BOOKS

Mayo Clinic Heart Book. New York: William Morrow and Company, 2000.

Wild, C. L., and M. J. Neary. *Heart Defects in Children: What Every Parent Should Know.* Minneapolis: Chronimed Publishing, 2000.

Williams, R. A. *The Athlete and Heart Disease*. Philadelphia: Lippincott Williams & Wilkins, 1999.

PERIODICALS

"Coping with Congenital Heart Disease in Your Baby." *American Family Physician* 59 (April 1, 1999): 1867.

Hyett, Jon, et. al. "Using Fetal Nuchal Translucency to Secreen for Major Congenital Cardiac Defects at 10–14 Weeks: Population Based Cohort Study." *Lancet* 318 (January 1999): 81-85.

ORGANIZATIONS

American Heart Association. 7272 Greenville Ave., Dallas, TX 75231-4596. (214) 373-6300 or (800) 242-8721. <inquire@heart.org>. <http://www.americanheart.org>.

Congenital Heart Disease Information and Resources. 1561 Clark Dr., Yardley, PA 19067. <http://www.tchin.org>.

Texas Heart Institute Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. (800) 292-2221. <http://www.tmc.edu/thi/his.html>.

Melissa Knopper

Conjunctivitis

Definition

Conjuctivitis is an inflammation or redness of the lining of the white part of the eye and the underside of the eyelid (conjunctiva) that can be caused by infection, allergic reaction, or physical agents like infrared or ultraviolet light.

Description

Conjunctivitis is the inflammation of the conjunctiva, a thin, delicate membrane that covers the eyeball and lines the eyelid. Conjunctivitis is an extremely common eye problem because the conjunctiva is continually

exposed to microorganisms and environmental agents that can cause infections or allergic reactions. Conjunctivitis can be acute or chronic depending upon how long the condition lasts, the severity of symptoms, and the type of organism or agent involved. It can also affect one or both eyes and, if caused by infection, can be very easily transmitted to others during close physical contact, particularly among children in a daycare center. Other names for conjunctivitis include pink eye and red eye.

Causes and symptoms

Conjunctivitis may be caused by a viral infection, such as a cold, acute respiratory infection, or disease such as **measles**, herpes simplex, or herpes zoster. Symptoms include mild to severe discomfort in one or both eyes, redness, swelling of the eyelids, and watery, yellow, or green discharge. Symptoms may last anywhere from several days to two weeks. Infection with an adenovirus, however, may also cause a significant amount of pus-like discharge and a scratchy, foreign body-type of sensation in the eye. This may also be accompanied by swelling and tenderness of the lymph nodes near the ear.

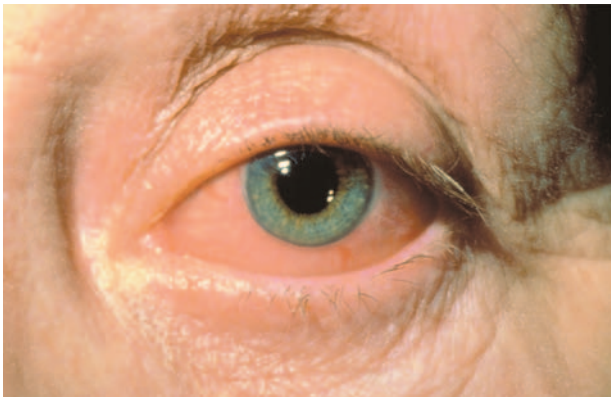
Bacterial conjunctivitis can occur in adults and children and is caused by organisms such as *Staphylococcus*, *Streptococcus*, and *Hemophilus*. Symptoms of bacterial conjunctivitis include a pus-like discharge and crusty eyelids after awakening. Redness of the conjunctiva can be mild to severe and may be accompanied by swelling. Persons with symptoms of conjunctivitis who are sexually active may possibly be infected with the bacteria that cause either **gonorrhea** or chlamydia. There may be large amounts of pus-like discharge, and symptoms may include intolerance to light (photophobia), watery mucous discharge, and tenderness in the lymph nodes near the ear that may persist for up to three months.

Conjunctivitis may also be caused by environmental hazards, such as wind, smoke, dust, and allergic reactions caused by pollen, dust, or grass. Symptoms range from **itching** and redness to a mucous discharge. Persons who wear contact lenses may develop allergic conjunctivitis caused by the various eye solutions and foreign proteins contained in them.

Other less common causes of conjunctivitis include exposure to sun lamps or the electrical arcs used during welding, and problems with inadequate drainage of the tear ducts.

Diagnosis

An accurate diagnosis of conjunctivitis centers on taking a patient history to learn when symptoms began, how long the condition has been going on, the symptoms experienced, and other predisposing factors, such as upper respiratory complaints, **allergies**, **sexually transmitted diseases**, herpes simplex infections, and exposure to persons with pink eye. It may be helpful to learn whether an aspect of an individual's occupation may be the cause, for example, welding. Diagnostic tests are usually not indicated unless initial treatment fails or an infection with gonorrhea or chlamydia is suspected. In such cases, the discharge may be cultured and Gram stained to determine the organism responsible for causing the condition. Cultures and smears are relatively painless.



This person has severe conjunctivitis, most likely caused by an allergic reaction. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

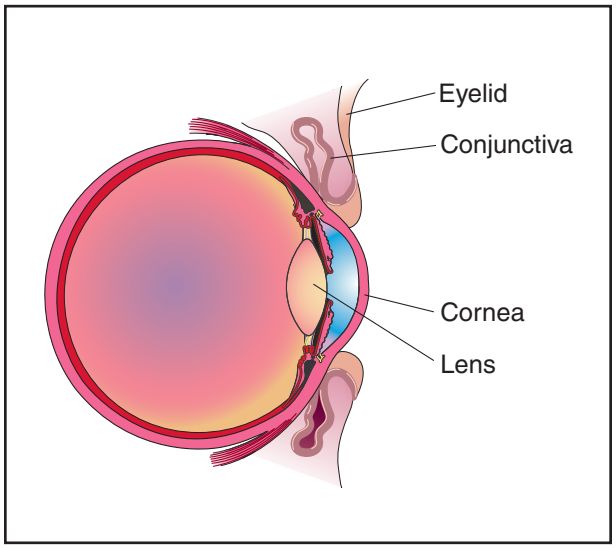
The treatment of conjunctivitis depends on what caused the condition. In all cases, warm compresses applied to the affected eye several times a day may help to reduce discomfort.

Conjunctivitis due to a viral infection, particularly those due to adenoviruses, are usually treated by applying warm compresses to the eye(s) and applying topical antibiotic ointments to prevent secondary bacterial infections.

Viral conjunctivitis caused by herpes simplex should be referred to an ophthalmologist. Topical steroids are commonly prescribed in combination with antiviral therapy.

In cases of bacterial conjunctivitis, a physician may prescribe an antibiotic eye ointment or eye drops containing sodium sulfacetamide (Sulamyd) to be applied daily for seven to 14 days. If, after 72 hours, the condition does not improve, a physician or primary care provider should be notified because the bacteria involved may be resistant to the antibiotic used or the cause may not be bacterial.

For cases of conjunctivitis caused by a gonococcal organism, a physician may prescribe an intramuscular injection of ceftriaxone (Rocephin) and a topical antibi-



Conjunctivitis is the inflammation of the conjunctiva, a thin, delicate membrane that covers the eyeball and lines the eyelid. It may be caused by a viral infection, such as a cold or acute respiratory infection, or by such diseases as measles, herpes simplex, or herpes zoster. *(Illustration by Electronic Illustrators Group.)*

otic ointment containing erythromycin or bactracin to be applied four times daily for two to three weeks. Sexual partners should also be treated.

With accompanying chlamydia infection, a topical antibiotic ointment containing erythromycin (Ilotycin) may be prescribed to be applied 1-2 times daily. In addition, oral erythromycin or tetracycline therapy may be indicated for three to four weeks. Here again, sexual partners should also be treated.

Allergic conjunctivitis can be treated by removing the allergic substance from a person's environment, if possible; by applying cool compresses to the eye; and by administering eye drops four to six times daily for four days. Also, the antihistamine diphenhydramine hydrochloride (Benadryl) may help to relieve itchy eyes.

Alternative treatment

Conjunctivitis caused by gonococcal and chlamydial infection usually requires conventional medical treatment. With bacterial, viral, and allergic conjunctivitis, however, alternative options can be helpful. Internal immune enhancement with supplementation can aid in the resolution of bacterial and viral conjunctivitis. Removal of the allergic agent is an essential step in treating allergic conjunctivitis. As with any of the recommended treatments, however, if no improvement is seen within 48–72 hours, a physician should be consulted.

Homeopathically, there are a number of acute remedies designed to treat conjunctivitis. These include *Pulsatilla* (windflower, *Pulsatilla nigricans*), *Belladonna*, and eyebright (*Euphrasia officinalis*). Eye drops, prepared with homeopathic remedies and/or herbs, can be a good substitute for pharmaceutical eye drops. Eye washes can also be made. Herbal eyewashes made with eyebright (1 tsp. dried herb steeped in 1 pint of boiling water) or chamomile (*Matricaria recutita*; 2–3 tsp in 1 pt of boiling water) may be helpful. Eyewashes should be strained and cooled before use, and close attention should be paid to make sure that any solution put into the eye is sterile.

Other simple home remedies may help relieve the discomfort associated with conjunctivitis. A boric acid eyewash can be used to clean and soothe the eyes. A warm compress applied to the eyes for five to 10 minutes three times a day can help relieve the discomfort of bacterial and viral conjunctivitis. A cool compress or cool, damp tea bags placed on the eyes can ease the discomfort of allergic conjunctivitis.

Prognosis

If treated properly, the prognosis for conjunctivitis is good. Conjunctivitis caused by an allergic reaction should clear up once the allergen is removed. However, allergic conjunctivitis will likely recur if the individual again comes into contact with the particular allergen. Conjunctivitis caused by bacteria or a virus, if treated properly, is usually resolved in 10–14 days. If there is no relief of symptoms in 48–72 hours, or there is moderate to severe eye **pain**, changes in vision, or the conjunctivitis is suspected to be caused by herpes simplex, a physician should be notified immediately. If untreated or if treatment fails and is not corrected, conjunctivitis may cause **visual impairment** by spreading to other parts of the eye, such as the cornea.

Prevention

Conjunctivitis can, in many cases, be prevented, or at least the course of the disease can be shortened by following some simple practices.

- Frequently wash hands using antiseptic soap, and use single-use towels during the disease to prevent spreading the infection.
- Avoid chemical irritants and known allergens.
- If in an area where welding occurs, use the proper protective eye wear and screens to prevent damaging the eyes.
- Use a clean tissue to remove discharge from eyes, and wash hands to prevent the spread of infection.

KEY TERMS

Adenovirus—A virus that affects the upper respiratory tract.

Chlamydia—The most common bacterial sexually transmitted disease in the United States that often accompanies gonorrhea and is known for its lack of evident symptoms in the majority of women.

Gonococcal—The bacteria *Neisseria gonorrheae* that causes gonorrhea, a sexually transmitted infection of the genitals and urinary tract. The gonococcal organism may occasionally affect the eye, causing blindness if not treated.

Herpes simplex virus—A virus that can cause fever and blistering on the skin, mucous membranes, or genitalia.

Herpes zoster virus—Acute inflammatory virus that attacks the nerve cells on the root of each spinal nerve with skin eruptions along a sensory nerve ending.

Staphylococcus—A bacterial organism, looking much like a cluster of grapes, that can infect various body systems.

Streptococcus—An organism that causes infections of either the upper respiratory or gastrointestinal tract.

- If medication is prescribed, finish the course of **antibiotics**, as directed, to make sure that the infection is cleared up and does not recur.
- Avoid contact, such as vigorous physical activities, with other persons until symptoms resolve.

Resources

BOOKS

"The Conjunctiva." In *Ophthamology Principles and Concepts.* 8th ed. Ed. Frank Newell. St. Louis: Mosby-Year Books Inc., 1996.

Schwab, Ivan R., and Chandler R. Dawson. "Conjunctiva." In *General Ophthamology.* 14th ed. Ed. Daniel G. Vaughan, Taylor Asbury, and Paul Riordan-Eva. Norwalk, CT: Appleton & Lange, 1995.

Uphold, Constance R., and Mary Virginia Graham. "Problems of the Eyes." In *Clinical Guidelines in Adult Health.* Gainesville, FL: Barmarrae Books, 1994.

PERIODICALS

Brown, Melissa. "The Red Eye." *Current Concepts in Ophthalmology* (Jan. 1995): 9-15.

Weber, Carol Martinez and Joseph Eichenbaum. "Acute Red Eye: Differentiating Viral Conjunctivitis From Other Less Common Causes." *Postgraduate Medicine* (May 1997): 185-195.

OTHER

Griffith, H. Winter. "Conjunctivitis (Pink Eye)." *ThriveOnline.* <http://thriveonline.oxygen.com>.

Lisa Papp, RN

Consciousness disorders *see* **Coma**

Constipation

Definition

Constipation is an acute or chronic condition in which bowel movements occur less often than usual or consist of hard, dry stools that are painful or difficult to pass. Bowel habits vary, but an adult who has not had a bowel movement in three days or a child who has not had a bowel movement in four days is considered constipated.

Description

Constipation is one of the most common medical complaints in the United States. Constipation can occur at any age, and is more common among individuals who resist the urge to move their bowels at their body's signal. This often happens when children start school or enter daycare and feel shy about asking permission to use the bathroom.

Constipation is more common in women than in men and is especially apt to occur during **pregnancy**. Age alone does not increase the frequency of constipation, but elderly people (especially women) are more likely to suffer from constipation.

Although this condition is rarely serious, it can lead to:

- bowel obstruction
- chronic constipation
- hemorrhoids (a mass of dilated veins in swollen tissue around the anus)
- hernia (a protrusion of an organ through a tear in the muscle wall)
- spastic colitis (**irritable bowel syndrome**, a condition characterized by alternating periods of **diarrhea** and constipation)
- laxative dependency

Chronic constipation may be a symptom of colorectal **cancer**, depression, diabetes, diverticulosis (small pouches in the muscles of the large intestine), **lead poisoning**, or **Parkinson's disease**.

In someone who is elderly or disabled, constipation may be a symptom of bowel impaction, a more serious condition in which feces are trapped in the lower part of the large intestine. A doctor should be called if an elderly or disabled person is constipated for a week or more or if a child seems to be constipated.

A doctor should be notified whenever constipation occurs after starting a new prescription, vitamin, or mineral supplement or is accompanied by blood in the stools, changes in bowel patterns, or **fever** and abdominal **pain**.

Causes and symptoms

Constipation usually results from not getting enough **exercise**, not drinking enough water, or from a diet that does not include an adequate amount of fiber-rich foods like beans, bran cereals, fruits, raw vegetables, rice, and whole-grain breads.

Other causes of constipation include anal fissure (a tear or crack in the lining of the anus); **chronic kidney failure**; colon or **rectal cancer**; depression; **hypercalcemia** (abnormally high levels of calcium in the blood); **hypothyroidism** (underactive thyroid gland); illness requiring complete bed rest; irritable bowel syndrome; and **stress**.

Constipation can also be a side effect of:

- aluminum salts in **antacids**
- antihistamines
- antipsychotic drugs
- aspirin
- belladonna (*Atopa belladonna,* source of atropine, a medication used to relieve spasms and dilate the pupils of the eye)
- beta blockers (medications used to stabilize irregular heartbeat, lower high blood pressure, reduce chest pain)
- blood pressure medications
- calcium channel blockers (medication prescribed to treat high blood pressure, chest pain, some types of irregular heartbeat and **stroke**, and some non-cardiac diseases)
- diuretics (drugs that promote the formation and secretion of urine)
- iron or calcium supplements
- narcotics (potentially addictive drugs that relieve pain and cause mood changes)
- tricyclic antidepressants (medications prescribed to treat chronic pain, depression, headaches, and other illnesses)

An adult who is constipated may feel bloated, have a **headache**, swollen abdomen, or pass rock-like feces; or strain, bleed, or feel pain during bowel movements. A constipated baby may strain, cry, draw the legs toward the abdomen, or arch the back when having a bowel movement.

Diagnosis

Everyone becomes constipated once in a while, but a doctor should be notified if significant changes in bowel patterns last for more than a week or if symptoms continue more than three weeks after increasing activity and fiber and fluid intake.

The patient's observations and medical history help a primary care physician diagnose constipation. The doctor uses his fingers to see if there is a hardened mass in the abdomen, and may perform a **rectal examination**. Other diagnostic procedures include a **barium enema**, which reveals blockage inside the intestine; laboratory analysis of blood and stool samples for internal bleeding or other symptoms of systemic disease; and a **sigmoidoscopy** (examination of the sigmoid area of the colon with a flexible tube equipped with a magnifying lens).

Physical and psychological assessments and a detailed history of bowel habits are especially important when an elderly person complains of constipation.

Treatment

If changes in diet and activity fail to relieve occasional constipation, an over-the-counter laxative may be used for a few days. Preparations that soften stools or add bulk (bran, psyllium) work more slowly but are safer than Epsom salts and other harsh **laxatives** or herbal laxatives containing senna (*Cassia senna*) or buckthorn (*Rhamnus purshianna*), which can harm the nerves and lining of the colon.

A woman who is pregnant should never use a laxative. Neither should anyone who is experiencing abdominal pain, nausea, or vomiting.

A warm-water or mineral oil enema can relieve constipation, and a non-digestible sugar (lactulose) or special electrolyte solution is recommended for adults and older children with stubborn symptoms.

If a patient has an impacted bowel, the doctor inserts a gloved finger into the rectum and gently dislodges the hardened feces.

Alternative treatment

Initially, alternative practitioners will suggest that the patient drink an adequate amount of water each day (six to eight glasses), exercise on a regular basis, and eat a diet high in soluble and insoluble fibers. Soluble fibers include pectin, flax, and gums; insoluble fibers include psyllium and brans from grains like wheat and oats. Fresh fruits and vegetables contain both soluble and insoluble fibers. Castor oil, applied topically to the abdomen and covered by a heat source (a heating pad or hot water bottle), can help relieve constipation when used nightly for 20–30 minutes.

Acupressure

This needleless form of **acupuncture** is said to relax the abdomen, ease discomfort, and stimulate regular bowel movements when diet and exercise fail to do so. After lying down, the patient closes his eyes and takes a deep breath. For two minutes, he applies gentle fingertip pressure to a point about two and one-half inches below the navel.

Accupressure can also be applied to the outer edges of one elbow crease and maintained for 30 seconds before pressing the crease of the other elbow. This should be done three times a day to relieve constipation.

Aromatherapy

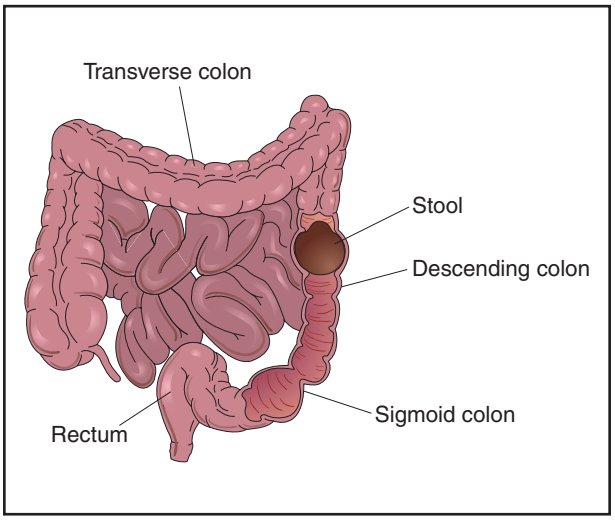
Six drops of rosemary (*Rosmarinus officinalis*) and six drops of thyme (*Thymus* spp.) diluted by 1 oz of almond oil, olive oil, or another carrier oil can relieve constipation when used to massage the abdomen.

Herbal therapy

A variety of herbal therapies can be useful in the treatment of constipation. Several herbs, including chamomile (*Matricaria recutita*), dandelion (*Taraxacum mongolicum*), and burdock (*Arctium lappa*), act as bitters, stimulating the movement of the digestive and excretory systems. There are also "laxative" herbs that assist with bowel movement. Two of these are senna (*Cassia senna*) and buckthorn (*Rhamnus purshiana*). These "laxative" herbs are stronger acting on elimination than bitters and can sometimes cause cramping (mixing them with a calming herb like fennel or caraway can help reduce cramping). Both senna and buckthorn are powerful herbs that are best used with direction from an experienced practitioner, since they can have adverse side effects and the patient may become dependent on them.

Homeopathy

Homeopathy also can offer assistance with constipation. There are acute remedies for constipation that can be found in one of the many home remedy books on homeopathic medicine. A constitutional prescription also can help rebalance someone who is struggling with constipation.



Constipation is an acute or chronic condition in which bowel movements occur less often than usual or consist of hard, dry stools that are painful or difficult to pass. *(Illustration by Electronic Illustrators Group).*

Massage

Massaging the leg from knee to hip in the morning, at night, and before trying to move the bowels is said to relieve constipation. There is also a specific Swedish massage technique that can help relieve constipation.

Yoga

The knee-chest position, said to relieve gas and stimulate abdominal organs, involves:

- standing straight with arms at the sides
- lifting the right knee toward the chest
- grasping the right ankle with the left hand
- pulling the leg as close to the chest as possible
- holding the position for about eight seconds
- repeating these steps with the left leg

The cobra position, which can be repeated as many as four time a day, involves:

- lying on the stomach with legs together
- placing the palms just below the shoulders, holding elbows close to the body
- inhaling, then lifting the head (face forward) and chest off the floor

- keeping the navel in contact with the floor
- looking as far upward as possible
- holding this position for three to six seconds
- exhaling and lowering the chest

Prognosis

Changes in diet and exercise usually eliminate the problem.

Prevention

Most Americans consume between 11–18 g of fiber a day. Consumption of 30 grams of fiber and between six and eight glasses of water each day can generally prevent constipation.

Thirty-five grams of fiber a day (an amount equal to five servings of fruits and vegetables, and a large bowl of high-fiber cereal) can relieve constipation.

Daily use of 500 mg vitamin C and 400 mg magnesium can prevent constipation. If symptoms do occur, each dosage can be increased by 100 mg a day, up to a maximum of 5,000 mg vitamin C and 1,000 mg magnesium. Use of preventive doses should be resumed after relief occurs, and vitamin C should be decreased to the pre-diarrhea dosage if the patient develops diarrhea.

Sitting on the toilet for 10 minutes at the same time every day, preferably after a meal, can induce regular bowel movements. This may not become effective for a few months, and it is important to defecate whenever necessary.

Fiber supplements containing psyllium (*Plantago psyllium*) usually become effective within about 48 hours and can be used every day without causing dependency. Powdered flaxseed (*Linium usitatissimum*) works the same way. Insoluble fiber, like wheat or oat bran, is as effective as psyllium but may give the patient gas at first.

Resources

BOOKS

The Consumer's Medical Desk Reference. Ed. Charles B. Inlander. New York: Hyperion, 1995.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

New Choices in Natural Healing. Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

PERIODICALS

Harari D., et al. "Bowel Habit in Relation to Age and Gender: Findings from the National Health Interview Survey and Clinical Implications." *Archives of Internal Medicine* (Feb. 1996): 315-320.

Karlsrud, K., and P. Schneider. "Tummy Troubles." *Parents*, Apr. 1997, 83-84.

OTHER

"Constipation." *ThriveOnline*. 15 Mar. 1998 <http://thriveonline.oxygen.com>.

Maureen Haggerty

Constitutional homeopathic remedies *see* **Homeopathic remedies, constitutional prescribing**

Consumption *see* **Tuberculosis**

Contact dermatitis

Definition

Contact **dermatitis** is the name for any skin inflammation that occurs when the skin's surface comes in contact with a substance originating outside the body. There are two kinds of contact dermatitis, irritant and allergic.

Description

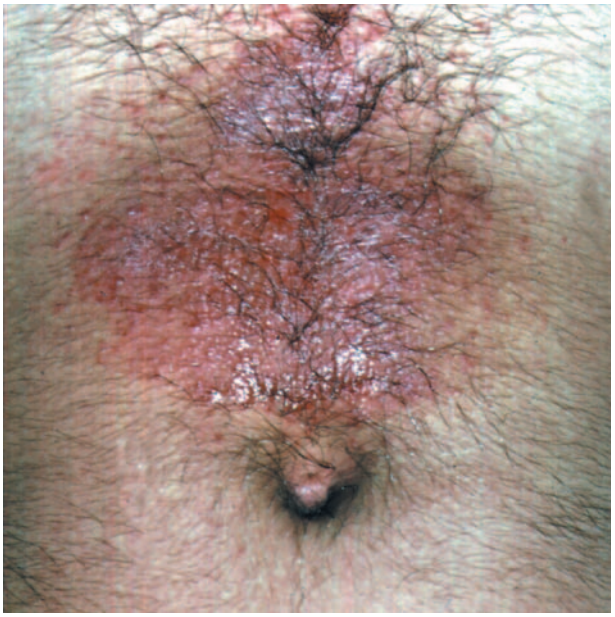
Thousands of natural and man-made substances can cause contact dermatitis, which is the most common skin condition requiring medical attention and the foremost source of work-related disease. Florists, domestic workers, hairdressers, food preparers, and employees in industry, construction, and health care are the people most at risk of contracting work-related contact dermatitis. Americans spend roughly $300 million a year in their quest for relief from contact dermatitis, not counting the considerable sums devoted by governments and businesses to regulating and policing the use of skin-threatening chemicals in the workplace. But exactly how many people suffer from contact dermatitis remains unclear; a 1997 article in the *Journal of the American Medical Association* notes that figures ranging from 1% to 15% have been put forward for Western industrial nations.

Causes and symptoms

Irritant contact dermatitis (ICD) is the more commonly reported of the two kinds of contact dermatitis, and is seen in about 80% of cases. It can be caused by soaps, detergents, solvents, adhesives, fiberglass, and other substances that are able to directly injure the skin. Most attacks are slight and confined to the hands and forearms, but can affect any part of the body that comes

in contact with an irritating substance. The symptoms can take many forms: redness, **itching**, crusting, swelling, blistering, oozing, dryness, scaliness, thickening of the skin, and a feeling of warmth at the site of contact. In extreme cases, severe blistering can occur and open sores can form. Jobs that require frequent skin exposure to water, such as hairdressing and food preparation, can make the skin more susceptible to ICD.

Allergic contact dermatitis (ACD) results when repeated exposure to an allergen (an allergy-causing substance) triggers an immune response that inflames the skin. Tens of thousands of drugs, pesticides, cosmetics, food additives, commercial chemicals, and other substances have been identified as potential allergens. Fewer than 30, however, are responsible the majority of ACD cases. Common culprits include poison ivy, poison oak, and poison sumac; fragrances and preservatives in cosmetics and personal care products; latex items such as gloves and condoms; and formaldehyde. Many people find that they are allergic to the nickel in inexpensive jewelry. ACD is usually confined to the area of skin that comes in contact with the allergen, typically the hands or face. Symptoms range from mild to severe and resemble those of ICD; a patch test may be needed to determine which kind of contact dermatitis a person is suffering from.



The abdomen of a male patient afflicted with contact dermatitis, triggered by an allergic reaction to a nickel belt buckle. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

Diagnosis begins with a **physical examination** and asking the patient questions about his or her health and daily activities. When contact dermatitis is suspected, the doctor attempts to learn as much as possible about the patient's hobbies, workplace duties, use of medications and cosmetics, etc.—anything that might shed light on the source of the disease. In some cases, an examination of the home or workplace is undertaken. If the dermatitis is mild, responds well to treatment, and does not recur, ordinarily the investigation is at an end. More difficult cases require patch testing to identify the allergen.

Two methods of patch testing are currently used. The most widely used method, the Finn chamber method, employs a multiwell, aluminum patch. Each well is filled with a small amount of the allergen being tested and the patch is taped to normal skin on the patient's upper back. After 48 hours, the patch is removed and an initial reading is taken. A second reading is made a few days later. The second method of patch testing involves applying a small amount of the test substance to directly to normal skin and covering it with a dressing that keeps air out and keeps the test substance in (occlusive dressing). After 48 hours, the dressing is taken off to see if a reaction has occurred. Identifying the allergen may require repeated testing, can take weeks or months, and is not always successful. Moreover, patch testing works only with ACD, though it is considered an essential step in ruling out ICD.

Treatment

The best treatment for contact dermatitis is to identify the allergen or irritating substance and avoid further contact with it. If the culprit is, for instance, a cosmetic, avoidance is a simple matter, but in some situations, such as an allergy to an essential workplace chemical for which no substitute can be found, avoidance may be impossible or force the sufferer to find new work or make other drastic changes in his or her life. Barrier creams and protective clothing such as gloves, masks, and long-sleeved shirts are ways of coping with contact dermatitis when avoidance is impossible, though they are not always effective.

For the symptoms themselves, treatments in mild cases include cool compresses and nonprescription lotions and ointments. When the symptoms are severe, **corticosteroids** applied to the skin or taken orally are used. Contact dermatitis that leads to a bacterial skin infection is treated with **antibiotics**.

Alternative treatment

Herbal remedies have been used for centuries to treat skin disorders including contact dermatitis. An experienced herbalist can recommend the remedies that

KEY TERMS

Antibiotics—Substances used against microorganisms that cause infection.

Corticosteroids—A group of anti-inflammatory substances often used to treat skin conditions.

Immune response—The protective reaction by the immune system against foreign antigens (substances that the body perceives as potentially dangerous). The immune system combats disease by neutralizing or destroying antigens.

will be most effective for an individual's condition. Among the herbs often recommended are:

- Burdock (*Arctium lappa*) minimizes inflammation and boosts the immune system. It is taken internally as a tea or tincture (a concentrated herbal extract prepared with alcohol).
- Calendula (*Calendula officinalis*) is a natural antiseptic and anti-inflammatory agent. It is applied topically in a lotion, ointment, or oil to the affected area.
- Aloe (*Aloe barbadensis*) soothes skin irritations. The gel is applied topically to the affected area.

A homeopath treating a patient with contact dermatitis will do a thorough investigation of the individual's history and exposures before prescribing a remedy. One homeopathic remedy commonly prescribed to relieve the itching associated with contact dermatitis is *Rhus toxicodendron* taken internally three to four times daily.

Poison ivy, poison oak, and poison sumac are common culprits in cases of allergic contact dermatitis. Following exposure to these plants, rash development may be prevented by washing the area with soap and water within 15 minutes of exposure. The leaves of jewelweed (*Impatiens* spp.), which often grows near poison ivy, may neutralize the poison-ivy allergen if rubbed on the skin right after contact. Several topical remedies may help relieve the itching associated with allergic contact dermatitis, including the juice of plantain leaves (*Plantago major*); a paste made of equal parts of green clay and goldenseal root (*Hydrastis canadensis*); a paste made of salt, water, clay, and peppermint (*Mentha piperita*) oil; and calamine lotion.

Prognosis

If the offending substance is promptly identified and avoided, the chances of a quick and complete recovery are excellent. Otherwise, symptom management—not cure—is the best doctors can offer. For some people, contact dermatitis becomes a chronic and disabling condition that can have a profound effect on employability and quality of life.

Prevention

Avoidance of known or suspected allergens or irritating substances is the best prevention. If avoidance is difficult, barrier creams and protective clothing can be tried. Skin that comes in contact with an offending substance should be thoroughly washed as soon as possible.

Resources

BOOKS

Swerlick, Robert A., and Thomas J. Lawley. "Eczema, Psoriasis, Cutaneous Infections, Acne, and Other Common Skin Disorders." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Wolf Jr., John E. "Contact Dermatitis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Beltrani, Vincent S., and Vincent P. Beltrani. "Contact Dermatitis." *Annals of Allergy, Asthma, and Immunology* 78 (Feb. 1997): 160-75.

Leung, Donald Y. M., et al. "Allergic and Immunologic Skin Disorders." *Journal of the American Medical Association* 278 (1997): 1914+.

Rietschel, Robert L. "Occupational Contact Dermatitis." *The Lancet* 349 (1997): 1093+.

OTHER

Stewart, Leslie. "Contact Dermatitis." *National Jewish Medical Research Center Page.* 25 Aug. 1995. 17 June 1998 <http://www.nationaljewish.org/main.html>.

Howard Baker

Contact lenses *see* **Eye glasses and contact lenses**

Continent urinary diversion *see* **Urinary diversion surgery**

Continuous ambulatory electrocardiography *see* **Holter monitoring**

Continuous positive airway *see* **Inhalation therapies**

Contraception

Definition

Contraception (birth control) prevents **pregnancy** by interfering with the normal process of ovulation, fer-

Various types of contraception. *(Photo Researchers, Inc. Reproduced by permission.)*

Types Of Contraceptives

Effectiveness	Predicted (%)	Actual (%)
Birth control pills	99.9	97
Condoms	98	88
Depo Provera	99.7	99.7
Diaphragm	94	82
IUDs	99.2	97
Norplant	99.7	99.7
Tubal sterilization	99.8	99.6
Spermicides	97	79
Vasectomy	99.9	99.9

tilization, and implantation. There are different kinds of birth control that act at different points in the process.

Purpose

Every month, a woman's body begins the process that can potentially lead to pregnancy. An egg (ovum) matures, the mucus that is secreted by the cervix (a cylindrical-shaped organ at the lower end of the uterus) changes to be more inviting to sperm, and the lining of the uterus grows in preparation for receiving a fertilized egg. Any woman who wants to prevent pregnancy must use a reliable form of birth control.

Birth control (contraception) is designed to interfere with the normal process and prevent the pregnancy that could result. There are different kinds of birth control that act at different points in the process, from ovulation, through fertilization, to implantation. Each method has its own side effects and risks. Some methods are more reliable than others.

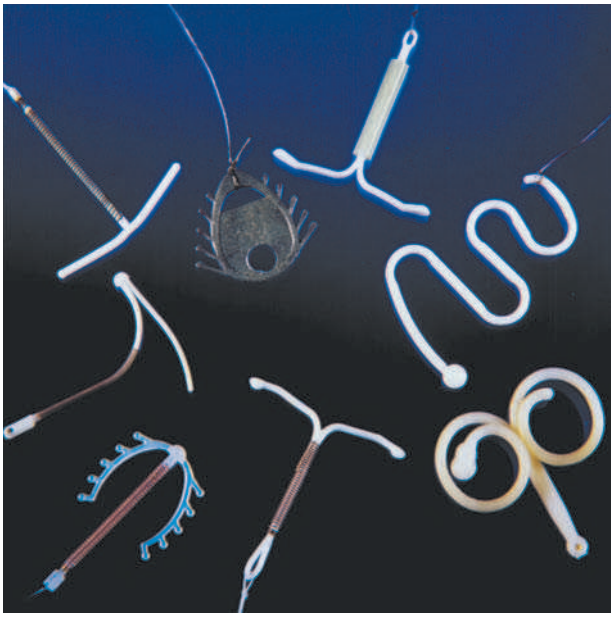
Although there are many different types of birth control, they can be divided into a few groups based on how they work. These groups include:

- Hormonal methods—These use medications (hormones) to prevent ovulation. Hormonal methods include birth control pills (**oral contraceptives**), Depo Provera injections and Norplant.
- Barrier methods—These methods work by preventing the sperm from getting to and fertilizing the egg. Barrier methods include the **condom**, diaphragm, and cervical cap. The condom is the only form of birth control that also protects against **sexually transmitted diseases**, including HIV (the virus that causes **AIDS**).
- Spermicides—These medications kill sperm on contact. Most spermicides contain nonoxynyl-9. Spermicides come in many different forms such as jelly, foam, tablets, and even a transparent film. All are placed in the vagina. Spermicides work best when they are used at the same time as a barrier method.
- Intrauterine devices—Intrauterine contraceptive devices (IUDs) are inserted into the uterus, where they stay from one to 10 years. An **IUD** prevents the fertilized egg from implanting in the lining of the uterus, and may have other effects as well.
- Tubal sterilization—Tubal sterilization is a permanent form of contraception for women. Each fallopian tube is either tied or burned closed. The sperm cannot reach the egg, and the egg cannot travel to the uterus.
- Vasectomy—is the male form of sterilization, and should also be considered permanent. In **vasectomy**, the vas defrens, the tiny tubes that carry the sperm into the semen, are cut and tied off. Thus, no sperm can get into the semen.

Unfortunately, there is no perfect form of birth control. Only abstinence (not having sexual intercourse) can protect against unwanted pregnancy with 100% reliability. The failure rates, which means the rates of pregnancy, for most forms of birth control are quite low. However, some forms of birth control are more difficult or inconvenient to use than others. In actual practice, the birth control methods that are more difficult or inconvenient have much higher failure rates because they are not used faithfully.

Description

All the different forms of birth control have one thing in common. They are only effective if used faithfully. Birth control pills will work only if taken every day; the



A variety of intrauterine contraceptive devices. The probability of a pregnancy for year of use is about 2 to 3%. IUDs made with copper coils should be replaced every 3 to 5 years. *(Photo Researchers, Inc. Reproduced by permission.)*

diaphragm is effective only if used during every episode of sexual intercourse. The same is true for condoms and the cervical cap. Some methods are automatically working every day, no matter what. These methods include Depo Provera, Norplant, the IUD, and tubal sterilization.

There are many different ways to use birth control. They can be divided into several groups:

- By mouth (oral)—Birth control pills must be taken by mouth every day.
- Injected—Depo Provera is a hormonal medication that is given by injection every three months.
- Implanted—Norplant is a long-acting hormonal form of birth control that is implanted under the skin of the upper arm.
- Vaginal—Spermicides and barrier methods work in the vagina.
- Intra-uterine—The IUD is inserted into the uterus.
- Surgical—Tubal sterilization is a form of surgery. A doctor must perform the procedure in a hospital or surgical clinic. Many women need general anesthesia.

The methods of birth control differ from each other in the timing of when they are used. Some methods of birth control must be used specifically at the time of sexual intercourse (condoms, diaphragm, cervical cap, spermicides). All other methods of birth control must be working all the time to provide protection (hormonal methods, IUDs, tubal sterilization).

Precautions

There are risks associated with some forms of birth control. Some of the risks of each method are listed below:

- Birth control pills—The hormone (estrogen) in birth control pills can increase the risk of **heart attack** in women over 40 who smoke.
- IUD—The IUD can increase the risk of serious pelvic infection. The IUD can also injure the uterus by poking into or through the uterine wall. Surgery might be needed to fix this.
- Tubal sterilization—"Tying the tubes" is a surgical procedure and has all the risks of any other surgery, including the risks of anesthesia, infection, and bleeding.

Preparation

No specific preparation is needed before using contraception. However, a woman must be sure that she is not already pregnant before using a hormonal method or having an IUD placed.

Aftercare

No aftercare is needed.

Risks

Many methods of birth control have side effects. Knowing the side effects can help a woman to determine which method of birth control is right for her.

- Hormonal methods—The hormones in birth control pills, Depo Provera, and Norplant can cause changes in menstrual periods, changes in mood, weight gain, **acne**, and headaches. In addition, it may take many months to begin ovulating again once a woman stops using Depo Provera or Norplant.
- Barrier methods—A woman must insert the diaphragm in just the right way to be sure that it works properly. Some women get more urinary tract infections if they use a diaphragm. This is because the diaphragm can press against the urethra, the tube that connects the bladder to the outside.
- Spermicides—Some women and men are allergic to spermicides or find them irritating to the skin.
- IUD—The IUD is a foreign body that stays inside the uterus, and the uterus tries to get it out. A woman may have heavier menstrual periods and more menstrual cramping with an IUD in place.

KEY TERMS

Fallopian tubes—The thin tubes that connect the ovary to the uterus. Ova (eggs) travel from the ovary to the uterus. If the egg has been fertilized, it can implant in the uterus.

Fertilization—The joining of the sperm and the egg; conception.

Implantation—The process in which the fertilized egg embeds itself in the wall of the uterus.

Ovulation—The release of an egg (ovum) from the ovary.

- Tubal sterilization—Some women report increased menstrual discomfort after **tubal ligation**. It is not known if this is related to the tubal ligation itself.

There is no perfect form of birth control. Every method has a small failure rate and side effects. Some methods carry additional risks. However, every method of birth control can be effective if used properly.

Resources

BOOKS

Osathanondh, Rapin, Michael R. Stelluto, and Karen J. Carlson. "Contraception." In *Primary Care of Women*, ed. Karen J. Carlson and Stephanie A. Eisenstat. St. Louis: Mosby-Year Book, Inc., 1995.

Osathanondh, Rapin. "Conception Control." In *Kistner's Gynecology*, ed. Kenneth J. Ryan, Ross S. Berkowitz, and Robert L. Barbieri. St. Louis: Mosby, 1995.

Amy B. Tuteur, MD

Contractures

Definition

Contractures are the chronic loss of joint motion due to structural changes in non-bony tissue. These non-bony tissues include muscles, ligaments, and tendons.

Description

Contractures can occur at any joint of the body. This joint dysfunction may be a result of **immobilization** from injury or disease; nerve injury, such as spinal cord damage and **stroke**; or muscle, tendon, or ligament disease.

Causes and symptoms

There are a number of pathologies and diseases that can lead to joint contractures. The primary causes resulting in a joint contraction are muscle imbalance, **pain**, prolonged bed rest, and immobilization. Because of the frequency of **fractures** and surgery, immobilization is the most frequent cause of joint contractures. Symptoms include a significant loss of motion to any specific joint that results in immobility. If the contracture is of a significant degree, pain can result even without any voluntary joint movement.

Diagnosis

Manual testing of joint mobility by a healthcare professional skilled in joint mobilization techniques (e.g. a physical therapist) will identify indications of restricted structures within the joint. Measuring the motion of the joint with a device termed a "goniometer" can be useful if the decrease of motion can be shown to be a proven result of a joint contracture. X rays can be of some benefit in the diagnosis of contractures, because a visible decrease in joint space may indicate a tight, contracted joint. Most physicians will make the diagnosis after a thorough **physical examination** involving physical and manual testing of the joint motion.

Treatment

Manual techniques

Joint mobilization and stretching of soft tissues is a common technique used to increase joint elasticity. Structures are stretched in similar directions to those which take place upon normal joint motion. Some healthcare professionals may use some form of heat prior to the stretching and mobilization. If appropriate, **exercise** may follow manual techniques to help maintain the additional motion achieved.

Mechanical techniques

Devices known as continuous passive motion machines are very popular, especially following surgery of joints. Continuous passive motion machines (CPM) are specifically adjusted to each individual's need. This method is administered within the first 24–72 hours after the injury or surgery. The joint is mechanically moved through the patient's tolerable motion. CPM machines have been proved to accelerate the return motion process, allowing patients more function in less time.

KEY TERMS

Mobilization—Making movable, restoring the power of motion in a joint. Movement which increases joint mobility.

Muscle tone—Also termed tonus; the normal state of balanced tension in the tissues of the body, especially the muscles.

Casting or splinting

Casting or splinting techniques are used to provide a constant stretch to the soft tissues surrounding a joint. It is most effective when used to increase motion of a joint from prolonged immobilization. It is also popular for treating contractures resulting from an increase in muscle tone from nerve injury. After an initial holding cast is applied for seven to 10 days, a series of positional casts are applied at weekly intervals. Before the application of each new cast, the joint is moved as much as can be tolerated by the patient, and measured by a goniometer. When as much motion as possible is obtained after stretching, another final cast is applied to maintain the newly acquired motion.

Surgery

In some cases the contracture may be severe and not respond to conservative treatment. In this event, manipulation of the joint under a general anesthesia may be necessary.

Alternative treatment

In some areas of the body, **chiropractic** techniques have been found to be useful to improve motion. **Massage therapy** can be beneficial by promoting additional circulation to joint structures, causing better elasticity. **Yoga** can help prevent as well as rehabilitate a contracture and can facilitate the return of joint mobility.

Prognosis

Prognosis of contractures will depend upon the cause of the contracture. In general, the earlier the treatment for the contracture begins, the better the prognosis.

Prevention

Prevention of contractures and deformities from **spinal cord injury**, fracture, and immobilization is achieved through a program of positioning, splinting if appropriate, and range-of-motion exercises either manually or mechanically aided. These activities should be started as early as possible for optimal results.

Resources

BOOKS

Umphred, Darcy A. "Traumatic Spinal Cord Injury." In *Neurological Rehabilitation*. St. Louis: C. V. Mosby Co., 1990.

PERIODICALS

Ito, Caryn S. "Conservative Management of Joint Deformities and Dynamic Posturing." *Orthopaedic Physical Therapy Clinics of North America* 2, no. 1 (Mar. 1993): 25-38.

Murphy, John. "Continuous Passive Motion." *Advance Magazine for Physical Therapists* (Jan. 1996): 8.

ORGANIZATIONS

The American College of Rheumatology. 1800 Century Place, Suite 250, Atlanta, GA 30345. (404) 633-3777. <http://www.rheumatology.org>.

American Physical Therapy Association. 1111 North Fairfax St., Alexandria, Virginia 22314. (800) 999-2782. <https://www.apta.org>.

Jeffrey P. Larson, RPT

Conversion disorder *see* **Somatoform disorders**

Cooley's anemia *see* **Thalassemia**

Cooling treatments

Definition

Cooling treatments lower body temperature in order to relieve **pain**, swelling, constriction of blood vessels, and to decrease the liklihood of cellular damage by slowing the metabolism. Sponge baths, cold compresses, and cold packs are all wet cooling treatments. Dry treatments, such as ice bags and chemical cold packs, are also used to lower body temperature.

Purpose

The most common reason for cooling a body is **fever** or hyperthermia (extremely high fever). The body can sustain temperatures up to 104°F (40°C) with relative safety; however, when temperatures rise above 104°F (40°C), damage to the brain, muscles, blood, and kidneys is increasingly likely. Cooling treatments are also applied immediately following sprains, **bruises**, **burns**, eye injuries, and muscle spasms to help alleviate the resulting swelling, pain, and discoloration of the skin.

Cooling treatments slow chemical reactions within the body. For this reason, cooling tissues below normal temperature (98.6°F/37°C) can prevent injury from inadequate oxygen or **nutrition**. Cold water drowning victims suffering from **hypothermia** (cooling of the body below its normal temperature) have been successfully resuscitated after long periods underwater without medical complications because of this effect. For the past 40 years, heart surgeons have been experimenting with hypothermia to protect tissues from lack of blood circulation during an operation. Neurosurgeons are also working with hypothermia to protect the very sensitive brain tissues during periods of absent or reduced blood flow.

Description

Depending on the medical need, various cooling methods are used.

- Cold packs and ice bags are placed on a localized site and provide topical relief. These compresses should be covered with a waterproof material to protect the skin. Repeated treatments produce the desired pain and swelling relief.
- Cold treatments are placed on the groin and under the arms to treat hyperthermia. Treatments are refreshed periodically until the appropriate temperature is attained.
- A tepid sponge bath relieves fever without cooling the body too fast. Eighty degrees Farenheit is still 20°F below body temperature and yet warm enough not to drive blood from the skin, thereby preventing the cooling from getting to the body's core. Limbs are bathed first and then the chest, abdomen, back, and buttocks.
- Perfusion of isolated regions like the brain by using cooled blood is an experimental treatment, offering promising results for the treatment of stroke.

Preparation

Topical treatments are prepared with ice, cold water (59°F/15°C), and chemical cold packs. Tepid baths should be 80–93°F (26.7–34°C).

Risks

Small children, adults with circulation problems, and the elderly are all at risk of tissue damage. Rapid cooling causes chills, which in effect raise the body's temperature by raising its metabolism. Blood clots may form from thickened blood caused by the temperature change.

Resources

PERIODICALS

Barone, F. C., G. Z. Feuerstein, and R. F. White. "Brain Cooling During Transient Focal Ischemia Provides Complete Neuroprotection." *Neuroscience & Biobehavioral Reviews* 21 (Jan. 1997): 31-44.

Imamaki M., T. Hirayama, and M. Nakajima. "Separate-Hypothermia Retrograde Cerebral Perfusion." *Annals of Thoracic Surgery* 63 (Feb. 1997): 54754-54758.

Plattner, O., et al. "Efficacy of Intraoperative Cooling Methods." *Anesthesiology* 87 (Nov. 1997): 1089-1095.

J. Ricker Polsdorfer, MD

Coombs' tests

Definition

Coombs' tests are blood tests that identify the causes of anemia.

Purpose

Anemia, which literally means no blood, refers to blood with abnormally low oxygen-carrying capacity. The hemoglobin in red blood cells carries oxygen. One of the many causes of anemia is destruction of red blood cells, a process called hemolysis (*hemo* means blood and *lysis* means disintegration). A simple **blood count** detects anemia. Even the test done before a blood donation can identify anemia. To detect hemolysis requires other tests. The Coombs' tests are conducted in order to determine the cause of anemia.

One characteristic of hemolysis is the autoimmune response against the body's red blood cells. Instead of protecting the body from outside agents, the immune system attacks parts of its own body with a deluge of antibodies. Autoimmunity is thought to be the cause of many collagen-vascular diseases, including **rheumatoid arthritis** and **systemic lupus erythematosus**. It is also the cause of the autoimmune hemolytic **anemias**. The Coombs' tests detect the antibodies responsible for the destruction of the red blood cells.

Causes of autoimmune **hemolytic anemia** include:

- drugs such as penicillin, methyldopa (lowers blood pressure), and quinidine (treats heart rhythm disturbances)
- cancers of the lymph system—Hodgkin's disease and lymphomas
- virus infections
- collagen-vascular diseases
- mismatched blood transfusions
- Rh incompatibility between a mother and fetus. This disease is called erythroblastosis fetalis

KEY TERMS

Antibody—A protein made by the immune system and used as a weapon against foreign invaders in the body.

Antigen—The chemical that stimulates an immune response.

Anemia—Reduced oxygen-carrying capacity of the blood, due to too little hemoglobin or too few red blood cells.

Collagen-vascular disease—Various diseases inflaming and destroying connective tissue.

Hematologist—Physician who specializes in diseases of the blood.

Hemoglobin—The red pigment in blood that carries oxygen.

Hemolysis—Breaking apart red blood cells.

Rh—A blood typing group, like the ABO system. When a mother is Rh negative and her baby is Rh positive, she may develop antibodies to the baby's blood that will cause it to hemolyze.

Many times the cause cannot be identified.

Description

There are two Coombs' tests. A direct Coombs' test detects the two different antigens that might induce hemolysis in the patient's red blood cells. An indirect Coombs' test looks for antibodies to someone else's red blood cells in the patient's serum (the blood without the cells). Combining the two tests gives clues to the origin of the hemolysis.

Preparation

No preparation is needed for this test. It will probably be among the second or third set of blood tests done after anemia is diagnosed and there is a suspicion that its cause is hemolysis.

Aftercare

Coombs' tests are done on blood that is drawn from the arm.

Risks

Taking blood for testing is the most common medical procedure performed. The worst complication is a bruise at the site of the puncture or punctures. It is extremely rare for the needle to injure an important structure such as an artery or a nerve.

Normal results

If the Coombs' tests are negative, the anemia is unlikely to be autoimmune, and the hematologist will have to search elsewhere for a cause.

Abnormal results

If the test is positive, the antigens that react will narrow the search for a cause. Coombs' tests are also done for blood **transfusion** reactions to determine why the transfused blood did not match, and when there is a chance a newborn may have an Rh problem.

Resources

BOOKS

Rosse, Wendell, and H. Franklin Bunn. "Hemolytic Anemias and Acute Blood Loss." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Schreiber, Alan D. "Autoimmune Hemolytic Anemia." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Teresa Norris, RN

Coordination tests *see* **Balance and coordination tests**

COPD *see* **Emphysema; Chronic obstructive lung disease**

Copper deficiency *see* **Mineral deficiency**

Copper excess *see* **Wilson's disease**

Cor pulmonale

Definition

Cor pulmonale is an increase in bulk of the right ventricle of the heart, generally caused by chronic diseases or malfunction of the lungs. This condition can lead to **heart failure**.

Description

Cor pulmonale, or pulmonary heart disease, occurs in 25% of patients with chronic obstructive pulmonary dis-

ease (COPD). In fact, about 85% of patients diagnosed with cor pulmonale have COPD. Chronic **bronchitis** and **emphysema** are types of COPD. High blood pressure in the blood vessels of the lungs (**pulmonary hypertension**) causes the enlargement of the right ventricle. In addition to COPD, cor pulmonale may also be caused by lung diseases, such as **cystic fibrosis**, **pulmonary embolism,** and pneumoconiosis. Loss of lung tissue after **lung surgery** or certain chest-wall disturbances can produce cor pulmonale, as can neuromuscular diseases, such as **muscular dystrophy**. A large pulmonary thromboembolism (blood clot) may lead to acute cor pulmonale.

Causes and symptoms

Any respiratory disease or malfunction that affects the circulatory system of the lungs may lead to cor pulmonale. These circulatory changes cause the right ventricle to compensate for the extra work required to pump blood through the lungs. The right ventricle has thin walls and is crescent-shaped. The resulting pressure causes the right ventricle to dilate and bulge, eventually leading to its failure.

Cor pulmonale should be expected in any patient with COPD and other respiratory or neuromuscular diseases. Initial symptoms of cor pulmonale may actually reflect those of the underlying disease. These may include chronic coughing, **wheezing**, weakness, **fatigue**, and **shortness of breath**. **Edema** (abnormal buildup of fluid), weakness, and discomfort in the upper chest may be evident in cor pulmonale.

Diagnosis

An electrocardiograph (EKG) will show signs such as frequent premature contractions in the atria or ventricles. Chest x rays may show enlargement of the right descending pulmonary artery. This sign, along with an enlarged main pulmonary artery, indicates pulmonary artery **hypertension** in patients with COPD. **Magnetic resonance imaging** (MRI) is often the preferred method of diagnosis for cor pulmonale because it can clearly show and measure volume of the pulmonary arteries. Other tests used to support a diagnosis of cor pulmonale may include arterial **blood gas analysis**, pulmonary function tests, and **hematocrit**.

Treatment

Treatment of cor pulmonale is aimed at increasing a patient's **exercise** tolerance and improving oxygen levels of the arterial blood. Treatment is also aimed at the underlying condition that is producing cor pulmonale. Common treatments include **antibiotics** for respiratory infection; anticoagulants to reduce the risk of thromboembolism; and digitalis, oxygen, and **phlebotomy** to reduce red blood cell count. A low-salt diet and restricted fluids are often prescribed.

KEY TERMS

Ventricle—A cavity, as in the brain or heart. The right ventricle of the heart drives blood from the heart into the pulmonary artery, which supplies blood to the lungs.

Alternative treatment

Co-management of the patient with cor pulmonale should be coordinated between the medical doctor and the alternative practitioner. The first step in treatment is to determine the cause of the condition and to evaluate all organ systems of the body. Dietary considerations, for example, a low-salt diet and reduced fluid intake aimed at reducing the edema associated with cor pulmonale, can be supportive aspects of treatment.

Prognosis

The prognosis for cor pulmonale is poor, particularly because it occurs late in the process of serious disease.

Prevention

Cor pulmonale is best prevented by prevention of COPD and other irreversible diseases that lead to heart failure. **Smoking** cessation is critically important. Carefully following the recommended course of treatment for the underlying disease may help prevent cor pulmonale.

Resources

BOOKS

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Rothfield, Glenn S., Suzanne Levert, and Greg Rothfield. *Natural Medicine for Heart Disease: The Best Alternative Methods for Prevention and Treatment: High Cholesterol, High Blood Pressure, Stroke, Chest*. New York: Rodale Press, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

J. Ricker Polsdorfer, MD

Cori's disease *see* **Glycogen storage diseases**

Corkscrew esophagus *see* **Diffuse esophageal spasm**

Corneal abrasion

Definition

A corneal abrasion is a worn or scraped-off area of the outer, clear layer of the eye (cornea).

Description

The cornea is the clear, dome-shaped outer area of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the iris (pupil). The outermost layer of the eyeball consists of the cornea and the white part of the eye (sclera). A corneal abrasion is basically a superficial cut or scrape on the cornea. A corneal abrasion is not as serious as a corneal ulcer, which is generally deeper and more severe than an abrasion.

Causes and symptoms

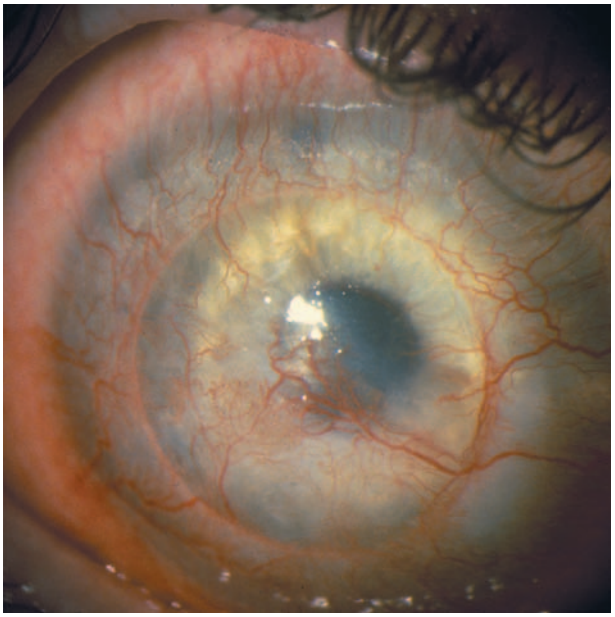
A corneal abrasion is usually the result of direct injury to the eye, often from a fingernail scratch, makeup brushes, contact lenses, foreign body, or even twigs. Patients often complain of feeling a foreign body in their eye, and they may have **pain**, sensitivity to light, or tearing.

Diagnosis

Ophthalmologists and optometrists, who treat eye disorders, are well qualified to diagnose corneal abrasions. The doctor will check the patient's vision (visual acuity) in both eyes with an eye chart. A patient history will also be taken, which may help to determine the cause of the abrasion. A slit lamp, which is basically a microscope and light source, will allow the doctor to see the abrasion. Fluorescein, a yellow dye, may be placed into the eye to determine the extent of the abrasion. The fluorescein will temporarily stain the affected area.

Treatment

The cornea has a remarkable ability to heal itself, so treatment is designed to minimize complications. If the abrasion is very small, the doctor might just suggest an eye lubricant and a follow-up visit the next day. A very small abrasion should heal in one to two days; others usually in one week. However, to avoid a possible infection, an antibiotic eye drop may be prescribed. Sometimes additional eye drops may make the eye feel more comfortable. Depending upon the extent of the abrasion, some doctors may patch the affected eye. It is very important to go for the follow-up checkup to make sure an infection does not occur. Use of contact lenses should not be resumed without the doctor's approval.



A close-up view of an abrasion on patient's cornea. *(Photograph by Dennis R. Cain, CRA, Custom Medical Stock Photo. Reproduced by permission.)*

Prognosis

In typical cases, the prognosis is good. The cornea will heal itself, usually within several days. A very deep abrasion may lead to scarring. If the abrasion does not heal properly, a recurrent corneal erosion (RCE) may result months or even years later. The symptoms are the same as for an abrasion (e.g., tearing, foreign body sensation, and blurred vision), but it will keep occurring. Similar or additional treatment for the RCE may be necessary.

Prevention

Everyone should wear eye protection whenever this is recommended. This should be standard practice when using power tools and playing certain sports. Goggles should even be worn when mowing the lawn, because a twig can be thrown upward toward the face. Contact lens wearers should be careful to follow their doctors' instructions on caring for and wearing their lenses. Ill-fitting or dirty lenses could lead to an abrasion, so patients should go for their prescribed checkups.

Resources

BOOKS

Elkington, A. R., and P. T. Khaw. *The ABC of Eyes*. 2nd ed. American College of Physicians Press, 1994.

Friedlaender, Mitchell H. *20/20: A Total Guide to Improving Your Vision and Preventing Eye Disease*. Rodale Press, 1991.

ORGANIZATIONS

American Academy of Family Physicians. 8880 Ward Parkway, Kansas City, MO 64114. (816) 333-9700. <http://www.aafp.org>.

Richard H. Lampert

Corneal infection *see* **Keratitis**

Corneal keratoplasty *see* **Corneal transplantation**

Corneal transplantation

Definition

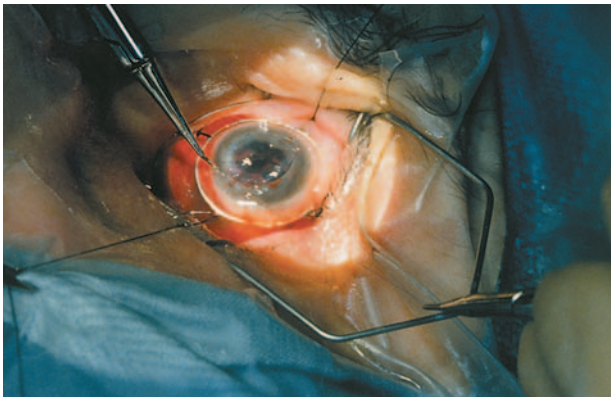
In corneal transplant, also known as keratoplasty, a patient's damaged cornea is replaced by the cornea from the eye of a human cadaver. This is the single most common type of human transplant surgery and has the highest success rate. Eye banks acquire and store eyes from donor individuals largely to supply the need for transplant corneas.

Purpose

Corneal transplant is used when vision is lost in an eye because the cornea has been damaged by disease or traumatic injury. Some of the disease conditions that might require corneal transplant include the bulging outward of the cornea (keratoconus), a malfunction of the inner layer of the cornea (Fuchs' dystrophy), and painful swelling of the cornea (pseudophakic bullous keratopathy). Some of these conditions cause cloudiness of the cornea; others alter its natural curvature, which can also reduce the quality of vision.

Injury to the cornea can occur because of chemical **burns**, mechanical trauma, or infection by viruses, bacteria, fungi, or protozoa. The herpes virus produces one of the more common infections leading to corneal transplant.

Surgery would only be used when damage to the cornea is too severe to be treated with corrective lenses. Occasionally, corneal transplant is combined with other types of eye surgery (such as **cataract surgery**) to solve multiple eye problems in one procedure.



A corneal transplant in progress. *(Photograph by Chet Szymecki, Phototake NYC. Reproduced by permission.)*

Precautions

Corneal transplant is a very safe procedure that can be performed on almost any patient who would benefit from it. Any active infection or inflammation of the eye usually needs to be brought under control before surgery can be performed.

Description

The cornea is the transparent layer of tissue at the very front of the eye. It is composed almost entirely of a special type of collagen. It normally contains no blood vessels, but because it contains nerve endings, damage to the cornea can be very painful.

In a corneal transplant, a disc of tissue is removed from the center of the eye and replaced by a corresponding disc from a donor eye. The circular incision is made using an instrument called a trephine. In one form of corneal transplant (penetrating keratoplasty), the disc removed is the entire thickness of the cornea and so is the replacement disc. Over 90% of all corneal transplants in the United States are of this type. In lamellar keratoplasty, on the other hand, only the outer layer of the cornea is removed and replaced.

The donor cornea is attached with extremely fine sutures. Surgery can be performed under anesthesia that is confined to one area of the body while the patient is awake (local anesthesia) or under anesthesia that places the entire body of the patient in a state of unconsciousness (general anesthesia.) Surgery requires 30–90 minutes.

Over 40,000 corneal transplants are performed in the United States each year. Medicare reimbursement for a corneal transplant in one eye was about $1,200 in 1997.

A less common but related procedure called epikeratophakia involves suturing the donor cornea directly

KEY TERMS

Cadaver—The human body after death.

Cataract—A condition of cloudiness of the lens of the eye.

Cornea—The transparent layer of tissue at the very front of the eye.

Corticosteroids—Synthetic hormones widely used to fight inflammation.

Epikeratophakia—A procedure in which the donor cornea is attached directly onto the host cornea.

Epithelial cells—Cells that form a thin surface coating on the outside of a body structure.

Fibrous connective tissue—Dense tissue found in various parts of the body containing very few living cells.

Fuchs' dystrophy—A hereditary disease of the inner layer of the cornea. Treatment requires penetrating keratoplasty. The lens of the eye may also be affected and require surgical replacement at the same time as the cornea.

Glaucoma—A vision defect caused when excessive fluid pressure within the eye damages the optic nerve.

Histocompatibility antigens—Proteins scattered throughout body tissues that are unique for almost every individual.

Keratoconus—An eye condition in which the cornea bulges outward, interfering with normal vision. Usually both eyes are affected.

Pseudophakic bullous keratopathy—Painful swelling of the cornea occasionally occurring after surgery to implant an artificial lens in place of a lens affected by cataract.

Retinal detachment—A serious vision disorder in which the light-detecting layer of cells inside the eye (retina) is separated from its normal support tissue and no longer functions properly.

Trephine—A small surgical instrument that is rotated to cut a circular incision.

onto the surface of the existing host cornea. The only tissue removed from the host is the extremely thin epithelial cell layer on the outside of the host cornea. There is no permanent damage to the host cornea, and this procedure can be reversed. It is usually employed in children. In adults, the use of contact lenses can usually achieve the same goals.

Preparation

No special preparation for corneal transplant is needed. Some eye surgeons may request the patient have a complete **physical examination** before surgery. The patient may also be asked to skip breakfast on the day of surgery.

Aftercare

Corneal transplant is often performed on an outpatient basis, although some patients need brief hospitalization after surgery. The patient will wear an eye patch at least overnight. An eye shield or glasses must be worn to protect the eye until the surgical wound has healed. Eye drops will be prescribed for the patient to use for several weeks after surgery. These drops include **antibiotics** to prevent infection as well as **corticosteroids** to reduce inflammation and prevent graft rejection.

For the first few days after surgery, the eye may feel scratchy and irritated. Vision will be somewhat blurry for as long as several months.

Sutures are often left in place for six months, and occasionally for as long as two years.

Risks

Corneal transplants are highly successful, with over 90% of operations in United States achieving restoration of sight. However, there is always some risk associated with any surgery. Complications that can occur include infection, **glaucoma**, **retinal detachment**, cataract formation, and rejection of the donor cornea.

Graft rejection occurs in 5–30% of patients, a complication possible with any procedure involving tissue transplantation from another person (allograft). Allograft rejection results from a reaction of the patient's immune system to the donor tissue. Cell surface proteins called histocompatibility antigens trigger this reaction. These antigens are often associated with vascular tissue (blood vessels) within the graft tissue. Since the cornea normally contains no blood vessels, it experiences a very low rate of rejection. Generally, blood typing and **tissue typing** are not needed in corneal transplants, and no close match between donor and recipient is required. Symp-

toms of rejection include persistent discomfort, sensitivity to light, redness, or a change in vision.

If a rejection reaction does occur, it can usually be blocked by steroid treatment. Rejection reactions may become noticeable within weeks after surgery, but may not occur until 10 or even 20 years after the transplant. When full rejection does occur, the surgery will usually need to be repeated.

Although the cornea is not normally vascular, some corneal diseases cause vascularization (the growth of blood vessels) into the cornea. In patients with these conditions, careful testing of both donor and recipient is performed just as in transplantation of other organs and tissues such as hearts, kidneys, and bone marrow. In such patients, repeated surgery is sometimes necessary in order to achieve a successful transplant.

Cornea donors are carefully screened. Individuals with infectious diseases are not accepted as donors.

Resources

BOOKS

Boruchoff, S. Arthur, and Richard A. Thoft. "Keratoplasty: Lamellar and Penetrating." In *The Cornea*, ed. Gilbert Smolin and Richard A. Thoft. Boston: Little, Brown and Co., 1994.

Brightbill, Frederick S., ed. *Corneal Surgery.* St. Louis: Mosby, 1993.

Bruner, William E., Walter J. Stark, and A. Edward Maumenee. *Manual of Corneal Surgery.* New York: Churchill Livingstone, 1987.

General Ophthalmology. 14th ed. Ed. Daniel Vaughan. Stamford: Appleton & Lange, 1995.

Miller, Stephen J. H. *Parsons' Diseases of the Eye.* 18th ed. New York: Churchill Livingstone, 1990.

PERIODICALS

Watson, B. C., and G. L. White Jr. "Corneal Transplantation." *American Family Physician* 54 (Nov. 1996): 1945-1948.

ORGANIZATIONS

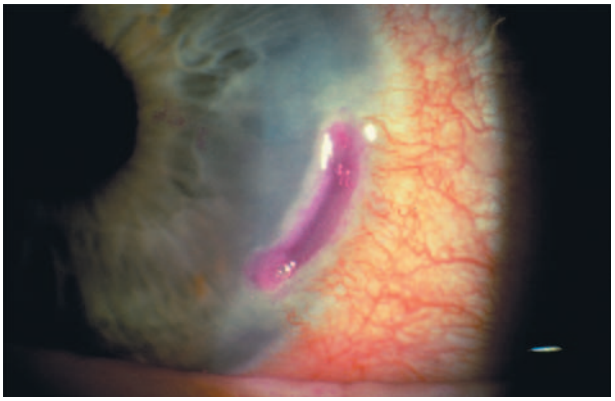
American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

Victor Leipzig, PhD

Corneal ulcers

Definition

The cornea, the clear front part of the eye through which light passes, is subject to many infections and to injury from exposure and from **foreign objects**. Infection and injury cause inflammation of the cornea—a condition called **keratitis**. Tissue loss because of inflammation produces an ulcer. The ulcer can either be centrally located, thus greatly affecting vision, or peripherally located. There are about 30,000 cases of bacterial corneal ulcers in the United States each year.



A close-up view of an ulcer on cornea. *(Custom Medical Stock Photo. Reproduced by permission.)*

Description

The most common cause of corneal ulcers is germs, but most of them cannot invade a healthy cornea with adequate tears and a functioning eyelid. They gain access because injury has impaired these defense mechanisms. A direct injury from a foreign object inoculates germs directly through the outer layer of the cornea, just as it does to the skin. A caustic chemical can inflame the cornea by itself or so damage it that germs can invade. Improper use of contact lenses has become a common cause of corneal injury. Eyelid or tear function failure is the other way to make the eye vulnerable to infection. Tears and the eyelid together wash the eye and prevent foreign material from settling in. Tears contain enzymes and other substances to help protect against infection. Certain diseases dry up tear production, leaving the cornea dry and defenseless. Other diseases paralyze or weaken the eyelids so that they cannot effectively protect and cleanse the eyes.

Causes and symptoms

Viruses, bacteria, fungi, and a protozoan called *Acanthamoeba* can all invade the cornea and damage it under suitable conditions.

- Bacteria from a common **conjunctivitis** (pink eye) rarely spread to the cornea, but can if untreated.

KEY TERMS

Fluorescein—A fluorescent chemical used to examine the cornea.

Germ—A disease-causing microorganism.

Inflammation—The body's reaction to irritation.

Topical corticosteroids—Cortisone and related drugs used on the skin and in the eye, usually for allergic conditions.

- Fecal bacteria are more likely to be able to infect the cornea.
- A bacterium called *Pseudomonas aeruginosa*, which can contaminate eyedrops, is particularly able to cause corneal infection.
- A group of incomplete bacteria known as *Chlamydia* can be transmitted to the eye directly by flies or dirty hands. One form of chlamydial infection is the leading cause of blindness in developing countries and is known as Egyptian ophthalmia or **trachoma**. Another type of *Chlamydia* causes a sexually transmitted disease.
- Other sexually transmitted diseases—for example, syphilis—can affect the cornea.

The most common viruses to damage the cornea are adenoviruses and herpes viruses. Viral and fungal infections are often caused by improper use of topical **corticosteroids**. If topical corticosteroids are used in a patient with herpes simplex keratitis, the ulcer can get much worse and blindness could result.

Symptoms are obvious. The cornea is intensely sensitive, so corneal ulcers normally produce severe **pain**. If the corneal ulcer is centrally located, vision is impaired or completely absent. Tearing is present and the eye is red. It hurts to look at bright lights.

Diagnosis

The doctor will take a case history to try to determine the cause of the ulcer. This can include improper use of contact lenses; injury, such as a scratch from a twig; or severe dry eye. An instrument called a slit lamp will be used to examine the cornea. The slit lamp is a microscope with a light source that magnifies the cornea, allowing the extent of the ulcer to be seen. Fluorescein, a yellow dye, may be used to illuminate further detail. If a germ is responsible for the ulcer, identification may require scraping samples directly from the cornea, conjunctiva, and lids, and sending them to the laboratory.

Treatment

A corneal ulcer needs to be treated aggressively, as it can result in loss of vision. The first step is to eliminate infection. Broad spectrum **antibiotics** will be used before the lab results come back. Medications may then be changed to more specifically target the cause of the infection. A combination of medications may be necessary. Patients should return for their follow-up visits so that the doctor can monitor the healing process. The cornea can heal from many insults, but if it remains scarred, **corneal transplantation** may be necessary to restore vision. If the corneal ulcer is large, hospitalization may be necessary.

Prognosis

Treated early enough, corneal infections will usually resolve, perhaps even without the formation of an ulcer. However, left untreated, infections can lead to ulcers and the corneal ulcer can result in scarring or perforation of the cornea. Other problems may occur as well, including **glaucoma**. Patients with certain systemic diseases that impede healing (such as **diabetes mellitus** or **rheumatoid arthritis**) may need more aggressive treatment. The later the treatment, the more damage will be done and the more scarring will result. Corneal transplant is standard treatment with a high probability of success.

Prevention

Attentive care of contact lenses will greatly reduce the incidence of corneal damage and ulceration. Germs that cause no problems in the mouth or on the hands can damage the eye, so contact lens wearers must wash their hands before touching their lenses and must not use saliva to moisten them. Tap water should not be used to rinse the lenses. Contacts should be removed whenever there is irritation and left out until the eyes are back to normal. It is not advisable to wear contact lenses while swimming or in hot tubs. Daily wear contact lenses have been found to be less of a risk than contacts for overnight wear (extended wear). Organisms have been cultured from contact lens cases, so the cases should be rinsed in hot water and allowed to air dry. Cases should be replaced every three months. Patients should follow their doctors' schedules for replacement of the contacts.

Eye protection in the workplace, or wherever tiny particles are flying around, is essential. Ultraviolet (UV) coatings on glasses or sunglasses can help protect the eyes from the sun's rays. Goggles with UV protection should be worn when skiing or in suntanning salons to protect against UV rays. Prompt attention to any red eye should prevent progressive damage.

For people with inadequate tears, use of artificial tears eyedrops will prevent damage from drying. Eyelids that do not close adequately may temporarily have to be sewn shut to protect the eye until more lasting treatment can be instituted.

Resources

BOOKS

Newell, Frank W. "Ulcerative Keratitis." In *Ophthalmology: Principles and Concepts*. 8th ed. St. Louis: Mosby, 1996.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

J. Ricker Polsdorfer, MD

Corns and calluses

Definition

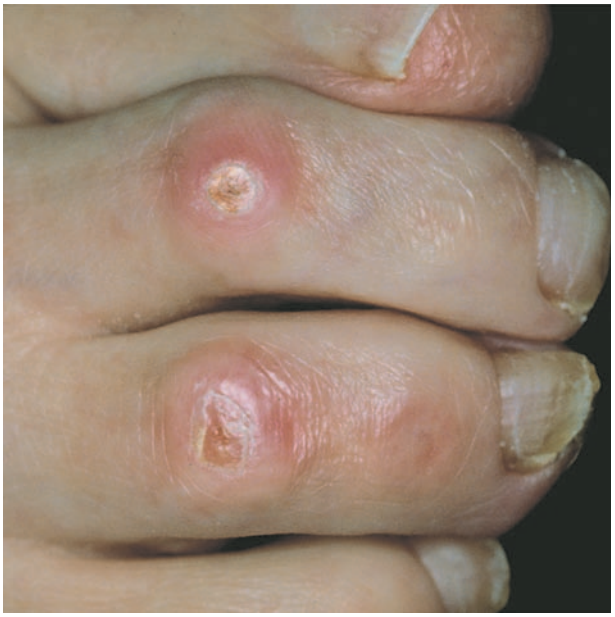
A corn is a small, painful, raised bump on the outer skin layer. A callus is a rough, thickened patch of skin.

Description

Corns and calluses are one of the three major foot problems in the United States. The other two are foot infections and toenail problems. Corns and calluses affect about 5% of the population.

Corns usually appear on non-weight-bearing areas like the outside of the little toe or the tops of other toes. Women have corns more often than men, probably because women wear high-heeled shoes and other shoes that do not fit properly. Corns have hard cores shaped like inverted pyramids. Sharp **pain** occurs whenever downward pressure is applied, and a dull ache may be felt at other times.

Calluses occur most often on the heels and balls of the feet, the knees, and the palms of the hands. However, they can develop on any part of the body that is subject to repeated pressure or irritation. Calluses are usually more than an inch wide—larger than corns. They generally don't hurt unless pressure is applied.



Corns on toes. *(Custom Medical Stock Photo. Reproduced by permission.)*

Types of corns

A hard corn is a compact lump with a thick core. Hard corns usually form on the tops of the toes, on the outside of the little toe, or on the sole of the foot.

A soft corn is a small, inflamed patch of skin with a smooth center. Soft corns usually appear between the toes.

A seed corn is the least common type of corn. Occurring only on the heel or ball of the foot, a seed corn consists of a circle of stiff skin surrounding a plug of cholesterol.

Types of calluses

A plantar callus, a callus that occurs on the sole of the foot, has a white center. Hereditary calluses develop where there is no apparent friction, run in families, and occur most often in children.

Causes and symptoms

Corns and calluses form to prevent injury to skin that is repeatedly pinched, rubbed, or irritated. The most common causes are:

- shoes that are too tight or too loose, or have very high heels
- tight socks or stockings
- deformed toes

KEY TERMS

Ayurveda—Ayurveda is a system of wholistic medicine from India that aims to bring the individual into harmony with nature. It provides guidance regarding food and lifestyle, so that healthy people can stay healthy and people with health challenges can improve their health.

Bursitis—Inflammation of a bursa, a fluid-filled cavity or sac. In the body, bursae are located at places where friction might otherwise develop.

- walking down a long hill, or standing or walking on a hard surface for a long time

Jobs or hobbies that cause steady or recurring pressure on the same spot can also cause calluses.

Symptoms include hard growths on the skin in response to direct pressure. Corns may be extremely sore and surrounded by inflamed, swollen skin.

Diagnosis

Corns can be recognized on sight. A family physician or podiatrist may scrape skin off what seems to be a callus, but may actually be a wart. If the lesion is a wart, it will bleed. A callus will not bleed, but will reveal another layer of dead skin.

Treatment

Corns and calluses do not usually require medical attention unless the person who has them has **diabetes mellitus**, poor circulation, or other problems that make self-care difficult.

Treatment should begin as soon as an abnormality appears. The first step is to identify and eliminate the source of pressure. Placing moleskin pads over corns can relieve pressure, and large wads of cotton, lamb's wool, or moleskin can cushion calluses.

Using hydrocortisone creams or soaking feet in a solution of Epsom salts and very warm water for at least five minutes a day before rubbing the area with a pumice stone will remove part or all of some calluses. Rubbing corns just makes them hurt more.

Applying petroleum jelly or lanolin-enriched hand lotion helps keep skin soft, but corn-removing ointments that contain acid can damage healthy skin. They should never be used by pregnant women or by people who are diabetic or who have poor circulation.

It is important to see a doctor if the skin of a corn or callus is cut, because it may become infected. If a corn discharges pus or clear fluid, it is infected. A family physician, podiatrist, or orthopedist may:

- remove (debride) affected layers of skin
- prescribe oral **antibiotics** to eliminate infection
- drain pus from infected corns
- inject cortisone into the affected area to decrease pain or inflammation
- perform surgery to correct toe deformities or remove bits of bone

Alternative treatment

Standing and walking correctly can sometimes eliminate excess foot pressure. Several types of bodywork can help correct body imbalances. Bodywork is a term used for any of a number of systems, including **Aston-Patterning**, the **Feldenkrais method**, and **rolfing**, that manipulate the body through massage, movement education, or meditational techniques.

Aloe (*Aloe barbadensis*) cream is an effective skin softener, and two or three daily applications of calendula (*Calendula officinalis*) salve can soften skin and prevent inflammation. One teaspoon of lemon juice mixed with one teaspoon of dried chamomile (*Martricaria recutita*) tea and one crushed garlic clove dissolves thickened skin.

An ayurvedic practitioner may recommend the following treatment:

- apply each day a paste made by combining one teaspoon of aloe vera gel with half that amount of turmeric (*Circuma longa*)
- bandage overnight
- soak in warm water for 10 minutes every morning
- massage gently with mustard (*Brassica cruciferae*) oil

Prognosis

Most corns and calluses disappear about three weeks after the pressure that caused them is eliminated. They are apt to recur if the pressure returns.

Extreme pain can change the way a person stands or walks. Such changes can, in turn, cause pain in the ankle, back, hip, or knee.

Bursitis, a painful, inflamed fluid-filled sac, can develop beneath a corn. An ulcer or broken area within a corn can reach to the bone. Infection can have serious consequences for people who have diabetes or poor circulation.

Prevention

Corns and calluses can usually be prevented by avoiding friction-causing activities and wearing shoes that fit properly, are activity-appropriate, and are kept in good repair. Soles and heels that wear unevenly may indicate a need for corrective footwear or special insoles. Socks and stockings should not cramp the toes. Gloves, kneepads, and other protective gear should also be worn as needed.

Feet should be measured, while standing, whenever buying new shoes. It is best to shop for shoes late in the day, when feet are likely to be swollen. It is also important to buy shoes with toe-wiggling room and to try new shoes on both feet.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

New Choices in Natural Healing. Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

ORGANIZATIONS

American Podiatric Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814-1698. (301) 571-9200. <http://www.apma.org>.

OTHER

"Corn or Callus." *ThriveOnline*. 20 Apr. 1998 <http://thriveonline.oxygen.com>.

"Corns/Calluses." *YourHealth.com*. 20 Apr. 1998 <http://www.yourhealth.com>.

"Foot Disorders." *Foot Talk Home Page*. <http://www.foottalk.com/corns.htm>.

"Foot Facts." *American Podiatric Medical Association*. 20 Apr. 1998 <http://www.apma.org>.

Maureen Haggerty

Coronary artery bypass graft surgery

Definition

Coronary artery bypass graft surgery is a surgical procedure in which one or more blocked coronary arteries are bypassed by a blood vessel graft to restore normal blood flow to the heart. These grafts usually come from the patient's own arteries and veins located in the leg, arm, or chest.

Purpose

Coronary artery bypass graft surgery (also called coronary artery bypass surgery, CABG, and bypass operation) is performed to restore blood flow to the heart. This relieves chest **pain** and **ischemia**, improves the patient's quality of life, and in some cases, prolongs the patient's life. The goals of the procedure are to enable the patient to resume a normal lifestyle and to lower the risk of a **heart attack**.

The decision to perform coronary artery bypass graft surgery is a complex one, and there is some disagreement among experts as to when it is indicated. Many experts feel that it has been performed too frequently in the United States. According to the American Heart Association, appropriate candidates for coronary artery bypass graft surgery include patients with blockages in at least three major coronary arteries, especially if the blockages are in arteries that feed the heart's left ventricle; patients with **angina** so severe that even mild exertion causes chest pain; and patients who cannot tolerate percutaneous transluminal coronary **angioplasty** and do not respond well to drug therapy. It is well accepted that coronary artery bypass graft surgery is the treatment of choice for patients with severe **coronary artery disease** (three or more diseased arteries with impaired function in the left ventricle).

Precautions

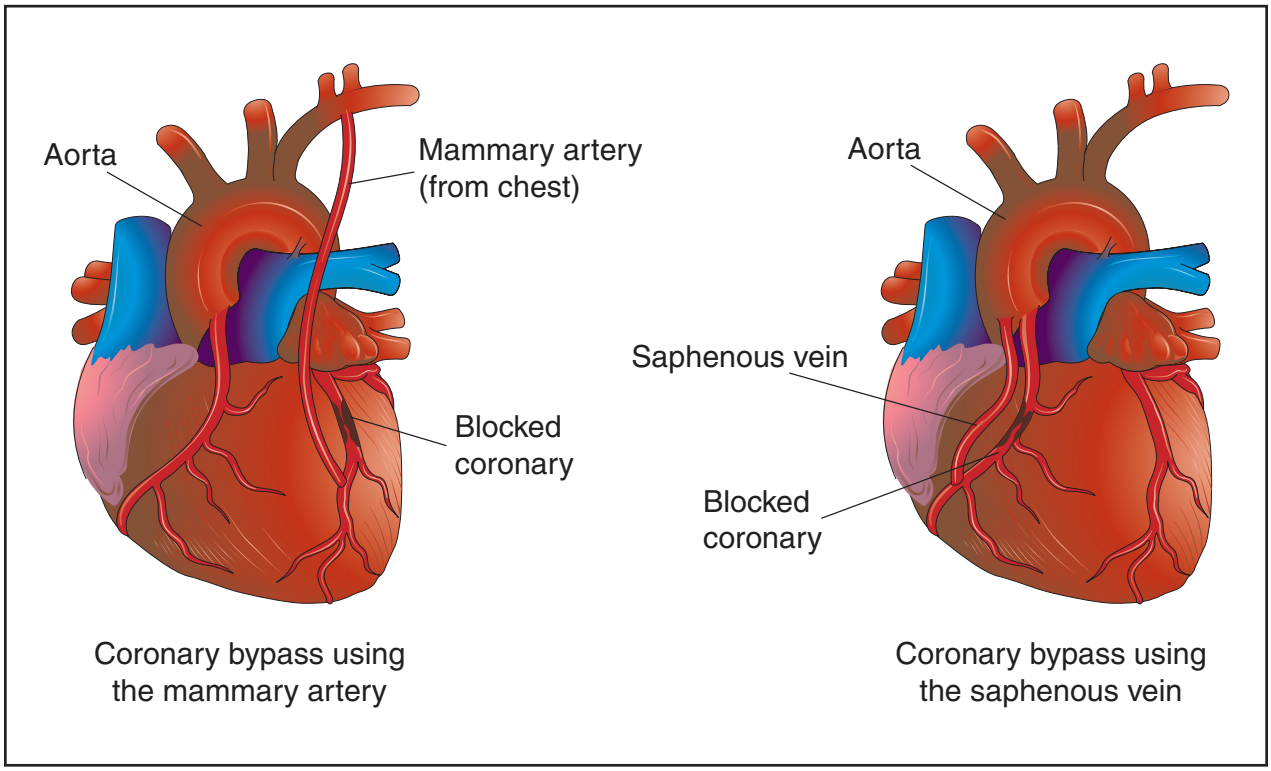
Coronary artery bypass graft surgery should ideally be postponed for three months after a heart attack. Patients should be medically stable before the surgery, if possible.

Description

Coronary artery bypass graft surgery builds a detour around one or more blocked coronary arteries with a graft from a healthy vein or artery. The graft goes around the clogged artery (or arteries) to create new pathways for oxygen-rich blood to flow to the heart.

Coronary artery bypass graft surgery is major surgery performed in a hospital. The length of the procedure depends upon the number of arteries being bypassed, but it generally takes from four to six hours—sometimes longer. The average hospital stay is four to seven days. Full recovery from coronary artery bypass graft surgery takes three to four months. Within four to six weeks, people with sedentary office jobs can return to work; people with physical jobs must wait longer and sometimes change careers.

Coronary artery bypass graft surgery is widely performed in the United States. The American Heart Association estimates that 573,000 coronary artery bypass graft surgeries were performed on 363,000 patients in 1995. Seventy-four percent of these procedures were performed on men and 44% on men and women under the age of 65 (1995 data). The estimated average cost of this procedure in 1995 was $44,820.



Coronary artery bypass graft surgery builds a detour around one or more blocked coronary arteries with a graft from a healthy vein or artery. The graft goes around the clogged artery (or arteries) to create new pathways for oxygen-rich blood to flow to the heart. *(Illustration by Electronic Illustrators Group.)*

Procedure

The surgery team for coronary artery bypass graft surgery includes the cardiovascular surgeon, assisting surgeons, a cardiovascular anesthesiologist, a perfusion technologist (who operates the heart-lung machine), and specially trained nurses. After general anesthesia is administered, the surgeon removes the veins or prepares the arteries for grafting. If the saphenous vein is to be used, a series of incisions are made in the patient's thigh or calf. More commonly, a segment of the internal mammary artery will be used and the incisions are made in the chest wall. The surgeon then makes an incision from the patient's neck to navel, saws through the breastbone, and retracts the rib cage open to expose the heart. The patient is connected to a heart-lung machine, also called a cardiopulmonary bypass pump, that cools the body to reduce the need for oxygen and takes over for the heart and lungs during the procedure. The heart is then stopped and a cold solution of potassium-enriched normal saline is injected into the aortic root and the coronary arteries to lower the temperature of the heart, which prevents damage to the tissue.

Next, a small opening is made just below the blockage in the diseased coronary artery. Blood will be redirected through this opening once the graft is sewn in place. If a leg vein is used, one end is connected to the coronary artery and the other to the aorta. If a mammary artery is used, one end is connected to the coronary artery while the other remains attached to the aorta. The procedure is repeated on as many coronary arteries as necessary. Most patients who have coronary artery bypass graft surgery have at least three grafts done during the procedure.

Electric shocks start the heart pumping again after the grafts have been completed. The heart-lung machine is turned off and the blood slowly returns to normal body temperature. After implanting pacing electrodes (if needed) and inserting a chest tube, the surgeon closes the chest cavity.

Success rate of coronary artery bypass graft surgery

About 90% of patients experience significant improvements after coronary artery bypass graft surgery. Patients experience full relief from chest pain and resume their normal activities in about 70% of the cases; the remaining 20% experience partial relief. In 5–10% of coronary artery bypass graft surgeries, the bypass graft stops supplying blood to the bypassed artery within one year. Younger peo-

ple who are healthy except for the heart disease do well with bypass surgery. Patients who have poorer results from coronary artery bypass graft surgery include those over the age of 70, those who have poor left ventricular function, or are undergoing a repeat surgery or other procedures concurrently, and those who continue **smoking**, do not treat **high cholesterol** or other coronary risk factors, or have another debilitating disease.

Long term, symptoms recur in only about 3–4% of patients per year. Five years after coronary artery bypass graft surgery, survival expectancy is 90%, at 10 years it is about 80%, at 15 years it is about 55%, and at 20 years it is about 40%.

Angina recurs in about 40% of patients after about 10 years. In most cases, it is less severe than before the surgery and can be controlled by drug therapy. In patients who have had vein grafts, 40% of the grafts are severely obstructed 10 years after the procedure. Repeat coronary artery bypass graft surgery may be necessary, and is usually less successful than the first surgery.

Minimally invasive coronary artery bypass graft surgery

There are two new types of minimally invasive coronary artery bypass graft surgery: port-access coronary artery bypass (also called PACAB or PortCAB) and minimally invasive coronary artery bypass (also called MIDCAB). These procedures are minimally invasive because they do not require the neck-to-navel incision, sawing through the breastbone, or opening the rib cage to expose the heart. Both procedures enable surgeons to work on the coronary arteries through small chest holes called ports and other small incisions. Port-access coronary artery bypass requires the use of a heart-lung machine but minimally invasive coronary artery bypass does not. Advantages of these procedures over standard coronary artery bypass graft surgery include a shorter hospital stay, a shorter recovery period, and lower costs.

Port-access coronary artery bypass enables surgeons to perform bypasses through smaller incisions. Using a video monitor to view the procedure, the surgeon passes instruments through ports in the patient's chest to perform the bypass. Mammary arteries or leg veins are used for the grafts. Minimally invasive coronary artery bypass is performed on a beating heart and is appropriate only for bypasses of one or two arteries. Small ports are made in the patient's chest, along with a small incision directly over the coronary artery to be bypassed. Generally, the surgeon uses a mammary artery for the bypass.

Early data on outcomes for port-access coronary artery bypass and minimally invasive coronary artery bypass are favorable. Mortality rates with port-access coronary artery bypass and minimally invasive coronary artery bypass are both less than 3%—about the same as in standard coronary artery bypass graft surgery. One clinical trial indicated that survival at seven years was the same in minimally invasive coronary artery bypass and standard coronary artery bypass graft surgery, but that another intervention was necessary five times more often with minimally invasive coronary artery bypass than with standard coronary artery bypass graft surgery. The American Heart Association Council on Cardio-Thoracic and Vascular Surgery feels that both procedures appear promising but that further study is needed. More data covering longer term outcomes are necessary in order to fully assess these procedures.

Preparation

The patient is usually admitted to the hospital the day before the coronary artery bypass graft surgery is scheduled. Coronary **angiography** has been previously performed to show the surgeon where the arteries are blocked and where the grafts might best be positioned. The patient is given a blood-thinning drug—usually heparin—that helps to prevent blood clots. The evening before the surgery, the patient showers with antiseptic soap and is shaved from chin to toes. After midnight, food and fluids are restricted. A sedative is prescribed on the morning of surgery and sometimes the night before. Heart monitoring begins.

Aftercare

The patient recovers in a surgical intensive care unit for at least the first two days after the surgery. He or she is connected to chest and breathing tubes, a mechanical ventilator, a heart monitor and other monitoring equipment, and a urinary catheter. The breathing tube and ventilator are usually removed within six hours of surgery, but the other tubes remain in place as long as the patient is in the intensive care unit. Drugs are prescribed to control pain and to prevent unwanted blood clotting. The patient is closely monitored. Vital signs and other parameters, such as heart sounds and oxygen and carbon dioxide levels in arterial blood, are checked frequently. The chest tube is checked to ensure that it is draining properly. The patient is fed intravenously for the first day or two. Daily doses of **aspirin** are started within six to 24 hours after the procedure. Chest physiotherapy is started after the ventilator and breathing tube are removed. The therapy includes coughing, turning frequently, and taking deep breaths. Other exercises will be encouraged to improve the patient's circulation and prevent complications due to prolonged bed rest.

If there are no complications, the patient begins to resume a normal routine around the second day. This includes eating regular food, sitting up, and walking

KEY TERMS

Aorta—The main artery which carries blood from the heart to the rest of the body The aorta is the largest artery in the body.

Graft—To implant living tissue surgically. In coronary artery bypass graft surgery, healthy veins or arteries are grafted to coronary arteries.

Mammary artery—A chest wall artery that descends from the aorta and is commonly used for bypass grafts.

Saphenous vein—A long vein in the thigh or calf commonly used for bypass grafts.

Ventricles—The left and right ventricles are the large chambers of the heart. The ventricles propel blood to the lungs and the rest of the body.

around a little bit. Before being released from the hospital, the patient usually spends a few days under observation in a non-surgical unit. During this time, counseling is usually provided on eating right and starting a light **exercise** program to keep the heart healthy. Patients should eat a lot of fruits, vegetables, grains, and non-fat or low-fat dairy products, and reduce fats to less than 30% of all calories. An exercise program will usually be tailored for the patient, who will be encouraged to participate in a **cardiac rehabilitation** program where exercise will be supervised by professionals. Cardiac **rehabilitation** programs, offered by hospitals and other organizations, may also include classes on heart-healthy living.

Full recovery from coronary artery bypass graft surgery takes three to four months and is a gradual process. Upon release from the hospital, the patient will feel weak because of the extended bed rest in the hospital. Within a few weeks, the patient should begin to feel stronger.

While the incision scar from coronary artery bypass graft surgery heals, which takes one to two months, it may be sore. The scar should not be bumped, scratched, or otherwise disturbed. An exercise test is often conducted after the patient leaves the hospital to determine how effective the surgery was and to confirm that progressive exercise is safe.

Risks

Coronary artery bypass graft surgery is major surgery and patients may experience any of the complications associated with major surgery. The risk of **death** during coronary artery bypass graft surgery is two to three percent. Possible complications include graft closure and development of blockages in other arteries, long-term development of atherosclerotic disease of saphenous vein grafts, abnormal heart rhythms, high or low blood pressure, blood clots that can lead to a **stroke** or heart attack, infections, and depression. There is a higher risk for complications in patients who are heavy smokers, patients who have serious lung, kidney, or metabolic problems, or patients who have a reduced supply of blood to the brain.

Resources

BOOKS

American Heart Association. "Considering Surgery or Other Interventions." In *Guide to Heart Attack Treatment, Recovery, Prevention*. New York: Time Books, 1996.

DeBakey, Michael E., and Antonio M. Gotto Jr. "Surgical Treatment of Coronary Artery Disease." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

Texas Heart Institute. "Heart Surgery." In *Texas Heart Institute Heart Owners Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

Bauman, Alisa. "Too Many Bypasses?" *Men's Health* 78 (Mar. 1998): 80-81.

Faxon, David P. "Myocardial Revascularization in 1997: Angioplasty Versus Bypass Surgery." *American Family Physician* (1 Oct. 1997): 1409-1417.

Hicks Jr., George L. "Cardiac Surgery." *Journal of the American College of Surgeons* 186, no. 2 (Feb. 1998): 129-132.

Smith, Laquita Bowen. "Not-So-Open Heart Surgery: New Equipment Allows for a Three-Inch Incision." *Memphis Business Journal* 18, no. 53 (12 May 1997): 49.

Solomon, Allen J., and Bernard J. Gersh. "Management of Chronic Stable Angina: Medical Therapy, Percutaneous Transluminal Coronary Angioplasty, and Coronary Artery Bypass Graft Surgery." *Annals of Internal Medicine* 128 (1 Feb. 1998): 216-223.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Lori De Milto

Coronary artery disease

Definition

Coronary artery disease is a narrowing or blockage of the arteries and vessels that provide oxygen and nutri-

ents to the heart. It is caused by **atherosclerosis**, an accumulation of fatty materials on the inner linings of arteries. The resulting blockage restricts blood flow to the heart. When the blood flow is completely cut off, the result is a **heart attack**.

Description

Coronary artery disease, also called coronary heart disease or heart disease, is the leading cause of **death** for both men and women in the United States. According to the American Heart Association, in 1995 one in every 4.8 deaths in the United States was caused by coronary artery disease. About every 29 seconds, one American will have a heart attack; about every minute, one American will die from a heart attack. Fourteen million Americans have active symptoms of coronary artery disease (heart attack or chest pains). Many millions more have silent coronary disease, the first indication of which can be sudden death.

Coronary artery disease occurs when the coronary arteries become partially blocked or clogged. This blockage limits the flow of blood from the coronary arteries, which are the major arteries supplying oxygen-rich blood to the heart. The coronary arteries expand when the heart is working harder and needs more oxygen. Arteries would expand, for example, when a person is climbing stairs, exercising, or having sex. If the arteries are unable to expand, the heart is deprived of oxygen (myocardial **ischemia**). When the blockage is limited, chest **pain** or pressure, called **angina,** may occur. When the blockage cuts off the flow of blood, the result is heart attack (myocardial infarction or heart muscle death).

Healthy coronary arteries are clean, smooth, and slick. The artery walls are flexible and can expand to let more blood through when the heart needs to work harder. The disease process in arteries is thought to begin with an injury to the linings and walls of the arteries. This injury makes them susceptible to atherosclerosis and blood clots (thrombosis).

Causes and symptoms

Coronary artery disease is usually caused by atherosclerosis. Cholesterol and other fatty substances accumulate on the inner wall of the arteries. They attract fibrous tissue, blood components, and calcium and harden into artery-clogging plaques. Atherosclerotic plaques often form blood clots that can also block the coronary arteries (coronary thrombosis). Congenital defects and muscle spasms can also block blood flow. Recent research indicates that infection from organisms such as chlamydia bacteria may be responsible for some cases of coronary artery disease.

A number of major contributing factors increase the risk of developing coronary artery disease. Some of these can be changed and some cannot. People with more risk factors are more likely to develop coronary artery disease.

Major risk factors

Major risk factors significantly increase the chance of developing coronary artery disease. Those that cannot be changed are:

- Heredity—People whose parents have coronary artery disease are more likely to develop it. African-Americans are also at increased risk because they experience a higher rate of severe **hypertension** than whites do.
- Sex—Men are more likely to have heart attacks than women are and to have them at a younger age. Over age 60, however, women have coronary artery disease at a rate equal to that of men.
- Age—Men who are 45 years of age and older and women who are 55 years of age and older are more likely to have coronary artery disease. Occasionally, coronary disease may strike a person in the 30s. Older people (those over 65) are more likely to die of a heart attack. Older women are twice as likely as older men to die within a few weeks of a heart attack.

Major risk factors that can be changed are:

- Smoking—Smoking increases both the chance of developing coronary artery disease and the chance of dying from it. Smokers are two to four times more likely than are non-smokers to die of sudden heart attack. They are more than twice as likely as non-smokers to have a heart attack. They are also more likely to die within an hour of a heart attack. Second hand smoke may also increase risk.
- High cholesterol—Dietary sources of cholesterol are meat, eggs, and other animal products. The body also produces it. Age, sex, heredity, and diet affect one's blood cholesterol. Total blood cholesterol is considered high at levels above 240 mg/dL and borderline at 200-239 mg/dL. High-risk levels of low-density lipoprotein (LDL cholesterol) begin at 130–159 mg/dL, depending on other risk factors. Risk of developing coronary artery disease increases steadily as blood cholesterol levels increase above 160 mg/dL. When a person has other risk factors, the risk multiplies.
- High blood pressure—High blood pressure makes the heart work harder and weakens it over time. It increases the risk of heart attack, **stroke**, kidney failure, and congestive **heart failure**. A blood pressure of 140 over 90 or above is considered high. As the numbers rise, high blood pressure goes from Stage 1 (mild) to Stage 4 (very severe). In combination with **obesity**, **smoking**,

high cholesterol, or diabetes, high blood pressure raises the risk of heart attack or stroke several times.

- Lack of physical activity—Lack of **exercise** increases the risk of coronary artery disease. Even modest physical activity, like walking, is beneficial if done regularly.
- Diabetes mellitus—The risk of developing coronary artery disease is seriously increased for diabetics. More than 80% of diabetics die of some type of heart or blood vessel disease.

Contributing risk factors

Contributing risk factors have been linked to coronary artery disease, but their significance is not known yet. Contributing risk factors are:

- Obesity—Excess weight increases the strain on the heart and increases the risk of developing coronary artery disease even if no other risk factors are present. Obesity increases blood pressure and blood cholesterol and can lead to diabetes.
- **Stress** and anger—Some scientists believe that stress and anger can contribute to the development of coronary artery disease and increase the blood's tendency to form clots (thrombosis). Stress, the mental and physical reaction to life's irritations and challenges, increases the heart rate and blood pressure and can injure the lining of the arteries. Evidence shows that anger increases the risk of dying from heart disease. The risk of heart attack is more than double after an episode of anger.

Chest pain (angina) is the main symptom of coronary heart disease but it is not always present. Other symptoms include **shortness of breath**, chest heaviness, tightness, pain, a burning sensation, squeezing, or pressure either behind the breastbone or in the arms, neck, or jaws. Many people have no symptoms of coronary artery disease before having a heart attack; 63% of women and 48% of men who died suddenly of coronary artery disease had no previous symptoms of the disease, according to the American Heart Association.

Diagnosis

Diagnosis begins with a visit to the physician, who will take a medical history, discuss symptoms, listen to the heart, and perform basic screening tests. These tests will measure weight, blood pressure, blood lipid levels, and **fasting** blood glucose levels. Other diagnostic tests include resting and exercise electrocardiogram, **echocardiography**, radionuclide scans, and coronary **angiography**. The treadmill exercise (stress) test is an appropriate screening test for those with high risk factors even when they feel well.

An electrocardiogram (ECG) shows the heart's activity and may reveal a lack of oxygen (ischemia). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through an oscilloscope (a monitor) to a recorder that traces them on paper. The test takes about 10 minutes and is performed in a physician's office. A definite diagnosis cannot be made from **electrocardiography**. About 50% of patients with significant coronary artery disease have normal resting electrocardiograms. Another type of electrocardiogram, known as the exercise **stress test**, measures how the heart and blood vessels respond to exertion when the patient is exercising on a treadmill or a stationary bike. This test is performed in a physician's office or an exercise laboratory. It takes 15–30 minutes. It is not perfectly accurate. It sometimes gives a normal reading when the patient has a heart problem or an abnormal reading when the patient does not.

If the electrocardiogram reveals a problem or is inconclusive, the next step is exercise echocardiography or nuclear scanning (angiography). Echocardiography, cardiac ultrasound, uses sound waves to create an image of the heart's chambers and valves. A technician applies gel to a hand-held transducer, then presses it against the patient's chest. The heart's sound waves are converted into an image that can be displayed on a monitor. It does not reveal the coronary arteries themselves, but can detect abnormalities in heart wall motion caused by coronary disease. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30–60 minutes.

Radionuclide angiography enables physicians to see the blood flow of the coronary arteries. Nuclear scans are performed by injecting a small amount of radiopharmaceutical such as thallium into the bloodstream. A device that uses gamma rays to produce an image of the radioactive material (gamma camera) records pictures of the heart. Radionuclide scans are not dangerous. The radiation exposure is about the same as that in a **chest x ray**. The tiny amount of radioactive material used disappears from the body in a few days. Radionuclide scans cost about four times as much as exercise stress tests but provide more information.

In radionuclide angiography, a scanning camera passes back and forth over the patient who lies on a table. Radionuclide angiography is usually performed in a hospital's nuclear medicine department and takes 30–60 minutes. Thallium scanning is usually done in conjunction with an exercise stress test. When the stress test is finished, thallium or sestamibi is injected. The patient resumes exercise for one minute to absorb the thallium. For patients who cannot exercise, cardiac blood flow and heart rate may be increased by intravenous dipyridamole (Persantine) or adenosine. Thallium scanning is done

twice, immediately after injecting the radiopharmaceutical and again four hours (and maybe 24 hours) later. It is usually performed in a hospital's nuclear medicine department. Each scan takes 30–60 minutes.

Coronary angiography is the most accurate method for making a diagnosis of coronary artery disease, but it is also the most invasive. It is a form of **cardiac catheterization** that shows the heart's chambers, great vessels, and coronary arteries using x-ray technology. During coronary angiography the patient is awake but sedated. ECG electrodes are placed on the patient's chest and an intravenous line is inserted. A local anesthetic is injected into the site where the catheter will be inserted. The cardiologist inserts a catheter into a blood vessel and guides it into the heart. A contrast dye is injected to make the heart visible on x-ray cinematography. Coronary angiography is performed in a cardiac catheterization laboratory either in an outpatient or inpatient surgery unit. It takes from 30 minutes to two hours.

Treatment

Coronary artery disease can be treated many ways. The choice of treatment depends on the severity of the disease. Treatments include lifestyle changes and drug therapy, percutaneous transluminal coronary **angioplasty**, and coronary artery bypass surgery. Coronary artery disease is a chronic disease requiring lifelong care. Angioplasty or bypass surgery is not a "cure."

People with less severe coronary artery disease may gain adequate control through lifestyle changes and drug therapy. Many of the lifestyle changes that prevent disease progression—a low-fat, low-cholesterol diet, weight loss if needed, exercise, and not smoking—also help prevent the disease from developing. These lifestyle changes are discussed in more detail under prevention.

Drugs such as nitrates, beta-blockers, and calcium-channel blockers relieve chest pain and complications of coronary artery disease, but they cannot clear blocked arteries. Nitrates (nitroglycerin) improve blood flow to the heart. Beta-blockers (acebutelol, propranolol) reduce the amount of oxygen required by the heart during stress. One type of calcium-channel blocker (verapamil, diltiazem hydrochloride) helps keep the arteries open and reduces blood pressure. **Aspirin** helps prevent blood clots from forming on plaques, reducing the likelihood of a heart attack. Cholesterol-lowering medications are also indicated in most cases.

Percutaneous transluminal coronary angioplasty and bypass surgery are procedures that enter the body (invasive procedures) to improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty, usually called coronary angioplasty, is a non-surgical procedure. A catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compressing the plaque to enlarge the blood vessel and open the blocked artery. The balloon is deflated, and the catheter is removed. Coronary angioplasty is performed by a cardiologist in a hospital and generally requires a stay of one or two days. Coronary angioplasty is successful about 90% of the

KEY TERMS

Atherosclerosis—A process in which the walls of the coronary arteries thicken due to the accumulation of plaque in the blood vessels. Atherosclerosis is the cause of coronary artery disease.

Angina—Chest pain that happens when diseased blood vessels restrict the flow of blood to the heart. Angina is often the first symptom of coronary artery disease.

Beta-blocker—A drug that blocks some of the effects of fight-or-flight hormone adrenaline (epinephrine and norepinephrine), slowing the heart rate and lowering the blood pressure.

Calcium-channel blocker—A drug that blocks the entry of calcium into the muscle cells of small blood vessels (arterioles) and keeps them from narrowing.

Coronary arteries—The main arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into two branches. These are the arteries in which coronary artery disease occurs.

HDL cholesterol—High-density lipoprotein cholesterol is a component of cholesterol that helps protect against heart disease. HDL is nicknamed "good" cholesterol

LDL Cholesterol—Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL increase the risk of coronary heart disease. LDL is nicknamed "bad" cholesterol.

Plaque—A deposit of fatty and other substances that accumulate in the lining of the artery wall.

Triglyceride—A fat that comes from food or is made from other energy sources in the body. Elevated triglyceride levels contribute to the development of atherosclerosis.

time, but for one-third of patients the artery narrows again within six months. The procedure can be repeated. It is less invasive and less expensive than coronary artery bypass surgery.

In coronary artery bypass surgery, a healthy artery or vein from an arm, leg, or chest wall is used to build a detour around the coronary artery blockage. The healthy vessel then supplies oxygen-rich blood to the heart. Bypass surgery is major surgery. It is appropriate for those patients with blockages in two or three major coronary arteries, those with severely narrowed left main coronary arteries, and those who have not responded to other treatments. It is performed in a hospital under general anesthesia. A heart-lung machine is used to support the patient while the healthy vein or artery is attached past the blockage to the coronary artery. About 70% of patients who have bypass surgery experience full relief from angina; about 20% experience partial relief. Only about 3–4% of patients per year experience a return of symptoms. Survival rates after bypass surgery decrease over time. At five years after surgery, survival expectancy is 90%; at 10 years about 80%, at 15 years about 55%, and at 20 years about 40%.

Three semi-experimental surgical procedures for unblocking coronary arteries are currently being studied. **Atherectomy** is a procedure in which the cardiologist shaves off and removes strips of plaque from the blocked artery. In laser angioplasty, a catheter with a laser tip is inserted into the affected artery to burn or break down the plaque. A metal coil called a stent can be implanted permanently to keep a blocked artery open. Stenting is becoming more common.

Alternative treatment

Natural therapies may reduce the risk of certain types of heart disease, but once symptoms appear, conventional medical attention is necessary. A healthy diet (including cold-water fish as a source of essential fatty acids) and exercise, important components of conventional prevention and treatment strategies, also are emphasized in alternative approaches to coronary artery disease. Herbal medicine has a variety of remedies that may have a beneficial effect on coronary artery disease. For example, ginger (*Zingiber officinale*) may help reduce cholesterol. Garlic (*Allium sativum*), ginger, and hot red or chili peppers are all circulatory enhancers that can help prevent blood clots. **Yoga** and other bodywork, massage, relaxation therapies, and talking therapies may also help prevent coronary artery disease and stop, or even reverse, the progression of atherosclerosis. Vitamin and mineral therapy to reduce, reverse, or protect against coronary artery disease includes chromium; calcium and magnesium; B-complex **vitamins**; the anti-oxidant vitamins C and E; selenium; and zinc. **Traditional Chinese medicine** may recommend herbal remedies, massage, **acupuncture**, and dietary modification.

Prognosis

In many cases, coronary artery disease can be successfully treated. Advances in medicine and healthier lifestyles have caused a substantial decline in death rates from coronary artery disease since the mid-1980s. New diagnostic techniques enable doctors to identify and treat coronary artery disease in its earliest stages. New technologies and surgical procedures have extended the lives of many patients who would otherwise have died. Research on coronary artery disease continues.

Prevention

A healthy lifestyle can help prevent coronary artery disease and help keep it from progressing. A heart-healthy lifestyle includes eating right, regular exercise, maintaining a healthy weight, no smoking, moderate drinking, no recreational drugs, controlling hypertension, and managing stress. **Cardiac rehabilitation** programs are excellent to help prevent recurring coronary problems for people who are at risk and who have had coronary events and procedures.

Eat right

A healthy diet includes a variety of foods that are low in fat, especially saturated fat, low in cholesterol, and high in fiber. It includes plenty of fruits and vegetables and limited sodium. Some foods are low in fat but high in cholesterol and some are low in cholesterol but high in fat. Saturated fat raises cholesterol and, in excessive amounts, increases the amount of the clot-forming proteins in blood. Polyunsaturated and monounsaturated fats are good for the heart. Fat should comprise no more than 30% of total daily calories.

Cholesterol, a waxy substance containing fats, is found in foods such as meat, eggs, and other animal products. It is also produced in the liver. Soluble fiber can help lower cholesterol. Dietary cholesterol should be limited to about 300 milligrams per day. Many popular lipid-lowering drugs can reduce LDL cholesterol by an average of 25–30% when used with a low-fat, low-cholesterol diet.

Fruits and vegetables are rich in fiber, vitamins, and **minerals**. They are low-calorie and nearly fat free. Vitamin C and beta-carotene, found in many fruits and vegetables, keep LDL-cholesterol from turning into a form that damages coronary arteries.

Excess sodium can increase the risk of high blood pressure. Many processed foods contain large amounts of sodium. Limit daily intake to about 2,400 milligrams, about the amount in a teaspoon of salt.

The "Food Guide" Pyramid developed by the U.S. Departments of Agriculture and Health and Human Services provides easy-to-follow guidelines for daily heart-healthy eating. It recommends six to 11 servings of bread, cereal, rice, and pasta; three to five servings of vegetables; two to four servings of fruit; two to three servings of milk, yogurt, and cheese; and two to three servings of meat, poultry, fish, dry beans, eggs, and nuts. Fats, oils, and sweets should be used sparingly. Canola and olive oil are better for the heart than other cooking oils. Coronary patients should be on a strict diet.

Exercise regularly

Aerobic exercise can lower blood pressure, help control weight, and increase HDL ("good") cholesterol. It may keep the blood vessels more flexible. The Centers for Disease Control and Prevention and the American College of Sports Medicine recommend moderate to intense aerobic exercise lasting about 30 minutes four or more times per week for maximum heart health. Three 10-minute exercise periods are also beneficial. Aerobic exercise—activities such as walking, jogging, and cycling—uses the large muscle groups and forces the body to use oxygen more efficiently. It can also include everyday activities such as active gardening, climbing stairs, or brisk housework. People with coronary artery disease or risk factors should consult a doctor before beginning an exercise program.

Maintain a desirable body weight

About one quarter of all Americans are overweight and nearly one-tenth are obese, according to the Surgeon General's Report on **Nutrition** and Health. People who are 20% or more over their ideal body weight have an increased risk of developing coronary artery disease. Losing weight can help reduce total and LDL cholesterol, reduce triglycerides, and boost HDL cholesterol. It may also reduce blood pressure. Eating right and exercising are two key components of losing weight.

Avoid recreational drugs

Do not smoke or use tobacco. Smoking has many adverse effects on the heart. It increases the heart rate, constricts major arteries, and can create irregular heartbeats. It raises blood pressure, contributes to the development of plaque, increases the formation of blood clots, and causes blood platelets to cluster and impede blood flow. Heart damage caused by smoking can be repaired by quitting. Even heavy smokers can return to heart health. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within five to 10 years after they quit.

Drink in moderation. Modest consumption of alcohol may actually protect against coronary artery disease because alcohol appears to raise levels of HDL ("good") cholesterol. The American Heart Association defines moderate consumption as one ounce of alcohol per day, roughly one cocktail, one 8-ounce glass of wine, or two 12-ounce glasses of beer. However, even moderate drinking can increase risk factors for heart disease for some people (by raising blood pressure, for example). Excessive drinking is always bad for the heart. It usually raises blood pressure and can poison the heart and cause abnormal heart rhythms or even heart failure.

Do not use other recreational drugs. Commonly used recreational drugs, particularly **cocaine** and "crack," can seriously harm the heart and should never be used.

Seek treatment for hypertension

High blood pressure, one of the most common and serious risk factors for coronary artery disease, can be completely controlled through lifestyle changes and medication. Moderate hypertension can be controlled by reducing dietary intake of sodium and fat, exercising regularly, managing stress, abstaining from smoking, and drinking alcohol in moderation. People for whom these changes do not work or people with severe hypertension may be helped by many categories of medication.

Manage stress

Everyone experiences stress, the mental and physical reaction to life's irritations and challenges. Stress can sometimes be avoided and when it is inevitable, it can be controlled. Techniques for controlling stress include: taking life more slowly, spending more time with family and friends, thinking positively, getting enough sleep, exercising, and practicing relaxation techniques.

Resources

BOOKS

American Heart Association and American Cancer Society. *Living Well, Staying Well.* New York: Time Books, 1996.

DeBakey Michael E., and Antonio M. Gotto Jr. "Coronary Artery Disease," and "Surgical Treatment of Coronary Artery Disease." In *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

"Heart Disease." In *New Choices in Natural Healing*, ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

"Heart Disease." In *The Complete Family Guide to Alternative Medicine*, ed. C. Norman Shealy. New York: Barnes & Noble Books, 1996.

"Heart Problems." In *The Alternative Advisor: The Complete Guide to Natural Therapies & Alternative Treatments*. Alexandria, VA: Time-Life Books, 1997.
Notelovitz, Morris, and Diana Tonnessen. *The Essential Heart Book for Women*. New York: St. Martin's Press, 1996.
Texas Heart Institute. "Coronary Artery Disease, Angina, and Heart Attacks." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

"Exercise Stress Test: A Simple Way to Spot Heart Disease." *Mayo Clinic Health Letter* (Sept. 1996).
"More Evidence for Infection as a Cause of Heart Disease." *Harvard Heart Letter* 7 (Feb. 1997): 6-7.
"Women and Heart Disease" *Harvard Women's Health Watch* 4 (July 1997): 4-5.
Zamula, Evelyn. "Balloons to Bypass Bypass Surgery." *FDA Consumer* 22 (1 May 1988): 24-27.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.
National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.
Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Facts About Coronary Heart Disease." *National Heart, Lung, and Blood Institute*. 27 Nov. 1998. 3 Mar. 1998 <http://www.nhlbi.nih.gov/index.htm>.
"Heart and Stroke 1998 Update." *American Heart Association*. 3 Mar. 1998 <http://www.americanheart.org>.

Lori De Milto

Coronary disease *see* **Coronary artery disease**

Coronary heart disease *see* **Coronary artery disease**

Coronary stenting

Definition

A coronary stent is an artificial support device used in the coronary artery to keep the vessel open.

Purpose

The coronary stent is a relatively new tool used to keep coronary arteries expanded, usually following a balloon **angioplasty**. Balloon angioplasty is used in patients with **coronary artery disease**. In this disease, the blood vessels on the heart become narrow. When this happens, the oxygen supply is reduced to the heart muscle. The primary cause of coronary artery disease is fat deposits blocking the arteries (**atherosclerosis**). In many cases, balloon angioplasty is unsuccessful and the vessel closes after the procedure (restenosis). By forming a rigid support, the stent can prevent restenosis and reduce the need for coronary bypass surgery. The stent is usually a stainless steel mesh tube. Since the stent will be placed inside an artery, the device comes in various sizes to match the size of the artery.

Precautions

Any foreign object in the body, like a stent, will increase the risk of thrombosis. Anticlotting medication is given to prevent this complication.

Description

Coronary stenting usually follows balloon angioplasty, which requires inserting a balloon catheter into the femoral artery in the upper thigh. When this catheter is positioned at the location of the blockage in the coronary artery, it is slowly inflated to widen that artery, and is then removed. The stent catheter is then threaded into the artery and the stent is placed around a deflated balloon. When this is correctly positioned in the coronary artery, the balloon is inflated, expanding the stent against the walls of the coronary artery. The balloon catheter is removed, leaving the stent in place to hold the coronary artery open. A cardiac **angiography** will follow to insure that the stent is keeping the artery open.

Alternative procedures

Balloon angioplasty and coronary stenting are performed to relieve the symptoms of coronary artery disease. By the time coronary artery disease progresses and requires balloon angioplasty, there is no alternative to balloon angioplasty other than coronary bypass surgery. Coronary bypass surgery carries greater risks. However, since coronary artery disease can be related to high fat **diets**, **smoking**, and lack of **exercise**, changes in lifestyle may reduce the risk of developing the disease. Various medications for cholesterol, high blood pressure, and diabetes also can help treat or prevent coronary artery disease.

Preparation

Before the stent is inserted, the patient will probably be instructed to take **aspirin** for several days. Aspirin can help decrease the possibility of blood clots forming at the

KEY TERMS

Balloon angioplasty—The use of a balloon attached to a catheter to widen an artery that has become narrowed. As the balloon is inflated, it opens the artery.

Cardiac angiography—A procedure used to visualize blood vessels of the heart. A catheter is used to inject a dye into the vessels; the vessels can then be seen by x ray.

Catheter—A long thin flexible tube that can be inserted into the body; in this case, it is threaded to the heart.

Restenosis—The narrowing of a blood vessel after it has been opened, usually by balloon angioplasty.

Thrombosis—The development of a blood clot in the vessels. This thrombosis may clog a blood vessel and stop the flow of blood.

stent. Because anesthesia will be used during the procedure, the patient should not eat or drink after midnight of the previous day.

Aftercare

Following the procedure, blood thinners (anticoagulants) will be given through a needle in a vein for about 24 hours. The patient should remain flat and still for awhile to allow the femoral artery to heal from the insertion of the catheter. Medication to control blood clotting should be taken after the patient is discharged from the hospital. A special diet may also be recommended that is low in vitamin K and cholesterol. With time, the patient should begin light exercise, like walking. It is important that no **magnetic resonance imaging** (MRI) tests are given for six months because the magnetic field may move the stent.

Risks

Although coronary stents greatly reduce the risk of restenosis following balloon angioplasty, there is still some risk that the stented artery may close. Thrombosis, bleeding, and artery damage are also risks.

Resources

BOOKS

Garratt, Kirk N., Guy S. Reeder, and David R. Holmes Jr. "Cardiac Catheterization and Angiography." In *Mayo Clinic Practice of Cardiology*, ed. Emilio R. Giuliani, et al. St. Louis: Mosby Publishing, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

OTHER

AdvocateHealthCare. <http://www.advocatehealth.com>.

Cindy L. A. Jones, PhD

Coronary thrombosis *see* **Heart attack**

Coronavirus infection *see* **Common cold**

Corticosteroids

Definition

Corticosteriods are a group of natural and synthetic analogues of the hormones secreted by the hypothalamic-anterior pituitary-adrenocortical (HPA) axis, more commonly referred to as the pituitary gland. These include glucocorticoids, which are anti-inflammatory agents with a large number of other functions; mineralocorticoids, which control salt and water balance primarily through action on the kidneys; and corticotropins, which control secretion of hormones by the pituitary gland.

Purpose

Glucocorticoids have multiple effects, and are used for a large number of conditions. They affect glucose utilization, fat metabolism, and bone development, and are potent anti-inflammatory agents. They may be used for replacement of natural hormones in patients with pituitary deficiency (**Addison's disease**), as well as for a wide number of other conditions including, but not limited to, arthritis, **asthma**, anemia, various cancers, and skin inflammations. Additional uses include inhibition of **nausea and vomiting** after **chemotherapy**, treatment of **septic shock**, treatment of spinal cord injuries, and treatment of hirisutism (excessive hair growth). The choice of drug will vary with the condition. Cortisone and hydrocortisone, which have both glucocorticoid and mineralocorticoid effects, are the drugs of choice for replacement therapy of natural hormone deficiency. Synthetic compounds, which have greater anti-inflammatory effects and less effect on salt and water balance, are usually preferred for other purposes. These compounds include dexamethasone, which is almost exclusively glucocorticoid in its actions, as well as prednisone, prednisolone,

KEY TERMS

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Ointment—A thick, spreadable substance that contains medicine and is meant to be used on the outside of the body.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: controlled human studies have demonstrated no fetal risk. Category B: animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: no adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: evidence of fetal risk, but benefits outweigh risks. Category X: evidence of fetal risk. Risks outweigh any benefits.

betamethasone, trimacinolone, and others. Glucocorticoids are formulated in oral dosage forms, topical creams and ointments, oral and nasal inhalations, rectal foams, and ear and eye drops.

Mineralocorticoids control the retention of sodium in the kidneys. In mineralocorticoid deficiency, there is excessive loss of sodium through the kidneys, with resulting water loss. Fludrocortisone (Florinef) is the only drug available for treatment of mineralocorticoid deficiency, and is available only in an oral dosage form.

Corticotropin (ACTH, adrenocorticotropic hormone) stimulates the pituitary gland to release cortisone. A deficiency of corticotropic hormone will have the same effects as a deficiency of cortisone. The hormone, which is available under the brand names Acthar and Actrel, is used for diagnostic testing, to determine the cause of a glucocorticoid deficiency, but is rarely used for replacement therapy since direct administration of glucocorticoids may be easier and offers better control over dosages.

Recommended dosage

The dosage of glucocorticoids varies with the drug, route of administration, condition being treated, and patient. Consult specific references.

Fludrocortisone, for use in replacement therapy, is normally dosed at 0.1 mg/day. Some patients require higher doses. It should normally be administered in conjunction with cortisone or hydrocortisone.

ACTH, when used for diagnostic purposes, is given as 10–25 units dissolved in 500 ml of 5% dextrose injection-infused IV over eight hours. A long-acting form, which may be used for replacement therapy, is given by subcutaneous (SC) or intramuscular (IM) injection at a dose of 40 to 80 units every 24–72 hours.

Precautions

Glucocorticoids

The most significant risk associated with administration of glucocorticoids is suppression of natural corticosteroid secretion. When the hormones are administered, they suppress the secretion of ACTH, which in turn reduces the secretion of the natural hormones. The extent of suppression varies with dose, drug potency, duration of treatment, and individual patient response. While suppression is seen primarily with drugs administered systemically, it can also occur with topical drugs such as creams and ointments, or drugs administered by inhalation. Abrupt cessation of corticosteroids may result in acute adrenal crisis (Addisonian crisis) that is marked by **dehydration** with severe vomiting and **diarrhea**, **hypotension**, and loss of consciousness. Acute adrenal crisis is potentially fatal.

Chronic overdose of glucocorticoids leads to Cushingoid syndrome, which is clinically identical to **Cushing's syndrome** and differs only in that in Cushingoid, the excessive steroids are from drug therapy rather than excessive glandular secretion. Symptoms vary, but most people have upper body **obesity**, rounded face, increased fat around the neck, and thinning arms and legs. In its later stages, this condition leads to weakening of bones and muscles with rib and spinal column **fractures**.

The short term adverse effects of corticosteroids are generally mild, and include **indigestion**, increased appetite, **insomnia**, and nervousness. There are also a very large number of infrequent adverse reactions, the most significant of which is drug induced-paranoia. Delerium, depression, menstrual irregularity, and increased hair growth are also possible. Consult detailed reviews for further information.

Long-term use of topical glucocorticoids can result in thinning of the skin. Oral steroid inhalations may cause

fungal overgrowth in the oral cavity. Patients must be instructed to rinse their mouths carefully after each dose. Corticosteroids are **pregnancy** category C. The drugs have caused congenital malformations in animal studies, including cleft palate. Breastfeeding should be avoided.

Mineralocorticoids

Because fludrocortisone has glucocorticoid activity as well as mineralocorticoid action, the same hazards and precautions apply to fludrocortisone as to the glucocorticoids. Overdose of fludrocortisone may also cause **edema**, **hypertension,** and congestive **heart failure**.

Corticotropins

Corticotropin has all the same risks as the glucocorticoids. Prolonged use may cause reduced response to the stimulatory effects of corticotropin.

Warnings and contraindications

Use corticosteroids with caution in patients with the following conditions:

- osteoporosis or any other bone disease
- current or past tuberculosis
- glaucoma or cataracts
- infections of any type (virus, bacteria, fungus, amoeba)
- sores in the nose or recent nose surgery (if using nasal spray forms of corticosteroids)
- underactive or overactive thyroid
- liver disease
- stomach or intestine problems
- diabetes
- heart disease
- high blood pressure
- high cholesterol
- kidney disease or kidney stones
- myasthenia gravis
- systemic lupus erythematosus (SLE)
- emotional problems
- skin conditions that cause the skin to be thinner to bruise more easily

Interactions

Corticosteroids have many drug interactions. Consult specific references.

Resources

ORGANIZATIONS

American Academy of Allergy, Asthma and Immunology. 611 East Wells Street, Milwaukee, WI 53202. (414) 272-6071. <http://www.aaaai.org>.

Asthma and Allergy Foundation of America. 1125 15th Street NW, Suite 502, Washington, DC 20005. (800) 727-8462. <http://www.aafa.org>.

National Heart, Lung and Blood Institute. National Institutes of Health. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov/nhlbi/nhlbi.htm>.

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Corticotropin test *see* **Adrenocorticotropic hormone test**

Cortisol tests

Definition

This test is a measure of serum cortisol (also known as hydrocortisone), or urine cortisol (also known as urinary free cortisol), an important hormone produced by a pair of endocrine glands called the adrenal glands.

Purpose

This test is performed on patients who may have malfunctioning adrenal glands. Blood and urine cortisol, together with the determination of adrenocorticotropic hormone (ACTH), are the three most important tests in the investigation of **Cushing's syndrome** (caused by an overproduction of cortisol) and **Addison's disease** (caused by the underproduction of cortisol).

Precautions

Increased levels of cortisol are associated with **pregnancy**. Physical and emotional **stress** can also elevate cortisol levels. Drugs that may cause increased levels of cortisol include estrogen, **oral contraceptives**, amphetamines, cortisone, and spironolactone (Aldactone). Drugs that may cause decreased levels include androgens, aminoglutethimide, betamethasone, and other steroid medications, danazol, lithium, levodopa, metyrapone and phenytoin (Dilantin).

Description

Cortisol is a potent hormone known as a glucocorticoid that affects the metabolism of carbohydrates, proteins, and fats, but especially glucose. Cortisol increases blood sugar levels by stimulating the release of glucose from glucose stores in cells. It also acts to inhibit insulin, thus affecting glucose transport into cells.

The hypothalamus (an area of the brain), the pituitary gland (sometimes called the "master gland"), and

KEY TERMS

Addison's disease—A rare disorder in which symptoms are caused by a deficiency of hydrocortisone (cortisol) and aldosterone, two corticosteroid hormones normally produced by a part of the adrenal glands called the adrenal cortex. Symptoms include weakness, tiredness, vague abdominal pain, weight loss, skin pigmentation and low blood pressure.

Adrenal glands—A pair of endocrine glands (glands that secrete hormones directly into the bloodstream) that are located on top of the kidneys.

Adrenocorticotropic hormone (ACTH)—Also called corticotropin, this hormone is produced by the pituitary gland to stimulate the adrenal cortex to release various corticosteroid hormones.

Cushing's syndrome—A hormonal disorder caused by an abnormally high level of corticosteroid hormones that are produced by the adrenal glands. Corticosteroid hormones control the body's use of nutrients and the excretion of salts and water in the urine. Symptoms include high blood sugar levels, a moon face, weight gain, and increased blood pressure

the adrenal glands coordinate the production of cortisol. After corticotropin-releasing hormone (CRH) is made in the hypothalamus, CRH stimulates the pituitary to produce adrenocorticotropic hormone (ACTH). The production of ACTH in turn stimulates a part of the adrenal glands known as the adrenal cortex to produce cortisol. Rising levels of cortisol act as a negative feedback to curtail further production of CRH and ACTH, thus completing an elaborate feedback mechanism.

There are two methods for evaluating cortisol: blood and urine. The most reliable index of cortisol secretion is the 24-hour urine sample collection, but when blood levels are required or requested by the physician, plasma cortisol should be measured in the morning and again in the afternoon. Cortisol levels normally rise and fall during the day in what is called a diurnal variation, so that cortisol is at its highest level between 6–8 A.M. and gradually falls, reaching its lowest point around midnight. One reason for ordering blood cortisol levels versus a 24-hour urine collection is that sometimes the earliest sign of adrenal malfunction is the loss of this diurnal variation, even though the cortisol levels are not yet elevated. For example, individuals with Cushing's syndrome often have upper normal plasma cortisol levels in the morning and exhibit no decline as the day progresses.

Preparation

When testing for cortisol levels through the blood, a blood specimen is usually collected at 8 A.M. and again at 4 P.M. It should be noted that normal values may be transposed in individuals who have worked during the night and slept during the day for long periods of time.

When testing for cortisol level through the urine, a 24-hour urine sample is collected, refrigerated, and sent to the reference laboratory for examination.

Risks

Risks for the blood test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges for cortisol vary from laboratory to laboratory but are usually within the following ranges for blood:

- adults (8 A.M.): 6–28 mg/dL; adults (4 P.M.): 2–12 mg/dL
- child one to six years (8 A.M.): 3–21 mg/dL; child one to six years (4 P.M.): 3–10 mg/dL
- newborn: 1/24 mg/dL

Reference ranges for cortisol vary from laboratory to laboratory, but are usually within the following ranges for 24-hour urine collection:

- adult: 10–100 mg/24 hours
- adolescent: 5–55 mg/24 hours
- child: 2–27 mg/24 hours

Abnormal results

Increased levels of cortisol are found in Cushing's syndrome, excess thyroid (**hyperthyroidism**), **obesity**, ACTH-producing tumors, and high levels of stress.

Decreased levels of cortisol are found in Addison's disease, conditions of low thyroid, and **hypopituitarism**, in which pituitary activity is diminished.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp, Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Cosmetic dentistry

Definition

Cosmetic dentistry includes a variety of dental treatments aimed at improving the appearance of the teeth.

Purpose

The purpose of cosmetic dentistry is to improve the appearance of the teeth using bleaching, bonding, veneers, reshaping, orthodontics, or implants.

Description

Bleaching is done to lighten teeth that are stained or discolored. It entails the use of a bleaching solution applied by a dentist or a gel in a tray that fits over the teeth used at home under a dentist's supervision. Bonding involves applying tooth-colored plastic putty, called composite resin, to the surface of chipped or broken teeth. This resin is also used to fill cavities in front teeth (giving a more natural-looking result) and to fill gaps between teeth. Veneers are thin, porcelain shells that cover the front of the teeth. They can improve the appearance of damaged, discolored, misshapen, or misaligned teeth. Reshaping involves the removal of enamel from a misshapen tooth so that it matches other teeth. Orthodontics uses braces to correct the position of crowded or misaligned teeth. Implants are artificial teeth which are attached directly to the jaw to replace missing teeth.

Preparation

Bleaching involves having a custom-made bleaching tray made by the dentist. This tray is worn at home for several hours each day or night. Teeth slowly become white over a period of one to six weeks. Bleaching can also be done in a dentist's office. A heat- or light-activated bleaching solution is applied to six to eight teeth per visit.

Bonding involves etching the surface of the tooth so composite resin can adhere. The dentist then contours the resin to the right shape, and smooths and polishes the resin after it is hard and dry.

To prepare for the application of a veneer, a thin layer of enamel is removed from the tooth (so that the finished tooth will be flush with surrounding teeth) and an impression of the tooth is taken from which the veneer will be created. Before a veneer is applied, the tooth is etched with an acid solution and an adhesive resin is painted on the tooth. The veneer is then applied, the resin is hardened with a bonding light, and the dentist polishes the veneer.

KEY TERMS

Bleaching—Technique used to brighten stained teeth.

Bonding—Rebuilding, reshaping, and covering tooth defects using tooth-colored materials.

Composite resin—Plastic material matching natural tooth color used to replace missing parts of a tooth.

During cosmetic reshaping, some enamel is removed from the uneven tooth so it more closely matches other teeth.

Orthodontics involves applying braces to the teeth, and wires are threaded through the braces. These wires are adjusted to gradually move the teeth to the desired new positions. Over time, crowded or misaligned teeth are straightened.

Implants are more secure and natural looking than dentures or bridgework, but are much more expensive. First an anchor for the implant is attached to the jaw bone. This surgery can take several hours. About six months later, after the bone around the anchor has healed, a post is attached to the anchor, and an artificial tooth is attached to the post. The whole process may take about nine months to complete.

Aftercare

Periodic touch-up may be needed to keep the teeth white if the teeth have been bleached or bonded. Also, the resin used in bonded teeth can be chipped by ice, popcorn kernels, or hard candy, requiring repair. Veneered teeth may need to be reveneered after five to 12 years. Once orthodontic braces are removed, regular visits to the orthodontist are advised because teeth can shift position. Implanted teeth require regular dental checkups to ensure that the anchor and post are stable.

Risks

After teeth are bleached, they may darken faster if exposed to staining products such as coffee or tobacco. Some patients experience increased sensitivity to cold while teeth are being bleached, but the sensitivity usually disappears shortly after completion of the treatment.

Bonded teeth, like bleached teeth, may also stain more easily than natural teeth. Bonding materials also chip easily.

Because cosmetic reshaping involves the removal of enamel, the process is irreversible because enamel cannot be replaced once it is removed.

The anchors of implanted teeth can loosen and cause **pain**; regular dental checkups are recommended.

Normal results

Cosmetic dentistry can improve the appearance of stained, chipped, misshapen, or crowded teeth.

Resources

ORGANIZATIONS

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

Joseph Knight, PA

Cosmetic surgery *see* **Plastic, cosmetic, and reconstructive surgery**

Costochondritis

Definition

Costochondritis is an inflammation and associated tenderness of the cartilage (i.e., the costochondral joints) that attaches the front of the ribs to the breastbone.

Description

Costochondritis causes **pain** in the lower rib area or upper breastbone. Some patients fear they are having a **heart attack**. The most severe pain is usually between the breast and the upper abdomen. The pain may be greater when in sitting or reclining positions. **Stress** may aggravate this condition. Generally the third or fourth ribs are affected. However, any of the seven costochondral junctions may be affected, and more often than not more than one site is involved. The inflammation can involve cartilage areas on both sides of the sternum, but usually is on one side only. Costochondritis should be distinguished from Tietze Syndrome, which is an inflammation involving the same area of the chest, but also includes swelling.

Causes and symptoms

The causes of costochondritis are not well-understood and may be difficult to establish. The most likely causes include injury, repetitive minor trauma, and unusual excessive physical activity.

KEY TERMS

Inflammation—Process whereby the immune system reacts to infection or other stimulus, characterized by pain, swelling, redness, and warmth of the affected part

The primary symptom of costochondritis is severe chest wall pain, which may vary in intensity. The pain becomes worse with trunk movement, deep breathing, and/or exertion, and better with decreased movement, quiet breathing, or changing of position. It is usually localized but may radiate extensively from the chest area. The pain has been described as sharp, nagging, aching, or pressure-like.

Diagnosis

Diagnosis is based on pain upon palpation (gentle pressing) of the affected joints. Swelling is not associated with costochondritis. Diagnosis is also dependent on the exclusion of other causes, including heart attack or bacterial or fungal infections found in IV drug users or postoperative **thoracic surgery** patients.

Treatment

The goals of treatment are to reduce inflammation and to control pain. To accomplish these goals, nonsteroidal anti-inflammatory agents (NSAIDs) are used, with ibuprofen usually selected as the drug of choice. Other NSAIDS options are flurbiprofen, mefenamic acid, ketoprofen, and naproxen. Additional treatment recommendations include the use of local heat, **biofeedback**, and gentle stretching of the pectoralis muscles two to three times a day.

For more difficult cases, where the patient continues to exhibit pain and discomfort, cortisone injections are used as therapy.

Alternative treatment

Supplements that are used to reduce inflammation have been used to treat costochondritis. Examples of such supplements include ginger root, evening primrose oil, bromelain, vitamin E, omega-3 oils, and white willow bark. Glucosamine/chondroitin sulfate, which may aid in the healing of cartilage, has also been used. Other alternative therapies include **acupuncture** and massages.

Prognosis

The prognosis for recovery from costochondritis is good. For most patients, the condition lessens in six

months to a year. However, after one year, about one-half of patients continue with some discomfort, while about one-third still report tenderness with palpation.

Prevention

Though the causes of costochondritis are not well known, avoidance of activities that may strain (e.g., the repetitive misuse of muscles) or cause trauma to the rib cage is recommended to prevent the occurrence of costochondritis. Modification of improper posture or ergonomics of the home or work place may also deter the development of this condition.

Resources

OTHER

Day, C. *Costochondritis Web Site.* 2001. <http://www.geocities.com/Hots/2338/#Frequently%20Asked%20Questions>.

Flowers, L. K., and B. D. Wippermann. "Costochondritis." *eMedicine Journal: Emergency Medicine/Rheumatology.* 23 Feb. 2001. <http://www.emedicine.com/emerg/topic116.htm>.

Judith Sims

Cotrel-Dubousset spinal instrumentation *see* **Spinal instrumentation**

Cough

Definition

A cough is a forceful release of air from the lungs that can be heard. Coughing protects the respiratory system by clearing it of irritants and secretions.

Description

While people can generally cough voluntarily, a cough is usually a reflex triggered when an irritant stimulates one or more of the cough receptors found at different points in the respiratory system. These receptors then send a message to the cough center in the brain, which in turn tells the body to cough. A cough begins with a deep breath in, at which point the opening between the vocal cords at the upper part of the larynx (glottis) shuts, trapping the air in the lungs. As the diaphragm and other muscles involved in breathing press against the lungs, the glottis suddenly opens, producing an explosive outflow of air at speeds greater than 100 mi (160 km) per hour.

In normal situations, most people cough once or twice an hour during the day to clear the airway of irritants. However, when the level of irritants in the air is high or when the respiratory system becomes infected, coughing may become frequent and prolonged. It may interfere with **exercise** or sleep, and it may also cause distress if accompanied by **dizziness**, chest **pain**, or breathlessness. In the majority cases, frequent coughing lasts one to two weeks and tapers off as the irritant or infection subsides. If a cough lasts more than three weeks it is considered a chronic cough, and physicians will try to determine a cause beyond an acute infection or irritant.

Coughs are generally described as either dry or productive. A dry cough does not bring up a mixture of mucus, irritants, and other substances from the lungs (sputum), while a productive cough does. In the case of a bacterial infection, the sputum brought up in a productive cough may be greenish, gray, or brown. In the case of an allergy or viral infection it may be clear or white. In the most serious conditions, the sputum may contain blood.

Causes and symptoms

In the majority of cases, coughs are caused by respiratory infections, including:

- colds or **influenza**, the most common causes of coughs
- **bronchitis**, an inflammation of the mucous membranes of the bronchial tubes
- croup, a viral inflammation of the larynx, windpipe, and bronchial passages that produces a bark-like cough in children
- whooping cough, a bacterial infection accompanied by the high-pitched cough for which it is named
- **pneumonia**, a potentially serious bacterial infection that produces discolored or bloody mucus
- **tuberculosis**, another serious bacterial infection that produces bloody sputum
- fungal infections, such as **aspergillosis**, **histoplasmosis**, and cryptococcoses

Environmental pollutants, such as cigarette smoke, dust, or smog, can also cause a cough. In the case of cigarette smokers, the nicotine present in the smoke paralyzes the hairs (cilia) that regularly flush mucus from the respiratory system. The mucus then builds up, forcing the body to removed it by coughing. Post-nasal drip, the irritating trickle of mucus from the nasal passages into the throat caused by **allergies** or **sinusitis**, can also result in a cough. Some chronic conditions, such as **asthma**, chronic bronchitis, **emphysema**, and **cystic fibrosis**, are characterized in part by a cough. A condition in which stomach acid backs up into the esophagus (gastroe-

KEY TERMS

Antitussives—Drugs used to suppress coughing.

Expectorant—Drug used to thin mucus.

Gastroesophageal reflux—Condition in which stomach acid backs up into the esophagus.

Glottis—The opening between the vocal cords at the upper part of the larynx.

Larynx—A part of the respiratory tract between the pharynx and the trachea, having walls of cartilage and muscle and containing the vocal cords.

Sputum—The mixture of mucus, irritants, and other substances expelled from the lungs by coughing.

sophageal reflux) can cause coughing, especially when a person is lying down. A cough can also be a side-effect of medications that are administered via an inhaler. It can also be a side-effect of beta-blockers and ACE inhibitors, which are drugs used for treating high blood pressure.

Diagnosis

To determine the cause of a cough, a physician should take an exact medical history and perform an exam. Information regarding the duration of the cough, what other symptoms may accompany it, and what environmental factors may influence it aid the doctor in his or her diagnosis. The appearance of the sputum will also help determine what type of infection, if any, may be involved. The doctor may even observe the sputum microscopically for the presence of bacteria and white blood cells. Chest x rays may help indicate the presence and extent of such infections as pneumonia or tuberculosis. If these actions are not enough to determine the cause of the cough, a **bronchoscopy** or **laryngoscopy** may be ordered. These tests use slender tubular instruments to inspect the interior of the bronchi and larynx.

Treatment

Treatment of a cough generally involves addressing the condition causing it. An acute infection such as pneumonia may require **antibiotics**, an asthma-induced cough may be treated with the use of bronchodialators, or an antihistamine may be administered in the case of an allergy. Physicians prefer not to suppress a productive cough, since it aids the body in clearing respiratory system of infective agents and irritants. However, cough medicines may be given if the patient cannot rest because of the cough or if the cough is not productive, as is the case with most coughs associated with colds or flu. The two types of drugs used to treat coughs are antitussives and **expectorants**.

Antitussives

Antitussives are drugs that suppress a cough. Narcotics—primarily codeine—are used as antitussives and work by depressing the cough center in the brain. However, they can cause such side effects as drowsiness, nausea, and **constipation**. Dextromethorphan, the primary ingredient in many over-the-counter cough remedies, also depresses the brain's cough center, but without the side effects associated with narcotics. Demulcents relieve coughing by coating irritated passageways.

Expectorants

Expectorants are drugs that make mucus easier to cough up by thinning it. Guaifenesin and terpin hydrate are the primary ingredients in most over-the-counter expectorants. However, some studies have shown that in acute infections, simply increasing fluid intake has the same thinning effect as taking expectorants.

Alternative treatment

Coughs due to bacterial or viral upper respiratory infections may be effectively treated with botanical and homeopathic therapies. The choice of remedy will vary and be specific to the type of cough the patient has. Some combination over-the-counter herbal and homeopathic cough formulas can be very effective for cough relief. Lingering coughs or coughing up blood should be treated by a trained practitioner.

Many health practitioners advise increasing fluids and breathing in warm, humidified air as ways of loosening chest congestion. Others recommend hot tea flavored with honey as a temporary home remedy for coughs caused by colds or flu. Various **vitamins**, such as vitamin C, may be helpful in preventing or treating conditions (including colds and flu) that lead to coughs. Avoiding of mucous-producing foods can be effective in healing a cough condition. These mucous-producing foods can vary, based on individual intolerance, but dairy products are a major mucous-producing food for most people.

Prognosis

Because the majority of coughs are related to the **common cold** or influenza, most will end in seven to 21 days. The outcome of coughs due to a more serious underlying disease depends on the pathology of that disease.

Prevention

It is important to identify and treat the underlying disease and origin of the cough. Avoid **smoking** and coming in direct contact with people experiencing cold or flu symptoms. Wash hands frequently during episodes of upper-respiratory illnesses.

Resources

BOOKS

Chandrasoma, Parakrama, and Clive R. Taylor. *Concise Pathology.* East Norwalk, CT: Appleton & Lange, 1991.

Schumann, Lorna. "Alterations in Respiratory Function." In *Perspectives on Pathophysiology*, ed. Lee-Ellen Copstead. Philadelphia: W. B. Saunders Co., 1994.

PERIODICALS

Philp, Elizabeth B. "Chronic Cough." *American Family Physician* 56 (1 Oct. 1997).

ORGANIZATIONS

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Jeffrey P. Larson, RPT

KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bronchitis—Inflammation of the air passages of the lungs.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Emphysema—An irreversible lung disease in which breathing becomes increasingly difficult.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Phenylketonuria (PKU)—A genetic disorder in which the body lacks an important enzyme. If untreated, the disorder can lead to brain damage and mental retardation.

Cough suppressants

Definition

Cough suppressants are medicines that prevent or stop coughing.

Purpose

Cough suppressants act on the center in the brain that controls the cough reflex. They are meant to be used only to relieve dry, hacking coughs associated with colds and flu. They should not be used to treat coughs that bring up mucus or the chronic coughs associated with **smoking**, **asthma**, **emphysema** or other lung problems.

Many cough medicines contain cough suppressants along with other ingredients. Some combinations of ingredients may cancel each other's effects. One example is the combination of cough suppressant with an expectorant—a medicine that loosens and clears mucus from the airways. The cough suppressant interferes with the ability to cough up the mucus that the expectorant loosens.

Description

The cough suppressant described here, dextromethorphan, is an ingredient in many cough medicines, such as Vicks Formula 44, Drixoral Cough Liquid Caps, Sucrets Cough Control, Benylin DM and some Robitussin products. These medicines come in capsule, tablet, lozenge, and liquid forms and are available without a physician's prescription.

Recommended dosage

Regular (short-acting) capsules, lozenges, syrups, or tablets:

ADULTS AND CHILDREN OVER 12. 10-30 mg every 4-8 hours, as needed.

CHILDREN 6-12. 5-15 mg every 4-8 hours, as needed.

CHILDREN 2-6. 2.5-7.5 mg every 4-8 hours, as needed.

Children under 6 should not be given lozenges containing dextromethorphan because of the high dose of dextromethorphan in each lozenge.

CHILDREN UNDER 2. Check with child's physician.

Children under 6 should not be given lozenges containing dextromethorphan.

For extended-release oral suspension

ADULTS AND CHILDREN OVER 12. 60 mg every 12 hours, as needed.

CHILDREN 6-12. 30 mg every 12 hours, as needed.

CHILDREN 2-6. 15 mg every 12 hours, as needed.

CHILDREN UNDER 2. Check with child's physician.

Precautions

Do not take more than the recommended daily dosage of dextromethorphan.

Dextromethorphan is not meant to be used for coughs associated with smoking, asthma, emphysema, chronic **bronchitis**, or other lung conditions. It also should not be used for coughs that produce mucus.

A lingering cough could be a sign of a serious medical condition. Coughs that last more than seven days or are associated with **fever**, rash, **sore throat**, or lasting **headache** should have medical attention. Call a physician as soon as possible.

People with **phenylketonuria** should be aware that some products with dextromethorphan also contain the artificial sweetener aspartame, which breaks down in the body to phenylalanine.

Anyone who has asthma or liver disease should check with a physician before taking dextromethorphan.

Women who are pregnant or breastfeeding or who plan to become pregnant should check with their physicians before taking dextromethorphan.

The dye tartrazine is an ingredient in some cough suppressant products. This dye causes allergic reactions in some people, especially those who are allergic to **aspirin**.

Side effects

Side effects are rare, but may include nausea, vomiting, stomach upset, slight drowsiness, and **dizziness**.

Interactions

Patients who take **monoamine oxidase inhibitors** (MAO inhibitors) should be aware that the co-administration of products containing dextromethorphan can cause dizziness, **fainting**, fever, nausea, and possibly **coma**. Do not take dextromethorphan unless a physician permits the use of the two drugs together.

When dextromethorphan is taken with medicines that cause drowsiness, this effect may be enhanced.

Nancy Ross-Flanigan

Coughing and deep-breathing exercises *see* **Chest physical therapy**

Coxsackievirus infections *see* **Enterovirus infections**

CPK test *see* **Creatine kinase test**

CPR *see* **Cardiopulmonary resuscitation**

Crab lice *see* **Lice infestation**

Cradle cap *see* **Seborrheic dermatitis**

Cramps *see* **Dysmenorrhea**

Cranial arteritis *see* **Temporal arteritis**

Cranial manipulation *see* **Craniosacral therapy**

Craniopharyngioma *see* **Pituitary tumors**

Craniosacral therapy

Definition

Craniosacral therapy is a holistic healing practice that uses very light touching to balance the craniosacral system in the body, which includes the bones, nerves, fluids, and connective tissues of the cranium and spinal area.

Purpose

According to Upledger, craniosacral therapy is ideally suited for **attention-deficit hyperactivity disorder** (ADHD), headaches, chronic middle ear infection, **pain**, and general health maintenance. It is recommended for **autism**, **fibromyalgia**, heart disease, **osteoarthritis**, **pneumonia**, **rheumatoid arthritis**, chronic sinus infections, and **gastroenteritis** (inflammation of the lining of the stomach or small intestine). It is also used with other therapies to treat **chronic fatigue syndrome**, back pain, and menstrual irregularity. In addition, other craniosacral practitioners have reported benefits for eye dysfunction, **dyslexia**, depression, motor coordination difficulties, temporomandibular joint dysfunction (TMD), hyperactivity, **colic**, **asthma** in babies, floppy baby syndrome, **whiplash**, **cerebral palsy**, certain **birth defects**, and other central nervous system disorders.

Description

Origins

The first written reference to the movement of the spinal nerves and its importance in life, clarity, and "bringing quiet to the heart" is found in a 4,000-year-old text from China. Craniosacral work was referred to as "the art of listening." Bone setters in the Middle Ages also sensed the subtle movements of the body. They used these movements to help reset **fractures** and dislocations and to treat headaches.

In the early 1900s, the research of Dr. William Sutherland, an American osteopathic physician, detailed the movement of the cranium and pelvis. Before his research it was believed that the cranium was a solid immovable mass. Sutherland reported that the skull is actually made up of 22 separate and movable bones that are connected by layers of tissue. He called his work cranial **osteopathy**. Nephi Cotton, an American chiropractor and contemporary of Sutherland, called this approach craniology. The graduates of these two disciplines have refined and enhanced these original approaches and renamed their work as sacro-occipital technique, cranial **movement therapy**, or craniosacral therapy.

Dr. John Upledger, an osteopathic physician, and others at the Department of Biomechanics at Michigan State University, College of Osteopathic Medicine learned of Sutherland's research and developed it further. He researched the clinical observations of various osteopathic physicians. This research provided the basis for Upledger's work that he named craniosacral therapy.

Craniosacral therapy addresses the craniosacral system. This system includes the cranium, spine, and sacrum that are connected by a continuous membrane of connective tissue deep inside the body, called the dura mater. The dura mater also encloses the brain and the central nervous system. Sutherland noticed that cerebral spinal fluid rises and falls within the compartment of the dura mata. He called this movement the primary respiratory impulse; today it is known as the craniosacral rhythm (CSR) or the cranial wave.

Craniosacral therapists can most easily feel the CSR in the body by lightly touching the base of the skull or the sacrum. During a session, they feel for disturbances in the rate, amplitude, symmetry, and quality of flow of the CSR. A therapist uses very gentle touch to balance the flow of the CSR. Once the cerebrospinal fluid moves freely, the body's natural healing responses can function.

A craniosacral session generally lasts 30–90 minutes. The client remains fully clothed and lays down on a massage table while the therapist gently assesses the flow of the CSR. Upledger describes several techniques which may be used in a craniosacral therapy session. The first is energy cyst release. "This technique is a hands-on method of releasing foreign or disruptive energies from the patient's body. Energy cysts may cause the disruption of the tissues and organs were they are located." The therapist feels these cysts in the client's body and gently releases the blockage of energy.

Sutherland first wrote about a second practice called direction of energy. In this technique the therapist intends energy to pass from one of his hands, through the patient, into the other hand.

WILLIAM SUTHERLAND (1873–1954)

William Garner Sutherland studied osteopathy under its founder, Andrew Taylor Still. Dr. Sutherland made his own important discovery while examining the sutures of cranial bones the skull bones that protect the brain. What he noticed is that the sutures were designed for motion. Sutherland termed this motion the *Breath of Life*. Through his experiments and research he determined that primary respiration was essential to all other physiological functions.

When Sutherland developed his techniques for craniosacral therapy, he wanted it to serve as a vehicle for listening to the body's rhythmic motions and treat the patterns of inertia when those motions become congested. He believed that the stresses—any physical or emotional trauma—created an imbalance in the body that needed correction to restore it to full health. The therapy is a hands-on method so that the therapist can feel the subtleties of the patterns of movement and inertia. Sutherland felt that this was the way to encourage self-healing and restoration of the body's own mechanisms, taking a holistic approach to creating optimal health.

The Craniosacral Therapy Educational Trust, based on Sutherland's pioneering work, is located at 10 Normington Close, Leigham Court Road, London SW16 2QS, United Kingdom. The phone number is 07000 785778.

The third technique is called myofascial release. This is a manipulative form of bodywork that releases tension in the fascia or connective tissue of the body. This form of bodywork uses stronger touch.

Upledger's fourth technique is position of release. This involves following the client's body into the positions in which an injury occurred and holding it there. When the rhythm of the CSR suddenly stops the therapist knows that the trauma has been released.

The last technique is somatoemotional release. This technique was developed by Upledger and is an offshoot of craniosacral therapy. It is used to release the mind and body of the residual effects of trauma and injury that are "locked in the tissues."

The cost of a session varies due to the length of time needed and the qualifications of the therapist. The cost may be covered by insurance when the therapy is performed or prescribed by a licensed health care provider.

Precautions

This gentle approach is extremely safe in most cases. However, craniosacral therapy is not recommended in

cases of acute systemic infections, recent skull fracture, intracranial hemorrhage or aneurysm, or herniation of the medulla oblongata (brain stem). Craniosacral therapy does not preclude the use of other medical approaches.

Side effects

Some people may experience mild discomfort after a treatment. This may be due to re-experiencing a trauma or injury or a previously numb area may come back to life and be more sensitive. These side effects are temporary.

Research and general acceptance

More than 40 scientific papers have been published that document the various effects of craniosacral therapy. There are also 10 authoritative textbooks on this therapy. The most notable scientific papers include Viola M. Fryman's work documenting the successful treatment of 1,250 newborn children with birth defects. Edna Lay and Stephen Blood showed the effects on TMD, and John Wood documented results with psychiatric disorders. The American Dental Association has found craniosacral therapy to be an effective adjunct to orthodontic work. However, the conventional medical community has not endorsed these techniques.

Resources

BOOKS

Knaster, Mirka. *Discovering the Body's Wisdom.* New York: Bantam Books, 1996.

Milne, Hugh. *Heart of Listening: A Visionary Approach to Craniosacral Work: Anatomy. Technique, Transcendence.* 2nd ed. Berkeley, CA: North Atlantic Books, 1998.

Upledger, John E. "CranioSacral Therapy." In *Clinician's Complete Reference to Complementary and Alternative Medicine,* ed. Donald Novey. St. Louis, MO: 2000.

Upledger, John E. *Your Inner Physician and You: CranioSacral Therapy Somatoemotional Release.* Berkeley, CA: North Atlantic Books, 1991.

Upledger, John E. and John Vredevoogd. *Craniosacral Therapy.* Seattle: Eastland Press, 1983.

ORGANIZATIONS

Milne Institute Inc. P.O. Box 2716, Monterey, CA 93942-2716. (831) 649-1825. Fax: (831) 649-1826. <milneinst@aol.com>. <http://www.milne institute.com>.

Upledger Institute. 11211 Prosperity Farms Road, Palm Beach Gardens, FL 33410. (800) 233-5880. Fax: (561) 622-4771. <http://www.upledger.com>.

OTHER

Milne, Hugh. *A Client's Introduction to Craniosacral Work.* Pamphlet. Milne Institute.

Linda Chrisman

Craniotomy

Definition

Surgical removal of part of the skull to expose the brain.

Purpose

A craniotomy is the most commonly performed surgery for brain **tumor removal**. It may also be done to remove a blood clot and control hemorrhage, inspect the brain, perform a biopsy, or relieve pressure inside the skull.

Precautions

Before the operation, the patient will have undergone diagnostic procedures such as **computed tomography scans** (CT) or **magnetic resonance imaging** (MRI) scans to determine the underlying problem that required the craniotomy and to get a better look at the brain's structure. Cerebral **angiography** may be used to study the blood supply to the tumor, aneurysm, or other brain lesion.

Description

There are two basic ways to open the skull:

- a curving incision from behind the hairline, in front of the ear, arching above the eye
- at the nape of the neck around the occipital lobe

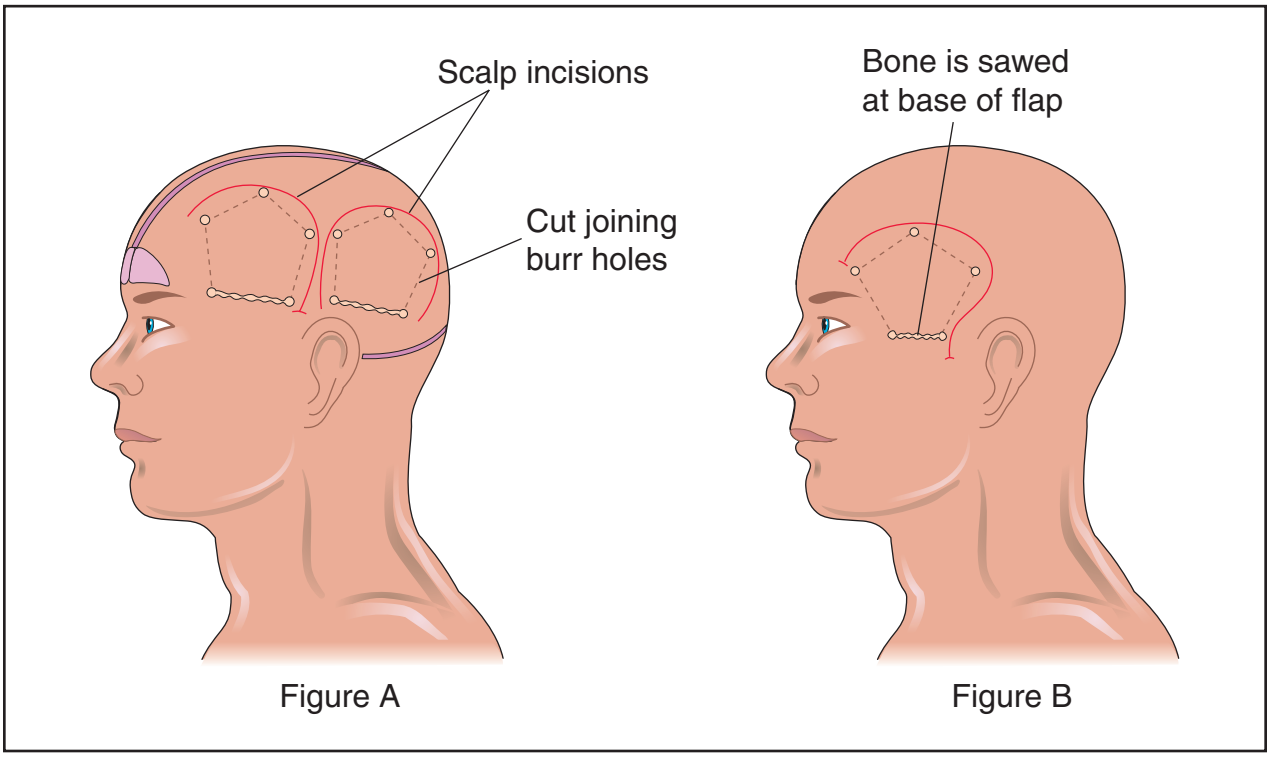
The surgeon marks with a felt tip pen a large square flap on the scalp that covers the surgical area. Following this mark, the surgeon makes an incision into the skin as far as the thin membrane covering the skull bone. Because the scalp is well supplied with blood, the surgeon will have to seal many small arteries. The surgeon then folds back a skin flap to expose the bone.

Using a high speed hand drill or an automatic craniotome, the surgeon makes a circle of holes in the skull, and pushes a soft metal guide under the bone from one hole to the next. A fine wire saw is then moved along the guide channel under the bone between adjacent holes. The surgeon saws through the bone until the bone flap can be removed to expose the brain.

After the surgery for the underlying cause is completed, the piece of skull is replaced and secured with pieces of fine, soft wire. Finally, the surgeon sutures the membrane, muscle, and skin of the scalp.

Preparation

Before the surgery, patients are usually given drugs to ease **anxiety**, and other medications to reduce the risk



A craniotomy is the most commonly performed surgery for brain tumor removal. There are two basic ways to open the skull: a curving incision from behind the hairline in front of the ear and at the nape of the neck (figure A). To reach the brain, the surgeon uses a hand drill to make holes in the skull, pushing a soft metal guide under the bone. The bone is sawed through until the bone flap can be removed to expose the brain (figure B). *(Illustration by Electronic Illustrators Group.)*

of swelling, seizures, and infection after the operation. Fluids may be restricted, and a diuretic may be given before and during surgery if the patient has a tendency to retain water. A catheter is inserted before the patient goes to the operating room.

The scalp is shaved in the operating room right before surgery; this is done so that any small nicks in the skin won't have a chance to become infected before the operation.

Aftercare

Oxygen, painkillers, and drugs to control swelling and seizures are given after the operation. Codeine may be given to relieve the **headache** that may occur as a result of stretching or irritation of the nerves of the scalp that happens during the craniotomy. Some type of drainage from the head may be in place, depending on the reason for the surgery.

Patients are usually out of bed within a day and out of the hospital within a week. Headache and **pain** from the scalp wound can be controlled with medications.

The bandage on the skull should be changed regularly. Sutures closing the scalp will be removed, but soft wires used to reattach the skull are permanent and require no further attention. The patient should avoid getting the scalp wet until all the sutures have been removed. A clean cap or scarf can be worn until the hair grows back.

Risks

Accessing the area of the brain that needs repair may damage other brain tissue. Therefore, the procedure carries with it some risk of brain damage that could leave the patient with some loss of brain function. The surgeon performing the operation can give the patient an assessment of the risk of his or her particular procedure.

Normal results

While every patient's experience is different depending on the reason for the surgery, age, and overall health, if the surgery has been successful, recovery is usually rapid because of the good supply of blood to the area.

Abnormal results

Possible complications after craniotomy include:

KEY TERMS

Craniotome—A type of surgical drill used to operate on the skull. It has a self-controlled system that stops the drill when the bone is penetrated.

- swelling of the brain
- excessive intracranial pressure
- infection
- seizures

Resources

BOOKS

Smeltzer, Suzanne, and Brenda Bare. "Management of Patients with Neurological Dysfunction." In *Brunner and Suddarth's Textbook of Medical/Surgical Nursing*. 7th ed. Philadelphia: J. B. Lippincott Co., 1992.

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

Carol A. Turkington

Creatine kinase test

Definition

The creatine kinase test measures the blood levels of certain muscle and brain enzyme proteins.

Purpose

Creatine kinase (CK or CPK) is an enzyme (a type of protein) found in muscle and brain. Normally, very little CK is found circulating in the blood. Elevated levels indicate damage to either muscle or brain; possibly from a myocardial infarction (**heart attack**), muscle disease, or **stroke**.

There are three types, or isoforms, of CK:

- CK-I, or BB, is produced primarily by brain and smooth muscle.
- CK-II, or MB, is produced primarily by heart muscle.
- CK-III, or MM, is produced primarily by skeletal muscle.

Precautions

No special precautions are necessary, except in patients with a bleeding disorder.

Description

A small amount of blood is drawn and used for laboratory analysis.

Preparation

Physical activity may cause a rise in CK levels, especially the CK-III fraction. Therefore, patients should not engage in strenuous physical activity the day of the test. The patient should report any recent injections, falls, or **bruises** that have occurred, as these may elevate CK levels as well.

Aftercare

No aftercare is required, except to keep the puncture site clean while it heals.

Risks

There are no risks to this test beyond the very slight risk of infection at the puncture site.

Normal results

In females, total CK should be 10–79 units per liter (U/L). In males, total CK should be 17–148 U/L. CK levels are reduced in the first half of **pregnancy**, and increased in the second half. CK levels are elevated in newborns.

The distribution of isoenzymes should be:

- CK-I: 0%
- CK-II: 0–5%
- CK-III: 95–100%

Abnormal results

Elevation of CK-I may be seen in stroke, extreme **shock**, or **brain tumor**.

Elevation of CK-II is seen after a myocardial infarction. It begins to rise three to six hours after the heart attack, and may peak within 24 hours. It should then return to normal. For this reason, it is a useful marker for recent myocardial infarction, but not for one which occurred more than a day before the test.

Elevation of CK-III indicates skeletal muscle damage. This may occur from normal **exercise**, trauma, or muscle disease. CK levels may be very high early on in **muscular dystrophy**, but may fall to normal later as muscle tissue is lost. Elevated CK is also seen in myositis, myoglobinuria, **toxoplasmosis**, and **trichinosis**. **Hypothyroidism** may also cause elevated CK.

KEY TERMS

Skeletal muscles—Muscles which move the skeleton. All of the muscles under voluntary control are skeletal muscles.

Smooth muscles—Muscles that surround the linings of the digestive system, airways, and circulatory system.

Resources

BOOKS

Corbett, Jane Vincent. *Laboratory Tests and Diagnostic Procedures with Nursing Diagnoses*. 2nd ed. Los Altos, CA: Appleton & Lange, 1987.

Richard Robinson

Creatine phosphkinase test *see* **Creatine kinase test**

Creatinine test

Definition

Creatine is an important compound produced by the body. It combines with phosphorus to make a high-energy phosphate compound in the body. Creatine phosphate is used in skeletal muscle contraction.

Purpose

The creatinine test is used to diagnose impaired kidney function and to determine renal (kidney) damage.

Precautions

A diet high in meat content can cause transient elevations of serum creatinine. Some drugs that may increase creatinine values include gentamicin, cimetidine, heavy-metal chemotherapeutic agents (e.g., cisplatin), and other drugs toxic to the kidneys, such as the **cephalosporins**.

Description

The creatinine test is used to measure the amount of creatinine in the blood. Because creatinine is a nonprotein end-product of creatine phosphate, which is used in skeletal muscle contraction, the daily production of creatine, and the following product, creatinine, depends on muscle mass, which fluctuates very little.

Creatinine is excreted entirely by the kidneys, and therefore is directly related to renal function. When the kidneys are functioning normally, the serum creatinine level should remain constant and normal. Slight increases in creatine levels can appear after meals, especially after ingestion of large quantities of meat, and some diurnal variation may occur, with a low point at 7 A.M. and a peak at 7 P.M. Serious renal disorders, such as **glomerulonephritis**, **pyelonephritis**, and urinary obstruction, will cause abnormal elevations.

The creatinine level is interpreted in conjunction with another kidney function test called the Blood Urea Nitrogen (BUN). The serum creatinine level has much the same significance as the BUN but tends to rise later. Because of this, determinations of creatinine help to chronicle a disease process. Generally, a doubling of creatinine suggests a 50% reduction in kidney filtration rate.

Preparation

The creatinine test requires a blood sample. It is recommended that the patient be **fasting** (nothing to eat or drink) for at least eight hours before the test. The physician may also require that ascorbic acid (vitamin C), **barbiturates**, and **diuretics** be withheld for 24 hours.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal values can vary from laboratory to laboratory, but are generally in the following ranges:

- Adult female: 0.5–1.1 mg/dL
- Adult male: 0.6–1.2 mg/dL
- Adolescent: 0.5–1.0 mg/dL
- Child: 0.3–0.7 mg/dL
- Infant: 0.2–0.4 mg/dL
- Newborn: 0.3–1.2 mg/dL

Note that variations between sources for serum creatinine normal ranges are greater than for other important tests. For example, due to the greater amount of muscle mass generally present, males normally demonstrate higher creatinine levels than females. Also, because the kidney filtration rate normally increases in **pregnancy**, serum creatinine should be slightly less during such peri-

KEY TERMS

Glomerulonephritis—Glomerulonephritis is an inflammation of the filtering units of the kidney (glomeruli). The condition hinders removal of waste products, salt, and water from the bloodstream, leading to serious complications. It is the most common cause of renal failure.

Pyelonephritis—Pyelonephritis is an inflammation of the kidney itself, usually caused by a bacterial infection. In its most serious form, complications can include high blood pressure (hypertension) and renal failure.

ods. In older patients, creatinine is reduced because of decreased muscle mass. Similarly, other patients may have creatinine levels in which muscle abnormalities must be taken into consideration, such as long-term corticosteroid therapy, high thyroid (**hyperthyroidism**), **muscular dystrophy**, or **paralysis**.

Abnormal results

Two to 4 mg/dL indicate the presence of impairment of renal function. Greater than 4 mg/dL indicates serious impairment in renal function.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Creeping eruption *see* **Cutaneous larva migrans**

CREST syndrome *see* **Scleroderma**

Cretinism *see* **Hypothyroidism**

Creutzfeldt-Jakob disease

Definition

Creutzfeldt-Jakob disease (CJD) is a transmissible, rapidly progressing, fatal neurodegenerative disorder called a spongioform degeneration that seems to be related to "mad cow disease."

Description

Before 1995, Creutzfeldt-Jakob disease was little-known outside of the medical profession; even within it, many practitioners did not know much about it. Most doctors had never seen a case. With the recognition of a so-called "new variant" or simply variant form of CJD with the strong possibility that those with it became infected simply by eating contaminated beef, CJD has become one of the most talked-about diseases in the world. Additionally, the radical theory that the infectious agent is a normal protein that has been changed in its form has also sparked much interest.

First described in the first part of the twentieth century independently by Cretzfeldt and Jakob, CJD is a neurodegenerative disease causing a rapidly progressing **dementia** ending in **death**, usually within eight months of the onset of symptoms. It is also a very rare disease, affecting only about one in every million in the population through out the world. In the United States, CJD is thought to affect about 250 people each year. CJD affects adults primarily between ages 50 and 75.

Spongiform encephalopathies

The most obvious pathologic feature of CJD is the formation of numerous fluid-filled spaces in the brain (vacuoles) resulting in a sponge-like appearance. CJD is one of several human "spongiform encephalopathies," diseases that produce this characteristic change in brain tissue. Others are kuru; Gerstmann-Straussler-Scheinker disease, a genetic predominantly characterized by cerebellar ataxia (a kind of movement disorder); and fatal familial **insomnia**, associated with progressive insomnia, autonomic system disfunction, and weakness caused by motor system dysfunction.

Kuru was prevalent among the Fore people in Papua, New Guinea, and spread from infected individuals after their deaths through the practice of ritual cannibalism, in which the relatives of the dead person honored him by consuming his organs, including the brain. Discovery of the infectious nature of kuru won the Nobel Prize for Carleton Gadjusek in 1976. The incubation period for kuru was between four to 30 years or more. While kuru has virtually disappeared following the cessation of these cannibalistic practices, several new cases continue to arise each year.

Cases of CJD have been grouped into three types: familial, iatrogenic, and sporadic.

- Familial CJD, representing 5–15% of cases, is inherited in an autosomal dominant manner, meaning that either parent may pass along the disease to a child, who may then develop CJD later in life.
- Iatrogenic CJD occurs when a person is infected during a medical procedure, such as organ donation, blood **transfusion**, or brain surgery. The rise in organ donation has increased this route of transmission; grafts of infected corneas and dura mater (the tissue covering the brain) have been shown to transmit CJD. Another source is hormones concentrated from the pituitary glands of cadavers, some of whom carried CJD, for use in people with growth hormone deficiencies. Iatrogenic infection from exposure to nerve-containing tissue represents a small fraction of all cases. The incubation period between exposure to the infectious agent is very long and is estimated to be from less than 10 to more than 30 years. It remains unlikely, but not impossible, that blood from patients with CJD is infectious to others by transfusion.
- Sporadic CJD represents at least 85% of all cases. Sporadic cases have no identifiable source of infection. Death usually follows first symptoms within eight months.

Animal forms and "mad cow disease"

Six forms of spongiform encephalopathies are known to occur in other mammals: scrapie in sheep, recognized for more than 200 years; chronic wasting disease in elk and mule deer in Wyoming and Colorado; transmissible mink encephalopathy; exotic ungulate encephalopathy in some types of zoo animals; feline spongiform encephalopathy in domestic cats; and bovine spongiform encephalopathy (BSE) in cows.

BSE was first recognized in Britain in 1986. Besides the spongiform changes in the brain, BSE causes dementia-like behavioral changes—hence the name "mad cow disease." BSE was thought to be an altered form of scrapie, transmitted to cows when they were fed sheep offal (slaughterhouse waste) as part of their feed, but it is now thought to be more likely to be a primary cattle disease spread by contaminated feed.

The use of slaughterhouse offal in animal feed has been common in many countries and has been practiced for at least 50 years. The trigger for the BSE epidemic in Great Britain seems to have come in the early 1980s, when the use of organic solvents for preparation of offal was altered there. It is possible that these solvents had been destroying the agent called a prion, thereby preventing infection, and that the change in preparation procedure opened the way for the agent to "jump species" and cause BSE in cows that consumed scrapie-infected meal. The slaughter of infected (but not yet visibly sick) cows at the end of their useful farm lives, and the use of their carcasses for feed, spread the infection rapidly and widely. For at least a year after BSE was first recognized in British herds, infected bovine remains continued to be incorporated into feed, spreading the disease still further. Although milk from infected cows has never been shown to pass the infectious agent, passage from infected mother to calf may have occurred through unknown means.

Beginning in 1988, the British government took steps to stop the spread of BSE, banning the use of bovine offal in feed and other products and ordering the slaughter of infected cows. By then, the slow-acting agent had become epidemic in British herds. In 1992, it was diagnosed in over 25,000 animals (1% of the British herd). By mid-1997, the cumulative number of BSE cases in the United Kingdom had risen to more than 170,000. The feeding ban did stem the tide of the epidemic; however, the number of new cases each week fell from a peak of 1,000 in 1993 to less than 300 two years later.

The export of British feed and beef to member countries was banned by the European Union, but cases of BSE had developed in Europe by then as well; however, by mid-1997, only about 1,000 cases had been identified. In 1989, the United States banned import of British beef and began monitoring United States herds in 1990. To date, no BSE has been detected in the United States, and only one case has been reported in North America in a cow imported to Canada from Great Britain.

Variant CJD: The human equivalent of mad cow disease?

From the beginning of the BSE epidemic, scientists and others in Britain feared that BSE might jump species again to infect humans who had consumed infected beef. This, however, had never occurred in scrapie from sheep, a disease known from hundreds of years. In 1996, the first report of this possibility occurred and this fear seemed to be realized with the first cases of a new variant of Creutzfeldt-Jacob disease, termed nvCJD, now just vCJD. Its victims are much younger than the 60–65 year old average for CJD, and the time from symptom onset to death has averaged 12 months or more instead of eight. The disease appears to cause more psychiatric symptoms early on. EEG abnormalities characteristic of CJD are not typically seen in vCJD.

As of July 2001, the total number of human cases of vCJD is 102. It is of major concern that the number of cases per year seems to be increasing by a factor of 1.35 each year. Almost all the cases have been found in Great Britain with three in France, one in Ireland, and one suspected in Hong Kong (who spent time in Great Britain).

Evidence is growing stronger that vCJD is in fact caused by BSE:

- almost all of the cases so far have occurred in Great Britain, the location of the BSE epidemic.
- BSE injected into monkeys produces a disease very similar to vCJD
- BSE and vCJD produce the same brain lesions after the same incubation period when injected into laboratory mice
- brain proteins isolated from vCJD victims, but not from the other forms of CJD, share similar molecular characteristics with brain proteins of animals that died from BSE

Many researchers now treat the BSE-vCJD connection as solidly established.

Assuming that BSE is the source, the question that has loomed from the beginning has been is how many people will eventually be affected. Epidemiological models of infectious disease produce estimates ranging from less than one hundred (a level already broken) to tens of thousands or more, depending on the assumptions used by the modelers. The incubation period of vCJD in humans is not known, nor are the genetic and environmental risk factors that influence susceptibility, nor the quantity of infectious agent needed to cause the disease. It is estimated that between one and two million infected cattle have been eaten by humans, most in the earliest stages of the epidemic. Estimates cannot be based on the very few cases that have developed so far. These cases could represent the very few people with the right combination of exposure and susceptibility to a relatively fast-developing infection, or they could be the first few victims of a slower-acting, more highly infectious agent.

Causes and symptoms

Causes

It is clear that Creutzfeldt-Jakob disease is caused by an infectious agent, but it is not yet clear what type of agent that is. Originally assumed to be a virus, evidence is accumulating that, instead, CJD is caused by a protein called a prion (PREE-on, for "proteinaceous infectious particle") transmitted from victim to victim. The other spongiform encephalopathies are also hypothesized to be due to prion infection.

If this hypothesis is proved true, it would represent one of the most radical new ideas in biology since the discovery of deoxyribonucleic acid (DNA). All infectious diseases, in fact all life, uses nucleic acids—DNA or ribonucleic acid (RNA)—to code the instructions needed for reproduction. Inactivation of the nucleic acids destroys the capacity to reproduce. However, when these same measures are applied to infected tissue from spongiform encephalopathy victims, infectivity is not destroyed. Furthermore, purification of infected tissue to concentrate the infectious fraction yields protein, not nucleic acid. While it remains possible that some highly stable nucleic acid remains hidden within the purified protein, this is seemingly less and less likely as further experiments are done. The "prion hypothesis," as it is called, is now widely accepted, at least provisionally, by most researchers in the field. The most vocal proponent of the hypothesis, Stanley Prusiner, was awarded the Nobel Prize in 1997 for his work in the prion diseases.

A prion is an altered form of a normal brain protein. The normal protein has a helical shape along part of its length. In the prion form, a sheet structure replaces the helix. According to the hypothesis, when the normal form interacts with the prion form, some of its helical part is converted to a sheet, thus creating a new prion capable of transforming other normal forms. In this way, the disease process resembles crystallization more than typical viral infection, in which the virus commands the host's cellular machinery to reproduce more of the virus. Build-up of the sheet form causes accumulation of abnormal protein clumps and degeneration of brain cells, which is thought to cause the disease.

The brain protein affected by the prion, called PrP, is part of the membrane of brain cells, but its exact function is unknown. It is composed of about 250 subunits, called amino acids, coded for by a gene on chromosome 20. Slight genetic differences, called polymorphisms, give rise to two slightly different normal protein forms: subunit 129 is a "methionine" in one form, but is "valine" in the other. A person may have all of one, all of the other, or a mixture of the two, depending on their genetic inheritance. Both forms have the normal helical structure, and function normally. However, susceptibility to prion conversion is influenced by subunit 129: a person with a mixture of forms is more resistant to conversion. All the cases of vCJD tested have had just methionine at 129. Exposure to the infectious agent is, of course, still required for disease development. Prion diseases are not contagious in the usual sense, and transmission from an infected person to another person requires direct inoculation of infectious material.

Familial CJD, on the other hand, does not require exposure, but develops through the inheritance of other, more disruptive mutations in the gene for the normal PrP protein. Researchers believe these mutations increase the likelihood that the protein may more spontaneously "flip" to the sheet form; once created, these can then convert other normal-form molecules. The other two inherited human prion diseases, Gerstmann-Straussler-

Scheinker disease and fatal familial insomnia, involve different mutations in the same gene.

The large majority of CJD cases are sporadic, meaning they have no known route of infection or genetic link. Causes of sporadic CJD are likely to be diverse and may include spontaneous genetic mutation, spontaneous protein changes, or unrecognized exposure to infectious agents. It is highly likely that future research will identify more risk factors associated with sporadic CJD.

Symptoms

About one in four people with CJD begin their illness with weakness, changes in sleep patterns, weight loss, or loss of appetite or sexual drive. A person with CJD may first complain of visual disturbances, including double vision, blurry vision, or partial loss of vision. Some visual symptoms are secondary to cortical blindness related to death of nerve cells in the occipital lobe of the brain responsible for vision. This form of visual loss is unusual in that patients may be unaware that they are unable to see. These symptoms may appear weeks to months before the onset of dementia.

The most characteristic symptom of CJD is rapidly progressing dementia, or loss of mental function. Dementia is marked by:

- memory losses
- impaired abstraction and planning
- language and comprehension disturbances
- poor judgment
- disorientation
- decreased attention and increased restlessness
- personality changes and psychosis
- hallucinations

Muscle spasms and jerking movements, called myoclonus, are also a prominent symptom of CJD. Balance and coordination disturbance (ataxia), is common in CJD, and is more pronounced in nvCJD. Stiffness, difficulty moving, and other features representing **Parkinson's disease** are seen and can progress to akinetic **mutism**, which is a state of being unable to speak or move.

Diagnosis

CJD is diagnosed by a clinical neurological exam and **electroencephalography** (EEG), which shows characteristic spikes called triphasic sharp waves. **Magnetic resonance imaging** (MRI) or **computed tomography scans** (CT) should be done to exclude other forms of dementia, and in CJD typically shows atrophy or loss of brain tissue. Lumbar puncture, or spinal tap, may be done to rule out other causes of dementia (as cell count, chemical analysis, and other routine tests are normal in CJD) and to identify elevated levels of marker proteins known as 14-3-3. Another marker, neuron-specific enolase, may also be increased in CJD. CJD is conclusively diagnosed after death by brain **autopsy**. Scientists are investigating whether testing lymphatic tissue such as the tonsil may be an early tool in vCJD diagnosis. Additionally, recent studies have suggested that other blood tests may be useful as well.

Treatment

There is no cure for CJD, and no treatment that slows the progression of the disease. Drug therapy and nursing care are aimed at minimizing psychiatric symptoms and increasing patient comfort. However, the rapid progression of CJD frustrates most attempts at treatment, since decreasing cognitive function and more prominent behavioral symptoms develop so quickly. Despite the generally grim prognosis, a few CJD patients progress more slowly and live longer than the average; for these patients, treatment will be more satisfactory. Scientists are investigating whether some medicines that can "break" the abnormal protein form may be useful and whether a vaccine could help.

Prognosis

Creutzfeldt-Jakob disease is invariably fatal, with death following symptom onset by an average of eight months. About 5% of patients live longer than two years. Death from vCJD has averaged approximately 12 months after onset.

Prevention

There is no known way to prevent sporadic CJD, by far the most common type. Not everyone who inherits the gene mutation for familial CJD will develop the disease, but at present, there is no known way to predict who will and who won't succumb. The incidence of iatrogenic CJD has fallen with recognition of its sources, the development of better screening techniques for infected tissue, and the use of sterilization techniques for surgical instruments that inactivate prion proteins.

Strategies for prevention of vCJD are a controversial matter, as they involve a significant sector of the agricultural industry and a central feature of the diet in many countries. The infectious potential of contaminated meat is unknown, because the ability to detect prions within meat is limited. Surveillance of North American herds strongly suggests there is no BSE here, and strict regulations on imports of European livestock make future outbreaks highly unlikely. Therefore, avoidance of all meat

KEY TERMS

Autosomal dominant inheritance—A pattern of inheritance in which a trait will be expressed if the gene is inherited from either parent.

Encephalopathy—Brain disorder characterized by memory impairment and other symptoms.

Iatrogenic—Caused by a medical procedure.

Nucleic acids—The cellular molecules DNA and RNA that act as coded instructions for the production of proteins and are copied for transmission of inherited traits.

originating in North America, simply on grounds of BSE risk, is a personal choice unsupported by current data. The ban on the export of British beef continues in countries of the European Union, although some herds in these countries have developed low levels of infection as well.

Resources

BOOKS

Rampton, S. and J. C. Stauber. *Mad Cow U.S.A.: Could the Nightmare Happen Here?* Common Courage Press, 1997.

Ratzan, S. C., ed. *Mad Cow Crisis : Health and the Public Good.* New York: University Press, 1998.

PERIODICALS

Haywood, A. M. "Transmissible Spongiform Encephalopathies." *New England Journal of Medicine* 337 (December 18, 1997): 1821-1828.

Prusiner, S. B. "Prion Disease and the BSE Crisis." *Science* 278 (October 10, 1997): 245-251.

Prusiner, S. B."The Prion Diseases." *Scientific American* 272 (January 1995): 48-57.

ORGANIZATION

Creutzfeldt-Jakob Disease Foundation. P.O. Box 611625, North Miami, FL 33261-1625. <http://members.aol.com/crjakob/contact.html>.

The UK Creutzfeldt-Jakob Disease Surveillance Unit. <http://www.cjd.ed.ac.uk/index.htm>.

Larry I. Lutwick, MD

Cri du chat syndrome

Definition

Cri du chat syndrome occurs when a piece of chromosomal material is missing from a particular region on chromosome 5. Individuals with this syndrome have unusual facial features, poor muscle tone(hypotonia), small head size (microcephaly), and **mental retardation**. A classic feature of the syndrome is the cat-like cry made by infants with this disorder.

Description

Dr. Jerome Lejeune first described cri du chat syndrome in 1963. The syndrome is named for the cat-like cry made by infants with this genetic disorder. *Cri du chat* means "cry of the cat" in French. This unusual cry is caused by abnormal development of the larynx (organ in the throat responsible for voice production). Cri du chat syndrome is also called "5p minus syndrome" because it is caused by a deletion, or removal, of genetic material from chromosome 5. The deletion that causes cri du chat syndrome occurs on the short or "p" arm of chromosome 5. This deleted genetic material is vital for normal development. Absence of this material results in the features associated with cri du chat syndrome.

A high-pitched mewing cry during infancy is a classic feature of cri du chat. Infants with cri du chat also typically have low birth weight, slow growth, a small head (microcephaly) and poor muscle tone (hypotonia). Infants with cri du chat may have congenital heart defects. Individuals with cri du chat syndrome have language difficulties, delayed motor skill development, and mental retardation. Behavioral problems may also develop as the child matures.

It has been estimated that cri du chat syndrome occurs in one of every 50,000 live births. According to the 5p minus Society, approximately 50–60 children are born with cri du chat syndrome in the United States each year. It can occur in all races and in both sexes.

Causes and symptoms

Cri du chat is the result of a chromosome abnormality—a deleted piece of chromosomal material on chromosome 5. In 90% of patients with cri du chat syndrome, the deletion is sporadic. This means that it happens randomly and is not hereditary. If a child has cri du chat due to a sporadic deletion, the chance the parents could have another child with cri du chat is 1%. In approximately 10% of patients with cri du chat, there is a hereditary chromosomal rearrangement that causes the deletion. If a parent has this rearrangement, the risk for them to have a child with cri du chat is greater than 1%.

An abnormal larynx causes the unusual cat-like cry made by infants that is a hallmark feature of the syndrome. As children with cri du chat get older, the cat-like cry becomes less noticeable. This can make the diagnosis more difficult in older patients. In addition to the cat-like

KEY TERMS

Aminocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Centromere—The centromere is the constricted region of a chromosome. It performs certain functions during cell division.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Congenital—Refers to a disorder that is present at birth.

Deletion—The absence of genetic material that is normally found in a chromosome. Often, the genetic material is missing due to an error in replication of an egg or sperm cell.

Hypotonia—Reduced or diminished muscle tone.

Karyotyping—A laboratory procedure in which chromosomes are separated from cells, stained and arranged so that their structure can be studied under the microscope.

Microcephaly—An abnormally small head.

cry, individuals with cri du chat also have unusual facial features. These facial differences can be very subtle or more obvious. Microcephaly (small head size) is common. During infancy many patients with cri du chat do not gain weight or grow normally. Approximately 30% of infants with cri du chat have a congenital heart defect. Hypotonia (poor muscle tone) is also common, leading to problems with eating and slow, but normal, development. Mental retardation is present in all patients with cri du chat, but the degree of mental retardation varies between patients.

Diagnosis

During infancy, the diagnosis of cri du chat syndrome is strongly suspected if the characteristic cat-like cry is heard. If a child has this unusual cry or other features seen in cri du chat syndrome, chromosome testing should be performed. Chromosome analysis provides the definitive diagnosis of cri du chat syndrome and can be performed from a blood test. Chromosome analysis, also called "karyotyping," involves staining the chromosomes and examining them under a microscope. In some cases the deletion of material from chromosome 5 can be easily seen. In other cases, further testing must be performed. FISH (fluorescence in-situ hybridization) is a special technique that detects very small deletions. The majority of the deletions that cause cri du chat syndrome can be identified using the FISH technique.

Cri du chat syndrome can be detected before birth if the mother undergoes **amniocentesis** testing or chorionic villus sampling(CVS). This testing would only be recommended if the mother or father is known to have a chromosome rearrangement, or if they already have a child with cri du chat syndrome.

Treatment

Currently, there is no cure for cri du chat syndrome. Treatment consists of supportive care and developmental therapy.

Prognosis

Individuals with cri du chat have a 10% mortality during infancy due to complications associated with congenital heart defects, hypotonia, and feeding difficulties. Once these problems are controlled, most individuals with cri du chat syndrome have a normal lifespan. The degree of mental retardation can be severe. However, a recent study suggested that the severity is somewhat affected by the amount of therapy received.

Resources

BOOKS

Gardner, R. J. McKinlay, and Grant R. Sutherland. *Chromosome Abnormalities and Genetic Counseling.* New York: Oxford University Press, 1996.

Jones, Kenneth. *Smith's Recognizable Patterns of Human Malformation*. 5th ed. Philadelphia: W.B. Saunders Company, 1997.

Rimoin, David, Michael Connor, and Reed Pyeritz. *Emery and Rimoin's Principles and Practice of Medical Genetics,* 3rd ed. New York: Churchill Livingstone, 1996.

PERIODICALS

Van Buggenhout, G. J. C. M., et al. "Cri du Chat Syndrome: Changing Phenotype in Older Patients." *American Journal of Medical Genetics* 90 (2000): 203-215.

ORGANIZATIONS

5p- Society. 7108 Katella Ave. #502, Stanton, CA 90680. (888) 970-0777. <http://www.fivepminus.org>.

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington, DC 20008. (202) 966-5557. Fax: (202) 966-8553. <http://www.geneticalliance.org>.

Cri du Chat Society. Dept. of Human Genetics, Box 33, MCV Station, Richmond VA 23298. (804) 786-9632.

Cri du Chat Syndrome Support Group. <http://www.cridchat.u-net.com>.

National Organization for Rare Disorders (NORD). P.O. Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

OTHER

OMIM—Online Mendelian Inheritance in Man. <http://www.ncbi.nlm.nih.gov/Omim/>.

Holly Ann Ishmael, MS

Crib death *see* **Sudden infant death syndrome**

Crohn's disease

Definition

Crohn's disease is a type of inflammatory bowel disease (IBD), resulting in swelling and dysfunction of the intestinal tract.

Description

Crohn's disease involves inflammation of the intestine, especially the small intestine. Inflammation refers to swelling, redness, and loss of normal function. There is evidence that the inflammation is caused by various products of the immune system that attack the body itself instead of helpfully attacking a foreign invader (a virus or bacteria, for example). The inflammation of Crohn's disease most commonly affects the last part of the ileum (a section of the small intestine), and often includes the large intestine (the colon). However, inflammation may also occur in other areas of the gastrointestinal tract, affecting the mouth, esophagus, or stomach. Crohn's disease differs from **ulcerative colitis**, the other major type of IBD, in two important ways:

- The inflammation of Crohn's disease may be discontinuous, meaning that areas of involvement in the intestine may be separated by normal, unaffected segments of intestine. The affected areas are called "regional enteritis," while the normal areas are called "skip areas."
- The inflammation of Crohn's disease affects all the layers of the intestinal wall, while ulcerative colitis affects only the lining of the intestine.

Also, ulcerative colitis does not usually involve the small intestine; in rare cases it involves the terminal ileum (so-called "backwash" ileitis).

In addition to inflammation, Crohn's disease causes ulcerations, or irritated pits in the intestinal wall. These pits occur because the inflammation has made areas of tissue shed.

Crohn's disease may be diagnosed at any age, although most diagnoses are made between the ages of 15–35. About 0.02–0.04% of the population suffers from this disorder, with men and women having an equal chance of being stricken. Whites are more frequently affected than other racial groups, and people of Jewish origin are between three and six times more likely to suffer from IBD. IBD runs in families; an IBD patient has a 20% chance of having other relatives who are fellow sufferers.

Crohn's disease is a chronic disorder. While the symptoms can be improved, a patient will not be completely cured of the underlying disease.

Causes and symptoms

The cause of Crohn's disease is unknown. No infectious agent (virus, bacteria, or fungi) has been identified as the cause of Crohn's disease. Still, some researchers have theorized that some type of infection may have originally been responsible for triggering the immune system, resulting in the continuing and out-of-control cycle of inflammation that occurs in Crohn's disease. Other evidence for a disorder of the immune system includes the high incidence of other immune disorders that may occur along with Crohn's disease.

The first symptoms of Crohn's disease include **diarrhea**, **fever**, abdominal **pain**, inability to eat, weight loss, and **fatigue**. Some patients have severe pain that mimics **appendicitis**. It is rare, however, for patients to notice blood in their bowel movements. Because Crohn's disease severely limits the ability of the affected intestine to absorb

the nutrients from food, a patient with Crohn's disease can have signs of **malnutrition**, depending on the amount of intestine affected and the duration of the disease.

The combination of severe inflammation, ulceration, and scarring that occurs in Crohn's disease can result in serious complications, including obstruction, **abscess** formation, and fistula formation.

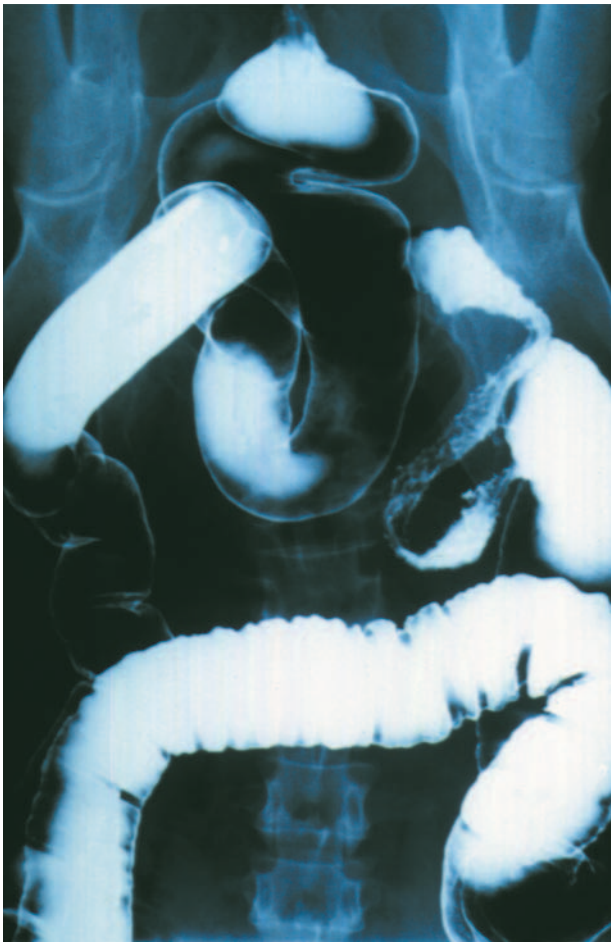
An obstruction is a blockage in the intestine. This obstruction prevents the intestinal contents from passing beyond the point of the blockage. The intestinal contents "back up," resulting in **constipation**, vomiting, and intense pain. Although rare in Crohn's disease (because of the increased thickness of the intestinal wall due to swelling and scarring), a severe bowel obstruction can result in an intestinal wall perforation (a hole in the intestine). Such a hole in the intestinal wall would allow the intestinal contents, usually containing bacteria, to enter the abdomen. This complication could result in a severe, life-threatening infection.

Abcess formation is the development of a walled-off pocket of infection. A patient with an abscess will have bouts of fever, increased abdominal pain, and may have a lump or mass that can be felt through the wall of the abdomen.

Fistula formation is the formation of abnormal channels. These channels may connect one area of the intestine to another neighboring section of intestine. Fistuals may join an area of the intestine to the vagina or bladder, or they may drain an area of the intestine through the skin. Abscesses and fistulas commonly affect the area around the anus and rectum (the very last portions of the colon allowing waste to leave the body). These abnormal connections allow the bacteria that normally live in the intestine to enter other areas of the body, causing potentially serious infections.

Patients suffering from Crohn's disease also have a significant chance of experiencing other disorders. Some of these may relate specifically to the intestinal disease, and others appear to have some relationship to the imbalanced immune system. The faulty absorption state of the bowel can result in **gallstones** and **kidney stones**. Inflamed areas in the abdomen may press on the tube that drains urine from the kidney to the bladder (the ureter). Ureter compression can make urine back up into the kidney, enlarge the ureter and kidney, and can potentially lead to kidney damage. Patients with Crohn's disease also frequently suffer from:

- arthritis (inflammation of the joints)
- spondylitis (inflammation of the vertebrae, the bones of the spine)
- ulcers of the mouth and skin



A barium x-ray showing the colon of a patient with Crohn's disease where the large and small intestines join (bottom left). *(Custom Medical Stock Photo. Reproduced by permission.)*

- painful, red bumps on the skin
- inflammation of several eye areas
- inflammation of the liver, gallbladder, and/or the channels (ducts) that carry bile between and within the liver, gallbladder, and intestine

The chance of developing **cancer** of the intestine is greater than normal among patients with Crohn's disease, although this chance is not as high as among those patients with ulcerative colitis

Diagnosis

Diagnosis is first suspected based on a patient's symptoms. Blood tests may reveal an increase in certain types of white blood cells, an indication that some type of inflammation is occurring in the body. The blood tests may also reveal anemia and other signs of malnutrition due to malabsorption (low blood protein; variations in

KEY TERMS

Abscess—A walled-off pocket of pus caused by infection.

Endoscope—A medical instrument that can be passed into an area of the body (the bladder or intestine, for example) to allow examination of that area. The endoscope usually has a fiber-optic camera that allows a greatly magnified image to be shown on a television screen viewed by the operator. Many endoscopes also allow the operator to retrieve a small sample (biopsy) of the area being examined to more closely view the tissue under a microscope.

Fistule—An abnormal channel that creates an open passageway between two structures that do not normally connect.

Gastrointestinal tract—The entire length of the digestive system, running from the stomach, through the small intestine, large intestine, and out the rectum and anus.

Immune system—The body system responsible for producing various cells and chemicals that fight infection by viruses, bacteria, fungi, and other foreign invaders. In autoimmune disease, these cells and chemicals turn against the body itself.

Inflammation—The result of the body's attempts to fight off and wall off an area that is infected. Inflammation results in the classic signs of redness, heat, swelling, and loss of function.

Obstruction—A blockage.

Ulceration—A pitted area or break in the continuity of a surface such as skin or mucous membrane.

the amount of calcium, potassium, and magnesium present in the blood; changes in certain markers of liver function). Stool samples may be examined to make sure that no infectious agent is causing the diarrhea, and to see if the waste contains blood.

During an endoscopic exam, a doctor passes a flexible tube with a tiny, fiber-optic camera device through the rectum and into the colon. The doctor can then carefully examine the lining of the intestine for signs of inflammation and ulceration that might suggest Crohn's disease. A tiny sample (a biopsy) of the intestine can also be taken through the endoscope, and the tissue will be examined under a microscope for evidence of Crohn's disease.

X rays can be helpful for diagnosis, and also for determining how much of the intestine is involved in the disease. For these x rays, the patient must either drink a chalky solution containing barium, or receive a **barium enema** (a solution that is administered through the rectum). Barium helps to "light up" the intestine, allowing more detail to be seen on the resulting x rays.

While Crohn's disease and ulcerative colitis are similar, they are also very different. Although it can be difficult to determine whether a patient has Crohn's disease or ulcerative colitis, it is important to make every effort to distinguish between these two diseases. Because the long-term complications of the diseases are different, treatment will depend on careful diagnosis of the specific IBD present.

Treatment

Treatments for Crohn's disease try to reduce the underlying inflammation, the resulting malabsorption/malnutrition, the uncomfortable symptoms of crampy abdominal pain and diarrhea, and the possible complications (obstructions, abscesses, and fistulas).

Inflammation can be treated with a drug called sulfasalazine. Sulfasalazine is made up of two parts. One part is related to the sulfa **antibiotics**; the other part is a form of the anti-inflammatory chemical, salicylic acid (related to **aspirin**). Sulfasalazine is not well absorbed from the intestine, so it stays mostly within the intestine, where it is broken down into its components. It is believed that the salicylic acid component actively treats Crohn's disease by fighting inflammation. Some patients do not respond to sulfasalazine, and require steroid medications (such as prednisone). Steroids, however, must be used carefully to avoid the complications of these drugs, including increased risk of infection and weakening of bones (**osteoporosis**). Some very potent immunosuppressive drugs, which interfere with the products of the immune system and can hopefully decrease inflammation, may be used for those patients who do not improve on steroids.

A new drug called infliximab (Remicade) appears to be a powerful treatment for Crohn's disease, particularly for patients who have not responded well to other forms of treatment. Infliximab is administered through infusion, and consists of a monoclonal antibody that interferes with the inflammatory process mediated by tumor necrosis factor-alpha (TNF-a). Patients taking infliximab seem to be able to decrease their use of steroid medications, and require fewer surgical interventions. Furthermore, infliximab is the first medication approved for treating fistulas. Unfortunately, infliximab can only be used on a short-term basis, because its interference with TNF-a activity can also predispose patients to serious infection. More

research is needed to try to harness the benefits of infliximab, while avoiding the potential complications.

Serious cases of malabsorption/malnutrition may need to be treated by providing nutritional supplements. These supplements must be in a form that can be absorbed from the damaged, inflamed intestine. Some patients find that certain foods are hard to digest, including milk, large quantities of fiber, and spicy foods. When patients are suffering from an obstruction, or during periods of time when symptoms of the disease are at their worst, they may need to drink specially formulated, high-calorie liquid supplements. Those patients who are severely ill may need to receive their **nutrition** through a needle inserted in a vein (intravenously), or even by a tiny tube (a catheter) inserted directly into a major vein in the chest.

A number of medications are available to help decrease the cramping and pain associated with Crohn's disease. These include loperamide, tincture of opium, and codeine. Some fiber preparations (methylcellulose or psyllium) may be helpful, although some patients do not tolerate them well.

The first step in treating an obstruction involves general attempts to decrease inflammation with sulfasalazine, steroids, or immunosuppressive drugs. A patient with a severe obstruction will have to stop taking all food and drink by mouth, allowing the bowel to "rest." Abscesses and other infections will require antibiotics. Surgery may be required to repair an obstruction that does not resolve on its own, to remove an abscess, or to repair a fistula. Such surgery may involve the removal of a section of the intestine. In extremely severe cases of Crohn's disease that do not respond to treatment, a patient may need to have the entire large intestine removed (an operation called a colectomy). In this case, a piece of the remaining small intestine is pulled through an opening in the abdomen. This bit of intestine is fashioned surgically to allow a special bag to be placed over it. This bag catches the body's waste, which no longer can be passed through the large intestine and out of the anus. This opening, which will remain in place for life, is called an ileostomy.

Prognosis

Crohn's disease is a life-long illness. The severity of the disease can vary, and a patient can experience periods of time when the disease is not active and he or she is symptom-free. However, the complications and risks of Crohn's disease tend to increase over time. Well over 60% of all patients with Crohn's disease will require surgery, and about half of these patients will require more than one operation over time. About 5–10% of all Crohn's patients will die of their disease, primarily due to massive infection.

Resources

BOOKS

Glickman, Robert. "Inflammatory Bowel Disease: Ulcerative Colitis and Crohn's Disease." In *Harrison's Principles of Internal Medicine,* ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Long, James W. *The Essential Guide to Chronic Illness*. New York: Harper Perennial, 1997.

Saibil, Fred. *Crohn's Disease and Ulcerative Colitis*. Buffalo, NY: Firefly Books, 1997.

PERIODICALS

Peppercorn, Mark A., and Susannah K. Gordon. "Making Sense of a Mystery Ailment: Inflammatory Bowel Disease." *Harvard Health Letter* 22, no. 2 (December 1996): 4+.

Sachar, David. "Maintenance Strategies in Crohn's Disease." *Hospital Practice* 31, no. 1 (January 15, 1996): 99+.

ORGANIZATION

Crohn's & Colitis Foundation of America, Inc. 386 Park Avenue South, 17th Floor, New York, NY 10016-8804. (800) 932-2423.

Rosalyn S. Carson-DeWitt

Cromolyn *see* **Antiasthmatic drugs**

Cross-eye *see* **Strabismus**

Cross-gender identification *see* **Gender identity disorder**

Croup

Definition

Croup is a common childhood ailment. Typically, it arises from a viral infection of the larynx (voice box) and is associated with mild upper respiratory symptoms such as a runny nose and **cough**. The key symptom is a harsh barking cough. Croup is usually not serious, and most children recover within a few days. In a small percentage of cases, a child develops breathing difficulties and may need medical attention.

Description

At one time, the term croup was primarily associated with **diphtheria**, a life-threatening respiratory infection. Owing to widespread vaccinations, diphtheria has become rare in the United States, and croup currently

refers to a mild viral infection of the larynx. Croup is also known as laryngotracheitis, a medical term that describes the inflammation of the trachea (windpipe) and larynx.

Parainfluenza viruses are the typical root cause of the infection, but **influenza** (flu) and cold viruses may sometimes be responsible. All of these viruses are highly contagious and easily transmitted between individuals via sneezing and coughing. Children between the ages of three months and six years are usually affected, with the greatest incidence at one to two years of age. Croup can occur at any time of the year, but it is most typical during early autumn and winter. The characteristic harsh barking of a croupy cough can be very distressing, but it rarely indicates a serious problem. Most children with croup can be treated very effectively at home; however, 1–5% may require medical treatment.

Croup may sometimes be confused with more serious conditions, such as **epiglottitis** or bacterial tracheitis. These ailments arise from bacterial infection and must receive medical treatment.

Causes and symptoms

Owing to an upper respiratory viral infection, the larynx and trachea may become inflamed or swollen. The hallmark sign of croup is a harsh, barking cough. This cough may be preceded by one to three days of symptoms that resemble a slight cold. A croupy cough is often accompanied by a runny nose, hoarseness, and a low **fever**. When the child inhales, there may be a raspy or high-pitched noise, called **stridor**, owing to the narrowed airway and accumulated mucus. In the presence of stridor, medical attention is required.

However, the airway rarely narrows so much that breathing is impeded. Symptoms usually abate completely within a few days. Medical treatment may be sought if the child's symptoms do not respond to home treatment.

Emergency medical treatment is required immediately if the child has difficulty breathing, swallowing, or talking; develops a high fever (103°F/39.4°C or more); seems unalert or confused; or has pale or blue-tinged skin.

Diagnosis

Croup is diagnosed based on the symptoms. If symptoms are particularly severe, or do not respond to treatment, an x ray of the throat area is done to assess the possibility of epiglottitis or other blockage of the airway.

Treatment

Home treatment is the usual method of managing croup symptoms. It is important that the child is kept comfortable and calm to the best degree possible, because crying can make symptoms seem worse. Humid air can help a child with croup feel more comfortable. Recommended methods include sitting in a steamy bathroom with the hot water running or using a cool-water vaporizer or humidifier. Breathing may also be eased by going outside into cooler air. The child should drink frequently in order to stay well hydrated. To treat any fever, the child may be given an appropriate dose of **acetaminophen** (like Tylenol). **Antihistamines** and **decongestants** are ineffective in treating croup. Children under the age of 18 should not be given aspirin, as it may cause **Reye's syndrome**, a life-threatening disease of the brain.

If the child does not respond to home treatment, medical treatment at a doctor's office or an emergency room could be necessary. Based on the severity of symptoms and the response to treatment, the child may need to be admitted to a hospital.

For immediate symptom relief, epinephrine may be administered as an inhaled aerosol. Effects last for up to two hours, but there is a possibility that symptoms may return. For that reason, the child is kept under supervision for three or more hours. Another effective drug is a glucocorticoid, dexamethasone. This drug requires more time to take effect, but is longer lasting. It can be administered orally or as an injection. Another glucocorticoid, budesonide, has been used outside the United States for treating croup. It is administered as an inhaled aerosol and has been shown to be effective; however, it is not available as a treatment option in the United States.

Of the 1–5% of children requiring medical treatment, approximately 1% need respiratory support. Such support involves intubation (inserting a tube into the trachea) and oxygen administration.

Alternative treatment

Botanical/herbal medicines can be helpful in healing the cough that is commonly associated with croup. Several herbs to consider for cough treatment include aniseed (*Pimpinella anisum*), sundew (*Drosera rotundifolia*), thyme (*Thymus vulgaris*), and wild cherry bark (*Prunus serotina*). Homeopathic medicine can be very effective in treating cases of croup. Choosing the correct remedy (a common choice is aconite or monkshood, *Aconitum napellus*) is always the key to the success of this type of treatment.

Prognosis

Croup is a temporary condition and children typically recover completely within three to six days. Children can experience one or more episodes of croup during early childhood; however, croup is rarely a dangerous condition.

KEY TERMS

Diphtheria—A serious, frequently fatal, bacterial infection that affects the respiratory tract. Vaccinations given in childhood have made diphtheria very rare in the United States.

Epiglottitis—A bacterial infection that affects the epiglottis. The epiglottis is a flap of tissue that prevents food and fluid from entering the trachea. The infection causes it to become swollen, potentially blocking the airway. Other symptoms include a high fever, nonbarking cough, muffled voice, and an inability to swallow properly (possibly indicated by drooling).

Glucocorticoid—A hormone that helps in digestion of carbohydrates and reduces inflammation.

Larynx—Commonly called the voice box, it is the area of the trachea that contains the vocal cords.

Stridor—The medical term used to describe the high-pitched or rasping noise made when air is inhaled.

Trachea—Commonly called the windpipe, it is the air pathway that connects the nose and mouth to the lungs.

Prevention

Croup is caused by highly transmissible viruses. Similar to other common childhood ailments, prevention is not applicable.

Resources

PERIODICALS

Folland, David S. "Treatment of Croup: Sending Home an Improved Child and Relieved Parents." *Postgraduate Medicine* 101, no. 3 (Mar. 1997): 271.

Pappas, Diane E., Gregory F. Hayden, and J. Owen Hendley. "Epiglottitis and Croup: Keys to Therapy at Home and in the Hospital." *Consultant* 37, no. 4 (Apr. 1997): 857.

Julia Barrett

Cryoglobulin test

Definition

Cryoglobulin is an abnormal blood protein associated with several diseases. Testing for cryoglobulin is done when a person has symptoms of this protein or is being evaluated for one of the associated diseases.

Purpose

Cryoglobulin clumps in cold temperatures. This physical characteristic causes people with cryoglobulin to have symptoms during cold weather: blanching, numbness, and **pain** in their fingers or toes (Raynaud's phenomenon); bleeding into the skin (purpura); and pain in joints (arthralgia). People with these symptoms or any other symptoms that appear in cold weather should be tested for cryoglobulin.

Diseases that cause the body to make extra or abnormal proteins are often associated with cryoglobulin. These diseases include cancers involving white blood cells, infections, **autoimmune disorders**, and rheumatoid diseases.

This test provides information about the cause of symptoms in a person who already has a disease process. It doesn't diagnose a specific disease or monitor the course of a disease.

Precautions

This test is not a screening test for disease in a person without symptoms.

Description

Laboratory testing for cryoglobulin is based on the fact that cryoglobulin clumps when cooled and dissolves when warmed. The test is done on a person's serum (the yellow liquid part of blood that separates from the cells after the blood clots). The serum is kept warm from the time drawn until the cells and the serum are separated in the laboratory. The serum is placed at 33.8°F (1°C) for one to seven days. If there is clumping, cryoglobulins are present. The amount of cryoglobulins is determined by measuring the amount of clumping. Negative tests are checked through seven days.

Additional testing is done to find out what kind of cryoglobulin protein is present. There are three kinds of cryoglobulin, each associated with different diseases.

The test, also called the cold sensitivity antibodies test, is covered by insurance when medically necessary. Results are usually available the following day.

Preparation

This test requires 15–20 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a

KEY TERMS

Cryoglobulin—An abnormal blood protein associated with several diseases. It is characterized by its tendency to clump in cold temperatures.

needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes. The blood must be kept warm, at body temperature, until the laboratory can separate the cells from the serum.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Negative or absent.

Abnormal results

If the person has cryoglobulin, the amount is reported. Larger amounts of cryoglobulin are associated with cancers or abnormalities involving white blood cells, moderate amounts are associated with autoimmune disorders and rheumatoid diseases, and smaller amounts are associated with infections.

The type of cryoglobulin is also reported. Type I cryoglobulin, also called monoclonal cryoglobulinemia, is found in cancers or abnormalities of white blood cells. Type II, also called mixed cryoglobulinemia, is associated with autoimmune disorders, rheumatoid diseases, and infections, particularly chronic **hepatitis B**.

The physician must interpret the cryoglobulin result along with other test results and the patient's clinical condition and medical history.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Mayo Medical Laboratories. *Interpretive Handbook*. Rochester, MN: Mayo Medical Laboratories, 1997.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Nancy J. Nordenson

Cryosurgery *see* **Cryotherapy**

Cryotherapy

Definition

Cryotherapy is a technique that uses an extremely cold liquid or instrument to freeze and destroy abnormal skin cells that require removal. The technique has been in use since the turn of the century, but modern techniques have made it widely available to dermatologists and primary care doctors. The technique is also called cryosurgery.

Purpose

Cryotherapy can be employed to destroy a variety of benign skin growths, such as **warts**, pre-cancerous lesions (such as actinic keratoses), and malignant lesions (such as basal cell and squamous cell cancers). The goal of cryotherapy is to freeze and destroy targeted skin growths while preserving the surrounding skin from injury.

Precautions

Cryotherapy is not recommended for certain areas of the body because of the danger of destruction of tissue or unacceptable scarring. These areas include: skin that overlies nerves, the corners of the eyes, the fold of skin between the nose and lip, the skin surrounding the nostrils, and the border between the lips and the rest of the face. Lesions that are suspected or known to be **malignant melanoma** should not be treated with cryotherapy, but should instead be removed surgically. Similarly, basal cell or squamous cell carcinomas that have reappeared at the site of a previously treated tumor should also be removed surgically. If it remains unclear whether a growth is benign or malignant, a sample of tissue should be removed for analysis (biopsy) by a pathologist before any attempts to destroy the lesion with cryotherapy. Care should be taken in people with diabetes or certain circulation problems when cryotherapy is considered for growths located on their lower legs, ankles, and feet. In these patients, healing can be poor and the risk of infection can be higher than for other patients.

Description

There are three main techniques to performing cryotherapy. In the simplest technique, usually reserved for warts and other benign skin growths, the physician

will dip a cotton swab or other applicator into a cup containing a "cryogen," such as liquid nitrogen, and apply it directly to the skin growth to freeze it. At a temperature of -320°F (-196°C), liquid nitrogen is the coldest cryogen available. The goal is to freeze the skin growth as quickly as possible, and then let it thaw slowly to cause maximum destruction of the skin cells. A second application may be necessary depending on the size of the growth. In another cryotherapy technique, a device is used to direct a small spray of liquid nitrogen or other cryogen directly onto the skin growth. Freezing may last from five to 20 seconds, depending on the size of the lesion. A second freeze-thaw cycle may be required. Sometimes, the physician will insert a small needle connected to a thermometer into the lesion to make certain the lesion is cooled to a low enough temperature to guarantee maximum destruction. In a third option, liquid nitrogen or another cryogen is circulated through a probe to cool it to low temperatures. The probe is then brought into direct contact with the skin lesion to freeze it. The freeze time can take two to three times longer than with the spray technique.

KEY TERMS

Actinic keratosis—A crusty, scaly pre-cancerous skin lesion caused by damage from the sun. Frequently treated with cryotherapy.

Basal cell cancer—The most common form of skin cancer; it usually appears as one or several nodules having a central depression. It rarely spreads (metasticizes), but is locally invasive.

Cryogen—A substance with a very low boiling point, such as liquid nitrogen, used in cryotherapy treatment.

Melanoma—The most dangerous form of skin cancer. It should not be treated with cryotherapy, but should be removed surgically instead.

Squamous cell cancer—A form of skin cancer that usually originates in sun-damaged areas or pre-existing lesions; at first local and superficial, it may later spread to other areas of the body.

Preparation

Extensive preparation prior to cryotherapy is not required. The area to be treated should be clean and dry, but sterile preparation is not necessary. Patients should know that they will experience some **pain** at the time of the freezing, but local anesthesia is usually not required. The physician may want to reduce the size of certain growths, such as warts, prior to the cryotherapy procedure, and may have patients apply salicylic acid preparations to the growth over several weeks. Sometimes, the physician will pare away some of the tissue using a device called a curette or a scalpel.

Aftercare

Redness, swelling, and the formation of a blister at the site of cryotherapy are all expected results of the treatment. A gauze dressing is applied and patients should wash the site three or four times daily while fluid continues to ooze from the wound, usually for five to 14 days. A dry crust then forms that falls off by itself. **Wounds** on the head and neck may take four to six weeks to heal, but those on the body, arms, and legs can take longer. Some patients experience pain at the site following the treatment. This can usually be eased with **acetaminophen** (Tylenol), though in some cases a stronger pain reliever may be required.

Risks

Cryotherapy poses little risk and can be well-tolerated by elderly and other patients who are not good candidates for other surgical procedures. As with other surgical procedures, there is some risk of scarring, infection, and damage to underlying skin and tissue. These risks are generally minimal in the hands of experienced users of cryotherapy.

Normal results

Some redness, swelling, blistering and oozing of fluid are all common results of cryotherapy. Healing time can vary by the site treated and the cryotherapy technique used. When cryogen is applied directly to the growth, healing may occur in three weeks. Growths treated on the head and neck with the spray technique may take four to six weeks to heal; growths treated on other areas of the body may take considerably longer. Cryotherapy boasts high success rates in permanently removing skin growths; even for malignant lesions such as squamous cell and basal cell cancers, studies have shown a cure rate of up to 98%. For certain types of growths, such as some forms of warts, repeat treatments over several weeks are necessary to prevent the growth's return.

Abnormal results

Although cryotherapy is a relatively low risk procedure, some side effects may occur as a result of the treatment. They include:

- Infection. Though uncommon, infection is more likely on the lower legs where healing can take several months.

- Pigmentary changes. Both hypopigmentation (lightening of the skin) and **hyperpigmentation** (darkening of the skin) are possible after cryotherapy. Both generally last a few months, but can be longer lasting.
- Nerve damage. Though rare, damage to nerves is possible, particularly in areas where they lie closer to the surface of the skin, such as the fingers, the wrist, and the area behind the ear. Reports suggest this will disappear within several months.

Resources

BOOKS

Lynch, Peter J., and W. Mitchell Sams Jr. *Principles and Practice of Dermatology.* 2nd ed. New York: Churchill Livingstone, 1996.

Roenigk, Randall K., and Henry H. Roenigk Jr. *Roenigk and Roenigk's Dermatologic Surgery: Principles and Practice*. New York: Marcel Dekker, 1996.

PERIODICALS

Jester, David M. "Cryotherapy of Dermal Abnormalities." *Primary Care* 24 (June 1997): 269-280.

Young, R., and R. Sinclair. "Practical Cryosurgery." *Australian Family Physician* 26 (Sept. 1997): 1045-1047.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asds-net.org>.

Richard H. Camer

Cryptococcosis

Definition

Cryptococcosis is an infection caused by inhaling the fungus *Cryptococcus neoformans*. It is one of the diseases most often affecting **AIDS** patients. Cryptococcosis may be limited to the lungs, but frequently spreads throughout the body. Although almost any organ can be infected, the fungus is often fatal if it infects the nervous system where it causes an inflammation of the membranes covering the brain and spinal cord (**meningitis**).

Description

The fungus causing cryptococcus, *C. neoformans*, is found worldwide in soil contaminated with pigeon or other bird droppings. It has also been found on unwashed raw fruit. Cryptococcosis is a rare disease in healthy individuals, but is the most common fungal infection affecting people with AIDS.

People with **Hodgkin's disease** or who are taking large doses of drugs that suppress the functioning of the immune system (**corticosteroids**, **chemotherapy** drugs) are also more susceptible to cryptococcal infection. Cryptococcosis is also called cryptococcal meningitis (when the brain is infected), Busse-Buschke disease, European **blastomycosis**, torular meningitis, or torulosis.

Causes and symptoms

Once the cryptococcal fungus reaches the lungs, three things can happen. The immune system can heal the body without medical intervention, the disease can stay localized in the lungs, or it can spread throughout the body. In healthy people with normally functioning immune systems, the body usually heals itself, and the infected person notices no symptoms and has no complications (asymptomatic). The disease does not spread from one person to another.

Cryptococcosis is an opportunistic infection that puts people with immune system diseases at higher risk of developing more serious forms of the disease. In the United States, 6–10% of all patients with AIDS get cryptococcosis.

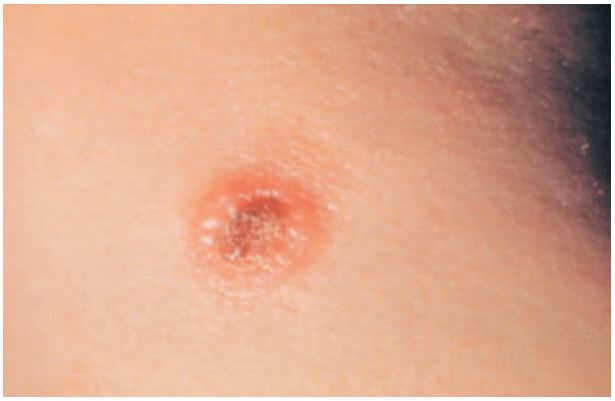
If the body does not heal itself, the fungus begins to grow in the lungs and form nodules that can be seen on chest x rays. In the early stages of infection, an individual usually only exhibits symptoms of a respiratory infection, such as a dry **cough**, so the disease is rarely diagnosed.

The fungus can remain dormant in the lungs and produce an active infection later if the immune system is weakened. If the disease becomes active, it can cause cryptococcal **pneumonia** in the lungs. Unfortunately, however, cryptococcal pneumonia has symptoms similar to other pneumonias (cough, chest **pain**, difficulty breathing), making it difficult to accurately diagnose. The infection can spread to other parts of the body, particularly the brain and central nervous system.

Most patients are not diagnosed as having cryptococcosis until they show signs of cryptococcal meningitis, or infection of the membranes surrounding the brain and spinal cord. Symptoms appear gradually over a period of two to four weeks. **Fever** and **headache** are the most common symptoms, occurring in about 85% of patients. Nausea, vomiting, unwanted weight loss, and **fatigue** are also common. Other symptoms seen in 25–30% of patients are blurred vision, stiff neck, aversion to light, and seizures. Since the symptoms of classic

meningitis, such as stiff neck and aversion to light, do not occur in many patients, diagnosis is often delayed. In addition to meningitis, inflammation of the brain (**encephalitis**) and brain lesions called cryptococcomas or tortulomas can also develop.

In addition to the brain, the cryptococcal infection can spread to the kidneys, bone marrow, heart, adrenal glands, lymph nodes, urinary tract, blood, and skin. Often times preceding the development of cryptococcal meningitis, painless **rashes** and lesions that mimic other skin diseases, such as *molluscum contagiosum*, may develop. A small percentage of patients with brain infections show infections in other organs as well.



This lesion appearing on this person's body is due to exposure of the *C. neoformans* fungus. *(Photo Researchers, Inc. Reproduced by permission.)*

Diagnosis

Physicians who regularly work with AIDS patients have the most experience in diagnosing cryptococcosis. The preferred methods of diagnosis use simple and very accurate blood and cerebrospinal fluid (CSF) tests that detect the presence of an antigen produced by the fungus. The cerebrospinal fluid test is generally more sensitive to detecting the meningitis form of the infection. CSF is collected during a procedure called a lumbar puncture, during which an anesthetic is applied to a small area of the back near the spine and a needle is used to withdraw a sample of cerebrospinal fluid from the space between the vertebrae and the spinal cord. Once obtained, a small amount of ink (called India ink) is added to a sample of CSF or a sample prepared from **skin lesions**. If the fungus is present, it will become visible when the ink binds to the capsule or covering that surrounds the fungus. Faster results are obtained with the India ink test, but it is less accurate than the blood test (75–85% accuracy compared to 99% accuracy with the blood test) because some strains are not visible using this method. Antigen tests are routinely recommended for non-symptomatic patients with advanced AIDS.

Another way to diagnose cryptococcosis is to culture a sample of sputum, tissue from a **lung biopsy**, or CSF in the laboratory to isolate the fungus. Cultures are also done to assess the effectiveness of treatment.

Chest x rays are useful in assessing lung damage and may reveal a single mass or multiple distinct nodules, but the x ray alone does not lead to a definitive diagnosis of cryptococcosis.

Treatment

Once cryptococcosis is diagnosed, treatment begins with amphotericin B (Fungizone), sometimes in combination with 5-flucytosine (Ancobon). Amphotericin B is a powerful fungistatic drug with potentially toxic side effects, such as kidney toxicity and lower concentrations of an important blood component called hemoglobin. This medication can also cause fever, chills, **nausea and vomiting**, **diarrhea**, headache, and muscle aches. Treatment is generally given intravenously during a hospital stay and continues until the patient is stable or improving (no more than two to three weeks). 5-flucytosine is given orally. Patients may also receive other medication to minimize the side effects from these drugs.

Amphotericin B, with or without 5-flucytosine, is given for several weeks until the patient is stable, after which the patient receives oral fluconazole (Diflucan). Fluconazole is a broad-spectrum antifungal drug with few serious side effects. Patient with AIDS must continue taking fluconazole for the rest of their lives to prevent a relapse of cryptococcosis. Sometimes fluconazole is given to patients with advanced AIDS as a preventative (prophylactic) measure.

Because of the high cost of fluconazole, the manufacturer of the drug, Pfizer, has established a financial assistance plan to make the drug available at lower cost to those who meet certain criteria. Patients needing this drug should ask their doctors about this program.

Prognosis

Untreated cryptococcosis is always fatal. The acute mortality rate for patients with AIDS is 10–25%. Most deaths are attributable to cryptococcal meningitis and occur within two weeks after diagnosis. For AIDS patients who do not receive continued suppressive therapy (fluconazole), the relapse rate is 50–60% within six months and a shortened life expectancy. Once the cryptococcosis infection has been successfully treated, individuals may be left with a variety of neurologic symptoms,

KEY TERMS

Adrenal gland—A pair of organs located above the kidneys. The outer tissue of the gland produces the hormones epinephrine (adrenaline) and norepinephrine, while the inner tissue produces several steroid hormones.

Amphotericin B (Fengizone)—An antifungal medication, prescribed for topical or systemic use in treating fungal infections.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein or particle capable of eliciting an immune response.

Asymptomatic—Persons who carry a disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Biopsy—The removal of a tissue sample for diagnostic purposes.

Cerebrospinal fluid (CSF)—The clear fluid that surrounds the spinal cord and brain and acts as a shock absorber.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Encephalitis—Inflammation of the brain.

Hodgkin's disease—A disease that causes chronic inflammation of the lymph nodes, spleen, liver and kidneys. It is also called malignant lymphoma.

Hydrocephalus—Build-up of fluid around the brain.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

India ink test—A diagnostic test used to detect the cyptococcal organism *C. neoformans*. A dye, called India ink, is added to a sample of CSF fluid, and if the fungi is present, they will become visible as the dye binds to the capsule surrounding the fungus.

Lumbar puncture—Also called a spinal tap, a procedure in which a thin needle is used to withdraw a sample of cerebrospinal fluid for diagnostic purposes from the area surrounding the spine.

Meningitis—Inflammation of the membranes covering the brain and spinal cord called the meninges.

Molluscum contagiosum—A disease of the skin and mucuous membranes, caused by a poxvirus and found all over the world.

Opportunistic infection—An infection that is normally mild in a healthy individual, but which takes advantage of an ill person's weakened immune system to move into the body, grow, spread, and cause serious illness.

Pneumonia—Inflammation of the lungs, typically caused by a virus, bacteria, or other organism.

such as weakness, headache, and hearing or visual loss. In addition, fluid may accumulate around the brain (**hydrocephalus**).

Prevention

The best way to prevent cryptococcosis is to stay free of HIV infection. People with suppressed immune systems should try to stay away from areas contaminated with pigeon or other bird droppings, such as the attics of old buildings, barns, and areas under bridges where pigeons roost.

Resources

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Aids Clearinghouse. 800-458-5231.

National Aids Hotline. 800-342-AIDS.

Project Inform. 205 13th Street, #2001, San Francisco, CA 94103. (800) 822-7422. <http://www.projinf.org>.

OTHER

Powderly, William G. "Cryptococcosis." *Journal of the International Association of Physicians in AIDS Care*. July 1996 <http://www.iapac.org/diseases/fungi/cocc.html>.

"Project Inform Cryptococcal Infections Fact Sheet." *Project Inform*. 21 May 1996 <http://www.projinf.org>.

Tish Davidson

Cryptococcus neoformans infection *see* **Cryptococcosis**

Cryptorchidism *see* **Undescended testes**

Cryptosporidiosis

Definition

Cryptosporidiosis refers to infection by the spore-forming protozoan known as *Cryptosporidia*. Protozoa are a group of parasites that infect the human intestine, and include the better known *Giardia*. *Cryptosporidia* was first identified in 1976 as a cause of disease in humans.

Description

Cryptosporidia are normally passed in the feces of infected persons and animals in the form of cysts. The cysts can remain in the ground and water for months, and when ingested produce symptoms after maturing in the intestine and the bile ducts. When viewed under the microscope, they appear as small bluish-staining round bodies. Most common sources of infection are other humans, water supplies, or reservoirs. These are contaminated by animals that defecate in these areas. An outbreak in Milwaukee in 1993 in which over 400,000 persons were affected was traced to the city's water supply. Cysts of *Cryptosporidia* are extremely resistant to the disinfectants that are commonly used in most water treatment plants and are incompletely removed by filtration.

Most persons who experience significant symptoms have an altered immune system, and suffer from diseases such as **AIDS** and **cancer**. However, as shown in the Milwaukee outbreak, even those with normal immunity can experience symptoms.

Causes and symptoms

Cysts of *Cryptosporidia* mature in the intestine and bile ducts within three to five days of ingestion. As noted, large-scale infections from contaminated water supplies has been documented. However, human to human transmission (such as occurs in day care centers or through sexual behavior) is also an important cause.

Many individuals can be infected without any illness, but the major symptom is **diarrhea**, which is often watery and incapacitating. **Dehydration**, low-grade **fever**, nausea, and abdominal cramps are frequent.

In those with a normal immune system, the disease usually lasts about 10 days. For patients with altered immunity (immunocompromised), the story is quite different, with diarrhea becoming chronic, debilitating, and even fatal.

Complications

Dehydration and **malnutrition** are the most common effects of infection. In about 20% of AIDS patients, bile duct infection also occurs and causes symptoms similar to gallbladder attacks. Eighty percent or more of those with infection of the bile ducts die from the disease. The lungs and pancreas are also sometimes involved. *Cryptosporidia* are just one cause of the diarrhea wasting syndrome in AIDS, which results in severe weight loss and malnutrition.

Diagnosis

This is based on either finding the characteristic cysts in stool specimens, or on biopsy of an infected organ, such as the intestine.

Treatment

The first aim of treatment is to avoid dehydration. Oral Rehydration Solution (ORS) or intravenous fluids may be needed. Medications used to treat diarrhea by decreasing intestinal motility (Anti-Motility Agents), such as loperamide or diphenoxylate, are also useful, but should only be used with the advice of a physician.

Treatment aimed directly at *Cryptosporidia* is only partially effective, and rarely eliminates the organism. The medication most commonly used is paromomycin (Humatin), but others are presently under evaluation.

Prognosis

Cryptosporidia rarely cause a serious disease in persons with normal immune systems. Replacement of fluids is all that is usually needed. On the other hand, those with altered immune systems often suffer for months to years. Paramomycin and other drugs have been able to improve symptoms in over half of those treated. Unfortunately, many organisms are resistant, and recurrence is frequent.

Prevention

The best way to prevent cryptosporidiosis is to minimize exposure to cysts from infected humans and animals. Proper hand washing technique, especially in day care centers, is recommended.

Resources

BOOKS

Davis, Charles E. "Laboratory Diagnosis of Parasitic Infection." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Liu, Leo X., and Peter F. Weller. "Therapy for Parasitic Infections." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Nash, Theodore E., and Peter F. Weller. "Cryptosporidiosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

KEY TERMS

Anti-motility medications—Medications such as loperamide (sold as Imodium), dephenoxylate (sold as Lomotil), or medications containing codeine or narcotics that decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Cyst—A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

Immunocompromised—A change or alteration of the immune system that normally serves to fight off infections and other illnesses. This can involve changes in antibodies that the body produces (hygogammaglobulinemia), or defect in the cells that partake in the immune response. Diseases such as AIDS and cancer exhibit changes in the body's natural immunity.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Parasite—An organism that lives on or in another and takes nourishment (food and fluids) from that organism.

Protozoa—Group of extremely small single cell (unicellular) or acellular organisms that are found in moist soil or water. They tend to exist as parasites, living off other life forms.

Spore—A resistant form of certain species of bacteria, protozoa, and other organisms.

Owen, Robert L. "Cryptosporidia." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Weller, Peter F. "Protozoal and Helminthic Infection: General Consideration." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Heyworth, Martin F. "Parasitic Diseases in Immunocompromised Hosts." *Gastrointestinal Clinics of North America: Parasitic Diseases of the Liver and Intestines* (Sept. 1996): 691-707.

Lew, Edward A., Machael A. Poles, and Douglas T. Dieterich. "Diarrheal Disease Associated with HIV Infection." *Gastroenterology Clinics of North America* (June 1997): 259-290.

Vakil, Nimish B., et al. "Biliary Cryptosporidiosis in HIV-Infected People after the Waterborne Outbreak of Cryptosporidiosis in Milwaukee." *New England Journal of Medicine* 334, no. 1 (1996): 19.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Cryptosporidiosis." *Centers for Disease Control.* <http://www.cdc.gov/ncidod/diseases/crypto/crypto.htm>.

Vakil, Nimish B., et al. "Biliary Cryptosporidiosis in HIV-Infected People after the Waterborne Outbreak of Cryptosporidiosis in Milwaukee." *New England Journal of Medicine Online.* <http://content.nejm.org>.

David Kaminstein, MD

C-section *see* **Cesarean section**

CSF analysis *see* **Cerebrospinal fluid (CSF) analysis**

CT-guided biopsy

Definition

Computed tomography (CT) is a process that images anatomic information from a cross-sectional plane of the body. Biopsy is the process of taking a sample of tissue from the body for analysis. CT is commonly used in biopsies to provide images that help guide the tools or equipment necessary to perform the biopsy to the appropriate area of the body.

Purpose

CT is used in the process of performing a biopsy, such as a needle biopsy, in order to guide the needle to the site of the biopsy and to provide rapid and precise localization of the needle. CT enables imaging of areas that are normally beyond visible boundaries. This enables the physician to see the target area clearly and help to ensure that the tissue being removed is from the target lesion.

Precautions

The patient that suffers from claustrophobia will want to discuss this with their physician. This procedure

KEY TERMS

Lesion—A pathologic change in tissues.

Malignancy—A locally invasive and destructive growth.

involves the patient being placed into the CT scanner, typically a small, enclosed area. Depending on the specific type of biopsies being performed, certain anesthetics will be used, so discuss drug **allergies** with your physician.

Description

CT can assist in providing more enhanced images of a suspicious lesion. It helps to determine whether a tumor is truly solitary or not. CT can characterize the tumor and aid in the estimation of malignancy.

Preparation

Since there are many different types of biopsies, you should follow the instructions from your physician to prepare for your CT-guided biopsy. Patients who suffer from claustrophobia should discuss their concerns with the physician. In some cases, medicine can be given that will relax the patient during the procedure.

Risks

CT-guided biopsy does not increase the risk of the biopsy any more than any other radiologic imaging such as x ray.

Normal results

Because the area being biopsied, as well as the specific type of biopsy procedure can vary, results will vary. Before undergoing the procedure, notification procedure should be clearly defined.

Resources

BOOKS

Stedman's Medical Dictionary. 27th ed. Philadelphia: Lippincot Williams & Wilkins, 2000.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment.* Los Altos: Lange Medical Publications, 2001.

PERIODICALS

Garpestad, E., et. al. "CT Fluoroscopy Guidance for Transbronchial Needle Aspiration." *Chest* 119 (February 2001).

Shaffer, K. "Role of Radiology for Imaging and Biopsy of Solitary Pulmonary Nodules." *Chest* 116 (December 1999).

White, C.S., C.A. Meyer, and P. A. Templeton. "CT Fluoroscopy for Throacic Interventional Procedures." *Radiologic Clinics of North America* 38 (March 2000).

White, C.S., et. al. "Transbronchial Needle Aspiration: Guidance with CT Fluoroscopy." *Chest* 118 (December 2000).

Kim A. Sharp

CT-myelogram *see* **Myelography**

CT scan *see* **Computed tomography scans**

Culture-fair test

Definition

A culture-fair test is a test designed to be free of cultural bias, as far as possible, so that no one culture has an advantage over another. The test is designed to not be influenced by verbal ability, cultural climate, or educational level.

Purpose

The purpose of a culture-fair test is to eliminate any social or cultural advantages, or disadvantages, that a person may have due to their upbringing. The test can be administered to anyone, from any nation, speaking any language. A culture-fair test may help identify learning or emotional problems. The duration of the test varies for the individual types of tests available, but the time is approximately between 12–18 minutes per section (a test usually has two to four sections).

A culture-fair test is often administered by employers in order to determine the best location for new employees in a large company. The wide variety of culture-fair tests availiable allows the administrator to select which area is most vital, whether it be general intelligence, knowledge of a specific area, or emotional stability.

Precautions

There is doubt as to whether any test can truly be culturally unbiased or can ever be made completely fair to all persons independent of culture. There are no other precautions.

Description

A culture-fair test is a non-verbal paper-pencil test that can be administered to patients as young as four

years old. The patient only needs the ability to recognize shapes and figures and perceive their respective relationships. Some examples of tasks in the test may include:

- completing series
- classifying
- solving matrices
- evaluating conditions

The culture-fair test is also often referred to as a culture-free test or unbiased test. There are many variations of the test including class, economic, and intelligence tests. The threading theme among the various tests is their design to be culturally unbiased.

Preparation

The only preparation necessary to administer the test is pre-ordered materials and a quiet and secluded location for the duration of the test.

Aftercare

Post-test treatment depends on the results of the test and the specifics of the individual patient. Any further treatment is best prescribed by the doctor.

Risks

There are no risks associated with the culture-fair test.

Normal results

The results can be compared to the key that comes with the purchase of a culture-fair test. All results should be compared to the included key.

Abnormal results

The results can be compared to the key that comes with the purchase of a culture-fair test. All results should be compared to the included key.

Resources

BOOKS

Maddox, Taddy. *Test, 4th ed.* Austin, Texas: Pro-Ed Inc., 1997.

Reber, Arthur S. *The Penguin Dictionary of Psychology,* 1995.

Michael Sherwin Walston
Ronald Watson, PhD

Cultures for sexually transmitted diseases
see **Sexually transmitted diseases cultures**

Cushing's syndrome

Definition

Cushing's syndrome is a relatively rare endocrine (hormonal) disorder resulting from excessive exposure to the hormone cortisol. The disorder, which leads to a variety of symptoms and physical abnormalities, is most commonly caused by taking medications containing the hormone over a long period of time. A more rare form of the disorder occurs when the body itself produces an excessive amount of cortisol.

Description

The adrenals are two glands, each of which is perched on the upper part of the two kidneys. The outer part of the gland is known as the cortex; the inner part is known as the medulla. Each of these parts of the adrenal gland is responsible for producing different types of hormones. Regulation of hormone production and release from the adrenal cortex involves the pituitary gland, a small gland located at the base of the brain. After the hypothalamus (the part of the brain containing secretions important to metabolic activities) sends "releasing hormones" to the pituitary gland, the pituitary secretes a hormone called adrenocorticotropic hormone (ACTH). The ACTH then travels through the bloodstream to the adrenal cortex, where it encourages the production and release of cortisol (sometimes called the "stress" hormone) and other adrenocortical hormones.

Cortisol, a very potent glucocorticoid—a group of adrenocortical hormones that protects the body from **stress** and affect protein and carbohydrate metabolism—is involved in regulating the functioning of nearly every type of organ and tissue in the body, and is considered to be one of the few hormones absolutely necessary for life. Cortisol is involved in:

- complex processing and utilization of many nutrients, including sugars (carbohydrates), fats, and proteins
- normal functioning of the circulatory system and the heart
- functioning of muscles
- normal kidney function
- production of blood cells
- normal processes involved in maintaining the skeletal system
- proper functioning of the brain and nerves
- normal responses of the immune system

Cushing's syndrome, also called hypercortisolism, has an adverse effect on all of the processes described

above. The syndrome occurs in approximately 10 to 15 out of every one million people per year, usually striking adults between the ages of 20 and 50.

Causes and symptoms

The most common cause of Cushing's syndrome is the long-term use of glucocorticoid hormones in medications. Medications such as prednisone are used in a number of inflammatory conditions. Such conditions include **rheumatoid arthritis**, **asthma**, **vasculitis**, lupus, and a variety of other **autoimmune disorders** in which the body's immune cells accidentally attack some part of the body itself. In these disorders, the glucocorticoids are used to dampen the immune response, thereby decreasing damage to the body.

Cushing's syndrome can also be caused by three different categories of disease:

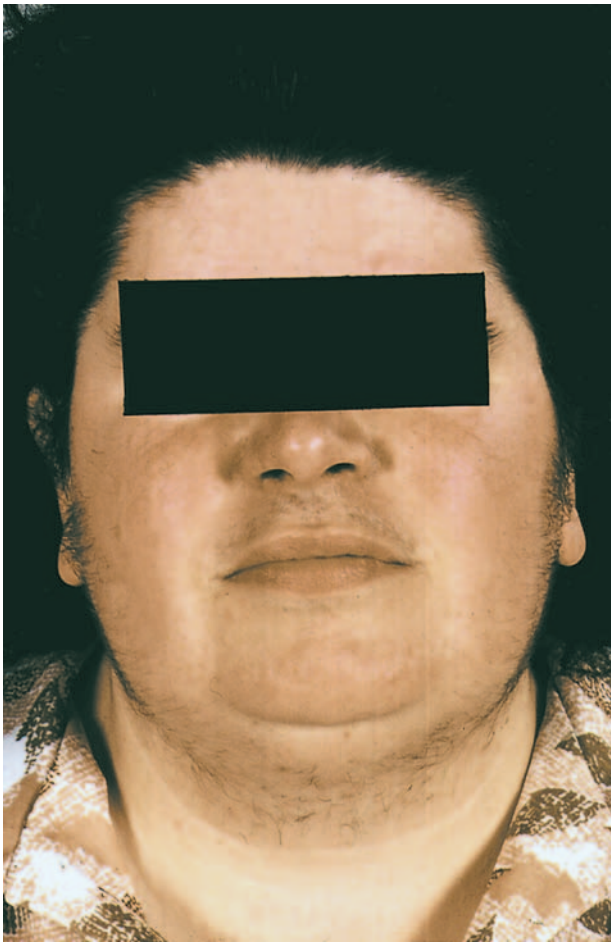
- a pituitary tumor producing abnormally large quantities of ACTH
- the abnormal production of ACTH by some source other than the pituitary
- a tumor within the adrenal gland overproducing cortisol

Although it is rare, about two-thirds of endogenous (occurring within the body rather than from a source outside the body, like a medication) Cushing's syndrome is a result of Cushing's disease. The term "Cushing's disease" refers to Cushing's syndrome, which is caused by excessive secretion of ACTH by a pituitary tumor, usually an adenoma (noncancerous tumor). The pituitary tumor causes increased growth of the adrenal cortex (hyperplasia) and increased cortisol production. Cushing's disease affects women more often than men.

Tumors in locations other than the pituitary can also produce ACTH. This is called ectopic ACTH syndrome ("ectopic" refers to something existing out of its normal place). Tumors in the lung account for more than half of all cases of ectopic ACTH syndrome. Other types of tumors that may produce ACTH include tumors of the thymus, the pancreas, the thyroid, and the adrenal gland. Nearly all adrenal gland tumors are benign (noncancerous), although in rare instances a tumor may actually be cancerous.

Symptoms of cortisol excess (resulting from medication or from the body's excess production of the hormone) include:

- weight gain
- an abnormal accumulation of fatty pads in the face (creating the distinctive "moon face" of Cushing's syndrome); in the trunk (termed "truncal obesity"); and over the upper back and the back of the neck (giving the individual what has been called a "buffalo hump")
- purple and pink stretch marks across the abdomen and flanks
- high blood pressure
- weak, thinning bones (osteoporosis)
- weak muscles
- low energy
- thin, fragile skin, with a tendency toward both bruising and slow healing
- abnormalities in the processing of sugars (glucose), with occasional development of actual diabetes
- kidney stones
- increased risk of infections
- emotional disturbances, including mood swings, depression, irritability, confusion, or even a complete break with reality (psychosis)



Woman with Cushing's syndrome. *(Photo Researchers, Inc. Reproduced by permission.)*

KEY TERMS

Adenoma—A type of noncancerous (benign) tumor that often involves the overgrowth of certain cells of the type normally found within glands.

Adrenocorticotropic hormone (ACTH)—A pituitary hormone that stimulates the cortex of the adrenal glands to produce adrenal cortical hormones.

Cortisol—A hormone secreted by the cortex of the adrenal gland. Cortisol regulates the function of nearly every organ and tissue in the body.

Ectopic—In an abnormal position.

Endocrine—Pertaining to a gland that secretes directly into the bloodstream.

Gland—A collection of cells whose function is to release certain chemicals (hormones) that are important to the functioning of other, sometimes distantly located, organs or body systems.

Glucocorticoids—General class of adrenal cortical hormones that are mainly active in protecting against stress and in protein and carbohydrate metabolism.

Hormone—A chemical produced in one part of the body that travels to another part of the body in order to exert its effect.

Hypothalamus—the part of the brain containing secretions important to metabolic activities.

Pituitary—A gland located at the base of the brain, the pituitary produces a number of hormones, including hormones that regulate growth and reproductive function.

- irregular menstrual periods in women
- decreased sex drive in men and difficulty maintaining an erection
- abormal hair growth in women (in a male pattern, such as in the beard and mustache area), as well as loss of hair from the head (receding hair line)

Diagnosis

Diagnosing Cushing's syndrome can be complex. Diagnosis must not only identify the cortisol excess, but also locate its source. Many of the symptoms listed above can be attributed to numerous other diseases. Although a number of these symptoms seen together would certainly suggest Cushing's syndrome, the symptoms are still not specific to Cushing's syndrome. Following a review of the patient's medical history, **physical examination**, and routine blood tests, a series of more sophisticated tests is available to achieve a diagnosis.

24-hour free cortisol test

This is the most specific diagnostic test for identifying Cushing's syndrome. It involves measuring the amount of cortisol present in the urine over a 24-hour period. When excess cortisol is present in the bloodstream, it is processed by the kidneys and removed as waste in the urine. This 24-hour free cortisol test requires that an individual collect exactly 24-hours' worth of urine in a single container. The urine is then analyzed in a laboratory to determine the quantity of cortisol present. This technique can also be paired with the administration of dexamethasone, which in a normal individual would cause urine cortisol to be very low. Once a diagnosis has been made using the 24-hour free cortisol test, other tests are used to find the exact location of the abnormality causing excess cortisol production.

Dexamethasone suppression test

This test is useful in distinguishing individuals with excess ACTH production due to a pituitary adenoma from those with ectopic ACTH-producing tumors. Patients are given dexamethasone (a synthetic glucocorticoid) orally every six hours for four days. Low doses of dexamethasone are given during the first two days; for the last two days, higher doses are administered. Before dexamethasone is administered, as well as on each day of the test, 24-hour urine collections are obtained.

Because cortisol and other glucocorticoids signal the pituitary to decrease ACTH, the normal response after taking dexamethasone is a drop in blood and urine cortisol levels. Thus, the cortisol response to dexamethasone differs depending on whether the cause of Cushing's syndrome is a pituitary adenoma or an ectopic ACTH-producing tumor.

However, the dexamethasone suppression test may produce false-positive results in patients with conditions such as depression, alcohol abuse, high estrogen levels, acute illness, and stress. On the other hand, drugs such as phenytoin and phenobarbital may produce false-negative results. Thus, patients are usually advised to stop taking these drugs at least one week prior to the test.

Corticotropin-releasing hormone (CRH) stimulation test

The CRH stimulation test is given to help distinguish between patients with pituitary adenomas and

those with either ectopic ACTH syndrome or cortisol-secreting adrenal tumors. In this test, patients are given an injection of CRH, the corticotropin-releasing hormone that causes the pituitary to secrete ACTH. In patients with pituitary adenomas, blood levels of ACTH and cortisol usually rise. However, in patients with ectopic ACTH syndrome, this rise is rarely seen. In patients with cortisol-secreting adrenal tumors, this rise almost never occurs.

Petrosal sinus sampling

Although this test is not always necessary, it may be used to distinguish between a pituitary adenoma and an ectopic source of ACTH. Petrosal sinus sampling involves drawing blood directly from veins that drain the pituitary. This test, which is usually performed with local anesthesia and mild **sedation**, requires inserting tiny, flexible tubes (catheters) through a vein in the upper thigh or groin area. The catheters are then threaded up slowly until they reach veins in an area of the skull known as the petrosal sinuses. X rays are typically used to confirm the correct position of the catheters. Often CRH is also given during the test to increase the accuracy of results.

When blood tested from the petrosal sinuses reveals a higher ACTH level than blood drawn from a vein in the forearm, the likely diagnosis is a pituitary adenoma. When the two samples show similar levels of ACTH, the diagnosis indicates ectopic ACTH syndrome.

Radiologic imaging tests

Imaging tests such as **computed tomography scans** (CT) and **magnetic resonance imaging** (MRI) are only used to look at the pituitary and adrenal glands after a firm diagnosis has already been made. The presence of a pituitary or adrenal tumor does not necessarily guarantee that it is the source of increased ACTH production. Many healthy people with no symptoms or disease whatsoever have noncancerous tumors in the pituitary and adrenal glands. Thus, CT and MRI is often used to image the pituitary and adrenal glands in preparation for surgery.

Treatment

The choice of a specific treatment depends on the type of problem causing the cortisol excess. Pituitary and adrenal adenomas are usually removed surgically. Malignant adrenal tumors always require surgical removal.

Treatment of ectopic ACTH syndrome also involves removing all of the cancerous cells that are producing ACTH. This may be done through surgery, **chemotherapy** (using combinations of cancer-killing drugs), or **radiation therapy** (using x rays to kill **cancer** cells), depending on the type of cancer and how far it has spread. Radiation therapy may also be used on the pituitary (with or without surgery) for patients who cannot undergo surgery, or for patients whose surgery did not successfully decrease pituitary release of ACTH.

There are a number of drugs that are effective in decreasing adrenal production of cortisol. These medications include mitotane, ketoconazole, metyrapone, trilostane, aminoglutethimide, and **mifepristone**. These drugs are sometimes given prior to surgery in an effort to reverse the problems brought on by cortisol excess. However, the drugs may also need to be administered after surgery (sometimes along with radiation treatments) in patients who continue to have excess pituitary production of ACTH.

Because pituitary surgery can cause ACTH levels to drop too low, some patients require short-term treatment with a cortisol-like medication after surgery. Patients who need adrenal surgery may also require glucocorticoid replacement. If the entire adrenal gland has been removed, the patient must take oral glucocorticoids for the rest of his or her life.

Prognosis

Prognosis depends on the source of the problem. When pituitary adenomas are identified as the source of increased ACTH leading to cortisol excess, about 80% of patients are cured by surgery. When cortisol excess is due to some other form of cancer, the prognosis depends on the type of cancer and the extent of its spread.

Resources

BOOKS

Brickner, Colleen. *Inside Out: An Autobiography.* Spokane, WA: A.H. Clark Co., 1992.

DeGroot, Leslie J., ed., et al. "Cushing's syndrome." In *Endocrinology, Vol. 2*. Philadelphia: W.B. Saunders Co., 1995, 1741-69.

Williams, Gordon H., and Robert G. Dluhy. "Hyperfunction of the Adrenal Cortex." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

PERIODICALS

Boscaro, Marco, Luisa Barzon, Francesco Fallo, and Nicoletta Sonino. "Cushing's Syndrome." *Lancet* 357 (2001): 783-91.

Boscaro, Marco, Luisa Barzon, and Nicoletta Sonino. "The Diagnosis of Cushing's Syndrome: Atypical Presentations and Laboratory Shortcomings." *Archives of Internal Medicine* 160 (2000): 3045-53.

Findlay, C. A., J. F. Macdonald, A. M. Wallace, N. Geddes, and M. D. C. Donaldson. "Childhood Cushing's Syndrome Induced by Betamethasone Nose Drops, and Repeat Pre-

scriptions." *British Medical Journal* 3, no.17 (12 Sept., 1998): 739-40.
Kirk, Lawrence F., Robert B. Hash, Harold P. Katner, and Tom Jones. "Cushing's Disease: Clinical Manifestations and Diagnostic Evaluation." *American Family Physician* 62, no. 5 (1 Sept., 2001): 1119-27.
Newell-Price J., and A. Grossman. "Diagnosis and Management of Cushing's Syndrome." *Lancet* 353 (1999): 2087-88.
Orth, David N. "Cushing's Syndrome." *The New England Journal of Medicine* 332, no. 12 (23 Mar., 1995): 791-803.
Utiger, Robert D. "Treatment, and Retreatment, of Cushing's Disease." *The New England Journal of Medicine* 336, no.3 (16 Jan., 1997): 215-17.

ORGANIZATION

Cushing's Support and Research Foundation, Inc. 65 East India Row, Suite 22B, Boston, MA 02110. (617) 723-3674. <http://www.world.std.com>.
National Adrenal Disease Foundation. 505 Northern Boulevard, Suite 200, Great Neck, NY 11021. (516) 487-4992. <http://www.medhelp.org>.
National Institute of Neurological Disorders and Stroke (NINDS). National Institutes of Health, Bethesda, MD 20892-2560. <http://www.ninds.nih.gov>.
Pituitary Network Association. 16350 Ventura Boulevard, #231, Encino, CA 91436. (805)499-9973. <http://www.pituitary.org>.

Rosalyn Carson-DeWitt

Cutaneous larva migrans

Definition

Cutaneous larvae migrans is a parasitic skin disease caused by a hookworm larvae that usually infests dogs, cats, and other animals. Humans can pick up the infection by walking barefoot on soil or beaches contaminated with animal feces.

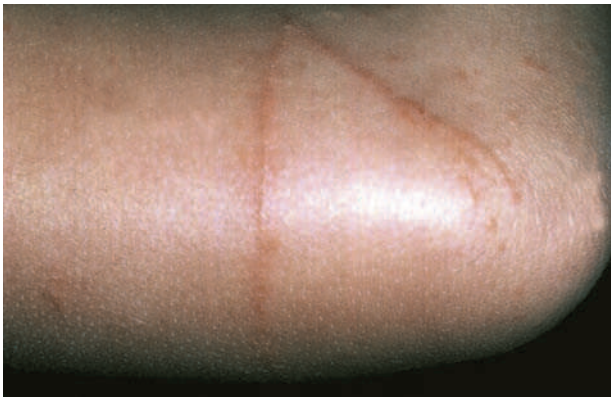
Description

Cutaneous larvae migrans (also called "creeping eruption" or "ground itch") is found in southeastern and Gulf states, and in tropical developing countries.

The hookworms that cause the condition are small, round blood-sucking worms that infest about 700 million people around the world. Cutaneous larvae migrans occurs most often among children, those who crawl beneath raised buildings, and sunbathers who lie down on wet sand contaminated with hookworm larvae.

Causes and symptoms

After an animal passes feces that are infested with hookworm eggs, the eggs hatch into infective larvae that are able to penetrate human skin (even through solid material, such as a beach towel). The larvae are commonly found in shaded, moist, or sandy areas (such as beaches, a child's sandbox, or areas underneath a house), where they are easily picked up by bare feet or buttocks.



Linear red rashes around a patient's knee caused by burrowing larvae of the dog hookworm *Ancylostoma braziliensis*. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

In minor infestations, there may be no symptoms at all. In more severe cases, a red elevation of the skin (papule) appears within a few hours after the larvae have penetrated the skin. This usually arises first in areas that are in contact with the soil, such as the feet, hands, and buttocks.

Between a few days and a few months after infection, the larvae begin to migrate beneath the skin, leaving extremely itchy red lines that may be accompanied by blisters. These red lines usually appear at the top of the sole of the foot or on the buttocks.

Tyically, the larvae travel through the bloodstream, to the lungs, and then migrate into the mouth where they are swallowed and attach to the small intestine lining. There they mature into adult worms. In cases where the larvae migrate through the lungs, they can produce anemia, **cough**, and **pneumonia**, in addition to the itchy rash.

Diagnosis

The condition can be diagnosed by microscopic inspection of feces which can reveal hookworm eggs. In addition visual inspection of the skin would reveal telltale itchy red lines and blisters.

Treatment

People without intestinal symptoms do not need treatment, since the worms will eventually die or be

KEY TERMS

Larvae—Immature forms of certain worms.

excreted. Thiabendazole or albendazole are used to treat the infestation. Mild infections can be treated by applying one of the drugs to the skin along the tracks and the normal skin surrounding the area. Thiabendazole also can be given internally, but taken this way it can cause side effects including **dizziness**, nausea, and vomiting

Prognosis

No matter how severe an infestation, with adequate treatment patients recover completely. However, if the patient scratches the lesions open, the areas can become vulnerable to bacterial infection.

Prevention

In the United States, the prevalence of dogs and cats with hookworms is the reason why the infective larvae are found so commonly in soil and sand. The play habits of children, together with their attraction to pets, puts them at high risk for hookworm infection and cutaneous larvae migrans.

Human hookworm infestation can be prevented by practicing good personal hygiene, deworming pets, and not allowing children to play in potentially contaminated environments.

Resources

BOOKS

Turkington, Carol A., and Jeffrey S. Dover. *Skin Deep: An A-Z of Skin Disorders, Treatments and Health.* 2nd ed. New York: Facts on File, 1998.

PERIODICALS

Rizzitelli, G., G. Scarabelli, and S. Veraldi. "Albendazole: A New Therapeutic Regimen in Cutaneous Larva Migrans." *International Journal of Dermatology* 36, no. 9 (Sept. 1997): 700-703.

Carol A. Turkington

Cutaneous T-cell lymphoma

Definition

Cutaneous T-cell lymphoma (CTCL) is a malignancy of the T-helper (CD4+) cells of the immune system.

Description

CTCL, also known as mycosis fungoides, is a **cancer** of the white blood cells that primarily affects the skin and only secondarily affects other sites. This disease involves the uncontrollable proliferation of T-lymphocytes known as T-helper cells, so named because of their role in the immune response. T-helper cells are characterized by the presence of a protein receptor on its surface called CD4. Accordingly, T-helper cells are said to be CD4+.

The proliferation of T-helper cells results in the penetration, or infiltration, of these abnormal cells into the epidermal layer of the skin. The skin reacts with slightly scaling lesions that itch, although the sites of greatest infiltration do not necessarily correspond to the sites of the lesions. The lesions are most often located on the trunk, but can be present on any part of the body. In the most common course of the disease, the patchy lesions progress to palpable plaques that are deeper red and have more defined edges. As the disease worsens, skin tumors develop that are often mushroom-shaped, hence the name mycosis fungoides. Finally, the cancer progresses to extracutanous involvement, often in the lymph nodes or the viscera.

CTCL is a rare disease, with an annual incidence of about 0.29 cases per 100,000 persons in the United States. It is about half as common in Eastern Europe. However, this discrepancy may be attributed to a differing physician awareness of the disease rather than a true difference in occurrence. In the Unites States, there are about 500 to 600 new cases a year and about 100 to 200 deaths. Usually seen in older adults, the median age at diagnosis is 55 to 60 years, and it strikes twice as many men as women.

Causes and symptoms

The cause of CTCL is unknown. Exposure to chemicals or pesticides has been suggested but the most recent study on the subject failed to show a connection between exposure and development of the disease. The ability to isolate various viruses from cell lines grown from cells of CTCL patients raises the question of a viral cause, but studies have been unable to confirm these suspicions.

The symptoms of CTCL are seen primarily in the skin, with itchy red patches or plaques and, usually over time, mushroom-shaped skin tumors. Any part of the skin can be involved and the extent and distribution of the rash or tumors vary greatly from patient to patient. The only really universal symptom of the disease is the itch and this symptom is usually what brings the patient to the doctor for treatment. If the disease spreads outside of the skin, the symptoms include swelling of the lymph

nodes, usually most severe in those draining the areas with skin involvement. Spread to the viscera is most often manifested as disorders of the lungs, upper digestive tract, central nervous system, or liver but virtually any organ can be shown to be involved at **autopsy**.

Diagnosis

Diagnosis of CTCL is often difficult in the early stages because of its slow progression and ability to mimic many other benign skin conditions. The early patches of CTCL resemble eczema, **psoriasis**, and **contact dermatitis**. In a further complication, the early manifestations of the disease can respond favorably to the topical corticosteroid treatments prescribed for these skin disorders. This has the unfortunate result of the disease being missed and the patient remaining untreated for years. CTCL is most likely discovered when a physician maintains a suspicion about the disease, performs multiple skin biopsies, and provides close follow-up after the initial presentation.

Skin biopsies showing penetration of abnormal cells into the epidermal tissue are necessary to make a firm diagnosis of CTCL. Several molecular studies can also help support the diagnosis. The first looks at the cellular proteins seen on the surface of the abnormal cells. Many cases of CTCL show the retention of the CD4+ protein, but the loss of other proteins usually seen on the surface of mature CD4+ cells, such as Leu-8 or Leu-9. The abnormal cells also show unusual rearrangements at the genetic level for the gene that encodes the T-cell receptors. These rearrangements can be identified using Southern blot analysis. The information from the molecular tests, combined with the presence of abnormal cells in the epidermis, strongly supports the CTCL diagnosis.

Treatment

Treatment of CTCL depends on the stage of the disease. The current staging of this disease was first presented at the International Consensus Conference on CTCL in 1997. The staging attempts to show the complex interaction between the various outward symptoms of the disease and prognosis. The system has seven clinical stages based on skin involvement (tumor = T), lymph node involvement (LN), and presence of visceral metastases (M).

The first stage, IA, is characterized by plaques covering less than 10% of the body (T1) and no visceral involvement (M0). Lymph node condition at this stage can be uninvolved, reactive to the skin disease, or dermatopathic (biopsies showing CTCL involvement) but not enlarged (LN0-2). The shorthand expression of this stage is therefore T1, LN0-2, M0. The next stage, IB, differs from IA in that greater than 10% of the body is covered by plaques (T2, LN0-2, M0). Stage IIA occurs with any amount of plaques in addition to the ability to palpate the lymph node and the lymph uninvolved, reactive, or dermatopathic (T1-2, LN0-2, M0).

Treatments applied to the skin are preferred for patients having these preliminary stages of the disease, commonly topical **chemotherapy** with mechlorethamine hydrochloride (nitrogen mustard) or **phototherapy** of psoralen plus ultraviolet A (PUVA). Topical chemotherapy involves application to the skin of nitrogen mustard, an alkylating agent, in a concentration of 10–20 mg/dL in an aqueous or ointment base. Treatment of affected skin is suggested at a minimum and application over the entire skin surface is often recommended. Care needs to be taken that coverage of involved skin is adequate, as patients who self-apply the drug often cannot reach all affected areas. The most common side effect is skin hypersensitivity to the drug. Nearly all patients respond favorably to this treatment, with a 32–61% complete response rate, based on amount of skin involvement. Unfortunately, only 10–15% of patients maintain a complete response rate after discontinuing the treatment.

Phototherapy involves treatment with an orally administered drug, 8-methyloxypsoralen, that renders the skin sensitive to long-wave ultraviolet light (UVA), followed by controlled exposure to the radiation. During the initial treatment period, which may last as long as six months, patients are treated two to three times weekly. This is reduced to about once monthly after initial clearing of the lesions. Redness of the skin and blistering are the most common side effects of the treatment and are much more common in patients presenting with overall skin redness, or erythroderma, so lower intensities of light are usually used in this case. About 50% of all patients experience complete clearance with this treatment. Some patients with very fair skin and limited skin involvement can successfully treat themselves at home with special lamps and no psoralen.

The next stage, IIB, involves one or more cutaneous tumors, in combination with absent or present palpable lymph nodes, lymph uninvolved, reactive, or dermatopathic, and no visceral involvement (T3, LN0-2, M0). Stage III is characterized by erythroderma, an abnormal redness over widespread areas of the skin (T4, LN0-2, M0).

For more extensive disease, **radiation therapy** is an effective treatment option. It is generally used after the topical treatments have proven ineffective. Individual plaques or tumors can be treated using electrons, orthovoltage x rays, or megavoltage photons with exposure in the range of 15 to 25 Gy. Photon therapy has proven particularly useful once the lymph nodes are involved. Anoth-

er possibility is total-skin electron beam therapy (TSEB), although the availability of this treatment method is limited. It involves irradiation of the entire body with energized electrons. Side effects of this treatment include loss of finger and toe nails, acute redness of the skin, and inability to sweat for about six to 12 months after therapy. Almost all patients respond favorably to radiation treatment and any reoccurrence is usually much less severe.

Combinations of different types of treatments is a very common approach to the management of CTCL. Topical nitrogen mustard or PUVA is often used after completion of radiation treatment to prolong the effects. The addition of genetically engineered interferon to PUVA therapy significantly increases the percentage of patients showing a complete response. Furthermore, although treatments using chemotherapy drugs alone, such as deoxycofomycin or etretinate, have been disappointing for CTCL, combining these drugs with interferon has shown promising results. Interferon has also been combined with retinoid treatments, although the mechanism of action of retinoids (Vitamin A analogues) against CTCL is unknown.

The final two stages of the disease are IVA and IVB. IVA presents as any amount of skin involvement, absent or present palpable lymph nodes, no visceral involvement, and lymph that contains large clusters of convoluted cells or obliterated nodes (T1-4, LN3-4). IVB differs in the addition of palpable lymph nodes and visceral involvement (T1-4, LN3-4, M1). All of the treatment methods described above are appropriate for the final two stages of the disease.

Alternative treatment

Itching of the skin is one of the most troublesome symptoms of CTCL. One alternative treatment for itchiness is the application of a brewed solution of chickweed that is applied to the skin using cloth compresses. Another suggested topical application is a mixture of vitamin E, vitamin A, unflavored yogurt, honey, and zinc oxide. Evening primrose oil applied topically is also claimed to reduce itch and promote healing.

Prognosis

The prognosis for CTCL is dependent on the stage of the disease. Prognosis is very good if the disease has only progressed to Stage IA, with a mean survival of 20 or more years. At this point, the disease is a very low mortality risk to the patient, with most deaths occurring to persons in this group unrelated to CTCL. For patients diagnosed at stages IB and IIA, the median survival is about 12 years. The disease in both of these stages involves intermediate risk to the patient. Patients in stage III and IVA have a mean life expectancy of about five years. At these later stages, the disease is high risk, with most deaths occurring by infection due to the depleted immune system of the later-stage patient. Once a patient has reached stage IVB, the mean life expectancy is one year.

KEY TERMS

Alkylating agent—A chemical that alters the composition of the genetic material of rapidly dividing cells, such as cancer cells, causing selective cell death; used as a topical chemotherapeutic agent to treat CTCL.

Erythroderma—An abnormal reddening of the entire skin surface.

T-helper cells—A cellular component of the immune system that plays a major role in ridding the body of bacteria and viruses, characterized by the presence of the CD4 protein on its surface; the type of cell that divides uncontrollable with CTCL.

Total-skin electron beam therapy—A method of radiation therapy used to treat CTCL that involves bombarding the entire body surface with high-energy electrons.

Prevention

Studies have been unable to link CTCL to any environmental or genetic factors, so prevention at this time is not possible.

Resources

BOOKS

Hoppe, Richard T. "Mycosis Fungoides and Other Cutanous Lymphomas." In *The Lymphomas*, ed. George P. Canellos, et al. Philadelphia: W.B. Saunders Co., 1999.

Wilson, Lynn D., et al. "Cutaneous T-Cell Lymphomas." In *Cancer Principles & Practice of Oncology*, ed. Vincent T. DeVita, et al. Philadelphia: Lippincott Williams & Wilkins, 2001.

PERIODICALS

Elmer, Kathleen B., and Rita M. George, "Cutaneous T-Cell Lymphoma Presenting as Benign Dermatoses." *American Family Physician* 59 (May 1999): 2809–2815.

ORGANIZATIONS

National Cancer Institute. Building 31 Room 10A31 31 Center Drive MSC 2580 Bethesda, MD 20892-2580. (800)422-6237. <http://cancernet.nci.nih.gov>.

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Cutis laxa

Definition

Cutis laxa (Latin for loose or lax skin) is a connective tissue disorder in which the skin lacks elasticity and hangs in loose folds.

Description

Cutis laxa is extremely rare; less than a few hundred cases worldwide have been described.

The several forms of cutis laxa are divided into primary cutis laxa, which is present from birth and is hereditary, secondary cutis laxa, which arises later in life and may be either hereditary, and acquired cutis laxa, which arises later in life and is not hereditary. Loose skin, the primary and most obvious symptom of these diseases, is caused by underlying defects in connective tissue structure, which also cause more serious internal problems in vocal cords, bones, cartilage, blood vessels, bladder, kidney, digestive system, and lungs. The loose skin is particularly obvious on the face, and children with the disorder look sad or mournful.

There are four genetic forms of the disease: sex-linked, autosomal dominant, and two types of autosomal recessive inheritance. The recessive forms are the most common and are usually more severe than the other forms.

Causes and Symptoms

Sex-linked cutis laxa is caused by a defective gene on the X chromosome. In addition to loose skin, its symptoms are mild **mental retardation**, loose joints, bone abnormalities (like hooked nose, pigeon breast, and funnel breast), frequent loose stools, urinary tract blockages, and deficiencies in lysyl oxidase, an enzyme required for the formation of properly functioning connective tissue. (But the defective gene does not code for lysyl oxidase.)

Autosomal dominant cutis laxa is caused by a defective gene carried on an autosomal (not sex-linked) chromosome. Its symptoms are loose, hanging skin, missing elastic fibers, premature **aging**, and pulmonary **emphysema**. Only a few families are known with cutis laxa inherited as a dominant trait.

Autosomal recessive cutis laxa type 1 is caused by a defective gene on chromosome 5. Symptoms include emphysema; diverticula in the esophagus, duodenum, and bladder; lax and dislocated joints; tortuous arteries; hernias; lysyl oxidase deficiencies; and retarded growth.

Autosomal recessive cutis laxa type 2 is also inherited as a recessive trait. In addition to the loose skin, this form of the disease is characterized by bone abnormalities, the delayed joining of the cranial (skull) bones, hip dislocation, curvature of the spine, flat feet, and excessive **tooth decay**.

Acquired cutis laxa tends to follow (and may be caused by) severe illness characterized by **fever**, inflammation, and a severe skin rash (**erythema multiforme**); an injury to the nerves that control blood vessel dilation and contraction; or an autoimmune condition.

Diagnosis

The signs of cutis laxa are very obvious, and it is usually easy to diagnose by examining the skin. The determination of which form of cutis laxa is present is aided by information about the associated symptoms and by family histories.

Treatment

There is no effective cure for any of these disorders. Complications are treated by appropriate specialists, for example, cardiologists, gastroenterologists, rheumatologists, and dermatologists. Plastic surgery can be helpful for cosmetic purposes, but the skin may become loose again.

Prognosis

The prognosis for cutis laxa varies with the form of the disorder. The effects may be relatively mild with individuals living a fairly normal, full life, or the disease may be fatal.

Prevention

The inherited forms of cutis laxa are genetically determined and are not currently preventable. **Genetic counseling** can be helpful for anyone with a family history of cutis laxa. The cause of acquired cutis laxa is not known, so no preventive measures can be taken.

Resources

BOOKS

Pope, F. Michael. "Pseudoxanthoma Elasticum, Cutis Laxa, and Other Disorders of Elastic Tissue." In *Emery and Rimoin's Principles and Practice of Medical Genetics.* 3rd ed. Ed. David L. Rimoin, et al. New York: Churchill Livingstone, 1998.

ORGANIZATIONS

British Coalition of Heritable Disorders of Connective Tissue. Rochester House, 5 Aldershot Road, Fleet, Hampshire GU13 9NG, United Kingdom. (012) 52-810472.

National Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse, National Institutes of Health. 1 AMS Circle, Bethesda, Maryland 20892-3675. (877) 226-4267. <http://www.nih.gov/niams/healthinfo/info.htm>.

KEY TERMS

Autosomal—Refers to the 22 pairs (in humans) of chromosomes not involved with sex determination.

Connective tissue—Tissue that supports and binds other tissue; much of it occurs outside of cells (extra-cellular) and consists of fibrous webs of the polymers, elastin and collagen. Cutis laxa is associated with defects in these fibers.

Diverticula—Pouches in the walls of organs.

Dominant trait—A genetic trait where one copy of the gene is sufficient to yield an outward display of the trait; dominant genes mask the presence of recessive genes; dominant traits can be inherited from only one parent.

Duodenum—The uppermost part of the small intestine, about 10 in (25 cm) long.

Esophagus—The tube connecting the throat to the stomach, about 10 in (25 cm) long.

Funnel breast (also known as pectus excavatum)—A condition where there is a hollow depression in the lower part of the chest.

Gene—A portion of a DNA molecule that either codes for a protein or RNA molecule or has a regulatory function.

Lysyl oxidase—An enzyme required for the crosslinking of elastin and collagen molecules to form properly functioning connective tissue; present in relatively low levels in at least some forms of cutis laxa.

Pigeon breast (also known as pectus carinatum)—A chest shape with a central projection resembling the keel of a boat.

Recessive trait—An inherited trait that is outwardly obvious only when two copies of the gene for that trait are present; an individual displaying a recessive trait must have inherited one copy of the defective gene from each parent.

Sex-linked—Refers to genes or traits carried on one of the sex chromosomes, usually the X.

Tortuous arteries—Arteries with many bends and twists.

X chromosome—One of the two types of sex chromosomes; females have two X chromosomes, while males have one X chromosome and one Y chromosome.

OTHER

OMIM Homepage, Online Mendelian Inheritance in Man. <http://www.ncbi.nlm.nih.gov/Omim>.

Lorraine Lica, PhD

Cuts *see* **Wounds**

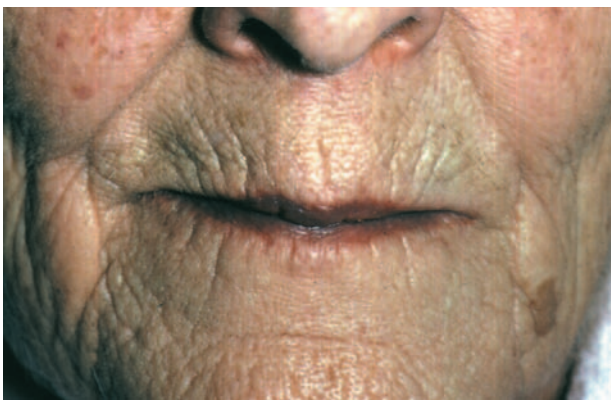
CVA *see* **Stroke**

CVS *see* **Chorionic villus sampling**

Cyanosis

Definition

Cyanosis is a physical sign causing bluish discoloration of the skin and mucous membranes. Cyanosis is caused by a lack of oxygen in the blood. Cyanosis is associated with cold temperatures, **heart failure**, lung diseases, and smothering. It is seen in infants at birth as a result of heart defects, **respiratory distress syndrome**, or lung and breathing problems.



This elderly woman's lips turned purple due to central cyanosis, a condition most commonly due to slow blood circulation, leading to a bluish skin coloration. *(Photo Researchers, Inc. Reproduced by permission.)*

Description

Blood contains a red pigment (hemoglobin) in its red blood cells. Hemoglobin picks up oxygen from the lungs, then circulates it through arteries and releases it to cells through tiny capillaries. After giving up its oxygen, blood cir-

KEY TERMS

Hemoglobin—A colored substance (pigment) in the blood that carries oxygen to tissues and gives blood its red color.

Respiratory distress syndrome—Also known as hyaline membrane disease, this is a condition of premature infants in which the lungs are imperfectly expanded due to a lack of a substance on the lungs that reduces tension.

culates back to the lungs through capillaries and veins. Hemoglobin, as well as blood, is bright red when it contains oxygen, but appears dark or "bluish" after it gives up oxygen.

The blue discoloration of cyanosis is seen most readily in the beds of the fingernails and toenails, and on the lips and tongue. It often appears transiently as a result of slowed blood flow through the skin due to the cold. As such, it is not a serious symptom. However, in other cases, cyanosis is a serious symptom of underlying disease.

Causes and symptoms

The blue color of the skin and mucous membranes is caused by a lack of oxygen in the blood. Low blood oxygen may be caused by poor blood circulation, or heart or breathing problems. It can also be caused by being in a low-oxygen environment or by **carbon monoxide poisoning**. More rarely, cyanosis can be present at birth as a sign of **congenital heart disease**, in which some of the blood is not pumped to the lungs where oxygen would make the blood a bright red color. Instead, the blood goes to the rest of the body and remains unoxygenated. Cyanosis also may be caused by **poisoning** from chemicals, drugs, or contaminated food and water.

Other signs of low blood oxygen may accompany cyanosis, including feeling lightheaded or **fainting**.

Treatment

Treatment of the underlying disease can restore proper color to the skin.

Prognosis

If the underlying condition (such as heart or lung disease) can be properly treated, the skin will return to its normal shade.

Resources

BOOKS

Carolson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

Franck, Irene, and David Brownstone. *The Parent's Desk Reference.* New York: Prentice Hall, 1991.

Carol A. Turkington

Cyclic vomiting syndrome

Definition

Cyclic vomiting syndrome (CVS) is a rare disorder characterized by recurring periods of vomiting in an otherwise normal child.

Description

Children in the pre-school or early school years are most susceptible to CVS, although it can appear anywhere from infancy to adulthood. This disorder was identified a century ago, but its cause is still unknown. Episodes can be triggered by emotional **stress** or infections, can last hours or days, and can return at any time. Abdominal **pain** is a frequent feature.

Causes and symptoms

The cause of CVS is still a mystery. Similarities to migraine suggest a common cause, but as yet no firm evidence has surfaced. Patients can usually identify some factor that precedes an attack. Vomiting can be protracted and lead to complications such as **dehydration**, chemical imbalances, tearing and burning, and bleeding of the esophagus (swallowing tube). Between attacks, there is no sign of any illness.

Diagnosis

The most important and difficult aspect of CVS is to be sure there is not an acute and life-threatening event in progress. So many diseases can cause vomiting—from bowel obstruction to epilepsy—that an accurate and timely diagnosis is critical. Because there is no way to prove the diagnosis of CVS, the physician must instead disprove every other diagnosis. This can be tedious, expensive, exhausting, and involve almost every system in the body. The first episode may be diagnosed as a stomach flu when nothing more serious turns up. Only after several episodes and several fruitless searches for a cause will a physician normally consider the diagnosis of CVS.

Treatment

Several different medications have given good results in small trials. The **antimigraine drugs** amitriptyline and cyproheptadine performed well for one study group. Propanolol is sometimes effective, and erythromycin helped several patients in one study, not because it is an antibiotic but because it irritates the stomach and encourages it to move its contents forward instead of in reverse.

Alternative treatment

Constitutional homeopathic medicine can work well in treating CVS because it addresses rebalancing the whole person, not just the symptoms.

Prognosis

The disease may go on for many years without a change in pattern. If the acute complications of prolonged vomiting can be successfully prevented or managed, most patients can lead normal lives between episodes. Medications may ease the symptoms during attacks.

Resources

PERIODICALS

Andersen, J. M., et al. "Effective Prophylactic Therapy for Cyclic Vomiting Syndrome in Children Using Amitriptyline or Cyproheptadine." *Pediatrics* 100 (Dec. 1997): 977-981.

Fleisher, D. R. "Cyclic Vomiting Syndrome: A Paroxismal Disorder of Brain-Gut Interaction." *Journal of Pediatric Gastroenterology & Nutrition* 25 (1997): S13.

Fleisher, D. R. "Management of Cyclic Vomiting Syndrome." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): S52-56.

Fleisher, D. R. "The Cyclic Vomiting Syndrome Described." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): S1-5.

Forbes, D., and G. Withers. "Prophylactic Therapy in Cyclic Vomiting Syndrome." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): S57-59.

Forbes, D. "Differential Diagnosis of Cyclic Vomiting Syndrome." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): S11-14.

Li, B.U. "Cyclic Vomiting Syndrome. Introduction." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): 7-8.

Li, B. U. "Cyclic Vomiting: The Pattern and Syndrome Paradigm." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): S6-10.

Vanderhoof, J. A., et al. "Treatment of Cyclic Vomiting in Childhood with Erythromycin." *Journal of Pediatric Gastroenterology & Nutrition* 21 (1995): S60-62.

J. Ricker Polsdorfer, MD

Cyclobenzaprine *see* **Muscle relaxants**

Cyclophospha *see* **Anticancer drugs**

Cyclospora infection *see* **Cyclosporiasis**

Cyclosporiasis

Definition

Cyclosporiasis refers to infection by the spore-forming protozoan known as *Cyclospora*. Protozoa are a group of parasites that infect the human intestine. Parasites are organisms that live in another body, called the host, and get food and liquids from that host. This parasite is a member of the group of protozoa known as coccidia, to which *Cryptosporidia* also belongs. This group of parasites infects the human intestine, and causes chronic recurrent infections in those with altered immunity or **AIDS**. Even in people with normal immune function, *Cyclopsora* can cause prolonged bouts of **diarrhea** and other gastrointestinal symptoms.

Description

Until recently, *Cyclospora* was considered to be a form of algae. The parasite causes a common form of waterborne infectious diarrhea throughout the world. Just how the parasite gets into water sources is not yet clear. It is known that ingestion of small cysts in contaminated water leads to disease.

Causes and symptoms

Symptoms begin after an incubation period of about a day or so following ingestion of cysts. A brief period of flu-like illness characterized by weakness and low-grade **fever** is followed by watery diarrhea, nausea, loss of appetite, and muscle aches. In some patients, symptoms may wax and wane for weeks, and there are those in whom nausea and burping may predominate. It is also believed that infection can occur without any symptoms at all.

In patients with abnormal immunity (immunocompromised patients), such as those with AIDS and **cancer**, prolonged diarrhea and severe weight loss often become a major problem. The bile ducts are also susceptible to infection in AIDS patients.

Diagnosis

The disease should be suspected in anyone with a history of prolonged or recurrent diarrhea. The parasite is identified either by staining stool specimens or by apply-

KEY TERMS

Anti-motility medications—Medications such as loperamide (sold as Imodium), dephenoxylate (sold as Lomotil), or medications containing codeine or narcotics that decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Cyst—A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

Immunocompromised—A change or alteration of the immune system that normally serves to fight off infections other illnesses. This can involve changes in antibodies that the body produces (hygogammaglobulinemia), or a defect in the cells that partake in the immune response. Diseases such as AIDS and cancer exhibit changes in the body's natural immunity.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Parasite—An organism that lives on or in another and takes nourishment (food and fluids) from that organism.

Protozoa—Group of extremely small single cell (unicellular) or acellular organisms that are found in moist soil or water. They tend to exist as parasites, living off other life forms.

Spore—A resistant form of certain species of bacteria, protozoa, and other organisms.

ing certain fluorescent ultraviolet techniques to find the characteristic cysts. Biopsy of an infected organ such as the intestine through an endoscope is another way to make the diagnosis.

Treatment

The first aim of treatment as with any severe diarrheal illness is to avoid **dehydration** and **malnutrition**. Oral Rehydration Solution (ORS) or intravenous fluids are sometimes needed. Medications used to treat diarrhea by decreasing intestinal motility, such as loperamide or diphenoxylate are also useful, but should only be used with the advice of a physician.

The use of the medication, trimethoprim-sulfamethoxazole (Bactrim) for one week can be successful in treating intestinal infections and prevents relapse in those with a normal immune system. The same medicine can be prescribed to treat infections of both the intestine or bile ducts in immunocompromised individuals, but maintenance or continuous treatment is often needed.

Prognosis

The outlook is quite good for individuals in whom a diagnosis is made. Even without treatment, symptoms usually do not last much more than a month or so except in cases with altered immunity. Fortunately, treatment is usually successful even in those patients.

Prevention

Aside from a waterborne source as the origin of infection, little else is known about how the parasite is transmitted. Therefore, little can be done regarding prevention, except to maintain proper hand washing techniques and hygiene.

Resources

BOOKS

Davis, Charles E. "Laboratory Diagnosis of Parasitic Infection." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Liu, Leo X., and Peter F. Weller. "Therapy for Parasitic Infections." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Nash, Theodore E., and Peter F. Weller. "Cyclosporiasis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Owen, Robert L. "Cyclospora Cayetanensis." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Weller, Peter F. "Protozoal and Helminthic Infection: General Consideration." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Lew, Edward A., Michael A. Poles, and Douglas T. Dieterich. "Diarrheal Disease Associated with HIV Infection." *Gastroenterology Clinics of North America* (June 1997): 259-290.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Cyclopsora." *Centers for Disease Control.* <http://www.cdc.gov/ncidod/diseases/cyclospo/cyclohp.htm>.

David Kaminstein, MD

Cyclosporine *see* **Immunosuppressant drugs**

Cystectomy

Definition

Cystectomy is a surgical procedure to remove the bladder.

Purpose

Cystectomy is performed to treat **cancer** of the bladder. Radiation and **chemotherapy** are also used to treat **bladder cancer**. Surgery is used to remove cancer when it is in the muscle of the bladder.

Precautions

Cystectomy is an aggressive treatment that may not be appropriate for patients with superficial tumors that respond to more conservative treatment.

Description

Cystectomy is a major surgical operation. The patient is placed under general anesthesia. An incision is made across the lower abdomen. The ureters are located, tied and cut. The ureters connect the kidneys to the bladder. Cutting them frees the bladder for removal. The bladder and associated organs are removed. In men, the prostate is removed with the bladder. In women, the uterus, fallopian tubes, ovaries, and part of the vagina are removed with the bladder. The bladder collects urine from the kidneys for excretion at a later time. Since the bladder is removed, a new method must be created to remove the urine. A small piece of the small intestine is removed, cleaned, and tied at one end to form a tube. The other end is used to form a stoma, an opening through the abdominal wall to the outside. The ureters are then connected to the tube. Urine produced by the kidneys now flows down the ureters, into the tube, and through the stoma. The patient wears a bag to collect the urine.

Preparation

The medical team will discuss the procedure and tell the patient where the stoma will appear and what it will look like. The patient receives instruction on caring for a stoma and bag. Counseling may be initiated. A period of **fasting** and an enema may be required.

KEY TERMS

Ureters—Tubes that connect the kidneys to the bladder. Urine produced by the kidneys passes through the ureters to the bladder.

Aftercare

After the operation, the patient is given fluid-based **nutrition** until the intestines being to function normally again. **Antibiotics** are given to prevent infection of the incision sites. The nature of the organs removed mean that there will be major lifestyle changes for the person undergoing the operation. Men will become impotent because nerves controlling penile erection are cut during removal of the bladder. In women, **infertility** is a consequence because the ovaries and uterus are removed. However, most women who undergo cystectomy are postmenopausal and past their childbearing years.

Both men and women are fitted with an external bag that connects to the stoma and collects the urine. The bag is generally worn around the waist under the clothing. It takes a period of adjustment to get used to wearing the bag. Because there is no bladder, urine is excreted as it is produced, essentially continuously. The stoma must be treated properly to ensure that it does not become infected or blocked. Patients must be trained to care for their stoma. Often there is a period of psychological adjustment to the major change in life style created by the stoma and bag. Patients should be prepared for this by discussion with their physician.

Risks

As with any major surgery, there is a risk of infection; in this case, infection of the intestine is especially dangerous as it can lead to **peritonitis** (inflammation of the membrane lining the abdomen).

Normal results

The bladder is successfully removed and a stoma created. Intestinal function returns to normal and the patient learns proper care of the stoma and bag. He or she adjusts to lifestyle changes and returns to a normal routine of work and recreation, some sports excluded.

Abnormal results

The patient develops an infection at the incision site. The patient does not make a successful psychological adjustment to the long term consequences of **impotence**

and urinary diversion. In some women, the vagina is constricted, which may require a secondary procedure.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Current Surgical Diagnosis and Treatment. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Sabiston, D. C., and H. K. Lyrly. *Essentials of Surgery.* Philadelphia: W. B. Saunders Co., 1994.

John T. Lohr, PhD

Cystic fibrosis

Definition

Cystic fibrosis (CF) is an inherited disease that affects the lungs, digestive system, sweat glands, and male fertility. Its name derives from the fibrous scar tissue that develops in the pancreas, one of the principal organs affected by the disease.

Description

Cystic fibrosis affects the body's ability to move salt and water in and out of cells. This defect causes the lungs and pancreas to secrete thick mucus, blocking passageways and preventing proper function.

CF affects approximately 30,000 children and young adults in the United States, and about 3,000 babies are born with CF every year. CF primarily affects people of white northern-European descent; rates are much lower in non-white populations.

Many of the symptoms of CF can be treated with drugs or nutritional supplements. Close attention to and prompt treatment of respiratory and digestive complications have dramatically increased the expected life span of a person with CF. While several decades ago most children with CF died by age two, today about half of all people with CF live past age 31. That median age is expected to grow as new treatments are developed, and it is estimated that a person born in 1998 with CF has a median expected life span of 40 years.

Causes and symptoms

Causes

Cystic fibrosis is a genetic disease, meaning it is caused by a defect in the person's genes. Genes, found in the nucleus of all the body's cells, control cell function by serving as the blueprint for the production of proteins. Proteins carry out a wide variety of functions within cells. The gene that, when defective, causes CF, is called the CFTR gene, which stands for cystic fibrosis transmembrane conductance regulator. A simple defect in this gene leads to all the consequences of CF. There are over 500 known defects in the CFTR gene that can cause CF. However, 70% of all people with a defective CFTR gene have the same defect, known as delta-F508.

Much as sentences are composed of long strings of words, each made of letters; genes can be thought of as long strings of chemical words, each made of chemical letters, called nucleotides. Just as a sentence can be changed by rearranging its letters, genes can be mutated, or changed, by changes in the sequence of their nucleotide letters. The gene defects in CF are called point mutations, meaning that the gene is mutated only at one small spot along its length. In other words, the delta-F508 mutation is a loss of one "letter" out of thousands within the CFTR gene. As a result, the CFTR protein made from its blueprint is made incorrectly, and cannot perform its function properly.

The CFTR protein helps to produce mucus. Mucus is a complex mixture of salts, water, sugars, and proteins that cleanses, lubricates, and protects many passageways in the body, including those in the lungs and pancreas. The role of the CFTR protein is to allow chloride ions to exit the mucus-producing cells. When the chloride ions leave these cells, water follows, thinning the mucus. In this way, the CFTR protein helps to keep mucus from becoming thick and sluggish, thus allowing the mucus to be moved steadily along the passageways to aid in cleansing.

In CF, the CFTR protein cannot allow chloride ions out of the mucus-producing cells. With less chloride leaving, less water leaves, and the mucus becomes thick and sticky. It can no longer move freely through the passageways, so they become clogged. In the pancreas, clogged passageways prevent secretion of digestive enzymes into the intestine, causing serious impairment of digestion—especially of fat—which may lead to **malnutrition**. Mucus in the lungs may plug the airways, preventing good air exchange and, ultimately, leading to **emphysema**. The mucus is also a rich source of nutrients for bacteria, leading to frequent infections.

INHERITANCE OF CYSTIC FIBROSIS. To understand the inheritance pattern of CF, it is important to realize that genes actually have two functions. First, as noted above, they serve as the blueprint for the production of proteins. Second, they are the material of inheritance: parents pass on characteristics to their children by combining the genes in egg and sperm to make a new individual.

DOROTHY ANDERSEN, MD (1901–1963)

(Library of Congress)

Dorothy Andersen was born on May 15, 1901, in Asheville, North Carolina. She was the only child of Hans Peter Andersen and the former Mary Louise Mason. Orphaned as a young adult, Andersen put herself through Saint Johnsbury Academy and Mount Holyoke College before enrolling in the Johns Hopkins School of Medicine, from which she received her M.D. in 1926.

Andersen turned instead to medical research as a pathologist at Babies Hospital of the Columbia-Presbyterian Medical Center in New York City, where she stayed for more than 20 years, eventually becoming chief of pathology in 1952. Andersen is probably best known for discovery of cystic fibrosis in 1935. That discovery came about during the postmortem examination of a child who had supposedly died of celiac disease, a nutritional disorder. She searched for similar cases in the autopsy files and in medical literature, eventually realizing that she had found a disease that had never been described and to which she gave the name cystic fibrosis.

Each person actually has two copies of each gene, including the CFTR gene, in each of their body cells. During sperm and egg production, however, these two copies separate, so that each sperm or egg contains only one copy of each gene. When sperm and egg unite, the newly created cell once again has two copies of each gene.

The two gene copies may be the same or they may be slightly different. For the CFTR gene, for instance, a person may have two normal copies, or one normal and one mutated copy, or two mutated copies. A person with two mutated copies will develop cystic fibrosis. A person with one mutated copy is said to be a carrier. A carrier will not have symptoms of CF, but can pass on the mutated CFTR gene to his/her children.

When two carriers have children, they have a one in four chance of having a child with CF each time they conceive. They have a two in four chance of having a child who is a carrier, and a one in four chance of having a child with two normal CFTR genes.

Approximately one in every 25 Americans of northern-European descent is a carrier of the mutated CF gene, while only one in 17,000 African Americans and one in 30,000 Asian Americans are carriers. Since carriers are symptom-free, very few people will know whether or not they are carriers unless there is a family history of the disease. Two white Americans with no family history of CF have a one in 2,500 chance of having a child with CF.

It may seem puzzling that a mutated gene with such harmful consequences would remain so common; one might guess that the high mortality of CF would quickly lead to loss of the mutated gene from the population. Some researchers now believe the reason for the persistence of the CF gene is that carriers, those with only one copy of the gene, are protected from the full effects of **cholera**, a microorganism that infects the intestine, causing intense **diarrhea** and eventual **death** by **dehydration**. It is believed that having one copy of the CF gene is enough to prevent the full effects of cholera infection, while not enough to cause the symptoms of CF. This so-called "heterozygote advantage" is seen in some other genetic disorders, including sickle-cell anemia.

Symptoms

The most severe effects of cystic fibrosis are seen in two body systems: the gastrointestinal (digestive) system, and the respiratory tract, from the nose to the lungs. CF also affects the sweat glands and male fertility. Symptoms develop gradually, with gastrointestinal symptoms often the first to appear.

GASTROINTESTINAL SYSTEM. Ten to fifteen percent of babies who inherit CF have meconium **ileus** at birth.

Meconium is the first dark stool that a baby passes after birth; ileus is an obstruction of the digestive tract. The meconium of a newborn with meconium ileus is thickened and sticky, due to the presence of thickened mucus from the intestinal glands. Meconium ileus causes abdominal swelling and vomiting, and often requires surgery immediately after birth. Presence of meconium ileus is considered highly indicative of CF. Borderline cases may be misdiagnosed, however, and attributed instead to "milk allergy."

Other abdominal symptoms are caused by the inability of the pancreas to supply digestive enzymes to the intestine. During normal digestion, as food passes from the stomach into the small intestine, it is mixed with pancreatic secretions which help to break down the nutrients for absorption. While the intestines themselves also provide some digestive enzymes, the pancreas is the major source of enzymes for the digestion of all types of foods, especially fats and proteins.

In CF, thick mucus blocks the pancreatic duct, which is eventually closed off completely by scar tissue formation, leading to a condition known as pancreatic insufficiency. Without pancreatic enzymes, large amounts of undigested food pass into the large intestine. Bacterial action on this rich food source can cause gas and abdominal swelling. The large amount of fat remaining in the feces makes it bulky, oily, and foul-smelling.

Because nutrients are only poorly digested and absorbed, the person with CF is often ravenously hungry, underweight, and shorter than expected for his age. When CF is not treated for a longer period, a child may develop symptoms of malnutrition, including anemia, bloating, and, paradoxically, appetite loss.

Diabetes becomes increasingly likely as a person with CF ages. Scarring of the pancreas slowly destroys those pancreatic cells which produce insulin, producing type I, or insulin-dependent diabetes.

Gall stones affect approximately 10% of adults with CF. Liver problems are less common, but can be caused by the buildup of fat within the liver. Complications of liver enlargement may include internal hemorrhaging, abdominal fluid (**ascites**), spleen enlargement, and liver failure.

Other gastrointestinal symptoms can include a prolapsed rectum, in which part of the rectal lining protrudes through the anus; intestinal obstruction; and rarely, **intussusception**, in which part of the intestinal tube slips over an adjoining part, cutting off blood supply.

Somewhat less than 10% of people with CF do not have gastrointestinal symptoms. Most of these people do not have the delta-F508 mutation, but rather a different one, which presumably allows at least some of their CFTR proteins to function normally in the pancreas.

RESPIRATORY TRACT. The respiratory tract includes the nose, the throat, the trachea (or windpipe), the bronchi (which branch off from the trachea within each lung), the smaller bronchioles, and the blind sacs called alveoli, in which gas exchange takes place between air and blood.

Swelling of the sinuses within the nose is common in people with CF. This usually shows up on x-ray, and may aid the diagnosis of CF. However, this swelling, called pansinusitis, rarely causes problems, and does not usually require treatment.

Nasal polyps, or growths, affect about one in five people with CF. These growths are not cancerous, and do not require removal unless they become annoying. While nasal polyps appear in older people without CF, especially those with **allergies**, they are rare in children without CF.

The lungs are the site of the most life-threatening effects of CF. The production of a thick, sticky mucus increases the likelihood of infection, decreases the ability to protect against infection, causes inflammation and swelling, decreases the functional capacity of the lungs, and may lead to emphysema. People with CF will live with chronic populations of bacteria in their lungs, and lung infection is the major cause of death for those with CF.

The bronchioles and bronchi normally produce a thin, clear mucus that traps foreign particles including bacteria and viruses. Tiny hair-like projections on the surface of these passageways slowly sweep the mucus along, out of the lungs and up the trachea to the back of the throat, where it may be swallowed or coughed up. This "mucociliary escalator" is one of the principal defenses against lung infection.

The thickened mucus of CF prevents easy movement out of the lungs, and increases the irritation and inflammation of lung tissue. This inflammation swells the passageways, partially closing them down, further hampering the movement of mucus. A person with CF is likely to **cough** more frequently and more vigorously as the lungs attempt to clean themselves out.

At the same time, infection becomes more likely since the mucus is a rich source of nutrients. **Bronchitis**, bronchiolitis, and **pneumonia** are frequent in CF. The most common infecting organisms are the bacteria *Staphylococcus aureus*, *Haemophilus influenzae*, and *Pseudomonas aeruginosa*. A small percentage of people with CF have infections caused by *Burkholderia cepacia*, a bacterium which is resistant to most current **antibiotics** (*Burkholderia cepacia* was formerly known as

Pseudomonas cepacia.) The fungus *Aspergillus fumigatus* may infect older children and adults.

The body's response to infection is to increase mucus production; white blood cells fighting the infection thicken the mucus even further as they break down and release their cell contents. These white blood cells also provoke more inflammation, continuing the downward spiral that marks untreated CF.

As mucus accumulates, it can plug up the smaller passageways in the lungs, decreasing functional lung volume. Getting enough air can become difficult; tiredness, **shortness of breath**, and intolerance of **exercise** become more common. Because air passes obstructions more easily during inhalation than during exhalation, over time, air becomes trapped in the smallest chambers of the lungs, the alveoli. As millions of alveoli gradually expand, the chest takes on the enlarged, barrel-shaped appearance typical of emphysema.

For unknown reasons, recurrent respiratory infections lead to "digital clubbing," in which the last joint of the fingers and toes becomes slightly enlarged.

SWEAT GLANDS. The CFTR protein helps to regulate the amount of salt in sweat. People with CF have sweat that is much saltier than normal, and measuring the saltiness of a person's sweat is the most important diagnostic test for CF. Parents may notice that their infants taste salty when they kiss them. Excess salt loss is not usually a problem except during prolonged exercise or heat. While most older children and adults with CF compensate for this extra salt loss by eating more salty foods, infants and young children are in danger of suffering its effects (such as heat prostration), especially during summer. Heat prostration is marked by lethargy, weakness, and loss of appetite, and should be treated as an emergency condition.

FERTILITY. Ninety-eight percent of men with CF are sterile, due to complete obstruction or absence of the vas deferens, the tube carrying sperm out of the testes. While boys and men with CF form normal sperm and have normal levels of sex hormones, sperm are unable to leave the testes, and fertilization is not possible. Most women with CF are fertile, though they often have more trouble getting pregnant than women without CF. In both boys and girls, **puberty** is often delayed, most likely due to the effects of poor **nutrition** or chronic lung infection. Women with good lung health usually have no problems with **pregnancy**, while those with ongoing lung infection often do poorly.

KEY TERMS

Carrier—A person with one copy of a defective gene, who does not have the disease it causes, but can pass along the defective gene to offspring.

CFTR—Cystic fibrosis transmembrane conductance regulator, the protein responsible for regulating chloride movement across cells in some tissues. When a person has two defective copies of the CFTR gene, cystic fibrosis is the result.

Emphysema—A pathological accumulation of air in organs or tissues; term especially applied to the condition when in the lungs.

Mucociliary escalator—The coordinated action of tiny projections on the surfaces of cells lining the respiratory tract, which moves mucus up and out of the lungs.

Mucolytic—An agent that dissolves or destroys mucin, the chief component of mucus.

Pancreatic insufficiency—Reduction or absence of pancreatic secretions into the digestive system due to scarring and blockage of the pancreatic duct.

Diagnosis

The decision to test a child for cystic fibrosis may be triggered by concerns about recurring gastrointestinal or respiratory symptoms, or salty sweat. A child born with meconium ileus will be tested before leaving the hospital. Families with a history of CF may wish to have all children tested, especially if there is a child who already has the disease. Some hospitals now require routine screening of newborns for CF.

Sweat test

The sweat test is both the easiest and most accurate test for CF. In this test, a small amount of the drug pilocarpine is placed on the skin. A very small electrical current is then applied to the area, which drives the pilocarpine into the skin. The drug stimulates sweating in the treated area. The sweat is absorbed onto a piece of filter paper, and is then analyzed for its salt content. A person with CF will have salt concentrations that are one-and-one-half to two times greater than normal. The test can be done on persons of any age, including newborns, and its results can be determined within an hour. Virtually every person who has CF will test positively on it, and virtually everyone who does not will test negatively.

Genetic testing

The discovery of the CFTR gene in 1989 allowed the development of an accurate genetic test for CF.

Genes from a small blood or tissue sample are analyzed for specific mutations; presence of two copies of the mutated gene confirms the diagnosis of CF in all but a very few cases. However, since there are so many different possible mutations, and since testing for all of them would be too expensive and time-consuming, a negative gene test cannot rule out the possibility of CF.

Couples planning a family may decide to have themselves tested if one or both have a family history of CF. Prenatal **genetic testing** is possible through **amniocentesis**. Many couples who already have one child with CF decide to undergo prenatal screening in subsequent pregnancies, and use the results to determine whether to terminate the pregnancy. Siblings in these families are also usually tested, both to determine if they will develop CF, and to determine if they are carriers, to aid in their own family planning. If the sibling has no symptoms, determining his carrier status is often delayed until his teen years or later, when he is closer to needing the information to make decisions.

Newborn screening

Some states now require screening of newborns for CF, using a test known as the IRT test. This is a blood test which measures the level of immunoreactive trypsinogen, which is generally higher in babies with CF than those without it. This test gives many false positive results immediately after birth, and so requires a second test several weeks later. A second positive result is usually followed by a sweat test.

Treatment

There is no cure for CF. Treatment has advanced considerably in the past several decades, increasing both the life span and the quality of life for most people affected by CF. Early diagnosis is important to prevent malnutrition and infection from weakening the young child. With proper management, many people with CF engage in the full range of school and sports activities.

Nutrition

People with CF usually require high-calorie **diets** and vitamin supplements. Height, weight, and growth of a person with CF are monitored regularly. Most people with CF need to take pancreatic enzymes to supplement or replace the inadequate secretions of the pancreas. Tablets containing pancreatic enzymes are taken with every meal; depending on the size of the tablet and the meal, as many as 20 tablets may be needed. Because of incomplete absorption even with pancreatic enzymes, a person with CF needs to take in about 30% more food than a person without CF. Low-fat diets are *not* recommended except in special circumstances, since fat is a source of both essential fatty acids and abundant calories.

Some people with CF cannot absorb enough nutrients from the foods they eat, even with specialized diets and enzymes. For these people, tube feeding is an option. Nutrients can be introduced directly into the stomach through a tube inserted either through the nose (a nasogastric tube) or through the abdominal wall (a **gastrostomy** tube). A jejunostomy tube, inserted into the small intestine, is also an option. Tube feeding can provide nutrition at any time, including at night while the person is sleeping, allowing constant intake of high-quality nutrients. The feeding tube may be removed during the day, allowing normal meals to be taken.

Respiratory health

The key to maintaining respiratory health in a person with CF is regular monitoring and early treatment. Lung function tests are done frequently to track changes in functional lung volume and respiratory effort. Sputum samples are analyzed to determine the types of bacteria present in the lungs. Chest x rays are usually taken at least once a year. Lung scans, using a radioactive gas, can show closed off areas not seen on the x ray. Circulation in the lungs may be monitored by injection of a radioactive substance into the bloodstream.

People with CF live with chronic bacterial colonization; that is, their lungs are constantly host to several species of bacteria. Good general health, especially good nutrition, can keep the immune system healthy, which decreases the frequency with which these colonies begin an infection, or attack on the lung tissue. Exercise is another important way to maintain health, and people with CF are encouraged to maintain a program of regular exercise.

In addition, clearing mucus from the lungs helps to prevent infection; and mucus control is an important aspect of CF management. Postural drainage is used to allow gravity to aid the mucociliary escalator. For this technique, the person with CF lies on a tilted surface with head downward, alternately on the stomach, back, or side, depending on the section of lung to be drained. An assistant thumps the rib cage to help loosen the secretions. A device called a "flutter" offers another way to loosen secretions: it consists of a stainless steel ball in a tube. When a person exhales through it, the ball vibrates, sending vibrations back through the air in the lungs. Some special breathing techniques may also help clear the lungs.

Several drugs are available to prevent the airways from becoming clogged with mucus. **Bronchodilators** and theophyllines open up the airways; steroids reduce inflammation; and mucolytics loosen secretions. Acetyl-

cysteine (Mucomyst) has been used as a mucolytic for many years but is not prescribe frequently now, while DNase (Pulmozyme) is a newer product gaining in popularity. DNase breaks down the DNA from dead white blood cells and bacteria found in thick mucus.

People with CF may pick up bacteria from other CF patients. This is especially true of *Burkholderia cepacia*, which is not usually found in people without CF. While the ideal recommendation from a health standpoint might be to avoid contact with others who have CF, this is not usually practical (since CF clinics are a major site of care), nor does it meet the psychological and social needs of many people with CF. At a minimum, CF centers recommend avoiding prolonged close contact between people with CF, and scrupulous hygiene, including frequent hand washing. Some CF clinics schedule appointments on different days for those with and without *B. cepacia* colonies.

Some doctors choose to prescribe antibiotics only during infection, while others prefer long-term antibiotic treatment against *S. aureus*. The choice of antibiotic depends on the particular organism or organisms found. Some antibiotics are given as aerosols directly into the lungs. Antibiotic treatment may be prolonged and aggressive.

Supplemental oxygen may be needed as lung disease progresses. **Respiratory failure** may develop, requiring temporary use of a ventilator to perform the work of breathing.

Lung transplantation has become increasingly common for people with CF, although the number of people who receive them is still much lower than those who want them. Transplantation is not a cure, however, and has been likened to trading one disease for another. Long-term immunosuppression is required, increasing the likelihood of other types of infection. About 50% of adults and more than 80% of children who receive lung transplants live longer than two years. Liver transplants are also done for CF patients whose livers have been damaged by fibrosis.

Long-term use of ibuprofen has been shown to help some people with CF, presumably by reducing inflammation in the lungs. Close medical supervision is necessary, however, since the effective dose is high and not everyone benefits. Ibuprofen at the required doses interferes with kidney function, and together with aminoglycoside antibiotics, may cause kidney failure.

A number of experimental treatments are currently the subject of much research. Some evidence indicates that aminoglycoside antibiotics may help overcome the genetic defect in some CF mutations, allowing the protein to be made normally. While promising, these results would apply to only about 5% of those with CF.

Gene therapy is currently the most ambitious approach to curing CF. In this set of techniques, nondefective copies of the CFTR gene are delivered to affected cells, where they are taken up and used to create the CFTR protein. While elegant and simple in theory, gene therapy has met with a large number of difficulties in trials so far, including immune resistance, very short duration of the introduced gene, and inadequately widespread delivery.

Alternative treatment

In homeopathic medicine, the symptoms of the disease would be addressed to enhance the quality of life for the person with cystic fibrosis. Treating the cause of CF, because of the genetic basis for the disease, is not possible. Homeopathic medicine seeks to treat the whole person, however, and in CF, this approach might include:

- mucolytics to help thin mucous
- supplementation of pancreatic enzymes to assist in digestion
- respiratory symptoms can be addressed to open lung passages
- hydrotherapy techniques to help ease the respiratory symptoms and help the body eliminate
- immune enhancements can help revent the development of secondary infections
- dietary enhancements and adjustments are used to treat digestive and nutritional problems

Prognosis

People with CF may lead relatively normal lives with the control of symptoms. The possible effect of pregnancy on the health of a woman with CF requires careful consideration before beginning a family as do issues of longevity and their children's status as carriers. Although most men with CF are functionally sterile, new procedures for removing sperm from the testes are being tried, and may offer more men the chance to become fathers.

Approximately half of people with CF live past the age of 30. Because of better and earlier treatment, a person born today with CF is expected, on average, to live to age 40.

Prevention

Adults with a family history of cystic fibrosis may obtain a genetic test of their carrier status for purposes of family planning. Prenatal testing is also available. There is currently no known way to prevent development of CF in a person with two defective gene copies.

Resources

BOOKS

Harris, Ann, and Maurice Super. *Cystic Fibrosis: The Facts.* New York: Oxford University Press, 1995.

Orenstein, David. *Cystic Fibrosis: A Guide for Patient and Family.* Philadelphia: Lippincott-Raven, 1997.

ORGANIZATIONS

Cystic Fibrosis Foundation. 6931 Arlington Road, Bethesda, MD 20814. (800) 344-4823. <http://www.cff.org>.

OTHER

CysticFibrosis.com. <http://www.cysticfibrosis.com>.

Richard Robinson

Cystinuria

Definition

Cystinuria is an inborn error of amino acid transport that results in the defective absorption by the kidneys of the amino acid called cystine. The name means "cystine in the urine."

Description

Cystine is an amino acid. Amino acids are organic compounds needed by the body to make proteins and for many normal functions. When the kidneys don't absorb cystine, this compound builds up in the urine. When the amount of cystine in the urine exceeds its solubility (the greatest amount that can be dissolved), crystals form. As the amount of cystine continues to increase in the urine, the number of crystals also increases. When very large numbers of cystine crystals form, they clump together into what is called a stone.

Causes and symptoms

Cystinuria is a rare disease that occurs when people inherit an abnormal gene from their parents. This disease occurs in differing degrees of severity in people who have inherited either one or two abnormal genes. Humans have two copies of each gene. When both are abnormal, the condition is called homozygous for the disease. When one copy is normal and the other is abnormal, the condition is called heterozygous for the disease. Persons with one abnormal gene can have a milder form of cystinuria that rarely results in the formation of stones.

Severe cystinuria occurs when people are homozygous for the disease. For these individuals, the kidneys may excrete as much as 30 times the normal amount of cystine. Research has shown that this condition is caused by mutations on chromosome number two (humans have 23 pairs of chromosomes).

A person who has inherited cystinuria may have other abnormal bodily functions. In addition to excess levels of the amino acid cystine, high amounts of the amino acids lysine, arginine, and ornithine are found in the urine. This condition indicates that these amino acids are not being reabsorbed by the body.

When excess cystine crystals clump together to form a stone, the stone can block portions of the interior of the kidney or the tube (the ureter) that connects the kidney to the urinary bladder. These cystine stones can be painful, and depending upon where the stone becomes trapped, the **pain** can be felt in the lower back or the abdomen. **Nausea and vomiting** can also occur, and patients may sometimes feel the need to urinate often. Cystine stones can also cause blood in the urine. When the urinary tract is blocked by a stone, urinary tract infections or kidney failure may result.

Diagnosis

Small stones (called "silent") often do not cause any symptoms, although they can be detected by an x ray. Large stones are often painful and easily noticed by the patient. Blood in the urine can also mean that a stone has formed.

When the urine contains extremely high amounts of cystine, yellow-brown hexagonal crystals are visible when a sample is examined under the microscope. Urine samples can also be mixed with chemicals that change color when high levels of cystine are present. When the compound nitroprusside is added to urine that has been made alkaline by the addition of ammonia, the urine specimen turns red if it contains excess cystine.

Treatment

No treatment can decrease cystine excretion. The best treatment for cystinuria is to prevent stones from forming. Stones can be prevented by drinking enough liquid each day (about 5–7 qts) to produce at least 8 pts of urine, thus keeping the concentration of cystine in the urine low. Because a person doesn't drink throughout the night, less urine is produced, and the likelihood of stone formation increases. This risk can be minimized by drinking water or other liquids just before going to bed.

Drug treatments

In addition to drinking large amounts of fluids, it is helpful to make the urine more alkaline. Cystine dis-

solves more easily in alkaline urine. To increase urine alkalinity, a person may take sodium bicarbonate and acetazolamide. Penicillamine, a drug that increases the solubility of cystine, may be prescribed for patients who do not respond well to other therapies. This drug must be used with caution, however, because it can cause serious side effects or allergic reactions. For those unable to take penicillamine, another drug, alpha-mercaptopropionylglycine (Thiola), may be prescribed.

Surgical treatments

Most stones can be removed from the body by normal urination, helped by drinking large amounts of water. Large stones that cannot be passed this way must be removed by surgical procedures.

Large stones can be surgically removed by having a device called a uretoscope placed into the urethra, up through the bladder and into the ureter, where the trapped stone can be seen and removed. Another method involves using sound-wave energy aimed from outside the body to break the large stone into small pieces that can be passed by urination. This external technique is called extracorporeal shock-wave **lithotripsy** (ESWL).

For large stones in the kidney, a procedure called percutaneous nephrolithomy may be used. In this procedure, the surgeon makes a small incision in the back over the kidney. An instrument called a nephroscope is inserted through the incision into the kidney. The surgeon uses the nephroscope to locate and remove the stone. If the stone is very large, it may be broken up into smaller pieces by an ultrasonic or other kind of probe before removal.

Prognosis

As many as 50% of patients who have had surgical treatment for a kidney stone will have another stone within five years if no medicines are used to treat this condition.

Prevention

Cystinuria is a genetic disorder that currently cannot be prevented.

Resources

BOOKS

Elsas, Louis S., Nicola Longo, and Leon E. Rosenberg. "Inherited Defects of Membrane Transport." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Kidney Stones in Adults." In *Kidney and Urinary Tract Diseases and Disorders Sourcebook*, ed. Linda M. Ross. Detroit: Omnigraphics, 1997.

KEY TERMS

Alkaline—A solution is considered alkaline if it contains fewer hydrogen atoms than pure water.

Amino acid—An organic compound made of an amino group (containing nitrogen and hydrogen) and a carbolic acid group. Amino acids are an essential part of protein molecules.

Nephroscope—An instrument made of a light source in a tube. The tube is inserted into the kidney through an incision in the back and used to locate kidney stones. The stones are broken up with high frequency sound waves and removed by suction through the scope.

Nitroprusside—A compound that is used in laboratory tests to identify large amounts of cystine in urine samples.

Uretoscope—A tube-shaped device inserted into the body through the urinary system that allows objects to be both seen and grasped for removal.

Presti Jr., Joseph C., Marshall L. Stoller, and Peter R. Carroll. "Urology." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

Cystinuria Support Network. 21001 NE 36th St., Redmond, WA 98053. (425) 868-2996. <http://www.cystinuria.com>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

Dominic De Bellis, PhD

Cystitis

Definition

Cystitis is defined as inflammation of the urinary bladder. **Urethritis** is an inflammation of the urethra, which is the passageway that connects the bladder with the exterior of the body. Sometimes cystitis and urethritis are referred to collectively as a lower urinary tract infection, or UTI. Infection of the upper urinary tract involves the spread of bacteria to the kidney and is called **pyelonephritis**.

Description

The frequency of bladder infections in humans varies significantly according to age and sex. The male/female

ratio of UTIs in children younger than 12 months is 4:1 because of the high rate of **birth defects** in the urinary tract of male infants. In adult life, the male/female ratio of UTIs is 1:50. After age 50, however, the incidence among males increases due to prostate disorders.

Cystitis in women

Cystitis is a common female problem. It is estimated that 50% of adult women experience at least one episode of dysuria (painful urination); half of these patients have a bacterial UTI. Between 2–5% of women's visits to primary care doctors are for UTI symptoms. About 90% of UTIs in women are uncomplicated but recurrent.

Cystitis in men

UTIs are uncommon in younger and middle-aged men, but may occur as complications of bacterial infections of the kidney or prostate gland.

Cystitis in children

In children, cystitis is often caused by congenital abnormalities (present at birth) of the urinary tract. **Vesicoureteral reflux** is a condition in which the child cannot completely empty the bladder. It allows urine to remain in or flow backward (reflux) into the partially empty bladder.

Causes and symptoms

The causes of cystitis vary according to sex because of the differences in anatomical structure of the urinary tract.

Females

Most bladder infections in women are so-called ascending infections, which means that they are caused by disease agents traveling upward through the urethra to the bladder. The relative shortness of the female urethra (1.2–2 in in length) makes it easy for bacteria to gain entry to the bladder and multiply. The most common bacteria associated with UTIs in women include ***Escherichia coli*** (about 80% of cases), *Staphylococcus saprophyticus*, *Klebsiella*, *Enterobacter*, and *Proteus* species. Risk factors for UTIs in women include:

- Sexual intercourse. The risk of infection increases if the woman has multiple partners.
- Use of a diaphragm for **contraception**
- An abnormally short urethra
- Diabetes or chronic **dehydration**
- The absence of a specific enzyme (fucosyltransferase) in vaginal secretions. The lack of this enzyme makes it easier for the vagina to harbor bacteria that cause UTIs.
- Inadequate personal hygiene. Bacteria from fecal matter or vaginal discharges can enter the female urethra because its opening is very close to the vagina and anus.
- History of previous UTIs. About 80% of women with cystitis develop recurrences within two years.

The early symptoms of cystitis in women are dysuria, or **pain** on urination; urgency, or a sudden strong desire to urinate; and increased frequency of urination. About 50% of female patients experience **fever**, pain in the lower back or flanks, **nausea and vomiting**, or shaking chills. These symptoms indicate pyelonephritis, or spread of the infection to the upper urinary tract.

Males

Most UTIs in adult males are complications of kidney or prostate infections. They are usually associated with a tumor or **kidney stones** that block the flow of urine and are often persistent infections caused by drug-resistant organisms. UTIs in men are most likely to be caused by *E. coli* or another gram-negative bacterium. *S. saprophyticus*, which is the second most common cause of UTIs in women, rarely causes infections in men. Risk factors for UTIs in men include:

- Lack of **circumcision**. The foreskin can harbor bacteria that cause UTIs.
- Urinary catheterization. The longer the period of catheterization, the higher the risk of UTIs.

The symptoms of cystitis and pyelonephritis in men are the same as in women.

Hemorrhagic cystitis

Hemorrhagic cystitis, which is marked by large quantities of blood in the urine, is caused by an acute bacterial infection of the bladder. In some cases, hemorrhagic cystitis is a side effect of **radiation therapy** or treatment with cyclophosphamide. Hemorrhagic cystitis in children is associated with adenovirus type 11.

Diagnosis

When cystitis is suspected, the doctor will first examine the patient's abdomen and lower back, to evaluate unusual enlargements of the kidneys or swelling of the bladder. In small children, the doctor will check for fever, abdominal masses, and a swollen bladder.

The next step in diagnosis is collection of a urine sample. The procedure differs somewhat for women and men. Laboratory testing of urine samples can now be performed with dipsticks that indicate immune system responses to infection, as well as with microscopic analysis of samples. Normal human urine is sterile. The

presence of bacteria or pus in the urine usually indicates infection. The presence of hematuria, or blood in the urine, may indicate acute UTIs, kidney disease, kidney stones, inflammation of the prostate (in men), **endometriosis** (in women), or **cancer** of the urinary tract. In some cases, blood in the urine results from athletic training, particularly in runners.

Females

Female patients require a pelvic examination as part of the procedure to obtain urine specimens. The patient lies on an obstetrical table with legs in the stirrups. The doctor first takes a vaginal culture smear. The patient is then asked to void while lying on the table. The first 5–10 ml are collected to test for urethral infection. A midstream urine sample of 200 ml is then collected to test for bladder infection.

In women, a vaginal bacterial count that is higher than those of the two urine samples indicates vaginitis. A high bacterial count in the first urine sample indicates urethritis. A count of more than 104 bacteria CFU/ml (colony forming units per milliliter) in the midstream sample indicates a bladder or kidney infection. A colony is a large number of microorganisms that grow from a single cell within a substance called a culture. A bacterial count can be given in CFU (colony forming units).

Males

In male patients, the doctor will cleanse the opening to the urethra with an antiseptic before collecting the urine sample. The first 10 ml of specimen are collected separately. The patient then voids a midstream sample of 200 ml. Following the second sample, the doctor will massage the patient's prostate and collect several drops of prostatic fluid. The patient then voids a third urine specimen for prostatic culture.

A high bacterial count in the first urine specimen or the prostatic specimens indicates urethritis or prostate infections respectively. A bacterial count greater than 100,000 bacteria CFU/ml in the midstream sample suggests a bladder or kidney infection.

Other tests

Women with recurrent UTIs can be given ultrasound tests of the kidneys and bladder together with a voiding cystourethrogram to test for structural abnormalities. (A cystourethrogram is an x-ray test in which an iodine dye is used to better view the urinary bladder and urethra.) Voiding cystourethrograms are also used to evaluate children with UTIs. In some cases, **computed tomography scans** (CT scans) can be used to evaluate patients for possible cancers in the urinary tract.

KEY TERMS

Bacteriuria—The presence of bacteria in the urine.

Dysuria—Painful or difficult urination.

Hematuria—The presence of blood in the urine.

Pyelonephritis—Bacterial inflammation of the upper urinary tract.

Urethritis—Inflammation of the urethra, which is the passage through which the urine moves from the bladder to the outside of the body.

Treatment

Medications

Uncomplicated cystitis is treated with **antibiotics**. These include penicillin, ampicillin, and amoxicillin; sulfisoxazole or sulfamethoxazole; trimethoprim; nitrofurantoin; **cephalosporins**; or **fluoroquinolones**. (Flouroquinolones are generally not used in children under 18 years of age.) Treatment for women is short-term; most patients respond within three days. Men do not respond as well to short-term treatment and require seven to 10 days of oral antibiotics for uncomplicated UTIs.

Patients of either sex may be given phenazopyridine or flavoxate to relieve painful urination.

Trimethoprim and nitrofurantoin are preferred for treating recurrent UTIs in women.

Over 50% of older men with UTIs also suffer from infection of the prostate gland. Some antibiotics, including amoxicillin and the cephalosporins, do not affect the prostate gland. Fluoroquinolone antibiotics or trimethoprim are the drugs of choice for these patients.

Patients with pyelonephritis can be treated with oral antibiotics or intramuscular doses of cephalosporins. Medications are given for 10–14 days, and sometimes longer. If the patient requires hospitalization because of high fever and dehydration caused by vomiting, antibiotics can be given intravenously.

Surgery

A minority of women with complicated UTIs may require surgical treatment to prevent recurrent infections. Surgery is also used to treat reflux problems (movement of the urine backwards) or other structural abnormalities in children and anatomical abnormalities in adult males.

Alternative treatment

Alternative treatment for cystitis may emphasize eliminating all sugar from the diet and drinking lots of water. Drinking unsweetened cranberry juice not only adds fluid, but is also thought to help prevent cystitis by making it more difficult for bacteria to cling to the bladder wall. A variety of herbal therapies are also recommended. Generally, the recommended herbs are antimicrobials, such as garlic (*Allium sativum*), goldenseal (*Hydrastis canadensis*), and bearberry (*Arctostaphylos uva-ursi*), and/or demulcents that soothe and coat the urinary tract, including corn silk and marsh mallow (*Althaea officinalis*).

Homeopathic medicine can also be effective in treating cystitis. Choosing the correct remedy based on the individual's symptoms is always key to the success of this type of treatment. **Acupuncture** and Chinese traditional herbal medicine can also be helpful in treating acute and chronic cases of cystitis.

Prognosis

Females

The prognosis for recovery from uncomplicated cystitis is excellent.

Males

The prognosis for recovery from uncomplicated UTIs is excellent; however, complicated UTIs in males are difficult to treat because they often involve bacteria that are resistant to commonly used antibiotics.

Prevention

Females

Women with two or more UTIs within a six-month period are sometimes given prophylactic treatment, usually nitrofurantoin or trimethoprim for three to six months. In some cases the patient is advised to take an antibiotic tablet following sexual intercourse.

Other preventive measures for women include:

- drinking large amounts of fluid
- voiding frequently, particularly after intercourse
- proper cleansing of the area around the urethra

Males

The primary preventive measure for males is prompt treatment of prostate infections. Chronic **prostatitis** may go unnoticed, but can trigger recurrent UTIs. In addition, males who require temporary catheterization following surgery can be given antibiotics to lower the risk of UTIs.

Resources

BOOKS

Anderson, E. Everett. "Dysuria, Pyuria, and Hematuria." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Donovan, James F., and Richard D. Williams. "Urology." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

"Genitourinary Disorders: Lower Urinary Tract and Male Genital Tract Infections." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

King, Lowell R. "Bacterial Infections of the Urinary Tract in Girls." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Lower Urinary Tract Infection." In *Professional Guide to Diseases*, ed. Stanley Loeb et al. Springhouse, PA: Springhouse Corporation, 1991.

Mata, John A. "Bacterial Infections of the Urinary Tract in Females." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Robertson, Jack R., and David B. Hebert. "Gynecologic Urology." In *Current Obstetric & Gynecologic Diagnosis & Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Stamford: Appleton & Lange, 1994.

Rebecca J. Frey

Cystometry

Definition

Cystometry is a test of bladder function in which pressure and volume of fluid in the bladder is measured during filling, storage, and voiding.

Purpose

The urinary bladder stores urine produced by the kidneys. The main muscle of the bladder wall, the detrusor, relaxes to allow expansion of the bladder during filling. The urethra, the tube through which urine exits, is held closed by a ring of muscle, known as the urethral sphincter. As volume increases, stretching of the detrusor and pressure on the sphincter sends signals to the brain, indicating the need for urination, or voiding. Voluntary relaxation of the sphincter and automatic contractions of the detrusor allow successful and virtually complete voiding.

A cystometry study is performed to diagnose problems with urination, including incontinence, urinary retention, and recurrent urinary tract infections. Urinary difficulties may occur because of weak or hyperactive sphincter or detrusor, or incoordination of their two

activities. Infection of the bladder or urethra may cause incontinence, as can obstruction of the urethra from scar tissue, prostate enlargement, or other benign or cancerous growths. Loss of sensation due to nerve damage can lead to chronic overfilling.

Precautions

The mild irritation of the urinary tract necessary for insertion of the catheter may occasionally cause flushing, sweating, and nausea.

Description

The patient begins by emptying the bladder as much as possible. A thin plastic catheter is then slowly inserted into the urethra until it reaches the bladder. Measurements are taken of the residual urine volume and bladder pressure. Pressure measurements may require a rectal probe to account for the contribution of the abdominal muscles to the pressure recording.

The bladder is then gradually filled with either warm water, room temperature water, saline solution, carbon dioxide gas, or a contrast solution for x-ray analysis, depending on the type of study being done. The patient is asked to describe sensations during filling, including temperature sensations and when the first feeling of bladder fullness occurs. Once the bladder is completely full, the patient is asked to begin voiding, and measurements are again made of pressure and volume, as well as flow rate and pressure.

Preparation

There is no special preparation needed for this test. The patient may be asked to stop taking certain medications in advance of the test, including sedatives, cholinergics, and anticholinergics.

Aftercare

Cystometry can be somewhat uncomfortable. The patient may wish to reserve an hour or so afterward to recover. Urinary frequency or urgency, and some reddening of the urine, may last for a day. Increasing fluid intake helps to flush out the bladder, but caffeinated, carbonated, or alcoholic beverages are discouraged, because they may irritate the bladder lining. Signs of infection, such as **fever**, chills, **low back pain**, or persistent blood in the urine, should be reported to the examining physician.

Risks

There is a slight risk of infection due to tearing of the urethral lining.

KEY TERMS

Detrusor—Muscle of the bladder wall.

Sphincter—Ring of muscle between the bladder and the urethra that functions to close off the urethra.

Urethra—Tube that empties urine from the bladder to the exterior of the body.

Normal results

The normal bladder should not begin contractions during filling and should initially expand without resistance. A feeling of fullness occurs with a volume of 100–200 ml. The adult bladder capacity is 300–500 ml. The sphincter should relax and open when the patient wills it, accompanied by detrusor contractions. During voiding, detrusor contraction should be smooth and lead to a steady urine stream.

Abnormal results

Inability of the bladder to relax during filling, or low bladder volume, may indicate interstitial **cystitis**, prostate enlargement, or **bladder cancer**. Contraction of the bladder during filling may be due to irritation from infection or cysts, obstruction of the bladder outlet, or neurological disease such as **stroke**, **multiple sclerosis**, or **spinal cord injury**. Diminished sensation may occur with nerve lesions, **peripheral neuropathy**, or chronic overfilling.

Resources

BOOKS

Lamm D. L., A. S. Paola, and F. A. Paola. *Campbell's Urology: Review and Assessment*. W. B. Saunders Co., 1995.

OTHER

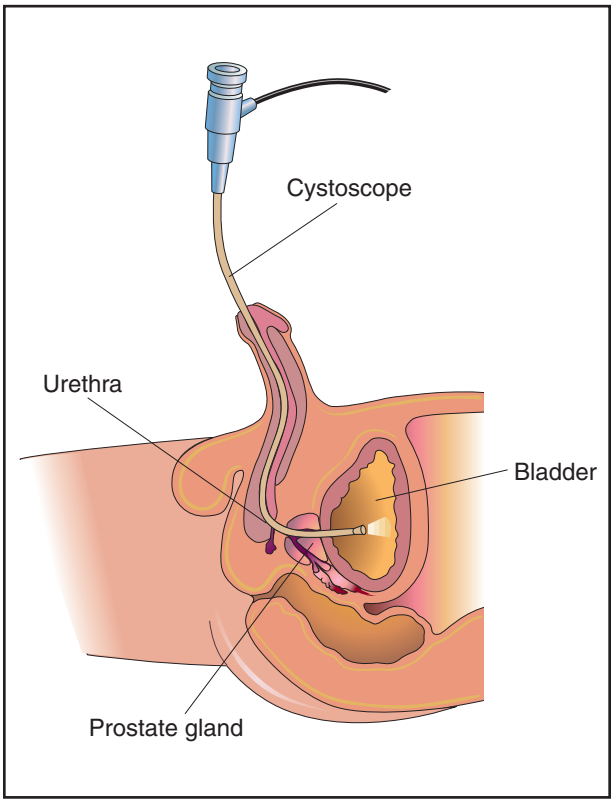
"Cystometrogram, Simple and Complex." *HealthGate Page*. <http://www.healthgate.com/HealthGate/free/dph/static/dph.0085.shtml>.

Richard Robinson

Cystoscopy

Definition

Cystoscopy (cystourethroscopy) is a diagnostic procedure that is used to look at the bladder (lower urinary



Cystoscopy is a diagnostic procedure which is used to view the bladder, collect urine samples, and examine the prostate gland. This procedure also enables biopsies to be taken. The primary instrument used in cystoscopy is the cystoscope, a tube which is inserted through the penis into the urethra, and ultimately into the bladder. *(Illustration by Electronic Illustrators Group.)*

tract), collect urine samples, and examine the prostate gland. Performed with an optic instrument known as a cystoscope (urethroscope), this instrument uses a lighted tip for guidance to aid in diagnosing urinary tract disease and prostate disease. Performed by a urologist, this surgical test also enables biopsies to be taken or small stones to be removed by way of a hollow channel in the cystoscope.

Purpose

Categorized as an endoscopic procedure, cystoscopy is used by urologists to examine the entire bladder lining and take biopsies of any areas that look questionable. This test is not used on a routine basis, but may benefit the urologist who is needing further information about a patient who displays the following symptoms or diagnosis:

- blood in the urine (also known as hematuria)
- incontinence or the inabililty to control urination
- a urinary tract infection
- a urinary tract which display signs of congenital abnormalities
- tumors located in the bladder
- the presence of bladder or **kidney stones**
- a stiffness or strained feeling of the urethra or ureters
- symptoms of an **enlarged prostate**

Blood and urine studies, in addition to x rays of the kidneys, ureters, and bladder, may all occur before a cystoscopy. At the time of surgery, a retrograde pyelogram may also be performed. Additional blood studies may be needed immediately following surgery.

Precautions

While the cystoscopy procedure is commonly relied upon to gather additional diagnostic information, it is an invasive surgical technique that may involve risks for certain patients. Those who are extremely overweight (obese), smoke, are recovering from a recent illness, or are treating a chronic condition may face additional risks from surgery.

Surgical risk also increases in patients who are currently using certain drugs including antihypertensives; **muscle relaxants**; tranquilizers; sleep inducers; insulin; sedatives; **beta blockers**; or cortisone. Those who use mind-altering drugs also put themselves at increased risk of complications during surgery. The following mind-altering drugs should be avoided: narcotics; psychedelics; hallucinogens; marijuana; sedatives; hypnotics; or **cocaine**.

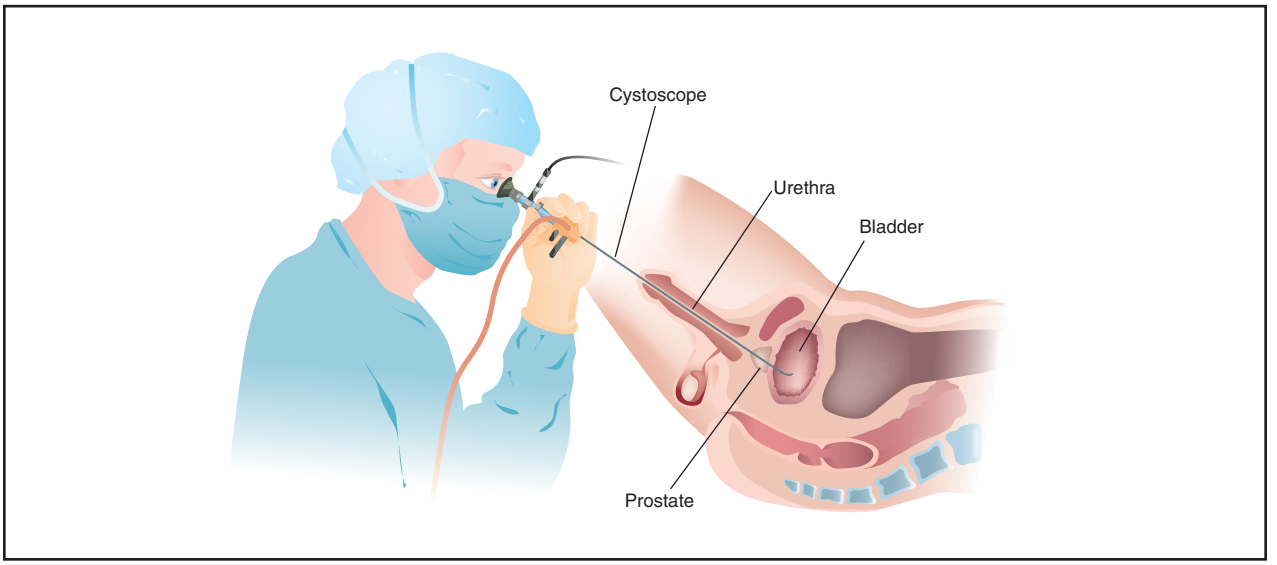
Description

Depending on the type of information needed from a cystoscopy, the procedure typically takes 10–40 minutes to complete. The patient will be asked to urinate before surgery which allows an accurate measurement of the remaining urine in the bladder. A well lubricated cystoscope is inserted through the urethra into the bladder where a urine sample is taken. Fluid is then pushed in to inflate the bladder and allow the urologist to examine the entire bladder wall.

During an examination, the urologist may take the following steps: remove either bladder or kidney stones; gather tissue samples; and treat any suspicious lesions. In order to perform x-ray studies (retrograde pyelogram), a harmless dye is injected into the ureters by way of a catheter that is passed through the previously placed cystoscope. After completion of all needed tests, the cystoscope is removed.

Preparation

As a procedure that can be completed in a hospital, doctor's office, or outpatient surgical facility, an injection



A cystoscope helps the doctor examine the urethra, bladder, and prostate. *(Illustration by Argosy Inc.)*

of spinal or general anesthesia may be used prior to a cystoscopy. While this test is typically performed on an outpatient basis, a patient may require up to three days of recovery in the hospital.

Aftercare

Patients who have undergone a cystoscopy will be instructed to follow these steps to ensure a quick recovery:

- due to soreness or discomfort that may occur in the urethra, especially while urinating, several warm baths a day are recommended to relieve any **pain**
- allow four days for recovery
- blood may appear in the urine—this is common, and soon clears up in one to two days following the procedure
- avoid strenuous **exercise** for a minimum of two weeks following surgery
- sexual relations may continue when the urologist determines that healing is complete
- wait at least two days after surgery before driving

Patients may also be prescribed pain relievers and **antibiotics** following surgery. Minor pain may also be treated with over-the-counter, non-prescription drugs such as **acetaminophen**.

Risks

As with any surgical procedure, there are some risks involved with a cystoscopy. Complications may include: profuse bleeding; a damaged urethra; a perforated bladder; a urinary tract infection; or an injured penis.

Patients should also contact their physician if they experience any of the following symptoms following surgery: pain, redness, swelling, drainage, or bleeding from the surgical site; signs of infection that may include **headache**, muscle aches, **dizziness** or an overall ill feeling and **fever**; nausea or vomiting; strenuous or painful urination; or symptoms that may result as side-effects from the medication.

Normal results

A successful cystoscopy includes a thorough examination of the bladder and collection of urine samples for cultures. If no abnormalities are seen, the results are indicated as normal.

Abnormal results

Cystoscopy allows the urologist to detect inflammation of the bladder lining, prostatic enlargement, or tumors. If these are seen, further evaluation or biopsies may be needed in addition to the removal of some tumors.

Resources

BOOKS

Buckman, Robert. "Bladder." In *What You Really Need To Know About Cancer: A Comprehensive Guide for Patients and Their Families*. Baltimore: The Johns Hopkins University Press, 1997.

Griffith, H. Winter. "Cystoscopy." In *Complete Guide To Symptoms, Illness & Surgery*. New York: Berkley Publishing Group, 1995.

KEY TERMS

Endoscopy—Examination of body organs or cavities through the use of an endoscope (a lighted optical instrument used to see inside body cavities), such as a cystoscope used to complete a cystoscopy.

Retrograde pyelogram—A pyelography or x-ray technique where radiopaque dye is injected into the kidneys from below, by way of the ureters, allowing further examination of the kidneys.

Ureter—The tube that carries urine from the kidney to the bladder, with each kidney having one ureter.

Urethra—A passageway from the bladder to the outside for the discharge of urine. In the female, this canal lies between the vagina and clitoris; in the male, the urethra travels through the penis, opening at the tip.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

"Urology." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

PERIODICALS

"RX For Enlarged Prostate: Patient Involvement." *Executive Health's Good Health Report* (Apr. 1994): 1+.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Beth A. Kapes

Cystourethroscopy *see* **Cystoscopy**

Cytomegalic inclusion disease *see* **Cytomegalovirus infection**

Cytomegalovirus antibody screening test

Definition

Cytomegalovirus (CMV) is a common human virus. Antibodies to CMV are evidence of a current or past infection.

Purpose

Consequences of a CMV infection can be devastating in a pregnant woman, a transplant patient, or a person with human **immunodeficiency** virus (HIV). Antibody screening helps control the infection risk for these groups.

In a healthy, nonpregnant person, CMV infection is almost never serious. Symptoms, if present, are mild, often resembling **infectious mononucleosis** due to Epstein-Barr virus. Antibody screening distinguishes between these two infections.

Description

When first exposed to CMV, a person's immune system is triggered and quickly makes antibodies to fight the virus. Antibodies are special proteins designed to attack and destroy foreign material, in this case, the cytomegalovirus.

The test combines a person's serum with a substance to which CMV antibodies attach. This antibody-antigen complex is measured and the amount of original antibody determined. If positive for antibodies, the serum is diluted, or titered, and the test repeated until the serum is so dilute it no longer gives a positive result. The last dilution that gives a positive result is the titer reported.

A test positive for CMV antibodies means the person has been infected with the virus, either currently or in the past; it doesn't mean the person has lifetime immunity. After an infection, this virus, like all members of the herpes virus group, can stay hidden inside a person and cause infection if the person's immune system later weakens and antibody protection decreases. In fact, reactivation of such hidden (or latent) infection is not at all uncommon and usually occurs without symptoms.

Transplant patients and people with weakened immune systems, including those with HIV, are vulnerable to infection from several routes, including from another person, from a donated organ or transfused blood, or from reactivation of a past infection. Before transplant, both the recipient and donor are usually tested for antibodies. A recipient who has never had CMV (negative for antibodies), should not receive an organ from a donor who has had CMV (positive for antibodies). CVM infection can be associated with organ rejection, or can cause illness such as **pneumonia**, hepatitis, or **death**. Similarly, blood is usually screened for CMV antibodies before being transfused into a person with a weakened immune system.

CMV infection is the most common congenital infection (existing at birth). The infection, passed from mother to baby, can cause permanent mental or physical damage, or death. The antibody screening test tells a

woman whether or not she has antibody protection against the virus in case she is exposed during **pregnancy**.

Tests that measure a specific type of antibody help tell the difference between a current and a past infection. Immunoglobulin M (IgM) antibodies appear at the beginning of an infection and last only weeks. Immunoglobulin G (IgG) antibodies appear 10–14 days later and can last a lifetime. A person suspected of having a current infection should be tested at the beginning of the infection and again 10–14 days later.

The CMV antibody screening test is also called the transplant reaction screening test. Results are usually available the following day.

Preparation

This test requires 5 mL of blood. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

A person without previous exposure to CMV will test negative.

Abnormal results

The presence of antibodies means the person has been infected with CMV, either now or in the past. An antibody titer at least four times higher at the end of the illness than at the beginning, or the presence of IgM antibodies, indicates a recent or current first time infection.

People with weak immune systems may not generate antibodies against CMV. A current infection in a transplant patient or a person with HIV is confirmed with other tests, such as viral culture.

Resources

BOOKS

American Association of Blood Banks. *Technical Manual*. 12th ed. Bethesda: American Association of Blood Banks, 1996.

Isada, Carlos M., et al. *Infectious Diseases Handbook*. Hudson: Lexi-Comp Inc., 1995.

Mayo Medical Laboratories. *Interpretive Handbook*. Rochester, MN: Mayo Medical Laboratories, 1997.

KEY TERMS

Antibody—A special protein built by the body as a defense against foreign material entering the body.

Cytomegalovirus (CMV)—A common human virus causing mild or no symptoms in healthy people, but permanent damage or death to an infected fetus, a transplant patient, or a person with HIV.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

PERIODICALS

Laliberte, Kimberly A. "CMV Screening: Interpreting the Test Result." *Advance for Medical Laboratory Professionals* (14 July 1997): 12-13, 17.

Nancy J. Nordenson

Cytomegalovirus infection

Definition

Cytomegalovirus (CMV) is a virus related to the group of herpes viruses. Infection with CMV can cause no symptoms, or can be the source of serious illness in people with weak immune systems. CMV infection is also an important cause of **birth defects**.

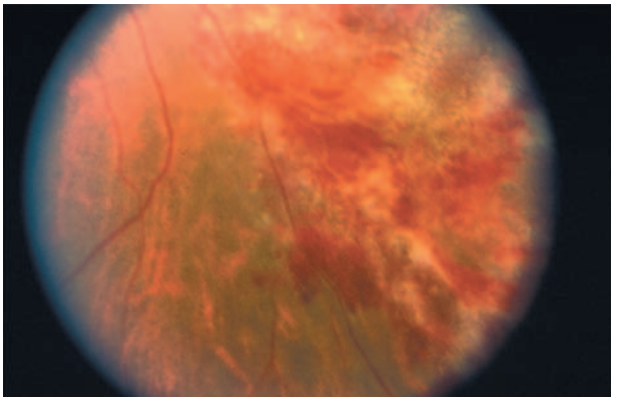
Description

CMV is an extremely common organism worldwide. It is believed that about 85% of the adult population in the United States have been infected by CMV at some point in their lives. CMV is found in almost all of the body's organs. It is also found in body fluids, including semen, saliva, urine, feces, breast milk, blood, and secretions of the cervix (the narrow, lower section of the uterus).

CMV is also able to cross the placenta (the organ that provides oxygen and nutrients to the unborn baby in the uterus). Because CMV can cross the placental barrier, initial infection in a pregnant woman can lead to infection of the developing baby.

Causes and symptoms

CMV is passed between people through contact with body fluids. CMV can also be passed on through sexual



An infected retina of an AIDS patient. Cytomegaloviruses are herpes viruses that can, among other problems, act as opportunistic infectious agents in suppressed immune systems, a common problem with AIDS sufferers. *(Custom Medical Stock Photo. Reproduced by permission.)*

contact. Babies can be born infected with CMV, either becoming infected in the uterus (congenital infection) or during birth (from infected cervical secretions).

Like other herpes viruses, CMV remains inactive (dormant) within the body for life after the initial infection. Some of the more serious types of CMV infections occur in people who have been harboring the dormant virus, only to have it reactivate when their immune system is stressed. Immune systems may be weakened because of **cancer chemotherapy**, medications given after organ transplantation, or diseases that significantly lower immune resistance like acquired **immunodeficiency** syndrome (**AIDS**).

In a healthy person, initial CMV infection often occurs without symptoms and is rarely noticed. Occasionally, a first-time infection with CMV may cause a mild illness called mononucleosis. Symptoms include swollen glands, liver, and spleen; **fever**; increased white blood cells; **headache**; **fatigue**; and **sore throat**. About 8% of all mononucleosis cases are due to CMV infection. A similar infection, though slightly more serious, may occur two to four weeks after receiving a blood **transfusion** containing CMV.

In people with weakened immune systems, CMV infection can cause more serious and potentially life-threatening illnesses. These illnesses include **pneumonia**, and inflammations of the liver (hepatitis), brain (**encephalitis**), esophagus (esophagitis), large intestine (colitis), and retina of the eye (retinitis).

Babies who contract CMV from their mothers during birth rarely develop any illness from these infections. Infants born prematurely who become CMV infected during birth have a greater chance of complications, including pneumonia, hepatitis, and decreased blood platelets.

However, an unborn baby is at great risk for serious problems when the mother becomes infected with CMV for the first time while pregnant. About 10% of these babies will be born with obvious problems, including **prematurity**, lung problems, an enlarged liver and spleen, **jaundice**, anemia, low birth weight, small head size, and inflammation of the retina. About 90% of these babies may appear perfectly normal at birth. Unfortunately, about 20% of these babies will later develop severe hearing impairments and **mental retardation**.

Diagnosis

Body fluids or tissues can be tested to reveal CMV infection. However, this information is not always particularly helpful because CMV stays dormant in the cells for life. Tests to look for special immune cells (antibodies) directed specifically against CMV are useful in proving that a person has been infected with CMV. However, these tests do not give any information regarding when the CMV infection first occurred.

Treatment

Ganciclovir and foscarnet are both antiviral medications that have been used to treat patients with weak immune systems who develop a serious illness from CMV (including retinitis). As of 1998, research is still being done to try to find useful drugs to treat newborn babies suffering from congenital infection with CMV. **Antiviral drugs** are not used to treat CMV infection in otherwise healthy patients because the drugs have significant side effects that outweigh their benefits.

Prognosis

Prognosis in healthy people with CMV infection is excellent. About 0.1% of all newborn babies will have serious damage from CMV infection occurring while they were developing in the uterus. About 50% of all transplant patients will develop severe illnesses due to reactivation of dormant CMV infection. These illnesses have a high rate of serious complications and **death**.

Prevention

Prevention of CMV infection in the normal, healthy person involves good handwashing. Blood products can be screened or treated to insure that they do not contain CMV.

Resources

BOOKS

Corey, Lawrence. "Herpesviruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Hirsch, Martin S. "Cytomegalovirus and Human Herpesvirus Types 6, 7, and 8." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Arribas, J. R., et al. "Cytomegalovirus Encephalitis." *AIDS Weekly Plus* (4 Nov. 1996): 30.

Plis, Michael A., and Henry Masur. "Promising New Treatments for Cytomegalovirus Retinitis." *Journal of the American Medical Association* 273, no. 18 (10 May 1995): 1457+.

Shelton, Brenda K. "Understanding Cytomegalovirus Infection." *Nursing* 25, no. 1 (Jan. 1995): 32.

ORGANIZATIONS

Baylor College of Medicine. 1 Baylor Plaza, Houston, TX 77030. (713) 798-4951. <http://public.bcm.tmc.edu>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

Rosalyn Carson-DeWitt, MD

D

D & C *see* **Dilatation and curettage**

Dacryocystitis

Definition

Dacryocystitis is an inflammation of the tear sac (lacrimal sac) at the inner corner of the eye.

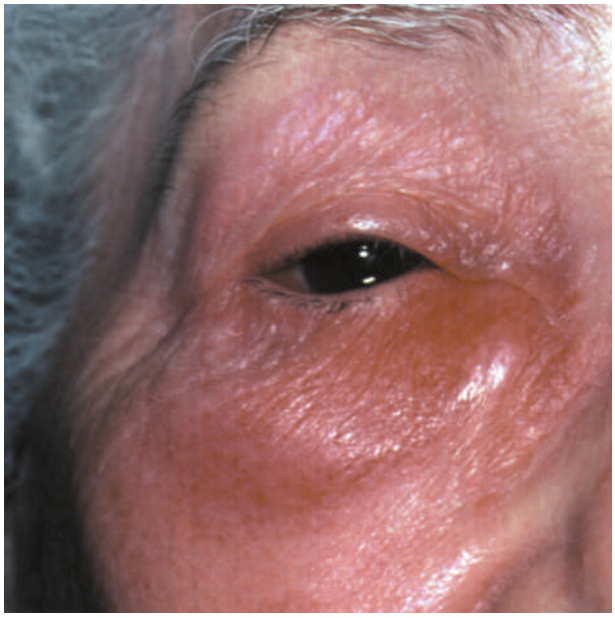
Description

Tears drain into little openings (puncta) in the inner corners of the eyelids. From there, the tears travel through little tube-like structures (canaliculi) to the lacrimal sac. The nasolacrimal ducts then take the tears from the lacrimal sac to the nose. That's why people need to blow their nose when they cry a lot.

Dacryocystitis is usually caused by a blockage of the nasolacrimal duct, which allows fluid to drain into the nasal passages. When the lacrimal sac does not drain, bacteria can grow in the trapped fluid. This condition is most common in infants and people over 40 years old.

Causes and symptoms

In newborn infants, the nasolacrimal duct may fail to form an opening—a condition called dacryostenosis. The cause of dacryocystitis in adults is usually associated with inflammation and infection in the nasal region. Dacryocystitis can be acute, having a sudden onset, or it can be chronic, with symptoms occurring over the course of weeks or months. Symptoms of acute dacryocystitis can include **pain**, redness, tearing, and swelling at the inner corner of the eye by the nose. In chronic dacryocystitis, the eye area may be swollen, watery or teary, and, when pressure is applied to the area, there may be a discharge of pus or mucus through the punctum.



Dacryocystitis of the right eye. The inner corner of the lower lid is bulging from an inflamed tear sac. Blockage of the tear duct causes fluid to be trapped in the tear sac, which becomes infected. *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

Dacryocystitis usually occurs in only one eye. As mentioned, the symptoms can range from watery eyes, pain, swelling, and redness to a discharge of pus when pressure is applied to the area between the bridge of the nose and the inner eyelids. A sample of the pus may be collected on a swab or in a tube for laboratory analysis. The type of antibiotic and treatment may depend on which bacteria is present. In the acute form, a blood test may reveal an elevated white blood cell (WBC) count; with a chronic infection, the WBC count is usually normal. To identify the exact location of the blockage, an x ray can be taken after a dye is injected into the duct in a procedure called dacryocystography.

KEY TERMS

Canaliculi—Also known as lacrimal ducts, these tube-like structures carry the tears from the eyes to the lacrimal sac.

Cannula— A narrow tube that can be inserted into a duct.

Dacryocystography—An x ray of the tear duct after injection of a dye that is used to help locate a blockage in the duct.

Dacryocystorhinostomy—A surgical procedure to drain the tear sac into the nasal passage.

Dacryostenosis—Obstruction or narrowing of the nasolacrimal duct. May be present at birth.

Nasoacrimal duct—The tube that carries the tears from the lacrimal sac to the nose.

Punctum—Tiny opening at the inner corners of the upper and lower lids. The area for the beginning of tear drainage.

Treatment

A warm compress applied to the area can help relieve pain and promote drainage. Topical and oral **antibiotics** may be prescribed if an infection is present. Intravenous antibiotics may be needed if the infection is severe. In some cases, a tiny tube (cannula) is inserted into the tear duct which is then flushed with a sterile salt water solution (sterile saline). If other treatments fail to clear up the symptoms, surgery (dacryocystorhinostomy) to drain the lacrimal sac into the nasal cavity can be performed. In extreme cases, the lacrimal sac will be removed completely.

In infants, gentle massage of the lacrimal sac four times daily for up to nine months can drain the sac and sometimes clear a blockage. As the infant grows, the duct may open by itself. If the duct does not open, it may need to be dilated with a minor surgical procedure.

Prognosis

Treatment of dacryocystitis with antibiotics is usually successful in clearing the infection that is present. If there is a permanent blockage that prevents drainage, infection may recur and surgery may be required to open the duct. If left untreated, the infected sac can rupture, forming an open, draining sore.

Prevention

There are no specific recommendations for the prevention of dacryocystitis; however, good hygiene may decrease the chances of infection.

Resources

BOOKS

"Lacrimal Apparatus." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Eckman, Margaret, and Nancy Priff, eds. "Disorders of the Eyelids and Lacrimal Ducts." In *Diseases.* 2nd ed. Springhouse, PA: Springhouse Corporation, 1997.

Gorbach, Sherwood L., John G. Bartlett, and Neil R. Blacklow, eds. "Dacryocystitis." In *Infectious Diseases.* 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

"Dacryocystitis." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Altha Roberts Edgren

Dandruff *see* **Seborrheic dermatitis**

Death

Definition

Death is defined as the cessation of all vital functions of the body including the heartbeat, brain activity (including the brain stem), and breathing.

Description

Death comes in many forms, whether it be expected after a diagnosis of terminal illness or an unexpected accident or medical condition.

Terminal illness

When a terminal illness is diagnosed, a person, family, friends, and physicians are all able to prepare for the impending death. A terminally ill individual goes through several levels of emotional acceptance while in the process of dying. First, there is denial and **isolation**. This is followed by anger and resentment. Thirdly, a person tries to escape the inevitable. With the realization that death is eminent, most people suffer from depression. Lastly, the reality of death is realized and accepted.

Causes and symptoms

As of 2001, the two leading causes of death for both men and women in the United States were heart disease and **cancer**. Accidental death was a distant third followed by such problems as **stroke**, chronic lung disorders, **pneumonia**, suicide, **cirrhosis**, **diabetes mellitus**, and murder. The order of these causes of death varies among persons of different age, ethnicity, and gender.

Diagnosis

In an age of organ transplantation, identifying the moment of death may now involve another life. It thereby takes on supreme legal importance. It is largely due to the need for transplant organs that death has been so precisely defined.

The official signs of death include the following:

- no pupil reaction to light
- no response of the eyes to caloric (warm or cold) stimulation
- no jaw reflex (the jaw will react like the knee if hit with a reflex hammer)
- no gag reflex (touching the back of the throat induces vomiting)
- no response to **pain**
- no breathing
- a body temperature above 86°F (30°C), which eliminates the possibility of resuscitation following cold-water drowning
- no other cause for the above, such as a **head injury**
- no drugs present in the body that could cause apparent death
- all of the above for 12 hours
- all of the above for six hours and a flat-line electroencephalogram (brain wave study)
- no blood circulating to the brain, as demonstrated by **angiography**

Current ability to resuscitate people who have "died" has produced some remarkable stories. Drowning in cold water (under 50°F/10°C) so effectively slows metabolism that some persons have been revived after a half hour under water.

Treatment

Only recently has there been concerted public effort to address the care of the dying in an effort to improve their comfort and lessen their alienation from those still living. Hospice care represents one of the greatest advances made in this direction. There has also been a liberalization of the use of narcotics and other drugs for symptomatic relief and improvement in the quality of life for the dying.

Living will

One of the most difficult issues surrounding death in the era of technology is that there is now a choice, not of the event itself, but of its timing. When to die, and more often, when to let a loved one die, is coming within people's power to determine. This is both a blessing and a dilemma. Insofar as the decision can be made

ELISABETH KÜBLER-ROSS (1926–)

Contemporary physician who has become a world authority on the subject of death and after-death states. Born in Switzerland on July 8, 1926, she worked as a country doctor before moving to the United States. During World War II she spent weekends at the Kantonspital (Cantonai Hospital) in Zürich, where she volunteered to assist escaped refugees. After the war she visited Majdanek concentration camp, where the horrors of the death chambers stimulated in her a desire to help people facing death and to understand the human impulses of love and destruction. She extended her medical background by becoming a practicing psychiatrist. Her formal work with dying patients began in 1965 when she was a faculty member at the University of Chicago. She also conducted research on basic questions concerning life after death at the Manhattan State Hospital, New York. Her studies of death and dying have involved accounts by patients who reported out-of-the-body travel. Her research tends to show that while dying can be painful, death itself is a peaceful condition. Her 1969 text, *On Death and Dying*, was hailed by her colleagues and also became a popular best-seller.

In 1978 Kübler-Ross helped to found Shanti Nilaya (Final Home of Peace), a healing and growth center in Escondido, California. This was an extension of her well-known "Life-Death and Transition" workshops conducted in various parts of the United States and Canada, involving physicians, nurses, social workers, laypeople, and terminally ill patients. Much of Kübler-Ross's later research was directed toward proving the existence of life after death. Her publication *To Live Until We Say Good-bye* (1979) was both praised as a "celebration of life" and criticized as "prettifying" the real situation. She has also dealt with issues such as AIDS and "near death" experiences. In the mid-1980s Shanti Nilaya moved from San Diego County, California, to Head Waters, Virginia, where it continues to offer courses and short- and long-term therapeutic sessions.

KEY TERMS

Angiography—X rays of blood vessels filled with a contrast agent.

Caloric testing—Flushing warm and cold water into the ear stimulates the labyrinth and causes vertigo and nystagmus if all the nerve pathways are intact.

Electroencephalogram —Recording of electrical activity in the brain.

Hospice—Systematized care of dying persons.

Living will—A legal document detailing a person's wishes during the end of life, to be carried out by designated decision makers.

Stroke—Interruption of blood flow to a part of the brain with consequent brain damage, also known as a cerebrovascular accident (CVA).

ahead of time, a living will is an attempt to address this dilemma. By outlining the conditions under which one would rather be allowed to die, a person can contribute significantly to that final decision, even if not competent to do so at the time of actual death. The problem is that there are uncertainties surrounding every severely ill person. Each instance presents a greater or lesser chance of survival. The chance is often greater than zero. The best living will follows an intimate discussion with decision makers covering the many possible scenarios surrounding the end of life. This discussion is difficult, for few people like to contemplate their own demise. However, the benefits of a living will are substantial, both to physicians and to loved ones who are faced with making final decisions. Most states have passed living will laws, honoring instructions on artificial **life support** that were made while a person was still mentally competent.

Euthanasia

Another issue that has received much attention is assisted suicide (euthanasia). In 1997, the State of Oregon placed the issue on the ballot, amid much consternation and dispute. Perhaps the main reason euthanasia has become front page news is because Dr. Jack Kevorkian, a pathologist from Michigan, is one of its most vocal advocates. The issue highlights the many new problems generated by increasing ability to intervene effectively in the final moments of life and unnaturally prolong the process of dying. The public appearance of euthanasia has also stimulated discussion about more compassionate care of the dying.

Prevention

Autopsy after death is a way to precisely determine a cause of death. The word autopsy is derived from Greek meaning to see with one's own eyes. A pathologist extensively examines a body and submits a detailed report to an attending physician. Although an autopsy can do nothing for an individual after death, it can benefit the family and, in some cases, medical science. Hereditary disorders and disease may be found. This knowledge could be used to prevent illness in other family members. Information culled from an autopsy can be used to further medical research. The link between **smoking** and lung cancer was confirmed from data gathered through autopsy. Early information about **AIDS** was also compiled through autopsy reports.

Resources

BOOKS

Finkbeiner, J. *Autopsy: A Manual & Atlas*. Philadelphia: Saunders, 2001.

Iserson, Kenneth B. *Death to Dust: What Happens to Dead Bodies?* Tucson: Galen Press Ltd, 2001.

Kubler-Ross, Elisabeth. *Death Is of Vital Importance*. Tarrytown, NY: Station Hill Press, 1995.

Kubler-Ross, Elisabeth. *On Death and Dying*. New York: Collier Books, 1993.

Lo, Bernard. "Ethical Issues in Clinical Medicine." *Harrison's Principles of Internal Medicine*. 14th ed. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Mount, Balfour M. "Care of Dying Patients and Their Families." In *Cecil Textbook of Medicine*. 21st ed. Ed. Lee Goldman, et al. Philadelphia: W. B. Saunders, 2000.

Sheaff, Michael T., and Deborah J. Hopster. *Post Mortem Technique Handbook*. New York: Springer Verlag, 2001.

PERIODICALS

Barone, F. C., et al. "Brain Cooling During Transient Focal Ischemia Provides Complete Neuroprotection." *Neuroscience and Biobehavioral Reviews* 21 (1997): 31-44.

Dobell, A. R., and J. S. Bailey. "Charles Drew and the Origins of Deep Hypothermic Circulatory Arrest." *Annals of Thoracic Surgery* 63 (1997): 1193-1199.

Roger, V. L., et al. "Time Trends in the Prevalence of Atherosclerosis: A Population-based Autopsy Study." *American Journal of Medicine* 110, no. 4 (2001): 267-273.

Targonski, P., et al. "Referral to Autopsy: Effect of Atemortem Cardiovascular Disease. A Population-based Study in Olmsted County, Minnesota." *Annals of Epidemiology* 11, no. 4 (2001): 264-270.

ORGANIZATIONS

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000. <http://www.aafp.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http://www.ama-assn.org>.

American Society of Clinical Pathologists. 2100 West Harrison Street, Chicago, IL 60612. (312) 738-1336. <http://www.ascp.org/index.asp>.
College of American Pathologists. 325 Waukegan Road, Northfield, IL 60093. (800) 323-4040. <http://www.cap.org>.
Hospice Foundation of America. 2001 S St. NW Suite 300, Washington, DC 20009. (800) 854-3402. <http://www.hospicefoundation.org>.

OTHER

American Association of Retired Persons. <http://www.aarp.org>.
Association for Death Education and Counseling. <http://www. adec.org>.
Death and Dying Grief Support. <http://www.death-dying.com>.
National Center for Health Statistics. <http://www.cdc.gov/nchs>.

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Debridement

Definition

Debridement is the process of removing non-living tissue from pressure ulcers, **burns**, and other **wounds**.

Purpose

Debridement speeds the healing of pressure ulcers, burns, and other wounds. Wounds that contain non-living (necrotic) tissue take longer to heal. The necrotic tissue may become colonized with bacteria, producing an unpleasant odor. Though the wound is not necessarily infected, the bacteria can cause inflammation and strain the body's ability to fight infection. Necrotic tissue may also hide pockets of pus called abscesses. Abscesses can develop into a general infection that may lead to **amputation** or **death**.

Precautions

Not all wounds need debridement. Sometimes it is better to leave a hardened crust of dead tissue, called an eschar, than to remove it and create an open wound, particularly if the crust is stable and the wound is not inflamed. Before performing debridement, the physician will take a medical history with attention to factors that might complicate healing, such as medications being taken and **smoking**. The physician will also note the cause of the wound and the ways it has been treated. Some ulcers and other wounds occur in places where blood flow is impaired, for example, the foot ulcers that can accompany **diabetes mellitus**. In such cases, the physician or nurse may decide not to debride the wound because blood flow may be insufficient for proper healing.

Description

In debridement, dead tissue is removed so that the remaining living tissue can adequately heal. Dead tissue exposed to the air will form a hard black crust, called an eschar. Deeper tissue will remain moist and may appear white, or yellow and soft, or flimsy. The four major debridement techniques are surgical, mechanical, chemical, and autolytic.

Surgical debridement

Surgical debridement (also known as sharp debridement) uses a scalpel, scissors, or other instrument to cut dead tissue from a wound. It is the quickest and most efficient method of debridement. It is the preferred method if there is rapidly developing inflammation of the body's connective tissues (**cellulitis**) or a more generalized infection (**sepsis**) that has entered the bloodstream. The procedure can be performed at a patient's bedside. If the target tissue is deep or close to another organ, however, or if the patient is experiencing extreme **pain**, the procedure may be done in an operating room. Surgical debridement is generally performed by a physician, but in some areas of the country an advance practice nurse or physician assistant may perform the procedure.

The physician will begin by flushing the area with a saline (salt water) solution, and then will apply a topical anesthetic gel to the edges of the wound to minimize pain. Using a forceps to grip the dead tissue, the physician will cut it away bit by bit with a scalpel or scissors. Sometimes it is necessary to leave some dead tissue behind rather than disturb living tissue. The physician may repeat the process again at another session.

Mechanical debridement

In mechanical debridement, a saline-moistened dressing is allowed to dry overnight and adhere to the dead tissue. When the dressing is removed, the dead tissue is pulled away too. This process is one of the oldest methods of debridement. It can be very painful because the dressing can adhere to living as well as nonliving tissue. Because mechanical debridement cannot select between good and bad tissue, it is an unacceptable debridement method for clean wounds where a new layer of healing cells is already developing.

Chemical debridement

Chemical debridement makes use of certain enzymes and other compounds to dissolve necrotic tissue. It is more

KEY TERMS

Eschar—A hardened black crust of dead tissue that may form over a wound.

Pressure ulcer—Also known as a decubitus ulcer, pressure ulcers are open wounds that form whenever prolonged pressure is applied to skin covering bony outcrops of the body. Patients who are bedridden are at risk of developing pressure ulcers. Pressure ulcers are commonly known as bedsores.

Sepsis—A severe systemic infection in which bacteria have entered the blood stream.

selective than mechanical debridement. In fact, the body makes its own enzyme, collagenase, to break down collagen, one of the major building blocks of skin. A pharmaceutical version of collagenase is available and is highly effective as a debridement agent. As with other debridement techniques, the area first is flushed with saline. Any crust of dead tissue is etched in a cross-hatched pattern to allow the enzyme to penetrate. A topical antibiotic is also applied to prevent introducing infection into the bloodstream. A moist dressing is then placed over the wound.

Autolytic debridement

Autolytic debridement takes advantage of the body's own ability to dissolve dead tissue. The key to the technique is keeping the wound moist, which can be accomplished with a variety of dressings. These dressings help to trap wound fluid that contains growth factors, enzymes, and immune cells that promote wound healing. Autolytic debridement is more selective than any other debridement method, but it also takes the longest to work. It is inappropriate for wounds that have become infected.

Preparation

The physician or nurse will begin by assessing the need for debridement. The wound will be examined, frequently by inserting a gloved finger into the wound to estimate the depth of dead tissue and evaluate whether it lies close to other organs, bone, or important body features. The area may be flushed with a saline solution before debridement begins, and a topical anesthetic gel or injection may be applied if surgical or mechanical debridement is being performed.

Aftercare

After surgical debridement, the wound will be packed with a dry dressing for a day to control bleeding. Afterward, moist dressings are applied to promote wound healing. Moist dressings are also used after mechanical, chemical, and autolytic debridement. Many factors contribute to wound healing, which frequently can take considerable time. Debridement may need to be repeated.

Risks

It is possible that underlying tendons, blood vessels or other structures will be damaged during the examination of the wound and during surgical debridement. Surface bacteria may also be introduced deeper into the body, causing infection.

Normal results

Removal of dead tissue from pressure ulcers and other wounds speeds healing. Although these procedures cause some pain, they are generally well tolerated by patients and can be managed more aggressively. It is not uncommon to debride a wound again in a subsequent session.

Resources

BOOKS

Maklebust, JoAnn, and Mary Y. Sieggreen. *Pressure Ulcers: Guidelines for Prevention and Nursing Management,* 2nd ed. Springhouse, PA: Springhouse Corporation, 1996.

PERIODICALS

Bale, S. "A Guide to Wound Debridement." *Journal of Wound Care* 6 (Apr. 1997): 179-182.

Sieggreen, Mary Y., and JoAnn Maklebust. "Debridement: Choices and Challenges." *Advances in Wound Care*, 10 (Mar./Apr. 1997): 32-37.

ORGANIZATIONS

American Academy of Wound Management. 1255 23rd St., NW, Washington, DC 20037. (202) 521-0368. <http://www.aawm.org>.

Wound Care Institute. 1100 N.E. 163rd Street, Suite #101, North Miami Beach, FL 33162. (305) 919-9192. <http://woundcare.org>.

Richard H. Camer

Decompression sickness

Definition

Decompression sickness (DCS) is a dangerous and occasionally lethal condition caused by nitrogen bubbles that form in the blood and other tissues of scuba divers who surface too quickly.

Description

According to the Divers Alert Network (DAN), a worldwide organization devoted to safe-diving research and promotion, less than 1% of divers fall victim to DCS or the rarer bubble problem called **gas embolism**, air **embolism**, or arterial gas embolism (AGE). A study of the United States military community in Okinawa, where tens of thousands of sport and military dives are made each year, identified 84 DCS and 10 AGE cases in 1989–95, including nine deaths. This translated into estimates of one case in every 7,400 dives and one **death** in every 76,900 dives. DCS symptoms can be quite mild, however, and many cases certainly go unnoticed by divers.

At times the terminology adopted by writers on DCS can be confusing. Some substitute the term decompression illness (DCI) for DCS. Others treat DCI as a label encompassing both DCS and AGE. An older term for DCS is caisson disease, coined in the nineteenth century when it was discovered that bridge construction crews working at the bottom of lakes and rivers in large pressurized enclosures (caissons) were experiencing joint **pain** (a typical DCS symptom) on returning to the surface.

Causes and symptoms

The air we breathe is mostly a mixture of two gases, nitrogen (78%) and oxygen (21%). Unlike oxygen, nitrogen is a biologically inert gas, meaning that it is not metabolized (converted into other substances) by the body. For this reason, most of the nitrogen we inhale is expelled when we exhale, but some is dissolved into the blood and other tissues. During a dive, however, the lungs take in more nitrogen than usual. This happens because the surrounding water pressure is greater than the air pressure at sea level (twice as great at 33 ft [10 m], for instance). As the water pressure increases, so does the pressure of the nitrogen in the compressed air inhaled by the diver. Because increased pressure causes an increase in gas density, the diver takes in more nitrogen with each breath than he or she would at sea level. Instead of being exhaled, however, the extra nitrogen safely dissolves into the tissues, where it remains until the diver begins his or her return to the surface (under some circumstances the extra nitrogen can cause **nitrogen narcosis**, but that condition is distinct from DCS). On the way up, decompression occurs (in other words, the water pressure drops), and with the change in pressure, the extra nitrogen gradually diffuses out of the tissues and is delivered by the bloodstream to the lungs, which expel it from the body. If the diver surfaces too quickly, however, potentially dangerous nitrogen bubbles can form in the tissues and cause DCS. These bubbles can compress nerves, obstruct arteries, veins, and lymphatic vessels, and trigger harmful chemical reactions in the blood. The precise reasons for bubble formation remain unclear.

How much extra nitrogen enters the tissues varies with the dive's depth and duration. Dive tables prepared by the U.S. Navy and other organizations specify how long most divers can safely remain at a particular depth. If the dive table limits are exceeded, the diver must pause on the way up to allow the nitrogen to diffuse into the bloodstream without forming bubbles; these pauses are called decompression stops, and are carefully calibrated. DCS can occur, however, even when a diver obeys safe diving rules. In such cases, the predisposing factors include **fatigue**, **obesity**, **dehydration**, **hypothermia**, and recent alcohol use. As well, people who fly or travel to high-altitude locations without letting 12–24 hours pass after their last dive are at risk for DCS as well because their bodies undergo further decompression. This is true even when flying in commercial aircraft. Many travelers are unaware that to save money on fuel the cabin pressure in commercial aircraft is set much lower than the pressure at sea level. At 30,000 ft (9,144 m), for instance, cabin pressure is usually equivalent to the pressure at 7,000–8,000 ft (2,133–2,438 m) above sea level, a safe setting for everyone but recent divers. Exactly how long a diver should wait before flying or traveling to a high-altitude location depends on how much diving he or she has done and other considerations. If there is uncertainty about the appropriate waiting period, the sensible course of action is to let the full 24 hours pass.

Because the nitrogen bubbles that cause DCS can affect any of the body's tissues, including the blood, bones, nerves, and muscles, many kinds of symptoms are possible. Symptoms can appear minutes after a diver surfaces, and in about 80% of cases do so within eight hours. Pain is often the only symptom; this is sometimes called the bends, although many people incorrectly use that term as a synonym for DCS itself. The pain, which ranges from mild to severe, is usually limited to the joints, but can be felt anywhere. Severe **itching** (pruritis), skin **rashes**, and skin mottling (cutis marmorata) are other possible symptoms. All of these are sometimes classified as manifestations of type 1 or "mild" DCS. type 2 or "serious" DCS can lead, among other things, to **paralysis**, brain damage, heart attacks, and death. Many DCS victims, however, experience both type 1 and type 2 symptoms.

Diagnosis

Diagnosis requires taking a medical history (questioning the patient about his or her health and recent activities) and conducting a **physical examination**.

KEY TERMS

Gas embolism—The presence of a gas bubble in the bloodstream that obstructs circulation.

Hyperbaric chamber—A sealed compartment in which air pressure is gradually increased and then gradually decreased, allowing nitrogen bubbles to shrink and the nitrogen to safely diffuse out of body tissue.

Lymphatic vessels—Vessels that carry a fluid called lymph from the tissues to the bloodstream.

Nitrogen narcosis—Also called "rapture of the deep," the condition is caused by increased nitrogen pressure at depth and is characterized by symptoms similar to alcohol intoxication.

Treatment

DCS is treated by giving the patient oxygen and placing him or her in a hyperbaric chamber, an enclosure in which the air pressure is first gradually increased and then gradually decreased. This shrinks the bubbles and allows the nitrogen to safely diffuse out of the tissues. Hyperbaric chamber facilities exist throughout the United States. No matter how mild one's symptoms may appear, immediate transportation to a facility is essential. Treatment is necessary even if the symptoms clear up before the facility is reached, because bubbles may still be in the bloodstream and pose a threat. DAN maintains a list of facilities and a 24-hour hotline that can provide advice on handling DCS and other diving emergencies.

Prognosis

DCS sufferers who undergo chamber treatment within a few hours of symptom onset usually enjoy a full recovery. If treatment is delayed the consequences are less predictable, although many people have been helped even after several days have passed. A 1992 DAN report on diving accidents indicated that full recovery following chamber treatment was immediate for about 50% of divers. Some people, however, suffer numbness, tingling, or other symptoms that last weeks, months, or even a lifetime. In the Okinawa study, six of the 94 patients experienced "long-lasting" symptoms even after repeated chamber treatments.

Prevention

The obvious way to minimize the risk of falling victim to DCS is to follow the rules on safe diving and air travel after a dive. People who are obese, suffer from lung or heart problems, or are otherwise in poor health should not dive. And because the effect of nitrogen diffusion on the fetus remains unknown, diving while pregnant is not recommended.

Resources

BOOKS

Martin, Lawrence. *Scuba Diving Explained: Questions and Answers on Physiology and Medical Aspects of Scuba Diving*. Flagstaff, AZ: Best Publishing, 1997.

Piantadosi, Claude A. "Physical, Chemical, and Aspiration Injuries of the Lung." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Arness, Mark K. "Scuba Decompression Illness and Diving Fatalities in an Overseas Military Community." *Aviation, Space, and Environmental Medicine* (Apr. 1997): 325-333.

Clenney, Timothy L., and Lorenz F. Lassen. "Recreational Scuba Diving Injuries." *American Family Physician* (Apr. 1996): 1761+.

ORGANIZATIONS

American College of Hyperbaric Medicine. P.O. Box 25914-130, Houston, Texas 77265. (713) 528-0657. <http://www.hyperbaricmedicine.org>.

Divers Alert Network. The Peter B. Bennett Center, 6 West Colony Place, Durham, NC 27705. (800) 446-2671. <http://www.diversalertnetwork.org>.

Undersea and Hyperbaric Medical Society. 10531 Metropolitan Ave., Kensington, MD 20895. (301) 942-2980. <http://www.uhms.org>.

Howard Baker

Decongestants

Definition

Decongestants are medicines used to relieve nasal congestion (stuffy nose).

Purpose

A congested or stuffy nose is a common symptom of colds and **allergies**. This congestion results when membranes lining the nose become swollen. Decongestants relieve the swelling by narrowing the blood vessels that supply the nose. This reduces the blood supply to the swollen membranes, causing the membranes to shrink.

These medicines do not cure colds or reverse the effects of histamines—chemicals released as part of the

allergic reaction. They will not relieve all of the symptoms associated with colds and allergies, only the stuffiness.

When considering whether to use a decongestant for cold symptoms, keep in mind that most colds go away with or without treatment and that taking medicine is not the only way to relieve a stuffy nose. Drinking hot tea or broth or eating chicken soup may help. There are also adhesive strips can be placed on the nose to help widen the nasal passages, making breathing through the nasal passages a bit easier when congestion is present.

Precautions

Decongestant nasal sprays and nose drops may cause a problem called rebound congestion if used repeatedly over several days. When this happens, the nose remains stuffy or gets worse with every dose. The only way to stop the cycle is to stop using the drug. The stuffiness should then go away within about a week. Anyone who shows signs of severe rebound congestion should also contact his or her physician.

Do not use decongestant nasal sprays for more than three days. Decongestants taken by mouth should not be used for more than seven days. If the congestion has not gone away in this time, or if the symptoms are accompanied by **fever**, call a physician.

Do not use a decongestant nasal spray after the product's expiration date. If the product has become cloudy or discolored, throw it away and do not use it. Do not share droppers or spray bottles with anyone else, as this could spread infection. Do not let droppers and bottle tips touch countertops or other surfaces.

Some decongestants cause drowsiness. People who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

In general, older people may be more sensitive to the effects of decongestants and may need to take lower doses to avoid side effects. People in this age group should not take long-acting (extended release) forms of decongestants unless they have previously taken a short-acting form with no ill effects.

Children may also be more sensitive to the effects of decongestants. Before giving any decongestant to a child, check the package label carefully. Some of these medicines are too strong for use in children. Serious side effects are possible if they are given large amounts of these drugs or if they swallow nose drops, nasal spray or eye drops. If this happens, call a physician or poison center immediately.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take decongestants. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to decongestants in the past should let his or her physician know before these drugs or any similar drugs are prescribed. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

PREGNANCY. In studies of laboratory animals, some decongestants have had unwanted effects on fetuses. However, it is not known whether such effects also occur in people. Women who are pregnant or who plan to become pregnant should check with their physicians before taking decongestants.

BREASTFEEDING. Some decongestants pass into breast milk and may have unwanted effects on nursing babies whose mothers take the drugs. Women who are breastfeeding should check with their physicians before using decongestants. If they need to take the medicine, it may be necessary to bottle feed the baby with formula while taking it.

OTHER MEDICAL CONDITIONS. Anyone with heart or blood vessel disease, high blood pressure, diabetes, **enlarged prostate**, or overactive thyroid should not take decongestants unless under a physician's supervision. The medicine can increase blood sugar in people with diabetes. It can be especially dangerous in people with high blood pressure, as it may increase blood pressure.

Before using decongestants, people with any of these medical problems should make sure their physicians are aware of their conditions:

- glaucoma
- history of mental illness

Decongestants may have a variety of side effects, and may also interact with other medications the patient is taking.

Side effects

DECONGESTANT NASAL SPRAYS AND NOSE DROPS. The most common side effects from decongestant nasal sprays and nose drops are sneezing and temporary burning, stinging, or dryness. These effects are usually temporary and do not need medical attention. If any of the following side effects occur after using a decongestant nasal spray or nose drops, stop using the medicine immediately and call the physician:

- increased blood pressure
- **headache**
- fast, slow, or fluttery heartbeat
- nervousness
- **dizziness**
- nausea
- sleep problems

DECONGESTANTS TAKEN BY MOUTH. The most common side effects of decongestants taken by mouth are nervousness, restlessness, excitability, dizziness, drowsiness, headache, nausea, weakness, and sleep problems. Anyone who has these symptoms while taking decongestants should stop taking them immediately.

Patients who have these symptoms while taking decongestants should call the physician immediately:

- increased blood pressure
- fast, irregular, or fluttery heartbeat
- severe headache
- tightness or discomfort in the chest
- breathing problems
- fear or anxiety
- **hallucinations**
- trembling or shaking
- convulsions (seizures)
- pale skin
- painful or difficult urination

Other side effects may occur. Anyone who has unusual symptoms after taking a decongestant should get in touch with his or her physician.

Interactions with other medicines

Decongestants may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Do not take decongestants at the same time as these drugs:

- Monoamine oxidase inhibitors (MAO inhibitors) such as phenzeline (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and **Parkinson's disease**. Do not take decongestants at the same time as a MAO inhibitor or within two weeks of stopping treatment with an MAO inhibitor unless a physician approves.
- Other products containing the same or other decongestants.
- Caffeine.

In addition, anyone who takes decongestants should let the physician know all other medicines he or she is taking. Among the drugs that may interact with decongestants are:

- tricyclic antidepressants such as imipramine (Tofranil) or desipramine (Norpramin)
- the antidepressant maprotiline (Ludiomil)
- amantadine (Symmetrel)
- amphetamines
- medicine to relieve **asthma** or other breathing problems
- methylphenidate (Ritalin)
- appetite suppressants
- other medicine for colds, sinus problems, hay fever or other allergies
- beta-blockers such as atenolol (Tenormin) and propranolol (Inderal)
- digitalis glycosides, used to treat heart conditions

The list above does not include every drug that may interact with decongestants. Be sure to check with a physician or pharmacist before combining decongestants with any other prescription or nonprescription (over-the-counter) medicine.

Description

Decongestants are sold in many forms, including tablets, capsules, caplets, gelcaps, liqui-caps, liquids, nasal sprays, and nose drops. These drugs are sometimes combined with other medicines in cold and allergy products designed to relieve several symptoms. Some decongestant products require a physician's prescription, but there are also many nonprescription (over-the-counter) products. Ask a physician or pharmacist about choosing an appropriate decongestant.

Commonly used decongestants include oxymetazoline (Afrin and other brands) and pseudoephedrine (Sudafed, Actifed, and other brands). The decongestant oxymetazoline is also used in some eye drops to relieve redness and **itching**.

The recommended dosage depends on the drug. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and always take the medicine exactly as directed. If using nonprescription (over-the-counter) types, follow the directions on the package label or ask a pharmacist for assistance. Never take larger or more frequent doses, and do not take the drug for longer than directed.

KEY TERMS

Fetus—A developing baby inside the womb.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Risks

Anyone considering taking a decongestant should take a close look at the labels of any already in their medicine cabinet. In 2000, the Food and Drug Administration prohibited over-the-counter sales of medicines containing the decongestant phenylpropanolamine. The medicine is associated with an increased risk of **stroke** in people ages 18 to 49, especially women. Many cold remedies contained this medicine. Contact a pharmacist if there is any question about the ingredients in a medication. Over-the-counter remedies containing phenylpropanolamine should be discarded.

Normal results

The desired result when taking decongestants is the short-term relief of nasal congestion.

Resources

PERIODICALS

"An Ingredient Under Fire: Drugmakers are Jittery After an FDA Panel Ruling." *Newsweek* (October 30, 2000): 59.

Henderson, Charles W. "Voluntary Withdrawal of Cold and Allergy Products Announced." *Medical Letter on the CDC and FDA* (November 26, 2000).

OTHER

"Medline Plus Health Information". *U.S. National Library of Medicine*. <http://www.nlm.nih.gov/medlineplus>.

Deanna M. Swartout-Corbeil, RN

Decubitus ulcers *see* **Bedsores**

Deep vein thrombosis

Definition

Deep vein thrombosis (DVT) is a blood clot in a major vein, usually in the legs and/or pelvis.

Description

Deep vein thrombosis is a common but difficult to detect illness that can be fatal if not treated effectively. According to the American Heart Association, more than two million Americans develop deep vein thrombosis annually. An estimated 600,000 of these develop **pulmonary embolism**, a potentially fatal complication where the blood clots break off and form pulmonary emboli, plugs that block the lung arteries. Sixty thousand people die of pulmonary **embolism** each year. Deep vein thrombosis is also called venous thromboembolism, **thrombophlebitis** or phlebothrombosis.

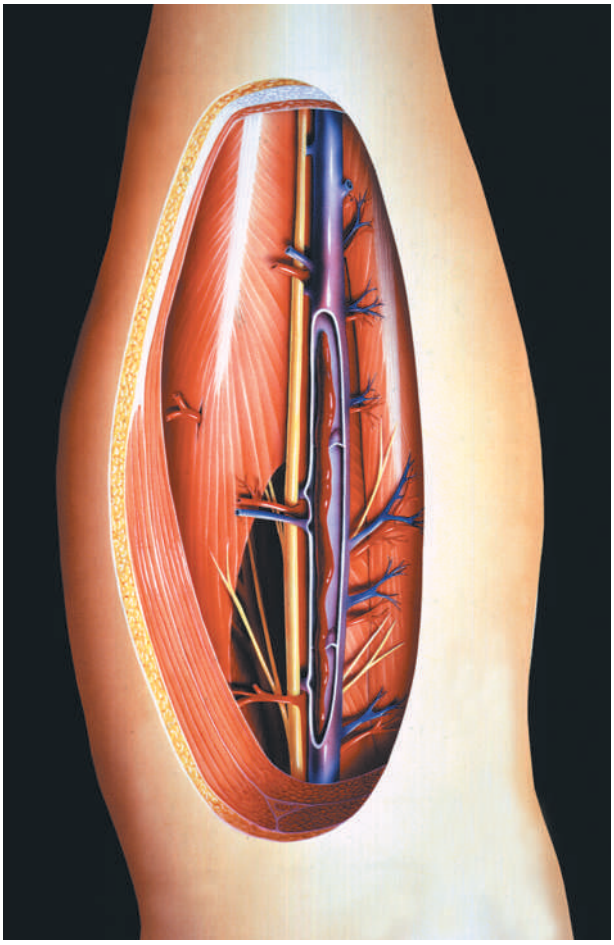
Deep vein thrombosis is a major complication in patients who have had **orthopedic surgery** or pelvic, abdominal, or **thoracic surgery**. Patients with **cancer** and other chronic illnesses (including congestive **heart failure**), as well as those who have suffered a recent myocardial infarction, are also at high risk for developing DVT. Deep vein thrombosis can be chronic, with recurrent episodes.

Causes and symptoms

Deep vein thrombosis is caused by blood clots in blood vessels that form in veins where blood flow is sluggish or has been disturbed, in pockets in the calf's deep veins, or in veins that have been traumatized. Symptoms include swelling and tenderness of the calf or thigh, and possibly warmth. Only 23–50% of patients experience symptoms, so it's often "silent." Some individuals and families have underlying clotting tendencies that can be tested for.

Diagnosis

Deep vein thrombosis can be detected through **venography** and radionuclide venography, **Doppler ultrasonography**, and impedance plethysmography. Venography is the most accurate test, but it is not used much, because it is often painful, expensive, exposes the patient to radiation, and can cause reactions and complications. Venography identifies the location, extent, and degree of attachment of the blood clots, and enables the condition of the deep leg veins to be assessed. A contrast solution is injected into a foot vein through a catheter. The physician observes the movement of the solution through the vein with a fluoroscope while a series of x rays are taken. Venography takes 30–45 minutes and can be done in a physician's office, a laboratory, or a hospital. Radionuclide venography, in which a radioactive isotope is injected, is occasionally used, especially if a patient has had reactions to contrast solutions.



This illustration features a dissected human lower leg showing clot formation (thrombosis) along the length of a vein. *(Custom Medical Stock Photo. Reproduced by permission.)*

Doppler ultrasonography is usually the preferred procedure for detecting deep vein thrombosis. This technique uses sound waves to measure blood flow through leg veins and arteries. A blood pressure cuff is wrapped around the patient's ankle and a transducer with gel on it is placed over pulse points of the foot and lower leg. High-frequency sounds bounce off the soft tissue, and the echoes are converted into images on a monitor. It is very accurate in detecting clots above the knee that can become pulmonary embolisms. Usually performed in a physician's office or hospital outpatient diagnostic center, Doppler ultrasound usually takes 30–45 minutes.

Impedance plethysmography records changes in blood volume and vessel resistance. A blood pressure cuff is wrapped around the leg above the knee, four electrodes are placed near the knee and the ankle, and the cuff is inflated. How efficiently the veins return to normal is measured. Performed in a physician's office, it takes about 15 minutes.

KEY TERMS

Pulmonary embolism —An obstruction of a blood vessel in the lungs, usually caused by a blood clot that blocks a coronary artery. Pulmonary embolism can be very serious and, in some cases, fatal.

Thrombosis—The development of a blood clot inside a blood vessel.

Treatment

Deep vein thrombosis can be treated with drug therapy, bed rest, and gradient elastic stockings. Medications include anticoagulants that "thin" blood to prevent further growth of blood clots, as well as clot-dissolving drugs. Heparin is a common injectable anticoagulant, and is usually followed by coumadin tablets for at least three months. Bed rest with the patient's legs elevated is necessary until the condition improves. Gradient elastic stockings should then be worn, and standing for long periods of time avoided. In some cases, a filter is placed in the major vein (the inferior vena cava) to trap emboli or clots before they get to the heart and lungs.

Alternative treatment

Deep vein thrombosis can be life-threatening and must be treated with conventional medical therapies. However, there are alternative therapies that can be used in conjunction with emergency treatments to dissolve the clot that help support the body and prevent recurrence. A trained alternative health care practitioner should be consulted due to the severity of this condition.

Prognosis

In many cases, deep vein thrombosis can be successfully treated if diagnosed early.

Prevention

Deep vein thrombosis can be prevented through prophylactic anticoagulant drugs and venous stasis prevention with gradient elastic stockings and intermittent pneumatic compression of the legs. High-risk patients often need to remain on anticoagulants like Coumadin indefinitely.

Resources

BOOKS

DeBakey, Michael E., and Antonio M. Gotto Jr. "Invasive Diagnostic Procedures" and "Diseases of the Vein." In *The*

New Living Heart. Holbrook, MA: Adams Media Corporation, 1997.
Texas Heart Institute. "Diseases of the Peripheral Arteries and Veins." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.
"Venous Imaging." In *Diagnostic Nuclear Medicine*. 3rd ed. Baltimore: Williams & Wilkins, 1996.
"Venous Thromboembolism." In *Mayo Clinic Practice of Cardiology*. 3rd ed. St. Louis: Mosby, 1996.

PERIODICALS

Barloon, T. J., G. R. Bergus, and J. Seabold. "Diagnostic Imaging of Lower Limb, Deep Venous Thrombosis." *American Family Physician* 56 (1 September 1997): 791-801.
Davidson, Bruce L., and Eric J. Deppert. "Ultrasound for the Diagnosis of Deep Vein Thrombosis: Where to Now?" *British Medical Journal* 316 (3 January 1998): 2.

Lori De Milto

Deer-fly fever *see* **Tularemia**

Defibrillation

Definition

Defibrillation is a process in which an electronic device sends an electric shock to the heart to stop an extremely rapid, irregular heartbeat, and restore the normal heart rhythm.

Purpose

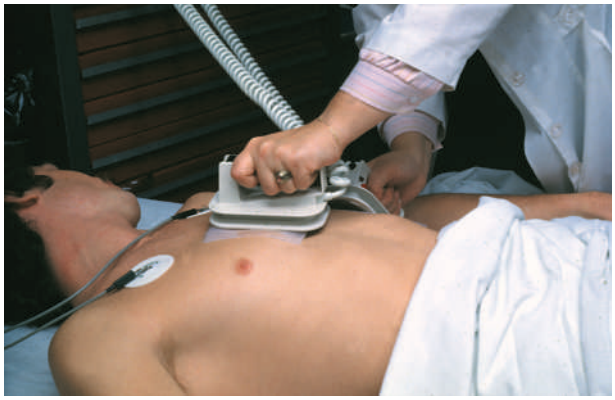
Defibrillation is performed to correct life-threatening fibrillations of the heart, which could result in cardiac arrest. It should be performed immediately after identifying that the patient is experiencing a cardiac emergency, has no pulse, and is unresponsive.

Precautions

Defibrillation should not be performed on a patient who has a pulse or is alert, as this could cause a lethal heart rhythm disturbance or cardiac arrest. The paddles used in the procedure should not be placed on a woman's breasts or over a pacemaker.

Description

Fibrillations cause the heart to stop pumping blood, leading to brain damage and/or cardiac arrest. About 10% of the ability to restart the heart is lost with every minute that the heart stays in fibrillation. **Death** can occur in minutes unless the normal heart rhythm is restored through defibrillation. Because immediate defibrillation is crucial to the patient's survival, the American Heart Association has called for the integration of defibrillation into an effective emergency cardiac care system. The system should include early access, early **cardiopulmonary resuscitation**, early defibrillation, and early advanced cardiac care.



Defibrillation by paddles. *(Photograph by Patricia Barber, RBP, Custom Medical Stock Photo. Reproduced by permission.)*

Defibrillators deliver a brief electric shock to the heart, which enables the heart's natural pacemaker to regain control and establish a normal heart rhythm. The defibrillator is an electronic device with electrocardiogram leads and paddles. During defibrillation, the paddles are placed on the patient's chest, caregivers stand back, and the electric shock is delivered. The patient's pulse and heart rhythm are continually monitored. Medications to treat possible causes of the abnormal heart rhythm may be administered. Defibrillation continues until the patient's condition stabilizes or the procedure is ordered to be discontinued.

Early defibrillators, about the size and weight of a car battery, were used primarily in ambulances and hospitals. The American Heart Association now advocates public access defibrillation; this calls for placing automated external defibrillators (AEDS) in police vehicles, airplanes, and at public events, etc. The AEDS are smaller, lighter, less expensive, and easier to use than the early defibrillators. They are computerized to provide simple, verbal instructions to the operator and to make it impossible to deliver a shock to a patient whose heart is not fibrillating. The placement of AEDs is likely to expand to many public locations.

Preparation

After help is called for, cardiopulmonary resuscitation (**CPR**) is begun and continued until the caregivers arrive and set up the defibrillator. Electrocardiogram

KEY TERMS

Cardiac arrest—A condition in which the heart stops functioning. Fibrillation can lead to cardiac arrest if not corrected quickly.

Fibrillation—Very rapid contractions or twitching of small muscle fibers in the heart.

Pacemaker—A surgically implanted electronic device that sends out electrical impulses to regulate a slow or erratic heartbeat.

leads are attached to the patient's chest. Gel or paste is applied to the defibrillator paddles, or two gel pads are placed on the patient's chest. The caregivers verify lack of a pulse, and select a charge.

Aftercare

After defibrillation, the patient's cardiac status, breathing, and vital signs are monitored until he or she is stable. Typically, this monitoring takes place after the patient has been removed to an intensive care or cardiac care unit in a hospital. An electrocardiogram and **chest x ray** are taken. The patient's skin is cleansed to remove gel or paste, and, if necessary, ointment is applied to **burns**. An intravenous line provides additional medication, as needed.

Risks

Skin burns from the defibrillator paddles are the most common complication of defibrillation. Other risks include injury to the heart muscle, abnormal heart rhythms, and blood clots.

Resources

BOOKS

Giuliani, E. R., et. al., eds. "Arrhythmias." In *Mayo Clinic Practice of Cardiology.* 3rd ed. Ed. E.R. Giuliani. St. Louis: Mosby, 1996.

PERIODICALS

Matarese, Leonard. "Police and AEDS: A Chance to Save Thousands of Lives Each Year." *Public Management* 79 (June 1997): 4.

"Medical Breakthroughs That Could Save Your Life." *Body Bulletin* (Feb. 1998): 1.

"Upping the Odds of Survival." *Hospitals and Health Networks* 71 (5 June 1997): 13.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

OTHER

"AARC Clinical Practice Guideline: Defibrillation During Resuscitation." *American Association of Respiratory Care*. 29 Apr. 1998 <http://www.hsc.missouri.edu/~shrp/rtwww/rcweb/aarc/ddrcpg.html>.

"Defibrillation." *American Heart Association.* 1997. 9 Apr. 1998 <http://www.americanheart.org>.

Lori De Milto

Definitive cancer therapy *see* **Cancer therapy, definitive**

Degenerative arthritis *see* **Osteoarthritis**

Dehydration

Definition

Dehydration is the loss of water and salts essential for normal body function.

Description

Dehydration occurs when the body loses more fluid than it takes in. This condition can result from illness; a hot, dry climate; prolonged exposure to sun or high temperatures; not drinking enough water; and overuse of **diuretics** or other medications that increase urination. Dehydration can upset the delicate fluid-salt balance needed to maintain healthy cells and tissues.

Water accounts for about 60% of a man's body weight. It represents about 50% of a woman's weight. Young and middle-aged adults who drink when they're thirsty do not generally have to do anything more to maintain their body's fluid balance. Children need more water because they expend more energy, but most children who drink when they are thirsty get as much water as their systems require.

Age and dehydration

Adults over the age of 60 who drink only when they are thirsty probably get only about 90% of the fluid they need. Developing a habit of drinking only in response to the body's thirst signals raises an older person's risk of becoming dehydrated. Seniors who have relocated to areas where the weather is warmer or dryer than the climate they are accustomed to are even likelier to become dehydrated unless they make it a practice to drink even when they are not thirsty.

Dehydration in children usually results from losing large amounts of fluid and not drinking enough water to replace the loss. This condition generally occurs in children who have stomach flu characterized by vomiting and **diarrhea**, or who can not or will not take enough fluids to compensate for excessive losses associated with **fever** and sweating of acute illness. An infant can become dehydrated only hours after becoming ill. Dehydration is a major cause of infant illness and **death** throughout the world.

Types of dehydration

Mild dehydration is the loss of no more than 5% of the body's fluid. Loss of 5–10% is considered moderate dehydration. Severe dehydration (loss of 10–15% of body fluids) is a life-threatening condition that requires immediate medical care.

Complications of dehydration

When the body's fluid supply is severely depleted, hypovolemic **shock** is likely to occur. This condition, which is also called physical collapse, is characterized by pale, cool, clammy skin; rapid heartbeat; and shallow breathing.

Blood pressure sometimes drops so low it can not be measured, and skin at the knees and elbows may become blotchy. **Anxiety**, restlessness, and thirst increase. After the patient's temperature reaches 107°F (41.7°C) damage to the brain and other vital organs occurs quickly.

Causes and symptoms

Strenuous activity, excessive sweating, high fever, and prolonged vomiting or diarrhea are common causes of dehydration. So are staying in the sun too long, not drinking enough fluids, and visiting or moving to a warm region where it doesn't often rain. Alcohol, **caffeine**, and diuretics or other medications that increase the amount of fluid excreted can cause dehydration.

Reduced fluid intake can be a result of:

- appetite loss associated with acute illness
- excessive urination (polyuria)
- nausea
- bacterial or viral infection or inflammation of the pharynx (pharyngitis)
- inflammation of the mouth caused by illness, infection, irritation, or vitamin deficiency (**stomatitis**)

Other conditions that can lead to dehydration include:

- disease of the adrenal glands, which regulate the body's water and salt balance and the function of many organ systems
- diabetes mellitus
- eating disorders
- kidney disease
- chronic lung disease

An infant who does not wet a diaper in an eight-hour period is dehydrated. The soft spot on the baby's head (fontanel) may be depressed. Symptoms of dehydration at any age include cracked lips, dry or sticky mouth, lethargy, and sunken eyes. A person who is dehydrated cries without shedding tears and does not urinate very often. The skin is less elastic than it should be and is slow to return to its normal position after being pinched.

Dehydration can cause confusion, **constipation**, discomfort, drowsiness, fever, and thirst. The skin turns pale and cold, the mucous membranes lining the mouth and nose lose their natural moisture. The pulse sometimes races and breathing becomes rapid. Significant fluid loss can cause serious neurological problems.

Diagnosis

The patient's symptoms and medical history usually suggest dehydration. **Physical examination** may reveal shock, rapid heart rate, and/or low blood pressure. Laboratory tests, including blood tests (to check electrolyte levels) and urine tests (e.g., urine specific gravity and creatinine), are used to evaluate the severity of the problem. Other laboratory tests may be ordered to determine the underlying condition (such as diabetes or an adrenal gland disorder) causing the dehydration.

Treatment

Increased fluid intake and replacement of lost electrolytes are usually sufficient to restore fluid balances in patients who are mildly or moderately dehydrated. For individuals who are mildly dehydrated, just drinking plain water may be all the treatment that is needed. Adults who need to replace lost electrolytes may drink sports beverages (e.g., Gatorade or Recharge) or consume a little additional salt. Parents should follow label instructions when giving children Pedialyte or other commercial products recommended to relieve dehydration. Children who are dehydrated should receive only clear fluids for the first 24 hours.

A child who is vomiting should sip one or two teaspoons of liquid every 10 minutes. A child who is less

than a year old and who is not vomiting should be given one tablespoon of liquid every 20 minutes. A child who is more than one year old and who is not vomiting should take two tablespoons of liquid every 30 minutes. A baby who is being breast-fed should be given clear liquids for two consecutive feedings before breastfeeding is resumed. A bottle-fed baby should be given formula diluted to half its strength for the first 24 hours after developing symptoms of dehydration.

In order to accurately calculate fluid loss, it's important to chart weight changes every day and keep a record of how many times a patient vomits or has diarrhea. Parents should note how many times a baby's diaper must be changed.

Children and adults can gradually return to their normal diet after they have stopped vomiting and no longer have diarrhea. Bland foods should be reintroduced first, with other foods added as the digestive system is able to tolerate them. Milk, ice cream, cheese, and butter should not be eaten until 72 hours after symptoms have disappeared.

Medical care

Severe dehydration can require hospitalization and intravenous fluid replacement. If an individual's blood pressure drops enough to cause or threaten the development of shock, medical treatment is usually required. A doctor should be notified whenever an infant or child exhibits signs of dehydration or a parent is concerned that a stomach virus or other acute illness may lead to dehydration.

A doctor should also be notified if:

- a child less than three months old develops a fever higher than 100°F (37.8°C)
- a child more than three months old develops a fever higher than 102°F (38.9°C)
- symptoms of dehydration worsen
- an individual urinates very sparingly or does not urinate at all during a six-hour period
- dizziness, listlessness, or excessive thirst occur
- a person who is dieting and using diuretics loses more than 3 lb (1.3 kg) in a day or more than 5 lb (2.3 kg) a week

When treating dehydration, the underlying cause must also be addressed. For example, if dehydration is caused by vomiting or diarrhea, medications may be prescribed to resolve these symptoms. Patients who are dehydrated due to diabetes, kidney disease, or adrenal gland disorders must receive treatment for these conditions as well as for the resulting dehydration.

KEY TERMS

Electrolytes—Mineral salts, such as sodium and potassium, dissolved in body fluid.

Alternative treatment

Gelatin water can be substituted for electrolyte-replacement solutions. It is made by diluting a 3-oz package in a quart of water or by adding one-quarter teaspoon of salt and a tablespoon of sugar to a pint of water.

Prognosis

Mild dehydration rarely results in complications. If the cause is eliminated and lost fluid is replaced, mild dehydration can usually be cured in 24–48 hours.

Vomiting and diarrhea that continue for several days without adequate fluid replacement can be fatal. The risk of life-threatening complications is greater for young children and the elderly. However, dehydration that is rapidly recognized and treated has a good outcome.

Prevention

Patients who are vomiting or who have diarrhea can prevent dehydration by drinking enough fluid for their urine to remain the color of pale straw. Ensuring that patients always drink adequate fluids during an illness will help prevent dehydration. Infants and young children with diarrhea and vomiting can be given electrolyte solutions such as Pedialyte to help prevent dehydration. People who are not ill can maintain proper fluid balance by drinking several glasses of water before going outside on a hot day. It is also a good idea to avoid coffee and tea, which increase body temperature and water loss.

Patients should know whether any medication they are taking can cause dehydration and should get prompt medical care to correct any underlying condition that increases the risk of dehydration.

Other methods of preventing dehydration and ensuring adequate fluid intake include:

- eating more soup at mealtime
- drinking plenty of water and juice at mealtime and between meals
- keeping a glass of water nearby when working or relaxing

Resources

BOOKS

Larson, David, E., ed. *Mayo Clinic Family Health Book.* New York: William Morrow, 1990.

OTHER

"Dehydration." *HealthAnswers.com.* 8 May 1998 <http://www.healthanswers.com>.
"Dehydration." *Loyola University Health System.* 13 May 1998 <http://www.luhs.org>.
"Dehydration." *ThriveOnline.* 8 May 1998 <http://thriveonline.oxygen.com>.
"Hydration—Getting Enough Water." *Loyola University Health System.* 13 May 1998 <http://www.luhs.org>.

Maureen Haggerty

Delavirdine *see* **Non-nucleoside reverse transcriptase inhibitors**

Delayed hypersensitivity skin test

Definition

A delayed hypersensitivity test (DHT) is an immune function test measuring the presence of activated T cells that recognize a certain substance.

Purpose

The immune system protects against infection by viruses, bacteria, fungi, and parasites. After initial exposure to a foreign substance, or antigen, the immune system creates both antibodies and sensitized T cells. Both these immune agents respond when the body is reexposed to the antigen. Antibodies, which are circulating proteins, respond within minutes, to give what is termed an immediate hypersensitivity reaction. T cells' responses occur over several days, and are thus called delayed hypersensitivity reactions. The cascade of events initiated by the T cells leads to hardening (induration) and redness (erythema) at the injection site.

A DHT is performed for one of three reasons:

- To test for exposure to specific diseases, such as **tuberculosis** (TB). Tuberculosis testing is done by injecting into the skin a small volume of TB antigen, which contains no organisms (live or dead) but can still provoke an immune response.
- To test for allergic sensitivity to potential skin irritants, such as poison ivy. Skin allergy testing is usually done by placing a series of adhesive patches on the skin containing potential allergens, or allergy-causing substances.
- To assess the vitality of the T cell response as part of the evaluation of immune system health in infection, **cancer**, immune disorders, pre-transplantation screening, **aging**, and **malnutrition**. DHT can help predict survival in immunocompromised patients, and evaluate the success of restorative therapy. Antigens used for these tests must be ones the patient has been exposed to before, and, therefore, include inactivated antigens from common infectious agents to which the patient might have been exposed, such as **mumps**, *Candida albicans*, **tetanus** toxoid, and trichophyton (a skin fungus).

Precautions

No special precautions are necessary for most patients. Those with known hypersensitivity to certain skin irritants should alert the clinician performing the test. Some commercial preparations of fungal antigens contain mercury, a source of irritation to some patients.

Description

The most accurate TB test is the Mantoux test, in which a small amount of TB antigen is injected into the skin. The area is examined 48–72 hours after the injection.

In the patch test, 20–30 adhesive patches are usually placed on the upper back. The patches are kept in place and the area is kept dry for 48 hours. The patches are then removed, and the skin is examined 24 hours afterward, and possibly again a day or more following that. Patch testing is usually performed following a patient complaint of skin irritation from an unknown substance. Testing may suggest several candidates; identifying the right one requires careful review of the patient's possible exposure.

The test of overall T cell responsiveness is performed with several injections. Each area injected is circled and marked. Results are read 48 hours after the injection.

Preparation

No special preparation is necessary.

KEY TERMS

Allergen—A foreign substance that provokes an immune reaction in some sensitive people but not in most others.

Anaphylaxis—An exaggerated, life-threatening hypersensitivity reaction to a previously encountered antigen.

Antibody—An immune system protein made to fight infection.

Antigen—A foreign substance detected that provokes an immune reaction.

Aftercare

Patches should be kept dry. Injection sites may be washed, but excessive rubbing should be avoided. Patches and injection sites may become reddened or irritated. If a patch causes severe **itching** or discomfort, the patient should remove it immediately.

Risks

DHT is quite safe for virtually all people. There is no risk of infection from the agents injected, since they are purified antigens, not whole organisms. Life threatening, hypersensitive reactions (**anaphylaxis**) are a very small risk; patients should notify the administering physician immediately if signs of **wheezing**, swelling, or diffuse redness of the skin develops.

Normal results

Absence of exposure to TB is indicated by absent or very little skin reaction; redness or hardness smaller than 5 mm (about 0.25 in) is considered normal for a person not exposed or infected with TB.

Patch test sites should be normal or only slightly red.

T cell responsiveness tests should be positive; that is, the injected areas should be reddened and hard. Two affected areas of 2 mm or more is considered a positive result.

Abnormal results

TB exposure is indicated by a reaction of 10 mm or more. The degree of redness is not important. A 5–10 mm area could indicate exposure if there is an underlying risk to TB.

Patch test areas that become reddened and irritated indicate reaction to the substance in the patch.

Absence of any reaction to injected areas indicates lack of T cell responsiveness, a condition called anergy. T cell anergy is seen in immune deficiency diseases including **AIDS**, some cases of infectious diseases, malignancies, immunosuppressive therapy (including corticosteroid treatment), some autoimmune diseases, malnutrition, major surgery, and some viral immunizations.

Resources

BOOKS

Davies, R., and S. Ollier. *Allergy: The Facts*. Oxford University Press, 1989.

Lawlor Jr., G. J., et. al. *Manual of Allergy and Immunology.* Little, Brown and Co., 1995.

Richard Robinson

Delirium

Definition

Delirium is a state of mental confusion that develops quickly and usually fluctuates in intensity.

Description

Delirium is a syndrome, or group of symptoms, caused by a disturbance in the normal functioning of the brain. The delirious patient has a reduced awareness of and responsiveness to the environment, which may be manifested as disorientation, incoherence, and memory disturbance. Delirium is often marked by **hallucinations**, **delusions**, and a dream-like state.

Delirium affects at least one in 10 hospitalized patients, and is a common part of many terminal illnesses. Delirium is more common in the elderly than in the general population. While it is not a specific disease itself, patients with delirium usually fare worse than those with the same illness who do not have delirium.

Causes and symptoms

Causes

There are a large number of possible causes of delirium. Metabolic disorders are the single most common cause, accounting for 20–40% of all cases. This type of delirium, termed "metabolic encephalopathy," may result from organ failure, including liver or kidney failure. Other metabolic causes include **diabetes mellitus**, **hyperthyroidism** and **hypothyroidism**, vitamin defi-

ciencies, and imbalances of fluids and electrolytes in the blood. Severe **dehydration** can also cause delirium.

Drug intoxication ("intoxication confusional state") is responsible for up to 20% of delirium cases, either from side effects, overdose, or deliberate ingestion of a mind-altering substance. Medicinal drugs with delirium as a possible side effect or result of overdose include:

- anticholinergics, including atropine, scopolamine, chlorpromazine (an antipsychotic), and diphenhydramine (an antihistamine)
- sedatives, including **barbiturates**, **benzodiazepines**, and ethanol (drinking alcohol)
- antidepressant drugs
- anticonvulsant drugs
- nonsteroidal anti-inflammatory drugs (NSAIDs), including ibuprofen and **acetaminophen**
- corticosteroids, including prednisone
- anticancer drugs, including methotrexate and procarbazine
- lithium
- cimetidine
- antibiotics
- L-dopa

Delirium may result from ingestion of legal or illegal psychoactive drugs, including:

- ethanol (drinking alcohol)
- marijuana
- LSD (**lysergic acid diethylamide**) and other hallucinogens
- amphetamines
- cocaine
- opiates, including heroin and morphine
- PCP (phencyclidine)
- inhalants

Drug withdrawal may also cause delirium. Delirium tremens, or "DTs," may occur during alcohol withdrawal after prolonged or intense consumption. Withdrawal symptoms are also possible from many of the psychoactive prescription drugs.

Poisons may cause delirium ("toxic encephalopathy"), including:

- solvents, such as gasoline, kerosene, turpentine, benzene, and alcohols
- carbon monoxide
- refrigerants (Freon)

KEY TERMS

Dementia—A loss of mental ability severe enough to interfere with functioning. While dementia and delirium have some of the same symptoms, dementia has a much slower onset.

Electroencephalogram (EEG)— A chart of the brain wave patterns picked up by electrodes placed on the scalp. This is useful for diagnosing central nervous system disorders.

Encephalopathy—A brain dysfunction or disorder.

- heavy metals, such as lead, mercury, and arsenic
- insecticides, such as Parathion and Sevin
- mushrooms, such as *Amanita* species
- plants such as jimsonweed (*Datura stramonium*) and morning glory (*Ipomoea* spp.)
- animal venoms

Other causes of delirium include:

- infection
- fever
- head trauma
- epilepsy
- brain hemorrhage or infarction
- brain tumor
- low blood oxygen (hypoxemia)
- high blood carbon dioxide (hypercapnia)
- post-surgical complication.

Symptoms

The symptoms of delirium come on quickly, in hours or days, in contrast to those of **dementia**, which develop much more slowly. Delirium symptoms typically fluctuate through the day, with periods of relative calm and lucidity alternating with periods of florid delirium. The hallmark of delirium is a fluctuating level of consciousness. Symptoms may include:

- decreased awareness of the environment
- confusion or disorientation, especially of time
- memory impairment, especially of recent events
- hallucinations
- illusions and misinterpreted stimuli
- increased or decreased activity level

- mood disturbance, possibly including **anxiety**, euphoria or depression
- language or speech impairment

Diagnosis

Delirium is diagnosed through the medical history and recognition of symptoms during **mental status examination**. The most important part of diagnosis is determining the cause of the delirium. Tests may include blood and urine analysis for levels of drugs, fluids, electrolytes, and blood gases, and to test for infection; lumbar puncture ("spinal tap") to test for central nervous system infection; x ray, **computed tomography scans** (CT), or **magnetic resonance imaging** (MRI) scans to look for tumors, hemorrhage, or other brain abnormality; thyroid tests; **electroencephalography** (EEG); **electrocardiography** (ECG); and possibly others as dictated by the likely cause.

Treatment

Treatment of delirium begins with recognizing and treating the underlying cause. Delirium itself is managed by reducing disturbing stimuli, or providing soothing ones; use of simple, clear language in communication; and reassurance, especially from family members. Physical restraints may be needed if the patient is a danger to himself or others, or if he insists on removing necessary medical equipment such as intravenous lines or monitors. Sedatives or **antipsychotic drugs** may be used to reduce anxiety, hallucinations, and delusions.

Prognosis

Persons with delirium usually have a worse prognosis for the underlying disease than the person without delirium. Nonetheless, those without terminal illness usually recover from delirium. They may not, however, regain all their original cognitive abilities, and may be left with some permanent impairments, including **fatigue**, irritability, difficulty concentrating, or mood changes.

Prevention

Prevention of delirium is focused on treating or avoiding its underlying causes. The most preventable forms are those induced by drugs. Strategies for reducing delirium include following prescriptions, consulting the prescribing physician immediately if symptoms occur, and consulting the physician before discontinuing the drug, even if it has been ineffective; avoiding intoxication with legal or illegal drugs, and seeking professional assistance before suddenly discontinuing an addictive drug such as alcohol or heroin; maintaining good **nutrition**, which promotes general health and can minimize the likelihood of delirium from alcohol intoxication and withdrawal; and avoiding exposure to solvents, insecticides, heavy metals, or biological poisons in the home or workplace.

Resources

BOOKS

Guze, Samuel, ed. *Adult Psychiatry.* Mosby Year Book, 1997.
Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Richard Robinson

Delta virus hepatitis *see* **Hepatitis D**

Delusions

Definition

A delusion is an unshakable belief in something untrue. These irrational beliefs defy normal reasoning, and remain firm even when overwhelming proof is presented to dispute them. Delusions are often accompanied by **hallucinations** and/or feelings of **paranoia**, which act to strengthen confidence in the delusion. Delusions are distinct from culturally or religiously based beliefs that may be seen as untrue by outsiders.

Description

Delusions are a common symptom of several mood and personality-related mental illnesses, including **schizoaffective disorder**, **schizophrenia**, shared psychotic disorder, major depressive disorder, and **bipolar disorder**. They are also the major feature of delusional disorder. Individuals with delusional disorder suffer from long-term, complex delusions that fall into one of six categories: persecutory, grandiose, jealousy, erotomanic, somatic, or mixed. There are also delusional disorders such as **dementia** that clearly have organic or physical causes.

Persecutory

Individuals with persecutory delusional disorder are plagued by feelings of paranoia and an irrational yet unshakable belief that someone is plotting against them, or out to harm them.

Grandiose

Individuals with grandiose delusional disorder have an over-inflated sense of self-worth. Their delusions center on their own importance, such as believing that they have done or created something of extreme value or have a "special mission."

Jealousy

Jealous delusions are unjustified and irrational beliefs that an individual's spouse or significant other has been unfaithful.

Erotomanic

Individuals with erotomanic delusional disorder believe that another person, often a stranger, is in love with them. The object of their affection is typically of a higher social status, sometimes a celebrity. This type of delusional disorder may lead to stalking or other potentially dangerous behavior.

Somatic

Somatic delusions involve the belief that something is physically wrong with the individual. The delusion may involve a medical condition or illness or a perceived deformity. This condition differs from **hypochondriasis** in that the deformity is perceived as a fixed condition not a temporary illness.

Mixed

Mixed delusions are those characterized by two or more of persecutory, grandiose, jealousy, erotomanic, or somatic themes.

Causes and symptoms

Some studies have indicated that delusions may be generated by abnormalities in the limbic system, the portion of the brain on the inner edge of the cerebral cortex that is believed to regulate emotions. The exact source of delusions has not been conclusively found, but potential causes include genetics, neurological abnormalities, and changes in brain chemistry. Delusions are also a known possible side effect of drug use and abuse (e.g., amphetamines, **cocaine**, PCP).

Diagnosis

Patients with delusional symptoms should undergo a thorough **physical examination** and patient history to rule out possible organic causes (such as dementia). If a psychological cause is suspected, a mental health professional will typically conduct an interview with the patient and administer one of several clinical inventories, or tests, to evaluate mental status.

KEY TERMS

Hallucinations—False or distorted sensory experiences that appear to be real perceptions.

Paranoia—An unfounded or exaggerated distrust of others.

Shared psychotic disorder—Also known as folie à deux; shared psychotic disorder is an uncommon disorder in which the same delusion is shared by two or more individuals.

Treatment

Delusions that are symptomatic of delusional disorder should be treated by a psychologist and/or psychiatrist. Though **antipsychotic drugs** are often not effective, antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), or risperidone (Risperdal) may be prescribed, and cognitive therapy or psychotherapy may be attempted.

If an underlying condition such as schizophrenia, depression, or drug abuse is found to be triggering the delusions, an appropriate course of medication and/or psychosocial therapy is employed to treat the primary disorder. The medication, typically, will include an antipsychotic agent.

Prognosis

Delusional disorder is typically a chronic condition, but with appropriate treatment, a remission of delusional symptoms occurs in up to 50% of patients. However, because of their strong belief in the reality of their delusions and a lack of insight into their condition, individuals with this disorder may never seek treatment, or may be resistant to exploring their condition in psychotherapy.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S., and Nicholas G. Ward. "Schizophrenia and Related Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Siegel, Ronald K. *Whispers: The Voices of Paranoia*. New York: Crown, 1994.

PERIODICALS

Manschreck, Theo C. "Delusional Disorder: The Recognition and Management of Paranoia." *Journal of Clinical Psychiatry* 57, supplement 3 (1996): 32-38.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Institutes of Mental Health (NIMH). 6001 Executive Boulevard, Rm. 8184, MSC 9663

Paula Anne Ford-Martin

Dementia

Definition

Dementia is a loss of mental ability severe enough to interfere with normal activities of daily living, lasting more than six months, not present since birth, and not associated with a loss or alteration of consciousness.

Description

Dementia is a group of symptoms caused by gradual **death** of brain cells. The loss of cognitive abilities that occurs with dementia leads to impairments in memory, reasoning, planning, and personality. While the overwhelming number of people with dementia are elderly, it is not an inevitable part of **aging**. Instead, dementia is caused by specific brain diseases. **Alzheimer's disease** (AD) is the most common cause, followed by vascular or multi-infarct dementia.

The prevalence of dementia has been difficult to determine, partly because of differences in definition among different studies, and partly because there is some normal decline in functional ability with age. Dementia affects 5–8% of all people between ages 65 and 74, and up to 20% of those between 75 and 84. Estimates for dementia in those 85 and over range from 30–47%. Between two and four million Americans have AD; that number is expected to grow to as many as 14 million by the middle of the twenty-first century as the population as a whole ages.

The cost of dementia can be considerable. While most people with dementia are retired and do not suffer income losses from their disease, the cost of care is often enormous. Financial burdens include lost wages for family caregivers, medical supplies and drugs, and home modifications to ensure safety. Nursing home care may cost several thousand dollars a month or more. The psychological cost is not as easily quantifiable but can be even more profound. The person with dementia loses control of many of the essential features of his life and personality, and loved ones lose a family member even as they continue to cope with the burdens of increasing dependence and unpredictability.

Causes and symptoms

Causes

Dementia is usually caused by degeneration in the cerebral cortex, the part of the brain responsible for thoughts, memories, actions and personality. Death of brain cells in this region leads to the cognitive impairment which characterizes dementia.

The most common cause of dementia is AD, accounting for half to three quarters of all cases. The brain of a person with AD becomes clogged with two abnormal structures, called neurofibrillary tangles and senile plaques. Neurofibrillary tangles are twisted masses of protein fibers inside nerve cells, or neurons. Senile plaques are composed of parts of neurons surrounding a group of proteins called beta-amyloid deposits. Why these structures develop is unknown. Current research indicates possible roles for inflammation, blood flow restriction, and toxic molecular fragments known as free radicals. Several genes have been associated with higher incidences of AD, although the exact role of these genes is still unknown.

Vascular dementia is estimated to cause from 5–30% of all dementias. It occurs from decrease in blood flow to the brain, most commonly due to a series of small strokes (multi-infarct dementia). Other cerebrovascular causes include: **vasculitis** from **syphilis**, **Lyme disease**, or **systemic lupus erythematosus**; **subdural hematoma**; and **subarachnoid hemorrhage**. Because of the usually sudden nature of its cause, the symptoms of vascular dementia tend to begin more abruptly than those of Alzheimer's dementia. Symptoms may progress stepwise with the occurrence of new strokes. Unlike AD, the incidence of vascular dementia is lower after age 75.

Other conditions which may cause dementia include:

- AIDS
- Parkinson's disease
- Lewy body disease
- Pick's disease

- Huntington's disease
- Creutzfeldt-Jakob disease
- brain tumor
- **hydrocephalus**
- head trauma
- multiple sclerosis
- prolonged abuse of alcohol or other drugs
- vitamin deficiency: thiamin, niacin, or B_{12}
- hypothyroidism
- hypercalcemia

Symptoms

Dementia is marked by a gradual impoverishment of thought and other mental activities. Losses eventually affect virtually every aspect of mental life. The slow progression of dementia is in contrast with **delirium**, which involves some of the same symptoms, but has a very rapid onset and fluctuating course with alteration in the level of consciousness. However, delirium may occur with dementia, especially since the person with dementia is more susceptible to the delirium-inducing effects of may types of drugs.

Symptoms include*:*

- Memory losses. Memory loss is usually the first symptom noticed. It may begin with misplacing valuables such as a wallet or car keys, then progress to forgetting appointments, where the car was left, and the route home, for instance. More profound losses follow, such as forgetting the names and faces of family members.
- Impaired abstraction and planning. The person with dementia may lose the ability to perform familiar tasks, to plan activities, and to draw simple conclusions from facts.
- Language and comprehension disturbances. The person may be unable to understand instructions, or follow the logic of moderately complex sentences. Later, he or she may not understand his or her own sentences, and have difficulty forming thoughts into words.
- Poor judgment. The person may not recognize the consequences of his or her actions or be able to evaluate the appropriateness of behavior. Behavior may become ribald, overly-friendly, or aggressive. Personal hygiene may be ignored.
- Impaired orientation ability. The person may not be able to identify the time of day, even from obvious visual clues; or may not recognize his or her location, even if familiar. This disability may stem partly from losses of memory and partly from impaired abstraction.
- Decreased attention and increased restlessness. This may cause the person with dementia to begin an activity and quickly lose interest, and to wander frequently. Wandering may cause significant safety problems, when combined with disorientation and memory losses. The person may begin to cook something on the stove, then become distracted and wander away while it is cooking.
- Personality changes and **psychosis**. The person may lose interest in once-pleasurable activities, and become more passive, depressed, or anxious. **Delusions**, suspicion, **paranoia**, and **hallucinations** may occur later in the disease. Sleep disturbances may occur, including **insomnia** and sleep interruptions.

Diagnosis

Since dementia usually progresses slowly, diagnosing it in its early stages can be difficult. Several office visits over several months or more may be needed. Diagnosis begins with a thorough physical exam and complete medical history, usually including comments from family members or caregivers. A family history of either AD or cerebrovascular disease may provide clues to the cause of symptoms. Simple tests of mental function, including word recall, object naming, and number-symbol matching, are used to track changes in the person's cognitive ability.

Depression is common in the elderly and can be mistaken for dementia; therefore, ruling out depression is an important part of the diagnosis. Distinguishing dementia from the mild normal cognitive decline of advanced age is also critical. The medical history includes a complete listing of drugs being taken, since a number of drugs can cause dementia-like symptoms.

Determining the cause of dementia may require a variety of medical tests, chosen to match the most likely etiology. Cerebrovascular disease, hydrocephalus, and tumors may be diagnosed with x-rays, CT or MRI scans, and vascular imaging studies. Blood tests may reveal nutritional deficiencies or hormone imbalances.

Treatment

Treatment of dementia begins with treatment of the underlying disease, where possible. The underlying causes of nutritional, hormonal, tumor-caused and drug-related dementias may be reversible to some extent. Treatment for stroke-related dementia begins by minimizing the risk of further strokes, through **smoking** cessation, **aspirin** therapy, and treatment of **hypertension**, for instance. There are no therapies that can reverse the progression of AD. Aspirin, estrogen,

vitamin E, and selegiline are currently being evaluated for their ability to slow the rate of progression.

Care for a person with dementia can be difficult and complex. The patient must learn to cope with functional and cognitive limitations, while family members or other caregivers assume increasing responsibility for the person's physical needs. In progressive dementias such as AD, the person may ultimately become completely dependent. Education of the patient and family early on in the disease progression can help them anticipate and plan for inevitable changes.

Symptoms of dementia may be treated with a combination of psychotherapy, environmental modifications, and medication. Drug therapy can be complicated by forgetfulness, especially if the prescribed drug must be taken several times daily.

Behavioral approaches may be used to reduce the frequency or severity of problem behaviors, such as aggression or socially inappropriate conduct. Problem behavior may be a reaction to frustration or overstimulation; understanding and modifying the situations that trigger it can be effective. Strategies may include breaking down complex tasks, such as dressing or feeding, into simpler steps, or reducing the amount of activity in the environment to avoid confusion and agitation. Pleasurable activities, such as crafts, games, and music, can provide therapeutic stimulation and improve mood.

Modifying the environment can increase safety and comfort while decreasing agitation. Home modifications for safety include removal or lock-up of hazards such as sharp knives, dangerous chemicals, and tools. Childproof latches or Dutch doors may be used to limit access as well. Lowering the hot water temperature to 120°F (48.9°C) or less reduces the risk of scalding. Bed rails and bathroom safety rails can be important safety measures, as well. Confusion may be reduced with simpler decorative schemes and presence of familiar objects. Covering or disguising doors (with a mural, for example) may reduce the tendency to wander. Positioning the bed in view of the bathroom can decrease incontinence.

Two drugs, tacrine (Cognex) and donepezil (Aricept), are commonly prescribed for AD. These drugs inhibit the breakdown of acetylcholine in the brain, prolonging its ability to conduct chemical messages between brain cells. They provide temporary improvement in cognitive functions for about 40% of patients with mild to moderate AD. Hydergine is sometimes prescribed as well, though it is of questionable benefit for most patients.

Psychotic symptoms, including paranoia, delusions, and hallucinations, may be treated with **antipsychotic drugs**, such as haloperidol, chlorpromazine, risperidone, and clozapine. Side effects of these drugs can be significant. **Antianxiety drugs** such as Valium may improve behavioral symptoms, especially agitation and **anxiety**, although BuSpar has fewer side effects. The anticonvulsant carbamazepine is also sometimes prescribed for agitation. Depression is treated with antidepressants, usually beginning with **selective serotonin reuptake inhibitors** (SSRIs) such as Prozac or Paxil, followed by **monoamine oxidase inhibitors** or tricyclic antidepressants. **Electroconvulsive therapy** may be appropriate for some patients with severe depression who are unresponsive to drug therapy. In general, medications should be administered very cautiously to demented patients, in the lowest possible effective doses, to minimize side effects. Supervision of taking medications is generally required.

Long-term institutional care may be needed for the person with dementia, as profound cognitive losses often precede death by a number of years. Early planning for the financial burden of nursing home care is critical. Useful information about financial planning for long-term care is available through the Alzheimer's Association.

Family members or others caring for a person with dementia are often subject to extreme **stress**, and may develop feelings of anger, resentment, guilt, and hopelessness, in addition to the sorrow they feel for their loved one and for themselves. Depression is an extremely common consequence of being a full-time caregiver for a person with dementia. Support groups can be an important way to deal with the stress of caregiving. The location and contact numbers for caregiver support groups are available from the Alzheimer's Association; they may also be available through a local social service agency or the patient's physician. Medical treatment for depression may be an important adjunct to group support.

Alternative treatment

Several drugs are currently being tested for their ability to slow the progress of AD. These include acetyl-l-carnitine, which acts on the cellular energy structures known as mitochondria; propentofylline, which may aid circulation; milameline, which acts similarly to tacrine and donezepil; and ginkgo extract.

Ginkgo extract, derived from the leaves of the *Ginkgo biloba* tree, interferes with a circulatory protein called platelet activating factor. It also increases circulation and oxygenation to the brain. Ginkgo extract has been used for many years in China and is widely prescribed in Europe for treatment of circulatory problems. A 1997 study of patients with dementia seemed to show that gingko extract could improve their symptoms, though the study was criticized for certain flaws in its method.

KEY TERMS

Donepezil—A drug commonly prescribed for Alzheimer's disease that provides temporary improvement in cognitive functions for some patients with mild-to-moderate forms of the disease.

Ginkgo extract—Made from the leaves of the *Ginkgo biloba* tree, this extract, used in other countries to treat circulatory problems, may improve the symptoms of patients with dementia.

Neurofibrillary tangles—Abnormal structures, composed of twisted masses of protein fibers within nerve cells, found in the brains of persons with Alzheimer's disease.

Senile plaques—Abnormal structures, composed of parts of nerve cells surrounding protein deposits, found in the brains of persons with Alzheimer's disease.

Tacrine—A drug commonly prescribed for Alzheimer's disease that provides temporary improvement in cognitive functions for some patients with mild-to-moderate forms of the disease.

Prognosis

The prognosis for dementia depends on the underlying disease. On average, people with Alzheimer's disease live eight years past their diagnosis, with a range from one to 20 years. Vascular dementia is usually progressive, with death from **stroke**, infection, or heart disease.

Prevention

There is no known way to prevent Alzheimer's disease, although several of the drugs under investigation may reduce its risk or slow its progression. The risk of developing multi-infarct dementia may be reduced by reducing the risk of stroke.

Resources

BOOKS

Jacques, Alan. *Understanding Dementia*. New York: Churchill Livingstone, 1992.

Mace, Nancy L., and Peter V. Rabins. *The 36-Hour Day*. Baltimore: John Hopkins University Press, 1995.

ORGANIZATIONS

Alzheimer's Association. 919 North Michigan Ave., Suite 1000, Chicago, IL 60611. (800) 272-3900. <http://www. alz.org>.

Richard Robinson

Demyelinating disease *see* **Multiple sclerosis**

Dengue fever

Definition

Dengue fever is a disease caused by one of a number of viruses that are carried by mosquitoes. These mosquitoes then transmit the virus to humans.

Description

The virus that causes dengue fever is called an arbovirus, which stands for arthropod-borne virus. Mosquitoes are a type of arthropod. In a number of regions, mosquitoes carry this virus and are responsible for passing it along to humans. These regions include the Middle East, the far East, Africa, and the Caribbean Islands. In these locations, the dengue fever arbovirus is endemic, meaning that the virus naturally and consistently lives in that location. The disease only shows up in the United States sporadically.

In order to understand how dengue fever is transmitted, several terms need to be defined. The word "host" means an animal (including a human) that can be infected with a particular disease. The word "vector" means an organism that can carry a particular disease-causing agent (like a virus or bacteria) without actually developing the disease. The vector can then pass the virus or bacteria on to a new host.

Many of the common illnesses in the United States (including the **common cold**, many viral causes of **diarrhea**, and **influenza** or "flu") are spread because the viruses that cause these illness can be passed directly from person to person. However, dengue fever cannot be passed directly from one infected person to another. Instead, the virus responsible for dengue fever requires an intermediate vector, a mosquito, that carries the virus from one host to another. The mosquito that carries the arbovirus responsible for dengue fever is the same type of mosquito that can transmit other diseases, including **yellow fever**. This mosquito is called *Aedes egypti*. The most common victims are children younger than 10 years of age.

Causes and symptoms

Dengue fever can occur when a mosquito carrying the arbovirus bites a human, passing the virus on to the new host. Once in the body, the virus travels to various glands where it multiplies. The virus can then enter the

bloodstream. The presence of the virus within the blood vessels, especially those feeding the skin, causes changes to these blood vessels. The vessels swell and leak. The spleen and lymph nodes become enlarged, and patches of liver tissue die. A process called disseminated intravascular coagulation (DIC) occurs, where chemicals responsible for clotting are used up and lead to a risk of severe bleeding (hemorrhage).

After the virus has been transmitted to the human host, a period of incubation occurs. During this time (lasting about five to eight days) the virus multiplies. Symptoms of the disease appear suddenly and include high **fever**, chills, **headache**, eye **pain**, red eyes, enlarged lymph nodes, a red flush to the face, lower back pain, extreme weakness, and severe aches in the legs and joints.

This initial period of illness lasts about two–three days. After this time, the fever drops rapidly and the patient sweats heavily. After about a day of feeling relatively well, the patient's temperature increases again, although not as much as the first time. A rash of small red bumps begins on the arms and legs, spreading to the chest, abdomen, and back. It rarely affects the face. The palms of the hands and the soles of the feet become swollen and turn bright red. The characteristic combination of fever, rash, and headache are called the "dengue triad." Most people recover fully from dengue fever, although weakness and **fatigue** may last for several weeks. Once a person has been infected with dengue fever, his or her immune system keeps producing cells that prevent reinfection for about a year.

More severe illness may occur in some people. These people may be experiencing dengue fever for the first time. However, in some cases a person may have already had dengue fever at one time, recovered, and then is reinfected with the virus. In these cases, the first infection teaches the immune system to recognize the presence of the arbovirus. When the immune cells encounter the virus during later infections, the immune system over-reacts. These types of illnesses, called dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS), involve more severe symptoms. Fever and headache are the first symptoms, but the other initial symptoms of dengue fever are absent. The patient develops a **cough**, followed by the appearance of small purplish spots (petechiae) on the skin. These petechiae are areas where blood is leaking out of the vessels. Large bruised areas appear as the bleeding worsens and abdominal pain may be severe. The patient may begin to vomit a substance that looks like coffee grounds. This is actually a sign of bleeding into the stomach. As the blood vessels become more damaged, they leak more and continue to increase in diameter (dilate), causing a decrease in blood flow to all tissues of the body. This state of low blood flow is called shock. Shock can result in damage to the body's organs (especially the heart and kidneys) because low blood flow deprives them of oxygen.

Diagnosis

Diagnosis should be suspected in endemic areas whenever a high fever goes on for two to seven days, especially if accompanied by a bleeding tendency. Symptoms of shock should suggest the progression of the disease to DSS.

The arbovirus causing dengue fever is one of the few types of arbovirus that can be isolated from the serum of the blood. The serum is the fluid in which blood cells are suspended. Serum can be tested because the phase in which the virus travels throughout the bloodstream is longer in dengue fever than in other arboviral infections. A number of tests are used to look for reactions between the patient's serum and laboratory-produced antibodies. Antibodies are special cells that recognize the markers (or antigens) present on invading organisms. During these tests, antibodies are added to a sample of the patient's serum. Healthcare workers then look for reactions that would only occur if viral antigens were present in that serum.

Treatment

There is no treatment available to shorten the course of dengue fever, DHF, or DSS. Medications can be given to lower the fever and to decrease the pain of muscle aches and headaches. Fluids are given through a needle in a vein to prevent **dehydration**. Blood transfusions may be necessary if severe hemorrhaging occurs. Oxygen should be administered to patients in shock.

Prognosis

The prognosis for uncomplicated dengue fever is very good, and almost 100% of patients fully recover. However, as many as 6–30% of all patients die when DHF occurs. The **death** rate is especially high among the youngest patients (under one year old). In places where excellent medical care is available, very close monitoring and immediate treatment of complications lowers the death rate among DHF and DSS patients to about 1%.

Prevention

Prevention of dengue fever means decreasing the mosquito population. Any sources of standing water (buckets, vases, etc.) where the mosquitoes can breed must be eliminated. Mosquito repellant is recommended for those areas where dengue fever is endemic. To help break the cycle of transmission, sick patients should be

KEY TERMS

Endemic—Naturally and consistently present in a certain geographical region.

Host—The organism (such as a monkey or human) in which another organism (such as a virus or bacteria) is living.

Vector—A carrier organism (such as a fly or mosquito) that delivers a virus (or other agent of infection) to a host.

placed in bed nets so that mosquitoes cannot bite them and become arboviral vectors.

Resources

BOOKS

Douglas, R. Gordon. "Other Arthropod-Borne Viruses." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Arthropod-Borne and Other Zoonotic Viruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Farley, Dixie. "Treating Tropical Diseases." *FDA Consumer* (Jan./Feb. 1997): 26+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Dental caries *see* **Tooth decay**

Dental cavity *see* **Tooth decay**

Dental hygiene *see* **Oral hygiene**

Dental injuries *see* **Dental trauma**

Dental trauma

Definition

Dental trauma is injury to the mouth, including teeth, lips, gums, tongue, and jawbones. The most common dental trauma is a broken or lost tooth.

Description

Dental trauma may be inflicted in a number of ways: contact sports, motor vehicle accidents, fights, falls, eating hard foods, drinking hot liquids, and other such mishaps. As oral tissues are highly sensitive, injuries to the mouth are typically very painful. Dental trauma should receive prompt treatment from a dentist.

Causes and symptoms

Soft tissue injuries, such as a "fat lip," a burned tongue, or a cut inside the cheek, are characterized by **pain**, redness, and swelling with or without bleeding. A broken tooth often has a sharp edge that may cut the tongue and cheek. Depending on the position of the fracture, the tooth may or may not cause **toothache** pain. When a tooth is knocked out (evulsed), the socket is swollen, painful, and bloody. A jawbone may be broken if the upper and lower teeth no longer fit together properly (**malocclusion**), or if the jaws have pain with limited ability to open and close (mobility), especially around the temporomandibular joint (TMJ).

Diagnosis

Dental trauma is readily apparent upon examination. Dental x rays may be taken to determine the extent of the damage to broken teeth. More comprehensive x rays are needed to diagnose a broken jaw.

Treatment

Soft tissue injuries may require only cold compresses to reduce swelling. Bleeding may be controlled with direct pressure applied with clean gauze. Deep lacerations and punctures may require stitches. Pain may be managed with **aspirin** or **acetaminophen** (Tylenol, Aspirin Free Excedrin) or ibuprofen (Motrin, Advil).

Treatment of a broken tooth will vary depending on the severity of the fracture. For immediate first aid, the injured tooth and surrounding area should be rinsed gently with warm water to remove dirt, then covered with a cold compress to reduce swelling and ease pain. A dentist should examine the injury as soon as possible. Any pieces from the broken tooth should be saved and brought along.

If a piece of the outer tooth has chipped off, but the inner core (pulp) is undisturbed, the dentist may simply smooth the rough edges or replace the missing section with a small composite filling. In some cases, a fragment of broken tooth may be bonded back into place. If enough tooth is missing to compromise the entire tooth structure, but the pulp is not permanently damaged, the tooth will require a protective coverage with a gold or

porcelain crown. If the pulp has been seriously damaged, the tooth will require **root canal treatment** before it receives a crown. A tooth that is vertically fractured or fractured below the gumline will require root canal treatment and protective restoration. A tooth which no longer has enough remaining structure to retain a crown may have to be extracted (surgically removed).

When a permanent tooth has been knocked out, it may be saved with prompt action. The tooth must be found immediately after it has been lost. It should be picked up by the natural crown (the top part covered by hard enamel). It must not be handled by the root. If the tooth is dirty, it may be gently rinsed under running water. It should never be scrubbed, and it should never be washed with soap, toothpaste, mouthwash, or other chemicals. The tooth should not be dried or wrapped in a tissue or cloth. It must be kept moist at all times.

The tooth may be placed in a clean container of milk, cool water with or without a pinch of salt, or in saliva. If possible, the patient and the tooth should be brought to the dentist within 30 minutes of the tooth loss. Rapid action improves the chances of successful re-implantation; however, it is possible to save a tooth after 30 minutes, if the tooth has been kept moist and handled properly.

The body usually rejects re-implantation of a primary (baby) tooth. In this case, the empty socket is treated as a soft tissue injury and monitored until the permanent tooth erupts.

A broken jaw must be set back into its proper position and stabilized with wires while it heals. Healing may take six weeks or longer, depending on the patient's age and the severity of the fracture.

Alternative treatment

There is no substitute for treatment by a dentist or other medical professional. There are, however, homeopathic remedies and herbs that can be used simultaneously with dental care and throughout the healing process. Homeopathic arnica (*Arnica montana*) should be taken as soon as possible after the injury to help the body deal with the trauma. Repeating a dose several times daily for the duration of healing is also useful. Homeopathic hypericum (*Hypericum perforatum*) can be taken if nerve pain is involved, especially with a **tooth extraction** or root canal. Homeopathic comfrey (*Symphytum officinale)* may be helpful in treating pain due to broken jaw bones, but should only be used after the bones have been reset. Calendula (*Calendula officinalis*) and plantain (*Plantago major*) can be used as a mouth rinse to enhance tissue healing. These herbs should not be used with deep lacerations that need to heal from the inside first.

KEY TERMS

Crown—1 The natural part of the tooth covered by enamel. 2 A restorative crown is a protective shell that fits over a tooth.

Eruption—The process of a tooth breaking through the gum tissue to grow into place in the mouth.

Evulsion—The forceful, and usually accidental, removal of a tooth from its socket in the bone.

Extraction—The surgical removal of a tooth from its socket in the bone.

Malocclusion—A problem in the way the upper and lower teeth fit together in biting or chewing.

Pulp—The soft innermost layer of a tooth containing blood vessels and nerves.

Root canal treatment—The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

Temporomandibular joint (TMJ)—The jaw joint formed by the mandible (lower jaw bone) moving against the temporal (temple and side) bone of the skull.

Prognosis

When dental trauma receives timely attention and proper treatment, the prognosis for healing is good. As with other types of trauma, infection may be a complication, but a course of antibiotics is generally effective.

Prevention

Most dental trauma is preventable. Car seat belts should always be worn, and young children should be secured in appropriate car seats. Homes should be monitored for potential tripping and slipping hazards. Childproofing measures should be taken, especially for toddlers. In addition to placing gates across stairs and padding sharp table edges, electrical cords should be tucked away. Young children may receive severe oral **burns** from gnawing on live power cords.

Everyone who participates in contact sports should wear a mouthguard to avoid dental trauma. Athletes in football, ice hockey, wrestling, and boxing commonly wear mouthguards. The mandatory use of mouthguards in football prevents about 200,000 oral injuries annually. Mouthguards should also be worn along with helmets in noncontact sports such as skateboarding, in-line skating,

and bicycling. An athlete who does not wear a mouthguard is 60 times more likely to sustain dental trauma than one who does. Any activity involving speed, an increased chance of falling, and potential contact with a hard piece of equipment has the likelihood of dental trauma that may be prevented or substantially reduced in severity with the use of mouthguards.

Resources

ORGANIZATIONS

American Academy of Pediatric Dentistry. 211 East Chicago Ave., Ste. 700, Chicago, IL 60611-2616. (312) 337-2169. <http://www.aapd.org>.

American Association of Endodontists. 211 East Chicago Ave., Ste. 1100, Chicago, IL 60611-2691. (800) 872-3636. <http://www.aae.org>.

American Association of Oral and Maxillofacial Surgeons. 9700 West Bryn Mawr Ave., Rosemont, IL 60018-5701. (847) 678-6200. <http://www.aaoms.org>.

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

Donald Gardner Barstow

Depersonalization disorder *see* **Dissociative disorders**

Depo-Provera/Norplant

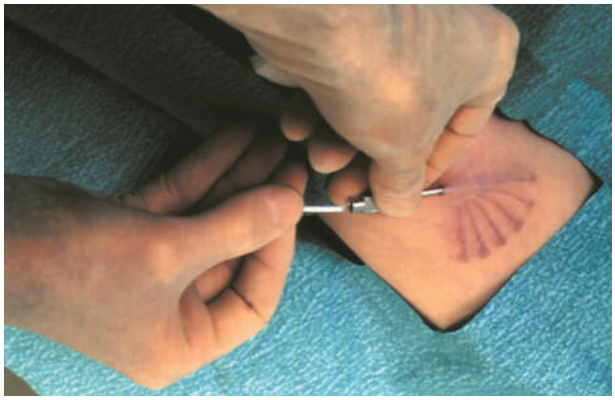
Definition

Norplant is a long-acting hormone that is inserted under the skin and prevents conception for up to five years. Depo-Provera is also a hormone, but is administered by intramuscular injection and provides protection against **pregnancy** for three months. Lunelle is another injectable contraceptive that is administered monthly (every 28 to 30 days); it was approved by the Food and Drug Administration (FDA) in October 2000. The hormone in Norplant and Depo-Provera is progestin, a synthetic hormone similar to one found naturally in a woman's body; Lunelle contains the hormones progestin and estrogen.

Purpose

The purpose of these hormones is to prevent pregnancy; they are about 99% effective in achieving this goal. No hormonal contraceptive methods provide protection from **AIDS** or other **sexually transmitted diseases**.

Depo-Provera and Lunelle are given as an injection and work in several ways to prevent conception. First, the egg (ovum) is prevented from maturing and being released. The mucus in the cervix (opening into the uterus or womb) becomes thicker, making it difficult for the sperm to enter. Depo-Provera and Lunelle also cause the lining of the uterus to become thinner, making implantation of a fertilized egg unlikely.



A physician inserts a contraceptive implant under the skin of a woman's arm. *(Photo Researchers, Inc. Reproduced by permission.)*

An injection of Depo-Provera or Lunelle must be given within the first five days of a normal period. Depo-Provera provides protection against pregnancy for three months, while Lunelle provides similar protection for one month. Ovulation (release of a mature egg) typically occurs within 60 days of the last injection of Lunelle, about twice as fast after use of Depo-Provera. Also, because Lunelle is a combined hormone contraceptive as opposed to progestin-only Depo-Provera and Norplant, it is less likely to cause irregular or absent menstruation.

Norplant capsules contain a synthetic hormone that is slowly released over a period of up to five years. It functions like Depo-Provera in that it prevents the ovaries from producing ova (eggs) and also results in thicker mucus in the cervix, which prevents the sperm from passing through the cervix. Norplant can be inserted at any time.

Preparation

The woman being considered for Depo-Provera or Lunelle will have a pelvic and breast examination, a **Pap test** (a microscopic examination of cell samples taken from the cervix), blood pressure check, weight check, and a review of her medical history. Women who have **diabetes mellitus**, major depression, blood clotting problems, liver disease, or weight problems should use these methods only under strict medical supervision. Depo-Provera or Lunelle should not be used if the woman is pregnant, has unexplained vaginal bleeding,

KEY TERMS

Hormone—A chemical produced in a gland or organ and transported by the blood to another area of the body where it produces a specific effect.

Pap test—A microscopic examination of cell samples taken from the cervix.

suffers from severe liver disease, has **breast cancer**, or has a history of blood clots or **stroke**.

Individuals who select Norplant will receive the same basic **physical examination**. If approved for this method, a site of implantation will be selected (usually the inside of the upper arm), and the area prepared for minor surgery. The skin will be washed with soap and water, and an antiseptic, such as iodine solution, will be applied. The physician will use a local anesthetic to numb the area, a small incision will be made, the six Norplant capsules will be inserted, and the incision sewn up (sutured). Protection against pregnancy normally begins within 24 hours. If necessary, the implants can be removed in 15–20 minutes. Norplant should not be used by women who are pregnant, have blood clotting problems, or have unexplained vaginal bleeding. Advantages include light periods with less cramping and decreased anemia. This form of birth control may also be protective against **endometrial cancer**.

Because Depo-Provera and Norplant use only the hormone progestin, they may provide an alternative for women who can not use estrogen-containing birth control pills. One benefit of Lunelle, however, is that its effects wear off more quickly than Depo-Provera, an important factor in the event that a woman has serious side effects or wants to become pregnant.

Risks

The most common side effects associated with Depo-Provera and Lunelle are yellowing of the skin, **headache**, nervousness, **dizziness**, abdominal **pain**, hair loss, rash, increase in the number of migraine headaches, increased or decreased interest in sexual intercourse, the development of dark spots on the skin, depression, and weakness. Danger signs that need to reported immediately include weight gain, heavy vaginal bleeding, frequent urination, blurred vision, **fainting**, severe abdominal pain, and coughing up blood. Because the effects of Depo-Provera may last up to 12 weeks, it may take a longer time for women trying to conceive to become pregnant after discontinuing the injections.

The main reactions to Norplant include headache, weight gain, irregular periods or no period at all, breast tenderness, **acne**, gain or loss of facial hair, color changes of the skin over the area of insertion, and **ovarian cysts**. The doctor should be notified immediately of lumps in the breast, heavy vaginal bleeding, yellowing of the skin or eyes, or infection of the incision. Women who use Norplant are discouraged from **smoking**.

Normal results

These hormone contraceptive methods normally result in a success rate of 99%.

Resources

BOOKS

Dickason, Elizabeth Jean, Bonnie Lang Silverman, and Judith A. Kaplan. *Maternal-Infant Nursing Care*. 3rd ed. St. Louis: Mosby-Year Book, Inc., 1998.

Gorrie, Trula Meyers, Emily Slone McKinney, and Sharon Smith Murray. *Foundations of Maternal-Newborn Nursing*. 2nd ed. Philadelphia: W. B. Saunders Company, 1998.

Nichols, Francine H., and Elaine Zwelling. *Maternal-Newborn Nursing: Theory and Practice*. Philadelphia: W. B. Saunders Company, 1997.

Olds, Sally B., Marcia L. London, and Patricia Wieland Ladewig. *Maternal-Newborn Nursing: A Family Centered Approach*. Menlo Park: Addison-Wesley, 1996.

OTHER

"Depo Provera." *Planned Parenthood of Western Washington*. <http://www.ppww.org/depo.htm>.

"Lunelle." *Food and Drug Administration (FDA) Page*. <http://www.fda.gov/cder/foi/label/2000/20874lbl.pdf>.

"Is Depo-Provera For You?" *Planned Parenthood Federation of America, Inc*. <http://www.plannedparenthood.org/Library/birthcontrol/depoforyou.html>.

Donald Gardner Barstow

Depression *see* **Bipolar disorder; Postpartum depression**

Depressive disorders

Definition

Depression or depressive disorders (unipolar depression) are mental illnesses characterized by a profound and persistent feeling of sadness or despair and/or a loss of interest in things that were once pleasurable. Disturbance in sleep, appetite, and mental processes are a common accompaniment.

Description

Everyone experiences feelings of unhappiness and sadness occasionally. But when these depressed feelings start to dominate everyday life and cause physical and mental deterioration, they become what are known as depressive disorders. Each year in the United States, depressive disorders affect an estimated 17 million people at an approximate annual direct and indirect cost of $53 billion. One in four women is likely to experience an episode of severe depression in her lifetime, with a 10–20% lifetime prevalence, compared to 5–10% for men. The average age a first depressive episode occurs is in the mid-20s, although the disorder strikes all age groups indiscriminately, from children to the elderly.

There are two main categories of depressive disorders: major depressive disorder and dysthymic disorder. Major depressive disorder is a moderate to severe episode of depression lasting two or more weeks. Individuals experiencing this major depressive episode may have trouble sleeping, lose interest in activities they once took pleasure in, experience a change in weight, have difficulty concentrating, feel worthless and hopeless, or have a preoccupation with **death** or suicide. In children, the major depression may appear as irritability.

While major depressive episodes may be acute (intense but short-lived), dysthymic disorder is an ongoing, chronic depression that lasts two or more years (one or more years in children) and has an average duration of 16 years. The mild to moderate depression of dysthymic disorder may rise and fall in intensity, and those afflicted with the disorder may experience some periods of normal, non-depressed mood of up to two months in length. Its onset is gradual, and dysthymic patients may not be able to pinpoint exactly when they started feeling depressed. Individuals with dysthymic disorder may experience a change in sleeping and eating patterns, low self-esteem, **fatigue**, trouble concentrating, and feelings of hopelessness.

Depression can also occur in **bipolar disorder**, an affective mental illness that causes radical emotional changes and mood swings, from manic highs to depressive lows. The majority of bipolar individuals experience alternating episodes of **mania** and depression.

Signs Of Mental Depression

Depressed mood
Lack of interest or pleasure in daily activities
Significant weight loss (without dieting) or weight gain
Difficulty sleeping or excessive sleeping
Loss of energy
Feelings of worthlessness or guilt
Difficulty in making decisions
Restlessness
Recurrent thoughts of death

Causes and symptoms

The causes behind depression are complex and not yet fully understood. While an imbalance of certain neurotransmitters—the chemicals in the brain that transmit messages between nerve cell— is believed to be key to depression, external factors such as upbringing (more so in dysthymia than major depression) may be as important. For example, it is speculated that, if an individual is abused and neglected throughout childhood and adolescence, a pattern of low self-esteem and negative thinking may emerge. From that, a lifelong pattern of depression may follow.

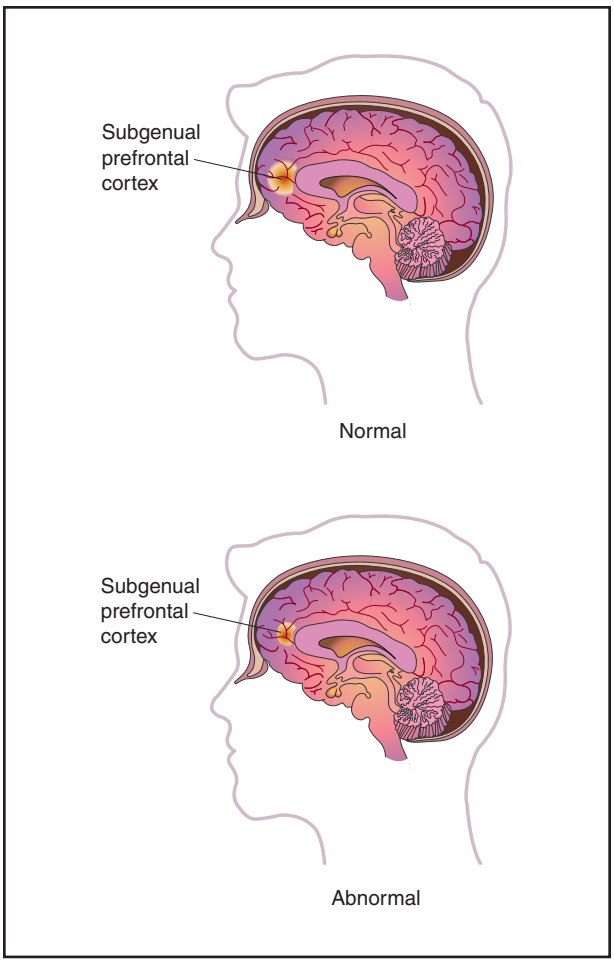
Heredity does seem to play a role in who develops depressive disorders. Individuals with major depression in their immediate family are up to three times more likely to have the disorder themselves. It would seem that biological and genetic factors may make certain individuals pre-disposed or prone to depressive disorders, but environmental circumstances may often trigger the disorder.

External stressors and significant life changes, such as chronic medical problems, death of a loved one, divorce or estrangement, **miscarriage**, or loss of a job, can also result in a form of depression known as adjustment disorder. Although periods of adjustment disorder usually resolve themselves, occasionally they may evolve into a major depressive disorder.

Major depressive episode

Individuals experiencing a major depressive episode have a depressed mood and/or a diminished interest or pleasure in activities. Children experiencing a major depressive episode may appear or feel irritable rather than depressed. In addition, five or more of the following symptoms will occur on an almost daily basis for a period of at least two weeks:

- Significant change in weight.
- **Insomnia** or hypersomnia (excessive sleep).
- Psychomotor agitation or retardation.
- Fatigue or loss of energy.
- Feelings of worthlessness or inappropriate guilt.
- Diminished ability to think or to concentrate, or indecisiveness.
- Recurrent thoughts of death or suicidal and/or suicide attempts.



Recent scientific research has indicated that the size of the subgenual prefrontal cortex of the brain (located behind the bridge of the nose) may be a determining factor in hereditary depressive disorders. *(Illustration by Electronic Illustrators Group.)*

Dysthymic disorder

Dysthymia commonly occurs in tandem with other psychiatric and physical conditions. Up to 70% of dysthymic patients have both dysthymic disorder and major depressive disorder, known as double depression. Substance abuse, panic disorders, **personality disorders**, social **phobias**, and other psychiatric conditions are also found in many dysthymic patients. Dysthymia is prevalent in patients with certain medical conditions, including **multiple sclerosis**, **AIDS**, **hypothyroidism**, **chronic fatigue syndrome**, **Parkinson's disease**, diabetes, and post-cardiac transplantation. The connection between dysthymic disorder and these medical conditions is unclear, but it may be related to the way the medical condition and/or its pharmacological treatment affects neurotransmitters. Dysthymic disorder can lengthen or complicate the recovery of patients also suffering from medical conditions.

Along with an underlying feeling of depression, people with dysthymic disorder experience two or more of the following symptoms on an almost daily basis for a period for two or more years (most suffer for five years), or one year or more for children:

- under or overeating
- insomnia or hypersomnia
- low energy or fatigue
- low self-esteem
- poor concentration or trouble making decisions
- feelings of hopelessness

Diagnosis

In addition to an interview, several clinical inventories or scales may be used to assess a patient's mental status and determine the presence of depressive symptoms. Among these tests are: the Hamilton Depression Scale (HAM-D), Child Depression Inventory (CDI), Geriatric Depression Scale (GDS), Beck Depression Inventory (BDI), and the Zung Self-Rating Scale for Depression. These tests may be administered in an outpatient or hospital setting by a general practitioner, social worker, psychiatrist, or psychologist.

Treatment

Major depressive and dysthymic disorders are typically treated with antidepressants or psychosocial therapy. Psychosocial therapy focuses on the personal and interpersonal issues behind depression, while antidepressant medication is prescribed to provide more immediate relief for the symptoms of the disorder. When used together correctly, therapy and antidepressants are a powerful treatment plan for the depressed patient.

Antidepressants

Selective serotonin reuptake inhibitors (SSRIs) such as fluoxetine (Prozac) and sertraline (Zoloft) reduce depression by increasing levels of serotonin, a neurotransmitter. Some clinicians prefer SSRIs for treatment of dysthymic disorder. **Anxiety**, **diarrhea**, drowsiness, **headache**, sweating, nausea, poor sexual functioning, and insomnia are all possible side effects of SSRIs.

Tricyclic antidepressants (TCAs) are less expensive than SSRIs, but have more severe side-effects, which may include persistent **dry mouth**, **sedation**, **dizziness**, and cardiac **arrhythmias**. Because of these side effects, caution is taken when prescribing TCAs to elderly patients. TCAs include amitriptyline (Elavil), imipramine (Tofranil), and nortriptyline (Aventyl, Pamelor). A 10-day supply of TCAs can be lethal if ingested all at once, so these

drugs may not be a preferred treatment option for patients at risk for suicide.

Monoamine oxidase inhibitors (MAOIS) such as tranylcypromine (Parnate) and phenelzine (Nardil) block the action of monoamine oxidase (MAO), an enzyme in the central nervous system. Patients taking MAOIs must cut foods high in tyramine (found in aged cheeses and meats) out of their diet to avoid potentially serious hypertensive side effects.

Heterocyclics include bupropion (Wellbutrin) and trazodone (Desyrel). Bupropion should not be prescribed to patients with a **seizure disorder**. Side effects of the drug may include agitation, anxiety, confusion, tremor, dry mouth, fast or irregular heartbeat, headache, low blood pressure, and insomnia. Because trazodone has a sedative effect, it is useful in treating depressed patients with insomnia. Other possible side effects of trazodone include dry mouth, gastrointestinal distress, dizziness, and headache.

Psychosocial therapy

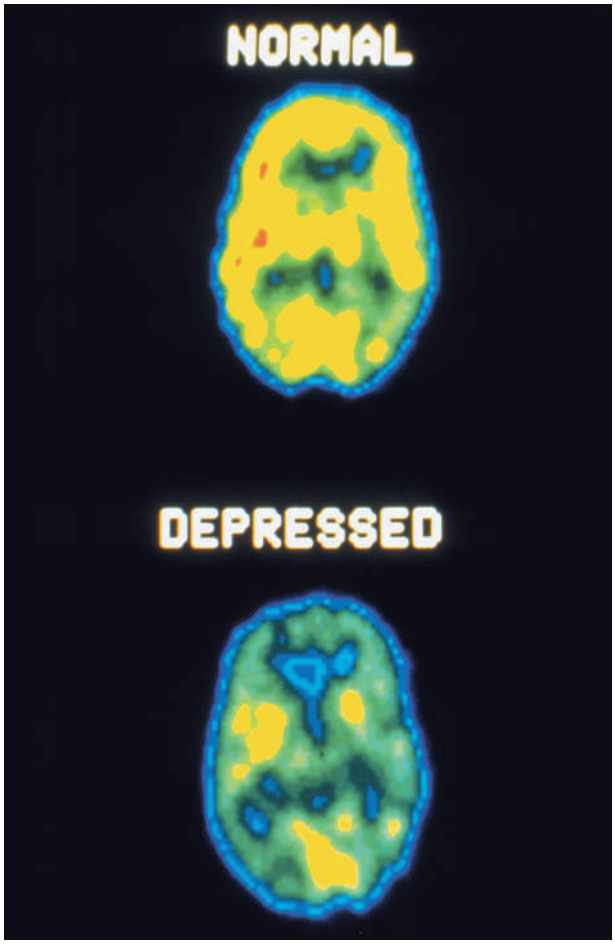
Psychotherapy explores an individual's life to bring to light possible contributing causes of the present depression. During treatment, the therapist helps the patient to become self-aware of his or her thinking patterns and how they came to be. There are several different subtypes of psychotherapy, but all have the common goal of helping the patient develop healthy problem solving and coping skills.

Cognitive-behavioral therapy assumes that the patient's faulty thinking is causing the current depression and focuses on changing the depressed patient's thought patterns and perceptions. The therapist helps the patient identify negative or distorted thought patterns and the emotions and behavior that accompany them, and then retrains the depressed individual to recognize the thinking and react differently to it.

Electroconvulsant therapy

ECT, or **electroconvulsive therapy**, is usually employed after all therapy and pharmaceutical treatment options have been explored. However, it is sometimes used early in treatment when severe depression is present and the patient refuses oral medication, or when the patient is becoming dehydrated, extremely suicidal, or psychotic.

The treatment consists of a series of electrical pulses that move into the brain through electrodes on the patient's head. ECT is given under general anesthesia and patients are administered a muscle relaxant to prevent convulsions. Although the exact mechanisms behind the success of ECT therapy are not known, it is believed that the electrical current modifies the electrochemical processes of the brain, consequently relieving depression. Headaches, muscle soreness, nausea, and confusion are possible side effects immediately following an ECT procedure. Memory loss, typically transient, has also been reported in ECT patients.



Positron emission tomography (PET) scans comparing a normal brain with that of someone with a depressed mental disorder. *(Photo Researchers, Inc. Reproduced by permission.)*

Alternative treatment

St. John's wort (*Hypericum perforatum*) is used throughout Europe to treat depressive symptoms. Unlike traditional prescription antidepressants, this herbal antidepressant has few reported side effects. Some users may experience high blood pressure, headaches, stiff neck, nausea, and vomiting. As of early 1998, United States. clinical trials organized by the National Institute of Mental Health were still in the planning phase. Its efficacy in severe depression is very uncertain.

Homeopathic treatment can also be very therapuetic in treating depression. Good **nutrition**, proper sleep,

KEY TERMS

Hypersomnia— The need to sleep excessively; a symptom of dysthymic and major depressive disorder.

Neurotransmitter—A chemical in the brain that transmits messages between neurons, or nerve cells. Changes in the levels of certain neurotransmitters, such as serotonin, norepinephrine, and dopamine, are thought to be related to depressive disorders.

Psychomotor agitation—Disturbed physical and mental processes (e.g., fidgeting, wringing of hands, racing thoughts); a symptom of major depressive disorder.

Psychomotor retardation—Slowed physical and mental processes (e.g., slowed thinking, walking, and talking); a symptom of major depressive disorder.

exercise, and full engagement in life are very important to a healthy mental state.

Prognosis

Untreated or improperly treated depression is the number one cause of suicide in the United States. Proper treatment relieves symptoms in 80–90% of depressed patients. After each major depressive episode, the risk of recurrence climbs significantly—50% after one episode, 70% after two episodes, and 90% after three episodes. For this reason, patients need to be aware of the symptoms of recurring depression and may require long-term maintenance treatment of antidepressants and/or therapy.

Prevention

Patient education in the form of therapy or self-help groups is crucial for training patients with depressive disorders to recognize symptoms of depression and to take an active part in their treatment program. Extended maintenance treatment with antidepressants may be required in some patients to prevent relapse. Early intervention with children with depression is effective in arresting development of more severe problems.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S., and Nicholas G. Ward. "Mood Disorders." *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Thompson, Tracy. *The Beast: A Reckoning with Depression*. New York: GP Putnam, 1995.

Whybrow, Peter C. *A Mood Apart*. New York: HarperCollins, 1997.

PERIODICALS

Hirschfeld, R. M., et al. "The National Depressive and Manic-Depressive Association Consensus Statement on the Undertreatment of Depression." *The Journal of the American Medical Association* 277, no. 4 (1997): 333-40.

Miller, Mark D. "Recognizing and Treating Depression in the Elderly." *Medscape Mental Health* 2, no. 3 (1997).

Miller, Sue. "A Natural Mood Booster." *Newsweek*, 5 May 1997: 74-5.

Sansone, Randy A. and Lori A. Sansone. "Dysthymic Disorder: The Chronic Depression." *American Family Physician*, 53, no. 8 (June 1996): 2588-96.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington, DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Depressive and Manic-Depressive Association (NDMDA). 730 N. Franklin St., Suite 501, Chicago, IL 60610. (800) 826-3632. <http://www.ndmda.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Paula Anne Ford-Martin

Dermabrasion *see* **Skin resurfacing**

Dermatitis

Definition

Dermatitis is a general term used to describe inflammation of the skin.

Description

Most types of dermatitis are characterized by an itchy pink or red rash.

Contact dermatitis is an allergic reaction to something that irritates the skin and is manifested by one or more lines of red, swollen, blistered skin that may itch or

seep. It usually appears within 48 hours after touching or brushing against a substance to which the skin is sensitive. The condition is more common in adults than in children.

Contact dermatitis can occur on any part of the body, but it usually affects the hands, feet, and groin. Contact dermatitis usually does not spread from one person to another, nor does it spread beyond the area exposed to the irritant unless affected skin comes into contact with another part of the body. However, in the case of some irritants, such as poison ivy, contact dermatitis can be passed to another person or to another part of the body.

Stasis dermatitis is characterized by scaly, greasy looking skin on the lower legs and around the ankles. Stasis dermatitis is most apt to affect the inner side of the calf.

Nummular dermatitis, which is also called nummular eczematous dermatitis or nummular eczema, generally affects the hands, arms, legs, and buttocks of men and women older than 55 years of age. This stubborn inflamed rash forms circular, sometimes itchy, patches and is characterized by flares and periods of inactivity.

Atopic dermatitis is characterized by **itching**, scaling, swelling, and sometimes blistering. In early childhood it is called infantile eczema and is characterized by redness, oozing, and crusting. It is usually found on the face, inside the elbows, and behind the knees.

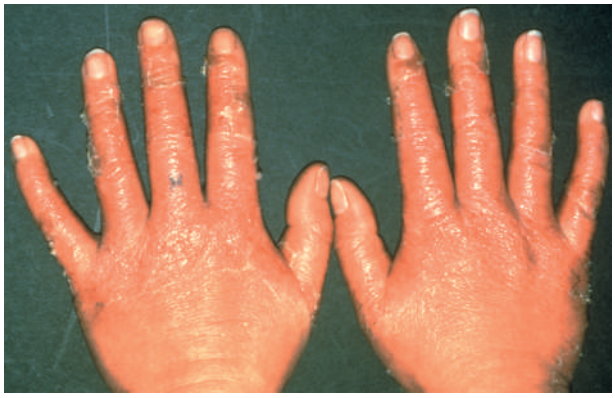
Seborrheic dermatitis may be dry or moist and is characterized by greasy scales and yellowish crusts on the scalp, eyelids, face, external surfaces of the ears, underarms, breasts, and groin. In infants it is called "cradle cap."

Causes and symptoms

Allergic reactions are genetically determined, and different substances cause contact dermatitis to develop in different people. A reaction to resin produced by poison ivy, poison oak, or poison sumac is the most common source of symptoms. It is, in fact, the most common allergy in this country, affecting one of every two people in the United States.

Flowers, herbs, and vegetables can also affect the skin of some people. **Burns** and **sunburn** increase the risk of dermatitis developing, and chemical irritants that can cause the condition include:

- chlorine
- cleansers
- detergents and soaps
- fabric softeners
- glues used on artificial nails
- perfumes
- topical medications



Dermatitis on hands and fingers. *(Custom Medical Stock Photo. Reproduced by permission.)*

Contact dermatitis can develop when the first contact occurs or after years of use or exposure.

Stasis dermatitis, a consequence of poor circulation, occurs when leg veins can no longer return blood to the heart as efficiently as they once did. When that happens, fluid collects in the lower legs and causes them to swell. Stasis dermatitis can also result in a rash that can break down into sores known as stasis ulcers.

The cause of nummular dermatitis is not known, but it usually occurs in cold weather and is most common in people who have dry skin. Hot weather and **stress** can aggravate this condition, as can the following:

- **allergies**
- fabric softeners
- soaps and detergents
- wool clothing
- bathing more than once a day

Atopic dermatitis can be caused by allergies, **asthma**, or stress, and there seems to be a genetic predisposition for atopic conditions. It is sometimes caused by an allergy to nickel in jewelry.

Seborrheic dermatitis (for which there may also be a genetic predisposition) is usually caused by overproduction of the oil glands. In adults it can be associated with **diabetes mellitus** or gold allergy. In infants and adults it may be caused by a biotin deficiency.

Diagnosis

The diagnosis of dermatitis is made on the basis of how the rash looks and its location. The doctor may scrape off a small piece of affected skin for microscopic examination or direct the patient to discontinue use of any potential irritant that has recently come into contact with

KEY TERMS

Allergic reaction—An inappropriate or exaggerated genetically determined reaction to a chemical that occurs only on the second or subsequent exposures to the offending agent, after the first contact has sensitized the body.

Corticosteriod—A group of synthetic hormones that are used to prevent or reduce inflammation. Toxic effects may result from rapid withdrawal after prolonged use or from continued use of large doses.

Patch test—A skin test that is done to identify allergens. A suspected substance is applied to the skin. After 24–48 hours, if the area is red and swollen, the test is positive for that substance. If no reaction occurs, another substance is applied. This is continued until the patient experiences an allergic reaction where the irritant was applied to the skin.

Rash—A spotted, pink or red skin eruption that may be accompanied by itching and is caused by disease, contact with an allergen, food ingestion, or drug reaction.

Ulcer—An open sore on the skin, resulting from tissue destruction, that is usually accompanied by redness, pain, or infection.

the affected area. Two weeks after the rash disappears, the patient may resume use of the substances, one at a time, until the condition recurs. Eliminating the substance most recently added should eliminate the irritation.

If the origin of the irritation has still not been identified, a dermatologist may perform one or more patch tests. This involves dabbing a small amount of a suspected irritant onto skin on the patient's back. If no irritation develops within a few days, another patch test is performed. The process continues until the patient experiences an allergic reaction at the spot where the irritant was applied.

Treatment

Treating contact dermatitis begins with eliminating or avoiding the source of irritation. Prescription or over-the-counter corticosteroid creams can lessen inflammation and relieve irritation. Creams, lotions, or ointments not specifically formulated for dermatitis can intensify the irritation. Oral **antihistamines** are sometimes recommended to alleviate itching, and **antibiotics** are prescribed if the rash becomes infected. Medications taken by mouth to relieve symptoms of dermatitis can make skin red and scaly and cause hair loss.

Patients who have a history of dermatitis should remove their rings before washing their hands. They should use bath oils or glycerine-based soaps and bathe in lukewarm saltwater.

Patting rather than rubbing the skin after bathing and thoroughly massaging lubricating lotion or nonprescription cortisone creams into still-damp skin can soothe red, irritated nummular dermatitis. Highly concentrated cortisone preparations should not be applied to the face, armpits, groin, or rectal area. Periodic medical monitoring is necessary to detect side effects in patients who use such preparations on **rashes** covering large areas of the body.

Coal-tar salves can help relieve symptoms of nummular dermatitis that have not responded to other treatments, but these ointments have an unpleasant odor and stain clothing.

Patients who have stasis dermatitis should elevate their legs as often as possible and sleep with a pillow between the lower legs.

Tar or zinc paste may also be used to treat stasis dermatitis. Because these compounds must remain in contact with the rash for as long as two weeks, the paste and bandages must be applied by a nurse or a doctor.

Coal-tar shampoos may be used for seborrheic dermatitis that occurs on the scalp. Sun exposure after the use of these shampoos should be avoided because the risk of sunburn of the scalp is increased.

Alternative treatment

Some herbal therapies can be useful for skin conditions. Among the herbs most often recommended are:

- Burdock root (*Arctium lappa*)
- Calendula (*Calendula officinalis*) ointment
- Chamomile (*Matricaria recutita*) ointment
- Cleavers (*Galium* ssp.)
- Evening primrose oil (*Oenothera biennis*)
- Nettles (*Urtica dioica*)

Contact dermatitis can be treated botanically and homeopathically. Grindelia (*Grindelia* spp.) and sassafras (*Sassafras albidum*) can help when applied topically. Determining the source of the problem and eliminating it is essential. Oatmeal baths are very helpful in relieving the itch. Bentonite clay packs or any mud pack draws the fluid out, and helps dry up the lesions. Cortisone creams are not recommended.

Stasis dermatitis should be treated by a trained practitioner. This condition responds well to topical herbal therapies, however, the cause must also be addressed.

Selenium-based shampoos, topical applications of flax oil and/or olive oil, and biotin supplementation are among the therapies recommended for seborrheic dermatitis.

Prognosis

Dermatitis is often chronic, but symptoms can generally be controlled.

Prevention

Contact dermatitis can be prevented by avoiding the source of irritation. If the irritant cannot be avoided completely, the patient should wear gloves and other protective clothing whenever exposure is likely to occur.

Immediately washing the exposed area with soap and water can stem allergic reactions to poison ivy, poison oak, or poison sumac, but because soaps can dry the skin, patients susceptible to dermatitis should use them only on the face, feet, genitals, and underarms.

Clothing should be loose fitting and 100% cotton. New clothing should be washed in dye-free, unscented detergent before being worn.

Injury to the lower leg can cause stasis dermatitis to ulcerate (form open sores). If stasis ulcers develop, a doctor should be notified immediately.

Yoga and other relaxation techniques may help prevent atopic dermatitis caused by stress.

Avoidance of sweating may aid in preventing seborrheic dermatitis.

A patient who has dermatitis should also notify a doctor if any of the following occurs:

- fever develops
- skin oozes or other signs of infection appear
- symptoms do not begin to subside after seven days' treatment
- he/she comes into contact with someone who has a wart, **cold sore**, or other viral skin infection

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

New Choices in Natural Healing. Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

OTHER

"Allergic Contact Dermatitis." *The Skin Site*. 10 Apr. 1998 <http://www.skinsite.com/info_allergic.htm>.

"Dermatitis, Contact." *ThriveOnline*. 10 Apr. 1998 <http://thriveonline.oxygen.com>.

"Nummular Dermatitis." *The Skin Site*. 7 Apr. 1998 <http://www.skinsite.com/info_nummular_dermatitis.htm>.

"Poison Ivy, Oak, Sumac." *ThriveOnline*. 10 Apr. 1998 <http://thriveonline.oxygen.com>.

"Stasis Dermatitis." *The Skin Site*. 7 Apr. 1998 <http://www.skinsite.com/info_stasis_dermatitis.htm>.

Maureen Haggerty

Dermatophyte infections *see* **Ringworm**

DES exposure

Definition

DES (diethylstilbestrol) is a hormone that was prescribed for pregnant women in the 1950s and early 1960s. Many years later, doctors discovered that the daughters of the women who received DES were at high risk for a variety of problems, including **infertility**, **premature labor**, and **cancer** of the vagina and cervix.

Description

In the 1950s and early 1960s, several drug companies claimed that DES (diethylstilbestrol) could prevent miscarriages. DES is a synthetic hormone, related to estrogen. Since up to 20% of all pregnancies end in **miscarriage**, this seemed like an important breakthrough and DES was prescribed for many women who had bleeding in early **pregnancy**. Ultimately, it was found to have no effect on miscarriages and the practice of prescribing DES was stopped in the 1960s. Almost 10 years later, the daughters of women who had taken DES during pregnancy began to develop unusual symptoms.

Doctors discovered that when these young women reached their teens, they were at higher risk for a variety of problems, including:

- clear cell adenocarcinoma of the vagina and cervix
- infertility
- premature labor and other problems in pregnancy

Causes and symptoms

DES has affected a very specific group of women. These are women who were exposed to DES in utero before 18 weeks of pregnancy. In other words, their mothers must have taken DES within the first four to five months of pregnancy. It is now known that the female reproductive organs are formed during that time. DES

KEY TERMS

Cervix—The opening at the bottom of the uterus.

Colposcopy—A special examination of the cervix using a magnifying scope. This is a procedure that can be done in the doctor's office.

Fallopian tubes—The tubes that carry the ovum (egg) from the ovary to the uterus.

Pap smear—A screening test for precancerous and cancerous cells on the cervix. This simple test is done during a routine pelvic exam and involves scraping cells from the cervix.

appears to interfere with proper growth and development of the uterus, cervix, vagina, and fallopian tubes.

In the early 1970s, there was an increase in a rare form of cancer, clear cell adenocarcinoma of the vagina and cervix. Up until that time, doctors had seen these cancers only in elderly women. Suddenly, young women who had the disease appeared.

This was so unusual that researchers studied these women to see if they had anything in common. After a great deal of questioning and examination, it was found that they all had one factor in common. All of the young women had been exposed to DES in utero in the early weeks of pregnancy.

Today, it is difficult to imagine how shocking this discovery was. Doctors had only recently recognized that medications and exposure to chemicals during pregnancy could cause **birth defects**. This was a birth defect that had gone undetected for almost two decades.

Since then, doctors have studied DES daughters very carefully. Fortunately, the risk of clear cell adenocarcinoma is actually quite low. In fact, it appears that if a DES daughter has not developed this cancer by age 30, she will not develop it. Since all DES daughters are now over age 30, there should be no further cases related to DES exposure. However, there are a number of other symptoms and problems associated with DES exposure.

- Cervix and vagina. DES daughters often have distinctive changes of the cervix and vagina that can be seen during a **pelvic exam**. These changes include a cervical hood (a vaginal fold draped over the cervix), cockscomb cervix (an abnormally shaped cervix), and adenosis (glandular cells normally located within the cervix that appear on the outside of the cervix and in the vagina).
- Fallopian tubes. Some DES daughters have fallopian tube abnormalities that lead to infertility.
- Uterus. Many DES daughters have a uterus that is abnormal in size and shape. The classic sign is the T-shaped uterus. In the normal uterus, the cavity (hollow space inside) is rounded. In a T-shaped uterus, the cavity is reduced to a thin T. The abnormal shape of the inside of the uterus makes it harder for a woman to get pregnant and leads to a higher risk of premature labor and birth.

Diagnosis

Women who have been exposed to DES should have a pelvic exam at least once a year. In addition to the usual pelvic exam and Pap smear, DES daughters should also have Pap smears of the vagina and, if possible, **colposcopy**. During colposcopy, the doctor looks at the cervix and vagina through a special magnifying scope. In this way, tiny areas of abnormal cells can be seen. This procedure is easily performed in the doctor's office.

When DES daughters get pregnant, they may be at high risk for premature labor and birth and should be monitored very carefully.

Not all women who were exposed to DES develop problems in pregnancy. However, if problems like infertility or miscarriage do occur, the doctor may recommend a special x-ray test to check the woman's fallopian tubes and uterus. This special test is called a hysterosalpingogram.

Treatment

There is no treatment for the abnormalities of the fallopian tubes and uterus caused by DES exposure. Fortunately, there are treatments that can help with infertility and premature labor. Clear cell adenocarcinoma of the vagina or cervix must be treated with surgery and, possibly, **chemotherapy**.

Resources

BOOKS

Laufer, Mark R., and Donald P. Goldstein. "Pediatric and Adolescent Gynecology." In *Kistner's Gynecology*, ed. Kenneth J. Ryan, Ross S. Berkowitz, and Robert L. Barbieri. St. Louis: Mosby, 1995.

Sheets, Ellen. "Clear Cell Adenocarcinoma of the Cervix." In *Kistner's Gynecology*, ed. Kenneth J. Ryan, Ross S. Berkowitz, and Robert L. Barbieri. St. Louis: Mosby, 1995.

Amy B. Tuteur, MD

Detached retina *see* **Retinal detachment**

Detoxification

Definition

Detoxification is one of the more widely used treatments and concepts in alternative medicine. It is based on the principle that illnesses can be caused by the accumulation of toxic substances (toxins) in the body. Eliminating existing toxins and avoiding new toxins are essential parts of the healing process. Detoxification utilizes a variety of tests and techniques.

Purpose

Detoxification is helpful for those patients suffering from many chronic diseases and conditions, including **allergies**, **anxiety**, arthritis, **asthma**, chronic infections, depression, diabetes, headaches, heart disease, **high cholesterol**, low blood sugar levels, digestive disorders, mental illness, and **obesity**. It is helpful for those with conditions that are influenced by environmental factors, such as **cancer**, as well as for those who have been exposed to high levels of toxic materials due to accident or occupation. Detoxification therapy is useful for those suffering from allergies or immune system problems that conventional medicine is unable to diagnose or treat, including **chronic fatigue syndrome**, environmental illness/multiple chemical sensitivity, and **fibromyalgia**. Symptoms for those suffering these conditions may include unexplained **fatigue**, increased allergies, hypersensitivity to common materials, intolerance to certain foods and **indigestion**, aches and pains, low grade **fever**, headaches, **insomnia**, depression, sore throats, sudden weight loss or gain, lowered resistance to infection, general malaise, and disability. Detoxification can be used as a beneficial preventative measure and as a tool to increase overall health, vitality, and resistance to disease.

Description

Origins

Detoxification methods of healing have been used for thousands of years. **Fasting**, is one of the oldest therapeutic practices in medicine. Hippocrates, the ancient Greek known as the "Father of Western medicine," recommended fasting as a means for improving health. **Ayurvedic medicine**, a traditional healing system that has developed over thousands of years, utilizes detoxification methods to treat many chronic conditions and to prevent illness.

Detoxification treatment has become one of the cornerstones of alternative medicine. Conventional medicine notes that environmental factors can play a significant role in many illnesses. Environmental medicine is a field that studies exactly how those environmental factors influence disease. Conditions such as asthma, cancer, chronic fatigue syndrome, **multiple chemical sensitivity**, and many others are strongly influenced by exposure to toxic or allergenic substances in the environment. The United States Centers for Disease Control estimate that over 80% of all illnesses have environmental and lifestyle causes.

Detoxification has also become a prominent treatment as people have become more aware of environmental pollution. It is estimated that one in every four Americans suffers from some level of **heavy metal poisoning**. Heavy metals, such as lead, mercury, cadmium, and arsenic, are by-products of industry. Synthetic agriculture chemicals, many of which are known to cause health problems, are also found in food, air, and water. American agriculture uses nearly 10 lb (4.5 kg) of pesticides per person on the food supply each year. These toxins have become almost unavoidable. Pesticides that are used only on crops in the southern United States have been found in the tissue of animals in the far north of Canada. DDT, a cancer-causing insecticide that has been banned for decades, is still regularly found in the fatty tissue of animals, birds, and fish, even in extremely remote regions such as the North Pole.

The problem of toxins in the environment is compounded because humans are at the top of the food chain and are more likely to be exposed to an accumulation of toxic substances in the food supply. For instance, pesticides and herbicides are sprayed on grains that are then fed to farm animals. Toxic substances are stored in the fatty tissue of those animals. In addition, those animals are often injected with synthetic hormones, **antibiotics**, and other chemicals. When people eat meat products, they are exposed to the full range of chemicals and additives used along the entire agricultural chain. Detoxification specialists call this build up of toxins *bioaccumulation*. They assert that the bioaccumulation of toxic substances over time is responsible for many physical and mental disorders, especially ones that are increasing rapidly (like asthma, cancer, and mental illness). As a result, detoxification therapies are increasing in importance and popularity.

Toxins in the body include heavy metals and various chemicals such as pesticides, pollutants, and food additives. Drugs and alcohol have toxic effects in the body. Toxins are produced as normal by-products in the intestines by the bacteria that break down food. The digestion of protein also creates toxic by-products in the body.

The body has natural methods of detoxification. Individual cells get detoxified in the lymph and circulatory system. The liver is the principle organ of detoxifi-

cation, assisted by the kidneys and intestines. Toxins can be excreted from the body by the kidneys, bowels, skin, and lungs. Detoxification treatments become necessary when the body's natural detoxification systems become overwhelmed. This can be caused by long-term effects of improper diet, **stress**, overeating, sedentary lifestyles, illness, and poor health habits in general. When a build up of toxic substances in the body creates illness, it's called toxemia. Some people's digestive tracts become unable to digest food properly, due to years of overeating and **diets** that are high in fat and processed foods and low in fiber (the average American diet). When this happens, food cannot pass through the digestive tract efficiently. Instead of being digested properly or eliminated from the bowel, food can literally rot inside the digestive tract and produce toxic by-products. This state is known as toxic colon syndrome or intestinal toxemia.

Detoxification therapies try to activate and assist the body's own detoxification processes. They also try to eliminate additional exposure to toxins and strengthen the body and immune system so that toxic imbalances won't occur in the future.

Testing for toxic substances

Detoxification specialists use a variety of tests to determine the causes contributing to toxic conditions. These causes include infections, allergies, addictions, toxic chemicals, and digestive and organ dysfunction. Blood, urine, stool, and hair analyses, as well as **allergy tests**, are used to measure a variety of bodily functions that may indicate problems. Detoxification therapists usually have access to laboratories that specialize in sophisticated diagnostic tests for toxic conditions.

People who have toxemia are often susceptible to infection because their immune systems are weakened. Infections can be caused by parasites, bacteria, viruses, and a common yeast. Therapists will screen patients for underlying infections that may be contributing to illness.

Liver function is studied closely with blood and urine tests because the liver is the principle organ in the body responsible for removing toxic compounds. When the liver detoxifies a substance from the body, it does so in two phases. Tests are performed that indicate where problems may be occurring in these phases, which may point to specific types of toxins. Blood and urine tests can also be completed that screen for toxic chemicals such as PCBs (environmental poisons), formaldehyde (a common preservative), pesticides, and heavy metals. Another useful blood test is a test for zinc deficiency, which may reveal heavy metal **poisoning**. Hair analysis is used to test for heavy metal levels in the body. Blood and urine tests check immune system activity, and hormone levels can also indicate specific toxic compounds. A 24-hour urine analysis, where samples are taken around the clock, allows therapists to determine the efficiency of the digestive tract and kidneys. Together with stool analysis, these tests may indicate toxic bowel syndrome and digestive system disorders. Certain blood and urine tests may point to nutritional deficiencies and proper recovery diets can be designed for patients as well.

Detoxification therapists may also perform extensive allergy and hypersensitivity tests. Intradermal (between layers of the skin) and sublingual (under the tongue) allergy tests are used to determine a patient's sensitivity to a variety of common substances, including formaldehyde, auto exhaust, perfume, tobacco, chlorine, jet fuel, and other chemicals.

Food allergies require additional tests because these allergies often cause reactions that are delayed for several days after the food is eaten. The RAST (radioallergosorbent test) is a blood test that determines the level of antibodies (immunoglobulins) in the blood after specific foods are eaten. The cytotoxic test is a blood test that determines if certain substances affect blood cells, including foods and chemicals. The ELISA-ACT (enzyme-linked immunoserological assay activated cell test) is considered to be one of the most accurate tests for allergies and hypersensitivity to foods, chemicals, and other agents. Other tests for food allergies are the elimination and rotation diets, in which foods are systematically evaluated to determine the ones that are causing problems.

Detoxification therapists usually interview and counsel patients closely to determine and correct lifestyle, occupational, psychological, and emotional factors that may also be contributing to illness.

Detoxification therapies

Detoxification therapists use a variety of healing techniques after a diagnosis is made. The first step is to eliminate a patient's exposure to all toxic or allergenic substances. These include heavy metals, chemicals, radiation (from x rays, power lines, cell phones, computer screens, and microwaves), smog, polluted water, foods, drugs, **caffeine**, alcohol, perfume, excess noise, and stress. If mercury poisoning has been determined, the patient will be advised to have mercury fillings from the teeth removed, preferably by a holistic dentist.

Specific treatments are used to stimulate and assist the body's detoxification process. Dietary change is immediately enacted, eliminating allergic and unhealthy foods, and emphasizing foods that assist detoxification and support healing. Detoxification diets are generally low in fat, high in fiber, and vegetarian with a raw food emphasis. Processed foods, alcohol, and caffeine are

Common Herbs Used For Detoxification

Antibiotics	Anticatarrhals (Help Eliminate Mucus)	Blood Cleaners
Clove	Boneset	Burdock root
Echinacea	Echinacea	Dandelion root
Eucalyptus	Garlic	Echinacea
Garlic	Goldenseal root	Oregon grape root
Myrrh	Hyssop	Red clover blossoms
Prickly ash bark	Sage	Yellow dock root
Propolis	Yarrow	
Wormwood		
Diaphoretics/Skin Cleaners	**Diuretics**	**Laxatives**
Boneset	Cleavers	Buckthorn
Burdock root	Corn silk	Cascara sagrada
Cayenne pepper	Horsetail	Dandelion root
Elder flowers	Juniper berries	Licorice root
Ginger root	Parsley leaf	Rhubarb root
Goldenseal root	Uva ursi	Senna leaf
Peppermint	Yarrow dock	Yellow dock
Oregon grape root		
Yellow dock		

avoided. Nutritional supplements such as **vitamins**, **minerals**, antioxidants, amino acids, and essential fatty acids are often prescribed. Spirulina is a sea algae that is frequently given to assist in eliminating heavy metals. Lipotropic agents are certain vitamins and nutrients that promote the flow of bile and fat from the liver.

Many herbal supplements are used in detoxification therapies as well. Milk thistle extract, called silymarin, is one of the more potent herbs for detoxifying the liver. Naturopathy, Ayurvedic medicine, and **traditional Chinese medicine** (TCM) recommend numerous herbal formulas for detoxification and immune strengthening. If infections or parasites have been found, these are treated with herbal formulas and, in difficult cases, antibiotics.

For toxic bowel syndrome and digestive tract disorders, herbal **laxatives** and high fiber foods such as psyllium seeds may be given to cleanse the digestive tract and promote elimination. Colonics are used to cleanse the lower intestines. Digestive enzymes are prescribed to improve digestion, and acidophilus and other friendly bacteria are reintroduced into the system with nutritional supplements.

Fasting is another major therapy in detoxification. Fasting is one of the quickest ways to promote the elimination of stored toxins in the body and to prompt the healing process. People with severe toxic conditions are supervised closely during fasting because the number of toxins in the body temporarily increases as they are being released.

Chelation therapy is used by detoxification specialists to rid the body of heavy metals. Chelates are particular substances that bind to heavy metals and speed their elimination. Homeopathic remedies have also been shown to be effective for removing heavy metals.

Sweating therapies can also detoxify the body because the skin is a major organ of elimination. Sweating helps release those toxins that are stored in the subcutaneous (under the skin) fat cells. Saunas, therapeutic baths, and **exercise** are some of these treatments. Body therapies may also be prescribed, including **massage therapy**, **acupressure**, **shiatsu**, manual lymph drainage, and **polarity therapy**. These body therapies seek to improve circulatory and structural problems, reduce stress, and promote healing responses in the body. Mind/body therapies such as psychotherapy, counseling, and stress management techniques may be used to heal the psychological components of illness and to help patients overcome their negative patterns contributing to illness.

Practitioners and treatment costs

The costs of detoxification therapies can vary widely, depending on the number of tests and treatments required. Detoxification treatments can be lengthy and involved since illnesses associated with toxic conditions usually develop over many years and may not clear up quickly. Detoxification treatments may be lengthy because they often strive for the holistic healing of the body, mind, and emotions.

Practitioners may be conventionally trained medical doctors with specialties in environmental medicine or interests in alternative treatment. The majority of detoxification therapists are alternative practitioners, such as naturopaths, homeopaths, ayurvedic doctors, or traditional Chinese doctors. Insurance coverage varies, depending

KEY TERMS

Allergen—A foreign substance, such as mites in house dust or animal dander, that when inhaled,causes the airways to narrow and produces symptoms of asthma.

Antibody—A protein, also called immunoglobulin, produced by immune system cells to remove antigens (the foreign substances that trigger the immune response).

Fibromyalgia—A condition of debilitating pain, among other symptoms, in the muscles and the myofascia (the thin connective tissue that surrounds muscles, bones, and organs).

Hypersensitivity—The state where even a tiny amount of allergen can cause severe allergic reactions.

Multiple chemical sensitivity—A condition characterized by severe and crippling allergic reactions to commonly used substances, particularly chemicals. Also called environmental illness.

on the practitioner and the treatment involved. Consumers should review their individual insurance policies regarding treatment coverage.

Preparations

Patients can assist diagnosis and treatment by keeping detailed diaries of their activities, symptoms, and contact with environmental factors that may be affecting their health. Reducing exposure to environmental toxins and making immediate dietary and lifestyle changes may speed the detoxification process.

Side effects

During the detoxification process, patients may experience side effects of fatigue, malaise, aches and pains, emotional duress, **acne**, headaches, allergies, and symptoms of colds and flu. Detoxification specialists claim that these negative side effects are part of the healing process. These reactions are sometimes called *healing crises*, which are caused by temporarily increased levels of toxins in the body due to elimination and cleansing.

Research and general acceptance

Although environmental medicine is gaining more respect within conventional medicine, detoxification treatment is scarcely mentioned by the medical establishment. The research that exists on detoxification is largely testimonial, consisting of individual personal accounts of healing without statistics or controlled scientific experiments. In the alternative medical community, detoxification is an essential and widely accepted treatment for many illnesses and chronic conditions.

Resources

BOOKS

Goldberg, Burton. *Chronic Fatigue, Fibromyalgia and Environmental Illness*. Tiburon, CA: Future Medicine, 1998.

Lappe, Marc. *Chemical Deception: The Toxic Threat to Health and the Environment*. San Francisco: Sierra Club, 1991.

Lawson, Lynn. *Staying Well in a Toxic World*. Chicago: Noble, 1993.

Randolph, Theron G., M.D. *Environmental Medicine: Beginnings and Bibliographies of Clinical Ecology*. Fort Collins, CO: Clinical Ecology Publications, 1987.

PERIODICALS

Alternative Therapies Magazine. P.O. Box 17969, Durham, NC 27715. (919) 668-8825. <http://www.alternative-therapies.com>.

Journal of Occupational and Environmental Medicine. 1114 N. Arlington Heights Rd., Arlington Heights, IL 60004. (847) 818-1800.

ORGANIZATIONS

American Holistic Medical Association. 4101 Lake Boone Trail, Suite 201, Raleigh, NC 27607.

Cancer Prevention Coalition. 2121 West Taylor St., Chicago, IL 60612. (312) 996-2297. <http:\\www.preventcancer.com>.

Center for Occupational and Environmental Medicine.7510 Northforest Dr., North Charleston, SC 29420. (843) 572-1600. <http:\\www.coem.com>.

Northeast Center for Environmental Medicine. P.O. Box 2716, Syracuse, NY 13220. (800) 846-ONUS.

Northwest Center for Environmental Medicine. 177 NE 102nd St., Portland, OR 97220. (503) 561-0966.

OTHER

A Citizens Toxic Waste Manual. Greenpeace USA, 1436 U St. NW, Washington, DC 20009. (202) 462-1177.

Douglas Dupler

Deviated septum

Definition

The nasal septum is a thin structure, separating the two sides of the nose. If it is not in the middle of the nose, then it is deviated.

Description

The nasal septum is composed of two parts. Toward the back of the head the nasal septum is rigid bone, but further forward the bone becomes cartilage. With one finger in each nostril this cartilage can easily be bent back and forth. If the nasal septum is sufficiently displaced to one side, it will impede the flow of air and mucus through the nose. This condition, called a deviated septum, can cause symptoms and disease.

Causes and symptoms

A deviated septum can be a simple variation in normal structure or the result of a broken nose. Any narrowing of the nasal passageway that it causes will threaten the drainage of secretions from the sinuses, which must pass through the nose. It is a general rule of medicine that when flow is obstructed, whether it is mucus from the sinuses or bile from the gall bladder, infection results. People with **allergic rhinitis** (hay fever) are at greater risk of obstruction because their nasal passageways are already narrowed by the swollen membranes lining them. The result is **sinusitis**, which can be acute and severe or chronic and lingering.

Diagnosis

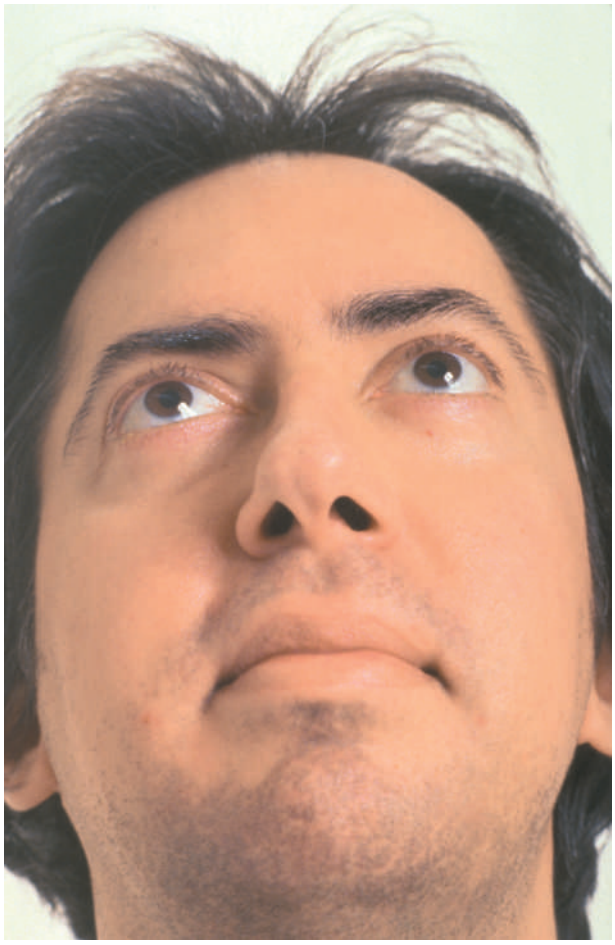
It is easy to see that a septum is deviated. It is more difficult to determine if that deviation needs correction. It is common for a patient to complain that he/she can breathe through only one nostril. Then the diagnosis is easy. A deviated septum may also contribute to **snoring**, **sleep apnea**, and other breathing disorders.

Treatment

The definitive treatment is surgical repositioning of the septum, accomplished by breaking it loose and fixing it in a proper place while it heals. **Decongestants** like pseudoephedrine or phenylpropanolamine will shrink the membranes and thereby enlarge the passages. **Antihistamines**, nasal cortisone spray, and other allergy treatments may also be temporarily beneficial.

Alternative treatment

As a palliative, saline drops and sprays are very helpful in loosening mucus in the obstructed side and preventing drying in the other side, where all the air blows. Hot peppers, such as jalapenos, can produce enough tears and discharge to flush out a stopped-up nose. An even more effective treatment is called a nasal lavage, often done using a small pot with a spout. Saline solution is poured into one nostril and allowed to flow out the other nostril.



A close-up of person with a deviated septum. *(Custom Medical Stock Photo. Reproduced by permission.)*

Then, the process is repeated in reverse. These therapies are all useful to take care of symptoms, but do not correct the problem. Nasospecific, a procedure where a deflated balloon is inserted in the nostril and inflated to a large enough degree to adjust the septal deviation, can be an alternative to surgery. A trained practitioner in the nasospecific procedure is necessary.

Prognosis

Surgical repair is curative and carries little risk. Chronic infection can be painful and lead to complications until it is resolved. If there is continued obstruction, the infection will very likely return.

Prevention

Avoidance of virus colds, airborne dusts, air pollution, and known allergens will minimize the irritation and swelling of the membranes lining the nasal passages.

KEY TERMS

Allergen—Any substance that irritates people sensitive (allergic) to it.

Allergic rhinitis—Swelling and inflammation of the nasal membranes caused by sensitivity to airborne matter like pollen or cat hair.

Saline—A salt solution in water. Normal saline has the same salt concentration as the body, 0.9%.

Sinuses—The nasal sinuses, air-filled cavities surrounding the eyes and nose, like the nose itself are lined with mucus-producing membranes. They provide cleansing to the nose, resonance to the voice, and structure to the face.

Sinusitis—Infection of the sinuses.

Sleep apnea—A condition in which breathing is temporarily interrupted during sleep. It leads to high blood pressure, sleepiness, and a variety of other problems.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of the Nose, Throat, Ear, Head, and Neck*. Philadelphia: Lea & Febiger, 1991.

J. Ricker Polsdorfer, MD

Dextromethorphan *see* **Cough suppressants**

Diabetes insipidus

Definition

Diabetes insipidus (DI) is a disorder that causes the patient to produce tremendous quantities of urine. The massively increased urine output is usually accompanied by intense thirst.

Description

The balance of fluid within the body is maintained through a number of mechanisms. One important chemical involved in fluid balance is called antidiuretic hormone (ADH). ADH is produced by the pituitary, a small gland located at the base of the brain. In a healthy person and under normal conditions, ADH is continuously released. ADH influences the amount of fluid that the kidneys reabsorb into the circulatory system and the amount of fluid that the kidneys pass out of the body in the form of urine.

Production of ADH is regulated by the osmolality of the circulating blood. Osmolality refers to the concentration of dissolved chemicals (such as sodium, potassium, and chloride; together called solute) circulating in the fluid base of the blood (plasma). When there is very little fluid compared to the concentration of solute, the pituitary will increase ADH production. This tells the kidneys to retain more water and to decrease the amount of urine produced. As fluid is retained, the concentration of solute will normalize. At other times, when the fluid content of the blood is high in comparison to the concentration of solute, ADH production will decrease. The kidneys are then free to pass an increased amount of fluid out of the body in the urine. Again, this will allow the plasma osmolality to return to normal.

Diabetes insipidus occurs when either the amount of ADH produced by the pituitary is below normal (central DI), or the kidneys' ability to respond to ADH is defective (nephrogenic DI). In either case, a person with DI will pass extraordinarily large quantities of urine, sometimes reaching 10 or more liters each day. At the same time, the patient's blood will be very highly concentrated, with low fluid volume and high concentrations of solute.

DI occurs on average when a person is about 24 years old, and occurs more frequently in males than in females.

Causes and symptoms

DI may run in families. The cause of this type of DI is unknown. Other times, central DI can be caused by:

- an injury to the head
- brain surgery
- cancers that have spread to the pituitary gland (most commonly occurring with **breast cancer**)
- sarcoidosis (or other related disorders), causing destruction of the pituitary gland
- any condition or illness that causes decreased oxygen delivery to the brain
- the use of certain medications that decrease ADH production (like the antiseizure drug phenytoin)
- the excessive use of alcohol

Central DI may also occur in women who are pregnant or have just given birth, and in patients with **AIDS** who have suffered certain types of brain infections. Nephrogenic DI sometimes occurs in patients who are

taking the medication lithium, patients who have high levels of blood calcium, and patients who are pregnant.

DI is easily confused with an entirely unrelated disorder, psychogenic polydipsia. Polydipsia refers to drinking large amounts of water. Psychogenic polydipsia is a psychiatric problem that makes a person drink huge quantities of water uncontrollably.

Symptoms of DI include extreme thirst and the production of tremendous quantities of urine. Patients with DI typically drink huge amounts of water, and usually report a specific craving for cold water. When the amount of water passed in the urine exceeds the patient's ability to drink ample replacement water, the patient may begin to suffer from symptoms of **dehydration**. These symptoms include weakness, **fatigue**, **fever**, low blood pressure, increased heart rate, **dizziness**, and confusion. If left untreated, the patient could lapse into unconsciousness and die.

Diagnosis

Diagnosis should be suspected in any patient with sudden increased thirst and urination. Laboratory examination of urine will reveal very dilute urine, made up mostly of water with no solute. Examination of the blood will reveal very concentrated blood, high in solute and low in fluid volume.

A water deprivation test may be performed. This test requires a patient to stop all fluid intake. The patient is weighed just before the test begins, and urine is collected and examined hourly. The test is stopped when:

- the patient has lost more than 5% of his or her original body weight
- the patient has reached certain limits of low blood pressure and increased heart rate
- the urine is no longer changing significantly from one sample to the next in terms of solute concentration

The next step of the test involves injecting a synthetic form of ADH, with one last urine sample examined 60 minutes later. Comparing plasma and urine osmolality allows the doctor to diagnose either central DI, nephrogenic DI, partial DI, or psychogenic polydipsia.

Treatment

A number of medications can be given to decrease the quantity of fluid passed out into the urine. These include vasopressin (Pitressin) injected and desmopressin acetate (DDAVP) inhaled through the nose. Other medications that may be given include some antidiuretic drugs (chlorpropamide, clofibrate, carbamazepine). Patients with nephrogenic DI, however, will also require special **diets** that restrict the amount of solute taken in. These patients are also treated with a type of medication called a thiazide diuretic.

KEY TERMS

Concentration—Refers to the amount of solute present in a solution, compared to the total amount of solvent.

Dilute—A solution that has comparatively more fluid in it, relative to the quantity of solute.

Osmolality—A measure of the solute-to-solvent concentration of a solution.

Solute—Solid substances that are dissolved in liquid in order to make a solution.

Prognosis

Uncomplicated diabetes insipidus is controllable with adequate intake of water and most patients can lead normal lives.

Resources

BOOKS

Fishman, Mark C., et al. *Medicine*. Philadelphia: J. B. Lippincott Co., 1996.

Moses, Arnold M., and David H. P. Streeten. "Deficiency of Vasopressin: Diabetes Insipidus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Adam, Patricia. "Evaluation and Management of Diabetes Insipidus." *American Family Physician* 55, no. 6 (1 May 1997): 2146+.

Singer, Irwin, et al. "The Management of Diabetes Insipidus in Adults." *Archives of Internal Medicine* 157, no. 12 (23 June 1997): 1293+.

Rosalyn Carson-DeWitt, MD

Diabetes mellitus

Definition

Diabetes mellitus is a condition in which the pancreas no longer produces enough insulin or when cells stop responding to the insulin that is produced, so that

glucose in the blood cannot be absorbed into the cells of the body. Symptoms include frequent urination, lethargy, excessive thirst, and hunger. The treatment includes changes in diet, oral medications, and in some cases, daily injections of insulin.

Description

Diabetes mellitus is a chronic disease that causes serious health complications including renal (kidney) failure, heart disease, **stroke**, and blindness. Approximately 14 million Americans (about 5% of the population) have diabetes. Unfortunately, as many as one-half are unaware that they have it.

Background

Every cell in the human body needs energy in order to function. The body's primary energy source is glucose, a simple sugar resulting from the digestion of foods containing carbohydrates (sugars and starches). Glucose from the digested food circulates in the blood as a ready energy source for any cells that need it. Insulin is a hormone or chemical produced by cells in the pancreas, an organ located behind the stomach. Insulin bonds to a receptor site on the outside of cell and acts like a key to open a doorway into the cell through which glucose can enter. Some of the glucose can be converted to concentrated energy sources like glycogen or fatty acids and saved for later use. When there is not enough insulin produced or when the doorway no longer recognizes the insulin key, glucose stays in the blood rather entering the cells.

The body will attempt to dilute the high level of glucose in the blood, a condition called hyperglycemia, by drawing water out of the cells and into the bloodstream in an effort to dilute the sugar and excrete it in the urine. It is not unusual for people with undiagnosed diabetes to be constantly thirsty, drink large quantities of water, and urinate frequently as their bodies try to get rid of the extra glucose. This creates high levels of glucose in the urine.

At the same time that the body is trying to get rid of glucose from the blood, the cells are starving for glucose and sending signals to the body to eat more food, thus making patients extremely hungry. To provide energy for the starving cells, the body also tries to convert fats and proteins to glucose. The breakdown of fats and proteins for energy causes acid compounds called ketones to form in the blood. Ketones will also be excreted in the urine. As ketones build up in the blood, a condition called ketoacidosis can occur. This condition can be life threatening if left untreated, leading to **coma** and **death**.

Types of diabetes mellitus

Type I diabetes, sometimes called juvenile diabetes, begins most commonly in childhood or adolescence. In this form of diabetes, the body produces little or no insulin. It is characterized by a sudden onset and occurs more frequently in populations descended from Northern European countries (Finland, Scotland, Scandinavia) than in those from Southern European countries, the Middle East, or Asia. In the United States, approximately three people in 1,000 develop Type I diabetes. This form is also called insulin-dependent diabetes because people who develop this type need to have daily injections of insulin.

Brittle diabetics are a subgroup of Type I where patients have frequent and rapid swings of blood sugar levels between hyperglycemia (a condition where there is too much glucose or sugar in the blood) and **hypoglycemia** (a condition where there is abnormally low levels of glucose or sugar in the blood). These patients may require several injections of different types of insulin during the day to keep the blood sugar level within a fairly normal range.

The more common form of diabetes, Type II, occurs in approximately 3–5% of Americans under 50 years of age, and increases to 10–15% in those over 50. More than 90% of the diabetics in the United States are Type II diabetics. Sometimes called age-onset or adult-onset diabetes, this form of diabetes occurs most often in people who are overweight and who do not **exercise**. It is also more common in people of Native American, Hispanic, and African-American descent. People who have migrated to Western cultures from East India, Japan, and Australian Aboriginal cultures are also more likely to develop Type II diabetes than those who remain in their original countries.

Type II is considered a milder form of diabetes because of its slow onset (sometimes developing over the course of several years) and because it can usually be controlled with diet and oral medication. The consequences of uncontrolled and untreated Type II diabetes, however, are the just as serious as those for Type I. This form is also called noninsulin-dependent diabetes, a term that is somewhat misleading. Many people with Type II diabetes can control the condition with diet and oral medications, however, insulin injections are sometimes necessary if treatment with diet and oral medication is not working.

Another form of diabetes called **gestational diabetes** can develop during **pregnancy** and generally resolves after the baby is delivered. This diabetic condition develops during the second or third trimester of pregnancy in about 2% of pregnancies. The condition is usually treated by diet, however, insulin injections may

be required. These women who have diabetes during pregnancy are at higher risk for developing Type II diabetes within 5–10 years.

Diabetes can also develop as a result of pancreatic disease, **alcoholism**, **malnutrition**, or other severe illnesses that **stress** the body.

Causes and symptoms

Causes

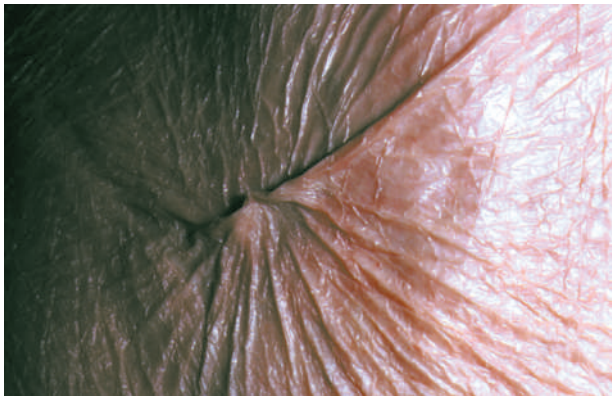
The causes of diabetes mellitus are unclear, however, there seem to be both hereditary (genetic factors passed on in families) and environmental factors involved. Research has shown that some people who develop diabetes have common genetic markers. In Type I diabetes, the immune system, the body's defense system against infection, is believed to be triggered by a virus or another microorganism to destroy the cells in the pancreas that produce insulin. In Type II diabetes, age, **obesity**, and family history of diabetes play a roll.

In Type II diabetes, the pancreas may produce enough insulin, however, cells have become resistant to the insulin produced and it may not work as effectively. Symptoms of Type II diabetes can begin so gradually that a person may not know that they have it. Early signs are lethargy extreme thirst, and frequent urination. Other symptoms may include sudden weight loss, slow wound healing, urinary tract infections, gum disease, or blurred vision. It is not unusual for Type II diabetes to be detected while a patient is seeing a doctor about another health concern that is actually being caused by the yet undiagnosed diabetes.

Individuals who are at high risk of developing Type II diabetes mellitus include people who:

- are obese (more than 20% above their ideal body weight)
- have a relative with diabetes mellitus
- belong to a high-risk ethnic population (African-American, Native American, Hispanic, or Native Hawaiian)
- have been diagnosed with gestational diabetes or have delivered a baby weighing more than 9 lbs (4 kg)
- have high blood pressure (140/90 mmHg or above)
- have a high density lipoprotein cholesterol level less than or equal to 35 mg/dL and/or a triglyceride level greater than or equal to 250 mg/dL
- have had impaired glucose tolerance or impaired **fasting** glucose on previous testing

Several common medications can impair the body's use of insulin, causing a condition known as secondary diabetes. These medications include treatments for high blood pressure (furosemide, clonidine, and thiazide **diuretics**), drugs with hormonal activity (**oral contraceptives**, thyroid hormone, progestins, and glucocorticorids), and the anti-inflammation drug indomethacin. Several drugs that are used to treat **mood disorders** (such as **anxiety** and depression) can also impair glucose absorption. These drugs include haloperidol, lithium carbonate, phenothiazines, tricyclic antidepressants, and adrenergic agonists. Other medications that can cause diabetes symptoms include isoniazid, nicotinic acid, cimetidine, and heparin.



Wrinkled, dehydrated skin of a person in a diabetic coma. Untreated diabetes mellitus results in elevated blood glucose levels, causing a variety of symptoms that can culminate in a diabetic coma. *(Photo Researchers, Inc. Reproduced by permission.)*

Symptoms

Symptoms of diabetes can develop suddenly (over days or weeks) in previously healthy children or adolescents, or can develop gradually (over several years) in overweight adults over the age of 40. The classic symptoms include feeling tired and sick, frequent urination, excessive thirst, excessive hunger, and weight loss.

Ketoacidosis, a condition due to **starvation** or uncontrolled diabetes, is common in Type I diabetes. Ketones are acid compounds that form in the blood when the body breaks down fats and proteins. Symptoms include abdominal **pain**, vomiting, rapid breathing, extreme lethargy and drowsiness. Patients with ketoacidosis will also have a sweet breath odor. Left untreated, this condition can lead to coma and death.

With Type II diabetes, the condition may not become evident until the patient presents for medical treatment for some other condition. A patient may have heart disease, chronic infections of the gums and urinary tract, blurred vision, numbness in the feet and legs, or slow-healing **wounds**. Women may experience genital **itching**.

KEY TERMS

Cataracts—A condition where the lens of the eye becomes cloudy.

Diabetic peripheral neuropathy—A condition where the sensitivity of nerves to pain, temperature, and pressure is dulled particularly in the legs and feet.

Diabetic retinopathy—A condition where the tiny blood vessels to the retina, the tissues that sense light at the back of the eye, are damaged, leading to blurred vision, sudden blindness, or black spots, lines, or flashing light in the field of vision.

Glaucoma—A condition where pressure within the eye causes damage to the optic nerve, which sends visual images to the brain.

Hyperglycemia—A condition where there is too much glucose or sugar in the blood.

Hypoglycemia—A condition where there is too little glucose or sugar in the blood.

Insulin—A hormone or chemical produced by the pancreas, insulin is needed by cells of the body in order to use glucose (sugar), the body's main source of energy.

Ketoacidosis—A condition due to starvation or uncontrolled Type I diabetes. Ketones are acid compounds that form in the blood when the body breaks down fats and proteins. Symptoms include abdominal pain, vomiting, rapid breathing, extreme tiredness, and drowsiness.

Kidney dialysis—A process where blood is filtered through a dialysis machine to remove waste products that would normally be removed by the kidneys. The filtered blood is then circulated back into the patient. This process is also called renal dialysis.

Pancreas—A gland located behind the stomach that produces insulin.

Diagnosis

Diabetes is suspected based on symptoms. Urine and blood tests can be used to confirm a diagnose of diabetes based on the amount of glucose. Urine tests can also detect ketones and protein in the urine that may help diagnose diabetes and assess how well the kidneys are functioning. These tests can also be used to monitor the disease once the patient is on a standardized diet, oral medications, or insulin.

Urine tests

Clinistix and Diastix are paper strips or dipsticks that change color when dipped in urine. The test strip is compared to a chart which shows the amount of glucose in the urine based on the change in color. The level of glucose in the urine lags behind the level of glucose in the blood. Testing the urine with a test stick, paper strip, or tablet that changes color when sugar is present is not as accurate as blood testing, however it can give a fast and simple reading.

Ketones in the urine can be detected using similar types of dipstick tests (Acetest or Ketostix). Ketoacidosis can be a life-threatening situation in Type I diabetics, so having a quick and simple test to detect ketones can assist in establishing a diagnosis sooner.

Another dipstick test can determine the presence of protein or albumin in the urine. Protein in the urine can indicate problems with kidney function and can be used to track the development of renal failure. A more sensitive test for urine protein uses radioactively tagged chemicals to detect microalbuminuria, small amounts of protein in the urine, that may not show up on dipstick tests.

Blood tests

FASTING GLUCOSE TEST. Blood is drawn from a vein in the patient's arm after a period at least eight hours when the patient has not eaten, usually in the morning before breakfast. The red blood cells are separated from the sample and the amount of glucose is measured in the remaining plasma. A plasma level of 7.8 mmol/L (200 mg/L) or greater can indicate diabetes. The fasting glucose test is usually repeated on another day to confirm the results.

POSTPRANDIAL GLUCOSE TEST. Blood is taken right after the patient has eaten a meal.

ORAL GLUCOSE TOLERANCE TEST. Blood samples are taken from a vein before and after a patient drinks a thick, sweet syrup of glucose and other sugars. In a non-diabetic, the level of glucose in the blood goes up immediately after the drink and then decreases gradually as insulin is used by the body to metabolize, or absorb, the sugar. In a diabetic, the glucose in the blood goes up and stays high after drinking the sweetened liquid. A plasma glucose level of 11.1 mmol/L (200 mg/dL) or higher at two hours after drinking the syrup and at one other point during the two-hour test period confirms the diagnosis of diabetes.

A diagnosis of diabetes is confirmed if there are symptoms of diabetes and a plasma glucose level of at least 11.1 mmol/L, a fasting plasma glucose level of at least 7 mmol/L; or a two-hour plasma glucose level of at least 11.1 mmol/L during an oral glucose tolerance test.

Home blood glucose monitoring kits are available so patients with diabetes can monitor their own levels. A small needle or lancet is used to prick the finger and a drop of blood is collected and analyzed by a monitoring device. Some patients may test their blood glucose levels several times during a day and use this information to adjust their doses of insulin.

Treatment

There is currently no cure for diabetes; the condition, however, can be managed so that patients can live a relatively normal life. Treatment of diabetes focuses on two goals: keeping blood glucose within normal range and preventing the development of long-term complications. Careful monitoring of diet, exercise, and blood glucose levels are as important as the use of insulin or oral medications in preventing complications of diabetes.

Dietary changes

Diet and moderate exercise are the first treatments implemented in diabetes. For many Type II diabetics, weight loss may be an important goal in helping them to control their diabetes. A well-balanced, nutritious diet provides approximately 50–60% of calories from carbohydrates, approximately 10–20% of calories from protein, and less than 30% of calories from fat. The number of calories required by an individual depends on their age, weight, and activity level. The calorie intake also needs to be distributed over the course of the entire day so surges of glucose entering the blood system are kept to a minimum.

Keeping track of the number of calories provided by different foods can become complicated, so patients are usually advised to consult a nutritionist or dietitian. An individualized, easy to manage diet plan can be set up for each patient. Both the American Diabetes Association and the American Dietetic Association recommend **diets** based on the use of food exchange lists. Each food exchange contains a known amount of calories in the form of protein, fat, or carbohydrate. A patient's diet plan will consist of a certain number of exchanges from each food category (meat or protein, fruits, breads and starches, vegetables, and fats) to be eaten at meal times and as snacks. Patients have flexibility in choosing which foods they eat as long as they stick with the number of exchanges prescribed.

For many Type II diabetics, weight loss is an important factor in controlling their condition. The food exchange system, along with a plan of moderate exercise, can help them lose excess weight and improve their overall health.

Oral medications

Oral medications are available to lower blood glucose in Type II diabetics. The drugs first prescribed for Type II diabetes are in a class of compounds called sulfonylureas and include tolbutamide, tolazamide, acetohexamide, and chlorpropamide. Newer drugs in the same class are now available and include glyburide, glimeperide, and glipizide. The way that these drugs work is not well understood, however, they seem to stimulate cells of the pancreas to produce more insulin. New medications that are available to treat diabetes include metformin, acarbose, and troglitizone. The choice of the right medication depends in part on the individual patient profile. All drugs have side effects that may make them inappropriate for particular patients. Some for example, may stimulate weight gain or cause stomach irritation, so they may not be the best treatment for someone who is already overweight or who also has stomach ulcers. While these medications are an important aspect of treatment for Type II diabetes, they are not a substitute for a well planned diet and moderate exercise. Oral medications are not effective for Type I diabetes, in which the patient produces little or no insulin.

Insulin

Patients with Type I diabetes need daily injections of insulin to help their bodies use glucose. The amount and type of insulin required depends on the height, weight, age, food intake, and activity level of the individual diabetic patient. Some patients with Type II diabetes may need to use insulin injections if their diabetes cannot be controlled with diet, exercise, and oral medication. Injections are given subcutaneously, that is, just under the skin, using a small needle and syringe. Injection sites can be anywhere on the body where there is looser skin, including the upper arm, abdomen, or upper thigh.

Purified human insulin is most commonly used, however, insulin from beef and pork sources are also available. Insulin may be given as an injection of a single dose of one type of insulin once a day. Different types of insulin can be mixed and given in one dose or split into two or more doses during a day. Patients who require multiple injections over the course of a day may be able to use an insulin pump that administers small doses of insulin on demand. The small battery-operated pump is worn outside the body and is connected to a needle that is inserted into the abdomen. Pumps can be programmed to inject small doses of insulin at various times during the day, or the patient may be able to adjust the insulin doses to coincide with meals and exercise.

Regular insulin is fast-acting and starts to work within 15–30 minutes, with its peak glucose-lowering effect about two hours after it is injected. Its effects last for about four to six hours. NPH (neutral protamine Hagedorn) and Lente insulin are intermediate-acting, starting to work within one to three hours and lasting up to 18–26 hours. Ultra-lente is a long-acting form of insulin that starts to work within four to eight hours and lasts 28–36 hours.

Hypoglycemia, or low blood sugar, can be caused by too much insulin, too little food (or eating too late to coincide with the action of the insulin), alcohol consumption, or increased exercise. A patient with symptoms of hypoglycemia may be hungry, cranky, confused, and tired. The patient may become sweaty and shaky. Left untreated, the patient can lose consciousness or have a seizure. This condition is sometimes called an insulin reaction and should be treated by giving the patient something sweet to eat or drink like a candy, sugar cubes, juice, or another high sugar snack.

Surgery

Transplantation of a healthy pancreas into a diabetic patient is a successful treatment, however, this transplant is usually done only if a kidney transplant is performed at the same time. Although a pancreas transplant is possible, it is not clear if the potential benefits outweigh the risks of the surgery and drug therapy needed.

Alternative treatment

Since diabetes can be life-threatening if not properly managed, patients should not attempt to treat this condition without medicial supervision. A variety of alternative therapies can be helpful in managing the symptoms of diabetes and supporting patients with the disease. **Acupuncture** can help relieve the pain associated with **diabetic neuropathy** by stimulation of cetain points. A qualified practitioner should be consulted. Herbal remedies may also be helpful in managing diabetes. Although there is no herbal substitute for insulin, some herbs may help adjust blood sugar levels or manage other diabetic symptoms. Some options include:

- fenugreek (*Trigonella foenum-graecum*) has been shown in some studies to reduce blood insulin and glucose levels while also lowering cholesterol
- bilberry (*Vaccinium myrtillus*) may lower blood glucose levels, as well as helping to maintain healthy blood vessels
- garlic (*Allium sativum*) may lower blood sugar and cholesterol levels
- onions (*Allium cepa*) may help lower blood glucose levels by freeing insulin to metabolize it
- cayenne pepper (*Capsicum frutescens*) can help relieve pain in the peripheral nerves (a type of diabetic neuropathy)
- ginkgo (*Gingko biloba*) may maintain blood flow to the retina, helping to prevent diabetic retinopathy

Any therapy that lowers stress levels can also be useful in treating diabetes by helping to reduce insulin requirements. Among the alternative treatments that aim to lower stress are **hypnotherapy**, **biofeedback**, and **meditation**.

Prognosis

Uncontrolled diabetes is a leading cause of blindness, end-stage renal disease, and limb amputations. It also doubles the risks of heart disease and increases the risk of stroke. Eye problems including **cataracts**, **glaucoma**, and diabetic retinopathy are also more common in diabetics.

Diabetic **peripheral neuropathy** is a condition where nerve endings, particularly in the legs and feet become less sensitive. Diabetic foot ulcers are a particular problem since the patient does not feel the pain of a blister, callous, or other minor injury. Poor blood circulation in the legs and feet contribute to delayed wound healing. The inability to sense pain along with the complications of delayed wound healing can result in minor injuries, blisters, or callouses becoming infected and difficult to treat. In cases of severe infection, the infected tissue begins to break down and rot away. The most serious consequence of this condition is the need for **amputation** of toes, feet, or legs due to severe infection.

Heart disease and kidney disease are common complications of diabetes. Long-term complications may include the need for **kidney dialysis** or a kidney transplant due to kidney failure.

Babies born to diabetic mothers have an increased risk of **birth defects** and distress at birth.

Prevention

Research continues on ways to prevent diabetes and to detect those at risk for developing diabetes. While the onset of Type I diabetes is unpredictable, the risk of developing Type II diabetes can be reduced by maintaining ideal weight and exercising regularly. The physical and emotional stress of surgery, illness, pregnancy, and alcoholism can increase the risks of diabetes, so maintaining a healthy lifestyle is critical to preventing the onset of Type II diabetes and preventing further complications of the disease.

Resources

BOOKS

"Diabetes Mellitus." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Foster, Daniel W. "Diabetes Mellitus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Garber, Alan J. "Diabetes Mellitus." In *Internal Medicine*, ed. Jay H. Stein, et al. St. Louis: Mosby, 1998.

Karam, John H. "Diabetes Mellitus & Hypoglycemia." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Sherwin, Robert S. "Diabetes Mellitus." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Smit, Charles Kent, John P. Sheehan, and Margaret M. Ulchaker. "Diabetes Mellitus." In *Family Medicine, Principles and Practice*. 5th ed. Ed. Robert B. Taylor. New York: Springer-Verlag, 1998.

PERIODICALS

"Trends in the Prevalence and Incidence of Self-Reported Diabetes Mellitus-United States, 1980-1994." *Morbidity & Mortality Weekly Report* 46 (1997): 1014-1018.

"Updated Guidelines for the Diagnosis of Diabetes in the US." *Drugs & Therapy Perspectives* 10 (1997): 12-13.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

American Dietetic Association. 216 W. Jackson Blvd., Chicago, IL 60606-6995. (312) 899-0040. <http://www.eatright.org>.

Juvenile Diabetes Foundation. 120 Wall St., 19th Floor, New York, NY 10005. (800) 533-2873. <http://www.jdf.org>.

National Diabetes Information Clearinghouse. 1 Information Way, Bethesda, MD 20892-3560. (800) 860-8747. <http://www.niddk.nih.gov/health/diabetes/ndic.htm>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

OTHER

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

"Insulin-Dependent Diabetes." National Institute of Diabetes and Digestive and Kidney Diseases. National Institutes of Health, NIH Publication No. 94-2098.

"Noninsulin-Dependent Diabetes." National Institute of Diabetes and Digestive and Kidney Diseases. National Institutes of Health, NIH Publication No. 92-241.

Altha Roberts Edgren

Diabetic control index *see* **Glycosylated hemoglobin test**

Diabetic foot infections

Definition

Diabetic foot infections are infections that can develop in the skin, muscles, or bones of the foot as a result of the nerve damage and poor circulation that is associated with diabetes.

Description

People who have diabetes have a greater-than-average chance of developing foot infections. Because a person who has diabetes may not feel foot **pain** or discomfort, problems can remain undetected until **fever**, weakness, or other signs of systemic infection appear. As a result, even minor irritations occur more often, heal more slowly, and are more likely to result in serious health problems.

With diabetes, foot infections occur more frequently because the disease causes nervous system changes and poor circulation. Because the nerves that control sweating no longer work, the skin of the feet can become very dry and cracked, and calluses tend to occur more frequently and build up faster. If not trimmed regularly, these calluses can turn into open sores or ulcers. Because diabetic nerve damage can cause a loss of sensation (neuropathy), if the feet are not regularly inspected, an ulcer can quickly become infected and, if not treated, may result in the **death** of tissue (**gangrene**) or **amputation**.

The risk of infection is greatest for people who are over the age of 60 and for those who have one or more of the following:

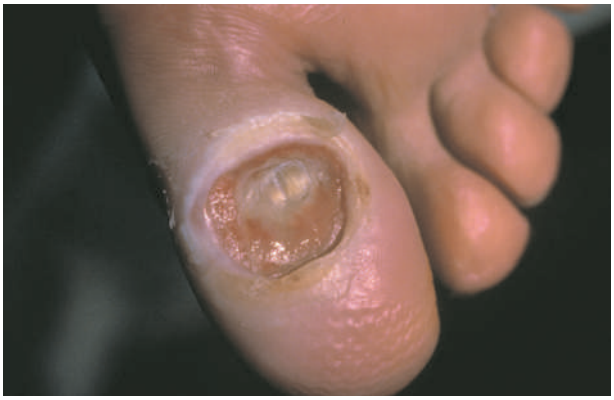
- poorly controlled diabetes
- foot ulcers
- laser treatment for changes in the retina
- kidney or vascular disease
- loss of sensation (neuropathy)

Causes and symptoms

Bacteria can cause an infection through small cracks (fissures) that can develop in the dry skin around the heel and on other parts of the foot or through corns, calluses, blisters, hangnails, or ulcers. If not treated, the bacterial infection can destroy skin, tissue, and bone or spread throughout the body.

Common sites of diabetic foot infections include the following:

- blisters, corns, or callouses that bleed beneath the skin
- bunions, hammertoes, or other abnormalities in the bones of the foot



Persons with diabetes often suffer from foot ulcers, as shown above. *(Custom Medical Stock Photo. Reproduced by permission.)*

- scar tissue that has grown over the site of an earlier infection
- foot ulcers caused by pressure, nerve damage, or poor circulation (Ulcers occur most often over the ball of the foot, on the bottom of the big toe, or on the sides of the foot due to poorly fitting shoes.)
- injuries that tear or puncture the skin.

Diagnosis

A physician who specializes in the treatment of the foot (podiatrist) or the doctor who normally treats the patient's diabetes will treat the infection. An x ray of the foot will be taken to determine whether the bone has become infected. A sample from the wound will be cultured to identify the organism that is causing the infection so that the appropriate antibiotic can be selected.

Treatment

From the results of the culture, the appropriate antibiotic will be prescribed. Any dead or infected tissue will be surgically removed and, if necessary, a cast and/or special shoes may be used to protect the area. In addition, the patient will be instructed to keep off their feet. If the ulcer does not heal, the physician may perform surgery to increase blood flow to the foot. It is also important for the patient to practice good diabetes control and keep blood glucose levels from getting too high.

Alternative treatment

Acupuncture and vitamin C can boost the body's infection-fighting ability. A variety of other **vitamins** and herbs may improve general health and diabetes control. Because diabetes is a potentially deadly disease, it can be dangerous to try alternative approaches without a doctor's approval or without consulting a trained practitioner of alternative medicine.

KEY TERMS

Fissure—A deep crack.

Neuropathy—An abnormality of the nerves outside the brain and spinal cord.

Ulcer—A sore or lesion.

Prognosis

Without proper treatment, diabetic foot infections can lead to serious illness, gangrene, amputation, and even death if the infection spreads throughout the body. If treated properly and the patient practices good **foot care**, the prognosis is generally optimistic

Prevention

There are many things that a diabetic individual can do to prevent the occurrence of foot infections, including the following:

- control blood glucose and do not allow it to get too high
- avoid **smoking**
- keep blood pressure and cholesterol under control
- exercise to stimulate blood flow
- keep feet clean, dry, and warm
- check your feet every day for blisters, scratches, and skin that is hard, broken, inflamed or that feels hot or cold when touched
- after bathing, carefully dry feet and apply thin coat of petroleum jelly or hand cream to prevent dry skin from cracking
- use a pumice stone and emery board to trim calluses
- do not neglect an ulcer, should one develop

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

Marble, Alexander, et al., eds. *Joslin's Diabetes Mellitus*. 12th ed. Philadelphia: Lea & Jebiger, 1985.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

Juvenile Diabetes Foundation. 120 Wall St., 19th Floor, New York, NY 10005. (800) 533-2873. <http://www.jdf.org>.

National Diabetes Information Clearinghouse. 1 Information Way, Bethesda, MD 20892-3560. (800) 860-8747. <http://www.niddk.nih.gov/health/diabetes/ndic.htm>.

OTHER

"Foot Care." *American Diabetes Association.* 17 Feb. 1998 <http://www.diabetes.org>.

Maureen Haggerty

Diabetic ketoacidosis

Definition

Diabetic ketoacidosis is a dangerous complication of **diabetes mellitus** in which the chemical balance of the body becomes far too acidic.

Description

Diabetic ketoacidosis (DKA) always results from a severe insulin deficiency. Insulin is the hormone secreted by the body to lower the blood sugar levels when they become too high. Diabetes mellitus is the disease resulting from the inability of the body to produce or respond properly to insulin, required by the body to convert glucose to energy. In childhood diabetes, DKA complications represent the leading cause of **death**, mostly due to the accumulation of abnormally large amounts of fluid in the brain (cerebral **edema**). DKA combines three major features: hyperglycemia, meaning excessively high blood sugar kevels hyperketonemia, meaning an overproduction of ketones by the body; and acidosis, meaning that the blood has become too acidic.

Insulin deficiency is responsible for all three conditions: the body glucose goes largely unused since most cells are unable to transport glucose into the cell without the presence of insulin; this condition makes the body use stored fat as an alternative source instead of the unavailable glucose for energy, a process that produces acidic ketones, which build up because they require insulin to be broken down. The presence of excess ketones in the bloodstream in turn causes the blood to become more acidic than the body tissues, which creates a toxic condition.

Causes and symptoms

DKA is most commonly seen in individuals with type I diabetes, under 19 years of age and is usually caused by the interruption of their insulin treatment or by acute infection or trauma. A small number of people with type II diabetes also experience ketoacidosis, but this is rare given the fact that type II diabetics still produce some insulin naturally. When DKA occurs in type II patients, it is usually caused by a decrease in food intake and an increased insulin deficiency due to hyperglycemia.

Some common DKA symptoms include:

- high blood sugar levels
- frequent urination (polyuria) and thirst
- fatigue and lethargy
- nausea
- vomiting
- abdominal pain
- fruity odor to breath
- rapid, deep breathing
- muscle stiffness or aching
- **coma**

Diagnosis

Diagnosis requires the demonstration of hyperglycemia, hyperketonemia, and acidosis. DKA is established if the patient's urine or blood is strongly positive for glucose and ketones. Normal glucose levels in a nondiabetic person on average range from 80–110 mg/dl. A person with diabetes will typically fluctuate outside those parameters. DKA glucose levels exceed 250 mg/dl and can reach 400 to 800 mg/dL. A low serum bicarbonate level (usually below 15 mEq/L) is also present, indicative of acidosis.

A blood test or **urinalysis** can quickly determine the concentration of glucose in the bloodstream. Test strips are available to patients commercially can submerge in urine to detect the presence or concentration of ketones.

Treatment

Ketoacidosis is treated under medical supervision and usually in a hospital setting.

Basic treatment includes:

- administering insulin to correct the hyperglycemia and hyperketonemia

KEY TERMS

Acidosis—A condition that causes the pH of the blood to drop and become more acidic.

Diabetes mellitus—Disease characterized by the inability of the body to produce or respond properly to insulin, which is required by the body to convert glucose to energy.

Edema—The presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body.

Glucose—The type of sugar found in the blood.

Hyperglycemia—Condition characterized by excessively high levels of glucose in the blood, and occurs when the body does not have enough insulin or cannot use the insulin it does have to turn glucose into energy. Hyperglycemia is often indicative of diabetes that is out of control.

Hyperketonemia—Condition characterized by an overproduction of ketones by the body.

Hypoglycemia—Lower than normal levels of glucose in the blood.

Hypokalemia—A deficiency of potassium in the blood.

Insulin—A hormone secreted by the pancreas in response to high blood sugar levels that induces hypoglycemia. Insulin regulates the body's use of glucose and the levels of glucose in the blood by acting to open the cells so that they can intake glucose.

Ketones—Poisonous acidic chemicals produced by the body when fat instead of glucose is burned for energy. Breakdown of fat occurs when not enough insulin is present to channel glucose into body cells.

Lactic acidosis—A serious condition caused by the build up of lactic acid in the blood, causing it to become excessively acidic. Lactic acid is a by-product of glucose metabolism.

Metabolism—The sum of all chemical reactions that occur in the body resulting in growth, transformation of foodstuffs into energy, waste elimination and other bodily functions.

Polyuria—Excessive secretion of urine.

Type I diabetes—Also called juvenile diabetes. Type I diabetes typically begins early in life. Affected individuals have a primary insulin deficiency and must take insulin to stay alive.

Type II diabetes—Type II diabetes is the most common form of diabetes and usually appears in middle aged adults. It is often associated with obesity and may be delayed or controlled with diet and exercise.

- Replacing fluids intravenously lost through excessive urination and vomiting
- Balancing electrolytes to re-establish the chemical equilibrium of the blood and prevent potassium deficiency (**hypokalemia**) during treatment
- Treatment for any associated bacterial infection

Prognosis

With proper medical attention, DKA is almost always successfully treated. The DKA mortality rate is about 10%. Coma on admission adversely affects the prognosis. The major causes of death are circulatory collapse, hypokalemia, infection, and cerebral edema.

Prevention

Once diabetes has been diagnosed, prevention measures to avoid DKA include regular monitoring of blood glucose, administration of insulin, and lifestyle maintenance. Glucose monitoring is especially important during periods of **stress**, infection, and trauma when glucose concentrations typically increase as a response to these situations. Ketone tests should also be performed during these periods or when glucose is elevated.

Resources

BOOKS

Saudek, Christopher D., Richard R. Rubin, and Cynthia S. Shump. *The Johns Hopkins Guide to Diabetes*. Baltimore: The Johns Hopkins University Press, 1997.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311.(800)-342-2383. <http://www.diabetes.org/>.

Juvenile Diabetes Foundation. 120 Wall St., New York, NY 10005. (800) 533-CURE. <http://www.jdf.org/>.

National Institute of Diabetes and Digestive and Kidney Disorders (NIDDK). 31 Center Drive, MSC 2560, Bethesda, MD 20892-2560. <http://www.niddk.nih.gov>.

Gary Gilles

Diabetic neuropathy

Definition

Diabetic neuropathy is a nerve disorder caused by **diabetes mellitus**. Diabetic neuropathy may be diffuse, affecting several parts of the body, or focal, affecting a specific nerve and part of the body.

Description

The nervous system consists of two major divisions: the central nervous systems (CNS) which includes the brain, the cranial nerves, and the spinal cord, and the peripheral nervous system (PNS) which includes the nerves that link the CNS with the sensory organs, muscles, blood vessels, and glands of the body. These peripheral nerves are either motor, meaning that they are involved in motor activity such as walking, or sensory, meaning that they carry sensory information back to the CNS. The PNS also works with the CNS to regulate involuntary (autonomic) processes such as breathing, heartbeat, blood pressure, etc.

There are two types of diffuse diabetic neuropathy that affect different nervous system functions. Diffuse **peripheral neuropathy** primarily affects the limbs, damaging the nerves of the feet and hands. Autonomic neuropathy is the other form of diffuse neuropathy and it affects the heart and other internal organs.

Focal—or localized—diabetic neuropathy affects specific nerves, most commonly in the torso, leg, or head.

Diabetic neuropathy can lead to muscular weakness, loss of feeling or sensation, and loss of autonomic functions such as digestion, erection, bladder control and sweating among others.

The longer a person has diabetes, the more likely the development of one or more forms of neuropathy. Approximately 60–70% of patients with diabetes have neuropathy, but only about 5% will experience painful symptoms.

Causes and symptoms

The exact cause of diabetic neuropathy is not known. Researchers believe that the process of nerve damage is related to high glucose concentrations in the blood that could cause chemical changes in nerves, disrupting their ability to effectively send messages. High blood glucose is also known to damage the blood vessels that carry oxygen and other nutrients to the nerves. In addition, some people may have a genetic predisposition to develop neuropathy.

There is a wide range of symptoms associated with diabetic neuropathy, and they depend on which nerves and parts of the body affected and also on the type of neuropathy present. Some patients have very mild symptoms, while others are severely disabled.

Common symptoms of diffuse peripheral neuropathy include:

- numbness and feelings of tingling or burning
- insensitivity to **pain**
- needle-like jabs of pain
- extreme sensitivity to touch
- loss of balance and coordination

Common symptoms of diffuse autonomic neuropathy include:

- impaired urination and sexual function
- bladder infections
- stomach disorders, due to the impaired ability of the stomach to empty (gastric stasis)
- nausea, vomiting, bloating
- dizziness, lightheadedness, **fainting** spells
- loss of appetite

Common symptoms of focal neuropathy include:

- pain in the front of a thigh
- severe pain in the lower back
- pain in the chest or stomach
- ache behind an eye
- double vision
- paralysis on one side of the face

In severe diabetic neuropathy loss of sensation can lead to injuries that are unnoticed, progressing to infections, ulceration, and possibly **amputation**.

Diagnosis

The diagnosis of neuropathy is based on the symptoms that present during a physical exam. Pain assessment is usually the first step. Patients may have more than one type of pain, and the history helps the doctor determine whether a the pain has a neuropathic cause.

The exam may include:

- a screening test for lost sensation
- nerve conduction studies to check the flow of electric current through a nerve
- electromyography (EMG) to see how well muscles respond to electrical impulses transmitted by nearby nerves.

KEY TERMS

Central nervous system (CNS)—Part of the nervous system consisting of the brain, cranial nerves, and spinal cord. The brain is the center of higher processes, such as thought and emotion, and is responsible for the coordination and control of bodily activities and the interpretation of information from the senses. The cranial nerves and spinal cord link the brain to the peripheral nervous system.

Diabetes mellitus—Disease characterized by the inability of the body to produce or respond properly to insulin, required by the body to convert glucose to energy.

Glucose—The type of sugar found in the blood.

Peripheral nervous system (PNS)—One of the two major divisions of the nervous system. PNS nerves link the central nervous system with sensory organs, muscles, blood vessels, and glands.

- ultrasound to show how the bladder and other parts of the urinary tract are functioning
- sometimes a nerve biopsy may be performed.

Specialists who treat diabetic neuropathy include:

- neurologists: specialists in nervous system disorders
- urologists: specialists in urinary tract disorder
- gastroenterologists: specialists in digestive disorders
- podiatrists: specialists in caring for the feet

Treatment

Treatment of diabetic neuropathy is usually focused on treating the symptoms associated with the neuropathy and addressing the underlying cause by improving the control of blood sugar levels, which may heal the early stages of neuropathy.

There is no cure for the permanent nerve damage caused by neuropathy. To help control pain, the choice of proven drug therapies has broadened during the past decade. Pain medication, such as the topical skin cream capsaicin, is usually no stronger than codeine because of the potential for **addiction** with long-term use of such drugs. Four main classes of drugs are available for **pain management**, alone or in combination: tricyclic antidepressants (Imipramine, Nortriptyline), narcotic **analgesics** (Morphine), anticonvulsants (Carbamazepine, Gabapentin), and antiarrhythmics.

Prognosis

Early stage diabetic neuropathy can usually be reversed with good glucose control. Once nerve damage has occurred it cannot be reversed. The prognosis is largely dependent on the management of the underlying condition, diabetes, which may halt the progression of the neuropathy and improve symptoms. Recovery, if it occurs, is slow.

Prevention

Tight glucose control and the avoidance of alcohol and cigarettes help protect nerves from damage.

Resources

BOOKS

Saudek, Christopher D., Richard R. Rubin, and Cynthia S. Shump. *The Johns Hopkins Guide to Diabetes*. Baltimore: The Johns Hopkins University Press, 1997.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383). <http://www.diabetes.org/>.

Juvenile Diabetes Foundation. 120 Wall St., New York, NY 10005. (800) 533-CURE. <http://www.jdf.org/>.

National Institute of Diabetes and Digestive and Kidney Disorders (NIDDK). 31 Center Drive, MSC 2560, Bethesda, MD 20892-2560. <http://www.niddk.nih.gov>.

Gary Gilles

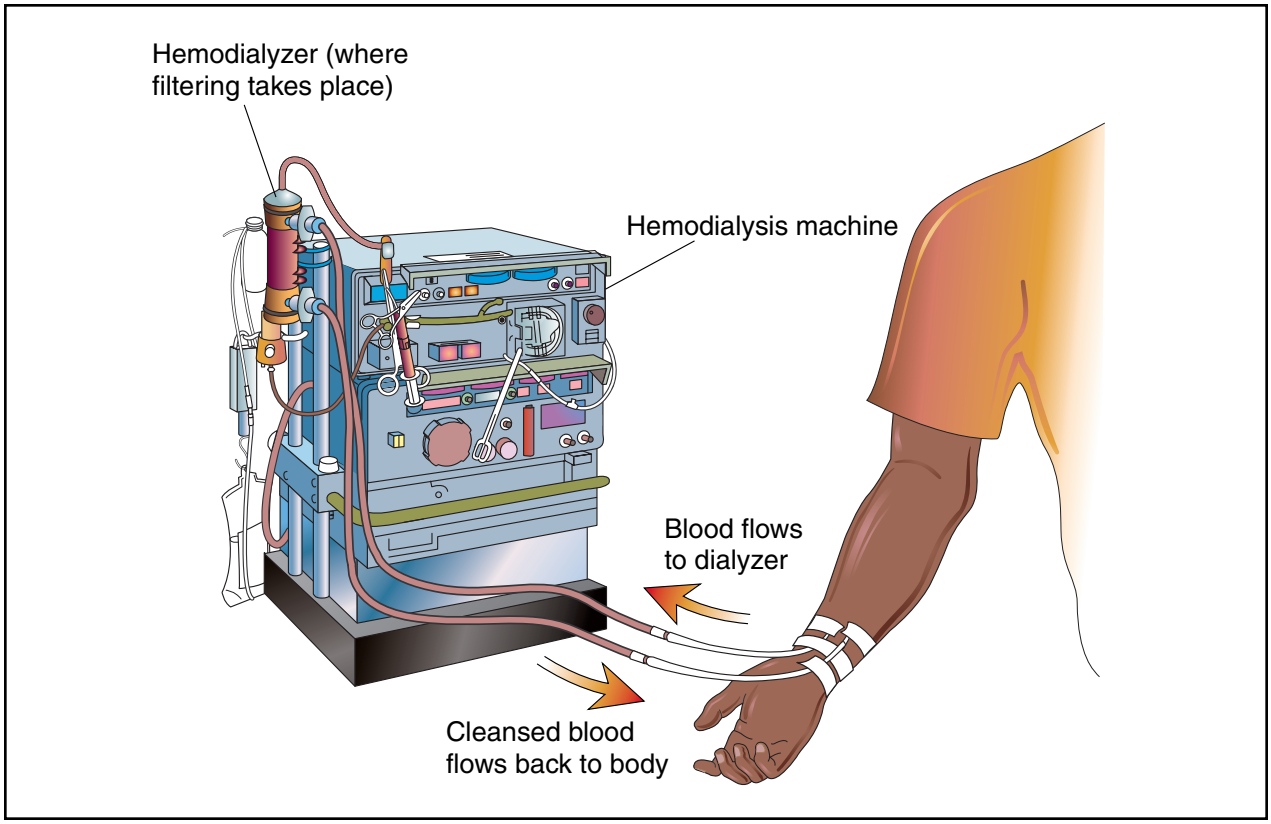
Dialysis, kidney

Definition

Dialysis treatment replaces the function of the kidneys, which normally serve as the body's natural filtration system. Through the use of a blood filter and a chemical solution known as dialysate, the treatment removes waste products and excess fluids from the bloodstream, while maintaining the proper chemical balance of the blood. There are two types of dialysis treatment : hemodialysis and peritoneal dialysis.

Purpose

Dialysis can be used in the treatment of patients suffering from **poisoning** or overdose, in order to quickly remove drugs from the bloodstream. Its most prevalent application, however, is for patients with temporary or permanent kidney failure. For patients with end-stage renal disease (ESRD), whose kidneys are no longer capable of adequately removing fluids and wastes from their body or



Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. This treatment involves circulating the patient's blood outside of the body through a dialysis circuit. The blood is filtered and cleansed inside the hemodialyzer and returned to the body. (*Illustration by Electronic Illustrators Group.*)

of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream, dialysis is the only treatment option available outside of **kidney transplantation**. In 1996 in the United States, over 200,000 people underwent regular dialysis treatments to manage their ESRD.

Precautions

Blood pressure changes associated with hemodialysis may pose a risk for patients with heart problems. Peritoneal dialysis may be the preferred treatment option in these cases.

Peritoneal dialysis is not recommended for patients with abdominal adhesions or other abdominal defects, such as a **hernia**, that might compromise the efficiency of the treatment. It is also not recommended for patients who suffer frequent bouts of diverticulitis, an inflammation of small pouches in the intestinal tract.

Description

There are two types of dialysis treatment: hemodialysis and peritoneal dialysis:

Hemodialysis

Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. The treatment involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. Two needles are inserted into the patient's vein, or access site, and are attached to the ECC, which consists of plastic blood tubing, a filter known as a dialyzer (artificial kidney), and a dialysis machine that monitors and maintains blood flow and administers dialysate. Dialysate is a chemical bath that is used to draw waste products out of the blood.

Since the 1980s, the majority of hemodialysis treatments in the United States have been performed with hollow fiber dialyzers. A hollow fiber dialyzer is composed of thousands of tube-like hollow fiber strands encased in a clear plastic cylinder several inches in diameter. There are two compartments within the dialyzer (the blood compartment and the dialysate compartment). The membrane that separates these two compartments is semipermeable. This means that it allows the passage of certain sized molecules across it, but prevents the pas-

KEY TERMS

Access site—The vein tapped for vascular access in hemodialysis treatments. For patients with temporary treatment needs, access to the bloodstream is gained by inserting a catheter into the subclavian vein near the patient's collarbone. Patients in long-term dialysis require stronger, more durable access sites, called fistulas or grafts, that are surgically-created.

Dialysate—A chemical bath used in dialysis to draw fluids and toxins out of the bloodstream and supply electrolytes and other chemicals to the bloodstream.

Dialysis prescription—The general parameters of dialysis treatment that vary according to each patient's individual needs. Treatment length, type of dialyzer and dialysate used, and rate of ultrafiltration are all part of the dialysis prescription.

Dialyzer—An artificial kidney usually composed of hollow fiber that is used in hemodialysis to eliminate waste products from the blood and remove excess fluids from the bloodstream.

Erythropoietin—A hormone produced by the kidneys that stimulates the production of red blood cells by bone marrow.

ESRD—End-stage renal disease; chronic or permanent kidney failure.

Extracorporeal circuit (ECC)—The path the hemodialysis patient's blood takes outside of the body. It typically consists of plastic tubing, a hemodialysis machine, and a dialyzer.

Hematocrit (Hct) level—A measure of red blood cells.

Peritoneum—The abdominal cavity; the peritoneum acts as a blood filter in peritoneal dialysis.

sage of other, larger molecules. As blood is pushed through the blood compartment in one direction, suction or vacuum pressure pulls the dialysate through the dialysate compartment in a countercurrent, or opposite direction. These opposing pressures work to drain excess fluids out of the bloodstream and into the dialysate, a process called ultrafiltration.

A second process called diffusion moves waste products in the blood across the membrane into the dialysate compartment, where they are carried out of the body. At the same time, electrolytes and other chemicals in the dialysate solution cross the membrane into the blood compartment. The purified, chemically-balanced blood is then returned to the body.

Most hemodialysis patients require treatment three times a week, for an average of three to four hours per dialysis "run." Specific treatment schedules depend on the type of dialyzer used and the patient's current physical condition. While the treatment prescription and regimen is usually overseen by a nephrologist (a doctor that specializes in the kidney), dialysis treatments are typically administered by a nurse or patient care technician in outpatient clinics known as dialysis centers, or in hospital-based dialysis units. In-home hemodialysis treatment is also an option for some patients, although access to this type of treatment may be limited by financial and lifestyle factors. An investment in equipment is required and another person in the household should be available for support and assistance with treatments.

Peritoneal dialysis

In peritoneal dialysis, the patient's peritoneum, or lining of the abdomen, acts as a blood filter. A catheter is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a waiting period of six to 24 hours, depending on the treatment method used, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate.

There are three types of peritoneal dialysis:

- Continuous ambulatory peritoneal dialysis (CAPD). A continuous treatment that is self-administered and requires no machine. The patient inserts fresh dialysate solution into the abdominal cavity, waits four to six hours, and removes the used solution. The solution is immediately replaced with fresh dialysate. A bag attached to the catheter is worn under clothing.
- Continuous cyclic peritoneal dialysis (CCPD). An overnight treatment that uses a machine to drain and refill the abdominal cavity, CCPD takes 10–12 hours per session.
- Intermittent peritoneal dialysis (IPD). This hospital-based treatment is performed several times a week. A machine administers and drains the dialysate solution, and sessions can take up to 24 hours.

Peritoneal dialysis is often the treatment option of choice in infants and children, whose small size can make vascular (through a vein) access difficult to maintain. Peritoneal dialysis can also be done outside of a clinical setting, which is more conducive to regular school attendance.

Preparation

Patients are weighed immediately before and after each hemodialysis treatment to assess their fluid retention. Blood pressure and temperature are taken and the patient is assessed for physical changes since their last dialysis run. Regular blood tests monitor chemical and waste levels in the blood. Prior to treatment, patients are typically administered a dose of heparin, an anticoagulant that prevents blood clotting, to ensure the free flow of blood through the dialyzer and an uninterrupted dialysis run for the patient.

Aftercare

Both hemodialysis and peritoneal dialysis patients need to be vigilant about keeping their access sites and catheters clean and infection-free during and between dialysis runs.

Dialysis is just one facet of a comprehensive treatment approach for ESRD. Although dialysis treatment is very effective in removing toxins and fluids from the body, there are several functions of the kidney it cannot mimic, such as regulating high blood pressure and red blood cell production. Patients with ESRD need to watch their diet and fluid intake carefully and take medications as prescribed to manage their disease.

Risks

Many of the risks and side effects associated with dialysis are a combined result of both the treatment and the poor physical condition of the ESRD patient. Dialysis patients should always report side effects to their healthcare provider.

Anemia

Hematocrit (Hct) levels, a measure of red blood cells, are typically low in ESRD patients. This deficiency is caused by a lack of the hormone erythropoietin, which is normally produced by the kidneys. The problem is elevated in hemodialysis patients, who may incur blood loss during hemodialysis treatments. Epoetin alfa, or EPO (sold under the trade name Epogen), a hormone therapy, and intravenous or oral iron supplements are used to manage anemia in dialysis patients.

Cramps, nausea, vomiting, and headaches

Some hemodialysis patients experience cramps and flu-like symptoms during treatment. These can be caused by a number of factors, including the type of dialysate used, composition of the dialyzer membrane, water quality in the dialysis unit, and the ultrafiltration rate of the treatment. Adjustment of the dialysis prescription often helps alleviate many symptoms.

Hypotension

Because of the **stress** placed on the cardiovascular system with regular hemodialysis treatments, patients are at risk for **hypotension**, a sudden drop in blood pressure. This can often be controlled by medication and adjustment of the patient's dialysis prescription.

Infection

Both hemodialysis and peritoneal dialysis patients are at risk for infection. Hemodialysis patients should keep their access sites clean and watch for signs of redness and warmth that could indicate infection. Peritoneal dialysis patients must follow the same precautions with their catheter. **Peritonitis**, an infection of the peritoneum, causes flu-like symptoms and can disrupt dialysis treatments if not caught early.

Infectious diseases

Because there is a great deal of blood exposure involved in dialysis treatment, a slight risk of contracting **hepatitis B** and **hepatitis C** exists. The hepatitis B **vaccination** is recommended for most hemodialysis patients. As of 1997, there has only been one documented case of HIV being transmitted in a United States dialysis unit to a staff member, and no documented cases of HIV ever being transmitted between dialysis patients in the United States. The strict standards of **infection control** practiced in modern hemodialysis units makes the chance of contracting one of these diseases very small.

Normal results

Puffiness in the patient related to **edema**, or fluid retention, may be relieved after dialysis treatment. The patient's overall sense of physical well-being may also be improved. Because dialysis is an ongoing treatment process for many patients, a baseline for normalcy can be difficult to gauge.

Resources

BOOKS

Bock, G. H., E. J. Ruley, and M. P. Moore. *A Parent's Guide to Kidney Disorders*. Minneapolis: University of Minnesota Press, 1993.

Cameron, J. S. *Kidney Failure: The Facts*. New York: Oxford University Press, 1996.

Lazarus, J. Michael, and Raymond M. Hakim. "Medical Aspects of Hemodialysis." In *The Kidney*, ed. Barry M. Brenner and Floyd C. Rector Jr. Philadelphia: W. B. Saunders Co., 1991.

National Kidney Foundation. *Dialysis Outcomes Quality Initiatives (NOQI)*. Vol. 1-5. New York: National Kidney Foundation, 1997.
Nissenson, Allen R., and Richard N. Fine, eds. *Dialysis Therapy.* 2nd ed. Philadelphia: Hanley & Belfus, Inc., 1993.
Nolph, Karl D. "Peritoneal Dialysis." In *The Kidney*, ed. Barry M. Brenner and Floyd C. Rector Jr. Philadelphia: W. B. Saunders Co., 1991.
U.S. Renal Data System. *USRDS 1997 Annual Data Report.* Bethesda, MD: The National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1996.

PERIODICALS

Degroot, Patricia J., Sally Rubens Kenler, and Johanna T. Dwyer. "Optimizing Dialysis: Past, Present, and Future." *Nutrition Today* 32 (Jan/Feb. 1997): 30-6.
"Dialysis: Need for Artificial Kidney Treatment Is Increasing." *Mayo Clinic Health Letter*, 15 (Feb. 1997): 1-4.
Favero, Martin S. "Infection Control." *Dialysis and Transplantation* 25 (Oct. 1996): 699-702.
Friedman, Elia A. "End-Stage Renal Disease Therapy: An American Success Story." *The Journal of the American Medical Association* 275 (Apr. 1996): 1118-22.

ORGANIZATIONS

American Association of Kidney Patients. 100 S. Ashley Dr., #280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.
American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.
National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.
United States Renal Data System (USRDS). The University of Michigan, 315 W. Huron, Suite 240, Ann Arbor, MI 48103. (734) 998-6611. <http://www.med.umich.edu/usrds>.

Paula Anne Ford-Martin

Diaper rash

Definition

Dermatitis of the buttocks, genitals, lower abdomen, or thigh folds of an infant or toddler is commonly referred to as diaper rash.

Description

The outside layer of skin normally forms a protective barrier that prevents infection. One of the primary causes of dermatitis in the diaper area is prolonged skin contact with wetness. Under these circumstances, natural oils are stripped away, the outer layer of skin is damaged, and there is increased susceptibility to infection by bacteria or yeast.

Diaper rash is a term that covers a broad variety of skin conditions that occur on the same area of the body. Some babies are more prone to diaper rash than others.

Causes and symptoms

Frequently a flat, red rash is caused by simple chafing of the diaper against tender skin, initiating a friction rash. This type of rash is not seen in the skin folds. It may be more pronounced around the edges of the diaper, at the waist and leg bands. The baby generally doesn't appear to experience much discomfort. Sometimes the chemicals or detergents in the diaper are contributing factors and may result in **contact dermatitis**. These **rashes** should clear up easily with proper attention. Ignoring the condition may lead to a secondary infection that is more difficult to resolve.

Friction of skin against itself can cause a rash in the baby's skin folds, called intertrigo. This rash appears as reddened areas that may ooze and is often uncomfortable when the diaper is wet. Intertrigo can also be found on other areas of the body where there are deep skin folds that tend to trap moisture.

Seborrheic dermatitis is the diaper area equivalent of cradle cap. It is scaly and greasy in appearance and may be worse in the folds of the skin.

Yeast, or candidal dermatitis, is the most common infectious cause of diaper rash. The affected areas are raised and quite red with distinct borders, and satellite lesions may occur around the edges. Yeast is part of the normal skin flora, and is often an opportunistic invader when simple diaper rash is untreated. It is particularly common after treatment with **antibiotics**, which kill the good bacteria that normally keep the yeast population in check. Usual treatments for diaper rash will not clear it up. Repeated or difficult to resolve episodes of yeast infection may warrant further medical attention, since this is sometimes associated with diabetes or immune problems.

Another infectious cause of diaper rash is **impetigo**. This bacterial infection is characterized by blisters that ooze and crust.

Diagnosis

The presence of **skin lesions** in the diaper area means that the baby has diaper rash. However, there are several types of rash that may require specific treatment

in order to heal. It is useful to be able to distinguish them by appearance as described above.

A baby with a rash that does not clear up within two to three days or a rash with blisters or bleeding should be seen by a healthcare professional for further evaluation.

Treatment

Antibiotics are generally prescribed for rashes caused by bacteria, particularly impetigo. This may be a topical or oral formulation, depending on the size of the area involved and the severity of the infection.

Over-the-counter antifungal creams, such as Lotrimin, are often recommended to treat a rash resulting from yeast. If topical treatment is not effective, an oral antifungal may be prescribed.

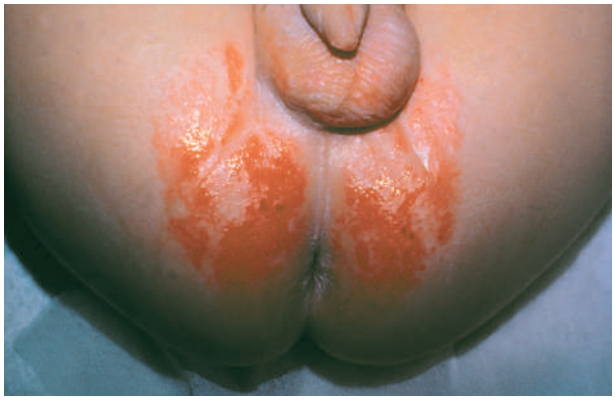
Mild steroid creams, such as 0.5–1% hydrocortisone, can be used for seborrheic dermatitis and sometimes intertrigo. Prescription strength creams may be needed for short-term treatment of more stubborn cases.

Alternative treatment

Good diaper hygiene will prevent or clear up many simple cases of diaper rash. Diapers should be checked very frequently and changed as soon as they are wet or soiled. Good air circulation is also important for healthy skin. Babies should have some time without wearing a diaper, and a waterproof pad can be used to protect the bed or other surface. Rubber pants, or other occlusive fabrics, should not be used over the diaper area. Some cloth-like disposable diapers promote better air circulation than plastic-type diapers. It may be necessary for mothers to experiment with diaper types to see if the baby's skin reacts better to cloth or disposable ones. If disposable diapers are used, the baby's skin may react differently to various brands. If the baby is wearing cloth diapers, they should be washed in a mild detergent and double rinsed.

The diaper area should be cleaned with something mild, even plain water. Some wipes contain alcohol or chemicals that can be irritating for some babies. Plain water may be the best cleansing substance when there is a rash. Using warm water in a spray bottle (or giving a quick bath) and then lightly patting the skin dry can produce less skin trauma than using wipes. In the event of suspected yeast, a tablespoon of cider vinegar can be added to a cup of warm water and used as a cleansing solution. This is dilute enough that it should not burn, but acidifies the skin pH enough to hamper the yeast growth.

Barrier ointments can be valuable to treat rashes. Those that contain zinc oxide are especially effective. These creams and ointments protect already irritated skin from the additional insult of urine and stool, particularly if the baby has **diarrhea**. Cornstarch powder may be used on rashes that are moist, such as impetigo.



Baby with severe diaper rash. *(Custom Medical Stock Photo. Reproduced by permission.)*

Nutrition

What the baby eats can make a difference in stool frequency and acidity. Typically, breast-fed babies will have fewer problems with rashes. When adding a new food to the diet, the baby should be observed closely to see whether rashes are produced around the baby's mouth or anus. If this occurs, the new food should be discontinued.

Babies who are taking antibiotics are more likely to get rashes due to yeast. To help bring the good bacterial counts back to normal, *Lactobacillus bifidus* can be added to the diet. It is available in powder form from most health food stores.

Herbal treatment

Some herbal preparations can be useful for diaper rash. Calendula reduces inflammation, tightens tissues, and disinfects. It has been recommended for seborrheic dermatitis as well as for general inflammation of the skin. The ointment should be applied at each diaper change. Chickweed ointment can also be soothing for irritated skin and may be applied once or twice daily.

Prognosis

Treated appropriately, diaper rash will resolve fairly quickly if there is no underlying health problem or skin disease.

Prevention

Frequent diaper changes are important to keep the skin dry and healthy. Application of powders and oint-

KEY TERMS

Dermatitis—Inflammation of the skin.

ments is not necessary when there is no rash. Finding the best combination of cleansing and diapering products for the individual baby will also help to prevent diaper rash.

Resources

BOOKS

Eisenberg, Arlene, Heidi Murkoff, and Sandee Hathaway. *What to Expect the First Year.* New York: Workman Publishing, 1989.

Sears, William, and Martha Sears. *The Baby Book.* Boston: Little, Brown and Company, 1993.

OTHER

Greene, Alan. "Diaper Rash." *Dr. Greene's HouseCalls.* <http:// drgreene.com/960430.asp> (1996).

Judith Turner

Diaphragm (birth control)

Definition

Diaphragms are dome-shaped barrier methods of **contraception** that block sperm from entering the uterus. They are made of latex (rubber) and formed like a shallow cup. Since vaginas vary in size, each patient will need to be fitted by a doctor or nurse with a diaphragm that conforms to the shape and contour of the vagina as well as the strength of the muscles in the vaginal walls. Diaphragms must be used with spermicidal cream or jelly. The device should cause no discomfort, and neither the woman nor her partner should feel that it is there.

Purpose

The purpose of a diaphragm is to prevent access to the womb (uterus) by the sperm and thus prevent conception. The level of effectiveness is about 95%.

Precautions

Each client will undergo a **physical examination** and a Pap smear. If these are normal, the physician will fit the patient for the device and give instructions on how to insert, remove, and clean the object. She will also be taught the signs and symptoms of potential complications.

Description

Prior to insertion, the inside of the dome and the rim are covered with a thick layer (perhaps a tablespoon) of a spermicide that is compatible with the diaphragm being used. The domed area covers the opening into the uterus (cervix) and keeps the spermicide in place. As a result, any sperm that might get under the diaphragm will be destroyed.

Diaphragms may be inserted two to three hours prior to intercourse, and must be left in place for six to eight hours following sexual relations. During this time the woman may not swim, bathe, or douche, but she may shower. If she desires to have intercourse again before the six to eight hours have passed, the diaphragm should not be removed. Instead, an applicator full of spermicide should be deposited into the vagina.

A diaphragm will last for a year or more. It should be examined weekly for holes. This can be done by holding it up to the light or filling it with water.

Preparation

Before inserting the diaphragm, the woman should empty her bladder and wash her hands with soap and water. The device should be checked for leaks by filling it with water or holding it up to the light. A spermicidal jelly is then applied to the inside and outside, and especially around the rim. While standing with one foot elevated on a chair or step, lying down, or squatting, the woman folds the diaphragm inward toward the middle and inserts it into the vagina as far as it will go.

Aftercare

When removed, the diaphragm should be washed with a mild soap and water. After being dried, it can be dusted with corn starch before being returned to its container. The diaphragm should always be stored away from sunlight and heat in a cool, dry place. It should not be washed with harsh or perfumed soaps or used with perfumed powders because either of these substances can damage the diaphragm.

Risks

Although rare, wearing the diaphragm longer than the recommended time can result in **toxic shock syndrome**. The signs and symptoms of this serious illness include sudden onset of high **fever**, vomiting, **diarrhea**, **dizziness**, faintness, weakness, aching muscles and joints, and rash. The doctor must be notified immediately if any of these conditions appear. An allergic reaction to the spermicide or the material from which the device is

KEY TERMS

Spermicide—A substance that kills sperm.

Toxic shock syndrome—An uncommon, but potentially fatal, disease that has been associated with the use of diaphragms and vaginal tampons. The symptoms include high fever, vomiting, and diarrhea.

made is also possible. Diaphragm use is also associated with an increased risk of bladder infections.

It should be noted that the diaphragm can become dislodged during intercourse, which could result in an unwanted **pregnancy**. To ensure a secure fit, a woman should be examined for a refitting if she gains or loses more than 10 lbs (4.5 kg), or after she gives birth.

Normal results

Consumers can expect an efficiency rate of about 95% in preventing pregnancy. Using a male **condom** in conjunction with the diaphragm decreases the potential for pregnancy. Diaphragms provide no protection against **AIDS** or other **sexually transmitted diseases**.

Resources

BOOKS

Dickason, Elizabeth Jean, Bonnie Lang Silverman, and Judith A. Kaplan. *Maternal-Infant Nursing Care.* 3rd ed. St. Louis: Mosby-Year Book, Inc., 1998.

Gorrie, Trula Meyers, Emily Slone McKinney, and Sharon Smith Murray. *Foundations of Maternal-Newborn Nursing.* 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

Nichols, Francine H., and Elaine Zwelling. *Maternal-Newborn Nursing: Theory and Practice.* Philadelphia.: W. B. Saunders Co., 1997.

Olds, Sally B., Marcia L. London, and Patricia Wieland Ladewig. *Maternal-Newborn Nursing: A Family Centered Approach.* Menlo Park: Addison-Wesley, 1996.

ORGANIZATIONS

Planned Parenthood Federation of America, Inc. 810 Seventh Ave., New York, NY,10019. (800) 669-0156. <http://www.plannedparenthood.org>.

OTHER

"The Diaphragm." *Cincinnati Women's Services.* <http://gynpages.com/cws/8.html>.

"Guide to Safer Sex." *Sexual Health InfoCenter.* <http://www.sexhealth.org/infocenter/GuideSS/diaphragm.htm>.

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Diaphragmatic hernia *see* **Hernia**

Diarrhea

Definition

To most individuals, diarrhea means an increased frequency or decreased consistency of bowel movements; however, the medical definition is more exact than this. In many developed countries, the average number of bowel movements is three per day. However, researchers have found that diarrhea best correlates with an increase in stool weight; stool weights above 10 oz (300 g) per day generally indicates diarrhea. This is mainly due to excess water, which normally makes up 60–85% of fecal matter. In this way, true diarrhea is distinguished from diseases that cause only an increase in the number of bowel movements (hyperdefecation), or incontinence (involuntary loss of bowel contents).

Diarrhea is also classified by physicians into acute, which lasts one to two weeks, and chronic, which continues for longer than 23 weeks. Viral and bacterial infections are the most common causes of acute diarrhea.

Description

In many cases, acute infectious diarrhea is a mild, limited annoyance. However, worldwide acute infectious diarrhea has a huge impact, causing over five million deaths per year. While most deaths are among children under five years of age in developing nations, the impact, even in developed countries, is considerable. For example, over 250,000 individuals are admitted to hospitals in the United States each year because of one of these episodes. Rapid diagnosis and proper treatment can prevent much of the suffering associated with these devastating illnesses.

Chronic diarrhea also has a considerable effect on health, as well as on social and economic well being. Patients with **celiac disease**, inflammatory bowel disease, and other prolonged diarrheal illnesses develop nutritional deficiencies that diminish growth and immunity. They affect social interaction and result in the loss of many working hours.

Causes and symptoms

Diarrhea occurs because more fluid passes through the large intestine (colon) than that organ can absorb. As a rule, the colon can absorb several times more fluid than is required on a daily basis. However, when this reserve capacity is overwhelmed, diarrhea occurs.

Diarrhea is caused by infections or illnesses that either lead to excess production of fluids or prevent absorption of fluids. Also, certain substances in the colon,

such as fats and bile acids, can interfere with water absorption and cause diarrhea. In addition, rapid passage of material through the colon can also do the same.

Symptoms related to any diarrheal illness are often those associated with any injury to the gastrointestinal tract, such as **fever**, nausea, vomiting, and abdominal **pain**. All or none of these may be present depending on the disease causing the diarrhea. The number of bowel movements can vary—up to 20 or more per day. In some patients, blood or pus is present in the stool. Bowel movements may be difficult to flush (float) or contain undigested food material.

The most common causes of acute diarrhea are infections (the cause of **traveler's diarrhea**), **food poisoning**, and medications. Medications are a frequent and often over-looked cause, especially **antibiotics** and **antacids**. Less often, various sugar free foods, which sometimes contain poorly absorbable materials, cause diarrhea.

Chronic diarrhea is frequently due to many of the same things that cause the shorter episodes (infections, medications, etc.); symptoms just last longer. Some infections can become chronic. This occurs mainly with parasitic infections (such as *Giardia*) or when patients have altered immunity (**AIDS**).

The following are the more usual causes of chronic diarrhea:

- AIDS
- colon **cancer** and other bowel tumors
- endocrine or hormonal abnormalities (thyroid, **diabetes mellitus**, etc.)
- food allergy
- inflammatory bowel disease (**Crohn's disease** and **ulcerative colitis**)
- lactose intolerance
- malabsorption syndromes (celiac and Whipple's disease)
- other (alcohol, microscopic colitis, radiation, surgery)

Complications

The major effects of diarrhea are **dehydration**, **malnutrition**, and weight loss. Signs of dehydration can be hard to notice, but increasing thirst, **dry mouth**, weakness or lightheadedness (particularly if worsening on standing), or a darkening/decrease in urination are suggestive. Severe dehydration leads to changes in the body's chemistry and could become life-threatening. Dehydration from diarrhea can result in kidney failure, neurological symptoms, arthritis, and skin problems.

Diagnosis

Most cases of acute diarrhea never need diagnosis or treatment, as many are mild and produce few problems. But patients with fever over 102°F (38.9°C), signs of dehydration, bloody bowel movements, severe abdominal pain, known immune disease, or prior use of antibiotics need prompt medical evaluation.

When diagnostic studies are needed, the most useful are **stool culture** and examination for parasites; however these are often negative and a cause cannot be found in a large number of patients. The earlier cultures are performed, the greater the chance of obtaining a positive result. For those with a history of antibiotic use in the preceding two months, stool samples need to be examined for the toxins that cause **antibiotic-associated colitis**. Tests are also available to check stool samples for microscopic amounts of blood and for cells that indicate severe inflammation of the colon. Examination with an endoscope is sometimes helpful in determining severity and extent of inflammation. Tests to check changes in blood chemistry (potassium, magnesium, etc.) and a complete **blood count** (CBC) are also often performed.

Chronic diarrhea is quite different, and most patients with this condition will receive some degree of testing. Many exams are the same as for an acute episode, as some infections and parasites cause both types of diarrhea. A careful history to evaluate medication use, dietary changes, family history of illnesses, and other symptoms is necessary. Key points in determining the seriousness of symptoms are weight loss of over 10 lb (4.5 kg), blood in the stool, and nocturnal diarrhea (symptoms that awaken the patient from sleep).

Both prescription and over-the-counter medications can contain additives, such as lactose and sorbitol, that will produce diarrhea in sensitive individuals. Review of **allergies** or skin changes may also point to a cause. Social history may indicate if **stress** is playing a role or identify activities which can be associated with diarrhea (for example, diarrhea that occurs in runners).

A combination of stool, blood, and urine tests may be needed in the evaluation of chronic diarrhea; in addition a number of endoscopic and x-ray studies are frequently required.

Treatment

Treatment is ideally directed toward correcting the cause; however, the first aim should be to prevent or treat dehydration and nutritional deficiencies. The type of fluid and nutrient replacement will depend on whether oral feedings can be taken and the severity of fluid loss-

es. Oral rehydration solution (ORS) or intravenous fluids are the choices; ORS is preferred if possible.

A physician should be notified if the patient is dehydrated, and if oral replacement is suggested then commercial (Pedialyte and others) or homemade preparations can be used. The World Health Organization (WHO) has provided this easy recipe for home preparation, which can be taken in small frequent sips:

- Table salt—3/4 tsp
- Baking powder—1 tsp
- Orange juice—1 c
- Water—1 qt (1 L)

When feasible, food intake should be continued even in those with acute diarrhea. A physician should be consulted as to what type and how much food is permitted.

Anti-motility agents (loperamide, diphenoxylate) are useful for those with chronic symptoms; their use is limited or even contraindicated in most individuals with acute diarrhea, especially in those with high fever or bloody bowel movements. They should not be taken without the advice of a physician.

Other treatments are available, depending on the cause of symptoms. For example, the bulk agent psyllium helps some patients by absorbing excess fluid and solidifying stools; cholestyramine, which binds bile acids, is effective in treating bile salt induced diarrhea. Low fat **diets** or more easily digestible fat is useful in some patients. New **antidiarrheal drugs** that decrease excessive secretion of fluid by the intestinal tract is another approach for some diseases. Avoidance of medications or other products that are known to cause diarrhea (such as lactose) is curative in some, but should be discussed with a physician.

Alternative treatment

It is especially important to find the cause of diarrhea, since stopping diarrhea when it is the body's way of eliminating something foreign is not helpful and can be harmful in the long run.

One effective alternative approach to preventing and treating diarrhea involves oral supplementation of aspects of the normal flora in the colon with the yeasts *Lactobacillus acidophilus*, *L. bifidus*, or *Saccharomyces boulardii*. In clinical settings, these "biotherapeutic" agents have repeatedly been helpful in the resolution of diarrhea, especially antibiotic-associated diarrhea. Their effectiveness is also supported by the results of a research study published in the *Journal of the American Medical Association* in 1996.

KEY TERMS

Anti-motiltiy medications—Medications such as loperamide (Imodium), diphenoxylate (Lomotil), or medications containing codeine or narcotics that decrease the ability of the intestine to contract. These can worsen the condition of a patient with dysentery or colitis.

Colitis—Inflammation of the colon.

Endoscope—An endoscope, as used in the field of gastroenterology, is a thin flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. Both diagnosis, through biopsies or other means, and therapeutic procedures can be done with this instrument.

Endoscopy—The performance of an exam using an endoscope is known generally as endoscopy.

Lactose intolerance—An inability to properly digest milk and dairy products.

Oral rehydration solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Steatorrhea—Excessive amounts of fat in the feces.

Nutrient replacement also plays a role in preventing and treating episodes of diarrhea. Zinc especially appears to have an effect on the immune system, and deficiency of this mineral can lead to chronic diarrhea. Also, zinc replacement improves growth in young patients. Plenty of fluids, especially water, should be taken by individuals suffering from diarrhea to prevent dehydration. The BRAT diet also can be useful in helping to resolve diarrhea. This diet limits food intake to bananas, rice, applesauce, and toast. These foods provide soluble and insoluble fiber without irritation. If the toast is slightly burnt, the charcoal can help sequester toxins and pull them from the body.

Acute homeopathic remedies can be very effective for treating diarrhea especially in infants and young children.

Prognosis

Prognosis is related to the cause of the diarrhea; for most individuals in developed countries, a bout of acute, infectious diarrhea is at best uncomfortable. However, in

both industrialized and developing areas, serious complications and **death** can occur.

For those with chronic symptoms, an extensive number of tests are usually necessary to make a proper diagnosis and begin treatment; a specific diagnosis is found in 90% of patients. In some, however, no specific cause is found and only treatment with bulk agents or antimotility agents is indicated.

Prevention

Proper hygiene and food handling techniques will prevent many cases. Traveler's diarrhea can be avoided by use of Pepto-Bismol and/or antibiotics, if necessary. The most important action is to prevent the complications of dehydration.

Resources

BOOKS

Fine, Kenneth D. "Diarrhea." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Friedman, Lawrence S., and Kurt J. Isselbacher. "Diarrhea." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hamer, Davidson H., and Sherwood L. Gorbach. "Treatment of Infectious Diarrhea." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Company. 1997.

Thielman, Nathan M., and Richard L. Guerrant. "Food-Borne Illness." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Wolfe, Martin S. "Acute Infectious Diarrhea." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Donowitz, Mark, Freddy T. Kokke, and Roxan Saidi. "Evaluation of Patients with Chronic Diarrhea." *New England Journal of Medicine* 332 (16 Mar. 1995): 725-729.

Dupont, Herbert L., and The Practice Parameters Committee of the American College of Gastroenterology. "Guidelines on Acute Infectious Diarrhea in Adults." *American Journal of Gastroenterology* 92 (1997): 1962-1975.

Fekety, Robert. "Guidelines for the Diagnosis and Management of Clostridium Difficile-Associated Diarrhea and Colitis." *American Journal of Gastroenterology* 92 (1997): 739-750.

Gianella, Ralph A. "Acute Infectious Diarrhea." *Gastroenterology Clinics of North America* (Sept. 1993): 483-707.

Penny, Mary E., and Claudio F. Lanata. "Zinc in the Management of Diarrhea in Young Children." *New England Journal of Medicine* 333 (28 Sept. 1995): 873-874.

"Traveler's Diarrhea: Don't Let It Ruin Your Trip." *Mayo Clinic Health Letter* (Jan. 1997).

"When Microbes Are on the Menu." *Harvard Health Letter* (Dec. 1994): 4-5.

ORGANIZATIONS

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

OTHER

"Directory of Digestive Diseases Organizations for Patients." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.

"A Neglected Modality for the Treatment and Prevention of Selected Intestinal and Vaginal Infections." *JAMA*. <http://pubs.ama-assn.org>.

Selected publications and documents on diarrhoeal diseases (including cholera). *World Health Organization (WHO)*. <http://www.who.ch/chd/pub/cdd/cddpub.htm>.

David Kaminstein, MD

Diazep *see* **Benzodiazepines**

Diclofenac *see* **Nonsteroidal anti-inflammatory drugs**

Dicyclomine *see* **Antispasmodic drugs**

Didanosine *see* **Antiretroviral drugs**

Diets

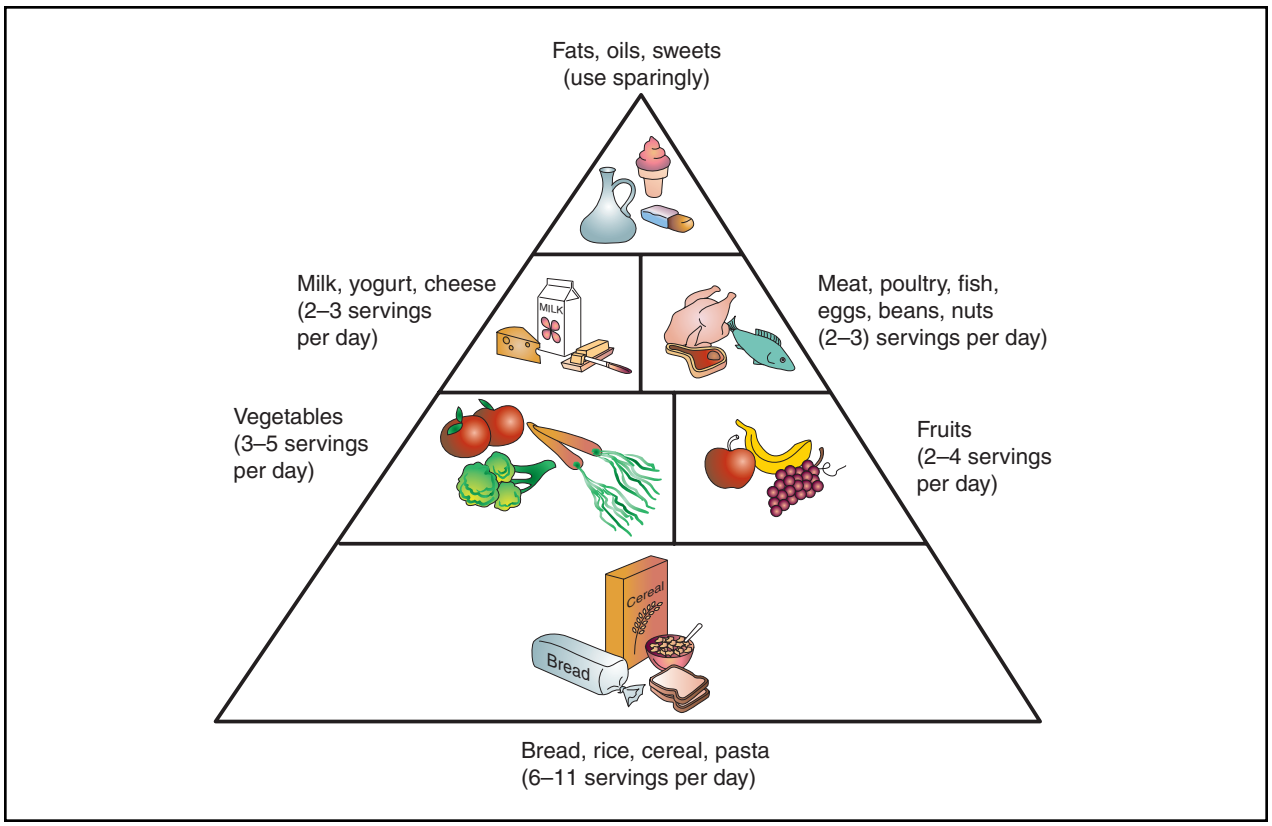
Definition

Humans may alter their usual eating habits for many reasons, including weight loss, disease prevention or treatment, removing toxins from the body, or to achieve a general improvement in physical and mental health. Others adopt special diets for religious reasons. In the case of some vegetarians and vegans, dietary changes are made out of ethical concerns for the rights of animals.

Purpose

People who are moderately to severely overweight can derive substantial health benefits from a weight-loss diet. A weight reduction of just 10–20 (4.5–9.1 kg) can result in reduced cholesterol levels and lower blood pressure. Weight-related health problems include heart disease, diabetes, high blood pressure, and high levels of blood sugar and cholesterol.

In individuals who are not overweight, dietary changes may also be useful in the prevention or treatment of a range of ailments including acquired immunodeficiency syndrome (**AIDS**), **cancer**, **osteoporosis**, inflammatory bowel disease, chronic pulmonary disease,



Suggested daily food servings. *(Illustration by Electronic Illustrators Group.)*

renal disease, **Parkinson's disease**, seizure disorders, and food **allergies** and intolerances.

Description

Origins

The practice of altering diet for special reasons has existed since antiquity. For example, Judaism has included numerous dietary restrictions for thousands of years. One ancient Jewish sect, the Essenes, is said to have developed a primitive **detoxification** diet aimed at preparing the bodies, minds, and spirits of its members for the coming of a "messiah" who would deliver them from their Roman captors. Preventative and therapeutic diets became quite popular during the late twentieth century. Books promoting the latest dietary plan continue to make the bestseller lists, although not all of the information given is considered authoritative.

The idea of a healthful diet is to provide all of the calories and nutrients needed by the body for optimal performance, at the same time ensuring that neither nutritional deficiencies nor excesses occur. Diet plans that claim to accomplish those objectives are so numerous they are virtually uncountable. These diets employ a variety of approaches, including the following:

- Fixed-menu: Offers little choice to the dieter. Specifies exactly which foods will be consumed. Easy to follow, but may be considered "boring" to some dieters.
- Formula: Replaces some or all meals with a nutritionally balanced liquid formula or powder.
- Exchange-type: Allows the dieter to choose between selected foods from each food group.
- Flexible: Doesn't concern itself with the overall diet, simply with one aspect such as fat or energy.

Diets may also be classified according to the types of foods they allow. For example, an omnivorous diet consists of both animal and plant foods, whereas a lacto-ovo-vegetarian diet permits no animal flesh, but does include eggs, milk, and dairy products. A vegan diet is a stricter form of **vegetarianism** in which eggs, cheese, and other milk products are prohibited.

A third way of classifying diets is according to their purpose: religious, weight-loss, detoxification, lifestyle-related, or aimed at prevention or treatment of a specific disease.

Precautions

Dieters should be cautious about plans that severely restrict the size of food portions, or that eliminate entire food groups from the diet. It is highly probable that they will become discouraged and drop out of such programs. The best diet is one that can be maintained indefinitely without ill effects, that offers sufficient variety and balance to provide everything needed for good health, and that is considerate of personal food preferences.

Low-fat diets are not recommended for children under the age of two. Young children need extra fat to maintain their active, growing bodies. Fat intake may be gradually reduced between the ages of two and five, after which it should be limited to a maximum of 30% of total calories through adulthood. Saturated fat should be restricted to no more than 10% of total calories.

Weight-loss dieters should be wary of the "yo-yo" effect that occurs when numerous attempts are made to reduce weight using high-risk, quick-fix diets. This continued "cycling" between weight loss and weight gain can slow the basal metabolic rate and can sometimes lead to eating disorders. The dieter may become discouraged and frustrated by this success/failure cycle. The end result of "yo-yo" dieting is that it becomes more difficult to maintain a healthy weight.

Caution should also be exercised about weight-loss diets that require continued purchases of special prepackaged foods. Not only do these tend to be costly and overprocessed, they may also prevent dieters from learning the food-selection and preparation skills essential to maintenance of weight loss. Further, dieters should consider whether they want to carry these special foods to work, restaurants, or homes of friends.

Concern has been expressed about weight-loss diet plans that do not include **exercise**, considered essential to long-term weight management. Some diets and supplements may be inadvisable for patients with special conditions or situations.

Certain fad diets purporting to be official diets of groups such as the American Heart Association and the Mayo Clinic are in no way endorsed by those institutions. Patients thinking of starting such a diet should check with the institution to ensure its name has not been misappropriated by an unscrupulous practitioner.

Side effects

A wide range of side effects (some quite serious) can result from special diets, especially those that are nutritionally unbalanced. Further problems can arise if the dieter is taking high doses of dietary supplements. Food is essential to life, and improper **nutrition** can result in serious illness or **death**.

Research and general acceptance

It is agreed among traditional and complementary practitioners that many patients could substantially benefit from improved eating habits. Specialized diets have proved effective against a wide variety of conditions and diseases. However, dozens of unproved but widely publicized "fad diets" emerge each year, prompting widespread concerns about their usefulness, cost to the consumer, and their safety.

Resources

ORGANIZATIONS

American Dietetic Association. 216 West Jackson Blvd., Chicago, IL 60606-6995. (312) 899-0040. <http://www.eatright.org>.

David Helwig

Diffuse esophageal spasm

Definition

Diffuse esophageal spasm is a term used to define an uncoordinated or spastic esophagus.

Description

The esophagus is a muscular tube that actively transports food from the throat to the stomach by rhythmic contractions known as peristalsis. The actual mechanism and anatomy are quite complex, involving three distinct segments and allowing a person to swallow even when upside-down. Diffuse esophageal spasm describes a condition where the entire esophagus is spastic—along its entire length, the muscular activity is increased and uncoordinated. The name corkscrew esophagus describes perfectly the appearance of this disorder on x rays.

X rays may reveal a slightly different appearance and result in the designation rosary bead esophagus, but the cause is still diffuse spasm, and the two entities behave in the same way.

Causes and symptoms

The cause appears to be disruption of the complex system of nerves that coordinates the muscular activity. The result is difficulty swallowing (dysphagia) and **pain** that feels like a **heart attack** and can involve the entire chest, jaw, and arms.

KEY TERMS

Contrast agent—A substance that produces shadows on x rays.

Manometry—Measurement of pressure.

Peristalsis—Slow, rhythmic contractions of the muscles in a tubular organ, such as the intestines, that propel the contents along.

Diagnosis

Swallowing problems usually call for esophagograms. In the x ray department, the patient is given a contrast agent to drink. During swallowing, x rays record the passage of the agent down the esophagus and into the stomach. Instead of a straight tube with well-coordinated waves of contraction, the resulting x rays show a writhing organ resembling a giant corkscrew.

Another test that is used in many disorders of esophageal motility is manometry. Pressures inside the esophagus are measured every inch or so using a balloon device that is passed all the way down to the stomach. The result is a precise record of its activity that yields a specific diagnosis.

Treatment

Soft and liquid foods pass more easily than solid pieces. Medications of several types are helpful—nifedipine, hydralazine, isoproterenol, and nitrates being the most successful. Several other treatments have uncertain results. For severe cases, relief is obtained two-thirds of the time by cutting the muscles along the entire length of the esophagus. This is a major surgical procedure.

Prognosis

This condition does not go away, nor is treatment entirely satisfactory. Patients need to be careful of what they eat and continue on medication if a beneficial one is found. Fortunately, the condition does not get progressively worse as time passes.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Clouse, Ray E. "Motor disorders of the esophagus." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Goyal, Raj K. "Diseases of the Esophagus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

DiGeorge syndrome

Definition

DiGeorge syndrome (also called congenital thymic hypoplasia, or third and fourth pharyngeal pouch syndrome) is a birth defect that is caused by an abnormal chromosome and affects the baby's immune system. The syndrome is marked by absence or underdevelopment of the thymus and parathyroid glands. It is named for the pediatrician who first described it in 1965.

Description

The prevalence of DiGeorge syndrome is debated; the estimates range from 1:4000 to 1:6395. Because the symptoms caused by the chromosomal abnormality vary somewhat from patient to patient, the syndrome probably occurs much more often than was previously thought. DiGeorge syndrome is sometimes described as one of the "CATCH 22" disorders, so named because of their characteristics—cardiac defects, abnormal facial features, thymus underdevelopment, cleft palate, and hypocalcemia—caused by a deletion of several genes in chromosome 22. The specific facial features associated with DiGeorge syndrome include low-set ears, wide-set eyes, a small jaw, and a short groove in the upper lip. The male/female ratio is 1:1. The syndrome appears to be equally common in all racial and ethnic groups.

Causes and symptoms

DiGeorge syndrome is caused either by inheritance of a defective chromosome 22 or by a new defect in chromosome 22 in the fetus. The type of defect that is involved is called deletion. A deletion occurs when the genetic material in the chromosomes does not recombine properly during the formation of sperm or egg cells. The deletion means that several genes from chromosome 22 are missing in DiGeorge syndrome patients. According to a 1999 study, 6% of children with DiGeorge syndrome inherited the deletion from a parent, while 94% had a new deletion. Other conditions that are associated with

DiGeorge syndrome are diabetes (a condition where the pancreas no longer produces enough insulin) in the mother and **fetal alcohol syndrome** (a pattern of **birth defects** and learning and behavioral problems affecting individuals whose mothers consumed alcohol during **pregnancy**).

The loss of the genes in the deleted material means that the baby's third and fourth pharyngeal pouches fail to develop normally during the twelfth week of pregnancy. This developmental failure results in a completely or partially absent thymus gland and parathyroid glands. In addition, 74% of fetuses with DiGeorge syndrome have severe heart defects. The child is born with a defective immune system and an abnormally low level of calcium in the blood.

These defects usually become apparent within 48 hours of birth. The infant's heart defects may lead to **heart failure**, or there may be seizures and other evidence of a low level of calcium in the blood (**hypocalcemia**).

Diagnosis

Diagnosis of DiGeorge syndrome can be made by ultrasound examination around the eighteenth week of pregnancy, when abnormalities in the development of the heart or the palate can be detected. Another technique that is used to diagnose the syndrome before birth is called fluorescence in situ hybridization, or FISH. This technique uses DNA probes from the DiGeorge region on chromosome 22. FISH can be performed on cell samples obtained by **amniocentesis** as early as the fourteenth week of pregnancy. It confirms about 95% of cases of DiGeorge syndrome.

If the mother has not had prenatal testing, the diagnosis of DiGeorge syndrome is sometimes suggested by the child's facial features at birth. In other cases, the doctor makes the diagnosis during heart surgery when he or she notices the absence or abnormal location of the thymus gland. The diagnosis can be confirmed by blood tests for calcium, phosphorus, and parathyroid hormone levels, and by the sheep cell test for immune function.

Treatment

Hypocalcemia

Hypocalcemia in DiGeorge patients is unusually difficult to treat. Infants are usually given calcium and vitamin D by mouth. Severe cases have been treated by transplantation of fetal thymus tissue or bone marrow.

Heart defects

Infants with life-threatening heart defects are treated surgically.

Defective immune function

Children with DiGeorge syndrome should be kept on low-phosphorus **diets** and kept away from crowds or other sources of infection. They should not be immunized with vaccines made from live viruses or given **corticosteroids**.

Prognosis

The prognosis is variable; many infants with DiGeorge syndrome die from overwhelming infection, seizures, or heart failure within the first year. Advances in heart surgery indicate that the prognosis is most closely linked to the severity of the heart defects and the partial presence of the thymus gland. In most children who survive, the number of T cells, a type of white blood cell, in the blood rises spontaneously as they mature. Survivors are likely to be mentally retarded, however, and to have other developmental difficulties, including psychiatric problems in later life.

Prevention

Genetic counseling is recommended for parents of children with DiGeorge syndrome because the disorder can be detected prior to birth. Although most children with DiGeorge syndrome did not inherit the chromosome deletion from their parents, they have a 50% chance of passing the deletion on to their own children.

Because of the association between DiGeorge syndrome and fetal alcohol syndrome, pregnant women should avoid drinking alcoholic beverages.

Resources

BOOKS

"Common Multiple Congenital Anomaly Syndromes." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

"DiGeorge Syndrome." In *Physicians' Guide to Rare Diseases*, ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Company, Inc., 1995.

"Immunology; Allergic Disorders: Immunodeficiency Diseases." In *The Merck Manual of Diagnosis and Therapy*, ed. Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1999.

McDonald-McGinn, Donna M., et al. *22q11 Deletion Syndrome*. Philadelphia: The Children's Hospital of Philadelphia, 1999.

Sujansky, Eva, et al. "Genetics & Dysmorphology." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford, CT: Appleton & Lange, 1997.

ORGANIZATIONS

Canadian 22q Group. 320 Cote Street Antoine, West Montreal, Quebec H3Y 2J4.

KEY TERMS

Deletion—A genetic abnormality in which a segment of a chromosome is lost. DiGeorge syndrome is caused by a deletion on human chromosome 22.

Fetal alcohol syndrome—A cluster of birth defects that includes abnormal facial features and mental retardation, caused by the mother's consumption of alcoholic beverages during pregnancy.

Fluorescence in situ hybridization (FISH)—A technique for diagnosing DiGeorge syndrome before birth by analyzing cells obtained by amniocentesis with DNA probes. FISH is about 95% accurate.

Hypocalcemia—An abnormally low level of calcium in the blood.

Hypoplasia—A deficiency or underdevelopment of a tissue or body structure.

T cells—A type of white blood cell produced in the thymus gland. T cells are an important part of the immune system. Infants born with an underdeveloped or absent thymus do not have a normal level of T cells in their blood.

Chromosome Deletion Outreach, Inc. P.O. Box 724, Boca Raton, FL 33429-0724. (888) 236-6680.

International DiGeorge/VCF Support Network, c/o Family Voices of New York. 46 1/2 Clinton Avenue, Cortland, NY 13045. (607) 753-1250.

Rebecca J. Frey, PhD

Digital rectal examination *see* **Rectal examination**

Digitalis drugs

Definition

Digitalis drugs are medicines made from a type of foxglove plant (*Digitalis purpurea*) that have a stimulating effect on the heart.

Purpose

Digitalis drugs are used to treat heart problems such as congestive **heart failure** and irregular heartbeat. These medicines help make the heart stronger and more efficient. This, in turn, improves blood circulation and helps relieve the swelling of the hands and ankles that is common in people with heart problems.

Description

Digitalis drugs, also known as digitalis glycosides, are available only with a physician's prescription. They are sold in tablet, capsule, liquid, and injectable forms. Commonly used digitalis drugs are digitoxin (Crystodigin) and digoxin (Lanoxin).

Recommended dosage

The recommended dosage is different for each patient. The physician who prescribes the medicine will determine the correct dose. Taking exactly the right amount of medicine and taking it exactly as directed are very important. Never take larger or more frequent doses. During treatment with a digitalis heart medicine, the physician will monitor blood levels of the drug and will decide whether the dose needs to be changed. Patients should never change the dose of this medicine unless told to do so by their physicians.

Precautions

Seeing a physician regularly while taking digitalis drugs is very important. The physician will check to make sure the medicine is working as it should and will make any necessary changes in dosage or in instructions for taking the medicine.

Patients taking digitalis drugs should learn to take their pulse and should check it regularly while under treatment with this medicine. Changes in pulse rate, rhythm, or force could be signs of side effects.

Do not stop taking this medicine suddenly without checking with the physician who prescribed it. This could cause a serious change in heart function.

Digitalis drugs are responsible for many accidental poisonings in children. Keep this medicine out of the reach of children.

Be alert to the signs of overdose. Overdosing is a serious concern with digitalis drugs, because the amount of medicine that most people need to help their heart problems is very close to the amount that can cause problems from overdose. If any of these signs of overdose occur, check with a physician as soon as possible:

- loss of appetite
- nausea
- vomiting

Digitalis purpurea. *(Photo Researcher, Inc. Reproduced by permission.)*

- pain in the lower stomach
- diarrhea
- extreme tiredness or weakness
- extremely slow or irregular heartbeat (or fast heartbeat in children)
- blurred vision or other vision changes
- drowsiness
- confusion or depression
- headache
- fainting

Anyone who is taking digitalis drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment. Physicians may advise people taking digitalis drugs to wear or carry medical identification indicating that they are taking this medicine.

Patients need to be very careful not to accidentally take this medicine in place of another medicine that looks similar. Patients who are taking other medicines that look like their digitalis medicine should ask their pharmacists for suggestions on how to avoid mix-ups.

Anyone who has had unusual reactions to digitalis drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant or breastfeeding or who may become pregnant should check with their physicians before using digitalis drugs.

Older people may be especially sensitive to the effects of digitalis drugs, which may increase the chance of overdose.

Before using digitalis drugs, people with any of the following medical problems should make sure their physicians are aware of their conditions:

- heart disease
- heart rhythm problems
- severe lung disease
- kidney disease
- liver disease
- thyroid disease

Side effects

Side effects are rare with this medicine. Check with a physician as soon as possible if a skin rash, **hives,** or any other unusual or troublesome symptoms occur. Watch for signs of overdose.

Interactions

Digitalis drugs may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. For example:

- Taking digitalis drugs with other heart medicines, amphetamines, or diet pills could increase the risk of heart rhythm problems.
- Calcium channel blockers, used to treat high blood pressure, may cause higher than usual levels of digitalis drugs in the body that could lead to symptoms of overdose as covered in the above section.
- Diuretics (water pills) or other medicines that lower the amount of potassium in the body may increase the side effects of digitalis drugs.
- Medicines that increase the amount of potassium in the body may raise the risk of serious heart rhythm problems when taken with digitalis drugs.

• Diarrhea medicine or cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid) may keep digitalis medicines from being absorbed into the body. To prevent this problem, digitalis drugs should be taken several hours before or after taking these medicines.

The list above does not include every drug that may interact with digitalis drugs. Be sure to check with a physician or pharmacist before taking any other prescription or nonprescription (over-the-counter) medicine.

In addition, a diet high in fiber may interfere with the effects of digitalis drugs by preventing the medicine from being absorbed into the body. To avoid this problem, eat high fiber foods (such as bran products, whole wheat bread, and fresh fruits and vegetables) several hours before or after taking digitalis medicine.

Nancy Ross-Flanigan

Digoxin *see* **Digitalis drugs; Antiarrhythmic drugs**

Dilatation and curettage

Definition

Dilatation and curettage (D & C) is a gynecological procedure in which the lining of the uterus (endometrium) is scraped away.

Purpose

D & C is commonly used to obtain tissue for microscopic evaluation to rule out **cancer**. D & C may also be used to diagnose and treat heavy menstrual bleeding, and to diagnose endometrial polyps and **uterine fibroids**. A D & C can be used as a treatment as well, to remove **pregnancy** tissue after a **miscarriage**, incomplete abortion, or **childbirth**. Endometrial polyps may be removed, and sometimes benign uterine tumors (fibroids) may be scraped away. D & C can also be used as an early abortion technique up to 16 weeks.

Description

D & C is usually performed under general anesthesia, although local or epidural anesthesia can also be used. A local lessens risk and costs, but the woman will feel cramping during the procedure. The type of anesthesia used often depends upon the reason for the D & C.

In the procedure (which takes only minutes to perform), the doctor inserts an instrument to hold open the

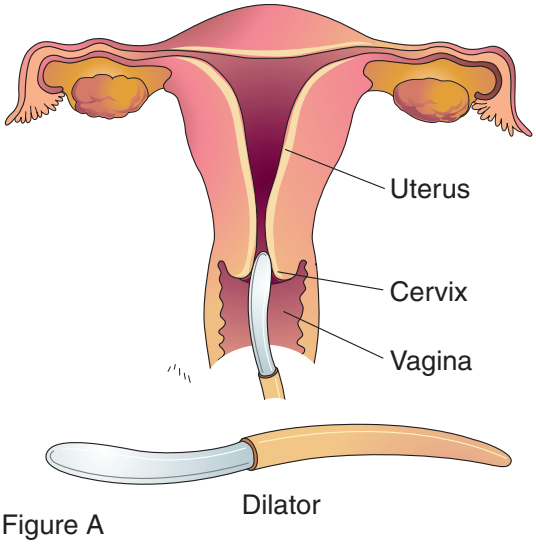


Figure A

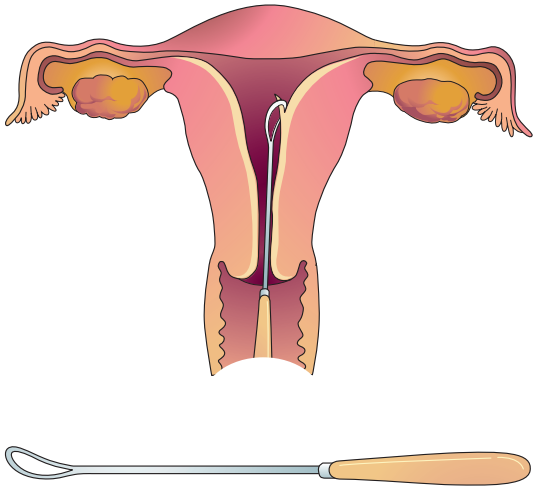


Figure B

When performing a D & C, the physician inserts a speculum to separate and hold the vaginal walls, then stretches open the cervix with a dilator. Once the cervix is dilated, the physician will insert a curette into the uterus and scrapes away small portions of the uterine lining for laboratory analysis. *(Illustration by Electronic Illustrators Group.)*

KEY TERMS

Endometrial polyps—A growth in the lining of the uterus (endometrium) that may cause bleeding and can develop into cancer.

Epidural anesthesia—A type of anesthesia that is injected into the epidural space of the spinal cord to numb the nerves leading to the lower half of the body.

Uterine fibroid—A noncancerous tumor of the uterus that can range from the size of a pea to the size of a grapefruit. Small fibroids require no treatment, but those causing serious symptoms may need to be removed.

vaginal walls, and then stretches the opening of the uterus to the vagina (the cervix) by inserting a series of tapering rods, each thicker than the previous one, or by using other specialized instruments. This process of opening the cervix is called dilation.

Once the cervix is dilated, the physician inserts a spoon-shaped surgical device called a curette into the uterus. The curette is used to scrape away the uterine lining. One or more small tissue samples from the lining of the uterus or the cervical canal are sent for analysis by microscope to check for abnormal cells.

Although simpler, less expensive techniques such as a vacuum aspiration are quickly replacing the D & C as a diagnostic method, it is still often used to diagnose and treat a number of conditions.

Preparation

Because opening the cervix can be painful, sedatives may be given before the procedure begins. Deep breathing and other relaxation techniques may help ease cramping during cervical dilation.

Aftercare

A woman who has had a D & C performed in a hospital can usually go home the same day or the next day. Many women experience backache and mild cramps after the procedure, and may pass small blood clots for a day or so. Vaginal staining or bleeding may continue for several weeks.

Most women can resume normal activities almost immediately. Patients should avoid sexual intercourse, douching, and tampon use for at least two weeks to prevent infection while the cervix is closing and to allow the endometrium to heal completely.

Risks

The primary risk after the procedure is infection. Signs of infection include:

- fever
- heavy bleeding
- severe cramps
- foul-smelling vaginal discharge

A woman should report any of these symptoms to her doctor, who can treat the infection with **antibiotics** before it becomes serious.

D & C is a surgical operation, which carries certain risks associated with general anesthesia. Rare complications include puncture of the uterus (which usually heals on its own) or puncture of the bowel or bladder (which require further surgery to repair).

Normal results

Removal of the uterine lining causes no side effects, and may be beneficial if the lining has thickened so much that it causes heavy periods. The uterine lining soon grows again normally, as part of the menstrual cycle.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Carol A. Turkington

Dilated cardiomyopathy *see* **Congestive cardiomyopathy**

Diltiazem *see* **Calcium channel blockers**

Dilution test *see* **Kidney function tests**

Diphenhydramine *see* **Antihistamines**

Diphtheria

Definition

Diphtheria is a potentially fatal, contagious disease that usually involves the nose, throat, and air passages,

but may also infect the skin. Its most striking feature is the formation of a grayish membrane covering the tonsils and upper part of the throat.

Description

Like many other upper respiratory diseases, diphtheria is most likely to break out during the winter months. At one time it was a major childhood killer, but it is now rare in developed countries because of widespread immunization. Since 1988, all confirmed cases in the United States have involved visitors or immigrants. In countries that do not have routine immunization against this infection, the mortality rate varies from 1.5–25%.

Persons who have not been immunized may get diphtheria at any age. The disease is spread most often by droplets from the coughing or sneezing of an infected person or carrier. The incubation period is two to seven days, with an average of three days. It is vital to seek medical help at once when diphtheria is suspected, because treatment requires emergency measures for adults as well as children.

Causes and symptoms

The symptoms of diphtheria are caused by toxins produced by the diphtheria bacillus, *Corynebacterium diphtheriae* (from the Greek for "rubber membrane"). In fact, toxin production is related to infections of the bacillus itself with a particular bacteria virus called a phage (from bacteriophage; a virus that infects bacteria). The intoxication destroys healthy tissue in the upper area of the throat around the tonsils, or in open **wounds** in the skin. Fluid from the dying cells then coagulates to form the telltale gray or grayish green membrane. Inside the membrane, the bacteria produce an exotoxin, which is a poisonous secretion that causes the life-threatening symptoms of diphtheria. The exotoxin is carried throughout the body in the bloodstream, destroying healthy tissue in other parts of the body.

The most serious complications caused by the exotoxin are inflammations of the heart muscle (**myocarditis**) and damage to the nervous system. The risk of serious complications is increased as the time between onset of symptoms and the administration of antitoxin increases, and as the size of the membrane formed increases. The myocarditis may cause disturbances in the heart rhythm and may culminate in **heart failure**. The symptoms of nervous system involvement can include seeing double (diplopia), painful or difficult swallowing, and slurred speech or loss of voice, which are all indications of the exotoxin's effect on nerve functions. The exotoxin may also cause severe swelling in the neck ("bull neck").

The signs and symptoms of diphtheria vary according to the location of the infection:

Nasal

Nasal diphtheria produces few symptoms other than a watery or bloody discharge. On examination, there may be a small visible membrane in the nasal passages. Nasal infection rarely causes complications by itself, but it is a public health problem because it spreads the disease more rapidly than other forms of diphtheria.

Pharyngeal

Pharyngeal diphtheria gets its name from the pharynx, which is the part of the upper throat that connects the mouth and nasal passages with the voice box. This is the most common form of diphtheria, causing the characteristic throat membrane. The membrane often bleeds if it is scraped or cut. It is important not to try to remove the membrane because the trauma may increase the body's absorption of the exotoxin. Other signs and symptoms of pharyngeal diphtheria include mild **sore throat**, **fever** of 101–102°F (38.3–38.9°C), a rapid pulse, and general body weakness.

Laryngeal

Laryngeal diphtheria, which involves the voice box or larynx, is the form most likely to produce serious complications. The fever is usually higher in this form of diphtheria (103–104°F or 39.4–40°C) and the patient is very weak. Patients may have a severe **cough**, have difficulty breathing, or lose their voice completely. The development of a "bull neck" indicates a high level of exotoxin in the bloodstream. Obstruction of the airway may result in respiratory compromise and **death**.

Skin

This form of diphtheria, which is sometimes called cutaneous diphtheria, accounts for about 33% of diphtheria cases. It is found chiefly among people with poor hygiene. Any break in the skin can become infected with diphtheria. The infected tissue develops an ulcerated area and a diphtheria membrane may form over the wound but is not always present. The wound or ulcer is slow to heal and may be numb or insensitive when touched.

Diagnosis

Because diphtheria must be treated as quickly as possible, doctors usually make the diagnosis on the basis of the visible symptoms without waiting for test results.

In making the diagnosis, the doctor examines the patient's eyes, ears, nose, and throat in order to rule out

other diseases that may cause fever and sore throat, such as **infectious mononucleosis**, a sinus infection, or **strep throat**. The most important single symptom that suggests diphtheria is the membrane. When a patient develops skin infections during an outbreak of diphtheria, the doctor will consider the possibility of cutaneous diphtheria and take a smear to confirm the diagnosis.

Laboratory tests

The diagnosis of diphtheria can be confirmed by the results of a culture obtained from the infected area. Material from the swab is put on a microscope slide and stained using a procedure called Gram's stain. The diphtheria bacillus is called Gram-positive because it holds the dye after the slide is rinsed with alcohol. Under the microscope, diphtheria bacilli look like beaded rod-shaped cells, grouped in patterns that resemble Chinese characters. Another laboratory test involves growing the diphtheria bacillus on a special material called Loeffler's medium.

Treatment

Diphtheria is a serious disease requiring hospital treatment in an intensive care unit if the patient has developed respiratory symptoms. Treatment includes a combination of medications and supportive care:

Antitoxin

The most important step is prompt administration of diphtheria antitoxin, without waiting for laboratory results. The antitoxin is made from horse serum and works by neutralizing any circulating exotoxin. The doctor must first test the patient for sensitivity to animal serum. Patients who are sensitive (about 10%) must be desensitized with diluted antitoxin, since the antitoxin is the only specific substance that will counteract diphtheria exotoxin. No human antitoxin is available for the treatment of diphtheria.

The dose ranges from 20,000–100,000 units, depending on the severity and length of time of symptoms occurring before treatment. Diphtheria antitoxin is usually given intravenously.

Antibiotics

Antibiotics are given to wipe out the bacteria, to prevent the spread of the disease, and to protect the patient from developing **pneumonia**. They are not a substitute for treatment with antitoxin. Both adults and children may be given penicillin, ampicillin, or erythromycin. Erythromycin appears to be more effective than penicillin in treating people who are carriers because of better penetration into the infected area.

Cutaneous diphtheria is usually treated by cleansing the wound thoroughly with soap and water, and giving the patient antibiotics for 10 days.

Supportive care

Diphtheria patients need bed rest with intensive nursing care, including extra fluids, oxygenation, and monitoring for possible heart problems, airway blockage, or involvement of the nervous system. Patients with laryngeal diphtheria are kept in a **croup** tent or high-humidity environment; they may also need throat suctioning or emergency surgery if their airway is blocked.

Patients recovering from diphtheria should rest at home for a minimum of two to three weeks, especially if they have heart complications. In addition, patients should be immunized against diphtheria after recovery, because having the disease does not always induce antitoxin formation and protect them from reinfection.

Prevention of complications

Diphtheria patients who develop myocarditis may be treated with oxygen and with medications to prevent irregular heart rhythms. An artificial pacemaker may be needed. Patients with difficulty swallowing can be fed through a tube inserted into the stomach through the nose. Patients who cannot breathe are usually put on mechanical respirators.

Prognosis

The prognosis depends on the size and location of the membrane and on early treatment with antitoxin; the longer the delay, the higher the death rate. The most vulnerable patients are children under age 15 and those who develop pneumonia or myocarditis. Nasal and cutaneous diphtheria are rarely fatal.

Prevention

Prevention of diphtheria has four aspects:

Immunization

Universal immunization is the most effective means of preventing diphtheria. The standard course of immunization for healthy children is three doses of DPT (diphtheria-tetanus-pertussis) preparation given between two months and six months of age, with booster doses given at 18 months and at entry into school. Adults should be immunized at 10 year intervals with Td (tetanus-diphtheria) toxoid. A toxoid is a bacterial toxin that is treated to make it harmless but still can induce immunity to the disease.

KEY TERMS

Antitoxin—An antibody against an exotoxin, usually derived from horse serum.

Bacillus—A rod-shaped bacterium, such as the diphtheria bacterium.

Carrier—A person who may harbor an organism without symptoms and may transmit it to others.

Cutaneous—Located in the skin.

Diphtheria-tetanus-pertussis (DTP)—The standard preparation used to immunize children against diphtheria, tetanus, and whooping cough. A so-called "acellular pertussis" vaccine (aP) is usually used since its release in the mid-1990s.

Exotoxin—A poisonous secretion produced by bacilli which is carried in the bloodstream to other parts of the body.

Gram's stain—A dye staining technique used in laboratory tests to determine the presence and type of bacteria.

Loeffler's medium—A special substance used to grow diphtheria bacilli to confirm the diagnosis.

Myocarditis—Inflammation of the heart tissue.

Toxoid—A preparation made from inactivated exotoxin, used in immunization.

Isolation of patients

Diphtheria patients must be isolated for one to seven days or until two successive cultures show that they are no longer contagious. Children placed in **isolation** are usually assigned a primary nurse for emotional support.

Identification and treatment of contacts

Because diphtheria is highly contagious and has a short incubation period, family members and other contacts of diphtheria patients must be watched for symptoms and tested to see if they are carriers. They are usually given antibiotics for seven days and a booster shot of diphtheria/tetanus toxoid.

Reporting cases to public health authorities

Reporting is necessary to track potential epidemics, to help doctors identify the specific strain of diphtheria, and to see if resistance to penicillin or erythromycin has developed.

Resources

BOOKS

Abzug, Mark J. "Infectious Diseases: Bacterial, Spirochetal, Protozoal, Metazoal, & Mycotic." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Chambers, Henry F. "Infectious Diseases: Bacterial & Chlamydial." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Childhood Infections: Bacterial Infections." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Mirza, Ayesha, and Russell W. Steele. "Diphtheria." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Ogle, John W. "Infections: Bacterial & Spirochetal." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Simoes, Eric A. F., and Jessie R. Groothuis. "Immunization." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Diplegia *see* **Paralysis**

Direct Coombs' test *see* **Coombs' tests**

Direct laryngoscopy *see* **Laryngoscopy**

Discoid lupus erythematosus

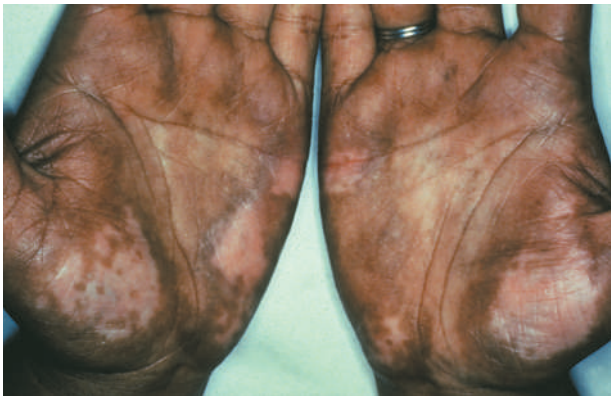
Definition

Discoid lupus erythematosus (DLE) is a disease in which coin-shaped (discoid) red bumps appear on the skin.

Description

The disease called discoid lupus erythematosus only affects the skin, although similar discoid **skin lesions** can occur in the serious disease called **systemic lupus erythematosus** (SLE). Only about 10% of all patients with DLE will go on to develop the multi-organ disease SLE.

The tendency to develop DLE seems to run in families. Although men or women of any age can develop DLE, it occurs in women three times more frequently than in men. The typical DLE patient is a woman in her 30s.



Discoloration of the hands is one characteristic of discoid lupus erythematosus. *(Custom Medical Stock Photo. Reproduced by permission.)*

Causes and symptoms

The cause of DLE is unknown. It is thought that DLE (like SLE) may be an autoimmune disorder. **Autoimmune disorders** are those that occur when cells of the immune system are misdirected against the body. Normally, immune cells work to recognize and help destroy foreign invaders like bacteria, viruses, and fungi. In autoimmune disorders, these cells mistakenly recognize various tissues of the body as foreign invaders, and attack and destroy these tissues. In SLE, the misdirected immune cells are antibodies. In DLE, the damaging cells are believed to be a type of white blood cell called a T lymphocyte. The injury to the skin results in inflammation and the characteristic discoid lesions.

In DLE, the characteristic skin lesion is circular and raised. The reddish rash is about 5–10 mm in diameter, with the center often somewhat scaly and lighter in color than the darker outer ring. The surface of these lesions is sometimes described as "warty." There is rarely any **itching** or **pain** associated with discoid lesions. They tend to appear on the face, ears, neck, scalp, chest, back, and arms. As DLE lesions heal, they leave thickened, scarred areas of skin. When the scalp is severely affected, there may be associated hair loss (**alopecia**).

People with DLE tend to be quite sensitive to the sun. They are more likely to get a **sunburn**, and the sun is likely to worsen their discoid lesions.

Diagnosis

Diagnosis of DLE usually requires a **skin biopsy**. A small sample of a discoid lesion is removed, specially prepared, and examined under a microscope. Usually, the lesion has certain microscopic characteristics that allow it to be identified as a DLE lesion. Blood tests will not reveal the type of antibodies present in SLE, and **physical examination** usually does not reveal anything other than the skin lesions. If antibodies exist in the blood, or if other symptoms or physical signs are found, it is possible that the discoid lesions are a sign of SLE rather than DLE.

Treatment

Treatment of DLE primarily involves the use of a variety of skin creams. **Sunscreens** are used for protection. Steroid creams can be applied to decrease inflammation. Occasionally, small amounts of a steroid preparation will be injected with a needle into a specific lesion. Because of their long list of side effects, steroid preparations taken by mouth are avoided. Sometimes, short-term treatment with oral steroids will be used for particularly severe DLE outbreaks. Medications used to treat the infectious disease **malaria** are often used to treat DLE.

Alternative treatment

Alternative treatments for DLE include eating a healthy diet, low in red meat and dairy products and high in fish containing omega-3 fatty acids. These types of fish include mackerel, sardines, and salmon. Following a healthy diet is thought to decrease inflammation. Dietary supplements believed to be helpful include **vitamins** B, C, E, and selenium. Vitamin A is also recommended to improve DLE lesions. Constitutional homeopathic treatment can help heal DLE as well as help prevent it developing into SLE.

Prognosis

For the most part, the prognosis for people with DLE is excellent. While the lesions may be cosmetically unsightly, they are not life threatening and usually do not cause a patient to change his or her lifestyle. Only about 10% of patients with DLE will go on to develop SLE.

Prevention

DLE cannot be prevented. Recommendations to prevent flares of DLE in patients with the disease include avoiding exposure to sun and consistently using sunscreen.

Resources

BOOKS

Aaseng, Nathan. *Autoimmune Diseases*. New York: F. Watts, 1995.

Hahn, Bevra Hannahs. "Systemic Lupus Erythematosus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

KEY TERMS

Antibody—Specialized cells of the immune system that can recognize organisms invading the body (like bacteria, viruses, and fungi). The antibodies are then able to start a complex chain of events designed to kill these foreign invaders.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system then attacks and causes damage to these tissues.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body that work together to defend the body against foreign invaders (bacteria, viruses, fungi, etc.).

Long, James W. *The Essential Guide to Chronic Illness*. New York: HarperPerennial, 1997.

Wallace, Daniel J. *The Lupus Book*. New York: Oxford University Press, 1995.

PERIODICALS

Mann, Judy. "The Harsh Realities of Lupus." *The Washington Post*, 120, no. 281 (8 Oct. 1997): C12.

Umansky, Diane. "Living with Lupus." *American Health for Women* 16, no. 5 (June 1997): 92+.

ORGANIZATIONS

The American College of Rheumatology. 1800 Century Place, Suite 250, Atlanta, GA 30345. (404) 633-3777. <http://www.rheumatology.org>.

Lupus Foundation of America. 1300 Piccard Dr., Suite 200, Rockville, MD 20850. (800) 558-0121. <http://www.lupus.org>.

Rosalyn Carson-DeWitt, MD

Disk removal

Definition

One of the most common types of back surgery is disk removal (diskectomy), the removal of an intervertebral disk, the flexible plate that connects any two adjacent vertebrae in the spine. Intervertebral disks act as **shock** absorbers, protecting the brain and spinal cord from the impact produced by the body's movements.

Purpose

About 150,000 Americans undergo disk removal each year in the United States. Removing the invertebral disk is performed to treat back **pain** that has lasted at least six weeks as a result of an abnormal disk and that has not responded to conservative treatment. Surgery is also performed if there is pressure on the lumbosacral nerve roots that causes weakness or bowel or bladder disfunction.

As a person ages, the disks between the vertebrae degenerate and dry out, and the fibers holding them in place tear. Eventually, the disk can form a blister-like bulge, compressing nerves in the spine and causing pain. This is called a "prolapsed" (or herniated) disk. If such a disk causes muscle weakness or interferes with bladder or bowel function because it is pressing on a nerve root, immediate surgery to remove the disk may be needed.

The aim of the surgery is to try to relieve all pressure on nerve roots by removing the pulpy material from the disk, or the disk itself. If it is necessary to remove material from several nearby vertebrae, the spine may become unsteady. In this case, the surgeon will perform a spinal fusion, removing all the disks between two or more vertebrae and roughening the bones so that the vertebrae heal together. Bone strips taken from the patient's leg or hip may be used to help hold the vertebrae together. Spinal fusion decreases pain but it also decreases spinal mobility.

Precautions

The doctor will obtain x rays, neuroimaging studies, including computed tomography scan (CT scan) myelogram and **magnetic resonance imaging** (MRI), and clinical exams to determine the precise location of the affected disk.

Description

The surgery is done under general anaesthesia, which puts the patient to sleep and affects the whole body. Operating on the patient's back, the neurosurgeon or orthopedic surgeon makes an opening into the vertebral canal, and then moves the dura and the bundle of nerves called the "cauda equina" (horse's tail) aside, which exposes the disk. If a portion of the disk has moved from between the vertebrae out into the nerve canal, it is simply removed. If the disk itself has become fragmented and partially displaced, or not fragmented but bulging extensively, the surgeon will remove the bulging or displaced part of the disk and the part that lies in the space between the vertebrae.

Preparation

The patient is given an injection an hour before the surgery to dry up internal fluids and encourage drowsiness.

KEY TERMS

Diskectomy—The surgical removal of a portion of an invertebral disk.

Dura—The strongest and outermost of three membranes that protect the brain, spinal cord, and nerves of the cauda equina.

Herniated disk—A blisterlike bulging or protrusion of the contents of the disk out through the fibers that normally hold them in place. It is also called a ruptured disk, slipped disk, or displaced disk.

Intervertebral disk—Cylindrical elastic-like gel pads that separate and join each pair of vertebrae in the spine.

Laminectomy—An operation in which the surgeon cuts through the covering of a vertebra to reach a herniated disk in order to remove it.

Vertebra—The bones that make up the back bone (spine).

Aftercare

After the operation, the patient will awaken lying flat and face down, and must remain this way for several days, changing position only to avoid **bedsores**. There maybe slight pain or stiffness in the back area.

Patients should sleep on a firm mattress and avoid bending at the waist, lifting heavy weights, or sitting in one spot for a long time (such as riding in a car).

After surgery, patients can usually leave the hospital on the fourth or fifth day. They must:

- avoid sitting for more than 15–20 minutes
- use a reclined chair
- avoid bending, twisting, or lifting
- begin gentle walking (indoors or outdoors), gradually increasing
- begin stationary biking or gentle swimming after two weeks
- continue **exercise** for the next four weeks
- slow down if they experience more than minor pain in the back or leg

Risks

All surgery carries some risk due to heart and lung problems or the anesthesia itself, but this risk is generally extremely small. (The risk of **death** from general anesthesia for all types of surgery, for example, is only about 1 in 1,600.)

The most common risk of the surgery is infection, which occurs in 1–2% of cases. Rarely, the surgery can damage nerves in the lower back or major blood vessels in front of the disk. Occasionally, there may be some residual **paralysis** of a particular leg or bladder muscle after surgery, but this is the result of the disk problem that necessitated the surgery, not the operation itself.

While disk removals can relieve pain in 90% of cases, there are some people who do not get pain relief, depending on how long they had the condition requiring surgery and other factors.

Normal results

After about five days, most patients can leave the hospital. They can resume all normal activities, including work, after four to six weeks of recuperation at home.

In properly evaluated patients, there is a very good chance that disk removal will be successful in easing pain. Even in patients over age 60, disk surgery has a "good to excellent" result for 87% of patients. Disk surgery can relieve both back and leg pain, but the greatest pain relief will occur with the leg pain.

Resources

BOOKS

White III, Augustus. *Your Aching Back*. New York: Simon & Schuster, 1990.

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

Carol A. Turkington

Diskectomy *see* **Disk removal**

Dislocations and subluxations

Definition

In medicine, the terms dislocation and subluxation refer to the displacement of bones that form a joint. These conditions affecting the joint most often result from trauma that causes adjoining bones to no longer align with each other. A partial or incomplete dislocation is called a subluxation.

Description

In a healthy joint, the bones are normally held together with tough, fibrous bands called ligaments. These ligaments are attached to each bone along with a fibrous sac surrounding the joint called the articular capsule or joint capsule. The ligaments and joint capsule are relatively strong and nonelastic but permit movement within normal limits for each particular joint. In the event of a dislocation, one of the bones making up the joint is forced out of its natural alignment from excessive stretching and tearing of the joint ligaments and capsule. Muscles and tendons surrounding the joint are usually stretched and injured to some degree.

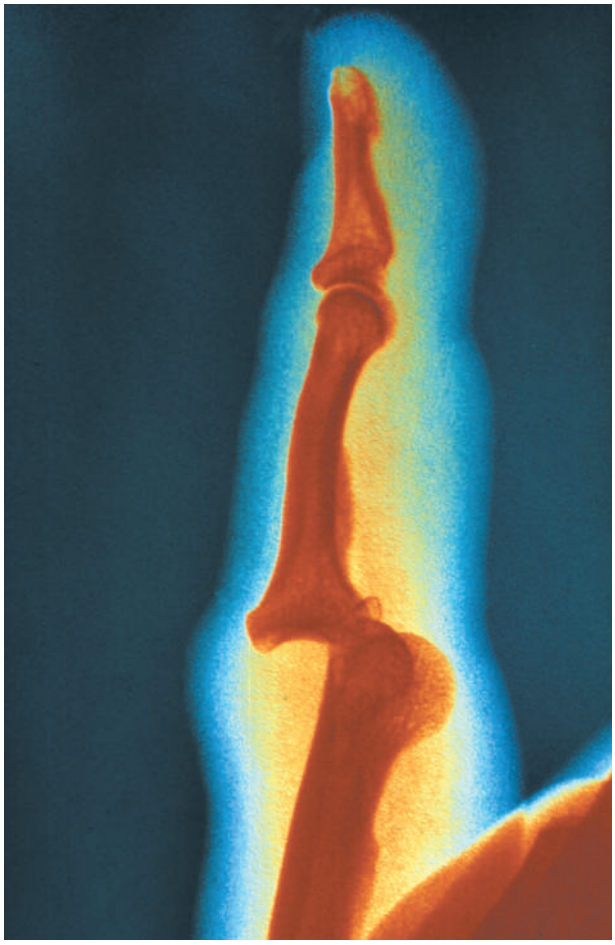
Causes and symptoms

A violent movement at the joint that exceeds normal limits usually causes a joint dislocation. Although dislocations often result from trauma, they sometimes occur as a result of disease affecting the joint structures. In the process of the dislocation, there is tearing of the ligaments and the articular capsule, which are vital structures for connecting the bone. Following a dislocation, the bones affected are often immobile and the affected limb may be locked in an abnormal position; **fractures** are also a concern with severe dislocations.

Important factors in recognizing a dislocation or subluxation include a history of experiencing a fall or receiving a blow in a particular joint followed by the sudden onset of loss of function to the involved limb. Immediately after the dislocation, the joint almost always swells significantly and feels painful when pressure is applied (point tenderness). If trauma to the joint causing the dislocation or subluxation is violent in nature, small chips of bone can be torn away with the supporting structures. Chronic recurrent dislocations may take place without severe **pain** because of the somewhat slack condition of the surrounding muscles and other supporting tissues. A first-time dislocation is considered and treated as a possible fracture. Risk factors that can increase susceptibility of joint dislocation and subluxation are shallow or abnormally formed joint surfaces present at birth (congenital) and/or other diseases of ligaments and tissue around a joint. Some infants are born with a hip dislocation. Both sexes and all ages are affected.

Diagnosis

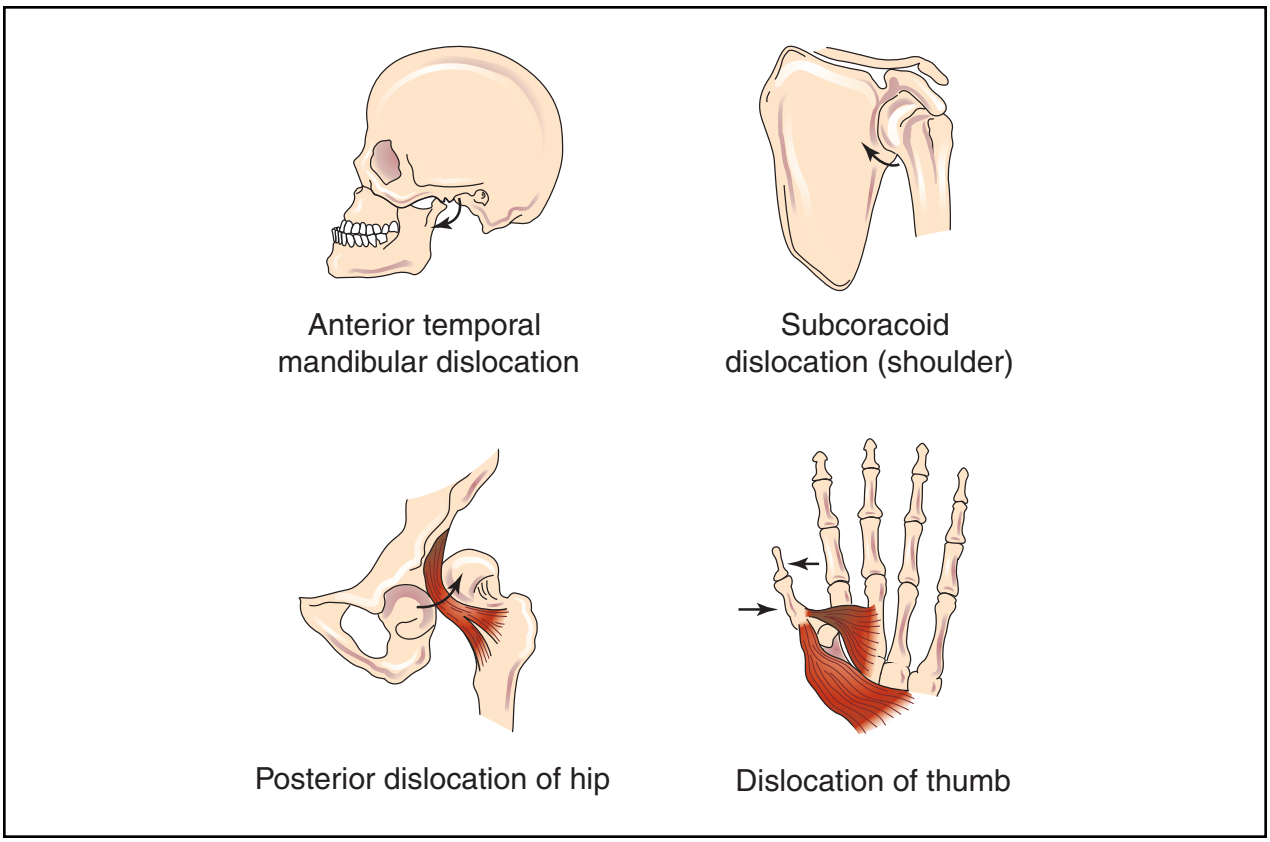
A thorough medical history and physical exam by a physician is the first step in the correct diagnosis of dislocations and subluxations. X rays of the joint and adjacent bones can locate and help determine the extent of dislocated joints



This x ray shows the dislocation between two bones in a finger. *(Photo Researchers, Inc. Reproduced by permission.)*

Treatment

Immediately after the dislocation, the application of ice is helpful to control swelling and decrease pain. If the patient needs to be transported, it is important to prevent the joint from moving (**immobilization**). At times, a cast or splint may be used to immobilize the joint and ensure proper alignment and healing. The treatment of realigning bones following a dislocation is called reduction. This may include simple maneuvers that manipulate the joint to reposition the bones or surgical procedures to restore the joint to its normal position. A general anesthesia or muscle relaxant may be used to help make joint reduction possible by relaxing surrounding muscles in spasm. **Acetaminophen** or **aspirin** are sometimes used to control moderate pain, and narcotics may be prescribed by the physician if the pain is severe. Recurring dislocation may require surgical reconstruction or replacement of the joint. It is not recommended to attempt to reset a dislocated joint outside of a medical



Dislocations and subluxations refer to the displacement of bones that form a joint. Such conditions most often result from trauma causing adjoining bones to no longer touch each other. A partial or incomplete dislocation is called a subluxation. The illustrations above indicate dislocation of the jaw bone, shoulder blade, hip bone, and the thumb. *(Illustration by Electronic Illustrators Group.)*

environment with experienced medical personnel, because a fracture may be present.

Alternative treatment

Chiropractic care has been shown to be effective for joint subluxation and dislocation, especially in the spine. Swelling can be addressed using botanical therapies. Bromelain, a pineapple enzyme, and tumeric (*Curcuma longa*) are the most potent botanical remedies for this purpose. Acute homeopathic care with arnica (*Arnica montana*) can reduce the trauma to the body. Ligament and tendon strengthening can be assisted both botanically and homeopathically.

Prognosis

Joint ligaments have poor blood supply and, therefore, heal slowly. This healing process continues long after the symptoms of the dislocation injury have diminished. Once a joint has been either subluxated or completely dislocated, the connective tissue binding or holding it in correct alignment is stretched to such an extent that the joint becomes extremely vulnerable to repeated dislocations. However, this chance of recurrent dislocation and subluxation will decrease if a proper **rehabilitation** program is implemented to strengthen surrounding muscles of the joint. Most joint dislocations are curable with prompt treatment. After the dislocation has been corrected, the joint may require immobilization with a cast or sling for two to eight weeks.

Prevention

When an individual is involved in strenuous sports or heavy work, involved joints may be protected by elastic bandage wraps, tape wraps, knee and shoulder pads, or special support stockings. Keeping the muscles surrounding the joint strong will also help prevent dislocations. Long-term problems may also be prevented by allowing an adequate amount of time for an injured joint to rest and heal prior to resuming full activity.

KEY TERMS

Articular capsule—An envelope of tissue that surrounds a free moving joint, composed of an external layer of white fibrous tissue and an external synovial membrane that secretes a lubricant into the joint.

Resources

BOOKS

Arnheim, Daniel D. *Modern Principals of Athletic Training*. St. Louis: Times Mirror/Mosby College Publishing Co., 1989.

Magee, David J. *Orthopedic Physical Assessment*. Philidelphia: W. B. Saunders Co., 1992.

Scully, Rosemary M., and Marylou R. Barnes. *Physical Therapy*. Philadelphia: J. B. Lippincott Co., 1989.

PERIODICALS

Gorden, Everett J. "Fractures and Dislocations: An Overview." *Trauma* 37, no. 5 (Feb. 1996): 5-36.

OTHER

Griffith, H. Winter. "Dislocations or Subluxation." *ThriveOnline*. 1998. 25 Mar. 1998 <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Disopyramide *see* **Antiarrhythmic drugs**

Disproportionate dwarfism *see* **Achondroplasia**

Dissecting aneurysm *see* **Aortic dissection**

Dissecting hematoma *see* **Aortic dissection**

Disseminated lupus erythematosus *see* **Systemic lupus erythematosus**

Dissociative disorders

Definition

The dissociative disorders are a group of mental disorders that affect consciousness are defined as causing significant interference with the patient's general functioning, including social relationships and employment.

Description

In order to have a clear picture of these disorders, dissociation should first be understood. Dissociation is a mechanism that allows the mind to separate or compartmentalize certain memories or thoughts from normal consciousness. These split-off mental contents are not erased. They may resurface spontaneously or be triggered by objects or events in the person's environment.

Dissociation is a process that occurs along a spectrum of severity. It does not necessarily mean that a person has a dissociative disorder or other mental illness. A mild degree of dissociation occurs with some physical stressors; people who have gone without sleep for a long period of time, have had "laughing gas" for dental surgery, or have been in a minor accident often have brief dissociative experiences. Another commonplace example of dissociation is a person becoming involved in a book or movie so completely that the surroundings or the passage of time are not noticed. Another example might be driving on the highway and taking several exits without noticing or remembering. Dissociation is related to hypnosis in that hypnotic trance also involves a temporarily altered state of consciousness. Most patients with dissociative disorders are highly hypnotizable.

People in other cultures sometimes have dissociative experiences in the course of religious (in certain trance states) or other group activities. These occurrences should not be judged in terms of what is considered "normal" in the United States.

Moderate or severe forms of dissociation are caused by such traumatic experiences as childhood **abuse**, combat, criminal attacks, brainwashing in hostage situations, or involvement in a natural or transportation disaster. Patients with **acute stress disorder**, **post-traumatic stress disorder** (PTSD), or conversion disorder and somatization disorder may develop dissociative symptoms. Recent studies of trauma indicate that the human brain stores traumatic memories in a different way than normal memories. Traumatic memories are not processed or integrated into a person's ongoing life in the same fashion as normal memories. Instead they are dissociated, or "split off," and may erupt into consciousness from time to time without warning. The affected person cannot control or "edit" these memories. Over a period of time, these two sets of memories, the normal and the traumatic, may coexist as parallel sets without being combined or blended. In extreme cases, different sets of dissociated memories may alter subpersonalities of patients with dissociative identity disorder (**multiple personality disorder**).

The dissociative disorders vary in their severity and the suddenness of onset. It is difficult to give statistics

for their frequency in the United States because they are a relatively new category and are often misdiagnosed. And, criterion for diagnosis require significant impairment in social or vocational functioning.

Dissociative amnesia

Dissociative **amnesia** is a disorder in which the distinctive feature is the patient's inability to remember important personal information to a degree that cannot be explained by normal forgetfulness. In many cases, it is a reaction to a traumatic accident or witnessing a violent crime. Patients with dissociative amnesia may develop depersonalization or trance states as part of the disorder, but they do not experience a change in identity.

Dissociative fugue

Dissociative fugue is a disorder in which a person temporarily loses his or her sense of personal identity and travels to another location where he or she may assume a new identity. Again, this condition usually follows a major stressor or trauma. Apart from inability to recall their past or personal information, patients with dissociative fugue do not behave strangely or appear disturbed to others. Cases of dissociative fugue are more common in wartime or in communities disrupted by a natural disaster.

Depersonalization disorder

Depersonalization disorder is a disturbance in which the patient's primary symptom is a sense of detachment from the self. Depersonalization as a symptom (not as a disorder) is quite common in college-age populations. It is often associated with sleep deprivation or "recreational" drug use. It may be accompanied by "derealization" (where objects in an environment appear altered). Patients sometimes describe depersonalization as feeling like a robot or watching themselves from the outside. Depersonalization disorder may also involve feelings of numbness or loss of emotional "aliveness."

Dissociative identity disorder (DID)

Dissociative identity disorder (DID) is the newer name for multiple personality disorder (MPD). DID is considered the most severe dissociative disorder and involves all of the major dissociative symptoms.

Dissociative disorder not otherwise specified (DDNOS)

DDNOS is a diagnostic category ascribed to patients with dissociative symptoms that do not meet the full criteria for a specific dissociative disorder.

Causes and symptoms

The moderate to severe dissociation that occurs in patients with dissociative disorders is understood to result from a set of causes:

- an innate ability to dissociate easily
- repeated episodes of severe physical or sexual abuse in childhood
- the lack of a supportive or comforting person to counteract abusive relative(s)
- the influence of other relatives with dissociative symptoms or disorders

The relationship of dissociative disorders to childhood abuse has led to intense controversy and lawsuits concerning the accuracy of childhood memories. The brain's storage, retrieval, and interpretation of memories are still not fully understood. Controversy also exists regarding how much individuals presenting dissociative disorders have been influenced by books and movies to describe a certain set of symptoms (scripting).

The major dissociative symptoms are:

Amnesia

Amnesia in a dissociative disorder is marked by gaps in a patient's memory for long periods of time or for traumatic events. Doctors can distinguish this type of amnesia from loss of memory caused by head injuries or drug intoxication, because the amnesia is "spotty" and related to highly charged events and feelings.

Depersonalization

Depersonalization is a dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving. Some patients experience depersonalization as being outside their bodies or watching a movie of themselves.

Derealization

Derealization is a dissociative symptom in which the external environment is perceived as unreal. The patient may see walls, buildings, or other objects as changing in shape, size, or color. In some cases, the patient may feel that other persons are machines or robots, though the patient is able to acknowledge the unreality of this feeling.

Identity disturbances

Patients with dissociative fugue, DDNOS, or DID often experience confusion about their identities or even assume new identities. Identity disturbances result from the patient having split off entire personality traits

or characteristics as well as memories. When a stressful or traumatic experience triggers the reemergence of these dissociated parts, the patient may act differently, answer to a different name, or appear confused by his or her surroundings.

Diagnosis

When a doctor is evaluating a patient with dissociative symptoms, he or she will first rule out physical conditions that sometimes produce amnesia, depersonalization, or derealization. These physical conditions include epilepsy, head injuries, brain disease, side effects of medications, substance abuse, intoxication, **AIDS, dementia** complex, or recent periods of extreme physical **stress** and sleeplessness. In some cases, the doctor may give the patient an electroencephalogram (EEG) to exclude epilepsy or other seizure disorders.

If the patient appears to be physically normal, the doctor will rule out psychotic disturbances, including **schizophrenia**. In addition, doctors can use some **psychological tests** to narrow the diagnosis. One is a screener, the Dissociative Experiences Scale (DES). If the patient has a high score on this test, he or she can be evaluated further with the Dissociative Disorders Interview Schedule (DDIS) or the Structured Clinical Interview for *DSM-IV* Dissociative Disorders (SCID-D). It is also possible for doctors to measure a patient's hypnotizability as part of a diagnostic evaluation.

Treatment

Treatment of the dissociative disorders often combines several methods.

Psychotherapy

Patients with dissociative disorders often require treatment by a therapist with some specialized understanding of dissociation. This background is particularly important if the patient's symptoms include identity problems. Many patients with dissociative disorders are helped by group as well as individual treatment.

Medications

Some doctors will prescribe tranquilizers or antidepressants for the **anxiety** and/or depression that often accompany dissociative disorders. Patients with dissociative disorders are, however, at risk for abusing or becoming dependent on medications. As of 2001, there is no drug that can reliably counteract dissociation itself.

Hypnosis

Hypnosis is frequently recommended as a method of treatment for dissociative disorders, partly because hypnosis is related to the process of dissociation. Hypnosis may help patients recover repressed ideas and memories. Therapists treating patients with DID sometimes use hypnosis in the process of "fusing" the patient's alternate personalities.

KEY TERMS

Amnesia—A general medical term for loss of memory that is not due to ordinary forgetfulness. Amnesia can be caused by head injuries, brain disease, or epilepsy, as well as by dissociation.

Depersonalization—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

Derealization—A dissociative symptom in which the external environment is perceived as unreal.

Dissociation—A psychological mechanism that allows the mind to split off traumatic memories or disturbing ideas from conscious awareness.

Fugue—A dissociative experience during which a person travels away from home, has amnesia for their past, and may be confused about their identity but otherwise appear normal.

Hypnosis—The means by which a state of extreme relaxation and suggestibility is induced: used to treat amnesia and identity disturbances that occur in dissociative disorders.

Multiple personality disorder (MPD)—An older term for dissociative identity disorder (DID).

Trauma—A disastrous or life-threatening event that can cause severe emotional distress, including dissociative symptoms and disorders.

Prognosis

Prognoses for dissociative disorders vary. Recovery from dissociative fugue is usually rapid. Dissociative amnesia may resolve quickly, but can become a chronic disorder in some patients. Depersonalization disorder, DDNOS, and DID are usually chronic conditions. DID usually requires five or more years of treatment for recovery.

Prevention

Since the primary cause of dissociative disorders is thought to involve extended periods of humanly inflicted trauma, prevention depends on the elimination of **child**

abuse and psychological abuse of adult prisoners or hostages.

Resources

BOOKS

"Dissociative Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Kolb, Lawrence C., and Keith H. Brodie. *Modern Clinical Psychiatry.* Philadelphia: W. B. Saunders Co., 1982.

Napier, Nancy J. *Getting Through The Day: Strategies for Adults Hurt as Children*. New York and London: W. W. Norton & Co., 1994.

Nemiah, John C. "Psychoneurotic Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

Noll, Richard. *The Encyclopedia of Schizophrenia and the Psychotic Disorders*. New York: Facts On File, 1992.

Pascuzzi, Robert M., and Mary C. Weber. "Conversion Disorders, Malingering, and Dissociative Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Psychiatric Disorders: Hysterical Neurosis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

van der Kolk, Bessel A., and Onno van der Hart. "The Intrusive Past: The Flexibility of Memory and the Engraving of Trauma." In *Trauma: Explorations in Memory*, ed. Cathy Caruth. Baltimore: The Johns Hopkins University Press, 1995.

Rebecca J. Frey

Dissociative identity disorder *see* **Multiple personality disorder**

Diuretics

Definition

Diuretics are medicines that help reduce the amount of water in the body.

Purpose

Diuretics are used to treat the buildup of excess fluid in the body that occurs with some medical conditions such as congestive **heart failure**, liver disease, and kidney disease. Some diuretics are also prescribed to treat high blood pressure. These drugs act on the kidneys to increase urine output. This reduces the amount of fluid in the bloodstream, which in turn lowers blood pressure.

Description

There are several types of diuretics, also called water pills:

- Loop diuretics, such as bumetanide (Bumex) and furosemide (Lasix), get their name from the loop-shaped part of the kidneys where they have their effect.
- Thiazide diuretics include such commonly used diuretics as hydrochlorothiazide (HydroDIURIL, Esidrix), chlorothiazide (Diuril), and chlorthalidone (Hygroton).
- Potassium-sparing diuretics prevent the loss of potassium, which is a problem with other types of diuretics. Examples of potassium-sparing diuretics are amiloride (Midamor) and triamterene (Dyrenium).

In addition, some medicines contain combinations of two diuretics. The brands Dyazide and Maxzide, for example, contain the thiazide diuretic hydrochlorothiazide with the potassium-sparing diuretic triamterene.

Some nonprescription (over-the-counter) medicines contain diuretics. However, the medicines described here cannot be bought without a physician's prescription. They are available in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of diuretic and may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and take the medicine exactly as directed.

Precautions

Seeing a physician regularly while taking a diuretic is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects.

Some people feel unusually tired when they first start taking diuretics. This effect usually becomes less noticeable over time, as the body adjusts to the medicine.

Because diuretics increase urine output, people who take this medicine may need to urinate more often, even during the night. Health care professionals can help patients schedule their doses to avoid interfering with their sleep or regular activities.

For patients taking the kinds of diuretics that rob potassium from the body, physicians may recommend adding potassium-rich foods or drinks, such as citrus fruits and juices, to the diet. Or they may suggest taking a potassium supplement or taking another medicine that keeps the body from losing too much potassium. If the physician recommends any of these measures, be sure to closely follow his or her directions. Do not make other diet changes without checking with the physician. People who are taking potassium-sparing diuretics should not add potassium to their **diets**, as too much potassium may be harmful.

People who take diuretics may lose too much water or potassium when they get sick, especially if they have severe vomiting and **diarrhea**. They should check with their physicians if they become ill.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. Older people are especially likely to have this problem. Drinking alcohol, exercising, standing for long periods, or being in hot weather may make the problem worse. To lessen the problem, get up gradually and hold onto something for support if possible. Avoid drinking too much alcohol and be careful in hot weather or when exercising or standing for a long time.

Anyone who is taking a diuretic should be sure to tell the health care professional in charge before having surgical or dental procedures, medical tests or emergency treatment.

Some diuretics make the skin more sensitive to sunlight. Even brief exposure to sun can cause a severe **sunburn**, **itching**, a rash, redness, or other changes in skin color. While being treated with this medicine, avoid being in direct sunlight, especially between 10 a.m. and 3 p.m.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use tanning beds, tanning booths, or sunlamps. People with fair skin may need to use a sunscreen with a higher skin protection factor.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take diuretics. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to diuretics or **sulfonamides** (sulfa drugs) in the past should let his or her physician know before using a diuretic. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Diuretics will not help the swelling of hands and feet that some women have during **pregnancy**. In general, pregnant women should not use diuretics unless a physician recommends their use. Although studies have not been done on pregnant women, studies of laboratory animals show that some diuretics can cause harmful effects when taken during pregnancy.

BREASTFEEDING. Some diuretics pass into breast milk, but no reports exist of problems in nursing babies whose mothers use this medicine. However, thiazide diuretics may decrease the flow of breast milk. Women who are breastfeeding and need to use a diuretic should check with their physicians.

OTHER MEDICAL CONDITIONS. Side effects of some diuretics may be more likely in people who have had a recent **heart attack** or who have liver disease or severe kidney disease. Other diuretics may not work properly in people with liver disease or severe kidney disease. Diuretics may worsen certain medical conditions, such as **gout**, **kidney stones**, **pancreatitis**, lupus erythematosus, and hearing problems. In addition, people with diabetes should be aware that diuretics may increase blood sugar levels. People with heart or blood vessel disease should know that some diuretics increase cholesterol or triglyceride levels. The risk of an allergic reaction to certain diuretics is greater in people with bronchial **asthma**. Before using diuretics, people with any of these medical problems should make sure their physicians are aware of their conditions. Also, people who have trouble urinating or who have high potassium levels in their blood may not be able to take diuretics and should check with a physician before using them.

USE OF CERTAIN MEDICINES. Taking diuretics with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Some side effects, such as loss of appetite, **nausea and vomiting**, stomach cramps, diarrhea and **dizziness**, usually lessen or go away as the body adjusts to the medicine. These problems do not need medical attention unless they continue or interfere with normal activities.

Patients taking potassium-sparing diuretics should know the signs of too much potassium and should check with a physician as soon as possible if any of these symptoms occur:

- irregular heartbeat
- breathing problems
- numbness or tingling in the hands, feet, or lips

KEY TERMS

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Lupus erythematosus—A chronic disease that affects the skin, joints, and certain internal organs.

Pancreas—A gland located beneath the stomach. The pancreas produces juices that help break down food.

Potassium—A mineral found in whole grains, meat, legumes, and some fruits and vegetables. Potassium is important for many body processes, including proper functioning of the nerves and muscles.

Triglyceride—A substance formed in the body from fat in the diet. Triglycerides are the main fatty materials in the blood. Together with protein, they make up high- and low-density lipoproteins (HDLs and LDLs). Triglyceride levels are important in the diagnosis and treatment of many diseases including high blood pressure, diabetes, and heart disease.

- confusion or nervousness
- unusual tiredness or weakness
- weak or heavy feeling in the legs

Patients taking diuretics that cause potassium loss should know the signs of too little potassium and should check with a physician as soon as possible if they have any of these symptoms:

- fast or irregular heartbeat
- weak pulse
- nausea or vomiting
- dry mouth
- excessive thirst
- muscle cramps or **pain**
- unusual tiredness or weakness
- mental or mood changes

Interactions

Diuretics may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes a diuretic should let the physician know all other medicines he or she is taking and should ask whether the possible interactions can interfere with drug therapy. Among the drugs that may interact with diuretics are:

- Angiotensin-converting enzyme (ACE) inhibitors, such as benazepril (Lotensin), captopril (Capoten), and enalapril (Vasotec), used to treat high blood pressure. Taking these drugs with potassium-sparing diuretics may cause levels of potassium in the blood to be too high, increasing the chance of side effects.
- Cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid). Taking these drugs with combination diuretics such as Dyazide and Maxzide may keep the diuretic from working. Take the diuretic at least one hour before or four hours after the cholesterol-lowering drug.
- Cyclosporine (Sandimmune), a medicine that suppresses the immune system. Taking this medicine with potassium-sparing diuretics may increase the chance of side effects by causing levels of potassium in the blood to be too high.
- Potassium supplements, other medicines containing potassium, or salt substitutes that contain potassium. Taking these with potassium-sparing diuretics may lead to too much potassium in the blood, increasing the chance of side effects.
- Lithium, used to treat **bipolar disorder** (manic-depressive illness). Using this medicine with potassium-sparing diuretics may allow lithium to build up to poisonous levels in the body.
- Digitalis heart drugs, such as digoxin (Lanoxin). Using this medicine with combination diuretics such as triamterene-hydrocholorthiazide (Dyazide, Maxzide) may cause blood levels of the heart medicine to be too high, making side effects such as changes in heartbeat more likely.

The list above does not include every drug that may interact with diuretics. Check with a physician or pharmacist before combining diuretics with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Diverticulitis *see* **Diverticulosis and diverticulitis**

Diverticulosis and diverticulitis

Definition

Diverticulosis refers to a condition in which the inner, lining layer of the large intestine (colon) bulges

out (herniates) through the outer, muscular layer. These outpouchings are called diverticula. Diverticulitis refers to the development of inflammation and infection in one or more diverticula.

Description

Diverticula tend to occur most frequently in the last segment of the large intestine, the sigmoid colon. They occur with decreasing frequency as one examines further back toward the beginning of the large intestine. The chance of developing diverticula increases with age, so that by the age of 50, about 20–50% of all people will have some diverticula. By the age of 90, virtually everyone will have developed some diverticula. Most diverticula measure about 3 mm to just over 3 cm in diameter. Larger diverticula, termed giant diverticula, are quite infrequent, but may measure as large as 15 cm in diameter.

Causes and symptoms

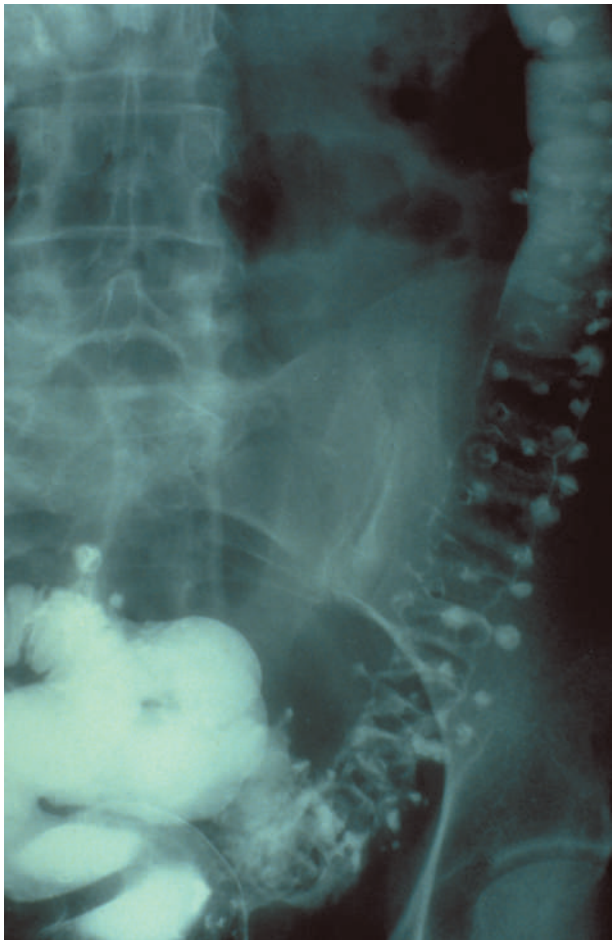
Diverticula are believed to be caused by overly forceful contractions of the muscular wall of the large intestine. As areas of this wall spasm, they become weaker and weaker, allowing the inner lining to bulge through. The anatomically weakest areas of the intestinal wall occur next to blood vessels which course through the wall, so diverticula commonly occur in this location.

Diverticula are most common in the developed countries of the West (North America, Great Britain, northern and western Europe). This is thought to be due to the diet of these countries, which tends to be quite low in fiber. A diet low in fiber results in the production of smaller volumes of stool. In order to move this smaller stool along the colon and out of the rectum, the colon must narrow itself significantly, and does so by contracting down forcefully. This causes an increase in pressure, which, over time, weakens the muscular wall of the intestine and allows diverticular pockets to develop.

The origin of giant diverticula development is not completely understood, although one theory involves gas repeatedly entering and becoming trapped in an already-existing diverticulum, causing stretching and expansion of that diverticulum.

The great majority of people with diverticulosis will remain symptom-free. Many diverticula are quite accidentally discovered during examinations for other conditions of the intestinal tract.

Some people with diverticulosis have symptoms such as **constipation**, cramping, and bloating. It is unclear whether these symptoms are actually caused by the diverticula themselves, or whether some other gastrointestinal condition (such as **irritable bowel syndrome**) might be responsible. A complication of diverticulosis occurs because many diverticula develop in areas very near blood vessels. Therefore, one serious risk of diverticulosis involves bleeding. Although an infrequent complication, the bleeding can be quite severe. Seventy-five percent of such bleeding episodes occur due to diverticula located on the right side of the colon. About 50% of the time, such bleeding will stop on its own.



A barium study x ray showing colonic diverticulosis. *(Custom Medical Stock Photo. Reproduced by permission.)*

One of the most common and potentially serious complications of diverticulosis is inflammation and infection of a particular diverticulum, called diverticulitis.

Diverticulitis is three times more likely to occur in the left side of the large intestine. Since most diverticula are located in the sigmoid colon (the final segment of the large intestine which empties into the rectum), most diverticulitis also takes place in the sigmoid. The elderly have the most serious complications from diverticulitis, although very severe infections can also occur in patients

under the age of 50. Men are three times as likely as women to be stricken with diverticulitis.

Diverticulitis is believed to occur when a hardened piece of stool, undigested food, and bacteria (called a fecalith) becomes lodged in a diverticulum. This blockage interferes with the blood supply to the area, and infection sets in.

An individual with diverticulitis will experience **pain** (especially in the lower left side of the abdomen) and **fever**. In response to the infection and the irritation of nearby tissues within the abdomen, the abdominal muscles may begin to spasm. About 25% of all patients with diverticulitis will have some rectal bleeding, although this rarely becomes severe. Walled-off pockets of infection, called abscesses, may appear within the wall of the intestine, or even on the exterior surface of the intestine. When a diverticulum weakens sufficiently, and is filled to bulging with infected pus, a perforation in the intestinal wall may develop. When the infected contents of the intestine spill out into the abdomen, the severe infection called **peritonitis** may occur. Peritonitis is an infection and inflammation of the lining of the abdominal cavity, the peritoneum. Other complications of diverticulitis include the formation of abnormal connections between two organs that normally do not connect (fistulas; for example, the intestine and the bladder), and scarring outside of the intestine which squeezes off a portion of the intestine, obstructing it.

Diagnosis

As mentioned, the majority of diverticula do not cause any symptoms, and are often found by coincidence during an examination being performed for some other medical condition.

When diverticula are suspected because a patient begins to have sudden rectal bleeding, the location of the bleeding can be studied by performing an **angiography**. Angiography involves inserting a tiny tube through an artery in the leg, and moving it up into one of the major arteries of the gastrointestinal system. A particular chemical (contrast medium) which will show up on x-ray films is injected, and the area of bleeding is located by looking for an area where the contrast is leaking into the interior (lumen) of the intestine.

A procedure called endoscopy provides another method for examining the colon and locating the site of bleeding. In endoscopy, a small, flexible scope (endoscope) is inserted through the rectum and into the intestine. The scope usually bears a fiber-optic camera, which allows the view through this endoscope to be projected onto a television screen. The operator can introduce the endoscope further and further through the intestine to find the location of the bleeding.

Diagnosis of diverticulitis is not difficult in patients with previously diagnosed diverticulosis. The presence of abdominal pain and fever in such an individual would make the suspicion of diverticulitis quite high. Examination of the abdomen will usually reveal tenderness to touch, with the patient's abdominal muscles contracting strongly to protect the tender area. During a rectal exam (performed by inserting a finger into the rectum), a doctor may be able to feel an abnormal mass. Touching this mass may prove painful to the patient.

When a practitioner is suspicious of diverticulitis as the cause for the patient's symptoms, he or she will most likely avoid the types of tests usually used to diagnose gastrointestinal disorders. These include **barium enema** and endoscopy. The concern is that the increased pressure exerted on the intestine during these exams may increase the likelihood of intestinal perforation. After medical treatment for the diverticulitis, these examinations may be performed in order to learn the extent of the patient's disease.

Treatment

Only about 20% of patients with diverticulosis ever have symptoms which lead them to seek medical help. Most people never know that they have diverticula. For those individuals who have cramping pain and constipation believed to be due to diverticulosis, the usual prescription involves increasing the fiber in the diet. This can be done by adding special diet supplements of bran or psyllium seed, which increase stool volume. Bleeding diverticula can usually be treated by bed rest, with blood **transfusion** needed for more severe bleeding (hemorrhaging). In cases of very heavy hemorrhaging, medications which encourage clotting can be injected during the course of a diagnostic angiography.

While there are almost no situations when uncomplicated diverticulosis requires surgery, giant diverticula always require removal. This is due to the very high chance of infection and perforation of these diverticula. When giant diverticula are diagnosed, the usual treatment involves removing that portion of the intestine.

Treatment for uncomplicated diverticulitis usually requires hospitalization. "Resting the bowel" is a mainstay of treatment, and involves keeping the patient from eating or sometimes even drinking anything by mouth. Therefore, the patient will need to receive fluids through a needle in the vein (intravenous or IV fluids). **Antibiotics** will also be administered through the IV. Some physicians will agree to try treatment at home for very mildly ill patients. These patients will be put on a liquid diet and receive oral antibiotics.

The various complications of diverticulitis need to be treated aggressively, because the **death** rate from such things as perforation and peritonitis is quite high. Abscesses can be drained of their infected contents by inserting a needle through the skin of the abdomen and into the **abscess**. When this is unsuccessful, open abdominal surgery will be required to remove the piece of the intestine containing the abscess. Fistulas require surgical repair, including the removal of the length of intestine containing the origin of the fistula, followed by immediate reconnection of the two free ends of intestine. Peritonitis requires open surgery. The entire abdominal cavity is cleaned by being irrigated (washed) with a warmed sterile saltwater solution, and the damaged piece of intestine is removed. Obstructions require immediate surgery to prevent perforation. Massive, uncontrollable bleeding, while rare, may require removal of part or all of the large intestine.

During any of these types of operations, the surgeon must make an important decision regarding the quantity of intestine which must be removed. When the amount of intestine removed is great, it may be necessary to perform a **colostomy**. A colostomy involves pulling the end of the remaining intestine through the abdominal wall, to the outside. This bit of intestine is then fashioned so that a bag can be fit over it. The patient's waste (feces) collect in the bag, because the intestine no longer connects with the rectum. This colostomy may be temporary, in which case another operation will be required to reconnect the intestine, after some months of substantial healing has occurred. Other times, the colostomy will need to be permanent, and the patient will have to adjust to living permanently with the colostomy bag. Most people with colostomies are able to go on with a very active life.

Occasionally, a patient will have such severe diverticular disease that a surgeon recommends planning ahead, and schedules removal of a portion of the colon. This is done to avoid the high risk of surgery performed after a complication has set in. Certain developments in a patient will identify those patients who are at very high risk of experiencing dangerous complications. Such elective surgery may be recommended:

- when an older individual has had several attacks of diverticulitis
- when someone under the age of 50 has had even one attack
- when treatment does not get rid of a painful mass
- when the intestine appears to be narrowing on x-ray examination (this could suggest the presence of **cancer**)
- when certain patients begin to regularly experience painful urination or urinary infections (this suggests that there may be a connection between the intestine and the bladder)
- when there is any question of cancer
- when the diverticular disease appears to be progressing rapidly

KEY TERMS

Angiography—An x-ray study of the arteries in a particular part of the body. Angiography is often performed in order to localize internal bleeding.

Bowel obstruction—A blockage in the intestine which prevents the normal flow of waste down the length of the intestine.

Colostomy—A procedure performed when a large quantity of intestine is removed. The end piece of the intestine leading to the rectum is closed.

Diverticula—Outpouchings in the large intestine caused when the inner, lining layer of the large intestine (colon) bulges out (herniates) through the outer, muscular layer.

Endoscopy—Examination of an area of the gastrointestinal tract by putting a lighted scope, usually bearing a fiber-optic camera, into the rectum, and passing it through the intestine.

Fistula—An abnormal connection formed between two organs that usually have no connection whatsoever.

Sigmoid colon—The final portion of the large intestine that empties into the rectum.

Prognosis

The prognosis for people with diverticula is excellent, with only 20% of such patients ever seeking any medical help for their condition.

While diverticulitis can be a difficult and painful disease, it is usually quite treatable. Prognosis is worse for individuals who have other medical problems, particularly those requiring the use of steroid medications, which increase the chances of developing a serious infection. Prognosis is also worse in the elderly.

Prevention

While there is no absolutely certain way to prevent the development of diverticula, it is believed that high-fiber **diets** are of help. Foods that are recommended for

their high fiber content include whole grain breads and cereals, and all types of fruits and vegetables. Most experts suggest that individuals take in about 0.71–1.23 oz (20–35 g) of fiber daily. If this is not possible to achieve through a person's diet, there are fiber products which can be mixed into 8 oz (.237 l) of water or juice, and which provide about 0.13–19 oz (4–6 g) of fiber.

Resources

BOOKS

Isselbacher, Kurt J., and Alan Epstein. "Diverticular, Vascular, and Other Disorders of the Intestine and Peritoneum." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Cerda, James J., et al. "Diverticulitis: Current Management Strategies." *Patient Care* 31, no. 12 (15 July 1997): 170+.

Cunningham, Mark A., et al. "Medical Versus Surgical Management of Diverticulitis in Patients Under Age 40." *American Journal of Surgery* 174, no. 6 (Dec. 1997): 733+.

"Diet and Diverticular Disease in Men." *Nutrition Research Newsletter* 14, no. 2 (Nov. 1994): 28.

"Diet for Diverticulosis." *Consumer Reports on Health* 8, no. 11 (Nov. 1996): 132.

"Keeping Diverticulosis Silent." *Berkeley Wellness Letter* 12, no. 4 (Jan. 1996): 6+.

Munson, Marty, and Teresa Yeykal. "Outrun Trouble: Running and Bran Cereal in the Prevention of Diverticular Disease." *Prevention*, 47, no. 9 (Sept. 1995): 38+.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Rosalyn Carson-DeWitt, MD

Dizziness

Definition

As a disorder, dizziness is classified into three categories—vertigo, syncope, and nonsyncope nonvertigo. Each category has a characteristic set of symptoms, all related to the sense of balance. In general, syncope is defined by a brief loss of consciousness (**fainting**) or by dimmed vision and feeling uncoordinated, confused, and lightheaded. Many people experience a sensation like syncope when they stand up too fast. Vertigo is the feeling that either the individual or the surroundings are spinning. This sensation is like being on a spinning amusement park ride. Individuals with nonsyncope nonvertigo dizziness feel as though they cannot keep their balance. This feeling may become worse with movement.

Description

The brain coordinates information from the eyes, the inner ear, and the body's senses to maintain balance. If any of these information sources is disrupted, the brain may not be able to compensate. For example, people sometimes experience **motion sickness** because the information from their body tells the brain that they are sitting still, but information from the eyes indicates that they are moving. The messages don't correspond and dizziness results.

Vision and the body's senses are the most important systems for maintaining balance, but problems in the inner ear are the most frequent cause of dizziness. The inner ear, also called the vestibular system, contains fluid that helps fine tune the information the brain receives from the eyes and the body. When fluid volume or pressure in one inner ear changes, information about balance is altered. The discrepancy gives conflicting messages to the brain about balance and induces dizziness.

Certain medical conditions can cause dizziness, because they affect the systems that maintain balance. For example, the inner ear is very sensitive to changes in blood flow. Because medical conditions such as high blood pressure or low blood sugar can affect blood flow, these conditions are frequently accompanied by dizziness. Circulation disorders are the most common causes of dizziness. Other causes are **head injury**, ear infection, **allergies**, and nervous system disorders.

Dizziness often disappears without treatment or with treatment of the underlying problem, but it can be long term or chronic. According to the National Institutes of Health, 42% of Americans will seek medical help for dizziness at some point in their lives. The costs may exceed a billion dollars and account for five million doctor visits annually. Episodes of dizziness increase with age. Among people aged 75 or older, dizziness is the most frequent reason for seeing a doctor.

Causes and symptoms

Careful attention to symptoms can help determine the underlying cause of the dizziness. Underlying problems may be benign and easily treated or they may be dangerous and in need of intensive therapy. Not all cases of dizziness can be linked to a specific cause. More than one type of dizziness can be experienced at the same time and symptoms may be mixed. Episodes of dizziness may last for a few seconds or for days. The length of an episode is related to the underlying cause.

The symptoms of syncope include dimmed vision, loss of coordination, confusion, lightheadedness, and sweating. These symptoms can lead to a brief loss of con-

sciousness or fainting. They are related to a reduced flow of blood to the brain; they often occur when a person is standing up and can be relieved by sitting or lying down. Vertigo is characterized by a sensation of spinning or turning, accompanied by nausea, vomiting, ringing in the ears, **headache**, or **fatigue**. An individual may have trouble walking, remaining coordinated, or keeping balance. Nonsyncope nonvertigo dizziness is characterized by a feeling of being off balance that becomes worse if the individual tries moving or performing detail-intense tasks.

A person may experience dizziness for many reasons. Syncope is associated with low blood pressure, heart problems, and disorders in the autonomic nervous system, the system of involuntary functions such as breathing. Syncope may also arise from emotional distress, **pain**, and other reactions to outside stressors. Nonsyncope nonvertigo dizziness may be caused by rapid breathing, low blood sugar, or **migraine headache**, as well as by more serious medical conditions.

Vertigo is often associated with inner ear problems called vestibular disorders. A particularly intense vestibular disorder, Méniére's disease, interferes with the volume of fluid in the inner ear. This disease, which affects approximately one in every 1,000 people, causes intermittent vertigo over the course of weeks, months, or years. Méniére's disease is often accompanied by ringing or buzzing in the ear, **hearing loss**, and a feeling that the ear is blocked. Damage to the nerve that leads from the ear to the brain can also cause vertigo. Such damage can result from head injury or a tumor. An **acoustic neuroma**, for example, is a benign tumor that wraps around the nerve. Vertigo can also be caused by disorders of the central nervous system and the circulatory system, such as hardening of the arteries (arteriosclerosis), **stroke**, or **multiple sclerosis**.

Some medications cause changes in blood pressure or blood flow. These medications can cause dizziness in some people. Prescription medications carry warnings of such side effects, but common drugs, such as **caffeine** or nicotine can also cause dizziness. Certain **antibiotics** can damage the inner ear and cause hearing loss and dizziness.

Diet may cause dizziness. The role of diet may be direct, as through alcohol intake. It may be also be indirect, as through arteriosclerosis caused by a high-fat diet. Some people experience a slight dip in blood sugar and mild dizziness if they miss a meal, but this condition is rarely dangerous unless the person is diabetic. Food sensitivities or allergies can also be a cause of dizziness. Chronic conditions, such as heart disease, and serious acute problems, such as seizures and strokes, can cause dizziness. However, such conditions usually exhibit other characteristic symptoms.

Diagnosis

During the initial medical examination, an individual with dizziness should provide a detailed description of the type of dizziness experienced, when it occurs, and how often each episode lasts. A diary of symptoms may help track this information. Report any symptoms that accompany the dizziness, such as a ringing in the ear or nausea, any recent injury or infection, and any medication taken.

Blood pressure, pulse, respiration, and body temperature are checked, and the ear, nose, and throat are scrutinized. The sense of balance is assessed by moving the individual's head to various positions or by tilt-table testing. In tilt-table testing, the person lies on a table that can be shifted into different positions and reports any dizziness that occurs.

Further tests may be indicated by the initial examination. Hearing tests help assess ear damage. x rays, computed tomography scan (CT scan), and **magnetic resonance imaging** (MRI) can pinpoint evidence of nerve damage, tumor, or other structural problems. If a vestibular disorder is suspected, a technique called electronystagmography (ENG) may be used. ENG measures the electrical impulses generated by eye movements. Blood tests can determine diabetes, **high cholesterol**, and other diseases. In some cases, a heart evaluation may be useful. Despite thorough testing, an underlying cause cannot always be determined.

Treatment

Treatment is determined by the underlying cause. If an individual has a cold or **influenza**, a few days of bed rest is usually adequate to resolve dizziness. Other causes of dizziness, such as mild vestibular system damage, may resolve without medical treatment.

If dizziness continues, drug therapy may prove helpful. Because circulatory problems often cause dizziness, medication may be prescribed to control blood pressure or to treat arteriosclerosis. Sedatives may be useful to relieve the tension that can trigger or aggravate dizziness. Low blood sugar associated with diabetes sometimes causes dizziness and is treated by controlling blood sugar levels. An individual may be asked to avoid caffeine, nicotine, alcohol, and any substances that cause allergic reactions. A low-salt diet may also help some people.

When other measures have failed, surgery may be suggested to relieve pressure on the inner ear. If the dizziness is not treatable by drugs, surgery, or other means, physical therapy may be used and the patient may be taught coping mechanisms for the problem.

KEY TERMS

Acoustic neuroma—A benign tumor that grows on the nerve leading from the inner ear to the brain. As the tumor grows, it exerts pressure on the inner ear and causes severe vertigo.

Arteriosclerosis—Hardening of the arteries caused by high blood cholesterol and high blood pressure.

Autonomic nervous system—The part of the nervous system that controls involuntary functions such as breathing and heart beat.

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Electronystagmography—A method for measuring the electricity generated by eye movements. Electrodes are placed on the skin around the eye and the individual is subjected to a variety of stimuli so that the quality of eye movements can be assessed.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Vestibular system—The area of the inner ear that helps maintain balance.

Alternative treatment

Because dizziness may arise from serious conditions, it is advisable to seek medical treatment. Alternative treatments can often be used alongside conventional medicine without conflict. Relaxation techniques, such as **yoga** and **massage therapy** that focus on relieving tension, are popularly recommended methods for reducing **stress**. Aromatherapists recommend a warm bath scented with essential oils of lavender, geranium, and sandalwood.

Homeopathic therapies can work very effectively for dizziness, and are especially applicable when no organic cause can be identified. An osteopath or chiropractor may suggest adjustments of the head, jaw, neck, and lower back to relieve pressure on the inner ear. Acupuncturists also offer some treatment options for acute and chronic cases of dizziness. Nutritionists may be able to offer advice and guidance in choosing dietary supplements, identifying foods to avoid, and balancing nutritional needs.

Prognosis

Outcome depends on the cause of dizziness. Controlling or curing the underlying factors usually relieves dizziness. In some cases, dizziness disappears without treatment. In a few cases, dizziness can become a permanent disabling condition and a person's options are limited.

Prevention

Most people learn through experience that certain activities will make them dizzy and they learn to avoid them. For example, if reading in a car produces motion sickness, an individual leaves reading materials for after the trip. Changes to the diet can also cut down on episodes of dizziness in susceptible people. Relaxation techniques can help ward off tension and **anxiety** that can cause dizziness.

These techniques can help minimize or even prevent dizziness for people with chronic diseases. For example, persons with Méniére's disease may avoid episodes of vertigo by leaving salt, alcohol, and caffeine out of their **diets**. Reducing blood cholesterol can help diminish arteriosclerosis and indirectly treat dizziness.

Some cases of dizziness cannot be prevented. Acoustic neuromas, for example, are not predictable or preventable. When the underlying cause of dizziness cannot be discovered, it may be difficult to recommend preventive measures. Alternative approaches designed to rebalance the body's energy flow, such as **acupuncture** and constitutional **homeopathy**, may be helpful in cases where the cause of dizziness cannot be pinpointed.

Resources

BOOKS

Yardley, Lucy. *Vertigo and Dizziness*. New York: Routledge, 1994.

PERIODICALS

Bowen, James. "Dizziness: A Diagnostic Puzzle." *Hospital Medicine* 34, no.1 (1998): 39.

Ruckenstein, Michael J. "A Practical Approach to Dizziness." *Postgraduate Medicine* 97, no.3 (Mar. 1995): 70.

ORGANIZATIONS

Méniére's Network. 1817 Patterson St., Nashville, TN 37203. (800) 545-4327. <http://www.earfoundation.org>.

The Vestibular Disorders Association. PO Box 4467, Portland, OR 97208-4467. (503) 229-7705. <http://www.teleport.com/~veda>.

Julia Barrett

DKA *see* **Diabetic ketoacidosis**

DLE *see* **Discoid lupus erythematosus**

Domestic violence *see* **Abuse**

Donovanosis *see* **Granuloma inguinale**

Doppler echocardiography *see* **Echocardiography**

Doppler ultrasonography

Definition

Doppler ultrasonography is a non-invasive diagnostic procedure that changes sound waves into an image that can be viewed on a monitor.

Purpose

Doppler ultrasonography can detect the direction, velocity, and turbulence of blood flow. It is frequently used to detect problems with heart valves or to measure blood flow through the arteries. Specifically, it is useful in the work up of **stroke** patients, in assessing blood flow in the abdomen or legs, and in viewing the heart to monitor carotid artery diseases.

Precautions

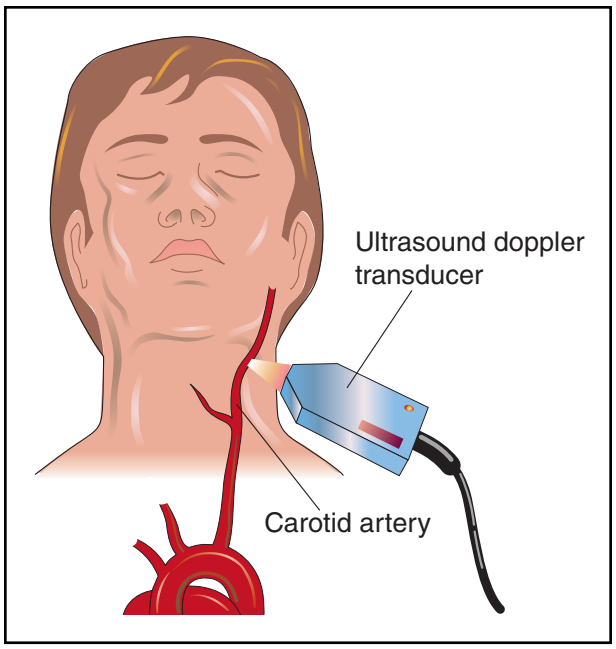
The test is widely used because it is noninvasive, uses no x rays, and gives excellent images. It is harmless, painless, and widely available.

Description

Doppler ultrasonography makes use of two different principles. The ultrasound principle is this: when a high-frequency sound is produced and aimed at a target, it will be reflected by its target and the reflected sound can be detected back at its origin. In addition, it is known that certain crystals (called piezoelectric crystals) produce an electrical pulse when vibrated by a returning sound.

The Doppler principle is simply that sound pitch increases as the source moves toward the listener and decreases as it moves away.

Medical science utilizes these two principles in the following way. A transducer (sometimes called a probe) containing piezoelectric crystals sends a series of short sound pulses into the body and pauses between each pulse to listen for the returning sounds. The machine then determines the direction and depth of each returning sound and coverts this into a point of light on a television monitor. Thousands of these pulses are computed and displayed every second to produce an image of the organ being studied. The image allows the doctor to see the organ functioning in real time.



Doppler ultrasonography can detect the direction, velocity, and turbulence of blood flow. Because it is non-invasive and uses no x rays, doppler ultrasongraphy is widely used for numerous diagnostic procedures. *(Illustration by Electronic Illustrators Group.)*

The newest addition to this test is the addition of color. Adding color to the image shows the direction and rate of blood flow more clearly.

During a Doppler ultrasonography procedure the technician will apply a gel to the skin, then place the transducer against the skin at various angles. The transducer sends the information it receives to a television monitor that shows a moving image of the organ being studied. The technician can save these images either on video tape, paper, or x-ray film for further study.

Preparation

There is no special preparation needed for this test. The ultrasound technician may apply a clear gel to the skin in order to help the transducer more freely over the body.

Aftercare

No aftercare is necessary.

Normal results

A Doppler ultrasonography test showing no restricted blood flow, is a normal finding.

KEY TERMS

Doppler effect—The principle that the sound of an object moving toward you has a higher pitch than the sound when it's moving away from you.

Transducer—The part of a machine that changes signals in one form into another form.

Ultrasound—Sound that is too high for the human ear to hear.

Abnormal results

Disrupted or obstructed blood flow through the neck arteries may indicate the person is a risk of having a stroke. (Narrowed arterial flow in the legs does not necessarily indicate a risk of stroke.)

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

Office Practice of Neurology. Ed. Martin Samuels and Steven Feske. New York: Churchill Livingstone, 1996.

von Reutern, G. M., and H. J. von Budingen. *Ultrasound Diagnosis of Cerebrovascular Disease*. New York: Georg Thieme Verlag, 1993.

Dorothy Elinor Stonely

Down syndrome

Definition

Down syndrome is the most common cause of **mental retardation** and malformation in a newborn. It occurs because of the presence of an extra chromosome.

Description

Chromosomes are the units of genetic information that exist within every cell of the body. Twenty-three distinctive pairs, or 46 total chromosomes, are located within the nucleus (central structure) of each cell. When a baby is conceived by the combining of one sperm cell with one egg cell, the baby receives 23 chromosomes from each parent, for a total of 46 chromosomes. Sometimes, an accident in the production of a sperm or egg cell causes that cell to contain 24 chromosomes. This event is referred to as nondisjunction. When this defective cell is involved in the conception of a baby, that baby will have a total of 47 chromosomes. The extra chromosome in Down syndrome is labeled number 21. For this reason, the existence of three such chromosomes is sometimes referred to as Trisomy 21.

In a very rare number of Down syndrome cases (about 1–2%), the original egg and sperm cells are completely normal. The problem occurs sometime shortly after fertilization; during the phase where cells are dividing rapidly. One cell divides abnormally, creating a line of cells with an extra chromosome 21. This form of genetic disorder is called a mosaic. The individual with this type of Down syndrome has two types of cells: those with 46 chromosomes (the normal number), and those with 47 chromosomes (as occurs in Down syndrome). Some researchers have suggested that individuals with this type of mosaic form of Down syndrome have less severe signs and symptoms of the disorder.

Another relatively rare genetic accident which can cause Down syndrome is called translocation. During cell division, the number 21 chromosome somehow breaks. A piece of the 21 chromosome then becomes attached to another chromosome. Each cell still has 46 chromosomes, but the extra piece of chromosome 21 results in the signs and symptoms of Down syndrome. Translocations occur in about 3–4% of cases of Down syndrome.

Down syndrome occurs in about one in every 800–1,000 births. It affects an equal number of boys and girls. Less than 25% of Down syndrome cases occur due to an extra chromosome in the sperm cell. The majority of cases of Down syndrome occur due to an extra chromosome 21 within the egg cell supplied by the mother (nondisjunction). As a woman's age (maternal age) increases, the risk of having a Down syndrome baby increases significantly. For example, at younger ages, the risk is about one in 4,000. By the time the woman is age 35, the risk increases to one in 400; by age 40 the risk increases to one in 110; and by age 45 the risk becomes one in 35. There is no increased risk of either mosaicism or translocation with increased maternal age.

Causes and symptoms

While Down syndrome is a chromosomal disorder, a baby is usually identified at birth through observation of a set of common physical characteristics. Babies with Down syndrome tend to be overly quiet, less responsive, with weak, floppy muscles. Furthermore, a number of physical signs may be present. These include:

- flat appearing face
- small head

- flat bridge of the nose
- smaller than normal, low-set nose
- small mouth, which causes the tongue to stick out and to appear overly large
- upward slanting eyes
- extra folds of skin located at the inside corner of each eye, near the nose (called epicanthal folds)
- rounded cheeks
- small, misshapen ears
- small, wide hands
- an unusual, deep crease across the center of the palm (called a simian crease)
- a malformed fifth finger
- a wide space between the big and the second toes
- unusual creases on the soles of the feet
- overly-flexible joints (sometimes referred to as being double-jointed)
- ahorter than normal height

Other types of defects often accompany Down syndrome. About 30–50% of all children with Down syndrome are found to have heart defects. A number of different heart defects are common in Down syndrome, including abnormal openings (holes) in the walls that separate the heart's chambers (**atrial septal defect**, **ventricular septal defect**). These result in abnormal patterns of blood flow within the heart. The abnormal blood flow often means that less oxygen is sent into circulation throughout the body. Another heart defect that occurs in Down syndrome is called **Tetralogy of Fallot**. Tetralogy of Fallot consists of a hole in the heart, along with three other major heart defects.

Malformations of the gastrointestinal tract are present in about 5–7% of children with Down syndrome. The most common malformation is a narrowed, obstructed duodenum (the part of the intestine into which the stomach empties). This disorder, called duodenal atresia, interferes with the baby's milk or formula leaving the stomach and entering the intestine for digestion. The baby often vomits forcibly after feeding, and cannot gain weight appropriately until the defect is repaired.

Other medical conditions that occur in patients with Down syndrome include an increased chance of developing infections, especially ear infections and **pneumonia**; certain kidney disorders; thyroid disease (especially low or hypothyroid); **hearing loss**; vision impairment requiring glasses (corrective lenses); and a 20-times greater chance of developing leukemia (a blood disorder).

Development in a baby and child with Down syndrome occurs at a much slower than normal rate. Because of weak, floppy muscles (hypotonia), babies learn to sit up, crawl, and walk much later than their normal peers. Talking is also quite delayed. The level of mental retardation is considered to be mild-to-moderate in Down syndrome. The actual IQ range of Down syndrome children is quite varied, but the majority of such children are in what is sometimes known as the trainable range. This means that most people with Down syndrome can be trained to do regular self-care tasks, function in a socially appropriate manner in a normal home environment, and even hold simple jobs.

As people with Down syndrome age, they face an increased chance of developing the brain disease called Alzheimer's (sometimes referred to as **dementia** or senility). Most people have a six in 100 risk of developing Alzheimer's, but people with Down syndrome have a 25 in 100 chance of the disease. **Alzheimer's disease** causes the brain to shrink and to break down. The number of brain cells decreases, and abnormal deposits and structural arrangements occur. This process results in a loss of brain functioning. People with Alzheimer's have strikingly faulty memories. Over time, people with Alzheimer's disease will lapse into an increasingly unresponsive state. Some researchers have shown that even Down syndrome patients who do not appear to have Alzheimer's disease have the same changes occurring to the structures and cells of their brains.

As people with Down syndrome age, they also have an increased chance of developing a number of other illnesses, including **cataracts**, thyroid problems, diabetes, and seizure disorders.

Diagnosis

Diagnosis is usually suspected at birth, when the characteristic physical signs of Down syndrome are noted. Once this suspicion has been raised, **genetic testing** (chromosome analysis) can be undertaken in order to verify the presence of the disorder. This testing is usually done on a blood sample, although chromosome analysis can also be done on other types of tissue, including skin. The cells to be studied are prepared in a laboratory. Chemical stain is added to make the characteristics of the cells and the chromosomes stand out. Chemicals are added to prompt the cells to go through normal development, up to the point where the chromosomes are most visible, prior to cell division. At this point, they are examined under a microscope and photographed. The photograph is used to sort the different sizes and shapes of chromosomes into pairs. In most cases of Down syndrome, one extra chromosome 21 will be revealed. The final result of such testing, with the photographed chromosomes paired and organized by shape and size, is called the individual's karyotype.

Treatment

No treatment is available to cure Down syndrome. Treatment is directed at addressing the individual concerns of a particular patient. For example, heart defects will many times require surgical repair, as will duodenal atresia. Many Down syndrome patients will need to wear glasses to correct vision. Patients with hearing impairment benefit from **hearing aids**.

A new drug, referred to as a "smart drug," has been receiving some attention in the treatment of Down syndrome patients. This drug, piracetam, has not been proven to increase intellectual ability, despite testimonials that have been receiving attention on television and the Internet. Piracetam has not been approved for use in the United States, although it is being sold via the Internet. The National Down Syndrome Society and the National Down Syndrome Congress do not recommend the use of this drug as of 2001.

While some decades ago, all Down syndrome children were quickly placed into institutions for lifelong care. Research shows very clearly that the best outlook for children with Down syndrome is a normal family life in their own home. This requires careful support and education of the parents and the siblings. It is a life-changing event to learn that a new baby has a permanent condition that will effect essentially all aspects of his or her development. Some community groups exist to help families deal with the emotional effects of this new information, and to help plan for the baby's future. Schools are required to provide services for children with Down syndrome, sometimes in separate special education classrooms, and sometimes in regular classrooms (this is called mainstreaming or inclusion).

Prognosis

The prognosis in Down syndrome is quite variable, depending on the types of complications (heart defects, susceptibility to infections, development of leukemia) of each individual baby. The severity of the retardation can also vary significantly. Without the presence of heart defects, about 90% of children with Down syndrome live into their teens. People with Down syndrome appear to go through the normal physical changes of **aging** more rapidly, however. The average age of **death** for an individual with Down syndrome is about 50–55 years.

Still, the prognosis for a baby born with Down syndrome is better than ever before. Because of modern medical treatments, including **antibiotics** to treat infections and surgery to treat heart defects and duodenal atresia, life expectancy has greatly increased. Community and family support allows people with Down syndrome to have rich, meaningful relationships. Because of educational programs, some people with Down syndrome are able to hold jobs.

Men with Down syndrome appear to be uniformly sterile (meaning that they are unable to have offspring). Women with Down syndrome, however, are fully capable of having babies. About 50% of these babies, however, will also be born with Down syndrome.

Prevention

Efforts at prevention of Down syndrome are aimed at **genetic counseling** of couples who are preparing to have babies. A counselor needs to inform a woman that her risk of having a baby with Down syndrome increases with her increasing age. Two types of testing is available during a **pregnancy** to determine if the baby being carried has Down syndrome.

Screening tests are used to estimate the chance that an individual woman will have a baby with Down syndrome. At 14–17 weeks of pregnancy, measurements of a substance called AFP (alpha-fetoprotein) can be performed. AFP is normally found circulating in the blood of a pregnant woman, but may be unusually high or low with certain disorders. Carrying a baby with Down syndrome often causes AFP to be lower than normal. This information alone, or along with measurements of two other hormones, is considered along with the mother's age to calculate the risk of the baby being born with Down syndrome. These results are only predictions, and are only correct about 60% of the time.

The only way to definitively establish (with about 98–99% accuracy) the presence or absence of Down syndrome in a developing baby, is to test tissue from the pregnancy itself. This is usually done either by **amniocentesis** or **chorionic villus sampling** (CVS). In amniocentesis, a small amount of the fluid in which the baby is floating is withdrawn with a long, thin needle. In chorionic villus sampling, a tiny tube is inserted into the opening of the uterus to retrieve a small sample of the placenta (the organ that attaches the growing baby to the mother via the umbilical cord, and provides oxygen and **nutrition**). Both amniocentesis and CVS allow the baby's own karyotype to be determined. A couple must then decide whether to use this information in order to begin to prepare for the arrival of a baby with Down syndrome, or to terminate the pregnancy.

Once a couple has had one baby with Down syndrome, they are often concerned about the likelihood of future offspring also being born with the disorder. Most research indicates that this chance remains the same as for any woman at a similar age. However, when the baby

KEY TERMS

Chromosome—The structures that carry genetic information. Chromosomes are located within every cell, and are responsible for directing the development and functioning of all the cells in the body. The normal number is 46 (23 pairs).

Karyotype—The specific chromosomal makeup of a particular cell.

Mental retardation—A condition where an individual has a lower-than-normal IQ, and thus is developmentally delayed.

Mosaic—A term referring to a genetic situation, in which an individual's cells do not have the exact same composition of chromosomes. In Down syndrome, this may mean that some of the individual's cells have a normal 46 chromosomes, while other cells have an abnormal 47 chromosomes.

Nondisjunction—A genetic term referring to an event which takes place during cell division, in which a genetic accident causes an egg or sperm cell to have 24 chromosomes, rather than the normal 23.

Translocation—A genetic term referring to a situation during cell division in which a piece of one chromosome breaks off and sticks to another chromosome.

Trisomy—The condition of having three identical chromosomes, instead of the normal two.

with Down syndrome has the type that results from a translocation, it is possible that one of the two parents is a carrier of that defect. A carrier "carries" the genetic defect, but does not actually have the disorder. When one parent is a carrier of a translocation, the chance of future offspring having Down syndrome is greatly increased. The specific risk will have to be calculated by a genetic counselor.

Resources

BOOKS

Carey, John C. "Chromosomal Disorders." In *Rudolph's Pediatrics,* ed. Abraham M. Rudolph. Stamford: Appleton & Lange, 1998.

Shapiro, Larry J. "Human Genetics." In *Nelson Textbook of Pediatrics,* ed. Richard Behrman. Philadelphia: W. B. Saunders Co., 1998.

Stray-Gunderson, K. *Babies with Down Syndrome: A New Parents' Guide*. Kensington: Woodbine House, 1986.

Tingey, C. *Down Syndrome: A Resource Handbook*. Boston: Little, Brown, Inc., 1988.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment*. Los Altos: Lange Medical Publications, 2001.

PERIODICALS

Carlson, Tucker, and Jason Cowley. "When a Life is Worth Living: Down's Syndrome Children." *The Times*, 29 Nov. 1996, 18+.

"Medical and Surgical Care for Children with Down Syndrome." *The Exceptional Parent* 25, no. 11 (Nov. 1995): 78+.

Roan, Shari. "Elixir of Hope?" *Los Angeles Times* 6 Mar. 1996, E1.

Tanner, Lindsey. "Study: Drug May Hurt Syndrome Kids." *Chicago: Associated Press*, 12 Apr. 2001.

ORGANIZATION

National Down Syndrome Congress. 1605 Chantilly Drive, Suite 250, Atlanta, GA 30324-3269. (800) 232-6372.

National Down Syndrome Society. 666 Broadway, 8th Floor, New York, NY 10012-2317. (800) 221-4602. <http://www.ndss.org>.

Kim A. Sharp, M.Ln.

Down's syndrome *see* **Down syndrome**

Doxazosin *see* **Alpha$_1$-adrenergic blockers**

Doxepin *see* **Antidepressants, tricyclic**

Doxycycline *see* **Tetracyclines**

Dracontiasis *see* **Guinea worm infection**

Dracunculiasis *see* **Guinea worm infection**

Drooping eyelid *see* **Ptosis**

Drowning *see* **Near-drowning**

Drug abuse *see* **Substance abuse and dependence**

Drug addiction *see* **Substance abuse and dependence**

Drug dependence *see* **Substance abuse and dependence**

Drug metabolism/interactions

Definition

Drug metabolism is the process by which the body breaks down and converts medication into active chemical substances.

Precautions

Drugs can interact with other drugs, foods, and beverages. Interactions can lessen or magnify the desired therapeutic effect of a drug, or may cause unwanted or unexpected side effects. There are thousands of possible drug-to-drug and drug-to-food interactions, and many medications and supplements are contraindicated (not recommended) under certain conditions or in patients with specific diseases and disorders. This is why it is imperative that patients always keep their physician fully informed about all drugs and dietary supplements (including herbal remedies) they are taking.

Description

The primary site of drug metabolism is the liver, the organ that plays a major role in metabolism, digestion, **detoxification,** and elimination of substances from the body. Enzymes in the liver are responsible for chemically changing drug components into substances known as metabolites. Metabolites are then bound to other substances for excretion through the lungs, or bodily fluids such as saliva, sweat, breast milk, and urine, or through reabsorption by the intestines. The primary mode of excretion is through the kidneys.

The family of liver isoenzymes known as cytochrome P-450 are crucial to drug metabolism. These enzymes (labeled CYP1A2, CYP2C9, CYP2C19, CYP2D6, and CYP3A4) have a catabolic action on substances, breaking them down into metabolites. Consequently, they also act to lower the concentration of medication in the bloodstream.

Drug interactions can occur when one drug inhibits or induces a P-450 that acts on another drug. An example is nicotine, a drug contained in tobacco, and known to induce P-450s. Individuals with liver disease (e.g., **cirrhosis**) may also have insufficient levels of P-450 enzymes. As a result, the concentration of drugs metabolized by these enzymes (e.g., amprenavir and other **protease inhibitors**) remains high and can build up to toxic levels in the bloodstream. In addition, certain medications and foods, such as grapefruit juice, can inactivate or lessen the metabolic activity of P-450s. Changing the drug dosage can alleviate the problem in some cases.

The metabolic rate can vary significantly from person to person, and drug dosages that work quickly and effectively in one individual may not work well for another. Factors such as genetics, environment, **nutrition** and age also influence drug metabolism; infants and elderly patients may have a reduced capacity to metabolize certain drugs, and may require adjustments in dosage.

Causes and symptoms

Drugs that commonly interact with other medications include:

- **Diuretics**. Diuretics such as hydrochlorothiazide can reduce serum potassium and sodium electrolyte levels when taken with digoxin and lithium, respectively.
- Monoamine oxidase inhibitors (MAOIs). MAOI antidepressants can cause convulsions and other serious side effects when used with tricyclic antidepressants (e.g., Imipramine, Nortriptyline), **selective serotonin reuptake inhibitors** (SSRIs), or sympathomimetic drugs (e.g., amphetamines).
- **Antibiotics**. Antibiotics may reduce the efficiency of oral contraceptives.
- Metals. Medications containing metals, such as **antacids** with aluminum additives and iron supplements, can reduce the absorption of **tetracyclines** and fluoroquinolones.
- Drugs that inhibit liver enzyme function. Drugs that slow drug metabolism include ciprofloxacin, erythromycin, fluoxetine, nefazodone, paroxetine, and ritonavir. The therapeutic effect of other medications taken with these drugs may be amplified. Warfarin, a blood thinner, should be used with great caution in individuals taking these drugs.

Foods and beverages that may interact with drugs include:

- Grapefruit juice. Grapefruit juice inhibits the metabolism of many medications, including cyclosporine, felodipine, nifedipine, nitrendipine, nisoldipine, carbamazepine, triazolam, and midazolam.
- Foods and beverages with tyramines. Red wine, malted beers, smoked foods (e.g., fish and meats), dried fruits, and aged cheeses may contain tyramines, and can cause a severe and dangerous elevation in blood pressure when taken with MAOI inhibitors (a class of antidepressants).
- Dairy products. Milk, cream, and other dairy products containing calcium can prevention the absorption of antibiotics such as tetracycline, doxycycline, and ciprofloxacin when they are taken with the drug. In addition, whole milk with vitamin D can cause milk-alkali syndrome in patients taking aluminum hydroxide antacids.
- Caffeinated beverages. The **caffeine** contained in coffee and colas can influence drug metabolism.
- Alcohol. Alcohol is a central nervous system depressant, and should not be taken with other CNS depressants

KEY TERMS

Catabolism—A process of metabolism that breaks down complex substances into simple ones.

Cirrhosis—Liver disease characterized by the widespread disruption of the normal liver structure and function.

CNS depressant—Anything that depresses, or slows, the sympathetic impulses of the central nervous system (i.e., respiratory rate, heart rate).

Drug interaction—A chemical or physiological reaction that can occur when two different drugs are taken together.

Enzymes—Organic substances (proteins) composed of amino acids that trigger and regulate chemical reactions in the body. There are over 700 identified human enzymes.

Liver—A solid organ located on the right in the upper abdomen. It plays a major role in metabolism, digestion, detoxification, and elimination of substances from the body.

Metabolism—The sum of all the physical and chemical processes occurring in the body to organize and maintain life.

Metabolites—Substances produced by metabolism or by a metabolic process.

Milk-alkali syndrome—Elevated blood calcium levels and alkalosis caused by excessive intake of milk and alkalis. Usually occurs in the treatment of peptic ulcer.

(e.g., antipsychotics, **antihistamines**). In addition, certain fermented beverages may contain tyramines

This list is not all-inclusive and individuals should always let their doctor and pharmacist know when they are taking other medications, herbal remedies, or dietary supplements. Anyone who experiences a serious reaction to a drug that is not consistent with its product labelling should report the event to their doctor and/or the MedWatch adverse event reporting system of the United States Food and Drug Administration (FDA).

Alternative treatment

The growing use of herbal supplements has also increased the opportunity for adverse drug and herbal interactions. In 2000, the FDA issued a warning on the popular herb **St. John's wort** (*Hypericum perforatum*). The supplement was found to inhibit the effect of indinavir, a protease inhibitor used in the treatment of HIV. It may also affect the action of cyclosporine and other protease inhibitors (e.g., amprenavir, ritonavir). Further clinical studies are still necessary to determine the full metabolic effects of the herb.

Other herbs which may interact with allopathic medications include gingko bilboa, ginseng, and garlic, which may all heighten the blood thinning effect of the anticoagulant warfarin. Because herbs are regulated by the FDA as dietary supplements, they do not require the same extensive clinical trials and premarket testing as drugs do before they are cleared for sale in the United States As such, there is still much to learn about the potential interactions and adverse effects associated with herbal supplements. Individuals who experience serious side effects from dietary supplements should report them to FDA's MedWatch program.

Diagnosis

Drug interactions can be difficult to detect. In some cases, adverse reactions may closely resemble the symptoms of the disease or condition the medication was prescribed to treat. Patients who take a number of medications or self-treat with over-the-counter drugs and/or herbal remedies may not be able to determine which drug actually triggered the interaction. A 2001 study by University of Florida researchers found that less than half of the women participating disclosed their use of herbal therapies to their healthcare providers. In cases where a serious drug or herb interaction occurs, withholding this information can delay diagnosis and put the patient at increased risk.

Treatment

Treatment of a drug interaction is dependant on a number of factors, including the medication(s) or supplements used and the medical history of the patient. A dosage adjustment may reverse the effects of some interactions. Serious or life-threatening interactions will require more aggressive therapies.

Prevention

Patients with chronic health conditions, particularly those with liver disorders, should always inform their

healthcare professional before taking any over-the-counter (OTC) medications or dietary supplements. Because of the risk for a drug-to-drug interaction, individuals should also let their doctor know if they are taking drugs prescribed by other physicians. Individuals should closely follow instructions for use and package directions on both prescription and over-the-counter drugs. Consulting with a pharmacist and/or physician may be beneficial if package directions are unclear to the patient.

As a rule, grapefruit juice should not be taken with medication unless recommended by a doctor. Patients taking MAOI inhibitors should always check food and beverage labels to ensure tyramines aren't included, and should avoid all fermented drinks.

Resources

BOOKS

Beers, Mark H., and Robert Berkow. *The Merck Manual of Diagnosis and Therapy, 17th ed.* Whitehouse Station, NJ: Merck & Co., Inc., 1999.

Medical Economics Company. *The Physicians Desk Reference (PDR).* 55th edition. Montvale, NJ: Medical Economics Company, 2001.

PERIODICALS

Hardy, Mary L. "Herb-Drug Interactions: An Evidence-Based Table." *Internal Medicine Alert* 23 (January 29, 2001): 1.

ORGANIZATION

United States Food and Drug Administration (FDA). MedWatch Adverse Events Reporting Program. 5600 Fishers Lane, Rockville, MD 20852-9787. 800-FDA-1088. <http://www.fda.gov/medwatch/>.

Paula Anne Ford-Martin

Drug overdose

Definition

A drug overdose is the accidental or intentional use of a drug or medicine in an amount that is higher than is normally used.

Description

All drugs have the potential to be misused, whether legally prescribed by a doctor, purchased over-the-counter at the local drug store, or bought illegally on the street. Taken in combination with other drugs or with alcohol, even drugs normally considered safe can cause **death** or serious long term consequences. Children are particularly at risk for accidental overdose, accounting for over one million poisonings each year from drugs, alcohol, and other chemicals and toxic substances. People who suffer from depression and who have suicidal thoughts are also at high risk for drug overdose.

Causes and symptoms

Accidental drug overdose may be the result of misuse of prescription medicines or commonly used medications like **pain** relievers and cold remedies. Symptoms differ depending on the drug taken. Some of the drugs commonly involved in overdoses are listed below along with symptoms and outcomes.

Acetaminophen is the generic name for the commonly used pain reliever Tylenol. Overdose of this drug causes liver damage with symptoms that include loss of appetite, tiredness, **nausea and vomiting**, paleness, and sweating. The next stage of symptoms indicates liver failure and includes abdominal pain and tenderness, swelling of the liver, and abnormal blood tests for liver enzymes. In the last stage of this **poisoning**, liver failure advances and the patient becomes jaundiced, with yellowing of the skin and whites of the eyes. They may also experience kidney failure, bleeding disorders, and encephalopathy (swelling of the brain).

Anticholinergic drugs (drugs that block the action of acetylcholine, a neurotransmitter) like atropine, scopolamine, belladonna, **antihistamines**, and antipsychotic agents cause the skin and moist tissues (like in the mouth and nose) to become dry and flushed. Dilated pupils, an inability to urinate, and mental disturbances are also symptoms. Severe toxicity can lead to seizures, abnormal heart rhythms, extremely high blood pressure, and **coma**.

Antidepressant drugs like amitriptyline, desipramine, and nortriptyline can cause irregular heart rate, vomiting, low blood pressure, confusion, and seizures. An overdose of antidepressants also causes symptoms similar to those seen with anticholinergic drug overdoses.

Cholinergic drugs (drugs that stimulate the parasympathetic nervous system) like carbamate and pilocarpine cause nausea, **diarrhea**, increased secretion of body fluids (sweat, tears, saliva, and urine), **fatigue**, and muscle weakness. Convulsions are possible. Death can occur due to **respiratory failure** and **heart failure**.

Cocaine and crack cocaine overdoses cause seizures, high blood pressure, increased heart rate, **paranoia**, and other changes in behavior. **Heart attack** or **stroke** are serious risks within three days after cocaine overdose.

Depressant drugs (tranquilizers, **antianxiety drugs**, sleeping pills) cause sleepiness, slowed or slurred speech, difficulty walking or standing, blurred vision, impaired ability to think, disorientation, and mood changes. Over-

dose symptoms can include slowed breathing, very low blood pressure, stupor, coma, **shock**, and death.

Digoxin, a drug used to regulate the heart, can cause irregular heart beats, nausea, confusion, loss of appetite, and blurred vision.

Narcotics or opiates are drugs like heroin, morphine, and codeine. Clonidine and diphenoxylate (Lomotil) are also in this category. Overdose with opiate drugs causes **sedation** (sleepiness), low blood pressure, slowed heart rate, and slowed breathing. Pinpoint pupils, where the black centers of the eyes become smaller than normal, are common in opiate overdose. However, if other drugs are taken at the same time as the opiates, they may counteract this effect on the pupils. A serious risk is that the patient will stop breathing.

Salicylates are found in **aspirin** and some creams or ointments used for muscle and joint pain (like Ben-Gay), and creams for **psoriasis**, a skin condition. Initial symptoms are gastrointestinal irritation, **fever**, and vomiting, possibly with blood in the vomit. This overdose will cause **metabolic acidosis** and **respiratory alkalosis**, conditions where the body's acid/base balance is malfunctioning. Symptoms include rapid heart beat and fast breathing. Nervous system symptoms include confusion, **hallucinations**, tiredness, and ringing in the ears. An increased tendency to bleed is also common. Serious complications include acute renal failure, coma, and heart failure. Acute salicylate poisoning can lead to death.

Diagnosis

Diagnosis of a drug overdose may be based on the symptoms that develop, however, the drug may do extensive damage to the body before significant symptoms develop. If the patient is conscious, he or she may be able to tell what drugs were taken and in what amounts. The patient's recent medical and social history may also help in a diagnosis. For example, a list of medications that the patient takes, whether or not alcohol was consumed recently, even if the patient has eaten in the last few hours before the overdose, can be valuable in determining what was taken and how fast it will be absorbed into the system.

Different drugs have varying effects on the body's acid/base balance and on certain elements in the blood like potassium and calcium. Blood tests can be used to detect changes in body chemistry that may give clues to what drugs were taken. Blood can also be screened for various drugs in the system. Once the overdose drug is identified, blood tests can be used to monitor how fast the drug is being cleared out of the body. Urine tests can also be used to screen for some drugs and to detect changes in the body's chemistry. Blood and urine tests may show if there is damage to the liver or kidneys as a result of the overdose.

Treatment

Immediate care

If a drug overdose is discovered or suspected, and the person is unconscious, having convulsions, or is not breathing, call for emergency help immediately. If the person who took the drug is not having symptoms, don't wait to see if symptoms develop; call a poison control center immediately. Providing as much information as possible to the poison control center can help determine what the next course of action should be.

The poison control center, paramedics, and emergency room staff will want to know:

- what drug(s) were taken—try to locate the drug's container.
- how much of the drug was taken
- when was the drug taken
- was the drug taken with alcohol or any other drugs or chemicals
- what is the age of the patient
- what symptoms are the patient experiencing
- is the patient conscious
- is the patient breathing

The poison control center may recommend trying to get the patient to vomit. A liquid called **ipecac** syrup, which is used to induce vomiting, is available from pharmacies without a prescription. Pediatricians may recommend that families keep ipecac syrup on hand in households with children. This medication should be used only on the advice of a medical professional. Vomiting should not be induced if the patient is unconscious.

Emergency care

Emergency medical treatment may include:

- Assessment of the patient's airway and breathing to making sure that the trachea, the passage to the lungs, is not blocked. If needed, a tube may be inserted through the mouth and into the trachea to help the patient breath. This procedure is called intubation.
- Assessment of the patient's heart rate, blood pressure, body temperature, and other physical signs that might indicate the effects of the drug.
- Blood and urine samples may be collected to test for the presence of the suspected overdose drug, and any other drugs or alcohol that might be present.

KEY TERMS

Gastric lavage—Also called a stomach pump. For this procedure, a flexible tube is inserted through the nose, down the throat, and into the stomach and the contents of the stomach are suctioned out. The inside of the stomach is rinsed with a saline (salt water) solution.

Intubation—A procedure where a tube is inserted through the mouth and into the trachea keep the airway open and to help the patient breathe.

- Elimination of the drug that has not yet been absorbed is attempted. Vomiting may be induced using ipecac syrup or other drugs that cause vomiting. Ipecac syrup should not be given to patients who overdosed with tricyclic antidepressants, theophylline, or any drug that causes a significant change in mental status. If a patient vomits while unconscious, there is a serious risk of **choking**.
- Gastric lavage, or washing out the stomach, may be attempted. For this procedure a tube flexible tube is inserted through the nose, down the throat, and into the stomach. The contents of the stomach are then suctioned out through the tube. A solution of saline (salt water) is injected into the tube to rinse out the stomach. This solution is then suctioned out. This is the process used when someone has his/her stomach pumped.
- Activated charcoal is sometimes given to absorb the drug.
- Medication to stimulate urination or defecation may be given to try to flush the excess drug out of the body faster.
- Intravenous (IV) fluids may be given. An intravenous line, a needle inserted into a vein, may be put into the arm or back of the hand. Fluids, either sterile saline (salt water solution) or dextrose (sugar water solution), can be administered through this line. Increasing fluids can help to flush the drug out of the system and to reestablish balance of fluids and **minerals** in the body. The pH (acid/base balance) of the body may need to be corrected by administering electrolytes like sodium, potassium, and bicarbonate through this IV line. If drugs need to be administered quickly, they can also be injected directly into the IV line.
- Hemodialysis is a procedure where blood is circulated out of the body, pumped through a dialysis machine, then reintroduced back into the body. This process can be used to filter some drugs out of the blood. It may also be used temporarily or long term if the kidneys are damaged due to the overdose.
- Antidotes are available for some drug overdoses. An antidote is another drug that counteracts or blocks the overdose drug. For example, acetaminophen overdose can be treated with an oral medication, N-acetylcysteine (Mucomyst), if the level of acetaminophen found in the blood is extremely high. Naloxone is an anti-narcotic drug that is given to counteract narcotic poisoning. Nalmefen or **methadone** may also be used.
- Psychiatric evaluation may be recommended if the drug overdose was taken deliberately.

Prognosis

While many victims of drug overdose recover without long term effects, there can be serious consequences. Some drug overdoses cause the failure of major organs like the kidneys or liver, or failure of whole systems like the respiratory or circulatory systems. Patients who survive drug overdose may need **kidney dialysis**, kidney or liver transplant, or ongoing care as a result of heart failure, stroke, or coma. Death can occur in almost any drug overdose situation, particularly if treatment is not started immediately.

Prevention

To protect children from accidental drug overdose, all medications should be stored in containers with child resistant caps. All drugs should be out of sight and out of reach of children, preferably in a locked cabinet. Prescription medications should be used according to directions and only by the person whose name is on the label. Threats of suicide need to be taken seriously and appropriate help sought for people with depression or other mental illness that may lead to suicide.

Resources

BOOKS

Clinical Manual of Poisoning and Drug Overdose. Paramus: Appleton-Century-Crofts and Fleschner Publishing Co., 1994.

Deglin, Judith Hopfer, and April Hazard Vallerand. *Davis's Drug Guide for Nurses.* 5th ed. Philadelphia: F. A. Davis Co., 1996.

Ellerhorn, Matthew J. *Ellerhorn's Medical Toxicology: Diagnosis and Treatment of Human Poisoning.* 2nd ed. Baltimore: Williams & Wilkins, 1996.

Haddad, Lester M. *Clinical Management of Poisoning and Drug Overdose.* 3rd ed. Philadelphia: W. B. Saunders Co., 1998.

"Poisoning." In *The Merck Manual.* 16th ed. Rahway: Merck, 1992.

PERIODICALS

"Recognition and Treatment of Serious Antipsychotic Drug Overdose." *Drugs & Therapy Perspectives* 11 (1998): 13-16.

OTHER

"Drug Overdose." *American Institute of Preventative Medicine.* <http://www.healthy.net>.

Graber, Mark A., and Rhea Allen."Emergency Medicine: Overdose and Toxindromes." *University of Iowa Family Practice Handbook*. <http://www.vh.org/Providers/ClinRef/FPHandbook/Chapter01/20-1.html>.

Altha Roberts Edgren

Drug therapy monitoring

Definition

Drug therapy monitoring, also known as Therapeutic Drug Monitoring (TDM), is a means of monitoring drug levels in the blood.

Purpose

TDM is employed to measure blood drug levels so that the most effective dosage can be determined, with toxicity prevented. TDM is also utilized to identify noncompliant patients (those patients who, for whatever reason, either cannot or will not comply with drug dosages as prescribed by the physician).

Precautions

Because so many different factors influence blood drug levels, the following points should be taken into consideration during TDM: the age and weight of the patient; the route of administration of the drug; the drug's absorption rate, excretion rate, delivery rate, and dosage; other medications the patient is taking; other diseases the patient has; the patient's compliance regarding the drug treatment regimen; and the laboratory methods used to test for the drug.

Description

TDM is a practical tool that can help the physician provide effective and safe drug therapy in patients who need medication. Monitoring can be used to confirm a blood drug concentration level that is above or below the therapeutic range, or if the desired therapeutic effect of the drug is not as expected. If this is the case, and dosages beyond normal then have to be prescribed, TDM can minimize the time that elapses.

TDM is important for patients who have other diseases that can affect drug levels, or who take other medicines that may affect drug levels by interacting with the drug being tested. As an example, without drug monitoring, the physician cannot be sure if a patient's lack of response to an antibiotic reflects bacterial resistance, or is the result of failure to reach the proper therapeutic range of antibiotic concentration in the blood. In cases of life-threatening infections, timing of effective antibiotic therapy is critical to success. It is equally crucial to avoid toxicity in a seriously ill patient. Therefore, if toxic symptoms appear with standard dosages, TDM can be used to determine changes in dosing.

Drawn blood, used for TDM, demonstrates a drug action in the body at any specific time, whereas drug levels examined from urine samples reflect the presence of a drug over many days (depending on the rate of excretion). Therefore, blood testing is the procedure of choice when definite data are required. However, for adequate absorption and therapeutic levels to be accurate, it is important to allow for sufficient time to pass between the administration of the medication and the collection of the blood sample.

Blood specimens for drug monitoring can be taken at two different times: during the drug's highest therapeutic concentration ("peak" level), or its lowest ("trough" level). Occasionally called residual levels, trough levels show sufficient therapeutic levels; whereas peak levels show **poisoning** (toxicity). Peak and trough levels should fall within the therapeutic range.

Preparation

In preparing for this test, the following guidelines should be observed:

- Depending on the drug to be tested, the physician should decide if the patient is to be **fasting** (nothing to eat or drink for a specified period of hours) before the test.
- For patients suspected of symptoms of drug toxicity, the best time to draw the blood specimen is when the symptoms are occurring.
- If there is a question as to whether an adequate dose of the drug is being achieved, it is best to obtain trough (lowest therapeutic concentration) levels.
- Peak (highest concentration) levels are usually obtained one to two hours after oral intake, approximately one hour after intramuscular (IM) administration (a shot in the muscle), and approximately 30 minutes after intravenous (IV) administration. Residual, or trough, levels are usually obtained within 15 minutes of the next scheduled dose.

Therapeutic Drug Monitoring: Therapeutic And Toxic Range

Drug Level*	Use	Therapeutic Level*	Toxic
Aceteminophen mg/ml	Analgesic, antipyretic	Depends on use	>250
Amikacin mg/ml	Antibiotic	12–25 mg/ml**	>25
Aminophylline ng/ml	Bronchodilator	10–20 mg/ml	>20
Amitriptyline ng/ml	Antidepressant	120–150 ng/ml	>500
Carbamazepine mg/ml	Anticonvulsant	5–12 mg/ml	>12
Chloramphenicol mg/ml	Antibiotic	10–20 mg/ml	>25
Digoxin ng/ml	Cardiotonic	0.8–2.0 ng/ml	>2.4
Gentamicin	Antibiotic	4–12 mg/L	>12 mg/L
Lidocaine	Antiarrhythmic	1.5–5.0 mg/ml	>5 mg/ml
Lithium mEq/L	Antimanic	0.7–2.0 mEq/L	>2.0
Nortriptyline ng/ml	Antidepressant	50–150 ng/ml	>500
Phenobarbital mg/ml	Anticonvulsant	10–30 mg/ml	>40
Phenytoin mg/ml	Anticonvulsant	7–20 mg/ml	>30
Procainamide mg/ml	Antiarrhythmic	4–8 mg/ml	>16
Propranolol ng/ml	Antiarrhythmic	50–100 ng/ml	>150
Quinidine mg/ml	Antiarrhytmic	1–4 mg/ml	>10
Theophylline mg/ml	Bronchodilator	10–20 mg/ml	>20
Tobramycin mg/ml	Antibiotic	4–12 mg/ml**	>12
Valproic acid mg/ml	Anticonvulsant	50–100 mg/ml	>100

* Values are laboratory-specific
**Concentration obtained 30 minutes after the end of a 30–minute infusion.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after blood is drawn, or accumulation of blood under the puncture site (hematoma).

Resources

BOOKS

Lane, Keryn A. G. *The Merck Manual of Medical Information*. Merck Research Laboratories, 1997.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Drugs used in labor

Definition

These drugs are used to induce (start) or continue labor.

Purpose

The drug decribed here, oxytocin, makes the uterus (womb) contract. Physicians use it to deliberately start labor. Because there are some risks with using oxytocin, this should be done only when there are good medical reasons. Any woman who is being given oxytocin should make sure she has discussed the benefits and risks with her physician.

Oxytocin also may be used to control bleeding after delivery or to help make the milk flow in women who are breastfeeding their babies.

Description

Oxytocin is a hormone and is available only with a physician's prescription. When used to start or continue labor, it is slowly injected into a vein. A nasal spray form is used to increase milk flow in breastfeeding. Some commonly used brand names are Pitocin and Syntocinon.

Recommended dosage

The dosages given here are average doses. However, doses may be different for different patients. Follow the orders of the physician who prescribed the drug.

For increasing milk production:

One spray into one or both nostrils, two to three minutes before nursing or using a breast pump.

For starting or continuing labor:

The physician in charge will determine the appropriate dose.

Precautions

Oxytocin does not help increase or continue labor in all patients. When it does not help, the physician may deliver the baby by **cesarean section**.

KEY TERMS

Cesarean section—The delivery of a baby through a surgical procedure.

Fetus—A developing baby inside the womb.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

In women who are especially sensitive to oxytocin, the drug may cause contractions to become too strong. This could tear the uterus or deprive the fetus of blood and oxygen during labor.

Oxytocin does not help improve milk flow in all women who are breastfeeding. Check with a physician if the drug does not seem to be working.

Women with heart disease, high blood pressure, or kidney disease should let their physicians know about these conditions before taking oxytocin. Also, anyone who has had an unusual reaction to oxytocin in the past should inform their physician.

Side effects

Oxytocin has caused irregular heartbeat and increased bleeding in some women after delivery. It may also cause **jaundice** (yellowing of the eyes and skin) in newborns.

Other side effects are rare, but may include nausea, vomiting, confusion, **dizziness**, convulsions, breathing problems, **headache**, **hives**, skin rash, **itching**, pelvic or abdominal **pain**, and weakness. The nasal spray form may cause watery eyes or irritation of the nose.

Interactions

Anyone who takes oxytocin should let the physician know all other medicines she is taking.

Nancy Ross-Flanigan

Dry mouth

Definition

Dry mouth, known medically as xerostomia, is the abnormal reduction of saliva due to medication, disease, or medical therapy.

Description

Dry mouth due to the lack of saliva can be a serious medical problem. Decreased salivation can make swallowing difficult, can decrease taste sensation, and can promote **tooth decay**.

Causes and symptoms

Dry mouth, resulting from thickened or reduced salvia flow, can be caused by a number of factors: medications, both prescription and over-the-counter; systemic diseases, such as anemia or diabetes, manifestations of **Sjögren's syndrome** (as **rheumatoid arthritis**, lupus, chronic hardening and thickening of the skin, or chronic and progressive inflammation of sketal muscles); infections of the salivary glands; blockage of the salivary ducts caused by stones or tumors forming in the ducts through which the saliva passes; **dehydration**; medical therapies, such as local surgery or radiation; secretion reduction normally involved in the **aging** proces; and emotional **stress**.

Diagnosis

The diagnosis of dry mouth is not difficult. The patient will state that his or her saliva is very thick or non-existent. Finding the cause of the dry mouth may be more difficult and require some laboratory testing. Salivary gland biopsy for stones or tumors should be performed if indicated.

Treatment

The treatment of dry mouth involves the management of the condition causing it. If dry mouth is caused by medication, the medication should be changed. If dry mouth is caused by blockage of the salivary ducts, the cause of the blockage should be investigated. When systemic diseases, such as diabetes and anemia, are brought under control dry mouth problems may decrease.

The use of caffeine-containing beverages, alcoholic beverages, and mouthwashes containing alcohol should be minimized. The drinking of water and fruit juices will decrease dry mouth problems. Chewing gum and lemon drops can be used to stimulate saliva flow. Bitters also can initiate salivary flow as long as the salivary glands and ducts are functional. Commercial saliva substitutes are available without prescription and can be used as frequently as needed. Use of a humidifier in the bedroom reduces nighttime oral dryness.

Prognosis

The prognosis for patients with xerostomia due to medication problems is good, if the offending agent can

KEY TERMS

Salivary duct—Tube through which saliva is carried from the salivary gland to the mouth.

Salivary gland—Gland in which saliva forms.

be changed. Dry mouth due to systemic problems may be eliminated or improved once the disease causing the dry mouth is under control. Persistent xerostomia can be managed well with saliva substitutes.

Prevention

A patient needs to ask his or her health care provider if any medication to be prescribed will cause dry mouth. Patients with persistent xerostomia need to practice good **oral hygiene** and visit a dentist on a regular basis; the lack of adequate saliva can cause severe dental decay. The salivary glands are very sensitive to radiation, so any patient scheduled for **radiation therapy** of the head and neck needs to discuss with the radiation therapist ways to minimize exposure of the salivary glands to radiation.

Resources

BOOKS

Conn's Current Therapy, 1996. Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Essential Otolaryngology. 6th ed. Ed. K. Lee. Norwalk, CT: Appleton & Lange.

ORGANIZATIONS

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Joseph Knight, PA

Dry skin *see* **Ichthyosis**

Dual energy x-ray absorptiometry (DXA) scan *see* **Bone density test**

DUB *see* **Dysfunctional uterine bleeding**

Duchenne muscular dystrophy *see* **Muscular dystrophy**

Duodenal atresia *see* **Duodenal obstruction**

Duodenal obstruction

Definition

Duodenal obstruction is a failure of food to pass out of the stomach either from a complete or partial obstruction.

Description

The duodenum is the first part of the intestine, into which the stomach, the gall bladder, and the pancreas empty their contents. The pylorus connects the duodenum with the stomach and contains the valve that regulates stomach emptying. Obstruction usually occurs right at this outlet, so that the gall bladder and pancreas are unable to drain their secretions without hindrance.

Causes and symptoms

Obstruction of the duodenum occurs in adults and infants, each for a different set of reasons. In adults, the usual cause is a peptic ulcer of such antiquity that repeated cycles of injury and scarring have narrowed the passageway. Medical treatment of ulcers has progressed to the point where such obstinate ulcer disease is rarely seen any more. In infants, the conditions are congenital—either the channel is underdeveloped or the pylorus is overdeveloped. The first type is called duodenal hypoplasia and the second is termed hypertrophic **pyloric stenosis**. In rare cases, the channel may be missing altogether, a condition called duodenal atresia. To say that these anomalies are congenital is not to say their cause is understood. As with most **birth defects**, the specific cause is not known.

Food that cannot exit the stomach in the forward direction will return whence it came. Vomiting is the constant symptom of duodenal obstruction. It may be preceded by **indigestion** and nausea as the stomach attempts to squeeze its contents through an ever narrowing outlet.

Hypertrophic pyloric stenosis appears soon after birth. The infant will vomit feedings, lose weight, and be restless and irritable.

Diagnosis

X rays taken with contrast material in the stomach readily demonstrate the site of the blockage and often the ulcer that caused it. Gastroscopy is another way to evaluate the problem. In infants, x rays may not be necessary to detect pyloric stenosis. It is often possible to feel the enlarged pylorus, like an olive, deep under the ribs and see the stomach rippling as it labors to force food through.

Treatment

Bowel obstruction requires a surgeon, sometimes immediately. Newer surgical techniques constantly improve the outcome, but obstruction is a mechanical problem that needs a mechanical solution. Most adults who come to surgery for obstruction have suffered for years from peptic ulcer disease. They will usually benefit from **ulcer surgery** at the same time their obstruction is relieved. The surgeon will therefore select a procedure that combines relief of obstruction with remedy for ulcer disease. There are many choices. In fact, even without obstruction, functional considerations require ulcer surgery to include enhancement of stomach emptying.

To treat an infant with hypertrophic pyloric stenosis, some surgeons have had success with forceful balloon dilation of the pylorus done through a gastroscope, but the standard procedure is to cut across the overdeveloped circular muscle that is constricting the stomach outlet. There are reports of infant hypertrophic pyloric stenosis remitting without surgery following a very careful feeding schedule, but mortality is unacceptably high.

Prognosis

A functioning and unrestricted intestine is a prerequisite for living independent of the most advanced and continuous medical care available. Achieving this desirable goal is the rule with surgery for duodenal obstructions of all types. The bowel is so malleable that there is a rearrangement to suit every occasion. The variety of possible configurations is limited only by the surgeon's imagination.

Prevention

Prompt and effective treatment of peptic ulcers will prevent chronic scarring and narrowing. Drugs developed over the past few decades have all but eliminated the need for ulcer surgery.

Resources

BOOKS

Barker, L. Randol, ed., et al. *Principles of Ambulatory Medicine*. Baltimore: Williams & Wilkins, 1995.

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Hay, William W., ed., et al. *Current Pediatric Diagnosis and Treatment*. Stamford: Appleton & Lange, 1997.

McGuigan, James E. "Peptic Ulcer and Gastritis. In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

McQuaid, Kenneth R. "Alimentary Tract." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

KEY TERMS

Atresia—Failure to develop; complete absence.

Contrast agent—A substance that produces shadows on an x ray so that hollow structures can be more easily seen.

Gastroscopy—Looking into the stomach with a flexible viewing instrument called a gastroscope.

Hypoplasia—Incomplete development.

Peptic ulcer—A wound in the lower stomach and duodenum caused by stomach acid and a newly discovered germ called *Helicobacter pylori*.

"Pyloric Stenosis and Other Congenital Abnormalities of the Stomach." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Redel, Carol A., and R. Jeff Zeiwner. "Anatomy and Anomalies of the Stomach and Duodenum." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Wyllie, Robert. "Intestinal Atresia, Stenosis and Malrotation." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Duodenal stenosis *see* **Duodenal obstruction**

Duodenal ulcers *see* **Ulcers (digestive)**

Duodenum x rays *see* **Hypotonic duodenography**

Duplicated ureter *see* **Congenital ureter anomalies**

Dwarfism *see* **Achondroplasia; Pituitary dwarfism**

Dysfunctional uterine bleeding

Definition

Dysfunctional uterine bleeding is irregular, abnormal uterine bleeding that is not caused by a tumor, infection, or **pregnancy**.

Description

Dysfunctional uterine bleeding (DUB) is a disorder that occurs most frequently in women at the beginning and end of their reproductive lives. About half the cases occur in women over 45 years of age, and about one fifth occur in women under age 20.

Dysfunctional uterine bleeding is diagnosed when other causes of uterine bleeding have been eliminated. Failure of the ovary to release an egg during the menstrual cycle occurs in about 70% of women with DUB. This is probably related to a hormonal imbalance.

DUB is common in women who have **polycystic ovary syndrome** (cysts on the ovaries). Women who are on dialysis may also have heavy or prolonged periods. So do some women who use an intrauterine device (**IUD**) for birth control.

DUB is similar to several other types of uterine bleeding disorders and sometimes overlaps these conditions.

Menorrhagia

Menorrhagia, sometimes called hypermenorrhea, is another term for abnormally long, heavy periods. This type of period can be a symptom of DUB, or many other diseases or disorders. In menorrhagia, menstrual periods occur regularly, but last more than seven days, and blood loss exceeds 3 oz (88.7 ml). Passing blood clots is common. Between 15–20% of healthy women experience debilitating menorrhagia that interferes with their normal activities. Menorrhagia may or may not signify a serious underlying problem.

Metrorrhagia

Metrorrhagia is bleeding between menstrual periods. Bleeding is heavy and irregular as opposed to ovulatory spotting which is light bleeding, in mid-cycle, at the time of ovulation.

Polymenorrhea

Polymenorrhea describes the condition of having too frequent periods. Periods occur more often than every 21 days, and ovulation usually does not occur during the cycle.

Causes and symptoms

Dysfunctional uterine bleeding often occurs when the endometrium, or lining of the uterus, is stimulated to grow by the hormone estrogen. When exposure to estrogen is extended, or not balanced by the presence of progesterone, the endometrium continues to grow until it outgrows its blood supply. Then it sloughs off, causing irregular bleeding. If the bleeding is heavy enough and frequent enough, anemia can result.

Menorrhagia is representative of DUB. It is caused by many conditions including some outside the reproductive system. Causes of menorrhagia include:

- adenomyosis (a benign condition characterized by growths in the area of the uterus)
- imbalance between the hormones estrogen and progesterone
- fibroid tumors
- pelvic infection
- **endometrial cancer** (**cancer** of the inner mucous membrane of the uterus)
- endometrial polyps
- **endometriosis** (a condition in which endometrial or endrometrial-like tissue appears outside of its normal place in the uterus)
- use of an intrauterine device (IUD) for **contraception**
- hypothyroidism
- blood clotting problems (rare)
- lupus erythematosus
- pelvic inflammatory disease
- steroid therapy
- advanced liver disease
- renal (kidney) disease
- chemotherapy (cancer treatment with chemicals)

To diagnose dysfunctional uterine bleeding, many of the potential causes mentioned above must be eliminated. When all potential causes connected with pregnancy, infection, and tumors (benign or malignant) are eliminated, then menorrhagia is presumed to be caused by dysfunctional uterine bleeding.

Diagnosis

Diagnosis of any menstrual irregularity begins with the patient herself. The doctor will ask for a detailed description of the problem, and take a history of how long it has existed, and any patterns the patient has observed. A woman can assist the doctor in diagnosing the cause of abnormal uterine bleeding by keeping a record of the time, frequency, length, and quantity of bleeding. She should also tell the doctor about any illnesses, including long-standing conditions, like **diabetes mellitus**. The doctor will also inquire about sexual activity, use of contraceptives, current medications, and past surgical procedures.

Laboratory tests

After taking the woman's history, the gynecologist or family practitioner does a pelvic examination and Pap smear. To rule out specific causes of abnormal bleeding, the doctor may also do a pregnancy test and blood tests to check the level of thyroid hormone. Based on the initial test results, the doctor may want to do tests to determine the level of other hormones that play a role in reproduction. A test of blood clotting time and an adrenal function test are also commonly done.

Imaging

Imaging tests are important diagnostic tools for evaluating abnormal uterine bleeding. Ultrasound examination of the pelvic and abdominal area is used to help locate **uterine fibroids**, also called uterine leiomyoma, a type of tumor. Visual examination through hysterscopy—where a camera inside a thin tube is inserted directly into the uterus so that the doctor can see the uterine lining—is also used to assess the condition of the uterus.

Hystersalpingography can help outline endometrial polyps and fibroids and help detect endometrial cancer. In this procedure an x ray is taken after contrast media has been injected into the cervix. **Magnetic resonance imaging** (MRI) of the pelvic region can also be used to locate fibroids and tumors.

Invasive procedures

Endometrial biopsy (the removal and examination of endometrial tissue) is the most important testing procedure. It allows the doctor to sample small areas of the uterine lining, while cervical biopsy allows the cervix to be sampled. Tissues are then examined for any abnormalities.

Dilation and curettage (D & C), once common is rarely done today for diagnosis of DUB. It is done while the patient is under either general or regional anesthesia. Women over 30 are more likely to need a D & C, as part of the diagnostic procedure, than younger women.

Because DUB is diagnosed by eliminating other possible disorders, diagnosis can take a long time and involve many tests and procedures. Older women are likely to need more extensive tests than adolescents because the likelihood of reproductive cancers is greater in this age group, and therefore must be definitively eliminated before treating bleeding symptoms.

Treatment

Treatment of DUB depends on the cause of the bleeding and the age of the patient. When the underlying cause of the disorder is known, that disorder is treated.

KEY TERMS

Dilation and curettage (D & C)—A procedure performed under anesthesia during which the cervix is dilated, and tissue lining the uterus is scraped out with a metal spoon-shaped instrument or a suction tube. The procedure can be either diagnostic, or to remove polyps.

Endometrial biopsy—The removal of tissue either by suction or scraping of samples of tissue from the uterus. The cervix is not dilated. The procedure has a lower rate of diagnostic accuracy than a D & C, but can be done as an office procedure under local anesthesia.

Endometrial cancer—Cancer of the inner mucous membrane of the uterus.

Fibroids, or fibroid tumors—Fibroid tumors are non-cancerous (benign) growths in the uterus. They occur in 30–40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Hypothyroidism—A disorder in which the thyroid gland produces too little thyroid hormone causing a decrease in the rate of metabolism with associated effects on the reproductive system.

Lupus erythematosus—A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

Progesterone—A hormone naturally secreted by the ovary, or manufactured synthetically, that prepares the uterus for implantation of a fertilized egg.

Prostaglandins—A group of chemicals that mediate, or determine the actions of other chemicals in the cell or body.

Otherwise the goal of treatment is to relieve the symptoms to a degree that uterine bleeding does not interfere with a woman's normal activities or cause anemia.

Generally the first approach to controlling DUB is to use **oral contraceptives** that provide a balance between the hormones estrogen and progesterone. Oral contraceptives are often very effective in adolescents and young women in their twenties. NSAIDs (**nonsteroidal anti-inflammatory drugs**), like Naprosyn and Motrin, are also used to treat DUB.

When bleeding cannot be controlled by hormone treatment, surgery may be necessary. Dilation and curettage sometimes relieves the symptoms of DUB. If that fails, endometrial ablation removes the uterine lining, but preserves a woman's uterus. This procedure is sometimes be used instead of **hysterectomy**. However, as it affects the uterus, it can only be used when a woman has completed her childbearing years. The prescription of iron is also important to decrease the risk of enemia.

Until the 1980s, hysterectomy often was used to treat heavy uterine bleeding. Today hysterectomy is used less frequently to treat DUB, and then only after other methods of controlling the symptoms have failed. A hysterectomy leaves a woman unable to bear children, and, therefore, is limited largely to women who are unable to, or uninterested in, bearing children. Still, hysterectomy is a common treatment for long-standing DUB in women done with childbearing.

Alternative treatment

Alternative practitioners concentrate on good **nutrition** as a way to prevent heavy periods that are not caused by uterine fibroids, endometrial polyps, endometriosis, or cancer. Iron supplementation (100 mg per day) not only helps prevent anemia, but also appears to reduce menorrhagia in many women. Other recommended dietary supplements include **vitamins** A and C. Vitamin C improves capillary fragility and enhances iron uptake.

Vitamin E and bioflavonoid supplements are also recommended. Vitamin E can help reduce blood flow, and bioflavonoids help strengthen the capillaries. Vitamin K is known to play a role in clotting and is helpful in situations where heavy bleeding may be due to clotting abnormalities

Botanical medicines used to assist in treating abnormal bleeding include spotted cranesbill (*Geranium maculatum*), birthroot (*Trillium pendulum*), blue cohosh (*Caulophyllum thalictroides*), witch hazel (*Hamamelis virginiana*), shepherd's purse (*Capsella bursa-pastoris*), and yarrow (*Achillea millifolia*). These are all stiptic herbs that act to tighten blood vessels and tissue. Hormonal balance can also be addressed with herbal formulations containing phytoestrogens and phytoprogesterone.

Prognosis

Response to treatment for DUB is highly individual and is not easy to predict. The outcome depends largely on the woman's medical condition and her age. Many women, especially adolescents, are successfully treated with hormones (usually oral contraceptives). As a last resort, hysterectomy removes the source of the problem by removing the uterus, but this operation is not without risk, or the possibility of complications.

Prevention

Dysfunctional uterine bleeding is not a preventable disorder.

Resources

BOOKS

DeCherney, Alan H., and Martin L. Peroll. "Complications of Menstruation." In *Current Obstetric and Gynecologic Diagnosis and Treatment*. 8th ed. Norwalk, CT: Appleton & Lange, 1994.

Murray, Michael T., and Joseph E. Pizzorno. "Heavy Periods." In *An Encyclopedia of Natural Medicine*. Rocklin, CA: Prima Publishing, 1991.

OTHER

"Menorrhagia." *The wellness web* <http://wellweb.com/INDEX/MENORRHAGIA.htm>.

Tish Davidson

Dyslexia

Definition

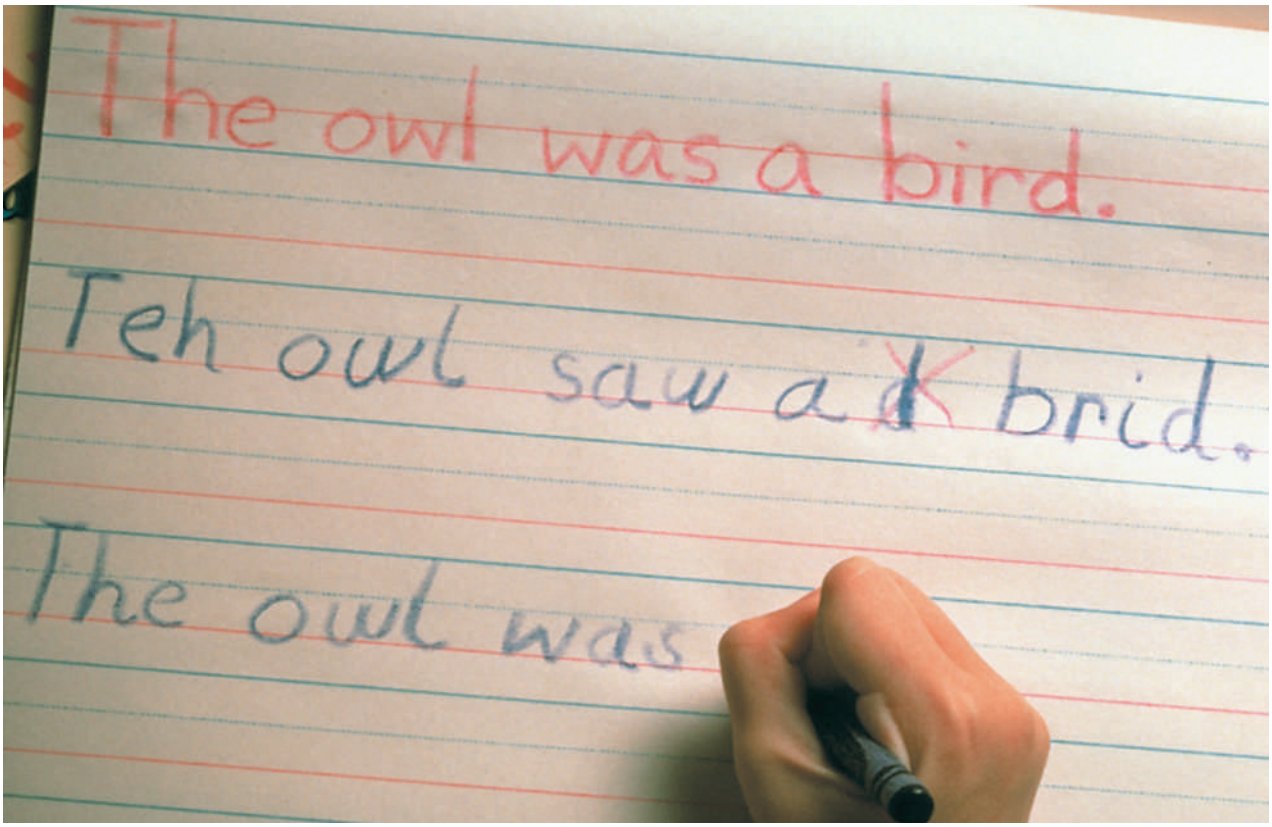
Dyslexia is a learning disability characterized by problems in reading, spelling, writing, speaking, or listening. In many cases, dyslexia appears to be inherited.

Description

The word dyslexia is derived from the Greek word, *dys* (meaning poor or inadequate) and the word *lexis* (meaning words or language).

The National Institutes of Health estimates that about 15% of the United States population is affected by learning disabilities, mostly with problems in language and reading. The condition appears in all ages, races, and income levels. Dyslexia is not a disease, but describes rather a different kind of mind that learns in a different way from other people. Many people with the condition are gifted and very productive; dyslexia is not at all linked to low intelligence. In fact, intelligence has nothing to do with dyslexia.

Dyslexic children seem to have trouble learning early reading skills, problems hearing individual sounds in words, analyzing whole words in parts, and blending sounds into words. Letters such as "d" and "b" may be confused.



A student with dyslexia has difficulty copying words. *(Photograph by Will & Deni McIntyre, Photo Researchers, Inc. Reproduced by permission.)*

When a person is dyslexic, there is often an unexpected difference between achievement and aptitude. However, each person with dyslexia has different strengths and weaknesses, although many have unusual talents in art, athletics, architecture, graphics, drama, music, or engineering. These special talents are often in areas that require the ability to integrate sight, spatial skills, and coordination.

Often, a person with dyslexia has a problem translating language into thought (such as in listening or reading), or translating thought into language (such as in writing or speaking).

Common characteristics include problems with:

- identifying single words
- understanding sounds in words, sound order, or rhymes
- spelling
- transposing letters in words
- handwriting
- reading comprehension
- delayed spoken language
- confusion with directions, or right/left handedness
- confusion with opposites (up/down, early/late, and so on)
- mathematics

Causes and symptoms

The underlying cause of dyslexia is not known, although research suggests the condition is often inherited. In 1999, The Centre for Reading Research in Norway presented the first research to study the largest family with reading problems ever known. By studying the reading and writing abilities of close to 80 family members across four generations the researchers reported, for the first time, that chromosome 2 can be involved in the inheritability of dyslexia. When a fault occurs on this gene it leads to difficulties in processing written language. Previous studies have pointed out linkages of other potential dyslexia genes to chromosome 1, chromosome 15 (DYX1 gene), and to chromosome 6 (DYX2 gene). The researchers who pinpointed the newly localized gene on chromosome 2 (DYX3) hope that this finding will lead to earlier and more precise diagnoses of dyslexia.

New research suggests a possible link with a subtle visual problem that affects the speed with which affected

KEY TERMS

Spatial skills—The ability to locate objects in three dimensional world using sight or touch.

people can read. Other experts believe that dyslexia is related to differences in the structure and function of the brain that manifests differently in different people.

Diagnosis

Anyone who is suspected to have dyslexia should have a comprehensive evaluation, including hearing, vision, and intelligence testing. The test should include all areas of learning and learning processes, not just reading.

As further research pinpoints the genes responsible for some cases of dyslexia, there is a possibility that earlier testing will be established to allow for timely interventions to prevent the onset of the condition and to treat it when it does occur.

Unfortunately, in many schools, a child is not identified as having dyslexia until after repeated failures.

Treatment

If a child is diagnosed with dyslexia, the parents should find out from the school or the diagnostician exactly what the problem is, and what method of teaching is recommended and why. No single method will work with every child, and experts often disagree as to the best method to use.

The primary focus of treatment is aimed at helping the specific learning problem of each affected person. Most often, this may include modifying teaching methods and the educational environment, since traditional educational methods will not always work with a dyslexic child.

People with dyslexia need a structured language program, with direct instruction in the letter-sound system. Teachers must give the rules governing written language. Most experts agree that the teacher should emphasize the association between simple phonetic units with letters or letter groups, rather than an approach that stresses memorizing whole words.

It is important to teach these students using all the senses: hearing, touching, writing, and speaking, provided by an instructor who is specifically trained in a program that is effective for dyslexic students.

Prognosis

Many successful and even famous people have dyslexia. How well a person with dyslexia functions in life depends on the way the disability affects that person. There is a great deal of variation among different people with dyslexia, producing different symptoms and different degrees of severity.

Prognosis is usually good if the condition is diagnosed early, and if the person has a strong self image with supportive family, friends, and teachers. It is imperative for a good outcome that the person be involved in a good remedial program.

Resources

BOOKS

Davis, Ronald D., and Eldon M. Braun. *The Gift of Dyslexia: Why Some of the Smartest People Can't Read and How They Can Learn*. New York: Perigee, 1997.

Guyer, Barbara P., and Sally E. Shaywitz. *The Pretenders: Gifted People Who Have Difficulty Learning*. Homewood: High Tide Press, 1997.

PERIODICALS

American Academy of Pediatrics, et al. "Learning Disabilities, Dyslexia and Vision." *Pediatrics* 90 no.1 (1992): 124-126.

Rumsey, J. M. "The Biology of Developmental Dyslexia." *Journal of the American Medical Association* 268 no.7 (Aug. 19, 1992): 912-915.

Fagerheim, Toril, et al. "A New Gene (DYX3) for Dyslexia is Located on Chromosome 2." *Journal of Medical Genetics* 36: (Sept. 1999): 664-669.

ORGANIZATION

International Dyslexia Association (formerly the Orton Dyslexia Society). 8600 LaSalle Rd., Chester Bldg., Ste. 382, Baltimore, MD 21286. (800) ABC-D123.

Learning Disabilities Association. 4156 Library Rd., Pittsburgh, PA 15234. (412) 341-1515.

Beth Kapes

Dyslipidemia *see* **Hyperlipoproteinemia**

Dysmenorrhea

Definition

Dysmenorrhea is the occurrance of painful cramps during menstruation.

Description

More than half of all girls and women suffer from dysmenorrhea (cramps), a dull or throbbing **pain** that

usually centers in the lower mid-abdomen, radiating toward the lower back or thighs. Menstruating women of any age can experience cramps.

While the pain may be only mild for some women, others experience severe discomfort that can significantly interfere with everyday activities for several days each month.

Causes and symptoms

Dysmenorrhea is called "primary" when there is no specific abnormality, and "secondary" when the pain is caused by an underlying gynecological problem. It is believed that primary dysmenorrhea occurs when hormone-like substances called "prostaglandins" produced by uterine tissue trigger strong muscle contractions in the uterus during menstruation. However, the level of prostaglandins doesn't seem to have anything to do with how strong a woman's cramps are. Some women have high levels of prostaglandins and no cramps, whereas other women with low levels have severe cramps. This is why experts assume that cramps must also be related to other things (such as genetics, **stress**, and different body types) in addition to prostaglandins. The first year or two of a girl's periods are not usually very painful. However, once ovulation begins, the blood levels of the prostaglandins rise, leading to stronger contractions.

Secondary dysmenorrhea may be caused by **endometriosis**, fibroid tumors, or an infection in the pelvis.

The likelihood that a woman will have cramps increases if she:

- has a family history of painful periods
- leads a stressful life
- doesn't get enough **exercise**
- uses **caffeine**
- has pelvic inflammatory disease

Symptoms include a dull, throbbing cramping in the lower abdomen that may radiate to the lower back and thighs. In addition, some women may experience **nausea and vomiting**, **diarrhea**, irritability, sweating, or **dizziness**. Cramps usually last for two or three days at the beginning of each menstrual period. Many women often notice their painful periods disappear after they have their first child, probably due to the stretching of the opening of the uterus or because the birth improves the uterine blood supply and muscle activity.

Diagnosis

A doctor should perform a thorough **pelvic exam** and take a patient history to rule out an underlying condition that could cause cramps.

KEY TERMS

Endometriosis—The growth of uterine tissue outside the uterus.

Hormone—A chemical messenger secreted by a gland and released into the blood, which allows it to travel to distant cells where it exerts an effect.

Ovary—One of the two almond-shaped glands in the female body that produces the hormones estrogen and progesterone.

Ovulation—The monthly release of an egg from an ovary.

Progesterone—The hormone produced by the ovary after ovulation that prepares the uterine lining for a fertilized egg.

Uterus—The female reproductive organ that contains and nourishes a fetus from implantation until birth.

Treatment

Secondary dysmenorrhea is controlled by treating the underlying disorder.

Several drugs can lessen or completely eliminate the pain of primary dysmenorrhea. The most popular choice are the **nonsteroidal anti-inflammatory drugs** (NSAIDs), which prevent or decrease the formation of prostaglandins. These include **aspirin**, ibuprofen (Advil), and naproxen (Aleve). For more severe pain, prescription strength ibuprofen (Motrin) is available. These drugs are usually begun at the first sign of the period and taken for a day or two. There are many different types of NSAIDs, and women may find that one works better for them than the others.

If an NSAID is not available, **acetaminophen** (Tylenol) may also help ease the pain. Heat applied to the painful area may bring relief, and a warm bath twice a day also may help. While birth control pills will ease the pain of dysmenorrhea because they lead to lower hormone levels, they are not usually prescribed just for **pain management** unless the woman also wants to use them as a birth control method. This is because these pills may carry other more significant side effects and risks.

New studies of a drug patch containing glyceryl trinitrate to treat dysmenorrhea suggest that it also may help ease pain. This drug has been used in the past to ease preterm contractions in pregnant women.

Alternative treatment

Simply changing the position of the body can help ease cramps. The simplest technique is assuming the fetal position, with knees pulled up to the chest while hugging a heating pad or pillow to the abdomen. Likewise, several **yoga** positions are popular ways to ease menstrual pain. In the "cat stretch," position, the woman rests on her hands and knees, slowly arching the back. The pelvic tilt is another popular yoga position, in which the woman lies with knees bent, and then lifts the pelvis and buttocks.

Dietary recommendations to ease cramps include increasing fiber, calcium, and complex carbohydrates, cutting fat, red meat, dairy products, caffeine, salt, and sugar. **Smoking** also has been found to worsen cramps. Recent research suggests that vitamin B supplements, primarily vitamin B_6 in a complex, magnesium, and fish oil supplements (omega-3 fatty acids) also may help relieve cramps.

Other women find relief through visualization, concentrating on the pain as a particular color and gaining control of the sensations. **Aromatherapy** and massage may ease pain for some women. Others find that imagining a white light hovering over the painful area can actually lessen the pain for brief periods.

Exercise may be a way to reduce the pain of menstrual cramps through the brain's production of endorphins, the body's own painkillers. And orgasm can make a woman feel more comfortable by releasing tension in the pelvic muscles.

Acupuncture and Chinese herbs are another popular alternative treatments for cramps.

Prognosis

Medication should lessen or eliminate pain.

Prevention

NSAIDs taken a day before the period begins should eliminate cramps for some women.

Resources

BOOKS

Carlson, Karen J., Stephanie Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

PERIODICALS

Hale, Ellen. "Taming Menstrual Cramps." *FDA Consumer* 25, no. 5 (June 1991): 26-29.

Harel, Z., et al. "Supplementation with Omega-3 Polyunsaturated Fatty Acids in the Management of Dysmenorrhea in Adolescents." *American Journal of Obstetrics and Gynecology* 174 (Apr. 1996): 335-8.

McDonald, Claire, and Susan McDonald. "A Woman's Guide to Self-care." *Natural Health* (Jan. Feb. 1998): 121-142.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., PO Box 96920

Federation of Feminist Women's Health Centers.1469 Humboldt Rd, Suite 200, Chico, CA 96928. (530) 891-1911.

National Women's Health Network. 514 10th St. NW, Suite 400, Washington, DC 20004. (202) 628-7814. <http://www.womenshealthnetwork.org>.

Carol A. Turkington

Dysmetria *see* **Movement disorders**

Dyspepsia

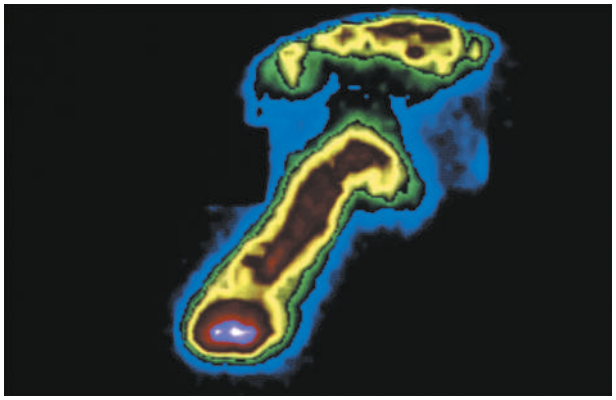
Definition

Dyspepsia can be defined as painful, difficult, or disturbed digestion, which may be accompanied by symptoms such as **nausea and vomiting**, **heartburn**, bloating, and stomach discomfort.

Causes and symptoms

The digestive problems may have an identifiable cause, such as bacterial or viral infection, peptic ulcer, gallbladder, or liver disease. The bacteria *Helicobacter pylori* is often found in those individuals suffering from duodenal or gastric ulcers. Investigation of recurrent **indigestion** should rule out these possible causes.

Often, there is no organic cause for the problem, in which case dyspepsia is classified as functional or nonulcer dyspepsia. There is evidence that functional dyspepsia may be related to abnormal motility of the upper gastrointestinal tract (a state known as dysmotility in which the esophagus, stomach, and upper intestine behave abnormally). These patients may respond to a group of drugs called prokinate agents. A review of eating habits (e.g. chewing with the mouth open, gulping food, or talking while chewing) may reveal a tendency to swallow air. This may contribute to feeling bloated, or to excessive belching. **Smoking**, **caffeine**, alcohol, or carbonated beverages may contribute to the discomfort. When there is sensitivity or allergy to certain food substances, eating those foods may cause gastrointestinal distress. Some medications are associated with indigestion. Stomach problems may also be a response to **stress** or emotional unrest.



A false-color gamma scan of a human stomach with dyspepsia, or indigestion, during tests to study its rate of emptying. *(Photograph by Jean-Perrin, Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Anemia—Diagnosed through laboratory study of the blood, a deficiency in hemoglobin or red blood cells, often associated with paleness or loss of energy.

Endoscopy—A diagnostic procedure using a lighted instrument to examine a body cavity or internal organ. Endoscopy permits collection of tissue and culture specimens.

Diagnosis

A **physical examination** by a health care professional may reveal mid-abdominal **pain**. A **rectal examination** may be done to rule out bleeding. If blood is found on rectal exam, laboratory studies, including a **blood count** may be ordered. Endoscopy and barium studies may be used to rule out underlying gastrointestinal disease. Upper gastrointestinal x-ray studies using barium may allow for visualization of abnormalities. Endoscopy permits collection of tissue and culture specimens which may be used to further confirm a diagnosis.

Treatment

The treatment of dyspepsia is based on assessment of symptoms and suspected causative factors. Clinical evaluation is aimed at distinguishing those patients who require immediate diagnostic work-ups from those who can safely benefit from more conservative initial treatment. Some of the latter may require only reassurance, dietary modifications, or antacid use. Medications to block production of stomach acids, prokinate agents, or antibiotic treatment may be considered. Further diagnostic investigation is indicated if there is severe abdominal pain, pain radiating to the back, unexplained weight loss, difficulty swallowing, a palpable mass, or anemia. Additional work-up is also indicated if a patient does not respond to prescribed medications.

Prognosis

Statistics show an average of 20% of patients with dyspepsia have duodenalor gastric ulcer disease, 20% have **irritable bowel syndrome**, fewer than 1% of patients had **cancer**, and the range for functional, or non-ulcer dyspepsia (**gastritis** or superficial erosions), was from 5–40%.

Resources

BOOKS

Suddarth, Doris. *The Lippincott Manual of Nursing Practice*. Philadelphia: J. B. Lippincott, 1991.

PERIODICALS

Goldfinger, S. E. "Sensitive Stomachs: Non-ulcer Dyspepsia." *Harvard Health Letter* (Jan. 1992): 4-5.

Talley, N. J. "Non-ulcer Dyspepsia: Current Approaches to Diagnosis and Management." *American Family Physician* (May 1993): 1407-1416.

OTHER

"Clinical Economics: Gastrointestinal Disease in Primary Care." 23 Apr. 1998 <http://www.avicenna.com>.

"Endoscopy for Dyspepsia." 4 Apr. 1998 <http://www.medmatrix.org>.

Graber, Mark A., and Rhea Allen. *University of Iowa Family Practice Handbook*. 23 Apr. 1998 <http:www.vh.org/providers/ClinRef/FPHandbook>.

Kathleen D. Wright, RN

Dysphasia *see* **Aphasia**

Dyspnea *see* **Shortness of breath**

Dysthymic disorder *see* **Depressive disorders**

Dystonia *see* **Movement disorders**

E

E. coli see ***Escherichia coli***

E. coli infection *see* **Enterobacterial infections**

E. coli O157:H7 infection ***see Escherichia coli***

Ear canal infection *see* **Otitis externa**

Ear exam with an otoscope

Definition

An otoscope is a hand-held instrument with a tiny light and a cone-shaped attachment called an ear speculum, which is used to examine the ear canal. An ear examination is a normal part of most physical examinations by a doctor or nurse. It is also done when an ear infection or other type of ear problem is suspected.

Purpose

An otoscope is used to look into the ear canal to see the ear drum. Redness or fluid in the eardrum can indicate an ear infection. Some otoscopes can deliver a small puff of air to the eardrum to see if the eardrum will vibrate (which is normal). This type of ear examination with an otoscope can also detect a build up of wax in the ear canal, or a rupture or puncture of the eardrum.

Precautions

No special precautions are required. However, if an ear infection is present, an ear examination may cause some discomfort or **pain**.

Description

An ear examination with an otoscope is usually done by a doctor or a nurse as part of a complete **physical examination**. The ears may also be examined if an ear infection is suspected due to **fever**, ear pain, or **hearing loss**. The patient will often be asked to tip the head slightly toward the shoulder so the ear to be examined is pointing up. The doctor or nurse may hold the ear lobe as the speculum is inserted into the ear, and may adjust the position of the otoscope to get a better view of the ear canal and eardrum. Both ears are usually examined, even if there seems to be a problem with just one ear.

Preparation

No special preparation is required prior to an ear examination with an otoscope. The ear speculum, which is inserted into the ear, is cleaned and sanitized before it is used. The speculums come in various sizes, and the doctor or nurse will select the size that will be most comfortable for the patient's ear.

Aftercare

If an ear infection is diagnosed, the patient may require treatment with **antibiotics**. If there is a buildup of wax in the ear canal, it might be rinsed or scraped out.

Risks

This type of ear examination is simple and generally harmless. Caution should always be used any time an object is inserted into the ear. This process could irritate an infected external ear canal and could rupture an eardrum if performed improperly or if the patient moves.

Normal results

The ear canal is normally skin-colored and is covered with tiny hairs. It is normal for the ear canal to have some yellowish-brown earwax. The eardrum is typically thin, shiny, and pearly-white to light gray in color. The tiny bones in the middle ear can be seen pushing on the

KEY TERMS

Ear speculum—A cone- or funnel-shaped attachment for an otoscope which is inserted into the ear canal to examine the eardrum.

Otoscope—A hand-held instrument with a tiny light and a funnel-shaped attachment called an ear speculum, which is used to examine the ear canal and eardrum.

eardrum membrane like tent poles. The light from the otoscope will reflect off of the surface of the ear drum.

Abnormal results

An ear infection will cause the eardrum to look red and swollen. In cases where the eardrum has ruptured, there may be fluid draining from the middle ear. A doctor may also see scarring, retraction of the eardrum, or bulging of the eardrum.

Resources

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Ear Foundation. 1817 Patterson St., Nashville, TN 37203. (800) 545-4327. <http://www.earfoundation.org>.

Hearing Health Information. 2100 W. 3rd St., Los Angeles, CA 90057. (213) 483-4431.

National Institute on Deafness and Other Communication Disorders. National Institutes of Health, 31 Center Drive, MSC 2320, Bethesda, MD USA 20892-2320. (800) 241-1044. <http://www.nidcd.nih.gov>.

OTHER

"Ear Test." *HealthAnswers.com.* <http://www.healthanswers.com>.

Altha Roberts Edgren

Ear surgery

Definition

Ear surgery is the treatment of diseases, injuries, or deformations of the ear by operation with instruments.

Purpose

Ear surgery is performed to correct certain types of **hearing loss**, and to treat diseases of, injuries to, or deformities of the ear's auditory tube, middle ear, inner ear, and auditory and vestibular systems. Ear surgery is commonly performed to treat conductive hearing loss, persistent ear infections, unhealed perforated eardrums, congenital ear defects, and tumors.

Ear surgery is performed on children and adults. In some cases, surgery is the only treatment; in others, it is used only when more conservative medical treatment fails.

Precautions

The precautions vary, depending on the type ofear surgery under consideration. For example, **stapedectomy** (removal of parts of the middle ear and insertion of prosthesis parts) should not be performed on people with external or middle ear infection or inner ear disease. For people with complete hearing loss in the other ear, it should be performed cautiously. Microsurgery for the removal of a cholesteatoma (a cyst-like mass of cells in the middle ear) should not be performed on patients who are extremely ill or have other medical conditions. Tympanoplasty (any surgical procedure on the eardrum or middle ear) should not be performed on patients with chronic sinus or nasal problems or in some patients with medical problems such as poorly controlled diabetes and heart disease. Surgery for congenital microtia and atresia (abscense of normal bodily openings, such as the outer ear canal) should not be performed if the middle ear space is totally or almost totally absent.

Description

Most ear surgery is microsurgery, performed with an operating microscope to enable the surgeon to view the very small structures of the ear. The use of minimally invasive **laser surgery** for middle ear procedures is growing. Laser surgery reduces the amount of trauma due to vibration, enhances coagulation, and enables surgeons to access hard to reach places in the middle ear. Laser surgery can be performed in an office operating suite. Types of ear surgery include stapedectomy, tympanoplasty, myringotomy and ear tube surgery, ear surgery to repair a **perforated eardrum**, **cochlear implants**, and **tumor removal**.

Stapedectomy

To restore hearing loss, which is usually due to **otosclerosis**, stapedectomy is performed. Stapedectomy is the removal of all or part of the stapes, one of the bones in the middle ear, and replacement with a tiny prosthesis. An incision is made in the middle ear, the small bones are identified, and the stapes is removed. The stainless steel wire and cellulose sponge prosthesis is inserted, blood

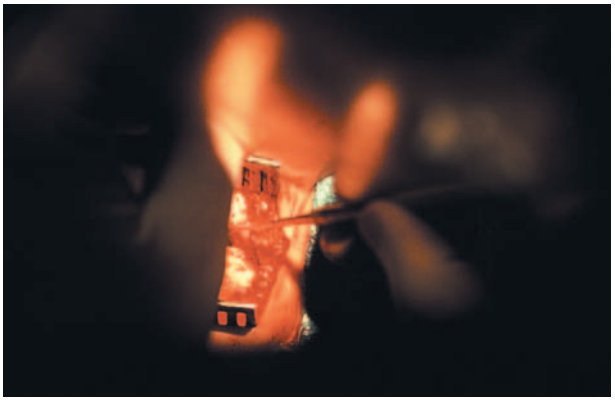
and fluid are drained, and the wound is closed. Performed in a hospital or outpatient surgical facility under local or general anesthetic, full recovery takes about three weeks but hearing should improve immediately.

Tympanoplasty

Tympanoplasty is performed to reconstruct the eardrum after partial or total conductive hearing loss, usually caused by chronic middle ear infections, or perforations that do not heal. This is usually a same day surgery, performed under either local or general anesthesia. After making an incision in the ear to view the perforation, the ear drum is elevated away from the ear canal and lifted forward. If the bones of hearing (ossicular chain) are functioning, tissue is taken from the ear and grafted to the eardrum to close the perforation. A thin sheet of silastic and Gelfoam hold the graft in place. The ear is stitched together, and a sterile patch is placed on the outside of the ear canal. Tympanoplasty is successful in over 90% of all cases. The need for ossicular reconstruction (reconstruction of tiny bones of the middle ear) is sometimes known before surgery and and even when identified during surgery, can usually be done while reconstructing the eardrum. If the gap between the anvil bone and the stapes is small, a small piece of bone or cartilage from the patient can be inserted; if is is large, the incus bone is removed, modelled into a prosthesis, and reinserted between the stapes and the malleus. Reconstruction could also be achieved by inserting a strut made from artificial bone. For tympanoplasty with ossicular reconstruction, the patient usually stays in the hospital overnight. The recovery period is about four weeks.

Myringotomy and ear tube surgery

Myringotomy and ear tube surgery is performed to drain ear fluid and prevent ear infections when **antibiotics** don't work or when ear infections are chronic. The process normalizes pressure in the middle ear and decreases fluid accumulation. It is most commonly performed on infants and children, in whom ear infections are most frequent, and may be done on one or both ears. The surgeon makes a small hole in the ear drum, then uses suction to remove fluid. A small ear tube of metal or plastic is inserted into the ear drum to allow continual drainage. The tube prevents infections as long as it stays in place, which varies from six months to three years. When the tube falls out, the hole grows over. As many of 25% of children under the age of two who need ear tubes may need them again. Myringotomy and ear tube surgery is performed in a hospital, using a general anesthetic for most children and a local anesthetic for older children or adults. No anesthetic may be used for infants. The procedure usually takes about two hours. Most patients can go home the same day; children under three years of age and those with chronic diseases usually stay overnight.



Microsurgery being performed in the inner ear. *(Photograph by Hans Halberstadt, Photo Researchers, Inc. Reproduced by permission.)*

Ear surgery for a perforated eardrum

Ear surgery for a perforated eardrum is only performed in rare cases where it does not heal on its own. In most cases, this is performed in a surgeon's office using a topical anesthetic. The surgeon scratches the undersurface of the eardrum, stimulating the skin to heal and the eardrum to close. A thin patch placed on the eardrum's outer surface allows the skin under the eardrum to heal.

Cochlear implants

Cochlear implants stimulate nerve ends within the inner ear, enabling deaf children to hear. The device has a microphone that remains outside the ear, a processor that selects and codes speech sounds, and a receiver/stimulator to convert the coded sounds to electric signals that stimulate the hearing nerve and are recognized by the brain as sound. During surgery, an incision is made behind and slightly above the ear. A circular hole is drilled in the bone to receive the device's internal coil. The mastoid bone leading to the middle ear is opened to receive the electrodes. The internal coil is inserted and secured, followed by the electrodes. The wound is stitched up and when it heals, an external unit comprised of a stimulator with a microphone is worn behind the ear. Performed in a hospital under general anesthesia, the operation takes about two hours and usually requires a hospital stay overnight. The patient can resume normal activities in two to three weeks.

Ear surgery for tumors

Some ear tumors can be very serious and should be removed surgically. For a tumor on the skin of the ear canal, the skin is removed surgically, the bone beneath it

KEY TERMS

Auditory—Relating to the sense of the organs of hearing.

Cholesteatoma—A cystic mass of cells in the middle ear, occurring as a congential defect or as a serious complication of a disease or traumtic condition of the ear.

Otologic—Relating to the study, diagnosis, and treatment of diseases of the ear and related structures.

is drilled away, and a skin graft is placed in the ear canal. If the tumor is near the eardrum, the skin of the ear canal and the eardrum are removed along with the bone surrounding the ear canal. A skin graft is placed on the bare bone. For basal cell cancers and low grade glandular malignancies, surgical resection of the ear canal is adequate. Squamous cell carcinoma, a serious form of **cancer**, of the external ear canal requires radical surgery, followed by **radiation therapy**. Cholesteatoma, a benign tumor caused by an infection in a perforated eardrum that did not heal properly and can destroy the bones of hearing, is removed with microsurgery. **Mastoidectomy** is performed for **mastoiditis**, an inflammation of the middle ear, if medical therapy does not work. Petrous apicectomy is performed to drain the petrous apicitis, the bone between the middle ear and the clivis.

Ear surgery for congenital ear defects

Congenital atresia, the absence of the external ear canal, and congenital microtia, abnormal growth of the external ear, often occur together, although atresia can occur without microtia. Surgery to reconstruct the ear usually takes place when the child is four or five years old and may require several operations. A facial plastic surgeon and an ear surgeon work together, repairing the microtia first and then the atresia. During surgery, a bony opening is created over the bones of hearing. The surfaces of the bony ear canal are then relined with a skin graft from the thigh or abdomen. Tissue from behind the eardrum is used to create a new eardrum. In many cases, the middle ear will also need to be reconstructed. Surgery is performed in a hospital under general anesthesia.

Other types of ear surgery

Surgery may also be appropriate to remove multiple bony overgrowths of the ear canal or in rare cases of compromised auditory tube function, to narrow the tube.

Preparation

The preparation depends upon the type of ear surgery performed. For many procedures, blood and urine studies and hearing tests are conducted.

Aftercare

The type of aftercare depends upon the type of surgery performed. In most cases, the ear(s) should be kept dry and warm. Non-prescription drugs such as **acetaminophen** can be used for **pain**.

Risks

The type of risk depends on the type of surgery performed. Total hearing loss is rare.

Resources

BOOKS

"Ear, Nose & Throat." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

PERIODICALS

"Avoiding Ear Surgery." *Mothering* (July/Aug. 1997): 44.

Nissen, Alan J. "Laser Applications in Otologic Surgery." *Ear, Nose & Throat Journal* 74 (July 1995): 477.

Silverstein, Herbert, and Seth I. Rosenberg. *Ear, Nose & Throat Journal* 76 (Sept. 1997): 674.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

American Hearing Research Foundation. 55 E. Washington St., Suite 2022, Chicago, IL 60602. (312) 726-9670. <http://www.american-hearing.org/>.

American Speech-Language-Hearing Association. 10801 Rockville Pike, Rockville, MD 20852. (800) 638-8255. <http://www.asha.org>.

OTHER

"Ears: Entrance to the Everyday World of Hearing and Balance." *The Ear Surgery Information Center.* 31 May 1998 <http://206.0.212.22/INDEX.html>.

"Ear Infections and Ear Tube Surgery." *KidsHealth.org*. 1997. 31 May 1998 <http://kidshealth.org/parent/health/ear_infections.html>.

"Myringotomy; Ear Infection, Middle (Otitis Media); Eardrum, Ruptured; Staples Removal; Tympanoplasty; and Cochlear Implant." *ThriveOnline*. 28 May 1998 <http://thriveonline.oxygen.com>.

Lori De Milto

Ear tubes *see* **Myringotomy and ear tubes**

Ear wax impaction *see* **Cerumen impaction**

Eardrum perforation *see* **Perforated eardrum**

Eastern equine encephalitis *see* **Arbovirus encephalitis**

Eating disorders *see* **Anorexia nervosa; Bulimia nervosa**

Eaton agent pneumonia *see* **Mycoplasma infections**

Ebola virus infection *see* **Hemorrhagic fevers**

Ecchymosis *see* **Bruises**

ECG *see* **Electrocardiography**

Echinacea

Definition

Echinacea, or purple coneflower, is a perennial herb of the Composite family, commonly known as the daisy family. Most often referred to as the purple coneflower, this hardy plant also known as Sampson root, Missouri snakeroot, and rudbeckia. The prominent, bristly seed head inspired the generic name of the plant, taken from the Greek word *echinos* meaning hedgehog.

Description

Echinacea is a North American prairie native, abundant in the Midwest, and cultivated widely in ornamental and medicinal gardens. The purple-pink rays of the blossom droop downward from a brassy hued center cone composed of many small, tubular florets. The conspicuous flowers bloom singly on stout, prickly stems from mid-summer to autumn. Flower heads may grow to 4 in (10.16 cm) across. The dark green leaves are opposite, entire, lanceolate, toothed, and hairy with three prominent veins. The narrow upper leaves are attached to the stem with stalks. The lower leaves are longer, emerging from the stem without a leaf stalk, and growing to 8 in (20.32 cm) in length. The plant develops deep, slender, black roots. Echinacea propagates easily from seed or by root cuttings. However, due to its increasing popularity as an herbal supplement, echinacea is numbered among the 19 medicinal plants considered at risk by the Vermont nonprofit organization, United Plant Savers.

Purpose

Three species of echinacea are useful medicinally: *Echinacea augustifolia, Echinacea purpurea*, and *Echinacea pallida*. The entire plant has numerous medicinal properties that act synergistically to good effect. Echinacea is most often used to boost the immune system and fight infection. Research has shown that echinacea increases production of interferon in the body. It is antiseptic and antimicrobial, with properties that act to increase the number of white blood cells available to destroy bacteria and slow the spread of infection. As a depurative, the herbal extract cleanses and purifies the bloodstream, and has been used effectively to treat **boils**. Echinacea is vulnerary, promoting wound healing through the action of a chemical substance in the root known as caffeic acid glycoside. As an alterative and an immunomodulator, echinacea acts gradually to promote beneficial change in the entire system. It has also been used to treat urinary infection and *Candida albicans* infections. Echinacea is a febrifuge, useful in reducing fevers. It is also useful in the treatment of **hemorrhoids**. A tincture, or a strong decoction of echinacea serves as an effective mouthwash for the treatment of pyorrhea and gingivitis.

Native American plains Indians relied on echinacea as an all-purpose antiseptic. The Sioux tribe valued the root as a remedy for snake bite, the Cheyenne tribe chewed the root to quench thirst, and another tribe washed their hands in a decoction of echinacea to increase their tolerance of heat. European settlers learned of the North American herb's many uses, and soon numerous echinacea-based remedies were commercially available from pharmaceutical companies in the United States. Echinacea was a popular remedy in the United States through the 1930s. It was among many medicinal herbs listed in the *U.S. Pharmacopoeia*, the official United States government listing of pharmaceutical raw materials and recipes. The herb fell out of popular use in the United States with the availability of **antibiotics**. In West Germany, over 200 preparations are made from the species *E. purpurea*. Commercially prepared salves, tinctures, teas, and extracts are marketed using standardized extracts. Echinacea is regaining its status in the United States as a household medicine-chest staple in many homes. It is one of the best-selling herbal supplements in United States health food stores.

Clinical studies have found that the entire plant possesses medicinal properties with varying levels of effectiveness. Echinacea is of particular benefit in the treatment of upper respiratory tract infections. Some research has shown that echinacea activates the macrophages that destroy **cancer** cells and pathogens. When taken after cancer treatments, an extract of the root has been found to increase the body's production of white blood cells. Echinacea has been shown to be most effective when taken at the first sign of illness, rather than when used as a daily preventative. Other research has demonstrated the signifi-

KEY TERMS

Alterative—A medicinal substance that acts gradually to nourish and improve the system.

Antimicrobial—A plant substance that acts to inhibit the growth of harmful microorganisms, or acts to destroy them.

Febrifuge—A plant substance that acts to prevent or reduce fever.

Glycoside—An herbal carbohydrate that exerts powerful effect on hormone-producing tissues. The glycoside breaks down into a sugar and a non-sugar component.

Lanceolate—Narrow, leaf shape that is longer than it is wide, and pointed at the end.

Macrophage—Specialized cells present throughout the lymphoid tissues of the body that circulate in the bloodstream. Macrophages have a surface marker that stimulates other cells to react to an antigen.

cant effect of *E. purpurea* root on reducing the duration and severity of colds and flu. Some herbal references list only the root as the medicinal part, others include the aerial parts of the plant, particularly the leaf. But research studies in Europe and the United States have concluded that the entire plant is medicinally effective. Most research has been done on the species *E. pallida* and *E. purpurea*. All three species of echinacea are rich in **vitamins** and **minerals**. Echinacea is an herbal source of niacin, chromium, iron, manganese, selenium, silicon, and zinc.

Preparations

The quality of any herbal supplement depends greatly on the conditions of weather and soil where the herb was grown, the timing and care in harvesting, and the manner of preparation and storage.

Decoction is the best method to extract the mineral salts and other healing components from the coarser herb materials, such as the root, bark, and stems. It is prepared by adding 1 oz (28.4 g) of the dried plant materials, or 2 oz (56.7 g) of fresh plant parts, to 1 pt (0.47 l) of pure, unchlorinated, boiled water in a non-metallic pot. Simmer for about one half hour. Strain and cover. A decoction may be refrigerated for up to two days and retain its healing qualities.

An infusion is the method used to derive benefits from the leaves, flowers, and stems in the form of an herbal tea. Use twice as much fresh, chopped herb as dried herb. Steep in 1 pt (0.47 l) of boiled, unchlorinated water for 10–15 minutes. Strain and cover. Drink warm, sweetened with honey if desired. A standard dose is three cups per day. An infusion will keep for up to two days in the refrigerator and retain its healing qualities.

A tincture is the usual method to prepare a concentrated form of the herbal remedy. Tinctures, properly prepared and stored, will retain medicinal potency for two years or more. Combine 4 oz (114 g) of finely cut fresh or powdered dry herb with 1 pt (0.47 l) of brandy, gin, or vodka in a glass container. The alcohol should be enough to cover the plant parts and have a 50/50 ratio of alcohol to water. Place the mixture away from light for about two weeks, shaking several times each day. Strain and store in a tightly capped, dark glass bottle. A standard dose is 0.14 oz (4 ml) of the tincture three times a day.

Precautions

Echinacea is considered safe in recommended doses. Pregnant or lactating women, however, are advised not to take echinacea in injection form. Because the plant has proven immuno-modulating properties, individuals with systemic lupus erythmatosus, **rheumatoid arthritis**, **tuberculosis**, leukemia, **multiple sclerosis**, or **AIDS** should consult their physician before using echinacea. Echinacea should not be given to children under two years of age, and it should only be given to children over two in consultation with a physician. Research indicates that echinacea is most effective when taken at first onset of symptoms of cold or flu, and when usage is continued no longer than eight weeks. There is some indication that the herb loses its effectiveness when used over a long period of time. It is necessary to interrupt use for a minimum of several weeks in order to give the body's immune system the opportunity to rest and adjust.

Side effects

No side effects are reported with oral administration of echinacea, either in tincture, capsule, or as a tea, when taken according to recommended doses. Chills, **fever**, and allergic reactions have been reported in some research studies using an injection of the plant extract.

Interactions

None reported. When used in combination with other herbs, dosage should be lowered.

Resources

BOOKS

Foster, Steven, and James A. Duke. *A Field Guide to Medicinal Plants*. New York: The Peterson Field Guide Series, Houghton Mifflin Company, 1990.

Hoffmann, David. *The New Holistic Herbal*. Massachusetts: Element Books Inc., 1986.
Kowalchik, Claire, and William H. Hylton, eds. *Rodale's Illustrated Encyclopedia of Herbs*. Pennsylvania: Rodale Press Inc., 1987.
McIntyre, Anne. *The Medicinal Garden*. Henry Holt and Company Inc., 1997.
Official Proceedings. *Medicines from the Earth, Protocols for Botanical Healing*. Massachusetts: Gaia Herbal Research Institute, 1996.
Ondra, Nancy, ed. "200 Herbal Remedies." In *The Complete Book of Natural & Medicinal Cures*. Pennsylvania: Rodale Press Inc., 1994.
Weed, Susun S. *Wise Woman Ways, Menopausal Years*. New York: Ash Tree Publishing, 1992.

PERIODICALS

Deneen, Sally, and Tracey C. Rembert. "Stalking Medicinal Plants, An International Trade Imperils Wild Herbs." *E Magazine* (July/Aug. 1999).

OTHER

Herb World News Online, Research Reviews. 1999. Herb Research Foundation. <http://www.herbs.org>.

Clare Hanrahan

KEY TERMS

Allergenic—A substance capable of causing an allergic reaction.

Cholangitis—Infection or inflammation of the bile ducts; often causes abdominal pain, fever, and jaundice.

Computed tomography (CT) scan—A specialized x-ray procedure in which cross-sections of the area in question can be examined in detail.

Cyst—A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

Embryo—The very beginning stages of development of an organism.

Jaundice—The yellow-greenish coloring of the skin and eyes due to the presence of bile pigments. The presence of jaundice is usually, but not always, a sign of liver disease.

Tapeworm—An intestinal parasite that attaches to the intestine or travels to other organs such as the liver and lungs.

Ultrasound—A noninvasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition.

Echinococcosis

Definition

Echinococcosis (Hydatid disease) refers to human infection by the immature (larval) form of tapeworm, *Echinococcus*. One of three forms of the *Echinococcus* spp., *E. granulosus*, lives on dogs and livestock, and infects humans through contact with these animals. Allergic reactions and damage to various organs from cyst formation are the most common forms of disease in humans.

Description

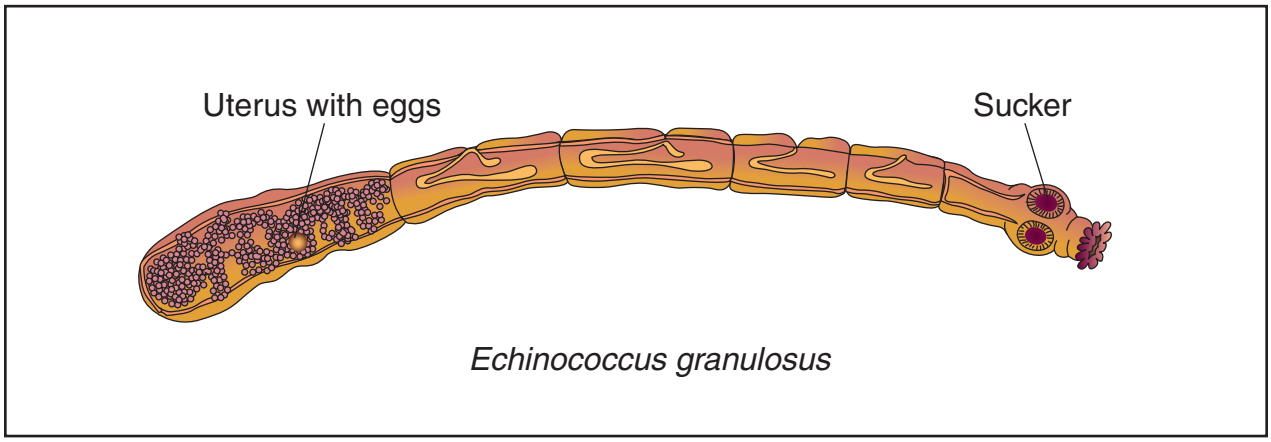
E. granulosus is found in many areas of Africa, China, South America, Australia, New Zealand, and Mediterranean and eastern Europe, as well as in parts of the western United States. The parasite lives in regions where dogs and livestock cohabitate. Direct exposure to infectious dogs as well as parasitic eggs released into the environment during shedding are both sources of human infection.

In humans, cysts containing the larvae develop after ingestion of eggs. Cysts form primarily in the lungs and liver. Cysts developing in the liver are responsible for about two-thirds of echinococcosis cases. Echinococcosis is a significant public health problem in many areas of the world, but control programs have decreased the rate of infection in some regions. In Kenya alone, the numbers of persons infected each year is as high as 220 per 100,000 population.

Causes and symptoms

After ingestion, the eggs develop into embryos within the intestines and then travel to the liver and lungs through major blood vessels. The embryos then begin to form cysts within the liver and lungs, causing damage as they enlarge over a period of five to 20 years. Cysts may become over 8 in (20.3 cm)or more in size and contain a huge amount of highly allergenic fluid. Studies show that while the liver is most often targeted, lungs, brain, heart, and bone can also be affected.

The major symptoms are due to compression damage, blockage of vessels and ducts (such as the bile ducts), and leakage of fluid from cysts. The following symptoms are frequent.



Infection with the larva of *Echinococcus granulosus* (shown above) is responsible for the disease echinococcosis. *(Illustration by Electronic Illustrators Group.)*

- Liver involvement causes **pain** and eventually **jaundice** or **cholangitis** due to blockage of bile ducts. Infection of cysts leads to abscesses in up to 20%.
- Lung cysts cause **cough** and chest pain.
- Bone cysts cause **fractures** and damage to bone tissue.
- Heart involvement leads to irregularities of heart beat and inflammation of the covering of the heart (pericardium).
- Allergic reactions occur from leakage of cyst fluid that contains antigens. **Itching**, **fever**, and **rashes** are frequent, and fatal allergic reactions (**anaphylaxis**) have been reported. Eosinophils, which are blood cells involved in allergic reactions, are increased in many patients.

Diagnosis

X rays, **computed tomography scans** (CT scans), and ultrasound are very helpful in detecting cysts. Some cysts will develop characteristic hardening of organ tissues from calcium deposits (calcifications). Blood tests to detect antibodies are useful when positive, but up to 50% of patients have negative results. Examination of aspirated cyst fluid for parasites can be diagnostic, but carries the danger of a fatal allergic reaction. Treatment with anti-parasitic medications before aspiration is reported to decrease allergic complications and decrease the risk of spread during the procedure.

Treatment

Treatment depends on the size and location of cysts, as well as the symptoms they are producing. Surgical removal of cysts and/or surrounding tissue is the accepted method of treatment, but carries a risk of cyst rupture with spread or allergic reactions. Recent studies using medication alongside aspiration and drainage of cysts instead of surgery are very encouraging.

The medication albenzadole can be taken before or after surgery or alone without surgery. However, its effectiveness as a single treatment is still not known. Multiple courses of medication are often necessary, with cure rates of only about 30%. Response to treatment is best monitored by serial CT scans or similar x-ray studies.

Prevention

Good hand washing, treating infected dogs, and preventing dogs access to slaughter houses discourage spread of the disease. Limiting the population of stray dogs has also been helpful.

Resources

BOOKS

Chung, Raymond T., and Lawrence S. Friedman. "Echinococcus." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Nutman, Thomas B., and Peter F. Weller. "Echinococcosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Ammann, Rudolph W., and Johannes Eckert. "Echinococcus." *Gastroenterology Clinics of North America* (Sept. 1996): 655-689.

Khuroo, Mohammad, et al. "Percutaneous Drainage Compared with Surgery for Hepatic Hydatid Cysts." *New England Journal of Medicine* 337 (25 Sept. 1997): 881-87.

OTHER

"Alveolar Hydatid Disease (Echinococcosis)." *Centers for Disease Control*. 28 May 1998 <http://www.cdc.gov/ncidod/dpd/ahd.htm>.

"Percutaneous Drainage Compared with Surgery for Hepatic Hydatid Cysts." *New England Journal of Medicine Online*. <http://content.nejm.org>.

David Kaminstein, MD

Echinococcus granulosus infection *see* **Echinococcosis**

A patient getting an EKG. *(Photo Researchers. Reproduced by permission.)*

Echocardiography

Definition

Echocardiography is a diagnostic test that uses ultrasound waves to create an image of the heart muscle. Ultrasound waves that rebound or echo off the heart can show the size, shape, and movement of the heart's valves and chambers as well as the flow of blood through the heart. Echocardiography may show such abnormalities as poorly functioning heart valves or damage to the heart tissue from a past **heart attack**.

Purpose

Echocardiography is used to diagnose certain cardiovascular diseases. In fact, it is one of the most widely used diagnostic tests for heart disease. It can provide a wealth of helpful information, including the size and shape of the heart, its pumping strength, and the location and extent of any damage to its tissues. It is especially useful for assessing diseases of the heart valves. It not only allows doctors to evaluate the heart valves, but it can detect abnormalities in the pattern of blood flow, such as the backward flow of blood through partly closed heart valves, known as regurgitation. By assessing the motion of the heart wall, echocardiography can help detect the presence and assess the severity of **coronary artery disease**, as well as help determine whether any chest **pain** is related to heart disease. Echocardiography can also help detect **hypertrophic cardiomyopathy**, in which the walls of the heart thicken in an attempt to compensate for heart muscle weakness. The biggest advantage to echocardiography is that it is noninvasive (doesn't involve breaking the skin or entering body cavities) and has no known risks or side effects.

Precautions

Echocardiography is an extremely safe procedure and no special precautions are required.

Description

Echocardiography creates an image of the heart using ultra-high-frequency sound waves—sound waves that are too high in frequency to be heard by the human ear. The technique is very similar to ultrasound scanning commonly used to visualize the fetus during **pregnancy**.

An echocardiography examination generally lasts between 15–30 minutes. The patient lies bare-chested on an examination table. A special gel is spread over the chest to help the transducer make good contact and slide smoothly over the skin. The transducer, a small hand-held device at the end of a flexible cable, is placed against the chest. Essentially a modified microphone, the transducer directs ultrasound waves into the chest. Some of the waves get echoed (or reflected) back to the transducer. Since different tissues and blood all reflect ultrasound waves differently, these sound waves can be translated into a meaningful image of the heart, which can be displayed on a monitor or recorded on paper or tape. The patient does not feel the sound waves, and the entire procedure is painless. In fact, there are no known side effects.

Occasionally, variations of the echocardiography test are used. For example, Doppler echocardiography employs a special microphone that allows technicians to measure and analyze the direction and speed of blood flow through blood vessels and heart valves. This makes it especially useful for detecting and evaluating regurgitation through the heart valves. By assessing the speed of blood flow at different locations around an obstruction, it can also help to precisely locate the obstruction.

An **exercise** echocardiogram is an echocardiogram performed during exercise, when the heart muscle must work harder to supply blood to the body. This allows doctors to detect heart problems that might not be evident when the body is at rest and needs less blood. For

KEY TERMS

Noninvasive—Pertaining to a diagnostic procedure or treatment that does not require the skin to be broken or a body cavity to be entered.

Regurgitation—Backward flow of blood through a partly closed heart valve.

Transducer—A device that converts electrical signals into ultrasound waves and ultrasound waves back into electrical impulses.

Ultrasound—Sound waves at a frequency of over 20,000 kHz, often used for diagnostic imaging.

patients who are unable to exercise, certain drugs can be used to mimic the effects of exercise by dilating the blood vessels and making the heart beat faster.

Preparation

The patient removes any clothing and jewelry above the chest.

Aftercare

No special measures need to be taken following echocardiography.

Risks

There are no known risks associated with the use of echocardiography.

Normal results

A normal echocardiogram shows a normal heart structure and the normal flow of blood through the heart chambers and heart valves. However, a normal echocardiogram does not rule out the possibility of heart disease.

Abnormal results

An echocardiogram may show a number of abnormalities in the structure and function of the heart, such as:

- thickening of the wall of the heart muscle (especially the left ventricle)
- abnormal motion of the heart muscle
- blood leaking backward through the heart valves (regurgitation)
- decreased blood flow through a heart valve (stenosis)

Resources

BOOKS

Faculty Members of the Yale University School of Medicine. *The Patient's Book of Medical Tests*. Boston: Houghton Mifflin Co., 1997.

PERIODICALS

Rose, Verna L. "American College of Cardiology and American Heart Association Address the Use of Echocardiography. *American Family Physician* 56 (1 Oct. 1997): 1489-90.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

Echovirus infections *see* **Enterovirus infections**

Eclampsia *see* **Preeclampsia and eclampsia**

ECT *see* **Electroconvulsive therapy**

Ectopic orifice of the ureter *see* **Congenital ureter anomalies**

Ectopic pregnancy

Definition

In an ectopic **pregnancy**, the fertilized egg implants in a location outside the uterus and tries to develop there. The word ectopic means "in an abnormal place or position." The most common site is the fallopian tube, the tube that normally carries eggs from the ovary to the uterus. However, ectopic pregnancy can also occur in the ovary, the abdomen, and the cervical canal (the opening from the uterus to the vaginal canal). The phrases tubal pregnancy, ovarian pregnancy, cervical pregnancy, and abdominal pregnancy refer to the specific area of an ectopic pregnancy.

Description

Once a month, an egg is produced in a woman's ovary and travels down the fallopian tube where it meets the male's sperm and is fertilized. In a normal pregnancy the fertilized egg, or zygote, continues on its passage down the fallopian tube and enters the uterus in three to five days. The zygote continues to grow, implanting itself securely in the wall of the uterus. The zygote's cells develop into the embryo (the organism in its first two months of develop-

ment) and placenta (a spongy structure that lines the uterus and nourishes the developing organism).

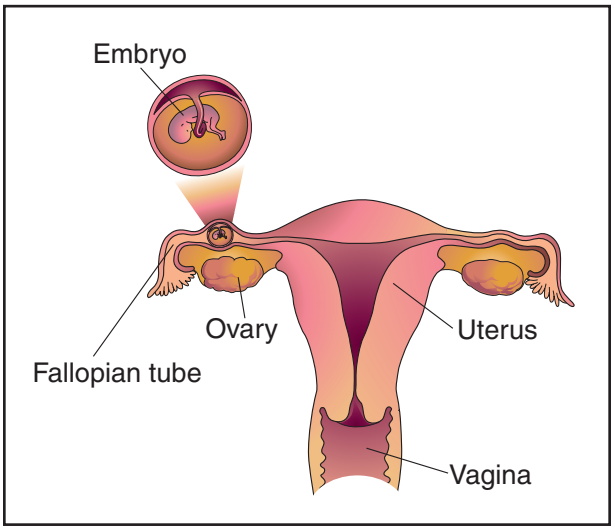
In a tubal ectopic pregnancy, the fertilized egg cannot make it all the way down the tube because of scarring or obstruction. The fallopian tube is too narrow for the growing zygote. Eventually the thin walls of the tube stretch and may burst (rupture), resulting in severe bleeding and possibly the **death** of the mother. More than 95% percent of all ectopic pregnancies occur in the fallopian tube. Only 1.5% develop in the abdomen; less than 1% develop in the ovary or the cervix.

Causes and symptoms

As many as 50% of women with ectopic pregnancies have a history of **pelvic inflammatory disease** (PID). This is an infection of the fallopian tubes (salpingitis) that can spread to the uterus or ovaries. It is most commonly caused by the organisms *Gonorrhea* and *Chlamydia* and is usually transmitted by sexual intercourse.

Other conditions also increase the risk of ectopic pregnancy. They include:

- **Endometriosis**. A condition in which the tissue that normally lines the uterus is found outside the uterus, and can block a fallopian tube.
- Exposure to diethylsilbestrol (DES) as a fetus. If a woman's mother took DES (a synthetic version of the hormone estrogen) during pregnancy, the woman may have abnormalities in her fallopian tubes that can make ectopic pregnancy more likely.
- Taking hormones. Estrogen and progesterone are hormones that regulate the menstrual cycle and may be in medications prescribed by a doctor for birth control or other reasons. Taking these hormones can affect the interior lining of the fallopian tubes and slow the movement of the fertilized egg down the tube. Women who become pregnant in spite of taking some progesterone-only contraceptives have a greater chance of an ectopic pregnancy. Ectopic pregnancy is also more likely when the ovaries are artificially stimulated with hormones to produce eggs for **in vitro fertilization** (a procedure in which eggs are taken from a woman's body, fertilized, and then placed in the uterus in an attempt to conceive a child).
- Use of an intrauterine device (**IUD**). These contraceptive devices are designed to prevent fertilized eggs from becoming implanted in the uterus, but they have only a minimal effect on preventing ectopic pregnancies. Therefore, if a woman becomes pregnant while using an IUD for **contraception**, the fertilized egg is more likely to be implanted someplace other than the uterus. For example, among women who become pregnant while using a progesterone-bearing IUD, about 15% have ectopic pregnancies.



In an ectopic pregnancy, the fertilized egg implants in a location outside the uterus and attempts to develop at that site. The most common site of an ectopic pregnancy is the fallopian tube, but it can occur in the ovary, the abdomen, and the cervical wall. More than 95% of all ectopic pregnancies occur in the fallopian tube. *(Illustration by Electronic Illustrators Group.)*

- Surgery on a fallopian tube. The risk of ectopic pregnancy can be as high as 60% after undergoing elective tubal sterilization, a procedure in which the fallopian tubes are severed to prevent pregnancy. Women who have successful surgery to reverse the procedure are also more likely to have an ectopic pregnancy.

Early symptoms

In an ectopic pregnancy all the hormonal changes associated with a normal pregnancy may occur. The early symptoms include: **fatigue**; nausea; a missed period; breast tenderness; **low back pain**; mild cramping on one side of the pelvis; and abnormal vaginal bleeding, usually spotting.

Later symptoms

As the embryo grows too large for the confined space in the tube, the first sign that something is wrong may be a stabbing **pain** in the pelvis or abdomen. If the tube has ruptured, blood may irritate the diaphragm and cause shoulder pain. Other warning signs are lightheadedness and **fainting**.

Diagnosis

To confirm an early diagnosis of ectopic pregnancy, the doctor must determine first that the patient is pregnant and that the location of the embryo is outside the uterus. If an ectopic pregnancy is suspected, the doctor

KEY TERMS

Embryo—In humans, the developing organism from conception until approximately the end of the second month.

Fallopian tube—The tube that carries the egg from the ovary to the uterus.

Human chorionic gonadotropin (hCG)—A hormone excreted during the development of an embryo or fetus.

Laparoscopy—Examination of the contents of the abdominal cavity with a fiberoptic tube inserted through a small incision.

Laparotomy—Surgical incision into the abdomen to locate, repair, and/or remove injured or diseased tissues.

Pelvic inflammatory disease (PID)—Acute or chronic inflammation in the pelvic cavity, particularly inflammation of the fallopian tubes (salpingitis) and its complications.

Rupture—A breaking apart of an organ or tissue.

Salpingitis—Inflammation of the fallopian tube.

Tubal pregnancy—Pregnancy in one of the fallopian tubes.

Zygote—The fertilized egg.

will perform a pelvic examination to locate the source of pain and to detect a mass in the abdomen.

Several laboratory tests of the patient's blood provide information for diagnosis. Measurement of the human chorionic gonadotropin (hCG) level in the patient's blood serum is the most useful laboratory test in the early stages. In a normal pregnancy, the level of this hormone doubles about every two days during the first 10 weeks. In an ectopic pregnancy, the rate of the increase is much slower and the low hCG for the stage of the pregnancy is a strong indication that the pregnancy is abnormal. (It could also represent a **miscarriage** in progress.) The level is usually tested several times over a period of days to determine whether or not it is increasing at a normal rate.

Progesterone levels in the blood are also measured. Lower than expected levels can indicate that the pregnancy is not normal.

An ultrasound examination may provide information about whether or not the pregnancy is ectopic. A device called a transducer, which emits high frequency sound waves, is moved over the surface of the patient's abdomen or inserted into the vagina. The sound waves bounce off of the internal organs and create an image on a screen. The doctor should be able to see whether or not there is a fetus developing in the uterus after at least five weeks of gestation. Before that point, a normal pregnancy is too small to see.

A culdocentesis may also help confirm a diagnosis. In this procedure a needle is inserted into the space at the top of the vagina, behind the uterus and in front of the rectum. Blood in this area may indicate bleeding from a ruptured fallopian tube.

A **laparoscopy** will enable the doctor to see the patient's reproductive organs and examine an ectopic pregnancy. In this technique, a hollow tube with a light on one end is inserted through a small incision in the abdomen. Through this instrument the internal organs can be observed.

Treatment

Ectopic pregnancy requires immediate treatment. The earlier the condition is treated, the better the chance to preserve the fallopian tube intact for future normal pregnancies.

Medical

If the ectopic pregnancy is discovered in a very early stage of development, the drug methotrexate may be given. The best results are obtained when the pregnancy is less than six weeks old and the tubal mass is no more than 1.4 in (3.5 cm) in diameter. Methotrexate, which has been used successfully since 1987, works by inhibiting the growth of rapidly growing cells. (It is also used to treat some cancers.) Most side effects are mild and temporary, but the patient must be monitored after treatment. Usually the medication is injected into the muscle in a single dose, but may also be given intravenously or injected directly into the fallopian tube to dissolve the embryonic tissue. Methotrexate has also been used to treat ovarian, abdominal, and cervical pregnancies that are discovered in the early stages.

Surgical

When a laparoscopy is done to visualize the ectopic pregnancy, the scope can be fitted with surgical tools and used to remove the ectopic mass immediately after it is identified. The affected fallopian tube can be repaired or removed as necessary. This procedure can be done without requiring the patient to stay in the hospital overnight.

When the pregnancy has ruptured, a surgical incision into the abdomen, or laparotomy, is performed to

stop the immediate loss of blood and to remove the embryo. This usually requires general anesthesia and a hospital stay. Every effort is made to preserve and repair the injured fallopian tube. However, if the fallopian tube has already ruptured, repair is extremely difficult and the tube is usually removed.

Alternative treatment

Ectopic pregnancy was first described in the eleventh century and was a potentially fatal condition until the advent of surgery and blood transfusions in the early twentieth century. The sophisticated diagnostic tools and surgical procedures developed since the 1970s have equipped modern medicine with the tools to not only save a woman's life, but also to preserve her future fertility.

Although there are herbal remedies for the temporary relief of the common symptoms of **anxiety** and abdominal discomfort, prompt medical treatment is the only sure remedy for ectopic pregnancy.

Prognosis

Ectopic pregnancies are the leading cause of pregnancy-related deaths in the first trimester and account for 9% of all pregnancy-related deaths in the United States. More than 1% of pregnancies are ectopic, and they are becoming more common. The reason for this increase is not clearly understood, though it is thought that the dramatic increase in **sexually transmitted diseases** (STD) is at least partly responsible.

The earlier an ectopic pregnancy is diagnosed and treated, the better the outcome. The chances of having a successful pregnancy are lower after an ectopic pregnancy, but depend on the extent of permanent fallopian tube damage. If the tube has been spared, chances are as high as 60%. The chances of a successful pregnancy after the removal of one tube are 40%.

Prevention

Many forms of ectopic pregnancy cannot be prevented. However, tubal pregnancies, which make up the majority of ectopic pregnancies, may be prevented by avoiding conditions that cause damage to the fallopian tubes. Since half of all women who experience ectopic pregnancy have a history of PID, avoiding this infection or getting early diagnosis and treatment for sexually transmitted diseases will decrease the risk of a future problem.

Resources

BOOKS

Cunningham, F. Gary, et al. "Ectopic Pregnancy." In *Williams Obstetrics*. Appleton & Lange, 1997.

Stabile, Isabel. *Ectopic Pregnancy: Diagnosis and Management*. Cambridge University Press, 1996.

PERIODICALS

Maiolatesi, C. R. "Methotrexate for Nonsurgical Treatment of Ectopic Pregnancy: Nursing Implications." *Journal of Obstetrical Gynecological Neonatal Nursing* (Mar./Apr. 1996): 205-208.

ORGANIZATIONS

Resolve. 1310 Broadway, Somerville, MA 02144-1731. (617) 623-0744. <http://www.resolve.org>.

Karen Ericson, RN

Eczema *see* **Dermatitis**

ED *see* **Impotence**

Edema

Definition

Edema is a condition of abnormally large fluid volume in the circulatory system or in tissues between the body's cells (interstitial spaces).

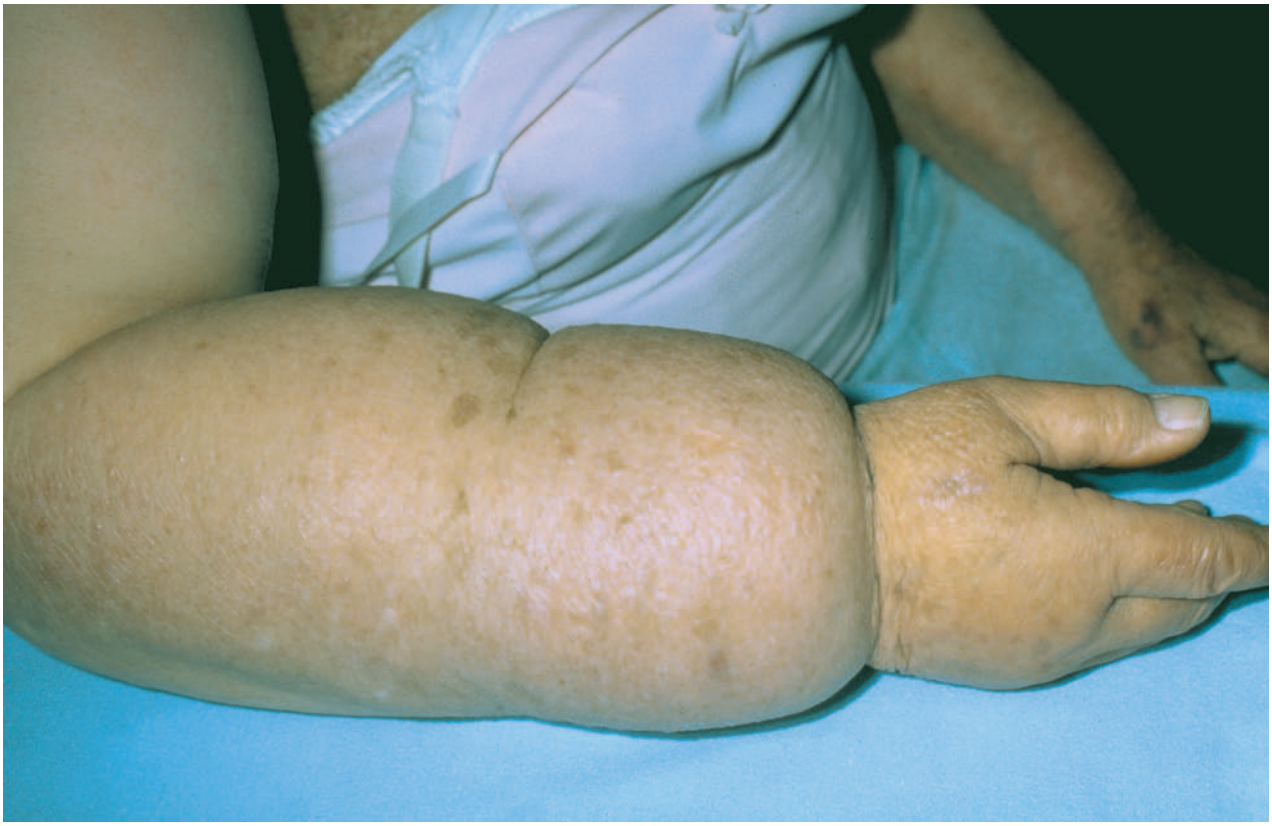
Description

Normally the body maintains a balance of fluid in tissues by ensuring that the same of amount of water entering the body also leaves it. The circulatory system transports fluid within the body via its network of blood vessels. The fluid, which contains oxygen and nutrients needed by the cells, moves from the walls of the blood vessels into the body's tissues. After its nutrients are used up, fluid moves back into the blood vessels and returns to the heart. The lymphatic system (a network of channels in the body that carry lymph, a colorless fluid containing white blood cells to fight infection) also absorbs and transports this fluid. In edema, either too much fluid moves from the blood vessels into the tissues, or not enough fluid moves from the tissues back into the blood vessels. This fluid imbalance can cause mild to severe swelling in one or more parts of the body.

Causes and symptoms

Many ordinary factors can upset the balance of fluid in the body to cause edema, including:

- Immobility. The leg muscles normally contract and compress blood vessels to promote blood flow with walking or running. When these muscles are not used,



Gross lymphedema in the arm of an elderly woman following radiotherapy treatment for breast cancer. *(Photograph by Dr. P. Marazzi. Photo Researchers, Inc. Reproduced by permission.)*

blood can collect in the veins, making it difficult for fluid to move from tissues back into the vessels.

- Heat. Warm temperatures cause the blood vessels to expand, making it easier for fluid to cross into surrounding tissues. High humidity also aggravates this situation.
- Medications. Certain drugs, such as steroids, hormone replacements, **nonsteroidal anti-inflammatory drugs** (NSAIDs), and some blood pressure medications may affect how fast fluid leaves blood vessels.
- Intake of salty foods. The body needs a constant concentration of salt in its tissues. When excess salt is taken in, the body dilutes it by retaining fluid.
- Menstruation and **pregnancy**. The changing levels of hormones affect the rate at which fluid enters and leaves the tissues.

Some medical conditions may also cause edema, including:

- **Heart failure**. When the heart is unable to maintain adequate blood flow throughout the circulatory system, the excess fluid pressure within the blood vessels can cause shifts into the interstitial spaces. Left-sided heart failure can cause **pulmonary edema**, as fluid shifts into the lungs. The patient may develop rapid, shallow respirations, **shortness of breath**, and a **cough**. Right-sided heart failure can cause pitting edema, a swelling in the tissue under the skin of the lower legs and feet. Pressing this tissue with a finger tip leads to a noticeable momentary indentation.
- Kidney disease. The decrease in sodium and water excretion can result in fluid retention and overload.
- Thyroid or liver disease. These conditions can change the concentration of protein in the blood, affecting fluid movement in and out of the tissues. In advanced liver disease, the liver is enlarged and fluid may build-up in the abdomen.
- Malnutrition. Protein levels are decreased in the blood, and in an effort to maintain a balance of concentrations, fluid shifts out of the vessels and causes edema in tissue spaces.

Some conditions that may cause swelling in just one leg include:

- Blood clots. Clots can cause pooling of fluid and may be accompanied by discoloration and **pain**. In some instances, clots may cause no pain.
- Weakened veins. **Varicose veins**, or veins whose walls or valves are weak, can allow blood to pool in the legs. This is a common condition.
- Infection and inflammation. Infection in leg tissues can cause inflammation and increasing blood flow to the area. Inflammatory diseases, such as **gout** or arthritis, can also result in swelling.
- **Lymphedema**. Blocked lymph channels may be caused by infection, scar tissue, or hereditary conditions. Lymph that can't drain properly results in edema. Lymphedema may also occur after **cancer** treatments, when the lymph system is impaired by surgery, radiation, or **chemotherapy**.
- Tumor. Abnormal masses can compress leg vessels and lymph channels, affecting the rate of fluid movement.

Symptoms vary depending on the cause of edema. In general, weight gain, puffy eyelids, and swelling of the legs may occur as a result of excess fluid volume. Pulse rate and blood pressure may be elevated. Hand and neck veins may be observed as fuller.

Diagnosis

Edema is a sign of an underlying problem, rather than a disease unto itself. A diagnostic explanation should be sought. Patient history and presenting symptoms, along with laboratory blood studies, if indicated, assist the health professional in determining the cause of the edema.

Treatment

Treatment of edema is based on the cause. Simple steps to lessen fluid build-up may include:

- Reducing sodium intake. A high sodium level causes or aggravates fluid retention.
- Maintaining proper weight. Being overweight slows body fluid circulation and puts extra pressure on the veins.
- **Exercise**. Regular exercise stimulates circulation.
- Elevation of the legs. Placing the legs at least 12 in (30.5 cm) above the level of the heart for 10–15 minutes, three to four times a day, stimulates excess fluid re-entry into the circulatory system.
- Use of support stocking. Elastic stockings, available at most medical supply or drug stores, will compress the leg vessels, promoting circulation and decreasing pooling of fluid due to gravity.

KEY TERMS

Digitalis—A naturally occuring compound used in the preparation of the medication, digoxin, prescribed to increase the heart rate and strengthen the force of the heart's contractions.

Diuretics—Medications used in the treatment of fluid overload, to promote excretion of sodium and water.

Interstitial spaces—Areas of the body occuring outside the vessels or organs, between the cells.

Pitting edema—A swelling in the tissue under the skin, resulting from fluid accumulation, that is measured by the depth of indentation made by finger pressure over a boney prominence.

- Massage. Massaging the body part can help to stimulate the release of excess fluids, but should be avoided if the patient has blood clots in the veins.
- Travel breaks. Sitting for long periods will increase swelling in the feet and ankles. Standing and/or walking at least every hour or two will help stimulate blood flow.

The three "Ds"—diuretics, digitalis, and diet—are frequently prescribed for medical conditions that result in excess fluid volume. **Diuretics** are medications that promote urination of sodium and water. Digoxin is a digitalis preparation that is sometimes needed to decrease heart rate and increase the strength of the heart's contractions. Dietary recommendations include less sodium in order to decrease fluid retention. Consideration of adequate protein intake is also made.

For patients with lymphedema, a combination of therapies may prove effective. Combined decongestive therapy includes the use of manual lymph drainage (MLD), compression bandaging, garments and pumps, and physical therapy. MLD involves the use of light massage of the subcutaneous tissue where the lymph vessels predominate. Massage begins in an area of the body trunk where there is normal lymph function and proceeds to areas of lymphatic insufficiency, in an effort to stimulate new drainage tract development. (MLD should not be used for patients with active cancer, deep vein clots, congestive heart failure, or cellulitis.) MLD sessions are followed by application of compression garments or pumps. Physical therapy is aimed at strengthening the affected limb and increasing joint mobility.

Alternative treatment

Dietary changes, in addition to cutting back the amount of sodium eaten, may also help reduce edema. Foods that worsen edema, such as alcohol, **caffeine**, sugar, dairy products, soy sauce, animal protein, chocolate, olives, and pickles, should be avoided. Diuretic herbs can also help relieve edema. One of the best herbs for this purpose is dandelion (*Taraxacum mongolicum*), since, in addition to its diuretic action, it is a rich source of potassium. (Diuretics flush potassium from the body and it must be replaced to avoid potassium deficiency.) **Hydrotherapy** using daily contrast applications of hot and cold (either compresses or immersion) may also be helpful.

Resources

BOOKS

Monahan, Frances D., and Marianne Neighbors. *Medical-Surgical Nursing: Foundation for Clinical Practice*. 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

ORGANIZATIONS

Lymphedema and Wound Care Clinic of Austin. 5750 Balcones Dr., Ste. 110, Austin, TX 78731. (512) 453-1930.

Kathleen D. Wright, RN

Edrophonium test *see* **Tensilon test**

Edwards' syndrome

Definition

Edwards' syndrome is caused by an extra copy of chromosome 18. For this reason, it is also called trisomy 18 syndrome. The extra chromosome is lethal for most babies born with this condition. It causes major physical abnormalities and severe **mental retardation**, and very few children afflicted with this disease survive beyond a year.

Description

Humans normally have 23 pairs of chromosomes. Chromosomes are numbered 1–22, and the 23rd pair is composed of the sex chromosomes, X and Y. A person inherits one set of 23 chromosomes from each parent. Occasionally, a genetic error occurs during egg or sperm cell formation. A child conceived with such an egg or sperm cell may inherit an incorrect number of chromosomes.

In the case of Edwards' syndrome, the child inherits three, rather than two, copies of chromosome 18. Trisomy 18 occurs in approximately one in every 3,000 newborns and affects girls more often than boys. Women older than their early thirties have a greater risk of conceiving a child with trisomy 18, but it can occur in younger women.

Causes and symptoms

A third copy of chromosome 18 causes numerous abnormalities. Most children born with Edwards' syndrome appear weak and fragile, and they are often underweight. The head is unusually small and the back of the head is prominent. The ears are malformed and low-set, and the mouth and jaw are small. The baby may also have a cleft lip or cleft palate. Frequently, the hands are clenched into fists, and the index finger overlaps the other fingers. The child may have clubfeet and toes may be webbed or fused.

Numerous problems involving the internal organs may be present. Abnormalities often occur in the lungs and diaphragm (the muscle that controls breathing), and heart defects and blood vessel malformations are common. The child may also have malformed kidneys and abnormalities of the urogenital system.

Diagnosis

Physical abnormalities point to Edwards' syndrome, but definitive diagnosis relies on karyotyping. Karyotyping involves drawing the baby's blood or bone marrow for a microscopic examination of the chromosomes. Using special stains and microscopy, individual chromosomes are identified, and the presence of an extra chromosome 18 is revealed.

Trisomy 18 can be detected before birth. If a pregnant woman is older than 35, has a family history of genetic abnormalities, has previously conceived a child with a genetic abnormality, or has suffered earlier miscarriages, she may undergo tests to determine whether her child carries genetic abnormalities. Potential tests include maternal serum analysis or screening, ultrasonography, **amniocentesis**, and **chorionic villus sampling**.

Treatment

There is no cure for Edwards' syndrome. Since trisomy 18 babies frequently have major physical abnormalities, doctors and parents face difficult choices regarding treatment. Abnormalities can be treated to a certain degree with surgery, but extreme invasive procedures may not be in the best interests of an infant whose lifespan is measured in days or weeks. Medical therapy often consists of supportive care with the goal of making the infant comfortable, rather than prolonging life.

KEY TERMS

Aminocentesis—A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus to withdraw a small sample of amniotic fluid. The amniotic fluid can be examined for signs of disease or other problems afflicting the fetus.

Chorionic villus sampling—A medical test that is best done during weeks 10–12 of a pregnancy. The procedure involves inserting a needle into the placenta and withdrawing a small amount of the chorionic membrane for analysis.

Chromosome—A structure composed of deoxyribonucleic acid (DNA) contained within a cell's nucleus (center) in where genetic information is stored. Human have 23 pairs of chromosomes, each of which has recognizable characteristics (such as length and staining patterns) that allow individual chromosomes to be identified. Identification is assigned by number (1–22) or letter (X or Y).

Karyotyping—A laboratory test used to study an individual's chromosome make-up. Chromosomes are separated from cells, stained, and arranged in order from largest to smallest so that their number and structure can be studied under a microscope.

Maternal serum analyte screening—A medical procedure in which a pregnant woman's blood is drawn and analyzed for the levels of certain hormones and proteins. These levels can indicate whether there may be an abnormality in the unborn child. This test is not a definitive indicator of a problem and is followed by more specific testing such as amniocentesis or chorionic villus sampling.

Trisomy—A condition in which a third copy of a chromosome is inherited. Normally only two copies should be inherited.

Ultrasound—A medical test that is also called ultrasonography. Sound waves are directed against internal structures in the body. As sound waves bounce off the internal structure, they create an image on a video screen. An ultrasound of a fetus at weeks 16–20 of a pregnancy can be used to determine structural abnormalities.

Prognosis

Most children born with trisomy 18 die within their first year of life. The average lifespan is less than two months for 50% of the children, and 90–95% die before their first birthday. The 5–10% of children who survive their first year are severely mentally retarded. They need support to walk, and learning is limited. Verbal communication is also limited, but they can learn to recognize and interact with others.

Prevention

Edwards' syndrome cannot be prevented.

Resources

BOOKS

Gardner, R. J. McKinlay, and Grant R. Sutherland. *Chromosome Abnormalities and Genetic Counseling*. New York: Oxford University Press, 1996.

Jones, Kenneth Lyons. *Smith's Recognizable Patterns of Human Malformation*. 5th ed. W. B. Saunders Co., 1997.

ORGANIZATIONS

The Chromosome 18 Registry & Research Society. 6302 Fox Head, San Antonio, TX 78247. (210) 657-4968. <http://www.chromosome18.org>.

Support Organization for Trisomy 18, 13, and Related Disorders (SOFT). 2982 South Union St., Rochester, NY 14624. (800) 716-7638. <http://www.trisomy.org>.

Julia Barrett

EEG *see* **Electroencephalography**

Egyptian conjunctivitis *see* **Trachoma**

Ehlers-Danlos syndrome

Definition

The Ehlers-Danlos syndromes (EDS) refer to a group of inherited disorders that affect collagen structure and function. Genetic abnormalities in the manufacturing of collagen within the body affect connective tissues, causing them to be abnormally weak.

Description

Collagen is a strong, fibrous protein that lends strength and elasticity to connective tissues such as the

skin, tendons, organ walls, cartilage, and blood vessels. Each of these connective tissues requires collagen tailored to meet its specific purposes. The many roles of collagen are reflected in the number of genes dedicated to its production. There are at least 28 genes in humans that encode at least 19 different types of collagen. Mutations in these genes can affect basic construction as well as the fine-tuned processing of the collagen.

EDS was originally described by Dr. Van Meekeren in 1682. Dr. Ehlers and Dr. Danlos further characterized the disease in 1901 and 1908, respectively. Today, according to the Ehlers-Danlos National Foundation, one in 5,000 to one in 10,000 people are affected by some form of EDS.

EDS is a group of genetic disorders that usually affects the skin, ligaments, joints, and blood vessels. Classification of EDS types was revised in 1997. The new classification involves categorizing the different forms of EDS into six major sub-types, including classical, hypermobility, vascular, kyphoscoliosis, arthrochalasia, and dermatosparaxis, and a collection of rare or poorly defined varieties. This new classification is simpler and based more on descriptions of the actual symptoms.

Classical type

Under the old classification system, EDS classical type was divided into two separate types: type I and type II. The major symptoms involved in EDS classical type are the skin and joints. The skin has a smooth, velvety texture and **bruises** easily. Affected individuals typically have extensive scaring, particularly at the knees, elbows, forehead, and chin. The joints are hyperextensible, giving a tendency towards dislocation of the hip, shoulder, elbow, knee, or clavicle. Due to decreased muscle tone, affected infants may experience a delay in reaching motor milestones. Children may have a tendency to develop hernias or other organ shifts within the abdomen. Sprains and partial or complete joint dilocations are also common. Symptoms can range from mild to severe. EDS classical type is inherited in an autosomal dominant manner.

There are three major clinical diagnostic criteria for EDS classical type. These include skin hyperextensibility, unusually wide scars, and joint hypermobility. At this time there is no definitive test for the diagnosis of classical EDS. Both DNA and biochemical studies have been used to help identify affected individuals. In some cases, a **skin biopsy** has been found to be useful in confirming a diagnosis. Unfortunately, these tests are not sensitive enough to identify all individuals with classical EDS. If there are multiple affected individuals in a family, it may be possible to perform prenatal diagnosis using a DNA information technique known as a linkage study.

Hypermobility type

Excessively loose joints are the hallmark of this EDS type, formerly known as EDS type III. Both large joints, such as the elbows and knees, and small joints, such as toes and fingers, are affected. Partial and total joint dislocations are common, and particularly involve the jaw, knee, and shoulder. Many individuals experience chronic limb and joint **pain**, although x rays of these joints appear normal. The skin may also bruise easily. **Osteoarthritis** is a common occurrence in adults. EDS hypermobility type is inherited in an autosomal dominant manner.

There are two major clinical diagnostic criteria for EDS hypermobility type. These include skin involvement (either hyperextensible skin or smooth and velvety skin) and generalized joint hypermobility. At this time there is no test for this form of EDS.

Vascular type

Formerly called EDS type IV, EDS vascular type is the most severe form. The connective tissue in the intestines, arteries, uterus, and other hollow organs may be unusually weak, leading to organ or blood vessel rupture. Such ruptures are most likely between ages 20 and 40, although they can occur any time, and may be life-threatening.

There is a classic facial appearance associated with EDS vascular type. Affected individuals tend to have large eyes, a thin pinched nose, thin lips, and a slim body. The skin is thin and translucent, with veins dramatically visible, particularly across the chest.

The large joints have normal stability, but small joints in the hands and feet are loose, showing hyperextensibility. The skin bruises easily. Other complications may include collapsed lungs, premature **aging** of the skin on the hands and feet, and ruptured arteries and veins. After surgery there tends to be poor wound healing, a complication that tends to be frequent and severe. **Pregnancy** also carries the risk complications. During and after pregnancy there is an increased risk of the uterus rupturing and of arterial bleeding. Due to the severe complications associated with EDS type IV, **death** usually occurs before the fifth decade. A study of 419 individuals with EDS vascular type, completed in 2000, found that the median survival rate was 48 years, with a range of six to 73 years. EDS vascular type is inherited in an autosomal dominant manner.

There are four major clinical diagnostic criteria for EDS vascular type. These include thin translucent skin, arterial/intestinal/uterine fragility or rupture, extensive bruising, and characteristic facial appearance. EDS vascular type is caused by a change in the gene COL3A1,

which codes for one of the collagen chains used to build Collage type III. Laboratory testing is available for this form of EDS. A skin biopsy may be used to demonstrate the structurally abnormal collagen. This type of biochemical test identifies more than 95% of individuals with EDS vascular type. Laboratory testing is recommended for individuals with two or more of the major criteria.

DNA analysis may als be used to identify the change within the COL3A1 gene. This information may be helpful for **genetic counseling** purposes. Prenatal testing is available for pregnancies in which an affected parent has been identified and their DNA mutation is known or their biochemical defect has been demonstrated.

Kyphoscoliosis type

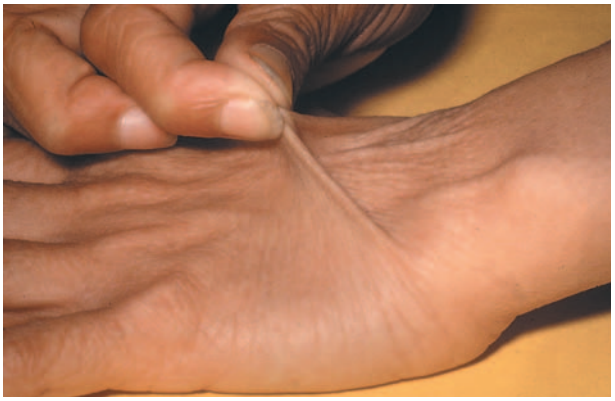
The major symptoms of kyphoscoliosis type, formerly called EDS type VI, are general joint looseness. At birth, the muscle tone is poor, and motor skill development is subsequently delayed. Also, infants with this type of EDS have an abnormal curvature of the spine (**scoliosis**). The scoliosis becomes progressively worse with age, with affected individuals usually unable to walk by age 20. The eyes and skin are fragile and easily damaged, and blood vessel involvement is a possibility. The bones may also be affected as demonstrated by a decrease in bone mass. Kyphoscoliosis type is inherited in an autosomal recessive manner.

There are four major clinical diagnostic criteria for EDS kyphoscoliosis type. These include generaly loose joints, low muscle tone at birth, scoliosis at birth (which worsens with age), and a fragility of the eyes, which may give the white area of the eye a blue tint or cause the eye to rupture. This form of EDS is caused by a change in the PLOD gene on chromosome 1, which encodes the enzyme lysyl hydroxylase. A laboratory test is available in which urinary hydroxylysyl pryridinoline is measured. This test, performed on urine is extremely senstive and specific for EDS kyphoscolios type. Laboratory testing is recommended for infants with three or more of the major diagnostic criteria.

Prenatal testing is available if a pregnancy is known to be at risk and an identified affected family member has had positive laboratory testing. An **amniocentesis** may be performed in which fetal cells are removed from the amniotic fluid and enzyme activity is measured.

Arthrochalasia type

Dislocation of the hip joint typically accompanies arthrochalasia type EDS, formerly called EDS type VIIB. Other joints are also unusually loose, leading to recurrent partial and total dislocations. The skin has a high degree of stretchability and bruises easily. Individuals with this type of EDS may also experience mildly diminished bone mass, scoliosis, and poor muscle tone. Arthrochalasia type is inherited in an autosomal dominant manner.



Elasticity of the skin is one characteristic of this rare disorder. *(Photograph by Biophoto Associates, Photo Researchers, Inc. Reproduced by permission.)*

There are two major clinical diagnostic criteria for EDS arthrochalasia type. These include sever generalized joing hypermobility and bilateral hip dislocation present at birth. This form of EDS is caused by a change in either of two components of Collage type I, called proa1(I) type A and proa2(I) type B. A skin biopsy may be preformed to demonstrate an abnormality in either components. Direct DNA testing is also available.

Dermatosparaxis type

Individuals with this type of EDS, once called type VIIC, have extremely fragile skin that bruises easily but does not scar excessively. The skin is soft and may sag, leading to an aged appearance even in young adults. Individuals may also experience hernias. Dermatosparaxis type is inherited in an autosomal recessive manner.

There are two major clinical diagnostic criteria for EDS dematosparaxis type. These include severe skin fragility and sagging or aged appearing skin. This form of EDS is caused by a change in the enzyme called procollagen I N-terminal peptidase. A skin biopsy may be preformed for a definitive diagnosis of Dermatosparaxis type.

Other types

There are several other forms of EDS that have not been as clearly defined as the aforementioned types. Forms of EDS within this category may present with soft, mildly stretchable skin, shortened bones, chronic **diarrhea**, joint hypermobility and dislocation, bladder rupture, or poor wound healing. Inheritance patterns within this group include X-linked recessive, autosomal dominant, and autosomal recessive.

KEY TERMS

Arthrochalasia—Excessive loosness of the joints.

Blood vessels—General term for arteries, veins, and capillaries that transport blood throughout the body.

Cartilage—Supportive connective tissue that cushions bone at the joints or which connects muscle to bone.

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Connective tissue—A group of tissues responsible for support throughout the body; includes cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

Dermatosparaxis—Skin fragility caused by abnormal collagen.

Hernia—A rupture in the wall of a body cavity, through which an organ may protrude.

Homeopathic—A holistic and natural approach to healthcare.

Hyperextensibility—The ability to extend a joint beyond the normal range.

Hypermobility—Unusual flexibility of the joints, allowing them to be bent or moved beyond their normal range of motion.

Joint dislocation—The displacement of a bone.

Kyphoscoliosis—Abnormal front-to-back and side-to-side curvature of the spine.

Ligament—A type of connective tissue that connects bones or cartilage and provides support and strength to joints.

Osteoarthritis—A degenerative joint disease that causes pain and stiffness.

Scoliosis—An abnormal, side-to-side curvature of the spine.

Tendon—A strong connective tissue that connects muscle to bone.

Uterus—A muscular, hollow organ of the female reproductive tract. The uterus contains and nourishes the embryo and fetus from the time the fertilized egg is implanted until birth.

Vascular—Having to do with blood vessels.

Causes and symptoms

There are numerous types of EDS, all caused by changes in one of several genes. The manner in which EDS is inherited depends on the specific gene involved. There are three patterns of inheritance for EDS: autosomal dominant, autosomal recessive, and X-linked (extremely rare).

Chromosomes are made up of hundreds of small units known as genes, which contain the genetic material necessary for an individual to develop and function. Humans have 46 chromosomes, which are matched into 23 pairs. Because chromosomes are inherited in pairs, each individual receives two copies of each chromosome and likewise two copies of each gene.

Changes or mutations in genes can cause genetic diseases in several different ways, many of which are represented within the spectrum of EDS. In autosomal dominant EDS, only one copy of a specific gene must be changed for a person to have EDS. In autosomal recessive EDS, both copies of a specific gene must be changed for a person to have EDS. If only one copy of an autosomal recessive EDS gene is changed the person is referred to as a carrier, meaning they do not have any of the signs or symptoms of the disease itself, but carry the possibility of passing on the disorder to a future child. In X-linked EDS a specific gene on the X chromosome must be changed. However, this affects males and females differently because males and females have a different number of X chromosomes.

As of 2001 the few X-linked forms of EDS fall under the category of X-linked recessive. As with autosomal recessive, this implies that both copies of a specific gene must be changed for a person to be affected. However, because males only have one X-chromosome, they are affected if an X-linked recessive EDS gene is changed on their single X-chromosome. That is, they are affected even though they have only one changed copy. On the other hand, that same gene must be changed on both of the X-chromosomes in a female for her to be affected.

Although there is much information regarding the changes in genes that cause EDS and their various inheritance patterns, the exact gene mutation for all types of EDS is not known.

Diagnosis

Clinical symptoms such as extreme joint looseness and unusual skin qualities, along with family history, can

lead to a diagnosis of EDS. Specific tests, such as skin biopsies are available for diagnosis of certain types of EDS, including vascular, arthrochalasia, and dermatosparaxis types. A skin biopsy involves removing a small sample of skin and examining its microscopic structure. A urine test is available for the Kyphoscoliosis type.

Management of all types of EDS may include genetic counseling to help the affected individual and their family understand the disorder and its impact on other family members and future children.

If a couple has had a child diagnosed with EDS the chance that they will have another child with the same disorder depends on with what form of EDS the child has been diagnosed and if either parent is affected by the same disease or not.

Individuals diagnosed with an autosomal dominant form of EDS have a 50% chance of passing the same disorder on to a child in each pregnancy. Individuals diagnosed with an autosomal recessive form of EDS have an extremely low risk of having a child with the same disorder.

X-linked recessive EDS is accompanied by a slightly more complicated pattern of inheritance. If a father with an X-linked recessive form of EDS passes a copy of his X chromosome to his children, the sons will be unaffected and the daughters will be carriers. If a mother is a carrier for an X-linked recessive form of EDS, she may have affected or unaffected sons, or carrier or unaffected daughters, depending on the second sex chromosome inherited from the father.

Prenatal diagnosis is available for specific forms of EDS, including kyphosocliosis type and vascular type. However, prenatal testing is only a possibility in these types if the underlying defect has been found in another family member.

Treatment

Medical therapy relies on managing symptoms and trying to prevent further complications. There is no cure for EDS.

Braces may be prescribed to stabilize joints, although surgery is sometimes necessary to repair joint damage caused by repeated dislocations. Physical therapy teaches individuals how to strengthen muscles around joints and may help to prevent or limit damage. Elective surgery is discouraged due to the high possibility of complications.

Alternative treatment

There are anecdotal reports that large daily doses 0.04–0.14 oz (1–4 g) of vitamin C may help decrease bruising and aid in wound healing. Constitutional homeopathic treatment may be helpful in maintaining optimal health in persons with a diagnosis of EDS. An individual with EDS should discuss these types of therapies with their doctor before beginning them on their own. Therapy that does not require medical consultation involves protecting the skin with sunscreen and avoiding activities that place **stress** on the joints.

Prognosis

The outlook for individuals with EDS depends on the type of EDS with which they have been diagnosed. Symptoms vary in severity, even within one sub-type, and the frequency of complications changes on an individual basis. Some individuals have negligible symptoms while others are severely restricted in their daily life. Extreme joint instability and scoliosis may limit a person's mobility. Most individuals will have a normal lifespan. However, those with blood vessel involvement, particularly those with EDS vascular type, have an increased risk of fatal complications.

EDS is a lifelong condition. Affected individuals may face social obstacles related to their disease on a daily basis. Some people with EDS have reported living with fears of significant and painful skin ruptures, becoming pregnant (especially those with EDS vascular type), their condition worsening, becoming unemployed due to physical and emotional burdens, and social stigmatization in general.

Constant bruises, skin **wounds**, and trips to the hospital take their toll on both affected children and their parents. Prior to diagnosis parents of children with EDS have found themselves under suspicion of **child abuse**.

Some people with EDS are not diagnosed until well into adulthood and, in the case of EDS vascular type, occasionally not until after death due to complications of the disorder. Not only may the diagnosis itself be devastating to the family, but in many cases other family members find out for the first time they are at risk for being affected.

Although individuals with EDS face significant challenges, it is important to remember that each person is unique with their own distinguished qualities and potential. Persons with EDS go on to have families, to have careers, and to be accomplished citizens, surmounting the challenges of their disease.

Resources

PERIODICALS

"Clinical and Genetic Features of Ehlers-Danlos Syndrome Type IV, the Vascular Type." *The New England Journal of Medicine* 342, no. 10 (2000).

"Ehlers-Danlos Syndromes: Revised Nosology, Villefranche, 1997." *American Journal of Medical Genetics* 77 (1998): 31–37.
"Living a Restricted Life with Ehlers-Danlos Syndrome." *International Journal of Nursing Studies* 37 (2000): 111–118.

ORGANIZATIONS

Elhers-Danlos National Foundation. 6399 Wilshire Blvd., Ste 203, Los Angeles, CA 90048 (323) 651-3038. Fax: (323) 651-1366. <http://www.ednf.org>.
Ehlers-Danlos Support Group- UK. PO Box 335, Farnham, Surrey, GU10 1XJ. UK. <http://www. atv.ndirect.co.uk>.

OTHER

GeneClinics. <http://www.geneclinics.org>.

Java O. Solis, MS

Ehrlichiosis

Definition

Ehrlichiosis is a bacterial infection that is spread by ticks. Symptoms include **fever**, chills, **headache**, muscle aches, and tiredness.

Description

Ehrlichiosis is a tick-borne disease caused by infection with *Ehrlichia* bacteria. Ticks are small, blood-sucking arachnids. Although some ticks carry disease-causing organisms, most do not. When an animal or person is bitten by a tick that carries bacteria, the bacteria are passed to that person or animal during the tick's feeding process. It is believed that the tick must remain attached to the person or animal for at least 24 hours to spread the infection.

There are two forms of ehrlichiosis in the United States; human monocytic ehrlichiosis and human granulocytic ehrlichiosis. Monocytic ehrlichiosis is caused by *Ehrlichia chaffeensis*, which is spread by the Lone Star tick, *Amblyomma americanum*. As of early 1998, about 400 cases of monocytic ehrlichiosis had been reported in 30 states, primarily in the southeastern and south central United States. The bacteria that causes granulocytic ehrlichiosis is not known, but suspected to be either *Ehrlichia equi* or *Ehrlichia phagocytophila*. Granulocytic ehrlichiosis is probably spread by the blacklegged tick *Ixodes scapularis* (which also spreads **Lyme disease**). About 100 cases of granulocytic ehrlichiosis have been reported in Connecticut, Massachusetts, Rhode Island, Minnesota, New York, and Wisconsin.

Causes and symptoms

Both forms of ehrlichiosis have similar symptoms, and the illnesses can range from mild to severe and life-threatening. Risk factors include old age and exposure to ticks through work or recreation. Symptoms occur seven to 21 days following a tick bite although patients may not recall being bitten. Fever, tiredness, headache, muscle aches, chills, loss of appetite, confusion, nausea, and vomiting are common to both diseases. A rash may occur.

Diagnosis

Ehrlichiosis may be diagnosed and treated by doctors who specialize in blood diseases (hematologists) or an infectious disease specialist. Because ehrlichiosis is not very common and the symptoms are not unique, it may be misdiagnosed. A recent history of a tick bite is helpful in the diagnosis. Blood tests will be done to look for antibodies to *Ehrlichia*. Staining and microscopic examination of the blood sample may show *Ehrlichia* bacteria inside white blood cells. Another test, called polymerase chain reaction (PCR), is a very sensitive assay to detect bacteria in the blood sample, but it is not always available.

Treatment

Antibiotic treatment should begin immediately if ehrlichiosis is suspected, even if laboratory results are not available. Treatment with either tetracycline (Sumycin, Achromycin V) or doxycycline (Monodox, Vibramycin) is recommended. Many patients with ehrlichiosis are admitted to the hospital for treatment.

Prognosis

For otherwise healthy people, a full recovery is expected following treatment for ehrlichiosis. Elderly patients are at a higher risk for severe disease, which may be fatal. Serious complications include lung or gastrointestinal bleeding. Two to 10 patients out of 100 die from the disease.

Prevention

The only prevention for ehrlichiosis is to minimize exposure to ticks by staying on the trail when walking through the woods, avoiding tall grasses, wearing long sleeves and tucking pant legs into socks, wearing insect

KEY TERMS

Tick-borne disease—A disease that is spread to animals by the bite of an infected tick.

repellent, and checking for ticks after an outing. Remove a tick as soon as possible by grasping the tick with tweezers and gently pulling.

Resources

BOOKS

McDade, Joseph E., and James G. Olsen. "Ehrlichiosis, Q Fever, Typhus, Rickettsialpox, and Other Rickettsioses." In *Infectious Diseases*. 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

EKG *see* **Electrocardiography**

Elder abuse *see* **Abuse**

Electric shock injuries

Definition

Electric shock injuries are caused by lightning or electric current from a mechanical source passing through the body.

Description

Electric shocks are responsible for about 1,000 deaths in the United States each year, or about 1% of all accidental deaths.

Causes and symptoms

The severity of injury depends on the current's pressure (voltage), the amount of current (amperage), the type of current (direct vs. alternating), the body's resistance to the current, the current's path through the body, and how long the body remains in contact with the current. The interplay of these factors can produce effects ranging from barely noticeable tingling to instant **death**; every part of the body is vulnerable. Although the severity of injury is determined primarily by the voltage, low voltage can be just as dangerous as high voltage under the right circumstances. People have been killed by shocks of just 50 volts.

How electric shocks affect the skin is determined by the skin's resistance, which in turn is dependent upon the wetness, thickness, and cleanliness of the skin. Thin or wet skin is much less resistant than thick or dry skin. When skin resistance is low, the current may cause little or no skin damage but severely burn internal organs and tissues. Conversely, high skin resistance can produce severe skin **burns** but prevent the current from entering the body.

The nervous system (the brain, spinal cord, and nerves) is particularly vulnerable to injury. In fact, neurological problems are the most common kind of nonlethal harm suffered by electric shock victims. Some neurological damage is minor and clears up on its own or with medical treatment, but some is severe and permanent. Neurological problems may be apparent immediately after the accident, or gradually develop over a period of up to three years.

Damage to the respiratory and cardiovascular systems is most acute at the moment of injury. Electric shocks can paralyze the respiratory system or disrupt heart action, causing instant death. Also at risk are the smaller veins and arteries, which dissipate heat less easily than the larger blood vessels and can develop blood clots. Damage to the smaller vessels is probably one reason why **amputation** is often required following high-voltage injuries.

Many other sorts of injuries are possible after an electric shock, including **cataracts**, kidney failure, and substantial destruction of muscle tissue. The victim may suffer a fall or be hit by debris from exploding equipment. An electric arc may set clothing or nearby flammable substances on fire. Strong shocks are often accompanied by violent muscle spasms that can break and dislocate bones. These spasms can also freeze the victim in place and prevent him or her from breaking away from the source of the current.

Diagnosis

Diagnosis relies on gathering information about the circumstances of the accident, a thorough **physical examination**, and monitoring of cardiovascular and kidney activity. The victim's neurological condition can fluctuate rapidly and requires close observation. A computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) may be necessary to check for brain injury.

Treatment

When an electric shock accident happens at home or in the workplace, the main power should immediately be

KEY TERMS

Antibiotics—Substances used against microorganisms that cause infection.

Cataract—Clouding of the lens of the eye or its capsule (surrounding membrane).

Computed tomography scan (CT scan)—A process that uses x rays to create three-dimensional images of structures inside the body.

Electrolytes—Substances that conduct electric current within the body and are essential for sustaining life.

Magnetic resonance imaging (MRI)—The use of electromagnetic energy to create images of structures inside the body.

Skin grafting—A technique in which a piece of healthy skin from the patient's body (or a donor's) is used to cover another part of the patient's body that has lost its skin.

shut off. If that cannot be done, and current is still flowing through the victim, the alternative is to stand on a dry, nonconducting surface such as a folded newspaper, flattened cardboard carton, or plastic or rubber mat and use a nonconducting object such as a wooden broomstick (never a damp or metallic object) to push the victim away from the source of the current. The victim and the source of the current must not be touched while the current is still flowing, for this can electrocute the rescuer. Emergency medical help should be summoned as quickly as possible. People who are trained to perform **cardiopulmonary resuscitation** (**CPR**) should, if appropriate, begin first aid while waiting for emergency medical help to arrive.

Burn victims usually require treatment at a burn center. Fluid replacement therapy is necessary to restore lost fluids and electrolytes. Severely injured tissue is repaired surgically, which can involve **skin grafting** or amputation. **Antibiotics** and antibacterial creams are used to prevent infection. Victims may also require treatment for kidney failure. Following surgery, physical therapy to facilitate recovery, and psychological counseling to cope with disfigurement, may be necessary.

Prognosis

Electric shocks cause death in 3–15% of cases. Many survivors require amputation or are disfigured by their burns. Injuries from household appliances and other low-voltage sources are less likely to produce extreme damage.

Prevention

Parents and other adults need to be alert to possible electric dangers in the home. Damaged electric appliances, wiring, cords, and plugs should be repaired or replaced. Electrical repairs should be attempted only by people with the proper training. Hair dryers, radios, and other electric appliances should never be used in the bathroom or anywhere else they might accidentally come in contact with water. Young children need to be kept away from electric appliances and should be taught about the dangers of electricity as soon as they are old enough. Electric outlets require safety covers in homes with young children.

During thunderstorms, people should go indoors immediately, even if no rain is falling, and boaters should return to shore as rapidly as possible. People who cannot reach indoor shelter should move away from metallic objects such as golf clubs and fishing rods and lie down in low-ground areas. Standing or lying under or next to tall or metallic structures is unsafe. An automobile is appropriate cover, as long as the radio is off. Telephones, computers, hair dryers, and other appliances that can act as conduits for lightning should not be used during thunderstorms.

Resources

BOOKS

Dimick, Alan R. "Electrical Injuries." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Howard Baker

Electrical nerve stimulation

Definition

Electrical nerve stimulation, also called transcutaneous electrical nerve stimulation (TENS), is a noninvasive, drug-free **pain management** technique. By sending electrical signals to underlying nerves, the battery-powered TENS device can relieve a wide range of chronic and acute **pain**.

Purpose

TENS is used to relieve pain caused by a variety of chronic conditions, including:

- neck and lower back pain
- headache/migraine
- arthritis
- post-herpetic **neuralgia** (lingering chronic pain after an attack of **shingles**)

- sciatica (pain radiating from lower back, through the legs, to the foot)
- temporomandibular joint pain
- osteoarthritis
- amputation (phantom limb)
- fibromyalgia (a condition causing aching and stiffness throughout the body)

The device is also effective against short-term pain, such as:

- shingles (painful skin eruptions along the nerves)
- bursitis (inflammation of tissue surrounding a joint)
- childbirth
- post-surgical pain
- fractures
- muscle and joint pain
- sports injuries
- menstrual cramps

Precautions

Because TENS may interfere with pacemaker function, patients with **pacemakers** should consult a cardiologist before using a TENS unit. Patients should also avoid electrical stimulation in the front of the neck, which can be hazardous. The safety of the device during **pregnancy** has not been established.

TENS doesn't cure any condition; it simply eases pain. Patients who are not sure what is causing their pain should consult a physician before using TENS.

Description

The TENS device is a small battery-powered stimulator that produces low-intensity electrical signals through electrodes on or near a painful area, producing a tingling sensation that reduces pain. There is no dosage limitation, and the patient controls the amount of pain relief.

Some experts believe TENS works by blocking pain signals in the spinal cord, or by delivering electrical impulses to underlying nerve fibers that lessen the experience of pain. Others suspect that the electrical stimulation triggers the release of natural painkillers in the body.

Patients can rent a TENS unit before buying one, to see if it is effective against their pain.

Preparation

After TENS has been prescribed, a doctor will refer the patient to a TENS specialist, who will explain how to use the machine. The specialist works with the patient to determine the settings and electrode placements for the best pain relief.

KEY TERMS

Fibromyalgia—A condition characterized by aching and stiffness, fatigue and poor sleep, as well as tenderness at various sites on the body.

Osteoarthritis—A painful joint disease aggravated by mechanical stress.

Phantom limb—The perception that a limb is present (and throbbing with pain) after it has been amputated.

Post-herpetic neuralgia—Lingering pain that can last for years after an attack of shingles.

Sciatica—Pain that radiates along the sciatic nerve, extending from the buttock down the leg to the foot.

Temporomandibular joint pain (TMJ)—Pain and other symptoms affecting the head, jaw, and face that are caused when the jaw joints and muscles controlling them don't work together correctly.

Risks

TENS is nonaddictive and completely safe. The only side effect may be a slight skin irritation or redness in some people, which can be prevented by using different gels or electrodes.

Normal results

The amount of relief a person gets using TENS depends on the underlying cause of the pain, a person's mental state, and whether or not medication is also used. At least one study found that both a real TENS machine and a placebo were equally effective in reducing pain. This suggests that at least part of its effectiveness may be due to the patient's belief in its ability to ease pain.

Carol A. Turkington

Electrical stimulation of the brain

Definition

Electrical stimulation of the brain (ESB) is a relatively new technique used to treat chronic **pain** and

KEY TERMS

Infarction—A sudden insuffiency of local blood supply.

Neuralgia—Pain extending along one or more nerves.

Neuropathy—A functional disturbance or change in the nervous system.

Parkinson disease—A chronic neurological illness that causes tremors, stiffness, and difficulty in moving and walking.

tremors associated with **Parkinson disease**. ESB is administered by passing an electrical current through an electrode implanted in the brain.

Purpose

While the implantation of electrodes in the brain is used to treat or diagnose several disorders, the term ESB is limited here to the treatment of tremors, and as a **pain management** tool for patients suffering from back problems and other chronic injuries and illnesses.

Precautions

An ESB tremor control device, used in treating Parkinson patients, may interfere with or be affected by cardiac **pacemakers** and other medical equipment. As a result, patients with other implanted medical equipment may not be good candidates for the therapy.

Description

Electrical stimulation of the brain, or deep brain stimulation, is effective in treating tremors in up to 88% of Parkinson disease patients. An electrode is implanted into the thalamus (part of the brain) of the patient, and attached to an electric pulse generator via an extension wire. The pulse generator is implanted into the patient's pectoral, or chest area, and the extension wire is tunneled under the skin. The pulse generator sends out intermittent electrical stimulation to the electrode in the thalamus, which inhibits or partially relieves the tremor. The generator can be turned on and off with a magnet, and needs to be replaced every three to five years.

Similar methods have been used to treat chronic pain that responded unfavorably to conventional therapies. A remote transmitter allows these patients to trigger electric stimulation to relieve their symptoms on an as-needed basis. Patients with failed back syndrome, trigeminal neuropathy (pertaining to the fifth cranial nerve), and **peripheral neuropathy** fared well for pain control with this treatment, while patients with **spinal cord injury** and postherpetic neuralagia (pain along the nerves following herpes) did poorly.

Preparation

The patient should be free of any type of infection before undergoing an ESB procedure. He or she may be advised to discontinue any medication for a prescribed period of time before surgery.

Aftercare

After neurosurgery, patients should undergo regular head dressing changes, minimize exposure to others, and practice good personal hygiene in order to prevent a brain infection. The head may also be kept elevated for a prescribed period of time in order to decrease swelling of the brain.

Risks

The implantation of electrodes into the brain carries risks of hemorrhage, infarction, infection, and cerebral **edema**. These complications could cause irreversible neurological damage.

Patients with an implanted ESB tremor control device may experience headaches, disequilibrium (a disturbance of the sense of balance), burning or tingling of the skin, or partial **paralysis**.

Normal results

ESB is effective in pain control for specific conditions. It can provide long-term pain relief with few side effects or complications.

For the control of tremors a deep brain stimulator does provide some relief. It is recommended for patients with tremors severe enough to affect their quality of life.

Resources

PERIODICALS

Dewar, Sandra, et al. "Intracranial Electrode Monitoring for Seizure Localization: Indications, Methods and Prevention of Complications." *Journal of Neuroscience Nursing* 28, no. 5 (Oct. 1996):. 280 8.

Kumar, K., C. Toth, and R. K. Nath. "Deep Brain Stimulation for Intractable Pain: A 15-Year Experience." *Neurosurgery* 40, no. 4 (Apr. 1997): 736 46.

Oostra, K., M. Van Laere, and B. Scheirlinck. "Use of Electrical Stimulation in Brain-Injured Patients: A Case Report." *Brain Injury* 11, no. 10 (Oct. 1997): 761 4.

OTHER

The Parkinson's Web. <http://pdweb.mgh.harvard.edu>.
University of Southern California. *The ANGEL Neurosurgical Information Resource*. <http://www.usc.edu/hsc/neurosurgery/angel.html>.

Paula Anne Ford-Martin

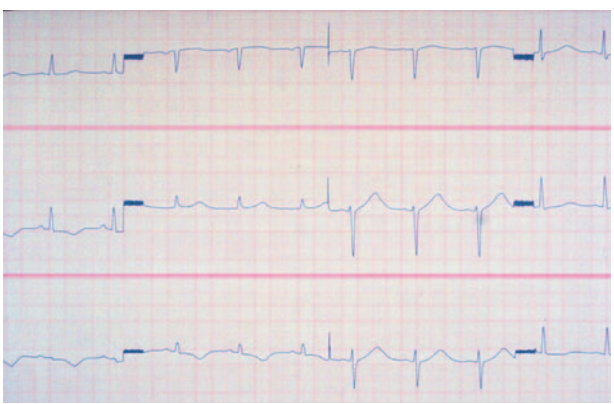
Electrocardiography

Definition

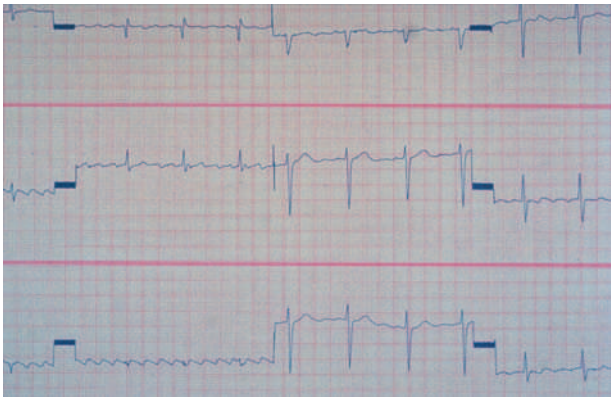
Electrocardiography is a commonly used, non-invasive procedure for recording electrical changes in the heart. The record, which is called an electrocardiogram (ECG or EKG), shows the series of waves that relate to the electrical impulses which occur during each beat of the heart. The results are printed on paper or displayed on a monitor. The waves in a normal record are named P, Q, R, S, and T and follow in alphabetical order. The number of waves may vary, and other waves may be present.

Purpose

Electrocardiography is a starting point for detecting many cardiac problems. It is used routinely in physical examinations and for monitoring the patient's condition during and after surgery, as well as during intensive care. It is the basic measurement used for tests such as **exercise** tolerance. It is used to evaluate causes of symptoms such as chest **pain**, **shortness of breath**, and **palpitations**.



This EKG strip shows evidence of Wolff-Parkinson-White syndrome. *(Custom Medical Stock Photo. Reproduced by permission.)*



An EKG strip indicting atrial flutter. *(Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

No special precautions are required.

Description

The patient disrobes from the waist up, and electrodes (tiny wires in adhesive pads) are applied to specific sites on the arms, legs, and chest. When attached, the electrodes are called leads; three to 12 leads may be employed.

Muscle movement may interfere with the recording, which lasts for several beats of the heart. In cases where rhythm disturbances are suspected to be infrequent, the patient may wear a small Holter monitor in order to record continuously over a 24-hour period; this is known as ambulatory monitoring.

Preparation

The skin is cleaned to obtain good electrical contact at the electrode positions.

Aftercare

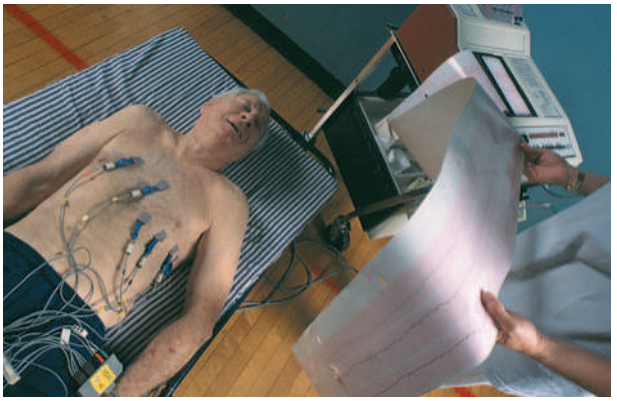
To avoid skin irritation from the salty gel used to obtain good electrical contact, the skin should be thoroughly cleaned after removal of the electrodes.

Risks

No complications from this procedure have been observed.

Normal results

When the heart is operating normally, each part contracts in a specific order. Contraction of the muscle is



A patient undergoing electrocardiography. *(Russell Curtis, Photo Researchers. Reproduced by permission.)*

triggered by an electrical impulse. These electrical impulses travel through specialized cells that form a conduction system. Following this pathway ensures that contractions will occur in a coordinated manner.

When the presence of all waves is observed in the electrocardiogram and these waves follow the order defined alphabetically, the heart is said to show a normal sinus rhythm, and impulses may be assumed to be following the regular conduction pathway.

The heart is described as showing arrhythmia or dysrhythmia when time intervals between waves, the order, or the number of waves do not fit this pattern. Other features that may be altered include the direction of wave deflection and wave widths.

In the normal heart, electrical impulses—at a rate of 60–100 times per minute—originate in the sinus node. The sinus node is located in the first chamber, known as the right atrium, where blood re-enters the heart. After traveling down to the junction between the upper and lower chambers, the signal stimulates the atrioventricular node. From here, after a delay, it passes by specialized routes through the lower chambers or ventricles. In many disease states, the passage of the electrical impulse can be interrupted in a variety of ways, causing the heart to perform less efficiently.

Abnormal results

Special training is required for interpretation of the electrocardiogram. To summarize the features used in interpretations in the simplest manner, the P wave of the electrocardiogram is associated with the contraction of the atria. The QRS series of waves, or QRS complex, is associated with ventricular contraction, with the T wave coming after the contraction. Finally, the P-Q or P-R interval gives a value for the time taken for the electrical impulse to travel from the atria to the ventricle (normally less than 0.2 sec).

KEY TERMS

Ambulatory monitoring—ECG recording over a prolonged period during which the patient can move around.

Arrhythmia or dysrhythmia—Abnormal rhythm in hearts that contract in an irregular way.

ECG or EKG—A record of the waves that relate to the electrical impulses produced at each beat of the heart.

Electrodes—Tiny wires in adhesive pads that are applied to the body for ECG measurement.

Fibrillation—Rapid, uncoordinated contractions of the upper or the lower chambers of the heart.

Lead—Name given the electrode when it is attached to the skin.

The cause of dysrhythmia is ectopic beats. Ectopic beats are premature heart beats that arise from a site other than the sinus node—commonly from the atria, atrioventricular node, or the ventricle. When these dysrhythmias are only occasional, they may produce no symptoms, or a feeling of the heart turning over or "flip-flopping" may be experienced. These occasional dysrhythmias are common in healthy people, but they also can be an indication of heart disease.

The varied sources of dysrhythmias provide a wide range of alterations in the form of the electrocardiogram. Ectopic beats that start in the ventricle display an abnormal QRS complex. This can indicate disease associated with insufficient blood supply to the muscle (myocardial **ischemia**). Multiple ectopic sites lead to rapid and uncoordinated contractions of the atria or ventricles. This condition is known as fibrillation. In atrial fibrillation, P waves are absent, and the QRS complex appears at erratic intervals, or "irregularly irregular."

When the atrial impulse fails to reach the ventricle, a condition known as **heart block** results. If this is partial, the P-R interval (the time for the impulse to reach the ventricle) is prolonged. If complete, the ventricles beat independently of the atria at about 40 beats per minute, and the QRS complex is mostly dissociated from the P wave.

Resources

BOOKS

Atwood, Sandra, et al. *Introduction to Basic Cardiac Dysrhythmias*. St. Louis: Mosby, 1990.

Conover, Mary Boudreau. *Understanding Electrocardiography.* St. Louis: Mosby, 1996.
Walter, John B. *Introduction to the Principles of Disease.* Philadelphia: W. B. Saunders Co., 1992.

PERIODICALS

Morton, Patricia Gonce. "Using the 12-Lead ECG to Detect Ischemia, Injury, and Infarction." *Critical Care Nurse* (Apr. 1996): 85-95.
Van Riper, Sharon, and Ann Luciano. "Basic Cardiac Arrhythmias: A Review for Postanesthesia Care Unit Nurses." *Journal of Postanesthesia Nursing* (Feb. 1994): 2-13.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Alison M. Grant

Electroconvulsive therapy

Definition

Electroconvulsive therapy (ECT) is a medical treatment for severe mental illness in which a small, carefully controlled amount of electricity is introduced into the brain. This electrical stimulation, used in conjunction with anesthesia and muscle relaxant medications, produces a mild generalized seizure or convulsion. While used to treat a variety of psychiatric disorders, it is most effective in the treatment of severe depression, and provides the most rapid relief currently available for this illness.

Purpose

The purpose of electroconvulsive therapy is to provide relief from the signs and symptoms of mental illnesses such as severe depression, **mania**, and **schizophrenia**. ECT is indicated when patients need rapid improvement because they are suicidal, self-injurious, refuse to eat or drink, cannot or will not take medication as prescribed, or present some other danger to themselves. Antidepressant medications, while effective in many cases, may take two to six weeks to produce a therapeutic effect. Antipsychotic medications used to treat mania and schizophrenia have many uncomfortable and sometimes dangerous side effects, limiting their use. In addition, some patients develop **allergies** and therefore are unable to take their medicine.

Precautions

The most common risks associated with ECT are disturbances in heart rhythm. Broken or dislocated bones occur very rarely.

Description

The treatment of severe mental illness, such as schizophrenia, using electroconvulsive therapy was introduced in 1938 by two Italian doctors named Cerletti and Bini. In those days many doctors believed that convulsions were incompatible with schizophrenia since, according to their obervations, this disease rarely occurred in individuals suffering from epilepsy. They concluded, therefore, that if convulsions could be artifically produced in patients with schizophrenia, the illness could be cured. Some doctors were already using a variety of chemicals to produce seizures, but many of their patients died or suffered severe injuries because the strength of the convulsions could not be well controlled.

Electroconvulsive therapy is among the most controversial of all procedures used to treat mental illness. When it was first introduced, many people were frightened simply because it was called "shock treatment." Many assumed the procedure would be painful, others thought it was a form of electrocution, and still others believed it would cause brain damage. Unfortunately, unfavorable publicity in newspapers, magazines, and movies added to these fears.

Indeed, in those early years, patients and families were rarely educated by doctors and nurses regarding this or other forms of psychiatric treatment. In addition, no anesthesia or **muscle relaxants** were used. As a result, patients had violent seizures, and even though they did not remember them, the procedure itself was frightening.

The way these treatments are given today is very different from the procedures used in the past. Currently, ECT is offered on both an inpatient and outpatient basis. Hospitals have specially equipped rooms with oxygen, suction, and **cardiopulmonary resuscitation** (**CPR**) in order to deal with the rare emergency.

The treatment is carried out as follows: approximately 30 minutes before the scheduled treatment time, the patient may receive an injection of a medication (such as atropine) that keeps the pulse rate from decreasing too much during the convulsion. Next, the patient is placed on a cot and hooked up to a machine that automatically takes and displays vital signs (temperature, pulse, respiration, and blood pressure) on a television-like monitor. A mild anesthetic is then injected into a vein, followed by a medication (such a Anectine) that relaxes all of the muscles in the body so that the seizure is mild, and the risk of broken bones is virtually eliminated.

When the patient is both relaxed and asleep, an airway is placed in the mouth to aid with breathing. Electrodes are placed on the sides of the head in the temple areas. An electric current is passed through the brain by means of a machine specifically designed for this pur-

pose. The usual dose of electricity is 70–150 volts for 0.1–0.5 seconds. In the first stage of the seizure (tonic phase), the muscles in the body that have not been paralyzed by medication contract for a period of five to 15 seconds. This is followed by the second stage (clonic phase) that is characterized by twitching movements, usually visible only in the toes or in a non-paralyzed arm or leg. These are caused by alternating contraction and relaxation of these same muscles. This stage lasts approximately 10–60 seconds. The entire procedure, from beginning to end, lasts about 30 minutes.

The total number of treatments a patient will receive depends upon many factors such as age, diagnosis, the history of illness, family support, and response to therapy. Patients with depression, for example, usually require six to 12 treatments. Treatments are usually administered every other day, three times a week.

The electrodes may be placed on both sides of the head (bilateral) or one side (unilateral). While bilateral ECT appears to be somewhat more effective, unilateral ECT is preferred for individuals who experience prolonged confusion or forgetfulness following treatment. Many doctors begin treatment with unilateral ECT, then change to bilateral if the patient is not improving.

Post-treatment confusion and forgetfulness are common, though disturbing symptoms associated with ECT. Doctors and nurses must be patient and supportive by providing patients with factual information about recovery. Elderly patients, for example, may become increasingly confused and forgetful as the treatments continue. These symptoms usually subside with time, but a small minority of patients state that they have never fully recovered from these effects.

With the introduction of antipsychotics in the 1950s, the use of ECT became less frequent. These new medications provided relief for untold thousands of patients who suffered greatly from their illness. However, there are a number of side effects associated with these drugs, some of which are irreversible. Another drawback is that some medications do not produce a therapeutic effect for two to six weeks. During this time the patient may present a danger to himself or others. In addition, there are patients who do not respond to medicine or who have severe allergic reactions. For these individuals, ECT may be the only treatment that will help.

Preparation

Patients and relatives are prepared for ECT by being shown video tapes that explain both the procedure and the risks involved. The physician then answers any questions these individuals may have, and the patient is asked to sign an "Informed Consent Form." This gives the doctor and the hospital permission to administer the treatment.

KEY TERMS

Mania—A mood disorder in which a person experiences prolonged elation or irritability characterized by overactivity that can lead to exhaustion and medical emergencies.

Relapse—A return of the signs and symptoms of an illness.

Schizophrenia—A severe mental illness in which a person has difficulty distinguishing what is real from what is not real. It is often characterized by hallucinations, delusions, and withdrawal from people and social activities.

Once the form is signed, the doctor performs a complete **physical examination**, and orders a number of tests that can help identify any potential problem. These tests may include a **chest x ray**, an electrocardiogram (ECG), **urinalysis**, spinal x ray, brain wave (EEG), and complete **blood count** (CBC).

Some medications, such as lithium and a type of antidepressant known as **monoamine oxidase inhibitors**, should be discontinued for some time before treatment. Patients are instructed not to eat or drink for at least eight hours prior to the procedure in order to reduce the possibility of vomiting and **choking**.

Aftercare

After the treatment, patients are moved to a recovery area. Vital signs are recorded every five minutes until the patient is fully awake, which may take 15–30 minutes. Some initial confusion may be present but usually disappears in a matter of minutes. There may be complaints of **headache**, muscle **pain**, or back pain. Such discomfort is quickly relieved by mild medications such as **aspirin**.

Risks

Advanced medical technology has substantially reduced the complications associated with ECT. These include slow heart beat (bradycardia), rapid heart beat (tachycardia), memory loss, and confusion. Persons at high risk for ECT include those with recent **heart attack**, uncontrolled blood pressure, brain tumors, and previous spinal injuries.

Normal results

ECT often produces dramatic improvement in the signs and symptoms of major depression, especially in

elderly individuals, sometimes during the first week of treatment. While it is estimated that 50% of these patients will experience a future return of symptoms, the prognosis for each episode of illness is good. Mania also often responds well to treatment. The picture is not as bright for schizophrenia, which is more difficult to treat and is characterized by frequent relapses.

A few patients are placed on maintenance ECT. This means they return to the hospital every one to two months, as needed, for an additional treatment. These individuals are thus able to keep their illness under control and lead a normal and productive life.

Resources

BOOKS

Antai-Otong, Deborah. *Psychiatric Nursing: Biological and Behavioral Concepts*. Philadelphia: W. B. Saunders Co., 1995.

Haber, Judith, et al. *Comprehensive Psychiatric Nursing*. St. Louis: Mosby-Year Book, Inc., 1997.

Stuart, Gail W., and Michele T. Laraia. *Principles and Practice of Psychiatric Nursing*. St. Louis: Mosby-Year Book, Inc., 1998.

Townsend, Mary C. *Psychiatric Mental Health Nursing: Concepts of Care*. Philadelphia: F. A. Davis Co., 1996.

ORGANIZATIONS

National Institutes of Health. 5600 Fishers Lane. Room 7CO2, Rockville, MD 20857. (301) 496-4000. <http://www.nih.gov>.

Donald G. Barstow, RN

Electrocution *see* **Electric shock injuries**

Electroencephalography

Definition

Electroencephalography, or EEG, is a neurological test that uses an electronic monitoring device to measure and record electrical activity in the brain.

Purpose

The EEG is a key tool in the diagnosis and management of epilepsy and other seizure disorders. It is also used to assist in the diagnosis of brain damage and disease (e.g., **stroke**, tumors, **encephalitis**), **mental retardation**, **sleep disorders**, degenerative diseases such as **Alzheimer's disease** and **Parkinson's disease**, and certain mental disorders (e.g., **alcoholism**, **schizophrenia**, **autism**).

An EEG may also be used to monitor brain activity during surgery and to determine brain **death**.

Precautions

Electroencephalography should be administered and interpreted by a trained medical professional only. Data from an EEG is only one element of a complete medical and/or psychological patient assessment, and should never be used alone as the sole basis for a diagnosis.

Description

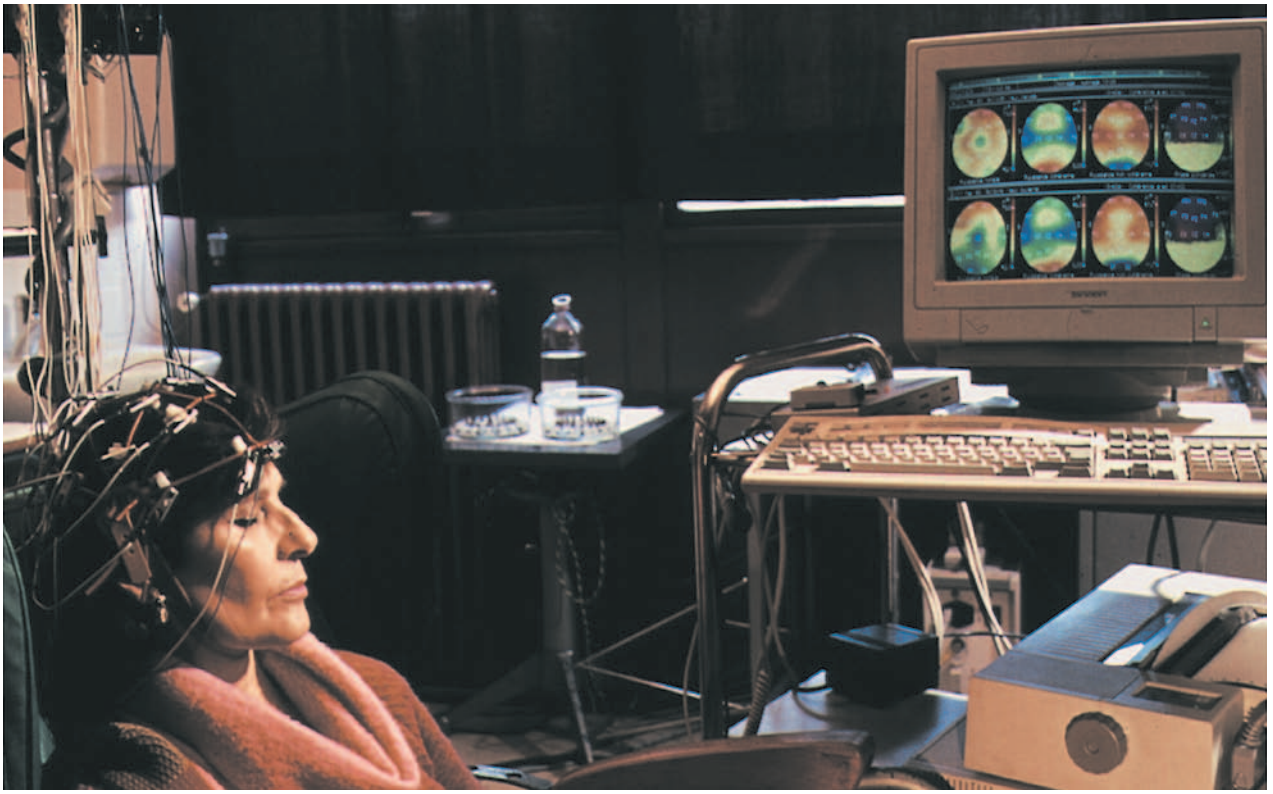
Before the EEG begins, a nurse or technician attaches approximately 16–20 electrodes to the patient's scalp with a conductive, washable paste. Depending on the purpose for the EEG, implantable or invasive electrodes are occasionally used. Implantable electrodes include sphenoidal electrodes, which are fine wires inserted under the zygomatic arch, or cheekbone; and depth electrodes, which are surgically-implanted into the brain. The EEG electrodes are painless, and are used to measure the electrical activity in various regions of the brain.

For the test, the patient lies on a bed, padded table, or comfortable chair and is asked to relax and remain still during the EEG testing period. An EEG usually takes no more than one hour. During the test procedure, the patient may be asked to breathe slowly or quickly; visual stimuli such as flashing lights or a patterned board may be used to stimulate certain types of brain activity. Throughout the procedure, the electroencephalograph machine makes a continuous graphic record of the patient's brain activity, or brainwaves, on a long strip of recording paper or on a computer screen. This graphic record is called an electroencephalogram.

The sleep EEG uses the same equipment and procedures as a regular EEG. Patients undergoing a sleep EEG are encouraged to fall asleep completely rather than just relax. They are typically provided a bed and a quiet room conducive to sleep. A sleep EEG lasts up to three hours.

In an ambulatory EEG, patients are hooked up to a portable cassette recorder. They then go about their normal activities, and take their normal rest and sleep for a period of up to 24 hours. During this period, the patient and patient's family record any symptoms or abnormal behaviors, which can later be correlated with the EEG to see if they represent seizures.

Many insurance plans provide reimbursement for EEG testing. Costs for an EEG range from $100 to more than $500, depending on the purpose and type of test (i.e., asleep or awake, and invasive or non-invasive electrodes). Because coverage may be dependent on the dis-



This woman is undergoing an electroencephalogram (EEG) to diagnose Alzheimer's disease. On the computer screen at the right are the colored scans of the electrical activity in her brain. Alzheimer's patients show a specific abnormality in their EEGs. *(Photograph by Catherine Pouedras, Photo Researchers, Inc. Reproduced by permission.)*

order or illness the EEG is evaluating, patients should check with their individual insurance plan.

Preparation

Full instructions should be given to EEG patients when they schedule their test. Typically, individuals on medications that affect the central nervous system, such as anticonvulsants, stimulants, or antidepressants, are told to discontinue their prescription for a short time prior to the test (usually one to two days). Patients may be asked to avoid food and beverages that contain **caffeine**, a central nervous system stimulant. However, any such request should be cleared by the treating physician. Patients may also be asked to arrive for the test with clean hair free of spray or other styling products.

Patients undergoing a sleep EEG may be asked to remain awake the night before their test. They may be given a sedative prior to the test to induce sleep.

Aftercare

If the patient has suspended regular medication for the test, the EEG nurse or technician should advise him when he can begin taking it again.

Risks

Being off medication for one to two days may trigger seizures. Certain procedures used during EEG may trigger seizures in patients with epilepsy. Those procedures include flashing lights and deep breathing. If the EEG is being used as a diagnostic for epilepsy (i.e., to determine the type of seizures an individual is suffering from), this may be a desired effect, although the patient needs to be monitored closely so that the seizure can be aborted if necessary. This type of test is known as an ictal EEG.

Normal results

In reading and interpreting brainwave patterns, a neurologist or other physician will evaluate the type of brainwaves and the symmetry, location, and consistency of brainwave patterns. He will also look at the brainwave response to certain stimuli presented during the EEG test (such as flashing lights or noise). There are four basic types of brainwaves: alpha, beta, theta, and delta. "Normal" brainwave patterns vary widely, depending on factors of age and activity. For example, awake and relaxed individuals typically register an alpha wave pattern of eight to 13 cycles per second. Young

KEY TERMS

Epilepsy—A neurological disorder characterized by recurrent seizures with or without a loss of consciousness.

Ictal EEG—Used to measure brain activity during a seizure. May be useful in learning more about patients who aren't responding to conventional treatments.

children and sleeping adults may have a delta wave pattern of under four cycles per second.

Abnormal results

The EEG readings of patients with epilepsy or other seizure disorders display bursts or spikes of electrical activity. In focal epilepsy, spikes are restricted to one hemisphere of the brain. If spikes are generalized to both hemispheres of the brain, multifocal epilepsy may be present.

The diagnostic brainwave patterns of other disorders varies widely. The appearance of excess theta waves (four to eight cycles per second) may indicate brain injury. Brain wave patterns in patients with brain disease, mental retardation, and brain injury show overall slowing. A trained medical specialist should interpret EEG results in the context of the patient's medical history, and other pertinent medical test results.

Resources

BOOKS

Niedermeyer, E., and F. Lopes da Silva, eds. *Electroencephalography: Basic Principles, Clinical Applications and Related Fields*. 3rd ed. Baltimore: Williams & Wilkins, 1993.

Restak, Richard M. *Brainscapes: An Introduction to What Neuroscience Has Learned About the Structure, Function, and Abilities of the Brain*. New York: Hyperion, 1995.

Paula Anne Ford-Martin

Electrolyte disorders

Definition

An electrolyte disorder is an imbalance of certain ionized salts (i.e., bicarbonate, calcium, chloride, magnesium, phosphate, potassium, and sodium) in the blood.

Description

Electrolytes are ionized molecules found throughout the blood, tissues, and cells of the body. These molecules, which are either positive (cations) or negative (anions), conduct an electric current and help to balance pH and acid-base levels in the body. Electrolytes also facilitate the passage of fluid between and within cells through a process known as *osmosis* and play a part in regulating the function of the neuromuscular, endocrine, and excretory systems.

The serum electrolytes include:

- Sodium (Na). A positively charged electrolyte that helps to balance fluid levels in the body and facilitates neuromuscular functioning.
- Potassium (K). A main component of cellular fluid, this positive electrolyte helps to regulate neuromuscular function and osmotic pressure.
- Calcium (Ca). A cation, or positive electrolyte, that affects neuromuscular performance and contributes to skeletal growth and blood coagulation.
- Magnesium (Mg). Influences muscle contractions and intracellular activity. A cation.
- Chloride (CI). An anion, or negative electrolyte, that regulates blood pressure.
- Phosphate (HPO4). Negative electrolyte that impacts metabolism and regulates acid-base balance and calcium levels.
- Bicarbonate (HCO3). A negatively charged electrolyte that assists in the regulation of blood pH levels. Bicarbonate insufficiencies and elevations cause acid-base disorders (i.e., acidosis, alkalosis).

Medications, chronic diseases, and trauma (i.e., **burns**, **fractures, etc.**) may cause the concentration of certain electrolytes in the body to become too high (hyper-) or too low (hypo-). When this happens, an electrolyte imbalance, or disorder, results.

Causes and symptoms

Sodium

HYPERNATREMIA. Sodium helps the kidneys to regulate the amount of water the body retains or excretes. Consequently, individuals with elevated serum sodium levels also suffer from a loss of fluids, or **dehydration**. **Hypernatremia** can be caused by inadequate water intake, excessive fluid loss (i.e., **diabetes insipidus**, kidney disease, severe burns, and prolonged vomiting or **diarrhea**), or sodium retention (caused by excessive sodium intake or aldosteronism). In addition, certain drugs,

including loop **diuretics**, **corticosteroids**, and antihypertensive medications may cause elevated sodium levels.

Symptoms of hypernatremia include:

- thirst
- orthostatic hypotension
- dry mouth and mucous membranes
- dark, concentrated urine
- loss of elasticity in the skin
- irregular heartbeat (tachycardia)
- irritability
- fatigue
- lethargy
- heavy, labored breathing
- muscle twitching and/or seizures

HYPONATREMIA. Up to 1% of all hospitalized patients develop **hyponatremia**, making it one of the most common electrolyte disorders. Diuretics, certain psychoactive drugs (i.e., fluoxetine, sertraline, haloperidol), specific antipsychotics (lithium), vasopressin, chlorpropamide, the illicit drug "ecstasy", and other pharmaceuticals can cause decreased sodium levels, or hyponatremia. Low sodium levels may also be triggered by inadequate dietary intake of sodium, excessive perspiration, water intoxication, and impairment of adrenal gland or kidney function.

Symptoms of hyponatremia include:

- nausea, abdominal cramping, and/or vomiting
- headache
- edema (swelling)
- muscle weakness and/or tremor
- paralysis
- disorientation
- slowed breathing
- seizures
- **coma**

Potassium

HYPERKALEMIA. **Hyperkalemia** may be caused by ketoacidosis (diabetic coma), myocardial infarction (**heart attack**), severe burns, kidney failure, **fasting**, **bulimia nervosa**, gastrointestinal bleeding, adrenal insufficiency, or **Addison's disease**. Diuretic drugs, cyclosporin, lithium, heparin, ACE inhibitors, **beta blockers**, and trimethoprim can increase serum potassium levels, as can heavy **exercise**. The condition may also be secondary to hypernatremia (low serum concentrations of sodium). Symptoms may include:

- weakness
- nausea and/or abdominal pain
- irregular heartbeat (arrhythmia)
- diarrhea
- muscle pain

HYPOKALEMIA. Severe dehydration, aldosteronism, **Cushing's syndrome**, kidney disease, long-term diuretic therapy, certain **penicillins**, laxative abuse, congestive **heart failure**, and adrenal gland impairments can all cause depletion of potassium levels in the bloodstream. A substance known as glycyrrhetinic acid, which is found in licorice and chewing tobacco, can also deplete potassium serum levels. Symptoms of **hypokalemia** include:

- weakness
- paralysis
- increased urination
- irregular heartbeat (arrhythmia)
- orthostatic hypotension
- muscle pain
- tetany

Calcium

HYPERCALCEMIA. Blood calcium levels may be elevated in cases of thyroid disorder, **multiple myeloma**, metastatic **cancer**, multiple bone fractures, milk-alkali syndrome, and Paget's disease. Excessive use of calcium-containing supplements and certain over-the-counter medications (i.e., **antacids**) may also cause **hypercalcemia**. Symptoms include:

- fatigue
- constipation
- depression
- confusion
- muscle pain
- nausea and vomiting
- dehydration
- increased urination
- irregular heartbeat (arrhythmia)

HYPOCALCEMIA. Thyroid disorders, kidney failure, severe burns, **sepsis**, **vitamin D deficiency**, and medications such as heparin and glucogan can deplete blood calcium levels. Lowered levels cause:

- muscle cramps and spasms
- tetany and/or convulsions
- mood changes (depression, irritability)
- dry skin

• brittle nails
• facial twitching

Magnesium

HYPERMAGNESEMIA. Excessive magnesium levels may occur with end-stage renal disease, Addison's disease, or an overdose of magnesium salts. Hypermagnesemia is characterized by:

• lethargy
• hypotension
• decreased heart and respiratory rate
• muscle weakness
• diminished tendon reflexes

HYPOMAGNESEMIA. Inadequate dietary intake of magnesium, often caused by chronic **alcoholism** or **malnutrition**, is a common cause of hypomagnesemia. Other causes include malabsorption syndromes, **pancreatitis**, aldosteronism, burns, **hyperparathyroidism**, digestive system disorders, and diuretic use. Symptoms of low serum magnesium levels include:

• leg and foot cramps
• weight loss
• vomiting
• muscle spasms, twitching, and tremors
• seizures
• muscle weakness
• arrthymia

Chloride

HYPERCHLOREMIA. Severe dehydration, kidney failure, hemodialysis, traumatic brain injury, and aldosteronism can also cause hyperchloremia. Drugs such as boric acid and ammonium chloride and the intravenous (IV) infusion of sodium chloride can also boost chloride levels, resulting in hyperchloremic **metabolic acidosis**. Symptoms include:

• weakness
• headache
• nausea
• cardiac arrest

HYPOCHLOREMIA. Hypochloremia usually occurs as a result of sodium and potassium depletion (i.e., hyponatremia, hypokalemia). Severe depletion of serum chloride levels causes *metabolic alkalosis*. This alkalization of the bloodstream is characterized by:

• mental confusion
• slowed breathing
• paralysis
• muscle tension or spasm

Phosphate

HYPERPHOSPHATEMIA. Skeletal fractures or disease, kidney failure, **hypoparathyroidism**, hemodialysis, **diabetic ketoacidosis**, acromegaly, systemic infection, and intestinal obstruction can all cause phosphate retention and build-up in the blood. The disorder occurs concurrently with **hypocalcemia**. Individuals with mild hyperphosphatemia are typically asymptomatic, but signs of severe hyperphosphatemia include:

• tingling in hands and fingers
• muscle spasms and cramps
• convulsions
• cardiac arrest

HYPOPHOSPHATEMIA. Serum phosphate levels of 2 mg/dL or below may be caused by hypomagnesemia and hypokalemia. Severe burns, alcoholism, diabetic ketoacidosis, kidney disease, hyperparathyroidism, **hypothyroidism**, Cushing's syndrome, malnutrition, hemodialysis, vitamin D deficiency, and prolonged diuretic therapy can also diminish blood phosphate levels. There are typically few physical signs of mild phosphate depletion. Symptoms of severe hypophosphatemia include:

• muscle weakness
• weight loss
• bone deformities (osteomalacia)

Diagnosis

Diagnosis is performed by a physician or other qualified healthcare provider who will take a medical history, discuss symptoms, perform a complete **physical examination**, and prescribe appropriate laboratory tests. Because electrolyte disorders commonly affect the neuromuscular system, the provider will test reflexes. If a calcium imbalance is suspected, the physician will also check for Chvostek's sign, a reflex test that triggers an involuntary facial twitch, and Trousseau's sign, a muscle spasm that occurs in response to pressure on the upper arm.

Serum electrolyte imbalances can be detected through blood tests. Blood is drawn from a vein on the back of the hand or inside of the elbow by a medical technician, or phlebotomist, and analyzed at a lab.

Normal levels of electrolytes are:

• Sodium. 135–145 mEq/L (serum)
• Potassium. 3.5–5.5 mEq/L (serum)

KEY TERMS

Acid-base balance—A balance of acidity and alkalinity of fluids in the body that keeps the pH level of blood around 7.35–7.45.

Aldosteronism—A condition defined by high serum levels of aldosterone, a hormone secreted by the adrenal gland that is responsible for increasing sodium reabsorption in the kidneys.

Addison's disease—A disease characterized by a deficiency in adrenocortical hormones due to destruction of the adrenal gland.

Bulimia nervosa—An eating disorder characterized by binging and purging (self-induced vomiting) behaviors.

Milk-alkali syndrome—Elevated blood calcium levels and alkalosis caused by excessive intake of milk and alkalis. Usually occurs in the treatment of peptic ulcer.

Orthostatic hypotension—A drop in blood pressure that causes faintness or dizziness and occurs when one rises to a standing position. Also known as postural hypotension.

Osmotic pressure—Pressure that occurs when two solutions of differing concentrations are separated by a semipermeable membrane, such as a cellular wall, and the lower concentration solute is drawn across the membrane into the higher concentration solute (osmosis).

Tetany—A disorder of the nervous system characterized by muscle cramps, spasms of the arms and legs, and numbness of the extremities.

- Calcium. 8.8–10.4 mg/dL (total Ca; serum); 4.7–5.2 mg/dL (unbound Ca; serum)
- Magnesium. 1.4–2.1 mEq/L (plasma)
- Chloride. 100–108 mEq/L (serum)
- Phosphate. 2.5–4.5 mg/dL (plasma; adults)

Standard ranges for test results may vary due to differing laboratory standards and physiological variances (i.e., gender, age, and other factors). Other blood tests that determine pH levels and acid-base balance may also be performed.

Treatment

Treatment of electrolyte disorders depends on the underlying cause of the problem and the type of electrolyte involved. If the disorder is caused by poor diet or improper fluid intake, nutritional changes may be prescribed. If medications such as diuretics triggered the imbalance, discontinuing or adjusting the drug therapy may effectively treat the condition. Fluid and electrolyte replacement therapy, either intravenously or by mouth, can reverse electrolyte depletion.

Hemodialysis treatment may be required to reduce serum potassium levels in hyperkalemic patients with impaired kidney function. It may also be recommended for renal patients suffering from severe hypermagnesemia.

Prognosis

A patient's long-term prognosis depends upon the root cause of the electrolyte disorder. However, when treated quickly and appropriately, electrolyte imbalances in and of themselves are usually effectively reversed.

When they are mild, some electrolyte imbalances have few to no symptoms and may pass unnoticed. For example, transient hyperphosphatemia is usually fairly benign. However, long-term elevations of blood phosphate levels can lead to potentially fatal soft tissue and vascular calcifications and bone disease, and severe serum phosphate deficiencies (hypophosphatemia) can cause encephalopathy, coma, and **death**.

Severe hypernatremia has a mortality rate of 40–60%. Death is commonly due to cerebrovascular damage and hemorrhage resulting from dehydration and shrinkage of the brain cells.

Prevention

Physicians should use caution when prescribing drugs known to affect electrolyte levels and acid-base balance. Individuals with kidney disease, thyroid problems, and other conditions that may place them at risk for developing an electrolyte disorder should be educated on the signs and symptoms.

Resources

BOOKS

Post, Theodore, and Burton Rose. *Clinical Physiology of Acid-Base and Electrolyte Disorders, 5th ed.* New York: McGraw-Hill Professional, 2001.

PERIODICALS

Cohn, Jay N., et al. "New Guidelines for Potassium Replacement in Clinical Practice: A Contemporary Review by the National Council on Potassium in Clinical Practice." *Archives of Internal Medicine* 160, no.16 (Sept. 11, 2000): 2429 36.

Kumar, Sumit and Tomas Berl. "Sodium." *The Lancet* 352, no. 9123 (18, July 1998): 220.

Paula Ford-Martin

Electrolyte tests

Definition

Electrolytes are positively and negatively charged molecules, called ions, that are found within cells, between cells, in the bloodstream, and in other fluids throughout the body. Electrolytes with a positive charge include sodium, potassium, calcium, and magnesium; the negative ions are chloride, bicarbonate, and phosphate. The concentrations of these ions in the bloodstream remain fairly constant throughout the day in a healthy person. Changes in the concentration of one or more of these ions can occur during various acute and chronic disease states and can lead to serious consequences.

Purpose

Tests that measure the concentration of electrolytes are useful in the emergency room and to obtain clues for the diagnosis of specific diseases. Electrolyte tests are used for diagnosing dietary deficiencies, excess loss of nutrients due to urination, vomiting, and **diarrhea**, or abnormal shifts in the location of an electrolyte within the body. When an abnormal electrolyte value is detected, the physician may either act to immediately correct the imbalance directly (in the case of an emergency) or run further tests to determine the underlying cause of the abnormal electrolyte value. Electrolyte disturbances can occur with malfunctioning of the kidney (renal failure), infections that produce severe and continual diarrhea or vomiting, drugs that cause loss of electrolytes in the urine (**diuretics**), **poisoning** due to accidental consumption of electrolytes, or diseases involving hormones that regulate electrolyte concentrations.

Precautions

Electrolyte tests are performed from routine blood tests. The techniques are simple, automated, and fairly uniform throughout the United States. During the preparation of blood plasma or serum, health workers must take care not to break the red blood cells, especially when testing for serum potassium. Because the concentration of potassium within red blood cells is much higher than in the surrounding plasma or serum, broken cells would cause falsely elevated potassium levels.

Description

Electrolyte tests are typically conducted on blood plasma or serum, urine, and diarrheal fluids. Electrolytes can be classified in at least five different ways. One way is that some electrolytes tend to exist mostly inside cells, or are intracellular, while others tend to be outside cells, or are extracellular. Potassium, phosphate, and magnesium occur at much greater levels inside the cell than outside, while sodium and chloride occur at much greater levels extracellularly. A second classification distinguishes those electrolytes that participate directly in the transmission of nerve impulses and those that do not. Sodium, potassium, and calcium are the important electrolytes involved in nerve impulses, and disorders affecting them are most closely associated with neurological disorders. A third classification focuses on electrolytes that are able to form a tight union, or complex, with one another. Calcium and phosphate have the greatest tendency to form complexes with each other. Disorders that cause an increase in either plasma calcium or phosphate can result in the deposit of calcium-phosphate crystals in the soft tissues of the body. A fourth classification concerns those electrolytes that influence the acidity or alkalinity of the bloodstream, also known as the pH. The pH of the bloodstream is normally in the range of 7.35–7.45. A decrease below this range is called acidosis, while a pH above this range is called alkalosis. The electrolytes most closely associated with the pH of the bloodstream are bicarbonate, chloride, and phosphate.

Preparation

All electrolyte tests can be performed on plasma or serum. Plasma is prepared by withdrawing a blood sample and placing it in a test tube containing a chemical that prevents blood from clotting (an anticoagulant). Serum is prepared by withdrawing a blood sample, placing it in a test tube, and allowing it to clot. The blood spontaneously clots within a minute of withdrawing the blood from a vein. The serum or plasma is then rapidly spun with a centrifuge in order to remove the blood cells or clot.

Normal results

Electrolyte concentrations are similar whether measured in serum or plasma. Values can be expressed in terms of weight per unit volume (mg/deciliter; mg/dL) or in the number of molecules in a volume, or molarity (moles or millimoles/liter; M or mM). The range of normal values sometimes varies slightly between different age groups, for males and females, and between different analytical laboratories.

The normal level of serum sodium is in the range of 136–145 mM. The normal levels of serum potassium are 3.5–5.0 mM. Note that sodium occurs at a much higher concentration than potassium. The normal concentration of total serum calcium (bound calcium plus free calcium) is in the range of 8.8–10.4 mg/dL. About 40% of the total calcium in the plasma is loosely bound to proteins; this

calcium is referred to as bound calcium. The normal range of free calcium is 4.8–5.2 mg/dL. The normal concentration of serum magnesium is in the range of 2.0–3.0 mg/dL.

The normal concentration range of chloride is 350–375 mg/dL or 98–106 mM. The normal level of phosphate, as expressed as the concentration of phosphorus, is 2.0–4.3 mg/dL. Bicarbonate is an electrolyte that is freely and spontaneously interconvertable with carbonic acid and carbon dioxide. The normal concentration of carbonic acid (H_2CO_3) is about 1.35 mM. The normal concentration of bicarbonate (HCO_3^-) is about 27 mM. The concentration of total carbon dioxide is the sum of carbonic acid and bicarbonate; this sum is normally in the range of 26–28 mM. The ratio of bicarbonate/carbonic acid is more significant than the actual concentrations of these two forms of carbon dioxide. Its normal value is 27/1.35 (equivalent to 20/1).

Abnormal results

Positively charged electrolytes

High serum sodium levels (**hypernatremia**) occur at sodium concentrations over 145 mM, with severe hypernatremia over 152 mM. Hypernatremia is usually caused by diseases that cause excessive urination. In these cases, water is lost, but sodium is still retained in the body. The symptoms include confusion and can lead to convulsions and **coma**. Low serum sodium levels (**hyponatremia**) are below 130 mM, with severe hyponatremia at or below 125 mM. Hyponatremia often occurs with severe diarrhea, with losses of both water and sodium, but with sodium loss exceeding water loss. Hyponatremia provokes clinical problems only if serum sodium falls below 125 mM, especially if this has occurred rapidly. The symptoms can be as mild as tiredness but may lead to convulsions and coma.

High serum potassium (**hyperkalemia**) occurs at potassium levels above 5.0 mM; it is considered severe over 8.0 mM. Hyperkalemia is relatively uncommon, but sometimes occurs in patients with kidney failure who take potassium supplements. Hyperkalemia can result in abnormal beating of the heart (cardiac **arrhythmias**). Low serum potassium (**hypokalemia**) occurs when serum potassium falls below 3.0 mM. It can result from low dietary potassium, as during **starvation** or in patients with **anorexia nervosa**; from excessive losses via the kidneys, as caused by diuretic drugs; or by diseases of the adrenal or pituitary glands. Mild hypokalemia causes muscle weakness, while severe hypokalemia can cause **paralysis**, the inability to breathe, and cardiac arrhythmias.

High levels of calcium ions (**hypercalcemia**) occur at free calcium ion concentrations over 5.2 mg/dL or total serum calcium above 10.4 mg/dL. Hypercalcemia usually occurs when the body dissolves bone at an abnormally fast rate, increasing both serum calcium and serum phosphate. Sudden hypercalcemia can cause vomiting and coma, while prolonged and moderate hypercalcemia results in the deposit of calcium phosphate crystals in the kidneys and eye. **Hypocalcemia** occurs when serum free calcium ions fall below 4.4 mg/dL, or when total serum calcium falls below 8.8 mg/dL. Hypocalcemia can result from **hypoparathyroidism** (low parathyroid hormone), from failure to produce 1,25-dihydroxyvitamin D, from low levels of plasma magnesium, and from phosphate poisoning (the phosphate enters the bloodstream and forms a complex with the free serum calcium). Hypocalcemia can cause depression and muscle spasms.

Hypermagnesemia occurs at serum magnesium levels over 25 mM (60 mg/dL). Hypermagnesemia is rare but can occur with the excessive consumption of magnesium salts. Hypomagnesemia occurs when serum magnesium levels fall below 0.8 mM, and can result from poor **nutrition**. Chronic **alcoholism** is the most common cause of hypomagnesemia, in part because of poor diet. Magnesium levels below 0.5 mM (1.2 mg/dL) cause serum calcium levels to decline. Some of the symptoms of hypomagnesemia, including twitching and convulsions, actually result from the concurrent hypocalcemia. Hypomagnesemia can also result in hypokalemia and thereby cause cardiac arrhythmias.

Negatively charged electrolytes

Serum chloride levels sometimes increase to abnormal levels as an undesirable side effect of medical treatment with sodium chloride or ammonium chloride. The toxicity of chloride results not from the chloride itself, but from the fact that the chloride occurs as the acid, hydrogen chloride (more commonly known as hydrochloric acid, or HCl). An overdose of chloride may cause the accumulation of hydrochloric acid in the bloodstream, with consequent acidosis. **Renal tubular acidosis**, one of many kidney diseases, involves the failure to release acid into the urine. The acidosis produces weakness, **headache**, nausea, and cardiac arrest. Low plasma chloride leads to the opposite situation: a decline in the acid content of the bloodstream. This is known as alkalization of the bloodstream, or alkalosis. Hydrochloric acid, originally from extracellular fluids, can be lost by vomiting. At its most severe, alkalosis results in paralysis (tetany).

Hyperphosphatemia occurs at serum phosphate levels above 5 mg/dL. It can result from the failure of the kidneys to excrete phosphate into the urine, causing phosphate to accumulate in the bloodstream. Hyperphosphatemia can also be caused by the impaired action of parathyroid hormone and by phosphate poisoning. Severe hyperphos-

phatemia can cause paralysis, convulsions, and cardiac arrest. These symptoms result because the phosphate, occurring in elevated levels, complexes with free serum calcium, resulting in hypocalcemia. Tests for heart function (an electrocardiogram) and parathyroid hormone levels are used in the diagnosis of hyperphosphatemia. Hypophosphatemia occurs if serum phosphorus falls to 2.0 mg/dL or lower. It often results from a shift of inorganic phosphate from the bloodstream to various organs and tissues. This shift can be caused by a rise in pH (alkalization) of the bloodstream, which can occur during hyperventilation, a reaction in various disease states. A shift in phosphate to intracellular tissues may draw calcium away from the bloodstream via the formation of insoluble calcium phosphate crystals within cells, with consequent hypocalcemia. Thus, tests for abnormalities in phosphate metabolism also involve tests for serum calcium.

Bicarbonate metabolism involves several compounds. When dietary starches, sugars, and fats are broken down for energy production, carbon dioxide is created. Much of this carbon dioxide (CO_2) spontaneously converts to carbonic acid (H_2CO_3), and some of the carbonic acid spontaneously converts to bicarbonate (HCO_3^-) plus a hydrogen ion (H^+). Eventually, almost every molecule of carbon dioxide produced in the body, whether in the form of carbon dioxide, carbonic acid, or bicarbonate, must convert back to carbon dioxide in order to leave via the lungs during normal breathing.

If one holds one's breath, carbon dioxide cannot escape from the lungs, but continues to be generated within the body. This results in an increase in production of carbonic acid. A portion of the carbonic acid breaks apart (dissociates), causing an increase in hydrogen ions in the plasma, with a resulting acidosis. Tests for serum bicarbonate levels are accompanied by tests for acidosis (pH test). Conversely, when one breathes too rapidly (hyperventilation), the carbon dioxide is drawn off from the bloodstream and expelled in the breath at an increased rate. This results in an increase in the rate of combination of bicarbonate with hydrogen ions, resulting in alkalosis. Acidosis and alkalosis can be produced by means other than by altering the rate of breathing. The carbonic acid and bicarbonate in the bloodstream minimize (or buffer) any trend to acidosis or alkalosis. Tests for bicarbonate are generally accompanied by tests for blood pH and possibly tests for kidney malfunction, abnormal hormone function, or gastrointestinal disorders.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Klahr, S. "Acid-base and Fluid and Electrolyte Disorders." In *Textbook of Primary Care Medicine*, ed. J. Noble. St. Louis: Mosby, 1996.

PERIODICALS

Fried, L. F., and P. M. Palevsky. "Hyponatremia and hypernatremia." *Medical Clinics of North America* 81 (1997): 585-609.

Sutters, M., C. L. Gaboury, and W. M. Bennett. "Severe Hyperphosphatemia and Hypocalcemia: a Dilemma in Patient Management." *Journal of the American Society of Nephrology* 7 (1996): 2056-2061.

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Electromyography

Definition

Electromyography (EMG) is an electrical recording of muscle activity that aids in the diagnosis of neuromuscular disease.

Purpose

Muscles are stimulated by signals from nerve cells called motor neurons. This stimulation causes electrical activity in the muscle, which in turn causes contraction. This electrical activity is detected by a needle electrode inserted into the muscle and connected to a recording device. Together, the electrode and recorder are called an electromyography machine. EMG can determine whether a particular muscle is responding appropriately to stimulation, and whether a muscle remains inactive when not stimulated.

EMG is performed most often to help diagnose different diseases causing weakness. Although EMG is a test of the motor system, it may help identify abnormalities of nerves or spinal nerve roots that may be associated with **pain** or numbness. Other symptoms for which EMG may be useful include numbness, atrophy, stiffness, fasciculation, cramp, deformity, and spasticity. EMG results can help determine whether symptoms are due to a muscle disease or a neurological disorder, and, when combined with clinical findings, usually allow a confident diagnosis.

EMG can help diagnose many muscle and nerve disorders, including:

- muscular dystrophy
- congenital **myopathies**
- mitochondrial myopathies

KEY TERMS

Motor neurons—Nerve cells that transmit signals from the brain or spinal cord to the muscles.

Motor unit action potentials—Spikes of electrical activity recorded during an EMG that reflect the number of motor units (motor neurons and the muscle fibers they transmit signals to) activated when the patient voluntarily contracts a muscle.

- metabolic myopathies
- myotonias
- peripheral neuropathies
- radiculopathies
- nerve lesions
- amyotrophic lateral sclerosis
- polio
- spinal muscular atrophy
- guillain-Barré syndrome
- ataxias
- myasthenias

Precautions

No special precautions are needed for this test. Patients with a history of bleeding disorder should consult with their treating physician before the test. If a muscle biopsy is planned as part of the diagnostic work-up, EMG should not be performed at the same site, as it may effect the microscopic appearance of the muscle.

Description

During an EMG test, a fine needle is inserted into the muscle to be tested. This may cause some discomfort, similar to that of an injection. Recordings are made while the muscle is at rest, and then during the contraction. The person performing the test may move the limb being tested, and direct the patient to move it with various levels of force. The needle may be repositioned in the same muscle for further recording. Other muscles may be tested as well. A typical session lasts from 30–60 minutes.

A slightly different test, the *nerve conduction velocity test*, is often performed at the same time with the same equipment. In this test, stimulating and recording electrodes are used, and small electrical shocks are applied to measure the ability of the nerve to conduct electrical signals. This test may cause mild tingling and discomfort similar to a mild **shock** from static electricity. Evoked potentials may also be performed for additional diagnostic information. Nerve conduction velocity and evoked potential testing are especially helpful when pain or sensory complaints are more prominent than weakness.

Preparation

No special preparation is needed. The doctor supervising and interpreting the test should be given information about the symptoms, medical conditions, suspected diagnosis, neuroimaging studies, and other test results.

Aftercare

Minor pain and bleeding may continue for several hours after the test. The muscle may be tender for a day or two.

Risks

There are no significant risks to this test, other than those associated with any needle insertion (pain, bleeding, bruising, or infection).

Normal results

There should be some brief EMG activity during needle insertion. This activity may be increased in diseases of the nerve and decreased in long-standing muscle disorders where muscle tissue is replaced by fibrous tissue or fat. Muscle tissue normally shows no EMG activity when at rest or when moved passively by the examiner. When the patient actively contracts the muscle, spikes (motor unit action potentials) should appear on the recording screen, reflecting the electrical activity within. As the muscle is contracted more forcefully, more groups of muscle fibers are recruited or activated, causing more EMG activity.

Abnormal results

The interpretation of EMG results is not a simple matter, requiring analysis of the onset, duration, amplitude, and other characteristics of the spike patterns.

Electrical activity at rest is abnormal; the particular pattern of firing may indicate denervation (for example, a nerve lesion, radiculopathy, or lower motor neuron degeneration), myotonia, or inflammatory myopathy.

Decreases in the amplitude and duration of spikes are associated with muscle diseases, which also show faster recruitment of other muscle fibers to compensate for weakness. Recruitment is reduced in nerve disorders.

Resources

BOOKS

Basmajian, J., and C. DeLuca. *Muscles Alive: Their Function Revealed by Electromyography.* 5th ed. Baltimore: Williams & Wilkins, 1985.

OTHER

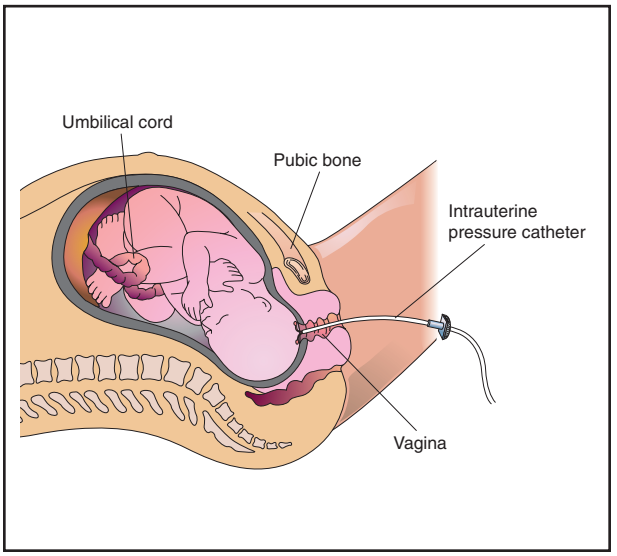
Falck, B., E. Stalberg, and L. Korpinen. *The Expert Electromyographer.* <http://www.tut.fi/~korpinen/EMG.htm>.

Richard Robinson

Electronic fetal monitoring

Definition

Electronic fetal monitoring (EFM) is a method for examining the condition of a baby in the uterus by noting any unusual changes in its heart rate. Electronic fetal monitoring is performed late in **pregnancy** or continuously during labor to ensure normal delivery of a healthy baby. EFM can be utilized either externally or internally in the womb.



Electronic fetal monitoring (EFM) is performed late in pregnancy or continuously during labor to ensure normal delivery of a healthy baby. EFM can be utilized either externally or internally in the womb. The illustration above shows the internal procedure, in which an electrode is attached directly to the baby's scalp to monitor the heart rate. Uterine contractions are recorded using an intrauterine pressure catheter which is inserted through the cervix into the uterus. *(Illustration by the Electronic Illustrators Group.)*

Purpose

The heart rate of a fetus undergoes constant adjustment as it responds to its environment and other stimuli. The fetal monitor records an unborn baby's heart rate and graphs it on a piece of paper. Electronic fetal monitoring is usually advised for high-risk pregnancies, when the baby is in danger of distress. Specific reasons for EFM include: babies in a breech position, **premature labor**, and induced labor, among others.

When electronic fetal monitoring was originally introduced in the 1960s and 1970s, the hope was that it would help physicians diagnose fetal hypoxia, or lack of oxygen, in time to prevent damage to the baby. This lack of oxygen, also known as perinatal asphyxia or birth asphyxia, is an important cause of **stillbirth** and newborn deaths. It occurs when there are less than normal amounts of oxygen delivered to the body or an organ and there is build-up of carbon dioxide in the body or tissue. A lack of blood flow to an organ can cause asphyxia. Perinatal asphyxia can occur a long time before birth, shortly before birth, during delivery, or after birth. If the interruption to the supply of oxygen is short, the baby may recover without any damage. If the time is longer, there may be some injury that is reversible. If the time period without oxygen is very long, there may be permanent injury to one or more organs of the body. It is important, to detect any signs of asphyxia as soon as possible. One of the signs is an abnormal heart rate and rhythm in the unborn baby, which can be detected by electronic fetal monitoring.

The fetal monitor is a more intricate version of the machine that a health care provider uses to listen to a baby's heartbeat. The monitor that is used during prenatal visits just picks up the sound of the baby's heart beating. The fetal monitor also keeps a continuous paper record of the heart rate. In addition, the fetal monitor can record uterine contractions on the lower part of the paper strip. This helps the doctor or midwife determine how a baby is handling the **stress** of contractions. The normal pattern is for the baby's heartbeat to drop slightly during a contraction and then go back to normal after the contraction is over. EFM looks for any changes from this normal pattern, particularly if there is a drastic drop in the baby's heart beat or if the heart rate does not recover immediately after a contraction.

Because it is an indirect test, it is not perfect. When an adult complains to a provider about not feeling well, checking the heart rate is only one of many things that the doctor will do. With an unborn baby, however, checking the heart rate is basically the only thing that a doctor or midwife can do.

Fetal monitoring can be helpful in a variety of different situations. During pregnancy, fetal monitoring can be used as a part of **antepartum testing**. If the practitioner

KEY TERMS

Breech presentation—Fetal position in which the buttocks come first.

A cesarean section—delivery of a baby through an incision in the mother's abdomen instead of through the vagina.

Hypoxia—An oxygen deficiency.

feels that a baby may be at increased risk of problems toward the end of pregnancy, a baby can be checked every week or every other week with a non-stress test. In this test, changes in the baby's heart rate are measured along with the fetus' own movements. The heart rate of a healthy baby should go up whenever she or he moves.

Fetal monitoring is used on and off during early labor. As labor progresses, more monitoring is often needed. Usually, as the time for delivery nears, the monitor is left on continuously since the end of labor tends to be the most stressful time for the baby.

A baby who is having trouble in labor will show characteristic changes in heart rate after a contraction (late decelerations). If a baby is not receiving enough oxygen to withstand the stress of labor and delivery is many hours away, a **cesarean section** (C-section) may be necessary.

Description

Using the external fetal monitor is simple and painless. Two elastic belts are placed around the mother's abdomen. One belt holds a listening device in place while the other belt holds the contraction monitor. The nurse or midwife adjusts the belts to get the best readings from each device.

Sometimes, it is difficult to hear the baby's heartbeat with the external monitoring device. Other times, the monitor may show subtle signs of a developing problem. In either case, the doctor or midwife may recommend that the external belt be replaced with an internal monitor.

The internal monitor is an electronic wire that rests directly on the baby's head. The provider can place it on the baby's head during an internal exam. The internal monitor can only be used when the cervix is already open. This device provides a more accurate record of the baby's heart rate.

Preparation

There are no special preparations needed for fetal monitoring.

Risks

External EFM poses no direct risks to the baby. However, because of being connected to the machine, the mother cannot walk around. This inactivity may prolong labor and reduce oxygen levels in the mother's blood, both of which can be detrimental to the unborn baby. Another problem is that electronic fetal monitoring seems to be associated with an increase in caesarian deliveries. There is a concern that EFM can give false alarms of distress in the baby, and that this can lead to unneeded caesarians. With internal monitoring, there is a higher risk for infection. For these and other reasons, the United States Preventive Services Task Force states that there is some evidence that using electronic fetal monitoring on low-risk women in labor might not be indicated. Many physicians, however, continue to use EFM routinely, and believe it to be of value in both low-risk and high-risk labors.

Normal results

An unborn baby's heart rate normally ranges from 120–160 beats per minute (bpm). A baby who is receiving enough oxygen through the placenta will move around. The monitor strip will show the baby's heart rate rising briefly as he/she moves (just as an adult's heart rate rises when he/she moves).

The baby's monitor strip is considered to be reactive when the baby's heart rate rises at least 20 bpm above the baseline heart rate for at least 20 seconds. This must occur at least twice in a 20-minute period. A reactive heart rate tracing (also known as a reactive non-stress test) is considered a sign of the baby's well being.

Abnormal results

If the baby's heart rate drops very low or rises very high, this signals a serious problem. In either of these cases it is obvious that the baby is in distress and must be delivered soon. However, many babies who are having problems do not give such clear signs.

During a contraction, the flow of oxygen (from the mother) through the placenta (to the baby) is temporarily stopped. It is as if the baby has to hold its breath during each contraction. Both the placenta and the baby are designed to withstand this condition. Between contractions, the baby should be receiving more than enough oxygen to do well during the contraction.

The first sign that a baby is not getting enough oxygen between contractions is often a drop in the baby's heart rate after the contraction (late deceleration). The baby's heart rate recovers to a normal level between contractions, only to drop again after the next contraction. This is also a more subtle sign of distress.

These babies will do fine if they are delivered in a short period of time. Sometimes, these signs develop long before delivery is expected. In that case, a C-section may be necessary.

Resources

PERIODICALS

Sweha, Amir, et al. "Interpretation of the Electronic Fetal Heart Rate During Labor" *American Family Physician* (May 1, 1999).

Kripke, Clarissa C. "Why Are We Using Electronic Fetal Monitoring?" *American Family Physician* (May 1, 1999).

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Electrophysiology study of the heart

Definition

An electrophysiology (EP) study of the heart is a nonsurgical analysis of the electrical conduction system (normal or abnormal) of the heart. The test employs cardiac catheters and sophisticated computers to generate electrocardiogram (EKG) tracings and electrical measurements with exquisite precision from within the heart chambers.

The EP study can be performed solely for diagnostic purposes. It also is performed to pinpoint the exact location of electrical signals (cardiac mapping) in conjunction with a therapeutic procedure called **catheter ablation**.

The test is simple, not painful, and performed in a special laboratory under controlled clinical circumstances by cardiologists and nurses who subspecialize in electrophysiology.

Purpose

A cardiologist may recommend an EP study when the standard EKG, Holter monitor, event recorder, **stress test**, echocardiogram, or angiogram cannot provide enough information to evaluate an abnormal heart rhythm, called an arrhythmia.

An EP study also may be beneficial in diagnosing a suspected arrhythmia in a patient who shows symptoms of an arrhythmia but in whom it could not be detected from other tests.

The purpose and great value of an EP study is that it offers more detailed information to the doctor about the electrical activity in the heart than the aforementioned noninvasive tests because electrodes are placed directly *on* heart tissue. This allows the electrophysiologist to determine the specific location of an arrhythmia and, oftentimes, correct it during the same procedure. This corrective treatment is permanent and considered a cure, and, in many cases, the patient may not need to take heart medications.

EP studies may be helpful in assessing:

- certain tachycardias or bradycardias of unknown cause.
- patients who have been resuscitated after experiencing **sudden cardiac death**.
- various symptoms of unknown cause, such as chest **pain**, **shortness of breath**, **fatigue**, or syncope (dizziness/fainting).
- response to anti-arrhythmic therapy.

Precautions

Pregnant patients should not undergo an EP study because of exposure to radiation during the study, which may be harmful to the growing baby.

Patients who have **coronary artery disease** may need to have that treated before having an EP study.

Description

The rhythmic pumping action of the heart, which is essentially a muscle, is the result of electrical impulses traveling throughout the walls of the four heart chambers. These impulses originate in the sinoatrial (SA) node, which are specialized cells situated in the top right chamber of the heart: the right atrium. Normally, the SA node, acting like a spark plug, spontaneously generates the impulses, which travel through specific pathways throughout the atria to the atrioventricular (AV) node. The AV node is a relay station, sending the impulses to more specialized muscle fibers throughout the bottom chambers of the heart: the ventricles. If these pathways become damaged or blocked or if extra (abnormal) pathways exist, the heart's rhythm may be altered (perhaps too slow, too fast, or irregular), which can seriously affect the heart's pumping ability.

The patient is transported to the x-ray table in the EP lab and connected to various monitors. Sterile sheets are placed over him or her. A minimum of two catheters are inserted into the right femoral (thigh) vein in the groin area. Depending on the type of arrhythmia, the number of catheters used in an EP test and their route to the heart may vary. For certain tachycardias, two more catheters may be inserted in the left groin and one in the internal jugular (neck) vein or in the subclavian (below the clavi-

An electrophysiologist nurse monitors a patient's heart rhythm during an electrophysiology study for tachycardia. *(Photograph by Collette Placek. Reproduced by permission.)*

cle) vein. The catheters are about 0.08 in (2 mm) in diameter, about the size of a spaghetti noodle. The catheters used in catheter ablation are slightly larger.

With the help of fluoroscopy (x rays on a television screen), all the catheters are guided to several specific locations in the heart. Typically, four to 10 electrodes are located on the end of the catheters, which have the ability to send electrical signals to stimulate the heart (called pacing) and to receive electrical signals from the heart—but not at the same time (just as a walkie-talkie cannot send and receive messages at the same time).

First, the electrodes are positioned to receive signals from inside the heart chambers. This allows the doctor to measure how fast the electrical impulses travel currently in the patient's heart. These measurements are called the patient's baseline measurements. Next, the electrodes are positioned to pace: The EP team actually tries to induce (sometimes in combination with various heart drugs) the arrhythmia that the patient has previously experienced so the team can observe it in a controlled environment, compare it to the patient's clinical or spontaneous arrhythmia, and decide how to treat it.

Once the arrhythmia is induced and the team determines it can be treated with catheter ablation, cardiac mapping is performed to locate precisely the origin and route of the abnormal pathway. When this is accomplished, the ablating electrode catheter is positioned directly against the abnormal pathway, and high radiofrequency energy is delivered through the electrode to destroy (burn) the tissue in this area.

Preparation

The following preparations are made for an EP study:

- the patient may be advised to stop taking certain medications, especially heart drugs, that may interfere with the test results.
- blood tests usually are ordered the week before the test.
- the patient undergoes conscious **sedation** (awake but relaxed) during the test. This is accomplished quite often with the anesthetic drugs VersedR (Roche laboratories) and fentanyl.
- a local anesthetic is injected at the site of catheter insertion.

Aftercare

The patient needs to rest flat in bed for several hours after the procedure to allow healing at the catheter insertion sites.

The patient often returns home either the same day of the test or the next day. Someone should drive him or her home.

The doctor may prescribe drugs and/or insert an AFCD to treat the arrhythmia and may do a possible follow-up EP study.

Risks

The EP diagnostic study and catheter ablation are low-risk procedures. There is a small risk of bleeding and/or infection at the site of catheter insertion, but this occurs less than 1% of the time. Blood clot formation occurs only two in 1,000 instances and is minimized with blood thinner medications administered during the procedure. Vascular injuries causing hemorrhage or **thrombophlebitis** are possible but occur less than 0.7% of the time. Cardiac perforations occur only in one or two per 1,000 instances. If the right internal jugular vein is accessed, the small possibility of puncturing the lung with the catheter exists, which, at worst, could cause a collapsed lung.

Because **ventricular tachycardia** or fibrillation (lethal **arrhythmias**) may be induced in the patient, the EP lab personnel must be prepared to defibrillate the patient as necessary.

Normal results

The heart initiates and conducts electrical impulses normally.

Abnormal results

Confirmation of arrhythmias, such as:

- supraventricular tachycardias
- ventricular arrhythmias
- accessory (extra) pathways
- bradycardias

KEY TERMS

Ablation—Remove or destroy, such as by burning or cutting.

Angiogram—X ray of a blood vessel after special x-ray dye has been injected into it.

Bradycardia—Slow heartbeat.

Cardiac catheter—Long, thin, flexible tube, that is threaded into the heart through a blood vessel.

Cardiologist—Doctor who specializes in diagnosing and treating heart diseases.

Echocardiogram—Ultrasound image of the heart.

Electrocardiogram—Tracing of the electrical activity of the heart.

Electrode—Medium for conducting an electrical current—in this case, platinum wires.

Electrophysiology—Study of how electrical signals in the body relate to physiologic function.

Event recorder—A small machine, worn by a patient usually for several days or weeks, that is activated by the patient to record his or her EKG when a symptom is detected.

Fibrillation—Rapid, random contraction (quivering).

Holter monitor—A small machine, worn by a patient usually for 24 hours, that continuously records the patient's EKG during usual daily activity.

Stress test—Recording a patient's EKG during exercise.

Supraventricular tachycardia—A fast heart beat that originates above the ventricles.

Tachycardia—Fast heartbeat.

Vascular—Pertaining to blood vessels.

Resources

BOOKS

Grubb, Blair P., and Brian Olshansky. *Syncope: Mechanisms and Management*. Armonk, NY: Futura Publishing, 1997.

Horovitz, Emmanuel. *Heartbeat: A Complete Guide to Understanding and Preventing Heart Disease*. Los Angeles: Health Trend Publishing, 1988.

Singer, Igor. *Interventional Electrophysiology*. Baltimore: Williams & Wilkins, 1997.

ORGANIZATIONS

Cardiac Arrhythmia Research and Education Foundation (C.A.R.E.). 2082 Michelson Dr. #301 Irvine, CA 92612 (800)-404-9500. <http://www.longqt.com>.

Medtronics Manufacturer of Therapeutic Devices. 710 Medtronic Parkway NE, Minneapolis, MN 55432-5604. (800) 328-2518. <http://www.medtronic.com>.

Midwest Heart Specialists. Physician Office Building, 3825 Highland Ave., Tower 2, Ste. 400, Downers Grove, IL 60515. (630) 719-4799. <http://www.midwestheart.com>.

United States Catheter Instruments (USCI). 129 Concord Road Billerica, MA 01821. (800) 826-2273.

Collette L. Placek

Electroshock therapy *see* **Electroconvulsive therapy**

Elephantiasis

Definition

The word elephantiasis is a vivid and accurate term for the syndrome it describes: the gross (visible) enlargement of the arms, legs, or genitals to elephantoid size.

Description

True elephantiasis is the result of a parasitic infection caused by three specific kinds of round worms. The long, threadlike worms block the body's lymphatic system—a network of channels, lymph nodes, and organs that helps maintain proper fluid levels in the body by draining lymph from tissues into the bloodstream. This blockage causes fluids to collect in the tissues, which can lead to great swelling, called "lymphedema." Limbs can swell so enormously that they resemble an elephant's foreleg in size, texture, and color. This is the severely disfiguring and disabling condition of elephantiasis.

There are a few different causes of elephantiasis, but the agents responsible for most of the elephantiasis in the world are filarial worms: white, slender round worms found in most tropical and subtropical places. They are transmitted by particular kinds (species) of mosquitoes, that is, bloodsucking insects. Infection with these worms is called "lymphatic filariasis" and over a long period of time can cause elephantiasis.

Lymphatic **filariasis** is a disease of underdeveloped regions found in South America, Central Africa, Asia, the Pacific Islands, and the Caribbean. It is a disease that has been present for centuries, as ancient Persian and Indian writings clearly described elephant-like swellings of the arms, legs, and genitals. It is estimated that 120 million people in the world have lymphatic filariasis, as of 1997. The disease appears to be spreading, in spite of decades of research in this area.

Other terms for elephantiasis are Barbados leg, elephant leg, morbus herculeus, mal de Cayenne, and myelolymphangioma.

Other situations that can lead to elephantiasis are:

- a protozoan disease called **leishmaniasis**
- a repeated streptococcal infection
- the surgical removal of lymph nodes (usually to prevent the spread of **cancer**)
- a hereditary birth defect

Causes and symptoms

Three kinds of round worms cause elephantiasis filariasis: *Wuchereria bancrofti*, *Brugia malayi*, and *Brugia timori*. Of these three, *W. bancrofti* makes up about 90% of the cases. Man is the only known host of *W. bancrofti*.

Culex, *Aedes*, and *Anopheles* mosquitoes are the carriers of *W. bancrofti*. *Anopheles* and *Mansonia* mosquitoes are the carriers of *B. malayi*. In addition, *Anopheles* mosquitoes are the carriers of *B. timori*.

Infected female mosquitoes take a blood meal from a human, and, in doing so, introduce larval forms of the particular parasite they carry to the person. These larvae migrate toward a lymphatic channel, then travel to various places within the lymphatic system, usually positioning themselves in or near lymph nodes throughout the body. During this time, they mature into more developed larvae and eventually into adult worms. Depending upon the species of round worm, this development can take a few months or more than a year. The adult worms grow to about 1 in (2.5 cm) to 4 in (10 cm) long.

The adult worms can live from about three to eight years. Some have been known to live to 20 years, and in one case 40 years. The adult worms begin reproducing numerous live embryos, called microfilariae. The microfilariae travel to the bloodstream, where they can be ingested by a mosquito when it takes a blood meal from the infected person. If they are not ingested by a mosquito, the microfilariae die within about 12 months. If they are ingested by a mosquito, they continue to mature. They are totally dependent on their specific species of mosquito to develop further. The cycle continues when the mosquito takes another blood meal.

Most of the symptoms an infected person experiences are due to the blockage of the lymphatic system by the adult worms and due to the substances (excretions and secretions) produced by the worms.

The body's allergic reactions may include repeated episodes of **fever**, shaking chills, sweating, headaches, vomiting, and **pain**. Enlarged lymph nodes, swelling of the affected area, skin ulcers, bone and joint pain, tiredness, and red streaks along the arm or leg also may occur. Abscesses can form in lymph nodes or in the lymphatic vessels. They may appear at the surface of the skin as well.

Long-term infection with lymphatic filariasis can lead to **lymphedema**, hydrocele (a buildup of fluid in any saclike cavity or duct) in the scrotum, and elephantiasis of the legs, scrotum, arms, penis, breasts, and vulvae. The most common site of elephantiasis is the leg. It typically begins in the ankle and progresses to the foot and leg. At first the swollen leg may feel soft to the touch but eventually becomes hard and thick. The skin may appear darkened or warty and may even crack, allowing bacteria to infect the leg and complicate the disease. The microfilariae usually don't cause injury. In some instances, they cause "eosinophilia," an increased number of eosinophils (a type of white blood cells) in the blood.

This disease is more intense in people who never have been exposed to lymphatic filariasis than it is in the native people of tropical areas where the disease occurs. This is because many of the native people often are immunologically tolerant.

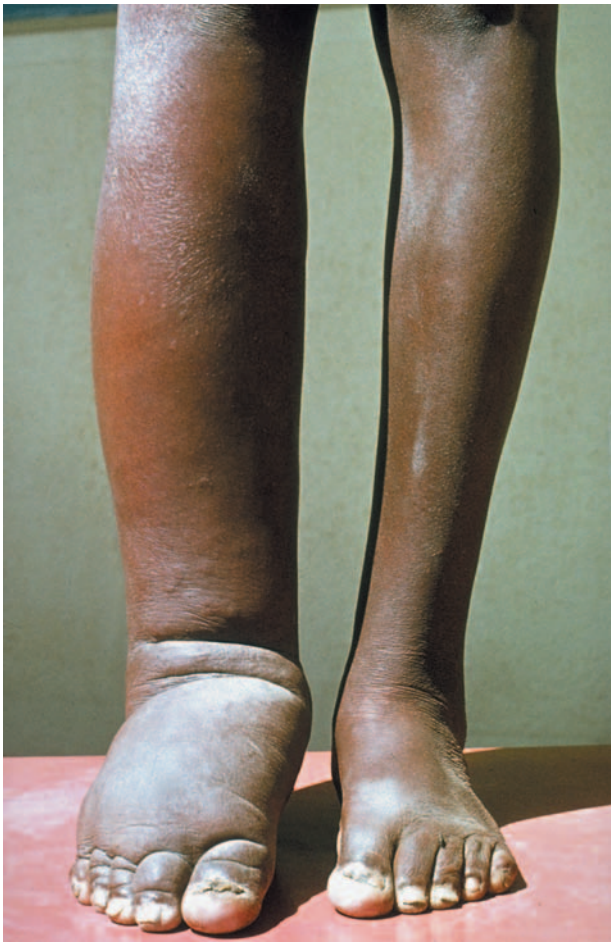
Diagnosis

The only sure way to diagnose lymphatic filariasis is by detecting the parasite itself, either the adult worms or the microfilariae.

Microscopic examination of the person's blood may reveal microfilariae. But many times, people who have been infected for a long time do not have microfilariae in their bloodstream. The absence of them, therefore, does not mean necessarily that the person is not infected. In these cases, examining the urine or hydrocele fluid or performing other clinical tests is necessary.

Collecting blood from the individual for microscopic examination should be done during the night when the microfilariae are more numerous in the bloodstream. (Interestingly, this is when mosquitoes bite most frequently.) During the day microfilariae migrate to deeper blood vessels in the body, especially in the lung. If it is decided to perform the blood test during the day, the infected individual may be given a "provocative" dose of medication to provoke the microfilariae to enter the bloodstream. Blood then can be collected an hour later for examination.

Detecting the adult worms can be difficult because they are deep within the lymphatic system and difficult to get to. Biopsies usually are not performed because they usually don't reveal much information.



Man suffering from elephantiasis. *(Photograph by C. James Webb, Phototake NYC. Reproduced by permission.)*

Treatment

The drug of choice in treating lymphatic filariasis is diethylcarbamazine (DEC). The trade name in the United States is Hetrazan.

The treatment schedule is typically 2 mg/kg per day, three times a day, for three weeks. The drug is taken in tablet form.

DEC kills the microfilariae quickly and injures or kills the adult worms slowly, if at all. If all the adult worms are not killed, remaining paired males and females may continue to produce more larvae. Therefore, several courses of DEC treatment over a long time period may be necessary to rid the individual of the parasites.

DEC has been shown to reduce the size of enlarged lymph nodes and, when taken long-term, to reduce elephantiasis. In India, DEC has been given in the form of a medicated salt, which helps prevent spread of the disease.

KEY TERMS

Antigen—Any substance (usually a protein) that causes an immune response by the body to produce antibodies.

Filarial—Threadlike. The word "filament" is formed from the same root word.

Host—A person or animal in which a parasite lives, is nourished, grows, and reproduces.

Lymph—A watery substance that collects in the tissues and organs of the body and eventually drains into the bloodstream.

Lymphatic system—A network composed of vessels, lymph nodes, the tonsils, the thymus gland, and the spleen. It is responsible for transporting fluid and nutrients to the bloodstream and for maturing certain blood cells that are part of the body's immune system.

Lymphedema—The unnatural accumulation of lymph in the tissues of the body, which results in swelling in that area.

Protozoa—(Plural form of protozoan) Single-celled organisms (not bacteria) of which about 30 kinds cause disease in humans.

Streptococcal—Pertaining to any of the *Streptococcus* bacteria. These organisms can cause pneumonia, skin infections, and many other diseases.

The side effects of DEC almost all are due to the body's natural allergic reactions to the dying parasites rather than to the DEC itself. For this reason, DEC must be given carefully to reduce the danger to the individual. Side effects may include fever, chills, **headache**, **dizziness**, **nausea and vomiting**, **itching**, and joint pain. These side effects usually occur within the first few days of treatment. These side effects usually subside as the individual continues taking the drug.

There is an alternate treatment plan for the use of DEC. This plan is designed to kill the parasites slowly (to reduce allergic reactions to the dead microfilariae and dying adult worms within the body). Lower doses of DEC are taken for the first few days, followed by the higher dose of 2 mg/kg per day for the remaining three weeks. In addition, steroids may be prescribed to prevent the individual's body from reacting severely to the dead worms.

Another drug used is Ivermectin. Early research studies of Ivermectin show that it is excellent in killing microfilariae, but the effects of this drug on the adult worms are still being investigated. It is probable that patients will need to continue using DEC to kill the adult worms. Mild side effects of Ivermectin include headache, fever, and myalgia.

Other means of managing lymphatic filariasis are pressure bandages to wrap the swollen limb and elastic stockings to help reduce the pressure. Exercising and elevating a bandaged limb also can help reduce its size.

Surgery can be performed to reduce elephantiasis by removing excess fatty and fibrous tissue, draining the swelled area, and removing the dead worms.

Prognosis

With DEC treatment, the prognosis is good for early and mild cases of lymphatic filariasis. The prognosis is poor, however, for heavy parasitic infestations.

Prevention

The two main ways to control this disease are to take DEC preventively, which has shown to be effective, and to reduce the number of carrier insects in a particular area.

Avoiding mosquito bites with insecticides and insect repellents is helpful, as is wearing protective clothing and using bed netting.

Much effort has been made in cleaning the breeding sites (stagnant water) of mosquitoes near people's homes in areas where filariasis is found.

Before visiting countries where lymphatic filariasis is found, it would be wise to consult a travel physician to learn about current preventative measures.

Resources

BOOKS

Ash, Laurence R. *Atlas of Human Parasitology.* 4th ed. Chicago: ASCP Press, 1997.

Conn's Current Therapy, 1996. Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Weatherall, D. J. *Oxford Textbook of Medicine.* 3rd ed. Oxford, England: Oxford University Press, 1996.

Zatouroff, Michael. *Diagnosis in Color: Physical Signs in General Medicine.* 2nd ed. London: Mosby-Wolfe, 1996.

PERIODICALS

Bandyopadhyay, Lalita. "Lymphatic Filariasis and the Women of India." *Social Science and Medicine* 42, no.10 (May 1996): 1401-1410.

Eberhard, Mark L. "A Survey of Knowledge, Attitudes, and Perceptions (KAPs) of Lymphatic Filariasis, Elephantiasis, and Hydrocele Among Residents in an Endemic Area in Haiti." *American Journal of Tropical Medicine and Hygiene* 54, no. 3 (Mar. 1996): 299-303.

Rajan, T. V. "Immunopathogenetic Aspects of Disease Induced by Helminth Parasites." *Chemical Immunology* 66 (1997): 125-158.

ORGANIZATIONS

National Institute of Allergies and Infectious Diseases, Division of Microbiology and Infectious Diseases. Building 31, Room. 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892. <http://www.niaid.nih.gov>.

National Lymphedema Network (NLN). 2211 Post St., Suite 404, San Francisco, CA 94115. (800) 541-3259. <http://www.hooked.net>.

National Organization for Rare Disorders. PO Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Collette L. Placek

Enzyme-linked Immunosorbant (ELISA) *see* **AIDS tests**

Embolism

Definition

An embolism is an obstruction in a blood vessel due to a blood clot or other foreign matter that gets stuck while traveling through the bloodstream. The plural of embolism is emboli.

Description

Emboli have moved from the place where they were formed through the bloodstream to another part of the body, where they obstruct an artery and block the flow of blood. The emboli are usually formed from blood clots but are occasionally comprised of air, fat, or tumor tissue. Embolic events can be multiple and small, or single and massive. They can be life-threatening and require immediate emergency medical care. There are three general categories of emboli: arterial, gas, and pulmonary. Pulmonary emboli are the most common.

Arterial embolism

In arterial emboli, blood flow is blocked at the junction of major arteries, most often at the groin, knee, or thigh. Arterial emboli are generally a complication of heart disease. An **arterial embolism** in the brain (cerebral embolism) causes **stroke**, which can be fatal. An estimated 5–14% of all strokes are caused by cerebral emboli. Arterial emboli to the extremities can lead to tissue **death** and **amputation** of the affected limb if not treated effectively within hours. Intestines and kidneys can also suffer damage from emboli.

Gas embolism

Gas emboli result from the compression of respiratory gases into the blood and other tissues due to rapid changes in environmental pressure, for example, while flying or scuba diving. As external pressure decreases, gases (like nitrogen) that are dissolved in the blood and other tissues become small bubbles that can block blood flow and cause organ damage.

Pulmonary embolism

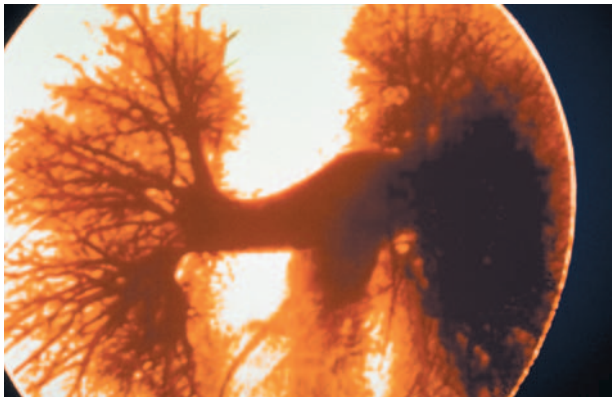
In a **pulmonary embolism**, a common illness, blood flow is blocked at a pulmonary artery. When emboli block the main pulmonary artery, and in cases where there are no initial symptoms, a pulmonary embolism can quickly become fatal. According to the American Heart Association, an estimated 600,000 Americans develop pulmonary emboli annually and 60,000 die from it.

A pulmonary embolism is difficult to diagnose. Less than 10% of patients who die from a pulmonary embolism were diagnosed with the condition. More than 90% of cases of pulmonary emboli are complications of **deep vein thrombosis**, blood clots in the deep vein of the leg or pelvis.

Causes and symptoms

Arterial emboli are usually a complication of heart disease where blood clots form in the heart's chambers. Gas emboli are caused by rapid changes in environmental pressure that could happen when flying or scuba diving. A pulmonary embolism is caused by blood clots that travel through the blood stream to the lungs and block a pulmonary artery. More than 90% of the cases of pulmonary embolism are a complication of deep vein thrombosis, which typically occurs in patients who have had **orthopedic surgery** and patients with **cancer** or other chronic illnesses like congestive **heart failure**.

Risk factors for arterial and pulmonary emboli include: prolonged bed rest, surgery, **childbirth**, **heart attack**, stroke, congestive heart failure, cancer, **obesity**, a broken hip or leg, **oral contraceptives**, sickle cell anemia, chest trauma, certain congenital heart defects, and old age. Risk factors for gas emboli include: scuba diving, amateur plane flight, **exercise**, injury, obesity, **dehy-**



A close up view of a pulmonary embolism. *(Custom Medical Stock Photo. Reproduced by permission.)*

dration, excessive alcohol, colds, and medications such as narcotics and **antihistamines**.

Common symptoms of a pulmonary embolism include:

- labored breathing, sometimes accompanied by chest **pain**
- a rapid pulse
- a **cough** that may produce sputum
- a low-grade **fever**
- fluid build-up in the lungs

Less common symptoms include:

- coughing up blood
- pain caused by movement or breathing
- leg swelling
- bluish skin
- fainting
- swollen neck veins

Symptoms of an arterial embolism include:

- severe pain in the area of the embolism
- pale, bluish cool skin
- numbness
- tingling
- muscular weakness or **paralysis**

Diagnosis

An embolism can be diagnosed through the patient's history, a physical exam, and diagnostic tests. For arterial emboli, cardiac ultrasound and/or arteriography are ordered. For a pulmonary embolism, a **chest x ray**, lung scan, pulmonary **angiography**, **electrocardiography**, arterial blood gas measurements, and **venography** or venous ultrasound could be ordered.

Diagnosing an arterial embolism

Ultrasound uses sound waves to create an image of the heart, organs, or arteries. The technician applies gel to a hand-held transducer then presses it against the patient's body. The ultrasound's sound waves arteries are converted into an image that can be displayed on a monitor. Performed in an outpatient diagnostic laboratory, the test takes 30–60 minutes.

An arteriogram is an x ray in which a contrast medium is injected to make the arteries visible on the x ray. It can be performed in a radiology unit, outpatient clinic, or diagnostic center of a hospital.

Diagnosing a pulmonary embolism

A chest x ray can show fluid build-up and detect other respiratory diseases. The perfusion lung scan shows poor flow of blood in areas beyond blocked arteries. The patient inhales a small amount of radiopharmaceutical and pictures of airflow into the lungs are taken with a gamma camera. Then a different radiopharmaceutical is injected into an arm vein and lung blood flow is scanned. A normal result essentially rules out a pulmonary embolism. A lung scan can be performed in a hospital or an outpatient facility and takes about 45 minutes.

Pulmonary angiography is the most reliable test for diagnosing a pulmonary embolism but it is not used often because it is expensive, invasive, and not readily available in most hospitals. Pulmonary angiography is a radiographic test which involves injection of a radio contrast agent to show the pulmonary arteries. A cinematic camera records the blood flow through the patient, who lies on a table. Pulmonary angiography is usually performed in a hospital's radiology medicine department and takes 30–60 minutes.

An electrocardiograph shows the heart's electrical activity and helps distinguish a pulmonary embolism from a heart attack. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. Impulses of the heart's activity are traced on paper. The test takes about 10 minutes.

Arterial blood gas measurements are sometimes helpful but, alone, they are not diagnostic for pulmonary embolism. Blood is taken from an artery instead of a vein, usually in the wrist.

Venography is used to look for the most likely source of a pulmonary embolism, deep vein thrombosis. It is very accurate, but it is not used often, because it is painful, expensive, exposes the patient to a fairly high dose of radiation, and can cause complications. Venogra-

phy identifies the location, extent, and degree of attachment of the blood clots and enables the condition of the deep leg veins to be assessed. A contrast solution is injected into a foot vein through a catheter. The physician observes the movement of the solution through the vein with a fluoroscope while a series of x rays are taken. Venography takes between 30–45 minutes and can be done in a physician's office, a laboratory, or a hospital. Radionuclide venography, in which a radioactive isotope is injected, is occasionally used, especially if a patient has had reactions to contrast solutions. Venous ultrasound is the preferred evaluation of leg veins.

Treatment

Patients with emboli require immediate hospitalization. They are generally treated with clot-dissolving and/or clot-preventing drugs. **Thrombolytic therapy** to dissolve blood clots is the definitive treatment for a very severe pulmonary embolism. Streptokinase, urokinase, and recombinant tissue plasminogen activator (TPA) are used. Heparin is the anticoagulant drug of choice for preventing formation of blood clots. Warfarin, an oral anticoagulant, is sometimes used concurrently and is usually continued after the hospitalization.

In the case of an arterial embolism, the affected limb is placed in a dependent position and kept warm. Embolectomy is the treatment of choice in the majority of early cases of arterial emboli in the extremities. In this procedure, a balloon-tipped catheter is inserted into the artery to remove thromboembolic matter.

With a pulmonary embolism, oxygen therapy is often used to maintain normal oxygen concentrations. For people who can't take anticoagulants and in some other cases, surgery may be needed to insert a device that filters blood returning to the heart and lungs.

Prognosis

Of patients hospitalized with an arterial embolism, 25–30% die, and 5–25% require amputation of a limb. About 10% of patients with a pulmonary embolism die suddenly within the first hour of onset of the condition. The outcome for all other patients is generally good; only 3% of patients die who are properly diagnosed early and treated. In cases of an undiagnosed pulmonary embolism, about 30% of patients die.

Prevention

Embolism can be prevented in high risk patients through antithrombotic drugs such as heparin, venous interruption, gradient elastic stockings, and intermittent pneumatic compression of the legs. The combination of graduated compression stockings and low-dose heparin is significantly more effective than low-dose heparin alone.

Gradient elastic stockings, also called anti-embolism stockings, decrease the risk of blood clots by compressing superficial leg veins and forcing blood into the deep veins. They can be knee-, thigh-, or waist-length. Many physicians order the use of stockings before surgery and until there is no longer an elevated risk of developing blood clots. The risk of deep vein thrombosis after surgery is reduced 50% with the use of these stockings. The American Heart Association recommends that the use of graduated compression stockings be considered for all high-risk surgical patients.

Intermittent pneumatic compression involves wrapping knee- or thigh-high cuffs around the legs to prevent blood clots. The cuffs are connected to a pump which inflates and deflates, mimicking the heart's normal pumping action and reducing the pooling of blood. Intermittent pneumatic compression can be used during surgery and recovery and continues until there is no longer an elevated risk of developing blood clots. The American Heart Association recommends the use of intermittent pneumatic compression for patients who cannot take anticoagulants, for example, spinal cord and brain trauma patients.

KEY TERMS

Anticoagulants—Drugs that suppress, delay, or prevent blood clots. Anticoagulants are used to treat embolisms.

Artery—A blood vessel that carries blood from the heart to other body tissues. Embolisms obstruct arteries.

Deep vein thrombosis—A blood clot in the calf's deep vein. This frequently leads to pulmonary embolism if untreated.

Emboli—Clots or other substances that travel through the blood stream and get stuck in an artery, blocking circulation.

Thrombolytics—Drugs that dissolve blood clots. Thrombolytics are used to treat embolisms.

Resources

BOOKS

"Arterial Occlusive Disease." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

DeBakey, M. E., and A. M. Gotto. "Invasive Diagnostic Procedures." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

"Disorders of the Pulmonary Circulation," "Arterial Embolism," and "Other Disorders Due to Physical Agents." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Noble, John, ed. "Arterial Emboli and Acute Thrombosis." In *Textbook of Primary Care Medicine*. 2nd ed. St. Louis: Mosby, 1996.

Texas Heart Institute. "Diseases of the Peripheral Arteries and Veins." In *Texas Heart Institute's Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

ACCP Consensus Committee on Pulmonary Embolism. "Opinions Regarding the Diagnosis of Venous Thromboembolic Disease." *Chest* 113, no. 2 (Feb. 1998): 499-503.

Charland, Scott L., and Dawn Klinter. "Low-Molecular Weight Heraprins in the Treatment of Pulmonary Embolism." *The Annals of Pharmacotherapy* 32 (Feb. 1998): 258-263.

Tapson, Victor F. "Pulmonary Embolism-New Diagnostic Approaches." *The New England Journal of Medicine* 336, no. 20 (15 May 1997): 1449-1451.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

OTHER

"Management of Deep Vein Thrombosis and Pulmonary Embolism." and "Stroke (Brain Attack)." *American Heart Association*. 3 Mar. 1998 <http://www.americanheart.org>.

"Warfin and Compression Treatment Prevents Coagulation in Knee ReplacementsAmerican." *Academy of Orthopaedic Surgeons Online*. 15 Feb. 1997. 22 Apr. 1998 <http://www.aaos.org>.

Lori De Milto

EMG *see* **Electromyography**

Emollient bath *see* **Therapeutic baths**

Emphysema

Definition

Emphysema is a chronic respiratory disease where there is over-inflation of the air sacs (alveoli) in the lungs, causing a decrease in lung function, and often, breathlessness.

Description

Emphysema is the most common cause of **death** from respiratory disease in the United States, and is the fourth most common cause of death overall. There are 1.8 million Americans with the disease, which ranks fifteenth among chronic conditions that cause limitations of activity. The disease is usually caused by **smoking**, but a small number of cases are caused by an inherited defect.

Normally functioning lungs are elastic, efficiently expanding and recoiling as air passes freely through the bronchus to the alveoli, where oxygen is moved into the blood and carbon dioxide is filtered out. When a person inhales cigarette smoke or certain other irritants, his or her immune system responds by releasing substances that are meant to defend the lungs against the smoke. These substances can also attack the cells of the lungs, but the body normally inhibits such action with the release of other substances. In smokers and those with the inherited defect, however, no such prevention occurs and the lung tissue is damaged in such a way that it loses its elasticity. The small passageways (bronchioles) leading to the alveoli collapse, trapping air within the alveoli. The alveoli, unable to recoil efficiently and move the air out, over expand and rupture. As the disease progresses, coughing and **shortness of breath** occur. In the later stages, the lungs cannot supply enough oxygen to the blood. Emphysema often occurs with other respiratory diseases, particularly chronic **bronchitis**. These two diseases are often referred to as one disorder called chronic obstructive pulmonary disease (COPD).

Emphysema is most common among people aged 50 and older. Those with inherited emphysema may experience the onset as early as their thirties or fourties Men are more likely than women to develop emphysema, but female cases are increasing as the number of female smokers rises.

Causes and symptoms

Heavy cigarette smoking causes about 80–90% of all emphysema cases. However a few cases are the result of an inherited deficiency of a substance called alpha-1-antitrypsin (AAT). The number of Americans with this deficiency is relatively small, probably no greater than 70,000. Pipe, cigar, and marijuana smoking can also damage the lungs. While a person may be less likely to inhale cigar and pipe smoke, these types of smoke can also impair lung function. Marijuana smoke may be even more damaging because it is inhaled deeply and held in by the smoker.

The symptoms of emphysema develop gradually over many years. It is a common occurrence for many emphysema patients to have lost over half of their functioning lung tissue before they become aware that something is wrong. Shortness of breath, a chronic mild **cough** (which may be productive of large amounts of dark, thick sputum, and often dismissed as "smoker's cough"), and sometimes weight loss are associated with emphysema.

Initially, a patient may only notice shortness of breath when he or she is exercising. However, as the disease progresses, it will occur with less exertion or no exertion at all. Emphysema patients may also develop an enlarged, or "barrel," chest. Other symptoms may be skipped breaths, difficulty sleeping, morning headaches, increased difficulty breathing while lying down, chronic **fatigue**, and swelling of the feet, ankles, or legs. Those with emphysema are at risk for a variety of other complications resulting from weakened lung function, including **pneumonia**.

Diagnosis

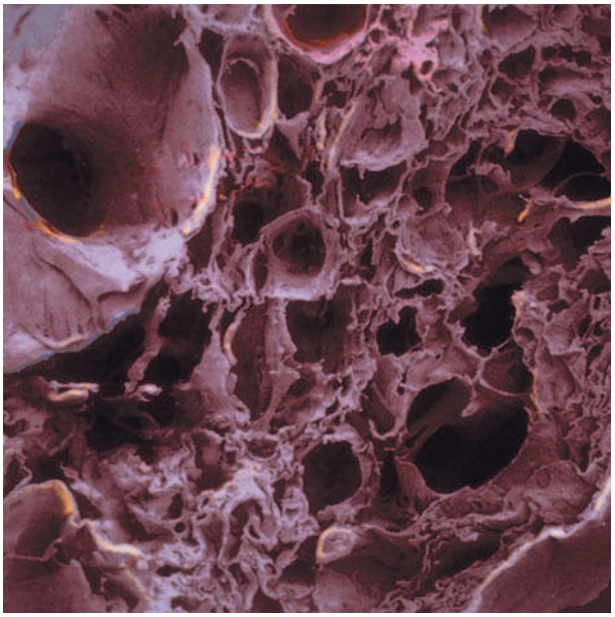
A variety of pulmonary function tests may be ordered. In the early stages of emphysema, the only result may be dysfunction of the small airways. Patients with emphysema may show an increase in the total amount of air that is in the lungs (total lung capacity), but a decrease in the amount of air that can be breathed out after taking a deep breath (vital capacity). With severe emphysema, vital capacity is substantially below normal. Spirometry, a procedure that measures air flow and lung volume, helps in the diagnosis of emphysema.

A **chest x ray** is often ordered to aid in the diagnosis of emphysema, though patients in the early stages of the disease may have normal findings. Abnormal findings on the chest x ray include over-inflation of the lungs and an abnormally increased chest diameter. The diaphragm may appear depressed or flattened. In addition, patients with advanced emphysema may show a smaller or vertical heart. The physician may observe blisters in the lungs and bulging of the accessory muscles of the respiratory system. Late in the disease, an EKG will show signs of right ventricular failure in the heart and increased hemoglobin due to lower levels of oxygen in the patient's blood.

Treatment

Treatment methods for emphysema do not cure or reverse the damage to the lungs. However, they may slow the progression of the disease, relieve symptoms, and help control possibly fatal complications. The first step in treatment for smokers is to quit, so as to prevent any further deterioration of breathing ability. Smoking cessation programs may be effective. Consistent encouragement along with the help of health care professionals as well as family and friends can help increase the success rate of someone attempting to quit.

If the patient and the health care team develop and maintain a complete program of respiratory care, disability can be decreased, acute episodes of illness may be prevented, and the number of hospitalizations reduced. However, only quitting smoking has been shown to slow down the progression of the disease, and among all other



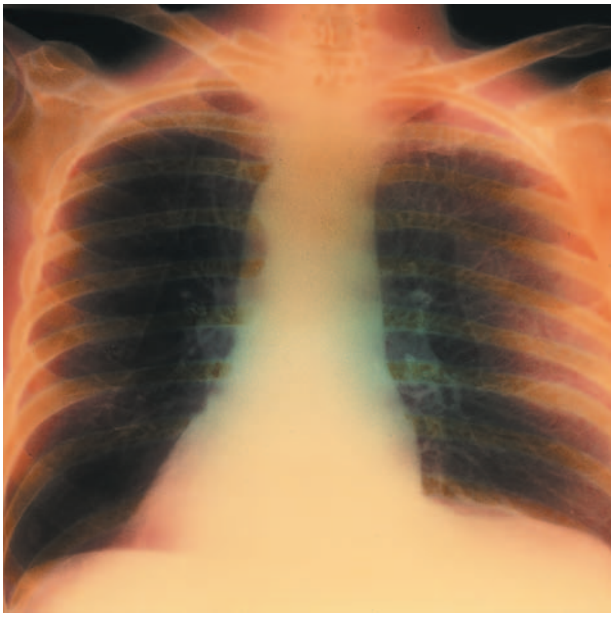
A scanning electron microscopy (SEM) of lung tissue indicating emphysema. *(Photograph by Hossler, Ph.D., Custom Medical Stock Photo. Reproduced by permission.)*

treatments, only oxygen therapy has shown an increase in the survival rate.

Home oxygen therapy may improve the survival times in those patients with advanced emphysema who also have low blood oxygen levels. It may improve the patient's tolerance of **exercise**, as well as improve their performance in certain aspects of brain function and muscle coordination. The functioning of the heart may also improve with an increased concentration of oxygen in the blood. Oxygen may also decrease **insomnia** and headaches. Some patients may only receive oxygen at night, but studies have illustrated that it is most effective when administered at least 18, but preferably 24 hours per day. Portable oxygen tanks prescribed to patients carry a limited supply and must be refilled on a regular basis by a home health provider. Medicare and most insurance companies cover a large proportion of the cost of home oxygen therapy. Patients should be instructed regarding special safety issues involving the transport and presence of oxygen in the home.

A variety of medications may be used in the treatment of emphysema. Usually the patient responds best to a combination of medicines, rather than one single drug.

Bronchodilators are sometimes used to help alleviate the patient's symptoms by relaxing and opening the airways. They can be inhaled, taken by mouth, or injected. Another category of medication often used is **corticosteroids** or steroids. These help to decrease the



X ray showing emphysema in the lungs. *(Photo Researchers. Reproduced by permission.)*

inflammation of the airway walls. They are occasionally used if bronchodilators are ineffective in preventing airway obstruction. Some patients' lung function improves with corticosteroids, and inhaled steroids may be beneficial to patients with few side effects. A variety of **antibiotics** are frequently given at the first sign of a respiratory infection, such as increased amounts of sputum, or if there has been a change in the color of the sputum. **Expectorants** can help to loosen respiratory secretions, enabling the patient to more easily expel them from the airways.

Many of the medications prescribed involve the use of a metered dose inhaler (MDI) that may require special instruction to be used correctly. MDIs are a convenient and safe method of delivering medication to the lungs. However, if they are used incorrectly the medication will not get to the right place. Proper technique is essential for the medication to be effective.

For some patients, surgical treatment may be the best option. Lung volume reduction surgery is a surgical procedure in which the most diseased parts of the lung are removed to enable the remaining lung and breathing muscles to work more efficiently. Preliminary studies suggest improved survival rates and better functioning with the surgery. Another surgical procedure used for emphysema patients is **lung transplantation**. Transplantation may involve one or both lungs. However, it is a risky and expensive procedure, and donor organs may not be available.

For those patients with advanced emphysema, keeping the air passages reasonably clear of secretions can prove difficult. Some common methods for mobilizing and removing secretions include:

- Postural drainage. This helps to remove secretions from the airways. The patient lies in a position that allows gravity to aid in draining different parts of the lung. This is often done after the patient inhales an aerosol medication. The basic position involves the patient lying on the bed with his chest and head over the side and the forearms resting on the floor.
- Chest percussion. This technique involves lightly clapping the back and chest, and may help to loosen thick secretions.
- Coughing and deep breathing. These techniques may aid the patient in bringing up secretions.
- Aerosol treatments. These treatments may involve solutions of saline, often mixed with a bronchodilator, which are then inhaled as an aerosol. The aerosols thin and loosen secretions. A treatment normally takes 10 to 15 minutes, and is given three or four times a day.

Patients with COPD can learn to perform a variety of self-help measures that may help improve their symptoms and their ability to participate in everyday activities. These measures include:

- Avoiding any exposure to dusts and fumes.
- Avoiding air pollution, including the cigarette smoke of others.
- Avoiding other people who have infections like the cold or flu. Get a pneumonia **vaccination** and a yearly flu shot.
- Drinking plenty of fluids. This helps to loosen respiratory secretions so they can be brought up more easily through coughing.
- Avoiding extreme temperatures of heat or cold. Also avoiding high altitudes. (Special precautions can be taken that may enable the emphysema patient to fly on a plane.)
- Maintaining adequate nutritional intake. Normally a high protein diet taken in many small feedings is recommended.

Alternative treatment

Many patients are interested in whether any alternative treatments for emphysema are available. Some practitioners recommend supplements of antioxidant nutrients. There have also been some studies indicating a correlation between a low Vitamin A levels and COPD, with suggestions that supplements of vitamin A might be ben-

KEY TERMS

Alveoli—Small cells or cavities. In the lungs, these are air sacs where oxygen enters the blood and carbon dioxide is filtered out.

Pulmonary—Related to or associated with the lungs.

eficial. Aromatherapists have used essential oils like eucalyptus, lavender, pine, and rosemary to help relieve nasal congestion and make breathing easier. The herb elecampane may act as an expectorant to help patients clear mucus from the lungs. The patient should discuss these remedies with their health care practitioner prior to trying them, as some may interact with the more traditional treatments that are already being used.

Prognosis

Emphysema is a serious and chronic disease that cannot be reversed. If detected early, the effects and progression can be slowed, particularly if the patient stops smoking immediately. Complications of emphysema include higher risks for pneumonia and acute bronchitis. Overall, the prognosis for patients with emphysema is poor, with a survival rate for all those with COPD of four years, and even less for emphysema. However, individual cases vary and many patients can live much longer with supplemental oxygen and other treatment measures.

Prevention

The best way to prevent emphysema is to avoid smoking. Even patients with inherited emphysema should avoid smoking, as it especially worsens the onset and severity. If patients quit smoking as soon as evidence of small airway obstruction begins, they can significantly improve their prognosis.

Resources

BOOKS

Beers, Mark H., and Robert Berkow, eds. *The Merck Manual of Diagnosis and Therapy, 17th ed.* Whitehouse Station, NJ: Merck and Company, Inc., 1999.

PERIODICALS

"Data Mounting on Merits of Lung Volume Reduction Surgery." *Family Practice News* (February 15, 2001): 5.

Lewis, Laurie. "Optimal Treatment for COPD." *Patient Care* (May 30, 2000): 60.

ORGANIZATIONS

American Lung Association. 1740 Broadway New York, NY 10019. (212) 315-8700. <http://www.lungusa.org>.

The National Emphysema Foundation. 15 Stevens St. Norwalk, CT 06856. <http://www.emphysemafoundation.org>.

The National Heart, Lung and Blood Institute. <http://www.nhlbi. nih.gov>.

Deanna Swartout-Corbeil, RN

Empyema

Definition

Empyema is a condition in which pus and fluid from infected tissue collects in a body cavity. The name comes from the Greek word *empyein* meaning pus-producing (suppurate). Empyema is most often used to refer to collections of pus in the space around the lungs (pleural cavity), but sometimes refers to similar collections in the gall bladder or the pelvic cavity. Empyema in the pleural cavity is sometimes called empyema thoracis, or empyema of the chest, to distinguish it from empyema elsewhere in the body.

Description

Empyema may have a number of causes but is most frequently a complication of **pneumonia**. Its development can be divided into three phases: an acute phase in which the body cavity fills with a thin fluid containing some pus; a second stage in which the fluid thickens and a fibrous, coagulation protein (fibrin) begins to accumulate within the cavity; and a third or chronic stage in which the lung or other organ is encased within a thick covering of fibrous material.

Causes and symptoms

Empyema thoracis can be caused by a number of different organisms, including bacteria, fungi, and amebas, in connection with pneumonia, chest **wounds**, chest surgery, lung abscesses, or a ruptured esophagus. The infective organism can get into the pleural cavity either through the bloodstream or other circulatory system, in secretions from lung tissue, or on the surfaces of surgical instruments or objects that cause open chest wounds. The most common organisms that cause empyema are the following bacteria: *Streptococcus pneumoniae*, *Haemophilus influenzae,* and *Staphylococcus aureus*. *S. aureus* is the most common cause in all age groups, accounting for 90% of cases of empyema in infants and children. Pelvic empyema in

KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Decortication—Surgical removal of the fibrous peel that covers the lungs in third-stage empyema.

Empyema—The collection of pus in a body cavity, particularly the lung or pleural cavity.

Fibrin—A fibrous blood protein vital to coagulation and blood clot formation.

Percussion—A diagnostic technique in which the back, chest, or abdomen is tapped to determine whether body cavities contain abnormal fluid.

Pleural cavity—The space surrounding the lungs, including the membranes covering the lungs and lining the inside of the chest wall.

Pneumonia—Inflammation of the lungs usually caused by a virus, bacteria, or other organism.

Resection—The surgical removal of part of an organ or body structure, as in rib resection.

Suppurate—To produce or discharge pus.

Thoracentesis—A procedure in which fluid is withdrawn from the pleural cavity through a needle inserted between the ribs. The fluid may be withdrawn either for diagnostic tests or to drain the cavity.

Video-assisted thoracic surgery (VATS)—A technique used to aid in the placement of chest tubes or when performing decortications when treating advanced empyema.

women is most often caused by *Bacteroides* strains or *Pseudomonas aeruginosa*. In elderly, chronically ill, or alcoholic patients, empyema is often caused by *Klebsiella pneumoniae* species of bacteria.

When the disease organisms arrive in the cavity surrounding the lungs, they infect the tissues that cover the lungs and line the chest wall. As the body attempts to fight off the infection, the cavity fills up with tissue fluid, pus, and dead tissue cells. Empyema of the gall bladder or pelvis results from similar reactions to infection in those parts of the body.

The signs and symptoms of empyema vary somewhat according to the location of the infection and its severity. In empyema thoracis, patients usually exhibit symptoms of pneumonia, including **fever**, **cough**, **fatigue**, **shortness of breath**, and chest **pain**. They may prefer to lie on the side of the body affected by the empyema. Family members may notice **bad breath**. In severe cases, the patient may become dehydrated, cough up blood or greenish-brown sputum, run a fever as high as 105°F (40.6°C), or fall into a **coma**.

Patients with thoracic empyema may develop potentially life-threatening complications if the condition is not treated. The infected tissues may develop large collections of pus (abscesses) that can rupture into the patient's airway, or the infection may spread to the tissues surrounding the heart. In extreme cases the empyema may spread to the brain by means of bacteria carried in the bloodstream.

In pelvic empyema, the infection produces large amounts of thick, foul-smelling pus that is rapidly replaced even after drainage. Empyema of the gallbladder is marked by intense pain on the upper right side of the abdomen, high fever, and rigidity of the muscles over the infected area.

Diagnosis

A physician may consider the possibility of empyema thoracis in patients with pneumonia or other symptoms of lung infection. When listening to sounds within the patient's chest with a stethoscope, the sounds of breathing will be partly muffled and harder to hear in the patients with empyema. The area of the chest over the infection will sound dull when tapped or thumped (percussed). On an x ray, empyema thoracis will appear as a cloudy or opaque area. The amount of fluid present in the pleural cavity can be estimated using an ultrasound imaging procedure. The diagnosis of empyema, however, has to be confirmed with laboratory tests because its symptoms can be caused by other disease conditions.

The diagnosis of empyema is usually confirmed by analyzing a sample of fluid taken from the pleural cavity. The sample is obtained by a procedure called **thoracentesis**. In this procedure, the patient is given a local anesthetic, a needle is inserted into the pleural cavity through the back between the ribs on the infected side, and a sample of fluid is withdrawn. If the patient has empyema, there will be a very high level of one particular kind of immune cell (white blood cells), a high level of protein, and a very low level of blood sugar. The fluid can also be tested for the specific disease organism by staining or tissue cultures. In some cases, the color, smell, or consistency of the tissue fluid also helps to confirm the diagnosis.

Treatment

Empyema is treated using a combination of medications and surgical techniques. Treatment with medication involves intravenously administering a two-week course

of **antibiotics**. It is important to give antibiotics as soon as possible to prevent first-stage empyema from progressing to its later stages. The antibiotics most commonly used are penicillin and vancomycin. Patients experiencing difficulty breathing are also given oxygen therapy.

Surgical treatment of empyema has two goals: drainage of the infected fluid and closing up of the space left in the pleural cavity. If the infection is still in its early stages, the fluid can be drained by thoracentesis. In second-stage empyema, the surgeon will insert a chest tube in the patient's rib cage or remove part of a rib (rib resection) in order to drain the fluid. In third-stage empyema, the surgeon may cut or peel away the thick fibrous layer coating the lung. This procedure is called decortication. When the fibrous covering is removed, the lung will expand to fill the space in the chest cavity. The doctor can use video-assisted **thoracic surgery** (VATS) techniques to position the chest tube or to perform a limited decortication. The VATS technique allows a physician to see within the body during certain surgical procedures. Empyema of the gallbladder is a serious condition that is treated with intravenous antibiotics and surgical removal of the gallbladder.

Prognosis

The prognosis for recovery is generally good, except in those cases with complications, such as a **brain abscess** or blood **poisoning**, or cases caused by certain types of streptococci.

Resources

BOOKS

"Bedside Procedures: Thoracentesis." In *Surgery On Call*, ed. Leonard G. Gomella and Alan T. Lefor. Stamford: Appleton & Lange, 1996.

Chambers, Henry F. "Infectious Diseases: Bacterial & Chlamydial." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Larsen, Gary L., et al. "Respiratory Tract & Mediastinum." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Nakeeb, Attila, and Keith D. Lillemoe. "Cholelithiasis and Cholecystitis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Stauffer, John L. "Lung." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Turley, Kevin. "Thoracic Wall, Pleura, Mediastinum, and Lung." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Whyte, Richard I. "Pleural Effusion and Empyema Thoracis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Rebecca J. Frey

Enalapril *see* **Angiotensin-converting enzyme inhibitors**

Encephalitis

Definition

Encephalitis is an inflammation of the brain, usually caused by a direct viral infection or a hypersensitivity reaction to a virus or foreign protein. Brain inflammation caused by a bacterial infection is sometimes called cerebritis. When both the brain and spinal cord are involved, the disorder is called encephalomyelitis. An inflammation of the brain's covering, or meninges, is called **meningitis**.

Description

Encephalitis is an inflammation of the brain. The inflammation is a reaction of the body's immune system to infection or invasion. During the inflammation, the brain's tissues become swollen. The combination of the infection and the immune reaction to it can cause **headache** and a **fever**, as well as more severe symptoms in some cases.

Approximately 2,000 cases of encephalitis are reported to the Centers for Disease Control in Atlanta, GA each year. The viruses causing primary encephalitis can be epidemic or sporadic. The **polio** virus is an epidemic cause. Arthropod-borne viral encephalitis is responsible for most epidemic viral encephalitis. The viruses live in animal hosts and mosquitos that transmit the disease. The most common form of non-epidemic or sporadic encephalitis is caused by the herpes simplex virus, type 1 (HSV-1) and has a high rate of **death**. **Mumps** is another example of a sporadic cause.

Causes and symptoms

Causes

There are more than a dozen viruses that can cause encephalitis, spread by either human-to human contact or by animal bites. Encephalitis may occur with several common viral infections of childhood. Viruses and viral diseases that may cause encephalitis include:

- **chickenpox**
- **measles**
- mumps
- Epstein-Barr virus (EBV)

- cytomegalovirus infection
- HIV
- herpes simplex
- herpes zoster (**shingles**)
- herpes B
- polio
- **rabies**
- mosquito-borne viruses (arboviruses)

Primary encephalitis is caused by direct infection by the virus, while secondary encephalitis is due to a post-infectious immune reaction to viral infection elsewhere in the body. Secondary encephalitis may occur with measles, chickenpox, mumps, **rubella**, and EBV. In secondary encephalitis, symptoms usually begin five to 10 days after the onset of the disease itself and are related to the breakdown of the myelin sheath that covers nerve fibers.

In rare cases, encephalitis may follow **vaccination** against some of the viral diseases listed above. **Creutzfeldt-Jakob disease**, a very rare brain disorder caused by an infectious particle called a prion, may also cause encephalitis.

Mosquitoes spread viruses responsible for equine encephalitis (eastern and western types), St. Louis encephalitis, California encephalitis, and **Japanese encephalitis**. **Lyme disease**, spread by ticks, can cause encephalitis, as can Colorado tick fever. Rabies is most often spread by animal bites from dogs, cats, mice, raccoons, squirrels, and bats and may cause encephalitis.

Equine encephalitis is carried by mosquitoes that do not normally bite humans but do bite horses and birds. It is occasionally picked up from these animals by mosquitoes that do bite humans. Japanese encephalitis and St. Louis encephalitis are also carried by mosquitoes. The risk of contracting a mosquito-borne virus is greatest in mid- to late summer, when mosquitoes are most active, in those rural areas where these viruses are known to exist. Eastern equine encephalitis occurs in eastern and southeastern United States; western equine and California encephalitis occur throughout the West; and St. Louis encephalitis occurs throughout the country. Japanese encephalitis does not occur in the United States, but is found throughout much of Asia. The viruses responsible for these diseases are classified as arbovirus and these diseases are collectively called **arbovirus encephalitis**.

Herpes simplex encephalitis, the most common form of sporadic encephalitis in western countries, is a disease with significantly high mortality. It occurs in children and adults and both sides of the brain are affected. It is theorized that brain infection is caused by the virus moving from a peripheral location to the brain via two nerves, the olfactory and the trigeminal (largest nerves in the skull).

Herpes simplex encephalitis is responsible for 10% of all encephalitis cases and is the main cause of sporadic, fatal encephalitis. In untreated patients, the rate of death is 70% while the mortality is 15–20% in patients who have been treated with acyclovir. The symptoms of herpes simplex encephalitis are fever, rapidly disintegrating mental state, headache, and behavioral changes.

Symptoms

The symptoms of encephalitis range from very mild to very severe and may include:

- headache
- fever
- lethargy (sleepiness, decreased alertness, and **fatigue**)
- malaise
- nausea and vomiting
- visual disturbances
- tremor
- decreased consciousness (drowsiness, confusion, **delirium**, and unconsciousness)
- stiff neck
- seizures

Symptoms may progress rapidly, changing from mild to severe within several days or even several hours.

Diagnosis

Diagnosis of encephalitis includes careful questioning to determine possible exposure to viral sources. Tests that can help confirm the diagnosis and rule out other disorders include:

- Blood tests. These are to detect antibodies to viral antigens, and foreign proteins.
- Cerebrospinal fluid analysis (spinal tap). This detects viral antigens, and provides culture specimens for the virus or bacteria that may be present in the cerebrospinal fluid.
- Electroencephalogram (EEG).
- CT and MRI scans.

A **brain biopsy** (surgical gathering of a small tissue sample) may be recommended in some cases where treatment to date has been ineffective and the cause of the encephalitis is unclear. Definite diagnosis by biopsy may allow specific treatment that would otherwise be too risky.

Treatment

Choice of treatment for encephalitis will depend on the cause. Bacterial encephalitis is treated with **antibiotics**. Viral encephalitis is usually treated with **antiviral drugs** including acyclovir, ganciclovir, foscarnet, ribovarin, and AZT. Viruses that respond to acyclovir include herpes simplex, the most common cause of sporadic (non-epidemic) encephalitis in the United States.

The symptoms of encephalitis may be treated with a number of different drugs. **Corticosteroids**, including prednisone and dexamethasone, are sometimes prescribed to reduce inflammation and brain swelling. **Anticonvulsant drugs**, including dilantin and phenytoin, are used to control seizures. Fever may be reduced with **acetaminophen** or other fever-reducing drugs.

A person with encephalitis must be monitored carefully, since symptoms may change rapidly. Blood tests may be required regularly to track levels of fluids and salts in the blood.

Prognosis

Encephalitis symptoms may last several weeks. Most cases of encephalitis are mild, and recovery is usually quick. Mild encephalitis usually leaves no residual neurological problems. Overall, approximately 10% of those with encephalitis die from their infections or complications such as secondary infection. Some forms of encephalitis have more severe courses, including herpes encephalitis, in which mortality is 15–20% with treatment, and 70–80% without. Antiviral treatment is ineffective for eastern equine encephalitis, and mortality is approximately 30%.

Permanent neurological consequences may follow recovery in some cases. Consequences may include personality changes, memory loss, language difficulties, seizures, and partial **paralysis**.

Prevention

Because encephalitis is due to infection, it may be prevented by avoiding the infection. Minimizing contact with others who have any of the viral illness listed above may reduce the chances of becoming infected. Most infections are spread by hand-to-hand or hand-to-mouth contact; frequent hand washing may reduce the likelihood of infection if contact cannot be avoided.

Mosquito-borne viruses may be avoided by preventing mosquito bites. Mosquitoes are most active at dawn and dusk, and are most common in moist areas with standing water. Minimizing exposed skin and use of mosquito repellents on other areas can reduce the chances of being bitten.

KEY TERMS

Cerebrospinal fluid analysis—A analysis that is important in diagnosing diseases of the central nervous system. The fluid within the spine will indicate the presence of viruses, bacteria, and blood. Infections such as encephalitis will be indicated by an increase of cell count and total protein in the fluid.

Computerized tomography (CT) Scan—A test to examine organs within the body and detect evidence of tumors, blood clots, and accumulation of fluids.

Electroencephalagram (EEG)—A chart of the brain waves picked up by the electrodes placed on the scalp. Changes in brain wave activity can be an indication of nervous system disorders.

Inflammation—A response from the immune system to an injury. The signs are redness, heat, swelling, and pain.

Magnetic Resonance Imaging (MRI)—MRI is diagnostic radiography using electromagnetic energy to create an image of the central nervous system (CNS), blood system, and musculoskeletal system.

Vaccine—A prepartation containing killed or weakened microorganisms used to build immunity against infection from that microorganism.

Virus—A very small organism that can only live within a cell. They are unable to reproduce outside that cell.

Vaccines are available against some viruses, including polio, herpes B, Japanese encephalitis, and equine encephalitis. Rabies vaccine is available for animals; it is also given to people after exposure. Japanese encephalitis vaccine is recommended for those traveling to Asia and staying in affected rural areas during transmission season.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hurst, J. Willis. *Medicine for the Practicing Physician*. Stamford: Appleton & Lange, 1988.

Office Practice of Neurology. Ed. Martin Samuels and Steven Feske. New York: Churchill Livingstone, 1996.

The Merck Manual. Whitehouse Station, NJ: Merck and Co. Inc., 1996.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Richard Robinson

Encephalocele *see* **Congenital brain defects**

Endarterectomy

Definition

Endarterectomy is an operation to remove or bypass the fatty deposits, or blockage, in an artery narrowed by the buildup of fatty tissue (**atherosclerosis**).

Purpose

Removing the fatty deposits restores normal blood flow to the part of the body supplied by the artery. An endarterectomy is performed to treat cerebrovascular disease in which there is a serious reduction of blood supply to the brain (carotid endarterectomy), or to treat **peripheral vascular disease** (impaired blood supply to the legs).

Endarterectomy is most often performed on one of the two main arteries in the neck (the carotids) opening the narrowed arteries leading to the brain. When performed by an experienced surgeon, the practice is extremely effective, reducing the risk of **stroke** by up to 70%. Recent studies indicate it is effective in preventing stroke, even among those patients who had no warning signs except narrowed arteries detected by their doctors on a routine exam.

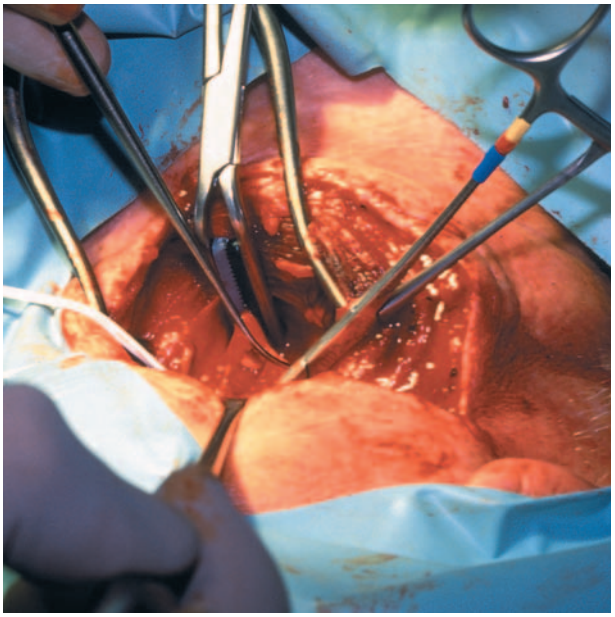
Precautions

Before the surgery, a full medical exam is usually done to assess any specific health problems, such as diabetes, high blood pressure, heart disease, or stroke. If possible, reversible health problems, such as cigarette **smoking** or being overweight, should be corrected.

Description

Carotid artery disease

Every person has four carotid arteries (the internal and external carotids on each side of the neck) through which blood from the heart moves into the brain. If one of these arteries becomes blocked by fat and cholesterol, the patient may have a range of symptoms, including:



In this procedure, surgeons are removing plaque from the carotid artery. *(Custom Medical Stock Photo. Reproduced by permission.)*

- weakness in one arm, leg, half of the face, or one entire side of the body
- numbness tingling
- **paralysis** of an arm, leg, or face
- slurred speech
- dizziness
- confusion, **fainting,** or **coma**
- stroke

Removing this fatty buildup, or bypassing a blocked segment, may restore blood flow to the brain, eliminate or decrease the symptoms, and lessen the risk of a stroke.

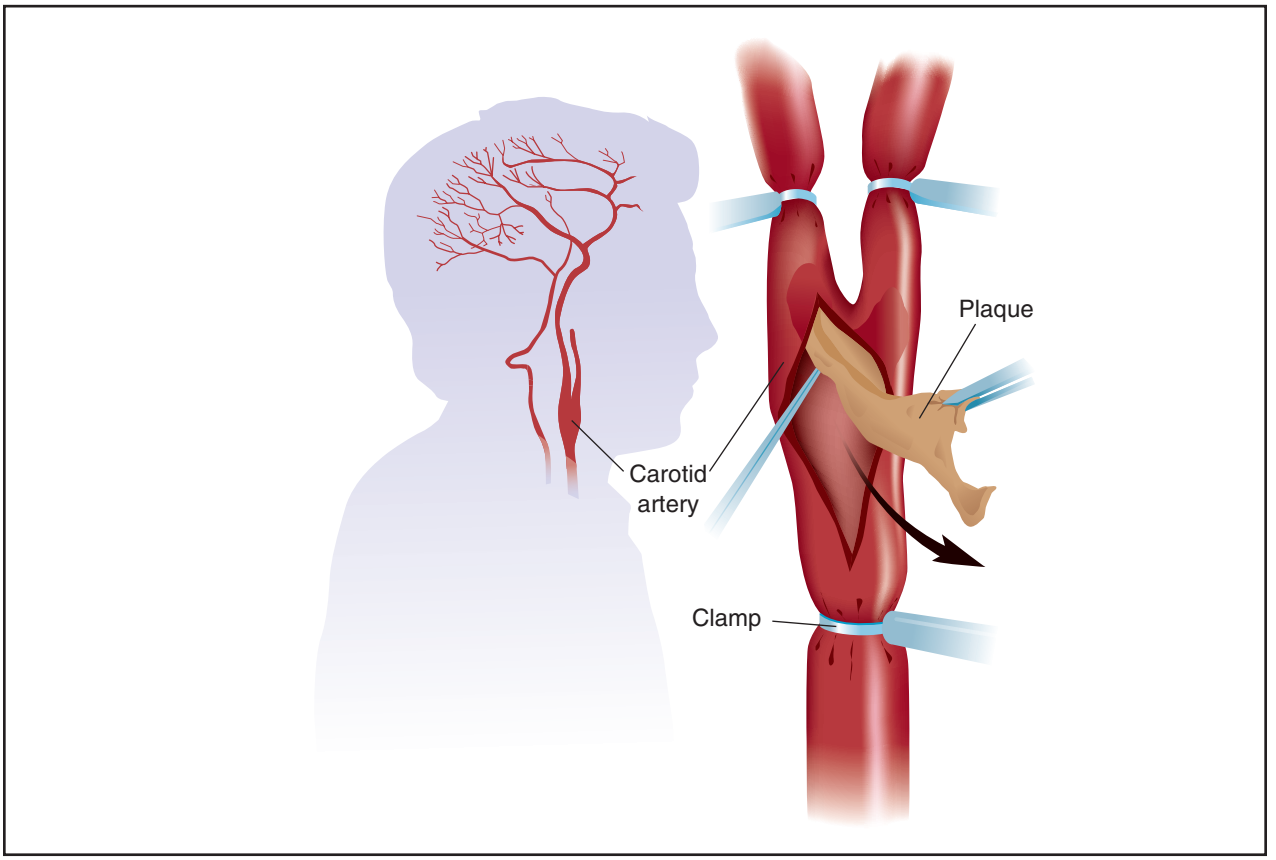
Peripheral vascular disease

When the blood vessels in the legs (and sometimes the arms) become narrowed, this can restrict blood flow and cause **pain** in the affected area. In severe cases, the tissue may die, requiring **amputation**.

The narrowing is usually caused by buildup of fatty plaques in the vessels, often as the result of smoking, high blood pressure, or poorly-controlled **diabetes mellitus**. The vessels usually narrow slowly, but it's possible for a blood clot to form quickly, causing sudden severe pain in the affected leg or arm.

Procedure

Endarterectomy is a delicate operation that may require several hours. The surgeon begins by making an



Plaque is removed from the carotid artery by clamping the artery, cutting the plaque out, and closing the opening back up. *(Illustration by Argosy Inc.)*

incision over the blocked artery and inserting a tube above and below the blockage to redirect the blood flow while the artery is opened.

Next, the surgeon removes the fat and cholesterol buildup, along with any blood clots that have formed, with a blunt dissecting instrument. Then the surgeon bathes the clean wall in salt solution combined with heparin, an anticoagulant. Then the surgeon stitches the artery just enough so that the bypass shunt tube can be removed, and then he/she stitches the artery completely closed. After checking to make sure no blood is leaking, the surgeon next closes the skin incision with stitches.

The operation should improve symptoms, although its long-term effects may be more limited, since arterial narrowing is rarely confined to one area of one artery. If narrowing is a problem throughout the body, arterial reconstructive surgery may be required.

The total cost of an endarterectomy, including diagnostic tests, surgery, hospitalization, and follow-up care, will vary according to hospital, doctor, and area of the country where the operation is performed, but a patient can expect to pay in the range of $15,000. Patients who are very young, very old, or very ill, or who need more extensive surgery, may require more expensive treatment.

Preparation

Before surgery, the doctor pinpoints the location of the narrowed artery with an x-ray procedure called **angiography**. For surgery to be effective, the degree of narrowing should be at least 70%, but it should not be total. Patients undergoing angiography are given a local anesthetic, but the endarterectomy itself requires the use of a general anesthesia.

Aftercare

After the surgery, the patient spends the first two days lying flat in bed. Patients who have had carotid endarterectomy should not bend the neck sharply during this time. Because the blood flow to the brain is now greatly increased, patients may experience a brief but severe **headache**, or lightheadedness. There may be a slight loss of sensation in the skin, or maybe a droop in

KEY TERMS

Carotid arteries—The four principal arteries of the neck and head. There are two common carotid arteries, each of which divides into the two main branches (internal and external).

Diabetes mellitus—A disorder in which the pancreas doesn't produce enough (or any) insulin. As a result, the blood levels of sugar become very high. Among other things, diabetes can lead to the breakdown of small blood vessels and a high risk of atherosclerosis and high blood pressure.

Stroke—Damage to the part of the brain caused by an interruption of the blood supply. In some cases, small pieces of plaque in the carotid artery may break loose and block an artery in the brain. A narrowed carotid artery also can be the source of blood clots travelling to the brain, or the artery can become completely clogged, blocking all blood flow to the brain.

the mouth, if any of the nerves in the neck were lightly bruised during surgery. In time, this should correct itself.

Risks

The amount of risk depends on the hospital, the skill of the surgeon, and the severity of underlying disease. Patients who have just had an acute stroke are at greatest risk. During carotid artery surgery, blood flow is interrupted through the artery, so that paralysis and other stroke symptoms may occur. These may resolve after surgery, or may result in permanent stroke. Paralysis is usually one-sided; other stroke symptoms may include loss of half the field of vision, loss of sensation, double vision, speech problems, and personality changes. Risks of endarterectomy to treat either carotid artery or peripheral vascular disease include:

- reactions to anesthesia
- bleeding
- infection
- blood clots

Normal results

The results after successful surgery are usually striking. The newly opened artery should help to restore normal blood flow. In carotid endarterectomy, surgery should prevent the risk of brain damage and stroke. However, the buildup of fat and cholesterol usually affects all arteries, not just the one that was operated on. Affected arteries in other parts of the body may be equally clogged and potentially dangerous. Even arteries that were operated electively will likely, begin to clog up again after the surgery.

For this reason, lifestyle changes (no smoking, low fat, low cholesterol diet) are important, especially if diet and lifestyle contributed to the development of the problem in the first place.

Resources

BOOKS

"Carotid Endarterectomy." In *The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations*, ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

PERIODICALS

"Better Blood Flow: Surgery May Strike Down Stroke Risk." *Prevention* 47 (1 Feb. 1995): 50-52.

ORGANIZATIONS

National Institute of Neurological Disorders and Stroke. PO Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

National Institute of Neurological Disorders at the Neurology Institute. PO Box 5801, Bethesda, MD 20824.

Carol A. Turkington

Endemic syphilis *see* **Bejel**

Endocardial resection *see* **Myocardial resection**

Endocarditis

Definition

The endocardium is the inner lining of the heart muscle, which also covers the heart valves. When the endocardium becomes damaged, bacteria from the blood stream can become lodged on the heart valves or heart lining. The resulting infection is known as endocarditis.

Description

The endocardium lines all four chambers of the heart—two at the top (the right and left atria) and two at the bottom (the right and left ventricles)—through which blood passes as the heart beats. It also covers the four valves (the tricuspid valve, the pulmonary valve, the mitral valve, and the aortic valve), which normally open

and close to allow the blood to flow in only one direction through the heart during each contraction.

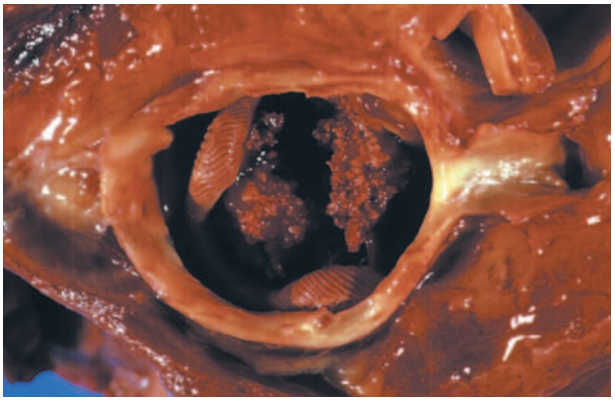
For the heart to pump blood efficiently, the four chambers must contract and relax, and the four valves must open and close, in a well coordinated fashion. By damaging the valves or the walls of the heart chambers, endocarditis can interfere with the ability of the heart to do its job.

Endocarditis rarely occurs in people with healthy, normal hearts. Rather, it most commonly occurs when there is damage to the endocardium. The endocardium may be affected by a congenital heart defect, such as **mitral valve prolapse**, in which blood leaks through a poorly functioning mitral valve back into the heart. It may also be damaged by a prior scarring of the heart muscle, such as **rheumatic fever**, or replacement of a heart valve. Any of these conditions can damage the endocardium and make it more susceptible to infection.

Bacteria can get into the blood stream (a condition known as **bacteremia**) in a number of different ways: It may spread from a localized infection such as a urinary tract infection, **pneumonia**, or skin infection or get into the blood stream as a result of certain medical conditions, such as severe **periodontal disease**, **colon cancer**, or inflammatory bowel disease. It can enter the blood stream during minor procedures, such as periodontal surgery, tooth extractions, teeth cleaning, tonsil removal, prostate removal, or endoscopic examination. It can also be introduced through in-dwelling catheters, which are used for intravenous medications, intravenous feeding, or dialysis. In people who use intravenous drugs, the bacteria can enter the blood stream through unsterilized, contaminated needles and syringes. (People who are prone to endocarditis generally need to take prescribed **antibiotics** before certain surgical or dental procedures to help prevent this infection.)

If not discovered and treated, infective endocarditis can permanently damage the heart muscle, especially the valves. For the heart to work properly, all four valves must be functioning well, opening at the right time to let blood flow in the right direction and closing at the right time to keep the blood from flowing in the wrong direction. If the valve is damaged, this may allow blood to flow backward—a condition known as regurgitation. As a result of a poorly functioning valve, the heart muscle has to work harder to pump blood and may become weakened, leading to **heart failure**. Heart failure is a chronic condition in which the heart is unable to pump blood well enough to supply blood adequately to the body.

Another danger associated with endocarditis is that the vegetation formed by bacteria colonizing on heart valves may break off, forming emboli. These emboli may travel through the circulation and become lodged in blood vessels. By blocking the flow of blood, emboli can starve various tissues of nutrients and oxygen, damaging them. For instance, an embolus lodged in the blood vessels of the lungs may cause pneumonia-like symptoms. An embolus may also affect the brain, damaging nerve tissue, or the kidneys, causing kidney disease. Emboli may also weaken the tiny blood vessels called capillaries, causing hemorrhages (leaking blood vessels) throughout the body.



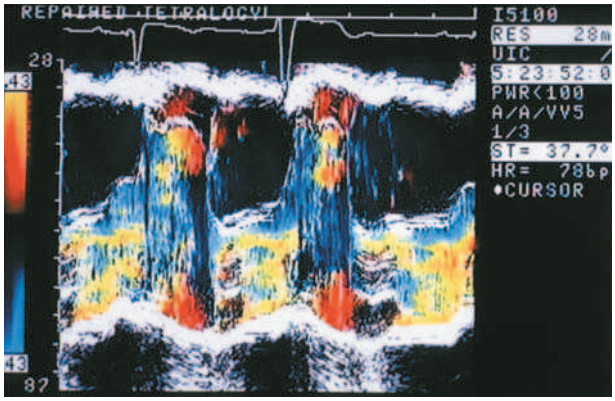
A close-up view of an infected artificial heart valve showing bacterial endocarditis (the granulated tissue at center of image). When infection occurs early after surgery, it is likely that organisms have gained entry during the operative period. This type of infection is usually caused by *Staphylococcus epidermidis* and *S. aureus* and is treated with antibiotic drugs. *(Photograph by Dr. E. Walker, Photo Researchers, Inc. Reproduced by permission.)*

Causes and symptoms

Most cases of infective endocarditis occur in people between the ages of 15 and 60, with a median age at onset of about 50 years. Men are affected about twice as often as women are. Other factors that put people at increased risk for endocarditis are congenital heart problems, heart surgery, previous episodes of endocarditis, and intravenous drug use.

While there is no single specific symptom of endocarditis, a number of symptoms may be present. The most common symptom is a mild **fever**, which rarely goes above 102°F (38.9°C). Other symptoms include chills, weakness, **cough**, trouble breathing, headaches, aching joints, and loss of appetite.

Emboli may also cause a variety of symptoms, depending on their location. Emboli throughout the body may cause Osler's nodes, small, reddish, painful bumps most commonly found on the inside of fingers and toes. Emboli may also cause petechiae, tiny purple



This echocardiogram shows an aortic regurgitation due to endocarditis, an infection of the lining membrane of the cardiac chambers. *(Custom Medical Stock Photo. Reproduced by permission.)*

or red spots on the skin, resulting from hemorrhages under the skin's surface. Tiny hemorrhages resembling splinters may also appear under the fingernails or toenails. If emboli become lodged in the blood vessels of the lungs, they may cause coughing or **shortness of breath**. Emboli lodged in the brain may cause symptoms of a mini-stroke, such as numbness, weakness, or **paralysis** on one side of the body or sudden vision loss or double vision. Emboli may also damage the kidneys, causing blood to appear in the urine. Sometimes the capillaries on the surface of the spleen rupture, causing the spleen to become enlarged and tender to the touch. Anyone experiencing any of these symptoms should seek medical help immediately.

Diagnosis

Doctors begin the diagnosis by taking a history, asking the patient about the symptoms mentioned above. During a **physical examination**, the doctor may also uncover signs such as fever, an enlarged spleen, signs of kidney disease, or hemorrhaging. Listening to the patient's chest with a stethoscope, the doctor may also hear a heart murmur. A heart murmur may indicate abnormal flow of blood through one of the heart chambers or valves.

Doctors take a sample of the patient's blood to test it for bacteria and other microorganisms that may be causing the infection. They usually also use a test called **echocardiography**, which uses ultrasound waves to make images of the heart, to check for abnormalities in the structure of the heart wall or valves. One of the telltale signs they look for in echocardiography is vegetation, the abnormal growth of tissue around a valve composed of blood platelets, bacteria, and a clotting protein called fibrin. Another tell-tale sign is regurgitation, or the backward flow of blood, through one of the heart valves. A normal echocardiogram does not exclude the possibility of endocarditis, but an abnormal echocardiogram can confirm its presence. If an echocardiogram cannot be done or its results are inconclusive, a modified technique called **transesophageal echocardiography** is sometimes performed. Transesophageal echocardiography involves passing an ultrasound device into the esophagus to get a clearer image of the heart.

Treatment

When doctors suspect infective endocarditis, they will admit the patient to a hospital and begin treating the infection before they even have the results of the **blood culture**. Their choice of antibiotics depends on what the most likely infecting microorganism is. Once the results of the blood culture become available, the doctor can adjust the medications, using specific antibiotics known to be effective against the specific microorganism involved.

Unfortunately, in recent years, the treatment of endocarditis has become more complicated as a result of antibiotic resistance. Over the past few years, especially as antibiotics have been overprescribed, more and more strains of bacteria have become increasingly resistant to a wider range of antibiotics. For this reason, doctors may need to try a few different types of antibiotics—or even a combination of antibiotics—to successfully treat the infection. Antibiotics are usually given for about one month, but may need to be given for an even longer period of time if the infection is resistant to treatment.

Once the fever and the worst of the symptoms have gone away, the patient may be able to continue antibiotic therapy at home. During this time, the patient should make regular visits to the health care team for further testing and physical examination to make sure that the antibiotic therapy is working, that it is not causing adverse side effects, and that there are no complications such as emboli or heart failure. The patient should alert the health-care team to any symptoms that could indicate serious complications: For instance, trouble breathing or swelling in the legs could indicate congestive heart failure. **Headache**, joint **pain**, blood in the urine, or **stroke** symptoms could indicate an embolus, and fever and chills could indicate that the treatment is not working and the infection is worsening. Finally, **diarrhea**, rash, **itching**, or joint pain may suggest a bad reaction to the antibiotics. Anyone experiencing any of these symptoms should alert the health care team immediately.

In some cases, surgery may be needed. These include cases of congestive heart failure, recurring

KEY TERMS

Aortic valve—The valve between the left ventricle of the heart and the aorta.

Bacteremia—An infection caused by bacteria in the blood.

Congestive heart failure—A condition in which the heart muscle cannot pump blood as efficiently as it should.

Echocardiography—A diagnostic test using reflected sound waves to study the structure and motion of the heart muscle.

Embolus—A bit of foreign material, such as gas, a piece of tissue, or tiny clot, that travels in the circulation until it becomes lodged in a blood vessel.

Endocardium—The inner wall of the heart muscle, which also covers the heart valves.

Mitral valve—The valve between the left atrium and the left ventricle of the heart.

Osler's nodes—Small, raised, reddish, tender areas associated with endocarditis, commonly found inside the fingers or toes.

Petechiae—Tiny purple or red spots on the skin associated with endocarditis, resulting from hemorrhages under the skin's surface.

Pulmonary valve—The valve between the right ventricle of the heart and the pulmonary artery.

Transducer—A device that converts electrical signals into ultrasound waves and ultrasound waves back into electrical impulses.

Transesophageal echocardiography—A diagnostic test using an ultrasound device, passed into the esophagus of the patient, to create a clear image of the heart muscle.

Tricuspid valve—The valve between the right atrium and the right ventricle of the heart.

Vegetation—An abnormal growth of tissue around a valve, composed of blood platelets, bacteria, and a protein involved in clotting.

emboli, infection that doesn't respond to treatment, poorly functioning heart valves, and endocarditis involving prosthetic (artificial) valves. The most common surgical treatment involves cutting away (debriding) damaged tissue and replacing the damaged valve.

Prognosis

If left untreated, infective endocarditis continues to progress and is always fatal. However, if it is diagnosed and properly treated within the first six weeks of infection, the infection can be completely cured in about 90% of the cases. The prognosis depends on a number of factors, such as the patient's age and overall physical condition, the severity of the diseases involved, the exact site of the infection, how vulnerable the microorganisms are to antibiotics, and what kind of complications the endocarditis may be causing.

Prevention

Some people are especially prone to endocarditis. These include people with past episodes of endocarditis, those with congenital heart problems or heart damage from rheumatic fever, and those with artificial heart valves. Intravenous drug users are also at increased risk. Anyone who falls into a high-risk category should alert his or her health-care professionals before undergoing any surgical or dental procedures. High-risk patients must be treated in advance with antibiotics before these procedures to minimize the risk of infection.

Resources

BOOKS

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

Auten, Gramce M., and Victor Del Bene. "Endocarditis: Current Guidelines on Prophylaxis, Diagnosis, and Treatment." *Consultant* 36 (May 1996): 973-78.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

Endocrine pancreatic cancer *see* **Pancreatic cancer, endocrine**

Endometrial biopsy

Definition

Endometrial biopsy is a procedure in which a sample of the endometrium (tissue lining the inside of the uterus) is removed for microscopic examination.

Purpose

The test is most often performed to find out the cause of abnormal uterine bleeding. Abnormal bleeding includes bleeding between menstrual periods, excessive bleeding during a menstrual period, or bleeding after **menopause**. Since abnormal uterine bleeding can indicate **cancer**, an endometrial biopsy is done to rule out **endometrial cancer** or hyperplasia (a potentially precancerous condition).

Endometrial biopsies are also done as a screening test for endometrial cancer in postmenopausal women on **hormone replacement therapy**. Hormone replacement therapy usually requires a woman to take estrogen and progesterone. An endometrial biopsy is particularly useful in cases where postmenopausal women take estrogen, but cannot take progesterone. Estrogen in the system without the balancing effect of progesterone has been linked to an increased risk of endometrial cancer.

An endometrial biopsy can also be used as part of an **infertility** exam to rule out problems with the development of the endometrium. This condition is called luteal phase defect and can cause the endometrium to not support a **pregnancy**. An endometrial biopsy can also be used to evaluate the problem of repeated early miscarriages.

Precautions

If the endometrial biopsy is being done to investigate why a woman is unable to get pregnant, the test must be performed at a specific time during the menstrual cycle. Since the test evaluates whether the endometrium is developed adequately to support implantation and growth of a fertilized egg, it is critical to perform the test approximately three days before the expected menstrual period.

Description

The test is performed by a doctor who specializes in women's reproductive health (an obstetrician/gynecologist). The test is performed either in the doctor's office or in a local hospital. The patient may be asked to take **pain** medication (like Motrin or Aleve) an hour or so before the procedure. A local anesthetic may be injected into the cervix in order to decrease pain and discomfort during the procedure.

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Cervix—The opening of the uterus extending into the vagina.

Endometrium—The layer lining the inner cavity of the uterus; this layer changes daily throughout the menstrual cycle.

Uterus—The hollow, muscular female organ that supports the development and nourishment of the unborn baby during pregnancy.

The woman will be asked to lie on her back with knees apart and feet in stirrups. The doctor will first conduct a thorough exam of the pelvic region, including the vulva (the external genitals), vagina, and uterus. A speculum (an instrument that is used to hold the walls of the vagina open) will be inserted into the vagina. A small, hollow plastic tube is then passed into the uterine cavity. A small piece of the uterine lining is sucked out with a plunger that is attached to the tube. Once the sample is obtained, the instruments are removed. The sample is sent to the laboratory for microscopic examination.

The patient may experience some pain when the cervix is grasped. The patient may also feel some cramping, pressure, and discomfort when the instruments are inserted into the uterus and the tissue sample is collected.

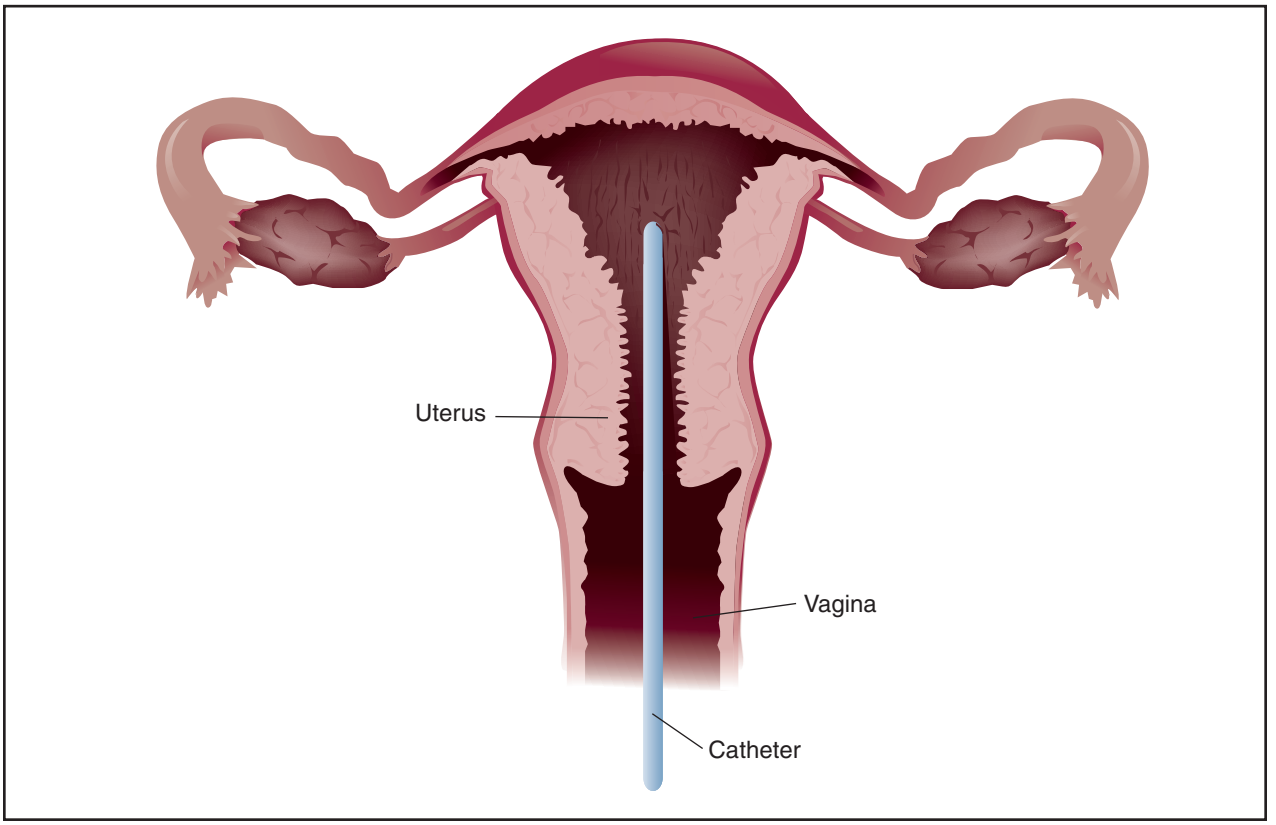
Preparation

For the small number of endometrial biopsies that are done as part of infertility testing, a pregnancy test is also often performed before the procedure. Since the biopsy is performed late in the menstrual cycle, it is possible that the woman may be pregnant.

Aftercare

The biopsy may cause a small amount of bleeding (spotting). The woman can resume normal activities right away. If cramping becomes severe, heavy bleeding occurs, or the woman develops a high temperature, the doctor should be notified immediately.

If the test is being done to determine the cause of infertility, the onset of the menstrual period following the biopsy should be reported to the doctor. This will allow the doctor to correctly predict if the endometrium has been developing at the expected rate.



A catheter is inserted into the uterus to remove uterine cells for further examination. *(Illustration by Argosy Inc.)*

Risks

The risks of an endometrial biopsy are very small. There is a possibility that prolonged bleeding may occur after the procedure. There is also a slight chance of an infection. Very rarely, there are instances when the uterus is pierced (perforated) or the cervix is torn because of the biopsy.

Normal results

Most biopsies are done to rule out endometrial cancer or endometrial hyperplasia. A normal result shows no cancerous or precancerous cells. Normal results also show that the uterine lining is changing at the proper rate. If it is, then the results of the biopsy are said to be "in-phase" because the tissue looks appropriate and has developed normally for the late phase of the menstrual cycle.

Abnormal results

If the endometrium is not developing at the appropriate rate, the results are said to be "out-of-phase" or abnormal. The endometrium has not developed appropriately and cannot support a pregnancy. This condition is called luteal phase defect and may need to be treated with progesterone.

Abnormal appearance of the cells forming the uterine tissue could also indicate uterine cancer, or the presence of fibroids or polyps in the uterus.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Piotrowski, Nancy A., ed. "Endometrial Biopsy." In *Magill's Medical Guide Health and Illness Supplement*. Vol. 4. Pasadena: Salem Press, 1996.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute. 681 Fifth Ave., New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Gynecologic Cancer Foundation. 401 North Michigan Ave., Chicago, IL 60611. (800) 444-4441.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Lata Cherath, PhD

Endometrial cancer

Definition

Endometrial **cancer** develops when the cells that make up the inner lining of the uterus (the endometrium) become abnormal and grow uncontrollably.

Description

Endometrial cancer (also called uterine cancer) is the fourth most common type of cancer among women and the most common gynecologic cancer. Approximately 34,000 women are diagnosed with endometrial cancer each year. In 1998, approximately 6,300 women died from this cancer. Although endometrial cancer generally occurs in women who have gone through **menopause** and are 45 years of age or older, 30% of the women with endometrial cancer are younger than 40 years of age. The average age at diagnosis is 60 years old.

The uterus, or womb, is the hollow female organ that supports the development of the unborn baby during **pregnancy**. The uterus has a thick muscular wall and an inner lining called the endometrium. The endometrium is very sensitive to hormones and it changes daily during the menstrual cycle. The endometrium is designed to provide an ideal environment for the fertilized egg to implant and begin to grow. If pregnancy does not occur, the endometrium is shed causing the menstrual period.

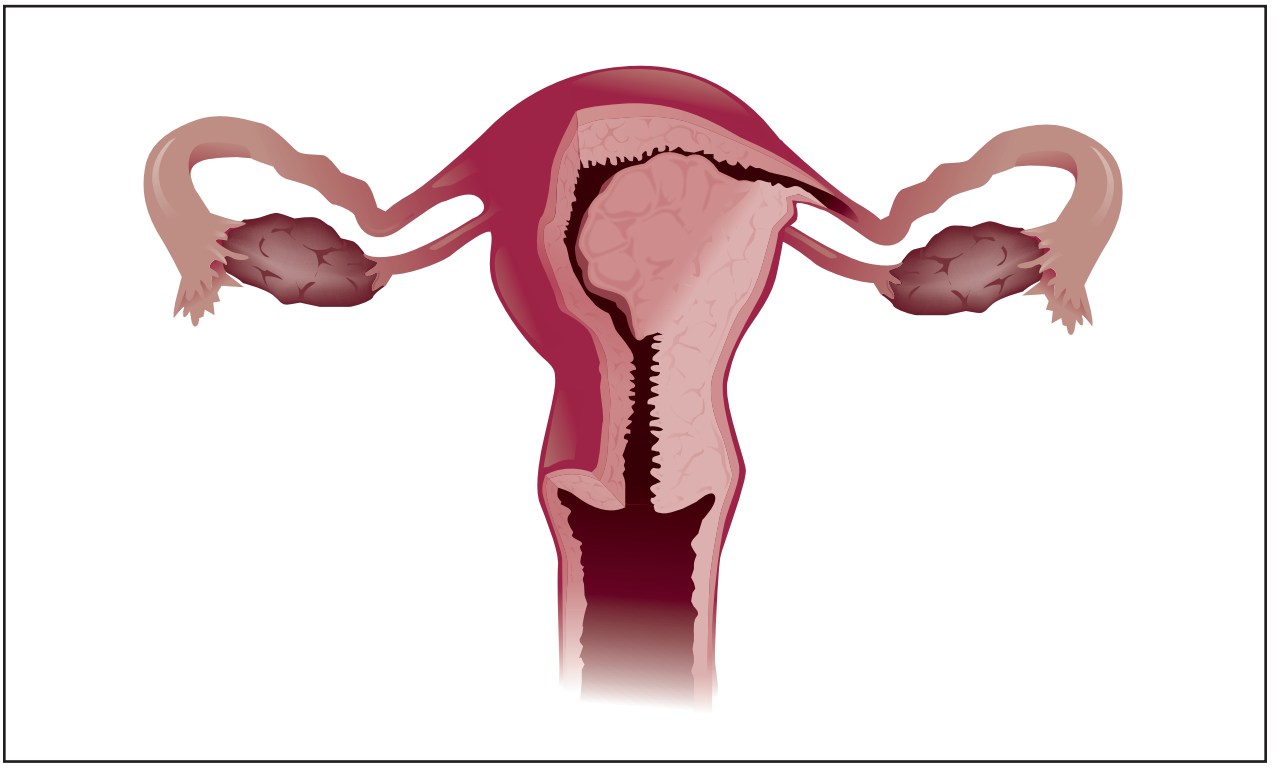
More than 95% of uterine cancers arise in the endometrium. The most common type of uterine cancer is adenocarcinoma. It arises from an abnormal multiplication of endometrial cells (atypical adenomatous hyperplasia) and is made up of mature, specialized cells (well-differentiated). Less commonly, endometrial cancer arises without a preceding hyperplasia and is made up of poorly differentiated cells. The more common of these types are the papillary serous and clear cell carcinomas. Poorly differentiated endometrial cancers are often associated with a less promising prognosis.

The highest incidence of endometrial cancer in the United States is in Caucasians, Hawaiians, Japanese, and African Americans. American Indians, Koreans, and Vietnamese have the lowest incidence. African American and Hawaiian women are more likely to be diagnosed with advanced cancer and, therefore, have a higher risk of dying from the disease.

Causes and symptoms

Although the exact cause of endometrial cancer is unknown, it is clear that high levels of estrogen, when not balanced by progesterone, can lead to abnormal growth of the endometrium. Factors that increase a woman's risk of developing endometrial cancer are:

- Age. The risk is considerably higher in women who are over the age of 50 and have gone through menopause.
- **Obesity**. Being overweight is a very strong risk factor for this cancer. Fatty tissue can change other normal body chemicals into estrogen, which can promote endometrial cancer.
- Estrogen replacement therapy. Women receiving estrogen supplements after menopause have a 12 times higher risk of getting endometrial cancer if progesterone is not taken simultaneously.
- Diabetes. Diabetics have twice the risk of getting this cancer as nondiabetic women. It is not clear if this risk is due to the fact that many diabetics are also obese and hypertensive. One 1998 study found that women who were obese and diabetic were three times more likely to develop endometrial cancer than women who were obese but nondiabetic. This study also found that nonobese diabetics were not at risk of developing endometrial cancer.
- **Hypertension**. High blood pressure (or hypertension) is also considered a risk factor for uterine cancer.
- Irregular menstrual periods. During the menstrual cycle, there is interaction between the hormones estrogen and progesterone. Women who do not ovulate regularly are exposed to high estrogen levels for longer periods of time. If a woman does not ovulate regularly, this delicate balance is upset and may increase her chances of getting uterine cancer.
- Early first menstruation or late menopause. Having the first period at a young age (the mean age of menses is 12.16 years in African American girls and 12.88 years in caucasian girls) or going through menopause at a late age (over age 51) seem to put women at a slightly higher risk for developing endometrial cancer.
- Tamoxifen. This drug, which is used to treat or prevent **breast cancer**, increases a woman's chance of developing endometrial cancer. Tamoxifen users tend to have more advanced endometrial cancer with an associated poorer survival rate than those who do not take the drug. In many cases, however, the value of tamoxifen for treating breast cancer and for preventing the cancer from spreading far outweighs the small risk of getting endometrial cancer.
- Family history. Some studies suggest that endometrial cancer runs in certain families. Women with inherited mutations in the BRCA1 and BRCA2 genes are at a higher risk of developing breast, ovarian, and other gynecologic cancers. Those with the hereditary non-



Cancer located in the uterus. *(Illustration by Argosy Inc.)*

polyposis colorectal cancer gene have a higher risk of developing endometrial cancer.

- Breast, ovarian, or **colon cancer**. Women who have a history of these other types of cancer are at an increased risk of developing endometrial cancer.
- Low parity or nulliparity. Endometrial cancer is more common in women who have born few (low parity) or no (nulliparity) children. The high levels of progesterone produced during pregnancy has a protective effect against endometrial cancer. The results of one study suggest that nulliparity is associated with a lower survival rate.
- Infertility. Risk is increased due to nulliparity or the use of fertility drugs.
- Polycystic ovary syndrome. The increased level of estrogen associated with this abnormality raises the risk of cancers of the breast and endometrium.

The most common symptom of endometrial cancer is unusual vaginal spotting, bleeding, or discharge. In women who are near menopause (perimenopausal), symptoms of endometrial cancer could include bleeding between periods (intermenstrual bleeding), heavy bleeding that lasts for more than seven days, or short menstrual cycles (fewer than 21 days). For women who have gone through menopause, any vaginal bleeding or abnormal discharge is suspect. **Pain** in the pelvic region and the presence of a lump (mass) are symptoms that occur late in the disease.

Diagnosis

If endometrial cancer is suspected, a series of tests will be conducted to confirm the diagnosis. The first step will involve taking a complete personal and family medical history. A **physical examination**, which will include a thorough pelvic examination, will also be done.

The doctor may order an **endometrial biopsy**. This is generally performed in the doctor's office and does not require anesthesia. A thin, flexible tube is inserted through the cervix and into the uterus. A small piece of endometrial tissue is removed. The patient may experience some discomfort, which can be minimized by taking an anti-inflammatory medication (like Advil or Motrin) an hour before the procedure.

If an adequate amount of tissue was not obtained by the endometrial biopsy, or if the biopsy tissue looks abnormal but confirmation is needed, the doctor may perform a **dilatation and curettage** (D & C). This procedure is done in the outpatient surgery department of a hospital

KEY TERMS

Adjuvant therapy—A treatment done when there is no evidence of residual cancer in order to aid the primary treatment. Adjuvant treatments for endometrial cancer are radiation therapy, chemotherapy, and hormone therapy.

Atypical adenomatous hyperplasia—The overgrowth of the endometrium. This precancerous condition is estimated to progress to cancer in one third of the cases.

Dilation and curettage (D & C)—A procedure in which the doctor opens the cervix and uses a special instrument to scrape tissue from the inside of the uterus.

Endometrial biopsy—A procedure in which a sample of the endometrium is removed and examined under a microscope.

Endometrium—The mucosal layer lining the inner cavity of the uterus. The endometrium's structure changes with age and with the menstrual cycle.

Estrogen—A female hormone responsible for stimulating the development and maintenance of female secondary sexual characteristics.

Estrogen replacement therapy (ERT)—A treatment in which estrogen is used therapeutically during menopause to alleviate certain symptoms such as hot flashes. ERT has also been shown to reduce the risk of osteoporosis and heart disease in women.

Progesterone—A female hormone that acts on the inner lining of the uterus and prepares it for implantation of the fertilized egg.

Progestins—A female hormone, like progesterone, that acts on the inner lining of the uterus.

and takes about an hour. The patient may be given general anesthesia. The doctor dilates the cervix and uses a special instrument to scrape tissue from inside the uterus.

The tissue that is obtained from the biopsy or the D & C is sent to a laboratory for examination. If cancer is found, then the type of cancer will be determined. The treatment and prognosis depends on the type and stage of the cancer.

Trans-vaginal ultrasound may be used to measure the thickness of the endometrium. For this painless procedure, a wand-like ultrasound transducer is inserted into the vagina to enable visualization and measurement of the uterus, the thickness of the uterine lining, and other pelvic organs.

Other possible diagnostic procedures include sonohysterography and **hysteroscopy**. For sonohysteroscopy, a small tube is passed through the cervix and into the uterus. A small amount of a salt water (saline) solution is injected through the tube to open the space within the uterus and allow ultrasound visualization of the endometrium. For hysteroscopy, a wand-like camera is passed through the cervix to allow direct visualization of the endometrium. Both of these procedures cause discomfort, which may be reduced by taking an anti-inflammatory medication prior to the procedure.

Treatment

Clinical staging

The International Federation of Gynecology and Obstetrics (FIGO) has adopted a staging system for endometrial cancer. The stage of cancer is determined after surgery. Endometrial cancer is categorized into four stages (I, II, III, and IV) that are subdivided (A, B, and possibly C) based on the depth or spread of cancerous tissue. Seventy percent of all uterine cancers are stage I, 10–15% are stage II, and the remainder are stages III and IV. The cancer is also graded (G1, G2, and G3) based upon microscopic analysis of the aggressiveness of the cancer cells.

The FIGO stages for endometrial cancer are:

- Stage I. Cancer is limited to the uterus.
- Stage II. Cancer involves the uterus and cervix.
- Stage III. Cancer has spread out of the uterus but is restricted to the pelvic region.
- Stage IV. Cancer has spread to the bladder, bowel, or other distant locations.

The mainstay of treatment for most stages of endometrial cancer is surgery. **Radiation therapy**, hormonal therapy, and **chemotherapy** are additional treatments (called adjuvant therapy). The necessity of adjuvant therapy is a controversial topic which should be discussed with the patient's treatment team.

Surgery

Most women with endometrial cancer, except those with stage IV disease, are treated with a **hysterectomy**. A simple hysterectomy involves the removal of the uterus. In a bilateral **salpingo-oophorectomy** with total hysterectomy, the ovaries, fallopian tubes, and uterus are

removed. This may be necessary because endometrial cancer often spreads to the ovaries first. The lymph nodes in the pelvic region may also be biopsied or removed to check for metastasis. Hysterectomy is traditionally performed through an incision in the abdomen (laparotomy), however, endoscopic surgery (**laparoscopy**) with vaginal hysterectomy is also being used. Women with stage I disease may require no further treatment. However, those with higher grade disease will receive adjuvant therapy.

Radiation therapy

The decision to use radiation therapy depends on the stage of the disease. Radiation therapy may be used before surgery (preoperatively) and/or after surgery (postoperatively). Radiation given from a machine that is outside the body is called external radiation therapy. Sometimes applicators containing radioactive compounds are placed inside the vagina or uterus. This is called internal radiation therapy or brachytherapy and requires hospitalization.

Side effects are common with radiation therapy. The skin in the treated area may become red and dry. **Fatigue**, upset stomach, **diarrhea**, and nausea are also common complaints. Radiation therapy in the pelvic area may cause the vagina to become narrow (vaginal stenosis), making intercourse painful. **Premature menopause** and some problems with urination may also occur.

Chemotherapy

Chemotherapy is usually reserved for women with stage IV or recurrent disease because this therapy is not a very effective treatment for endometrial cancer. The **anticancer drugs** are given by mouth or intravenously. Side effects include stomach upset, vomiting, appetite loss, hair loss, mouth or vaginal sores, fatigue, menstrual cycle changes, and premature menopause. There is also an increased chance of infections.

Hormonal therapy

Hormonal therapy uses drugs like progesterone to slow the growth of endometrial cells. These drugs are usually available as pills. This therapy is usually reserved for women with advanced or recurrent disease. Side effects include fatigue, fluid retention, and appetite and weight changes.

Alternative treatment

Although alternative and complementary therapies are used by many cancer patients, very few controlled studies on the effectiveness of such therapies exist. Mind-body techniques, such as prayer, **biofeedback**, visualization, **meditation**, and **yoga**, have not shown any effect in reducing cancer, but they can reduce **stress** and lessen some of the side effects of cancer treatments. Clinical studies of hydrazine sulfate found that it had no effect on cancer and even worsened the health and well-being of the study subjects. One clinical study of the drug amygdalin (Laetrile) found that it had no effect on cancer. Laetrile can be toxic and has caused deaths. Shark cartilage, although highly touted as an effective cancer treatment, is an improbable therapy that has not been the subject of clinical study.

The American Cancer Society has found that the "metabolic diets" pose serious risk to the patient. The effectiveness of the macrobiotic, Gerson, and Kelley **diets** and the Manner metabolic therapy has not been scientifically proven. The FDA was unable to substantiate the anticancer claims made about the popular Cancell treatment.

There is no evidence for the effectiveness of most over-the-counter herbal cancer remedies. Some herbals have shown an anticancer effect. As shown in clinical studies, Polysaccharide krestin, from the mushroom *Coriolus versicolor*, has significant effectiveness against cancer. In a small study, the green alga *Chlorella pyrenoidosa* has been shown to have anticancer activity. In a few small studies, evening primrose oil has shown some benefit in the treatment of cancer.

Prognosis

Because it is possible to detect endometrial cancer early, the chances of curing it are excellent. The five year survival rates for endometrial cancer by stage are: 90%, stage I; 60%, stage II; 40%, stage III; and 5%, stage IV. Endometrial cancer most often spreads to the lungs, liver, bones, brain, vagina, and certain lymph nodes.

Prevention

Women (especially postmenopausal women) should report any abnormal vaginal bleeding or discharge to the doctor. Controlling obesity, blood pressure, and diabetes can help to reduce the risk of this disease. Women on estrogen replacement therapy have a substantially reduced risk of endometrial cancer if progestins are taken simultaneously. Long term use of birth control pills has been shown to reduce the risk of this cancer. Women who have irregular periods may be prescribed birth control pills to help prevent endometrial cancer. Women who are taking tamoxifen and those who carry the hereditary nonpolyposis colorectal cancer gene should be screened regularly, receiving annual pelvic examinations.

Resources

BOOKS

Bruss, Katherine, Christina Salter, and Esmeralda Galan, eds. *American Cancer Society's Guide to Complementary and*

Alternative Cancer Methods. Atlanta: American Cancer Society, 2000.

Burke, Thomas, Patricia Eifel, and Muggia Franco. "Cancers of the Uterine Body." In *Cancer: Principles & Practice of Oncology*, ed. Vincent DeVita, Samuel Hellman, and Steven Rosenberg. Philadelphia: Lippincott Williams & Wilkins, 2001, 1573– 86.

Long, Harry. "Carcinoma of the Endometrium." In *Current Therapy in Cancer*, ed. John Foley, Julie Vose, and James Armitage. Philadelphia: W. B. Saunders Company, 1999, 162–66.

Primack, Aron. "Complementary/Alternative Therapies in the Prevention and Treatment of Cancer." In *Complementary/Alternative Medicine: An Evidence- Based Approach*, ed. John Spencer and Joseph Jacobs. St. Louis: Mosby, 1999, 123–69.

PERIODICALS

Bristow, Robert. "Endometrial Cancer." *Current Opinion in Oncology* 11 (Sept. 1999): 388–393.

Canavan, Timothy and Nipa Doshi. "Endometrial Cancer." *American Family Physician* 59 (June 1999): 3069–3077.

Elit, Laurie. "Endometrial Cancer: Prevention, Detection, Management, and Follow up." *Canadian Family Physician* 46 (Apr. 2000): 887–892.

Hogberg, Thomas, Margareta Fredstorp, and Anuja Jhingran. "Indications for Adjuvant Radiotherapy in Endometrial Carcinoma." *Hematology/Oncology Clinics of North America: Current Therapeutic Issues in Gynecologic Cancer* 13 (Feb. 1999): 189–209.

ORGANIZATIONS

American Cancer Society, National Headquarters. 1599 Clifton Rd. NE, Atlanta, GA 30329. (800) 227-2345. <http://www.cancer.org/>.

Cancer Research Institute, National Headquarters. 681 Fifth Ave., New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Gynecologic Cancer Foundation. 401 North Michigan Ave., Chicago, IL 60611. (800) 444-4441. <http://www.wcn.org>.

National Cancer Institute, National Institutes of Health. 9000 Rockville Pike, Bethesda, MD 20892. (800) 422-6237. <http://cancernet.nci.nih.gov/>.

OTHER

"Cancer of the Uterus." *Cancernet*. Dec. 2000. 13 Mar. 2001 <http://cancernet.nci.nih.gov/wyntk_pubs/uterus.htm>.

Lata Cherath
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Endometriosis

Definition

Endometriosis is a condition in which bits of the tissue similar to the lining of the uterus (endometrium) grow in other parts of the body. Like the uterine lining, this tissue builds up and sheds in response to monthly hormonal cycles. However, there is no natural outlet for the blood discarded from these implants. Instead, it falls onto surrounding organs, causing swelling and inflammation. This repeated irritation leads to the development of scar tissue and adhesions in the area of the endometrial implants.

Description

Endometriosis is estimated to affect 7% of women of childbearing age in the United States. It most commonly strikes between the ages of 25 and 40. Endometriosis can also appear in the teen years, but never before the start of menstruation. It is seldom seen in postmenopausal women.

Endometriosis was once called the "career woman's disease" because it was thought to be a product of delayed childbearing. The statistics defy such a narrow generalization; however, **pregnancy** may slow the progress of the condition. A more important predictor of a woman's risk is if her female relatives have endometriosis. Another influencing factor is the length of a woman's menstrual cycle. Women whose periods last longer than a week with an interval of less than 27 days between them seem to be more prone to the condition.

Endometrial implants are most often found on the pelvic organs—the ovaries, uterus, fallopian tubes, and in the cavity behind the uterus. Occasionally, this tissue grows in such distant parts of the body as the lungs, arms, and kidneys. Newly formed implants appear as small bumps on the surfaces of the organs and supporting ligaments and are sometimes said to look like "powder burns." **Ovarian cysts** may form around endometrial tissue (endometriomas) and may range from pea to grapefruit size. Endometriosis is a progressive condition that usually advances slowly, over the course of many years. Doctors rank cases from minimal to severe based on factors such as the number and size of the endometrial implants, their appearance and location, and the extent of the scar tissue and adhesions in the vicinity of the growths.

Causes and symptoms

Although the exact cause of endometriosis is unknown, a number of theories have been put forward. Some of the more popular ones are:

- Implantation theory. Originally proposed in the 1920s, this theory states that a reversal in the direction of menstrual flow sends discarded endometrial cells into the body cavity where they attach to internal organs and seed endometrial implants. There is considerable evidence to support this explanation. Reversed menstrual

flow occurs in 70–90% of women and is thought to be more common in women with endometriosis. However, many women with reversed menstrual flow do not develop endometriosis.

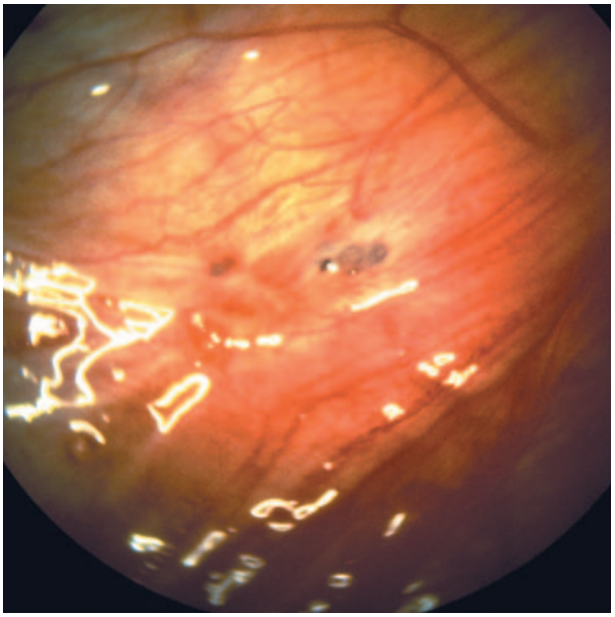
- Vascular-lymphatic theory. This theory suggests that the lymph system or blood vessels (vascular system) is the vehicle for the distribution of endometrial cells out of the uterus.
- Coelomic metaplasia theory. According to this hypothesis, remnants of tissue left over from prenatal development of the woman's reproductive tract transforms into endometrial cells throughout the body.
- Induction theory. This explanation postulates that an unidentified substance found in the body forces cells from the lining of the body cavity to change into endometrial cells.

In addition to these theories, the following factors are thought to influence the development of endometriosis:

- Heredity. A woman's chance of developing endometriosis is seven times greater if her mother or sisters have the disease.
- Immune system function. Women with endometriosis may have lower functioning immune systems that have trouble eliminating stray endometrial cells. This would explain why a high percentage of women experience reversed menstrual flow while relatively few develop endometriosis.
- Dioxin exposure. Some research suggests a link between the exposure to dioxin (TCCD), a toxic chemical found in weed killers, and the development of endometriosis.

While many women with endometriosis suffer debilitating symptoms, others have the disease without knowing it. Paradoxically, there does not seem to be any relation between the severity of the symptoms and the extent of the disease. The most common symptoms are:

- Menstrual **pain**. Pain in the lower abdomen that begins a day or two before the menstrual period starts and continues through to the end is typical of endometriosis. Some women also report lower back aches and pain during urination and bowel movement, especially during their periods.
- Painful sexual intercourse. Pressure on the vagina and cervix causes severe pain for some women.
- Abnormal bleeding. Heavy menstrual periods, irregular bleeding, and spotting are common features of endometriosis.
- **Infertility**. There is a strong association between endometriosis and infertility, although the reasons for this have not been fully explained. It is thought that the build up of scar tissue and adhesions blocks the fallopian tubes and prevents the ovaries from releasing eggs. Endometriosis may also affect fertility by causing hormonal irregularities and a higher rate of early **miscarriage**.



An endoscopic view of endometriosis on pelvic wall. *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

If a doctor suspects endometriosis, the first step will be to perform a **pelvic exam** to try to feel if implants are present. Very often there is no strong evidence of endometriosis from a physical exam. The only way to make a definitive diagnosis is through minor surgery called a **laparoscopy**. A laparoscope, a slender scope with a light on the end, is inserted into the woman's abdomen through a small incision near her belly button. This allows the doctor to examine the internal organs for endometriotic growths. Often, a sample of tissue is taken for later examination in the laboratory. Endometriosis is sometimes discovered when a woman has abdominal surgery for another reason such as **tubal ligation** or **hysterectomy**.

Various imaging techniques such as ultrasound, computed tomography scan (CT scan), or **magnetic resonance imaging** (MRI) can offer additional information but aren't useful in making the initial diagnosis. A blood test may also be ordered because women with endometriosis have higher levels of the blood protein CA125. Testing for this substance before and after treatment can predict a recurrence of the disease, but the test is not reliable as a diagnostic tool.

Treatment

How endometriosis is treated depends on the woman's symptoms, her age, the extent of the disease, and her personal preferences. The condition cannot be fully eradicated without surgery. Conservative treatment focuses on managing the pain, preserving fertility, and delaying the progress of the condition.

Pain relief

Over-the-counter pain relievers such as **aspirin** and **acetaminophen** (Tylenol) are useful for mild cramping and menstrual pain. Prescription-strength and over-the-counter **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as ibuprofen (Motrin, Advil) and naproxen (Naprosyn), are also effective. If pain is severe, a doctor may prescribe narcotic medications, although these can be addicting and are rarely used.

Hormonal treatments

Hormonal therapies effectively tame endometriosis but also act as contraceptives. A woman who is hoping to become pregnant would take these medications for a period of time, then try to conceive within several months of discontinuing treatment.

- Oral contraceptives. Continuously taking estrogen-progestin pills tricks the body into thinking it is pregnant. This state of pseudopregnancy means reduced pelvic pain and a temporary withering of endometrial implants.
- Danazol (Danocrine) and gestrinone are synthetic male hormones that lower estrogen levels, prevent menstruation, and shrink endometrial tissues. On the downside, they lead to weight gain and menopause-like symptoms, and cause some women to develop masculine characteristics.
- Progestins. Medroxyprogesterone (Depo-Provera) and related drugs may also be used in treating endometriosis. They have been proven effective in minimizing pain and halting the progress of the condition, but are rarely used because of the high rate of side effects.
- Gonadotropin-releasing hormone (GnHR) agonists. These estrogen-inhibiting drugs successfully limit pain and prevent the growth of endometrial implants. They can cause **menopause** symptoms, however, and doses have to be regulated to prevent bone loss associated with low estrogen levels.

Surgery

Removing the uterus, ovaries, and fallopian tubes is the only permanent method of eliminating endometriosis. This is an extreme measure that deprives a woman of her ability to bear children and forces her body into menopause. Endometrial implants and ovarian cysts can be removed with **laser surgery** performed through a laparoscope. For women with minimal endometriosis, this technique is usually successful in reducing pain and slowing the condition's progress. It may also help infertile women increase their chances of becoming pregnant.

Alternative treatment

Although severe endometriosis should not be self-treated, many women find they can help their condition through alternative therapies. Taking vitamin B complex combined with **vitamins** C, E, and the **minerals** calcium, magnesium, and selenium can help the depression and lack of energy that may accompany endometriosis. B vitamins also counteract the side effects of hormonal drugs. Other women have found relief when they turned to a macrobiotic diet. Less extreme **diets** that cut out sugar, salt, and processed foods are sometimes helpful as well. Mind-body therapies such as relaxation and visualization help women cope with pain. Other avenues to combat pain include **acupuncture** and **biofeedback** techniques. Still other women report positive results after being treated by chiropractors or homeopathic doctors.

Prognosis

Most women who have endometriosis have minimal symptoms and do well. Overall, endometriosis symptoms come back in an average of 40% of women over the five years following treatment. With hormonal therapy, pain returned after five years in 37% of patients with minimal symptoms and 74% of those with severe cases. The highest success rate from conservative treatment followed complete removal of implants using laser surgery. Eighty percent of these women were still pain-free five years later. In cases that don't respond to these treatments, a woman and her doctor may consider surgery to remove her reproductive organs.

Prevention

There is no proven way to prevent endometriosis. One study, however, indicated that girls who begin participating in aerobic **exercise** at a young age are less likely to develop the condition.

Resources

BOOKS

Breitkopf, Lyle J. *Coping With Endometriosis*. Prentice Hall, 1988.

D'Hooghe, Thomas M., and Joseph A. Hill. "Endometriosis." In *Novak's Gynecology.* 12th ed. Ed. Jonathan S. Berek, et al. Baltimore: Lippincott, 1996.

KEY TERMS

Adhesions—Web-like scar tissue that may develop as a result of endometriosis and bind organs to one another.

Dioxin—A toxic chemical found in weed killers that has been linked to the development of endometriosis.

Endometrial implants—Growths of endometrial tissue that attach to organs, primarily in the pelvic cavity.

Endometrium—The tissue lining the uterus that grows and sheds each month during a woman's menstrual cycle.

Estrogen—A female hormone that promotes the growth of endometrial tissue.

Hormonal therapy—Use of hormone medications to inhibit menstruation and relieve the symptoms of endometriosis.

Laparoscopy—A diagnostic procedure for endometriosis performed by inserting a slender, wand-like instrument through a small incision in the woman's abdomen.

Menopause—The end of a woman's menstrual periods when the body stops making estrogen.

Retrograde menstruation—Menstrual flow that travels into the body cavity rather than being expelled through the uterus.

The Endometriosis Sourcebook. Ed. Mary Lou Ballweg, et al. Chicago: Congdon & Weed, 1995.

Overcoming Endometriosis. Ed. Mary Lou Ballweg, et al. Chicago: Congdon & Weed, 1987.

ORGANIZATIONS

Endometriosis Association International Headquarters. 8585 North 76th Place, Milwaukee, WI 53223. (800) 992-3636. <http://EndometriosisAssn.org>.

Stephanie Slon

Endometritis *see* **Pelvic inflammatory disease**

Endorectal ultrasound

Definition

Endorectal ultrasound (ERUS) is a procedure where a probe is inserted into the rectum and high frequency sound waves (ultrasound waves) are generated. The pattern of echoes as they bounce off tissues is converted into a picture (sonogram) on a television screen.

Purpose

ERUS is used as a diagnostic procedure in **rectal cancer** to determine stage of the tumor and as a postradiation, presurgical examination to assess extent of tumor shrinkage. ERUS can also be used in cases of anal fistula (an abnormal passage) and problems with the anal sphincter muscles (muscles that control the opening and closing of the anus).

Precautions

Normal precautions should be taken with any diagnostic procedure. Since the population in which this procedure is normally done is elderly, the imaging staff should be extra cautious about stressing the patient. The procedure is invasive and may be embarrassing to some. Other patients may be anxious about their medical condition since endorectal ultrasounds are not routine. This places an added burden on already stressed hearts and nervous systems. Physicians, nurses, and technicians may need to be prepared for **stress** reactions that could include the heart, **asthma**, or anxious behaviors.

Description

ERUS has been used as a means to determine the depth of rectal cancers and to assess whether the tumor has affected surrounding tissues. This pre-treatment procedure has proven to be an accurate tool for tailoring surgery for patients.

Problems with interpretation of the sonograms after radiation and before surgery have resulted in tumors being identified that were merely the formation of fibrous tissues that remained after the tumors had been eliminated by the radiation. Yet, some of the fibrous areas actually hid residual tumors. Rectal anatomy itself can affect the accuracy of ultrasound reading. This makes ERUS problematic in determining the amount of tumor reduction a patient has after **radiation therapy**.

Preparation

The patient must evacuate the bowels completely before the procedure is done. This usually is assisted though the use of several **enemas**. The patient may be told to adhere to a liquid diet the day prior to doing this procedure. The probe is inserted, usually with little discomfort for the patient since it will only be examining the first few inches of the colon.

KEY TERMS

Anal sphincter muscles—Muscles that control the opening and closing of the anus.

Fistula—An abnormal passage.

Sonogram—The picture formed by the pattern of echoes from an ultra sound.

Ultrasound waves—High frequency sound waves.

Aftercare

Since ERUS is a minor invasive procedure, there is no aftercare.

Risks

There are no risks to having an ultrasound.

Normal results

Normal results after an endorectal ultrasound are normal, healthy tissues.

Abnormal results

Abnormal results range from any number of congenital deformities in the lining of the rectum to serious rectal cancers.

Resources

BOOKS

Johnston, Lorraine. *Colon and Rectal Cancer: A Comprehensive Guide for Patients and Families*. Sebastopol, CA: O'Reilly, 2000.

Levin, Bernard. *Colorectal Cancer: A Thorough and Compassionate Resource for Patients and Their Families*. New York: Villard, 1999.

PERIODICALS

Gavioli, M. A. Bagni, I. Piccagli, S. Fundaro, and G. Natalini. "Usefulness of Endorectal Ultrasound after Preoperative Radiotherapy in Rectal Cancer: Comparison between Sonographic and Histopathologic Changes." *Dis Colon Rectum* (August 2000): 1075-83.

OTHER

American Society of Colon and Rectal Surgeons. "Practice Parameters for the Treatment of Rectal Carcinoma." 9 May 2001. <http://www.asco.org/prof/me/html/abstracts/gasc/m_969.htm>.

National Cancer Institute. "NCI/PDQ Patient Statement: Rectal Cancer Updated 11/2000." *OncoLink*. 9 May 2001. <http://www.oncolink.upenn.edu/pdq_html/2/engl/20007 6.html>.

Janie F. Franz

Endoscopic retrograde cholangiopancreatography

Definition

Endoscopic retrograde cholangiopancreatography (ERCP) is a technique in which a hollow tube called an endoscope is passed through the mouth and stomach to the duodenum (the first part of the small intestine). This procedure was developed to examine abnormalities of the bile ducts, pancreas, and gallbladder. It was developed during the late 1960s and is used today to diagnose and treat blockages of the bile and pancreatic ducts.

The term has three parts to its definition:

- endoscopic refers to the use of an endoscope
- retrograde refers to the injection of dye up into the bile ducts in a direction opposing, or against, the normal flow of bile down the ducts
- cholangiopancreatography means visualization of the bile ducts (cholangio) and pancreas (pancreato)

Purpose

Until the 1970s, methods to visualize the bile ducts produced images that were of relatively poor quality and often misleading; in addition, the pancreatic duct could not be examined at all. Patients with symptoms related to the bile ducts or pancreatic ducts frequently needed surgery to diagnose and treat their conditions.

Using ERCP, physicians can obtain high-quality x rays of these structures and identify areas of narrowing (strictures), cancers, and **gallstones**. This procedure can help determine whether bile or pancreatic ducts are blocked; it also identifies where they are blocked along with the cause of the blockage. ERCP may then be used to relieve the blockage. For patients requiring surgery or additional procedures for treatment, ERCP outlines the anatomical changes for the surgeon.

Precautions

The most important precaution is that the examination should be performed by an experienced physician. The procedure is much more technically difficult than many other gastrointestinal endoscopic studies. Patients

should seek physicians with experience performing ERCP. Patients should inform the physician about any **allergies** (including allergies to contrast dyes, iodine, or shellfish), medication use, and medical problems. Occasionally, patients may need to be admitted to the hospital after the procedure.

Description

After **sedation**, a specially adapted endoscope is passed through the mouth, through the stomach, then into the duodenum. The opening to ducts that empty from the liver and pancreas is identified, and a plastic tube or catheter is placed into the orifice (opening). Contrast dye is then injected into the ducts, and with the assistance of a radiologist, pictures are taken.

Preparation

The upper intestinal tract must be empty for the procedure, so patients should not eat or drink for at least six to 12 hours before the exam. Patients should ask the physician about taking their medications before the procedure.

Aftercare

Someone should be available to take the person home after the procedure and stay with them for a while; patients will not be able to drive themselves because they undergo sedation during this test. **Pain** or any other unusual symptoms should be reported to the physician.

Risks

ERCP-related complications can be broken down into those related to medications used during the procedure, the diagnostic part of the procedure, and those related to endoscopic therapy. The overall complication rate is 5–10%; most of those occur when diagnostic ERCP is combined with a therapeutic procedure. During the exam, the endoscopist can cut or stretch structures (such as the muscle leading to the bile duct) to treat the cause of the patient's symptoms. Although the use of sedatives carries a risk of decreasing cardiac and respiratory function, it is very difficult to perform these procedures without these drugs.

The major complications related to diagnostic ERCP are **pancreatitis** (inflammation of the pancreas) and **cholangitis** (inflammation of the bile ducts). **Bacteremia** (the passage of bacteria into the blood stream) and perforation (hole in the intestinal tract) are additional risks.

Normal results

Because certain standards have been set for the normal diameter or width of the pancreatic duct and bile ducts, measurements using x rays are taken to determine if the ducts are too large (dilated) or too narrow (strictured). The ducts and gallbladder should be free of stones or tumors.

KEY TERMS

Endoscope, endoscopy—An endoscope used in the field of gastroenterology is a hollow, thin, flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of contrast. The performance of an exam using an endoscope is referred to as endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can also be done using these instruments.

Visualization—The process of making an internal organ visible. A radiopaque substance is introduced into the body, then an x-ray picture of the desired area is taken.

Abnormal results

When areas in the pancreatic or bile ducts (including those in the liver) are too wide or too narrow compared with the standard, the test is considered abnormal. Once these findings are demonstrated using ERCP, symptoms are usually present; they generally do not change without treatment. Stones, identified as opaque or solid structures within the ducts, are also considered abnormal. Masses or tumors may also be seen, but sometimes the diagnosis is made not by direct visualization of the tumor, but by indirect signs, such as a single narrowing of one of the ducts. Overall, ERCP has an excellent record in diagnosing these abnormalities.

Resources

BOOKS

Ostroff, James W., and Jeanne M. LaBerge. "Endoscopic and Radiologic Treatment of Biliary Disease." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*. Ed. by Mark Feldman, et al. Philadelphia: W.B. Saunders Company, 1997.

PERIODICALS

Aliperti, Giuseppe. "Complications Related to Diagnostic and Therapeutic Endoscopic Retrograde Cholangiopancreatography" *Gastrointestinal Endoscopy Clinics of North America* (Apr. 1996): 379–407.

Baillie, John. "Treatment of Acute Biliary Pancreatitis." *New England Journal of Medicine* 336, no. 4 (1997): 286.
Wigton, Robert S. "Measuring Procedural Skills." *Annals of Internal Medicine* 125 (1996): 1003–4.

OTHER

Endoscopic Retrograde Cholangiopancreatography. 21 June 2001 <http://www.asge.org>.
Measuring Procedural Skills. 21 June 2001 <http://www.acponline.org/journals/annals/15dec96/procskil.htm>.
Treatment of Acute Biliary Pancreatitis. 21 June 2001 <http://content.nejm.org>.

David S. Kaminstein

Endoscopic sclerotherapy *see* **Sclerotherapy for esophageal varices**

Endoscopic sphincterotomy

Definition

Endoscopic sphincterotomy or endoscopic retrograde sphincterotomy (ERS) is a relatively new endoscopic technique developed to examine and treat abnormalities of the bile ducts, pancreas and gallbladder. The procedure was developed as an extension to the diagnostic examination, ERCP (**endoscopic retrograde cholangiopancreatography**); with the addition of "sphincterotomy," abnormalities found during the study could be treated at the same time without the need for invasive surgery.

The term ERS has three parts to its definition;

- endoscopic refers to the use of an endoscope
- retrograde refers to the insertion of the endoscope *up* into the ducts in a direction opposite to or against the normal flow of bile *down* the ducts
- sphincterotomy, which means cutting of the sphincter or muscle that lies at the juncture of the intestine with both the bile and pancreatic ducts

Purpose

Until the 1970s, patients with symptoms related to disease of the bile ducts or pancreas frequently needed surgery to diagnose the cause and treat any abnormalities. ERCP allowed physicians for the first time to obtain high quality x rays of the common bile and pancreatic ducts, and detect areas of narrowing (strictures), stones, and tumors. ERCP was not initially designed for treatment. ERS was developed shortly after and enabled physicians to treat the abnormalities identified by the injection of dye and x rays.

The revolutionary technique made possible the endoscopic removal of stones and stretching of areas of narrowing (strictures). It has since been expanded to include drainage of bile from blocked ducts and treatment of various abnormalities of the pancreas.

Precautions

The most important precaution related to both ERCP and ERS is to have the procedure performed by an experienced physician. ERS is technically more difficult than many other gastrointestinal endoscopic studies, including ERCP. Patients should inquire as to the physician's experience with the procedure. The physician should also be informed of any **allergies**, medication use, and medical problems.

Description

ERS is generally performed only after ERCP has been successfully accomplished and detail of the anatomy and abnormalities is known. During ERS, a number of various instruments are inserted through the endoscope in order to "cut" or stretch the sphincter. Once this is done, additional instruments are passed that enable the removal of stones and the stretching of narrowed regions of the ducts. Drains (stents) can also be used to prevent a narrowed area from rapidly returning to its previously narrowed state.

Preparation

The upper intestinal tract must be empty for the procedure, so patients must not eat or drink for at least six to 12 hours before the exam. Patients need to inquire about taking their medications before the procedure. Some patients may require **antibiotics** before and/or after the procedure. When possible, **aspirin** or NSAIDS should not be taken within several days before the procedure, because they interfere with blood clotting.

Aftercare

When ERS is performed, physicians will usually want to observe the patient closely for several hours to ensure that there are no signs of complications. **Pain** or any other unusual symptoms should be reported. Admission to the hospital may be advised.

Risks

ERS complications are related either to the drugs used during the procedure, or the results of dye injection or cutting of tissue. The overall complication rate is 5–10%. During the exam, the endoscopist can cut or

KEY TERMS

Endoscope, Endoscopy—An endoscope as used in the field of gastroenterology is a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x-ray dye. The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

NSAIDS—This abbreviation stands for nonsteroidal anti-inflammatory drugs, which are medications such as Ibufprofen that are used to control pain and inflammation. Most may be purchased over the counter. One of their major side effects is that they decrease the effect of the normal blood clotting factors in blood. In patients undergoing surgical or endoscopic procedures, this can lead to an increased risk of bleeding.

stretch structures (such as the muscle leading to the bile duct) to treat the cause of the patient's symptoms. Cutting or stretching of these structures can sometimes cause a hole or perforation. The use of sedatives also carries a risk of decreasing cardiac and respiratory function, however, it is very difficult to perform these procedures without these drugs.

Other major complications related to ERCP or ERS are **pancreatitis** (inflammation of the pancreas) and **cholangitis** (inflammation of the bile ducts). **Bacteremia** (the passage of bacteria into the blood stream) and bleeding are also risks.

Normal results

Certain standards have been set for the diameter or width of the pancreatic and bile ducts. Measurements by x ray are used to determine if the ducts are too large (dilated) or too narrow (strictured). Lastly, the ducts and gallbladder should be free of any solid particles, such as stones, and free of areas of narrowing.

Resources

BOOKS

Ostroff, James W., and Jeanne M. Laberge. "Endoscopic and Radiologic Treatment of Biliary Disease." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Company. 1997.

PERIODICALS

Aliperti, Giuseppe. "Complications Related to Diagnostic and Therapeutic Endoscopic Retrograde Cholangiopancreatography." *Gastrointestinal Endoscopy Clinics of North America* (Apr. 1996): 379-407.

Baillie, John. "Treatment of Acute Biliary Pancreatitis." *New England Journal of Medicine* 336, no. 4 (1997): 286.

Cotton, Peter B., and Hawes, Robert H. "Therapeutic Biliary Endoscopy." *Gastrointestinal Endoscopy Clinics of North America* (Jan. 1996): 1-263.

Wigton, Robert S. "Measuring Procedural Skills." *Annals of Internal Medicine* 125 (1996): 1003-1004.

OTHER

"Endoscopic Retrograde Cholangiopancreatography." *American Society for Gastrointestinal Endoscopy.* <http://www.asge.org>.

"Treatment of Acute Biliary Pancreatitis." *New England Journal of Medicine Online.* <http://content.nejm.org>.

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Enemas

Definition

An enema is the insertion of a solution into the rectum and lower intestine.

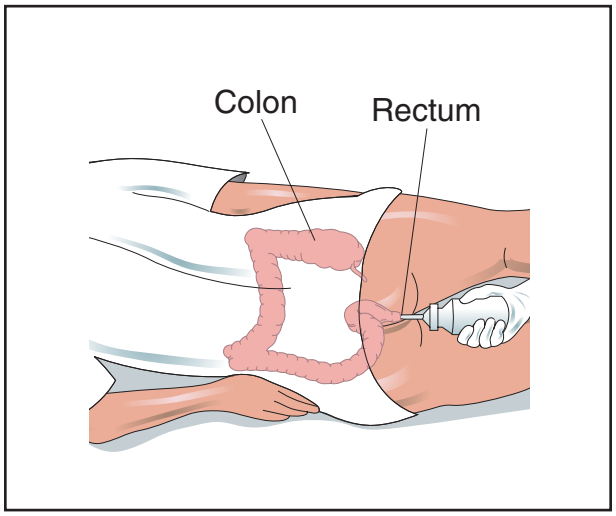
Purpose

Enemas may be given for the following purposes:

- to remove feces when an individual is constipated or impacted,
- to remove feces and cleanse the rectum in preparation for an examination,
- to remove feces prior to a surgical procedure to prevent contamination of the surgical area,
- to administer drugs or anesthetic agents.

Precautions

The rectal tube used for infusion of the enema solution should be smooth and flexible to decrease the possibility of damage to the mucous membrane that lines the rectum. Tap water is commonly used for adults but should not be used for infants because of the danger of electrolyte (substance that conducts electric current within the body and is essential for sustaining life) imbalance. The colon absorbs water, and repeated tap



Enemas may be given for the following purposes: to remove feces when an individual is constipated, or to remove feces and cleanse the rectum in preparation for an examination, or prior to surgery to prevent contamination. There are two types of enemas: the high enema, given to cleanse the large bowel, and the low enema, to cleanse only the lower bowel. *(Illustration by Electronic Illustrators Group.)*

water enemas can cause cardiovascular overload and electrolyte imbalance. Similarly, repeated saline enemas can cause increased absorption of fluid and electrolytes into the bloodstream, resulting in overload. Individuals receiving frequent enemas should be observed for overload symptoms that include **dizziness**, sweating, or vomiting.

Soap suds and saline used for cleansing enemas can cause irritation of the lining of the bowel, with repeated use or a solution that is too strong. Only white soap should be used; the bar should not have been previously used, to prevent infusing undesirable organisms into the individual receiving the enema. Common household detergents are considered too strong for the rectum and bowel. The commercially prepared castile soap is preferred, and should be used in concentration no greater than 5 cc soap to 1,000 cc of water.

Description

Cleansing enemas act by stimulation of bowel activity through irritation of the lower bowel, and by distention with the volume of fluid instilled. When the enema is administered, the individual is usually lying on the left side, which places the sigmoid colon (lower portion of bowel) below the rectum and facilitates infusion of fluid. The length of time it takes to administer an enema depends on the amount of fluid to be infused. The amount of fluid administered will vary depending on the age and size of the person receiving the enema, however general guidelines would be:

- Infant: 250 cc or less
- Toddler and preschooler: 500 cc or less
- School-aged child: 500–1,000 cc
- Adult: 750–1,000 cc

Some may differentiate between high and low enemas. A high enema, given to cleanse as much of the large bowel as possible, is usually administered at higher pressure and with larger volume (1,000 cc), and the individual changes position several times in order for the fluid to flow up into the bowel. A low enema, intended to cleanse only the lower bowel, is administered at lower pressure, using about 500 cc of fluid.

Oil retention enemas serve to lubricate the rectum and lower bowel, and soften the stool. For adults, about 150–200 cc of oil is instilled, while in small children, 75–150 cc of oil is considered adequate. Salad oil or liquid petrolatum are commonly used at a temperature of 91°F (32.8°C). There are also commercially prepared oil retention enemas. The oil is usually retained for one to three hours before it is expelled.

The rectal tube used for infusion of the solution, usually made of rubber or plastic, has two or more openings at the end through which the solution can flow into the bowel. The distance to which the tube must be inserted is dependent upon the age and size of the patient. For adult, insertion is usually 3–4 in (7.5–10 cm); for children, approximately 2–3 in (5–7.5 cm); and for infants, only 1–1.5 in (2.5–3.75 cm). The rectal tube is lubricated before insertion with a water soluble lubricant to ease insertion and decrease irritation to the rectal tissues.

The higher the container of solution is placed, the greater the force in which the fluid flows into the patient. Routinely, the container should be no higher than 12 in (30 cm) above the level of the bed; for a high cleansing enema, the container may be 12–18 in (30–45 cm) above the bed level, because the fluid is to be instilled higher into the bowel.

Preparation

The solution used in the procedure is measured, mixed, and warmed before administration of the enema.

Aftercare

If necessary, a specimen will be collected for diagnostic evaluation. If the enema was given to alleviate **constipation**, the better approach to combatting consti-

KEY TERMS

Electrolyte—A substance that conducts electric current within the body and is essential for sustaining life.

Intestine—Also called the bowels and divided into large and small intestine, they extend from the stomach to the anus, where waste products exit the body. The small intestine is about 20 ft (6.1 m) long and the large intestine, about 5 ft (1.5 m) long.

Rectum—The portion of bowel just before the anus. The prefix *recto* is used with a variety of words in relation to conditions that affect the rectum.

pation in the future is with a high fiber diet (five to six servings of whole grain foods) and adequate fluid intake (seven to eight glasses of water per day). Regular **exercise** and going to the bathroom when necessary will also help. If constipation is a chronic problem, medical help should be consulted to determine if there is underlying disorder.

Risks

Habitual use of enemas as a means to combat constipation can make the problem even more severe when their use is discontinued. Enemas should be used only as a last resort for treatment of constipation and with a doctor's recommendation. Enemas should not be administered to individuals who have recently had colon or rectal surgery, a **heart attack**, or who suffer from an unknown abdominal condition or an irregular heartbeat.

Resources

OTHER

Eller, D. "Spring Cleaning from the Inside Out." *Remedy* May/June 1997. 28 May 1998 <http://thriveonline.oxygen.com>.

Weiss, R. "Enhancing the process of elimination." *Washington Post Health*. 29 Nov. 1994. 28 May 1998 <http://thriveonline.oxygen.com>.

Kathleen D. Wright, RN

Enlarged prostate

Definition

A non-cancerous condition that affects many men past 50 years of age, enlarged prostate makes urinating more difficult by narrowing the urethra, a tube running from the bladder through the prostate gland. It can be effectively treated by surgery and, today, by certain drugs.

Description

The common term for enlarged prostate is BPH, which stands for benign (non-cancerous) prostatic hyperplasia or hypertrophy. Hyperplasia means that the prostate cells are dividing too rapidly, increasing the total number of cells, and, therefore, the size of the organ itself. Hypertrophy simply means "enlargement." BPH is part of the **aging** process. The actual changes in the prostate may start as early as the 30s but take place very gradually, so that significant enlargement and symptoms usually do not appear until after age 50. Past this age the chances of the prostate enlarging and causing urinary symptoms become progressively greater. More than 40% of men in their 70s have an enlarged prostate. Symptoms generally appear between ages 55–75. About 10% of all men eventually will require treatment for BPH.

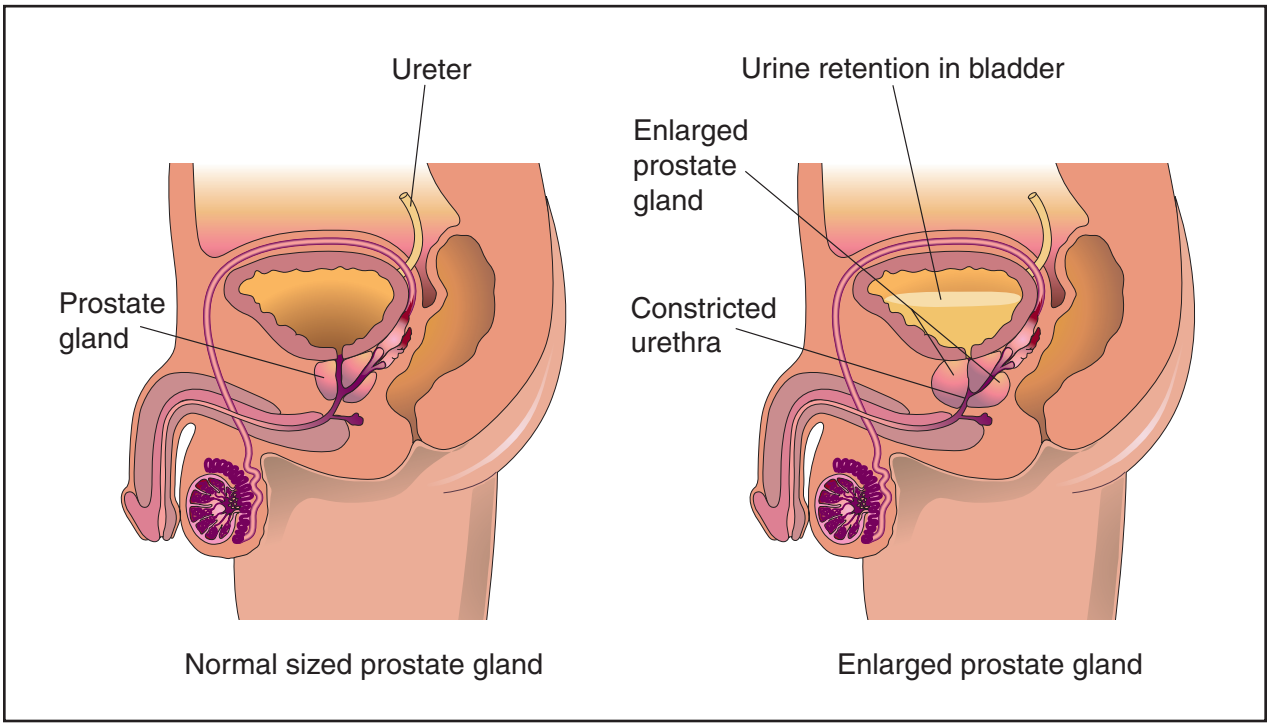
BPH has been viewed as a rare condition in African, Chinese and other Asian peoples for reasons that are not clear.

Causes and symptoms

The cause of BPH is a mystery, but age-related changes in the levels of hormones circulating in the blood may be a factor. Whatever the cause, an enlarging prostate gradually narrows the urethra and obstructs the flow of urine. Even though the muscle in the bladder wall becomes stronger in an attempt to push urine through the smaller urethra, in time, the bladder fails to empty completely at each urination. The urine that collects in the bladder can become infected and lead to stone formation. The kidneys themselves may be damaged by infection or by urine constantly "backing up."

When the enlarging prostate gland narrows the urethra, a man will have increasing trouble starting the urine stream. Because some urine remains behind in the bladder, he will have to urinate more often, perhaps two or three times at night (nocturia). The need to urinate can become very urgent and, in time, urine may dribble out to stain a man's clothing. Other symptoms of BPH are a weak and sometimes a split stream and general aching or **pain** in the perineum (the area between the scrotum and anus). Some men may have considerable enlargement of the prostate before even mild symptoms develop.

If a man must strain hard to force out the urine, small veins in the bladder wall and urethra may rupture,



An enlarged prostate is a non-cancerous condition in which the narrowing of the urethra makes the elimination of urine more difficult. It most often occurs in men over age 50. *(Illustration by Electronic Illustrators Group.)*

causing blood to appear in the urine. If the urinary stream becomes totally blocked, the urine collecting in the bladder may cause severe discomfort, a condition called acute urinary retention. Urine that stagnates in the bladder can easily become infected. A burning feeling during urination and **fever** are clues that infection may have developed. Finally, if urine backs up long enough it may increase pressure in the kidneys, though this rarely causes permanent kidney damage.

Diagnosis

When a man's symptoms point to BPH, the first thing the physician will want to do is a digital **rectal examination**, inserting a finger into the anus to feel whether—and how much—the prostate is enlarged. A smooth prostate surface suggests BPH, whereas a distinct lump in the gland might mean **prostate cancer**. The next step is a blood test for a substance called prostate-specific antigen or PSA. Between 30–50% of men with BPH have an elevated PSA level. This does not mean **cancer** by any means, but other measures are needed to make sure that the prostate enlargement is in fact benign. An ultrasound exam of the prostate, which is entirely safe and delivers no radiation, can show whether it is enlarged and may show that cancer is present.

If digital or ultrasound examination of the prostate raises the suspicion of cancer, most urologists will recommend that a prostatic tissue biopsy be performed. This is usually done using a lance-like instrument that is inserted into the rectum. It pierces the rectal wall and, guided by the physcian's finger, obtains six to eight pieces of prostatic tissue that are sent to the laboratory for microscopic examination. If cancer is present, the prognosis and treatment are changed accordingly.

A catheter placed through the urethra and into the bladder can show how much urine remains in the bladder after the patient urinates—a measure of how severe the obstruction is. Another and very simple test for obstruction is to have the man urinate into a uroflowmeter, which measures the rate of urine flow. A very certain—though invasive—way of confirming obstruction from an enlarged prostate is to pass a special viewing instrument called a cystoscope into the bladder, but this is not often necessary.

It is routine to check a urine sample for an increased number of white blood cells, which may mean there is infection of the bladder or kidneys. The same sample may be cultured to show what type of bacterium is causing the infection, and which **antibiotics** will work best. The state of the kidneys may be checked in two ways: imaging by either ultrasound or injecting a dye (the intra-

venous urogram, or pyelogram); or a blood test for creatinine, which collects in the blood when the kidneys cannot eliminate it.

Treatment

Drugs

A class of drugs called alpha-adrenergic blockers, which includes phenoxybenzamine and doxazosin, relax the muscle tissue surrounding the bladder outlet and lining the wall of the urethra to permit urine to flow more freely. These drugs improve obstructive symptoms, but do not keep the prostate from enlarging. Other drugs (finasteride is a good example) do shrink the prostate and may delay the need for surgery. Symptoms may not, however, improve until the drug has been used for three months or longer. Antibiotic drugs are given promptly whenever infection is diagnosed. Some medications, including **antihistamines** and some **decongestants**, can make the symptoms of BPH suddenly worse and even cause acute urinary retention, and therefore should be avoided.

Intermediate treatments

When drugs have failed to control symptoms of BPH but the physician does not believe that conventional surgery is yet needed, a procedure called transurethral needle ablation may be tried. In the office and using local anesthesia, a needle is inserted into the prostate and radiofrequency energy is applied to destroy the tissue that is obstructing urine flow. Another new approach is microwave hyperthermia, using a device called the Prostatron to deliver microwave energy to the prostate through a catheter. This procedure is done at an outpatient surgery center.

Surgery

For many years the standard operation for BPH has been transurethral resection (TUR) of the prostate. Under general or spinal anesthesia, a cystoscope is passed through the urethra and prostate tissue surrounding the urethra is removed using either a cutting instrument or a heated wire loop. The small pieces of prostate tissue are washed out through the scope. No incision is needed for TUR. There normally is some blood in the urine for a few days following the procedure. In a few men—less than 5% of all those having TUR—urine will continue to escape unintentionally. Other uncommon complications include a temporary rise in blood pressure with mental confusion, which is treated by giving salt solution. Impotence—the inability to achieve lasting penile erections—does occur, but probably in fewer than 10% of patients. A narrowing or stricture rarely develops in the urethra, but this can be treated fairly easily.

KEY TERMS

Catheter—A rubber or plastic tube placed through the urethra into the bladder to remove excess urine when the flow of urine is cut off, or to prevent urinary infection.

Creatinine—One of the "waste" substances normally excreted by the kidneys into the urine. When urine flow is slowed, creatinine may collect in the blood and cause toxic effects.

Hyperplasia—A condition where cells, such as those making up the prostate gland, rapidly divide abnormally and cause the organ to become enlarged.

Hypertrophy—A technical term for enlargement, as in BPH (benign prostatic hypertrophy).

Urethra—In males, the tube that conducts urine from the bladder through the penis to the outside of the body. When narrowed by an enlarging prostate, symptoms of BPH develop.

Urinary retention—The result of progressive obstruction of the urethra by an enlarging prostate, causing urine to remain in the bladder even after urination.

Alternatives to TUR, some only recently introduced, include:

- Laser ablation of the prostate. Laser energy is applied to the prostate through a special fiber passed through a cystoscope. The procedure is done in an operating room, and several patients have retained urine postoperatively.
- Transurethral incision of the prostate. Less invasive than standard TUR, an incision is made through the prostate to open up the part of the urethra passing through it. This may work well in men whose prostate is not grossly enlarged.
- Transurethral vaporization. A small roller ball is used to break up and vaporize the obstructing prostatic tissue, rather than cutting it away as in standard TUR. This is equally successful but patients usually can leave the hospital within 24 hours, and there is less blood loss.
- If the prostate is greatly enlarged—as is the case in about 5–10% of those diagnosed, an incision is made to perform an open **prostatectomy**, removing the entire gland under direct vision.

Alternative treatment

An extract of the **saw palmetto** (*Serenoa repens* or *S. serrulata*) has been shown to stop or decrease the hyperplasia of the prostate. Symptoms of BPH will improve after taking the herb for one to two months, but continued use is recommended.

Prognosis

In a man without symptoms whose prostate is enlarged, it is hard to predict when urinary symptoms will develop and how rapidly they will progress. For this reasons some specialists (urologists) advise a period of "watchful waiting." When BPH is treated by conventional TUR, there is a small risk of complications but, in the great majority of men, urinary symptoms will be relieved and their quality of life will be much enhanced. In the future, it is possible that the less invasive forms of surgical treatment will be increasingly used to achieve results as good as those of the standard operation. It also is possible that new medications will be developed that shrink the prostate and eliminate obstructive symptoms so that surgery can be avoided altogether.

Prevention

Whether or not BPH is caused by hormonal changes in aging men, there is no known way of preventing it. Once it does develop and symptoms are present that interfere seriously with the patient's life, timely medical or surgical treatment will reliably prevent symptoms from getting worse. Also, if the condition is treated before the prostate has become grossly enlarged, the risk of complications is minimal. One of the potentially most serious complications of BPH, urinary infection (and possible infection of the kidneys), can be prevented by using a catheter to drain excess urine out of the bladder so that it does not collect, stagnate, and become infected.

Resources

BOOKS

Rous, Stephen N. *The Prostate Book: Sound Advice on Symptoms and Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Selmans, Sandra. *Prostate: Questions You Have...Answers You Need*. Allentown, PA: People's Medical Society, 1996.

Walsh, Patrick C., and Janet F. Worthington. *The Prostate: A Guide for Men and the Women Who Love Them*. New York: Warner Books, 1997.

ORGANIZATIONS

Prostate Health Council. American Foundation for Urologic Disease. 1128 N. Charles St., Baltimore, MD 21201. (800) 242-AFUD.

David A. Cramer, MD

Entamoeba histolytica infection *see* **Amebiasis**

Enteric fever *see* **Typhoid fever**

Enterically transmitted non-A non-B *see* **Hepatitis E**

Enterobacterial infections

Definition

Enterobacterial infections are disorders of the digestive tract and other organ systems produced by a group of gram-negative, rod-shaped bacteria called Enterobacteriaceae. Gram-negative means that the organisms do not retain the violet color of the dye used to make Gram stains. The most troublesome organism in this group is ***Escherichia coli***. Other enterobacteria are species of *Salmonella*, *Shigella*, *Klebsiella*, *Enterobacter*, *Serratia*, *Proteus*, and *Yersinia*.

Description

Enterobacterial infections can be produced by bacteria that normally live in the human digestive tract without causing serious disease, or by bacteria that enter from the outside. In many cases these infections are nosocomial, which means that they can be acquired in the hospital. *Klebsiella* and *Proteus* sometimes cause **pneumonia**, ear and sinus infections, and urinary tract infections. *Enterobacter* and *Serratia* often cause bacterial infection of the blood (**bacteremia**), particularly in patients with weakened immune systems.

Diarrhea caused by enterobacteria is a common problem in the United States. It is estimated that each person in the general population has an average of 1.5 episodes of diarrhea each year, with higher rates in children, institutionalized people, and Native Americans. This type of enterobacterial infection can range from a minor nuisance to a life-threatening disorder, especially in infants, elderly persons, **AIDS** patients, and malnourished people. Enterobacterial infections are one of the two leading killers of children in developing countries.

Causes and symptoms

Causes

Enterobacterial infections in the digestive tract typically start when the organisms invade the mucous tissues that line the digestive tract. They may be bacteria that are

already present in the stomach and intestines, or they may be transmitted by contaminated food and water. It is also possible for enterobacterial infections to spread by person-to-person contact. The usual incubation period is 12–72 hours.

***ESCHERICHIA COLI* INFECTIONS.** *E. coli* infections cause most of the enterobacterial infections in the United States. The organisms are categorized according to whether they are invasive or noninvasive. Noninvasive types of *E. coli* include what are called enteropathogenic *E. coli*, or EPEC, and enterotoxigenic *E. coli*, or ETEC. EPEC and ETEC types produce a bacterial poison (toxin) in the stomach that interacts with the digestive juices and causes the patient to lose large amounts of water through the intestines.

The invasive types of *E. coli* are called enterohemorrhagic *E. coli*, or EHEC, and enteroinvasive *E. coli,* or EIEC. These subtypes invade the stomach tissues directly, causing tissue destruction and bloody stools. EHEC can produce complications leading to **hemolytic-uremic syndrome** (HUS), a potentially fatal disorder marked by the destruction of red blood cells and kidney failure. EHEC has become a growing problem in the United States because of outbreaks caused by contaminated food. A particular type of EHEC known as O157:H7 has been identified since 1982 in undercooked hamburgers, unpasteurized milk, and apple juice. Between 2–7% of infections caused by O157:H7 develop into HUS.

Symptoms

The symptoms of enterobacterial infections are sometimes classified according to the type of diarrhea they produce.

WATERY DIARRHEA. Patients infected with ETEC, EPEC, some types of *Salmonella*, and some types of *Shigella* develop a watery diarrhea. These infections are located in the small intestine, result from bacterial toxins interacting with digestive juices, do not produce inflammation, and do not usually need treatment with **antibiotics**.

BLOODY DIARRHEA (DYSENTERY). Bloody diarrhea is sometimes called dysentery. It is produced by EHEC, EIEC, some types of *Salmonella*, some types of *Shigella*, and *Yersinia*. In dysentery, the infection is located in the colon, cells and tissues are destroyed, inflammation is present, and antibiotic therapy is usually required.

NECROTIZING ENTEROCOLITIS (NEC). **Necrotizing enterocolitis** (NEC) is a disorder that begins in newborn infants shortly after birth. Although NEC is not yet fully understood, it is thought that it results from a bacterial or viral invasion of damaged intestinal tissues. The disease organisms then cause the **death** (necrosis) of bowel tissue or **gangrene** of the bowel. NEC is primarily a disease of **prematurity**; 60–80% of cases occur in high-risk preterm infants. NEC is responsible for 2–5% of cases in newborn intensive care units (NICU). Enterobacteriaceae that have been identified in infants with NEC include *Salmonella*, *E. coli*, *Klebsiella*, and *Enterobacter*.

Diagnosis

Patient history

The diagnosis of enterobacterial infections is complicated by the fact that viruses, protozoa, and other types of bacteria can also cause diarrhea. In most cases of mild diarrhea, it is not critical to identify the organism because the disorder is self-limiting. Some groups of patients, however, should have stool tests. They include:

- patients with bloody diarrhea,
- patients with watery diarrhea who have become dehydrated,
- patients with watery diarrhea that has lasted longer than three days without decreasing in amount,
- patients with disorders of the immune system.

The patient history is useful for public health reasons as well as helping the doctor determine what type of enterobacterium may be causing the infection. The doctor will ask about the frequency and appearance of the diarrhea as well as other digestive symptoms. If the patient is nauseated and vomiting, the infection is more likely to be located in the small intestine. If the patient is running a **fever**, a diagnosis of dysentery is more likely. The doctor will also ask if anyone else in the patient's family or workplace is sick. Some types of enterobacteriaceae are more likely to cause group outbreaks than others. Other questions include the patient's food intake over the last few days and whether he or she has recently traveled to countries with **typhoid fever** or **cholera** outbreaks.

Physical examination

The most important parts of the **physical examination** are checking for signs of severe fluid loss and examining the abdomen to rule out typhoid fever. The doctor will look at the inside of the patient's mouth and evaluate the skin for signs of **dehydration**. The presence of a skin rash and an enlarged spleen suggests typhoid rather than a bacterial infection. If the patient's abdomen hurts when the doctor examines it, a diagnosis of dysentery is more likely.

Laboratory tests

The most common test that is used to identify the cause of diarrhea is the stool test. Examining a stool sample under a microscope can help to rule out parasitic and

protozoal infections. Routine stool cultures, however, cannot be used to identify any of the four types of *E. coli* that cause intestinal infections. ETEC, EPEC, and EIEC are unusual in the United States and can usually be identified only by specialists in research laboratories. Because of concern about EHEC outbreaks, however, most laboratories in the United States can now screen for O157:H7 with a test that identifies its characteristic toxin. All patients with bloody diarrhea should have a stool sample tested for *E. coli* O157:H7.

Treatment

The initial treatment of enterobacterial diarrhea is usually empiric. Empiric means that the doctor treats the patient on the basis of the visible symptoms and professional experience in treating infections, without waiting for laboratory test results. Since the results of stool cultures can take as long as two days, it is important to prevent dehydration. The patient will be given fluids to restore the electrolyte balance and paregoric to relieve abdominal cramping.

Newborn infants and patients with immune system disorders will be given antibiotics intravenously once the organism has been identified. Gentamicin, tobramycin, and amikacin are being used more frequently to treat enterobacterial infections because many of the organisms are becoming resistant to ampicillin and cephalosporin antibiotics.

Alternative treatment

Alternative treatments for diarrhea are intended to relieve the discomfort of abdominal cramping. Most alternative practitioners advise consulting a medical doctor if the patient has sunken eyes, dry eyes or mouth, or other signs of dehydration.

Herbal medicine

Herbalists may recommend cloves taken as an infusion or ginger given in drop doses to control intestinal cramps, eliminate gas, and prevent vomiting. Peppermint (*Mentha piperita*) or chamomile (*Matricaria recutita*) tea may also ease cramps and intestinal spasms.

Homeopathy

Homeopathic practitioners frequently recommend *Arsenicum album* for diarrhea caused by contaminated food, and *Belladonna* for diarrhea that comes on suddenly with mucus in the stools. *Veratrum album* would be given for watery diarrhea, and *Podophyllum* for diarrhea with few other symptoms.

KEY TERMS

Dysentery—A type of diarrhea caused by infection and characterized by mucus and blood in the stools.

Empirical treatment—Medical treatment that is given on the basis of the doctor's observations and experience.

Escherichia coli—A type of enterobacterium that is responsible for most cases of severe bacterial diarrhea in the United States.

Hemolytic-uremic syndrome (HUS)—A potentially fatal complication of *E. coli* infections characterized by kidney failure and destruction of red blood cells.

Necrotizing enterocolitis (NEC)—A disorder in newborns caused by bacterial or viral invasion of vulnerable intestinal tissues.

Nosocomial infections—Infections acquired in hospitals.

Toxin—A poison produced by certain types of bacteria.

Prognosis

The prognosis for most enterobacterial infections is good; most patients recover in about a week or 10 days without needing antibiotics. HUS, on the other hand, has a mortality rate of 3–5% even with intensive care. About a third of the survivors have long-term problems with kidney function, and another 8% develop high blood pressure, seizure disorders, and blindness.

Prevention

The World Health Organization (WHO) offers the following suggestions for preventing enterobacterial infections, including *E. coli* O157:H7 dysentery:

- Cook ground beef or hamburgers until the meat is thoroughly done. Juices from the meat should be completely clear, not pink or red. All parts of the meat should reach a temperature of 70°C (158°F) or higher.
- Do not drink unpasteurized milk or use products made from raw milk.
- Wash hands thoroughly and frequently, especially after using the toilet.
- Wash fruits and vegetables carefully, or peel them. Keep all kitchen surfaces and serving utensils clean.

- If drinking water is not known to be safe, boil it or drink bottled water.
- Keep cooked foods separate from raw foods, and avoid touching cooked foods with knives or other utensils that have been used with raw meat.

Resources

BOOKS

Bennish, Michael L., and Carlos Seas. "Bacterial Diarrheas." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Escherichia coli and Other Enterobacteriaceae Infections." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

"Infectious Disease: Enterobacteriaceae Infections." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Necrotizing Enterocolitis." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

Ogle, John W. "Infections: Bacterial & Spirochetal." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Escherichia coli O157:H7." *World Health Organization.* 7 June 1998 <http://www.who.int/home-page/index.en.shtml>.

"Escherichia coli O157:H7." *Medscape Today* 7 June 1998 <http://www.medscape.com/Home/Topics/multispecialty/multispecialty.html>.

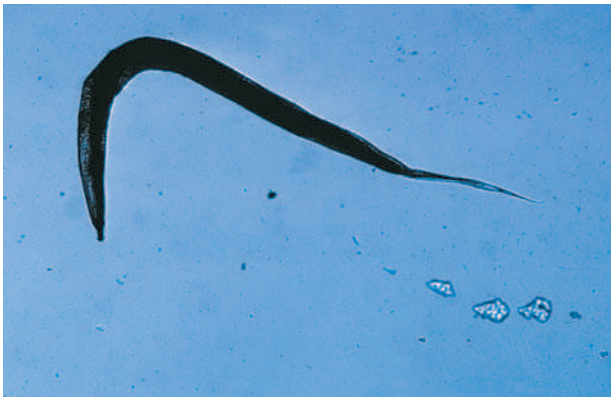
"Preventing foodborne illness." *Centers for Disease Control.* 7 June 1998 <http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm>.

Rebecca J. Frey

Enterobiasis

Definition

Enterobiasis, or pinworm infection as it is commonly called, is an intestinal infection caused by the parasitic roundworm called *Enterobius vermicularis*. The most common symptom of this irritating, but not particularly dangerous, disease is **itching** around the anal area.



The pinworm of the genus *Enterobius* pictured above is the source of this infestation occurring in children. *(Photo Researchers, Inc. Reproduced by permission.)*

Description

Enterobiasis is also called seatworm infection or oxyuriasis. In the United States, enterobiasis is the most common worm infection, and some estimate that approximately 10% of the United States population is infected. Worldwide, approximately 200 million people are infected. Enterobiasis can affect people of any age, but is most common among children ages 5–14 and particularly affects those in the daycare setting.

Causes and symptoms

The disease is highly contagious and is caused by a parasitic worm called *Enterobius vermicularis*. The adult female worm is about the size of a staple (approximately 0.4 in [1 cm] long and 0.02 in [0.5 mm] wide) and has a pointed tip. The disease is transmitted by ingesting the eggs of the pinworm. These eggs travel to the small intestine where, after approximately one month, they hatch and mature into adult worms. During the night, the female adult worms travel to the area around the anus and deposit eggs in the folds of the anal area. A single female pinworm can lay 10,000 eggs and, after laying eggs, dies. The eggs are capable of causing infection after six hours at body temperature.

Significant itching in the anal region is caused by the movement of the adult worm as the eggs are deposited. When an individual scratches the anal region, the tiny eggs get under the finger nails and in the underwear and night clothes. Anything the individual touches with the contaminated fingers, for example, toys, bedding, blankets, bathroom door knobs, or sinks, becomes contaminated. The eggs are very hardy and can live on surfaces for two to three weeks. Anyone touching these contaminated surfaces can ingest the eggs and become infected. An individ-

KEY TERMS

Anus—The opening through which feces are eliminated.

Hemorrhoid—An area around the anus where veins become dilated and the tissue swells, causing itching and pain.

Rectum—The end of the large intestine in which feces collects for elimination through the anus.

Vaginitis—Inflammation of the vagina.

ual can also become infected by inhaling and swallowing the eggs, for example, when the bedcovers are shaken.

Many individuals with enterobiasis exhibit no symptoms. When present, however, symptoms of the infection begin approximately two weeks after ingesting the pinworm eggs. The main symptom is itching around the anus. Because the itching intensifies at night, when the female worms comes to the anus to lay eggs, it often leads to disrupted sleep and irritability. Poor sleeping at night in small children can be related to pinworms. Occasionally, the itching causes some bleeding and bruising in the region, and secondary bacterial infections can occur. In females, the itching may spread to the vagina and sometimes causes an infection of the vaginal region (vaginitis). Enterobiasis usually lasts one to two months.

Diagnosis

First, a physician will rule out other potential causes of the itching, such as **hemorrhoids**, lice, or fungal or bacterial infection. Once these have been ruled out, an accurate diagnosis of enterobiasis will require that either the eggs or the adult worms are detected. Rarely, the adult worms are seen as thin, yellowish-white threads, about 0.4 in (1 cm) long, in the stools of the infected person. Usually, an hour or so after the individual goes to sleep, the adult female worms may be seen moving around laying eggs if a flashlight is shone at the rectal area.

An easier method is to observe the eggs under the microscope. In order to collect a specimen for laboratory diagnosis, the physician may provide a paddle with a sticky adhesive on one side, or an individual may be instructed to place a piece of shiny cellophane tape sticky side down against the anal opening. The best time to perform this test is at night or as soon as the individual wakes up in the morning, before having a bowel movement or taking a bath or shower. The pinworm eggs will stick to the tape, which can then be placed on a specimen slide. When under a microscope in the laboratory, the eggs will be clearly visible.

Treatment

In order to treat the disease, either mebendazole (Vermox) or pyrantel pamoate (Pin-X) will be given in two oral doses spaced two weeks apart. These medications eradicate the infection in approximately 90% of cases. Re-infection is common and several treatments may be required. Because the infection is easily spread through contact with contaminated clothing or surfaces, it is recommended that all family members receive the therapeutic dose. Sometimes a series of six treatments are given, each spaced two weeks apart. If family members continue to be infected, a source outside the house may be responsible.

To relieve the rectal itching, a shallow warm bath with either half a cup of table salt, or Epsom salts is recommended. Also, application of an ointment containing zinc oxide or regular petroleum jelly can be used to relieve rectal itching.

Prognosis

Pinworms cause little damage and can be easily eradicated with proper treatment. Full recovery is expected.

Prevention

The disease can be prevented by treating all the infected cases and thus eliminating the source of infection. Some ways to keep from catching or spreading the disease include the following recommendations:

- wash hands thoroughly before handling food and eating
- keep finger nails short and clean
- avoiding scratching the anal area
- take early morning showers to wash away eggs deposited overnight
- once the infection has been identified, and treatment is started, change the bed linen, night clothes, and underwear daily
- machine wash linens in hot water and dry with heat to kill any eggs
- open the blinds or curtains since eggs are sensitive to sunlight

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1992.

Zinsser, Hans. *Zinsser Microbiology.* 19th ed. Ed. Wolfgang K. Joklik, et al. Stamford: Appleton Lange, 1988.

Lata Cherath, PhD

Enterohemorrhagic *E. coli* see ***Escherichia coli***

Enterostomy

Definition

An enterostomy is an operation in which the surgeon makes a passage into the patient's small intestine through the abdomen with an opening to allow for drainage or to insert a tube for feeding. The opening is called a stoma, from the Greek word for mouth. Enterostomies may be either temporary or permanent. They are classified according to the part of the intestine that is used to create the stoma. If the ileum, which is the lowest of the three sections of the small intestine, is used to make the stoma, the operation is called an ileostomy. If the jejunum, which is the middle section of the small intestine, is used, the operation is called a jejunostomy. Some people use the word *ostomy* as a word that covers all types of enterostomies.

Purpose

Enterostomies are performed in order to create a new opening for the passage of fecal matter when normal intestinal functioning is interrupted or when diseases of the intestines cannot be treated by medications or less radical surgery. Some situations that may require enterostomies include:

- Healing of inflamed bowel segments. Enterostomies performed for this reason are usually temporary.
- Emergency treatment of gunshot or other penetrating **wounds** of the abdomen. An enterostomy is needed to prevent the contents of the intestine from causing a serious inflammation of the inside of the abdominal cavity (**peritonitis**). These enterostomies are also often temporary.
- Placement of a tube for enteral feeding. Enteral feeding is a method for conveying nutritional solutions directly into the stomach or jejunum through a tube. Tube enterostomies may be long-term but are not permanent.
- Removal of diseased sections of the intestines. Ileostomies performed for this reason are permanent. The most common disorders requiring permanent ileostomy are **Crohn's disease**, **familial polyposis**, and **ulcerative colitis**. Familial polyposis and ulcerative colitis are serious health risks because they can develop into **cancer**.
- Treatment of advanced cancer or other causes of intestinal obstruction.

Precautions

Enterostomies are usually performed only as emergency treatments for traumatic injuries in the abdomen or as final measures for serious disorders of the intestines. Most patients do not refuse to have the operation performed when the need for it is explained to them. A small minority, however, refuse enterostomies because of strong psychological reactions to personal disfigurement and the need to relearn bowel habits.

Description

Ileostomy

Ileostomies represent about 25% of enterostomies. They are performed after the surgeon removes a diseased colon and sometimes the rectum as well. The most common ileostomy is called a Brooke ileostomy after the English surgeon who developed it. In a Brooke ileostomy, the surgeon makes the stoma in the lower right section of the abdomen. The ileum is pulled through an opening (incision) in the muscle layer. The surgeon then turns the cut end of the intestine inside out and sews it to the edges of the hole. He or she then positions an appliance for collecting the fecal material. The appliance consists of a plastic bag that fits over the stoma and lies flat against the abdomen. The patient is taught to drain the bag from time to time during the day. Ileostomies need to be emptied frequently because the digested food contains large amounts of water. Shortly after the operation, the ileostomy produces 1–2 qt (0.9–1.91) of fluid per day; after a month or two of adjustment, the volume decreases to 1–2 pt (0.5–0.9)per day.

KOCK POUCH (CONTINENT ILEOSTOMY). The Kock pouch is a variation of the basic ileostomy and is named for its Swedish inventor. In the Kock technique, the surgeon forms a pouch inside the abdominal cavity behind the stoma that collects the fecal material. The stoma is shaped into a valve to prevent fluid from leaking onto the patient's abdomen. The patient then empties the pouch several times daily by inserting a tube (catheter) through the valve. The Kock technique is sometimes called a continent ileostomy because the fluid is contained inside the abdomen. It is successful in 70–90% of patients who have it done.

KEY TERMS

Crohn's disease—A disease of the intestines that causes inflammation leading to scarring, thickening of the walls of the intestine, and eventual obstruction.

Duodenum—The first of the three segments of the small intestine. The duodenum connects the stomach and the jejunum.

Enteral nutrition—A technique for feeding patients with liquid formulas conveyed directly into the stomach or jejunum through tubes.

Enterostomal therapist (ET)—A specialized counselor, usually a registered nurse, who provides ostomy patients with education and counseling before the operation. After surgery, the ET helps the patient learn to take care of the stoma and appliance, and offers long-term emotional support.

Familial polyposis—A disease that runs in families in which lumps of tissue (polyps) form inside the colon. Familial polyposis may develop into cancer.

Ileum—The third segment of the small intestine, connecting the jejunum and the large intestine.

Jejunum—The second of the three segments of the small intestine, connecting the duodenum and the ileum.

Kock pouch—A type of ileostomy in which the surgeon forms an artificial rectum from a section of the ileum. A Kock pouch is sometimes called a continent ileostomy because it is drained with a tube.

Ostomy—A common term for all types of enterostomies.

Stoma—The surgically constructed mouth or passage between the intestine and the outside of the patient's body.

Tube enterostomy—An enterostomy performed to allow the insertion of a feeding tube into the jejunum or stomach.

Ulcerative colitis—A disease of the colon characterized by inflammation of the mucous lining, ulcerated areas of tissue, and bloody diarrhea.

Jejunostomy

A jejunostomy is similar to an ileostomy except that the stoma is placed in the second section of the small intestine rather than the third. Jejunostomies are performed less frequently than ileostomies. They are almost always temporary procedures.

Tube enterostomies

Tube enterostomies are operations in which the surgeon makes a stoma into the stomach itself or the jejunum in order to insert a tube for liquid nutrients. Tube enterostomies are performed in patients who need tube feeding for longer than six weeks, or who have had recent mouth or nose surgery. As long as the patient's intestinal tract can function, **tube feedings** are considered preferable to intravenous feeding. Enteral **nutrition** is safer than intravenous fluids and helps to keep the patient's digestive tract functioning.

Preparation

Preoperative preparation includes both patient education and physical preparation.

Patient education

If the patient is going to have a permanent ileostomy, the doctor will explain what will happen during the operation and why it is necessary. Most patients are willing to accept an **ostomy** as an alternative to the chronic **pain** and **diarrhea** of ulcerative colitis or the risk of cancer from other intestinal disorders. The patient can also meet with an enterostomal therapist (ET) or a member of the United Ostomy Association, which is a support group for people with ostomies.

Medical preparation

The patient is prepared for surgery with an evaluation of his or her nutritional status, possible need for blood transfusions, and **antibiotics** if necessary. If the patient does not have an intestinal obstruction or severe inflammation, he or she may be given a large quantity of a polyethylene glycol (PEG) solution to cleanse the intestines before surgery.

Aftercare

Aftercare of an enterostomy is both psychological and medical.

Medical aftercare

If the enterostomy is temporary, aftercare consists of the usual monitoring of surgical wounds for infection or bleeding. If the patient has had a permanent ileostomy, aftercare includes learning to use the appliance or empty the Kock pouch; learning to keep the stoma clean; and readjusting bathroom habits. Recovery takes a long time because major surgery is a **shock** to the system and the intestines take several days to resume normal functioning. The patient's fluid intake and output will be checked frequently to minimize the risk of **dehydration**.

Patient education

Ileostomy patients must learn to watch their fluid and salt intake. They are at greater risk of becoming dehydrated in hot weather, from **exercise**, or from diarrhea. In some cases they may need extra bananas or orange juice in the diet to keep up the level of potassium in the blood.

Patient education includes social concerns as well as physical self-care. Many ileostomy patients are worried about the effects of the operation on their close relationships and employment. If the patient has not seen an ET before the operation, the aftercare period is a good time to find out about self-help and support groups. The ET can also evaluate the patient's emotional reactions to the ostomy.

Risks

Enterostomies are not considered high-risk operations by themselves. About 40% of ileostomy patients have complications afterward, however; about 15% require minor surgical corrections. Possible complications include:

- skin irritation caused by leakage of digestive fluids onto the skin around the stoma, irritation is the most common complication of ileostomies
- diarrhea
- the development of abscesses
- gallstones or stones in the urinary tract
- inflammation of the ileum
- odors (can often be prevented by a change in diet)
- intestinal obstruction
- a section of the bowel pushing out of the body (prolapse)

Normal results

Normal results include recovery from the surgery with few or no complications. About 95% of people with ostomies recover completely, are able to return to work, and consider themselves to be in good health. Many ileostomy patients enjoy being able to eat a full range of foods rather than living on a restricted diet. Some patients, however, need to be referred to psychotherapists to deal with depression or other emotional problems after the operation.

Resources

BOOKS

Altman, Roberta, and Michael J. Sarg. *The Cancer Dictionary.* New York: Facts On File, Inc., 1992.

Baron, Robert B. "Nutrition." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Bowel Surgery with Ostomy." In *Everything You Need to Know about Medical Treatments*, ed. Matthew Cahill, et al. Springhouse, PA: Springhouse Corporation, 1996.

"Nutritional Management of the Surgical Patient: Determining the Route of Nutritional Support." In *Surgery On Call*, ed. Leonard G. Gomella and Alan T. Lefor. Stamford: Appleton & Lange, 1996.

Schrock, Theodore R. "Large Intestine." In *Current Surgical Diagnosis and Treatment.* 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Smith, Roger. "Ileostomy and Colostomy." In *Magill's Medical Guide: Health and Illness, Supplement.* Vol. 5. Ed. Nancy A. Piotrowski. Pasadena, CA: Salem Press, Inc., 1996.

ORGANIZATIONS

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. <http://www.uoa.org>.

Rebecca J. Frey

Enterovirus infections

Definition

Enteroviruses are so named because they reproduce initially in the gastrointestinal tract after infection occurs. Despite, this, they usually do not lead to intestinal symptoms; rather it is their spread to organs, such as the nervous system, heart, skin, and others that causes disease. Enteroviruses are part of a larger group of viruses known as Picornaviruses. The word comes from the combination of "pico" (Spanish, meaning "a little bit"), and RNA (ribonucleic acid, an important component of genetic material).

Description

There are four groups of enteroviruses: Coxsackievirus, Echovirus, ungrouped Enterovirus, and Y Poliovirus.

Viruses are generally divided into those that use DNA (desoxyribonucleic acid) or RNA as their genetic material; all enteroviruses are RNA viruses. They are found worldwide, but infection is more common in areas of poor hygiene and overcrowding.

Although most cases of enterovirus do not produce symptoms, some five to 10 million individuals in the United States each year suffer from one of the enteroviral diseases. Illness is more common in the very young. While there are close to seventy different strains of enteroviruses, over 70% of infections are caused by only 10 types.

The virus is most commonly transmitted by the fecal-oral route (contamination of fingers or objects by human waste material); in some instances transmission is through contaminated food or water. Passage of some strains of virus by way of air droplets can lead to respiratory illness. Infection of fetuses by way of the placenta has also been documented. Breast milk contains antibodies which can protect newborns.

The incubation period for most enteroviruses ranges from two to 14 days. In areas of temperate climate, infections occur mainly in the summer and fall.

Causes and symptoms

Enteroviruses are believed to be the cause of at least 10 distinct illnesses. Once they enter the body, they multiply in the cells that line the gastrointestinal tract, and eventually reach sites of lymphatic tissue (such as the tonsils). While most of these diseases are of short duration and do not cause significant injury, some can produce severe illness.

The main syndromes caused by the various enteroviruses are the following:

- Summer grippe (nonspecific febrile illness). This is the most common syndrome, and is characterized by flu-like symptoms of **fever**, **headache**, and weakness, that typically last three to four days. Many patients also develop upper respiratory symptoms and some **nausea and vomiting**. One of the major ways to distinguish this disease from **influenza**, is the fact that grippe most often occurs in the summer.
- Generalized disease of the newborn is a potentially serious infection in which infants from one week to three months of age develop a syndrome that can be difficult to distinguish from a severe bacterial infection. Fever, irritability, and decreased responsiveness or excessive sleepiness are the major symptoms. Inflammation of heart muscle (**myocarditis**), low blood pressure, hepatitis, and **meningitis** sometimes complicate the illness.
- Aseptic meningitis **encephalitis** is a well known syndrome caused by this group of viruses. In fact, enteroviruses are responsible for over 90% of cases of aseptic meningitis, and most often hits children and young adults. Headache, fever, avoidance of light, and eye **pain** are characteristic. Drowsiness may be prominent, and other symptoms include **sore throat**, **cough**, muscle pain, and rash. Occasionally, not only the meninges—the covering around the brain and spinal cord— is infected, but also brain tissue itself, producing encephalitis. The illness resolves after about a week or so, and permanent damage is unusual. Enteroviruses can also produce the Guillian-Barré syndrome, which involves weakness and **paralysis** of the extremities and even the muscles of respiration.
- Pleurodynia (Bornholm's disease) is due to viral infection and inflammation of the chest and abdominal muscles used for breathing. Pain occurs as acute episodes, lasting 30 minutes or so. Coxsackie B virus is the usual cause of the illness.
- Myocarditis and/or **pericarditis** involves infection of the heart muscle (myocardium) and the covering around the heart (pericardium). Infants and young adults are the most susceptible, and for some reason, over two-thirds of cases occur in males. The disease usually begins as an upper respiratory tract infection with cough, **shortness of breath,** and fever. Chest pain, increasing shortness of breath, irregularities of cardiac rhythm, and **heart failure** sometimes develop. Some patients wind up with long term heart failure if the heart muscle is significantly affected.
- Exanthems is the medical term for **rashes**, and enterovirus is the number one cause of summer and fall rashes in children. They occur anywhere on the body, and often resemble diseases such as **measles**.
- Hand-foot-and-mouth disease occurs initially as a sore throat (often involving the tongue as well), and is followed by a rash on the hands, and sometimes the feet. The rash often forms small blisters, which lead to ulcers. Symptoms generally resolve within a week. A specific Coxsackievirus (A16) is the most frequent cause of this highly infectious disease.
- Herpangina is most often caused by one of the Coxsackie A viruses, and appears as the acute onset of fever and sore throat. This last symptom is particularly severe, as the virus produces multiple ulcers in the throat. Swallowing becomes very painful; symptoms can persist for several weeks.
- Acute hemorrhagic **conjunctivitis** involves viral infection of the conjunctiva, which is a covering around the eye. Pain, blurred vision, aversion to light, and a discharge from the eye are the main symptoms. Headache

and fever occur in about one in five patients. The disease runs its course in about 10 days.

A number of other illnesses have been attributed to enteroviruses, including **pneumonia** and other respiratory infections, myositis or muscle inflammation, arthritis, and acute inflammation of the kidneys. It is clear then that these viruses produce a number of various illnesses, most often in younger age groups.

Diagnosis

In the majority of cases, diagnosis is based on the characteristic symptoms that the virus produces (such as the chest pain in pleurodynia). Rarely is it necessary to identify a specific strain of virus causing the illness. It is more important to be certain that the infection is due to a virus which does not require treatment with **antibiotics**.

Culture, or growing the organism outside of the body, is helpful only when obtained from areas that tend to indicate recent infection, such as from swollen joints, cerebrospinal fluid, or blood. Cultures from other areas, such as the throat, can be misleading. This is because the virus may remain for long periods of time in places with a large amount of lymphatic tissue. As a rule, cultures done early in the illness are more likely to identify the virus.

New techniques that involve identification of viral genetic material (PCR) are useful in certain cases, but are not indicated for routine testing.

Treatment

As noted above, enterovirus is capable of attacking many different organs and producing a variety of symptoms. Most infections are mild and improve without complications, and require no specific therapy. When the virus attacks critical organs however, such as the heart, respiratory muscles, nervous system, etc., then specialized care is often needed.

As of 2001, no effective antiviral medication for enterovirus has undergone investigation in patients, though some drugs appear promising for the future. In some patients who are unable to produce antibodies (hypogammaglobunemia), administrating antibodies themselves is helpful.

Prognosis

The overall outlook for enterovirus infection depends on the organs involved, and the immune condition of the individual patient. Unless vital organs are involved or immunity is abnormal, infection causes few problems. On the other hand, patients who have diseases that affect antibody production can develop chronic infection of the brain or meninges.

KEY TERMS

Antibodies—Proteins that are formed by the body and play a role in defense against infection.

Antibiotic—A medication that is designed to kill or weaken bacteria.

Meninges—Outer covering of the spinal cord and brain. Infection is called meningitis, which can lead to damage to the brain or spinal cord and lead to death.

Prevention

In the hospital setting, the best means of avoiding transmission of infection is the use of good hand-washing practices and other appropriate precautions (gowns and gloves for hospital staff). The virus is found in feces for up to one week after infection; therefore precautions that isolate waste material (enteric precautions) will help decrease the chance of spreading the illness.

Resources

BOOKS

Cohen, Jeffrey I. "Enteroviruses and Reoviruses." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

McKenna, W. J., and M. J. Davies. "Immunosuppression for Myocarditis." *New England Journal of Medicine* 333, no. 5 (1995): 312.

Venditti Jr, F. J., and J. T. Fallon. "MGH Case Records (Case 47-1993): A 28-year-old Man with Recurrent Ventricular Tachycardia and Fysfunction of Multiple Organs- Case Records of the Massachusetts General Hospital." *New England Journal of Medicine* 329, no.22 (1993): 1639.

OTHER

"Hand, Foot and Mouth Disease." *The Picarnovirus Home Page*. <http://www.iah.bbsrc.ac.uk/virus/Picornaviridae/picornavirus.htm>.

"Weekly Clinicopathological Exercises: Case 47- 1993: A 28-Year-Old Man with Recurrent Ventricular Tachycardia and Dysfunction of Multiple Organs." *New England Journal of Medicine Online*. <http://content.nejm.org>.

David Kaminstein, MD

Entropy *see* **Eyelid disorders**

Enuresis *see* **Bed-wetting**

Environmental medicine *see* **Wilderness medicine**

Enzyme therapy

Definition

Enyzme therapy is a plan of dietary supplements of plant and animal enzymes used to facilitate the digestive process and improve the body's ability to maintain balanced metabolism.

Purpose

In traditional medicine, enzyme supplements are often prescribed for patients suffering from disorders that affect the digestive process, such as **cystic fibrosis**, Gaucher's disease, and **celiac disease**. A program of enzyme supplementation is rarely recommended for healthy patients. However, proponents of enzyme therapy believe that such a program is beneficial for everyone. They point to enzymes' ability to purify the blood, strengthen the immune system, enhance mental capacity, cleanse the colon, and maintain proper pH balance in urine. They feel that by improving the digestive process, the body is better able to combat infection and disease.

Some evidence exists that pancreatic enzymes derived from animal sources are helpful in **cancer** treatment. The enzymes may be able to dissolve the coating on cancer cells and may make it easier for the immune system to attack the cancer.

A partial list of the wide variety of complaints and illnesses that can be treated by enzyme therapy includes:

- AIDS
- anemia
- alcohol consumption
- anxiety
- acute inflammation
- back pain
- cancer
- colds
- chronic **fatigue** syndrome
- colitis
- constipation
- **diarrhea**
- food **allergies**
- gastritis
- gastric duodenal ulcer
- gout
- headaches
- hepatitis
- hypoglycemia
- infections
- mucous congestion
- multiple sclerosis
- nervous disorders
- nutritional disorders
- obesity
- premenstrual syndrome (PMS)
- stress

Description

Origins

Enzymes are protein molecules used by the body to perform all of its chemical actions and reactions. The body manufactures several thousands of enzymes. Among them are the digestive enzymes produced by the stomach, pancreas, small intestine, and the salivary glands of the mouth. Their energy-producing properties are responsible for not only the digestion of nutrients, but their absorption, transportation, metabolization, and elimination as well.

Enzyme therapy is based on the work of Dr. Edward Howell in the 1920s and 1930s. Howell proposed that enzymes from foods work in the stomach to pre-digest food. He advocated the consumption of large amounts of plant enzymes, theorizing that if the body had to use less of its own enzymes for digestion, it could store them for maintaining metabolic harmony. Four categories of plant enzymes are helpful in pre-digestion: protease, amylase, lipase, and cellulase. Cellulase is particularly helpful because the body is unable to produce it.

Animal enzymes, such as pepsin extracted from the stomach of pigs, work more effectively in the duodenum. They are typically used for the treatment of nondigestive ailments.

The seven categories of food enzymes and their activities

- amylase breaks down starches
- cellulase breaks down fibers
- lactase breaks down dairy products
- lipase breaks down fats
- maltase breaks down grains
- protease breaks down proteins
- sucrase breaks down sugars

Enzyme theory generated further interest as the human diet became more dependent on processed and cooked foods. Enzymes are extremely sensitive to heat, and temperatures above 118°F (48°C) destroy them. Modern processes of pasteurization, canning, and microwaving are particularly harmful to the enzymes in food.

Enzyme supplements are extracted from plants like pineapple and papaya and from the organs of cows and pigs. The supplements are typically given in tablet or capsule form. Pancreatic enzymes may also be given by injection. The dosage varies with the condition being treated. For nondigestive ailments, the supplements are taken in the hour before meals so that they can be quickly absorbed into the blood. For digestive ailments, the supplements are taken immediately before meals accompanied by a large glass of fluids. Pancreatic enzymes may be accompanied by doses of vitamin A.

7Preparations

No special preparations are necessary before beginning enzyme therapy. However, it is always advisable to talk to a doctor or pharmacist before purchasing enzymes and beginning therapy.

Precautions

People with allergies to beef, pork, pineapples, and papaya may suffer allergic reactions to enzyme supplements. Tablets are often coated to prevent them from breaking down in the stomach, and usually shouldn't be chewed or crushed. People who have difficulty swallowing pills can request enzyme supplements in capsule form. The capsules can then be opened and the contents sprinkled onto soft foods like applesauce.

Side effects

Side effects associated with enzyme therapy include **heartburn**, **nausea and vomiting**, diarrhea, bloating, gas, and **acne**. According to the principles of therapy, these are temporary cleansing symptoms. Drinking eight to ten glasses of water daily and getting regular **exercise** can reduce the discomfort of these side effects. Individuals may also experience an increase in bowel movements, perhaps one or two per day. This is also considered a positive effect.

Plant enzymes are safe for pregnant women, although they should always check with a doctor before using enzymes. Pregnant women should avoid animal enzymes. In rare cases, extremely high doses of enzymes can result in a build up of uric acid in the blood or urine and can cause a break down of proteins.

Research and general acceptance

In the United States, the Food and Drug Administration (FDA) has classified enzymes as a food. Therefore, they can be purchased without a prescription. However, insurance coverage is usually dependent upon the therapy resulting from a doctor's orders.

KEY TERMS

Celiac disease—A chronic disease characterized by defective digestion and use of fats.

Cystic fibrosis—A genetic disease that causes multiple digestive, excretion, and respiratory complications. Among the effects, the pancreas fails to provide secretions needed for the digestion of food.

Duodenum—The first part of the small intestine.

Gaucher's disease—A rare genetic disease caused by a deficiency of enzymes needed for the processing of fatty acids.

Metabolism—The system of chemical processes necessary for living cells to remain healthy.

Resources

BOOKS

Cassileth, Barrie R. *The Alternative Medicine Handbook*. New York: W.W. Norton, 1998.

OTHER

Enzyme Therapy for Your Health. <http://members.tripod.com/~colloid/enzyme.htm.

Questions and Answers about Food Enzymes and Nutrition. <http://www.enzymes.com/.

Therapies: Enzyme Therapy. <http://library.thinkquest.org/24206/enzyme-therapy.html.

Mary McNulty

Eosinophilic granuloma *see* **Histiocytosis X**

Eosinophilic pneumonia

Definition

Eosinophilic **pneumonia** is a group of diseases in which there is an above normal number of eosinophils in the lungs and blood.

Description

Eosinophilia is an increase in the number of eosinophils. Eosinophilic pneumonia is characterized by a large number of eosinophils in the lungs, usually in the absence of an infectious disease. Eosinophils are one of the white blood cells and are classified as a granulocyte. They are part of the non-specific immune system and participate in inflammatory reactions. Eosinophils contain cationic molecules that are useful for destroying infectious agents, especially heiminthic parasites (worms). There are several types of eosinophilic pneumonia. Loffler's pneumonia is a temporary infiltration of eosinophils into the lungs. The patient will feel tired, have a **cough**, spasms of the bronchial airway, and difficulty breathing. Loffler's pneumonia will clear spontaneously, but slowly over the course of about a month. Another form of eosinophilic pneumonia, pulmonary infiltrates with eosinophilia (PIE), is a more serious and potentially fatal disease. In PIE, the patient experiences **asthma**, pulmonary infiltrates, disorders of the peripheral nervous system, central nervous systems symptoms, and periarteritis nodosa.

Causes and symptoms

Pneumonia with eosinophils occurs as part of a hypersensitivity reaction. A hypersensitivity reaction is an over-reaction of the immune system to a particular stimulus. As part of the hypersensitive reaction, cells of the immune system are produced in increased numbers and migrate into areas targeted by the hypersensitivity reaction. In the case of eosinophilic pneumonia, the lungs are the target. Generally, eosinophilia pneumonia is not a reaction to an infection. There is a correlation between asthma and eosinophilic pneumonia. Eosinophilic pneumonia can also be caused by drugs and, in some people, by polluted air. The symptoms range from mild (coughing, **wheezing**, and **shortness of breath**) to severe and life threatening (severe shortness of breath and difficulty getting enough oxygen). The symptoms may resolve spontaneously or can persist for long periods of time. In a few cases, the disease may rapidly produce life-threatening pneumonia.

KEY TERMS

Infiltrates—Cells or body fluids that have passed into a tissue or body cavity.

Sputum—Material coughed up from the throat or lungs.

Diagnosis

Since eosinophilia is common to a number of conditions, the physician must rule out asthma and infection by helminths when diagnosing eosinophilic pneumonia. A whole **blood count** will reveal an increased number of eosinophils in the blood. An x ray of the lungs may show the presence of infiltrates (the eosinophils and fluid). If sputum is produced in coughing, eosinophils will be seen instead of the more normal profile of granulocytes seen when an infectious agent is present.

Treatment

Eosinophilic pneumonia may not respond to drugs used to treat asthma. Eosinophilic pneumonia is usually treated with steroids, particularly glucocorticosteroids. Steroids are not effective against infectious agents, but the main disease process in eosinophilic pneumonia is an inflammatory reaction, not a response to infection. When eosinophilia is produced as a consequence of asthma or an infection by helminths, treatment of the asthma or helminths will reduce the eosinophilia.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Clinical Immunology: Principles and Practice. Ed. R. R. Rich. St. Louis: Mosby, 1995.

Hurst, J. Willis. *Medicine for the Practicing Physician.* Stamford: Appleton & Lange, 1988.

John T. Lohr, PhD

Ephedrine *see* **Bronchodilators**

Epicondylitis *see* **Tennis elbow**

Epidemic icterus *see* **Hepatitis A**

Epidemic typhus *see* **Typhus**

Epidemic viral gastroenteritis *see* **Rotavirus infections**

Epidermolysis bullosa

Definition

Epidermolysis bullosa (EB) is a group of rare inherited skin diseases that are characterized by the development of blisters following minimal pressure to the skin. Blistering often appears in infancy in response to simply being held or handled. In rarer forms of the disorder, EB can be life-threatening. There is no cure for the disorder. Treatment focuses on preventing and treating **wounds** and infection.

KEY TERMS

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Dermis—The layer of skin beneath the epidermis.

Epidermis—The outermost layer of the skin.

Keratin—A tough, nonwater-soluble protein found in the nails, hair, and the outermost layer of skin. Human hair is made up largely of keratin.

Description

Epidermolysis bullosa has three major forms and at least 16 subtypes. The three major forms are EB simplex, junctional EB, and dystrophic EB. These can range in severity from mild blistering to more disfiguring and life-threatening disease. Physicians diagnose the form of the disease based on where the blister forms in relation to the epidermis (the skin's outermost layer) and the deeper dermis layer.

The prevalence of epidermolysis varies among different populations. A study in Scotland estimated the prevalence to be one in 20,400. Researchers in other parts of the world estimate the prevalence to be one in 100,000. This variance is due to the variability of expression. Many cases of epidermolysis bullosa are often not accurately diagnosed and thus, are not reported.

Causes and symptoms

EB can be inherited as the result of a dominant genetic abnormality (only one parent carries the abnormal gene) or a recessive genetic abnormality (both parents carry the abnormal gene).

EB simplex results from mutations in genes responsible for keratin 5 and 14, which are proteins that give cells of the epidermis its structure. EB simplex is transmitted in an autosomal dominant fashion.

Dystrophic EB is caused by mutations in genes for type VII collagen, the protein contained in the fibers anchoring the epidermis to the deeper layers of the skin. The genetic mutations for junctional EB are found in the genes responsible for producing the protein Laminin-5. Dystrophic EB is an autosomal disorder and will only result if both parents transmit an abnormal gene during conception.

EB simplex, the most common form of EB, is the least serious form of the disease. In most affected individuals, the blisters are mild and do not scar after they heal. Some forms of EB simplex affect just the hands and feet. Other forms of EB simplex can lead to more widespread blistering, as well as hair loss and missing teeth. Recurrent blistering is annoying but not life threatening.

The second, or junctional, form of EB does not lead to scarring. However, skin on the areas prone to blistering, such as elbows and knees, often shrinks. In one variation of junctional EB, called gravis junctional EB of Herlitz, the blistering can be so severe that affected infants may not survive due to massive infection and **dehydration**.

The third form of EB, dystrophic EB, varies greatly in terms of severity, but more typically affects the arms and legs. In one variation, called Hallopeau-Siemens EB, repeated blistering and scarring of the hands and feet causes the fingers and toes to fuse, leaving them dysfunctional and with a mitten-like appearance.

Diagnosis

Physicians and researchers distinguish between the three major subtypes of EB based on which layer of the epidermis separates from the deeper dermis layer of the skin below. Patients suspected of having EB should have a fresh blister biopsied for review. This sample of tissue is examined under an electron microscope or under a conventional microscope using a technique called immunofluorescence, which helps to map the underlying structure.

Knowing that a family member has EB can help establish the diagnosis, but it is possible that parents or siblings will show no sign of the disease, either because it is caused by a new genetic mutation, or because the parents are carriers of the recessive trait and do not display the disease.

Treatment

The most important treatment for EB is daily wound care. Because the skin is very fragile, care must be taken to be certain that dressing changes do not cause further damage. Tape should not be applied directly to skin and

bandages should be soaked off. Infection is a major concern, so a topical antibiotic, such as bacitracin, mupirocin, or sulfadiazine, should be routinely applied. Among persons with recessive dystrophic EB, the anticonvulsant phenytoin is sometimes effective because it decreases production of an enzyme that breaks down collagen.

Prognosis

The prognosis of EB varies depending on the subtype of the disease. Individuals with EB simplex can live long, fulfilling lives. The severity of the junctional and dystrophic forms of EB can vary greatly. Infants affected with some forms of the disease often do not survive infancy; other forms can lead to severe scarring and disfigurement.

Resources

BOOKS

Fine, Jo-David, et al. *Epidermolysis Bullosa: Clinical, Epidemiologic, and Laboratory Advances, and the Findings of the National Epidermolysis Bullosa Registry.* Baltimore: Johns Hopkins Univ Press, 1999.

Fitzpatrick, Thomas B., Richard A. Johnson, Wolff Klaus, and Dick Suurmond. *Color Atlas and Synopsis of Clinical Dermatology.* 4th ed. New York: McGraw-Hill, 2000.

Lin, Andrew N., and D. Martin Carter. *Epidermolysis Bullosa: Basic and Clinical Aspects.* New York: Springer Verlag, 1992.

Mallory, S.B. *Atlas of Pediatric Dermatology.* Pearl River, NY: Parthenon, 2001.

PERIODICALS

Brust, Mary D., and Andrew N. Lin. "Epidermolysis Bullosa: Practical Management and Clinical Update." *Dermatology Nursing* 8 (April 1996): 81–9.

Cotell, S., N. D. Robinson, and L. S. Chan. "Autoimmune Blistering Skin Diseases." *American Journal of Emerging Medicine* 18, no. 3 (2000): 288–99.

Eichenfield, L. F., and P. J. Honig. "Blistering Disorders in Childhood." *Pediatric Clinics of North America* 38, no. 4 (1991): 959–76.

Horn, H. M., G.C. Priestley, R. A. Eady, and M.J. Tidman. "The Prevalence of Epidermolysis bullosa in Scotland." *British Journal of Dermatology* 136, no. 4 (1997): 560–64.

Lin, Andrew N. "Management of Patients with Epidermolysis Bullosa." *Dermatologic Clinics* 14 (April 1996): 381–87.

McKenna, K. E., M. Y. Walsh, and E. A. Bingham. "Epidermolysis bullosa in Northern Ireland." *British Journal of Dermatology* 127, no. 4 (1992): 318–21.

ORGANIZATIONS

American Academy of Dermatology. PO Box 4014, 930 N. Meacham Rd., Schaumburg, IL 60168-4014. (847) 330-0230. Fax: (847) 330-0050. <http://www.aad.org>.

Dystrophic Epidermolysis Bullosa Research Association of America (DebRA). 40 Rector St., Suite 1403, New York, NY 10006. (212) 513-4090. Fax: (212) 513-4099. <staff.debra@exario.net>. <http://www.debra.org>.

Dystrophic Epidermolysis Bullosa Research Association of United Kingdom, (DebRA). 13 Wellington Bus. Park, Dukes Ride, Crowthorne, Berkshire, RG45 6LS. UK 011-01344 771961. <admin@debra.org.uk.> <http://www.debra.org.uk>.

National Epidermolysis Bullosa Registry. University of North Carolina at Chapel Hill, Bolin Heights Bldg. #1, CB# 3369, Chapel Hill, NC 27514-3369. (919) 966-2007. Fax: (919) 966-7080. <eb_registry@med.unc.edu.> <http://www.med.unc.edu/derm/nebr_site>.

OTHER

Dermatology Online Atlas. <http://www.dermis.net/doia/diagnose.asp?zugr=d&lang=e&diagnr=757320&topic=t>.

Dystrophic Epidermolysis Bullosa Research Association International. <http://debra-international.org/index1.htm>.

Epidermolysis Bullosa Medical Research Foundation. <http://www.med.stanford.edu/school/dermatology/ebmrf/>.

Oregon Health Sciences University. <http://www.ohsu.edu/cliniweb/C17/C17.800.865.410.html>.

University of Iowa College of Medicine. <http://tray.dermatology.uiowa.edu/EBA-001.htm>.

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Epididymitis

Definition

Epididymitis is inflammation or infection of the epididymis. In this long coiled tube attached to the upper part of each testicle, sperm mature and are stored before ejaculation.

Description

Epididymitis is the most common cause of **pain** in the scrotum. The acute form is usually associated with the most severe pain and swelling. If symptoms last for more than six weeks after treatment begins, the condition is considered chronic.

Epididymitis can occur any time after the onset of **puberty** but is most common between the ages of 18 and 40. It is especially common among members of the military who **exercise** for extended periods without emptying their bladders.

Factors that increase the risk of developing epididymitis include:

- infection of the bladder, kidney, prostate, or urinary tract
- other recent illness

- narrowing of the urethra (the tube that drains urine from the bladder)
- use of a urethral catheter.

Causes and symptoms

Although epididymitis can be caused by the same organisms that cause some **sexually transmitted diseases** (STDs) or occur after prostate surgery, the condition is generally due to pus-generating bacteria associated with infections in other parts of the body.

Epididymitis can also be caused by injury or infection of the scrotum or by irritation from urine that has accumulated in the vas deferens (the duct through which sperm travels after leaving the epididymis).

Epididymitis is characterized by sudden redness and swelling of the scrotum. The affected testicle is hard and sore, and the other testicle may feel tender. The patient has chills and **fever** and usually has acute **urethritis** (inflammation of the urethra).

Enlarged lymph nodes in the groin cause scrotal pain that intensifies throughout the day and may become so severe that walking normally becomes impossible.

Diagnosis

Laboratory tests used to diagnose epididymitis include:

- urinalysis and urine culture
- examination of discharges from the urethra and prostate gland
- blood tests to measure white-cell counts

Treatment

Because epididymitis that affects both testicles can make a man sterile, antibiotic therapy must be initiated as soon as symptoms appear. To prevent reinfection, medication must be taken exactly as prescribed, even if the patient's symptoms disappear or he begins to feel better. Over-the-counter anti-inflammatories can relieve pain but should not be used without the approval of a family physician or urologist.

Bed rest is recommended until symptoms subside, and patients are advised to wear athletic supporters when they resume normal activities. If pain is severe, a local anesthetic like lidocaine (Xylocaine) may be injected directly into the spermatic cord.

Self-care

A patient who has epididymitis should not drink beverages that contain **caffeine**. To prevent **constipation**, he should use stool softeners or eat plenty of fruit, nuts, whole grain cereals, and other foods with laxative properties.

An ice bag wrapped in a towel can reduce pain and swelling but should be removed from the inflamed area for a few minutes every hour to prevent **burns**.

Strenuous activity should be avoided until symptoms disappear. Sexual activity should not be resumed until a month after symptoms disappear.

If a second course of treatment doesn't eradicate stubborn symptoms, longterm anti-inflammatory therapy may be recommended. In rare instances, chronic symptoms require surgery.

Surgery

Each of the surgical procedures used to treat epididymitis is performed under local anesthesia on an outpatient basis. Both of them cause sterility.

Epididymectomy involves removing the inflamed section of the epididymitis through a small incision in the scrotum.

Bilateral **vasectomy** prevents fluid and sperm from passing through the epididymis. This procedure is usually performed on men who have chronic epididymitis or on elderly patients undergoing prostate surgery.

Prognosis

Pain generally subsides 24–72 hours after treatment begins. Complete healing may take weeks or months.

Prevention

Using condoms and not having sex with anyone who has an STD can prevent some cases of epididymitis.

Resources

BOOKS

Shaw, Michael, ed. *Everything You Need to Know About Diseases.* Springhouse, PA: Springhouse Corporation, 1996.

OTHER

"Epididymitis." *Digital Urology Journal*. 7 June 1998 <http://www.duj.com/epididymitis.html>.

"Epididymitis." *ThriveOnline*. 6 June 1998 <http://thriveonline.oxygen.com>.

Epidural abscess *see* **Central nervous system infections**

Epidural anesthetic *see* **Anesthesia, local**

Epiglottitis

Definition

Epiglottitis is an infection of the epiglottis, which can lead to severe airway obstruction.

Description

When air is inhaled (inspired), it passes through the nose and the nasopharynx or through the mouth and the oropharynx. These are both connected to the larynx, a tube made of cartilage. The air continues down the larynx to the trachea. The trachea then splits into two branches, the left and right bronchi (bronchial tubes). These bronchi branch into smaller air tubes that run within the lungs, leading to the small air sacs of the lungs (alveoli).

Either food, liquid, or air may be taken in through the mouth. While air goes into the larynx and the respiratory system, food and liquid are directed into the tube leading to the stomach, the esophagus. Because food or liquid in the bronchial tubes or lungs could cause a blockage or lead to an infection, the airway is protected. The epiglottis is a leaf-like piece of cartilage extending upwards from the larynx. The epiglottis can close down over the larynx when someone is eating or drinking, preventing these food and liquids from entering the airway.

Epiglottitis is an infection and inflammation of the epiglottis. Because the epiglottis may swell considerably, there is a danger that the airway will be blocked off by the very structure designed to protect it. Air is then unable to reach the lungs. Without intervention, epiglottitis has the potential to be fatal.

Epiglottitis is primarily a disease of two to seven-year-old children, although older children and adults can also contract it. Boys are twice as likely as girls to develop this infection. Because epiglottitis involves swelling and infection of tissues, which are all located at or above the level of the epiglottis, it is sometimes referred to as supraglottitis (*supra,* meaning above). About 25% of all children with this infection also have **pneumonia**.

Causes and symptoms

The most common cause of epiglottitis is infection with the bacteria called *Haemophilus influenzae type b.* Other types of bacteria are also occasionally responsible for this infection, including some types of *Streptococcus* bacteria and the bacteria responsible for causing **diphtheria**.

A patient with epiglottitis typically experiences a sudden **fever**, and begins having severe throat and neck **pain**. Because the swollen epiglottis interferes significantly with air movement, every breath creates a loud, harsh, high-pitched sound referred to as **stridor**. Because the vocal cords are located in the larynx just below the area of the epiglottis, the swollen epiglottis makes the patient's voice sound muffled and strained. Swallowing becomes difficult, and the patient may drool. The patient often leans forward and juts out his or her jaw, while struggling for breath.

Epiglottitis strikes suddenly and progresses quickly. A child may begin complaining of a **sore throat**, and within a few hours be suffering from extremely severe airway obstruction.

Diagnosis

Diagnosis begins with a high level of suspicion that a quickly progressing illness with fever, sore throat, and airway obstruction is very likely to be epiglottitis. If epiglottitis is suspected, no efforts should be made to look at the throat, or to swab the throat in order to obtain a culture for identification of the causative organism. These maneuvers may cause the larynx to go into spasm (laryngospasm), completely closing the airway. These procedures should only be performed in a fully-equipped operating room, so that if laryngospasm occurs, a breathing tube can be immediately placed in order to keep the airway open.

An instrument called a laryngoscope is often used in the operating room to view the epiglottis, which will appear cherry-red and quite swollen. An x-ray picture taken from the side of the neck should also be obtained. The swollen epiglottis has a characteristic appearance, called the "thumb sign."

Treatment

Treatment almost always involves the immediate establishment of an artificial airway: inserting a breathing tube into the throat (intubation); or making a tiny opening toward the base of the neck and putting a breathing tube into the trachea (tracheostomy). Because the patient's apparent level of distress may not match the actual severity of the situation, and because the disease's progression can be quite surprisingly rapid, it is preferable to go ahead and place the artificial airway, rather than adopting a wait-and-see approach.

Because epiglottitis is caused by a bacteria, **antibiotics** such as cefotaxime, ceftriaxone, or ampicillin with sulbactam should be given through a needle placed in a vein (intravenously). This prevents the bacteria that are circulating throughout the bloodstream from causing infection elsewhere in the body.

KEY TERMS

Epiglottis—A leaf-like piece of cartilage extending upwards from the larynx, which can close like a lid over the trachea to prevent the airway from receiving any food or liquid being swallowed.

Extubation—Removal of a breathing tube.

Intubation—Putting a breathing tube into the airway.

Laryngospasm—Spasm of the larynx.

Larynx—The part of the airway lying between the pharynx and the trachea.

Nasopharynx—The part of the airway into which the nose leads.

Oropharynx—The part of the airway into which the mouth leads.

Supraglottitis—Another term for epiglottitis.

Trachea—The part of the airway that leads into the bronchial tubes.

Tracheostomy—A procedure in which a small opening is made in the neck and into the trachea. A breathing tube is then placed through this opening.

Prognosis

With treatment (including the establishment of an artificial airway), only about 1% of children with epiglottitis die. Without the artificial airway, this figure jumps to 6%. Most patients recover form the infection, and can have the breathing tube removed (extubation) within a few days.

Prevention

Prevention involves the use of a vaccine against *H. influenzae type b* (called the Hib vaccine). It is given to babies at two, four, six, and 15 months. Use of this vaccine has made epiglottitis a very rare occurrence.

Resources

BOOKS

Durand, Marlenel. "Laryngitis, Croup, and Epiglottitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Orenstein, David. "Acute Inflammatory Upper Airway Obstruction." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George, and Kenneth J. Ryan. "Middle and Lower Respiratory Tract Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

ORGANIZATIONS

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Epilepsy *see* **Seizure disorder**

Epinephrine *see* **Bronchodilators**

Episiotomy

Definition

An episiotomy is a surgical incision made in the area between the vagina and anus (perineum). This is done during the last stages of labor and delivery to expand the opening of the vagina to prevent tearing during the delivery of the baby.

Purpose

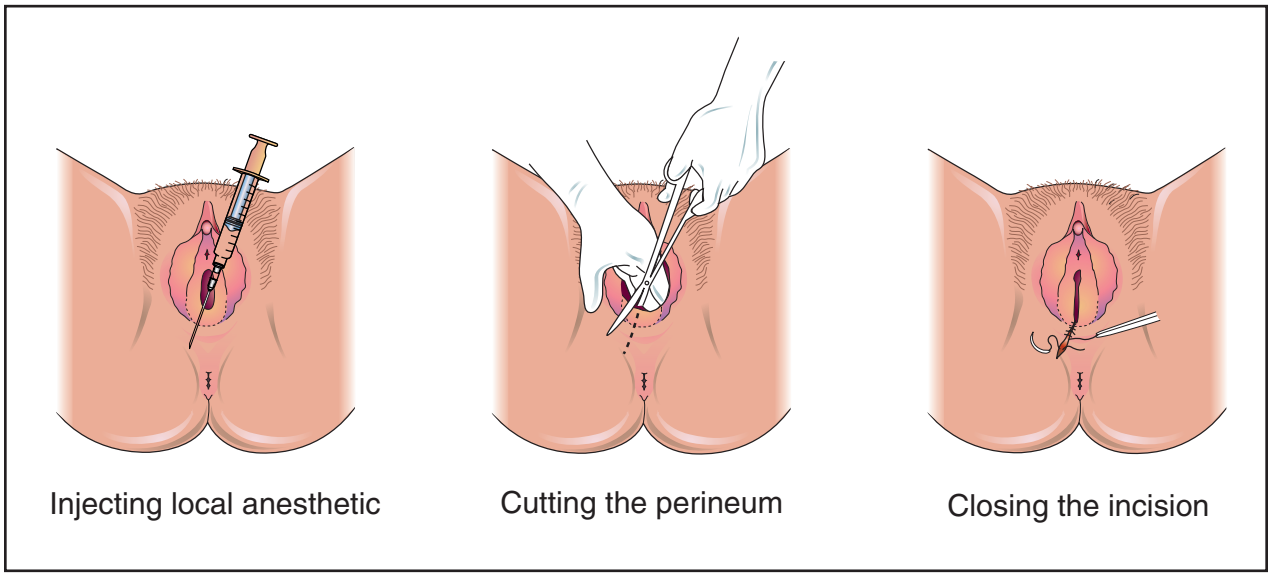
This procedure is usually done during the delivery or birthing process when the vaginal opening does not stretch enough to allow the baby to be delivered without tearing the surrounding tissue.

Precautions

Prior to the onset of labor, pregnant women may want to discuss the use of episiotomy with their care providers. It is possible that, with adequate preparation and if the stages of labor and delivery are managed with adequate coaching and support, the need for an episiotomy may be reduced.

Description

An episiotomy is a surgical incision, usually made with sterile scissors, in the perineum as the baby's head is being delivered. This procedure may be used if the tissue around the vaginal opening begins tearing or does not seem to be stretching enough to allow the baby to be delivered.



An episiotomy is a surgical incision made in the perineum, the area of tissue between the vaginal opening and the anus, during the birthing process. This procedure may be used if the tissue around the vaginal opening begins to tear or is not stretching enough to allow the baby to be delivered vaginally. In the United States, the rate of episiotomies being performed is estimated at 65–95%. *(Illustration by Electronic Illustrators Group.)*

In most cases, the physician makes a midline incision along a straight line from the lowest edge of the vaginal opening to toward the anus. In other cases, the episiotomy is performed by making a diagonal incision across the midline between the vagina and anus. This method is used much less often, may be more painful, and may require more healing time than the midline incision. After the baby is delivered through the extended vaginal opening, the incision is closed with stitches. A local anesthetic agent may be applied or injected to numb the area before it is sewn up (sutured).

Several reasons are cited for performing episiotomies. Some experts believe that an episiotomy speeds up the birthing process, making it easier for the baby to be delivered. This can be important if there is any sign of distress that may harm the mother or baby. Because tissues in this area may tear during the delivery, another reason for performing an episiotomy is that a clean incision is easier to repair than a jagged tear and may heal faster. Although the use of episiotomy is sometimes described as protecting the pelvic muscles and possibly preventing future problems with **urinary incontinence**, it is not clear that the procedure actually helps.

The use of episiotomy during the birthing process is fairly widespread in the United States. Estimates of episiotomy use in hospitals range from 65–95% of deliveries, depending on how many times the mother has given birth previously. This routine use of episiotomy is being reexamined in many hospitals and health care settings. However, an episiotomy is always necessary during a forceps delivery because of the size of the forceps.

Preparation

It may be possible to avoid the need for an episiotomy. Pregnant women may want to talk with their care providers about the use of episiotomy during the delivery. Kegel exercises are often recommended during the **pregnancy** to help strengthen the pelvic floor muscles. Prenatal perineal massage may help to stretch and relax the tissue around the vaginal opening. During the delivery process, warm compresses can be applied to the area along with the use of perineal massage. Coaching and support are also important during the delivery process. A slowed, controlled pushing during the second stage of labor (when the mother gets the urge to push) may allow the tissues to stretch rather than tear. Also, an upright birthing position (rather than one where the mother is lying down) may decrease the need for an episiotomy.

Aftercare

The area of the episiotomy may be uncomfortable or even painful for several days. Several practices can relieve some of the **pain**. Cold packs can be applied to the perineal area to reduce swelling and discomfort. Use of the **Sitz bath** available at the hospital or birth center can ease the discomfort, too. This unit circulates warm water over the area. A squirt bottle with water can be used to clean the area after urination or defecation rather

KEY TERMS

Kegel exercises—A series of contractions and relaxations of the muscles in the perineal area. These exercises are thought to strengthen the pelvic floor and may help prevent urinary incontinence in women.

Perineum—The area between the opening of the vagina and the anus in a woman, or the area between the scrotum and the anus in a man.

Sitz bath—A shallow tub or bowl, sometimes mounted above a toilet, that allows the perineum and buttocks to be immersed in circulating water.

Urinary incontinence—The inability to prevent the leakage or discharge of urine. This situation becomes more common as people age, and is more common in women who have given birth to more than one child.

than wiping with tissue. Also, the area should be patted dry rather than wiped. Cleansing pads soaked in witch hazel (such as Tucks) are very effective for cleaning the area and also feel soothing.

Risks

Several side effects of episiotomy have been reported, including infection, increased pain, prolonged healing time, and increased discomfort once sexual intercourse is resumed. There is also the risk that the episiotomy incision will be deeper or longer than is necessary to permit the birth of the infant. There is a risk of increased bleeding.

Normal results

In a normal and well managed delivery, an episiotomy may be avoided altogether. If an episiotomy is deemed to be necessary, a simple midline incision will be made to extend the vaginal opening without additional tearing or extensive trauma to the perineal area. Although there may be some pain associated with the healing of the episiotomy incision, relief can usually be provided with mild pain relievers and supportive measures, such as the application of cold packs.

Abnormal results

An episiotomy incision that is too long or deep may extend into the rectum, causing more bleeding and an increased risk of infection. Additional tearing or tissue damage may occur beyond the episiotomy incision, leaving a cut and a tear to be repaired.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

PERIODICALS

Klein, M. C., et al. "Relationship of Episiotomy to Perineal Trauma and Morbidity, Sexual Dysfunction, and Pelvic Floor Relaxation." *American Journal of Obstetrics and Gynecology* 171 (1994): 591-598.

Lydon-Rochelle, M. T., L. Albers, and D. Teaf. "Perineal Outcomes and Nurse-Midwifery Management." *Journal of Nurse Midwifery* 40, no. 1 (Jan./Feb. 1995): 13-18.

OTHER

Childbirth.org. <http://www.childbirth.org>.

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Epispadias *see* **Hypospadias and epispadias**

Epistaxis *see* **Nosebleed**

EPS *see* **Electrophysiology study of the heart**

Epstein-Barr virus test

Definition

The Epstein-Barr virus test is a blood test, or group of tests, to determine the presence or absence of antibodies in the blood stream directed against proteins of the Epstein-Barr virus, the cause of **infectious mononucleosis**.

Purpose

The test is primarily used to detect whether first time infection (called primary infection) with the Epstein-Barr virus is currently occurring, or has occurred within a short period of time. The pattern of the antibodies detected can, however, tell if the person has never been infected with the Epstein-Barr virus, or if the infection occurred in the more distant past. These tests are mostly utilized in the diagnosis of Epstein-Barr virus-associated infectious mononucleosis when the more common diagnostic test, the heterophile antibody, is negative, or in situations where the infection is manifesting unusual symptoms. Therefore, the tests are often not needed in a situa-

tion where a doctor believes that a person has mononucleosis and the heterophile test (also called the monospot test) is positive.

In addition, Epstein-Barr virus testing is usually not needed in the evaluation of a patient who has long-lasting **fatigue**, and may have the **chronic fatigue syndrome**. Initially, it was thought that discovering a particular pattern of antibodies to this virus was helpful in the diagnosis of chronic fatigue syndrome, but this no longer appears to be the case.

Precautions

As in any blood test, standard precautions should be performed to prevent infection at the site where the blood is obtained, and to prevent excess bleeding. Normally, the site is cleaned with an antiseptic liquid prior to the blood being obtained; a sterile non-reusable needle and syringe are used; and, once the needle is removed, pressure is placed at the site until bleeding has stopped.

Description

These tests are more often performed in a consulting laboratory than at a physician's office or in a hospital laboratory. Like most antibody tests, they are performed on serum, the liquid part of the blood obtained after the whole blood is allowed to clot in a tube. Antibodies can be detected against several components of the Epstein-Barr virus (EBV). These components are the EBV early antigen (EA), the viral capsid antigen (VCA), and the nuclear antigen (EBNA). These several antigens are different proteins that are produced in the process (stages) of the virus' growth.

At the time of infection with Epstein-Barr virus, antibodies to EA are found and usually last for four to six months only. This antibody, however, persists substantially longer in about 10% of persons who have had EBV infection in the more remote past. The absence of antibody to EA when other EBV antibodies are present strongly suggests that first time infection with EBV occurred in the past.

Antibody to VCA is found both early and late in EBV infection. At the time of infection, antibody of both the IgM and IgG types are detectable. After four to six months, usually, only the IgG antibody against VCA can be found.

Unlike antibodies to EA and VCA, antibody to EBNA does not usually develop until recovery from first time infection of this virus. Therefore, finding detectable amounts of antibody to EBNA during an illness which might be caused by EBV makes the causal relationship very unlikely.

Preparation

The skin area from which the blood sample will be obtained is wiped with an antiseptic such as alcohol or iodine.

Aftercare

The aftercare is similar to that for any blood test. Usually, pressure is applied to the area for several moments until bleeding stops. If the results are difficult to interpret, it may be necessary to re-test later, after waiting one to three weeks. The change in the amounts of antibody detected between the two tests can be particularly useful, at times, in helping to make a diagnosis.

Risks

There are no risks over and above those of having blood drawn for any other purpose. These tests are more expensive than many other blood tests but are usually covered by medical insurance.

Normal results

The pattern of the three antibodies can be used to determine whether the person has not had infection with EBV to this point (is susceptible to infection); is currently, or recently, infected with EBV for the first time; or has had first time infection with EBV sometime in the past (more than six months ago).

If one defines "normal" results as either not having EBV in the past, and call that category one; or having had it in the past, and call that category two. Most young children below the age of five will fall into category one, while most adults over the age of 20 years will fall into category two.

The results for susceptibility are:

- antibody to EA = negative
- antibody to VCA (either IgM or IgG) = negative
- antibody to EBNA = Negative

The results for past infection are:

- antibody to EA = negative (90% of time)
- antibody to VCA IgM = negative
- antibody to VCA IgG = positive
- antibody to EBNA = positive

It is important to realize that the Epstein-Barr virus, like all the human herpes viruses, does not totally leave the body after the patient recovers from illness. With EBV, the virus will intermittently recur in the saliva of people without any symptoms. Such people will have a

test pattern of previous infection. It is this group of people who can transmit EBV to others without themselves being ill.

Abnormal results

The results for current or recent infection are:

- antibody to EA = positive
- antibody to VCA IgM = positive
- antibody to VCA IgG = positive
- antibody to EBNA = negative

Without the pattern of the three antibodies, it can be difficult to be accurate in interpretation. The presence of antibody to VCA IgM is the best single test for current or recent first time infection.

Resources

BOOKS

Bailey, R. Eugene. "Infectious Mononucleosis." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Fleischer, Gary R. "Epstein-Barr Virus." In *Textbook of Human Virology.* 2nd ed. Ed. Robert B. Belshe. St. Louis: Mosby Year Book, 1990.

PERIODICALS

Henle, G., W. Henle, and C. A. Horowitz. "Epstein-Barr Virus Specific Diagnosis: Tests in Infectious Mononucleosis." *Human Pathology* 5 (1997): 551-558.

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ERCP *see* **Endoscopic retrograde cholangiopancreatography**

Erectile disorder *see* **Impotence**

Ergotamine *see* **Antimigraine drugs**

Erosive gastritis *see* **Gastritis**

Erysipelas

Definition

Erysipelas is a skin infection that often follows **strep throat**.

Description

Erysipelas, also called St. Anthony's fire, is caused by infection by Group A *Streptococci*. This same type of bacteria is responsible for such infections as strep throat, and infections of both surgical and other kinds of **wounds** in the skin. The infection occurs most often in young infants and the elderly.

KEY TERMS

Bacteremia—The presence of bacteria in the blood.

Streptococcus—A bacteria that causes erysipelas and strep throat, as well as other infections.

Causes and symptoms

Erysipelas usually occurs rather abruptly. When the preceding infection was strep throat, the rash begins on the face. Occasionally, when the preceding infection was of a wound from an injury or operation, the rash will appear on an arm or leg.

Classically, the usual presentation is a bright-red, butterfly-shaped rash appearing across the bridge of the nose and the cheeks. It is hot to the touch, painful, shiny, and swollen, with clearly defined margins. The edges of the rash are a raised ridge, hard to the touch. There may be fluid-filled bumps scattered along the area. The rash spreads rapidly. Some patients have swelling of the eyelids, sometimes so severe that their eyes swell shut. The patient may have **fever**, chills, loss of energy, **nausea and vomiting**, and swollen, tender lymph nodes. In severe cases, walled-off areas of pus (abscesses) may develop beneath the skin. If left untreated, the streptococcal bacteria may begin circulating in the bloodstream (a condition called **bacteremia**). A patient may then develop an overwhelming, systemic infection called **sepsis**, with a high risk of **death**.

Diagnosis

The rash of erysipelas is very characteristic, raising the practitioner's suspicion towards that diagnosis, especially when coupled with a history of recent strep infection. Attempts to culture (grow) the bacteria from a sample of the rash usually fail. When the bacteria are present in the blood, they may be grown in a laboratory, and identified under a microscope. Other laboratory tests involve reacting fluorescently-tagged antibodies with a sample of the patient's infected tissue. This type of test may be successful in positively identifying the streptococcal bacteria.

Treatment

Penicillin is the drug of choice for treating erysipelas. It can usually be given by mouth, although in severe cases (or in cases of diagnosed bacteremia) it may be given through a needle placed in a vein (intravenously).

Even with antibiotic treatment, swelling may continue to spread. Other symptoms, such as fever, **pain**, and redness, usually decrease rapidly after penicillin is started. Cold packs and pain relievers may help decrease discomfort. Within about five to 10 days, the affected skin may begin drying up and flaking off.

Prognosis

With prompt treatment, the prognosis from erysipelas is excellent. Delay of treatment, however, increases the chance for bacteremia and the potential for death from overwhelming sepsis. This is particularly true of people with weakened immune systems (babies, the elderly, and people ill with other diseases, especially Acquired Immunodeficiency Syndrome, or **AIDS**). Frequently, an individual who has had erysipelas will have it occur again in the same location.

Prevention

Prevention involves appropriate and complete treatment of **streptococcal infections**, including strep throat and wound infections.

Resources

BOOKS

Bolognia, Jean L., and Irwin M. Braverman. "Skin Manifestations of Internal Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Streptococci." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stevens, Dennis L. "Infections of the Skin, Muscle, and Soft Tissues." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

Todd, James. "Bacterial Infections." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Huerter, Christopher, et al. "Helpful Clues to Common Rashes." *Patient Care* 31, 8 (30 Apr. 1997): 9+.

Rosalyn Carson-DeWitt, MD

Erythema infectiosum *see* **Fifth disease**

Erythema multiforme

Definition

Erythema multiforme is a skin disease that causes lesions and redness around the lesions.

Description

Erythema multiforme appears on the skin and the mucous membranes (the lining of the mouth, digestive tract, vagina, and other organs). Large, symmetrical red blotches appear all over the skin in a circular pattern. On mucous membranes, it begins as blisters and progresses to ulcers. A more advanced form, called Stevens-Johnson syndrome, can be severe and even fatal.

Causes and symptoms

Erythema multiforme has many causes, most commonly are drugs. Penicillin, **sulfonamides**, certain epilepsy drugs, **aspirin**, and **acetaminophen** are the most likely medication-induced causes. Erythema multiforme can also be caused by certain diseases. Herpes virus and mycoplasma **pneumonia** are likely infectious causes.

Diagnosis

The appearance of the rash is sufficiently unique to identify it on sight. Having identified it, the physician will determine the underlying cause.

Treatment

Erythema multiforme is inadvertently treated when the causative agent, whether it be a drug or a disease, is treated. In severe cases, cortisone-like medication is often used along with general supportive measures and prevention of infection.

Prognosis

As a rule, the rash abates by itself without damaging the skin. Only in the case of infection, severe blistering, or continued use of an offending drug does complications occur.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Fritsch, Peter O., and Peter M. Elias. "Erythema Multiforme and Toxic Epidermal Necrolysis." In *Dermatology in Gen-*

KEY TERMS

Herpes virus—Viruses that can infect the skin, mucous membranes, and brain, and they are responsible for such diseases as herpes simplex, chicken pox, and shingles.

Mycoplasma pneumonia—An incomplete bacterium that infects the lung.

eral Medicine, ed. Thomas B. Fitzpatrick, et al. New York: McGraw-Hill, 1993.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

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Erythema nodosum

Definition

Erythema nodosum is a skin disorder characterized by painful red nodules appearing mostly on the shins.

Description

Erythema nodosum is an eruption of tender red lumps on both shins and occasionally the arms and face. Bruising often accompanies the nodule formation. Erythema nodosum is most prevalent in young adults.

Causes and symptoms

Erythema nodosum can be caused by many important and treatable diseases. Among them are **tuberculosis**, several fungal lung infections, **leprosy**, inflammatory bowel disease, and some potentially dangerous bacterial infections. Drugs can also induce erythema nodosum. The most common are penicillin, **sulfonamides**, and birth control pills.

Diagnosis

There are a few other skin eruptions that mimic erythema nodosum, so the physician may have to perform a biopsy to sort them out. There are a few types of *panniculitis,* fat inflammation, that may signal a **cancer** somewhere in the body, and there are other kinds of inflammation that may confuse the diagnosis.

KEY TERMS

Biopsy—Surgical removal of tissue for diagnostic purposes.

Panniculitis—Inflammation of fatty tissue.

Once the skin problem has been diagnosed, its underlying cause must then be identified. A lengthy evaluation may ensue, and often times the cause remains unknown.

Treatment

Painful nodules can be treated with mild **pain** killers and local application of ice packs. Medical attention will be directed toward the underlying disease.

The nodules will eventually disappear, leaving no trace behind.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Berger, Timothy G., "Skin and Appendages." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Bondi, Edward E., and Gerald S. Lazarus. "Panniculitis." In *Dermatology in General Medicine*, ed. Thomas B. Fitzpatrick, et al. New York: McGraw-Hill, 1993.

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Erythremia *see* **Polycythemia vera**

Erythroblastosis fetalis

Definition

Erythroblastosis fetalis refers to two potentially disabling or fatal blood disorders in infants: Rh incompatibility disease and ABO incompatibility disease. Either disease may be apparent before birth and can cause fetal **death** in some cases. The disorder is caused by incompatibility between a mother's blood and her unborn baby's blood. Because of the incompatibility, the mother's immune system may launch an immune response against the baby's red blood cells. As a result, the baby's blood

cells are destroyed, and the baby may suffer severe anemia (deficiency in red blood cells), brain damage, or death.

Description

Red blood cells carry several types of proteins, called antigens, on their surfaces. The A, B, and O antigens are used to classify a person's blood as type A, B, AB, or O. Each parent passes one A, B, or O antigen gene to their child. How the genes are paired determines the person's blood type.

A person who inherits an A antigen gene from each parent has type A blood; receiving two B antigen genes corresponds with type B blood; and inheriting A and B antigen genes means a person has type AB blood. If the O antigen gene is inherited from both parents, the child has type O blood; however, the pairing of A and O antigen genes corresponds with type A blood; and if the B antigen gene is matched with the O antigen gene, the person has type B blood.

Another red blood cell antigen, called the Rh factor, also plays a role in describing a person's blood type. A person with at least one copy of the gene for the Rh factor has Rh-positive blood; if no copies are inherited, the person's blood type is Rh-negative. In blood typing, the presence of A, B, and O antigens, plus the presence or absence of the Rh-factor, determine a person's specific blood type, such as A-positive, B-negative, and so on.

A person's blood type has no effect on health. However, an individual's immune system considers only that person's specific blood type, or a close match, acceptable. If a radically different blood type is introduced into the bloodstream, the immune system produces antibodies, proteins that specifically attack and destroy any cell carrying the foreign antigen.

Determining a person's blood type is very important if she becomes pregnant. Blood cells from the unborn baby (fetal red blood cells) can cross over into the mother's bloodstream, especially at delivery. If the mother and her baby have compatible blood types, the crossover does not present any danger. However, if the blood types are incompatible, the mother's immune system manufactures antibodies against the baby's blood.

Usually, this incompatibility is not a factor in a first **pregnancy**, because few fetal blood cells reach the mother's bloodstream until delivery. The antibodies that form after delivery cannot affect the first child. In later pregnancies, fetuses and babies may be in grave danger. The danger arises from the possibility that the mother's antibodies will attack the fetal red blood cells. If this happens, the fetus or baby can suffer severe health effects and may die.

There are two types of incompatibility diseases: Rh incompatibility disease and ABO incompatibility disease. Both diseases have similar symptoms, but Rh disease is much more severe, because anti-Rh antibodies cross over the placenta more readily than anti-A or anti-B antibodies. (The immune system does not form antibodies against the O antigen.) Therefore, a greater percentage of the baby's blood cells are destroyed by Rh disease.

Both incompatibility diseases are uncommon in the United States due to medical advances over the last 50 years. For example, prior to 1946 (when newborn blood transfusions were introduced) 20,000 babies were affected by Rh disease yearly. Further advances, such as suppressing the mother's antibody response, have reduced the incidence of Rh disease to approximately 4,000 cases per year.

Rh disease only occurs if a mother is Rh-negative and her baby is Rh-positive. For this situation to occur, the baby must inherit the Rh factor gene from the father. Most people are Rh-positive. Only 15% of the caucasian population is Rh-negative, compared to 5–7% of the african american population and virtually none of Asian populations.

ABO incompatibility disease is almost always limited to babies with A or B antigens whose mothers have type O blood. Approximately one third of these babies show evidence of the mother's antibodies in their bloodstream, but only a small percentage develop symptoms of ABO incompatibility disease.

Cause and symptoms

Rh disease and ABO incompatibility disease are caused when a mother's immune system produces antibodies against the red blood cells of her unborn child. The antibodies cause the baby's red blood cells to be destroyed and the baby develops anemia. The baby's body tries to compensate for the anemia by releasing immature red blood cells, called erythroblasts, from the bone marrow.

The overproduction of erythroblasts can cause the liver and spleen to become enlarged, potentially causing liver damage or a ruptured spleen. The emphasis on erythroblast production is at the cost of producing other types of blood cells, such as platelets and other factors important for blood clotting. Since the blood lacks clotting factors, excessive bleeding can be a complication.

The destroyed red blood cells release the blood's red pigment (hemoglobin) which degrades into a yellow substance called bilirubin. Bilirubin is normally produced as red blood cells die, but the body is only equipped to handle a certain low level of bilirubin in the bloodstream at one time. Erythroblastosis fetalis overwhelms the removal system, and high levels of bilirubin

KEY TERMS

Amniocentesis—A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus to withdraw a small sample of amniotic fluid. The amniotic fluid can be examined for sign of disease or other problems afflicting the fetus.

Amniotic fluid—The fluid that surrounds a fetus in the uterus.

Anemia—A condition in which there is an abnormally low number of red blood cells in the bloodstream. Major symptoms are paleness, shortness of breath, unusually fast or strong heart beats, and tiredness.

Antibody—A protein molecule produced by the immune system in response to a protein that is not recognized as belonging in the body.

Antigen—A protein that can elicit an immune response in the form of antibody formation. With regard to red blood cells, the major antigens are A, B, O, and the Rh factor.

Bilirubin—A yellow-colored end-product of hemoglobin degradation. It is normally present at very low levels in the bloodstream; at high levels, it produces jaundice.

Cordocentesis—A procedure for delivering a blood transfusion to a fetus. It involves a fine needle being threaded through a pregnant woman's abdomen and into the umbilical cord with the aid of ultrasound imaging.

Hemoglobin—A molecule in red blood cells that transports oxygen and gives the cells their characteristic color.

Hydrops fetalis—A condition in which a fetus or newborn baby accumulates fluids, causing swollen arms and legs and impaired breathing.

Hyperbilirubinemia—A condition in which bilirubin accumulates to abnormally high levels in the bloodstream

Placenta—A protective membrane that surrounds and protects the fetus during pregnancy.

Platelet—A blood factor that is important in forming blood clots.

Rh factor—An antigen that is found on the red blood cells of most people. If it is present, the blood type is referred to as Rh-positive; if absent, the blood type is Rh-negative.

accumulate, causing hyperbilirubinemia, a condition in which the baby becomes jaundiced. The **jaundice** is apparent from the yellowish tone of the baby's eyes and skin. If hyperbilirubinemia cannot be controlled, the baby develops kernicterus. The term kernicterus means that bilirubin is being deposited in the brain, possibly causing permanent damage.

Other symptoms that may be present include high levels of insulin and low blood sugar, as well as a condition called hydrops fetalis. Hydrops fetalis is characterized by an accumulation of fluids within the baby's body, giving it a swollen appearance. This fluid accumulation inhibits normal breathing, because the lungs cannot expand fully and may contain fluid. If this condition continues for an extended period, it can interfere with lung growth. Hydrops fetalis and anemia can also contribute to heart problems.

Diagnosis

Erythroblastosis fetalis can be predicted before birth by determining the mother's blood type. If she is Rh-negative, the father's blood is tested to determine whether he is Rh-positive. If the father is Rh-positive, the mother's blood will be checked for antibodies against the Rh factor. A test that demonstrates no antibodies is repeated at week 26 or 27 of the pregnancy. If antibodies are present, treatment is begun.

In cases in which incompatibility is not identified before birth, the baby suffers recognizable characteristic symptoms such as anemia, hyperbilirubinemia, and hydrops fetalis. The blood incompatibility is uncovered through blood tests such as the Coombs test, which measures the level of maternal antibodies attached to the baby's red blood cells. Other blood tests reveal anemia, abnormal blood counts, and high levels of bilirubin.

Treatment

When a mother has antibodies against her unborn infant's blood, the pregnancy is watched very carefully. The antibodies are monitored and if levels increase, **amniocentesis**, fetal umbilical cord blood sampling, and ultrasound are used to assess any effects on the baby. Trouble is indicated by high levels of bilirubin in the amniotic fluid or baby's blood, or if the ultrasound

reveals hydrops fetalis. If the baby is in danger, and the pregnancy is at least 32–34 weeks along, labor is induced. Under 32 weeks, the baby is given blood transfusions while still in the mother's uterus.

There are two techniques that are used to deliver a blood **transfusion** to a baby before birth. In the first, a needle is inserted through the mother's abdomen and uterus, and into the baby's abdomen. Red blood cells injected into the baby's abdominal cavity are absorbed into its bloodstream. In early pregnancy or if the baby's bilirubin levels are gravely high, cordocentesis is performed. This procedure involves sliding a very fine needle through the mother's abdomen and, guided by ultrasound, into a vein in the umbilical cord to inject red blood cells directly into the baby's bloodstream.

After birth, the severity of the baby's symptoms are assessed. One or more transfusions may be necessary to treat anemia, hyperbilirubinemia, and bleeding. Hyperbilirubinemia is also treated with **phototherapy**, a treatment in which the baby is placed under a special light. This light causes changes in how the bilirubin molecule is shaped, which makes it easier to excrete. The baby may also receive oxygen and intravenous fluids containing electrolytes or drugs to treat other symptoms.

Prognosis

In many cases of blood type incompatibility, the symptoms of erythroblastosis fetalis are prevented with careful monitoring and blood type screening. Treatment of minor symptoms is typically successful and the baby will not suffer long-term problems.

Nevertheless, erythroblastosis is a very serious condition for approximately 4,000 babies annually. In about 15% of cases, the baby is severely affected and dies before birth. Babies who survive pregnancy may develop kernicterus, which can lead to deafness, speech problems, **cerebral palsy**, or **mental retardation**. Extended hydrops fetalis can inhibit lung growth and contribute to **heart failure**. These serious complications are life threatening, but with good medical treatment, the fatality rate is very low. According to the U.S. Centers for Disease Control and Prevention, there were 21 infant deaths in the United States during 1996 that were attributable to hemolytic disease (erythroblastosis fetalis) and jaundice.

Prevention

With any pregnancy, whether it results in a live birth, **miscarriage**, **stillbirth**, or abortion, blood typing is a universal precaution against blood compatibility disease. Blood types cannot be changed, but adequate forewarning allows precautions and treatments that limit the danger to unborn babies.

If an Rh-negative woman gives birth to an Rh-positive baby, she is given an injection of immunoglobulin G, a type of antibody protein, within 72 hours of the birth. The immunoglobulin destroys any fetal blood cells in her bloodstream before her immune system can react to them. In cases where this precaution is not taken, antibodies are created and future pregnancies may be complicated.

Resources

BOOKS

Phibbs, Roderic H. "Hemolytic Disease of the Newborn (Erythroblastosis Fetalis)." In *Rudolph's Pediatric*, ed. Abraham M. Rudolph, et al. Stamford: Appleton & Lange, 1996.

PERIODICALS

Bowman, John. "The Management of Hemolytic Disease in the Fetus and Newborn." *Seminars in Perinatology* 21, no. 1 (Feb. 1997): 39.

Peterec, Steven M. "Management of Neonatal Rh Disease." *Clinics in Perinatology* 22, no. 3 (Sept. 1995): 561.

Julia Barrett

Erythrocyte sedimentation rate

Definition

The erythrocyte sedimentation rate (ESR), or sedimentation rate (sed rate), is a measure of the settling of red blood cells in a tube of blood during one hour. The rate is an indication of inflammation and increases in many diseases.

Purpose

ESR is increased in rheumatoid diseases, most infections, and in **cancer**. An advanced rate doesn't diagnose a specific disease, but it does indicate that an underlying disease may be present.

A physician can use ESR to monitor a person with an associated disease. When the disease worsens, the ESR increases; when the disease improves, the ESR decreases. The ESR doesn't always follow the course of cancer.

ESR is called an acute-phase reactant test, meaning that it reacts to acute conditions in the body, such as infection or trauma. The rate increase follows a rise in temperature and white blood cells count, peaks after several days, and usually lasts longer than the elevated temperature or white blood cells count.

Precautions

The ESR should not be used to screen healthy persons for disease.

Description

The ESR test is a simple test dating back to the ancient Greeks. A specific amount of diluted, unclotted blood is placed in a special narrow tube and left undisturbed for exactly one hour. The red cells settle towards the bottom of the tube, and the pale yellow liquid (plasma) rises to the top. After 60 minutes, measurements are taken of the distance the red cells traveled to settle at the bottom of the tube. Two methods, the Westergren and the Wintrobe, are used by laboratories; each method produces slightly different results. Most laboratories use the Westergren method.

Normally red cells don't settle far toward the bottom of the tube. Many diseases make extra or abnormal proteins that cause the red cells to move close together, stack up, and form a column (rouleaux). In a group, red cells are heavier and fall faster. The faster they fall, the further they settle, and the higher the ESR.

The ESR test is covered by insurance when medically necessary. Results are usually available the same or following day.

Preparation

This test requires 7mL–10 mL of blood. A healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site. Pressure applied to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort. The patient may feel dizzy or faint.

Normal results

A normal value does not rule out disease. Normal values for the Westergren method are: Men 0 mm/hour–15 mm/hour; women 0 mm/hour–20 mm/hour; and children 0 mm/hour–10 mm/hour.

Abnormal results

The highest ESR levels are usually seen in a cancer of a certain type of white blood cell (**multiple myeloma**) and rheumatoid disease, such as **rheumatoid arthritis**. Many other diseases also increase the ESR: infection, kidney disease, anemia, diseases involving white blood cells, cancer, and autoimmune and inflammatory diseases.

Any disease that changes the shape and size of red blood cells decreases the ESR. Distorted cells, such as with **sickle cell disease**, do not stack, and consequently do not settle far, even in the presence of an ESR-associated disease. Diseases that cause the body to make less protein or extra red blood cells also decrease the ESR.

KEY TERMS

Acute phase reactant—A substance in the blood that increases as a response to an acute conditions such as infection, injury, tissue destruction, some cancers, burns, surgery, or trauma.

Erythrocyte sedimentation rate (ESR)—The distance that red blood cells settle in a tube of blood in one hour. It is an indication of inflammation.

Rouleaux—The stacking up of red blood cells, caused by extra or abnormal proteins in the blood that decrease the normal distance red cells maintain between each other.

Resources

PERIODICALS

Olshaker, Jonathan S., and David A. Jerrard. "The Erythrocyte Sedimentation Rate." *The Journal of Emergency Medicine* (Nov. 1997): 869-874.

Saadeh, Constantine. "The Erythrocyte Sedimentation Rate: Old and New Clinical Applications." *Southern Medical Journal* (Mar. 1998) : 220-255.

Nancy J. Nordenson

Erythromycins

Definition

Erythromycins are medicines that kill bacteria or prevent their growth.

Purpose

Erythromycins are **antibiotics**, medicines used to treat infections caused by microorganisms. Physicians

prescribe these drugs for many types of infections caused by bacteria, including **strep throat**, sinus infections, **pneumonia**, ear infections, **tonsillitis**, **bronchitis**, **gonorrhea**, **pelvic inflammatory disease** (PID), and urinary tract infections. Some medicines in this group are also used to treat **Legionnaires' disease** and ulcers caused by bacteria. These drugs will *not* work for colds, flu, and other infections caused by viruses.

Description

The drugs described here include erythromycins (Erythrocin, Ery-C, E-Mycin, and other brands) and medicines that are chemically related to erythromycins, such as azithromycin (Zithromax) and clarithromycin (Biaxin). They are available only with a physician's prescription and are sold in capsule, tablet (regular and chewable), liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of erythromycin, the strength of the medicine, and the medical problem for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take erythromycins exactly as directed. Never take larger, smaller, more frequent, or less frequent doses. To make sure the infection clears up completely, it is very important to take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve. This is important with all types of infections, but it is especially important in "strep" infections, which can lead to serious heart problems if they are not cleared up completely.

Erythromycins work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. Some of these medicines are most effective when taken with a full glass of water on an empty stomach, but they may be taken with food if stomach upset is a problem. Others work equally well when taken with or without food. Check package directions or ask the physician or pharmacist for instructions on how to take the medicine.

Precautions

Symptoms should begin to improve within a few days of beginning to take this medicine. If they do not, or if they get worse, check with the physician who prescribed the medicine.

Erythromycins may cause mild **diarrhea**, that usually goes away during treatment. However, severe diarrhea could be a sign of a very serious side effect. Anyone who develops severe diarrhea while taking erythromycin or related drugs should stop taking the medicine and call a physician immediately.

Special conditions

Taking erythromycins may cause problems for people with certain medical conditions or people who are taking certain other medicines. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to erythromycins, azithromycin, or clarithromycin in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Some medicines in this group may cause problems in pregnant women and have the potential to cause **birth defects**. Women who are pregnant or who may become pregnant should check with their physicians before taking these drugs.

BREASTFEEDING. Erythromycins pass into breast milk. Mothers who are breastfeeding and who need to take this medicine should check with their physicians.

OTHER MEDICAL CONDITIONS. Before using erythromycins, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart disease
- liver disease
- hearing loss

USE OF CERTAIN MEDICINES. Taking erythromycins with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are mild diarrhea, nausea, vomiting, and stomach or abdominal cramps. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as sore mouth or tongue and vaginal **itching** and discharge also may occur and do not need medical attention unless they persist or are bothersome.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with a physician immediately:

- severe stomach **pain**, nausea, vomiting, or diarrhea

KEY TERMS

Bronchitis—Inflammation of the air passages of the lungs.

Gonorrhea—A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Legionnaire's disease—A lung disease caused by a bacterium.

Microorganism—An organism that is too small to be seen with the naked eye.

Pelvic inflammatory disease (PID)—Inflammation of the female reproductive tract, caused by any of several microorganisms. Symptoms include severe abdominal pain, high fever, and vaginal discharge. Severe cases can result in sterility.

Pneumonia—A disease in which the lungs become inflamed. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

Sinus—Any of several air-filled cavities in the bones of the skull.

Strep throat—A sore throat caused by infection with *Streptococcus* bacteria. Symptoms include sore throat, chills, fever, and swollen lymph nodes in the neck.

Tonsillitis—Inflammation of a tonsil, a small mass of tissue in the throat.

Urinary tract—The passage through which urine flows from the kidneys out of the body.

- **fever**
- skin rash, redness, or itching
- unusual tiredness or weakness

Although rare, very serious reactions to azithromycin (Zithromax) are possible, including extreme swelling of the lips, face, and neck, and **anaphylaxis** (a violent allergic reaction). Anyone who develops these symptoms after taking azithromycin should stop taking the medicine and get immediate medical help.

Other rare side effects may occur with erythromycins and related drugs. Anyone who has unusual symptoms after taking these medicines should get in touch with his or her physician.

Interactions

Erythromycins may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes erythromycins should let the physician know all other medicines he or she is taking. Among the drugs that may interact with erythromycins are:

- acetaminophen (Tylenol)
- medicine for overactive thyroid
- male hormones (androgens)
- female hormones (estrogens)
- other antibiotics
- blood thinners
- disulfiram (Antabuse), used to treat alcohol abuse
- antiseizure medicines such as valproic acid (Depakote, Depakene)
- caffeine
- the **antihistamines** astemizole (Hismanal)
- antiviral drugs such as (zidovudine) Retrovir

The list above does not include every drug that may interact with erythromycins. Be sure to check with a physician or pharmacist before combining erythromycins with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Erythropoietin *see* **Cancer therapy, supportive; Immunologic therapies**

Erythropoietin test

Definition

Erythropoietin, also called EPO, is a type of protein called a glycoprotein that is formed mainly in the kidneys to stimulate the production of red blood cells.

KEY TERMS

Anemia—A condition in which the hemoglobin concentration in the blood is below normal.

Polycythemia vera—A condition characterized by an unusually large number of red blood cells in the blood due to increased production by the bone marrow. Symptoms include headaches, blurred vision, high blood pressure, dizziness, and night sweats.

Secondary polycythemia—Secondary polycythemia occurs when the excess of red blood cells is caused by a condition other than polycythemia vera. For example, when low levels of oxygen in the blood stimulate the bone marrow to produce more red blood cells, as in chronic lung disease.

Purpose

The erythropoietin (EPO) test is used to determine if hormonal secretion is causing changes in the red blood cells. The test has great value in evaluating low hemoglobin (anemia), and another disorder called polycythemia, in which unusually large numbers of red blood cells are found in the blood. The EPO test is also used to identify kidney tumors and to evaluate abuse by athletes who believe commercially prepared erythropoietin enhances performance.

Precautions

Not every laboratory is equipped to evaluate EPO, so the reference laboratory (a large commercial lab that does tests for hospitals not equipped to do them) performing the test may require as many as four days to complete the analysis. It should also be noted that EPO values increase in **pregnancy**, in which significantly higher levels are found before the twenty-fourth week.

Description

Erythropoietin is produced primarily in the kidneys but interacts with other factors in the bone marrow to increase red cell production. EPO is unique among the blood cell growth factors, because it is the only one that behaves like a hormone.

Erythropoietin acts as the principal regulator in the production of red blood cells (erythrocytes) by controlling the number, the kinds, and the survival of the cells. Because of this ability, it is being investigated for use in **cancer** patients to prevent anemia (hemoglobin concentration in the blood is lower than normal), or to treat anemia that has been induced by **chemotherapy** and **bone marrow transplantation** (BMT).

The correction of anemia can result in reduced **transfusion** requirements, so the erythropoietin test is used to diagnose anemia, including the anemia of end-stage renal disease. Erythropoietin determination is also valuable in diagnosing a condition known as polycythemia, when increased numbers of red blood cells occur. Levels of erythropoietin are extremely low in **polycythemia vera** but are normal or high in **secondary polycythemia**. It happens rarely, but cysts in the liver or kidneys, as well as tumors in the kidneys or brain, can also produce erythropoietin. Patients with these conditions can have high levels of erythropoietin and may develop secondary polycythemia.

Some athletes use EPO to enhance performance, as the increased red cell volume adds more oxygen-carrying capacity to the blood. Adverse reactions to this practice can include clotting abnormalities, **headache**, seizures, high blood pressure, nausea, vomiting, **diarrhea**, and rash.

Preparation

The EPO test requires a blood sample. The patient is to fast with nothing to eat or drink for at least eight hours before the test. It is also suggested that the patient lie down for 30 minutes before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, and hematoma (blood accumulating under the puncture site).

Normal results

Reference values vary from laboratory to laboratory, but a general normal range is 11–48 mU/ml (milliunits per milliliter).

Abnormal results

Low levels of EPO are found in anemic patients with inadequate or absent production of erythropoietin. Severe kidney disease may decrease production of EPO, and congenital absence of EPO can occur.

Elevated levels of EPO can be found in some **anemias** when the body tries to overcompensate for reduced blood volume. Elevated levels are also seen in polycythemia, and erythropoietin-secreting tumors.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

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ESB *see* **Electrical stimulation of the brain**

Escherichia coli

Definition

E. coli (Escherichia coli) is one of several types of bacteria that normally inhabit the intestine of humans and animals (commensal organism). Some strains of *E. coli* are capable of causing disease under certain conditions when the immune system is compromised or disease may result from an environmental exposure.

Description

E. coli bacteria may give rise to infections in **wounds**, the urinary tract, biliary tract, and abdominal cavity (**peritonitis**). This organism may cause septicemia, neonatal **meningitis**, infantile **gastroenteritis**, tourist **diarrhea**, and hemorrhagic diarrhea. An *E. coli* infection may also arise due to environmental exposure. Infections with this type of bacteria pose a serious threat to public health with outbreaks arising from food and water that has been contaminated with human or animal feces or sewage. This type of bacteria has been used as a biological indicator for safety of drinking water since the 1890s. Exposure may also occur during hospitalization, resulting in **pneumonia** in immunocompromised patients or those on a ventilator

Causes and symptoms

The symptoms of infection and resulting complications are dependent upon the strain of *E. coli* and the site of infection. These bacteria produce toxins that have a wide range of effects. Symptoms caused by some *E. coli* infections range from mild to severe, bloody diarrhea, acute abdominal **pain**, vomiting, and **fever**. Gastrointestinal complications that can cause *E. coli* infections include **irritable bowel syndrome** (IBS) ischemic colitis, **appendicitis**, perforation of the large bowel, and in some instances **gangrene** in the colon. Other known *E. coli*-causing infections may include chronic renal failure, **pancreatitis**, and **diabetes mellitus**. Some neurological symptoms such as drowsiness, seizure and **coma** may occur. In infants, *E. coli* infections are present in cases of infantile gastroenteritis and neonatal meningitis.

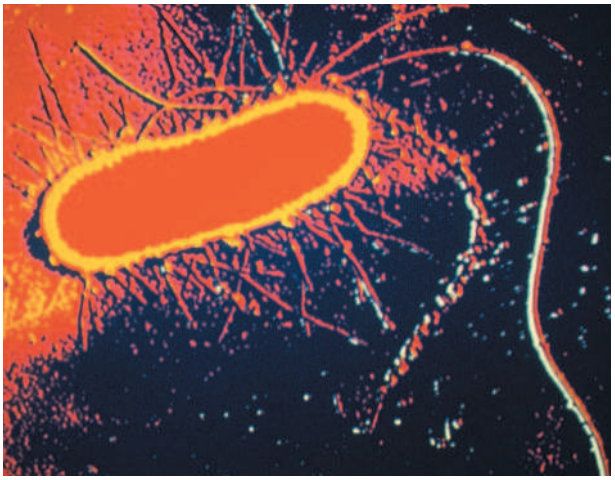
Strains of *E. coli* that produce diarrhea were initially distinguished by their O (somatic) antigens found on the bacterial surface. Although there is an overlap in characteristics between strains, they may be classified into four main groups; enterohemorrahagic (0157),enteropathogenic (055,0111), enterotoxigenic (06,078), and enteroinvasive (0124,0164).

E.coli O157 (VTEC)

The O157:H7 strain is the member of the group most often associated with a particularly severe form of diarrhea. (The O indicates the somatic antigen, while the H denotes the flagellar antigen, both of which are found on the cell surface of the bacteria.) The bacterium was discovered in 1977, and first reports of infections followed in 1982. *E. coli* O157:H7, as it is frequently referred to by researchers, causes bloody diarrhea in many infected patients. It accounts for about 2% of all cases of diarrhea in the western world, and at least one-third of cases of hemorrhagic colitis, or about 20,000 cases per year

E. coli O157:H7 is also the most common cause of unique syndromes, known as the **Hemolytic-Uremic Syndrome** (HUS) and thrombocytopenic purpura (TTP), which causes kidney failure, **hemolytic anemia**, and **thrombocytopenia**. Usually, infection with this strain of bacteria will subside without further complications. However, about 5% of people who are infected will develop HUS/TTP. This infection also accounts for the majority of episodes of HUS, especially in children.

This strain of bacteria produces a potent toxin called verotoxin, named for toxin's ability to kill green monkey kidney or "vero" cells. Bacteria that produce verotoxin are referred to as Verotoxin-producing *E. coli* (VTEC). The numbers of bacteria that are necessary to reproduce infectious levels of bacteria are quite small, estimated at 10-100 viable bacteria. These toxins are lethal for intestinal cells and those that line vessels (endothelial cells), inhibiting protein synthesis causing cell **death**. It is believed that the damage to blood vessels results in the formation of clots, which eventually leads to the Hemolytic-Uremic Syndrome. HUS/TTP is a serious, often fatal, syndrome that has other causes in addition to *E. coli* O157:H7; it is characterized by the breaking up of red blood cells (hemolysis) and kidney failure (uremia). The syndrome occurs most often in the very young and very old.



A magnified image of the *E. coli* bacterium. *(The Stock Market. Reproduced by permission.)*

E. coli O157:H7 is commonly found in cattle and poultry, and outbreaks have of disease have been associated with cattle and bovine products. There are reports of contamination from unpasteurized apple juice, hamburger meat, radish sprouts, lettuce, and potatoes, as well as other food sources. Environmental contamination may occur in water drained from cattle pastures or water containing human sewage used for drinking or swimming. Human to human transmission, through contact with fecal matter, has also been identified in daycare centers.

After an incubation period of three to four days on average, watery diarrhea begins, which rapidly progresses to bloody diarrhea in many victims, in which case the bowel movement may be mostly blood. Nausea, vomiting, and low-grade fever are also frequently present. Gastrointestinal symptoms last for about one week, and recovery is often spontaneous. Symptomatic infection may occur in about 10% of infected individuals. About 5-10% of individuals, usually at the extremes of age or elevated leukocyte count, develop HUS/TTP, and ultimately, kidney failure. Patients taking **antibiotics** or medications for gastric acidity may also be at risk. Neurological symptoms can also occur as part of HUS/TTP and consist of seizures, **paralysis**, and coma. **Rectal prolapse** may also be a complication, and in some cases colitis, appendicitis, perforation of the large bowel, and gangrene in the bowel. Systemically, the most prevalent complications of *E. coli* 157 infections are HUS and TTP.

E. coli non-O157 (VTEC)

These strains of *E. coli* produce verotoxin, but are strains other than O157. There have been as many as one hundred different types implicated in the development of disease. Strain OH111 was found to be involved in outbreaks in Australia, Japan, and Italy. The O128, O103, and O55 groups have also been implicated in diarrhea outbreaks. In Britain, cases of infantile gastroenteritis in maternity hospitals and neonatal units have been attributed to the *E. coli* non-0157 group. Many of these organisms have been identified in cattle.

Enterotoxigenic E. coli

Two toxins may be produced by this group, the heat-labile enterotoxin (LT) that can produce enteritis in infants, and a heat stable enterotoxin (ST), the action of which has yet to be determined.

Enteroinvasive E. coli

Some strains of the enteroinvasive *E. coli* have been involved in the development of gastroenteritis in infants. These organisms do not produce and enterotoxin. The cells of the intestine are affected, with the development of symptoms that are typical of a shigellae infection.

Diagnosis

Diagnosis of a specific type of infection is dependant upon the characteristics of the particular strain of the organism.

E. coli O157:H7 (HUS)

This particular strain of *E. coli* is suspected when bloody diarrhea, bloody stools, lack of fever, elevated leukocyte count, and abdominal tenderness are present. Stool cultures are used to tentatively identify the bacteria. Unfortunately, cultures are often negative or inconclusive if done after 48 hours of symptoms. Further tests are usually needed, however, for confirmation of infection. This may include a full **blood count**, blood film, and tests to determine urea, electrolyte, and LDH (lactate dehydrogenase) levels. Damaged red blood cells, and elevated levels of creatinine, urea, and LDH with a drop in **platelet count** may indicate that HUS will develop. Immunomagnetic separation is now being used for diagnosis as well.

E. coli non-O157 (VTEC)

Diagnosis is often difficult for these types of bacteria, but production of enterohemolysin (Ehly) is used as an indicator. Other diagnostic tests are used to detect verotoxins, including ELISA (enzyme-linked immunosorbent assays), colony immunoblotting, and DNA-based tests.

E. coli 0157 STEC

Methods for detection of this type of bacteria are under development, including culture growth media

selective for this organism. Immunomagnetic separation and specific ELISA, latex agglutination tests, colony immunoblot assays, and other immunological-based detection methods are being explored.

Treatment

Uncomplicated cases of the *E. coli* O157:H7 the infection clear up within ten days. It is not certain that antibiotics are helpful in treating *E. coli* O157:H7 and there is some evidence that they may be harmful. **Dehydration** resulting from diarrhea must be treated with either Oral Rehydration Solution (ORS) or intravenous fluids. Anti-motility agents that decrease the intestines' ability to contract, should not be used in any patient with bloody diarrhea. Treatment of HUS, if it develops, involves correction of clotting factors, plasma exchange, and **kidney dialysis**. Blood transfusions may be required. Treatment methods for other *E. coli* infections are similar. Antibiotics are often used in the treatment of *E. coli* infections, but their role is controversial. Some antibiotics may enhance the development of HUS/TTP depending upon their action, as well as the use of anti diarrhea medications that should be avoided. Phosphoenolpyruvate analogues may be helpful. Gentamicin, ampicillin, ceftazidime, or beta-lactamase-stable cephalosporin may be administered for neonatal meningitis. Antibiotic therapy is further complicated by the presence of antibiotic resistant organisms.

Alternative treatment

Studies have been conducted to determine if diarrhea symptoms can be reduced by alternative therapies such as the consumption of herbal teas, psyllium, and **acupuncture**. Patients should consult their doctors before using any alternative treatments, as *E. coli* can be life threatening and should be closely monitored.

Prognosis

In most cases of O157:H7, symptoms last for about a week and recovery is often spontaneous. Ten percent of individuals with *E. coli* O157:H7 infection develop HUS; 5% of those will die of the disease. Some who recover from HUS will be left with some degree of kidney damage and possibly irritable bowel syndrome. Additionally, there is a possibility of chronic *E. coli* infection.

Infants that develop *E. coli* infections may be permanently affected. Gastroenteritis may leave the child with **lactose intolerance**. Neonates developing meningitis from *E. coli* strains have a high morbidity and mortality rate

Prevention

Thorough cooking of all meat and poultry products and adhering to proper food preparation is the most effective way to avoid infection. More studies are needed to determine the appropriate safety margins for killing these bacteria. Food irradiation methods are also being developed to sanitize food. Vaccinations to *E. coli* 0157 are under development, as are medications aimed at limiting the effects of the verotoxin. The enforcement of regulations for meat production and water are critical. Steam pasteurization is used in the United States and is being explored in other countries.

Prevention of *E. coli* gastroenteritis in infants is best achieved by breast-feeding. The breast milk contains antibodies that combat the infection. For bottle-fed infants, care should be taken in the preparation of the milk and bottles. Good hygiene of the umbilical cord area is important. Keeping this area clean and dry may reduce infection.

KEY TERMS

Antigen—A substance, usually a protein, that causes the formation of an antibody and reacts specifically with that antibody.

Anti-motility medications—Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing Codeine or narcotics which decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Colitis—Inflammation of the colon or large intestine, usually causing diarrhea which may be bloody.

Food irradiation methods—A process using radiant energy to kill microogranisms in food, to extend the amount of time in that food can be sold and eaten safely.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Urea—Chemical formed during the body's metabolism of nitrogen and normally excreted by the kidney. Urea levels rise in the blood when kidney failure occurs.

Resources

BOOKS

Hamer, Davidson H., and Sherwood L. Gorbach. "*Escherichia coli*." In *Sleisenger & Fordtran's Gastrointestinal and*

Liver Disease, ed. by Mark Feldman, et al. Philadelphia: W.B. Saunders Company, 1997.
Shanson, D. C. *Microbiology in Clinical Practice.* Woburn:Butterworth-Heinemann,1999.
Sleigh, J. Douglas, and Morag Timbury. *Note on Medical Bacteriology.* Edinburch: Chruchill Lingstone, 1998.
Thielman, Nathan M., and Richard L. Guerrant. "Food-Borne Illness." In *Conn's Current Therapy, 1996,* ed. by Robert E. Rakel. Philadelphia: W.B. Saunders Company, 1996.
Wolfe, Martin S. "Acute Infectious Diarrhea." In *Conn's Current Therapy, 1996,* ed. by Robert E. Rakel. Philadelphia: W.B. Saunders Company, 1996.

PERIODICALS

Bender, Jeffery B., et al. "Surveillance for *Escherichia coli* O157:H7 Infections in Minnesota by Molecular Subtyping." *New England Journal of Medicine* 337, no. (6)(1997): 388.
Chart, H., M. Sussman, and D. E. S. Stewart-Tull, eds. " *E. coli*-Friend or Foe?" *Journal of Applied Microbiology* The Society for Applied Microbiology Symposium Series No. 29.
Long K., E. Vasquez-Garibay, J. Mathewson, J. de la Cabada, and H. DuPont. "The Impact of Infant Feeding Patterns on Infection and Diarrheal Disease Due to Enterotoxigenic *Escherichia coli*." *Salud Publica Mex* (July/Aug. 1999): 263-70.
Rondeau, Eric, and Marie-Noëlle Peraldi. "*Escherichia coli* and the Hemolytic-Uremic Syndrome." *New England Journal of Medicine* 335 (1996): 660.
"Traveler's Diarrhea: Don't Let It Ruin Your Trip." *Mayo Clinic Health Letter* (Jan. 1997).

ORGANIZATION

Division of Bacterial and Mycotic Diseases. National Center for Infectious Diseases Centers for Disease Control and Prevention. 1600 Clifton Road, Mailstop C09 Atlanta, Georgia 30333. 21 May, 2001 <http://www.cdc.gov>.

OTHER

"Preventing Foodborne Illness: *Escherichia coli* 0157:H7." (9 August 1996). Centers for Disease Control and Prevention, <http://www.cdc. gov/ncidod/dbmd/diseaseinfo/escherichia coli_g.htm>. (30 May 2000).

Jill Granger
David Kaminstein

Esophageal acidity test *see* **Esophageal function tests**

Esophageal aperistalsis *see* **Achalasia**

Esophageal atresia

Definition

Esophageal atresia is a serious birth defect in which the esophagus, the long tube that connects the mouth to the stomach, is segmented and closed off at any point. This condition usually occurs with **tracheoesophageal fistula**, a condition in which the esophagus is improperly attached to the trachea, the nearby tube that connects the nasal area to the lungs. Esophageal atresia occurs in approximately 1 in 4,000 live births.

Description

Failure of an unborn child (fetus) to develop properly results in **birth defects**. Many of these defects involve organs that do not function, or function only incidentally, before birth, and, as a result, go undetected until the baby is born. In this case, the digestive tract is unnecessary for fetal growth, since all **nutrition** comes from the mother through the placenta and umbilical cord.

During fetal development, the esophagus and the trachea arise from the same original tissue. Normally, the two tubes would form separately (differentiate); however, in cases of esphageal atresia and tracheoesophageal fistulas, they do not, resulting in various malformed configurations. The most common configuration is the "C" type, in which the upper part of the esophagus abruptly ends in a blind pouch, while the lower part attaches itself to the trachea. This configuration occurs in 85–90% of cases. Esophageal atresia without involvement of the trachea occurs in only 8% of cases.

Causes and symptoms

The cause of esophageal atresia, like that of most birth defects, is unknown.

An infant born with this defect will at first appear all right, swallowing normally. However, the blind pouch will begin to fill with mucus and saliva that would normally pass through the esophagus to the stomach. These secretions back up into the mouth and nasal area, causing the baby to drool excessively. When fed, the baby will also immediately regurgitate what he or she has eaten. **Choking** and coughing may also occur as the baby breaths in the fluid backing up from the esophagus. Aspiration **pneumonia**, an infection of the respiratory system caused by inhalation of the contents of the digestive tract, may also develop.

Diagnosis

Physicians who suspect esophageal atresia after being presented with the above symptoms diagnose the condition using x-ray imaging or by passing a catheter through the nose and into the esophagus. Esophageal atresia is indicated if the catheter hits an obstruction 4–5 in (10–13 cm) from the nostrils.

KEY TERMS

Fetal—Refers to the fetus, also known in the first two months after conception as an embryo.

Fistula—Unnatural connection between two hollow organs or one organ and the outside.

Treatment

Infants with esophageal atresia are unlikely to survive without surgery to reconnect the esophagus. The procedure is done as soon as possible; however, **prematurity**, the presence of other birth defects, or complications of apiration pneumonia may delay surgery. Once diagnosed, the baby will be fed intraveneously until he or she has recovered sufficiently from the operation. Mucus and saliva will also be continuously removed via a catheter until recovery has occured. When surgery is performed, the esophagus is reconnected and, if neccessary, separated from the trachea. If the two ends of the esophagus are too far apart to be reattached, tissue from the large intestine is used to join them.

Prognosis

Surgery to correct esophageal atresia is usually successful. Post-operative complications may include difficulty swallowing, since the esophagus may not contract efficiently, and gastrointestinal reflux, in which the acidic contents of stomach back up into the lower part of the esophagus, possibly causing ulcers.

Resources

BOOKS

"Atresia and Tracheoesophageal Fistula." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Long, John D., and Roy Orlando. "Anatomy and Development and Acquired Anomalies of the Esophagus." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

J. Ricker Polsdorfer, MD

Esophageal cancer

Definition

Esophageal **cancer** is a malignancy that develops in tissues of the hollow, muscular canal (esophagus) along which food and liquid travel from the throat to the stomach.

Description

Esophageal cancer usually originates in the inner layers of the lining of the esophagus and grows outward. In time, the tumor can obstruct the passage of food and liquid, making swallowing painful and difficult. Since most patients are not diagnosed until the late stages of the disease, esophageal cancer is associated with poor quality of life and low survival rates.

Squamous cell carcinoma is the most common type of esophageal cancer, accounting for 95% of all esophageal cancers worldwide. The esophagus is normally lined with thin, flat squamous cells that resemble tiny roof **shingles**. Squamous cell carcinoma can develop at any point along the esophagus but is most common in the middle portion.

Adenocarcinoma has surpassed squamous cell carcinoma as the most common type of esophageal cancer in the United States. Adenocarcinoma originates in glandular tissue not normally present in the lining of the esophagus. Before adenocarcinoma can develop, glandular cells must replace a section of squamous cells. This occurs in Barrett's esophagus, a precancerous condition in which chronic acid reflux from the stomach stimulates a transformation in cell type in the lower portion of the esophagus.

A very small fraction of esophageal cancers are melanomas, **sarcomas**, or lymphomas.

There is great variability in the incidence of esophageal cancer with regard to geography, ethnicity, and gender. The overall incidence is increasing. About 13,000 new cases of esophageal cancer are diagnosed in the United States each year. During the same 12-month period, 12,000 people die of this disease. It strikes between five and ten North Americans per 100,000. In some areas of China the cancer is endemic.

Squamous cell carcinoma usually occurs in the sixth or seventh decade of life, with a greater incidence in African-Americans than in others. Adenocarcinoma develops earlier and is much more common in white patients. In general, esophageal cancer occurs more frequently in men than in women.

Causes and symptoms

The exact cause of esophageal cancer is unknown, although many investigators believe that chronic irritation of the esophagus is a major culprit. Most of the identified risk factors represent a form of chronic irritation.

However, the wide variance in the distribution of esophageal cancer among different demographic groups raises the possibility that genetic factors also play a role.

Several risk factors are associated with esophageal cancer.

- Tobacco and alcohol consumption are the major risk factors, especially for squamous cell carcinoma. **Smoking** and alcohol abuse each increase the risk of squamous cell carcinoma by five-fold. The effects of the two are synergistic, in that the combination of smoking and alchohol increases the risk by 25- to 100- fold. It is estimated that drinking about 13 ounces of alcohol every day for an extended period of time raises the risk of developing esophageal cancer by 18%. That likelihood increases to 44% in individuals who also smoke one or two packs of cigarettes a day. Smokeless tobacco also increases the risk for esophageal cancer.

- Gastroesophageal reflux is a condition in which acid from the stomach refluxes backwards into the lower portion of the esophagus, sometimes causing symptoms of **heartburn**. In some cases of gastroesophageal reflux, the chronic exposure to acid causes the inner lining of the lower esophagus to change from squamous cells to glandular cells. This is called Barrett's esophagus. Patients with Barrett's esophagus are roughly 30 to 40 times more likely than the general population to develop adenocarcinoma of the esophagus.

- A diet low in fruits, vegetables, zinc, riboflavin, and other **vitamins** can increase risk of developing to esophageal cancer.

- Caustic injury to the esophagus inflicted by swallowing lye or other substances that damage esophageal cells can lead to the development of squamous cell esophageal cancer in later life.

- Achalasia is a condition in which the lower esophageal sphincter (muscle) cannot relax enough to let food pass into the stomach. Squamous cell esophageal cancer develops in about 6% of patients with achalasia.

- Tylosis is a rare inherited disease characterized by excess skin on the palms and soles. Affected patients have a much higher probability of developing esophageal cancer than the general population. They should have regular screenings to detect the disease in its early, most curable stages.

- Esophageal webs, which are protrusions of tissue into the esophagus, and diverticula, which are outpouchings of the wall of the esophagus, are associated with a higher incidence of esophageal cancer.

Symptoms

Unfortunately, symptoms generally don't appear until the tumor has grown so large that the patient cannot be cured. Dysphagia (trouble swallowing or a sensation of having food stuck in the throat or chest) is the most common symptom. Swallowing problems may occur occasionally at first, and patients often react by eating more slowly and chewing their food more carefully and, as the tumor grows, switching to soft foods or a liquid diet. Without treatment, the tumor will eventually prevent even liquid from passing into the stomach. A sensation of burning or slight mid-chest pressure is a rare, often-disregarded symptom of esophageal cancer. Painful swallowing is usually a symptom of a large tumor obstructing the opening of the esophagus. It can lead to regurgitation of food, weight loss, physical wasting, and **malnutrition**. Anyone who has trouble swallowing, loses a significant amount of weight without dieting, or cannot eat solid food because it is too painful to swallow should see a doctor.

Diagnosis

A barium swallow is usually the first test performed on a patient whose symptoms suggest esophageal cancer. After the patient swallows a small amount of barium, a series of x rays can highlight any bumps or flat raised areas on the normally smooth surface of the esophageal wall. It can also detect large, irregular areas that narrow the esophagus in patients with advanced cancer, but it cannot provide information about disease that has spread beyond the esophagus. A double contrast study is a barium swallow with air blown into the esophagus to improve the way the barium coats the esophageal lining. Endoscopy is a diagnostic procedure in which a thin lighted tube (endoscope) is passed through the mouth, down the throat, and into the esophagus. Cells that appear abnormal are removed for biopsy. Once a diagnosis of esophageal cancer has been confirmed through biopsy, staging tests are performed to determine whether the disease has spread (metastasized) to tissues or organs near the original tumor or in other parts of the body. These tests may include computed tomography, endoscopic ultrasound, **thoracoscopy**, **laparoscopy**, and **positron emission tomography**.

Treatment

Treatment for esophageal cancer is determined by the stage of the disease and the patient's general health. The most important distinction to make is whether the cancer is curable. If the cancer is in the early stages, cure may be possible. If the cancer is advanced or if the patient will not tolerate major surgery, treatment is usually directed at palliation (relief of symptoms only) instead of cure.

Staging

Stage 0 is the earliest stage of the disease. Cancer cells are confined to the innermost lining of the esophagus. Stage I esophageal cancer has spread slightly deeper, but still has not extended to nearby tissues, lymph nodes, or other organs. In Stage IIA, cancer has invaded the thick, muscular layer of the esophagus that propels food into the stomach and may involve connective tissue covering the outside of the esophagus. In Stage IIB, cancer has spread to lymph nodes near the esophagus and may have invaded deeper layers of esophageal tissue. Stage III esophageal cancer has spread to tissues or lymph nodes near the esophagus or to the trachea (windpipe) or other organs near the esophagus. Stage IV cancer has spread to distant organs like the liver, bones, and brain. Recurrent esophageal cancer is disease that develops in the esophagus or another part of the body after initial treatment.

Surgery

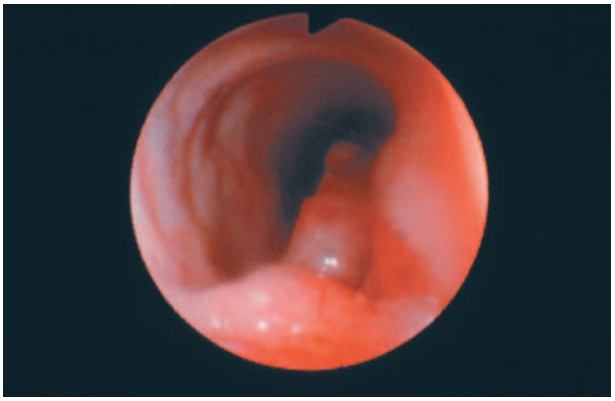
The most common operations for the treatment of esophageal cancer are esophagectomy and esophagogastrectomy. Esophagectomy is the removal of the cancerous part of the esophagus and nearby lymph nodes. This procedure is performed only on patients with very early cancer that has not spread to the stomach. Esophagogastrectomy is the removal of the cancerous part of the esophagus, nearby lymph nodes, and the upper part of the stomach. The resected esophagus is replaced with the stomach or parts of intestine so the patient can swallow. These procedures can significantly relieve symptoms and improve the nutritional status of more than 80% of patients with dysphagia. Although surgery can cure some patients whose disease has not spread beyond the esophagus, but more than 75% of esophageal cancers have spread to other organs before being diagnosed. Less extensive surgical procedures can be used for palliation.

Chemotherapy

Oral or intravenous **chemotherapy** alone will not cure esophageal cancer, but pre-operative treatments can shrink tumors and increase the probability that cancer can be surgically eradicated. Palliative chemotherapy can relieve symptoms of advanced cancer but will not alter the outcome of the disease.

Radiation

External beam or internal radiation, delivered by machine or implanted near cancer cells inside the body, is only rarely used as the primary form of treatment. Post-operative radiation is sometimes used to kill cancer cells that couldn't be surgically removed. Palliative radiation is effective in relieving dysphagia in patients who cannot be cured. However, radiation is most useful when combined with chemotherapy as either the definitive treatment or preoperative treatment.



A close-up view of a cancerous esophageal tumor. *(Custom Medical Stock Photo. Reproduced by permission.)*

Palliation

In addition to surgery, chemotherapy, and radiation, other palliative measures can provide symptomatic relief. Dilatation of the narrowed portion of the esophagus with soft tubes can provide short-term relief of dysphagia. Placement of a flexible, self-expanding stent within the narrowed portion is also useful in allowing more food intake.

Follow-up treatments

Regular barium swallows and other imaging studies are necessary to detect recurrence or spread of disease or new tumor development.

Alternative treatment

Photodynamic therapy (PDT) involves intravenously injecting a drug that is absorbed by cancer cells and kills them after they are exposed to specific laser beams. PDT can be used for palliation, but it also cured some early esophageal cancers during preliminary studies. Researchers are comparing its benefits with those of more established therapies.

Endoscopic laser therapy involves delivering short, powerful laser treatments to the tumor through an endoscope. It can improve dysphagia, but multiple treatments are required, and the benefit is seldom long-lasting.

Prognosis

Since most patients are diagnosed when the cancer has spread to lymph nodes or other structures, the prog-

KEY TERMS

Computed tomography—A radiology test by which images of cross-sectional planes of the body are obtained.

Endoscopic ultrasound—A radiology test utilizing high frequency sound waves, conducted via an endoscope.

Laparoscopy—Examination of the contents of the abdomen through a thin, lighted tube passed through a small incision.

Positron emission tomography—A radiology test by which images of cross-sectional planes of the body are obtained, utilizing the properties of the positron. The positron is a subatomic particle of equal mass to the electron, but of opposite charge.

Synergistic—The combined action of two or more processes is greater than the sum of each acting separately.

Thoracoscopy—Examination of the contents of the chest through a thin, lighted tube passed through a small incision.

nosis for esophageal cancer is poor. Generally, no more than half of all patients are candidates for curative treatment. Even if cure is attempted, the cancer can recur.

Prevention

There is no known way to prevent esophageal cancer.

Resources

BOOKS

Heitmiller, Richard F., Arlene A. Forastiere,and Lawrence R. Kleinberg. "Esophagus." In *Clinical Oncology*. 2nd ed. Ed. Martin D. Abeloff. New York: Churchill Livingstone, 2000.

Zwischenberger, Joseph B., Scott K. Alpard, and Mark B. Orringer. "Esophageal Cancer." In *Sabiston Textbook of Surgery*. by Courtney Townsend Jr., 16th ed. Ed. Philadelphia: W. B. Saunders Company, 2001.

ORGANIZATIONS

American Cancer Society. "Esophageal Cancer." 6 July 2001.<http:// www3.cancer.org>.

National Coalition for Cancer Survivorship. 1010 Wayne Avenue, 5th Floor, Suite 300, Silver Spring, MD 20910. (888) 650-9127.

Maureen Haggerty
Kevin O. Hwang, M.D.

Esophageal diverticula *see* **Esophageal pouches**

Esophageal function tests

Definition

The esophagus is the swallowing tube through which food passes on its way from the mouth to the stomach. The main function of this organ is to propel food down into the stomach. There is also a mechanism to prevent food from coming back up or "refluxing" from the stomach into the esophagus. Esophageal function tests are used to determine if these processes are normal or abnormal.

Purpose

The esophagus is a long, muscular tube that also has two muscles (or sphincters) at the top and bottom. All of these muscular areas must contract in an exact sequence for swallowing to proceed normally. There are three main symptoms that occur when esophageal function is abnormal: difficulty with swallowing (dysphagia), **heartburn**, and chest **pain**.

Doctors perform a variety of tests to evaluate these symptoms. Endoscopy, which is not a test of esophageal function, is often used to determine if the lining of the esophagus has any ulcers, tumors, or areas of narrowing (strictures). Many times, however, endoscopy only shows the doctor if there is injury to the esophageal lining, and the procedure gives no information about the cause of the problem.

Therefore, in addition to endoscopy, several studies are available that measure esophageal function. There are three basic types of tests used to assess esophageal function:

- Manometry is used to study the way the muscles of the esophagus contract, and is most useful for the investigation of difficulty with swallowing.
- Esophageal pH monitoring measures changes in esophageal acidity, and is valuable for evaluating patients with heartburn or gastroesophageal reflux disease (GERD).
- X-ray studies investigate swallowing difficulties. They either follow the progress of barium during swallowing using a fluoroscope, or they use radioactive scanning techniques.

Precautions

Pregnant patients undergoing x-ray exams should carefully review the risks and benefits with their doctors. Most x-ray exams of the gastrointestinal tract do not involve radiation levels that are harmful to the unborn baby.

Description

Manometry

This study is designed to measure the pressure changes produced by contraction of the muscular portions of the esophagus. An abnormality in the function of any one of the segments of the swallowing tube causes difficulty in swallowing. Doctors call this symptom dysphagia. This exam is most useful in evaluating those patients whose endoscopy is negative.

During manometry, the patient swallows a thin tube carrying a device that senses changes in pressures in the esophagus. Readings are taken at rest and during swallowing. Medications are sometimes given during the study to help in the diagnosis. The results are then transmitted to recording equipment. Manometry can best identify diseases that produce disturbances of motility or contractions of the esophagus.

Esophageal pH monitoring

This procedure involves measuring the esophagus' exposure to acid that has "refluxed" from the stomach. The test is ideal for evaluating recurring heartburn or GERD. Too much acid produces not only heartburn, but also ulcers that can bleed or produce areas of narrowing (strictures) when they heal.

Normally, acid refluxes into the esophagus in only small amounts for short periods of time. A muscle called the lower esophageal sphincter prevents excessive reflux. Spontaneous contractions that increase esophageal emptying and production of saliva are other important protective mechanisms.

"pH" is the scientific term that tells just how acidic or alkaline a substance is. Researchers have shown that in the esophagus, the presence of acid is damaging only if it persists for prolonged periods. Therefore, the test has been designed to monitor the level of acidity over 24 hours, usually in the home. In this way, patients maintain their daily routine, documenting their symptoms, and at what point in their activities they occurred. During this period, a thin tube with a pH monitor remains in the esophagus to record changes. After the study, a computer is used to compare changes in acidity with symptoms reported by the patient.

Surgery is an effective and long-lasting treatment for symptoms of recurrent reflux and is the choice of many patients and doctors. pH monitoring is usually performed before surgery to confirm the diagnosis and to judge the effects of drug therapy.

X-ray tests

These fall into two categories: (1) those done with the use of barium and a fluoroscope; and (2) those performed with radioactive materials.

Studies performed with fluoroscopy are of greatest value in identifying a structural abnormality of the esophagus. Although this is not truly an esophageal function test, it does allow doctors to consider other diagnostic possibilities. Often a sandwich or marshmallow coated with barium is used to identify the site of an obstruction.

During fluoroscopy, the radiologist can observe the passage of material through the esophagus in real time, and video recordings can also be done. This is particularly useful when the swallowing symptoms appear to involve mainly the upper region of the esophagus. The most common cause of swallowing difficulties is a previous **stroke**, although other diseases of the neuromuscular system (like **myasthenia gravis**) can produce the same symptoms.

Scans using low-dose radioactive materials are useful because they are able not only to demonstrate that food passes through the esophagus more slowly than normal, but also how slow. These studies involve swallowing food coated with material that is followed by a nuclear medicine scanner. Scans are best used when other methods have failed to make a diagnosis, or if it is necessary to determine the degree of the abnormality. As of 1997, scans mainly served as research tools.

Preparation

Patients should not eat or drink for several hours before the exam. Many medications affect the esophagus; doses sometimes need to be adjusted or even stopped for a while. Patients must inform doctors of all medications taken, including over-the-counter medications (purchased without a doctor's prescription), and any known **allergies**.

Aftercare

For most of these studies, no special care is needed after the procedure. Patients can often go about normal daily activities following any of these tests. One exception is for those who undergo an x-ray exam with the use of barium. This can have a constipating effect and patients should ask about using a mild laxative later on.

Risks

Exposure of a fetus to x rays, especially in the first three months, is a potential risk.

Other studies of esophageal function are essentially free of any significant risk. The tubes passed during these procedures are small, and most patients adjust to them quite well. However, since medications cannot be used to relax patients, some may not tolerate the exam.

Abnormal results

Manometry is used to diagnose abnormalities related to contraction or relaxation of the various muscular regions of the esophagus. These studies cannot distinguish whether injury to either the muscle or nerves of the esophagus is producing the abnormal results. Only the final effect on esophageal muscle is identified. Results should be interpreted in light of the patient's entire medical history.

For example, there are many diseases that cause poor relaxation of the lower esophageal sphincter. When no cause is found, the disease is called **achalasia**.

Abnormal results of pH tests can confirm symptoms of heartburn or indicate a cause of chest pain (or rarely, swallowing difficulties). Doctors may want to start or change medications based on these results, or even repeat the test using different doses of medication. As noted above, these studies are indicated before surgical treatment of GERD.

X-ray tests can only serve to document an abnormality, and they are far from perfect. If they are negative, then other studies are often needed.

Resources

BOOKS

Clouse, Ray E., and N. E. Diamant. "Motor Physiology and Motor Disorders of the Esophagus." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Dent, John, and Richard H. Holloway. "Esophageal Motility and Reflux Testing." *Gastroenterology Clinics of North America* 25 (Mar. 1996): 51-73.

Mittal, Ravinder K., and David H. Balaban. "The Esophagogastric Junction." *New England Journal of Medicine* 336 (27 Mar. 1997): 924-932.

David Kaminstein, MD

Esophageal laceration *see* **Mallory-Weiss syndrome**

Esophageal manometry *see* **Esophageal function tests**

Esophageal pouches

Definition

Esophageal pouches, also known as esophageal diverticula, are pocket-like structures formed when the interior space of the esophagus, the tube that connects the mouth to the stomach, protrudes into the walls that surround it.

Description

The esophagus is a muscular tube that propels food into the stomach. A defect in the wall of the esophagus may allow the lining to herniate, creating a space where food can be caught. Pouches can appear anywhere between the throat and the stomach. They occur primarily in men and usually later in life.

Different names for the condition apply to different locations along the esophagus:

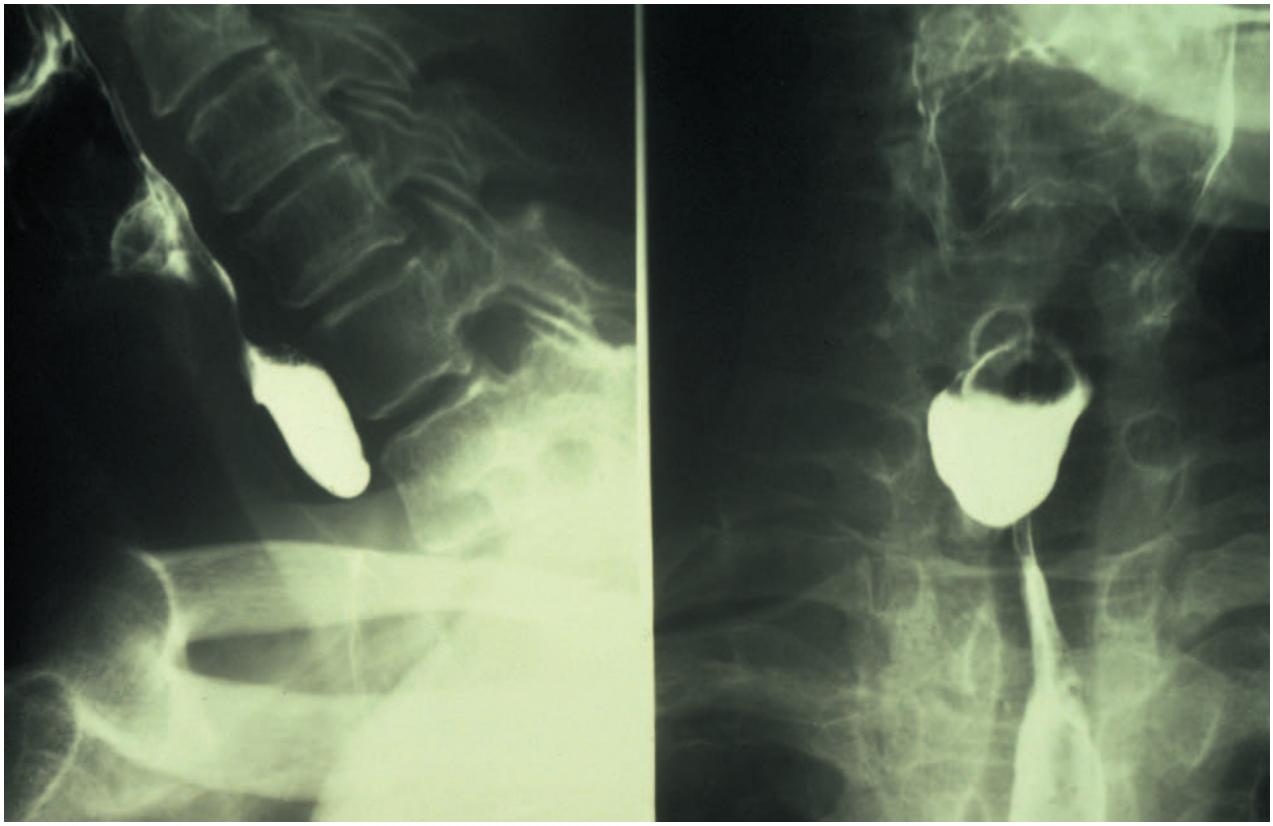
- Zenker's diverticula are pharyngeal pouches, or ones that occur in the upper neck area at the top of the esophagus.
- **Traction** diverticula are a type of mid-esophageal pouch.
- Epiphrenic diverticula occur at the bottom of the esophagus near where it enters the stomach.

Causes and symptoms

To propel food into the stomach (or out of it during vomiting) the esophagus generates internal pressure just like the bowel. Under certain circumstances, that pressure can herniate the esophageal lining through a weakness in the wall, creating a pouch (a balloon squeezed in the hand will herniate through the fingers in the same way). Pouches are more common in people who have motility disorders of the esophagus, swallowing that is not well coordinated and may be spastic. A traction diverticulum can develop from a scar that pulls the esophagus out of shape. Food and saliva can collect in all of these pouches.

Pouches in the neck usually cause **bad breath** (halitosis) and the regurgitation of swallowed food and saliva. Some patients with Zenker's diverticula can push on their neck and make old food appear in their mouths. Pouches near the stomach may cause swallowing problems, conditions known as *achalasia* or *dysphagia*. Mid-esophageal pouches usually cause no symptoms.

In the most serious cases, a person may be unable to swallow because the esophagus is obstructed, or the esphagus may rupture, spilling its contents into the chest or neck.



A split x-ray image of the upper chest, neck, and esophagus (left), and chest and esophagus (right). *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

Difficulty swallowing, bad breath, or food reappearing in the back of the mouth are among the signs physicians look for when diagnosing this condition. Sometimes the patient may also experience **pain** in the chest resembling a **heart attack**. A series of x rays taken while swallowing a contrast agent usually demonstrates the diverticulum clearly. An esophagoscopy may also be needed to gather more detail. Manometry, measuring pressures inside the esophagus using a balloon that is passed down it, may help determine the cause of the diverticula.

Treatment

Treatment for this condition is primarily aimed at alleviating symptoms. Physicians direct the patient to eat a bland diet, to chew his or her food thoroughly, and to drink water after eating to clean out the pouches. If the condition is severe, several types of surgery are available to remove the pouches and repair the defects. If a pouch is due to a stenosis (narrowing) in the esophagus it may be possible to relieve it by passing a dilator through it, a process called bougeinage.

KEY TERMS

Achalasia—Failure of the lower end of the esophagus (or another tubular valve) to open, resulting in obstruction, either partial or complete.

Contrast agent—A substance that produces shadows on an x ray so that hollow structures can be more easily seen.

Dysphagia—Difficult swallowing.

Esophagoscopy—Looking down the esophagus with a flexible viewing instrument.

Herniate—To protrude beyond usual limits.

Manometry—Pressure measurement.

Prognosis

The two complications that can render these nuisances dangerous, obstruction and rupture, are emergencies. Both require immediate medical attention. Other

than that, diverticula will usually grow slowly over the years, gradually increasing the symptoms they cause.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Goyal, Raj K. "Diseases of the Esophagus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Esophageal ulcers *see* **Ulcers (digestive)**

Esophagogastroduodenoscopy

Definition

An endoscope as used in the field of gastroenterology (the medical study of the stomach and intestines) is a thin, flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is limited to the examination of the inside of the gastrointestinal tract's upper portion, it is called upper endoscopy or esphagogastroduodenoscopy (EGD). With the endoscope, the esophagus (swallowing tube), stomach, and duodenum (first portion of the small intestine) can be easily examined, and abnormalities frequently treated. Patients are usually sedated during the exam.

Purpose

EGD is performed to evaluate or treat symptoms relating to the upper gastrointestinal tract, such as:

- upper abdominal or chest **pain**
- nausea or vomiting
- difficulty swallowing (dysphagia)
- bleeding from the upper intestinal tract
- anemia (low **blood count**). EGD can be used to treat certain conditions, such as an area of narrowing or bleeding in the upper gastrointestinal tract

Upper endoscopy is more accurate than x rays for detecting inflammation, ulcers, or tumors. It is used to diagnose early **cancer** and can frequently determine whether a growth is benign (not cancerous) or malignant (cancerous).

KEY TERMS

Pathologist—A doctor who specializes in the anatomic (structural) and chemical changes that occur with diseases. These doctors function in the laboratory, examining biopsy specimens, and regulating studies performed by the hospital laboratories (blood tests, urine tests, etc). Pathologists also perform autopsies.

Biopsies (small tissue samples) of inflamed or "suspicious" areas can be obtained and examined by a pathologist. Cell scrapings can also be taken by the introduction of a small brush; this helps in the diagnosis of cancer or infections.

When treating conditions in the upper gastrointestinal tract, small instruments are passed through the endoscope that can stretch narrowed areas (strictures), or remove swallowed objects (such as coins or pins). In addition, bleeding from ulcers or vessels can be treated by a number of endoscopic techniques.

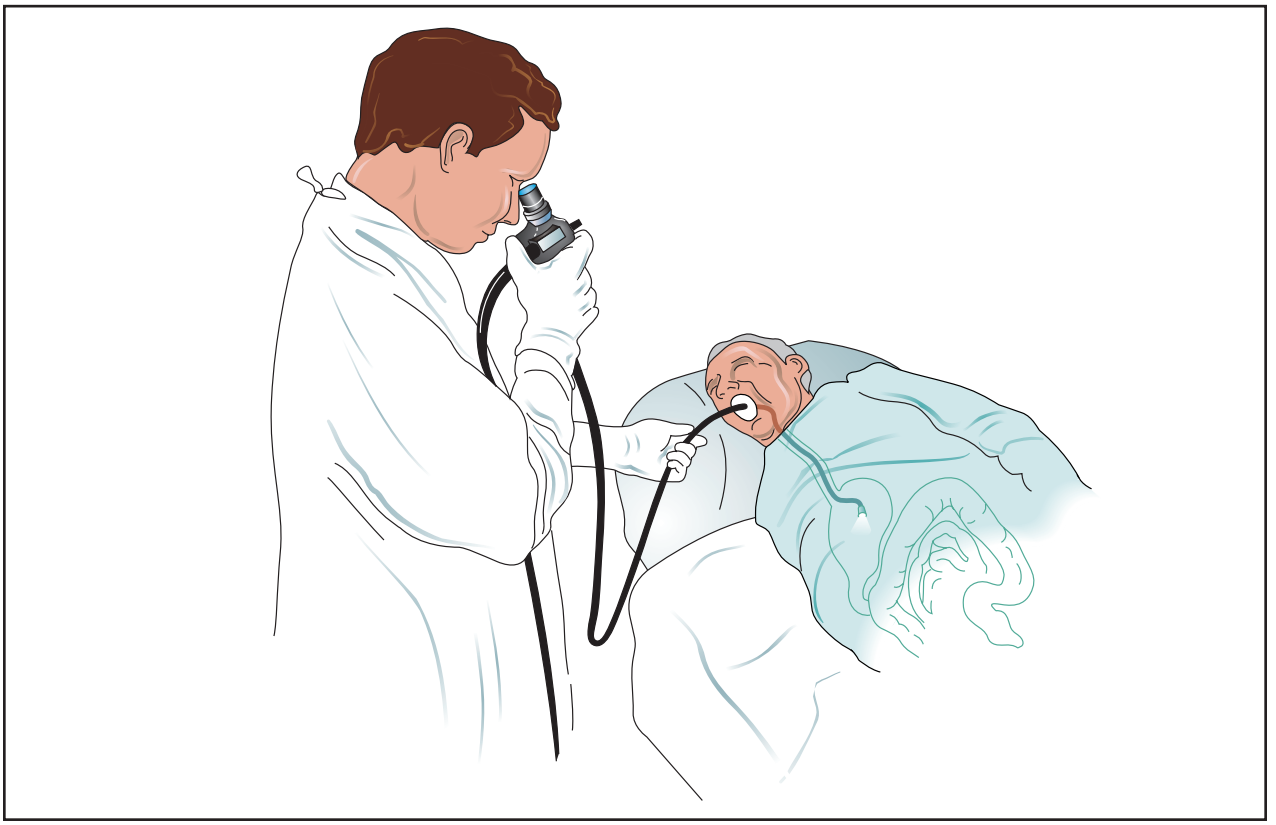
Recent studies have shown the usefulness of endoscopic removal of early tumors of the esophagus or stomach. This is done either with injection of certain materials (like alcohol), or with the use of instruments (like lasers) that burn the tumor. Other techniques combining medications and lasers also show promise.

Precautions

Patients should inquire as to the doctor's expertise with these procedures, especially when therapy is the main goal. The doctor should be informed of any **allergies**, medication use, and medical problems.

Description

First, a "topical" (local) medication to numb the gag reflex is given either by spray or is gargled. Patients are usually sedated for the procedure (though not always) by injection of medications into a vein. The endoscopist then has the patient swallow the scope, which is passed through the upper gastrointestinal tract. The lens or camera at the end of the instrument allows the endoscopist to examine each portion of the upper gastrointestinal tract; photos can be taken for reference. Air is pumped in through the instrument to allow proper observation. Biopsies and other procedures can be performed without any significant discomfort.



Esophagogastroduodenoscopy (EGD) is performed to evaluate or treat symptoms relating to the upper gastrointestinal tract. By inserting an endoscope into the mouth and guiding it through the gastrointestinal tract, the esophagus, stomach, and duodenum can be examined and abnormalities treated. *(Illustration by Electronic Illustrators Group.)*

Preparation

The upper intestinal tract must be empty for the procedure, so it is necessary NOT to eat or drink for at least 6–12 hours before the exam. Patients need to inquire about taking their medications before the procedure.

Aftercare

Someone should be available to take the person home after the procedure and stay with them for a while; patients will not be able to drive themselves due to **sedation**. Pain or any other unusual symptoms should be reported immediately.

It is important to recognize early signs of any possible complication. The doctor should be notified if the patient has **fever**, trouble swallowing, or increasing throat, chest, or abdominal pain.

Risks

EGD is safe and well tolerated; however, complications can occur as with any procedure. These are most often due to medications used during the procedure, or are related to endoscopic therapy. The overall complication rate of EGD is less than 2%, and many of these complications are minor (such as inflammation of the vein through which medication is given). However, serious ones can and do occur, and almost half of them are related to the heart or lungs. Bleeding or perforations (holes in the gastrointestinal tract) are also reported, especially when tumors or narrowed areas are treated or biopsied. Infections have also been rarely transmitted; improved cleaning techniques should be able to prevent them.

Resources

BOOKS

Young, Harvey S., and Keeffe, Emmet B. "Complications of Gastrointestinal Endoscopy." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Chan, Mary F. "Complications of Upper Gastrointestinal Endoscopy." *Gastrointestinal Endoscopy Clinics of North America* 6, no. 2 (Apr. 1996): 287-303.

OTHER

"Understanding Upper Endoscopy." *American Society for Gastrointestinal Endoscopy.* <http://www.asge.org>.

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Essential tremor *see* **Tremors**

Estradiol *see* **Hormone replacement therapy**

Estrogen *see* **Hormone replacement therapy**

Estrogen fractions test *see* **Sex hormones tests**

Estrogen replacement therapy *see* **Hormone replacement therapy**

Ethambutol *see* **Antituberculosis drugs**

Etodolac *see* **Nonsteroidal anti-inflammatory drugs**

Evoked potential studies

Definition

Evoked potential studies are a group of tests of the nervous system that measure electrical signals along the nerve pathways.

Purpose

Nerves convey information to the body by sending electrical signals down the length of the nerve. These signals can be recorded by wires placed over the nerves on the surface of the skin, in a procedure called an evoked potential (EP) study. The person conducting the test evokes the patient's neural activity by visual or auditory stimulation or using a mild electrical shock. This causes changes in the electrical potential in the nerves. Analysis of the signals can provide information about the condition of nerve pathways, especially those in the brain and spinal cord. They can indicate the presence of disease or degeneration, and can help determine the location of nerve lesions.

There are three major types of EP studies used regularly:

- Visual evoked potentials are used to diagnose visual losses due to optic nerve damage, especially from **multiple sclerosis**. They are also useful to diagnose "hysterical blindness," in which loss of vision is not due to any nerve damage.
- Auditory evoked potentials are used to diagnose hearing losses. They can distinguish damage to the acoustic nerve (which carries signals from the ear to the brain stem) from damage to the auditory pathways within the brainstem. Most auditory EPs record activity from the brainstem, and are therefore called "brainstem auditory evoked potentials." Disorders diagnosed with auditory EPs include **acoustic neuroma** (tumors of the inner ear) and multiple sclerosis (chronic disease in which nerves lose patches of their outer covering). They may also be used to assess high frequency hearing ability, to determine brain **death**, and to monitor brainstem function during surgery
- Somatosensory evoked potentials record transmission of nerve impulses from the limbs to the brain, and can be used to diagnose nerve damage or degeneration within the spinal cord or nerve roots from multiple sclerosis, trauma, or other degenerative disease. Somatosensory EPs can be used to distinguish central versus peripheral nerve disease, when combined with results from a nerve conduction velocity test, which measures nerve function in the extremities.

Precautions

Evoked potential studies are painless, noninvasive, and without any significant risk. Somatosensory EP tests involve very mild electric shocks, usually felt as a tingling.

Description

The person performing the test locates and marks specific spots on the patient's head for placement of electrodes. These spots are cleaned, and an adhesive conducting paste is applied. Cup electrodes are attached. For somatosensory EP, spots on the arm or leg are also marked and cleaned; electrodes may be taped in place. The patient sits or reclines in a chair throughout the tests.

For a visual EP, the patient focuses on a TV screen which displays a checkerboard pattern. The eye not being tested is covered with a patch. For children or others whose attention may wander, goggles are used which show the pattern to one eye at a time. Each eye is usually tested twice, and the entire procedure takes approximately 30–45 minutes.

For auditory EP, headphones are used to deliver a series of clicks to one ear at a time. A masking or static sound is played into the other ear. Each ear is usually tested twice, and the entire procedure takes approximately 30–45 minutes.

For somatosensory EP, mild electrical shocks are delivered to the arm or leg. This may cause some twitching and tingling. The stimulus lasts for about two minutes at a time, and the entire procedure takes approximately 30 minutes.

KEY TERMS

Nerve conduction velocity test—A test of the speed of conduction of nerves, performed on the nerves in the arm and leg.

After the tests, the electrodes are removed with acetone and the scalp is cleaned.

Preparation

Hair must be clean, dry, and free of any braids, pins, or jewelry. The patient should shampoo before the test, and must not use any hair spray, gel, or other hair care products after shampooing. Clothing should be loose and comfortable. The patient may eat and take some medications as usual before the test, although sedative medications should be avoided on the day of the test, if possible. It is best to check with the physician supervising the test for specific instructions.

Aftercare

This test is painless and has no residual effects. The patient may return to work or other activities immediately afterward.

Normal results

EP test results are displayed as jagged electrical tracings (wave forms), which have characteristic shapes, heights, and lengths, indicating the speed and intensity of signal transmission. Results are read by someone trained in evoked potential studies.

Abnormal results

Changes in the electrical tracings may indicate damage to or degeneration of nerve pathways to the brain from the eyes, ears, or limbs. Absence of any activity may mean complete loss of nerve function in that pathway. Other changes may provide evidence of the type and location of nerve damage.

Resources

BOOKS

Misulis, Karl E. *Spehlmann's Evoked Potential Primer.* 2nd ed. Boston: Butterworth-Heinemann, 1994.

Office Practice of Neurology. Samuels, Martin and Steven Feske, eds. New York: Churchill Livingstone, 1996.

Richard Robinson

Evoked responses *see* **Evoked potential studies**

Exanthema subitum *see* **Roseola**

Exercise

Definition

Exercise is physical activity that is planned, structured, and repetitive for the purpose of conditioning any part of the body. Exercise is utilized to improve health, maintain fitness and is important as a means of physical **rehabilitation**.

Purpose

Exercise is useful in preventing or treating coronary heart disease, **osteoporosis**, weakness, diabetes, **obesity**, and depression. Range of motion is one aspect of exercise important for increasing or maintaining joint function. Strengthening exercises provide appropriate resistance to the muscles to increase endurance and strength. **Cardiac rehabilitation** exercises are developed and individualized to improve the cardiovascular system for prevention and rehabilitation of cardiac disorders and diseases. A well-balanced exercise program can improve general health, build endurance, and delay many of the effects of **aging**. The benefits of exercise not only improve physical health, but also enhance emotional well-being.

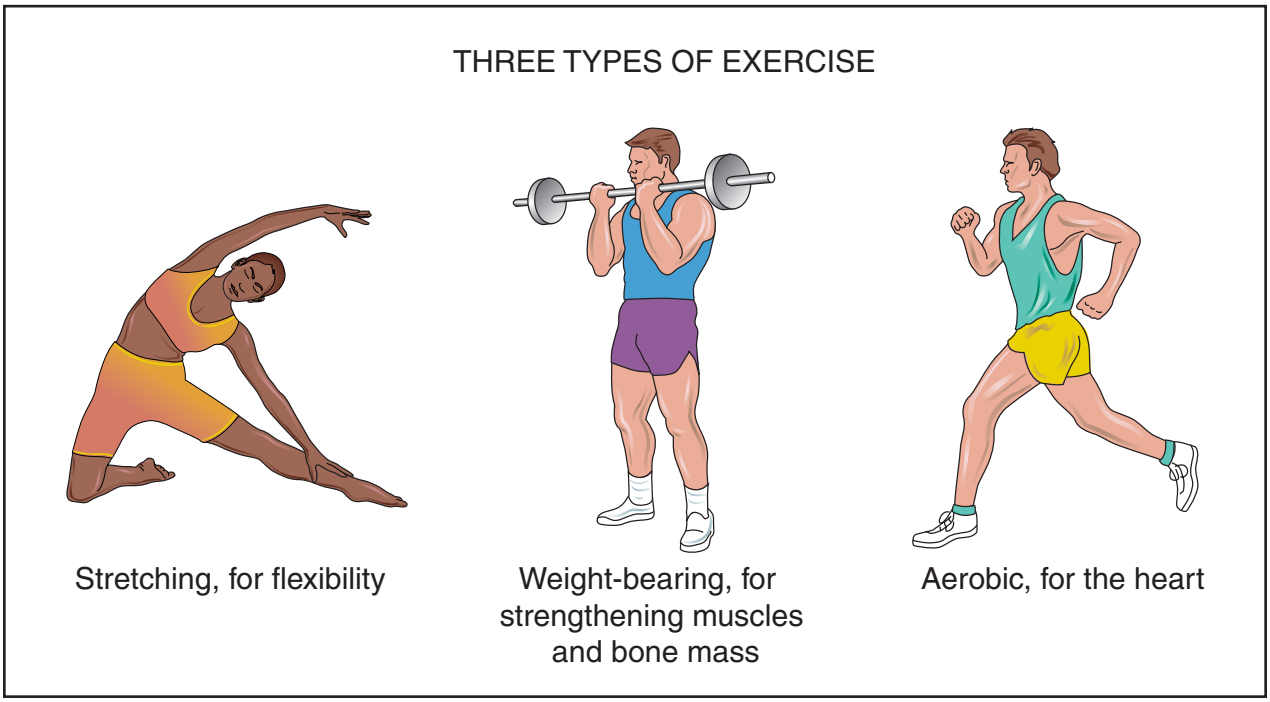
Precautions

Before beginning any exercise program, an evaluation by a physician is recommended to rule out any potential health risks. Once health and fitness are determined, and any or all physical restrictions identified, an individual's exercise program should be under the supervision of a health care professional. This is especially the case when exercise is used as a form of rehabilitation. If symptoms of **dizziness**, nausea, excessive **shortness of breath**, or chest **pain** are present during any exercise program, an individual should stop the activity and inform a physician about these symptoms before resuming activity. Exercise equipment must be checked to determine if it can bear the weight of people of all sizes and shapes.

Description

Range of motion exercise

Range of motion exercise refers to activity whose goal is improving movement of a specific joint. This



Exercise is utilized to improve health, maintain fitness, and is important as a means of physical rehabilitation. *(Illustration by Electronic Illustrators Group.)*

motion is influenced by several structures: configuration of bone surfaces within the joint, joint capsule, ligaments, and muscles and tendons acting on the joint. There are three types of range of motion exercises: passive, active, and active assists. Passive range of motion is movement applied to a joint solely by another person or persons or a passive motion machine. When passive range of motion is applied, the joint of an individual receiving exercise is completely relaxed while the outside force moves the body part, such as a leg or arm, throughout the available range. Injury, surgery, or **immobilization** of a joint may affect the normal joint range of motion. Active range of motion is movement of a joint provided entirely by the individual performing the exercise. In this case, there is no outside force aiding in the movement. Active assist range of motion is described as a joint receiving partial assistance from an outside force. This range of motion may result from the majority of motion applied by an exerciser or by the person or persons assisting the individual. It may also be a half-and-half effort on the joint from each source.

Strengthening exercise

Strengthening exercise increases muscle strength and mass, bone strength, and the body's metabolism. It can help attain and maintain proper weight and improve body image and self-esteem. A certain level of muscle strength is needed to do daily activities, such as walking, running and climbing stairs. Strengthening exercises increase this muscle strength by putting more strain on a muscle than it is normally accustomed to receiving. This increased load stimulates the growth of proteins inside each muscle cell that allow the muscle as a whole to contract. There is evidence indicating that strength training may be better than aerobic exercise alone for improving self-esteem and body image. Weight training allows one immediate feedback, through observation of progress in muscle growth and improved muscle tone. Strengthening exercise can take the form of isometric, isotonic and isokinetic strengthening.

ISOMETRIC EXERCISE. During isometric exercises, muscles contract. However, there is no motion in the affected joints. The muscle fibers maintain a constant length throughout the entire contraction. The exercises are usually performed against an immovable surface or object such as pressing one's hand against a wall. The muscles of the arm are contracting but the wall is not reacting or moving as a result of the physical effort. Isometric training is effective for developing total strength of a particular muscle or group of muscles. It is often used for rehabilitation since the exact area of muscle weakness can be isolated and strengthening can be administered at the proper joint angle. This kind of training can provide a relatively quick and convenient method

for overloading and strengthening muscles without any special equipment and with little chance of injury.

ISOTONIC EXERCISE. Isotonic exercise differs from isometric exercise in that there is movement of a joint during the muscle contraction. A classic example of an isotonic exercise is weight training with dumbbells and barbells. As the weight is lifted throughout the range of motion, the muscle shortens and lengthens. Calisthenics are also an example of isotonic exercise. These would include chin-ups, push-ups, and sit-ups, all of which use body weight as the resistance force.

ISOKINETIC EXERCISE. Isokinetic exercise utilizes machines that control the speed of contraction within the range of motion. Isokinetic exercise attempts to combine the best features of both isometrics and weight training. It provides muscular overload at a constant preset speed while a muscle mobilizes its force through the full range of motion. For example, an isokinetic stationary bicycle set at 90 revolutions per minute means that despite how hard and fast the exerciser works, the isokinetic properties of the bicycle will allow the exerciser to pedal only as fast as 90 revolutions per minute. Machines known as Cybex and Biodex provide isokinetic results; they are generally used by physical therapists and are not readily available to the general population.

Cardiac rehabilitation

Exercise can be very helpful in prevention and rehabilitation of cardiac disorders and disease. With an individually designed exercise program set at a level considered safe for that individual, people with symptoms of **heart failure** can substantially improve their fitness levels. The greatest benefit occurs as muscles improve the efficiency of their oxygen use, which reduces the need for the heart to pump as much blood. While such exercise doesn't appear to improve the condition of the heart itself, the increased fitness level reduces the total workload of the heart. The related increase in endurance should also translate into a generally more active lifestyle. Endurance or aerobic routines, such as running, brisk walking, cycling, or swimming, increase the strength and efficiency of the muscles of the heart.

Preparation

A **physical examination** by a physician is important to determine if strenuous exercise is appropriate or detrimental for an individual. Prior to the exercise program, proper stretching is important to prevent the possibility of soft tissue injury resulting from tight muscles, tendons, ligaments, and other joint-related structures.

KEY TERMS

Aerobic—Exercise training that is geared to provide a sufficient cardiovascular overload to stimulate increases in cardiac output.

Calisthenics—Exercise involving free movement without the aid of equipment.

Endurance—The time limit of a person's ability to maintain either a specific force or power involving muscular contractions.

Osteoporosis—A disorder characterized by loss of calcium in the bone, leading to thinning of the bones. It occurs frequently in postmenopausal women.

Aftercare

Proper cool down after exercise is important in reducing the occurrence of painful muscle spasms. It has been documented that proper cool down may also decrease frequency and intensity of muscle stiffness the day following any exercise program.

Risks

Improper warm up can lead to muscle strains. Overexertion with not enough time between exercise sessions to recuperate can also lead to muscle strains, resulting in inactivity due to pain. **Stress fractures** are also a possibility if activities are strenuous over long periods of time without proper rest. Although exercise is safe for the majority of children and adults, there is still a need for further studies to identify potential risks.

Normal results

Significant health benefits are obtained by including a moderate amount of physical exercise in the form of an exercise prescription. This is much like a drug prescription in that it also helps enhance the health of those who take it in the proper dosage. Physical activity plays a positive role in preventing disease and improving overall health status. People of all ages, both male and female, benefit from regular physical activity. Regular exercise also provides significant psychological benefits and improves quality of life.

Abnormal results

There is a possibility of exercise burnout if an exercise program is not varied and adequate rest periods are

not taken between exercise sessions. Muscle, joint, and cardiac disorders have been noted among people who exercise. However, they often have had preexisting or underlying illnesses.

Resources

BOOKS

Bookhout, Mark R., and Grenman, Philip. *Principles of Exercise Prescription*. Woburn, MA: Butterworth-Heinemann, 2001.

Harr, Eric. *The Portable Personal Trainer.* New York: Broadway Books, 2001.

McArdle, William D., Frank I. Katch, and Victor L. Katch. *Exercise Physiology: Energy, Nutrition, and Human Performance, 5th ed*. Philadelphia: Lippincott, 2001.

Redding, Morgan. *Physical Fitness : Concepts and Applications*. Dubuque, IA: Kendall/Hunt Publishing, 2001.

Roberts, Matt. *90-Day Fitness Plan*. Littleton, CO: DK Publishers, 2001.

PERIODICALS

Brun, J. F., M. Dumortier, C. Fedou, and J. Mercier. "Exercise Hypoglycemia in Nondiabetic Subjects." *Diabetes and Metabolism* 27 (2001): 92-106.

Evans, E. M., R. E. Van Pelt, E. F. Binder, D. B. Williams, A. A. Ehsani, and W. M. Kohrt. "Effects of HRT and Exercise Training on Insulin Action, Glucose Tolerance, and Body Composition in Older Women." *Journal of Applied Physiology* 90 (2001): 2033-2040.

Killian, K. J. "Is Exercise Tolerance Limited by the Hart or the Lungs?" *Clinical Investigations in Medicine* 24 (2001): 110-117.

Resnick, B. "Testing a model of exercise behavior in older adults". *Research in Nursing and Health*, 24 no. 2: 83-92. (2001).

ORGANIZATIONS

American Alliance for Health, Physical Education, Recreation & Dance. 1900 Association Dr., Reston, VA 20191-1598. (800) 213-7193. Fax: (703) 476-9527. <aahperd@aahperd.org>. <http://www.aahperd.org>.

American College of Sports Medicine. 401 W. Michigan Street, Indianapolis, IN 46202-3233. (317) 637-9200. Fax: (317) 634-7817. <mkeckhaver@acsm.org>. <http://www.acsm.org/>.

American Council on Exercise. 5820 Oberlin Drive, Suite 102, San Diego, CA 92121-3787. (800) 825-3636. Fax: (858) 535-1778. <http://www.acefitness. org/>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http://www.ama-assn.org/>.

American Physical Therapy Association. 1111 North Fairfax Street Alexandria, VA 22314. (703) 684-2782. <http://www.apta.org>.

National Athletic Trainers' Association. 2952 Stemmons Freeway, Dallas, TX 75247-6916. (800) 879-6282. Fax: (214) 637-2206. <http://www.nata.org/>.

OTHER

American Diabetes Association. <http://www.diabetes.org/exercise/>.

American Heart Association. <http://www.americanheart.org>.

American Orthopaedic Society for Sports Medicine. <http://www.sportsmed.org/>.

American Society of Exercise Physiologists. <http://www.css.edu/asep/>.

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Exercise electrocardiogram *see* **Stress test**

Exercise stress test *see* **Stress test**

Exhibitionism *see* **Sexual perversions**

Exocrine pancreatic cancer *see* **Pancreatic cancer, exocrine**

Exophthalmos

Definition

When there is an increase in the volume of the tissue behind the eyes, the eyes will appear to bulge out of the face. The terms exophthalmos and proptosis apply. Proptosis can refer to any organ that is displaced forward, while exophthalmos refers just to the eyes.

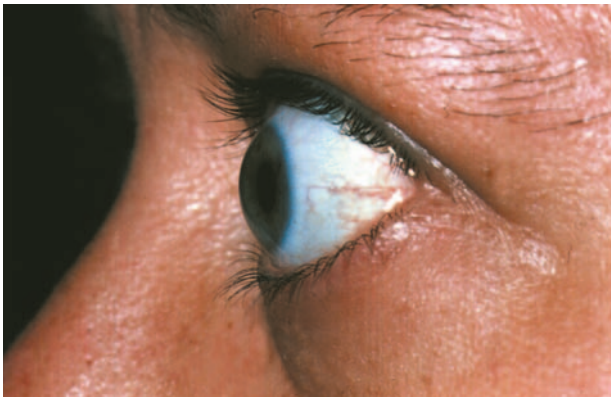
Description

The eye socket (orbit) is made of bone and therefore will not yield to increased pressure within it. Only forward displacement of the eyeball (globe) will allow more room if tissue behind the eye is increasing.

Causes and symptoms

The most common cause of exophthalmos is Graves' disease, overactivity of the thyroid gland. The contents of the orbits swell due to inflammation, forcing the eyes forward. The inflammation affects primarily the muscles. This combination of muscle impairment and forward displacement reduces eye movement, causing double vision and crossed eyes (**strabismus**). The optic nerves can also be affected, reducing vision, and the clear membrane (conjunctiva) covering the white part of the eyes and lining the inside of the eyelids can swell. Finally, the eyes may protrude so far that the eyelids cannot close over them, leading to corneal damage.

Exophthalmos from Graves' disease is bilateral (occurring on both sides), but not necessarily symmetri-



A side view of the bulging eye (exophthalmos) of a person suffering from thytoxicosis. Exophthalmos is caused by swelling of the soft tissue in the eye socket, which forces the eyeball to be pushed forward and the eyelids stretched apart. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

cal. In contrast, exophthalmos from orbital tumors or a blood clot in the brain happens on only one side.

Diagnosis

Exophthalmos is obvious when it is advanced enough to cause complications. When there is doubt in the early stages, a mechanical device called an exophthalmometer can measure the protrusion. **Computed tomography scans** (CT scans) are of great value in examining the bony components of the orbit. **Magnetic resonance imaging** (MRI) scanning is equally valuable for displaying the contents of the orbit, because it "sees through" the bone.

Treatment

If a tumor is growing behind the eye, it needs to be removed. If Graves' disease is the cause, it may subside with treatment of the overactive thyroid, but this is not guaranteed. Local care to the front of the eye to keep it moist is necessary if the eyelid cannot close.

Prognosis

Exophthalmos can be progressive. Its progress must be carefully followed, treating complications as they occur.

Prevention

Vision can usually be preserved with attentive treatment. There is currently no way to prevent any of the underlying conditions that lead to exophthalmos.

KEY TERMS

Conjunctivae—The clear membranes that line the inside of the eyelids and cover the white part (sclera) of the eyeballs.

Cornea—The clear, dome-shaped part of the front of the eye, through which light first enters the eye. It is located in front of the colored part of the eye (iris).

Inflammation—The body's reaction to invasion by foreign matter, particularly infection. The result is swelling and redness from an increase in water and blood, and pain from the chemical activity of the reaction.

Strabismus—Any deviation of the eyes from a common direction. Commonly called a turned eye.

Thyroid—A gland in the neck overlying the windpipe that regulates the speed of metabolic processes by producing a hormone, thyroxin.

Resources

BOOKS

Newell, Frank W. "Endocrine Disease and the Eye." In *Ophthalmology: Principles and Concepts*. 8th ed. St. Louis: Mosby, 1996.

Newell, Frank W. "The Orbit." In *Ophthalmology: Principles and Concepts*. 8th ed. St. Louis: Mosby, 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Expectorants

Definition

Expectorants are drugs that loosen and clear mucus and phlegm from the respiratory tract.

Purpose

The drug described here, guaifenesin, is a common ingredient in **cough** medicines. It is classified as an expectorant, a medicine that helps clear mucus and other secretions from the respiratory tract. However, some debate exists about how effectively guaifenesin does this. In addition, some cough medicines contain other ingredi-

KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bronchitis—Inflammation of the air passages of the lungs.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Cough suppressant—Medicine that stops or prevents coughing.

Emphysema—An irreversible lung disease in which breathing becomes increasingly difficult.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Phlegm—Thick mucus produced in the air passages.

Respiratory tract—The air passages from the nose into the lungs.

Secretion—A substance, such as saliva or mucus, that is produced and given off by a cell or a gland.

ents that may cancel out guaifenesin's effects. **Cough suppressants** such as codeine, for example, work against guaifenesin because they discourage coughing up the secretions that the expectorant loosens.

There are other ways to loosen and clear the respiratory secretions associated with colds. These include using a humidifier and drinking six to eight glasses of water a day.

Description

Guaifenesin is an ingredient in many cough medicines, such as Anti-Tuss, Dristan Cold & Cough, Guaifed, GuaiCough, and some Robitussin products. Some products that contain guaifenesin are available only with a physician's prescription; others can be bought without a prescription. They come in several forms, including capsules, tablets, and liquids.

Recommended dosage

Adults and children 12 and over

200–400 mg every four hours. No more than 2,400 mg in 24 hours.

Children 6–11

100–200 mg every four hours. No more than 1,200 mg in 24 hours.

Children 2–5

50–100 mg every four hours. No more than 600 mg in 24 hours.

Children under two

Not recommended.

Precautions

Do not take more than the recommended daily dosage of guaifenesin.

Guaifenesin is not meant to be used for coughs associated with **asthma**, **emphysema**, chronic **bronchitis**, or **smoking**. It also should not be used for coughs that are producing a large amount of mucus.

A lingering cough could be a sign of a serious medical condition. Coughs that last more than seven days or are associated with **fever**, rash, **sore throat**, or lasting **headache** should have medical attention. Call a physician as soon as possible.

Some studies suggest that guaifenesin causes **birth defects**. Women who are pregnant or plan to become pregnant should check with their physicians before using any products that contain guaifenesin. Whether guaifenesin passes into breast milk is not known, but no ill effects have been reported in nursing babies whose mothers used guaifenesin.

Side effects

Side effects are rare, but may include vomiting, **diarrhea**, stomach upset, headache, skin rash, and **hives**.

Interactions

Guaifenesin is not known to interact with any foods or other drugs. However, cough medicines that contain guaifenesin may contain other ingredients that do interact with foods or drugs. Check with a physician or pharmacist for details about specific products.

Nancy Ross-Flanigan

Exstrophy of the urinary bladder *see* **Congenital bladder anomalies**

External fetal monitoring *see* **Electronic fetal monitoring**

External otitis *see* **Otitis externa**

External sphincter electromyography

Definition

External sphincter **electromyography** helps physicians determine how well the external urinary sphincter muscle is working by measuring the electrical activity in it during contraction and relaxation.

KEY TERMS

Anti-cholinergic drug—A medication that blocks or subdues the action of the neurotransmitter acetylcholine.

Cholinergic drug—A medication that mimics or enhances the action of the neurotransmitter acetylcholine.

Sphincter—A circular muscle that aids in the opening or closing of an opening in the body.

Purpose

The external sphincter muscle is the ring-like muscle that controls urine release from the bladder. When a patient cannot voluntarily control urination (incontinence), a physician may order this test to determine if the problem is caused by the failure of this muscle. The voluntary contraction or release of a muscle such as the external sphincter involves a complex process in which the nerves controlling the muscle signal it to move through the release and uptake of chemicals called neurotransmitters and the generation of electrical impulses. This test records the electrical impulses given off when the muscle contracts or relaxes and allows the physician to determine if the muscle is working properly, if it has been damaged by disease, or some other condition.

Precautions

Patients who are taking **muscle relaxants** or drugs that act like or have an effect on the neurotransmitter acetylcholine (cholinergic or anti-cholinergic drugs) should tell the doctor since they will change the test results. The results will also be altered if the patient moves during the test or if the electrodes are improperly placed.

Description

The patient puts on a surgical gown and lies down on the examining table. The procedure, which takes between 30–60 minutes, may be conducted one of three ways:

- Skin electrodes. This is the most commonly used method of recording information. The skin where the electrodes will be placed is cleaned and shaved and an electrically conductive paste is applied. The electrodes are then taped in place. For female patients, the electrodes are taped around the urethra, while for male patients they are placed between the scrotum and the anus.
- Needle electrodes. This is considered the most accurate method, since the electrodes are inserted directly into the muscle, using needles to guide placement. For male patients, a gloved finger is inserted in the rectum, then needles with wires attached are inserted through the skin between the anus and the scrotum. For female patients, the needles are inserted around the urethra. The discomfort of placing the needles is about the same as that of an injection. The needles are withdrawn, and the wires are taped to the thigh.
- Anal plug electrodes. The tip of an anal plug is lubricated and inserted into the rectum as the patient relaxes the anal sphincter. Electrodes are attached to the anal plug.

Once the electrodes are in place and attached to the recording device, the patient is asked to alternately contract and relax the external sphincter muscle. The electrical activity generated during these contractions and relaxations is recorded on a graph called an electromyogram.

Preparation

Before the test, the patient should discuss with the doctor whether it is necessary to temporarily discontinue any medications, and follow the doctor's orders. No changes in diet or activity are necessary.

Aftercare

Women may see some blood in their urine the first time they urinate after the test. Blood in the urine of men or blood in the urine of women after the first urination should be reported the doctor. The patient should take a warm bath and drink plenty of fluids to ease any discomfort after the test.

Risks

Complications of external sphincter electromyography are rare. Occasionally patients report blood in their urine after being tested with needle electrodes. Also, the urethra may become mildly irritated causing a change in the normal frequency of urination.

Normal results

In a normally functioning external sphincter muscle, the electromyogram will show increased electrical activi-

ty when the patient tightens the muscle and a little or no electrical activity when it is relaxed.

Abnormal results

A diseased external sphincter muscle will produce an abnormal pattern of electrical activity. Conditions that affect the external sphincter may include **multiple sclerosis**, **neurogenic bladder**, **Parkinson's disease**, **spinal cord injury**, and **stress** incontinence. However, additional tests must be done in order to confirm any of these diagnoses.

Resources

BOOKS

"External Sphincter Electromyography." In *Illustrated Guide to Diagnostic Tests*, ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

Tish Davidson

Extracorporeal membrane oxygenation

Definition

Extracorporeal membrane oxygenation (ECMO) is a special procedure that uses an artificial heart-lung machine to take over the work of the lungs (and sometimes also the heart). ECMO is used most often in newborns and young children, but it also can be used as a last resort for adults whose heart or lungs are failing.

Purpose

In newborns, ECMO is used to support or replace an infant's undeveloped or failing lungs by providing oxygen and removing carbon dioxide waste products so the lungs can rest. Infants who need ECMO may include those with:

- meconium aspiration syndrome (breathing in of a newborn's first stool by a fetus or newborn, which can block air passages and interfere with lung expansion)
- persistent **pulmonary hypertension** (a disorder in which the blood pressure in the arteries supplying the lungs is abnormally high)
- respiratory distress syndrome (a lung disorder usually of premature infants that causes increasing difficulty in breathing, leading to a life-threatening deficiency of oxygen in the blood)
- congenital diaphragmatic **hernia** (the profusion of part of the stomach through an opening in the diaphragm).
- pneumonia
- blood **poisoning**

ECMO is also used to support a child or adult patient's damaged, infected, or failing lungs for a few hours to allow treatment or healing. It is effective for those patients with severe, but reversible, heart or lung problems who haven't responded to treatment with a ventilator, drugs, or extra oxygen. Adults and children who need ECMO usually have one of these problems:

- heart failure
- pneumonia
- **respiratory failure** caused by trauma or severe infection

The ECMO procedure can help a patient's lungs and heart rest and recover, but it will not cure the underlying disease. Any patient who requires ECMO is seriously ill and will likely die without the treatment. Because there is some risk involved, this method is used only when other means of support have failed.

Precautions

Typically, ECMO patients have daily chest x rays and blood work, and constant vital sign monitoring. They are usually placed on a special rotating bed that is designed to decrease pressure on the skin and help move secretions from the lungs.

After the patient is stable on ECMO, the breathing machine settings will be lowered to "rest" settings, which allows the lungs to rest without the risk of too much oxygen or pressure from the ventilator.

Description

There are two types of ECMO: Venoarterial (V-A) ECMO supports the heart and lungs, and is used for patients with blood pressure or heart functioning problems in addition to respiratory problems. Venovenous (V-V) ECMO supports the lungs only.

V-A ECMO requires the insertion of two tubes, one in the jugular and one in the carotid artery. In the V-V ECMO procedure, the surgeon places a plastic tube into the jugular vein through a small incision in the neck.

Once in place, the tubes are connected to the ECMO circuit, and then the machine is turned on. The patient's blood flows out through the tube and may look very dark because it contains very little oxygen. A pump pushes the blood through an artificial membrane lung, where oxygen is added and carbon dioxide is removed. The size of the

artificial lung depends on the size of the patient; sometimes adults need two lungs. The blood is then warmed and returned to the patient. A steady amount of blood (called the flow rate) is pushed through the ECMO machine every minute. As the patient improves, the flow rate is lowered.

Many patients require heavy **sedation** while they are on ECMO to lessen the amount of oxygen needed by the muscles.

As the patient improves, the amount of ECMO support will be decreased gradually, until the machine is turned off for a brief trial period. If the patient does well without ECMO, the treatment is stopped.

Typically, newborns remain on ECMO for three to seven days, although some babies need more time (especially if they have a diaphragmatic hernia). Once the baby is off ECMO, he or she will still need a ventilator (breathing machine) for a few days or weeks. Adults may remain on ECMO for days to weeks, depending on the condition of the patient, but treatment may be continued for a longer time depending on the type of heart or lung disease, the amount of damage to the lungs before ECMO was begun, and the presence of any other illnesses or health problems.

Preparation

Before ECMO is begun, the patient receives medication to ease **pain** and restrict movement.

Aftercare

Because infants on ECMO may have been struggling with low oxygen levels before treatment, they may be at higher risk for developmental problems. They will need to be monitored as they grow.

Risks

Bleeding is the biggest risk for ECMO patients, since blood thinners are given to guard against blood clots. Bleeding can occur anywhere in the body, but is most serious when it occurs in the brain. This is why doctors periodically perform ultrasound brain scans of anyone on ECMO. **Stroke**, which may be caused by bleeding or blood clots in the brain, has occurred in some patients undergoing ECMO.

If bleeding becomes a problem, the patient may require frequent blood transfusions or operations to control the bleeding. If the bleeding can't be stopped, ECMO will be withdrawn.

Other risks include infection or vocal cord injury. Some patients develop severe blood infections that cause irreversible damage to vital organs.

KEY TERMS

Carotid artery—Two main arteries (passageway carrying blood from the heart to other parts of the body) that carry blood to the brain.

Congenital diaphragmatic hernia—The profusion of part of the stomach through an opening in the diaphragm.

Meconium aspiration syndrome—Breathing in of meconium (a newborn's first stool) by a fetus or newborn, which can block air passages and interfere with lung expansion.

Membrane oxygenator—The artificial lung that adds oxygen and removes carbon dioxide.

Pulmonary hypertension—A disorder in which the blood pressure in the arteries supplying the lungs is abnormally high.

Respiratory distress syndrome—A lung disorder usually of premature infants that causes increasing difficulty in breathing, leading to a life-threatening deficiency of oxygen in the blood.

Venoarterial (V-A) bypass—The type of ECMO that provides both heart and lung support, using two tubes (one in the jugular vein and one in the carotid artery).

Venovenous (V-V) bypass—The type of ECMO that provides lung support only, using a tube inserted into the jugular vein.

There is a small chance that some part of the complex equipment may fail, which could introduce air into the system or affect the patient's blood levels, causing damage or **death** of vital organs (including the brain). For this reason, the ECMO circuit is constantly monitored by a trained technologist.

Normal results

Lungs and/or heart return to healthy functioning.

Abnormal results

Lungs and/or heart do not improve while on ECMO.

Resources

PERIODICALS

American Academy of Pediatrics. "Recommendations on Extracorporeal Membrane Oxygenation." *Pediatrics* 85 (Apr. 1990): 618-619.

Anderson III, Harry, and Cynthia Steimie, et al. "Extracorporeal Life Support for Adult Cardiorespiratory Failure." *Surgery* 114 (1993): 161.

Shanley, Charles J., Ronald B. Hirschi, et.al. "Extracorporeal Life Support for Neonatal Respiratory Failure: A 20-year Experience." *Annals of Surgery* 220 (1994): 269.

UK Collaborative ECMO Trial Group. "Extracorporeal Membrane Oxygenation Improved Survival in Mature Newborn Infants with Severe Respiratory Failure." *Lancet* 348 (13 July 1996): 75-82.

ORGANIZATIONS

American Society of Extra-Corporeal Technology. 11480 Sunset Hills Rd., Ste. 210E, Reston, VA 20190. (703) 435-8556. <http://www.amsect.org>.

ECMO Moms and Dads. PO Box 53848, Lubbock, TX 79543. (806) 794-0259.

Extracorporeal Life Support Organization. 1327 Jones Dr., Ste. 101, Ann Arbor, MI 48105. (734) 998-6600. <http://www.elso.med.umich.edu>.

Carol A. Turkington

Extracorporeal shock-wave *see* **Lithotripsy**

Extrinsic allergic alveolitis *see* **Hypersensitivity pneumonitis**

Eye and orbit sonograms *see* **Eye and orbit ultrasounds**

Eye and orbit ultrasounds

Definition

Ultrasound imaging equipment allows eye specialists (ophthalmologists) to "see" the eye in great detail without the **pain** and risk of exploratory surgery, or the limitations and uncertainty inherent to traditional visual examination. Ultrasound is used to detect and diagnose many eye diseases and injuries, to measure the eye prior to corrective surgery, and directly as a treatment tool.

Purpose

An ophthalmologist uses ultrasonic imaging to help diagnose the underlying cause(s) of a patient's symptoms, to assess the general condition of an injured eye, and to measure the eye prior to corrective surgery. Situations that may call for ultrasonic imaging include:

- Excessive tearing or visible infection. These external symptoms could indicate a serious underlying problem such as a tumor, an internal infection, the presence of a deeply lodged irritant (foreign body), or the effects of a previously unrecognized injury. When presented with general symptoms, ultrasound can speed diagnosis if a serious condition is suspected.
- Impaired vision. Fuzzy vision, poor night vision, restricted (tunnel) vision, blind spots, extreme light sensitivity, and even blindness can all stem from inner eye conditions ranging from **glaucoma** and **cataracts**, to retinitis, detached retina, tumors, or impaired blood circulation. Again, high resolution ultrasound can quickly identify causes and pinpoint their location. A special type of ultrasound, known as Doppler, can even perceive and measure circulation in the tiny blood vessels of the eye.
- Eye trauma. The eye can be damaged by a direct impact or a puncture wound, as a result of a general head trauma, or by intense light exposure. Even when the cause of injury is obvious, ultrasound can reveal the exact type, extent, and location of damage, from deformations and ruptures to internal bleeding, and help to guide emergency care efforts.
- Lens replacement surgery. Exact measurement of the eye's optical dimensions with ultrasound greatly improves the visual outcome for cataract patients receiving permanent synthetic lenses; and for severely myopic patients receiving implanted corrective lenses.

Ophthalmic ultrasound imaging is also used routinely to guide the precise placement of instruments during surgery, and can be used directly for the treatment of glaucoma and tumors of the eye.

Precautions

Ultrasound of the eye, properly performed by qualified personnel using appropriate equipment, has no risks. There is no evidence to suggest that the procedure itself poses any threat to a healthy eye, or worsens the condition of a diseased or injured eye.

Description

Ophthalmic ultrasound equipment sends high frequency pulses of sound into the eye, where they bounce off the boundaries between different structures in the eye and produce a distinctive pattern of echoes. This echo pattern is received and interpreted by a computer to produce an image on a television screen. The time it takes an echo to return to the receiver corresponds to the depth it traveled into the eye.

Single transducer (the sound transmitter/receiver) ultrasound is used to measure distances within the eye. This is A-mode ultrasound. A linear array of transduc-

ers in a single small probe, B-mode, provides a picture of a cross section through the eye. Doppler mode ultrasound combines B-mode with the ability to detect and measure the flow of blood in the tiny vessels of the eye.

As a direct treatment tool, the vibrations of high intensity A-mode ultrasound can be used to heat and erode tumors. The same technique can be used to control glaucoma by selectively destroying the cells which produce the fluid that causes the internal pressure of the eye to rise.

The procedure followed in a regular ultrasonic **eye examination** is relatively simple. The patient relaxes in a comfortable chair in a darkened room. Mild anesthetic eye drops are administered and the head is held secure. The ultrasonic probe, coated with a sterile gel to ensure good contact, is lightly pressed against the eye as the images are made. The probe may be applied to the eyelid or directly to the eye, as necessary. The patient feels nothing else, and the whole office procedure takes about 15 minutes.

Preparation

Preparation by the patient is generally unnecessary, although under special circumstances an ophthalmologist may perform pretest procedures. The ophthalmologist and/or ultrasound technician will conduct all preparations at the time of the test.

Aftercare

Patients may experience partial and temporary blurred vision, as well as "eye strain" headaches. These symptoms usually fade within an hour of the procedure, during which time patients should rest their eyes and avoid all activities that require good eyesight, like driving.

Risks

Improperly focused, high-intensity ultrasound could burn and physically disrupt delicate eye tissue and cause injury. This risk is, however, slight and would arise only from improper use, or as a potential side effect of tumor or glaucoma treatment.

Normal results

A normal ultrasound scan would indicate a fully healthy eye. For therapeutic ultrasound, a normal result would be an improvement in the targeted condition, such as shrinking of a tumor or lessening of pressure inside the eye of a glaucoma patient.

KEY TERMS

Cataracts—A clouding of the lens of the eye or the material immediately surrounding it, causing blurred vision. For many people it occurs naturally with aging, but may also result from injury.

Glaucoma—A common eye disease characterized by increased fluid pressure in the eye that damages the optic nerve, which carries sensations to the brain. Glaucoma can be caused by another eye disorder, such as a tumor or congenital malformation, or appear without obvious cause, but if untreated it generally leads to blindness.

Intraocular—Literally, within the eye.

Ophthalmologist—A medical doctor specializing in eye care who is generally, but not necessarily, an eye surgeon.

Retina—The third and innermost membrane of the eye, which contains the light-sensitive nerve tissue that leads into the optic nerve and is the primary instument of vision. Inflammation of the retina (retinitis) has many causes, including over-exposure to intense light, diabetes, and syphilis.

Abnormal results

Because diagnostic ultrasound is generally used to investigate symptoms, the results of a scan will often be abnormal and they will detect evidence of an underlying condition.

Resources

BOOKS

Guthoff, Rudolf. *Ultrsound in Ophthalmologic Diagnosis: A Practical Guide*. New York: Thieme Medical Publishers, 1991.

Shtasel, Philip. *Medical Tests and Diagnostic Procedures: A Patient's Guide to Just What the Doctor Ordered*. New York: Harper & Row, 1991.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

Moyer, Paula. "High-frequency Doppler Boosts Small Vessel Imaging." *Ophthalmology Times* (15 Oct. 1996): 50.

Murray, Maxine. "Basics of Ultrasonography." *Student British Medical Journal* (Aug. 1996): 269-272.

Nash, Karen. "High Tech A/B-scans: How High?" *Ophthalmology Times* (Apr. 1995): 19.

Sabbagh, Leslie. "The Growing Effect of Ultrasound." *Ophthalmology Times* (Jan. 1995): 16.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Institute of Ultrasound in Medicine. 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707-5906. (800) 638-5352. <http://www.aium.org>.

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892-3655. (301) 496-5248. <http://www.nei.nih.gov>.

Kurt Richard Sternlof

Eye cancer

Definition

A cancerous growth in any part of the eye.

Description

Eye **cancer** can occur in many parts of the eye where a tumor can occur. Because of this there are several types of ocular cancer. Their occurrence varies in the age of the affected individual. This article will focus on **retinoblastoma**, the most common eye cancer in children, and intraocular melanoma, the most common eye cancer in adults.

Retinoblastoma can occur at any age but is most often seen in children younger than five. About 200 children a year are diagnosed with it in the United States. Retinoblastoma starts with a small tumor in the retina, the very back of the eye. In growing children, the retina originates from cells called retinoblasts that grow and divide very quickly. These cells eventually become the mature cells of the retina when they stop growing. In the case of retinoblastoma the retinoblasts don't stop growing and form a tumor that can continue to grow and cause further complications if not treated quickly.

Retinoblastoma typically has three classifications: intraocular, extraocular and recurrent retinoblastoma. In the intraocular form the cancer can be found in one or both eyes but not in tissue external of the eye. In the extraocular form the cancer has spread outside the eye. It can spread to the tissue surrounding the eye or it can invade other areas of the body. In the recurrent form the cancer returns after already being treated. It may recur in the eye, its surrounding tissues, or elsewhere in the body.

Intraocular melanoma is a rare cancer overall, yet it is the most common eye cancer seen in adults. It is when cancer cells are found in the uvea of the eye. The uvea includes the iris (the colored portion of eye), the ciliary body (an eye muscle that focuses the lens) and the choroid (found in the back of the eye next to the retina).

Intraocular cancer of the iris usually grows slowly and usually doesn't spread. The tumor is seen on the iris as a darker spot than the surrounding area. Intraocular cancer of the choroid or ciliary body occurs in the back of the eye. They are classified by size with a small tumor being 2-3 mm or smaller and a medium or large tumor being bigger than 3 mm.

Intraocular cancer can spread and become extraocular as well. If not found and treated early enough it can spread to the surrounding tissues, the optic nerve or into the eye socket.

Causes and symptoms

Genetics is thought to play a role in eye cancer. In regards to retinoblastoma, it is believed that if a tumor develops only in one eye then it isn't hereditary. However, if a tumor occurs in both eyes then it is hereditary. Those who have hereditary retinoblastoma have a rare risk of developing a tumor in the brain and should be monitored on a regular basis.

The cause of intraocular melanoma is still vague. Genetics could play a role, but age is also a factor. Interestingly enough, this type of cancer is seen most often in white people from a northern European descent.

The symptoms of this type of cancer usually begin with blurred vision and tenderness of the eye. Advanced symptoms may include loss of vision. If these symptoms persist a person should make an appointment with their ophthalmologist.

Diagnosis

An ophthalmologist makes a diagnosis. The doctor is usually able to see the tumor through the pupil or directly on the iris if the cancer is intraocular melanoma of the iris. Because the doctor can usually readily see the tumor a biopsy is rarely needed.

An ultrasound or a fluorescein **angiography** are two tests doctors use to further diagnose eye cancers. In an ultrasound sound waves are pointed at the tumor and depending on how they reflect off the tumor the doctor can better diagnose it. In a fluorescein angiography a fluorescent dye is injected into the patients arm. When this dye circulates through the body and reaches the eye a series of rapid pictures are taken through the pupil. The tumor will show up in these photos.

Once a diagnosis has been made, the treatment can begin.

Treatment

The treatment depends on how far advanced the tumor is. If the tumor is in the advanced stages and there is little hope of regaining vision the most effective treat-

ment is an enucleation, the removal of the eye. This obviously is a drastic treatment and is avoided if possible. Other eye surgeries include the following:

- choroidectomy-removal of part of the choroid,
- iridectomy-removal of part of the iris,
- iridocyclectomy-removal of parts of the ciliary body and parts of iris,
- iridotrabeculectomy-removal of parts of the supporting tissues around the cornea and iris.

In eye cancer where the tumor is small and there is a good chance that the vision will be restored less drastic measures than the above surgeries are taken. Radiation and **chemotherapy** are two courses of treatment that help in killing off the existing tumor and preventing its spread into other areas of the body.

Besides radiation and chemotherapy there are other methods of treating eye cancer. **Cryotherapy** uses extreme cold to destroy the cancer cells. Thermotherapy uses heat to destroy the cancer cells. Photocoagulation uses a laser to destroy blood vessels that supply the tumor with nutrients. If the tumor isn't advanced these are good options to treat it in order to avoid losing an eye.

A radiation/surgical treatment for eye cancer is brachytherapy. A small plaque with radioactive iodine on one side and gold on the other is stitched to the eye behind the tumor with the radioactive iodine facing the tumor. The gold is used to shield the other tissues from the radiation. It is left there for a period of time depending on the dosage of radiation needed and then it is removed. In this way the tumor is treated and hopefully will shrink and eventually die.

Alternative Treatment

Other than the treatments above, there aren't any alternative treatments. New clinical trials are constantly under way to further the treatment of the disease in the future.

Prognosis

All forms of retinoblastoma and intraocular melanoma are treatable. Enucleation can usually be avoided if found early enough. The outlook is positive for people with eye cancer.

Prevention

A good healthy diet and lifestyle are always recommended to prevent cancer. Known carcinogens should always be avoided.

KEY TERMS

Carcinogen—A substance that is known to cause cancer.

Cornea—The clear layer that covers the front part of the eye.

Enucleation—Surgical removal of the eye.

Pupil—The hole in the eye that allows light in.

Resources

PERIODICALS

Wilson, Czechonska, Finger, Rausen, Hooper, and Haik. "Chemotherapy for Eye Cancer." *Survey of Ophthalmology* (March/April 2001): 416-44.

OTHER

The American Cancer Society. 2000. <http://www.cancer.org>.
Cancer Net. 2001. <http://www.cancernet.nci.nih.gov>.
JHMI. 2001. <http://www.med.jhu.edu>.
National Eye Institute. 1998. <http://www.nei.nih.gov>.

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Ronald Watson, PhD

Eye examination

Definition

An eye examination is a series of tests that measure a person's ocular health and visual status, to detect abnormalities in the components of the visual system, and to determine how well the person can see.

Purpose

An eye examination is performed by an ophthalmologist M.D. or D.O. (doctor of **osteopathy**), or an optometrist (O.D.) to determine if there are any pre-existing or potential vision problems. Eye exams may also reveal the presence of many non-eye diseases. Many systemic diseases can affect the eyes, and since the blood vessels on the retina are observed during the exam, certain problems may be uncovered (e.g., high blood pressure or diabetes).

Infants should be examined by a physician to detect any physical abnormalities. Frequency of eye exams then generally differs with age and the health of the person. Eye exams can be performed in infants, and if a problem is

noted the infant can be seen, generally by a pediatric ophthalmologist. A child with no symptoms should have an eye exam at age three. Early exams are important because permanent decreases in vision (e.g., **amblyopia**, also called lazy eye) can occur if not treated early (usually by ages 6–9). Again, with no other symptoms, the second exam should take place before first grade. After first grade, the American Optometric Association recommends an eye exam every two years; ages 19–40, every two to three years; ages 41–60, every two years; and annually after that. However, these are recommendations for healthy people with no risk factors. Patients should ask their doctors how often they should come for exams. Some patients have risk factors for eye disease (e.g., people with diabetes or a family history of eye disease; African Americans, who are at higher risk for **glaucoma**) and may need more frequent checkups. Also, if children seem to be having trouble in school, problems with reading, rubbing their eyes when reading, etc., an eye exam may be necessary sooner.

Precautions

The examiner needs to know if the patient is taking any medications or has any existing health conditions. Some medications, even over-the-counter (OTC) medications can affect vision or even interfere with the eyedrops the doctor may use during the exam. Certain eyedrops would not be used if the patient has **asthma**, heart problems, or other conditions.

The patient may need someone to drive them home in case the eyes were dilated. Bringing sunglasses to the exam may also help decrease the glare from light until the dilating drops wear off.

Description

An eye examination, given by an ophthalmologist or optometrist, costs about $100. It may or may not be covered by insurance. It begins with information from the patient (case history) and continues with a set of primary tests, plus additional specialized tests given as needed, dictated by the outcomes of initial testing and the patient's age. The primary tests can be divided into two groups, those that evaluate the physical state of the eyes and surrounding areas, and those that measure the ability to see.

The order of the tests for the exam may differ from doctor to doctor, however, most exams will include the following procedures:

Information gathering and initial observations

The examiner will take eye and medical histories that include the patient's chief complaint, any past eye disorders, all medications being taken (e.g., OTC medications, **antibiotics**, and birth control pills), any blood relatives with eye disorders, and any systemic disorders the patient may have. The patient should also tell the doctor about hobbies and work conditions. This information helps in modifying prescriptions and lets the doctor know how the patient uses his or her eyes. For example, using a computer screen vs. construction work, the working distance of a computer screen may affect the prescription; the construction worker needs protective eyewear.

The patient should bring their current pair of glasses to the exam. The doctor can get the prescription from the glasses by using an instrument called a lensometer.

Visual acuity examination

Visual acuity measures how clearly the patient can see. It is measured for each eye separately, with and without the current prescription. It is usually measured with a Snellen eye chart, a poster with lines of different-sized letters, each line with a number at the side denoting the distance from which a person with normal vision can read that line. Other kinds of eye charts with identifiable figures are available for children or anyone unfamiliar with the Roman alphabet. These charts are made to be placed at a certain distance (usually 20 ft) from the person being tested. At this distance, people with normal vision can read a certain line (usually the lowest), marked the 20/20 line; these people are said to have 20/20 vision. For people who can't read the smallest line, the examiner assigns a ratio based on the smallest line they can read. The first number (numerator) of the ratio is the distance between the chart and the patient, and the second number (denominator) is the distance where a person with normal vision would be able to read that line. The ratio 20/40 means the patient can see at 20 ft. what people with normal vision can see at 40 ft. away.

When a patient is unable to read any lines on the chart, they are moved closer until they can read the line with the largest letters. The acuity is still measured the same way. A ratio of 5/200 means the person being tested can see at 5 ft what a normal person can see 200 ft.

When a patient can't read the chart at all, the examiner may hold up some fingers and ask the patient to count them at various distances, and records the result as "counting fingers" at the distance of recognition. If the patient cannot count the examiner's fingers at any distance, the examiner determines if the patient can see hand movements. If so, the result is recorded as "hand movements." If not, the examiner determines if the patient can detect light from a penlight. If the patient can detect the light but not its direction, the result is recorded at "light perception." If the patient can recognize its

direction, the result is recorded as "light projection." If the patient cannot detect the light at all, the result is recorded as "no light perception."

Eye movement examination and cover tests

The examiner asks the patient to look up and down, and to the right and left to see if the patient can move the eyes to their full extent. The examiner asks the patient to stare at an object, then quickly covers one eye and notes any movement in the eye that remains uncovered. This procedure is repeated with the other eye. This, and another similar cover test, helps to determine if there is an undetected eye turn or problem with fixation. The doctor may also have the patient look at a pen and follow it as it is moved close to the eyes. This checks convergence.

Iris and pupil examination

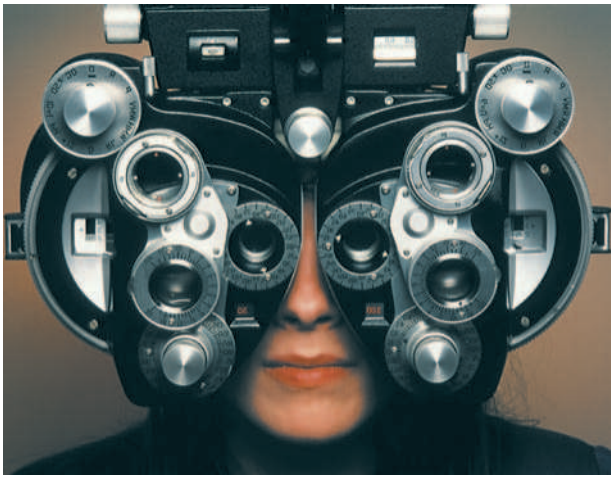
The doctor checks the pupil's response to light (if it dilates and constricts appropriately). The iris is viewed for symmetry and physical appearance. The iris is checked more thoroughly later using a slit lamp.

Refractive error determination-Refraction

The examiner will determine the refractive error and obtain a prescription for corrective lenses for people whose visual acuity is less than 20/20. An instrument called a phoropter, which the patient sits behind, is generally used (sometimes the refraction can be done with a trial frame that the patient wears). The phoropter is equipped with many lenses that allow the examiner to test many combinations of corrections to learn which correction allows the patient to see the eye chart most clearly. This is the part of the exam when the doctor usually says, "Which is better, one or two?" The phoropter also contains prisms, and sometimes the doctor will intentionally make the patient see double. This may help in determining a slight eye turn. The exam will check vision at distance and near (reading).

A prescription for corrective lenses can also be supplied by automated refracting devices, which measure the necessary refraction by shining a light into the eye and observing the reflected light. Another objective way to obtain a prescription is using a hand-held retinoscope. As in the automated method just mentioned, the doctor shines a light in the patient's eyes and can determine an objective prescription. This is helpful in young children or infants.

Sometimes drops will be instilled in the patient's eyes before this part of the exam. The drops may relax accommodation so that the refraction will be more accurate. This is helpful in children and people who are farsighted.



A woman looking through a refractor. *(Photograph by John Greim, Photo Researchers. Reproduced by permission.)*

After the refraction and other visual status tests, for example color tests or binocularity tests (can the patient see 3-D, or have depth perception), the doctor will check the health of the eyes and surrounding areas. The main instruments used are the ophthalmoscope and the slit lamp.

Ophthalmoscopic examination

These observations are best accomplished after dilating the pupils and require an ophthalmoscope. The ophthalmoscope most frequently used is a called a *direct ophthalmoscope*. It is a hand-held illuminated 15X multi-lens magnifier that lets the examiner view the inside back area of the eye (fundus). The retina, blood vessels, optic nerve, and other structures are examined.

Slit lamp examination

The slit lamp is a microscope with a light source that can be adjusted. This magnifies the external and some internal structures of the eyes. The lid and lid margin, cornea, iris, pupil, conjunctiva, sclera, and lens are examined. The slit lamp is also used in contact lens evaluations. A little probe called a tonometer may be used at this time to check the pressure of the eyes. A colored eyedrop may be instilled immediately prior to this test. The drop has a local anesthetic so the patient won't feel the probe touch the eye. It is a quick procedure.

Visual field measurement

A perimeter, the instrument for measuring visual fields, is a hollow hemisphere, equipped with a light source that projects dots of light over the inside surface. The patient's head is positioned so that the eye being tested is at the center of the sphere and 13 in (about 33

KEY TERMS

Amblyopia—Decreased visual acuity, usually in one eye, in the absence of any structural abnormality in the eye.

Conjunctiva—The mucous membrane that covers the white part of the eyes (sclera) and lines the eyelids.

Cornea—Clear outer covering of the front of the eye.

Floaters—Translucent specks that float across the visual field, due to small objects floating in the vitreous humor.

Fundus—The inside of an organ. In the eye, refers to the back area that can be seen with the ophthalmoscope.

Glaucoma—There are many types of glaucoma. Glaucoma results in optic nerve damage and a decreased visual field and blindness if not treated. It is usually associated with increased IOP, but that is not always the case. The three factors associated with glaucoma are increased IOP, a change in the optic nerve head, and changes in the visual field.

Gonioscope—An instrument used to inspect the eye (e.g., the anterior chamber). It consists of a magnifier and a lens equipped with mirrors; it's placed on the patient's cornea.

Iris—The colored ring just behind the cornea and in front of the lens that controls the amount of light sent to the retina.

Macula—The central part of the retina where the rods and cones are densest.

Ophthalmoscope—An instrument designed to view structures in the back of the eye.

Optic nerve—The nerve that carries visual messages from the retina to the brain.

Pupil—The circular opening that looks like a black hole in the middle of the iris.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages which are then sent to the brain via the optic nerve.

Sclera—The tough, fibrous, white outer protective covering that surrounds the eye.

Slit lamp—A microscope that projects a linear slit beam of light onto the eye; allows viewing of the conjunctiva, cornea, iris, aqueous humor, lens, and eyelid.

Tonometer—An instrument that measures intraocular pressure (IOP).

Ultrasonography—A method of obtaining structural information about internal tissues and organs where an image is produced because different tissues bounce back ultrasonic waves differently.

cm) from all points on the inside surface of the hemisphere. The patient stares straight ahead at an image on the center of the surface and signals whenever he or she detects a flash of light. The perimeter records which flashes are seen and which are missed and maps the patient's field of vision and blindspots.

Intraocular pressure (IOP) measurement

Tonometers are used to measure IOP. Some tonometers measure pressure by expelling a puff of air (noncontact tonometer) towards the eyeball from a very short distance. Other tonometers are placed directly on the cornea. The noncontact tonometers are not as accurate as the contact tonometers and are sometimes used for screenings.

Completing the evaluation with additional tests

Depending upon the results other tests may be necessary. These can include, but are not limited to binocular indirect ophthalmoscopy, gonioscopy, color tests, contrast sensitivity testing, ultasonography, and others. The patient may have to return for additional visits.

Results

External observations

INITIAL OBSERVATIONS AND SLIT LAMP EXAM. Some general observations the doctor may be looking for include: head tilt; drooping eyelids (**ptosis**); eye turns; red eyes (injection); eye movement; size, shape, and color of the iris; clarity of the cornea, anterior chamber, and lens. The anterior chamber lies behind the cornea and in front of the iris. If it appears cloudy or if cells can be seen in it during the slit lamp exam an inflammation may be present. A narrow anterior chamber may put the patient at risk for glaucoma. A clouding of the normally clear lens is called a cataract.

Internal observations

OPHTHALMOSCOPIC EXAM. The observations include, but are not limited to the retina, blood vessels, and optic nerve. The optic nerve enters the back of the eye and can be checked for swelling or other problems. The blood vessels can be viewed as can the retina. The macula is a 3–5 mm area in the back of the eye and is responsible for central vision. The fovea is a small area located within the macula and is responsible for sharp vision. When a person looks at something, they are pointing the fovea at the object. Changes in the macular area can be observed with the ophthalmoscope. Retinal tears or detachments can also be seen.

Visual ability

VISUAL ACUITY. The refraction will determine the refractive status for each eye for distance and for near. A prescription for glasses is made after taking many things into consideration. The eye doctor may alter a prescription based upon many factors. Different materials for glasses may be suggested. For example, polycarbonate may be suggested for children or people active in sports because it is very impact resistant. Bifocals, trifocals, single-vision spectacles, and contact lenses are also options.

VISUAL FIELDS. A normal visual field extends about 60° upward, about 75° downward, about 65° toward the nose, and about 100° toward the ear and has one blind spot close to the center. Defects in the visual field signify damage to the retina, optic nerve, or the neurological visual pathway.

Seeing clearly does not necessarily mean the eyes are healthy or that the eyes are working together as a team. Regular checkups can detect abnormalities, hopefully before a problem arises. The eye doctor can suggest ways to help protect the eyes and vision (e.g., safety goggles, ultraviolet (UV) coatings on lenses). A person should also have an eye exam if they notice a change in vision, eyestrain, blur, flashes of light, a sudden onset of floaters (little dots), distortion of objects, double vision, redness, **pain** or discharge.

Resources

BOOKS

Chang, David F. "Ophthalmologic Examination." In *General Ophthalmology.* 14th ed. Ed. Daniel Vaughan. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Lorraine Lica, PhD

Eye exercises *see* **Vision training**

Eye glasses and contact lenses

Definition

Eyeglasses and contact lenses are devices that correct refractive errors in vision. Eyeglass lenses are mounted in frames worn on the face, sitting mostly on the ears and nose, so that the lenses are positioned in front of the eyes. Contact lenses appear to be worn in direct contact with the cornea, but they actually float on a layer of tears that separates them from the cornea.

Purpose

The purpose of eyeglasses and contact lenses is to correct or improve the vision of people with nearsightedness (**myopia**), farsightedness (**hyperopia**), **presbyopia**, and **astigmatism**.

Precautions

People allergic to certain plastics should not wear contact lenses or eyeglass frames or lenses manufactured from that type of plastic. People allergic to nickel should not wear Flexon frames. People at risk of being in accidents that might shatter glass lenses should wear plastic lenses, preferably polycarbonate. (Lenses made from polycarbonate, the same type of plastic used for the space shuttle windshield, are about 50 times stronger than other lens materials.) Also, people at risk of receiving electric shock should avoid metal frames.

People employed in certain occupations may be prohibited from wearing contact lenses, or may be required to wear safety eyewear over the contact lenses. Some occupations, such as construction or auto repair, may require safety lenses and safety frames. Physicians and employers should be consulted for recommendations.

Description

Eyes are examined by optometrists (O.D.) or by ophthalmologists (M.D. or D.O.—doctor of **osteopathy**). Prescriptions, if necessary, are then given to patients for

glasses. The glasses are generally made by an optician. A separate contact lens-fitting exam is necessary if the patient wants contact lenses, because an eyeglass prescription is not the same as a contact lens prescription.

Eyeglasses

Over 140 million people in the United States wear eyeglasses. People whose eyes have refractive errors do not see clearly without glasses, because the light emitted from the objects they are observing does not come into focus on their retinas. For people who are farsighted, images come into focus behind the retina; for people who are nearsighted, images come into focus in front of the retina.

LENSES. Lenses work by changing the direction of light so that images come into focus on the retina. The greater the index of refraction of the lens material and the greater the difference in the curvature between the two surfaces of the lens, the greater the change in direction of light that passes through it, and the greater the correction.

Lenses can be unifocal, with one correction for all distances, or they can be correct for more than one distance (multifocal). One type of multifocal, the bifocal, has an area of the lens (usually at the bottom) that corrects for nearby objects (about 14 in from the eyes); the remainder of the lens corrects for distant objects (about 20 ft from the eyes). Another type of multifocal, a trifocal, has an area in-between that corrects for intermediate distances (usually about 28 in). Conventional bifocals and trifocals have visible lines between the areas of different correction; however, lenses where the correction gradually changes from one area to the other, without visible lines, have been available since the 1970s. Such lenses are sometimes called progressives or no-line bifocals.

To be suitable for eyeglass lenses, a material must be transparent, without bubbles, and have a high index of refraction. The greater the index of refraction, the thinner the lens can be. Lenses are made from either glass or plastic (hard resin). The advantage of plastic is that it is lightweight and more impact resistant than glass. The advantage of glass is that it is scratch resistant and provides the clearest possible vision.

Glass was the first material to be used for eyeglass lenses, and was used for several hundred years before plastic was introduced. The crown glass used for eyeglass lenses has an index of refraction of 1.52.

Optical-quality acrylic was introduced for eyeglass use in the early 1940s, but because it was easily scratched, brittle, and discolored rapidly, it did not supplant glass as the material of choice. Furthermore, it had a relatively low index of refraction, so it wasn't suitable for people with large refractive errors. A plastic called CR-39, introduced in the 1960s, was more suitable. Today, eyeglass wearers can also choose between polycarbonate, which is the most impact-resistant material available for eyewear, and polyurethane, which has exceptional optical qualities and an index of refraction of up to 1.66, much higher than the conventional plastics used for lenses, and even higher than glass. Patients with high prescriptions should ask about high index material options for their lenses. Aspheric lenses are also useful for high prescriptions. They are flatter and lighter than conventional lenses.

There are many lenses and lens-coating options for individual needs, including coatings that block the ultraviolet (UV) light or UV and blue light which have been found to be harmful to the eyes. Such coatings are not needed on polycarbonate lenses, which already have UV protection. UV coatings are particularly important on sunglasses and ski goggles. Sunglasses, when nonprescription, should be labeled with an indication that they block out 99–100% of both UV-A and UV-B rays.

There are anti-scratch coatings that increase the surface hardness of lenses (an important feature when using plastic lenses) and anti-reflective (AR) coatings that eliminate almost all glare and allow other people to see the eyes of the wearer. AR coatings may be particularly helpful to people who use computers or who drive at night. Mirror coatings that prevent other people from seeing the wearer's eyes are also available. There is a whole spectrum of tints, from light tints to darker tints, used in sunglasses. Tint, however, does not block-out UV rays, so a UV coating is needed. Polaroid lenses that block out much of the reflected light also allow better vision in sunny weather and are helpful for people who enjoy boating. Photosensitive (photochromatic) lenses that darken in the presence of bright light are handy for people who don't want to carry an extra set of glasses. Photochromatic lenses are available in glass and plastic.

FRAMES. Frames can be made from metal or plastic, and they can be rimless. There is an almost unlimited variety of shapes, colors, and sizes. The type and degree of refractive correction in the lens determine to some extent the type of frame most suitable. Some lenses are too thick to fit in metal rims, and some large-correction prescriptions are best suited to frames with small-area lenses.

Rimless frames are the least noticeable type, and they are lightweight because the nosepiece and temples are attached directly to the lenses, eliminating the weight of the rims. They tend to not be as sturdy as frames with rims, so they are not a good choice for people who frequently

remove their glasses and put them on again. They are also not very suitable for lenses that correct a high degree of farsightedness, because such lenses are thin at the edges.

Metal frames are less noticeable than plastic, and they are lightweight. They are available in solid gold, gold-filled, anodized aluminum, nickel, silver, stainless steel, and now titanium and titanium alloy. Until the late 1980s, when titanium-nickel alloy and titanium frames were introduced, metal frames were, in general, more fragile than plastic frames. The titanium frames, however, are very strong and lightweight. An alloy of titanium and nickel, called Flexon, is not only strong and lightweight, but returns to its original shape after being twisted or dented. It is not perfect for everyone, though, because some people are sensitive to its nickel. Flexon frames are also relatively expensive.

Plastic frames are durable, can accommodate just about any lens prescription, and are available in a wide range of prices. They are also offered in a variety of plastics (including acrylic, epoxy, cellulose acetate, cellulose propionate, polyamide, and nylon) and in different colors, shapes, and levels of resistance to breakage. Epoxy frames are resilient and return to their original shape after being deformed, so they do not need to be adjusted as frequently as other types. Nylon frames are almost unbreakable. They revert to their original shape after extreme trauma and distortion; because of this property, though, they cannot be readjusted after they are manufactured.

FIT. The patient should have the distance between the eyes (PD) measured, so that the optical centers of the lenses will be in front of the patient's pupils. Bifocal heights also have to be measured with the chosen frame in place and adjusted on the patient. Again, this is so the lenses will be positioned correctly. If not positioned correctly, the patient may experience eyestrain or other problems. This can occur with over-the-counter reading glasses. The distance between the lenses is for a "standard" person. Generally, this will not be a problem, but if a patient is sensitive or has more closely set eyes, for example, it may pose a problem. Persons buying ready-made sunglasses or reading glasses should hold them up to see if they appear clear. They should also hold the lenses to see an object with straight lines reflected off of the lenses. If the lines don't appear straight, the lenses may be warped or inferior.

Patients may sometimes need a few days to adjust to a new prescription; however, problems should be reported, because the glasses may need to be rechecked.

Contact lenses

Over 32 million people in the United States wear these small lenses that fit on top of the cornea. They provide a field of view unobstructed by eyeglass frames; they do not fog-up or get splattered, so it is possible to see well while walking in the rain; and they are less noticeable than any eyeglass style. On the other hand, they take time to get accustomed to; require more measurements for fitting; require many follow-up visits to the eye doctor; can lead to complications such as infections and corneal damage; and may not correct astigmatism as well as eyeglasses, especially if the astigmatism is severe.

Originally, hard contact lenses were made of a material called PMMA. Although still available, the more common types of contact lenses are listed below:

- Rigid gas-permeable (RGP) daily-wear lenses are made of plastic that does not absorb water but allows oxygen to get from the atmosphere to the cornea. (This is important because the cornea has no blood supply and needs to get its oxygen from the atmosphere through the film of tears that moves beneath the lens.) They must be removed and cleaned each night.
- Rigid gas-permeable (RGP) extended-wear lenses are made from plastic that also does not absorb water but is more permeable to oxygen than the plastic used for daily-wear lenses. They can be worn up to a week.
- Daily wear soft lenses are made of plastic that is permeable to oxygen and absorbs water; therefore, they are soft and flexible. These lenses must be removed and cleaned each night, and they do not correct all vision problems. Soft lenses are easier to get used to than rigid lenses, but are more prone to tears and do not last as long.
- Extended-wear soft lenses are highly permeable to oxygen, are flexible by virtue of their ability to absorb water, and can usually be worn for up to one week. They do not correct all vision problems. There is more of a risk of infection with extended-wear lenses than with daily-wear lenses.
- Extended-wear disposable lenses are soft lenses worn continually for up to six days and then discarded, with no need for cleaning.
- Planned-replacement soft lenses are daily wear lenses that are replaced on a regular schedule, which is usually every two weeks, monthly, or quarterly. They must also be cleaned.

Soft contact lenses come in a variety of materials. There are also different kinds of RGP and soft multifocal contact lenses available. Monovision, where one contact lens corrects for distance vision while the other corrects for near vision, may be an option for presbyopic patients. Monovision, however, may affect depth perception and may not be appropriate for everyone. Contact lenses also

KEY TERMS

Astigmatism—Assymetric vision defects due to irregularities in the cornea.

Cornea—The clear outer covering of the front of the eye.

Index of refraction—A constant number for any material for any given color of light that is an indicator of the degree of the bending of the light caused by that material.

Lens—A device that bends light waves.

Permeable—Capable of allowing substances to pass through.

Polycarbonate—A very strong type of plastic often used in safety glasses, sport glasses, and children's eyeglasses. Polycarbonate lenses have approximately 50 times the impact resistance of glass lenses.

Polymer—A substance formed by joining smaller molecules. For example, plastic, acrylic, cellulose acetate, cellulose propionate, nylon, etc.

Presbyopia—A condition affecting people over the age of 40 where the system of accommodation that allows focusing of near objects fails to work because of age-related hardening of the lens of the eye.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages sent to the brain via the optic nerve.

Ultraviolet (UV) light—Part of the electromagnetic spectrum with a wavelength just below that of visible light. It is damaging to living material, especially eyes and DNA.

come in a variety of tints. Soft contacts are available that can change dark-colored eyes a different color. Even though such lenses have no prescription, they must still be fitted and checked to make sure that an eye infection does not occur. People should NEVER wear someone else's contact lenses. This can lead to infection or damage to the eye.

Aftercare

Contact lens wearers must be examined periodically by their eye doctors to make sure that the lenses fit properly and that there is no infection. Both infection and lenses that do not fit properly can damage the cornea. Patients can be allergic to certain solutions that are used to clean or lubricate the lenses. For that reason, patients should not randomly switch products unless they speak with their doctor. Contact lens wearers should seek immediate attention if they experience eye **pain**, a burning sensation, red eyes, intolerable sensitivity to light, cloudy vision, or an inability to keep the eyes open.

To avoid infection, it is important for contact lens wearers to exactly follow their instructions for lens insertion and removal, as well as cleaning. Soft contact lens wearers should never use tap water to rinse their lenses or to make-up solutions. All contact lens wearers should also always have a pair of glasses and a carrying case for their contacts with them, in case the contacts have to be removed due to eye irritation.

Risks

Wearing contact lenses increases the risk of corneal damage and eye infections.

Normal results

The normal expectation is that people will achieve 20/20 vision while wearing corrective lenses.

Resources

BOOKS

Zinn, Walter J., and Herbert Solomon. *Complete Guide to Eyecare, Eyeglasses & Contact Lenses*. 4th ed. Federick Fell, 1997.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Optician Association of America. 7023 Little RiverTurnpike, Suite 207, Annandale, VA 22003. (703) 916- 8856. <http://www.opticians.org>.

OTHER

Contact Lens Council. <http://www.contactlenscouncil.org>.

Lorraine Lica, PhD

Eye muscle surgery

Definition

Eye muscle surgery is surgery to weaken, strengthen, or reposition any of the muscles that move the eyeball (the extraocular muscles).

Purpose

The purpose of eye muscle surgery is generally to align the pair of eyes so that they gaze in the same direction and move together as a team, either to improve appearance or to aid in the development of binocular vision in a young child. To achieve binocular vision, the goal is to align the eyes so that the location of the image on the retina of one eye corresponds to the location of the image on the retina of the other eye.

In addition, sometimes eye muscle surgery can help people with other eye disorders (**nystagmus** and Duane syndrome, for example).

Precautions

Depth perception (stereopsis) develops around the age of three months old. For successful development of binocular vision and the ability to perceive three-dimensionally, the surgery should not be postponed past the age of four. The earlier the surgery the better the outcome, so an early diagnosis is important. Surgery may even be performed before two years old. After surgery, if binocular vision is to develop, corrective lenses and eye exercises (vision therapy) will probably be necessary.

Description

The extraocular muscles attach via tendons to the sclera (the white, opaque, outer protective covering of the eyeball) at different places just behind an imaginary equator circling the top, bottom, left, and right of the eye. The other end of each of these muscles attaches to a part of the orbit (the eye socket in the skull). These muscles enable the eyes to move up, down, to one side or the other, or any angle in between.

Normally both eyes move together, receive the same image on corresponding locations on both retinas, and the brain fuses these images into one three-dimensional image. The exception is in **strabismus** which is a disorder where one or both eyes deviate out of alignment, most often outwardly (exotropia) or toward the nose (esotropia). The brain now receives two different images, and either suppresses one or the person sees double (diplopia). This deviation can be adjusted by weakening or strengthening the appropriate muscles to move the eyes toward the center. For example, if an eye turns upward, the muscle at the bottom of the eye could be strengthened.

Rarely, eye muscle surgery is performed on people with nystagmus or Duane syndrome. Nystagmus is a condition where one or both eyes move rapidly or oscillate; it can sometimes be helped by moving the eyes to the position of least oscillation. Duane syndrome is a disorder where there is limited horizontal eye movement; it can sometimes be relieved by surgery to weaken an eye muscle.

There are two methods to alter extraocular muscles. Traditional surgery can be used to strengthen, weaken, or reposition an extraocular muscle. The surgeon first makes an incision in the conjunctiva (the clear membrane covering the sclera), then puts a suture into the muscle to prevent it from getting lost and loosens the muscle from the eyeball with a surgical hook. During a resection, the muscle is detached from the sclera, a piece of muscle is removed so the muscle is now shorter, and the muscle is reattached to the same place. This strengths the muscle. In a recession, the muscle is made weaker by repositioning it. More than one extraocular eye muscle might be operated on at the same time.

Another way of weakening eye muscles, using botulinum toxin injected into the muscle, was introduced in the early 1980s. Although the botulinum toxin wears off, the realignment may be permanent, depending upon whether neurological connections for binocular vision were established during the time the toxin was active. This technique can also be used to adjust a muscle after traditional surgery.

The cost of eye muscle surgery is about $2,000–$4,000, and about 700,000 surgeries are performed annually in the United States.

Preparation

Patients should make sure their doctors are aware of any medications that they are taking, even over-the-counter medications. Patients should not take **aspirin**, or any other blood-thinning medications for ten days prior to surgery, and should not eat or drink after midnight the night before.

Aftercare

Patients will need someone to drive them home after their surgery. They should continue to avoid aspirin and other non-steroidal anti-inflammatory agents for an additional three days, but they can take **acetaminophen** (e.g., Tylenol). Patients should discuss this with the surgeon to be clear what medications they can or cannot take. **Pain** will subside after two to three days, and patients can resume most normal activities within a few days. Again,

KEY TERMS

Botulinum toxin (botulin)—A neurotoxin made by *Clostridium botulinum*; causes paralysis in high doses, but is used medically in small, localized doses to treat disorders associated with involuntary muscle contraction and spasms, in addition to strabismus.

Conjunctiva—The mucous membrane that covers the eyes and lines the eyelids.

Extraocular muscles—The muscles (lateral rectus, medial rectus, inferior rectus, superior rectus, superior oblique, and inferior oblique) that move the eyeball.

Orbit—The cavity in the skull containing the eyeball; formed from seven bones: frontal, maxillary, sphenoid, lacrimal, zygomatic, ethmoid, and palatine.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages sent to the brain via the optic nerve.

Sclera—The tough, fibrous, white outer protective covering of the eyeball.

Strabismus—A disorder where the two eyes do not point in the same direction.

this may vary with the patient and the patient should discuss returning to normal activity with the surgeon. They should not get their eyes wet for three to four days and should refrain from swimming for 10 days. Operated eyes will be red for about two weeks.

Risks

As with any surgery, there are risks involved. Eye muscle surgery is relatively safe, but very rarely a cut muscle gets lost and can not be retrieved. This, and other serious reactions, including those caused by anesthetics, can result in vision loss in the affected eye. Occasionally, retinal or nerve damage occurs. Double vision is not uncommon after eye muscle surgery. As mentioned earlier, glasses or vision therapy may be necessary.

Normal results

Cosmetic improvement is likely with success rate estimates varying from about 65–85%. According to the best statistics as of 1998, binocular vision is improved in young children about 35% of the time. There is no improvement, or the condition worsens 15–35% of the time. A second operation may rectify less-than-perfect outcomes.

Resources

BOOKS

Good, William V., and Craig S. Hoyt. *Strabismus Management*. Boston: Butterworth-Hienemann, 1996.

Salmans, Sandra. *Your Eyes: Questions You Have... Answers You Need*. Allentown, PA: People's Medical Society, 1996.

von Noorden, Gunter K. *Binocular Vision and Ocular Motility: Theory and Management of Strabismus*. 5th ed. St. Louis:Mosby-Year Book, 1996.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Academy of Pediatric Ophthalmology and Strabismus (AAPOS). <http://med-aapos.bu.edu>.

OTHER

Olitsky, Scott E., and Leonard B. Nelson. *Strabismus Web Book*. 4 May 1998 <http://www.smbs.buffalo.edu/oph/ped/webbook.htm>.

Lorraine Lica, PhD

Eye training *see* **Vision training**

Eyelid disorders

Definition

An eyelid disorder is any abnormal condition that affects the eyelids.

Description

Eyelids consist of thin folds of skin, muscle, and connective tissue. The eyelids protect the eyes and spread tears over the front of the eyes. The inside of the eyelids are lined with the conjunctiva of the eyelid (the palpebral conjunctiva), and the outside of the lids are covered with the body's thinnest skin. Some common lid problems include the following: stye, blepharitis, chalazion, entropion, ectropion, eyelid **edema**, and eyelid tumors.

Stye

A stye is an infection of one of the three types of eyelid glands near the lid margins, at the base of the lashes.

Chalazion

A chalazion is an enlargement of a meibomian gland (an oil-producing gland in the eyelid), usually not associated with an infectious agent. More likely, the gland opening is clogged. Initially, a chalazion may resemble a stye, but it usually grows larger. A chalazion may also be located in the middle of the lid and be internal.

Blepharitis

Blepharitis is the inflammation of the eyelid margins, often with scales and crust. It can lead to eyelash loss, chalazia, styes, ectropion, corneal damage, excessive tearing, and chronic **conjunctivitis**.

Entropion

Entropion is a condition where the eyelid margin (usually the lower one) is turned inward; the eyelashes touch the eye and irritate the cornea.

Ectropion

Ectropion is a condition where one or both eyelid margins turn outward, exposing both the conjunctiva that covers the eye and the conjunctiva that lines the eyelid.

Eyelid edema

Eyelid edema is a condition where the eyelids contain excessive fluid.

Eyelid tumors

Eyelids are susceptible to the same skin tumors as the skin over the rest of the body, including noncancerous tumors and cancerous tumors (basal cell carcinoma, squamous cell carcinoma, **malignant melanoma**, and sebaceous gland carcinoma). Eyelid muscles are susceptible to sarcoma.

Causes and symptoms

Stye

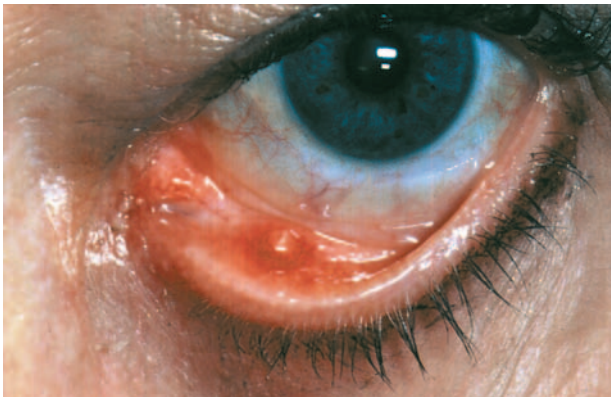
Styes are usually caused by bacterial **staphylococcal infections**. The symptoms are **pain** and inflammation in one or more localized regions near the eyelid margin.

Chalazion

A chalazion is caused by a blockage in the outflow duct of a meibomian gland. Symptoms are inflammation and swelling in the form of a round lump in the lid that may be painful.

Blepharitis

Some cases of blepharitis are caused by bacterial infection and some by head lice, but in some cases, the cause is unclear. It may also be caused by an overproduction of oil by the meibomian glands. Blepharitis can be a chronic condition that begins in early childhood and can last throughout life. Symptoms can include **itching**, burning, a feeling that something is in the eye, inflammation, and scales or matted, hard crusts surrounding the eyelashes.



A chalazion on the eyelid. This condition is caused by an obstruction of one of the meibomian glands which lubricate the edge of the eyelid. *(Photo Researchers, Inc. Reproduced by permission.)*

Entropion

Entropion usually results from **aging**, but sometimes can be due to a congenital defect, a spastic eyelid muscle, or a scar on the inside of the lid that could be from surgery, injury, or disease. It is accompanied by excessive tearing, redness, and discomfort.

Ectropion

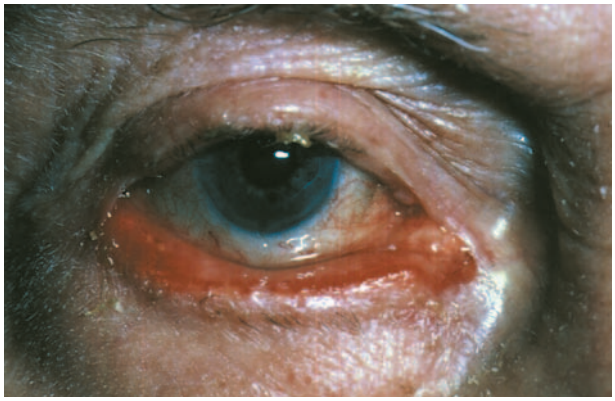
Similar to entropion, the usual cause of ectropion is aging. It also can be due to a spastic eyelid muscle or a scar, as in entropion. It also can be the result of **allergies**. Symptoms are excessive tearing and hardening of the eyelid conjunctiva.

Eyelid edema

Eyelid edema is most often caused by allergic reactions, for example, allergies to eye makeup, eyedrops or other drugs, or plant allergens such as pollen. **Trichinosis**, a disease caused by eating undercooked meat, also causes eyelid edema. However, swelling can also be caused by more serious causes, such as infection, and can lead to orbital **cellulitis** which can threaten vision. Symptoms can include swelling, itching, redness, or pain.

Eyelid tumors

Tumors found on the eyelids are caused by the same conditions that cause these tumors elsewhere on the



A close-up of the eye of an elderly patient showing ectropion of the lower eyelid. Ectropion is a condition in which the eyelid turns away from the eye. The most common type is senile ectropion (seen here), in which the droop of the eyelid is due to loss of tissue elasticity in old age and weakness in the muscles surrounding the eye. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

body. They are usually painless and may or may not be pigmented. Some possible causes include **AIDS** (**Kaposi's sarcoma**) or increased exposure to ultraviolet (UV) rays which may lead to skin **cancer**.

Diagnosis

An instrument called a slit lamp is generally used to magnify the structures of the eyes. The doctor may press on the lid margin to see if oil can be expressed from the meibomian glands. The doctor may invert the lid to see the inside of the lid. Biopsy is used to diagnose cancerous tumors.

Treatment

Stye

Styes are treated with warm-hot compresses for 10–15 minutes, three to four times a day. Sometimes topical **antibiotics** may be prescribed. If the initial treatment is ineffective, styes are lanced and drained.

Chalazion

About 25% of chalazia will disappear spontaneously, but hot compresses may speed the process. Because chalazia are inside the lid, topical medications are generally of no benefit. Medication may need to be injected by the doctor into the chalazion or if that doesn't help the chalazion may need to be excised. If what appears to be a chalazion recurs on the same site as any previous one, the possibility of sebaceous gland carcinoma should be investigated by biopsy.

Blepharitis

Blepharitis is treated with hot compresses, with antibiotic ointment, and by cleaning the eyelids with a moist washcloth and then with baby shampoo. Good hygiene is essential. If the blepharitis doesn't clear up with treatment or if it seems to be a chronic problem, the patient may have **acnerosacea**. These patients may need to see a dermatologist as well.

Entropion and ectropion

Both entropion and ectropion can be surgically corrected. Prior to surgery, the lower lid of entropion can be taped down to keep the lashes off the eye, and both can be treated with lubricating drops to keep the cornea moist.

Eyelid edema

Patients with swollen eyelids should contact their eye doctor. A severely swollen lid can press on the eye and possibly increase the intraocular pressure. An infection needs to be ruled out. Or, something as simple as an allergy to nail polish and then touching the eyes can cause swelling. The best treatment for allergic eyelid edema is to find and remove the substance causing the allergy. When that is not possible, as in the case of plant allergens, cold compresses and immunosuppresesive drugs such as corticosteroid creams are helpful. However, steroids can cause **cataracts** and increase intraocular pressure and patients must be very careful not to get the cream in their eyes. This should not be done unless under a doctor's care. For edema caused by trichinosis, the trichinosis must be treated.

Eyelid tumors

Cancerous tumors should be removed upon discovery, and noncancerous tumors should be removed before they become big enough to interfere with vision or eyelid function. Eyelid tumors require special consideration because of their sensitive location. It is important that treatment not compromise vision, eye movement, or eyelid movement. Accordingly, eyelid reconstruction will sometimes accompany tumor excision.

Prognosis

The prognosis for styes and chalazia is good to excellent. With treatment, blepharitis, ectropion, and entropion usually have good outcomes. The prognosis for nonmalignant tumors, basal cell carcinoma, and squamous cell carcinoma is good once they are properly removed. Survival rate for malignant melanoma depends upon how early it was discovered and if it was completely removed. Sebaceous carcinomas are difficult to detect, so poor outcomes are more frequent.

All of these eyelid disorders, if not treated, can lead to other, possibly serious vision problems—dry eye, **astigmatism**, or even vision loss, for example. An ophthalmologist or optometrist should be consulted.

Prevention

Good lid hygiene is very important. Regular eyelid washing with baby shampoo helps prevent styes, chalazia, blepharitis, and eyelid edema. To avoid these problems, it's also important to refrain from touching and rubbing the eyes and eyelids, especially with hands that have not just been washed.

Blepharitis is associated with dandruff, which is caused by a kind of bacteria that is one of the causes of blepharitis. Controlling dandruff by washing the hair, scalp, and eyebrows with shampoo containing selenium sulfide to kill the bacteria helps control the blepharitis. When using anything near the eyes, it is important to read the label or consult with a doctor first.

Avoiding allergens helps prevent allergic eyelid edema. Staying inside as much as possible when pollen counts are high and eliminating the use of, or at least removing eye makeup thoroughly, or using hypo-allergenic makeup may help if the person is sensitive to those substances.

Sunscreen, UV-blocking sunglasses, and wide brimmed hats can help prevent eyelid tumors.

Entropian and ectropian seem to be unpreventable.

Resources

BOOKS

Newell, Frank W. *Ophthalmology: Principles and Concepts.* 8th ed. St. Louis: Mosby, 1996.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

American Society of Ophthalmic Plastic and Reconstructive Surgery. 1133 West Morse Blvd, #201, Winter Park, FL 32789. (407) 647-8839. <http://www.asoprs.org>.

OTHER

"Eyelid Abnormalities." *Eye Clinic of Fairbanks.* <http://www.eyeclinicfbks.com/ECFLID.htm>.

RxMed. <http://www.rxmed.com>.

Lorraine Lica, PhD

KEY TERMS

Allergen—A substance capable of inducing an allergic response.

Allergic reaction—An immune system reaction to a substance in the environment; symptoms include rash, inflammation, sneezing, itchy watery eyes, and runny nose.

Conjunctiva—The mucous membrane that covers the white part of the eyes and lines the eyelids.

Edema—A condition where tissues contain excessive fluid.

Meibomian gland—Oil-producing glands in the eyelids that open near the eyelid margins.

Eyelid edema *see* **Eyelid disorders**

Eyelid plastic surgery *see* **Blepharoplasty**

F

Fabry's disease *see* **Lipidoses**

Face lift

Definition

Face lift surgery is a cosmetic procedure that involves redirecting some of the skin and muscle tissue of the face and neck to counter signs of **aging** produced by gravity.

Purpose

The purpose of face lift surgery, also known as facialplasty, rhytidoplasty, or cervicofacial rhytidectomy, is to improve the appearance of the face by repositioning the skin and tightening some of the underlying muscle and tissue. The procedure is designed to counter sagging and looseness in skin and muscle tissue caused by gravity as the patient ages. Face lift surgery will not erase all facial wrinkles, as the term rhytidectomy (which literally means "surgical removal of wrinkles") might imply. Wrinkles around the mouth and eyes, for example, may benefit little from face lift surgery. Other procedures, such as **blepharoplasty**, chemical peel, or dermabrasion, also may be necessary.

Precautions

Patients with other medical conditions should consult with their primary physician before undergoing face lift surgery. Lung problems, heart disease, and certain other conditions can lead to a higher risk of complications. Patients who take medications that can alter the way their blood clots (including female hormones, **aspirin**, and some non-aspirin **pain** relievers) should stop these medications prior to surgery to lower the risk that a hematoma will form. A hematoma, a pocket of blood below the skin, is the most frequent complication of face lift surgery.

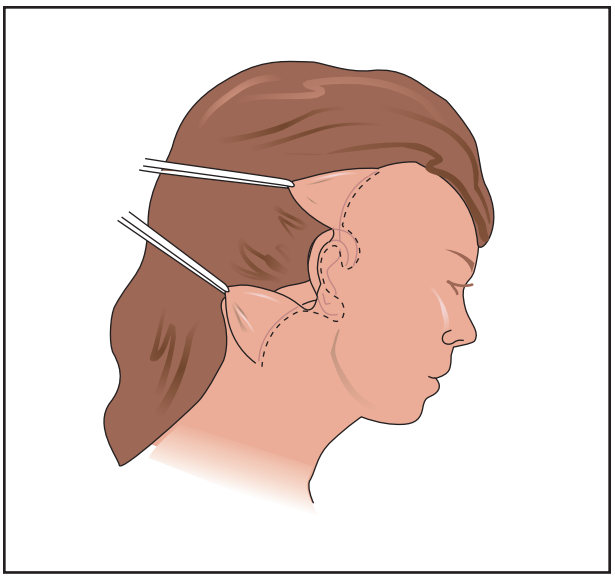
Description

Face lift surgery can be performed on an outpatient basis with local anesthetics. Patients typically also receive "twilight anesthesia," an intravenous sedative that helps to lower their awareness of the procedure being performed.

There are a number of variations of face lift surgery. Which one is used will depend on the patient's facial structure, how much correction is needed, and the preferences of the surgeon performing the procedure. In a typical face lift surgery, the surgeon begins by making an incision within the hairline just above the ear. The incision continues down along the front edge of the ear, around the earlobe, and then up and behind the ear extending back into the hairline. The location of this incision is designed to hide any sign of the procedure later. The same procedure is repeated on the other side of the face. Using various instruments, the surgeon will then work to separate the skin of the face from its underlying tissue, moving down to the cheek and into the neck area and below the chin. Fat deposits over the cheeks and in the neck may be removed surgically or with **liposuction** at this time. The surgeon will then work to free up and tighten certain bands of muscle and tissue that extend up from the shoulder, below the chin, and up and behind the neck. If these muscles and tissue are not tightened, the looseness and sagging appearance of the skin will return. The surgeon then trims excess skin from the edges of the original incision, pulls the skin back, and staples or sutures it into place.

Preparation

Prior to the procedure, patients meet with their surgeon to discuss the surgery, clarify the results that can be achieved, and discuss the potential problems that can occur. Having realistic expectations is important in any cosmetic procedure. Patients will learn, for example, that although face lift surgery can improve the contour of the face and neck, other procedures will be necessary to reduce the appearance of many wrinkles. As mentioned



In a typical face lift surgery, the surgeon begins by making an incision within the hairline just above the ear. The incision continues down along the front of the ear, around the earlobe, and then up and behind the ear extending back into the hairline, as shown above. The same procedure is repeated on the other side of the face. The surgeon will then separate the skin from the tissue, remove fat deposits over the cheeks and neck, tighten up muscles and tissues below the chin and upwards behind the neck. The surgeon then trims excess skin from the original incision, pulls the skin back, and sutures it into place. *(Illustration by Electronic Illustrators Group.)*

earlier, patients will stop taking aspirin, birth control or female hormones, and other medications affecting blood clotting about two weeks before the procedure. Some physicians prescribe vitamin C and K in the belief that this promotes healing. Patients will also be advised to stop **smoking** and to avoid exposure to passive smoke before the procedure and afterward. Some surgeons also recommend **antibiotics** be taken beforehand to limit the risk of infection. Some surgeons also use a steroid injection before or after the procedure, to reduce swelling.

Aftercare

After the surgery, a pressure bandage will be applied to the face to reduce the risk of hematoma. The patient may spend a few hours resting in a recovery room to ensure no bleeding has occurred. The patient then returns home. Some surgeons recommend that the patient remain reclining for the next 24 hours, consuming a liquid diet, and avoiding any movements that lead the neck to flex. Ice packs for the first few days can help to reduce swelling and lower the risk of hematoma. Patients continue taking an antibiotic until the first stitches come out about five days after the procedure. The balance are removed seven to 10 days later. Many patients return to work and limited activities within two weeks of the procedure.

KEY TERMS

Hematoma—A complication of surgery in which a collection of blood forms below the skin.

Rhytidectomy—It literally means "wrinkle excision." It is another, misleading, term for face lift surgery.

Twilight anesthesia—An intravenous mixture of sedatives and other medications that decreases patients' awareness of the procedure being performed.

Risks

The major complication seen following face lift surgery is a hematoma. If a hematoma forms, the patient may have to return to have the stitches reopened to find the source of the bleeding. Most hematomas form within 48 hours of surgery. The typical sign is pain or swelling affecting one side of the face but not the other.

Another risk of face lift surgery is nerve damage. Sometimes it can affect the patient's ability to raise an eyebrow, or distort his smile, or leave him with limited feeling in his earlobe. Most of these nerve injuries, however, repair themselves within 2–6 months.

Normal results

Some swelling and bruising is normal following face lift surgery. After these disappear, the patient should see a noticeable improvement in the contour of his face and neck. Some fine wrinkling of the skin may be improved, but deep wrinkles are likely to require another cosmetic procedure to improve their appearance.

Abnormal results

In addition to the risks outlined above, other complications of face lift surgery include infection, scarring, and hair loss near incision lines.

Resources

BOOKS

Asken, Saul. "Cervicofacial Rhytidectomy." In *Cosmetic Surgery of the Skin: Principles and Techniques*, ed. William P. Coleman. St. Louis: Mosby, 1997.

Tardy Jr., M. Eugene, and Mark Lingensmith."Face-List Surgery: Principles and Variations." In *Roenigk and Roenigk's Dermatologic Surgery: Principles and Practice*, ed. Randall K. Roenigk and Henry H. Roenigk. New York: Marcel Dekker, 1996.

PERIODICALS

Matarasso, Alan. "Facialplasty." *Dermatologic Clinics*, 15 (Oct. 1997): 649-658.

Springer, Rachelle C. "Rhytidectomy: From Consultation to Recovery." *Plastic Surgical Nursing*, 16 (Spring 1996): 27-30.

ORGANIZATIONS

American Society for Dermatologic Surgery. 930 N. Meacham Road, PO Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asds-net.org>.

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

Richard H. Camer

Facial nerve paralysis *see* **Bell's palsy**

Factitious disorders

Definition

Factitious disorders are a group of mental disturbances in which patients intentionally act physically or mentally ill without obvious benefits. The name factitious comes from a Latin word that means artificial. These disorders are not **malingering**, which is defined as pretending illness when the "patient" has a clear motive, such as financial gain.

Description

Patients with factitious disorders produce or exaggerate the symptoms of a physical or mental illness by a variety of methods, including contaminating urine samples with blood, taking hallucinogens, injecting themselves with bacteria to produce infections, and other similar behaviors.

There are no reliable statistics on the frequency of factitious disorders, but they are more common in men than in women. The following conditions are sometimes classified as factitious disorders:

Munchausen syndrome

Munchausen syndrome refers to patients whose factitious symptoms are dramatized and exaggerated. Many persons with Munchausen go so far as to undergo major surgery repeatedly, and, to avoid detection, at several locations. Many have been employed in hospitals or in health care professions. The syndrome's onset is in early adulthood.

Munchausen by proxy

Munchausen by proxy is the name given to factitious disorders in children produced by parents or other caregivers. The parent may falsify the child's medical history or tamper with laboratory tests in order to make the child appear sick. Occasionally, they may actually injure the child to assure that the child will be treated.

Ganser's syndrome

Ganser's syndrome is an unusual dissociative reaction to extreme **stress** in which the patient gives absurd or silly answers to simple questions. It has sometimes been labeled as psychiatric malingering, but is more often classified as a factitious disorder.

Causes and symptoms

No single explanation of factitious disorders covers all cases. These disorders are variously attributed to underlying **personality disorders**; **child abuse**; the wish to repeat a satisfying childhood relationship with a doctor; and the desire to deceive or test authority figures. Also, the wish to assume the role of patient and be cared for is involved. In many cases, the suffering of a major personal loss has been implicated.

The following are regarded as indications of a factitious disorder:

- dramatic but inconsistent medical history
- extensive knowledge of medicine and/or hospitals
- negative test results followed by further symptom development
- symptoms that occur only when the patient is not being observed
- few visitors
- arguments with hospital staff or similar acting-out behaviors
- eagerness to undergo operations and other procedures

When patients with factitious disorders are confronted, they usually deny that their symptoms are intentional. They may become angry and leave the hospital. In many cases they enter another hospital, which has led to the nickname "hospital hoboes."

KEY TERMS

Ganser's syndrome—An unusual factitious disorder characterized by dissociative symptoms and absurd answers to direct questions.

Malingering—Pretending to be sick in order to be relieved of an unwanted duty or obtain some other obvious benefit.

Munchausen by proxy—A factitious disorder in children produced by a parent or other caregiver.

Munchausen syndrome—A factitious disorder in which the patient's symptoms are dramatized and exaggerated.

Diagnosis

Diagnosis of factitious disorders is usually based on the exclusion of bona fide medical or psychiatric conditions, together with a combination of the signs listed earlier. In some cases, the diagnosis is made on the basis of records from other hospitals.

Treatment

Treatment of factitious disorders is usually limited to prompt recognition of the condition and the refusal to give unnecessary medications or to perform unneeded procedures. Factitious disorder patients do not usually remain in the hospital long enough for effective psychiatric treatment. Some clinicians have tried psychotherapeutic treatment for factitious disorder patients, and there are anecdotal reports that antidepressant or antipsychotic medications are helpful in certain cases.

Prognosis

Some patients have only one or two episodes of factitious disorders; others develop a chronic form that may be lifelong. Successful treatment of the chronic form appears to be rare.

Resources

BOOKS

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis & Treatment 1998*. 37th ed. Ed. Stephen J. McPhee, et al. Stamford: Appleton & Lange, 1997.

"Factitious Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Noll, Richard. *The Encyclopedia of Schizophrenia and the Psychotic Disorders*. New York: Facts On File, 1992.

Pascuzzi, Robert M., and Mary C. Weber. "Conversion Disorders, Malingering, and Dissociative Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Psychiatric Disorders: Munchausen Syndrome." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Raney, David F. "Behavioral, Psychosocial & Psychiatric Pediatrics." In *Handbook of Pediatrics*, edited by Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Rebecca J. Frey

Factor IX deficiency *see* **Hemophilia**

Factor VIII deficiency *see* **Hemophilia**

Failure to thrive

Definition

Failure to thrive (FTT) is used to describe a delay in a child's growth or development. It is usually applied to infants and children up to two years of age who do not gain or maintain weight as they should. Failure to thrive is not a specific disease, but rather a cluster of symptoms which may come from a variety of sources.

Description

Shortly after birth most infants loose some weight. After that expected loss, babies should gain weight at a steady and predictable rate. When a baby does not gain weigh as expected, or continues to loose weight, it is not thriving. Failure to thrive may be due to one or more conditions.

Organic failure to thrive (OFTT) implies that the organs involved with digestion and absorption of food are malformed or incomplete so the baby cannot digest its food. Non-organic failure to thrive (NOFTT) is the most common cause of FTT and implies the baby is not receiving enough food due to economic factors or parental neglect, or do to psychosocial problems.

Causes and symptoms

Occasionally, there may be an underlying physical condition that inhibits the baby's ability to take in, digest, or process food. These defects can occur in the esophagus, stomach, small or large intestine, rectum or anus. Usually the defect is an incomplete development of the organ, and it must be surgically corrected. Most physical defects can be detected shortly after birth.

Failure to thrive may also result from lack of available food or the quality of the food offered. This can be due to economic factors in the family, parental beliefs and concepts of **nutrition**, or neglect of the child. In addition, if the baby is being breast fed, the quality or quantity of the mother's milk may be the source of the problem.

Psychosocial problems, often stemming from a lack of nurturing parent-child relations can lead to a failure to thrive. The child may exhibit poor appetite due to depression from insufficient attention from parents.

Infants and toddlers, whose growth is substantially less than expected, are considered to be suffering from FTT.

Diagnosis

Most babies are weighed at birth and that weight is used as a base line for future well-baby check-ups. If the baby is not gaining weight at a predictable rate, the doctor will do a more extensive examination. If there are no apparent physical deformities in the digestive tract, the doctor will examine the child's environment. As part of that examination, the doctor will look at the family history of height and weight. In addition, the parents will be asked about feedings, illnesses, and family routines. If the mother is breastfeeding the doctor will also evaluate her diet, general health, and well being as it affects the quantity and quality of her milk.

Diagnosis of FTT is confirmed by a positive growth and behavioral response to increased nutrition.

Treatment

If there is an underlying physical reason for failure to thrive, such as a disorder of swallowing mechanism or intestinal problems, correcting that problem should reverse the condition. If the condition is caused by environmental factors, the physician will suggest several ways parents may provide adequate food for the child. Maternal education and parental counseling may also be recommended. In extreme cases, hospitalization or a more nurturing home may be necessary.

Prognosis

The first year of life is important as a foundation for growth and physical and intellectual development in the future. Children with extreme failure to thrive in the first year may never catch up to their peers even if their physical growth improves. In about one third of these extreme cases, mental development remains below normal and roughly half will continue to have psychosocial and eating problems throughout life.

KEY TERMS

Esophagus—The muscular tube which connects the mouth and stomach.

Psychosocial—A term referring to the mind's ability to, consciously or unconsciously, adjust and relate the body to its social environment.

When failure to thrive is identified and corrected early, most children catch up to their peers and remain healthy and well developed.

Prevention

Initial failure to thrive caused by physical defects cannot be prevented but can often be corrected before they become a danger to the child. Maternal education and emotional and economic support systems all help to prevent failure to thrive in those cases where there is no physical deformity.

Resources

ORGANIZATIONS

American Humane Association, Children's Division. 63 Inverness Drive East, Englewood, CO 80112-5117. (800) 227-4645. <www.americanhumane.org>.

Federation for Children With Special Needs. 1135 Tremont Street, Suite 420, Boston, MA 02120. (617) 236-7210. <http://www.fcsn.org>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic. htm>.

Dorothy Elinor Stonely

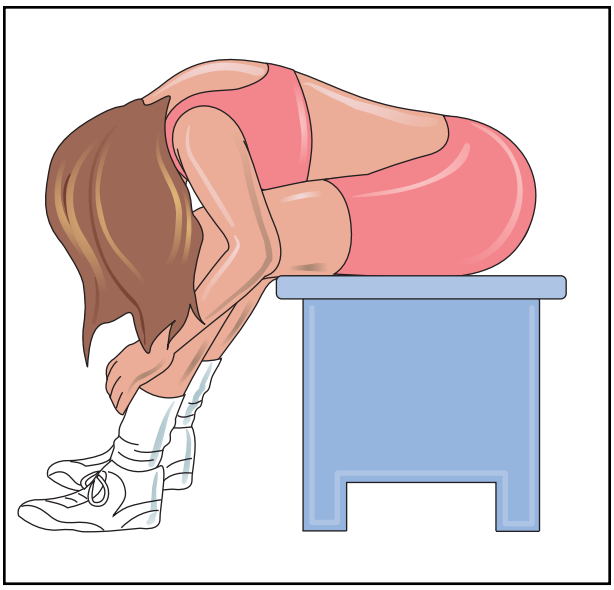
Fainting

Definition

Fainting is loss of consciousness caused by a temporary lack of oxygen to the brain. Known by the medical term "syncope," fainting may be preceded by **dizziness**, nausea, or a feeling of extreme weakness.

Description

When a person faints, the loss of consciousness is brief. The person will wake up as soon as normal blood flow is restored to the brain. Blood flow is usually



If a person is feeling faint, unconsciousness may be prevented by sitting with the head between the knees, as shown in the illustration above, or by lying flat with the legs raised. *Illustration by Electronic Illustrators Group.)*

restored by lying flat for a short time. This position puts the head on the same level as the heart so that blood flows more easily to the brain.

A fainting episode may be completely harmless and of no significance, but it can be a symptom of a serious underlying disorder. No matter how trivial it seems, a fainting episode should be treated as a medical emergency until the cause is determined.

Causes and symptoms

Extreme **pain**, fear, or **stress** may bring on fainting. This type of fainting is caused by overstimulation of the vagus nerve, a nerve connected to the brain that helps control breathing and circulation. In addition, a person who stands still or erect for too long may faint. This type of fainting occurs because blood pools in the leg veins, reducing the amount that is available for the heart to pump to the brain. This type of fainting is quite common in older people or those taking drugs to treat high blood pressure.

When an older person feels faint upon turning the head or looking upward suddenly, the cause could be **osteoarthritis** of the neck bones. Osteoarthritis damages the cartilage between the neck bones and causes pressure on blood vessels leading to the brain.

Fainting can be a symptom of a disease such as Stokes-Adams syndrome, a condition in which blood flow to the brain is temporarily reduced because of an irregular heartbeat. Some people may experience fainting associated with weakness in the limbs or a temporary problem in speaking caused by obstructed blood flow in vessels passing through the neck to the brain. Pregnant women frequently feel faint. Fainting may also occur as a result of low blood sugar. Low blood sugar can occur if a person skips a meal or has diabetes.

Fainting can also be caused by:

- prolonged coughing
- straining to defecate or urinate
- blowing a wind instrument too hard
- remaining in a stuffy environment with too little oxygen

Sometimes fainting may be caused by a temporary drop in the blood supply to the brain caused by a **transient ischemic attack** (TIA). A TIA, sometimes called a mini-stroke, is a disruption in the blood supply to the brain caused by a blocked or burst blood vessel. Seek help immediately if a fainting spell is followed by one or more of the symptoms listed below:

- numbness or tingling in any body part
- blurred vision
- confusion
- difficulty speaking
- loss of movement in arms or legs

A few seconds before fainting, a person may sweat or become pale, feel nauseated or dizzy, and have blurred vision or racing heartbeat. Once the person loses consciousness, the pupils may dilate as the heart rate slows down. There may be abnormal movements. Muscles may tighten or the back may arch. These movements do not last long and they are not violent.

In most cases, the patient regains consciousness within a few minutes, but the fainting spell may be followed by nervousness, **headache**, nausea, dizziness, pallor or sweating. The person may faint again, especially if he or she stands up within 30 minutes.

Diagnosis

Most episodes of fainting are a one-time occurrence. When a person experiences repeated fainting spells, a physician should be consulted.

Treatment

Most of the time, a person who faints ends up lying on the floor. If this happens, the patient should be rolled onto his or her back. Because someone who faints often vomits, bystanders should keep the airway open. A person who is fainting should not be held upright or in a sitting position. These positions prevent blood flow to the brain and may bring on a seizure.

KEY TERMS

Osteoarthritis—A disease characterized by damage to the cartilage in the joints. The joints become inflamed, deformed, and enlarged, and movement becomes painful.

Stokes-Adams syndrome—Recurrent episodes of temporary loss of consciousness (fainting) caused by an insufficient flow of blood from the heart to the brain. This syndrome is caused by a very rapid or a very slow heartbeat.

Transient ischemic attack (TIA)—A brief interruption of the blood supply to part of the brain that causes a temporary impairment of vision, speech, or movement. Usually, the episode lasts for just a few moments, but it may be a warning sign for a full-scale stroke.

Vagus nerve—A cranial nerve, that is, a nerve connected to the brain. The vagus nerve has branches to most of the major organs in the body, including the larynx, throat, windpipe, lungs, heart, and most of the digestive system.

Bystanders should check the patient's breathing and pulse rate. The pulse may be weak and slow. If there are no signs of breathing or heart rate, the problem is more serious than fainting, and **cardiopulmonary resuscitation** (**CPR**) must begin.

If breathing and pulse rates seem normal, the person's legs should be raised above the level of the head so that gravity can help the blood flow to the brain. Belts, collars or any other constrictive clothing should be loosened.

If the person does not regain consciousness within a minute or two after fainting, medical help should be summoned.

Prognosis

After a fainting spell, the person should regain normal color but may continue to feel weak for a short time. Lying down quietly for a few moments may help.

In most cases, an attack of fainting is not serious. As soon as the underlying pain or stress passes, the danger of repeated episodes also is eliminated.

Prevention

If a person is feeling faint, unconsciousness may be prevented by sitting with the head between the knees or lying flat with the legs raised.

A person who has fainted should lie flat for 10–15 minutes after regaining consciousness to give the system a chance to regain its balance. Standing up too soon may bring on another fainting spell.

Resources

BOOKS

Greenberg, David A., et al. *Clinical Neurology.* 2nd ed. Norwalk, CT: Appleton & Lange, 1993.

Carol A. Turkington

Falciparum malaria *see* **Malaria**

Fallopian tube ligation *see* **Tubal ligation**

Fallopian tube removal *see* **Salpingectomy**

Fallopian tube x rays *see* **Hysterosalpingography**

Famciclovir *see* **Antiviral drugs**

Familial Mediterranean fever

Definition

Familial Mediterranean **fever** (FMF) is an inherited disorder of the inflammatory response characterized by recurring attacks of fever, accompanied by intense **pain** in the abdomen, chest, or joints. Attacks usually last 12–72 hours, and can occasionally involve a skin rash. Kidney disease is a serious concern if the disorder is not treated. FMF is most prevalent in people of Armenian, Sephardic-Jewish, Arabic, and Turkish ancestry.

Description

FMF could be described as a disorder of "inappropriate" inflammation. That is, an event that in a normal situation causes a mild or unnoticeable inflammation might cause a severe inflammatory response in someone with FMF. Certain areas of the body are at risk for FMF-related symptoms. A serosa is a serous (fluid-producing) membrane that can be found inside the abdominal cavity (peritoneum), around the lungs (pleura), around the heart (pericardium), and inside the joints (synovium). The symptoms of FMF are due to inflammation of one or more of the serosal membranes (serositis). Thus, FMF is also sometimes called recurrent polyserositis.

During an attack, large numbers of neutrophils, a type of white blood cell, move into the affected areas

causing painful inflammation and fever. These episodes may be accompanied by a skin rash or joint pain. In a few cases, chronic arthritis is a problem. **Amyloidosis** is a potentially serious condition in which proteins called amyloids are mistakenly produced and deposited in organs and tissues throughout the body. Left untreated, amyloidosis often leads to kidney failure, which is the major long-term health risk in FMF.

In most cases, the attacks of fever and pain are first noticed in childhood or adolescence. The interval between these episodes may be days or months, and is not predictable. However, during these intervals people with FMF typically lead normal lives. It is not entirely clear what brings on an attack, but people with FMF often report mild physical trauma, physical exertion, or emotional **stress** just prior to the onset of symptoms. Treatment for FMF involves an oral medication called colchicine, which is highly effective for the episodes of fever and pain, as well as for amyloidosis and the kidney disease that can result from it.

FMF is most common in certain ethnic groups from the eastern Mediterranean region, but cases in other ethnic groups in other parts of the world are increasingly being reported. FMF is also known by many other names. They include: recurrent hereditary polyserositis, benign paroxysmal **peritonitis**, familial paroxysmal polyserositis, paroxysmal polyserositis, familial recurrent polyserositis, periodic fever, periodic amyloid syndrome, periodic peritonitis syndrome, Reimann periodic disease, Reimann syndrome, Siegel-Cattan-Mamou syndrome, and Armenian syndrome.

Estimates of the incidence of FMF in specific eastern Mediterranean populations range from 1 in 2000 to 1 in 100, depending on the population studied. Specific mutations in the MEFV gene are more common in certain ethnic groups, and may cause a somewhat different course of the disease. A few mutations in the MEFV gene likely became common in a small population in the eastern Mediterranean several thousand years ago. It is postulated that carrying a single copy of a mutated gene produced a modified (but not abnormal) inflammatory response that may have been protective against some infectious agent at that time. Those who carried a single "beneficial" mutation in the MEFV gene were more likely to survive and reproduce, which may explain the high carrier frequency (up to one in five) in some populations. People of Armenian, Sephardic-Jewish, Arabic, and Turkish ancestry are at greatest risk for FMF. However, a better understanding and recognition of the symptoms of FMF in recent years has resulted in more reports of the condition in other ethnic groups, such as Italians and Armenian-Americans.

Causes and symptoms

FMF is a genetic condition inherited in an autosomal recessive fashion. Mutations in the MEFV gene (short for Mediterranean Fever) on chromosome number 16 are the underlying cause of FMF. Autosomal recessive inheritance implies that a person with FMF has mutations in both copies of the MEFV gene. All genes come in pairs, and one copy of each pair is inherited from each parent. If neither parent of a child with FMF has the condition, it means they carry one mutated copy of the MEFV gene, but also one normal copy, which is enough to protect them from disease. If both parents carry the same autosomal recessive gene, there is a one in four chance in each **pregnancy** that the child will inherit both recessive genes, and thus have the condition.

The MEFV gene carries the instructions for production of a protein called pyrin, named for pyrexia, a medical term for fever. The research group in France that co-discovered the protein named it marenostrin, after ancient Latin words that referred to the Mediterranean Sea. The movement of neutrophils into an area of the body where trauma or infection has occurred is the major cause of inflammation, which is a normal process. Research has shown that pyrin has some function in controlling neutrophils. In a situation where minor trauma or stress occurs, some initial inflammation may follow, but a functional pyrin protein is responsible for shutting-down the response of neutrophils once they are no longer needed. An abnormal pyrin protein associated with FMF may be partly functional, but unstable. In some instances, the abnormal pyrin itself seems to be "stressed", and loses its ability to regulate neutrophils and inflammation. Left unregulated, a normal, mild inflammation spirals out of control. Exactly what causes pyrin in FMF to lose its ability to control neutrophils in some situations is not known.

The recurrent acute attacks of FMF typically begin in childhood or adolescence. Episodes of fever and painful inflammation usually last 12–72 hours. About 90% of people with FMF have their first attack by age 20. The group of symptoms that characterizes FMF includes the following:

Fever

An FMF attack is nearly always accompanied by a fever, but it may not be noticed in every case. Fevers are typically 100–104°F (38–40°C). Some people experience chills prior to the onset of fever.

Abdominal pain

Nearly all people with FMF experience abdominal pain at one point or another, and for most it is the most

KEY TERMS

Acute phase reactants—Blood proteins whose concentrations increase or decrease in reaction to the inflammation process.

Amyloid—A waxy translucent substance composed mostly of protein, that forms plaques (abnormal deposits) in the brain.

Amyloidosis—Accumulation of amyloid deposits in various organs and tissues in the body such that normal functioning of an organ is compromised.

Colchicine—A compound that blocks the assembly of microtubules–protein fibers necessary for cell division and some kinds of cell movements, including neutrophil migration. Side effects may include diarrhea, abdominal bloating, and gas.

Leukocyte—A white blood cell. The neutrophils are a type of leukocyte.

Leukocytosis—An increase in the number of leukocytes in the blood.

Neutrophil—The primary type of white blood cell involved in inflammation. Neutrophils are a type of granulocyte, also known as a polymorphonuclear leukocyte.

Pericarditis—Inflammation of the pericardium, the membrane surrounding the heart.

Peritonitis—Inflammation of the peritoneum, the membrane surrounding the abdominal contents.

Pleuritis—Inflammation of the pleura, the membrane surrounding the lungs.

Pyrexia—A medical term denoting fevers.

Serositis—Inflammation of a serosal membrane. Polyserositis refers to the inflammation of two or more serosal membranes.

Synovitis—Inflammation of the synovium, a membrane found inside joints.

common complaint. The pain can range from mild to severe, and can be diffuse or localized. It can mimic **appendicitis**, and many people with undiagnosed FMF have had appendectomies or exploratory surgery of the abdomen done, only to have the fever and abdominal pain return.

Chest pain

Pleuritis, also called **pleurisy**, occurs in up to half of the affected individuals in certain ethnic groups. The pain is usually on one side of the chest. **Pericarditis** would also be felt as chest pain.

Joint pain

About 50% of people with FMF experience joint pain during attacks. The pain is usually confined to one joint at a time, and often involves the hip, knee, or ankle. For some people, however, the recurrent joint pain becomes chronic arthritis.

Myalgia

Up to 20% of individuals report muscle pain. These episodes typically last less than two days, and tend to occur in the evening or after physical exertion. Rare cases of muscle pain and fever lasting up to one month have been reported.

Skin rash

A rash, described as erysipelas-like erythema, accompanies attacks in a minority of people, and most often occurs on the front of the lower leg or top of the foot. The rash appears as a red, warm, swollen area about 4–6 in (10–15 cm) in diameter.

Amyloidosis

FMF is associated with high levels in the blood of a protein called serum amyloid A (SAA). Over time, excess SAA tends to be deposited in tissues and organs throughout the body. The presence and deposition of excess SAA is known as amyloidosis. Amyloidosis may affect the gastrointestinal tract, liver, spleen, heart, and testes, but effects on the kidneys are of greatest concern. The frequency of amyloidosis varies among the different ethnic groups, and its overall incidence is difficult to determine because of the use of colchicine to avert the problem. Left untreated, however, those individuals who do develop amyloidosis of the kidneys may require a renal transplant, or may even die of renal failure. The frequency and severity of a person's attacks of fever and serositis seem to have no relation to whether they will develop amyloidosis. In fact, a few people with FMF have been described who have had amyloidosis but apparently no other FMF-related symptoms.

Other symptoms

A small percentage of boys with FMF develop painful inflammation around the testes, headaches are a common occurrence during attacks, and certain types of **vasculitis** (inflammation of the blood vessels) seem to be more common in FMF.

Diagnosis

Individually, the symptoms that define FMF are common. Fevers occur for many reasons, and nonspecific pains in the abdomen, chest, and joints are also frequent ailments. Several infections can result in symptoms similar to FMF (Mallaret **meningitis**, for instance), and many people with FMF undergo exploratory abdominal surgery and ineffective treatments before they are finally diagnosed. Membership in a less commonly affected ethnic group may delay or hinder the correct diagnosis.

In general, symptoms involving one or more of the following broad groups should lead to suspicion of FMF: Unexplained recurrent fevers, polyserositis, skin rash, and/or joint pain; abnormal blood studies (see below); and renal or other disease associated with amyloidosis. A family history of FMF or its symptoms would obviously be an important clue, but the recessive nature of FMF means there usually is no family history. The diagnosis may be confirmed when a person with unexplained fever and pain responds to treatment with colchicine since colchicine is not known to have a beneficial effect on any other condition similar to FMF. Abnormal results on a blood test typically include **leukocytosis** (elevated number of neutrophils in the blood), an increased **erythrocyte sedimentation rate** (rate at which red blood cells form a sediment in a blood sample), and increased levels of proteins associated with inflammation (called acute phase reactants) such as SAA.

Direct analysis of the MEFV gene for FMF mutations is the only method to be certain of the diagnosis. However, it is not yet possible to detect all MEFV gene mutations that might cause FMF. Thus, if DNA analysis is negative, clinical methods must be relied upon. If both members of a couple were proven to be FMF carriers through **genetic testing**, highly accurate prenatal diagnosis would be available in any subsequent pregnancy.

Similar syndromes of periodic fever and inflammation include familial Hibernian fever and hyperimmunoglobulinemia D syndrome, but both are more rare than FMF.

Treatment

Colchicine is a chemical compound that can be used as a medication, and is frequently prescribed for **gout**. Some years ago, colchicine was discovered to also be effective in reducing the frequency and severity of attacks in FMF. Treatment for FMF at this point consists of taking colchicine daily. Studies have shown that about 75% of FMF patients achieve complete remission of their symptoms, and about 95% show marked improvement when taking colchicine. Lower effectiveness has been reported, but there is some question about the number of FMF patients who choose not to take their colchicine between attacks when they are feeling well, and thus lose some of the ability to prevent attacks. Compliance with taking colchicine every day may be hampered by its side effects, which include **diarrhea**, nausea, abdominal bloating, and gas. There is a theoretical risk that colchicine use could damage chromosomes in sperms and eggs, or in an embryo during pregnancy, or that it might reduce fertility. However, studies looking at reproduction in men and women who have used colchicine have so far not shown any increased risks. Colchicine is also effective in preventing, delaying, or reversing renal disease associated with amyloidosis.

Other medications may be used as needed to deal with the pain and fever associated with FMF attacks. Dialysis and/or renal transplant might become necessary in someone with advanced kidney disease. Given its genetic nature, there is no cure for FMF, nor is there likely to be in the near future. Any couple that has a child diagnosed with FMF, or anyone with a family history of the condition (especially those in high-risk ethnic groups), should be offered **genetic counseling** to obtain the most up-to-date information on FMF and testing options.

Prognosis

For those individuals who are diagnosed early enough and take colchicine consistently, the prognosis is excellent. Most will have very few, if any, attacks of fever and polyserositis, and will likely not develop serious complications of amyloidosis. The problem of misdiagnosing FMF continues, but education attempts directed at both the public and medical care providers should improve the situation. Future research should provide a better understanding of the inflammation process, focusing on how neutrophils are genetically regulated. That information could then be used to develop treatments for FMF with fewer side effects, and might also assist in developing therapies for other diseases in which abnormal inflammation and immune response are a problem.

Resources

BOOKS

Kastner, Daniel L. "Intermittent and Periodic Arthritic Syndromes." In *Arthritis and Allied Conditions: A Textbook of*

Rheumatology. 13th ed. Ed. William J. Koopman. Baltimore: Williams & Wilkins, 1996.

Sha'ar, Khuzama H., and Haroutone K. Armenian. "Familial Paroxysmal Polyserositis (Familial Mediterranean Fever)." In *Genetic Disorders Among Arab Populations,* ed. Ahmad S. Teebi, and Talaat I. Faraq. New York: Oxford University Press, 1997.

PERIODICALS

Ben-Chetrit, Eldad, and Micha Levy. "Familial Mediterranean Fever." *The Lancet* 351 (28 Feb. 1998): 659-64.

Kastner, Daniel L. "Familial Mediterranean Fever: The Genetics of Inflammation." *Hospital Practice* 33 (15 Apr. 1998):131-146.

Samuels, Jonathan, et al. "Familial Mediterranean Fever at the Millennium: Clinical Spectrum, Ancient Mutations, and a Survey of 100 American Referrals to the National Institutes of Health." *Medicine* 77 (July 1998):268-97.

ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases. National Institutes of Health, One AMS Circle, Bethesda, MD 20892. <http://www.nih.gov/niams>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

National Society of Genetic Counselors. 233 Canterbury Dr., Wallingford, PA 19086-6617. (610) 872-1192. <http://www.nsgc.org/GeneticCounselingYou.asp>.

Scott J. Polzin, M.S.

Familial polyposis

Definition

Familial polyposis is an inherited condition which primarily affects the large intestine (colon and rectum). Large numbers of projecting masses of swollen and thickened or tumorous membrane (polyps) develop on the inner lining of this part of the bowel. The polyps eventually become malignant.

Description

Familial polyposis (FP) is known by many synonyms, most include some combination of words which reflect what is known about the disease. As the disease is inherited, the word, family, is often included. Because these mushroom-like growths are the most obvious manifestation of the disorder, the word, polyp, is usually in the term as well. Adenoma refers to the particular kind of polyp that is typically discovered. Some of the names found in medical texts and journals include polyposis coli, familial colonic polyposis, multiple familial polyposis, familial adenomatous colon polyposis, adenomatosis of the colon and rectum (ACR), and familial adenomatous polyposis (FAP). The last term and its abbreviation have been commonly used since the early 1990s. It will be used in this discussion.

Familial polyposis or familial adenomatous polyposis (FAP) is a premalignant disease. This means that a person with FAP, if left untreated, will invariably develop **cancer**. Individuals with this disorder grow hundreds of polyps throughout their large intestines. The polyps, which may also be called adenomas, commonly develop just after **puberty**. Approximately half of all FAP patients will have polyps by age 14. Ninety percent will have detectable polyps by age 25. Usually by age 35–40, one or more of these polyps will become cancerous.

FAP is a rare disease. One in 8,000 people in the United States have FAP. However, it may be very common in affected families. FAP is inherited in an autosomal dominant pattern. This means that a person with FAP has a 50% chance of passing the condition down to each of their children. FAP can also develop in someone with no family history of the disorder, due to a new genetic mutation in that individual. It is thought that approximately one percent of all colorectal cancers in the United States can be attributed to FAP.

Causes and symptoms

FAP is caused by a portion of a gene that mutates or changes. The original cause of the mutation is unknown. Its exact role in FAP is not completely clear. Researchers theorize that the normal gene directs the manufacture of a protein which helps control cell growth. The mutated gene section in FAP generates an abnormal protein which does not perform its normal function. Cells grow out of control, causing the development of multiple, sometimes hundreds, of polyps. One or more of these eventually becomes cancerous.

Many individuals develop polyps without displaying any symptoms. Others experience such gastrointestinal problems as **diarrhea**, **constipation**, abdominal cramps, blood in the stool, or weight loss. FAP patients may also develop nonmalignant tumors (desmoid tumors), and/or some bone and dental abnormalities. In addition, they may exhibit a "spot" on the retina of the eye (congenital hypertrophy of the retinal pigment epithelium, or CHRPE).

Relatives of individuals with diagnosed FAP are at high risk of having the disease themselves. There are no other known risk factors for this condition.

Diagnosis

The abnormal portion of the gene that causes FAP in most patients can be detected. A blood test can then be performed which identifies family members who have the same mutation. They will eventually develop the condition. Children who have a parent with FAP, and siblings of affected patients whose parental history is incomplete, should be evaluated. The polyps characteristic of FAP have been found in children as young as age five. Testing of appropriate individuals should take place as soon as the diagnosis of FAP is established in one member of a family.

Relatives of people with diagnosed FAP should **exercise** caution regarding where they seek advice and testing. One study of a commercially available blood test found that less than 20% of patients received any **genetic counseling**, and almost one third of their physicians misinterpreted the test results.

Registries for FAP patients can be found at many sites in the United States. Such a registry specializes in identification, assistance, and education of people with a particular disease, and is usually a separate department in a research hospital. A team of health professionals who have expertise in the disorder staff the registry.

Testing within a research setting and/or at a facility with a registry of patients with FAP is more likely to safeguard against problems, such as the misunderstanding of test results. As part of a research project, sometimes counseling as well as blood tests are available at no charge to the patient. Insurance coverage varies. Concerns about confidentiality, and future insurance and employment discrimination, may prompt individuals to pay for the examination out of pocket. Commercial blood tests cost approximately $250 per sample.

If the abnormal gene is found in a family member, annual screening for colon polyps is recommended, beginning at age 11. Flexible **sigmoidoscopy** is used for this examination. It is usually done in a physician's office, or in a hospital department, most often by a gastroenterologist or a surgeon. Food intake may be restricted for 24 hours prior to the procedure. Before the study, the intestine is cleared of stool by one or more small **enemas**. Some physicians prefer to sedate the patient, to help them relax. Then a flexible, lighted, hollow tube (sigmoidoscope) is inserted into the anus and maneuvered into the large intestine. The physician examines the wall of the colon to look for polyps. If polyps are found, one or more may be removed for biopsy.

Most patients report little discomfort during the examination. The procedure itself takes five to fifteen minutes. The patient may be at the facility an hour, or more, if recovery from **sedation** is needed. If no medication was administered, driving and resumption of normal activities are permitted immediately. The cost of the procedure varies widely, but, as of 1997, it was covered by Medicare, indicating the likelihood of other types of insurance coverage.

In some cases the portion of the gene responsible for FAP cannot be identified. Family members of these patients cannot have a predictive blood test. The current recommendation is for these patients to have the same annual examination with flexible sigmoidoscopy as patients with a diagnosed FAP gene. A noninvasive screening **eye examination** to detect CHRPE, associated with FAP, may also be performed.

Treatment

The only definitive treatment for FAP is surgical removal of the lower intestine. Since the goal is to prevent cancer, the operation is done as soon as adenomatous polyps are found on sigmoidoscopy. Waiting until a polyp becomes malignant is unsafe, as the cancer may invade surrounding tissues.

There are several choices about the type of surgery to treat this condition. Some authorities advocate removal of the colon, leaving the rectum or lowest portion of the intestine in place. The small intestine can be attached to the rectum, allowing normal bowel function. This is often called ileorectal anastomosis. Others argue that this section is also liable to develop polyps, needs to be monitored regularly, and may require eventual removal.

Excision of the entire lower intestine with preservation of normal bowel function is possible. This entails a more complex surgical procedure. The patient may experience more complications and a longer recovery period. However, the risk of polyp development in this area is very low. Periodic examination of the intestine may not be needed once healing is complete.

The more intricate surgery may be referred to as a J-pouch procedure, an ileal pouch-anal anastomosis, a restorative proctocolectomy, or an ileoanal reservoir procedure. It involves creating a "pouch" of tissue from the small intestine, which is attached to the anus. This serves as a reservoir or holding area for stool, much as the rectum does normally. The surgery is often done in several stages. A temporary ileostomy, which creates an opening of the small intestines onto the abdomen, is required. When all procedures are completed, and after a recuperation period, the patient regains normal bowel function through the anus.

Some researchers suggest that as **genetic testing** becomes more developed, the specific portion of the gene involved may dictate the type of surgery chosen. Those at high risk of developing **rectal polyps** may be

advised to have the more complex operation. FAP patients felt to be at lower risk for rectal polyps might be counseled to consider the less radical surgery.

Medical therapy to treat the adenomatous polyps has been attempted. Some **nonsteroidal anti-inflammatory drugs** have been effective in reducing the number and size of the polyps. It is possible that these agents will be used as an additional treatment for FAP, but they are unlikely to replace surgery.

Individuals with FAP are at increased risk for cancers of the upper digestive tract including the upper portion of the small bowel (dudodenum) and the channels where bile flows (biliary tract). Cancers of the thyroid, pancreas, and adrenal gland are also more commonly found among FAP patients. Periodic examination for the development of malignancy in these areas is considered part of the treatment of FAP. In some cases, such as cancer involving the duodenum, the tests themselves carry a chance of complications. The risk of the study must be weighed against the potential benefits of knowing the results. Non-malignant growths, called desmoid tumors, also occur more frequently in patients with FAP. Although they are not malignant, they grow quickly into surrounding tissues, causing many difficulties, even **death** in some cases.

Prognosis

The major cause of death in many patients with FAP remains colorectal cancer. One study suggested that even with improved disease recognition, social and emotional factors, such as fear of surgery, may significantly delay a patient's treatment. In recent years, the trend is towards mortality from other causes, such as desmoid tumors or cancers other than colorectal. It has been estimated that a patient with known FAP has a relative risk of dying over three times greater than that of the average population, at a given age.

Prevention

FAP cannot be prevented. Aggressive diagnosis, treatment, and follow-up monitoring are keys to successful management of the disease.

Resources

ORGANIZATIONS

Familial Polyposis Registry. Department of Colorectal Surgery. Cleveland Clinic Foundation. 9500 Euclid Ave., Cleveland OH 44195-5001. (216) 444-6470.

National Organization for Rare Disorders. PO Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Ellen S. Weber, MSN

KEY TERMS

Gene—The basic unit of heredity, made of DNA. Each gene occupies certain location on a chromosome.

Mutation—An alteration in a gene, especially one capable of producing a new trait, or a change in function.

Family therapy

Definition

Family therapy is a form of psychotherapy that involves all the members of a nuclear or extended family. It may be conducted by a pair or team of therapists. In many cases the team consists of a man and a woman in order to treat gender-related issues or serve as role models for family members. Although some forms of family therapy are based on behavioral or psychodynamic principles, the most widespread form is based on family systems theory. This approach regards the family, as a whole, as the unit of treatment, and emphasizes such factors as relationships and communication patterns rather than traits or symptoms in individual members.

Family therapy is a relatively recent development in psychotherapy. It began shortly after World War II, when doctors, who were treating schizophrenic patients, noticed that the patients' families communicated in disturbed ways. The doctors also found that the patients' symptoms rose or fell according to the level of tension between their parents. These observations led to considering a family as an organism or system with its own internal rules, patterns of functioning, and tendency to resist change. The therapists started to treat the families of schizophrenic patients as whole units rather than focusing on the hospitalized member. They found that in many cases the family member with **schizophrenia** improved when the "patient" was the family system. (This should not be misunderstood to mean that schizophrenia is caused by family problems, although family problems may worsen the condition.) This approach of involving the entire family in the treatment plan and therapy was then applied to families with problems other than the presence of schizophrenia.

Family therapy is becoming an increasingly common form of treatment as changes in American society are reflected in family structures. It has led to two further developments: couples therapy, which treats relationship

problems between marriage partners or gay couples; and the extension of family therapy to religious communities or other groups that resemble families.

Purpose

Family therapy is often recommended in the following situations:

- Treatment of a family member with schizophrenia or **multiple personality disorder** (MPD). Family therapy helps other family members understand their relative's disorder and adjust to the psychological changes that may be occurring in the relative.
- Families with problems across generational boundaries. These would include problems caused by parents sharing housing with grandparents, or children being reared by grandparents.
- Families that deviate from social norms (common-law relationships, gay couples rearing children, etc.). These families may not have internal problems but may be troubled by outsiders' judgmental attitudes.
- Families with members from a mixture of racial, cultural, or religious backgrounds.
- Families who are scapegoating a member or undermining the treatment of a member in individual therapy.
- Families where the identified patient's problems seem inextricably tied to problems with other family members.
- Blended families with adjustment difficulties.

Most family therapists presuppose an average level of intelligence and education on the part of adult members of the family.

Precautions

Some families are not considered suitable candidates for family therapy. They include:

- families in which one, or both, of the parents is psychotic or has been diagnosed with antisocial or paranoid personality disorder,
- families whose cultural or religious values are opposed to, or suspicious of, psychotherapy,
- families with members who cannot participate in treatment sessions because of physical illness or similar limitations,
- families with members with very rigid personality structures, (here, members might be at risk for an emotional or psychological crisis),
- families whose members cannot or will not be able to meet regularly for treatment,
- families that are unstable or on the verge of breakup.

Description

Family therapy tends to be short-term treatment, usually several months in length, with a focus on resolving specific problems such as eating disorders, difficulties with school, or adjustments to bereavement or geographical relocation. It is not normally used for long-term or intensive restructuring of severely dysfunctional families.

In family therapy sessions, all members of the family and both therapists (if there is more than one) are present at most sessions. The therapists seek to analyze the process of family interaction and communication as a whole; they do not take sides with specific members. They may make occasional comments or remarks intended to help family members become more conscious of patterns or structures that had been previously taken for granted. Family therapists, who work as a team, also model new behaviors for the family through their interactions with each other during sessions.

Family therapy is based on family systems theory, which understands the family to be a living organism that is more than the sum of its individual members. Family therapy uses "systems" theory to evaluate family members in terms of their position or role within the system as a whole. Problems are treated by changing the way the system works rather than trying to "fix" a specific member. Family systems theory is based on several major concepts:

The identified patient

The identified patient (IP) is the family member with the symptom that has brought the family into treatment. The concept of the IP is used by family therapists to keep the family from scapegoating the IP or using him or her as a way of avoiding problems in the rest of the system.

Homeostasis (balance)

The concept of homeostasis means that the family system seeks to maintain its customary organization and functioning over time. It tends to resist change. The family therapist can use the concept of homeostasis to explain why a certain family symptom has surfaced at a given time, why a specific member has become the IP, and what is likely to happen when the family begins to change.

The extended family field

The extended family field refers to the nuclear family, plus the network of grandparents and other members of the extended family. This concept is used to explain the intergenerational transmission of attitudes, problems, behaviors, and other issues.

Differentiation

Differentiation refers to the ability of each family member to maintain his or her own sense of self, while

remaining emotionally connected to the family. One mark of a healthy family is its capacity to allow members to differentiate, while family members still feel that they are "members in good standing" of the family.

Triangular relationships

Family systems theory maintains that emotional relationships in families are usually triangular. Whenever any two persons in the family system have problems with each other, they will "triangle in" a third member as a way of stabilizing their own relationship. The triangles in a family system usually interlock in a way that maintains family homeostasis. Common family triangles include a child and its parents; two children and one parent; a parent, a child, and a grandparent; three siblings; or, husband, wife, and an in-law.

Preparation

In some instances the family may have been referred to a specialist in family therapy by their pediatrician or other primary care provider. It is estimated that as many as 50% of office visits to pediatricians have to do with developmental problems in children that are affecting their families. Some family doctors use symptom checklists or psychological screeners to assess a family's need for therapy.

Family therapists may be either psychiatrists, clinical psychologists, or other professionals certified by a specialty board in marriage and family therapy. They will usually evaluate a family for treatment by scheduling a series of interviews with the members of the immediate family, including young children, and significant or symptomatic members of the extended family. This process allows the therapist(s) to find out how each member of the family sees the problem, as well as to form first impressions of the family's functioning. Family therapists typically look for the level and types of emotions expressed, patterns of dominance and submission, the roles played by family members, communication styles, and the locations of emotional triangles. They will also note whether these patterns are rigid or relatively flexible.

Preparation also usually includes drawing a genogram, which is a diagram that depicts significant persons and events in the family's history. Genograms also include annotations about the medical history and major personality traits of each member. Genograms help in uncovering intergenerational patterns of behavior, marriage choices, family alliances and conflicts, the existence of family secrets, and other information that sheds light on the family's present situation.

Risks

The chief risk in family therapy is the possible unsettling of rigid personality defenses in individuals, or couple relationships that had been fragile before the beginning of therapy. Intensive family therapy may also be difficult for psychotic family members.

KEY TERMS

Blended family—A family formed by the remarriage of a divorced or widowed parent. It includes the new husband and wife, plus some or all of their children from previous marriages.

Differentiation—The ability to retain one's identity within a family system while maintaining emotional connections with the other members.

Extended family field—A person's family of origin plus grandparents, in-laws, and other relatives.

Family systems theory—An approach to treatment that emphasizes the interdependency of family members rather than focusing on individuals in isolation from the family. This theory underlies the most influential forms of contemporary family therapy.

Genogram—A family tree diagram that represents the names, birth order, sex, and relationships of the members of a family. Therapists use genograms to detect recurrent patterns in the family history and to help the members understand their problem(s).

Homeostasis—The tendency of a family system to maintain internal stability and resist change.

Identified patient (IP)—The family member in whom the family's symptom has emerged or is most obvious.

Nuclear family—The basic family unit, consisting of father, mother, and their biological children.

Triangling—A process in which two family members lower the tension level between them by drawing in a third member.

Normal results

Normal results vary, but in good circumstances, they include greater insight, increased differentiation of individual family members, improved communication within the family, loosening of previously automatic behavior patterns, and resolution of the problem that led the family to seek treatment.

Resources

BOOKS

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics & Psychiatric Disorders: Psychosocial Assessment of Children

& Families." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.
Friedman, Edwin H. *Generation to Generation: Family Process in Church and Synagogue*. New York: The Guilford Press, 1985.
Glick, Robert Alan, and Henry I. Spitz. "Common Approaches to Psychotherapy: Family Therapy." In *The Columbia University College of Physicians and Surgeons Complete Home Guide to Mental Health*, ed. Frederic I. Kass, et al. New York: Henry Holt and Co., 1992.
Meissner, W. W. "The Psychotherapies: Individual, Family, and Group." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.
Napier, Augustus Y. *The Family Crucible*. New York: Harper & Row Publishers, 1988.

Rebecca J. Frey

Famine fever *see* **Relapsing fever**

Fanconi's syndrome

Definition

Fanconi's syndrome is a set of kidney malfunctions brought about by a variety of seemingly unrelated disorders. Kidney malfunction leads to excessive urine production and excessive thirst, resulting in deficits of water, calcium, potassium, magnesium, and other substances in the body. It often leads to bone disease and stunted growth.

Description

Normally, kidneys cleanse the blood and keep its salt, water, and acidity in balance, leaving what the body needs in the blood and putting what the body doesn't need into the urine, which leaves the body. This task is performed in two steps. First, the blood is filtered through a kidney structure with small holes that keep the cells and large molecules in the blood. Second, some of the small molecules in the filtrate, needed by the body, are reabsorbed and returned to the bloodstream.

This reabsorption step is defective in Fanconi's syndrome. As a consequence, substances that are normally reabsorbed, like glucose, amino acids, small proteins, water, calcium, potassium, magnesium, bicarbonate, and phosphate, are lost and the body becomes overly acidic.

Fanconi's syndrome is also known as Fanconi syndrome, renal Fanconi syndrome, Fanconi renaltubular syndrome, and Lignac-de Toni-Debré-Fanconi syndrome. Fanconi's anemia is, however, a totally different disease.

Causes and symptoms

Causes

Fanconi's syndrome can be caused by a variety of genetic defects and by certain environmental assaults.

The genetic diseases known to give rise to Fanconi's syndrome are cystinosis (the most common cause in children), **galactosemia**, glycogen storage disease, **hereditary fructose intolerance**, Lowe syndrome, **Wilson disease**, tyrosinemia, medullary cystic disease, vitamin D dependency, and familial idiopathic Fanconi's syndrome.

Environmental assaults that cause Fanconi's syndrome include exposure to heavy metals (like cadmium, lead, mercury, platinum, uranium), certain drugs (like outdated tetracycline and gentamicin), other substances (like Lysol, paraquat, toluene, the amino acid lysine taken as a nutritional supplement), and **kidney transplantation**.

Symptoms

Fanconi's syndrome symptoms related directly to impaired absorption include excessive urine production and urination; excessive thirst; **dehydration**; **constipation**; **anorexia nervosa**; vomiting; elevated levels of glucose, phosphate, calcium, uric acid, amino acids, and protein (especially beta$_2$-microglobulin and lysozyme) in the urine; elevated levels of chloride and decreased levels of phosphate and calcium in the blood; and excessively acidic blood.

The most noticeable indirect consequences of impaired reabsorption are the bone diseases, rickets and osteomalacia. Rickets affects children and is associated with bone deformities, failure to grow, and difficulty walking. If a person acquires Fanconi's syndrome as an adult, the bone disease is termed osteomalacia and is accompanied by severe bone **pain** and spontaneous **fractures**. Unlike rickets due to **malnutrition**, these diseases cannot be reversed with vitamin D. Muscle weakness and occasional **paralysis** are other indirect consequences of the ineffective reabsorption.

Diagnosis

Diagnosis of Fanconi's syndrome can be made by urine and blood tests. It is also important to find the underlying cause to decide on the best treatment. Other symptoms specific to a particular patient will point to other useful diagnostic tests. For example, high levels of

blood galactose in conjunction with symptoms of Fanconi's syndrome indicate the patient is suffering from galactosemia, while high blood levels of cadmium indicate the patient is suffering from cadmium **poisoning**.

Treatment

Fanconi's syndrome is best treated by attacking the underlying cause whenever possible. For example, when cystinosis is treated with the drug cysteamine to lower cystine levels in the body or Wilson disease is treated with penicillamine to lower the levels of copper, accompanying symptoms of Fanconi's syndrome will subside. If the patient has acquired the disease from a heavy metal or another toxic agent, all contact with the toxic agent should stop; the condition will then likely disappear.

Nevertheless, additional treatment will be necessary either when it's not possible to treat the underlying cause or while waiting for the kidneys to resume normal function. This is done by restricting sodium chloride (table salt), giving **antacids** to counteract the excessive acidity of the blood, and supplying potassium supplements.

Kidney transplant is the treatment of last resort, used for patients whose kidneys have failed.

Prognosis

Fanconi's syndrome can be reversible. Fanconi's syndrome caused by kidney transplantation usually reverses itself within the first year after transplant surgery. When caused by a toxin in the environment, Fanconi's syndrome generally can be reversed by removing the causative agent from the patient's environment. If it is caused by a genetic disease, it can usually be reversed by treating the disease. However, if Fanconi's syndrome is not treated or if treatment is unsuccessful, the kidneys can fail.

Prevention

Fanconi's syndrome caused secondarily by the genetic diseases galactosemia, glycogen storage disease, hereditary fructose intolerance, and tyrosinemia is prevented by appropriate dietary restrictions to treat the genetic disease, starting in infancy.

Fanconi's syndrome caused by heavy metals and other toxins can be prevented by avoiding these substances.

Resources

BOOKS

Bergeron, Michael, André Gougoux, and Patrick Vinay. "The Renal Fanconi Syndrome." In *The Metabolic and Molecular Bases of Inherited Disease*. 7th ed. Ed. Charles R. Scriver, et al. New York: McGraw-Hill, Inc., 1995.

KEY TERMS

Acidosis—Condition where the body is more acidic than normal; associated with headache, nausea, vomiting, and visual disturbances.

Fanconi's anemia—An inherited form of aplastic anemia.

Filtrate—The part of filtered material that flows through the filter.

Idiopathic—Refers to a disease of unknown cause.

Polydipsia—Excessive thirst.

Polyuria—Excessive production of urine.

ORGANIZATIONS

The American Society of Nephrology. 2025 M Street NW #800, Washington, DC 20036. (202) 367-1190. <http://www.asn-online.com>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

OTHER

"Online Mendelian Inheritance in Man." OMIM Homepage. <http://www.ncbi.nlm.nih.gov/Omim>.

Lorraine Lica, PhD

Farsightedness *see* **Hyperopia**

FAS *see* **Fetal alcohol syndrome**

Fasciotomy

Definition

Fasciotomy is a surgical procedure that cuts away the fascia to relieve tension or pressure

Purpose

The fascia is thin connective tissue covering, or separating, the muscles and internal organs of the body. It varies in thickness, density, elasticity, and composition, and is different from ligaments and tendons.

The fascia can be injured either through constant strain or through trauma. Fasciitis is an inflammation of the fascia. The most common condition for which fasciotomy is performed is plantar fasciitis, an inflammation of the fascia on the bottom of the foot that is sometimes called a heel spur or stone bruise.

Plantar fasciitis is caused by long periods on the feet, being overweight, and wearing shoes that do not support the foot well. Teachers, mail carriers, runners, and others who make heavy use of their feet are especially likely to suffer from plantar fasciitis.

Plantar fasciitis results in moderate to disabling heel **pain**. If nine to twelve months of conservative treatment (reducing time on feet, non-steroid anti-inflammatory drugs, arch supports) under the supervision of a doctor does not result in pain relief, a fasciotomy may be done. Fasciotomy removes a small portion of the fascia to relieve tension and pain. Connective tissue grows back into the cut space left by the cut, effectively lengthening the fascia.

When a fasciotomy is performed on other parts of the body, it is usually done to relieve pressure from a compression injury to a limb. This type of injury often occurs during contact sports. The blood vessels of the limb are damaged. They swell and leak, causing inflammation. Fluid builds up in the area contained by the fascia. A fasciotomy is done to relieve this pressure and prevent tissue **death**. Similar injury occurs in high voltage electrical **burns** where deep tissue damage occurs.

Precautions

In the case of injury, fasciotomy is done on an emergency basis, and the outcome of the surgery depends largely on the general health of the patient. Plantar fasciotomies are appropriate for most people whose foot problems cannot be resolved in any other way.

Description

Fasciotomy in the limbs is usually done by a surgeon under general or regional anesthesia. An incision is made in the skin, and a small area of fascia is removed where it will best relieve pressure. Then the incision is closed.

Plantar fasciotomy is an endoscopic (performed with the use of an endoscope) procedure. It is done by a foot specialist in a doctor's office or outpatient surgical clinic under local anesthesia and takes 20 minutes to one hour. The doctor makes two small incisions on either side of the heel. An endoscope is inserted in one to guide the doctor in where to cut. A tiny knife is inserted in the other. A portion of the fascia is cut from near the heel; then the incisions are closed.

Preparation

Little preparation is done before a fasciotomy. When the fasciotomy is related to burn injuries, the fluid and electrolyte status of the patient are constantly monitored.

KEY TERMS

Endoscope—A tube that contains a tiny camera and light, that is inserted in the body to allow a doctor to see inside without making a large incision.

Aftercare

Aftercare depends on the reason for the fasciotomy. People who have endoscopic plantar fasciotomy can walk without pain almost immediately, return to wearing their regular shoes within three to five days, and return to normal activities within three weeks. Most will need to wear arch supports in their shoes.

Risks

In endoscopic plantar fasciotomy, the greatest risk is that the arch will drop slightly as a result of this surgery, causing other foot problems. Risks involved with other types of fasciotomy are those associated with the administration of anesthesia and the development of blood clots.

Normal results

Fasciotomy in the limbs reduces pressure, thus reducing tissue death. Endoscopic plantar fasciotomy has a success rate of 90–95%.

Resources

BOOKS

"Blast Injuries." In *Current Surgical Diagnosis and Treatment.* 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

OTHER

"New Treatments for Heel Spur Syndrome." <http://www.footspecialist.com/heelspur.html>.

"Plantar Fasciitis." *Heelspurs.com.* 9 Apr. 1998 <http://www.heelspurs.com>.

Tish Davidson

Fasting

Definition

Fasting is voluntarily not eating food for varying lengths of time. Fasting is used as a medical therapy for many conditions. It is also a spiritual practice in many religions.

Purpose

Fasting can be used for nearly every chronic condition, including **allergies**, **anxiety**, arthritis, **asthma**, depression, diabetes, headaches, heart disease, **high cholesterol**, low blood sugar, digestive disorders, mental illness, and **obesity**. Fasting is an effective and safe weight loss method. It is frequently prescribed as a **detoxification** treatment for those with conditions that may be influenced by environmental factors, such as **cancer** and **multiple chemical sensitivity**. Fasting has been used successfully to help treat people who have been exposed to high levels of toxic materials due to accident or occupation. Fasting is thought to be beneficial as a preventative measure to increase overall health, vitality, and resistance to disease. Fasting is also used as a method of mental and spiritual rejuvenation.

Description

Origins

Used for thousands of years, fasting is one of the oldest therapies in medicine. Many of the great doctors of ancient times and many of the oldest healing systems have recommended it as an integral method of healing and prevention. Hippocrates, the father of Western medicine, believed fasting enabled the body to heal itself. Paracelsus, another great healer in the Western tradition, wrote 500 years ago that "fasting is the greatest remedy, the physician within." **Ayurvedic medicine**, the world's oldest healing system, has long advocated fasting as a major treatment.

Fasting has also been used in nearly every religion in the world, including Christianity, Judaism, Buddhism, and Islam. Many of history's great spiritual leaders fasted for mental and spiritual clarity, including Jesus, Buddha, and Mohammed. In one of the famous political acts of the last century, the Indian leader Mahatma Gandhi fasted for 21 days to promote peace.

Fasting has been used in Europe as a medical treatment for years. Many spas and treatment centers, particularly those in Germany, Sweden, and Russia, use medically supervised fasting. Fasting has gained popularity in American alternative medicine over the past several decades, and many doctors feel it is beneficial. Fasting is a central therapy in detoxification, a healing method founded on the principle that the build up of toxic substances in the body is responsible for many illnesses and conditions.

The principle of fasting is simple. When the intake of food is temporarily stopped, many systems of the body are given a break from the hard work of digestion. The extra energy gives the body the chance to heal and restore itself, and burning stored calories gets rid of toxic substances stored in the body.

The digestive tract is the part of the body most exposed to environmental threats, including bacteria, viruses, parasites, and toxins. It requires the most immune system support. When food is broken down in the intestines, it travels through the blood to the liver, the largest organ of the body's natural detoxification system. The liver breaks down and removes the toxic by-products produced by digestion, including natural ones and the chemicals now present in the food supply. During fasting, the liver and immune system are essentially freed to detoxify and heal other parts of the body.

Many healers claim that fasting is a particularly useful therapy for Americans and for the modern lifestyle, subjected to heavy **diets**, overeating, and constant exposure to food additives and chemicals. Some alternative practitioners have gone so far as to estimate that the average American is carrying 5-10 pounds of toxic substances in their bodies, for which fasting is the quickest and most effective means of removal.

Physiology of fasting

Through evolution, the body became very efficient at storing energy and handling situations when no food was available. For many centuries, fasting was probably a normal occurrence for most people, and the body adapted to it. It is estimated that even very thin people can survive for 40 days or more without food. The body has a special mechanism that is initiated when no food is eaten. Fasting is not **starvation**, but rather the body's burning of stored energy. Starvation occurs when the body no longer has any stored energy and begins using essential tissues such as organs for an energy source. Therapeutic fasts are stopped long before this happens.

Many physiological changes occur in the body during fasting. During the first day or so, the body uses its glycogen reserves, the sugars that are the basic energy supply. After these are depleted, the body begins using fat. However, the brain, which has high fuel requirements, still needs glucose (sugars converted from glycogen). To obtain glucose for the brain, the body begins to break down muscle tissue during the second day of the fast. Thus, during fasting some muscle loss will occur. To fuel the brain, the body would need to burn over a pound of muscle a day, but the body has developed another way to create energy that saves important muscle mass. This protein-sparing process is called ketosis, which occurs during the third day of a fast for men and the second day for women. In this highly efficient state, the liver begins converting stored fat and other nonessential tissues into ketones, which can be used by the brain, muscles, and

heart as energy. It is at this point in the fast that sensations of hunger generally go away, and many people experience normal or even increased energy levels. Hormone levels and certain functions become more stable in this state as well. The goal of most fasts is to allow the body to reach the ketosis state in order to burn excess fat and unneeded or damaged tissue. Thus, fasts longer than three days are generally recommended as therapy.

Weight loss occurs most rapidly during the first few days of a fast, up to 2 pounds per day. In following days, the figure drops to around 0.5 pound per day. An average weight loss of a pound a day for an entire fast can be expected.

Performing a fast

Fasts can be performed for varying lengths of time, depending on the person and his or her health requirements. For chronic conditions, therapists recommend from two to four weeks to get the most benefits. Seven-day fasts are also commonly performed. A popular fasting program for prevention and general health is a three-day fast taken four times per year, at the change of each season. These can be easily performed over long weekends. Preventative fasts of one day per week are used by many people as well.

Juice fasts are also used by many people, although these are not technically fasts. Juice fasts are less intensive than water fasts because the body doesn't reach the ketosis stage. The advantage of juice fasts is that fruit and vegetable drinks can supply extra energy and nutrients. People can fit a few days of juice fasting into their normal schedules without significant drops in energy. Juice fasts are also said to have cleansing and detoxifying effects. The disadvantage of juice fasts is that the body never gets to the ketosis stage, so these fasters are thought to lack the deep detoxification and healing effects of the water fast.

Medical supervision is recommended for any fast over three days. Most alternative medicine practitioners, such as homeopaths, naturopathic doctors, and ayurvedic doctors, can supervise and monitor patients during fasts. Those performing extended fasts and those with health conditions may require blood, urine, and other tests during fasting. There are many alternative health clinics that perform medically supervised fasts as well. Some conventional medical doctors may also supervise patients during fasts. Costs and insurance coverage vary, depending on the doctor, clinic, and requirements of the patient.

Preparations

Fasts must be entered and exited with care. To enter a fast, the diet should be gradually lightened over a few days. First, heavy foods such as meats and dairy products should be eliminated for a day or two. Grains, nuts, and beans should then be reduced for several days. The day before a fast, only easily digested foods like fruits, light salads, and soups should be eaten. During the fast, only pure water and occasional herbal teas should be drunk.

Fasts should be ended as gradually as they are entered, going from lighter to heavier foods progressively. The diet after a fast should emphasize fresh, wholesome foods. Fasters should particularly take care not to overeat when they complete a fast.

Precautions

Fasting isn't appropriate for everyone and, in some cases, could be harmful. Any person undertaking a first fast longer than three days should seek medical supervision. Those with health conditions should always have medical support during fasting. Plenty of water should be taken by fasters since **dehydration** can occur. Saunas and sweating therapies are sometimes recommended to assist detoxification, but should be used sparingly. Those fasting should significantly slow down their lifestyles. Taking time off of work is helpful, or at least reducing the work load. Fasters should also get plenty of rest. **Exercise** should be kept light, such as walking and gentle stretching.

Side effects

Those fasting may experience side effects of **fatigue**, malaise, aches and pains, emotional duress, **acne**, headaches, allergies, swelling, vomiting, **bad breath**, and symptoms of colds and flu. These reactions are sometimes called *healing crises*, which are caused by temporarily increased levels of toxins in the body due to elimination and cleansing. Lower energy levels should be expected during a fast.

Research and general acceptance

The physiology of fasting has been widely studied and documented by medical science. Beneficial effects such as lowered cholesterol and improved general functioning have been shown. Fasting as a treatment for illness and disease has been studied less, although some studies around the world have shown beneficial results. A 1984 study showed that workers in Taiwan who had severe chemical **poisoning** had dramatic improvement after a ten-day fast. In Russia and Japan, studies have demonstrated fasting to be an effective treatment for mental illness. Fasting has been featured on the cover of medical journals, although mainstream medicine has generally ignored fasting and detoxification treatments as valid medical procedures.

KEY TERMS

Ayurvedic medicine—A traditional healing system developed in India.

Toxin—A substance that has poisonous effects on the body.

The majority of research that exists on fasting is testimonial, consisting of individual personal accounts of healing without statistics or controlled scientific experiments. In the alternative medical community, fasting is an essential and widely accepted treatment for many illnesses and chronic conditions.

Resources

BOOKS

Cott, Alan. *Fasting: The Ultimate Diet*. Chicago: Hastings House, 1997.

Fuhrman, Joel, M.D. *Fasting and Eating for Health*. New York: St. Martin's, 1995.

Page, Linda, N.D. *Healthy Healing*. CA: Healthy Healing Publications, 1998.

ORGANIZATIONS

Fasting Center International. 32 West Anapurna St., #360, Santa Barbara, CA 93101. <http://www.fasting.com>.

Douglas Dupler

Fasting blood sugar test *see* **Blood sugar tests**

Fasting plasma glucose test *see* **Blood sugar tests**

Fatigue

Definition

Fatigue is physical and/or mental exhaustion that can be triggered by **stress**, medication, overwork, or mental and physical illness or disease.

Description

Everyone experiences fatigue occasionally. It is the body's way of signaling its need for rest and sleep. But when fatigue becomes a persistent feeling of tiredness or exhaustion that goes beyond normal sleepiness, it is usually a sign that something more serious is amiss.

Physically, fatigue is characterized by a profound lack of energy, feelings of muscle weakness, and slowed movements or central nervous system reactions. Fatigue can also trigger serious mental exhaustion. Persistent fatigue can cause a lack of mental clarity (or feeling of mental "fuzziness"), difficulty concentrating, and in some cases, memory loss.

Causes and symptoms

Fatigue may be the result of one or more environmental causes such as inadequate rest, improper diet, work and home stressors, or poor physical conditioning, or one symptom of a chronic medical condition or disease process in the body. Heart disease, low blood pressure, diabetes, end-stage renal disease, iron-deficiency anemia, **narcolepsy**, and **cancer** can cause long-term, ongoing fatigue symptoms. Acute illnesses such as viral and bacterial infections can also trigger temporary feelings of exhaustion. In addition, mental disorders such as depression can also cause fatigue.

A number of medications, including **antihistamines**, **antibiotics**, and blood pressure medications, may cause drowsiness as a side-effect. Individuals already suffering from fatigue who are prescribed one of these medications may wish to check with their healthcare provider about alternative treatments.

Extreme fatigue which persists, unabated, for at least six months, is not the result of a diagnosed disease or illness, and is characterized by flu-like symptoms such as swollen lymph nodes, **sore throat**, and muscle weakness and/or **pain** may indicate a diagnosis of **chronic fatigue syndrome**. Chronic fatigue syndrome (sometimes called chronic fatigue immune deficiency syndrome), is a debilitating illness that causes overwhelming exhaustion and a constellation of neurological and immunological symptoms. Between 1.5 and 2 million Americans are estimated to suffer from the disorder.

Diagnosis

Because fatigue is a symptom of a number of different disorders, diseases, and lifestyle choices, diagnosis may be difficult. A thorough examination and patient history by a qualified healthcare provider is the first step in determining the cause of the fatigue. A physician can rule out physical conditions and diseases that feature fatigue as a symptom, and can also determine if prescription drugs, poor dietary habits, work environment, or other external stressors could be triggering the exhaustion. Several diagnostic tests may also be required to rule

out common physical causes of exhaustion, such as blood tests to check for iron-deficiency anemia.

Diagnosis of chronic fatigue syndrome is significantly more difficult. Because there is no specific biological marker or conclusive blood test to check for the disorder, healthcare providers must rely on the patient's presentation and severity of symptoms to make a diagnosis. In many cases, individuals with chronic fatigue syndrome go through a battery of invasive diagnostic tests and several years of consultation with medical professionals before receiving a correct diagnosis.

Treatment

Conventional medicine recommends the dietary and lifestyle changes outlined above as a first line of defense against fatigue. Individuals who experience occasional fatigue symptoms may benefit from short term use of caffeine-containing central nervous stimulants, which make people more alert, less drowsy, and improve coordination. However, these should be prescribed with extreme caution, as overuse of the drug can lead to serious **sleep disorders**, like **insomnia**.

Another reason to avoid extended use of **caffeine** is its associated withdrawal symptoms. People who use large amounts of caffeine over long periods build up a tolerance to it. When that happens, they have to use more and more caffeine to get the same effects. Heavy caffeine use can also lead to dependence. If an individual stops using caffeine abruptly, withdrawal symptoms may occur, including **headache**, fatigue, drowsiness, yawning, irritability, restlessness, vomiting, or runny nose. These symptoms can go on for as long as a week.

Alternative treatment

The treatment of fatigue depends on its direct cause, but there are several commonly prescribed treatments for non-specific fatigue, including dietary and lifestyle changes, the use of essential oils and herbal therapies, deep breathing exercises, **traditional Chinese medicine**, and color therapy.

Dietary changes

Inadequate or inappropriate nutritional intake can cause fatigue symptoms. To maintain an adequate energy supply and promote overall physical well-being, individuals should eat a balanced diet and observe the following nutritional guidelines:

- Drink plenty of water. Individuals should try to drink 9 to 12 glasses of water a day. **Dehydration** can reduce blood volume, which leads to feelings of fatigue.
- Eat iron-rich foods (i.e., liver, raisins, spinach, apricots). Iron enables the blood to transport oxygen throughout the tissues, organs, and muscles, and diminished oxygenation of the blood can result in fatigue.
- Avoid high-fat meals and snacks. High fat foods take longer to digest, reducing blood flow to the brain, heart, and rest of the body while blood flow is increased to the stomach.
- Eat unrefined carbohydrates and proteins together for sustained energy.
- Balance proteins. Limiting protein to 15–20 grams per meal and two snacks of 15 grams is recommended, but not getting enough protein adds to fatigue. Pregnant or breastfeeding women should get more protein.
- Get the recommended daily allowance of B complex **vitamins** (specifically, pantothenic acid, **folic acid**, thiamine, and vitamin B_{12}). Deficiencies in these vitamins can trigger fatigue.
- Get the recommended daily allowance of selenium, riboflavin, and niacin. These are all essential nutritional elements in metabolizing food energy.
- Control portions. Individuals should only eat when they're hungry, and stop when they're full. An overstuffed stomach can cause short-term fatigue, and individuals who are overweight are much more likely to regularly experience fatigue symptoms.

Lifestyle changes

Lifestyle factors such as a high-stress job, erratic work hours, lack of social or family support, or erratic sleep patterns can all cause prolonged fatigue. If stress is an issue, a number of relaxation therapies and techniques are available to help alleviate tension, including massage, **yoga**, **aromatherapy**, **hydrotherapy**, progressive relaxation exercises, **meditation**, and **guided imagery**. Some individuals may also benefit from individual or family counseling or psychotherapy sessions to work through stress-related fatigue that is a result of family or social issues.

Maintaining healthy sleep patterns is critical to proper rest. Having a set "bedtime" helps to keep sleep on schedule. A calm and restful sleeping environment is also important to healthy sleep. Above all, the bedroom should be quiet and comfortable, away from loud noises and with adequate window treatments to keep sunlight and streetlights out. Removing distractions from the bedroom such as televisions and telephones can also be helpful.

Essential oils

Aromatherapists, hydrotherapists, and other holistic healthcare providers may recommend the use of essential

oils of rosemary (*Rosmarinus officinalis*), eucalyptus blue gum (*Eucalyptus globulus*), peppermint, (*Mentha x piperata*), or scots pine oil (*Pinus sylvestris*) to stimulate the nervous system and reduce fatigue. These oils can be added to bathwater or massage oil as a topical application. Citrus oils such as lemon, orange, grapefruit, and lime have a similar effect, and can be added to a steam bath or vaporizer for inhalation.

Herbal remedies

Herbal remedies that act as circulatory stimulants can offset the symptoms of fatigue in some individuals. An herbalist may recommend an infusion of ginger (*Zingiber officinale*) root or treatment with cayenne (*Capsicum annuum*), balmony (*Chelone glabra*), damiana (*Turnera diffusa*), ginseng (*Panax ginseng*), or rosemary (*Rosmarinus officinalis*) to treat ongoing fatigue.

An infusion is prepared by mixing the herb with boiling water, steeping it for several minutes, and then removing the herb from the infusion before drinking. A strainer, tea ball, or infuser can be used to immerse loose herb in the boiling water before steeping and separating it. A second method of infusion is to mix the loose herbal preparation with cold water first, bringing the mixture to a boil in a pan or teapot, and then separating the tea from the infusion with a strainer before drinking.

Caffeine-containing **central nervous system stimulants** such as tea (*Camellia senensis*) and cola (*Cola nitida*) can provide temporary, short-term relief of fatigue symptoms. However, long-term use of caffeine can cause restlessness, irritability, and other unwanted side effects, and in some cases may actually work to increase fatigue after the stimulating effects of the caffeine wear off. To avoid these problems, caffeine intake should be limited to 300 mg or less a day (the equivalent of 4-8 cups of brewed, hot tea).

Traditional Chinese medicine

Chinese medicine regards fatigue as a blockage or misalignment of *qi*, or energy flow, inside the human body. The practitioner of Chinese medicine chooses **acupuncture** and/or herbal therapy to rebalance the entire system. The Chinese formula Minot Bupleurum soup (or Xiao Chia Hu Tang) has been used for nearly 2,000 years for the type of chronic fatigue that comes after the flu. In this condition, the person has low-grade **fever**, nausea, and fatigue. There are other formulas that are helpful in other cases. Acupuncture involves the placement of a series of thin needles into the skin at targeted locations on the body known as acupoints in order to harmonize the energy flow within the human body.

KEY TERMS

Aromatherapy—The therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being.

Guided imagery—The use of relaxation and mental visualization to improve mood and/or physical well-being.

Hydrotherapy—Hydrotherapy, or water therapy, is use of water (hot, cold, steam, or ice) to relieve discomfort and promote physical well-being.

Deep breathing exercises

Individuals under stress often experience fast, shallow breathing. This type of breathing, known as chest breathing, can lead to **shortness of breath**, increased muscle tension, inadequate oxygenation of blood, and fatigue. Breathing exercises can both improve respiratory function and relieve stress and fatigue.

Deep breathing exercises are best performed while laying flat on the back on a hard surface, usually the floor. The knees are bent, and the body (particularly the mouth, nose, and face) is relaxed. One hand should be placed on the chest and one on the abdomen to monitor breathing technique. With proper breathing techniques, the abdomen will rise further than the chest. The individual takes a series of long, deep breaths through the nose, attempting to raise the abdomen instead of the chest. Air is exhaled through the relaxed mouth. Deep breathing can be continued for up to 20 minutes. After the **exercise** is complete, the individual checks again for body tension and relaxation. Once deep breathing techniques have been mastered, an individual can use deep breathing at any time or place as a quick method of relieving tension and preventing fatigue.

Color therapy

Color therapy, also known as chromatherapy, is based on the premise that certain colors are infused with healing energies. The therapy uses the seven colors of the rainbow to promote balance and healing in the mind and body. Red promotes energy, empowerment, and stimulation. Physically, it is thought to improve circulation and stimulate red blood cell production. Red is associated with the seventh chakra, located at the root; or base of spine. In yoga, the chakras are specific spiritual energy centers of the body.

Therapeutic color can be administered in a number of ways. Practitioners of Ayurvedic, or traditional Indian

medicine, wrap their patients in colored cloth chosen for its therapeutic hue. Individuals suffering from fatigue would be wrapped in reds and oranges chosen for their uplifting and energizing properties. Patients may also be bathed in light from a color filtered light source to enhance the healing effects of the treatment.

Individuals may also be treated with color-infused water. This is achieved by placing translucent red colored paper or colored plastic wrap over and around a glass of water and placing the glass in direct sunlight so the water can soak up the healing properties and vibrations of the color. Environmental color sources may also be used to promote feelings of stimulation and energy. Red wall and window treatments, furniture, clothing, and even food may be recommended for their energizing healing properties.

Color therapy can be used in conjunction with both hydrotherapy and aromatherapy to heighten the therapeutic effect. Spas and holistic healthcare providers may recommend red color baths or soaks, which combine the benefits of a warm or hot water soak with energizing essential oils and the fatigue-fighting effects of bright red hues used in color therapy.

Prognosis

Fatigue related to a chronic disease or condition may last indefinitely, but can be alleviated to a degree through some of the treatment options outlined here. Exhaustion that can be linked to environmental stressors is usually easily alleviated when those stressors are dealt with properly.

There is no known cure for chronic fatigue syndrome, but steps can be taken to lessen symptoms and improve quality of life for these individuals while researchers continue to seek a cure.

Prevention

Many of the treatments outlined above are also recommended to prevent the onset of fatigue. Getting adequate rest and maintaining a consistent bedtime schedule are the most effective ways to combat fatigue. A balanced diet and moderate exercise program are also important to maintaining a consistent energy level.

Resources

BOOKS

Davis, Martha et al. *The Relaxation & Stress Reduction Workbook*. 4th ed. Oakland, CA: New Harbinger Publications, Inc., 1995.

Hoffman, David. *The Complete Illustrated Herbal*. New York: Barnes & Noble Books, 1999.

Johnson, Hillary. *Osler's Web: Inside the Labyrinth of the Chronic Fatigue Syndrome Epidemic*. New York: Crown Publishers, 1996.

Lawless, Julia. *The Complete Illustrated Guide to Aromatherapy*. Boston: Element Books, 1997.

Medical Economics Corporation. *The PDR for Herbal Medicines*. Montvale, NJ: Medical Economics Corporation, 1998.

Paula Ford-Martin

Fatty liver

Definition

Fatty liver is the collection of excessive amounts of triglycerides and other fats inside liver cells.

Description

Also called steatosis, fatty liver can be a temporary or long-term condition, which is not harmful itself, but may indicate some other type of problem. Left untreated, it can contribute to other illnesses. It is usually reversible once the cause of the problem is diagnosed and corrected. The liver is the organ responsible for changing fats eaten in the diet to types of fat that can be stored and used by the body. Triglycerides are one of the forms of fat stored by the body and used for energy and new cell formation. The break down of fats in the liver can be disrupted by **alcoholism**, **malnutrition**, **pregnancy**, or **poisoning**. In fatty liver, large droplets of fat, containing mostly triglycerides, collect within cells of the liver. The condition is generally not painful and may go unnoticed for a long period of time. In severe cases, the liver can increase to over three times its normal size and may be painful and tender.

Causes and symptoms

The most common cause of fatty liver in the United States is alcoholism. In alcoholic fatty liver, over consumption of alcohol changes the way that the liver breaks down and stores fats. Often, people with chronic alcoholism also suffer from malnutrition by eating irregularly and not consuming a balanced diet. Conditions that can also cause fatty liver are other forms of malnutrition (especially when there is not enough protein in the diet), **obesity**, **diabetes mellitus**, and **Reye's syndrome** in children. Pregnancy can cause a rare, but serious form of fatty liver that starts late in pregnancy and may be associated with **jaundice** and liver failure. Some drug overdoses or toxic chemical poisonings, such as carbon tetrachloride, can also cause fatty liver.

Often, there are no symptoms associated with fatty liver. If there are symptoms, they can include **pain** under the rib cage on the right side of the body, swelling of the

abdomen, jaundice, and **fever**. Symptoms that occur less often in alcoholic fatty liver, but more often in pregnancy related fatty liver, are nausea, vomiting, loss of appetite, and abdominal pain.

Diagnosis

During a **physical examination**, a doctor might notice that the liver is enlarged and tender when the abdomen is palpated (examined with the tips of the fingers while the patient lies flat). Blood tests may be used to determine if the liver is functioning properly. A **liver biopsy**, where a small sample of liver tissue is removed with a long needle or though a very small incision, can be used to confirm fatty liver. In pregnant women, the fatty liver condition is usually associated with another serious complication, pre-eclampsia or eclampsia. In this condition, the mother has seriously high blood pressure, swelling, and possibly, seizures. Laboratory abnormalities include elevations of the SGOT (serum glutamic-oxaloacetic transaminase) and SGPT (serum glutamic pyruvic transaminase). In many cases the alkaline phosphatase will be significantly elevated due to **cholestasis** produced by the fatty infiltration.

Treatment

Treatment involves correcting the condition that caused fatty liver and providing supportive care. In fatty liver caused by alcoholism, the treatment is to give up drinking alcohol and to eat a healthy, well balanced diet. In fatty liver associated with pregnancy, the recommended treatment is to deliver the baby, if the pregnancy is far enough along. Vitamin and mineral supplements along with nutritional support may be useful.

Prognosis

Fatty liver is usually reversible if recognized and treated. There may be some long-term tendency toward other types of liver problems depending on how long and how severe the fatty liver condition was. In pregnant women with the condition, the situation can be life threatening for both the mother and the infant. Left untreated, there is a high risk of **death** for both the mother and baby. Severe liver damage that may require a liver transplant can occur in the mother if the condition is not recognized early.

Prevention

Prevention consists of maintaining a well balanced diet and healthy lifestyle with moderate or no alcohol consumption. Pregnant women require good prenatal care so that symptoms can be recognized and treated as early as possible. To prevent Reye's syndrome, children should not be given **aspirin** to treat symptoms of the flu or other viruses.

KEY TERMS

Jaundice—A condition where the skin and whites of the eyes take on a yellowish color due to an increase of bilirubin (a compound produced by the liver) in the blood.

Reye's syndrome—A serious, life-threatening illness in children, usually developing after a bout of flu or chickenpox, and often associated with the use of aspirin. In fatal cases, there is evidence of accumulation of fat in the liver.

Triglycerides—A type of fat consumed in the diet and produced by and stored in the body as an energy source.

Resources

BOOKS

"Acute Fatty Liver of Pregnancy." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Fatty Liver." *The Merck Manual*. 16th ed. Rahway, NJ: Merck Research Laboratories, 1992.

"Fatty Liver (Steatosis)." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Friedman, Scott L. "Cirrhosis of the Liver and Its Major Sequelae." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Everson, Gregory T. "Liver Problems in Pregnancy: Part 2, Managing Pre-Existing and Pregnancy-Induced Liver Disease." *Medscape Women's Health* 3, no. 2 (1998).

Altha Roberts Edgren

Febrile agglutination tests *see* **Fever evaluation tests**

Fecal fat test *see* **Stool fat test**

Fecal incontinence

Definition

Fecal incontinence is the inability to control the passage of gas or stools (feces) through the anus. For some

people fecal incontinence is a relatively minor problem, as when it is limited to a slight occasional soiling of underwear, but for other people it involves a considerable loss of bowel control and has a devastating effect on quality of life and psychological well-being. Fortunately, professional medical treatment is usually able to restore bowel control or at least substantially reduce the severity of the condition.

Description

Fecal incontinence, also called bowel incontinence, can occur at any age, but is most common among people over the age of 65, who sometimes have to cope with **urinary incontinence** as well. It was reported in 1998 that about 2% of adults experience fecal incontinence at least once a week whereas for healthy independent adults over the age of 65 the figure is about 7%. An extensive American survey, published in 1993, found fecal soiling in 7.1% of the surveyed population, with gross incontinence in 0.7%. For men and women the incidence of soiling was the same, but women were almost twice as likely to suffer from gross incontinence.

The wider public health impact of fecal incontinence is considerable. In the United States, more than $400 million is spent each year on disposable underwear and other incontinence aids. Fecal incontinence is the second most common reason for seeking a nursing home placement. One-third of the institutionalized elderly suffer from this condition. Incontinence sufferers, however, often hesitate to ask their doctors for help because they are embarrassed or ashamed. The 1993 American survey discovered that only one-sixth of those experiencing soiling had sought medical advice, and only one-half of those afflicted with gross incontinence.

Causes and symptoms

Fecal incontinence can result from a wide variety of medical conditions, including childbirth-related anal injuries, other causes of damage to the anus or rectum, and nervous system problems.

Vaginal-delivery **childbirth** is a major cause of fecal incontinence. In many cases, childbirth results in damage to the anal sphincter, which is the ring of muscle that closes the anus and keeps stools within the rectum until a person can find an appropriate opportunity to defecate. Nerve injuries during childbirth may also be a factor in some cases. An ultrasound study of first-time mothers found sphincter injuries in 35%. About one-third of the injured women developed fecal incontinence or an uncontrollable and powerful urge to defecate (urgency) within six weeks of giving birth. Childbirth-related incontinence is usually restricted to gas, but for some women involves the passing of liquid or solid stools.

The removal of **hemorrhoids** by surgery or other techniques (hemorrhoidectomies) can also cause anal damage and fecal incontinence, as can more complex operations affecting the anus and surrounding areas. Anal and rectal infections as well as **Crohn's disease** can lead to incontinence by damaging the muscles that control defecation. For some people, incontinence becomes a problem when the anal muscles begin to weaken in midlife or old age.

Dementia, **mental retardation**, strokes, brain tumors, **multiple sclerosis**, and other conditions that affect the nervous system can cause fecal incontinence by interfering with muscle function or the normal rectal sensations that trigger sphincter contraction and are necessary for bowel control. One study of multiple sclerosis patients discovered that about half were incontinent. Nerve damage caused by long-lasting **diabetes mellitus** (**diabetic neuropathy**) is another condition that can give rise to incontinence.

Diagnosis

Medical assessments in cases of fecal incontinence typically involve three steps: asking questions about the patient's past and current health (the medical history); a **physical examination** of the anal region; and testing for objective information regarding anal and rectal function.

Patient history

The medical history relies on questions that allow the doctor to evaluate the nature and severity of the problem and its effect on the patient's life. The doctor asks, for instance, how long the patient has been suffering from incontinence; how often and under what circumstances incontinence occurs; whether the patient has any control over defecation; and whether the patient has obstacles to defecation in his or her everyday surroundings, such as a toilet that can be reached only by climbing a long flight of stairs. For women who have given birth, a detailed obstetric history is also necessary.

Physical examination

The physical examination begins with a visual inspection of the anus and the area lying between the anus and the genitals (the perineum) for hemorrhoids, infections, and other conditions that might explain the patient's difficulties. During this phase of the examination the doctor asks the patient to bear down. Bearing down enables the doctor to check whether **rectal pro-**

lapse or certain other problems exist. Rectal prolapse means that the patient's rectum has been weakened and drops down through the anus. Next, the doctor uses a pin or probe to **stroke** the perianal skin. Normally this touching causes the anal sphincter to contract and the anus to pucker; if it does not, nerve damage may be present. The final phase of the examination requires the doctor to examine internal structures by carefully inserting a gloved and lubricated finger into the anal canal. This allows the doctor to judge the strength of the anal sphincter and a key muscle (the puborectalis muscle) in maintaining continence; to look for abnormalities such as scars and rectal masses; and to learn many other things about the patient's medical situation. At this point the doctor performs the anal wink test again and asks the patient to squeeze and bear down.

Laboratory tests

Information from the medical history and physical examination usually needs to be supplemented by tests that provide objective measurements of anal and rectal function. Anorectal manometry, a common procedure, involves inserting a small tube (catheter) or balloon device into the anal canal or rectum. Manometry measures, among other things, pressure levels in the anal canal, rectal sensation, and anal and rectal reflexes. Tests are also available for assessing nerve damage. An anal ultrasound probe can supply accurate images of the anal sphincter and reveal whether injury has occurred. **Magnetic resonance imaging**, which requires the insertion of a coil into the anal canal, is useful at times.

Treatment

Fecal incontinence arising from an underlying condition such as diabetic neuropathy can sometimes be helped by treating the underlying condition. When that does not work, or no underlying condition can be discovered, one approach is to have the patient use a suppository or enema to stimulate defecation at the same time every day or every other day. The goal is to restore regular bowel habits and keep the bowels free of stools. Medications such as loperamide (Imodium) and codeine phosphate are often effective in halting incontinence, but only in less severe cases involving liquid stools or urgency. Dietary changes and exercises done at home to strengthen the anal muscles may also help.

Good results have been reported for **biofeedback** training, although the subject has not been properly researched. In successful cases, patients regain complete control over defecation, or at least improve their control, by learning to contract the external part of the anal sphincter whenever stools enter the rectum. All healthy people have this ability. Biofeedback training begins with the insertion into the rectum of a balloon manometry device hooked up to a pressure monitor. The presence of stools in the rectum is simulated by inflating the balloon, which causes pressure changes that are recorded on the monitor. The monitor also records sphincter contraction. By watching the monitor and following instructions from the equipment operator, the patient gradually learns to contract the sphincter automatically in response to fullness in the rectum. Sometimes one training session is enough, but often several are needed. Biofeedback is not an appropriate treatment in all cases, however. It is used only with patients who are highly motivated; who are able, to some extent, to sense the presence of stools in the rectum; and who have not lost all ability to contract the external anal sphincter. One specialist suggests that possibly two-thirds of incontinence sufferers are candidates for biofeedback.

Some people may require surgery. Sphincter damage caused by childbirth is often effectively treated with surgery, however, as are certain other kinds of incontinence-related sphincter injuries. Sometimes surgical treat-

KEY TERMS

Anus—The opening at the lower end of the rectum.

Colostomy—A surgical procedure in which an opening is made in the wall of the abdomen to allow a part of the large intestine (the colon) to empty outside the body.

Crohn's disease—A disease marked by inflammation of the intestines.

Defecation—Passage of stools through the anus.

Hemorrhoids—Enlarged veins in the anus or rectum. They are sometimes associated with fecal incontinence.

Rectum—The lower section of the large intestine that holds stools before defecation.

Sphincter—A circular band of muscle that surrounds and encloses an opening to the body or to one of its hollow organs. Damage to the sphincter surrounding the anus can cause fecal incontinence.

Stools—Undigested food and other waste that is eliminated through the anus.

Suppository—A solid medication that slowly dissolves after being inserted into the rectum or other body cavity.

ment requires building an artificial sphincter using a thigh muscle (the gracilis muscle). At one time a **colostomy** was necessary for severe cases of incontinence, but is now rarely performed.

Prognosis

Fecal incontinence is a problem that usually responds well to professional medical treatment, even among elderly and institutionalized patients. If complete bowel control cannot be restored, the impact of incontinence on everyday life can still be lessened considerably in most cases. When incontinence remains a problem despite medical treatment, disposable underwear and other commercial incontinence products are available to make life easier. Doctors and nurses can offer advice on coping with incontinence, and people should never be embarrassed about seeking their assistance. Counseling and information are also available from support groups.

Resources

BOOKS

Schiller, Lawrence R. "Fecal Incontinence." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Hirsh, Tina, and Tony Lembo. "Diagnosis and Management of Fecal Incontinence in Elderly Patients." *American Family Physician* (Oct. 1996): 1559+.

Kamm, Michael A. "Faecal Incontinence." *British Medical Journal* 316 (1998): 528+.

ORGANIZATIONS

International Foundation for Functional Gastrointestinal Disorders. PO Box 17864, Milwaukee, WI 53217. (888) 964-2001. <http://www.iffgd.org>.

National Association for Continence. PO Box 8310, Spartanburg, SC 29305-8310. (800) 252-3337. <http://www.nafc.org>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Howard Baker

Fecal lipids test *see* **Stool fat test**

Fecal occult blood test

Definition

The fecal occult blood test (FOBT) is performed as part of the routine **physical examination** during the examination of the rectum. It is used to detect microscopic blood in the stool and is a screening tool for colorectal **cancer**.

Purpose

FOBT uses chemical indicators on stool samples to detect the presence of blood not otherwise visible. (The word "occult" in the test's name means that the blood is hidden from view.) Blood originating from or passing through the gastrointestinal tract can signal many conditions requiring further diagnostic procedures and, possibly, medical intervention. These conditions may be benign or malignant and some of them include:

- colorectal and gastric cancers
- ulcers
- hemorrhoids
- polyps
- inflammatory bowel disease
- irritations or lesions of the gastrointestinal tract caused by medications (such as **nonsteroidal anti-inflammatory drugs**, also called NSAIDs)
- irritations or lesions of the gastrointestinal tract caused by stomach acid disorders, such as reflux esophagitis

The FOBT is used routinely (in conjunction with a **rectal examination** performed by a physician) to screen for colorectal cancer, particularly after age 50. The ordering of this test should not be taken as an indication that cancer is suspected. The FOBT must be combined with regular screening endoscopy (such as a **sigmoidoscopy**) to detect cancers at an early stage.

Precautions

Certain foods and medicines can influence the test results. Some fruits contain chemicals that prevent the guaiac, the chemical in which the test paper is soaked, from reacting with the blood. **Aspirin** and some NSAIDs irritate the stomach, resulting in bleeding and should be avoided prior to the examination, along with red meat and many vegetables and fruits containing vitamin C. All of these factors could result in a false-positive test.

Description

Feces for the stool samples is obtained either by the physician at the rectal examination or by the patient at home, using a small spatula or a collection device. In most cases, the collection of stool samples can easily be done at home, using a kit supplied by the physician. The standard kit contains a specially prepared card on which

a small sample of stool will be spread, using a stick provided in the kit. The sample is placed in a special envelope and either mailed or brought in for analysis. When the physician applies hydrogen peroxide to the back of the sample, the paper will turn blue if an abnormal amount of blood is present.

Types of fecal occult blood tests

Hemoccult is one type of fecal occult blood test, and it is the most commonly used. The Hemoccult test takes less than five minutes to perform and may be performed in the physician's office or in the laboratory. The Hemoccult blood test can detect bleeding from the colon as low as 0.5 mg per day.

Tests that use anti-hemoglobin antibodies (or immunochemical tests) to detect blood in the stool are also used. Immunochemical tests can detect up to 0.7 mg of hemoglobin in the stool and do not require dietary restrictions. Immunochemical tests

- are not accurate for screening for stomach cancer
- are more sensitive than Hemoccult tests in detecting colorectal cancer
- are more expensive than Hemoccult tests

Hemoquant, another fecal occult blood test, is used to detect as much as 500 mg/g of blood in the stool. Like the Hemoccult, the Hemoquant test is affected by red meat. It is not affected by chemicals in vegetables.

Fecal blood may also be measured by measuring the chromium in the red blood cells in the feces. The stool is collected for three to ten days. The test is used in cases where the exact amount of the blood loss is required and it is the only test that can exclude blood loss from the gastrointestines with accuracy.

Preparation

For 72 hours prior to collecting samples, patients should avoid red meats, NSAIDs (including aspirin), **antacids**, steroids, iron supplements, and vitamin C, including citrus fruits and other foods containing large amounts of vitamin C. Foods like uncooked broccoli, uncooked turnips, cauliflower, uncooked cantaloupe, uncooked radish and horseradish and parsnips should be avoided and not eaten during the 72 hours prior to the examination. Fish, chicken, pork, fruits (other than melons) and many cooked vegetables are permitted in the diet.

Results

Many factors can result in false-positive and false-negative findings.

KEY TERMS

Occult—Not visible or easily detected.

Positive results

It is important to note that a true-positive finding only signifies the presence of blood—it is not an indication of cancer. The National Cancer Institute states that, in its experience, less than 10% of all positive results were caused by cancer. The FOBT is positive in 1–5% of the unscreened population and 2–10% of those are found to have cancer. The physician will want to follow up on a positive result with further tests, as indicated by other factors in the patient's history or condition.

Negative results

Alternatively, a negative result (meaning no blood was detected) does not guarantee the absence of **colon cancer**, which may bleed only occasionally or not at all. (Only 50% of colon cancers are FOBT-positive.)

Conclusions

Screening using the FOBT has been demonstrated to reduce colorectal cancer. However, because only half of colorectal cancers are FOBT-positive, FOBT must be combined with regular screening endoscopy to increase the detection of pre-malignant colorectal polyps and cancers. Since, through FOBT, cancer may be detected early, the benefits of possible early detection must be considered along with the likelihood of complications and costs for additional studies.

Resources

BOOKS

DeVita, Vincent, Samuel Hellman, and Steven Rosenburg. *Cancer:Principles and Practices of Oncology.* PA: Lippincott Williams & Wilkins, 2001.

Yamada, Tadetaka, ed. *Textbook of Gastroenterology Volumes One and Two*. PA: Lippincott Williams & Wilkins, 2001.

PERIODICALS

From the Centers for Disease Control and Prevention. "Trends in Screening for Colorectal Cancer—United States, 1997 and 1999." *Journal of the American Medical Association* 28 (March 2001):12.

ORGANIZATIONS

American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.

National Cancer Institute (NCI). (800) 422-6237. <http://rex.nci.nih.gov>.

OTHER

"Colorectal Cancer Screening." *WebMD*. <http://my.webmd.com/content/article/2955.291>.

"Fecal Occult Bood Test." *Virtual Health Fair.* 10 July 2001 <http://vfair.com/resources/ lab/fecal.htm>.

"Colon and Rectum Cancer." *American Cancer Society.* 10 July 2001 <http://www.cancer.org>.

Jill S. Lasker
Cheryl Branche, M.D.

Feldenkrais method

Definition

The Feldenkrais method is an educational system that allows the body to move and function more efficiently and comfortably. Its goal is to re-educate the nervous system and improve motor ability. The system can accomplish much more, relieving pressure on joints and weak points, and allowing the body to heal repetitive strain injuries. Continued use of the method can relieve **pain** and lead to higher standards of achievement in sports, the martial arts, dancing and other physical disciplines.

Pupils are taught to become aware of their movements and to become aware of how they use their bodies, thus discovering possible areas of **stress** and strain. The goal of Feldenkrais is to take the individual from merely functioning, to functioning well, free of pain and restriction of movement. Feldenkrais himself stated that his goal was, "To make the impossible possible, the possible easy, and the easy, elegant."

Purpose

This method of re-educating the nervous system can be beneficial to a wide range of people, including athletes, children, the elderly, martial artists, those who are handicapped, people with special needs, and those suffering from degenerative diseases. It has also proved popular with artists, particularly musicians, a number of whom have used Feldenkrais to improve their performance.

The Feldenkrais Guild of North America (FGNA) states that over half of the those who turn to Feldenkrais practitioners are seeking relief from pain. Many people who have pain from an injury compensate by changing their movements to limit pain. Often these changed movements remain after the pain from the original injury is gone, and new pain may occur. Feldenkrais helps students become aware of the changed movements and allows them to learn new movements that relieve their pain. Apart from the obvious physical benefits of more efficient movement and freedom from pain and restriction, Feldenkrais practitioners assert that there are other positive benefits for overall physical and mental health. Feldenkrais can result in increased awareness, flexibility, and coordination, and better relaxation. Feldenkrais practitioners have also noted other benefits in their students, including improvements in awareness, flexibility, coordination, breathing, digestion, sleep, mood, mental alertness, energy, and range of motion, as well as reduced stress and **hypertension**, and fewer headaches and backaches.

Musicians and athletes can improve their performance in many ways when they learn to use their bodies more efficiently. Feldenkrais can also help injured athletes regain lost potential and free them from pain and restriction of movement.

There are numerous accounts of the remarkable results obtained when Feldenkrais is taught to handicapped children so that they can learn to function despite their limitations. Handicapped people can learn to make full use of whatever potential they have, and to have more confidence in their abilities. Practitioners who specialize in teaching Feldenkrais to those who have handicaps have in many cases allowed the patient to discover ways of performing tasks which were previously thought to be impossible for them.

The elderly, whose movements are often restricted by pain and stiffness, can learn to overcome these obstacles with Feldenkrais instruction. In some instances even severe cases of arthritis have been conquered. Theoretically, Feldenkrais can make possible renewed levels of energy and freedom from restriction.

Description

Origins

Moshe Feldenkrais (1904–1984) was a Russian-born Israeli physicist and engineer who was also an active soccer player and judo master. He devised his system in response to his own recurring knee injury, which had restricted his movement and caused him great pain over a long period of time. Feldenkrais believed that repeated muscle patterns cause the parts of the brain controlling those muscles to stay in a fixed pattern as well. He thought that the more the muscles are used, the more parts of the brain can be activated.

He devised a method of re-educating the neuromuscular system and re-evaluating movement to increase efficiency and reduce stress, using his knowledge of mechanics and engineering, and applying some of his martial arts training.

Feldenkrais is described a being a dual system, with two components: "Awareness Through Movement" and "Functional Integration." The system aims to re-educate the body so that habitual movements that cause strain or pain can be relearned to improve efficiency and eliminate dangerous or painful action.

Feldenkrais helps to translate intention into action. In practice, an individual can learn to achieve his or her highest potential, while at the same time learning to avoid and eliminate stresses, strains, and the possibility of injury.

Functional integration

During this session, the patient wears comfortable clothing, and may sit, stand, walk, or lie on a low padded table. The practitioner helps the pupil by guiding him or her through a number of movements. The practitioner may use touch to communicate with the student, but touch is not used to correct any movements. The purpose of this session is to increase a student's awareness of his or her own movement and become open to different possibilities for movement. The instruction can be focused on a particular activity that the student does every day, or that causes him or her pain. The student can learn to alter habitual movements and re-educate the neuromuscular system. This type of session is particularly useful for those who suffer from limitations originating from misuse, stress, illness, or accident. It can also help athletes and musicians perform to the best of their ability by increasing their possibilities for movement. It offers students the potential for improving their physical and mental performance in addition to heightening the sense of well-being.

Awareness through movement

Feldenkrais's martial arts background can be clearly identified in many of the aspects of Awareness Through Movement (ATM). During group sessions, pupils are taught to become acutely aware of all their movements and to imagine them, so that they can improve the efficiency of their actions in their minds, and put them into practice. Pupils are encouraged to be disciplined about practicing their exercises, to achieve maximum benefit.

Awareness through movement is described as an exploratory, nonjudgmental process through which pupils are encouraged to observe and learn about themselves and their movements. The range of this therapy is wide, and there are thousands of different lessons designed to help specific areas.

MOSHE FELDENKRAIS (1904–1984)

Moshe Feldenkrais was born on the border between Russia and Poland. When he was only a boy of 13, he traveled to Palestine on foot. The journey took a year, and once there, young Feldenkrais worked as a laborer and cartographer, also tutoring others in mathematics. Moving to France in 1933, he graduated in mechanical and electrical engineering from the Ecole des Travaux Publiques de Paris.

Feldendrais became the first person to open a Judo center in Paris after meeting with Jigaro Kano. He was also one of the first Europeans to become a black belt in Judo, in 1936.

Obtaining his Ph.D. at the Sorbonne, he went on to assist Nobel Prize laureate, Frédéric Joliot-Curie at the Curie Institute. During World War II in England, he worked on the new sonar anti-submarine research.

Prompted by a recurring leg injury, he applied his knowledge of the martial arts and his training as an engineer to devise a method of re-integrating the body. The concept was that more efficient movement would allow for the treatment of pain or disability, and the better-functioning of the body as a whole. Later on, he would begin to teach what he had learned to others in Tel Aviv.

In addition to many books about judo, including *Higher Judo*, he wrote six books on his method.

Patricia Skinner

Preparations

No preparation is necessary for the practice of Feldenkrais, and all are encouraged to seek help from this system. No condition is considered a preclusion to the benefits of Feldenkrais.

Precautions

As with any therapy or treatment, care should be taken to choose a qualified practitioner. Feldenkrais practitioners stress that the body must not be forced to do anything, and if any movement is painful, or even uncomfortable, it should be discontinued immediately and the patient should seek professional help.

KEY TERMS

Neuromuscular—The body system of nerves and muscles as they function together.

Repetitive strain injury—Injury resulting from a repeated movement such as typing or throwing a ball.

Side effects

No known side effects are associated with the practice of Feldenkrais.

Research and general acceptance

Since Moshe Feldenkrais began to teach his method, it has gradually gained acceptance as an education system. Published research using the method can be found in United States and foreign publications.

Resources

BOOKS

Alon, Ruthy. *Mindful Spontaneity: Lessons in the Feldenkrais Method.* 2nd ed. Berkeley: North Atlantic Books, 1996.

Bratman, Steven. *The Alternative Medicine Sourcebook.* 2nd ed. Chicago: Lowell House, 1999.

Feldenkrais, Moshe. *Awareness Through Movement.* New York: Harper, 1991.

Rywerant, Yochanan. *The Feldenkrais Method.* Chicago: Keats Publishing, 1991.

Shafarman, Steven. *Awareness Heals: The Feldenkrais Method for Dynamic Health.* Cambridge, MA: Perseus Publishing, 1997.

Somerville, Robert. *Alternative Medicine: The Definitive Guide.* Tiburon, CA: Future Medicine Publishing, Inc., 1999.

Stillerman, Elaine. *The Encyclopedia of Bodywork.* New York: Facts On File, Inc., 1996.

Thomas, Richard, and C. Norman Shealy, eds. *The Complete Family Guide to Alternative Medicine.* Dorset, UK: Element Books Ltd., 1996.

Zemach-Bersin, David and Kaethe, and Mark Reese. *Relaxercise.* New York: Harper, 1990.

ORGANIZATIONS

Feldenkrais Guild of North America. 3611 SW Hood Ave., Suite 100, Portland, OR 97201. (800) 775-2118. (503) 221-6612. Fax: (503) 221-6616. <http://www.feldenkrais.com/>.

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Female circumcision *see* **Female genital mutilation**

Female condom *see* **Condom**

Female genital mutilation

Definition

Female genital mutilation (FGM) is the cutting, or partial or total removal, of the external female genitalia for cultural, religious, or other non-medical reasons. It is usually performed on girls between the ages of four and 10. It is also called female **circumcision**.

Purpose

FGM results in the cutting or removal of the tissues around the vagina that give women pleasurable sexual feelings. This procedure is used for social and cultural control of women's sexuality. In its most extreme form, infibulation, where the girl's vagina is sewn shut, the procedure ensures virginity. In some cultures where female circumcision has been a tradition for hundreds of years, this procedure is considered a rite of passage for young girls. Families fear that if their daughters are left uncircumcised, they may not be marriageable. As in most cultures, there is also the fear that the girl might bring shame to the family by being sexually active and becoming pregnant before marriage.

Precautions

It is illegal to perform FGM in many countries, including the United States, Canada, France, Great Britain, Sweden, Switzerland, Egypt, Kenya, and Senegal. This procedure is usually done in the home or somewhere other than a medical setting. Often, it is performed by a family member or by a local "circumciser," using knives, razor blades, or other tools that may not be sterilized before use.

Description

Female circumcision includes a wide range of procedures. The simplest form involves a small cut to the clitoris or labial tissue. A Sunna circumcision removes the prepuce (a fold of skin that covers the clitoris) and/or the tip of the clitoris. A clitoridectomy removes the entire clitoris and some or all of the surrounding tissue; this procedure occurs in approximately 80% of cases. The most extreme form of genital mutilation is excision and infibulation, in which the clitoris and all of the surround tissue are cut away and the remaining skin is sewn together. Only a small opening is left for the passage of

urine and menstrual blood. Infibulation accounts for approximately 15% of FGM procedures.

The World Health Organization (WHO) estimates that between 100 million and 140 million girls and women have undergone some form of FGM. As a very deeply rooted cultural and religious tradition still practiced in over 28 African and Asian countries, up to two million girls per year are at risk. The following countries have the highest number of occurrences of FGM: Djibouti (98%), Egypt (97%), Eritrea (95%), Guinea (99%), Mali (94%), Sierra Leone (90%), and Somalia (98-100%). As more people move to Western countries from countries where female circumcision is performed, the practice has come to the attention of health professionals in the United States, Canada, Europe, and Australia.

In an effort to integrate old customs with modern medical care, some immigrant families have requested that physicians perform the procedure. While trying to be sensitive to cultural traditions, health care providers are sometimes put in the difficult position of choosing to perform this procedure in a medical facility under sanitary conditions, or refusing the request, knowing that it may be done anyway with no medical supervision. Some families who are intent on having this procedure done will take their daughters back to the country they immigrated from in order to have the girls circumcised.

Many national and international medical organizations including the American Medical Association (AMA), Canadian medical organizations, and WHO oppose the practice of female genital mutilation. The United Nations (UN) considers female genital mutilation a violation of human rights. WHO has undertaken a number of projects aimed at decreasing the incidence of FGM. These include the following activities:

- publishing a statement addressing the regional status of FGM and encouraging the development of national policy against its practice,
- organizing training for regional community workers,
- developing educational materials for local health care workers,
- providing alternative occupations for individuals who perform FGM procedures.

KEY TERMS

Circumcision—A procedure, usually with religious or cultural significance, where the prepuce or skin covering the tip of the penis on a boy, or the clitoris on a girl, is cut away.

Clitoridectomy—A procedure where the clitoris and possibly some of the surrounding labial tissue at the opening of the vagina is cut away.

Infibulation—A procedure where the tissue around the vagina is sewn shut, leaving only a small opening for the passage of urine and menstrual blood.

Aftercare

A girl or young woman who has recently had the procedure performed may require supportive care to control bleeding and **antibiotics** to prevent infection. Women who were circumcised as children may require medical care to treat complications. Pregnant women who have been infibulated may have to have the labial tissue cut open to allow the baby to be delivered. Aftercare should be provided with a supportive and nonjudgmental approach towards the girls and women who have undergone this procedure.

Risks

The immediate risks after the procedure are hemorrhage (excessive bleeding), severe **pain**, and infection (including abscesses, **tetanus**, and **gangrene**). The most severe consequence is **death** due to excessive blood loss. Long term complications include scarring, interference with the drainage of urine and menstrual blood, chronic urinary tract infections, pelvic and back pain, and **infertility**. Sexual intercourse can be painful. Complications of **childbirth** are also a risk. It is unclear whether it is related to the procedure itself, or related to the general condition of medical practice, but infant and maternal death rates are generally higher in those communities where female circumcision is practiced.

Resources

PERIODICALS

Eyega, Z., and E. Conneely. "Facts and Fiction Regarding Female Circumcision/Female Genital Mutilation: A Pilot Study in New York City." *Journal of American Medical Women's Association* 52, no. 4 (Fall 1997): 174-178, 187.

"Female Genital Mutilation: At the Crossroads of Women's Health & Human Rights." *Public Health Magazine* 5 no. 1 (Winter 1995).

Jones, W.K., et al. "Female Genital Mutilation. Female Circumcision. Who Is At Risk In the U.S.?" *Public Health Report* 112, no. 5 (Sept./Oct. 1997): 368-377.

Ortiz, E.T. "Female Genital Mutilation and Public Health: Lessons From the British Experience." *Health Care Women International* 19, no. 2 (Mar./Apr. 1998): 119-129.

Winkel, E. "A Muslim Perspective on Female Circumcision." *Women & Health* 23, no. 1 (1995): 1-7.

OTHER

The Female Genital Mutilation Research Homepage. <http://www.hollyfeld.org/fgm.

"Female Genital Mutilation." *The World Health Organization*. <http://www.who.int/frh-whd/FGM/index.htm.

Altha Roberts Edgren

Female sexual arousal disorder

Definition

Female sexual arousal disorder (FSAD) occurs when a woman is continually unable to attain or maintain arousal and lubrication during intercourse, is unable to reach orgasm, or has no desire for sexual intercourse.

Description

The disorder typically affects up to 25 percent of all American women, or an estimated 47 million women. Three-fourths of women with FSAD are postmenopausal. Women describe it as being "unable to get turned on," or being continually disinterested in sex. It is also called "frigidity." Other terms for the disorder include dyspareunia and vaginismus, both of which involve **pain** during intercourse.

Causes and symptoms

There are numerous causes of this disorder. They include:

- physical problems, such as **endometriosis**, **cystitis**, or vaginitis
- systemic problems, such as diabetes, high blood pressure, or **hypothyroidism**. Even **pregnancy** or the postpartum period (time after delivery of a child) may affect desire. **Menopause** is also known to reduce sexual desire.
- medications, including **oral contraceptives**, antidepressants, antihypertensives, and tranquilizers
- surgery, such as **mastectomy** or **hysterectomy** which may affect how a woman feels about her sexual self.
- stress
- depression
- use of alcohol, drugs, or cigarette **smoking**

Symptoms vary. A woman may have no desire for sex, or may not be able to maintain arousal, or may be unable to reach orgasm. She may also have pain during sex or orgasm, which interferes with her desire for intercourse.

Diagnosis

To make a diagnosis, a woman's physician - either family doctor, gynecologist, or even urologist — takes a complete medical history to determine when the problem started, how it presents, how severe it is, and what the patient thinks may be causing it. The doctor will also conduct a complete **physical examination**, looking for any abnormalities in the genital region

Treatment

The physician should start by providing education about the disorder and recommending various non-medical treatment strategies. These include:

- use of erotic materials, such as vibrators, books, magazines and videos
- sensual massage, avoiding the genitals
- position changes to reduce pain
- use of lubricants to moisten the vagina and genital area
- kegel exercises to strengthen the vagina and clitoris
- therapy to overcome any relationship or sexual **abuse** issues

Medical treatments include:

- estrogen replacement therapy, which may help with vaginal dryness, pain and arousal
- testosterone therapy in women who have low levels of this male hormone (side effects, however, may include deepening voice, hair growth, and acne)
- the EROS clitoral therapy device (EROS-CTD), recently approved by the Food and Drug Administration; a small vacuum pump, placed over the clitoris and gently activated to provide a gentle suction designed to increase blood flow to the region, which, in turn, helps with arousal
- using the herb yohimbine combined with nitric oxide has been found to increase vaginal blood flow in postmenopausal women and thus help with some forms of FSAD

Alternative treatment

Natural estrogens, such as those found in soy products and flax, may be effective. Herbal remedies include belladonna, gingko, and motherwort. However, there is no scientific evidence to prove these herbs actually help.

KEY TERMS

Dyspareunia— pain in the pelvic area during or after sexual intercourse.

Vaginismus —An involuntary spasm of the muscles surrounding the vagina, making penetration painful or impossible.

Some women squirt vitamin E in their vagina to increase lubrication.

Women may also want to see a sexual therapist for additional help.

Prognosis

Generally, once women seek the appropriate help they are quite likely to find a way to resolve their problems. Often, a holistic approach, using physical as well as emotional therapies, is required for success.

Prevention

Maintaining a close and open relationship with a partner is one way to avoid the emotional pain and isolation that can lead to **sexual dysfunction**. Additionally, women should learn if any medications they take affect sexual function, and should refrain from alcohol and drugs and quit smoking. Women who have anxieties and fears about sexual intercourse, whether because of earlier abuse, rape, or a prudish upbringing, should deal with those issues through therapy.

Resources

BOOKS

Berman M.D., Jennifer, and Laura Berman, Phd. Elisabeth Bumiller. *For Women Only: A Revolutionary Guide to Overcoming Sexual Dysfunction and Reclaiming Your Sex Life*. Henry Holt & Company, Inc., 2001.

Reichman, Judith. *I'm Not in the Mood: What Every Woman Should Know About Improving Her Libido*. Quill Publishing, 1999.

Rako, Susan M.D. *The Hormone of Desire: The Truth About Testosterone, Sexuality, and Menopause*. Three Rivers Press, 1999.

PERIODICALS

"Restoring Sexual Health." *Consumer Reports On Health*. (March 2001): 8-10.

"Consumer Update: Female Sexual Problems." *American Association for Marriage and Family Therapy* (14 June 1999).

ORGANIZATIONS

Female Sexual Medicine Center UCLA Medical Center 924 Westwood Blvd., Suite 520 Los Angeles, CA 90024. (310) 825-0025 <www.newshe.com>.

National Women's Health Resource Center, 120 Albany Street Suite 820 New Brunswick, NJ 08901. (877) 986-9472. <www.healthywomen.org>.

Debra Gordon

Female infertility *see* **Infertility**

Femoral hernia *see* **Hernia**

Fetal alcohol syndrome

Definition

Fetal alcohol syndrome (FAS) is a pattern of **birth defects**, learning, and behavioral problems affecting individuals whose mothers consumed alcohol during **pregnancy**.

Description

FAS is the most common preventable cause of **mental retardation**. This condition was first recognized and reported in the medical literature in 1968 in France and in 1973 in the United States. Alcohol is a teratogen, the term used for any drug, chemical, maternal disease or other environmental exposure that can cause birth defects or functional impairment in a developing fetus. Some features may be present at birth including low birth weight, **prematurity**, and microcephaly. Characteristic facial features may be present at birth, or may become more obvious over time. Signs of brain damage include delays in development, behavioral abnormalities, and mental retardation, but affected individuals exhibit a wide range of abilities and disabilities. It has only been since 1991 that the long-term outcome of FAS has been known. Learning, behavioral, and emotional problems are common in adolescents and adults with FAS. Fetal Alcohol Effect (FAE), a term no longer favored, is sometimes used to describe individuals with some, but not all, of the features of FAS. In 1996, the Institute of Medicine suggested a five-level system to describe the birth defects, learning and behavioral difficulties in offspring of women who drank alcohol during pregnancy. This system contains criteria including confirmation of maternal alcohol exposure, characteristic facial features, growth problems, learning and behavioral problems, and birth defects known to be associated with prenatal alcohol exposure.

The incidence of FAS varies among different populations studied, and ranges from approximately one in 200 to one in 2000 at birth. However, a recent study reported in 1997, utilizing the Institute of Medicine criteria, estimated the prevalence in Seattle, Washington from 1975–1981 at nearly one in 100 live births. Avoiding alcohol during pregnancy, including the earliest weeks of the pregnancy can prevent FAS. There is no amount of alcohol use during pregnancy that has been proven to be completely safe.

There is no racial or ethnic predilection for FAS. Individuals from different genetic backgrounds exposed to similar amounts of alcohol during pregnancy may exhibit different signs or symptoms of FAS. Several studies have estimated that between 25–45% of chronic alcoholic women will give birth to a child with FAS if they continue to drink during pregnancy. The risk of FAS appears to increase as a chronic alcoholic woman progresses in her childbearing years and continues to drink. That is, a child with FAS will often be one of the last born to a chronic alcoholic woman, although older siblings may exhibit milder features of FAS. Binge drinking, defined as sporadic use of five or more standard alcoholic drinks per occasion, and "moderate" daily drinking (two to four 12 oz bottles of beer, eight to 16 ounces of wine, two to four ounces of liquor) can also result in offspring with features of FAS.

Causes and symptoms

FAS is not a genetic or inherited disorder. It is a pattern of birth defects, learning, and behavioral problems that are the result of maternal alcohol use during the pregnancy. The alcohol freely crosses the placenta and causes damage to the developing embryo or fetus. Alcohol use by the father cannot cause FAS. If a woman who has FAS drinks alcohol during pregnancy, then she may also have a child with FAS. Not all individuals from alcohol exposed pregnancies have obvious signs or symptoms of FAS; individuals of different genetic backgrounds may be more or less susceptible to the damage that alcohol can cause. The dose of alcohol, the time during pregnancy that alcohol is used, and the pattern of alcohol use all contribute to the different signs and symptoms that are found.

Classic features of FAS include short stature, low birthweight and poor weight gain, microcephaly, and a characteristic pattern of facial features. These facial features in infants and children may include small eye openings (measured from inner corner to outer corner), epicanthal folds (folds of tissue at the inner corner of the eye), small or short nose, low or flat nasal bridge, smooth or poorly developed philtrum (the area of the upper lip above the colored part of the lip and below the nose), thin upper lip, and small chin. Some of these features are nonspecific, meaning they can occur in other conditions, or be appropriate for age, racial, or family background. Other major and minor birth defects that have been reported include cleft palate, congenital heart defects, **strabismus**, **hearing loss**, defects of the spine and joints, alteration of the hand creases, small fingernails, and toenails. Since FAS was first described in infants and children, the diagnosis is sometimes more difficult to recognize in older adolescents and adults. Short stature and microcephaly remain common features, but weight may normalize, and the individual may actually become overweight for his/her height. The chin and nose grow proportionately more than the middle part of the face and dental crowding may become a problem. The small eye openings and the appearance of the upper lip and philtrum may continue to be characteristic. Pubertal changes typically occur at the normal time.

Newborns with FAS may have difficulties with feeding due to a poor suck, have irregular sleep-wake cycles, decreased or increased muscle tone, seizures or **tremors**. Delays in achieving developmental milestones such as rolling over, crawling, walking and talking may become apparent in infancy. Behavior and learning difficulties typical in the preschool or early school years include poor attention span, hyperactivity, poor motor skills, and slow language development. Attention deficit-hyperactivity disorder is a common associated diagnosis. Learning disabilities or mental retardation may be diagnosed during this time. Arithmetic is often the most difficult subject for a child with FAS. During middle school and high school years the behavioral difficulties and learning difficulties can be significant. Memory problems, poor judgment, difficulties with daily living skills, difficulties with abstract reasoning skills, and poor social skills are often apparent by this time. It is important to note that animal and human studies have shown that neurologic and behavioral abnormalities can be present without characteristic facial features. These individuals may not be identified as having FAS, but may fulfill criteria for alcohol- related diagnoses, as set forth by the Institute of Medicine.

In 1991, Streissguth and others reported some of the first long-term follow-up studies of adolescents and adults with FAS. In the approximate 60 individuals they studied, the average IQ was 68, with 70 being the lower limit of the normal range. However, the range of IQ was quite large, as low as 20 (severely retarded) to as high as 105 (normal). The average achievement levels for reading, spelling, and arithmetic were fourth grade, third grade and second grade, respectively. The Vineland Adaptive Behavior Scale was used to measure adaptive functioning in these individuals. The composite score for this group showed functioning at the level of a seven-

year-old. Daily living skills were at a level of nine years, and social skills were at the level of a six-year-old.

In 1996, Streissguth and others published further data regarding the disabilities in children, adolescents and adults with FAS. Secondary disabilities, that is, those disabilities not present at birth and that might be preventable with proper diagnosis, treatment, and intervention, were described. These secondary disabilities include: mental health problems; disrupted school experiences; trouble with the law; incarceration for mental health problems, drug abuse, or a crime; inappropriate sexual behavior; alcohol and drug abuse; problems with employment; dependent living; and difficulties parenting their own children. In that study, only seven out of 90 adults were living and working independently and successfully. In addition to the studies by Streissguth, several other authors in different countries have now reported on long term outcome of individuals diagnosed with FAS. In general, the neurologic, behavioral and emotional disorders become the most problematic for the individuals. The physical features change over time, sometimes making the correct diagnosis more difficult in older individuals, without old photographs and other historical data to review. Mental health problems including attention deficit, depression, panic attacks, **psychosis** and suicide threats and attempts, and overall were present in over 90% of the individuals studied by Streissguth. A 1996 study in Germany reported more than 70% of the adolescents they studied had persistent and severe developmental disabilities and many had psychiatric disorders, the most common of which were emotional disorders, repetitive habits, **speech disorders**, and hyperactivity disorders.

Diagnosis

FAS is a clinical diagnosis, which means that there is no blood, x ray or psychological test that can be performed to confirm the suspected diagnosis. The diagnosis is made based on the history of maternal alcohol use, and detailed **physical examination** for the characteristic major and minor birth defects and characteristic facial features. It is often helpful to examine siblings and parents of an individual suspected of having FAS, either in person or by photographs, to determine whether findings on the examination might be familial, of if other siblings may also be affected. Sometimes, genetic tests are performed to rule out other conditions that may present with developmental delay or birth defects. Individuals with developmental delay, birth defects or other unusual features are often referred to a clinical geneticist, developmental pediatrician, or neurologist for evaluation and diagnosis of FAS. Psychoeducational testing to determine IQ and/or the presence of learning disabilities may also be part of the evaluation process.

KEY TERMS

Cleft palate—A congenital malformation in which there is an abnormal opening in the roof of the mouth that allows the nasal passages and the mouth to be improperly connected.

Congenital—Refers to a disorder which is present at birth.

IQ—Abbreviation for Intelligence Quotient. Compares an individual's mental age to his/her true or chronological age and multiplies that ratio by 100.

Microcephaly—An abnormally small head.

Miscarriage—Spontaneous pregnancy loss.

Placenta—The organ responsible for oxygen and nutrition exchange between a pregnant mother and her developing baby.

Strabismus—An improper muscle balance of the ocular musles resulting in crossed or divergent eyes.

Teratogen—Any drug, chemical, maternal disease, or exposure that can cause physical or functional defects in an exposed embryo or fetus.

Treatment

There is no treatment for FAS that will reverse or change the physical features or brain damage associated with maternal alcohol use during the pregnancy. Most of the birth defects associated with prenatal alcohol exposure are correctable with surgery. Children should have psychoeducational evaluation to help plan appropriate educational interventions. Common associated diagnoses such as attention deficit-hyperactivity disorder, depression, or **anxiety** should be recognized and treated appropriately. The disabilities that present during childhood persist into adult life. However, some of the secondary disabilities mentioned above may be avoided or lessened by early and correct diagnosis, better understanding of the life-long complications of FAS, and intervention. Streissguth has describe a model in which an individual affected by FAS has one or more advocates to help provide guidance, structure and support as the individual seeks to become independent, successful in school or employment, and develop satisfying social relationships.

Prognosis

The prognosis for FAS depends on the severity of birth defects and the brain damage present at birth. **Miscarriage**, **stillbirth** or **death** in the first few weeks of

life may be outcomes in very severe cases. Major birth defects associated with FAS are usually treatable with surgery. Some of the factors that have been found to reduce the risk of secondary disabilities in FAS individuals include diagnosis before the age of six years, stable and nurturing home environments, never having experienced personal violence, and referral and eligibility for disability services. The long-term data helps in understanding the difficulties that individuals with FAS encounter throughout their lifetime and can help families, caregivers and professionals provide the care, supervision, education and treatment geared toward their special needs.

Prevention of FAS is the key. Prevention efforts must include public education efforts aimed at the entire population, not just women of child bearing age, appropriate treatment for women with high-risk drinking habits, and increased recognition and knowledge about FAS by professionals, parents, and caregivers.

Resources

BOOKS

Jones, Kenneth Lyons. *Smith's Recognizable Patterns of Human Malformation*. 5th ed. Philadelphia: W.B. Saunders Company, 1997.

Streissguth, Ann. *Fetal Alcohol Syndrome: A Guide for Families and Communities*. Baltimore: Paul H. Brookes Publishing Company, 1997.

PERIODICALS

Committee of Substance Abuse and Committee on Children with Disabilities. "Fetal Alcohol Syndrome and Alcohol-Related Neurodevelopmental Disorders." *Pediatrics* 106 (Aug. 2000): 358-361.

Cramer, C., and F. Davidhizar. "FAS/FAE: Impact on Children." *Journal of Child Health Care* 3 (Autumn 1999): 31-34.

Gladstone, J., et al. "Reproductive Risks of Binge Drinking During Pregnancy." *Reproductive Toxicology* 10 (Jan./Feb. 1996): 3-13.

Hannigan, J. H., and D. R. Armant. "Alcohol in Pregnancy and Neonatal Outcome." *Seminars in Neonatology* 5 (Aug. 2000): 243-54.

Olson, Heather Carmichael, et al. "Association of Prenatal Alcohol Exposure with Behavioral and Learning Problems in Early Adolescence." *Journal of the American Academy of Child and Adolescent Psychiatry* 36 (Sept. 1997): 1187-1194.

"Prenatal Exposure to Alcohol." *Alcohol Research and Health* 24 (2000): 32-41.

Sampson, Paul D., et al. "Incidence of Fetal Alcohol Syndrome and Prevalence of Alcohol-Related Neurodevelopmental Disorder." *Teratology* 56 (Nov. 1997): 317-326.

Streissguth, Ann Pytkowicz, et al. "Fetal Alcohol Syndrome in Adolescents and Adults." *JAMA* 265 (Apr. 1991): 1961-1967.

ORGANIZATIONS

Arc's Fetal Alcohol Syndrome Resource Guide. The Arc's Publication Desk, 3300 Pleasant Valley Lane, Suite C, Arlington, TX 76015. (888) 368-8009. <http://www.thearc.org/misc/faslist.html>.

Fetal Alcohol Syndrome Family Resource Institute. PO Box 2525, Lynnwood, WA 98036. (800) 999-3429. <http://www.fetalalcoholsyndrome.org>.

Institute of Medicine. National Academy Press, Washington, DC. <http://www.come-over.to/FAS/IOMsummary.htm>.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (888) 663-4637. <resourcecenter@modimes.org>. <http://www.modimes.org>.

Nofas. 216 G St. NE, Washington, DC 20002. (202) 785-4585. <http://www.nofas.org>.

Laurie Heron Seaver

Ferritin test *see* **Iron tests**

Fetal death *see* **Stillbirth**

Fetal hemoglobin test

Definition

Fetal hemoglobin (Hemoglobin F), Alkali-resistant hemoglobin, HBF (or Hb F), is the major hemoglobin component in the bloodstream of the fetus. After birth, it decreases rapidly until only traces are found in normal children and adults.

Purpose

The determination of fetal hemoglobin is an aid in evaluating low concentrations of hemoglobin in the blood (anemia), as well as the hereditary persistence of fetal hemoglobin, and a group of inherited disorders affecting hemoglobin, among which are the thalassemias and sickle cell anemia.

Description

At birth, the newborn's blood is comprised of 60%–90% of fetal hemoglobin. The fetal hemoglobin then rapidly decreases to 2% or less after the second to fourth years. By the time of adulthood, only traces (0.5% or less) are found in the bloodstream.

In some diseases associated with abnormal hemoglobin production (see Hemoglobinopathy, below), fetal hemoglobin may persist in larger amounts. When this occurs, the elevation raises the question of possible underlying disease.

For example, HBF can be found in higher levels in hereditary hemolytic **anemias**, in all types of leukemias, in **pregnancy**, diabetes, thyroid disease, and during anticonvulsant drug therapy. It may also reappear in adults when the bone marrow is overactive, as in the disorders of **pernicious anemia**, **multiple myeloma**, and metastatic **cancer** in the marrow. When HBF is increased after age four, it should be investigated for cause.

Hemoglobinopathy

Hemoglobin is the oxygen-carrying pigment found in red blood cells. It is a large molecule made in the bone marrow from two components, heme and globin.

Defects in hemoglobin production may be either genetic or acquired. The genetic defects are further subdivided into errors of heme production (porphyria), and those of globin production (known collectively as the **hemoglobinopathies**).

There are two categories of hemoglobinopathy. In the first category, abnormal globin chains give rise to abnormal hemoglobin molecules. In the second category, normal hemoglobin chains are produced but in abnormal amounts. An example of the first category is the disorder of sickle cell anemia, the inherited condition characterized by curved (sickle-shaped) red blood cells and chronic **hemolytic anemia**. Disorders in the second category are called the thalassemias, which are further divided into types according to which amino acid chain is affected (alpha or beta), and whether there is one defective gene (**thalassemia** minor) or two defective genes (thalassemia major).

Preparation

This test requires a blood sample. The patient is not required to be in a **fasting** state (nothing to eat or drink for a period of hours before the test).

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference values vary from laboratory to laboratory but are generally found within the following ranges:

- six months to adult: up to 2% of the total hemoglobin
- newborn to six months: up to 75% of the total hemoglobin

KEY TERMS

Anemia—A disorder characterized by a reduced blood level of hemoglobin, the oxygen-carrying pigment of blood.

Hemolytic anemia—A form of anemia caused by premature destruction of red cells in the blood stream (a process called hemolysis). Hemolytic anemias are classified according to whether the cause of the problem is inside the red blood cell (in which case it is usually an inherited condition), or outside the cell (usually acquired later in life).

Abnormal results

Greater than 2% of total hemoglobin is abnormal.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Fetishes *see* **Sexual perversions**

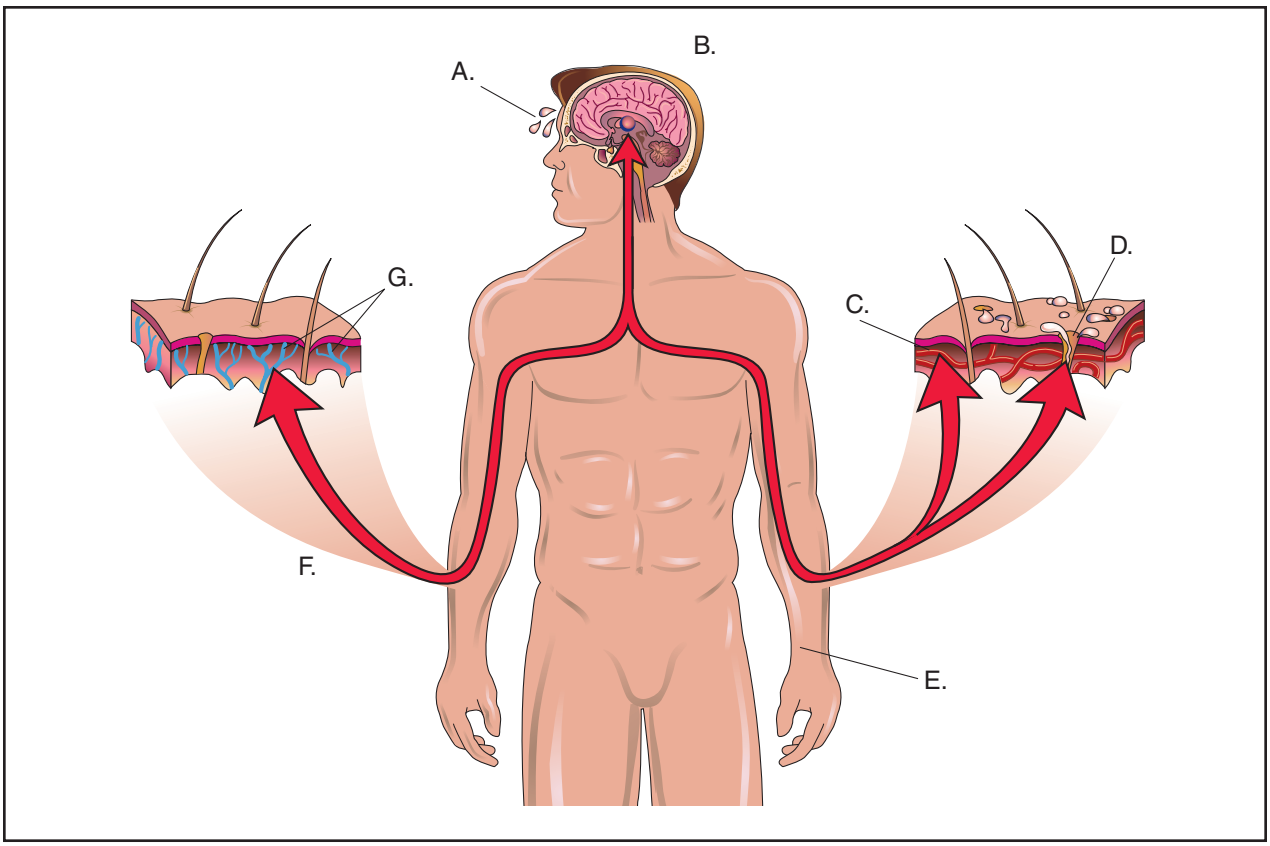
Fever

Definition

A fever is any body temperature elevation over 100°F (37.8°C).

Description

A healthy person's body temperature fluctuates between 97°F (36.1°C) and 100°F (37.8°C), with the average being 98.6°F (37°C). The body maintains stability within this range by balancing the heat produced by the metabolism with the heat lost to the environment. The "thermostat" that controls this process is located in the hypothalamus, a small structure located deep within the brain. The nervous system constantly relays information about the body's temperature to the thermostat, which in turn activates different physical responses designed to



A dramatic rise in body temperature often includes the following symptoms: A. Loss of fluid results in dehydration. B. The hypothalamic set-point is increased, raising metabolism. C. Blood vessels in skin dilate. D. Sweat glands produce excess perspiration. E. Increased pulse rate. F. Increased hypothalmic set-point may introduce chills and shivering to promote heat production from muscles. G. Skin becomes more heat-sensitive. *(Illustration by Electronic Illustrators Group.)*

cool or warm the body, depending on the circumstances. These responses include: decreasing or increasing the flow of blood from the body's core, where it is warmed, to the surface, where it is cooled; slowing down or speeding up the rate at which the body turns food into energy (metabolic rate); inducing shivering, which generates heat through muscle contraction; and inducing sweating, which cools the body through evaporation.

A fever occurs when the thermostat resets at a higher temperature, primarily in response to an infection. To reach the higher temperature, the body moves blood to the warmer interior, increases the metabolic rate, and induces shivering. The "chills" that often accompany a fever are caused by the movement of blood to the body's core, leaving the surface and extremities cold. Once the higher temperature is achieved, the shivering and chills stop. When the infection has been overcome or drugs such as **aspirin** or **acetaminophen** (Tylenol) have been taken, the thermostat resets to normal and the body's cooling mechanisms switch on: the blood moves to the surface and sweating occurs.

Fever is an important component of the immune response, though its role is not completely understood. Physicians believe that an elevated body temperature has several effects. The immune system chemicals that react with the fever-inducing agent and trigger the resetting of the thermostat also increase the production of cells that fight off the invading bacteria or viruses. Higher temperatures also inhibit the growth of some bacteria, while at the same time speeding up the chemical reactions that help the body's cells repair themselves. In addition, the increased heart rate that may accompany the changes in blood circulation also speeds the arrival of white blood cells to the sites of infection.

Causes and symptoms

Fevers are primarily caused by viral or bacterial infections, such as **pneumonia** or **influenza**. However, other conditions can induce a fever, including allergic reactions; autoimmune diseases; trauma, such as breaking a bone; **cancer**; excessive exposure to the sun; intense

exercise; hormonal imbalances; certain drugs; and damage to the hypothalamus. When an infection occurs, fever-inducing agents called pyrogens are released, either by the body's immune system or by the invading cells themselves, that trigger the resetting of the thermostat. In other circumstances, the immune system may overreact (allergic reactions) or become damaged (autoimmune diseases), causing the uncontrolled release of pyrogens. A **stroke** or tumor can damage the hypothalamus, causing the body's thermostat to malfunction. Excessive exposure to the sun or intensely exercising in hot weather can result in heat stroke, a condition in which the body's cooling mechanisms fail. Malignant hyperthermia is a rare, inherited condition in which a person develops a very high fever when given certain anesthetics or **muscle relaxants** in preparation for surgery.

How long a fever lasts and how high it may go depends on several factors, including its cause, the age of the patient, and his or her overall health. Most fevers caused by infections are acute, appearing suddenly and then dissipating as the immune system defeats the infectious agent. An infectious fever may also rise and fall throughout the day, reaching its peek in the late afternoon or early evening. A low-grade fever that lasts for several weeks is associated with autoimmune diseases such as lupus or with some cancers, particularly leukemia and lymphoma.

KEY TERMS

Antipyretic—A drug that lowers fever, like aspirin or acetaminophen.

Autoimmune disease—Condition in which a person's immune system attacks the body's own cells, causing tissue destruction.

Febrile seizure—Convulsions brought on by fever.

Malignant hyperthermia—A rare, inherited condition in which a person develops a very high fever when given certain anesthetics or muscle relaxants in preparation for surgery.

Meningitis—A potentially fatal inflammation of the thin membrane covering the brain and spinal cord.

Metabolism—The chemical process by which the body turns food into energy, which can be given off as heat.

Pyrogen—A chemical circulating in the blood that causes a rise in body temperature.

Reye's syndrome—A disorder principally affecting the liver and brain, marked by the rapid development of life-threatening neurological symptoms.

Diagnosis

A fever is usually diagnosed using a thermometer. A variety of different thermometers are available, including traditional glass and mercury ones used for oral or rectal temperature readings and more sophisticated electronic ones that can be inserted in the ear to quickly register the body's temperature. For adults and older children, temperature readings are usually taken orally. Younger children who cannot or will not hold a thermometer in their mouths can have their temperature taken by placing an oral thermometer under their armpit. Infants generally have their temperature taken rectally using a rectal thermometer.

As important as registering a patient's temperature is determining the underlying cause of the fever. The presence or absence of accompanying symptoms, a patient's medical history, and information about what he or she may have ingested, any recent trips taken, or possible exposures to illness help the physician make a diagnosis. Blood tests can aid in identifying an infectious agent by detecting the presence of antibodies against it or providing samples for growth of the organism in a culture. Blood tests can also provide the doctor with white blood cell counts. Ultrasound tests, **magnetic resonance imaging** (MRI) tests, or computed tomography (CT) scans may be ordered if the doctor cannot readily determine the cause of a fever.

Treatment

Physicians agree that the most effective treatment for a fever is to address its underlying cause, such as through the administration of **antibiotics**. Also, because a fever helps the immune system fight infection, it usually should be allowed to run its course. Drugs to lower fever (antipyretics) can be given if a patient (particularly a child) is uncomfortable. These include aspirin, acetaminophen (Tylenol), and ibuprofin (Advil). Aspirin, however, should not be given to a child or adolescent with a fever since this drug has been linked to an increased risk of **Reye's syndrome**. Bathing a patient in cool water can also help alleviate a high fever.

A fever requires emergency treatment under the following circumstances:

- newborn (three months or younger) with a fever over 100.5°F (38°C)
- infant or child with a fever over 103°F (39.4°C)
- fever accompanied by severe **headache**, neck stiffness, mental confusion, or severe swelling of the throat

A very high fever in a small child can trigger seizures (febrile seizures) and therefore should be treated immediately. A fever accompanied by the above symptoms can indicate the presence of a serious infection, such as **meningitis**, and should be brought to the immediate attention of a physician.

Prognosis

Most fevers caused by infection end as soon as the immune system rids the body of the pathogen and do not produce any lasting effects. The prognosis for fevers associated with more chronic conditions, such as autoimmune disease, depends upon the overall outcome of the disorder.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Gelfand, Jeffrey. "Fever, Including Fever of Unknown Origin." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Bridget Travers

Fever blister *see* **Cold sore**

Fever evaluation tests

Definition

Fever evaluation tests, better known as febrile agglutinins tests, are performed to detect the presence of antibodies in the blood that are sensitive to temperature changes. Antibodies are proteins produced by the immune system in response to specific infectious agents, such as viruses or bateria. Febrile agglutinins are antibodies that cause red blood cells to clump, but only when the blood is warmed to temperatures higher than the average body temperature of 98.6°F (37°C).

Purpose

The febrile agglutinins test is used to confirm the diagonsis of certain infectious diseases that stimulate the body to produce febrile agglutinins. The disease most commonly diagnosed by this test is **brucellosis**, a infection caused by bacteria belonging to the genus *Brucella* and characterized by intermittent fever, sweating, chills, aches, and mental depression. The test is also used to diagnose certain other infectious diseases: salmonellosis, caused by *Salmonella* bacteria and marked by nausea and severe **diarrhea**; rickettsial infections, a group of diseases caused by the bacteria *Rickettsia*; and **tularemia**, also called rabbit fever, a bacterial infection characterized by a high fever and swollen lymph nodes. The febrile agglutinins test can also be used to confirm the presence of two types of **cancer**, leukemia and lymphoma; however, doctors rarely use the test for this purpose, since other diagnostic tests are more reliable.

Description

A febrile agglutinins test can be performed at a doctor's office or a hospital. A nurse or technician will collect a few drops of blood (about 7ml) in a small tube that has been cooled slightly. The specimen is then taken to a laboratory where it heated and examined for clumping. If the cells clump after warming and unclump as they cool, a febrile agglutinin titer (concentration) of greater than 1:80 is present.

Normal results

The results of febrile agglutinins tests require a doctor's interpretation. In general, however, a normal value is lower than 1:32.

Abnormal results

An value higher than 1:80 suggests a diagnosis for brucellosis or one of the other conditions indicated by this test.

Jill S. Lasker

Fever of unknown origin

Definition

Fever of unknown origin (FUO) refers to the presence of a documented fever for a specified time, for which a cause has not been found after a basic medical evaluation. The classic criteria developed in 1961 included: temperature greater than 101°F (38.3°C), for at least three weeks, and inability to find a cause after one week of study. Within the past decade, a revision has been proposed that categorizes FUO into classic, hospital acquired FUO, FUO associated with low white blood counts, and HIV associated FUO (**AIDS** related).

Description

Fever is a natural response of the body that helps in fighting off foreign substances, such as microorganisms, toxins, etc. Body temperature is set by the thermoregulatory center, located in an area in the brain called hypothalamus. Body temperature is not constant all day, but actually is lowest at 6 A.M. and highest around 4–6 P.M. In addition, temperature varies in different regions of the body; for example, rectal and urine temperatures are about one degree Fahrenheit higher than oral temperature and rectal temperature is higher than urine. It is also important to realize that certain normal conditions can effect body temperature, such as **pregnancy**, food ingestion, age, and certain hormonal changes.

Substances that cause fever are known as "pyrogens." There are two types of pyrogens; exogenous and endogenous. Those that originate outside the body, such as bacterial toxins, are called "exogenous" pyrogens. Pyrogens formed by the body's own cells in response to an outside stimulus (such as a bacterial toxin) are called "endogenous" pyrogens.

Researchers have discovered that there are several "endogenous" pyrogens. These are made up of small groups of amino acids, the building blocks of proteins. These natural pyrogens have other functions in addition to inducing fever; they have been named "cytokines". When cytokines are injected into humans, fever and chills develop within an hour. Interferon, tumor necrosis factor, and various interleukins are the major fever producing cytokines.

The production of fever is a very complex process; somehow, these cytokines cause the thermoregulatory center in the hypothalamus to reset the normal temperature level. The body's initial response is to conserve heat by vasoconstriction, a process in which blood vessels narrow and prevent heat loss from the skin and elsewhere. This alone will raise temperature by two to three degrees. Certain behavioral activities also occur, such as adding more clothes, seeking a warmer environment, etc. If the hypothalamus requires more heat, then shivering occurs.

Fever is a body defense mechanism. It has been shown that one of the effects of temperature increase is to slow bacterial growth. However, fever also has some downsides; the body's metabolic rate is increased and with it, oxygen consumption. This can have a devastating effect on those with poor circulation. In addition, fever can lead to seizures in the very young.

When temperature elevation occurs for an extended period of time and no cause is found, the term FUO is then used. The far majority of these patients are eventually found to have one of several diseases.

KEY TERMS

AIDS—Acquired immune deficiency syndrome is often represented by these initials. The disease is associated with infection by the human immunodeficiency virus (HIV), and has the main feature of repeated infections, due to failure of certain parts of the immune system. Infection by HIV damages part of the body's natural immunity, and leads to recurrent illnesses.

Antibiotic—A medication that is designed to kill or weaken bacteria.

Computed tomography scan (CT Scan)—A specialized x-ray procedure in which cross-sections of the area in question can be examined in detail. This allows physicians to examine organs such as the pancreas, bile ducts, and others which are often the site of hidden infections.

Magnetic Resonance Imaging (MRI)—This is a new technique similar to CT Scan, but based on the magnetic properties of various areas of the body to compose images.

NSAID—Nonsteroidal anti-inflammatory drugs are medications such as aspirin and ibuprofen that decrease pain and inflammation. Many can now be obtained without a doctor's prescription.

Ultrasound—A non-invasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition. It is very useful for diagnosing diseases of the gallbladder, liver, and hidden infections, such as abscesses.

Causes and symptoms

The most frequent cause of FUO is still infection, though the percentage has decreased in recent years. **Tuberculosis** remains an important cause, especially when it occurs outside the lungs. The decrease in infections as a cause of FUO is due in part to improved culture techniques. In addition, technological advances have made it easier to diagnose non-infectious causes. For example, tumors and autoimmune diseases in particular are now easier to diagnose. (An autoimmune disease is one that arises when the body tolerance for its own cell antigenic cell markers disappears.)

Allergies to medications can also cause prolonged fever; sometimes patients will have other symptoms suggesting an allergic reaction, such as a rash.

There are many possible causes of FUO; generally though, a diagnosis can be found. About 10% of patients will wind up without a definite cause, and about the same percentage have "factitious fevers" (either self induced or no fever at all).

Some general symptoms tend to occur along with fever; these are called constitutional symptoms and consist of myalgias (muscle aches), chills, and **headache**.

Diagnosis

Few symptoms in medicine present such a diagnostic challenge as fever. Nonetheless, if a careful, logical, and thorough evaluation is performed, a diagnosis will be found in most cases. The patient's past medical history as well as travel, social, and family history should be carefully searched for important clues.

Usually the first step is to search for an infectious cause. Skin and other screening tests for diseases such as tuberculosis, and examination of blood, urine, and stool, are generally indicated. Antibody levels to a number of infectious agents can be measured; if these are rising, they may point to an active infection.

Various x-ray studies are also of value. In addition to standard examinations, recently developed radiological techniques using ultrasound, computed tomography scan (CT scan) and **magnetic resonance imaging** (MRI) scans are now available. These enable physicians to examine areas that were once accessible only through surgery. Furthermore, new studies using radioactive materials (nuclear medicine), can detect areas of infection and inflammation previously almost impossible to find, even with surgery.

Biopsies of any suspicious areas found on an x-ray exam can be performed by either traditional or newer surgical techniques. Material obtained by biopsy is then examined by a pathologist to look for clues as to the cause of the fever. Evidence of infection, tumor or other diseases can be found in this way. Portions of the biopsy are also sent to the laboratory for culture in an attempt to grow and identify an infectious organism.

Patients with HIV are an especially difficult problem, as they often suffer from many unusual infections. HIV itself is a potential cause of fever.

Treatment

Most patients who undergo evaluation for FUO do not receive treatment until a clear-cut cause is found. **Antibiotics** or medications designed to suppress a fever (such as NSAIDs) will only hide the true cause. Once physicians are satisfied that there is no infectious cause, they may use medications such as NSAIDs, or **corticosteroids** to decrease inflammation and diminish constitutional symptoms.

The development of FUO in certain settings, such as that acquired by patients in the hospital or in those with a low white **blood count**, often needs rapid treatment to avoid serious complications. Therefore, in these instances patients may be placed on antibiotics after a minimal number of diagnostic studies. Once test results are known, treatment can be adjusted as needed.

Prognosis

The outlook for patients with FUO depends on the cause of the fever. If the basic illness is easily treatable and can be found rather quickly, the potential for a cure is quite good. Some patients continue with temperature elevations for six months or more; if no serious disease is found, medications such as NSAIDs are used to decrease the effects of the fever. Careful follow-up and reevaluation is recommended in these cases.

Resources

BOOKS

Gelfand, Jeffrey A., and Charles A. Dinarello. "Fever of Unknown Origin." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

McCarthy, Paul L. "Infants with Fever." *New England Journal of Medicine* 329, no. 20 (1993): 1493.

OTHER

"Bone Marrow Biopsy in the Diagnosis of Fever of Unknown Origin in Patients With Acquired Immunodeficiency Syndrome.'" "Long-term Follow-up of Patients With Undiagnosed Fever of Unknown Origin," "Utility of Scintigraphic Methods in Patients With Fever of Unknown Origin." *Journal of the Medical Association.* <http://pubs.ama-assn.org>.

David Kaminstein, MD

Fiber-modified diet *see* **Diets**

Fibrin degradation products *see* **Fibrin split products**

Fibrin split products

Definition

Fibrin split products (FSP) are fragments of protein released from a dissolving clot. The fibrin split products test is one of several tests done to evaluate a person with

blood clotting problems (coagulation), particularly disseminated intravascular coagulation (DIC).

KEY TERMS

Coagulation—The entire process of blood clotting.

Coagulation cascade—A sequence of biochemical activities to stop bleeding by forming a clot.

Disseminated intravascular coagulation (DIC)—A serious medical condition that develops when the normal balance between bleeding and clotting is disturbed. Excessive bleeding and clotting injures body organs, and causes anemia or death.

Fibrin split products (FSP)—Pieces of the protein fibrin released from a dissolving clot.

Fibrinolysis—The clot dissolving portion of the coagulation process.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

Purpose

High levels of FSP in a person's blood are associated with DIC, a serious medical condition that develops when the normal balance between bleeding and clotting is disturbed. Excessive bleeding and clotting injures body organs, and causes anemia or **death**.

Description

Coagulation begins typically with an injury to some part of the body. The injury sets in motion a cascade of biochemical activities (the coagulation cascade) to stop the bleeding, by forming a clot from a mixture of the blood protein fibrin and platelets.

Once bleeding is stopped, another blood protein dissolves the clot by breaking down the fibrin into fragments. Measurement of these fragments gives information about the clot dissolving portion of coagulation, called fibrinolysis.

In DIC, the coagulation cascade is triggered in an abnormal way. A blood infection, a **transfusion** reaction, a large amount of tissue damage, such as a burn, a dead fetus, and some cancers can begin the chain of biochemical events leading to blood clots. The coagulation cascade becomes overwhelmed with excessive clotting followed by excessive bleeding. As the large number of clots dissolve, fibrin split products accumulate in the blood and encourage even more bleeding.

Laboratory tests for FSP are done on the yellow liquid portion left over after blood clots (serum). A person's serum is mixed with a substance that binds to FSP. This bound complex is measured, and the original amount of FSP is determined. Some test methods give an actual measurement of FSP; some give a titer, or dilution. Methods that provide a titer look for the presence or absence of FSP. If the serum is positive for FSP, the serum is diluted, or titered, and the test is done again. These steps are repeated until the serum is so dilute that it no longer gives a positive result. The last dilution that gives a positive result is the titer reported.

The FSP test is covered by insurance when medically necessary. Results are usually available within one to two hours. Other names for this test are fibrin degradation products, fibrin breakdown products, or FDP.

Preparation

This test requires 0.17 oz (5 ml) of blood. A healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site. Pressure applied to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort. The patient may feel dizzy or faint.

Risks

People with coagulation problems may bleed longer than normal. The healthcare provider must make sure bleeding has stopped before leaving the patient unattended.

Normal results

Negative at a less than or equal to 1:4 dilution or less than 10 g/mL.

Abnormal results

High levels of FSP indicate DIC. Results of the test must be interpreted by the physician according to the person's clinical symptoms and medical history. Other conditions that increase blood clotting activity also increase FSP: venous thrombosis, surgery and trans-

plants, blood clots in the lung, certain cancers, and **heart attack** (myocardial infarction).

Resources

BOOKS

Miller, Jonathan L. "Blood Coagulation and Fibrinolysis." In *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Hardaway, Robert M., and Charles H. Williams. "Disseminated Intravascular Coagulation: An Update." *Comprehensive Therapy* (Nov. 1996): 737-743.

Nancy J. Nordenson

KEY TERMS

Fibrin—The last step in the coagulation process. Fibrin forms strands that add bulk to a forming blood clot to hold it in place and help "plug" an injured blood vessel wall.

Platelet—An irregularly shaped cell-like particle in the blood that is an important part of blood clotting. Platelets are activated when an injury causes a blood vessel to break. They change shape from round to spiny, "sticking" to the broken vessel wall and to each other to begin the clotting process.

Prothrombin—A type of protein called a glycoprotein that is converted to thrombin during the clotting process.

Thrombin—An enzyme that converts fibrinogen into strands of fibrin.

Fibrinogen test

Definition

Fibrinogen (Factor I) is a protein that originates in the liver. It is converted to fibrin during the blood-clotting process (coagulation).

Purpose

The fibrinogen test aids in the diagnosis of suspected clotting or bleeding disorders caused by fibrinogen abnormalities.

Precautions

This test is not recommended for patients with active bleeding, acute infection or illness, or in those patients who have received blood transfusions within four weeks.

Drugs that may increase fibrinogen levels include estrogens and **oral contraceptives**. Drugs that may cause decreased levels include anabolic steroids, androgens, phenobarbital, urokinase, streptokinase, and valproic acid.

Description

Fibrinogen plays two essential roles in the body: it is a protein called an acute-phase reactant that becomes elevated with tissue inflammation or tissue destruction, and it is also a vital part of the "common pathway" of the coagulation process.

In order for blood to clot, fibrinogen must be converted to fibrin by the action of an enzyme called thrombin. Fibrin molecules clump together to form long filaments, which trap blood cells to form a solid clot.

The conversion of fibrinogen to fibrin is the last step of the "coagulation cascade," a series of reactions in the blood triggered by tissue injury and platelet activation. With each step in the cascade, a coagulation factor in the blood is converted from an inactive to an active form. The active form of the factor then activates several molecules of the next factor in the series, and so on, until the final step, when fibrinogen is converted into fibrin.

The factors involved in the coagulation cascade are numbered I, II, and V through XIII. Factor I is fibrinogen, while factor II (fibrinogen's immediate precursor) is called prothrombin. Most of the coagulation factors are made in the liver, which needs an adequate supply of vitamin K to manufacture the different clotting factors.

When fibrinogen acts as an "acute-phase reactant," it rises sharply during tissue inflammation or injury. When this occurs, high fibrinogen levels may be a predictor for an increased risk of heart or circulatory disease. Other conditions in which fibrinogen is elevated are cancers of the stomach, breast, or kidney, and inflammatory disorders like **rheumatoid arthritis**.

Reduced fibrinogen levels can be found in liver disease, **prostate cancer**, lung disease, bone marrow lesions, malnourishment, and certain bleeding disorders. The low levels can be used to evaluate disseminated intravascular coagulation (DIS), a serious medical condition that develops when there is a disturbed balance between bleeding and clotting. Other conditions related to decreased fibrinogen levels are those in which fibrino-

gen is completely absent (congenital afibrinogenemia), conditions in which levels are low (hypofibrinogenemia), and conditions of abnormal fibrinogen (dysfibrinogenemia). Obstetric complications or trauma may also cause low levels. Large-volume blood transfusions cause low levels because banked blood does not contain fibrinogen.

Preparation

This test is performed with a blood sample, which can be drawn at any time of day. The patient does not have to be **fasting** (nothing to eat or drink).

Aftercare

Because a fibrinogen test is often ordered when a bleeding disorder is suspected, the patient should apply pressure or a pressure dressing to the blood-drawn site site for a period of time after blood is drawn, and then reexamine the site for bleeding.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after procedure, or the seeing the accumulation of blood under the puncture site (hematoma).

Normal results

Normal reference ranges are laboratory-specific, but are usually within the following:

- adult: 200 mg/dL–400 mg/dL
- newborn: 125 mg/dL–300 mg/dL

Abnormal results

Spontaneous bleeding can occur with values less than 100 mg/dL.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Fibrocystic breast disease *see* **Fibrocystic condition of the breast**

Fibroadenoma

Definition

Fibroadenomas are benign breast tumors commonly found in young women. Fibroadenoma means "a tumor composed of glandular (related to gland) and fibrous (containing fibers) tissues."

Description

Breast fibroadenomas, abnormal growths of glandular and fibrous tissues, are most common between the ages of 15 and 30, and are found in 10% of all women (20% of African-American women). They are found rarely in postmenopausal women.

Described as feeling like marbles, these firm, round, movable, and "rubbery" lumps range from 1–5 cm in size. Giant fibroadenomas are larger, lemon-sized lumps. Usually single, from 10–15% of women have more than one.

While some types of breast lumps come and go during the menstrual cycle, fibroadenomas typically do not disappear after a woman's period, and should be checked by a doctor.

Causes and symptoms

The cause of breast fibroadenomas is unknown. They may be dependent upon estrogen, because they are common in premenopausal women, can be found in postmenopausal women taking estrogen, and because they grow larger in pregnant women.

Fibroadenomas usually cause no symptoms and may be discovered during **breast self-examination**, or during a routine check-up.

Diagnosis

When the doctor takes a complete medical history, they will ask when the lump was first noticed, if there were any symptoms or changes in lump size, and if there is any personal or family history of breast disease.

The doctor thoroughly feels the breasts (palpates). Tests are done, usually including **mammography** or ultrasound scans, or surgical removal of cells or tissue for examination under a the microscope (biopsy).

Diagnostic tests include:

- Mammogram. An x-ray examination of the breast.
- Ultrasound scan. A technique that uses sound waves to display a two-dimensional image of the breast, showing whether a lump is solid or fluid-filled (cystic).
- Fine-needle aspiration biopsy. A minor procedure wherein fluid or cells are drawn out of the lump through a small needle (aspirated).

KEY TERMS

Aspiration —To withdraw material with a needle and syringe.

Biopsy —To remove cells or tissue for microscopic examination.

Estrogen—Female sex hormone produced by the ovaries.

- Core biopsy. A procedure wherein a larger piece of tissue is withdrawn from the lump through a larger needle.
- Incisional biopsy. A surgical procedure wherein a piece of the lump is removed through an cut (incision).
- Excisional biopsy. A surgical procedure wherein the entire lump is removed through an cut (incision).

Most insurance plans cover the costs of diagnosing and treating fibroadenomas.

Treatment

Performed usually in outpatient settings, breast fibroadenomas are removed by **lumpectomy**, or surgical excision under local or general anesthesia. Sometimes lumps in younger women are not removed but are monitored by self-examination, yearly doctor check-ups, and mammograms. Surgery is generally recommended for women over 30, and for lumps that are painful or enlarging.

Alternative treatments

Alternative treatments for breast fibroadenomas include a low-fat, high-fiber, vegetarian-type diet; a reduction in **caffeine** intake; supplementation with evening primrose oil (Oenothera biennis), flax oil, or fish oil and **vitamins** E and C; and the application of hot compresses to the breast. In addition, a focus on liver cleansing is important to assist the body in conjugation and elimination of excess estrogens. Botanical remedies can be useful in hormone balancing, as can **acupuncture** and **homeopathy**. Massaging the breasts with castor oil, straight or infused with herbs or essential oils, can help fibroadenomas reduce and dissipate, as well as keep women in touch with changes in their breast tissue.

Prognosis

Breast fibroadenomas are not cancerous. The lumps recur in up to 20% of women. A small number of lumps disappear on their own.

Prevention

Breast fibroadenomas cannot be prevented. They can be discovered early by regular breast self-examination.

Resources

BOOKS

Giuliano, Armando E. "Breast: Fibroadenoma of the Breast." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Hacker, Neville F. "Breast Disease: A Gynecologic Perspective." In *Essentials of Obstetrics and Gynecology*, ed. Neville F. Hacker, et al. Philadelphia: W. B. Saunders Co., 1992.

"Breast Problems. Soothing Tactics for Pain, Tenderness, and Worry." In *New Choices in Natural Healing*, ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

Love, Susan M., and Karen Lindsay. "Lumps and Lumpiness." In *Dr. Susan Love's Breast Book*. Reading, MA: Addison-Wesley Publishing Co., 1995.

Rosenthal, M. Sara. "Is It Cancer?" In *The Breast Sourcebook: Everything You Need to Know About Breast Cancer Detection, Treatment, and Prevention*. Los Angeles: Lowell House, 1996.

PERIODICALS

Deckers, Peter J., and Andrew Ricci Jr. "Pain and Lumps in the Female Breast." *Hospital Practice* 28 (Feb. 1992): 67-73, 77-78, 87-94.

Delaney, Lisa. "Breast Protection At Your Fingertips." *Prevention Magazine*, July 1994, 81-83, 86-87, 137.

Donegan, William L. "Evaluation of a Palpable Breast Mass." *The New England Journal of Medicine* 24 (Sept. 1992): 937-942.

Dupont, William, D., David L. Page, and Fritz F. Parl. "Long-Term Risk of Breast Cancer in Women with Fibroadenoma." *The New England Journal of Medicine* 7 (July 1994): 10-15.

Glaser, Vicki. "Benign Breast Disorders." *Patient Care* 14 (Apr. 1997): 140-151.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., PO Box 96920

Mercedes McLaughlin

Fibrocystic condition of the breast

Definition

Fibrocystic condition of the breast is a term that may refer to a variety of symptoms: breast lumpiness or tenderness, microscopic breast tissue, and/or the x ray or ultrasound picture of the breast. It has been called a

"wastebasket" diagnosis because a wide range of vaguely defined benign breast conditions may be labeled as fibrocystic condition. It is not a **cancer**, and the majority of types of fibrocystic conditions do not increase the risk of **breast cancer**.

Description

There is no such thing as a normal or typical female breast. Breasts come in all shapes and sizes, with varying textures from smooth to extremely lumpy. The tissues of the female breast change in response to hormone levels, normal **aging**, nursing (**lactation**), weight fluctuations, and injury. To further complicate matters, the breast has several types of tissue; each of these tissue types may respond differently to changes in body chemistry.

Fibrocystic breast condition may be called fibrocystic disease, although it is clearly not a single, specific disease process. Variations or changes in the way the breast feels or looks on x ray may cause the condition to be called "fibrocystic change." Other names have been used to refer to this imprecise and ill-defined term: mammary dysplasia, mastopathy, chronic cystic **mastitis**, indurative mastopathy, mastalgia, lumpy breasts, or physiologic nodularity.

Estimates vary, but 40–90% of all women have some evidence of "fibrocystic" condition, change, or disease. It is most common among women between the ages 30 and 50, but may be seen at other ages.

Causes and symptoms

Fibrocystic condition of the breast refers to technical findings on diagnostic testing (signs); however, this discussion focuses on symptoms that may fall under the general category of the fibrocystic condition. First, a brief review of the structure and function of the breast may be useful.

The breast is not supposed to be a soft, smooth organ. It is actually a type of sweat gland. Milk, the breasts' version of sweat, is secreted when the breast receives appropriate hormonal and environmental stimulation.

The normal breast contains milk glands, with their accompanying ducts, or pipelines, for transporting the milk. These complex structures may not only alter in size, but can increase or decrease in number as needed. Fibrous connective tissue, fatty tissue, nerves, blood and lymph vessels, and lymph nodes, with their different shapes and textures, lie among the ever-changing milk glands. It is no wonder that a woman's breasts may not feel uniform in texture and that the "lumpiness" may wax and wane.

The fibrocystic condition refers to the tenderness, enlargement, and/or changing "lumpiness" that many women encounter just before or during their menstrual periods. At this time, female hormones are preparing the breasts for **pregnancy**, by stimulating the milk-producing cells, and storing fluid. Each breast may contain as much as three to six teaspoons of excess fluid. Swelling, with increased sensitivity or **pain**, may result. If pregnancy does not occur, the body reabsorbs the fluid, and the engorgement and discomfort are relieved.

Symptoms of fibrocystic breast condition range from mildly annoying in some women to extremely painful in others. The severity of discomfort may vary from month to month in the same woman. Although sometimes distressing, this experience is the body's normal response to routine hormonal changes.

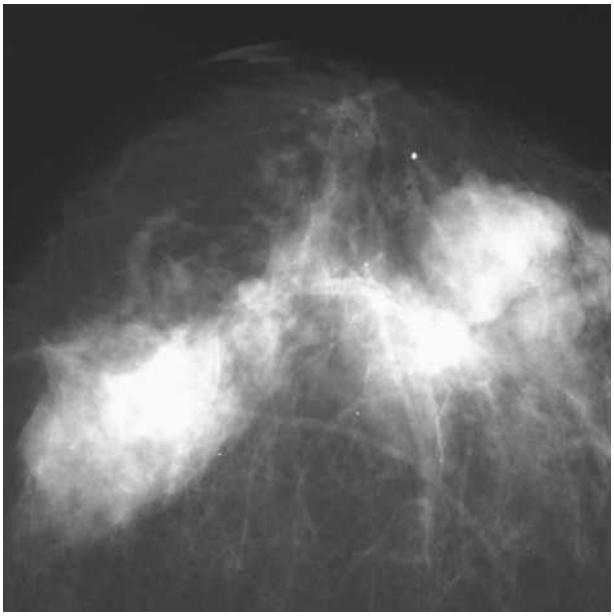
This cycle of breast sensitivity, pain and/or enlargement, can also result from medications. Some hormone replacement therapies (estrogen and progesterone) used for postmenopausal women can produce these effects. Other medications, primarily, but not exclusively those with hormones may also provoke these symptoms.

Breast pain unrelated to hormone shifts is called "noncyclic" pain. "Trigger-zone breast pain" is a term that may also be used to describe this area-specific pain. This type of pain may be continuous, or it may be felt intermittently. Trauma, such as a blow to the chest area, a prior **breast biopsy**, or sensitivity to certain medications may also underlie this type of pain. Fibrocystic condition of the breast may be cited as the cause of otherwise unexplained breast pain.

Lumps, apart from those clearly associated with hormone cycles, may also be placed under the heading of fibrocystic condition. These lumps stand out from enlarged general breast tissue. Although noncancerous lumps may occur, the obvious concern with such lumps is cancer.

Noncancerous breast lumps include:

- Adenosis. This condition refers to the enlargement of breast lobules, which contain a greater number of glands than usual. If a group of lobules are found near each other, the affected area may be large enough to be felt.
- Cysts. These are fluid-filled sacs in the breast and probably develop as ducts that become clogged with old cells in the process of normal emptying and filling. Cysts usually feel soft and round or oval. However a cyst deep within the breast may feel hard, as it pushes up against firmer breast tissue. A woman with a cyst may experience pain, especially if it increases in size before her menstrual cycle, as is often the case. Women between the age of 30 and 50 are most likely to develop cysts.
- Epithelial hyperplasia. Also called proliferative breast disease, this condition refers to an overgrowth of cells lining either the ducts or the lobules.



A mammogram of a female breast indicating multiple cysts. *(Custom Medical Stock Photo. Reproduced by permission.)*

- Fibroadenomas. These are tumors that form in the tissues outside the milk ducts. The cause of fibroadenomas is unknown. They generally feel smooth and firm, with a somewhat rubber-like texture. Typically a **fibroadenoma** is not attached to surrounding tissue and moves slightly when touched. They are most commonly found in adolescents and women in their early twenties but can occur at any age.
- Fibrosis. Sometimes one area of breast tissue persistently feels thicker or more prominent than the rest of the breast. This feeling may be caused by old hardened scar tissue and/or dead fat tissue as a result of surgery or trauma. Often the cause of this type of breast tissue is unknown.
- Miscellaneous disorders. A number of other benign (noncancerous) breast problems may be placed under the heading of "fibrocystic condition." These problems include disorders that may lead to breast inflammation (mastitis), infection, and/or nipple discharge.

Atypical ductal hyperplasia

The condition known as atypical ductal hyperplasia (ADH) is a condition in which the cells lining the milk ducts of the breast are growing abnormally. This condition may appear as spots of calcium salts, or calcifications, on the mammogram. A biopsy removed from the breast would confirm the diagnosis. Atypical ductal hyperplasia is not a cancer. In most women, this condition will cause no problems. However, for some women, especially women with family histories of breast cancer, the risk of developing breast cancer is increased. (One study with over 3,000 female participants indicated that about 20% of the participants with atypical hyperplasia and a family history of breast cancer developed breast cancer, as compared to the 8% of participants who developed the disease with atypical hyperplasia and no family history of breast cancer.) For women with ADH and a family history of breast cancer, more frequent mammograms and closer monitoring may be required.

Diagnosis

Breast cancer is the most common concern of women who feel a breast lump or experience an abnormal breast symptom. For peace of mind, and to rule out any possibility of cancer, any newly discovered breast lumps should be brought to the attention of a family physician or an obstetrician-gynecologist. He or she will obtain a history and conduct thorough **physical examination** of the area. Depending on the findings on physical examination, the patient is usually referred for tests. The most common of these tests include:

- **Mammography**. A mammogram is an x-ray examination of the breasts. The two major types of abnormalities doctors look for are masses and calcifications; either abnormality may be benign or malignant. The size, shape, and edges of these masses help doctors determine whether or not cancer is present. Sometimes, however, this test may be difficult to interpret, however, due to dense breast tissue.
- Ultrasonography. If a suspicious lump is detected during mammography, an ultrasound (the use of high-frequency sound waves to outline the shape of various organs and tissues in the body) is useful (although not definitive) in distinguishing benign from cancerous growths.
- Ductography. A ductogram (also called a galactogram) is a test that is sometimes useful in evaluating nipple discharge. A very fine tube is threaded into the opening of the duct onto the nipple. A small amount of dye is injected, outlining the shape of the duct on an x ray, and indicates whether or not there is a mass in the duct.
- Biopsy. If a lump cannot be proven benign by mammography and ultrasound, a breast biopsy may be considered. Usually a tissue sample is removed through a needle (fine-needle aspiration biopsy, or FNAB) to obtain a sample of the lump. The sample is examined under the microscope by a pathologist, and a detailed diagnosis regarding the type of benign lesion or cancer is established. In some cases, however, FNAB may not provide a clear diagnosis, and another type of biopsy (such as a surgical biopsy, core-needle biopsy, or other stereotactic biopsy methods—such as the Mammotome or Advanced Breast Biopsy Instrument) may be required.

Other breast conditions such as inflammation or infection are usually recognized on the basis of suspicious history, breastfeeding, or characteristic symptoms such as pain, redness, and swelling. A positive response to appropriate therapies often confirms the diagnosis.

Treatment

Once a specific disorder within the broad category of fibrocystic condition is identified, treatment can be prescribed. There are a number of treatment options for women with a lump that has been diagnosed as benign. If it is not causing a great deal of pain, the growth may be left in the breast. However, some women may choose to have a lump such as a fibroadenoma surgically removed, especially if it is large. Another option to relieve the discomfort of a painful benign lump is to have the cyst suctioned, or drained. If there is any uncertainty regarding diagnosis, the fluid may be sent to the lab for analysis.

Symptoms of cycle breast sensitivity and engorgement may also be treated with diet, medication, and/or physical modifications. For example,

- Although there is no scientific data to support this claim, many women have reported relief of symptoms when **caffeine** was reduced or eliminated from their **diets**. Decreasing salt before and during the period when breasts are most sensitive may also ease swelling and discomfort. Low-fat diets and elimination of dairy products also appear to decrease soreness for some women. However, it may take several months to realize the effects of these various treatments.
- Over-the-counter **analgesics** such as **acetaminophen** (Tylenol) or ibuprofen (Advil) may be recommended. In some cases, treatment with prescription drugs such as hormones or hormone blockers may prove successful. **Oral contraceptives** may also be prescribed.
- Warm soaks or ice packs may provide comfort. A well-fitted support bra can minimize physical movement and do much to relieve breast discomfort. Breast massage may promote removal of excess fluid from tissues and alleviate symptoms. Massaging the breast with castor oil, straight or infused with herbs or essential oils, can help reduce and dissipate fibroadenomas as well as keep women in touch with changes in their breast tissue.
- Infections are often treated with warm compresses and **antibiotics**. Lactating women are encouraged to continue breastfeeding because it promotes drainage and healing. However, a serious infection may progress to form an **abscess** that may need surgical drainage.
- Some studies of alternative or complementary treatments, although controversial, have indicated that **vitamins** A, B complex and E, and mineral supplements may reduce the risk of developing fibrocystic condition of the breast. Evening primrose oil (*Oenothera biennis*), flaxseed oil, and fish oils have been reported to be effective in relieving cyclic breast pain for some women.

Prognosis

Most benign breast conditions carry no increased risk for the development of breast cancer. However, a small percentage of biopsies uncover overgrowth of tissue in a particular pattern in some women; this pattern indicates a 15–20% increased risk of breast cancer over the next 20 years. Strict attention to early detection measures, such as annual mammograms, is especially important for these women.

Prevention

There is no proven method of preventing the various manifestations of fibrocystic condition from occurring. Some alternative health care practitioners believe that eliminating foods high in methyl xanthines (primarily coffee and chocolate) can decrease or reverse fibrocystic breast changes.

Resources

BOOKS

Goldmann, David R., and David A. Horowitz, eds. *The American College of Physicians Home Medical Guide: Breast Problems*. New York: Dorling Kindersley, 2000.

Kneece, Judy C. *Finding a Lump In Your Breast*. Columbia, SC: EduCare Publishing, 1996.

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book, 3rd rev. ed*. Reading, MA.: Addison-Wesley, 2000.

Singer, Sydney Ross. *Get It Off! Understanding the Cause of Breast Pain, Cysts, and Cancer.* Pahoa, HI: ISCD Press, 2000.

PERIODICALS

"Benign Conditions." *Harvard Women's Health Watch* 5 (May 1998): 4-5.

Duijm, Lucien E.M., et al. "Value of Breast Imaging in Women With Painful Breasts: Observational Follow Up Study." *British Medical Journal* 317 (Nov. 1998): 1492-1495.

Horner, N.K. and J.W. Lampe. "Potential Mechanisms of Diet Therapy for Fibrocystic Breast Conditions Show Inadequate Evidence of Effectiveness." *Journal of the American Dietetic Association* 100 (Nov. 2000):1368-1380.

Mannello, F., M. Malatesta, and G. Gazzanelli. "Breast Cancer in Women With Palpable Breast Cysts." *Lancet* 354 (Aug. 1999): 677- 678.

Morrow, Monica. "The Evaluation of Common Breast Problems." *American Family Physician* 61 (15 Apr. 2000): 2371-2378, 2385.

Page, D. L., and W. D. Dupont. "Premalignant Conditions and Markers of Elevated Risk in the Breast and Their Management." *Surgical Clinics of North America* 70, no. 4 (Aug. 1990): 831-51.

KEY TERMS

Advanced Breast Biopsy Instrument (ABBI)—Uses a rotating circular knife and thin heated electrical wire to remove a large cylinder of abnormal breast tissue.

Lobules—A small lobe or subdivision of a lobe (often on a gland) that may be seen on the surface of the gland by bumps or bulges.

Lymph nodes—Rounded, encapsulated bodies consisting of an accumulation of lymphatic tissue.

Mammotome—A method for removing breast biopsies using suction to draw tissue into an opening in the side of a cylinder inserted into the breast tissue. A rotating knife then cuts tissue samples from the rest of the breast; also known as a vacuum-assisted biopsy

Stereotactic biopsy—A biopsy taken by precisely locating areas of abnormal growth through the use of delicate instruments.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329. (800) ACS-2345 <http://www.cancer.org>.

American College of Obstetricians and Gynecologists. 409 12th St., S.W., P.O. Box 96920, Washington, DC 20090-6920. <http://www.acog.org>.

Cancer Information Service (CIS). 9000 Rockville Pike, Building 31, Suite 10A18, Bethesda, MD 20892. (800) 4-CANCER.

OTHER

National Cancer Institute. *Understanding Breast Changes: A Health Guide for All Women.* 10 July 2001 <http://rex.nci.nih.gov/MAMMOG_WEB/PUBS_POSTERS/UNDRSTNDNG/UNDER_STANDING_CHANGE.html>.

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Fibroids *see* **Uterine fibroids**

Fibromyalgia

Definition

Fibromyalgia is described as inflammation of the fibrous or connective tissue of the body. Widespread muscle **pain**, **fatigue**, and multiple tender points characterize these conditions. Fibrositis, fibromyalgia, and fibromyositis are names given to a set of symptoms believed to be caused by the same general problem.

Description

Fibromyalgia is more common than previously thought, with as many as 3–6% of the population affected by the disorder. Fibromyalgia is more prevalent in adults than children, with more women affected than men, particularly women of childbearing age.

Causes and symptoms

The exact cause of fibromyalgia is not known. Sometimes it occurs in several members of a family, suggesting that it may be an inherited disorder. People with fibromyalgia are most likely to complain of three primary symptoms: muscle and joint pain, stiffness, and fatigue.

Pain is the major symptom with aches, tenderness, and stiffness of multiple muscles, joints, and soft tissues. The pain also tends to move from one part of the body to another. It is most common in the neck, shoulders, chest, arms, legs, hips, and back. Although the pain is present most of the time and may last for years, the severity of the pain is changeable and dependent on individual patient perception.

Symptoms of fatigue may result from the individual's chronic pain coupled with **anxiety** about the problem and how to find relief. The inflammatory process also produces chemicals that are known to cause fatigue. Other common symptoms are tension headaches, difficulty swallowing, recurrent abdominal pain, **diarrhea**, and numbness or tingling of the extremities. **Stress**, anxiety, depression, or lack of sleep can increase symptoms. Intensity of symptoms is variable ranging from gradual improvement to episodes of recurrent symptoms.

Diagnosis

Diagnosis is difficult and frequently missed because symptoms of fibromyalgia are vague and generalized. Coexisting nerve and muscle disorders such as **rheumatoid arthritis**, spinal arthritis, or **Lyme disease** may further complicate the diagnostic process. Presently, there are no tests available to specifically diagnose fibromyalgia. The diagnosis is usually made after ruling out other medical conditions with similar symptoms.

Because of the emotional distress experienced by people with this condition and the influence of stress on the symptoms themselves, fibromyalgia has often been labeled a psychological problem. Recognition of the

underlying inflammatory process involved in fibromyalgia has helped promote the validity of this disease.

In 1990, the America College of Rheumatology developed standards for fibromyalgia that health care practitioners can use to diagnose this condition. According to these standards, a person is thought to have fibromyalgia if he or she has widespread pain in combination with tenderness in at least 11 of the 18 sites known as trigger points. Trigger point sites include the base of the neck, along the backbone, in front of the hip and elbow, and at the rear of the knee and shoulder.

Treatment

There is no known cure for fibromyalgia. Therefore, the goal of treatment is successful symptom management. Treatment usually requires a combination of therapies, **exercise**, proper rest, and diet. A patient's clear understanding of his or her role in the recovery process is imperative for successful management of this condition.

Treatments found to be helpful include heat and occasionally cold applications. A regular stretching program is often useful. Aerobic activities focusing on increasing the heart rate are the preferred forms of exercise over most other forms of exertion. Exercise programs need to include good warm-up and cool-down sessions, with special attention given to avoiding exercises causing joint pain. The diet should include a large variety of fruits and vegetables which provide the body with trace elements and **minerals** that are necessary for healthy muscles.

Adequate rest is essential in the treatment of fibromyalgia. Avoidance of stimulating foods or drinks (such as coffee) and medications like **decongestants** prior to bedtime is advised. If diet, exercise, and adequate rest do not relieve the symptoms of fibromyalgia, medications may be prescribed. Medications prescribed and found to have some benefit include **antidepressant drugs**, **muscle relaxants**, and anti-inflammatory drugs.

People with fibromyalgia often need a rheumatology consultation (a meeting with a doctor who specializes in disorders of the joints, muscles, and soft tissue) to decide the cause of various rheumatic symptoms, to be educated about fibromyalgia and its treatment, and to exclude other rheumatic diseases. A treatment program must be individualized to meet the patient's needs. The rheumatologist, as the team leader, enlists and coordinates the expertise of other health professionals in the care of the patient.

Alternative treatment

Massage therapy can be helpful, especially when a family member is instructed on specific massage techniques to manage episodes of increased symptoms. Specific attention to mental health, including psychological consultation, may also be important, since depression may precede or accompany fibromyalgia. Other alternative therapies, including **hellerwork**, **rolfing**, homeopathic medicine, Chinese traditional medicine (both **acupuncture** and herbs), **polarity therapy**, and Western botanical medicine, can assist the person with fibromyalgia to function day to day and can contribute to healing.

KEY TERMS

Connective tissue—Tissue that supports and binds other body tissue and parts.

Lyme disease —An acute recurrent inflammatory disease involving one or a few joints, believed to be transmitted by a tickborne virus. The condition was originally described in the community of Lyme, Connecticut, but has also been reported in other parts of the United States and other countries. Knees, other large joints are most commonly involved with local inflammation and swelling.

Rheumatology—The study of disorders characterized by inflammation, degeneration of connective tissue, and related structures of the body. These disorders are sometimes collectively referred to as rheumatism.

Prognosis

Fibromyalgia is a chronic problem. The symptoms sometimes improve and at other times worsen, but they often continue for months to years.

Prevention

There is no known or specific way to prevent fibromyalgia. However, similar to many other medical conditions, remaining as healthy as possible with a good diet, safe exercise, and adequate rest is the best prevention.

Resources

BOOKS

Schumacher, H. R. *Primer on the Rheumatic Diseases*. Atlanta: Arthritis Foundation, 1988.

ORGANIZATIONS

The American College of Rheumatology. 1800 Century Place, Suite 250, Atlanta, GA 30345. (404) 633-3777. <http://www.rheumatology.org>.

Arthritis Foundation.1300 W. Peachtree St., Atlanta, GA 30309. (800) 283-7800. <http://www.arthritis.org>.

Jeffrey P. Larson, RPT

Fibromyomas *see* **Uterine fibroids**

Fibrous breast lumps *see* **Fibroadenoma**

Fifth disease

Definition

Fifth disease is a mild childhood illness caused by the human parvovirus B19 that causes flu-like symptoms and a rash. It is called fifth disease because it was fifth on a list of common childhood illnesses that are accompanied by a rash, including **measles**, **rubella** or German measles, **scarlet fever** (or scarlatina), and scarlatinella, a variant of scarlet **fever**.

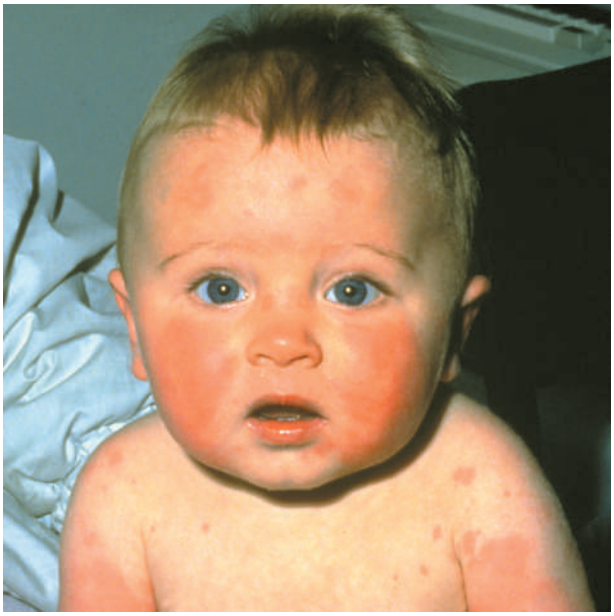
Description

The Latin name for the disease is *erythema infectiosum*, meaning infectious redness. It is also called the "slapped cheek disease" because, when the bright red rash first appears on the cheeks, it looks as if the face has been slapped. Anyone can get the disease, but it occurs more frequently in school-aged children. The disease is usually mild, and both children and adults usually recover quickly without complications. In fact, some individuals exhibit no symptoms and never even feel ill. Outbreaks most often occur in the winter and spring.

Causes and symptoms

Fifth disease is caused by the human parvovirus B19, a member of the Parvoviridae family of viruses, that lives in the nose and throat of the infected person. The virus is spread through the air by coughing and sneezing. Because the virus needs a rapidly dividing cell in order to multiply, it attacks the red blood cells of the body. Once infected, a person is believed to be immune to reinfection.

Symptoms may appear four to 21 days after being exposed to the virus. Initial symptoms are flu-like and include **headache**, body ache, **sore throat**, a mild fever of 101°F (38.3°C), and chills. It is at this time, prior to the development of the rash, that individuals are contagious. These symptoms last for two to three days. In children, a bright red rash that looks like a slap mark develops suddenly on the cheeks. The rash may be flat or raised and may or may not be itchy. Sometimes, the rash spreads to the arms, legs, and trunk, where it has a lace-like or net-like appearance. The rash can also involve the palms of the hands and soles of the feet. By the time the rash appears, individuals are no longer infectious. On average, the rash lasts for 10–11 days, but may last for as long as five to six weeks. The rash may fade away and then reappear upon exposure to sunlight, hot baths, emotional distress, or vigorous **exercise**.



This infant has a rash caused by Fifth disease, or erythema infectiosum. *(Custom Medical Stock Photo. Reproduced by permission.)*

Adults generally do not develop a rash, but instead may have swollen and painful joints, especially in the hands and feet. In adults, symptoms such as sore throat, headache, muscle and joint **pain**, abdominal pain, **diarrhea**, and vomiting occur more frequently than in children and are usually more severe. The joint pain can be arthritis-like and last for several months, especially in women, but the disease does not appear to progress to **rheumatoid arthritis**.

The virus causes the destruction of red blood cells and, therefore, a deficiency in the oxygen-carrying capacity of the blood (anemia) can result. In healthy people, the anemia is mild and only lasts a short while. In people with weakened immune systems, however, either because they have a chronic disease like **AIDS** or **cancer** (immunocompromised), or are receiving medication to suppress the immune system (immunosuppressed), such as organ transplant recipients, this anemia can be severe and last long after the infection has subsided. Symptoms of anemia include **fatigue**, lack of color, lack of energy, and **shortness of breath**. Some individuals with sickle cell anemia, iron deficiency, a number of different hereditary blood disorders, and those who have received bone marrow transplantations may be susceptible to developing a potentially life-threatening complication called a transient aplastic crisis where the body is temporarily unable to form new red blood cells.

In very rare instances, the virus can cause inflammation of different areas of the body, including the brain (**encephalitis**), the covering of the brain and spinal cord (**meningitis**), the lungs (pneumonitis), the liver (hepatitis), and the heart muscle (**myocarditis**). The virus can also aggravate symptoms for people with an autoimmune disease called **systemic lupus erythematosus**.

There is some concern about fifth disease in pregnant women. Although no association with an increased number of **birth defects** has been demonstrated, there is concern that infection during the first three months of **pregnancy** may lead to a slight increase in the number of miscarriages. There is also some concern that infection later in pregnancy may involve a very small risk of premature delivery or stillbirths. As a result, women who get fifth disease while they are pregnant should be monitored closely by a physician.

Diagnosis

Fifth disease is usually suspected based on a patient's symptoms, including the typical appearance of the bright red rash on the cheeks, patient history, age, and the time of year. The physician will also exclude other potential causes for the symptoms and rash, including rubella, **infectious mononucleosis**, bacterial infections like **Lyme disease**, allergic reactions, and lupus.

In addition, there is a blood test for fifth disease, but it is generally used only for pregnant women and for people who have weakened immune systems or who suffer from blood disorders, such as sickle cell anemia. The test involves measuring for a particular antibody or protein that the body produces in response to infection with the human parvovirus B19. The test is 92–97% specific for this disease.

Because fifth disease can pose problems for an unborn fetus exposed to the disease through the mother, testing may also be conducted while a fetus is still in the uterus. This test uses fluid collected from the sac around the fetus (amniotic fluid) instead of blood to detect the viral DNA.

Treatment

In general, no specific treatment for fifth disease is required. The symptoms can be treated using over-the counter medications, such as **acetaminophen** (Tylenol) or ibuprofen (Motrin, Advil). If the rash itches, calamine lotion can be applied. **Aspirin** is usually not given to children under the age of 18 to prevent the development of a serious illness called **Reye's syndrome**.

Patients who are receiving medications to suppress the immune system in the treatment of some other condition may be allowed to temporarily decrease the medications in order to allow the immune system to combat the infection and recover from the anemia. Those with weakened (not suppressed) immune systems, such as AIDS patients, may be given immunoglobulin intravenously to help the immune system fight the infection. People with severe anemia or who experience an aplastic crisis may require hospitalization and blood transfusions.

KEY TERMS

Anemia—A congenital or acquired deficiency in the iron-carrying capacity of the blood.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Immunocompromised—A state in which the immune system is weakened or is not functioning properly due to chronic disease.

Immunosuppressed—A state in which the immune system is suppressed by medications during the treatment of other disorders, like cancer, or following an organ transplantation.

Reye's syndrome—A very serious, rare disease, most common in children, that involves an upper respiratory tract infection followed by brain and liver damage.

Sickle cell anemia—A hereditary blood disorder in which the red blood cells are misshapen into crescent or sickle shapes resulting in the reduced oxygen-carrying capacity of the lungs.

Prognosis

Generally, fifth disease is mild, and patients tend to improve without any complications. In cases where the patient is either immunocompromised or immunosuppressed, a life-threatening aplastic crisis can occur. With prompt treatment, however, the prognosis is good. Mothers who develop the infection while pregnant can pass the infection on to their fetus, and as such, stand an increased risk of **miscarriage** and **stillbirth**. There are tests and treatments, however, that can be performed on the fetus while still in the uterus that can reduce the risk of anemia or other complications.

Prevention

Currently, there is no vaccine against fifth disease. Avoiding contact with persons who exhibit symptoms of a cold and maintaining good personal hygiene by regularly washing hands may minimize the chances of an

infection. Pregnant women should avoid exposure to persons infected with the disease and notify their obstetrician immediately if they are exposed so that they can be tested and monitored closely.

Resources

BOOKS

Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1992.

Ray, C. George. "Rubella and Other Viral Exanthems." In *Harrison's Principles of Internal Medicine*, ed. Jean D. Wilson, et al. New York: McGraw Hill, 1991.

Zinsser, Hans. *Zinsser Microbiology.* 19th ed. Ed. Wolfgang K. Joklik, et al. Stamford: Appleton Lange, 1988.

Lata Cherath, PhD

Filariasis

Definition

Filiariasis is the name for a group of tropical diseases caused by various thread-like parasitic round worms (nematodes) and their larvae. The larvae transmit the disease to humans through a mosquito bite. Filariasis is characterized by **fever**, chills, **headache**, and **skin lesions** in the early stages and, if untreated, can progress to include gross enlargement of the limbs and genitalia in a condition called **elephantiasis**.

Description

Approximately 170 million people in the tropical and subtropical areas of southeast Asia, South America, Africa, and the islands of the Pacific are affected by this debilitating parasitic disease. While filariasis is rarely fatal, it is the second leading cause of permanent and long-term disability in the world. The World Health Organization (WHO) has named filariasis one of only six "potentially eradicable" infectious diseases and has embarked upon a 20-year campaign to eradicate the disease.

In all cases, a mosquito first bites an infected individual then bites another uninfected individual, transferring some of the worm larvae to the new host. Once within the body, the larvae migrate to a particular part of the body and mature to adult worms. Filariasis is classified into three distinct types according to the part of the body that becomes infected: lymphatic filariasis affects the circulatory system that moves tissue fluid and immune cells (lymphatic system); subcutaneous filariasis infects the areas beneath the skin and whites of the eye; and serous cavity filariasis infects body cavities but does not cause disease. Several different types of worms can be responsible for each type of filariasis, but the most common species include the following: *Wucheria bancrofti, Brugia malayi* (lymphatic filariasis), *Onchocerca volvulus, Loa loa, Mansonella streptocerca, Dracunculus medinensis* (subcutaneous filariasis), *Mansonella pustans*, and *Mansonella ozzardi* (serous cavity filariasis).

The two most common types of the disease are Bancroftian and Malayan filariasis, both forms of lymphatic filariasis. The Bancroftian variety is found throughout Africa, southern and southeastern Asia, the Pacific islands, and the tropical and subtropical regions of South America and the Caribbean. Malayan filariasis occurs only in southern and southeastern Asia. Filariasis is occasionally found in the United States, especially among immigrants from the Caribbean and Pacific islands.

A larvae matures into an adult worm within six months to one year and can live between four and six years. Each female worm can produce millions of larvae, and these larvae only appear in the bloodstream at night, when they may be transmitted, via an insect bite, to another host. A single bite is usually not enough to acquire an infection, therefore, short-term travelers are usually safe. A series of multiple bites over a period of time is required to establish an infection. As a result, those individuals who are regularly active outdoors at night and those who spend more time in remote jungle areas are at an increased risk of contracting the filariasis infection.

Causes and symptoms

In cases of lymphatic filariasis, the most common form of the disease, the disease is caused by the adult worms actually living in the lymphatic vessels near the lymph nodes where they distort the vessels and cause local inflammation. In advanced stages, the worms can actually obstruct the vessels, causing the surrounding tissue to become enlarged. In Bancroftian filariasis, the legs and genitals are most often involved, while the Malayan variety affects the legs below the knees. Repeated episodes of inflammation lead to blockages of the lymphatic system, especially in the genitals and legs. This causes the affected area to become grossly enlarged, with thickened, coarse skin, leading to a condition called elephantiasis.

In conjunctiva filariasis, the worms' larvae migrate to the eye and can sometimes be seen moving beneath the skin or beneath the white part of the eye (conjunctiva). If untreated, this disease can cause a type of blindness known as onchocerciasis.

Symptoms vary, depending on what type of parasitic worm has caused the infection, but all infections usually

begin with chills, headache, and fever between three months and one year after the insect bite. There may also be swelling, redness, and **pain** in the arms, legs, or scrotum. Areas of pus (abscesses) may appear as a result of dying worms or a secondary bacterial infection.

Diagnosis

The disease is diagnosed by taking a patient history, performing a **physical examination**, and by screening blood specimens for specific proteins produced by the immune system in response to this infection (antibodies). Early diagnosis may be difficult because, in the first stages, the disease mimics other bacterial skin infections. To make an accurate diagnosis, the physician looks for a pattern of inflammation and signs of lymphatic obstruction, together with the patient's possible exposure to filariasis in an area where filariasis is common. The larvae (microfilariae) can also be found in the blood, but because mosquitos, which spread the disease, are active at night, the larvae are usually only found in the blood between about 10 pm and 2 am.

Treatment

Either ivermectin, albendazole, or diethylcarbamazine is used to treat a filariasis infection by eliminating the larvae, impairing the adult worms' ability to reproduce, and by actually killing adult worms. Unfortunately, much of the tissue damage may not be reversible. The medication is started at low doses to prevent reactions caused by large numbers of dying parasites.

While effective, the medications can cause severe side effects in up to 70% of patients as a result either of the drug itself or the massive **death** of parasites in the blood. Diethylcarbamazine, for example, can cause severe allergic reactions and the formation of pus-filled sores (abscesses). These side effects can be controlled using **antihistamines** and anti-inflammatory drugs (**corticosteroids**). Rarely, treatment with diethylcarbamazine in someone with very high levels of parasite infection may lead to a fatal inflammation of the brain (**encephalitis**). In this case, the fever is followed by headache and confusion, then stupor and **coma** caused when massive numbers of larvae and parasites die. Other common drug reactions include **dizziness**, weakness, and nausea.

Symptoms caused by the death of the parasites include fever, headache, muscle pain, abdominal pain, **nausea and vomiting**, weakness, dizziness, lethargy, and **asthma**. Reactions usually begin within two days of starting treatment and may last between two and four days.

No treatment can reverse elephantiasis. Surgery may be used to remove surplus tissue and provide a way to drain the fluid around the damaged lymphatic vessels. Surgery may also be used to ease massive enlargement of the scrotum. Elephantiasis of the legs can also be helped by elevating the legs and providing support with elastic bandages.

Prognosis

The outlook is good in early or mild cases, especially if the patient can avoid being infected again. The disease is rarely fatal, and with continued WHO medical intervention, even gross elephantiasis is now becoming rare.

Prevention

The best method of preventing filariasis is to prevent being repeatedly bitten by the mosquitoes that carry the disease. Some methods of preventing insect bites include the following:

- limit outdoor activities at night, particularly in rural or jungle areas
- wear long sleeves and pants and avoid dark-colored clothing that attracts mosquitoes
- avoid perfumes and colognes
- treat one or two sets of clothing ahead of time with permethrin (Duramon, Permanone)
- wear DEET insect repellent or, especially for children, try citronella or lemon eucalyptus, to repel insects
- if sleeping in an open area or in a room with poor screens, use a bed net to avoid being bitten while asleep
- use air conditioning, the cooler air makes insects less active

In addition, filariasis can be controlled in highly infested areas by taking ivermectin preventatively before being bitten. Currently, there is no vaccine available, but scientists are working on a preventative vaccine at this time.

Resources

BOOKS

Infectious Disease. Ed. Barbara A. Bannister, et al. Oxford, England: Blackwell Scientific, Inc., 1996.

Turkington, Carol A. *Infectious Diseases A to Z*. New York: Facts on File, Inc., 1998.

Van De Graaff, Kent. *Survey of Infectious and Parasitic Diseases*. New York: McGraw Hill, 1996.

Wilks, David, Mark Farrington, and David Rubenstein. *The Infectious Diseases Manual*. Oxford, England: Blackwell Scientific, Inc., 1995.

PERIODICALS

Burnham, Gilbert M. "Ivermectin Where Loa Loa is Endemic." *The Lancet* 349, no. 0070 (5 July 1997): 2-3.

KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Conjunctiva—The mucous membrane that lines the inside of the eyelid and the exposed surface of the eyeball.

Elephantiasis—A condition characterized by the gross enlargement of limbs and/or the genitalia that is also accompanied by a hardening and stretching of the overlying skin. Often a result of an obstruction in the lymphatic system caused by infection with a filarial worm.

Encephalitis—Inflammation of the brain.

Lymphatic system—The circulatory system that drains and circulates fluid containing nutrients, waste products, and immune cells, from between cells, organs, and other tissue spaces.

Microfilariae—The larvae and infective form of filarial worms.

Nematode—Round worms.

Subcutaneous—The area directly beneath the skin.

Cunningham, Nancy M. "Lymphatic Filariasis in Immigrants From Developing Countries." *American Family Physician* 55, no. 4 (Mar. 1997): 1199-1204.

WHO editors. "Lymphatic Filariasis: Diagnosis and Pathogenesis." *Bulletin of the World Health Organization* 71, no. 2 (Mar./Apr. 1993): 135-41.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Institute of Allergies and Infectious Diseases, Division of Microbiology and Infectious Diseases. Building 31, Room. 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892. <http://www.niaid.nih.gov>.

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

OTHER

"Bacterial Diseases." *Healthtouch Online Page*. <http://www.healthtouch.com>.

"Filariasis (Other Than Loa Loa and Onchocerciasis)." *Travel Health Information Page*. 5 Mar. 1997 <http://www.travelhealth.com>.

International Society of Travel Medicine. <http:www.istm.org>.

King, J. W. "Bug Bytes." *Louisiana State University Medical Center*. <http://www.ccm.lsumc.edu/bugbytes>.

"Lymphatic Filariasis." *Centers for Disease Control*. <http://www.cdc.gov/travel/yellowbk/page117.htm>.

Carol A. Turkington

Filgras *see* **Cancer therapy, supportive; Immunologic therapies**

Fingernail removal *see* **Nail removal**

Fingertip injuries

Definition

Fingertip trauma covers cuts, accumulation of blood (hematoma), bone breakage, or **amputation** in the fingertip.

Description

The fingertips are specialized areas of the hand with highly developed sensory and manipulative functions. Large sensory and motor areas located in the brain regulate the precise and delicate functions of fingertips. The fingertip is the site where extensor and flexor tendons insert. Fingertip injuries are extremely common since the hands hold a wide array of objects. In 2001, the approximately 10% of all accidents in the United States referred for Emergency Room consults involve the hand. Hand injuries are frequently the result of job injuries and account for 11–14% of on-the-job injuries and 6% of compensation paid injuries. Injury to the nail bed occurs in approximately 15–24% of fingertip injuries.

Fingertip injuries can result in amputation or tissue loss. The injury is assessed whether the bone and underlying tissue are intact and the size of the wound area. The pulp is the area of skin opposite the fingernail and is usually very vulnerable to injury. Pulp injuries commonly occur in persons who use or are in close contact with fast moving mechanical devices. These injuries can crush, cut, and puncture. The fingertips can also be injured by common crushing accidents. This could cause the development of a subungal hematoma (an accumulation of blood under the nail). At the base of the distal phalanx (the first circular skin fold from the tip) injuries can occur that can fracture the underlying bone in the area. Quite commonly

a hammer, closing a door, or sport accidents usually cause these injuries. These **fractures** can be simple, requiring little treatment or more complicated involving the joint. The accident may involve the point of insertion of a tendon. Usually this occurs when the terminal joint is being forced to flex while held straight. This motion typically occurs when tucking in sheets during bed making, a common cause of tendon injury. This injury causes a loss of extension (straightening the finger) ability.

Causes and symptoms

Accidental amputations will usually result in profuse bleeding and tissue loss. Injuries to the pulp can occur as from fast moving mechanical instruments, such as drills. These injuries may puncture the pulp. Injuries such as a subungal hematoma are caused by a crushing type injury. Fractures typically occur as the result of crushing injuries or tendon avulsion. These crushing injuries are frequently caused during sport injury and can be treated by simple interventions such as **immobilization** or more complex procedures if tendons are affected (the trauma is then treated as a tendon injury). Fractures can cause **pain** and, depending on the extent of swelling, there may be some restriction of movement. Tendon injuries can be caused when the terminal joint is exposed to force flexing motion (moving the finger toward the palm) while held straight.

Diagnosis

The attending clinician should evaluate the injury in a careful and systematic manner. The appearance of the hand can provide valuable information concerning presence of fractures, vascular status, and tendon involvement. Bones and joints should be evaluated for motion and tenderness. Nerves should be examined for sensory (feeling sensations) and motor (movement) functioning. Amputations usually profusely bleed and there is tissue loss. The wound is treated based on loss of tissue, bone, and wound area. Injuries to the pulp can be obvious during inspection. Subungal hematoma usually present a purplish-black discoloration under the nail. This is due to a hematoma underneath the nail. Radiographs may be required to assess the alignment of fractures or detect foreign bodies. Patients usually suffer from pain since injuries to the fingertip bone are usually painful and movement may be partially restricted due to swelling of the affected area. Tendon injuries usually result in the loss of ability to straighten or bend the finger.

Treatment

Amputation with bone and underlying tissue intact and a wound area 1 cm or less should be cleaned and treated with a dressing. With these types of **wounds** healthy tissue will usually grow and replace the injured area. Larger wounds may require surgical intervention. Puncture wounds should be cleaned and left open to heal. Patients typically receive **antibiotics** to prevent infection. A procedure called trephining treats subungal hematomas. This procedure is usually done with a straight cutting needle positioned over the nail. The clinician spins the needle with forefinger and thumb until a hole is made through the nail.

Patients who have extensive crush injuries or subungal hematomas involving laceration to skin folds or nail damage should have the nail removed to examine the underlying tissue (called the matrix). Patients who have a closed subungal hematoma with an intact nail and no other damage (no nail disruption or laceration) are treated conservatively. If the fracture is located two-thirds below the fingertip immobilization using a splint may be needed. Conservative treatment is recommended for crush injuries that fracture the terminal phalanx if a subungal hematoma is not present. Severe fractures near the fist circular skin crease may require surgical correction to prevent irregularity of the joint surface, which can cause difficulty with movement. Injury to a flexor tendon usually requires surgical repair. If this is not possible, the finger and wrist should be placed in a splint with specific positioning to prevent further damage.

Prognosis

Prognosis depends on the extent of traumatic damage to the affected area. Nail lacerations that are not treated may cause nail deformities. When amputation is accompanied with loss of two-thirds of the nail, half of the fingers develop beaking, or a curved nail. Aftercare and follow up are important components of treatment. The patient is advised to keep the hand elevated, check with a clinician two days after treatment, and to splint fractures for two weeks in the extended position. Usually a nail takes about 100 days to fully grow. Healing for an amputation takes about 21 to 27 days. This markedly

KEY TERMS

Distal—Movement away from the origin.

Flex—To bend.

Laceration—A cut in the skin

Phalanx—A bone of the fingers or toes.

Tendon—A structure that connects a skeletal muscle to bone.

decreases in elderly patients, primarily due to a compromised circulation normally part of advancing age.

Resources

BOOKS

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Year Book, Inc., 1998.

Townshend, Courtney M., et al. *Sabiston Textbook of Surgery.* 16th ed. W. B. Saunders Company, 2001.

PERIODICALS

Shetty, P., S. Dicksheet, and T. Scalea. "Fingertip Injuries: Immediate Reconstruction versus Delayed Healing." *American Journal of Emergency Medicine* 14 (Jan. 1996).

ORGANIZATION

American Society of Plastic Surgeons. 444 E. Algonquin Rd., Arlington Heights, IL. (888) 475-2784.

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Fish and shellfish poisoning

Definition

Fish and shellfish **poisoning** is a common but often unrecognized group of illnesses related to food. Three of these illnesses include ciguatera, scombroid, and paralytic shellfish poisoning.

Ciguatera

Definition

Ciguatera (from the Spanish word for a poisonous snail) is a food-related illness that causes abdominal and neurological symptoms.

Causes and symptoms

Ciguatera is caused by eating fish that have a toxin called ciguatoxin. Scientists believe this toxin is acquired by the fish through the food chain, and is originally produced by small algae microorganisms (dinoflagellates). The fish most likely contaminated with ciguatoxin are those that feed close to tropical reefs, including red snapper, grouper, and barracuda. Larger fish are more likely to contain the toxin. Although not as common in the United States, ciguatera is commonly diagnosed on many of the islands in the Pacific Ocean.

Illness from ciguatera can occur in just a few minutes to about 30 hours after eating. Most cases occur one to six hours after eating the contaminated fish. Initial symptoms are abdominal cramps, nausea, vomiting, or watery **diarrhea**. The most characteristic symptoms of the illness are those involving the nervous system. These include **numbness and tingling** around the lips, tongue, and mouth; **itching**; **dry mouth**; metallic taste in the mouth; and blurry vision. In more prominent cases, patients may complain of temporary blindness, a slow pulse, and a feeling that their teeth are loose. Patients may also have the strange symptom of reversal of hot and cold sensations on the skin, where cold things feel very hot or painful to the touch. In very severe cases, there may be difficulties in breathing or low blood pressure.

Diagnosis

Ciguatera diagnosis is based on the typical combination of symptoms after eating fish. There are no readily available blood or urine tests to detect the poisoning, but some researchers have developed a test for the toxin left on any remaining fish. A person does not have to be in a tropical area to get ciguatera. Fish can be caught from one of these distant areas, and can then be shipped and eaten locally. It is important to report suspected cases to local public health officials because more cases may occur from other contaminated fish.

Treatment

The treatment for this illness is general. Patients are given fluids (by mouth or through a vein) and medications to decrease the itching or to treat vomiting and/or diarrhea. The neurological symptoms can cause discomfort and treatment with amitriptyline (a medicine that has been used for depression) may be useful. Other medications may also be given.

Prognosis

Although **death** can occur, almost all patients diagnosed with ciguatera will recover. Recovery, however, can be slow and some symptoms can last for weeks or even months. Symptoms can also be aggravated by other illnesses or alcohol.

Prevention

Knowing the kinds of fish linked to ciguatera can help a person avoid eating high-risk fish. However, over 400 different kinds of fish have been linked to the disease, even salmon. A particular fish in a given area may be more likely to cause ciguatera than other fish. For example, red snapper is most often the source of ciguatera in the Pacific, while barracuda is more likely to contain the toxin in Florida. This is why it is illegal to sell barracuda in Florida for human consumption. Cooking the fish does not prevent ciguatera.

Scombroid

Definition

Scombroid is a fish-associated illness caused by eating improperly handled fish. Fish linked to this disease are usually in the Scombridae family, which includes yellowfin tuna, skipjack, bonito, and mackerel.

Causes and symptoms

Scombroid occurs after eating fish that has not been properly refrigerated after capture. Unlike ciguatera, the toxins linked with scombroid are not contracted by the fish from its surroundings. Bacteria that are normally found in fish act directly on a chemical (called histidine) in the flesh of fish that are not properly cooled when stored. This interaction produces histamine and other chemicals that cause the illness when the fish is eaten.

Symptoms of scombroid occur quickly after eating the fish, as soon as 10 minutes. Since histamine is released by certain cells in the body during an allergic reaction, scombroid can be confused with a fish allergy. Scombroid causes flushing of the face, sweating, a burning feeling in the mouth or throat, vomiting, diarrhea, and headaches. A rash that looks like a **sunburn** may occur, and a small number of patients have **hives**. Some patients have a metallic or peppery taste in their mouths. In more severe cases, rapid pulse, blurred vision, and difficulty breathing can occur. Symptoms usually last about four hours.

Diagnosis

Like ciguatera, scombroid poisoning is diagnosed based on typical symptoms occurring after eating fish. There are usually no available tests for the patient. Experimentally, however, elevated levels of histamine-related products have been found in the urine. It may be possible for public health officials to test any remaining fish flesh for histamine levels. Improperly refrigerated fish caught in both temperate and tropical waters have been linked to the illness. An outbreak of similar cases may be helpful in correctly diagnosing the problem.

Treatment

The treatment for scombroid is usually general. **Antihistamines** like diphenhydramine (Benadryl) may shorten the duration of the illness, but the illness will go away on its own. Some doctors have found that cimetidine (Tagamet) given through a vein may be helpful as well. In rare, more severe cases, epinephrine (adrenaline) may be used.

KEY TERMS

Algae—Plants that have one cell.

Histamine—A chemical found naturally in the body that produces inflammation and increases blood flow; the uncomfortable symptoms of an allergy attack or an allergic reaction are generally caused by the release of histamine.

Toxin—A poisonous substance usually produced by a living thing.

Prognosis

Although sometimes dramatic and alarming symptoms can occur, scombroid is usually not serious. The patient should be reassured that scombroid is not a fish allergy.

Prevention

Adequate storage of the target fish will always prevent scombroid. Since the fish does not appear spoiled or smell bad, the consumer cannot detect the risk of the illness before eating the fish. Cooking the fish does not prevent scombroid. Suspected cases should be reported to public health officials.

Paralytic shellfish poisoning

Definition

Paralytic shellfish poisoning (PSP) is a nervous system disease caused by eating cooked or raw shellfish that contain environmental toxins. These toxins are produced by a group of algae (dinoflagellates). It is unclear whether these toxins are related to the "blooming" of the algae, also called red tide because the algae can turn the water reddish brown. PSP occurs mostly in May through November.

Causes and symptoms

PSP develops usually within minutes after eating a contaminated shellfish, most commonly a mussel, clam, or oyster. Symptoms include **headache**, a floating feeling, **dizziness**, lack of coordination, and tingling of the mouth, arms, or legs. Muscle weakness causing difficulty swallowing or speaking may occur. Abdominal symptoms such as nausea, vomiting, and diarrhea can also occur. Unlike ciguatera and scombroid, PSP may have a much more serious outcome. PSP may cause difficulty breathing related to weakness or **paralysis** of the breathing muscle. The symptoms may last for six to 12 hours, but a patient may continue to feel weak for a week or more.

Diagnosis

PSP diagnosis is based on symptoms after eating shellfish, even if the shellfish are adequately cooked. No blood or urine test is available to diagnose the illness, but tests in mice to detect the toxin from the eaten fish can be done by public health officials.

Treatment

The treatment of PSP is mostly supportive. If early symptoms are recognized, the doctor will try to flush the toxin from the gastrointestinal tract with medications that create diarrhea. Vomiting may be induced if the patient has no signs of weakness. In cases where the muscles of breathing are weakened, the patient may be placed on a respirator until the weakness goes away. However, this measure is not usually needed. Likewise, the use of a machine to clean the blood (dialysis) has been used in severe cases.

Prognosis

The prognosis for PSP is quite good, especially if the patient has passed the initial 12 hours of illness without needing breathing support. Most deaths occur during this period if breathing help is not available.

Prevention

Measures to control PSP require detecting rising numbers of algae in coastal waters by periodic microscopic examination. By law, shellfish beds are closed when levels of the toxin-producing organisms are above acceptable standards. Cooking the shellfish does not prevent this disease. Suspected cases should be reported to public health officials.

Resources

PERIODICALS

Barton, Erik D., Paula Tanner, Steven G. Turchen, et al. "Ciguatera Fish Poisoning: A Southern California Epidemic." *Western Journal of Medicine* 163, no. 1 (July 1995): 31-35.

Eastaugh, Janet, and Suzanne Shepherd. "Infectious and Toxic Syndromes from Fish and Shellfish Consumption." *Archives of Internal Medicine* 149 (Aug. 1989): 1735-1740.

Gellert, George A., John Ralls, Corwin Brown, et al. "Scombroid Fish Poisoning: Underreporting and Prevention Among Noncommercial Recreational Fishers." *Western Journal of Medicine* 157, no. 6 (Dec. 1992): 645-647.

Larry Lutwick, MD, FACP

5p- syndrome *see* **Cri du chat syndrome**

Flesh-eating disease

Definition

Flesh-eating disease is more properly called necrotizing fasciitis, a rare condition in which bacteria destroy tissues underlying the skin. This tissue **death**, called necrosis or **gangrene**, spreads rapidly. This disease can be fatal in as little as 12 to 24 hours.

Description

Although the term is technically incorrect, flesh-eating disease is an apt descriptor: the infection appears to devour body tissue. Media reports increased in the middle and late 1990s, but the disease is not new. Hippocrates described it more than three millennia ago and thousands of reports exist from the Civil War. Approximately 500 to 1,500 cases of necrotizing fasciitis occur in the United States each year.

Flesh-eating disease is divided into two types. Type I is caused by anaerobic bacteria, with or without the presence of aerobic bacteria. Type II, also called hemolytic streptococcal gangrene, is caused by group A streptococci; other bacteria may or may not be present. The disease may also be called synergistic gangrene.

Type I fasciitis typically affects the trunk, abdomen, and genital area. For example, Fournier's gangrene is a "flesh-eating" disease in which the infection encompasses the external genitalia. The arms and legs are most often affected in type II fasciitis, but the infection may appear anywhere.

Causes and symptoms

The two most important factors in determining whether or not a person will develop flesh-eating disease are: the virulence (ability to cause disease) of the bacteria and the susceptibility (ability of a person's immune system to respond to infection) of the person who becomes infected with this bacteria.

In nearly every case of flesh-eating disease, a skin injury precedes the disease. As bacteria grow beneath the skin's surface, they produce toxins. These toxins destroy superficial fascia, subcutaneous fat, and deep fascia. In some cases, the overlying dermis and the underlying muscle are also affected.

Initially, the infected area appears red and swollen and feels hot. The area is extremely painful, which is a prominent feature of the disease. Over the course of hours or days, the skin may become blue-gray, and fluid-filled blisters may form. As nerves are destroyed the area

becomes numb. An individual may go into **shock** and develop dangerously low blood pressure. Multiple organ failure may occur, quickly followed by death.

Diagnosis

The appearance of the skin, paired with **pain** and **fever** raises the possibility of flesh-eating disease. An x ray, **magnetic resonance imaging** (MRI), or **computed tomography scans** (CT scans) of the area reveals a feathery pattern in the tissue, caused by accumulating gas in the dying tissue. Necrosis is evident during exploratory surgery, during which samples are collected for bacterial identification.

Treatment

Rapid, aggressive medical treatment, specifically, antibiotic therapy and surgical **debridement**, is imperative. **Antibiotics** may include penicillin, an aminoglycoside or third-generation cephalosporin, and clindamycin or metronidazole. **Analgesics** are employed for pain control. During surgical debridement, dead tissue is stripped away. After surgery, patients are rigorously monitored for continued infection, shock, or other complications. If available, hyperbaric oxygen therapy has also be used.

Prognosis

Flesh-eating disease has a fatality rate of about 30%. Diabetes, arteriosclerosis, immunosuppression, kidney disease, **malnutrition**, and **obesity** are connected with a poor prognosis. Older individuals and intravenous drug users may also be at higher risk. The infection site also has a role. Survivors may require plastic surgery and may have to contend with permanent physical disability and psychological adjustment.

Prevention

Flesh-eating disease, which occurs very rarely, cannot be definitively prevented. The best ways to lower the risk of contracting flesh-eating disease are:

- take care to avoid any injury to the skin that may give the bacteria a place of entry
- when skin injuries do occur, they should be promptly washed and treated with an antibiotic ointment or spray
- people who have any skin injury should rigorously attempt to avoid people who are infected with streptococci bacteria. A bacteria that causes a simple **strep throat** in one person may cause flesh-eating disease in another
- have any areas of unexplained redness, pain, or swelling examined by a doctor, particularly if the affected area seems to be expanding

KEY TERMS

Aerobic bacteria—Bacteria that require oxygen to live and grow.

Anaerobic bacteria—Bacteria that require the absence of oxygen to live and grow.

CT scan (computed tomography scan)—Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Debridement—Surgical procedure in which dead or dying tissue is removed.

Dermis—The deepest layer of skin.

Fascia, deep—A fibrous layer of tissue that envelopes muscles.

Fascia, superficial—A fibrous layer of tissue that lies between the deepest layer of skin and the subcutaneous fat.

Gangrene—An extensive area of dead tissue.

Hyperbaric oxygen therapy—A treatment in which the patient is placed in a chamber and breathes oxygen at higher-than-atmospheric pressure. This high-pressure oxygen stops bacteria from growing and, at high enough pressure, kills them.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Necrosis—Abnormal death of cells, potentially caused by disease or infection.

Subcutaneous—Referring to the area beneath the skin.

Resources

BOOKS

Roemmele, Jacqueline A., Donna Batdorff, and Alan L. Bisno. *Surviving the 'Flesh-Eating Bacteria' : Understanding, Preventing, Treating, and Living With the Effects of Necrotizing Fascitis*. New York: Avery Penguin Putnam, 2000.

PERIODICALS

Kotrappa, Kavitha S., Radhey S. Bansal, and Navin M. Amin. "Necrotizing Fasciitis." *American Family Physician* 53 (May 1996): 1691.

Meltzer, Daniel L., and Martin Kabongo. "Necrotizing Fasciitis: A Diagnostic Challenge." *American Family Physician* 56 (Jan. 1997): 145.

Ruth-Sahd, Lisa A., and Mary Pirrung. "The Infection That Eats Patients Alive." *RN 1997* (Mar. 1997): 28.

ORGANIZATIONS

National Necrotizing Fascitis Foundation. PO Box 145, Niantic, CT 06357. (616) 261-2538. <http://www.nnff.org/>.

Paul A. Johnson

Flight medicine *see* **Aviation medicine**

Floppy mitral valve *see* **Mitral valve prolapse**

Flower remedies

Definition

Flower remedies are specially prepared flower essences, containing the healing energy of plants. They are prescribed according to a patient's emotional disposition, as ascertained by the therapist, doctor, or patients themselves.

Purpose

Flower remedies are more homeopathic than herbal in the way they work, effecting energy levels rather than chemical balances. They have been described as "liquid energy." The theory is that they encapsulate the flowers' healing energy, and are said to deal with and overcome negative emotions, and so relieve blockages in the flow of human energy that can cause illness.

Description

Origins

Perhaps the most famous and widely used system is the Bach flower remedies. This system originated in the 1920s when British physician and bacteriologist, Dr. Edward Bach (1886–1936), noticed that patients with physical complaints often seemed to be suffering from **anxiety** or some kind of negative emotion. He concluded that assessing a patient's emotional disposition and prescribing an appropriate flower essence could treat the physical illness. Bach was a qualified medical doctor, but he also practiced **homeopathy**.

As a result of his own serious illness in 1917, Bach began a search for a new and simple system of medicine that would treat the whole person. In 1930, he gave up his flourishing practice on Harley Street at the Royal London Homeopathic Hospital and moved to the countryside to devote his life to this research. It is known that at this point, he ceased to dispense the mixture of homeopathy and allopathic medicine that he had been using. Instead, he began investigating the healing properties of plant essences and discovered that he possessed an "intuition" for judging the properties of each flower. Accordingly, he developed the system of treatment that bears his name, and is also the foundation for all other flower-remedy systems.

The Bach Flower Remedies were ostensibly the only system of significance from the 1920s until in the 1970s, when there was a renewed interest in the subject by doctors working in the field of natural medicine. Perhaps the most notable was Dr. Richard Katz, who was seeking new methods of dealing with modern **stress** and the resulting ailments. He focused on the concept of a psychic, psychological effect and chose to pursue this line of research.

In 1979, Katz founded the Flower Essence Society in California, (FES). This society pledged to further the research and development of Bach's principles. As of 2000, FES hosts a database of over 100 flower essences from more than 50 countries. FES is now an international organization of health practitioners, researchers, students, and others concerned with flower essence therapy.

The Society has connections with an estimated 50,000 active practitioners from around the world, who use flower essence therapy as part of their treatment. FES encourages the study of the plants themselves to determine the characteristics of flower essences. They are compiling an extensive database of case studies and practitioner reports of the use of essences therapeutically, allowing verification and development of the original definitions. They are also engaged in the scientific study of flower essence therapy.

FES says they have developed the theories of Paracelsus and Goethe who researched the "signatures" and "gestures" of botanical specimens, on the premise that the human body and soul are a reflection of the system of nature. FES plant research interprets the therapeutic properties of flower essences according to these insights.

In this regard, they have devised 12 "windows of perception" for monitoring the attributes of plants. Each of these windows reveals an aspect of the plant's qualities, although they maintain that what they are seeking is a "whole which is greater than the sum of its parts." The 12 windows are not considered independent classifications, but more of a blended tapestry of views of the qualities that each plant possesses.

The first window is concerned with the "form" of a plant—its shape classification. The second focuses on its "gesture" or spatial relationship. The third window is a plant's botanical classification; the Flower Essence Society maintains that considering a plant's botanical family

is essential to obtaining an overview of its properties as a flower essence. The fourth window concerns the time orientation of a particular specimen regarding the daily and seasonal cycles. Why do some flowers bloom at different times of the day, while others, such as the evening primrose, respond to the moon? The fifth window observes a plant's relationship to its environment. Where a plant chooses to grow, and where it cannot survive, reveals much about its qualities. The sixth window observes a plant's relationship to the Four Elements and the Four Ethers, as FES maintains that plants exist in one of the elemental or etheric forces in addition to their physical life. "Elements" refers to those developed by the Greeks, as opposed to the modern concept of "molecular building blocks." It seems that commonly, two elements predominate in a plant, indicating a polarity of qualities, while two can be said to be recessive. The seventh window relates to a plant's relationship with the other kingdoms of nature: mineral, animal and human, while the eighth relates to the color and color variations of a plant. Katz explains how the language of color tells us so much about the "soul qualities" of a plant. The ninth window concerns all other sensory perceptions of a plant, such as fragrance, texture, and taste. The tenth window involves assessing the chemical substances and properties; the eleventh studies medicinal and herbal uses, as by studying the physical healing properties of plants, we can also understand something of their more subtle effects on the soul. Finally, the twelfth window involves the study of the lore, mythology, folk wisdom, and spiritual and ritual qualities associated with a particular plant. Katz relates how in the past, human beings were more in touch with the natural world, and the remnants of this unconscious plant wisdom live on in the form of folklore, mythology, and so on.

Because flower remedies operate on approximately the same principles as homeopathy, practitioners quite often prescribe the two therapies in conjunction with each other. They can also be used concurrently with allopathic medicine.

The system consists of 38 remedies, each for a different disposition. The basic theory is that if the remedy for the correct disposition is chosen, the physical illness resulting from the present emotional state can then be cured. There is a rescue remedy made up of five of the essences—cherry plum, clematis, impatiens, rock star, and star of Bethlehem—that is recommended for the treatment of any kind of physical or emotional shock. Therapists recommended that rescue remedy be kept on hand to help with all emergencies.

The 38 Bach Remedies

- agrimony: puts on a cheerful front, hides true feelings, and worries or problems
- aspen: feelings of apprehension, dark foreboding, and premonitions
- beech: critical, intolerant, picky
- centaury: easily comes under the influence of others, weak willed
- cerato: unsure, no confidence in own judgement, intuition, and seeks approval from others
- cherry plum: phobic, fear of being out of control, and tension
- chestnut bud: repeats mistakes, does not learn from experience
- chicory: self–centered, possessive, clingy, demanding, self pity
- clematis: absent minded, dreamy, apathetic, and lack of connection with reality
- crab apple: a "cleanser" for prudishness, self–disgust, feeling unclean
- elm: a sense of being temporarily overwhelmed in people who are usually capable and in control
- gentian: discouraged, doubting, despondent
- gorse: feelings of pessimism, accepting defeat
- heather: need for company, talks about self, and concentrates on own problems

EDWARD BACH (1886–1936)

Edward Bach was a graduate of University College Hospital (M.B., B.S., M.R.C.S.) in England. He left his flourishing Harley Street practice in favor of homeopathy, seeking a more natural system of healing than allopathic medicine. He concluded that healing should be as simple and natural as the development of plants, which were nourished and given healing properties by earth, air, water, and sun.

Bach believed that he could sense the individual healing properties of flowers by placing his hands over the petals. His remedies were prepared by floating summer flowers in a bowl of clear stream water exposed to sunlight for three hours.

He developed 38 remedies, one for each of the negative states of mind suffered by human beings, which he classified under seven group headings: fear, uncertainty, insufficient interest in present circumstances, loneliness, over-sensitivity to influences and ideas, despondency or despair, and overcare for the welfare of others. The Bach remedies can be prescribed for plants, animals, and other living creatures as well as human beings.

- holly: jealousy, envy, suspicion, anger, and hatred
- honeysuckle: reluctance to enter the present and let the past go
- hornbeam: reluctant to face a new day, weary, can't cope (mental fatigue)
- impatiens: impatience, always in a hurry, and resentful of constraints
- larch: feelings of inadequacy and apprehension, lack of confidence and will to succeed
- mimulus: fearful of specific things, shy, and timid
- mustard: beset by "dark cloud" and gloom for no apparent reason
- oak: courageous, persevering, naturally strong but temporarily overcome by difficulties
- olive: for physical and mental renewal, to overcome exhaustion from problems of long–standing
- pine: for self–reproach, always apologizing, assuming guilt
- red chestnut: constant worry and concern for others
- rock rose: panic, intense alarm, dread, horror
- rock water: rigid–minded, self–denial, restriction
- scleranthus: indecision, uncertainty, fluctuating moods
- star of Bethlehem: consoling, following shock or grief or serious news
- sweet chestnut: desolation, despair, bleak outlook
- vervain: insistent, fanatical, over–enthusiastic
- vine: dominating, overbearing, autocratic, tyrannical
- walnut: protects during a period of adjustment or vulnerability
- water violet: proud, aloof, reserved, enjoys being alone
- white chestnut: preoccupation with worry, unwanted thoughts
- wild oat: drifting, lack of direction in life
- wild rose: apathy, resignation, no point in life
- willow bitter: resentful, dissatisfied, feeling life is unfair

Originally, Bach collected the dew from chosen flowers by hand to provide his patients with the required remedy. This became impractical when his treatment became so popular that production could not keep up with demand. He then set about finding a way to manufacture the remedies, and found that floating the freshly picked petals on the surface of spring water in a glass bowl and leaving them in strong sunlight for three hours produced the desired effect. Therapists explain that the water is "potentized" by the essence of the flowers. The potentized water can then be bottled and sold. For more woody specimens, the procedure is to boil them in a sterilized pan of water for 30 minutes. These two methods produce "mother tinctures" and the same two methods devised by Bach are still used today. Flower essences do not contain any artificial chemical substances, except for alcohol preservative.

Bach Flower Remedies

Name	Remedy
Agrimony	Upset by arguments, nonconfrontational, conceals worry and pain
Aspen	Fear of the unknown, anxiety, prone to nightmares, and apprehension
Beech	Critical, intolerant, and negative
Centaury	Submissive and weak-willed
Cerato	Self doubting and overly dependent
Cherry Plum	Emotional thoughts and desparation
Chestnut	Repeats mistakes and has no hindsight
Chicory	Selfish, controlling, attention-seeking, and possessive
Clematis	Absorbed, impractical, and indifferent
Crab Apple	Shame and self-loathing
Elm	Overwelhmed and feelings of inadequacy
Gentian	Negative, doubt, and depression
Gorse	Pessimism, hopelessness, and despair
Heather	Self-centered and self-absorbed
Holly	Jealousy, hatred, suspicion, and envy
Honeysuckle	Homesick, living in the past, and nostalgic
Hornbeam	Procrastination, fatigue, and mental exhaustion
Impatiens	Impatience, irritability, and impulsive
Larch	No confidence, inferiority complex, and despondency
Mimulus	Timid, shy, and fear of the unknown
Mustard	Sadness and depression of unknown origin
Oak	Obstinate, inflexible, and overachieving
Olive	Exhaustion
Pine	Guilt and self blame
Red Chesnut	Fear and anxiety for loved ones
Rock Rose	Nightmares, hysteria, terror, and panic
Rock Water	Obsessive, repression, perfectionism, and self denial
Scleranthus	Indecision, low mental clarity, and confusion
Star-of-Bethlehem	Grief and distress
Sweet Chesnut	Despair and hopelessness
Vervain	Overbearing and fanatical
Vine	Arrogant, ruthless, and inflexible
Walnut	Difficulty accepting change
Water Violet	Pride and aloofness
White Chestnut	Worry, preoccupation, and unwanted thoughts
Wild Oat	Dissatisfaction
Wild Rose	Apathy and resignation
Willow	Self pity and bitterness

Bach remedies cost around $10 each, and there is no set time limit for treatment. It may take days, weeks, or in some cases months. Flower essences cost around $6 each, and there is also no set time for the length of treatment, or the amount of essences that may be taken. These treatments are not generally covered by medical insurance.

Precautions

Bach remedies and flower essences are not difficult to understand, and are considered suitable for self administration. The only difficulty may be in finding the correct remedy, as it can sometimes be tricky to pinpoint an

individual's emotional disposition. They are even safe for babies, children, and animals. An important aspect of treatment with flower remedies, is that if you feel instinctively that you need a particular remedy, you are encouraged to act on that instinct. However, it is advisable not to continue a particular remedy once you feel you no longer need it, and to try a different one if you feel that progress is not being made.

The remedies are administered from a stoppered bottle and need to be diluted. Individuals sensitive to alcohol can apply the concentrate directly to temples, wrists, behind the ears, or underarms. They should be kept in a cool dark place; like this they should last indefinitely. However, a diluted remedy should not be kept longer than three weeks. Two drops of each diluted remedy should be taken four times a day, including first thing in the morning and last thing at night. If the rescue remedy is being used, four drops should be used instead. Most therapists recommend that they be taken in spring water, but the remedy can be taken directly from the bottle, if care is taken that the dropper does not touch the tongue, as this would introduce bacteria that would spoil the remedy.

It is not recommended that more than six or seven Bach remedies be used at any one time. Instead, it is preferable to divide a larger amount up into two lots to ensure the optimum effectiveness of the remedies. No combination, or amount of combinations of the remedies can cause any harm, rather they become less effective.

Unlike FES, the Bach Centre does not encourage research to "prove" that the remedies work, preferring that people find out for themselves. They strive to keep the use of the Bach remedies as simple as possible, and to this end they do not keep case records. Bach warned before he died that others would try to change his work and make it more complicated. He was determined to keep it simple so that anyone could use it, and that is why he limited the system to only 38 remedies. The Centre points out that many who have used Bach's research as a starting point have added other remedies to the list, even some that Bach himself rejected.

Side effects

Flower remedies or essences are generally regarded as being totally safe, and there are no known side effects apart from the rare appearance of a slight rash, which is not a reason to discontinue treatment, says the Bach Centre.

Research and general acceptance

Bach flower remedies and flower essences have not yet officially won the support of allopathic medicine, despite the fact that more and more medical doctors are referring patients for such treatments on the strength of personal conviction. However, it is difficult to discount the scores of testimonials. Some practitioners refer skeptics to the research that has been done regarding the "auras" of living things. Theoretically, the stronger the aura, the more alive an organism is. Flower essences have very strong auras.

KEY TERMS

Aura—Emanation of light from living things (plants and animals) that can be recorded by Kirlian photography.

Essence—The constituent of a plant that determines its characteristics.

Potentize—The process of transferring the healing energy of a plant into spring water.

Window—A perspective adopted to assess the property of a given plant.

Resources

BOOKS

Bach, Edward. *Heal Thyself.* Essex, UK: C.W. Daniel Company, Ltd., 1931.

Drury, N. *Bach Flower Remedies.* New York: Sterling, 1989.

Kaslof, Leslie. *The Traditional Flower Remedies of Dr. Edward Bach.* New Canaan, CT: Keats, 1993

Somerville, R. *Flower Remedies* New York: Time-Life Books.

Vlannis, Gregory. *Flowers to the Rescue.* New York: Thorras, 1986.

ORGANIZATIONS

The Dr. Edward Bach Centre, Mount. Vernon, Bakers Lane, Sotwell, Oxon, OX10 OPX, UK. <centre@bachcentre.com>. <http://www.bachcentre.com>.

The Flower Essence Society. P.O. Box 459, Nevada City, CA 95959. (800) 736-9222. Fax: (530) 265-0584. <mail@flowersociety.org>. <http://www.flowersociety.org>.

Patricia Skinner

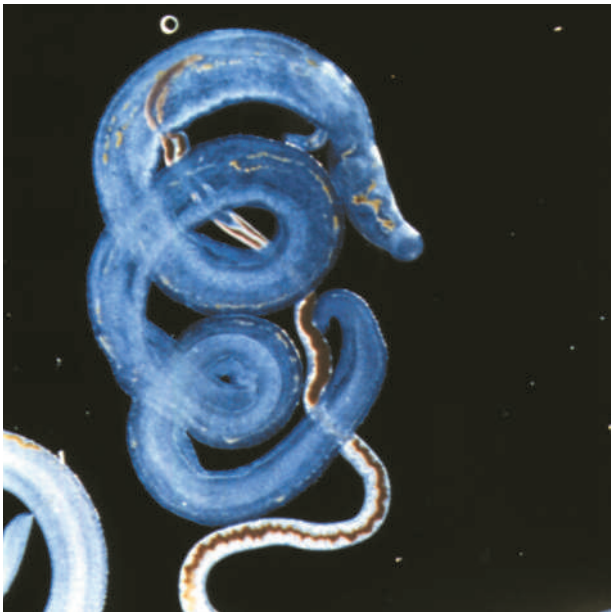
Flu *see* **Influenza**

Flucona *see* **Antifungal drugs, systemic**

Fluke infections

Definition

Fluke infections are diseases of the digestive tract and other organ systems caused by several different



A micrograph of adult intestinal blood flukes, *Schistosoma mansoni.* Humans can become infected while bathing or working in contaminated water. *(Photo Researchers, Inc. Reproduced by permission.)*

species of parasitic flatworms (Trematodes) that have complex life cycles involving hosts other than human beings. Trematode comes from a Greek word that means having holes and refers to the external suckers that adult flukes use to draw nourishment from their hosts. Fluke infections are contracted by eating uncooked fish, plants, or animals from fluke-infected waters. Symptoms vary according to the type of fluke infection.

Description

In humans, fluke infections can be classified according to those diseases caused by liver flukes and those caused by lung flukes. Diseases caused by liver flukes include fascioliasis, opisthorchiasis, and clonorchiasis. Cases of liver fluke infection have been reported in Europe and the United States, as well as the Middle East, China, Japan, and Africa. Diseases caused by lung flukes include paragonimiasis. Paragonimiasis is a common infection in the Far East, Southeast Asia, Africa, Central and South America, Indonesia, and the Pacific Islands. It is estimated that between 40 million and 100 million people worldwide suffer from either liver or lung fluke infections.

In their adult stage, liver and lung flukes are symmetrical in shape, ranging between 1/4–1 in in length, and look somewhat like long, plump leaves or blades of grass. They enter through the mouth and can infect any person at any age.

Causes and symptoms

The symptoms of fluke infection differ somewhat according to the type of fluke involved. All forms of liver and lung fluke infection, however, have the following characteristics:

- most persons who get infected do not develop symptoms (asymptomatic)
- the early symptoms of an acute fluke infection are not unique to these diseases alone (nonspecific symptoms)
- infection does not confer immunity against re-infection by the same species or infection by other species of flukes
- infection is usually associated with eating uncooked fish, plants, or animals that live in fresh water

Fascioliasis

Fascioliasis is caused by *Fasciola hepatica*, the sheep liver fluke. The fluke has a three-part life cycle that begins when eggs from a host's feces are deposited in water. The eggs release free-swimming larvae (miracidia) that infect snails. The snails then release free-swimming larvae with tails (cercariae) that form cysts containing larvae in the infective stage (metacercariae) on vegetation growing in fresh water. Humans become infected when they eat watercress, water chestnuts, or other plants covered with the encysted metacercariae.

When a person eats contaminated plants, the cysts are broken open in the digestive system, and the metacercariae leave their cysts, pass through the wall of the intestine, and enter the liver, where they cause inflammation and destroy tissue. After a period of 10–15 weeks in the liver, the adult flukes move to the bile ducts and produce eggs. Acute fascioliasis is marked by abdominal **pain** with **headache**, loss of appetite, anemia, and vomiting. Some patients develop **hives**, muscle pains, or a yellow-color to the skin and whites of the eyes (**jaundice**). Chronic forms of the disease may produce complications, including blockage of the bile ducts or the migration of adult flukes to other parts of the body.

Opisthorchiasis and clonorchiasis

These infections are caused by *Clonorchis sinensis*, the Chinese liver fluke, and *Opisthorchis viverrini* or *O. felineus*. The diseases are widespread, affecting more than 20 million people in Japan, China, Southeast Asia, and India. The life cycle of these liver flukes is similar to that of *F. hepatica* except that the etacercariae are encysted in freshwater fish rather than on plants. Dogs, cats, and other mammals that eat raw fish can be infected with opisthorchiasis and clonorchiasis.

KEY TERMS

Aspirator—A medical instrument that uses suction to withdraw fluids from the lungs, digestive tract, or other parts of the body for laboratory testing.

Asymptomatic—Persons who carry a disease and are usually capable of transmitting the disease but, who do not exhibit symptoms of the disease are said to be asymptomatic.

Cercaria (plural, cercariae)—An intermediate-stage of the fluke larva, released into water by infected snails.

Cross-reaction—A reaction that occurs in blood testing when a disease agent reacts to the specific antibody for another disease agent. Cross-reactions are common in blood tests for fluke infections because the different species are closely related.

Encysted—Enclosed in a cyst or capsule. Flukes spend part of their life cycle as encysted larvae.

Fluke—A parasitic flatworm that has external suckers. Flukes are sometimes called trematodes.

Host—The living animal that supplies nutrition to a parasite.

Jaundice—Yellowing of the skin and the whites of the eyes as a result of excess bile in the blood due to an improperly functioning liver.

Metacercaria (plural, metacercariae)—The encysted stage of a fluke larva that produces infection in human beings.

Miracidium (plural, miracidia)—The free-swimming larval form in the life cycle of the liver fluke.

Parasite—An organism that lives on or inside an animal of a different species and feeds on it or draws nutrients from it.

Trematode—Parasitic flatworms or another name for fluke, taken from a Greek word that means having holes.

The symptoms of opisthorchiasis and clonorchiasis are similar to those of fascioliasis and include both acute and chronic forms. In acute infection, the patient may be tired, have a low-grade **fever**, pains in the joints, a swollen liver, abdominal pain, and a skin rash. The acute syndrome may be difficult to diagnose because the fluke eggs do not appear in the patient's stool for three to four weeks after infection. Patients with the chronic form of the disease experience a loss of appetite, **fatigue**, low-grade fever, **diarrhea**, and an enlarged liver that feels sore when the abdomen is pressed.

Paragonimiasis

Paragonimiasis is caused by a lung fluke, either *Paragonimus westermani* or *P. skrjabini*. These flukes are larger than liver flukes and infect meat- or fish-eating animals as well as humans. Their life cycle is similar to that of liver flukes except that their encysted larvae infect crabs and crayfish rather than plants or fish. Humans can ingest the encysted metacercariae from drinking contaminated water or eating raw or undercooked crabs and crayfish.

In humans, the metacercariae are released from their cysts in the small intestine and migrate to the lungs or the brain in 1% of cases. In the lungs, the flukes lay their eggs and form areas of inflammation covered with a thin layer of fibrous tissue. These areas of infection may eventually rupture, causing the patient to **cough** up fluke eggs, blood, and inflamed tissue. The period between the beginning of the infection and the appearance of the eggs during coughing is about six weeks. Patients with lung infections may have chest pain and fever as well as rust-colored or bloody sputum. Lung infections can lead to **lung abscess**, **pneumonia**, or **bronchitis**. Patients with fluke infections of the brain may experience seizures or a fatal inflammation of brain tissue called **encephalitis**. Some patients also develop diarrhea and abdominal pain or lumps under the skin that contain adult flukes.

Diagnosis

Diagnosis of fluke infections is based on a combination of the patient's history, particularly travel or residence in areas known to have flukes, and identification of the fluke's eggs or adult forms. In some patients, the eggs are found in fluid from the lungs, bile duct, or small intestine. Samples of these fluids can be obtained with a suction instrument (aspirator). Because most types of fluke infections are rare in the United States, stool specimens or body fluid samples may need to be sent to a laboratory with experts in unusual diseases or conditions to identify the specific parasite. In some cases, adult flukes may be found in the patient's stools, vomit, sputum, or skin lumps (for lung flukes). In the case of lung flukes, it is important for the doctor to rule out **tuberculosis** as a possible diagnosis. A tuberculosis skin test and **chest x ray** will usually be sufficient to do this.

Blood tests may be useful in diagnosing fluke infections, but their usefulness is limited because of cross-reactions. A cross-reaction occurs in blood testing when a particular disease agent reacts with antibodies specific to another disease agent. This result means that the doctor may know that the person is infected by flukes but cannot tell from the blood test alone which specific type of fluke is causing the disease. In addition, blood tests for fluke infections cannot distinguish between past and current infections. In some cases, sophisticated imaging techniques, such as **computed tomography scans** (CT scans) or ultrasound scans of the patient's chest or brain (for lung flukes) or abdomen (for liver flukes), are useful in confirming a diagnosis of fluke infection.

Treatment

Liver and lung fluke infections are treated with medications. These include triclabendazole, praziquantel, bithionol, albendazole, and mebendazole. Praziquantel works by paralyzing the flukes' suckers, forcing them to drop away from the walls of the host's blood vessels. In the United States, bithionol is available only from the Centers for Disease Control (CDC). Depending on the species of fluke and the severity of infection, the course of treatment can vary from several days to several weeks. Cure rates vary from 50–95%. Most patients experience mild temporary side effects from these drugs, including diarrhea, **dizziness**, or headache.

Prognosis

The prognosis for recovery from liver fluke infections is good, although patients with serious infections may be more vulnerable to other diseases, particularly if significant liver damage has occurred. Most patients with lung fluke infections also recover, however, severe infections of the brain can cause **death** from the destruction of central nervous system or brain tissue.

Prevention

No vaccines have been developed that are effective against lung or liver fluke infections. Prevention of these infections includes the following measures:

- boiling or purifying drinking water
- avoiding raw or undercooked fish or salads made from fresh aquatic plants; all food eaten in areas with fluke infestations should be cooked thoroughly; pickling or **smoking** will not kill fluke cysts in fish or shellfish
- control or eradication of the snails that serve as the flukes' intermediate hosts

Resources

BOOKS

Goldsmith, Robert S. "Infectious Diseases: Protozoal & Helminthic." *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Houston, Stan, and Kinga Kowalewska-Grochowska. "Other Trematodes." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Howell, M. J. "Fascioliasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Phillips, Elizabeth, and Jay S. Keystone. "Intestinal Parasites." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Praziquantel." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

Sirisinha, Stitaya. "Opisthorchiasis-Clonorchiasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Weinberg, Adriana, and Myron J. Levin. "Infections: Parasitic & Mycotic." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Fluoroquinolones

Definition

Fluoroquinolones are medicines that kill bacteria or prevent their growth.

Purpose

Fluoroquinolones are **antibiotics**, medicines used to treat infections caused by microorganisms. Physicians prescribe these drugs for bacterial infections in many parts of the body. For example, they are used to treat bone and joint infections, skin infections, urinary tract infections, inflammation of the prostate, serious ear infections, **bronchitis**, **pneumonia**, **tuberculosis**, some **sexually transmitted diseases** (STD), and some infections that affect people with **AIDS**.

Description

Fluoroquinolones are available only with a physician's prescription and are sold in tablet and injectable forms. Examples of these medicines are moxifloxacin (Avelox), ciprofloxacin (Cipro), ofloxacin (Floxin), levofloxacin (Levaquin), lomefloxacin (Maxaquin), nor-

floxacin (Noroxin), enoxacin (Penetrex), gatifloxacin (Tequin), and sparfloxacin (Zagam).

Recommended dosage

The recommended dosage depends on the type and strength of fluoroquinolone, and the kind of infection for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

To make sure the infection clears up completely, take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon.

Fluoroquinolones work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. For best results, take this medicine with a full glass of water and drink several more glasses throughout the day, every day during treatment with the drug. The extra water will help prevent some side effects. Some fluoroquinolones should be taken on an empty stomach; others may be taken with meals. Check package directions or ask the physician or pharmacist for instructions on how to take the medicine.

Precautions

Research suggests that fluoroquinolones may cause bone development problems in children and teenagers. Infants, children, teenagers, pregnant women, and women who are breastfeeding should not take this medicine unless directed to do so by a physician.

Although such side effects are rare, some people have had severe and life-threatening reactions to fluoroquinolones. Call a physician immediately if any of these signs of a dangerous reaction occur:

- swelling of the face and throat
- swallowing problems
- shortness of breath
- rapid heartbeat
- tingling of fingers or toes
- **itching** or **hives**
- loss of consciousness

Some fluoroquinolones may weaken the tendons in the shoulder, hand, or heel, making the tendons more likely to tear. Anyone who notices **pain** or inflammation in these or other tendon areas should stop taking the medicine immediately and call a physician. Rest and avoid **exercise** until the physician determines whether the tendons are damaged. If the tendons are torn, surgery may be necessary to repair them.

These medicines make some people feel drowsy, dizzy, lightheaded, or less alert. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with fluoroquinolones, avoid being in direct sunlight, especially between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use tanning beds, tanning booths, or sunlamps.

KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Bronchitis—Inflammation of the air passages of the lungs.

Digestive tract—The stomach, intestines, and other parts of the body through which food passes.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Microorganism—An organism that is too small to be seen with the naked eye.

Pneumonia—A disease in which the lungs become inflamed. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

Prostate—A donut-shaped gland in males below the bladder that contributes to the production of semen.

Sexually transmitted disease (STD)—A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact.

Tendon—A tough band of tissue that connects muscle to bone.

Tuberculosis—An infectious disease that usually affects the lungs, but may also affect other parts of the body. Symptoms include fever, weight loss, and coughing up blood.

Urinary tract—The passage through which urine flows from the kidneys out of the body.

Do not take **antacids** that contain aluminum, calcium, or magnesium at the same time as fluoroquinolones. The antacids may keep the fluoroquinolones from working as they should. If antacids are needed, take them at least two hours before or two hours after taking norfloxacin or ofloxacin, at least four hours before or two hours after taking ciprofloxacin. Follow the same instructions for taking sucralfate (Carafate), a medicine used to treat stomach ulcers and other irritation in the digestive tract and mouth.

Anyone who has had unusual reactions to fluoroquinolones or related medicines such as cinoxacin (Cinobac) or nalidixic acid (NegGram) in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Before using fluoroquinolones, people with any of these medical problems should make sure their physicians are aware of their conditions:

- kidney disease
- liver disease with kidney disease
- diseases of the brain or spinal cord, including hardening of the arteries in the brain, epilepsy, and other seizure disorders

Taking fluoroquinolones with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are mild **diarrhea**, nausea, vomiting, stomach or abdominal pain, **dizziness**, drowsiness, lightheadedness, nervousness, sleep problems, and **headache**. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they are bothersome.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with a physician immediately:

- skin rash or other skin problems such as itching, peeling, hives, or redness
- **fever**
- agitation or confusion
- hallucinations
- shakiness or **tremors**
- seizures or convulsions
- tingling of fingers or toes
- pain where the medicine was injected (lasting after the injection)
- pain in the calves, spreading to the heels
- swelling of the calves or lower legs
- swelling of the face or neck
- swallowing problems
- rapid heartbeat
- shortness of breath
- loss of consciousness

Other rare side effects may occur. Anyone who has unusual symptoms after taking fluoroquinolones should get in touch with his or her physician.

Interactions

Fluoroquinolones may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes fluoroquinolones should let the physician know all other medicines he or she is taking. Among the drugs that may interact with fluoroquinolones are:

- antacids that contain aluminum, calcium, or magnesium
- medicines that contain iron or zinc, including multivitamin and mineral supplements
- sucralfate (Carafate)
- caffeine
- blood thinning drugs such as warfarin (Coumadin)
- airway opening drugs (**bronchodilators**) such as aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (choledyl and other brands)
- didanosine (Videx), used to treat HIV infection.

The list above does not include every drug that may interact with fluoroquinolones. Be sure to check with a physician or pharmacist before combining fluoroquinolones with any other prescription or nonprescription (over-the-counter) medicine.

Resources

OTHER

"Fluoroquinolones (Systemic)." National Library of medicine. <http://www.nlm.nih.gov/medlineplus/druginfo/fluoroquinolonessystemic202656.html>.

Rosalyn Carson-DeWitt

Fluoxetine *see* **Selective serotonin reuptake inhibitors**

Flurbiprofen *see* **Nonsteroidal anti-inflammatory drugs**

Focal glomeruloscle *see* **Nephrotic syndrome**

Folic acid

Definition

Folic acid is a water-soluable vitamin belonging to the B-complex group of **vitamins**. These vitamins help the body break down complex carbohydrates into simple sugars to be used for energy. Excess B vitamins are excreted from the body rather than stored for later use. This is why sufficient daily intake of folic acid is necessary.

Description

Folic acid is also known as folate, or folacin. It is one of the nutrients most often found to be deficient in the Western diet, and there is evidence that deficiency is a problem on a worldwide scale. Folic acid is found in leafy green vegetables, beans, peas and lentils, liver, beets, brussel sprouts, poultry, nutritional yeast, tuna, wheat germ, mushrooms, oranges, asparagus, broccoli, spinach, bananas, strawberries, and cantaloupes. In 1998, the U.S. Food and Drug Administration (FDA) required food manufacturers to add folic acid to enriched bread and grain products to boost intake and to help prevent neural tube defects (NTD).

Purpose

Folic acid works together with vitamin B_{12} and vitamin C to metabolize protein in the body. It is important for the formation of red and white blood cells. It is necessary for the proper differentiation and growth of cells and for the development of the fetus. It is also used to form the nucleic acid of DNA and RNA. It increases the appetite and stimulates the production of stomach acid for digestion and it aids in maintaining a healthy liver. A deficiency of folic acid may lead to anemia, in which there is decreased production of red blood cells. This reduces the amounts of oxygen and nutrients that are able to get to the tissues. Symptoms may include **fatigue**, reduced secretion of digestive acids, confusion, and forgetfulness. During **pregnancy**, a folic acid deficiency may lead to preeclampsia, premature birth, and increased bleeding after birth.

People who are at high risk of strokes and heart disease may greatly benefit by taking folic acid supplements. An elevated blood level of the amino acid homocysteine has been identified as a risk factor for some of these diseases. High levels of homocysteine have also been found to contribute to problems with **osteoporosis**. Folic acid, together with vitamins B_6 and B_{12}, helps break down homocysteine, and may help reverse the problems associated with elevated levels.

Pregnant women have an increased need for folic acid, both for themselves and their child. Folic acid is necessary for the proper growth and development of the fetus. Adequate intake of folic acid is vital for the prevention of several types of **birth defects**, particularly NTDs. The neural tube of the embryo develops into the brain, spinal cord, spinal column, and the skull. If this tube forms incompletely during the first few months of pregnancy a serious, and often fatal, defect results in **spina bifida** or anencephaly. Folic acid, taken from one year to one month before conception through the first four months of pregnancy, can reduce the risk of NTDs by 50–70%. It also helps prevent a **cleft lip and palate**.

Research shows that folic acid can be used to successfully treat cervical dysplasia, a condition diagnosed by a Pap smear, of having abnormal cells in the cervix. This condition is considered to be a possible precursor to **cervical cancer**, and is diagnosed as an abnormal Pap smear. Daily consumption of 1,000 mcg of folic acid for three or more months has resulted in improved cervical cells upon repeat Pap smears.

Studies suggest that long-term use of folic acid supplements may also help prevent lung and **colon cancer**. Researchers have also found that alcoholics who have low folic acid levels face a greatly increased possibility of developing colon **cancer**.

Preparations

To correct a folic acid deficiency, supplements are taken in addition to food. Since the functioning of the B vitamins is interrelated, it is generally recommended that the appropriate dose of B-complex vitamins be taken in place of single B vitamin supplements. The Recommended Dietary Allowances (RDA) for folate is 400 mcg per day for adults, 600 mcg per day for pregnant women, and 500 mcg for nursing women. Medicinal dosages of up to 1,000-2,000 mcg per day may be prescribed.

Precautions

Folic acid is not stable. It is easily destroyed by exposure to light, air, water, and cooking. Therefore, the supplement should be stored in a dark container in a cold, dry place, such as a refrigerator. Many medications interfere with the body's absorption and use of folic acid. This includes sulfa drugs, sleeping pills, estrogen, anticonvulsants, birth control pills, **antacids**, quinine, and

KEY TERMS

Homocysteine—An amino aid involved in the breakdown and absorption of protein in the body.

Preeclampsia—A serious disorder of late pregnancy in which the blood pressure rises, there is a large amount of retained fluids, and the kidneys become less effective and excrete proteins directly into the urine.

Raynaud's disease—A symptom of various underlying conditions affecting blood circulation in the fingers and toes and causing them to be sensitive to cold.

Recommended Daily Allowance (RDA)—Guidelines for the amounts of vitamins and minerals necessary for proper health and nutrition established by the National Academy of Sciences in 1989.

Water-soluble vitamins—Vitamins that are not stored in the body and are easily excreted. They must, therefore, be consumed regularly as foods or supplements to maintain health.

some **antibiotics**. Using large amounts of folic acid (e.g., over 5,000 mcg per day) can mask a vitamin B_{12} deficiency and thereby risk of irreversible nerve damage.

Side effects

At levels of 5,000 mcg or less, folic acid is generally safe for use. Side effects are uncommon. However, large doses may cause nausea, decreased appetite, bloating, gas, decreased ability to concentrate, and **insomnia**. Large doses may also decrease the effects of phenytoin (Dilantin), a seizure medication.

Interactions

As with all B-complex vitamins, it is best to take folic acid with the other B vitamins. Vitamin C is important to the absorption and functioning of folic acid in the body.

Resources

BOOKS

Braverman, Eric R., M.D., Carl C. Pfeiffer, M.D., Ph.D., Ken Blum, Ph.D., and Richard Smayda, D.O. *The Healing Nutrients Within*. New Canaan, CT: Keats Publishing, 1997.

Kirschmann, John D. and Gayla J. Kirschmann. *Nutrition Almanac*. New York: McGraw-Hill, 1996.

PERIODICALS

Fallest-Strobl, Patricia, Ph.D., David Koch, James Stein, and Patrick McBride. "Homocysteine: A New Risk Factor for Atherosclerosis." *American Family Physician* (October 15, 1997): 1607-14.

Giovannuci, Edward, et al. "Alcohol, low-methionine-low-folate diets, and risk of colon cancer in men." *Journal of the National Cancer Institute* (February 15, 1995): 265-73.

Shaw, Gary M., et al. "Risks of orofacial clefts in children born to women using multivitamins containing folic acid periconceptually." *The Lancet* (August 12, 1995): 393-96.

ORGANIZATIONS

Centers for Disease Control and Prevention. 4770 Buford Highway NE, MSF-45, Atlanta, GA 30341-3724. (888)232-6789. Flo@cdc.gov. <http://www.cdc.gov/nceh/programs/cddh/folic/folicfaqs.htm>.

OTHER

Adams, Suzanne L. *The Art of Cytology: Folic Acid/ B-12 Deficiency* suzann@concetric.net. <http://www.concentric.net/~Suza2/page22.htm>.

"Folic Acid." <http://www.cybervitamins.com/folicacid.htm>.

"Folic Acid: Coming to A Grocery Store Near You." <http://www.mayohealth.org/mayo/9710/htm/folic.htm>.

"Folic acid (oral/injectible)." Dr. Koop.com.Inc. 700 N. Mopac, Suite 400, Austin, TX 48731. <http://www.drkoop.com/hcr/drugstore/pharmacy/leaflets/english/d00241a1.asp.

Pregnancy and Nutrition Update. <http://www.mayohealth.org/mayo/9601/htm/pregvit.htm>.

Patience Paradox

Folic acid deficiency anemia

Definition

Folic acid deficiency, an abnormally low level of one of the B **vitamins**, results in anemia characterized by red blood cells that are large in size but few in number.

Description

Folic acid is necessary for growth and cellular repair, since it is a critical component of DNA and RNA as well as essential for the formation and maturation of red blood cells. Folic acid deficiency is one of the most common of all vitamin deficiencies. Although it occurs in both males and females, folic acid deficiency anemia most often affects women over 30. It becomes increasingly common as age impedes the body's ability to absorb folic acid, a water-soluble vitamin that is manufactured by intestinal bacteria and stored for a short time in the liver. Folic acid deficiency has also been implicat-

ed as a cause of neural tube defects in the developing fetus. Recent research has shown that adequate amounts of folic acid can prevent up to half of these **birth defects**, if women start taking folic acid supplements shortly before conception.

A healthy adult needs at least 400 mcg of folic acid every day. Requirements at least double during **pregnancy**, and increase by 50% when a woman is breastfeeding. The average American diet, high in fats, sugar, and white flour, provides about 200 mcg of folic acid, approximately the amount needed to maintain tissue stores of the substance for six to nine months before a deficiency develops. Most of the folic acid in foods (with the exception of the folic acid added to enriched flour and breakfast cereals) occurs as folate. Folate is only about half as available for the body to use as is the folic acid in pills and supplements. Folate also is easily destroyed by sunlight, overcooking, or the storing of foods at room temperature for an extended period of time.

Good dietary sources of folate include:

- leafy green vegetables
- liver
- mushrooms
- oatmeal
- peanut butter
- red beans
- soy
- wheat germ

Causes and symptoms

This condition usually results from a diet lacking in foods with high folic acid content, or from the body's inability to digest foods or absorb foods having high folic acid content. Other factors that increase the risk of developing folic acid deficiency anemia are:

- age
- alcoholism
- birth-control pills, anticonvulsant therapy, sulfa **antibiotics**, and certain other medications
- illness
- smoking
- stress

Fatigue is often the first sign of folic acid deficiency anemia. Other symptoms include:

- anorexia nervosa
- pale skin
- paranoia
- rapid heart beat
- sore, inflamed tongue
- weakness
- weight loss

Diagnosis

Diagnostic procedures include blood tests to measure hemoglobin, an iron-containing compound that carries oxygen to cells throughout the body. Symptoms may be reevaluated after the patient has taken prescription folic acid supplements.

Treatment

Folic acid supplements are usually prescribed, and self-care includes avoiding:

- alcohol
- non-herbal tea, **antacids**, and phosphates (contained in beer, ice cream, and soft drinks), which restrict iron absorption
- tobacco

A person with folic acid deficiency anemia should rest as often as necessary until restored energy levels make it possible to resume regular activities. A doctor should be seen if **fever**, chills, muscle aches, or new symptoms develop during treatment, or if symptoms do not improve after two weeks of treatment.

Alternative treatment

Alternative therapies for folic acid deficiency anemia may include **reflexology** concentrated on areas that influence the liver and spleen. Increasing consumption of foods high in folate is helpful. Eating a mixture of yogurt (8 oz) and turmeric (1 tsp) also may help resolve symptoms. A physician should be contacted if the tongue becomes slick or smooth or the patient:

- bruises or tires easily
- feels ill for more than five days
- feels weak or out of breath
- looks pale or jaundiced

Prognosis

Although adequate folic acid intake usually cures this condition in about three weeks, folic acid deficiency anemia can make patients infertile or more susceptible to infection. Severe deficiencies can result in congestive **heart failure**.

Prevention

Eating raw or lightly cooked vegetables every day will help maintain normal folic acid levels, as will taking a folic acid supplement containing at least 400 mcg of this vitamin. Because folic acid deficiency can cause birth defects, all women of childbearing age who can become pregnant should consume at least 400 mcg of folic acid daily; a woman who is pregnant should have regular medical checkups, and take a good prenatal vitamin.

Resources

BOOKS

New Choices in Natural Healing. Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

OTHER

"Folic-Acid Deficiency Anemia." *ThriveOnline*. 6 Apr. 1998 <http://thriveonline.oxygen.com>.

"Gastrointestinal Disorders: Malabsorption Syndromes." *The Meck Page*. 13 Apr. 1998 <http://www.merck.com>.

Maureen Haggerty

Follicle-stimulating hormone test

Definition

The follicle-stimulating hormone (FSH) test measures the amount of FSH in the blood. FSH is a hormone that regulates the growth and development of eggs and sperm, and this test is used to diagnose or evaluate disorders involving the pituitary gland and reproductive system.

Purpose

FSH testing is performed if a physician suspects the patient may have a disorder involving the reproductive system or pituitary gland. The pituitary gland produces FSH, which stimulates the growth of the sacks (follicles) that surround the eggs in a woman's ovaries. This is important for the process of ovulation, in which the egg is released. In men, FSH stimulates production of sperm. If there are abnormal levels of FSH in the blood it may mean that one of several disorders are present. Normal fluctuations occur as a result of **puberty**, the menstrual cycle, **pregnancy**, and **menopause**.

The FSH test is performed more often on women than on men. In women, it is used to determine if menopause has begun, to diagnose **infertility** and **menstrual disorders** (such as anovulatory bleeding), to measure hormone levels in children who enter puberty at an early age, and to diagnose other disorders. In men, it can be used to determine early puberty, abnormal tissue growth on one or more of the hormone-secreting (endocrine) glands (called multiple endocrine neoplasia), or to diagnose other disorders.

Description

The FSH test is a blood test. Blood will be drawn from the patient and analyzed in a laboratory.

Preparation

In preparation for the test, there are no food or fluid intake restrictions. Patients may be advised to discontinue certain medications for 48 hours before the test. A menstruating woman having hot flashes or irregular periods should be tested on the second or third day of her menstrual cycle. A woman who has missed a period and is having other menopausal symptoms can be tested at any time.

Aftercare

No aftercare is necessary.

Risks

There are no risks associated with this test.

Normal results

Normal FSH test results vary according to age and sexual maturity. The phase of a woman's menstrual cycle or use of birth-control pills also affects test results.

For an adult male, normal results range from about 4–25 units of FSH in every liter of blood (U/L) or about 5–20 micro-international units in every milliliter.

For a premenopausal woman, normal values range from 4–30 U/L or 5–20 micro-international units per milliliter. In a pregnant woman, FSH levels are too low to measure. After menopause, normal values range from 40–250 U/L or 50–100 micro-international units per milliliter.

FSH levels fluctuate during premenopause. If no other symptoms are present, an elevated FSH level should not be interpreted as proof that menopause has begun.

Abnormal results

Anorexia nervosa and disorders of the hypothalamus or pituitary gland can result in abnormally low FSH levels.

Abnormal levels can also indicate:

- infertility
- hypopituitarism
- klinefelter syndrome (in men)

KEY TERMS

Anovulatory bleeding—Bleeding without release of an egg from an ovary.

Hypopituitarism—Underactivity of the pituitary gland.

Hypothalamus—The part of the brain that controls the endocrine system.

Klinefelter's syndrome—Chromosomal abnormality characterized by small testes and male infertility.

Multiple endocrine neoplasia—Abnormal tissue growth on one or more of the endocrine (hormone-secreting) glands.

Polycystic ovary disease—A condition in which a woman has little or no menstruation, is infertile, has excessive body hair, and is obese. The ovaries may contain several cysts.

Turner syndrome—Chromosomal abnormality characterized by immature reproductive organs in women.

- turner syndrome
- ovarian failure
- polycystic ovary syndrome

Resources

BOOKS

Everything You Need to Know About Medical Tests. Ed. Michael Shaw, et al. Springhouse, PA: Springhouse Corporation, 1996.

OTHER

"Follicle-Stimulating Hormone Test." *ThriveOnline*. 24 Feb. 1998 <http://thriveonline.oxygen.com>.

"Follicle-Stimulating Hormone Test." *HealthAnswers.com* 25 Feb. 1998 <http://www.healthanswers.com>.

Maureen Haggerty

Follicular cysts *see* **Ovarian cysts**

Folliculitis

Definition

Folliculitis is inflammation or infection of one or more hair follicles (openings in the skin that enclose hair).

Description

Folliculitis can affect both women and men at any age. It can develop on any part of the body, but is most likely to occur on the scalp, face, or parts of the arms, armpits, or legs not usually covered by clothing.

Small, yellowish-white blister-like lumps (pustules) surrounded by narrow red rings are usually present with both bacterial folliculitis and fungal folliculitis. Hair can grow through or alongside of the pustules, which sometimes ooze blood-stained pus.

Folliculitis can cause **boils** and, in rare instances, serious skin infections. Bacteria from folliculitis can enter the blood stream and travel to other parts of the body.

Causes and symptoms

Folliculitis develops when bacteria, such as *Staphylococcus,* or a fungus enters the body through a cut, scrape, surgical incision, or other break in the skin near a hair follicle. Scratching the affected area can trap fungus or bacteria under the fingernails and spread the infection to hair follicles on other parts of the body.

The bacteria that cause folliculitis are contagious. A person who has folliculitis can infect others who live in the same household.

Factors that increase the risk of developing folliculitis include:

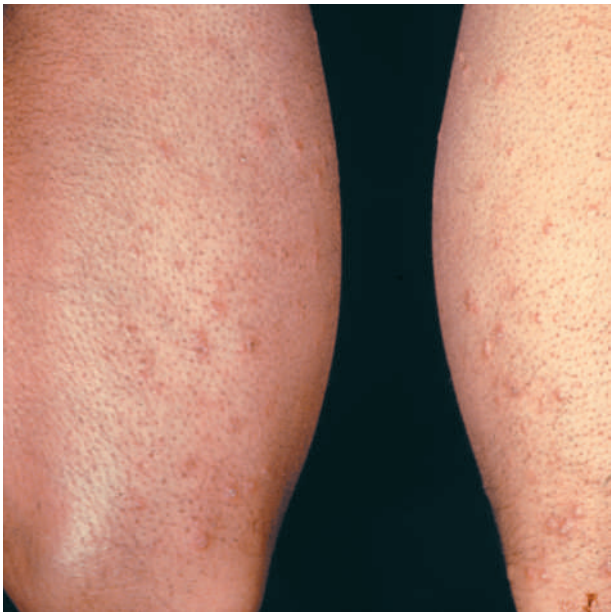
- dermatitis
- diabetes
- dirty, crowded living conditions
- eczema
- exposure to hot, humid temperatures
- infection in the nose or other recent illness
- tight clothing

Diagnosis

Diagnosis is based on the patient's medical history and observations. Laboratory analysis of the substance drained from a pustule can be used to distinguish bacterial folliculitis from fungal folliculitis.

Treatment

Bacterial folliculitis may disappear without treatment, but is likely to recur. Non-prescription topical **antibiotics** like Bacitracin, Mycitracin, or Neomycin, gently rubbed on to affected areas three or four times a day, can clear up a small number of bacterial folliculitis pustules. Oral antibiotics such as erythromycin (Ery-



Acne folliculitis. *(Custom Medical Stock Photo. Reproduced by permission.)*

thocin) may be prescribed if the infection is widespread. The drug griseofulvin (Fulvicin) and topical antifungal medications are used to treat fungal folliculitis.

A doctor should be notified if:

- pustules spread after treatment has begun or reappear after treatment is completed
- the patient's **fever** climbs above 100°F (37.8°C)
- the patient develops boils or swollen ankles
- redness, swelling, warmth, or **pain** indicate that the infection has spread
- unexplained new symptoms appear

Alternative treatment

Eating a balanced diet, including protein, complex carbohydrates, healthy fats, fresh fruits and vegetables, and drinking eight to 10 glasses of water a day may stimulate the body's immune system and shorten the course of the infection. Garlic (*Allium sativum*) and goldenseal (*Hydrastis canadensis*), both antiseptic agents against staph infections, may be taken. The daily dosage would vary from person to person and is based on the severity of the infection. **Echinacea** (*Echinacea* spp.) is helpful in modulating immune function. Again, the dosage would vary.

Daily doses of 30–50 mg zinc and 1,000–5,000 mg Vitamin C (taken in equal amounts at several times during the day), and 300–2,000 mg bioflavinoids can also strengthen the body's infection-fighting ability. High doses of **vitamins** and **minerals** should not be used without a doctor's approval.

Prognosis

If properly treated, the symptoms of bacterial folliculitis generally disappear in about two weeks. Fungal folliculitis should clear up within six weeks. But it can worsen if the condition is misdiagnosed and inappropriately treated with steroid creams.

Prevention

Anyone who has a tendency to develop folliculitis should cleanse the skin with antibacterial soap twice a day and before shaving and should not use oily skin lotions. Men should not shave while the beard area is infected. When they begin shaving again, they should use a new blade each time. Women who have had fungal folliculitis should use depilatory creams instead of razors. Daily shampooing can help prevent folliculitis in the scalp. The spread of infection can be prevented by not sharing towels or washcloths

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

OTHER

"Bacterial folliculitis." *ThriveOnline*. 5 Apr. 1998 <http://thriveonline.oxygen.com>.

"Folliculitis." *ThriveOnline*. 5 Apr. 1998 <http://thriveonline.oxygen.com>.

"Fungal Folliculitis." *ThriveOnline*. 5 Apr. 1998 <http://thriveonline.oxygen.com>.

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Foot acupressure *see* **Reflexology**

Food poisoning

Definition

Food **poisoning** is a general term for health problems arising from eating contaminated food. Food may be contaminated by bacteria, viruses, environmental toxins, or toxins present within the food itself, such as the poisons in some mushrooms or certain seafood. Symptoms of food poisoning usually involve nausea, vomiting

and/or **diarrhea**. Some food-borne toxins can affect the nervous system.

Description

Every year millions of people suffer from bouts of vomiting and diarrhea each year that they blame on "something I ate." These people are generally correct. Each year in the United States, one to two bouts of diarrheal illness occur in every adult. The Centers for Disease Control and Prevention (CDC) estimates that there are from six to 33 million cases of food poisoning in the United States annually. Many cases are mild and pass so rapidly that they are never diagnosed. Occasionally a severe outbreak creates a newsworthy public health hazard.

Classical food poisoning, sometimes incorrectly called ptomaine poisoning, is caused by a variety of different bacteria. The most common are *Salmonella*, *Staphylococcus aureus*, ***Escherichia coli*** O157:H7 or other E. coli strains, *Shigella*, and *Clostridium botulinum*. Each has a slightly different incubation period and duration, but all except *C. botulinum* cause inflammation of the intestines and diarrhea. Sometimes food poisoning is called bacterial **gastroenteritis** or infectious diarrhea. Food and water can also be contaminated by viruses (such as the Norwalk agent that causes diarrhea and the viruses of **hepatitis A** and E), environmental toxins (heavy metals), and poisons produced within the food itself (**mushroom poisoning** or **fish and shellfish poisoning**).

Careless food handling during the trip from farm to table creates conditions for the growth of bacteria that make people sick. Vegetables that are eaten raw, such as lettuce, may be contaminated by bacteria in soil, water, and dust during washing and packing. Home canned and commercially canned food may be improperly processed at too low a temperature or for too short a time to kill the bacteria.

Raw meats carry many food-borne bacterial diseases. The United States Food and Drug Administration (FDA) estimates that 60% or more of raw poultry sold at retail carry some disease-causing bacteria. Other raw meat products and eggs are contaminated to a lesser degree. Thorough cooking kills the bacteria and makes the food harmless. However, properly cooked food can become re-contaminated if it comes in contact with plates, cutting boards, countertops, or utensils that were used with raw meat and not cleaned and sanitized.

Cooked foods can also be contaminated after cooking by bacteria carried by food handlers or from bacteria in the environment. It is estimated that 50% of healthy people have the bacteria *Staphylococcus aureus* in their nasal passages and throat, and on their skin and hair. Rubbing a runny nose, then touching food can introduce the bacteria into cooked food. Bacteria flourish at room temperature, and will rapidly grow into quantities capable of making people sick. To prevent this growth, food must be kept hot or cold, but never just warm.

Although the food supply in the United States is probably the safest in the world, anyone can get food poisoning. Serious outbreaks are rare. When they occur, the very young, the very old, and those with immune system weaknesses have the most severe and life-threatening cases. For example, this group is 20 times more likely to become infected with the *Salmonella* bacteria than the general population.

Travel outside the United States to countries where less attention is paid to sanitation, water purification, and good food handling practices increases the chances that a person will get food poisoning. People living in institutions such as nursing homes are also more likely to get food poisoning.

Causes and symptoms

The symptoms of food poisoning occur because food-borne bacteria release toxins or poisons as a byproduct of their growth in the body. These toxins (except those from *C. botulinum*) cause inflammation and swelling of the stomach, small intestine and/or large intestine. The result is abdominal muscle cramping, vomiting, diarrhea, **fever**, and the chance of **dehydration**. The severity of symptoms depends on the type of bacteria, the amount consumed, and the individual's general health and sensitivity to the bacterial toxin.

Salmonella

According to a 2001 report from the CDC, *Salmonella* caused almost 50,000 culture-confirmed cases of food poisoning in the United States annually. However, between two and four million probably occur each year. *Salmonella* is found in egg yolks from infected chickens, in raw and undercooked poultry and in other meats, dairy products, fish, shrimp, and many more foods. The CDC estimates that one out of every 50 consumers is exposed to a contaminated egg yolk each year. However, thorough cooking kills the bacteria and makes the food harmless. *Salmonella* is also found in the feces of pet reptiles such as turtles, lizards, and snakes.

About one out of every 1,000 people get food poisoning from *Salmonella*. Of these, two-thirds are under age 20, with the majority under age nine. Most cases occur in the warm months between July and October.

Symptoms of food poisoning begin eight to 72 hours after eating food contaminated with *Salmonella*. These include traditional food poisoning symptoms of abdomi-

nal **pain**, diarrhea, vomiting, and fever. The symptoms generally last one to five days. Dehydration can be a complication in severe cases. People generally recover without antibiotic treatment, although they may feel tired for a week after the active symptoms subside.

Staphylococcus aureus

Staphylococcus aureus is found on humans and in the environment in dust, air, and sewage. The bacteria is spread primarily by food handlers using poor sanitary practices. Almost any food can be contaminated, but salad dressings, milk products, cream pastries, and any food kept at room temperature, rather than hot or cold are likely candidates.

It is difficult to estimate the number of cases of food poisoning from *Staphylococcus aureus* that occur each year, because its symptoms are so similar to those caused by other foodborne bacteria. Many cases are mild and the victim never sees a doctor.

Symptoms appear rapidly, usually one to six hours after the contaminated food is eaten. The acute symptoms of vomiting and severe abdominal cramps without fever usually last only three to six hours and rarely more than 24 hours. Most people recover without medical assistance. Deaths are rare.

Escherichia coli (E. coli)

There are many strains of *E. coli*, and not all of them are harmful. The strain that causes most severe food poisoning is *E. coli O157:H7*. Food poisoning by *E. coli* occurs in three out of every 10,000 people. Foodborne *E. coli* is found and transmitted mainly in food derived from cows such as raw milk, raw or rare ground beef and fruit or vegetables that are contaminated.

Symptoms of food poisoning from *E. coli* are slower to appear than those caused by some of the other foodborne bacteria. *E. coli* produces toxins in the large intestine rather than higher up in the digestive system. This accounts for the delay in symptoms and the fact that vomiting rarely occurs in *E. coli* food poisoning.

One to three days after eating contaminated food, the victim with *E. coli O157:H7* begins to have severe abdominal cramps and watery diarrhea that usually becomes bloody within 24 hours. There is little or no fever, and rarely does the victim vomit. The bloody, watery diarrhea lasts from one to eight days in uncomplicated cases.

Campylobacter jejuni (C. jejuni)

According to the FDA, *C. jejuni* is the leading cause of bacterial diarrhea in the United States. It is responsible for more cases of bacterial diarrhea than *Shigella* and *Salmonella* combined. Anyone can get food poisoning from *C. jejuni*, but children under five and young adults between the ages of 15 and 29 are more frequently infected.

C. jejuni is carried by healthy cattle, chickens, birds, and flies. It is not carried by healthy people in the United States or Europe. The bacteria is also found ponds and stream water. The ingestion of only a few hundred *C. jejuni* bacteria can make a person sick.

Symptoms of food poisoning begin two to five days after eating food contaminated with *C. jejuni*. These symptoms include fever, abdominal pain, nausea, **headache**, muscle pain, and diarrhea. The diarrhea can be watery or sticky and may contain blood. Symptoms last from seven to 10 days, and relapses occur in about one quarter of people who are infected. Dehydration is a common complication. Other complications such as arthritis-like joint pain and **hemolytic-uremic syndrome** (HUS) are rare.

Shigella

Shigella is a common cause of diarrhea in travelers to developing countries. It is associated with contaminated food and water, crowded living conditions, and poor sanitation. The bacterial toxins affect the small intestine.

Symptoms of food poisoning by *Shigella* appear 36–72 hours after eating contaminated food. These symptoms are slightly different from those associated with most foodborne bacteria. In addition to the familiar watery diarrhea, nausea, vomiting, abdominal cramps, chills and fever occur. The diarrhea may be quite severe with cramps progressing to classical dysentery. Up to 40% of children with severe infections show neurological symptoms. These include seizures caused by fever, confusion, headache, lethargy, and a stiff neck that resembles **meningitis**.

The disease runs its course usually in two to three days but may last longer. Dehydration is a common complication. Most people recover on their own, although they may feel exhausted, but children who are malnourished or have weakened immune systems may die.

Clostridium botulinum (C. botulinum)

C. botulinum, which causes both adult **botulism** and infant botulism, is unlike any of the other foodborne bacteria. First, *C. botulinum* is an anaerobic bacterium in that it can only live in the absence of oxygen. Second, the toxins from *C. botulinum* are neurotoxins. They poison the nervous system, causing **paralysis** without the vomiting and diarrhea associated with other foodborne illnesses. Third, toxins that cause adult botulism are released when the bacteria grows in an airless environment outside the body. They can be broken down and made harm-

less by heat. Finally, botulism is much more likely to be fatal even in tiny quantities.

Adult botulism outbreaks are usually associated with home canned food, although occasionally commercially canned or vacuum packed foods are responsible for the disease. *C. botulinum* grows well in non-acidic, oxygen-free environments. If food is canned at too low heat or for too brief a time, the bacteria is not killed. It reproduces inside the can or jar, releasing its deadly neurotoxin. The toxin can be made harmless by heating the contaminated food to boiling for ten minutes. However, even a very small amount of the *C. botulinum* toxin can cause serious illness or **death**.

Symptoms of adult botulism appear about 18–36 hours after the contaminated food is eaten, although there are documented times of onset ranging from four hours to eight days. Initially a person suffering from botulism feels weakness and **dizziness** followed by double vision. Symptoms progress to difficulty speaking and swallowing. Paralysis moves down the body, and when the respiratory muscles are paralyzed, death results from asphyxiation. People who show any signs of botulism poisoning must receive immediate emergency medical care to increase their chance of survival.

Infant botulism is a form of botulism first recognized in 1976. It differs from food-borne botulism in its causes and symptoms. Infant botulism occurs when a child under the age of one year ingests the spores of *C. botulinum*. These spores are found in soil, but a more common source of spores is honey.

The *C. botulinum* spores lodge in the baby's intestinal tract and begin to grow, producing their neurotoxin. Onset of symptoms is gradual. Initially the baby is constipated. This is followed by poor feeding, lethargy, weakness, drooling, and a distinctive wailing cry. Eventually, the baby loses the ability to control its head muscles. From there the paralysis progresses to the rest of the body.

Diagnosis

One important aspect of diagnosing food poisoning is for doctors to determine if a number of people have eaten the same food and show the same symptoms of illness. When this happens, food poisoning is strongly suspected. The diagnosis is confirmed when the suspected bacteria is found in a **stool culture** or a fecal smear from the person. Other laboratory tests are used to isolate bacteria from a sample of the contaminated food. Botulism is usually diagnosed from its distinctive neurological symptoms, since rapid treatment is essential. Many cases of food poisoning go undiagnosed, since a definite diagnosis is not necessary to effectively treat the symptoms. Because it takes time for symptoms to develop, it is not necessarily the most recent food one has eaten that is the cause of the symptoms.

Common Pathogens Causing Food Poisoning

Pathogen	Common Host(s)
Campylobacter	Poultry
E.coli 0157:H7	Undercooked, contaminated ground beef
Listeria	Found in a variety of raw foods, such as uncooked meats and vegetables, and in processed foods that become contaminated after processing
Salmonella	Poultry, eggs, meat, and milk
Shigella	This bacteria is transmitted through direct contact with an infected person or from food or water that become contaminated by an infected person
Vibrio	Contaminated seafood

Treatment

Treatment of food poisoning, except that caused by *C. botulinum,* focuses on preventing dehydration by replacing fluids and electrolytes lost through vomiting and diarrhea. Electrolytes are salts and **minerals** that form electrically charges particles (ions) in body fluids. Electrolytes are important because they control body fluid balance and are important for all major body reactions. Pharmacists can recommend effective, pleasant-tasting, electrolytically balanced replacement fluids that are available without a prescription. When more fluids are being lost than can be consumed, dehydration may occur. Dehydration more likely to happen in the very young, the elderly, and people who are taking **diuretics**. To prevent dehydration, a doctor may give fluids intravenously.

In very serious cases of food poisoning, medications may be given to stop abdominal cramping and vomiting. Anti-diarrheal medications are not usually given. Stopping the diarrhea keeps the toxins in the body longer and may prolong the infection.

People with food poisoning should modify their diet. During period of active vomiting and diarrhea they should not try to eat and should drink only clear liquids frequently but in small quantities. Once active symptoms stop, they should eat bland, soft, easy to digest foods for two to three days. One example is the BRAT diet of bananas, rice, applesauce, and toast, all of which are easy to digest. Milk products, spicy food, alcohol and fresh fruit should be avoided for a few days, although babies should continue to breastfeed. These modifications are often all the treatment that is necessary.

Severe bacterial food poisonings are sometimes treated with **antibiotics**. Trimethoprim and sulfamethox-

KEY TERMS

Diuretic—Medication that increases the urine output of the body.

Electrolytes—Salts and minerals that produce electrically charged particles (ions) in body fluids. Common human electrolytes are sodium chloride, potassium, calcium, and sodium bicarbonate. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost all major biochemical reactions in the body.

Lactobacillus acidophilus—This bacteria is found in yogurt and changes the balance of the bacteria in the intestine in a beneficial way.

Platelets—Blood cells that help the blood to clot.

azole (Septra, Bactrim), ampicillin (Amcill, Polycill) or ciprofloxacin (Ciloxan, Cipro) are most frequently used.

Botulism is treated in a different way from other bacterial food poisonings. Botulism antitoxin is given to adults, but not infants, if it can be administered within 72 hours after symptoms are first observed. If given later, it provides no benefit.

Both infants and adults require hospitalization, often in the intensive care unit. If the ability to breathe is impaired, patients are put on a mechanical ventilator to assist their breathing and are fed intravenously until the paralysis passes.

Alternative treatment

Alternative practitioners offer the same advice as traditional practitioners concerning diet modification. In addition they recommend taking charcoal tablets, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, and citrus seed extract. An electrolyte replacement fluid can be made at home by adding one teaspoon of salt and four teaspoons of sugar to one quart of water. For food poisoning other than botulism, two homeopathic remedies, either *Arsenicum album* or *Nux vomica*, are strongly recommended.

Prognosis

Most cases of food poisoning (except botulism) clear up on their own within one week without medical assistance. The ill person may continue feel tired for a few days after active symptoms stop. So long as the ill person does not become dehydrated, there are few complications. Deaths are rare and usually occur in the very young, the very old and people whose immune systems are already weakened.

Complications of *Salmonella* food poisoning include arthritis-like symptoms that occur three to four weeks after infection. Although deaths from *Salmonella* are rare, they do occur. Most deaths caused by *Salmonella* food poisoning have occurred in elderly people in nursing homes.

Adults usually recover without medical intervention, but many children need to be hospitalized as the result of *E. coli* food poisoning. *E. coli* toxins may be absorbed into the blood stream where they destroy red blood cells and platelets. Platelets are important in blood clotting. About 5% of victims develop hemolytic-uremic syndrome which results in sudden kidney failure and makes dialysis necessary. (Dialysis is a medical procedure used to filter the body's waste product when the kidneys have failed).

Botulism is the deadliest of the bacterial food-borne illnesses. With prompt medical care, the death rate is less than 10%.

Prevention

Food poisoning is almost entirely preventable by practicing good sanitation and good food handling techniques. These include:

- keep hot foods hot and cold foods cold
- cook meat to the recommended internal temperature, use a meat thermometer to check and cook eggs until they are no longer runny
- refrigerate leftovers promptly, do not let food stand at room temperature
- avoid contaminating surfaces and other foods with the juices of uncooked meats
- wash fruits and vegetables before using
- purchase pasteurized dairy products and fruit juices
- throw away bulging or leaking cans or any food that smells spoiled
- wash hands well before and during food preparation and after using the bathroom
- sanitize food preparation surfaces regularly

Resources

PERIODICALS

U. S. Food and Drug Administration. "The Unwelcome Dinner Guest: Preventing Food-Borne Illness." In *FDA Consumer* (December 1997).

ORGANIZATION

Centers for Disease Control and Prevention. <http://www.cdc.gov>.

OTHER

U. S. Food and Drug Administration. Center for Food Safety and Applied Nutrition. *Bad Bug Book*. <http://vm.cfsan.fda.gov>.

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Foot care

Definition

Foot care involves all aspects of preventative and corrective care of the foot and ankle. Doctors specializing in foot care are called podiatrists.

Purpose

During an average lifetime, each person walks about 115,000 miles and three-quarters of people have foot problems at some point in their lives.

Foot problems can arise from wearing ill-fitting shoes, from general wear and tear, as a result of injury, or as a complication of disease. People with **diabetes mellitus** or circulatory diseases are 20 times more likely to have foot problems than the general public.

Podiatrists are doctors who specialize in treating the foot and ankle. Other doctors who have experience with foot problems are family physicians, orthopedists, sports medicine specialists, and those who care for diabetics. Problems with the feet include foot **pain**, joint inflammation, plantar **warts**, fungal infections (like **athlete's foot**), nerve disorders, torn ligaments, broken bones, bacterial infections, and tissue injuries (like frostbite).

Precautions

People with diabetes or circulatory disorders should be alert to even small foot problems. In these people, a break in the skin can lead to infection, **gangrene**, and **amputation**.

Description

Daily foot care for people likely to develop foot problems includes washing the feet in tepid water with mild soap and oiling the feet with vegetable oil or a lanolin-based lotion. Toenails should be cut straight across above the level of the skin after soaking the feet in tepid water. **Corns and calluses** should not be cut. If they need removal, it should be done under the care of a doctor. Athletes foot and plantar warts should also be treated by a doctor if they develop in high risk patients.

Many people with diabetes or circulatory disorders have problems with cold feet. These problems can be reduced by avoiding **smoking** tobacco (smoking constricts the blood vessels), wearing warm socks, not crossing the legs while sitting or not sitting in one position too long, or avoiding constricting stockings.

People with circulatory problems should not use heating pads or hot water bottles on their feet, as even moderate heat can damage the skin if circulation is impaired.

Preparation

No special preparation other than an understanding of the nature of foot problems is necessary to begin routine foot care.

Aftercare

Foot care is preventative and should be ongoing throughout a person's life.

Risks

There are no risks associated with foot care. The risks are in ignoring the feet and allowing problems to develop.

Normal results

With regular care, foot disorders such as infections, skin ulcers, and gangrene can be prevented.

Resources

BOOKS

"Foot Problems." In *The Complete Guide to Symptoms, Illness and Surgery.* 3rd ed. Ed. H. Winter Griffith, et al. New York: Berkeley Publishing, 1995.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

American Podiatry Association. 20 Chevy Chase Circle, NW, Washington, D.C. 20015.

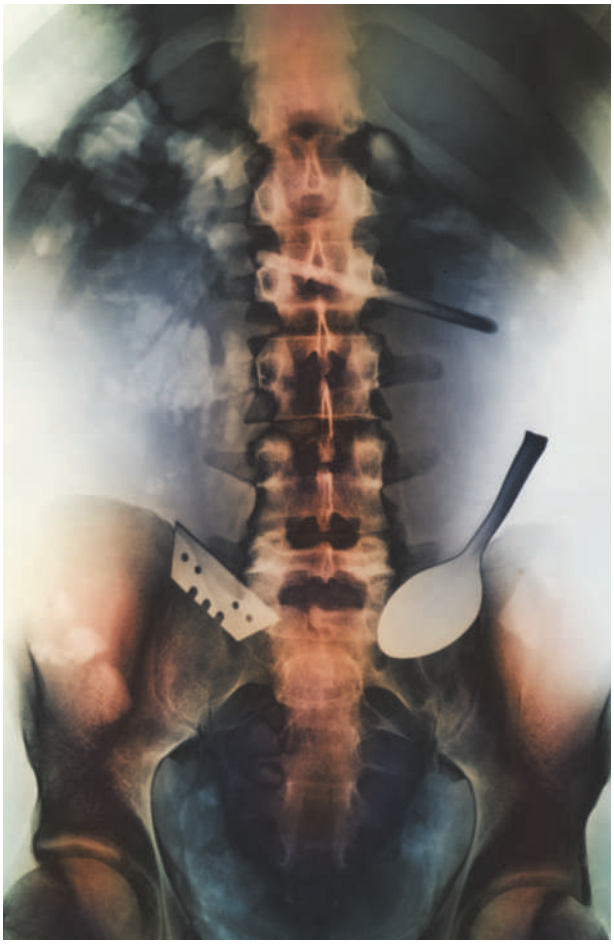
Tish Davidson

Foreign bodies *see* **Foreign objects**

Foreign objects

Definition

"Foreign" means "originating elsewhere" or simply "outside the body." Foreign bodies typically become



X ray of swallowed spoon and blade in the intestine. *(Photo Researchers. Reproduced by permission.)*

lodged in the eyes, ears, nose, airways, and rectum of human beings.

Description

Both children and adults experience problems caused by foreign objects getting stuck in their bodies. Young children, in particular, are naturally curious and may intentionally put shiny objects, such as coins or button batteries, into their mouths. They also like to stick things in their ears and up their noses. Adults may accidentally swallow a non-food object or inhale a foreign body that gets stuck in the throat. Even if an object like a toothpick successfully passes through the esophagus and into the stomach, it can get stuck inside the rectum. Airborne particles can lodge in the eyes of people at any age.

Foreign bodies can be in hollow organs (like swallowed batteries) or in tissues (like bullets). They can be inert or irritating. If they irritate they will cause inflammation and scarring. They can bring infection with them or acquire it and protect it from the body's immune defenses. They can obstruct passageways either by their size or by the scarring they cause. Some can be toxic.

Causes and symptoms

Eyes

Dust, dirt, sand, or other airborne material can lodge in the eyes, causing minor irritation and redness. More serious damage can be caused by hard or sharp objects that penetrate the surface and become embedded in the cornea or conjunctiva (the mucous membranes around the inner surface of the eyelids). Swelling, redness, bleeding from the surface blood vessels, sensitivity to light, and sudden vision problems are all symptoms of foreign matter in the eyes.

Ears and nose

Children will sometimes put things into their noses, ears, and other openings. Beans, popcorn kernels, raisins, and beads are just a few of the many items that have been found in these bodily cavities. On occasion, insects may also fly into the ears and nose. **Pain**, **hearing loss**, and a sense of something stuck in the ear are symptoms of foreign bodies in the ears. A smelly, bloody discharge from one nostril is a symptom of foreign bodies in the nose.

Airways and stomach

At a certain age children will eat anything. A very partial list of items recovered from young stomachs includes the following: Coins, chicken bones, fish bones, beads, rocks, plastic toys, pins, keys, round stones, marbles, nails, rings, batteries, ball bearings, screws, staples, washers, a heart pendant, a clothespin spring, and a toy soldier. Some of these items will pass right on through and come out the other end. The progress of metal objects has been successfully followed with a metal detector. Others, like sharp bones, can get stuck and cause trouble. Batteries are corrosive and must be removed immediately.

Children eat things and stick things into their bodily openings of their own volition. But they inhale them unwittingly. The most commonly inhaled item is probably a peanut. A crayon and a cockroach have been found in a child's windpipes. These items always cause symptoms (difficulty swallowing and spitting up saliva, for instance) and may elude detection for some time while the child is being treated for **asthma** or recurring **pneumonia**.

Adults are not exempt from unorthodox inedibles. Dental devices are commonly swallowed. Adults with mental illness or subversive motives may swallow inappropriate objects, such as toothbrushes.

Rectum

Sometimes a foreign object will successfully pass throught the throat and stomach only to get stuck at the juncture between the rectum and the anal canal. Items may also be self-introduced to enhance sexual stimulation and then get stuck. Sudden sharp pain during elimination may signify that an object is lodged in the rectum. Other symptoms vary depending upon the size of the object, its location, how long it has been in place, and whether or not infection has set in.

Diagnosis

The symptoms are as diverse as the objects and their locations. The most common manifestation of a foreign object anywhere in the body is infection. Even if the object started out sterile, germs still seem to find it and are able to hide from the body's defenses there. Blockage of passageways—breathing, digestive or excretory—is another result. Pain is common.

Treatment

Eyes

Small particles like sand may be removable without medical help, but if the object is not visible or cannot be retrieved, prompt emergency treatment is necessary. Trauma to the eyes can lead to loss of vision and should never be ignored. Before attempting any treatment, the person should move to a well-lighted area where the object can be more easily spotted. Hands should be washed and only clean, preferably sterile, materials should make contact with the eyes. If the particle is small, it can be dislodged by blinking or pulling the upper lid over the lower lid and flushing out the speck. A clean cloth can also be used to pick out the offending particle. Afterwards, the eye should be rinsed with clean, lukewarm water or an opthalmic wash.

If the foreign object cannot be removed at home, the eye should be lightly covered with sterile gauze to discourage rubbing. A physician will use a strong light and possibly special eyedrops to locate the object. Surgical tweezers can effectively remove many objects. An antibiotic sterile ointment and a patch may be prescribed. If the foreign body has penetrated the deeper layers of the eye, an opthalmic surgeon will be consulted for emergency treatment.

Ears and nose

A number of ingenious extraction methods have been devised for removing foreign objects from the nose and ears. A bead in a nostril, for example, can be popped out by blowing into the mouth while holding the other nostril closed. Skilled practitioners have removed peas from the ears by tiny improvised corkscrews; marbles by q-tips with super glue. Tweezers often work well, too. Insects can be floated out of the ear by pouring warm (not hot) mineral oil, olive oil, or baby oil into the ear canal. Items that are lodged deep in the ear canal are more difficult to remove because of the possibility of damaging the ear drum. These require emergency treatment from a qualified physician.

Airways and stomach

Mechanical obstruction of the airways, which commonly occurs when food gets lodged in the throat, can be treated by applying the **Heimlich maneuver**. If the object is lodged lower in the airway, a bronchoscope (a special instrument to view the airway and remove obstructions) can be inserted. On other occasions, as when the object is blocking the entrance to the stomach, a fiberoptic endoscope (an illuminated instrument that views the interior of a body cavity) may be used. The physician typically administers a sedative and anesthetizes the throat. The foreign object will then either be pulled out or pushed into the stomach, depending on whether or not the physician

KEY TERMS

Bronchoscope—An illuminated instrument that is inserted into the airway to inspect and retrieve objects from the bronchial tubes.

Conjunctiva—Mucous membranes around the inner surface of the eyelid.

Cornea—The rounded, transparent portion of the eye that covers the pupil and iris and lets light into the interior

Endoscopy—The surgical use of long, thin instruments that have both viewing and operating capabilities.

Heimlich maneuver—An emergency procedure for removing a foreign object lodged in the airway that is preventing the person from breathing. To perform the Heimlich maneuver on a conscious adult, the rescuer stands behind the victim and encircles his waist. The rescuer makes a fist with one hand and places the other hand on top, positioned below the rib cage and above the waist. The rescuer then applies pressure by a series of upward and inward thrusts to force the foreign object back up the victim's trachea.

thinks it will pass through the digestive tract on its own. Objects in the digestive tract that are neither irritating, sharp nor large may be followed as they continue on through. Sterile objects that are causing no symptoms may be left in place. Surgical removal of the offending object is necessary if it is causing symptoms.

Rectum

A rectal retractor can remove objects that a physician can feel during **physical examination**. Surgery may be required for objects deeply lodged within the recturm.

Prevention

Using common sense and following safety precautions are the best ways to prevent foreign objects from entering the body. For instance, parents and grandparents should toddler-proof their homes, storing batteries in a locked cabinet and properly disposing of used batteries, so they are not in a location where curious preschoolers can fish them out of a wastebasket. To minimize the chance of youngsters inhaling food, parents should not allow children to eat while walking or playing. Adults should chew food thoroughly and not talk while chewing. Many eye injuries can be prevented by wearing safety glasses while using tools

Resources

PERIODICALS

Cohen, J. S., and J. M. Sackier. "Management of colorectal foreign bodies." *Journal of the Royal College of Surgeons of Edinburgh* 41. no. 5 (Oct. 1996): 312-5.

Darrow, D. H., and L. D. Holinger. "Aerodigestive Tract Foreign Bodies in the Older Child and Adolescent." *Annals of Otology, Rhinology & Laryngology* 105, no. 4 (Apr. 1996): 267-71.

Gilchrist, B. F., et al. "Pearls and Perils in the Management of Prolonged, Peculiar, Penetrating Esophageal Foreign Bodies in Children." *Journal of Pediatric Surgery* 32, no. 10 (Oct. 1997): 1429-31.

Kadish, H. A., and H. M. Corneli "Removal of Nasal Foreign Bodies in the Pediatric Population." *American Journal of Emergency Medicine* 15, no. 1 (Jan. 1997): 54-6.

Kouraklis, G. et al. "Management of Foreign Bodies of the Rectum: Report of 21 Cases." *Journal of the Royal College of Surgeons of Edinburgh* 42, no. 4 (Aug. 1997): 246-7.

Manca, D. "Up Your Nose. Quick and Somewhat Dirty Method of Removing Foreign Bodies from Children's Noses." *Canadian Family Physician* 43 (Feb. 1997): 223.

Marlow, T. J., et al. "Endobronchial Cockroach: An Unusual Foreign Body Aspiration." *Journal of Emergency Medicine* 15, no. 4 (July/Aug. 1997): 487-9.

O'Sullivan, S. T. et al. "Deliberate Ingestion of Foreign Bodies by Institutionalised Psychiatric Hospital Patients and Prison Inmates." *Irish Journal of Medical Science* 165, no. 4 (Oct./Dec. 1996): 294-6.

Reilly, J. S., et al. "Size/Shape Analysis of Aerodigestive Foreign Bodies in Children: A Multi-institutional Study." *American Journal of Otolaryngology* 16, no. 3 (May/June 1995): 190-3.

Tidey, B., et al. "The Use of a Metal Detector to Locate Ingested Metallic Foreign Bodies in Children." *Journal of Accident & Emergency Medicine* 13, no. 5 (Sept. 1996): 341-2.

Velitchkov, N. G., et al. "Ingested Foreign Bodies of the Gastrointestinal Tract: Retrospective Analysis of 542 Cases." *World Journal of Surgery* 20, no. 8 (Oct. 1996): 1001-5.

J. Ricker Polsdorfer, MD

Fourn *see* **Flesh-eating disease**

47, XXY syndrome *see* **Klinefelter syndrome**

Fracture repair

Definition

Fracture repair is the process of rejoining and realigning the ends of broken bones. This procedure is usually performed by an orthopedist, general surgeon, or family doctor. In cases of an emergency, first aid measures should be evoked for temporary realignment and **immobilization** until proper medical help is available.

Purpose

Fracture repair is required when there is a need for restoration of the normal position and function of the broken bone. Throughout the stages of fracture healing, the bones must be held firmly in the correct position. In the event the fracture is not properly repaired, malalignment of the bone may occur, resulting in possible physical dysfunction of the bone or joint of that region of the body.

Precautions

Precautions for fracture repair are anything found to be significant with patients' medical diagnosis and history. This would include an individual's tolerance to anesthesia and the presence of bleeding disorders that may be present to complicate surgery.

Description

Fracture repair is applied by means of **traction**, surgery, and/or by immobilization of the bones. The bone fragments are aligned as close as possible to the normal position without injuring the skin. Metal wires or screws may be needed to align smaller bone fragments. Once the

broken ends of the bone are set, the affected area is immobilized for several weeks and kept rigid with a sling, plaster cast, brace or splint. With the use of traction, muscle pull on the fracture site is overcome by weights attached to a series of ropes running over pulleys. Strategically implanted electrical stimulation devices have proven beneficial in healing a fracture site, especially when the fracture is healing poorly and repair by other means is difficult.

Preparation

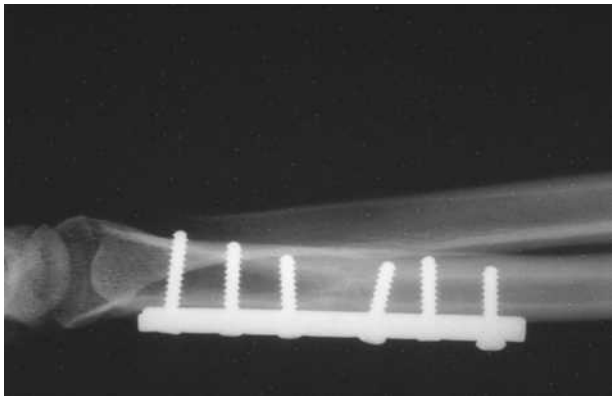
Emergency splinting may be required to immobilize the body part or parts involved. When fracture repair is necessary, the procedure is often performed in a hospital but can also be successfully done in an outpatient surgical facility, doctor's office or emergency room. Before any surgery for fracture repair, blood and urine studies may be taken from the patient. X rays may follow this if not previously acquired. It has been noted however, that not all **fractures** are immediately apparent on an initial x-ray examination. In this case, where a fracture is definitely suspected the extent of the fracture can be properly diagnosed by repeating the x rays 10–14 days later. Depending upon the situation, local or general anesthesia may be used for fracture repair.

Aftercare

After surgery, x rays may be again taken through the cast or splint to evaluate if rejoined pieces remain in good position for healing. This is usually performed either before the application of the splint or at least before the patient is awakened from the general anesthesia. The patient needs to be cautious not to place excess pressure on any part of the cast until it is completely dry. The patient also should avoid excess pressure on the operative site until complete healing has taken place and the injury has been re-examined by the physician. If the cast becomes exposed to moisture it may soften and require repair. The patient should also be instructed to keep the injured region propped up whenever possible to reduce the possibility of swelling.

Risks

Surgical risks of fracture repair are greater in patients over 60 years of age because the bones often taking longer to heal properly. **Obesity** may place extra **stress** on the healing site, affecting healing and possibly risking reinjury. **Smoking** may slow the healing process after fracture repair, as well as poor **nutrition**, **alcoholism**, and chronic illness. Some medications may affect the fracture site, causing poor union. Such medications include anti-hypertensives and cortisone.



An x-ray image of a healing fracture. *(Photograph by Bates, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

Possible complications following fracture repair include excessive bleeding, improper fit of joined bone ends, pressure on nearby nerves, delayed healing, and a permanent incomplete healing of the fracture. If there is a poor blood supply to the fractured site with one of the portions of broken bone not properly supplied by the blood, the bony portion will die and healing of the fracture will not take place. This is called aseptic necrosis. Poor immobilization of the fracture from improper casting which permits motion between the bone parts may prevent healing and repair of the bone with possible deformity. Infection can interfere with bone repair. This risk is greater in the case of a compound fracture (a bone fracture causing an open wound) where ideal conditions are present for severe streptococcal and **staphylococcal infections**. Occasionally, fractured bones in the elderly may possibly never heal properly. The risk is increased when nutrition is poor.

Normal results

Once the procedure for fracture repair is completed, the body begins to produce new tissue to bridge the broken pieces. At first, this tissue (called a callus) is soft and easily injured. Later, the body deposits bone **minerals** until the callus becomes a solid piece of bone. The fracture site is thus strengthened further with extra bone. It usually takes about six weeks for a broken bone to heal together. The exact time required for healing depends on the type of fracture and the extent of damage. Before the use of x rays, fracture repair was not always accurate, resulting in crippling deformities. With modern x-ray technology, the physician can view the extent of the fracture, check the setting following the repair, and be certain after the procedure that the bones have not moved from their intended alignment. Children's bones usually heal relatively rapidly.

KEY TERMS

Compound fracture — A fracture in which the broken end or ends of the bone have torn through the skin. Compound fractures are also known as open fractures

Staphylococcal infection—An infection caused by any of several pathogenic species of staphylococcus, commonly characterized by the formation of abscesses of the skin or other organs.

Streptococcal infection—An infection caused by a pathogenic bacteria of one of several species of the genus streptococcus or their toxins. Almost any organ in the body may be involved.

Abnormal results

Abnormal results of fracture repair include damage to nearby nerves or primary blood vessels. Improper alignment causing deformity is also an abnormal outcome, however, with today's medical technology it is relatively rare.

Resources

BOOKS

Arnheim, Daniel D. *Modern Principals of Athletic Training*. St. Louis: Times Mirror/Mosby College Publishing Co., 1989.

Magee, David J. *Orthopedic Physical Assessment*. Philidelphia: W. B. Saunders Co., 1992.

Scully, Rosemary M., and Marylou R. Barnes. *Physical Therapy*. Philadelphia: J. B. Lippincott Co., 1989.

PERIODICALS

Gorden, Everett J. "Fractures and Dislocations: An Overview." *Trauma* 37, no. 5 (Feb. 1996): 5-36.

OTHER

Griffith, H. Winter. "Fracture Repair." *ThriveOnline*. 1998. 3 Mar. 1998 <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Fractures

Definition

A fracture is a complete or incomplete break in a bone resulting from the application of excessive force.

Description

A fracture usually results from traumatic injury to bones causing the continuity of bone tissues or bony cartilage to be disrupted or broken. Fracture classifications include simple, compound, incomplete and complete. Simple fractures (more recently called "closed") are not obvious as the skin has not been ruptured and remains intact. Compound fractures (now commonly called "open") break the skin, exposing bone and causing additional soft tissue injury and possible infection. A single fracture means that one fracture only has occurred and multiple fractures refer to more than one fracture occurring in the same bone. Fractures are termed complete if the break is completely through the bone and described as incomplete or "greenstick" if the fracture occurs partly across a bone shaft. This latter type of fracture is often the result of bending or crushing forces applied to a bone.

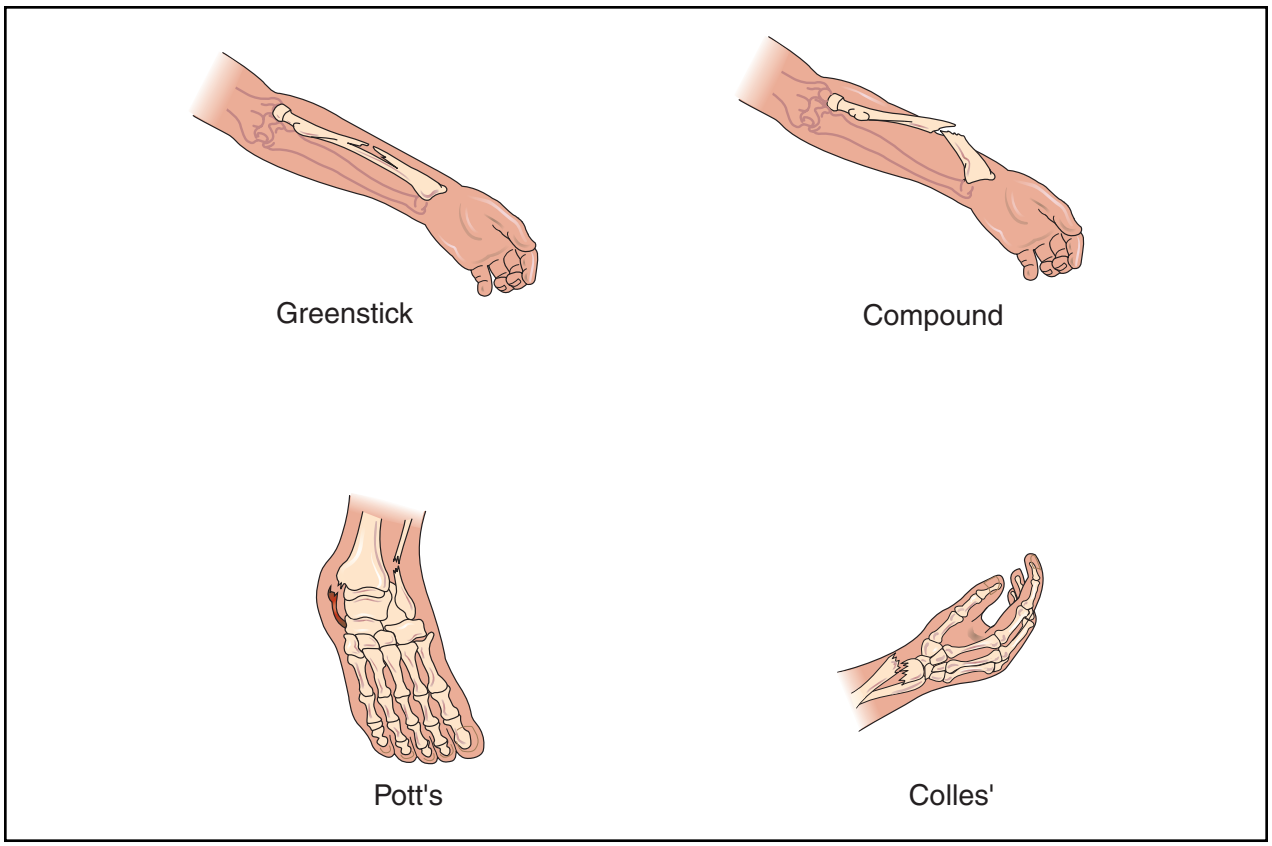
Fractures are also named according to the specific part of the bone involved and the nature of the break. Identification of a fracture line can further classify fractures. Types include linear, oblique, transverse, longitudinal, and spiral fractures. Fractures can be further subdivided by the positions of bony fragments and are described as comminuted, non-displaced, impacted, overriding, angulated, displaced, avulsed, and segmental. Additionally, an injury may be classified as a fracture-dislocation when a fracture involves the bony structures of any joint with associated dislocation of the same joint.

Fractures line identification

Linear fractures have a break that runs parallel to the bone's main axis or in the direction of the bone's shaft. For example, a linear fracture of the arm bone could extend the entire length of the bone. Oblique and transverse fractures differ in that an oblique fracture crosses a bone at approximately a 45° angle to the bone's axis. In contrast, a transverse fracture crosses a bone's axis at a 90° angle. A longitudinal fracture is similar to a linear fracture. Its fracture line extends along the shaft but is more irregular in shape and does not run parallel to the bone's axis. Spiral fractures are described as crossing a bone at an oblique angle, creating a spiral pattern. This break usually occurs in the long bones of the body such as the upper arm bone (humerus) or the thigh bone (femur).

Bony fragment position identification

Comminuted fractures have two or more fragments broken into small pieces, in addition to the upper and lower halves of a fractured bone. Fragments of bone that maintain their normal alignment following a fracture are described as being non-displaced. An impacted fracture is characterized as a bone fragment forced into or onto



Fractures usually result from a traumatic injury to a bone where the continuity of bone tissues or bony cartilage is disrupted or broken. The illustrations above feature common sites where fractures occur. *(Illustration by Electronic Illustrators Group.)*

another fragment resulting from a compressive force. Overriding is a term used to describe bony fragments that overlap and shorten the total length of a bone. Angulated fragments result in pieces of bone being at angles to each other. A displaced bony fragment occurs from disruption of normal bone alignment with deformity of these segments separate from one another. An avulsed fragment occurs when bone fragments are pulled from their normal position by forceful muscle contractions or resistance from ligaments. Segmental fragmented positioning occurs if fractures in two adjacent areas occur, leaving an isolated central segment. An example of segmental alignment is when the arm bone fractures in two separate places, with displacement of the middle section of bone.

Causes and symptoms

Individuals with high activity levels appear to be at greater risk for fractures. This group includes children and athletes participating in contact sports. Because of an increase in bone brittleness with **aging**, elderly persons are also included in this high-risk population. Up to the age of 50, more men suffer from fractures than women due to occupational hazards. However, after the age of 50, women are more prone to fractures than men. Specific diseases causing an increased risk for fractures include Paget's disease, rickets, **osteogenesis imperfecta**, **osteoporosis**, bone **cancer** and tumors, and prolonged disuse of a nonfunctional body part such as after a **stroke**.

Symptoms of fractures usually begin with **pain** that increases with attempted movement or use of the area and swelling at the involved site. The skin in the area may be pale and an obvious deformity may be present. In more severe cases, there may be a loss of pulse below the fracture site, such as in the extremities, accompanied by numbness, tingling, or **paralysis** below the fracture. An open or compound fracture is often accompanied by bleeding or bruising. If the lower limbs or pelvis are fractured, pain and resistance to movement usually accompany the injury causing difficulty with weight bearing.

Diagnosis

Diagnosis begins immediately with an individual's own observation of symptoms. A thorough medical his-

KEY TERMS

Avulsion fracture—A fracture caused by the tearing away of a fragment of bone where a strong ligament or tendon attachment forcibly pulls the fragment away from the bone tissue.

Axis—A line that passes through the center of the body or body part.

Comminuted fracture—A fracture where there are several breaks in a bone creating numerous fragments.

Compartment syndrome—Compartment syndrome is a condition in which a muscle swells but is constricted by the connective tissue around it, which cuts off blood supply to the muscle.

Contrast hydrotherapy—A series of hot and cold water applications. A hot compress (as hot as an individual can tolerate) is applied for three minutes followed by an ice cold compress for 30 seconds. These applications are repeated three times each and ending with the cold compress.

Osteogenesis imperfecta—A genetic disorder involving defective development of connective tissues, characterized by brittle and fragile bones that are easily fractured by the slightest trauma.

Osteoporosis—Literally meaning "porous bones," this condition occurs when bones lose an excessive amount of their protein and mineral content, particularly calcium. Over time, bone mass and strength are reduced leading to increased risk of fractures.

Paget's disease—Chromic disorder of unknown cause, usually affecting middle aged and elderly people, characterized by enlarged and deformed bones. Excessive breakdown and formation of bone tissue occurs with Paget's disease and can cause bone to weaken, resulting in bone pain, arthritis, deformities, and fractures.

Reduction—The restoration of a body part to its original position after displacement, such as the reduction of a fractured bone by bringing ends or fragments back into original alignment. The use of local or general anesthesia usually accompanies a fracture reduction. If performed by outside manipulation only, the reduction is described as closed; if surgery is necessary, it is described as open.

Rickets—A condition caused by the dietary deficiency of vitamin D, calcium, and usually phosphorus, seen primarily in infancy and childhood, and characterized by abnormal bone formation.

Traction—The process of placing a bone, limb, or group of muscles under tension by applying weights and pulleys. The goal is to realign or immobilize the part or to relieve pressure on that particular area to promote healing and restore function.

tory and physical exam by a physician often reveals the presence of a fracture. An x ray of the injured area is the most common test used to determine the presence of a bone fracture. Any x ray series performed involves at least two views of the area to confirm the presence of the fracture because not all fractures are apparent on a single x-ray. Some fractures are often difficult to see and may require several views at different angles to see clear fracture lines. In some cases, CT, MRI or other imaging tests are required to demonstrate fracture. Sometimes, especially with children, the initial x ray may not show any fractures but repeat x rays seven to 14 days later may show changes in the bone(s) of the affected area. If a fracture is open and occurs in conjunction with soft tissue injury, further laboratory studies are often conducted to determine if blood loss has occurred.

In the event of exercise-related **stress** fractures (micro-fractures due to excessive stress), a tuning fork can provide a simple, inexpensive test. The tuning fork is a metal instrument with a stem and two prongs that vibrate when struck. If an individual has increased pain when the tuning fork is placed on a bone, such as the tibia or shinbone, the likelihood of a stress fracture is high. Bone scans also are helpful in detecting stress fractures. In this diagnostic procedure, a radioactive tracer is injected into the bloodstream and images are taken of specific areas or the entire skeleton by CT or MRI.

Treatment

Treatment depends on the type of fracture, its severity, the individual's age and general health. The first priority in treating any fracture is to address the entire medical status of the patient. Medical personnel are trained not allow a painful, deformed limb to distract them from potentially life-threatening injury elsewhere or **shock**. If an open fracture is accompanied by serious soft tissue injury, it may be necessary to control bleeding and the shock that can accompany loss of blood.

First aid is the appropriate initial treatment in emergency situations. It includes proper splinting, control of blood loss, and monitoring vital signs such as breathing and circulation.

Immobilization

Immobilization of a fracture site can be done internally or externally. The primary goal of immobilization is to maintain the realignment of a bone long enough for healing to start and progress. Immobilization by external fixation uses splints, casts, or braces. This may be the primary and only procedure for fracture treatment. Splinting to immobilize a fracture can be done with or without **traction**. In emergency situations if the injured individual must be moved by someone other than a trained medical person, splinting is a useful form of fracture management. It should be done without causing additional pain and without moving the bone segments. In a clinical environment, plaster of Paris casts are used for immobilization. Braces are useful as they often allow movement above and below a fracture site. Treatments for stress fractures include rest and decreasing or stopping any activity that causes or increases pain.

Fracture reduction

Fracture reduction is the procedure by which a fractured bone is realigned in normal position. It can be either closed or open. Closed reduction refers to realigning bones without breaking the skin. It is performed with manual manipulation and/or traction and is commonly done with some kind of anesthetic. Open reduction primarily refers to surgery that is performed to realign bones or fragments. Fractures with little or no displacement may not require any form of reduction.

Traction is used to help reposition a broken bone. It works by applying pressure to restore proper alignment. The traction device immobilizes the area and maintains realignment as the bone heals. A fractured bone is immobilized by applying opposing force at both ends of the injured area, using an equal amount of traction and countertraction. Weights provide the traction pull needed or the pull is achieved by positioning the individual's body weight appropriately. Traction is a form of closed reduction and is sometimes used as an alternative to surgery. Since it restricts movement of the affected limb or body part, it may confine a person to bed rest for an extended period of time.

A person may need open reduction if there is an open, severe, or comminuted fracture. This procedure allows a physician to examine and surgically correct associated soft tissue damage while reducing the fracture and, if necessary, applying internal or external devices. Internal fixation involves the use of metallic devices inserted into or through bone to hold the fracture in a set position and alignment while it heals. Devices include plates, nails, screws, and rods. When healing is complete, the surgeon may or may not remove these devices. Virtually any hip fracture requires open reduction and internal fixation so that the bone will be able to support the patient's weight.

Alternative treatment

In addition to the importance of calcium for strong bones, many alternative treatment approaches recommend use of mineral supplements to help build and maintain a healthy, resilient skeleton. Some physical therapists use electro-stimulation over a fractured site to promote and expedite healing. Chinese traditional medicine may be helpful by working to reconnect chi through the meridian lines along the line of a fracture. **Homeopathy** can enhance the body's healing process. Two particularly useful homeopathic remedies are *Arnica* (*Arnica montana*) and *Symphytum* (*Symphytum officinalis*). If possible, applying contrast **hydrotherapy** to an extremity (e.g., a hand or foot) of a fractured area can assist healing by enhancing circulation.

Prognosis

Fractures involving joint surfaces almost always lead to some degree of arthritis of the joint. Fractures can normally be cured with proper first aid and appropriate aftercare. If determined necessary by a physician, the fractured site should be manipulated, realigned, and immobilized as soon as possible. Realignment has been shown to be much more difficult after six hours. Healing time varies from person to person with the elderly generally needing more time to heal completely. A non-union fracture may result when a fracture does not heal, such as in the case of an elderly person or an individual with medical complications. Recovery is complete when there is no bone motion at the fracture site, and x rays indicate complete healing. Open fractures may lead to bone infections, which delay the healing process. Another possible complication is compartment syndrome, a painful condition resulting from the expansion of enclosed tissue and that may occur when a body part is immobilized in a cast.

Prevention

Adequate calcium intake is necessary for strong bones and can help decrease the risk of fractures. People who do not get enough calcium in their **diets** can take a calcium supplement. **Exercise** can help strengthen bones by increasing bone density, thereby decreasing the risk of fractures from falls. A University of Southern California study reported that older people who exercised one or

more hours per day had approximately half the incidence of hip fractures as those who exercised fewer than 30 minutes per day or not at all.

Fractures can be prevented if safety measures are taken seriously. These measures include using seat belts in cars and encouraging children to wear protective sports gear. Estrogen replacement for women past the age of 50 has been shown to help prevent osteoporosis and the fractures that may result from this condition. In one study, elderly women on estrogen replacement therapy demonstrated the lowest occurrence of hip fractures when compared to similar women not on estrogen replacement therapy.

Resources

BOOKS

Burr, David B. *Musculoskeletal Fatigue and Stress Fracture.* Boca Raton, FL: CRC Press, 2001.

Jupiter, J. *Fractures and Dislocations of the Hand.* St. Louis: Mosby, 2001.

Moehring, H. David, and Adam Greenspan. *Fractures: Diagnosis and Treatment.* New York: McGraw Hill, 2000.

Ogden, John A. *Skeletal Injury in the Child.* New York: Springer Verlag, 2000.

Schenck, Robert C., and Ronnie P. Barnes. *Athletic Training and Sports Medicine, 3rd ed.* Chicago: American Academy of Orthopaedic Surgery, 1999.

Wiss, Donald A., and Christopher B. Williams. *Fractures.* Baltimore: Williams & Wilkins, 1998.

PERIODICALS

Lesho, Emil P. "Tuning Fork Test Finds Fractures." *Military Medicine* 162 (1997): 802-803.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018-4262. (847) 823-7186 or (800) 346-2267. Fax: (847) 823-8125. <http://orthoinfo.aaos.org/>.

American College of Sports Medicine. 401 W. Michigan St., Indianapolis, IN 46202. (317) 637-9200, Fax: (317) 634-7817.

Children's Orthopedics of Atlanta. <http://www.childrensortho.com/fractures.htm>.

Nemours Foundation. <http://kidshealth.org/kid/ill_injure/aches/broken_bones.html>.

OTHER

"About the Human." <http://orthopedics.about.com/health/orthopedics/blhipfracture.htm>.

Family Practice Notebook.com. <http://www.fpnotebook.com/FRA.htm>.

National Library of Medicine. <http://medlineplus.adam.com/ency/article/000001.htm>.

University of Iowa. <http://www.vh.org/Providers/ClinRef/FPHandbook/Chapter06/18-6.html>.

L. Fleming Fallon, Jr., MD, DrPH

Fragile X syndrome

Definition

Fragile X syndrome is the most common form of inherited **mental retardation**. Individuals with this condition have developmental delay, variable levels of mental retardation, and behavioral and emotional difficulties. They may also have characteristic physical traits. Generally, males are affected with moderate mental retardation and females with mild mental retardation.

Description

Fragile X syndrome is also known as Martin-Bell syndrome, Marker X syndrome, and FRAXA syndrome. It is the most common form of inherited mental retardation. Fragile X syndrome is caused by a mutation in the FMR-1 gene, located on the X chromosome. The role of the gene is unclear, but it is probably important in early development.

In order to understand fragile X syndrome it is important to understand how human genes and chromosomes influence this condition. Normally, each cell in the body contains 46 (23 pairs of) chromosomes. These chromosomes consist of genetic material (DNA) needed for the production of proteins, which lead to growth, development, and physical/intellectual characteristics. The first 22 pairs of chromosomes are the same in males and females. The remaining two chromosomes are called the sex chromosomes (X and Y). The sex chromosomes determine whether a person is male or female. Males have only one X chromosome, which is inherited from the mother at conception, and they receive a Y chromosome from the father. Females inherit two X chromosomes, one from each parent. Fragile X syndrome is caused by a mutation in a gene called FMR-1. This gene is located on the X chromosome. The FMR-1 gene is thought to play an important role in the development of the brain, but the exact way that the gene acts in the body is not fully understood.

Fragile X syndrome affects males and females of all ethnic groups. It is estimated that there are about one in 4,000 to one in 6,250 males affected with fragile X syndrome. There are approximately half as many females with fragile X syndrome as there are males. The carrier frequency in unaffected females is one in 100 to one in 600, with one study finding a carrier frequency of one in 250.

Causes and symptoms

For reasons not fully understood, the CGG sequence in the FMR-1 gene can expand to contain between 54 and 230 repeats. This stage of expansion is called a pre-

KEY TERMS

Amniocentesis—A procedure performed at 16-18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

CGG or CGG sequence—Shorthand for the DNA sequence: cytosine-guanine-guanine. Cytosine and guanine are two of the four molecules, otherwise called nucleic acids, that make up DNA.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10-12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

FMR-1 gene—A gene found on the X chromosome. Its exact purpose is unknown, but it is suspected that the gene plays a role in brain development.

Mitral valve prolapse—A heart defect in which one of the valves of the heart (which normally controls blood flow) becomes floppy. Mitral valve prolapse may be detected as a heart murmur but there are usually no symptoms.

Premutation—A change in a gene that precedes a mutation; this change does not alter the function of the gene.

X chromosome—One of the two sex chromosomes (the other is Y) containing genetic material that, among other things, determine a person's gender.

mutation. People who carry a premutation do not usually have symptoms of fragile X syndrome; although there have been reports of individuals with a premutation and subtle intellectual or behavioral symptoms. Individuals who carry a fragile X premutation are at risk to have children or grandchildren with the condition. Female premutation carriers may also be at increased risk for earlier onset of **menopause**; however, premutation carriers may exist through several generations of a family and no symptoms of fragile X syndrome will appear.

The size of the premutation can expand over succeeding generations. Once the size of the premutation exceeds 230 repeats, it becomes a full mutation and the FMR-1 gene is disabled. Individuals who carry the full mutation may have fragile X syndrome. Since the FMR-1 gene is located on the X chromosome, males are more likely to develop symptoms than females. This is because males have only one copy of the X chromosome. Males who inherit the full mutation are expected to have mental impairment. A female's normal X chromosome may compensate for her chromosome with the fragile X gene mutation. Females who inherit the full mutation have an approximately 50% risk of mental impairment. The phenomenon of an expanding trinucleotide repeat in successive generations is called anticipation. Another unique aspect fragile X syndrome is that mosaicism is present in 15–20% those affected by the condition. Mosaicism is when there is the presence of cells of two different genetic materials in the same individual.

The mutation involves a short sequence of DNA in the FMR-1 gene. This sequence is designated CGG. Normally, the CGG sequence is repeated between six to 54 times. People who have repeats in this range do not have fragile X syndrome and are not at increased risk to have children with fragile X syndrome. Those affected by fragile X syndrome have expanded CGG repeats (over 200) in the first exon of the FMR1 gene (the full mutation)

Fragile X syndrome inherited in an X-linked dominant manner (characters are transmitted by genes on the X chromosome). When a man carries a premutation on his X chromosome, it tends to be stable and usually will not expand if he passes it on to his daughters (he passes his Y chromosome to his sons). Thus, all of his daughters will be premutation carriers like he is. When a woman carries a premutation, it is unstable and can expand as she passes it on to her children, therefore a man's grandchildren are at greater risk of developing the syndrome. There is a 50% risk for a premutation carrier female to transmit an abnormal mutation with each **pregnancy**. The likelihood for the premutation to expand is related to the number of

repeats present; the higher the number of repeats, the greater the chance that the premutation will expand to a full mutation in the next generation. All mothers of a child with a full mutation are carriers of an FMR-1 gene expansion. Ninety-nine percent of patients with fragile X syndrome have a CGG expansion, and less than one percent have a point mutation or deletion on the FMR1 gene.

Individuals with fragile X syndrome appear normal at birth but their development is delayed. Most boys with fragile X syndrome have mental impairment. The severity of mental impairment ranges from learning disabilities to severe mental retardation. Behavioral problems include attention deficit and hyperactivity at a young age. Some may show aggressive behavior in adulthood. Short attention span, poor eye contact, delayed and disordered speech and language, emotional instability, and unusual hand mannerisms (hand flapping or hand biting) are also seen frequently. Characteristic physical traits appear later in childhood. These traits include a long and narrow face, prominent jaw, large ears, and enlarged testes. In females who carry a full mutation, the physical and behavioral features and mental retardation tend to be less severe. About 50% of females who have a full mutation are mentally retarded. Other behavioral characteristics include whirling, spinning, and occasionally **autism**.

Children with fragile X syndrome often have frequent ear and sinus infections. Nearsightedness and lazy eye are also common. Many babies with fragile X syndrome may have trouble with sucking and some experience digestive disorders that cause frequent gagging and vomiting. A small percentage of children with fragile X syndrome may experience seizures. Children with fragile X syndrome also tend to have loose joints which may result in joint dislocations. Some children develop a curvature in the spine, flat feet, and a heart condition known as **mitral valve prolapse**.

Diagnosis

Any child with signs of developmental delay of speech, language, or motor development with no known cause should be considered for fragile X testing, especially if there is a family history of the condition. Behavioral and developmental problems may indicate fragile X syndrome, particularly if there is a family history of mental retardation. Definitive identification of the fragile X syndrome is made by means of a genetic test to assess the number of CGG sequence repeats in the FMR-1 gene. Individuals with the premutation or full mutation may be identified through **genetic testing**. Genetic testing for the fragile X mutation can be done on the developing baby before birth through **amniocentesis** or **chorionic villus sampling** (CVS), and is 99% effective in detecting the condition due to trinucleotide repeat expansion. Prenatal testing should only be undertaken after the fragile X carrier status of the parents has been confirmed and the couple has been counseled regarding the risks of recurrence. While prenatal testing is possible to do with CVS, the results can be difficult to interpret and additional testing may be required.

Treatment

Presently there is no cure for fragile X syndrome. Management includes such approaches as speech therapy, occupational therapy, and physical therapy. The expertise of psychologists, special education teachers, and genetic counselors may also be beneficial. Drugs may be used to treat hyperactivity, seizures, and other problems. Establishing a regular routine, avoiding over stimulation, and using calming techniques may also help in the management of behavioral problems. Children with a troubled heart valve may need to see a heart specialist and take medications before surgery or dental procedures. Children with frequent ear and sinus infections may need to take medications or have special tubes placed in their ears to drain excess fluid. Mainstreaming of children with fragile X syndrome into regular classrooms is encouraged because they do well imitating behavior. Peer tutoring and positive reinforcement are also encouraged.

Prognosis

Early diagnosis and intensive intervention offer the best prognosis for individuals with fragile X syndrome. Adults with fragile X syndrome may benefit from vocational training and may need to live in a supervised setting. Life span is typically normal.

Resources

BOOK

Sutherland, Grant R., and John C. Mulley. "Fragile X Syndrome." In *Emery and Rimoin's Principles and Practice of Medical Genetics,* Ed. David L. Rimoin, J. Michael Connor, and Reed E. Pyeritz, 1745–66. New York: Churchill Livingstone, 1997.

PERIODICALS

de Vries, B.B.A., et al. "The Fragile X Syndrome." *Journal of Medical Genetics* 35 (1998): 579–89.

Kaufmann, Walter E., and Allan L. Reiss. "Molecular and Cellular Genetics of Fragile X Syndrome." *American Journal of Medical Genetics* 88 (1999): 11–24.

ORGANIZATIONS

Arc of the United States (formerly Association for Retarded Citizens of the US). 500 East Border St., Suite 300, Arlington, TX 76010. (817) 261-6003. <http://thearc.org>.

National Fragile X Foundation. PO Box 190488, San Francisco, CA 94119-0988. (800) 688-8765 or (510) 763-6030. Fax: (510) 763-6223. natlfx@sprintmail.com. <http://nfxf.org>.
National Fragile X Syndrome Support Group. 206 Sherman Rd., Glenview, IL 60025. (708) 724-8626.

OTHER

"Fragile X Site Mental Retardation 1;FMR1." *Online Mendelian Inheritance in Man* <http://www3.ncbi.nlm.nih.gov/Omim/>. (March 6, 2001).
Tarleton, Jack, and Robert A. Saul. "Fragile X Syndrome." *GeneClinics* <http://www.geneclinics.org>. (6 March. 2001).

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Frambesia *see* **Yaws**

Francisella tularensis infection *see* **Tularemia**

Fresh cell therapy *see* **Cell therapy**

Friedreich's ataxia

Definition

Friedreich's ataxia (FA) is an inherited, progressive nervous system disorder causing loss of balance and coordination.

Description

Ataxia is a condition marked by impaired coordination. Friedreich's ataxia is the most common inherited ataxia, affecting between 3,000–5,000 people in the United States. FA is an autosomal recessive disease, which means that two defective gene copies must be inherited to develop symptoms, one from each parent. A person with only one defective gene copy will not show signs of FA, but may pass along the gene to offspring. Couples with one child affected by FA have a 25% chance in each **pregnancy** of conceiving another affected child.

Causes and symptoms

Causes

The gene for FA codes for a protein called frataxin. Normal frataxin is found in the cellular energy structures known as mitochondria, where it is thought to be involved in regulating the transport of iron. In FA, the frataxin gene on chromosome 9 is expanded with nonsense information known as a "triple repeat." This extra DNA interferes with normal production of frataxin, thereby impairing iron transport. Normally, there are 10-21 repeats of the frataxin gene. In FA, this sequence may be repeated between 200-900 times. The types of symptoms and severity of FA seems to be associated with the number of repetitions. Patients with more copies have more severe symptomatology. Researchers are still wrestling with how frataxin and the repeats on chromosome 9 are involved in causing FA. One theory suggests that FA develops in part because defects in iron transport prevent efficient use of cellular energy supplies.

The nerve cells most affected by FA are those in the spinal cord involved in relaying information between muscles and the brain. Tight control of movement requires complex feedback between the muscles promoting a movement, those restraining it, and the brain. Without this control, movements become uncoordinated, jerky, and inappropriate to the desired action.

Symptoms

Symptoms of FA usually first appear between the ages of 8 and 15, although onset as early as 18 months or as late as age 25 is possible. The first symptom is usually gait incoordination. A child with FA may graze doorways when passing through, for instance, or trip over low obstacles. Unsteadiness when standing still and deterioration of position sense is common. Foot deformities and walking up off the heels often results from uneven muscle weakness in the legs. **Muscle spasms and cramps** may occur, especially at night.

Ataxia in the arms follows, usually within several years, leading to decreased hand-eye coordination. Arm weakness does not usually occur until much later. Speech and swallowing difficulties are common. **Diabetes mellitus** may also occur. **Nystagmus**, or eye tremor, is common, along with some loss of visual acuity. **Hearing loss** may also occur. A side-to-side curvature of the spine (**scoliosis**) occurs in many cases, and may become severe.

Heartbeat abnormalities occur in about two thirds of FA patients, leading to **shortness of breath** after exertion, swelling in the lower limbs, and frequent complaints of cold feet.

Diagnosis

Diagnosis of FA involves a careful medical history and thorough neurological exam. Lab tests include **electromyography**, an electrical test of muscle, and a nerve conduction velocity test. An electrocardiogram may be performed to diagnose heart arrhythmia.

Direct DNA testing is available, allowing FA to be more easily distinguished from other types of ataxia. The same test may be used to determine the presence of the genetic defect in unaffected individuals, such as siblings.

KEY TERMS

Ataxia—A condition marked by impaired coordination.

Scoliosis—An abnormal, side-to-side curvature of the spine.

Treatment

There is no cure for FA, nor any treatment that can slow its progress. Amantadine may provide some limited improvement in ataxic symptoms, but is not recommended in patients with cardiac abnormalities. Physical and occupational therapy are used to maintain range of motion in weakened muscles, and to design adaptive techniques and devices to compensate for loss of coordination and strength. Some patients find that using weights on the arms can help dampen the worst of the uncoordinated arm movements.

Heart **arrhythmias** and diabetes are treated with drugs specific to those conditions.

Prognosis

The rate of progression of FA is highly variable. Most patients lose the ability to walk within 15 years of symptom onset, and 95% require a wheelchair for mobility by age 45. Reduction in lifespan from FA complications is also quite variable. Average age at **death** is in the mid-thirties, but may be as late as the mid-sixties. As of mid-1998, the particular length of the triple repeat has not been correlated strongly enough with disease progression to allow prediction of the course of the disease on this basis.

Prevention

There is no way to prevent development of FA in a person carrying two defective gene copies.

Resources

BOOKS

Feldman, Eva L. "Hereditary Cerebellar Ataxias and Related Disorders." In *Cecil Textbook of Medicine*, ed. Russel L. Cecil et al. Philadelphia: W.B. Saunders Company, 2000.

"Spinocerebellar Degeneration (Friedreich's Ataxia)." In *Harrison's Principles of Internal Medicine*, edited by Kurt J. Isselbacher et al. New York: McGraw-Hill, 2001.

ORGANIZATIONS

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (520) 529-2000 or (800) 572-1717. <http://www.mdausa.org>.

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Frostbite and frostnip

Definition

Frostbite is the term for damage to the skin and other tissues caused by freezing. Frostnip is a mild form of cold injury.

Description

In North America, frostbite is largely confined to Alaska, Canada, and the northern states. Recent years have witnessed a substantial decline in the number of cases, probably for several reasons, including better winter clothing and footwear and greater public understanding of how to avoid cold-weather dangers. At the same time, the nature of the at-risk population has changed as rising numbers of homeless people have made frostbite an urban as well as a rural public health concern. The growing popularity of outdoor winter activities has also expanded the at-risk population.

Causes and symptoms

Frostbite

Skin exposed to temperatures a little below the freezing mark can take hours to freeze, but very cold skin can freeze in minutes or seconds. Air temperature, wind speed, and moisture all affect how cold the skin becomes. A strong wind can lower skin temperature considerably by dispersing the thin protective layer of warm air that surrounds our bodies. Wet clothing readily draws heat away from the skin because water is a potent conductor of heat. The evaporation of moisture on the skin also produces cooling. For these reasons, wet skin or clothing on a windy day can lead to frostbite even if the air temperature is above the freezing mark.

The extent of permanent injury, however, is determined not by how cold the skin and the underlying tissues become but by how long they remain frozen. Consequently, homeless people and others whose self-preservation instincts may be clouded by alcohol or psychiatric illness face a greater risk of frostbite-related **amputation** because they are more likely to stay out in the cold when prudence dictates seeking shelter or medical attention. Alcohol also affects blood circulation in the extremities in a way that can increase the severity of injury (as does **smoking**). A review of 125 Saskatchewan frostbite cases found a tie to alcohol in 46% and to psychiatric illness in 17%. Other risk factors identified by researchers include inadequate clothing, previous cold injury, **fatigue**, wound infection, **atherosclerosis** (an arterial disease), and diabetes. Driving in poor weather can also be dan-

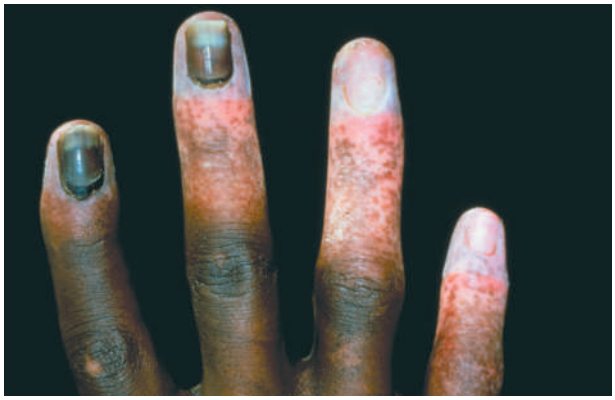
gerous: vehicular failure was a predisposing factor in 15% of the Saskatchewan cases.

Three nearly simultaneous physiological processes underlie frostbite injury: tissue freezing, tissue hypoxia, and the release of inflammatory mediators. Tissue freezing causes ice crystal formation and other changes that damage and eventually kill cells. Much of this harm occurs because the ice produces pressure changes that cause water (crucial for cell survival) to flow out of the cells. Tissue hypoxia (oxygen deficiency) occurs when the blood vessels in the hands, feet, and other extremities narrow in response to cold. Among its many tasks, blood transfers body heat to the skin, which then dissipates the heat into the environment. Blood vessel narrowing is the body's way of protecting vital internal organs at the expense of the extremities by reducing heat flow away from the core. However, blood also carries life-sustaining oxygen to the skin and other tissues, and narrowed vessels result in oxygen **starvation**. Narrowing also causes acidosis (an increase in tissue acidity) and increases blood viscosity (thickness). Ultimately, blood stops flowing through the capillaries (the tiny blood vessels that connect the arteries and veins) and blood clots form in the arterioles and venules (the smallest arteries and veins). Damage also occurs to the endothelial cells that line the blood vessels. Hypoxia, blood clots, and endothelial damage lead, in turn, to the release of inflammatory mediators (substances that act as links in the inflammatory process), which promote further endothelial damage, hypoxia, and cell destruction.

Frostbite is classified by degree of injury (first, second, third, or fourth), or simply divided into two types, superficial (corresponding to first- or second-degree injury) and deep (corresponding to third- or fourth-degree injury). Most frostbite injuries affect the feet or hands. The remaining 10% of cases typically involve the ears, nose, cheeks, or penis. Once frostbite sets in, the affected part begins to feel cold and, usually, numb; this is followed by a feeling of clumsiness. The skin turns white or yellowish. Many patients experience severe **pain** in the affected part during rewarming treatment and an intense throbbing pain that arises two or three days later and can last days or weeks. As the skin begins to thaw during treatment, **edema** (excess tissue fluid) often accumulates, causing swelling. In second- and higher-degree frostbite, blisters appear. Third-degree cases produce deep, blood-filled blisters and, during the second week, a hard black eschar (scab). Fourth-degree frostbite penetrates below the skin to the muscles, tendons, nerves, and bones. In severe cases of frostbite the dead tissue can mummify and drop off. Infection is also a possibility.

Frostnip

Like frostbite, frostnip is associated with ice crystal formation in the tissues, but no tissue destruction occurs and the crystals dissolve as soon as the skin is warmed. Frostnip affects areas such as the earlobes, cheeks, nose, fingers, and toes. The skin turns pale and one experiences numbness or tingling in the affected part until warming begins.



A human hand with frostbite. *(Photo Researchers, Inc. Reproduced by permission.)*

Diagnosis

Frostbite diagnosis relies on a **physical examination** and may also include conventional radiography (x rays), **angiography** (x-ray examination of the blood vessels using an injected dye to provide contrast), thermography (use of a heat-sensitive device for measuring blood flow), and other techniques for predicting the course of injury and identifying tissue that requires surgical removal. During the initial treatment period, however, a physician cannot judge how a case will progress. Diagnostic tests only become useful three to five days after rewarming, once the blood vessels have stabilized.

Treatment

Frostbite

Emergency medical help should always be summoned whenever frostbite is suspected. While waiting for help to arrive, one should, if possible, remove wet or tight clothing and put on dry, loose clothing or wraps. A splint and padding are used to protect the injured area. Rubbing the area with snow or anything else is dangerous. The key to prehospital treatment is to avoid partial thawing and refreezing, which releases more inflammatory mediators and makes the injury substantially worse. For this reason, the affected part must be kept away from heat sources such as campfires and car heaters. Experts advise rewarming in the field only when emergency help will take more than two hours to arrive and refreezing can be prevented.

Because the outcome of a frostbite injury cannot be predicted at first, all hospital treatment follows the same

route. Treatment begins by rewarming the affected part for 15–30 minutes in water at a temperature of 104–108°F (40–42.2°C). This rapid rewarming halts ice crystal formation and dilates narrowed blood vessels. Aloe vera (which acts against inflammatory mediators) is applied to the affected part, which is then splinted, elevated, and wrapped in a dressing. Depending on the extent of injury, blisters may be debrided (cleaned by removing foreign material) or simply covered with aloe vera. A **tetanus** shot and, possibly, penicillin, are used to prevent infection, and the patient is given ibuprofen to combat inflammation. Narcotics are needed in most cases to reduce the excruciating pain that occurs as sensation returns during rewarming. Except when injury is minimal, treatment generally requires a hospital stay of several days, during which **hydrotherapy** and physical therapy are used to restore the affected part to health. Experts recommend a cautious approach to tissue removal, and advise that 22–45 days must pass before a decision on amputation can safely be made.

Frostnip

Frostnipped fingers are helped by blowing warm air on them or holding them under one's armpits. Other frostnipped areas can be covered with warm hands. The injured areas should never be rubbed.

Alternative treatment

Alternative practitioners suggest several kinds of treatment to speed recovery from frostbite after leaving the hospital. Bathing the affected part in warm water or using contrast hydrotherapy can help enhance circulation. Contrast hydrotherapy involves a series of hot and cold water applications. A hot compress (as hot as the patient can stand) is applied to the affected area for three minutes followed by an ice cold compress for 30 seconds. These applications are repeated three times each, ending with the cold compress. Nutritional therapy to promote tissue growth in damaged areas may also be helpful. Homeopathic and botanical therapies may also assist recovery from frostbite. Homeopathic *Hypericum* (*Hypericum perforatum*) is recommended when nerve ending are affected (especially in the fingers and toes) and *Arnica* (*Arnica montana*) is prescribed for **shock**. Cayenne pepper (*Capsicum frutescens*) can enhance circulation and relieve pain. Drinking hot ginger (*Zingiber officinale*) tea also aids circulation. Other possible approaches include **acupuncture** to avoid permanent nerve damage and oxygen therapy.

Prognosis

The rapid rewarming approach to frostbite treatment, pioneered in the 1980s, has proved to be much more effective than older methods in preventing tissue loss and amputation. A study of 56 first-, second-, and third-degree frostbite patients treated with rapid rewarming in 1982–85 found that 68% recovered without tissue loss, 25% experienced some tissue loss, and 7% needed amputation. In a comparison group of 98 patients, treatment using older methods resulted in a tissue loss rate of nearly 35% and an amputation rate of nearly 33%. Although the comparison group included a higher proportion of second- and third-degree cases, the difference in treatment results was determined to be statistically significant.

The extreme throbbing pain that many frostbite sufferers endure for days or weeks after rewarming is not the only prolonged symptom of frostbite. During the first weeks or months, people often experience tingling, a burning sensation, or a sensation resembling shocks from an electric current. Other possible consequences of frostbite include skin—color changes, nail deformation or loss, joint stiffness and pain, **hyperhidrosis** (excessive sweating), and heightened sensitivity to cold. For everyone, a degree of sensory loss lasting at least four years—and sometimes a lifetime—is inevitable.

Prevention

With the appropriate knowledge and precautions, frostbite can be prevented even in the coldest and most challenging environments. Appropriate clothing and footwear are essential. To prevent heat loss and keep the blood circulating properly, clothing should be worn loosely and in layers. Covering the hands, feet, and head is also crucial for preventing heat loss. Outer garments need to be wind and water resistant, and wet clothing and footwear must be replaced as quickly as possible. Alcohol and drugs should be avoided because of their harmful effects on judgment and reasoning. Experts also warn against alcohol use and smoking in the cold because of the circulatory changes they produce. Paying close attention to the weather report before venturing outdoors and avoiding unnecessary risks such as driving in isolated areas during a blizzard are also important.

Resources

BOOKS

Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Puyallup, WA: Future Medicine Publishing, Inc., 1993.

Danzl, Daniel F. "Disturbances Due to Cold." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

McCauley, Robert L., et al. "Frostbite and Other Cold-Induced Injuries." In *Wilderness Medicine: Management of Wilderness and Environmental Emergencies*, ed. Paul S. Auerbach. St. Louis: Mosby, 1995.

PERIODICALS

Gill Jr., Paul G. "Winning the Cold War." *Outdoor Life* (Feb. 1993): 62+.

Phillips, David. "How Frostbite Performs Its Misery." *Canadian Geographic* (Jan./Feb. 1995): 20+.

Reamy, Brian V. "Frostbite: Review and Current Concepts." *Journal of the American Board of Family Practice* (Jan./Feb. 1998): 34-40.

Winkelmann, Terry. "The Cold Facts about Frostbite." *Stride* (Winter 1997).

Howard Baker

Frostnip *see* **Frostbite and frostnip**

FSH test *see* **Follicle-stimulating hormone test**

Fugue *see* **Dissociative disorders**

FUO *see* **Fever of unknown origin**

Furosemide *see* **Diuretics**

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CONTENTS

PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Medicine 2* is a medical reference product designed to inform and educate readers about a wide variety of disorders, conditions, treatments, and diagnostic tests. The Gale Group believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioner. While the Gale Group has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, the Gale Group makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of medical opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their health care provider.

INTRODUCTION

The *Gale Encyclopedia of Medicine 2 (GEM2)* is a one-stop source for medical information on nearly 1,700 common medical disorders, conditions, tests, and treatments, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart attack. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 2* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

SCOPE

Almost 1,700 full-length articles are included in the *Gale Encyclopedia of Medicine 2*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses, eg. acetaminophen (Tylenol). Throughout the *Gale Encyclopedia of Medicine 2*, many prominent individuals are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Description	Purpose
Causes and symptoms	Precautions
Diagnosis	Description
Treatment	Preparation
Alternative treatment	Aftercare
Prognosis	Risks
Prevention	Normal/Abnormal results
Resources	Resources
Key terms	Key terms

In recent years there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 2* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies.

INCLUSION CRITERIA

A preliminary list of diseases, disorders, tests and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM2* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale Group editor.

ABOUT THE CONTRIBUTORS

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM2* medical advisors reviewed the completed essays to insure that they are appropriate, up-to-date, and medically accurate.

HOW TO USE THIS BOOK

The *Gale Encyclopedia of Medicine 2* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.

- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms are also cross-referenced.
- A list of **key terms** are provided where appropriate to define unfamiliar terms or concepts.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix contains an extensive list of organizations arranged in alphabetical order.
- **Resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

GRAPHICS

The *Gale Encyclopedia of Medicine 2* is enhanced with over 675 color images, including photos, charts, tables, and customized line drawings.

ADVISORY BOARD

A number of experts in the library and medical communities provided invaluable assistance in the formulation of this encyclopedia. Our advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. The editor would like to express her appreciation to them.

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Galactorrhea

Definition

Galactorrhea is the secretion of breast milk in men, or in women who are not breastfeeding an infant.

Description

Lactation, or the production of breast milk, is a normal condition occurring in women after delivery of a baby. Many women who have had children may even be able to express a small amount of breast milk from the nipple up to two years after **childbirth**. Galactorrhea, or hyperlactation, however, is a rare condition that can occur in both men and women, where a white or grayish fluid is secreted by the nipples of both breasts. While this condition is not serious in itself, galactorrhea can indicate more serious conditions, including hormone imbalances or the presence of tumors.

Causes and symptoms

Causes

Galactorrhea is associated with a number of conditions. The normal production of breast milk is controlled by a hormone called prolactin, which is secreted by the pituitary gland in the brain. Any condition that upsets the balance of hormones in the blood or the production of hormones by the pituitary gland or sexual organs can stimulate the production of prolactin.

Often, a patient with galactorrhea will have a high level of prolactin in the blood. A tumor in the pituitary gland can cause this overproduction of prolactin. At least 30% of women with galactorrhea, menstrual abnormalities, and high prolactin levels have a pituitary gland tumor. Other types of brain tumors, head injuries, or **encephalitis** (an infection of the brain) can also cause galactorrhea.

Tumors or growths in the ovaries or other reproductive organs in women, or in the testicles or related sexual organs of men, can also stimulate the production of prolactin. Any discharge of fluid from the breast after a woman has passed **menopause** may indicate **breast cancer**. However, most often the discharge associated with breast **cancer** will be from one breast only. In galactorrhea both breasts are usually involved. The presence of blood in the fluid discharged from the breast could indicate a benign growth in the breast tissue itself. In approximately 10–15% of patients with blood in the fluid, carcinoma of the breast tissue is present.

A number of medications and drugs can also cause galactorrhea as a side-effect. Hormonal therapies (like **oral contraceptives**), drugs for treatment of depression or other psychiatric conditions, tranquilizers, morphine, heroin, and some medications for high blood pressure can cause galactorrhea.

Several normal physiologic situations can cause production of breast milk. Nipple stimulation in men or women during sexual intercourse may induce lactation, for women particularly during or just after **pregnancy**.

Even after extensive testing, no specific cause can be determined for some patients with galactorrhea.

Symptoms

The primary symptom of galactorrhea is the discharge of milky fluid from both breasts. In women, galactorrhea may be associated with **infertility**, menstrual cycle irregularities, hot flushes, or amenorrhea—a condition where menstruation stops completely. Men may experience loss of sexual interest and **impotence**. Headaches and visual disturbances have also been associated with some cases of galactorrhea.

Diagnosis

Galactorrhea is generally considered a symptom that may indicate a more serious problem. Collection of a thorough medical history, including pregnancies, surgeries, and consumption of drugs and medications is a

KEY TERMS

Amenorrhea—Abnormal cessation of menstruation.

Bromocriptine—Also known as Parlodel, the main drug used to treat galactorrhea by reducing levels of the hormone prolactin.

Hyperlactation—Another term for galactorrhea.

Lactation—The production of breast milk.

first step in diagnosing the cause of galactorrhea. A **physical examination**, along with a breast examination, will usually be conducted. Blood and urine samples may be taken to determine levels of various hormones in the body, including prolactin and compounds related to thyroid function.

A mammogram (an x ray of the breast) or an ultrasound scan (using high frequency sound waves) might be used to determine if there are any tumors or cysts present in the breasts themselves. If a tumor of the pituitary gland is suspected, a series of computer assisted x rays called a computed tomography scan (CT scan) may be done. Another procedure that may be useful is a **magnetic resonance imaging** (MRI) scan to locate tumors or abnormalities in tissues.

Treatment

Treatment for galactorrhea will depend on the cause of the condition and the symptoms. The drug bromocriptine is often prescribed first to reduce the secretion of prolactin and to decrease the size of **pituitary tumors**. This drug will control galactorrhea symptoms and in many cases may be the only therapy necessary. Oral estrogen and progestins (hormone pills, like birth control pills) may control symptoms of galactorrhea for some women. Surgery to remove a tumor may be required for patients who have more serious symptoms of **headache** and vision loss, or if the tumor shows signs of enlargement despite drug treatment. **Radiation therapy** has also been used to reduce tumor size when surgery is not possible or not totally successful. A combination of drug, surgery, and radiation treatment can also be used.

Galactorrhea is more of a nuisance than a real threat to health. While it is important to find the cause of the condition, even if a tumor is discovered in the pituitary gland, it may not require treatment. With very small, slow-growing tumors, some physicians may suggest a "wait and see" approach.

Prognosis

Treatment with bromocriptine is usually effective in stopping milk secretion, however, symptoms may recur if drug therapy is discontinued. Surgical removal or radiation treatment may correct the problem permanently if it is related to a tumor. Frequent monitoring of hormone status and tumor size may be recommended.

Prevention

There is no way to prevent galactorrhea. If the condition is caused by the use of a particular drug, a patient may be able to switch to a different drug that does not have the side-effect of galactorrhea.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

"Galactorrhea." In *Current Medical Diagnosis & Treatment, 1998*. 37th ed. Stamford: Appleton & Lange, 1997.

"Galactorrhea (Hyperprolactinemia)." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

"Galactorrhea." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Altha Roberts Edgren

Galactosemia

Definition

Galactosemia is an inherited disease in which the transformation of galactose to glucose is blocked, allowing galactose to increase to toxic levels in the body. If galactosemia is untreated, high levels of galactose cause vomiting, **diarrhea**, lethargy, low blood sugar, brain damage, **jaundice**, liver enlargement, **cataracts**, susceptibility to infection, and **death**.

Description

Galactosemia is a rare but potentially life-threatening disease that results from the inability to metabolize galactose. Serious consequences from galactosemia can be prevented by screening newborns at birth with a simple blood test.

Galactosemia is an inborn error of metabolism. "Metabolism" refers to all chemical reactions that take

place in living organisms. A metabolic pathway is a series of reactions where the product of each step in the series is the starting material for the next step. Enzymes are the chemicals that help the reactions occur. Their ability to function depends on their structure, and their structure is determined by the deoxyribonucleic acid (DNA) sequence of the genes that encode them. Inborn errors of metabolism are caused by mutations in these genes which do not allow the enzymes to function properly.

Sugars are sometimes called "the energy molecules," and galactose and glucose are both sugars. For galactose to be utilized for energy, it must be transformed into something that can enter the metabolic pathway that converts glucose into energy (plus water and carbon dioxide). This is important for infants because they typically get most of their nutrient energy from milk, which contains a high level of galactose. Each molecule of lactose, the major sugar constituent of milk, is made up of a molecule of galactose and a molecule of glucose, and so galactose makes up 20% of the energy source of a typical infant's diet.

Three enzymes are required to convert galactose into glucose-1-phosphate (a phosphorylated glucose that can enter the metabolic pathway that turns glucose into energy). Each of these three enzymes is encoded by a separate gene. If any of these enzymes fail to function, galactose build-up and galactosemia result. Thus, there are three types of galactosemia with a different gene responsible for each.

Every cell in a person's body has two copies of each gene. Each of the forms of galactosemia is inherited as a recessive trait, which means that galactosemia is only present in individuals with two mutated copies of one of the three genes. This also means that carriers, with only one copy of a gene mutation, will not be aware that they are carrying a mutation (unless they have had a genetic test), as it is masked by the normal gene they also carry and they have no symptoms of the disease. For each step in the conversion of galactose to glucose, if only one of the two copies of the gene controlling that step is normal (i.e. for carriers), enough functional enzyme is made so that the pathway is not blocked at that step. If a person has galactosemia, both copies of the gene coding for one of the enzymes required to convert glucose to galactose are defective and the pathway becomes blocked. If two carriers of the same defective gene have children, the chance of any of their children getting galactosemia (the chance of a child getting two copies of the defective gene) is 25% (one in four) for each **pregnancy**.

Classic galactosemia occurs in the United States about one in every 50,000–70,000 live births.

Causes and symptoms

Galactosemia I

Galactosemia I (also called classic galactosemia), the first form to be discovered, is caused by defects in both copies of the gene that codes for an enzyme called galactose-1-phosphate uridyl transferase (GALT). There are 30 known different mutations in this gene that cause GALT to malfunction.

Newborns with galactosemia I appear normal at birth, but begin to develop symptoms after they are given milk for the first time. Symptoms include vomiting, diarrhea, lethargy (sluggishness or **fatigue**), low blood glucose, jaundice (a yellowing of the skin and eyes), enlarged liver, protein and amino acids in the urine, and susceptibility to infection, especially from gram negative bacteria. Cataracts (a grayish white film on the eye lens) can appear within a few days after birth. People with galactosemia frequently have symptoms as they grow older even though they have been given a galactose-free diet. These symptoms include **speech disorders**, cataracts, ovarian atrophy and **infertility** in females, learning disabilities, and behavioral problems.

Galactosemia II

Galactosemia II is caused by defects in both copies of the gene that codes for an enzyme called galactokinase (GALK). The frequency of occurrence of galactosemia II is about one in 100,000–155,000 births.

Galactosemia II is less harmful than galactosemia I. Babies born with galactosemia II will develop cataracts at an early age unless they are given a galactose-free diet. They do not generally suffer from liver damage or neurologic disturbances.

Galactosemia III

Galactosemia III is caused by defects in the gene that codes for an enzyme called uridyl diphosphogalactose-4-epimerase (GALE). This form of galactosemia is very rare.

There are two forms of galactosemia III, a severe form, which is exceedingly rare, and a benign form. The benign form has no symptoms and requires no special diet. However, newborns with galactosemia III, including the benign form, have high levels of galactose-1-phosphate that show up on the initial screenings for elevated galactose and galactose-1-phosphate. This situation illustrates one aspect of the importance of follow-up enzyme function tests. Tests showing normal levels of GALT and GALK allow people affected by the benign form of galactosemia III to enjoy a normal diet.

KEY TERMS

Casein hydrolysate—A preparation made from the milk protein casein, which is hydrolyzed to break it down into its constituent amino acids. Amino acids are the building blocks of proteins.

Catalyst—A substance that changes the rate of a chemical reaction, but is not physically changed by the process.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Galactose—One of the two simple sugars, together with glucose, that makes up the protein, lactose, found in milk. Galactose can be toxic in high levels.

Glucose—One of the two simple sugars, together with galactose, that makes up the protein, lactose, found in milk. Glucose is the form of sugar that is usable by the body to generate energy.

Lactose—A sugar made up of of glucose and galactose. It is the primary sugar in milk.

Metabolic pathway—A sequence of chemical reactions that lead from some precursor to a product, where the product of each step in the series is the starting material for the next step.

Metabolism—The total combination of all of the chemical processes that occur within cells and tissues of a living body.

Recessive trait—An inherited trait or characteristic that is outwardly obvious only when two copies of the gene for that trait are present.

The severe form has symptoms similar to those of galactosemia I, but with more severe neurological problems, including seizures. Only two cases of this rare form had been reported as of 1997.

Diagnosis

The newborn screening test for classic galactosemia is quick and straightforward; all but three states require testing on all newborns. Blood from a baby who is two to three days old is usually first screened for high levels of galactose and galactose-1-phosphate. If either of these compounds is elevated, further tests are performed to find out which enzymes (GALT, GALK, or GALE) are present or missing. DNA testing may also be performed to confirm the diagnosis.

If there is a strong suspicion that a baby has galactosemia, galactose is removed from their diet right away. In this case, an initial screen for galactose or galactose-1-phosphate will be meaningless. In the absence of galactose in the diet, this test will be negative whether the baby has galactosemia or not. In this case, tests to measure enzyme levels must be given to find out if the suspected baby is indeed galactosemic.

In addition, galactosemic babies who are refusing milk or vomiting will not have elevated levels of galactose or galactose phosphate, and their condition will not be detected by the initial screen. Any baby with symptoms of galactosemia (for example, vomiting) should be given enzyme tests.

Treatment

Galactosemia I and II are treated by removing galactose from the diet. Since galactose is a break-down product of lactose, the primary sugar constituent of milk, this means all milk and foods containing milk products must be totally eliminated. Other foods like legumes, organ meats, and processed meats also contain considerable galactose and must be avoided. Pills that use lactose as a filler must also be avoided. Soy-based and casein hydrolysate-based formulas are recommended for infants with galactosemia.

Treatment of the severe form of galactosemia III with a galactose-restricted diet has been tried, but this disorder is so rare that the long-term effects of this treatment are unknown.

Prognosis

Early detection in the newborn period is the key to controlling symptoms. Long-term effects in untreated babies include severe **mental retardation**, **cirrhosis** of the liver, and death. About 75% of the untreated babies die within the first two weeks of life. On the other hand, with treatment, a significant proportion of people with galactosemia I can lead nearly normal lives, although speech defects, learning disabilities, and behavioral problems are common. In addition, cataracts due to galactosemia II can be completely prevented by a galactose-free diet.

Prevention

Since galactosemia is a recessive genetic disease, the disease is usually detected on a newborn screening test, since most people are unaware that they are carriers of a gene mutation causing the disease. For couples with a previous child with galactosemia, prenatal diagnosis is available to determine whether a pregnancy is similarly

affected. Families in which a child has been diagnosed with galactosemia can have DNA testing which can enable other more distant relatives to determine their carrier status. Prospective parents can then use that information to conduct family planning or to prepare for a child with special circumstances. Children born with galactosemia should be put on a special diet right away, to reduce the symptoms and complications of the disease.

Resources

BOOKS

Ng, Won G., Thomas F. Roe, and George N. Donnell. "Carbohydrate Metabolism." In *Emery and Rimoin's Principles and Practice of Medical Genetics,* edited by David L. Rimoin, J. Michael Connor, and Reed E. Pyeritz. 3rd. ed. New York: Churchill Livingstone, 1998.

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Metabolic Information Network. PO Box 670847, Dallas, TX 75367-0847. (214) 696-2188 or (800) 945-2188.

Parents of Galactosemic Children, Inc. 2148 Bryton Dr., Powell OH 43065. <http://www.galactosemia.org/index.htm>.

OTHER

"GeneCards: Human Genes, Proteins and Diseases." <http://bioinfo.weizmann.ac.il/cards/>.

"Vermont Newborn Screening Program: Galactosemia." <http://www.vtmednet.org/~m145037/vhgi_mem/nbsman/galacto.htm>.

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Gallbladder cancer

Definition

Cancer of the gallbladder is cancer of the pear-shaped organ that lies on the undersurface of the liver.

Description

Bile from the liver is funneled into the gallbladder by way of the cystic duct. Between meals, the gallbladder stores a large amount of bile. To do this, it must absorb much of the water and electrolytes from the bile. In fact, the inner surface of the gallbladder is the most absorptive surface in the body. After a meal, the gallbladder's muscular walls contract to deliver the bile back through the cystic duct and eventually into the small intestine, where the bile can help digest food.

Demographics

About 5,000 people are diagnosed with gallbladder cancer each year in the United States, making it the fifth most common gastrointestinal cancer. It is more common in females than males and most patients are elderly. Southwest American Indians have a particularly high incidence—six times that of the general population.

Causes and symptoms

Gallstones are the most significant risk factor for the development of gallbladder cancer. Roughly 75 to 90 percent of patients with gallbladder cancer also have gallstones. Larger gallstones are associated with a higher chance of developing gallbladder cancer. Chronic inflammation of the gallbladder from infection also increases the risk for gallbladder cancer.

Unfortunately, sometimes cancer of the gallbladder does not produce symptoms until late in the disease. When symptoms are evident, the most common is **pain** in the upper right portion of the abdomen, underneath the right ribcage. Patients with gallbladder cancer may also report symptoms such as nausea, vomiting, weakness, **jaundice**, skin **itching**, **fever**, chills, poor appetite, and weight loss.

Diagnosis

Gallbladder cancer is often misdiagnosed because it mimics other more common conditions, such as gallstones, **cholecystitis**, and **pancreatitis**. But the imaging tests that are utilized to evaluate these other conditions can also detect gallbladder cancer. For example, ultrasound is a quick, noninvasive imaging test that reliably diagnoses gallstones and cholecystitis. It can also detect the presence of gallbladder cancer as well as show how far the cancer has spread. If cancer is suspected, a computed tomography scan is useful in confirming the presence of an abnormal mass and further demonstrating the size and extent of the tumor. Cholangiography, usually performed to evaluate a patient with jaundice, can also detect gallbladder cancer.

There are no specific laboratory tests for gallbladder cancer. Tumors can obstruct the normal flow of bile from the liver to the small intestine. Bilirubin, a component of bile, builds up within the liver and is absorbed into the bloodstream in excess amounts. This can be detected in a blood test, but it can also manifest clinically as jaundice. Elevated bilirubin levels and clinical jaundice can also occur with other conditions, such as gallstones.

On occasion, gallbladder cancer is diagnosed incidentally. About one percent of all patients who have their gallbladder removed for symptomatic gallstones are

KEY TERMS

Cholangiography—Radiographic examination of the bile ducts after injection with a special dye

Cholecystitis—Inflammation of the gallbladder, usually due to infection

Computed tomography—A radiology test by which images of cross-sectional planes of the body are obtained

Jaundice—Yellowish staining of the skin and eyes due to excess bilirubin in the bloodstream

Metastasis—The spread of tumor cells from one part of the body to another through blood vessels or lymphatic vessels

Pancreatitis—Inflammation of the pancreas

Stent—Slender hollow catheter or rod placed within a vessel or duct to provide support or maintain patency

Ultrasound—A radiology test utilizing high frequency sound waves

found to have gallbladder cancer. The cancer is found either by the surgeon or by the pathologist who inspects the gallbladder with a microscope.

Treatment

Staging of gallbladder cancer is determined by the how far the cancer has spread. The effectiveness of treatment declines as the stage progresses. Stage I cancer is confined to the wall of the gallbladder. Approximately 25% of cancers are at this stage at the time of diagnosis. Stage II cancer has penetrated the full thickness of the wall, but has not spread to nearby lymph nodes or invaded adjacent organs. Stage III cancer has spread to nearby lymph nodes or has invaded the liver, stomach, colon, small intestine, or large intestine. Stage IV disease has invaded very deeply into two or more adjacent organs or has spread to distant lymph nodes or organs by way of metastasis.

Early Stage I cancers involving only the innermost layer of the gallbladder wall can be cured by simple removal of the gallbladder. Cancers at this stage are sometimes found incidentally when the gallbladder is removed in the treatment of gallstones or cholecystitis. The majority of patients have good survival rates. Late Stage I cancers, which involve the outer muscular layers of the gallbladder wall, are generally treated in the same way as Stage II or III cancers. Removal of the gallbladder is not sufficient for these stages. The surgeon also removes nearby lymph nodes as well as a portion of the adjacent liver (radical surgery). Survival rates for these patients are considerably worse than for those with early Stage I disease. Patients with early Stage IV disease may benefit from radical surgery, but the issue is controversial. Late Stage IV cancer has spread too extensively to allow complete excision. Surgery is not an option for these patients.

Other therapies

When long-term survival is not likely, the focus of therapy shifts to improving quality of life. Jaundice and blockage of the stomach are two problems faced by patients with advanced cancer of the gallbladder. These can be treated with surgery, or alternatively, by special interventional techniques employed by the gastroenterologist or radiologist. A stent can be placed across the bile ducts in order to re-establish the flow of bile and relieve jaundice. A small feeding tube can be placed in the small intestine to allow feeding when the stomach is blocked. Pain may be treated with conventional pain medicines or a celiac **ganglion** nerve block.

Current **chemotherapy** or **radiation therapy** cannot cure gallbladder cancer, but they may offer some benefit in certain patients. For cancer that is too advanced for surgical cure, treatment with chemotherapeutic agents such as 5-fluorouracil may lengthen survival for a few months. The limited benefit of chemotherapy must be weighed carefully against its side effects. Radiation therapy is sometimes used after attempted surgical resection of the cancer to extend survival for a few months or relieve jaundice.

Resources

BOOKS

Ahrendt, Steven A. and Henry A. Pitt. "Biliary Tract." In *Sabiston Textbook of Surgery*, edited by Courtney Townsend Jr., 16th ed. Philadelphia: W.B. Saunders Company, 2001, pp. 1076-1111.

Corsetti, Ralph L. and Harold J. Wanebo. "Bile Duct Cancer." In *Current Surgical Therapy*, edited by John L. Cameron, sixth ed. St Louis: Mosby, 1998, pp.462-468.

"Gallbladder Carcinoma." In *Clinical Oncology*, edited by Abeloff, Martin D., second ed. New York: Churchill Livingstone, 2000, pp.1730-1737.

OTHER

National Cancer Institute Cancer Trials web site. <http://cancertrials.nci.nih.gov/system>. <http://www.cancertrials.com>.

Kevin O. Hwang, M.D.

Gallbladder disease *see* **Cholecystitis**

Gallbladder nuclear medicine scan

Definition

A nuclear medicine scan of the gallbladder is used to produce a set of images that look like x rays. The procedure uses a small amount of radioactive dye which is injected into the body. The dye accumulates in the organ, in this case, the gallbladder. A special camera called a scintillation or gamma camera produces images based on how the dye travels through the system and how the radiation is absorbed by the tissues. The procedure is also called cholescintigraphy or a hepatobiliary scan.

KEY TERMS

Cholecystitis—Inflammation of the gallbladder.

Cholescintigraphy—Another term for a gallbladder nuclear medicine scan.

Hepatobiliary scan—Another term for a gallbladder nuclear medicine scan.

Scintillation or gamma camera—A camera, somewhat like an x-ray machine, used to photograph internal organs after the patient has been injected with a radioactive material.

Purpose

A nuclear medicine scan can be used to diagnose disease and to find abnormalities in a body organ. A gallbladder scan can detect **gallstones**, tumors, or defects of the gallbladder. It can also be used to diagnose blockages of the bile duct that leads from the gallbladder to the small intestine. Unlike ultrasound, a gallbladder nuclear medicine scan can assess gallbladder function.

Precautions

Women who are pregnant or breastfeeding should tell their doctors before a scan is performed. Some medications or even eating a high fat meal before the procedure can interfere with the results of the scan.

Description

The gallbladder is a small pear-shaped sac located under the liver. The liver produces bile, a yellowish-green mixture of salts, acids, and other chemicals, that are stored in the gallbladder. Bile is secreted into the small intestine to help the body digest fats from foods.

Gallbladder disease, gallstones, **cancer**, or other abnormalities can cause **pain** and other symptoms. A gallbladder condition might be suspected if a patient has chronic or occasional pain in the upper right side of the abdomen. The pain may be stabbing and intense with sudden onset or it may be more of a dull, occasional ache. Loss of appetite, **nausea and vomiting** can also occur. **Fever** may indicate the presence of infection. **Jaundice**, a yellowing of the skin and whites of the eyes, may also indicate that the gallbladder is involved.

A gallbladder nuclear medicine scan may be used to diagnose gallstones, blockage of the bile duct or other abnormalities, and to assess gallbladder functioning and inflammation (**cholecystitis**). The scan is usually performed in a hospital or clinical radiology department. The patient lies on an examination table while a small amount of radioactive dye is injected into a vein in the arm. This dye circulates through the blood and collects in the gallbladder. As the dye moves through the gallbladder, a series of pictures is taken using a special camera called a *scintillation* or *gamma camera*. This procedure produces images that look like x rays. The test usually takes one to two hours to complete, but can last up to four hours.

The results of the scan are read by a radiologist, a doctor specializing in x rays and other types of scanning techniques. A report is sent, usually within 24 hours, to the doctor who will discuss the results with the patient.

Preparation

The patient may be required to withhold food and liquids for up to eight hours before the scan.

Aftercare

No special care is required after the procedure. Once the scan is complete, the patient can return to normal activities.

Risks

Nuclear medicine scans use a very small amount of radioactive material, and the risk of radiation is minimal. Very rarely, a patient may have a reaction to the dye material used.

Normal results

A normal scan shows a gallbladder without gallstones. There will be no evidence of growths or tumors, and no signs of infection or swelling. The normal gall-

bladder fills with bile and secretes it through the bile duct without blockages.

Abnormal results

An abnormal scan may show abnormal gallbladder emptying (suggesting gallbladder dysfunction or inflammation), or gallstones in the gallbladder or in the bile duct. The presence of tumors, growths or other types of blockages of the duct or the gallbladder itself could also appear on an abnormal scan.

Resources

BOOKS

"Common Nuclear Scan and Why They are Performed." In *The Consumer's Medical Desk Reference*, ed. Charles B. Inlander. New York: Hyperion, 1995.

"Hepatic Scans." in *Infectious Diseases*. 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

OTHER

"Gallbladder Scan, Radioisotope." Infonet. <http://infonet.med.cornell.edu>.

"Nuclear Medicine." Washington Radiology Associates Page. <http://www.wrapc.com>.

Altha Roberts Edgren

Gallbladder surgery *see* **Cholecystectomy**

Gallbladder x rays

Definition

This is an x-ray exam of the gallbladder (GB), a sac-like organ that stores bile that is located under the liver. The study involves taking tablets containing dye (contrast) which outline any abnormalities when x rays are taken the following day. The test was once the standard for diagnosing diseases of the GB such as **gallstones**, but is used less frequently now. This is due to advances in diagnostic ultrasound, which is quick, accurate and doesn't involve exposure to ionizing radiation. When functional parameters of the gallbladder need to be demonstrated, scintigraphy is now the study of choice. OCG, however, can be useful when a gallbladder is contracted down due to the presence of many, many gallstones. It can also help determine whether the cystic duct is clear, prior to surgical procedures such as **lithotripsy**. OCG may also be used to evaluate gallbladder disease that doesn't involve gallstones, such as adenomyomatosis of the gallbladder or cholesterolosis of the gallbladder.

Purpose

This test, also known as an oral cholecystogram or OCG, is usually ordered to help physicians diagnose disorders of the gallbladder, such as gallstones and tumors, which show up as solid dark structures. It is performed to help in the investigation of patients with upper abdominal **pain**. The test also measures gallbladder function, as the failure of the organ to visualize can signify a non-functioning or diseased gallbladder. The gallbladder may also not visualize if the bilirubin level is over 4 and the study should not be performed under these circumstances.

Precautions

Your physician must be notified if you are pregnant or allergic to iodine. Patients with a history of severe kidney damage, have an increased risk of injury or side effects from the procedure. In those cases, ultrasound is commonly used instead of the x-ray examination. Some people experience side effects from the contrast material (dye tablets), especially **diarrhea**. During preparation for the test, patients should not use any **laxatives**. Diabetics should discuss the need for any adjustment in medication with their physician.

Description

The exam is performed in the radiology department. The night before the test, patients swallow six tablets (one at a time) that contain the contrast (x-ray dye). The following day at the hospital, the radiologist examines the gallbladder with a fluoroscope (a special x ray that projects the image onto a video monitor). Sometimes, patients are then asked to drink a highfat formula that will cause the gallbladder to contract and release bile. X rays will then be taken at various intervals. There is no discomfort from the test. If the gallbladder is not seen, the patient may be asked to return the following day for x rays.

Preparation

The day before the test patients are instructed to eat a high fat lunch (eggs, butter, milk, salad oils, or fatty meats), and a fat-free meal (fruits, vegetables, bread, tea or coffee, and only lean meat) in the evening. Two hours after the evening meal, six tablets containing the contrast medium, are taken, one a time. After that, no food or fluid is permitted until after the test.

Aftercare

No special care is required after the study.

KEY TERMS

Bile—A yellow-green liquid produced by the liver, which is released through the bile ducts into the small intestines to help digest fat.

Bilirubin—A reddish-yellow pigment formed from the destruction of red blood cells, and metabolized by the liver. Levels of bilirubin in the blood increase in patients with liver disease or blockage of the bile ducts.

Ultrasound—A non-invasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition. It requires no preparation and no radiation occurs; it has become the "gold standard" for diagnosis of stones in the gallbladder, but is less accurate in diagnosing stones in the bile ducts. Gallstones as small as 2 mm can be identified.

Risks

There is a small chance of an allergic reaction to the contrast material. In addition, there is low radiation exposure. X rays are monitored and regulated to provide the minimum amount of radiation exposure needed to produce the image. Most experts feel that the risk is low compared with the benefits. Pregnant women and children are more sensitive to the risks of x rays, and the risk versus benefits should be discussed with the treating physician.

Normal results

The x ray will show normal structures for the age of the patient. The gallbladder should visualize, and be free of any solid structures, such as stones, polyps, etc.

Abnormal results

Abnormal results may show gallstones, tumors, or cholesterol polyps (a tumor growing from the lining that is usually noncancerous). Typically stones will "float" or move around as the patient changes position, whereas tumors will stay in the same place.

Resources

BOOKS

Levenson, Deborah E. and Fromm, Hans. "Oral Cholecystogram." In *Hepatology: A Textbook of Liver Disease,* edited by David Zakim and Thomas D. Boyer et al. Philadelphia: W.B. Saunders Company. 1996, p.1883.

Sleisenger and Fordtran's Gastrointestinal and Liver Disease: Pathophysiology/Diagnosis/ Management, edited Mark Feldman, et al. Philadelphia: W.B. Saunders Company, 1998.

Zeaman, Robert K. "Oral Cholecystography." In *Bockus Gastroenterology*, edited by William S. Haubrich et al. Philadelphia: W.B. Saunders Company. 1995, pp. 208-211.

OTHER

"Gall Bladder Exam." Harvard Medical School. <http://www.bih.harvard.edu/radiology/Modalities/Xray/ xraysSubdivsf/gallbl.html>.

"Gallstones." National Institutes of Health. <http://www.niddk.nih.gov/health/digest/pubs/gallstns/ gallstns.htm>.

"Oral cholecystogram." Healthanswers.com. <http://www.healthanswers.com/database/ami/converted/003821.html>.

Rosalyn Carson-DeWitt, MD

Gallium scan of the body

Definition

A gallium scan of the body is a nuclear medicine test that is conducted using a camera that detects gallium, a form of radionuclide, or radioactive chemical substance.

Purpose

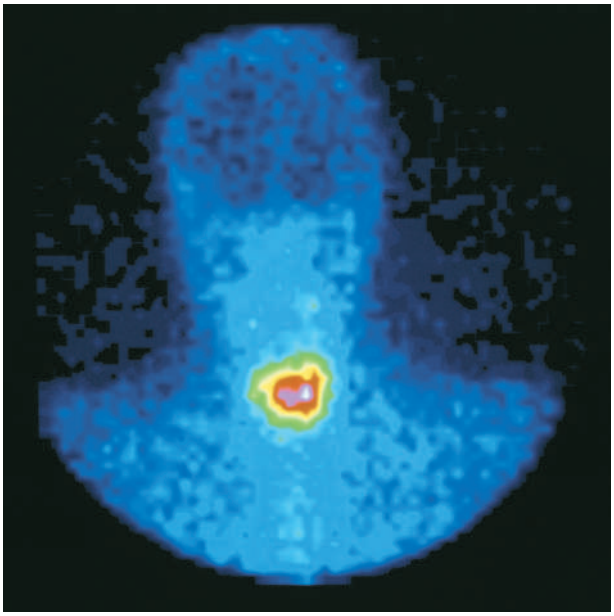
Most gallium scans are ordered to detect cancerous tumors, infections, or areas of inflammation in the body. Gallium is known to accumulate in inflamed, infected, or cancerous tissues. The scans are used to determine whether a patient with an unexplained **fever** has an infection and the site of the infection, if present. Gallium scans also may be used to evaluate **cancer** following **chemotherapy** or **radiation therapy**.

Precautions

Children and women who are pregnant or breast-feeding are only given gallium scans if the potential diagnostic benefits will outweigh the risks.

Description

The patient will usually be asked to come to the testing facility 24–48 hours before the procedure to receive the injection of gallium. Sometimes, the injection will be given only four to six hours before the study or as long as 72 hours before the procedure. The timeframe is based on the area or organs of the body being studied.



Gallium scan highlighting the thyroid gland. *(Photo Researchers. Reproduced by permission.)*

For the study itself the patient lies very still for approximately 30–60 minutes. A camera is moved across the patient's body to detect and capture images of concentrations of the gallium. The camera picks up signals from any accumulated areas of the radionuclide. In most cases, the patient is lying down throughout the procedure. Back (posterior) and front (anterior) views will usually be taken, and sometimes a side (lateral) view is used. The camera may occasionally touch the patient's skin, but will not cause any discomfort. A clicking noise may be heard throughout the procedure; this is only the sound of the scanner registering radiation.

Preparation

The intravenous injection of gallium is done in a separate appointment prior to the procedure. Generally, no special dietary requirements are necessary. Sometimes the physician will ask that the patient have light or clear meals within a day or less of the procedure. Many patients will be given **laxatives** or an enema prior to the scan to eliminate any residual gallium from the bowels.

Aftercare

There is generally no aftercare required following a gallium scan. However, women who are breastfeeding who have a scan will be cautioned against breastfeeding for four weeks following the exam.

Risks

There is a minimal risk of exposure to radiation from the gallium injection, but the exposure from one gallium scan is generally less than exposure from x rays.

Normal results

A radiologist trained in nuclear medicine or a nuclear medicine specialist will interpret the exam results and compare them to other diagnostic tests. It is normal for gallium to accumulate in the liver, spleen, bones, breast tissue, and large bowel.

Abnormal results

An abnormal concentration of gallium in areas other than those where it normally concentrates may indicate the presence of disease. Concentrations may be due to inflammation, infection, or the presence of tumor tissue. Often, additional tests are required to determine if the tumors are malignant (cancerous) or benign.

Even though gallium normally concentrates in organs such as the liver or spleen, abnormally high concentrations will suggest certain diseases and conditions. For example, Hodgkin's or non-Hodgkin's lymphoma may be diagnosed or staged if there is abnormal gallium activity in the lymph nodes. After a patient receives cancer treatment, such as radiation therapy or chemotherapy, a gallium scan may help to find new or recurring tumors or to record regression of a treated tumor. Physicians can narrow causes of liver problems by noting abnormal gallium activity in the liver. Gallium scans also may be used to diagnose lung diseases or a disease called **sarcoidosis**, in the chest.

Resources

BOOKS

Fischbach, Frances T. *A Manual of Laboratory and Diagnostic Tests*. Philadelphia, PA: Lippincott-Raven Publishers, 1996.

Illustrated Guide to Diagnostic Tests. Springhouse, PA: Springhouse Corporation, 1998.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Road NE, Atlanta, GA 30329. (404) 320-3333. <http://www.cancer.org>.

American College of Nuclear Medicine. PO Box 175, Landisville, PA 31906. (717) 898-6006.

American Liver Foundation. 1425 Pompton Avenue, Cedar Grove NJ 07009. (800) GO LIVER (465-4837). <http://www.liverfoundation.org>.

Society of Nuclear Medicine. 1850 Samuel Morse Drive, Reston, VA 10016. (703) 708-9000. <http://www.snm.org>.

KEY TERMS

Benign—Not cancerous. Benign tumors are not considered immediate threats, but may still require some form of treatment.

Gallium—A form of radionuclide that is used to help locate tumors and inflammation (specifically referred to as GA67 citrate).

Malignant—This term, usually used to describe a tumor, means cancerous, becoming worse and possibly growing.

Nuclear medicine—A subspecialty of radiology used to show the function and anatomy of body organs. Very small amounts of radioactive substances, or tracers, are detected with a special camera as they accumulate in certain organs and tissues.

Radionuclide—A chemical substance, called an isotope, that exhibits radioactivity. A gamma camera, used in nuclear medicine procedures, will pick up the radioactive signals as the substance gathers in an organ or tissue. They are sometimes referred to as tracers.

OTHER

"A Patient's Guide to Nuclear Medicine." *University of Iowa Virtual Hospital*. <http://www.vh.org/Patients/IHB/Rad/NucMed/PatGuideNucMed/PatGuideNucMed.html>. 2 July 2001.

Teresa G. Norris

Gallstone removal

Definition

Also known as cholelithotomy, gallstone removal is the medical procedure that rids the gallbladder of calculus buildup.

Purpose

The gallbladder is not a vital organ. Its function is to store bile, concentrate it, and release it during digestion. Bile is supposed to retain all of its chemicals in solution, but commonly one of them crystallizes and forms sand, gravel, and finally stones.

The chemistry of **gallstones** is complex and interesting. Like too much sugar in solution, chemicals in bile will form crystals as the gallbladder draws water out of the bile. The solubility of these chemicals is based on the concentration of three chemicals, not just one—bile acids, phospholipids, and cholesterol. If the chemicals are out of balance, one or the other will not remain in solution. Certain people, in particular the Pima tribe of Native Americans in Arizona, have a genetic predisposition to forming gallstones. Scandinavians also have a higher than average incidence of this disease. Dietary fat and cholesterol are also implicated in their formation. Overweight women in their middle years constitute the vast majority of patients with gallstones in every group.

As the bile crystals aggregate to form stones, they move about, eventually occluding the outlet and preventing the gallbladder from emptying. This creates symptoms. It also results in irritation, inflammation, and sometimes infection of the gallbladder. The pattern is usually one of intermittent obstruction due to stones moving in and out of the way. All the while the gallbladder is becoming more scarred. Sometimes infection fills it with pus—a serious complication.

On occasion a stone will travel down the cystic duct into the common bile duct and get stuck there. This will back bile up into the liver as well as the gallbladder. If the stone sticks at the Ampulla of Vater, the pancreas will also be plugged and will develop **pancreatitis**. These stones can cause a lot of trouble.

Bile is composed of several waste products of metabolism, all of which are supposed to remain in liquid form. The complex chemistry of the liver depends on many chemical processes, which depend in turn upon the chemicals in the diet and the genes that direct those processes. There are greater variations in the output of chemical waste products than there is allowance for their cohabitation in the bile. Incompatible mixes result in the formation of solids.

Gallstones will cause the sudden onset of **pain** in the upper abdomen. Pain will last for 30 minutes to several hours. Pain may move to the right shoulder blade. Nausea with or without vomiting may accompany the pain.

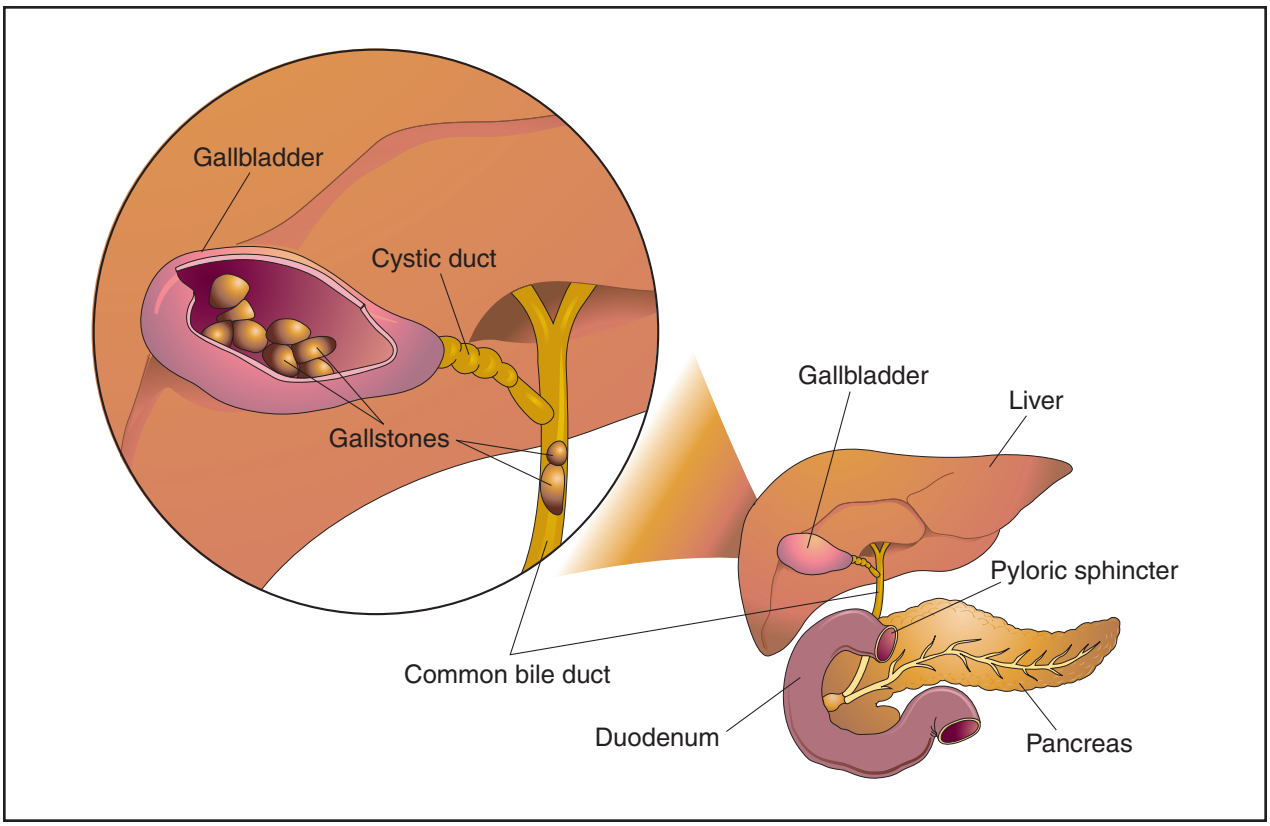
Precautions

Individuals suffering from sickle cell anemia, children, and patients with large stones may seek other treatments.

Description

Laparoscopic cholecystectomy

Surgery to remove the entire gallbladder with all its stones is usually the best treatment, provided the patient



Gallstone removal, also known as cholelithotomy, usually involves the surgical removal of the entire gallbladder, but in recent years the procedure done by laparoscopy has resulted in smaller surgical incisions and faster recovery time. *(Illustration by Electronic Illustrators Group.)*

is able to tolerate the procedure. Over the past decade, a new technique of removing the gallbladder using a laparoscope has resulted in quicker recovery and much smaller surgical incisions than the six-inch gash under the right ribs that used to be standard. Not everyone is a candidate for this approach.

If a stone is lodged in the bile ducts, additional surgery must be done to remove it. After surgery, the surgeon will ordinarily leave in a drain to collect bile until the system is healed. The drain can also be used to inject contrast material and take x rays during or after surgery.

Endoscopic retrograde cholangiopancreatoscopy (ERCP)

A procedure called endoscopic retrograde cholangiopancreatoscopy (ERCP) allows the removal of some bile duct stones through the mouth, throat, esophagus, stomach, duodenum, and biliary system without the need for surgical incisions. ERCP can also be used to inject contrast agents into the biliary system, providing superbly detailed pictures.

Cholelithotomy

Rare circumstances require different techniques. Patients too ill for a complete **cholecystectomy** (removal of the gallbladder), sometimes only the stones are removed, a procedure called cholelithotomy. But that does not cure the problem. The liver will go on making faulty bile, and stones will reform, unless the composition of the bile is altered.

Ursodeoxycholic acid

For patients who cannot receive the laparoscopic procedure, there is also a nonsurgical treatment in which ursodeoxycholic acid is used to dissolve the gallstones. Extracorporeal shock-wave **lithotripsy** has also been successfully used to break up gallstones. During the procedure, high-amplitude sound waves target the stones, slowly breaking them up.

Preparation

There are a number of imaging studies that identify gallbladder disease, but most gallstones will not show up

KEY TERMS

Cholecystectomy—Surgical removal of the gallbladder.

Cholelithotomy—Surgical incision into the gallbladder to remove stones.

Contrast agent—A substance that causes shadows on x rays (or other images of the body).

Endoscope—One of several instruments designed to enter body cavities. They combine viewing and operating capabilities.

Jaundice—A yellow color of the skin and eyes due to excess bile that is not removed by the liver.

Laparoscopy—Surgery through pencil-sized viewing instruments and tools so that incisions need be less than half an inch long.

on conventional x rays. That requires contrast agents given by mouth that are excreted into the bile. Ultrasound is very useful and can be enhanced by doing it through an endoscope in the stomach. CT (**computed tomography scans**) and MRI (**magnetic resonance imaging**) scanning are not used routinely but are helpful in detecting common duct stones and complications.

Aftercare

Without a gallbladder, stones rarely reform. Patients who have continued symptoms after their gallbladder is removed may need an ERCP to detect residual stones or damage to the bile ducts caused by the stones before they were removed. Once in a while the Ampulla of Vater is too tight for bile to flow through and causes symptoms until it is opened up.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Bilhartz, Lyman E., and Jay D. Horton. "Gallstone Disease and Its Complications." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

Friedman, Lawrence J. "Liver, Biliary Tract and Pancreas." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Hoffmann, Alan F. "Bile Secretion and the Enterohepatic Circulation of Bile Acids." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Mulvihill, Sean J. "Surgical Management of Gallstone Disease and Postoperative Complications." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Paumgartner, Gustav. "Non-surgical Management of Gallstone Disease" In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

J. Ricker Polsdorfer, MD

Gallstones

Definition

A gallstone is a solid crystal deposit that forms in the gallbladder, which is a pear-shaped organ that stores bile salts until they are needed to help digest fatty foods. Gallstones can migrate to other parts of the digestive tract and cause severe **pain** with life-threatening complications.

Description

Gallstones vary in size and chemical structure. A gallstone may be as tiny as a grain of sand or as large as a golf ball. Eighty percent of gallstones are composed of cholesterol. They are formed when the liver produces more cholesterol than digestive juices can liquefy. The remaining 20% of gallstones are composed of calcium and an orange-yellow waste product called bilirubin. Bilirubin gives urine its characteristic color and sometimes causes **jaundice**.

Gallstones are the most common of all gallbladder problems. They are responsible for 90% of gallbladder and bile duct disease, and are the fifth most common reason for hospitalization of adults in the United States. Gallstones usually develop in adults between the ages of 20 and 50; about 20% of patients with gallstones are over 40. The risk of developing gallstones increases with age—at least 20% of people over 60 have a single large stone or as many as several thousand smaller ones. The gender ratio of gallstone patients changes with age. Young women are between two and six times more likely to develop gallstones than men in the same age group. In patients over 50, the condition affects men and women with equal frequency. Native Americans develop gallstones more often than any other segment of the population; Mexican-Americans have the second-highest incidence of this disease.

Definitions

Gallstones can cause several different disorders. Cholelithiasis is defined as the presence of gallstones within the gallbladder itself. Choledocholithiasis is the presence of gallstones within the common bile duct that leads into the first portion of the small intestine (the duodenum). The stones in the duct may have been formed inside it or carried there from the gallbladder. These gallstones prevent bile from flowing into the duodenum. Ten percent of patients with gallstones have choledocholithiasis, which is sometimes called common-duct stones. Patients who don't develop infection usually recover completely from this disorder.

Cholecystitis is a disorder marked by inflammation of the gallbladder. It is usually caused by the passage of a stone from the gallbladder into the cystic duct, which is a tube that connects the gallbladder to the common bile duct. In 5–10% of cases, however, cholecystitis develops in the absence of gallstones. This form of the disorder is called acalculous cholecystitis. Cholecystitis causes painful enlargement of the gallbladder and is responsible for 10–25% of all gallbladder surgery. Chronic cholecystitis is most common in the elderly. The acute form is most likely to occur in middle-aged adults.

Cholesterolosis or cholesterol polyps is characterized by deposits of cholesterol crystals in the lining of the gallbladder. This condition may be caused by high levels of cholesterol or inadequate quantities of bile salts, and is usually treated by surgery.

Gallstone **ileus**, which results from a gallstone's blocking the entrance to the large intestine, is most common in elderly people. Surgery usually cures this condition.

Narrowing (stricture) of the common bile duct develops in as many as 5% of patients whose gallbladders have been surgically removed. This condition is characterized by inability to digest fatty foods and by abdominal pain, which sometimes occurs in spasms. Patients with stricture of the common bile duct are likely to recover after appropriate surgical treatment.

Causes and symptoms

Gallstones are caused by an alteration in the chemical composition of bile. Bile is a digestive fluid that helps the body absorb fat. Gallstones tend to run in families. In addition, high levels of estrogen, insulin, or cholesterol can increase a person's risk of developing them.

Pregnancy or the use of birth control pills can slow down gallbladder activity and increase the risk of gallstones. So can diabetes, **pancreatitis**, and **celiac disease**. Other factors influencing gallstone formation are:

- infection
- obesity
- intestinal disorders
- coronary artery disease or other recent illness
- multiple pregnancies
- a high-fat, low-fiber diet
- smoking
- heavy drinking
- rapid weight loss

Gallbladder attacks usually follow a meal of rich, high-fat foods. The attacks often occur in the middle of the night, sometimes waking the patient with intense pain that ends in a visit to the emergency room. The pain of a gallbladder attack begins in the abdomen and may radiate to the chest, back, or the area between the shoulders. Other symptoms of gallstones include:

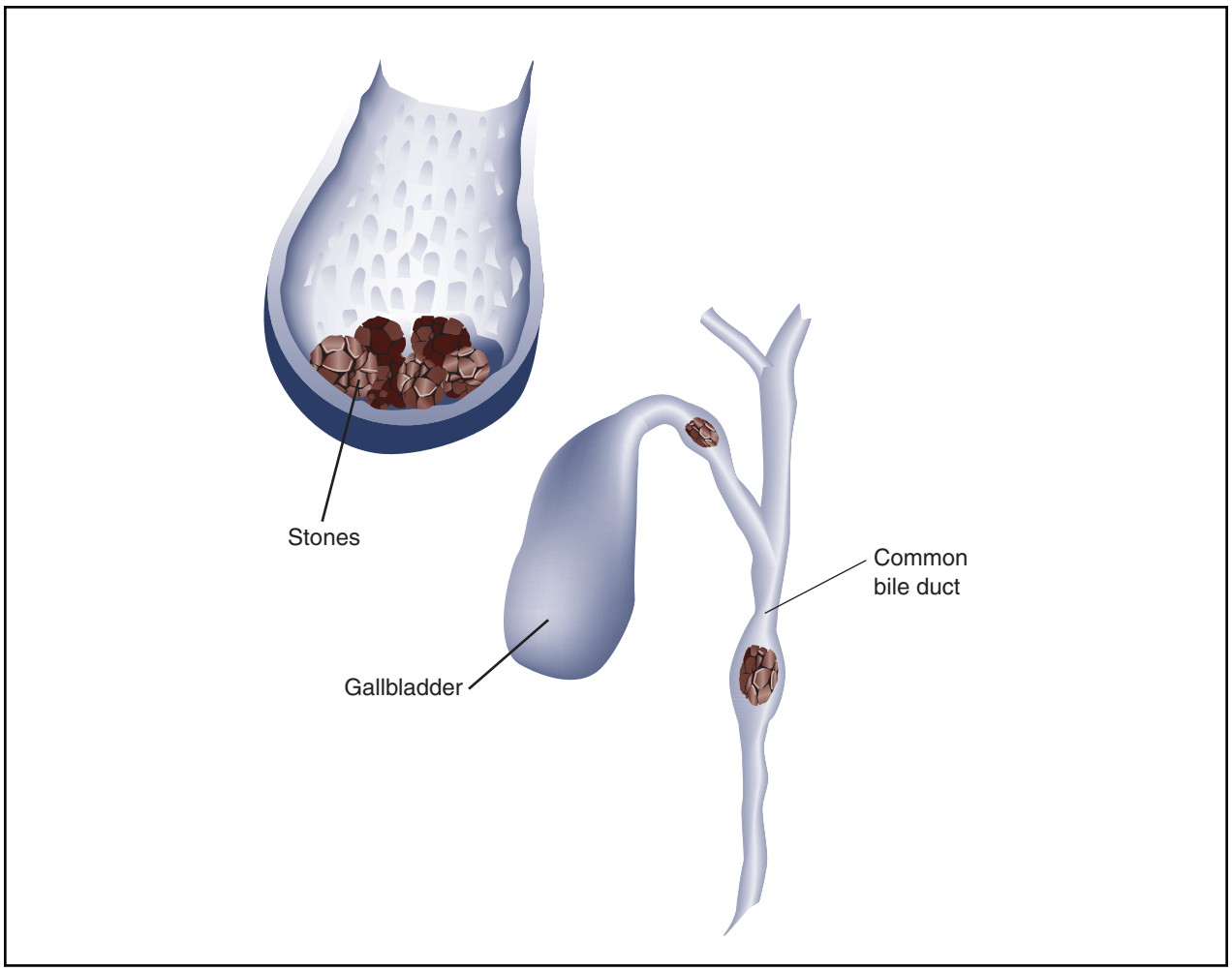
- inability to digest fatty foods
- low-grade **fever**
- chills and sweating
- nausea and vomiting
- indigestion
- gas
- belching.
- clay-colored bowel movements

Diagnosis

Gallstones may be diagnosed by a family doctor, a specialist in digestive problems (a gastroenterologist), or a specialist in internal medicine. The doctor will first examine the patient's skin for signs of jaundice and feel (palpate) the abdomen for soreness or swelling. After the basic **physical examination**, the doctor will order blood counts or blood chemistry tests to detect evidence of bile duct obstruction and to rule out other illnesses that cause fever and pain, including stomach ulcers, **appendicitis**, and heart attacks.

More sophisticated procedures used to diagnose gallstones include:

- Ultrasound imaging. Ultrasound has an accuracy rate of 96%.
- Cholecystography (cholecystogram, gallbladder series, gallbladder x ray). This type of study shows how the gallbladder contracts after the patient has eaten a high-fat meal.
- Fluoroscopy. This imaging technique allows the doctor to distinguish between jaundice caused by pancreatic **cancer** and jaundice caused by gallbladder or bile duct disorders.



Gallstones form in the gallbladder but can migrate to other parts of the body via the bile duct. *(Illustration by Argosy Inc.)*

- Endoscopy (ERCP). ERCP uses a special dye to outline the pancreatic and common bile ducts and locate the position of the gallstones.
- Radioisotopic scan. This technique reveals blockage of the cystic duct.

Treatment

Watchful waiting

One-third of all patients with gallstones never experience a second attack. For this reason many doctors advise watchful waiting after the first episode. Reducing the amount of fat in the diet or following a sensible plan of gradual weight loss may be the only treatments required for occasional mild attacks. A patient diagnosed with gallstones may be able to manage more troublesome episodes by:

- applying heat to the affected area
- resting and taking occasional sips of water
- using non-prescription forms of **acetaminophen** (Tylenol or Anacin-3)

A doctor should be notified if pain intensifies or lasts for more than three hours; if the patient's fever rises above 101°F (38.3°C); or if the skin or whites of the eyes turn yellow.

Surgery

Surgical removal of the gallbladder (**cholecystectomy**) is the most common conventional treatment for recurrent attacks. Laparoscopic surgery, the technique most widely used, is a safe, effective procedure that involves less pain and a shorter recovery period than traditional open surgery. In this technique, the doctor makes a small cut (incision) in the patient's abdomen and removes the gallbladder through a long tube called a laparoscope.

KEY TERMS

Acalculous cholecystitis—Inflammation of the gallbladder that occurs without the presence of gallstones.

Bilirubin—A reddish-yellow waste product produced by the liver that colors urine and is involved in the formation of some gallstones.

Celiac disease—Inability to digest wheat protein (gluten), which causes weight loss, lack of energy, and pale, foul-smelling stools.

Cholecystectomy—Surgical removal of the gallbladder.

Cholecystitis—Inflammation of the gallbladder.

Choledocholithiasis—The presence of gallstones within the common bile duct.

Cholelithiasis—The presence of gallstones within the gallbladder.

Cholesterolosis—Cholesterol crystals or deposits in the lining of the gallbladder.

Common bile duct—The passage through which bile travels from the cystic duct to the small intestine.

Gallstone ileus—Obstruction of the large intestine caused by a gallstone that has blocked the intestinal opening.

Lithotripsy—A nonsurgical technique for removing gallstones by breaking them apart with high-frequency sound waves.

Nonsurgical approaches

LITHOTRIPSY. Shock wave therapy (**lithotripsy**) uses high-frequency sound waves to break up the gallstones. The patient can then take bile salts to dissolve the fragments. Bile salt tablets are sometimes prescribed without lithotripsy to dissolve stones composed of cholesterol by raising the level of bile acids in the gallbladder. This approach requires long-term treatment, since it may take months or years for this method to dissolve a sizeable stone.

CONTACT DISSOLUTION. Contact dissolution can destroy gallstones in a matter of hours. This minimally invasive procedure involves using a tube (catheter) inserted into the abdomen to inject medication directly into the gallbladder.

Alternative treatment

Alternative therapies, like non-surgical treatments, may provide temporary relief of gallstone symptoms. Alternative approaches to the symptoms of gallbladder disorders include **homeopathy**, Chinese traditional herbal medicine, and **acupuncture**. Dietary changes may also help relieve the symptoms of gallstones. Since gallstones seem to develop more often in people who are obese, eating a balanced diet, exercising, and losing weight may help keep gallstones from forming.

Prognosis

Forty percent of all patients with gallstones have "silent gallstones" that produce no symptoms. Silent stones, discovered only when their presence is indicated by tests performed to diagnose other symptoms, do not require treatment.

Gallstone problems that require treatment can be surgically corrected. Although most patients recover, some develop infections that must be treated with **antibiotics**.

In rare instances, severe inflammation can cause the gallbladder to burst. The resulting infection can be fatal.

Prevention

The best way to prevent gallstones is to minimize risk factors. In addition, a 1998 study suggests that vigorous **exercise** may lower a man's risk of developing gallstones by as much as 28%. The researchers have not yet determined whether physical activity benefits women to the same extent.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments.* Alexandria, VA: Time Life, Inc., 1996.

New Choices in Natural Healing. Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

Shaw, Michael, ed. *Everything You Need to Know About Diseases.* Springhouse, PA: Springhouse Corporation, 1996.

PERIODICALS

"Exercise Prevents Gallstone Disease." *Journal Watch* (15 Apr. 1998): 63-64.

ORGANIZATIONS

National Digestive Diseases Clearinghouse (NDDIC). 2 Information Way

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

OTHER

"Gallbladder Problems." St. Luke's Episcopal Hospital Page. 3 Mar. 1998 <http://www.sleh.com/sleh>.

"Gallstones." Geisinger Health System Home Page. 17 Apr. 1998 <http://www.geisinger.edu>.

"Gallstones." ThriveOnline. 6 Apr. 1998 <http://thriveonline.oxygen.com>.

Oral Cholecystogram." HealthGate Page. 17 Apr. 1998 <http://www3.healthgate.com>.

Maureen Haggerty

Gamete intrafallopian transfer *see* **Infertility therapies**

Gamma-glutamyl transferase test *see* **Liver function tests**

Gammaglobulin

KEY TERMS

Hepatitis—Inflammation of the liver caused by a virus, chemical or drugs. There are several different types of hepatitis, including the most common forms: hepatitis A, hepatitis B, and hepatitis C.

Immune system—The body's natural defenses against disease and infection.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Definition

Gammaglobulin is a type of protein found in the blood. When gammaglobulins are extracted from the blood of many people and combined, they can be used to prevent or treat infections.

Purpose

This medicine is used to treat or prevent diseases that occur when the body's own immune system is not effective against the disease. When disease-causing agents enter the body, they normally trigger the production of antibodies, proteins that circulate in the blood and help fight the disease. Gammaglobulin contains some of these antibodies. When gammaglobulins are taken from the blood of people who have recovered from diseases such as **chickenpox** or hepatitis, they can be given to other people to make them temporarily immune to those diseases. With hepatitis, for example, this is done when someone who has not been vaccinated against hepatitis is exposed to the disease.

Description

Gammaglobulin, also known as immunoglobulin, immune serum globulin or serum therapy, is injected either into a vein or into a muscle. When injected into a vein, it produces results more quickly than when injected into a muscle.

Recommended dosage

Doses are different for different people and depend on the person's body weight and the condition for which he or she is being treated.

Precautions

Anyone who has had unusual reactions to gammaglobulin in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

People who have certain medical conditions may have problems if they take gammaglobulins. For example:

- Gammaglobulins may worsen heart problems or deficiencies of immunoglobin A (IgA, a type of antibody)
- Certain patients with low levels of gammaglobulins in the blood (conditions called agammaglobulinemia and hypogammaglobulinemia) may be more likely to have side effects when they take gammaglobulin.

Side effects

Minor side effects such as **headache**, backache, joint or muscle **pain**, and a general feeling of illness usually go away as the body adjusts to this medicine. These problems do not need medical attention unless they continue.

Other side effects, such as breathing problems or a fast or pounding heartbeat, should be brought to a physician's attention as soon as possible.

Anyone who shows the following signs of overdose should check with a physician immediately:

- unusual tiredness or weakness

- dizziness
- nausea
- vomiting
- fever
- chills
- tightness in the chest
- red face
- sweating

Interactions

Anyone who takes gammaglobulin should let the physician know all other medicines he or she is taking and should ask whether interactions with gammaglobulin could interfere with treatment.

Nancy Ross-Flanigan

Ganglion

Definition

A ganglion is a small, usually hard bump above a tendon or in the capsule that encloses a joint. A ganglion is also called a synovial **hernia** or synovial cyst.

Description

A ganglion is a non-cancerous cyst filled with a thick, jelly-like fluid. Ganglions can develop on or beneath the surface of the skin and usually occur between the ages of 20 and 40.

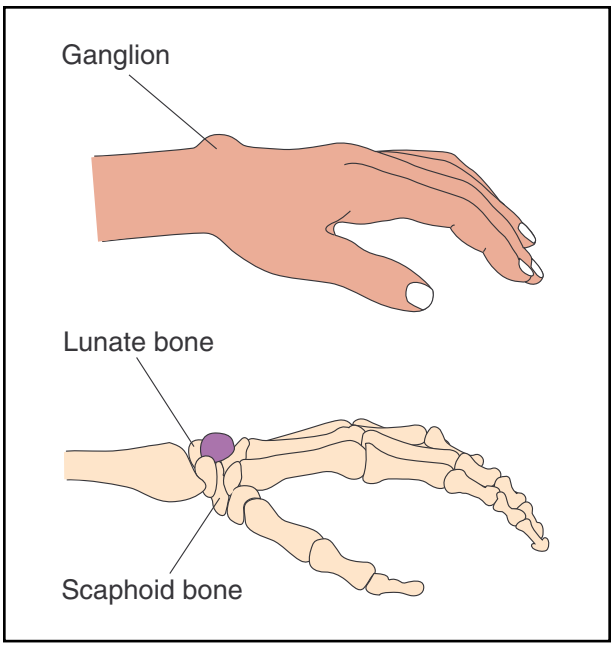
Most ganglions develop on the hand or wrist. This condition is common in people who bowl or who play handball, raquetball, squash, or tennis. Runners and athletes who jump, ski, or play contact sports often develop foot ganglions.

Causes and symptoms

Mild sprains or other repeated injuries can irritate and tear the thin membrane covering a tendon, causing fluid to leak into a sac that swells and forms a ganglion.

Ganglions are usually painless, but range of motion may be impaired. Flexing or bending the affected area can cause discomfort, as can continuing to perform the activity that caused the condition.

Cysts on the surface of the skin usually develop slowly but may result from injury or severe strain. An internal ganglion can cause soreness or a dull, aching sensation, but the mass cannot always be felt. Symptoms sometimes become evident only when the cyst causes pressure on a nerve or outgrows the membrane surrounding it.



A ganglion is a non-cancerous cyst filled with a thick, jelly-like fluid. Ganglions can develop on or beneath the surface of the skin, most likely on the hand or wrist, although runners and skiers often develop them on the foot. *(Illustration by Electronic Illustrators Group.)*

Diagnosis

Diagnosis is usually made through **physical examination** as well as such imaging studies as x ray, ultrasound, and **magnetic resonance imaging** (MRI). Fluid may be withdrawn from the cyst and evaluated.

Treatment

Some ganglions disappear without treatment, and some reappear despite treatment.

Acetaminophen (Tylenol) or other over-the-counter **analgesics** can be used to control mild **pain**. Steroids or local anesthetics may be injected into cysts that cause severe pain or other troublesome symptoms. Surgery performed in a hospital operating room or an outpatient facility, is the only treatment guaranteed to remove a ganglion. The condition can recur if the entire cyst is not removed.

A doctor should be notified if the surgical site drains, bleeds, or becomes

- inflamed

• painful

• swollen or if the patient feels ill or develops:

• head or muscle aches

• dizziness

• fever following surgery

The patient may bathe or shower as usual, but should keep the surgical site dry and covered with a bandage for two or three days after the operation. Patients may resume normal activities as soon as they feel comfortable doing so.

Prognosis

Possible complications include excessive post-operative bleeding and infection of the surgical site. Calcification, or hardening, of the ganglion is rare.

Prevention

Exercises that increase muscle strength and flexibility can prevent ganglions. Warming and cooling down before and after workouts may also decrease the rate of developing ganglions.

Resources

BOOKS

Taylor, Robert B., ed. *Family Medicine Principles and Practice*. New York: Springer Verlag, 1994.

OTHER

"Foot Ganglion." ThriveOnline. 25 May 1998 <http://thriveonline.oxygen.com>.

"Hand or Wrist Ganglion." ThriveOnline. 25 May 1998 <http://thriveonline.oxygen.com>.

Maureen Haggerty

Gangrene

Definition

Gangrene is the term used to describe the decay or **death** of an organ or tissue caused by a lack of blood supply. It is a complication resulting from infectious or inflammatory processes, injury, or degenerative changes associated with chronic diseases, such as **diabetes mellitus**.

Description

Gangrene may be caused by a variety of chronic diseases and post-traumatic, post-surgical, and spontaneous causes. There are three major types of gangrene: dry, moist, and gas (a type of moist gangrene).

Dry gangrene is a condition that results when one or more arteries become obstructed. In this type of gangrene, the tissue slowly dies, due to receiving little or no blood supply, but does not become infected. The affected area becomes cold and black, begins to dry out and wither, and eventually drops off over a period of weeks or months. Dry gangrene is most common in persons with advanced blockages of the arteries (arteriosclerosis) resulting from diabetes.

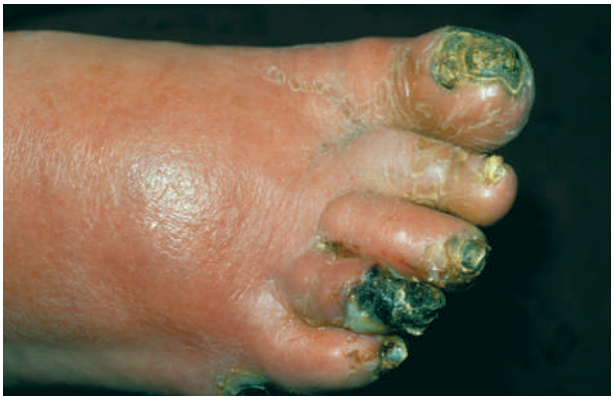
Moist gangrene may occur in the toes, feet, or legs after a crushing injury or as a result of some other factor that causes blood flow to the area to suddenly stop. When blood flow ceases, bacteria begin to invade the muscle and thrive, multiplying quickly without interference from the body's immune system.

Gas gangrene, also called myonecrosis, is a type of moist gangrene that is commonly caused by bacterial infection with *Clostridium welchii, Cl. perfringes, Cl. septicum, Cl. novyi, Cl. histolyticum, Cl. sporogenes*, or other species that are capable of thriving under conditions where there is little oxygen (anaerobic). Once present in tissue, these bacteria produce gasses and poisonous toxins as they grow. Normally inhabiting the gastrointestinal, respiratory, and female genital tract, they often infect thigh **amputationwounds**, especially in those individuals who have lost control of their bowel functions (incontinence). Gangrene, incontinence, and debility often are combined in patients with diabetes, and it is in the amputation stump of diabetic patients that gas gangrene is often found to occur.

Other causative organisms for moist gangrene include various bacterial strains, including *Streptococcus* and *Staphylococcus*. A serious, but rare form of infection with Group A *Streptococcus* can impede blood flow and, if untreated, can progress to synergistic gangrene, more commonly called necrotizing fasciitis, or infection of the skin and tissues directly beneath the skin.

Chronic diseases, such as diabetes mellitus, arteriosclerosis, or diseases affecting the blood vessels, such as **Buerger's disease** or **Raynaud's disease**, can cause gangrene. Post-traumatic causes of gangrene include compound **fractures**, **burns**, and injections given under the skin or in a muscle. Gangrene may occur following surgery, particularly in individuals with diabetes mellitus or other long-term (chronic) disease. In addition, gas gangrene can be also be a complication of dry gangrene or occur spontaneously in association with an underlying **cancer**.

In the United States, approximately 50% of moist gangrene cases are the result of a severe traumatic injury,



A close-up of gangrene in the toes of a diabetic patient. *(Photo Researchers, Inc. Reproduced by permission.)*

and 40% occur following surgery. Car and industrial accidents, crush injuries, and gunshot wounds are the most common traumatic causes. Because of prompt surgical management of wounds with the removal of dead tissue, the incidence of gangrene from trauma has significantly diminished. Surgeries involving the bile ducts or intestine are the most frequent procedures causing gangrene. Approximately two-thirds of cases affect the extremities, and the remaining one-third involve the abdominal wall.

Symptoms

Areas of either dry or moist gangrene are initially characterized by a red line on the skin that marks the border of the affected tissues. As tissues begin to die, dry gangrene may cause some **pain** in the early stages or may go unnoticed, especially in the elderly or in those individuals with diminished sensation to the affected area. Initially, the area becomes cold, numb, and pale before later changing in color to brown, then black. This dead tissue will gradually separate from the healthy tissue and fall off.

Moist gangrene and gas gangrene are distinctly different. Gas gangrene does not involve the skin as much, but usually only the muscle. In moist or gas gangrene, there is a sensation of heaviness in the affected region that is followed by severe pain. The pain is caused by swelling resulting from fluid or gas accumulation in the tissues. This pain peaks, on average, between one to four days following the injury, with a range of eight hours to several weeks. The swollen skin may initially be blistered, red, and warm to the touch before progressing to a bronze, brown, or black color. In approximately 80% of cases, the affected and surrounding tissues may produce crackling sounds (crepitus), as a result of gas bubbles accumulating under the skin. The gas may be felt beneath the skin (palpable). In wet gangrene, the pus is foul-smelling, while in gas gangrene, there is no true pus, just an almost "sweet" smelling watery discharge.

Fever, rapid heart rate, rapid breathing, altered mental state, loss of appetite, **diarrhea**, vomiting, and vascular collapse may also occur if the bacterial toxins are allowed to spread in the bloodstream. Gas gangrene can be a life-threatening condition and should receive prompt medical attention

Diagnosis

A diagnosis of gangrene will be based on a combination of the patient history, a **physical examination**, and the results of blood and other laboratory tests. A physician will look for a history of recent trauma, surgery, cancer, or chronic disease. Blood tests will be used to determine whether infection is present and determine the extent to which an infection has spread.

A sample of drainage from a wound, or obtained through surgical exploration, may be cultured with oxygen (aerobic) and without oxygen (anaerobic) to identify the microorganism causing the infection and to aid in determining which antibiotic will be most effective. The sample obtained from a person with gangrene will contain few, if any, white blood cells and, when stained (with Gram stain) and examined under the microscope, will show the presence of purple (Gram positive), rod-shaped bacteria.

X ray studies and more sophisticated imaging techniques, such as **computed tomography scans** (CT) or **magnetic resonance imaging** (MRI), may be helpful in making a diagnosis since gas accumulation and muscle death (myonecrosis) may be visible. These techniques, however, are not sufficient alone to provide an accurate diagnosis of gangrene.

Precise diagnosis of gas gangrene often requires surgical exploration of the wound. During such a procedure, the exposed muscle may appear pale, beefy-red, or in the most advanced stages, black. If infected, the muscle will fail to contract with stimulation, and the cut surface will not bleed.

Treatment

Gas gangrene is a medical emergency because of the threat of the infection rapidly spreading via the bloodstream and infecting vital organs. It requires immediate surgery and administration of **antibiotics**.

Areas of dry gangrene that remain free from infection (aseptic) in the extremities are most often left to wither and fall off. Treatments applied to the wound externally (topically) are generally not effective without adequate

blood supply to support wound healing. Assessment by a vascular surgeon, along with x rays to determine blood supply and circulation to the affected area, can help determine whether surgical intervention would be beneficial.

Once the causative organism has been identified, moist gangrene requires the prompt initiation of intravenous, intramuscular, and/or topical broad-spectrum antibiotic therapy. In addition, the infected tissue must be removed surgically (**debridement**), and amputation of the affected extremity may be necessary. Pain medications (**analgesics**) are prescribed to control discomfort. Intravenous fluids and, occasionally, blood transfusions are indicated to counteract **shock** and replenish red blood cells and electrolytes. Adequate hydration and **nutrition** are vital to wound healing.

Although still controversial, some cases of gangrene are treated by administering oxygen under pressure greater than that of the atmosphere (hyperbaric) to the patient in a specially designed chamber. The theory behind using hyperbaric oxygen is that more oxygen will become dissolved in the patient's bloodstream, and therefore, more oxygen will be delivered to the gangrenous areas. By providing optimal oxygenation, the body's ability to fight off the bacterial infection are believed to be improved, and there is a direct toxic effect on the bacteria that thrive in an oxygen-free environment. Some studies have shown that the use of hyperbaric oxygen produces marked pain relief, reduces the number of amputations required, and reduces the extent of surgical debridement required. Patients receiving hyperbaric oxygen treatments must be monitored closely for evidence of oxygen toxicity. Symptoms of this toxicity include slow heart rate, profuse sweating, ringing in the ears, **shortness of breath**, **nausea and vomiting**, twitching of the lips/cheeks/eyelids/nose, and convulsions.

The emotional needs of the patient must also be met. The individual with gangrene should be offered moral support, along with an opportunity to share questions and concerns about changes in body image. In addition, particularly in cases where amputation was required, physical, vocational, and **rehabilitation** therapy will also be required.

KEY TERMS

Aerobic—Organism that grows and thrives only in environments containing oxygen.

Anaerobic—Organism that grows and thrives in an oxygen-free environment.

Arteriosclerosis—Build-up of fatty plaques within the arteries that can lead to the obstruction of blood flow.

Aseptic—Without contamination with bacteria or other microorganisms.

Crepitus—A crackling sound.

Gram stain—A staining procedure used to visualize and classify bacteria. The Gram stain procedure allows the identification of purple (Gram positive) organisms and red (Gram negative) organisms.

Hyperbaric oxygen—Medical treatment in which oxygen is administered in specially designed chambers, under pressures greater than that of the atmosphere, in order to treat specific medical conditions.

Incontinence—A condition characterized by the inability to control urination or bowel functions.

Myonecrosis—The destruction or death of muscle tissue.

Sepsis—The spreading of an infection in the bloodstream.

Thrombosis—The formation of a blood clot in a vein or artery that may obstruct local blood flow or may dislodge, travel downstream, and obstruct blood flow at a remote location.

Prognosis

Except in cases where the infection has been allowed to spread through the blood stream, prognosis is generally favorable. Anaerobic wound infection can progress quickly from initial injury to gas gangrene within one to two days, and the spread of the infection in the blood stream is associated with a 20–25% mortality rate. If recognized and treated early, however, approximately 80% of those with gas gangrene survive, and only 15–20% require any form of amputation. Unfortunately, the individual with dry gangrene most often has multiple other health problems that complicate recovery, and it is usually those other system failures that can prove fatal.

Prevention

Patients with diabetes or severe arteriosclerosis should take particular care of their hands and feet because of the risk of infection associated with even a minor injury. Education about proper **foot care** is vital. Diminished blood flow as a result of narrowed vessels will not lessen the body's defenses against invading bacteria. Measures taken towards the reestablishment of circulation are recommended whenever possible. Any abrasion, break in the skin, or infection tissue should be cared

for immediately. Any dying or infected skin must be removed promptly to prevent the spread of bacteria.

Penetrating abdominal wounds should be surgically explored and drained, any tears in the intestinal walls closed, and antibiotic treatment begun early. Patients undergoing elective intestinal surgery should receive preventive antibiotic therapy. Use of antibiotics prior to and directly following surgery has been shown to significantly reduce the rate of infection from 20–30% to 4–8%.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

Brunner, Lillian, and Doris Suddarth. *The Lippincott Manual of Nursing Practice*. J. B. Lippincott Co., 1991.

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Basoglu, M., et al. "Fournier's Gangrene: Review of Fifteen Cases." *American Surgeon* (Nov. 1997): 1019-1021.

Garcia-Olmo, D., et al. "Postoperative Gangrenous Peritonitis After Laparoscopic Cholecystectomy: A New Complication for a New Technique." *Laparoscopic and Endoscopic Surgery* (June 1997): 179-180.

Howse, Elizabeth A. "Meleney's Synergistic Gangrene: A Case Study." *Critical Care Nurse* (Dec. 1995): 59-64.

Laor, E., et al. "Outcome Prediction in Patients with Fournier's Gangrene." *Journal of Urology* (July 1995): 89-92.

Pizzorno, R., et al. "Hyperbaric Oxygen Therapy in the Treatment of Fournier's Disease in Eleven Male Patients." *Journal of Urology* (Sept. 1997): 837-840.

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Gas embolism

Definition

Gas **embolism**, also called air embolism, is the presence of gas bubbles in the bloodstream that obstruct circulation.

Description

Gas embolism may occur with decompression from increased pressure; it typically occurs in ascending divers who have been breathing compressed air. If a diver does not fully exhale upon ascent, the air in the lungs expands as the pressure decreases, overinflating the lungs and forcing bubbles of gas (emboli) into the bloodstream. When gas emboli reach the arteries to the brain, the blood blockage causes unconsciousness. Gas embolism is second only to drowning as a cause of **death** among divers.

Gas embolism may also result from trauma or medical procedures such as catheterization and open heart surgery that allow air into the circulatory system.

Causes and symptoms

Gas embolism occurs independent of diving depth; it may occur in as little as 6 ft of water. It is frequently caused by a diver holding his breath during ascent. It may also result from an airway obstruction or other condition that prevents a diver from fully exhaling.

The primary sign of gas embolism is immediate loss of consciousness; it may or may not be accompanied by convulsions.

Diagnosis

Any unconscious diver should be assumed to be the victim of gas embolism, regardless of whether consciousness was lost during or promptly after ascent. A doctor may also find pockets of air in the chest around the lungs and sometimes a collapsed lung from overinflation and rupture. Coughing up blood or a bloody froth around the mouth are visible signs of lung injury.

Treatment

Prompt **recompression treatment** in a hyperbaric (high-pressure) chamber is necessary to deflate the gas bubbles in the bloodstream, dissolve the gases into the blood, and restore adequate oxygenated blood flow to the brain and other organs. Recompression by returning the diver to deeper water will not work, and should not be attempted. The patient should be kept lying down and given oxygen while being transported for recompression treatment.

Before the diver receives recompression treatment, other lifesaving efforts may be necessary. If the diver isn't breathing, artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered. In the absence of a pulse, **cardiopulmonary resuscitation** (**CPR**) must be performed.

Prognosis

The prognosis is dependent upon the promptness of recompression treatment and the extent of the damage caused by oxygen deprivation.

Prevention

All divers should receive adequate training in the use of compressed air and a complete evaluation of fitness for diving. People with a medical history of lung cysts or

KEY TERMS

Compressed air—Air that is held under pressure in a tank to be breathed underwater by divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

Compression—An increase in pressure from the surrounding water that occurs with increasing diving depth.

Decompression—A decrease in pressure from the surrounding water that occurs with decreasing diving depth.

Emboli—Plural of embolus. An embolus is something that blocks the blood flow in a blood vessel. It may be a gas bubble, a blood clot, a fat globule, a mass of bacteria, or other foreign body. It usually forms somewhere else and travels through the circulatory system until it gets stuck.

Hyperbaric chamber—A sealed compartment in which patients are exposed to controlled pressures up to three times normal atmospheric pressure. Hyperbaric treatment may be used to regulate blood gases, reduce gas emboli, and provide higher levels of oxygen more quickly in cases of severe gas poisoning.

Recompression—Restoring the elevated pressure of the diving environment to treat gas embolism by decreasing bubble size.

spontaneous collapsed lung (**pneumothorax**), and those with active **asthma** or other lung disease must not dive, for they would be at extreme risk for gas embolism. Patients with conditions such as **alcoholism** and drug abuse are also discouraged from diving. Individuals with certain other medical conditions such as diabetes may be able to dive safely with careful training and supervision.

Resources

BOOKS

Martin, Lawrence. *Scuba Diving Explained: Questions and Answers on Physiology and Medical Aspects of Scuba Diving.* Flagstaff, AZ: Best Publishing, 1997.

ORGANIZATIONS

American College of Hyperbaric Medicine. PO Box 25914-130, Houston, Texas 77265. (713) 528-0657. <http://www.hyperbaricmedicine.org>.

Divers Alert Network. The Peter B. Bennett Center, 6 West Colony Place, Durham, NC 27705. (800) 446-2671. <http://www.diversalertnetwork.org>.

Undersea and Hyperbaric Medical Society. 10531 Metropolitan Ave., Kensington, MD 20895. (301) 942-2980. <http://www.uhms.org>.

Bethany Thivierge

Gas gangrene *see* **Gangrene**

Gastrectomy

Definition

Gastrectomy is the surgical removal of all or part of the stomach.

Purpose

Gastrectomy is performed for several reasons, most commonly to remove a malignant tumor or to cure a perforated or bleeding stomach ulcer.

Description

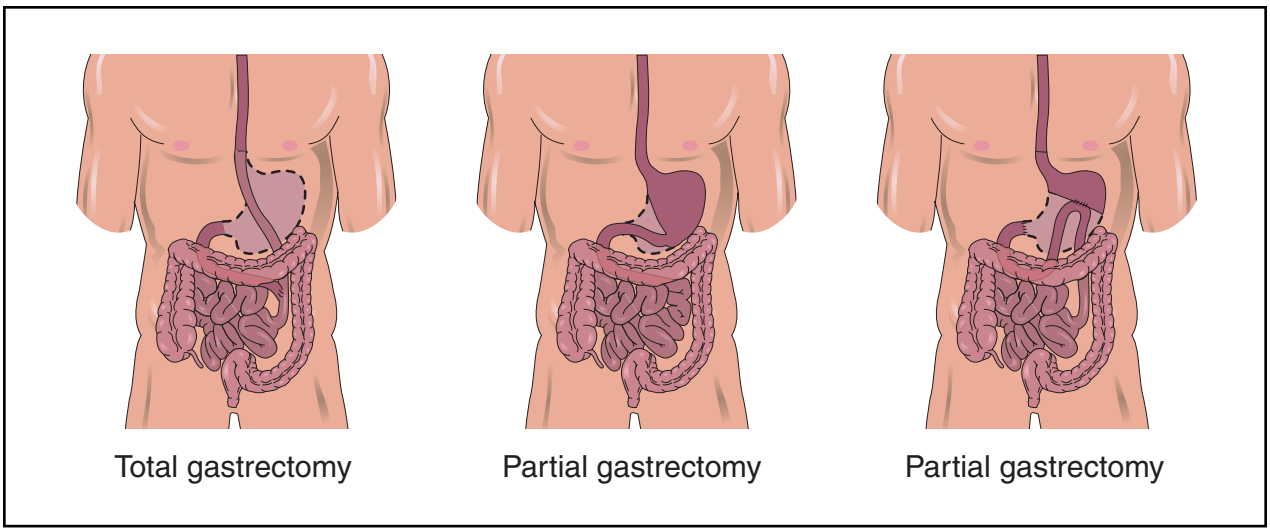
Gastrectomy for cancer

Removal of the tumor, often with removal of surrounding lymph nodes, is the only curative treatment for various forms of gastric (stomach) **cancer**. For many patients, this entails removing not just the tumor but part of the stomach as well. The extent to which lymph nodes should also be removed is a subject of some debate, but some studies show additional survival benefit associated with removal of a greater number of lymph nodes.

Gastrectomy, either total or subtotal (also called partial), is the treatment of choice for gastric adenocarcinomas, primary gastric lymphomas (originating in the stomach), and the rare leiomyosarcomas (also called gastric **sarcomas**). Adenocarcinomas are by far the most common form of **stomach cancer** and are less curable than the relatively uncommon lymphomas, for which gastrectomy offers good odds for survival.

After gastrectomy, the surgeon may "reconstruct" the altered portions of the digestive tract so that it continues to function. Several different surgical techniques are used, but, generally speaking, the surgeon attaches any remaining portion of the stomach to the small intestine.

Gastrectomy for gastric cancer is almost always done by the traditional "open" surgery technique, which requires a wide incision to open the abdomen. However, some surgeons use a laparoscopic technique that requires only a small incision. The laparoscope is connected to a



Gastrectomy, the surgical removal of all or part of the stomach, is performed primarily to remove a malignant tumor or to cure a bleeding stomach ulcer. Following the gastrectomy, the surgeon may reconstruct the altered portions of the digestive tract so that it continues to function. *(Illustration by Electronic Illustrators Group.)*

tiny video camera that projects a picture of the abdominal contents onto a monitor for the surgeon's viewing. The stomach is operated on through this incision.

The potential benefits of laparoscopic surgery include less postoperative **pain**, decreased hospitalization, and earlier return to normal activities. The use of laparoscopic gastrectomy is limited, however. Only patients with early stage gastric cancers or those whose surgery is only intended for palliation—pain and symptomatic relief rather than cure—should be considered for this minimally invasive technique. It can only be performed by surgeons experienced in this type of surgery.

Gastrectomy for ulcers

Gastrectomy is also occasionally used in the treatment of severe peptic ulcer disease or its complications. While the vast majority of peptic ulcers (gastric ulcers in the stomach or duodenal ulcers in the duodenum) are managed with medication, partial gastrectomy is sometimes required for peptic ulcer patients who have complications. These include patients who do not respond satisfactorily to medical therapy, those who develop a bleeding or perforated ulcer, and those who develop pyloric obstruction, a blockage to the exit from the stomach.

The surgical procedure for severe ulcer disease is also called an antrectomy, a limited form of gastrectomy in which the antrum, a portion of the stomach, is removed. For duodenal ulcers, antrectomy may be combined with other surgical procedures that are aimed at reducing the secretion of gastric acid, which is associated with ulcer formation. This additional surgery is commonly a **vagotomy**, surgery on the vagus nerve that disables the acid-producing portion of the stomach.

Preparation

Before undergoing gastrectomy, patients may need a variety of tests, such as x rays, **computed tomography scans** (CT scans), ultrasonography, or endoscopic biopsies (microscopic examination of tissue), to assure the diagnosis and localize the tumor or ulcer. **Laparoscopy** may be done to diagnose a malignancy or to determine the extent of a tumor that is already diagnosed. When a tumor is strongly suspected, laparoscopy is often performed immediately before the surgery to remove the tumor; this avoids the need to anesthetize the patient twice and sometimes avoids the need for surgery altogether if the tumor found on laparoscopy is deemed inoperable.

Aftercare

It is important to follow any instructions that have been given for postoperative care. Major surgery usually requires a recuperation time of several weeks.

Risks

Surgery for peptic ulcer is effective, but it may result in a variety of postoperative complications. After gastrectomy, as many as 30% of patients have significant symptoms. An operation called highly selective vagotomy is now preferred for ulcer management, and is safer than gastrectomy.

After a gastrectomy, several abnormalities may develop that produce symptoms related to food intake. This happens largely because the stomach, which serves as a food reservoir, has been reduced in its capacity by the surgery. Other surgical procedures that often accompany gastrectomy for ulcer disease can also contribute to later symptoms: vagotomy, which lessens acid production and slows stomach emptying, and **pyloroplasty**, which enlarges the opening between the stomach and small intestine to facilitate emptying of the stomach.

Some patients experience light-headedness, heart **palpitations** or racing heart, sweating, and **nausea and vomiting** after a meal. These may be symptoms of "dumping syndrome," as food is rapidly "dumped" into the small intestine from the stomach. This is treated by adjusting the diet and pattern of eating, for example, eating smaller, more frequent meals, and limiting liquids.

Patients who have abdominal bloating and pain after eating, frequently followed by nausea and vomiting, may have what is called the afferent loop syndrome. This is treated by surgical correction. Patients who have early satiety (feeling of fullness after eating), abdominal discomfort, and vomiting may have bile reflux **gastritis** (also called bilious vomiting), which is also surgically correctable. Many patients also experience weight loss.

Reactive **hypoglycemia** is a condition that results when blood sugar becomes too high after a meal, stimulating the release of insulin, about two hours after eating. A high-protein diet and smaller meals are advised.

Ulcers recur in a small percentage of patients after surgery for peptic ulcer, usually in the first few years. Further surgery is usually necessary.

Vitamin and mineral supplementation is necessary after gastrectomy to correct certain deficiencies, especially vitamin B_{12}, iron, and folate. Vitamin D and calcium are also needed to prevent and treat the bone problems that often occur. These include softening and bending of the bones, which can produce pain, and **osteoporosis**, a loss of bone mass. According to one study, the risk for spinal **fractures** may be as high as 50% after gastrectomy.

Depending on the extent of surgery, the risk for postoperative **death** after gastrectomy for gastric cancer has been reported as 1–3% and the risk of non-fatal complications as 9–18%.

Normal results

Overall survival after gastrectomy for gastric cancer varies greatly by the stage of disease at the time of surgery. For early gastric cancer, the five-year survival rate is up to 80–90%; for late-stage disease, the prognosis is bad. For gastric adenocarcinomas that are amenable to gastrectomy, the five-year survival rate is 10–30%, depending on the location of the tumor. The prognosis for patients with gastric lymphoma is better, with five-year survival rates reported at 40–60%.

Most studies have shown that patients can have an acceptable quality of life after gastrectomy for a potentially curable gastric cancer. Many patients will maintain a healthy appetite and eat a normal diet. Others may lose weight and not enjoy meals as much. Some studies show that patients who have total gastrectomies have more disease-related or treatment-related symptoms after surgery and poorer physical function than patients who have subtotal gastrectomies. There does not appear to be much difference, however, in emotional status or social activity level between patients who have undergone total versus subtotal gastrectomies.

KEY TERMS

Antrectomy—A surgical procedure for ulcer disease in which the antrum, a portion of the stomach, is removed.

Laparoscopy—The examination of the inside of the abdomen through a lighted tube, sometimes accompanied by surgery.

Resources

BOOKS

"Disorders of the Stomach and Duodenum." In *The Merck Manual*. Whitehouse Station, NJ: Merck & Co., Inc., 1992.

"Stomach and Duodenum: Complications of Surgery for Peptic Ulcer Disease." In *Steisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Caroline A. Helwick

Gastric acid determination

Definition

Gastric acid determination, also known as stomach acid determination, gastric analysis, or basal gastric secretion, is a procedure to evaluate gastric (stomach) function.

The test specifically determines the presence of gastric acid, as well as the amount of gastric acid secreted. It is often done in conjunction with the gastric acid stimulation test, a procedure that measures gastric acid output after injection of a drug to stimulate gastric acid secretion.

Purpose

The purpose of the gastric acid determination is to evaluate gastric function by measuring the amount of acid as suctioned directly from the stomach. The complete gastric acid determination includes the basal gastric secretion test, which measures acid secretion while the patient is in a **fasting** state (nothing to eat or drink), followed by the gastric acid stimulation test, which measures the secretion of gastric acid for one hour after injection of pentagastrin or a similar drug that stimulates gastric acid output. The Gastric acid stimulation test is done when the basal secretion test suggests abnormalities in gastric secretion. It is normally performed immediately afterward.

The basal gastric secretion test is indicated for patients with obscure gastric **pain**, loss of appetite, and weight loss. It is also utilized for suspected peptic (related to the stomach) ulcer, severe stomach inflammation (**gastritis**), and Zollinger-Ellison (Z-E) syndrome (a condition in which a pancreatic tumor, called a **gastrinoma**, stimulates the stomach to secrete excessive amounts of acid, resulting in peptic ulcers). Because external factors like the sight or odor of food, as well as psychological **stress**, can stimulate gastric secretion, accurate testing requires that the patient be relaxed and isolated from all sources of sensory stimulation. Abnormal basal secretion can suggest various gastric and duodenal disorders, so further evaluation requires the gastric acid stimulation test.

The gastric acid stimulation test is indicated when abnormalities are found during the basal secretion test. These abnormalities can be caused by a number of disorders, including duodenal ulcer, **pernicious anemia**, and gastric **cancer**. The test will detect abnormalities, but x rays and other studies are necessary for a definitive diagnosis.

Precautions

Because both the basal gastric secretion test and the gastric acid stimulation test require insertion of a gastric tube (intubation) through the mouth or nasal passage, neither test is recommended for patients with esophageal problems, **aortic aneurysm**, severe gastric hemorrhage, or congestive **heart failure**. The gastric acid stimulation test is also not recommended in patients who are sensitive to pentagastrin (the drug used to stimulate gastric acid output).

Description

This test, whether performed for basal gastric acid secretion, gastric acid stimulation, or both, requires the passage of a lubricated rubber tube, either by mouth or through the nasal passage, while the patient is in a sitting or reclining position on the left side. The tube is situated in the stomach, with proper positioning confirmed by fluoroscopy or x ray.

Basal gastric acid secretion

After a wait of approximately 10–15 minutes for the patient to adjust to the presence of the tube, and with the patient in a sitting position, specimens are obtained every 15 minutes for a period of 90 minutes. The first two specimens are discarded to eliminate gastric contents that might be affected by the stress of the intubation process. The patient is allowed no liquids during the test, and saliva must be ejected to avoid diluting the stomach contents.

The four specimens collected during the test constitute the *basal acid output*. If analysis suggests abnormally low gastric secretion, the gastric acid stimulation test is performed immediately afterward.

Gastric acid stimulation test

After the basal samples have been collected, the tube remains in place for the gastric acid stimulation test. Pentagastrin, or a similar drug that stimulates gastric acid output, is injected under the skin (subcutaneously). After 15 minutes, a specimen is collected every 15 minutes for one hour. These specimens are called the *poststimulation specimens*. As is the case with the basal gastric secretion test, the patient can have no liquids during this test, and must eject saliva to avoid diluting the stomach contents.

Preparation

The patient should be fasting (nothing to eat or drink after the evening meal) on the day prior to the test, but may have water up to one hour before the test. **Antacids**, anticholinergics, cholinergics, alcohol, H_2-receptor antagonists (Tagamet, Pepcid, Axid, Zantac), reserpine, adrenergic blockers, and adrenocorticosteroids should be withheld for one to three days before the test, as the physician requests. If pentagastrin is to be administered for the gastric acid secretion test, medical supervision should be maintained, as possible side effects may occur.

Aftercare

Complications such as nausea, vomiting, and abdominal distention or pain are possible following removal of the gastric tube. If the patient has a **sore**

KEY TERMS

Achlorhydria—An abnormal condition in which hydrochloric acid is absent from the secretions of the gastric glands in the stomach.

Pernicious anemia—One of the main types of anemia, caused by inadequate absorption of vitamin B_{12}. Symptoms include tingling in the hands, legs, and feet, spastic movements, weight loss, confusion, depression, and decreased intellectual function.

Zollinger-Ellison syndrome—A rare condition characterized by severe and recurrent peptic ulcers in the stomach, duodenum, and upper small intestine, caused by a tumor, or tumors, usually found in the pancreas. The tumor secretes the hormone gastrin, which stimulates the stomach and duodenum to produce large quantities of acid, leading to ulceration. Most often cancerous, the tumor must be removed surgically; otherwise total surgical removal of the stomach is necessary.

throat, soothing lozenges may be given. The patient may also resume the usual diet and any medications that were withheld for the test(s).

Risks

There is a slight risk that the gastric tube may be inserted improperly, entering the windpipe (trachea) and not the esophagus. If this happens, the patient may have a difficult time breathing or may experience a coughing spell until the tube is removed and reinserted properly. Also, because the tube can be difficult to swallow, if a patient has an overactive gag reflex, there may be a transient rise in blood pressure due to **anxiety**.

Normal results

Reference values for the *basal gastric secretion test* vary by laboratory, but are usually within the following ranges:

- men: 1–5 mEq/h
- women: 0.2–3.8 mEq/h

Reference values for the *gastric acid stimulation test* vary by laboratory, but are usually within the following ranges:

- men: 18–28 mEq/h
- women: 11–21 mEq/h

Abnormal results

Abnormal findings in the *basal gastric secretion test* are considered nonspecific and must be evaluated in conjunction with the results of a gastric acid stimulation test. Elevated secretion may suggest different types of ulcers; when markedly elevated, Zollinger-Ellison syndrome is suspected. Depressed secretion can indicate gastric cancer, while complete absence of secretion (achlorhydria) may suggest pernicious anemia.

Elevated gastric secretion levels in the *gastric acid stimulation test* may be indicative of duodenal ulcer; high levels of secretion again suggest Zollinger-Ellison syndrome.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Gastric carcinoma *see* **Stomach cancer**

Gastric emptying scan

Definition

A gastric emptying scan (GES) is an x-ray exam using special radioactive material that allows physicians to identify abnormalities related to emptying of the stomach. Diseases that involve changes in the way the stomach contracts (motility disorders) are best diagnosed by this test.

Purpose

The study is used most frequently to evaluate patients who have symptoms suggestive of decreased, delayed, or rapid gastric emptying, and no visible abnormality to explain their symptoms.

Symptoms pointing to a delay in gastric emptying are non-specific, and may be due to a number of causes, such as ulcers, diabetes, tumors, and others. These symptoms include nausea, upper abdominal bloating, and at times vomiting. Another significant symptom is called "early satiety," which means feeling full after eating only a small amount of food. In some patients, weight loss is

KEY TERMS

Endoscopy—The examination of the inside of an organ with an instrument that has a light at the end of it and an optical system for examination of the organ.

Motility—Motility is spontaneous movement. One example is the automatic stomach contractions that move the food content along from the stomach into the intestines. A motility disease is one that involves changes in the way the stomach contracts.

also present. In addition to symptoms, the finding of a large amount of material in the stomach after an overnight fast suggests abnormal emptying, but does not distinguish between an actual blockage or an irregularity in gastric contractions. It is therefore essential to find out what is causing material to remain in the stomach.

Since many diseases can produce the above symptoms, structural lesions (such as tumors or regions of narrowing or scar tissue) need to be ruled out first. This is usually done by upper gastrointestinal series test or by endoscopy (examination of the inside of an organ, in this instance the stomach, with an instrument that has a light at the end of it and an optical system for examination of the organ). Once it is clear that a mechanical or physical lesion is not the cause of symptoms, attempts to document an abnormality in the nervous or muscular function of the stomach is then begun. GES is usually the first step in that evaluation.

Precautions

The exam should not be performed on pregnant women, but is otherwise quite safe. Since eggs are usually used to hold the radioactive material, patients should notify their physician if they are allergic to eggs. However, other materials can be used in place of an egg.

Description

Gastric emptying scans have undergone several changes since the initial studies in the late 1970s. During the study, patients are asked to ingest an egg sandwich containing a radioactive substance (for example, technetium) that can be followed by a special camera. The emptying of the material from the stomach is then followed and displayed both in the form of an image, as well as the percentage emptied over several hours (generally two and four hours). Studies are in progress using substances that are not radioactive, but this procedure is not available to the patient as of yet.

Preparation

The only preparation involved is for the patient to fast overnight before the test.

Risks

The radiation exposure during the study is quite small and safe, unless the patient is pregnant.

Normal results

There are several different measurements considered normal, depending on the radioactive material and solid meal used. The value is expressed as a percentage of emptying over a period of time. For a technetium-filled egg sandwich, normal emptying is 78 minutes for half the material to leave the stomach, with a variation of 11 minutes either way.

Abnormal results

GES scan studies that show emptying of the stomach in a longer than accepted period is abnormal. Severity of test results and symptoms do not always match; therefore, the physician must carefully interpret these findings. Diabetic injury to the nerves that supply the stomach (called diabetic gastroparesis) is one of the most common causes of abnormal gastric motility. However, up to 30% of patients have no obvious cause to explain the abnormal results and symptoms. These cases are called idiopathic (of unknown cause). GES is often used to follow the effect of medications used for treatment of motility disorders.

Resources

BOOKS

Camilleri, Michael, and Charlene M. Prather. "Gastric Motor Physiology and Motor Disorders." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Maurer, Alan H., Leon S. Malumd, and Robert S. Fisher. "Radionuclide Scintigraphy of the Gastrointestinal Tract." In *Bockus Gastroenterology*, ed. William S. Haubrich, et al. Philadelphia: W. B. Saunders Co., 1995.

PERIODICALS

Quigley, Eamonn. "Gastric and Small Intestinal Motility in Health and Disease." *Gastroenterology Clinics of North America* (Mar. 1996): 113-145.

ORGANIZATIONS

American Pseudo-obstruction and Hirschprung's Disease Society. 158 Pleasant St., North Andover, MA 01845-2797. <http://www.tiac.net/users/aphs>.

David Kaminstein, MD

Gastric lavage *see* **Stomach flushing**
Gastric stapling *see* **Obesity surgery**
Gastric ulcers *see* **Ulcers (digestive)**

Gastrinoma

Definition

Gastrinomas are tumors associated with a rare gastroenterological disorder known as Zollinger-Ellison syndrome (ZES). They occur primarily in the pancreas and duodenum (beginning of the small intestine) and secrete large quantities of the hormone gastrin, triggering gastric acid production that produces ulcers. They may be malignant (cancerous) or benign.

Description

Gastrinomas are an integral part of the Zollinger-Ellison syndrome (ZES). In fact, ZES is also known as gastrinoma. This syndrome consists of ulcer disease in the upper gastrointestinal tract, marked increases in the secretion of gastric acid in the stomach, and tumors of the islet cells in the pancreas. The tumors produce large amounts of gastrin that are responsible for the characteristics of Zollinger-Ellison syndrome, namely severe ulcer disease. Although usually located within the pancreas, they may occur in other organs.

Gastrinomas may occur randomly and sporadically, or they may be inherited as part of a genetic condition called multiple endocrine neoplasia type 1 (MEN-1) syndrome. About half of persons with MEN-1 have gastrinomas, which tend to be more numerous and smaller than tumors in sporadic cases.

About half of ZES patients have multiple gastrinomas, which can vary in size from 1–20 mm. Gastrinomas found in the pancreas are usually much larger than duodenal gastrinomas. About two thirds of gastrinomas are malignant (cancerous). These usually grow slowly, but some may invade surrounding sites rapidly and metastasize (spread) widely. Sometimes, gastrinomas are found only in the lymph nodes, and it is uncertain whether these malignancies have originated in the lymph nodes or have metastasized from a tumor not visible in the pancreas or duodenum.

There is some evidence that the more malignant form of gastrinomas is more frequent in larger pancreatic tumors, especially in females and in persons with a shorter disease symptom duration and higher serum gastrin levels.

Causes and symptoms

Most persons with gastrinomas secrete profound amounts of gastric acid, and almost all develop ulcers, mostly in the duodenum or stomach. Early in the course of the disease, symptoms are typical of peptic ulcers, however once the disease is established, the ulcers become more persistent and symptomatic, and may respond poorly to standard anti-ulcer therapy. Abdominal **pain** is the predominant symptom of ulcer disease. About 40% of patients have **diarrhea** as well. In some patients, diarrhea is the primary symptom of gastrinoma.

Diagnosis

Persons with gastrinomas have many of the same symptoms as persons with ulcers. Their levels of gastric acid, however, are usually far greater than those in common ulcer disease. Gastrinomas are usually diagnosed by a blood test that measures the level of gastrin in the blood. Patients with gastrinomas often have gastrin levels more than 200 pg/mL, which is 4–10 times higher than normal. Serum gastrin levels as high as 450,000 pg/mL have occurred.

When the serum gastrin test does not show these extremely high levels of gastrin, patients may be given certain foods or injections in an attempt to provoke a response that will help diagnose the condition. The most useful of these provocative tests is the secretin injection test (or secretin stimulation or provocative test), which will almost always produce a positive response in persons with gastrinomas but seldom in persons without them.

Surgically, gastrinomas are often difficult to locate, even with careful inspection. They may be missed in at least 10–20% of patients with ZES. Gastrinomas are sometimes found only because they have metastasized and produced symptoms related to the spread of malignancy. Such metastasis may be the most reliable indication of whether the gastrinoma is malignant or benign.

Diagnostic imaging techniques help locate the gastrinomas. The most sophisticated is an x-ray test called radionuclide octreotide scanning (also known as somatostatin receptor scintigraphy or 111In pentetreotide SPECT). A study by the National Institutes of Health (NIH) found this test to be superior to other imaging methods, such as computed tomography scan (CT) or **magnetic resonance imaging** (MRI), in pinpointing the location of tumors and guiding physicians in treatment.

Approximately half of all gastrinomas do not show up on imaging studies. Therefore, exploratory surgery is often recommended to try to locate and remove the tumors.

KEY TERMS

Gastrin—A hormone secreted in the stomach that is involved in the production of gastric acid. Overproduction of gastric acid contributes to peptic ulcer formation.

Multiple endocrine neoplasia type 1 (MEN-1)—An inherited condition marked by multiple malignancies of the pituitary gland, parathyroid gland, and islet cells of the pancreas. About half of MEN-1 patients with pancreatic islet cell tumors will have gastrinomas, gastrin-producing tumors that lead to ulcer disease.

Peptic ulcer—An eroded area in the stomach lining or in the first part of the duodenum (beginning of the small intestine).

Serum gastrin test—A laboratory test that is performed on a blood sample to determine that level of the hormone gastrin. High levels of gastrin indicate the presence a duodenal ulcer or a gastrinoma.

Sporadic—Occurring at random or by chance, and not as a result of a genetically determined, or inherited, trait.

Treatment

Therapy for gastrinomas should be individualized, since patients tend to have varying degrees of disease and symptoms. Treatment is aimed at eliminating the overproduction of gastric acid and removing the gastrin-producing tumors.

Drugs

Gastrinomas may not be easily treated by the standard anti-ulcer approaches. The medical treatment of choice is with drugs called proton pump inhibitors, such as omeprazole or lansoprazole, daily. These drugs are potent inhibitors of gastric acid. High doses of H-2 receptor antagonists may also reduce gastric acid secretion, improve symptoms, and induce ulcer healing. These drugs must be continued indefinitely, since even a brief discontinuation will cause ulcer recurrence. **Antacids** may provide some relief, but it is usually not longlasting or healing.

Surgery

Because of the likelihood that gastrinomas may be malignant, in both sporadic tumors and those associated with the inherited MEN-1 syndrome, surgery to locate and remove gastrinomas is frequently advised. It is now known that complete surgical removal of gastrinomas can cure the overproduction of gastrin, even in patients who have metastases to the lymph nodes. Surgery in patients with MEN-1 and ZES, however, remains controversial since the benefit is less clear.

Freedom from disease after surgery is judged by improved symptoms, reduced gastric acid production, reduced need for drug therapy, normalization of serum gastrin levels, and normalization of results from the secretin stimulation test and imaging studies.

Prognosis

Medical therapy often controls symptoms, and surgery may or may not cure gastrinoma. About 50% of ZES patients in whom gastrinomas are not removed will die from malignant spread of the tumor. In patients with gastrinomas as part of MEN-1 syndrome, the cure rate is extremely low.

A NIH study of patients who had surgical removal of gastrinomas found that 42% were disease-free one year after surgery and 35% were disease-free at five years. Disease recurrences can often be detected with a serum gastrin test or secretin stimulation test.

When gastrinomas are malignant, they often grow slowly. The principal sites of metastasis are the regional lymph nodes and liver, but they may also spread to other structures. About one quarter of patients with gastrinomas have liver metastases at the time of diagnosis. This appears to be more frequent with pancreatic gastrinomas than duodenal gastrinomas.

Metastases of malignant gastrinomas to the liver is very serious. Survival five years after diagnosis is 20–30%, however patients with gastrinomas found only in the lymph nodes have been known to live as long as 25 years after diagnosis, without evidence of further tumor spread. In fact, the life expectancy of patients with gastrinomas that have spread to the lymph nodes is no different from that of patients with gastrinomas that cannot even be found at surgery for about 90%, five years after diagnosis.

Resources

BOOKS

Friedman, Lawrence S., and Walter L. Peterson. "Peptic Ulcer and Related Diseases." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Delcore, R., and S. R. Friesen. "The Place for Curative Surgical Procedures in the Treatment of Sporadic and Familial

Zollinger-Ellison Syndrome." *Current Opinion in General Surgery* (1994): 69-76.
Meko, J. B., and J. A. Norton. "Management of Patients with Zollinger-Ellison Syndrome." *Annual Review of Medicine* 46 (1995): 395-411.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

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Gastritis

Definition

Gastritis commonly refers to inflammation of the lining of the stomach, but the term is often used to cover a variety of symptoms resulting from stomach lining inflammation and symptoms of burning or discomfort. True gastritis comes in several forms and is diagnosed using a combination of tests. In the 1990s, scientists discovered that the main cause of true gastritis is infection from a bacterium called *Helicobacter pylori* (*H. pylori*).

Description

Gastritis should not be confused with common symptoms of upper abdominal discomfort. It has been associated with resulting ulcers, particularly peptic ulcers. And in some cases, chronic gastritis can lead to more serious complications.

Nonerosive H. pylori gastritis

The main cause of true gastritis is *H. pylori* infection. *H. pylori* is indicated in an average of 90% of patients with chronic gastritis. This form of nonerosive gastritis is the result of infection with *Helicobacter pylori* bacterium, a microorganism whose outer layer is resistant to the normal effects of stomach acid in breaking down bacteria.

The resistance of *H. pylori* means that the bacterium may rest in the stomach for long periods of times, even years, and eventually cause symptoms of gastritis or ulcers when other factors are introduced, such as the presence of specific genes or ingestion of **nonsteroidal anti-inflammatory drugs** (NSAIDS). Study of the role of *H. pylori* in development of gastritis and peptic ulcers has disproved the former belief that **stress** lead to most stomach and duodenal ulcers and has resulted in improved treatment and reduction of stomach ulcers. *H. pylori* is most likely transmitted between humans, although the specific routes of transmission were still under study in early 1998. Studies were also underway to determine the role of *H. pylori* and resulting chronic gastritis in development of gastric **cancer**.

Erosive and hemorrhagic gastritis

After *H. pylori*, the second most common cause of chronic gastritis is use of nonsteroidal anti-inflammatory drugs. These commonly used **pain** killers, including **aspirin**, fenoprofen, ibuprofen and naproxen, among others, can lead to gastritis and peptic ulcers. Other forms of erosive gastritis are those due to alcohol and corrosive agents or due to trauma such as ingestion of foreign bodies.

Other forms of gastritis

Clinicians differ on the classification of the less common and specific forms of gastritis, particularly since there is so much overlap with *H. pylori* in development of chronic gastritis and complications of gastritis. Other types of gastritis that may be diagnosed include:

- Acute stress gastritis—the most serious form of gastritis which usually occurs in critically ill patients, such as those in intensive care. Stress erosions may develop suddenly as a result of severe trauma or stress to the stomach lining.
- Atrophic gastritis is the result of chronic gastritis which is leading to atrophy, or decrease in size and wasting away, of the gastric lining. Gastric atrophy is the final stage of chronic gastritis and may be a precursor to gastric cancer.
- Superficial gastritis is a term often used to describe the initial stages of chronic gastritis.
- Uncommon specific forms of gastritis include granulomatous, eosiniphilic and lymphocytic gastritis.

Causes and symptoms

Nonerosive H. pylori gastritis

H. pylori gastritis is caused by infection from the *H. pylori* bacterium. It is believed that most infection occurs in childhood. The route of its transmission was still under study in 1998 and clinicians guessed that there may be more than one route for the bacterium. Its prevalence and distribution differs in nations around the world. The presence of *H. pylori* has been detected in 86–99% of patients with chronic superficial gastritis. However, physicians are still learning about the link of *H. pylori* to chronic gastritis and peptic ulcers, since many patients with *H. pylori* infection do not develop symptoms or

peptic ulcers. *H. pylori* is also seen in 90–100% of patients with duodenal ulcers.

Symptoms of *H. pylori* gastritis include abdominal pain and reduced acid secretion in the stomach. However, the majority of patients with *H. pylori* infection suffer no symptoms, even though the infection may lead to ulcers and resulting symptoms. Ulcer symptoms include dull, gnawing pain, often two to three hours after meals and pain in the middle of the night when the stomach is empty.

Erosive and hemorrhagic gastritis

The most common cause of this form of gastritis is use of NSAIDS. Other causes may be **alcoholism** or stress from surgery or critical illness. The role of NSAIDS in development of gastritis and peptic ulcers depends on the dose level. Although even low doses of aspirin or other nonsteroidal anti-inflammatory drugs may cause some gastric upset, low doses generally will not lead to gastritis. However, as many as 10–30% of patients on higher and more frequent doses of NSAIDS, such as those with chronic arthritis, may develop gastric ulcers. In 1998, studies were underway to understand the role of *H. pylori* in gastritis and ulcers among patients using NSAIDS.

Patients with erosive gastritis may also show no symptoms. When symptoms do occur, they may include **anorexia nervosa**, gastric pain, **nausea and vomiting**.

Other Forms of Gastritis

Less common forms of gastritis may result from a number of generalized diseases or from complications of chronic gastritis. Any number of mechanisms may cause various less common forms of gastritis and they may differ slightly in their symptoms and clinical signs. However, they all have in common inflammation of the gastric mucosa.

Diagnosis

Nonerosive H. pylori gastritis

H. pylori gastritis is easily diagnosed through the use of the urea breath test. This test detects active presence of *H. pylori* infection. Other serological tests, which may be readily available in a physician's office, may be used to detect *H. pylori* infection. Newly developed versions offer rapid diagnosis. The choice of test will depend on cost, availability and the physician's experience, since nearly all of the available tests have an accuracy rate of 90% or better. Endoscopy, or the examination of the stomach area using a hollow tube inserted through the mouth, may be ordered to confirm diagnosis. A biopsy of the gastric lining may also be ordered.

Erosive or hemorrhagic gastritis

Clinical history of the patient may be particularly important in the diagnosis of this type of gastritis, since its cause is most often the result of chronic use of NSAIDS, alcoholism, or other substances.

Other forms of gastritis

Gastritis that has developed to the stage of duodenal or gastric ulcers usually requires endoscopy for diagnosis. It allows the physician to perform a biopsy for possible malignancy and for *H. pylori*. Sometimes, an upper gastrointestinal x-ray study with barium is ordered. Some diseases such as Zollinger-Ellison syndrome, an ulcer disease of the upper gastrointestinal tract, may show large mucosal folds in the stomach and duodenum on radiographs or in endoscopy. Other tests check for changes in gastric function.

Treatment

H. pylori gastritis

The discovery of *H. pylori's* role in development of gastritis and ulcers has led to improved treatment of chronic gastritis. In particular, relapse rates for duodenal and gastric ulcers has been reduced with successful treatment of *H. pylori* infection. Since the infection can be treated with **antibiotics**, the bacterium can be completely eliminated up to 90% of the time.

Although *H. pylori* can be successfully treated, the treatment may be uncomfortable for patients and relies heavily on patient compliance. In 1998, studies were underway to identify the best treatment method based on simplicity, patient cooperation and results. No single antibiotic had been found which would eliminate *H. pylori* on its own, so a combination of antibiotics has been prescribed to treat the infection.

DUAL THERAPY. Dual therapy involves the use of an antibiotic and a proton pump inhibitor. Proton pump inhibitors help reduce stomach acid by halting the mechanism that pumps acid into the stomach. This also helps promote healing of ulcers or inflammation. Dual therapy has not been proven to be as effective as triple therapy, but may be ordered for some patients who can more comfortably handle the use of less drugs and will therefore more likely follow the two-week course of therapy.

TRIPLE THERAPY. As of early 1998, triple therapy was the preferred treatment for patients with *H. pylori* gastritis. It is estimated that triple therapy successfully eliminates 80–95% of *H. pylori* cases. This treatment regimen usually involves a two-week course of three drugs. An antibiotic such as amoxicillin or tetracycline, and another

antibiotic such as clarithomycin or metronidazole are used in combination with bismuth subsalicylate, a substance found in the over-the-counter medication, Pepto-Bismol, which helps protect the lining of the stomach from acid. Physicians were experimenting with various combinations of drugs and time of treatment to balance side effects with effectiveness. Side effects of triple therapy are not serious, but may cause enough discomfort that patients are not inclined to follow the treatment.

OTHER TREATMENT THERAPIES. Scientists have experimented with quadruple therapy, which adds an antisecretory drug, or one which suppresses gastric secretion, to the standard triple therapy. One study showed this therapy to be effective with only a week's course of treatment in more than 90% of patients. Short course therapy was attempted with triple therapy involving antibiotics and a proton pump inhibitor and seemed effective in eliminating *H. pylori* in one week for more than 90% of patients. The goal is to develop the most effective therapy combination that can work in one week of treatment or less.

MEASURING H. PYLORI TREATMENT EFFECTIVENESS. In order to ensure that *H. pylori* has been eradicated, physicians will test patients following treatment. The breath test is the preferred method to check for remaining signs of *H. pylori*.

Treatment of erosive gastritis

Since few patients with this form of gastritis show symptoms, treatment may depend on severity of symptoms. When symptoms do occur, patients may be treated with therapy similar to that for *H. pylori*, especially since some studies have demonstrated a link between *H. pylori* and NSAIDS in causing ulcers. Avoidance of NSAIDS will most likely be prescribed.

Other forms of gastritis

Specific treatment will depend on the cause and type of gastritis. These may include prednisone or antibiotics. Critically ill patients at high risk for bleeding may be treated with preventive drugs to reduce risk of acute stress gastritis. If stress gastritis does occur, the patient is treated with constant infusion of a drug to stop bleeding. Sometimes surgery is recommended, but is weighed with the possibility of surgical complications or **death**. Once torrential bleeding occurs in acute stress gastritis, mortality is as high as greater than 60%.

Alternative treatment

Alternative forms of treatment for gastritis and ulcers should be used cautiously and in conjunction with conventional medical care, particularly now that scientists have confirmed the role of *H. pylori* in gastritis and ulcers. Alternative treatments can help address gastritis symptoms with diet and nutritional supplements, herbal medicine and **ayurvedic medicine**. It is believed that zinc, vitamin A and beta-carotene aid in the stomach lining's ability to repair and regenerate itself. Herbs thought to stimulate the immune system and reduce inflammation include **echinacea** (*Echinacea* spp.) and goldenseal (*Hydrastis canadensis*). Ayurvedic medicine involves **meditation**. There are also certain herbs and nutritional supplements aimed at helping to treat ulcers.

KEY TERMS

Duodenal—Refers to the duodenum, or the first part of the small intestine.

Gastric—Relating to the stomach.

Mucosa—The mucous membrane, or the thin layer which lines body cavities and passages.

Ulcer—A break in the skin or mucous membrane. It can fester and pus like a sore.

Prognosis

The discovery of *H. pylori* has improved the prognosis for patients with gastritis and ulcers. Since treatment exists to eradicate the infection, recurrence is much less common. As of 1998, the only patients requiring treatment for *H. pylori* were those at high risk because of factors such as NSAIDS use or for those with ulcers and other complicating factors or symptoms. Research will continue into the most effective treatment of *H. pylori*, especially in light of the bacterium's resistance to certain antibiotics. Regular treatment of patients with gastric and duodenal ulcers has been recommended, since H. pylori plays such a consistently high role in development of ulcers. It is believed that *H. pylori* also plays a role in the eventual development of serious gastritis complications and cancer. Detection and treatment of *H. pylori* infection may help reduce occurrence of these diseases. The prognosis for patients with acute stress gastritis is much poorer, with a 60 percent or higher mortality rate among those bleeding heavily.

Prevention

The widespread detection and treatment of *H. pylori* as a preventive measure in gastritis has been discussed but not resolved. Until more is known about the routes

through which *H. pylori* is spread, specific prevention recommendations are not available. Erosive gastritis from NSAIDS can be prevented with cessation of use of these drugs. An education campaign was launched in 1998 to educate patients, particularly an **aging** population of arthritis sufferers, about risk for ulcers from NSAIDS and alternative drugs.

Resources

BOOKS

Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Puyallup, WA: Future Medicine Publishing, Inc., 1993.

LaMont, J. Thomas. *Gastrointestinal Infections, Diagnosis and Management*. Marcel Dekker, Inc. 1997.

PERIODICALS

Podolski, J. L. "Recent Advances in Peptic Ulcer Disease: H. pylori Infection and Its Treatement." *Gastroenterology Nursing* 19, no. 4: 128-136.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

OTHER

American College of Gastroenterology Page. <http://www.acg.org>.

HealthAnswers.com. <http://www.healthanswers.com>.

Teresa Norris, RN

Gastroduodenostomy (Billroth I) *see* **Ulcer surgery**

Gastroenteritis

Definition

Gastroenteritis is a catchall term for infection or irritation of the digestive tract, particularly the stomach and intestine. It is frequently referred to as the stomach or intestinal flu, although the **influenza** virus is not associated with this illness. Major symptoms include **nausea and vomiting**, **diarrhea**, and abdominal cramps. These symptoms are sometimes also accompanied by **fever** and overall weakness. Gastroenteritis typically lasts about three days. Adults usually recover without problem, but children, the elderly, and anyone with an underlying disease are more vulnerable to complications such as **dehydration**.

Description

Gastroenteritis is an uncomfortable and inconvenient ailment, but it is rarely life-threatening in the United States and other developed nations. However, an estimated 220,000 children younger than age five are hospitalized with gastroenteritis symptoms in the United States annually. Of these children, 300 die as a result of severe diarrhea and dehydration. In developing nations, diarrheal illnesses are a major source of mortality. In 1990, approximately three million deaths occurred worldwide as a result of diarrheal illness.

The most common cause of gastroenteritis is viral infection. Viruses such as rotavirus, adenovirus, astrovirus, and calicivirus and small round-structured viruses (SRSVs) are found all over the world. Exposure typically occurs through the fecal-oral route, such as by consuming foods contaminated by fecal material related to poor sanitation. However, the infective dose can be very low (approximately 100 virus particles), so other routes of transmission are quite probable.

Typically, children are more vulnerable to rotaviruses, the most significant cause of acute watery diarrhea. Annually, worldwide, rotaviruses are estimated to cause 800,000 deaths in children below age five. For this reason, much research has gone into developing a vaccine to protect children from this virus. Adults can be infected with rotaviruses, but these infections typically have minimal or no symptoms.

Children are also susceptible to adenoviruses and astroviruses, which are minor causes of childhood gastroenteritis. Adults experience illness from astroviruses as well, but the major causes of adult viral gastroenteritis are the caliciviruses and SRSVs. These viruses also cause illness in children. The SRSVs are a type of calicivirus and include the Norwalk, Southhampton, and Lonsdale viruses. These viruses are the most likely to produce vomiting as a major symptom.

Bacterial gastroenteritis is frequently a result of poor sanitation, the lack of safe drinking water, or contaminated food—conditions common in developing nations. Natural or man-made disasters can make underlying problems in sanitation and food safety worse. In developed nations, the modern food production system potentially exposes millions of people to disease-causing bacteria through its intensive production and distribution methods. Common types of bacterial gastroenteritis can be linked to *Salmonella* and *Campylobacter* bacteria; however, ***Escherichia coli*** 0157 and *Listeria monocytogenes* are creating increased concern in developed nations. **Cholera** and Shigella remain two diseases of great concern in developing countries, and research to develop long-term vaccines against them is underway.

Causes and symptoms

Gastroenteritis arises from ingestion of viruses, certain bacteria, or parasites. Food that has spoiled may also cause illness. Certain medications and excessive alcohol can irritate the digestive tract to the point of inducing gastroenteritis. Regardless of the cause, the symptoms of gastroenteritis include diarrhea, nausea and vomiting, and abdominal **pain** and cramps. Sufferers may also experience bloating, low fever, and overall tiredness. Typically, the symptoms last only two to three days, but some viruses may last up to a week.

A usual bout of gastroenteritis shouldn't require a visit to the doctor. However, medical treatment is essential if symptoms worsen or if there are complications. Infants, young children, the elderly, and persons with underlying disease require special attention in this regard.

The greatest danger presented by gastroenteritis is dehydration. The loss of fluids through diarrhea and vomiting can upset the body's electrolyte balance, leading to potentially life-threatening problems such as heart beat abnormalities (arrhythmia). The risk of dehydration increases as symptoms are prolonged. Dehydration should be suspected if a **dry mouth**, increased or excessive thirst, or scanty urination is experienced.

If symptoms do not resolve within a week, an infection or disorder more serious than gastroenteritis may be involved. Symptoms of great concern include a high fever (102° F [38.9°C] or above), blood or mucus in the diarrhea, blood in the vomit, and severe abdominal pain or swelling. These symptoms require prompt medical attention.

Diagnosis

The symptoms of gastroenteritis are usually enough to identify the illness. Unless there is an outbreak affecting several people or complications are encountered in a particular case, identifying the specific cause of the illness is not a priority. However, if identification of the infectious agent is required, a stool sample will be collected and analyzed for the presence of viruses, disease-causing (pathogenic) bacteria, or parasites.

Treatment

Gastroenteritis is a self-limiting illness which will resolve by itself. However, for comfort and convenience, a person may use over-the-counter medications such as Pepto Bismol to relieve the symptoms. These medications work by altering the ability of the intestine to move or secrete spontaneously, absorbing toxins and water, or altering intestinal microflora. Some over-the-counter medicines use more than one element to treat symptoms.

If over-the-counter medications are ineffective and medical treatment is sought, a doctor may prescribe a more powerful anti-diarrheal drug, such as motofen or lomotil. Should pathogenic bacteria or parasites be identified in the patient's stool sample, medications such as **antibiotics** will be prescribed.

It is important to stay hydrated and nourished during a bout of gastroenteritis. If dehydration is absent, the drinking of generous amounts of nonalcoholic fluids, such as water or juice, is adequate. **Caffeine**, since it increases urine output, should be avoided. The traditional BRAT diet—bananas, rice, applesauce, and toast—is tolerated by the tender gastrointestinal system, but it is not particularly nutritious. Many, but not all, medical researchers recommend a diet that includes complex carbohydrates (e.g., rice, wheat, potatoes, bread, and cereal), lean meats, yogurt, fruit, and vegetables. Milk and other dairy products shouldn't create problems if they are part of the normal diet. Fatty foods or foods with a lot of sugar should be avoided. These recommendations are based on clinical experience and controlled trials, but are not universally accepted.

Minimal to moderate dehydration is treated with oral rehydrating solutions that contain glucose and electrolytes. These solutions are commercially available under names such as Naturalyte, Pedialyte, Infalyte, and Rehydralyte. Oral rehydrating solutions are formulated based on physiological properties. Fluids that are not based on these properties—such as cola, apple juice, broth, and sports beverages—are not recommended to treat dehydration. If vomiting interferes with oral rehydration, small frequent fluid intake may be better tolerated. Should oral rehydration fail or severe dehydration occur, medical treatment in the form of intravenous (IV) therapy is required. IV therapy can be followed with oral rehydration as the patient's condition improves. Once normal hydration is achieved, the patient can return to a regular diet.

Alternative treatment

Symptoms of uncomplicated gastroenteritis can be relieved with adjustments in diet, herbal remedies, and **homeopathy**. An infusion of meadowsweet (*Filipendula ulmaria*) may be effective in reducing nausea and stomach acidity. Once the worst symptoms are relieved, slippery elm (*Ulmus fulva*) can help calm the digestive tract. Of the homeopathic remedies available, *Arsenicum album*, **ipecac**, or *Nux vomica* are three said to relieve the symptoms of gastroenteritis.

Probiotics, bacteria that are beneficial to a person's health, are recommended during the recovery phase of gastroenteritis. Specifically, live cultures of *Lactobacillus acidophilus* are said to be effective in soothing the digestive tract and returning the intestinal flora to normal. *L. aci-*

KEY TERMS

Dehydration—A condition in which the body lacks the normal level of fluids, potentially impairing normal body functions.

Electrolyte—An ion, or weakly charged element, that conducts reactions and signals in the body. Examples of electrolytes are sodium and potassium ions.

Glucose—A sugar that serves as the body's primary source of fuel.

Influenza—A virus that affects the respiratory system, causing fever, congestion, muscle aches, and headaches.

Intravenous (IV) therapy—Administration of intravenous fluids.

Microflora—The bacterial population in the intestine.

Pathogenic bacteria—Bacteria that produce illness.

Probiotics—Bacteria that are beneficial to a person's health, either through protecting the body against pathogenic bacteria or assisting in recovery from an illness.

dophilus is found in live-culture yogurt, as well as in capsule or powder form at health food stores. The use of probiotics is found in folk remedies and has some support in the medical literature. Castor oil packs to the abdomen can reduce inflammation and also reduce spasms or discomfort.

Prognosis

Gastroenteritis is usually resolved within two to three days and there are no long-term effects. If dehydration occurs, recovery is extended by a few days.

Prevention

There are few steps that can be taken to avoid gastroenteritis. Ensuring that food is well-cooked and unspoiled can prevent bacterial gastroenteritis, but may not be effective against viral gastroenteritis.

Resources

BOOKS

Midthun, Karen, and Albert Z. Kapikian. "Viral Gastroenteritis." In *Gastrointestinal and Hepatic Infections*, ed. Christina Surawicz and Robert L. Owen. Philadelphia: W. B. Saunders Co., 1995.

PERIODICALS

Farthing, M., et al. "The Management of Infective Gastroenteritis in Adults." *Journal of Infection* 33 (1996): 143.

Gorbach, Sherwood L. "Efficacy of Lactobacillus in Treatment of Acute Diarrhea." *Nutrition Today* 31, no. 6 (Dec. 1996): 195.

Hart, C. Anthony, and Nigel A. Cunliffe. "Viral Gastroenteritis." *Current Opinion in Infectious Diseases* 10 (1997): 408.

Moss, Peter J., and Michael W. McKendrick. "Bacterial Gastroenteritis." *Current Opinion in Infectious Diseases* 10 (1997): 402.

Subcommittee on Acute Gastroenteritis. "Practice Parameter: The Management of Acute Gastroenteritis in Young Children." *Pediatrics* 97 (Mar. 1996): 424.

Julia Barrett

Gastroesophageal reflux *see* **Heartburn**

Gastrointestinal bleeding studies *see* **GI bleeding studies**

Gastrointestinal study *see* **Liver nuclear medicine scan**

Gastrojejunostomy *see* **Ulcer surgery**

Gastroschisis *see* **Abdominal wall defects**

Gastrostomy

Definition

Gastrostomy is a surgical procedure for inserting a tube through the abdomen wall and into the stomach. The tube is used for feeding or drainage.

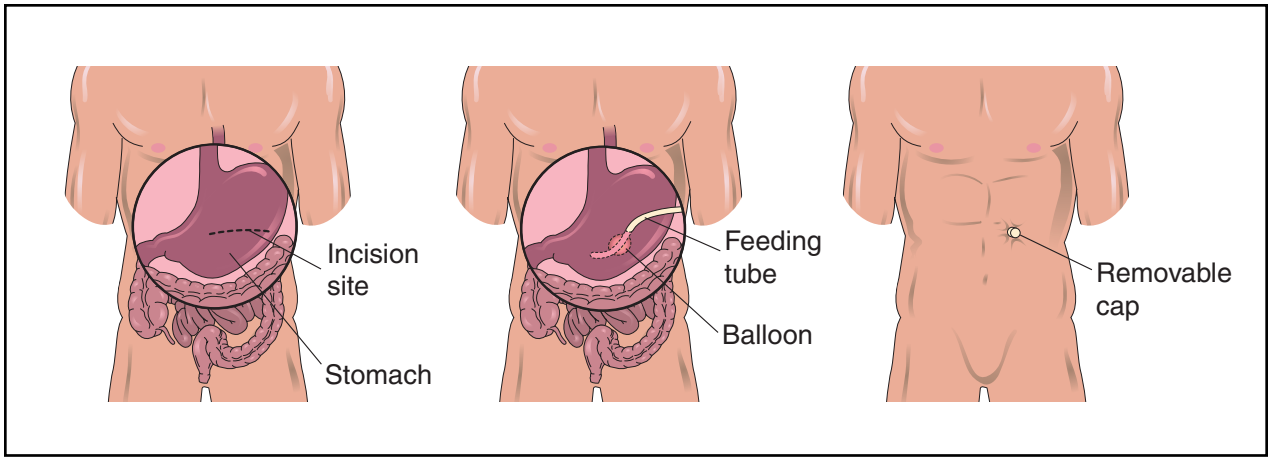
Purpose

Gastrostomy is performed because a patient temporarily or permanently needs to be fed directly through a tube in the stomach. Reasons for feeding by gastrostomy include **birth defects** of the mouth, esophagus, or stomach, and problems sucking or swallowing.

Gastrostomy is also performed to provide drainage for the stomach when it is necessary to bypass a long-standing obstruction of the stomach outlet into the small intestine. Obstructions may be caused by peptic ulcer scarring or a tumor.

Precautions

Gastrostomy is a relatively simple procedure. As with any surgery, patients are more likely to experience compli-



Gastrostomy is a procedure in which the surgeon makes an opening into the stomach and inserts a feeding tube for feeding or for drainage. *(Illustration by Electronic Illustrators Group.)*

cations if they are smokers, obese, use alcohol heavily, or use illicit drugs. In addition, some prescription medications may increase risks associated with anesthesia.

Description

Gastrostomy, also called gastrostomy tube insertion, is surgery performed by a general surgeon to give an external opening into the stomach. Surgery is performed either when the patient is under general anesthesia—where the patient feels as if he is in a deep sleep and has no awareness of what is happening—or under local anesthesia. With local anesthesia, the patient is awake, but the part of the body cut during the operation is numbed.

A small incision is made on the left side of the abdomen; then, an incision is made through the stomach. A small, flexible, hollow tube, usually made of polyvinylchloride or rubber, is inserted into the stomach. The stomach is stitched closed around the tube, and the incision is closed. The procedure is performed at a hospital or free-standing surgery center.

The length of time the patient needs to remain in the hospital depends on the age of the patient and the patient's general health. In some cases, the hospital stay can be as short as one day, but often is longer. Normally, the stomach and abdomen heal in five to seven days.

The cost of the surgery varies, depending on the age and health of the patient. Younger, sicker patients require more intensive, thus more expensive, care.

Preparation

Prior to the operation, the doctor will perform endoscopy and take x rays of the gastrointestinal tract. Blood and urine tests will also be performed, and the patient may meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia.

Aftercare

Immediately after the operation, the patient is fed intravenously for at least 24 hours. Once bowel sounds are heard, indicating that the gastrointestinal system is working, the patient can begin clear liquid feedings through the tube. Gradually feedings are increased.

Patient education concerning use and care of the gastrostomy tube is very important. Patients and their families are taught how to recognize and prevent infection around the tube, how to feed through the tube, how to handle tube blockage, what to do if the tube pulls out, and what normal activities can be continued.

Risks

There are few risks associated with this surgery. The main complications are infection, bleeding, dislodgment of the tube, stomach bloating, nausea, and **diarrhea**.

Normal results

The patient is able to eat through the gastrostomy tube, or the stomach can be drained through the tube.

Resources

BOOKS

Griffith, H. Winter. *Complete Guide to Symptoms, Illness, & Surgery.* 3rd ed. New York: The Body Press/Perigee, 1995.

KEY TERMS

Endoscopy—A procedure in which an instrument containing a camera is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

OTHER

"Stomach Tube Insertion." HealthAnswers.com. <http://www.healthanswers.com>.

Tish Davidson

Gaucher disease

Definition

Gaucher disease is a rare genetic disorder that results in accumulation of fatty molecules called cerebrosides. It can have serious effects on numerous body organs including the liver, spleen, bones and central nervous system. Treatments based on molecular biology are becoming available, but are very expensive.

Description

Gaucher disease was first described by the French physician Philippe Gaucher in 1882. It is the most common of a class of diseases called lysosomal storage diseases, each of which is characterized by the accumulation of a specific chemical substance (a different substance depending on the exact disease). Gaucher disease is characterized by a wide array of different symptoms and the severity of the disease ranges from undetectable to lethal.

Three forms of the disease are recognized: Types I, II and III. Type I is by far the most common and shows the mildest symptoms. It is non-neuronopathic, meaning that the nervous system is not attacked. The onset of Type I can occur at any age in childhood or adult life with the average age of onset at about 21 years. Some affected individuals are have no symptoms throughout adult life. Type II, the infantile form, accounts for less than 1% of patients with Gaucher disease. It is neuronopathic (attacks the nervous system); nervous system effects are severe, and victims often die within the first year of life. Type III most often has its onset during childhood and has some of the features of both the adult and infantile forms. This affects less than 5% of persons with Gaucher disease.

Gaucher disease is caused by the absence, or near absence, of activity of an enzyme called glucocerebrosidase (GC). The normal action of GC is to break down a common molecule called glucocerebroside. If not broken down, glucocerebroside accumulates in certain cells to levels that can cause damage, especially in the spleen, liver, and bone. The common link among these organs is that they house a cell type called a macrophage. A macrophage is a large cell that surrounds and consumes a foreign substance (such as bacteria) in the body. The cellular structures in which glucocerebroside accumulates are called lysosomes.

The three forms of Gaucher disease also differ in their population genetics. Type I is most common in persons of eastern European (Ashkenazi) Jewish descent. Among this population, the disease occurs at a rate of one in 450 live births and about one in 10 to 15 persons are carriers, making it the most common genetic disease affecting Jewish people. The other two types are equally frequent in all ethnic groups. Type II occurs at a rate of one in 100,000 live births, while Type III is estimated to occur in one in 50,000 live births.

Causes and symptoms

Lack of the GC enzyme is caused by a mutation in the glucocerebrosidase gene. The gene is located on chromosome 1. As of 2000, there have been over 100 mutations described in this gene that causes Gaucher disease. Gaucher disease is inherited in an autosomal recessive pattern. This means that two defective gene copies must be inherited, one from each parent, for the disease to manifest itself. Persons with only one gene mutation are carriers for the disorder. A person who is a carrier for Gaucher disease does not have any symptoms and does not know he or she is a carrier unless he or she has had specific testing. When both parents are carriers for Gaucher disease, there is a one in four chance (25%) in each **pregnancy** for a child to have Gaucher disease. There is a two in three chance that a healthy sibling of an affected child is a carrier.

The results of Gaucher disease are widespread in the body and include excessive growth of the liver and spleen (hepatosplenomegaly), weakening of bones, and, in acute cases, severe nervous system damage. Many patients experience "bone crises," which are episodes of extreme **pain** in their bones.

There is a wide array of other problems that occur with Gaucher disease, such as anemia (fewer than normal red blood cells). Just how these other symptoms are caused is not known. Nor is it known why some patients have very mild disease and others have much more significant problems. Even identical twins with the disease can have differing symptoms.

Diagnosis

Diagnosis of Gaucher disease, based initially on the symptoms described above, can be confirmed by microscopic, enzymatic, and molecular tests. Biopsy (surgical removal of tissue from a problem area) of tissue is helpful for microscopic diagnosis. When biopsy tissue is examined under the microscope, cells will appear swollen and will show characteristic features of the cytoplasm (part of the cell body along with the nucleus) and nucleus. Enzyme tests will show deficiency (<30% of normal levels) of the enzyme GC. Molecular analysis of DNA samples looking at four of the more common mutations will show defects in the gene for GC in 95% of Ashkenazi Jewish individuals and in 75% of non-Jewish people. Diagnosis can be performed prenatally (before birth) if the parents' mutations are known using **amniocentesis** or **chorionic villus sampling**.

Diagnosis as to which of the three types of Gaucher disease an individual has is based on the symptoms, rather than on test results.

Treatment

Until the 1990s, only supportive therapy could be offered. **Analgesics** are used to control pain. Orthopedic treatment is used for bone **fractures**. In some cases, surgical removal of the spleen may be necessary. Several treatments for anemia have been used, including vitamin and iron supplements, blood transfusions, and bone marrow transplants.

The newest form of treatment for Gaucher disease is enzyme replacement therapy, in which GC can be administered intravenously. The enzyme can be prepared either by purification from placentas (alglucerase) or by recombinant DNA manufacturing techniques (imiglucerase). Either way, the cost of treatment ranges from $100,000 to $400,000 per year, which can prevent many from obtaining treatment.

Enzyme replacement is effective at reducing most Gaucher symptoms. The notable exception is neurologic damage in Type II disease, which remains unimproved by this treatment. This treatment is not recommended for individuals who are asymptomatic. As of 2000, the efficacy for the treatment of Type III Gaucher disease is not known. Many questions remain about enzyme replacement therapy in regard to dosage, and method and frequency of administration. The treatment program should be individualized for each patient.

Prognosis

A patient's expected lifespan varies greatly with the type of Gaucher disease. Infants with Type II disease have a life span of one to four years. Patients with Types I and III of the disease have highly variable outcomes with some patients dying in childhood and others living full lives. Little is known about the reasons for this variability.

KEY TERMS

Cerebrosides—Fatty carbohydrates that occur in the brain and nervous system.

Enzymatic replacement therapy—A treatment method used to replace missing enzymes. It is possible to synthesize enzymes and then inject them intravenously into patients.

Glucocerebroside—A cerebroside that contains glucose in the molecule.

Prevention

Genetic counseling is advised for individuals with Gaucher disease and for their relatives to accurately assess risk and discuss testing options. For couples who previously had a child with Gaucher or in situations where both parents are carriers for known Gaucher mutations, prenatal diagnosis is available to determine whether a pregnancy is affected. Families in which a person has been diagnosed with Gaucher disease can have DNA testing, which enables other relatives to determine their carrier status. Prospective parents can then use that information to conduct family planning or to prepare for a child who may have special circumstances.

Families in which both parents are known to be a carrier of a mutation for Gaucher disease could consider preimplantation genetic diagnosis. This relatively new procedure can select an embryo without both Gaucher disease mutations prior to implantation of the embryo into the uterus. This technique is only available at selected genetics centers.

As of 2000, population screening for Gaucher disease is not standard of care.

Resources

PERIODICALS

Beutler, E. "Gaucher Disease." *Archives of Internal Medicine* 159 (1999): 881-2.

Charrow, J., et al. "Gaucher Disease: Recommendations on Diagnosis, Evaluation, and Monitoring." *Archives of Internal Medicine* 158 (1998): 1754-1760.

Grabowski, Gregory A. "Current Issues in Enzyme Therapy for Gaucher Disease." *Drugs* 52 (August 1996): 159-167.

NIH Technology Assessment Conference. "Gaucher Disease: Current Issues in Diagnosis and Treatment." *JAMA* 275 (February 12, 1996): 548-553.

ORGANIZATIONS

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington, DC 20008. (202) 966-5557. Fax: (202) 966-8553. <http://www.geneticalliance.org>.

Children's Gaucher Research Fund. PO Box 2123, Granite Bay, CA 95746-2123. (916) 797-3700. Fax: (916) 797-3707. <http://www.childrensgaucher.org>.

National Gaucher Foundation. 11140 Rockville Pike, Suite 350, Rockville, MD 20852-3106. (800) 925-8885. <http://www.gaucherdisease.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

OTHER

"Cerezyme." Genzyme Therapeutics. <http://www.cerezyme.com>.

"Gaucher Disease: Current Issues in Diagnosis and Treatment." <http://text.nlm.nih.gov/nih/ta/www/16.html>.

"Living with Gaucher Disease: A Guide for Patients, Parents, Relatives, and Friends." <http://neuro-www3.mgh.harvard.edu/gaucher/living.html>.

National Foundation for Jewish Genetic Diseases (NFJGD). <http://www.nfjgd.org/>.

Amy Vance

Gay and lesbian health

Definition

Lesbian, gay, bisexual, and transgender (LGBT) individuals are as diverse as the general population in terms of race, ethnicity, age, religion, education, income, and family history. A number of health concerns are unique to or shared by the LGBT community, however, including an increased risk of certain cancers, infectious and **sexually transmitted diseases** (STDs), and mental health disorders; issues relating to **nutrition** and weight, tobacco use, and substance abuse; and discrimination by health care and insurance providers.

Description

The definitions of different sexual identities have shifted over the years, as have the perceptions and stereotypes of the general population. Because of the wide range of behaviors and identities that exist in the LGBT community, it is difficult to develop an inclusive definition. It is generally accepted, however, that gay men and lesbians are sexually attracted to or participate in sexual behaviors with individuals of the same gender, while bisexual men and women are sexually attracted to or participate in sexual behaviors with individuals of both genders. Transgender individuals live part- or full-time in a gender role opposite to their genetic sex.

It is estimated that approximately 2.8% of men and 1.4% of women identify as being gay, lesbian, or bisexual while 9.1% of men and 4.3% of women have participated in sexual behavior with someone of the same gender at least once. The true extent of the transgender community has not been well researched in the United States; one study from the Netherlands in 1993 found that one in 11,900 males and one in 30,400 females are transgender.

There are a number of issues that arise when trying to define sexual orientation. Many gay men and lesbians have participated in or continue to participate in sexual activities with members of the opposite sex but choose not to identify as heterosexuals or bisexuals. Others have never participated in sexual activities at all yet still identify as gay, lesbian, or bisexual. Some men and women identifying as bisexuals are in long-term, monogamous relationships with individuals of the same or opposite sex. Male-to-female (MTF) or female-to-male (FTM) transgender individuals may or may not identify themselves as gay or lesbian.

The implications of these identity issues are far-reaching. Misdiagnoses or improper medical recommendations might come from health care providers who have mistakenly assumed sexual behaviors or risks from the patient's stated identity. For example, a provider might incorrectly assume that a lesbian patient has never had sexual intercourse with a male and therefore would not have contracted STDs not normally transmitted by sexual activities between women. It has been difficult to closely estimate the numbers of LGBT individuals in the United States because of varying definitions. Likewise, the statistics in medical or social studies and surveys on LGBT issues might vary widely depending on what definitions were provided for the respondents. Because of this, many researchers have opted for the more inclusive terms of "men who have sex with men" (MSM) and "women who have sex with women" (WSW) to categorize gay, lesbian, and bisexual respondents.

Important health care issues

Many LGBT individuals have difficulty revealing their sexual identity ("coming out") to their health care providers. They may fear discrimination from providers or believe that their confidentiality might be breached. In some cases health care workers have been poorly trained to address the needs of LGBT individuals or have difficulty communicating with their LGBT patient (one study

indicated that 40% of physicians are uncomfortable providing care for gay or lesbian patients). In addition, many questions posed in questionnaires or examinations are heterosexually biased (e.g. asking a lesbian which birth control methods she uses or a gay man if he is married, single, or divorced).

Other reasons why LGBT individuals are often hesitant to share their sexual identity are more logistical. Many insurance companies deny benefits to long-term partners on the basis that they are not married. LGBT patients may have inadequate access to health care, either because they live in a remote rural area or in the crowded inner city. Some same-sex partners encounter discrimination in hospitals and clinics when they are denied the rights usually given to spouses of a patient such as visiting, making medical decisions, and participating in consultations with physicians.

Some of the health concerns and risk factors that are relevant to LBGT individuals may be shared by the general population, while others are more specific to the LGBT community, and still others are specific to different subgroups of LGBT individuals. These health concerns may be grouped into the following areas of concern:

- Sexual behavior issues: STDs such as human **immunodeficiency** virus (HIV) and acquired immune deficiency syndrome (**AIDS**), **hepatitis A** virus (HAV), **hepatitis B** virus (HBV), bacterial vaginosis, **gonorrhea**, chlamydia, and **genital warts** (human papillomavirus or HPV); anal, ovarian, and cervical **cancer**.
- Cultural issues: body image, nutrition, weight, and eating disorders; drug and alcohol abuse; tobacco use; parenting and family planning.
- Discrimination issues: inadequate medical care; harassment at work, school, or home; difficulty in obtaining housing, insurance coverage, or child custody; violence.
- Sexual identity issues: conflicts with family, friends, and work mates; psychological issues such as **anxiety**, depression, and suicide; economic hardship.

CANCER. Cancer is the second leading cause of **death** in the United States. In 2000, it was estimated that 1,220,100 individuals were diagnosed with cancer and 552,200 lost their lives as a result. LBGT individuals are at an increased risk for certain types of cancers. Some researchers believe that those who do not disclose their sexual identity live with an added **stress** that suppresses the immune system, thus leaving them with an increased risk of tumor growth.

Several studies have indicated that lesbians have higher risk for developing **breast cancer**. This is partially related to higher rates of risk factors such as **obesity**, alcohol use, tobacco use, and nulliparity (not bearing children). It has also been shown that lesbians are less likely to be screened for breast cancer than heterosexual women. Lesbians also have additional risk of developing **ovarian cancer**, due to inadequate access to health care, nulliparity, and not using **oral contraceptives** (use of oral contraceptives has been shown to decrease the risk of getting ovarian cancer).

Gay and bisexual men (or more generally, men who have sex with men [MSM]) are at higher risk of developing non-Hodgkin's lymphoma, **Hodgkin's disease**, and **anal cancer**. **Kaposi's sarcoma**, an AIDS-associated cancer, used to be found in the gay community at rates thousands of times more than the general population before more effective **antiretroviral drugs** became available for people infected with HIV. Anal cancer is associated with transmission of human papillomavirus (HPV); a 1998 study indicated 73% of HIV-positive and 23% of HIV-negative MSM were infected with more than one type of HPV. The risk factors associated with MSM are also associated with increased rates of anal cancer (i.e. **smoking**, having many sexual partners, and receiving anal intercourse).

AIDS. As of 2000, more than 753,900 individuals have been diagnosed with AIDS in the United States; of total cases, 84% are men, 16% are women, and 1% are children 12 years old or younger. The major risk groups associated with AIDS transmission are MSM who engage in high-risk sexual behaviors, intravenous drug users (IDUs) who share needles, heterosexuals who engage in high-risk sexual behaviors, inmates at correctional facilities, and neonates (newborns) whose mothers are infected with HIV.

Approximately 54% of cumulative AIDS cases are men who have sex with men. MSM also constitute 38% of newly reported HIV cases each year. An annual decrease has occurred in the number of reported AIDS-related deaths, partially attributable to the development of advanced therapies that are extending the life expectancies of AIDS patients. These new treatments, however, have inadvertently caused decreased rates of safe sex practices; one 1998 study revealed that 18% of HIV-positive men were having safe sex less often since advances in treatment.

Few studies have looked at the transmission of HIV in women who have sex with women (WSW). HIV transmission might occur in WSW because of intercourse with males or intravenous drug use. Several small studies conducted in the 1990s found no evidence of HIV transmission from sexual activities between women.

OTHER STDS. It is estimated that 333 million cases of curable STDs occur each year worldwide. Among the

most commonly found STDs in the United States are chlamydia, gonorrhea, AIDS, **syphilis**, and hepatitis B virus (HBV). Over 15 million new infections are estimated to occur each year in the United State, with approximately four million of those occurring in adolescents.

MSM are at most risk of developing **urethritis** (inflammation of the urethra), **proctitis** (inflammation of the rectum), pharyngitis (inflammation of the cavity at the back of the mouth), gonorrhea, chlamydia, HAV, HBV, syphilis, herpes, and HPV. HAV and HBV are both vaccine-preventable viruses but rates of **vaccination** among MSM are low; in 1996 the Centers for Disease Control and Prevention (CDC) found that only 3% of MSM had been vaccinated against HBV. In May 2001 the Food and Drug Administration (FDA) approved a new vaccine that combines the HAV and HBV in one, with hopes that vaccination rates will increase.

It appears that STDs are less common in women who have sex only with women than in bisexual or heterosexual women. Genital **warts**, **trichomoniasis**, and bacterial vaginosis are transmittable during sexual activity between women. Chlamydia, herpes, syphilis, gonorrhea, and HAV are also able to be transmitted between women, although at lower rates.

MENTAL HEALTH. Forty million Americans are estimated to be diagnosed with a mental disorder, a condition in which abnormalities in thought, feeling, and/or behavior cause distress or impair function. Of these, only 25% seek and obtain care from mental health professionals.

Homosexuality was labeled as a mental disorder until 1973 when it was declassified by the American Psychiatric Association; in 1986 "ego-dystonic homosexuality" was removed from the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III). More recently, studies have shown that LGBT individuals are at increased risk of depression, panic attacks, substance abuse, and suicide. MSM have been shown to have higher rates of depression, anxiety, and **conduct disorder** than heterosexual males, although not much study has been done in this area. WSW have been shown to have increased rates of alcohol and drug abuse.

Gender identity disorder is defined as "a strong and persistent cross-gender identification...manifested by symptoms such as a stated desire to be the other sex, frequently passing as the other sex, desire to live or be treated as the other sex, or the conviction that he or she as the typical feelings and reactions of the other sex" (DSM-IV, 302.85). Transvestic fetishism is defined as involving "recurrent, intense sexually arousing fantasies, sexual urges, or behaviors involving cross-dressing" (DSM-IV, 302.3). Both disorders lead to a "disturbance that causes clinically significant distress or impairment in social, occupational, or other important areas of functioning." This last point iterates that transgender individuals not automatically considered under DSM-IV to have a mental disorder.

NUTRITION AND WEIGHT. Diet and nutritional factors are associated with a number of diseases including cancer, **stroke**, diabetes, heart disease, and **osteoporosis**. It has been shown that lesbians are more likely than heterosexual women to be obese, have a higher body mass index (BMI), and have higher rates of smoking, but are also more likely to have a healthier body image (42% compared to 21% of heterosexual women). Gay men and adolescents, on the other hand, have been shown to have increased rates of eating disorder behaviors than heterosexual men; examples are binge eating (25% compared to 11%), purging behaviors (12% to 4%), and poor body image (28% to 12%).

SUBSTANCE AND TOBACCO USE. Marijuana and **cocaine** use has been shown to be higher among lesbians than heterosexual women. The incidence of the use of some drugs is higher in gay men than heterosexual men; these include marijuana, psychedelic drugs, ecstasy, barbituates, and stimulants such as amyl or butyl nitrate ("poppers"). There is some indication that the use of some illicit drugs speeds up the replication of HIV, although more research needs to be done in this area.

Cigarette smoking is responsible for 430,000 deaths a year in the United States, with an estimated 3,000 nonsmokers dying as a result of exposure to secondhand smoke. In 1997 the rate of smoking among all adults was 25%. In contrast, 36% of gay men and lesbians were noted to be smokers. Lesbians are more than two times as likely to become heavy smokers than heterosexual women.

Prevention

There are numerous ways that health care providers can improve the access to and experience of health care services for LGBT individuals. These include:

- rewording questionnaires and examinations to be inclusive of LGBT patients
- providing referrals to social service agencies and counseling services that are LGBT-friendly
- taking educational courses that are sensitive to the needs of LGBT patients
- treating the families of LGBT patients as one would the families of heterosexual patients
- maintaining the strictest code of confidentiality
- developing and maintaining health care centers or clinics that address LGBT-specific needs

KEY TERMS

Gender identity disorder—a mental disorder in which cross-gender identification (including wanting to live and be treated as the other sex) causes distress or impairment of normal function.

Pharyngitis—inflammation of the cavity at the back of the mouth.

Proctitis—inflammation of the rectum.

Nulliparity—never having carried a pregnancy.

Transvestic fetishism—a mental disorder in which fantasies, sexual urges, or behaviors involving cross-dressing cause distress or impairment of normal function.

Urethritis—inflammation of the urethra.

- asking non-threatening questions to determine if a person is at risk of an STD
- educating patients of risk factors associated with STDs, possible vaccines, and treatments available
- providing services to individuals in the process of disclosing their sexual identity and, if applicable, their families

Resources

ORGANIZATIONS

Gay and Lesbian Medical Association. 459 Fulton Street, Suite 107, San Francisco, CA 94102. (415) 225-4547. <http://www.glma.org>.

Parents, Families, and Friends of Lesbians and Gays. 1726 M Street NW, Suite 400, Washington, DC 20036. (202) 467-8180. <http://www.pflag.org>.

OTHER

Albert, Sarah. "Lesbians and Gays More Likely to Smoke, Survey Says." GayHealth Website. 16 May 2001. <http://www.gayhealth.com/templates/990224450425720214843000001/news/index.html?record=554>.

Dean, Laura, Ilan H. Meyer, Kevin Robinson, Randall L. Sell, Robert Sember, Vincent M. B. Silenzio, Deborah J. Bowen, Judith Bradford, Esther Rothblum, Jocelyn White, Patricia Dunn, Ann Lawrence, Daniel Wolfe, and Jessica Xavier. "Lesbian, Gay, Bisexual, and Transgender Health: Findings and Concerns." *Journal of the Gay and Lesbian Medical Association*. October 2000. <http://www.glma.org/pub/jglma/vol4/3/index.html>.

Garbo, Jon. "FDA Approves Combo Vaccine for Hepatitis A and B." GayHealth Website. 14 May 2001. <http://www.gayhealth.com/templates/990224624673431396483000002/news?record=553>.

"Healthy People 2010 Companion Document for Lesbian, Gay, Bisexual, and Transgender (LGBT) Health." Gay and Lesbian Medical Association. April 2001. <http://www.glma.org/policy/hp2010/index.html>.

Stéphanie Islane Dionne

Gender identity disorder

Definition

The psychological diagnosis gender identity disorder (GID) is used to describe a male or female that feels a strong identification with the opposite sex and experiences considerable distress because of their actual sex.

Description

Gender identity disorder can affect children, adolescents, and adults. Individuals with gender identity disorder have strong cross-gender identification. They believe that they are, or should be, the opposite sex. They are uncomfortable with their sexual role and organs and may express a desire to alter their bodies. While not all persons with GID are labeled as transsexuals, there are those who are determined to undergo sex change procedures or have done so, and, therefore, are classified as transsexual. They often attempt to pass socially as the opposite sex. Transsexuals alter their physical appearance cosmetically and hormonally, and may eventually undergo a sex-change operation.

Children with gender identity disorder refuse to dress and act in sex-stereotypical ways. It is important to remember that many emotionally healthy children experience fantasies about being a member of the opposite sex. The distinction between these children and gender identity disordered children is that the latter experience significant interference in functioning because of their cross-gender identification. They may become severely depressed, anxious, or socially withdrawn.

Causes and symptoms

The cause of gender identity disorder is not known. It has been theorized that a prenatal hormonal imbalance may predispose individuals to the disorder. Problems in the individual's family interactions or family dynamics have also been postulated as having some causal impact.

The *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (*DSM-IV*), the diagnostic reference standard for United States mental health profes-

KEY TERMS

Cross-dressing—Dressing in clothing that is stereotypical of the opposite sex.

Gender identity disorder (GID)—A strong and lasting cross-gender identification and persistent discomfort with one's biological gender (sex) role. This discomfort must cause a significant amount of distress or impairment in the functioning of the individual.

Transsexual—A person with gender identity disorder who has an overwhelming desire to change anatomic sex; one who seeks hormonal or surgical treatment to change sex.

sionals, describes the criteria for gender identity disorder as an individual's strong and lasting cross-gender identification and their persistent discomfort with their biological gender role. This discomfort must cause a significant amount of distress or impairment in the functioning of the individual.

DSM-IV specifies that children must display at least four of the following symptoms of cross-gender identification for a diagnosis of gender identity disorder:

- a repeatedly stated desire to be, or insistence that he or she is, the opposite sex
- a preference for cross-dressing
- a strong and lasting preference to play make-believe and role-playing games as a member of the opposite sex or persistent fantasies that he or she is the opposite sex
- a strong desire to participate in the stereotypical games of the opposite sex
- a strong preference for friends and playmates of the opposite sex

Diagnosis

Gender identity disorder is typically diagnosed by a psychiatrist or psychologist, who conducts an interview with the patient and takes a detailed social history. Family members may also be interviewed during the assessment process. This evaluation usually takes place in an outpatient setting.

Treatment

Treatment for children with gender identity disorder focuses on treating secondary problems such as depression and **anxiety**, and improving self-esteem. Treatment may also work on instilling positive identifications with the child's biological gender. Children typically undergo psychosocial therapy sessions; their parents may also be referred for family or individual therapy.

Transsexual adults often request hormone and surgical treatments to suppress their biological sex characteristics and acquire those of the opposite sex. A team of health professionals, including the treating psychologist or psychiatrist, medical doctors, and several surgical specialists, oversee this transitioning process. Because of the irreversible nature of the surgery, candidates for sex-change surgery are evaluated extensively and are often required to spend a period of time integrating themselves into the cross-gender role before the procedure begins. Counseling and peer support are also invaluable to transsexual individuals.

Prognosis

Long-term follow up studies have shown positive results for many transsexuals who have undergone sex-change surgery. However, significant social, personal, and occupational issues may result from surgical sex changes, and the patient may require psychotherapy or counseling.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Israel, Gianna E., and Donald E. Tarver. *Transgender Care: Recommended Guidelines, Practical Information and Personal Accounts*. Philadelphia: Temple University Press, 1997.

Maxmen, Jerrold S., and Nicholas G. Ward. "Sexual and Gender Identity Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

PERIODICALS

Dickey, Robert. "Diagnosing and Treating Gender Identity Disorder in Women." *Medscape Mental Health* 2, no. 9 (1997).

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP). 3615 Wisconsin Ave. NW, Washington, DC 20016. (202) 966-7300. <http://www.aacap.org>.

OTHER

The National Transgender Guide. <http://www.tgguide.com>.

Paula Anne Ford-Martin

Gene therapy

Definition

Gene therapy is a rapidly growing field of medicine in which genes are introduced into the body to treat diseases. Genes control heredity and provide the basic biological code for determining a cell's specific functions. Gene therapy seeks to provide genes that correct or supplant the disease-controlling functions of cells that are not, in essence, doing their job. Somatic gene therapy introduces therapeutic genes at the tissue or cellular level to treat a specific individual. Germ-line gene therapy inserts genes into reproductive cells or possibly into embryos to correct genetic defects that could be passed on to future generations. Initially conceived as an approach for treating inherited diseases, like **cystic fibrosis** and Huntington's disease, the scope of potential gene therapies has grown to include treatments for cancers, arthritis, and infectious diseases. Although gene therapy testing in humans has advanced rapidly, many questions surround its use. For example, some scientists are concerned that the therapeutic genes themselves may cause disease. Others fear that germ-line gene therapy may be used to control human development in ways not connected with disease, like intelligence or appearance.

The biological basis of gene therapy

Gene therapy has grown out of the science of genetics or how heredity works. Scientists know that life begins in a cell, the basic building block of all multicellular organisms. Humans, for instance, are made up of trillions of cells, each performing a specific function. Within the cell's nucleus (the center part of a cell that regulates its chemical functions) are pairs of chromosomes. These threadlike structures are made up of a single molecule of DNA (deoxyribonucleic acid), which carries the blueprint of life in the form of codes, or genes, that determine inherited characteristics.

A DNA molecule looks like two ladders with one of the sides taken off both and then twisted around each other. The rungs of these ladders meet (resulting in a spiral staircase-like structure) and are called base pairs. Base pairs are made up of nitrogen molecules and arranged in specific sequences. Millions of these base pairs, or sequences, can make up a single gene, specifically defined as a segment of the chromosome and DNA that contains certain hereditary information. The gene, or combination of genes formed by these base pairs ultimately direct an organism's growth and characteristics through the production of certain chemicals, primarily proteins, which carry out most of the body's chemical functions and biological reactions.

Scientists have long known that alterations in genes present within cells can cause inherited diseases like cystic fibrosis, sickle-cell anemia, and **hemophilia**. Similarly, errors in the total number of chromosomes can cause conditions such as **Down syndrome** or Turner's syndrome. As the study of genetics advanced, however, scientists learned that an altered genetic sequence can also make people more susceptible to diseases, like **atherosclerosis**, **cancer**, and even **schizophrenia**. These diseases have a genetic component, but are also influenced by environmental factors (like diet and lifestyle). The objective of gene therapy is to treat diseases by introducing functional genes into the body to alter the cells involved in the disease process by either replacing missing genes or providing copies of functioning genes to replace nonfunctioning ones. The inserted genes can be naturally-occurring genes that produce the desired effect or may be genetically engineered (or altered) genes.

Scientists have known how to manipulate a gene's structure in the laboratory since the early 1970s through a process called gene splicing. The process involves removing a fragment of DNA containing the specific genetic sequence desired, then inserting it into the DNA of another gene. The resultant product is called recombinant DNA and the process is genetic engineering.

There are basically two types of gene therapy. Germ-line gene therapy introduces genes into reproductive cells (sperm and eggs) or someday possibly into embryos in hopes of correcting genetic abnormalities that could be passed on to future generations. Most of the current work in applying gene therapy, however, has been in the realm of somatic gene therapy. In this type of gene therapy, therapeutic genes are inserted into tissue or cells to produce a naturally occurring protein or substance that is lacking or not functioning correctly in an individual patient.

Viral vectors

In both types of therapy, scientists need something to transport either the entire gene or a recombinant DNA to the cell's nucleus, where the chromosomes and DNA reside. In essence, vectors are molecular delivery trucks. One of the first and most popular vectors developed were viruses because they invade cells as part of the natural infection process. Viruses have the potential to be excellent vectors because they have a specific relationship with the host in that they colonize certain cell types and tissues in specific organs. As a result, vectors are chosen according to their attraction to certain cells and areas of the body.

One of the first vectors used was retroviruses. Because these viruses are easily cloned (artificially reproduced) in the laboratory, scientists have studied

them extensively and learned a great deal about their biological action. They have also learned how to remove the genetic information which governs viral replication, thus reducing the chances of infection.

Retroviruses work best in actively dividing cells, but cells in the body are relatively stable and do not divide often. As a result, these cells are used primarily for *ex vivo* (outside the body) manipulation. First, the cells are removed from the patient's body, and the virus, or vector, carrying the gene is inserted into them. Next, the cells are placed into a nutrient culture where they grow and replicate. Once enough cells are gathered, they are returned to the body, usually by injection into the blood stream. Theoretically, as long as these cells survive, they will provide the desired therapy.

Another class of viruses, called the adenoviruses, may also prove to be good gene vectors. These viruses can effectively infect nondividing cells in the body, where the desired gene product is then expressed naturally. In addition to being a more efficient approach to gene transportation, these viruses, which cause respiratory infections, are more easily purified and made stable than retroviruses, resulting in less chance of an unwanted viral infection. However, these viruses live for several days in the body, and some concern surrounds the possibility of infecting others with the viruses through sneezing or coughing. Other viral vectors include **influenza** viruses, Sindbis virus, and a herpes virus that infects nerve cells.

Scientists have also delved into nonviral vectors. These vectors rely on the natural biological process in which cells uptake (or gather) macromolecules. One approach is to use liposomes, globules of fat produced by the body and taken up by cells. Scientists are also investigating the introduction of raw recombinant DNA by injecting it into the bloodstream or placing it on microscopic beads of gold shot into the skin with a "gene-gun." Another possible vector under development is based on dendrimer molecules. A class of polymers (naturally occurring or artificial substances that have a high molecular weight and formed by smaller molecules of the same or similar substances), is "constructed" in the laboratory by combining these smaller molecules. They have been used in manufacturing Styrofoam, polyethylene cartons, and Plexiglass. In the laboratory, dendrimers have shown the ability to transport genetic material into human cells. They can also be designed to form an affinity for particular cell membranes by attaching to certain sugars and protein groups.

The history of gene therapy

In the early 1970s, scientists proposed "gene surgery" for treating inherited diseases caused by faulty genes. The idea was to take out the disease-causing gene and surgically implant a gene that functioned properly. Although sound in theory, scientists, then and now, lack the biological knowledge or technical expertise needed to perform such a precise surgery in the human body.

However, in 1983, a group of scientists from Baylor College of Medicine in Houston, Texas, proposed that gene therapy could one day be a viable approach for treating Lesch-Nyhan disease, a rare neurological disorder. The scientists conducted experiments in which an enzyme-producing gene (a specific type of protein) for correcting the disease was injected into a group of cells for replication. The scientists theorized the cells could then be injected into people with Lesch-Nyhan disease, thus correcting the genetic defect that caused the disease.

As the science of genetics advanced throughout the 1980s, gene therapy gained an established foothold in the minds of medical scientists as a promising approach to treatments for specific diseases. One of the major reasons for the growth of gene therapy was scientists' increasing ability to identify the specific genetic malfunctions that caused inherited diseases. Interest grew as further studies of DNA and chromosomes (where genes reside) showed that specific genetic abnormalities in one or more genes occurred in successive generations of certain family members who suffered from diseases like intestinal cancer, manic-depression, **Alzheimer's disease**, heart disease, diabetes, and many more. Although the genes may not be the only cause of the disease in all cases, they may make certain individuals more susceptible to developing the disease because of environmental influences, like **smoking**, pollution, and **stress**. In fact, some scientists theorize that all diseases may have a genetic component.

On September 14, 1990, a four-year old girl suffering from a genetic disorder that prevented her body from producing a crucial enzyme became the first person to undergo gene therapy in the United States. Because her body could not produce adenosine deaminase (ADA), she had a weakened immune system, making her extremely susceptible to severe, life-threatening infections. W. French Anderson and colleagues at the National Institutes of Health's Clinical Center in Bethesda, Maryland, took white blood cells (which are crucial to proper immune system functioning) from the girl, inserted ADA producing genes into them, and then transfused the cells back into the patient. Although the young girl continued to show an increased ability to produce ADA, debate arose as to whether the improvement resulted from the gene therapy or from an additional drug treatment she received.

Nevertheless, a new era of gene therapy began as more and more scientists sought to conduct clinical trial (testing in humans) research in this area. In that same

year, gene therapy was tested on patients suffering from melanoma (skin cancer). The goal was to help them produce antibodies (disease fighting substances in the immune system) to battle the cancer.

These experiments have spawned an ever growing number of attempts at gene therapies designed to perform a variety of functions in the body. For example, a gene therapy for cystic fibrosis aims to supply a gene that alters cells, enabling them to produce a specific protein to battle the disease. Another approach was used for brain cancer patients, in which the inserted gene was designed to make the cancer cells more likely to respond to drug treatment. Another gene therapy approach for patients suffering from artery blockage, which can lead to strokes, induces the growth of new blood vessels near clogged arteries, thus ensuring normal blood circulation.

Currently, there are a host of new gene therapy agents in clinical trials. In the United States, both nucleic acid based (*in vivo*) treatments and cell-based (*ex vivo*) treatments are being investigated. Nucleic acid based gene therapy uses vectors (like viruses) to deliver modified genes to target cells. Cell-based gene therapy techniques remove cells from the patient in order to genetically alter them then reintroduce them to the patient's body. Presently, gene therapies for the following diseases are being developed: cystic fibrosis (using adenoviral vector), HIV infection (cell-based), **malignant melanoma** (cell-based), Duchenne **muscular dystrophy** (cell-based), hemophilia B (cell-based), **kidney cancer** (cell-based), Gaucher's Disease (retroviral vector), **breast cancer** (retroviral vector), and lung cancer (retroviral vector). When a cell or individual is treated using gene therapy and successful incorporation of engineered genes has occurred, the cell or individual is said to be *transgenic*.

The medical establishment's contribution to transgenic research has been supported by increased government funding. In 1991, the U.S. government provided $58 million for gene therapy research, with increases in funding of $15-40 million dollars a year over the following four years. With fierce competition over the promise of societal benefit in addition to huge profits, large pharmaceutical corporations have moved to the forefront of transgenic research. In an effort to be first in developing new therapies, and armed with billions of dollars of research funds, such corporations are making impressive strides toward making gene therapy a viable reality in the treatment of once elusive diseases.

Diseases targeted for treatment by gene therapy

The potential scope of gene therapy is enormous. More than 4,200 diseases have been identified as resulting directly from abnormal genes, and countless others that may be partially influenced by a person's genetic makeup. Initial research has concentrated on developing gene therapies for diseases whose genetic origins have been established and for other diseases that can be cured or ameliorated by substances genes produce.

Early detection of cancer. The researcher's pen marks a band on a DNA sequencing autoradiogram confirming a bladder cancer. *(Custom Medical Stock Photo. Reproduced by permission.)*

The following are examples of potential gene therapies. People suffering from cystic fibrosis lack a gene needed to produce a salt-regulating protein. This protein regulates the flow of chloride into epithelial cells, (the cells that line the inner and outer skin layers) which cover the air passages of the nose and lungs. Without this regulation, patients with cystic fibrosis build up a thick mucus that makes them prone to lung infections. A gene therapy technique to correct this abnormality might employ an adenovirus to transfer a normal copy of what scientists call the cystic fibrosis transmembrane conductance regulator, or CTRF, gene. The gene is introduced into the patient by spraying it into the nose or lungs.

Familial **hypercholesterolemia** (FH) is also an inherited disease, resulting in the inability to process cholesterol properly, which leads to high levels of artery-clogging fat in the blood stream. Patients with FH often suffer heart attacks and strokes because of blocked arteries. A gene therapy approach used to battle FH is much more intricate than most gene therapies because it involves partial surgical removal of patients' livers (*ex vivo* transgene therapy). Corrected copies of a gene that serve to reduce cholesterol build-up are inserted into the liver sections, which are then transplanted back into the patients.

Gene therapy has also been tested on patients with **AIDS**. AIDS is caused by the human **immunodeficiency** virus (HIV), which weakens the body's immune system to the point that sufferers are unable to fight off diseases

like pneumonias and cancer. In one approach, genes that produce specific HIV proteins have been altered to stimulate immune system functioning without causing the negative effects that a complete HIV molecule has on the immune system. These genes are then injected in the patient's blood stream. Another approach to treating AIDS is to insert, via white blood cells, genes that have been genetically engineered to produce a receptor that would attract HIV and reduce its chances of replicating.

Several cancers also have the potential to be treated with gene therapy. A therapy tested for melanoma, or skin cancer, involves introducing a gene with an anticancer protein called tumor necrosis factor (TNF) into test tube samples of the patient's own cancer cells, which are then reintroduced into the patient. In brain cancer, the approach is to insert a specific gene that increases the cancer cells' susceptibility to a common drug used in fighting the disease.

Gaucher disease is an inherited disease caused by a mutant gene that inhibits the production of an enzyme called glucocerebrosidase. Patients with Gaucher disease have enlarged livers and spleens and eventually their bones deteriorate. Clinical gene therapy trials focus on inserting the gene for producing this enzyme.

Gene therapy is also being considered as an approach to solving a problem associated with a surgical procedure known as balloon **angioplasty**. In this procedure, a stent (in this case, a type of tubular scaffolding) is used to open the clogged artery. However, in response to the trauma of the stent insertion, the body initiates a natural healing process that produces too many cells in the artery and results in restenosis, or reclosing of the artery. The gene therapy approach to preventing this unwanted side effect is to cover the outside of the stents with a soluble gel. This gel contains vectors for genes that reduce this overactive healing response.

The Human Genome Project

Although great strides have been made in gene therapy in a relatively short time, its potential usefulness has been limited by lack of scientific data concerning the multitude of functions that genes control in the human body. For instance, it is now known that the vast majority of genetic material does not store information for the creation of proteins, but rather is involved in the control and regulation of gene expression, and is, thus, much more difficult to interpret. Even so, each individual cell in the body carries thousands of genes coding for proteins, with some estimates as high as 150,000 genes. For gene therapy to advance to its full potential, scientists must discover the biological role of each of these individual genes and where the base pairs that make them up are located on DNA.

To address this issue, the National Institutes of Health initiated the Human Genome Project in 1990. Led by James D. Watson (one of the co-discoverers of the chemical makeup of DNA) the project's 15-year goal is to map the entire human genome (a combination of the words gene and chromosomes). A genome map would clearly identify the location of all genes as well as the more than three billion base pairs that make them up. With a precise knowledge of gene locations and functions, scientists may one day be able to conquer or control diseases that have plagued humanity for centuries.

Scientists participating in the Human Genome Project have identified an average of one new gene a day, but many expect this rate of discovery to increase. By the year 2005, their goal is to determine the exact location of all the genes on human DNA and the exact sequence of the base pairs that make them up. Some of the genes identified through this project include a gene that predisposes people to **obesity**, one associated with programmed cell **death** (apoptosis), a gene that guides HIV viral reproduction, and the genes of inherited disorders like Huntington's disease, Lou Gehrig's disease, and some colon and breast cancers. In February of 2001, scientists published a rought draft of the complete human genome. With fewer than the anticipated number of genes found, between 30,000 –40,000, the consequences of this announcement are enormous. Scientists caution however, that the initial publication is only a draft of the human genome and much more work is still ahead for the completion of the project. As the human genome is completed, there will be more information available for gene therapy research and implementation.

The future of gene therapy

Gene therapy seems elegantly simple in its concept: supply the human body with a gene that can correct a biological malfunction that causes a disease. However, there are many obstacles and some distinct questions concerning the viability of gene therapy. For example, viral vectors must be carefully controlled lest they infect the patient with a viral disease. Some vectors, like retroviruses, can also enter cells functioning properly and interfere with the natural biological processes, possibly leading to other diseases. Other viral vectors, like the adenoviruses, are often recognized and destroyed by the immune system so their therapeutic effects are short-lived. Maintaining gene expression so it performs its role properly after vector delivery is difficult. As a result, some therapies need to be repeated often to provide long-lasting benefits.

One of the most pressing issues, however, is gene regulation. Genes work in concert to regulate their functioning. In other words, several genes may play a part in turning other genes on and off. For example, certain

KEY TERMS

Cell—The smallest living units of the body which group together to form tissues and help the body perform specific functions.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Clinical trial—The testing of a drug or some other type of therapy in a specific population of patients.

Clone—A cell or organism derived through asexual (without sex) reproduction containing the identical genetic information of the parent cell or organism.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Embryo—The earliest stage of development of a human infant, usually used to refer to the first eight weeks of pregnancy. The term *fetus* is used from roughly the third month of pregnancy until delivery.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Eugenics—A social movement in which the population of a society, country, or the world is to be improved by controlling the passing on of hereditary information through mating.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Gene transcription—The process by which genetic information is copied from DNA to RNA, resulting in a specific protein formation.

Genetic engineering—The manipulation of genetic material to produce specific results in an organism.

Genetics—The study of hereditary traits passed on through the genes.

Germ-line gene therapy—The introduction of genes into reproductive cells or embryos to correct inherited genetic defects that can cause disease.

Liposome—Fat molecule made up of layers of lipids.

Macromolecules—A large molecule composed of thousands of atoms.

Nitrogen—A gaseous element that makes up the base pairs in DNA.

Nucleus—The central part of a cell that contains most of its genetic material, including chromosomes and DNA.

Protein—Important building blocks of the body, composed of amino acids, involved in the formation of body structures and controlling the basic functions of the human body.

Somatic gene therapy—The introduction of genes into tissue or cells to treat a genetic related disease in an individual.

Vectors—Something used to transport genetic information to a cell.

genes work together to stimulate cell division and growth, but if these are not regulated, the inserted genes could cause tumor formation and cancer. Another difficulty is learning how to make the gene go into action only when needed. For the best and safest therapeutic effort, a specific gene should turn on, for example, when certain levels of a protein or enzyme are low and must be replaced. But the gene should also remain dormant when not needed to ensure it doesn't oversupply a substance and disturb the body's delicate chemical makeup.

One approach to gene regulation is to attach other genes that detect certain biological activities and then react as a type of automatic off-and-on switch that regulates the activity of the other genes according to biological cues. Although still in the rudimentary stages, researchers are making headway in inhibiting some gene functioning by using a synthetic DNA to block gene transcriptions (the copying of genetic information). This approach may have implications for gene therapy.

The ethics of gene therapy

While gene therapy holds promise as a revolutionary approach to treating disease, ethical concerns over its use and ramifications have been expressed by scientists and

lay people alike. For example, since much needs to be learned about how these genes actually work and their long-term effect, is it ethical to test these therapies on humans, where they could have a disastrous result? As with most clinical trials concerning new therapies, including many drugs, the patients participating in these studies have usually not responded to more established therapies and are often so ill the novel therapy is their only hope for long-term survival.

Another questionable outgrowth of gene therapy is that scientists could possibly manipulate genes to genetically control traits in human offspring that are not health related. For example, perhaps a gene could be inserted to ensure that a child would not be bald, a seemingly harmless goal. However, what if genetic manipulation was used to alter skin color, prevent homosexuality, or ensure good looks? If a gene is found that can enhance intelligence of children who are not yet born, will everyone in society, the rich and the poor, have access to the technology or will it be so expensive only the elite can afford it?

The Human Genome Project, which plays such an integral role for the future of gene therapy, also has social repercussions. If individual genetic codes can be determined, will such information be used against people? For example, will someone more susceptible to a disease have to pay higher insurance premiums or be denied health insurance altogether? Will employers discriminate between two potential employees, one with a "healthy" genome and the other with genetic abnormalities?

Some of these concerns can be traced back to the eugenics movement popular in the first half of the twentieth century. This genetic "philosophy" was a societal movement that encouraged people with "positive" traits to reproduce while those with less desirable traits were sanctioned from having children. Eugenics was used to pass strict immigration laws in the United States, barring less suitable people from entering the country lest they reduce the quality of the country's collective gene pool. Probably the most notorious example of eugenics in action was the rise of Nazism in Germany, which resulted in the Eugenic Sterilization Law of 1933. The law required sterilization for those suffering from certain disabilities and even for some who were simply deemed "ugly." To ensure that this novel science is not abused, many governments have established organizations specifically for overseeing the development of gene therapy. In the United States, the Food and Drug Administration and the National Institutes of Health requires scientists to take a precise series of steps and meet stringent requirements before approving clinical trials.

In fact, gene therapy has been immersed in more controversy and surrounded by more scrutiny in both the health and ethical arena than most other technologies (except, perhaps, for cloning) that promise to substantially change society. Despite the health and ethical questions surrounding gene therapy, the field will continue to grow and is likely to change medicine faster than any previous medical advancement.

Resources

BOOKS

Hyde, Margaret O., and Lawrence E. Hyde. *Cloning and the New Genetics*. Springfield, NJ: Enslow Publishers, Inc., 1984.

Stwertka, Eve, and Albert Stwertka. *Genetic Engineering*. New York: Franklin Watts, 1989.

Thompson, Larry. *Correcting the Code: Inventing the Genetic Cure for the Human Body.* New York: Simon & Schuster, 1994.

PERIODICALS

Christensen R. "Cutaneous Gene Therapy—An Update." *Histochemical Cell Biology* (January 2001): 73-82.

"Initial Sequencing and Analysis of the Human Genome." *Nature* (February 15, 2001): 860-921.

Nevin, Norman. "What Has Happened to Gene Therapy?" *European Journal of Pediatrics* (2000): S240-S242.

Pekkanen, John. "Genetics: Medicine's Amazing Leap." *Readers Digest* (September 1991): 23-32.

Schemck, Harold M., Jr. "A New Era of Gene Therapy." *FDA Consumer* (December 1991): 14-19.

Weiss, Rick. "Gene Therapy at a Crossroads." *Washington Post* (19 October 1994): 12-15.

ORGANIZATIONS

The National Human Genome Research Institute. The National Institutes of Health. 9000 Rockville Pike, Bethesda, MD 20892. (301) 496-2433. <http://www.nhgri.nih.gov>.

OTHER

Online Mendelian Inheritance in Man. Online genetic testing information sponsored by National Center for Biotechnology Information. <http://www.ncbi.nlm.nih.gov/Omim/>.

Katherine Hunt, MS

General adaptation syndrome

Definition

General adaptation syndrome describes the body's short-term and long-term reaction to **stress**.

Description

Originally described by Hans De Solye in the 1920s, the general adaptation syndrome describes a three stage

reaction to stress. Stressors in humans include physical stressors, such as **starvation**, being hit by a car, or suffering through severe weather. Additionally, humans can suffer emotional or mental stress, such as the loss of a loved one, the inability to solve a problem, or even having a difficult day at work.

Stage 1: Alarm reaction

The first stage of the general adaptation stage, the alarm reaction, is the immediate reaction to a stressor. In the initial phase of stress, humans exhibit a "fight or flight" response, which causes one to be ready for physical activity. However, this initial response can also decrease the effectiveness of the immune system, making persons more susceptible to illness during this phase.

Stage 2: Stage of resistance

Stage 2 might also be named the stage of adaptation, instead of the stage of resistance. During this phase, if the stress continues, the body adapts to the stressors it is exposed to. Changes at many levels take place in order to reduce the effect of the stressor. For example, if the stressor is starvation (possibly due to anorexia), the person might experienced a reduced desire for physical activity to conserve energy, and the absorption of nutrients from food might be maximized.

Stage 3: Stage of exhaustion

At this stage, the stress has continued for some time. The body's resistance to the stress may gradually be reduced, or may collapse quickly. Generally, this means the immune system, and the body's ability to resist disease, may be almost totally eliminated. Patients who experience long-term stress may succumb to heart attacks or severe infection due to their reduced immunity. For example, a person with a stressful job may experience long-term stress that might lead to high blood pressure and an eventual **heart attack**.

Stress, a useful reaction?

Although stress can lead to disease, a researcher named Huethner has suggested that long-term stress may cause humans to better adapt to their environment. He argues that severe, long-term stress can cause persons to reject long-held assumptions or behaviors, and that stress can actually help the brain make physical changes that reflect these mental or emotional changes. In short, stress might allow persons to change the way they think and act for the better.

Causes and symptoms

Stress is the cause of general adaptation syndrome and it can manifest as **fatigue**, irritability, difficulty concentrating, and difficulty sleeping. Persons may also experience other symptoms that are signs of stress. Persons experiencing unusual symptoms, such as hair loss, without another medical explanation might consider stress as the cause.

KEY TERMS

Stressor—Any external stimuli that causes stress, ranging from starvation to test-taking.

Diagnosis

Diagnosis is difficult. Some physiological changes, such as increased cortisol levels, are characteristic of long-term stress.

Treatment

Treatment should involve **stress reduction**. Stress may be thought of as occurring in two steps. The first step is the occurrence of the external stressor, the second is the reaction to the external stressor. Stress reduction strategies generally fall into three categories: avoiding stressors, changing the reaction to the stressor(s), or relieving stress after the reaction to the stressor(s). Many strategies for stress reduction, such as exercising, listening to music, **aromatherapy**, and massage relieve stress after it occurs. Many psychotherapeutic approaches attempt to reduce the response of the patient to stressors. Persons wishing to reduce stress should consult a medical professional with whom they feel comfortable to discuss which option, or combination of options, they can use to reduce stress.

Resources

PERIODICALS

Huethner, G. "The central adaptation syndrome: Psychosocial stress as a trigger for adaptive modifications of brain structure and brain function." *Progress in Neurobiology* 48 (1996): 569-612.

OTHER

"Stress management, General adaptation syndrome, GAS." <http://www.holisticonline.com/stress/stress_GAS.htm>.

Michael Zuck, PhD

General anesthetic *see* **Anesthesia, general**

General surgery

Definition

General surgery is the treatment of injury, deformity, and disease using operative procedures.

Purpose

General surgery is frequently performed to alleviate suffering when a cure is unlikely through medication alone. It can be used for routine procedures performed in a physician's office, such as **vasectomy**, or for more complicated operations requiring a medical team in a hospital setting, such as laparoscopic **cholecystectomy** (removal of the gallbladder). Areas of the body treated by general surgery include the stomach, liver, intestines, appendix, breasts, thyroid gland, salivary glands, some arteries and veins, and the skin. The brain, heart, eyes, and feet, to name only a few, are areas that require specialized surgical repair.

New methods and techniques are less invasive than previous practices, permitting procedures that were considered impossible in the past. For example, microsurgery has been used in reattaching severed body parts by successfully reconnecting small blood vessels and nerves.

Precautions

Patients who are obese, smoke, have bleeding tendencies, or are over 60, need to follow special precautions, as do patients who have recently experienced an illness such as **pneumonia** or a **heart attack**. Patients on medications such as heart and blood pressure medicine, blood thinners, **muscle relaxants**, tranquilizers, insulin, or sedatives, may require special lab tests prior to surgery and special monitoring during surgery. Special precautions may be necessary for patients using mind-altering drugs such as narcotics, psychedelics, hallucinogens, marijuana, sedatives, or **cocaine** since these drugs may interact with the anesthetic agents used during surgery.

Description

In earlier times, surgery was a dangerous and dirty practice. Until the middle of the 19th century, as many patients died of surgery as were cured. With the discovery and development of general anesthesia in the mid-1800s, surgery became more humane. And as knowledge about infections grew, surgery became more successful as sterile practices were introduced into the operating room. The last 50 years of the 20th century have seen continued advancements.

Types of General Surgery

General surgery experienced major advances with the introduction of the endoscope. This is an instrument for visualizing the interior of a body canal or a hollow organ. Endoscopic surgery relies on this pencil-thin instrument, capable of its own lighting system and small video camera. The endoscope is inserted through tiny incisions called portals. While viewing the procedure on a video screen, the surgeon then operates with various other small, precise instruments inserted through one or more of the portals. The specific area of the body treated determines the type of endoscopic surgery performed. For example, **colonoscopy** uses an endoscope, which can be equipped with a device for obtaining tissue samples for visual examination of the colon. Gastroscopy uses an endoscope inserted through the mouth to examine the interior of the stomach. **Arthroscopy** refers to joint surgery, and abdominal procedures are called laparoscopies.

Endoscopy is used in both treatment and diagnosis especially involving the digestive and female reproductive systems. Endoscopy has advantages over many other surgical procedures, resulting in a quicker recovery and shorter hospital stay. This non-invasive technique is being used for appendectomies, gallbladder surgery, hysterectomies and the repair of shoulder and knee ligaments. However, endoscopy does not come without limitations such as complications and high operating expense. Also, endoscopy doesn't offer advantages over conventional surgery in all procedures. Some literature states that as general surgeons become more experienced in their prospective fields, additional non-invasive surgery will be a more common option to patients.

ONE-DAY SURGERY. One-day surgery is also termed same-day, or outpatient surgery. Surgical procedures usually take two hours or less and involve minimal blood loss and a short recovery time. In the majority of surgical cases, oral medications control postoperative **pain**. Cataract removal, **laparoscopy**, tonsillectomy, repair of broken bones, **hernia repair**, and a wide range of cosmetic procedures are common same-day surgical procedures. Many individuals prefer the convenience and atmosphere of one-day surgery centers, as there is less competition for attention with more serious surgical cases. These centers are accredited by the Joint Commission on Accreditation of Healthcare Organizations or the Accreditation Association for Ambulatory Health Care.

Preparation

The preparation of patients has advanced significantly with improved diagnostic techniques and procedures. Before surgery the patient may be asked to undergo a series of tests including blood and urine studies, x

rays and specific heart studies if the patient's past medical history and/or physical exam warrants this testing. Before any general surgery the physician will explain the nature of the surgery needed, the reason for the procedure, and the anticipated outcome. The risks involved will be discussed along with the types of anesthesia utilized. The expected length of recovery and limitations imposed during the recovery period are also explained in detail before any general surgical procedure.

Surgical procedures most often require some type of anesthetic. Some procedures require only local anesthesia, produced by injecting the anesthetic agent into the skin near the site of the operation. The patient remains awake with this form of medication. Injecting anesthetic agents into a primary nerve located near the surgical site produces block anesthesia (also known as regional anesthesia), which is a more extensive local anesthesia. The patient remains conscious, but is usually sedated. General anesthesia involves injecting anesthetic agents into the blood stream and/or inhaling medicines through a mask placed over the patient's face. During general anesthesia, the patient is asleep and an airway tube is usually placed into the windpipe to help keep the airway open.

As part of the preoperative preparation, the patient will receive printed educational material and may be asked to review audio or videotapes. The patient will be instructed to shower or bathe the evening before or morning of surgery and may be asked to scrub the operative site with a special antibacterial soap. Instructions will also be given to the patient to ingest nothing by mouth for a determined period of time prior to the surgical procedure.

Aftercare

After surgery, blood studies and a laboratory examination of removed fluid or tissue are often performed especially in the case of **cancer** surgery. After the operation, the patient is brought to a recovery room and vital signs, fluid status, dressings and surgical drains are monitored. Pain medications are offered and used as necessary. Breathing exercises are encouraged to maximize respiratory function and leg exercises are encouraged to promote adequate circulation and prevent pooling of blood in the lower extremities. Patients must have a responsible adult accompany them home if leaving the same day as the surgery was performed.

Risks

One of the risks involved with general surgery is the potential for postoperative complications. These complications include—but are not limited to—pneumonia, internal bleeding, and wound infection as well as adverse reactions to anesthesia.

KEY TERMS

Appendectomy—Removal of the appendix.

Endoscope—Instrument for examining visually the inside of a body canal or a hollow organ such as the stomach, colon, or bladder.

Hysterectomy—Surgical removal of part or all of the uterus.

Laparoscopic cholecystectomy—Removal of the gallbladder using a laparoscope, a fiberoptical instrument inserted through the abdomen.

Microsurgery—Surgery on small body structures or cells performed with the aid of a microscope and other specialized instruments.

Portal—An entrance or a means of entrance.

Normal results

Advances in diagnostic and surgical techniques have increased the success rate of general surgery by many times compared to the past. Today's less invasive surgical procedures have reduced the length of hospital stays, shortened recovery time, decreased postoperative pain and decreased the size of surgical incision. On the average, a conventional abdominal surgery requires a three to six-day hospital stay and three to six-week recovery time.

Abnormal results

Abnormal results from general surgery include persistent pain, swelling, redness, drainage or bleeding in the surgical area and surgical wound infection resulting in slow healing.

Resources

BOOKS

Dawson, Dawn P., ed., et al. *Magill's Medical Guide: Health and Illness Supplement*. Pasadena, CA: Salem Press, Inc., 1996.

Larson, David E., ed. *Mayo Clinic Family Health Book*. 2nd ed. New York: William Morrow, 1996.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

OTHER

"General Surgery." *ThriveOnline*. 27 May 1998 <http://thriveonline.oxygen.com>.

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Generalized anxiety disorder

Definition

Generalized **anxiety** disorder is a condition characterized by "free floating" anxiety or apprehension not linked to a specific cause or situation.

Description

Some degree of fear and anxiety is perfectly normal. In the face of real danger, fear makes people more alert and also prepares the body to fight or flee (the so-called "fight or flight" response). When people are afraid, their hearts beat faster and they breathe faster in anticipation of the physical activity that will be required of them. However, sometimes people can become anxious even when there is no identifiable cause, and this anxiety can become overwhelming and very unpleasant, interfering with their daily lives. People with debilitating anxiety are said to be suffering from **anxiety disorders**, such as **phobias**, panic disorders, and generalized anxiety disorder. The person with generalized anxiety disorder generally has chronic (officially, having more days with anxiety than not for at least six months), recurrent episodes of anxiety that can last days, weeks, or even months.

Causes and symptoms

Generalized anxiety disorder afflicts between 2–3% of the general population, and is slightly more common in women than in men. It accounts for almost one-third of cases referred to psychiatrists by general practitioners.

Generalized anxiety disorder may result from a combination of causes. Some people are genetically predisposed to developing it. Psychological traumas that occur during childhood, such as prolonged separation from parents, may make people more vulnerable as well. Stressful life events, such as a move, a major job change, the loss of a loved one, or a divorce, can trigger or contribute to the anxiety.

Psychologically, the person with generalized anxiety disorder may develop a sense of dread for no apparent reason—the irrational feeling that some nameless catastrophe is about to happen. Physical symptoms similar to those found with **panic disorder** may be present, although not as severe. They may include trembling, sweating, heart **palpitations** (the feeling of the heart pounding in the chest), nausea, and "butterflies in the stomach."

According to the *Diagnostic and Statistical Manual of Mental Disorders,* 4th edition, a person must have at least three of the following symptoms, with some being present more days than not for at least six months, in order to be diagnosed with generalized anxiety disorder:

- restlessness or feeling on edge
- being easily fatigued
- difficulty concentrating
- irritability
- muscle tension
- sleep disturbance

While generalized anxiety disorder is not completely debilitating, it can compromise a person's effectiveness and quality of life.

Diagnosis

Anyone with chronic anxiety for no apparent reason should see a physician. The physician may diagnose the condition based on the patient's description of the physical and emotional symptoms. The doctor will also try to rule out other medical conditions that may be causing the symptoms, such as excessive **caffeine** use, thyroid disease, **hypoglycemia**, cardiac problems, or drug or alcohol withdrawal. Psychological conditions, such as depressive disorder with anxiety, will also need to be ruled out.

Since generalized anxiety disorder often co-occurs with **mood disorders** and substance abuse, the clinician may have to treat these conditions as well, and therefore must consider them in making the diagnosis.

Treatment

Over the short term, a group of tranquilizers called **benzodiazepines**, such as clonazepam (Klonipin) may help ease the symptoms of generalized anxiety disorder. Sometimes **antidepressant drugs**, such as amitryptiline (Elavil), or **selective serotonin reuptake inhibitors** (SSRIs), such as fluoxetine (Prozac) or sertraline (Zoloft), are also used.

Psychotherapy can be effective in treating generalized anxiety disorder. The therapy may take many forms. In some cases, psychodynamically-oriented psychotherapy can help patients work through this anxiety and solve problems in their lives. Cognitive behavioral therapy aims to reshape the way people perceive and react to potential stressors in their lives. Relaxation techniques have also been used in treatment, as well as in prevention efforts.

Prognosis

When properly treated, most patients with generalized anxiety disorder experience improvement in their symptoms.

KEY TERMS

Cognitive behavioral therapy—A psychotherapeutic approach that aims at altering cognitions—including thoughts, beliefs, and images—as a way of altering behavior.

Prevention

While preventive measures have not been established, a number of techniques may help manage anxiety, such as relaxation techniques, breathing exercises, and distraction—putting the anxiety out of one's mind by focusing thoughts on something else.

Resources

BOOKS

Diagnostic and Statistical Manual of Mental Disorders. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Hallowell, Edward M. *Worry: Controlling It and Using It Wisely*. New York: Pantheon Books, 1997.

PERIODICALS

Hale, Anthony S. "ABC of Mental Health." *British Medical Journal* 314 (28 June 1997): 1886-89.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

Anxiety Disorders Association of America. 11900 Park Lawn Drive, Ste. 100, Rockville, MD 20852. (800) 545-7367. <http://www.adaa.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Robert Scott Dinsmoor

Genetic counseling

Definition

Genetic counseling aims to facilitate the exchange of information regarding a person's genetic legacy. It attempts to:

- accurately diagnose a disorder
- assess the risk of recurrence in the concerned family members and their relatives
- provide alternatives for decision-making
- provide support groups that will help family members cope with the recurrence of a disorder

Purpose

Genetic counselors work with people concerned about the risk of an inherited disease. The counselor does not prevent the incidence of a disease in a family, but can help family members assess the risk for certain hereditary diseases and offer guidance. Many couples seek genetic counseling because there is a family history of known genetic disorders, **infertility**, **miscarriage**, still births, or early infant mortality. Other reasons for participating in genetic counseling may be the influences of a job or lifestyle that exposes a potential parent to health risks such as radiation, chemicals, or drugs. Any family history of **mental retardation** can be of concern as is a strong family history of heart disease at an early age. Recent statistics show a 3% chance of delivering a baby with **birth defects**. An additional 2% chance of having a baby with **Down syndrome** is present for women in their late thirties and older.

Precautions

Amniocentesis, one of the specific tests used to gather information for genetic counseling, is best performed between weeks 15 and 17 of a **pregnancy** and an additional one to four weeks may be required to culture skin cells and analyze them. Thus, these test data are not available to assist prospective parents in decision-making until the second trimester of the pregnancy. Individuals who participate in genetic counseling and associated testing also must be aware that there are no cures or treatments for some of the disorders that may be identified.

Description

With approximately 2,000 genes identified and approximately 5,000 disorders caused by genetic defects, genetic counseling is important in the medical discipline of obstetrics. Genetic counselors, educated in the medical and the psychosocial aspects of genetic diseases, convey complex information to help people make life decisions. There are limitations to the power of genetic counseling, though, since many of the diseases that have been shown to have a genetic basis currently offer no cure (for example, Down syndrome or Huntington's disease). Although a genetic counselor cannot predict the future unequivocally, he or she can discuss the occurrence of a disease in terms of probability.

A genetic counselor, with the aid of the patient or family, creates a detailed family pedigree that includes the incidence of disease in first-degree (parents, siblings, and children) and second-degree (aunts, uncles, and

KEY TERMS

Sickle-cell anemia—A chronic, inherited blood disorder characterized by crescent-shaped red blood cells. It occurs primarily in people of African descent, and produces symptoms including episodic pain in the joints, fever, leg ulcers, and jaundice.

Tay-Sachs disease—A hereditary disease affecting young children of eastern European Jewish descent. This disease is caused by an enzyme deficiency leading to the accumulation of gangliosides (galactose-containing cerebrosides) found in the surface membranes of nerve cells in the brain and nerve tissue. This deficiency results in mental retardation, convulsions, blindness, and, finally, death.

Thalassemia—An inherited group of anemias occurring primarily among people of Mediterranean descent. It is caused by defective formation of part of the hemoglobin molecule.

grandparents) relatives. Before or after this pedigree is completed, certain genetic tests are performed using DNA analysis, x ray, ultrasound, urine analysis, **skin biopsy**, and physical evaluation. For a pregnant woman, prenatal diagnosis can be made using amniocentesis or **chorionic villus sampling**.

Family pedigree

An important aspect of the genetic counseling session is the compilation of a family pedigree or medical history. To accurately assess the risk of inherited diseases, information on three generations, including health status and/or cause of **death**, is usually needed. If the family history is complicated information from more distant relatives may be helpful, and medical records may be requested for any family members who have had a genetic disorder. Through an examination of the family history a counselor may be able to discuss the probability of future occurrence of genetic disorders. In all cases, the counselor provides information in a non-directive way that leaves the decision-making up to the client.

Screening tests

Screening blood tests help identify individuals who carry genes for recessive genetic disorders. Screening tests are usually only done if:

- The disease is lethal or causes severe handicaps or disabilities
- The person is likely to be a carrier due to family pedigree or membership in an at-risk ethnic, geographic or racial group
- The disorder can be treated or reproductive options exist
- A reliable test is available.

Genetic disorders such as **Tay-Sachs disease**, sickle-cell anemia, and **thalassemia** meet these criteria, and screening tests are commonly done to identify carriers of these diseases. In addition, screening tests may be done for individuals with family histories of Huntington's disease (a degenerative neurological disease) or **hemophilia** (a bleeding disorder). Such screening tests can eliminate the need for more invasive tests during a pregnancy.

Another screening test commonly used in the United States in the alpha-fetoprotein (AFP) test. This test is done on a sample of maternal blood around week 16 of a pregnancy. An elevation in the serum AFP level indicates that the fetus may have certain birth defects such as neural tube defects (including **spina bifida** and anencephaly). If the test yields an elevated result, it may be run again after seven days. If the level is still elevated after repeat testing, additional diagnostic tests (e.g. ultrasound and/or amniocentesis) are done in an attempt to identify the specific birth defect present.

Ultrasound

Ultrasound is a noninvasive procedure which uses sound waves to produce a reflected image of the fetus upon a screen. It is used to determine the age and position of the fetus, and the location of the placenta. Ultrasound is also useful in detecting visible birth defects such as spina bifida (a defect in the development of the vertebrae of the spinal column and/or the spinal cord). It is also useful for detecting heart defects, and malformations of the head, face, body, and limbs. This procedure, however, cannot detect biochemical or chromosomal alterations in the fetus.

Amniocentesis

Amniocentesis is useful in determining genetic and developmental disorders not detectable by ultrasound. This procedure involves the insertion of a needle through the abdomen and into the uterus of a pregnant woman. A sample of amniotic fluid is withdrawn containing skin cells that have been shed by the fetus. The sample is sent to a laboratory where fetal cells contained in the fluid are isolated and grown in order to provide enough genetic material for testing. This takes about seven to 14 days. The material is then extracted and treated so that visual examination for defects can be made. For some disorders, like Tay-Sachs disease, the simple presence of a

telltale chemical compound in the amniotic fluid is enough to confirm a diagnosis.

Chorionic villus sampling

Chorionic villus sampling involves the removal of a small amount of tissue directly from the chorionic villi (minute vascular projections of the fetal chorion that combine with maternal uterine tissue to form the placenta). In the laboratory, the chromosomes of the fetal cells are analyzed for number and type. Extra chromosomes, such as are present in Down syndrome, can be identified. Additional laboratory tests can be performed to look for specific disorders and the results are usually available within a week after the sample is taken. The primary benefit of this procedure is that it is usually performed between weeks 10 and 12 of a pregnancy, allowing earlier detection of fetal disorders.

Preparation

Genetic diagnosis requires that a couple share information about inherited disorders in their background with the genetic counselor, including details of any genetic diseases in either family. A couple undergoing genetic counseling also reports any past miscarriages and discusses the possibility of exposure to chemicals, radiation (including x rays), or other occupational environmental hazards. The couple also needs to disclose information about personal habits before or during pregnancy such as drug or alcohol abuse and the use of prescription or over-the-counter drugs taken by the mother since the beginning of pregnancy. The genetic counselor explains the procedures used in any testing that will be done and describes what each test can and cannot reveal.

Aftercare

Genetic counseling provides couples with information that can help them make decisions about future pregnancies. It also gives couples additional time to emotionally prepare if a disorder is detected in the fetus. The counselor discusses the results of any testing and informs the couple if a problem is apparent. The doctor or genetic counselor also discusses the treatment options available. Genetic counseling is done in a non-directive way, so that any treatment selected remains the personal choice of the individuals involved. Genetic counseling can provide information essential for family planning and pregnancy management, thus maximizing the chances of a positive outcome.

Risks

Because prenatal testing, such as amniocentesis and chorionic villus sampling, is invasive and carries a 1% risk of miscarriage it should never be considered routine.

Normal results

Screening tests and/or prenatal tests reveal no birth defects or genetic abnormalities.

Abnormal results

A birth defect or genetic disorder is detected. The early diagnosis of birth defects and genetic disorders allows a greater number of treatment options. Some disorders can be treated in utero (before birth while the fetus is still in the uterus), while others may require early delivery, immediate surgery, or **cesarean section** to minimize fetal trauma. Prior warning of fetal difficulties allows parents time to prepare emotionally for the birth of the child. In some instances, termination of the pregnancy may be chosen. Whatever the test results, this information is essential for family planning and pregnancy management.

Resources

BOOKS

Banasik, Jacquelyn L. "Genetic and Developmental Disorders." In *Perspectives on Pathophysiology* by Lee-Ellen C. Copstead. Philadelphia: W. B. Saunders Co., 1994.

Milunsky, Aubrey. *Choices Not Chances: An Essential Guide to Your Heredity and Health.* Boston: Little Brown, 1989.

Pierce, Benjamin A. *The Family Genetic Sourcebook.* New York: John Wiley & Sons, 1990.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

American Society of Human Genetics. 9650 Rockville Pike, Bethesda, MD 20814-3998. (301) 571-1825. <http://www.faseb.org/genetics/ashg/ashgmenu.htm>.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

OTHER

"Genetic Screening Before or During Pregnancy." InteliHealth Page. 19 June 1998 <http://www.intelihealth.com>.

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Genetic studies *see* **Genetic testing**

Genetic testing

Definition

A genetic test examines the genetic information contained inside a person's cells, called DNA, to determine

if that person has or will develop a certain disease or could pass a disease to his or her offspring. Genetic tests also determine whether or not couples are at a higher risk than the general population for having a child affected with a genetic disorder.

Purpose

Some families or ethnic groups have a higher incidence of a certain disease than does the population as a whole. For example, individuals from Eastern European, Ashkenazi Jewish descent are at higher risk for carrying genes for rare conditions that occur much less frequently in populations from other parts of the world. Before having a child, a couple from such a family or ethnic group may want to know if their child would be at risk of having that disease. Genetic testing for this type of purpose is called genetic screening.

During **pregnancy**, the baby's cells can be studied for certain genetic disorders or chromosomal problems such as **Down syndrome**. Chromosome testing is most commonly offered when the mother is 35 years or older at the time of delivery. When there is a family medical history of a genetic disease or there are individuals in a family affected with developmental and physical delays, genetic testing may also be offered during pregnancy. Genetic testing during pregnancy is called prenatal diagnosis.

Prior to becoming pregnant, couples who are having difficulty conceiving a child or who have suffered multiple miscarriages may be tested to see if a genetic cause can be identified.

A genetic disease may be diagnosed at birth by doing a physical evaluation of the baby and observing characteristics of the disorder. Genetic testing can help to confirm the diagnosis made by the physical evaluation. In addition, genetic testing is used routinely on all newborns to screen for certain genetic diseases which can affect a newborn baby's health shortly after birth.

There are several genetic diseases and conditions in which the symptoms do not occur until adulthood. One such example is Huntington's disease. This is a serious disorder affecting the way in which individuals walk, talk and function on a daily basis. Genetic testing may be able to determine if someone at risk for the disease will in fact develop the disease.

Some genetic defects may make a person more susceptible to certain types of **cancer**. Testing for these defects can help predict a person's risk. Other types of genetic tests help diagnose and predict and monitor the course of certain kinds of cancer, particularly leukemia and lymphoma.

Precautions

Because genetic testing is not always accurate and because there are many concerns surrounding insurance and employment discrimination for the individual receiving a genetic test, **genetic counseling** should always be performed prior to genetic testing. A genetic counselor is an individual with a master's degree in genetic counseling. A medical geneticist is a physician specializing and board certified in genetics.

A genetic counselor reviews the person's family history and medical records and the reason for the test. The counselor explains the likelihood that the test will detect all possible causes of the disease in question (known as the sensitivity of the test), and the likelihood that the disease will develop if the test is positive (known as the positive predictive value of the test).

Learning about the disease in question, the benefits and risks of both a positive and a negative result, and what treatment choices are available if the result is positive, will help prepare the person undergoing testing. During the genetic counseling session, the individual interested in genetic testing will be asked to consider how the test results will affect his or her life, family, and future decisions.

After this discussion, the person should have the opportunity to indicate in writing that he or she gave informed consent to have the test performed, verifying that the counselor provided complete and understandable information.

Description

Genes and chromosomes

Deoxyribonucleic acid (DNA) is a long molecule made up of two strands of genetic material coiled around each other in a unique double helix structure. This structure was discovered in 1953 by Francis Crick and James Watson.

DNA is found in the nucleus, or center, of most cells (Some cells, such as a red blood cell, don't have a nucleus). Each person's DNA is a unique blueprint, giving instructions for a person's physical traits, such as eye color, hair texture, height, and susceptibility to disease. DNA is organized into structures called chromosomes.

The instructions are contained in DNA's long strands as a code spelled out by pairs of bases, which are four chemicals that make up DNA. The bases occur as pairs because a base on one strand lines up with and is bound to a corresponding base on the other strand. The order of these bases form DNA's code. The order of the bases on a DNA strand is important to ensuring that we are not

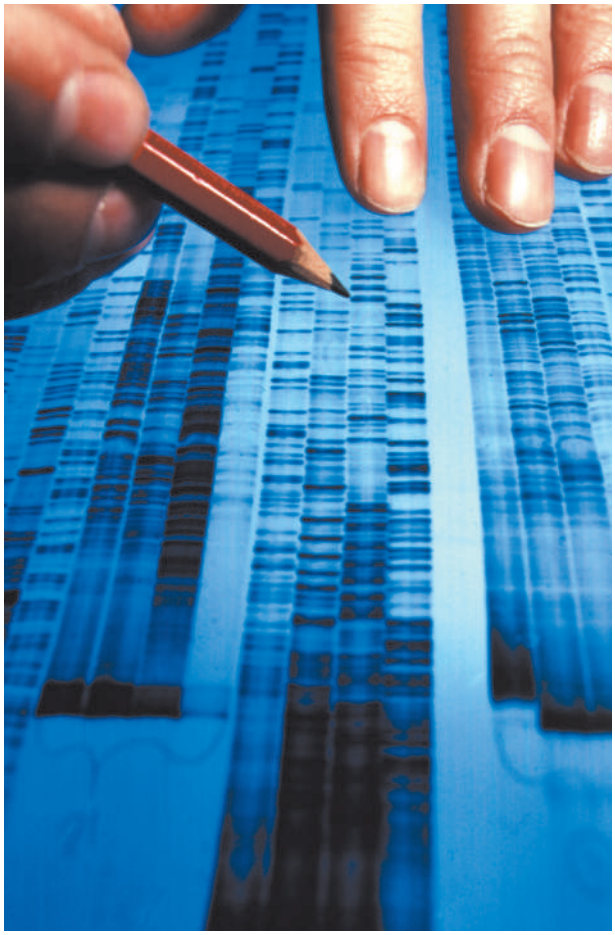
affected with any genetic diseases. When the bases are out of order, or missing, then often times, our cells do not produce important proteins which can lead to a genetic disorder. While our genes are found in every cell of our body, not every gene is functioning all of the time. Some genes are turned on during critical points in development and then remain silent for the rest of our lives. While other genes remain active all of our lives so that our cells can produce important proteins that help us digest food properly or fight off the **common cold**.

The specific order of the base pairs on a strand of DNA is important in order for the correct protein to be produced. A grouping of three base pairs on the DNA strand is called a codon. Each codon, or three base pairs, comes together to spell a word. A string of many codons together can be thought of as a series of words all coming together to make a sentence. This sentence is what instructs our cells to make a protein that helps our bodies function properly.

Our DNA strands containing a hundred to several thousand copies of genes are found on structures called chromosomes. Each cell typically has 46 chromosomes arranged into 23 pairs. Each parent contributes one chromosome to each pair. The first 22 pairs are called autosomal chromosomes, or non-sex chromosomes and are assigned a number from 1–22. The last pair are the sex chromosomes and include the X and the Y chromosomes. If a child receives an X chromosome from each parent, the child is female. If a child receives an X from the mother, and a Y from the father, the child is male.

Just as each parent contributes one chromosome to each pair, so each parent contributes one gene from each chromosome. The pair of genes produces a specific trait in the child. In autosomal dominant conditions, it takes only one copy of a gene to influence a specific trait. The stronger gene is called dominant; the weaker gene, recessive. Two copies of a recessive gene are needed to control a trait while only one copy of a dominant gene is needed. Our sex chromosomes, the X and the Y also contain important genes. Some genetic diseases are caused by missing, or altered genes on one of the sex chromosomes. Males are most often affected by sex chromosome diseases when they inherit an X chromosome with missing or mutated genes from their mother.

TYPES OF GENETIC MUTATIONS. Genetic disease results from a change, or mutation, in a chromosome or in one or several base pairs on a gene. Some of us inherit these mutations from our parents, called hereditary or germline mutations, while other mutations can occur spontaneously, or for the first time in an affected child. For many of the adult on-set diseases, genetic mutations



A scientist examines a DNA sequencing autoradiogram on a light box. *(Photo Researchers, Inc. Reproduced by permission.)*

can occur over the lifetime of the individual. This is called acquired or somatic mutations and these occur while the cells are making copies of themselves or dividing in two. There may be some environmental effects, such as radiation or other chemicals, which can contribute to these types of mutations as well.

There are a variety of different types of mutations that can occur in our genetic code to cause a disease. And for each genetic disease, there may be more than one type of mutation to cause the disease. For some genetic diseases, the same mutation occurs in every individual affected with the disease. For example, the most common form of dwarfism, called **achondroplasia**, occurs because of a single base pair substitution. This same mutation occurs in all individuals affected with the disease. Other genetic diseases are caused by different types of genetic mutations that may occur anywhere along the length of a gene. For example, **cystic fibrosis**, the most common genetic disease in the caucasian population is caused by over hundreds of different mutations along the

gene. Individual families may carry the same mutation as each other, but not as the rest of the population affected with the same genetic disease.

Some genetic diseases occur as a result of a larger mutation which can occur when the chromosome itself is either rearranged or altered or when a baby is born with more than the expected number of chromosomes. There are only a few types of chromosome rearrangements which are possibly hereditary, or passed on from the mother or the father. The majority of chromosome alterations where the baby is born with too many chromosomes or missing a chromosome, occurs sporadically or for the first time with a new baby.

The type of mutation that causes a genetic disease will determine the type of genetic test to be performed. In some situations, more than one type of genetic test will be performed to arrive at a diagnosis. The cost of genetic tests vary: chromosome studies can cost hundreds of dollars and certain gene studies, thousands. Insurance coverage also varies with the company and the policy. It may take several days or several weeks to complete a test. Research testing where the exact location of a gene has not yet been identified, can take several months to years for results.

Types of Genetic Testing

Direct DNA mutation analysis

Direct DNA sequencing examines the direct base pair sequence of a gene for specific gene mutations. Some genes contain more than 100,000 bases and a mutation of any one base can make the gene nonfunctional and cause disease. The more mutations possible, the less likely it is for a test to detect all of them. This test is usually done on white blood cells from a person's blood but can also be performed on other tissues. There are different ways in which to perform direct DNA mutation analysis. When the specific genetic mutation is known, it is possible to perform a complete analysis of the genetic code, also called direct sequencing. There are several different lab techniques used to test for a direct mutation. One common approach begins by using chemicals to separate DNA from the rest of the cell. Next, the two strands of DNA are separated by heating. Special enzymes (called restriction enzymes) are added to the single strands of DNA and then act like scissors and cut the strands in specific places. The DNA fragments are then sorted by size through a process called electrophoresis. A special piece of DNA, called a probe, is added to the fragments. The probe is designed to bind to specific mutated portions of the gene. When bound to the probe, the mutated portions appear on x-ray film with a distinct banding pattern.

Indirect DNA Testing

Family linkage studies are done to study a disease when the exact type and location of the genetic alteration is not known, but the general location on the chromosome has been identified. These studies are possible when a chromosome marker has been found associated with a disease. Chromosomes contain certain regions that vary in appearance between individuals. These regions are called polymorphisms and do not cause a genetic disease to occur. If a polymorphism is always present in family members with the same genetic disease, and absent in family members without the disease, it is likely that the gene responsible for the disease is near that polymorphism. The gene mutation can be indirectly detected in family members by looking for the polymorphism.

To look for the polymorphism, DNA is isolated from cells in the same way it is for direct DNA mutation analysis. A probe is added that will detect the large polymorphism on the chromosome. When bound to the probe, this region will appear on x-ray film with a distinct banding pattern. The pattern of banding of a person being tested for the disease is compared to the pattern from a family member affected by the disease.

Linkage studies have disadvantages not found in direct DNA mutation analysis. These studies require multiple family members to participate in the testing. If key family members choose not to participate, the incomplete family history may make testing other members useless. The indirect method of detecting a mutated gene also causes more opportunity for error.

Chromosome analysis

Various genetic syndromes are caused by structural chromosome abnormalities. To analyze a person's chromosomes, his or her cells are allowed to grow and multiply in the laboratory until they reach a certain stage of growth. The length of growing time varies with the type of cells. Cells from blood and bone marrow take one to two days; fetal cells from amniotic fluid take seven to 10 days.

When the cells are ready, they are placed on a microscope slide using a technique to make them burst open, spreading their chromosomes. The slides are stained: the stain creates a banding pattern unique to each chromosome. Under a microscope, the chromosomes are counted, identified, and analyzed based on their size, shape, and stained appearance.

A karyotype is the final step in the chromosome analysis. After the chromosomes are counted, a photograph is taken of the chromosomes from one or more cells as seen through the microscope. Then the chromo-

KEY TERMS

Autosomal disease—A disease caused by a gene located on an autosomal chromosome.

Carrier—A person who possesses a gene for an abnormal trait without showing signs of the disorder. The person may pass the abnormal gene on to offspring.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Dominant gene—A gene, whose presence as a single copy, controls the expression of a trait.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Karyotype—A standard arrangement of photographic or computer-generated images of chromosome pairs from a cell in ascending numerical order, from largest to smallest.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Positive predictive value (PPV)—The probability that a person with a positive test result has, or will get, the disease.

Recessive gene—A type of gene that is not expressed as a trait unless inherited by both parents.

Sensitivity—The proportion of people with a disease who are correctly diagnosed (test positive based on diagnostic criteria). The higher the sensitivity of a test or diagnostic criteria, the lower the rate of 'false negatives,' people who have a disease but are not identified through the test.

Sex-linked disorder—A disorder caused by a gene located on a sex chromosome, usually the X chromosome.

somes are cut out and arranged side-by-side with their partner in ascending numerical order, from largest to smallest. The karyotype is done either manually or using a computer attached to the microscope. Chromosome analysis is also called cytogenetics.

Applications for Genetic Testing

Newborn screening

Genetic testing is used most often for newborn screening. Every year, millions of newborn babies have their blood samples tested for potentially serious genetic diseases.

Carrier testing

An individual who has a gene associated with a disease but never exhibits any symptoms of the disease is called a carrier. A carrier is a person who is not affected by the mutated gene he or she possesses, but can pass the gene to an offspring. Genetic tests have been developed that tell prospective parents whether or not they are carriers of certain diseases. If one or both parents are a carrier, the risk of passing the disease to a child can be predicted.

To predict the risk, it is necessary to know if the gene in question is autosomal or sex-linked. If the gene is carried on any one of chromosomes 1–22, the resulting disease is called an autosomal disease. If the gene is carried on the X or Y chromosome, it is called a sex-linked disease.

Sex-linked diseases, such as the bleeding condition **hemophilia**, are usually carried on the X chromosome. A woman who carries a disease-associated mutated gene on one of her X chromosomes, has a 50% chance of passing that gene to her son. A son who inherits that gene will develop the disease because he does not have another normal copy of the gene on a second X chromosome to compensate for the mutated copy. A daughter who inherits the disease associated mutated gene from her mother, on one of her X chromosomes will be at risk for having a son affected with the disease.

The risk of passing an autosomal disease to a child depends on whether the gene is dominant or recessive. A

prospective parent carrying a dominant gene, has a 50% chance of passing the gene to a child. A child needs to receive only one copy of the mutated gene to be affected by the disease.

If the gene is recessive, a child needs to receive two copies of the mutated gene, one from each parent, to be affected by the disease. When both prospective parents are carriers, their child has a 25% chance of inheriting two copies of the mutated gene and being affected by the disease; a 50% chance of inheriting one copy of the mutated gene, and being a carrier of the disease but not affected; and a 25% chance of inheriting two normal genes. When only one prospective parent is a carrier, a child has a 50% chance of inheriting one mutated gene and being an unaffected carrier of the disease, and a 50% chance of inheriting two normal genes.

Cystic fibrosis is a disease that affects the lungs and pancreas and is discovered in early childhood. It is the most common autosomal recessive genetic disease found in the caucasian population: one in 25 people of Northern European ancestry are carriers of a mutated cystic fibrosis gene. The gene, located on chromosome 7, was identified in 1989.

The gene mutation for cystic fibrosis is detected by a direct DNA test. Over 600 mutations of the cystic fibrosis gene have been found; each of these mutations cause the same disease. Tests are available for the most common mutations. Tests that check for the 86 of the most common mutations in the Caucasian population will detect 90% of carriers for cystic fibrosis. (The percentage of mutations detected varies according to the individual's ethnic background). If a person tests negative, it is likely, but not guaranteed that he or she does not have the gene. Both prospective parents must be carriers of the gene to have a child with cystic fibrosis.

Tay-Sachs disease, also autosomal recessive, affects children primarily of Ashkenazi Jewish descent. Children with this disease die between the ages of two and five. This disease was previously detected by looking for a missing enzyme. The mutated gene has now been identified and can be detected using direct DNA mutation analysis.

Presymptomatic testing

Not all genetic diseases show their effect immediately at birth or early in childhood. Although the gene mutation is present at birth, some diseases do-not appear until adulthood. If a specific mutated gene responsible for a late-onset disease has been identified, a person from an affected family can be tested before symptoms appear.

Huntington's disease is one example of a late-onset autosomal dominant disease. Its symptoms of mental confusion and abnormal body movements do not appear until middle to late adulthood. The chromosome location of the gene responsible for Huntington's chorea was located in 1983 after studying the DNA from a large Venezuelan family affected by the disease. Ten years later the gene was identified. A test is now available to detect the presence of the expanded base pair sequence responsible for causing the disease. The presence of this expanded sequence means the person will develop the disease.

Another late onset disease, Alzheimer's does not have as well a understood genetic cause as Huntington's disease. The specific genetic cause of **Alzheimer's disease** is not as clear. Although many cases appear to be inherited in an autosomal dominant pattern, many cases exist as single incidents in a family. Like Huntington's, symptoms of mental deterioration first appear in adulthood. Genetic research has found an association between this disease and genes on four different chromosomes. The validity of looking for these genes in a person without symptoms or without family history of the disease is still being studied.

CANCER SUSCEPTIBILITY TESTING. Cancer can result from an inherited (germline) mutated gene or a gene that mutated sometime during a person's lifetime (acquired mutation). Some genes, called tumor suppressor genes, produce proteins that protect the body from cancer. If one of these genes develops a mutation, it is unable to produce the protective protein. If the second copy of the gene is normal, its action may be sufficient to continue production, but if that gene later also develops a mutation, the person is vulnerable to cancer. Other genes, called oncogenes, are involved in the normal growth of cells. A mutation in an oncogene can cause too much growth, the beginning of cancer.

Direct DNA tests are currently available to look for gene mutations identified and linked to several kinds of cancer. People with a family history of these cancers are those most likely to be tested. If one of these mutated genes is found, the person is more susceptible to developing the cancer. The likelihood that the person will develop the cancer, even with the mutated gene, is not always known because other genetic and environmental factors are also involved in the development of cancer.

Cancer susceptibility tests are most useful when a positive test result can be followed with clear treatment options. In families with **familial polyposis** of the colon, testing a child for a mutated APC gene can reveal whether or not the child needs frequent monitoring for the disease. In families with potentially fatal familial medullary **thyroid cancer** or multiple endocrine neoplasia type 2, finding a mutated RET gene in a child provides the opportunity for that child to have preventive

removal of the thyroid gland. In the same way, MSH1 and MSH2 mutations can reveal which members in an affected family are vulnerable to familiar colorectal cancer and would benefit from aggressive monitoring.

In 1994, a mutation linked to early-onset familial breast and **ovarian cancer** was identified. BRCA1 is located on chromosome 17. Women with a mutated form of this gene have an increased risk of developing breast and ovarian cancer. A second related gene, BRCA2, was later discovered. Located on chromosome 13, it also carries increased risk of breast and ovarian cancer. Although both genes are rare in the general population, they are slightly more common in women of Ashkenazi Jewish descent.

When a woman is found to have a mutation of one of these genes, the likelihood that she will get breast or ovarian cancer increases, but not to 100%. Other genetic and environmental factors influence the outcome.

Testing for these genes is most valuable in families where a mutation has already been found. BRCA1 and BRCA2 are large genes; BRCA1 includes 100,000 bases. More than 120 mutations to this gene have been discovered, but a mutation could occur in any one of the bases. Studies show tests for these genes may miss 30% of existing mutations. The rate of missed mutations, the unknown disease likelihood in spite of a positive result, and the lack of a clear preventive response to a positive result, make the value of this test for the general population uncertain.

Prenatal and postnatal chromosome analysis

Chromosome analysis can be done on fetal cells primarily when the mother is age 35 or older at the time of delivery, experienced multiple miscarriages, or reports a family history of a genetic abnormality. Prenatal testing is done on the fetal cells from a chorionic villi sampling (from the baby's developing placenta) at 9–12 weeks or from the amniotic fluid (the fluid surrounding the baby) at 15–22 weeks of pregnancy. Cells from amniotic fluid grow for seven to 10 days before they are ready to be analyzed. Chorionic villi cells have the potential to grow faster and can be analyzed sooner.

Chromosome analysis using blood cells is done on a child who is born with or later develops signs of **mental retardation** or physical malformation. In the older child, chromosome analysis may be done to investigate developmental delays.

Extra or missing chromosomes cause mental and physical abnormalities. A child born with an extra chromosome 21 (trisomy 21) has Down syndrome. An extra chromosome 13 or 18 also produce well known syndromes. A missing X chromosome causes **Turner syndrome** and an extra X in a male causes **Klinefelter syndrome**. Other abnormalities are caused by extra or missing pieces of chromosomes. **Fragile X syndrome** is a sex-linked disease, causing mental retardation in males.

Chromosome material may also be rearranged, such as the end of chromosome 1 moved to the end of chromosome 3.This is called a chromosomal translocation. If no material is added or deleted in the exchange, the person may not be affected. Such an exchange, however, can cause **infertility** or abnormalities if passed to children.

Evaluation of a man and woman's infertility or repeated miscarriages will include blood studies of both to check for a chromosome translocation. Many chromosome abnormalities are incompatible with life; babies with these abnormalities often miscarrry during the first trimester. Cells from a baby that died before birth can be studied to look for chromosome abnormalities that may have caused the **death**.

Cancer diagnosis and prognosis

Certain cancers, particularly leukemia and lymphoma, are associated with changes in chromosomes: extra or missing complete chromosomes, extra or missing portions of chromosomes, or exchanges of material (translocations) between chromosomes. Studies show that the locations of the chromosome breaks are at locations of tumor suppressor genes or oncogenes.

Chromosome analysis on cells from blood, bone marrow, or solid tumor helps diagnose certain kinds of leukemia and lymphoma and often helps predict how well the person will respond to treatment. After treatment has begun, periodic monitoring of these chromosome changes in the blood and bone marrow gives the physician information as to the effectiveness of the treatment.

A well-known chromosome rearrangement is found in chronic myelogenous leukemia. This leukemia is associated with an exchange of material between chromosomes 9 and 22. The resulting smaller chromosome 22 is called the Philadelphia chromosome.

Preparation

Most tests for genetic diseases of children and adults are done on blood. To collect the 5–10 mL of blood needed, a healthcare worker draws blood from a vein in the inner elbow region. Collection of the sample takes only a few minutes.

Prenatal testing is done either on amniotic fluid or a **chorionic villus sampling**. To collect amniotic fluid, a physician performs a procedure called **amniocentesis**. An ultrasound is done to find the baby's position and an area filled with amniotic fluid. The physician inserts a needle

through the woman's skin and the wall of her uterus and withdraws 5–10 mL of amniotic fluid. Placental tissue for a chorionic villus sampling is taken through the cervix. Each procedures take approximately 30 minutes.

Bone marrow is used for chromosome analysis in a person with leukemia or lymphoma. The person is given local anesthesia. Then the physician inserts a needle through the skin and into the bone (usually the sternum or hip bone). One-half to 2 mL of bone marrow is withdrawn. This procedure takes approximately 30 minutes.

Aftercare

After blood collection the person can feel discomfort or bruising at the puncture site or may become dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

The chorionic villi sampling, amniocentesis and bone marrow procedures are all done under a physician's supervision. The person is asked to rest after the procedure and is watched for weakness and signs of bleeding.

Risks

Collection of amniotic fluid and chorionic villi sampling, have the risk of **miscarriage**, infection, and bleeding; the risks are higher for the chorionic villi sampling. Because of the potential risks for miscarriage, 0.5% following the amniocentesis and 1% following the chorionic villi sampling procedure, both of these prenatal tests are offered to couples, but not required. A woman should tell her physician immediately if she has cramping, bleeding, fluid loss, an increased temperature, or a change in the baby's movement following either of these procedures.

After bone marrow collection, the puncture site may become tender and the person's temperature may rise. These are signs of a possible infection.

Genetic testing involves other nonphysical risks. Many people fear the possible loss of privacy about personal health information. Results of genetic tests may be reported to insurance companies and affect a person's insurability. Some people pay out-of-pocket for genetic tests to avoid this possibility. Laws have been proposed to deal with this problem. Other family members may be affected by the results of a person's genetic test. Privacy of the person tested and the family members affected is a consideration when deciding to have a test and to share the results.

A positive result carries a psychological burden, especially if the test indicates the person will develop a disease, such as Huntington's chorea. The news that a person may be susceptible to a specific kind of cancer, while it may encourage positive preventive measures, may also negatively shadow many decisions and activities.

A genetic test result may also be inconclusive meaning no definitive result can be given to the individual or family. This may cause the individual to feel more anxious and frustrated and experience psychological difficulties.

Prior to undergoing genetic testing, individuals need to learn from the genetic counselor the likelihood that the test could miss a mutation or abnormality.

Normal results

A normal result for chromosome analysis is 46, XX or 46, XY. This means there are 46 chromosomes (including two X chromosomes for a female or one X and one Y for a male) with no structural abnormalities. A normal result for a direct DNA mutation analysis or linkage study is no gene mutation found.

There can be some benefits from genetic testing when the individual tested is not found to carry a genetic mutation. Those who learn with great certainty they are no longer at risk for a genetic disease, may choose not to undergo prophylactic therapies and may feel less anxious and relieved.

Abnormal results

An abnormal chromosome analysis report will include the total number of chromosomes and will identify the abnormality found. Tests for gene mutations will report the mutations found.

There are many ethical issues to consider with an abnormal prenatal test result. Many of the diseases tested for during a pregnancy, cannot be treated or cured. In addition, some diseases tested for during pregnancy, may have a late-onset of symptoms or have minimal effects on the affected individual.

Before making decisions based on an abnormal test result, the person should meet again with a genetic counselor to fully understand the meaning of the results, learn what options are available based on the test result, and what are the risks and benefits of each of those options.

Resources

BOOKS

Berg, Paul, and Maxine Singer. *Dealing with Genes: The Language of Heredity.* Mill Valley, CA: University Science Books, 1992.

Farkas, Daniel H. *DNA Simplified: The Hitchhiker's Guide to DNA*. Washington, DC: American Association of Clinical Chemistry Press, 1996.

Gelehrter, Thomas D., Francis S. Collins, and David Ginsburg. *Principles of Medical Genetics*. 2nd ed. Baltimore: Williams and Wilkins, 1998.
Grody, Wayne W., and Walter W. Noll. "Molecular Diagnosis of Genetic Diseases." In *Clinical Diagnosis and Management by Laboratory Methods,* edited by John B. Henry. 19th ed. Philadelphia: W. B. Saunders Company, 1996, pp. 1374-1389.
Holtzman, Neil A., and Michael S. Watson, eds. *Promoting Safe and Effective Genetic Testing in the United States. Final Report of the Task Force on Genetic Testing*. National Institutes of Health-Department of Energy Working Group on Ethical, Legal, and Social Implications of Human Genome Research, 1997.
Motulsky, Arno G., Richard A. King, and Jerome I. Rotter. *The Genetic Basis of Common Diseases*. New York: Oxford University Press, 1992.
Mueller, Robert F., and Ian D. Young. *Emery's Elements of Medical Genetics*. 9th ed. New York and Edinburgh: Churchill Livingstone, 1995.
Watson, James D. *The Double Helix*. New York: Atheneum, 1968.

PERIODICALS

Auxter, Sue. "Genetic Information—What Should be Regulated?" *Clinical Laboratory News* (December 1997): 9-11.
Biesecker, Barbara Bowles. "Genetic Susceptibility Testing for Breast and Ovarian Cancer: A Progress Report." *Journal of the American Medical Women's Association* (Winter 1997): 22-27.
Fink, Leslie, and Francis S. Collins. "The Human Genome Project: View From the National Institutes of Health." *Journal of the American Medical Women's Association* (Winter 1997): 4-7, 15.
Holtzman, Neil A., et al. "Predictive Genetic Testing: From Basic Research to Clinical Practice." *Science* (October 24, 1997): 602-605.
Karnes, Pamela S. "Ordering and Interpreting DNA Tests." *Mayo Clinical Proceedings* (December 1996): 1192-1195.
Malone, Kathleen E, et al. "BRCA1 Mutations and Breast Cancer in the General Population." *Journal of the American Medical Association* (March 25, 1998): 922-929.
McKinnon, Wendy C., et al. "Predisposition Genetic Testing for Late-Onset Disorders in Adults: A Position Paper of the National Society of Genetic Counselors." *Journal of the American Medical Association* (October 15, 1997): 1217-1221.
Newman, Beth, et al. "Frequency of Breast Cancer Attributable to BRCA1 in a Population-Based Series of American Women." *Journal of the American Medical Association* (March 25, 1998): 915-921.
Ponder, Bruce. "Genetic Testing for Cancer Risk." *Science* (November 7, 1997): 1050-1054.
Roses, Allen. "Genetic Testing for Alzheimer Disease. Practical and Ethical Issues." *Archives of Neurology* (October 1997): 1226-1229.
Whittaker, Lori. "Clinical Applications of Genetic Testing: Implications for the Family Physician." *American Family Physician* (May 1996): 2077-2084.
Wisecarver, James. "The ABCs of DNA." *Laboratory Medicine* (January 1997): 48-52.
Yablonsky, Terri. "Genetic Testing Helps Patients and Researchers Predict the Future." *Laboratory Medicine* (May 1997): 316-321.
Yablonsky, Terri. "Unlocking the Secrets to Disease. Genetic Tests Usher in a New Era in Medicine." *Laboratory Medicine* (April 1997): 252-256.
Yan, Hai. "Genetic Testing-Present and Future." *Science* (September 15, 2000): 1890-1892.

ORGANIZATIONS

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington, DC 20008. (202) 966-5557. Fax: (202) 966-8553. <http://www.geneticalliance.org>.
American College of Medical Genetics. 9650 Rockville Pike, Bethesda, MD 20814-3998. (301) 571-1825. <http://www.faseb.org/genetics/acmg/acmgmenu.htm>.
American Society of Human Genetics. 9650 Rockville Pike, Bethesda, MD 20814-3998. (301) 571-1825. <http://www.faseb.org/genetics/ashg/ashgmenu.htm>.
Centers for Disease Control. GDP Office, 4770 Buford Highway NE, Atlanta, GA 30341-3724. (770) 488-3235. <http://www.cdc.gov/genetics>.
March of Dimes Birth Defects Foundation. 1275 Manaroneck Ave., White Plains, NY 10605. (888) 663-4637. resourcecenter@modimes.org. <http://www.modimes.org>.
National Human Genome Research Institute. The National Institutes of Health, 9000 Rockville Pike, Bethesda, MD 20892. (301) 496-2433. <http://www.nhgri.nih.gov>.
National Society of Genetic Counselors. 233 Canterbury Dr., Wallingford, PA 19086-6617. (610) 872-1192. <http://www.nsgc.org/GeneticCounselingYou.asp>.

OTHER

Blazing a Genetic Trail. Online genetic tutorial. <http://www.hhmi.org/GeneticTrail/>.
The Gene Letter. Online newsletter. <http://www.geneletter.org>.
Online Mendelian Inheritance in Man. Online genetic testing information sponsored by National Center for Biotechnology Information. <http://www.ncbi.nlm.nih.gov/Omim/>.
Understanding Gene Testing. Online brochure produced by the U.S. Department of Health and Human Services. <http://www.gene.com/ae/AE/AEPC/NIH/index.html>.

Katherine S. Hunt, MS

Genital herpes

Definition

Genital herpes is a sexually transmitted disease caused by a herpes virus. The disease is characterized by the formation of fluid-filled, painful blisters in the genital area.

Description

Genital herpes (herpes genitalis, herpes progenitalis) is characterized by the formation of fluid-filled blisters on the genital organs of men and women. The word "herpes" comes from the Greek adjective *herpestes,* meaning *creeping,* which refers to the serpent-like pattern that the blisters may form. Genital herpes is a sexually transmitted disease which means that it is spread from person-to-person only by sexual contact. Herpes may be spread by vaginal, anal, and oral sexual activity. It is not spread by objects (such as a toilet seat or doorknob), swimming pools, hot tubs, or through the air.

Genital herpes is a disease resulting from an infection by a herpes simplex virus. There are eight different kinds of human herpes viruses. Only two of these, herpes simplex types 1 and 2, can cause genital herpes. It has been commonly believed that herpes simplex virus type 1 infects above the waist (causing cold sores) and herpes simplex virus type 2 infects below the waist (causing genital sores). This is not completely true. Both herpes virus type 1 and type 2 can cause herpes lesions on the lips or genitals, but recurrent cold sores are almost always type 1. The two viruses seem to have evolved to infect better at one site or the other, especially with regard to recurrent disease.

To determine the occurrence of herpes type 2 infection in the United States, the Centers for Disease Control and Prevention (CDC) used information from a survey called the National Health and **Nutrition** Examination Survey III (1988–1994). This survey of 40,000 noninstitutionalized people found that 21.9% of persons age 12 or older had antibodies to herpes type 2. This means that 45 million Americans have been exposed at some point in their lives to herpes simplex virus type 2. More women (25.6%) than men (17.8%) had antibodies. The racial differences for herpes type 2 antibodies were whites, 17.6%; blacks, 45.9%; and Mexican Americans, 22.3%. Interestingly, only 2.6% of adults reported that they have had genital herpes. Over half (50% to 60%) of the white adults in the United States have antibodies to herpes simplex virus type 1. The occurrence of antibodies to herpes type 1 is higher in blacks.

Viruses are different from bacteria. While bacteria are independent and can reproduce on their own, viruses cannot reproduce without the help of a cell. Viruses enter human cells and force them to make more virus. A human cell infected with herpes virus releases thousands of new viruses before it is killed. The cell **death** and resulting tissue damage causes the actual sores. The highest risk for spreading the virus is the time period beginning with the appearance of blisters and ending with scab formation.

Herpes virus can also infect a cell and instead of making the cell produce new viruses, it hides inside the cell and waits. Herpes virus hides in cells of the nervous system called "neurons." This is called "latency." A latent virus can wait inside neurons for days, months, or even years. At some future time, the virus "awakens" and causes the cell to produce thousands of new viruses which causes an active infection. Sometimes an active infection occurs without visible sores. Therefore, an infected person can spread herpes virus to other people even in the absence of sores.

This process of latency and active infection is best understood by considering the genital sore cycle. An active infection is obvious because sores are present. The first infection is called the "primary" infection. This active infection is then controlled by the body's immune system and the sores heal. In between active infections, the virus is latent. At some point in the future latent viruses become activated and once again cause sores. These are called "recurrent infections" or "outbreaks." Genital sores caused by herpes type 1 recur much less frequently than sores caused by herpes type 2.

Although it is unknown what triggers latent viruses to activate, several conditions seem to bring on infections. These include illness, tiredness, exposure to sunlight, menstruation, skin damage, food allergy and hot or cold temperatures. Although many people believe that **stress** can bring on their genital herpes outbreaks, there is no scientific evidence that there is a link between stress and recurrences. However, at least one clinical study has shown a connection between how well people cope with stress and their belief that stress and recurrent infections are linked.

Newborn babies who are infected with herpes virus experience a very severe, and possibly fatal disease. This is called "neonatal herpes infection." In the United States, one in 3,000–5,000 babies born will be infected with herpes virus. Babies can become infected during passage through the birth canal, but can become infected during the **pregnancy** if the membranes rupture early. Doctors will perform a **Cesarean section** on women who go into labor with active genital herpes.

Causes and symptoms

While anyone can be infected by herpes virus, not everyone will show symptoms. Risk factors for genital herpes include: early age at first sexual activity, multiple sexual partners, and a medical history of other sexually-transmitted diseases.

Most patients with genital herpes experience a prodrome (symptoms of oncoming disease) of **pain**, burning, **itching**, or tingling at the site where blisters will

form. This prodrome stage may last anywhere from a few hours, to one to two days. The herpes infection prodrome can occur for both the primary infection and recurrent infections. The prodrome for recurrent infections may be severe and cause a severe burning or stabbing pain in the genital area, legs, or buttocks.

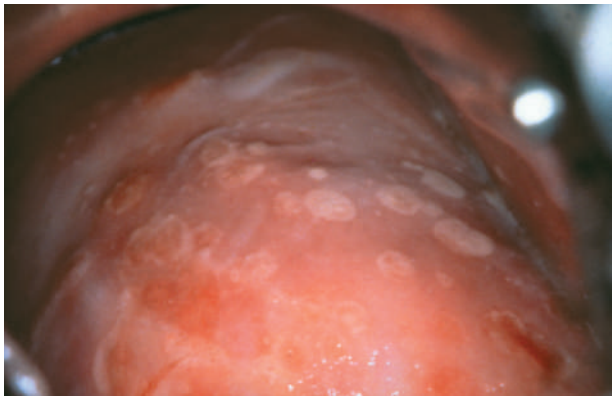
Primary genital herpes

The first symptoms of herpes usually occur within two to seven days after contact with an infected person but may take up to two weeks. Symptoms of the primary infection are usually more severe than those of recurrent infections. For up to 70% of the patients, the primary infection causes symptoms which affect the whole body (called "constitutional symptoms") including tiredness, **headache**, **fever**, chills, muscle aches, loss of appetite, as well as painful, swollen lymph nodes in the groin. These symptoms are greatest during the first three to four days of the infection and disappear within one week. The primary infection is more severe in women than in men.

Following the prodrome come the herpes blisters, which are similar on men and women. First, small red bumps appear. These bumps quickly become fluid-filled blisters. In dry areas, the blisters become filled with pus and take on a white to gray appearance, become covered with a scab, and heal within two to three weeks. In moist areas, the fluid-filled blisters burst and form painful ulcers which drain before healing. New blisters may appear over a period of one week or longer and may join together to form very large ulcers. The pain is relieved within two weeks and the blisters and ulcers heal without scarring by three to four weeks.

Women can experience a very severe and painful primary infection. Herpes blisters first appear on the labia majora (outer lips), labia minora (inner lips), and entrance to the vagina. Blisters often appear on the clitoris, at the urinary opening, around the anal opening, and on the buttocks and thighs. In addition, women may get herpes blisters on the lips, breasts, fingers, and eyes. The vagina and cervix are almost always involved which causes a watery discharge. Other symptoms that occur in women are: painful or difficult urination (83%), swelling of the urinary tube (85%), **meningitis** (36%), and throat infection (13%). Most women develop painful, swollen lymph nodes (lymphadenopathy) in the groin and pelvis. About one in ten women get a vaginal yeast infection as a complication of the primary herpes infection.

In men, the herpes blisters usually form on the penis but can also appear on the scrotum, thighs, and buttocks. Fewer than half of the men with primary herpes experience the constitutional symptoms. Thirty percent to 40% of men have a discharge from the urinary tube. Some men develop painful swollen lymph nodes (lymphadenopathy) in the groin and pelvis. Although less frequently than women, men too may experience painful or difficult urination (44%), swelling of the urinary tube (27%), meningitis (13%), and throat infection (7%).



Female cervix covered with herpes lesions *(Photo Researchers. Reproduced by permission.)*

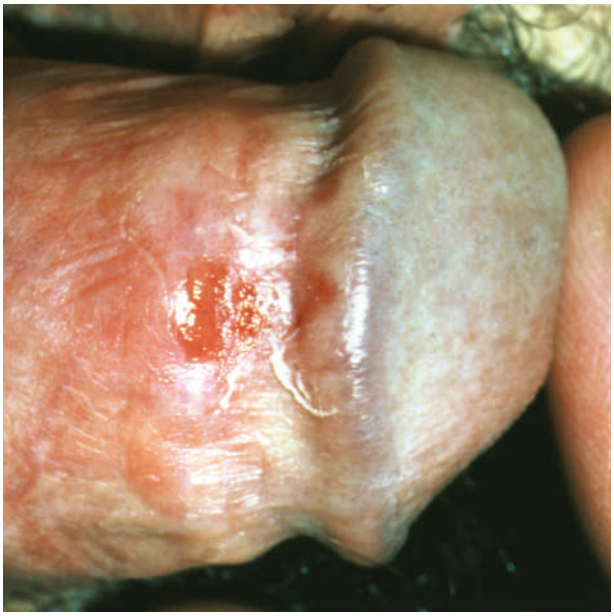
Recurrent genital herpes

One or more outbreaks of genital herpes per year occur in 60–90% of those infected with herpes virus. About 40% of the persons infected with herpes simplex virus type 2 will experience six or more outbreaks each year. Genital herpes recurrences are less severe than the primary infection; however, women still experience more severe symptoms and pain than men. Constitutional symptoms are not usually present. Blisters will appear at the same sites during each outbreak. Usually there are fewer blisters, less pain, and the time period from the beginning of symptoms to healing is shorter than the primary infection. One out of every four women experience painful or difficult urination during recurrent infection. Both men and women may develop lymphadenopathy.

Diagnosis

Because genital herpes is so common, it is diagnosed primarily by symptoms. It can be diagnosed and treated by the family doctor, dermatologists (doctors who specialize in skin diseases), urologists (doctors who specialize in the urinary tract diseases of men and women and the genital organs of men), gynecologists (doctors who specialize in the diseases of women's genital organs) and infectious disease specialists. The diagnosis and treatment of this infectious disease should be covered by most insurance providers.

Laboratory tests may be performed to look for the virus. Because healing sores do not shed much virus, a



A close-up view of a man's penis with a blister (center of image) caused by the herpes simplex virus. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

sample from an open sore would be taken for viral culture. A sterile cotton swab would be wiped over open sores and the sample used to infect human cells in culture. Cells which are killed by herpes virus have a certain appearance under microscopic examination. The results of this test are available within two to ten days. Other areas which may be sampled, depending upon the disease symptoms in a particular patient, include the urinary tract, vagina, cervix, throat, eye tissues, and cerebrospinal fluid.

Direct staining and microscopic examination of the lesion sample may also be used. A blood test may be performed to see if the patient has antibodies to herpes virus. The results of blood testing are available within one day. The disadvantage of this blood test is that it usually does not distinguish between herpes type 1 and 2, and only determines that the patient has had a herpes infection at some point in his or her life. Therefore, the viral culture test must be performed to be absolutely certain that the sores are caused by herpes virus.

Because genital sores can be symptoms of many other diseases, the doctor must determine the exact cause of the sores. The above mentioned tests are performed to determine that herpes virus is causing the genital sores. Other diseases which may cause genital sores are **syphilis**, **chancroid**, **lymphogranuloma venereum**, **granuloma inguinale**, herpes zoster, erythema multiform, Behçet's syndrome, inflammatory bowel disease, **contact dermatitis**, **candidiasis**, and **impetigo**.

Because most newborns who are infected with herpes virus were born to mothers who had no symptoms of infection it is important to check all newborn babies for symptoms. Any skin sore should be sampled to determine if it is caused by herpes simplex. Babies should be checked for sores in their mouth and for signs of herpes infection in their eyes.

Treatment

There is no cure for herpes virus infections. There are **antiviral drugs** available which have some effect in lessening the symptoms and decreasing the length of herpes outbreaks. There is evidence that some may also prevent future outbreaks. These antiviral drugs work by interfering with the replication of the viruses and are most effective when taken as early in the infection process as possible. For the best results, drug treatment should begin during the prodrome stage before blisters are visible. Depending on the length of the outbreak, drug treatment could continue for up to 10 days.

Acyclovir (Zovirax) is the drug of choice for herpes infection and can be given intravenously, taken by mouth (orally), or applied directly to sores as an ointment. Acyclovir has been in use for many years and only five out of 100 patients experience side effects. Side effects of acyclovir treatment include nausea, vomiting, itchy rash, and **hives**. Although acyclovir is the recommended drug for treating herpes infections, other drugs may be used including famciclovir (Famvir), valacyclovir (Valtrex), vidarabine (Vira-A), idoxuridine (Herplex Liquifilm, Stoxil), trifluorothymidine (Viroptic), and penciclovir (Denavir).

Acyclovir is effective in treating both the primary infection and recurrent outbreaks. When taken intravenously or orally, acyclovir reduces the healing time, virus shedding period, and duration of vesicles. The standard oral dose of acyclovir for primary herpes is 200 mg five times daily or 400 mg three times daily for a period of 10 days. Recurrent herpes is treated with the same doses for a period of five days. Intravenous acyclovir is given to patients who require hospitalization because of severe primary infections or herpes complications such as aseptic meningitis or sacral ganglionitis (inflammation of nerve bundles).

Patients with frequent outbreaks (greater than six to eight per year) may benefit from long term use of acyclovir which is called "suppressive therapy." Patients on suppressive therapy have longer periods between herpes outbreaks. The specific dosage used for suppression needs to be determined for each patient and should be reevaluated every few years. Alternatively, patients may use short term suppressive therapy to lessen the chance

of developing an active infection during special occasions such as weddings or holidays.

There are several things that a patient may do to lessen the pain of genital sores. Wearing loose fitting clothing and cotton underwear is helpful. Removing clothing or wearing loose pajamas while at home may reduce pain. Soaking in a tub of warm water and using a blow dryer on the "cool" setting to dry the infected area is helpful. Putting an ice pack on the affected area for 10 minutes, followed by five minutes off and then repeating this procedure may relieve pain. A zinc sulfate ointment may help to heal the sores. Application of a baking soda compress to sores may be soothing.

Neonatal herpes

Newborn babies with herpes virus infections are treated with intravenous acyclovir or vidarabine for 10 days. These drugs have greatly reduced deaths and increased the number of babies who appear normal at one year of age. However, because neonatal herpes infection is so serious, even with treatment babies may not survive, or may suffer nervous system damage. Infected babies may be treated with long term suppressive therapy.

Alternative treatment

An imbalance in the amino acids lysine and arginine is thought to be one contributing factor in herpes virus outbreaks. A ratio of lysine to arginine that is in balance (that is more lysine than arginine is present) seems to help the immune system work optimally. Thus, a diet that is rich in lysine may help prevent recurrences of genital herpes. Foods that contain high levels of lysine include most vegetables, legumes, fish, turkey, beef, lamb, cheese, and chicken. Patients may take 500 mg of lysine daily and increase to 1,000 mg three times a day during an outbreak. Intake of the amino acid arginine should be reduced. Foods rich in arginine that should be avoided are chocolate, peanuts, almonds, and other nuts and seeds.

Clinical experience indicates a connection between high stress and herpes outbreaks. Some patients respond well to **stress reduction** and relaxation techniques. **Acupressure** and massage may relieve tiredness and stress. **Meditation**, **yoga**, **tai chi**, and **hypnotherapy** can also help relieve stress and promote relaxation.

Some herbs, including **echinacea** (*Echinacea* spp.) and garlic (*Allium sativum*), are believed to strengthen the body's defenses against viral infections. Red marine algae (family Dumontiaceae), both taken internally and applied topically, is thought to be effective in treating herpes type I and type II infections. Other topical treatments may be helpful in inhibiting the growth of the herpes virus, in minimizing the damage it causes, or in helping the sores heal. Zinc sulphate ointment seems to help sores heal and to fight recurrence. Lithium succinate ointment may interfere with viral replication. An ointment made with glycyrrhizinic acid, a component of licorice (*Glycyrrhiza glabra*), seems to inactivate the virus. Topical applications of vitamin E or tea tree oil (*Melaleuca* spp.) help dry up herpes sores. Specific combinations of homeopathic remedies may also be helpful treatments for genital herpes.

KEY TERMS

Groin—The region of the body that lies between the abdomen and the thighs.

Latent virus—A nonactive virus which is in a dormant state within a cell. Herpes virus is latent in cells of the nervous system.

Prodrome—Symptoms which warn of the beginning of disease. The herpes prodrome consists of pain, burning, tingling, or itching at a site before blisters are visible.

Recurrence—The return of an active herpes infection following a period of latency.

Ulcer—A painful, pus-draining, depression in the skin caused by an infection.

Prognosis

Although physically and emotionally painful, genital herpes is usually not a serious disease. The primary infection can be severe and may require hospitalization for treatment. Complications of the primary infection may involve the cervix, urinary system, anal opening, and the nervous system. Persons who have a decreased ability to produce an immune response to infection (called "immunocompromised") due to disease or medication are at risk for a very severe, and possibly fatal, herpes infection. Even with antiviral treatment, neonatal herpes infections can be fatal or cause permanent nervous system damage.

Prevention

The only way to prevent genital herpes is to avoid contact with infected persons. This is not an easy solution because many people aren't aware that they are infected and can easily spread the virus to others. Avoid all sexual contact with an infected person during a herpes outbreak. Because herpes virus can be spread at any

time, **condom** use is recommended to prevent the spread of virus to uninfected partners. As of early 1998 there were no herpes vaccines available, although new herpes vaccines are being tested in humans.

Resources

BOOKS

Ebel, Charles. *Managing Herpes: How to Live and Love With a Chronic STD*. American Social Health Association, 1998.

Sacks, Stephen L. *The Truth About Herpes*. Gordon Soules Book Publisher, 1997.

PERIODICALS

Murray, Michael T. "Natural Help for Herpes and Cold Sores." *Let's Live*, Apr. 1997: 68+.

OTHER

JAMA. 8 Apr. 1998 <http://pubs.ama-assn.org>.

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Genital warts

Definition

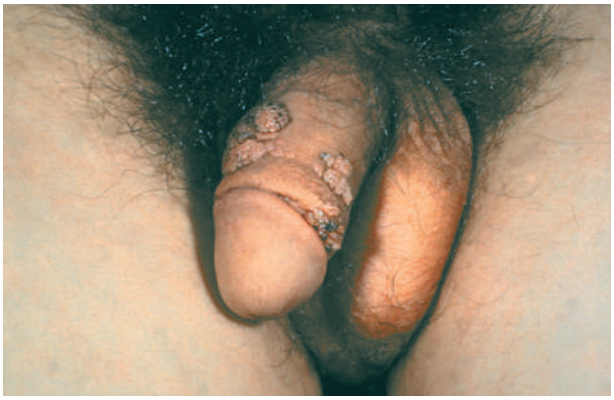
Genital **warts**, which are also called condylomata acuminata or venereal warts, are growths in the genital area caused by a sexually transmitted papillomavirus. A papillomavirus is a virus that produces papillomas, or benign growths on the skin and mucous membranes.

Description

Genital warts are the most common sexually transmitted disease (STD) in the general population. It is estimated that 1% of sexually active people between the ages of 18 and 45 have genital warts; however, polymerase chain reaction (PCR) testing indicates that as many as 40% of sexually active adults carry the human papillomavirus (HPV) that causes genital warts.

Genital warts vary somewhat in appearance. They may be either flat or resemble raspberries or cauliflower in appearance. The warts begin as small red or pink growths and grow as large as four inches across, interfering with intercourse and **childbirth**. The warts grow in the moist tissues of the genital areas. In women, they occur on the external genitals and on the walls of the vagina and cervix; in men, they develop in the urethra and on the shaft of the penis. The warts then spread to the area behind the genitals surrounding the anus.

Risk factors for genital warts include:



Man with genital warts. *(Custom Medical Stock Photo. Reproduced by permission.)*

- multiple sexual partners
- infection with another STD
- pregnancy
- anal intercourse
- poor personal hygiene
- heavy perspiration

Causes and symptoms

There are about 80 types of human papillomavirus. Genital warts are caused by HPV types 1, 2, 6, 11, 16, and 18. HPV is transmitted by sexual contact. The incubation period varies from one to six months.

The symptoms include bleeding, **pain**, and odor as well as the visible warts.

Diagnosis

The diagnosis is usually made by examining scrapings from the warts under a darkfield microscope. If the warts are caused by HPV, they will turn white when a 5% solution of white vinegar is added. If the warts reappear, the doctor may order a biopsy to rule out **cancer**.

Treatment

No treatment for genital warts is completely effective because therapy depends on destroying skin infected by the virus. There are no drugs that will kill the virus directly.

Medications

Genital warts were treated until recently with applications of podophyllum resin, a corrosive substance that cannot be given to pregnant patients. A milder form of podophyllum, podofilox (Condylox), has been introduced. Women are also treated with 5-fluorouracil cream,

bichloroacetic acid, or trichloroacetic acid. All of these substances irritate the skin and require weeks of treatment.

Genital warts can also be treated with injections of interferon. Interferon works best in combination with podofilox applications.

Surgery

Surgery may be necessary to remove warts blocking the patient's vagina, urethra, or anus. Surgical techniques include the use of liquid nitrogen, electrosurgery, and **laser surgery**.

Prognosis

Genital warts are benign growths and are not cancerous by themselves. Repeated HPV infection in women, however, appears to increase the risk of later **cervical cancer**. Women infected with HPV types 16 and 18 should have yearly cervical smears. Recurrence is common with all present methods of treatment—including surgery—because HPV can remain latent in apparently normal surrounding skin.

Prevention

The only reliable method of prevention is sexual abstinence. The use of condoms minimizes but does not eliminate the risk of HPV transmission. The patient's sexual contacts should be notified and examined.

Resources

BOOKS

Berger, Timothy G. "Skin and Appendages." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Curry, Stephen L., and David L. Barclay. "Benign Disorders of the Vulva & Vagina." In *Current Obstetric & Gynecologic Diagnosis & Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Norwalk, CT: Appleton & Lange, 1994.

Edwards, Libby. "Condylomata Acuminata." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Foster, David C. "Vulvar and Vaginal Disease." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Genital Warts." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Hunt, Thomas K., and Reid V. Mueller. "Inflammation, Infection, & Antibiotics." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

MacKay, H. Trent. "Gynecology." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

KEY TERMS

Condylomata acuminata—Another name for genital warts.

Papilloma—A benign growth on the skin or mucous membrane. Viruses that cause these growths are called human papillomaviruses (HPVs).

Podophyllum resin—A medication derived from the May apple or mandrake and used to treat genital warts.

"Podophyllum Resin." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

"Sexually Transmitted Diseases: Genital Warts." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Tyring, Stephen K. "Viral Diseases of the Skin." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Rebecca J. Frey

Gentamicin *see* **Aminoglycosides**

German measles *see* **Rubella**

Gestalt therapy

Definition

Gestalt therapy is a humanistic therapy technique that focuses on gaining an awareness of emotions and behaviors in the present rather than in the past. The therapist does not interpret experiences for the patient. Instead, the therapist and patient work together to help the patient understand him/herself. This type of therapy focuses on experiencing the present situation rather than talking about what occurred in the past. Patients are encouraged to become aware of immediate needs, meet them, and let them recede into the background. The well-adjusted person is seen as someone who has a constant flow of needs and is able to satisfy those needs.

Purpose

In Gestalt therapy (from the German word meaning *form*), the major goal is self-awareness. Patients work on uncovering and resolving interpersonal issues during

therapy. Unresolved issues are unable to fade into the background of consciousness because the needs they represent are never met. In Gestalt therapy, the goal is to discover people connected with a patient's unresolved issues and try to engage those people (or images of those people) in interactions that can lead to a resolution. Gestalt therapy is most useful for patients open to working on self-awareness.

Precautions

The choice of a therapist is crucial. Some people who call themselves "therapists" have limited training in Gestalt therapy. It is important that the therapist be a licensed mental health professional. Additionally, some individuals may not be able to tolerate the intensity of this type of therapy.

Description

Gestalt therapy has developed into a form of therapy that emphasizes medium to large groups, although many Gestalt techniques can be used in one-on-one therapy. Gestalt therapy probably has a greater range of formats than any other therapy technique. It is practiced in individual, couples, and family therapies, as well as in therapy with children.

Ideally, the patient identifies current sensations and emotions, particularly ones that are painful or disruptive. Patients are confronted with their unconscious feelings and needs, and are assisted to accept and assert those repressed parts of themselves.

The most powerful techniques involve role-playing. For example, the patient talks to an empty chair as they imagine that a person associated with an unresolved issue is sitting in the chair. As the patient talks to the "person" in the chair, the patient imagines that the person responds to the expressed feelings. Although this technique may sound artificial and might make some people feel self-conscious, it can be a powerful way to approach buried feelings and gain new insight into them.

Sometimes patients use battacca bats, padded sticks that can be used to hit chairs or sofas. Using a battacca bat can help a patient safely express anger. A patient may also experience a Gestalt therapy marathon, where the participants and one or more facilitators have nonstop **group therapy** over a weekend. The effects of the intense emotion and the lack of sleep can eliminate many psychological defenses and allow significant progress to be made in a short time. This is true only if the patient has adequate psychological strength for a marathon and is carefully monitored by the therapist.

Preparation

Gestalt therapy begins with the first contact. There is no separate diagnostic or assessment period. Instead, assessment and screening are done as part of the ongoing relationship between patient and therapist. This assessment includes determining the patient's willingness and support for work using Gestalt methods, as well as determining the compatibility between the patient and the therapist. Unfortunately, some "encounter groups" led by poorly trained individuals do not provide adequate pretherapy screening and assessment.

Aftercare

Sessions are usually held once a week. Frequency of sessions held is based on how long the patient can go between sessions without losing the momentum from the previous session. Patients and therapists discuss when to start sessions, when to stop sessions, and what kind of activities to use during a session. However, the patient is encouraged and required to make choices.

Risks

Disturbed people with severe mental illness may not be suitable candidates for Gestalt therapy. Facilities that provide Gestalt therapy and train Gestalt therapists vary. Since there are no national standards for these Gestalt facilities, there are no set national standards for Gestalt therapy or Gestalt therapists.

Normal results

Scientific documentation on the effectiveness of Gestalt therapy is limited. Evidence suggests that this type of therapy may not be reliably effective.

Abnormal results

This approach can be anti-intellectual and can discount thoughts, thought patterns, and beliefs. In the hands of an ineffective therapist, Gestalt procedures can become a series of mechanical exercises, allowing the therapist as a person to stay hidden. Moreover, there is a potential for the therapist to manipulate the patient with powerful techniques, especially in therapy marathons where **fatigue** may make a patient vulnerable.

Resources

BOOKS

Ellis, Willis D. *A Source Book of Gestalt Psychology.* New York: Routledge & Gegan Paul, 1969.

Kendall, Philip C., and Julian D. Norton-Ford. *Clinical Psychology: Scientific and Professional Dimensions*. New York: John Wiley & Sons, 1982.
Kohler, Wolfgang *Gestalt Psychology.* New York: Liveright Publishing Corporation, 1947.
Pursglove, Paul David. *Recognitions in Gestalt Therapy.* New York: Funk & Wagnalls, 1968.
Yontef, Gary. *Awareness, Dialogue, and Process*. Highland, NY: The Gestalt Journal Press, 1993.

ORGANIZATIONS

Association for the Advancement of Gestalt Therapy. 400 East 58th St., New York, NY 10022. (212) 486-1581. <http://www.aagt.org>.

David James Doermann

Gestational diabetes

Definition

Gestational diabetes is a condition that occurs during **pregnancy**. Like other forms of diabetes, gestational diabetes involves a defect in the way the body processes and uses sugars (glucose) in the diet. Gestational diabetes, however, has a number of characteristics that are different from other forms of diabetes.

Description

Glucose is a form of sugar that is present in many foods, including sweets, potatoes, pasta, and breads. The body uses glucose to provide energy. It is stored in the liver, muscles, and fatty tissue. The pancreas produces a hormone (a chemical produced in one part of the body, which travels to another part of the body in order to exert its effect) called insulin. Insulin is required to allow glucose to enter the liver, muscles, and fatty tissues, thus reducing the amount of glucose in the blood. In diabetes, blood levels of glucose remain abnormally high. In many forms of diabetes, this is because the pancreas does not produce enough insulin.

In gestational diabetes, the pancreas is not at fault. Instead, the problem is in the placenta. During pregnancy, the placenta provides the baby with nourishment. It also produces a number of hormones that interfere with the body's usual response to insulin. This condition is referred to as "insulin resistance." Most pregnant women do not suffer from gestational diabetes, because the pancreas works to produce extra quantities of insulin in order to compensate for insulin resistance. However, when a woman's pancreas cannot produce enough extra insulin, blood levels of glucose stay abnormally high, and the woman is considered to have gestational diabetes.

About 1–3% of all pregnant women develop gestational diabetes. Women at risk for gestational diabetes include those who:

- are overweight
- have a family history of diabetes
- have previously given birth to a very large, heavy baby
- have previously had a baby who was stillborn, or born with a birth defect
- have an excess amount of amniotic fluid (the cushioning fluid within the uterus that surrounds the developing fetus)
- are over 25 years of age
- belong to an ethnic group known to experience higher rates of gestational diabetes (in the United States, these groups include Mexican-Americans, American Indians, African-Americans, as well as individuals from Asia, India, or the Pacific Islands)
- have a previous history of gestational diabetes during a pregnancy

Causes and symptoms

Most women with gestational diabetes have no recognizable symptoms. However, leaving gestational diabetes undiagnosed and untreated is risky to the developing fetus. Left untreated, a diabetic mother's blood sugar levels will be consistently high. This sugar will cross the placenta and pour into the baby's system through the umbilical cord. The unborn baby's pancreas will respond to this high level of sugar by constantly putting out large amounts of insulin. The insulin will allow the fetus's cells to take in glucose, where it will be converted to fat and stored. A baby who has been exposed to constantly high levels of sugar throughout pregnancy will be abnormally large. Such a baby will often grow so large that he or she cannot be born through the vagina, but will instead need to be born through a surgical procedure (**cesarean section**).

Furthermore, when the baby is born, the baby will still have an abnormally large amount of insulin circulating. After birth, when the mother and baby are no longer attached to each other via the placenta and umbilical cord, the baby will no longer be receiving the mother's high level of sugar. The baby's high level of insulin, however, will very quickly use up the glucose circulating in the baby's bloodstream. The baby is then at risk for having a dangerously low level of blood glucose (a condition called **hypoglycemia**).

Diagnosis

Since gestational diabetes most often exists with no symptoms detectable by the patient, and since its existence

KEY TERMS

Glucose—A form of sugar. The final product of the breakdown of carbohydrates (starches).

Insulin—A hormone produced by the pancreas that is central to the processing of sugars and carbohydrates in the diet.

Placenta—An organ that is attached to the inside wall of the mother's uterus and to the fetus via the umbilical cord. The placenta allows oxygen and nutrients from the mother's bloodstream to pass into the unborn baby.

puts the developing baby at considerable risk, screening for the disorder is a routine part of pregnancy care. This screening is usually done between the 24th and 28th week of pregnancy. By this point in the pregnancy, the placental hormones have reached a sufficient level to cause insulin resistance. Screening for gestational diabetes involves the pregnant woman drinking a special solution that contains exactly 50 grams of glucose. An hour later, the woman's blood is drawn and tested for its glucose level. A level less than 140 mg/dl is considered normal.

When the screening glucose level is over 140 mg/dl, a special three-hour glucose tolerance test is performed. This involves following a special diet for three days prior to the test. This diet is set-up to contain at least 150 grams of carbohydrate each day. Just before the test, the patient is instructed to eat and drink nothing (except water) for 10–14 hours. A blood sample is then tested to determine the **fasting** glucose level. The patient then drinks a special solution containing exactly 100 grams of glucose, and her blood is tested every hour for the next three hours. If two or more of these levels are elevated over normal, then the patient is considered to have gestational diabetes.

Treatment

Treatment for gestational diabetes will depend on the severity of the diabetes. Mild forms can be treated with diet (decreasing the intake of sugars and fats, in particular). Many women are put on strict, detailed **diets**, and are asked to stay within a certain range of calorie intake. **Exercise** is sometimes used to keep blood sugar levels lower. Patients are often asked to regularly measure their blood sugar. This is done by poking a finger with a needle called a lancet, putting a drop of blood on a special type of paper, and feeding the paper into a meter which analyzes and reports the blood sugar level. When diet and exercise do not keep blood glucose levels within an acceptable range, a patient may need to take regular shots of insulin.

Many babies born to women with gestational diabetes are large enough to cause more difficult deliveries, and they may require the use of forceps, suction, or cesarean section. Once the baby is born, it is important to carefully monitor its blood glucose levels. These levels may drop sharply and dangerously once the baby is no longer receiving large quantities of sugar from the mother. When this occurs, it is easily resolved by giving the baby glucose.

Prognosis

Prognosis for women with gestational diabetes, and their babies, is generally good. Almost all such women stop being diabetic after the birth of their baby. However, some research has shown that nearly 50% of these women will develop a permanent form of diabetes within 15 years. The child of a mother with gestational diabetes has a greater-than-normal chance of developing diabetes sometime in adulthood, also. A woman who has had gestational diabetes during one pregnancy has about a 66% chance of having it again during any subsequent pregnancies. Women who had gestational diabetes usually are tested for diabetes at the post-partum checkup or after stopping breastfeeding.

Prevention

There is no known way to actually prevent diabetes, particularly since gestational diabetes is due to the effects of normal hormones of pregnancy. However, the effects of insulin resistance can be best handled through careful attention to diet, avoiding becoming overweight throughout life, and participating in reasonable exercise.

Resources

BOOKS

Ferris, Thomas F. "Gestational Diabetes." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Lowe, Ernest, and Gary Arsham. *Diabetes: A Guide to Living Well.* Minneapolis: Chronimed Publishing, 1997.

PERIODICALS

Bartholomew, Sallie P. "Make Way for Baby." *Diabetes Forecast* 50, no.12 (Dec. 1997): 20+.

Morrison, John C. "Prediction of Continued Glucose Intolerance in Women with Gestational Diabetes." *Clinical Diabetes* 14, no. 6 (Nov./Dec. 1996): 156.

Pasui, Kristine and Kay F. McFarland. "Management of Diabetes in Pregnancy." *American Family Physician* 55, no.8 (June 1997): 2731+.

Weller, Kenneth A. "Diagnosis and Management of Gestational Diabetes." *American Family Physician* 53, no. 6 (1 May 1996): 2053+.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

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GI bleeding studies

Definition

GI bleeding studies uses radioactive materials in the investigation of bleeding from the gastrointestinal (GI) tract. These studies go under various names such as "GI bleeding scans" or "Tagged red blood cell scans." They are performed and interpreted by radiologists (physicians who specialize in diagnosis and treatment of diseases by means of x rays or related substances).

Purpose

These studies are designed to find the source of blood loss from the GI tract; that is the stomach, small bowel, or colon. They work best when bleeding is either too slow, intermittent, or too rapid to be identified by other means, such as endoscopy, upper GI series, or **barium enema**.

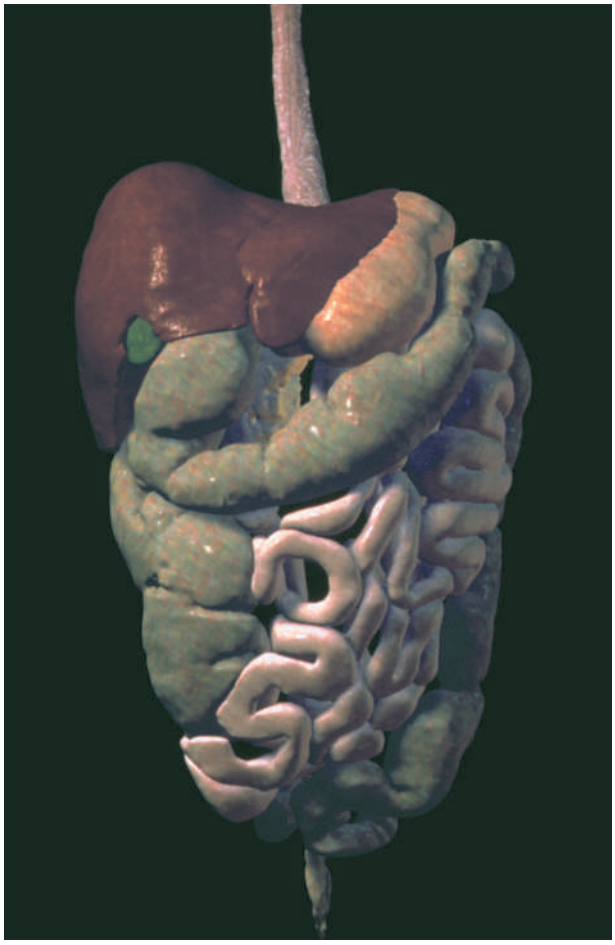
They are particularly useful when other methods have not been able to determine the site or cause of bleeding.

Precautions

Because of the use of radioactive materials, these studies are best avoided in pregnant patients. Another important relates to the interpretation of these tests, whether normal or abnormal. Since these studies are far from perfect, they can only be used as "guides" as to the cause or site of bleeding. In most instances, further studies must be performed to confirm their findings.

Description

Bleeding scans are based on the accumulation of radioactive material as it exits from the vessels during a bleeding episode. Blood is first withdrawn from the patient. Then, the blood, along with a radioactive substance is injected into a vein and over several hours scans measuring radioactivity are performed. The studies were initially reported to be very sensitive and accurate; however, critical evaluation of these tests have shown them to be less accurate than originally believed.



A clay model of the human digestive system. *(Custom Medical Stock Photo. Reproduced by permission.)*

Preparation

No preparation is needed for these tests. They are often done on an "emergency" basis.

Aftercare

No special care is needed after the exam.

Risks

Bleeding scans are free of any risks or side-effects, aside from the fact that they should best be avoided in **pregnancy**.

Normal results

A normal exam would fail to show any evidence of accumulation of radioactive material on the scan. However, scans may be normal in as many as 70% of patients who later turn out to have significant causes of bleeding. This is known as a false-negative result. A patient must

KEY TERMS

Endoscope, Endoscopy—An endoscope as used in the field of gastroenterology is a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract. The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

be bleeding at the same time the scan is performed for it to be seen. Therefore, not finding evidence of a bleeding source during the study, can be misleading.

Abnormal results

The accumulation of radioactive material indicating a "leakage" of blood from the vessels is abnormal. The scan gives a rough, though not exact, guide as to the location of the bleeding. It can tell where the bleeding may be, but usually not the cause. Thus, extreme caution and skill is needed in interpreting these scans, and decisions involving surgery or other treatment should await more definitive tests.

Resources

BOOKS

Lane, Loren. "Radionuclide Scanning." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Mujica, Victor R. and Barkin, Jamie S. "Occult Gastrointestinal Bleeding." *Gastrointestinal Endoscopy Clinics of North America* (Oct. 1996): 833-845

Shapiro, Marcelle J. "Radionuclide Scans." *Gastroenterology Clinics of North America* (Mar. 1994): 125-128

David Kaminstein, MD

Giant-cell arteritis *see* **Temporal arteritis**

Giardiasis

Definition

Giardiasis is a common intestinal infection spread by eating contaminated food, drinking contaminated water, or through direct contact with the organism that causes the disease, *Giardia lamblia*. Giardiasis is found throughout the world and is a common cause of traveller's **diarrhea**. In the United States it is a growing problem, especially among children in childcare centers.

Description

Giardia is one of the most common intestinal parasites in the world, infecting as much as 20% of the entire population of the earth. It is common in overcrowded developing countries with poor sanitation and a lack of clean water. Recent tests have found *Giardia* in 7% of all stool samples tested nationwide, indicating that this disease is much more widespread than was originally believed. It has been found not only in humans, but also in wild and domestic animals.

Giardiasis is becoming a growing problem in the United States, where it affects three times more children than adults. In recent years, giardiasis outbreaks have been common among people in schools or daycare centers and at catered affairs and large public picnic areas. Children can easily pass on the infection by touching contaminated toys, changing tables, utensils, or their own feces, and then touching other people. For this reason, infection spreads quickly through a daycare center or institution for the developmentally disabled.

Unfiltered streams or lakes that may be contaminated by human or animal wastes are a common source of infection. Outbreaks can occur among campers and hikers who drink untreated water from mountain streams. While 20 million Americans drink unfiltered city water from streams or rivers, giardiasis outbreaks from tainted city water have been rare. Most of these problems have occurred not due to the absence of filters, but because of malfunctions in city water treatment plants, such as a temporary drop in chlorine levels. It is possible to become infected in a public swimming pool, however, since *Giardia* can survive in chlorinated water for about 15 minutes. During that time, it is possible for an individual to swallow contaminated pool water and become infected.

Causes and symptoms

Giardiasis is spread by food or water contaminated by the *Giardia lamblia* protozoan organism found in the human intestinal tract and feces. When the cysts are ingested, the stomach acid degrades the cysts and releases the active parasite into the body. Once within the body, the parasites cling to the lining of the small intestine, reproduce, and are swept into the fecal stream. As the liquid content of the bowel dries up, the parasites form cysts, which are then passed in the feces. Once excreted, the cysts can survive in water for more than three months. The parasite is spread

further by direct fecal-oral contamination, such as can occur if food is prepared without adequate hand-washing, or by ingesting the cysts in water or food.

Giardiasis is not fatal, and about two-thirds of infected people exhibit no symptoms. Symptoms will not occur until between one and two weeks after infection. When present, symptoms include explosive, watery diarrhea that can last for a week or more and, in chronic cases, may persist for months. Because the infection interferes with the body's ability to absorb fats from the intestinal tract, the stool is filled with fat. Other symptoms include foul-smelling and greasy feces, stomach pains, gas and bloating, loss of appetite, **nausea and vomiting**. In cases in which the infection becomeschronic, lasting for months or years, symptoms might include poor digestion, problems digesting milk, intermittent diarrhea, **fatigue**, weakness, and significant weight loss.

Diagnosis

Diagnosis can be difficult because it can be easy to overlook the presence of the giardia cysts during a routine inspection of a stool specimen. In the past, the condition has been diagnosed by examining three stool samples for the presence of the parasites. However, because the organism is shed in some stool samples and not others, the infection may not be discovered using this method.

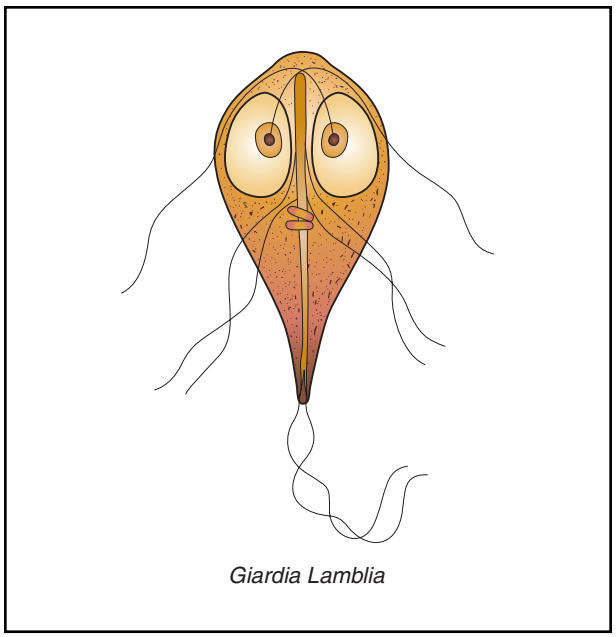
A newer, more accurate method of diagnosing the condition is the enzyme-linked immunosorbent assay (ELISA) that detects cysts and antigen in stool, and is approximately 90% accurate. While slightly more expensive, it only needs to be done once and is therefore less expensive overall than the earlier test.

Treatment

Acute giardiasis can usually be allowed to run its natural course and tends to clear up on its own. **Antibiotics** are helpful, however, in easing symptoms and preventing the spread of infection. Medications include metronidazole, furazolidone and paromomycin. Healthy carriers with no symptoms do not need antibiotic treatment. If treatment should fail, the patient should wait two weeks and repeat the drug course. Anyone with an impaired immune system (immunocompromised), such as a person with **AIDS**, may need to be treated with a combination of medications.

Prognosis

Giardiasis is rarely fatal, and when treated promptly, antibiotics usually cure the infection. While most people respond quickly to treatment, some have lingering symptoms and suffer with diarrhea and cramps for long periods, losing weight and not growing well. Those most at-risk for a course like this are the elderly, people with a weakened immune system, malnourished children, and anyone with low stomach acid.



Infection with the protozoon *Giardia lamblia*, shown above, causes diarrhea in humans. *(Illustration by Electronic Illustrators Group).*

Prevention

The best way to avoid giardiasis is to avoid drinking untreated surface water, especially from mountain streams. The condition also can be minimized by practicing the following preventive measures:

- thoroughly washing hands before handling food
- maintaining good personal cleanliness
- boiling any untreated water for at least three minutes
- properly disposing of fecal material

Children with severe diarrhea (and others who are unable to control their bowel habits) should be kept at home until the stool returns to normal. If an outbreak occurs in a daycare center, the director should notify the local health department. Some local health departments require a follow-up stool testing to confirm that the person is no longer contagious. People not in high-risk settings can return to their routine activities after recovery.

Resources

BOOKS

Infectious Disease. Ed. Barbara A. Bannister, et al. Oxford, England: Blackwell Scientific, Inc., 1996.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A substance (usually a protein) identified as foreign by the body's immune system, triggering the release of antibodies as part of the body's defense mechanism.

Enzyme-linked immunosorbent assay (ELISA)—A laboratory technique used to detect specific antigens or antibodies. It can be used to diagnose giardiasis.

Giardia lamblia—A type of protozoa with a whip-like tail that infects the human intestinal tract, causing giardiasis. The protozoa will not spread to other parts of the body.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Turkington, Carol A. *Infectious Diseases A to Z.* New York: Facts on File, Inc., 1998.

Van De Graaff, Kent. *Survey of Infectious and Parasitic Diseases.* New York: McGraw Hill, 1996.

Wilks, David, Mark Farrington, and David Rubenstein. *The Infectious Diseases Manual.* Oxford, England: Blackwell Scientific, Inc., 1995.

PERIODICALS

Hunter, Beatrice Trum. "Giardiasis: The Most Common Parasitic Infection." *Consumers' Research Magazine*, 76, no. 4 (Apr. 1993): 8-9.

Moser, Penny Ward. "Danger in Diaperland." *In Health*, 5, no. 5 (Sept./Oct. 1991).

"Diarrhea and Day Care Centers." *Pediatrics for Parents*, June 1991: 6.

Springer, Ilene. "The Summer Vacation Health Guide." *Ladies Home Journal*, 109, no. 7 (July 1992): 54-57.

Tufts editors. "A Backwoods Parasite Heads for Town." *Tufts University Health & Nutrition Letter* 15, no. 6 (Aug. 1997): 3.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Institute of Allergies and Infectious Diseases, Division of Microbiology and Infectious Diseases. Building 31, Room. 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892. <http://www.niaid.nih.gov>.

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

OTHER

Centers for Disease Control. <http://www.cdc.gov/ncidod/EID/eidtext.htm>.

International Society of Travel Medicine. <http:www.istm.org>.

Carol A. Turkington

Giardia lamblia infection *see* **Giardiasis**

Gigantism *see* **Acromegaly and gigantism**

Gilchrist's disease *see* **Blastomycosis**

Gilles de la Tourette's syndrome *see* **Tourette syndrome**

Gingivitis *see* **Periodontal disease**

Ginkgo biloba

Definition

Ginkgo biloba, known as the maidenhair tree, is one of the oldest trees on Earth, once part of the flora of the Mesozoic period. The ginkgo tree is the only surviving species of the Ginkgoaceae family. This ancient deciduous tree may live for thousands of years. Ginkgo is indigenous to China, Japan, and Korea, but also thrived in North America and Europe prior to the Ice Age. This drastic climate change destroyed the wild ginkgo tree throughout much of the world. In China, ginkgo was cultivated in temple gardens as a sacred tree known as *bai gou*, thus assuring its survival there for over 200 million years. Ginkgo fossils found from the Permian period are identical to the living tree, which is sometimes called a living fossil.

Description

Ginkgo trees may grow to 122 ft (37.2 m) tall and measure 4 ft (1.2 m) in girth. The female trees have a somewhat pointed shape at the top, like a pyramid. The male trees are broader at the crown. The bark of the ornamental ginkgo tree is rough and fissured and may be an ash to dark-brown in color. Distinctive, fan-shaped leaves with long stalks emerge from a sheath on the stem. Leaves are bright green in spring and summer, and turn to golden yellow in the fall. Ginkgo trees may take as long as 30 years to flower. Ginkgo is dioecious, with male and female flowers blooming on separate trees. Blossoms grow singly from the axils of the leaf. The female flowers

appear at the end of a leafless branch. The yellow, plum-shaped fruits develop an unpleasant scent as they ripen. They contain an edible inner seed that is available in Asian country marketplaces. Ginkgo's longevity may be due, in part, to its remarkable resistance to disease, pollution, and insect damage. Ginkgo trees are part of the landscape plan in many urban areas throughout the world. Millions of ginkgo trees, grown for harvest of the medicinal leaves, are raised on plantations in the United States, France, South Korea, and Japan, and are exported to Europe for pharmaceutical processing.

Purpose

Ginkgo leaves, fresh or dry, and seeds, separated from the outer layer of the fruit, are used medicinally. Ginkgo has remarkable healing virtues that have been recorded as far back as 2800 B.C. in the oldest Chinese materia medica. Ginkgo seeds were traditionally served to guests along with alcohol drinks in Japan. An enzyme present in the ginkgo seed has been shown in clinical research to speed up alcohol metabolism in the body, underscoring the wisdom of this folk custom. The leaf extract has been used in Asia for thousands of years to treat **allergies**, **asthma**, and **bronchitis**. It is also valued in Chinese medicine as a heart tonic, helpful in the treatment of cardiac arrhythmia. Ginkgo was first introduced to Europe in 1730, and to North America in 1784 where it was planted as an exotic garden ornamental near Philadelphia. Ginkgo medicinal extracts are the primary prescription medicines used in France and Germany.

Ginkgo acts to increase blood flow throughout the body, particularly cerebral blood flow. It acts as a circulatory system tonic, stimulating greater tone in the venous system. The herb is a useful and proven remedy for numerous diseases caused by restricted blood flow. European physicians prescribe the extract for treatment of **Raynaud's disease**, a condition of impaired circulation to the fingers. It is also recommended to treat intermittent claudication, a circulatory condition that results in painful cramping of the calf muscles in the leg and impairs the ability to walk. German herbalists recommend ingesting the extract for treatment of leg ulcers, and large doses are used to treat **varicose veins**. Ginkgo is widely recommended in Europe for the treatment of **stroke**. The dried leaf extract may also act to prevent hemmorrhagic stroke by strengthening the blood capillaries throughout the body. In studies of patients with atherosclerotic clogging of the penile artery, long-term therapy with ginkgo extract has provided significant improvement in erectile function. Ginkgo extract also acts to eliminate damaging free-radicals in the body, and has been shown to be effective in treatment of **premenstrual syndrome**, relieving tender or painful breasts.

Ginkgo biloba leaves. *(Photograph by Robert J. Huffman. Field Mark Publications. Reproduced by permission.)*

Ginkgo extract has proven benefits to elderly persons. This ancient herb acts to enhance oxygen utilization and thus improves memory, concentration, and other mental faculties. The herbal extract is used to treat **Alzheimer's disease**. It has been shown to have beneficial effect on the hippocampus, an area of the brain affected by Alzheimer's disease. The herbal extract has also been shown to significantly improve long-distance vision and may reverse damage to the retina of the eye. Studies have also confirmed its value in the treatment of depression in elderly persons. The ginkgo extract may provide relief for persons with **headache**, **sinusitis**, and vertigo. It may also help relieve chronic ringing in the ears known as **tinnitus**.

The active constituents in the ginkgo tree, known as ginkgolides, interfere with a blood protein known as the platelet activating factor, or PAF. Other phytochemicals in ginkgo include flavonoids, biflavonoides, proanthocyanidins, trilactonic diterpenes (including the ginkgolides A, B, C, and M), and bilabolide, a trilactonic sesquiterpene. The therapeutic effects of this herb have not been attributed to a single chemical constituent; rather, the medicinal benefits are due to the synergy between the various chemical constituents. The standardized extract of ginkgo must be taken consistently to be effective. A period of at least 12 weeks of use may be required before the beneficial results are evident.

Preparations

Ginkgo's active principles are dilute in the leaves. The herb must be processed to extract the active phytochemicals before it is medicinally useful. It would take an estimated 50 fresh ginkgo leaves to yield one standard dose of the extract. Dry extracts of the leaf, standardized to a potency of 24% flavone glycosides and 6% terpenes, are commercially available. A standard dose is 40 mg,

three times daily, though dosages as high as 240 mg daily are sometimes indicated.

Ginkgo extracts are widely used in Europe where they are sold in prescription form or over the counter as an approved drug. This is not the case in the United States, where ginkgo extract is sold as a food supplement in tablet and capsule form.

Precautions

Ginkgo is generally safe and non-toxic in therapeutic dosages. Exceeding a daily dose of 240 mg of the dried extract may result in restlessness, **diarrhea**, and mild gastrointestinal disorders. Those on anticoagulants should have their doctor adjust their dose or should avoid ginkgo in order to avoid over-thinning their blood and hemorrhaging. Ginkgo should be avoided two days before and one to two weeks after surgery to avoid bleeding complications.

Side effects

Severe allergic skin reactions, similar to those caused by poison ivy, have been reported after contact with the fruit pulp of ginkgo. Eating even a small amount of the fruit has caused severe gastrointestinal irritation in some persons. People with persistent headaches should stop taking ginkgo. Some patients on medications for nervous system disease should avoid ginkgo. It can interact with some other medicines, but clinical information is still emerging.

Interactions

The chemically active ginkgolides present in the extract, specifically the ginkgolide B component, act to reduce the clotting time of blood and may interact with antithrombotic medicines, including **aspirin**.

Resources

BOOKS

Duke, James A., Ph.D. *The Green Pharmacy.* Emmaus, PA: Rodale Press, 1997.

Elias, Jason, and Shelagh Ryan Masline. *The A to Z Guide to Healing Herbal Remedies.* New York: Lynn Sonberg Book Associates, 1996.

Murray, Michael T. *The Healing Power of Herbs.* 2nd ed. Roseville, CA: Prima Publications, Inc., 1995.

Ody, Penelope. *The Complete Medicinal Herbal.* New York: DK Publishing, Inc., 1993.

PDR for Herbal Medicines. Montvale, NJ: Medical Economics Company, 1998.

Prevention's 200 Herbal Remedies. Emmaus, PA: Rodale Press, Inc., 1997.

Tyler, Varro E., Ph.D. *Herbs Of Choice, The Therapeutic Use of Phytomedicinals.* Binghamton, NY: Haworth Press, Inc., 1994.

Tyler, Varro E., Ph.D. *The Honest Herbal.* Binghamton, NY: Haworth Press, Inc., 1993.

Weiss, Gaea and Shandor. *Growing & Using The Healing Herbs.* New York: Random House Value Pub., Inc., 1992.

Clare Hanrahan

Ginseng, Korean

Definition

Korean ginseng is one of the most widely used and acclaimed herbs in the world. Its scientific name is *Panax ginseng*, which is the species from which Chinese, Korean, red, and white ginseng are produced. Chinese and Korean ginseng are the same plant cultivated in different regions, and have slightly different properties according to Chinese medicine. White ginseng is simply the dried or powdered root of Korean ginseng, while red ginseng is the same root that is steamed and dried in heat or sunlight. Red ginseng is said to be slightly stronger and more stimulating in the body than white, according to Chinese herbalism.

Description

Korean ginseng has had a long and illustrious history as an herb for health, and has been used for thousands of years throughout the Orient as a medicine and tonic. Early Chinese medicine texts written in the first century A.D. mention ginseng, and ginseng has long been classified by Chinese medicine as a "superior" herb. This means it is said to promote longevity and vitality. Legends around the world have touted ginseng as an aphrodisiac and sexual tonic. Researchers have found a slight connection between sex drive and consuming ginseng, although a direct link and the mechanism of action are still researched and disputed.

Korean ginseng grows on moist, shaded mountainsides in China, Korea, and Russia. It is a perennial herb that reaches heights of two or more feet, and is distinguished by its dark green leaves and red clusters of berries. The root of the plant is the part valued for its medicinal properties. The root is long and slender and sometimes resembles the shape of the human body. Asian legends claim that this "man-root" has magical powers for those lucky enough to afford or find it, and the roots bearing the closest resemblance to the human body are still the most valuable ones. The word *ren shen*

in Chinese means roughly "the essence of the earth in the shape of a man."

Korean ginseng has historically been one of the most expensive of herbs, as it has been highly in demand in China and the Far East for centuries. Wars have been fought in Asia over lands where it grew wild. Wild Korean ginseng is now nearly extinct from many regions. Single roots of wild plants have recently been auctioned in China and New York City for sums approaching $50,000. Most of the world's supply of Korean ginseng is cultivated by farmers in Korea and China.

Because of the number of herbs sold under the name of ginseng, there can be some confusion for the consumer. Korean ginseng is a member of the *Araliaceae* family of plants, which also includes closely related American ginseng (*Panax quinquefolius*) and Siberian ginseng (*Eleutherococcus senticosus*). Both American and Siberian ginseng are considered by Chinese herbalists to be different herbs than Korean ginseng, and are said to have different effects and healing properties in the body. To add more confusion, there are eight herbs in Chinese medicine which are sometimes called ginseng, including black ginseng, purple ginseng, and prince's ginseng, some of which are not at all botanically related to *Panax ginseng*, so consumers should choose ginseng products with awareness.

Dried Korean ginseng. *(Custom Medical Stock Photo. Reproduced by permission.)*

Purpose

The word *panax* is formed from Greek roots meaning "cure-all," and *Panax ginseng* has long been considered to be one of the great healing and strengthening herbs in natural medicine. Ginseng is classified as an *adaptogen*, which is a substance that helps the body adapt to **stress** and balance itself without causing major side effects. Korean ginseng is used as a tonic for improving overall health and stamina, and Chinese herbalists particularly recommend it for the ill, weak, or elderly. Korean ginseng has long been asserted to have longevity, anti-senility, and memory improvement effects in the aged population. As it helps the body to adapt to stress, athletes may use ginseng as herbal support during rigorous training. Korean ginseng generally increases physical and mental energy. It is a good tonic for the adrenal glands, and is used by those suffering from exhaustion, burnout, or debilitation from chronic illness.

Traditional Chinese medicine also prescribes Korean ginseng to treat diabetes, and research has shown that it enhances the release of insulin from the pancreas and lowers blood sugar levels. Korean ginseng has been demonstrated to lower blood **cholesterol** levels. It has also been shown to have antioxidant effects and to increase immune system activity, which makes it a good herbal support for those suffering from **cancer** and **AIDS** and other chronic conditions that impair the immune system. Further uses of Korean ginseng in Chinese medicine include treatment of **impotence**, **asthma**, and digestive weakness.

Research

Scientists have isolated what they believe are the primary active ingredients in ginseng, chemicals termed *saponin triterpenoid glycosides*, or commonly called *ginsenocides*. There are nearly 30 ginsenocides in Korean ginseng. Much research on Korean ginseng has been conducted in China, but controlled human experiments with it have not been easily accessible to the English-speaking world. Recent research in China was summarized by Dr. C. Lui in the February 1992 issue of the *Journal of Ethnopharmacology*, where he wrote that *Panax ginseng* was found to contain 28 ginsenocides that "act on the central nervous system, cardiovascular system and endocrine secretion, promote immune function, and have effects on anti-aging and relieving stress."

To summarize other research, Korean ginseng has been shown in studies to have significant effects for the following.

- Physical improvement and performance enhancement for athletes: A study performed over three years in Germany showed athletes given ginseng had favorable improvement in several categories over a control group who took a placebo. Another 1982 study showed that athletes given ginseng had improved oxygen intake and faster recovery time than those given placebos.
- Mental performance improvement and mood enhancement: In general, studies show that ginseng enhances mental performance, learning time, and memory. One study of sixteen volunteers showed improvement on a wide variety of mental tests, including mathematics. Another study showed that those performing intricate and mentally demanding tasks improved performance when given Korean ginseng. Finally, a study has shown improvement of mood in **depression** sufferers with the use of ginseng.
- Antifatigue and antistress actions: Patients with chronic **fatigue** who were given ginseng showed a statistically significant improvement in physical tests and in mental attention and concentration, when compared with those given placebos.
- Lowering blood sugar: Animal studies have shown that ginseng can facilitate the release of insulin from the pancreas and increase the number of insulin receptors in the body.
- Antioxidant properties: Scientific analysis of ginseng has shown that it has antioxidant effects, similar to the effects of vitamins A, C, and E. Thus, ginseng could be beneficial in combating the negative effects of pollution, radiation, and aging.
- Cholesterol reduction: Some studies have shown that Korean ginseng reduces total cholesterol and increases levels of good cholesterol in the body.
- Anticancer effects and immune system stimulation: Several tests have shown that Korean ginseng increases immune cell activity in the body, including the activity of T-cells and lymphocytes, which are instrumental in fighting cancer and other immune system disorders like AIDS. A Korean study indicates that taking ginseng may reduce the chances of getting cancer, as a survey of more than 1,800 patients in a hospital in Seoul showed that those who did not have cancer were more likely to have taken ginseng regularly than those patients who had contracted cancer.
- Physical and mental improvement in the elderly: One study showed significant improvement in an elderly test group in visual and auditory reaction time and cardiopulmonary function when given controlled amounts of Korean ginseng. Korean ginseng has also been shown to alleviate symptoms of menopause.
- Impotence: Studies of human sexual function and Korean ginseng have been generally inconclusive, despite the wide acclaim of ginseng as a sexual tonic. Tests with lab animals and ginseng have shown some interesting results, indicating that Korean ginseng promotes the growth of male reproductive organs, increases sperm and testoterone levels, and increases sexual activity in laboratory animals. In general, scientists believe the link between ginseng and sex drive is due to ginseng's effect of strengthening overall health and balancing the hormonal system.

Preparations

Korean ginseng can be purchased as whole roots, powder, liquid extracts, and tea. Roots should be sliced and boiled in water for up to 45 minutes to extract all the beneficial nutrients. One to five grams of dry root is the recommended amount for one serving of tea. Herbalists recommend that ginseng not be boiled in metal pots, to protect its antioxidant properties. Ginseng should be taken between meals for best assimilation.

Some high quality Korean ginseng extracts and products are standardized to contain a specified amount of ginsenosides. The recommended dosage for extracts containing four to eight percent of ginsenosides is 100 mg once or twice daily. The recommended dosage for non-standardized root powder or extracts is 1–2 g daily, taken in capsules or as a tea. It is recommended that ginseng be taken in cycles and not continuously; after each week of taking ginseng, a few days without ingesting the herb should be observed. Likewise, Korean ginseng should not be taken longer than two months at a time, after which one month's rest period should be allowed before resuming the cycle again. Chinese herbalists recommend that ginseng be taken primarily in the autumn and winter months.

Precautions

Consumers should be aware of the different kinds of ginseng, and which type is best suited for them. Red Korean ginseng is considered stronger and more stimulating than white, wild ginseng is stronger than cultivated, and Korean ginseng is generally believed to be slightly stronger than Chinese. Furthermore, American and Siberian ginseng have slightly different properties than Korean ginseng, and consumers should make an informed choice as to which herb is best suited for them. Chinese herbalists do not recommend Korean ginseng for those people who have "heat" disorders in their bodies, such as ulcers, high blood pressure, tension headaches, and symptoms associated with high stress levels. Korean ginseng is generally not recommended for

those with symptoms of nervousness, mental imbalance, inflammation, or **fever**. Korean ginseng is not recommended for pregnant or lactating women, and women of childbearing age should use ginseng sparingly, as some studies imply that it can influence estrogen levels. Also, Chinese herbalists typically only prescribe ginseng to older people or the weak, as they believe that younger and stronger people do not benefit as much from it and ginseng is "wasted on the young."

Because of the number of and demand for ginseng products on the market, consumers should search for a reputable brand, preferably with a standardized percentage of active ingredients. To illustrate the mislabeling found with some ginseng products, *Consumer Reports* magazine analyzed ten nationally-distributed ginseng products in 1995. They found that several of them lacked significant amounts of ginsenocides, despite claims on the packaging to the contrary. Ginseng fraud has led the American Botanical Council, publisher of *HerbalGram* magazine, to initiate the Ginseng Evaluation Program, a comprehensive study and standardization of ginseng products on the American market. This study and its labeling standards are still under development, and consumers should watch for it.

Side effects

Korean ginseng acts as a slight stimulant in the body, and in some cases can cause overstimulation, irritability, nervousness and **insomnia**, although strong side effects are generally rare. Taking too high a dosage of ginseng, or taking ginseng for too long without a break, can cause *ginseng intoxication*, for which symptoms might include headaches, insomnia, seeing spots, **dizziness**, shortage of breath and gastrointestinal discomfort. Long term use may cause menstrual abnormalities and breast tenderness in some women.

Interactions

Those taking hormonal drugs should use ginseng with care. Ginseng should not be taken with **caffeine** or other stimulants as these may increase its stimulatory effects and cause uncomfortable side effects.

Resources

BOOKS

Duke, J.A. *Ginseng: A Concise Handbook.* Algonac, MI: Reference Publications, 1989.

Foster, S. and Chongxi, Y. *Herbal Emissaries.* Rochester, VT: Healing Arts Press, 1992.

Fulder, Stephan. *The Book of Ginseng and Other Chinese Herbs for Vitality.* Rochester, VT: Healing Arts Press, 1993.

KEY TERMS

Adaptogen—Substance that improves the body's ability to adapt to stress.

Ginsenocide—Active substances found in ginseng.

Hobbs, Christopher. *Ginseng: The Energy Herb.* Loveland, CO: Botanica Press, 1996.

PERIODICALS

HerbalGram (a quarterly journal of the American Botanical Council and Herb Research Foundation). P.O. Box 144345, Austin, TX 78714-4345. (800) 373-7105.

Douglas Dupler

Glaucoma

Definition

Glaucoma is a group of eye diseases characterized by damage to the optic nerve usually due to excessively high intraocular pressure (IOP).This increased pressure within the eye, if untreated can lead to optic nerve damage resulting in progressive, permanent vision loss, starting with unnoticeable blind spots at the edges of the field of vision, progressing to tunnel vision, and then to blindness.

Description

Between two to three million people in the United States have glaucoma, and 120,000 of those are legally blind as a result. It is the leading cause of preventable blindness in the United States and the most frequent cause of blindness in African-Americans, who are at about a three-fold higher risk of glaucoma than the rest of the population. The risk of glaucoma increases dramatically with age, but it can strike any age group, even newborn infants and fetuses.

Glaucoma can be classified into two categories: open-angle glaucoma and narrow-angle glaucoma. To understand what glaucoma is and what these terms mean, it is useful to understand eye structure.

Eyes are sphere-shaped. A tough, non-leaky protective sheath (the sclera) covers the entire eye, except for the clear cornea at the front and the optic nerve at the back. Light comes into the eye through the cornea, then

passes through the lens, which focuses it onto the retina (the innermost surface at the back of the eye). The rods and cones of the retina transform the light energy into electrical messages, which are transmitted to the brain by the bundle of nerves known as the optic nerve.

The iris, the colored part of the eye shaped like a round picture frame, is between the dome-shaped cornea and the lens. It controls the amount of light that enters the eye by opening and closing its central hole (pupil) like the diaphragm in a camera. The iris, cornea, and lens are bathed in a liquid called the aqueous humor, which is somewhat similar to plasma. This liquid is continually produced by nearby ciliary tissues and moved out of the eye into the bloodstream by a system of drainage canals (called the trabecular meshwork). The drainage area is located in front of the iris, in the angle formed between the iris and the point at which the iris appears to meet the inside of the cornea.

Glaucoma occurs if the aqueous humor is not removed rapidly enough or if it is made too rapidly, causing pressure to build-up. The high pressure distorts the shape of the optic nerve and destroys the nerve. Destroyed nerve cells result in blind spots in places where the image from the retina is not being transmitted to the brain.

Open-angle glaucoma accounts for over 90% of all cases. It is called "open-angle" because the angle between the iris and the cornea is open, allowing drainage of the aqueous humor. It is usually chronic and progresses slowly. In narrow-angle glaucoma, the angle where aqueous fluid drainage occurs is narrow, and therefore may drain slowly or may be at risk of becoming closed. A closed-angle glaucoma attack is usually acute, occurring when the drainage area is blocked. This can occur, for example, if the iris and lens suddenly adhere to each other and the iris is pushed forward. In patients with very narrow angles, this can occur when the eyes dilate (e.g., when entering a dark room, or if taking certain medications).

Congenital glaucoma occurs in babies and is the result of incomplete development of the eye's drainage canals during embryonic development. Microsurgery can often correct the defects or they can be treated with a combination of medicine and surgery.

One rare form of open-angle glaucoma, normal tension glaucoma, is different. People with normal-tension glaucoma have optic nerve damage in the presence of normal IOP. As of 1998, the mechanism of this disease is a mystery but is generally detected after an examination of the optic nerve. Those at higher risk for this form of glaucoma are people with a familial history of normal tension glaucoma, people of Japanese ancestory, and people with a history of systemic heart disease such as irregular heart rhythm.

Glaucoma is also a secondary condition of over 60 widely diverse diseases and can also result from injury, inflammation, tumor, or in advanced cases of cataract or diabetes.

Causes and symptoms

Causes

The cause of vision loss in all forms of glaucoma is optic nerve damage. There are many underlying causes and forms of glaucoma. Most causes of glaucoma are not known, but it is clear that a number of different processes are involved, and a malfunction in any one of them could cause glaucoma. For example, trauma to the eye could result in the angle becoming blocked, or, as a person ages, the lens becomes larger and may push the iris forward. The cause of optic nerve damage in normal-tension glaucoma is also unknown, but there is speculation that the optic nerves of these patients are susceptible to damage at lower pressures than what is usually considered to be abnormally high.

It is probable that most glaucoma is inherited. At least ten defective genes that cause glaucoma have been identified.

Symptoms

At first, chronic open-angle glaucoma is without noticeable symptoms. The pressure build-up is gradual and there is no discomfort. Moreover, the vision loss is too gradual to be noticed and each eye fills-in the image where its partner has a blind spot. However, if it is not treated, vision loss becomes evident, and the condition can be very painful.

On the other hand, acute closed-angle glaucoma is obvious from the beginning of an attack. The symptoms are, blurred vision, severe **pain**, sensitivity to light, nausea, and halos around lights. The normally clear corneas may be hazy. This is an ocular emergency and needs to be treated immediately.

Similarly, congenital glaucoma is evident at birth. Symptoms are bulging eyes, cloudy corneas, excessive tearing, and sensitivity to light.

Diagnosis

Intraocular pressure, visual field defects, the angle in the eye where the iris meets the cornea, and the appearance of the optic nerve are all considered in the diagnosis of glaucoma. IOP is measured with an instrument known as a tonometer. One type of tonometer involves numbing the eye with an eyedrop that has a yellow coloring in it and touching the cornea with a small probe. This quick

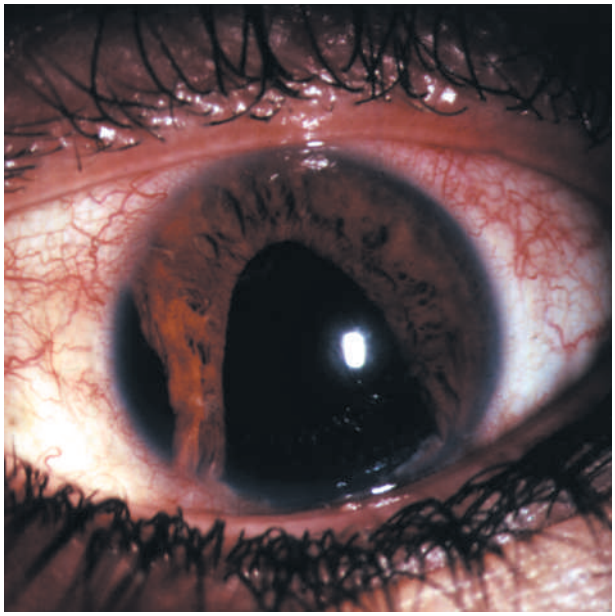
test is a routine part of an **eye examination** and is usually included without extra charge in the cost of a visit to an ophthalmologist or optometrist.

Ophthalmoscopes, hand-held instruments with a light source, are used to detect optic nerve damage by looking through the pupil. The optic nerve is examined for changes; the remainder of the back of the eye can be examined as well. Other types of lenses that can be used to examine the back of the eye may also be used. A slit lamp will allow the doctor to examine the front of the eye (i.e., cornea, iris, and lens).

Visual field tests (perimetry) can detect blind spots in a patient's field of vision before the patient is aware of them. Certain defects may indicate glaucoma.

Another test, gonioscopy, can distinguish between narrow-angle and open-angle glaucoma. A gonioscope, which is a hand-held contact lens with a mirror, allows visualization of the angle between the iris and the cornea.

Intraocular pressure can vary throughout the day. For that reason, the doctor may have a patient return for several visits to measure the IOP at different times of the day.



A close-up view of an inflamed eye with acute glaucoma and an irregularly enlarged pupil. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Medications

When glaucoma is diagnosed, drugs, typically given as eye drops, are usually tried before surgery. Several classes of medications are effective at lowering IOP and thus preventing optic nerve damage in chronic and neonatal glaucoma. **Beta blockers**, like Timoptic; carbonic anhydrase inhibitors, like acetazolamide; and alpha-2 agonists, such as Alphagan, inhibit the production of aqueous humor. Miotics, like pilocarpine, and prostaglandin analogues, like Xalatan, increase the outflow of aqueous humor. Cosopt is the first eyedrop that is a combined beta blocker (Timoptic) and carbonic anhydrase inhibitor and may be helpful for patients required to take more than one glaucoma medication each day. The Food and drug administration recently approved two new prostaglandin-related drugs, Travatan and Lumigan on March 16, 2001. These drugs work by decreasing intraocular pressure and may be considered for people with glaucoma that are unable to tolerate other IOP lowering drugs. Additionally, Travatan may work best for African-Americans with glaucoma (a population at high risk for glaucoma).

It is important for patients to tell their doctors about any conditions they have or medications they are taking. Certain drugs used to treat glaucoma should not be prescribed for patients with pre-existing conditions. All of these drugs mentioned above have side effects, some of which are rare but serious and potentially life-threatening, so patients taking them should be monitored closely, especially for cardiovascular, pulmonary, and behavioral symptoms. Different medications lower IOP by different amounts, and a combination of medications may be necessary. It is important that patients take their medications and that their regimens are monitored regularly, to be sure that the IOP is lowered sufficiently. IOP should be measured three to four times per year.

As of 1998, normal-tension glaucoma is treated in the same way as chronic high-intraocular-pressure glaucoma. This reduces IOP to less-than-normal levels, on the theory that overly susceptible optic nerves are less likely to be damaged at lower pressures. Research underway may point to better treatments for this form of glaucoma.

Attacks of acute closed-angle glaucoma are medical emergencies. IOP is rapidly lowered by successive deployment of acetazolamide, hyperosmotic agents, a topical beta-blocker, and pilocarpine. Epinephrine should not be used because it exacerbates angle closure.

Surgery

There are several types of **laser surgery** used to treat glaucoma. Laser peripheral iridotomy makes an opening in the iris allowing the fluid to drain, argon laser trabeculoplasty is aimed at the fluid channel opening to help the drainage system function and laser cyclophotocoagulation is used to decrease the amount of fluid made. Microsurgery, also called "filtering surgery" has been used in many different types of glaucoma. A new opening is cre-

KEY TERMS

Agonist—A drug that mimics one of the body's own molecules.

Alpha-2 agonist (alpha-2 adrenergic receptor agonist)—A class of drugs that bind to and stimulate alpha-2 adrenergic receptors, causing responses similar to those of adrenaline and noradrenaline. They inhibit aqueous humor production and a have a wide variety of effects, including dry mouth, fatigue, and drowsiness.

Aqueous humor—A transparent liquid, contained within the eye, that is composed of water, sugars, vitamins, proteins, and other nutrients.

Betablocker (beta-adrenergic blocker)—A class of drugs that bind beta-adrenergic receptors and thereby decrease the ability of the body's own natural epinephrine to bind to those receptors, leading to inhibition of various processes in the body's sympathetic system. Betablockers can slow the heart rate, constrict airways in the lungs, lower blood pressure, and reduce aqueous secretion by ciliary tissues in the eye.

Carbonic anhydrase inhibitor—A class of diuretic drugs that inhibit the enzyme carbonic anhydrase, an enzyme involved in producing bicarbonate, which is required for aqueous humor production by the ciliary tissues in the eye. Thus, inhibitors of this enzyme inhibit aqueous humor production. Some side effects are urinary frequency, kidney stones, loss of the sense of taste, depression, and anemia.

Cornea—Clear, bowl-shaped structure at the front of the eye. It is located in front of the colored part of the eye (iris). The cornea lets light into the eye and partially focuses it.

Gonioscope—An instrument used to examine the trabecular meshwork; consists of a magnifier and a lens equipped with mirrors, which sits on the patient's cornea.

Hyperosmotic drugs—Refers to a class of drugs for glaucoma that increase the osmotic pressure in the blood, which then pulls water from the eye into the blood.

Iris—The colored part of the eye just behind the cornea and in front of the lens that controls the amount of light sent to the retina.

Lens (the crystalline lens)—A transparent structure in the eye that focuses light onto the retina.

Laser cyclophotocoagulation—A procedure used for severe glaucoma in patients who have not responded well to previous treatments. The laser partially destroys the tissues that make the fluid of the eye.

Laser peripheral iridotomy—This procedure makes a drainage hole in the iris allowing the fluid to drain from the eye

Laser Trabeculoplasty—In this procedure the laser attempts to open the normal drainage channels of the eye so fluid can drain more effectively.

Miotic—A drug that causes pupils to contract.

Ophthalmoscope—An instrument, with special lighting, designed to view structures in the back of the eye.

Optic nerve—The nerve that carries visual messages from the retina to the brain.

Prostaglandin—A group of molecules that exert local effects on a variety of processes including fluid balance, blood flow, and gastrointestinal function.

Prostaglandin analogue—A class of drugs that are similar in structure and function to prostaglandin.

Retina—The inner, light-sensitive layer of the eye containing rods and cones.

Sclera—The tough, fibrous, white outer protective covering that surrounds the eye.

Tonometry—The measurement of pressure.

Trabecular meshwork—A sponge-like tissue located near the cornea and iris that functions to drain the aqueous humor from the eye into the blood.

ated in the sclera allowing the intraocular fluid to bypass the blocked drainage canals. The tissue over this opening forms a little blister or bleb on the clear conjuctiva that Doctors monitor ensuring that fluid is draining. These surgeries are usually successful, but the effects often last less than a year. Nevertheless, they are an effective treatment for patients whose IOP is not sufficiently lowered by drugs and for those who can't tolerate the drugs. Because all surgeries have risks, patients should speak to their doctors about the procedure being performed.

Alternative treatment

Vitamin C, vitamin B_1 (thiamine), chromium, zinc,bilberry and rutin may reduce IOP.

There is evidence that medicinal marijuana lowers IOP, too. However, marijuana has serious side effects and contains carcinogens, and any IOP-lowering medication must be taken continually to avoid optic nerve damage. Although the Food and Drug Administration (FDA) and National Institutes of Health (NIH) currently recommend against treating glaucoma with marijuana, they are supporting research to learn more about it and to determine the feasibility of separating the components that lower IOP from components that produce side effects and carcinogens.

Any glaucoma patient using alternative methods to attempt to prevent optic nerve damage should also be under the care of a traditionally trained ophthalmologist or optometrist who is licensed to treat glaucoma, so that IOP and optic nerve damage can be monitored.

Prognosis

About half of the people stricken by glaucoma are not aware of it. For them, the prognosis is not good, and many of them will become blind. Sight lost due to glaucoma cannot be restored. On the other hand, the prognosis for treated glaucoma is excellent.

Prevention

Because glaucoma may not initially result in symptoms, the best form of prevention is to have regular eye exams.

Patients with narrow angles should avoid certain medications (even over-the-counter medications, such as some cold or allergy medications).Any person who is glaucoma-susceptible (i.e. narrow angles and borderline IOPs) should read the warning labels on over-the-counter medicines and inform their physicians of products they are considering taking.Steroids may also raise IOP, so patients may need to be monitored more frequently if it is necessary to use steroids for another medical condition.

Not enough is known about the underlying mechanisms of glaucoma to prevent the disease itself. However, prevention of optic nerve damage from glaucoma is essential and can be effectively accomplished when the condition is diagnosed and treated. As more is learned about the genes that cause glaucoma, it will become possible to test DNA and identify potential glaucoma victims, so they can be treated even before their IOP becomes elevated.

Resources

BOOKS

Epstein, David L., R. Rand Allingham, and Joel S. Schuman. *Chandler and Grant's Glaucoma,* 4th ed. Baltimore: Williams & Wilkins, 1997.

Marks, Edith and Rita Montauredes. *Coping with Glaucoma.* Garden City Park, NY: Avery, 1997.

ORGANIZATION

American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. <http://www.eyenet.org/aao_index.html>.

Glaucoma Research Foundation. 200 Pine Street, suite 200 San Francisco,CA 94104. (415) 986-3162, (800) 826-6693. info@glaucoma.org. <http://www.glaucoma.org/.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.prevent-blindness.org.

OTHER

Titcomb, Lucy. "Treatment of Glaucoma." *Pharmacy Magazine*. <http://www.pharmacymag.co.uk/glau.htm> (29 April 1998).

Bonny McClain

Glaucoma surgery *see* **Trabeculectomy**

Glioma *see* **Brain tumor**

Glipizide *see* **Antidiabetic drugs**

Glomerulonephritis

Definition

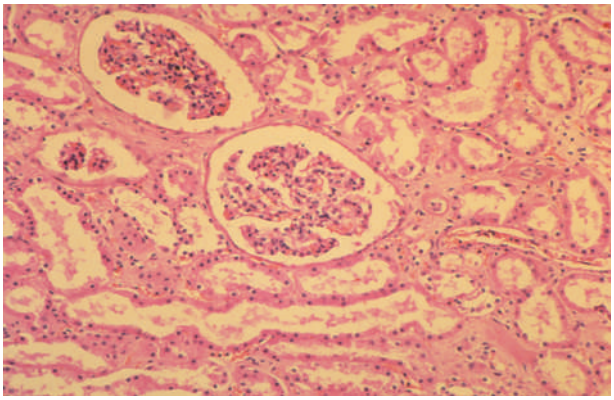
Acute glomerulonephritis is an inflammatory disease of both kidneys predominantly affecting children from ages two to 12. Chronic glomerulonephritis can develop over a period of 10–20 years and is most often associated with other systemic disease, including diabetes, **malaria**, hepatitis, or **systemic lupus erythematosus**.

Description

Acute glomerulonephritis is an inflammation of the glomeruli, bundles of tiny vessels inside the kidneys. The damaged glomeruli cannot effectively filter waste products and excess water from the bloodstream to make urine. The kidneys appear enlarged, fatty, and congested.

Causes and symptoms

Acute glomerulonephritis most often follows a streptococcal infection of the throat or skin. In children,



A close-up view of glomerulonephritis affecting the kidney. *(Custom Medical Stock Photo. Reproduced by permission.)*

it is most often associated with an upper respiratory infection, **tonsillitis**, or **scarlet fever**. Kidney symptoms usually begin two to three weeks after the initial infection. Exposure to certain paints, glue or other organic solvents may also be the causative agent. It is thought that the kidney is damaged with exposure to the toxins that are excreted into the urine.

Mild glomerulonephritis may produce no symptoms, and diagnosis is made with laboratory studies of the urine and blood. Individuals with more severe cases of the disease may exhibit:

- fatigue
- nausea and vomiting
- shortness of breath
- disturbed vision
- high blood pressure
- swelling, especially noted in the face, hands, feet, and ankles
- blood and protein in the urine, resulting in a smoky or slightly red appearance

The individual with chronic glomerulonephritis may discover their condition with a routine physical exam revealing high blood pressure, or an eye exam showing vascular or hemorrhagic changes. The kidneys may be reduced to as little as one-fifth their normal size, consisting largely of fibrous tissues.

Diagnosis

Diagnosis of glomerulonephritis is established based on medical history, combined with laboratory studies. A "dipstick" test of urine will reveal increased protein levels. A 24 hour urine collection allows measurement of the excretion of proteins and creatinine. Creatinine clearance from the bloodstream by the kidneys is considered an index of the glomerular filtration rate. Blood studies may reveal a low **blood count**, and may also be checked for the presence of a streptococcal antibody titer(a sophisticated blood test indicating presence of streptococcal infection). A **kidney biopsy** may also be performed, using ultrasound to guide the needle for obtaining the specimen.

Treatment

The main objectives in the treatment of acute glomerulonephritis are to:

- decrease the damage to the glomeruli
- decrease the metabolic demands on the kidneys
- improve kidney function

Bedrest helps in maintaining adequate blood flow to the kidney. If residual infection is suspected, antibiotic therapy may be needed. In the presence of fluid overload, **diuretics** may be used to increase output with urination. Iron and vitamin supplements may be ordered if anemia develops, and antihypertensives, if high blood pressure accompanies the illness. In order to rest the kidney during the acute phase, decreased sodium and protein intake may be recommended. The amount of protein allowed is dependent upon the amount lost in the urine, and the requirements of the individual patient. Sodium limitations depend on the amount of **edema** present. Fluid restrictions are adjusted according to the patient's urinary output and body weight.

An accurate daily record of the patient's weight, fluid intake and urinary output assist in estimating kidney function. The patient must be watched for signs of complications and recurrent infection. As edema is reduced and the urine becomes free of protein and red blood cells, the patient is allowed to increase activity. A woman who has had glomerulonephritis requires special medical attention during **pregnancy**.

Prognosis

In acute glomerulonephritis, symptoms usually subside in two weeks to several months, with 90% of children recovering without complications and adults recovering more slowly. Chronic glomerulonephritis is a disease that tends to progress slowly, so that there are no symptoms until the kidneys can no longer function. The resultant renal failure may require dialysis or kidney transplant.

Prevention

Prevention of glomerulonephritis is best accomplished by avoiding upper respiratory infections, as well

KEY TERMS

Dialysis—A process of filtering and removing waste products from the bloodstream. Two main types are hemodialysis and peritoneal dialysis. In hemodialysis, the blood flows out of the body into a machine that filters out the waste products and routes the cleansed blood back into the body. In peritoneal dialysis, the cleansing occurs inside the body. Dialysis fluid is injected into the peritoneal cavity and wastes are filtered through the peritoneum, the thin membrane that surrounds the abdominal organs.

Glomeruli—Groups of tiny blood vessels with very thin walls that function as filters in the kidney. Glomeruli become inflamed and are destroyed in the disease process of glomerulonephritis.

Renal—Relating to the kidneys, from the Latin word *renes*.

as other acute and chronic infections, especially those of a streptococcal origin. Cultures of the infection site, usually the throat, should be obtained and antibiotic sensibility of the offending organism determined. Prompt medical assessment for necessary antibiotic therapy should be sought when infection is suspected. The use of prophylactic immunizations is recommended as appropriate.

Resources

BOOKS

Branch, William. *Office Practice of Medicine*. Philadelphia: W. B. Saunders Co., 1982.

Brunner, Lillian, and Doris Suddarth. *Textbook of Medical-Surgical Nursing*. Philadelphia: J. B. Lippincott, 1975.

ORGANIZATIONS

American Association of Kidney Patients. 100 S. Ashley Dr., #280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

National Kidney Foundation and Urologic Diseases Information Clearinghouse. 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5390. <http://www.niddk.nih.gov/health/kidney/nkudic.htm>.

OTHER

"Glomerulonephritis." Healthtouch Online Page. 29 Mar. 1998 <http://www.healthtouch.com>.

"Glomerulonephritis." ThriveOnline. 29 Mar. 1998 <http://thriveonline.oxygen.com>.

Kathleen D. Wright, RN

Glossopharyngeal neuralgia *see* **Neuralgia**

Glucose-6-phosphate dehydrogenase deficiency

Definition

Glucose-6-phosphate dehydrogenase deficiency is an inherited condition caused by a defect or defects in the gene that codes for the enzyme, glucose-6-phosphate dehydrogenase (G6PD). It can cause **hemolytic anemia**, varying in severity from life-long anemia, to rare bouts of anemia to total unawareness of the condition. The episodes of hemolytic anemia are usually triggered by oxidants, infection, or by eating fava beans.

Description

G6PD deficiency is the most common enzyme deficiency in the world, with about 400 million people living with it. It is most prevalent in people of African, Mediterranean, and Asian ancestry. The incidence in different populations varies from zero in South American Indians to less than 0.1% of Northern Europeans to about 50% of Kurdish males. In the United States, it is most common among African American males; about 11 to 14% are G6PD-deficient.

G6PD deficiency is a recessive sex-linked trait. Thus, males have only one copy of the G6PD gene, but females have two copies. Recessive genes are masked in the presence of a gene that encodes normal G6PD. Accordingly, females with one copy of the gene for G6PD deficiency are usually normal, while males with one copy have the trait.

G6PD is present in all human cells but is particularly important to red blood cells. It is required to make NADPH in red blood cells but not in other cells. It is also required to make glutathione. Glutathione and NADPH both help protect red blood cells against oxidative damage. Thus, when G6PD is defective, oxidative damage to red blood cells readily occurs, and they break open as a result. This event is called hemolysis, and multiple hemolyses in a short time span constitute an episode of hemolytic anemia.

As of 1998, there are almost 100 different known forms of G6PD enzyme molecules encoded by defective

KEY TERMS

Bilirubin—A breakdown product derived from hemoglobin; removed from the blood by the liver.

Enzyme—A protein catalyst; one of the two kinds of biological catalysts, which are exceedingly specific; each different enzyme only catalyzes one or two specific reactions.

Enzyme activity—A measure of the ability of an enzyme to catalyze a specific reaction.

Glutathione—A molecule that acts as a co-enzyme in cellular oxidation-reduction reactions.

Hemolysis—Lysis (opening) of red blood cells, with concomitant leakage of cell contents from the cells.

Hemolytic anemia—Anemia due to hemolysis.

Jaundice—Yellowish skin color due to liver disease.

Neonatal—Describes babies just after they are born.

Recessive trait—An inherited trait that is outwardly obvious only when two copies of the gene for that trait are present—as opposed to a dominant trait where one copy of the gene for the dominant trait is sufficient to display the trait. The recessive condition is said to be masked by the presence of the dominant gene when both are present; i.e., the recessive condition is seen only in the absence of the dominant gene.

Sex-linked—Refers to genes or traits carried on one of the sex chromosomes, usually the X.

X chromosome—One of the two types of sex chromosomes, present twice in female cells and once in male cells.

G6PD genes, yet not one of them is completely inactive. This suggests that G6PD is indispensable. Many G6PD defective enzymes are deficient in their stability rather than their initial ability to function. Since red blood cells lack nuclei, they, unlike other cells, cannot synthesize new enzyme molecules to replace defective ones. Hence, we expect young red blood cells to have new, functional G6PD and older cells to have non-functioning G6PD. This explains why episodes of hemolytic anemia are frequently self-limiting; new red blood cells are generated with enzymes able to afford protection from oxidation.

The geographic distribution of G6PD deficiency, allowing for migration, coincides with the geographic distribution of **malaria**. This fact and survival statistics suggest that G6PD deficiency protects against malaria.

Glucose-6-phosphate dehydrogenase deficiency is also known as G6PD deficiency, favism, and primaquine sensitivity.

Causes and symptoms

Causes

G6PD deficiency is caused by one copy of a defective G6PD gene in males or two copies of a defective G6PD gene in females. Hemolytic anemic attacks can be caused by oxidants, infection, and or by eating fava beans.

Symptoms

The most significant consequence of this disorder is hemolytic anemia, which is usually episodic, but the vast majority of people with G6PD deficiency have no symptoms.

The many different forms of G6PD deficiency have been divided into five classes according to severity.

- Class 1—enzyme deficiency with chronic hemolytic anemia
- Class 2—severe enzyme deficiency with less than 10% of normal activity
- Class 3—moderate to mild enzyme deficiency with 10–60% of normal activity
- Class 4—very mild or no enzyme deficiency
- Class 5—increased enzyme activity Fortunately, only a small number of people fall into Class 1.

The major symptoms of hemolytic anemia are **jaundice**, dark urine, abdominal **pain**, back pain, lowered red blood cell count, and elevated bilirubin. People who suffer from severe and chronic forms of G6PD deficiency in addition may have **gallstones**, enlarged spleens, defective white blood cells, and **cataracts**.

Attacks of hemolytic anemia are serious for infants. Brain damage and **death** are possible but preventable outcomes. Newborns with G6PD deficiency are about 1.5 times as likely to get **neonatal jaundice** than newborns without G6PD deficiency.

Diagnosis

Blood tests can detect G6PD deficiency, either by measuring the G6PD enzyme activity between episodes

or by measuring bilirubin during an episode. Such tests cost about $50.00. Family histories are helpful, too.

Treatment

In a typical attack of hemolytic anemia, no treatment is needed; the patient will recover in about eight days. However, blood transfusions are necessary in severe cases. Recent success treating elevated bilirubin in newborns by exposing them to bright light has decreased the need for neonatal transfusions.

Alternative treatment

Vitamin E and **folic acid** (both anti-oxidants) may help decrease hemolysis in G6PD-deficient individuals.

Prognosis

The prognosis for almost everyone with G6PD deficiency is excellent. Large studies have shown that G6PD-deficient individuals do not acquire any illnesses more frequently than the rest of the population. In fact the opposite may be true for some diseases like ischemic heart disease and cerebrovascular disease.

Prevention

Most episodes of hemolytic anemia can be prevented by avoiding fava beans, oxidant drugs, and oxidant chemicals. All of the following oxidants can trigger attacks: acetanilid, dapsone, doxorubicin, furazolidone, methylene blue, nalidixic acid, napthalene, niridazole, nitrofurantoin, phenazopyridine, phenylhydrazine, primaquine, quinidine, quinine, sulfacetamide, sulfamethoxazole, sulfonamide, sulfapyridine, thiazolesulfone, toluidine blue, and trinitrotoluene. Since infections also trigger hemolytic attacks and have other dire consequences, sometimes it is advisable to use one of the listed drugs.

It is especially important to screen newborns who are likely to have G6PD deficiency to ensure that G6PD-deficient babies won't be subjected to any of the triggers of hemolytic anemia. Pregnant women, especially in areas where G6PD deficiency is prevalent, should avoid eating fava beans.

Resources

BOOKS

Luzzatto, Lucio, and Atul Mehta. "Glucose 6-Phosphate Dehydrogenase Deficiency." In *The Metabolic and Molecular Bases of Inherited Disease*. 7th ed. Ed. Charles R. Scriver, et al. New York: McGraw-Hill, Inc., 1995.

ORGANIZATIONS

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington, D.C. 20008. (202) 966-5557. <http://www.geneticalliance.org>.

OTHER

Favism Home Page. <http://rialto.com/favism/index.htm>.

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Glucosylcerebroside lipidosis *see* **Gaucher disease**

Gluten enteropathy *see* **Celiac disease**

Glyburide *see* **Antidiabetic drugs**

Glycogen storage diseases

Definition

Glycogen serves as the primary fuel reserve for the body's energy needs. Glycogen storage diseases, also known as glycogenoses, are genetically linked metabolic disorders that involve the enzymes regulating glycogen metabolism. Symptoms vary by the glycogen storage disease (GSD) type and can include muscle cramps and wasting, enlarged liver, and low blood sugar. Disruption of glycogen metabolism also affects other biochemical pathways as the body seeks alternative fuel sources. Accumulation of abnormal metabolic by-products can damage the kidneys and other organs. GSD can be fatal, but the risk hinges on the type of GSD.

Description

Most of the body's cells rely on glucose as an energy source. Glucose levels in the blood are very stringently controlled within a range or 70–100 mg/dL, primarily by hormones such as insulin and glucagon. Immediately after a meal, blood glucose levels rise and exceed the body's immediate energy requirements. In a process analogous to putting money in the bank, the body bundles up the extra glucose and stores it as glycogen in the liver and muscles. Later, as the blood glucose levels begin to dip, the body makes a withdrawal from its glycogen savings.

The system for glycogen metabolism relies on a complex system of enzymes. These enzymes are responsible for creating glycogen from glucose, transporting the glycogen to and from storage areas within cells, and extracting glucose from the glycogen as needed. Both creating and tearing down the glycogen macromolecule are multistep processes requiring a different enzyme at each step. If one of these enzymes is defective and fails to complete its step, the process halts. Such enzyme defects are the underlying cause of GSDs.

The enzyme defect arises from an error in its gene. Since the error is in the genetic code, GSDs can be passed down from generation-to-generation. However, all but one GSD are linked to autosomal genes, which means a person inherits one copy of the gene from each parent. Following a Mendelian inheritance pattern, the normal gene is dominant and the defective gene is recessive. As long as a child receives at least one normal gene, there is no risk for a GSD. GSDs appear only if a person inherits a defective gene from both parents.

The most common forms of GSD are Types I, II, III, and IV, which may account for more than 90% of all cases. The most common form is Type I, or von Gierke's disease, which occurs in one out of every 100,000 births. Other forms, such as Types VI and IX, are so rare that reliable statistics are not available. The overall frequency of all forms of glycogen storage disease is approximately one in 20,000–25,000 live births.

Causes and symptoms

GSD symptoms depend on the enzyme affected. Since glycogen storage occurs mainly in muscles and the liver, those sites display the most prominent symptoms.

There are at least 10 different types of GSDs which are classified according to the enzyme affected:

- Type Ia, or von Gierke's disease, is caused by glucose-6-phosphatase deficiency in the liver, kidney, and small intestine. The last step in glycogenolysis, the breaking down of glycogen to glucose, is the transformation of glucose-6-phosphate to glucose. In GSD I, that step does not occur. As a result, the liver is clogged with excess glycogen and becomes enlarged and fatty. Other symptoms include low blood sugar and elevated levels of lactate, lipids, and uric acid in the blood. Growth is impaired, **puberty** is often delayed, and bones may be weakened by **osteoporosis**. Blood platelets are also affected and frequent nosebleeds and easy bruising are common. Primary symptoms improve with age, but after age 20–30, liver tumors, **liver cancer**, chronic renal disease, and **gout** may appear.
- Type Ib is caused by glucose-6-phosphatase translocase deficiency. In order to carry out the final step of glycogenolysis, glucose-6-phosphate has to be transported into a cell's endoplasmic reticulum. If translocase, the enzyme responsible for that movement, is missing or defective, the same symptoms occur as in Type Ia. Additionally, the immune system is weakened and victims are susceptible to bacterial infections, such as **pneumonia**, mouth and gum infections, and inflammatory bowel disease. Types Ic and Id are also caused by defects in the translocase system.
- Type II, or Pompe's disease or acid maltase deficiency, is caused by lysosomal alpha-D-glucosidase deficiency in skeletal and heart muscles. GSD II is subdivided according to the age of onset. In the infantile form, infants seem normal at birth, but within a few months they develop muscle weakness, trouble breathing, and an enlarged heart. Cardiac failure and **death** usually occur before age 2, despite medical treatment. The juvenile and adult forms of GSD II affect mainly the skeletal muscles in the body's limbs and torso. Unlike the infantile form, treatment can extend life, but there is no cure. **Respiratory failure** is the primary cause of death.
- Type III, or Cori's disease, is caused by glycogen debrancher enzyme deficiency in the liver, muscles, and some blood cells, such as leukocytes and erythrocytes. About 15% of GSD III cases only involve the liver. The glycogen molecule is not a simple straight chain of linked glucose molecules, but rather an intricate network of short chains that branch off from one another. In glycogenolysis, a particular enzyme is required to unlink the branch points. When that enzyme fails, symptoms similar to GSD I occur; in childhood, it may be difficult to distinguish the two GSDs by symptoms alone. In addition to the low blood sugar, retarded growth, and enlarged liver causing a swollen abdomen, GSD III also causes muscles prone to wasting, an enlarged heart, and heightened levels of lipids in the blood. The muscle wasting increases with age, but the other symptoms become less severe.
- Type IV, or Andersen's disease, is caused by glycogen brancher enzyme deficiency in the liver, brain, heart, skeletal muscles, and skin fibroblasts. The glycogen constructed in GSD IV is abnormal and insoluble. As it accumulates in the cells, cell death leads to organ damage. Infants born with GSD IV appear normal at birth, but are diagnosed with enlarged livers and **failure to thrive** within their first year. Infants who survive beyond their first birthday develop **cirrhosis** of the liver by age 3–5 and die as a result of chronic liver failure.
- Type V, or McArdle's disease, is caused by glycogen phosphorylase deficiency in skeletal muscles. Under normal circumstances, muscles cells rely on oxidation of fatty acids during rest or light activity. More demanding activity requires that they draw on their glycogen stockpile. In GSD V, this form of glycogenolysis is disabled and glucose is not available. The main symptoms are muscle weakness and cramping brought on by **exercise**, as well as burgundy-colored urine after exercise due to myoglobin (a breakdown product of muscle) in the urine.
- Type VI, or Hers' disease, is caused by liver phosphorylase deficiency, which blocks the first step of

glycogenolysis. In contrast to other GSDs, Type VI seems to be linked to the X chromosome. Low blood sugar is one of the key symptoms, but it is not as severe as in some other forms of GSD. An enlarged liver and mildly retarded growth also occur.

- Type VII, or Tarui's disease, is caused by muscle phosphofructokinase deficiency. Although glucose may be available as a fuel in muscles, the cells cannot metabolize it. Therefore, abnormally high levels of glycogen are stockpiled in the muscle cells. The symptoms are similar to GSD V, but also include anemia and increased levels of uric acid.
- Types VIII and XI are caused by defects of enzymes in the liver phosphorylase activating-deactivating cascade and have symptoms similar to GSD VI.
- Type IX is caused by liver glycogen phosphorylase kinase deficiency and, symptom-wise, is very similar to GSD VI. The main differences are that the symptoms may not be as severe and may also include exercise-related problems in the muscles, such as **pain** and cramps. The symptoms abate after puberty with proper treatment. Most cases of GSD IX are linked to the X chromosome and therefore affect males.
- Type X is caused by a defect in the cyclic adenosine monophosphate-dependent (AMP) kinase enzyme and presents symptoms similar to GSDs VI and IX.

Diagnosis

Diagnosis usually occurs in infancy or childhood, although some milder types of GSD go unnoticed well into adulthood and old age. It is even conceivable that some of the milder GSDs are never diagnosed.

The four major symptoms that typically lead a doctor to suspect GSDs are low blood sugar, enlarged liver, retarded growth, and an abnormal blood biochemistry profile. A definitive diagnosis is obtained by biopsy of the affected organ or organs. The biopsy sample is tested for its glycogen content and assayed for enzyme activity. There are DNA-based techniques for diagnosing some GSDs from more easily available samples, such as blood or skin. These DNA techniques can also be used for prenatal testing.

Treatment

Some GSD types cannot be treated, while others are relatively easy to control through symptom management. In more severe cases, receiving an organ transplant is the only option. In the most severe cases, there are no available treatments and the victim dies within the first few years of life.

Of the treatable types of GSD, many are treated by manipulating the diet. The key to managing GSD I is to maintain consistent levels of blood glucose through a combination of nocturnal intragastric feeding (usually for infants and children), frequent high-carbohydrate meals during the day, and regular oral doses of cornstarch (people over age 2). Juvenile and adult forms of GSD II can be managed somewhat by a high protein diet, which also helps in cases of GSD III, GSD VI, and GSD IX. GSD V and GSD VII can also be managed with a high protein diet and by avoiding strenuous exercise.

For GSD cases in which dietary therapy is ineffective, organ transplantation may be the only viable alternative. Liver transplants have been effective in reversing the symptoms of GSD IV.

Advances in genetic therapy offer hope for effective treatment in the future. This therapy involves using viruses to deliver a correct form of the gene to affected cells. Another potential therapy utilizes transgenic animals to produce correct copies of the defective enzyme in their milk. In late 1997, a Dutch pharmaceutical company, Pharming Health Care Products, began clinical trials to treat GSD II with human alpha-glucosidase derived from the milk of transgenic rabbits. Researchers at Duke University in North Carolina are also focusing on a treatment for Pompe's disease and, aided by Synpac Pharmaceuticals Limited of the United Kingdom, plan to begin clinical trials of a recombinant form of the enzyme in 1998.

Prognosis

People with well-managed, treatable types of GSD can lead long, relatively normal lives. This goal is accomplished with the milder types of GSD, such as Types VI, IX, and X. As the GSD type becomes more severe, a greater level of vigilance against infections and other complications is required. Given current treatment options, complications such as liver disease, **heart failure**, and respiratory failure may not be warded-off indefinitely. Quality of life and life expectancy are substantially decreased.

Prevention

Because GSD is an inherited condition, it is not preventable. If both parents carry the defective gene, there is a one-in-four chance that their offspring will inherit the disorder. Other children may be carriers or they may miss inheriting the gene altogether.

Through chorionic villi sampling and **amniocentesis**, the disorder can be detected prior to birth. Some types of GSD can be detected even before conception occurs, if both parents are tested for the presence of the defective

KEY TERMS

Amniocentesis—A medical test done during pregnancy in which a small sample of the amniotic fluid is taken from around the fetus. The fluid contains fetal cells that can be examined for genetic abnormalities.

Autosomal gene—A gene found on one of the 22 autosomal chromosome pairs; i.e., not on a sex (X or Y) chromosome.

Chorionic villus sampling—A medical test done during pregnancy in which a sample of the membrane surrounding the fetus is removed for examination. This examination can reveal genetic fetal abnormalities.

Glucose—A form of sugar that serves as the body's main energy source.

Glycogen—A macromolecule composed mainly of glucose that serves as the storage form of glucose that is not immediately needed by the body.

Glycogenolysis—The process of tearing-down a glycogen molecule to free up glucose.

Glycogenosis—An alternate term for glycogen storage disease. The plural form is glycogenoses.

Gout—A painful condition in which uric acid precipitates from the blood and accumulates in joints and connective tissues.

Mendelian inheritance—An inheritance pattern for autosomal gene pairs. The genetic trait displayed results from one parent's gene dominating over the gene inherited from the other parent.

Osteoporosis—A disease in which the bones become weak and brittle.

Renal disease—Kidney disease.

Transgenic animal—Animals that have had genes from other species inserted into their genetic code.

gene. Before undergoing such testing, the prospective parents should meet with a genetic counselor and other professionals in order to make an informed decision.

Resources

BOOKS

Chen, Yuan-Tsong, and Ann Burchell. "Glycogen Storage Diseases." In *The Metabolic and Molecular Bases of Inherited Disease*. 7th ed. Ed. Charles R. Scriver, et al. New York: McGraw-Hill, Inc., 1995.

PERIODICALS

Goldberg, Teresia, and Alfred Slonim. "Nutrition Therapy for Hepatic Glycogen Storage Diseases." *Journal of the American Dietetic Association* 93, no. 12 (Dec. 1993): 1423.

Talente, Gregg M., Rosalind A. Coleman, Craig Alter, et al. "Glycogen Storage Disease in Adults." *Annals of Internal Medicine* 120 (1994): 218.

Triomphe, Teeny J. "Glycogen Storage Disease: A Basic Understanding and Guide to Nursing Care." *Journal of Pediatric Nursing* 12, no. 4 (Aug. 1997): 238.

ORGANIZATIONS

Acid Maltase Deficiency Association. PO Box 700248, San Antonio, TX 78270-0248. (210) 494-6144. <http://www.amda-pompe.org>.

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

Association for Glycogen Storage Disease. PO Box 896, Durant, Iowa 52747-9769. (319) 785-6038.

Julia Barrett

Glycosylated hemoglobin test

Definition

Glycosylated hemoglobin is a test that indicates how much sugar has been in a person's blood during the past two to four months. It is used to monitor the effectiveness of diabetes treatment.

Purpose

Diabetes is a disease in which a person cannot effectively use sugar in the blood. Left untreated, blood sugar levels can be very high. High sugar levels increase risk of complications, such as damage to eyes, kidneys, heart, nerves, blood vessels, and other organs.

A routine blood sugar test reveals how close to normal a sugar level is at the time of the test. The glycosylated **hemoglobin test** reveals how close to normal it has been during the past several months.

This information helps a physician evaluate how well a person is responding to diabetes treatment and to determine how long sugar levels have been high in a person newly diagnosed with diabetes.

KEY TERMS

Diabetes mellitus—A disease in which a person can't effectively use sugar in the blood to meet the needs of the body. It is caused by a lack of the hormone insulin.

Glucose—The main form of sugar used by the body for energy.

Glycosylated hemoglobin—A test that measures the amount of hemoglobin bound to glucose. It is a measure of how much glucose has been in the blood during the past two to four months.

Description

The Diabetes Control and Complications Trial (DCCT) demonstrated that persons with diabetes who maintained blood glucose (sugar) and total **fasting** hemoglobin levels at or close to a normal range decreased their risk of complications by 50–75%. Based on results of this study, the American Diabetes Association (ADA) recommends routine glycosylated hemoglobin testing to measure long-term control of blood sugar.

Glycosylated hemoglobin measures the percentage of hemoglobin bound to glucose. Hemoglobin is a protein found in every red blood cell. As hemoglobin and glucose are together in the red blood cell, the glucose gradually binds to the A1c form of hemoglobin in a process called glycosylation. The amount bound reflects how much glucose has been in the blood during the past average 120-day lifespan of red cells.

Several methods are used to measure the amount of bound hemoglobin and glucose. They are electrophoresis, chromatography, and immunoassay. All are based on the separation of hemoglobin bound to glucose from that without glucose.

The ADA recommends glycosylated hemoglobin be done during a person's first diabetes evaluation, again after treatment is begun and sugar levels are stabilized, then repeated semiannually. If the person does not meet treatment goals or sugar levels have not stabilized, the test should be repeated quarterly.

Other names for the test include: Hemoglobin A1c, Diabetic control index, GHb, glycosylated hemoglobin, and glycated hemoglobin. The test is covered by insurance. Results are usually available the following day.

Preparation

A person does not need to fast before this test. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes. This test requires 5 mL of blood.

Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure to the puncture site until bleeding stops reduces bruising. Warm packs relieve discomfort.

Normal results

Diabetes treatment should achieve glycosylated hemoglobin levels of less than 7.0%. Normal values for a non-diabetic person is 4.0–6.0%.

Because laboratories use different methods, results from different laboratories can not always be compared. The National Glycosylation Standardization Program gives a certification to laboratories using tests standardized to those used in the DCCT study.

Abnormal results

Results require interpretation by a physician with knowledge of the person's clinical condition, as well as the test method used. Some methods give false high or low results if the person has an abnormal hemoglobin, such as hemoglobin S or F.

Conditions that increase the lifespan of red cells, such as a **splenectomy** (removal of the spleen), falsely increase levels. Conditions that decrease the lifespan, such as hemolysis (disruption of the red blood cell membrane), falsely decrease levels.

Resources

PERIODICALS

American Diabetes Association. "Position Statement: Standards of Medical Care for Patients with Diabetes Mellitus." *Diabetes Care* (Jan. 1998): S23-31.

American Diabetes Association. "Position Statement: Tests of Glycemia in Diabetes." *Diabetes Care* (Jan. 1998): S69-71.

American Diabetes Association. "Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus." *Diabetes Care* (July 1997): 1183-1197.

The DCCT Research Group. "The Effects of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus." *New England Journal of Medicine* (Sept. 1993): 977-986.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Diabetes Information Clearinghouse. 1 Information Way, Bethesda, MD 20892-3560. (800) 860-8747. <http://www.niddk.nih.gov/health/diabetes/ndic.htm>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

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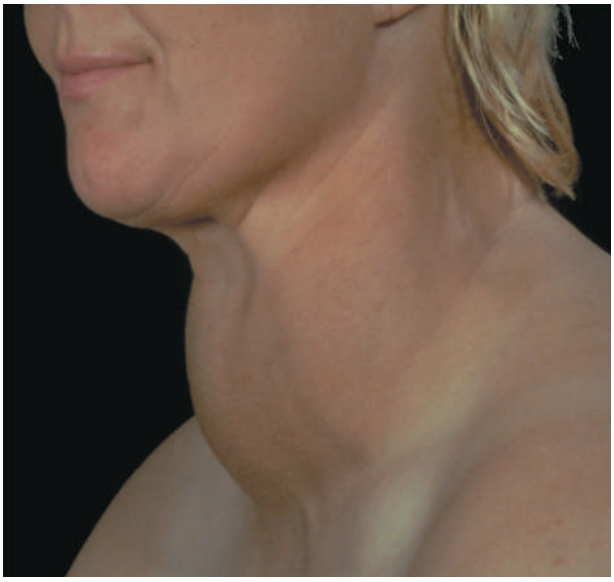


This woman's goiter may have been caused by an insufficient intake of iodine. *(Custom Medical Stock Photo. Reproduced by permission.)*

Goiter

Definition

Goiter refers to any visible enlargement of the thyroid gland.

Description

The thyroid gland sits astride the trachea (windpipe) and is shaped like a butterfly. It makes thyroxin, a hormone that regulates the metabolic activity of the body, rather like the gas pedal on a car. Too much thyroxin increases the metabolism, causing weight loss, temperature elevation, nervousness, and irritability. Too little thyroxin slows the metabolism down, deepens the voice, causes weight gain and water retention, and retards growth and mental development in children. Both conditions also alter hair and skin growth, bowel function, and menstrual flow.

Curiously, the thyroid gland is often enlarged whether it is making too much hormone, too little, or sometimes even when it is functioning normally. The thyroid is controlled by the pituitary gland, which secretes thyroid stimulating hormone (TSH) in response to the amount of thyroxin it finds in the blood. TSH increases the amount of thyroxin secreted by the thyroid and also causes the thyroid gland to grow.

- Hyperthyroid goiter—If the amount of stimulating hormone is excessive, the thyroid will both enlarge and secrete too much thyroxin. The result—hyperthyroidism with a goiter. Graves' disease is the most common form of this disorder.
- Euthyroid goiter—The thyroid is the only organ in the body to use iodine. If dietary iodine is slightly inadequate, too little thyroxin will be secreted, and the pituitary will sense the deficiency and produce more TSH. The thyroid gland will enlarge enough to make sufficient thyroxin.
- Hypothyroid goiter—If dietary iodine is severely reduced, even an enlarged gland will not be able to make enough thyroxin. The gland will keep growing under the influence of TSH, but it may never be able to make enough thyroxin.

Causes and symptoms

Excess TSH (or similar hormones), cysts, and tumors will enlarge the thyroid gland. Of these, TSH enlarges the entire gland while cysts and tumors enlarge only a part of it.

The only symptom from a goiter is the large swelling just above the breast bone. Rarely, it may constrict the trachea (windpipe) or esophagus and cause difficulty breathing or swallowing. The rest of the symptoms come from thyroxin or the lack of it.

Diagnosis

The size, shape, and texture of the thyroid gland help the physician determine the cause. A battery of blood

KEY TERMS

Cyst—A liquid-filled structure developing abnormally in the body.

Euthyroid—Having the right amount of thyroxin stimulation.

Hyperthyroid—Having too much thyroxin stimulation.

Hypothyroid—Having too little thyroxin stimulation.

Pituitary gland—The master gland, located in the middle of the head, that controls most of the other glandss by secreting stimulating hormones.

Radiotherapy—The use of ionizing radiation, either as x rays or radioactive isotopes, to treat disease.

Thyroxin—The hormone secreted by the thyroid gland.

tests are required to verify the specific thyroid disease. Functional imaging studies using radioactive iodine determine how active the gland is and what it looks like.

Treatment

Goiters of all types will regress with treatment of the underlying condition. Dietary iodine may be all that is needed. However, if an iodine deficient thyroid that has grown in size to accommodate its deficiency is suddenly supplied an adequate amount of iodine, it could suddenly make large amounts of thyroxin and cause a thyroid storm, the equivalent of racing your car motor at top speed.

Hyperthyroidism can be treated with medications, therapeutic doses of radioactive iodine, or surgical reduction. Surgery is much less common now than it used to be because of progress in drugs and radiotherapy.

Prognosis

Although goiters diminish in size, the thyroid may not return to normal. Sometimes thyroid function does not return after treatment, but thyroxin is easy to take as a pill.

Prevention

Euthyroid goiter and hypothyroid goiter are common around the world because many regions have inadequate dietary iodine, including some places in the United States. International relief groups are providing iodized salt to many of these populations. Because **mental retardation** is a common result of **hypothyroidism** in children, this is an extremely important project.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Gregerman, Robert I. "Thyroid disorders" In *Principles of Ambulatory Medicine*, ed. L. Randol Barker, et al. Baltimore: Williams & Wilkins, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

International Council for the Control of Iodine Deficiency Disorders. 43 Circuit Road, Chester Hill, MA, 02167. (207) 335-2221. <http://www.tulane.edu/~icec/icciddhome.htm>.

The Micronutrient Initiative (c/o International Development Research Centre). 250 Albert St., Ottawa, Ontario, Canada K1G 3H9. (613) 236-6163, ext. 2050. <http://www.idrc.ca/mi/index.htm>.

J. Ricker Polsdorfer, MD

Gonadal dysgenesis *see* **Turner syndrome**

Gonorrhea

Definition

Gonorrhea is a highly contagious sexually transmitted disease that is caused by the bacterium *Neisseria gonorrhoeae*. The mucous membranes of the genital region may become inflamed without the development of any other symptoms. When symptoms do occur, they are different in men and women. In men, gonorrhea usually begins as an infection of the vessel that carries urine and sperm (urethra). In women, it will most likely infect the narrow part of the uterus (cervix). If untreated, gonorrhea can result in serious medical complications.

Description

Gonorrhea is commonly referred to as "the clap." The incidence of gonorrhea has steadily declined since the 1980s, largely due to increased public awareness campaigns and the risk of contracting other **sexually transmitted diseases**, such as **AIDS**. Still, current estimates range from 400,000 to as many as one million projected cases of gonorrhea in the United States each year. These estimates vary due to the private nature of the dis-

ease and the consequent underreporting that occurs. The majority of reported cases of gonorrhea come from public health clinics.

The disease affects people of all ages, races, and socioeconomic levels, but some individuals are more at-risk than others. Adolescents and young adults are the highest risk group, with more than 80% of the reported cases each year occurring in the 15–29 age group. Those individuals with multiple sexual partners and who use no barrier **contraception**, such as condoms, are most at-risk. Reported rates vary among racial and ethnic groups.

The risk factors for gonorrhea are not unlike those for all sexually transmitted diseases. Both men and women can become infected through a variety of sexual contact behaviors, including oral, anal, or vaginal intercourse. The disease is transmitted very efficiently. In fact, women run a 60–90% chance of contracting the disease after just one sexual encounter with an infected male. The disease can also be transmitted from an infected mother to her infant during delivery.

Causes and symptoms

If treated early, gonorrhea can be cured. Unfortunately, many individuals with gonorrhea, particularly women, will experience no symptoms to alert them to the possibility that they have contracted gonorrhea, and therefore, many do not seek treatment. When present, the symptoms and complications of gonorrhea are primarily limited to the genital, urinary, and gastrointestinal systems and usually begin between one day and two weeks following infection. If left untreated, serious complications can result if the disease spreads to the bloodstream and infects the brain, heart valves, and joints. Untreated gonorrhea can also result in severe damage to the reproductive system, making an individual unable to conceive a child (sterile).

Symptoms of gonorrhea in women

As many as 80% of women with gonorrhea show no symptoms. If present, symptoms may include the following:

- bleeding between menstrual periods
- chronic abdominal **pain**.
- painful urination.
- vaginal discharge, often cloudy and yellow.
- in the case of oral infection, there may be no symptoms or only a **sore throat**.
- anal infection may cause rectal **itching** or discharge.

Because women often do not show any symptoms, complications are more likely to occur as the disease progresses. The most common complication is **pelvic inflammatory disease** (PID). PID can occur in up to 40% of women with gonorrhea and may result in damage to the fallopian tubes, a **pregnancy** developing outside the uterus (**ectopic pregnancy**), or sterility. If an infected woman is pregnant, gonorrhea can be passed on to her newborn through the birth canal during delivery. These infants may experience eye infections that could lead to blindness.

Symptoms of gonorrhea in men

Men are more likely to experience the following symptoms:

- thick and cloudy discharge from the penis.
- burning or pain during urination.
- more frequent urination.
- in the case of oral infection, there may be no symptoms or only a sore throat.
- anal infection may cause rectal itching or discharge.

In men, complications can affect the prostate, testicles, and surrounding glands. Inflammation, tissue **death** and pus formation (abscesses), and scarring can occur and result in sterility.

Diagnosis

The diagnosis of gonorrhea can be made at a public health clinic or a family physician office. First, the doctor will discuss symptoms and the patient's known contact or at-risk behavior. There are three methods available to test for the presence of *Neisseria gonorrhoeae*. These include a culture, a Gram stain, and an ELISA test. Culture of secretions from the infected area is the preferred method for gonorrhea screening in patients with or without symptoms. A cotton swab can be used to collect enough sample for a culture. The sample is incubated for up to two days, providing enough time for the bacteria to multiply and be accurately identified. This test is nearly 100% accurate.

Gram stains are more accurate in the diagnosis of gonorrhea in men than in women. To perform this test, a small amount of discharge from the infected area will be placed on a slide, stained with a special dye, and examined under a microscope for the presence of the gonococcus bacteria. The advantage to this test is that results can be obtained very quickly at the initial visit. Because it requires that the physician or technician to be able to recognize and accurately identify the bacteria simply by looking at it under a microscope, however, this test is only approximately 70% accurate. As a result, one of the other methods will also probably be used to confirm the diagnosis.

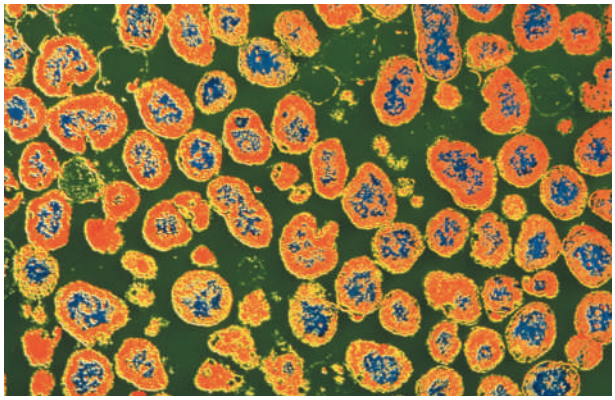
ELISA, or enzyme-linked immunosorbent assay, has emerged as a rapid and sensitive test for gonorrhea. It is much more sensitive than the gram stain and is more convenient than the culture test, which involves the transport and storage of samples. As of late 1997, several other diagnostic tests were being researched with the goal of providing a cost-effective method of screening for a variety of sexually transmitted diseases. One of the most interesting of these is a home test that can be taken by the patient themselves, allowing for a degree of privacy and confidentiality.

When a patient suspects exposure to or experiences symptoms of gonorrhea, he or she may see a public health provider or family practice physician. Physicians trained in obstetrics or gynecology may also be involved, particularly if gynecological complications occur. Men who experience complications may be referred to a urologist. There are also infectious disease doctors who specialize in the treatment and research of all infectious diseases, including those transmitted sexually. All doctors must report this highly contagious disease to public health officials, and patients are asked to provide the names of sex partners during the suspected period of infection so that they can be notified of the risk.

Treatment

Gonorrhea has become more difficult and expensive to treat since the 1970s, due to the increased resistance of gonorrhea to certain **antibiotics**. In fact, according to projections from the Centers for Disease Control and Prevention, 30% of the strains of gonorrhea were resistant to routine antibiotics in 1994, and resistance has been increasing steadily. Furthermore, many patients have both gonorrhea and chlamydial infections. Therefore, two drug treatment regimens are common. Medications used to treat gonorrhea include ceftriaxone, cefixime, spectinomycin, ciprofloxacin, and ofloxacin. Ceftriaxone and doxycycline or azithromycin are often given simultaneously to treat possible co-existing chlamydia (in pregnant women, erythromycin should be substituted for the aforementioned anti-chlamydial agents).

An extremely important consideration is to make sure that all of the prescribed medication is taken. If a course of antibiotics is not completed, the medication will only kill those organisms that are susceptible to the antibiotic, allowing those that are resistant to the effects of that particular antibiotic to multiply and possibly cause a new infection that will be more difficult to treat. Patients should refrain from sexual intercourse until treatment is complete and return for follow-up testing. Any sexual partners during the time of infection, even if those partners do not show symptoms, should be notified and treated when any sexually transmitted disease is involved.



A transmission electron microscopy (TEM) image of *Neisseria gonorrhoeae.* *(Custom Medical Stock Photo. Reproduced by permission.)*

Alternative treatment

Although there is no known alternative to antibiotics in the treatment of gonorrhea, there are herbs and **minerals** that may be used to supplement antibiotic treatment:

- *Lactobacillus acidophilus* or live-culture yogurts are helpful, while taking antibiotics, to replenish gastrointestinal flora.
- The following supplements may be used to improve the body's immune function: zinc, multivitamins and mineral complexes, vitamin C, and garlic (*Allium sativum*).
- Several herbs may reduce some symptoms or help speed healing: kelp has balanced **vitamins** and minerals. Calendula (*Calendula officinalis*), myrrh (*Commiphora molmol*), and thuja (*Thuja occidentalis*) may help reduce discharge and inflammation when used as a tea or douche.
- Hot baths may also help reduce pain and inflammation.
- A variety of herbs may help with symptoms of the reproductive and urinary systems.
- If a physician approves, **fasting**, combined with certain juices, may help cleanse the urinary and gastrointestinal systems.
- There may be **acupressure** and **acupuncture** points that will help with system cleansing. These exact pressure points can be provided and treated by an acupressurist or acupuncturist.

Prognosis

The prognosis for patients with gonorrhea varies based on how early the disease is detected and treated. If treated early and properly, patients can be entirely cured of the disease. Up to 40% of female patients who are not

KEY TERMS

Cervix—The narrow part or neck of the uterus.

Chlamydia—The most common bacterial sexually transmitted disease in the United States that often accompanies gonorrhea and is known for its lack of evident symptoms in the majority of women.

Ectopic pregnancy—A pregnancy that occurs outside the uterus, such as in the fallopian tubes. Although the fetus will not survive, in some cases, ectopic pregnancy can also result in the death of the mother.

ELISA—Enzyme-linked immunosorbent assay. This test has been used a screening test for AIDS for many years and has also been used to detect gonorrhea bacteria.

HIV—Human immunodeficiency virus, the virus that causes AIDS. The risk of acquiring AIDS is increased by the presence of gonorrhea or other sexually transmitted diseases.

Neisseria gonorrhoeae—The bacterium that causes gonorrhea. It cannot survive for any length of time outside the human body.

Pelvic inflammatory disease (PID)—An infection of the upper genital tract that is the most serious threat to a woman's ability to reproduce. At least 25% of women who contract the disease, which can be a complication of gonorrhea, will experience long-term consequences such as infertility or ectopic pregnancy.

Sexually transmitted diseases (STDs)—A group of diseases which are transmitted by sexual contact. In addition to gonorrhea, this groups generally includes chlamydia, HIV (AIDS), herpes, syphilis, and genital warts.

Sterile—Unable to conceive a child.

Urethra—The canal leading from the bladder, and in men, also a path for sperm fluid.

Urethritis—Inflammation of the urethra.

treated early may develop pelvic inflammatory disease (PID) and the possibility of resulting sterility. Although the risk of **infertility** is higher in women than in men, men may also become sterile if the urethra becomes inflamed (**urethritis**) as a result of an untreated gonorrhea infection. Following an episode of PID, a woman is six to 10 times more likely, should a pregnancy occur, to have a pregnancy develop outside the uterus (ectopic pregnancy), which can result in death. Liver infection may also occur in untreated women. In approximately 2% of patients with untreated gonorrhea, the gonococcal infection may spread throughout the body and can cause **fever**, arthritis-like joint pain, and **skin lesions**.

Prevention

Currently, there is no vaccine for gonorrhea, but several are under development. The best prevention is to abstain from having sex or to engage in sex only when in a mutually monogamous relationship in which both partners have been tested for gonorrhea, AIDS, and other sexually transmitted diseases. The next line of defense is the use of condoms, which have been shown to be highly effective in preventing disease (and unwanted pregnancies). To be 100% effective, condoms must be used properly. A female birth-control device that blocks the entry of sperm into the cervix (diaphragm) can also reduce the risk of infection. The risk of contracting gonorrhea increases with the number of sexual partners. Any man or woman who has sexual contact with more than one partner is advised to be tested regularly for gonorrhea and other sexually transmitted diseases.

Resources

BOOKS

Balch, James F. *Prescription for Nutritional Healing*. Garden City Park, NY: Avery Publishing Group, 1997.

Committee on Prevention and Control of Sexually Transmitted Diseases. *The Hidden Epidemic: Confronting Sexually Transmitted Diseases*. Edited by Thomas R. England and William T. Butler. Washington, DC: National Academy Press, 1997.

Ross, Linda A. *Sexually Transmitted Diseases Sourcebook: Basic Information About Herpes, Chlamydia, Gonorrhea, Hepatitis, Nongonococcal Urethritis, Pelvic Inflammatory Disease, Syphilis, AIDS, and More, Along with Current Data on Treatments and Preventions*. Detroit, MI: Omnigraphics, 1997.

Sparling, P. Fredrick. "Gonococcal Infections." In *Cecil Textbook of Medicine*, edited by Russel L. Cecil et al. Philadelphia: W.B. Saunders Company, 2000.

PERIODICALS

Centers for Disease Control and Prevention. "Gonorrhea Among Men Who Have Sex With Men: Selected Sexually Transmitted Diseases Clinics, 1993-1996." *Journal of the*

American Medical Association, 278 (October 15, 1997): 1228-1229.
Newland, Jamesetta A. "Gonorrhea in Women." *American Journal of Nursing,* 97 (August 1997): 16AA.
Newland, Jamesetta A. "Urethritis in Men." *American Journal of Nursing,* 97 (August 1997): 16BB.
"Tips from Other Journals: Trends in Antibiotic Resistance of Gonorrhea." *American Family Physician,* 56 (October 1, 1997): 5.

ORGANIZATIONS

American Foundation for the Prevention of Venereal Disease, Inc. 799 Broadway, Suite 638, New York, NY 10003. (212) 759-2069.
American Social Health Association. P.O. Box 13827, Research Triangle Park, NC 27709. (800) 227-8922 (National STD Hotline) or voice line at (919) 361-8400. <http://sunsite.unc.edu/ASHA/>.
National Center for HIV, STD, and TB Prevention. Centers for Disease Control and Prevention, 1600 Clifton NE, Atlanta, GA 30333. <http://www.cdc.gov/nchstp/od/nchstp.html>. NCHST@cpsod1.em.cdc.gov.
National Institute of Allergy and Infectious Diseases. National Institutes of Health, Bethesda, MD 20892.

Teresa G. Norris

Goodpasture's syndrome

Definition

An uncommon and life-threatening hypersensitivity disorder believed to be an autoimmune process related to antibody formation in the body. Goodpasture's syndrome is characterized by renal (kidney) disease and lung hemorrhage.

Description

The disorder is characterized by autoimmune reaction which deposits of antibodies in the membranes of both the lung and kidneys, causing both inflammation of kidney (**glomerulonephritis**) and lung bleeding. It is typically a disease of young males.

Causes and symptoms

The exact cause is unknown. It is an autoimmune disorder; that is, the immune system is fighting the body's own normal tissues through creating antibodies that attack the lungs and kidneys. Sometimes the disorder is triggered by a viral infection, or by the inhalation of gasoline or other hydrocarbon solvents. An association also exists between cigarette **smoking** and the syndrome. The target antigen of the Goodpasture's antibodies has been localized to a protein chain (type IV collagen).

Symptoms include foamy, bloody, or dark colored urine, decreased urine output, **cough** with bloody sputum, difficulty breathing after exertion, weakness, **fatigue**, nausea or vomiting, weight loss, nonspecific chest **pain** and/or pale skin.

Diagnosis

The clinician will perform a battery of tests to confirm a diagnosis. These tests include a complete **blood count** (CBC) to confirm anemia, iron levels to check for blood loss and blood urea nitrogen (BUN) and creatinine levels to test the kidney function. A **urinalysis** will be done to check for damage to the kidneys. A sputum test will be done to look for specific antibodies. A **chest x ray** will be done to assess the amount of fluid in the lung tissues. A lung needle biopsy and a **kidney biopsy** will show immune system deposits. The kidney biopsy can also show the presence of the harmful antibodies that attack the lungs and kidneys.

Treatment

Treatment is focused on slowing the progression of the disease. Treatment is most effective when begun early, before kidney function has deteriorated to a point where the kidney is permanently damaged, and dialysis is necessary. **Corticosteroids**, such as prednisone, or other anti-inflammatory medications may be used to reduce the immune response. Immune suppressants such as cyclophosphamide or azathioprine are used aggressively to reduce immune system effects.

A procedure whereby blood plasma, which contains antibodies, is removed from the body and replaced with fluids or donated plasma (**plasmapheresis**) may be performed daily for two or more weeks to remove circulating antibodies. It is fairly effective in slowing or reversing the disorder. Dialysis to clean the blood of wastes may be required if kidney function is poor. A kidney transplant may be successful, especially if performed after circulating antibodies have been absent for several months.

Prognosis

The probable outcome is variable. Most cases progress to severe renal failure and end-stage renal disease within months. Early diagnosis and treatment makes the probable outcome more favorable.

Prevention

No known prevention of Goodpasture's syndrome exists. People should avoid glue sniffing and the siphoning gasoline. Stopping smoking, if a family history of

KEY TERMS

Antibody—A protein molecule produced by the immune system in response to a protein that is not recognized as belonging in the body.

Antigen—Any substance that, as a result of coming in contact with appropriate cells,induces a state of sensitivity and/or immune responsiveness after a period of time and that reacts in a demonstrable way with antibodies.

Autoimmune disorder—An abnormality within the body whereby the immune system incorrectly attacks the body's normal tissues, thereby causing disease or organ dysfunction.

Blood urea nitrogen (BUN)—A test used to measure the blood level of urea nitrogen, a waste that is normally filtered from the kidneys.

Creatinine—A test used to measure the blood level of creatinine, a waste product filtered out of the blood by the kidneys. Higher than usual levels of this substance may indicate kidney disease.

Glomerulus (glomeruli)—A small tuft of blood capillaries in the kidney, responsible for filtering out waste products.

renal failure exists, may prevent some cases. Early diagnosis and treatment may slow progression of the disorder.

Resources

BOOKS

Berkow, Robert. *The Merck Manual of Medical Information.* Whitehouse Station: Merck Research Laboratories, 1997.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment.* Los Altos: Lange Medical Publications, 2001.

Couser, William G. "Glomerular Disorders." In *Cecil Textbook of Medicine,* edited by James B. Wyngaarden, et al. Philadelphia: W. B. Saunders Company, 1992.

PERIODICALS

Ball, Joseph A. and Young, K. randall. "Pulmonary Manifestations of Goodpasture's Syndrome: Antiglomerular basement Membrane Disease and Related Disorders." *Clinics in Chest Medicine* (December 1998): 777-791.

ORGANIZATIONS

American Kidney Fund. 6110 Executive Boulevard, Suite 1010, Rockville, MD 20852. (800) 638-8299. <http://www.akfinc.org.

National Kidney Foundation. 30 East 33rd Street, New York, NY 10016. (800) 622-9010. <http://www.kidney.org.

Kim A. Sharp, M.Ln.
Robert Scott Dinsmoor

Gout

Definition

Gout is a form of acute arthritis that causes severe **pain** and swelling in the joints. It most commonly affects the big toe, but may also affect the heel, ankle, hand, wrist, or elbow. Gout usually comes on suddenly, goes away after 5–10 days, and can keep recurring. Gout is different from other forms of arthritis because it occurs when there are high levels of uric acid circulating in the blood, which can cause urate crystals to settle in the tissues of the joints.

Description

Uric acid, which is found naturally in the blood stream, is formed as the body breaks down waste products, mainly those containing purine, a substance that is produced by the body and is also found in high concentrations in some foods, including brains, liver, sardines, anchovies, and dried peas and beans. Normally, the kidneys filter uric acid out of the blood and excrete it in the urine. Sometimes, however, the body produces too much uric acid or the kidneys aren't efficient enough at filtering it from the blood, and it builds up in the blood stream, a condition known as hyperuricemia. A person's susceptibility to gout may increase because of the inheritance of certain genes or from being overweight and eating a rich diet. In some cases, another disease (such as lymphoma, leukemia, or **hemolytic anemia**) may be the underlying cause of the uric acid buildup that results in gout.

Hyperuricemia doesn't always cause gout. However, over the course of years, sharp urate crystals build up in the synovial fluid of the joints. Often, some precipitating event, such as an infection, surgery, a stubbed toe, or even a heavy drinking binge can cause inflammation. White blood cells, mistaking the urate crystals for a foreign invader, flood into the joint and surround the crystals, causing inflammation—in other words, the redness, swelling, and pain that are the hallmarks of a gout attack.

Causes and symptoms

As a result of high levels of uric acid in the blood, needle-like urate crystals gradually accumulate in the joints. Urate crystals may be present in the joint for a long time without causing symptoms. Infection, injury to the joint, surgery, drinking too much, or eating the wrong kinds of foods may suddenly bring on the symptoms, which include pain, tenderness, redness, warmth, and swelling of the joint. In many cases, the gout attack begins in the middle of the night. The pain is often so excruciating that the sufferer cannot bear weight on the

joint or tolerate the pressure of bedcovers. The inflamed skin over the joint may be red, shiny, and dry, and the inflammation may be accompanied by a mild **fever**. These symptoms may go away in about a week and disappear for months or years at a time. However, over the course of time, attacks of gout recur more and more frequently, last longer, and affect more joints. Eventually, stone-like deposits known as tophi may build up in the joints, ligaments, and tendons, leading to permanent joint deformity and decreased motion. (In addition to causing the tophi associated with gout, hyperuricemia can also cause **kidney stones**, also called renal calculi or uroliths.)

Gout affects an estimated one million Americans. It most commonly afflicts men (800,000 men versus 200,000 women). Uric-acid levels tend to increase in men at **puberty**, and, because it takes 20 years of hyperuricemia to cause gout symptoms, men commonly develop gout in their late 30s or early 40s. Women more typically develop gout later in life, starting in their 60s. According to some medical experts, estrogen protects against hyperuricemia, and when estrogen levels fall during **menopause**, urate crystals can begin to build up in the joints. Excess body weight, regular excessive alcohol intake, the use of blood pressure medications called **diuretics**, and high levels of certain fatty substances in the blood (serum triglycerides) associated with an increased risk of heart disease can all increase a person's risk of developing gout.

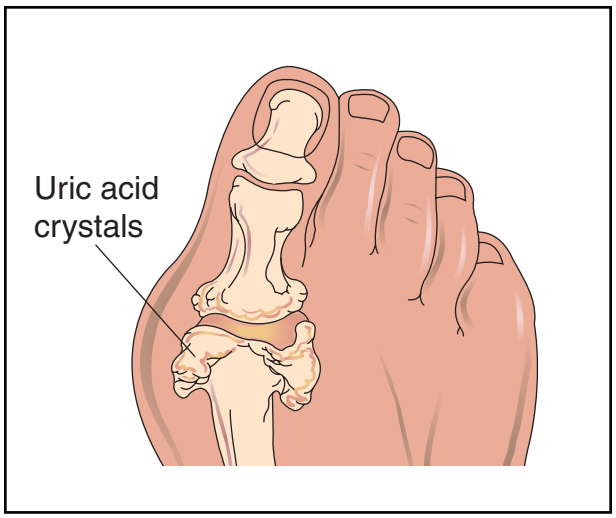
Diagnosis

Usually, physicians can diagnose gout based on the **physical examination** and medical history (the patient's description of symptoms and other information). Doctors can also administer a test that measures the level of uric acid in the blood. While normal uric acid levels don't necessarily rule out gout and high levels don't confirm it, the presence of hyperuricemia increases the likelihood of gout. The development of a tophus can confirm the diagnosis of gout. The most definitive way to diagnose gout is to take a sample of fluid from the joint and test it for urate crystals.

Treatment

The goals of treatment for gout consist of alleviating pain, avoiding severe attacks in the future, and preventing long-term joint damage. In addition to taking pain medications as prescribed by their doctors, people having gout attacks are encouraged to rest and to increase the amount of fluids that they drink.

Acute attacks of gout can be treated with nonaspirin, **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as naproxen sodium (Aleve), ibuprofen (Advil), or



Gout, a form of acute arthritis, most commonly occurs in the big toe. It is caused by high levels of uric acid in the blood, in which urate crystals settle in the tissues of the joints and produce severe pain and swelling. *(Illustration by Electronic Illustrators Group.)*

indomethacin (Indocin). In some cases, these drugs can aggravate a peptic ulcer or existing kidney disease and cannot be used. Doctors sometimes also use colchicine (Colbenemid), especially in cases where nonsteroidal anti-inflammatory drugs cannot be used. Colchicine may cause **diarrhea**, which tends to go away once the patient stops taking it. **Corticosteroids** such as prednisone (Deltasone) and adrenocorticotropic hormone (Acthar) may be given orally or may be injected directly into the joint for a more concentrated effect. While all of these drugs have the potential to cause side effects, they are used for only about 48 hours and are not likely to cause major problems. However, **aspirin** and closely related drugs (salicylates) should be avoided because they can ultimately worsen gout.

Once an acute attack has been successfully treated, doctors try to prevent future attacks of gout and long-term joint damage by lowering uric acid levels in the blood. There are two types of drugs for correcting hyperuricemia. Uricosuric drugs, such as probenecid (Benemid) and sulfinpyrazone (Anturane), lower the levels of urate in the blood by increasing its removal from the body (excretion) through the urine. These drugs may promote the formation of kidney stones, and they may not work for all patients, especially those with kidney disease. Allopurinol (Zyloprim), a type of drug called a xanthine-oxidase inhibitor, blocks the production of urate in the body, and can dissolve kidney stones as well as treating gout. The potential side effects of allopurinol include rash, a skin condition known as **dermatitis**, and liver

KEY TERMS

Allopurinol—A drug that corrects hyperuricemia by inhibiting urate production.

Colchicine—A drug used to treat painful flare-ups of gout.

Corticosteroids—Medications related to a natural body hormone called hydrocortisone, which are used to treat inflammation.

Hyperuricemia—High levels of a waste product called uric acid in the blood.

Probenecid—A drug that corrects hyperuricemia by increasing the urinary excretion of urate.

Purine—A substance found in foods that is broken down into urate and may contribute to hyperuricemia and gout.

Sulfinpyrazone—A drug that corrects hyperuricemia by increasing the urinary excretion of urate.

Synovial fluid—Fluid surrounding the joints which acts as a lubricant, reducing the friction between the joints.

Urate crystals—Crystals formed by high levels of uric acid in the blood.

dysfunction. Once people begin taking these medications, they must take them for life or the gout will continue to return.

Alternative treatment

The alternative medicine approach to gout focuses on correcting hyperuricemia by losing weight and limiting the intake of alcohol and purine-rich foods. In addition, consuming garlic (*Allium sativum*) has been recommended to help prevent gout. Increasing fluid intake, especially by drinking water, is also recommended. During an acute attack, contrast **hydrotherapy** (alternating three-minute hot compresses with 30-second cold compresses) can help dissolve the crystals and resolve the pain faster.

Prognosis

Gout cannot be cured but usually it can be managed successfully. As tophi dissolve, joint mobility generally improves. (In some cases, however, medicines alone do not dissolve the tophi and they must be removed surgically.) Lowering uric acid in the blood also helps to prevent or improve the kidney problems that may accompany gout.

Prevention

For centuries, gout has been known as a "rich man's disease" or a disease of overindulgence in food and drink. While this view is perhaps a little overstated and oversimplified, lifestyle factors clearly influence a person's risk of developing gout. Since **obesity** and excessive alcohol intake are associated with hyperuricemia and gout, losing weight and limiting alcohol intake can help ward off gout. **Dehydration** may also promote the formation of urate crystals, so people taking diuretics or "water pills" may be better off switching to another type of blood pressure medication, and everyone should be sure to drink at least six to eight glasses of water each day. Since purine is broken down in the body into urate, it may also be helpful to avoid foods high in purine, such as organ meats, sardines, anchovies, red meat, gravies, beans, beer, and wine.

Resources

BOOKS

Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Puyallup, WA: Future Medicine Publishing, Inc., 1993.

PERIODICALS

Conos, Juan J., and Robert A. Kalish. "Gout: Effective drug therapy for acute attacks and for the long term." *Consultant* (Aug. 1996): 1752-55.

Emmerson, Bryan T. "The Management of Gout." *New England Journal of Medicine* (15 Feb. 1996): 445-51.

Flieger, Ken. "Getting to Know Gout." *FDA Consultant* (Mar. 1995): 19-22.

Sauber, Colleen M. "Still Painful After All These Years." *Harvard Health Letter* (June 1995): 6-8.

Smith, Michael L. "Gout, Hyperuricemia, and Crystal Arthritis." *British Medical Journal* (25 Feb. 1995): 521-24.

ORGANIZATIONS

Arthritis Foundation.1300 W. Peachtree St., Atlanta, GA 30309. (800) 283-7800. <http://www.arthritis.org>.

Gout drugs

Definition

Gout drugs are medicines that prevent or relieve the symptoms of gout, a disease that affects the joints and kidneys.

Purpose

Gout is a disease in which uric acid, a waste product that normally passes out of the body in urine, collects

and forms crystals in the joints and the kidneys. When uric acid crystals build up in the joints, the tissue around the joint becomes inflamed, and nerve endings in the area become irritated, causing extreme **pain**. Uric acid crystals in the kidneys can lead to **kidney stones** and eventually to kidney failure.

The symptoms of gout—severe pain, usually in the hand or foot (often at the base of the big toe), but sometimes in the elbow or knee—should be reported to a health care professional. If not treated, gout can lead to high blood pressure, deformed joints, and even **death** from kidney failure. Fortunately, the condition is easily treated. For patients who have just had their first attack, physicians may prescribe only medicine to reduce the pain and inflammation, such as **nonsteroidal anti-inflammatory drugs**, **corticosteroids**, or colchicine. Patients may also be advised to change their eating and drinking habits, avoiding organ meats and other protein-rich foods, cutting out alcoholic beverages, and drinking more water. Some people never have another gout attack after the first. For those who do, physicians may prescribe additional drugs that either help the body get rid of uric acid or reduce the amount of uric acid the body produces. These drugs will not relieve gout attacks that already have started, but will help prevent attacks when taken regularly.

Description

Three main types of drugs are used in treating gout. Colchicine helps relieve the symptoms of gout by reducing inflammation. Allopurinol (Lopurin, Zyloprim) reduces the amount of uric acid produced in the body. Probenecid (Benemid, Probalan) and sulfinpyrazone (Anturane) help the body get rid of excess uric acid. Physicians may recommend that patients take more than one type of gout drug at the same time. Some of these medicines may also be prescribed for other medical conditions that are caused by too much uric acid in the body.

Recommended dosage

The recommended dosage depends on the type of gout drug. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take gout drugs exactly as directed. Never take larger or more frequent doses than recommended. Patients who are told to take more than one gout drug should carefully follow the physician's directions for taking all medicines.

Gout drugs such as allopurinol, probenecid, and sulfinpyrazone must be taken regularly to prevent gout attacks. The medicine may take some time to begin working, so gout attacks may continue for awhile after starting to take the drug. Continuing to take the drug is important, even if it does not seem to be working at first.

Colchicine may be taken regularly in low doses to help prevent gout attacks or in high doses for only a few hours at a time to relieve an attack. The chance of serious side effects is greater when this medicine is taken in high doses for short periods.

Precautions

Seeing a physician regularly while taking gout drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. Blood tests may be ordered to help the physician monitor how well the drug is working.

Drinking alcohol, including beer and wine, may increase the amount of uric acid in the body and may interfere with the effects of gout medicine. People with gout (or other conditions that result from excess uric acid) may need to limit the amount of alcohol they drink or stop drinking alcohol altogether.

Some people feel drowsy or less alert when taking gout drugs. Anyone who takes this type of medicine should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Some gout drugs may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Older people may be especially sensitive to the effects of colchicine. The drug may also stay in their bodies longer than it does in younger people. Both the increased sensitivity to the drug and the longer time for the drug to leave the body may increase the chance of side effects.

Special conditions

People who have certain medical conditions or who are taking certain other medicines can have problems if they take gout drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has ever had unusual reactions to gout drugs or to medicines used to relieve pain or inflammation should let his or her physician know before taking gout drugs. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

DIABETES. Some gout drugs may cause false results on certain urine sugar tests, but not on others. Diabetic patients who take gout drugs should check with their

physicians to find out if their medicine will affect the results of their urine sugar tests.

PREGNANCY. The effects of taking gout drugs during **pregnancy** are not fully understood. Women who are pregnant or who may become pregnant should check with their physicians before using gout drugs.

BREASTFEEDING. Gout drugs may pass into breast milk. Women who are taking this medicine and want to breastfeed their babies should check with their physicians.

OTHER MEDICAL CONDITIONS. Gout drugs may cause problems for people with certain medical conditions. For example, the risk of severe allergic reactions or other serious side effects is greater when people with these medical conditions take certain gout drugs:

- congestive heart disease
- high blood pressure
- blood disease
- diabetes
- kidney disease or kidney stones
- cancer being treated with drugs or radiation
- stomach or intestinal problems, including stomach ulcer (now or in the past)

Before using gout drugs, people with any of medical problems listed above should make sure their physicians are aware of their conditions.

USE OF CERTAIN MEDICINES. Taking gout drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

A skin rash that develops during treatment with gout drugs may be a sign of a serious and possibly life-threatening reaction. If any of these symptoms occur, stop taking the medicine and check with a physician immediately:

- skin rash, **itching**, or **hives**
- scaly or peeling skin
- chills, **fever**, **sore throat**, **nausea and vomiting**, yellow skin or eyes, joint pain, muscle aches or pains—especially if these symptoms occur at the same time or shortly after a skin rash

Patients taking colchicine should stop taking it immediately if they have **diarrhea**, stomach pain, nausea, or vomiting. If these symptoms continue for 3 hours or more after the medicine is stopped, check with a physician.

Other side effects of may also need medical attention. If any of the following symptoms occur while taking gout drugs, check with the physician who prescribed the medicine as soon as possible:

- pain in the side or lower back
- painful urination
- blood in the urine

Less serious side effects, such as **headache**, loss of appetite, and joint pain and inflammation usually go away as the body adjusts to the drug and do not need medical treatment.

Other side effects may occur. Anyone who has unusual symptoms while taking gout drugs should get in touch with his or her physician.

Interactions

Gout drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes gout drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with gout drugs are:

- **Aspirin** or other salicylates. These drugs may keep gout drugs from working properly.
- Nonsteroidal anti-inflammatory drugs such as indomethacin (Indocin) and ketoprofen (Orudis). Taking these medicines with probenecid may increase the chance of side effects from the nonsteroidal anti-inflammatory drugs.
- Blood thinners. When taken with blood thinners, such as warfarin (Coumadin), gout drugs may increase the chance of bleeding. A lower blood thinner dose may be necessary.
- Blood viscosity reducing medicines such as pentoxifylline (Trental). Taking this medicine with blood thinners may increase the chance of bleeding.
- Medicine for infections. Probenecid may increase the levels of these medicines in the blood. This may make the other medicine work better, but may also increase the risk of side effects.
- The immunosuppressant drug azathioprine (Imuran), used to prevent organ rejection in transplant patients and to treat **rheumatoid arthritis**. Taking this medicine with allopurinol can increase the risk of side effects from the azathioprine.
- Anticancer drugs such as mercaptopurine (Purinethol), plicamycin (Mithracin), and methotrexate (Rheumatrex). Taking this medicine with gout drugs may increase the risk of side effects from the anticancer drug.
- Antiretroviral drugs such as zidovudine (Retrovir). Probenecid may increase the level of this medicine in the blood. This may make side effects more likely.

KEY TERMS

Corticosteroids—Medicines that are similar to the natural hormone cortisone and belong to the family of drugs called steroids.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Kidney stone—A small, hard mass formed in the kidney from deposits of uric acid or other materials.

Nonsteroidal anti-inflammatory drug (NSAID)—A type of medicine used to relieve pain, swelling, and other symptoms of inflammation. Drugs in this group are not cortisone-like drugs (steroids).

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

- Antiseizure medicines such as Depakote (divalproex) and Depakene (valproic acid). Using these medicines with sulfinpyrazone may increase the chance of bleeding.

The list above does not include every drug that may interact with gout drugs. Be sure to check with a physician or pharmacist before combining gout drugs with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Gouty arthritis *see* **Gout**

Graft-vs.-host disease

Definition

Graft-vs.-host disease is an immune attack on the recipient by cells from a donor.

Description

The main problem with transplanting organs and tissues is that the recipient host does not recognize the new tissue as its own. Instead, it attacks it as foreign in the same way it attacks germs, to destroy it.

If immunogenic cells from the donor are transplanted along with the organ or tissue, they will attack the host, causing graft vs. host disease.

The only transplanted tissues that house enough immune cells to cause graft vs. host disease are the blood and the bone marrow. Blood transfusions are used every day in hospitals for many reasons. Bone marrow transplants are used to replace blood forming cells and immune cells. This is necessary for patients whose **cancer** treatment has destroyed their own bone marrow. Because bone marrow cells are among the most sensitive to radiation and **chemotherapy**, it often must be destroyed along with the cancer. This is true primarily of leukemias, but some other cancers have also been treated this way.

Causes and symptoms

Even if the donor and recipient are well matched, graft-vs.-host disease can still occur. There are many different elements involved in generating immune reactions, and each person is different, unless they are identical twins. Testing can often find donors who match all the major elements, but there are many minor ones that will always be different. How good a match is found also depends upon the urgency of the need and some good luck.

Blood **transfusion** graft-vs.-host disease affects mostly the blood. Blood cells perform three functions: carrying oxygen, fighting infections, and clotting. All of these cell types are decreased in a transfusion graft-vs.-host reaction, leading to anemia (lack of red blood cells in the blood), a decrease in resistance to infections, and an increase in bleeding. The reaction occurs between four to 30 days after the transfusion.

The tissues most affected by bone marrow graft-vs.-host disease are the skin, the liver, and the intestines. One form or the other occurs in close to half of the patients who receive bone marrow transplants.

Bone marrow graft-vs.-host disease comes in an acute and a chronic form. The acute form appears within two months of the transplant; the chronic form usually appears within three months. The acute disease produces a skin rash, liver abnormalities, and **diarrhea** that can be bloody. The skin rash is primarily a patchy thickening of the skin. Chronic disease can produce a similar skin rash, a tightening or an inflammation of the skin, lesions in the mouth, drying of the eyes and mouth, hair loss, liver damage, lung damage, and **indigestion**. The symptoms are similar to an autoimmune disease called **scleroderma**.

Both forms of graft-vs.-host disease bring with them an increased risk of infections, either because of the process itself or its treatment with cortisone-like drugs and immunosuppressives. Patients can die of liver failure, infection, or other severe disturbances of their system.

KEY TERMS

Anemia—Too few red blood cells, or too little hemoglobin in them.

Immunoglobulin—Chemicals in the blood that defend against infections.

Immunosuppressive—A chemical which suppresses an immune response.

Inflammation—The body's immune reaction to presumed foreign substances like germs. Inflammation is characterized by increased blood supply and activation of defense mechanisms. It produces redness, swelling, heat, and pain.

Lesion—Localized disease or damage.

Scleroderma—Progressive disease of the connective tissue of the skin and internal organs.

Treatment

Both the acute and the chronic disease are treated with cortisone-like drugs, immunosuppressive agents like cyclosporine, or with **antibiotics** and immune chemicals from donated blood (gamma globulin). Infection with one particular virus, called cytomegalovirus (CMV) is so likely a complication that some experts recommend treating it ahead of time.

Prognosis

Children with acute leukemias have greatly benefited from the treatment made possible by **bone marrow transplantation**. Survival rates have climbed by 15–50%. It is an interesting observation that patients who develop graft-vs.-host disease are less likely to have a recurrence of the leukemia that was being treated. This phenomenon is called graft-vs.-leukemia.

Bone marrow transplant patients who do not have a graft-vs.-host reaction gradually return to normal immune function in a year. A graft-vs.-host reaction may prolong the diminished immune capacity indefinitely, requiring supplemental treatment with immunoglobulins (gamma globulin).

Somehow the grafted cells develop a tolerance to their new home after six to 12 months, and the medications can be gradually withdrawn. Graft-vs.-host disease is not the only complication of blood transfusion or bone marrow transplantation. Host-vs.-graft or rejection is also common and may require a repeat transplant with another donor organ. Infections are a constant threat in bone marrow transplant because of the disease being treated, the prior radiation or chemotherapy and the medications used to treat the transplant.

Prevention

For recipients of blood transfusions who are especially likely to have graft-vs.-host reactions, the red blood cells can safely be irradiated (using x rays) to kill all the immune cells. The red blood cells are less sensitive to radiation and are not harmed by this treatment.

Much current research is directed towards solving the problem of graft-vs.-host disease. There are efforts to remove the immunogenic cells from the donor tissue, and there are also attempts to extract and purify bone marrow cells from the patient before treating the cancer. These cells are then given back to the patient after treatment has destroyed all that were left behind.

Resources

BOOKS

Armitage, James O. "Bone Marrow Transplantation." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Menitove, Jay E. "Blood Transfusion." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Rappeport, Joel. "Bone Marrow Transplantation." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Ruscetti, Francis W., Jonathan R. Keller, and Dan L. Longo. "Hematopoiesis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

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Grafts and grafting *see* **Bone grafting; Coronary artery bypass graft surgery; Graft-vs.-host disease; Skin grafting**

Granular conjunctivitis *see* **Trachoma**

Granulocytic ehrlichiosis *see* **Ehrlichiosis**

Granulocytopenia *see* **Neutropenia**

Granuloma inguinale

Definition

Granuloma inguinale is a sexually transmitted infection that affects the skin and mucous membranes of the anal and genital areas. Its name is derived from granulo-

ma, a medical term for a mass or growth of granulation tissue, and *inguinale*, a Latin word that means located in the groin. Granulation tissue is tissue formed during wound healing that is rich in blood capillaries and has a rough or lumpy surface.

Description

Granuloma inguinale is a chronic infection with frequent relapses caused by a rod-shaped bacterium. It occurs worldwide but is most common in tropical or subtropical countries, where it is associated with poverty and poor hygiene. As many as 20% of male patients with **sexually transmitted diseases** (STDs) in tropical countries have granuloma inguinale. The disease is less common in the United States, with fewer than 100 reported cases per year. Most patients are between the ages of 20 and 40 years, with a 2:1 male-to-female ratio.

Although granuloma inguinale is relatively uncommon in the United States in comparison with other STDs, it is still a significant public health problem. It can be acquired through casual sexual contacts when traveling abroad. Moreover, patients with granuloma inguinale are vulnerable to superinfection (infection by other disease agents) with other STDs, especially **syphilis**. Patients with granuloma inguinale are also a high-risk group for Acquired Immune Deficiency Syndrome (**AIDS**) transmission, because the disease causes open genital ulcers that can be easily invaded by the AIDS virus.

Granuloma inguinale is spread primarily through heterosexual and male homosexual contact; however, its occurrence in children and sexually inactive adults indicates that it may also be spread by contact with human feces. Granuloma inguinale is not highly contagious; however, persons with weakened immune systems are at greater risk of infection.

Causes and symptoms

Granuloma inguinale, which is sometimes called donovanosis, is caused by *Calymmatobacterium granulomatis*, a rod-shaped bacterium formerly called *Donovania granulomatis*. The bacterium has an incubation period ranging from eight days to 12 weeks, with an average of two to four weeks. The disease has a slow and gradual onset, beginning with an inconspicuous pimple or lumpy eruption on the skin. In 90% of patients, the initial sign of infection is in the genital region, but a minority of patients will develop the sore in their mouth or anal area if their sexual contact involved those parts of the body. Many patients do not notice the sore because it is small and not usually painful. In some women, the first symptom of granuloma inguinale is bleeding from the genitals.

The initial pimple or sore is typically followed by three stages of disease. In the first stage, the patient develops a mass of pink or dull red granulation tissue in the area around the anus. In the second stage, the bacteria erode the skin to form shallow, foul-smelling ulcers which spread from the genital and anal areas to the thighs and lower abdomen. The edges of the ulcers are marked by granulation tissue. In the third stage, the ulcerated areas form deep masses of keloid or scar tissue that may spread slowly for many years.

Patients with long-term infections are at risk for serious complications. The ulcers in second-stage granuloma inguinale often become superinfected with syphilis or other STD organisms. Superinfected ulcers become painful to touch, filled with pus and dead tissue, and are much more difficult to treat. There may be sizable areas of tissue destruction in superinfected patients. In addition, the scar tissue produced by third-stage infection can grow until it closes off parts of the patient's urinary tract. It is also associated with a higher risk of genital **cancer**.

Diagnosis

The most important aspect of diagnosis is distinguishing between granuloma inguinale and other STDs, particularly since many patients will be infected with more than one STD. Public health officials recommend that patients tested for granuloma inguinale be given a blood test for syphilis as well. In addition, the doctor will need to distinguish between granuloma inguinale and certain types of skin cancer, **amebiasis**, fungal infections, and other bacterial ulcers. The most significant distinguishing characteristic of granuloma inguinale is the skin ulcer, which is larger than in most other diseases, painless, irregular in shape, and likely to bleed when touched.

The diagnosis of granuloma inguinale is made by finding Donovan bodies in samples of the patient's skin tissue. Donovan bodies are oval rod-shaped organisms that appear inside infected tissue cells under a microscope. The doctor obtains a tissue sample either by cutting a piece of tissue from the edge of an skin ulcer with a scalpel or by taking a punch biopsy. To make a punch biopsy, the doctor will inject a local anesthetic into an ulcerated area and remove a piece of skin about 1/16 of an inch in size with a surgical skin punch. The tissue sample is then air-dried and stained with Wright's stain, a chemical that will cause the Donovan bodies to show up as dark purple safety pin-shaped objects inside lighter-staining capsules.

Treatment

Granuloma inguinale is treated with oral **antibiotics**. Three weeks of treatment with erythromycin, strepto-

KEY TERMS

Donovan bodies—Rod-shaped oval organisms found in tissue samples from patients with granuloma inguinale. Donovan bodies appear deep purple when stained with Wright's stain.

Granulation tissue—A kind of tissue formed during wound healing, with a rough or irregular surface and a rich supply of blood capillaries.

Granuloma—An inflammatory swelling or growth composed of granulation tissue, as in granuloma inguinale.

Keloid—An unusual or abnormal growth of scar tissue, as in the third stage of granuloma inguinale.

Punch biopsy—A method of obtaining skin samples under local anesthesia using a surgical skin punch.

Superinfection—A condition in which a patient with a contagious disease acquires a second infection, as when a patient with granuloma inguinale is also infected with syphilis.

Wright's stain—A chemical used to stain tissue samples for laboratory analysis.

mycin, or tetracycline, or 12 weeks of treatment with ampicillin are standard forms of therapy. Although the skin ulcers will start to show signs of healing in about a week, the patient must take the full course of medication to minimize the possibility of relapse.

Prognosis

Most patients with granuloma inguinale recover completely, although superinfected ulcers may require lengthy courses of medication. Early treatment prevents the complications associated with second- and third-stage infection.

Prevention

Prevention of granuloma inguinale has three important aspects:

- Avoidance of casual sexual contacts, particularly among homosexual males, in countries with high rates of the disease
- Tracing and examination of an infected person's recent sexual contacts
- Monitoring the patient's ulcers or scar tissue for signs of reinfection for a period of six months after antibiotic treatment

Resources

BOOKS

Chambers, Henry F. "Infectious Diseases: Bacterial & Chlamydial." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Goens, Jean L., et al. "Granuloma Inguinale." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Hunt, Thomas K., and Reid V. Mueller. "Inflammation, Infection, and Antibiotics." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

"Infectious Disease: Sexually Transmitted Diseases." In *The Merck Manual of Diagnosis and Therapy.* 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

Rebecca J. Frey

Granulomatous ileitis *see* **Crohn's disease**

Graves' disease *see* **Hyperthyroidism**

Greenfield filter *see* **Vena cava**

Grippe *see* **Influenza**

Group A streptococcus infection *see* **Streptococcal infections**

Group B streptococcus infection *see* **Streptococcal infections**

Group therapy

Definition

Group therapy is a form of psychosocial treatment where a small group of patients meet regularly to talk, interact, and discuss problems with each other and the group leader (therapist).

Purpose

Group therapy attempts to give individuals a safe and comfortable place where they can work out problems and emotional issues. Patients gain insight into their own thoughts and behavior, and offer suggestions and support to others. In addition, patients who have a difficult time

with interpersonal relationships can benefit from the social interactions that are a basic part of the group therapy experience.

Precautions

Patients who are suicidal, homicidal, psychotic, or in the midst of a major acute crisis are typically not referred for group therapy until their behavior and emotional state have stabilized. Depending on their level of functioning, cognitively impaired patients (like patients with organic brain disease or a traumatic brain injury) may also be unsuitable for group therapy intervention. Some patients with sociopathic traits are not suitable for most groups.

Description

A psychologist, psychiatrist, social worker, or other healthcare professional typically arranges and conducts group therapy sessions. In some therapy groups, two co-therapists share the responsibility of group leadership. Patients are selected on the basis of what they might gain from group therapy interaction and what they can contribute to the group as a whole.

Therapy groups may be homogeneous or heterogeneous. Homogeneous groups have members with similar diagnostic backgrounds (for example, they may all suffer from depression). Heterogeneous groups have a mix of individuals with different emotional issues. The number of group members varies widely, but is typically no more than 12. Groups may be time limited (with a predetermined number of sessions) or indefinite (where the group determines when therapy ends). Membership may be closed or open to new members once sessions begin.

The number of sessions in group therapy depends on the makeup, goals, and setting of the group. For example, a therapy group that is part of a substance abuse program to rehabilitate inpatients would be called short-term group therapy. This term is used because, as patients, the group members will only be in the hospital for a relatively short period of time. Long-term therapy groups may meet for six months, a year, or longer. The therapeutic approach used in therapy depends on the focus of the group and the psychological training of the therapist. Some common techniques include psychodynamic, cognitive-behavioral, and **Gestalt therapy**.

In a group therapy session, group members are encouraged to openly and honestly discuss the issues that brought them to therapy. They try to help other group members by offering their own suggestions, insights, and empathy regarding their problems. There are no definite rules for group therapy, only that members participate to the best of their ability. However, most therapy groups do have some basic ground rules that are usually discussed during the first session. Patients are asked not to share what goes on in therapy sessions with anyone outside of the group. This protects the confidentiality of the other members. They may also be asked not to see other group members socially outside of therapy because of the harmful effect it might have on the dynamics of the group.

The therapist's main task is to guide the group in self-discovery. Depending on the goals of the group and the training and style of the therapist, he or she may lead the group interaction or allow the group to take their own direction. Typically, the group leader does some of both, providing direction when the group gets off track while letting them set their own agenda. The therapist may guide the group by simply reinforcing the positive behaviors they engage in. For example, if a group member shows empathy to another member, or offers a constructive suggestion, the therapist will point this out and explain the value of these actions to the group. In almost all group therapy situations, the therapist will attempt to emphasize the common traits among group members so that members can gain a sense of group identity. Group members realize that others share the same issues they do.

The main benefit group therapy may have over individual psychotherapy is that some patients behave and react more like themselves in a group setting than they would one-on-one with a therapist. The group therapy patient gains a certain sense of identity and social acceptance from their membership in the group. Suddenly, they are not alone. They are surrounded by others who have the same anxieties and emotional issues that they have. Seeing how others deal with these issues may give them new solutions to their problems. Feedback from group members also offers them a unique insight into their own behavior, and the group provides a safe forum in which to practice new behaviors. Lastly, by helping others in the group work through their problems, group therapy members can gain more self-esteem. Group therapy may also simulate family experiences of patients and will allow family dynamic issues to emerge.

Self-help groups like Alcoholics Anonymous and Weight Watchers fall outside of the psychotherapy realm. These self-help groups do offer many of the same benefits of social support, identity, and belonging that make group therapy effective for many. Self-help group members meet to discuss a common area of concern (like **alcoholism**, eating disorders, bereavement, parenting). Group sessions are not run by a therapist, but by a non-professional leader, group member, or the group as a whole. Self-help groups are sometimes used in addition to psychotherapy or regular group therapy.

Group therapy is practiced in a variety of settings, including both inpatient and outpatient facilities, and is used to treat anxiety, mood, and personality disorders as well as psychoses. *(Photo Researchers, Inc. Reproduced by permission.)*

Preparation

Patients are typically referred for group therapy by a psychologist or psychiatrist. Some patients may need individual therapy first. Before group sessions begin, the therapist leading the session may conduct a short intake interview with the patient to determine if the group is right for the patient. This interview will also allow the therapist to determine if the addition of the patient will benefit the group. The patient may be given some preliminary information on the group before sessions begin. This may include guidelines for success (like being open, listening to others, taking risks), rules of the group (like maintaining confidentiality), and educational information on what group therapy is about.

Aftercare

The end of long-term group therapy may cause feelings of grief, loss, abandonment, anger, or rejection in some members. The group therapist will attempt to foster a sense of closure by encouraging members to explore their feelings and use newly acquired coping techniques to deal with them. Working through this termination phase of group therapy is an important part of the treatment process.

Risks

Some very fragile patients may not be able to tolerate aggressive or hostile comments from group members. Patients who have trouble communicating in group situations may be at risk for dropping out of group therapy. If no one comments on their silence or makes an attempt to interact with them, they may begin to feel even more isolated and alone instead of identifying with the group. Therefore, the therapist usually attempts to encourage silent members to participate early on in treatment.

Normal results

Studies have shown that both group and individual psychotherapy benefit about 85% of the patients that participate in them. Optimally, patients gain a better understanding of themselves, and perhaps a stronger set of interpersonal and coping skills through the group therapy process. Some patients may continue therapy after group therapy ends, either individually or in another group setting.

KEY TERMS

Cognitive-behavioral—A therapy technique that focuses on changing beliefs, images, and thoughts in order to change maladjusted behaviors.

Gestalt—A humanistic therapy technique that focuses on gaining an awareness of emotions and behaviors in the present rather than in the past.

Psychodynamic—A therapy technique that assumes improper or unwanted behavior is caused by unconscious, internal conflicts and focuses on gaining insight into these motivations.

Resources

BOOKS

Bernard, Harold S., and K. Roy MacKenzie, eds. *Basics of Group Psychotherapy.* New York: The Guilford Press, 1994.

Flores, Philip J. *Group Psychotherapy with Addicted Populations: An Integration of Twelve-Step and Psychodynamic Theory.* 2nd ed. New York: The Haworth Press, 1997.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

Paula Anne Ford-Martin

Growth hormone suppression test *see* **Growth hormone tests**

Growth hormone tests

Definition

Growth hormone (hGH), or somatotropin, is a hormone responsible for normal body growth and development by stimulating protein production in muscle cells and energy release from the breakdown of fats. Tests for growth hormone include Somatotropin hormone test, Somatomedin C, Growth hormone suppression test (glucose loading test), and Growth hormone stimulation test (Arginine test or Insulin tolerance test).

Purpose

Growth hormone tests are ordered for the following reasons:

- to identify growth deficiencies, including delayed **puberty** and small stature in adolescents which can result from pituitary or thyroid malfunction
- to aid in the diagnosis of hyperpituitarism that is evident in gigantism or acromegaly
- to screen for inadequate or reduced pituitary gland function
- to assist in the diagnosis of **pituitary tumors** or tumors related to the hypothalamus, an area of the brain
- to evaluate hGH therapy

Precautions

Taking certain drugs such as amphetamines, dopamine, **corticosteroids**, and phenothiazines may increase and decrease growth hormone secretion, respectively. Other factors influencing hGH secretion include **stress**, **exercise**, diet, and abnormal glucose levels. These tests should not be done within a week of any radioactive scan.

Description

Several hormones play important roles in human growth. The major human growth hormone (hGH), or somatotropin, is a protein made up of 191 amino acids which is secreted by the anterior pituitary gland and coordinates normal growth and development. Human growth is characterized by two spurts, one at birth and the other at puberty. hGH plays an important role at both of these times. Normal individuals have measurable levels of hGH throughtout life. Yet levels of hGH fluctuate during the day and are affected by eating and exercise. Receptors which respond to hGH exist on cells and tissues throughout the body. The most obvious effect of hGH is on linear skeletal development. But the metabolic effects of hGH on muscle, the liver, and fat cells are critical to its function. Humans have two forms of hGH, and the functional difference between the two is unclear. They are both formed from the same gene, but one lacks the amino acids in positions 32–46.

hGH is produced in the anterior portion of the pituitary gland by somatotrophs under the control of hormonal signals in the hypothalamus. Two hypothalamic hormones regulate hGH; they are growth hormone-releasing hormone (GHRH) and growth hormone—inhibiting hormone (GHIH). When blood glucose levels fall, GHRH triggers the secretion of stored hGH. As blood glucose levels rise, GHRH release is turned off. Increases in blood protein levels trigger a similar response. As a result of this hypothalamic feedback loop, hGH levels fluctuate throughout the day. Normal plasma hGH levels 1–3 ng/ML with peaks as high as 60 ng/ML.

In addition, plasma glucose and amino acid availability for growth is also regulated by the hormones adrenaline, glucagon, and insulin.

Most hGH is released at night. Peak spikes of hGH release occur around 10 P.M., midnight, and 2 A.M. The logic behind this night-time release is that most of hGH's effects are mediated by other hormones, including the somatomedins, IGH-I and IGH-II. As a result, the effects of hGH are spread out more evenly during the day.

A number of hormonal conditions can lead to excessive or diminished growth. Because of its critical role in producing hGH and other hormones, an aberrant pituitary gland will often yield altered growth. Dwarfism (very small stature) can be due to underproduction of hGH, lack of IGH-I, or a flaw in target tissue response to either of these growth hormones. Overproduction of hGH or IGH-I, or an exaggerated response to these hormones can lead to gigantism or acromegaly, both of which are characterized by a very large stature.

Gigantism is the result of hGH overproduction in early childhood leading to a skeletal height up to 8 feet (2.5m) or more. Acromegaly results when hGH is overproduced after the onset of puberty. In this condition, the epiphyseal plates of the long bone of the body do not close, and they remain responsive to additional stimulated growth by hGH. This disorder is characterized by an enlarged skull, hands and feet, nose, neck, and tongue.

Somatrotropin

Somatrotropin is used to identify hGH deficiency in adolescents with short stature, delayed sexual maturity, and other growth deficiencies. It also aids in documenting excess hGH production that is responsible for gigantism or acromegaly, and confirms underactivity or overproduction of the pituitary gland (**hypopituitarism** or hyperpituitarism). However, due to the episodic secretion of hGH, as well as hGH production in response to stress, exercise, or other factors, random assays are not an adequate determination of hGH deficiency. To negate these variables and obtain more accurate readings, a blood sample can be drawn one to 1.5 hours after sleep (hGH levels increase during sleep), or strenuous exercise can be performed for 30 minutes before blood is drawn (hGH levels increase after exercise). The hGH levels at the end of an exercise period are expected to be maximal.

Somatomedin C

The somatomedin C test is usually ordered to detect pituitary abnormalities, hGH deficiency, and acromegaly. Also called insulin-like growth factor (IGF-1), somatomedin C is considered a more accurate reflection of the blood concentration of hGH because such variables as time of day, activity levels, or diet does not influence the results. Somatomedin C is part of a group of peptides, called somatomedins, through which hGH exerts its effects. Because it circulates in the bloodstream bound to long-lasting proteins, it is more stable than hGH. Levels of somatomedin C do depend on hGH levels, however. As a result, somatomedin C levels are low when hGH levels are deficient. Abnormally low test results of somatomedin C require an abnormally reduced or absent hGH during an hGH stimulation test in order to diagnose hGH deficiency. Nonpituitary causes of reduced somatomedin C include **malnutrition**, severe chronic illness, severe liver disease, **hypothyroidism**, and Laron's dwarfism.

Growth hormone stimulation test

The hGH stimulation test, also called hGH Provocation test, Insulin Tolerance, or Arginine test, is performed to test the body's ability to produce human growth hormone, and to identify suspected hGH deficiency. A normal patient can have low hGH levels, but if hGH is still low after stimulation, a diagnosis can be more accurately made.

Insulin-induced **hypoglycemia** (via intravenous injection of insulin) stimulates hGH and corticotropin secretion as well. If such stimulation is unsuccessful, then there is a malfunction of the anterior pituitary gland. Blood samples may be obtained following an energetic exercise session lasting 20 minutes.

A substance called hGH-releasing factor has recently been used for hGH stimulation. This approach promises to be more accurate and specific for hGH deficiency caused by the pituitary. Growth hormone deficiency is also suspected when x ray determination of bone age indicates retarded growth in comparison to chronologic age. At present, the best method to identify hGH-deficient patients is a positive stimulation test followed by a positive response to a therapeutic trial of hGH.

Growth hormone suppression test

Also called the glucose loading test, this procedure is used to evaluate excessive baseline levels of human growth hormone, and to confirm diagnosis of gigantism in children and acromegaly in adults. The procedure requires two different blood samples, one drawn before the administration of 100 g of glucose (by mouth), and a second sample two hours after glucose ingestion.

Normally, a glucose load suppresses hGH secretion. In a patient with excessive hGH levels, failure of suppression indicates anterior pituitary dysfunction and confirms a diagnosis of **acromegaly and gigantism**.

Preparation

Somatotropin: This test requires a blood sample. The patient should be **fasting** (nothing to eat or drink from midnight the night before the test). Stress and/or exercise increases hGH levels, so the patient should be at complete rest for 30 minutes before the blood sample is drawn. If the physician has requested two samples, they should be drawn on consecutive days at approximately the same time on both days, preferably between 6 AM and 8 AM.

Somatomedin C: This test requires a blood sample. The patient should have nothing to eat or drink from midnight the night before the test.

Growth hormone stimulation: This test requires intravenous administration of medications and the withdrawal of frequent blood samples, which are obtained at 0, 60, and 90 minutes after injection of arginine and/or insulin. The patient should have nothing to eat or drink after midnight the night before the test.

Growth hormone suppression: This test requires two blood samples, one before the test and another two hours after administration of 100 g of glucose solution by mouth. The patient should have nothing to eat or drink after midnight, and physical activity should be limited for 10–12 hours before the test.

Risks

Growth hormone stimulation: Only minor discomfort is associated with this test, and results from the insertion of the IV line and the low blood sugar (hypoglycemia) induced by the insulin injection. Some patients may experience sleepiness, sweating and/or nervousness, all of which can be corrected after the test by ingestion of cookies, juice, or a glucose infusion. Severe cases of hypoglycemia may cause ketosis (excessive amounts of fatty acid byproducts in the body), acidosis (a disturbance of the body's acid-base balance), or **shock**. With the close observation required for the test, these are unlikely.

Growth hormone suppression: Some patients experience nausea after the administration of this amount of glucose. Ice chips can alleviate this symptom.

Normal results

Normal results may vary from laboratory to laboratory but are usually within the following ranges:

Somatotropin:

- men: 5 ng/ml
- women: less than 10 ng/ml
- children: 0–10 ng/ml
- newborn: 10–40 ng/ml

KEY TERMS

Acromegaly—A rare disease resulting from excessive growth hormone caused by a benign tumor. If such a tumor develops within the first ten years of life, the result is gigantism (in which growth is accelerated) and not acromegaly. Symptoms include coarsening of the facial features, enlargement of the hands, feet, ears, and nose, jutting of the jaw, and a long face.

Dwarfism, pituitary—Short stature. When caused by inadequate amounts of growth hormone (as opposed to late growth spurt or genetics), hGH deficiency results in abnormally slow growth and short stature with normal proportions.

Gigantism—Excessive growth, especially in height, resulting from overproduction during childhood or adolescence of growth hormone by a pituitary tumor. Untreated, the tumor eventually destroys the pituitary gland, resulting in death during early adulthood. If the tumor develops after growth has stopped, the result is acromegaly, not gigantism.

Pituitary gland—The pituitary is the most important of the endocrine glands (glands that release hormones directly into the bloodstream). Sometimes referred to as the "master gland," the pituitary regulates and controls the activities of other endocrine glands and many body processes.

Somatomedin C:

- adult: 42–110 ng/ml

Child:

- 0–8 years: Girls 7–110 ng/ml; Boys 4–87 ng/ml
- 9–10 years: Girls 39–186 ng/ml; Boys 26–98 ng/ml
- 11–13 years: Girls 66–215 ng/ml; Boys 44–207 ng/ml
- 14–16 years: Girls 96–256 ng/ml; Boys 48 255 ng/ml

Growth hormone stimulation: greater than 10 ng/ml.

Growth hormone suppression: Normally, glucose suppresses hGH to levels of undetectable to 3 ng/ml in 30 minutes to two hours. In children, rebound stimulation may occur after two to five hours.

Abnormal results

Somatotropin hormone: Excess hGH is responsible for the syndromes of gigantism and acromegaly. Excess secretion is stimulated by **anorexia nervosa**, stress,

hypoglycemia, and exercise. Decreased levels are seen in hGH deficiency, dwarfism, hyperglycemia, **failure to thrive**, and delayed sexual maturity.

Somatomedin C: Increased levels contribute to the syndromes of gigantism and acromegaly. Stress, major surgery, hypoglycemia, **starvation**, and exercise stimulate hGH secretion, which in turn stimulates somatomedin C.

Growth hormone stimulation: Decreased levels are seen in pituitary deficiency and hGH deficiency. Diseases of the pituitary can result in failure of the pituitary to secrete hGH and/or all the pituitary hormones. As a result, the hGH stimulation test will fail to stimulate hGH secretion.

Growth hormone suppression: The acromegaly syndrome elevates base hGH levels to 75 ng/ml, which in turn are not suppressed to less than 5 ng/ml during the test. Excess hGH secretion may cause unchanged or rising hGH levels in response to glucose loading, confirming a diagnosis of acromegaly or gigantism. In such cases, verification of results is required by repeating the test after a one-day rest.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

G6PD deficiency *see* **Glucose-6-phosphate dehydrogenase deficiency**

Guaifenesin *see* **Expectorants**

Guided imagery

Definition

Guided imagery is the use of relaxation and mental visualization to improve mood and/or physical well-being.

Purpose

The connection between the mind and physical health has been well documented and extensively studied. Positive mental imagery can promote relaxation and reduce **stress**, improve mood, control high blood pressure, alleviate **pain**, boost the immune system, and lower cholesterol and blood sugar levels. Through guided imagery techniques, patients can learn to control functions normally controlled by the autonomic nervous system, such as heart rate, blood pressure, respiratory rate, and body temperature.

One of the biggest benefits of using guided imagery as a therapeutic tool is its availability. Imagery can be used virtually anywhere, anytime. It is also an equal opportunity therapy. Although some initial training in the technique may be required, guided imagery is accessible to virtually everyone regardless of economic status, education, or geographical location.

Guided imagery also gives individuals a sense of empowerment, or control. The technique is induced by a therapist who guides the patient. The resulting mental imagery used is solely a product of the individual's imagination. Some individuals have difficulty imagining. They may not get actual clear images but perhaps vague feelings about the guided journey. However these individuals' brains and nervous systems responses seem to be the same as those with more detailed imaginings.

Patients who feel uncomfortable "opening up" in a traditional therapist-patient session may feel more at ease with a self-directed therapy like guided imagery.

Description

Guided imagery is simply the use of one's imagination to promote mental and physical health. It can be self-directed, where the individual puts himself into a relaxed state and creates his own images, or directed by others. When directed by others, an individual listens to a therapist, video, or audiotaped exercise that leads him through a relaxation and imagery exercise. Some therapists also use guided imagery in group settings.

Guided imagery is a two-part process. The first component involves reaching a state of deep relaxation through breathing and muscle relaxation techniques. During the relaxation phase, the person closes her eyes and focuses on the slow, in and out sensation of breathing. Or, she might focus on releasing the feelings of tension from her muscles, starting with the toes and working up to the top of the head. Relaxation tapes often feature soft music or tranquil, natural sounds such as rolling waves and chirping birds in order to promote feelings of relaxation.

Once complete relaxation is achieved, the second component of the exercise is the imagery, or visualization, itself. There are a number of different types of guided imagery techniques, limited only by the imagination. Some commonly used types include relaxation imagery, healing imagery, pain control imagery, and mental rehearsal.

Relaxation imagery

Relaxation imagery involves conjuring up pleasant, relaxing images that rest the mind and body. These may be experiences that have already happened, or new situations.

Healing imagery

Patients coping with diseases and injuries can imagine **cancer** cells dying, **wounds** healing, and the body mending itself. Or, patients may picture themselves healthy, happy, and symptom-free. Another healing imagery technique is based on the idea of *qi*, or energy flow, an idea borrowed from **traditional Chinese medicine**. Chinese medicine practitioners believe that illness is the result of a blockage or slowing of energy flow in the body. Individuals may use guided imagery to imagine energy moving freely throughout the body as a metaphor for good health.

Pain control imagery

Individuals can control pain through several imagery techniques. One method is to produce a mental image of the pain and then transform that image into something less frightening and more manageable. Another is to imagine the pain disappearing, and the patient as completely pain-free. Or, one may imagine the pain as something over which he has complete control. For example, patients with back problems may imagine their pain as a high voltage electric current surging through their spine. As they use guided imagery techniques, they can picture themselves reaching for an electrical switch and turning down the power on the current to alleviate the pain.

Mental rehearsal

Mental rehearsal involves imagining a situation or scenario and its ideal outcome. It can be used to reduce **anxiety** about an upcoming situation, such as labor and delivery, surgery, or even a critical life event such as an important competition or a job interview. Individuals picture themselves going through each step of the anxiety-producing event and then successfully completing it.

Preparations

For a successful guided imagery session, individuals should select a quiet, relaxing location where there is a comfortable place to sit or recline. If the guided imagery session is to be prompted with an audiotape or videotape, a stereo, VCR, or portable tape player should be available. Some people find that quiet background music improves their imagery sessions.

The session, which can last anywhere from a few minutes to an hour, should be uninterrupted. Taking the phone off the hook and asking family members for solitude can ensure a more successful and relaxing session.

KEY TERMS

Aromatherapy—The therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being.

Autonomic nervous system—The part of the nervous system that controls so-called involuntary functions such as heart rate, salivary gland secretion, respiratory function, and pupil dilation.

Imagery combined with other relaxation techniques such as **yoga**, massage, or **aromatherapy** can greatly enhance the effects of these therapies. It can be done virtually anywhere.

Precautions

Because of the state of extreme relaxation involved in guided imagery, individuals should never attempt to use guided imagery while driving or operating heavy machinery.

Side effects

Guided imagery can induce sleepiness, and some individuals may fall asleep during a session. Other than this, there are no known adverse side effects to guided imagery.

Research and general acceptance

Use of guided imagery is a widely accepted practice among mental healthcare providers and is gaining acceptance as a powerful pain control tool across a number of medical disciplines. Results of a study conducted at The Cleveland Clinic Foundation and published in 1999 found that cardiac surgery patients who used a guided imagery tape prior to surgery experienced less pain and anxiety. These patients also left the hospital earlier following surgery than patients who used pain medication only.

Another study conducted by Harvard Medical School researchers found that for more than 200 patients undergoing invasive vascular or renal surgery, guided imagery controlled pain and anxiety more effectively than medication alone.

Resources

BOOKS

Battino, Rubin. *Guided Imagery and Other Approaches to Healing*. Carmarthen, United Kingdom: Crown House Publishing, 2000.

PERIODICALS

Lang, Elvira, et al. "Adjunctive non-pharmacological analgesia for invasive medical procedures: a randomized trial." *The Lancet*. 355, no. 9214, (April 2000): 1486-1490.

ORGANIZATIONS

The Academy for Guided Imagery. P.O. Box 2070, Mill Valley, CA 94942. (800) 726-2070.

OTHER

Brennan, Patricia. "Stress First Aid Kit." (Guided imagery audiotape set.) Available from Inside Out Publishing at (888) 727-3296 or <http://www.facingthedawn.com>.

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Guillain-Barré syndrome

Definition

Guillain-Barré syndrome (GBS) causes progressive muscle weakness and **paralysis** (the complete inability to use a particular muscle or muscle group), which develops over days or up to four weeks, and lasts several weeks or even months.

Description

The classic scenario in GBS involves a patient who has just recovered from a typical, seemingly uncomplicated viral infection. Symptoms of muscle weakness appear one to four weeks later. The most common preceding infections are cytomegalovirus, herpes, Epstein-Barr virus, and viral hepatitis. A gastrointestinal infection with the bacteria *Campylobacter jejuni* is also common and may cause a severe type of GBS from which it is particularly difficult to recover. About 5% of GBS patients have a surgical procedure as a preceding event. Patients with lymphoma, **systemic lupus erythematosus**, or **AIDS** have a higher than normal risk of GBS. Other GBS patients have recently received an immunization, while still others have no known preceding event. In 1976–77, there was a vastly increased number of GBS cases among people who had been recently vaccinated against the Swine flu. The reason for this phenomenon has never been identified, and no other flu vaccine has caused such an increase in GBS cases.

Causes and symptoms

The cause of the weakness and paralysis of GBS is the loss of myelin, which is the material that coats nerve cells (the loss of myelin is called demyelination). Myelin is an insulating substance which is wrapped around nerves in the body, serving to speed conduction of nerve impulses. Without myelin, nerve conduction slows or stops. GBS has a short, severe course. It causes inflammation and destruction of the myelin sheath, and it disturbs multiple nerves. Therefore, it is considered an acute inflammatory demyelinating polyneuropathy.

The reason for the destruction of myelin in GBS is unknown, although it is thought that the underlying problem is autoimmune in nature. An autoimmune disorder is one in which the body's immune system, trained to fight against such foreign invaders as viruses and bacteria, somehow becomes improperly programmed. The immune system becomes confused, and is not able to distinguish between foreign invaders and the body itself. Elements of the immune system are unleashed against areas of the body, resulting in damage and destruction. For some reason, in the case of GBS, the myelin sheath appears to become a target for the body's own immune system.

The first symptoms of GBS consist of muscle weakness (legs first, then arms, then face), accompanied by prickly, tingling sensations (paresthesias). Symptoms affect both sides of the body simultaneously, a characteristic that helps distinguish GBS from other causes of weakness and paresthesias. Normal reflexes are first diminished, then lost. The weakness eventually affects all the voluntary muscles, resulting in paralysis. When those muscles necessary for breathing become paralyzed, the patient must be placed on a mechanical ventilator which takes over the function of breathing. This occurs about 30% of the time. Very severely ill GBS patients may have complications stemming from other nervous system abnormalities which can result in problems with fluid balance in the body, severely fluctuating blood pressure, and heart rhythm irregularities.

Diagnosis

Diagnosis of GBS is made by looking for a particular cluster of symptoms (progressively worse muscle weakness and then paralysis), and by examining the fluid that bathes the brain and spinal canal through **cerebrospinal fluid (CSF) analysis**. This fluid is obtained by inserting a needle into the lower back (lumbar region). When examined in a laboratory, the CSF of a GBS patient will reveal a greater-than-normal quantity of protein, with normal numbers of white blood cells and a normal amount of sugar. Electrodiagnostic studies may show slowing or block of conduction in nerve endings in parts of the body other than the brain. Minor abnormalities will be present in 90% of patients.

Treatment

There is no direct treatment for GBS. Instead, treatments are used that support the patient with the disabili-

ties caused by the disease. The progress of paralysis must be carefully monitored, in order to provide mechanical assistance for breathing if it becomes necessary. Careful attention must also be paid to the amount of fluid the patient is taking in by drinking and eliminating by urinating. Blood pressure, heart rate, and heart rhythm also must be monitored.

A procedure called **plasmapheresis**, performed early in the course of GBS, has been shown to shorten the course and severity of GBS. Plasmapheresis consists of withdrawing the patient's blood, passing it through an instrument that separates the different types of blood cells, and returning all the cellular components (red and white blood cells and platelets) along with either donor plasma or a manufactured replacement solution. This is thought to rid the blood of the substances that are attacking the patient's myelin.

It has also been shown that the use of high doses of immunoglobulin given intravenously (by drip through a needle in a vein) may be just as helpful as plasmapheresis. Immunoglobulin is a substance naturally manufactured by the body's immune system in response to various threats. It is interesting to note that corticosteroid medications (such as prednisone), often the mainstay of anti-autoimmune disease treatment, are not only unhelpful, but may in fact be harmful to patients with GBS.

Prognosis

About 85% of GBS patients make reasonably good recoveries. However, 30% of adult patients, and a greater percentage of children, never fully regain their previous level of muscle strength. Some of these patients suffer from residual weakness, others from permanent paralysis. About 10% of GBS patients begin to improve, then suffer a relapse. These patients suffer chronic GBS symptoms. About 5% of all GBS patients die, most from cardiac rhythm disturbances.

Patients with certain characteristics tend to have a worse outcome. These include people of older age, those who required breathing support with a mechanical ventilator, and those who had their worst symptoms within the first seven days.

Prevention

Because so little is known about what causes GBS to develop, there are no known methods of prevention.

Resources

BOOKS

Bosch, E. P., and H. Mitsumoto. "Disorders of Peripheral Nerves." In *Neurology in Clinical Practice: The Neurological Disorders*, ed. Walter G. Bradley, et al. Boston: Butterworth-Heinemann, 1996.

Griffin, J. W. "Immune-Mediated Neuropathies." In *Cecil Essentials of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Guberman, A. *An Introduction to Clinical Neurology.* Boston: Little, Brown and Co., 1994.

PERIODICALS

Fulgham, J. R. "Guillain-Barré syndrome." *Critical Care Clinics* (Jan. 1997): 1-15.

Rees, J. H. "Campylobacter jejuni Infection and Guillain-Barré Syndrome." *New England Journal of Medicine* (23 Nov. 1995): 1374-79.

Stern, V. "Terror of the Unknown." *The Guardian* (13 Feb. 1996): T10+.

Walling, A. D. "Comparisons of Treatments for Guillain-Barré Syndrome." *American Family Physician* (15 May 1997): 2510+.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Guillain-Barré Syndrome Foundation International. PO Box 262, Wynnewood, PA 19096. (610) 667-0131. (610) 667-0131. <http://www.webmast.com/gbs>.

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KEY TERMS

Autoimmune—The body's immune system directed against the body itself.

Demyelination—Disruption or destruction of the myelin sheath, leaving a bare nerve. Results in a slowing or stopping of impulses traveling along that nerve.

Inflammatory—Having to do with inflammation, the body's response to either invading foreign substances (such as viruses or bacteria) or to direct injury of body tissue.

Myelin—The substance that is wrapped around nerves, and which is responsible for speed and efficiency of impulses traveling through those nerves.

Guinea worm infection

Definition

Infection occurs when the parasitic guinea worm resides within the body. Infection is not apparent until a

pregnant female worm prepares to expel embryos. The infection is rarely fatal, but the latter stage is painful. The infection is also referred to as dracunculiasis, and less commonly as dracontiasis.

Description

Before the early 1980s, guinea worms infected 10–15 million people annually in central Africa and parts of Asia. By 1996, worldwide incidence of infection fell to fewer than 153,000 cases per year. Complete eradication of guinea worm infection is a goal of international water safety programs.

To survive, guinea worms require three things: water during the embryo stage, an intermediate host during early maturation, and a human host during adulthood. In bodies of water, such as ponds, guinea worm embryos are eaten by tiny, lobster-like water fleas. Once ingested, the embryos mature into larvae.

Humans become hosts by consuming water containing infected water fleas. Once in the human intestine, larvae burrow into surrounding tissue. After three to four months, the worms mate. Males die soon after, but pregnant females continue to grow. As adults, each threadlike worm can be three feet long and harbor three million embryos. More than one guinea worm can infect a person at the same time.

About eight months later, the female prepares to expel mature embryos by migrating toward the skin surface. Until this point, most people are unaware that they are infected. Extreme **pain** occurs as the worm emerges from under the skin, often around the infected person's ankle. The pain is temporarily relieved by immersing the area in water, an act that contaminates the water and starts the cycle again.

Causes and symptoms

Dracunculus medinensis, or guinea worm, causes infection. Symptoms are commonly absent until a pregnant worm prepares to expel embryos. By secreting an irritating chemical, the worm causes a blister to form on the skin surface. This chemical also causes nausea, vomiting, **dizziness**, and **diarrhea**. The blister is accompanied by a burning, stabbing pain and can form anywhere on the body; but, the usual site is the lower leg or foot. Once the blister breaks, an open sore remains until the worm has expelled all the embryos.

Diagnosis

Guinea worm infection is identified by the symptoms.

KEY TERMS

Guinea worm embryo—The guinea worm at its earliest life stage prior to or shortly after being expelled from an adult female worm.

Guinea worm larvae—The guinea worm during its middle life stage as it matures within a water flea. The larvae can only grow to adulthood within a human host.

Host—With regard to guinea worm infection, either the water flea or human from which the worm gets nourishment and shelter as it matures.

Secondary infection—An illness—typically caused by bacteria—that follows from a guinea worm infection.

Treatment

Most people infected with guinea worm rely on traditional medicine. The worm is extracted by gently and gradually pulling the worm out and winding it around a small strip of wood. Surgical removal is possible, but rarely done in rural areas. Extraction is complemented by herbs and oils to treat the wound site. Such treatment can ease extraction and may help prevent secondary infections.

Modern medicine offers safe surgical removal of the guinea worm, and drug therapy can prevent infection and pain. Using drugs to combat the worms has had mixed results.

Prognosis

If the worm is completely removed, the wound heals in approximately two to four weeks. However, if a worm emerges from a sensitive area, such as the sole of a foot, or if several worms are involved, healing requires more time. Recovery is also complicated if the worm breaks during extraction. Serious secondary infections frequently occur in such situations. There is the risk of permanent disability in some cases, and having one guinea worm infection does not confer immunity against future infections.

Prevention

Guinea worn infection is prevented by disrupting transmission. Wells and other protected water sources are usually safe from being contaminated with worm embryos. In open water sources, poisons may be used to kill water fleas. Otherwise, water must be boiled or filtered.

Resources

PERIODICALS

Hunter, John M. "An Introduction to Guinea Worm on the Eve of Its Departure: Dracunculiasis Transmission, Health Effects, Ecology and Control." *Social Science and Medicine* 43, no. 9 (1996): 1399.

OTHER

World Health Organization. 7 June 1998 <http://www.who.int/home-page/index.en.shtml>.

Julia Barrett

Gulf War syndrome

Definition

Gulf War syndrome describes a wide spectrum of illnesses and symptoms ranging from **asthma** to **sexual dysfunction** that have been reported by U.S. and U.S. allied soldiers who served in the Persian Gulf War in 1990–1991.

Description

Between 1994 and 1999, 145 federally funded research studies on Gulf War-related illnesses were undertaken at a cost of over $133 million. Despite this investment and the data collected from over 100,000 veterans who have registered with the Department of Defense (DOD) and/or Veterans Administration (VA) as having Gulf War-related illnesses, there is still much debate over the origin and nature of Gulf War syndrome. As of early 2001, the DOD has failed to establish a definite cause for the disorder. Veterans who have the illness experience a wide range of debilitating symptoms that elude a single diagnosis. Common symptoms include **fatigue**, trouble breathing, headaches, disturbed sleep, memory loss, and lack of concentration. Similar experiences among Gulf War veterans have been reported in the United Kingdom and Canada.

Causes and symptoms

There is much current debate over a possible causative agent for Gulf War syndrome other than the **stress** of warfare. Intensive efforts by the Veterans Administration and other public and private institutions have investigated a wide range of potential factors. These include chemical and biological weapons, the immunizations and preventive treatments used to protect against them, smoke from oil well fires, exposure to depleted uranium, and diseases endemic to the Arabian peninsula. So far investigators have not approached a consensus. In its final report released in December 2000, the Presidential Special Oversight Board for Department of Defense Investigations of Gulf War Chemical and Biological Incidents cited combat stress as a possible causative factor, but called for further research. There is also a likelihood that U.S. and allied forces were exposed to low levels of sarin and/or cyclosarin (nerve gases) released during the destruction of Iraqi munitions at Kharnisiyah, Iraq, and that these chemicals might be linked to the syndrome. In July 1997, the VA informed approximately 100,000 U.S. servicemen of their possible exposure to the nerve agents.

In October 1999, the U.S. Pentagon released a report that hypothesized that an experimental drug known as pyriostigmine bromide (PB) might be linked to the physical symptoms manifested in Gulf War Syndrome. The experimental drug was given to U.S. and Canadian troops during the war to protect soldiers against the effects of the chemical nerve agent soman. It has also been suggested that botulinum toxoid and **anthrax** vaccinations administered to soldiers during the conflict may be responsible for some manifestations of the syndrome.

Some studies have shown that Gulf War veterans have a higher incidence of positive tests for *Mycoplasma fermentans*, a bacteria, in their bloodstream. However, other clinical studies have not found a link between the bacterial infection and Gulf War-related illnesses.

Statistical analysis tells us that the following symptoms are about twice as likely to appear in Gulf War veterans than in their non-combat peers: depression, posttraumatic stress disorder (PTSD), chronic fatigue, cognitive dysfunction (diminished ability to calculate, order thoughts, evaluate, learn, and remember), **bronchitis**, asthma, **fibromyalgia**, alcohol abuse, **anxiety**, and sexual discomfort. PTSD is the modern equivalent of shell shock (World War I) and battle fatigue (World War II). It encompasses most of the psychological symptoms of war veterans, including nightmares, panic at sudden loud noises, and inability to adjust to peacetime living. **Chronic fatigue syndrome** has a specific medical definition that attempts to separate common fatigue from a more disabling illness in hope of finding a specific cause. Fibromyalgia is another newly defined syndrome, and as such it has arbitrarily rigid defining characteristics. These include a certain duration of illness, a specified minimum number of joint and muscle **pain** located in designated areas of the body, sleep disturbances, and other associated symptoms and signs.

Researchers have identified three distinct syndromes and several variations in Gulf War veterans. Type one patients suffer primarily from impaired thinking. Type

two patients have a greater degree of confusion and ataxia (loss of coordination). Type three patients were the most affected by joint pains, muscle pains, and extremity paresthesias (unnatural sensations like burning or tingling in the arms and legs). In each of the three types, researchers found different but measurable impairments on objective testing of neurological function. The business of the nervous system is much more complex and subtle than other body functions. Measuring it requires equally complex effort. The tests used in this study carefully measured and compared localized nerve performance at several different tasks against the same values in normal subjects. Brain wave response to noise and touch, eye muscle response to spinning, and caloric testing (stimulation of the ear with warm and cold water, which causes vertigo) were clearly different between the normal and the test subjects. The researchers concluded that there was "a generalized injury to the nervous system." Another research group concluded their study by stating that there was "a spectrum of neurologic injury involving the central, peripheral, and autonomic nervous systems."

Diagnosis

Until there is a clear definition of the disease, diagnosis is primarily an exercise in identifying those Gulf War veterans who have undefined illness in an effort to learn more about them and their symptoms. Both the Department of Defense and the Veterans Administration currently have programs devoted to this problem. Both the DOD's Comprehensive Clinical Evaluation Program and the VA's Persian Gulf Registry provide free, in-depth medical evaluations to Gulf War veterans and their families. In addition to providing individual veterans with critical medical care, these organizations use the cumulative data from these programs to advance research on Gulf War Syndrome itself.

Treatment

Specific treatment awaits specific diagnosis and identification of a causative agent. Meanwhile, veterans can benefit from the wide variety of supportive and nonspecific approaches to this and similar problems. There are many drugs available for symptomatic relief. Psychological counseling by those specializing in this area can be immensely beneficial, even life-saving for those contemplating suicide. Veterans' benefits are available for those who are impaired by their symptoms.

Alternative treatment

The symptoms can be worked with using many modalities of alternative health care. The key to working successfully with people living their lives with Gulf War syndrome is long-term, ongoing care, whether it be **hypnotherapy**, **acupuncture**, **homeopathy**, **nutrition**, vitamin/mineral therapy, or bodywork.

Experimental treatment with **antibiotics** is advocated by some healthcare professionals who believe that Gulf War illness is related to a *Mycoplasma fermentans* bacterial infection. However, a conclusive link has not been clinically proven.

KEY TERMS

Ataxia—Lack of coordination.

Caloric testing—Flushing warm and cold water into the ear stimulates the labyrinth and causes vertigo and nystagmus if all the nerve pathways are intact.

Endemic—Always there.

Paresthesia—An altered sensation often described as burning, tingling, or pin pricks.

Syndrome—Common features of a disease or features that appear together often enough to suggest they may represent a single, as yet unknown, disease entity. When a syndrome is first identified, an attempt is made to define it as strictly as possible, even to the exclusion of some cases, in order to separate out a pure enough sample to study. This process is most likely to identify a cause, a positive method of diagnosis, and a treatment. Later on, less typical cases can be considered.

Prognosis

The outlook for Persian Gulf War veterans is unclear, but will hopefully improve as more information is gathered about the illness. Gradual return to a functioning life may take many years of work and much help. It is important to note that even in the absence of an identifiable and curable cause, recovery is possible.

Resources

BOOKS

Isselbacher, Kurt, et al., ed. *Harrison's Principles of Internal Medicine* New York: McGraw-Hill, 1998, pp. 1955-1957.

Wheelwright, Jeff. *The Irritable Heart* New York: W.W. Norton & Co., 2001.

PERIODICALS

Knoke, James D. and Gregory C. Gray. "Hospitalizations for Unexplained Illnesses among U.S. Veterans of the Persian Gulf War." *Emerging Infectious Diseases*. 4(April/June 1998): 211-219.

"Self-reported illness and health status among Gulf War veterans. A population-based study. The Iowa Persian Gulf Study Group." *JAMA* 277 (January 15, 1997): 238-245.

ORGANIZATIONS

Office of the Special Assistant for Gulf War Illnesses. 5113 Leesburg Pike, Suite 901, Falls Church, VA, 22041. (703) 578-8518. <http://www.gulflink.osd.mil>.

The American Legion. Gulf War Veteran Issues. <http://www.legion.org/gulftoc.htm>.

U.S. Department of Defense. Comprehensive Clinical Evaluation Program (CCEP). (800)796-9699.

Veterans Administration. Persian Gulf Medical Information Helpline. 400 South 18th Street, St. Louis, Missouri 63103-2271. (800)749-8387.

Veterans Administration. Persian Gulf Registry. (800)PGW-VETS (800-749-8387). <http://www.va.gov/.

OTHER

Office of the Special Assistant for Gulf War Illnesses. *Fourth Annual Report: Office of the Special Assistant for Gulf War Illnesses.* Falls Church, VA: Office of the Special Assistant for Gulf War Illnesses, 2000. <http://www. gulflink.osd.mil/library/annual/4thannual_report_jan01.htm>.

Paula Anne Ford-Martin

Gum disease *see* **Periodontal disease**

Günther's disease *see* **Porphyrias**

Gynecomastia

Definition

Gyne refers to female, and mastia refers to the breast. Gynecomastia is strictly a male disease and is any growth of the adipose (fatty) and glandular tissue in a male breast. Not all breast growth in men is considered abnormal, just excess growth.

KEY TERMS

Androgen—Male sex hormone.

Cirrhosis—Diffuse scarring caused by alcohol or chronic hepatitis often leading to liver failure.

Estrogen—Sex hormone responsible for stimulating female sexual characteristics.

Klinefelter syndrome—A condition in a male characterized by having an extra X (female) chromosome and suffering from infertility and gynecomastia.

Thyroid—A gland in the neck that makes thyroxin. Thyroxin regulates the speed of metabolism.

Causes and symptoms

Breast growth is directed exclusively by female hormones—estrogens. Although men have some estrogen in their system, it is usually insufficient to cause much breast enlargement because it is counterbalanced by male hormones—androgens. Upsetting the balance, either by more of one or less of the other, results in the male developing female characteristics, breast growth being foremost.

At birth both male and female infants will have little breast buds from their mother's hormones. These recede until adolescence, when girls always, and boys sometimes, have breast growth. At this time, the boy's breast growth is minimal, often one-sided and temporary.

Extra or altered sex chromosomes can produce intersex problems of several kinds. Breast growth along with male genital development is seen in Klinefelter syndrome—the condition of having an extra X (female) chromosome—and a few other chromosomal anomalies. One of the several glands that produce hormones can malfunction for reasons other than chromosomes. Failure of androgen production is as likely to produce gynecomastia as overabundant estrogen production. Testicular failure and castration can also be a cause. Some cancers and some benign tumors can make estrogens. Lung **cancer** is known to increase estrogens.

If the hormone manufacturing organs are functioning properly, problems can still arise elsewhere. The liver is the principle chemical factory in the body. Other organs like the thyroid and kidneys also effect chemical processes. If any of these organs are diseased, a chemical imbalance can result that alters the manufacturing process. Men with **cirrhosis** of the liver will often develop gynecomastia from increased production of estrogens.

Finally, drugs can also cause breast enlargement. Estrogens are given to men to treat **prostate cancer** and a few other diseases. Marijuana and heroin, along with some prescription drugs, have estrogen effects in some men. On the list are methyldopa (for blood pressure), cimetidine (for peptic ulcers), diazepam (Valium), antidepressants, and spironolactone (a diuretic).

Diagnosis

Carefully feeling the area beneath the nipple of an adolescent boy with breast enlargement will reveal a discreet and sometimes tender lump the size of a fat nickel or quarter. For more serious gynecomastia, the underly-

ing disease will require evaluation, if it is not already well understood.

Treatment

This condition is usually not treated. If it is the result of endocrine disease, hormone manipulations may reduce the effects of the imbalance. There are a number of medical and surgical interventions possible. Radiation of misbehaving organs and cancers is considered an effective treatment.

Prognosis

The progress of gynecomastia is determined by its cause.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Fitzgerald, Paul A. "Endocrinology." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Wilson, Jean D. "Endocrine Disorders of the Breast." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

H

Habitual abortion *see* **Recurrent miscarriage**

Hair transplantation

Definition

Hair transplantation is a surgical procedure used to treat baldness or hair loss. Typically, tiny patches of scalp are removed from the back and sides of the head and implanted in the bald spots in the front and top of the head.

Purpose

Hair transplantation is a cosmetic procedure performed on men (and occasionally on women) who have significant hair loss, thinning hair, or bald spots where hair no longer grows. In men, hair loss and baldness are most commonly due to genetic factors (a tendency passed on in families) and age. Male pattern baldness, in which the hairline gradually recedes to expose more and more of the forehead, is the most common form. Men may also experience a gradual thinning of hair at the crown or very top of the skull. For women, hair loss is more commonly due to hormonal changes and is more likely to be a thinning of hair from the entire head. An estimated 50,000 men get transplants each year. Transplants can also be done to replace hair lost due to **burns**, injury, or diseases of the scalp.

Precautions

Although hair transplantation is a fairly simple procedure, some risks are associated with any surgery. It is important to inform the physician about any medications currently being used and about previous allergic reactions to drugs or anesthetic agents. Patients with blood clotting disorders also need to inform their physician before the procedure is performed.

Description

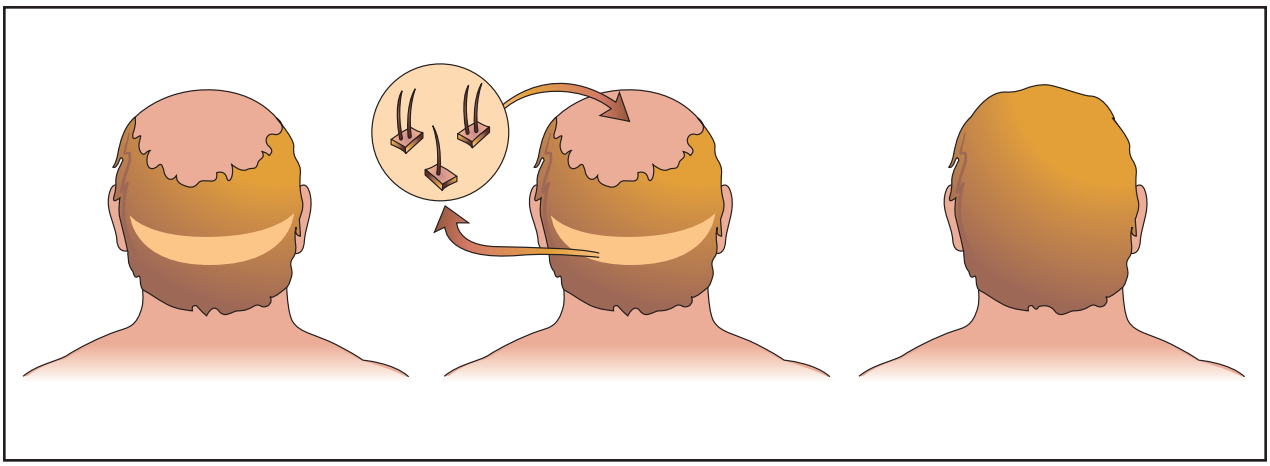
Hair transplantation surgery is performed by a physician in an office, clinic, or hospital setting. Each surgery lasts two to three hours during which approximately 250 grafts will be transplanted. A moderately balding man may require up to 1,000 grafts to get good coverage of a bald area, so a series of surgeries scheduled three to four months apart is usually required. The patient may be completely awake during the procedure with just a local anesthetic drug applied to numb the areas of the scalp. Some patients may be given a drug to help them relax or may be given an anesthetic drug that puts them to sleep.

The most common transplant procedure uses a thin strip of hair and scalp from the back of the head. This strip is cut into smaller clumps of five or six hairs. Tiny cuts are made in the balding area of the scalp and a clump is implanted into each slit. The doctor performing the surgery will attempt to recreate a natural looking hairline along the forehead. Minigrafts, micrografts, or implants of single hair follicles can be used to fill in between larger implant sites and can provide a more natural-looking hairline. The implants will also be arranged so that thick and thin hairs are interspersed and the hair will grow in the same direction.

Another type of hair replacement surgery is called scalp reduction. This involves removing some of the skin from the hairless area and "stretching" some of the nearby hair-covered scalp over the cut-away area.

Health insurance will not pay for hair transplants that are done for cosmetic reasons. Insurance may pay for hair replacement surgery to correct hair loss due to accident, burn, or disease.

It is important to be realistic about what the final result of a hair transplant will look like. This procedure does not create new hair, it simply redistributes the hair that the patient still has. Some research has been conducted where chest hair has been transplanted to the balding scalp, but this procedure is not widely practiced.



The most common hair transplant procedure involves taking small strips of scalp containing hair follicles from the donor area, usually at the sides or back of the head. These strips are then divided into several hundred smaller grafts. The surgeon relocates these grafts containing skin, follicle, and hair to tiny holes in the balding area by using microsurgical instruments or lasers. *(Illustration by Electronic Illustrators Group.)*

Preparation

It is important to find a respected, well-established, experienced surgeon and discuss the expected results prior to the surgery. The patient may need blood tests to check for bleeding or clotting problems and may be asked not to take **aspirin** products before the surgery. The type of anesthesia used will depend on how extensive the surgery will be and where it will be performed. The patient may be awake during the procedure, but may be given medication to help them relax. A local anesthetic drug which numbs the area will be applied or injected into the skin at the surgery sites.

Aftercare

The area may need to be bandaged overnight. The patient can return to normal activities; however, strenuous activities should be avoided in the first few days after the surgery. On rare occasions, the implants can be "ejected" from the scalp during vigorous **exercise**. There may be some swelling, bruising, **headache**, and discomfort around the graft areas and around the eyes. These symptoms can usually be controlled with a mild **pain** reliever like aspirin. Scabs may form at the graft sites and should not be scraped off. There may be some numbness at the sites, but it will diminish within two to three months.

Risks

Although there are rare cases of infection or scarring, the major risk is probably that the grafted area does not look the way the patient expected it to look.

Normal results

The transplanted hair will fall out within a few weeks, however, new hair will start to grow in the graft sites within about three months. A normal rate of hair growth is about 0.25–0.5 in (6–13 mm) per month.

Abnormal results

Major complications as a result of hair transplantation are extremely rare. Occasionally, a patient may have problems with delayed healing, infection, scarring, or rejection of the graft; but this is uncommon.

Resources

BOOKS

Strough, Dow B., and Robert S. Hamber, eds. *Hair Replacement-Surgical and Medical*. St. Louis: Mosby-Yearbook, 1996.

Unger, Walter P., ed. *Hair Transplantation*. 3rd ed. New York: Marcel Dekker, 1995.

PERIODICALS

Bernstein, R. M., and W. R. Rassman. "The Aesthetics of Follicular Transplantation." *Dermatologic Surgery (B2S)* 23, no. 9 (Sept. 1997): 785-799.

Bernstein, R. M., and W. R. Rassman. "Follicular Transplantation: Patient Evaluation and Surgical Planning." *Dermatologic Surgery (B2S)* 23, no. 9 (Sept. 1997): 771-784, 801-805.

Brady, D. A. "Chest Hair Used As Donor Material in Hair Restoration Surgery." *Dermatologic Surgery* 23, no. 9 (Sept. 1997): 841-844.

Byron, C. "Hair Raising." *Men's Health* 10, no. 6 (July/Aug. 1995): 72-77, 112, 114.

Chang, L. Y., et. al. "Use of the Scalp as a Donor Site for Large Burn Wound Coverage: Review of 150 Patients." *World Journal of Surgery* 22, no. 3 (Mar.1998): 296-300.
Fischer, David. "The Bald Truth." *U.S. News & World Report* (4 Aug. 1997): 44-50.
Hitzig, G. S., J. P. Schwinning, and S. L. Handler. "Linear Grafting Using a Modified Slot Method: Introducing the Linear Punch." *Dermatologic Surgery (B2S)* 23, no. 9 (Sept. 1997): 788-792.

ORGANIZATIONS

American Academy of Cosmetic Surgery. 401 N. Michigan Ave., Chicago, IL 60611-4267. (313) 527-6713. <http://www.cosmeticsurgeryonline.com>.
American Academy of Facial Plastic and Reconstructive Surgery. 1110 Vermont Avenue NW, Suite 220, Washington, DC 20005. 800-332-3223.

OTHER

"Hair Transplant." Ienhance. <http://www.ienhance.com>.
"Transplants; Flap Surgery; and The Perfect Candidate." Transplant Network. <http://www.hair-transplants.net>.

Altha Roberts Edgren

KEY TERMS

Anesthetic agents—Medication or drugs that can be injected with a needle or rubbed onto and area to make it numb before a surgical procedure. Anesthesia drugs may also be given by mouth, breathed in as a gas, or injected into a vein or muscle to make a patient relaxed or unconscious.

Hair follicle—A tube-like indentation in the skin from which a single hair grows.

Minigraft or micrograft—Transplantation of a small number of hair follicles, as few as one to three hairs, into a transplant site.

Transplantation—Surgically cutting out hair follicles and replanting them in a different spot on the head.

Hairy cell leukemia

Definition

Hairy cell leukemia is a disease in which a type of white blood cell called the lymphocyte, present in the blood and bone marrow, becomes malignant and proliferates. It is called hairy cell leukemia because the cells have tiny hair-like projections when viewed under the microscope.

Description

Hairy cell leukemia (HCL) is a rare **cancer**. It was first described in 1958 as *leukemic reticuloendotheliosis*, erroneously referring to a red blood cell because researchers were unsure of the cell of origin. It became more easily identifiable in the 1970s. There are approximately 600 new cases diagnosed every year in the United States, making up about 2% of the adult cases of leukemia each year.

HCL is found in cells located in the blood. There are three types of cells found in the blood: the red blood cells that carry oxygen to all the parts of the body; the white blood cells that are responsible for fighting infection and protecting the body from diseases; and the platelets that help in the clotting of blood. Hairy cell leukemia affects a type of white blood cell called the lymphocyte. Lymphocytes are made in the bone marrow, spleen, lymph nodes, and other organs. It specifically affects B-lymphocytes, which mature in the bone marrow. However, extremely rare variants of HCL have been discovered developing from T-lymphocytes, which mature in the thymus.

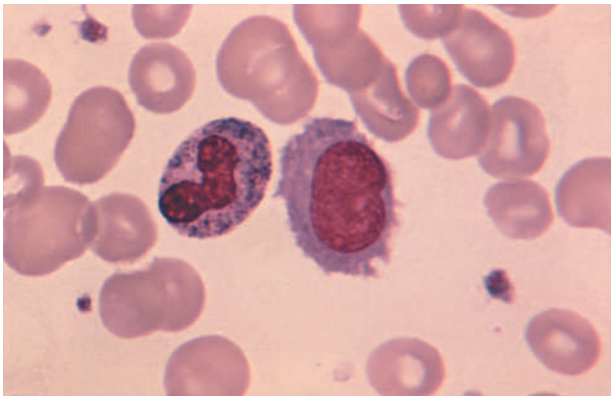
When hairy cell leukemia develops, the white blood cells become abnormal both in the way they appear (by acquiring hairy projections) and in the way they act (by proliferating without the normal control mechanisms). Further, the cells tend to accumulate in the spleen, causing it to become enlarged. The cells may also collect in the bone marrow and prevent it from producing normal blood cells. As a result, there may not be enough normal white blood cells in the blood to fight infection.

The median age at which people develop HCL is 52 years. Though it occurs in all ages, HCL more commonly develops in the older population. Men are four times more likely to develop HCL than women. There have been reports of familial aggregation of disease, with higher occurrences in Ashkenazi Jewish men. A potential genetic link is undergoing further investigation.

Causes and symptoms

The cause of hairy cell leukemia is not specifically known. However, exposure to radiation is a known cause of leukemia in general. Familial involvement is another theory, suggesting that there is a genetic component associated with this disease.

HCL is a chronic (slowly progressing) disease, and the patients may not show any symptoms for many years. As the disease advances, the patients may suffer from one or more of the following symptoms:



A magnified image of white blood cells with "hairy" projections. *(Photograph by M. Abbey. Photo Researchers, Inc. Reproduced by permission.)*

- weakness
- **fatigue**
- recurrent infections
- **fever**
- anemia
- bruising
- **pain** or discomfort in the abdominal area
- weight loss (uncommon)
- night sweats (uncommon)

Pain and discomfort are caused by an enlarged spleen, which results from the accumulation of the abnormal hairy cells in the spleen. Blood tests may show abnormal counts of all the different types of cells. This happens because the cancerous cells invade the bone marrow as well and prevent it from producing normal blood cells. Because of the low white cell count in the blood, the patient may have frequent infections. Fever often accompanies the infections. The patient is most susceptible to bacterial infections, but infections of any kind are the major cause of **death**. The low red cell count may cause anemia, fatigue, and weakness, and the low **platelet count** may cause the person to bruise and bleed easily.

Diagnosis

When a patient suffers from the above symptoms, the doctor will palpate the abdomen and may order scans to see if the spleen is enlarged (splenomegaly). An enlarged spleen is present in 80% of patients. An enlarged liver is less common, but can occur.

If the spleen is enlarged, the doctor may order several blood tests. In these tests, the total numbers of each of the different types of blood cells (CBC) are reported. Sixty to eighty percent of patients suffer from pancytopenia, which is a dramatic reduction in the number of red blood cells, white blood cells, and platelets circulating in the blood.

If the blood tests are abnormal, the doctor may order a **bone marrow aspiration and biopsy**. In order to establish a diagnosis, hairy cells must be present in the bone marrow.

Treatment

When physicians perform blood tests, they will determine the level of hemoglobin (the oxygen-transporting molecule of red blood cells). Serum hemoglobin levels and the size of the spleen, which can be measured on exam and by using an x ray, are proposed criteria for determining the stage of HCL. The following are the three proposed stages and their criteria:

- Stage I: Hemoglobin greater than 12 g/dL (1 g = approximately 0.02 pint and 1 dL = approximately 0.33 ounce) and spleen less than or equal to 10 cm (3.9 inches).
- Stage II: Hemoglobin between 8.5 and 12 g/dL and spleen greater than 10 cm (3.9 inches).
- Stage III: Hemoglobin less than 8.5 g/dL and spleen greater than 10 cm (3.9 inches).

Since there is generally no accepted staging system, another method for evaluating the progression of HCL is to group patients into two categories: untreated HCL and progressive HCL, in which hairy cells are present after therapy has been administered.

Some people with hairy cell leukemia have very few or no symptoms at all, and it is reasonable to expect that 10% of patients may not need any treatment. However, if the patient is symptomatic and needs intervention, HCL is especially responsive to treatment.

There are three main courses of treatment: **chemotherapy**, **splenectomy** (surgical removal of the spleen), and immunotherapy. Once a patient meets treatment criteria, purine analogues, particularly the drugs, pentostatin and cladribine, are the first-line therapy. Pentostatin is administered at 5mg/m^2 for two days every other week until total remission is achieved. Patients may experience side effects such as fever, nausea, vomiting, **photosensitivity**, and keratoconjuctivitis. However, follow-up studies estimate a relapse-free survival rate at 76%. Cladribine (2-CdA) taken at 0.1mg/kg/day for seven days also has an impressive response. Eighty-six percent of patients experience complete remission after treatment, while 16% experience partial remission. Fever is the principal side effect of 2-CdA.

Biological therapy or immunotherapy, where the body's own immune cells are used to fight cancer, is also being investigated in clinical trials for hairy cell leukemia. A substance called interferon that is produced by the white

blood cells of the body was the first systemic treatment that showed consistent results in fighting HCL. The FDA approved interferon-alpha (INF-alpha) to fight HCL. The mechanism by which INF-alpha works is not clearly understood. However, it is known that interferon stimulates the body's natural killer cells that are suppressed during HCL. The standard dosage is 2 MU/m^2 three times a week for 12 months. Side effects include fever, myalgia, malaise, **rashes**, and gastrointestinal complaints.

If the spleen is enlarged, it may be removed in a surgical procedure known as splenectomy. This usually causes a remission of the disease. However, 50% of patients that undergo splenectomy require some type of systemic treatment such as chemotherapy or immunotherapy. Splenectomy is not the most widely used course of treatment as it was many years ago. Although the spleen is not an indispensable organ, it is responsible for helping the body fight infection. Therefore, other therapies are preferred in order to salvage the spleen and its functions.

Most patients have excellent prognosis and can expect to live 10 years or longer. The disease may remain silent for years with treatment. Continual follow-up is necessary to monitor the patient for relapse and determine true cure rates.

Alternative treatment

Many individuals choose to supplement traditional therapy with complementary methods. Often, these methods improve the tolerance of side effects and symptoms as well as enrich the quality of life. The American Cancer Society recommends that patients talk to their doctor to ensure that the methods they are using are safely supplementing traditional therapy. Some complementary treatments include the following:

- yoga
- meditation
- religious practices and prayer
- music therapy
- art therapy
- massage therapy
- aromatherapy

Prevention

Since the cause for the disease is unknown and there are no specific risk factors, there is no known prevention.

Resources

BOOKS

Bast, Robert C. *Cancer Medicine*. Lewiston, NY: B.C. Decker Inc., 2000.

Cook, Allan R. *The New Cancer Sourcebook*. Detroit, MI: Omnigraphics, Inc., 1996.

DeVita, Vincent T. *Cancer Principles and Practice of Oncology, 5th Edition, Vol. 2*. Philadelphia: PA: Lippincott Williams & Wilkins, 1997.

Dollinger, Malin. *Everyone's Guide to Cancer Therapy.* Somerville House Books Limited, 1994.

Haskell, Charles M. *Cancer Treatment, 5th Edition*. Philadelphia: W.B. Saunders Company, 2001.

Morra, Marion E. *Choices*. Avon Books, October 1994.

Murphy, Gerald P. *Informed Decisions: The Complete book of Cancer Diagnosis, Treatment and Recovery.* Atlanta, GA: American Cancer Society, 1997.

ORGANIZATIONS

American Cancer Society (National Headquarters). 1599 Clifton Road, N.E. Atlanta, Georgia 30329. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute (National Headquarters). 681 Fifth Avenue, New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Hairy Cell Leukemia Research Foundation. 2345 County Farm Lane, Schaumburg, IL 60194. (800) 693-6173.

Leukemia Society of America, Inc. National Office, 600 Third Avenue, 4th Floor, New York, NY 10016. (800) 955-4LSA.

National Cancer Institute. 9000 Rockville Pike, Building 31, Room 10A16, Bethesda, Maryland, 20892. (800) 422-6237. <http://www.icic.nci.nih.gov>.

Oncolink. University of Pennsylvania Cancer Center. <http://cancer.med.upenn.edu>.

OTHER

NCI/PDQ Patient Statement, "Hairy cell leukemia." National Cancer Institute, 2001.

"Coping With Side Effects." National Cancer Institute. 2 July 2001. <http://cancernet.nci.nih.gov/chemotherapy/chemoside.html>.

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Halitosis *see* **Bad breath**

Hallucinations

Definition

Hallucinations are false or distorted sensory experiences that appear to be real perceptions. These sensory impressions are generated by the mind rather than by any external stimuli, and may be seen, heard, felt, and even smelled or tasted.

Description

A hallucination occurs when environmental, emotional, or physical factors such as **stress**, medication, extreme **fatigue**, or mental illness cause the mechanism within the brain that helps to distinguish conscious perceptions from internal, memory-based perceptions to misfire. As a result, hallucinations occur during periods of consciousness. They can appear in the form of visions, voices or sounds, tactile feelings (known as haptic hallucinations), smells, or tastes.

Patients suffering from **dementia** and psychotic disorders such as **schizophrenia** frequently experience hallucinations. Hallucinations can also occur in patients who are not mentally ill as a result of stress overload or exhaustion, or may be intentionally induced through the use of drugs, **meditation**, or sensory deprivation. A 1996 report, published in the *British Journal of Psychiatry*, noted that 37% of 4,972 people surveyed experienced hypnagogic hallucinations (hallucinations that occur as a person is falling to sleep). Hypnopomic hallucinations (hallucinations that occur just upon waking) were reported by 12% of the sample.

Causes and symptoms

Common causes of hallucinations include:

- Drugs. Hallucinogenics such as ecstasy (3,4-methylenedioxymethamphetamine, or MDMA), **LSD** (**lysergic acid diethylamide**, or acid), mescaline (3,4,5-trimethoxyphenethylamine, or peyote), and psilocybin (4-phosphoryloxy-N, N-dimethyltryptamine, or mushrooms) trigger hallucinations. Other drugs such as marijuana and PCP have hallucinatory effects. Certain prescription medications may also cause hallucinations. In addition, drug withdrawal may induce tactile and visual hallucinations; as in an alcoholic suffering from **delirium** tremens (DTs).
- Stress. Prolonged or extreme stress can impede thought processes and trigger hallucinations.
- Sleep deprivation and/or exhaustion. Physical and emotional exhaustion can induce hallucinations by blurring the line between sleep and wakefulness.
- Meditation and/or sensory deprivation. When the brain lacks external stimulation to form perceptions, it may compensate by referencing the memory and form hallucinatory perceptions. This condition is commonly found in blind and deaf individuals.
- Electrical or neurochemical activity in the brain. A hallucinatory sensation—usually involving touch—called an aura, often appears before, and gives warning of, a migraine. Also, auras involving smell and touch (tactile) are known to warn of the onset of an epileptic attack.
- Mental illness. Up to 75% of schizophrenic patients admitted for treatment report hallucinations.
- Brain damage or disease. Lesions or injuries to the brain may alter brain function and produce hallucinations.

Diagnosis

Aside from hypnogogic and hypnopompic hallucinations, more than one event suggests a person should seek evaluation. A general physician, psychologist, or psychiatrist will try to rule out possible organic, environmental, or psychological causes through a detailed medical examination and social history. If a psychological cause such as schizophrenia is suspected, a psychologist will typically conduct an interview with the patient and his family and administer one of several clinical inventories, or tests, to evaluate the mental status of the patient.

Occasionally, people who are in good mental health will experience a hallucination. If hallucinations are infrequent and transitory, and can be accounted for by short-term environmental factors such as sleep deprivation or meditation, no treatment may be necessary. However, if hallucinations are hampering an individual's ability to function, a general physician, psychologist, or psychiatrist should be consulted to pinpoint their source and recommend a treatment plan.

Treatment

Hallucinations that are symptomatic of a mental illness such as schizophrenia should be treated by a psychologist or psychiatrist. Antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), or risperidone (Risperdal) may be prescribed.

Prognosis

In many cases, chronic hallucinations caused by schizophrenia or some other mental illness can be controlled by medication. If hallucinations persist, psychosocial therapy can be helpful in teaching the patient the coping skills to deal with them. Hallucinations due to sleep deprivation or extreme stress generally stop after the cause is removed.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Siegel, Ronald K. *Fire in the Brain: Clinical Tales of Hallucination*. New York: Dutton, 1992.

PERIODICALS

Bental, R. P. "The Illusion of Reality: A Review and Integration of Psychological Research on Hallucinations." *Psychological Bulletin* 107, no. 1 (Jan. 1990): 82-95.

Beyerstein, Barry L. "Believing is Seeing: Organic and Psychological Reasons for Hallucinations and Other Anomalous Psychiatric Symptoms." *Medscape Mental Health* 1, no. 11 (1996).

Ohayon, M. M., et al. "Hypnagogic and Hypnopompic Hallucinations: Pathological Phenomena?" *The British Journal of Psychiatry* 169, no. 4 (Oct. 1996): 459-67.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

Paula Anne Ford-Martin

Hallucinogen *see* **Lysergic acid diethylamide**

Hallux valgus *see* **Bunion**

Haloperidol *see* **Antipsychotic drugs**

Hammertoe

Definition

Hammertoe is a condition in which the toe is bent in a claw-like position. It can be present in more than one toe but is most common in the second toe.

Description

Hammertoe is described as a deformity in which the toes bend downward with the toe joint usually enlarged. Over time, the joint enlarges and stiffens as it rubs against shoes. Other foot structures involved include the overlying skin and blood vessels and nerves connected to the involved toes.

Causes and symptoms

The shortening of tendons responsible for the control and movement of the affected toe or toes cause hammertoe. Top portions of the toes become callused from the friction produced against the inside of shoes. This common foot problem often results from improper fit of footwear. This is especially the case with high-heeled shoes placing pressure on the front part of the foot that compresses the smaller toes tightly together. The condition frequently stems from muscle imbalance, and usually leaves the affected individual with impaired balance.

KEY TERMS

Aura—A subjective sensation or motor phenomenon that precedes and indicates the onset of a neurological episode, such as a migraine or an epileptic seizure.

Hypnogogic hallucination—A hallucination, such as the sensation of falling, that occurs at the onset of sleep.

Hypnopompic hallucination—A hallucination that occurs as a person is waking from sleep.

Sensory deprivation—A situation where an individual finds himself in an environment without sensory cues. Also, (used here) the act of shutting one's senses off to outside sensory stimuli to achieve hallucinatory experiences and/or to observe the psychological results.

Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of hammertoe and other foot conditions. Because the condition involves bony deformity, x rays can help to confirm the diagnosis.

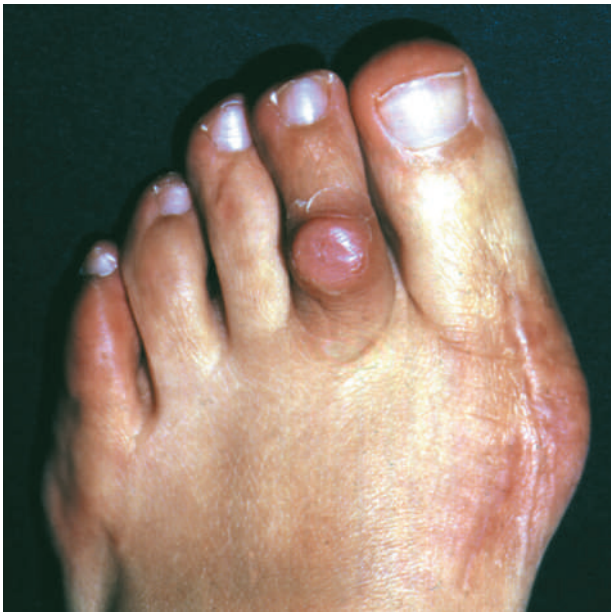
Treatment

Conservative

Wearing proper footwear and stockings with plenty of room in the toe region can provide treatment for hammertoe. Stretching exercises may be helpful in lengthening the excessively tight tendons.

Surgery

In advanced cases, where conservative treatment is unsuccessful, surgery may be recommended. The tendons that attach to the involved toes are located and an incision is made to free the connective tissue to the foot bones. Additional incisions are made so the toes no longer bend



Hammertoe most commonly affects the second toe which, as shown, often develops a corn over the deformity. *(Photograph by Dr. H.C. Robinson, Custom Medical Stock Photo. Reproduced by permission.)*

in a downward fashion. The middle joints of the affected toes are connected together permanently with surgical hardware such as pins and wire sutures. The incision is then closed with fine sutures. These sutures are removed approximately seven to ten days after surgery.

Alternative treatment

Various soft tissue and joint treatments offered by **chiropractic** and **massage therapy** may be useful to decrease the tightness of the affected structures.

Prognosis

If detected early, hammertoe can be treated non-surgically. If surgery becomes necessary, surgical risks are minimal with the overall outcome providing good results.

Prevention

Wearing comfortable shoes that fit well can prevent many foot ailments. Foot width may increase with age. Feet should always be measured before buying shoes. The upper part of the shoes should be made of a soft, flexible material to match the shape of the foot. Shoes made of leather can reduce the possibility of skin irritations. Soles should provide solid footing and not be slippery. Thick soles lessen pressure when walking on hard surfaces. Low-heeled shoes are more comfortable, safer, and less damaging than high-heeled shoes.

Resources

BOOKS

Scully, Rosemary M., and Marylou R. Barnes. *Physical Therapy.* Philadelphia: J. B. Lippincott Co., 1989.

ORGANIZATIONS

American Orthopedic Foot and Ankle Society. 222 South Prospect, Park Ridge, IL 60068.
American Podiatry Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814.

OTHER

"Hammertoe Correction." ThriveOnline. 4 Apr. 1998 <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Hand-foot-and-mouth disease

Definition

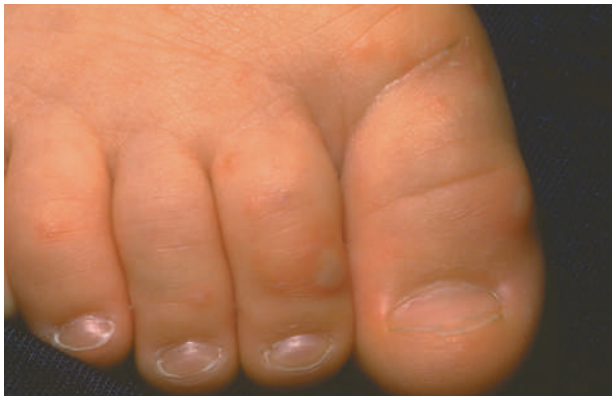
Hand-foot-and-mouth disease is an infection of young children in which characteristic fluid-filled blisters appear on the hands, feet, and inside the mouth.

Description

Coxsackie viruses belong to a family of viruses called enteroviruses. These viruses live in the gastrointestinal tract, and are therefore present in feces. They can be spread easily from one person to another when poor hygiene allows the virus within the feces to be passed from person to person. After exposure to the virus, development of symptoms takes only four to six days. Hand-foot-and-mouth disease can occur year-round, although the largest number of cases are in summer and fall months.

An outbreak of hand-foot-and-mouth disease occurred in Singapore in 2000, with more than 1,000 diagnosed cases, all in children, resulting in four deaths. A smaller outbreak occurred in Malaysia in 2000. In 1998, a serious outbreak of enterovirus 71 in Taiwan resulted in more than one million cases of hand-foot-and-mouth disease. Of these, there were 405 severe cases and 78 deaths, 71 of which were children younger than five years of age.

Hand-foot-and-mouth should not be confused with foot and mouth disease, which infects cattle but is extremely rare in humans. An outbreak of foot and mouth disease swept through Great Britain and into other parts of Europe and South America in 2001.



A child's foot with pustules on toes, indicating hand-foot-mouth disease. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Enteroviruses—Viruses which live in the gastrointestinal tract. Coxsackie viruses, viruses that cause hand-foot-mouth disease, are an enterovirus.

Vesicle—A bump on the skin filled with fluid.

Causes and symptoms

Hand-foot-and-mouth disease is very common among young children, and often occurs in clusters of children who are in daycare together. It is spread when poor handwashing after a diaper change or contact with saliva (drool) allows the virus to be passed from one child to another.

Within about four to six days of acquiring the virus, an infected child may develop a relatively low-grade **fever**, ranging from 99–102°F (37.2–38.9°C). Other symptoms include **fatigue**, loss of energy, decreased appetite, and a sore sensation in the mouth that may interfere with feeding. After one to two days, fluid-filled bumps (vesicles) appear on the inside of the mouth, along the surface of the tongue, on the roof of the mouth, and on the insides of the cheeks. These are tiny blisters, about 3–7 mm in diameter. Eventually, they may appear on the palms of the hands and on the soles of the feet. Occasionally, these vesicles may occur in the diaper region.

The vesicles in the mouth cause the majority of discomfort, and the child may refuse to eat or drink due to **pain**. This phase usually lasts for an average of a week. As long as the bumps have clear fluid within them, the disease is at its most contagious. The fluid within the vesicles contains large quantities of the causative viruses. Extra care should be taken to avoid contact with this fluid.

Diagnosis

Diagnosis is made by most practitioners solely on the basis of the unique appearance of blisters of the mouth, hands, and feet, in a child not appearing very ill.

Treatment

There are no treatments available to cure or decrease the duration of the disease. Medications like **acetaminophen** or ibuprofen may be helpful for decreasing pain, and allowing the child to eat and drink. It is important to try to encourage the child to take in adequate amounts of fluids, in the form of ice chips or popsicles if other foods or liquids are too uncomfortable.

Alternative treatment

There are no effective alternative treatments for hand-foot-and-mouth disease.

Prognosis

The prognosis for a child with hand-foot-and-mouth disease is excellent. The child is usually completely better within about a week of the start of the illness.

Prevention

Prevention involves careful attention to hygiene. Thorough, consistent hand-washing practices, and discouraging the sharing of clothes, towels, and stuffed toys are all helpful. Virus continues to be passed in the feces for several weeks after infection, so good hygiene should be practiced long after all signs of infection have passed.

Resources

BOOKS

Morag, Abraham, and Pearay L. Ogra. "Viral Infections." In *Nelson Textbook of Pediatrics, 16th Edition,* edited by Richard Behrman. Philadelphia: W.B. Saunders Co., 2000.

Ray, C. George. "Enteroviruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases,* edited by Kenneth J. Ryan. Norwalk, CT: Appleton and Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley and Sons, Inc., 1995.

PERIODICALS

Huerter, Christopher, et al. "Helpful Clues to Common Rashes." *Patient Care* 31, 8 (April 30, 1997): 9+.

No author. "New Tricks for an Old Enterovirus." *Infectious Disease Alert* (Dec. 15, 1999): 45.

Slavin, Kevin A. and Ilona J. Frieden. "Hand-Foot-And-Mouth Disease." *Archives of Pediatrics & Adolescent Medicine* (May 1998): 505-507.

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Hand-Schüller-Christian syndrome *see* **Histiocytosis X**

Hansen's disease *see* **Leprosy**

Hantavirus infections

Definition

Hantavirus infection is caused by a group of viruses that can infect humans with two serious illnesses: hemorrhagic **fever** with renal syndrome (HFRS), and Hantavirus pulmonary syndrome (HPS).

Description

Hantaviruses are found without causing symptoms within various species of rodents and are passed to humans by exposure to the urine, feces, or saliva of those infected rodents. Ten different hantaviruses have been identified as important in humans. Each is found in specific geographic regions, and therefore is spread by different rodent carriers. Further, each type of virus causes a slightly different form of illness in its human hosts:

- Hantaan virus is carried by the striped field mouse, and exists in Korea, China, Eastern Russia, and the Balkans. Hantaan virus causes a severe form of hemorrhagic fever with renal syndrome (HFRS).
- Puumula virus is carried by bank voles, and exists in Scandinavia, western Russia, and Europe. Puumula virus causes a milder form of HFRS, usually termed *nephropathia epidemica*.
- Seoul virus is carried by a type of rat called the Norway rat, and exists worldwide, but causes disease almost exclusively in Asia. Seoul virus causes a form of HFRS which is slightly milder than that caused by Hantaan virus, but results in liver complications.
- Prospect Hill virus is carried by meadow voles and exists in the United States, but has not been found to cause human disease.
- Sin Nombre virus, the most predominant strain in the United States, is carried by the deer mouse. This virus was responsible for severe cases of HPS that occurred in the Southwestern United States in 1993.
- Black Creek Canal virus has been found in Florida. It is predominantly carried by cotton rats.
- New York virus strain has been documented in New York State. The vectors for this virus seem to be deer mice and white-footed mice.
- Bayou virus has been reported in Louisiana and Texas and is carried by the marsh rice rat.
- Blue River virus has been found in Indiana and Oklahoma and seems to be associated with the white-footed mouse.
- Monongahela virus, discovered in 2000, has been found in Pennsylvania and is transmitted by the white-footed mouse.

Causes and symptoms

Hemorrhagic fever with renal syndrome (HFRS)

Hantaviruses that produce forms of hemorrhagic fever with renal syndrome (HFRS) cause a classic group of symptoms, including fever, malfunction of the kidneys, and low **platelet count**. Because platelets are blood cells important in proper clotting, low numbers of circulating platelets can result in spontaneous bleeding, or hemorrhage.

Patients with HFRS have **pain** in the head, abdomen, and lower back, and may report bloodshot eyes and blurry vision. Tiny pinpoint hemorrhages, called petechiae, may appear on the upper body and the soft palate in the mouth. The patient's face, chest, abdomen, and back often appear flushed and red, as if sunburned.

After about five days, the patient may have a sudden drop in blood pressure; often it drops low enough to cause the clinical syndrome called **shock**. Shock is a state in which blood circulation throughout the body is insufficient to deliver proper quantities of oxygen. Lengthy shock can result in permanent damage to the body's organs, particularly the brain, which is very sensitive to oxygen deprivation.

Around day eight of HFRS, kidney involvement results in multiple derangements of the body chemistry. Simultaneously, the hemorrhagic features of the illness begin to cause spontaneous bleeding, as demonstrated by bloody urine, bloody vomit, and in very serious cases, brain hemorrhages with resulting changes in consciousness.

Day eleven often brings further chemical derangements, with associated confusion, **hallucinations**, seizures, and lung complications. Those who survive this final phase usually begin to turn the corner towards recovery at this time, although recovery takes approximately six weeks.

Hantavirus pulmonary syndrome (HPS)

Hantavirus pulmonary syndrome (HPS) develops in four stages. They are:

- The incubation period. This lasts from one to five weeks from exposure. Here, the patient may exhibit no symptoms.
- The prodrome, or warning signs, stage. The patient begins with a fever, muscle aches, **headache**, **dizziness**, and abdominal pain and upset. Sometimes there is vomiting and diarrhea.
- The cardiopulmonary stage. The patient slips into this stage rapidly, sometimes within a day or two of initial symptoms; sometimes as long as 10 days later. There is a drop in blood pressure, shock, and leaking of the blood vessels of the lungs, which results in fluid accumulation in the lungs, and subsequent **shortness of breath**. The fluid accumulation can be so rapid and so severe as to put the patient in **respiratory failure** within only a few hours. Some patients experience severe abdominal tenderness.
- The convalescent stage. If the patient survives the respiratory complications of the previous stage, there is a rapid recovery, usually within a day or two. However, abnormal liver and lung functioning may persist for six months.

Diagnosis

The diagnosis of infection by a hantavirus uses serologic techniques. The patient's blood is drawn, and the ELISA (enzyme-linked immunosorbent assay) is done in a laboratory to identify the presence of specific immune substances (antibodies)—substances which an individual's body would only produce in response to the hantavirus.

It is very difficult to demonstrate the actual virus in human tissue, or to grow cultures of the virus within the laboratory, so the majority of diagnostic tests use indirect means to demonstrate the presence of the virus.

Treatment

Treatment of hantavirus infections is primarily supportive, because there are no agents available to kill the viruses and interrupt the infection. Broad-spectrum **antibiotics** are given until the diagnosis is confirmed. Supportive care consists of providing treatment in response to the patient's symptoms. Because both HFRS and HPS progress so rapidly, patients must be closely monitored, so that treatment may be started at the first sign of a particular problem. Low blood pressure is treated with medications. Blood transfusions are given for both hemorrhage and shock states. Hemodialysis is used in kidney failure. (Hemodialysis involves mechanically cleansing the blood outside of the body, to replace the kidney's normal function of removing various toxins form the blood.) Rapid respiratory assistance is critical, often requiring intubation.

The anti-viral agent ribavirin has been approved for use in early treatment of hantavirus infections.

KEY TERMS

Hemodialysis—A method of mechanically cleansing the blood outside of the body, in order to remove various substances which would normally be cleared by the kidneys. Hemodialysis is used when an individual is in relative, or complete, kidney failure.

Hemorrhagic—A condition resulting in massive, difficult-to-control bleeding.

Petechiae—Pinpoint size red spots caused by hemorrhaging under the skin.

Platelets—Circulating blood cells which are crucial to the mechanism of clotting.

Prodrome—Early symptoms or warning signs

Pulmonary—Referring to the lungs.

Renal—Referring to the kidneys.

Shock—Shock is a state in which blood circulation is insufficient to deliver adequate oxygen to vital organs.

Prognosis

The diseases caused by hantaviruses are extraordinarily lethal. About 6–15% of people who contract HFRS have died. Almost half of all people who contract HPS will die. It is essential that people living in areas where the hantaviruses exist seek quick medical treatment, should they begin to develop an illness that might be due to a hantavirus.

Prevention

There are no immunizations currently available against any of the hantaviruses. The only forms of prevention involve rodent control within the community and within individual households. The following is a list of preventative measures:

- Avoiding areas known to be infested by rodents is essential.
- Keep a clean home and keep food in rodent-proof containers.

- Dispose of garbage and empty pet food dishes at night.
- Set rodent traps around baseboards and in tight places. Dispose of dead animals with gloves and disinfect the area with bleach.
- Use rodenticide as necessary.
- Seal any entry holes 0.25 inch wide or wider around foundations with screen, cement, or metal flashing.
- Clear brush and junk from house foundations.
- Put metal flashing around house foundations.
- Elevate hay, woodpiles, and refuse containers.
- Air out all sealed outbuildings or cabins 30 minutes before cleaning for the season.
- When camping, do not sleep on the bare ground; sleep on a cot or in a tent with a floor.

Resources

BOOKS

Harper, David R. and Andrea S. Meyer. *Of Mice, Men, and Microbes: Hantavirus*. San Diego: Academic Press, 1999.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley and Sons, Inc., 1995.

PERIODICALS

Jones, Amy. "Setting a Trap for Hantavirus." *Nursing* (September 2000): 20.

Monroe, Martha C., Sergey P. Morzunov, Angela M. Johnson, Michael De. Bowen, et al. "Genetic Diversity and Distribution of Peromyscus-Borne Hantaviruses in North America." *Nursing* (January-February 1999): 75- 86.

Naughton, Laurie. "Hantavirus Infection in the United States: Are We Prepared?." *Physician Assistant* (May 2000): 33.

Rhodes III, Luther V., Cinnia Huang, Angela J. Sanchez, Stuart T. Nichol, et al. "Hantavirus Pulmonary Syndrome Associated with Monongahela Virus, Pennsylvania." *Emerging Infectious Diseases* (November 2000): 616.

Van Bevern, Pamela A. "Hantavirus Pulmonary Syndrome." *Clinician Reviews* (July 2000): 108.

ORGANIZATION

Centers for Disease Control and Prevention. (404) 332-4559. <http://www.cdc.gov/travel/travel.html>.

Janie F. Franz

Haptoglobin test

Definition

This test is done to help evaluate a person for **hemolytic anemia**.

Purpose

Haptoglobin is a blood protein made by the liver. The haptoglobin levels decrease in hemolytic anemia. Hemolytic **anemias** include a variety of conditions that result in hemolyzed, or burst, red blood cells.

Decreased values can also indicate a slower type of red cell destruction unrelated to anemia. For example, destruction can be caused by mechanical heart valves or abnormal hemoglobin, such as **sickle cell disease** or **thalassemia**.

Haptoglobin is known as an acute phase reactant. Its level increases during acute conditions such as infection, injury, tissue destruction, some cancers, **burns**, surgery, or trauma. Its purpose is to remove damaged cells and debris and rescue important material such as iron. Haptoglobin levels can be used to monitor the course of these conditions.

Description

Hemoglobin is the protein in the red blood cell that carries oxygen throughout the body. Iron is an essential part of hemoglobin; without iron, hemoglobin can not function. Haptoglobin's main role is to save iron by attaching itself to any hemoglobin released from a red cell.

When red blood cells are destroyed, the hemoglobin is released. Haptoglobin is always present in the blood waiting to bind to released hemoglobin. White blood cells (called macrophages) bring the haptoglobin-hemoglobin complex to the liver, where the haptoglobin and hemoglobin are separated and the iron is recycled.

In hemolytic anemia, so many red cells are destroyed that most of the available haptoglobin is needed to bind the released hemoglobin. The more severe the hemolysis, the less haptoglobin remains in the blood.

Haptoglobin is measured in several different ways. One way is called rate nephelometry. A person's serum is mixed with a substance that will bind to haptoglobin. The amount of bound haptoglobin is measured using a rate nephelometer, which measures the amount of light scattered by the bound haptoglobin. Another way of measuring haptoglobin is to measure it according to how much hemoglobin it can bind.

Preparation

This test requires 5 mL of blood. The person being tested should avoid taking **oral contraceptives** or androgens before this test. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

KEY TERMS

Acute phase reactant—A substance in the blood that increases as a response to an acute condition such as infection, injury, tissue destruction, some cancers, burns, surgery, or trauma.

Haptoglobin—A blood protein made by the liver. Its main role is to save iron by attaching itself to any hemoglobin released from a red cell.

Hemoglobin—The protein in the red blood cell that carries oxygen.

Hemolytic anemia—A variety of conditions that result in hemolyzed, or burst, red blood cells.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Normal results vary based on the laboratory and test method used. Haptoglobin is not present in newborns at birth, but develop adult levels by 6 months.

Abnormal results

Decreased haptoglobin levels usually indicates hemolytic anemia. Other causes of red cell destruction also decrease haptoglobin: a blood **transfusion** reaction; mechanical heart valve; abnormally shaped red cells; or abnormal hemoglobin, such as thalassemia or sickle cell anemia.

Haptoglobin levels are low in liver disease, because the liver can not manufacture normal amounts of haptoglobin. Low levels may also indicate an inherited lack of haptoglobin, a condition found particularly in African Americans.

Haptoglobin increases as a reaction to illness, trauma, or rheumatoid disease. High haptoglobin values should be followed-up with additional tests. Drugs can also effect haptoglobin levels.

Normal results vary widely from person to person. Unless the level is very high or very low, haptoglobin levels are most valuable when the results of several tests done on different days are compared.

Nancy J. Nordenson

Hardening of the arteries *see* **Atherosclerosis**
Harelip *see* **Cleft lip and palate**

Hartnup disease

Definition

Hartnup disease is an inherited nutritional disorder with primary symptoms including a red, scaly rash and sensitivity to sunlight.

Description

Hartnup disease was first identified in the 1950s in the Hartnup family in London. A defect in intestines and kidneys makes it difficult to break down and absorb protein in the diet. This causes a condition very similar to pellegra (niacin deficiency). The condition occurs in about one of every 26,000 live births.

Causes and symptoms

Hartnup disease is an in-born error of metabolism, that is, a condition where certain nutrients cannot be digested and absorbed properly. The condition is passed on genetically in families. It occurs when a person inherits two recessive genes for the disease, one from each parent. People with Hartnup disease are not able to absorb some of the amino acids (the smaller building blocks that make up proteins) in their intestines. One of the amino acids that is not well absorbed is tryptophan, which the body uses to make its own form of niacin.

The majority of people with this disorder do not show any symptoms. About 10–20% of people with Hartnup disease do have symptoms. The most prominent symptom is a red, scaly rash that gets worse when the patient is exposed to sunlight. **Headache**, **fainting**, and **diarrhea** may also occur. **Mental retardation**, cerebral ataxia (muscle weakness), and **delirium** (a confused, agitated, delusional state) are some of the more serious complications that can occur. Short stature has also been noted in some patients. Although this is an inherited disease, the development of symptoms depends on a variety of factors including diet, environment, and other genetic traits controlling amino acid levels in the body. Symptoms can be brought on by exposure to sunlight, **fever**, drugs, or other stresses. Poor **nutrition** frequently precedes an attack of symptoms. The frequency of attacks usually decreases as the patient gets older.

KEY TERMS

Amino acids—Proteins are made up of organic compounds called amino acids. The human body uses amino acids to build and repair body tissue. The body can make some of its own amino acids from other nutrients in the diet; these are called non-essential amino acids. Essential amino acids are those that cannot be made by the body but must be consumed in the diet. Animal proteins (like meat, eggs, fish, and milk) provide all of the amino acids.

Aminoaciduria—A condition confirmed by laboratory tests where high levels of amino acids are found in the urine.

Pellegra—A condition caused by a dietary deficiency of one of the B vitamins, called niacin.

Tryptophan—An essential amino acid that has to consumed in the diet because it cannot be manufactured by the body. Tryptophan is converted by the body to niacin, one of the B vitamins.

Diagnosis

The symptoms of this disease suggest a deficiency of a B vitamin called niacin. A detailed diet history can be used to assess if there is adequate protein and **vitamins** in the diet. The diagnosis of Hartnup disease is confirmed by a laboratory test of the urine which will contain an abnormally high amount of amino acids (aminoaciduria).

Treatment

The vitamin niacin is given as a treatment for Hartnup disease. The typical dosage ranges from 40–200 mg of nicotinamide (a form of niacin) per day to prevent pellagra-like symptoms. Some patients may require dietary supplements of tryptophan.

Eating a healthy, high protein diet can relieve the symptoms and prevent them from recurring.

Prognosis

The prognosis for a healthy life is good once the condition has been identified and treated.

Prevention

Hartnup disease is an inherited condition. Parents may not have the disease themselves, but may pass the genes responsible for it on to their children. **Genetic testing** can be used to identify carriers of the genes. Symptoms can usually be controlled with a high protein diet, vitamin supplements of niacin, and by avoiding the stresses that contribute to attacks of symptoms.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

"Hartnup Disease." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Neutral Aminoaciduria: Hartnup Disease." In *Internal Medicine*. 5th ed. Ed. Jay H. Stein. St. Louis: Mosby, 1998.

"Selected Disorders of Amino Acid Transport." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

National Organization for Rare Disorders. PO Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

NIH/National Institute of Diabetes, Digestive and Kidney Diseases. Building 31, Room 9A04, 31 Center Drive, Bethesda MD 20892-2560. (301) 496-3583.

OTHER

"Hartnup disorder." OMIM Homepage, Online Mendelian Inheritance in Man. <http://www.ncbi.nlm.nih.gov/Omim>.

"Nephrology: Hartnup disease." Medstudents.com. <http://www.medstudents.com>.

Altha Roberts Edgren

Hashimoto's disease *see* **Thyroiditis**

Hatha yoga

Definition

Hatha **yoga** is the most widely practiced form of yoga in America. It is the branch of yoga which concentrates on physical health and mental well-being. Hatha yoga uses bodily postures (*asanas*), breathing techniques (*pranayama*), and **meditation** (*dyana*) with the goal of bringing about a sound, healthy body and a clear, peaceful mind. There are nearly 200 hatha yoga postures, with hundreds of variations, which work to make the spine supple and to promote circulation in all the organs, glands, and tissues. Hatha yoga postures also stretch and align the body, promoting balance and flexibility.

Purpose

In a celebrated 1990 study, *Dr. Dean Ornish's Program for Reversing Heart Disease* (Random House), a cardiologist showed that yoga and meditation combined with a low-fat diet and group support could significantly reduce the blockage of coronary arteries. Other studies have shown yoga's benefit in reducing stress-related problems such as high blood pressure and cholesterol. Meditation has been adopted by medical schools and clinics as an effective **stress** management technique. Hatha yoga is also used by physical therapists to improve many injuries and disabilities, as the gentleness and adaptability of yoga make it an excellent **rehabilitation** program.

Yoga has been touted for its ability to reduce problems with such varying conditions as **asthma**, backaches, diabetes, **constipation**, **menopause**, **multiple sclerosis**, **varicose veins**, and **carpal tunnel syndrome**. A vegetarian diet is the dietary goal of yoga, and this change of lifestyle has been shown to significantly increase longevity and reduce heart disease.

Yoga as a daily **exercise** program can improve fitness, strength, and flexibility. People who practice yoga correctly every day report that it can promote high levels of overall health and energy. The mental component of yoga can clarify and discipline the mind, and yoga practitioners say its benefits can permeate all facets of a person's life and attitude, raising self-esteem and self-understanding.

Description

Origins

Yoga was developed in ancient India as far back as 5,000 years ago; sculptures detailing yoga positions have been found in India which date back to 3000 B.C. Yoga is derived from a Sanskrit word which means "union." The goal of classical yoga is to bring self-transcendence, or enlightenment, through physical, mental and spiritual health. Many people in the West mistakenly believe yoga to be a religion, but its teachers point out that it is a system of living designed to promote health, peace of mind, and deeper awareness of ourselves. There are several branches of yoga, each of which is a different path and philosophy toward self-improvement. Some of these paths include service to others, pursuit of wisdom, nonviolence, devotion to God, and observance of spiritual rituals. Hatha yoga is the path which has physical health and balance as a primary goal, for its practitioners believe that greater mental and spiritual awareness can be brought about with a healthy and pure body.

The origins of hatha yoga have been traced back to the eleventh century A.D. The Sanskrit word *ha* means "sun" and *tha* means "moon," and thus hatha, or literally sun-moon yoga, strives to balance opposing parts of the physical body, the front and back, left and right, top and bottom. Some yoga masters (*yogis*) claim that hatha yoga was originally developed by enlightened teachers to help people survive during the Age of Kali, or the spiritual dark ages, in which Hindus believe we are now living.

The original philosophers of yoga developed it as an eight-fold path to complete health. These eight steps include moral and ethical considerations (such as honesty, non-aggression, peacefulness, non-stealing, generosity, and sexual propriety), self-discipline (including purity, simplicity, devotion to God, and self-knowledge), posture, breath control, control of desires, concentration, meditation, and happiness. According to yogis, if these steps are followed diligently, a person can reach high levels of health and mental awareness.

As it has subsequently developed, hatha yoga has concentrated mainly on two of the eight paths, breathing and posture. Yogis believe breathing to be the most important metabolic function; we breathe roughly 23,000 times per day and use about 4,500 gallons of air, which increases during exercise. Thus, breathing is extremely important to health, and *prana*, or life-force, is found most abundantly in the air and in the breath. If we are breathing incorrectly, we are hampering our potential for optimal health. *Pranayama*, literally the "science of breathing" or "control of life force," is the yogic practice of breathing correctly and deeply.

In addition to breathing, hatha yoga utilizes asanas, or physical postures, to bring about flexibility, balance and strength in the body. Each of these postures has a definite form and precise steps for achieving the desired position and for exiting it. These postures, yogis maintain, have been scientifically developed to increase circulation and health in all parts of the body, from the muscular tissues to the glands and internal organs. Yogis claim that although hatha yoga can make the body as strong and fit as any exercise program, its real benefits come about because it is a system of maintenance and balance for the whole body.

Yoga was brought to America in the late 1800s, when Swami Vivekananda, an Indian yogi, presented a lecture on yoga in Chicago. Hatha yoga captured the imagination of the Western mind, because accomplished yogis could demonstrate incredible levels of fitness, flexibility, and control over their bodies and metabolism. Yoga has flourished in the West. Americans have brought to yoga their energy and zest for innovation, which troubles some Indian yogis and encourages others, as new variations and schools of yoga have developed. For instance, power yoga is a recent Americanized version of yoga which takes hatha yoga principles and speeds them

KEY TERMS

Asana—Yoga posture or stance.

Diaphragm breathing—Method of deep breathing using the entire lungs.

Dyana—Yoga meditation.

Meditation—Technique of mental relaxation.

Prana—Yoga term for life-enhancing nutrient found in air, food and water.

Pranayama—Yoga method of breathing.

up into an extremely rigorous aerobic workout, and many strict hatha yoga teachers oppose this sort of change to their philosophy. Other variations of hatha yoga in America now include Iyengar, Ashtanga, Kripalu, Integral, Viniyoga, Hidden Language, and Bikram yoga, to name a few. Sivananda yoga was practiced by Lilias Folen, who was responsible for introducing many Americans to yoga through public television.

Iyengar yoga was developed by B.K.S. Iyengar, who is widely accepted as one of the great living yogis. Iyengar uses classical hatha yoga asanas and breathing techniques, but emphasizes great precision and strict form in the poses, and uses many variations on a few postures. Iyengar allows the use of props such as belts, ropes, chairs, and blocks to enable students to get into postures they otherwise couldn't. In this respect, Iyengar yoga is good for physical therapy because it assists in the manipulation of inflexible or injured areas.

Ashtanga yoga, made popular by yogi K. Patabhi Jois, also uses hatha yoga asanas, but places an emphasis on the sequences in which these postures are performed. Ashtanga routines often unfold like long dances with many positions done quickly one after the other. Ashtanga is thus a rigorous form of hatha yoga, and sometimes can resemble a difficult aerobic workout. Ashtanga teachers claim that this form of yoga uses body heat, sweating, and deep breathing to purify the body.

Kripalu yoga uses hatha yoga positions but emphasizes the mental and emotional components of each asana. Its teachers believe that tension and long-held emotional problems can be released from the body by a deep and meditative approach to the yoga positions. Integral yoga seeks to combine all the paths of yoga, and is generally more meditative than physical, emphasizing spirituality and awareness in everyday life. Viniyoga tries to adapt hatha yoga techniques to each individual body and medical problem. Hidden Language yoga was developed by Swami Sivananda Radha, a Western man influenced by Jungian psychology. It emphasizes the symbolic and psychological parts of yoga postures and techniques. Its students are encouraged to write journals and participate in group discussions as part of their practice. Bikram yoga has become very popular in the late 1990s, as its popular teacher, Bikram Choudury, began teaching in Beverly Hills and has been endorsed by many famous celebrities. Bikram yoga uses the repetition of 26 specific poses and two breathing techniques to stretch and tone the whole body.

A hatha yoga routine consists of a series of physical postures and breathing techniques. Routines can take anywhere from 20 minutes to two hours, depending on the needs and ability of the practitioner. Yoga should always be adapted to one's state of health; that is, a shorter and easier routine should be used when a person is fatigued. Yoga is ideally practiced at the same time every day, to encourage the discipline of the practice. It can be done at any time of day; some prefer it in the morning as a wake-up routine, while others like to wind down and de-stress with yoga at the end of the day.

Yoga asanas consist of three basic movements: backward bends, forward bends, and twisting movements. These postures are always balanced; a back bend should be followed with a forward bend, and a leftward movement should be followed by one to the right. Diaphragm breathing is important during the poses, where the breath begins at the bottom of the lungs. The stomach should move outward with the inhalation and relax inward during exhalation. The breath should be through the nose at all times during hatha asanas. Typically, one inhales during backward bends and exhales during forward bending movements.

The mental component in yoga is as important as the physical movements. Yoga is not a competitive sport, but a means to self-awareness and self-improvement. An attitude of attention, care, and non-criticism is important; limitations should be acknowledged and calmly improved. Patience is important, and yoga stretches should be slow and worked up to gradually. The body should be worked with, and never against, and a person should never overexert. A yoga stretch should be done only so far as proper form and alignment of the whole body can be maintained. Some yoga stretches can be uncomfortable for beginners, and part of yoga is learning to distinguish between sensations that are beneficial and those that can signal potential injury. A good rule is that positions should be stopped when there is sharp **pain** in the joints, muscles, or tendons.

Preparations

All that is needed to perform hatha yoga is a flat floor and adequate space for stretching out. A well-ventilated

space is preferable, for facilitating proper breathing technique. Yoga mats are available which provide non-slip surfaces for standing poses. Loose, comfortable clothing should be worn. Yoga should be done on an empty stomach; a general rule is to wait three hours after a meal.

Yoga is an exercise that can be done anywhere and requires no special equipment. Yoga uses only gravity and the body itself as resistance, so it is a low-impact activity excellent for those who don't do well with other types of exercise. The mental component of yoga can appeal to those who get bored easily with exercise. By the same token, yoga can be a good stress management tool for those who prefer movement to sitting meditation.

Precautions

As with any exercise program, people should check with their doctors before starting yoga practice for the first time. Those with medical conditions, injuries or spinal problems should find a yoga teacher familiar with their conditions before beginning yoga. Pregnant women, particularly after the third month of **pregnancy**, should only perform a few yoga positions with the supervision of an experienced teacher. Some yoga asanas can be very difficult, and potentially injurious, for beginners, so teachers should always be consulted as preparation for advanced yoga positions. Certain yoga positions should not be performed by those with fevers, or during menstruation.

Side effects

Those just beginning hatha yoga programs often report **fatigue** and soreness throughout the body, as yoga stretches and exercises muscles and tendons which are often long-neglected. Some yogic breathing and meditation techniques can be difficult for beginners and can cause **dizziness** or disorientation; these are best performed under the guidance of a teacher.

Resources

BOOKS

Feuerstein, Georg. *Yoga for Dummies*. New York: IDG Books, 1999.

Bodian, Stephan, and Feuerstein, Georg. *Living Yoga*. New York: Putnam, 1993.

Christensen, Alice. *20 Minute Yoga Workouts*. New York: Fawcett, 1995.

Iyengar, B.K.S. *Light on Yoga*. New York: Schocken, 1975.

PERIODICALS

Yoga Journal. P.O. Box 469088, Escondido, CA 92046. <http:// www.yogajournal.com>.

Yoga International Magazine. R.R. 1 Box 407, Honesdale, PA 18431. <http://www.yimag.com>.

ORGANIZATIONS

International Association of Yoga Therapists (IAYT). 4150 Tivoli Ave., Los Angeles, CA 90066.

OTHER

<http://www.yogadirectory.com>.

<http://www.mv.com. (yoga for beginners web page).

Douglas Dupler

Haverhill fever *see* **Rat-bite fever**

Hay fever *see* **Allergic rhinitis**

HBF test *see* **Fetal hemoglobin test**

HCG *see* **Infertility drugs**

Head and neck cancer

Definition

The term head and neck cancers refers to a group of cancers found in the head and neck region. This includes tumors found in:

- The oral cavity (mouth). The lips, the tongue, the teeth, the gums, the lining inside the lips and cheeks, the floor of the mouth (under the tongue), the roof of the mouth and the small area behind the wisdom teeth are all included in the oral cavity.
- The oropharynx (which includes the back one-third of the tongue, the back of the throat and the tonsils).
- Nasopharynx (which includes the area behind the nose).
- Hypopharynx (lower part of the throat).
- The larynx (voice box, located in front of the neck, in the region of the Adam's apple). In the larynx, the **cancer** can occur in any of the three regions: the glottis (where the vocal cords are); the supraglottis (the area above the glottis), and the subglottis (the area that connects the glottis to the windpipe).

The most frequently occurring cancers of the head and neck area are oral cancers and laryngeal cancers. Almost half of all the head and neck cancers occur in the oral cavity, and a third of the cancers are found in the larynx. By definition, the term "head and neck cancers" usually excludes tumors that occur in the brain.

Description

Head and neck cancers involve the respiratory tract and the digestive tract; and they interfere with the functions of eating and breathing. Laryngeal cancers affect

speech. Loss of any of these functions is significant. Hence, early detection and appropriate treatment of head and neck cancers is of utmost importance.

Roughly 10% of all cancers are related to the head and the neck. It is estimated that more than 55,000 Americans will develop cancer of the head and neck in 1998, and nearly 13,000 will die from the disease. The American Cancer Society estimates that in 1998, approximately, 11,100 new cases of **laryngeal cancer** alone will be diagnosed and 4,300 people will die of this disease. Oral cancer is the sixth most common cancer in the United States. Approximately 40,000 new cases are diagnosed each year and it causes at least 8,000 deaths. Among the major cancers, the survival rate for head and neck cancers is one of the poorest. Less than 50% of the patients survive five years or more after initial diagnosis. This is because the early signs of head and neck cancers are frequently ignored. Hence, when it is first diagnosed, it is often in an advanced stage and not very amenable to treatment.

The risk for both oral cancer and laryngeal cancer seems to increase with age. Most of the cases occur in individuals over 40 years of age, the average age at diagnosis being 60. While oral cancer strikes men twice as often as it does women, laryngeal cancer is four times more common in men than in women. Both diseases are more common in black Americans than among whites.

Causes and symptoms

Although the exact cause for these cancers is unknown, tobacco is regarded as the single greatest risk factor: 75–80% of the oral and laryngeal cancer cases occur among smokers. Heavy alcohol use has also been included as a risk factor. A combination of tobacco and alcohol use increases the risk for oral cancer by 6–15 times more than for users of either substance alone. In rare cases, irritation to the lining of the mouth, due to jagged teeth or ill-fitting dentures, has been known to cause oral cancer. Exposure to asbestos appears to increase the risk of developing laryngeal cancer.

In the case of lip cancer, just like skin cancer, exposure to sun over a prolonged period has been shown to increase the risk. In the Southeast Asian countries (India and Sri Lanka), chewing of betel nut has been associated with cancer of the lining of the cheek. An increased incidence of nasal cavity cancer has been observed among furniture workers, probably due to the inhalation of wood dust. A virus (Epstein-Barr) has been shown to cause nasopharyngeal cancer.

Head and neck cancers are one of the easiest to detect. The early signs can be both seen and felt. The signs and symptoms depend on the location of the cancer:

- Mouth and oral cavity: a sore that does not heal within two weeks, unusual bleeding from the teeth or gums, a white or red patch in the mouth, a lump or thickening in the mouth, throat, or tongue.
- Larynx: persistent hoarseness or **sore throat**, difficulty breathing, or **pain**.
- Hypopharynx and oropharynx: difficulty in swallowing or chewing food, ear pain.
- Nose, sinuses, and nasopharyngeal cavity: pain, bloody discharges from the nose, blocked nose, and frequent sinus infections that do not respond to standard **antibiotics**.

When detected early and treated appropriately, head and neck cancers have an excellent chance of being cured completely.

Diagnosis

Specific diagnostic tests used depend on the location of the cancer. The standard tests are:

Physical examination

The first step in diagnosis is a complete and thorough examination of the oral and nasal cavity, using mirrors and other visual aids. The tongue and the back of the throat are examined as well. Any suspicious looking lumps or lesions are examined with fingers (palpation). In order to look inside the larynx, the doctor may sometimes perform a procedure known as **laryngoscopy**. In indirect laryngoscopy, the doctor looks down the throat with a small, long handled mirror. Sometimes the doctor inserts a lighted tube (laryngoscope or a fiberoptic scope) through the patient's nose or mouth. As the tube goes down the throat, the doctor can observe areas that cannot be seen by a simple mirror. This procedure is called a direct laryngoscopy. Sometimes patients may be given a mild sedative to help them relax, and a local anesthetic to ease any discomfort.

Blood tests

The doctor may order blood or other immunological tests. These tests are aimed at detecting antibodies to the Epstein-Barr virus, which has been known to cause cancer of the nasopharynx.

Imaging tests

X rays of the mouth, the sinuses, the skull, and the chest region may be required. A computed tomography scan (CT scan), a procedure in which a computer takes a series of x ray pictures of areas inside the body, may be done. Ultrasonograms (images generated using sound

waves) or an MRI (**magnetic resonance imaging**) a procedure in which a picture is created using magnets linked to a computer), are alternate procedures which a doctor may have done to get detailed pictures of the areas inside the body.

Biopsy

When a sore does not heal or a suspicious patch or lump is seen in the mouth, larynx, nasopharynx, or throat, a biopsy may be performed to rule out the possibility of cancer. The biopsy is the most definitive diagnostic tool for detecting the cancer. If cancerous cells are detected in the biopsied sample, the doctor may perform more extensive tests in order to find whether, and to where, the cancer may have spread.

Treatment

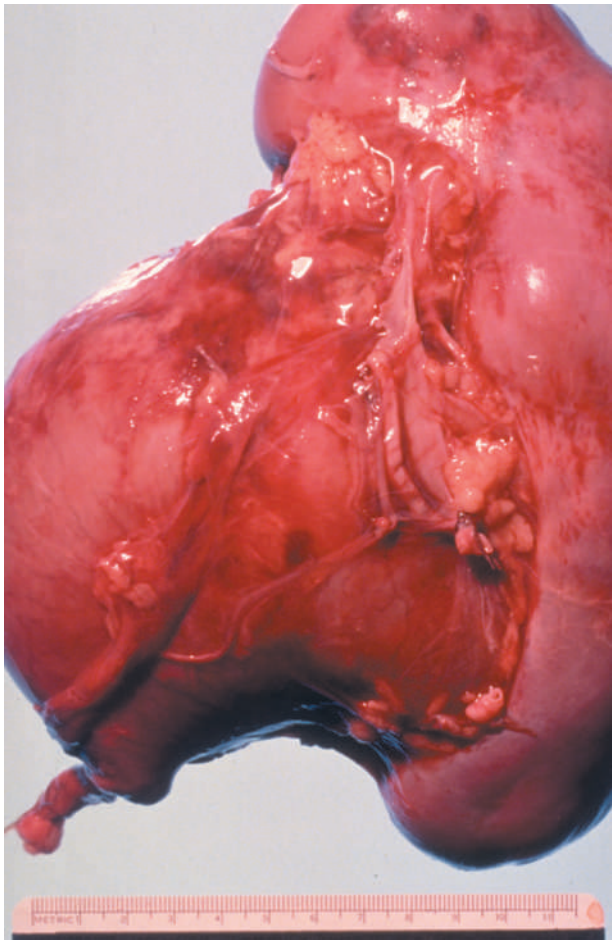
The cancers can be treated successfully if diagnosed early. The choice of treatment depends on the size of the tumor, its location, and whether it has spread to other parts of the body.

In the case of lip and mouth cancers, sometimes surgery is performed to remove the cancer. **Radiation therapy**, which destroys the cancerous cells, is also one of the primary modes of treatment, and may be used alone or in combination with surgery. If lip surgery is drastic, **rehabilitation** cosmetic or reconstructive surgery may have to be considered.

Cancers of the nasal cavity are often diagnosed late because they have no specific symptoms in their early stages, or the symptoms may just resemble chronic **sinusitis**. Hence, treatment is often complex, involving a combination of radiotherapy and surgery. Surgery is generally recommended for small tumors. If the cancer cannot be removed by surgery, radiotherapy is used alone.

Treatment of oropharynx cancers (cancers that are either in the back of the tongue, the throat, or the tonsils) generally involves radiation therapy and/or surgery. After aggressive surgery and radiation, rehabilitation is often necessary and is an essential part of the treatment. The patient may experience difficulties with swallowing, chewing, and speech and may require a team of health care workers, including speech therapists, prosthodontists, occupational therapists etc.

Cancers of the nasopharynx are different from the other head and neck cancers in that there does not appear to be any association between alcohol and tobacco use and the development of the cancer. In addition, the incidence is seen primarily in two age groups: young adults and 50–70 year-olds. The Epstein-Barr virus has been implicated as the causative agent in most patients. While



A specimen of a squamous cell carcinoma of the tongue and jaw. *(Custom Medical Stock Photo. Reproduced by permission.)*

80–90% of small tumors are curable by radiation therapy, advanced tumors that have spread to the bone and cranial nerves are difficult to control. Surgery is not very helpful and, hence, is rarely attempted. Radiation remains the only treatment of choice to treat the cancer that has metastasized (traveled) to the lymph nodes in the neck.

In the case of cancer of the larynx, radiotherapy is the first choice to treat small lesions. This is done in an attempt to preserve the voice. If the cancer recurs later, surgery may be attempted. If the cancer is limited to one of the two vocal cords, laser excision surgery is used. In order to treat advanced cancers, a combination of surgery and radiation therapy is often used. Because the chances of a cure in the case of advanced laryngeal cancers are rather low with current therapies, the patient may be advised to participate in clinical trials so they may get access to new experimental drugs and procedures, such as **chemotherapy**, that are being evaluated.

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Chemotherapy—Treatment of cancer with synthetic drugs that destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Clinical trials—Highly regulated and carefully controlled patient studies, where either new drugs to treat cancer or novel methods of treatment are investigated.

Computerized tomography scan (CT scan)—A medical procedure where a series of X-rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Laryngoscopy—A medical procedure that uses flexible, lighted, narrow tubes inserted through the mouth or nose to examine the larynx and other areas deep inside the neck.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes where pictures of areas inside the body can be created using a magnet linked to a computer.

Radiation therapy—Treatment using high energy radiation from x-ray machines, cobalt, radium, or other sources.

Stoma—When the entire larynx must be surgically removed, an opening is surgically created in the neck so that the windpipe can be brought out to the neck. This opening is called the stoma.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms, or pictures of areas inside the body.

X rays—High energy radiation used in high doses, either to diagnose or treat disease.

When only part of the larynx is removed, a relatively slight change in the voice may occur—the patient may sound slightly hoarse. However, in a total **laryngectomy**, the entire voice box is removed. The patients then have to re-learn to speak using different approaches, such as esophageal speech, tracheo-esophageal (TE) speech, or by means of an artificial larynx.

In esophageal speech, the patients are taught how to create a new type of voice by forcing air through the esophagus (food pipe) into the mouth. This method has a high success rate of approximately 65% and patients are even able to go back to jobs that require a high level of verbal communication, such as telephone operators and salespersons.

In the second approach, TE speech, a small opening, called a fistula, is created surgically between the trachea (breathing tube to the lungs) and the esophagus (tube into the stomach) to carry air into the throat. A small tube, known as the "voice prosthesis," is placed in the opening of the fistula to keep it open and to prevent food and liquid from going down into the trachea. In order to talk, the stoma (or the opening made at the base of the neck) must be covered with one's thumb during exhalation. As the air is forced out from the trachea into the esophagus, it vibrates the walls of the esophagus. This produces a sound that is then modified by the lips and tongue to produce normal sounding speech.

In the third approach, an artificial larynx, a battery driven vibrator, is placed on the outside of the throat. Sound is created as air passes through the stoma (opening made at the base of the neck) and the mouth forms words.

Prognosis

Oral Cavity

With early detection and immediate treatment, survival rates can be dramatically improved. For lip and oral cancer, if detected at its early stages, almost 80% of the patients survive five years or more. However, when diagnosed at the advanced stages, the five year survival rate drops to a mere 18%.

Nose and sinuses

Cancers of the nasal cavity often go undetected until they reach an advanced stage. If diagnosed at the early stages, the five-year survival rates are 60–70%. However, if cancers are more advanced, only 10–30% of the patients survive five years or more.

Oropharynx

In cancer of the oropharynx, 60–80% of the patients survive five years or more if the cancer is detected in the

early stages. As the cancer advances, the survival rate drops to 15–30%.

Nasopharynx

Patients who are diagnosed with early stage cancers that have originated in the nasopharynx have an excellent chance of a complete cure (almost 95%). Unfortunately, most of the time, the patients are in an advanced stage at the time of initial diagnosis. With the new chemotherapy drugs, the five year survival rate has improved and 5–40% of the patients survive five years or longer.

Larynx

Small cancers of the larynx have an excellent five-year survival rate of 75–95%. However, as with most of the head and neck cancers, the survival rates drop dramatically as the cancer advances. Only 15–25% of the patients survive five years or more after being initially diagnosed with advanced laryngeal cancer.

Prevention

Refraining from the use of all tobacco products (cigarettes, cigars, pipe tobacco, chewing tobacco), consuming alcohol in moderation, and practicing good **oral hygiene** are some of the measures that one can take to prevent head and neck cancers. Since there is an association between excessive exposure to the sun and lip cancer, people who spend a lot of time outdoors in the sun should protect themselves from the sun's harmful rays. Regular physical examinations, or mouth examination by the patient himself, or by the patient's doctor or dentist, can help detect oral cancer in its very early stages.

Since working with asbestos has been shown to increase one's risk of getting cancer of the larynx, asbestos workers should follow safety rules to avoid inhaling asbestos fibers. Also, **malnutrition** and vitamin deficiencies have been shown to have some association with an increased incidence of head and neck cancers. The American Cancer Society, therefore, recommends eating a healthy diet, consisting of at least five servings of fruits and vegetables every day, and six servings of food from other plant sources such as cereals, breads, grain products, rice, pasta and beans. Reducing one's intake of high-fat food from animal sources is advised.

Resources

BOOKS

Berkow, Robert, ed., et al. *Merck Manual of Diagnosis and Therapy.* 16th ed. Rahway, NJ: Merck Research Laboratories, 1992.

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Morra, Marion E., and Eve Potts. *Choices: The New, Most Up-To-Date Sourcebook for Cancer Information.* New York: Avon Books, 1994.

ORGANIZATIONS

American Association of Oral and Maxillofacial Surgeons. 9700 West Bryn Mawr Ave., Rosemont, IL 60018-5701. (847) 678-6200. <http://www.aaoms.org>.

International Association of Laryngectomies (IAL). 7440 North Shadeland Ave., Suite 100, Indianapolis, IN 46250.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

National Oral Health Information ClearingHouse; 1 NOHIC Way, Bethesda, MD 20892-3500. (301) 402-7364.

Oral Health Education Foundation, Inc. 5865 Colonist Drive, P.O. Box 396, Fairburn, GA 30213. (770) 969-7400.

Lata Cherath, PhD

Head injury

Definition

Injury to the head may damage the scalp, skull or brain. The most important consequence of head trauma is traumatic brain injury. Head injury may occur either as a closed head injury, such as the head hitting a car's windshield, or as a penetrating head injury, as when a bullet pierces the skull. Both may cause damage that ranges from mild to profound. Very severe injury can be fatal because of profound brain damage.

Description

External trauma to the head is capable of damaging the brain, even if there is no external evidence of damage. More serious injuries can cause skull fracture, blood clots between the skull and the brain, or bruising and tearing of the brain tissue itself.

Injuries to the head can be caused by traffic accidents, **sports injuries**, falls, workplace accidents, assaults, or bullets. Most people have had some type of head injury at least once in their lives, but rarely do they require a hospital visit.

However, each year about two million people suffer from a more serious head injury, and up to 750,000 of them are severe enough to require hospitalization. Brain injury is most likely to occur in males between ages 15 and 24, usually as a result of car and motorcycle acci-

dents. About 70% of all accidental deaths are due to head injuries, as are most of the disabilities that occur after trauma.

A person who has had a head injury and who is experiencing the following symptoms should seek medical care immediately:

- serious bleeding from the head or face
- loss of consciousness, however brief
- confusion and lethargy
- lack of pulse or breathing
- clear fluid drainage from the nose or ear

Causes and symptoms

A head injury may cause damage both from the direct physical injury to the brain and from secondary factors, such as lack of oxygen, brain swelling, and disturbance of blood flow. Both closed and penetrating head injuries can cause swirling movements throughout the brain, tearing nerve fibers and causing widespread bleeding or a blood clot in or around the brain. Swelling may raise pressure within the skull (intracranial pressure) and may block the flow of oxygen to the brain.

Head trauma may cause a **concussion**, in which there is a brief loss of consciousness without visible structural damage to the brain. In addition to loss of consciousness, initial symptoms of brain injury may include:

- memory loss and confusion
- vomiting
- **dizziness**
- partial **paralysis** or numbness
- shock
- anxiety

After a head injury, there may be a period of impaired consciousness followed by a period of confusion and impaired memory with disorientation and a breakdown in the ability to store and retrieve new information. Others experience temporary **amnesia** following head injury that begins with memory loss over a period of weeks, months, or years before the injury (retrograde amnesia). As the patient recovers, memory slowly returns. Post-traumatic amnesia refers to loss of memory for events during and after the accident.

Epilepsy occurs in 2–5% of those who have had a head injury; it is much more common in people who have had severe or penetrating injuries. Most cases of epilepsy appear right after the accident or within the first year, and become less likely with increased time following the accident.

Closed head injury

Closed head injury refers to brain injury without any penetrating injury to the brain. It may be the result of a direct blow to the head; of the moving head being rapidly stopped, such as when a person's head hits a windshield in a car accident; or by the sudden deceleration of the head without its striking another object. The kind of injury the brain receives in a closed head injury is determined by whether or not the head was unrestrained upon impact and the direction, force, and velocity of the blow. If the head is resting on impact, the maximum damage will be found at the impact site. A moving head will cause a "contrecoup injury" where the brain damage occurs on the side opposite the point of impact, as a result of the brain slamming into that side of the skull. A closed head injury also may occur without the head being struck, such as when a person experiences **whiplash**. This type of injury occurs because the brain is of a different density than the skull, and can be injured when delicate brain tissues hit against the rough, jagged inner surface of the skull.

Penetrating head injury

If the skull is fractured, bone fragments may be driven into the brain. Any object that penetrates the skull may implant foreign material and dirt into the brain, leading to an infection.

Skull fracture

A skull fracture is a medical emergency that must be treated promptly to prevent possible brain damage. Such an injury may be obvious if blood or bone fragments are visible, but it's possible for a fracture to have occurred without any apparent damage. A skull fracture should be suspected if there is:

- blood or clear fluid leaking from nose or ears
- unequal pupil size
- bruises or discoloration around the eyes or behind the ears
- swelling or depression of the part of the head

Intracranial hemorrhage

Bleeding (hemorrhage) inside the skull may accompany a head injury and cause additional damage to the brain. A blood clot (hematoma) may occur if a blood vessel between the skull and the brain ruptures; when the blood leaks out and forms a clot, it can press against brain tissue, causing symptoms from a few hours to a few weeks after the injury. If the clot is located between the bones of the skull and the covering of the brain (dura), it

is called an epidural hematoma. If the clot is between the dura and the brain tissue itself, the condition is called a **subdural hematoma**. In other cases, bleeding may occur deeper inside the brain. This condition is called intracerebral hemorrhage or intracerebral contusion (from the word for bruising).

In any case, if the blood flow is not stopped, it can lead to unconsciousness and **death**. The symptoms of bleeding within the skull include:

- nausea and vomiting
- **headache**
- loss of consciousness
- unequal pupil size
- lethargy

Postconcussion syndrome

If the head injury is mild, there may be no symptoms other than a slight headache, or there also may be confusion, dizziness, and blurred vision. While the head injury may seem to have been quite mild, in many cases symptoms persist for days or weeks. Up to 60% of patients who sustain a mild brain injury continue to experience a range of symptoms called "postconcussion syndrome," as long as six months or a year after the injury.

The symptoms of postconcussion syndrome can result in a puzzling interplay of behavioral, cognitive, and emotional complaints that can be difficult to diagnose, including:

- headache
- dizziness
- mental confusion
- behavior changes
- memory loss
- cognitive deficits
- depression
- emotional outbursts

Diagnosis

The extent of damage in a severe head injury can be assessed with computed tomography scan (CT scan), **magnetic resonance imaging** (MRI), **positron emission tomography** (**PET**) scans, electroencephalograms (EEG), and routine neurological and neuropsychological evaluations.

Doctors use the Glasgow **Coma** Scale to evaluate the extent of brain damage based on observing a patient's ability to open his or her eyes, respond verbally, and respond to stimulation by moving (motor response). Patients can score from three to 15 points on this scale. People who score below eight when they are admitted usually have suffered a severe brain injury and will need rehabilitative therapy as they recover. In general, higher scores on the Glasgow Coma Scale indicate less severe brain injury and a better prognosis for recovery.

A three-dimensional computed tomography (CT) scan of a human skull showing a depressed skull fracture above the right eye. *(Custom Medical Stock Photo. Reproduced by permission.)*

Patients with a mild head injury who experience symptoms are advised to seek out the care of a specialist; unless a family physician is thoroughly familiar with medical literature in this newly emerging area, experts warn that there is a good chance that patient complaints after a mild head injury will be downplayed or dismissed. In the case of mild head injury or postconcussion syndrome, CT and MRI scans, electroencephalograms (EEG), and routine neurological evaluations all may be normal because the damage is so subtle. In many cases, these tests can't detect the microscopic damage that

KEY TERMS

Computed tomography scan (CT)—A diagnostic technique in which the combined use of a computer and x rays produce clear cross-sectional images of tissue. It provides clearer, more detailed information than x rays alone.

Electroencephalogram (EEG)—A record of the tiny electrical impulses produced by the brain's activity. By measuring characteristic wave patterns, the EEG can help diagnose certain conditions of the brain.

Magnetic resonance imaging (MRI)—A diagnostic technique that provides high quality cross-sectional images of organs within the body without x rays or other radiation.

Positron emission tomography (PET) scan—A computerized diagnostic technique that uses radioactive substances to examine structures of the body. When used to assess the brain, it produces a three-dimensional image that reflects the metabolic and chemical activity of the brain.

occurs when fibers are stretched in a mild, diffuse injury. In this type of injury, the axons lose some of their covering and become less efficient. This mild injury to the white matter reduces the quality of communication between different parts or the brain. A PET scan, which evaluates cerebral blood flow and brain metabolism, may be of help in diagnosing mild head injury, although this is still largely considered to be an experimental procedure.

Patients with continuing symptoms after a mild head injury should call a local chapter of a head-injury foundation that can refer patients to the best nearby expert.

Treatment

If a concussion, bleeding inside the skull, or skull fracture is suspected, the patient should be kept quiet in a darkened room, with head and shoulders raised slightly on pillow or blanket.

After initial emergency treatment, a team of specialists may be needed to evaluate and treat the problems that result. A penetrating wound may require surgery. Those with severe injuries or with a deteriorating level of consciousness may be kept hospitalized for observation. If there is bleeding inside the skull, the blood may need to be surgically drained; if a clot has formed, it may need to be removed. Severe skull **fractures** also require surgery. Supportive care and specific treatments may be required if the patient experiences further complications. People who experience seizures, for example, may be given **anticonvulsant drugs**, and people who develop fluid on the brain (**hydrocephalus**) may have a shunt inserted to drain the fluid.

In the event of long-term disability as a result of head injury, there are a variety of treatment programs available, including long-term **rehabilitation**, coma treatment centers, transitional living programs, behavior management programs, life-long residential or day treatment programs and independent living programs.

Prognosis

Prompt, proper diagnosis and treatment can help alleviate some of the problems after a head injury. However, it is usually difficult to predict the outcome of a brain injury in the first few hours or days; a patient's prognosis may not be known for many months or even years.

The outlook for someone with a minor head injury is generally good, although recovery may be delayed and symptoms such as headache, dizziness, and cognitive problems can persist for up to a year or longer after an accident. This can limit a person's ability to work and cause strain in personal relationships.

Serious head injuries can be devastating, producing permanent mental and physical disability. Epileptic seizures may occur after a severe head injury, especially a penetrating brain injury, a severe skull fracture, or a serious brain hemorrhage. Recovery from a severe head injury can be very slow, and it may take five years or longer to heal completely. Risk factors associated with an increased likelihood of memory problems or seizures after head injury include age, length and depth of coma, duration of post-traumatic and retrograde amnesia, presence of focal brain injuries, and initial Glasgow Coma Scale score.

Prevention

Many severe head injuries could be prevented by wearing protective helmets during certain sports, or when riding a bike or motorcycle. Seat belts and airbags can prevent many head injuries as a result of car accidents. Appropriate protective headgear should always be worn on the job where head injuries are a possibility.

Resources

BOOKS

Greenberg, David A., et al. *Clinical Neurology.* 2nd ed. Norwalk, CT: Appleton & Lange, 1993.

Weiner, William J. *Neurology for the Non-Neurologist.* 3rd ed. Philadelphia: J. B. Lippincott, 1994.

PERIODICALS

Mild Traumatic Brain Injury Committee. "Definition of Mild Traumatic Brain Injury." *Journal of Head Trauma Rehabilitation* 8 (1993): 86-87.

Soren, S. and Kraus, J.F. "Occurrence, Severity and Outcomes of Brain Injury" *Journal of Head Trauma Rehabilitation* 6 (1991):1-10.

ORGANIZATIONS

American Epilepsy Society. 638 Prospect Ave., Hartford, CT 06105. (203) 232-4825.

Brain Injury Association. 1776 Massachusetts Ave. NW, Ste. 100, Washington, DC 20036. (800) 444-6443.

Family Caregiver Alliance. 425 Bush St., Ste. 500, San Francisco, CA 94108. (800) 445-8106. <http://www.caregiver.org>.

Head Injury Hotline. PO Box 84151, Seattle WA 98124. (206) 621- 8558. <http://www.headinjury.com>.

Head Trauma Support Project, Inc. 2500 Marconi Ave., Ste. 203, Sacramento, CA 95821. (916) 482-5770.

National Head Injury Foundation. 333 Turnpike Rd., Southboro, MA 01722. (617) 485-9950.

Carol A. Turkington

Head lice *see* **Lice infestation**

Head trauma *see* **Head injury**

Headache

Definition

A headache involves **pain** in the head which can arise from many disorders or may be a disorder in and of itself.

Description

There are three types of primary headaches: tension-type (muscular contraction headache), migraine (vascular headaches), and cluster. Virtually everyone experiences a tension-type headache at some point. An estimated 18% of American women suffer migraines, compared to 6% of men. Cluster headaches affect fewer than 0.5% of the population, and men account for approximately 80% of all cases. Headaches caused by illness are secondary headaches and are not included in these numbers.

Approximately 40–45 million people in the United States suffer chronic headaches. Headaches have an enormous impact on society due to missed workdays and productivity losses.

Causes and symptoms

Traditional theories about headaches link tension-type headaches to muscle contraction, and migraine and cluster headaches to blood vessel dilation (swelling). Pain-sensitive structures in the head include blood vessel walls, membranous coverings of the brain, and scalp and neck muscles. Brain tissue itself has no sensitivity to pain. Therefore, headaches may result from contraction of the muscles of the scalp, face or neck; dilation of the blood vessels in the head; or brain swelling that stretches the brain's coverings. Involvement of specific nerves of the face and head may also cause characteristic headaches. Sinus inflammation is a common cause of headache. Keeping a headache diary may help link headaches to stressful occurrences, menstrual phases, food triggers, or medication.

Tension-type headaches are often brought on by **stress**, overexertion, loud noise, and other external factors. The typical tension-type headache is described as a tightening around the head and neck, and an accompanying dull ache.

Migraines are intense throbbing headaches occurring on one or both sides of the head. The pain is accompanied by other symptoms such as nausea, vomiting, blurred vision, and aversion to light, sound, and movement. Migraines are often triggered by food items, such as red wine, chocolate, and aged cheeses. For women, a hormonal connection is likely, since headaches occur at specific points in the menstrual cycle, with use of **oral contraceptives**, or the use of **hormone replacement therapy** after **menopause**.

Cluster headaches cause excruciating pain. The severe, stabbing pain centers around one eye, and eye tearing and nasal congestion occur on the same side. The headache lasts from 15 minutes to four hours and may recur several times in a day. Heavy smokers are more likely to suffer cluster headaches, which are also associated with alcohol consumption.

Diagnosis

Since headaches arise from many causes, a physical exam assesses general health and a **neurologic exam** evaluates the possibility of neurologic disease that is causing the headache. If the headache is the primary illness, a doctor elicits a thorough history of the headache. Questions revolve around its frequency and duration, when it occurs, pain intensity and location, possible triggers, and any prior symptoms. This information aids in classifying the headache.

Warning signs that should point out the need for prompt medical intervention include:

- "Worst headache of my life." This may indicate **subarachnoid hemorrhage** from a ruptured aneurysm

KEY TERMS

Abortive—Referring to treatment which relieves symptoms of a disorder.

Analgesics—A class of pain-relieving medicines, including aspirin and Tylenol.

Biofeedback—A technique in which a person is taught to consciously control the body's response to a stimulus.

Chronic—Referring to a condition that occurs frequently or continuously or on a regular basis.

Prophylactic—Referring to treatment which prevents symptoms of a disorder from appearing.

Transcutaneous electrical nerve stimulation—A method that electrically stimulates nerve and blocks the transmission of pain signals, called TENS.

(swollen blood vessel) in the head or other neurological emergency.

- Headache accompanied by one-sided weakness, numbness, visual loss, speech difficulty, or other signs. This may indicate a **stroke**. Migraines may include neurological symptoms.
- Headache that becomes worse over a period of 6 months, especially if most prominent in the morning or if accompanied by neurological symptoms. This may indicate a **brain tumor**.
- Sudden onset of headache. If accompanied by **fever** and stiff neck, this can indicate **meningitis**.

Headache diagnosis may include neurological imaging tests such as computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI).

Treatment

Headache treatment is divided into two forms: abortive and prophylactic. Abortive treatment addresses a headache in progress, and prophylactic treatment prevents headache occurrence.

Tension-type and migraine headaches can be treated with **aspirin**, **acetaminophen**, ibuprofen, or naproxen. In early 1998, the FDA approved extra-strength Excedrin, which includes **caffeine**, for mild to moderate migraines. Prescription medications such as antidepressants and **muscle relaxants** can address tension-type headaches, and ergotamine tartrate or sumatriptan can relieve or prevent migraines. Cluster headaches may also be treated with ergotamine and sumatriptan, as well as by inhaling pure oxygen. Prophylactic treatments include prednisone, **calcium channel blockers**, and methysergide.

Alternative treatment

Alternative headache treatments include:

- acupuncture or **acupressure**
- biofeedback
- chiropractic
- herbal remedies using feverfew (*Chrysanthemum parthenium*), valerian (*Valeriana officinalis*), white willow (*Salix alba*), or skullcap (*Scutellaria lateriflora*), among others
- homeopathic remedies chosen specifically for the individual and his/her type of headache
- hydrotherapy
- massage
- magnesium supplements
- regular physical **exercise**
- relaxation techniques, such as **meditation** and **yoga**
- transcutaneous **electrical nerve stimulation** (TENS). (A test that electrically stimulates nerves and blocks the signals of pain transmission)

Prognosis

Headaches are typically resolved through the use of **analgesics** and other treatments.

Prevention

Some headaches may be prevented by avoiding triggering substances and situations, or by employing alternative therapies, such as yoga and regular exercise. Since food **allergies** are often linked with headaches, especially cluster headaches and migraines, identification and elimination of the allergy-causing food(s) from the diet can be an important preventive measure.

Resources

BOOKS

Rapoport, Alan M., and Fred D. Sheftell. *Headache Disorders: A Management Guide for Practitioners*. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Chaballa, Mark, and Karen J. Tietze. "Headache." *American Druggist* 213, no. 6 (1996): 42.

ORGANIZATIONS

American Council for Headache Education (ACHE). 19 Mantua Road, Mt. Royal, NJ 08061. (800) 255-2243. <http://www.achenet.org>.

National Headache Foundation. 428 W. St. James Place, Chicago, IL 60614. (800) 843-2256. <http://www.headaches.org>.

Julia Barrett

Hearing aids

Definition

A hearing aid is a device that can amplify sound waves in order to help a deaf or hard-of-hearing person hear sounds more clearly.

Purpose

Recent technology can help most people with **hearing loss** understand speech better and achieve better communication.

Precautions

It's important that a person being fitted for a hearing aid understand what an aid can and can't do. An aid can help a person hear better, but it won't return hearing to normal levels. Hearing aids boost all sounds, not just those the person wishes to hear. Especially when the source of sound is far away (such as up on a stage), environmental noise can interfere with good speech perception. And while the aid amplifies sound, it doesn't necessarily improve the clarity of the sound. A hearing aid is a machine, and can never duplicate the true sound that people with normal hearing experience, but it will help the person take advantage of the hearing that remains.

Description

More than 1,000 different models are available in the United States. All of them include a microphone (to pick up sound), amplifier (to boost sound strength), a receiver or speaker (to deliver sound to the ear), and are powered by a battery. Depending on the style, it's possible to add features to filter or block out background noise, minimize feedback, lower sound in noisy settings, or boost power when needed.

Hearing aids are either "monaural" (a hearing aid for one ear), or "binaural" (for two ears); more than 65% of all users have binaural aids. Hearing aids are divided into several different types:

- digital
- in-the-ear
- in-the-canal
- behind-the-ear
- on-the-body

Digital aids are sophisticated, very expensive aids that borrow computer technology to allow a person to tailor an aid to a specific hearing loss pattern. Using miniature computer chips, the aids can selectively boost certain frequencies while leaving others alone. This means a person could wear such an aid to a loud party, and screen out unwanted background noise, while tuning in on one-on-one conversations. The aid is programmed by the dealer to conform to the patient's specific hearing loss. Some models can be programmed to allow the wearer to choose different settings depending on the noise of the environment.

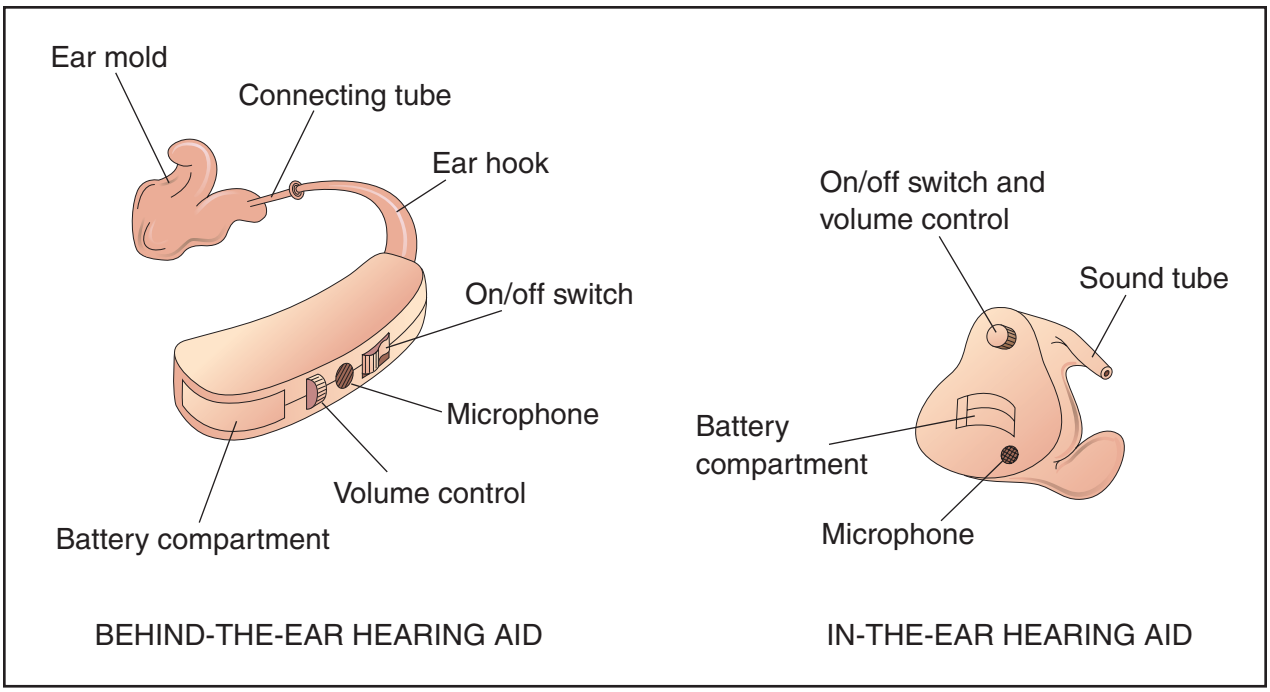
In-the-ear aids are lightweight devices whose custom-made housings contain all the components; this device fits into the ear canal with no visible wires or tubes. It's possible to control tone but not volume with these aids, so they are helpful only for people with mild hearing loss. Some people find these aids are easier to put on and take off than behind-the-ear aids. However, because they are custom-fit to a person's ear, it is not possible to try on before ordering. Some people find them uncomfortable in hot weather.

In-the-canal aids fit far into the ear canal, with only a small bit extending into the external ear. The smallest is the MicroCanal, which fits out of sight down next to the eardrum and is removed with a small transparent wire. These are extremely expensive, but they are not visible, offer better acoustics, and are easier to maintain. They can more closely mimic natural sound because of the position of the microphone; this position also cuts down on wind noise. But their small size makes them harder to handle, and their battery is especially small and difficult to insert. Adjusting the volume may be hard, since a person must stick a finger down into the ear to adjust volume, and this very tiny aid doesn't have the power of other, larger, aids.

Behind-the-ear aids include a microphone, amplifier and receiver inside a small curved case worn behind the ear; the case is connected to the earmold by a short plastic tube. The earmold extends into the ear canal. Some models have both tone and volume control, plus a telephone pickup device. However, many users, think them unattractive and out of date; and people who wear glasses find that the glasses interfere with the aid's fit. Others don't have space behind the ear for the mold to fit comfortably. However, they do offer a few advantages.

Behind-the-ear aids:

- don't require as much maintenance
- are easily interchangeable if they need to be serviced
- are more powerful



Hearing aids are devices that can amplify sound waves to help a deaf or hard-of-hearing person hear sounds more clearly. *(Illustration by Electronic Illustrators Group.)*

- are easier to handle than smaller aids
- can provide better sound quality
- tend to be more reliable

Eyeglass models are the same as behind-the-ear devices, except that the case fits into an eyeglass frame instead of resting behind the ears. Not many people buy this type of aid, but those who do believe it's less obvious, although there is a tube that travels from the temple of the glasses to the earmold. But it can be hard to fit this type of aid, and repairs can be problematic. Also, if the aid breaks, the person also loses the benefit of the glasses.

CROS or the crossover system type of hearing aid is often used in conjunction with the eyeglass model. The CROS (contralateral routing of signal) system features a microphone behind the ear that feeds the amplified signal to the better ear, eliminating "head shadow," which occurs when the head blocks sound from the better ear. This type may help make speech easier to understand for people with a high-frequency loss in both ears.

A BI-CROS system uses two microphones (one above each ear) that send signals to a single amplifier. Sound then travels to a single receiver, which transfers it to the better ear via a conventional earmold.

On-the-body aids feature a larger microphone, amplifier, and power supply inside a case carried inside the pocket, or attached to clothing. The receiver attaches directly to the earmold; its power comes through a flexible wire from the amplifier. Although larger than other aids, the on-the-body aids are more powerful and easier to adjust than other devices. While not popular for everyone, they are often used by those with a profound hearing loss, or by very young children. Some people who are almost totally deaf find they need the extra power boost available only from a body aid.

The latest aids on the market may eliminate the amplifier and speaker in favor of a tiny magnet mounted on a silicone disk, similar to a contact lens, which rests right on the eardrum. Called the Earlens, it is designed to be held in place by a thin film of oil. Users wear a wireless microphone, either in the ear or on a necklace, that picks up sounds and converts them into magnetic signals, making the magnet vibrate. As the Earlens vibrates, so does the eardrum, transmitting normal-sounding tones to the middle and inner ears.

Other researchers are bypassing the middle ear completely; they surgically implant a tiny magnet in the inner ear. By attaching a magnet to the round window, they open a second pathway to the inner ear. An electromagnetic coil implanted in bone behind the ear vibrates the implanted magnet. Unlike the Earlens, this magnetic implant would not block the normal hearing pathway.

Preparation

The fist step in getting a hearing aid is to have a medical exam and a hearing evaluation. (Most states prohibit anyone selling a hearing aid until the patient has been examined by a physician to rule out medical problems.) After performing a hearing evaluation, an audiologist should be able to determine whether a hearing aid will help, and which one will do the most good. This is especially important because aids can be very expensive (between $500 and $4,000), and are often not covered by health insurance. Hearing aids come in a wide range of styles and types, requiring careful testing to make sure the aid is the best choice for a particular hearing loss.

Some audiologists sell aids; others can make a recommendation, or give one a list of competent dealers in one's area. Patients should shop around and compare prices. In all but three states, hearing aids must be fitted and sold only by licensed specialists called dealers, specialists, dispensers, or dispensing audiologists.

The hearing aid dealer will make an impression of the consumer's ears using a putty-like material, from which a personalized earmold will be created. It's the dealer's job to make sure the aid fits properly. The person may need several visits to find the right hearing aid and learn how to use it. The dealer will help the consumer learn how to put the aid on, adjust the controls, and maintain the device. The dealer should be willing to service the aid and provide information about what to do if sensitivity to the earmold develops. (Some people are allergic to the materials in the mold.)

Aftercare

Within several weeks, the wearer should return to the dealer to have the aid checked, and to discuss the progress in wearing the aid. About 40% of all aids need some modification or adjustment in the beginning.

Within the first month of getting an aid, the patient should make an appointment for a full hearing examination to determine if the aid is functioning properly.

Risks

While there are no medical risks to hearing aids, there is a risk associated with hearing aids: many people end up not wearing their aids because they say everything seems loud when wearing them. This is because they have lived for so long with a hearing problem that they have forgotten how loud "normal" sound can be. Other potential problems with hearing aids include earmold discomfort, and a build up of excess ear wax after getting a hearing aid.

KEY TERMS

Audiologist—A person with a degree and/or certification in the areas of identification and measurement of hearing impairments and rehabilitation of those with hearing problems.

Eardrum—A paper-thin covering stretching across the ear canal that separates the middle and outer ears.

Middle ear—The small cavity between the eardrum and the oval window that houses the three tiny bones of hearing.

Oval window—A tiny opening at the entrance to the inner ear.

Normal results

A hearing aid will boost the loudness of sound, which can improve a person's ability to understand speech.

Resources

BOOKS

Carmen, Richard. *The Consumer Handbook on Hearing Loss and Hearing Aids*. New York: Auricle Ink Publishers, 1997.

Turkington, Carol A. *The Hearing Loss Sourcebook*. New York: Penguin, 1997.

PERIODICALS

Dickinson, Ben. "30/40/50: Listen Up While You Still Can." *Esquire* (1 Jan. 1998, 101).

Young, Leslie A. "Sonic Boomers: Clinton's Hearing Aid Catches His Generation's Ear." *Rocky Mountain News* (14 Oct. 1997): 3D.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684-3391.

Hear Now. 9745 E. Hampden Ave., Ste. 300, Denver, CO 80231. (800) 648-HEAR. (202) 651-5258.

Hearing Industries Association. 1800 M St. NW, Washington, DC 20036. (202) 651-5258.

National Hearing Aid Society. 20361 Middlebelt, Livonia, MI 48152. (800) 521-5247 or (313) 478-2610.

National Information Center on Deafness. Gallaudet College, 800 Florida Ave. NE, Washington, DC 20002. (202) 651-5051; (202) 651-5052 (TDD).

Carol A. Turkington

Hearing loss

Definition

Hearing loss is any degree of impairment of the ability to apprehend sound.

Description

Sound can be measured accurately. The term decibel (dB) refers to an amount of energy moving sound from its source to our ears or to a microphone. A drop of more than 10 dB in the level of sound a person can hear is significant.

Sound travels through a medium like air or water as waves of compression and rarefaction. These waves are collected by the external ear and cause the tympanic membrane (ear drum) to vibrate. The chain of ossicles connected to the ear drum—the incus, malleus, and stapes—carries the vibration to the oval window, increasing its amplitude 20 times on the way. There the energy causes a standing wave in the watery liquid (endolymph) inside the Organ of Corti. (A standing wave is one that does not move. A vibrating cup of coffee will demonstrate standing waves.) The configuration of the standing wave is determined by the frequency of the sound. Many thousands of tiny nerve fibers detect the highs and lows of the standing wave and transmit their findings to the brain, which interprets the signals as sound.

To summarize, sound energy passes through the air of the external ear, the bones of the middle ear and the liquid of the inner ear. It is then translated into nerve impulses, sent to the brain through nerves and understood there as sound. It follows that there are five steps in the hearing process:

- air conduction through the external ear to the ear drum
- bone conduction through the middle ear to the inner ear
- water conduction to the Organ of Corti
- nerve conduction into the brain
- interpretation by the brain

Hearing can be interrupted in several ways at each of the five steps.

The external ear canal can be blocked with ear wax, **foreign objects**, infection, and tumors. Overgrowth of the bone, a condition that occurs when the ear canal has been flushed with cold water repeatedly for years, can also narrow the passageway, making blockage and infection more likely. This condition occurs often in Northern Californian surfers and is therefore called "surfer's ear."

The ear drum is so thin a physician can see through it into the middle ear. Sharp objects, pressure from an infection in the middle ear, even a firm cuffing or slapping of the ear, can rupture it. It is also susceptible to pressure changes during scuba diving.

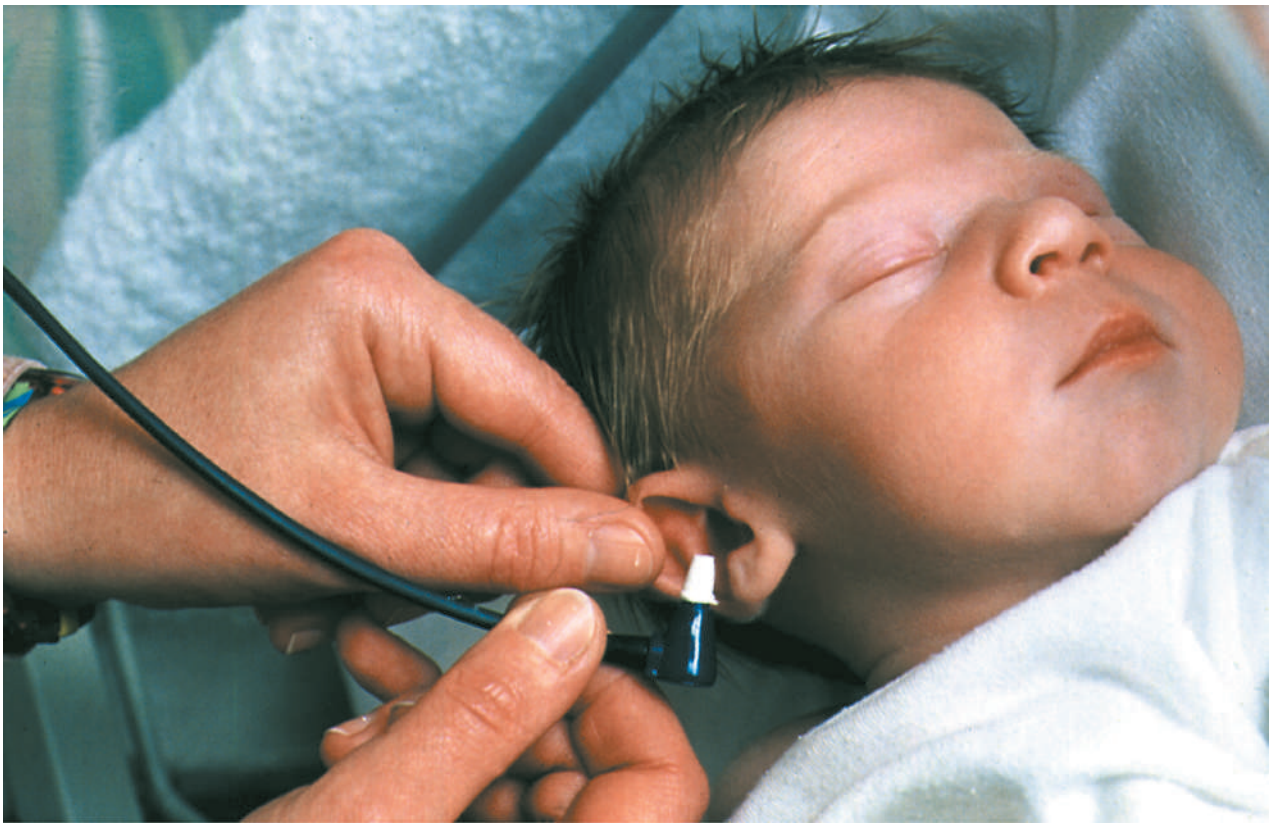
Several conditions can diminish the mobility of the ossicles (small bones) in the middle ear. **Otitis media** (an infection in the middle ear) occurs when fluid cannot escape into the throat because of blockage of the eustachian tube. The fluid that accumulates, whether it be pus or just mucus and dampens the motion of the ossicles. A disease called **otosclerosis** can bind the stapes in the oval window and thereby cause deafness.

All the conditions mentioned so far, those that occur in the external and middle ear, are causes of conductive hearing loss. The second category, sensory hearing loss, refers to damage to the Organ of Corti and the acoustic nerve. Prolonged exposure to loud noise is the leading cause of sensory hearing loss. A million people have this condition, many identified during the military draft and rejected as being unfit for duty. The cause is often believed to be prolonged exposure to rock music. Occupational noise exposure is the other leading cause of noise induced hearing loss (NIHL) and is ample reason for wearing ear protection on the job. A third of people over 65 have presbycusis—sensory hearing loss due to **aging**. Both NIHL and presbycusis are primarily high frequency losses. In most languages, it is the high frequency sounds that define speech, so these people hear plenty of noise, they just cannot easily make out what it means. They have particular trouble selecting out speech from background noise. Brain infections like **meningitis**, drugs such as the aminoglycoside **antibiotics** (streptomycin, gentamycin, kanamycin, tobramycin), and **Meniere's disease** also cause permanent sensory hearing loss. Meniere's disease combines attacks of hearing loss with attacks of vertigo. The symptoms may occur together or separately. High doses of salicylates like **aspirin** and quinine can cause a temporary high-frequency loss. Prolonged high doses can lead to permanent deafness. There is an hereditary form of sensory deafness and a congenital form most often caused by **rubella** (German **measles**).

Sudden hearing loss—at least 30dB in less than three days—is most commonly caused by cochleitis, a mysterious viral infection.

The final category of hearing loss is neural. Damage to the acoustic nerve and the parts of the brain that perform hearing are the most likely to produce permanent hearing loss. Strokes, **multiple sclerosis**, and acoustic neuromas are all possible causes of neural hearing loss.

Hearing can also be diminished by extra sounds generated by the ear, most of them from the same kinds of disorders that cause diminished hearing. These sounds are



An Oto-Acoustic Emission (OAE) hearing test being perfomred on a newborn baby. The probe emits harmless sound into the baby's ear, and the response of the inner ear is detected and registered on a computer. Early diagnosis of a hearing disorder is important in young children, who may experience difficulties in speech and language development. *(Photograph by James King-Holmes, Photo Researchers, Inc. Reproduced by permission.)*

referred to as **tinnitus** and can be ringing, blowing, clicking, or anything else that no one but the patient hears.

Diagnosis

An examination of the ears and nose combined with simple hearing tests done in the physician's office can detect many common causes of hearing loss. An audiogram often concludes the evaluation, since these simple means often produce a diagnosis. If the defect is in the brain or the acoustic nerve, further neurological testing and imaging will be required.

The audiogram has many uses in diagnosing hearing deficits. The pattern of hearing loss across the audible frequencies gives clues to the cause. Several alterations in the testing procedure can give additional information. For example, speech is perceived differently than pure tones. Adequate perception of sound combined with inability to recognize words points to a brain problem rather than a sensory or conductive deficit. Loudness perception is distorted by disease in certain areas but not in others. Acoustic neuromas often distort the perception of loudness.

Treatment

Conductive hearing loss can almost always be restored to some degree, if not completely.

- matter in the ear canal can be easily removed with a dramatic improvement in hearing.
- surfer's ear gradually regresses if cold water is avoided or a special ear plug is used. In advanced cases, surgeons can grind away the excess bone.
- middle ear infection with fluid is also simple to treat. If medications do not work, surgical drainage of the ear is accomplished through the ear drum, which heals completely after treatment.
- traumatically damaged ear drums can be repaired with a tiny skin graft.
- surgical repair of otosclerosis through an operating microscope is one of the most intricate of procedures, substituting tiny artificial parts for the original ossicles.

Sensory and neural hearing loss, on the other hand, cannot readily be cured. Fortunately it is not often complete, so that **hearing aids** can fill the deficit.

KEY TERMS

Decibel—A unit of the intensity of sound, a measure of loudness.

Meniere's disease—The combination of vertigo and decreased hearing caused by abnormalities in the inner ear.

Multiple sclerosis—A progressive disease of brain and nerve tissue.

Otosclerosis—A disease that scars and limits the motion of the small conducting bones in the middle ear.

Stroke—Sudden loss of blood supply to part of the brain.

In-the-ear hearing aids can boost the volume of sound by up to 70 dB. (Normal speech is about 60 dB.) Federal law now requires that they be dispensed only upon a physician's prescription. For complete conduction hearing loss there are now available bone conduction hearing aids and even devices that can be surgically implanted in the cochlea.

Tinnitus can sometimes be relieved by adding white noise (like the sound of wind or waves crashing on the shore) to the environment.

Decreased hearing is such a common problem that there are legions of organizations to provide assistance. Special language training, both in lip reading and signing, special schools and special camps for children are all available in most regions of the United States.

Alternative treatment

Conductive hearing loss can be treated with alternative therapies that are specific to the particular condition. Sensory hearing loss may be helped by homeopathic therapies. Oral supplementation with essential fatty acids such as flax oil and omega 3 oil can help alleviate the accumulation of wax in the ear.

Prevention

Prompt treatment and attentive follow-up of middle ear infections in children will prevent this cause of conductive hearing loss. Control of infectious childhood diseases such as measles has greatly reduced sensory hearing loss as a complication of epidemic diseases. Laws that require protection from loud noise in the workplace have achieved substantial reduction in noise induced hearing loss. Surfers should use the right kind of ear plugs.

Resources

BOOKS

Alberti, R. W. "Occupational Hearing Loss." In *Disorders of the Nose, Throat, Ear, Head, and Neck*, ed. John Jacob Ballenger. Philadelphia: Lea & Febiger, 1991.

Austin, David F. "Non-inflammatory Diseases of the Labyrinth." In *Disorders of the Nose, Throat, Ear, Head, and Neck*, ed. John Jacob Ballenger. Philadelphia: Lea & Febiger, 1991.

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Niparko, John K. "Hearing Loss and Associated Problems." In *Principles of Ambulatory Medicine*, ed. L. Randol Barker, et al. Baltimore: Williams & Wilkins, 1995.

Rakel, Robert E., ed. *Current Therapy.* Philadelphia: W. B. Saunders Co., 1998.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

PERIODICALS

Cohen, N., and S. Waltzman. "The Department of Veterans Affairs Cochlear Implant Study Group." *New England Journal of Medicine* 328 (1993): 233.

Nadol, J. B. "Hearing loss." *New England Journal of Medicine* 329 (1993): 92.

ORGANIZATIONS

Alexander Graham Bell Association for the Deaf. 3417 Volta Place NW, Washington, DC 20007. (202) 337-5220. <http://www.agbell.org>.

Auditory-Verbal International. 2121 Eisenhower Ave., Suite 402, Alexandria, VA 22314. (703) 739-1049. <avi@auditory-verbal.org>. <http://www.auditory-verbal.org/contact.htm>.

Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684-3391.

Central Institute for the Deaf. Washington University. St. Louis, Missouri. <http://cidmac.wustl.edu>.

The League for the Hard of Hearing. 71 West 23rd St., New York, New York 10010-4162. (212) 741-7650. <http://www.lhh.org>.

National Association of the Deaf. 814 Thayer Ave., Silver Spring, MD, 20910. (301) 587-1788. <http://nad.policy.net>.

National Institute on Deafness and Other Communication Disorders. National Institutes of Health, 31 Center Drive, MSC 2320, Bethesda, MD USA 20892-2320. (800) 241-1044. <http://www.nidcd.nih.gov>.

Self Help for Hard of Hearing People, Inc. 7800 Wisconsin Ave., Bethesda, MD 20814. (301) 657-2248. <http://www.shhh.org>.

The Sight & Hearing Association (SHA). <http://www.sightandhearing.org>.

The World Recreation Association of the Deaf (WRAD). <http://www.wrad.org>.

J. Ricker Polsdorfer, MD

Hearing test with an audiometer *see* **Audiometry**

Hearing tests with a tuning fork

Definition

A tuning fork is a metal instrument with a handle and two prongs or tines. Tuning forks, made of steel, aluminum, or magnesium-alloy will vibrate at a set frequency to produce a musical tone when struck. The vibrations produced can be used to assess a person's ability to hear various sound frequencies.

Purpose

A vibrating tuning fork held next to the ear or placed against the skull will stimulate the inner ear to vibrate, and can help determine if there is **hearing loss**.

Precautions

No special precautions are necessary when tuning forks are used to conduct a hearing test.

Description

Two types of hearing tests with tuning forks are typically conducted. In the Rinne test, the vibrating tuning fork is held against the skull, usually on the bone behind the ear (mastoid process) to cause vibrations through the bones of the skull and inner ear. It is also held next to, but not touching, the ear, to cause vibrations in the air next to the ear. The patient is asked to determine which sound is louder, the sound heard through the bone or through the air. A second hearing test using a tuning fork is the Weber test. For this test, the stem or handle of the vibrating tuning fork is placed at various points along the midline of the skull and face. The patient is then asked to identify which ear hears the sound created by the vibrations. Tuning forks of different sizes produce different frequencies of vibrations and can be used to establish the range of hearing for an individual patient.

Preparation

No special preparation is required for a hearing test with tuning forks.

Aftercare

No special aftercare is required. If hearing loss is revealed during testing with tuning forks, the patient may require further testing to determine the extent of the hearing loss.

KEY TERMS

Mastoid process—The protrusions of bone behind the ears at the base of the skull.

Rinne test—A hearing test using a vibrating tuning fork which is held near the ear and held at the back of the skull.

Weber test—A hearing test using a vibrating tuning fork which is held at various points along the midline of the skull and face.

Risks

There are no risks associated with the use of tuning forks to screen for hearing loss.

Normal results

With the Rinne test, a person will hear the tone of the vibration longer and louder when the tuning fork is held next to the ear, rather than when it is held against the mastoid bone. For the Weber test, the tone produced when the tuning fork is placed along the center of the skull, or face, sounds about the same volume in each ear.

Abnormal results

The Rinne test detects a hearing loss when a patient hears a louder and longer tone when the vibrating tuning fork is held against the mastoid bone than when it is held next to the ear. The volume of sound vibrations conducted through parts of the skull and face in the Weber test can indicate which ear may have a hearing loss.

Resources

BOOKS

"Clinical Evaluation of Complaints Referable to the Ears." In *The Merck Manual.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck & Co. Inc., 1992.

Stedman's Medical Dictionary. 26th ed. Ed. Marjory Spraycar. Baltimore: Williams & Wilkins, 1995.

PERIODICALS

Abdulrazzak, A. "Office Screening for Age-Related Hearing and Vision Loss." *Geriatrics* 52, no. 6 (June 1997): 45-57.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Ear Foundation. 1817 Patterson St., Nashville, TN 37203. (800) 545-4327. <http://www.earfoundation.org>.

Altha Roberts Edgren

Heart arrest *see* **Sudden cardiac death**

Heart arrhythmias *see* **Arrhythmias**

Heart attack

Definition

A heart attack is the **death** of, or damage to, part of the heart muscle because the supply of blood to the heart muscle is severely reduced or stopped.

Description

Heart attack is the leading cause of death in the United States. More than 1.5 million Americans suffer a heart attack every year, and almost half a million die, according to the American Heart Association. Most heart attacks are the end result of years of silent but progressive **coronary artery disease**, which can be prevented in many people. A heart attack is often the first symptom of coronary artery disease. According to the American Heart Association, 63% of women and 48% of men who died suddenly of coronary artery disease had no previous symptoms. Heart attacks are also called myocardial infarctions (MIs).

A heart attack occurs when one or more of the coronary arteries that supply blood to the heart are completely blocked and blood to the heart muscle is cut off. The blockage is usually caused by **atherosclerosis**, the build-up of plaque in the artery walls, and/or by a blood clot in a coronary artery. Sometimes, a healthy or atherosclerotic coronary artery has a spasm and the blood flow to part of the heart decreases or stops. Why this happens is unclear, but it can result in a heart attack.

About half of all heart attack victims wait at least two hours before seeking help. This increases their chance of sudden death or being disabled. The longer the artery remains blocked during a heart attack, the more damage will be done to the heart. If the blood supply is cut off severely or for a long time, muscle cells suffer irreversible injury and die. The patient can die. That is why it is important to recognize the signs of a heart attack and seek prompt medical attention at the nearest hospital with 24-hour emergency cardiac care.

About one fifth of all heart attacks are silent, that is, the victim does not know one has occurred. Although the victim feels no **pain**, silent heart attacks can still damage the heart.

The outcome of a heart attack also depends on where the blockage is, whether the heart rhythm is disturbed, and whether another coronary artery supplies blood to that part of the heart. Blockages in the left coronary artery are usually more serious than in the right coronary artery. Blockages that cause an arrhythmia, an irregular heartbeat, can cause sudden death.

Causes and symptoms

Heart attacks are generally caused by severe coronary artery disease. Most heart attacks are caused by blood clots that form on atherosclerotic plaque. This blocks a coronary artery from supplying oxygen-rich blood to part of the heart. A number of major and contributing risk factors increase the risk of developing coronary artery disease. Some of these can be changed and some cannot. People with more risk factors are more likely to develop coronary artery disease.

Major risk factors

Major risk factors significantly increase the risk of coronary artery disease. Those which cannot be changed are:

- Heredity. People whose parents have coronary artery disease are more likely to develop it. African Americans are also at increased risk, due to their higher rate of severe **hypertension** than whites.
- Sex. Men under the age of 60 years of age are more likely to have heart attacks than women of the same age.
- Age. Men over the age of 45 and women over the age of 55 are considered at risk. Older people (those over 65) are more likely to die of a heart attack. Older women are twice as likely to die within a few weeks of a heart attack as a man. This may be because of their other co-existing medical problems.

Major risk factors which can be changed are:

- **Smoking**. Smoking greatly increases both the chance of developing coronary artery disease and the change of dying from it. Smokers have two to four times the risk of non-smokers of **sudden cardiac death** and are more than twice as likely to have a heart attack. They are also more likely to die within an hour of a heart attack. Second-hand smoke may also increase risk.
- **High cholesterol**. Cholesterol is a soft, waxy substance that is produced by the body, as well as obtained from eating foods such as meat, eggs, and other animal prod-

ucts. Cholesterol level is affected by age, sex, heredity, and diet. Risk of developing coronary artery disease increases as blood cholesterol levels increase. When combined with other factors, the risk is even greater. Total cholesterol of 240 mg/dL and over poses a high risk, and 200–239 mg/dL a borderline high risk. In LDL cholesterol, high risk starts at 130–159 mg/dL, depending on other risk factors. HDL (healthy cholesterol) can lower or raise the coronary risk also.

- High blood pressure. High blood pressure makes the heart work harder, and over time, weakens it. It increases the risk of heart attack, **stroke**, kidney failure, and congestive **heart failure**. A blood pressure of 140 over 90 or above is considered high. As the numbers increase, high blood pressure goes from Stage 1 (mild) to Stage 4 (very severe). When combined with **obesity**, smoking, high cholesterol, or diabetes, the risk of heart attack or stroke increases several times.
- Lack of physical activity. This increases the risk of coronary artery disease. Even modest physical activity is beneficial if done regularly.

Contributing risk factors

Contributing risk factors have been linked to coronary artery disease, but their significance and prevalence are not known yet. Contributing risk factors are:

- Diabetes mellitus. The risk of developing coronary artery disease is seriously increased for diabetics. More than 80% of diabetics die of some type of heart or blood vessel disease.
- Obesity. Excess weight increases the strain on the heart and increases the risk of developing coronary artery disease, even if no other risk factors are present. Obesity increases both blood pressure and blood cholesterol, and can lead to diabetes.
- **Stress** and anger. Some scientists believe that stress and anger can contribute to the development of coronary artery disease. Stress, the mental and physical reaction to life's irritations and challenges, increases the heart rate and blood pressure, and can injure the lining of the arteries. Evidence shows that anger increases the risk of dying from heart disease and more than doubles the risk of having a heart attack right after an episode of anger.

More than 60% of heart attack victims experience symptoms before the heart attack occurs. These sometimes occur days or weeks before the heart attack. Sometimes, people do not recognize the symptoms of a heart attack or are in denial that they are having one. Symptoms are:

- Uncomfortable pressure, fullness, squeezing, or pain in the center of the chest. This lasts more than a few minutes, or may go away and return.
- Pain that spreads to the shoulders, neck, or arms.
- Chest discomfort accompanied by lightheadedness, **fainting**, sweating, nausea, or **shortness of breath**.

All of these symptoms do not occur with every heart attack. Sometimes, symptoms disappear and then reappear. A person with any of these symptoms should immediately call an emergency rescue service or be driven to the nearest hospital with a 24-hour cardiac care unit, whichever is quicker.

Diagnosis

Experienced emergency care personnel can usually diagnose a heart attack simply by looking at the patient. To confirm this diagnosis, they talk with the patient, check heart rate and blood pressure, perform an electrocardiogram, and take a blood sample. The electrocardiogram shows which coronary artery is blocked. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through an oscilloscope (a monitor) to a recorder, which traces them on paper. The blood test shows the leak of enzymes or other biochemical markers from damaged cells in the heart muscle.

Treatment

Heart attacks are treated with **cardiopulmonary resuscitation** (**CPR**) when necessary to start and keep the patient breathing and his heart beating. Additional treatment can include close monitoring, electric shock, drug therapy, re-vascularization procedures, percutaneous transluminal coronary **angioplasty** and coronary artery bypass surgery. Upon arrival at the hospital, the patient is closely monitored. An electrical-shock device, a defibrillator, may be used to restore a normal rhythm if the heartbeat is fluttering uncontrollably. Oxygen is often used to ease the heart's workload or to help victims of severe heart attack breath easier. If oxygen is used within hours of the heart attack, it may help limit damage to the heart.

Drugs to stabilize the patient and limit damage to the heart include thrombolytics, **aspirin**, anticoagulants, painkillers and tranquilizers, beta-blockers, ace-inhibitors, nitrates, rhythm-stabilizing drugs, and **diuretics**. Drugs that limit damage to the heart work only if given within a few hours of the heart attack. Thrombolytic drugs that break up blood clots and enable oxygen-rich blood to flow through the blocked artery increase the patient's chance of survival if given as soon as possible after the heart attack. Thrombolytics given within a few hours after a heart attack are the most effective. Injected intravenously, these include anisoylated plasminogen streptokinase activator complex (APSAC) or anistreplase

(Eminase), recombinant tissue-type plasminogen activator (r-tPA, Retevase, or Activase), and streptokinase (Streptase, Kabikinase).

To prevent additional heart attacks, aspirin and an anticoagulant drug often follow the thrombolytic drug. These prevent new blood clots from forming and existing blood clots from growing. Anticoagulant drugs help prevent the blood from clotting. The most common anticoagulants are heparin and warfarin. Heparin is given intravenously while the patient is in the hospital; warfarin, taken orally, is often given later. Aspirin helps to prevent the dissolved blood clots from reforming.

To relieve pain, a nitroglycerine tablet taken under the tongue may be given. If the pain continues, morphine sulfate may be prescribed. Tranquilizers such as diazepam (Valium) and alprazolam (Ativan) may be prescribed to lessen the trauma of a heart attack.

To slow down the heart rate and give the heart a chance to heal, beta-blockers are often given intravenously right after the heart attack. These can also help prevent the sometimes fatal **ventricular fibrillation**. Beta-blockers include atenolol (Tenormin), metoprolol (Lopressor), nadolol, pindolol (Visken), propranolol (Inderal), and timolol (Blocadren).

Nitrates, a type of vasodilator, are also given right after a heart attack to help improve the delivery of blood to the heart and ease heart failure symptoms. Nitrates include isosorbide mononitrate (Imdur), isosorbide dinitrate (Isordil, Sorbitrate), and nitroglycerin (Nitrostat).

When a heart attack causes an abnormal heartbeat, arrhythmia drugs may be given to restore the heart's normal rhythm. These include: amiodarone (Cordarone), atropine, bretylium, disopyramide (Norpace), lidocaine (Xylocaine), procainamide (Procan), propafenone (Rythmol), propranolol (Inderal), quinidine, and sotalol (Betapace). Angiotensin-converting enzyme (ACE) inhibitors reduce the resistance against which the heart beats and are used to manage and prevent heart failure. They are used to treat heart attack patients whose hearts do not pump well or who have symptoms of heart failure. Taken orally, they include Altace, Capoten, Lotensin, Monopril, Prinivil, Vasotec, and Zestril. Angiotensin receptor blockers, such as losartan (Cozaar) may substitute. Diuretics can help get rid of excess fluids that sometimes accumulate when the heart is not pumping effectively. Usually taken orally, they cause the body to dispose of fluids through urination. Common diuretics include: bumetanide (Bumex), chlorthalidone (Hygroton), chlorothiazide (Diuril), furosemide (Lasix), hydrochlorothiazide (HydroDIRUIL, Esidrix), spironolactone (Aldactone), and triamterene (Dyrenium).

Percutaneous transluminal coronary angioplasty and coronary artery bypass surgery are invasive revascularization procedures which open blocked coronary arteries and improve blood flow. They are usually performed only on patients for whom clot-dissolving drugs do not work, or who have poor **exercise** stress tests, poor left ventricular function, or **ischemia**. Generally, angioplasty is performed before coronary artery bypass surgery.

Percutaneous transluminal coronary angioplasty, usually called coronary angioplasty, is a non-surgical procedure in which a catheter (a tiny plastic tube) tipped with a balloon is threaded from a blood vessel in the thigh or arm into the blocked artery. The balloon is inflated and compresses the plaque to enlarge the blood vessel and open the blocked artery. The balloon is then deflated and the catheter is removed. Coronary angioplasty is performed by a cardiologist in a hospital and generally requires a two-day stay. It is successful about 90% of the time. For one third of patients, the artery narrows again within six months after the procedure. The procedure can be repeated. It is less invasive and less expensive than coronary artery bypass surgery.

In coronary artery bypass surgery, called bypass surgery, a detour is built around the coronary artery blockage with a healthy leg or chest wall artery or vein. The healthy vein then supplies oxygen-rich blood to the heart. Bypass surgery is major surgery appropriate for patients with blockages in two or three major coronary arteries or severely narrowed left main coronary arteries, as well as those who have not responded to other treatments. It is performed in a hospital under general anesthesia using a heart-lung machine to support the patient while the healthy vein is attached to the coronary artery. About 70% of patients who have bypass surgery experience full relief from **angina**; about 20% experience partial relief. Long term, symptoms recur in only about three or four percent of patients per year. Five years after bypass surgery, survival expectancy is 90%, at 10 years it is about 80%, at 15 years it is about 55%, and at 20 years it is about 40%.

There are three experimental surgical procedures for unblocking coronary arteries which are currently being studied: **atherectomy**, where the surgeon shaves off and removes strips of plaque from the blocked artery; laser angioplasty, where a catheter with a laser tip is inserted to burn or break down the plaque; and insertion of a metal coil called a stent that can be implanted permanently to keep a blocked artery open.

Prognosis

The aftermath of a heart attack is often severe. Two-thirds of heart attack patients never recover fully. Within

one year, 27% of men and 44% of women die. Within six years, 23% of men and 31% of women have another heart attack, 13% of men and 6% of women experience sudden death, and about 20% have heart failure. People who survive a heart attack have a chance of sudden death that is four to six times greater than others and a chance of illness and death that is two to nine times greater. Older women are more likely than men to die within a few weeks of a heart attack.

Prevention

Many heart attacks can be prevented through a healthy lifestyle, which can reduce the risk of developing coronary artery disease. For patients who have already had a heart attack, a healthy lifestyle and carefully following doctor's orders can prevent another heart attack. A heart healthy lifestyle includes eating right, regular exercise, maintaining a healthy weight, no smoking, moderate drinking, no illegal drugs, controlling hypertension, and managing stress.

A healthy diet includes a variety of foods that are low in fat (especially saturated fat), low in cholesterol, and high in fiber; plenty of fruits and vegetables; and limited sodium. Some foods are low in fat but high in cholesterol, and some are low in cholesterol but high in fat. Saturated fat raises cholesterol, and, in excessive amounts, it increases the amount of the proteins in blood that form blood clots. Polyunsaturated and monounsaturated fats are relatively good for the heart. Fat should comprise no more than 30 percent of total daily calories.

Cholesterol, a waxy, lipid-like substance, comes from eating foods such as meat, eggs, and other animal products. It is also produced in the liver. Soluble fiber can help lower cholesterol. Cholesterol should be limited to about 300 mg per day. Many popular lipid-lowering drugs can reduce LDL-cholesterol by an average of 25–30% when combined with a low-fat, low-cholesterol diet. Fruits and vegetables are rich in fiber, **vitamins**, and **minerals**. They are also low calorie and nearly fat free. Vitamin C and beta-carotene, found in many fruits and vegetables, keep LDL-cholesterol from turning into a form that damages coronary arteries. Excess sodium can increase the risk of high blood pressure. Many processed foods contain large amounts of sodium. Limit daily intake to about 2,400 mg—about the amount in a teaspoon of salt.

The "Food Guide" Pyramid developed by the U.S. Departments of Agriculture and Health and Human Services provides easy to follow guidelines for daily heart-healthy eating: six to 11 servings of bread, cereal, rice, and pasta; three to five servings of vegetables; two to four servings of fruit; two to three servings of milk, yogurt, and cheese; and 2–3 servings of meat, poultry, fish, dry beans, eggs, and nuts. Fats, oils, and sweets should be used sparingly.

Regular aerobic exercise can lower blood pressure, help control weight, and increase HDL ("good") cholesterol. It may keep the blood vessels more flexible. Moderate intensity aerobic exercise lasting about 30 minutes four or more times per week is recommended for maximum heart health, according to the Centers for Disease Control and Prevention and the American College of Sports Medicine. Three 10-minute exercise periods are also beneficial. Aerobic exercise—activities such as walking, jogging, and cycling—uses the large muscle groups and forces the body to use oxygen more efficiently. It can also include everyday activities such as active gardening, climbing stairs, or brisk housework.

Maintaining a desirable body weight is also important. About one quarter of all Americans are overweight, and nearly one-tenth are obese, according to the Surgeon General's Report on **Nutrition** and Health. People who are 20% or more over their ideal body weight have an increased risk of developing coronary artery disease. Losing weight can help reduce total and LDL cholesterol, reduce triglycerides, and boost relative levels of HDL cholesterol. It may also reduce blood pressure.

Smoking has many adverse effects on the heart. It increases the heart rate, constricts major arteries, and can

KEY TERMS

Angina—Chest pain that happens when diseased blood vessels restrict the flow of blood to the heart. Angina is often the first symptom of coronary artery disease.

Atherosclerosis—A process in which the walls of the coronary arteries thicken due to the accumulation of plaque in the blood vessels. Atherosclerosis is the cause of coronary artery disease.

Coronary arteries—The two arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into two branches. These are the arteries where coronary artery disease occurs.

Myocardial infarction—The technical term for heart attack. Myocardial means heart muscle and infarction means death of tissue from lack of oxygen.

Plaque—A deposit of fatty and other substances that accumulate in the lining of the artery wall.

create irregular heartbeats. It also raises blood pressure, contributes to the development of plaque, increases the formation of blood clots, and causes blood platelets to cluster and impede blood flow. Heart damage caused by smoking can be repaired by quitting—even heavy smokers can return to heart health. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within five to 10 years of quitting.

Drinking should be done in moderation. Modest consumption of alcohol can actually protect against coronary artery disease. This is believed to be because alcohol raises HDL ("good") cholesterol levels. The American Heart Association defines moderate consumption as one ounce of alcohol per day—roughly one cocktail, one 8-ounce glass of wine, or two 12-ounce glasses of beer. In some people, however, moderate drinking can increase risk factors for heart disease, such as raising blood pressure. Excessive drinking is always bad for the heart. It usually raises blood pressure, and can poison the heart and cause abnormal heart rhythms or even heart failure. Illegal drugs, like **cocaine**, can seriously harm the heart and should never be used.

High blood pressure, one of the most common and serious risk factors for coronary artery disease, can be completely controlled through lifestyle changes and medication. People with moderate hypertension may be able to control it through lifestyle changes such as reducing sodium and fat, exercising regularly, managing stress, quitting smoking, and drinking alcohol in moderation. If these changes do not work, and for people with severe hypertension, there are eight types of drugs that provide effective treatment.

Stress management means controlling mental and physical reactions to life's irritations and challenges. Techniques for controlling stress include: taking life more slowly, spending time with family and friends, thinking positively, getting enough sleep, exercising, and practicing relaxation techniques.

Daily aspirin therapy has been proven to help prevent blood clots associated with atherosclerosis. It can also prevent heart attacks from recurring, prevent heart attacks from being fatal, and lower the risk of strokes.

Resources

BOOKS

American Heart Association. *Guide to Heart Attack Treatment, Recovery, Prevention*. New York: Time Books, 1996.

DeBakey, Michael E., and Antonio M. Gotto Jr. *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

Notelovitz, Morris, and Diana Tonnessen. *The Essential Heart Book for Women*. New York: St. Martin's Press, 1996.

Texas Heart Institute. "Coronary Artery Disease, Angina, and Heart Attacks." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

"Drugs or Angioplasty After a Heart Attack?" *Harvard Health Letter* 22, no. 10 (Aug. 1997): 8.

Marble, Michelle. "FDA Urged to Expand Uses for Aspirin, Benefits for Women." *Women's Health Weekly*, 10 Feb. 1997).

"More on Anger and Heart Disease." *Harvard Heart Letter* (May 1997): 6-7.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Lori De Milto

Heart block

Definition

Heart block refers to a delay in the normal flow of electrical impulses that cause the heart to beat. They are further classified as first-, second-, or third-degree block.

Description

The muscles of the heart contract in a rhythmic order for each heart beat, because electrical impulses travel along a specific route called the conduction system. The main junction of this system is called the atrioventricular node (AV node). Just as on a highway, there are occasionally some delays getting the impulse from one point to another. These delays are classified according to their severity.

In first-degree heart block, the signal is just slowed down a little as it travels along the defective part of the conduction system so that it arrives late traveling from the atrium to the ventricle.

In second-degree heart block, not every impulse reaches its destination. The block may affect every other beat, every second or third beat, or be very rare. If the blockage is frequent, it results in an overall slowing of the heart called bradycardia.

Third-degree block, also called complete heart block, is the most serious. When no signals can travel through the AV node, the heart uses its backup impulse generator

in the lower portion of the heart. Though this impulse usually keeps the heart from stopping entirely, it is too slow to be an effective pump.

Causes and symptoms

First-degree heart block is fairly common. It is seen in teenagers, young adults and in well-trained athletes. The condition may be caused by **rheumatic fever**, some types of heart disease and by some drugs. First-degree heart block produces no symptoms.

Some cases of second-degree heart block may benefit from an artificial pace-maker. Second-degree block can occasionally progress to third-degree.

Third-degree heart block is a serious condition that affects the heart's ability to pump blood effectively. Symptoms include **fainting**, **dizziness** and sudden **heart failure**. If the ventricles beat more than 40 times per minute, symptoms are not as severe, but include tiredness, low blood pressure on standing, and **shortness of breath**.

Young children who have received a forceful blunt chest injury, can experience first-, or second-degree heart block.

Diagnosis

Diagnosis of first-, and second-degree heart block is made by observing it on an electrocardiograph (ECG).

Third-degree heart block usually results in symptoms such as fainting, dizziness and sudden heart failure, which require immediate medical care. A physical exam and ECG confirm the presence of heart block.

Treatment

Some second- and almost all third-degree heart blocks require an artificial pacemaker. In an emergency, a temporary pacemaker can be used until an implanted device is advisable. Most people need the pacemaker for the rest of their lives.

Prognosis

Most people with first- and second-degree heart block don't even know they have it. For people with third-degree block, once the heart has been restored to its normal, dependable rhythm, most people, live full and comfortable lives.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993

PERIODICALS

Grady, Thomas A., et al. "Prognostic Significance of Exercise-induced Left Bundle-branch Block." *Journal of the American Medical Association* 279, no. 2 (14 Jan.1998): 153.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Heart catheterization *see* **Cardiac catheterization**

Heart failure

Definition

Heart failure is a condition in which the heart has lost the ability to pump enough blood to the body's tissues. With too little blood being delivered, the organs and other tissues do not receive enough oxygen and nutrients to function properly.

Description

According to the American Heart Association, about 4.9 million Americans are living with congestive heart failure. Of these, 2.5 million are males and 2.4 million are females. Ten people out of every 1,000 people over age 65 have this condition. There are about 400,000 new cases each year.

Heart failure happens when a disease affects the heart's ability to deliver enough blood to the body's tissues. Often, a person with heart failure may have a buildup of fluid in the tissues, called **edema**. Heart failure with this kind of fluid buildup is called congestive heart failure. Where edema occurs in the body depends on the part of the heart that is affected by heart failure. Heart failure caused by abnormality of the lower left chamber of the heart (left ventricle) means that the left ventricle cannot pump blood out to the body as fast as it returns from the lungs. Because blood cannot get back to the heart, it begins to back up in the blood vessels of the lungs. Some of the fluid in the blood is forced into the breathing space of the lungs, causing **pulmonary edema**. A person with pulmonary edema has **shortness of breath**, which may be acute and severe and life threatening. A person with congestive heart failure feels tired because not enough blood circulates to supply the body's tissues with the oxygen and nutrients they need. Abnormalities of the heart structure and rhythm can also be responsible for left ventricular congestive heart failure.

In right-sided heart failure, the lower right chamber of the heart (right ventricle) cannot pump blood to the lungs as fast as it returns from the body through the veins. Blood then engorges the right side of the heart and the veins. Fluid backed up in the veins is forced out into the tissues, causing swelling (edema), usually in the feet and legs. Congestive heart failure of the right ventricle is often caused by abnormalities of the heart valves and lung disorders.

When the heart cannot pump enough blood, it tries to make up for this by becoming larger. By becoming enlarged (hypertrophic) the ventricle can contract more strongly and pump more blood. When this happens, the heart chamber becomes larger and the muscle in the heart wall becomes thicker. The heart also compensates by pumping more often to improve blood output and circulation. The kidneys try to compensate for a failing heart by retaining more salt and water to increase the volume of blood. This extra fluid can also cause edema. Eventually, as the condition worsens over time these measures are not enough to keep the heart pumping enough blood needed by the body. Kidneys often weaken under these circumstances, further aggravating the situation and making therapy more difficult.

For most people, heart failure is a chronic disease with no cure. However, it can be managed and treated with medicines and changes in diet, **exercise**, and lifestyle habits. **Heart transplantation** is considered in some cases.

Causes and symptoms

The most common causes of heart failure are:

- **coronary artery disease** and **heart attack** (which may be "silent")
- cardiomyopathy
- high blood pressure (**hypertension**)
- heart valve disease
- congenital heart disease
- **alcoholism** and drug abuse

The most common cause of heart failure is coronary artery disease. In coronary artery disease, the arteries supplying blood to the heart become narrowed or blocked. When blood flow to an area of the heart is completely blocked, the person has a heart attack. Some heart attacks go unrecognized. The heart muscle suffers damage when its blood supply is reduced or blocked. If the damage affects the heart's ability to pump blood, heart failure develops.

Cardiomyopathy is a general term for disease of the heart muscle. Cardiomyopathy may be caused by coronary artery disease and various other heart problems. Sometimes the cause of cardiomyopathy cannot be found. In these cases the heart muscle disease is called idiopathic cardiomyopathy. Whatever the cause, cardiomyopathy can weaken the heart, leading to heart failure.

High blood pressure is another common cause of heart failure. High blood pressure makes the heart work harder to pump blood. After a while, the heart cannot keep up and the symptoms of heart failure develop.

Defects of the heart valves, congenital heart diseases, alcoholism, and drug abuse cause damage to the heart that can all lead to heart failure.

A person with heart failure may experience the following:

- shortness of breath
- frequent coughing, especially when lying down
- swollen feet, ankles, and legs
- abdominal swelling and **pain**
- fatigue
- **dizziness** or **fainting**
- sudden death

A person with left-sided heart failure may have shortness of breath and coughing caused by the fluid buildup in the lungs. Pulmonary edema may cause the person to **cough** up bubbly phlegm that contains blood. With right-sided heart failure, fluid build-up in the veins and body tissues causes swelling in the feet, legs, and abdomen. When body tissues, such as organs and muscles, do not receive enough oxygen and nutrients they cannot function as well, leading to tiredness and dizziness.

Diagnosis

Diagnosis of heart failure is based on:

- symptoms
- medical history
- **physical examination**
- **chest x ray**
- electrocardiogram (ECG; also called EKG)
- other imaging tests
- **cardiac catheterization**

A person's symptoms can provide important clues to the presence of heart failure. Shortness of breath while engaging in activities and episodes of shortness of breath that wake a person from sleep are classic symptoms of heart failure. During the physical examination, the physician listens to the heart and lungs with a stethoscope for

KEY TERMS

Angioplasty—A technique for treating blocked coronary arteries by inserting a catheter with a tiny balloon at the tip into the artery and inflating it.

Angiotensin-converting enzyme (ACE) inhibitor—A drug that relaxes blood vessel walls and lowers blood pressure.

Arrhythmias—Abnormal heartbeat.

Atherosclerosis—Buildup of a fatty substance called a plaque inside blood vessels.

Calcium channel blocker—A drug that relaxes blood vessels and lowers blood pressure.

Cardiac catheterization—A diagnostic test for evaluating heart disease; a catheter is inserted into an artery and passed into the heart.

Cardiomyopathy—Disease of the heart muscle.

Catheter—A thin, hollow tube.

Congenital heart defects—Abnormal formation of structures of the heart or of its major blood vessels present at birth.

Congestive heart failure—A condition in which the heart cannot pump enough blood to supply the body's tissues with sufficient oxygen and nutrients; back up of blood in vessels and the lungs causes build up of fluid (congestion) in the tissues.

Coronary arteries—Arteries that supply blood to the heart muscle.

Coronary artery bypass—Surgical procedure to reroute blood around a blocked coronary artery.

Coronary artery disease—Narrowing or blockage of coronary arteries by atherosclerosis.

Digitalis—A drug that helps the heart muscle to have stronger pumping action.

Diuretic—A type of drug that helps the kidneys eliminate excess salt and water.

Edema—Swelling caused by fluid buildup in tissues.

Ejection fraction—A measure of the portion of blood that is pumped out of a filled ventricle.

Heart valves—Valves that regulate blood flow into and out of the heart chambers.

Hypertension—High blood pressure.

Hypertrophic—Enlarged.

Idiopathic cardiomyopathy—Cardiomyopathy without a known cause.

Pulmonary edema—Buildup of fluid in the tissue of the lungs.

Vasodilator—Any drug that relaxes blood vessel walls.

Ventricles—The two lower chambers of the heart.

telltale signs of heart failure. Irregular heart sounds, "gallops," a rapid heart rate, and murmurs of the heart valves may be heard. If there is fluid in the lungs a crackling sound may be heard. Rapid breathing or other changes in breathing may also be present. Patients with heart failure may also have a rapid pulse.

By pressing on the abdomen, the physician can feel if the liver is enlarged. The skin of the fingers and toes may have a bluish tint and feel cool if not enough oxygen is reaching them.

A chest x ray can show if there is fluid in the lungs and if the heart is enlarged. Abnormalities of heart valves and other structures may also be seen on chest x ray.

An electrocardiogram gives information on the heart rhythm and the size of the heart. It can show if the heart chamber is enlarged and if there is damage to the heart muscle from blocked arteries.

Besides chest x ray, other imaging tests may help make a diagnosis. **Echocardiography** uses sound waves to make images of the heart. These images can show if the heart wall or chambers are enlarged and if there are any abnormalities of the heart valves. An echocardiogram can also be used to find out how much blood the heart is pumping. It determines the amount of blood in the ventricle (ventricular volume) and the amount of blood the ventricle pumps each time it beats (called the ejection fraction). A healthy heart pumps at least one-half the amount of blood in the left ventricle with each heartbeat. Radionuclide ventriculography also measures the ejection fraction by imaging with very low doses of an injected radioactive substance as it travels through the heart.

Cardiac catheterization involves using a small tube (catheter) that is inserted through a blood vessel into the heart. It is used to measure pressure in the heart and amount of blood pumped by the heart. This test can help

find abnormalities of the coronary arteries, heart valves, and heart muscle, and other blood vessels. Combined with echocardiography and other tests, cardiac catheterization can help find the cause of heart failure. It is not always necessary, however.

Treatment

Heart failure usually is treated with lifestyle changes and medicines. Sometimes surgery is needed to correct abnormalities of the heart or heart valves. Heart transplantation is a last resort to be considered in certain cases.

Dietary changes to maintain proper weight and reduce salt intake may be needed. Reducing salt intake helps to lessen swelling in the legs, feet, and abdomen. Appropriate exercise may also be recommended, but it is important that heart failure patients only begin an exercise program with the advice of their doctors. Walking, bicycling, swimming, or low-impact aerobic exercises may be recommended. There are good heart **rehabilitation** programs at most larger hospitals.

Other lifestyle changes that may reduce the symptoms of heart failure include stopping **smoking** or other tobacco use, eliminating or reducing alcohol consumption, and not using harmful drugs.

One or more of the following types of medicines may be prescribed for heart failure:

- **diuretics**
- digitalis
- **vasodilators**
- beta blockers
- angiotensin converting enzyme inhibitors (ACE inhibitors)
- angiotensin receptor blockers (ARBs)
- **calcium channel blockers**

Diuretics help eliminate excess salt and water from the kidneys by making patients urinate more often. This helps reduce the swelling caused by fluid buildup in the tissues. Digitalis helps the heart muscle to have stronger pumping action. Vasodilators, ACE inhibitors, ARBs, and calcium channel blockers lower blood pressure and expand the blood vessels so blood can move more easily through them. This action makes it easier for the heart to pump blood through the vessels.

Surgery is used to correct certain heart conditions that cause heart failure. Congenital heart defects and abnormal heart valves can be repaired with surgery. Blocked coronary arteries can usually be treated with **angioplasty** or coronary artery bypass surgery.

With severe heart failure, the heart muscle may become so damaged that available treatments do not help. Patients with this stage of heart failure are said to have end-stage heart failure. Heart transplant is usually considered for patients with end-stage heart failure when all other treatments have stopped working.

Prognosis

Most patients with mild or moderate heart failure can be successfully treated with dietary and exercise programs and the right medications. Many people are able to participate in normal daily activities and lead relatively active lives.

Patients with severe heart failure may eventually have to consider heart transplantation. Approximately 50% of patients diagnosed with congestive heart failure live for five years with the condition. Women with heart failure usually live longer than men with heart failure.

Prevention

Heart failure is usually caused by the effects of some type of heart disease. The best way to try to prevent heart failure is to eat a healthy diet and get regular exercise, but many causes of heart failure cannot be prevented. People with risk factors for coronary disease (such as high blood pressure and **high cholesterol** levels) should work closely with their physician to reduce their likelihood of heart attack and heart failure.

Heart failure sometimes can be avoided by identifying and treating any conditions that might lead to heart disease. These include high blood pressure, alcoholism, and coronary artery disease. Regular blood pressure checks and obtaining immediate medical care for symptoms of coronary artery disease, such as chest pain, will help to get these conditions found and treated early, before they can damage the heart muscle.

Finally, diagnosing and treating heart failure before the heart becomes severely damaged can improve the prognosis. With proper treatment, many patients may continue to lead active lives for a number of years.

Resources

BOOKS

Bellenir, Karen, and Peter D. Dresser, eds. *Cardiovascular Diseases and Disorders Sourcebook*. Detroit: Omnigraphics, 1995.

Texas Heart Institute. *Heart Owner's Handbook*. New York: John Wiley and Sons, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Toni Rizzo

Heart murmurs

Definition

A heart murmur is an abnormal, extra sound during the heartbeat cycle made by blood moving through the heart and its valves. It is detected by the physician's examination using a stethoscope.

Description

A heart which is beating normal makes two sounds, "lubb" when the valves between the atria and ventricles close, and "dupp" when the valves between the ventricles and the major arteries close. A heart murmur is a series of vibratory sounds made by turbulent blood flow. The sounds are longer than normal heart sounds and can be heard between the normal sounds of the heart.

Heart murmurs are common in children and can also result from heart or valve defects. Nearly two thirds of heart murmurs in children are produced by a normal heart and are harmless. This type of heart murmur is usually called an "innocent" heart murmur. It can also be called "functional" or "physiologic." Innocent heart murmurs are usually very faint, intermittent, and occur in a small area of the chest. Pathologic heart murmurs may indicate the presence of a serious heart defect. They are louder, continual, and may be accompanied by a click or gallop.

Some heart murmurs are continually present; others happen only when the heart is working harder than usual, including during **exercise** or certain types of illness. Heart murmurs can be diastolic or systolic. Those which occur during relaxation of the heart between beats are called diastolic murmurs. Those which occur during contraction of the heart muscle are called systolic murmurs. The characteristics of the murmur may suggest specific alterations in the heart or its valves.

Causes and symptoms

Innocent heart murmurs are caused by blood flowing through the chambers and valves of the heart or the blood vessels near the heart. Sometimes **anxiety**, **stress**, **fever**, anemia, overactive thyroid, and **pregnancy** will cause innocent murmurs that can be heard by a physician using a stethoscope. Pathologic heart murmurs, however, are caused by structural abnormalities of the heart. These include defective heart valves or holes in the walls of the heart. Valve problems are more common. Valves that do not open completely cause blood to flow through a smaller opening than normal, while those that do not close properly may cause blood to go back through the valve. A hole in the wall between the left and right sides of the heart, called a septal defect, can cause heart murmurs. Some septal defects close on their own; others require surgery to prevent progressive damage to the heart.

The symptoms of heart murmurs differ depending on the cause of the heart murmur. Innocent heart murmurs and those which do not impair the function of the heart have no symptoms. Murmurs that are due to severe abnormalities of a heart valve may cause **shortness of breath**, **dizziness**, chest pains, **palpitations**, and lung congestion.

Diagnosis

Heart murmurs can be heard when a physician listens to the heart through a stethoscope during a regular checkup. Very loud heart murmurs and those with clicks or extra heart sounds should be evaluated further. Infants with heart murmurs who do not thrive, eat, or breath properly and older children who lose consciousness suddenly or are intolerant to exercise should also be evaluated. If the murmur sounds suspicious, the physician may order a **chest x ray**, an electrocardiogram, and an echocardiogram.

An electrocardiogram (ECG) shows the heart's activity and may reveal muscle thickening, damage, or a lack of oxygen. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through a monitor (oscilloscope) to a recorder which traces them on paper. The test takes about 10 minutes and is commonly performed in a physician's office. An exercise ECG can reveal additional information.

An echocardiogram (cardiac ultrasound), may be ordered to identify a structural problem that is causing the heart murmur. An echocardiogram uses sound waves to create an image of the heart's chambers and valves. The technician applies gel to a hand-held transducer then presses it against the patient's chest. The sound waves are converted into an image that can be displayed on a monitor. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30 minutes to an hour.

Treatment

Innocent heart murmurs do not affect the patient's health and require no treatment. Heart murmurs due to sep-

KEY TERMS

Atria—The upper two chambers of the heart.

Echocardiogram—A non-invasive ultrasound test that shows an image of the inside of the heart. An echocardiogram can be performed to identify any structural problems which cause a heart murmur.

Electrocardiogram—A test that shows the electrical activity of the heart by placing electronic sensors on the patient. This test can be used to confirm the presence of a heart murmur.

Pathologic—Characterized by disease or the structural and functional changes due to disease. Pathologic heart murmurs may indicate a heart defect.

Ventricles—The lower two chambers of the heart.

tal defects may require surgery. Those due to valvular defects may require **antibiotics** to prevent infection during certain surgical or dental procedures. Severely damaged or diseased valves can be repaired or replaced through surgery.

Alternative treatment

If a heart murmur requires surgical treatment, there are no alternative treatments, although there are alternative therapies that are helpful for pre- and post-surgical support of the patient. If the heart murmur is innocent, heart activity can be supported using the herb hawthorn (*Crataegus laevigata* or *C. oxyacantha*) or coenzyme Q10. These remedies improve heart contractility and the heart's ability to use oxygen. If the murmur is valvular in origin, herbs that act like antibiotics as well as options that build resistance to infection in the valve areas may be considered.

Prognosis

Most children with innocent heart murmurs grow out of them by the time they reach adulthood. Severe causes of heart murmurs may progress to severe symptoms and **death**.

Resources

PERIODICALS

Gutgesell, Howard P., et al. "Common Cardiovascular Problems in the Young: Part I. Murmurs, Chest Pain, Syncope and Irregular Rhythms." *American Family Physician* 56, no. 7 (1 Nov. 1997): 1825-1827.

Sapin, Samuel. "Recognizing Normal Heart Murmurs: A Logic-Based Mnemonic." *Pediatrics* 99, no. 4 (1 Apr. 1997): 616.

Smith, Karen M. "The Innocent Heart Murmur in Children." *Journal of Pediatric Health Care* 11, no. 5 (Sept./Oct. 1997): 207-214.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Heart Murmurs in Infants: Not Always Cause for Alarm." *Mayo Clinic Online*. 26 Feb. 1998. 5 Mar. 1998 <http://www.mayohealth.org>.

"When Your Child's Doctor Hears a Heart Murmur." *Children's National Medical Center.* 1998. 6 Mar. 1998 <http://www.cnmc.org/heart.htm>.

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Heart muscle infection *see* **Myocarditis**

Heart scan *see* **Echocardiography**

Heart septal defect *see* **Atrial septal defect**

Heart surgery for congenital defects

Definition

A variety of surgical procedures that are performed to repair the many types of heart defects that may be present at birth.

Purpose

Heart surgery for congenital defects is performed to repair a defect as much as possible and improve the flow of blood and oxygen to the body. While congenital heart defects vary in their severity, most require surgery. Surgery is recommended for congenital heart defects that result in a lack of oxygen, a poor quality of life, or a patient who does not thrive. Some types of congenital heart defects that don't cause symptoms are treated surgically because they can lead to serious complications.

Precautions

There are many types of surgery for congenital heart defects and many considerations in the decision to operate. The patient's cardiologist or surgeon will discuss these issues on an individual basis.

Description

There are many types of congenital heart defects. Most obstruct the flow of blood in the heart, or the vessels near it, or cause an abnormal flow of blood through the heart. Rarer types include newborns born with one ventricle, one side of the heart that is not completely formed, or the pulmonary artery and the aorta coming out of the same ventricle. Most congenital heart defects require surgery during infancy or childhood. Recommended ages for surgery for the most common congenital heart defects are:

- atrial septal defects: during the preschool years
- **patent ductus arteriosus**: between ages one and two
- **coarctation of the aorta**: in infancy, if it's symptomatic, at age four otherwise
- **tetralogy of Fallot**: age varies, depending on the patient's signs and symptoms
- **transposition of the great arteries**: often in the first weeks after birth, but before the patient is 12 months old

Surgical procedures seek to repair the defect as much as possible and restore circulation to as close to normal as possible. Sometimes, multiple, serial, surgical procedures are necessary. Smaller congenital heart defects can now be repaired in a **cardiac catheterization** lab instead of an operating room. Catheterization procedures include balloon atrial septostomy and **balloon valvuloplasty**. Surgical procedures include arterial switch, Damus-Kaye-Stansel procedure, Fontan procedure, Ross procedure, shunt procedure, and venous switch or intra-atrial baffle.

Catheterization procedures

Balloon atrial septostomy and balloon valvuloplasty are cardiac catheterization procedures. Cardiac catheterization procedures can save the lives of critically ill neonates and in some cases eliminate or delay more invasive surgical procedures. It is expected that catheterization procedures will continue to replace more types of surgery for congenital heart defects in the future. A thin tube called a catheter is inserted into an artery or vein in the leg, groin, or arm and threaded into the area of the heart which needs repair. The patient receives a local anesthetic at the insertion site and is awake but sedated during the procedure.

BALLOON ATRIAL SEPTOSTOMY. Balloon atrial septostomy is the standard procedure for correcting transposition of the great arteries; it is sometimes used in patients with mitral, pulmonary, or tricupsid atresia (atresia is a defect that causes the blood to carry too little oxygen to the body). Balloon atrial septostomy enlarges the atrial opening. A special balloon-tipped catheter is inserted into the right atrium and inflated to create a large opening in the atrial septum.

BALLOON VALVULOPLASTY. Balloon valvuloplasty uses a balloon-tipped catheter to open a narrowed heart valve, improving the flow of blood. It is the procedure of choice in pulmonary stenosis and is sometimes used in aortic stenosis. Balloons made of plastic polymers are placed at the end of the catheter and inflated to relieve the obstruction in the heart valve. Long-terms results are excellent in most cases. The operative **death** rate is 2–4%.

Surgical procedures

These procedures are performed under general anesthesia. Some require the use of a heart-lung machine, which cools the body to reduce the need for oxygen and takes over for the heart and lungs during the procedure.

ARTERIAL SWITCH. Arterial switch is performed to correct transposition of the great arteries, where the position of the pulmonary artery and the aorta are reversed. The procedure involves connecting the aorta to the left ventricle and the pulmonary artery to the right ventricle.

DAMUS-KAYE-STANSEL PROCEDURE. Transposition of the great arteries can also be corrected by the Damus-Kaye-Stansel procedure, in which the pulmonary artery is cut in two and connected to the ascending aorta and right ventricle.

FONTAN PROCEDURE. For tricuspid atresia and pulmonary atresia, the Fontan procedure connects the right atrium to the pulmonary artery directly or with a conduit, and the atrial defect is closed. Survival is over 90%.

PULMONARY ARTERY BANDING. Pulmonary artery banding is narrowing the pulmonary artery with a band to reduce blood flow and pressure in the lungs. It is used for **ventricular septal defect**, atrioventricular canal defect, and tricuspid atresia. Later, the band can be removed and the defect corrected with open heart surgery.

ROSS PROCEDURE. To correct aortic stenosis, the Ross procedure grafts the pulmonary artery to the aorta.

SHUNT PROCEDURE. For Tetralogy of Fallot, tricuspid atresia, or pulmonary atresia, the shunt procedure creates a passage between blood vessels, sending blood into parts of the body that need it.

VENOUS SWITCH. For transposition of the great arteries, venous switch creates a tunnel inside the atria to re-direct oxygen-rich blood to the right ventricle and aorta and venous blood to the left ventricle and pulmonary artery.

KEY TERMS

Atresia—A congenital defect in which the blood pumped through the body has too little oxygen. In tricuspid atresia, the baby lacks a triscupid valve. In pulmonary atresia, a pulmonary valve is missing.

Coarctation of the aorta—A congenital defect in which severe narrowing or constriction of the aorta obstructs the flow of blood.

Congenital heart defects—Congenital means conditions which are present at birth. Congenital heart disease includes a variety of defects that babies are born with.

Patent ductus arteriosus—A congenital defect in which the temporary blood vessel connecting the left pulmonary artery to the aorta in the fetus doesn't close in the newborn.

Septal defects—These are holes in the septum, the muscle wall separating the right and left sides of the heart. Atrial septal defects are openings between the two upper heart chambers and ventricular septal defects are openings between the two lower heart chambers.

Stenosis—A narrowing of the heart's valves. This congenital defect can occur in the pulmonary (lung) or aortic (the main heart artery) valve.

Tetralogy of Fallot—A cyanotic defect in which the blood pumped through the body has too little oxygen. Tetralogy of Fallot includes four defects: a large hole between the ventricles, narrowing at or beneath the pulmonary valve, an overly muscular right ventricle, and an aorta over the large hole.

Transposition of the great arteries—A cyanotic defect in which the blood pumped through the body has too little oxygen. The pulmonary artery and the aorta are reversed.

OTHER TYPES OF SURGERY. These surgical procedures are also used to treat common congenital heart defects. A medium to large ventricular or **atrial septal defect** can be closed by suturing it or covering it with a Dacron patch. For patent ductus arteriosus, surgery consists of dividing the ductus into two and tying off the ends. If performed within the patient's first few years, there is practically no risk associated with this operation. Surgery for coarctation of the aorta involves opening the chest wall, removing the defect, and reconnecting the ends of the aorta. If the defect is too long to be reconnected, a Dacron graft is used to replace the missing piece. In uncomplicated cases, the risk of the operation is 1–2%.

Preparation

Before surgery for congenital heart defects, the patient will receive a complete evaluation, which includes a physical exam, a detailed family history, a **chest x ray**, an electrocardiogram, an echocardiogram, and usually cardiac catheterization. For six to eight hours before the surgery, the patient cannot eat or drink anything. An electrocardiogram shows the heart's activity and may reveal a lack of oxygen. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs and the heart's impulses are traced on paper. An echocardiogram uses sound waves to create an image of the heart's chambers and valves. Gel is applied to a hand-held transducer and then pressed against the patient's chest. Cardiac catheterization is an invasive diagnostic technique used to evaluate the heart in which a long tube is inserted into a blood vessel and guided into the heart. A contrast solution is injected to make the heart visible on x rays.

Aftercare

After heart surgery for congenital defects, the patient goes to an intensive care ward where he or she is connected to a variety of tubes and monitors, including a ventilator. Patients are monitored every 15 minutes until vital signs are stable. Heart sounds, oxygenation, and the electrocardiogram are monitored. Chest tubes will be checked to ensure that they're draining properly and there is no hemorrhage. **Pain** medications will be administered. Complications such as **stroke**, lung blood clots, and reduced blood flow to the kidneys will be watched for. After the ventilator and breathing tube are removed, **chest physical therapy** and exercises to improve circulation will be started.

Risks

Complications from heart surgery for congenital defects can be severe. They include **shock**, congestive **heart failure**, lack of oxygen or too much carbon dioxide in the blood, irregular heartbeat, stroke, infection, kidney damage, lung blood clot, low blood pressure, hemorrhage, cardiac arrest, and death.

Resources

BOOKS

"Congenital Heart Disease." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

DeBakey, Michael E., and Antonio M. Gotto Jr. "Congenital Abnormalities of the Heart." In *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Park, Myung K. *Pediatric Cardiology for Practitioners*. 3rd ed. St. Louis: Mosby, 1996.
Texas Heart Institute. "Congenital Heart Disease." In *Texas Heart Institute Heart Owners Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

Hicks, George L. "Cardiac Surgery." *Journal of the American College of Surgeons* 186, no. 2 (Feb. 1998): 129-132.
Rao, P. S. "Interventional Pediatric Cardiology: State of the Art and Future Directions." *Pediatric Cardiology* 19 (1998): 107-124.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.
Congenital Heart Anomalies Support, Education & Resources, Inc. 2112 North Wilkins Road, Swanton, OH 43558. (419) 825-5575. <http://www.csun.edu/~hfmth006/chaser>.
Children's Health Information Network. 1561 Clark Drive, Yardley, PA 19067. (215) 493-3068. <http://www.tchin.org>.
Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

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Heart sonogram *see* **Echocardiography**

Heart transplantation

Definition

Heart transplantation, also called cardiac transplantation, is the replacement of a patient's diseased or injured heart with a healthy donor heart.

Purpose

Heart transplantation is performed on patients with end-stage **heart failure** or some other life-threatening heart disease. Before a doctor recommends heart transplantation for a patient, all other possible treatments for his or her disease must have been tried. The purpose of heart transplantation is to extend and improve the life of a person who would otherwise die from heart failure. Most patients who receive a new heart were so sick before transplantation that they could not live a normal life. Replacing a patient's diseased heart with a healthy, functioning donor heart often allows the recipient to return to normal daily activities.

Precautions

Because healthy donor hearts are in short supply, strict rules dictate who should or should not get a heart transplant. Patients who have conditions that might cause the new heart to fail should not have a heart transplant. Similarly, patients who may be too sick to survive the surgery or the side effects of the drugs they must take to keep their new heart working would not be good transplant candidates.

Patients who have any of the following conditions may not be eligible for heart transplantation:

- active infection
- pulmonary **hypertension**
- chronic lung disease with loss of more than 40% of lung function
- untreatable liver or kidney disease
- diabetes that has caused serious damage to vital organs
- disease of the blood vessels in the brain, such as a **stroke**
- serious disease of the arteries
- mental illness or any condition that would make a patient unable to take the necessary medicines on schedule
- continuing alcohol or drug abuse

Description

Patients with end-stage heart disease that threatens their life even after medical treatment may be considered for heart transplantation. Potential candidates must have a complete medical examination before they can be put on the transplant waiting list. Many types of tests are done, including blood tests, x rays, and tests of heart, lung, and other organ function. The results of these tests indicate to doctors how serious the heart disease is and whether or not a patient is healthy enough to survive the transplant surgery.

Organ waiting list

A person approved for heart transplantation is placed on the heart transplant waiting list of a heart transplant center. All patients on a waiting list are registered with the United Network for Organ Sharing (UNOS). UNOS has organ transplant specialists who run a national computer network that connects all the transplant centers and organ-donation organizations.

When a donor heart becomes available, information about it is entered into the UNOS computer and compared to information from patients on the waiting list. The computer program produces a list of patients ranked according to blood type, size of the heart, and how urgently they need a heart. Because the heart must be transplanted as quickly as possible, the list of local

patients is checked first for a good match. After that, a regional list, and then a national list, are checked. The patient's transplant team of heart and transplant specialists makes the final decision as to whether a donor heart is suitable for the patient.

The transplant procedure

When a heart becomes available and is approved for a patient, it is packed in a sterile cold solution and rushed to the hospital where the recipient is waiting.

Heart transplant surgery involves the following basic steps:

- A specialist in cardiovascular anesthesia gives the patient general anesthesia.
- Intravenous **antibiotics** are usually given to prevent bacterial wound infections.
- The patient is put on a heart/lung machine, which performs the functions of the heart and lungs and pumps the blood to the rest of the body during surgery. This procedure is called cardiopulmonary bypass.
- After adequate blood circulation is established, the patient's diseased heart is removed.
- The donor heart is attached to the patient's blood vessels.
- After the blood vessels are connected, the new heart is warmed up and begins beating. If the heart does not begin to beat immediately, the surgeon may start it with an electrical shock.
- The patient is taken off the heart/lung machine.
- The new heart is stimulated to maintain a regular beat with medications for two to five days after surgery, until the new heart functions normally on its own.

Heart transplant recipients are given immunosuppressive drugs to prevent the body from rejecting the new heart. These drugs are usually started before or during the heart transplant surgery. Immunosuppressive drugs keep the body's immune system from recognizing and attacking the new heart as foreign tissue. Normally, immune system cells recognize and attack foreign or abnormal cells, such as bacteria, **cancer** cells, and cells from a transplanted organ. The drugs suppress the immune cells and allow the new heart to function properly. However, they can also allow infections and other adverse effects to occur to the patient.

Because the chance of rejection is highest during the first few months after the transplantation, recipients are usually given a combination of three or four immunosuppressive drugs in high doses during this time. Afterwards, they must take maintenance doses of immunosuppressive drugs for the rest of their lives.

National Transplant Waiting List By Organ Type (June 2000)

Organ Needed	Number Waiting
Kidney	48,349
Liver	15,987
Heart	4,139
Lung	3,695
Kidney-Pancreas	2,437
Pancreas	942
Heart-Lung	212
Intestine	137

Cost and insurance coverage

The total cost for heart transplantation varies, depending on where it is performed, whether transportation and lodging are needed, and on whether there are any complications. The costs for the surgery and first year of care are estimated to be about $250,000. The medical tests and medications after the first year cost about $21,000 per year.

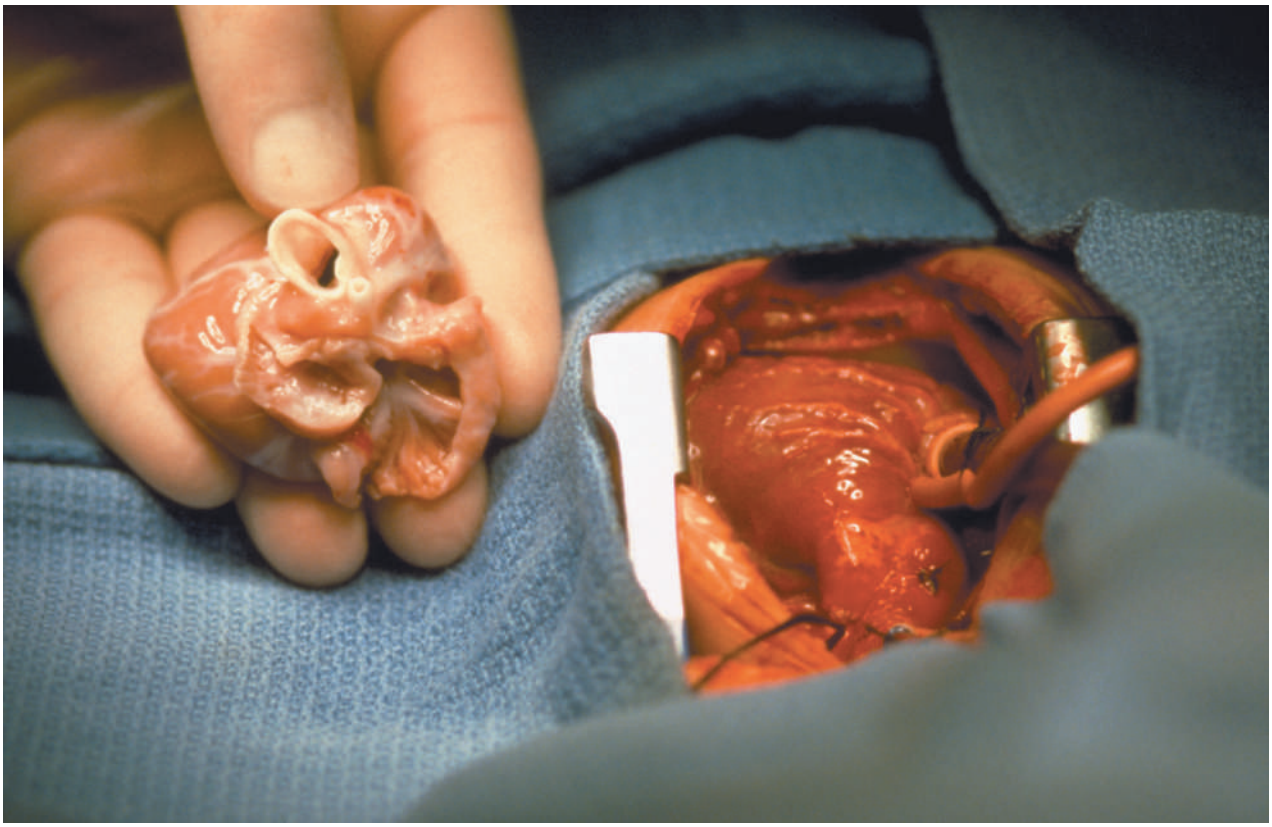
Insurance coverage for heart transplantation varies depending on the policy. Most commercial insurance companies pay a certain percentage of heart transplant costs. Medicare pays for heart transplants if the surgery is performed at Medicare-approved centers. Medicaid pays for heart transplants in 33 states and in the District of Colombia.

Preparation

Before patients are put on the transplant waiting list, their blood type is determined so a compatible donor heart can be found. The heart must come from a person with the same blood type as the patient, unless it is blood type O. A blood type O heart can be transplanted into a person with any type of blood.

A panel reactive antibodies (PRA) test is also done before heart transplantation. This test tells doctors whether or not the patient is at high risk for having a hyperacute reaction against a donor heart. A hyperacute reaction is a strong immune response against the new heart that happens within minutes to hours after the new heart is transplanted. If the PRA shows that a patient has a high risk for this kind of reaction, then a crossmatch is done between a patient and a donor heart before transplant surgery. A crossmatch checks how close the match is between the patient's tissue type and the tissue type of the donor heart.

Most people are not high risk and a crossmatch usually is not done before the transplant because the surgery must be done as quickly as possible after a donor heart is found.



A comparison of the old and new hearts of Dylan Stork, the smallest heart transplant recipient in the world. Dylan was seven weeks old and weighed 5.5 pounds (2.5 kg) at the time of the operation. *(Photograph by Alexander Tsiaras, Photo Researchers, Inc. Reproduced by permission.)*

While waiting for heart transplantation, patients are given treatment to keep the heart as healthy as possible. They are regularly checked to make sure the heart is pumping enough blood. Intravenous medications may be used to improve cardiac output. If these drugs are not effective, a mechanical pump can help keep the heart functioning until a donor heart becomes available. Inserted through an artery into the aorta, the pump assists the heart in pumping blood.

Aftercare

Immediately following surgery, patients are monitored closely in the intensive care unit (ICU) of the hospital for 24–72 hours. Most patients need to receive oxygen for four to 24 hours following surgery. Blood pressure, heart function, and other organ functions are carefully monitored during this time.

Heart transplant patients start taking immunosuppressive drugs before or during surgery to prevent immune rejection of the heart. High doses of immunosuppressive drugs are given at this time, because rejection is most likely to happen within the first few months after the surgery. A few months after surgery, lower doses of immunosuppressive drugs usually are given and must be taken for the rest of the patient's life.

For six to eight weeks after the transplant surgery, patients usually come back to the transplant center twice a week for physical examinations and medical tests. These tests check for any signs of infection, rejection of the new heart, or other complications.

In addition to **physical examination**, the following tests may be done during these visits:

- laboratory tests to check for infection
- chest x ray to check for early signs of lung infection
- electrocardiogram (ECG) to check heart function
- echocardiogram to check the function of the ventricles in the heart
- blood tests to check liver and kidney function
- complete blood counts (CBC) to check the numbers of blood cells
- taking of a small tissue sample from the donor heart (endomyocardial biopsy) to check for signs of rejection

KEY TERMS

Anesthesia—Loss of the ability to feel pain, caused by administration of an anesthetic drug.

Angina—Characteristic chest pain which occurs during exercise or stress in certain kinds of heart disease.

Cardiopulmonary bypass—Mechanically circulating the blood with a heart/lung machine that bypasses the heart and lungs.

Cardiovascular—Having to do with the heart and blood vessels.

Complete blood count (CBC)—A blood test to check the numbers of red blood cells, white blood cells, and platelets in the blood.

Coronary artery disease—Blockage of the arteries leading to the heart.

Crossmatch—A test to determine if patient and donor tissues are compatible.

Donor—A person who donates an organ for transplantation.

Echocardiogram—A test that visualizes and records the position and motion of the walls of the heart using ultrasound waves.

Electrocardiogram (ECG)—A test that measures electrical conduction of the heart.

End-stage heart failure—Severe heart disease that does not respond adequately to medical or surgical treatment.

Endomyocardial biopsy—Removal of a small sample of heart tissue to check it for signs of damage caused by organ rejection.

Fatigue—Loss of energy; tiredness.

Graft—A transplanted organ or other tissue.

Immunosuppressive drug—Medication used to suppress the immune system.

Inotropic drugs—Medications used to stimulate the heart beat.

Pulmonary hypertension—An increase in the pressure in the blood vessels of the lungs.

Recipient—A person who receives an organ transplant.

During the physical examination, the blood pressure is checked and the heart sounds are listened to with a stethoscope to determine if the heart is beating properly and pumping enough blood. Kidney and liver function are checked because these organs may lose function if the heart is being rejected.

An endomyocardial biopsy is the removal of a small sample of the heart muscle. This is done with a very small instrument that is inserted through an artery or vein and into the heart. The heart muscle tissue is examined under a microscope for signs that the heart is being rejected. Endomyocardial biopsy is usually done weekly for the first four to eight weeks after transplant surgery and then at longer intervals after that.

Risks

The most common and dangerous complications of heart transplant surgery are organ rejection and infection. Immunosuppressive drugs are given to prevent rejection of the heart. Most heart transplant patients have a rejection episode soon after transplantation, but doctors usually diagnose it immediately when it will respond readily to treatment. Rejection is treated with combinations of immunosuppressive drugs given in higher doses than maintenance immunosuppression. Most of these rejection situations are successfully treated.

Infection can result from the surgery, but most infections are a side effect of the immunosuppressive drugs. Immunosuppressive drugs keep the immune system from attacking the foreign cells of the donor heart. However, the suppressed immune cells are also unable to adequately fight bacteria, viruses, and other microorganisms. Microorganisms that normally do not affect persons with healthy immune systems can cause dangerous infections in transplant patients taking immunosuppressive drugs.

Patients are given antibiotics during surgery to prevent bacterial infection. Patients may also be given an antiviral drug to prevent virus infections. Patients who develop infections may need to have their immunosuppressive drugs changed or the dose adjusted. Infections are treated with antibiotics or other drugs, depending on the type of infection.

Other complications that can happen immediately after surgery are:

• bleeding

- pressure on the heart caused by fluid in the space surrounding the heart (pericardial tamponade)
- irregular heart beats
- reduced cardiac output
- increased amount of blood in the circulatory system
- decreased amount of blood in the circulatory system

About half of all heart transplant patients develop **coronary artery disease** 1–5 years after the transplant. The coronary arteries supply blood to the heart. Patients with this problem develop chest pains called **angina**. Other names for this complication are coronary allograft vascular disease and chronic rejection.

Outcomes

Heart transplantation is an appropriate treatment for many patients with end-stage heart failure. The outcomes of heart transplantation depend on the patient's age, health, and other factors. About 73% of heart transplant patients are alive four years after surgery.

After transplant, most patients regain normal heart function, meaning the heart pumps a normal amount of blood. A transplanted heart usually beats slightly faster than normal because the heart nerves are cut during surgery. The new heart also does not increase its rate as quickly during **exercise**. Even so, most patients feel much better and their capacity for exercise is dramatically improved from before they received the new heart. About 85% of patients return to work and other daily activities. Many are able to participate in sports.

Resources

BOOKS

Bellenir, Karen, and Peter D. Dresser, eds. *Cardiovascular Diseases and Disorders Sourcebook.* Detroit: Omnigraphics, 1995.

Texas Heart Institute. *Heart Owner's Handbook.* New York: John Wiley and Sons, 1996.

ORGANIZATIONS

American Council on Transplantation. P.O. Box 1709, Alexandria, VA 22313. 1-800-ACT-GIVE.

Health Services and Resources Administration, Division of Organ Transplantation. Room 11A-22, 5600 Fishers Lane, Rockville, MD 20857.

United Network for Organ Sharing (UNOS). 1-800-24-DONOR.

OTHER

Craven, John, and Susan Farrow. "Surviving Transplantation." *SupportNET Publications, 1996-1997.*

"Facts About Heart and Heart/Lung Transplants." *National Heart, Lung, and Blood Institute.* 27 Nov. 1998. 3 Mar. 1998 <http://www.nhlbi.nih.gov/index.htm>.

"What Every Patient Needs to Know." *United Network for Organ Sharing (UNOS).* <http://www.unos.org/frame_Default.asp?Category=Patients>.

Toni Rizzo

Heart tumors *see* **Myxoma**

Heart valve repair

Definition

Heart valve repair is a surgical procedure used to correct a malfunctioning heart valve. Repair usually involves separating the valve leaflets (the one-way "doors" of the heart valve which open and close to pump blood through the heart) or forcing them open with a balloon catheter, a technique known as *balloon valvuloplasty.*

Purpose

To correct damage to the mitral, aortic, pulmonary, or tricuspid heart valves caused by a systemic infection, **endocarditis**, rheumatic heart disease, a congenital heart defect, or mitral and/or aortic valve disease. Damaged valves may not open properly (stenosis) or they may not close adequately (valve regurgitation, insufficiency, or incompetence).

Precautions

Patients who have a diseased heart valve that is badly scarred or calcified may be better candidates for valve replacement surgery.

Description

Heart valve repair is performed in a hospital setting by a cardiac surgeon. During valve repair surgery, the patient's heart is stopped, and his/her blood is circulated outside of the body through an *extracorporeal bypass circuit*, also called heart-lung machine or just "the pump." The extracorporeal circuit consists of tubing and medical devices that take over the function of the patient's heart and lungs during the procedure. As blood passes through the circuit, carbon dioxide is removed from the bloodstream and replaced with oxygen. The oxygenated blood is then returned to the body. Other components may also be added to the circuit to filter fluids from the blood or concentrate red blood cells.

In cases of valve disease where the leaflets have become fused together, a procedure known as a valvulo-

KEY TERMS

Angiogram—An angiogram uses a radiopaque substance, or dye, to make the blood vessels or arteries visible under x ray.

Calcified—Hardened by calcium deposits.

Catheter—A long, thin, flexible tube used in valvuloplasty to widen the valve opening.

Echocardiogram—Ultrasound of the heart; generates a picture of the heart through the use of soundwaves.

Edema—Fluid accumulation in the body.

Scintigram—A nuclear angiogram; a scintigram involves injection of a radioactive substance into the patient's circulatory system. As the substance travels through the body, a special scanning camera takes pictures.

Stenosis—Narrowing of the heart valve opening.

tomy is performed. In valvulotomy, the leaflets of the valves are surgically separated, or partially resected, with an incision to increase the size of the valve opening. The surgeon may also make adjustments to the chordae, the cord-like tissue that connects the valve leaflets to the ventricle muscles, to improve valve function.

Another valve repair technique, **balloon valvuloplasty**, is used in patients with pulmonary, aortic, and **mitral valve stenosis** to force open the valve. Valvuloplasty is similar to a cardiac **angioplasty** procedure in that it involves the placement of a balloon-tipped catheter into the heart. Once inserted into the valve, the balloon is inflated and the valve dilates, or opens. Valvuloplasty does not require a bypass circuit.

Preparation

A number of diagnostic tests may be administered prior to valve repair surgery. **Magnetic resonance imaging** (MRI), echocardiogram, angiogram, and/or scintigram are used to help the surgeon get an accurate picture of the extent of damage to the heart valve and the status of the coronary arteries.

Aftercare

The patient's blood pressure and vital signs will be carefully monitored following a valve repair procedure, and he or she watched closely for signs of **edema** or congestive **heart failure**.

Echocardiography or other diagnostic tests are ordered for the patient at some point during or after surgery to evaluate valvular function. A **cardiac rehabilitation** program may also be recommended to assist the patient in improving **exercise** tolerance after the procedure.

Risks

As with any invasive surgical procedure, hemorrhage, infarction, **stroke**, heart attack, and infection are all possible complications of heart valve repair. The overall risks involved with the surgery depend largely on the complexity of the procedure and physical condition of the patient.

Normal results

Ideally, a successful heart valve repair procedure will return heart function to age-appropriate levels. If valvuloplasty is performed, a follow-up valve repair or replacement surgery may be necessary at a later date.

Resources

BOOKS

DeBakey, Michael E., and Antonio Gotto Jr. *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Paula Anne Ford-Martin

Heart valve replacement

Definition

Heart valve replacement is a surgical procedure during which surgeons remove a damaged valve from the heart and substitute a healthy one.

Purpose

Four valves direct blood to and from the body through the heart: the aortic valve, the pulmonic valve, the tricuspid valve, and the mitral valve. Any of these valves may malfunction because of a birth defect, infection, disease, or trauma. When the malfunction is so severe that it interferes with blood flow, an individual will have heart **palpitations**, **fainting** spells, and/or difficulty breathing. These symptoms will progressively worsen and cause **death** unless the damaged valve is replaced surgically.

Precautions

Abnormal tricuspid valves usually are not replaced because they do not cause serious symptoms. Mildly or

even moderately diseased mitral valves may not need to be replaced because their symptoms are tolerable or they can be treated with such drugs as **beta blockers** or calcium antagonists, which slow the heart rate. However, a severely diseased mitral valve should be repaired or replaced unless the person is too ill to tolerate the operation because of another condition or illness.

Description

After cutting through and separating the breastbone and ribs, surgeons place the patient on a cardiopulmonary bypass machine, which will perform the functions of the heart and lungs during the operation. They then open the heart and locate the faulty valve. Slicing around the edges of the valve, they loosen it from the tendons that connect it to the rest of the heart and withdraw it. The new valve is inserted and sutured into place. The patient is then taken off the bypass machine and the chest is closed. The surgery takes three to five hours and is covered by most insurance plans.

There are three types of replacement valves. One class is made from animal tissue, usually a pig's aortic valve. Another is mechanical and is made of metal and plastic. The third, includes human valves that have been removed from an organ donor or that, rarely, are the patient's own pulmonic valve.

There is no single ideal replacement valve. The choice between an animal valve or a mechanical valve depends largely on the age of the patient. Because valves obtained from animals have a life expectancy of 7–15 years, they usually are given to older patients. Mechanical valves are used in younger patients because they are more durable. Because mechanical valves are made of foreign material, however, blood clots can form on their surface. Therefore, patients who receive these valves must take anticoagulants the rest of their lives.

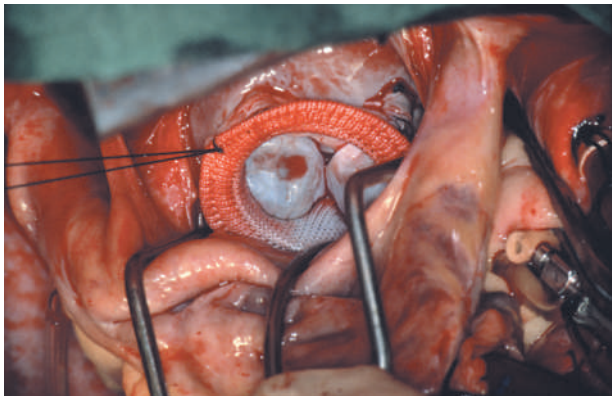
Donor or pulmonic valves are given only to those patients who will deteriorate rapidly because of a narrowing of the passageway between the aorta and the left ventrical (aortic stenosis). These valves are limited in their use because of the small supply available from donors and the strain that could be caused by removing and transferring a patient's own pulmonic valve.

Preparation

Before patients undergo heart valve replacement, they must be evaluated carefully for any signs that they may not tolerate the surgery.

Preoperative tests include:

- electrocardiography, which assesses the electrical activity of the heart



Open heart surgery showing replacement of a valve. *(Photograph byDavid Leah. Photo Researchers. Reproduced by permission.)*

- echocardiography, which uses sound waves to show the extent of the obstruction of blood flow through the heart and determine the degree of loss of heart function due to the malfunctioning valve
- chest x ray, which provides an overall view of the anatomy of the heart and the lungs

Cardiac catheterization may also be performed to further asses the valve and to determine if coronary bypass surgery should also be done.

Aftercare

A patient usually spends one to three days in the hospital intensive care unit (ICU) after heart valve replacement so that the working of his or her heart and circulation can be monitored closely. When first brought to the ICU after surgery, the patient undergoes a neurological examination to be sure he or she has not suffered a **stroke**. The patient continues to breathe by means of a tube inserted in the trachea at the time of surgery. This mechanical ventilation is not withdrawn until the patient is fully awake from anesthesia, shows signs that he or she can breathe satisfactorily without mechanical support, and has steadfast circulation.

Once stablilized, the patient is transferred to a standard medical/surgical unit where he or she receives drugs that will prevent excess fluid from building up around the heart. As soon as possible, the patient begins walking and exercising to regain strength. He or she is also placed on a diet that is low in salt and cholesterol.

After being released from the hospital, the patient continues a daily **exercise** program that includes vigorous walking, and he or she may also join a recommended **cardiac rehabilitation** program. He or she usually can

KEY TERMS

Anticoagulants—Drugs that prevent blood clots from forming.

Aortic valve—A fold in the channel leading from the aorta to the left ventricle of the heart. The aortic valve directs blood flow that has received oxygen from the lungs to the aorta which transmits blood to the rest of the body.

Cardiac catheterization—A thin tube called a catheter is inserted into an artery or vein in the leg, groin or arm. The catheter tube is carefully threaded into the area of the heart needing surgical repair. A local anaesthesia is used at the insertion sites.

Cardiopulmonary bypass machine—A mechanical instrument that takes over the circulation of the body while heart surgery is taking place.

Echocardiography—A diagnostic instrument that assesses the structure of the heart using sound waves.

Electrocardiography—A diagnostic instrument that evaluates the function of the heart by measuring the electrical activity generated by the beating of the heart.

Mitral valve—A fold in between the left atrium and the left ventricle of the heart that directs blood that has received oxygen from the lungs to the aortic valve and the aorta.

Pulmonic valve—A fold in the pulmonary artery that directs blood to the lungs. It may be transferred to replace a severely diseased aortic valve during heart valve replacement surgery for aortic stenosis.

Tricuspid valve—A fold in between the right atrium and the right ventricle of the heart that directs blood that needs oxygen to the lungs.

return to work or other normal activities within two months of the surgery.

Risks

Complications following heart valve replacement are not common, but can be serious. All valves made from animal tissue will develop calcium deposits over time. If these deposits hamper the function of the valve, it must be replaced. Valves may become dislodged. Blood clots may form on the surface of the substitute valve, break off into the general circulation, and become wedged in an artery supplying blood to the brain, kidneys, or legs. These blood clots may cause fainting spells, stroke, kidney failure, or loss of circulation to the legs. These blood clots can be treated with drugs or surgery.

Infection of heart muscle affects up to 2% of patients who have heart valve replacement. Such an infection is treated with intravenous **antibiotics**. If the infection persists, the new valve may have to be replaced.

Normal results

Few patients die as a result of the surgery. Approximately 3% of all patients die during or immediately after heart valve replacement, and less than 1% of patients below the age of 65 die because of the operation. The vast majority of patients who have heart valve replacement return to normal activity after the surgery. Depending on the type of valve they receive, these patients will have no symptoms of valve abnormality for at least seven years. Also, their quality of life will improve because they may no longer have difficulty breathing, fainting spells, or palpitations.

Resources

BOOKS

American Heart Association. *American Heart Association's Your Heart: An Owner's Manual*. Englewood Cliffs, NJ: Prentice Hall, 1991.

Schlant, Robert C., and Alexander, R. Wayne, eds. *The Heart, Arteries and Veins*. 18th ed. New York: McGraw-Hill, Inc., 1994.

Texas Heart Institute. *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley and Sons, 1996.

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

ORGANIZATIONS

The American College of Cardiology. 9111 Old Georgetown Road, Bethesda, MD 20814. (800) 253-4636. <http://www.acc.org>.

American College of Surgeons. 55 E. Erie St., Chicago, IL 60611. (312) 202-5000. <http://www.facs.org>.

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Karen Marie Sandrick

Heartburn

Definition

Heartburn is a burning sensation in the chest that can extend to the neck, throat, and face; it is worsened by bending or lying down. It is the primary symptom of gastroesophageal reflux, which is the movement of stomach acid into the esophagus. On rare occasions, it is due to **gastritis** (stomach lining inflammation).

Description

More than one third of the population is afflicted by heartburn, with about one tenth afflicted daily. Infrequent heartburn is usually without serious consequences, but chronic or frequent heartburn (recurring more than twice per week) can have severe consequences. Accordingly, early management is important.

Understanding heartburn depends on understanding the structure and action of the esophagus. The esophagus is a tube connecting the throat to the stomach. It is about 10 in (25 cm) long in adults, lined with squamous (plate-like) epithelial cells, coated with mucus, and surrounded by muscles that push food to the stomach by sequential waves of contraction (peristalsis). The lower esophageal sphincter (LES) is a thick band of muscles that encircles the esophagus just above the uppermost part of the stomach. This sphincter is usually tightly closed and normally opens only when food passes from the esophagus into the stomach. Thus, the contents of the stomach are normally kept from moving back into the esophagus.

The stomach has a thick mucous coating that protects it from the strong acid it secretes into its interior when food is present, but the much thinner esophageal coating doesn't provide protection against acid. Thus, if the LES opens inappropriately or fails to close completely, and stomach contents leak into the esophagus, the esophagus can be burned by acid. The resulting burning sensation is called heartburn.

Occasional heartburn has no serious long-lasting effects, but repeated episodes of gastroesophageal reflux can ultimately lead to esophageal inflammation (esophagitis) and other damage. If episodes occur more frequently than twice a week, and the esophagus is repeatedly subjected to acid and digestive enzymes from the stomach, ulcerations, scarring, and thickening of the esophagus walls can result. This thickening of the esophagus wall causes a narrowing of the interior of the esophagus. Such narrowing affects swallowing and peristaltic movements. Repeated irritation can also result in changes in the types of cells that line the esophagus. The condition associated with these changes is termed Barrett's syndrome and can lead to **esophageal cancer**.

Causes and symptoms

Causes

A number of different factors may contribute to LES malfunction with its consequent gastroesophageal acid reflux:

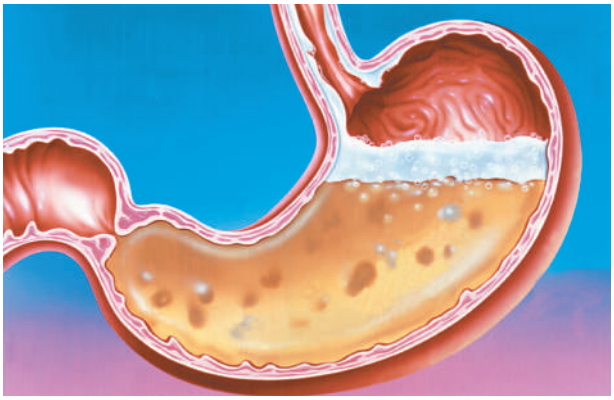
- The eating of large meals that distend the stomach can cause the LES to open inappropriately.
- Lying down within two to three hours of eating can cause the LES to open.
- Obesity, **pregnancy**, and tight clothing can impair the ability of the LES to stay closed by putting pressure on the abdomen.
- Certain drugs, notably nicotine, alcohol, diazepam (Valium), meperidine (Demerol), theophylline, morphine, prostaglandins, **calcium channel blockers**, nitrate heart medications, anticholinergic and adrenergic drugs (drugs that limit nerve reactions), including dopamine, can relax the LES.
- Progesterone is thought to relax the LES.
- Greasy foods and some other foods such as chocolate, coffee, and peppermint can relax the LES.
- Paralysis and **scleroderma** can cause the LES to malfunction.
- Hiatus **hernia** may also cause heartburn according to some gastroenterologists. (Hiatus hernia is a protrusion of part of the stomach through the diaphragm to a position next to the esophagus.).

Symptoms

Heartburn itself is a symptom. Other symptoms also caused by gastroesophageal reflux can be associated with heartburn. Often heartburn sufferers salivate excessively or regurgitate stomach contents into their mouths, leaving a sour or bitter taste. Frequent gastroesophageal reflux leads to additional complications including difficult or painful swallowing, **sore throat**, hoarseness, coughing, **laryngitis**, **wheezing**, **asthma**, **pneumonia**, gingivitis, **bad breath**, and earache.

Diagnosis

Gastroenterologists and internists are best equipped to diagnose and treat gastroesophageal reflux. Diagnosis is usually based solely on patient histories that report heartburn and other related symptoms. Additional diagnostic procedures can confirm the diagnosis and assess



An illustration of foaming antacid on top of the contents of a human stomach. Heartburn is caused by a backflow of the stomach's acidic contents into the esophagus, causing inflammation and a sense of pain that can rise to the throat. *(Illustration by John Bavosi, Custom Medical Stock Photo. Reproduced by permission.)*

damage to the esophagus, as well as monitor healing progress. The following diagnostic procedures are appropriate for anyone who has frequent, chronic, or difficult-to-treat heartburn or any of the complicating symptoms noted in the previous paragraph.

X rays taken after a patient swallows a barium suspension can reveal esophageal narrowing, ulcerations or a reflux episode as it occurs. However, this procedure cannot detect the structural changes associated with different degrees of esophagitis. This diagnostic procedure has traditionally been called the "upper GI series" or "barium swallow" and costs about $250.00.

Esophagoscopy is a newer procedure that uses a thin flexible tube to view the inside of the esophagus directly. It should be done by a gastroenterologist or gastrointestinal endoscopist and costs about $700. It gives an accurate picture of any damage present and gives the physician the ability to distinguish between different degrees of esophagitis.

Other tests may also be used. They include pressure measurements of the LES; measurements of esophageal acidity (pH), usually throughout a 24-hour period; and microscopic examination of biopsied tissue from the esophageal wall (to inspect esophageal cell structure for Barrett's syndrome and malignancies).

Note: A burning sensation in the chest is usually heartburn and is not associated with the heart. However, chest **pain** that radiates into the arms and is not accompanied by regurgitation is a warning of a possible serious heart problem. Anyone with these symptoms should contact a doctor immediately.

Treatment

Drugs

Occasional heartburn is probably best treated with over-the-counter **antacids**. These products go straight to the esophagus and immediately begin to decrease acidity. However, they should not be used as the sole treatment for heartburn sufferers who either have two or more episodes per week or who suffer for periods of over three weeks. There is a risk of kidney damage and other metabolic changes.

H2 blockers (histamine receptor blockers, such as Pepsid AC, Zantac, Tagamet) decrease stomach acid production and are effective against heartburn. H2 blocker treatment also allows healing of esophageal damage but is not very effective when there is a high degree of damage. It takes 30–45 minutes for these drugs to take effect, so they must be taken prior to an episode. Thus, they should be taken daily, usually two to four times per day for several weeks. Six to twelve weeks of standard-dose treatment relieves symptoms in about half the patients. Higher doses relieve symptoms in a greater fraction of the population, but at least 25% of heartburn sufferers are not helped by H2 blockers.

Proton-pump inhibitors also inhibit acid production by the stomach, but are much more effective than H2 blockers for some people. They are also more effective in aiding the healing process. Esophagitis is healed in about 90% of the patients undergoing proton-pump inhibitor treatment.

The long-term effects of inhibiting stomach acid production are unknown. Without the antiseptic effects of a consistently very acidic stomach environment, users of H2 blockers or proton-pump inhibitors may become more susceptible to bacterial and viral infection. Absorption of some drugs is also lowered by this less-acidic environment.

Prokinetic agents (also known as motility drugs) act on the LES, stimulating it to close more tightly, thereby keeping stomach contents out of the esophagus. It is not known how effectively these drugs promote healing. Some of the early motility drugs had serious neurological side effects, but a new drug, cisapride, seems to act only on digestive system nerve connections.

Surgery

Fundoplication, a surgical procedure to increase pressure on the LES by stretching and wrapping the upper part of the stomach around the sphincter, is a treatment of last resort. About 10% of heartburn sufferers undergo this procedure. It is not always effective and its effectiveness may decrease over time, especially several

KEY TERMS

Barrett's syndrome—Also called Barrett's esophagus or Barrett's epithelia, this is a condition where the squamous epithelial cells that normally line the esophagus are replaced by thicker columnar epithelial cells.

Digestive enzymes—Molecules that catalyze the breakdown of large molecules (usually food) into smaller molecules.

Esophagitis—Inflammation of the esophagus.

Fundoplication—A surgical procedure that increases pressure on the LES by stretching and wrapping the upper part of the stomach around the sphincter.

Gastroesophageal reflux—The flow of stomach contents into the esophagus.

Hiatus hernia—A protrusion of part of the stomach through the diaphragm to a position next to the esophagus.

Metabolic—Refers to the chemical reactions in living things.

Mucus—Thick, viscous, gel-like material that functions to moisten and protect inner body surfaces.

Peristalsis—A sequence of muscle contractions that progressively squeeze one small section of the digestive tract and then the next to push food along the tract, something like pushing toothpaste out of its tube.

Scleroderma—An autoimmune disease with many consequences, including esophageal wall thickening.

Squamous epithelial cells—Thin, flat cells found in layers or sheets covering surfaces such as skin and the linings of blood vessels and esophagus.

Ulceration—An open break in surface tissue.

years after surgery. Dr. Robert Marks and his colleagues at the University of Alabama reported in 1997 on the long-term outcome of this procedure. They found that 64% of the patients in their study who had fundoplication between 1992 and 1995 still suffered from heartburn and reported an impaired quality of life after the surgery.

However, **laparoscopy** (an examination of the interior of the abdomen by means of the laparoscope) now provides hope for better outcomes. Fundoplication performed with a laparoscope is less invasive. Five small incisions are required instead of one large incision. Patients recover faster, and it is likely that studies will show they suffer from fewer surgical complications.

Alternative treatment

Prevention, as outlined below, is a primary feature for heartburn management in alternative medicine and traditional medicine. Dietary adjustments can eliminate many causes of heartburn.

Herbal remedies include bananas, aloe vera gel, chamomile (*Matricaria recutita*), ginger (*Zingiber officinale*), and citrus juices, but there is little agreement here. For example, ginger, which seems to help some people, is claimed by other practitioners to *cause* heartburn and is thought to relax the LES. There are also many recommendations to *avoid* citrus juices, which are themselves acidic. Licorice (*Glycyrrhiza uralensis*) can help relieve the symptoms of heartburn by reestablishing balance in the acid output of the stomach.

Several homeopathic remedies are useful in treating heartburn symptoms. Among those most often recommended are *Nux vomica*, *Carbo vegetabilis*, and *Arsenicum album*. **Acupressure** and **acupuncture** may also be helpful in treating heartburn.

Sodium bicarbonate (baking soda) is an inexpensive alternative to use as an antacid. It reduces esophageal acidity immediately, but its effect is not long-lasting and should not be used by people on sodium-restricted **diets**.

Prognosis

The prognosis for people who get heartburn only occasionally or people without esophageal damage is excellent. The prognosis for people with esophageal damage who become involved in a treatment program that promotes healing is also excellent. The prognosis for anyone with esophageal **cancer** is very poor. There is a strong likelihood of a painful illness and a less than 5% chance of surviving more than five years.

Prevention

Given the lack of completely satisfactory treatments for heartburn or its consequences and the lack of a cure for esophageal cancer, prevention is of the utmost impor-

tance. Proponents of traditional *and* alternative medicine agree that people disposed to heartburn should:

- avoid eating large meals
- avoid alcohol, **caffeine**, fatty foods, fried foods, hot or spicy foods, chocolate, peppermint, and nicotine
- avoid drugs known to contribute to heartburn, such as nitrates (heart medications like Isonate and Nitrocap), calcium channel blockers (e.g., Cardizem and Procardia), and anticholinergic drugs (e.g., Pro-banthine and Bentyl), and check with their doctors about any drugs they are taking
- avoid clothing that fits tightly around the abdomen
- control body weight
- wait about three hours after eating before going to bed or lying down
- elevate the head of the bed 6–9 inches to alleviate heartburn at night. This can be done with bricks under the bed or with a wedge designed for this purpose

Resources

BOOKS

Castell, Donald O. *The Esophagus*. Boston: Little, Brown, and Co., 1995.

Wolfe, M. Michael, and Thomas Nesi. *The Fire Inside: Extinguishing Heartburn and Related Symptoms*. New York: Norton, 1996.

PERIODICALS

"Acid blockers: How You Can Head Off Heartburn Before it Starts." *Mayo Clinic Health Letter* (Nov. 1997).

Mittal, Ravinder K., and David H. Balaban. "Mechanisms of Disease: The Esophagogastric Junction." *New England Journal of Medicine* 336 (27 Mar. 1997): 924-932.

Vaezi, Michael F., and Joel E. Richter. "Gastroesophageal Reflux Disease." *Current Opinion in Gastroenterology* 13 (July 1997): 327-332.

ORGANIZATIONS

The American College of Gastroenterology (ACG). PO Box 3099, Alexandria, VA 22302. (800) HRT-BURN. <http://www.healthtouch.com>.

The American Gastroenterological Association (AGA). 7910 Woodmont Ave., 7th Floor, Bethesda, MD 20814. (310) 654-2055. <http://www.gastro.org/index.html>.

American Society for Gastrointestinal Endoscopy. 13 Elm St., Manchester, MA 01944. (508) 526-8330. <http://www.asge.org/doc/201>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Lorraine Lica, PhD

Heat cramps *see* **Heat disorders**

Heat disorders

Definition

Heat disorders are a group of physically related illnesses caused by prolonged exposure to hot temperatures, restricted fluid intake, or failure of temperature regulation mechanisms of the body. Disorders of heat exposure include heat cramps, heat exhaustion, and heat **stroke** (also called sunstroke). Hyperthermia is the general name given to heat-related illnesses. The two most common forms of hyperthermia are heat exhaustion and heat stroke, which is especially dangerous and requires immediate medical attention.

Description

Heat disorders are harmful to people of all ages, but their severity is likely to increase as people age. Heat cramps in a 16-year-old may be heat exhaustion in a 45-year-old and heat stroke in a 65-year-old. The body's temperature regulating mechanisms rely on the thermal regulating centers in the brain. Through these complex centers, the body tries to adapt to high temperatures by adjusting the amount of salt in the perspiration. Salt helps the cells in body tissues retain water. In hot weather, a healthy body will lose enough water to cool the body while creating the lowest level of chemical imbalance. Regardless of extreme weather conditions, the healthy human body keeps a steady temperature of approximately 98.6°F (37°C). In hot weather, or during vigorous activity, the body perspires. As perspiration evaporates from the skin, the body is cooled. If the body loses too much salt and fluids, the symptoms of **dehydration** can occur.

Heat cramps

Heat cramps are the least severe of the heat-related illnesses. This heat disorder is often the first signal that the body is having difficulty with increased temperature. Individuals exposed to excessive heat should think of heat cramps as a warning sign to a potential heat-related emergency.

Heat exhaustion

Heat exhaustion is a more serious and complex condition than heat cramps. Heat exhaustion can result from prolonged exposure to hot temperatures, restricted fluid intake, or failure of temperature regulation mechanisms of the body. It often affects athletes, firefighters, construction workers, factory workers, and anyone who wears heavy clothing in hot humid weather.

Heat stroke

Heat exhaustion can develop rapidly into heat stroke. Heat stroke can be life threatening and because the percentage of victims dying from heat stroke is very high, immediate medical attention is critical when problems first begin. Heat stroke, like heat exhaustion, is also a result of prolonged exposure to hot temperatures, restricted fluid intake, or failure of temperature regulation mechanisms of the body. However, the severity of impact on the body is much greater with heat stroke.

Causes and symptoms

Heat cramps

Heat cramps are painful muscle spasms caused by the excessive loss of salts (electrolytes), due to heavy perspiration. The muscle tissue becomes less flexible, causing **pain**, difficult movement, and involuntary tightness. Heavy exertion in extreme heat, restricted fluid intake, or failure of temperature regulation mechanisms of the body may lead to heat cramps. This disorder occurs more often in the legs and abdomen than in other areas of the body. Individuals at higher risk are those working in extreme heat, elderly people, young children, people with health problems, and those who are unable to naturally and properly cool their bodies. Individuals with poor circulation and who take medications to reduce excess body fluids can be at risk when conditions are hot and humid.

Heat exhaustion

Heat exhaustion is caused by exposure to high heat and humidity for many hours, resulting in excessive loss of fluids and salts through heavy perspiration. The skin may appear cool, moist, and pale. The individual may complain of **headache** and nausea with a feeling of overall weakness and exhaustion. **Dizziness**, faintness, and mental confusion are often present, as is rapid and weak pulse. Breathing becomes fast and shallow. Fluid loss reduces blood volume and lowers blood pressure. Yellow or orange urine often is a result of inadequate fluid intake, along with associated intense thirst. Insufficient water and salt intake or a deficiency in the production of sweat place an individual at high risk for heat exhaustion.

Heat stroke

Heat stroke is caused by overexposure to extreme heat, resulting in a breakdown in the body's heat regulating mechanisms. The body's temperature reaches a dangerous level, as high as 106°F (41.1°C). An individual with heat stroke has a body temperature higher than 104°F (40°C). Other symptoms include mental confusion with possible combativeness and bizarre behavior, staggering, and faintness.

The pulse becomes strong and rapid (160–180 beats per minute) with the skin taking on a dry and flushed appearance. There is often very little perspiration. The individual can quickly lose consciousness or have convulsions. Before heat-stroke, an individual suffers from heat exhaustion and the associated symptoms. When the body can no longer maintain a normal temperature, heat exhaustion becomes heat-stroke. Heat stroke is a life-threatening medical emergency that requires immediate initiation of life-saving measures.

KEY TERMS

Convulsions—Also termed seizures; a sudden violent contraction of a group of muscles.

Electrolytes—An element or compound that when melted or dissolved in water dissociates into ions and is able to conduct an electrical current. Careful and regular monitoring of electrolytes and intravenous replacement of fluid and electrolytes are part of the acute care in many illnesses.

Rehydration—The restoration of water or fluid to a body that has become dehydrated.

Diagnosis

The diagnosis of heat cramps usually involves the observation of individual symptoms such as muscle cramping and thirst. Diagnosis of heat exhaustion or heat stroke, however, may require a physician to review the medical history, document symptoms, and obtain a blood pressure and temperature reading. The physician may also take blood and urine samples for further laboratory testing. A test to measure the body's electrolytes can also give valuable information about chemical imbalances caused by the heat-related illness.

Treatment

Heat cramps

The care of heat cramps includes placing the individual at rest in a cool environment, while giving cool water with a teaspoon of salt per quart, or a commercial sports drink. Usually rest and liquids are all that is needed for the patient to recover. Mild stretching and massaging of the muscle area follows once the condition improves. The individual should not take salt tablets,

since this may actually worsen the condition. When the cramps stop, the person can usually start activity again if there are no other signs of illness. The individual needs to continue drinking fluids and should be watched carefully for further signs of heat-related illnesses.

Heat exhaustion

The individual suffering from heat exhaustion should stop all physical activity and move immediately to a cool place out of the sun, preferably a cool, air-conditioned location. She or he should then lay down with feet slightly elevated, remove or loosen clothing, and drink cold (but not iced), slightly salty water or commercial sports drink. Rest and replacement of fluids and salt is usually all the treatment that is needed, and hospitalization is rarely required. Following rehydration, the person usually recovers rapidly.

Heat stroke

Simply moving the individual afflicted with heat stroke to a cooler place is not enough to reverse the internal overheating. Emergency medical assistance should be called immediately. While waiting for help to arrive, quick action to lower body temperature must take place. Treatment involves getting the victim to a cool place, loosening clothes or undressing the heat stroke victim, and allowing air to circulate around the body. The next important step is wrapping the individual in wet towels or clothing, and placing ice packs in areas with the greatest blood supply. These areas include the neck, under the arm and knees, and in the groin. Once the patient is under medical care, **cooling treatments** may continue as appropriate. The victim's body temperature will be monitored constantly to guard against overcooling. Breathing and heart rate will be monitored closely, and fluids and electrolytes will be replaced intravenously. Anti-convulsant drugs may be given. After severe heat stroke, bed rest may be recommended for several days.

Prognosis

Prompt treatment for heat cramps is usually very effective with the individual returning to activity thereafter. Treatment of heat exhaustion usually brings full recovery in one to two days. Heatstroke is a very serious condition and its outcome depends upon general health and age. Due to the high internal temperature of heat stroke, permanent damage to internal organs is possible.

Prevention

Because heat cramps, heat exhaustion, and heat stroke have a cascade effect on each other, the prevention of the onset of all heat disorders is similar. Avoid strenuous **exercise** when it is very hot. Individuals exposed to extreme heat conditions should drink plenty of fluids. Wearing light and loose-fitting clothing in hot weather is important, regardless of the activity. It is important to consume water often and not to wait until thirst develops. If perspiration is excessive, fluid intake should be increased. When urine output decreases, fluid intake should also increase. Eating lightly salted foods can help replace salts lost through perspiration. Ventilation in any working areas in warm weather must be adequate. This can be achieved as simply as opening a window or using an electric fan. Proper ventilation will promote adequate sweat evaporation to cool the skin. Sunblocks and **sunscreens** with a protection factor of 15 (SPF 15) can be very helpful when one is exposed to extreme direct sunlight.

Resources

BOOKS

American Red Cross. *Standard First Aid*. St. Louis: Mosby Year Book, 1993.

Larson, David E., ed. *Mayo Clinic Family Health Book*. 2nd ed. New York: William Morrow, 1996.

Morris, M., M. Walsh, and Shelton G. Walsh. *The Team Physicians Hand Book*. Philadelphia: Hanley & Belfus, 1990.

OTHER

Griffith, H. Winter. "Complete Guide to Symptoms, Illness & Surgery." ThriveOnline. <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Heat exhaustion *see* **Heat disorders**

Heat treatments

Definition

Heat treatments are applications of therapeutic thermal agents to specific body areas experiencing injury or dysfunction.

Purpose

The general purpose of a heat treatment is to increase the extensibility of soft tissues, remove toxins from cells, enhance blood flow, increase function of the tissue cells, encourage muscle relaxation, and help relieve **pain**. There are two types of heat treatments: superficial and deep. Superficial heat treatments apply heat to the outside of the body. Deep heat treatments direct heat toward specific inner tissues through ultra-

sound or by electric current.Heat treatments are beneficial prior to **exercise**, providing a warm-up effect to the soft tissues involved.

Precautions

Heat treatments should not be used on individuals with circulation problems, heat intolerance, or lack of sensation in the affected area. Low blood circulation may contribute to heat-related injuries. Heat treatments also should not be used on individuals afflicted with heart, lung, or kidney diseases. Deep heat treatments should not be used on areas above the eye, heart, or on a pregnant patient. Deep heat treatments over areas with metal surgical implants should be avoided in case of rapid temperature increase and subsequent injury.

Description

There are four different ways to convey heat:

- Conduction is the transfer of heat between two objects in direct contact with each other.
- Conversion is the transition of one form of energy to heat.
- Radiation involves the transmission and absorption of electromagnetic waves to produce a heating effect.
- Convection occurs when a liquid or gas moves past a body part creating heat.

Hot packs, water bottles, and heating pads

Hot packs are a very common form of heat treatment utilizing conduction as a form of heat transfer. Moist heat packs are readily available in most hospitals, physical therapy centers, and athletic training rooms. Treatment temperature should not exceed 131°F (55°C). The pack is used over multiple layers of toweling to achieve a comfortable warming effect for approximately 30 minutes. More recently, several manufacturers have developed packs that may be warmed in a microwave over a specified amount of time prior to use.

Hot-water bottles are another form of superficial heat treatment. The bottles are filled half way with hot water between 115–125°F (46.1–52°C). Covered by a protective toweling, the hot-water bottle is placed on the treatment area and left until the water has cooled off.

Electrical heating pads continue to be used, however because of the need for an electrical outlet, safety and convenience become an issue.

Paraffin

Paraffin, a conductive form of superficial heat, is often used for heating uneven surfaces of the body such as the hands. It consists of melted paraffin wax and mineral oil. Paraffin placed in a small bath unit becomes solid at room temperature and is used as a liquid heat treatment when heated at 126–127.4°F (52–53°C). The most common form of paraffin application is called the dip and wax method. In this technique, the patient will dip eight to 12 times and then the extremity will be covered with a plastic bag and a towel for insulation. Most treatment sessions are about 20 minutes.

Hydrotherapy

Hydrotherapy is used in a form of heat treatment for many musculoskeletal disorders. The hydrotherapy tanks and pools are all generally set at warm temperatures, never exceeding 150°F (65.6°C). Because the patient often performs resistance exercises while in the water, higher water temperatures become a concern as the treatment becomes more physically draining. Because of this, many hydrotherapy baths are now being set at 95–110°F (35–43.3°C). There are also units available with moveable turbine jets, which provide a light massage effect. Hydrotherapy is helpful as a warm-up prior to exercise.

Fluidotherapy

Fluidotherapy is a form of heat treatment developed in the 1970s. It is a dry heat modality consisting of cellulose particles suspended in air. Units come in different sizes and some are restricted to only treating a hand or foot. The turbulence of the gas-solid mixture provides thermal contact with objects that are immersed in the medium. Temperatures of this treatment range from 110–123°F (43.3–50.5°C). Fluidotherapy allows the patient to exercise the limb during the treatment, and also massages the limb, increasing blood flow.

Ultrasound

Ultrasound heat treatments penetrate the body to provide relief to inner tissue. Ultrasound energy comes from the acoustic or sound spectrum and is undetectable to the human ear. By using conducting agents such as gel or mineral oil, the ultrasound transducer warms areas of the musculoskeletal system Some areas of the musculoskeletal system absorb ultrasound better that others. Muscle tissue and other connective tissue such as ligaments and tendons absorb this form of energy very well, however fat absorbs to a much lesser degree. Ultrasound has a relatively longlasting effect, continuing up to one hour.

Diathermy

Diathermy is another deep heat treatment. An electrode drum is used to apply heat to an affected area. It

consists of a wire coil surrounded by dead space and other insulators such as a plastic housing. Plenty of toweling must be layered between the unit and the patient. This device is unique in that it utilizes the basis of a magnetic field on connective tissues. One advantage of diathermy over various other heat treatments is that fat does resist an electrical field, which is not the case with a magnetic field. It is found to be helpful with those experiencing chronic **low back pain** and muscle spasms. Prior to ultrasound technology, diathermy was a popular heat therapy of the 1940s–1960s.

Preparation

Before administering any form of heat treatment, heat sensitivity is accessed and the skin over the affected area is cleansed. When a patient is undergoing any form of heat treatment, supervision should always be present especially in the treatment of hydrotherapy.

Aftercare

Once the heat treatment has been completed, any symptoms of **dizziness** and nausea should be noted and documented along with any skin irritations or discoloring not present prior to the heat treatment. A one hour interval between treatments should be adhered to in order to avoid restriction of blood flow.

Risks

All heat treatments have the potential of tissue damage resulting from excessive temperatures. Proper insulation and treatment duration should be carefully administered for each method. Overexposure during a superficial heat treatment may result in redness, blisters, **burns**, or reduced blood circulation. During ultrasound therapy, excessive treatment over bony areas with little soft tissue (such as hand, feet, and elbow) can cause excessive heat resulting in pain and possible tissue damage. Exposure to the electrode drum during diathermy may produce hot spots.

Resources

BOOKS

Scully, Rosemary M., and Marylou R. Barnes. *Physical Therapy.* Philadelphia: J. B. Lippincott Co., 1989.

PERIODICALS

Mclaughlin, Christine. "Hot Packs in the Clinic: Are They Overutilized?" *Advance Magazine for Physical Therapists* (29 Apr. 1996): 6.

Roland, Pamela. "Some Like It Hot and Cold." *Advance Magazine for Physical Therapists* (22 May 1995): 6.

ORGANIZATIONS

American Physical Therapy Association. 1111 North Fairfax St., Alexandria, Virginia 22314. (800) 999-2782. <https://www.apta.org>.

Jeffrey P. Larson, RPT

Heatstroke *see* **Heat disorders**

Heavy menstruation *see* **Dysfunctional uterine bleeding**

Heavy metal poisoning

Definition

Heavy metal **poisoning** is the toxic accumulation of heavy metals in the soft tissues of the body.

Description

Heavy metals are chemical elements that have a specific gravity (a measure of density) at least five times that of water. The heavy metals most often implicated in human poisoning are lead, mercury, arsenic, and cadmium. Some heavy metals, such as zinc, copper, chromium, iron, and manganese, are required by the body in small amounts, but these same elements can be toxic in larger quantities.

Heavy metals may enter the body in food, water, or air, or by absorption through the skin. Once in the body, they compete with and displace essential **minerals** such as zinc, copper, magnesium, and calcium, and interfere with organ system function. People may come in contact with heavy metals in industrial work, pharmaceutical manufacturing, and agriculture. Children may be poisoned as a result of playing in contaminated soil.

Causes and symptoms

Symptoms will vary, depending on the nature and the quantity of the heavy metal ingested. Patients may complain of nausea, vomiting, **diarrhea**, stomach **pain**, **headache**, sweating, and a metallic taste in the mouth. Depending on the metal, there may be blue-black lines in the gum tissues. In severe cases, patients exhibit obvious impairment of cognitive, motor, and language skills. The expression "mad as a hatter" comes from the mercury poisoning prevalent in 17th century France among hatmakers who soaked animal hides in a solution of mercuric nitrate to soften the hair.

Diagnosis

Heavy metal poisoning may be detected using blood and urine tests, hair and tissue analysis, or x ray.

In childhood, blood lead levels above 80 µg/dL generally indicate **lead poisoning**, however, significantly lower levels (>.30 µg/dL) can cause **mental retardation** and other cognitive and behavioral problems in affected children. The Centers for Disease Control and Pevention considers a blood lead level of 10 µg/dL or higher in children a cause for concern. In adults, symptoms of lead poisoning are usually seen when blood lead levels exceed 80 µg/dL for a number of weeks.

Blood levels of mercury should not exceed 3.6 µg/dL, while urine levels should not exceed 15 µg/dL. Symptoms of mercury poisoning may be seen when mercury levels exceed 20 µg/dL in blood and 60 µg/dL in urine. Mercury levels in hair may be used to gauge the severity of chronic mercury exposure.

Since arsenic is rapidly cleared from the blood, blood arsenic levels may not be very useful in diagnosis. Arsenic in the urine (measured in a 24-hour collection following 48 hours without eating seafood) may exceed 50 µg/dL in people with arsenic poisoning. If acute arsenic poisoning is suspected, an x ray may reveal ingested arsenic in the abdomen (since arsenic is opaque to x rays). Arsenic may also be detected in the hair and nails for months following exposure.

Cadmium toxicity is generally indicated when urine levels exceed 10 µg/dL of creatinine and blood levels exceed 5 µg/dL.

Treatment

The treatment for most heavy metal poisoning is **chelation therapy**. A chelating agent specific to the metal involved is given either orally, intramuscularly, or intravenously. The three most common chelating agents are calcium disodium edetate, dimercaprol (BAL), and penicillamine. The chelating agent encircles and binds to the metal in the body's tissues, forming a complex; that complex is then released from the tissue to travel in the bloodstream. The complex is filtered out of the blood by the kidneys and excreted in the urine. This process may be lengthy and painful, and typically requires hospitalization. Chelation therapy is effective in treating lead, mercury, and arsenic poisoning, but is not useful in treating cadmium poisoning. To date, no treatment has been proven effective for cadmium poisoning.

In cases of acute mercury or arsenic ingestion, vomiting may be induced. Washing out the stomach (gastric lavage) may also be useful. The patient may also require treatment such as intravenous fluids for complications of poisoning such as **shock**, anemia, and kidney failure.

KEY TERMS

Chelation—The process by which a molecule encircles and binds to a metal and removes it from tissue.

Heavy metal—One of 23 chemical elements that has a specific gravity (a measure of density) at least five times that of water.

Prognosis

The chelation process can only halt further effects of the poisoning; it cannot reverse neurological damage already sustained.

Prevention

Because exposure to heavy metals is often an occupational hazard, protective clothing and respirators should be provided and worn on the job. Protective clothing should then be left at the work site and not worn home, where it could carry toxic dust to family members. Industries are urged to reduce or replace the heavy metals in their processes wherever possible. Exposure to environmental sources of lead, including lead-based paints, plumbing fixtures, vehicle exhaust, and contaminated soil, should be reduced or eliminated.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Food and Drug Administration. Office of Inquiry and Consumer Information. 5600 Fisher Lane, Room 12-A-40, Rockville, MD 20857. (301) 827-4420. <http://www.fda.gov/fdahomepage.html>.

National Institutes of Health. National Institute of Environmental Health Sciences Clearinghouse. EnviroHealth, 2605 Meridian Parkway, Suite 115, Durham, NC 27713. (919) 361-9408.

National Organization for Rare Disorders. PO Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Bethany Thivierge

Heel spurs

Definition

A heel spur is a bony projection on the sole (plantar) region of the heel bone (also known as the calcaneous). This condition may accompany or result from severe cases of inflammation to the structure called plantar fascia. This associated plantar fascia is a fibrous band of connective tissue on the sole of the foot, extending from the heel to the toes.

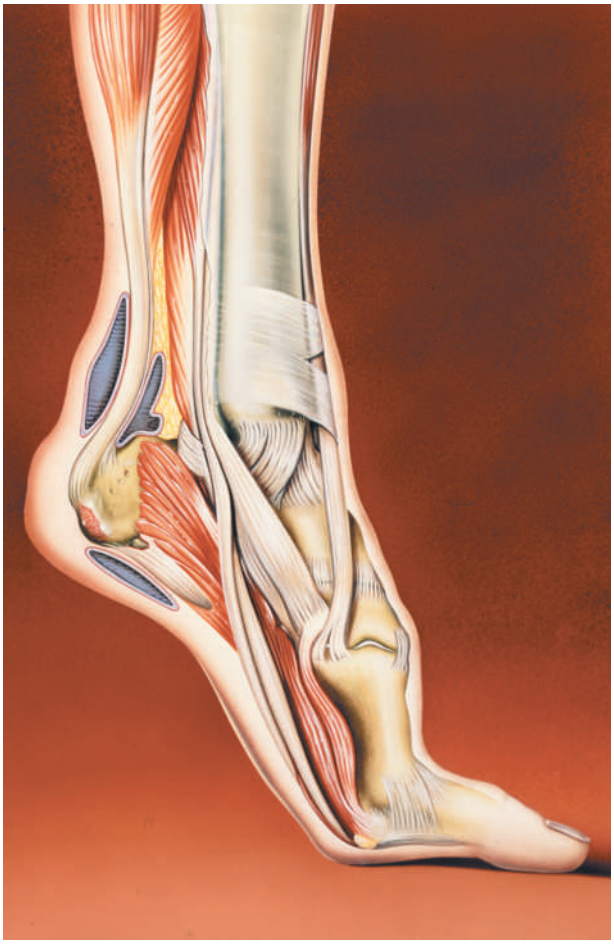
Description

Heel spurs are a common foot problem resulting from excess bone growth on the heel bone. The bone growth is usually located on the underside of the heel bone, extending forward to the toes. One explanation for this excess production of bone is a painful tearing of the plantar fascia connected between the toes and heel. This can result in either a heel spur or an inflammation of the plantar fascia, medically termed plantar fascitis. Because this condition is often correlated to a decrease in the arch of the foot, it is more prevalent after the age of six to eight years, when the arch is fully developed.

Causes and symptoms

One frequent cause of heel spurs is an abnormal motion and mal-alignment of the foot called pronation. For the foot to function properly, a certain degree of pronation is required. This motion is defined as an inward action of the foot, with dropping of the inside arch as one plants the heel and advances the weight distribution to the toes during walking. When foot pronation becomes extreme from the foot turning in and dropping beyond the normal limit, a condition known as excessive pronation creates a mechanical problem in the foot. In some cases the sole or bottom of the foot flattens and becomes unstable because of this excess pronation, especially during critical times of walking and athletic activities. The portion of the plantar fascia attached into the heel bone or calcaneous begins to stretch and pull away from the heel bone.

At the onset of this condition, **pain** and swelling become present, with discomfort particularly noted as pushing off with the toes occurs during walking. This movement of the foot stretches the fascia that is already irritated and inflamed. If this condition is allowed to continue, pain is noticed around the heel region because of the newly formed bone, in response to the **stress**. This results in the development of the heel spur. It is common among athletes and others who run and jump a significant amount.



Ilustration of bony projection, a spur, which developed from chronic irritation. *(Photo Researchers. Reproduced by permission.)*

An individual with the lower legs angulating inward, a condition called genu valgus or "knock knees," can have a tendency toward excessive pronation. As a result, this too can lead to a fallen arch resulting in plantar fascitis and heel spurs. Women tend to have more genu valgus than men do. Heel spurs can also result from an abnormally high arch.

Other factors leading to heel spurs include a sudden increase in daily activities, an increase in weight, or a change of shoes. Dramatic increase in training intensity or duration may cause plantar fascitis. Shoes that are too flexible in the middle of the arch or shoes that bend before the toe joints will cause an increase in tension in the plantar fascia and possibly lead to heel spurs.

The pain this condition causes forces an individual to attempt walking on his or her toes or ball of the foot to avoid pressure on the heel spur. This can lead to other compensations during walking or running that in turn cause additional problems to the ankle, knee, hip, or back.

Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of heel spurs and other foot conditions. X rays of the heel area are helpful, as excess bone production will be visible.

Treatment

Conservative

Heel spurs and plantar fascitis are usually controlled with conservative treatment. Early intervention includes stretching the calf muscles while avoiding re-injuring the plantar fascia. Decreasing or changing activities, losing excess weight, and improving the proper fitting of shoes are all important measures to decrease this common source of foot pain. Modification of footwear includes shoes with a raised heel and better arch support. Shoe orthotics recommended by a healthcare professional are often very helpful in conjunction with exercises to increase strength of the foot muscles and arch. The orthotic prevents excess pronation and lengthening of the plantar fascia and continued tearing of this structure. To aid in this reduction of inflammation, applying ice for 10–15 minutes after activities and use of anti-inflammatory medication can be helpful. Physical therapy can be beneficial with the use of heat modalities, such as ultrasound that creates a deep heat and reduces inflammation. If the pain caused by inflammation is constant, keeping the foot raised above the heart and/or compressed by wrapping with an ace bandage will help.

Corticosteroid injections are also frequently used to reduce pain and inflammation. Taping can help speed the healing process by protecting the fascia from reinjury, especially during stretching and walking.

Heel surgery

When chronic heel pain fails to respond to conservative treatment, surgical treatment may be necessary. Heel surgery can provide relief of pain and restore mobility. The type of procedure used is based on examination and usually consists of releasing the excessive tightness of the plantar fascia, called a plantar fascia release. Depending on the presence of excess bony build up, the procedure may or may not include removal of heel spurs. Similar to other surgical interventions, there are various modifications and surgical enhancements regarding surgery of the heel.

Alternative treatment

Acupuncture and accupressure have been used to address the pain of heel spurs, in addition to using friction massage to help break up scar tissue and delay onset of bony formations.

KEY TERMS

Calcaneous—The heel bone.

Genu valgus—Deformity in which the legs are curved inward so that the knees are close together, nearly or actually knocking as a person walks with ankles widely apart of each other.

Plantar fascia—A tough fibrous band of tissue surrounding the muscles of the sole of the foot. Also called plantar aponeurosis.

Pronation—The lowering or descending of the inner edge of the foot by turning the entire foot outwards.

Prognosis

Usually, heel spurs are curable with conservative treatment. If not, heel spurs are curable with surgery. About 10% of those that continue to see a physician for plantar fascitis have it for more than a year. If there is limited success after approximately one year of conservative treatment, patients are often advised to have surgery.

Prevention

To prevent this condition, wearing shoes with proper arches and support is very important. Proper stretching is always a necessity, especially when there is an increase in activities or a change in running technique. It is not recommended to attempt working through the pain, as this can change a mild case of heel spurs and plantar fascitis into a long lasting and painful episode of this condition.

Resources

BOOKS

Perkins, Kenneth E. "Lower Extremity Orthotics in Geriatric Rehabilitation." In *Geriatric Physical Therapy*. Ed. Andrew Guccione. St. Louis: Mosby Year Book Inc, 1993.

PERIODICALS

Feeny, Tracy. "If The Shoe Fits." *Advance Magazine for Physical Therapists*, July 1997, 7.

ORGANIZATIONS

American Orthopedic Foot and Ankle Society. 222 South Prospect, Park Ridge, IL 60068.

American Podiatry Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814.

OTHER

Roberts, Scott. "Plantar Fascitis." Heelspurs.com. 1998. 9 Apr. 1998 <http://www.heelspurs.com>.

Jeffrey P. Larson, RPT

Heimlich maneuver

Definition

The Heimlich maneuver is an emergency procedure for removing a foreign object lodged in the airway that is preventing a person from breathing.

Purpose

Every year about 3,000 adults die because they accidentally inhale rather than swallow food. The food gets stuck and blocks their trachea, making breathing impossible. **Death** follows rapidly unless the food or other foreign material can be displaced from the airway. This condition is so common it has been nicknamed the "cafe coronary."

In 1974 Dr. Henry Heimlich first described an emergency technique for expelling foreign material blocking the trachea. This technique, now called the Heimlich maneuver or abdominal thrusts, is simple enough that it can be performed immediately by anyone trained in the maneuver. The Heimlich maneuver is a standard part of all first aid courses.

The theory behind the Heimlich maneuver is that by compressing the abdomen below the level of the diaphragm, air is forced under pressure out of the lungs dislodging the obstruction in the trachea and bringing the foreign material back up into the mouth.

The Heimlich maneuver is used mainly when solid material like food, coins, vomit, or small toys are blocking the airway. There has been some controversy about whether the Heimlich maneuver is appropriate to use routinely on **near-drowning** victims. After several studies of the effectiveness of the Heimlich maneuver on reestablishing breathing in near-drowning victims, the American Red Cross and the American Heart Association both recommend that the Heimlich maneuver be used only as a last resort after traditional airway clearance techniques and **cardiopulmonary resuscitation** (**CPR**) have been tried repeatedly and failed or if it is clear that a solid foreign object is blocking the airway.

Precautions

Incorrect application of the Heimlich maneuver can damage the chest, ribs, and internal organs of the person on whom it is performed. People may also vomit after being treated with the Heimlich maneuver.

Description

The Heimlich maneuver can be performed on all people. Modifications are necessary if the **choking** victim is very obese, pregnant, a child, or an infant.

Indications that a person's airway is blocked include:

- The person can not speak or cry out.
- The person's face turns blue from lack of oxygen.
- The person desperately grabs at his or her throat.
- The person has a weak **cough**, and labored breathing produces a high-pitched noise.
- The person does all of the above, then becomes unconscious.

Performing the Heimlich maneuver on adults

To perform the Heimlich maneuver on a conscious adult, the rescuer stands behind the victim. The victim may either be sitting or standing. The rescuer makes a fist with one hand, and places it, thumb toward the victim, below the rib cage and above the waist. The rescuer encircles the victim's waist, placing his other hand on top of the fist.

In a series of 6–10 sharp and distinct thrusts upward and inward, the rescuer attempts to develop enough pressure to force the foreign object back up the trachea. If the maneuver fails, it is repeated. It is important not to give up if the first attempt fails. As the victim is deprived of oxygen, the muscles of the trachea relax slightly. Because of this loosening, it is possible that the foreign object may be expelled on a second or third attempt.

If the victim is unconscious, the rescuer should lay him or her on the floor, bend the chin forward, make sure the tongue is not blocking the airway, and feel in the mouth for **foreign objects**, being careful not to push any farther into the airway. The rescuer kneels astride the victim's thighs and places his fists between the bottom of the victim's breastbone and the navel. The rescuer then executes a series of 6–10 sharp compressions by pushing inward and upward.

After the abdominal thrusts, the rescuer repeats the process of lifting the chin, moving the tongue, feeling for and possibly removing the foreign material. If the airway is not clear, the rescuer repeats the abdominal thrusts as often as necessary. If the foreign object has been removed, but the victim is not breathing, the rescuer starts CPR.

Performing the Heimlich maneuver under special circumstances

OBVIOUSLY PREGNANT AND VERY OBESE PEOPLE. The main difference in performing the Heimlich maneuver on this group of people is in the placement of the fists. Instead of using abdominal thrusts, chest thrusts are used. The fists are placed against the middle of the breastbone, and the motion of the chest thrust is in and downward, rather than upward. If the victim is unconscious, the chest thrusts are similar to those used in CPR.

CHILDREN. The technique in children over one year of age is the same as in adults, except that the amount of force used is less than that used with adults in order to avoid damaging the child's ribs, breastbone, and internal organs.

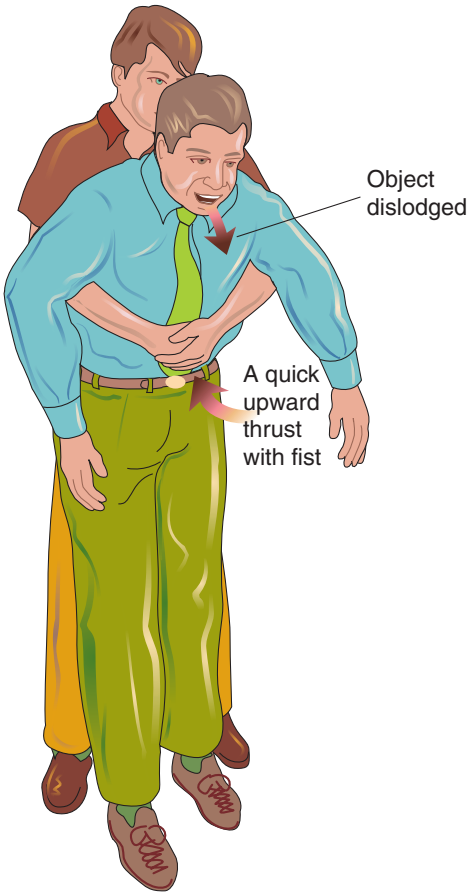
INFANTS UNDER ONE YEAR OLD. The rescuer sits down and lays the infant along his or her forearm with the infant's face pointed toward the floor. The rescuer's hand supports the infant's head, and his or her forearm rests on his or her own thigh for additional support. Using the heel of the other hand, the rescuer administers four or five rapid blows to the infant's back between the shoulder blades.

After administering the back blows, the rescuer sandwiches the infant between his or her arms, and turns the infant over so that the infant is lying face up supported by the opposite arm. Using the free hand, the rescuer places the index and middle finger on the center of the breastbone and makes four sharp chest thrusts. This series of back blows and chest thrusts is alternated until the foreign object is expelled.

SELF-ADMINISTRATION OF THE HEIMLICH MANEUVER. To apply the Heimlich maneuver to oneself, one should make a fist with one hand and place it in the middle of the body at a spot above the navel and below the breastbone, then grasp the fist with the other hand and push sharply inward and upward. If this fails, the victim should press the upper abdomen over the back of a chair, edge of a table, porch railing or something similar, and thrust up and inward until the object is dislodged.

Preparation

Any lay person can be trained to perform the Heimlich maneuver. Knowing how may save someone's life. Before doing the maneuver, it is important to determine if the airway is completely blocked. If the person choking can talk or cry, Heimlich maneuver is not appropriate. If the airway is not completely blocked, the choking victim should be allowed to try to cough up the foreign object on his or her own.



The Heimlich maneuver

To perform the Heimlich maneuver on a conscious adult (as illustrated above), the rescuer stands behind the victim and encircles his waist. The rescuer makes a fist with one hand and places the other hand on top, positioned below the rib cage and above the waist. The rescuer then applies pressure by a series of upward and inward thrusts to force the foreign object back up the victim's trachea. *Illustration by Electronic Illustrators Group.)*

Aftercare

Many people vomit after being treated with the Heimlich maneuver. Depending on the length and severity of the choking episode, the choking victim may need to be taken to a hospital emergency room.

Risks

Incorrectly applied, the Heimlich maneuver can break bones or damage internal organs. In infants, the rescuer should never attempt to sweep the baby's mouth without looking to remove foreign material. This is likely to push the material farther down the trachea.

KEY TERMS

Diaphragm—The thin layer of muscle that separates the chest cavity containing the lungs and heart from the abdominal cavity containing the intestines and digestive organs.

Trachea—The windpipe. A tube extending from below the voice box into the chest where it splits into two branches, the bronchi, that lead to each lung.

Normal results

In many cases the foreign material is dislodged from the throat, and the choking victim suffers no permanent effects of the episode. If the foreign material is not removed, the person dies from lack of oxygen.

Resources

BOOKS

"Heimlich Maneuver." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

PERIODICALS

Dworkin, Gerald "The Heimlich Maneuver Controversy in Near-Drowning Resuscitation." *Parks and Recreation* 32, no. 11 (Nov. 1997): 16.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Tish Davidson

Heliobacter pylori infection *see* **Heliobacteriosis**

Heliobacteriosis

Definition

Helicobacteriosis refers to infection of the gastrointestinal tract with the bacteria, *Helicobacter pylori* (*H. pylori*). While there are other rarer strains of *Helicobacter* species that can infect humans, only *H. pylori* has been convincingly shown to be a cause of disease in humans. The organism was first documented to cause injury to the stomach in 1983, by two researchers in Australia, who ingested the organism to prove their theory. Since then, *H. pylori* has been shown to be the main cause of ulcer disease, and has revolutionized the treatment of peptic ulcer disease. It is also believed to be linked to various cancers of the stomach.

Description

H. pylori is a gram-negative, spiral-shaped organism, that contains flagella (tail-like structures) and other properties. In addition to flagella, which help the organism to move around in the liquid mucous layer of the stomach, *H. pylori* also produces an enzyme called urease, that protects it from gastric acid present in the stomach. As the production of this enzyme is relatively unusual, new diagnostic tests have enabled rapid identification of the bacteria.

H. pylori also produces two other chemicals: a cytotoxin called vacA, and a protein known as cagA. Patients with ulcer disease are more likely to produce the cytotoxin (vacA). The cagA protein not only occurs frequently in ulcer disease but also in **cancer**. It is still not known how these substances enable *H. pylori* to cause disease.

Causes and symptoms

Infection with *H. pylori* is largely dependent on two factors; age and income status. The bacteria is acquired mainly in childhood, especially in areas of poor hygiene or overcrowding. *H. pylori* is two to three times more prevalent in developing, non-industrialized countries. In the United States for example, the organism is believed to be present in about one third of the population.

The exact way in which *H. pylori* gets passed from one individual to another is uncertain, but person to person transmission is most likely. In most cases, children are felt to be the source of spread. Reinfection of those who have been cured has been documented, especially in areas of overcrowding.

The bacteria is well adapted to survival within the stomach. Not only does it survive there for years, but once infection begins, a form of chronic inflammation (chronic **gastritis**) always develops. In most individuals, initial infection causes little or no symptoms; however, some individuals such as the original researchers who ingested the bacteria, wind up with abdominal **pain** and nausea.

In about 15% of infected persons, ulcer disease develops either in the stomach or duodenum. Why some develop ulcer disease and others do not, remains unclear. Ulcer symptoms are characterized by upper abdominal pain that is typically of a burning or "gnawing" type, and usually is rapidly relieved by **antacids** or food.

Acid secretion increases in most patients with duodenal ulcers. This increase returns to normal once *H. pylori* is eliminated. It is now known that elimination of the bacteria will substantially decrease the risk of recurrent bouts of ulcer disease in the vast majority (85% or so) of patients.

In the last decade it has been shown that *H. pylori* is not only the prime cause of ulcer disease of the stomach and duodenum, but is also strongly associated with various tumors of the stomach. Bacterial infection is nine times more common in patients with cancer of the stomach, and seven times more common in those with lymphoma of the stomach (tumor of the lymphatic tissue), called a MALT tumor. It is believed that the prolonged inflammation leads to changes in cell growth and tumors. Eliminating *H. pylori* can lead to regression of some tumors.

In addition to the above damage caused by *H. pylori*, some individuals lose normal gastric function, such as the ability to absorb vitamin B_{12}.

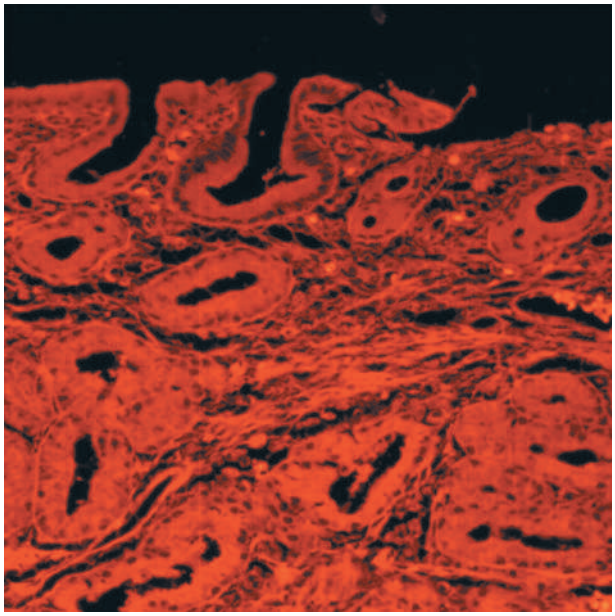
Diagnosis

There are basically two types of tests to identify infection: one group is "invasive" in that it involves the use of an endoscopy to obtain biopsy specimens for evaluation, while the other "noninvasive" methods depend on blood or breath samples. Invasive tests can be less accurate because of technical limitations: the biopsy may miss the area where the bacteria hides.

Invasive studies make use of tissue obtained by endoscopic biopsy to identify the organism. The bacteria can be searched for in pieces of biopsy tissue or grown (cultured) from the specimen. However, *H. pylori* is not easy to culture. Another method uses the bacteria's production of the enzyme urease. Biopsy specimens are placed on a card that changes color if urease is present. Results are often available within a few minutes, but can take up to 24 hours.

Noninvasive tests are of two types: blood tests and breath test. Blood tests measure antibodies to make a diagnosis accurately within minutes. This can be done immediately in the doctor's office. In addition, antibody levels can be measured several months after treatment, to see if *H. pylori* has been eradicated.

The breath test uses radioactive or non-radioactive forms of a compound called urea, which the patient drinks. The method that uses a radioactive form urea is easier to perform, as the equipment is commonly available in x-ray departments. Radiation exposure is less than that of a **chest x ray**. The test that uses non-radioactive urea is safer for children. The breath test is the best way to be sure of elimination of *H. pylori*. The test can be used within 30 days after treatment. This is an advantage over following antibody levels that take six months or longer to diminish.



A light microscopic image of a stomach ulcer. Gastric and duodenal ulcers are usually caused by infection with the bacteria *Helicobacter pylori*. This bacterium is also believed to be a cause of various cancers of the stomach. *(Photograph by J.L. Carson, Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

H. pylori peptic ulcers are treated with drugs to kill the bacteria, drugs to reduce stomach acid, and drugs to protect the lining of the stomach. The **antibiotics** most commonly used to kill the bacteria are: amoxicillin, clarithromycin, metronidazole, and tetracycline. Drugs used to reduce stomach acid may be histamine blockers or proton pump inhibitors. The most commonly used histamine blockers are: cimetidine, famotidine, nizatidine, and ranitidine. The most commonly used proton pump inhibitors are: lansoprazole and omeprazole. The drug bismuth subsalicylate (a component of Pepto-Bismol) is used to protect the stomach lining.

The most common drug treatment is a two-week course of treatment called triple therapy. This treatment regimen involves taking two antibiotics to kill the bacteria and either an acid reducer or a stomach-lining shield. This therapy has been shown to kill the bacteria, reduce ulcer symptoms, and prevent ulcer recurrence in over 90% of patients.

The main drawback of triple therapy is that some patients find it difficult to follow because it often requires taking as many as 20 pills a day. The antibiotics may also cause unpleasant side effects that may make certain patients less likely to follow the treatment proto-

KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Endoscope, Endoscopy—An Endoscope as used in the field of Gastroenterology is a thin flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x ray. The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

Gram-negative—Refers to the property of many bacteria in which they do not take or color with Gram's stain, a method which is used to identify bacteria. Gram-positive bacteria that take up the stain turn purple, while Gram-negative bacteria which do not take up the stain turn red.

col. These side effects include: dark stools, **diarrhea**, **dizziness**, **headache**, a metallic taste in the mouth, nausea, vomiting, and yeast infections in women.

Prognosis

The elimination of *H. pylori* and cure of ulcer disease is now possible in more than 90% of those infected. The finding that most ulcers are due to an infectious agent has brought a dramatic change in treatment and outlook for those suffering from that disease. Some patients will wind up with repeated infection, but this is most common in overcrowded areas.

Prevention

Attempts to develop a vaccine to protect against infection may be worthwhile in areas where the *H. pylori* infection rate and occurrence of cancer of the stomach is quite high, such as in Japan.

Resources

BOOKS

Atherton, John C., and Blaser, Martin J. "Helicobacter Infections." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998, pp. 941-943.

Peterson, Walter L., and Graham, David Y. "Helicobacter pylori." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease,* edited by Mark Feldman, et al. Philadelphia: W.B. Saunders Company. 1997, pp. 604-619.

PERIODICALS

Hunt, Richard H. "Peptic Ulcer Disease: Defining the Treatment Strategies in the Era of Helicobacter pylori." *American Journal of Gastroenterology* 92 no. 4 Supplement(1997): 36S.

Lee, Adrian. "The Helicobacter pylori Genome—New Insights into Pathogenesis and Therapeutics." *New England Journal of Medicine* 338 no. 12(1998): 832.

Parsonnet, Julie. "Helicobacter pylori in the Stomach—A Paradox Unmasked." *New England Journal of Medicine* 335 no. 4(1996): 278.

Rabeneck, Linda and Graham, David Y. "Helicobacter pylori: When to Test, When to Treat." *Annals of Internal Medicine* 126 no. 4(1997): 315.

Walsh, John H. and Peterson, Walter L. "Drug Therapy: The Treatment of Helicobacter pylori Infection in the Management of Peptic Ulcer Disease." *New England Journal of Medicine* 333 no. 15(1995): 984.

ORGANIZATION

The Helicobacter Foundation. <http://www.helico.com/>.

OTHER

"H. Pylori and Peptic Ulcer." National Institutes of Health. <http://www.niddk.nih.gov/health/digest/pubs/hpylori/hpylori.htm>.

"Management Strategies for Helicobacter pylori Seropositive Patients with Dyspepsia." <http://www.acponline.org/journals/annals/15feb97/treatcounsel.htm>.

"Moving closer to an ulcer vaccine." <http://www.msnbc.com/news/161712.asp>.

"Treating Stomach Ulcers and H. pylori Infection." <http://www.aafp.org/patientinfo/ulcers.html>.

"What Is Helicobacter pylori Infection?" Centers for Disease Control. <http://www.cdc.gov/ncidod/aip/aip_a2b.htm>.

Paul A. Johnson

Hellerwork

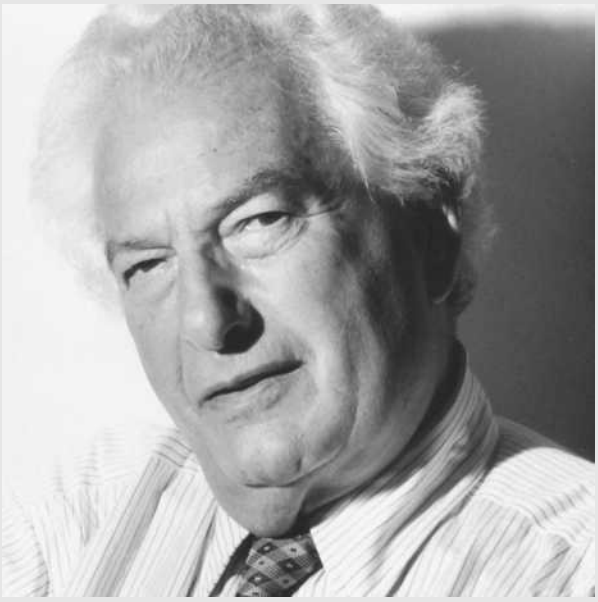
Definition

Hellerwork is a system of bodywork that combines deep tissue massage, body movement education, and verbal dialogue. It is designed to realign the body's structure for overall health, improvement of posture, and reduction of physical and mental **stress**.

Purpose

Hellerwork improves posture and brings the body's natural structure into proper balance and alignment. This

JOSEPH HELLER (1940–)



(AP/Wide World Photos. Reproduced by permission.)

Born in Poland, Joseph Heller attended school in Europe until age 16, when he immigrated to the United States. Living in Los Angeles, he attended the California Institute of Technology in Pasadena and graduated in 1962 with a degree in engineering. He worked for 10 years at the National Aeronautics and Space Administration's Jet Propulsion Laboratory (JPL) in Pasadena as an aerospace engineer. During his service at JPL, Heller became interested in humanistic psychology. After leaving JPL in 1972, he became director of Kairos, a center for human development in Los Angeles. He spent two years studying bioenergetics and gestalt. He also trained under Buckminster Fuller, flotation tank therapy developer John Lilly, self esteem trainer Virginia Satir, and body movement pioneer Judith Aston.

He became a certified Rolfer in 1972 and spent the next six years studying structural integration under Rolfing founder Ida P. Rolf. He became the first president of the Rolf Institute in 1975. During his training with Rolf, Heller began developing his own system of bodywork. He left the institute in 1978 and moved to Northern California where he founded Hellerwork. He conducts classes and continues his work today at his headquarters, 406 Berry St., Mt. Shasta, CA 96067.

realignment can bring relief from general aches and pains; improve breathing; and relieve physical and mental stress. Hellerwork has also been used to treat such specific physical problems as chronic back, neck, shoulder, and joint **pain** as well as repetitive stress injuries, including **carpal tunnel syndrome**. Hellerwork is also used to treat and prevent athletic injuries.

Description

Origins

Joseph Heller (1940–) developed Hellerwork, a system of structural integration patterned after **Rolfing**. Although Heller received a degree in engineering and worked for NASA's Jet Propulsion Laboratory in Pasadena, CA, he became interested in humanistic psychology in the 1970s. He spent two years studying bioenergetics and **Gestalt therapy** as well as studying under architect and futurist Buckminster Fuller (1895–1983), flotation tank therapy developer John Lilly, family therapist Virginia Satir, and body movement pioneer Judith Aston.

During this period, he trained for six years with Dr. Ida P. Rolf (1896-1979), the founder of Rolfing, and became a certified Rolfer in 1972. After Heller developed his own system of bodywork, he founded Hellerwork in 1979 and established a training facility in Mt. Shasta, California, where he continues his work.

Hellerwork is based largely on the principles of Rolfing, in which the body's connective tissue is manipulated or massaged to realign and balance the body's structure. Because Heller believes that physical realignment is insufficient, however, he expanded his system to include movement education and verbal dialogue as well as deep tissue massage.

Connective tissue massage

The **massage therapy** aspect of Hellerwork is designed to release the tension that exists in the deep connective tissue, called fascia, and return it to a normal alignment. The fascia is plastic and highly adaptable; it can tighten and harden in response to the general effects of gravity on the body, other ongoing physical stresses, negative attitudes and emotions, and periodic physical traumas. One example of ongoing physical stress is carrying a briefcase, which pulls down the shoulder on one side of the body. Over time, the connective tissue becomes hard and stiff; the body becomes adapted to that position even when the person is not carrying a briefcase. In trying to adjust to the uneven weight distribution, the rest of the body becomes unbalanced and out of proper alignment.

KEY TERMS

Bioenergetics—A system of therapy that combines breathing and body exercises, psychological therapy, and the free expression of emotions to release blocked physical and psychic energy.

Bodywork—A term that covers a variety of therapies that include massage, realignment of the body, and similar techniques to treat deeply ingrained stresses and traumas carried in the tissues of the body.

Chronic—A disease or condition that progresses slowly but persists or reoccurs over time.

Fascia—The sheet of connective tissue that covers the body under the skin and envelops the muscles and various organs.

Gestalt therapy—A form of therapy that focuses on helping patients reconnect with their bodies and their feelings directly, as contrasted with verbal intellectual analysis.

Kinesiology—The study of the anatomy and physiology of body movement, particularly in relation to therapy.

Rolfing—A deep-tissue therapy that involves manipulating the body's fascia to realign and balance the body's structure.

Heller believes that as people age, more of these stress and trauma patterns become ingrained in the connective tissue, further throwing the body out of alignment. As stress accumulates, the body shortens and stiffens, a process commonly attributed to **aging**. Hellerwork seeks to recondition the body and make the connective tissue less rigid.

Movement education

The second component of Hellerwork, movement education, trains patients in the proper physical movements needed to keep the body balanced and correctly aligned. Movement education focuses on common actions, such as sitting, standing, and walking. Hellerwork practitioners also teach better patterns of movement for activities that are specific to each individual, such as their job and favorite sports or social activities.

Verbal dialogue

Verbal dialogue is the third aspect of Hellerwork. It is designed to teach awareness of the relationships among emotions, life attitudes, and the body. Hellerwork practitioners believe that as patients become responsible for their attitudes, their body movements and patterns of self-expression improve. Dialogue focuses on the theme of each session and the area of the body that is worked on during that session.

Hellerwork consists of eleven 90-minute sessions costing about $90–100 each. The first three sessions focus on the surface layers of the fascia and on developmental issues of infancy and childhood. The next four sessions are the core sessions and work on the deep layers and on adolescent developmental issues. The final four treatments are the integrative sessions, and build upon all the previous ones, while also looking at questions of maturity.

Preparations

No advance preparations are required to begin Hellerwork treatment. The treatment is usually done on a massage table with the patient wearing only undergarments.

Precautions

Since Hellerwork involves vigorous deep tissue massage, it is often described as uncomfortable and sometimes painful, especially during the first several sessions. As it requires the use of hands, it may be a problem for people who do not like or are afraid of being touched. It is not recommended as a treatment for any disease or a chronic inflammatory condition such as arthritis, and can worsen such a condition. Anyone with a serious medical condition, including heart disease, diabetes, or respiratory problems, should consult a medical practitioner before undergoing Hellerwork.

Side effects

There are no reported serious side effects associated with Hellerwork when delivered by a certified practitioner to adults and juveniles.

Research and general acceptance

As most alternative or holistic treatments, there is little mainstream scientific research documenting the effectiveness of Hellerwork therapy. Since the deep tissue massage aspect of Hellerwork is similar to Rolfing, however, several scientific studies of Rolfing may be useful in evaluating Hellerwork. A 1988 study published in the *Journal of the American Physical Therapy Association* indicated that Rolfing stimulates the parasympathetic nervous system, which can help speed the recovery of damaged tissue. A 1997 article in *The Journal of*

Orthopaedic and Sports Physical Therapy reported that Rolfing can provide effective and sustained pain relief from lower back problems.

Resources

BOOKS

Bradford, Nikki, ed. *Alternative Healthcare.* San Diego, CA: Thunder Bay Press, 1997.

Claire, Thomas. *Bodywork: What Type of Massage to Get and How to Make the Most of It.* New York: William Morrow and Co., 1995.

Golten, Roger. *The Owner's Guide to the Body.* London: Thorsons, 1999.

Heller, Joseph. *Bodywise.* Berkeley, CA: Wingbow Press, 1991.

Levine, Andrew S., and Valerie J. Levine. *The Bodywork and Massage Sourcebook.* Lincolnwood, IL: Lowell House, 1999.

Nash, Barbara. *From Acupressure to Zen: An Encyclopedia of Natural Therapies.* Alameda, CA: Hunter House, Inc., 1996.

ORGANIZATIONS

Hellerwork. 406 Berry St. Mt. Shasta, CA 96067. (530) 926-2500. <http://www.hellerwork.com>.

Ken R. Wells

HELLP syndrome *see* **Preeclampsia and eclampsia**

Hemangiomas *see* **Birthmarks**

Hematocrit

Definition

The hematocrit measures how much space in the blood is occupied by red blood cells. It is useful when evaluating a person for anemia.

Purpose

Blood is made up of red and white blood cells, and plasma. A decrease in the number or size of red cells also decreases the amount of space they occupy, resulting in a lower hematocrit. An increase in the number or size of red cells increases the amount of space they occupy, resulting in a higher hematocrit. **Thalassemia** is a condition which can cause an increased number of red blood cells but a decreased size and hematocrit.

The hematocrit is usually done on a person with symptoms of anemia. An anemic person has fewer or smaller than normal red cells. A low hematocrit, combined with other abnormal blood tests, confirms the diagnosis.

KEY TERMS

Anemia—A condition where a person has fewer or smaller than normal red blood cells.

Hemoglobin—The percentage of space in blood occupied by red blood cells.

Some conditions, such as polycythemia, cause an overproduction of red blood cells, resulting in an increased hematocrit.

Transfusion decisions are based on the results of laboratory tests, including hematocrit. Transfusion is not considered if the hematocrit level is reasonable. The level differs for each person, depending on his or her clinical condition.

Description

Blood drawn from a fingerstick is often used for hematocrit testing. The blood fills a small tube, which is then spun in a small centrifuge. As the tube spins, the red blood cells go to the bottom of the tube, the white blood cells cover the red in a thin layer called the buffy coat, and the liquid plasma rises to the top. The spun tube is examined for the line that divides the red cells from the buffy coat and plasma. The height of the red cell column is measured as a percent of the total blood column. The higher the column of red cells, the higher the hematocrit.

The hematocrit test can also be done on an automated instrument as part of a complete **blood count**. It is also called Packed Red Cell Volume or Packed Cell Volume, or abbreviated as Hct or Crit. The test is covered by insurance when medically necessary. Results are usually available the same or following day.

Preparation

To collect the blood by fingerstick, a healthcare worker punctures a finger with a lancet and allows the blood to fill a small tube held to the puncture site.

Tests done on an automated instrument require 5–7 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the

puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Normal values vary with age and sex. Adult male range is 42–52%, adult female 36–48%.

Abnormal results

Hematocrit values decrease when the size or number of red cells decrease. This is most common in anemia, but other conditions have similar effects: excessive bleeding, damaged cells due to a mechanical heart valve, liver disease, and cancers affecting the bone marrow. Additional tests, and the person's symptoms and medical history help distinguish these conditions or diagnose a specific type of anemia. Hematocrit values increase when the size or number of red cells increase, such as in polycythemia.

Fluid volume in the blood affects the hematocrit. Pregnant women have extra fluid, which dilutes the blood, decreasing the hematocrit. **Dehydration** concentrates the blood, increasing the hematocrit.

Nancy J. Nordenson

Hemiplegia *see* **Paralysis**

Hemochromatosis

Definition

Hemochromatosis is an inherited blood disorder that causes the body to retain excessive amounts of iron. This iron overload can lead to serious health consequences, most notably **cirrhosis** of the liver.

Description

Hemochromatosis is also known as iron overload, bronze diabetes, hereditary hemochromatosis and familial hemochromatosis. The inherited disorder causes increased absorption of intestinal iron, well beyond that needed to replace the body's loss of iron. Iron overload diseases afflict as many as 1.5 million persons in the United States. The most common of these, as well as one of the most common genetic disorders in the United States, is hereditary hemochromatosis. Men and women are equally affected by hemochromatosis, but women are diagnosed later in life because of blood loss from menstruation and **childbirth**. It most commonly appears in patients between the ages of 40-60 years, since it takes many years for the body to accumulate excessive iron. Symptoms appear later in females than in males—usually after **menopause**.

Hemochromatosis causes excess iron storage in several organs of the body including the liver, pancreas, endocrine glands, heart, skin, joints, and intestinal lining. The buildup of iron in these organs can lead to serious complications, including **heart failure**, **liver cancer**, and cirrhosis of the liver. It is estimated that about 5% of cirrhosis cases are caused by hereditary hemochromatosis.

Idiopathic pulmonary hemosiderosis, a disorder afflicting children and young adults, is a similar overload disorder characterized by abnormal accumulation of hemosiderin. Hemosiderin is a protein found in most tissues, especially the liver. It is produced by digestion of hematin, an iron-related substance.

Hemochromatosis is one of the most common genetic disorders in the United States. Approximately one in nine individuals have one abnormal hemochromatosis gene (11% of the population). Since everyone has two copies of each gene, these individuals have an abnormal *HFE* gene and a normal gene. They are called carriers. Between 1/200-1/400 individuals have two abnormal genes for hemochromatosis and no normal gene.

With most autosomal recessive conditions, an affected person's parents are carriers. If more than one family member has the condition, they are siblings. Hemochromatosis is so common, however, that families are seen in which both parents are affected, or one parent is affected and the other parent is a carrier. More than one generation may be affected, which is not usually seen in rare autosomal recessive conditions.

Causes and symptoms

Hereditary hemochromatosis is an autosomal recessive condition. This means that individuals with hemochromatosis have inherited an altered (mutated) gene from both of their parents. Affected individuals have two abnormal hemochromatosis genes and no normal hemochromatosis gene.

The gene that causes hemochromatosis has been identified, and the most common abnormalities of the gene have been described. The gene is on chromosome 6; it is called *HFE*. Scientists have not confirmed the function of the normal gene product; they do know that it interacts with the cell receptor for transferrin. Transferrin binds and transports iron in the blood.

Because it is an autosomal recessive condition, siblings of individuals who have hemochromatosis are at a 25% risk to also be affected. However, the likelihood that

an individual will develop symptoms depends on which gene mutation he or she has as well as environmental factors. The two most common changes in the *HFE* gene are *C282Y* and *H63D*. The age at which symptoms begin is variable, even within the same family.

The symptoms of hemochromatosis include **fatigue**, weight loss, weakness, **shortness of breath**, heart **palpitations**, chronic abdominal **pain**, and impaired sexual performance. The patient may also show symptoms commonly connected with heart failure, diabetes or cirrhosis of the liver. Changes in the pigment of the skin may appear, such as grayness in certain areas, or a tanned or yellow (**jaundice**) appearance. The age of onset and initial symptoms vary.

Idiopathic pulmonary hemosiderosis may first, and only, appear as paleness of the skin. Sometimes, the patient will experience spitting of blood from the lungs or bronchial tubes.

KEY TERMS

Autosomal—Relating to any chromosome besides the X and Y sex chromosomes. Human cells contain 22 pairs of autosomes and one pair of sex chromosomes.

Cirrhosis—A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

Diabetes mellitus—The clinical name for common diabetes. It is a chronic disease characterized by inadequate production or use of insulin.

Phlebotomy—The taking of blood from the body through an incision in the vein, usually in the treatment of disease.

Diagnosis

The most common diagnostic methods for hemochromatosis are blood studies of iron, genetic blood studies, **magnetic resonance imaging** (MRI), and **liver biopsy**. Blood studies of transferrin–iron saturation and ferritin concentration are often used to screen for iron overload. Ferritin is a protein that transports iron and liver enzymes. Additional studies are performed to confirm the diagnosis.

Blood studies used to confirm the diagnosis include additional iron studies and/or genetic blood studies. Genetic blood studies became available in the late 1990s. **Genetic testing** is a reliable method of diagnosis. However, in the year 2001 scientists and physicians are studying how accurately having a hemochromatosis mutation predicts whether a person will develop symptoms. Most individuals affected with hemochromatosis (87%) have two identifiable gene mutations i.e. genetic testing will confirm the diagnosis in most individuals. Genetic studies are also be used to determine whether the affected person's family members are at risk for hemochromatosis. The results of genetic testing are the same whether or not a person has developed symptoms.

MRI scans and/or liver biopsy may be necessary to confirm the diagnosis. MRI studies of the liver (or other iron absorbing organs), with quantitative assessment of iron concentration, may reveal abnormal iron deposits. For the liver biopsy, a thin needle is inserted into the liver while the patient is under local anesthesia. The needle will extract a small amount of liver tissue, which can be analyzed microscopically to measure its iron content and other signs of hemochromatosis. Diagnosis of idiopathic pulmonary hemosiderosis begins with blood tests and x-ray studies of the chest.

Treatment

Patients who show signs of iron overload will often be treated with **phlebotomy**. Phlebotomy is a procedure that involves drawing blood from the patient, just like blood donation. Its purpose as a treatment is to rid the body of excess iron storage. Patients may need these procedures one or two times a week for a year or more. Less frequent phlebotomy may be continued in subsequent years to keep excess iron from accumulating. Patients who cannot tolerate phlebotomy due to other medical problems can be treated with Desferal (desferrioxamine). Diet restrictions may also be prescribed to limit the amount of iron ingested. Complications from hemochromatosis, such as cirrhosis or diabetes, may also require treatment. Treatment for idiopathic pulmonary hemosiderosis is based on symptoms.

Diet restrictions may help lower the amount of iron in the body, but do not prevent or treat hemochromatosis. Individuals who are affected or who know they have two *C282Y* and/or *H63D* genes may reduce iron intake by avoiding iron and mineral supplements, excess vitamin C, and uncooked seafood. If a patient is symptomatic, he/she may be advised to abstain from drinking alcohol.

Prognosis

With early detection and treatment, the prognosis is usually good. All potential symptoms are prevented if iron levels are kept within the normal range, which is possible if

the diagnosis is made before an individual is symptomatic. If a patient is symptomatic but treated successfully before he/she develops liver cirrhosis, the patient's life expectancy is near normal. However, if left untreated, complications may arise which can be fatal. These include liver **cancer**, liver cirrhosis, **diabetes mellitus**, congestive heart failure, and difficulty depleting iron overload through phlebotomy. Liver biopsy can be helpful in determining prognosis of more severely affected individuals. Genetic testing may also be helpful, as variable severity has been noted in patients who have two *C282Y* genes compared to patients with two *H63D* genes or one of each. Men are two times more likely than women to develop severe complications. The prognosis for patients with idiopathic pulmonary hemosiderosis is fair, depending on detection and complications.

Prevention

Screening for hemochromatosis is cost effective, particularly for certain groups of people. Relatives of patients with hemochromatosis—including children, siblings, and parents—should be tested by the most appropriate method. The best screening method may be iron and ferritin studies or genetic testing. If the affected person's diagnosis has been confirmed by genetic testing, relatives may have genetic testing to determine whether or not they have the genetic changes present in the affected individual. Many medical groups oppose genetic testing of children. Relatives who are affected but do not have symptoms can reduce iron intake and/or begin phlebotomy prior to the onset of symptoms, possibly preventing ever becoming symptomatic.

In the winter of 2000, population screening for hereditary hemochromatosis is being widely debated. Many doctors and scientists want population screening because hemochromatosis is easily and cheaply treated, and quite common. Arguments against treatment include the range of symptoms seen (and not seen) with certain gene mutations, and the risk of discrimination in health and life insurance. Whether or not population screening becomes favored by a majority, the publicity is beneficial. Hemochromatisis is a common, easily and effectively treated condition. However, diagnosis may be difficult because the presenting symptoms are the same as those seen with many other medical problems. The screening debate has the positive effect of increasing awareness and suspicion of hemochromatisis. Increased knowledge leads to earlier diagnosis and treatment of symptomatic individuals, and increased testing of their asymptomatic at–risk relatives.

Resources

BOOKS

Barton, James C., and Corwin Q. Edwards, eds. *Hemochromatosis: Genetics, Pathophysiology, Diagnosis and Treatment*. Cambridge: Cambridge University Press, 2000.

Crawford, Roberta. *The Iron Elephant*. Glyndon, MD: Vida Publishing, 1995.

PERIODICALS

"Iron Overload, Public Health and Genetics." *Annals of Internal Medicine Supplement* 129(Dec. 1998). <http://www.acponline.org/journals/annals/01dec98/supptoc.htm>.

Motulsky, A.G., and E. Beutler. "Population Screening for Hemochromatosis." *Annual Review of Public Health* 21 (2000): 65-79.

Wolfe, Yun Lee. "Case of the Ceaselss Fatigue." *Prevention Magazine* (July 1997): 88.

ORGANIZATIONS

American Hemochromatosis Society, Inc. 777 E. Atlantic Ave., PMB Z-363, Delray Beach, FL 33483-5352. (561) 266-9037 or (888) 655-IRON (4766). ahs@emi.net. <http://www.americanhs.org>.

American Liver Foundation. 75 Maiden Lane, Suite 603, New York, NY 10038. (800) 465-4837 or (888) 443-7222. <http://www.liverfoundation.org>.

Hemochromatosis Foundation, Inc. PO Box 8569, Albany, NY 12208-0569. (518) 489-0972. s.kleiner@shiva.hunter.cuny.edu. <http://www.hemochromatosis.org>.

Iron Disorders Institute, Inc. PO Box 3021, Greenville, SC 29602. (864) 241-0111. irondis@aol.com. <http://www.irondisorders.org>.

Iron Overload Diseases Association, Inc. 433 Westwind Dr., North Palm Beach, FL 33408. (561) 840-8512. iod@ironoverload.org.

OTHER

"Hemochromatosis." *GeneClinics*. <http://www.geneclinics.org/profiles/hemochromatosis/>.

Hemochromatosis Information Sheet. National Institute of Diabetes & Digestive & Kidney Diseases (NIDDK) <http://www.niddk.nih.gov/health/digest/pubs/hemochrom/hemochromatosis.htm>.

Hereditary Hemochromatosis. Lecture by Richard Fass, MD, hematologist, Advanced Oncology Associates, given April 25, 1999. <http://www.advancedoncology.org/listen.htm>. in Real Audio.

Michelle Q. Bosworth, MS, CGC

Hemodialysis *see* **Dialysis, kidney**

Hemoglobin electrophoresis

Definition

Hemoglobin electrophoresis (also called Hgb electrophoresis), is a test that measures the different types of hemoglobin in the blood. The method used is called electrophoresis, a process that causes movement of particles in an electric field, resulting in formation of "bands" that separate toward one end or the other in the field.

Purpose

Hgb electrophoresis is performed when a disorder associated with abnormal hemoglobin (hemoglobinopathy) is suspected. The test is used primarily to diagnose diseases involving these abnormal forms of hemoglobin, such as sickle cell anemia and **thalassemia**.

Precautions

Blood transfusions within the previous 12 weeks may alter test results.

Description

Hemoglobin (Hgb) is comprised of many different types, the most common being A_1, A_2, F, S, and C.

Hgb A_1 is the major component of hemoglobin in the normal red blood cell. Hgb A_2 is a minor component of normal hemoglobin, comprising approximately 2–3% of the total.

Hgb F is the major hemoglobin component in the fetus, but usually exists only in minimal quantities in the normal adult. Levels of Hgb F greater than 2% in patients over three years of age are considered abnormal.

Hgb S is an abnormal form of hemoglobin associated with the disease of sickle cell anemia, which occurs predominantly in African-Americans. A distinguishing characteristic of **sickle cell disease** is the crescent-shaped red blood cell. Because the survival rate of this type of cell is limited, patients with sickle cell disease also have anemia.

Hgb C is another hemoglobin variant found in African Americans. Red blood cells containing Hgb C have a decreased life span and are more readily destroyed than normal red blood cells, resulting in mild to severe **hemolytic anemia**.

Each of the major hemoglobin types has an electrical charge of a different degree, so the most useful method for separating and measuring normal and abnormal hemoglobins is electrophoresis. This process involves subjecting hemoglobin components from dissolved red blood cells to an electric field. The components then move away from each other at different rates, and when separated form a series of distinctly pigmented bands. The bands are then compared with those of a normal sample. Each band can be further assessed as a percentage of the total hemoglobin, thus indicating the severity of any abnormality.

Preparation

This test requires a blood sample. No special preparation is needed before the test.

KEY TERMS

Hemoglobin C disease—A disease of abnormal hemoglobin, occurring in 2–3% of African-Americans. Only those who have two genes for the disease develop anemia, which varies in severity. Symptoms include episodes of abdominal and joint pain, an enlarged spleen and mild jaundice.

Hemoglobin H disease—A thalassemia-like syndrome causing moderate anemia and red blood cell abnormalities.

Heterozygous—Two different genes controlling a specified inherited trait.

Homozygous—Identical genes controlling a specified inherited trait.

Thalassemias—The name for a group of inherited disorders resulting from an imbalance in the production of one of the four chains of amino acids that make up hemoglobin. Thalassemias are categorized according to the amino acid chain affected. The two main types are alpha-thalassemia and beta-thalassemia. The disorders are further characterized by the presence of one defective gene (thalassemia minor) or two defective genes (thalassemia major). Symptoms vary, but include anemia, jaundice, skin ulcers, gallstones, and an enlarged spleen.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal reference values can vary by laboratory, but are generally within the following ranges.

Adults:

- Hgb A_1: 95–98%
- Hgb A_2: 2–3%
- Hgb F: 0.8–2.0%
- Hgb S: 0%
- Hgb C: 0%.

Child (Hgb F):

- 6 months: 8%
- greater than 6 months: 1–2%
- newborn (Hgb F): 50–80%

Abnormal results

Abnormal reference values can vary by laboratory, but when they appear within these ranges, results are usually associated with the conditions that follow in parentheses.

Hgb A_2:

- 4–5.8% (β-thalassemia minor)
- under 2% (Hgb H disease)

Hgb F:

- 2–5% (β-thalassemia minor)
- 10–90% (β-thalassemia major)
- 5–35% (Heterozygous hereditary persistence of fetal hemoglobin, or HPFH)
- 100% (Homozygous HPFH)
- 15% (Homozygous Hgb S)

Homozygous Hgb S:

- 70–98% (Sickle cell disease).

Homozygous Hgb C:

- 90–98%(Hgb C disease)

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Hemoglobin F test *see* **Fetal hemoglobin test**

Hemoglobin test

Definition

Hemoglobin is a protein inside red blood cells that carries oxygen throughout the body. A hemoglobin test reveals how much hemoglobin is in a person's blood, helping to diagnose and monitor anemia and **polycythemia vera**.

Purpose

A hemoglobin test is done when a person is ill or during a general **physical examination**. Good health requires an adequate amount of hemoglobin. The amount of oxygen in the body tissues depends on how much hemoglobin is in the red cells. Without enough hemoglobin, the tissues lack oxygen and the heart and lungs must work harder to try to compensate.

If the test indicates a "less than" or "greater than" normal amount of hemoglobin, the cause of the decrease or increase must be discovered. A low hemoglobin usually means the person has anemia. Anemia results from conditions that decrease the number or size of red cells, such as excessive bleeding, a dietary deficiency, destruction of cells because of a **transfusion** reaction or mechanical heart valve, or an abnormally formed hemoglobin.

A high hemoglobin may be caused by polycythemia vera, a disease in which too many red blood cells are made.

Hemoglobin levels also help determine if a person needs a blood transfusion. Usually a person's hemoglobin must be below 8 gm/dl before a transfusion is considered.

Description

Hemoglobin is made of heme, an iron compound, and globin, a protein. The iron gives blood its red color. Hemoglobin tests make use of this red color. A chemical is added to a sample of blood to make the red blood cells burst. When they burst, the red cells release hemoglobin into the surrounding fluid, coloring it clear red. By measuring the color using an instrument called a spectrophotometer, the amount of hemoglobin is determined.

Hemoglobin is often ordered as part of a complete **blood count** (CBC), a test that includes other blood cell measurements.

Some people inherit hemoglobin with an abnormal structure. These abnormal hemoglobins cause diseases, such as sickle cell or Hemoglobin C disease. Special tests, using a process called **hemoglobin electrophoresis**, identify abnormal hemoglobins.

Preparation

This test requires 5 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

The person should avoid **smoking** before this test as smoking can increase hemoglobin levels.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the

KEY TERMS

Anemia—A condition characterized by a decrease in the size or number of red blood cells.

Hemoglobin—A protein inside red blood cells that carries oxygen to body tissues.

Polycythemia vera—A disease in which the bone marrow makes too many red blood cells.

puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Normal values vary with age and sex. Women generally have lower hemoglobin values than men. Men have 14.0–18.0 g/dL, while women have levels of 12.0–16.0 g/dL.

Abnormal results

A low hemoglobin usually indicates the person has anemia. Further tests are done to discover the cause and type of anemia. Dangerously low hemoglobin levels put a person at risk of a **heart attack**, congestive **heart failure**, or **stroke**.

A high hemoglobin indicates the body is making too many red cells. Further tests are done to see if this is caused by polycythemia vera, or as a reaction to illness, high altitudes, heart failure, or lung disease.

Fluid volume in the blood affects hemoglobin values. Pregnant women and people with **cirrhosis** have extra fluid, which dilutes the blood, decreasing the hemoglobin. **Dehydration** concentrates the blood, increasing the hemoglobin.

Resources

PERIODICALS

Hsia, Connie C. W. "Respiratory Function of Hemoglobin." *New England Journal of Medicine* 338 (Jan. 1998): 239-247.

Nancy J. Nordenson

Hemoglobinopathies

Definition

Hemoglobinopathies are genetic (inherited) disorders of hemoglobin, the oxygen-carrying protein of the red blood cells.

Description

The hemoglobin molecule is composed of four separate polypeptide chains of amino acids, two alpha chains and two beta chains, as well as four iron-bearing heme groups that bind oxygen. The alpha chains are coded for by two similar genes on chromosome 16; the beta chains by a single gene on chromosome 11. Mutations and deletions in these genes cause one of the many hemoglobinopathies.

In general, hemoglobinopathies are divided into those in which the gene abnormality results in a qualitative change in the hemoglobin molecule and those in which the change is quantitative. Sickle cell anemia (**sickle cell disease**) is the prime example of the former, and the group of disorders known as the thalassemias constitute the latter. It has been estimated that one third of a million people worldwide are seriously affected by one of these genetic disorders.

Causes and symptoms

Sickle cell anemia (SSA), an autosomal recessive disorder more common in the Black population, is caused by a single mutation in the gene that codes for the beta polypeptide. Approximately 1/400 to 1/600 African-Americans are born with the disorder, and, one in ten is a carrier of one copy of the mutation. In certain parts of the African continent, the prevalence of the disease reaches one in fifty individuals.

The sickle cell mutation results in the substitution of the amnio acid, valine, for glutamic acid in the sixth position of the beta polypeptide. In turn, this alters the conformation of the hemoglobin molecule and causes the red blood cells to assume a characteristic sickle shape under certain conditions. These sickle-shaped cells, no longer able to pass smoothly through small capillaries, can block the flow of blood. This obstruction results in symptoms including growth retardation, severe **pain** crises, tissue and organ damage, splenomegaly, and strokes. Individuals with SSA are anemic and prone to infections, particularly **pneumonia**, a significant cause of **death** in this group. Some or all of these symptoms are found in individuals who have the sickle mutation in both copies of their beta-globin gene. Persons with one abnormal gene and one normal gene are said to be carriers of the sickle cell trait. Carriers are unaffected because of the remaining normal copy of the gene.

The thalassemias are a diverse group of disorders characterized by the fact that the causative mutations result in a decrease in the amount of normal hemoglobin. Thalassemias are common in Mediterranean populations as well as in Africa, India, the Mideast, and Southeast Asia. The two main types of thalassemias are alpha-tha-

KEY TERMS

Autosomal recessive—A pattern of inheritance in which both copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is a gene that is located on one of the autosomes or non-sex chromosomes. When both parents have one abnormal copy of the same gene, they have a 25% chance with each pregnancy that their offspring will have the disorder.

Splenomegaly—Enlargement of the spleen.

lassemia due to mutations in the alpha polypeptide and beta-thalassemia resulting from beta chain mutations.

Since individuals possess a total of four genes for the alpha polypeptide (two genes on each of their two chromosomes 16), disease severity depends on how many of the four genes are abnormal. A defect in one or two of the genes has no clinical effect. Abnormalities of three results in a mild to moderately severe anemia (hemoglobin H disease) and splenomegaly. Loss of function of all four genes usually causes such severe oxygen deprivation that the affected fetus does not survive. A massive accumulation of fluid in the fetus (hydrops fetalis) results in **stillbirth** or neonatal death.

Beta thalassemias can range from mild and clinically insignificant (beta **thalassemia** minor) to severe and life-threatening (beta thalassemia major, also known as Cooley's anemia), depending on the exact nature of the gene mutation and whether one or both copies of the beta gene are affected. While the milder forms may only cause slight anemia, the more severe types result in growth retardation, skeletal changes, splenomegaly, vulnerability to infections, and death as early as the first decade of life.

Diagnosis

Many countries, including the United States, have made concerted efforts to screen for sickle cell anemia at birth because of the potential for beginning early treatment and counseling parents about their carrier status. Diagnosis is traditionally made by blood tests including **hemoglobin electrophoresis**. Similar tests are used to determine whether an individual is a sickle cell or thalassemia carrier. In certain populations with a high prevalence of one of the mutations, carrier testing is common. If both members of a couple are carriers of one of these conditions, it is possible through prenatal **genetic testing** to determine if the fetus will be affected, although the severity of the disease cannot always be predicted.

Treatment

Treatment of SSA has improved greatly in recent years with a resulting increase in life expectancy. The use of prophylactic (preventative) antibiotic therapy has been particularly successful. Other treatments include fluid therapy to prevent **dehydration**, oxygen supplementation, pain relievers, blood transfusions, and several different types of medications. Recent interest has focused on **bone marrow transplantation** and future directions include the possibility of gene replacement therapy.

Since the clinically important thalassemias are characterized by severe anemia, the traditional treatment has been blood **transfusion**, but the multiple transfusions needed to sustain life lead to an iron overload throughout the tissues of the body and eventual destruction of the heart and other organs. For this reason, transfusion therapy must also include infusions of medications such as deferoxamine (desferroxamine) to rid the body of excess iron. As with sickle cell anemia, bone marrow therapy has been successful in some cases.

Prognosis

Hemoglobinopathies are life-long disorders. The prognosis depends upon the exact nature of the mutation, the availability of effective treatment, as well as the individual's compliance with therapies.

Prevention

Because the hemoglobinopathies are inherited diseases, primary prevention involves carriers making reproductive decisions to prevent passage of the abnormal gene to their offspring. At present, most prevention is targeted toward the symptoms using treatments such as those described above.

Resources

BOOKS

Behrman, Richard E. et al. *Nelson Textbook of Pediatrics.* 16th ed. Philadelphia, W. B. Saunders, 2000.

Jorde, Lynn B. et al. *Medical Genetics.* 2nd ed. New York: Mosby, 1999.

PERIODICALS

Olivieri, Nancy F. "The beta-Thalassemias." *The New England Journal of Medicine* July 1999, 341(2):99-109.

Epstein, Franklin H."Pathogenesis and Treatment of Sickle Cell Disease." *The New England Journal of Medicine* September 1997, 337(11):762-769.

ORGANIZATIONS

American Sickle Cell Anemia Association. <http://www.ascaa.org>.

Sickle Cell Disease Association of American, Inc. <http://sicklecelldisease.org>.

The Sickle Cell Information Center. htt::://www.emory.edu. PO Box 109, Grady Memorial Hospital, 80 Bulter Street, SE, Atlanta, GA 30303, 404-616- 3572.

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Hemolytic anemia

Definition

Red blood cells have a normal life span of approximately 90–120 days, at which time the old cells are destroyed and replaced by the body's natural processes. Hemolytic anemia is a disorder in which the red blood cells are destroyed prematurely. The cells are broken down at a faster rate than the bone marrow can produce new cells. Hemoglobin, the component of red blood cells that carries oxygen, is released when these cells are destroyed.

Description

As a group, **anemias** (conditions in which the number of red blood cells or the amount of hemoglobin in them is below normal) are the most common blood disorders. Hemolytic anemias, which result from the increased destruction of red blood cells, are less common than anemias caused by excessive blood loss or by decreased hemoglobin or red cell production.

Since a number of factors can increase red blood cell destruction, hemolytic anemias are generally identified by the disorder that brings about the premature destruction. Those disorders are classified as either inherited or acquired. Inherited hemolytic anemias are caused by inborn defects in components of the red blood cells—the cell membrane, the enzymes, or the hemoglobin. Acquired hemolytic anemias are those that result from various other causes. With this type, red cells are produced normally, but are prematurely destroyed because of damage that occurs to them in the circulation.

Causes and symptoms

Inherited hemolytic anemias involve conditions that interfere with normal red blood cell production. Disorders that affect the red blood cell membrane include hereditary spherocytosis, in which the normally disk-shaped red cells become spherical, and hereditary elliptocytosis, in which the cells are oval, rather than disk-shaped. Other hereditary conditions that cause hemolytic anemia include disorders of the hemoglobin, such as sickle cell anemia and **thalassemia**, and red blood cell enzyme deficiencies, such as G6PD deficiency.

The causes of acquired hemolytic anemias vary, but the most common are responses to certain medications and infections. Medications may cause the body to develop antibodies that bind to the red blood cells and cause their destruction in the spleen. Immune hemolytic anemia most commonly involves antibodies that react against the red blood cells at body temperature (warm—antibody hemolytic anemia), which can cause premature destruction of the cells. About 20% of hemolytic anemias caused by warm antibodies come from diseases such as lymphocytic leukemia, 10% from an autoimmune disease, and others are drug-induced. Cold-antibody hemolytic anemia is a condition in which the antibodies react with the red blood cells at a temperature below that of normal body temperature. Red blood cells can also receive mechanical damage as they circulate through the blood vessels. Aneurysms, artificial heart valves, or very high blood pressure can cause the red cells to break up and release their contents. In addition, hemolytic anemia may be caused by a condition called **hypersplenism**, in which a large, overactive spleen rapidly destroys red blood cells.

Major symptoms of hemolytic anemias are similar to those for all anemias, including **shortness of breath**; noticeable increase in heart rate, especially with exertion; **fatigue**; pale appearance; and dark urine. A yellow tint, or **jaundice**, may be seen in the skin or eyes of hemolytic anemia patients. Examination may also show an enlarged spleen. A more emergent symptom of hemolytic anemia is **pain** in the upper abdomen. Severe anemia is indicated if there are signs of **heart failure** or an enlarged liver.

Diagnosis

In order to differentiate hemolytic anemia from others, physicians will examine the blood for the number of young red blood cells, since the number of young cells is increased in hemolytic anemia. The physician will also examine the abdominal area to check for spleen or liver enlargement. If the physician knows the duration of hemolysis, it may also help differentiate between types of anemia. There are a number of other indications that can be obtained from blood samples that will help a physician screen for hemolytic anemia. An antiglobulin (Coomb's) test may be performed as the initial screening exam after determining hemolysis. In the case of immune hemolytic anemia, a direct Coomb's test is almost always positive.

Treatment

Treatment will depend on the cause of the anemia, and may involve treatment of the underlying cause. If the

KEY TERMS

Antibody—Antibodies are parts of the immune system which counteract or eliminate foreign substances or antigens.

Erythrocyte—The name for red blood cells or red blood corpuscles. These components of the blood are responsible for carrying oxygen to tissues and removing carbon dioxide from tissues.

Hemolysis—The process of breaking down of red blood cells. As the cells are destroyed, hemoglobin, the component of red blood cells which carries the oxygen, is liberated.

Thalassemia—One of a group of inherited blood disorders characterized by a defect in the metabolism of hemoglobin, or the portion of the red blood cells that transports oxygen throughout the blood stream.

hemolytic anemia was brought on by hereditary spherocytosis, the spleen may be removed. Corticosteroid medications, or adrenal steroids, may be effective, especially in hemolytic anemia due to antibodies. If the cause of the disorder is a medication, the medication should be stopped. When anemia is severe in conditions such as sickle cell anemia and thalassemia, blood transfusions may be indicated.

Prognosis

Hemolytic anemias are seldom fatal. However, if left untreated, hemolytic anemia can lead to heart failure or liver complications.

Prevention

Hemolytic anemia due to inherited disorders can not be prevented. Acquired hemolytic anemia may be prevented if the underlying disorder is managed properly.

Resources

ORGANIZATIONS

American Autoimmune Related Diseases Association, Inc. *Focus: A quarterly newsletter of the AARDA*. Detroit, MI. (313) 371-8600. <http://www.aarda.org>.

The American Society of Hematology. 1200 19th Street NW, Suite 300, Washington, DC 20036-2422. (202) 857-1118. <http://www.hematology.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris, RN

Hemolytic-uremic syndrome

Definition

Hemolytic-uremic syndrome (HUS) is a rare condition that affects mostly children under the age of 10, but also may affect the elderly as well as persons with other illnesses. HUS, which most commonly develops after a severe bowel infection with certain toxic strains of a bacteria, is characterized by destruction of red blood cells, damage to the lining of blood vessel walls, and in severe cases, kidney failure.

Description

Most cases of HUS occur after an infection in the digestive system that has been caused by toxin-producing strains of the bacterium ***Escherichia coli***. About 75% of HUS cases in the United States are caused by the strain referred to as *E. coli* O157:H7, which is found in the intestinal tract of cattle,while the remaining cases are caused by non-O157 strains. Some children infected with *E. coli* O157:H7 will develop HUS. HUS also can follow respiratory infection episodes in young children. In the United States, there are about 20,000 infections and 250 deaths annually that are caused by *E. coli* O157:H7. HUS has also been known to occur in persons using drugs such as **oral contraceptives**, immunosuppressors, and antineoplastics, and in women during the postpartum period.

E. coli. O157:H7, first identified in 1982, and isolated with increasing frequency since then, is found in contaminated foods such as meat, dairy products, and juices. Infection with *E. coli*. O157:H7 causes severe **gastroenteritis**, which can include abdominal **pain**, vomiting, and bloody **diarrhea**. For most children, the vomiting and diarrhea stop within two to three days. However, about 5 to 10% of the children will develop HUS and will become pale, tired, and irritable. Toxins produced by the bacteria enter the blood stream, where they destroy red blood cells and platelets, which contribute to the clotting of blood. The damaged red blood cells and platelets clog tiny blood vessels in the kidneys, or form lesions to occur in the kidneys, making it difficult for the kidneys to remove wastes and extra fluid from the body, resulting in **hypertension**, fluid accumulation, and reduced production of urine.

Causes and symptoms

The most common way an *E. coli* O157:H7 infection is contracted is through the consumption of undercooked ground beef (e.g., eating hamburgers that are

still pink inside). Healthy cattle carry *E. coli* within their intestines. During the slaughtering process, the meat can become contaminated with the *E. coli* from the intestines. When contaminated beef is ground up, the *E. coli* are spread throughout the meat. Additional ways to contract an *E. coli* infection include drinking contaminated water and unpasteurized milk and juices, eating contaminated fruits and vegetables, and working with cattle. The infection is also easily transmitted from an infected person to others in settings such as day care centers and nursing homes when improper sanitary practices are used.

Symptoms of an *E. coli* O157:H7 infection start about seven days after infection with the bacteria. The first symptom is sudden onset of severe abdominal cramps. After a few hours, watery diarrhea starts, causing loss of fluids and electrolytes (**dehydration**), which causes the person to feel tired and ill. The watery diarrhea lasts for about a day, and then changes to bright red bloody stools, as the infection causes sores to form in the intestines. The bloody diarrhea lasts for two to five days, with as many as ten bowel movements a day. Additional symptoms may include **nausea and vomiting**, without a **fever**, or with only a mild fever. After about five to ten days, HUS can develop, which is characterized by paleness, irritability, and **fatigue**, as well as reduced urine production.

Diagnosis

The diagnosis of an *E. coli* infection is made through a **stool culture**. The culture must be taken within the first 48 hours after the start of the bloody diarrhea. If a positive culture is obtained, the patient should be monitored for the development of HUS, with treatment initiated as required.

Children should not go to day care until they have had two negative stool cultures. Older people in nursing homes should stay in bed until two stool cultures are negative.

Treatment

Treatment of HUS is supportive, with particular attention to management of fluids and electrolytes. Treatment generally is provided in a hospital setting. Blood transfusions may be required. In about 50% of the cases, short term replacement of kidney function is required in the form of dialysis. Most patients will recover kidney function and be able to discontinue dialysis.

Some studies have shown that the use of **antibiotics** and antimotility agents during an *E. coli* infection may worsen the course of the infection and should be avoided. However, other studies have been less definitive. Physicians should stay informed so that clinical practices matches medical advances on this aspect of treatment.

KEY TERMS

antineoplastics—an agent that inhibits or prevents the development, maturation, and proliferation of malignant cells.

gastroenteritis—an acute inflammation of the lining of the stomach and intestines, characterized by nausea, diarrhea, abdominal pain and weakness, which has various causes, including food poisoning due to infection with such organisms as *Escherichia coli*, *Staphylococcus aureus*and *Salmonella*species, consumption of irritating food or drink, or psychological factors such as anger, stress and fear.

Alternative treatment

Persons with HUS must be under the care of health care professionals skilled in the treatment of HUS.

Prognosis

Ninety percent of children with HUS who receive careful supportive care survive the initial acute stages of the condition, with most having no long-term effects. However, between 10 and 30 percent of the survivors will have kidney damage that will lead to kidney failure immediately or within several years. These children with kidney failure require on-going dialysis to remove wastes and extra fluids from their bodies, or may require a kidney transplant.

Prevention

Prevention of HUS caused by ingestion of foods contaminated with *E. coli* O157:H7 and other toxin-producing bacteria is accomplished through practicing hygienic food preparation techniques, including adequate handwashing, cooking of meat thoroughly, defrosting meats safely, vigorous washing of fruits and vegetables, and handling leftovers properly. Irradiation of meat has been approved by the United States Food and Drug Administration and the United States Department of Agriculture in order to decrease bacterial contamination of consumer meat supplies.

Resources

PERIODICALS

Koutkia, Polyxeni, Mylonakis, Eleftherios, and Flanigan, Timothy. Enterohemorrhagic *Escherichia coli*: An Emerging Pathogen." *American Family Physician* 56, no. 3 (September 1, 1997): 853-858.

American Family Physician. Fact Sheet: *Escherichia coli* O157:H7. "*American Family Physician*," 56, no. 3 (September 1, 1997): 859-861. <http://www.aafp.org/afp/970901 ap/970901c.html>.

OTHER

Hemolytic Uremic Syndrome Videotape. Lois Joy Galler Foundation for Hemolytic Uremic Syndrome, Inc., 1995.

National Kidney and Urologic Diseases Information Clearinghouse. Fact Sheet: Hemolytic Uremic Syndrome." NIH Publication No. 99-4570, <http://www.niddk.nih.gov/health/kidney/summary/hus/>., March 2000.

Judith Sims

Hemophilia

Definition

Hemophilia is a genetic disorder—usually inherited—of the mechanism of blood clotting. Depending on the degree of the disorder present in an individual, excess bleeding may occur only after specific, predictable events (such as surgery, dental procedures, or injury), or occur spontaneously, with no known initiating event.

Description

The normal mechanism for blood clotting is a complex series of events involving the interaction of the injured blood vessel, blood cells (called platelets), and over 20 different proteins which also circulate in the blood.

When a blood vessel is injured in a way that causes bleeding, platelets collect over the injured area, and form a temporary plug to prevent further bleeding. This temporary plug, however, is too disorganized to serve as a long-term solution, so a series of chemical events occur, resulting in the formation of a more reliable plug. The final plug involves tightly woven fibers of a material called fibrin. The production of fibrin requires the interaction of several chemicals, in particular a series of proteins called clotting factors. At least thirteen different clotting factors have been identified.

The clotting cascade, as it is usually called, is the series of events required to form the final fibrin clot. The cascade uses a technique called amplification to rapidly produce the proper sized fibrin clot from the small number of molecules initially activated by the injury.

In hemophilia, certain clotting factors are either decreased in quantity, absent, or improperly formed. Because the clotting cascade uses amplification to rapidly plug up a bleeding area, absence or inactivity of just one clotting factor can greatly increase **bleeding time**.

Hemophilia A is the most common type of bleeding disorder and involves decreased activity of factor VIII. There are three levels of factor VIII deficiency: severe, moderate, and mild. This classification is based on the percentage of normal factor VIII activity present:

- Individuals with less than 1% of normal factor VIII activity level have severe hemophilia. Half of all people with hemophilia A fall into this category. Such individuals frequently experience spontaneous bleeding, most frequently into their joints, skin, and muscles. Surgery or trauma can result in life-threatening hemorrhage, and must be carefully managed.
- Individuals with 1–5% of normal factor VIII activity level have moderate hemophilia, and are at risk for heavy bleeding after seemingly minor traumatic injury.
- Individuals with 5–40% of normal factor VIII activity level have mild hemophilia, and must prepare carefully for any surgery or dental procedures.

Individuals with hemophilia B have symptoms very similar to those of hemophilia A, but the deficient factor is factor IX. This type of hemophilia is also known as Christmas disease.

Hemophilia C is very rare, and much more mild than hemophilia A or B; it involves factor XI.

Hemophilia A affects between one in 5,000 to one in 10,000 males in most populations.

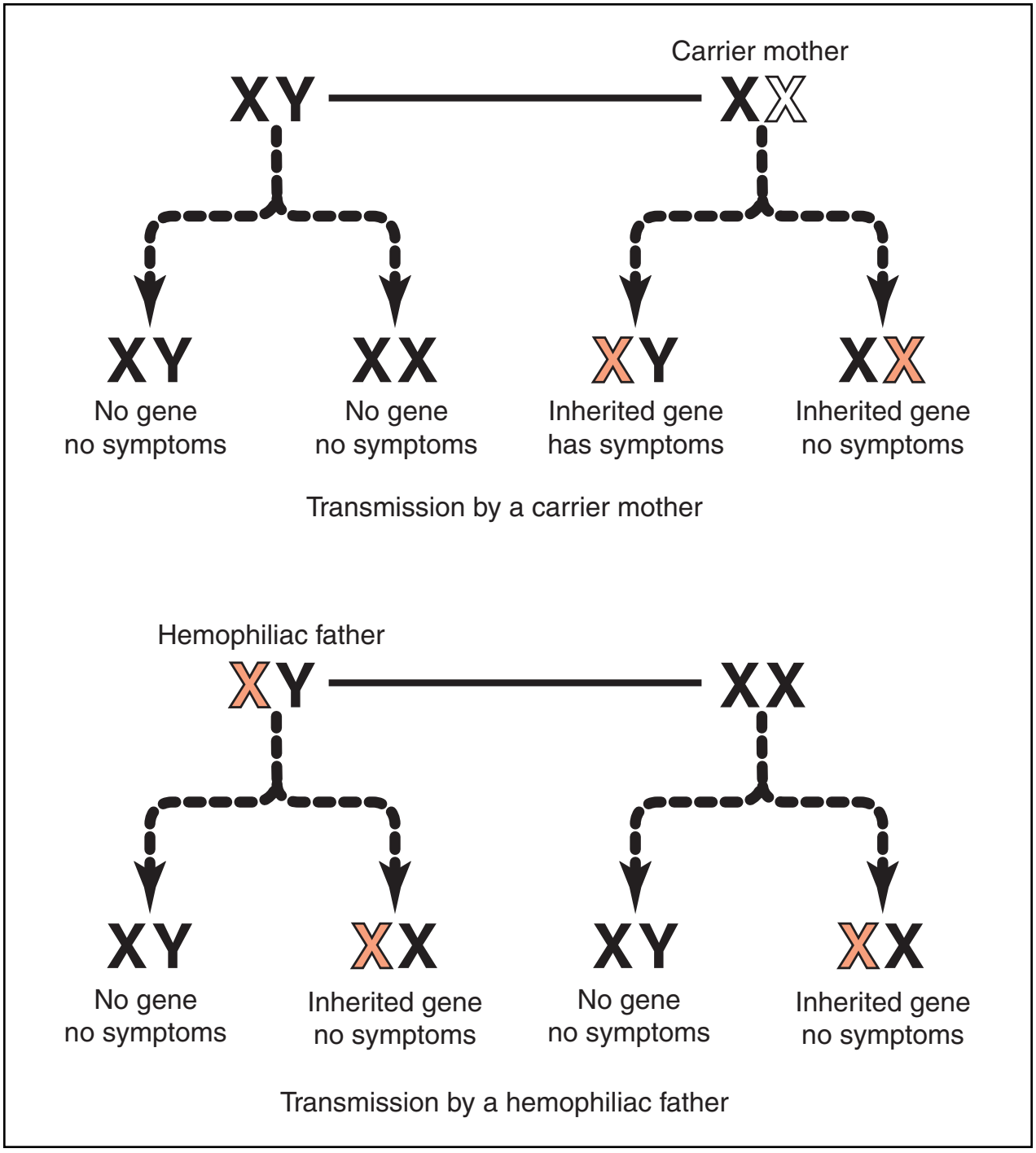
One recent study estimated the prevalence of hemophilia was 13.4 cases per 100,000 U.S. males (10.5 hemophilia A and 2.9 hemophilia B). By race/ethnicity, the prevalence was 13.2 cases/100,000 among white, 11.0 among African-American, and 11.5 among Hispanic males.

Causes and symptoms

Hemophilia A and B are both caused by a genetic defect present on the X chromosome. (Hemophilia C is inherited in a different fashion.) About 70% of all people with hemophilia A or B inherited the disease. The other 30% develop from a spontaneous genetic mutation.

The following concepts are important to understanding the inheritance of these diseases. All humans have two chromosomes determining their gender: females have XX, males have XY. Because the trait is carried only on the X chromosome, it is called "sex-linked." The chromosome's flawed unit is referred to as the gene.

Both factors VIII and IX are produced by a genetic defect of the X chromosome, so hemophilia A and B are both sex-linked diseases. Because a female child always



Hemophilia A and B are both caused by a genetic defect present on the X chromosome. Approximately 70% of people with hemophilia A or B inherited the disease, while the remaining 30% have hemophilia due to a spontaneous genetic mutation. *(Illustration by Electronic Illustrators Group.)*

receives two X chromosomes, she nearly always will receive at least one normal X chromosome. Therefore, even if she receives one flawed X chromosome, she will still be capable of producing a sufficient quantity of factors VIII and IX to avoid the symptoms of hemophilia. Such a person who has one flawed chromosome, but does not actually suffer from the disease, is called a carrier. She carries the flaw that causes hemophilia and can pass it on to her offspring. If, however, she has a son who receives her flawed X chromosome, he will be unable to

produce the right quantity of factors VIII or IX, and he will suffer some degree of hemophilia. (Males inherit one X and one Y chromosome, and therefore have only one X chromosome.)

In rare cases, a hemophiliac father and a carrier mother can pass on the right combination of parental chromosomes to result in a hemophiliac female child. This situation, however, is rare. The vast majority of people with either hemophilia A or B are male.

About 30% of all people with hemophilia A or B are the first member of their family to ever have the disease. These individuals have had the unfortunate occurrence of a spontaneous mutation; meaning that in their early development, some random genetic accident befell their X chromosome, resulting in the defect causing hemophilia A or B. Once such a spontaneous genetic mutation takes place, offspring of the affected person can inherit the newly-created, flawed chromosome.

In the case of severe hemophilia, the first bleeding event usually occurs prior to eighteen months of age. In some babies, hemophilia is suspected immediately, when a routine **circumcision** (removal of the foreskin of the penis) results in unusually heavy bleeding. Toddlers are at particular risk, because they fall frequently, and may bleed into the soft tissue of their arms and legs. These small bleeds result in bruising and noticeable lumps, but don't usually need treatment. As a child becomes more active, bleeding may occur into the muscles; a much more painful and debilitating problem. These muscle bleeds result in **pain** and pressure on the nerves in the area of the bleed. Damage to nerves can cause numbness and decreased ability to use the injured limb.

Some of the most problematic and frequent bleeds occur into the joints, particularly into the knees and elbows. Repeated bleeding into joints can result in scarring within the joints and permanent deformities. Individuals may develop arthritis in joints that have suffered continued irritation from the presence of blood. Mouth injuries can result in compression of the airway, and, therefore, can be life-threatening. A blow to the head, which might be totally insignificant in a normal individual, can result in bleeding into the skull and brain. Because the skull has no room for expansion, the hemophiliac individual is at risk for brain damage due to blood taking up space and exerting pressure on the delicate brain tissue.

People with hemophilia are at very high risk of hemorrhage (severe, heavy, uncontrollable bleeding) from injuries such as motor vehicle accidents and also from surgery.

Some other rare clotting disorders such as **Von Willebrand disease** present similar symptoms but are not usually called hemophilia.

Diagnosis

Various tests are available to measure, under very carefully controlled conditions, the length of time it takes to produce certain components of the final fibrin clot. Tests called assays can also determine the percentage of factors VIII and IX present compared to normal percentages. This information can help in demonstrating the type of hemophilia present, as well as the severity.

Individuals with a family history of hemophilia may benefit from **genetic counseling** before deciding to have a baby. Families with a positive history of hemophilia can also have tests done during a **pregnancy** to determine whether the fetus is a hemophiliac. The test called chorionic villous sampling examines proteins for the defects that lead to hemophilia. This test, which is associated with a 1% risk of **miscarriage**, can be performed at 10–14 weeks. The test called **amniocentesis** examines the DNA of fetal cells shed into the amniotic fluid for genetic mutations. Amniocentesis, which is associated with a one in 200 risk of miscarriage, is performed at 15–18 weeks gestation.

Treatment

The most important thing that individuals with hemophilia can do to prevent complications of this disease is to avoid injury. Those individuals who require dental work or any surgery may need to be pre-treated with an infusion of factor VIII to avoid hemorrhage. Also, hemophiliacs should be vaccinated against hepatitis. Medications or drugs that promote bleeding, such as **aspirin**, should be avoided.

Various types of factors VIII and IX are available to replace a patient's missing factors. These are administered intravenously (directly into the patient's veins by needle). These factor preparations may be obtained from a single donor, by pooling the donations of as many as thousands of donors, or by laboratory creation through highly advanced genetic techniques.

The frequency of treatment with factors depends on the severity of the individual patient's disease. Patients with relatively mild disease will only require treatment in the event of injury, or to prepare for scheduled surgical or dental procedures. Patients with more severe disease will require regular treatment to avoid spontaneous bleeding.

While appropriate treatment of hemophilia can both decrease suffering and be life-saving, complications associated with treatment can also be quite serious. About 20% of all patients with hemophilia A begin to produce

chemicals in their bodies which rapidly destroy infused factor VIII. The presence of such a chemical may greatly hamper efforts to prevent or stop a major hemorrhage.

Individuals who receive factor prepared from pooled donor blood are at risk for serious infections that may be passed through blood. Hepatitis, a severe and potentially fatal viral liver infection, may be contracted from pooled factor preparations. Recently, a good deal of concern has been raised about the possibility of hemophiliacs contracting a fatal slow virus infection of the brain (**Creutzfeldt-Jakob disease**) from blood products. Unfortunately, pooled factor preparations in the early 1980s were contaminated with human **immunodeficiency** virus (HIV), the virus which causes **AIDS**. A large number of hemophiliacs were infected with HIV and some statistics show that HIV is still the leading cause of **death** among hemophiliacs. Currently, careful methods of donor testing, as well as methods of inactivating viruses present in donated blood, have greatly lowered this risk.

The most exciting new treatments currently being researched involve efforts to transfer new genes to hemophiliacs. These new genes would have the ability to produce the missing factors. As yet, these techniques are not being performed on humans, but there is great hope that eventually this type of **gene therapy** will be available.

Prognosis

Prognosis is very difficult to generalize. Because there are so many variations in the severity of hemophilia, and because much of what befalls a hemophiliac patient will depend on issues such as physical activity level and accidental injuries, statistics on prognosis are not generally available.

KEY TERMS

Amplification—A process by which something is made larger. In clotting, only a very few chemicals are released by the initial injury; they result in a cascade of chemical reactions which produces increasingly larger quantities of different chemicals, resulting in an appropriately-sized, strong fibrin clot.

Factors—Coagulation factors are substances in the blood, such as proteins and minerals, that are necessary for clotting. Each clotting substance is designated with roman numerals I through XIII.

Fibrin—The final substance created through the clotting cascade, which provides a strong, reliable plug to prevent further bleeding from the initial injury.

Hemorrhage—Very severe, massive bleeding that is difficult to control. Hemorrhage can occur in hemophiliacs after what would be a relatively minor injury to a person with normal clotting factors.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Platelets—Small disc-shaped structures that circulate in the blood stream and participate in blood clotting.

Trauma—Injury.

Resources

BOOKS

Genetics and Public Health in the 21st Century: Using Genetic Information to Improve Health and Prevent Disease, edited by Muin J. Khoury, Wylie Burke, and Elizabeth J. Thomson. New York: Oxford University Press, 2000.

Hemophilia, edited by C.D. Forbes, L.M. Aledort, and R. Madhok. New York: Chapman & Hall, 1997.

Resnick, Susan. *Blood Saga: Hemophilia, AIDS, and the Survival of a Community.* Berkeley: University of California Press, 1999.

PERIODICALS

Soucie, J.M., et al. "Hemophilia Surveillance System Project Investigators: Occurrence of Hemophilia in the United States." *American Journal of Hematology* 59(1998): 288+.

Stephenson, J. "New Therapies Show Promise for Patients with Leukemia, Hemophilia, and Heart Disease." *JAMA* 285(January 1, 2001): 153+.

ORGANIZATIONS

National Hemophilia Foundation. 116 West 32nd St., 11th Floor, New York, NY 10001. (800) 42-HANDI. <http://www.info@hemophilia.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

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OTHER

March of Dimes. <www.modimes.org>.

National Organization for Rare Disorders. <www.rarediseases.org>.

Jennifer F. Wilson, MS

Hemophilus ducreyi infection *see* **Chancroid**

Hemophilus infections

Definition

Hemophilus infections, most of which are due to *Haemophilus influenzae* infections, are a group of contagious diseases that are caused by a gram-negative bacterium, and affect only humans. Some hemophilus infections are potentially fatal.

Description

H. influenzae is a common organism worldwide; it has been found in the nasal secretions of as many as 90% of healthy individuals in the general population. Hemophilus infections are characterized by acute inflammation with a discharge (exudate). They may affect almost any organ system, but are most common in the respiratory tract. The organism can be transmitted by person-to-person contact, or by contact with nasal discharges and other body fluids. Hemophilus infections in the United States are most likely to spread in the late winter or early spring.

The primary factor influencing the rate of infection is age; children between the ages of six months and four years are most vulnerable to *H. influenzae*. In previous years, about 50% of children would acquire a hemophilus infection before reaching one year of age; almost all children would develop one before age three. These figures are declining, however, as a result of the increasing use of hemophilus vaccines for children.

Adults are also susceptible to hemophilus diseases. *H. influenzae***pneumonia** is a common nosocomial infection (illnesses contracted in hospitals). The rate of hemophilus infections in the adult population has increased over the past 40 years. The reasons for this change are unclear, but some researchers speculate that the overuse of **antibiotics** has led to the development of drug-resistant strains of *H. influenzae*. The risk factors for hemophilus infections among adults include:

- smoking
- alcoholism
- chronic lung disease
- old age
- living in a city or institutional housing with a large group of people
- poor **nutrition** and hygiene
- HIV infection, or other immune system disorder

Causes and symptoms

Hemophilus infections are primarily caused by *Haemophilus influenzae*, a gram-negative bacterium that is capable of spreading from the nasal tissues and upper airway, where it is usually found, to the chest, throat, or middle ear. The organism sometimes invades localized areas of tissue, producing **meningitis**, **infectious arthritis**, **conjunctivitis**, **cellulitis**, **epiglottitis**, or inflammation of the membrane surrounding the heart. The most serious infections are caused by a strain called *H. influenzae* b (Hib). Before routine **vaccination**, Hib was the most common cause of bacterial meningitis, and responsible for most of the cases of acquired **mental retardation** in the United States.

Hemophilus infections in children

BACTERIAL SEPSIS IN THE NEWBORN. Bacterial **sepsis** (sepsis is the presence of illness-causing microorganisms, or their poisons, in the blood) is a potentially fatal illness in newborn infants. The child may acquire the disease organism as it passes through the mother's birth canal, or from the hospital environment. *H. influenzae* can also produce inflammations of the eye (conjunctivitis) in newborn children. The signs of sepsis may include **fever**, crankiness, feeding problems, breathing difficulties, pale or mottled skin, or drowsiness. Premature birth is the most significant risk factor for hemophilus infections in newborns.

EPIGLOTTITIS. Epiglottitis is a potentially fatal hemophilus infection. Although children are more likely to develop epiglottitis, it can occur in adults as well. When the epiglottis (a piece of cartilage behind the tongue which protects the opening to the windpipe by opening and closing) is infected, it can swell to the point where it blocks the windpipe. The symptoms of epiglottitis include a sudden high fever, drooling, the feeling of an object stuck in the throat, and **stridor**. The epiglottis will look swollen and bright red if the doctor examines the patient's throat with a laryngoscope (a viewing device).

MENINGITIS. Meningitis caused by Hib is most common in children between nine months and four years of age. The child usually develops upper respiratory symptoms followed by fever, loss of appetite, vomiting, **headache**, and a stiff or sore neck or back. In severe cases, the child may have convulsions or go into **shock** or **coma**.

OTHER INFECTIONS. Hib is the second most common cause of middle ear infection and **sinusitis** in children. The symptoms of sinusitis include fever, **pain**, **bad breath**, and coughing. Children may also develop infectious arthritis from Hib. The joints most frequently affected are the large weight-bearing joints.

Hemophilus infections in adults

PNEUMONIA. Hib pneumonia is the most common hemophilus infection in adults. The symptoms include **empyema** (sputum containing pus), and fever. The hemophilus organism can usually be identified from sputum samples. Hib pneumonia is increasingly common in the elderly.

MENINGITIS. Meningitis caused by Hib can develop in adults as a complication of an ear infection or sinusitis. The symptoms are similar to those in children but are usually less severe in adults.

Diagnosis

The diagnosis is usually based on a combination of the patient's symptoms and the results of blood counts, cultures, or antigen detection tests.

Laboratory tests

Laboratory tests can be used to confirm the diagnosis of hemophilus infections. The bacterium can be grown on chocolate agar, or identified by blood cultures or Gram stain of body fluids. Antigen detection tests can be used to identify hemophilus infections in children. These tests include latex agglutination and electrophoresis.

Other laboratory findings that are associated with hemophilus infections include anemia (low red blood cell count), and a drop in the number of white blood cells in children with severe infections. Adults often show an abnormally high level of white blood cells; cell counts of 15,000–30,000/mm^3 are not unusual.

Treatment

Because some hemophilus infections are potentially fatal, treatment is started without waiting for the results of laboratory tests.

Medications

Hemophilus infections are treated with antibiotics. Patients who are severely ill are given ampicillin or a third-generation cephalosporin, such as cefotaxime or ceftriaxone, intravenously. Patients with milder infections are given oral antibiotics, including amoxicillin, cefaclor, erythromycin, or trimethoprim-sulfamethoxazole. Patients who are allergic to penicillin are usually given cefaclor or trimethoprim-sulfamethoxazole.

Patients with Hib strains that are resistant to ampicillin may be given chloramphenicol. Chloramphenicol is not a first-choice drug because of its side effects, including interference with bone marrow production of blood cells.

The duration of antibiotic treatment depends on the location and severity of the hemophilus infection. Adults with respiratory tract infections, or Hib pneumonia, are usually given a 10–14 day course of antibiotics. Meningitis is usually treated for 10–14 days, but a seven-day course of treatment with ceftriaxone appears to be sufficient for infants and children. Ear infections are treated for seven to 10 days.

Supportive care

Patients with serious hemophilus infections require bed rest and a humidified environment (such as a **croup** tent) if the respiratory tract is affected. Patients with epiglottitis frequently require intubation (insertion of a breathing tube) or a **tracheotomy** to keep the airway open. Patients with inflammation of the heart membrane, pneumonia, or arthritis may need surgical treatment to drain infected fluid from the chest cavity or inflamed joints.

Supportive care also includes monitoring of blood cell counts for patients using chloramphenicol, ampicillin, or other drugs that may affect production of blood cells by the bone marrow.

Prognosis

The most important factors in the prognosis are the severity of the infection and promptness of treatment. Untreated hemophilus infections—particularly meningitis, sepsis, and epiglottitis—have a high mortality rate. Bacterial sepsis of the newborn has a mortality rate between 13–50%. The prognosis is usually good for patients with mild infections who are treated without delay. Children who develop Hib arthritis sometimes have lasting problems with joint function.

Prevention

Hemophilus vaccines

There are three different vaccines for hemophilus infections used to immunize children in the United States: PRP-D, HBOC, and PRP-OMP. PRP-D is used only in children older than 15 months. HBOC is administered to infants at two, four, and six months after birth, with a booster dose at 15–18 months. PRP-OMP is administered to infants at two and four months, with the third dose at

KEY TERMS

Bacterium—A microscopic one-celled organism. *Haemophilus influenzae* is a specific bacterium.

Epiglottitis—Inflammation of the epiglottis. The epiglottis is a piece of cartilage behind the tongue that closes the opening to the windpipe when a person swallows. An inflamed epiglottis can swell and close off the windpipe, thus causing the patient to suffocate.

Exudate—A discharge produced by the body. Some exudates are caused by infections.

Gram-negative—A term that means that a bacterium will not retain the violet color when stained with Gram's dye. *Haemophilus influenzae* is a gram-negative bacterium.

Intubation—The insertion of a tube into the patient's airway to protect the airway from collapsing. Intubation is sometimes done as an emergency procedure for patients with epiglottitis.

Nosocomial—Contracted in a hospital. Pneumonia caused by *H. influenzae* is an example of a nosocomial infection.

Sepsis—Invasion of body tissues by disease organisms or their toxins. Sepsis may be either localized or generalized. *Haemophilus influenzae* can cause bacterial sepsis in newborns.

Stridor—A harsh or crowing breath sound caused by partial blockage of the patient's upper airway.

Tracheotomy—An emergency procedure in which the surgeon cuts directly through the patient's neck into the windpipe in order to keep the airway open.

the child's first birthday. All three vaccines are given by intramuscular injection. About 5% of children may develop fever or soreness in the area of the injection.

Other measures

Other preventive measures include isolating patients with respiratory hemophilus infections; treating appropriate contacts of infected patients with rifampin; maintaining careful standards of cleanliness in hospitals, including proper disposal of soiled tissues; and washing hands properly.

Resources

BOOKS

Abzug, Mark J. "Infectious Diseases: Bacterial, Spirochetal, Protozoal, Metazoal, & Mycotic." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Apicella, Michael A., and Timothy F. Murphy. "Haemophilus, Infection and Immunity." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Chambers, Henry F. "Infectious Diseases: Bacterial & Chlamydial." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Hemophilus Influenzae Infection." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

"Infectious Disease: Bacterial Diseases." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Infectious Diseases: Neonatal Sepsis." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

Ogle, John W. "Immunization Procedures, Vaccines, Antisera & Skin Tests." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Rebecca J. Frey

Hemophilus influenzae infections *see* **Hemophilus infections**

Hemoptysis

Definition

Hemoptysis is the coughing up of blood or bloody sputum from the lungs or airway. It may be either self-limiting or recurrent. Massive hemoptysis is defined as 200–600 mL of blood coughed up within a period of 24 hours or less.

Description

Hemoptysis can range from small quantities of bloody sputum to life-threatening amounts of blood. The patient may or may not have chest **pain**.

Causes and symptoms

Hemoptysis can be caused by a range of disorders:

- Infections. These include **pneumonia**; **tuberculosis**; **aspergillosis**; and parasitic diseases, including ascariasis, **amebiasis**, and paragonimiasis.
- Tumors that erode blood vessel walls.
- Drug abuse. **Cocaine** can cause massive hemoptysis.
- Trauma. Chest injuries can cause bleeding into the lungs.
- Vascular disorders, including aneurysms, **pulmonary embolism**, and malformations of the blood vessels.
- Bronchitis. Its most common cause is long-term **smoking**.
- Foreign object(s) in the airway.
- Blood clotting disorders.
- Bleeding following such surgical procedures as bronchial biopsies and heart catheterization.

KEY TERMS

Aneurysm—A sac formed by the dilation of the wall of an artery, vein, or heart; it is filled with clotted blood or fluid.

Angiography—A technique for imaging the blood vessels by injecting a substance that is opaque to x rays.

Aspergillosis—A lung infection caused by the mold *Aspergillus fumigatus*.

Intubation—The insertion of a tube into a body canal or hollow organ, as into the trachea or stomach.

Pulmonary embolism—The blocking of an artery in the lung by a blood clot.

Diagnosis

The diagnosis of hemoptysis is complicated by the number of possible causes.

Patient history

It is important for the doctor to distinguish between blood from the lungs and blood coming from the nose, mouth, or digestive tract. Patients may aspirate, or breathe, blood from the nose or stomach into their lungs and **cough** it up. They may also swallow blood from the chest area and then vomit. The doctor will ask about stomach ulcers, repeated vomiting, liver disease, **alcoholism**, smoking, tuberculosis, mitral valve disease, or treatment with anticoagulant medications.

Physical examination

The doctor will examine the patient's nose, throat, mouth, and chest for bleeding from these areas and for signs of chest trauma. The doctor also listens to the patient's breathing and heartbeat for indications of heart abnormalities or lung disease.

Laboratory tests

Laboratory tests include blood tests to rule out clotting disorders, and to look for food particles or other evidence of blood from the stomach. Sputum can be tested for fungi, bacteria, or parasites.

X-ray and bronchoscopy

Chest x-rays and **bronchoscopy** are the most important studies for evaluating hemoptysis. They are used to evaluate the cause, location, and extent of the bleeding. The bronchoscope is a long, flexible tube used to identify tumors or remove **foreign objects**.

Imaging and other tests

Computed tomography scans (CT scans) are used to detect aneurysms and to confirm x-ray results. Ventilation-perfusion scanning is used to rule out pulmonary **embolism**. The doctor may also order an angiogram to rule out pulmonary embolism, or to locate a source of bleeding that could not be seen with the bronchoscope.

In spite of the number of diagnostic tests, the cause of hemoptysis cannot be determined in 20–30% of cases.

Treatment

Massive hemoptysis is a life-threatening emergency that requires treatment in an intensive care unit. The patient will be intubated (the insertion of a tube to help breathing) to protect the airway, and to allow evaluation of the source of the bleeding. Patients with lung **cancer**, bleeding from an aneurysm (blood clot), or persistent traumatic bleeding require chest surgery.

Patients with tuberculosis, aspergillosis, or bacterial pneumonia are given **antibiotics**.

Foreign objects are removed with a bronchoscope.

If the cause cannot be determined, the patient is monitored for further developments.

Prognosis

The prognosis depends on the underlying cause. In cases of massive hemoptysis, the mortality rate is about

15%. The rate of bleeding, however, is not a useful predictor of the patient's chances for recovery.

Resources

BOOKS

Idell, Steven. "Hemoptysis." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"On-Call Problems: Hemoptysis." In *Surgery On Call*, ed. Leonard G. Gomella and Alan T. Lefor. Stamford: Appleton & Lange, 1996.

"Pulmonary Disorders: Hemoptysis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Stauffer, John L. "Lung." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Hemorrhagic colitis *see* **Escherichia coli**

Hemorrhagic fever with renal syndrome *see* **Hantavirus infections**

Hemorrhagic fevers

Definition

Hemorrhagic fevers are caused by viruses that exist throughout the world. However, they are most common in tropical areas. Early symptoms, such as muscle aches and **fever**, can progress to a mild illness or to a more debilitating, potentially fatal disease. In severe cases, a prominent symptom is bleeding, or hemorrhaging, from orifices and internal organs.

Description

Although hemorrhagic fevers are regarded as emerging diseases, they probably have existed for many years. This designation isn't meant to imply that they are newly developing, but rather that human exposure to the causative viruses is increasing to the point of concern.

These viruses are maintained in nature in insect, arthropod (insects, spiders and other invertebrates with external hard skeletons), or animal populations—so-called disease reservoirs. Individuals within these populations become infected with a virus but do not die from it. In many cases, they don't even develop symptoms. Then the viruses are transmitted from a reservoir population to humans by vectors—either members of the reservoir population or an intervening species, such as mosquitoes.

Hemorrhagic fevers are generally endemic, or linked to specific locations. If many people reside in an endemic area, the number of cases may soar. For example, **dengue fever**, a type of hemorrhagic fever, affects approximately 100 million people annually. A large percentage of those infected live in densely populated southeast Asia; an area in which the disease vector, a mosquito, thrives. Some hemorrhagic fevers are exceedingly rare, because people very infrequently encounter the virus. Marburg hemorrhagic fever, which has affected fewer than 40 people since its discovery in 1967, provides one such example. Fatality rates are also variable. In cases of dengue hemorrhagic fever-dengue shock syndrome, 1–5% of the victims perish. On the other end of the spectrum is Ebola, an African hemorrhagic fever, that kills 30–90% of those infected.

The onset of hemorrhagic fevers may be sudden or gradual, but all of them are linked by the potential for hemorrhaging. However, not all cases progress to this very serious symptom. Hemorrhaging may be attributable to the destruction of blood coagulating factors or to increased permeability of body tissues. The severity of bleeding ranges from petechiae, which are pinpoint hemorrhages under the skin surface, to distinct bleeding from body orifices such as the nose or vagina.

Causes and symptoms

The viruses that cause hemorrhagic fevers are found most commonly in tropical locations; however, some are found in cooler climates. Typical disease vectors include rodents, ticks, or mosquitoes, but person-to-person transmission in health care settings or through sexual contact can also occur.

Filoviruses

Ebola is the most famous of the Filoviridae, a virus family that also includes the Marburg virus. Ebola is endemic to Africa, particularly the Republic of the Congo and Sudan; the Marburg virus is found in sub-Saharan Africa. The natural reservoir of filoviruses is unknown. The incubation period, or time between infection and appearance of symptoms, is thought to last three to eight days, possibly longer.

Symptoms appear suddenly, and include severe **headache**, fever, chills, muscle aches, malaise, and appetite loss. These symptoms may be accompanied by nausea, vomiting, **diarrhea**, and abdominal **pain**. Victims become apathetic and disoriented. Severe bleeding commonly occurs from the gastrointestinal tract, nose and throat, and vagina. Other bleeding symptoms include petechiae and oozing from injection sites. Ebola is fatal in 30–90% of cases.

Arenaviruses

Viruses of the Arenaviridae family cause the Argentinian, Brazilian, Bolivian, and Venezuelan hemorrhagic fevers. Lassa fever, which occurs in west Africa, also arises from an arenavirus. Infected rodents, the natural reservoir, shed virus particles in their urine and saliva, which humans may inhale or otherwise come in contact with.

Fever, muscle aches, malaise, and appetite loss gradually appear one to two weeks after infection with the South American viruses. Initial symptoms are followed by headache, back pain, **dizziness**, and gastrointestinal upset. The face and chest appear flushed and the gums begin to bleed. In about 30% of cases, the disease progresses to bleeding under the skin and from the mucous membranes, and/or to effects on the nervous system, such as **delirium**, **coma**, and convulsions. Untreated, South American hemorrhagic fevers have a 10–30% fatality rate.

Lassa fever also begins gradually, following an 8–14 day incubation. Initial symptoms resemble those of the South American hemorrhagic fevers, followed by a **sore throat**, muscle and joint pain, severe headache, pain above the stomach, and a dry **cough**. The face and neck become swollen, and fluid may accumulate in the lungs. Bleeding occurs in 15–20% of infected individuals, mostly from the gums and nose. Overall, the fatality rate is lower than 2%, but hospitals may encounter 20% fatality rates, treating typically the most serious of cases.

Flaviviruses

The Flaviviridae family includes the viruses that cause yellow and dengue fevers.

Yellow fever occurs in tropical areas of the Americas and Africa and is transmitted from monkeys to humans by mosquitoes. The virus may produce a mild, possibly unnoticed illness, but some individuals are suddenly stricken with a fever, weakness, **low back pain**, muscle pain, nausea, and vomiting. This phase lasts one to seven days, after which the symptoms recede for one to two days. Symptoms then return with greater intensity, along with **jaundice**, delirium, seizures, stupor, and coma. Bleeding occurs from the mucous membranes and under the skin surface, and dark blood appears in stools and vomit.

Mosquitoes also transmit the dengue virus. Dengue fever is endemic in southeast Asia and areas of the Americas. Cases have also been reported in the Caribbean, Saudi Arabia, and northern Australia. This virus causes either the mild dengue fever or the more serious dengue hemorrhagic fever-dengue shock syndrome (DHF-DSS).

In children, dengue fever is characterized by a sore throat, runny nose, slight cough, and a fever lasting for a week or less. Older children and adults experience more severe symptoms: fever, headache, muscle and joint pain, loss of appetite, and a rash. The skin appears flushed, and intense pain occurs in the bones and limbs. After nearly a week, the fever subsides for one to two days before returning. Minor hemorrhaging, such as from the gums, or more serious gastrointestinal bleeding may occur.

DHF-DSS primarily affects children younger than 15 years. The symptoms initially resemble those of dengue fever in adults, without the bone and limb pain. As the fever begins to abate, the individual's condition worsens and hemorrhaging occurs from the nose, gums, and injection sites. Bleeding is also seen from the gastrointestinal, genitourinary, and respiratory tracts.

Bunyaviruses

The Bunyaviridae family includes several hundred viruses but only a few are responsible for hemorrhagic fevers in humans.

KEY TERMS

Antibody—A molecule created by the body's immune system to combat a specific infectious agent, such as a virus or bacteria.

Antigen—A specific feature, such as a protein, on an infectious agent. Antibodies use this feature as a means of identifying infectious intruders.

Coagulating factors—Components within the blood that help form clots.

Endemic—Referring to a specific geographic area in which a disease may occur.

Hemorrhage—As a noun, this refers to the point at which blood is released. As a verb, this refers to bleeding.

Incubation—The time period between exposure to an infectious agent, such as a virus or bacteria, and the appearance of symptoms of illness.

Petechiae—Pinpoint hemorrhages that appear as reddish dots beneath the surface of the skin.

Reservoir—A population in which a virus is maintained without causing serious illness to the infected individuals.

Ribavirin—A drug that is used to combat viral infections.

Vector—A member of the reservoir population or an intervening species that can transmit a virus to a susceptible victim. Mosquitoes are common vectors, as are ticks and rodents.

Rift Valley fever is caused by the phlebovirus, found in sub-Saharan Africa and the Nile delta. Natural reservoirs are wild and domestic animals, and transmission occurs through contact with infected animals or through mosquito bites. The incubation period lasts 3–12 days. Most cases of Rift Valley fever are mild and may be symptomless. If symptoms develop, they include fever, backache, muscle and joint pain, and headache. Hemorrhagic symptoms occur rarely; while **death**, which occurs in fewer than 3% of cases, is attributable to massive liver damage.

Crimean-Congo hemorrhagic fever is caused by nairovirus and occurs in central and southern Africa, Asia, Eurasia, and the Middle East. The virus is found in hares, birds, ticks, and domestic animals and may be transmitted by ticks or by contact with infected animals. The nairovirus incubation period is three to 12 days; after which an individual experiences fever, chills, headache, severe muscle pain, pain above the stomach, nausea, vomiting, and appetite loss. Bleeding under the skin and gastrointestinal and vaginal bleeding may develop in the most severe cases. Death rates range from 10% in southern Russia to 50% in parts of Asia.

Hemorrhagic fever with renal (kidney) syndrome is caused by the hantaviruses: Hantaan, Seoul, Puumala, and Dobrava. Hantaan virus occurs in northern Asia, the Far East, and the Balkans; Seoul virus is found worldwide; Puumala virus is found in Scandinavia and northern Europe; while Dobrava virus occurs in the Balkans. Wild rodents are the natural reservoirs and transmit the virus via their excrement or body fluids or through direct contact. Initial symptoms develop within 10–40 days and include fever, headache, muscle pain, and dizziness. Other symptoms are blurry vision, abdominal and back pain, nausea, and vomiting. High levels of protein in the urine signal kidney damage; hemorrhaging may also occur. Death rates range from 0–10%.

Diagnosis

Since the hemorrhagic fevers share symptoms with many other diseases, positive identification of the disease relies on evidence of the viruses in the bloodstream—such as detection of antigens and antibodies—or **isolation** of the virus from the body. Disruptions in the normal levels of bloodstream components may be helpful in determining some, but not all, hemorrhagic fevers.

Treatment

Lassa fever, and possibly other hemorrhagic fevers, respond to ribavirin, an antiviral medication. However, most of the hemorrhagic fever viruses can only be treated with supportive care. Such care centers around maintaining correct fluid and electrolyte balances in the body and protecting the patient against secondary infections. Heparin and vitamin K administration, coagulation factor replacement, and blood transfusions may be effective in lessening or stopping hemorrhage in some cases.

Prognosis

Recovery from some hemorrhagic fevers is more certain than from others. The filoviruses are among the most lethal; fatality rates for Ebola range from 30–90%, while DHF-DSS cases result in a 1–5% fatality rate. Whether a case occurs during an epidemic or as an isolated case also has a bearing on the outcome. For example, isolated cases of yellow fever have a 5% mortality rate, but 20–50% of epidemic cases may be fatal.

Permanent disability can occur with some types of hemorrhagic fever. About 10% of severely ill Rift Valley fever victims suffer retina damage and may be permanently blind, and 25% of South American hemorrhagic fever victims suffer potentially permanent deafness.

Proper treatment is vital. In cases of DHF-DSS, fatality can be reduced from 40–50% to less than 2% with adequate medical care. For individuals who survive hemorrhagic fevers, prolonged convalescence is usually inevitable. However, survivors seem to gain lifelong immunity against the virus that made them ill.

Prevention

Hemorrhagic fevers can be prevented through vector control and personal protection measures. Attempts have been made in urban and settled areas to destroy mosquito and rodent populations. In areas where such measures are impossible, individuals can use insect repellents, mosquito netting, and other methods to minimize exposure.

Vaccines have been developed against yellow fever, Argentinian hemorrhagic fever, and Crimean-Congo hemorrhagic fever. Vaccines against other hemorrhagic fevers are being researched.

Resources

BOOKS

Garrett, Laurie. *The Coming Plague: Newly Emerging Diseases in a World Out of Balance.* New York: Farrar, Straus, and Giroux, 1994.

Gorbach, Sherwood L., John G. Bartlett, and Neil R. Blacklow, eds. Chapters 266, 267, and 269 in *Infectious Diseases.* 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Lacy, Mark D., and Raymond A. Smego. "Viral Hemorrhagic Fevers." *Advances in Pediatric Infectious Diseases* 12 (1997): 21.

Le Guenno, Bernard. "Emerging Viruses." *Scientific American* (Oct. 1995): 56.

Julia Barrett

Hemorrhoids

Definition

Hemorrhoids are enlarged veins in the anus or lower rectum. They often go unnoticed and usually clear up after a few days, but can cause long-lasting discomfort, bleeding and be excruciatingly painful. Effective medical treatments are available, however.

Description

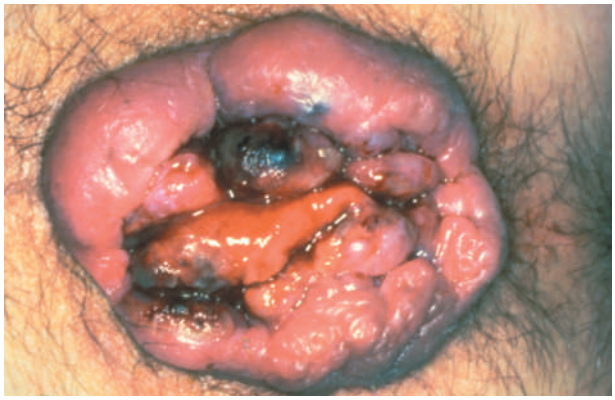
Hemorrhoids (also called piles) can be divided into two kinds, internal and external. Internal hemorrhoids lie inside the anus or lower rectum, beneath the anal or rectal lining. External hemorrhoids lie outside the anal opening. Both kinds can be present at the same time.

Hemorrhoids are a very common medical complaint. More than 75% of Americans have hemorrhoids at some point in their lives, typically after age 30. Pregnant women often develop hemorrhoids, but the condition usually clears up after **childbirth**. Men are more likely than women to suffer from hemorrhoids that require professional medical treatment.

Causes and symptoms

Precisely why hemorrhoids develop is unknown. Researchers have identified a number of reasons to explain hemorrhoidal swelling, including the simple fact that people's upright posture places a lot of pressure on the anal and rectal veins. **Aging**, **obesity**, **pregnancy**, chronic **constipation** or **diarrhea**, excessive use of **enemas** or **laxatives**, straining during bowel movements, and spending too much time on the toilet are considered contributing factors. Heredity may also play a part in some cases. There is no reason to believe that hemorrhoids are caused by jobs requiring, for instance, heavy lifting or long hours of sitting, although activities of that kind may make existing hemorrhoids worse.

The commonest symptom of internal hemorrhoids is bright red blood in the toilet bowl or on one's feces or toilet paper. When hemorrhoids remain inside the anus they are almost never painful, but they can prolapse (protrude outside the anus) and become irritated and sore. Sometimes, prolapsed hemorrhoids move back into the anal canal on their own or can be pushed back in, but at other times they remain permanently outside the anus until treated by a doctor.



Clinical photo of a thrombosed external hemorrhoid. *(Custom Medical Stock Photo. Reproduced by permission.)*

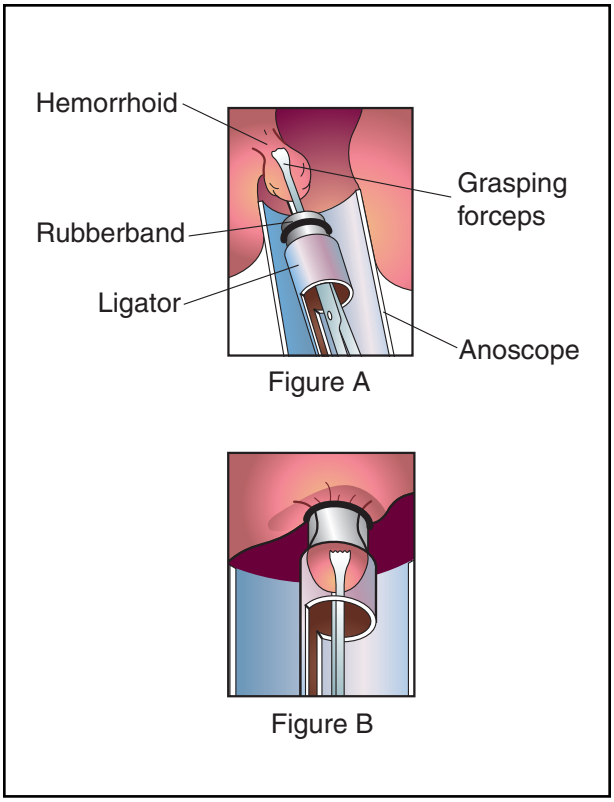
Small external hemorrhoids usually do not produce symptoms. Larger ones, however, can be painful and interfere with cleaning the anal area after a bowel movement. When, as sometimes happens, a blood clot forms in an external hemorrhoid (creating what is called a thrombosed hemorrhoid), the skin around the anus becomes inflamed and a very painful lump develops. On rare occasions the clot will begin to bleed after a few days and leave blood on the underwear. A thrombosed hemorrhoid will not cause an **embolism**.

Diagnosis

Diagnosis begins with a visual examination of the anus, followed by an internal examination during which the doctor carefully inserts a gloved and lubricated finger into the anus. The doctor may also use an anoscope, a small tube that allows him or her to see into the anal canal. Under some circumstances the doctor may wish to check for other problems by using a sigmoidoscope or colonoscope, a flexible instrument that allows inspection of the lower colon (in the case of the sigmoidoscope) or the entire colon (in the case of the colonoscope).

Treatment

Hemorrhoids can often be effectively dealt with by dietary and lifestyle changes. Softening the feces and avoiding constipation by adding fiber to one's diet is important, because hard feces lead to straining during defecation. Fruit, leafy vegetables, and whole-grain breads and cereals are good sources of fiber, as are bulk laxatives and fiber supplements such as Metamucil or Citrucel. Exercising, losing excess weight, and drinking six to eight glasses a day of water or another liquid (not alcohol) also helps.



Rubber band ligation is probably the most widely used treatment for internal hemorrhoids. An applicator is used to place one or two small rubber bands around the base of the hemorrhoid, cutting off its blood supply (figures A and B). After 3-10 days, the rubber bands and the hemorrhoid fall off, leaving a scab which disappears within a week or two. *(Illustration by Electronic Illustrators Group.)*

Soap or toilet paper that is perfumed may irritate the anal area and should be avoided, as should excessive cleaning, rubbing, or wiping of that area. Reading in the bathroom is also considered a bad idea, because it adds to the time one spends on the toilet and may increase the strain placed on the anal and rectal veins. After each bowel movement, wiping with a moistened tissue or pad sold for that purpose helps lessen irritation. Hemorrhoid **pain** is often eased by sitting in a tub of warm water for about 10 or 15 minutes two to four times a day (**sitz bath**). A cool compress or ice pack to reduce swelling is also recommended (the ice pack should be wrapped in a cloth or towel to prevent direct contact with the skin). Many people find that over-the-counter hemorrhoid creams and foams bring relief, but these medications do not make hemorrhoids disappear.

When painful hemorrhoids do not respond to home-based remedies, professional medical treatment is necessary. The choice of treatment depends on the type of hemorrhoid, what medical equipment is available, and other considerations.

Rubber band ligation is probably the most widely used of the many treatments for internal hemorrhoids (and the least costly for the patient). This procedure is performed in the office of a family doctor or specialist, or in a hospital on an outpatient basis. An applicator is used to place one or two small rubber bands around the base of the hemorrhoid, cutting off its blood supply. After three to 10 days the bands, the hemorrhoid falls off, leaving a sore that heals in a week or two. Because internal hemorrhoids are located in a part of the anus that does not sense pain, anesthetic is unnecessary and the procedure is painless in most cases. Although there can be minor discomfort and bleeding for a few days after the bands are applied, complications are rare and most people are soon able to return to work and other activities. If more than one hemorrhoid exists or if banding is not entirely effective the first time (as occasionally happens), the procedure may need to be repeated a few weeks later. After five years, 15–20% of patients experience a recurrence of internal hemorrhoids, but in most cases all that is needed is another banding.

External hemorrhoids, and some prolapsed internal hemorrhoids, are removed by conventional surgery in a hospital. Depending on the circumstances, this requires a local, regional, or general anesthetic. Surgery does cause a fair amount of discomfort, but an overnight hospital stay is usually not necessary. Full healing takes two to four weeks, but most people are able to resume normal activities at the end of a week. Hemorrhoids rarely return after surgery.

Alternative treatment

Like mainstream practitioners, alternative practitioners **stress** the importance of a high-fiber diet. To prevent hemorrhoids by strengthening the veins of the anus, rectum, and colon, they recommend blackberries, blueberries, cherries, vitamin C, butcher's broom (*Ruscus aculeatus*), and flavonoids (plant pigments found in fruit and fruit products, tea, and soy). Herbal teas, ointments, and suppositories, and other kinds of herbal preparations, are suggested for reducing discomfort and eliminating hemorrhoids. In particular, pilewort (*Ranunculusficaria*), applied in an ointment or taken as a tea, can reduce the pain of external hemorrhoids. **Acupuncture**, **acupressure**, **aromatherapy**, and **homeopathy** are also used to treat hemorrhoids.

Prognosis

Hemorrhoids do not cause **cancer** and are rarely dangerous or life threatening. Most clear up after a few days without professional medical treatment. However, because colorectal cancer and other digestive system diseases can cause anal bleeding and other hemorrhoid-like

KEY TERMS

Anus—The opening at the lower end of the rectum. The anus and rectum are both part of the large intestine, a digestive system organ.

Colon—The major part of the large intestine, a digestive system organ.

Defecation—Passage of feces through the anus.

Embolism—Obstruction of blood flow in an artery by a blood clot or other substance arising from another site. An untreated embolism can endanger health and even cause death.

Enema—The introduction of water or another liquid into the bowels through a tube inserted into the anus. Enemas are used to treat constipation and for other purposes.

Feces—Undigested food and other waste that is eliminated through the anus. Also called stools.

Rectum—The lower section of the large intestine, a digestive system organ. After food has passed through the stomach and intestines and been digested, the leftover material, in the form of feces, enters the rectum, where it stays until defecation.

Suppository—A medicinal substance that slowly dissolves after being inserted into the rectum (or other body cavity).

symptoms, people should always consult a doctor when those symptoms occur.

Prevention

A high-fiber diet and the other lifestyle changes recommended for coping with existing hemorrhoids also help to prevent hemorrhoids. Not straining during bowel movements is essential.

Resources

BOOKS

Billingham, Richard P. "Hemorrhoids, Anal Fissure, and Anorectal Abscess and Fistula." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Puyallup, WA: Future Medicine Publishing, Inc., 1993.

PERIODICALS

Pfenninger, John L. "Modern Treatments for Internal Haemorrhoids." *British Medical Journal* 314 (1997): 1211+.

Surrell, James. "Nonsurgical Treatment Options for Internal Hemorrhoids." *American Family Physician* (Sept. 1995): 821+.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Howard Baker

Henoch-Schönlein purpura *see* **Allergic purpura**

Hepatic carcinoma *see* **Liver cancer, primary**

Hepatic encephalopathy *see* **Liver encephalopathy**

Hepatitis-associated antigen (HAA) test *see* **Hepatitis virus tests**

Hepatitis A

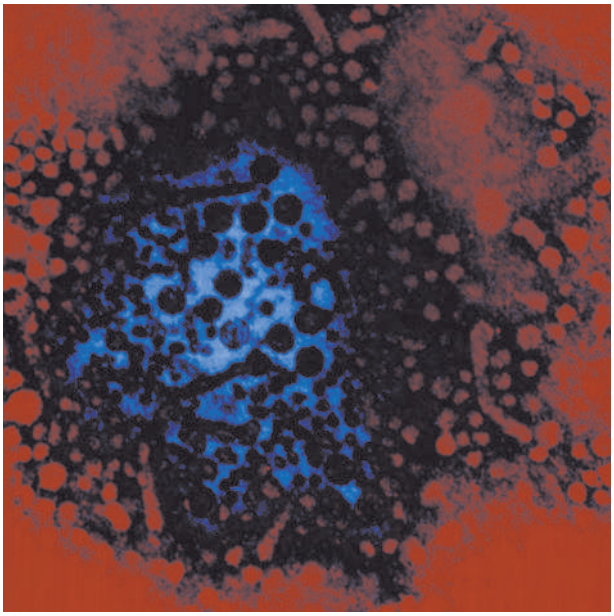
Definition

Hepatitis A is an inflammation of the liver caused by a virus, the hepatitis A virus (HAV). It varies in severity, running an acute course, generally starting within two to six weeks after contact with the virus, and lasting no longer than two or three months. HAV may occur in single cases after contact with an infected relative or sex partner. Alternately, epidemics may develop when food or drinking water is contaminated by the feces of an infected person.

Description

Hepatitis A was previously known as infectious hepatitis because it spread relatively easily from those infected to close household contacts. Once the infection ends, there is no lasting, chronic phase of illness. However it is not uncommon to have a second episode of symptoms about a month after the first; this is called a relapse, but it is not clear that the virus persists when symptoms recur. Both children and adults may be infected by HAV. Children are the chief victims, but very often have no more than a flu-like illness or no symptoms at all (so-called "subclinical" infection), whereas adults are far likelier to have more severe symptoms.

Epidemics of HAV infection can infect dozens and even hundreds (or, on rare occasions, thousands) of per-



Hepatitis A virus magnified 225,000 times. *(Custom Medical Stock Photo. Reproduced by permission.)*

sons. In the public's mind, outbreaks of hepatitis A usually are linked with the eating of contaminated food at a restaurant. It is true that food-handlers, who may themselves have no symptoms, can start an alarming, widespread epidemic. Many types of food can be infected by sewage containing HAV, but shellfish, such as clams and oysters, are common culprits.

Apart from contaminated food and water, certain groups are at increased risk of getting infectious hepatitis:

- Children at day care centers make up an estimated 14–40% of all cases of HAV infection in the United States. Changing diapers transmits infection through fecal-oral contact. Toys and other objects may remain contaminated for some time. Often a child without symptoms brings the infection home to siblings and parents.
- Troops living under crowded conditions at military camps or in the field. During World War II there were an estimated five million cases in German soldiers and civilians.
- Anyone living in heavily populated and squalid conditions, such as the very poor and those placed in refugee or prisoner-of-war camps.
- Homosexual men are increasingly at risk of HAV infection from oral-anal sexual contact.
- Travelers visiting an area where hepatitis A is common are at risk of becoming ill.

Causes and symptoms

The time from exposure to HAV and the onset of symptoms ranges from two to seven weeks and averages about a month. The virus is passed in the feces, especially late during this incubation period, before symptoms first appear. Infected persons are most contagious starting a week or so before symptoms develop, and remain so up until the time **jaundice** (yellowing of the skin) is noted.

Often the first symptoms to appear are **fatigue**, aching all over, nausea, and a loss of appetite. Those who like drinking coffee and **smoking** cigarettes may lose their taste for them. Mild **fever** is common; it seldom is higher than 101°F (38.3°C). The liver often enlarges, causing **pain** or tenderness in the right upper part of the abdomen. Jaundice then develops, typically lasting seven to ten days. Many patients do not visit the doctor until their skin turns yellow. As many as three out of four children have no symptoms of HAV infection, but about 85% of adults will have symptoms. Besides jaundice, the commonest are abdominal pain, loss of appetite, and feeling generally poorly.

Special situations

An occasional patient with hepatitis A will remain jaundiced for a month, two months or even longer, but eventually the jaundice will pass. Very rarely, a patient will develop such severe hepatitis that the liver fails. HAV infection causes about 100 deaths each year in the United States. In developed countries, a pregnant woman who contracts hepatitis A can be expected to do well although a different form of viral hepatitis (**hepatitis E**) can cause severe infection in pregnant women. In developing countries, however, the infection may prove fatal, probably because **nutrition** is not adequate.

Diagnosis

The early, flu-like symptoms and jaundice, as well as rapid recovery, suggest infectious hepatitis without special tests being done. If there is any question, a specialist in gastrointestinal disorders or infectious diseases can confirm the diagnosis—the detection of a specific antibody, called hepatitis A IgM antibody, that develops when HAV is present in the body. This test always registers positive when a patient has symptoms, and should continue to register positive for four to six months. However, hepatitis A IgM antibody will persist lifelong in the blood and is protective against reinfection.

Treatment

Once symptoms appear, no **antibiotics** or other medicines will shorten the course of infectious hepatitis. Patients

should rest in bed as needed, take a healthy diet, and avoid drinking alcohol and/or any medications that could further damage the liver. If a patient feels well it is all right to return to school or work even if some jaundice remains.

Prognosis

Most patients with acute hepatitis, even when severe, begin feeling better in two to three weeks, and recover completely in four to eight weeks. After recovering from hepatitis A, a person no longer carries the virus and remains immune for life. In the United States, serious complications are infrequent and deaths are very rare. In the United States, as many as 75% of adults over 50 years of age will have blood test evidence of previous hepatitis A.

Prevention

The single best way to keep from spreading hepatitis A infection is to wash the hands carefully after using the toilet. Those who are infected should not share items that might carry infection. Special care should be taken to avoid transmitting infection to a sex partner. Travelers should avoid water and ice if unsure of their purity, or they can boil water for one minute before drinking it. All foods eaten should be packaged, well cooked or, in the case of fresh fruit, peeled.

If exposure is a possibility, infection may be prevented by an injection of a serum fraction containing antibody against HAV. This material, called immune serum globulin (ISG), is 90% protective even when injected after exposure—providing it is given within two weeks. Anyone living with an infected patient should receive ISG. For long-term protection, a killed virus hepatitis A vaccine became available in 1995. More than 95% of those vaccinated will develop an adequate amount of anti-HAV antibody. Those who should consider being vaccinated include healthcare professionals, those working at day care and similar facilities, frequent travelers to areas with poor sanitation, those with any form of chronic liver disease, and those who are very sexually active. Starting in 2000, routine immunization with the hepatitis A vaccine was recommended for children born in states where the rate of hepatitis A was two or more times the national average (Alaska, Arizona, California, Idaho, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, and Washington) and suggested in states where the rate was 1.5 times the national average (Arkansas, Colorado, Missouri, Montana, Texas and Wyoming).

Resources

BOOKS

Johnson, A. *Liver Disease & Gallstones*. Oxford Academic Trade, 1993.

Rosenthal, M. Sara. *The Gastrointestinal Sourcebook*. Los Angeles, CA: Lowell House, 1997.

ORGANIZATION

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://sadieo.ucsf.edu/alf/alffinal/homepagealf.html>.

OTHER

HepNet: The Hepatitis Information Network. February 2, 1998. <http://www.hepnet.com>.

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KEY TERMS

Antibody—A substance made by the body in response to a foreign body, such as a virus, which is able to attack and destroy the invading virus.

Contamination—The process by which an object or body part becomes exposed to an infectious agent such as a virus.

Epidemic—A situation where a large number of infections by a particular agent, such as a virus, develops in a short time. The agent is rapidly transmitted to many individuals.

Incubation period—The interval from initial exposure to an infectious agent, such as a virus, and the first symptoms of illness.

Jaundice—Yellowing of the skin (and whites of the eyes) when pigments normally eliminated by the liver collect in high amounts in the blood.

Vaccine—A substance prepared from a weakened or killed virus which, when injected, helps the body to form antibodies that will prevent infection by the natural virus.

Hepatitis, alcoholic

Definition

Alcoholic hepatitis is an inflammation of the liver caused by alcohol.

Description

Irritation, be it from toxins or infections, causes a similar response in body organs. The response is known as inflammation and consists of:

KEY TERMS

Cirrhosis—Disruption of normal liver structure and function caused by any type of chronic disease such as hepatitis and alcohol abuse.

Fatty liver—An abnormal amount of fat tissue in the liver caused by alcohol abuse.

Hemolysis—Disintegration of read blood cells.

Protozoa—One celled microscopic organisms like amoeba.

- an increase in the blood to the affected organ
- redness and swelling of the organ
- influx of immune agents like white blood cells and their arsenal of chemical weapons
- **pain**

As the acute process subsides, there is either healing or lingering activity. Lingering activity—chronic disease—has a milder presentation with similar ingredients. Healing often takes the form of scarring, wherein normal functioning tissue is replaced by tough, fibrous, and nonproductive scar. Both chronic disease and healing can happen simultaneously, so that scar tissue progressively replaces normal tissue. This leads to **cirrhosis**, a liver so scarred it is unable to do its job adequately.

Alcohol can cause either an acute or a chronic disease in the liver. The acute disease can be severe, even fatal, and can bring with it hemolysis—blood cell destruction. Alcohol can also cause a third type of liver disease—fatty liver, in which the continuous action of alcohol turns the liver to useless fat. This condition eventually progresses to cirrhosis if the **poisoning** continues.

Causes and symptoms

Inflammation of the liver can be caused by a great variety of agents—poisons, drugs, viruses, bacteria, protozoa, and even larger organisms like worms. Alcohol is a poison if taken in more than modest amounts. It favors destroying stomach lining, liver, heart muscle, and brain tissue. The liver is a primary target because alcohol travels to the liver after leaving the intestines. Those who drink enough to get alcohol poisoning have a tendency to be undernourished, since alcohol provides ample calories but little **nutrition**. It is suspected that both the alcohol and the poor nutrition produce alcoholic hepatitis.

Diagnosis

Hepatitis of all kinds causes notable discomfort, loss of appetite, nausea, pain in the liver, and usually **jaundice** (turning yellow). Blood test abnormalities are unmistakably those of hepatitis, but selecting from so many the precise cause may take additional diagnostic work.

Treatment

As with all poisonings, removal of the offending agent is primary. There is no specific treatment for alcohol poisoning. General supportive measures must see the patient through until the liver has healed by itself. In the case of fulminant (sudden and severe) disease, the liver may be completely destroyed and have to be replaced by a transplant.

Prognosis

The liver is robust. It can heal without scarring after one or a few episodes of hepatitis that resolve without lingering. It can, moreover, regrow from a fragment of its former self, provided there is not disease or poison still inhibiting it.

Prevention

Alcohol is lethal in many ways when ingested in excess. Research suggests that the maximum healthy dose of alcohol per day is roughly one pure ounce—the amount in two cocktails, two glasses of wine, or two beers.

Resources

BOOKS

Boyd, William. *Textbook of Pathology.* Philadelphia: Lea & Febiger, 1970.

Friedman, Scott L. "Cirrhosis of the Liver and Its Major Sequelae." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Lidofsky, Steven D., and Bruce F. Scharschmidt. "Jaundice." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

McQuaid, Kenneth R. "Alimentary tract." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

Local chapters of Alcoholics Anonymous.

J. Ricker Polsdorfer, MD

Hepatitis, autoimmune

Definition

A form of liver inflammation in which the body's immune system attacks liver cells.

Description

Autoimmunity causes the body's defense mechanisms to turn against itself. Many of the tissues in the body can be the target of such an attack. While one tissue type predominates, others may be involved in a general misdirection of immune activity, perhaps because the specific target antigen is present in differing quantities in each of the affected tissues. There seem to be hereditary causes for autoimmunity, since these diseases tend to run in families and have genetic markers. Among the more common diseases believed to fall within this category are **rheumatoid arthritis**, **systemic lupus erythematosus**, **multiple sclerosis**, and **psoriasis**.

The process of autoimmune disease is very similar to infectious disease and allergy, so that great caution is observed in placing a disorder in this class. Germs were found to cause several diseases originally thought to be autoimmune. Allergens cause others. Many more may be uncovered. Autoimmunity is often believed to originate with a virus infection. A chemical in the virus resembles a body chemical so closely that the immune system attacks both.

Autoimmune hepatitis is similiar to viral hepatitis, a disease of the liver. It can be an acute disease that kills over a third of its victims within six months, it can persist for years, or it can return periodically. Some patients develop **cirrhosis** of the liver which, over time, causes the liver to cease functioning.

Causes and symptoms

Symptoms of autoimmune hepatitis resemble those of other types of hepatitis. Patients who develop autoimmune hepatitis experience **pain** under the right ribs, **fatigue** and general discomfort, loss of appetite, nausea, sometimes vomiting and **jaundice**. In addition, other parts of the body may be involved and contribute their own symptoms.

Diagnosis

Extensive laboratory testing may be required to differentiate this disease from viral hepatitis. The distinction may not even be made during the initial episode. There are certain markers of autoimmune disease in the blood that can lead to the correct diagnosis if they are sought. In advanced or chronic cases a **liver biopsy** may be necessary.

KEY TERMS

Allergen—Any chemical that causes an immune reaction only in people sensitive to it.

Antigen—Any chemical that can be the target of an immune response.

Biopsy—Surgical removal of a piece of tissue for examination.

Jaundice—A yellow color to the skin from bile that backs up into the circulation.

Treatment

Autoimmune hepatitis is among the few types of hepatitis that can be treated effectively. Since treatment itself introduces problems in at least 20% of patients, it is reserved for the more severe cases. Up to 80% of patients improve with cortisone treatment, although a cure is unlikely. Another drug—azathioprine—is sometimes used concurrently. Treatment continues for over a year and may be restarted during a relapse. At least half the patients relapse at some point, and most will still continue to have progressive liver scarring.

If the liver fails, transplant is the only recourse.

Prognosis

In spite of treatment autoimmune hepatitis can re-erupt at any time, and may continue to damage and scar the liver. The rate of progression varies considerably from patient to patient.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

McQuaid, Kenneth R. "Alimentary Tract." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Ockner, Robert K. "Chronic Hepatitis." *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

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Hepatitis B

Definition

Hepatitis B is a potentially serious form of liver inflammation due to infection by the hepatitis B virus (HBV). It occurs in both rapidly developing (acute) and long-lasting (chronic) forms, and is one of the commonest chronic infectious diseases worldwide. An effective vaccine is available which will prevent the disease in those who are later exposed.

Description

Commonly called "serum hepatitis," hepatitis B ranges from mild to very severe. Some people who are infected by HBV develop no symptoms and are totally unaware of the fact, but they may carry HBV in their blood and pass the infection on to others. In its chronic form, HBV infection may destroy the liver through a scarring process, called **cirrhosis**, or it may lead to **cancer** of the liver.

When a person is infected by HBV, the virus enters the bloodstream and body fluids, and is able to pass through tiny breaks in the skin, mouth, or the male or female genital area. There are several ways of getting the infection:

- During birth, a mother with hepatitis B may pass HBV on to her infant.
- Contact with infected blood is a common means of transmitting hepatitis B. One way this may happen is by being stuck with a needle. Both healthcare workers and those who inject drugs into their veins are at risk in this way.
- Having sex with a person infected by HBV is an important risk factor (especially anal sex).

Although there are many ways of passing on HBV, the virus actually is not very easily transmitted. There is no need to worry that casual contact, such as shaking hands, will expose one to hepatitis B. There is no reason not to share a workplace or even a bathroom with an infected person.

More than 300 million persons throughout the world are infected by HBV. While most who become chronic carriers of the virus live in Asia and Africa, there are no fewer than 1.5 million carriers in the United States. Because carriers represent a constant threat of transmitting the infection, the risk of hepatitis B is always highest where there are many carriers. Such areas are said to be endemic for hepatitis B. When infants or young children living in an endemic area are infected, their chance of becoming a chronic hepatitis B carrier is at least 90%. This probably is because their bodies are not able to make the substances (antibodies) that destroy the virus. In contrast, no more than 5% of infected teenagers and adults develop chronic infection.

Causes and symptoms

With the exception of HBV, all the common viruses that cause hepatitis are known as RNA viruses because they contain ribonucleic acid or RNA as their genetic material. HBV is the only deoxyribonucleic acid or DNA virus that is a major cause of hepatitis. HBV is made up of several fragments, called antigens, that stimulate the body's immune system to produce the antibodies that can neutralize or even destroy the infecting virus. It is, in fact, the immune reaction, not the virus, that seems to cause the liver inflammation.

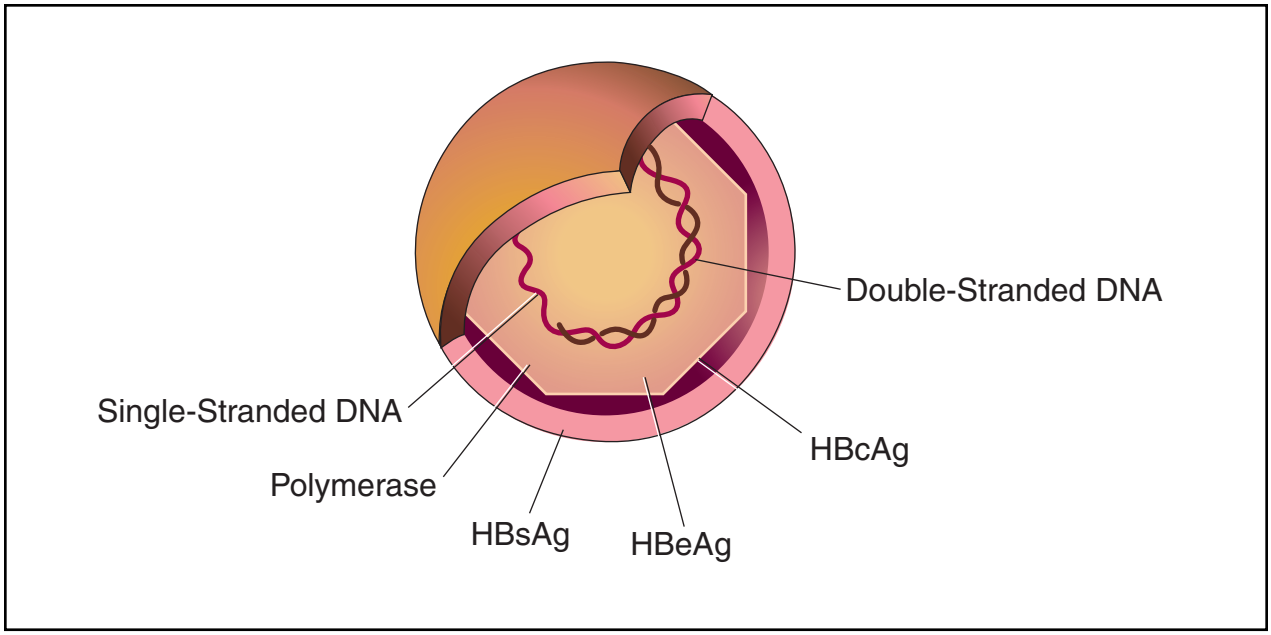
Acute hepatitis B

In the United States, a majority of acute HBV infections occur in teenagers and young adults. Half of these youth never develop symptoms, and only about 20%—or one in five infected patients—develop severe symptoms and yellowing of the skin (**jaundice**). Jaundice occurs when the infected liver is unable to get rid of certain colored substances, or pigments, as it normally does. The remaining 30% of patients have only "flu-like" symptoms and will probably not even be diagnosed as having hepatitis unless certain tests are done.

The commonest symptoms of acute hepatitis B are loss of appetite, nausea, generally feeling poorly, and **pain** or tenderness in the right upper part of the abdomen (where the liver is located). Compared to patients with **hepatitis A** or C, those with HBV infection are less able to continue their usual activities and require more time resting in bed.

Occasionally patients with HBV infection will develop joint swelling and pain (arthritis) as well as **hives** or a skin rash before jaundice appears. The joint symptoms usually last no longer than three to seven days.

Typically the symptoms of acute hepatitis B do not persist longer than two or three months. If they continue for four months, the patient has an abnormally long-lasting acute infection. In a small number of patients—probably fewer than 3%—the infection keeps getting worse as the liver cells die off. Jaundice deepens, and patients may bleed easily when the levels of coagulation factors (normally made by the liver) decrease. Large amounts of fluid collect in the abdomen and beneath the skin (**edema**). The least common outcome of acute HBV infection, seen in fewer than 1% of patients, is fulminant hepatitis, when the liver fails entirely. Only about half of these patients can be expected to live.



Hepatitis B virus (HBV) is composed of an inner protein core and an outer protein capsule. The outer capsule contains the hepatitis B surface antigen (HBsAg). The inner core contains HBV core antigen (HBcAg) and hepatitis B e-antigen (HBeAg). This cell also contains polymerase, which catalyzes the formation of the cell's DNA. HBV is the only hepatitis-causing virus that has DNA, instead of RNA. *(Illustration by Electronic Illustrators Group.)*

Chronic hepatitis B

HBV infection lasting longer than six months is said to be chronic. After this time it is much less likely for the infection to disappear. Not all carriers of the virus develop chronic liver disease; in fact, a majority have no symptoms. But, about one in every four HBV carriers do develop liver disease which gets worse over time, as the liver becomes more and more scarred and less able to carry out its normal functions. A badly scarred liver is called cirrhosis. Patients are likely to have an enlarged liver and spleen, as well as tiny clusters of abnormal blood vessels in the skin that resemble spiders.

The most serious complication of chronic HBV infection is **liver cancer**. Worldwide this is the commonest cancer to occur in men. Nevertheless, the overall chance that liver cancer will develop at any time in a patient's life is probably much lower than 10%. Patients with chronic hepatitis B who drink or smoke are more likely to develop liver cancer. It is not unusual for a person to simultaneously have both HBV infection and infection by HIV (human **immunodeficiency** virus, the cause of **AIDS**).

Diagnosis

Hepatitis B is diagnosed by detecting one of the viral antigens—called hepatitis B surface antigen (HBsAg)—in the blood. Later in the acute disease, HBsAg may no longer be present, in which case a test for antibodies to a different antigen—hepatitis B core antigen—is used. If HBsAg can be detected in the blood for longer than six months, chronic hepatitis B is diagnosed. A number of tests can be done to learn how well, or poorly, the liver is working. They include blood clotting tests and tests for enzymes which are found in abnormally high amounts when any form of hepatitis is present.

Treatment

There are no specific treatments for acute hepatitis B. Patients should rest in bed as needed, continue to eat a healthy diet, and avoid alcohol. Any non-critical surgery should be postponed.

Prognosis

Each year an estimated 150,000 persons in the United States get hepatitis B. More than 10,000 will require hospital care, and as many as 5,000 will die from complications of the infection. About 90% of all those infected will have acute disease only. A very large majority of these patients will recover within three months. It is the remaining 10%, with chronic infection, who account for most serious complications and deaths from HBV infection. In the United States, perhaps only 2% of all those

KEY TERMS

Antibody—A substance formed in the body in response to a foreign body, such as a virus, which can then attack and destroy the invading virus.

Antigen—Part of an invading microorganism, such as a virus, which causes tissue damage (in hepatitis, to the liver), and which also stimulates the body's immune system to produce antibodies.

Cirrhosis—The end result of many forms of liver disease, the condition of the liver when its cells have been damaged or destroyed and are replaced by scar tissue.

Vaccine—A substance prepared from a weakened or killed virus which, when injected, helps the body to form antibodies that will attack an invading virus and may prevent infection altogether.

who are infected will become chronically ill. The course of chronic HBV infection in any particular patient is unpredictable. Some patients who do well at first may later develop serious complications. Even when no symptoms of liver disease develop, chronic carriers remain a threat to others by serving as a source of infection.

Prevention

The best way to prevent any form of viral hepatitis is to avoid contact with blood and other body fluids of infected individuals. The use of condoms during sex is also advisable.

If a person is exposed to hepatitis B, a serum preparation containing a high level of antibody against HBV may prevent infection if given within three to seven days of exposure. Babies born of a mother with HBV should receive the vaccine within 24 hours. An effective and very safe vaccine is available that reliably prevents hepatitis B. **Vaccination** is suggested for most infants and for children aged 10 and younger whose parents are from a place where hepatitis B is common. Teenagers not vaccinated as children and all adults at risk of exposure also should be vaccinated against hepatitis B. Three doses are recommended.

Those at increased risk of getting hepatitis B, and who therefore should be vaccinated, include:

- household contacts of a person carrying HBV
- healthcare workers who often come in contact with patients' blood or other body fluids
- patients with kidney disease who periodically undergo hemodialysis
- homosexual men who are sexually active, and heterosexuals who have multiple sex partners
- persons coming from areas where HBV infection is a major problem
- prisoners and others living in crowded institutions
- drug abusers who use needles to inject drugs into their veins

Resources

BOOKS

Johnson, A. *Liver Disease & Gallstones*. Oxford Academic Trade, 1993.

ORGANIZATIONS

Hepatitis B Foundation. 101 Greenwood Ave., Suite 570, Jenkintown, PA 19046. (215) 884-8786. <info@hepb.org>.

OTHER

HepNet: The Hepatitis Information Network. 2 Feb. 1998 <http://www.hepnet.com>.

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Hepatitis C

Definition

Hepatitis C is a form of liver inflammation that causes primarily a long-lasting (chronic) disease. Acute (newly developed) hepatitis C is rarely observed as the early disease is generally quite mild. Spread mainly by contact with infected blood, the hepatitis C virus (HCV) causes most cases of viral liver infection not due to the A and B hepatitis viruses. In fact, before other viral types were found, hepatitis C was referred to as "non-A, non-B hepatitis." It is not a new infection, just newly diagnosable and has been widely present in the U.S. population for decades.

Description

HCV is a blood-borne virus that is and always was the major cause of "transfusion hepatitis," which can develop in patients who are given blood or most blood products except for gamma-globulin. The existence of a third hepatitis virus (besides the A and B viruses) became clear in 1974, but HCV was first identified in 1989. Thereafter, tests were devised to detect the virus in blood units before transfusing them. As a result, since the early 1990s transfused blood is less commonly the cause of hepatitis C.

The hepatitis C form of hepatitis is generally mild in its early, acute stage, but it is much likelier than **hepatitis B** (85% as compared to 10%) to produce chronic liver disease. Therefore, more than two of every three persons who are infected by HCV may continue to have the virus in their blood and so become carriers, who can transmit the infection to others.

The most common way of transmitting hepatitis C is when blood containing the virus enters another person's circulation through a break in the skin or the mucosa (inner lining) of the mouth or genitals. HCV also can be passed (although uncommonly) from an infected mother to the infant she is carrying. (The risk of infection from breast milk is very low.) Also, HCV can be rarely spread through sexual intercourse. Usually, however, the sexual contacts of chronic carriers of hepatitis C are not infected.

Those at increased risk of developing hepatitis C include:

- healthcare workers who come in contact with infected blood from a cut or bruise, or from a device or instrument that has been infected ("contaminated")
- persons who inject illicit drugs into their veins and skin, especially if they share needles and syringes with other users
- anyone who gets a tattoo or has his or her skin pierced with an infected needle
- persons with **hemophilia** (who because they bleed very easily may require large amounts of blood and blood products over time)
- patients with kidney disease who have periodic dialysis—a treatment that rids their blood of toxic substances—and often requires the patient to have blood transfusions

About one-fourth of patients with hepatitis C do not belong to any of these high-risk groups. Although blood **transfusion** is a much less common cause of HCV infection than in earlier years, cases still occur. Also, sexual transmission is possible, and may take place with either heterosexual or homosexual behavior.

KEY TERMS

Antibody—A substance formed in the body in response to a foreign body, such as a virus, which can attack and destroy the invading foreign body or virus.

Carrier—A person who, after recovering from a viral infection, continues to "carry" the virus in the blood and can pass it on to others who then may develop infection.

Contamination—Passage of an infectious organism, such as a virus, from an infected person to an object such as a needle, which then, when used, may pass infection to another person.

Hepatocellular carcinoma—A dangerous cancer of the liver that may develop in patients who have had hepatitis, sometimes as long as 20 or 30 years earlier.

Porphyria—Any of a group of disturbances of porphyrin metabolism characterized by excess pophyrins (various biologically active compounds with a distinct structure) in the urine and by extreme sensitivity to light.

Causes and symptoms

More than half of all patients who develop hepatitis C have no symptoms or signs of liver disease. Some, however, may have a minor illness with flu-like symptoms. Any form of hepatitis may keep the liver from eliminating certain colored (pigmented) substances as it normally does. These pigments collect in the skin, turning it yellow, and also may cause yellowing of the whites of the eyes. About one in four patients with hepatitis C will develop this yellowing of the skin called **jaundice** (or yellow jaundice). Some patients lose their appetite and frequently feel tired. Patients may also feel nauseous or even vomit.

In most patients, HCV can still be found in the blood six months after the start of acute infection, and these patients are considered to be carriers. If the virus persists for one year, it is very unlikely to disappear. About 20% of chronic carriers develop **cirrhosis** (scarring) of the liver when the virus damages or destroys large numbers of liver cells, which are then replaced by scar tissue. Cirrhosis may develop only after a long period of time (as long as 20 years) and often even more has passed. Most (four in five) patients will not develop cirrhosis and instead have a mild, chronic form of infection called chronic persistent hepatitis and when they die, will die with, not of, the infection.

Patients with chronic HCV infection are at risk of developing certain very serious complications:

- Patients with hepatitis C who develop cirrhosis may go on to have liver cancer—called hepatocellular carcinoma. Patients with **liver cancer** have an average life expectancy measured in months unless the tumor is totally removed.
- Patients also are at risk of developing a combination of joint **pain**, weakness, and areas of bleeding into the

skin. The kidneys and brain also may be affected. Perhaps 5% of patients with chronic HCV infection develop this condition, called cryoglobulinemia.

- Patients with porphyria (metabolic disturbances characterized by extreme sensitivity to light) develop blisters in areas of their skin that are exposed to sunlight. The skin also may be easily bruised, and, in time, can become discolored.

Diagnosis

Hepatitis C should be suspected if a patient develops jaundice and reports recent contact with the blood of a person who may have been infected. There is a blood test to detect HCV IgG antibody, a substance that the body makes to combat HCV. Care is required, as the test often does not show positive for up to two to three months after infection. Also, the test only shows whether a person has ever been infected by HCV, not whether the virus is still present. A less available and more expensive test measuring HCV RNA (the viral gene) can be found in early infection before the antibody is measurable. Simpler blood tests can be done to show how much jaundice-causing pigment is in a patient's blood, or to measure the levels of certain proteins made by the liver. High levels of these "liver enzymes" (called ALT and AST) indicate that the liver is inflamed. Rising levels could suggest that the infection is getting worse.

Treatment

Patients who fail to recover promptly may be advised to see a specialist in gastrointestinal disorders (which include liver disease) or infectious diseases. A balanced diet with little fat is best, and patients should limit their alcohol intake, or, better, avoid alcohol altogether. Any medication that can cause liver damage should be avoided. The amount of time in bed depends on how poorly a particular patient feels.

A natural body protein, interferon alpha, now can be made in large amounts by genetic engineering, and improves the outlook for many patients who have chronic hepatitis C. The protein can lessen the symptoms of infection and improve liver function. Not all patients respond, however, and others get less benefit the longer they take interferon. **Fever** and flu-like symptoms are frequent side effects of this treatment. Using a high dose for six months, nearly half of patients have responded positively. Half the patients who do respond well will relapse after the drug is stopped. A newer medication called ribavirin is now commonly used with interferon and, if tolerated, does increase response rates. A newer form of interferon, called pegylated interferon, is also being used for treatment. Because of the problems with treatment, many people have sought alternative medications such as milk thistle or certain Asian herbs.

When hepatitis destroys most or all of the liver, the only hope may be a liver transplant. Unfortunately the new liver usually becomes infected by HCV. On the other hand, total liver failure is less frequent than in patients with hepatitis B.

Prognosis

In roughly one-fifth of patients who develop hepatitis C, the acute infection will subside, and they will recover completely within four to eight weeks and have no later problems. Other patients face two risks: they themselves may develop chronic liver infection and possibly serious complications such as liver **cancer**, and, also, they will continue carrying the virus and may pass it on to others. The overall risk of developing cirrhosis, or liver scarring, is about 15% of all patients infected by HCV. Acute liver failure is less frequent in patients with chronic hepatitis C than in those with other forms of hepatitis.

Prevention

No vaccine has yet been developed to prevent hepatitis C in persons exposed to the virus. In addition, there is no role of gamma-globulin in the prevention of the infection. There are, however, many ways in which infection may be avoided:

- Those who inject drugs should never share needles, syringes, swabs, spoons, or anything else that comes in contact with bodily fluids. They should always use clean equipment.
- Hands should be washed before and after contact with another person's blood or if the skin is penetrated.
- The sharing of personal items should be avoided, particularly those that can puncture the skin or inside of the mouth, such as razors, nail files and scissors, and even toothbrushes.
- Condoms should be used for either vaginal or oral sex.

If a person does develop hepatitis C, its spread may be prevented by:

- not donating blood
- not sharing personal items with others
- wiping up any spilled blood while using gloves, household bleach, and disposable paper towels
- carefully covering any cut or wound with a bandaid or dressing
- practicing safe sex, especially during the acute phase of the infection

Resources

BOOKS

Everson, Gregory T., and Hedy Weinberg. *Living with Hepatitis C: Survivor's Guide*. New York: Hatherleigh Press, 1998.

Roybal, Beth Ann Petro. *Hepatitis C: A Personal Guide to Good Health*. Berkeley, CA: Ulysses Press, 1997.

ORGANIZATION

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://sadieo.ucsf.edu/alf/alffinal/homepagealf.html>.

OTHER

HepNet: The Hepatitis Information Network. February 2, 1998. <http://www.hepnet.com>.

Larry I. Lutwick, MD

Hepatitis D

Definition

Hepatitis D (or delta, the Greek letter "D"), is a form of liver inflammation that occurs only in patients who also are infected by the **hepatitis B** virus. Infection by the hepatitis delta virus (HDV) either occurs at the same time as hepatitis B develops, or develops later when infection by hepatitis B virus (HBV) has entered the chronic (long-lasting) stage.

Description

Delta hepatitis can be quite severe, but it is seen only in patients already infected by HBV. In the late 1970s, Italian physicians discovered that some patients with hepatitis B had another type of infectious agent in their liver cells. Later the new virus—HDV—was confirmed by experimentally infecting chimpanzees. When both viruses are present, acute infection tends to be more severe. Furthermore, patients with both infections are likelier than those with HBV alone to develop chronic liver disease, and, when it occurs, it is more severe.

About 300 million persons worldwide carry HBV. Of them, at least 5% probably also have delta hepatitis. In North America HDV infection appears to be less frequent: 4% of all patients with acute hepatitis B have HDV infection. The delta virus causes an estimated 2% of all cases of acute viral hepatitis in the United States. The rate of HDV infection varies widely in different parts of the world; it is a very serious infection in some countries and quite mild in others. Chronic delta hepatitis is a more serious disease than either chronic hepatitis B alone or **hepatitis C**.

Certain individuals—the same ones who are at increased risk of developing hepatitis B—are the prime candidates to be infected by HDV. For example:

- Not infrequently, HDV infection occurs in patients with chronic HBV infection who also have **hemophilia**, a bleeding disease. These patients are at risk because they require large amounts of transfused blood and blood products that may contain HDV.
- In some areas, one-fourth to one-half of patients with chronic HBV infection who inject themselves with illicit drugs become infected by HDV as well. Drug abusers who share contaminated needles are likely to infect one another.
- Patients who get HBV infection by sexual contact may also be infected by HDV, although the delta virus is less often spread in this way than is HBV itself. Between 10–25% of homosexual men with chronic HBV infection harbor the delta virus.
- Like hepatitis B, HDV infection may develop in health-care workers who are victims of a needle stick, and it also can be spread within households when personal items such as a razor or toothbrush are shared.

Causes and symptoms

The delta virus is a small and incomplete viral particle. Perhaps this is why it cannot cause infection on its own. Its companion virus, HBV, actually forms a covering over the HDV particle. In chronically ill patients (those whose virus persists longer than six months), the combined viruses cause inflammation throughout the liver and eventually destroy the liver cells, which are then replaced by scar tissue. This scarring is called **cirrhosis**.

When HBV and HDV infections develop at the same time, a condition called coinfection, recovery is the rule. Only 2–5% of patients become chronic carriers (have the virus remain in their blood more than six months after infection). It may be that HDV actually keeps HBV from reproducing as rapidly as it would if it were alone, so chronic infection is less likely.

When HBV infection occurs first and is followed by HDV infection, the condition is called superinfection. This is a more serious situation. Between half and two-thirds of patients with superinfection develop severe acute hepatitis. Once the liver cells contain large numbers of HBV viruses, HDV tends to reproduce more actively. Massive infection and liver failure are more common in superinfection. The risk of **liver cancer**, however, is no greater than from hepatitis B alone.

As with other forms of hepatitis, the earliest symptoms are nausea, loss of appetite, joint pains, and tired-

KEY TERMS

Alpha-interferon—A natural body substance that now can be made in large quantities and is an effective treatment for some types of viral inflammatory disease, including hepatitis C.

Antibody—A substance formed in the body in response to an invading microorganism, such as a virus, which can attack and destroy the invading virus.

Coinfection—Invasion of the body by two viruses at about the same time.

Hemophilia—A bleeding disease that may call for the transfusion of large amounts of blood and blood products.

Superinfection—Infection by a second virus after a previous infection by a different virus has become well established.

ness. There may be **fever** (not marked) and an enlarged liver may cause discomfort or actual **pain** in the right upper part of the abdomen. Later, **jaundice** (a yellowing of the skin and whites of the eyes that occurs when the liver is no longer able to eliminate certain pigmented substances) may develop.

Diagnosis

HDV infection may be diagnosed by detecting the antibody against the virus. Unfortunately this test cannot detect acute coinfection or superinfection as early as when symptoms first develop. Antibody against HDV usually is found no sooner than 30 days after symptoms appear. Until recently, the virus itself could only be identified by testing a small sample of liver tissue. Scientists now are developing a blood test for HDV that should make diagnosis faster and easier. When HDV is present, liver enzymes (proteins made by the liver) are present in abnormally high amounts. In some patients with coinfection, the enzyme levels peak twice, once when HBV infection starts and again at the time of HDV infection.

Treatment

As in any form of hepatitis, patients in the acute stage should rest in bed as needed, eat a balanced diet, and avoid alcohol. Alpha-interferon, the natural body substance which helps control hepatitis C, has generally not been found helpful in treating hepatitis D. If the liver is largely destroyed and has stopped functioning, **liver transplantation** is an option. Even when the procedure is successful, disease often recurs and cirrhosis may actually develop more rapidly than before.

Prognosis

A large majority of patients with coinfection of HBV and HDV recover from an episode of acute hepatitis. However, about two-thirds of patients chronically infected by HDV go on to develop cirrhosis of the liver. In one long-term study, just over half of patients who became carriers of HDV had moderate or severe liver disease, and one-fourth of them died. If very severe liver failure develops, the chance of a patient surviving is no better than 50%. A liver transplant may improve this figure to 70%. When transplantation is done for cirrhosis, rather than for liver failure, nearly 90% of patients live five years or longer. The major concern with transplantation is infection of the transplanted liver; this may occur in as many as 40% of transplant patients.

When a child with viral hepatitis develops cirrhosis, HDV infection is commonly responsible. A woman who develops delta hepatitis while pregnant will do as well as if she were not pregnant; and there is no increased risk that the newborn will be malformed in any way.

Prevention

The vaccine against hepatitis B also prevents delta hepatitis, since it cannot occur unless HBV infection is present. Hopefully, a vaccine can be developed that will keep delta infection from developing in chronic HBV carriers. However, if a person already has HBV infection, any exposure to blood should be strictly avoided. A high level of sexual activity with multiple partners is also a risk factor for delta hepatitis.

Resources

BOOKS

Johnson, A. *Liver Disease & Gallstones*. Oxford Academic Trade, 1993.

PERIODICALS

Tepper, M. L., and P. R. Gully. "Viral Hepatitis: Know Your D, E, F and Gs." *Canadian Medical Association Journal* (1997): 1735.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

David A. Cramer, MD

Hepatitis, drug-induced

Definition

Inflammation of the liver due to an adverse reaction with a drug.

Description

The liver is a very important organ to the body. It is a large internal organ weighing more than three pounds in the average adult. It performs over 100 functions including formation of bile, **detoxification** of harmful substances, vitamin storage and metabolism of carbohydrates, fats and proteins. Serious complications could arise when the liver becomes inflamed due to hepatitis when it is not able to perform these tasks. A virus most often causes hepatitis but certain drugs can also induce it.

Drug-induced hepatitis (also called toxic hepatitis) occurs in eight in every 10,000 people because the liver reacts abnormally during drug exposure, leading to liver damage. This pathology causes the liver not to function properly and the symptoms can begin to be seen. Women tend to be affected almost twice as often as men. Older people are more prone to this type of hepatitis because their bodies aren't able to repair themselves as fast as younger people. Drugs that can be associated with drug-induced hepatitis include **acetaminophen**, vitamin A, and PTU (a drug treatment for **tuberculosis**).

Causes and symptoms

There are three general types of drug-induced hepatitis: toxic, metabolic idiosyncrasy and immunologic idiosyncrasy. With toxic hepatitis liver damage as the result of a drug complication with hepatotoxins happens to everyone who takes that particular drug. On the other hand, hepatitis resulting from a metabolic or immunologic idiosyncrasy only happens to certain people, those predisposed to particular idiosyncrasy.

In patients with a metabolic idiosyncrasy the person metabolizes the drug differently than most people causing a harmful by-product that damages the liver. A metabolic idiosyncrasy is seen in 0.1-2% of people and it is complicated by use of alcohol.

With an immunologic idiosyncrasy the patient's body recognizes the metabolized drug by-products as foreign. This leads to the destruction of liver cells containing the by-product via the immune system resulting in hepatitis. An immunologic idiosyncrasy is seen in less than one person per 10,000 (0.01%) people and is more than twice as common in women.

KEY TERMS

Hepatitis—General inflammation of the liver.

Hepatomegaly—General swelling of the liver.

Hepatotoxin—A substance that is toxic to the liver.

Idiosyncrasy—A defect in that particular pathway resulting in an abnormality.

The symptoms of drug-induced hepatitis are similar to viral hepatitis. Drug induced hepatitis tends to be acute. If it is not caught soon enough the damage could be permanent resulting in chronic hepatitis. Some of the common symptoms are:

- nausea
- vomiting
- headache
- anorexia
- jaundice
- clay color stools
- dark urine
- hepatomegaly

Diagnosis

Diagnosis is typically made through a physical exam along with a patient history to identify any possible hepatotoxins. Blood tests are usually done as well. An increased white blood cell count is typical.

Treatment

There isn't any specific treatment other than immediate discontinuance of the causative agent. Rest during the acute phase of the disease is vital along with the intake of fluids to maintain hydration.

Prognosis

Usually the symptoms will go away after the drug has been eliminated due to the liver repairing itself. A full recovery is typically expected unless it wasn't treated quickly resulting in more liver damage being done than normal.

Prevention

If there is a history of liver damage certain medications should not be taken. Doctors will be familiar with these.

Resources

BOOKS

Feldman, Sleisenger and Scharschmidt. "Liver Diseases Caused by Drugs, Anesthetics, and Toxins." In *Gastrointestinal and Liver Disease* Philadelphia: W.B. Saunders Company, 2001, pp.1232-1237.

Holmes, Nancy H. "Hepatobiliary Disorders." In *Diseases* Pennsylvania: Springhouse Corporation, 2001, pp.744-53.

PERIODICALS

Hautekeete, Horsmans, Van Waeyenberge, Demanet, Henrion, Verbist, Brenard, Sempoux, Michielsen, Yap, Rahier and Geubel. "HLA Association of Amoxicillin-Clavulanate—Induced Hepatitis." *Gastroenterology* (November 1999): 1181-86.

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Hepatitis E

Definition

The hepatitis E virus (HEV) is a common cause of hepatitis that is transmitted via the intestinal tract, and is not caused by the **hepatitis A** virus. Spread most often by contaminated drinking water, HEV infection occurs mainly in developing countries.

Description

Hepatitis E is also known as epidemic non-A, non-B hepatitis. Like hepatitis A, it is an acute and short-lived illness that can sometimes cause liver failure. HEV, discovered in 1987, is spread by the fecal-oral route. It is constantly present (endemic) in countries where human waste is allowed to get into drinking water without first being purified. Large outbreaks (epidemics) have occurred in Asian and South American countries where there is poor sanitation. In the United States and Canada no outbreaks have been reported, but persons traveling to an endemic region may return with HEV.

Causes and symptoms

There are at least two strains of HEV, one found in Asia and another in Mexico. The virus may start dividing in the gastrointestinal tract, but it grows mostly in the liver. After an incubation period (the time from when a person is first infected by a virus until the appearance of the earliest symptoms) of two to eight weeks, infected persons develop **fever**, may feel nauseous, lose their appetite, and often have discomfort or actual **pain** in the right upper part of the abdomen where the liver is located. Some develop yellowing of the skin and the whites of the eyes (**jaundice**). Most often the illness is mild and disappears within a few weeks with no lasting effects. Children younger than 14 years and persons over age 50 seldom have jaundice or show other clinical signs of hepatitis.

Hepatitis E never becomes a chronic (long-lasting) illness, but on rare occasions the acute illness damages and destroys so many liver cells that the liver can no longer function. This is called fulminant liver failure, and may cause **death**. Pregnant women are at much higher risk of dying from fulminant liver failure; this increased risk is not true of any other type of viral hepatitis. The great majority of patients who recover from acute infection do not continue to carry HEV and cannot pass on the infection to others.

Diagnosis

HEV can be found by microscopically examining a stool sample, but this is not a reliable test, as the virus often dies when stored for a short time. Like other hepatitis viruses, HEV stimulates the body's immune system to produce a substance called an antibody, which can swallow up and destroy the virus. Blood tests can determine elevated antibody levels, which indicate the presence of HEV virus in the body. Unfortunately, such antibody blood tests are not widely available.

Treatment

There is no way of effectively treating the symptoms of any acute hepatitis, including hepatitis E. During acute infection, a patient should take a balanced diet and rest in bed as needed.

Prognosis

In the United States hepatitis E is not a fatal illness, but elsewhere about 1–2% of those infected die of advanced liver failure. In pregnant women the death rate is as high as 20%. It is not clear whether having hepatitis E once guarantees against future HEV infection.

Prevention

Most attempts to use blood serum containing HEV antibody to prevent hepatitis in those exposed to HEV have failed. Hopefully, this approach can be made to work so that pregnant women living in endemic areas can be protected. No vaccine is available, though several are being tested. It also is possible that effective anti-viral drugs will be found. The best ways to prevent hepatitis E are to provide safe drinking water and take precautions to use sterilized water and beverages when traveling.

KEY TERMS

Antibody—A substance made by the body's immune system in response to an invading virus, the antibodies then attack and destroy the virus.

Incubation period—The time from when a person is first infected by a virus until the appearance of the earliest symptoms.

Jaundice—Yellowing of the skin that occurs when pigments normally eliminated by the liver collect in high amounts in the blood.

Sanitation—The process of keeping drinking water, foods, or any anything else with which people come into contact free of microorganisms such as viruses.

Vaccine—A substance prepared from a weakened or killed virus which, when injected, stimulates the immune system to produce antibodies that can prevent infection by the natural virus.

Resources

BOOKS

Rosenthal, M. Sara. *The Gastrointestinal Sourcebook*. Los Angeles: Lowell House, 1997.

PERIODICALS

Mast, E. E., and M. J. Alter. "Epidemiology of Viral Hepatitis: An Overview." *Seminars in Virology* 4 (1993): 273-283.

Tepper, M. L., and P. R. Gully. "Viral Hepatitis: Know Your D, E, F and Gs." *Canadian Medical Association Journal* (1997): 1735.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

OTHER

King, J. W. *Bug Bytes*. Louisiana State University Medical Center <http://www.ccm.lsumc.edu/bugbytes>.

David A. Cramer, MD

Hepatitis G

Definition

Hepatitis G is a newly discovered form of liver inflammation caused by hepatitis G virus (HGV), a distant relative of the **hepatitis C** virus.

Description

HGV, also called hepatitis GB virus, was first described early in 1996. Little is known about the frequency of HGV infection, the nature of the illness, or how to prevent it. What is known is that transfused blood containing HGV has caused some cases of hepatitis. For this reason, patients with **hemophilia** and other bleeding conditions who require large amounts of blood or blood products are at risk of hepatitis G. HGV has been identified in between 1–2% of blood donors in the United States. Also at risk are patients with kidney disease who have blood exchange by hemodialysis, and those who inject drugs into their veins. It is possible that an infected mother can pass on the virus to her newborn infant. Sexual transmission also is a possibility.

Often patients with hepatitis G are infected at the same time by the **hepatitis B** or C virus, or both. In about three of every thousand patients with acute viral hepatitis, HGV is the only virus present. There is some indication that patients with hepatitis G may continue to carry the virus in their blood for many years, and so might be a source of infection in others.

Causes and symptoms

Some researchers believe that there may be a group of GB viruses, rather than just one. Others remain doubtful that HGV actually causes illness. If it does, the type of acute or chronic (long-lasting) illness that results is not clear. When diagnosed, acute HGV infection has usually been mild and brief. There is no evidence of serious complications, but it is possible that, like other hepatitis viruses, HGV can cause severe liver damage resulting in liver failure. The virus has been identified in as many as 20% of patients with long-lasting viral hepatitis, some of whom also have hepatitis C.

Diagnosis

The only method of detecting HGV is a complex and costly DNA test that is not widely available. Efforts are under way, however, to develop a test for the HGV antibody, which is formed in response to invasion by the virus. Once antibody is present, however, the virus itself generally has disappeared, making the test too late to be of use.

Treatment

There is no specific treatment for any form of acute hepatitis. Patients should rest in bed as needed, avoid alcohol, and be sure to eat a balanced diet.

Prognosis

What little is known about the course of hepatitis G suggests that illness is mild and does not last long. When

KEY TERMS

Antibody—A substance made by the body's immune system in response to an invading virus; antibodies then attack and destroy the virus.

Hemophilia—A bleeding disorder that often makes it necessary to give patients dozens or even hundreds of units of blood and blood products over time.

more patients have been followed up after the acute phase, it will become clear whether HGV can cause severe liver damage.

Prevention

Since hepatitis G is a blood-borne infection, prevention relies on avoiding any possible contact with contaminated blood. Drug users should not share needles, syringes, or other equipment.

Resources

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

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Hepatitis virus studies *see* **Hepatitis virus tests**

Hepatitis virus tests

Definition

Viral hepatitis is any type of liver inflammation caused by a viral infection. The three most common viruses now recognized to cause liver disease are **hepatitis A**, **hepatitis B**, and hepatitis non-A, non-B (also called **hepatitis C**). Several other types have been recognized: **hepatitis D**, **hepatitis E**, and the recently identified **hepatitis G**. A seventh type (hepatitis F) is suspected but not yet confirmed.

Purpose

The different types of viral hepatitis produce similar symptoms, but they differ in terms of transmission, course of treatment, prognosis, and carrier status. When the clinical history of a patient is insufficient for differentiation, hepatitis virus tests are used as an aid in diagnosis and in monitoring the course of the disease. These tests are based primarily on antigen-antibody reactions—an antigen being a protein foreign to the body, and an antibody another type of protein manufactured by lymphocytes (a type of white blood cell) to neutralize the antigen.

Description

There are five major types of viral hepatitis. The diseases, along with the antigen-antibody tests available to aid in diagnosis, are described below.

Hepatitis A

Commonly called infectious hepatitis, this is caused by the hepatitis A virus (HAV). It is usually a mild disease, most often spread by food and water contamination, but sometimes through sexual contact. Immunologic tests are not commercially available for the HAV antigen, but two types of antibodies to HAV can be detected. IgM antibody (anti-HAV/IgM), appears approximately three to four weeks after exposure and returns to normal within several months. IgG (anti-HAV/IgG) appears approximately two weeks after the IgM begins to increase and remains positive. Acute hepatitis is suspected if IgM is elevated; conversely, if IgG is elevated without IgM, a convalescent stage of HAV is presumed. IgG antibody can remain detectable for decades after infection.

Hepatitis B

Commonly known as serum hepatitis, this is caused by the hepatitis B virus (HBV). The disease can be mild or severe, and it can be acute (of limited duration) or chronic (ongoing). It is usually spread by sexual contact with another infected person, through contact with infected blood, by intravenous drug use, or from mother to child at birth.

HBV, also called the Dane particle, is composed of an inner protein core surrounded by an outer protein capsule. The outer capsule contains the hepatitis B surface antigen (HBsAg), formerly called the Australia antigen. The inner core contains HBV core antigen (HBcAg), and the hepatitis B e-antigen (HBeAg). Antibodies to these antigens are called anti-HBs, anti-HBc, and anti-HBe. Testing for these antigens and antibodies is as follows:

- Hepatitis B surface antigen (HBsAg). This is the first test for hepatitis B to become abnormal. HBsAg begins to elevate before the onset of clinical symptoms, peaks during the first week of symptoms, and usually disappears by the time the accompanying **jaundice** (yellow-

ing of the skin and other tissues) begins to subside. HBsAg indicates an active HBV infection. A person is considered to be a carrier if this antigen persists in the blood for six or more months.

- Hepatitis B surface antibody (anti-HBs). This appears approximately one month after the disappearance of the HBsAg, signaling the end of the acute infection period. Anti-HBs is the antibody that demonstrates immunity after administration of the hepatitis B vaccine. Its presence also indicates immunity to subsequent infection.
- Hepatitis B core antigen (HBcAg). No tests are commercially available to detect this antigen.
- Hepatitis B core antibody (anti-HBc). This appears just before acute hepatitis develops and remains elevated (although it slowly declines) for years. It is also present in chronic hepatitis. The hepatitis B core antibody is elevated during the time lag between the disappearance of the hepatitis B surface antigen and the appearance of the hepatitis B surface antibody in an interval called the "window." During this time, the hepatitis B core antibody is the only detectable marker of a recent hepatitis B infection.
- Hepatitis B e-antigen (HBeAg). This is more useful as an index of infection than for diagnostic purposes. The presence of this antigen correlates with early and active disease, as well as with high infectivity in patients with acute HBV infection. When HBeAg levels persist in the blood, the development of chronic HBV infection is suspected.
- Hepatitis B e-antibody (anti-HBe). In the bloodstream, this indicates a reduced risk of infectivity in patients who have previously been HBeAg positive. Chronic hepatitis B surface antigen carriers can be positive for either HBeAg or anti-HBe, but are less infectious when anti-HBe is present. Antibody to e antigen can persist for years, but usually disappears earlier than anti-HBs or anti-HBc.

Hepatitis C

Previously known as non-A, non-B hepatitis, this disease is primarily caused by the hepatitis C virus (HCV). It is generally mild, but more likely than hepatitis B to lead to chronic liver disease, possible liver failure, and the eventual need for transplant. Chronic carrier states develop in more than 80% of patients, and chronic liver disease is a major problem. As many as 20% of patients with chronic hepatitis C will develop liver failure or **liver cancer**. HCV is spread through sexual contact, as well as through sharing drug needles, although nearly half of infections can't be traced as to origin.

Hepatitis C is detected by HCV serology (tests on blood sera). A specific type of assay called enzyme-linked immunosorbent assay (ELISA) was developed to detect antibody to hepatitis C for diagnostic purposes, as well as for screening blood donors. Most cases of post-transfusion non-A, non-B hepatitis are caused by HCV, but application of this test has virtually eliminated post-transfusion hepatitis. An HCV viral titer to detect HCV RNA in the blood is now available, and recently, IgM anti-HCV core is proving to be a useful acute marker for HCV infection.

Hepatitis D

Also called delta hepatitis, this is caused by the hepatitis D virus (HDV). The disease occurs only in those who have HBV in the blood from a past or simultaneously occurring infection. Experts believe transmission may occur through sexual contact, but further research is needed to confirm that. Most cases occur among those who are frequently exposed to blood and blood products. Many cases also occur among drug users who share contaminated needles. Hepatitis D virus (HDV) antigen can be detected by radioimmunoassay within a few days after infection, together with IgM and total antibodies to HDV.

Hepatitis E

Caused by the hepatitis E virus (HEV), this is actually another type of non-A, non-B hepatitis. The virus is most often spread through fecally contaminated water, but the role of person-to-person transmission is unclear. This form of hepatitis is quite rare in the United States. There are currently no antigen or antibody tests widely available to accurately detect HEV.

Preparation

Hepatitis virus tests require a blood sample. It is not necessary for the patient to withhold food or fluids before any of these tests, unless requested to do so by the physician.

Risks

Risks for these tests are minimal for the patient, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges for the antigen/antibody tests are as follows:

- hepatitis A antibody, IgM: Negative
- hepatitis B core antibody: Negative
- hepatitis B e antibody: Negative

- hepatitis B e-antigen: Negative
- hepatitis B surface antibody: Varies with clinical circumstance (Note: As the presence of anti-HBs indicates past infection with resolution of previous hepatitis B infection, or **vaccination** against hepatitis B, additional patient history may be necessary for diagnosis.)
- hepatitis B surface antigen: Negative
- hepatitis C serology: Negative
- hepatitis D serology: Negative.

Abnormal results

Hepatitis A: A single positive anti-HAV test may indicate previous exposure to the virus, but due to the antibody persisting so long in the bloodstream, only evidence of a rising anti-HAV titer confirms hepatitis A. Determining recent infection rests on identifying the antibody as IgM (associated with recent infection). A negative anti-HAV test rules out hepatitis A.

Hepatitis B: High levels of HBsAg that continue for three or more months after onset of acute infection suggest development of chronic hepatitis or carrier status. Detection of anti-HBs signals late convalescence or recovery from infection. This antibody remains in the blood to provide immunity to reinfection.

Hepatitis C (non-A, non-B hepatitis): Anti-HBc develops after exposure to hepatitis B. As an early indicator of acute infection, antibody (IgM) to core antigen (anti-HBc IgM) is rarely detected in chronic infection, so it is useful in distinguishing acute from chronic infection, and hepatitis B from non-A, non-B.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Hepatobiliary scan *see* **Gallbladder nuclear medicine scan**

Hepatocellular carcinoma *see* **Liver cancer, primary**

Hepatolenticular degeneration *see* **Wilson's disease**

Hepatoma *see* **Liver cancer, primary**

Herbal medicine *see* **Herbalism, western**

Herbalism, traditional Chinese

Definition

Chinese herbalism is one of the major components of **traditional Chinese medicine** (TCM), or Oriental medicine (OM). In TCM, herbs are often used in conjunction with other techniques, such as **acupuncture** or massage. Chinese herbalism is a holistic medical system, meaning that it looks at treating a patient as a whole person, looking at the mental and spiritual health, as well as the physical health, of the individual. Illness is seen as a disharmony or imbalance among these aspects of the individual. Chinese herbalism has been practiced for over 4,000 years.

One of the earliest and certainly the most important Chinese herbal text is the *Huang Ti Nei Ching*, or *Yellow Emperor's Classic of Internal Medicine*. It is believed to be authored by Huang Ti during his reign over China, which started about 2697 B.C. Since that time, herbal practices have been more extensively documented and refined. In modern China, traditional Chinese herbalism is taught alongside conventional Western pharmacology. Chinese herbal remedies have been used in the West only relatively recently, over the past two decades. These remedies are more gentle and natural that conventional medicines. In addition, they have fewer unpleasant side effects. Individuals with chronic disorders in particular are increasingly drawn to the holistic aspect of Chinese herbalism and TCM in general.

Purpose

Because it is a safe, inexpensive solution to health problems of all kinds, Chinese herbalism is very popular in China. In recent years, herbalism has been modernized with the introduction of quality control. For example, herbs are subjected to absorption spectrometry to determine levels of heavy metals found in some. Because they are standardized, Chinese herbs are safer for self-treatment. This puts the individual, not the physician, in charge of the individual's health; that is a basic goal of Chinese herbalism.

Chinese herbalism offers unique advice regarding what foods can help and what can hinder, and an herbalist can help an individual discover what he is allergic to. In addition, Chinese herbs stimulate the immune system and provide beneficial nutrients, aside from their role in curing illness.

Five Popular Chinese Herbs Used In The U.S.

Herb	Purpose
Astragalus (huang chi)	Builds immune system, offsets side effects of chemotherapy and radiation treatments
Don Quai (dang qui)	Stimulates the production of red blood cells and bone marrow; increases cardiovascular endurance; regulates menstrual disorders
Ginseng (ren shen)	Increases physical stamina; general tonic
Reishi mushroom (ling zhi)	Eliminates toxins; increases physical stamina
Schisandra (wu wei zu)	Prevents fluid loss, e.g., excessive sweating, runny nose, incontinence

At M.D. Anderson Hospital in Texas, medical research has confirmed that patients undergoing **chemotherapy** were shown to have an improved degree of immune function when they took the tonic herb astragulus (*huang qi*). (It is well known that chemotherapy suppresses the immune system.) Research also showed that T-cell and macrophage activity and interferon production was increased in patients using the Chinese herbs ganoderma, lentinus, and polyporous, helping the body fight **cancer** cells. Agents also found in ganoderma were found to inhibit platelet aggregation and thrombocyte formation, which would be helpful to counter circulation and heart problems.

An ingredient of ginseng was found to promote adrenal function, which would give the herb properties of enhancing many hormone functions in the body.

Description

Origins

HISTORICAL BACKGROUND. Traditional Chinese medicine originated in the region of eastern Asia that today includes China, Tibet, Vietnam, Korea, and Japan. Tribal shamans and holy men who lived as hermits in the mountains of China as early as 3500 B.C. practiced what was called the "Way of Long Life." This regimen included a diet based on herbs and other plants; kung-fu exercises; and special breathing techniques that were thought to improve vitality and life expectancy.

After the Han dynasty, the next great age of Chinese medicine was under the Tang emperors, who ruled from A.D. 608 to 906. The first Tang emperor established China's first medical school in A.D. 629 Under the Song (A.D.) 960–1279 and Ming (A.D. 1368–1644) dynasties, new medical schools were established, their curricula and qualifying examinations were standardized, and the traditional herbal prescriptions were written down and collected into encyclopedias. One important difference between the development of medicine in China and in the West is the greater interest in the West in surgical procedures and techniques.

PHILOSOPHICAL BACKGROUND: THE COSMIC AND NATURAL ORDER. In Taoist thought, the Tao, or universal first principle, generated a duality of opposing principles that underlie all the patterns of nature. These principles, yin and yang, are mutually dependent as well as polar opposites. They are basic concepts in traditional Chinese medicine. Yin represents everything that is cold, moist, dim, passive, slow, heavy, and moving downward or inward; while yang represents heat, dryness, brightness, activity, rapidity, lightness, and upward or outward motion. Both forces are equally necessary in nature and in human well-being, and neither force can exist without the other. The dynamic interaction of these two principles is reflected in the cycles of the seasons, the human life cycle, and other natural phenomena. One objective of traditional Chinese medicine is to keep yin and yang in harmonious balance within a person.

In addition to yin and yang, Taoist teachers also believed that the Tao produced a third force, primordial energy or qi (also spelled chi or ki). The interplay between yin, yang, and qi gave rise to the Five Elements of water, metal, earth, wood, and fire. These entities are all reflected in the structure and functioning of the human body.

THE HUMAN BEING. Traditional Chinese physicians did not learn about the structures of the human body from dissection because they thought that cutting open a body insulted the person's ancestors. Instead they built up an understanding of the location and functions of the major organs over centuries of observation, and then correlated them with the principles of yin, yang, qi, and the Five Elements. Thus wood is related to the liver (yin) and the gall bladder (yang); fire to the heart (yin) and the small intestine (yang); earth to the spleen (yin) and the stomach (yang); metal to the lungs (yin) and the large intestine (yang); and water to the kidneys (yin) and the bladder (yang). The Chinese also believed that the body contains Five Essential Substances, which include blood, spirit, vital essence (a principle of growth and development produced by the body from qi and blood), Fluids (all body fluids other than blood, such as saliva, spinal fluid, sweat, etc.), and qi.

Chinese herbal treatment differs from Western herbalism in several respects. In Chinese practice, several different herbs may be used, according to each plant's effect on the individual's qi and the Five Elements. There are many formulas used within traditional Chinese medicine to treat certain common imbalance patterns. These formulas can be modified to fit specific individuals more closely.

A traditional Chinese herbal formula typically contains four classes of ingredients, arranged in a hierarchical order: a chief (the principal ingredient, chosen for the patient's specific illness); a deputy (to reinforce the chief's action or treat a coexisting condition); an assistant (to counteract side effects of the first two ingredients); and an envoy (to harmonize all the other ingredients and convey them to the parts of the body that they are to treat).

Methods of diagnosis

A Chinese herbalist will not prescribe a particular herb on the strength of symptoms only, but will take into consideration the physical condition, emotional health, and mental state of the patient. He or she may look at the condition of the patient's hair, skin, and tongue, as well as the appearance of the eyes, lips, and general complexion. The practitioner then listens to the sounds the body makes when breathing. He or she may smell the breath, body odor, or sputum in diagnosis.

TCM practitioners take an extensive medical history of a patient. He or she may ask about dietary habits, lifestyle, and sleep patterns. The patient will be questioned about chief medical complaints, as well as on his or her particular emotional state and sexual practices.

Chinese herbalists employ touch as a diagnostic tool. They may palpate the body or use light massage to assess the patient's physical health. Another chief component of Chinese medical diagnosis is pulse diagnosis, or sphygmology. This is a very refined art that takes practitioners years to master. Some practitioners can detect 12 different pulse points that correspond to the 12 major organs in Chinese medicine. There are over 30 pulse qualities that practitioners are able to detect on each point. The strength, speed, quality, and rhythm of the pulse, to name a few, will be determined before a diagnosis is given.

Herbs

Chinese herbs may be used alone or in combination. Relatively few are used alone for medicinal purposes. Practitioners believe that illness can be effectively treated by combining herbs based on their various characteristics and the patient's overall health. Every herb has four basic healing properties: nature, taste, affinity, and effect.

An herb's nature is described according to its yin or yang characteristics. Yang, or warming, herbs treat cold deficiencies. They are frequently used in the treatment of the upper respiratory tract, skin, or extremities. Yin, or cooling, herbs, treat hot excess conditions. They are most often used to treat internal conditions and problems with organs. Herbs can also be neutral in nature.

An herb's taste does not refer to its flavor, but to its effect on qi, blood, fluids, and phlegm. Sour herbs have a concentrating action. They are prescribed to treat bodily excess conditions, such as **diarrhea**, and concentrate qi. Bitter herbs have an eliminating or moving downward action. They are used to treat coughs, **constipation**, and heart problems. Sweet or bland herbs have a harmonizing action. They are used as restorative herbs and to treat **pain**. Spicy herbs have a stimulating action. They are prescribed to improve blood and qi circulation. Salty herbs have a softening action. They are used to treat constipation and other digestion problems.

An herb's affinity describes its action on a specific bodily organ. (Note that Chinese medicine does not have the anatomical correlation for organ names. They correspond more closely to the organ's function.) Sour herbs have an affinity for the liver and gallbladder. Bitter herbs act on the heart and small intestine. Sweet and bland herbs affect the stomach and spleen. Spicy herbs have an affinity for lungs and large intestine, whereas salty herbs act on the kidneys and bladder.

Chinese herbs are lastly classified according to their specific actions, which are divided into four effects. Herbs that dispel are used to treat an accumulation, sluggishness, or spasm by relaxing or redistributing. Herbs with an astringent action are used to consolidate or restrain a condition characterized by discharge or excessive elimination. Herbs that purge treat an obstruction or "poison" by encouraging elimination and **detoxification**. Tonifying herbs nourish, support, and calm where there is a deficiency.

Treatment of diabetes

The incidence of diabetes has increased quite dramatically in recent years, especially in the United States, where in general people take less **exercise**, and food is taken in greater quantity with a general reduction in quality. This has lead to a scramble to find new solutions to the problem, and many researchers have focused their interest on Chinese herbal remedies. In the search for more effective and more convenient treatments, the alkaloid berberine has come under close scrutiny for its many uses, among them the treatment of diabetes. In trials, rats given a mixture of berberine and alloxan showed less likelihood of incurring a rise in blood sugar. Patients suffering from type II diabetes who were given between 300 and 600 mg of berberine daily for between one and three

months, showed a reduction in blood sugar levels, when taken in conjunction with a controlled diet.

Treatment of AIDS and cancer

Independent researchers are investigating indications that Chinese herbalism can reduce the toxicity of chemotherapy and other medications, in addition to stimulating immune responses.

Preparations

Those who are unfamiliar with Chinese herbs and their uses should consult a practitioner before starting any treatment. Once a remedy is prescribed, it may be found at Oriental markets or health food stores. The remedies used in Chinese herbalism are standardized and sold prepared for use, with instructions for dosage. A Chinese herbalist may prescribe herbs to be made into tea, or taken as capsules.

Precautions

When treating a patient, the herbalist will aim to gently "nudge" the system into shape, rather than producing any immediate reaction. A return to health, therefore, may take time, and it is important that the patient realizes the principle of the treatment. Some practitioners estimate that treatment will take a month for every year that a chronic condition has existed. The advantage of the slow pace is that if there is a bad reaction to any herb, which is rare, it will be mild because the treatment itself is gentle.

As with most naturopathic therapies, Chinese herbal remedies work best when taken in conjunction with a healthy lifestyle and program of exercise.

Side effects

Some Chinese herbs are incompatible with certain prescription drugs, certain foods, or should not be taken during **pregnancy**. To be certain, a Chinese herbalist should be consulted.

Research and general acceptance

At present, there is renewed interest in the West in traditional Chinese medicine and Chinese herbalism. Of the 700 herbal remedies used by traditional Chinese practitioners, over 100 have been tested and found effective by the standards of Western science. Several United States agencies, including the National Institutes of Health, the Office of Alternative Medicine, and the Food and Drug Administration are currently investigating Chinese herbal medicine as well as acupuncture and *Tui na* massage. In general, however, Western studies of Chinese medicine focus on the effects of traditional treatments and the reasons for those effects, thus attempting to fit traditional Chinese medicine within the Western framework of precise physical measurements and scientific hypotheses.

KEY TERMS

Absorption spectrometry—A scientific procedure to determine chemical makeup of samples.

Interferon—A substance proved to be necessary in the body to help fight cancer cells.

Immune function—The body's defense system against bacteria, viruses and fungi, and any malfunction of the organism.

Pharmaco-dynamics—The study of the relationships and interactions of herbs.

Platelet aggregation—The clumping together of blood cells, possibly forming a clot.

Thrombocyte—Another name for platelet.

Resources

BOOKS

Molony, David. *The American Association of Oriental Medicine's Complete Guide to Chinese Herbal Medicine*. New York: Berkeley Publishing Group, 1998.

ORGANIZATIONS

National Center for Complementary and Alternative Medicine *http://nccam.nih.gov/nccam/*.

The California Association of Acupuncture and Oriental Medicine *http://www.CAAOM.ORG/medicine/overview.htm*

For help with herbs and a list of practitioners *http://www.craneherb.com/*.

Institute of Chinese Materia Medica, China Academy of Traditional Chinese Medicine *Beijing, 100700*.

Patricia Skinner

Herbalism, Western

Definition

Western herbalism is a form of the healing arts that draws from herbal traditions of Europe and the Americas, and that emphasizes the study and use of European and Native American herbs in the treatment and prevention of illness. Western herbalism is based on physicians'

and herbalists' clinical experience and traditional knowledge of medicinal plant remedies preserved by oral tradition and in written records over thousands of years. Western herbalism, like the much older system of **traditional Chinese medicine**, relies on the synergistic and curative properties of the plant to treat symptoms and disease and maintain health.

Western herbalism is based upon pharmocognosy, the study of natural products. Pharmocognosy includes the identification, extraction methods, and applications of specific plant constituents responsible for specific therapeutic actions, such as the use of digoxin from Digitalis leaf for **heart failure**. These constituents are extracted, purified and studied in vitro, in vivo, and in clinical research. They may be concentrated to deliver standardized, set doses. Sometimes, the natural constituent can be synthesized in the lab, or changed and patented. Practitioners may choose to use fresh medicinal plants, simple extracts, or standardized extracts.

In standardized extracts, a specific quantity of a constituent is called a marker compound, and it may or may not be the active constituent(s) in the plant medicine. There are preparations with standardized active constituent quantities, and preparations with greater emphasis on quality of crude plant material and traditional preparation methodology than on finalized total quantity of marker compounds. The preference between the two for precision dosing is philosophical, practical and variable. When using plant extracts in which the active constituents and their cofactors are well established, or the therapeutic and lethal dose are close, standardized products are often preferred. When using plant extracts whose active constituents remain obscure, or the active constituents when purified produce weaker therapeutic results or more undesirable side effects, the products produced under good manufacturing processes and according to the traditional *National Formulary U. S. Dispensatory* or *U. S. Pharmacopeia* are preferred.

Purpose

The benefits of botanical medicine may be subtle or dramatic, depending on the remedy used and the symptom or problem being addressed. Herbal remedies usually have a much slower effect than pharmaceutical drugs. Some herbal remedies have a cumulative effect and work slowly over time to restore balance, and others are indicated for short-term treatment of acute symptoms. When compared to the pharmaceutical drugs, herbal remedies prepared from the whole plant have relatively few side effects. This is due to the complex chemistry and synergistic action of the full range of phytochemicals present in the whole plant, and the relatively lower concentrations. They are generally safe when used in properly designated therapeutic dosages, and less costly than the isolated chemicals or synthetic prescription drugs available from western pharmaceutical corporations.

Description

Origins

Over 2,500 years ago Hippocrates wrote, "In medicine one must pay attention not to plausible theorizing but to experience and reason together." This Greek physician and herbalist from the fourth century B.C. is considered the father of western medicine. He stressed the importance of diet, water quality, climate, and social environment in the development of disease. Hippocrates believed in treating the whole person, rather than merely isolating and treating symptoms. He recognized the innate capacity of the body to heal itself, and emphasized the importance of keen observation in the medical practice. He recommended simple herbal remedies to assist the body in restoring health.

Ancient Greek medicine around the fifth century B.C. was a fertile ground for contrasting philosophies and religions. Greek physicians were influenced by the accumulated medical knowledge from Egypt, Persia, and Babylon. Medical advances flourished and practitioners and scholars were free to study and practice without religious and secular constraints. In the fourth century B.C., Theophrastus wrote the *Historia Plantarum*, considered to be the founding text in the science of botany.

During the first century A.D. Dioscorides, a Greek physician who traveled with the Roman legions, produced five medical texts. His herbal text, known as the *De Materia Medica* is considered to be among the most influential of all western herbal texts. It became a standard reference for practitioners for the next 1,500 years. This influential book also included information on medicinal herbs and treatments that had been used for centuries in Indian **Ayurvedic medicine**. Galen of Pergamon, who also lived in the first century A.D., was a Roman physician and student of anatomy and physiology. He authored a recipe book containing 130 antidotes and medicinal preparations. These elaborate mixtures, known as galenicals, sometimes included up to one hundred herbs and other substances. This complex approach to herbal medicine was a dramatic change from the simple remedies recommended by Hippocrates and employed by traditional folk healers. Galen developed a rigid system of medicine in which the physician, with his specialized knowledge of complex medical formulas, was considered the ultimate authority in matters of health care. The Galenic system, relying on theory and scholarship rather than observation, persisted throughout the

Middle Ages. The galenical compounds, along with bloodletting, and purging, were among the drastic techniques practiced by the medical professionals during those times; however, traditional herbal healers persisted outside the mainstream medical system.

During the eighth century a medical school was established in Salerno, Italy, where the herbal knowledge accumulated by Arab physicians was preserved. The Arabian Muslims conducted extensive research on medicinal herbs found in Europe, Persia, India, and the Far East. Arab businessmen opened the first herbal pharmacies early in the ninth century. The *Leech Book of Bald*, the work of a Christian monk, was compiled in the tenth century. It preserved important medical writings that had survived from the work of physicians in ancient Greece and Rome.

The Middle Ages in Europe were a time of widespread **death** by plagues and pestilence. The Black **Plague** of 1348, particularly, and other health catastrophes in later years, claimed so many lives that survivors began to lose faith in the dominant Galenic medical system. Fortunately, the knowledge of traditional herbal medicine had not been lost. Medieval monks who cultivated extensive medicinal gardens on the monastery grounds, also patiently copied the ancient herbal and medical texts. Folk medicine as practiced in Europe by traditional healers persisted, even though many women herbalists were persecuted as witches and enemies of the Catholic church and their herbal arts were suppressed.

The growing spice trade and explorations to the New World introduced exotic plants, and a whole new realm of botanical medicines became available to Europeans. Following the invention of the printing press in the fifteenth century, a large number of herbal texts, also simply called herbals, became available for popular use. Among them were the beautifully illustrated works of the German botanists Otto Brunfels and Leonhard Fuchs published in 1530, and the Dutch herbal of Belgian physician Rembert Dodoens, a popular work that was later reproduced in English. In 1597, the physician and gardener John Gerard published one of the most famous of the English herbals, still in print today. Gerard's herbal, known as *The Herball or General Historie of Plantes* was not an original work. Much of the content was taken from the translated text of his Belgian predecessor Dodoens. Gerard did, however, include descriptions of some of the more than one thousand species of rare and exotic plants and English flora from his own garden.

The correspondence of astrology with herbs was taught by Arab physicians who regarded astrology as a science helpful in the selection of medicines and in the treatment of diseases. This approach to western herbalism was particularly evident in the herbal texts published in the sixteenth and seventeenth centuries. One of the most popular and controversial English herbals is *The English Physician Enlarged* published in 1653. The author, Nicholas Culpeper, was an apothecary by trade. He also published a translation of the Latin language *London Pharmacopoeia* into English. Culpeper was a nonconformist in loyalist England, and was determined to make medical knowledge more accessible to the apothecaries, the tradesmen who prescribed most of the herbal remedies. Culpeper's herbal was criticized by the medical establishment for its mix of magic and astrology with botanical medicine, but it became one of the most popular compendiums of botanical medicine of its day. Culpeper also accepted the so-called "Doctrine of Signatures," practiced by medieval monks in their medicinal gardens. This theory teaches that the appearance of plants is the clue to their curative powers. Plants were chosen for treatment of particular medical conditions based on their associations with the four natural elements and with a planet or sign. The place where the plant grows, its dominant physical feature, and the smell and taste of an herb determined the plant's signature. Culpeper's herbal is still in print in facsimile copies, and some pharmocognosists and herbalists in the twenty-first century voice the same criticisms that Culpeper's early critics did.

A selection of Western herbal medical equipment and traditional herbs, including foxglove (upper right), ginger (center right), and periwinkle (lower left). *(Photo Researchers, Inc. Reproduced by permission.)*

European colonists brought their herbal knowledge and plant specimens to settlements in North America where they learned from the indigenous Americans how to make use of numerous nutritive and medicinal plants, native to the New World. Many European medicinal plants escaped cultivation from the early settlements and have become naturalized throughout North America. The

first record of Native American herbalism is found in the manuscript of the native Mexican Indian physician, Juan Badianus published in 1552. The American Folk tradition of herbalism developed as a blend of traditional European medicine and Native American herbalism. The pioneer necessity for self-reliance contributed to the perseverance of folk medicine well into the twentieth century.

In Europe in the seventeenth century, the alchemist Paracelsus changed the direction of western medicine with the introduction of chemical and mineral medicines. He was the son of a Swiss chemist and physician. Paracelsus began to apply chemicals, such as arsenic, mercury, sulfur, iron, and copper sulfate to treat disease. His chemical approach to the treatment of disease was a forerunner to the reliance in the twentieth century on chemical medicine as the orthodox treatment prescribed in mainstream medical practice.

The nineteenth and twentieth centuries brought a renewed interest in the practice of western herbalism and the development of natural therapies and health care systems that ran counter to the mainstream methods of combating disease symptoms with synthetic pharmaceuticals.

In the late eighteenth century, the German physician Samuel Hahnemann developed a system of medicine known as **homeopathy**. This approach to healing embraces the philosophy of "like cures like." Homeopathy uses extremely diluted solutions of herbs, animal products, and chemicals that are believed to hold a "trace memory" or energetic imprint of the substance used. Homeopathic remedies are used to amplify the patient's symptoms with remedies that would act to produce the same symptom in a healthy person. Homeopathy holds that the symptoms of illness are evidence of the body's natural process of healing and eliminating the cause of the disease.

In 1895, the European medical system known as Naturopathy was introduced to the North America. Like homeopathy, this medical approach is based on the Hippocratic idea of eliminating disease by assisting the body's natural healing abilities. The naturopath uses nontoxic methods to assist the body's natural healing processes, including nutritional supplements, herbal remedies, proper diet, and **exercise** to restore health.

Western herbalism is regaining popularity at a time when the world is assaulted by the **stress** of overpopulation and development that threatens the natural biodiversity necessary for these valuable medicinal plants to survive. The American herb market is growing rapidly and increasing numbers of individuals are choosing alternative therapies over the mainstream allopathic western medicine. It is projected that by the year 2002 consumers will spend more than seven billion dollars a year on herbal products. An estimated 2,400 acres of native plant habitat are lost to development every day. As much as 29% of all plant life in North America is in danger of extinction, including some of the most important native medicinal plants, according to the 1997 World Conservation Union Red List of Threatened Plants.

Though research into the efficacy and safety of traditional herbal remedies is increasing, it has been limited by the high costs of clinical studies and laboratory research, and by the fact that whole plants and their constituents are not generally patentable (therefore, there is no drug profit after market introduction). Outside the United States, herbalism has successfully combined with conventional medicine, and in some countries is fully integrated into the nations' health care systems. At the beginning of the twenty-first century, 80% of the world's population continues to rely on herbal treatments. The World Health Organization, an agency of the United Nations, promotes traditional herbal medicine for treatment of many local health problems, particularly in the third world where it is affordable and already well-integrated into the cultural fabric.

In the United States, the re-emergence in interest in holistic approaches to health care is evident. Citizens are demanding access to effective, safe, low-cost, natural medicine. Legislative and societal change is needed, however, before natural therapies can be fully integrated into the orthodox allopathic health care system and provide citizens with a wide range of choices for treatment. If the current trend continues, U. S. citizens will benefit from a choice among a variety of safe and effective medical treatments.

Herbs are generally defined as any plant or plant part that may be used for medicinal, nutritional, culinary, or other beneficial purposes. The active constituents of plants (if known) may be found in varying amounts in the root, stem, leaf, flower, and fruit, etc. of the plant. Herbs may be classified into many different categories. Some western herbalists categorize herbal remedies according to their strength, action, and characteristics. Categories may include sedatives, stimulants, **laxatives**, febrifuges (to reduce **fever**), and many others. One system of classification is based on a principle in traditional Chinese medicine that categorizes herbs into four classes: tonics, specifics, heroics, or cleansers and protectors. Within these broad classifications are the numerous medicinal actions of the whole herb which may be due to a specific chemical or combination of chemicals in the plant.

- Tonics. Herbs in this classification are also known as alteratives in western herbalism. They are generally mild in their action and act slowly in the body, providing gentle stimulation and **nutrition** to specific organs and systems. Tonic herbs act over time to strengthen and nourish the whole body. These herbs are generally safe and may be used regularly, even in large quantities.

These tonic herbs are known as "superior" remedies in traditional Chinese medicine. The therapeutic dose of tonic remedies is far removed from the possible toxic dose. American ginseng is an example of a tonic herb.

- Specifics. Herbs in this classification are strong and specific in their therapeutic action. They are generally used for short periods of time in smaller dosages to treat acute conditions. Herbs classified as specifics are not used beyond the therapeutic treatment period. **Echinacea** is a specific herb.
- Heroic. These herbs offer high potency but are potentially toxic, and should not be used in self-treatment. Because the therapeutic dosage may be close to the lethal dosage, these herbs are presented cautiously and closely monitored or avoided by trained clinicians. They should not be used continuously or without expert supervision. Poke (*Phytolacca americana*) is an example of a heroic remedy.
- Cleansers and protectors. These herbs, plants, and plant tissues remove wastes and pollutants, while minimally affecting regular body processes. An example of a cleanser is pectin. Pectins are the water soluble substances that bind cell walls in plant tissues, and some believe that they help remove heavy metals and environmental toxins from the body.

Preparations

Herbal preparations are commercially available in a variety of forms including tablets or capsules, tinctures, teas, fluid extracts, douches, washes, suppositories, dried herbs, and many other forms. The medicinal properties of herbs are extracted from the fresh or dried plant parts by the use of solvents appropriate to the particular herb. Alcohol, oil, water, vinegar, glycerin, and propylene glycol are some of the solvents used to extract and concentrate the medicinal properties. Steam distillation and cold-pressing techniques are used to extract the essential oils. The quality of any herbal remedy and the potency of the phytochemicals found in the herb depends greatly on the conditions of weather and soil where the herb was grown, the timing and care in harvesting, and the manner of preparation and storage.

Precautions

Herbal remedies prepared by infusion, decoction, or alcohol tincture from the appropriate plant part, such as the leaf, root, or flower are generally safe when ingested in properly designated therapeutic dosages. However, many herbs have specific contraindications for use when certain medical conditions are present. Not all herbal remedies may be safely administered to infants or small children. Many herbs are not safe for use by pregnant or lactating women. Some herbs are toxic, even deadly, in large amounts, and there is little research on the chronic toxicity that may result from prolonged use. Herbal remedies are sold in the United States as dietary supplements and are not regulated for content or efficacy. Self-diagnosis and treatment with botanical medicinals may be risky. A consultation with a clinical herbalist, Naturopathic physician, or certified clinical herbalist is prudent before undertaking a course of treatment.

Essential oils are highly concentrated and should not be ingested as a general rule. They should also be diluted in water or in a non-toxic carrier oil before application to the skin to prevent **contact dermatitis** or photo-sensitization. The toxicity of the concentrated essential oil varies depending on the chemical constituents of the herb.

The American Professor of Pharmacognosy, Varro E. Tyler, believes that "herbal chaos" prevails in the United States with regard to herbs and phytomedicinals. In part he blames the herb producers and marketers of crude herbs and remedies for what he terms unproven hyperbolic, poor quality control, deceptive labeling, resistance to standardization of dosage forms, and continued sale of herbs determined to be harmful.

Side effects

Herbs have a variety of complex phytochemicals that act on the body as a whole or on specific organs and systems. Some of these chemical constituents are mild and safe, even in large doses. Other herbs contain chemicals that act more strongly and may be toxic in large doses or when taken continuously. Drug interactions are possible with certain herbs when combined with certain pharmaceutical drugs. Some herbs are tonic in a small amount and toxic in larger dosages.

Research and general acceptance

Western herbalism is experiencing a revival of popular and professional interest. The number of training

KEY TERMS

In vitro—A biological reaction occurring in a laboratory apparatus.

In vivo—Occurring in a living organism.

Phyto-, as in phytochemical, phytomedicinal, and phytotherapy—Meaning, or pertaining to, a plant or plants.

Wildcrafting—Gathering of herbs or other natural materials.

schools and qualified herbal practitioners is growing to meet the demand. Western herbalism is incorporated into the medical practice of licensed Naturopathic doctors, who receive special training in clinical herbalism. Folk herbalists, heir to the continuing oral traditions passed from generation to generation in many rural areas, as well as amateur, self-taught herbalists, keep the practice of botanical medicine alive at the grassroots level. Traditional western herbalism relies on traditional use and materia medica, folk wisdom, and recent clinical research and advances in the extraction processes. These advances provide increased quality control on the concentration and potency of the active ingredients. Western physicians, educated in allopathic medicine, typically receive no training in the use of herbs. These doctors rely on pharmaceutical drugs for their patients, and some cite the following reasons for continuing to do so: lack of standardized dosages, lack of quality control in the preparation of herbal medicinals, and the dearth of clinical research verifying the safety and effectiveness of many traditional herbal remedies.

Herbalism is widely practiced throughout Europe, particularly in England, France, Italy, and Germany where phytomedicinals are available in prescription form and as over-the-counter remedies. In Germany, plant medicines are regulated by a special government body known as the Commission E. In the United States, however, despite increasing popularity, traditional herbalism is not integrated into the allopathic medical system. Phytomedicinals are sold as dietary supplements rather than being adequately researched and recognized as safe and effective drugs. The Dietary Supplement Health and Education Act of 1994 circumvented a U. S. Food and Drug Administration (FDA) effort to effectively remove botanicals from the marketplace and implement regulations restricting sale. Massive popular outcry against the proposed regulations on the sale of herbs and phytomedicinals resulted in this Congressional action. In 2000, U.S. President Bill Clinton, by executive order, created the White House Commission on Alternative Medicine in an effort to hold alternative medicine therapies "to the same standard of scientific rigor as more traditional health care interventions." That Commission is charged with recommending federal guidelines and legislation regarding the use of alternative medical therapies in the twenty-first century.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine, The Definitive Guide.* Washington: Future Medicine Publishing, Inc., 1993.

Kowalchik, Claire, and Hylton, William H. *Rodale's Illustrated Encyclopedia of Herbs*. Pennsylvania: Rodale Press, 1987.

Lust, John. *The Herb Book*. New York: Bantam Books, 1974.

McIntyre, Anne. *The Medicinal Garden*. New York: Henry Holt and Company, Inc., 1997.

Murray, Michael T. *The Healing Power of Herbs, 2nd ed*. California: Prima Publications, Inc., 1995.

Weiss, Gaea and Shandor Weiss. *Growing & Using The Healing Herbs*. New York: Wings Books, 1992.

PERIODICALS

Deneen, Sally, with Rembert, Tracey. "Uprooted, The Worldwide Plant Crisis Is Accelerating." *E Magazine* (July/August 1999) : 36-40.

Liebmann, Richard, N.D. "United Plant Savers—Planting the Future." *PanGaia* 22 (Winter 1999-2000) : 23- 26.

ORGANIZATIONS

National Center for the Preservation of Medicinal Herbs. 3350 Beech Grove Road, Rutland, Ohio 45775. (740)742- 4401.

United Plant Savers. P.O. Box 98, East Barre, Vermont 05649. (802)479-9825. <http://www.plantsavers.org>.

OTHER

Hobbs, Christopher. "Specific and Tonic Immune Herbs: Exploring a Practical System of Western Herbalism." Health World. <http://www.healthy.net/asp/templates/article.asp?PageType=Article&ID=960>.

Oracle Tree New Age Mall. "Western Medical Astrology: A Brief History." <http://ww.oracletree.com/avalonphysics/wesmedas.html>.

Tyler, Varro E., Ph.D. *Herbs and Health Care in the Twenty-first Century.* <http://www.richters.com/newdisplay.cgi?page=OttoRichter/1995.html>.

Wicke, Roger, Ph.D. "A World History of Herbology and Herbalism: Oppressed Arts." Rocky Mountain Herbal Institute. <http://www.rmhiherbalorg/a/f.ahrl.hist.html>.

Clare Hanrahan

Herbs *see* **Echinacea; Ginkgo biloba; Ginseng; Saw palmetto; St. John's wort**

Hereditary cerebral hemorrhage with amyloidosis *see* **Cerebral amyloid angiopathy**

Hereditary chorea *see* **Huntington's disease**

Hereditary fructose intolerance

Definition

Hereditary fructose intolerance is an inherited condition where the body does not produce the chemical needed to break down fructose (fruit sugar).

Description

Fructose is a sugar found naturally in fruits, vegetables, honey, and table sugar. Fructose intolerance is a dis-

order caused by the body's inability to produce an enzyme called aldolase B (also called fructose 1-phosphate aldolase) that is necessary for absorption of fructose. The undigested fructose collects in the liver and kidneys, eventually causing liver and kidney failure. One person in about 20,000 is born with this disorder. It is reported more frequently in the United States and Northern European countries than in other parts of the world. It occurs with equal frequency in males and females.

Causes and symptoms

Fructose intolerance is an inherited disorder passed on to children through their parents' genes. Both the mother and father have the gene that causes the condition, but may not have symptoms of fructose intolerance themselves. (This is called an autosomal recessive pattern of inheritance.) The disorder will not be apparent until the infant is fed formula, juice, fruits, or baby foods that contain fructose. Initial symptoms include vomiting, **dehydration**, and unexplained **fever**. Other symptoms include extreme thirst and excessive urination and sweating. There will also be a loss of appetite and a failure to grow. **Tremors** and seizures caused by low blood sugar can occur. The liver becomes swollen and the patient becomes jaundiced with yellowing of the eyes and skin. Left untreated, this condition can lead to **coma** and **death**.

Diagnosis

Urine tests can be used to detect fructose sugar in the urine. Blood tests can also be used to detect *hyperbilirubinemia* and high levels of liver enzymes in the blood. A **liver biopsy** may be performed to test for levels of enzymes present and to evaluate the extent of damage to the liver. A fructose-loading test where a dose of fructose is given to the patient in a well-controlled hospital or clinical setting may also be used to confirm fructose intolerance. Both the biopsy and the loading test can be very risky, particularly in infants that are already sick.

Treatment

Once diagnosed, fructose intolerance can be successfully treated by eliminating fructose from the diet. Patients usually respond within three to four weeks and can make a complete recovery if fructose-containing foods are avoided. Early recognition and treatment of the disease is important to avoid damage to the liver, kidneys, and small intestine.

Prognosis

If the condition is not recognized and the diet is not well controlled, death can occur in infants or young children. With a well-controlled diet, the child can develop normally.

KEY TERMS

Aldolase B—Also called fructose 1-phosphate aldolase, this chemical is produced in the liver, kidneys, and brain. It is needed for the breakdown of fructose, a sugar found in fruits, vegetables, honey, and other sweeteners.

Hyperbilirubinemia—A condition where there is a high level of bilirubin in the blood. Bilirubin is a natural by-product of the breakdown of red blood cells, however, a high level of bilirubin may indicate a problem with the liver.

Liver biopsy—A surgical procedure where a small piece of the liver is cut out for examination. A needle or narrow tube may be inserted either directly through the skin and muscle or through a small incision and passed into the liver for collection of a sample of liver tissue.

Prevention

Carriers of the gene for hereditary fructose intolerance can be identified through DNA analysis. Anyone who is known to carry the disease or who has the disease in his or her family can benefit from **genetic counseling**. Since this is a hereditary disorder, there is currently no known way to prevent it other than assisting at-risk individuals with family planning and reproductive decisions.

Resources

BOOKS

Greene, Harry L. "Fructose Intolerance." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

"Hereditary Fructose Intolerance." In *Internal Medicine*. 5th ed. Ed. Jay H. Stein. St. Louis: Mosby, 1998.

ORGANIZATIONS

National Institutes of Health. National Institute of Diabetes, Digestive and Kidney Diseases. Building 31, Room 9A04, 31 Center Drive, Bethesda, MD 20892-2560. (301) 496-3583.

OTHER

"What Is Hereditary Fructose Intolerance?" Hereditary Fructose Intolerance & Aldolase Homepage. <http://www.bu.edu/aldolase>.

Altha Roberts Edgren

Hereditary hemorrhagic telangiectasia

Definition

Hereditary hemorrhagic telangiectasia is an inherited condition characterized by abnormal blood vessels which are delicate and prone to bleeding. Hereditary hemorrhagic telangiectasia is also known as Rendu-Osler-Weber disease.

Description

The term telangiectasia refers to a spot formed, usually on the skin, by a dilated capillary or terminal artery. In hereditary hemorrhagic telangiectasia these spots occur because the blood vessel is fragile and bleeds easily. The bleeding may appear as small, red or reddish-violet spots on the face, lips, inside the mouth and nose or the tips of the fingers and toes. Other small telangiectasias may occur in the digestive tract.

Unlike **hemophilia**, where bleeding is caused by an ineffective clotting mechanism in the blood, bleeding in hereditary hemorrhagic telangiectasia is caused by fragile blood vessels. However, like hemophilia, bleeding may be extensive and can occur without warning.

Causes and symptoms

Hereditary hemorrhagic telangiectasia, an autosomal dominant inherited disorder, occurs in one in 50,000 people.

Recurrent nosebleeds are a nearly universal symptom in this condition. Usually the nosebleeds begin in childhood and become worse with age. The skin changes begin at **puberty**, and the condition becomes progressively worse until about 40 years of age, when it stabilizes.

Diagnosis

The physician will look for red spots on all areas of the skin, but especially on the upper half of the body, and in the mouth and nose and under the tongue.

Treatment

There is no specific treatment for hereditary hemorrhagic telangiectasia. The bleeding resulting from the condition can be stopped by applying compresses or direct pressure to the area. If necessary, a laser can be used to destroy the vessel. In severe cases, the leaking artery can be plugged or covered with a graft from normal tissue.

Prognosis

In most people, recurrent bleeding results in an iron deficiency. It is usually necessary to take iron supplements.

KEY TERMS

Autosomal dominant—A pattern of inheritance in which the dominant gene on any non-sex chromosome carries the defect.

Chromosome—A threadlike structure in the cell which transmits genetic information.

Prevention

Hereditary hemorrhagic telangiectasia is an inherited disorder and cannot be prevented.

Resources

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Association of Birth Defect Children, 3526 Emerywood Lane, Orlando, FL 32806,305/859-2821.

Dorothy Elinor Stonely

Hereditary hyperuricemia *see* **Lesch-Nyhan syndrome**

Hereditary spinocerebellar ataxia *see* **Friedreich's ataxia**

Hermaphroditism *see* **Intersex states**

Hernia

Definition

Hernia is a general term used to describe a bulge or protrusion of an organ through the structure or muscle that usually contains it.

Description

There are many different types of hernias. The most familiar type are those that occur in the abdomen, in which part of the intestines protrude through the abdominal wall. This may occur in different areas and, depending on the location, the hernia is given a different name.

An inguinal hernia appears as a bulge in the groin and may come and go depending on the position of the person or their level of physical activity. It can occur with

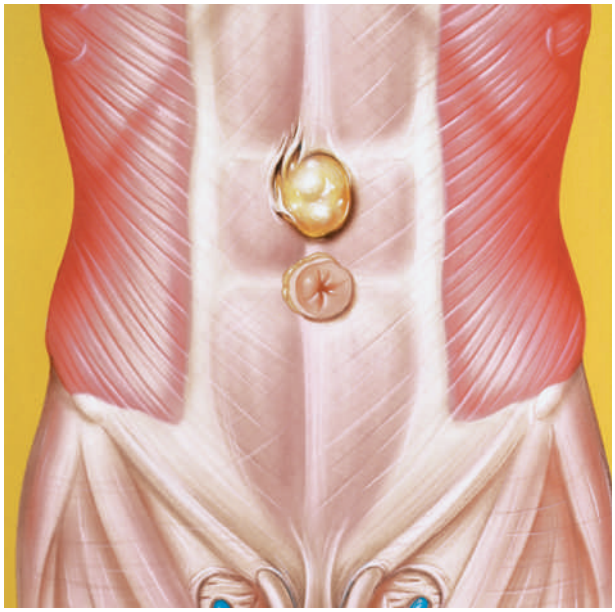
or without **pain**. In men, the protrusion may descend into the scrotum. Inguinal hernias account for 80% of all hernias and are more common in men.

Femoral hernias are similar to inguinal hernias but appear as a bulge slightly lower. They are more common in women due to the strain of **pregnancy**.

A ventral hernia is also called an incisional hernia because it generally occurs as a bulge in the abdomen at the site of an old surgical scar. It is caused by thinning or stretching of the scar tissue, and occurs more frequently in people who are obese or pregnant.

An umbilical hernia appears as a soft bulge at the navel (umbilicus). It is caused by a weakening of the area or an imperfect closure of the area in infants. This type of hernia is more common in women due to pregnancy, and in Chinese and black infants. Some umbilical hernias in infants disappear without treatment within the first year.

A hiatal or diaphragmatic hernia is different from abdominal hernias in that it is not visible on the outside of the body. With a hiatal hernia, the stomach bulges upward through the muscle that separates the chest from the abdomen (the diaphragm). This type of hernia occurs more often in women than in men, and it is treated differently from other types of hernias.



An illustration of an epigastric (abdominal) hernia in an adult male. The torso is shown with its skin removed. Epigastric hernia is caused commonly by a congenital weakness in muscles of the central upper abdomen; the intestine bulges out through the muscle at a point between the navel and breastbone. *(Photograph by John Bavosi, Photo Researchers, Inc. Reproduced by permission.)*

Causes and symptoms

Most hernias result from a weakness in the abdominal wall that either develops or that an infant is born with (congenital). Any increase in pressure in the abdomen, such as coughing, straining, heavy lifting, or pregnancy, can be a considered causative factor in developing an abdominal hernia. **Obesity** or recent excessive weight loss, as well as **aging** and previous surgery, are also risk factors.

Most abdominal hernias appear suddenly when the abdominal muscles are strained. The person may feel tenderness, a slight burning sensation, or a feeling of heaviness in the bulge. It may be possible for the person to push the hernia back into place with gentle pressure, or the hernia may disappear by itself when the person reclines. Being able to push the hernia back is called reducing it. On the other hand, some hernias cannot be pushed back into place, and are termed incarcerated or irreducible.

A hiatal hernia may also be caused by obesity, pregnancy, aging, or previous surgery. About 50% of all people with hiatal hernias do not have any symptoms. If symptoms exist they will include **heartburn**, usually 30–60 minutes following a meal. There may be some mid chest pain due to gastric acid from the stomach being pushed up into the esophagus. The pain and heartburn are usually worse when lying down. Frequent belching and feelings of abdominal fullness may also be present.

Diagnosis

Generally, abdominal hernias need to be seen and felt to be diagnosed. Usually the hernia will increase in size with an increase in abdominal pressure, so the doctor may ask the person to **cough** while he or she feels the area. Once a diagnosis of an abdominal hernia is made, the doctor will usually send the person to a surgeon for a consultation. Surgery provides the only cure for a hernia through the abdominal wall.

With a hiatal hernia, the diagnosis is based on the symptoms reported by the person. The doctor may then order tests to confirm the diagnosis. If a barium swallow is ordered, the person drinks a chalky white barium solution, which will help any protrusion through the diaphragm show up on the x ray that follows. Currently, a diagnosis of hiatal hernia is more frequently made by endoscopy. This procedure is done by a gastroenterologist (a specialist in digestive diseases). During an endoscopy the person is given an intravenous sedative and a small tube is inserted through the mouth, then into the esophagus and stomach where the doctor can visualize the her-

KEY TERMS

Endoscopy—A diagnostic procedure in which a tube is inserted through the mouth, into the esophagus and stomach. It is used to visualize various digestive disorders, including hiatal hernias.

Herniorrhaphy—Surgical repair of a hernia.

Incarcerated hernia—A hernia that can not be reduced, or pushed back into place inside the intestinal wall.

Reducible hernia—A hernia that can be gently pushed back into place or that disappears when the person lies down.

Strangulated hernia—A hernia that is so tightly incarcerated outside the abdominal wall that the intestine is blocked and the blood supply to that part of the intestine is cut off.

nia. The procedure takes about 30 minutes and usually causes no discomfort. It is done on an outpatient basis.

Treatment

Once an abdominal hernia occurs it tends to increase in size. Some patients with abdominal hernias wait and watch for a while prior to choosing surgery. In these cases, they must avoid strenuous physical activity such as heavy lifting or straining with **constipation**. They may also wear a truss, which is a support worn like a belt to keep a small hernia from protruding. People can tell if their hernia is getting worse if they develop severe constant pain, **nausea and vomiting**, or if the bulge does not return to normal when lying down or when they try to gently push it back in place. In these cases they should consult with their doctor immediately. But, ultimately, surgery is the treatment in almost all cases.

There are risks to not repairing a hernia surgically. Left untreated, a hernia may become incarcerated, which means it can no longer be reduced or pushed back into place. With an incarcerated hernia the intestines become trapped outside the abdomen. This could lead to a blockage in the intestine. If it is severe enough it may cut off the blood supply to the intestine and part of the intestine might actually die.

When the blood supply is cut off, the hernia is termed "strangulated." Because of the risk of tissue **death** (necrosis) and **gangrene**, and because the hernia can block food from moving through the bowel, a strangulated hernia is a medical emergency requiring immediate surgery. Repairing a hernia before it becomes incarcerated or strangulated is much safer than waiting until complications develop.

Surgical repair of a hernia is called a herniorrhaphy. The surgeon will push the bulging part of the intestine back into place and sew the overlying muscle back together. When the muscle is not strong enough, the surgeon may reinforce it with a synthetic mesh.

Surgery can be done on an outpatient basis. It usually takes 30 minutes in children and 60 minutes in adults. It can be done under either local or general anesthesia and is frequently done with a laparoscope. In this type of surgery, a tube that allows visualization of the abdominal cavity is inserted through a small puncture wound. Several small punctures are made to allow surgical instruments to be inserted. This type of surgery avoids a larger incision.

A hiatal hernia is treated differently. Medical treatment is preferred. Treatments include:

- avoiding reclining after meals
- avoiding spicy foods, acidic foods, alcohol, and tobacco
- eating small, frequent, bland meals
- eating a high-fiber diet

There are also several types of medications that help to manage the symptoms of a hiatal hernia. **Antacids** are used to neutralize gastric acid and decrease heartburn. Drugs that reduce the amount of acid produced in the stomach (H2 blockers) are also used. This class of drugs includes famotidine (sold under the name Pepcid), cimetidine (Tagamet), and ranitidine (Zantac). Omeprazole (Prilosec) is not an H2 blocker, but is another drug that suppresses gastric acid secretion and is used for hiatal hernias. Another option may be metoclopramide (Reglan), a drug that increases the tone of the muscle around the esophagus and causes the stomach to empty more quickly.

Alternative treatment

There are alternative therapies for hiatal hernia. Visceral manipulation, done by a trained therapist, can help replace the stomach to its proper positioning. Other options in addition to H2 blockers are available to help regulate stomach acid production and balance. One of them, deglycyrrhizinated licorice (DGL), helps balance stomach acid by improving the protective substances that line the stomach and intestines and by improving blood supply to these tissues. DGL does not interrupt the normal function of stomach acid.

As with traditional therapy, dietary modifications are important. Small, frequent meals will keep pressure down on the esophageal sphincter. Also, raising the head

of the bed several inches with blocks or books can help with both the quality and quantity of sleep.

Prognosis

Abdominal hernias generally do not recur in children but can recur in up to 10% of adult patients. Surgery is considered the only cure, and the prognosis is excellent if the hernia is corrected before it becomes strangulated.

Hiatal hernias are treated successfully with medication and diet modifications 85% of the time. The prognosis remains excellent even if surgery is required in adults who are in otherwise good health.

Prevention

Some hernias can be prevented by maintaining a reasonable weight, avoiding heavy lifting and constipation, and following a moderate **exercise** program to maintain good abdominal muscle tone.

Resources

BOOKS

Bare, Brenda G., and Suzanne C. Smeltzer. *Brunner and Suddarth's Textbook of Medical-Surgical Nursing*. 8th ed.Philadelphia: Lippincott-Raven Publishers, 1996.

Polaske, Arlene L., and Suzanne E. Tatro. *Luckmann's Core Principles and Practice of Medical Surgical Nursing*. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Kingsley, A. N., I. L. Lichtenstein, and W.K. Sieber. "Common Hernias In Primary Care." *Patient Care* (Apr. 1990): 98-119.

Leung, A. K. C., W. L. Robson, and A. L. Wong. "Diagnosis At a Glance." *Emergency Medicine* (Jan. 1993): 3536.

Lipsyte, R. "Pig-out Penalty. Hiatal Hernia." *American Health*, Nov. 1994, 49-50.

Spiro, H. M. "Hiatus Hernia and Reflux Esophagitis." *Hospital Practice* (Jan. 1994): 51-66.

Joyce S. Siok, RN

Hernia repair

Definition

Hernia repair is a surgical procedure to return an organ that protrudes through a weak area of muscle to its original position.

Purpose

Hernias occur when a weakness in the wall of the abdomen allows an organ, usually the intestines, to bulge out of place. Hernias may result from a genetic predisposition toward this weakness. They can also be the result of weakening the muscle through improper **exercise** or poor lifting techniques. Both children and adults get hernias. Some are painful, while others are not.

There are three levels of hernias. An uncomplicated hernia is one where the intestines bulge into the peritoneum (the membrane lining the abdomen), but they can still be manipulated back into the body (although they don't stay in place without corrective surgery). This is termed a reducible hernia.

If the intestines bulge through the hernia defect and become trapped, this is called an incarcerated hernia. If the blood supply to an incarcerated hernia is shut off, the hernia is called a strangulated hernia. Strangulated hernias can result in **gangrene**.

Both incarcerated and strangulated hernias are medical emergencies and require emergency surgery to correct. For this reason, doctors generally recommend the repair of an uncomplicated hernia, even if it causes no discomfort to the patient.

Precautions

Hernia repair can be performed under local, regional, or general anesthesia. The choice depends on the age and health of the patient and the type of hernia. Generally hernia repair is very safe surgery, but—as with any surgery—the risk of complications increases if the patient smokes, is obese, is very young or very old, uses alcohol heavily, or uses illicit drugs.

Description

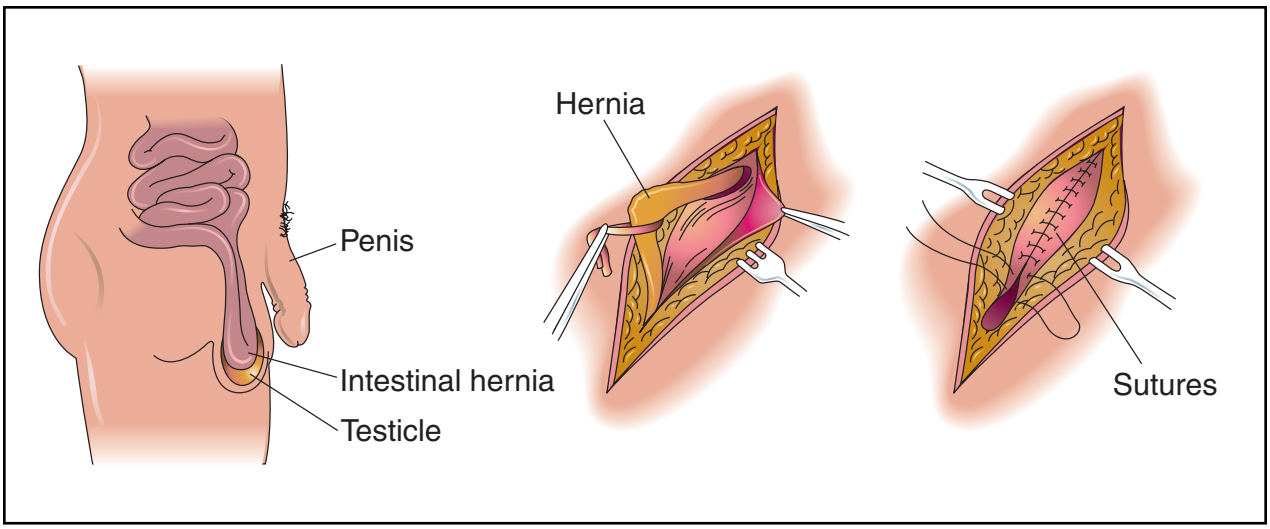
Hernia repairs are performed in a hospital or outpatient surgical facility by a general surgeon. Depending on the patient's age, health, and the type of hernia, patients may be able to go home the same day or may remain hospitalized for up to three to five days.

There are two types of hernia repair. A herniorrhaphy is used for simpler hernias. The intestines are returned to their proper place and the defect in the abdominal wall is mended. A hernioplasty is used for larger hernias. In this procedure, plastic or steel mesh is added to the abdominal wall to repair and reinforce the weak spot.

There are five kinds of common hernia repairs. They are named for the part of the body closest to the hernia, or bulge.

Femoral hernia repair

This procedure repairs a hernia that occurs in the groin where the thigh meets the abdomen. It is called a



In this inguinal hernia repair, an incision is made in the abdomen. The hernia is located, and the intestines are returned to the abdomen. The abdominal wall is then sutured together to close any space and reinforce the weak area. *(Illustration by Electronic Illustrators Group.)*

femoral hernia repair because it is near the spot where the femoral artery and vein pass from the leg into the trunk of the body. Sometimes this type of hernia creates a noticeable bulge.

An incision is made in the groin area. The tissues are separated from the hernia sac, and the intestines are returned to the abdomen. The area is often reinforced with webbing before it is sewn shut. The skin is closed with sutures or metal clips that can be removed in about one week.

Inguinal hernia repair

Inguinal hernia repair closes a weakness in the abdominal wall that is near the inguinal canal, the spot where the testes descend from the body into the scrotum. This type of hernia occurs in about two percent of adult males.

An incision is made in the abdomen, then the hernia is located and repaired. The surgeon must be alert not to injure the spermatic cord, the testes, or the blood supply to the testes. If the hernia is small, it is simply repaired. If it is large, the area is reinforced with mesh to prevent a recurrence. External skin sutures can be removed in about a week. Patients should not resume sexual activity until being cleared by their doctor.

Umbilical hernia repair

This procedure repairs a hernia that occurs when the intestines bulge through the abdomen wall near the navel. Umbilical hernias are most common in infants.

An incision is made near the navel. The hernia is located and the intestines are returned to the abdomen. The peritoneum is closed, then the large abdominal muscle is pulled over the weak spot in such a way as to reinforce the area. External sutures or skin clips can be removed in about 10 days.

Incisional hernia repair

Incisional hernias occur most frequently at the site of a scar from earlier abdominal surgery. Once again, the abdomen is opened and the intestines returned to their proper place. The area is reinforced with mesh, and the abdominal wall is reconstructed to prevent another hernia from developing. External sutures can be removed in about a week.

Hiatal hernia

A hiatal hernia repair is slightly different from the other hernias described here, because it corrects a weakness or opening in the diaphragm, the muscle that separates the chest cavity from the abdominal cavity. This surgery is done to prevent the stomach from shifting up into the chest cavity and to prevent the stomach from spilling gastric juices into the esophagus, causing **pain** and scarring.

An incision is made in the abdomen or chest, and the hole or weakness in the diaphragm is located and repaired. The top of the stomach is wrapped around the bottom of the esophagus, and they are sutured together to hold the stomach in place. Sometimes the vagus nerve is cut in order to decrease the amount of acid the stomach

produces. External sutures can be removed in about one week. This type of hernia repair often requires a longer hospital stay than the other types, although techniques are being improved that reduce invasiveness of the surgery and the length of the hospital stay.

Preparation

Before the operation, the patient will have blood and urine collected for testing. X rays are taken of the affected area. In a hiatal hernia, an endoscopy (a visual inspection of the organs) is done.

Patients should meet with the anesthesiologist before the operation to discuss any medications or conditions that might affect the administration of anesthesia. Patients may be asked to temporarily discontinue certain medications. The day of the operation, patients should not eat or drink anything. They may be given an enema to clear the bowels.

Aftercare

Patients should eat a clear liquid diet until the gastrointestinal tract begins functioning again. Normally this is a short period of time. After that, they are free to eat a healthy, well-balanced diet of their choice. They may bathe normally, using a gentle, unscented soap. An antibiotic ointment may be prescribed for the incision. After the operation, a hard ridge will form along the incision line. With time, this ridge softens and becomes less noticeable. Patients who remain in the hospital will have blood drawn for follow-up studies.

Patients should begin easy activities, such as walking, as soon as they are comfortable, but should avoid strenuous exercise for four to six weeks, and especially avoid heavy lifting. Learning and practicing proper lifting techniques is an important part of patient education after the operation. Patients may be given a laxative or stool softener so that they will not strain to have bowel movements. They should discuss with their doctor when to resume driving and sexual activity.

Risks

As with any surgery, there exists the possibility of excessive bleeding and infection after the surgery. In inguinal and femoral hernia repair, a slight risk of damage to the testicles or their blood supply exists for male patients. Accidental damage may be caused to the intestinal tract, but generally complications are few.

Normal results

The outcome of surgery depends on the age and health of the patient and on the type of hernia. Although most hernias can be repaired without complications, hernias recur in 10–20% of people who have had hernia surgery.

KEY TERMS

Endoscopy—A procedure in which an instrument containing a camera is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

Gangrene—Death and decay of body tissue because the blood supply is cut off. Tissues that have died in this way must be surgically removed.

Peritoneum—The transparent membrane lining the abdominal cavity that holds organs such as the intestines in place.

Resources

BOOKS

"Hernia Repair." In *The Complete Guide to Symptoms, Illness and Surgery.* 3rd ed. Ed. H. Winter Griffith, et al. New York: Berkeley Publishing, 1995.

"Hernia Repair." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

OTHER

"Hernia Repair." ThriveOnline. <http://thriveonline.oxygen.com>.

Tish Davidson

Herniated disk

Definition

Disk herniation is a rupture of fibrocartilagenous material (annulus fibrosis) that surrounds the intervertebral disk. This rupture involves the release of the disk's center portion containing a gelatinous substance called the nucleus pulposus. Pressure from the vertebrae above and below may cause the nucleus pulposus to be forced outward, placing pressure on a spinal nerve and causing considerable **pain** and damage to the nerve. This condition most frequently occurs in the lumbar region and is also commonly called herniated nucleus pulposus, prolapsed disk, ruptured intervertebral disk, or slipped disk.

Description

The spinal column is made up of 26 vertebrae that are joined together and permit forward and backward

bending, side bending, and rotation of the spine. Five distinct regions comprise the spinal column, including the cervical (neck) region, thoracic (chest) region, lumbar (low back) region, sacral and coccygeal (tailbone) region. The cervical region consists of seven vertebrae, the thoracic region includes 12 vertebrae, and the lumbar region contains five vertebrae. The sacrum is composed of five fused vertebrae, which are connected to four fused vertebrae forming the **coccyx**. Intervertebral disks lie between each adjacent vertebra.

Each disk is composed of a gelatinous material in the center, called the nucleus pulposus, surrounded by rings of a fiberous tissue (annulus fibrosus). In disk herniation, an intervertebral disk's central portion herniates or slips through the surrounding annulus fibrosus into the spinal canal, putting pressure on a nerve root. Disk herniation most commonly affects the lumbar region between the fifth lumbar vertebra and the first sacral vertebra. However, disk herniation can also occur in the cervical spine. The incidence of cervical disk herniation is most common between the fifth and sixth cervical vertebrae. The second most common area for cervical disk herniation occurs between the sixth and seventh cervical vertebrae. Disk herniation is less common in the thoracic region.

Predisposing factors associated with disk herniation include age, gender, and work environment. The peak age for occurrence of disk herniation is between 20–45 years of age. Studies have shown that males are more commonly affected than females in lumbar disk herniation by a 3:2 ratio. Prolonged exposure to a bent-forward work posture is correlated with an increased incidence of disk herniation.

There are four classifications of disk pathology:

- A protrusion may occur where a disk bulges without rupturing the annulus fibrosis.
- The disk may prolapse where the nucleus pulposus migrates to the outermost fibers of the annulus fibrosis.
- There may be a disk extrusion, which is the case if the annulus fibrosis perforates and material of the nucleus moves into the epidural space.
- The sequestrated disk may occur as fragments from the annulus fibrosis and nucleus pulposus are outside the disk proper.

Causes and symptoms

Any direct, forceful, and vertical pressure on the lumbar disks can cause the disk to push its fluid contents into the vertebral body. Herniated nucleus pulposus may occur suddenly from lifting, twisting, or direct injury, or it can occur gradually from degenerative changes with episodes of intensifying symptoms. The annulus may also become weakened over time, allowing stretching or tearing and leading to a disk herniation. Depending on the location of the herniation, the herniated material can also press directly on nerve roots or on the spinal cord, causing a shock-like pain (**sciatica**) down the legs, weakness, numbness, or problems with bowels, bladder, or sexual function.

Diagnosis

Several radiographic tests are useful for confirming a diagnosis of disk herniation and locating the source of pain. These tests also help the surgeon indicate the extent of the surgery needed to fully decompress the nerve. X rays show structural changes of the lumbar spine. **Myelography** is a special x ray of the spine in which a dye or air is injected into the patient's spinal canal. The patient lies strapped to a table as the table tilts in various directions and spot x rays are taken. X rays showing a narrowed dye column in the intervertebral disk area indicate possible disk herniation.

Computed tomography scan (CT or CAT scans) exhibit the details of pathology necessary to obtain consistently good surgical results. **Magnetic resonance imaging** (MRI) analysis of the disks can accurately detect the early stages of disk **aging** and degeneration. Electomyograms (EMGs) measure the electrical activity of the muscle contractions and possibly show evidence of nerve damage. An EMG is a powerful tool for assessing muscle **fatigue** associated with muscle impairment with **low back pain**.

Treatment

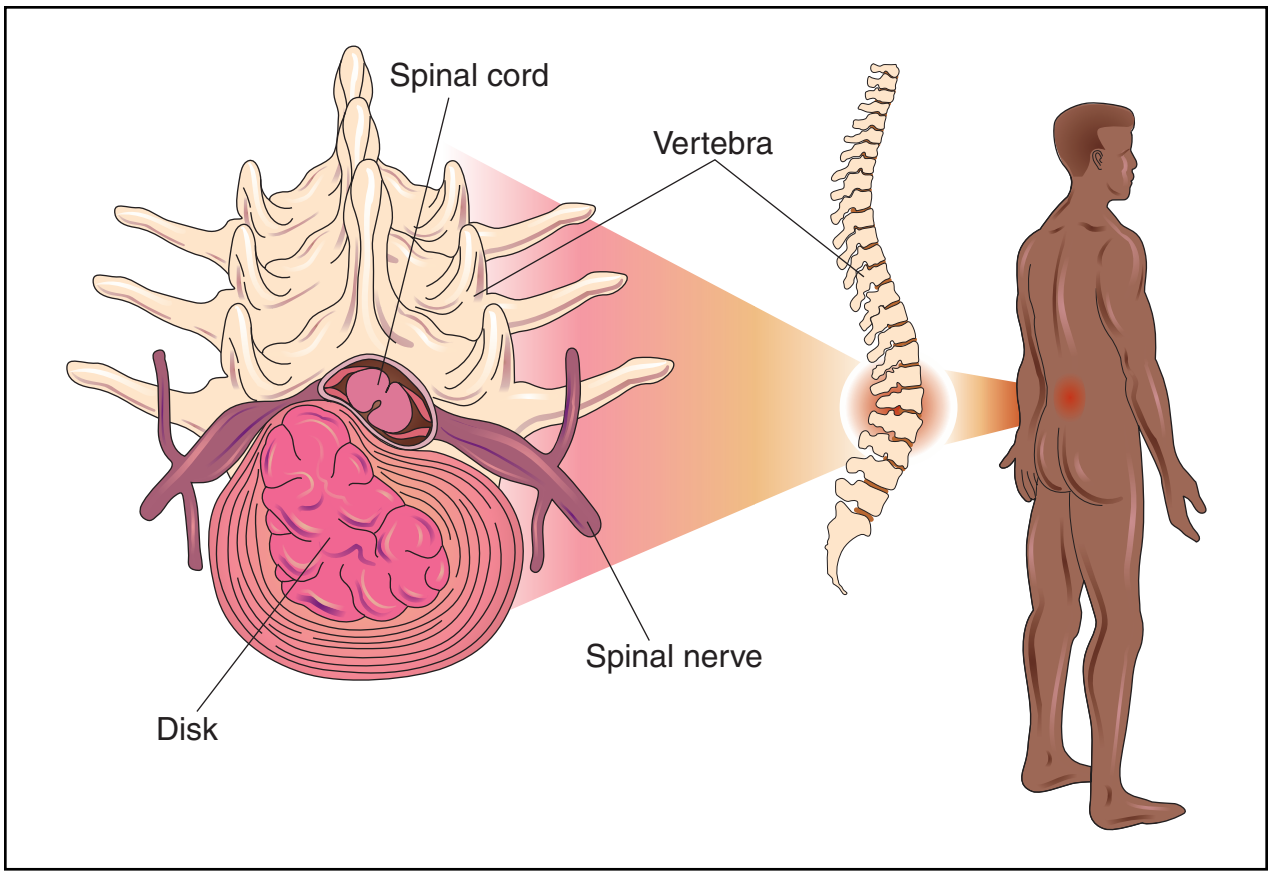
Drugs

Unless serious neurologic symptoms occur, herniated disks can initially be treated with pain medication and up to 48 hours of bed rest. There is no proven benefit from resting more than 48 hours. Patients are then encouraged to gradually increase their activity. Pain medications, including antiinflammatories, muscle relaxers, or in severe cases, narcotics, may be continued if needed.

Epidural steroid injections have been used to decrease pain by injecting an antiinflammatory drug, usually a corticosteroid, around the nerve root to reduce inflammation and **edema** (swelling). This partly relieves the pressure on the nerve root as well as resolves the inflammation.

Physical therapy

Physical therapists are skilled in treating acute back pain caused by the disk herniation. The physical therapist



A herniated disk refers to the rupture of fibrocartilagenous material, called the annulus fibrosis, that surrounds the intervertebral disk. When this occurs, pressure from the vertebrae above and below may force the disk's center portion, a gel-like substance, outward, placing additional pressure on the spinal nerve and causing pain and damage to the nerve. *(Illustration by Electronic Illustrators Group.)*

can provide noninvasive therapies, such as ultrasound or diathermy to project heat deep into the tissues of the back or administer manual therapy, if mobility of the spine is impaired. They may help improve posture and develop an **exercise** program for recovery and long-term protection. Appropriate exercise can help take pressure off inflamed nerve structures, while improving overall posture and flexibility. **Traction** can be used to try to decrease pressure on the disk. A lumbar support can be helpful for a herniated disk at this level as a temporary measure to reduce pain and improve posture.

Surgery

Surgery is often appropriate for conditions that do not improve with the usual treatment. In this event, a strong, flexible spine is important for a quick recovery after surgery. There are several surgical approaches to treating a herniated disk, including the classic discectomy, microdiscectomy, or percutaneous discectomy. The basic differences among these procedures are the size of the incision, how the disk is reached surgically, and how much of the disk is removed.

Discectomy is the surgical removal of the portion of the disk that is putting pressure on a nerve causing the back pain. In the classic disectomy, the surgeon first enters through the skin and then removes a bony portion of the vertebra called the lamina, hence the term laminectomy. The surgeon removes the disk material that is pressing on a nerve. Rarely is the entire lamina or disk entirely removed. Often, only one side is removed and the surgical procedure is termed hemi-laminectomy.

In microdiscectomy, through the use of an operating microscope, the surgeon removes the offending bone or disk tissue until the nerve is free from compression or stretch. This procedure is possible using local anesthesia. Microsurgery techniques vary and have several advantages over the standard discectomy, such as a smaller incision, less trauma to the musculature and nerves, and easier identification of structures by viewing into the disk space through microscope magnification.

Percutaneous disk excision is performed on an outpatient basis, is less expensive than other surgical procedures, and does not require a general anesthesia. The purpose of percutaneous disk excision is to reduce the volume of the affected disk indirectly by partial removal of the nucleus pulposus, leaving all the structures important to stability practically unaffected. In this procedure, large incisions are avoided by inserting devices that have cutting and suction capability. Suction is applied and the disk is sliced and aspirated.

Arthroscopic microdiscectomy is similar to percutaneous discectomy, however it incorporates modified arthroscopic instruments, including scopes and suction devices. A suction irrigation of saline solution is established through two entry sites. A video discoscope is introduced from one site and the deflecting instruments from the opposite side. In this way, the surgeon is able to search and extract the nuclear fragments under direct visualization.

Laser disk decompression is performed using similar means as percutaneous excision and arthroscopic microdiscectomy, however laser energy is used to remove the disk tissue. Here, laser energy is percutaneously introduced through a needle to vaporize a small volume of nucleus pulposus, thereby dropping the pressure of the disk and decompressing the involved neural tissues. One disadvantage of this procedure is the high initial cost of the laser equipment. It is important to realize that only a very small percentage of people with herniated lumbar disks go on to require surgery. Further, surgery should be followed by appropriate **rehabilitation** to decrease the chance of reinjury.

Chemonucleolysis

Chemonucleolysis is an alternative to surgical excision. Chymopapain, a purified enzyme derived from the papaya plant, is injected percutaneously into the disk space to reduce the size of the herniated disks. It hydrolyses proteins, thereby decreasing water-binding capacity, when injected into the nucleus pulposus inner disk material. The reduction in size of the disk relieves pressure on the nerve root.

Spinal fusion

Spinal fusion is the process by which bone grafts harvested from the iliac crest (thick border of the ilium located on the pelvis) are placed between the intervertebral bodies after the disk material is removed. This approach is used when there is a need to reestablish the normal bony relationship between the vertebrae. A total discectomy may be needed in some cases because lumbar spinal fusion can help prevent recurrent lumbar disk herniation at a particular level.

KEY TERMS

Annulus fibrosis—The outer portion of the intervertebral disk made primarily of fibrocartilage rings.

Epidural space—The space immediately surrounding the outermost membrane of the spinal cord.

Excision—The process of excising, removing, or amputating.

Fibrocartilage—Cartilage that consists of dense fibers.

Nucleus pulposus—The center portion of the intervertebral disk that is made up of a gelatinous substance.

Percutaneous—Performed through the skin.

Alternative treatment

Acupuncture involves the use of fine needles inserted along the pathway of the pain to move energy locally and relieve the pain. An acupuncturist determines the location of the nerves affected by the herniated disk and positions the needles appropriately. Massage therapists may also provide short-term relief from a herniated disk. Following manual examination and x-ray diagnosis, **chiropractic** treatment usually includes manipulation to correct muscle and joint malfunctions, while care is taken not to place an additional strain on the injured disk. If a full trial of conservative therapy fails, or if neurologic problems (weakness, bowel or bladder problems, and sensory loss) develop, the next step is usually evaluation by an orthopedic surgeon.

Prognosis

Only 5–10% of patients with unrelenting sciatica and neurological involvement, leading to chronic pain of the lumbar spine, need to have a surgical procedure performed. This strongly suggests that many patients with herniated disks at the lumbar level respond well to conservative treatment. For those patients who do require surgery for lumbar disk herniation, the reviewed procedures of nerve root decompression caused by disk herniation is favorable. Results of studies varied from 60–90% success rates. Disk surgery has progressively evolved in the direction of decreasing invasiveness. Each surgical procedure is not without possible complications, which can lead to chronic low back pain and restricted lifestyle.

Prevention

Proper exercises to strengthen the lower back and abdominal muscles are key in preventing excess **stress**

and compressive forces on lumbar disks. Good posture will help prevent problems on cervical, thoracic, and lumbar disks. A good flexibility program is critical for prevention of muscle and spasm that can cause an increase in compressive forces on disks at any level. Proper lifting of heavy objects is important for all muscles and levels of the individual disks. Good posture in sitting, standing, and lying down is helpful for the spine. Losing weight, if needed, can prevent weakness and unnecessary stress on the disks caused by **obesity**. Choosing proper footwear may also be helpful to reduce the impact forces to the lumbar disks while walking on hard surfaces. Wearing special back support devices may be helpful if heavy lifting is required with combinations of twisting.

Resources

BOOKS

Kessler, R. M. *Management of Common Musculoskeletal Disorders: Physical Therapy Principles and Methods.* Philadelphia: J. B. Lippincott Co., 1990.

Magee, David J. *Orthopedic Physical Assessment.* Philidelphia: W. B. Saunders Co., 1992.

Tourtellotte, C. *Musculoskeletal Problems.* Springhouse, PA: Springhouse Corp., 1988.

PERIODICALS

Choy, D. S. "Percutaneous Laser Disk Decompression: A New Therapeutic Modality." *Spine* 17 (1992): 949-956.

Frymore, J. W. "Back Pain and Sciatica." *The New England Journal of Medicine* 138 (1988).

OTHER

"Acupuncture." Acupuncture.com. 1998 <http://acupuncture.com/Acup/AcuInd.htm>.

"Back Pain." Healthtouch Online Page. <http://www.healthtouch.com>.

Jeffrey P. Larson, RPT

Hernioplasty *see* **Hernia repair**

Herniorrhaphy *see* **Hernia repair**

Herpes *see* **Cold sore**

Herpes encephalitis *see* **Encephalitis**

Herpes genitalis *see* **Genital herpes**

Herpes simplex *see* **Cold sore**

Herpes simplex type 2 *see* **Genital herpes**

Herpes type 2 *see* **Genital herpes**

Herpes zoster infection *see* **Shingles**

Heterotopic transplant *see* **Liver transplantation**

Heterotropia *see* **Strabismus**

HFRS *see* **Hantavirus infections**

Hiccups

Definition

Hiccups are the result of an involuntary, spasmodic contraction of the diaphragm followed by the closing of the throat.

Description

Hiccups are one of the most common, but thankfully mildest, disorders to which humans are prey. Virtually everyone experiences them at some point, but they rarely last long or require a doctor's care. Occasionally, a bout of hiccups will last longer than two days, earning it the name "persistent hiccups." Very few people will experience intractable hiccups, in which hiccups last longer than one month.

A hiccup involves the coordinated action of the diaphragm and the muscles that close off the windpipe (trachea). The diaphragm is a dome-shaped muscle separating the chest and abdomen, normally responsible for expanding the chest cavity for inhalation. Sensation from the diaphragm travels to the spinal cord through the phrenic nerve and the vagus nerve, which pass through the chest cavity and the neck. Within the spinal cord, nerve fibers from the brain monitor sensory information and adjust the outgoing messages that control contraction. These messages travel along the phrenic nerve.

Irritation of any of the nerves involved in this loop can cause the diaphragm to undergo involuntary contraction, or spasm, pulling air into the lungs. When this occurs, it triggers a reflex in the throat muscles. Less than a tenth of a second afterward, the trachea is closed off, making the characteristic "hic" sound.

Causes and symptoms

Hiccups can be caused by central nervous system disorders, injury or irritation to the phrenic and vagus nerves, and toxic or metabolic disorders affecting the central or peripheral nervous systems. They may be of unknown cause or may be a symptom of psychological **stress**. Hiccups often occur after drinking carbonated beverages or alcohol. They may also follow overeating or rapid temperature changes. Persistent or intractable hiccups may be caused by any condition which irritates or damages the relevant nerves, including:

- overstretching of the neck
- laryngitis
- heartburn (gastroesophageal reflux)
- irritation of the eardrum (which is innervated by the vagus nerve)
- general anesthesia
- surgery
- bloating
- tumor
- infection
- diabetes

Diagnosis

Hiccups are diagnosed by observation, and by hearing the characteristic sound. Diagnosing the cause of intractable hiccups may require imaging studies, blood tests, pH monitoring in the esophagus, and other tests.

Treatment

Most cases of hiccups will disappear on their own. Home remedies which interrupt or override the spasmodic nerve circuitry are often effective. Such remedies include:

- holding one's breath for as long as possible
- breathing into a paper bag
- swallowing a spoonful of sugar
- bending forward from the waist and drinking water from the wrong side of a glass

Treating any underlying disorder will usually cure the associated hiccups. Chlorpromazine (Thorazine) relieves intractable hiccups in 80% of cases. Metoclopramide (Reglan), carbamazepam, valproic acid (Depakene), and phenobarbital are also used. As a last resort, surgery to block the phrenic nerve may be performed, although it may lead to significant impairment of respiration.

Prognosis

Most cases of hiccups last no longer than several hours, with or without treatment.

Prevention

Some cases of hiccups can be avoided by drinking in moderation, avoiding very hot or very cold food, and avoiding cold showers. Carbonated beverages when drunk through a straw deliver more gas to the stomach than when sipped from a container; therefore, avoid using straws.

KEY TERMS

Nerve—Fibers that carry sensory information, movement stimuli, or both from the brain and spinal cord to other parts of the body and back again. Some nerves, including the vagus nerve, innervate distantly separated parts of the body.

Resources

BOOKS

Hurst, J. Willis. *Medicine for the Practicing Physician*. Stamford: Appleton & Lange, 1988.

Richard Robinson

High-altitude sickness *see* **Altitude sickness**

High-risk pregnancy

Definition

A high risk **pregnancy** is one in which some condition puts the mother, the developing fetus, or both at higher-than-normal risk for complications during or after the pregnancy and birth.

Description

A pregnancy can be considered a high-risk pregnancy for a variety of reasons. Factors can be divided into maternal and fetal. Maternal factors include age (younger than age 15, older than age 35); weight (pre-pregnancy weight under 100 lb or **obesity**); height (under five feet); history of complications during previous pregnancies (including **stillbirth**, fetal loss, preterm labor and/or deliver small-for-gestational age baby, large baby, pre-eclampsia or eclampsia); more than five previous pregnancies; bleeding during the third trimester; abnormalities of the reproductive tract; **uterine fibroids**; **hypertension**; Rh incompatability; **gestational diabetes**; infections of the vagina and/or cervix; kidney infection; **fever**; acute surgical emergency (**appendicitis**, gallbladder disease, bowel obstruction); post-term pregnancy; pre-existing chronic illness (such as **asthma**, autoimmune disease, **cancer**, sickle cell anemia, **tuberculosis**, herpes, **AIDS**, heart disease, kidney disease, **Crohn's disease**, **ulcerative colitis**, diabetes). Fetal factors include exposure to infection (especially herpes simplex, viral hepatitis,

mumps, **rubella**, varicella, **syphilis**, **toxoplasmosis**, and infections caused by coxsackievirus); exposure to damaging medications (especially phenytoin, **folic acid** antagonists, lithium, streptomycin, tetracycline, thalidomide, and warfarin); exposure to addictive substances (cigarette **smoking**, alcohol intake, and illicit or abused drugs). A pregnancy is also considered high-risk when prenatal tests indicate that the baby has a serious health problem (for example, a heart defect). In such cases, the mother will need special tests, and possibly medication, to carry the baby safely through to delivery. Furthermore, certain maternal or fetal problems may prompt a physician to deliver a baby early, or to choose a surgical delivery (cesarean section) rather than a vaginal delivery.

Most women will see one healthcare provider during pregnancy, either an obstetrician, a midwife, or a nurse practitioner. Women who have a medical problem may need to see a medical specialist as well. Women diagnosed with a high-risk pregnancy may also need the expert advice and care of a perinatologist. A perinatologist is a medical doctor (obstetrician) who specializes in the care of women who are at high risk for having problems during pregnancy. Perinatologists care for women who have pre-existing medical problems as well as women who develop complications during pregnancy.

Diagnosis

A woman with a high-risk pregnancy will need closer monitoring than the average pregnant woman. Such monitoring may include more frequent visits with the primary caregiver, tests to monitor the medical problem, blood tests to check the levels of medication, **amniocentesis**, serial ultrasound examination, and fetal monitoring. These tests are designed to track the original condition, survey for complications, verify that the fetus is growing adequately, and make decisions regarding whether labor may need to be induced to allow for early delivery of the fetus.

Treatment

Treatment varies widely with the type of disease, the effect that pregnancy has on the disease, and the effect that the disease has on pregnancy. Additional tests may help determine the need for changes in medication or additional treatment.

Prognosis

The prognosis depends in large part on the specific medical condition. Some medical conditions make it difficult to get pregnant and lead to a higher risk of problems in the baby. An example of this type of condition is thyroid disease. In thyroid disease, the thyroid gland (located in the neck) may produce too much or too little thyroid hormone. Abnormal levels of thyroid hormone can cause problems in pregnancy and affect the health of the baby. Fortunately, thyroid disease can be treated with medication. As long as the level of thyroid hormone is controlled throughout pregnancy, there should be no problems for mother or baby.

There are many medical conditions that usually do not interfere with pregnancy, but are themselves affected by pregnancy. This group includes asthma, epilepsy, and ulcerative colitis. For example, some women with ulcerative colitis experience a worsening of their symptoms during pregnancy, while others will have no change or may get better during pregnancy. The same is true of asthma; some women notice that their asthma symptoms are better during pregnancy, some find their asthma worse, and some women notice no change in symptoms during pregnancy. No one understands why this is so, but due to this unpredictability, all women with chronic illnesses should be monitored carefully throughout pregnancy.

There is also a group of medical conditions that can have a major impact on pregnancy. Women with lupus (disease caused by alterations in the immune system that result in inflammation of connective tissue and organs) or kidney disease face real risks during pregnancy. Pregnancy can cause their symptoms to worsen significantly and can lead to serious illness. Because these diseases can affect the mother's ability to supply oxygen and nutrients to the baby through the placenta, they can cause problems for the baby as well. These babies may not be able to grow and gain weight properly (**intrauterine growth retardation**). There is also an increased risk of stillbirth.

Diabetes is a medical condition that is both affected by pregnancy and affects pregnancy. Diabetes can lead to miscarriages, **birth defects**, and stillbirths. When a woman monitors her blood sugar carefully and treats high levels with insulin, the risk of these negative outcomes drops a great deal. Unfortunately, pregnancy makes diabetes much harder to control. In general, blood sugar and the need for insulin to control it rise throughout pregnancy.

Most medical conditions do not lead to complications in pregnancy. With frequent visits to healthcare providers, and careful attention to medication, women with medical problems usually enjoy healthy, successful pregnancies. There are a few medical conditions that can cause health risks to both mother and baby during pregnancy. Women with these medical problems should consider these risks before deciding to become pregnant. Many of these women will benefit from the care of a perinatologist dur-

KEY TERMS

Gestational diabetes—Diabetes of pregnancy leading to increased levels of blood sugar. Unlike diabetes mellitus, gestational diabetes is caused by pregnancy and goes away when pregnancy ends. Like diabetes mellitus, gestational diabetes is treated with a special diet and insulin, if necessary.

Preeclampsia—A disease that only affects pregnant women. The most common signs and symptoms are increased blood pressure, swelling in the hands and feet, and abnormal results on special blood and urine tests.

Premature labor—Labor beginning before 36 weeks of pregnancy.

ing pregnancy. Only rarely (in the case of severe heart disease, for example) are the risks to the mother so high that she should not consider pregnancy at all.

Prevention

A pre-pregnancy visit with a healthcare provider is especially important for a woman who has a medical problem. The doctor will discuss how women with this condition usually fare during pregnancy. For some diseases (such as lupus), pregnancy can mean increased risk of health problems for mother and baby.

Sometimes, the medication a woman needs to control a medical condition can cause problems for the baby. There may be another medication available that is safer for use in pregnancy. In some cases there is no other medication, and a woman must weigh the risks to the baby when deciding whether or not to become pregnant.

A woman who has not had a pre-pregnancy visit should contact a healthcare provider as soon as she learns she is pregnant. Often, the provider will schedule the first prenatal visit within a day or two, instead of waiting until eight to 10 weeks of pregnancy. This is because certain medical conditions can increase the risk of **miscarriage**. The provider will want to be sure that any medication is adjusted properly to increase the chance of having a successful pregnancy.

Resources

BOOKS

"High-Risk Pregnancies." In *The Merck Manual of Diagnosis and Therapy,* edited by Mark H. Beers, et al. Rahway, NJ: Merck Research Laboratories, 1999.

Carlson, Karen J., and Stephanie A. Eisenstat, eds. "Medical Problems in Pregnancy." In *Primary Care of Women.* St. Louis, MO: Mosby-Year Book, Inc. 1995, 346-383.

Cunningham, Gary, et al. "Medical and Surgical Complications in Pregnancy." In *Williams Obstetrics,* 20th ed. Stamford, CT: Appleton & Lange, 1997, 1045-1316.

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High blood phosphate level *see* **Phosphorus imbalance**

High blood pressure *see* **Pulmonary hypertension**

High calcium blood level *see* **Hypercalcemia**

High cholesterol *see* **Cholesterol, high**

High potassium blood level *see* **Hyperkalemia**

High sodium blood level *see* **Hypernatremia**

Hindu medicine *see* **Ayurvedic medicine**

Hip bath *see* **Sitz bath**

Hip replacement *see* **Joint replacement**

Hirschsprung's disease

Definition

Hirschsprung's disease, also known as congenital megacolon or aganglionic megacolon, is an abnormality in which certain nerve fibers are absent in segments of the bowel, resulting in severe bowel obstruction.

Description

Hirschsprung's disease is caused when certain nerve cells (called parasympathetic **ganglion** cells) in the wall of the large intestine (colon) do not develop before birth. Without these nerves, the affected segment of the colon lacks the ability to relax and move bowel contents along. This causes a constriction and as a result, the bowel above the constricted area dilates due to stool becoming trapped, producing megacolon (dilation of the colon). The disease can affect varying lengths of bowel segment, most often involving the region around the rectum. In up to 10% of children, however, the entire colon and part of the small intestine are involved.

Hirschprung's disease occurs once in every 5,000 live births, and it is about four times more common in males than females. Between 4% and 50% of siblings are also afflicted. The wide range for recurrence is due to the fact that the recurrence risk depends on the gender of the affected individual in the family (i.e., if a female is affected, the recurrence risk is higher) and the length of the aganglionic segment of the colon (i.e., the longer the segment that is affected, the higher the recurrence risk).

Causes and symptoms

Hirschsprung's disease occurs early in fetal development when, for unknown reasons, there is either failure of nerve cell development, failure of nerve cell migration, or arrest in nerve cell development in a segment of bowel. The absence of these nerve fibers, which help control the movement of bowel contents, is what results in intestinal obstruction accompanied by other symptoms.

There is a genetic basis to Hirschsprung's disease, and it is believed that it may be caused by different genetic factors in different subsets of families. Proof that genetic factors contribute to Hirschprung's disease is that it is known to run in families, and it has been seen in association with some chromosome abnormalities. For example, about 10% of children with the disease have **Down syndrome** (the most common chromosome abnormality). Molecular diagnostic techniques have identified many genes that cause susceptibility to Hirschprung's disease. As of 200l, there are a total of six genes: the RET gene, the glial cell line-derived neurotrophic factor gene, the endothelin-B receptor gene, endothelin converting enzyme, the endothelin-3 gene, and the Sry-related transcription factor SOX10. Mutations that inactivate the RET gene are the most frequent, occurring in 50% of familial cases (cases which run in families) and 15-20% of sporadic (non-familial) cases. Mutations in these genes do not cause the disease, but they make the chance of developing it more likely. Mutations in other genes or environmental factors are required to develop the disease, and these other factors are not understood.

For persons with a ganglion growth beyond the sigmoid segment of the colon, the inheritance pattern is autosomal dominant with reduced penetrance (risk closer to 50%). For persons with smaller segments involved, the inheritance pattern is multifactorial (caused by an interaction of more than one gene and environmental factors, risk lower than 50%) or autosomal recessive (one disease gene inherited from each parent, risk closer to 25%) with low penetrance.

The initial symptom is usually severe, continuous **constipation**. A newborn may fail to pass meconium (the first stool) within 24 hours of birth, may repeatedly vomit yellow or green colored bile and may have a distended (swollen, uncomfortable) abdomen. Occasionally, infants may have only mild or intermittent constipation, often with **diarrhea**.

While two-thirds of cases are diagnosed in the first three months of life, Hirschsprung's disease may also be diagnosed later in infancy or childhood. Occasionally, even adults are diagnosed with a variation of the disease. In older infants, symptoms and signs may include anorexia (lack of appetite or inability to eat), lack of the urge to move the bowels or empty the rectum on **physical examination**, distended abdomen, and a mass in the colon that can be felt by the physician during examination. It should be suspected in older children with abnormal bowel habits, especially a history of constipation dating back to infancy and ribbon-like stools.

Occasionally, the presenting symptom may be a severe intestinal infection called enterocolitis, which is life threatening. The symptoms are usually explosive, watery stools and **fever** in a very ill-appearing infant. It is important to diagnose the condition before the intestinal obstruction causes an overgrowth of bacteria that evolves into a medical emergency. Enterocolitis can lead to severe diarrhea and massive fluid loss, which can cause **death** from **dehydration** unless surgery is done immediately to relieve the obstruction.

Diagnosis

Hirschsprung's disease in the newborn must be distinguished from other causes of intestinal obstruction. The diagnosis is suspected by the child's medical history and physical examination, especially the rectal exam. The diagnosis is confirmed by a **barium enema** x ray, which shows a picture of the bowel. The x ray will indicate if a segment of bowel is constricted, causing dilation and obstruction. A biopsy of rectal tissue will reveal the absence of the nerve fibers. Adults may also undergo manometry, a balloon study (device used to enlarge the anus for the procedure) of internal anal sphincter pressure and relaxation.

Treatment

Hirschsprung's disease is treated surgically. The goal is to remove the diseased, nonfunctioning segment of the bowel and restore bowel function. This is often done in two stages. The first stage relieves the intestinal obstruction by performing a **colostomy**. This is the creation of an opening in the abdomen (stoma) through which bowel contents can be discharged into a waste bag. When the child's weight, age, or condition is deemed appropriate, surgeons close the stoma, remove

KEY TERMS

Anus—The opening at the end of the intestine that carries waste out of the body

Barium enema x ray—A procedure that involves the administration of barium into the intestines by a tube inserted into the rectum. Barium is a chalky substance that enhances the visualization of the gastrointestinal tract on x-ray.

Colostomy—The creation of an artificial opening into the colon through the skin for the purpose of removing bodily waste. Colostomies are usually required because key portions of the intestine have been removed.

Enterocolitis—Severe inflammation of the intestines that affects the intestinal lining, muscle, nerves and blood vessels.

Manometry—A balloon study of internal anal sphincter pressure and relaxation.

Meconium—The first waste products to be discharged from the body in a newborn infant, usually greenish in color and consisting of mucus, bile and so forth.

Megacolon—Dilation of the colon.

Parasympathetic ganglion cell—Type of nerve cell normally found in the wall of the colon.

the diseased portion of bowel, and perform a "pull-through" procedure, which repairs the colon by connecting functional bowel to the anus. This usually establishes fairly normal bowel function.

Prognosis

Overall, prognosis is very good. Most infants with Hirschsprung's disease achieve good bowel control after surgery, but a small percentage of children may have lingering problems with soilage or constipation. These infants are also at higher risk for an overgrowth of bacteria in the intestines, including subsequent episodes of enterocolitis, and should be closely followed by a physician. Mortality from enterocolitis or surgical complications in infancy is 20%.

Prevention

Hirschsprung's disease is a congenital abnormality that has no known means of prevention. It is important to diagnose the condition early in order to prevent the development of enterocolitis. **Genetic counseling** can be offered to a couple with a previous child with the disease or to an affected individual considering **pregnancy** to discuss recurrence risks and treatment options. Prenatal diagnosis is not available.

Resources

BOOKS

Buyse, Mary Louise, MD., ed. "Colon, Aganglionosis." In *Birth Defects Encyclopedia*. Oxford: Blackwell Scientific Publications, 1990.

Phillips, Sidney F., and John H. Pemberton. "Megacolon: Congenital and Acquired." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease,* edited by Mark Feldman, et al. Philadelphia: W.B. Saunders Co., 1998.

PERIODICALS

Kusafuka, T., and P. Puri. "Genetic Aspects of Hirschprung's Disease." *Seminars in Pediatric Surgery* 7 (1998): 148-55.

Martucciello, G., et al. "Pathogenesis of Hirschprung's Disease." *Journal of Pediatric Surgery* 35 (2000): 1017-25.

Munnes, M., et al. "Familial Form of Hirschprung Disease: Nucleotide Sequence Studies Reveal Point Mutations in the RET Proto-oncogene in Two of Six Families But Not in Other Candidate Genes." *American Journal of Medical Genetics* 94 (2000): 19-27.

Puri, P., K. Ohshiro, and T. Wester. "Hirschprung's Disease: A Search for Etiology." *Seminars in Pediatric Surgery* 7 (1998): 140-7.

Salomon, R., et al. "From Monogenic to Polygenic: Model of Hirschsprung Disease." *Pathol Biol (Paris)* 46 (1998): 705-7.

ORGANIZATIONS

American Pseudo-Obstruction& Hirschsprung's Society. 158 Pleasant St., North Andover, MA 01845. (978) 685-4477.

Pull-thru Network. 316 Thomas St., Bessemer, AL 35020. (205) 428-5953.

Amy Vance

Hirsutism

Definition

Excessive growth of facial or body hair in women is called hirsutism.

Description

Hirsutism is not a disease. The condition usually develops during **puberty** and becomes more pronounced as the years go by. However, an inherited tendency, overproduction of male hormones (androgens), medication, or disease, can cause it to appear at any age.

Women who have hirsutism usually have irregular menstrual cycles. They sometimes have small breasts and deep voices, and their muscles and genitals may become larger than women without the condition.

Types of hirsutism

Idiopathic hirsutism is probably hereditary, because there is usually a family history of the disorder. Women with idiopathic hirsutism have normal menstrual cycles and no evidence of any of the conditions associated with secondary hirsutism.

Secondary hirsutism is most often associated with **polycystic ovary syndrome** (an inherited hormonal disorder characterized by menstrual irregularities, biochemical abnormalities, and **obesity**). This type of hirsutism may also be caused by:

- malfunctions of the pituitary or adrenal glands
- use of male hormones or **minoxidil** (Loniten), a drug used to widen blood vessels
- adrenal or ovarian tumors

Causes and symptoms

Hirsutism is rarely caused by a serious underlying disorder. **Pregnancy** occasionally stimulates its development. Hirsutism triggered by tumors is very unusual.

Hair follicles usually become enlarged, and the hairs themselves become larger and darker. A woman whose hirsutism is caused by an increase in male hormones has a pattern of hair growth similar to that of a man. A woman whose hirsutism is not hormone-related has long, fine hairs on her face, arms, chest, and back.

Diagnosis

Diagnosis is based on a family history of hirsutism, a personal history of menstrual irregularities, and masculine traits. Laboratory tests are not needed to assess the status of patients whose menstrual cycles are normal and who have mild, gradually progressing hirsutism.

A family physician or endocrinologist may order blood tests to measure hormone levels in women with long-standing menstrual problems or more severe hirsutism. **Computed tomography scans** (CT scans) are sometimes performed to evaluate diseases of the adrenal glands. Additional diagnostic procedures may be used to confirm or rule out underlying diseases or disorders.

Treatment

Primary hirsutism can be treated mechanically. Mechanical treatment involves bleaching or physically removing unwanted hair by:

KEY TERMS

Idiopathic—A term for a disease with no known cause, from the Greek stems *idio* (peculiar or separate) and *pathy* (disease).

- cutting
- electrolysis
- shaving
- tweezing
- waxing
- using hair-removing creams (depilatories)

Low-dose dexamethasone (a synthetic adrenocortical steroid), birth-control pills, or medications that suppress male hormones (for example, spironolactone) may be prescribed for patients whose condition stems from high androgen levels.

Treatment of secondary hirsutism is determined by the underlying cause of the condition.

Prognosis

Birth-control pills alone cause this condition to stabilize in one of every two patients and to improve in one of every 10.

When spironolactone (Aldactone) is prescribed to suppress hair growth, 70% of patients experience improvement within six months. When women also take birth-control pills, menstrual cycles become regular and hair growth is suppressed even more.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216-2809. (205) 978-5000. <http://www.asrm.com>.

OTHER

"Hirsutism and Hyperandrogenism in Women." *Advanced Fertility Center of Chicago*. 26 Apr. 1998 <http://www.advancedfertility.com/hirsute.htm>.

Maureen Haggerty

Hispanic American health *see* **Minority health**

Histamine *see* **Antiulcer drugs**
Histamine headache *see* **Cluster headache**

Histiocytosis X

Definition

Histiocytosis X is a generic term that refers to an increase in the number of histiocytes, a type of white blood cell, that act as scavengers to remove foreign material from the blood and tissues. Since recent research demonstrated Langerhan cell involvement as well as histiocytes, this led to a proposal that the term Langerhans Cell Histiocytosis (LCH) be used in place of histiocytosis X. Either term refers to three separate illnesses (listed in order of increasing severity): eosinophilic granuloma, Hand-Schuller-Christian disease and Letterer-Siwe disease.

Description

Epidermal (skin) Langerhans cells (a form of dendritic cell) accumulate with other immune cells in various parts of the body and cause damage by the release of chemicals. Normally, Langerhans cells recognize foreign material, including bacteria, and stimulate the immune system to react to them. Langerhans cells are usually found in skin, lymph nodes, lungs, and the gastrointestinal tract. Under abnormal conditions these cells affect skin, bone, and the pituitary gland as well as the lungs, intestines, liver, spleen, bone marrow, and brain. Therefore, the disease is not confined to areas where Langerhans cells are normally found. The disease is more common in children than adults and tends to be most severe in very young children.

Histiocytosis X or LCH is a family of related conditions characterized by a distinct inflammatory and proliferative process but differs from each other in which parts of the body are involved. The least severe of the histiocytosis X/LCH family is eosinophilic granuloma. Approximately 60–80% of all diagnosed cases are in this classification, which usually occurs in children aged five to 10 years. The bones are involved 50–75% of the time, which includes the skull, or mandible, and the long bones. If the bone marrow is involved, anemia can result. With skull involvement, growths can occur behind the eyes, bulging them forward. The lungs are involved less than 10% of the time, and this involvement signals the worst prognosis.

Next in severity is Hand-Schuller-Christian disease, a chronic, scattered form of histiocytosis. It occurs most commonly from the age of one to three years and is a slowly progressive disease that affects the softened areas of the skull, other flat bones, the eyes, and skin. Letterer-Siwe disease is the acute form of this series of diseases. It is generally found from the time of birth to one year of age. It causes an enlarged liver, bruising and **skin lesions**, anemia, enlarged lymph glands, other organ involvement, and extensive skull lesions.

KEY TERMS

Anemia—Abnormally low level of red blood cells in the blood.

Biopsy—Surgical removal of tissue for examination.

CT or CAT—Computed tomography, a radiologic imaging that uses computer processing to generate an image of tissue density in slices through the patient's body.

Cytokines—The term used to include all protein messengers that regulate immune responses.

Dendritic—Branched like a tree.

Eosinophils—A leukocyte with coarse, round granules present.

Epidermal—The outermost layer of the skin.

Inflammatory—A localized protective response of the body caused by injury or destruction of tissues.

MRI—Magnetic resonance imaging, a noninvasive nuclear procedure that uses electromagnetic energy to create images of structures inside the body.

Pituitary gland—The master gland located in the middle of the head that controls the endocrine glands and affects most bodily functions.

Prostaglandins—A group of nine naturally occurring chemicals in the body that affect smooth muscles.

Serous—Thin and watery, like serum.

Causes and symptoms

This is a rare disorder affecting approximately 1 in 200,000 children or adults each year. Because it is so rare, little research has been done to determine the cause. Over time, it may lessen in its assault on the body but there are still problems from damage to the tissues. There are no apparent inheritance patterns in these diseases with the exception of a form involving the lymphatic system.

The symptoms of histiocytosis are caused by substances called cytokines and prostaglandins, which are nor-

mally produced by histiocytes and act as messengers between cells. When these chemicals are produced in excess amounts and in the wrong places, they cause tissue swelling and abnormal growth. Thus, symptoms may include painful lumps in the skull and limbs as well as **rashes** on the skin. General symptoms may include: poor appetite, failure to gain weight, recurrent **fever**, and irritability. Symptoms from other possible sites of involvement include:

- gums: Swelling, usually without significant discomfort
- ear: Chronic discharge
- liver or spleen: Abdominal discomfort or swelling
- pituitary: This gland at the base of the brain is affected at some stage in approximately 20%–30% of children causing a disturbance in water balance to produce thirst and frequent urination.
- eyes: Due to the bony disease, behind-the-eye bulging may occur (exophthalmos)
- lungs: Breathing problems

Diagnosis

The diagnosis can only be made by performing a biopsy, that is, taking a tissue sample under anesthesia from a site in the patient thought to be involved. Blood and urine tests, chest and other x rays, **magnetic resonance imaging** (MRI) and **computed tomography scans** (CAT scans) (to check the extent of involvement), and possibly bone marrow or breathing tests may be required to confirm the diagnosis.

Treatment

Although this disease is not **cancer**, most patients are treated in cancer clinics. There are two reasons for this:

- Historically, cancer specialists treated it before the cause was known.
- The treatment requires the use of drugs typically required to treat cancer.

Any cancer drugs utilized are usually given in smaller doses, which diminishes the severity of their side effects. **Radiation therapy** is rarely used, and special drugs may be prescribed for skin symptoms. If there is only one organ affected, steroids may be injected locally, or a drug called indomethacin may be used. Indomethacin is an anti-inflammatory medication that may achieve a similar response with less severe side effects.

Prognosis

The disease fluctuates markedly. If only one system is involved, the disease often resolves by itself. Multisystem disease usually needs treatment although it may disappear spontaneously. The disease is not normally fatal unless organs vital to life are damaged. In general, the younger the child at diagnosis and the more organs involved, the poorer the outlook. If the condition resolves, there could still be long-term complications because of the damage done while the disease was active.

Resources

BOOKS

Behrman, Richard E., Robert Kliegman, and Hal B. Jenson, eds. *Nelson Textbook of Pediatrics,* Philadelphia: W. B. Saunders, 2000.

PERIODICALS

Kobyahsi, M., O. Yamamoto, Y. Suenaga, and M. Asahi. "Electron Microscopic Study of Langerhans Cell Histiocytosis." *Journal of Dermatology* (July 27, 2000): 453–7.

Kusumakumary, P., F. V. James, V. G. Chellam, K. Ratheesan, and M. K. Nair. "Disseminated Langerhans Cell Histiocytosis in Children: Treatment Outcome." *American Journal of Clinical Oncology,* (April 2, 1999): 180–83.

ORGANIZATIONS

Histiocytosis Association of America, 302 North Broadway, Pitman, NJ 08071. 800–548–2758 (USA and Canada). <http://www.histio.org>.

OTHER

"Immunity Disorders." *Nurse Minerva*. 26 June 2001. <http://nurseminerva.co.uk/immunity.htm>.

Linda K. Bennington, CNS

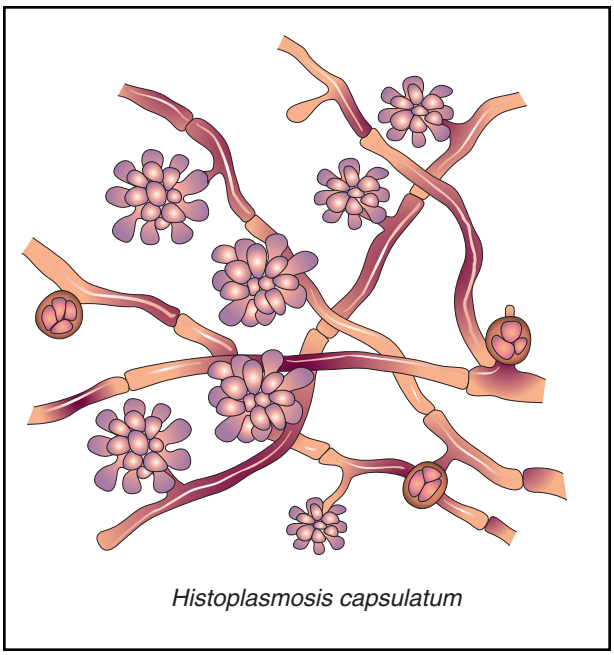
Histoplasmosis

Definition

Histoplasmosis is an infectious disease caused by inhaling the microscopic spores of the fungus *Histoplasma capsulatum*. The disease exists in three forms. Acute or primary histoplasmosis causes flu-like symptoms. Most people who are infected recover without medical intervention. Chronic histoplasmosis affects the lungs and can be fatal. Disseminated histoplasmosis affects many organ systems in the body and is often fatal, especially to people with acquired **immunodeficiency** syndrome (**AIDS**).

Description

Histoplasmosis is an airborne infection. The spores that cause this disease are found in soil that has been contaminated with bird or bat droppings. In the United



***Histoplasma capsulatum*. If a person inhales the spores of this fungus, they may contract histoplasmosis, an infectious disease which can exist in three forms: acute or primary histoplasmosis, which causes flu-like symptoms; chronic histoplasmosis, which affects the lungs and can be fatal; and disseminated histoplasmosis, which can affect multiple body systems and is often fatal.** *(Illustration by Electronic Illustrators Group.)*

States, the disease is most common in eastern and midwestern states and is widespread in the upper Mississippi, Ohio, Missouri, and St. Lawrence river valleys. Sometimes histoplasmosis is called Ohio Valley disease, Central Mississippi River Valley disease, Appalachian Mountain disease, Darling's disease, or *Histoplasma capsulatum* infection.

Anyone can get histoplasmosis, but people who come in contact with bird and bat excrement are more likely to be infected. This includes farmers, gardeners, bridge inspectors and painters, roofers, chimney cleaners, demolition and construction workers, people installing or servicing heating and air conditioning units, people restoring old or abandoned buildings, and people who explore caves.

The very young and the elderly, especially if they have a pre-existing lung disease or are heavy smokers, are more likely to develop symptoms that are more severe. People who have a weakened immune system, either from diseases such as AIDS or leukemia, or as the result of medications they take (**corticosteroids**, **chemotherapy** drugs), are more likely to develop chronic or disseminated histoplasmosis.

Causes and symptoms

When the spores of *H. capsulatum* are inhaled, they lodge in the lungs where they divide and cause lesions. This is known as acute or primary histoplasmosis. It is not contagious.

Many otherwise healthy people show no symptoms of infection at all. When symptoms do occur, they appear 3–17 days after exposure (average time is 10 days). The symptoms are usually mild and resemble those of a cold or flu; **fever**, dry **cough**, enlarged lymph glands, tiredness, and a general feeling of ill health. A small number of people develop bronchopneumonia. About 95% of people who are infected either experience no symptoms or have symptoms that clear up spontaneously. These people then have partial immunity to re-infection.

In some people, the spores that cause the disease continue to live in the lungs. In about 5% of people who are infected, usually those with chronic lung disease, diabetes mellitis, or weakened immune systems, the disease progresses to chronic histoplasmosis. This can take months or years. Symptoms of chronic histoplasmosis resemble those of **tuberculosis**. Cavities form in the lung tissue, parts of the lung may collapse, and the lungs fill with fluid. Chronic histoplasmosis is a serious disease that can result in **death**.

The rarest form of histoplasmosis is disseminated histoplasmosis. Disseminated histoplasmosis is seen almost exclusively in patients with AIDS or other immune defects. In disseminated histoplasmosis the infection may move to the spleen, liver, bone marrow, or adrenal glands. Symptoms include a worsening of those found in chronic histoplasmosis, as well as weight loss, **diarrhea**, the development of open sores in the mouth and nose, and enlargement of the spleen, liver, and adrenal gland.

Diagnosis

A simple skin test similar to that given for tuberculosis will tell if a person has previously been infected by the fungus *H. capsulatum*. Chest x rays often show lung damage caused by the fungus, but do not lead to a definitive diagnosis because the damage caused by other diseases has a similar appearance on the x ray. Diagnosis of chronic or disseminated histoplasmosis can be made by culturing a sample of sputum or other body fluids in the laboratory to isolate the fungus. The urine, blood serum, washings from the lungs, or cerebrospinal fluid can all be tested for the presence of an antigen produced in response to the infection. Most cases of primary histoplasmosis go undiagnosed.

Treatment

Acute primary histoplasmosis generally requires no treatment other than rest. Non-prescription drugs such as

acetaminophen (Tylenol) may be used to treat **pain** and relieve fever. Avoiding smoke and using a cool air humidifier may ease chest pain.

Patients with an intact immune system who develop chronic histoplasmosis are treated with the drug ketoconazole (Nizoral) or amphotericin B (Fungizone). Patients with suppressed immune systems are treated with amphotericin B, which is given intravenously. Because of its potentially toxic side effects, hospitalization is often required. The patient may also receive other drugs to minimize the side effects of the amphotericin B.

Patients with AIDS must continue to take the drug itraconazole (Sporonox) orally for the rest of their lives in order to prevent a relapse. If the patient can not tolerate itraconazole, the drug fluconazole (Diflucan) can be substituted.

Alternative treatment

In non-immunocompromised patients, alternative therapies can be very successful. Alternative treatment for fungal infections focuses on creating an environment where the fungus cannot survive. This is accomplished by maintaining good health and eating a diet low in dairy products, sugars, including honey and fruit juice, and foods like beer that contain yeast. This is complemented by a diet high in raw food. Supplements of antioxidant **vitamins** C, E, and A, along with B complex, may also be added to the diet. *Lactobacillus acidophilus* and *Bifidobacteria* will replenish the good bacteria in the intestines. Antifungal herbs, like garlic, can be consumed in relatively large does and for an extended period of time in order to be most effective.

Prognosis

Most people recover from primary histoplasmosis in a few weeks without medical intervention. Patients with chronic histoplasmosis who are treated with antifungal drugs generally recover rapidly if they do not have an underlying serious disease. When left untreated, or if serious disease is present, histoplasmosis can be fatal.

AIDS patients with disseminated histoplasmosis vary in their response to amphotericin B, depending on their general health and how well they tolerate the side effects of the drug. Treatment often suppresses the infection temporarily, but patients with AIDS are always in danger of a relapse and must continue to take medication for the rest of their lives to keep the infection at bay. New combinations of therapies and new drugs are constantly being evaluated, making hard statistics on prognosis difficult to come by. AIDS patients have problems with multiple opportunistic infections, making it difficult to isolate death rates due to any one particular fungal infection.

KEY TERMS

Acidophilus—The bacteria *Lactobacillus acidophilus,* usually found in yogurt.

Adrenal gland—A pair of organs located above the kidneys. The outer tissue of the gland produces the hormones epinephrine (adrenaline) and norepinephrine, while the inner tissue produces several steroid hormones.

Antigen—A foreign protein to which the body reacts by making antibodies.

Bifidobacteria—A group of bacteria normally present in the intestine. Commercial supplements are available.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Prevention

Since the spores of *H. capsulatum* are so widespread, it is almost impossible to prevent exposure in endemic areas. Dust suppression measures when working with contaminated soil may help limit exposure. Individuals who are at risk of developing the more severe forms of the disease should avoid situations where they will be exposed to bat and bird droppings.

Resources

BOOKS

Griffith, H. Winter. *Complete Guide to Symptoms, Illness & Surgery.* Putnam Berkely Group, 1995.

PERIODICALS

Medical Mycology Research Center. *Histoplasmosis capsulati and Histoplasmosis duboisii*. University of Texas Medical Branch at Galveston. (May 1997). <http://www.fungus.utmb.edu>.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Center for Infectious Diseases. Atlanta, Georgia. 404-639-3158. <http://www.cdc.gov/ncidod/ncid/ncid.htm.>

National Institute for Occupational Safety and Health. Cincinnati, Ohio. 800-356-4674.

OTHER

Histoplasmosis: Protecting Workers at Risk. Centers for Disease Control and Prevention. <http://www.cdc.gov/niosh/97146eng.html>.

Tish Davidson

HIV infection *see* **AIDS**

Hives

Definition

Hives is an allergic skin reaction causing localized redness, swelling, and **itching**.

Description

Hives is a reaction of the body's immune system that causes areas of the skin to swell, itch, and become reddened (wheals). When the reaction is limited to small areas of the skin, it is called "urticaria." Involvement of larger areas, such as whole sections of a limb, is called "angioedema."

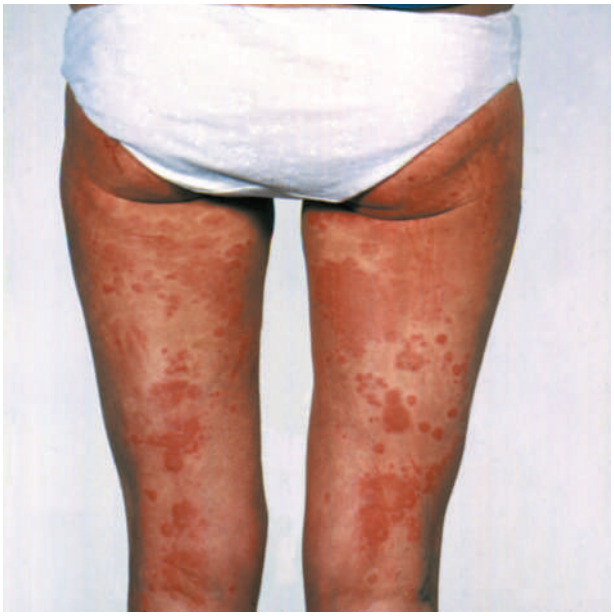
Causes and symptoms

Causes

Hives is an allergic reaction. The body's immune system is normally responsible for protection from foreign invaders. When it becomes sensitized to normally harmless substances, the resulting reaction is called an allergy. An attack of hives is set off when such a substance, called an allergen, is ingested, inhaled, or otherwise contacted. It interacts with immune cells called mast cells, which reside in the skin, airways, and digestive system. When mast cells encounter an allergen, they release histamine and other chemicals, both locally and into the bloodstream. These chemicals cause blood vessels to become more porous, allowing fluid to accumulate in tissue and leading to the swollen and reddish appearance of hives. Some of the chemicals released sensitize **pain** nerve endings, causing the affected area to become itchy and sensitive.

A wide variety of substances may cause hives in sensitive people, including foods, drugs, and insect bites or stings. Common culprits include:

- nuts, especially peanuts, walnuts, and Brazil nuts
- fish, mollusks, and shellfish
- eggs
- wheat
- milk
- strawberries
- food additives and preservatives
- penicillin or other **antibiotics**



Hives on the back of a young woman's legs. The accompanying inflammation develops as an allergic reaction which ranges in size from small spots to patches measuring several inches across. *(Photograph by John Radcliffe, Custom Medical Stock Photo. Reproduced by permission.)*

- flu vaccines
- tetanus toxoid vaccine
- gamma globulin
- bee, wasp, and hornet stings
- bites of mosquitoes, fleas, and scabies

Symptoms

Urticaria is characterized by redness, swelling, and itching of small areas of the skin. These patches usually grow and recede in less than a day, but may be replaced by others in other locations. Angioedema is characterized by more diffuse swelling. Swelling of the airways may cause **wheezing** and respiratory distress. In severe cases, airway obstruction may occur.

Diagnosis

Hives are easily diagnosed by visual inspection. The cause of hives is usually apparent, but may require a careful medical history in some cases.

Treatment

Mild cases of hives are treated with **antihistamines**, such as diphenhydramine (Benadryl). More severe cases may require oral **corticosteroids**, such as prednisone. Top-

KEY TERMS

Allergen—A substance capable of producing an immediate type of hypersensitivity,or allergy.

Wheal—A smooth, slightly elevated area on the body surface, which is redder or paler than the surrounding skin.

ical corticosteroids are not effective. Airway swelling may require emergency injection of epinephrine (adrenaline).

Alternative treatment

An alternative practitioner will try to determine what allergic substance is causing the reaction and help the patient eliminate or minimize its effects. To deal with the symptoms of hives, an oatmeal bath may help to relieve itching. Chickweed (*Stellaria media*), applied as a poultice (crushed or chopped herbs applied directly to the skin) or added to bath water, may also help relieve itching. Several homeopathic remedies, including *Urtica urens* and *Apis* (*Apis mellifica*), may help relieve the itch, redness, or swelling associated with hives.

Prognosis

Most cases of hives clear up within one to seven days without treatment, providing the cause (allergen) is found and avoided.

Prevention

Preventing hives depends on avoiding the allergen causing them. Analysis of new items in the diet or new drugs taken may reveal the likely source of the reaction. Chronic hives may be aggravated by **stress**, **caffeine**, alcohol, or tobacco; avoiding these may reduce the frequency of reactions.

Resources

BOOKS

Lawlor Jr., G. J., T. J. Fischer, and D. C. Adelman. *Manual of Allergy and Immunology.* Little, Brown, and Co., 1995.

Novick, N. L. *You Can Do Something About Your Allergies.* MacMillan, 1994.

Richard Robinson

HLA-B27 antigen test *see* **Tissue typing**

HLA test *see* **Human leukocyte antigen test**

HMG-CoA reductase inhibitors *see* **Cholesterol-reducing drugs**

Hodgkin's disease

Definition

Hodgkin's disease is a rare lymphoma, a **cancer** of the lymphatic system.

Description

Hodgkin's disease, or Hodgkin's lymphoma, was first described in 1832 by Thomas Hodgkin, a British physician. Hodgkin clearly differentiated between this disease and the much more common non-Hodgkin's lymphomas. Prior to 1970, few individuals survived Hodgkin's disease. Now, however, the majority of individuals with this cancer can be cured.

The lymphatic system

The lymphatic system is part of the body's immune system, for fighting disease, and a part of the blood-producing system. It includes the lymph vessels and nodes, and the spleen, bone marrow, and thymus. The narrow lymphatic vessels carry lymphatic fluid from throughout the body. The lymph nodes are small organs that filter the lymphatic fluid and trap foreign substances, including viruses, bacteria, and cancer cells. The spleen, in the upper left abdomen, removes old cells and debris from the blood. The bone marrow, the tissue inside the bones, produces new red and white blood cells.

Lymphocytes are white blood cells that recognize and destroy disease-causing organisms. Lymphocytes are produced in the lymph nodes, spleen, and bone marrow. They circulate throughout the body in the blood and lymphatic fluid. Clusters of immune cells also exist in major organs.

Hodgkin's lymphoma

Hodgkin's disease is a type of lymphoma in which antibody-producing cells of the lymphatic system begin to grow abnormally. It usually begins in a lymph node and progresses slowly, in a fairly predictable way, spreading via the lymphatic vessels from one group of lymph nodes to the next. Sometimes it invades organs that are adjacent to the lymph nodes. If the cancer cells spread to the blood, the disease can reach almost any site in the body. Advanced cases of Hodgkin's disease may involve the spleen, liver, bone marrow, and lungs.

There are different subtypes of Hodgkin's disease:

- nodular sclerosis (30–60% of cases)
- mixed cellularity (20–40% of cases)
- lymphocyte predominant (5–10% of cases)
- lymphocyte depleted (less than 5% of cases)
- unclassified

Demographics

The American Cancer Society estimates that there will be 7,400 new cases of Hodgkin's disease in the United States in 2001—3,500 in females and 3,900 in males. It is estimated that 700 men and 600 women in the United States will die of the disease in 2001.

Hodgkin's disease can occur at any age. However, the majority of cases develop in early adulthood (ages 15–40) and late adulthood (after age 55). Approximately 10–15% of cases are in children under age 17. It is more common in boys than in girls under the age of 10. The disease is very rare in children under five.

Causes and symptoms

The cause of Hodgkin's disease is not known. It is suspected that some interaction between an individual's genetic makeup, environmental exposures, and infectious agents may be responsible. Immune system deficiencies also may be involved.

Early symptoms of Hodgkin's disease may be similar to those of the flu:

- fevers, night sweats, chills
- **fatigue**
- loss of appetite
- weight loss
- itching
- pain after drinking alcoholic beverages
- swelling of one or more lymph nodes

Sudden or emergency symptoms of Hodgkin's disease include:

- sudden high fever
- loss of bladder and/or bowel control
- numbness in the arms and legs and a loss of strength

As lymph nodes swell, they may push on other structures, causing a variety of symptoms:

- pain due to pressure on nerve roots
- loss of function in muscle groups served by compressed nerves
- coughing or **shortness of breath** due to compression of the windpipe and/or airways, by swollen lymph nodes in the chest
- kidney failure from compression of the ureters, the tubes that carry urine from the kidneys to the bladder
- swelling in the face, neck, or legs, due to pressure on veins
- paralysis in the legs due to pressure on the spinal cord

As Hodgkin's disease progresses, the immune system becomes less effective at fighting infection. Thus, patients with Hodgkin's lymphoma become more susceptible to both common infections caused by bacteria and unusual (opportunistic) infections. Later symptoms of Hodgkin's disease include the formation of tumors.

Significantly, as many as 75% of individuals with Hodgkin's disease do not have any typical symptoms.

Diagnosis

As with many forms of cancer, diagnosis of Hodgkin's disease has two major components.

- identification of Hodgkin's lymphoma as the cause of the patient's disease
- staging of the disease to determine how far the cancer has spread

The initial diagnosis of Hodgkin's disease often results from abnormalities in a **chest x ray** that was performed because of nonspecific symptoms. The physician then takes a medical history to check for the presence of symptoms and conducts a complete **physical examination**.

Lymph node biopsy

The size, tenderness, firmness, and location of swollen lymph nodes are determined and correlated with any signs of infection. In particular, lymph nodes that do not shrink after treatment with **antibiotics** may be a cause for concern. The lymph nodes that are most often affected by Hodgkin's disease include those of the neck, above the collarbone, under the arms, and in the chest above the diaphragm.

Diagnosis of Hodgkin's disease requires either the removal of an entire enlarged lymph node (an excisional biopsy) or an incisional biopsy, in which only a small part of a large tumor is removed. If the node is near the skin, the biopsy is performed with a local anesthetic. However, if it is inside the chest or abdomen, general anesthesia is required.

The sample of biopsied tissue is examined under a microscope. Giant cells called Reed-Sternberg cells must be present to confirm a diagnosis of Hodgkin's disease.

These cells, which usually contain two or more nuclei, are named for the two pathologists who discovered them. Normal cells have only one nucleus (the organelle within the cell that contains the genetic material). Affected lymph nodes may contain only a few Reed-Sternberg cells and they may be difficult to recognize. Characteristics of other types of cells in the biopsied tissue help to diagnose the subtype of Hodgkin's disease.

A fine needle aspiration (FNA) biopsy, in which a thin needle and syringe are used to remove a small amount of fluid and bits of tissue from a tumor, has the advantage of not requiring surgery. An FNA may be performed prior to an excisional or incisional biopsy, to check for infection or for the spread of cancer from another organ. However an FNA biopsy does not provide enough tissue to diagnose Hodgkin's disease.

Occasionally, additional biopsies are required to diagnose Hodgkin's disease. In rare instances, other tests, that detect certain substances on the surfaces of cancer cells or changes in the DNA of cells, are used to distinguish Hodgkin's disease from non-Hodgkin's lymphoma.

Clinical staging

Staging is very important in Hodgkin's disease. This is because the cancer usually spreads in a predictable pattern, without skipping sets of lymph nodes until late in the progression of the disease.

IMAGING. Imaging of the abdomen, chest, and pelvis is used to identify areas of enlarged lymph nodes and abnormalities in the spleen or other organs. Computerized axial tomography (CT or CAT) scans use a rotating x ray beam to obtain pictures. **Magnetic resonance imaging** (MRI) uses magnetic fields and radio waves to produce images of the body. Chest x rays also may be taken. These images will reveal rounded lumps called nodules in the affected lymph nodes and other organs.

Another imaging technique for Hodgkin's disease is a gallium scan, in which the radioactive element gallium is injected into a vein. The cancer cells take up the gallium and a special camera that detects the gallium is used to determine the location and size of tumors. Gallium scans are used when Hodgkin's disease is in the chest and may be hard to detect by other methods. Gallium scans also are used to monitor progress during treatment.

A lymphangiogram, a radiograph of the lymphatic vessels, involves injecting a dye into a lymphatic vessel in the foot. Tracking of the dye locates the disease in the abdomen and pelvis. This method is used less frequently and is usually not used with children.

Positron emission tomography (**PET**) scans are an extremely accurate method for staging Hodgkin's disease. A very low dose of radioactive glucose, a sugar, is injected into the body. The glucose travels to metabolically-active sites, including cancerous regions that require large amounts of glucose. The PET scan detects the radioactivity and produces images of the entire body that distinguish between cancerous and non-cancerous tissues.

BONE MARROW. Anemia (a low red-blood-cell count), fevers, or night sweats are indications that Hodgkin's disease may be in the bone marrow. In these cases, a bone-marrow biopsy, in which a large needle is used to remove a narrow, cylindrical piece of bone, may be necessary to determine the spread of the cancer. Alternatively, an aspiration, in which a needle is used to remove small bits of bone marrow, may be used. The marrow usually is removed from the back of the hip or other large bone.

Pathological staging

Sometimes further staging, called pathological staging or a staging laparotomy, is used for Hodgkin's disease. In this operation, a surgeon checks the abdominal lymph nodes and other organs for cancer and removes small pieces of tissue. A pathologist examines the tissue samples for Hodgkin's disease cells. Usually the spleen

DOROTHY MENDENHALL (1874–1964)

Dorothy Reed Mendenhall, the last of three children, was born September 22, 1874, in Columbus, Ohio, to William Pratt Reed, a shoe manufacturer, and Grace Kimball Reed, both of whom had descended from English settlers who came to America in the seventeenth century. Mendenhall attended Smith College and obtained a baccalaureate degree. Although she initially contemplated a career in journalism, Mendenhall's interest in medicine was inspired by a biology course she attended.

Dorothy Reed Mendenhall was a well respected researcher, obstetrician, and pioneer in methods of childbirth. She was the first to discover that Hodgkin's disease was not a form of tuberculosis, as had been thought. This finding received international acclaim. As a result of her work, the cell type characteristic of Hodgkin's disease bears her name. The loss of her first child due to poor obstetrics changed her research career to a lifelong effort to reduce infant mortality rates. Mendenhall's efforts paid off with standards being set for weight and height for children ages birth to six and also in programs that stressed the health of both the mother and child in the birthing process.

is removed (a **splenectomy**) during the laparotomy. The splenectomy helps with staging Hodgkin's disease, as well as removing a disease site.

Treatment

The stages

All of the available treatments for Hodgkin's disease have serious side effects, both short and long-term. However, with accurate staging, physicians and patients often can choose the minimum treatment that will cure the disease. The staging system for Hodgkin's disease is the Ann Arbor Staging Classification, also called the Cotswold System or the Revised Ann Arbor System.

Hodgkin's disease is divided into four stages, with additional substages:

- Stage I: The disease is confined to one lymph node area
- Stage IE: The disease extends from the one lymph node area to adjacent regions
- Stage II: The disease is in two or more lymph node areas on one side of the diaphragm (the muscle below the lungs)
- Stage IIE: The disease extends to adjacent regions of at least one of these nodes
- Stage III: The disease is in lymph node areas on both sides of the diaphragm
- Stage IIIE/IIISE: The disease extends into adjacent areas or organs (IIIE) and/or the spleen (IIISE)
- Stage IV: The disease has spread from the lymphatic system to one or more other organs, such as the bone marrow or liver

Treatment for Hodgkin's disease depends both on the stage of the disease and whether or not symptoms are present. Stages are labeled with an A if no symptoms are present. If symptoms are present, the stage is labeled with a B. These symptoms include:

- loss of more than 10% of body weight over the previous six months
- fevers above 100°F (37.7°C)
- drenching night sweats

Radiation therapy

Radiation therapy and/or **chemotherapy** (drug therapy) are the standard treatments for Hodgkin's disease. If the disease is confined to one area of the body, radiotherapy is usually used. This treatment, with x rays or other high-energy rays, also is used when the disease is in bulky areas such as the chest, where chemotherapeutic drugs cannot reach all of the cancer. External-beam radiation, a focused beam from an external machine, is used to irradiate only the affected lymph nodes. This procedure is called involved field radiation.

More advanced stages of Hodgkin's disease may be treated with mantle field radiation, in which the lymph nodes of the neck, chest, and underarms are irradiated. Inverted Y field radiation is used to irradiate the spleen and the lymph nodes in the upper abdomen and pelvis. Total nodal irradiation includes both mantle field and inverted Y field radiation.

Since external-beam radiation damages healthy tissue near the cancer cells, the temporary side effects of radiotherapy can include sunburn-like skin damage, fatigue, nausea, and **diarrhea**. Other temporary side effects may include a **sore throat** and difficulty swallowing. Long-term side effects depend on the dose and the location of the radiation and the age of the patient. Since radiation of the ovaries causes permanent sterility (the inability to have offspring), the ovaries of girls and young women are protected during radiotherapy. Sometimes the ovaries are surgically moved from the region to be irradiated.

Chemotherapy

If the Hodgkin's disease has progressed to additional lymph nodes or other organs, or if there is a recurrence of the disease within two years of radiation treatment, chemotherapy is used.

Chemotherapy utilizes a combination of drugs, each of which kills cancer cells in a different way. The most common chemotherapy regimens for Hodgkin's disease are MOPP (either mechlorethamine or methotrexate with Oncovin, procarbazine, prednisone) and ABVD (Adriamycin or doxorubicin, bleomycin, vincristine, dacarbazine). Each of these consists of four different drugs. ABVD is used more frequently than MOPP because it has fewer severe side effects. However MOPP is used for individuals who are at risk for **heart failure**. The chemotherapeutic drugs may be injected into a vein or muscle, or taken orally, as a pill or liquid.

Children who are sexually mature when they develop Hodgkin's disease, and whose muscle and bone mass are almost completely developed, usually receive the same treatment as adults. Younger children usually are treated with chemotherapy, since radiation will adversely affect bone and muscle growth. However, radiation may be used in low dosages, in combination with chemotherapy. The chemotherapy for children with Hodgkin's disease usually includes more drugs than ABVD and MOPP.

The side effects of chemotherapy for Hodgkin's disease depend on the dose of drugs and the length of time they are taken. Since these drugs target rapidly dividing cancer

cells, they also affect normal cells that grow rapidly. These include the cells of the bone marrow, the linings of the mouth and intestines, and hair follicles. Damage to bone marrow leads to lower white blood cell counts and lower resistance to infection. It also leads to lower red blood cell counts, which can result in fatigue and easy bleeding and bruising. Damage to intestinal cells leads to a loss of appetite, nausea, and vomiting. Mouth sores and hair loss also are common side effects of chemotherapy. These side effects disappear when the chemotherapy is discontinued. Some drugs can reduce or prevent the **nausea and vomiting**.

Chemotherapy for Hodgkin's disease may lead to long-term complications. The drugs may damage the heart, lungs, kidneys, and liver. In children, growth may be impeded. Some chemotherapy can cause sterility, so men may choose to have their sperm frozen prior to treatment. Women may stop ovulating and menstruating during chemotherapy. This may or may not be permanent.

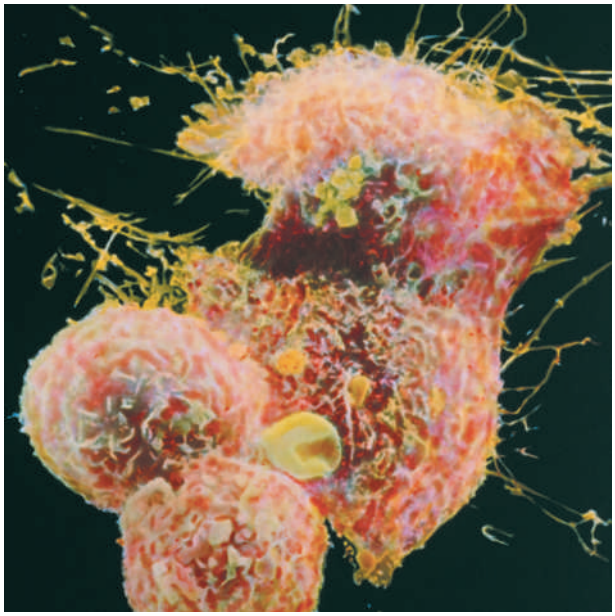
Treatment for higher-stage Hodgkin's disease often involves a combination of radiotherapy and chemotherapy. Following three or four chemotherapy regimens, involved field radiation may be directed at the most affected areas of the body. The long-term side effects often are more severe when radiation and chemotherapy are used in combination.

The development of a second type of cancer is the most serious risk from radiation and chemotherapy treatment for Hodgkin's disease. In particular, there is a risk of developing leukemia, **breast cancer**, bone cancer, or **thyroid cancer**. Chemotherapy, particularly MOPP, or chemotherapy in conjunction with radiotherapy, significantly increases the risk for leukemia.

RESISTANT, PROGRESSIVE, AND RECURRENT HODGKIN'S DISEASE. Following treatment, the original diagnostic tests for Hodgkin's disease are repeated, to determine whether all traces of the cancer have been eliminated and to check for long-term side effects of treatment. In resistant Hodgkin's disease, some cancer cells remain following treatment. If the cancer continues to spread during treatment, it is called progressive Hodgkin's disease. If the disease returns after treatment, it is known as recurrent Hodgkin's disease. It may recur in the area where it first started or elsewhere in the body. It may recur immediately after treatment or many years later.

Additional treatment is necessary with these types of Hodgkin's disease. If the initial treatment was radiation therapy alone, chemotherapy may be used, or vice versa. Chemotherapy with different drugs, or higher doses, may be used to treat recurrent Hodgkin's. However, radiation to the same area is never repeated.

BONE MARROW AND PERIPHERAL BLOOD STEM CELL TRANSPLANTATIONS. An autologous bone marrow and/or a peripheral blood stem cell transplantation (PBSCT) often is recommended for treating resistant or recurrent Hodgkin's disease, particularly if the disease recurs within a few months of a chemotherapy-induced remission. These transplants are autologous because they utilize the individual's own cells. The patient's bone marrow cells or peripheral blood stem cells (immature bone marrow cells found in the blood) are collected and frozen prior to high-dosage chemotherapy, which destroys bone marrow cells. A procedure called leukapheresis is used to collect the stem cells. Following the high-dosage chemotherapy, and possibly radiation, the bone marrow cells or stem cells are reinjected into the individual.



A scanning electron micrograph (SEM) image of dividing Hodgkin's cells from the pleural effusions (abnormal accumulations of fluid in the lungs) of a 55-year-old male patient. *(Photograph by Dr. Andrejs Liepins, Photo Researchers, Inc. Reproduced by permission.)*

Alternative treatment

Most complementary therapies for Hodgkin's disease are designed to stimulate the immune system to destroy cancer cells and repair normal cells that have been damaged by treatment. These therapies are used in conjunction with standard treatment.

Immunologic therapies, also known as immunotherapies, biological therapies, or biological response modifier therapies, utilize substances that are produced by the immune system. These include interferon (an immune system protein), monoclonal antibodies (specially engineered antibodies), colony-stimulating (growth) factors (such as filgrastim), and vaccines. Many immunotherapies for Hodgkin's disease are experimental and available

KEY TERMS

Antibody—An immune system protein that recognizes a specific foreign molecule.

Biopsy—The removal of a small sample of tissue for examination under a microscope; used for the diagnosis of cancer and to check for infection.

Bone marrow—Tissue inside the bones that produce red and white blood cells.

Chemotherapy—Treatment with various combinations of chemicals or drugs, particularly for the treatment of cancer.

Epstein-Barr virus (EBV)—Very common virus that infects immune cells and can cause mononucleosis.

Interferon—A potent immune-defense protein produced by viral-infected cells; used as an anti-cancer and anti-viral drug.

Interleukins—A family of potent immune-defense molecules; used in various medical therapies.

Laparotomy—A surgical incision of the abdomen.

Leukapheresis—A technique that uses a machine to remove stem cells from the blood; the cells are frozen and then returned to the patient following treatment that has destroyed the bone marrow.

Lymph nodes—Small round glands, located throughout the body and containing lymphocytes that remove foreign organisms and debris from the lymphatic fluid.

Lymphatic system—The vessels, lymph nodes, and organs, including the bone marrow, spleen, and thymus, that produce and carry white blood cells to fight disease.

Lymphocyte—White blood cells that produce antibodies and other agents for fighting disease.

PBSCT—Peripheral blood stem cell transplant; a method for replacing blood-forming cells that are destroyed by cancer treatment.

Radiotherapy—Disease treatment involving exposure to x rays or other types of radiation.

Reed-Sternberg cells—An abnormal lymphocyte that is characteristic of Hodgkin's disease.

Spleen—An organ of the lymphatic system, on the left side of the abdomen near the stomach; it produces and stores lymphocytes, filters the blood, and destroys old blood cells.

Splenectomy—Surgical removal of the spleen.

Staging—The use of various diagnostic methods to accurately determine the extent of disease; used to select the appropriate type and amount of treatment and to predict the outcome of treatment.

Stem cells—The cells from which all blood cells are derived.

Thymus—An organ of the lymphatic system, located behind the breast bone, that produces the T lymphocytes of the immune system.

Thyroid—A gland in the throat that produces hormones that regulate growth and metabolism.

only through clinical trials. These biological agents may have side effects.

Coenzyme Q10 (CoQ10) and polysaccharide K (PSK) are being evaluated for their ability to stimulate the immune system and protect healthy tissue, as well as possible anti-cancer activities. Camphor, also known as 714-X, green tea, and hoxsey (which is a mixture of a number of substances), have been promoted as immune system enhancers. However there is no evidence that they are effective against Hodgkin's disease. Hoxsey, in particular, can produce serious side effects.

Prognosis

Hodgkin's disease, particularly in children, is one of the most curable forms of cancer. Approximately 90% of individuals are cured of the disease with chemotherapy and/or radiation.

The one-year relative survival rate following treatment for Hodgkin's disease is 93%. Relative survival rates do not include individuals who die of causes other than Hodgkin's disease. The percentage of individuals who have not died of Hodgkin's disease within five years of diagnosis is 90–95% for those with stage I or stage II disease. The figure is 85–90% for those diagnosed with stage III Hodgkin's and approximately 80% for those diagnosed with stage IV disease. The 15-year relative survival rate is 63%. Approximately 75% of children are alive and cancer free 20 years after the original diagnosis of Hodgkin's.

Acute myelocytic leukemia, a very serious cancer, may develop in as many as 2–6% of individuals receiv-

ing certain types of treatment for Hodgkin's disease. Women under the age of 30 who are treated with radiation to the chest have a much higher risk for developing breast cancer. Both men and women are at higher risk for developing lung or thyroid cancers as a result of chest irradiation.

Individuals with the type of Hodgkin's disease known as nodular lymphocytic predominance have a 2% chance of developing non-Hodgkin's lymphoma. Apparently, this is a result of the Hodgkin's disease itself and not the treatment.

Resources

BOOKS

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy.* Kansas City: Andrews McKeel Publishing, 1997.

Freedman, Arnold S., and Lee M. Nadler. "Hodgkin's Disease." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Mauch, Peter M., et al., eds. *Hodgkin's Disease.* Philadelphia: Lippincott Williams & Wilkins, 1999.

Murphy, Gerald P., et al. *Informed Decisions.* New York: Viking, 1997.

Sutcliffe, Simon B., ed. *Lymphoma and You: A Guide for Patients Living with Hodgkin's Disease and Non-Hodgkin's Lymphoma*. Toronto: The Medicine Group Ltd., 1998.

PERIODICALS

Bhatia, S., L. L. Robison, O. Oberlin, M. Greenberg, G. Bunin, F. Fossati-Bellani, and A. T. Meadows. "Breast Cancer and Other Second Neoplasms after Childhood Hodgkin's Disease." *New England Journal of Medicine* 334, no. 12 (1996): 745-51.

Stoval, Ellen. "A Cancer Survivor Discusses Her Experiences." *Washington Post* 118 (February 14, 1995): WH15+.

ORGANIZATIONS

American Cancer Society. (800) ACS-2345. <http://www.cancer.org>. Provides information, funds for cancer research, prevention programs, and patient services, including education and support programs for patients and families, temporary accommodations for patients, and camps for children with cancer.

ClinicalTrials.gov. U. S. National Library of Medicine. National Institutes of Health. 8600 Rockville Pike, Bethesda, MD 20894. <http://clinicaltrials.gov/ct/gui/c/a1b/screen/BrowseAny/action/GetStudy?JServSessionIdcs_current=mgdpq4z7pm>. Information about clinical trials involving Hodgkin's disease.

Cure for Lymphoma Foundation. 215 Lexington Avenue, New York, NY 10016. (212) 213-9595. (800)-CFL-6848. infocfl@cfl.org. <http://www.cfl.org/home.html>. An advocacy organization that provides education and support programs, research grants, and information on clinical trials for Hodgkin's and non-Hodgkin's lymphomas.

The Leukemia and Lymphoma Society. 600 Third Avenue, New York, NY 10016. (800) 955-4572. (914) 949-5213. <http://www.leukemia-lymphoma.org>. Provides information, support, and guidance to patients and health care professionals.

The Lymphoma Research Foundation of America, Inc. 8800 Venice Boulevard, Suite 207, Los Angeles, CA 90034. (310) 204-7040. <http://www.lymphoma.org>. Supports research into treatments for lymphoma and provides educational and emotional support programs for patients and families.

National Cancer Institute. Public Inquiries Office, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800)-4-CANCER. <http://www.nci.nih.gov/>. <http://cancernet.nci.nih.gov>. Provides information on cancer and on clinical trials; conducts cancer research.

OTHER

FS-8 - Complementary and Alternative Therapies for Leukemia, Lymphoma, Hodgkin's Disease, and Myeloma. The Leukemia and Lymphoma Society. 27 Mar. 2001. <http://www.leukemia-lymphoma.org>.

"Hodgkin's Disease." *Cancer Resource Center.* 10 Dec. 1999. American Cancer Society. 27 Mar. 2001. <http://www3.cancer.org>.

"Hodgkin's Disease." *CancerNet.* 12 Dec. 2000. National Cancer Institute. NIH Publication No. 99-1555. 27 Mar. 2001. <http://cancernet.nci.nih.gov/wyntk_pubs/hodgkins.htm>.

"Hodgkin's Lymphoma." *Diseases & Conditions.* 13 Mar. 2001. MayoClinic.com. 27 Mar. 2001. <http://www.mayohealth.org>.

National Cancer Society. "NCI/PDQ Patient Statement: Adult Hodgkin's Disease." *Oncolink.* Nov. 2000. University of Pennsylvania Cancer Center. 27 Mar. 2001. <http://www.oncolink.upenn.edu/pdq_html/2/engl/200003.html>.

National Cancer Society. "NCI/PDQ Patient Statement: Childhood Hodgkin's Disease." *Oncolink.* Feb. 2001. University of Pennsylvania Cancer Center. 27 Mar. 2001 <http://www.oncolink.upenn.edu/pdq_html/2/engl/203043.html>.

"PET Scans Help Doctors Treat Hodgkin's Disease." *ACS News Today.* 13 Mar. 2001. American Cancer Society. 27 Mar. 2001 <http://www2.cancer.org>.

Rosalyn S. Carson-DeWitt, MD
Margaret Alic, Ph.D.

Holistic medicine

Definition

Holistic medicine is a term used to describe therapies that attempt to treat the patient as a whole person. That is, instead of treating an illness, as in orthodox allopathy, holistic medicine looks at an individual's overall physical, mental, spiritual, and emotional well-being

before recommending treatment. A practitioner with a holistic approach treats the symptoms of illness as well as looking for the underlying cause of the illness. Holistic medicine also attempts to prevent illness by placing a greater emphasis on optimizing health. The body's systems are seen as interdependent parts of the person's whole being. Its natural state is one of health, and an illness or disease is an imbalance in the body's systems. Holistic therapies tend to emphasize proper **nutrition** and avoidance of substances—such as chemicals—that pollute the body. Their techniques are non-invasive.

Some of the world's health systems that are holistic in nature include **naturopathic medicine**, **homeopathy**, and **traditional Chinese medicine**. Many alternative or natural therapies have a holistic approach, although that is not always the case. The term complementary medicine is used to refer to the use of both allopathic and holistic treatments. It is more often used in Great Britain, but is gaining acceptance in the United States.

There are no limits to the range of diseases and disorders that can be treated in a holistic way, as the principle of holistic healing is to balance the body, mind, spirit, and emotions so that the person's whole being functions smoothly. When an individual seeks holistic treatment for a particular illness or condition, other health problems improve without direct treatment, due to improvement in the performance of the immune system, which is one of the goals of holistic medicine.

Origins

The concept of holistic medicine is not new. In the 4th century B.C., Socrates warned that treating one part of the body only would not have good results. Hippocrates considered that many factors contribute to the health or otherwise of a human being, weather, nutrition, emotional factors, and in our time, a host of different sources of pollution can interfere with health. And of course, holistic medicine existed even before ancient Greece in some ancient healing traditions, such as those from India and China, which date back over 5,000 years. However, the term "holistic" only became part of everyday language in the 1970s, when Westerners began seeking an alternative to allopathic medicine.

Interestingly, it was only at the beginning of the twentieth century that the principles of holistic medicine fell out of favor in Western societies, with the advent of major advances in what we now call allopathic medicine. Paradoxically, many discoveries of the twentieth century have only served to confirm many natural medicine theories. In many cases, researchers have set out to debunk holistic medicine, only to find that their research confirms it, as has been the case, for example, with many herbal remedies.

Purpose

Many people are now turning to holistic medicine, often when suffering from chronic ailments that have not been successfully treated by allopathic means. Although many wonderful advances and discoveries have been made in modern medicine, surgery and drugs alone have a very poor record for producing optimal health because they are designed to attack illness. Holistic medicine is particularly helpful in treating chronic illnesses and maintaining health through proper nutrition and **stress** management.

Description

There are a number of therapies that come under the umbrella of "holistic medicine." They all use basically the same principles, promoting not only physical health, but also mental, emotional, and spiritual health. Most emphasize quality nutrition. Refined foods typically eaten in modern America contain chemical additives and preservatives, are high in fat, cholesterol, and sugars, and promote disease. Alternative nutritionists counter that by recommending whole foods whenever possible and minimizing the amount of meat—especially red meat—that is consumed. Many alternative therapies promote **vegetarianism** as a method of **detoxification**.

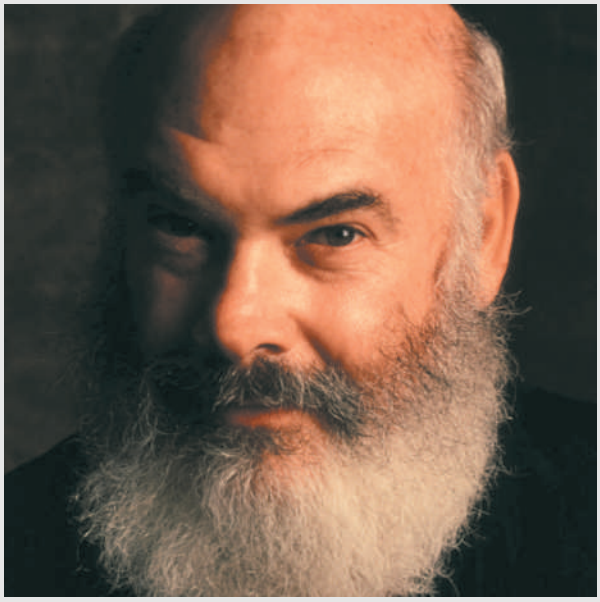
The aim of holistic medicine is to bring all areas of an individual's life, and most particularly the energy flowing through the body, back into harmony. Ultimately, of course, only the patient can be responsible for this, for no practitioner can make the necessary adjustments to diet and lifestyle to achieve health. The practice of holistic medicine does not rule out the practice of allopathic medicine; the two can complement each other.

A properly balanced holistic health regimen, which takes into consideration all aspects of human health and includes noninvasive and nonpharmaceutical healing methods, can often completely eradicate even acute health conditions safely. If a patient is being treated with allopathic medicine, holistic therapies may at least support the body during treatment, and alleviate the symptoms that often come with drug treatments and surgery. In addition, holistic therapies aim at the underlying source of the illness, to prevent recurrence.

Here are some of the major holistic therapies:

- herbal medicine
- homeopathy
- naturopathic medicine
- traditional Chinese medicine
- Ayurvedic medicine

ANDREW WEIL (1942–)



(Photograph by M. Greenberg. Gamma Liaison. Reproduced by permission.)

Dr. Andrew Weil, a Harvard-educated physician, adds credibility and expertise to the natural healing methods he espouses in his best-selling books, on his Internet Web site, in his talk show appearances, and in his popular audio CD of music and **meditation**. Weil's *Spontaneous Healing* spent more than a year on the best-seller list, and his 1997 book, *Eight Weeks to Optimum Health*, also was a runaway best-seller. Perhaps the best-known proponent of naturalistic healing methods, Weil has been trying to establish a field he calls integrative medicine. He is director of Tucson's Center for Integrative Medicine, which he founded in 1993. In 1997, he began training doctors in the discipline at the University of Arizona, where he teaches.

After getting his bachelor's degree in botany from Harvard University, Weil applied for admission to Harvard Medical School in 1964. During his second year, he led a group of students who argued they could succeed better studying on their own than going to classes; in fact, the group got higher scores on their final exams than their classmates. After graduating from Harvard Medical School, he volunteered at the notorious counter- cultural Haight-Asbury Free Clinic in San Francisco, CA. Later in 1969, Weil got a job in Washington, DC, with the National Institute of Mental Health's Drug Studies Division. From 1971 to 1975, he traveled extensively in South America and Africa, soaking up information about medicinal plants, **shamanism**, and natural healing techniques. He never returned to the practice of conventional medicine.

His approach to alternative medicine is eclectic, mingling traditional medicine with herbal therapy, **acupuncture**, **homeopathy**, **chiropractic**, hypnotism, cranial manipulation, and other alternative healing methods. Though his books discuss the benefits of everything from healing touch to herbal cures, Weil doesn't dismiss the benefits of standard Western medicine when appropriate.

- nutritional therapies
- **chiropractic**
- stress reduction
- psychotherapy
- massage

Because holistic medicine aims to treat the whole person, holistic practitioners sometimes may advise treatment from more than one type of practitioner. This is to ensure that all aspects of health are addressed. Some practitioners also specialize in more than one therapy, and so may be able to offer more comprehensive assistance.

Preparations

How to choose a holistic practitioner

- How did you hear of this therapist? A personal referral can sometimes be more reliable than a professional one. What do other professionals say about this therapist? What qualifications, board certification, or affiliations does this practitioner have?
- How do you feel personally about this practitioner? Do you feel comfortable in his/her office and with his/her staff? Is your sense of well being increased? Are you kept waiting for appointments?
- Do you have confidence in this practitioner, does he/she respect you as a person? Does he/she show an interest in your family, lifestyle, and diet? Are various treatment options explained to you?
- Is your personal dignity respected?
- Do you feel that this practitioner is sensitive to your feelings and fears regarding treatment?
- Is this practitioner a good advertisement for his/her profession? Signs of stress or ill health may mean that you would be better off choosing another practitioner.

- Do you feel that you are rushed into decisions, or do you feel that you are allowed time to make an informed choice regarding treatment?
- Are future health goals outlined for you? And do you feel that the practitioner is taking your progress seriously?
- Do you feel unconditionally accepted by this practitioner?
- Would you send your loved ones to this practitioner?

If you answered yes to all the above, then you have found a suitable practitioner. The cost of treatment by a holistic therapist varies widely, depending on the level of qualification and the discipline, so it is best to discuss how much treatment can be expected to cost with a practitioner before beginning a course. Some forms of holistic treatment may be covered by health insurance.

Precautions

Many people who try holistic therapies focus on one area of their health only, often detoxification and nutrition. However, practitioners stress that it is only when all areas of a person's potential well being are tackled that total health and happiness can be achieved. They stress that the spiritual and emotional health contribute just as much as physical and mental health to a person's overall state of well-being.

When seeking treatment from a holistic practitioner, it is important to ensure that they are properly qualified. Credentials and reputation should always be checked. In addition, it is important that allopathic physicians and alternative physicians communicate about a patient's care.

Side effects

One of the main advantages of holistic therapies is that they have few side effects when used correctly. If a reputable practitioner is chosen, and guidelines are adhered to, the worst that typically happens is that when lifestyle is changed, and fresh nutrients are provided, the body begins to eliminate toxins that may have accumulated in the cells over a lifetime.

Often this results in what is known in alternative medicine circles as a "healing crisis." This comes about when the cells eliminate poisons into the blood stream all at the same time, throwing the system into a state of toxic overload until it can clear the "backlog." Symptoms such as nausea, headaches, or sensitivities to noise and other stimulations may be experienced.

The answer to most otherwise healthy patients is often just to lie quietly in a darkened room and take herbal teas. However, in the case of someone who has a serious illness, such as arthritis, colitis, diabetes, or **cancer**, (the list is much longer than this), it is strongly advised that they seek the help of a qualified practitioner. Therapists can help patients achieve detoxification in a way that causes the least stress to their bodies.

Research and general acceptance

Traditionally, holistic medicine, in all its different forms, has been regarded with mistrust and skepticism on the part of the allopathic medical profession. This situation is gradually changing. As of the year 2000, many insurance companies will provide for some form of alternative, or complementary treatment.

In addition, many allopathic physicians, recognizing the role alternative medicine can play in overall health and well being, are actually referring patients to reputable practitioners, particularly chiropractic and relaxation therapists, for help with a varied range of complaints.

Training and certification

Holistic or alternative medicine practitioners are usually affiliated with an organization in their field. Training varies tremendously with the category, and ranges from no qualifications at all—experience only—to holding a Ph.D. from an accredited university. Again, credentials and memberships should be checked by prospective patients.

An excellent source for qualified practitioners is the American Board of Holistic Medicine, (AHBM), which was incorporated in 1996. Also, the American Holistic Medicine Association has a comprehensive list of practitioners in all types of therapies across the United States, which they call "the holistic doctor finder." However, they stress that it is the responsibility of the patient to check each practitioner's credentials prior to treatment.

The ABHM has established the core curriculum upon which board certification for holistic medicine will be based. It includes the following twelve categories:

Body

Physical and environmental health

- nutritional medicine
- exercise medicine
- environmental medicine

Mind

Mental and emotional health

- behavioral medicine

Spirit

Spiritual health

KEY TERMS

Detoxification—Treating the body in such a way that it eliminates poisons accumulated in the cells.

Healing crisis—When the body begins to eliminates toxins at an accelerated rate, unpleasant sensations may be experienced.

- spiritual attunement
- social health

The six specialized areas:

- biomolecular diagnosis and therapy
- botanical medicine
- energy medicine
- ethno-medicine—including traditional Chinese medicine, Ayurveda, and Native American medicine
- homeopathy
- manual medicine

Founded in 1978 for the purpose of uniting practitioners of holistic medicine, membership of the AHMA is open to licensed medical doctors (MDs) and doctors of osteopathic medicine (DOs) from every specialty, and to medical students studying for those degrees. Associate membership is open to health care practitioners who are certified, registered or licensed in the state in which they practice. The mission of the AHMA is to support practitioners in their personal and professional development as healers, and to educate physicians about holistic medicine.

Resources

BOOKS

Goldberg, Burton. *Alternative Medicine: The Definitive Guide*. Future Medicine Publishing, 1993.

Jensen, Dr. Bernard. *Foods That Heal*. Garden City, New York: Avery Publishing Group Inc.,1993.

Murrary, Michael, and Joseph Pizzorno. *Encyclopedia of Natural Medicine, 2nd edition* Rocklin, CA: Prima Health, 1998.

ORGANIZATIONS

American Holistic Medicine Association. <http://www.holisticmedicine.org/index.html>.

Holistic medicine Website. <http://www.holisticmed.com/whatis.html>.

American Holistic Health Association. Dept. R P.O. Box 17400 Anaheim, CA 92817-7400 USA Phone: (714) 779-6152 E-mail: ahha@healthy.net <http://www.healthy.net/pan/chg/ahha/rosen.html>.

Patricia Skinner

Holter monitoring

Definition

Holter monitoring is continuous monitoring of the electrical activity of a patient's heart muscle (**electrocardiography**) for 24 hours, using a special portable device called a Holter monitor. Patients wear the Holter monitor while carrying out their usual daily activities.

Purpose

Holter monitoring is used to help determine whether someone has an otherwise undetected heart disease, such as abnormal heart rhythm (cardiac arrhythmia), or inadequate blood flow through the heart. Specifically, it can detect abnormal electrical activity in the heart that may occur randomly or only under certain circumstances, such as during sleep or periods of physical activity or **stress**, which may or may not be picked up by standard, short-term electrocardiography performed in a doctor's office.

Traditionally, an **exercise stress test** has been used to screen people for "silent" heart disease (heart disease with none of the usual symptoms). However, an exercise stress test is not completely foolproof, often producing false negative results (indicating no heart disease when heart disease is actually present) and false positives (indicating heart disease when there is none). Furthermore, some people cannot undergo exercise stress testing because of other medical conditions, such as arthritis.

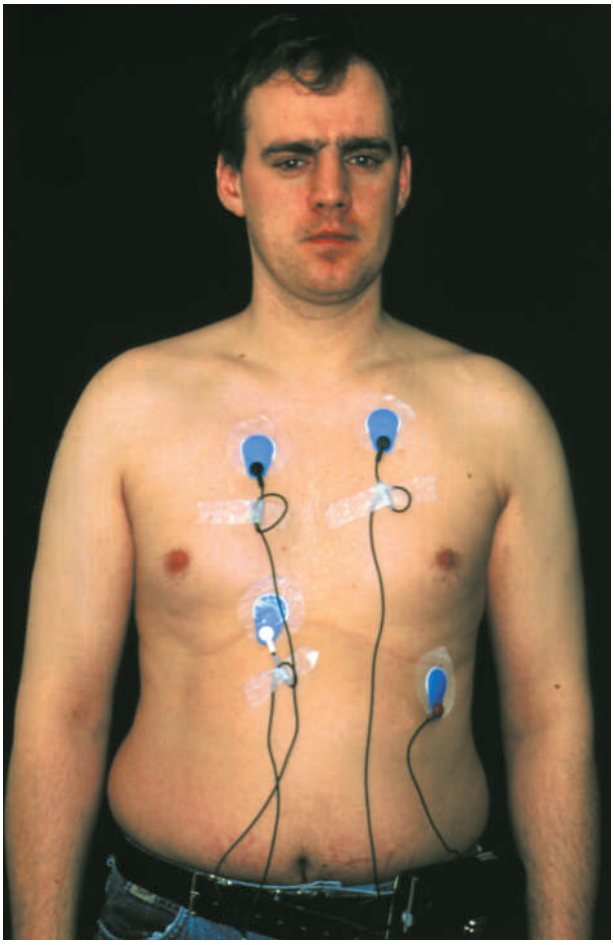
Holter monitoring, also known as ambulatory or 24-hour electrocardiography, offers an alternate means of testing people for heart disease. By monitoring electrocardiographic activity throughout the day, Holter monitoring can uncover heart problems that occur during the patient's everyday activities. It can also help to recognize any activities that may be causing the heart problems. And it can define and correlate symptoms that may be caused by irregularities of the heart.

Precautions

Holter monitoring is an extremely safe procedure and no special precautions are required.

Description

The technician affixes electrodes on the surface of the skin at specific areas of the patient's chest, using adhesive patches with special gel that conducts electrical impulses. Typically, electrodes are placed under each collarbone and each bottom rib, and several electrodes are placed across the chest in a rough outline of the heart.



A male patient wears electrodes attached to his chest, which is connected to a Holter monitor at his waist. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

The electrodes are attached to a portable electrocardiographic device called a Holter monitor, which records the electrical activity of the heart over 24–48 hours. The device is worn over the patient's shoulder or attached to a belt around the waist.

The Holter monitor records the continuous electrical activity throughout the course of the day, while the patient carries out his or her daily activities. During this time, the patient also keeps a detailed log or diary, recording his or her various activities, such as exercise, eating, sleeping, straining, breathing too hard (hyperventilating), and any stressful situations. The patient also notes the time and circumstances of any symptoms—especially chest **pain**, **dizziness**, **shortness of breath**, heart **palpitations**, and any other signs of heart trouble. Some Holter monitors allow patients to record their symptoms electronically, highlighting the portion of the electrocardiogram recorded while the symptoms are occurring.

After 24–48 hours, the Holter monitor is removed. A computer-assisted analysis is performed on the electrocardiographic recording, and the doctor compares the recording against the patient's log to see if there is any correlation between electrocardiographic abnormalities and any of the patient's activities or symptoms. The physician makes a final interpretation.

Preparation

In the doctor's office, electrodes are attached to the patient's chest. In some cases, the patient's chest hair may have to be shaved to facilitate attaching the electrodes. The patient then begins carrying the monitor on a shoulder harness, in a pocket, or on the belt while carrying out his or her usual daily routine. The patient should inform the doctor of any drugs he or she may be taking, because certain drugs can alter heart rhythms and may affect the results of the test.

Aftercare

The patient returns to the doctor's office to have the monitor and electrodes removed. No special measures need to be taken following Holter monitoring. The test results are usually available within a few days after the monitor is removed.

Risks

There are no known risks associated with Holter monitoring. The main complaint that people have with Holter monitoring is that the monitor may be cumbersome and interfere with certain activities, especially sleeping. Bathing and showering are not allowed during the study.

Normal results

A normal Holter monitoring test shows relatively normal electrical activity in the heart around the clock and no evidence of silent **ischemia** (deprivation of oxygen-rich blood).

Abnormal results

An abnormal result on Holter monitoring may indicate ischemia to the heart muscle or heart rhythm disturbances. Abnormalities are especially likely to show up during periods of stress or heavy activity, but sometimes serious abnormalities are recorded while the patient is sleeping.

Resources

BOOKS

Faculty Members of the Yale University School of Medicine. *The Patient's Book of Medical Tests*. Boston: Houghton Mifflin Co., 1997.

PERIODICALS

"Cardiac Stress Testing: New Variations on an Old Theme." *Harvard Men's Health Watch* 1 (Mar. 1997): 1-4.

"Use Cardiac Event Recorders to Evaluate Patients with Palpitations." *Modern Medicine* 64 (May 1996): 49.

"Use Holter Studies When Exercise Tests are Nondiagnostic." *Modern Medicine* 62 (Apr. 1994): 59.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

Holtzman ink blot test

Definition

The Holtzman Inkblot Technique (HIT) is a projective personality assessment test for persons ages five and up.

Purpose

The HIT is used to assess the personality structure of a test subject. It is sometimes used as a diagnostic tool in assessing **schizophrenia**, depression, **addiction**, and character disorders.

Precautions

Psychometric testing requires a clinically trained examiner. The HIT should be administered and interpreted by a trained psychologist, psychiatrist, or appropriately trained mental health professional.

Some consider projective tests to be less reliable than objective personality tests. If the examiner is not well-trained in psychometric evaluation, subjective interpretations may affect the outcome of the test.

Description

The HIT, developed by psychologist Wayne Holtzman and colleagues, was introduced in 1961. The test was designed to overcome some of the deficiencies of its famous predecessor, the Rorschach Inkblot Test.

Unlike the Rorschach, the Holtzman is a standardized measurement with clearly defined objective scoring criteria. The HIT consists of 45 inkblots. The test administrator, or examiner, has a stack of 47 cards with inkblots (45 test cards and 2 practice cards) face down in front of him or her. The examiner hands each card to the subject and asks the test subject what he or she sees in the inkblot. Only one response per inkblot is requested. Occasionally, the examiner may ask the test subject to clarify or elaborate on a response. The Administration of the HIT typically takes 50–80 minutes. The HIT is then scored against 22 personality-related characteristics.

The HIT can also be administered in a group setting. In group testing, 30–45 inkblots are projected onto a screen and test subjects provide written responses to each inkblot.

The 1997 Medicare reimbursement rate for psychological and neuropsychological testing is $58.35 an hour. Billing time typically includes test administration, scoring and interpretation, and reporting. Many insurance plans cover all or a portion of diagnostic psychological testing.

KEY TERMS

Projective personality assessment—A test in which the subject is asked to interpret ambiguous stimuli, such as an inkblot. The subject's responses provide insight into his or her thought processes.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

Normal results

Because of the complexity of the scoring process and the projective nature of the test, results for the HIT should only be interpreted by a clinically trained psychologist, psychiatrist, or appropriately trained mental health professional.

Resources

BOOKS

Maddox, Taddy. *Tests: A Comprehensive Reference for Assessments in Psychology, Education, and Business*. 4th ed. Austin: Pro-ed, 1997.

Shore, Milton. F, Patrick J. Brice, and Barbara G. Love. *When Your Child Needs Testing*. New York: Crossroad Publishing, 1992.

Wodrich, David L. *Children's Psychological Testing: A Guide for Nonpsychologists*. Baltimore: Paul H. Brookes Publishing, 1997.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

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Homeopathic medicine, acute prescribing

Definition

Acute homeopathic prescribing is that part of **homeopathy** that treats illness which has an abrupt onset and needs immediate attention. In homeopathic medicine, acute refers primarily to the speed of onset and self-limiting character of the disorder rather than its seriousness. Colds, **influenza**, sore throats, insect stings, cuts, **bruises**, vomiting, **diarrhea**, **fever**, muscle aches, and short-term **insomnia** are all examples of conditions that are treated by acute prescribing. The remedies given in acute homeopathic prescribing are intended to stimulate the body's internal ability to heal itself; they do not kill germs or suppress symptoms. Acute prescribing can be done—within limits—by patients at home, as well as by homeopathic practitioners. Study courses, self-treatment guides, and homeopathic home medicine kits are now available by mail order from homeopathic pharmacies and educational services.

Purpose

Homeopathic physicians seek to cure their patients on physical, mental, and emotional levels, and each treatment is tailored to a patient's individual needs. Homeopathy is generally a safe treatment, as it uses medicines in extremely diluted quantities, and there are usually minimal side effects. Its non-toxicity makes it a good choice for the treatment of children. Another benefit of homeopathy is the cost of treatments; homeopathic remedies are inexpensive, often a fraction of the cost of conventional drugs.

Acute homeopathic prescribing is thought to benefit a wide range of ailments. These include **altitude sickness**, **Bell's palsy**, the **common cold**, **allergies**, coughing, **dengue fever**, dysentery, earaches, migraine headaches, fever, **food poisoning**, grief, influenza, **motion sickness**, **shock**, **sore throat**, surgical complications, and reactions to vaccinations and drug therapy. Acute remedies may also be prescribed to treat insect stings, animal bites, and problems related to poison oak and poison ivy. It may be further employed in treating injuries including black eyes, **burns**, bruises, concussions, cuts, damaged tendons and ligaments, dislocations, **fractures**, herniated discs, nosebleeds, puncture **wounds**, sprains, and strains.

Description

Origins

Homeopathy is a gentle, painless, holistic system of healing developed during the 1790s by Samuel Hahnemann, a German physician. Experimenting on himself with the anti-malarial drug quinine, Hahnemann noticed that large doses of the medicine actually caused malaria-like symptoms, while smaller doses cured the symptoms. From this, he advanced his concept of *Similia similibus curentur*, or "let like be cured with like." Hahnemann then developed an extensive system of medicine based on this concept. He named it homeopathy, from the Greek words *homoios* (the same) and *pathos* (suffering).

Homeopathic remedies are almost always made from natural materials—plant, animal, or mineral substances—that have been treated to form mother tinctures or nonsoluble powders. Liquid extracts are then potentized, or increased in power, by a series of dilutions and succussions, or shakings. It is thought that succussion is necessary to transfer the energy of the natural substance to the solution. In addition, the potency of the remedy is regarded as increasing with each dilution. After the tincture has been diluted to the prescribed potency, the resulting solution is added to a bottle of sucrose/lactose tablets, which are stored in a cool, dark place. If the remedy is not soluble in water, it is ground to a fine powder and triturated with powdered lactose to achieve the desired potency.

Proponents of homeopathy over the years have included Louisa May Alcott, Charles Dickens, Benjamin Disraeli, Johann Wolfgang Goethe, Nathaniel Hawthorne, William James, Henry Wadsworth Longfellow, Pope Pius X, John D. Rockefeller, Harriet Beecher Stowe, William Thackeray, Daniel Webster, and W. B. Yeats. England's Royal Family has employed homeopathic practitioners since the 1830s.

Homeopathic prescribing differs in general from allopathic medicine in its tailoring of remedies to the patient's overall personality type and totality of symptoms, rather than to the disease. Whereas a conventional physician would prescribe the same medication or treatment regimen to all patients with the common cold, for example, a homeopathic practitioner would ask detailed questions about each patient's symptoms and the modalities, or factors, that make them better or worse. As a

result, the homeopath might prescribe six different remedies for six different patients with the same illness. In acute prescribing homeopathy, consultations are more brief compared to constitutional homeopathic prescribing. A typical patient might spend just 10–15 minutes with the practitioner, compared to more than an hour for constitutional prescribing.

Homeopathic classification of symptoms

Homeopathic practitioners use the word symptom in a more inclusive fashion than traditional medicine. In homeopathy, symptoms include any change that the patient experiences during the illness, including changes in emotional or mental patterns.

Homeopaths classify symptoms according to a hierarchy of four categories for purposes of acute prescribing:

- Peculiar symptoms. These are symptoms unique to the individual that do not occur in most persons with the acute disease. Homeopaths make note of peculiar symptoms because they often help to determine the remedy.
- Mental and emotional symptoms. These are important general symptoms that inform the homeopath about the patient's total experience of the disorder.
- Other general symptoms. These are physical symptoms felt throughout the patient's body, such as tiredness, changes in appetite, or restlessness.
- Particular symptoms. Particular symptoms are localized in the body; they include such symptoms as nausea, skin **rashes**, **headache**, etc.

During homeopathic case-taking, the practitioner will evaluate the intensity of the patient's symptoms, assess their depth within the patient's body, note any peculiar symptoms, evaluate the modalities of each symptom, and make a list of key symptoms to guide the selection of the proper medicine.

Homeopathic remedies

There are several hundred homeopathic remedies. Homeopathic medicines are usually formulated from diluted or triturated natural substances, including plants, **minerals**, or even venom from snakes or stinging insects. Some remedies may be given in a spray, ointment, or cream, but the most common forms of administration are liquid dilutions and two sizes of pellets, or cylindrical tablets (for triturated remedies). A dose consists of one drop of liquid; 10–20 small pellets; or 1–3 large pellets. Since the remedies are so dilute, the exact size of the dose is not of primary importance. The frequency of dosing is considered critical, however; patients are advised not to take further doses until the first has completed its effect.

KEY TERMS

Acute prescribing—Homeopathic treatment for self-limiting illnesses with abrupt onset.

Allopathy—Conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

Law of similars—The basic principle of homeopathic medicine that governs the selection of a specific remedy. It holds that a substance of natural origin that produces certain symptoms in a healthy person will cure those same symptoms in a sick person.

Modalities—The factors and circumstances that cause a patient's symptoms to improve or worsen.

Mother tincture—The first stage in the preparation of a homeopathic remedy, made by soaking a plant, animal, or mineral product in a solution of alcohol.

Potentization—The process of increasing the power of homeopathic preparations by successive dilutions and succussions of a mother tincture.

Succussion—The act of shaking diluted homeopathic remedies as part of the process of potentization.

Trituration—The process of diluting a nonsoluble substance for homeopathic use by grinding it to a fine powder and mixing it with lactose powder.

Homeopathic remedies can be kept indefinitely with proper handling. Proper handling includes storing the remedies in the original bottles and discarding them if they become contaminated by sunlight or other intense light; temperatures over 100°F (37.8°C); vapors from camphor, mothballs, or perfume; or from other homeopathic remedies being opened in the same room at the same time.

Preparations

Case-taking

The first step in acute prescribing is a lengthy interview with the patient, known as case-taking. In addition to noting the character, location, and severity of the patient's symptoms, the homeopath will ask about their modalities. The modalities are the circumstances or factors (e.g., weather, time of day, body position, behavior or activity, etc.) that make the symptoms either better or

worse. Case-taking can be done by the patient or a family member as well as by a homeopath.

Selection and administration of a remedy

The choice of a specific remedy is guided by the patient's total symptom profile rather than by the illness. Homeopathic remedies are prescribed according to the law of similars, which holds that a substance that produces specific symptoms in healthy people cures those symptoms in sick people when given in highly diluted forms. For example, a patient with influenza who is irritable, headachy, and suffering from joint or muscle pains is likely to be given *bryonia* (wild hops), because this plant extract would cause this symptom cluster in a healthy individual.

Patients are instructed to avoid touching homeopathic medicines with their fingers. The dose can be poured onto a piece of white paper or the bottle's cap and tipped directly into the mouth. Homeopathic remedies are not taken with water; patients should not eat or drink anything for 15–20 minutes before or after taking the dose.

Precautions

Homeopathic acute prescribing is not recommended for the treatment of chronic conditions requiring constitutional prescribing, for severe infections requiring antibiotic treatment, or for conditions requiring major surgery. It is also not recommended for the treatment of mental health problems.

Persons who are treating themselves with homeopathic remedies should follow professional guidelines regarding the limitations of home treatment. Most homeopathic home treatment guides include necessary information regarding symptoms and disorders that require professional attention.

Homeopathic remedies may lose their potency if used at the same time as other products. Some homeopathic practitioners recommend the avoidance of mint and mentholated products (toothpastes, candies, chewing gum, mouth rinses), as well as camphor and camphorated products (including eucalyptus and Tiger Balm), patchouli and other essential oils, moth balls, strong perfumes, aftershaves, scented soaps, **stress**, x rays, coffee, nicotine, recreational drugs (marijuana) and certain therapeutic drugs (most notably cortisone and prednisone) during treatment. Patients are also advised to avoid electric blankets and dental work, as these are thought to adversely affect homeopathic therapy. Homeopathic remedies should never be placed near magnets.

Practitioners caution that high-potency preparations should be used only under the supervision of a homeopathic practitioner.

Side effects

Homeopathic medicines are so diluted that sometimes no trace of the original substance can be detected. These medicines are therefore considered non-toxic and generally free of harmful side effects. There may, however, be individual reactions to homeopathic medicine.

An intensified healing response may occur as treatment begins, which causes symptoms to worsen, but the phenomenon is temporary. In some patients, old symptoms may re-appear from past conditions from which recovery was not complete. Such phenomena are taken as positive indications that the healing process has commenced.

Research and general acceptance

As Samuel Hahnemann's healing system grew in popularity during the 1800s, it quickly attracted vehement opposition from the medical and apothecary professions. Since the early 1900s, when the American Medical Association and pharmacists waged a battle against it, homeopathy has been neglected and sometimes ridiculed by mainstream medicine. Aside from politics, part of the reason for this is that there are some aspects of homeopathy which have not been completely explained scientifically. For instance, homeopaths have found that the more they dilute and succuss a remedy, the greater effect it seems to have on the body. Some homeopathic remedies are so diluted that not even a single molecule of the active agent remains in a solution, yet homeopaths maintain it still works; some studies have demonstrated this paradox, yet cannot explain it. Also, homeopathy puts an emphasis on analyzing symptoms and then applying remedies to these symptoms, rather than working by classifying diseases. Thus, some people with the same disease may require different homeopathic medicines and treatments. Furthermore, conventional medicine strives to find out how medicines work in the body before they use them; homeopathy is less concerned with the intricate biochemistry involved than with whether a remedy ultimately works and heals holistically. For all these reasons, conventional medicine claims that homeopathy is not scientific, but homeopaths are quick to reply that homeopathy has been scientifically developed and studied for centuries, with much documentation and success.

There continue to be many studies that affirm the effectiveness of homeopathic treatments. Among the most celebrated, the *British Medical Journal* in 1991 published a large analysis of homeopathic treatments that were given over the course of 25 years. This project involved over 100 studies of patients with problems ranging from vascular diseases, respiratory problems, infections, stomach problems, allergies, recovery from

surgeries, arthritis, trauma, psychological problems, diabetes, and others. The study found improvement with homeopathic treatment in most categories of problems, and concluded that the evidence was "sufficient for establishing homeopathy as a regular treatment for certain indications."

In the United Kingdom and other countries where homeopathy is especially popular, some medical doctors incorporate aspects of acute prescribing homeopathy into their practices. Countries in which homeopathy is popular include France, India, Pakistan, Sri Lanka, Brazil, and Argentina. Large homeopathic hospitals exist in London and Glasgow, and homeopathic medical centers can be found in India and South America.

Resources

BOOKS

Cummings, Stephen, and Dana Ullman. *Everybody's Guide to Homeopathic Medicines*. Los Angeles, Jeremy P. Tarcher, Inc., 1991.

MacEoin, Beth. *Homeopathy.* New York: HarperCollins Publishers, 1994.

Strohecker, James. *Alternative Medicine: The Definitive Guide.* Tiburon, Calif.: Future Medicine Publishing, Inc., 1999.

Ullman, Dana. *Discovering Homeopathy: Your Introduction to the Science and Art of Homeopathic Medicine.* Berkeley, Calif.: North Atlantic Books, 1991.

Vithoulkas, George. *Homeopathy: Medicine of the New Man.* New York: Fireside Books (Simon & Schuster), 1992.

ORGANIZATIONS

The American Institute of Homeopathy. 1585 Glencoe, Denver, CO 80220. (303) 898-5477.

The Council for Homeopathic Certification. P.O. Box 157, Corte Madera, CA 94976.

The International Foundation for Homeopathy. 2366 Eastlake Avenue East, #301, Seattle, WA 98102. (425)776-4147.

The National Center for Homeopathy. 801 North Fairfax Street, Suite 306, Alexandria, VA 22134. (703) 548-7790.

The North American Society of Homeopaths. 10700 Old County Rd. 15, #350, Minneapolis, MN 55441. (612) 593-9458.

Homeopathic medicine, constitutional prescribing

Definition

Constitutional homeopathic prescribing, also called classical prescribing, is a holistic system of medicine that has been practiced for more than 200 years. Unlike acute homeopathic prescribing, constitutional prescribing refers to the selection and administration of homeopathic preparations over a period of time for treatment related to what practitioners call miasmic disorders, those caused by an inherited predisposition to a disease. The term miasm comes from a Greek word meaning stain or pollution. As in acute prescribing, constitutional prescribing is holistic in that it is intended to treat the patient on the emotional and spiritual levels of his or her being as well as the physical. Constitutional prescribing is also aimed at eventual cure of the patient, not just suppression or relief of immediate symptoms.

Purpose

Homeopathic physicians seek to cure their patients on physical, mental, and emotional levels, and each treatment is tailored to a patient's individual needs. **Homeopathy** is generally a safe treatment, as it uses medicines in extremely diluted quantities, and there are usually minimal side effects. Its non-toxicity makes it a good choice for the treatment of children. Another benefit of homeopathy is the cost of treatments; homeopathic remedies are inexpensive, often a fraction of the cost of conventional drugs.

Classical homeopathy has been used to treat a wide range of diseases and conditions, most of which tend to be long-term. These include: **alcoholism**, **allergies**, **anxiety**, arthritis, **asthma**, bladder conditions, **chronic fatigue syndrome**, depression, drug dependencies, gastrointestinal problems, Gulf War sickness, **headache**, hearing problems, herpes, hypersensitivity, immune disorders, **insomnia**, joint problems, kidney conditions, liver problems, **Lyme disease**, lower back problems, **malaria**, **menopause**, menstrual problems, migraine, **multiple sclerosis**, **paralysis**, **phobias**, **shingles**, sinus problems, skin disorders, repetitive **stress** injury, rheumatism, vertigo, vision problems, and yeast infections.

Description

Origins

Homeopathy was developed during the 1790s by Samuel Hahnemann, a German physician. Experimenting on himself with the anti-malarial drug quinine, Hahnemann noticed that large doses of the medicine actually caused malaria-like symptoms, while smaller doses cured the symptoms. From this, he advanced his concept of *Similia similibus curentur*, or "let like be cured with like." Hahnemann then developed an extensive system of medicine based on this concept. He named it homeopathy, from the Greek words *homoios* (the same) and *pathos* (suffering).

There are several hundred homeopathic remedies. They are almost always made from natural materials—plant, animal, or mineral substances—that have been

treated to form mother tinctures or nonsoluble powders. Liquid extracts are then potentized, or increased in power, by a series of dilutions and succussions, or shakings. It is thought that succussion is necessary to transfer the energy of the natural substance to the solution. In addition, the potency of the remedy is regarded as increasing with each dilution. After the tincture has been diluted to the prescribed potency, the resulting solution is added to a bottle of sucrose/lactose tablets, which are stored in a cool, dark place. If the remedy is not soluble in water, it is ground to a fine powder and triturated with powdered lactose to achieve the desired potency.

Proponents of homeopathy over the years have included Louisa May Alcott, Charles Dickens, Benjamin Disraeli, Johann Wolfgang Goethe, Nathaniel Hawthorne, William James, Henry Wadsworth Longfellow, Pope Pius X, John D. Rockefeller, Harriet Beecher Stowe, William Thackeray, Daniel Webster, and W. B. Yeats. England's Royal Family has employed homeopathic practitioners since the 1830s.

Constitutional prescribing is based on the patient's symptom profile and specific aspects of homeopathic theory.

Homeopathic classification of symptoms

Homeopathic practitioners use the word symptom in a more inclusive fashion than traditional medicine. In homeopathy, symptoms include any change that the patient experiences during the illness, including changes in emotional or mental patterns.

Homeopaths classify symptoms according to a hierarchy of four categories:

- Peculiar symptoms. These are symptoms unique to the individual that do not occur in most persons. Homeopaths make note of peculiar symptoms because they often help to determine the remedy.
- Mental and emotional symptoms. These are important general symptoms that inform the homeopath about the patient's total experience of the disorder.
- Other general symptoms. These are physical symptoms felt throughout the patient's body, such as tiredness, changes in appetite, or restlessness.
- Particular symptoms. Particular symptoms are localized in the body; they include such symptoms as nausea, skin **rashes**, or headaches.

Miasms

Homeopaths regard the patient's symptom profile as a systemic manifestation of an underlying chronic disorder called a miasm. Miasms are serious disturbances of what homeopaths call the patient's vital force that are inherited from parents at the time of conception. Hahnemann believed that the parents' basic lifestyle, their emotional condition and habitual diet, and even the atmospheric conditions at the time of conception would affect the number and severity of miasms passed on to the child. Hahnemann himself distinguished three miasms: the psoric, which he considered the most universal source of chronic disease in humans; the syphilitic; and the sycotic, which he attributed to **gonorrhea**. Later homeopaths identified two additional miasms, the cancernic and the tuberculinic. The remaining major source of miasms is allopathic medicine. It is thought that specific allopathic treatments—particularly **smallpox** vaccinations, cortisone preparations, major tranquilizers, and antibiotics—can produce additional layers of miasms in the patient's constitution. Constitutional prescribing evaluates the person's current state or miasmic picture, and selects a remedy intended to correct or balance that state. The homeopath may prescribe a different remedy for each miasmic layer over time, but gives only one remedy at a time directed at the person's current state. The basic principle governing the prescription of each successive remedy is the law of similars, or "like cures like."

Hering's laws of cure

The homeopathic laws of cure were outlined by Constantine Hering, a student of Hahnemann who came to the United States in the 1830s. Hering enunciated three laws or principles of the patterns of healing that are used by homeopaths to evaluate the effectiveness of specific remedies and the overall progress of constitutional prescribing:

- Healing progresses from the deepest parts of the organism to the external parts. Homeopaths consider the person's mental and emotional dimensions, together with the brain, heart, and other vital organs, as a person's deepest parts. The skin, hands, and feet are considered the external parts.
- Symptoms appear or disappear in the reverse of their chronological order of appearance. In terms of constitutional treatment, this law means that miasms acquired later in life will resolve before earlier ones.
- Healing proceeds from the upper to the lower parts of the body.

Healing crises

Homeopaths use Hering's laws to explain the appearance of so-called healing crises, or aggravations, in the course of homeopathic treatment. It is not unusual for patients to experience temporary worsening of certain symptoms after taking their first doses of homeopathic

KEY TERMS

Aggravation—Another term used by homeopaths for the healing crisis.

Allopathy—Conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

Constitutional prescribing—Homeopathic treatment for long-term or chronic disorders related to inherited predispositions to certain types of illnesses.

Healing crisis—A temporary worsening of the patient's symptoms during successive stages of homeopathic treatment.

Law of similars—The basic principle of homeopathic medicine that governs the selection of a specific remedy. It holds that a substance of natural origin that produces certain symptoms in a healthy person will cure those same symptoms in a sick person.

Laws of cure—A set of three rules used by homeopaths to assess the progress of a patient's recovery.

Materia medica—In homeopathy, reference books compiled from provings of the various natural remedies.

Miasm—In homeopathic theory, a general weakness or predisposition to chronic disease that is transmitted down the generational chain.

Modalities—The factors and circumstances that cause a patient's symptoms to improve or worsen, including weather, time of day, effects of food, and similar factors.

Repertories—Homeopathic reference books consisting of descriptions of symptoms. The process of selecting a homeopathic remedy from the patient's symptom profile is called repertorizing.

treatment. For example, a person might notice that arthritic pains in the shoulders are better but that the hands feel worse. Hering's third law would indicate that the remedy is working because the symptoms are moving downward in the body. In constitutional prescribing, a remedy that removes one of the patient's miasmic layers will then allow the symptoms of an older miasm to emerge. Thus the patient may find that a physical disease is followed by a different set of physical problems or by emotional symptoms.

Preparations

The most important aspects of preparation for constitutional prescribing are the taking of a complete patient history and careful patient education.

Case-taking

Homeopathic case-taking for constitutional prescribing is similar to that for acute prescribing, but more in-depth. The initial interview generally takes one to two hours. The practitioner is concerned with recording the totality of the patient's symptoms and the modalities that influence their severity. Also included are general characteristics about the patient and his or her lifestyle choices. For example, a practitioner might ask the patient if he or she likes being outside or is generally hot or cold. There is also an emphasis on the patient's lifetime medical history, particularly records of allopathic treatments.

Patient education

Homeopaths regard patients as equal partners in the process of recovery. They will take the time to explain the theories underlying constitutional prescribing to the patient as well as taking the history. Patient education is especially important in constitutional prescribing in order to emphasize the need for patience with the slowness of results and length of treatment, and to minimize the possibility of self-treatment with allopathic drugs if the patient has a healing crisis.

Homeopathic remedies

In constitutional prescribing, one dose of the selected remedy is given. Patients then wait two to six weeks before following up with the homeopath, while the body begins the healing process. At the follow-up visit, the remedy may be repeated, or a different remedy prescribed. The preparation, selection, administration, and storage of remedies for constitutional prescribing are the same as for acute prescribing. These procedures are described more fully in the article on acute prescribing.

Precautions

Constitutional homeopathic prescribing is not appropriate for diseases or health crises requiring emergency treatment, whether medical, surgical, or psychiatric. In addition, constitutional prescribing should not be self-administered. Although home treatment kits of

homeopathic remedies are available for acute self-limited disorders, the knowledge of homeopathic theory and practice required for constitutional evaluation is beyond the scope of most patients.

Patients are instructed to avoid touching homeopathic medicines with their fingers. The dose can be poured onto a piece of white paper or the bottle's cap and tipped directly into the mouth. Homeopathic remedies are not taken with water; patients should not eat or drink anything for 15–20 minutes before or after taking the dose.

Homeopathic remedies may lose their potency if used at the same time as other products. Some homeopathic practitioners recommend the avoidance of mint and mentholated products (toothpastes, candies, chewing gum, mouth rinses), as well as camphor and camphorated products (including eucalyptus and Tiger Balm), patchouli and other essential oils, moth balls, strong perfumes, aftershaves, scented soaps, stress, x rays, coffee, nicotine, recreational drugs (marijuana) and certain therapeutic drugs (most notably cortisone and prednisone) during treatment. Patients are also advised to avoid electric blankets and dental work, as these are thought to adversely affect homeopathic therapy. Homeopathic remedies should never be placed near magnets.

Side effects

Homeopathic medicines are so diluted that sometimes no trace of the original substance can be detected. These medicines are therefore considered non-toxic and generally free of harmful side effects. The primary risks to the patient from constitutional homeopathic treatment are the symptoms of the healing crisis and individual reactions to homeopathic medicine. The complexity of constitutional prescribing requires homeopaths to have detailed knowledge of the *materia medica* and the repertories, and to take careful and extensive case notes.

An intensified healing response may occur as treatment begins, which causes symptoms to worsen, but the phenomenon is temporary. In some patients, old symptoms may re-appear from past conditions from which recovery was not complete. Such phenomena are taken as positive indications that the healing process has commenced.

Research and general acceptance

As Samuel Hahnemann's healing system grew in popularity during the 1800s, it quickly attracted vehement opposition from the medical and apothecary professions. Since the early 1900s, when the American Medical Association and pharmacists waged a battle against it, homeopathy has been neglected and sometimes ridiculed by mainstream medicine. Aside from politics, part of the reason for this is that there are some aspects of homeopathy which have not been completely explained scientifically. For instance, homeopaths have found that the more they dilute and succuss a remedy, the greater effect it seems to have on the body. Some homeopathic remedies are so diluted that not even a single molecule of the active agent remains in a solution, yet homeopaths maintain it still works; some studies have demonstrated this paradox, yet cannot explain it. Also, homeopathy puts an emphasis on analyzing symptoms and then applying remedies to these symptoms, rather than working by classifying diseases. Thus, some people with the same disease may require different homeopathic medicines and treatments. Furthermore, conventional medicine strives to find out how medicines work in the body before they use them; homeopathy is less concerned with the intricate biochemistry involved than with whether a remedy ultimately works and heals holistically. For all these reasons, conventional medicine claims that homeopathy is not scientific, but homeopaths are quick to reply that homeopathy has been scientifically developed and studied for centuries, with much documentation and success.

There continue to be many studies that affirm the effectiveness of homeopathic treatments. Among the most celebrated, the *British Medical Journal* in 1991 published a large analysis of homeopathic treatments that were given over the course of 25 years. This project involved over 100 studies of patients with problems ranging from vascular diseases, respiratory problems, infections, stomach problems, allergies, recovery from surgeries, arthritis, trauma, psychological problems, diabetes, and others. The study found improvement with homeopathic treatment in most categories of problems, and concluded that the evidence was "sufficient for establishing homeopathy as a regular treatment for certain indications."

In the United Kingdom and other countries where homeopathy is especially popular, some medical doctors incorporate aspects of acute prescribing homeopathy into their practices. Countries in which homeopathy is popular include France, India, Pakistan, Sri Lanka, Brazil, and Argentina. Large homeopathic hospitals exist in London and Glasgow, and homeopathic medical centers can be found in India and South America.

Resources

BOOKS

Cummings, Stephen, and Dana Ullman. *Everybody's Guide to Homeopathic Medicines*. Los Angeles, Jeremy P. Tarcher, Inc., 1991.

MacEoin, Beth. *Homeopathy.* New York: HarperCollins Publishers, 1994.

Strohecker, James. *Alternative Medicine: The Definitive Guide.* Tiburon, Calif.: Future Medicine Publishing, Inc., 1999.
Ullman, Dana. *Discovering Homeopathy: Your Introduction to the Science and Art of Homeopathic Medicine.* Berkeley, Calif.: North Atlantic Books, 1991.
Vithoulkas, George. *Homeopathy: Medicine of the New Man.* New York: Fireside Books (Simon & Schuster), 1992.

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Homeopathic medicine *see* **Homeopathy**

Homeopathy

Definition

Homeopathy, or homeopathic medicine, is a holistic system of treatment that originated in the late eighteenth century. The name homeopathy is derived from two Greek words that mean "like disease." The system is based on the idea that substances that produce symptoms of sickness in healthy people will have a curative effect when given in very dilute quantities to sick people who exhibit those same symptoms. Homeopathic remedies are believed to stimulate the body's own healing processes. Homeopaths use the term "allopathy," or "different than disease," to describe the use of drugs used in conventional medicine to oppose or counteract the symptom being treated.

Purpose

Homeopathic physicians seek to cure their patients on the physical, mental and emotional levels, and each treatment is tailored to a patient's individual needs. Homeopathy is generally a safe treatment, as it uses medicines in extremely diluted quantities, and there are usually minimal side effects. Its non-toxicity makes it a good choice for the treatment of children. Another benefit of homeopathy is the cost of treatments; homeopathic remedies are inexpensive, often a fraction of the cost of conventional drugs.

Homeopathic treatment has been shown effective in treating many conditions. Colds and flu may be effectively treated with aconite and bryonia. **Influenza** suffers in a double-blind study found that they were twice as likely to recover in 48 hours when they took homeopathic remedies. Studies have been published in British medical journals confirming the efficacy of homeopathic treatment for **rheumatoid arthritis**. Homeopathic remedies are effective in treating infections, circulatory problems, respiratory problems, heart disease, depression and nervous disorders, migraine headaches, **allergies**, arthritis, and diabetes. Homeopathy is a good treatment to explore for acute and chronic illnesses, particularly if these are found in the early stages and where there is not severe damage. Homeopathy can be used to assist the healing process after surgery or **chemotherapy**.

Description

Origins

Homeopathy was founded by German physician Samuel Hahnemann (1755–1843), who was much disturbed by the medical system of his time, believing that its cures were crude and some of its strong drugs and treatments did more harm than good to patients. Hahnemann performed experiments on himself using Peruvian bark, which contains quinine, a **malaria** remedy. He concluded that in a healthy person, quinine creates the same symptoms as malaria, including fevers and chills, which is the reason why it is effective as a remedy. He then began to analyze the remedies available in nature by what he called provings. Provings of homeopathic remedies are still compiled by dosing healthy adults with various substances and documenting the results, in terms of the dose needed to produce the symptoms and the length of the dose's effectiveness. The provings are collected in large homeopathic references called *materia medica* or materials of medicine.

Hahnemann formulated these principles of homeopathy:

- Law of Similars (like cures like)
- Law of the Infinitesimal Dose (The more diluted a remedy is, the more potent it is.)
- illness is specific to the individual

Hahnemann's Law of Similars was based on thinking that dated back to Hippocrates in the fourth century B.C. It is the same thinking that provided the basis for vaccinations created by Edward Jenner and Louis Pasteur. These vaccines provoke a reaction in the individual that protects against the actual disease. Allergy treatments work the same way. By exposing a person to minute quantities of the allergen, the person's tolerance levels are elevated.

Homeopathic Remedies That Work

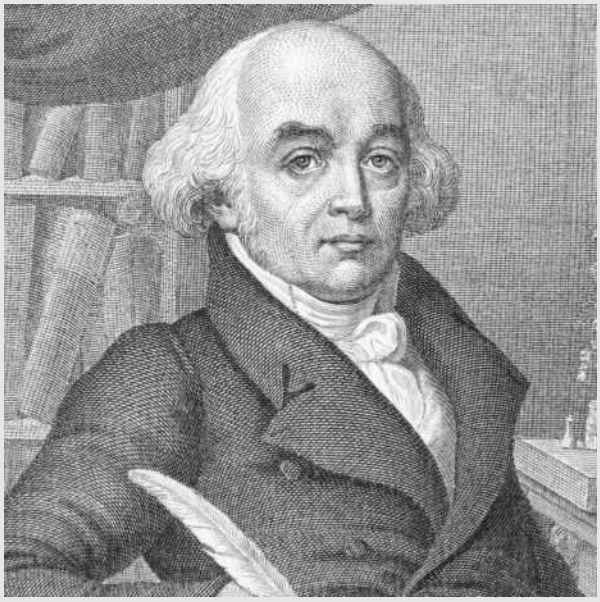
Name	Description
Aconite	Commonly known as monkshood, aconite is highly toxic. A nontoxic, diluted extract of aconite is used in homeopathy to treat symptoms similar to that of poison.
Allium cepa	Commonly known as red onion, homeopathic physicians use a dilute extract of red onion to treat symptoms similar to that of red onion—watery eyes, burning,etc.
Apis	Commonly known as the honeybee, apis as a homeopathic remedy is made from the body of the bee. It is used to treat symptoms similar to that of a bee sting—redness, swelling, etc.
Arnica	Commonly known as the mountain daisy, arnica is used by homeopathic physicians to treat bruises, sprains, and strains.
Arsenicum album	Also known as ars alb, arsenicum album is a diluted form of arsenic, a metallic poison. It is used by homeopathic physicians to treat symptoms similar to the effects of arsenic poisoning—dehydration, burning pain, etc.
Belladonna	Commonly known as deadly knightshade, belladonna is used in homeopathy to treat symptoms of dry mouth, nausea, delirium, etc.
Bryonia	Commonly known as wild hops, bryonia is used in homeopathy to treat vomiting, diarrhea, inflammation, etc.
Calcarea carbonica	Also known as calcium carbonate or calc carb, it is used in homeopathy to treat symptoms of exhaustion, depression, and anxiety.
Cantharis	Commonly known as Spanish fly, cantharis is used in homeopathy to treat conditions with symptoms of abdominal cramps, vomiting, diarrhea, convulsions, etc.
Chamomilla	Derived from German chamomile, it is used in homeopathy to treat irritability, impatience, etc. It is most often prescribed to children.
Ferrum phosphoricum	Also known as ferrum phos or iron phosphate, it is used to treat symptoms of low energy and anemia.
Gelsemium	Also known as yellow jasmine, it is used to treat conditions that effect vision, balance, though and locomotion.
Hepar sulphuris	Derived from the inner layer of oyster shells, hepar sulphuris is used to treat infection.
Hypericum	Commonly known as St. John's wort, hypericum is used to treat nerve damage.
Ignatia	Derived from seeds of a plant, this homeopathic remedy is prescribed to treat conditions with symptoms such as headache, cramping, and tremors.
Ipecac	Ipecac induces vomiting and causes gastrointestinal distress. Homeopaths prescribe it to treat similar symptoms.
Kali bichromicum	Commonly known as potassium bichromate, kali bichromicum is a poison used also in textile dyes, wood stain, etc. Homeopaths use it to treat localized pain.
Lachesis	Derived from the venom of the bushmaster snake, this homeopathic remedy is used to treat conditions that cause the same symptoms as the venom itself.
Ledum	Also known as marsh tea, ledum is used to treat infections, most often from animal bites, stings, cuts, etc.
Lycopodium	Commonly known as club moss, lycopodium is used to treat diarrhea, digestive upset, etc.
Mercurius vivus	Also known as quicksilver, it is used to treat symptoms of sweats, shaking, nausea, etc.
Natrum muriaticum	Commonly known as salt, it is used to treat conditions that cause excessive thirst and salt cravings.
Nux vomica	It is used to treat symptoms caused by overeating and too much caffeine or alcohol.
Phosphorus	It is used to treat symptoms of excessive thirst, fatigue, and nervousness.
Pulsatilla	It is used to treat conditions that are accompanied by discharge, such as bedwetting, sinusitis, etc.
Rhus toxicodendron	Commonly known as poison ivy, homeopaths use it to treat conditions with symptoms of fever, swollen glands, and restlessness.
Ruta	It is used to treat conditions with bruising, such as tennis elbow, sciatica, etc.
Sepia	Sepia is the discharge used by the cuttlefish to disappear from a predator. Homeopaths use sepia to treat symptoms of apathy and weakness.
Silica	Also called flint, silica is used by homeopaths to treat conditions that cause weakness, sweating, and sensitivity to cold.
Sulphur	It is used to treat conditions with symptoms of itching, burning pains, and odor.

The Law of the Infinitesimal Dose has always caused controversy among those outside the field of homeopathy. Hahnemann contended that as he diluted his remedies with water and alcohol and succussed, or shook, them, the remedies actually worked more effectively. In fact, diluted homeopathic remedies may have no chemical trace of the original substance. Practitioners believe that the electromagnetic energy of the original substance is retained in the dilution, but toxic side effects of the remedy are not. It is this electrochemical "message" that stimulates the body to heal itself.

Homeopathic practitioners believe that illness is specific to an individual. In other words, two people with severe headaches may not receive the same remedies. The practitioner will ask the patient questions about lifestyle, dietary habits, and personality traits, as well as specific questions about the nature of the **headache** and when it occurs. This information gathering is called profiling or case-taking.

In the early 1900s, homeopathy was popular in America, with over 15 percent of all doctors being homeopathic. There were 22 major homeopathic medical schools, including Boston University and the University of Michigan. However, with the formation of the American Medical Association, which restricted and closed down alternative practices, homeopathy declined for half a century. When the 1960s invigorated back-to-nature trends and distrust of artificial drugs and treatments, homeopathy began to grow again dramatically through the next decades. In 1993, *The New England Journal of Medicine* reported that 2.5 million Americans used homeopathic remedies and 800,000 patients visited homeopaths in 1990, and it has continued to grow. Homeopathy is much more popular in Europe than in the United States. French pharmacies are required to make homeopathic remedies available along with conventional medications. Homeopathic hospitals and clinics are part of the national health system in

SAMUEL HAHNEMANN (1755–1843)



(Corbis Corporation. Reproduced by permission.)

Samuel Christian Hahnemann created and developed the system called homeopathy. It is also known as *similia similibus curentor* or like cures like. Although his new methods initially met with ridicule and criticism, by the time of his death they were accepted the world over as a result of the great success he had with his new cure.

Hahnemann was born in Meissen, Saxony (now part of Germany) into a financially challenged middle class family. His parents initially educated him at home, where his father taught him never to accept anything he learned without first questioning it. He graduated as a physician at Erlangen in 1779 after studying at Leipzig and Vienna. He was also fluent in English, German, Italian, French, Greek, Arabic, Latin and Hebrew.

At age 27 he married his first wife, Johanna Henriette Kuchler, the daughter of an apothecary, with whom he had 11 children.

Living in poverty, Hahnemann began practicing medicine in 1781 and translating scientific texts to supplement his income. However, disillusioned with medicine, he eventually gave it up entirely.

He discovered the concept of homeopathy when considering the effect of quinine on malaria, and went on to cure soldiers and then sufferers of a typhus epidemic with astounding success. He documented his discoveries in the *Organon*, a treatise on his work. Homeopathy also proved its worth in 1831 when there was an outbreak of cholera. Hahnemann used homeopathic treatment with a 96% success rate, compared to the 41% of allopathic medicine. He also wrote his *Materia Medica Pura*.

In 1834, Hahnemann met his second wife, Marie Melanie d'Hervilly. Despite a great difference in age, they were happily married until his death in Paris on July 2, 1843, at the age of 88.

Britain. It is also practiced in India and Israel, among other countries.

A visit to a homeopath can be a different experience than a visit to a regular physician. Surveys have shown that homeopathic doctors spend much more time during initial consultations than conventional doctors spend. This is because a homeopath does a complete case-taking to get a complete picture of a person's general health and lifestyle, as well as particular symptoms, on the physical, mental and emotional levels. Some symptoms can be so subtle that the patient is not always completely aware of them, and the doctor must spend time getting to know the patient.

The initial visit often includes a long questionnaire about a patient's medical and family history, and then a long interview with the doctor, who prompts the patient with many questions. Sometimes a homeopathic doctor will use lab tests to establish a patient's general level of health. The initial interview usually lasts between one and two hours.

The purpose of homeopathy is the restoration of the body to homeostasis, or healthy balance, which is its natural state. The symptoms of a disease are regarded as the body's own defensive attempt to correct its imbalance, rather than as enemies to be defeated. Because a homeopath regards symptoms as positive evidence of the body's inner intelligence, he or she will prescribe a remedy designed to stimulate this internal curative process, rather than suppress the symptoms.

In homeopathy, the curative process extends beyond the relief of immediate symptoms of illness. Healing may come in many stages, as the practitioner treats layers of symptoms that are remnants of traumas or chronic disease in the patient's past. This is part of Hering's Laws of Cure, named for Constantine Hering, the father of homeopathy in America. Hering believed that healing starts from the deepest parts of the body to the extremities, and from the upper parts of the body to the lower parts. Hering's Laws also state that homeopaths should

treat disease symptoms in reverse chronological order, from the most recent to the oldest, restoring health in stages. Sometimes, the patient may feel worse before feeling better. This is called a healing crisis.

When prescribing a remedy, homeopaths will match a patient's symptoms with the proper remedy in a repertory or *materia medica* that has been compiled throughout the history of homeopathy. Classical homeopaths prescribe only one remedy at a time. However, it is becoming more common, especially in Europe, to use combination formulas of several remedies for the treatment of some combinations of symptoms.

The cost of homeopathic care can vary. The cost of visits will be comparable to conventional medicine, with initial visits ranging from $50 to $300. Non-M.D. homeopaths can charge from $50 to $250. Follow-up visits are less, at about $35 to $100. Homeopathic medicine is significantly cheaper than pharmaceuticals, and most remedies cost between $2 and $10. Some doctors provide remedies without charge. Homeopaths rarely use lab tests, which reduces the cost of treatment further. In general, homeopathy is much more economical than conventional medicine. In 1991, the French government did a study on the cost of homeopathic medicine, and found that it costs half as much to treat patients, considering all costs involved.

When homeopaths are licensed professionals, most insurance companies will pay for their fees. Consumers should consult their insurance policies to determine individual regulations. Insurance usually will not cover homeopathic medicine, because it is sold over-the-counter.

Precautions

Although homeopathic remedies sometimes use substances that are toxic, they are diluted and prescribed in non-toxic doses. Remedies should be prescribed by a homeopathic practitioner. Those preparing to take homeopathic remedies should also avoid taking *antidotes*, substances which homeopathic doctors believe cancel the effects of their remedies. These substances include alcohol, coffee, prescription drugs, peppermint (in toothpaste and mouthwash), camphor (in salves and lotions), and very spicy foods. Homeopathic medicine should also be handled with care, and should not be touched with the hands or fingers, which can contaminate it.

Side effects

A homeopathic *aggravation* sometimes occurs during initial treatment with homeopathic remedies. This means that symptoms can temporarily worsen during the process of healing. Although this is usually mild, the aggravation can sometimes be severe. Homeopaths see aggravation as a positive sign that the remedy is a good match for the patient's symptoms. The healing crisis, which happens when the patient is undergoing treatment for layers of symptoms, may also cause the patient to feel worse before feeling better. Some patients can experience emotional disturbances like weeping or depression, if suppressed emotional problems led to the illness in the first place.

Research and general acceptance

Since the early 1900s, when the American Medical Association and pharmacists waged a battle against it, homeopathy has been neglected and sometimes ridiculed by mainstream medicine. Aside from politics, part of the reason for this is that there are some aspects of homeopathy which have not been completely explained scientifically. For instance, homeopaths have found that the more they dilute and succuss a remedy, the greater effect it seems to have on the body. Some homeopathic remedies are so diluted that not even a single molecule of the active agent remains in a solution, yet it still works; studies have demonstrated this paradox, yet can't explain it. Also, homeopathy puts an emphasis on analyzing symptoms and then applying remedies to these symptoms, rather than working by classifying diseases. Thus, some people with the same disease may require different homeopathic medicines and treatments. Furthermore, conventional medicine strives to find out how medicines work in the body before they use them; homeopathy is less concerned with the intricate biochemistry involved than with whether a remedy ultimately works and heals holistically. For all these reasons, conventional medicine claims that homeopathy is not scientific, but homeopaths are quick to reply that homeopathy has been scientifically developed and studied for centuries, with much documentation and success.

There continue to be many studies that affirm the effectiveness of homeopathic treatments. Among the most celebrated, the *British Medical Journal* in 1991 published a large analysis of homeopathic treatments that were given over the course of 25 years. This project involved over 100 studies of patients with problems ranging from vascular diseases, respiratory problems, infections, stomach problems, allergies, recovery from surgeries, arthritis, trauma, psychological problems, diabetes, and others. The study found improvement with homeopathic treatment in most categories of problems, and concluded that the evidence was "sufficient for establishing homeopathy as a regular treatment for certain indications."

Resources

BOOKS

Castro, Miranda. *The Complete Homeopathy Handbook*. New York: St. Martin's, 1990.

KEY TERMS

Aggravation—Temporary increase in symptoms due to homeopathic remedy.

Antidote—Substance which cancels the effect of homeopathic remedies

Homeopath—A homeopathic physician.

Proving—Case study of the effect of a homeopathic medicine.

Repertory—Reference manual of homeopathic remedies.

Vital force—Innate wisdom and energy of the body.

Jonas, Wayne B., M.D., and Jennifer Jacobs, M.D. *Healing With Homeopathy.* New York: Warner, 1996.

Ullman, Dana, M.P.H. *The Consumer's Guide to Homeopathy.* New York: Putnam, 1996.

Weiner, Dr. Michael. *The Complete Book of Homeopathy.* New York: Avery, 1996.

PERIODICALS

Homeopathy Today. 801 N. Fairfax St. #306, Alexandria, VA 22314, phone (703) 548-7790.

Similimum. P.O. Box 69565, Portland, OR 97201, phone (503) 795-0579.

OTHER

<http://www.healthy.net/nch/> National Center for Homeopathy.

<http://www.ayurveda.com>. Ayurvedic Institute

<http://www.homeopathy.org>. North American Society of Homeopaths.

Hong Kong flu *see* **Influenza**

Hookworm disease

Definition

Hookworm disease is an illness caused by one of two types of S-shaped worms that infect the intestine of humans (the worm's host).

Description

Two types of hookworm are responsible for hookworm disease in humans. *Necator americanus* and *Ancylostoma duodenale* have similar life cycles and similar methods of causing illness. The adult worm of both *Necator americanus* and *Ancylostoma duodenale* is about 10 mm long, pinkish-white in color, and curved into an S-shape or double hook.

Both types of hookworm have similar life cycles. The females produce about 10,000–20,000 eggs per day. These eggs are passed out of the host's body in feces. The eggs enter the soil, where they incubate. After about 48 hours, the immature larval form hatches out of the eggs. These larvae take about six weeks to develop into the mature larval form that is capable of causing human infection. If exposed to human skin at this point (usually bare feet walking in the dirt or bare hands digging in the dirt), the larvae will bore through the skin and ride through the lymph circulation to the right side of the heart. The larvae are then pumped into the lungs. There they bore into the tiny air sacs (alveoli) of the lungs. Their presence within the lungs usually causes enough irritation to produce coughing. The larvae are coughed up into the throat and mouth, and are then swallowed and passed into the small intestine. It is within the intestine that they develop into the adult worm, producing illness in their human host.

Ancylostoma duodenale is found primarily in the Mediterranean, the Middle East, and throughout Asia. *Necator americanus* is common in tropical areas including Asia, parts of the Americas, and throughout Africa. Research suggests that at least 25% of all people in the world have hookworm disease. In the United States, 700,000 people are believed to be infected with hookworms at any given time.

Causes and symptoms

Hookworms cause trouble for their human host when the worms attach their mouths to the lining of the small intestine and suck the person's blood.

An itchy, slightly raised rash called "ground itch" may appear around the area where the larvae first bored through the skin. The skin in this area may become red and swollen. This lasts for several days and commonly occurs between the toes.

When the larvae are in the lungs, the patient may have a **fever**, **cough**, and some **wheezing**. Some people, however, have none of these symptoms.

Once established within the intestine, the adult worms can cause abdominal **pain**, decreased appetite, **diarrhea**, and weight loss. Most importantly, the worms suck between 0.03–0.2 ml of blood per day. When a worm moves from one area of the intestine to another, it detaches its mouth from the intestinal lining, leaving an irritated area that may continue to bleed for some time. This results in even further blood loss. A single adult worm can live for up to 14 years in a patient's intestine. Over time, the patient's blood loss may be very signifi-

A micrograph image of the head of the hookworm *Ancylostoma spp.* *(Photo Researchers, Inc. Reproduced by permission.)*

cant. Anemia is the most serious complication of hookworm disease, progressing over months or years. Children are particularly harmed by such anemia, and can suffer from heart problems, **mental retardation**, slowed growth, and delayed sexual development. In infants, hookworm disease can be deadly.

Diagnosis

Diagnosis of hookworm disease involves collecting a stool sample for examination under a microscope. Hookworm eggs have a characteristic appearance. Counting the eggs in a specific amount of feces allows the healthcare provider to estimate the severity of the infection.

Treatment

Minor infections are often left untreated, especially in areas where hookworm is very common. If treatment is required, the doctor will prescribe a three-day dose of medication. One to two weeks later, another stool sample will be taken to see if the infection is still present.

Anemia is treated with iron supplements. In severe cases, blood **transfusion** may be necessary. Two medications, pyrantel pamoate and mebendazole, are frequently used with good results.

Prognosis

The prognosis for patients with hookworm disease is generally good. However, reinfection rates are extremely high in countries with poor sanitation.

KEY TERMS

Alveoli—The small air sacs clustered at the ends of the bronchioles, in the lungs in which oxygen-carbon dioxide exchange takes place.

Anemia—Any condition where the oxygen-carrying capacity of the red blood cells is reduced; symptoms often include fatigue.

Host—The organism (like a human) in which another infecting organism (like a worm) is living.

Larva—An immature form of an organism, occurring early in that organism's development.

Prevention

Prevention of hookworm disease involves improving sanitation and avoiding contact with soil in areas with high rates of hookworm infection. Children should be required to wear shoes when playing outside in such areas, and people who are gardening should wear gloves.

Resources

BOOKS

Plorde, James J. "Hookworms." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Farley, Dixie. "Treating Tropical Diseases." *FDA Consumer* (Jan./Feb. 1997): 26+.

Hotez, P. J., and D. I. Pritchard. "Hookworm Infection." *Scientific American* (June 1995): 68+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Hormone replacement therapy

Definition

Hormone replacement therapy (HRT) is the use of synthetic or natural female hormones to make up for the

decline or lack of natural hormones produced in a woman's body. HRT is sometimes referred to as estrogen replacement therapy (ERT), because the first medications that were used in the 1960s for female hormone replacement were estrogen compounds.

Estrogens

In order to understand how HRT works and the controversies surrounding it, women should know that there are different types of estrogen medications commonly prescribed in the United States and Europe. These drugs are given in a variety of prescription strengths and methods of administration. There are at present three estrogen compounds used in Western countries. Only the first two are readily available in the United States.

- Estrone. Estrone is the form of estrogen present in women after **menopause**. It is available as tablets under the brand name Ogen. The most commonly prescribed estrogen in the United States, Premarin, is a so-called conjugated estrogen that is a mixture of estrone and other estrogens.
- Estradiol. This is the form of estrogen naturally present in premenopausal women. It is available as tablets (Estrace), skin patches (Estraderm), or vaginal creams (Estrace).
- Estriol. Estriol is a weaker form of estrogen produced by the breakdown of other forms of estrogen in the body. This is the form of estrogen most commonly given in Europe, under the brand name Estriol. It is the only form that is thought not to cause **cancer**.

In addition to pills taken by mouth, skin patches, and vaginal creams, estrogen preparations can be given by injection or by pellets implanted under the skin. Estrogen implants, however, are used less and less frequently.

Progestins

Most HRT programs include progestin treatment with estrogen compounds. Progestins—sometimes called progestogens—are synthetic forms of progesterone that are given to reduce the possibility that estrogen by itself will cause cancer of the uterus. Progestins are commonly prescribed under the brand names Provera and Depo-Provera. Other common brand names are Norlutate, Norlutin, and Aygestin.

Estrogen/testosterone combinations

Women's ovaries secrete small amounts of a male sex hormone (testosterone) throughout their lives. Women who have had both ovaries removed by surgery are sometimes given testosterone along with estrogen as part of HRT. Combinations of these hormones are available as tablets under the brand name Estratest or as vaginal creams. Women who cannot take estrogens can use 1% testosterone cream by itself for problems with vaginal soreness.

Estrogen/tranquilizer combinations

There are several medications that combine estrogen with a tranquilizer like chlordiazepoxide (sold under the trade name Menrium) or meprobamate (sold under the trade name PMB). Many doctors warn against these combination drugs because the tranquilizers can be habit-forming.

Purpose

HRT has two primary purposes: preventive treatment against **osteoporosis** and heart disease; and relief of physical symptoms associated with menopause.

Menopausal symptoms

Women in midlife enter a stage of development called menopause, when their menstrual periods become irregular and finally stop. The early phase of this transition is called the perimenopause. In the United States, the average age at menopause is presently 50 or 51, but some women begin menopause as early as 40 and others as late as 55. It can take as long as 10 years for a woman to complete the process. Women who have had their ovaries removed surgically are said to have undergone surgical menopause.

Doctors have not always agreed on definitions of the menopause. Some use age as the baseline. Others define menopause as the point when a woman has had no menstrual periods for a full calendar year. Still others define menopause as the end of ovulation. It is not always clear, however, when a woman has had her last period or when she has stopped ovulating. In addition, women who take **oral contraceptives** can have breakthrough bleeding long after they have stopped ovulating. As a result, some doctors now measure the level of follicle-stimulating hormone (FSH) in a woman's blood to estimate whether the woman has entered menopause. During perimenopause, the FSH levels in a woman's blood rise as her body attempts to stimulate the release of ripe ova. An FSH level over 40 is considered an indicator of menopause.

During the menopausal transition, the levels of estrogen in the woman's body drop. The lowered estrogen level is responsible for a group of symptoms that include hot flashes (or flushes), weight gain, changes in skin texture, mood swings, heart **palpitations**, sleep disturbances, a need to urinate more frequently, and loss of sexual desire. The estrogen that is given in HRT can eliminate hot flash-

es, night sweats, lack of vaginal lubrication, and urinary tract problems. HRT will not prevent weight gain or wrinkles. It also does not cure depression in most women.

Preventive care

HRT is recommended by many doctors on the grounds that estrogen replacement helps to protect women against two serious midlife health problems.

OSTEOPOROSIS. Osteoporosis is a disorder in which the bones become more brittle and more easily fractured. It is a particular problem for postmenopausal women because the lower levels of estrogen in the blood lead to weakening of the bone. About 25% of Caucasian women will develop severe osteoporosis; Asian women have a slightly lower risk level; Latino and African American women are least at risk.

In addition to race, there are other factors that put some women at higher risk of developing osteoporosis. Women in any of the following groups should take bone loss into account when considering HRT:

- family history of osteoporosis
- menopause before age 40
- kidney disease and dialysis
- thin body build or being underweight
- history of colitis, **Crohn's disease**, or chronic **diarrhea**
- thyroid medications
- childlessness
- chronic use of **antacids**
- lack of **exercise**
- poor food choices, including high salt intake, lack of vitamin D, high **caffeine** consumption, and low calcium intake
- **smoking** and alcohol abuse
- cortisone therapy

HEART DISEASE. Heart disease is a major health concern of women in midlife. It is the leading cause of **death** in women over 60. The primary disorders of the circulatory system in postmenopausal women are **stroke**, **hypertension**, and **coronary artery disease**. Current studies of women on HRT do not yield a completely clear picture. In particular, although estrogen given without progestins has been shown to offer some protection against heart disease, the effect of progestins in offsetting the benefits of estrogen complicates the research findings. It seems likely that estrogen levels are only part of the picture in evaluating a woman's risk of heart disease.

The major factors that are known to increase the risk of heart disease include:

- history of smoking
- being overweight
- high-fat **diets**
- alcohol abuse
- family history of heart disease
- high blood pressure
- high blood cholesterol levels
- diabetes.

Less important risk factors include being African American, having a sedentary lifestyle, undergoing menopause before age 45, and having high levels of family- or job-related **stress**.

Precautions

Medical conditions

Certain groups of women should not use HRT. They include women with:

- **breast cancer**
- cancer of the uterus
- abnormal vaginal bleeding that has not been diagnosed
- high blood pressure that rises when HRT is used
- liver disease
- **gallstones** or diseases of the gallbladder

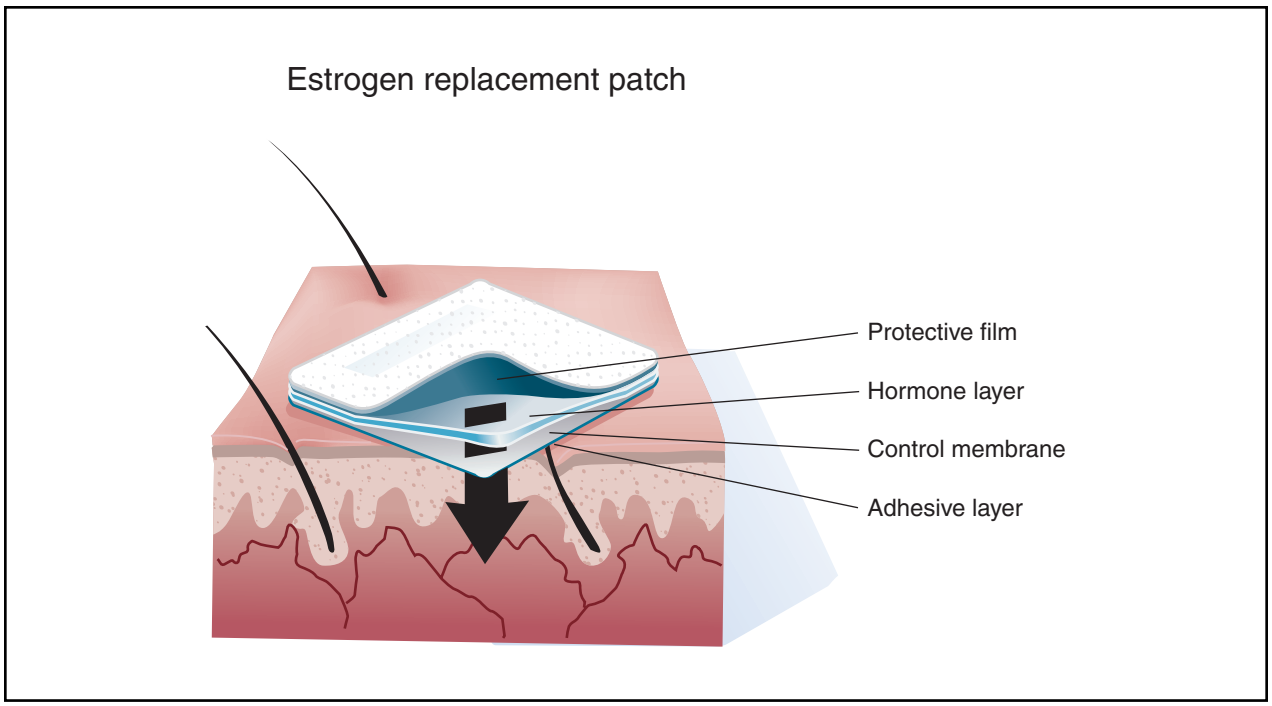
Drug interactions

HRT can interact with other prescription medications that a woman may be taking. Women who are taking **corticosteroids**, drugs to slow the clotting of blood (anticoagulants), and rifampin should ask their doctor about possible interactions.

Combining estrogens with certain other medicines can cause liver damage. Among the drugs that may cause liver damage when taken with estrogens are:

- acetaminophen (Tylenol), when used in high doses over long periods
- anabolic steroids such as nandrolone (Anabolin) or oxymetholone (Anadrol)
- medicine for infections
- antiseizure medicines such as divalproex (Depakote), valproic acid (Depakene), or phenytoin (Dilantin)
- antianxiety drugs, including chlorpromazine (Thorazine), prochlorperazine (Compazine), and thioridazine (Mellaril).

In addition, estrogens may interfere with the effects of bromocriptine (Parlodel), used to treat **Parkinson's**



Estrogen replacement patches adhere to a patient's skin and slowly administer estrogen to the body. *(Illustration by Argosy Inc.)*

disease and other conditions; they may also increase the chance of toxic side effects when taken with cyclosporine (Sandimmune), a drug that helps prevent organ transplant rejection.

Description

HRT medications come in several different forms, including tablets, stick-on patches, injections, and creams that are worn inside the vagina. The form prescribed depends on the purpose of the hormone replacement therapy. Women who want relief from vaginal dryness, for example, would be given a cream or vaginal ring. Women using HRT to relieve hot flashes or to prevent osteoporosis and heart disease often prefer oral medications or patches. All HRT medications used in the United States are available only with a doctor's prescription.

HRT treatment regimens

One of the complications of HRT is the number of treatment options, including combinations of types of estrogen; dosage levels; forms of administration; and whether or not progestins are used with the estrogen to offset the risk of uterine cancer. This variety, however, means that a woman who wants to use HRT while minimizing side effects can try different forms of medication or dosage schedules when she consults her doctor. It is vital, however, for women to follow their doctor's directions exactly and not change dosages themselves.

At present, women who are taking a combination of estrogens and progestins are placed on one of three dosage schedules:

- Estrogen pills taken daily from the first through the 25th day of each month, with a progestin pill taken daily during the last 10–14 days of the cycle. Both drugs are then stopped for the next five to six days to allow the uterus to shed its lining.
- Estrogen pills taken on a daily basis with low-dose progestin pills, also on a daily basis. Both medications are taken continuously with no days off.
- Estrogen pills and low-dose progestins taken on a daily basis for five days each week, with both medications stopped on the last two days of each week.

Controversies over HRT

It is important to know that there is still considerable disagreement over the advantages and disadvantages of HRT. Further research is ongoing and intensive concerning the benefits and/or risks.

INCREASED RISK OF BREAST CANCER. The most important controversy over HRT is whether it increases a woman's risk of developing breast cancer. Some studies not only indicate a connection, but suggest that the

KEY TERMS

Dilation and curettage (D & C)—A surgical procedure in which the patient's cervix is widened (dilated) and the endometrium is scraped with a scoop-shaped instrument (curette).

Estrogen—The primary sex hormone that controls normal sexual development in females. During the menstrual cycle, estrogen helps prepare the body for possible pregnancy.

Follicle-stimulating hormone (FSH)—A hormone produced by the pituitary gland that stimulates the follicles in the ovaries to swell and release ripe ova. Doctors sometimes use its levels in a woman's blood to evaluate whether she is in menopause.

Hormone—A substance secreted by an endocrine gland that is carried by blood or other body fluids to its target tissues or organs.

Hot flash—A warm or hot sensation on the face, neck and upper body, sometimes accompanied by flushing and sweating. Some women refer to hot flashes as hot flushes.

Osteoporosis—A bone disorder in which the bones become brittle, porous, and easily broken. It is a major health concern for postmenopausal women.

Ovary—The female sex gland that produces eggs and female reproductive hormones.

Ovulation—The cyclical process of egg maturation and release from the ovary.

Progesterone—A female hormone produced by the ovary. It functions to prepare the lining of the uterus to receive a fertilized ovum.

Progesterone challenge test—A test that is given to see if a woman is still secreting estrogen. It consists of doses of progesterone given over a 10-day period.

Progestin—Synthetic progesterone available as an oral medication.

Testosterone—A male sex hormone that is sometimes given as part of HRT to women whose ovaries have been removed. Testosterone helps with problems of sexual desire.

Uterus—The hollow organ in women in which fertilized eggs develop during pregnancy. The uterus is sometimes called the womb.

risk of breast cancer rises with the length of time that a woman has been taking HRT. According to an American study published in June 1998, the risk of breast cancer increases by 2.3% for each year that a woman takes HRT. A Swedish study found that the risk of breast cancer doubled after six years of HRT, which agrees with American findings that risk is connected to length of treatment.

TIMING AND LENGTH OF TREATMENT. One of the disagreements about HRT concerns the best time to begin using it. Some doctors think that women should begin using HRT while they are still in perimenopause. Others think that there is no harm in a woman's waiting to decide. Either way, the question of timing means that a woman should keep track of changes in her periods and other signs of perimenopause so that her doctor can evaluate her readiness for HRT.

The other question of timing concerns length of treatment. Some women use HRT only as long as they need it to relieve the symptoms of menopause. Others regard it as a lifetime commitment because of concerns about osteoporosis. One study found that the average length of time that women stay on HRT is 23 months.

UNWANTED SIDE EFFECTS. Much of the disagreement about unwanted side effects from HRT concerns the role of progestins in the estrogen/progestin combinations that are commonly prescribed. Many women who find that estrogen relieves hot flashes and other symptoms of menopause have the opposite experience with progestin. Progestin frequently causes moodiness, depression, sore breasts, weight gain, and severe headaches.

Other treatment approaches

Women who are uncertain about HRT, or who should not take estrogens, should know about other treatment options, such as natural progesterone. Progestins, which are synthetic hormones, were developed because natural progesterone cannot be absorbed in the body when taken in pill form. A new technique called micronization has made it possible for women to take natural progesterone by mouth. Many women prefer this form of hormone because it lacks the side effects of the synthetic progestins even though it is somewhat more expensive. The most common form of natural progesterone is called Prometrium and it is available by prescription only. Another form of natural progesterone consists of the hormone suspend-

ed in vitamin E oil. It is absorbed through the skin and is available without a prescription.

Alternative therapies are also available. Many mainstream as well as alternative practitioners recommend changes in diet and **nutrition** as helpful during menopause. Women who limit their intake of fats and salts, increase their use of fresh fruits and vegetables, cut out smoking, and drink only in moderation often find that these dietary changes help them feel better. Naturopaths typically recommend vitamin and mineral supplements for general well-being as well as for relief from hot flashes and leg cramps. In addition, herbal teas and tonics are helpful to some women in treating water retention, **insomnia**, **constipation**, or moodiness.

Women who find menopause emotionally stressful because of negative social attitudes toward older women are often helped by **meditation**, **biofeedback**, therapeutic massage, and other relaxation techniques. **Yoga** and **tai chi** provide physical exercise as well as **stress reduction**. Exercise is an important safeguard against osteoporosis.

Preparation

Women who are considering HRT should visit their doctor for a series of tests to make sure that they do not have any serious health disorders. They should have a Pap smear and breast examination to rule out cancer. They should also have a **urinalysis**, a **bone density test**, and blood tests to measure their red blood cell level, blood sugar level, cholesterol level, and liver and thyroid function.

In addition to these tests, most doctors will also give a progesterone challenge test. It consists of doses of progesterone given over a 10-day period to see if the woman is still producing her own estrogen. If she bleeds at the end of the test, she is still producing estrogen.

Aftercare

Aftercare is a very important part of HRT. Women who are taking HRT will need to see their doctor more frequently. At a minimum, they should be checked twice a year with a blood pressure test and breast examination. They should have a complete physical on a yearly basis. Any abnormal bleeding must be reported to the doctor as soon as it occurs. The doctor will need to order a tissue biopsy or dilation and curettage (D & C) in order to rule out cancer of the uterus.

Women who are taking HRT and decide to stop should taper their dosage over a period of several months rather than discontinuing abruptly. A gradual reduction minimizes the possibility of hot flashes and other side effects.

Risks

The short-term risks associated with HRT include a range of physical side effects. Common side effects include fluid retention, bloating, weight gain, sore breasts, leg cramps, vaginal discharges, migraine headaches, hair loss, **nausea and vomiting**, **acne**, depression, **shortness of breath**, and **dizziness**. Potentially serious side effects include tissue growths in the uterus (fibroids), gallstones, **thrombophlebitis**, **hypoglycemia**, abnormal growth (hyperplasia) of uterine tissue, thyroid disorders, high blood pressure, and cancer.

Normal results

Normal results of HRT include relief of hot flashes, night sweats, vaginal dryness, and urinary symptoms associated with menopause.

Resources

BOOKS

Compton, Madonna Sophia, MA. *Women at the Change: The Intelligent Woman's Guide to Menopause*. St. Paul: Llewellyn Publications, 1998.

Goldman, Lee, et al, eds. *Cecil Textbook of Medicine*. 21st ed. W. B. Saunders, 2000.

Goroll, Alan H. *Primary Care Medicine*. 4th ed. Lippincott Williams & Wilkins, 2000.

Greer, Germaine. *The Change: Women, Aging, and the Menopause*. New York: Fawcett Columbine, 1991.

Greenwood, Sadja. *Menopause, Naturally: Preparing for the Second Half of Life*. Volcano, CA: Volcano Press, 1992.

Nurses Drug Guide 1995. Ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

Sander, Pela. "Natural Healing Therapies." In *Women of the 14th Moon: Writings on Menopause*. Ed. Dena Taylor and Amber Coverdale Sumrall. Freedom, CA: The Crossing Press, 1991.

ORGANIZATION

American Heart Association. 7320 Greenville Avenue, Dallas, TX 75321. (214)373-6300.

National Women's Health Network. 514 10th Street, NW, Washington, DC 20004. (202) 347-1140.

North American Menopause Society (NAMS). 11100 Euclid Avenue, 7th Avenue, McDonald Hospital, Cleveland, OH 44105.

Women's International Pharmacy. 5708 Monona Drive, Madison, WI 53716. (800) 279-5708.

OTHER

Menopausal Hormone Replacement Therapy. Fact sheet. National Cancer Institute. <http://rex.nci.nih.gov>.

Laith Farid Gulli, M.D.

Hospital-acquired infections

Definition

A hospital-acquired infection is usually one that first appears three days after a patient is admitted to a hospital or other health-care facility. Infections acquired in a hospital are also called nosocomial infections.

Description

About 5–10% of patients admitted to hospitals in the United States develop a nosocomial infection. Hospital-acquired infections are usually related to a procedure or treatment used to diagnose or treat the patient's illness or injury. About 25% of these infections can be prevented by healthcare workers taking proper precautions when caring for patients.

Hospital-acquired infections can be caused by bacteria, viruses, fungi, or parasites. These microorganisms may already be present in the patient's body or may come from the environment, contaminated hospital equipment, healthcare workers, or other patients. Depending on the causal agents involved, an infection may start in any part of the body. A localized infection is limited to a specific part of the body and has local symptoms. For example, if a surgical wound in the abdomen becomes infected, the area of the wound becomes red, hot, and painful. A generalized infection is one that enters the bloodstream and causes general systemic symptoms such as **fever**, chills, low blood pressure, or mental confusion.

Hospital-acquired infections may develop from surgical procedures, catheters placed in the urinary tract or blood vessels, or from material from the nose or mouth that is inhaled into the lungs. The most common types of hospital-acquired infections are urinary tract infections (UTIs), **pneumonia**, and surgical wound infections.

Causes and symptoms

All hospitalized patients are susceptible to contracting a nosocomial infection. Some patients are at greater risk than others—young children, the elderly, and persons with compromised immune systems are more likely to get an infection. Other risk factors for getting a hospital-acquired infection are a long hospital stay, the use of indwelling catheters, failure of healthcare workers to wash their hands, and overuse of **antibiotics**.

Any type of invasive procedure can expose a patient to the possibility of infection. Common causes of hospital-acquired infections include:

- Urinary bladder catheterization
- Respiratory procedures
- surgery and **wounds**
- intravenous (IV) procedures

Urinary tract infection (UTI) is the most common type of hospital-acquired infection. Most hospital-acquired UTIs happen after **urinary catheterization**. Catheterization is the placement of a catheter through the urethra into the urinary bladder. This procedure is done to empty urine from the bladder, relieve pressure in the bladder, measure urine in the bladder, put medicine into the bladder, or for other medical reasons.

The healthy urinary bladder is sterile, which means it doesn't have any bacteria or other microorganisms in it. There may be bacteria in or around the urethra but they normally cannot enter the bladder. A catheter can pick up bacteria from the urethra and allow them into the bladder, causing an infection to start.

Bacteria from the intestinal tract are the most common type to cause UTIs. Patients with poorly functioning immune systems or who are taking antibiotics are also at risk for infection by a fungus called *Candida*.

Pneumonia is the second most common type of hospital-acquired infection. Bacteria and other microorganisms are easily brought into the throat by respiratory procedures commonly done in the hospital. The microorganisms come from contaminated equipment or the hands of health care workers. Some of these procedures are respiratory intubation, suctioning of material from the throat and mouth, and mechanical ventilation. The introduced microorganisms quickly colonize the throat area. This means that they grow and form a colony, but have not yet caused an infection. Once the throat is colonized, it is easy for a patient to inhale the microorganisms into the lungs.

Patients who cannot **cough** or gag very well are most likely to inhale colonized microorganisms into their lungs. Some respiratory procedures can keep patients from gagging or coughing. Patients who are sedated or who lose consciousness may also be unable to cough or gag. The inhaled microorganisms grow in the lungs and cause an infection that can lead to pneumonia.

Surgical procedures increase a patient's risk of getting an infection in the hospital. Surgery directly invades the patient's body, giving bacteria a way into normally sterile parts of the body. An infection can be acquired from contaminated surgical equipment or from healthcare workers. Following surgery, the surgical wound can become infected. Other wounds from trauma, **burns**, and ulcers may also become infected.

Many hospitalized patients need a steady supply of medications or nutrients delivered to their bloodstream. An intravenous (IV) catheter is placed in a vein and the medication or other substance is infused into the vein.

Bacteria transmitted from the surroundings, contaminated equipment, or healthcare workers' hands can invade the site where the catheter is inserted. A local infection may develop in the skin around the catheter. The bacteria can also enter the blood through the vein and cause a generalized infection. The longer a catheter is in place, the greater the risk of infection.

Other hospital procedures that put patients at risk for nosocomial infection are gastrointestinal procedures, obstetric procedures, and **kidney dialysis**.

Fever is often the first sign of infection. Other symptoms and signs of infection are rapid breathing, mental confusion, low blood pressure, reduced urine output, and a high white blood cell count.

Patients with a UTI may have **pain** when urinating and blood in the urine. Symptoms of pneumonia may include difficulty breathing and coughing. A localized infection causes swelling, redness, and tenderness at the site of infection.

KEY TERMS

Abscess—A localized pocket of pus at a site of infection.

Candida—A yeast-like fungal organism.

Catheter—A thin, hollow tube inserted into the body at specific points in order to inject or withdraw fluids from the body.

Generalized infection—An infection that has entered the bloodstream and has general systemic symptoms such as fever, chills, and low blood pressure.

Localized infection—An infection that is limited to a specific part of the body and has local symptoms.

Nosocomial infection—An infection acquired in the hospital.

Diagnosis

An infection is suspected any time a hospitalized patient develops a fever that cannot be explained by a known illness. Some patients, especially the elderly, may not develop a fever. In these patients, the first signs of infection may be rapid breathing or mental confusion.

Diagnosis of a hospital-acquired infection is based on:

- symptoms and signs of infection
- examination of wounds and catheter entry sites
- review of procedures that might have led to infection
- laboratory test results

A complete **physical examination** is conducted in order to locate symptoms and signs of infection. Wounds and the skin where catheters have been placed are examined for redness, swelling, or the presence of pus or an **abscess**. The physician reviews the patient's record of procedures performed in the hospital to determine if any posed a risk for infection.

Laboratory tests are done to look for signs of infection. A complete **blood count** can reveal if the white blood cell count is high. White blood cells are immune system cells that increase in numbers in response to an infection. White blood cells or blood may be present in the urine when there is a UTI.

Cultures of blood, urine, sputum, other body fluids, or tissue are done to look for infectious microorganisms. If an infection is present, it is necessary to identify the microorganism so the patient can be treated with the correct medication. A sample of the fluid or tissue is placed in a special medium that bacteria will grow in. Other tests can also be done on blood and body fluids to look for and identify bacteria, fungi, viruses, or other microorganisms responsible for an infection.

If a patient has symptoms suggestive of pneumonia, a **chest x ray** is done to look for infiltrates of white blood cells and other inflammatory substances in the lung tissue. Samples of sputum can be studied with a microscope or cultured to look for bacteria or fungi.

Treatment

Once the source of the infection is identified, the patient is treated with antibiotics or other medication that kills the responsible microorganism. Many different antibiotics are available that are effective against different bacteria. Some common antibiotics are penicillin, **cephalosporins**, **tetracyclines**, and erythromycin. More and more commonly, some types of bacteria are becoming resistant to the standard antibiotic treatments. When this happens, a different, more powerful antibiotic must be used. Two strong antibiotics that have been effective against resistant bacteria are vancomycin and imipenem, although some bacteria are developing resistance to these antibiotics as well.

Fungal infections are treated with antifungal medications. Examples of these are amphotericin B, nystatin, ketoconazole, itraconazole, and fluconazole.

A number of **antiviral drugs** have been developed that slow the growth or reproduction of viruses. Acyclovir, ganciclovir, foscarnet, and amantadine are examples of antiviral medications.

Prognosis

Hospital-acquired infections are serious illnesses that cause **death** in about 1% of cases. Rapid diagnosis and identification of the responsible microorganism is necessary, so treatment can be started as soon as possible.

Prevention

Hospitals and other healthcare facilities have developed extensive **infection control** programs to prevent nosocomial infections. These programs focus on identifying high risk procedures and other possible sources of infection. High risk procedures such as urinary catheterization should be performed only when necessary and catheters should be left in for as little time as possible. Medical instruments and equipment must be properly sterilized to ensure they are not contaminated. Frequent handwashing by healthcare workers and visitors is necessary to avoid passing infectious microorganisms to hospitalized patients.

Antibiotics should only be used when necessary. Use of antibiotics creates favorable conditions for infection with the fungal organism *Candida*. Overuse of antibiotics is also responsible for the development of bacteria that are resistant to antibiotics.

Resources

BOOKS

Andreoli, T. E., J. C. Bennet, C. C. Carpenter, and F. Plum. *Cecil Essentials of Medicine*. Philadelphia: W.B. Saunders Co., 1997.

Schaffer, S. D., and L. S. Garzon,, et al. *Infection Prevention and Safe Practice*. New York: Mosby-Year Book, 1996.

Toni Rizzo

Hot-spot imaging *see* **Technetium heart scan**

HRT *see* **Hormone replacement therapy**

HTLV-1 associated myelopathy *see* **Tropical spastic paraparesis**

HTLV-1 infection *see* **Tropical spastic paraparesis**

Human-potential movement

Definition

The human-potential movement is a term used for humanistic psychotherapies that first became popular in the 1960s and early 1970s. The movement emphasized the development of individuals through such techniques as encounter groups, sensitivity training, and primal therapy. Although the human-potential movement and humanistic therapy are sometimes used as synonyms, in reality, humanistic therapy preceded the human-potential movement and provided the movement's theoretical base. Humanistic therapy flourished in the 1940s and 1950s. Its theorists were mostly psychologists rather than medical doctors. They included Gordon Allport, Abraham Maslow, Everett Shostrom, Carl Rogers, and Fritz Perls.

The human-potential movement and humanistic therapy is distinguished by the following emphases:

- A concern for what is uniquely human rather than what humans share with other animals.
- A focus on each person's open-ended growth rather than reshaping individuals to fit society's demands.
- An interest in the here-and-now rather than in a person's childhood history or supposed unconscious conflicts.
- A holistic approach concerned with all levels of human being and functioning—not just the intellectual—including creative and spiritual functioning.
- A focus on psychological health rather than disturbance.

Purpose

The purpose of humanistic therapy is to allow a person to make full use of his or her personal capacities leading to self-actualization. Self-actualization requires the integration of all the components of one's unique personality. These elements or components of personality include the physical, emotional, intellectual, behavioral, and spiritual. The marks of a self-actualized person are maturity, self-awareness, and authenticity. Humanistic therapists think that most people—not only those with obvious problems—can benefit from opportunities for self-development. Humanistic therapy uses both individual and group approaches.

Precautions

Psychotic patients, substance abusers, and persons with severe **personality disorders** or disorders of impulse control may not be appropriate for treatment with humanistic methods.

Description

Humanistic approaches to individual treatment usually follow the same format as other forms of outpatient counseling. Therapists may be medical doctors, nurses, psychologists, social workers, or clergy. Humanistic group treatment formats are flexible, and a wide range of

KEY TERMS

Encounter group—A form of humanistic therapy in which participants meet with a trained leader to increase self-awareness and social skills through emotional sharing and confrontation.

Humanistic therapy—An approach to psychotherapy that emphasizes human uniqueness, positive qualities, and individual potential. It is sometimes used as a synonym for the human potential movement.

Primal therapy—A form of humanistic therapy that originated in the 1970s. Participants were encouraged to relive painful events and release feelings through screaming or crying rather than analysis.

Sensitivity training—A form of humanistic group therapy that began in the 1950s. Members participated in unstructured discussions in order to improve understanding of themselves and others.

treatment methods are used, ranging from encounter groups and therapy groups to assertiveness training and consciousness-raising groups. In addition, the humanistic tradition has fostered the publication of self-help books for people interested in psychological self-improvement.

Risks

The chief risks include the reinforcement of self-centered tendencies in some patients and the dangers resulting from encounter groups led by persons without adequate training. Poorly led encounter groups can be traumatic to persons with low tolerance for confrontation or "uncovering" of private issues.

Normal results

The anticipated outcome of humanistic therapy is a greater degree of personal wholeness, self-acceptance, and exploration of one's potential. In group treatment, participants are expected to grow in interpersonal empathy and relationship skills. However, there have been few controlled studies to determine the reasonableness of these expectations.

Resources

BOOKS

Lasch, Christopher. *The Culture of Narcissism: American Life in an Age of Diminishing Expectations*. New York: W. W. Norton & Co., 1978.

Meissner, W. W. "Theories of Personality." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

Rogers, Carl R. *Client-Centered Therapy.* Boston: Houghton Mifflin Co., 1965.

Severin, Frank T. "Humanistic Psychology." In *The Encyclopedia of Psychiatry, Psychology, and Psychoanalysis*, ed. Benjamin B. Wolman. New York: Henry Holt and Co., 1996.

Shostrom, Everett L. *From Manipulator to Master.* New York: Bantam Books, 1983.

Rebecca J. Frey

Human bite infections

Definition

Human bite infections are potentially serious infections caused by rapid growth of bacteria in broken skin.

Description

Bites—animal and human—are responsible for about 1% of visits to emergency rooms. Bite injuries are more common during the summer months.

Closed-fist injury

In adults, the most common form of human bite is the closed-fist injury, sometimes called the "fight bite." These injuries result from the breaking of the skin over the knuckle joint when a person's fist strikes someone's teeth during a fight.

Causes and symptoms

In children, bite infections result either from accidents during play or from fighting. Most infected bites in adults result from fighting.

The infection itself can be caused by a number of bacteria that live in the human mouth. These include streptococci, staphylococci, anaerobic organisms, and *Eikenella corrodens*. Infections that begin less than 24 hours after the injury are usually produced by a mixture of organisms and can cause a necrotizing infection (causing the **death** of a specific area of tissue), in which tissue is rapidly destroyed. If a bite is infected, the skin will be sore, red, swollen, and warm to the touch.

Diagnosis

In most cases the diagnosis is made by an emergency room doctor on the basis of the patient's history.

KEY TERMS

Closed-fist injury—A hand wound caused when the skin of the fist is torn open by contact with teeth.

Debridement—The surgical removal of dead tissue and/or foreign bodies from a wound or cut.

"Fight bite"—Another name for closed-fist injury.

Necrotizing—Causing the death of a specific area of tissue. Human bites frequently cause necrotizing infections.

Because the human mouth contains a variety of bacteria, the doctor will order a laboratory culture in order to choose the most effective antibiotic.

Treatment

Treatment involves surgical attention as well as medications. Because bites cause puncturing and tearing of skin rather than clean-edged cuts, they must be carefully cleansed. The doctor will wash the wound with water under high pressure and debride it. **Debridement** is the removal of dead tissue and **foreign objects** from a wound to prevent infection. If the bite is a closed-fist injury, the doctor will look for torn tendons or damage to the spaces between the joints. Examination includes x rays to check for bone **fractures** or foreign objects in the wound.

Doctors do not usually suture a bite wound because the connective tissues and other structures in the hand form many small closed spaces that make it easy for infection to spread. Emergency room doctors often consult surgical specialists if a patient has a deep closed-fist injury or one that appears already infected.

The doctor will make sure that the patient is immunized against **tetanus**, which is routine procedure for any open wound. Because of risk of infection, all patients with human bite **wounds** should be given **antibiotics**. Patients with closed-fist injuries may need inpatient treatment in addition to an intravenous antibiotic.

Prognosis

The prognosis depends on the location of the bite and whether it was caused by a child or an adult. Bites caused by children rarely become infected because they are usually shallow. Between 15–30% of bites caused by adults become infected, with a higher rate for closed-fist injuries.

Prevention

Prevention of human bite infections depends upon prompt treatment of any bite caused by a human being, particularly a closed-fist injury.

Resources

BOOKS

Battan, F. Keith. "Pediatric Emergencies: Bites and Stings." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Battan, F. Keith, et al. "Emergencies, Injuries, & Poisoning." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Jacobs, Richard A. "General Problems in Infectious Diseases: Animal & Human Bite Wounds." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Human chorionic gonadotropin *see* **Infertility drugs**

Human chorionic gonadotropin pregnancy test

Definition

The most common test of **pregnancy** involves the detection of a hormone known as human chorionic gonadotropin (hCG) in a sample of blood or urine.

Purpose

To determine whether or not a woman is pregnant.

Description

Shortly after a woman's egg is fertilized by her male partner's sperm and is implanted in the lining or the womb (uterus), a placenta begins to form. This organ will help nourish the developing new life. The placenta produces hCG, whose presence, along with other hormones, helps maintain the early stages of pregnancy. Because hCG is produced only by placental tissue and the hormone can be found in the blood or urine of a pregnant woman, it has become a convenient chemical test of pregnancy.

After implantation, the level of detectable hCG rises very rapidly, approximately doubling in quantity every

KEY TERMS

Ectopic pregnancy—A pregnancy that develops outside of the mother's uterus. Ectopic pregnancies often cause severe pain in the lower abdomen and are potentially life-threatening because of the massive blood loss that may occur as the developing embryo/fetus ruptures and damages the tissues in which it has implanted.

Embyro—In humans, the developing individual from the time of implantation to about the end of the second month after conception. From the third month to the point of delivery, the individual is called a fetus.

Hormone—A chemical produced by a specific organ or tissue of the body that is released into the bloodstream in order to exert an effect in another part of the body.

Human chorionic gonadotropin (hCG)—A hormone produced by the placenta of a developing pregnancy.

Hydatidform mole—A rare, generally benign grapelike mass that grows in the uterus from the remains of an abnormally developed embryo and surrounding tissue. In extremely rare cases, the mole develops into a choriocarcinoma, a malignant tumor whose cells can invade the wall of the uterus.

Implantation—The attachment of the fertilized egg or embryo to the wall of the uterus.

Menstrual cycle—A hormonally regulated series of monthly events that occur during the reproductive years of the human female to ensure that the proper internal environment exists for fertilization, implantation, and development of a baby. Each month, a mature egg is released from the follicle of an ovary. If an egg is released, fertilized, and implanted, the lining of the uterus continues to build. If fertilization and/or implantation does not occur, the egg and all of the excess uterine lining are shed from the body during menstruation.

Miscarriage—Loss of the embryo or fetus and other products of pregnancy before the middle of the second trimester. Often, early in a pregnancy, if the condition of the baby and/or the mother's uterus are not compatible with sustaining life, the pregnancy stops, and the contents of the uterus are expelled. For this reason, miscarriage is also referred to as spontaneous abortion.

Placenta—The organ that unites the developing new life (first called an embryo and later a fetus) to the mother's uterus. The placenta produces hCG, among other hormones, to help maintain the pregnancy. After delivery, the placenta, known at this point as afterbirth, is expelled.

two days until a peak is reached between the sixth and eighth week. Over the next ten or more weeks, the quantity of hCG slowly decreases. After this point, a much lower level is sustained for the duration of the pregnancy. Detectable levels of this hormone may even persist for a month or two after delivery.

Blood tests for hCG are the most sensitive and can detect a pregnancy earlier than urine tests. Blood tests for hCG can also distinguish normal pregnancies from impending miscarriages or pregnancies that occur outside of the uterus (ectopic pregnancies).

If a woman misses her menstrual period and wants to know if she may be pregnant, she can purchase one of many home pregnancy test kits that are currently available. Although each of these products may look slightly different and provide a different set of directions for use, each one detects the presence of hCG. This indicator contains chemical components called antibodies that are sensitive to a certain quantity of this hormone.

Precautions

Although home pregnancy tests may be advertised as having an accuracy of 97% or better, studies indicate that, in practice, pregnancy tests performed in the home may incorrectly indicate that a woman is not pregnant (a false positive result) between 25–50% of the time. Studies also indicate that the false negative results usually result from failing to follow the package directions or testing too soon after a missed menstrual period. Waiting a few days after the missed period was expected can increase the accuracy of the test. Blood and urine tests performed by a laboratory are from 97–100% accurate in detecting pregnancy.

Preparation

Generally, no preparation is required for a pregnancy test given in a doctor's office.

Home pregnancy test kits can be divided into two basic types. One type involves the use of a wand-like

device that a woman must place into her urine stream for a brief period of time. The other type of kit involves the use of a cup, a dropper, and a wand or stick with a small well. The cup is used to collect the urine, and the dropper is used to transfer a specific number of drops into the well. Results are displayed by a color change. It's important to follow the package directions very carefully (the techniques vary from brand to brand) and to read the results in the time specified.

Aftercare

No special care is required after a urine test for hCG. Women who feel faint or who continue to bleed after a blood test should be observed until the condition goes away.

Risks

Tests for hCG levels pose no direct risk to a woman's health. The main risk with a home pregnancy test is a false negative result, which may be lessened by following the manufacturer's instructions carefully and waiting at least several days after the expected menstrual period to test. A false negative result can cause a delay in seeking prenatal care, which can pose a risk to both the woman and the baby.

Abnormal results

In most cases, a positive result is an indication of pregnancy. However, false positive results may also occur. If a pregnancy test is performed within a month or two of a recent birth or **miscarriage**, it is possible to test positive for pregnancy since hCG may still be detected in a woman's urine. Sometimes positive pregnancy tests provide clues of an early miscarriage that might have otherwise gone unrecognized because it occurred before or just after a missed period. An **ectopic pregnancy** (one in which an embryo implants outside the uterus), certain types of masses (such as an ovarian tumor or a **hydatidiform mole**), and the use of some fertility drugs that contain hCG are among other possibilities behind false positive results.

Normal results

A woman should notify her physician immediately if her home pregnancy test is positive. Pregnancy can then be confirmed with hCG urine or blood tests taken in the doctor's office and evaluated by laboratory personnel. If performed accurately, home pregnancy tests have been found to be highly reliable. However, the versions of these tests performed by qualified laboratory technologists are considered to be definitive. Often, such a test will produce positive results before a woman experiences symptoms or before a doctor's exam reveals signs of pregnancy.

Resources

BOOKS

Cunningham, F. Gary, ed. *Williams Obstetrics*. 20th ed. Stamford: Appleton & Lang, 1977.

PERIODICALS

Bastian, L. A., et al. "Is This Patient Pregnant?" *The Journal of the American Medical Association* 278, no. 7: 586-591.

Peredy, T. R., and R. D. Powers. "Bedside Diagnostic Testing of Body Fluids." *American Journal of Emergency Medicine* 15, no. 4: 404-405.

"Pregnancy Tests: They Can't Get Much Simpler Than This." *Consumer Reports*, Oct. 1996, 48-49.

OTHER

"Reliable Ways to Find Out if You're Pregnant or Ready to Conceive." *Mayo Clinic Online*. 29 Feb. 1998 <http://www.mayohealth.org>.

Betty Mishkin

Human herpes *see* **Roseola**

Human leukocyte antigen test

Definition

The human leukocyte antigen test, also known as HLA, is a test that detects antigens (genetic markers) on white blood cells. There are four types of human leukocyte antigens: HLA-A, HLA-B, HLA-C, and HLA-D.

Purpose

The HLA test is used to provide evidence of tissue compatibility typing of tissue recipients and donors. It is also an aid in **genetic counseling** and in paternity testing.

Precautions

This test may have to be postponed if the patient has recently undergone a **transfusion**.

Description

Human leukocyte antigen (leukocyte is the name for white blood cell, while antigen refers to a genetic marker) is a substance that is located on the surface of white blood cells. This substance plays an important role in the body's immune response.

Because the HLA antigens are essential to immunity, identification aids in determination of the degree of tissue compatibility between transplant recipients and

donors. Testing is done to diminish the likelihood of rejection after transplant, and to avoid graft-versus-host disease (GVHD) following major organ or **bone marrow transplantation**. It should be noted that risk of GVHD exists even when the donor and recipient share major antigens. As an example, it was recently discovered that a mismatch of HA-1 (a minor antigen) was a cause of GVHD in bone marrow grafts from otherwise HLA-identical donors.

HLA can aid in paternity exclusion testing, a highly specialized area of forensic medicine. To resolve cases of disputed paternity, a man who demonstrates a phenotype (two haplotypes: one from the father and one from the mother) with no haplotype or antigen pair identical to one of the child's is excluded as the father. Conversely, a man who has one haplotype identical to one of the child's may be the father (the probability varies with the appearance of that particular haplotype in the population). Because of the issues involved, this type of testing is referred to experts.

Certain HLA types have been linked to diseases, such as **rheumatoid arthritis**, **multiple sclerosis**, serum lupus erythematosus, and other **autoimmune disorders**. By themselves, however, none of the HLA types are considered definitive. Because the clinical significance of many of the marker antigens has not yet been well defined, definitive diagnosis of disease is obtained by the use of more specific tests.

Preparation

The HLA test requires a blood sample. There is no need for the patient to be **fasting** (having nothing to eat or drink) before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Identification of specific leukocyte antigens, HLA-A, HLA-B, HLA-C and HLA-D.

Abnormal results

Incompatible groups between organ donors and recipients may cause unsuccessful tissue transplantation.

Certain diseases have a strong association with certain types of HLAs, which may aid in genetic counseling. For example, Hashimoto's **thyroiditis** (an autoimmune disorder involving underproduction by the thyroid gland) is associated with HLA-DR5, while B8 and Dw3 are allied with Graves' disease (another autoimmune disorder, but with overproduction by the thyroid gland). Hereditary **hemochromatosis** (too much iron in the blood) is associated with HLA-A3, B7, and B14. HLA-A3 is found in approximately 70% of patients with hemochromatosis, but as is the case with other HLA-associated disorders, the expense of HLA typing favors use of other tests. In cases of suspected hemochromatosis, for example, diagnosis is better aided by two tests called transferrin saturation and serum ferritin.

KEY TERMS

Autoimmune disorders—A disorder caused by a reaction of an individual's immune system against the organs or tissues of the body. Autoimmune processes can have different results: slow destruction of a particular type of cell or tissue, stimulation of an organ into excessive growth, or interference in function.

Haplotype—A set of alleles (an alternative form of a gene that can occupy a particular place on a chromosome) of a group of closely linked genes which are usually inherited as a unit.

Phenotype—1) The entire physical, biochemical, and physiologic makeup of an individual, as opposed to genotype. 2) The expression of a single gene or gene pair.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Humanistic therapy *see* **Gestalt therapy; Human-potential movement**

Humpback *see* **Kyphosis**

Hunchback *see* **Kyphosis**

Hunter's syndrome *see* **Mucopolysaccharidoses**

Huntington disease

Definition

Huntington disease is a progressive, neurodegenerative disease causing uncontrolled physical movements and mental deterioration. The disease was discovered by George Huntington of Pomeroy, Ohio, who first described a hereditary movement disorder.

Description

Huntington disease is also called Huntington chorea, from the Greek word for "dance," referring to the involuntary movements that develop as the disease progresses. It is occasionally referred to as "Woody Guthrie disease" for the American folk singer who died from it. Huntington disease (HD) causes progressive loss of cells in areas of the brain responsible for some aspects of movement control and mental abilities. A person with HD gradually develops abnormal movements and changes in cognition (thinking), behavior and personality.

The onset of symptoms of HD is usually between the ages of 30 and 50; although in 10% of cases, onset is in late childhood or early adolescence. Approximately 30,000 people in the United States are affected by HD, with another 150,000 at risk for developing this disorder. The frequency of HD is four to seven per 100,000 persons.

Causes and symptoms

Huntington disease is caused by a defect in the gene (an inherited unit which contains a code for a protein) of unknown function called huntingtin. The nucleotide codes (building blocks of genes arranged in a specific code which chemically forms into proteins), contain CAG repeats (40 or more of these repeat sequences). The extra building blocks in the huntingtin gene cause the protein that is made from it to contain an extra section as well. It is currently thought that this extra protein section, or portion, interacts with other proteins in brain cells where it occurs, and that this interaction ultimately leads to cell **death**.

The HD gene is a dominant gene, meaning that only one copy of it is needed to develop the disease. HD affects both males and females. The gene may be inherited from either parent, who will also be affected by the disease. A parent with the HD gene has a 50% chance of passing it on to each offspring. The chances of passing on the HD gene are not affected by the results of previous pregnancies.

The symptoms of HD fall into three categories: motor or movement symptoms, personality and behavioral changes and cognitive decline. The severity and rate of progression of each type of symptom can vary from person to person.

Early motor symptoms include restlessness, twitching and a desire to move about. Handwriting may become less controlled, and coordination may decline. Later symptoms include:

- dystonia, or sustained abnormal postures, including facial grimaces, a twisted neck, or an arched back
- chorea, in which involuntary jerking, twisting or writhing motions become pronounced
- slowness of voluntary movements, inability to regulate the speed or force of movements, inability to initiate movement and slowed reactions
- difficulty speaking and swallowing due to involvement of the throat muscles
- localized or generalized weakness and impaired balance ability
- rigidity, especially in late-stage disease

Personality and behavioral changes include depression, irritability, **anxiety** and apathy. The person with HD may become impulsive, aggressive or socially withdrawn.

Cognitive changes include loss of ability to plan and execute routine tasks, slowed thought, and impaired or inappropriate judgment. Short-term memory loss usually occurs, although long-term memory is usually not affected. The person with late-stage HD usually retains knowledge of his environment and recognizes family members or other loved ones, despite severe cognitive decline.

Diagnosis

Diagnosis of HD begins with a detailed medical history, and a thorough physical and neurological exam. Family medical history is very important. **Magnetic resonance imaging** (MRI) or computed tomography scan (CT scan) imaging may be performed to look for degeneration in the basal ganglia and cortex, the brain regions most affected in HD.

A genetic test is available for confirmation of the clinical diagnosis. In this test, a small blood sample is taken, and DNA from it is analyzed to determine the CAG repeat number. A person with a repeat number of 30 or below will not develop HD. A person with a repeat number between 35 and 40 may not develop the disease within their normal lifespan. A person with a very high number of repeats (70 or above) is likely to develop the juvenile-onset form. An important part of **genetic testing** is extensive **genetic counseling**.

Prenatal testing is available. A person at risk for HD (a child of an affected person) may obtain fetal testing without determining whether she herself carries the gene. This test, also called a linkage test, examines the pattern of DNA near the gene in both parent and fetus, but does not analyze for the triple nucleotide repeat (CAG). If the DNA patterns do not match, the fetus can be assumed not to have inherited the HD gene, even if present in the parent. A pattern match indicates the fetus probably has the same genetic makeup of the at-risk parent.

Treatment

There is no cure for HD, nor any treatment that can slow the rate of progression. Treatment is aimed at reducing the disability caused by the motor impairments, and treating behavioral and emotional symptoms.

Physical therapy is used to maintain strength and compensate for lost strength and balance. Stretching and range of motion exercises help minimize contracture, or muscle shortening, a result of weakness and disuse. The physical therapist also advises on the use of mobility aids such as walkers or wheelchairs.

Motor symptoms may be treated with drugs, although some studies suggest that anti-chorea treatment rarely improves function. Chorea (movements caused by abnormal muscle contractions) can be suppressed with drugs that deplete dopamine, an important brain chemical regulating movement. As HD progresses, natural dopamine levels fall, leading to loss of chorea and an increase in rigidity and movement slowness. Treatment with L-dopa (which resupplies dopamine) may be of some value. Frequent reassessment of the effectiveness and appropriateness of any drug therapy is necessary.

Occupational therapy is used to design compensatory strategies for lost abilities in the activities of daily living, such as eating, dressing, and grooming. The occupational therapist advises on modifications to the home that improve safety, accessibility, and comfort.

Difficulty swallowing may be lessened by preparation of softer foods, blending food in an electric blender, and taking care to eat slowly and carefully. Use of a straw for all liquids can help. The potential for **choking** on food is a concern, especially late in the disease progression. Caregivers should learn the use of the **Heimlich maneuver**. In addition, passage of food into the airways increases the risk for **pneumonia**. A gastric feeding tube may be needed, if swallowing becomes too difficult or dangerous.

Speech difficulties may be partially compensated by using picture boards or other augmentative communication devices. Loss of cognitive ability affects both speech production and understanding. A speech-language pathologist can work with the family to develop simplified and more directed communication strategies, including speaking slowly, using simple words, and repeating sentences exactly.

Early behavioral changes, including depression and anxiety, may respond to drug therapy. Maintaining a calm, familiar, and secure environment is useful as the disease progresses. Support groups for both patients and caregivers form an important part of treatment.

Experimental transplant of fetal brain tissue has been attempted in a few HD patients. Early results show some promise, but further trials are needed to establish the effectiveness of this treatment.

Prognosis

The person with Huntington disease may be able to maintain a job for several years after diagnosis, despite the increase in disability. Loss of cognitive functions and increase in motor and behavioral symptoms eventually prevent the person with HD from continuing employment. Ultimately, severe motor symptoms prevent mobility. Death usually occurs 15–20 years after disease onset. Progressive weakness of respiratory and swallowing muscles leads to increased risk of respiratory infection and choking, the most common causes of

KEY TERMS

Cognition—The mental activities associated with thinking, learning, and memory.

Computed tomography (CT) scan—An imaging procedure that produces a three-dimensional picture of organs or structures inside the body, such as the brain.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Heimlich maneuver—An action designed to expel an obstructing piece of food from the throat. It is performed by placing the fist on the abdomen, underneath the breastbone, grasping the fist with the other hand (from behind), and thrusting it inward and upward.

Neurodegenerative—Relating to degeneration of nerve tissues.

death. Future research in this area is currently focusing on nerve cell transplantation.

Resources

BOOK

Watts R.L., and W.C. Koller, eds. *Movement Disorders*. New York: McGraw-Hill, 1997.

ORGANIZATION

Huntington Disease Society of America. 140 W. 22nd St. New York, NY 10011. (800) 345-HDSA.

Laith Gulli, MD

Huntington's chorea *see* **Huntington's disease**

Hurler's syndrome *see* **Mucopolysaccharidoses**

HUS *see* **Hemolytic-uremic syndrome**

Hyaline *see* **Respiratory distress syndrome**

Hydatid *see* **Echinococcosis**

Hydatidiform mole

Definition

A hydatidiform mole is a relatively rare condition in which tissue around a fertilized egg that normally would have developed into the placenta instead develops as an abnormal cluster of cells. (This is also called a molar pregnancy.) This grapelike mass forms inside of the uterus after fertilization instead of a normal embryo. A hydatidiform mole triggers a positive **pregnancy** test and in some cases can become cancerous.

Description

A hydatidiform mole ("hydatid" means "drop of water" and "mole" means "spot") occurs in about 1 out of every 1,500 (1/1,500) pregnancies in the United States. In some parts of Asia, however, the incidence may be as high as 1 in 200 (1/200). Molar pregnancies are most likely to occur in younger and older women (especially over age 45) than in those between ages 20–40. About 1–2% of the time a woman who has had a molar pregnancy will have a second one.

A molar pregnancy occurs when cells of the chorionic villi (tiny projections that attach the placenta to the lining of the uterus) don't develop correctly. Instead, they turn into watery clusters that can't support a growing baby. A partial molar pregnancy includes an abnormal embryo (a fertilized egg that has begun to grow) that does not survive. In a compete molar pregnancy there is a small cluster of clear blisters or pouches that don't contain an embryo.

If not removed, about 15% of **moles** can become cancerous. They burrow into the wall of the uterus and cause serious bleeding. Another 5% will develop into fast-growing cancers called choriocarcinomas. Some of these tumors spread very quickly outside the uterus in other parts of the body. Fortunately, **cancer** developing from these moles is rare and highly curable.

Causes and symptoms

The cause of hydatidiform mole is unclear; some experts believe it is caused by problems with the chromosomes (the structures inside cells that contain genetic information) in either the egg or sperm, or both. It may be associated with poor **nutrition**, or a problem with the ovaries or the uterus. A mole sometimes can develop from placental tissue that is left behind in the uterus after a **miscarriage** or **childbirth**.

Women with a hydatidiform mole will have a positive pregnancy test and often believe they have a normal pregnancy for the first three or four months. However, in these cases the uterus will grow abnormally fast. By the end of the third month, if not earlier, the woman will experience vaginal bleeding ranging from scant spotting to excessive bleeding. She may have **hyperthyroidism** (overproduction of **thyroid hormones** causing symptoms such as weight loss, increased appetite, and intolerance to heat). Sometimes, the grapelike cluster of cells itself will be shed with the blood during this time. Other symptoms may include severe **nausea and vomiting** and high blood pressure. As the pregnancy progresses, the fetus will not move and there will be no fetal heartbeat.

Diagnosis

The physician may not suspect a molar pregnancy until after the third month or later, when the absence of a fetal heartbeat together with bleeding and severe nausea and vomiting indicates something is amiss.

First, the physician will examine the woman's abdomen, feeling for any strange lumps or abnormalities in the uterus. A tubal pregnancy, which can be life threatening if not treated, will be ruled out. Then the physician will check the levels of human chorionic gonadotropin (hCG), a hormone that is normally produced by a placenta or a mole. Abnormally high levels

of hCG together with the symptoms of vaginal bleeding, lack of fetal heartbeat, and an unusually large uterus all indicate a molar pregnancy. An ultrasound of the uterus to make sure there is no living fetus will confirm the diagnosis.

Treatment

It is extremely important to make sure that all of the mole is removed from the uterus, since it is possible that the tissue is potentially cancerous. Often, the tissue is naturally expelled by the fourth month of pregnancy. In some instances, the physician will give the woman a drug called oxytocin to trigger the release of the mole that is not spontaneously aborted.

If this does not happen, however, a vacuum aspiration can be performed to remove the mole. In a procedure similar to a **dilatation and curettage** (D & C), a woman is given an anesthetic (to deaden feeling during the procedure), her cervix (the structure at the bottom of the uterus) is dilated and the contents of the uterus is gently suctioned out. After the mole has been mostly removed, gentle scraping of the uterus lining is usually performed.

If the woman is older and does not want any more children, the uterus can be surgically removed (**hysterectomy**) instead of a vacuum aspiration because of the higher risk of cancerous moles in this age group.

Because of the cancer risk, the physician will continue to monitor the patient for at least two months after the end of a molar pregnancy. Since invasive disease is usually signaled by high levels of hCG that don't go down after the pregnancy has ended, the woman's hCG levels will be checked every two weeks. If the levels don't return to normal by that time, the mole may have become cancerous.

If the hCG level is normal, the woman's hCG will be tested each month for six months, and then every two months for a year.

If the mole has become cancerous, treatment includes removal of the cancerous issue and **chemotherapy**. If the cancer has spread to other parts of the body, radiation will be added. Specific treatment depends on how advanced the cancer is.

Women should make sure not to become pregnant within a year after hCG levels have returned to normal. If a woman were to become pregnant sooner than that, it would be difficult to tell whether the resulting high levels of hCG were caused by the pregnancy or a cancer from the mole.

KEY TERMS

Dilatation and curettage (D & C)—Dilating the cervix and scraping the lining of the uterus with an instrument called a curette.

Placenta—The circular, flat organ that connects the fetus via the umbilical cord to the uterus for oxygen, food, and elimination of wastes.

Prognosis

A woman with a molar pregnancy often goes through the same emotions and sense of loss as does a woman who has a miscarriage. Most of the time, she truly believed she was pregnant and now has suffered a loss of the baby she thought she was carrying. In addition, there is the added worry that the tissue left behind could become cancerous.

In the unlikely case that the mole is cancerous the cure rate is almost 100%. As long as the uterus was not removed, it would still be possible to have a child at a later time.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology*. 6th ed. St. Louis: Mosby, Inc., 1995.

Carol A. Turkington

Hydrocelectomy

Definition

Hydrocelectomy is a surgical procedure to remove a hydrocele. A hydrocele is collected fluid in the membrane surrounding the testes.

Purpose

Hydrocelectomy is performed to relieve the **pain** or reoccurrence of a hydrocele. Normally, hydroceles are not very painful. They tend to be a soft swelling in the membrane surrounding the testes. As the hydrocele

grows, the scrotum gets larger. Hydroceles do not damage the testes. The main symptom is scrotal swelling. There are two types of hydroceles depending on how they form. One type is seen in children, generally shortly after birth. It is caused by a failure of the processus vaginalis to close. Usually, surgery isn't used to treat hydrocele until after two years of age because the processus vaginalis frequently closes by itself if given extra time. In adults, hydroceles develop slowly. Most hydroceles develop because of blocked lymphatic flow. Hydroceles also develop after infection, injury, or local **cancer** tumors. Generally, hydroceles are treated by aspiration of the collected fluid. To do this, a needle is inserted into the scrotum and directed toward the hydrocele. Once there, as much fluid as possible is removed. Hydroceles can reoccur. Rarely, hydroceles grow larger and cause pain. Surgery is used to remove large or painful hydroceles. It is also the recommended procedure to remove hydroceles that reoccur after aspiration. Hydroceles are distinguished from other testicular problems by transillumination and **scrotal ultrasound** examinations.

Precautions

No special precautions are required for hydrocelectomy. It is typically performed on an outpatient basis.

Description

Aspiration of the fluid in a hydrocele is usually successful. However, aspiration may be only a temporary solution because of the potential that the hydrocele will reoccur. Generally, surgical repair of a hydrocele will eliminate the hydrocele. The extent of the surgery depends on whether other factors are present. If the hydrocele is uncomplicated, an incision is made in the scrotum. The hydrocele is cut out, removing the tissues involved in the hydrocele. If there are complications present, such as a **hernia**, an incision is made in the inguinal (groin) area. This approach allows repair of hernias and other complicating factors at the same time. Patients are placed under general anesthesia for these operations.

Preparation

A physician or nurse will explain the procedure and, in some cases, the need for a temporary drain to be inserted. The drain lessens the chance of infection and prevents fluid build-up.

Aftercare

Following surgery, the patient usually only needs a follow-up examination several weeks after the surgery to examine the incision and to check for signs of infection.

KEY TERMS

Aspiration—The process of removing fluids or gases from the body by suction.

Hernia—The protrusion of an organ or tissue through a wall that normally contains it.

Hydrocele—An accumulation of fluid in the membrane surrounding the testes (tunica vaginalis testis).

Risks

There is a slight risk of infection and internal hemorrhage as well as a chance of excessive bleeding from the surgical incision.

Normal results

There may be swelling of the scrotum for up to a month. The patient is able to resume most activities within 7–10 days, although heavy lifting and sexual activities may be delayed for up to six weeks. The hydrocele does not grow back.

Abnormal results

Swelling that lasts for several months is sometimes a complication of hydrocelectomy. Infection can also occur.

Resources

BOOKS

Hurst, J. Willis. *Medicine for the Practicing Physician.* Stamford: Appleton & Lange, 1988.

Sabiston, D. C., and H. K. Lyrly. *Essentials of Surgery.* Philadelphia: W. B. Saunders Co., 1994.

Current Surgical Diagnosis and Treatment. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Hydrocephalus

Definition

Hydrocephalus is an abnormal expansion of cavities (ventricles) within the brain that is caused by the accumulation of cerebrospinal fluid. Hydrocephalus comes from two Greek words: *hydros* means water and *cephalus* means head.

There are two main varieties of hydrocephalus: congenital and acquired. An obstruction of the cerebral

aqueduct (aqueductal stenosis) is the most frequent cause of congenital hydrocephalus. Acquired hydrocephalus may result from **spina bifida**, intraventricular hemorrhage, **meningitis**, head trauma, tumors, and cysts.

Description

Hydrocephalus is the result of an imbalance between the formation and drainage of cerebrospinal fluid (CSF). Approximately 500 milliliters (about a pint) of CSF is formed within the brain each day, by epidermal cells in structures collectively called the choroid plexus. These cells line chambers called ventricles that are located within the brain. There are four ventricles in a human brain. Once formed, CSF usually circulates among all the ventricles before it is absorbed and returned to the circulatory system. The normal adult volume of circulating CSF is 150 ml. The CSF turn-over rate is more than three times per day. Because production is independent of absorption, reduced absorption causes CSF to accumulate within the ventricles.

There are three different types of hydrocephalus. In the most common variety, reduced absorption occurs when one or more passages connecting the ventricles become blocked. This prevents the movement of CSF to its drainage sites in the subarachnoid space just inside the skull. This type of hydrocephalus is called "noncommunicating." In a second type, a reduction in the absorption rate is caused by damage to the absorptive tissue. This variety is called "communicating hydrocephalus."

Both of these types lead to an elevation of the CSF pressure within the brain. This increased pressure pushes aside the soft tissues of the brain. This squeezes and distorts them. This process also results in damage to these tissues. In infants whose skull bones have not yet fused, the intracranial pressure is partly relieved by expansion of the skull, so that symptoms may not be as dramatic. Both types of elevated-pressure hydrocephalus may occur from infancy to adulthood.

A third type of hydrocephalus, called "normal pressure hydrocephalus," is marked by ventricle enlargement without an apparent increase in CSF pressure. This type affects mainly the elderly.

Hydrocephalus has a variety of causes including:

- congenital brain defects
- hemorrhage, either into the ventricles or the subarachnoid space
- infection of the central nervous system (**syphilis**, herpes, meningitis, **encephalitis**, or mumps)
- tumor

Hydrocephalus is believed to occur in approximately one to two of every 1,000 live births. The incidence of adult onset hydrocephalus is not known. There is no known way to prevent hydrocephalus.

Causes and symptoms

Hydrocephalus that is congenital (present at birth) is thought to be caused by a complex interaction of genetic and environmental factors. Aqueductal stenosis, an obstruction of the cerebral aqueduct, is the most frequent cause of congenital hydrocephalus. As of 2001, the genetic factors are not well understood. According to the British Association for Spina Bifida and Hydrocephalus, in very rare circumstances, hydrocephalus is due to hereditary factors, which might affect future generations.

Signs and symptoms of elevated-pressure hydrocephalus include:

- headache
- nausea and vomiting, especially in the morning
- lethargy
- disturbances in walking (gait)
- double vision
- subtle difficulties in learning and memory
- delay in children achieving developmental milestones

Irritability is the most common sign of hydrocephalus in infants. If this is not treated, it may lead to lethargy. Bulging of the fontanelles, or the soft spots between the skull bones, may also be an early sign. When hydrocephalus occurs in infants, fusion of the skull bones is prevented. This leads to abnormal expansion of the skull.

Symptoms of normal pressure hydrocephalus include **dementia**, gait abnormalities, and incontinence (involuntary urination or bowel movements).

Diagnosis

Imaging studies—x ray, computed tomography scan (CT scan), ultrasound, and especially **magnetic resonance imaging** (MRI)—are used to assess the presence and location of obstructions, as well as changes in brain tissue that have occurred as a result of the hydrocephalus. Lumbar puncture (spinal tap) may be performed to aid in determining the cause when infection is suspected.

Treatment

The primary method of treatment for both elevated and normal pressure hydrocephalus is surgical

KEY TERMS

Cerebral ventricles—Spaces in the brain that are located between portions of the brain and filled with cerebrospinal fluid.

Cerebrospinal fluid—Fluid that circulates throughout the cerebral ventricles and around the spinal cord within the spinal canal.

Choroid plexus—Specialized cells located in the ventricles of the brain that produce cerebrospinal fluid.

Fontanelle—One of several "soft spots" on the skull where the developing bones of the skull have yet to fuse.

Shunt—A small tube placed in a ventricle of the brain to direct cerebrospinal fluid away from the blockage into another part of the body.

Stenosis—The constricting or narrowing of an opening or passageway.

Subarachnoid space—The space between two membranes surrounding the brain, the arachnoid and pia mater.

installation of a shunt. A shunt is a tube connecting the ventricles of the brain to an alternative drainage site, usually the abdominal cavity. A shunt contains a one-way valve to prevent reverse flow of fluid. In some cases of non-communicating hydrocephalus, a direct connection can be made between one of the ventricles and the subarachnoid space, allowing drainage without a shunt.

Installation of a shunt requires lifelong monitoring by the recipient or family members for signs of recurring hydrocephalus due to obstruction or failure of the shunt. Other than monitoring, no other management activity is usually required.

Some drugs may postpone the need for surgery by inhibiting the production of CSF. These include acetazolamide and furosemide. Other drugs that are used to delay surgery include glycerol, digoxin, and isosorbide.

Some cases of elevated pressure hydrocephalus may be avoided by preventing or treating the infectious diseases which precede them. Prenatal diagnosis of congenital brain malformation is often possible, offering the option of family planning.

Prognosis

The prognosis for elevated-pressure hydrocephalus depends on a wide variety of factors, including the cause, age of onset, and the timing of surgery. Studies indicate that about half of all children who receive appropriate treatment and follow-up will develop IQs greater than 85. Those with hydrocephalus at birth do better than those with later onset due to meningitis. For individuals with normal pressure hydrocephalus, approximately half will benefit by the installation of a shunt.

Resources

BOOKS

Drake, James M., and Christian Sainte-Rose. *Shunt Book.* Boston: Blackwell Science Inc., 1995.

Toporek, Chuck, and Kellie Robinson. *Hydrocephalus: A Guide for Patients, Families & Friends.* Cambridge, Mass.: O'Reilly & Associates, 1999.

PERIODICALS

Grant, Beth. "Hydrocephalus: diagnosis and treatment." *Radiologic Technology* 69, no. 2 (Nov–Dec 1997): 173–5.

"Hydrocephalus." *Review of Optometry* 137, no. 8 (August 15, 2000): 56A.

ORGANIZATIONS

Association for Spina Bifida and Hydrocephalus. 42 Park Rd., Peterborough, PE1 2UQ. UK 0173 355 5988. Fax: 017 3355 5985. postmaster@asbah.org. <http://www.asbah.demon.co.uk>.

Columbia Presbyterian Medical Center. Dept. of Neurological Surgery, 710 West 168 St., New York, NY 10032. (212) 305-0378. Fax: (212) 305-3629. <http://cpmcnet.columbia.edu/dept/nsg/PNS/Hydrocephalus.html>.

Hydrocephalus Association. 870 Market St., Suite 705, San Francisco, CA 94102. (415) 732-7040 or (888) 598-3789. (415) 732-7044. hydroassoc@aol.com. <http://neurosurgery.mgh.harvard.edu/ha>.

Hydrocephalus Foundation, Inc. (HyFI), 910 Rear Broadway, Saugus, MA 01906. (781) 942-1161. HyFI1@netscape.net. <http://www.hydrocephalus.org>.

OTHER

"Hydrocephalus." *American Association of Neurological Surgeons/Congress of Neurological Surgeons* <http://www.neurosurgery.org/pubpages/patres/hydrobroch.html>.

"Hydrocephalus." *Institute for Neurology and Neurosurgery.* Beth Israel Medical Center, New York, NY. <http://nyneurosurgery.org/child/hydrocephalus/hydrocephalus.htm>.

"Hydrocephalus." National Library of Medicine. *MEDLINEplus.* <http://www.nlm.nih.gov/medlineplus/hydrocephalus.html>.

L. Fleming Fallon, Jr., MD, PhD, DrPH

Hydrochlorothiazide *see* **Diuretics**

Hydrocodone *see* **Analgesics, opioid**

Hydrogen peroxide *see* **Antiseptics**

Hydronephrosis

Definition

Hydronephrosis is the swelling of the kidneys when urine flow is obstructed in any of part of the urinary tract. Swelling of the ureter, which always accompanies hydronephrosis, is called hydroureter. Hydronephrosis implies that a ureter and the renal pelvis (the connection of the ureter to the kidney) are overfilled with urine.

Description

The kidneys filter urine out of the blood as a waste product. It collects in the renal pelvis and flows down the ureters into the bladder. The ureters are not simple tubes, but muscular passages that actively propel urine into the bladder. At their lower end is a valve (the ureterovesical junction) that prevents urine from flowing backward into the ureter. The bladder stores urine. The prostate gland surrounds the bladder outlet in males. Urine then flows through the urethra and out of the body as a waste product.

Because the urinary tract is closed save for the one opening at the bottom, urine cannot escape. Instead, the parts distend. Rupture is rare unless there is violent trauma like an automobile accident.

Obstructed flow anywhere along the drainage route can cause swelling of the upper urinary tract, but if the obstruction is below the bladder, the ureterovesical valve will protect the upper tract to a certain extent. Even then, with no place to go, the urine will back up all the way to its source. Eventually, the back pressure causes kidney function to deteriorate.

Obstruction need not be complete for problems to arise. Intermittent or partial obstruction is far more common than complete blockage, allowing time for the parts to enlarge gradually. Furthermore, if a ureterovesical valve is absent or incompetent, the pressure generated by bladder emptying will force urine backward into the ureter and kidney, causing dilation even without mechanical obstruction.

Causes and symptoms

Causes are numerous. Various congenital deformities of the ureter may sooner or later produce back pressure. **Kidney stones** are a common cause. They form in the renal pelvis and become lodged in the kidney, usually at the ureterovesical junction. In older men, the continued growth of the prostate gland leads commonly to restricted urine flow out of the bladder. **Prostate cancer**, and **cancer** anywhere else along the urine pathways, can obstruct flow. **Pregnancy** normally causes ureteral obstruction from the pressure of the enlarged uterus (womb) on the ureters.

Symptoms relate to the passage of urine. Sometimes, urine may be difficult to pass, irregular, or uncontrolled. **Pain** from distension of the structures is present. Blood in the urine may be visible, but it is usually microscopic.

In all cases where bodily fluids cannot flow freely, infection is inevitable. Symptoms of urinary infection may include:

- Painful, burning urine.
- Cloudy urine
- Pain in the back, flank, or groin
- Fever, sweats, chills, and generalized discomfort

Patients often mistake a serious urinary infection for the flu.

Diagnosis

If the bladder is significantly distended, it can be felt through the abdomen. An analysis of the urine may reveal blood (if there is a stone), infection, or chemical changes suggesting kidney damage. Blood tests may also detect a decrease in kidney function.

All urinary obstructions will undergo imaging of some sort. Beginning with standard x rays to look for stones, radiologists, physicians specializing in the use of radiant energy for diagnostic purposes, will select from a wide array of tests. Ultrasound is simple, inexpensive, and very useful for these conditions. Standard x rays can be enhanced with contrast agents in several ways. If the kidneys are functioning, they will filter an x ray dye out of the blood and concentrate it in the urine, giving excellent pictures and also an assessment of kidney function. For better images of the lower urinary tract, contrast agents can be instilled from below. This is usually done with a cystoscope placed in the bladder. Through the cystoscope, a small tube can be threaded into the ureter through the ureterovesical valve, allowing dye to be injected all the way up to the kidney. CT and MRI scanning provide miraculous detail, more than is often needed for this condition.

KEY TERMS

Catheter—A tube placed into the body that allows fluids to pass through it.

Contrast agent—Substances that cast shadows on x rays or other imaging methods.

CT and MRI—Two high technology methods of creating images of internal organs. Computerized axial tomography (CT or CAT) uses x rays, while magnetic resonance imaging (MRI) uses magnet fields and radio-frequency signals. Both construct images using a computer.

Cystoscope—A pencil-thin instrument that allows viewing and operating inside the urinary system.

Renal pelvis—The middle section of the kidney where urine first collects after filtration from the blood.

Treatment

The obstruction must be relieved, even if it is partial or functional, as in the case of reflux from the bladder. If not, the kidney will ultimately be damaged, infection will appear, or both. The task may be as simple as placing a catheter through a restricting prostate or as complicated as removing a cancerous bladder and rebuilding a new one with a piece of bowel. In some cases, a badly damaged kidney may have to be removed.

Alternative treatment

Catheters or other urinary diversions may be better for weak or ill patients who cannot tolerate more extensive procedures. There is support using botanical medicine that can help the patient using a catheter avoid infections. Consultation with a trained health care practitioner is necessary.

Prognosis

After relief of the obstruction, a kidney may react with a brief flood of urine, but if the obstruction has been of short duration, normal kidney function will return. If one kidney is destroyed, the other will compensate for the lost organ.

Prevention

Kidney stones can be prevented by dietary changes and medication. Prompt evaluation of infections and urinary complaints will usually detect problems early enough to prevent long-term complications.

Resources

BOOKS

Gulmi, Frederick A. "Pathophysiology of Urinary Tract Obstruction." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

"Obstruction of the Urinary Tract." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Seifter, Julian L., and Barry M. Brenner. "Urinary Tract Obstruction." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Weiss, Robert M. "Physiology and Pharmacology of Renal Pelvis and Ureters." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

ORGANIZATIONS

American Association of Kidney Patients. 100 S. Ashley Dr., #280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Foundation. 6110 Executive Boulevard, #1010, Rockville, MD 20852. (800) 638-8299.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

J. Ricker Polsdorfer, MD

Hydrotherapy

Definition

Hydrotherapy, or water therapy, is the use of water (hot, cold, steam, or ice) to relieve discomfort and promote physical well-being.

Purpose

Hydrotherapy can soothe sore or inflamed muscles and joints, rehabilitate injured limbs, lower fevers, soothe headaches, promote relaxation, treat **burns** and frostbite, ease labor pains, and clear up skin problems. The temperature of water used affects the therapeutic properties of the treatment. Hot water is chosen for its relaxing properties. It is also thought to stimulate the immune system. Tepid water can also be used for **stress reduction**, and may be particularly relaxing in hot weather. Cold water is selected to reduce inflammation. Alternating hot and cold water can stimulate the circulatory system and improve

the immune system. Adding herbs and essential oils to water can enhance its therapeutic value. Steam is frequently used as a carrier for essential oils that are inhaled to treat respiratory problems.

Description

Origins

The therapeutic use of water has a long history. Ruins of an ancient bath were unearthed in Pakistan and date as far back as 4500 B.C. Bathhouses were an essential part of ancient Roman culture. The use of steam, baths, and aromatic massage to promote well being is documented since the first century. Roman physicians Galen and Celsus wrote of treating patients with warm and cold baths in order to prevent disease.

By the seventeenth and eighteenth centuries, bathhouses were extremely popular with the public throughout Europe. Public bathhouses made their first American appearance in the mid 1700s.

In the early nineteenth century, Sebastien Kneipp, a Bavarian priest and proponent of water healing, began treating his parishioners with cold water applications after he himself was cured of **tuberculosis** through the same methods. Kneipp wrote extensively on the subject, and opened a series of hydrotherapy clinics known as the Kneipp clinics, which are still in operation today. Around the same time in Austria, Vincenz Priessnitz was treating patients with baths, packs, and showers of cold spring water. Priessnitz also opened a spa that treated over 1,500 patients in its first year of operation, and became a model for physicians and other specialists to learn the techniques of hydrotherapy.

Water can be used therapeutically in a number of ways. Common forms of hydrotherapy include:

- Whirlpools, jacuzzis, and hot tubs. These soaking tubs use jet streams to massage the body. They are frequently used by physical therapists to help injured patients regain muscle strength and to soothe joint and muscle **pain**. Some midwives and obstetricians also approve of the use of hot tubs to soothe the pain of labor.
- Pools and Hubbard tanks. Physical therapists and **rehabilitation** specialists may prescribe underwater pool exercises as a low-impact method of rebuilding muscle strength in injured patients. The buoyancy experienced during pool immersion also helps ease pain in conditions such as arthritis.
- Baths. Tepid baths are prescribed to reduce a **fever**. Baths are also one of the oldest forms of relaxation therapy. Aromatherapists often recommend adding essential oils of lavender (*Lavandula angustifolia*) to a warm to hot bath to promote relaxation and **stress** reduction. Adding Epsom salts (magnesium sulfate) or Dead Sea salts to a bath can also promote relaxation and soothe rheumatism and arthritis.
- Showers. Showers are often prescribed to stimulate the circulation. Water jets from a shower head are also used to massage sore muscles.
- Moist compresses. Cold, moist compresses can reduce swelling and inflammation of an injury. They can also be used to cool a fever and treat a **headache**. Hot or warm compresses are useful for soothing muscle aches and treating abscesses.
- Steam treatments and saunas. Steam rooms and saunas are recommended to open the skin pores and cleanse the body of toxins. Steam inhalation is prescribed to treat respiratory infections. Adding botanicals to the steam bath can increase its therapeutic value.
- Internal hydrotherapy. **Colonic irrigation** is an enema that is designed to cleanse the entire bowel. Proponents of the therapy say it can cure a number of digestive problems. Douching, another form of internal hydrotherapy, directs a stream of water into the vagina for cleansing purposes. The water may or may not contain medications or other substances. Douches can be self-administered with kits available at most drug stores.

Preparations

Because of the expense of the equipment and the expertise required to administer effective treatment, hydrotherapy with pools, whirlpools, Hubbard tanks, and saunas is best taken in a professional healthcare facility, and/or under the supervision of a healthcare professional. However, baths, steam inhalation treatments, and compresses can be easily administered at home.

Bath preparations

Warm to hot bath water should be used for relaxation purposes, and a tepid bath is recommended for reducing fevers. Herbs can greatly enhance the therapeutic value of the bath for a variety of illnesses and minor discomforts.

Herbs for the bath can be added to the bath in two ways—as essential oils or whole herbs and flowers. Whole herbs and flowers can be placed in a muslin or cheesecloth bag that is tied at the top to make an herbal bath bag. The herbal bath bag is then soaked in the warm tub, and can remain there throughout the bath. When using essential oils, add five to 10 drops of oil to a full tub. Oils can be combined to enhance their

VINZENZ PRIESSNITZ (1799–1851)

(Betmann/CORBIS. Reproduced by permission.)

Hydrotherapy inventor Vinzenz Priessnitz was the son of a Silesian farmer from a remote Austrian territory in the Jeseniky Mountains. From the age of 12, Priessnitz dutifully provided for his blind father, his elderly mother, and his sister. His formal education was sporadic at best. However, Priessnitz possessed a level head and a high degree of intelligence along with a keen and active mind. As he matured he became extremely aware of his surroundings in nature.

At age 16, Priessnitz fell from a horse and was seriously hoofed by the animal. He received the morbid prognosis that he might be crippled at best, or might die at worst. He set to treating his own chest wound with cold packs, in emulation of a doe that he had once observed bathing a wound in a cool mountain stream. The hydrotherapy regimen proved highly effective and drew considerable attention to his small hometown of Gräfenberg. In 1822 he rebuilt the family home, renovating its wooden frame into a solid brick spa structure. The spa, known as the castle, housed as many as 1,500 guests each year by 1939. Among the guests were medical professionals who were intent upon exposing the therapy as a sham.

Detractors notwithstanding, word of the simple and effective treatment spread to Vienna, where Priessnitz traveled on occasion to provide counsel at the emperor's court. Priessnitz, for his remarkable discovery, received the Austrian Gold Civil Merit Medal First Class, the highest civilian honor of the Austrian government.

Priessnitz died on November 28, 1851. He was survived by a wife, Zofie Priessnitz, and a young son, Vinzenz Pavel. Joseph Schindler took over the operation of the spa at Gräfenberg following the death of its founder.

therapeutic value. Marjoram (*Origanum marjorana*) is good for relieving sore muscles; juniper (*Juniperus communis*) is recommended as a detoxifying agent for the treatment of arthritis; lavender, ylang ylang (*Conanga odorata*), and chamomile (*Chamaemelum nobilis*) are recommended for stress relief; cypress (*Cupressus sempervirens*), yarrow (*Achillea millefolium*), geranium (*Pelargonium graveolens*), clary sage (*Savlia sclaria*), and myrtle (*Myrtus communis*) can promote healing of **hemorrhoids**; and spike lavender and juniper (*Juniperus communis*) are recommended for rheumatism.

To prepare salts for the bath, add one or two handfuls of epsom salts or Dead Sea salts to boiling water until they are dissolved, and then add them to the tub.

A **sitz bath**, or hip bath, can also be taken at home to treat hemorrhoids and promote healing of an **episiotomy**. There is special apparatus available for taking a seated sitz bath, but it can also be taken in a regular tub partially filled with warm water.

Steam inhalation

Steam inhalation treatments can be easily administered with a bowl of steaming water and a large towel. For colds and other conditions with nasal congestion, aromatherapists recommend adding five drops of an essential oil that has decongestant properties, such as peppermint (*Mentha piperita*) and eucalyptus blue gum (*Eucalyptus globulus*). Oils that act as **expectorants**, such as myrtle (*Myrtus communis*) or rosemary (*Rosmarinus officinalis*), can also be used. After the oil is added, the individual should lean over the bowl of water and place the towel over head to trap the steam. After approximately three minutes of inhaling the steam, with eyes closed, the towel can be removed.

Other herbs and essential oils that can be beneficial in steam inhalation include:

- tea tree oil (*Melaleuca alternaifolia*) for **bronchitis** and sinus infections

- sandalwood (*Santalum album*), virginian cedarwood (*Juniperus virginiana*), and frankincense (*Boswellia carteri*) for sore throat
- lavender (*Lavandula angustifolia*) and thyme (*Thymus vulgaris*) for cough

Compresses

A cold compress is prepared by soaking a cloth or cotton pad in cold water and then applying it to the area of injury or distress. When the cloth reaches room temperature, it should be resoaked and reapplied. Applying gentle pressure to the compress with the hand may be useful. Cold compresses are generally used to reduce swelling, minimize bruising, and to treat headaches and sprains.

Warm or hot compresses are used to treat abscesses and muscle aches. A warm compress is prepared in the same manner as a cold compress, except steaming water is used to wet the cloth instead of cold water. Warm compresses should be refreshed and reapplied after they cool to room temperature.

Essential oils may be added to moist compresses to increase the therapeutic value of the treatment. Peppermint, a cooling oil, is especially effective when added to cold compresses. To add oils to compresses, place five drops of the oil into the bowl of water the compress is to be soaked in. Never apply essential oils directly to a cloth, as they may irritate the skin in undiluted form.

This patient is treating his injured left leg with a whirlpool bath. *(Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

Individuals with **paralysis**, frostbite, or other conditions that impair the nerve endings and cause reduced sensation should only take hydrotherapy treatments under the guidance of a trained hydrotherapist, physical therapist, or other appropriate healthcare professional. Because these individuals cannot accurately sense temperature changes in the water, they run the risk of being seriously burned without proper supervision. Diabetics and people with **hypertension** should also consult their healthcare professional before using hot tubs or other heat hydrotherapies.

Hot tubs, jacuzzis, and pools can become breeding grounds for bacteria and other infectious organisms if they are not cleaned regularly, maintained properly, kept at the appropriate temperatures, and treated with the proper chemicals. Individuals should check with their healthcare provider to ensure that the hydrotherapy equipment they are using is sanitary. Those who are using hot tubs and other hydrotherapy equipment in their homes should follow the directions for use and maintenance provided by the original equipment manufacturer.

Certain essential oils should not be used by pregnant or nursing women or by people with specific illnesses or physical conditions. Individuals suffering from any chronic or acute health condition should inform their healthcare provider before starting treatment with any essential oil.

Essential oils such as cinnamon leaf, juniper, lemon, eucalyptus blue gum, peppermint, and thyme can be extremely irritating to the skin if applied in full concentration. Oils used in hydrotherapy should always be diluted in water before they are applied to the skin. Individuals should never apply essential oils directly to the skin unless directed to do so by a trained healthcare professional and/or aromatherapist.

Colonic irrigation should only be performed by a healthcare professional. Pregnant women should never douche, as the practice can introduce bacteria into the

KEY TERMS

Contact dermatitis—Skin irritation as a result of contact with a foreign substance.

Episiotomy—An incision made in the perineum during labor to assist in delivery and to avoid abnormal tearing of the perineum.

Essential oil—A volatile oil extracted from the leaves, fruit, flowers, roots, or other components of a plant and used in aromatherapy, perfumes, and foods and beverages.

Hubbard tank—A large water tank or tub used for underwater exercises.

vagina and uterus. They should also avoid using hot tubs without the consent of their healthcare provider.

The vagina is self-cleansing, and douches have been known to upset the balance of vaginal pH and flora, promoting vaginitis and other infections. Some studies have linked excessive vaginal douching to increased incidence of **pelvic inflammatory disease** (PID).

Side effects

Most forms of hydrotherapy are well tolerated. There is a risk of allergic reaction (also known as **contact dermatitis**) for some patients using essential oils and herbs in their bath water. These individuals may want to test for allergic sensitization to herbs by performing a skin patch test (i.e., rubbing a small amount of diluted herb on the inside of their elbow and observing the spot for redness and irritation). People who experience an allergic reaction to an essential oil should discontinue its use and contact their healthcare professional for further guidance.

The most serious possible side effect of hydrotherapy is overheating, which may occur when an individual spends too much time in a hot tub or jacuzzi. However, when properly supervised, this is a minimal risk.

Research and general acceptance

Hydrotherapy treatments are used by both allopathic and complementary medicine to treat a wide variety of discomforts and disorders. Not as well accepted are invasive hydrotherapy techniques, such as colonic irrigation, **enemas**, and douching. These internal cleansing techniques can actually harm an individual by upsetting the natural balance of the digestive tract and the vagina. Most conventional medical professionals agree that vaginal douches are not necessary to promote hygiene in most women, and can actually do more harm than good.

Resources

BOOKS

Chaitow, Leon. *Hydrotherapy: Water Therapy for Health and Beauty.* Boston, MA: Element Books, 1999.

Lawless, Julia. *The Complete Illustrated Guide to Aromatherapy.* Boston, MA: Element Books, 1997.

PERIODICALS

Johnson, Kate. "Hydrotherapy Greatly Eases Delivery Stress, Pain." *OB GYN News* 34 (November 1999):27.

ORGANIZATIONS

The American Association of Naturopathic Physicians. 8201 Greensboro Drive, Suite 300, McLean, Virginia 22102. (206) 298-0126. <http://naturopathic.org>.

Paula Ford-Martin
J. Ricker Polsdorfer, MD

Hydroxzine *see* **Anti-itch drugs**

Hyperactivity *see* **Attention-deficit/Hyperactivity disorder (ADHD)**

Hyperaldosteronism

Definition

Hyperaldosteronism is a disorder which is defined by the body's overproduction of aldosterone, a hormone that controls sodium and potassium levels in the blood. Its overproduction leads to retention of salt and loss of potassium, which leads to **hypertension** (high blood pressure).

Description

Also known as Conn's syndrome, primary aldosteronism, and secondary aldosteronism, this disorder takes several forms. It often begins with a tumor that produces aldosterone. In fact, approximately 60–70% of the cases of primary aldosteronism result from tumors in the adrenal gland area. Aldosterone is normally produced by the adrenal cortex, or the outer portion of the gland that rests on top of each kidney. Primary aldosteronism is due to adenoma, a typically benign tumor in which the cells form to act as glands or cause the glands on which they rest to overproduce. It can cause a number of problems, most notably hypertension. In secondary aldosteronism, factors outside the adrenal gland may cause overproduc-

tion of aldosterone, or overproduction of renin, an enzyme stored in the kidney area that stimulates aldosterone and raises blood pressure. Obstructive renal artery disease may also cause hypertension from elevated renin stimulating aldosterone. **Oral contraceptives** have been known to increase the secretion of aldosterone in some patients. This disorder is more common in women.

Causes and symptoms

Hyperaldosteronism is most often caused by the invasion of adenoma. Other adrenal cancers and hyperplasia, or the increase in the bulk of an organ due to increased cell production, may also cause hyperaldosteronism. Those diseases and factors influencing the adrenal and kidney functions may lead to secondary aldosteronism. The primary symptom of hyperaldosteronism is moderate hypertension, or high blood pressure. In addition, a patient may experience **orthostatic hypotension**, or reduced blood pressure when a person stands after lying down. **Constipation**, muscle weakness (sometimes to the point of **periodic paralysis**), excessive urination, excessive thirst, **headache**, and personality changes are also possible symptoms. Some patients will show no obvious symptoms.

Diagnosis

Screening tests can be conducted to pinpoint a diagnosis of hyperaldosteronism. If a patient is taking drugs to reduce high blood pressure, the physician may order these drugs stopped for a time period before conducting tests, since these drugs will affect results. Blood and urine tests may be conducted to check for levels of aldosterone, potassium levels, or renin activity. A computed tomography scan (CT scan) may be ordered to detect tumors as small as five to seven mm. These combined tests approach 95% accuracy for detecting aldosterone-producing adenoma. Laboratory findings recording blood pressure, **edema**, and aldosterone and **plasma renin activity** can help the physician differentiate between primary aldosteronism and secondary aldosteronism.

Treatment

Once the physician has made a diagnosis of hyperaldosteronism, the adrenal glands should be checked for possible adenomas. This can be done through imaging or with a surgical dissection of the gland. Surgical or ablative treatment will vary depending on the number of tumors found. Since more than 60% of hyperaldosteronism cases are caused by these tumors, treatment of the tumors will help eliminate the resulting high blood pressure in many patients. Some patients will receive **antihypertensive drugs**, like **calcium channel blockers**, to control high blood pressure. The use of **diuretics** can help control hypertension by reducing volume. Potassium levels should be considered in the type of diuretic ordered and the levels should be checked throughout treatment. The most widely used drug for treatment of hyperaldosteronism is spironolactone. This drug helps control aldosterone, but should not be prescribed for some patients, especially those with certain kidney diseases. Spironolactone has several possible adverse effects, depending on the dosage. In all cases of hyperaldosteronism, the treatment should be carefully based on the specific type or underlying cause of the disorder.

KEY TERMS

Ablative—Used to describe a procedure involving removal of a tissue or body part, or destruction of its function.

Adenoma—A growth of cells, usually a benign tumor, that forms a gland or gland-like substance. These tumors can secrete hormones or cause changes in hormone production in nearby glands.

Adrenal—Refers to the glands which sit on top of each kidney and that secrete various hormones.

Antihypertensive—Used to describe drugs or treatments designed to control hypertension, or high blood pressure.

Diuretic—A substance or drug that is taken to promote the formation and release of urine. In the treatment of high blood pressure, diuretics can help reduce the overall fluid volume in the body.

Renal—Relating to the kidney. The renal artery is one of two branches of the large blood vessel in the stomach area that serves the kidneys, ureters (tubes that carry urine from the kidney to the bladder) and adrenal glands.

Alternative treatment

Patients may choose to work with their physician or alternative provider to control hypertension with diet, **stress reduction** (including massage, **meditation**, **biofeedback**, and **yoga**), and other remedies. Blood pressure elevation needs to be controlled and monitored by frequent blood pressure measurements. There is no alternative treatment known for the underlying adenoma.

Prognosis

Hyperaldosteronism carries with it all the possible complications of high blood pressure, including thicken-

ing of arterial walls and a higher risk of **angina**, kidney failure, **stroke**, or **heart attack**. Another possible, and less reversible complication than hypertension, is kidney damage. When primary aldosteronism is caused by a solitary adenoma, the prognosis is good. Once this tumor is removed, blood pressure will drop, and 70% of these patients have full remission. Patients whose hyperaldosteronism results from adrenal hyperplasia will remain hypertensive. However, in up to 70% of patients, blood pressure can be reduced somewhat with drug therapy. Many patients will be faced with the prospect of controlling their hypertension for the remainder of their lives.

Prevention

There is no known prevention for most causes of hyperaldosteronism.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

American Society of Hypertension. 515 Madison Ave., Suite 1212, New York, NY 10022. (212) 644-0650. <http://www.ash-us.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

OTHER

Hypertension Network. <http://www.bloodpressure.com>.

Teresa Norris, RN

Hyperbaric oxygenation *see* **Oxygen/ozone therapy**

Hyperbilirubinemia *see* **Neonatal jaundice**

Hypercalcemia

Definition

Hypercalcemia is an abnormally high level of calcium in the blood, usually more than 10.5 milligrams per deciliter of blood.

Description

Calcium plays an important role in the development and maintenance of bones in the body. It is also needed in tooth formation and is important in other body functions. Normally, the body maintains a balance between the amount of calcium in food sources and the calcium already available in the body's tissues. The balance can be upset if excess amounts of calcium are eaten or if the body is unable to process the mineral because of disease.

Calcium is one of the most important and most abundant **minerals** in the human body. Dairy products are the major source of calcium. Eggs, green leafy vegetables, broccoli, legumes, nuts, and whole grains provide smaller amounts. Only about 10–30% of the calcium in food is absorbed into the body. Most calcium is found in combination with other dietary components and must be broken down by the digestive system before it can be used. Calcium is absorbed into the body in the small intestine. Its absorption is influenced by such factors as the amount of vitamin D hormone available to aid the process and the levels of calcium already present in the body. As much as 99% of the body's calcium is stored in bone tissue. A healthy person experiences a constant turnover of calcium as bone tissue is built and reshaped. The remaining 1% of the body's calcium circulates in the blood and other body fluids. Circulating calcium plays an important role in the control of many body functions, such as blood clotting, transmission of nerve impulses, muscle contraction, and other metabolic activities. In the bloodstream, calcium maintains a constant balance with another mineral, phosphate.

Two main control agents are vital in maintaining calcium levels, vitamin D hormone and parathyroid hormone. A hormone is a chemical substance that is formed in one organ or part of the body and carried in the blood to another organ. It can alter the function, and sometimes the structure, of one or more organs.

- Parathyroid hormone (PTH). The four parathyroid glands are endocrine glands located next to the thyroid gland in the neck. A gland is a cell or group of cells that produces a material substance (secretion). When the level of calcium circulating in the blood drops, the parathyroid gland releases its hormone. PTH then acts in three ways to restore the normal blood calcium level. It stimulates the absorption of more calcium in the intestine; it takes more calcium from the bone tissue, and it causes the kidneys to excrete more phosphate.
- Vitamin D hormone. This hormone works with parathyroid hormone to control calcium absorption and affects the deposit of calcium and phosphate in the bone tissue.

The kidneys also help to control calcium levels. Healthy kidneys can increase calcium excretion almost fivefold to maintain normal concentrations in the body. Hypercalcemia can occur when the concentration of calcium overwhelms the ability of the kidneys to maintain balance.

Causes and symptoms

Causes of hypercalcemia

Many different conditions can cause hypercalcemia; the most common are **hyperparathyroidism** and **cancer**.

PRIMARY HYPERPARATHYROIDISM. Primary hyperparathyroidism is the excessive secretion of parathyroid hormone by one or more of the parathyroid glands. It is the most common cause of hypercalcemia in the general population. Women have this condition more frequently than men do, and it is more common in older people. It can appear thirty or more years after radiation treatments to the neck. Ninety percent of the cases of primary hyperparathyroidism are caused by a non-malignant growth on the gland.

Hyperparathyroidism can also occur as part of a rare hereditary disease called multiple endocrine neoplasia. In this disease, tumors develop on the parathyroid gland.

CANCER. People with cancer often have hypercalcemia. In fact, it is the most common life-threatening metabolic disorder associated with cancer. Ten to twenty percent of all persons with cancer have hypercalcemia. Cancers of the breast, lung, head and neck, and kidney are frequently associated with hypercalcemia. It also occurs frequently in association with certain cancers of the blood, particularly malignant myeloma. It is seen most often in patients with tumors of the lung (25–35%) and breast (20–40%), according to the National Cancer Institute. Cancer causes hypercalcemia in two ways. When a tumor grows into the bone, it destroys bony tissue (osteolysis). When the bone is not involved, factors secreted by cancer cells can increase calcium levels (humoral hypercalcemia of malignancy). The two mechanisms may operate at the same time.

Because immobility causes an increase in the loss of calcium from bone, cancer patients who are weak and spend most of their time in bed are more prone to hypercalcemia. Cancer patients are often dehydrated because they take in inadequate amounts of food and fluids and often suffer from **nausea and vomiting**. **Dehydration** reduces the ability of the kidneys to remove excess calcium from the body. Hormones and **diuretics** that increase the amount of fluid released by the body can also trigger hypercalcemia.

OTHER CAUSES. Other conditions can cause hypercalcemia. Excessive intake of vitamin D increases intestinal absorption of calcium. During therapy for peptic ulcers, abnormally high amounts of calcium **antacids** are sometimes taken. Overuse of antacids can cause milk-alkali syndrome and hypercalcemia. Diseases such as Paget's, in which bone is destroyed or reabsorbed, can also cause hypercalcemia. As in cancer or **paralysis** of the arms and legs, any condition in which the patient is immobilized for long periods of time can lead to hypercalcemia due to bone loss.

Common symptoms

Many patients with mild hypercalcemia have no symptoms and the condition is discovered during routine laboratory screening. Gastrointestinal symptoms include loss of appetite, nausea, vomiting, **constipation**, and abdominal **pain**. There may be a blockage in the bowel. If the kidneys are involved, the individual will have to urinate frequently during both the day and night and will be very thirsty. As the calcium levels rise, the symptoms become more serious. Stones may form in the kidneys and waste products can build up. Blood pressure rises. The heart rhythm may change. Muscles become increasingly weak. The individual may experience mood swings, confusion, **psychosis**, and eventually, **coma** and **death**.

Diagnosis

High levels of calcium in the blood are a good indication of hypercalcemia, but these levels may fluctuate. Calcium levels are influenced by other compounds in the blood that may combine with calcium. Higher calcium and lower phosphate levels may suggest primary hyperparathyroidism. The blood levels of protein (serum albumin) and parathyroid hormone (PTH) are also measured in the diagnosis of hypercalcemia. Too much PTH in the blood may indicate primary hyperparathyroidism. Levels of calcium and phosphate in the urine should also be measured. The medical history and physical condition of the individual must be taken into consideration, especially in the early stages of hypercalcemia when symptoms are mild.

Treatment

The treatment of hypercalcemia depends on how high the calcium level is and what is causing the elevation. Hypercalcemia can be life-threatening and rapid reduction may be necessary. If the patient has normal kidney function, fluids can be given by vein (intravenously) to clear the excess calcium. The amount of fluid taken in and eliminated must be carefully monitored. If the patient's kidneys are not working well, acute hemodyalysis is probably the safest and most effective method to reduce dangerous calcium levels. In this procedure, blood is circulated through tubes made of semi-permeable membranes against a special solution that filters out unwanted substances before returning the blood to the body.

Drugs such as furosemide, called loop diuretics, can be given after adequate fluid intake is established. These drugs inhibit calcium reabsorption in the kidneys and

KEY TERMS

Calcium—A silvery-yellow metal that is the basic element of lime and makes up about 3% of the earth's crust. It is the most abundant mineral in the human body. Calcium and phosphorous combine as calcium phosphate, the hard material of bones and teeth.

Hormone—A chemical substance that is carried through the blood to another part of the body, stimulating it to change its function or structure. Many hormones are produced by glands.

Metabolism—All the physical and chemical changes that take place within an organism.

Milk-alkali syndrome—A chronic disorder of the kidneys caused by the ingestion of large amounts of calcium and alkali in the treatment of peptic ulcer. The disorder is reversible in its early stages but can progress to kidney failure.

Mineral—A substance that does not contain carbon (inorganic) and is widely distributed in nature. Minerals play an important role in human metabolism.

Parathyroid hormone (PTH)—A chemical substance produced by the parathyroid glands. This hormone is a major element in regulating calcium in the body.

Vitamin D hormone—Vitamin D is a vitamin that also acts as a hormone. Vitamin D hormone acts with parathyroid hormone to regulate calcium levels in the blood and to supply appropriate amounts of calcium to all cells.

promote urine production. Drugs that inhibit bone loss, such as calcitonin, biphosphates, and plicamycin, are helpful in achieving long-term control. Phosphate pills help lower high calcium levels caused by a deficiency in phosphate. Anti-inflammatory agents such as steroids are helpful with some cancers and toxic levels of vitamin D.

Treatment of the underlying cause of the hypercalcemia will also correct the imbalance. Hyperparathyroidism is usually treated by surgical removal of one or more of the parathyroid glands and any tissue, other than the glands themselves, that is producing excessive amounts of the hormone.

The hypercalcemia caused by cancer is difficult to treat without controlling the cancer. Symptoms can be alleviated with fluids and drug therapy as outlined above.

Prognosis

Surgery to remove the parathyroid glands and any misplaced tissue that is producing excessive amounts of hormone succeeds in about 90% of all cases. Outcome is also influenced by whether any damage to the kidneys can be reversed.

Mild hypercalcemia can be controlled through good fluid intake and the use of effective drugs.

Hypercalcemia generally develops as a late complication of cancer and the expected outlook is grim without effective anticancer therapy.

Prevention

People with cancer who are at risk of developing hypercalcemia should be familiar with early symptoms and know when to see a doctor. Good fluid intake (up to four quarts of liquid a day if possible), controlling nausea and vomiting, paying attention to fevers, and keeping physically active as much as possible can help prevent problems. Dietary calcium restriction is not necessary because hypercalcemia reduces absorption of calcium in the intestine.

Resources

BOOKS

Shils, Maurice E., et al. *Modern Nutrition in Health and Disease*. Philadelphia: Lea & Febiger, 1994.

Williams, Sue Rodwell. *Essentials of Nutrition and Diet Therapy*. Philadelphia: Mosby, 1997.

OTHER

"Hypercalcemia." *National Cancer Institute Page*. <http://www.nci.nih.gov>.

Karen Ericson, RN

Hypercholesterolemia

Definition

Hypercholesterolemia refers to levels of cholesterol in the blood that are higher than normal.

Description

Cholesterol circulates in the blood stream. It is an essential molecule for the human body. Cholesterol is a molecule from which hormones and steroids are made. It is also used to maintain nerve cells. Between 75 and 80% of the cholesterol that circulates in a person's blood-

stream is made in that person's liver. The remainder is acquired from outside sources. Cholesterol is found in animal sources of food. It is not found in plants.

Normal blood cholesterol level is a number derived by laboratory analysis. A normal or desirable cholesterol level is defined as less than 200 mg of cholesterol per deciliter of blood (mg/dL). Blood cholesterol is considered to be borderline when it is in the range of 200 to 239 mg/dL. Elevated cholesterol level is 240 mg/dL or above. Elevated blood cholesterol is considered to be hypercholesterolemia.

Cholesterol has been divided into two major categories: low-density lipoprotein (LDL), the so-called "bad" cholesterol, and high-density lipoprotein (HDL), the so-called "good" cholesterol. Diet, **exercise**, **smoking**, alcohol, and certain illnesses can affect the levels of both types of cholesterol. Eating a high fat diet will increase one's level of LDL cholesterol. Exercising and reducing one's weight will both increase HDL cholesterol and lower LDL cholesterol.

The most common cause of elevated serum cholesterol is eating foods that are rich in saturated fats or contain high levels of cholesterol. Elevated cholesterol can also be caused by an underlying disease that raises blood cholesterol levels such as **diabetes mellitus**, kidney disease, liver disease, or **hypothyroidism**. It can also be caused by an inherited disorder in which cholesterol is not metabolized properly by the body. **Obesity**, which generally results from eating a diet high in fat, can also lead to elevated cholesterol levels in the blood. This is because obesity itself leads the body to produce excessive amounts of cholesterol.

Hypercholesterolemia increases the risk of heart disease. Elevated levels of circulating cholesterol cause deposits to form inside blood vessels. These deposits, called plaque, are composed of fats deposited from the bloodstream. When the deposits become sufficiently large, they block blood vessels and decrease the flow of blood. These deposits result in a disease process called **atherosclerosis**, which can cause blood clots to form that will ultimately totally stop blood flow. If this happens in the arteries supplying the heart, a **heart attack** will occur. If it happens in the brain, the result is a **stroke** where a portion of brain tissue dies. Atherosclerosis causes more deaths from heart disease than any other single condition. Heart disease has been the leading cause of **death** in the United States for the past half century.

There is a syndrome called familial hypercholesterolemia. Affected persons have consistently high levels of LDL. This leads to early clogging of the coronary arteries. In turn this leads to a heart attack. Among affected males, a first heart attack typically occurs in their 40s to 50s. Approximately 85% of men with this disorder have experienced a heart attack by the time they reach 60 years of age. The incidence of heart attacks among women with this disorder is also increased. However, it is delayed 10 years compared to men. The incidence of familial hypercholesterolemia is seven out of 1,000 people.

Causes and symptoms

Hypercholesterolemia is silent. There are no symptoms that are obvious to the naked eye. It is diagnosed by a blood test or after a heart attack or stroke occurs.

Diagnosis

Hypercholesterolemia is diagnosed by using a blood test. A blood specimen obtained after not eating or drinking anything (except water) for 12 hours. The **fasting** is done to determine the LDL and HDL cholesterol, which can only be determined accurately in a fasting state. Most experts agree on an acceptable limit for LDL cholesterol as 130 mg/dL. Total cholesterol of under 200 mg/dL for is thought to be in an acceptable range.

Treatment

If an individual's cholesterol is elevated, discussions with a physician should be scheduled to determine what course of treatment may be needed. Initial treatment for hypercholesterolemia usually requires dietary changes to reduce the intake of total fat, saturated fat, and cholesterol. Most health care professionals will recommend that a person's weight and height be proportionate. Further, experts counsel persons with elevated blood cholesterol levels to increase their intake of soluble fiber. Sources of soluble fiber include bran, foods containing whole grains and other sources of indigestible fiber such as lignin.

The reason for treating elevated cholesterol is to reduce an individual's risk of complications. If a diet low in cholesterol and saturated fats doesn't significantly reduce a person's cholesterol level, medication may be required. For every 1 percent reduction in cholesterol level, the risk of heart disease is reduced by 2 percent. It is also possible to partially reverse atherosclerosis that has already occurred by aggressively lowering cholesterol levels with diet and medications.

Prescription drugs are available to help lower cholesterol levels in the blood. Niacin, cholestyramine, cholestipol, lovastatin, simvastatin, pravastatin, fluvaststin and gemfibrazol have all been approved for use in the United States as of 2001.

Alternative treatment

There are advocates of treatment using **vitamins**, **minerals** and antioxidant substances in relatively high amounts.

KEY TERMS

Atherosclerosis—A disease process whereby plaques of fatty substances are deposited inside arteries, reducing the inside diameter of the vessels and eventually causing damage to the tissues located beyond the site of the blockage.

Coronary artery—One of five vessels that supply blood to the heart.

Deciliter (dL)—100 cubic centimeters (cc).

High density lipoprotein (HDL)—A fraction of total serum lipids, the so called "good" cholesterol.

Low density lipoprotein (LDL)—A fraction of total serum lipids, the so called "bad" cholesterol.

These amounts generally exceed those provided by the Food and Drug Administration in its Minimum Daily Requirements (MDR). Advocates of such therapies also include increased levels of exercise, attaining an ideal body weight and increasing levels of fiber in one's diet.

Some people have advocated the use of garlic, soy and isoflavones to lower serum cholesterol levels.

Prognosis

The prognosis for persons is in direct proportion to their serum cholesterol levels. Persons with hypercholesterolemia are at high risk of dying from heart disease or stroke.

Many studies have looked at the relationship between elevated cholesterol levels, increased risk for heart attack and death. In one research investigation of relatively young males who had no known heart disease, cholesterol levels were measured and participants were followed for 6 years. During this time, all heart attacks and deaths that occurred among participants were recorded. As serum cholesterol levels increased, so did the risk of experiencing a fatal heart attack. The risk of a fatal heart attack was approximately five times higher among persons having cholesterol levels of 300 mg/dL or more compared to those with cholesterol levels below 200 mg/dL.

The Framingham Heart Study is an ongoing research effort. Cholesterol levels, smoking habits, heart attack rates, and deaths in the population of an entire town have been recorded for over 40 years. After 30 years, more than 85% of persons with cholesterol levels of 180 mg/dL or less were still alive; almost a third of those with cholesterol levels greater than 260 mg/dL had died.

Prevention

Experts suggest the following steps to maintain serum cholesterol within normal limits: an important component is to maintain a normal weight for height and reducing one's weight if it is inappropriate for height. Change dietary habits by reducing the amount of fat and cholesterol consumed. Avoid smoking by not starting or quitting if currently a smoker. Increase levels of fiber in the diet by including foods such as beans, raw fruits, whole grains and vegetables. It is important to exercise on a regular basis. Aerobic exercise is especially helpful in reducing serum cholesterol levels.

Persons from families with a strong history of early heart attacks should be evaluated with a lipid screen. Proper diet, exercise and the use of effective drugs can reduce serum lipid levels.

Nutrition and cardiac experts offer the following suggestions:

- purchase low-fat or fat-free dairy products such as milk, cheese, sour cream, and yogurt
- eat lean red meats, chicken without skin, and fish
- reduce consumption of foods high in saturated fat such as french fries
- avoid foods that are rich sources of cholesterol such as eggs, liver, cheese, and bacon
- eat smaller servings
- keep a food journal and write down everything you eat every day
- prepare food by microwaving, boiling, broiling, or baking food instead of frying
- trim the fat from meat before cooking it.

Resources

BOOKS

Braunwald, Eugene, Douglas Zipes, and Perter Libby. *Heart Disease: A Textbook of Cardiovascular Medicine, 6th ed.* Philadelphia, Saunders, 2001.

Foody, J.M and Eugene Braunwald. *Preventive Cardiology: Strategies for the Prevention and Treatment of Coronary Artery Disease.* Totowa, NJ, Humana Press,, 2001.

Hiatt, William R, Judith Regensteiner, and Alan T. Hirsch. *Peripheral Arterial Disease Handbook* Boca Raton, FL, CRC Press, 2001.

Hiatt, William R. "Atherosclerotic peripheral arterial disease." In *Cecil Textbook of Medicine, 21st ed.,* edited by Goldman, Lee and Bennett, J. Claude. Philadelphia: W.B. Saunders, 2000, 357-362.

Libby, Peter. "Atherosclerosis." In *Harrison's Principles of Internal Medicine, 14th ed.,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998, 1345-1352.

Silver, Malcom and Schoen Gottleib. *Cardiovascular Pathology, 3rd ed.* Boston, Churchill Livingstone, 2001.

PERIODICALS

Jackson, P.R. "Cholesterol-lowering therapy for smokers." *The Lancet* 357(9260): 960-961, 2001.

Shamir R., A. Lerner, and E. A. Fisher. "Hypercholesterolemia in children." *Israel Medical Association Journal* 2(10): 767-771, 2000.

ORGANIZATIONS

American College of Cardiology, Heart House, 9111 Old Georgetown Road, Bethesda, MD 20814-1699. (800) 253-4636 or (301) 897-5400, Fax: (301) 897-9745. <http://www.acc.org/>. resource@acc.org.

American Heart Association, National Center. 7272 Greenville Avenue, Dallas, Texas 75231. (877) 242-4277. <http://www.americanheart.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http://www.ama-assn.org/>.

American Society of Nuclear Cardiology. 9111 Old Georgetown Road, Bethesda, MD 20814-1699. (301) 493-2360. Fax: (301) 493-2376, <http://www.asnc.org/>. admin@asnc.org.

OTHER

American Academy of Family Practice: <http://www.aafp.org/afp/20000201/675.html>.

American Heart Association: <http://www.americanheart.org/Scientific/pubs/hyperchol/>.

Merck Manual: <http://www.merck.com/pubs/mmanual/section2/chapter15/15c.htm>.

National Library of Medicine: <http://www.nlm.nih.gov/medlineplus/ency/article/000403.htm>.

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Hypercoagulation disorders

Definition

Hypercoagulation disorders (or hypercoagulable states or disorders) have the opposite effect of the more common **coagulation disorders**. In hypercoagulation, there is an increased tendency for clotting of the blood, which may put a patient at risk for obstruction of veins and arteries (phlebitis or **pulmonary embolism**).

Description

In normal hemostasis, or the stoppage of bleeding, clots form at the site of the blood vessel's injury. The difference between that sort of clotting and the clotting present in hypercoagulation is that these clots develop in circulating blood.

This disorder can cause clots throughout the body's blood vessels, sometimes creating a condition known as thrombosis. Thrombosis can lead to infarction, or **death** of tissue, as a result of blocked blood supply to the tissue. However, hypercoagulability does not always lead to thrombosis. In **pregnancy**, and other hypercoagulable states, the incidence of thrombosis is higher than that of the general population, but is still under 10%. However, in association with certain genetic disorders, hypercoagulation disorders may be more likely to lead to thrombosis. Hypercoagulation disorders may also be known as hyperhomocystinemia, antithrombin III deficiency, factor V leyden, and protein C or protein S deficiency.

Causes and symptoms

Hypercoagulation disorders may be acquired or hereditary. Some of the genetic disorders that lead to hypercoagulation are abnormal clotting factor V, variations in fibrinogen, and deficiencies in proteins C and S. Other body system diseases may also lead to these disorders, including diabetes, sickle cell anemia, **congenital heart disease**, lupus, **thalassemia**, polycythemia rubra vera, and others. Antithrombin III deficiency is a hereditary hypercoagulation disorder that affects both sexes. Symptoms include obstruction of a blood vessel by a clot (thromboembolic disease), vein inflammation (phlebitis), and ulcers of the lower parts of the legs. The role of proteins C and S is a complex one. In order for coagulation to occur, platelets (small, round fragments in the blood) help contract blood vessels to lessen blood loss and also to help plug damaged blood vessels. However, the conversion of platelets into actual clots is a complicated web involving proteins that are identified clotting factors. The factors are carried in the plasma, or liquid portion of the blood. Proteins C and S are two of the clotting factors that are present in the plasma to help regulate or activate parts of the clotting process. Protein C is considered an anticoagulant. Mutation defects in the proteins may decrease their concentrations in the blood, and may or may not affect their resulting anticoagulant activity. Factor V is an unstable clotting factor also present in plasma. Abnormal factor V resists the changes that normally occur through the influence of protein C, which can also lead to hypercoagulability. Prothrombin, a glycoprotein that converts to thrombin in the early stage of the clotting process, is affected by the presence of these proteins, as well as other clotting factors.

Diagnosis

The diagnosis of hypercoagulation disorders is completed with a combination of **physical examination**, medical history, and blood tests. An accurate medical history is important to determine possible symptoms and causes of hypercoagulation disorders. There are a number of blood tests that can determine the presence or

KEY TERMS

Antithrombin—Any substance that counters the effect of thrombin, an enzyme that converts fibrinogen into fibrin, leading to blood coagulation.

Congenital—Refers to a condition or disorder present at birth.

Hemostasis—The arrest of bleeding.

Heparin—An anticoagulant, or blood clot "dissolver."

Polycythemia—A condition characterized by an overabundance of red blood cells.

Thalassemia—One of a group of inherited blood disorders characterized by a defect in the metabolism of hemoglobin, or the portion of the red blood cells that transports oxygen throughout the blood stream.

Thrombosis—Formation of a clot in the blood that either blocks, or partially blocks, a blood vessel. The thrombus may lead to infarction, or death of tissue due to a blocked blood supply.

absence of proteins, clotting factors, and platelet counts in the blood. Among the tests used to detect hypercoagulation is the Antithrombin III assay. Protein C and Protein S concentrations can be diagnosed with immunoassay or plasma antigen level tests.

Treatment

Coumadin and heparin anticoagulants may be administered to reduce the clotting effects and maintain fluidity in the blood. Heparin is an anticoagulant that prevents thrombus formation and is used primarily for liver and lung clots.

Prognosis

The prognosis for patients with hypercoagulation disorders varies depending on the severity of the clotting and thrombosis. If undetected and untreated, thrombosis could lead to recurrent thrombosis and pulmonary **embolism**, a potentially fatal problem.

Prevention

Hereditary hypercoagulation disorders may not be prevented. Genetic and blood testing may help determine a person's tendency to develop these disorders.

Resources

BOOKS

Current Diagnosis. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

ORGANIZATIONS

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Hemophilia Foundation. 116 West 32nd St., 11th Floor, New York, NY 10001. 800-424-2634. <http://www.hemophilia.org/home.htm>.

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Hyperemesis gravidarum

Definition

Hyperemesis gravidarum means excessive vomiting during **pregnancy**.

Description

In pregnant women, **nausea and vomiting** (morning sickness) are common, affecting up to 80% of pregnancies. Hyperemesis, or extreme nausea and excessive vomiting, occur in about 1% of pregnancies. This condition causes uncontrollable vomiting, severe **dehydration**, and weight loss for the mother. However, hyperemesis gravidarum rarely causes problems for the unborn baby.

Causes and symptoms

The cause of nausea and vomiting during pregnancy is unknown but may be related to the level of certain hormones produced during pregnancy. Hyperemesis is seen more often in first pregnancies and multiple pregnancies (twins, triplets, etc.). The main symptom of hyperemesis is severe vomiting, which causes dehydration and weight loss.

Diagnosis

Although many women with morning sickness feel like they are vomiting everything they eat, they continue to gain weight and are not dehydrated; they do not have hyperemesis gravidarum. Women with this condition will start to show signs of **starvation**, including weight loss. **Physical examination** and laboratory tests of blood and urine samples will be used to help diagnose the condition. One of the most common tests used to help diagno-

sis and monitor hyperemesis gravidarum is a test for ketones in the urine. Excessive ketones in the urine (ketonuria) indicate that the body is not using carbohydrates from food as fuel and is inadequately trying to break down fat as fuel. Ketonuria is a sign that the body is beginning to operate in starvation mode.

Treatment

Hospitalization is often required. Intravenous fluids with substances that help the body conduct nerve signals (electrolytes) may be given to correct the dehydration and excessive acid in the blood (acidosis). Anti-nausea or sedative medications may be given by injection to stop the vomiting. In some cases, oral medication may be prescribed to control the nausea and vomiting while food is reintroduced. If food cannot be tolerated at all, intravenous nutritional supplements may be necessary. Injections of vitamin B_6, in particular, may help overcome nutritional deficiencies that often occur.

Alternative treatment

The severe vomiting associated with hyperemesis gravidarum requires medical attention. Milder episodes of nausea or vomiting may be reduced with deep breathing and relaxation exercises. The use of herbal remedies should be done with extreme caution during pregnancy, especially in the first trimester. Natural remedies to reduce nausea include a teaspoon of cider vinegar in a cup of warm water, or tea made from anise (*Pinpinella anisum*), fennel seed (*Foeniculum vulgare*), red raspberry (*Rubus idaeus*), or ginger (*Zingiber officinale*). Wristbands can be positioned over **acupressure** points on both wrists. **Aromatherapy** with lavender, rose, or chamomile can be soothing, as can smelling ground ginger. Homeopathic remedies—which use extremely diluted solutions as treatments—can be safe and effective for controlling symptoms in some women.

Prognosis

In virtually all cases, the pregnancy can continue to the successful delivery of a healthy baby.

Prevention

Although there is no evidence that hyperemesis gravidarum can be prevented, vomiting during pregnancy sometimes may be lessened. Maintaining a healthy diet, getting adequate sleep, and controlling **stress** may contribute to prevention or improvement of symptoms. Several strategies may help lessen the nausea and vomiting. Eating dry foods and limiting fluid intake may also be helpful. Small meals should be eaten frequently throughout the day, with a protein snack at night. Eating soda crackers before rising from bed in the morning may help prevent early morning nausea. Iron supplements may cause nausea and can be eliminated until the nausea is controlled. Sitting upright for 45 minutes after meals may also help.

KEY TERMS

Ketonuria—The presence of large amount of ketones in the urine. These byproducts of inadequate breakdown of nutrients indicate that the body is in starvation.

Resources

PERIODICALS

Cowan, M. J. "Hyperemesis gravidarum: Implications for Home Care and Infusion Therapies." *Journal of Intravenous Nursing* 19 (Jan./Feb. 1996): 46-58.

Hallak, M., et al. "Hyperemesis gravidarum. Effects on fetal outcome." *Journal of Reproductive Medicine* 41 (Nov. 1996): 871-874.

OTHER

Levy, B. T., and P. L. Brown. "Nausea and Vomiting in Pregnancy." *The Virtual Hospital Page*. University of Iowa. <http://www.vh.org>.

"Natural Remedies During Pregnancy: Frequently Asked Questions." *Childbirth.Org*. <http://www.childbirth.org/articles/remedy.html>.

Altha Roberts Edgren

Hyperhidrosis

Definition

A disorder marked by excessive sweating. It usually begins at **puberty** and affects the palms, soles, and armpits.

Description

Sweating is the body's way of cooling itself and is a normal response to a hot environment or intense **exercise**. However, excessive sweating unrelated to these conditions can be a problem for some people. Those with constantly moist hands may feel uncomfortable shaking hands or touching, while others with sweaty armpits and

KEY TERMS

Anticolinergic drugs—Drugs that block the action of the neurotransmitter acetylcholine.

Bromhidrosis—Bacterial breakdown of sweat and cellular debris resulting in a foul odor.

Contact dermatitis—Skin inflammation that occurs when the skin is exposed to a substance originating outside of the body.

Tinea pedis—Fungal infection of the feet of the skin characterized by dry, scaly lesions.

feet may have to contend with the unpleasant odor that results from the bacterial breakdown of sweat and cellular debris (bromhidrosis). People with hyperhidrosis often must change their clothes at least once a day, and their shoes can be ruined by the excess moisture. Hyperhidrosis may also contribute to such skin diseases as **athlete's foot** (tinea pedis) and **contact dermatitis**.

Causes and symptoms

Conditions or situations that can trigger hyperhidrosis are varied. They include stressful situations, eating spicy foods, consuming alcohol, the presence of underlying disorders (e.g. **tuberculosis**, **malaria**, lymphoma, and diabetes), **menopause**, hormonal imbalances, and the use of certain drugs. Physicians believe that hyperhidrosis can be linked to a breakdown in communication between the brain and the mechanisms that activate sweating. In addition, a genetic link may also exist: about 40% of people with the condition have a family history of it.

Diagnosis

The condition is diagnosed by patient report and a **physical examination**.

Treatment

Most over-the-counter antiperspirants are not strong enough to effectively prevent hyperhidrosis. To treat the disorder, doctors usually prescribe 20% aluminum chloride hexahydrate solution (Drysol), which the patient applies at night to the affected areas that are then wrapped in a plastic film until morning. Drysol works by blocking the sweat pores. Formaldehyde- and glutaraldehyde-based solutions can also be prescribed; however, formaldehyde may trigger an allergic reaction and glutaraldehyde can stain the skin (for this reason it is primarily applied to the soles). Anticolinergic drugs may also be used. In addition, an electrical device that emits low-voltage current can be held against the skin to reduce sweating. These treatments are usually conducted in a doctor's office on a daily basis for several weeks, followed by weekly visits. Dermatologists also recommend that patients wear clothing made of natural or absorbent fabrics also may help, avoid high-buttoned collars, use talc or cornstarch, and keep underarms shaved.

The only permanent cure for hyperhidrosis of the palms is a surgical procedure. To treat severe excessive sweating, a surgeon can remove a portion of the nerve near the top of the spine that controls palm sweat. However, not very many neurosurgeons in the United States will perform the procedure. Alternatively, it is possible to remove the sweat gland-bearing skin of the armpits, but this is a major procedure that may require skin grafts.

Prognosis

While the condition cannot be cured without radical surgery, it can usually be controlled effectively.

Resources

PERIODICALS

Angerman, Judith E. "Putting a Stop to Sweating." *Good Housekeeping*, 1 July 1995, 162.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

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Hyperhomocystinemia *see* **Hypercoagulation disorders**

Hypericum perforatum see **St. Johns wort**

Hyperkalemia

Definition

The normal concentration of potassium in the serum is in the range of 3.5 to 5.0 mM. Hyperkalemia refers to serum or plasma levels of potassium ions above 5.0 mM. The concentration of potassium is often expressed in units of milliequivalents per liter (mEq/L), rather than in units of millimolarity (mM). Both units mean the same thing when applied to concentrations of potassium ions.

Description

A normal adult who weighs about 70 kg contains a total of about 3.6 moles of potassium ions in the body. Most of this potassium (about 98%) occurs inside various cells and organs, where its concentration is about 150 mM. This level is in contrast to the much lower concentration found in the blood serum, where only about 0.4% of the body's potassium resides. Hyperkalemia can be caused by an overall excess of body potassium, or by a shift from inside to outside cells. For example, hyperkalemia can be caused by the sudden release of potassium ions from muscle into the surrounding fluids.

In a normal person, hyperkalemia from too much potassium in the diet is prevented by at least three types of regulatory processes. First, various cells and organs act to prevent hyperkalemia by taking up potassium from the blood. It is also prevented by the action of the kidneys, which excrete potassium into the urine. A third protective mechanism is vomiting. Consumption of a large dose of potassium ions, such as potassium chloride, induces a vomiting reflex to expel most of the potassium before it can be absorbed.

Causes and symptoms

Hyperkalemia can occur from a variety of causes, including the consumption of too much of a potassium salt; the failure of the kidneys to normally excrete potassium ions into the urine; the leakage of potassium from cells and tissues into the bloodstream; and from acidosis. The most common cause of hyperkalemia is kidney (or renal) disease, which accounts for about three quarters of all cases. Kidney function is measured by the glomerular filtration rate, the rate at which each kidney performs its continual processing and cleansing of blood. The normal glomerular filtration rate is about 100 ml/min. If the kidney is damaged so that the glomerular filtration rate is only 5 ml/min or less, hyperkalemia may result, especially if high-potassium foods are consumed. The elderly are at particular risk, since many regulatory functions of the body do not work well in this population. Elderly patients who are being treated with certain drugs for high blood pressure, such as spironolactone (Aldactone) and triamterene (Dyazide), must especially be monitored for possible hyperkalemia, as these medications promote the retention of potassium by the kidneys.

Hyperkalemia can also be caused by a disease of the adrenal gland called **Addison's disease**. The adrenal gland produces the hormone aldosterone that promotes the excretion of potassium into the urine by the kidney.

Hyperkalemia can also result from injury to muscle or other tissues. Since most of the potassium in the body is contained in muscle, a severe trauma that crushes muscle cells results in an immediate increase in the concentration of potassium in the blood. Hyperkalemia may also result from severe **burns** or infections.

KEY TERMS

Acidosis—An abnormally high acid (hydrogen ion) concentration in blood plasma. The unit of acid content is pH, with a lower value indicating more acidic conditions. Blood plasma normally has a pH of 7.35–7.45. Alkaline blood has a pH value greater than pH 7.45. When the blood pH value is less than 7.35, the patient is in acidosis.

Acidic blood plasma, or acidosis, is an occasional cause of hyperkalemia. Acidosis, which occurs in a number of diseases, is defined as an increase in the concentration of hydrogen ions in the bloodstream. In the body's attempt to correct the situation, hydrogen is taken up by muscle cells out of the blood in an exchange mechanism involving the transfer of potassium ions into the bloodstream. This can abnormally elevate the plasma's concentration of potassium ions. When acidosis is the cause of hyperkalemia, treating the patient for acidosis has two benefits: a reversal of both the acidosis and the hyperkalemia.

Symptoms of hyperkalemia include abnormalities in the behavior of the heart. Heart abnormalities of mild hyperkalemia (5.0 to 6.5 mM potassium) can be detected by an electrocardiogram (ECG or EKG). With severe hyperkalemia (over 8.0 mM potassium), the heart may beat at a dangerously rapid rate (fibrillation) or stop beating entirely (cardiac arrest). Patients with moderate or severe hyperkalemia may also develop nervous symptoms such as tingling of the skin, numbness of the hands or feet, weakness, or a flaccid **paralysis**, which is characteristic of both hyperkalemia and **hypokalemia** (low plasma potassium).

Diagnosis

Hyperkalemia can be measured by acquiring a sample of blood, preparing blood serum, and using a potassium sensitive electrode for measuring the concentration of potassium ions. Alternatively, atomic absorption spectroscopy can be used for measuring potassium. Since high or low potassium levels result in abnormalities in heart function, the electrocardiogram is usually the method of choice for the diagnosis of both hyperkalemia and hypokalemia.

Treatment

Insulin injections are used to treat hyperkalemia in emergency situations. Insulin is a hormone well known for its ability to stimulate the entry of sugar (glucose) into cells. It also provokes the uptake of potassium ions by cells, decreasing potassium ion concentration in the blood. When insulin is used to treat hyperkalemia, glucose is also injected. Serum potassium levels begin to decline within 30 to 60 minutes and remain low for several hours. In non-emergency situations, hyperkalemia can be treated with a low potassium diet. If this does not succeed, the patient can be given a special resin to bind potassium ions. One such resin, sodium polystyrene sulfonate (Kayexalate), remains in the intestines, where it absorbs potassium and forms a complex of resin and potassium. Eventually this complex is excreted in the feces. A typical dose of resin is 15 grams, taken one to four times per day. The correction of hyperkalemia with resin treatment takes at least 24 hours.

Prognosis

The prognosis for specifically correcting hyperkalemia is excellent. However, hyperkalemia is usually caused by kidney failure, an often irreversible and eventually fatal condition.

Prevention

Healthy people are not at risk for hyperkalemia. Patients with renal disease and those on certain diuretic medications must be monitored to prevent its occurrence.

Resources

BOOKS

The American Dietetic Association. *Handbook of Clinical Dietetics*. New Haven, CT: Yale University Press, 1992.

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Zeman, F., and D. M. Dey. *Applications in Medical Nutrition Therapy.* 2nd ed. Engelwood Cliffs, NJ: Prentice-Hall, 1995.

PERIODICALS

Greenberg, A. "Hyperkalemia: treatment options." *Seminars in Nephrology* 18 (1998): 46-57.

Tom Brody, PhD

Hyperkinetic disorder *see* **Attention-deficit/Hyperactivity disorder (ADHD)**

Hyperlipemia *see* **Hyperlipoproteinemia**

Hyperlipidemia *see* **Hyperlipoproteinemia**

Hyperlipoproteinemia

Definition

Hyperlipoproteinemia occurs when there is too much lipid (fat) in the blood. Shorter terms that mean the same thing are hyperlipidemia and hyperlipemia. Dyslipidemia refers to a redistribution of cholesterol from one place to another that increases the risk of vascular disease without increasing the total amount of cholesterol. When more precise terms are needed, **hypercholesterolemia** and hypertriglycericemia are used.

Description

It is commonly known that oil and water do not mix unless another substance like a detergent is added. Yet the body needs to transport both lipids (fats) and water-based blood within a single circulatory system. There must be a way to mix the two, so that essential fatty nutrients can be transported in the blood and so that fatty waste products can be carried away from tissues. The solution is to combine the lipids with protein to form water-soluble packages that can be transported in the blood.

These packages of fats are called lipoproteins. They are a complex mixture of triglycerides, cholesterol, phospholipids and special proteins. Some of these chemicals are fatty nutrients absorbed from the intestines on their way to being made part of the body. Cholesterol is a waste product on its way out of the body through the liver, the bile, and ultimately the bowel for excretion. The proteins and phospholipids make the packages water-soluble.

There are five different sizes of these chemical packages. Each package needs all four chemicals in it to hold everything in solution. They differ in how much of each they contain. If blood serum is spun very rapidly in an ultracentrifuge, these five packages will layer out according to their density. They have, therefore, been named according to their densities—high-density lipoproteins (HDL), low-density lipoproteins (LDL), intermediate-density lipoproteins (IDL), very low density lipoproteins (VLDL), and chylomicrons. Only the HDLs and the LDLs will be discussed in the rest of this article.

If there is not enough detergent in the laundry, the oily stains will remain in the clothes. In the same way, if the balance of chemicals in these packages is not right, cholesterol will stay in tissues rather than being excreted from the body. What is even worse, if the chemical composition of these packages changes, the cholesterol can fall out of the blood and stay where it lands. On the other hand, a different change in the balance can remove cholesterol from tissues where there is too much. This

appears to be exactly what is going on in **atherosclerosis**. The lesions contain lots of cholesterol.

The LDLs are overloaded with cholesterol. A minor change in the other chemicals in this package will leave cholesterol behind. The HDLs have a third to a half as much cholesterol. They seem to be able to pick up cholesterol left behind by the LDLs. It seems that atherosclerosis begins with tiny tears at stressed places in the walls of the arteries. Low density lipoproteins from the blood enter these tears, where their chemistry changes enough to leave cholesterol behind. The cholesterol causes irritation; the body responds with inflammation; damage and scarring follow. Eventually the artery gets so diseased blood cannot flow through it. Strokes and heart attacks are the result.

But if there are lots of HDLs in the blood, the cholesterol is rapidly picked up and not allowed to cause problems. Women before **menopause** have estrogen (the female hormone), which encourages the formation of HDLs. This is the reason they have so little vascular disease, and why they rapidly catch up to men after menopause, when estrogen levels fall. Replacement of estrogen after menopause sustains the protection through the later years.

Cholesterol is the root of the problem, but like any other root it cannot just be eliminated. Ninety percent of the cholesterol in the body is created there as a waste product of necessary processes. The solution lies in getting it out to the body without clogging the arteries.

Of course the story is much more complex. The body has dozens of chemical processes that make up, break down, and reconfigure all these chemicals. It is these processes that are the targets of intervention in the effort to cure vascular disease.

Diseases

Near the dawn of concern over cholesterol and vascular disease a family of hereditary diseases was identified, all of which produced abnormal quantities of blood fats. These diseases were called dyslipoproteinemias and came in both too much and too little varieties. The hyperlipoproteinemias found their way into five categories, depending on which chemical was in excess.

- Type 1 has a pure elevation of triglycerides in the chylomicron fraction. These people sometimes get **pancreatitis** and abdominal pains, but they do not seem to have an increase in vascular disease.
- Type 2 appears in two distinct genetic patterns and a third category, which is by far the most important kind, because everyone is at risk for it. All Type 2s have elevated cholesterol. Some have elevated triglycerides also. The familial (genetic) versions of Type 2 often develop xanthomas, which are yellow fatty deposits under the skin of the knuckles, elbows, buttocks or heels. They may also have xanthelasmas, smaller yellow patches on the eyelids.
- Type 3 appears in one in 10,000 people and elevates both triglycerides and cholesterol with consequent vascular disease.
- Type 4 elevates only triglycerides and does not increase the risk of vascular disease.
- Type 5 is similar to Type 1.
- Dyslipidemia refers to a normal amount of cholesterol that is mostly in LDLs, where it causes problems.

All but Type 2 are rare and of interest primarily because they give insight into the chemistry of blood fats.

In addition to the above genetic causes of blood fat disorders, a number of acquired conditions can raise lipoprotein levels.

- Diabetes mellitus, because it alters the way the body handles its energy needs, also affects the way it handles fats. The result is elevated triglycerides and reduced HDL cholesterol. This effect is amplified by **obesity**.
- Hypothyroidism is a common cause of lipid abnormalities. The thyroid hormone affects the rate of many chemical processes in the body, including the clearing of fats from the blood. The consequence is usually an elevation of cholesterol.
- Kidney disease affects the blood's proteins and consequently the composition of the fat packages. It usually raises the LDLs.

KEY TERMS

Atherosclerosis—Hardening of the arteries due to fat (cholesterol) deposits in their walls. Also known as *arteriosclerosis*.

Genetic—Refers to the genes, characteristics inherited from parents.

Inflammation—The body's response to irritation, by releasing chemicals that attack germs and tissues and also repair the damage done.

Lesion—Localized disease or damage.

Pancreatitis—Inflammation of the pancreas.

Serum—The liquid part of blood, from which all the cells have been removed.

- Liver disease, depending on its stage and severity, can raise or lower any of the blood fats.
- Alcohol raises triglycerides. In moderate amounts (if they are very moderate) it raises HDLs and can be beneficial.
- Cigarette **smoking** lowers HDL cholesterol, as does **malnutrition** and obesity.

Certain medications elevate blood fat levels. Because some of these medications are used to treat heart disease, it has been necessary to reevaluate their usefulness:

- Thiazides, water pills used to treat high blood pressure, can raise both cholesterol and triglycerides.
- Beta-blockers, another class of medication used to treat high blood pressure, cortisone-like drugs, and estrogen can raise triglycerides.
- Progesterone, the **pregnancy** hormone, raises cholesterol.

Not all of these effects are necessarily bad, nor are they necessarily even significant. For instance, estrogen is clearly beneficial. Each effect must be considered in the overall goal of treatment.

Causes and symptoms

A combination of heredity and diet is responsible for the majority of fat disorders. It is not so much the cholesterol in the diet that is the problem, because that accounts for only 10% of the body's store. It is the other fats in the diet that alter the way the body handles its cholesterol. There is a convincing relation between fats in the diet and the incidence of atherosclerosis. The guilty fats are mostly the animal fats, but palm and coconut oil are also harmful. These fats are called saturated fats for the chemical reason that most of their carbon atoms have as many hydrogen atoms attached as they can accommodate. More important than the kind of fat is the amount of fat. For many people, fat is half of their diet. A quarter to a fifth is a much healthier fraction, the rest of the diet being made up of complex carbohydrates and protein.

This disease is silent for decades, until the first episode of heart disease or **stroke**.

Diagnosis

It would be easier if simple cholesterol and triglyceride tests were all it took to assess the risk of atherosclerosis. But the important information is which package the cholesterol is in—the LDLs or the HDLs. That takes a more elaborate testing process. To complicate matters further, the amount of fats in the blood varies greatly in relation to the last meal—how long ago it was and what kind of food was eaten. A true estimate of the risk comes from several tests several weeks apart all done after at least twelve hours of **fasting**.

Treatment

Diet and lifestyle change are the primary focus for most cholesterol problems. It is a mistake to think that a pill will reverse the effects of a bad diet, obesity, smoking, excess alcohol, **stress**, and inactivity. Reducing the amount of fat in the diet by at least half is the most important move to make. Much of the food eaten to satisfy a "sweet tooth" is higher in fat than in sugar. A switch away from saturated fats is the next step, but the rush to polyunsaturated fats was ill-conceived. These, and particularly the hydrogenated fats in margarine, have problems of their own. They raise the risk of **cancer** and are considered more dangerous than animal fat by many experts. Theory supports population studies that suggest monounsaturated olive oil may be the healthiest of all.

There was a tremendous push at the end of the 20th century to use lipid-lowering medications. The most popular and most expensive agents, the "statins," hinder the body's production of cholesterol and sometimes damage the liver as a side effect. Their full name is 3-hydroxy-3-methylglutaryl-coemzyme A *(HMG-CoA)* reductase inhibitors. Their generic names are cervistatin, fluvastatin, lovastatin, pravastatin, and simvastatin. Studies show that these do lower cholesterol. Only recently, though, has any evidence appeared that this affects health and longevity. Earlier studies showed, in fact, an increased **death** rate among users of the first class of lipid-altering agents—the fibric acid derivatives. The chain of events connecting raised HDL and lowered LDL cholesterol to longer, healthier lives is still to be forged.

High-tech methods of rapidly reducing very high blood fat levels are performed for those rare disorders that require it. There are resins that bind cholesterol in the intestines. They taste awful, feel like glue and routinely cause gas, bloating, and **constipation**. For acute cases, there is a filtering system that takes fats directly out of the blood.

Niacin (nicotinic acid) lowers cholesterol very effectively and was the first medication proven to improve overall life expectancy. It can also be liver toxic, and the usual formulation causes a hot flash in many people. This can be overcome by taking a couple of aspirins half-an-hour before the niacin, or by taking a special preparation called "flush free," "inositol-bound" or inositol hexanicotinate. Omega-3 oil is a special kind found mostly in certain kinds of fish. It is beneficial in lowering cholesterol. An herbal alternative called gugulipid, *Commiphora mukul*, an extract of an Indian plant, is supposed to

work the same way as the expensive and liver toxic cholesterol-lowering medications.

Alternative treatment

To lower cholesterol, **naturopathic medicine**, **traditional Chinese medicine**, and **ayurvedic medicine** may be considered. Some herbal therapies include gugulipid, alfalfa (*Medicago sativa*), Asian ginseng (*Panax ginseng*), and fenugreek (*Trigonella foenum-graecum*). Garlic (*Allium sativum*) and onions are also reported to have cholesterol-lowering effects. In naturopathic medicine, the liver is considered to be an organ that needs cleansing and rebalancing. The liver is often treated with a botanical formula that will act as a bitter to stimulate bile flow in the liver. Before initiating alternative therapies, medical consultation is strongly advised.

Prognosis

The prognosis is good for Type 1 hyperlipoproteinemia with treatment; without treatment, death may result. For Type 2 the prognosis is poor even with treatment. The prognosis for type 3 is good when the prescribed diet is strictly followed. For types 4 and 5 the prognosis is uncertain, due to the risk of developing premature **coronary artery disease** and pancreatitis, respectively.

Prevention

Genetic inheritance cannot be changed, but its effects may be modified with proper treatment. Family members of an individual with hyperlipoproteinemia should consider having their blood lipids assessed. The sooner any problems are identified, the better the chances of limiting or preventing the associated health risks. Anyone with a family history of disorders leading to hyperlipoproteinemia also may benefit from **genetic testing** and counseling to assist them in making reproductive decisions.

Resources

BOOKS

Ginsberg, Henry N., and Ira J. Goldberg. "Disorders of Lipoprotein Metabolism." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Libby, Peter. "Atherosclerosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Weil, Andrew. *Natural Health, Natural Medicine*. Boston: Houghton Mifflin, 1995.

Witztum, Joseph L., and Daniel Sternberg. "The Hyperlipoproteinemias." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Bays, Harold E. "Drug Therapy for Hyperlipidemia." *Postgraduate Medicine* 91 (1992): 162.

Peters, Wayne L. "Hyperlipidemia: What to Do When Life-Style Changes Aren't Enough." *Postgraduate Medicine* 90 (1991): 213.

ORGANIZATIONS

Inherited High Cholesterol Foundation. 410 Chipeta Way, Room 167, Salt Lake City, UT 84104. (888) 244-2465.

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Hypermagnesemia *see* **Magnesium imbalance**

Hypermenorrhea *see* **Dysfunctional uterine bleeding**

Hypermetropia *see* **Hyperopia**

Hypernatremia

Definition

The normal concentration of sodium in the blood plasma is 136–145 mM. Hypernatremia is defined as a serum sodium level over 145 mM. Severe hypernatremia, with serum sodium above 152 mM, can result in seizures and **death**.

Description

Sodium is an atom, or ion, that carries a single positive charge. The sodium ion may be abbreviated as Na^+ or as simply Na. Sodium can occur as a salt in a crystalline solid. Sodium chloride (NaCl), sodium phosphate (Na_2HPO_4) and sodium bicarbonate ($NaHCO_3$) are commonly occurring salts. These salts can be dissolved in water or in juices of various foods. Dissolving involves the complete separation of ions, such as sodium and chloride in common table salt (NaCl).

About 40% of the body's sodium is contained in bone. Approximately 2–5% occurs within organs and cells and the remaining 55% is in blood plasma and other extracellular fluids. The amount of sodium in blood plasma is typically 140 mM, a much higher amount than is found in intracellular sodium (about 5 mM). This asymmetric distribution of sodium ions is essential for human life. It makes possible proper nerve conduction, the passage of various nutrients into cells, and the maintenance of blood pressure.

KEY TERMS

Blood plasma and serum—Blood plasma, or plasma, is prepared by obtaining a sample of blood and removing the blood cells. The red blood cells and white blood cells are removed by spinning with a centrifuge. Chemicals are added to prevent the blood's natural tendency clot. If these chemicals include sodium, then a false measurement of plasma sodium content will result. Serum is prepared by obtaining a blood sample, allowing formation of the blood clot, and removing the clot using a centrifuge. Both plasma and serum are light yellow in color.

The body continually regulates its handling of sodium. When dietary sodium is too high or low, the intestines and kidneys respond to adjust concentrations to normal. During the course of a day, the intestines absorb dietary sodium while the kidneys excrete a nearly equal amount of sodium into the urine. If a low sodium diet is consumed, the intestines increase their efficiency of sodium absorption, and the kidneys reduce its release into urine.

The concentration of sodium in the blood plasma depends on two things: the total amount of sodium and water in arteries, veins, and capillaries (the circulatory system). The body uses separate mechanisms to regulate sodium and water, but they work together to correct blood pressure when it is too high or too low. Too high a concentration of sodium, or hypernatremia, can be corrected either by decreasing sodium or by increasing body water. The existence of separate mechanisms that regulate sodium concentration account for the fact that there are numerous diseases that can cause hypernatremia, including diseases of the kidney, pituitary gland, and hypothalamus.

Causes and symptoms

Vasopressin, also called anti-diuretic hormone, is made by the hypothalamus and released by the pituitary gland into the bloodstream. There it travels to the kidney where it reduces the release of water into the urine. With less vasopressin production, the body fails to conserve water, and the result is a trend toward higher plasma sodium concentrations. Hypernatremia may occur in **diabetes insipidus**, a disease that causes excessive urine production. (It is not the same disease as **diabetes mellitus**, a disease resulting from impaired insulin production.) The defect involves either the failure of the hypothalamus to make vasopressin or the failure of the kidney to respond to vasopressin. In either case, the kidney is able to conserve and regulate the body's sodium levels, but is unable to conserve and retain the body's water. Hypernatremia does not occur in diabetes insipidus if the patient is able to drink enough water to keep up with urinary loss, which may be as high as 10 liters per day.

Hypernatremia may occur in unconscious (or comatose) patients due to the inability to drink water. Water is continually lost by evaporation from the lungs and in the urine. If the patient is not given water via infusion, the sodium concentration in the blood may increase and hypernatremia could develop. Hypernatremia can also occur in rare diseases in which the thirst impulse is impaired.

Hypernatremia can also occur accidentally in the hospital when patients are infused with solutions containing sodium, such as sodium bicarbonate for the treatment of acidosis (acidic blood). It can also be accidentally induced with sodium chloride infusions, especially in elderly patients with impaired kidney function.

Hypernatremia can cause neurological damage due to shrinkage of brain cells. Neurological symptoms include confusion, **coma**, **paralysis** of the lung muscles, and death. The severity of the symptoms is related to how rapidly the hypernatremia developed. Hypernatremia that comes on rapidly does not allow the cells of the brain time to adapt to their new high-sodium environment. Hypernatremia is especially dangerous for children and the elderly.

Diagnosis

Hypernatremia is diagnosed by acquiring a blood sample, preparing plasma, and using a sodium-sensitive electrode for measuring the concentration of sodium ions.

Treatment

Hypernatremia is treated with infusions of a solution of water containing 0.9% sodium chloride (0.9 grams NaCl/100 ml water), which is the normal concentration of sodium chloride in the blood plasma. The infusion is performed over many hours or days to prevent abrupt and dangerous changes in brain cell volume. In emergencies, such as when hypernatremia is causing neurological symptoms, infusions may be conducted with salt solutions containing 0.45% sodium chloride, which is half the normal physiologic level.

Prognosis

The prognosis for treating hypernatremia is excellent, except if neurological symptoms are severe or if overly rapid attempts are made to treat and reverse the condition.

Prevention

Hypernatremia occurs only in unusual circumstances that are not normally under a person's control.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Fried, L. F., and P. M. Palevsky. "Hyponatremia and hypernatremia." *Medical Clinics of North America* 81 (1997): 585-609.

Frizzell, R. T., et al. "Hyponatremia and ultramarathon running." *Journal of the American Medical Association* 255 (1986): 772-774.

Tom Brody, PhD

Hypernephroma *see* **Kidney cancer**

Hyperopia

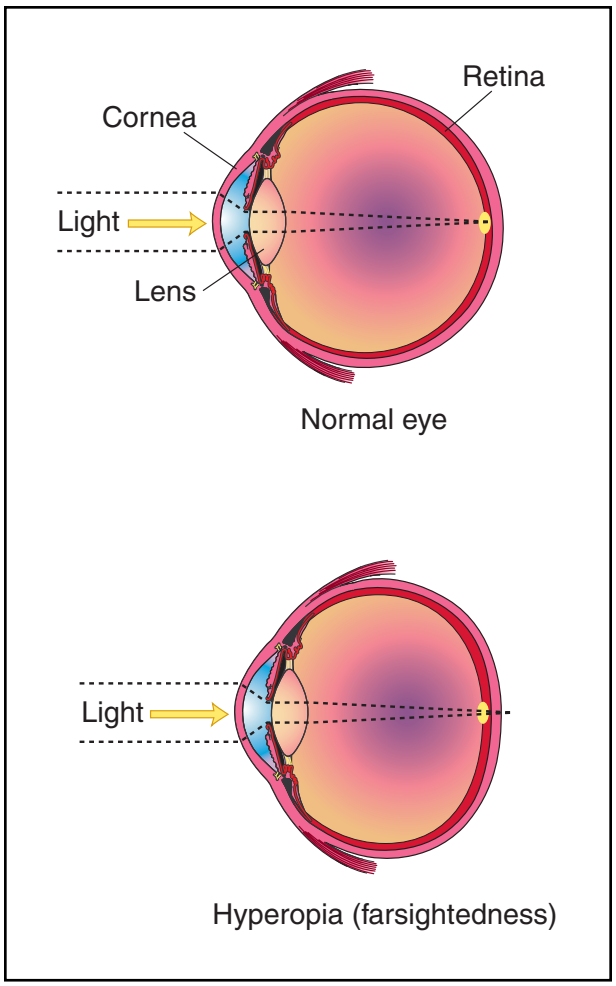
Definition

Hyperopia (farsightedness) is the condition of the eye where incoming rays of light reach the retina before they converge into a focused image.

Description

When light goes through transparent but dense material like the materials of the eye's lens system (the lens and cornea), its velocity decreases. If the surface of the dense material is not perpendicular to the incoming light, as is the case with the curved surfaces on lenses and corneas, the direction of the light changes. The greater the curvature of the lens system, the greater the change in the direction of the light.

When parallel light rays from an object go through the lens system of the eye, they are bent so they converge at a point some distance behind the lens. With perfect vision this point of convergence, where the light rays are focused, is on the retina. This happens when the cumulative curvature of the lens plus cornea and the distance from the lens to the retina are just right for each other. The condition where the point of focus of parallel light rays from an object is behind the retina is called hyperopia. This condition exists when the combined curvature of the lens and cornea is insufficient (e.g., flatter than needed for the length of the eyeball). This condition can be equivalently described by saying hyperopia exists when the eyeball is too short for the curvature of its lens system.



Hyperopia, or farsightedness, is a condition of the eye where incoming rays of light impinge on the retina before converging into a focused image, resulting in difficulty seeing nearby objects clearly. *(Illustration by Electronic Illustrators Group.)*

There is a connection between the focusing of the lens of the eye (accommodation) and convergence of the eyes (the two eyes turning in to point at a close object.) The best example is during reading. The lens accommodates to make the close-up material clear and the eyes turn in to look at the print and keep it single. Because of this connection between accommodation and convergence, if the lens needs to accommodate to focus for distance (to bring the image back onto the retina) the eyes may appear to turn in even when looking at the distance. This can cause a condition known as accommodative esotropia in children. The eyes turn in and the cause is accommodation because of hyperopia.

KEY TERMS

Cornea—The clear, dome-shaped outer covering of the front of the eye. It lies in front of the iris and pupil.

Iris—The colored ring just behind the cornea and in front of the lens that controls the amount of light sent to the retina.

Pupil—The black hole in the center of the iris. Light enters here on the way to the lens and retina.

Refraction—Method of determining the optical status of the eyes. Lenses are placed before the patient's eyes while reading from an eye chart. The result is the eyeglass or contact lens prescription.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages sent to the brain via the optic nerve.

Causes and symptoms

Babies are generally born slightly hyperopic. This tends to decrease with age. There is normal variation in eyeball length and curvature of the lens and cornea. Some combinations of these variables give rise to eyes where the cornea is too flat for the distance between the cornea and the retina. If the hyperopia is not too severe the lens may be able to accommodate and bring the image back onto the retina. This would result in clear distance vision, but the constant focusing might result in headaches or eyestrain. If the lens cannot accommodate for the full amount of the hyperopia the distance image would be blurry.

If the eyes are focusing for distance and now the person is looking at a near object, the eyes need to accommodate further. This may result in blurry near objects or headaches during near work.

Depending upon the amount of hyperopia, symptoms can range from none to clear distance vision but blurry near vision, to blurry distance and near vision. Headaches and eyestrain may also occur, particularly when doing near tasks. An eye turned in (esotropia) may be a result of hyperopia, particularly in children. However, because a turned eye may be a result of more serious causes it is very important to have it checked out.

Diagnosis

Because it is possible to have good visual acuity with some degree of hyperopia it is important to relax accommodation before the eye exam. This is done with the use of eyedrops and is called a cycloplegic exam or cycloplegic refraction. The drops relax the accommodation (thus making reading blurry until the drops wear off). Patients will usually be asked to have someone drive them home because of the blurriness. The doctor can then determine the patient's visual status with a handheld instrument called a retinoscope and/or have the patient read from an eye chart while placing different lenses in front of the patient's eyes. Refractive error is measured in units called diopters (D).

Treatment

The usual treatment for hyperopia is corrective lenses (spectacles or contact lenses).

Different surgical methods to correct hyperopia are under investigation. One approach is to implant corrective contact lenses behind the patient's iris. The first experimental implantable contact lenses were implanted in 1997. Another approach is to surgically increase the curvature of the eye's existing cornea or lens. Although there have been many reports of success using different kinds of lasers to increase corneal curvature, as of 1998 there are still problems with stability and predictability. The introduction of light-activated biologic tissue glue in 1997 holds promise for improvements in those areas.

Prognosis

The prognosis for fully corrected vision is excellent for patients with low to moderate amounts of hyperopia. Patients with very high hyperopia (+10.00D or more) may not achieve full correction. Moreover, surgery to correct hyperopia will probably be perfected and approved in the near future.

Hyperopia increases the chances of chronic **glaucoma**, but vision loss from glaucoma is preventable.

Prevention

Hyperopia is usually present at birth, and there is no known way to prevent it.

Resources

BOOKS

Newell, Frank W. *Ophthalmology: Principles and Concepts.* 8th ed. St. Louis: Mosby, 1996.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

OTHER

Edmiston, Dave. "Hyperopia." Lasikpatient.org. <http://www.lasikpatient.org>.

Lorraine Lica, PhD

Hyperparathyroidism

Definition

Parathyroid glands are four pea-sized glands located just behind the thyroid gland in the front of the neck. The function of parathyroid glands is to produce a hormone called parathyroid hormone (parathormone), which helps regulate calcium and phosphorous in the body. Hyperparathyroidism is the overproduction of this hormone.

Description

Thyroid glands and parathyroid glands, despite their similar name and proximity, are entirely separate, and each produces hormones with different functions. Hyperparathyroidism may be primary or secondary. It most often occurs in those over age 30, and most commonly in patients 50 to 60 years old. It rarely occurs in children or the elderly. Women are affected by the disease up to three times more often than men. It is estimated that 28 of every 100,000 people in the United States will develop hyperparathyroidism each year.

Normally, parathyroid glands produce the parathormone as calcium levels drop and lower to meet the demands of a growing skeleton, **pregnancy**, or **lactation**. However, when one or more parathyroid glands malfunctions, it can lead to overproduction of the hormone and elevated calcium level in the blood. Therefore, a common result of hyperparathyroidism is **hypercalcemia**, or an abnormally high level of calcium in the blood. Primary hyperparathyroidism occurs as a malfunction of one of the glands, usually as a result of a benign tumor, called adenoma. Secondary hyperparathyroidism occurs as the result of a metabolic abnormality outside the parathyroid glands, which causes a resistance to the function of the parathyroid hormones. Primary hyperparathyroidism is one of the most common endocrine disorders, led only by diabetes and **hyperthyroidism**.

Causes and symptoms

Often, there are no obvious symptoms or suspicion of hyperparathyroidism, and it is first diagnosed when a patient is discovered to be hypercalcemic during a routine blood chemistry profile. Patients may believe they have felt fine, but realize improvements in sleep, irritability, and memory following treatment. When symptoms are present, they may include development of gastric ulcers or **pancreatitis** because high calcium levels can cause inflammation and **pain** in the linings of the stomach and pancreas.

Most of the symptoms of hyperparathyroidism are those present as a result of hypercalcemia, such as **kidney stones**, **osteoporosis**, or bone degradation resulting from the bones giving up calcium. Muscle weakness, central nervous system disturbances such as depression, psychomotor and personality disturbances, and rarely, even **coma** can occur. Patients may also experience **heartburn**, nausea, **constipation**, or abdominal pain. In secondary hyperparathyroidism, patients may show signs of calcium imbalance such as deformities of the long bones. Symptoms of the underlying disease may also be present.

Most commonly, hyperparathyroidism occurs as the result of a single adenoma, or benign tumor, in one of the parathyroid glands. About 90% of all cases of hyperparathyroidism are caused by an adenoma. The tumors are seldom cancerous. They will grow to a much larger size than the parathyroid glands, often to the size of a walnut. Genetic disorders or multiple endocrine tumors can also cause a parathyroid gland to enlarge and oversecrete hormone. In 10% or fewer of patients with primary hyperparathyroidism, there is enlargement of all four parathyroid glands. This condition is called parathyroid hyperplasia.

Diagnosis

Diagnosis of hyperparathyroidism is most often made when a blood test (radioimmunoassay) reveals high levels of parathyroid hormone and calcium. A blood test that specifically measures the amount of parathyroid hormone has made diagnosis simpler. X ray examinations may be performed to look for areas of diffuse bone demineralization, bone cysts, outer bone absorption and erosion of the long bones of the fingers and toes. Hypercalcemia is mild or intermittent in some patients, but is an excellent indicator of primary hyperparathyroidism. Dual energy x ray absorptiometry (DEXA or DXA), a tool used to diagnose and measure osteoporosis, is used to show reduction in bone mass for primary hyperparathryroidism patients. Once a diagnosis of hyperparathyroidism is reached, the physician will probably order further tests to evaluate complications. For example, abdominal radiographs might reveal kidney stones.

For secondary hyperparathyroidism, normal or slightly decreased calcium levels in the blood and variable phosphorous levels may be visible. Patient history

KEY TERMS

Demineralization—A loss or decrease of minerals in the bones.

Endocrine—Glands and hormone secretions in the body circulation.

Phosphorous—Referring to a chemical element occurring in all living cells.

of familial kidney disease or convulsive disorders may suggest a diagnosis of secondary hyperparathyroidism. Other tests may reveal a disease or disorder, which is causing the secondary hyperparathyroidism.

Treatment

Hyperparathyroidism cases will usually be referred to an endocrinologist, a physician specializing in hormonal problems, or a nephrologist, who specializes in kidney and mineral disorders.

Patients with mild cases of hyperparathyroidism may not need immediate treatment if they have only slight elevations in blood calcium level and normal kidneys and bones. These patients should be regularly checked, probably as often as every six months, by **physical examination** and measurement of kidney function and calcium levels. A bone densitometry measurement should be performed every one or two years. After several years with no worsened symptoms, the length of time between exams may be increased.

Patients with more advanced hyperparathyroidism will usually have all or half of the affected parathyroid gland or glands surgically removed. This surgery is relatively safe and effective. The primary risks are those associated with general anesthesia. There are some instances when the surgery can be performed with the patient under regional, or cervical block, anesthesia. Often studies such as ultrasonography prior to surgery help pinpoint the affected areas.

Alternative treatment

Forcing fluids and reducing intake of calcium-rich foods can help decrease calcium levels prior to surgery or if surgery is not necessary.

Prognosis

Removal of the enlarged parathyroid gland or glands cures the disease 95% of the time and relief of bone pain may occur in as few as three days. In up to 5% of patients undergoing surgery, chronically low calcium levels may result, and these patients will require calcium supplement or vitamin D treatment. Damage to the kidneys as a result of hyperparathyroidism is often irreversible. Prognosis is generally good, however complications of hyperparathyroidism such as osteoporosis, bone **fractures**, kidney stones, peptic ulcers, pancreatitis, and nervous system difficulties may worsen prognosis.

Prevention

Secondary hyperparathyroidism may be prevented by early treatment of the disease causing it. Early recognition and treatment of hyperparathyroidism may prevent hypercalcemia. Since the cause of primary hyperparathyroidism, or the adenoma which causes parathyroid enlargement, is largely unknown, there are not prescribed prevention methods.

Resources

PERIODICALS

Allerheiligen, David A., et al. "Hyperparathyroidism." *American Family Physician* 58 (15 Apr.1998): 1795-1803.

ORGANIZATIONS

Osteoporosis and Related Bone Diseases-National Resource Center. 1150 17th S. NW, Ste. 500, Washington, DC 20036. (800) 624-2663.

The Paget Foundation. 200 Varick St., Ste. 1004. New York, NY 10014-4810. (800)23-PAGET.

OTHER

"Endocrine Disorder and Endocrine Surgery." Endocrine Web Page. <http://www.endocrineweb.com>.

Teresa Norris

Hyperpigmentation

Definition

Hyperpigmentation is the increase in the natural color of the skin.

Description

Melanin, a brown pigment manufactured by certain cells in the skin called melanocytes, is responsible for skin color. Melanin production is stimulated by a pituitary hormone called melanocyte stimulating hormone (MSH). Other pigments appear in the skin much less often.

Causes and symptoms

Darkened spots on the skin come in several varieties. The most ominous is **malignant melanoma**, a very aggressive **cancer** that begins as an innocent mole. The majority of **moles** (nevus), however, are and remain benign (harmless). The average person has several dozen, and certain people with a hereditary excess may have hundreds. Freckles, age spots, and cafe au lait spots, known as ephelides, are always flat and not as dark. Cafe au lait spots are seen mostly in people with another hereditary disorder called **neurofibromatosis**. "Port wine stains" are congenital dark red blotches on the skin. Other common dark colorations on the skin are called keratosis and consist of locally overgrown layers of skin that are dark primarily because there is more tissue than normal. A few of these turn into skin cancers of a much less dangerous kind than melanoma.

Darkened regions of the skin occur as a result of abnormal tanning when the skin is sensitive to sunlight. Several diseases and many drugs can cause **photosensitivity**. Among the common drugs responsible for this uncommon reaction are birth control pills, **antibiotics** (**sulfonamides** and **tetracyclines**), **diuretics**, **nonsteroidal anti-inflammatory drugs** (NSAID), **pain** relievers, and some psychoactive medications. Some of the same drugs may also cause patches of discolored skin known as localized drug reactions and representing an allergy to that drug. Sunlight darkens an abnormal chemical in the skin of patients with porphyria cutanea tarda. Several endocrine diseases, some cancers, and several drugs abnormally stimulate melanocytes, usually through an overproduction of MSH. Arsenic **poisoning** and **Addison's disease** are among these causes. A condition known as acanthosis nigricans is a velvety darkening of skin in folded areas (arm pits, groin, and neck) that can signal a cancer or hormone imbalance.

Of particular note is a condition called melasma (dark pigmentation of the skin), caused by the female hormone estrogen. Normal in **pregnancy**, this brownish discoloration of the face can also happen with birth control pills that contain estrogen.

Overall darkening of the skin may be due to pigmented chemicals in the skin. Silver, gold, and iron each have a characteristic color when visible in the skin. Several drugs and body chemicals, like bilirubin, can end up as deposits in the skin and discolor it.

There are a number of other rare entities that color the skin, each in its own peculiar way. Among these are strange syndromes that seem to be **birth defects** and vitamin and nutritional deficiencies.

KEY TERMS

Addison's disease—A degenerative disease that is characterized by weight loss, low blood pressure, extreme weakness, and dark brown pigmentation of the skin.

Dermatologist—A physician specializing in the study of skin conditions and diseases

Diuretic—A cause of increased urine flow.

Keratosis—A skin disease characterized by an overgrowth of skin, which usually appears discolored.

Lesion—Any localized abnormality.

Melasma—Dark pigmentation of the skin.

Neurofibromatosis—Otherwise known as von Recklinghausen's disease, consists of pigmented skin spots and numerous soft tumors all over the body.

Nevus—Birthmark or mole.

NSAID—Nonsteroidal anti-inflammatory drugs—aspirin, ibuprofen, naproxen, and many others.

Porphyria cutanea tarda—An inherited disease that results in the overproduction of porphyrins.

Syndrome—Common features of a disease or features that appear together often enough to suggest they may represent a single, as yet unknown, disease entity.

Diagnosis

The pattern of discoloration is immediately visible to the trained dermatologist, a physician specializing in skin diseases, and may be all that is required to name and characterize the discoloration. Many of these pigment changes are signs of internal disease that must be identified. Pigmentation changes may also be caused by medication, and the drug responsible for the reaction must be identified and removed.

Treatment

Skin sensitive to sunlight must be protected by shade or **sunscreens** with an SPF of 15 or greater. Skin cancers must be, and unsightly benign lesions may be, surgically removed. **Laser surgery** is an effective removal technique for many localized lesions. Because it spreads so rapidly, melanoma should be immediately removed, as well as some of the surrounding tissue to prevent regrowth.

Prevention

Sunlight is the leading cause of dark spots on the skin, so shade and sunscreens are necessary preventive strategies, especially in people who burn easily.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Bolognia, Jean L., and Irwin M. Braverman. "Skin Manifestations of Internal Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Mosher, David B. "Disorders of Pigmentation." In *Dermatology in General Medicine*, ed. Thomas B. Fitzpatrick, et al. New York: McGraw-Hill, 1993.

PERIODICALS

Bernstein L. J., et al. "The Short- and Long-term Side Effects of Carbon Dioxide Laser Resurfacing." *Dermatologic Surgery* 23 (July 1997): 519-525.

Fitzpatrick, R. E., et al. "Pulsed Carbon Dioxide Laser Resurfacing of Photo-aged Facial Skin." *Archives of Dermatology* 132 (Apr. 1996): 395-402.

Rubin, M. G. "A Peeler's Thoughts on Skin Improvement with Chemical Peels and Laser Resurfacing." *Clinics in Plastic Surgery* 24 (Apr. 1997): 407-409.

Waldorf, H. A., A. N. Kauvar, and R. G. Geronemus. "Skin Resurfacing of Fine to Deep Rhytides using a Char-free Carbon Dioxide Laser in 47 Patients." *Dermatologic Surgery* 21 (Nov. 1995): 940-946.

J. Ricker Polsdorfer, MD

Hyperprolactation *see* **Galactorrhea**

Hypersensitivity pneumonitis

Definition

Hypersensitivity pneumonitis refers to an inflammation of the lungs caused by repeated breathing in of a foreign substance, such an organic dust, a fungus, or a mold. The body's immune system reacts to these substances, called antigens, by forming antibodies, molecules that attack the invading antigen and try to destroy it. The combination of antigen and antibody produces acute inflammation, or pneumonitis (a hypersensitivity reaction), which later can develop into chronic lung disease that impairs the lungs' ability to take oxygen from the air and eliminate carbon dioxide.

Description

Hypersensitivity pneumonitis (HP) is sometimes called "allergic alveolitis." "Allergic" refers to the antigen-antibody reaction, and "alveolitis" means an inflammation of the tiny air sacs in the lungs where oxygen and CO_2 are exchanged, the alveoli. It also is known as "extrinsic" allergic alveolitis, meaning that the antigen that sets up the allergic reaction (also called an allergen) comes from the outside. Most of the antigens that cause this disease come from plant or animal proteins or microorganisms, and many of those affected are exposed either at work or in the course of some hobby or other activity. The first known type of HP, farmer's lung, is caused by antigens from tiny microorganisms living on moldy hay. An example of disease connected with a hobby is pigeon breeder's lung, caused by inhaling protein material from bird droppings or feathers. After a time, very little of the allergenic material is needed to set off a reaction in the lungs.

Roughly one in every 10,000 persons develops some form of HP. A mysterious aspect of this condition is that, even though many persons may be exposed to a particular antigen, only a small number of them will develop the disease. Genetic differences may determine who becomes ill; this remains unclear. Probably between 5% and 15% of all persons who are regularly exposed to organic materials develop HP. Most of those who do get it do *not* smoke (**smoking** may create the type of cells that take up antigens and neutralize them). The amount of antigen is an important factor in whether HP will develop and what form it will take. Sudden heavy exposure can produce symptoms in a matter of hours, whereas mild but frequent exposures tend to produce a long-lasting, "smoldering" illness. HP may be more likely to develop in persons exposed to polluted air or industrial fumes.

Typical changes occur in the lungs of persons with HP. In the acute stage, large numbers of inflammatory cells are found throughout the lungs and the air sacs may be filled by a thick fluid mixed with these cells. In the subacute stage, disease extends into the small breathing tubes, or bronchioles, and the inflammatory cells collect into tiny granules called granulomas. Finally, in the chronic stage of HP, the previously inflamed parts of the lungs become scarred and unable to function, as in **pulmonary fibrosis**.

Causes and symptoms

A number of different types of HP are known, since a wide range of allergens may produce an allergic reaction in the lungs. Many of them produce similar symptoms and abnormal physical findings, but some have their own typical features. Some of the more common forms are:

- Farmer's lung. Can affect any farmer who works with wet hay or other moldy dust. Small farmers who have to directly thresh and handle their hay are most at risk, as are those living in cold and humid areas where damp weather is common.
- Pigeon breeder's lung. Also called "bird fancier's lung," it is second to farmer's lung as the best known type of HP. A substance has been found in pigeon droppings that may cause the allergic reaction, but there may be more than one such substance. Besides pigeons, the disorder may follow exposure to ducks, geese, pheasants, and even canaries. Parakeets produce an especially severe form of disease. Most patients are middle-aged women, who usually care for birds either at home or on bird breeding farms.
- Bagassosis. Caused by bagasse, a substance produced when juice is extracted from sugar cane and is used in making paper and explosives. A fungus is probably responsible. Young and middle-aged men who work in the sugar industry are at risk.
- Byssinosis. A similar condition affecting workers who inhale dust from cotton, flax, or hemp.
- Humidifier lung. An acute form of HP caused by inhaling actinomycyetes, the same organisms that cause farmer's lung, which grow in contaminated humidifier vents, air conditioners, heating systems, and even saunas.
- Other antigens. HP has been seen in persons working with detergents, silicone, mushrooms, cheese, wood dust, maple bark, coffee, and furs.

In the acute stage, patients with HP begin coughing, develop **fever**, and note tightness in the chest as well as extreme tiredness and aching, four to eight hours after the most recent exposure. Most patients are well aware of the connection between their work (or an activity) and their symptoms. After a time, patients may have trouble breathing. They also may lose their appetite, lose weight, and generally feel ill. Finally, in the chronic stage, the patient will have increasing trouble breathing and may sometimes wheeze. With advanced disease, the skin may appear bluish (because too little oxygen is getting into the blood). When the physician listens to the patient's chest with a stethoscope, there may be crackling sounds or loud **wheezing**. In the late stages, club-shaped fingertips are a sign that the patient has not been getting enough oxygen for an extended period of time.

Diagnosis

No single test can make a definite diagnosis of HP. The key is to relate some specific exposure or activity to episodes of symptoms. The **chest x ray** may be normal in the acute stage, but later may show a hazy appearance that looks like "ground glass." There may be linear or rounded shadows in the central parts of the lungs. Studies of lung function in the acute stage typically show abnormally small lung volume. The ability to breathe at a fast rate is impaired. Blood from an artery typically has a low level of oxygen. Later, when the lungs have begun to scar, the airways (breathing tubes) are obstructed and the rate of air flow is reduced.

Some experts believe that skin testing can help diagnose HP and show which particular antigen is causing the symptoms. Small amounts of several suspect antigens are injected just beneath the surface of the skin, usually on the arm or back, and the reactions compared to that caused by injecting a harmless salt solution. Another diagnostic test is to place a thin tube into the airways, inject a small amount of fluid, and draw it back up (bronchoalveolar lavage). A very large number of cells called lymphocytes is typical of HP, and mast cells, which are part of the immune system, may also be seen. Rarely, a tissue sample (biopsy) of lung tissue may be taken through a tube placed in the airways and examined under a microscope. Finally, a patient may be "challenged" by actually inhaling a particular antigen in the form of an aerosol and noting whether lung function suddenly becomes worse. This test is usually not necessary.

Treatment

Treatment of HP requires identifying the offending antigen and avoiding further exposure. Although it may sometimes be necessary for a patient to find a totally different type of work, often it is possible to simply perform different duties or switch to a work site where exposure is minimal. In some cases, (like pigeon breeder's lung), wearing a mask can prevent exposure. If acute symptoms are severe, the patient may be treated with a steroid hormone for two to six weeks. This often suppresses the inflammatory response and allows the lungs a chance to recover. In the chronic stage, steroid treatment can delay further damage to the lungs and help preserve their function.

Prognosis

In general, most of the symptoms of HP disappear when the patient is no longer exposed to the causative allergen. The actual chances of complete recovery depend in part on what form of HP is present. Older patients and those exposed repeatedly for long periods after initially developing symptoms tend to have a poorer long-term outlook. The worst outcome is that long repeated episodes of exposure will cause chronic lung inflammation, scar the lungs, and permanently make then unable to properly provide oxygen to the blood. Rarely, a patient will become permanently disabled.

KEY TERMS

Allergen—An outside substance, such as dust or a mold, that, when inhaled, sets off an allregic (hypersensitivity) reaction in the lungs.

Fibrosis—A result of long-standing inflammatory disease in which normal tissue is replaced by scar tissue that is functionally useless.

Granuloma—A collection of inflammatory cells forming a microscopic lesion, many of which are scattered throughout the lung tissue in patients who have had numerous acute episodes of HP.

Hypersensitivity—After the body's immune system attacks an outside invader (such as organic dust or a fungus) many times, exposure to even a tiny amount of this allergen can provoke a strong inflammatory response.

Pneumonitis—Inflammation of the lung tissues.

Steroid—A natural body substance that may be given orally or by injection, and serves to dampen or even halt inflammation anywhere in the body, including the lungs.

Prevention

It is often not possible to prevent initial episodes of HP, because there is no way of predicting which individuals (such as farmers) will have an allergic reaction to a particular allergen. Once the connection is made between a type of exposure and definite hypersensitivity symptoms, prevention of further episodes is simple as long as further exposure can be avoided.

Exactly how to avoid exposure depends on a person's work or activities and what he or she is reacting to. People with farmer's lung can dry hay thoroughly before storing it. For pigeon breeder's lung (and many other types of HP), a mask can be worn. In many industrial settings, it is possible to take precautions that will limit the amount of allergen that workers will inhale. If it is not possible to avoid exposure altogether, exposure can be timed and strictly minimized.

Resources

BOOKS

Smolley, Lawrence A., and Debra F. Bryse. *Breathe Right Now: A Comprehensive Guide to Understanding and Treating the Most Common Breathing Disorders.* New York: W. W. Norton & Co., 1998.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Asthma and Allergy Foundation of America. 1233 20th Street, NW, Suite 402, Washington, DC 20036. (800) 727-8462. <http://www.aafa.org>.

OTHER

"Pulmonary Medicine." *Healthweb Page*. 12 Jan. 1998 <http://healthweb.org/browse.cfm?subjectid=81>.

David A. Cramer, MD

Hypersomnia *see* **Sleep disorders**

Hypersplenism

Definition

Hypersplenism is a type of disorder which causes the spleen to rapidly and prematurely destroy blood cells.

Description

The spleen is located in the upper left area of the abdomen. One of this organ's major functions is to remove blood cells from the body's bloodstream. In hypersplenism, its normal function accelerates, and it begins to automatically remove cells that may still be normal in function. Sometimes, the spleen will temporarily hold onto up to 90% of the body's platelets and 45% of the red blood cells. Hypersplenism may occur as a primary disease, leading to other complications, or as a secondary disease, resulting from an underlying disease or disorder. Hypersplenism is sometimes referred to as enlarged spleen (splenomegaly). An enlarged spleen is one of the symptoms of hypersplenism. What differentiates hypersplenism is its premature destruction of blood cells.

Causes and symptoms

Hypersplenism may be caused by a variety of disorders. Sometimes, it is brought on by a problem within the spleen itself and is referred to as primary hypersplenism. Secondary hypersplenism results from another disease such as chronic **malaria**, **rheumatoid arthritis**, **tuberculosis**, or **polycythemia vera**, a blood disorder. Spleen disorders in general are almost always secondary in nature. Hypersplenism may also be caused by tumors.

Symptoms of hypersplenism include easy bruising, easy contracting of bacterial diseases, **fever**, weakness, heart **palpitations**, and ulcerations of the mouth, legs and feet. Individuals may also bleed unexpectedly and

heavily from the nose or other mucous membranes, and from the gastrointestinal or urinary tracts. Most patients will develop an enlarged spleen, anemia, leukopenia, or abnormally low white blood cell counts, or **thrombocytopenia**, a deficiency of circulating platelets in the blood. Other symptoms may be present that reflect the underlying disease that has caused hypersplenism.

An enlarged spleen can be caused by a variety of diseases, including **hemolytic anemia**, liver **cirrhosis**, leukemia, malignant lymphoma and other infections and inflammatory diseases. Splenomegaly occurs in about 10% of **systemic lupus erythematosus** patients. Sometimes, it is caused by recent viral infection, such as mononucleosis. An enlarged spleen may cause **pain** in the upper left side of the abdomen and a premature feeling of fullness at meals.

Diagnosis

Diagnosis of hypersplenism begins with review of symptoms and patient history, and careful feeling (palpation) of the spleen. Sometimes, a physician can feel an enlarged spleen. X-ray studies, such as ultrasound and computed tomography scan (CT scan), may help diagnose an enlarged spleen and possible underlying causes, such as tumors. Blood tests indicate decreases in white blood cells, red blood cells, or platelets. Another test measures red blood cells in the liver and spleen after injection of a radioactive substance, and indicates areas where the spleen is holding on to large numbers of red cells or is destroying them.

Enlarged spleens are diagnosed using a combination of patient history, **physical examination**, including palpation of the spleen, if possible, and diagnostic tests. A history of fever and systemic symptoms may be present because of infection, malaria, or an inflammatory disorder. A complete **blood count** is taken to check counts of young red blood cells. **Liver function tests**, CT scans, and ultrasound exams can also help to detect an enlarged spleen.

Treatment

In secondary hypersplenism, the underlying disease must be treated to prevent further sequestration or destruction of blood cells, and possible spleen enlargement. Those therapies will be tried prior to removal of the spleen (**splenectomy**), which is avoided if possible. In severe cases, the spleen must be removed. Splenectomy will correct the effects of low blood cell concentrations in the blood.

Prognosis

Prognosis depends on the underlying cause and progression of the disease. Left untreated, spleen enlargement can lead to serious complications. Hypersplenism can also lead to complications due to decreased blood cell counts.

KEY TERMS

Cirrhosis—Hardening of an organ, usually the liver. Cirrhosis of the liver is a progressive disease which leads to destruction of liver cells, interference with blood flow in the liver, and interference with the function of the liver.

Palpitations—Throbbing or pulsation. Heart palpitations usually infer an irregular or rapid rhythm.

Polycythemia vera—A chronic disorder characterized by increased red blood cell mass and other malfunctions of the blood system. It most commonly occurs in males of Jewish ancestry between the ages of 40 and 60.

Systemic—Relating to a system, or especially the entire system.

Systemic lupus erythematosus—A connective tissue disease that results in fever, weakness, fatigue, joint pain and arthritis.

Ulcerations—Breaks in skin or mucous membranes that are often accompanied by loss of tissue on the surface.

Prevention

Some of the underlying causes of hypersplenism or enlarged spleen can be prevented, such as certain forms of anemia and cirrhosis of the liver due to alcohol. In other cases, the hypersplenism may not be preventable, as it is a complication to an underlying disorder.

Resources

BOOKS

Current Diagnosis. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

The American Society of Hematology. 1200 19th Street NW, Suite 300, Washington, DC 20036-2422. (202) 857-1118. <http://www.hematology.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris

Hypertension

Definition

Hypertension is high blood pressure. Blood pressure is the force of blood pushing against the walls of arteries as it flows through them. Arteries are the blood vessels that carry oxygenated blood from the heart to the body's tissues.

Description

As blood flows through arteries it pushes against the inside of the artery walls. The more pressure the blood exerts on the artery walls, the higher the blood pressure will be. The size of small arteries also affects the blood pressure. When the muscular walls of arteries are relaxed, or dilated, the pressure of the blood flowing through them is lower than when the artery walls narrow, or constrict.

Blood pressure is highest when the heart beats to push blood out into the arteries. When the heart relaxes to fill with blood again, the pressure is at its lowest point. Blood pressure when the heart beats is called systolic pressure. Blood pressure when the heart is at rest is called diastolic pressure. When blood pressure is measured, the systolic pressure is stated first and the diastolic pressure second. Blood pressure is measured in millimeters of mercury (mm Hg). For example, if a person's systolic pressure is 120 and diastolic pressure is 80, it is written as 120/80 mm Hg. The American Heart Association considers blood pressure less than 140 over 90 normal for adults.

Hypertension is a major health problem, especially because it has no symptoms. Many people have hypertension without knowing it. In the United States, about 50 million people age six and older have high blood pressure. Hypertension is more common in men than women and in people over the age of 65 than in younger persons. More than half of all Americans over the age of 65 have hypertension. It is also more common in African-Americans than in white Americans.

Hypertension is serious because people with the condition have a higher risk for heart disease and other medical problems than people with normal blood pressure. Serious complications can be avoided by getting regular blood pressure checks and treating hypertension as soon as it is diagnosed.

If left untreated, hypertension can lead to the following medical conditions:

- arteriosclerosis, also called **atherosclerosis**
- **heart attack**
- **stroke**
- enlarged heart
- kidney damage

Arteriosclerosis is hardening of the arteries. The walls of arteries have a layer of muscle and elastic tissue that makes them flexible and able to dilate and constrict as blood flows through them. High blood pressure can make the artery walls thicken and harden. When artery walls thicken, the inside of the blood vessel narrows. Cholesterol and fats are more likely to build up on the walls of damaged arteries, making them even narrower. Blood clots can also get trapped in narrowed arteries, blocking the flow of blood.

Arteries narrowed by arteriosclerosis may not deliver enough blood to organs and other tissues. Reduced or blocked blood flow to the heart can cause a heart attack. If an artery to the brain is blocked, a stroke can result.

Hypertension makes the heart work harder to pump blood through the body. The extra workload can make the heart muscle thicken and stretch. When the heart becomes too enlarged it cannot pump enough blood. If the hypertension is not treated, the heart may fail.

The kidneys remove the body's wastes from the blood. If hypertension thickens the arteries to the kidneys, less waste can be filtered from the blood. As the condition worsens, the kidneys fail and wastes build up in the blood. Dialysis or a kidney transplant are needed when the kidneys fail. About 25% of people who receive **kidney dialysis** have kidney failure caused by hypertension.

Causes and symptoms

Many different actions or situations can normally raise blood pressure. Physical activity can temporarily raise blood pressure. Stressful situations can make blood pressure go up. When the **stress** goes away, blood pressure usually returns to normal. These temporary increases in blood pressure are not considered hypertension. A diagnosis of hypertension is made only when a person has multiple high blood pressure readings over a period of time.

The cause of hypertension is not known in 90 to 95 percent of the people who have it. Hypertension without a known cause is called primary or essential hypertension.

When a person has hypertension caused by another medical condition, it is called secondary hypertension. Secondary hypertension can be caused by a number of different illnesses. Many people with kidney disorders have secondary hypertension. The kidneys regulate the balance of salt and water in the body. If the kidneys cannot rid the body of excess salt and water, blood pressure goes up. Kidney infections, a narrowing of the arteries

that carry blood to the kidneys, called **renal artery stenosis**, and other kidney disorders can disturb the salt and water balance.

Cushing's syndrome and tumors of the pituitary and adrenal glands often increase levels of the adrenal gland hormones cortisol, adrenalin, and aldosterone, which can cause hypertension. Other conditions that can cause hypertension are blood vessel diseases, thyroid gland disorders, some prescribed drugs, **alcoholism,** and **pregnancy**.

Even though the cause of most hypertension is not known, some people have risk factors that give them a greater chance of getting hypertension. Many of these risk factors can be changed to lower the chance of developing hypertension or as part of a treatment program to lower blood pressure.

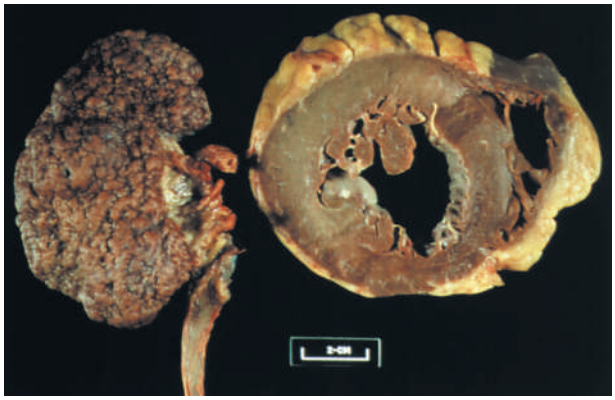
Risk factors for hypertension include:

- age over 60
- male sex
- race
- heredity
- salt sensitivity
- obesity
- inactive lifestyle
- heavy alcohol consumption
- use of **oral contraceptives**

Some risk factors for getting hypertension can be changed, while others cannot. Age, male sex, and race are risk factors that a person can't do anything about. Some people inherit a tendency to get hypertension. People with family members who have hypertension are more likely to develop it than those whose relatives are not hypertensive. A person with these risk factors can avoid or eliminate the other risk factors to lower their chance of developing hypertension.

Diagnosis

Because hypertension doesn't cause symptoms, it is important to have blood pressure checked regularly. Blood pressure is measured with an instrument called a sphygmomanometer. A cloth-covered rubber cuff is wrapped around the upper arm and inflated. When the cuff is inflated, an artery in the arm is squeezed to momentarily stop the flow of blood. Then, the air is let out of the cuff while a stethoscope placed over the artery is used to detect the sound of the blood spurting back through the artery. This first sound is the systolic pressure, the pressure when the heart beats. The last sound heard as the rest of the air is released is the diastolic pressure, the pressure between heart beats. Both sounds are recorded on the mercury gauge on the sphygmomanometer.



The effects of hypertension on the heart and kidney. Hypertension has caused renal atrophy and scarring, and left ventricular hypertrophy in the sectioned heart (at right). *(Photograph by Dr. E. Walker, Photo Researchers, Inc. Reproduced by permission.)*

Normal blood pressure is defined by a range of values. Blood pressure lower than 140/90 mm Hg is considered normal. A blood pressure around 120/80 mm Hg is considered the best level to avoid heart disease. A number of factors such as **pain**, stress or **anxiety** can cause a temporary increase in blood pressure. For this reason, hypertension is not diagnosed on one high blood pressure reading. If a blood pressure reading is 140/90 or higher for the first time, the physician will have the person return for another blood pressure check. Diagnosis of hypertension usually is made based on two or more readings after the first visit.

Systolic hypertension of the elderly is common and is diagnosed when the diastolic pressure is normal or low, but the systolic is elevated, e.g.170/70 mm Hg. This condition usually co-exists with hardening of the arteries (atherosclerosis).

Blood pressure measurements are classified in stages, according to severity:

- normal blood pressure: less than 130/85 mm Hg
- high normal: 130–139/85–89 mm Hg
- mild hypertension: 140–159/90–99 mm Hg
- moderate hypertension: 160–179/100–109 mm Hg
- severe hypertension: 180–209/110–119
- very severe hypertension: 210/120 or higher

A typical **physical examination** to evaluate hypertension includes:

- medical and family history

- physical examination
- ophthalmoscopy: Examination of the blood vessels in the eye
- **chest x ray**
- electrocardiograph (ECG)
- blood and urine tests

The medical and family history help the physician determine if the patient has any conditions or disorders that might contribute to or cause the hypertension. A family history of hypertension might suggest a genetic predisposition for hypertension.

The physical exam may include several blood pressure readings at different times and in different positions. The physician uses a stethoscope to listen to sounds made by the heart and blood flowing through the arteries. The pulse, reflexes, and height and weight are checked and recorded. Internal organs are palpated, or felt, to determine if they are enlarged.

Because hypertension can cause damage to the blood vessels in the eyes, the eyes may be checked with a instrument called an ophthalmoscope. The physician will look for thickening, narrowing, or hemorrhages in the blood vessels.

A chest x ray can detect an enlarged heart, other vascular (heart) abnormalities, or lung disease.

An electrocardiogram (ECG) measures the electrical activity of the heart. It can detect if the heart muscle is enlarged and if there is damage to the heart muscle from blocked arteries.

Urine and blood tests may be done to evaluate health and to detect the presence of disorders that might cause hypertension.

Treatment

There is no cure for primary hypertension, but blood pressure can almost always be lowered with the correct treatment. The goal of treatment is to lower blood pressure to levels that will prevent heart disease and other complications of hypertension. In secondary hypertension, the disease that is responsible for the hypertension is treated in addition to the hypertension itself. Successful treatment of the underlying disorder may cure the secondary hypertension.

Treatment to lower blood pressure usually includes changes in diet, getting regular **exercise**, and taking antihypertensive medications. Patients with mild or moderate hypertension who don't have damage to the heart or kidneys may first be treated with lifestyle changes.

Lifestyle changes that may reduce blood pressure by about 5 to 10 mm Hg include:

- reducing salt intake
- reducing fat intake
- losing weight
- getting regular exercise
- quitting **smoking**
- reducing alcohol consumption
- managing stress

Patients whose blood pressure remains higher than 139/90 will most likely be advised to take antihypertensive medication. Numerous drugs have been developed to treat hypertension. The choice of medication will depend on the stage of hypertension, side effects, other medical conditions the patient may have, and other medicines the patient is taking.

Patients with mild or moderate hypertension are initially treated with monotherapy, a single antihypertensive medicine. If treatment with a single medicine fails to lower blood pressure enough, a different medicine may be tried or another medicine may be added to the first. Patients with more severe hypertension may initially be given a combination of medicines to control their hypertension. Combining antihypertensive medicines with different types of action often controls blood pressure with smaller doses of each drug than would be needed for monotherapy.

Antihypertensive medicines fall into several classes of drugs:

- **diuretics**
- beta-blockers
- **calcium channel blockers**
- angiotensin converting enzyme inhibitors (ACE inhibitors)
- alpha-blockers
- alpha-beta blockers
- **vasodilators**
- peripheral acting adrenergic antagonists
- centrally acting agonists

Diuretics help the kidneys eliminate excess salt and water from the body's tissues and the blood. This helps reduce the swelling caused by fluid buildup in the tissues. The reduction of fluid dilates the walls of arteries and lowers blood pressure.

Beta-blockers lower blood pressure by acting on the nervous system to slow the heart rate and reduce the force of the heart's contraction. They are used with caution in patients with **heart failure**, **asthma**, diabetes, or circulation problems in the hands and feet.

Calcium channel blockers block the entry of calcium into muscle cells in artery walls. Muscle cells need calcium to constrict, so reducing their calcium keeps them more relaxed and lowers blood pressure.

ACE inhibitors block the production of substances that constrict blood vessels. They also help reduce the build-up of water and salt in the tissues. They are often given to patients with heart failure, kidney disease, or diabetes. ACE inhibitors may be used together with diuretics.

Alpha-blockers act on the nervous system to dilate arteries and reduce the force of the heart's contractions.

Alpha-beta blockers combine the actions of alpha and **beta blockers**.

Vasodilators act directly on arteries to relax their walls so blood can move more easily through them. They lower blood pressure rapidly and are injected in hypertensive emergencies when patients have dangerously high blood pressure.

Peripheral acting adrenergic antagonists act on the nervous system to relax arteries and reduce the force of the heart's contractions. They usually are prescribed together with a diuretic. Peripheral acting adrenergic antagonists can cause slowed mental function and lethargy.

Centrally acting agonists also act on the nervous system to relax arteries and slow the heart rate. They are usually used with other antihypertensive medicines.

KEY TERMS

Arteries—Blood vessels that carry blood to organs and other tissues of the body.

Arteriosclerosis—Hardening and thickening of artery walls.

Cushing's syndrome—A disorder in which too much of the adrenal hormone, cortisol, is produced; it may be caused by a pituitary or adrenal gland tumor.

Diastolic blood pressure—Blood pressure when the heart is resting between beats.

Hypertension—High blood pressure.

Renal artery stenosis—Disorder in which the arteries that supply blood to the kidneys constrict.

Sphygmomanometer—An instrument used to measure blood pressure.

Systolic blood pressure—Blood pressure when the heart contracts (beats).

Vasodilator—Any drug that relaxes blood vessel walls.

Ventricle—One of the two lower chambers of the heart.

Prognosis

There is no cure for hypertension. However, it can be well controlled with the proper treatment. Therapy with a combination of lifestyle changes and antihypertensive medicines usually can keep blood pressure at levels that will not cause damage to the heart or other organs. The key to avoiding serious complications of hypertension is to detect and treat it before damage occurs. Because antihypertensive medicines control blood pressure, but do not cure it, patients must continue taking the medications to maintain reduced blood pressure levels and avoid complications.

Prevention

Prevention of hypertension centers on avoiding or eliminating known risk factors. Even persons at risk because of age, race, or sex or those who have an inherited risk can lower their chance of developing hypertension.

The risk of developing hypertension can be reduced by making the same changes recommended for treating hypertension:

- reducing salt intake
- reducing fat intake
- losing weight
- getting regular exercise
- quitting smoking
- reducing alcohol consumption
- managing stress

Resources

BOOKS

Bellenir, Karen, and Peter D. Dresser, eds. *Cardiovascular Diseases and Disorders Sourcebook*. Detroit: Omnigraphics, 1995.

Texas Heart Institute. *Heart Owner's Handbook*. New York: John Wiley and Sons, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Toni Rizzo

Hyperthermia *see* **Fever**

Hyperthyroidism

Definition

Hyperthyroidism is the overproduction of **thyroid hormones** by an overactive thyroid.

Description

Located in the front of the neck, the thyroid gland produces the hormones thyroxine (T_4) and triiodothyronine (T_3) that regulate the body's metabolic rate by helping to form protein ribonucleic acid (RNA) and increasing oxygen absorption in every cell. In turn, the production of these hormones are controlled by thyroid-stimulating hormone (TSH) that is produced by the pituitary gland. When production of the thyroid hormones increases despite the level of TSH being produced, hyperthyroidism occurs. The excessive amount of thyroid hormones in the blood increases the body's metabolism, creating both mental and physical symptoms.

The term hyperthyroidism covers any disease which results in overabundance of thyroid hormone. Other names for hyperthyroidism, or specific diseases within the category, include Graves' disease, diffuse toxic **goiter**, Basedow's disease, Parry's disease, and thyrotoxicosis. The disease is 10 times more common in women than in men, and the annual incidence of hyperthyroidism in the United States is about one per 1,000 women. Although it occurs at all ages, hyperthyroidism is most likely to occur after the age of 15. There is a form of hyperthyroidism called Neonatal Grave's disease, which occurs in infants born of mothers with Graves' disease. Occult hyperthyroidism may occur in patients over 65 and is characterized by a distinct lack of typical symptoms. Diffuse toxic goiter occurs in as many as 80% of patients with hyperthyroidism.

Causes and symptoms

Hyperthyroidism is often associated with the body's production of autoantibodies in the blood which cause the thyroid to grow and secrete excess thyroid hormone. This condition, as well as other forms of hyperthyroidism, may be inherited. Regardless of the cause, hyperthyroidism produces the same symptoms, including weight loss with increased appetite, **shortness of breath** and **fatigue**, intolerance to heat, heart **palpitations**, increased frequency of bowel movements, weak muscles, **tremors**, **anxiety**, and difficulty sleeping. Women may also notice decreased menstrual flow and irregular menstrual cycles.

Patients with Graves' disease often have a goiter (visible enlargement of the thyroid gland), although as many as 10% do not. These patients may also have bulging eyes. Thyroid storm, a serious form of hyperthyroidism, may show up as sudden and acute symptoms, some of which mimic typical hyperthyroidism, as well as the addition of **fever**, substantial weakness, extreme restlessness, confusion, emotional swings or **psychosis**, and perhaps even **coma**.

Diagnosis

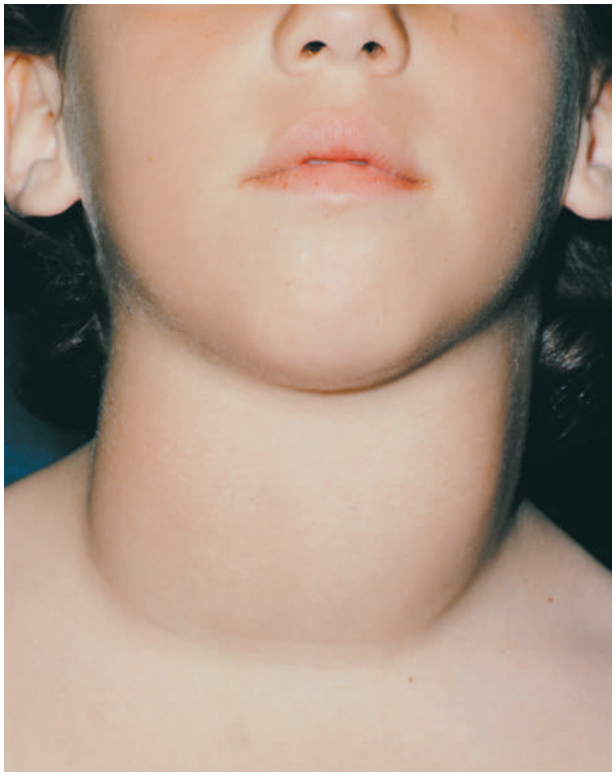
Physicians will look for physical signs and symptoms indicated by patient history. On inspection, the physician may note symptoms such as a goiter or eye bulging. Other symptoms or family history may be clues to a diagnosis of hyperthyroidism. An elevated body temperature (basal body temperature) above 98.6°F (37°C) may be an indication of a heightened metabolic rate (basal metabolic rate) and hyperthyroidism. A simple blood test can be performed to determine the amount of thyroid hormone in the patient's blood. The diagnosis is usually straightforward with this combination of clinical history, **physical examination**, and routine blood hormone tests. Radioimmunoassay, or a test to show concentrations of thyroid hormones with the use of a radioisotope mixed with fluid samples, helps confirm the diagnosis. A thyroid scan is a nuclear medicine procedure involving injection of a radioisotope dye which will tag the thyroid and help produce a clear image of inflammation or involvement of the entire thyroid. Other tests can determine thyroid function and thyroid-stimulating hormone levels. Ultrasonography, **computed tomography scans** (CT scan), and **magnetic resonance imaging** (MRI) may provide visual confirmation of a diagnosis or help to determine the extent of involvement.

Treatment

Treatment will depend on the specific disease and individual circumstances such as age, severity of disease, and other conditions affecting a patient's health.

Antithyroid drugs

Antithyroid drugs are often administered to help the patient's body cease overproduction of thyroid hormones. This medication may work for young adults, pregnant women, and others. Women who are pregnant should be treated with the lowest dose required to maintain thyroid function in order to minimize the risk of **hypothyroidism** in the infant.



A symptom of hyperthyroidism is the enlargement of the thyroid gland. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission.)*

KEY TERMS

Goiter—Chronic enlargement of the thyroid gland.

Gonads—Organs that produce sex cells—the ovaries and testes.

Palpitations—Rapid and forceful heartbeat.

Radioisotope—A chemical tagged with radioactive compounds that is injected during a nuclear medicine procedure to highlight organ or tissue.

Thyroidectomy—Removal of the thyroid gland.

Radioactive iodine

Radioactive iodine is often prescribed to damage cells that make thyroid hormone. The cells need iodine to make the hormone, so they will absorb any iodine found in the body. The patient may take an iodine capsule daily for several weeks, resulting in the eventual shrinkage of the thyroid in size, reduced hormone production and a return to normal blood levels. Some patients may receive a single larger oral dose of radioactive iodine to treat the disease more quickly. This should only be done for patients who are not of reproductive age or are not planning to have children, since a large amount can concentrate in the reproductive organs (gonads).

Surgery

Some patients may undergo surgery to treat hyperthyroidism. Most commonly, patients treated with **thyroidectomy**, in the form of partial or total removal of the thyroid, suffer from large goiter and have suffered relapses, even after repeated attempts to address the disease through drug therapy. Some patients may be candidates for surgery because they were not good candidates for iodine therapy, or refused iodine administration. Patients receiving thyroidectomy or iodine therapy must be carefully monitored for years to watch for signs of hypothyroidism, or insufficient production of thyroid hormones, which can occur as a complication of thyroid production suppression.

Alternative treatment

Consumption of foods such as broccoli, brussel sprouts, cabbage, cauliflower, kale, rutabagas, spinach, turnips, peaches, and pears can help naturally suppress thyroid hormone production. Caffeinated drinks and dairy products should be avoided. Under the supervision of a trained physician, high dosages of certain vitamin/mineral combinations can help alleviate hyperthyroidism.

Prognosis

Hyperthyroidism is generally treatable and carries a good prognosis. Most patients lead normal lives with proper treatment. Thyroid storm, however, can be life-threatening and can lead to heart, liver, or kidney failure.

Prevention

There are no known prevention methods for hyperthyroidism, since its causes are either inherited or not completely understood. The best prevention tactic is knowledge of family history and close attention to symptoms and signs of the disease. Careful attention to prescribed therapy can prevent complications of the disease.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine*. Puyallup, WA: Future Medicine Publishing Inc., 1994.

PERIODICALS

Lazarus, John H. "Hyperthyroidism." *The Lancet* 340 (1 Feb. 1997): 339-342.

ORGANIZATIONS

The Thyroid Foundation of America. 350 Ruth Sleeper Hall - RSL 350, Parkman St., Boston, MA. 02114. (800) 832-8321. <http://www.clark.net/pub/tfa>.

OTHER

"Endocrine Disorder and Endocrine Surgery." *Endocrine Web Page*. <http://www.endocrineweb.com>.

Teresa Norris

Hypertrophic cardiomyopathy

Definition

Cardiomyopathy is an ongoing disease process that damages the muscle wall of the lower chambers of the heart. Hypertrophic cardiomyopathy is a form of cardiomyopathy in which the walls of the heart's chambers thicken abnormally. Other names for hypertrophic cardiomyopathy are idiopathic hypertrophic subaortic stenosis and asymmetrical septal hypertrophy.

Description

Hypertrophic cardiomyopathy usually appears in young people, often in athletes. For this reason it is sometimes called athletic heart muscle disease. However, people of any age can develop hypertrophic cardiomyopathy. Often there are no symptoms of hypertrophic cardiomyopathy. Sudden **death** can occur, caused by a heart arrhythmia. The American Heart Association reports that 36% of young athletes who die suddenly have probable or definite hypertrophic cardiomyopathy.

Hypertrophic cardiomyopathy is the result of abnormal growth of the heart muscle cells. The wall between the heart's chambers (the septum) may become so thickened that it blocks the flow of blood through the lower left chamber (left ventricle). The thickened wall may push on the heart valve between the two left heart chambers (mitral valve), making it leaky. The thickened muscle walls also prevent the heart from stretching as much as it should to fill with blood.

Causes and symptoms

The cause of hypertrophic cardiomyopathy is not known. In about one-half of cases, the disease is inherited. An abnormal gene has been identified in these patients. In cases that are not hereditary, a gene that was normal at birth may later become abnormal.

Often people with hypertrophic cardiomyopathy have no symptoms. Unfortunately, the first sign of the condition may be sudden death caused by an abnormal heart rhythm. When symptoms do appear, they include **shortness of breath** on exertion, **dizziness**, **fainting**, **fatigue**, and chest **pain**.

Diagnosis

The diagnosis is based on the patient's symptoms (if any), a complete **physical examination**, and tests that detect abnormalities of the heart chambers. Usually, there is an abnormal heart murmur that worsens with the **Valsalva maneuver**. The electrocardiogram (ECG), which provides a record of electrical changes in the heart muscle during the heartbeat, also is typically abnormal.

Sometimes, a routine **chest x ray** may show that the heart is enlarged. **Echocardiography**, a procedure that produces images of the heart's structure, is usually done. These images can show if the heart wall is thickened and if there are any abnormalities of the heart valves.

Treatment

Treatment of hypertrophic cardiomyopathy usually consists of taking medicines and restricting strenuous **exercise**. Drugs called **beta blockers** and **calcium channel blockers** are usually prescribed. Beta blockers reduce the force of the heart's contractions. Calcium channel blockers can help improve the flexibility of the heart muscle walls, allowing them to stretch more. **Antiarrhythmic drugs** may also be given to prevent abnormal heart rhythms.

Patients with hypertrophic cardiomyopathy are also told to avoid strenuous exercise to reduce the risk of passing out or sudden death.

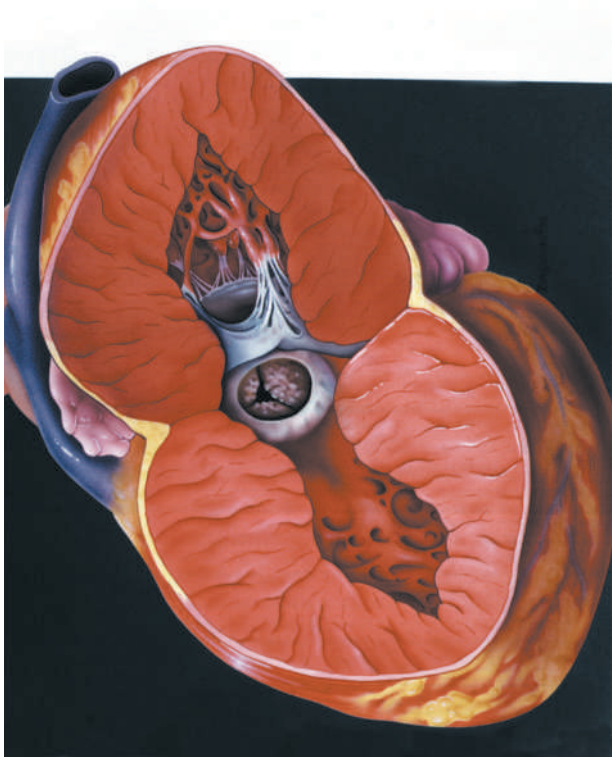
In some cases, if the medications do not help relieve symptoms, surgery may help. In an operation called myotomy-myectomy a piece of the septum is removed to improve blood flow through the heart chamber.

Some patients have **pacemakers** and/or defibrillators implanted to help control the heart rate and rhythm. Pacemakers and defibrillators provide electrical impulses to the heart, which can return the heart beat to a normal rhythm.

If these treatment methods fail and a patient develops **heart failure**, a heart transplant may be necessary.

Prognosis

Some people with hypertrophic cardiomyopathy may not have obstructed blood flow and may never expe-



This illustration shows hypertrophic muscle in the heart. The abnormally thick wall of muscle prevents the chambers from stretching to fill up with blood, making the heart less efficient. The extra tissue may also push on the heart valve (center), causing it to leak. *(Illustration by Bryson Biomedical Illustrations, Custom Medical Stock Photo. Reproduced by permission.)*

rience symptoms. Others may only experience mild symptoms. With treatment, symptoms may improve. In some patients, the disease may progress to heart failure.

Prevention

While hypertrophic cardiomyopathy cannot be prevented, precautionary measures may prevent sudden deaths. Anyone planning to take part in a program of strenuous competitive exercise should have a checkup by a physician first. A physical examination before athletic participation can usually, but not always, detect conditions like hypertrophic cardiomyopathy. Anyone who experiences symptoms of shortness of breath, tiredness, or fainting with exercise should see a physician.

Resources

BOOKS

Bellenir, Karen, and Peter D. Dresser, eds. *Cardiovascular Diseases and Disorders Sourcebook.* Detroit: Omnigraphics, 1995.

Texas Heart Institute. *Heart Owner's Handbook*. New York: John Wiley and Sons, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Toni Rizzo

KEY TERMS

Arrhythmias—Abnormal heartbeat.

Calcium channel blocker—A drug that relaxes blood vessels and lowers blood pressure.

Mitral valve—The heart valve that controls blood flow between the heart's left upper chamber (atrium) and left lower chamber (ventricle).

Septum—The muscular wall dividing the left and right heart chambers.

Ventricles—The two lower chambers of the heart.

Hypervitaminosis *see* **Vitamin toxicity**

Hyphema

Definition

A hyphema is an accumulation of blood in the front (anterior) chamber of the eye. It is usually caused by blunt eye trauma.

Description

The anterior chamber (AC) is located behind the front of the eye. The AC is filled with a fluid called aqueous humor. This fluid helps form a cushion for the eye and provides an important route for nutrient and waste transport. Contusive forces from high velocity projectiles (approximately 34% of emergency room cases) such as a rock, crab apples, ice balls, badminton birds, and bungee cords can tear local blood vessels in the eye. Blunt impact from a basketball or racketball accounts for about 62% of cases. Tearing a small blood vessel can cause

KEY TERMS

Microhyphema—Small bleed in the anterior chamber of the eye.

Ophthalmologist—A physician with specialized training in the medical and surgical treatment of eye diseases.

Optic Nerve—A cranial nerve that carries visual impulses to the brain for processing

seepage of blood into a visible layer portion of the AC, causing the affected person to have red eye.

Causes and symptoms

Hyphema is caused by blunt, projectile, or explosion (about 4% of cases) injuries. These injuries cause a local blood vessel in the eye to tear, filling the front portion of the AC with blood. The initial complaint is a dramatic decrease in vision that eventually gets better as blood seeps towards the back of the eye. Patients will have extreme **pain**, an increase in intraocular pressure (the pressure inside the eye), and nausea. Patients usually will show a red eye and a recent history of trauma. Patients are vulnerable to more bleeding three to five days post injury.

Diagnosis

All persons with hyphema must be examined by an ophthalmologist (a physician who specializes in the medical and surgical care of the eye). Usually the clinician will use an ophthalmoscope to visualize the internal structures and damage. In some cases there may be small microscopic bleeds that may form clots (microhyphema) and require specialized instrumentation (a slit lamp) for visualization.

Treatment

Bloodthinners, such as **aspirin** and nonsteroidal anti-inflammatory drugs, should be avoided. In most cases the affected person can be medically managed on an outpatient basis. The eye should be shielded, but not patched. The patient should be placed at bed rest with the head elevated 45°. This position allows blood to leave the AC allowing for better vision. Several studies suggest administering medications (aminocaproic acid) that stabilize clot formation, reducing the possibility of increased bleeding.

Prognosis

The outcome depends on the severity of the trauma. Most cases progress well with conservative treatment. Some cases may develop an increase in the pressure within the eye (**glaucoma**). If this develops the hyphema must be surgically removed by an ophthalmologist. In patients who have a preexisting blood disorder, surgical evacuation should be considered to prevent damage to the optic nerve (the nerve that transmits impulses for processing in the brain).

Prevention

The American Academy of Ophthalmology recommends special eyewear made of polycarbonate lenses when at risk of eye injury. This type of lens has sufficient impact resistance.

Resources

BOOKS

Behrman, Richard E., et al, eds. *Nelson Textbook of Pediatrics.* 16th ed. W. B. Saunders Company, 2000.

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Year Book, Inc., 1998.

Yanoff, Myron, et al, eds. *Ophthalmology.* Mosby International Ltd., 1999.

ORGANIZATION

American Academy of Ophthalmology. 2001. <http://www.aao.org>.

Laith Farid Gulli, M.D.

Hypnosis *see* **Hypnotherapy**

Hypnotherapy

Definition

Hypnotherapy is the treatment of a variety of health conditions by hypnotism or by inducing prolonged sleep.

Pioneers in this field, such as James Braid and James Esdaile discovered that hypnosis could be used to successfully anesthetize patients for surgeries. James Braid accidentally discovered that one of his patients began to enter a hypnotic state while staring at a fixed light as he waited for his **eye examination** to begin. Since mesmerism had fallen out of favor, Braid coined the term hypnotism, which is derived from the Greek word for sleep. Braid also used the techniques of monotony, rhythm, and imitation to assist in inducing a hypnotic state. As of 2000, these techniques are still in use.

Around 1900, there were very few preoperative anesthetic drugs available. Patients were naturally appre-

hensive when facing surgery. One out of four hundred patients would die, not from the surgical procedure, but from the anesthesia. Dr. Henry Munro was one of the first physicians to use hypnotherapy to alleviate patient fears about having surgery. He would get his patients into a hypnotic state and discuss their fears with them, telling them they would feel a lot better following surgery. Ether was the most common anesthetic at that time, and Dr. Munro found that he was able to perform surgery using only about 10% of the usual amount of ether.

Purpose

Hypnotherapy is used in a number of fields including psychotherapy, surgery, dentistry, research, and medicine. Hypnotherapy is commonly used as an alternative treatment for a wide range of health conditions, including weight control, **pain management**, and **smoking** cessation. It is also used to control **pain** in a variety of conditions such as **headache**, facial **neuralgia**, arthritis, **burns**, musculoskeletal disorders, **childbirth**, and many more. Hypnotherapy is being used in place of anesthesia, particularly in patients who prove to be allergic to anesthetic drugs, for surgeries such as hysterectomies, cesarean sections, certain cardiovascular procedures, **thyroidectomy**, and others. Dentistry is using hypnotherapy with success on patients who are allergic to all types of novocaine drugs. Hypnotherapy is also useful in helping patients overcome **phobias**.

Hypnotherapy is used for nonmedical patients as well as those who wish to overcome bad habits. Hypnotherapy has been shown to help those who suffer from performance **anxiety**, such as in sports, and speaking in public. In academic applications, it has also been shown to help with learning, participating in the classroom, concentrating, studying, focusing attention span, improving memory, and helping remove mental blocks about particular subjects.

In more general areas, hypnotherapy has been found to be beneficial for problems such as motivation, procrastination, decision making, personal achievement and development, job performance, buried or repressed memories, relaxation, and **stress** management.

Description

Origins

Hypnotherapy is thought to date back to the healing practices of ancient Greece and Egypt. Many religions such as Judaism, Christianity, Islam, and others have attributed trance-like behavior to spiritual or divine possession.

Austrian physician, Franz Mesmer (1734–1815), is credited with being the first person to scientifically investigate the idea of hypnotherapy, in 1779, to treat a variety of health conditions. Mesmer studied medicine at the University of Vienna and received his medical degree in 1766. Mesmer is believed to have been the first doctor to understand the relationship of psychological trauma to illness. He induced a trance-like state, which became known as mesmerism, in his patients to successfully treat nervous disorders. These techniques became the foundation for modern-day hypnotherapy.

Mesmer's original interest was in the effect of celestial bodies on human lives. He later became interested in the effects of magnetism, and found that magnets could have tremendous healing effects on the human body. Mesmer believed that the human body contained a magnetic fluid that promoted health and well being. It was thought that any blockage to the normal flow of this magnetic fluid would result in illness, and that the use of the mesmerism technique could restore the normal flow.

Mesmer performed his technique by passing his hands up and down the patient's body. The technique was supposed to transmit magnetic fluid from his hands to the bodies of his patients. During this time period, there was no clear delineation between health conditions that were physical or psychological in nature. Although Mesmer did not realize it at that time, his treatments were most effective for those conditions that were primarily psychosomatic.

Mesmer's technique appeared to be quite successful in the treatment of his patients, but he was the subject of scorn and ridicule from the medical profession. Because of all the controversy surrounding mesmerism, and because Mesmer's personality was quite eccentric, a commission was convened to investigate his techniques and procedures. A very distinguished panel of investigators included Benjamin Franklin, the French chemist Antoine-Laurent Lavoisier, and physician Jacques Guillotin. The commission acknowledged that patients did seem to obtain noticeable relief from their conditions, but the whole idea was dismissed as being medical quackery.

It took more than two hundred years for hypnotherapy to become incorporated into medical treatment. In 1955, the British Medical Association approved the use of hypnotherapy as a valid medical treatment, with the American Medical Association (AMA) giving its approval in 1958.

Hypnotherapy involves achieving a psychological state of awareness that is different from the ordinary state of consciousness. While in a hypnotic state, a variety of phenomena can occur. These phenomena include alterations in memory, heightened susceptibility to suggestion, **paralysis**, sweating, and blushing. All of these changes can be produced or removed in the hypnotic

state. Many studies have shown that roughly 90% of the population is capable of being hypnotized.

This state of awareness can be achieved by relaxing the body, focusing on breathing, and shifting attention away from the external environment. In this state, the patient has a heightened receptivity to suggestion. The usual procedure for inducing a hypnotic trance in another person is by direct command repeated in a soothing, monotonous tone of voice.

Preparations

Ideally, the following conditions should be present to successfully achieve a state of hypnosis:

- willingness to be hypnotized
- rapport between the patient or client and the hypnotherapist
- a comfortable environment that is conducive to relaxation

Precautions

Hypnotherapy can have negative outcomes. When used as entertainment, people have been hypnotized to say or do things that would normally embarrass them. There have been instances where people already dangerously close to psychological breakdown have been pushed into an emotional crisis during what was supposed to be a harmless demonstration of hypnosis. A statement from the World Hypnosis Organization (WHO) warns against performing hypnosis on patients suffering from **psychosis**, organic psychiatric conditions, or antisocial **personality disorders**. Because there are no standard licensing requirements, in the wrong hands, there is a risk that the hypnotist will have difficulty in controlling or ending a hypnotic state that has been induced in the patient.

There is a commonly held belief that a person cannot be coerced into doing things that they would not normally do while under hypnosis. The hynotherapist should take care however, not to give suggestions during hypnosis that are contrary to the patient's moral code.

Many religions do not condone the practice of hypnotherapy. Leaders of the Jehovah's Witnesses and Christian Science religions oppose the use of hypnotherapy and advise their members to avoid it completely, whether for entertainment or therapy. The Church of Jesus Christ of Latter-Day Saints approves it for medical purposes, but cautions members against allowing themselves to be hypnotized for entertainment or demonstration purposes.

In 1985, The AMA convened a commission that warned against using hypnotherapy to aid in recollection of events. The commission cited studies that showed the possibility of hypnotic recall resulting on confabulation or an artificial sense of certainty about the course of events. As a result, many states limit or prohibit testimony of hypnotized witnesses or victims.

Side effects

Experiments have been conducted to determine any side effects of hypnotherapy. Some subjects have reported side effects such as headache, stiff neck, drowsiness, cognitive distortion or confusion, **dizziness**, and anxiety. However, most of these effects cleared up within several hours of the hypnotherapy session.

Research and general acceptance

Research on the effectiveness of hypnotherapy on a variety of medical conditions is extensive. In one study, the use of hypnotherapy did not seem to alter the core symptoms in the treatment of attention-deficit hyperactivity disorder (**ADHD**); however, it did seem to be useful in managing the associated symptoms including sleep disturbances and tics.

Hypnotherapy is being studied in children who have common, chronic problems and to aid in relieving pain. Children are particularly good candidates for hypnotherapy because their lack of worldly experience enables them to move easily between the rational world and their imagination. Studies with children have shown responses to hypnotherapy ranging from diminished pain and anxiety during a number of medical procedures, a 50% range in reduction of symptoms or a complete resolution of a medical condition, and a reduction in use of anti-nausea medication and vomiting during **chemotherapy** for childhood cancers.

The use of hypnotherapy with **cancer** patients is another area being investigated. A meta-analysis of 116 studies showed very positive results of using hypnotherapy with cancer patients. Ninety-two percent showed a positive effect on depression; 93% showed a positive effect on physical well-being; 81% showed a positive effect on vomiting; and 92% showed a positive effect on pain.

Resources

BOOKS

Elman, Dave. *Hypnotherapy.* California: Westwood Publishing Co., 1964.

Kappas, John G. *Professional Hypnotism Manual: Introducing Physical and Emotional Suggestibility and Sexuality.* California: Panorama Publishing Company, 1987.

Murphy, Michael. *The Future of the Body: Explorations Into the Further Evolution of Human Nature*. California: Jeremy P. Tarcher, Inc., 1992.

Shrader, Wesley. *The Amazing Power of Hypnosis: What It Can Do for You*. New York: Doubleday & Company, Inc., 1976.
Targ, Russell and Jane Katra. *Miracles of Mind: Exploring Nonlocal Consciousness and Spiritual Healing*. California: New World Library, 1998.

PERIODICALS

Baumgaertel, Anna. "Attention-Deficit/Hyperactivity Disorder: Alternative and Controversial Treatments for Attention-Deficit/Hyperactivity Disorder." *Pediatric Clinics of North America* (October 1999).
Devine, E.C., and S.K. Westlake. "The effects of psychoeducational care provided to adults with cancer: meta-analysis of 116 studies." *Oncology Nursing Forum* (1995).
Margolis, Clorinda G. "Hypnotic Trance: The Old and the New." *Primary Care Clinics in Office Practice*.
Newell, Sallie and Rob W. Sanson-Fisher. "Australian on Bologists' self-reported knowledge and attitudes about non-traditional therapies used by cancer patients." *Medical Journal of Australia* (February 7, 2000).

ORGANIZATIONS

American Board of Hypnotherapy. 16842 Von Karman Avenue, Suite 476, Irvine, CA 92714. <http://www.hypnosis.com/.
American Psychotherapy & Medical Hypnosis Association. 210 S. Sierra, Reno, NV 89501. <http://members.xoom.com/Hypnosis/>.
American Society of Clinical Hypnosis. 200 E. Devon Avenue, Des Plaines, IL 60018.
International Council for Medical and Clinical Therapists. 7361 McWhorter Place, Suite 300, Annandale, VA 22003-5469. <http://www.ultradepth.com/ICMCT.htm>.
International Medical and Dental Hypnotherapy Association. 4110 Edgeland, Suite 800, Royal Oak, MI 48073-2285. <http://www.infinityinst.com>.
The National Board for Hypnotherapy and Hypnotic Anaesthesiology. 7841 West Ludlow Drive, Suite A, Peoria, AZ 85381. <http://www.nbha-medicine.com/index.html>.
National Guild of Hypnotists. PO Box 308, Merrimack, NH. <http://www.ngh.net>.
Society for Clinical and Experimental Hypnosis. 6728 Old McLean Village Drive, McLean, VA 22101.
World Hypnosis Organization, Inc. 2521 W. Montrose Avenue, Chicago, IL 60618. <http://www.worldhypnosis.org/about.html>.

Kim Sharp

Hypocalcemia

Definition

Hypocalcemia, a low bood calcium level, occurs when the concentration of free calcium ions in the blood falls below 4.0 mg/dL (dL=one tenth of a liter). The normal concentration of free calcium ions in the blood serum is 4.0–6.0 mg/dL.

Description

Calcium is an important mineral for maintaining human helath. It is not only a component of bones and teeth, but is also essential for normal blood clotting and necessary for normal muscle and nerve functions. The calcium ion (Ca^{2+}) has two positive charges. In bone, calcium ions occur as a complex with phosphate to form crystals of calcium phosphate. In the bloodstream, calcium ions also occur in complexes, and here calcium is found combined with proteins and various nutrients. However, in the bloodstream, calcium also occurs in a free form. Normally, about 47% of the calcium in the blood plasma is free, while 53% occurs in a complexed form. Although all of the calcium in the bloodstream serves a useful purpose, it is only the concentration of free calcium ions which has a direct influence on the functioning of our nerves and muscles. For this reason, the measurement of the concentration of free calcium is more important, in the diagnosis of disease, than measuring the level of total calcium or of complexed calcium. The level of total calcium in the blood serum is normally 8.5–10.5 mg/dL, while the level of free calcium is normally 4–5 mg/dl.

Causes and symptoms

Hypocalcemia can be caused by **hypoparathyroidism**, by failure to produce 1,25-dihydroxyvitamin D, by low levels of plasma magnesium, or by failure to get adequate amounts of calcium or vitamin D in the diet. Hypoparathyroidism involves the failure of the parathyroid gland to make parathyroid hormone. Parathyroid hormone controls and maintains plasma calcium levels. The hormone exerts its effect on the kidneys, where it triggers the synthesis of 1,25-dihydroxyvitamin D. Thus, hypocalcemia can be independently caused by damage to the parathyroid gland or to the kidneys. 1,25-Dihydroxyvitamin D stimulates the uptake of calcium from the diet and the mobilization of calcium from the bone. Bone mobilization means the natural process by which the body dissolves part of the bone in the skeleton in order to maintain or raise the levels of plasma calcium ions.

Low plasma magnesium levels (hypomagnesia) can result in hypocalcemia. Hypomagnesemia can occur with **alcoholism** or with diseases characterized by an inability to properly absorb fat. Magnesium is required for parathyroid hormone to play its part in maintaining plasma calcium levels. For this reason, any disease that results in lowered plasma magnesium levels may also cause hypocalcemia.

Hypocalcimia may also result from the consumption of toxic levels of phosphate. Phosphate is a constituent of certain enema formulas. An enema is a solution that is used to cleanse the intestines via a hose inserted into the

KEY TERMS

Plasma—Plasma is blood with the cells removed.

Serum—Serum is blood plasma with the blood clotting proteins removed.

rectum. Cases of hypocalcemia have been documented where people swallowed enema formulas, or where an enema has been administered to an infant.

Symptoms of severe hypocalcemia include numbness or tingling around the mouth or in the feet and hands, as well as in muscle spasms in the face, feet, and hands. Hypocalcemia can also result in depression, memory loss, or **hallucinations**. Severe hypocalcemia occurs when serum free calcium is under 3 mg/dL. Chronic and moderate hypocalcemia can result in **cataracts** (damage to the eyes). In this case, the term "chronic" means lasting one year or longer.

Diagnosis

Hypocalcemia is diagnosed by acquiring a sample of blood serum and measuring the concentraton of free calcium using a calcium-sensitive electrode. Hypocalcemia has several causes, and hence a full diagnosis requires assessment of health of the parathyroid gland, kidneys, and of plasma magnesium concentration.

Treatment

The method chosen for treatment depends on the exact cause and on the severity of the hypocalcemia. Severe hypocalcemia requires injection of calcium ions, usually in the form of calcium gluconate. Oral calcium supplements are prescribed for long term treatment (non-emergency) of hypocalcemia. The oral supplements may take the form of calcium carbonate, calcium chloride, calcium lactate, or calcium gluconate. Where hypocalcemia results from kidney failure, treatment includes injections of 1,25-dihydroxyvitamin D. Oral vitamin D supplements can increase gastrointestinal absorption of calcium. Where hypocalcemia results from hypoparathyroidism, treatment may include oral calcium, 1,25-dihydroxyvitamin D, or other drugs. Where low serum magnesium levels occur, concurrently with hypocalcemia, the magnesium deficiency must be corrected to effectively treat the hypocalcemia.

Prognosis

The prognosis for correcting hypocalcemia is excellent. However, the eye damage that may result from chronic hypocalcemia cannot be reversed.

Prevention

The first, and most obvious, way to help prevent hypocalcemia is to ensure that adequate amounts of calcium and vitamin D are consumed each day, either in the diet or as supplements. The hypocalcemia that may occur with damage to the parathyroid gland or to the kidneys cannot be prevented. Hypocalcemia resulting from overuse of **enemas** can be prevented by reducing enema usage. Hypocalcemia resulting from magnesium deficiency tends to occur in chronic alcoholics, and this type of hypocalcemia can be prevented by reducing alcohol consumption and increasing the intake of healthful food.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Zeman, F., and D. M. Dey. *Applications in Medical Nutrition Therapy.* 2nd ed. Engelwood Cliffs, NJ: Prentice-Hall, 1995.

PERIODICALS

Sutters, M., C. L. Gaboury, and W. M. Bennett. "Severe Hyperphosphatemia and Hypocalcemia: A Dilemma in Patient Management." *Journal of the American Society of Nephrology* 7 (1996): 2056-2061.

Tom Brody, PhD

Hypochondriac *see* **Hypochondriasis**

Hypochondriasis

Definition

Hypochondriasis is a mental disorder characterized by excessive fear of or preoccupation with a serious illness, despite medical testing and reassurance to the contrary. It was formerly called hypochondriacal neurosis.

Description

Although hypochondriasis is often considered a disorder that primarily affects adults, it is now increasingly recognized in children and adolescents. In addition, hypochondriasis may develop in elderly people without previous histories of health-related fears. The disorder accounts for about 5% of psychiatric patients and is equally common in men and women.

Causes and symptoms

The causes of hypochondriasis are not precisely known. Children may have physical symptoms that

resemble or mimic those of other family members. In adults, hypochondriasis may sometimes reflect a self-centered character structure or a wish to be taken care of by others; it may also have been copied from a parent's behavior. In elderly people, hypochondriasis may be associated with depression or grief. It may also involve biologically based hypersensitivity to internal stimuli.

Most hypochondriacs are worried about being physically sick, although some express fear of insanity. The symptoms reported can range from general descriptions of a specific illness to unusual complaints. In many instances the symptoms reflect intensified awareness of ordinary body functions, such as heartbeat, breathing, or stomach noises. It is important to understand that a hypochondriac's symptoms are not "in the head" in the sense of being delusional. The symptoms are real, but the patient misinterprets bodily functions and attributes them to a serious or even lethal cause.

Diagnosis

The diagnosis is often complicated by the patient's detailed understanding of symptoms and medical terminology from previous contacts with doctors. If a new doctor suspects hypochondriasis, he or she will usually order a complete medical workup in order to rule out physical disease.

Psychological evaluation is also necessary to rule out other disorders that involve feelings of **anxiety** or complaints of physical illness. These disorders include depression, **panic disorder**, and **schizophrenia** with somatic (physical) **delusions**. The following features are characteristic of hypochondriasis:

- The patient is not psychotic (out of touch with reality or hallucinating).
- The patient gets upset or blames the doctor when told there is "nothing wrong," or that there is a psychological basis for the problem.
- There is a correlation between episodes of hypochondriacal behavior and stressful periods in the patient's life.
- The behavior has lasted at least six months.

Evaluation of children and adolescents with hypochondriasis should include the possibility of **abuse** by family members.

Treatment

The goal of therapy is to help the patient (and family) live with the symptoms and to modify thinking and behavior that reinforces hypochondriacal symptoms. This treatment orientation is called supportive, as distinct from insight-oriented, because hypochondriacs usually resist psychological interpretations of their symptoms. Supportive treatment may include medications to relieve anxiety. Some clinicians look carefully for "masked" depression and treat with antidepressants.

Follow-up care includes regular physical checkups, because about 30% of patients with hypochondriasis will eventually develop a serious physical illness. The physician also tries to prevent unnecessary medical testing and "doctor shopping" on the patient's part.

KEY TERMS

Somatoform disorder—A category of psychiatric disorder characterized by conversion of emotional distress into physical symptoms or by symptoms of physical illness that have no discernible organic cause. Hypochondriasis is classified as a somatoform disorder.

Supportive therapy—Any form of treatment intended to relieve symptoms or help the patient live with them rather than attempt changes in character structure.

Prognosis

From 33–50% of patients with hypochondriasis can expect significant improvement from the current methods of treatment.

Resources

BOOKS

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics & Psychiatric Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Kennedy, Gary J., and Pamela Silverman. "Geriatric Psychiatry." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Nemiah, John C. "Psychoneurotic Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

"Psychiatric Disorders: The Neuroses." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Stone, Timothy E., and Romaine Hain. "Somatoform Disorders." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Rebecca J. Frey

Hypoesthesias *see* **Numbness and tingling**

Hypoglycemia

Definition

The condition called hypoglycemia is literally translated as low blood sugar. Hypoglycemia occurs when blood sugar (or blood glucose) concentrations fall below a level necessary to properly support the body's need for energy and stability throughout its cells.

Description

Carbohydrates are the main dietary source of the glucose that is manufactured in the liver and absorbed into the bloodstream to fuel the body's cells and organs. Glucose concentration is controlled by hormones, primarily insulin and glucagon. Glucose concentration is also controlled by epinephrine (adrenalin) and norepinephrine, as well as growth hormone. If these regulators are not working properly, levels of blood sugar can become either excessive (as in hyperglycemia) or inadequate (as in hypoglycemia). If a person has a blood sugar level of 50 mg/dl or less, he or she is considered hypoglycemic, although glucose levels vary widely from one person to another.

Hypoglycemia can occur in several ways.

Drug-induced hypoglycemia

Drug-induced hypoglycemia, a complication of diabetes, is the most commonly seen and most dangerous form of hypoglycemia.

Hypoglycemia occurs most often in diabetics who must inject insulin periodically to lower their blood sugar. While other diabetics are also vulnerable to low blood sugar episodes, they have a lower risk of a serious outcome than do insulin-dependant diabetics. Unless recognized and treated immediately, severe hypoglycemia in the insulin-dependent diabetic can lead to generalized convulsions followed by **amnesia** and unconsciousness. **Death**, though rare, is a possible outcome.

In insulin-dependent diabetics, hypoglycemia known as an insulin reaction or insulin **shock** can be caused by several factors. These include overmedicating with manufactured insulin, missing or delaying a meal, eating too little food for the amount of insulin taken, exercising too strenuously, drinking too much alcohol, or any combination of these factors.

Ideopathic or reactive hypoglycemia

Ideopathic or reactive hypoglycemia (also called postprandial hypoglycemia) occurs when some people eat. A number of reasons for this reaction have been proposed, but no single cause has been identified.

In some cases, this form of hypoglycemia appears to be associated with malfunctions or diseases of the liver, pituitary, adrenals, liver, or pancreas. These conditions are unrelated to diabetes. Children intolerant of a natural sugar (fructose) or who have inherited defects that affect digestion may also experience hypoglycemic attacks. Some children with a negative reaction to **aspirin** also experience reactive hypoglycemia. It sometimes occurs among people with an intolerance to the sugar found in milk (galactose), and it also often begins before diabetes strikes later on.

Fasting hypoglycemia

Fasting hypoglycemia sometimes occurs after long periods without food, but it also happens occasionally following strenuous **exercise**, such as running in a marathon.

Other factors sometimes associated with hypoglycemia include:

- pregnancy
- a weakened immune system
- a poor diet high in simple carbohydrates
- prolonged use of drugs, including antibiotics
- chronic physical or mental **stress**
- heartbeat irregularities (arrhythmias)
- **allergies**
- breast **cancer**
- high blood pressure treated with beta-blocker medications (after strenuous exercise)
- upper gastrointestinal tract surgery

Causes and symptoms

When carbohydrates are eaten, they are converted to glucose that goes into the bloodstream and is distributed throughout the body. Simultaneously, a combination of chemicals that regulate how our body's cells absorb that sugar is released from the liver, pancreas, and adrenal glands. These chemical regulators include insulin, glucagon, epinephrine (adrenalin), and norepinephrine. The mixture of these regulators released following digestion of carbohydrates is never the same, since the amount of carbohydrates that are eaten is never the same.

Interactions among the regulators are complicated. Any abnormalities in the effectiveness of any one of the regulators can reduce or increase the body's absorption of glucose. Gastrointestinal enzymes such as amylase and lactase that break down carbohydrates may not be functioning properly. These abnormalities may produce hyperglycemia or hypoglycemia, and can be detected when the level of glucose in the blood is measured.

Cell sensitivity to these regulators can be changed in many ways. Over time, a person's stress level, exercise patterns, advancing age, and dietary habits influence cellular sensitivity. For example, a diet consistently overly rich in carbohydrates increases insulin requirements over time. Eventually, cells can become less receptive to the effects of the regulating chemicals, which can lead to glucose intolerance.

Diet is both a major factor in producing hypoglycemia as well as the primary method for controlling it. **Diets** typical of western cultures contain excess carbohydrates, especially in the form of simple carbohydrates such as sweeteners, which are more easily converted to sugar. In poorer parts of the world, the typical diet contains even higher levels of carbohydrates. Fewer dairy products and meats are eaten, and grains, vegetables, and fruits are consumed. This dietary trend is balanced, however, since people in these cultures eat smaller meals and usually use carbohydrates more efficiently through physical labor.

Early symptoms of severe hypoglycemia, particularly in the drug-induced type of hypoglycemia, resemble an extreme shock reaction. Symptoms include:

- cold and pale skin
- numbness around the mouth
- apprehension
- heart **palpitations**
- emotional outbursts
- hand tremors
- mental cloudiness
- dilated pupils
- sweating
- fainting

Mild attacks, however, are more common in reactive hypoglycemia and are characterized by extreme tiredness. Patients first lose their alertness, then their muscle strength and coordination. Thinking grows fuzzy, and finally the patient becomes so tired that he or she becomes "zombie-like," awake but not functioning. Sometimes the patient will actually fall asleep. Unplanned naps are typical of the chronic hypoglycemic patient, particularly following meals.

Additional symptoms of reactive hypoglycemia include headaches, double vision, staggering or inability to walk, a craving for salt and/or sweets, abdominal distress, premenstrual tension, chronic colitis, allergies, ringing in the ears, unusual patterns in the frequency of urination, skin eruptions and inflammations, **pain** in the neck and shoulder muscles, memory problems, and sudden and excessive sweating.

Unfortunately, a number of these symptoms mimic those of other conditions. For example, the depression, **insomnia**, irritability, lack of concentration, crying spells, **phobias**, forgetfulness, confusion, unsocial behavior, and suicidal tendencies commonly seen in nervous system and psychiatric disorders may also be hypoglycemic symptoms. It is very important that anyone with symptoms that may suggest reactive hypoglycemia see a doctor.

Because all of its possible symptoms are not likely to be seen in any one person at a specific time, diagnosing hypoglycemia can be difficult. One or more of its many symptoms may be due to another illness. Symptoms may persist in a variety of forms for long periods of time. Symptoms can also change over time within the same person. Some of the factors that can influence symptoms include physical or mental activities, physical or mental state, the amount of time passed since the last meal, the amount and quality of sleep, and exercise patterns.

Diagnosis

Drug-induced hypoglycemia

Once diabetes is diagnosed, the patient then monitors his or her blood sugar level with a portable machine called a glucometer. The diabetic places a small blood sample on a test strip that the machine can read. If the test reveals that the blood sugar level is too low, the diabetic can make a correction by eating or drinking an additional carbohydrate.

Reactive hypoglycemia

Reactive hypoglycemia can only be diagnosed by a doctor. Symptoms usually improve after the patient has gone on an appropriate diet. Reactive hypoglycemia was diagnosed more frequently 10–20 years ago than today. Studies have shown that most people suffering from its symptoms test normal for blood sugar, leading many doctors to suggest that actual cases of reactive hypoglycemia are quite rare. Some doctors think that people with hypoglycemic symptoms may be particularly sensitive to the body's normal postmeal release of the hormone epinephrine, or are actually suffering from some other physical or mental problem. Others doctors believe reactive hypoglycemia is actually the early onset of diabetes that occurs

KEY TERMS

Adrenal glands—Two organs that sit atop the kidneys; these glands make and release hormones such as epinephrine.

Epinephrine—Also called adrenalin, a secretion of the adrenal glands (along with norepinephrine) that helps the liver release glucose and limits the release of insulin. Norepinephrine is both a hormone and a neurotransmitter, a substance that transmits nerve signals.

Fructose—A type of natural sugar found in many fruits, vegetables, and in honey.

Glucagon—A hormone produced in the pancreas that raises the level of glucose in the blood. An injectable form of glucagon, which can be bought in a drug store, is sometimes used to treat insulin shock.

Postprandial—After eating or after a meal.

after a number of years. There continues to be disagreement about the cause of reactive hypoglycemia.

A common test to diagnose hypoglycemia is the extended oral glucose tolerance test. Following an overnight fast, a concentrated solution of glucose is drunk and blood samples are taken hourly for five to six hours. Though this test remains helpful in early identification of diabetes, its use in diagnosing chronic reactive hypoglycemia has lost favor because it can trigger hypoglycemic symptoms in people with otherwise normal glucose readings. Some doctors now recommend that blood sugar be tested at the actual time a person experiences hypoglycemic symptoms.

Treatment

Treatment of the immediate symptoms of hypoglycemia can include eating sugar. For example, a patient can eat a piece of candy, drink milk, or drink fruit juice. Glucose tablets can be used by patients, especially those who are diabetic. Effective treatment of hypoglycemia over time requires the patient to follow a modified diet. Patients are usually encouraged to eat small, but frequent, meals throughout the day, avoiding excess simple sugars (including alcohol), fats, and fruit drinks. Those patients with severe hypoglycemia may require fast-acting glucagon injections that can stabilize their blood sugar within approximately 15 minutes.

Alternative treatment

A holistic approach to reactive hypoglycemia is based on the belief that a number of factors may create the condition. Among them are heredity, the effects of other illnesses, emotional stress, too much or too little exercise, bad lighting, poor diet, and environmental pollution. Therefore, a number of alternative methods have been proposed as useful in treating the condition. **Homeopathy**, **acupuncture**, and **applied kinesiology**, for example, have been used, as have herbal remedies. One of the herbal remedies commonly suggested for hypoglycemia is a decoction (an extract made by boiling) of gentian (*Gentiana lutea*). It should be drunk warm 15–30 minutes before a meal. Gentian is believed to help stimulate the endocrine (hormone-producing) glands.

In addition to the dietary modifications recommended above, people with hypoglycemia may benefit from supplementing their diet with chromium, which is believed to help improve blood sugar levels. Chromium is found in whole grain breads and cereals, cheese, molasses, lean meats, and brewer's yeast. Hypoglycemics should avoid alcohol, **caffeine**, and cigarette smoke, since these substances can cause significant swings in blood sugar levels.

Prevention

Drug-induced hypoglycemia

Preventing hypoglycemic insulin reactions in diabetics requires taking glucose readings through frequent blood sampling. Insulin can then be regulated based on those readings. Maintaining proper diet is also a factor. Programmable insulin pumps implanted under the skin have proven useful in reducing the incidence of hypoglycemic episodes for insulin-dependent diabetics. As of late 1997, clinical studies continue to seek additional ways to control diabetes and drug-induced hypoglycemia. Tests of a substance called pramlintide indicate that it may help improve glycemic control in diabetics.

Reactive hypoglycemia

The onset of reactive hypoglycemia can be avoided or at least delayed by following the same kind of diet used to control it. While not as restrictive as the diet diabetics must follow to keep tight control over their disease, it is quite similar.

There are a variety of diet recommendations for the reactive hypoglycemic. Patients should:

- avoid overeating
- never skip breakfast

- include protein in all meals and snacks, preferably from sources low in fat, such as the white meat of chicken or turkey, most fish, soy products, or skim milk
- restrict intake of fats (particularly saturated fats, such as animal fats), and avoid refined sugars and processed foods
- be aware of the differences between some vegetables, such as potatoes and carrots. These vegetables have a higher sugar content than others (like squash and broccoli). Patients should be aware of these differences and note any reactions they have to them.
- be aware of differences found in grain products. White flour is a carbohydrate that is rapidly absorbed into the bloodstream, while oats take much longer to break down in the body.
- keep a "food diary." Until the diet is stabilized, a patient should note what and how much he/she eats and drinks at every meal. If symptoms appear following a meal or snack, patients should note them and look for patterns.
- eat fresh fruits, but restrict the amount they eat at one time. Patients should remember to eat a source of protein whenever they eat high sources of carbohydrate like fruit. Apples make particularly good snacks because, of all fruits, the carbohydrate in apples is digested most slowly.
- follow a diet that is high in fiber. Fruit is a good source of fiber, as is oatmeal and oat bran, which slows the buildup of sugar in the blood during digestion.

A doctor can recommend a proper diet, and there are many cookbooks available for diabetics. Recipes found in such books are equally effective in helping to control hypoglycemia.

Prognosis

Like diabetes, there is no cure for reactive hypoglycemia, only ways to control it. While some chronic cases will continue through life (rarely is there complete remission of the condition), others will develop into type II (age onset) diabetes. Hypoglycemia appears to have a higher-than-average incidence in families where there has been a history of hypoglycemia or diabetes among their members, but whether hypoglycemia is a controllable warning of oncoming diabetes has not yet been determined by clinical research.

Resources

BOOKS

Eades, Michael R., and Mary Dan. *Protein Power.* New York: Bantam, 1995.

Krimmel, Patricia, and Edward Krimmel. *The Low Blood Sugar Handbook.* Bryn Mawr, PA: Franklin Publishers, 1992.

Ruggiero, Roberta. *The Do's and Don'ts of Low Blood Sugar.* Hollywood, FL: Frederick Fell Publishers.

PERIODICALS

Service, F. J. "Hypoglycemic Disorders." *New England Journal of Medicine* (27 Apr. 1995): 1144-1152.

ORGANIZATIONS

Hypoglycemia Association, Inc. 18008 New Hampshire Ave., PO Box 165, Ashton, MD 20861-0165.

National Hypoglycemia Association, Inc. PO Box 120, Ridgewood, NJ 07451. (201) 670-1189.

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Hypogonadism

Definition

Hypogonadism is the condition more prevalent in males in which the production of sex hormones and germ cells are inadequate.

Description

Gonads are the organs of sexual differentiation—in the female, they are ovaries; in the male, the testes. Along with producing eggs and sperm, they produce sex hormones that generate all the differences between men and women. If they produce too little sex hormone, then either the growth of the sexual organs or their function is impaired.

The gonads are not independent in their function, however. They are closely controlled by the pituitary gland. The pituitary hormones are the same for males and females, but the gonadal hormones are different. Men produce mostly androgens, and women produce mostly estrogens. These two hormones regulate the development of the embryo, determining whether it is a male or a female. They also direct the adolescent maturation of sex organs into their adult form. Further, they sustain those organs and their function throughout the reproductive years. The effects of estrogen reach beyond that to sustain bone strength and protect the cardiovascular system from degenerative disease.

Hormones can be inadequate during or after each stage of development—embryonic and adolescent. During each stage, inadequate hormone stimulation will prevent normal development. After each stage, a decrease in hormone stimulation will result in failed function and perhaps some shrinkage. The organs affected principally by sex hormones are the male and female genitals, both internal and external, and the female breasts. Body hair,

fat deposition, bone and muscle growth, and some brain functions are also influenced.

Causes and symptoms

Sex is determined at the moment of conception by sex chromosomes. Females have two X chromosomes, while males have one X and one Y chromosome. If the male sperm with the Y chromosome fertilizes an egg, the baby will be male. This is true throughout the animal kingdom. Genetic defects sometimes result in changes in the chromosomes. If sex chromosomes are involved, there is a change in the development of sexual characteristics.

Female is the default sex of the embryo, so most of the sex organ deficits at birth occur in boys. Some, but not all, are due to inadequate androgen stimulation. The penis may be small, the testicles undescended (cryptorchidism) or various degrees of "feminization" of the genitals may be present.

After birth, sexual development does not occur until **puberty**. Hypogonadism most often shows up as an abnormality in boys during puberty. Again, not every defect is due to inadequate hormones. Some are due to too much of the wrong ones. Kallmann's syndrome is a birth defect in the brain that prevents release of hormones and appears as failure of male puberty. Some boys have adequate amounts of androgen in their system but fail to respond to them, a condition known as androgen resistance.

Female problems in puberty are not caused by too little estrogen. Even female reproductive problems are rarely related to a simple lack of hormones, but rather to complex cycling rhythms gone wrong. All the problems with too little hormone happen during **menopause**, which is a normal hypogonadism.

A number of adverse events can damage the gonads and result in decreased hormone levels. The childhood disease **mumps**, if acquired after puberty, can infect and destroy the testicles—a disease called viral **orchitis**. Ionizing radiation and **chemotherapy**, trauma, several drugs (spironolactone, a diuretic and ketoconazole, an antifungal agent), alcohol, marijuana, heroin, **methadone**, and environmental toxins can all damage testicles and decrease their hormone production. Severe diseases in the liver or kidneys, certain infections, sickle cell anemia, and some cancers also affect gonads. To treat some male cancers, it is necessary to remove the testicles, thereby preventing the androgens from stimulating **cancer** growth. This procedure, still called castration or *orchiectomy*, removes androgen stimulation from the whole body.

KEY TERMS

Biopsy—Surgical removal of pieces of tissue for examination.

Embryo—Refers to life before birth, specifically the first two months after conception.

Fetus—The unborn person or animal, still in the womb.

Hypothalamus—Part of the brain just above the pituitary that stimulates pituitary gland function.

Ionizing radiation—X rays. Diagnostic x rays are too weak to do damage under normal circumstances, but x rays used to treat cancer must be used with great care.

Undescended testicle—A testicle that is still in the groin and has not made its way into the scrotum.

For several reasons the pituitary can fail. It happens rarely after **pregnancy**. It used to be removed to treat advanced breast or **prostate cancer**. Sometimes the pituitary develops a tumor that destroys it. Failure of the pituitary is called **hypopituitarism** and, of course, leaves the gonads with no stimulation to produce hormones.

Besides the tissue changes generated by hormone stimulation, the only other symptoms relate to sexual desire and function. Libido is enhanced by testosterone, and male sexual performance requires androgens. The role of female hormones in female sexual activity is less clear, although hormones strengthen tissues and promote healthy secretions, facilitating sexual activity.

Diagnosis

Presently, there are accurate blood tests for most of the hormones in the body, including those from the pituitary and even some from the hypothalamus. Chromosomes can be analyzed, and gonads can, but rarely are, biopsied.

Treatment

Replacement of missing body chemicals is much easier than suppressing excesses. Estrogen replacement is recommended for nearly all women after menopause for its many beneficial effects. Estrogen can be taken by mouth, injection, or skin patch. It is strongly recommended that the other female hormone, progesterone, be taken as well, because it prevents overgrowth of uterine lining and uterine cancer. Testosterone replacement is available for males who are deficient.

Resources

BOOKS

Carr, Bruce R., and Karen D. Bradshaw. "Disorders of the Ovary and Female Reproductive Tract." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Griffen, James E., and Jean D. Wilson. "Disorders of the Testes." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Matsaumoto, Alvin M. "The Testes." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

"Hypofunction of the Ovaries." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

"Hypofunction of the Testes." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Plymate, Stephen R. "Male Hypogonadism." In *Principles and Practice of Endocrinology and Metabolism*, ed. Kenneth L. Becker, et al. Philadelphia: J. B. Lippencott Co., 1995.

Schimke, R. Neil. "Genetic Diseases of Endocrinology and Metabolism." In *Principles and Practice of Endocrinology and Metabolism*, ed. Kenneth L. Becker, et al. Philadelphia: J. B. Lippencott Co., 1995.

PERIODICALS

Rosenberg, M. J., T. D. King, and M. C. Timmons. "Estrogen-androgen for Hormone Replacement." *Journal of Reproductive Medicine* 42 (July 1997): 394-404.

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Hypokalemia

Definition

Hypokalemia is a condition of below normal levels of potassium in the blood serum. Potassium, a necessary electrolyte, facilitates nerve impulse conduction and the contraction of skeletal and smooth muscles, including the heart. It also facilitates cell membrane function and proper enzyme activity. Levels must be kept in a proper (homeostatic) balance for the maintenance of health. The normal concentration of potassium in the serum is in the range of 3.5–5.0 mM. Hypokalemia means serum or plasma levels of potassium ions that fall below 3.5 mM. (Potassium concentrations are often expressed in units of milliequivalents per liter [mEq/L], rather than in units of millimolarity [mM], however, both units are identical and mean the same thing when applied to concentrations of potassium ions.)

Hypokalemia can result from two general causes: either from an overall depletion in the body's potassium or from excessive uptake of potassium by muscle from surrounding fluids.

Description

A normal adult weighing about 154 lbs (70 kg) has about 3.6 moles of potassium ions in his body. Most of this potassium (about 98%) occurs inside various cells and organs, where normal concentration are about 150 mM. Blood serum concentrations are much lower—only about 0.4% of the body's potassium is found in blood serum. As noted above, hypokalemia can be caused by the sudden uptake of potassium ions from the bloodstream by muscle or other organs or by an overall depletion of the body's potassium. Hypokalemia due to overall depletion tends to be a chronic phenomenon, while hypokalemia due to a shift in location tends to be a temporary disorder.

Causes and symptoms

Hypokalemia is most commonly caused by the use of **diuretics**. Diuretics are drugs that increase the excretion of water and salts in the urine. Diuretics are used to treat a number of medical conditions, including **hypertension** (high blood pressure), congestive **heart failure**, liver disease, and kidney disease. However, diuretic treatment can have the side effect of producing hypokalemia. In fact, the most common cause of hypokalemia in the elderly is the use of diuretics. The use of furosemide and thiazide, two commonly used diuretic drugs, can lead to hypokalemia. In contrast, spironolactone and triamterene are diuretics that do not provoke hypokalemia.

Other commons causes of hypokalemia are excessive **diarrhea** or vomiting. Diarrhea and vomiting can be produced by infections of the gastrointestinal tract. Due to a variety of organisms, including bacteria, protozoa, and viruses, diarrhea is a major world health problem. It is responsible for about a quarter of the 10 million infant deaths that occur each year. Although nearly all of these deaths occur in the poorer parts of Asia and Africa, diarrheal diseases are a leading cause of infant **death** in the United States. Diarrhea results in various abnormalities, such as **dehydration** (loss in body water), **hyponatremia** (low sodium level in the blood), and hypokalemia.

Because of the need for potassium to control muscle action, hypokalemia can cause the heart to stop beating. Young infants are especially at risk for death from this cause, especially where severe diarrhea continues for two weeks or longer. Diarrhea due to laxative abuse is an occasional cause of hypokalemia in the adolescent or adult. Enema abuse is a related cause of hypokalemia. Laxative abuse is especially difficult to diagnose and treat, because patients usually deny the practice. Up to 20% of persons

complaining of chronic diarrhea practice laxative abuse. Laxative abuse is often part of eating disorders, such as **anorexia nervosa** or **bulimia nervosa**. Hypokalemia that occurs with these eating disorders may be life-threatening.

Surprisingly, the potassium loss that accompanies vomiting is only partly due to loss of potassium from the vomit. Vomiting also has the effect of provoking an increase in potassium loss in the urine. Vomiting expels acid from the mouth, and this loss of acid results in alkalization of the blood. (Alkalization of the blood means that the pH of the blood increases slightly.) An increased blood pH has a direct effect on the kidneys. Alkaline blood provokes the kidneys to release excessive amounts of potassium in the urine. So, severe and continual vomiting can cause excessive losses of potassium from the body and hypokalemia.

A third general cause of hypokalemia is prolonged **fasting** and **starvation**. In most people, after three weeks of fasting, blood serum potassium levels will decline to below 3.0 mM and result in severe hypokalemia. However, in some persons, serum potassium may be naturally maintained at about 3.0 mM, even after 100 days of fasting. During fasting, muscle is naturally broken down, and the muscle protein is converted to sugar (glucose) to supply to the brain the glucose which is essential for its functioning. Other organs are able to survive with a mixed supply of fat and glucose. The potassium within the muscle cell is released during the gradual process of muscle breakdown that occurs with starvation, and this can help counteract the trend to hypokalemia during starvation. Eating an unbalanced diet does not cause hypokalemia because most foods, such as fruits (especially bananas, oranges, and melons), vegetables, meat, milk, and cheese, are good sources of potassium. Only foods such as butter, margarine, vegetable oil, soda water, jelly beans, and hard candies are extremely poor in potassium.

Alcoholism occasionally results in hypokalemia. About one half of alcoholics hospitalized for withdrawal symptoms experience hypokalemia. The hypokalemia of alcoholics occurs for a variety of reasons, usually poor **nutrition**, vomiting, and diarrhea. Hypokalemia can also be caused by **hyperaldosteronism**; **Cushing's syndrome**; hereditary kidney defects such as Liddle's syndrome, Bartter's syndrom, and Franconi's syndrome; and eating too much licorice.

Symptoms

Mild hypokalemia usually results in no symptoms, while moderate hypokalemia results in confusion, disorientation, weakness, and discomfort of muscles. On occasion, moderate hypokalemia causes cramps during **exercise**. Another symptom of moderate hypokalemia is a discomfort in the legs that is experienced while sitting still. The patient may experience an annoying feeling that can be relieved by shifting the positions of the legs or by stomping the feet on the floor. Severe hypokalemia results in extreme weakness of the body and, on occasion, in **paralysis**. The paralysis that occurs is "flaccid paralysis," or limpness. Paralysis of the muscles of the lungs results in death. Another dangerous result of severe hypokalemia is abnormal heart beat (arrhythmia) that can lead to death from cardiac arrest (cessation of heart beat). Moderate hypokalemia may be defined as serum potassium between 2.5 and 3.0 mM, while severe hypokalemia is defined as serum potassium under 2.5 mM.

Diagnosis

Hypokalemia can be measured by acquiring a sample of blood, preparing blood serum, and using a potassium sensitive electrode for measuring the concentration of potassium ions. Atomic absorption spectroscopy can also be used to measure the potassium ions. Since hypokalemia results in abnormalities in heart behavior, the electrocardiogram is usually used in the diagnosis of hypokalemia. The diagnosis of the cause of hypokalemia can be helped by measuring the potassium content of the urine. Where urinary potassium is under 25 mmoles per day, it means that the patient has experienced excessive losses of potassium due to diarrhea. The urinary potassium test is useful in cases where the patient is denying the practice of laxative or enema abuse. In contrast, where hypokalemia is due to the use of diuretic drugs, the content of potassium in the urine will be high—over 40 mmoles per day.

Treatment

In emergency situations, when severe hypokalemia is suspected, the patient should be put on a cardiac monitor, and respiratory status should be assessed. If laboratory test results show potassium levels below 2.5 mM, intravenous potassium should be given. In less urgent cases, potassium can be given orally in the pill form. Potassium supplements take the form of pills containing potassium chloride (KCl), potassium bicarbonate ($KHCO_3$), and potassium acetate. Oral potassium chloride is the safest and most effective treatment for hypokalemia. Generally, the consumption of 40–80 mmoles of KCl per day is sufficient to correct the hypokalemia that results from diuretic therapy. For many people taking diuretics, potassium supplements are not necessary as long as they eat a balanced diet containing foods rich in potassium.

Prognosis

The prognosis for correcting hypokalemia is excellent. However, in emergency situations, where potassium

KEY TERMS

Diuretics—A class of drugs that cause the kidneys to excrete excess sodium, water, and potassium.

pH—The unit of acid content is pH. The blood plasma normally has a pH of 7.35–7.45. Acidic blood has a pH value slightly less than pH 7.35. Alkaline blood has a pH value slightly greater than pH 7.45.

Potassium—An electrolyte necessary to proper functioning of the body.

is administered intravenously, the physician must be careful not to give too much potassium. The administration of potassium at high levels, or at a high rate, can lead to abnormally high levels of serum potassium.

Prevention

Hypokalemia is not a concern for healthy persons, since potassium is present in a great variety of foods. For patients taking diuretics, however, the American Dietetic Association recommends use of a high potassium diet. The American Dietetic Association states that if hypokalemia has already occurred, use of the high potassium diet alone may not reverse hypokalemia. Useful components of a high potassium diet include bananas, tomatoes, cantaloupes, figs, raisins, kidney beans, potatoes, and milk.

Resources

BOOKS

American Dietetic Association. *Handbook of Clinical Dietetics*. New Haven, CT: Yale University Press, 1992.

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Singer, Gary G., and Barry M. Brenner. "Fluid and Electrolyte Disturbances." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Zeman, F., and D. M. Dey. *Applications in Medical Nutrition Therapy.* 2nd ed. Engelwood Cliffs, NJ: Prentice-Hall, 1995.

PERIODICALS

Wingo, I. D., and C. S. Wingo. "Hypokalemia—Consequences, Causes, and Correction." *Journal of the American Society of Nephrology* 8 (1997): 1179-1188.

Tom Brody, PhD

Hypolipoproteinemia

Definition

Hypolipoproteinemia (or hypolipidemia) is the lack of fat in the blood.

Description

Although quite rare, hypolipoproteinemia is a serious condition. Blood absorbs fat from food in the intestine and transports it as a combined package with proteins and other chemicals like cholesterol. Much of the fat goes straight into the liver for processing. The cholesterol, a waste product, ends up in the bile. The proteins act as vessels, carrying the other chemicals around. These packages of fat, cholesterol, and proteins are called lipoproteins.

Causes and symptoms

Low blood fats can be the result of several diseases, or they can be a primary genetic disease with other associated abnormalities.

- **Malnutrition** is a lack of food, including fats, in the diet.
- Malabsorption is the inability of the bowel to absorb food, causing malnutrition.
- Anemia (too few red blood cells) and **hyperthyroidism** (too much thyroid hormone) also reduce blood fats.
- Rare genetic conditions called hypobetalipoproteinemia and abetalipoproteinemia cause malabsorption plus nerve, eye, and skin problems in early childhood.
- Tangier disease causes only the cholesterol to be low. It also produces nerve and eye problems in children.

Symptoms are associated more closely with the cause rather than the actual low blood fats.

Diagnosis

Blood studies of the various fat particles help identify both the low and high fat diseases. These tests are often done after an overnight fast to prevent interference from fat just being absorbed from food. Fats and proteins are grouped together and described by density—high-density lipoproteins (HDL), low-density lipoproteins (LDL), and very low-density lipoproteins (VLDL). There are also much bigger particles called chylomicrons. Each contain different proportions of cholesterol, fats, and protein.

Treatment

Supplemental vitamin E helps children with the betalipoprotein deficiencies. There is no known treat-

KEY TERMS

Cholesterol—A steroid alcohol found in animal cells and fluids.

Lipoprotein—Class of proteins that contain protein and lipid. The fundamental component of living cells.

ment for Tangier disease. Treatment of the causes of the other forms of low blood fats reverses the condition.

Resources

BOOKS

Ginsberg, Henry N., and Ira J. Goldberg. "Disorders Of Lipoprotein Metabolism." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Hypomagnesemia *see* **Magnesium imbalance**

Hyponatremia

Definition

The normal concentration of sodium in the blood plasma is 136–145 mM. Hyponatremia occurs when sodium falls below 130 mM. Plasma sodium levels of 125 mM or less are dangerous and can result in seizures and **coma**.

Description

Sodium is an atom, or ion, that carries a single positive charge. The sodium ion may be abbreviated as Na^+ or as simply Na. Sodium can occur as a salt in a crystalline solid. Sodium chloride (NaCl), sodium phosphate (Na_2HPO_4) and sodium bicarbonate ($NaHCO_3$) are commonly occurring salts. These salts can be dissolved in water or in juices of various foods. Dissolving involves the complete separation of ions, such as sodium and chloride in common table salt (NaCl).

About 40% of the body's sodium is contained in bone. Approximately 2–5% occurs within organs and cells and the remaining 55% is in blood plasma and other extracellular fluids. The amount of sodium in blood plasma is typically 140 mM, a much higher amount than is found in intracellular sodium (about 5 mM). This asymmetric distribution of sodium ions is essential for human life. It makes possible proper nerve conduction, the passage of various nutrients into cells, and the maintenance of blood pressure.

The body continually regulates its handling of sodium. When dietary sodium is too high or low, the intestines and kidneys respond to adjust concentrations to normal. During the course of a day, the intestines absorb dietary sodium while the kidneys excrete a nearly equal amount of sodium into the urine. If a low sodium diet is consumed, the intestines increase their efficiency of sodium absorption, and the kidneys reduce its release into urine.

The concentration of sodium in the blood plasma depends on two things: the total amount of sodium and water in arteries, veins, and capillaries (the circulatory system). The body uses separate mechanisms to regulate sodium and water, but they work together to correct blood pressure when it is too high or too low. Too low a concentration of sodium, or hyponatremia, can be corrected either by increasing sodium or by decreasing body water. The existence of separate mechanisms that regulate sodium concentration account for the fact that there are numerous diseases that can cause hyponatremia, including diseases of the kidney, pituitary gland, and hypothalamus.

Causes and symptoms

Hyponatremia can be caused by abnormal consumption or excretion of dietary sodium or water and by diseases that impair the body's ability to regulate them. Maintenance of a low salt diet for many months or excessive sweat loss during a race on a hot day can present a challenge to the body to conserve adequate sodium levels. While these conditions alone are not likely to cause hyponatremia, it can occur under special circumstances. For example, hyponatremia often occurs in patients taking diuretic drugs who maintain a low sodium diet. This is especially of concern in elderly patients, who have a reduced ability to regulate the concentrations of various nutrients in the bloodstream. Diuretic drugs that frequently cause hyponatremia include furosemide (Lasix), bumetanide (Bumex), and most commonly, the thiazides. **Diuretics** enhance the excretion of sodium into the urine, with the goal of correcting high blood pressure. However, too much sodium excretion can result in hyponatremia. Usually only mild hyponatremia occurs in patients taking diuretics, but when combined with a low sodium diet or with the excessive drinking of water, severe hyponatremia can develop.

Severe and prolonged **diarrhea** can also cause hyponatremia. Severe diarrhea, causing the daily output of 8–10 liters of fluid from the large intestines, results in the loss of large amounts of water, sodium, and various nutrients. Some diarrheal diseases release particularly large quantities of sodium and are therefore most likely to cause hyponatremia.

Drinking excess water sometimes causes hyponatremia, because the absorption of water into the bloodstream can dilute the sodium in the blood. This cause of hyponatremia is rare, but has been found in psychotic patients who compulsively drink more than 20 liters of water per day. Excessive drinking of beer, which is mainly water and low in sodium, can also produce hyponatremia when combined with a poor diet.

Marathon running, under certain conditions, leads to hyponatremia. Races of 25–50 miles can result in the loss of great quantities (8 to 10 liters) of sweat, which contains both sodium and water. Studies show that about 30% of marathon runners experience mild hyponatremia during a race. But runners who consume only pure water during a race can develop severe hyponatremia because the drinking water dilutes the sodium in the bloodstream. Such runners may experience neurological disorders as a result of the severe hyponatremia and require emergency treatment.

Hyponatremia also develops from disorders in organs that control the body's regulation of sodium or water. The adrenal gland secretes a hormone called aldosterone that travels to the kidney, where it causes the kidney to retain sodium by not excreting it into the urine. **Addison's disease** causes hyponatremia as a result of low levels of aldosterone due to damage to the adrenal gland. The hypothalamus and pituitary gland are also involved in sodium regulation by making and releasing vasopressin, known as anti-diuretic hormone, into the bloodstream. Like aldosterone, vasopressin acts in the kidney, but it causes it to reduce the amount of water released into urine. With more vasopressin production, the body conserves water, resulting in a lower concentration of plasma sodium. Certain types of **cancer** cells produce vasopressin, leading to hyponatremia.

Symptoms of moderate hyponatremia include tiredness, disorientation, **headache**, muscle cramps, and nausea. Severe hyponatremia can lead to seizures and coma. These neurological symptoms are thought to result from the movement of water into brain cells, causing them to swell and disrupt their functioning.

In most cases of hyponatremia, doctors are primarily concerned with discovering the underlying disease causing the decline in plasma sodium levels. **Death** that occurs during hyponatremia is usually due to other features of the disease rather than to the hyponatremia itself.

KEY TERMS

Blood plasma and serum—Blood plasma, or plasma, is prepared by obtaining a sample of blood and removing the blood cells. The red blood cells and white blood cells are removed by spinning with a centrifuge. Chemicals are added to prevent the blood's natural tendency to clot. If these chemicals include sodium, than a false measurement of plasma sodium content will result. Serum is prepared by obtaining a blood sample, allowing formation of the blood clot, and removing the clot using a centrifuge. Both plasma and serum are light yellow in color.

Diagnosis

Hyponatremia is diagnosed by acquiring a blood sample, preparing plasma, and using a sodium-sensitive electrode for measuring the concentration of sodium ions. Unless the cause is obvious, a variety of tests are subsequently run to determine if sodium was lost from the urine, diarrhea, or from vomiting. Tests are also used to determine abnormalities in aldosterone or vasopressin levels. The patient's diet and use of diuretics must also be considered.

Treatment

Severe hyponatremia can be treated by infusing a solution of 5% sodium chloride in water into the bloodstream. Moderate hyponatremia due to use of diuretics or an abnormal increase in vasopressin is often treated by instructions to drink less water each day. Hyponatremia due to adrenal gland insufficiency is treated with hormone injections.

Prognosis

Hyponatremia is just one manifestation of a variety of disorders. While hyponatremia can easily be corrected, the prognosis for the underlying condition that causes it varies.

Prevention

Patients who take diuretic medications must be checked regularly for the development of hyponatremia.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Fried, L. F., and P. M. Palevsky. "Hyponatremia and Hypernatremia." *Medical Clinics of North America* 81 (1997): 585-609.

Frizzell, R. T,. et al. "Hyponatremia and Ultramarathon Running." *Journal of the American Medical Association* 255 (1986): 772-774.

Tom Brody, PhD

Hypoparathyroidism

Definition

Hypoparathyroidism is the result of a decrease in production of parathyroid hormones by the parathyroid glands located behind the thyroid glands in the neck. The result is a low level of calcium in the blood.

Description

Parathyroid glands consist of four pea-shaped glands located on the back and side of the thyroid gland. The gland produces parathyroid hormone which, along with vitamin D and calcitonin, are important for the regulation of the calcium level in the body. Hypoparathyroidism affects both males and females of all ages.

Causes and symptoms

The accidental removal of the parathyroid glands during neck surgery is the most frequent cause of hypoparathyroidism. Complications of surgery on the parathyroid glands is another common cause of this disorder. There is the possibility of autoimmune genetic disorders causing hypoparathyroidism such as Hashimoto's **thyroiditis**, **pernicious anemia**, and **Addison's disease**. The destruction of the gland by radiation is a rare cause of hypoparathyroidism. Occasionally, the parathyroids are absent at birth causing low calcium levels and possible convulsions in the newborn. Symptoms in the advanced and continuous stages of hypoparathyroidism include splitting of the nails, inadequate tooth development and **mental retardation** in children, and seizures.

Abnormal low levels of calcium result in irritability of nerves, causing **numbness and tingling** of the hands and feet, with painful-cramp like muscle spasms known as tetany. Laryngeal spasms may also occur causing respiratory obstruction.

Diagnosis

Diagnostic measures begin with the individual's own observation of symptoms. A thorough medical history and **physical examination** by a physician is always required for an accurate diagnosis. The general practitioner may refer the individual to an endocrinologist, a medical specialist who studies the function of the parathyroid glands as well as other hormone producing glands. Laboratory studies include blood and urine tests to help determine phosphate and calcium levels. X rays are useful to determine any abnormalities in bone density associated with abnormal calcium levels. These **autoimmune disorders** may accompany hypoparathyroidism, but are not an actual cause of it.

Treatment

In the event of severe muscle spasms, hospitalization may be warranted for calcium injections. Raising carbon-dioxide levels in the blood, which can decrease muscle spasms, may be achieved in immediate situations by placing a paper bag over the mouth and blowing into it to "reuse" each breath. It is critical to obtain timely periodic laboratory tests to check calcium levels. A high calcium, low-phosphorous diet may be of significance and is directed by the physician or dietitian.

KEY TERMS

Addison's disease—A disease caused by partial or total failure of adrenocortical (relating to, or derived from the adrenal gland) function, which is characterized by a bronze-like pigmentation of the skin and mucous membranes, anemia, weakness, and low blood pressure.

Autoimmunity—A condition by which the body's defense mechanism attacks itself.

Calcitonin—A hormone produced by the thyroid gland in human beings that lowers plasma calcium and phosphate levels without increasing calcium accumulation.

Hashimoto's thyroiditis—The self destruction of the thyroid cells from an autoimmune disorder.

Hormones—A substance produced by one tissue and conveyed by the bloodstream to another to affect physiological activity, such as growth or metabolism.

Pernicious anemia—A severe anemia most often affecting older adults, caused by failure of the stomach to absorb vitamin B12 and characterized by abnormally large red blood cells, gastrointestinal disturbances, and lesions of the spinal cord.

Prognosis

Presently hypoparathyroidism is considered incurable. The disorder requires lifelong replacement therapy to control symptoms. Medical research however, continues to search for a cure.

Prevention

There are no specific preventive measures for hypoparathyroidism. However, careful surgical techniques are critical to reduce the risk of damage to the gland during surgery.

Resources

BOOKS

Chandrasoma, Parakrama, and Clive R. Taylor. *Concise Pathology.* East Norwalk, CT: Appleton & Lange, 1991.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

OTHER

"Hypoparathyroidism." *ThriveOnline.* 11 June 1998 <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Hypophysectomy

Definition

Hypophysectomy or hypophysis is the removal of the pituitary gland.

Purpose

The pituitary gland is in the middle of the head. Removing this master gland is a drastic step that was taken in the extreme circumstance of two cancers that had escaped all other forms of treatment. Cancers of the female breast and male prostate grow faster in the presence of sex hormones. It used to be that sex hormones could be suppressed only by removing their source, the glands that made them. After the gonads were removed, some cancers continued to grow, so other stimulants to their growth had to removed. At this point, some **cancer** specialists turned to the pituitary.

With the development of new therapeutic agents and methods, especially new ways to manipulate hormones without removing their source, this type of endocrine surgery has been largely relegated to history. However, tumors develop in the pituitary gland that require removal. Here, the idea is to remove the tumor but partially preserve the gland.

KEY TERMS

Endocrine system—Group of glands and parts of glands that control metabolic activity. Pituitary, thyroid, adrenals, ovaries, and testes are all part of the endocrine system.

Hormone—A chemical made in one place that has effects in distant places in the body. Hormone production is usually triggered by the pituitary gland.

Description

There are several surgical approaches to the pituitary. The surgeon will choose the best one for the specific procedure. The pituitary lies directly behind the nose, and access through the nose or the sinuses is often the best approach. Opening the skull and lifting the frontal lobe of the brain will expose the delicate neck of the pituitary gland. This approach works best if tumors have extended above the pituitary fossa (the cavity in which the gland lies).

Newer surgical methods using technology have made other approaches possible. Stereotaxis is a three-dimensional aiming technique using x rays or scans for guidance. Instruments can be placed in the brain with pinpoint accuracy through tiny holes in the skull. These instruments can then manipulate brain tissue, either to destroy it or remove it. Stereotaxis is also used to direct radiation with similar precision using a gamma knife. Access to some brain lesions can be gained through the blood vessels using tiny tubes and wires guided by x rays.

Preparation

Pituitary surgery is performed by neurosurgeons deep inside the skull. All the patient can do to prepare is keep as healthy as possible and trust that the surgeon will do his usual excellent job. Informed surgical consent is important so that the patient is fully confident of the need for surgery and the expected outcome.

Aftercare

Routine post-operative care is required. In addition, pituitary function will be assessed.

Risks

The risks of surgery are multiple. Procedures are painstakingly selected to minimize risk and maximize benefit. Unique to surgery on the pituitary is the risk of destroying the entire gland and leaving the entire endocrine system without guidance. This used to be the whole purpose of hypophysectomy. After the procedure, the endocrinologist, a physician specializing in the study and care of the endocrine system, would provide the patient with all the hormones needed. Patients with no pituitary function did and still do quite well because of the available hormone replacements.

Normal results

Complete removal of the pituitary was the goal for cancer treatment. Today, removal of tumors with preservation of the gland is the goal.

Abnormal results

Tumors may not be completely removed, due to their attachment to vital structures.

Resources

BOOKS

Biller, Beverly M. K., and Gilbert H. Daniels. "Neuroendocrine Regulation and Diseases of the Anterior Pituitary and Hypothalamus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Jameson, J. Larry. "Anterior Pituitary." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Youmans, Julian R. "Hypophysectomy." In *Neurological Surgery.* Philadelphia: W. B. Saunders Co., 1990.

J. Ricker Polsdorfer, MD

Hypopigmentation *see* **Albinism; Vitiligo**

Hypopituitarism

Definition

Hypopituitarism is loss of function in an endocrine gland due to failure of the pituitary gland to secrete hormones which stimulate that gland's function. The pituitary gland is located at the base of the brain. Patients diagnosed with hypopituitarism may be deficient in one single hormone, several hormones, or have complete pituitary failure.

Description

The pituitary is a pea-sized gland located at the base of the brain, and surrounded by bone. The hypothalamus, another endocrine organ in the brain, controls the function of the pituitary gland by providing "hormonal orders." In turn, the pituitary gland regulates the many hormones that control various functions and organs within the body. The posterior pituitary acts as a sort of storage area for the hypothalamus and passes on hormones that control function of the muscles and kidneys. The anterior pituitary produces its own hormones which help to regulate several endocrine functions.

In hypopituitarism, something interferes with the production and release of these hormones, thus affecting the function of the target gland. Commonly affected hormones may include:

Gonadotropin deficiency

Gonadotropin deficiency involves two distinct hormones affecting the reproductive system. Luteinizing hormone (LH) stimulates the testes in men and the ovaries in women. This deficiency can affect fertility in men and women and menstruation in women. Follicle-stimulating hormone (FSH) has similar effects to LH.

Thyroid stimulating hormone deficiency

Thyroid stimulating hormone (TSH) is involved in stimulation of the thyroid gland. A lack of stimulation in the gland leads to **hypothyroidism**.

Adrenocorticotopic hormone deficiency

Also known as corticotropin, adrenocorticotopic hormone (ACTH) stimulates the adrenal gland to produce a hormone similar to cortisone, called cortisol. The loss of this hormone can lead to serious problems.

Growth hormone deficiency

Growth hormone (GH) regulates the body's growth. Patients who lose supply of this hormone before physical maturity will suffer impaired growth. Loss of the hormone can also affect adults.

Other hormone deficiencies

Prolactin stimulates the female breast to produce milk. A hormone produced by the posterior pituitary, antidiuretic hormone (ADH), controls the function of the kidneys. When this hormone is deficient, **diabetes insipidus** can result. However, patients with hypopituitarism rarely suffer ADH deficiency, unless the hypopituitarism is the result of hypothalamus disease.

Multiple hormone deficiencies

Deficiency of a single pituitary hormone occurs less commonly than deficiency of more than one hormone. Sometimes referred to as progressive pituitary hormone deficiency or partial hypopituitarism, there is usually a predictable order of hormone loss. Generally, growth hormone is lost first, then luteinizing hormone deficiency follows. The loss of follicle-stimulating hormone, thyroid stimulating hormone and adrenocorticotopic hormones follow much later. The progressive loss of pituitary hormone secretion is usually a slow process, which can occur over a period of months or years. Hypopituitarism does occasionally start suddenly with rapid onset of symptoms.

Panhypopituitarism

This condition represents the loss of all hormones released by the anterior pituitary gland. Panhypopituitarism is also known as complete pituitary failure.

Causes and symptoms

There are three major mechanisms which lead to the development of hypopituitarism. The first involves decreased release of hypothalamic hormones that stimulate pituitary function. The cause of decreased hypothalamic function may be congenital or acquired through interference such as tumors, inflammation, infection, mass lesions or interruption of blood supply. A second category of causes is any event or mass which interrupts the delivery of hormones from the hypothalamus. These may include particular tumors and aneurysms. Damage to the pituitary stalk from injury or surgery can also lead to hypopituitarism.

The third cause of hypopituitarism is damage to the pituitary gland cells. Destroyed cells can not produce the pituitary hormones that would normally be secreted by the gland. Cells may be destroyed by a number of tumors and diseases. Hypopituitarism is often caused by tumors, the most common of which is pituitary adenoma.

Symptoms of hypopituitarism vary with the affected hormones and severity of deficiency. Frequently, patients have had years of symptoms that were nonspecific until a major illness or **stress** occurred. Overall symptoms may include **fatigue**, sensitivity to cold, weakness, decreased appetite, weight loss and abdominal **pain**. Low blood pressure, **headache** and visual disturbances are other associated symptoms.

Gonadotropin deficiency

Symptoms specific to this hormone deficiency include decreased interest in sex for women and **infertility** in women and men. Women may also have premature cessation of menstruation, hot flashes, vaginal dryness and pain during intercourse. Women who are postmenopausal will not have obvious symptoms such as these and may first present with headache or loss of vision. Men may also suffer **sexual dysfunction** as a result of gonadotropin deficiency. In acquired gonadotropin deficiency, both men and women may notice loss of body hair.

Thyroid stimulating hormone deficiency

Intolerance to cold, fatigue, weight gain, **constipation** and pale, waxy and dry skin indicate thyroid hormone deficiency.

Adrenocorticotopic hormone deficiency

Symptoms of ACTH deficiency include fatigue, weakness, weight loss and low blood pressure. Nausea, pale skin and loss of pubic and armpit hair in women may also indicate deficiency of ACTH.

Growth hormone deficiency

In children, growth hormone deficiency will result in short stature and growth retardation. Symptoms such as **obesity** and skin wrinkling may or may not show in adults and normal release of growth hormone normally declines with age.

Other hormone deficiencies

Prolactin deficiency is rare and is the result of partial or generalized anterior pituitary failure. When present, the symptom is absence of milk production in women. There are no known symptoms for men. ADH deficiency may produce symptoms of diabetes insipidus, such as excessive thirst and frequent urination.

Multiple hormone deficiencies

Patients with multiple hormone deficiencies will show symptoms of one or more specific hormone deficiencies or some of the generalized symptoms listed above.

Panhypopituitarism

The absence of any pituitary function should show symptoms of one or all of the specific hormone deficiencies. In addition to those symptoms, patients may have dry, pale skin that is finely textured. The face may appear finely wrinkled and contain a disinterested expression.

Diagnosis

Once the diagnosis of a single hormone deficiency is made, it is strongly recommended that tests for other hormone deficiencies be conducted.

Gonadotropin deficiency

The detection of low levels of gonadotropin can be accomplished through simple blood tests which measure luteinizing hormone and follicle-stimulating hormone, simultaneously with gonadal steroid levels. The combination of results can indicate to a physician if the cause of decreased hormone levels or function belongs to hypopituitarism or some sort of primary gonadal failure. Diagnosis will vary among men and women.

Thyroid stimulating hormone deficiency

Laboratory tests measuring thyroid function can help determine a diagnosis of TSH deficiency. The commonly used tests are T4 and TSH measurement done simultaneously to determine the reserve, or pool, of thyroid-stimulating hormone.

Adrenocorticotopic hormone deficiency

An insulin tolerance test may be given to determine if cortisol levels rise when **hypoglycemia** is induced. If they do not rise, there is insufficient reserve of cortisol, indicating an ACTH deficiency. If the insulin tolerance test is not safe for a particular patient, a glucagon test offers similar results. A CRH (corticotropin-releasing hormone) test may also be given. It involves injection of CRH to measure, through regularly drawn blood samples, a resulting rise in ACTH and cortisol. Other tests which stimulate ACTH may be ordered.

Growth hormone deficiency

Growth hormone deficiency is measured through the use of insulin-like growth factor I tests, which measure growth factors that are dependent on growth hormones. Sleep and **exercise** studies may also be used to test for growth hormone deficiency, since these activities are known to stimulate growth hormone secretion. Several drugs also induce secretion of growth hormone and may be given to measure hormone response. The standard test for growth hormone deficiency is the insulin-induced hypoglycemia test. This test does carry some risk from the induced hypoglycemia. Other tests include an arginine infusion test, clonidine test and growth-hormone releasing hormone test.

Other hormone deficiencies

If a test calculates normal levels of prolactin, deficiency of the hormone is eliminated as a diagnosis. A TRH (thyrotropin-releasing hormone) simulation test can determine prolactin levels. A number of tests are available to detect ADH levels and to determine diagnosis of diabetes insipidus.

Multiple and general hypopituitarism tests

Physicians should be aware that nonspecific symptoms can indicate deficiency of one or more hormones and should conduct a thorough clinical history. In general, diagnosis of hypopituitarism can be accomplished with a combination of dynamic tests and simple blood tests, as well as imaging exams. Most of these tests can be conducted in an outpatient lab or radiology facility. **Magnetic resonance imaging** (MRI) exams with gadolinium contrast enhancement are preferred imaging exams to study the region of the hypothalamus and pituitary gland. When MRI is not available, a properly conducted computed tomography scan (CT scan) exam can take its place. These exams can demonstrate a tumor or other mass, which may be interfering with pituitary function.

Panhypopituitarism

The insulin-induced hypoglycemia, or insulin tolerance test, which is used to determine specific hormone deficiencies, is an excellent test to diagnose panhypopituitarism. This test can reveal levels of growth hormone, ACTH (cortisol) and prolactin deficiency. The presence of insufficient levels of all of these hormones is a good indication of complete pituitary failure. Imaging studies and clinical history are also important.

Treatment

Treatment differs widely, depending on the age and sex of the patient, severity of the deficiency, the number of hormones involved, and even the underlying cause of the hypopituitarism. Immediate hormone replacement is generally administered to replace the specific deficient hormone. Patient education is encouraged to help patients manage the impact of their hormone deficiency on daily life. For instance, certain illnesses, accidents or surgical procedures may have adverse complications due to hypopituitarism.

Gonadotropin deficiency

Replacement of gonadal steroids is common treatment for LH and FSH deficiency. Estrogen for women and testosterone for men will be prescribed in the lowest effective dosage possible, since there can be complications to this therapy. To correct women's loss of libido, small doses of androgens may be prescribed. To restore fertility in men, regular hormone injections may be required. Male and female patients whose hypopituitarism results from hypothalamic disease may be successfully treated with a hypothalamic releasing hormone (GnRH), which can restore gonadal function and fertility.

Thyroid stimulating hormone deficiency

In patients who have hypothyroidism, the function of the adrenal glands will be tested and treated with steroids before administering thyroid hormone replacement.

Adrenocorticotopic hormone deficiency

Hydrocortisone or cortisone in divided doses may be given to replace this hormone deficiency. Most patients require 20 mg or less of hydrocortisone per day.

Growth hormone deficiency

It is essential to treat children suffering from growth hormone deficiency. The effectiveness of growth hormone therapy in adults, particularly elderly adults, is not as well documented. It is thought to help restore normal muscle to fat ratios. Growth hormone is an expensive and cautiously prescribed treatment.

Treatment of multiple deficiencies and panhypopituitarism

The treatment of hypopituitarism is usually very straightforward, but must normally continue for the remainder of the patient's life. Some patients may receive treatment with GnRH, the hypothalamic hormone. In most cases, treatment will be based on the specific deficiency demonstrated. Patients with hypopituitarism should be followed regularly to measure treatment effectiveness and to avoid overtreatment with hormone therapy. If the cause of the disorder is a tumor or lesion, radiation or surgical removal are treatment options. Successful removal may reverse the hypopituitarism. However, even after removal of the mass, **hormone replacement therapy** may still be necessary.

Prognosis

The prognosis for most patients with hypopituitarism is excellent. As long as therapy is continued, many experience normal life spans. However, hypopituitarism is usually a permanent condition and prognosis depends on the primary cause of the disorder. It can be potentially life threatening, particularly when acute hypopituitarism occurs as a result of a large pituitary tumor. Morbidity from the disease has increased, although the cause is not known. It is possible that increased morbidity and **death** are due to overtreatment with hormones. Any time that recovery of pituitary function can occur is preferred to lifelong hormone therapy.

Prevention

There is no known prevention of hypopituitarism, except for prevention of damage to the pituitary/hypothalamic area from injury.

KEY TERMS

Adenoma—A benign (not threatening or cancerous) tumor that originates in a gland.

Androgen—A hormone that usually stimulates the sex hormones of the male.

Congenital—Present at birth.

Diabetes insipidus—A disorder originating in the pituitary gland which is characterized by excessive thirst and urination.

Endocrine—Refers to the system of internal secretion of substances into the body system from glands.

Hypoglycemia—Abnormal decrease of sugar in the blood.

Hypothyroidism—Deficient activity of the thyroid gland and resulting loss of energy.

Resources

BOOKS

Current Diagnosis. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

ORGANIZATIONS

Alliance for Genetic Support Groups. 35 Wisconsin Circle, Suite 440. Chevy Chase, MD 20815-7015. <http://www.medhelp.org/geneticalliance>.

Human Growth Foundation. 997 Glen Cove Ave., Glen Head, NY 11545. (800) 451-6434. <http://www.hgfound.org>.

OTHER

HealthAnswers.com <http://www.healthanswers.com>.

Teresa Norris

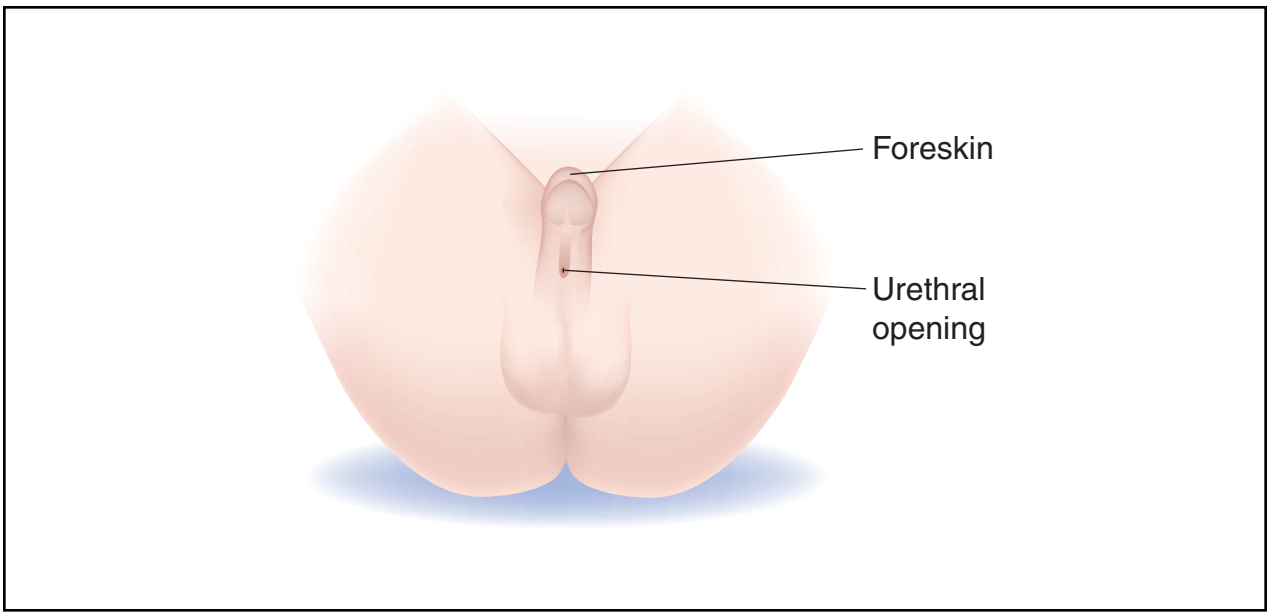
Hypoplastic anemia *see* **Aplastic anemia**

Hypospadias and epispadias

Definition

Hypospadias is a congenital defect, primarily of males, in which the urethra opens on the underside (ventrum) of the penis. The corresponding defect in females is an opening of the urethra into the vagina and is rare.

Epispadias (also called bladder exstrophy) is a congenital defect of males in which the urethra opens on the



In hypospadias, the urethra opens along the penile shaft rather than at the penile tip. *(Illustration by Argosy Inc.)*

upper surface (dorsum) of the penis. The corresponding defect in females is a fissure in the upper wall of the urethra and is quite rare.

Description

In a male, the external opening of the urinary tract (external meatus) is normally located at the tip of the penis. In a female, it is normally located between the clitoris and the vagina.

In males with hypospadias, the urethra opens on the inferior surface or underside of the penis. In females with hypospadias, the urethra opens into the cavity of the vagina.

In males with epispadias, the urethra opens on the superior surface or upper side of the penis. In females with epispadias, there is a crack or fissure in the wall of the urethra and out of the body through an opening in the skin above the clitoris.

During the embryological development of males, a groove of tissue folds inward and then fuses to form a tube that becomes the urethra. Hypospadias occurs when the tube does not form or does not fuse completely. Epispadias is due to a defect in the tissue that folds inward to form the urethra.

During the development of a female, similar processes occur to form the urethra. The problem is usually insufficient length of the tube that becomes the urethra. As a result, the urethra opens in an abnormal location, resulting in a hypospadias. Occasionally, fissures form in the bladder. These may extend to the surface of the abdomen and fuse with the adjacent skin. This is most often identified as a defect in the bladder although it is technically an epispadias.

Hypospadias in males generally occur alone. Female hypospadias may be associated with abnormalities of the genital tract, since the urinary and genital tracts are formed in the same embryonic process.

Because it represents incomplete development of the penis, some experts think that insufficient male hormone may be responsible for hypospadias.

In males, the incidence of hypospadias is approximately one per 250 to 300 live births. Epispadias is much less common, having an incidence of about one per 100,000 live male births.

In females, hypospadias is much less common than in males. It appears about once in every 500,000 live female births. Epispadias is even rarer. Reliable estimates of the prevalence of epispadias in females are not available. Epispadias in females is often diagnosed and recorded as a bladder anomaly.

Causes and symptoms

Hypospadias and epispadias are congenital defects of the urinary tract. This means that they occur during intrauterine development. There is no genetic basis for the defects. Specific causes for hypospadias are not known. This means that blood relatives do not have increased chances of developing them.

Hypospadias is usually not associated with other defects of the penis or urethra. In males, it can occur at any site along the underside of the penis. In females, the urethra exits the body in an abnormal location. This is usually due to inadequate length of the urethra.

Epispadias is associated with bladder abnormalities. In females, the front wall of the bladder does not fuse or close. The bladder fissure may extend to the external abdominal wall. In such a rare case, the front of the pelvis is also widely separated. In males, the bladder fissure extends into the urethra and simply becomes an opening somewhere along the upper surface of the penis.

Hypospadias is associated with difficulty in assigning gender to babies. This occurs when gender is not obvious at birth because of deformities in the sex organs.

Diagnosis

Male external urinary tract defects are discovered at birth during the first detailed examination of the newborn. Female urethral defects may not be discovered for some time due to the difficulty in viewing the infant vagina.

Treatment

Surgery is the treatment of choice for both hypospadias and epispadias. All surgical repairs should be undertaken early and completed without delay. This minimizes psychological trauma.

In males with hypospadias, one surgery is usually sufficient to repair the defect. With more complicated hypospadias (more than one abnormally situated urethral opening), multiple surgeries may be required. In females with hypospadias, surgical repair is technically more complicated but can usually be completed in a brief interval of time.

Repairing an epispadias is more difficult. In males, this may involve other structures in the penis. Males should not be circumcised since the foreskin is often needed for the repair. Unfortunately, choices may be required that affect the ability to inseminate a female partner. Reproduction requires that the urethral meatus be close to the tip of the penis. Cosmetic appearance and urinary continence are usually the primary goals. Surgery for these defects is successful 70 to 80% of the time. Modern treatment of complete male epispadias allows for an excellent genital appearance and achievement of urinary continence.

In females, repair of epispadias may require multiple surgical procedures. Urinary continence and cosmetic appearance are the usual primary considerations. Urinary continence is usually achieved although cosmetic appearance may be somewhat compromised. Fertility is not usually affected. Repair rates that are similar or better than those for males can usually be achieved for females.

Hypospadias in both males and females is more of a nuisance and hindrance to reproduction than a threat to health. If surgery is not an option, the condition may be allowed to persist. This usually leads to an increased risk of infections in the lower urinary tract.

Prognosis

With adequate surgical repair, most males with simple hypospadias can lead normal lives with a penis that appears and functions in a normal manner. This includes fathering children. Females with simple hypospadias also have normal lives, including conceiving and bearing children.

The prognosis for epispadias depends on the extent of the defect. Most males with relatively minor epispadias lead normal lives, including fathering children. As the extent of the defect increases, surgical reconstruction is generally acceptable. However, many of these men are unable to conceive children. Most epispadias in females can be surgically repaired. The chances of residual disfigurement increase as the extent of the epispadias increases. Fertility in females is not generally affected by epispadias.

Resources

BOOKS

Duckett, John W. "Hypospadias." In *Campbell's Urology*. Edited by Patrick C. Walsh, et al. Philadelphia: W. B. Saunders, 1998, 2093-2116.

Gearhart, John P. and Robert D. Jeffs. "Exstrophy-epispadias complex and bladder anomalies." In *Campbell's Urology,* Edited by Patrick C. Walsh, et al. Philadelphia: W. B. Saunders, 1998, 1977-1982.

Nelson, Waldo E., et al., ed. "Anomalies of the bladder." In *Nelson Textbook of Pediatrics*. Philadelphia: W. B. Saunders, 2000, 1639-1642.

Nelson, Waldo E., et al., ed. "Anomalies of the penis and urethra." In *Nelson Textbook of Pediatrics*. Philadelphia: W. B. Saunders, 2000, 1645-1650.

PERIODICALS

Kajbafzadeh AM, PG Duffy, PG Ransley: "The evolution of penile reconstruction in epispadias repair: a report of 180 cases." *Journal of Urology,* 1995, 154(2 Pt 2):858-61.

Shapiro E; H Lepor, RD Jeffs: "The inheritance of the exstrophy-epispadias complex." *Journal of Urology* (1984), 132(2):308-10.

ORGANIZATIONS

Association for the Bladder Exstrophy Community. PO Box 1472, Wake Forest, NC 27588-1472. (919) 624-9447. <http://www.bladderexstrophy.com/support.htm>.

KEY TERMS

Bladder—This is the organ that stores urine after it flows out of the kidneys and through the ureters.

Circumcision—The surgical removal of the foreskin of the penis.

Continence—Normal function of the urinary bladder and urethra, allowing fluid flow during urination and completely stopping flow at other times.

External meatus—The external opening through which urine and seminal fluid (in males only) leave the body.

Genital tract—The organs involved in reproduction. In a male, they include the penis, testicles, prostate and various tubular structures to transport seminal fluid and sperm. In a female, they include the clitoris, vagina, cervix, uterus, fallopian tubes and ovaries.

Urethra—The tubular portion of the urinary tract connecting the bladder and external meatus through which urine passes. In males, seminal fluid and sperm also pass through the urethra.

Hypospadias Association of America. 4950 S. Yosemite Street, Box F2-156, Greenwood Village, CO 80111. hypospadiasassn@yahoo.com. <http://www.hypospadias.net>.

Support for Parents with Hypospadias Boys. <http://clubs.yahoo.com/clubs/mumswithhypospadiaskids>.

University of California - San Francisco. <http://itsa.ucsf.edu/~uroweb/Uro/hypospadias/index.html>.

OTHER

Hatch, David A., MD. "Abnormal Development of the Penis and Male Urethra." *Genitourinary Development*. <http://www.meddean.luc.edu/lumen/MedEd/urology/abnpendv.htm>.

"Hypospadias." *Atlas of Congenital Deformities of the External Genitalia*. <http://www.atlasperovic.com/contents/9.htm>.

"Hypospadias." Columbia Presbyterian Hospital. <http://cpmcnet.cpmc.columbia.edu/dept/urology/pediatric/hypospadias.html>.

Johns Hopkins University Pediatric Urology Center. "Epispadias." Johns Hopkins Exstrophy Database. <http://www.med.jhu.edu/pediurol/pediatric/exstrophy/database/web4d.html>.

Society for Pediatric Urology. <http://www.spu.org/>.

The Penis.com. <http://www.the-penis.com/hypospadias.html>.

"Hypospadias." University of Michigan. <http://www.urology.med.umich.edu/clinic/pediatric/hypospadias.html>.

L. Fleming Fallon, Jr., MD, PhD, DrPH

Hypotension

Definition

Hypotension is the medical term for low blood pressure.

Description

The pressure of the blood in the arteries rises and falls as the heart and muscles handle demands of daily living, such as **exercise**, sleep and **stress**. Some healthy people have blood pressure well below the average for their age, even though they have a completely normal heart and blood vessels. This is often true of athletes who are in superior shape. The term "hypotension" is usually used only when blood pressure has fallen so far that enough blood can no longer reach the brain, causing **dizziness** and **fainting**.

Causes and symptoms

Postural hypotension is the most common type of low blood pressure. In this condition, symptoms appear after a person sits up or stands quickly. In normal people, the cardiovascular system must make a quick adjustment to raise blood pressure slightly to account for the change in position. For those with postural hypotension, the blood pressure adjustment is not adequate or it doesn't happen. Postural hypotension may occur if someone is taking certain drugs or medicine for high blood pressure. It also happens to diabetics when nerve damage has disrupted the reflexes that control blood pressure.

Many people have a chronic problem with low blood pressure that is not particularly serious. This may include people who require certain medications, who are pregnant, have bad veins, or have arteriosclerosis (hardening of the arteries).

The most serious problem with low blood pressure occurs when there is a sudden drop, which can be life-threatening due to widespread **ischemia** (insufficient supply of blood to an organ due to blockage in an artery). This type of low blood pressure may be due to a wide variety of causes, including:

- trauma with extensive blood loss
- serious burns
- shock from various causes (e.g. anaphylaxis)
- heart attack
- adrenal failure (Addisonian crisis)
- cancer
- severe fever
- serious infection (septicemia)

KEY TERMS

Arteriosclerosis—A group of disorders that causes thickening and loss of elasticity in artery walls.

Diagnosis

Blood pressure is a measure of the pressure in the arteries created by the heart contracting. During the day, a normal person's blood pressure changes constantly, depending on activity. Low blood pressure can be diagnosed by taking the blood pressure with a sphygmomanometer. This is a device with a soft rubber cuff that is inflated around the upper arm until it's tight enough to stop blood flow. The cuff is then slowly deflated until the health care worker, listening to the artery in the arm with a stethoscope, can hear the blood first as a beat forcing its way along the artery. This is the systolic pressure. The cuff is then deflated more until the beat disappears and the blood flows steadily through the open artery; this gives the diastolic pressure.

Blood pressure is recorded as systolic (higher) and diastolic (lower) pressures. A healthy young adult has a blood pressure of about 110/75, which typically rises with age to about 140/90 by age 60 (a reading now considered mildly elevated).

Treatment

Treatment of low blood pressure depends on the underlying cause, which can usually be resolved. For those people with postural hypotension, a medication adjustment may help prevent the problem. These individuals may find that rising more slowly, or getting out of bed in slow stages, helps the problem. Low blood pressure with no other symptoms does not need to be treated.

Prognosis

Low blood pressure as a result of injury or other underlying condition can usually be successfully treated if the trauma is not too extensive or is treated in time. Less serious forms of chronic low blood pressure have a good prognosis and do not require treatment.

Resources

BOOKS

Smeltzer, Suzanne C., and Brenda G. Bare. *Brunner and Suddarth's Textbook of Medical and Surgical Nursing*. 8th ed. Philadelphia: Lippincott-Raven Publishers, 1996.

Carol A. Turkington

Hypothermia

Definition

Hypothermia, a potentially fatal condition, occurs when body temperature falls below 95°F (35°C).

Description

Although hypothermia is an obvious danger for people living in cold climates, many cases have occurred when the air temperature is well above the freezing mark. Elderly people, for instance, have succumbed to hypothermia after prolonged exposure to indoor air temperatures of 50–65°F (10–18.3°C). In the United States, hypothermia is primarily an urban phenomenon associated with **alcoholism**, drug **addiction**, mental illness, and cold—water immersion accidents. The victims are often homeless male alcoholics. Officially, 11,817 deaths were attributed to hypothermia in the United States from 1979 to 1994, but experts suspect that many fatal cases go unrecognized. Nearly half the victims were 65 or older, with males dominating every age group. Nonwhites were also overrepresented in the statistics. Among males 65 and older, nonwhites outnumbered whites by more than four to one.

Causes and symptoms

Measured orally, a healthy person's body temperature can fluctuate between 97°F (36.1°C) and 100°F (37.8°C). Survival depends on maintaining temperature stability within this range by balancing the heat produced by metabolism with the heat lost to the environment through (for the most part) the skin and lungs. When environmental or other changes cause heat loss to outpace heat production, the brain triggers physiological and behavioral responses to restore the balance. The involuntary muscular activity of shivering, for example, aids heat production by accelerating metabolism. But if the cold **stress** is too great and the body's defenses are overwhelmed, body temperature begins to fall. Hypothermia is considered to begin once body temperature reaches 95°F (35°C), though even smaller drops in temperature can have an adverse effect.

Hypothermia is divided into two types: primary and secondary. Primary hypothermia occurs when the body's heat-balancing mechanisms are working properly but are subjected to extreme cold, whereas secondary hypothermia affects people whose heat-balancing mechanisms are impaired in some way and cannot respond adequately to moderate or perhaps even mild cold. Primary hypothermia typically involves exposure to cold air or immersion in cold water. The cold air

variety usually takes at least several hours to develop, but immersion hypothermia will occur within about an hour of entering the water, since water draws heat away from the body much faster than air does. In secondary hypothermia, the body's heat-balancing mechanisms can fail for any number of reasons, including strokes, diabetes, **malnutrition**, bacterial infection, thyroid disease, spinal cord injuries (which prevent the brain from receiving crucial temperature-related information from other parts of the body), and the use of medications and other substances that affect the brain or spinal cord. Alcohol is one such substance. In smaller amounts it can put people at risk by interfering with their ability to recognize and avoid cold-weather dangers. In larger amounts it shuts down the body's heat-balancing mechanisms.

Secondary hypothermia is often a threat to the elderly, who may be on medications or suffering from illnesses that affect their ability to conserve heat. Malnutrition and immobility can also put the elderly at risk. Some medical research suggests as well that shivering and blood vessel narrowing—two of the body's defenses against cold—may not be triggered as quickly in older people. For these and other reasons, the elderly can, over a period of days or even weeks, fall victim to hypothermia in poorly insulated homes or other surroundings that family, friends, and caregivers may not recognize as life threatening. Another risk for the elderly is the fact that hypothermia can easily be misdiagnosed as a **stroke** or some other common illness of old age.

The signs and symptoms of hypothermia follow a typical course, though the body temperatures at which they occur vary from person to person depending on age, health, and other factors. The impact of hypothermia on the nervous system often becomes apparent quite early. Coordination, for instance, may begin to suffer as soon as body temperature reaches 95°F (35°C). The early signs of hypothermia also include cold and pale skin and intense shivering; the latter stops between 90°F (32.2°C) and 86°F (30°C). As body temperature continues to fall, speech becomes slurred, the muscles go rigid, and the victim becomes disoriented and experiences eyesight problems. Other harmful consequences include **dehydration** as well as liver and kidney failure. Heart rate, respiratory rate, and blood pressure rise during the first stages of hypothermia, but fall once the 90°F (32.2°C) mark is passed. Below 86°F (30°C) most victims are comatose, and below 82°F (27.8°C) the heart's rhythm becomes dangerously disordered. Yet even at very low body temperatures, people can survive for several hours and be successfully revived, though they may appear to be dead.

Diagnosis

Information on the patient's prior health and activities often helps doctors establish a correct diagnosis and treatment plan. Pulse, blood pressure, temperature, and respiration require immediate monitoring. Because the temperature of the mouth is not an accurate guide to the body's core temperature, readings are taken at one or two other sites, usually the ear, rectum, or esophagus. Other diagnostic tools include **electrocardiography**, which is used to evaluate heart rhythm, and blood and urine tests, which provide several kinds of key information; a **chest x ray** is also required. A computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) may be needed to check for head and other injuries.

Treatment

Emergency medical help should be summoned whenever a person appears hypothermic. The danger signs include intense shivering; stiffness and numbness in the arms and legs; stumbling and clumsiness; sleepiness, confusion, disorientation, **amnesia**, and irrational behavior; and difficulty speaking. Until emergency help arrives, a victim of outdoor hypothermia should be brought to shelter and warmed by removing wet clothing and footwear, drying the skin, and wrapping him or her in warm blankets or a sleeping bag. Gentle handling is necessary when moving the victim to avoid disturbing the heart. Rubbing the skin or giving the victim alcohol can be harmful, though warm drinks such as clear soup and tea are recommended for those who can swallow. Anyone who aids a victim of hypothermia should also look for signs of frostbite and be aware that attempting to rewarm a frostbitten area of the body before emergency help arrives can be extremely dangerous. For this reason, frostbitten areas must be kept away from heat sources such as campfires and car heaters.

Rewarming is the essence of hospital treatment for hypothermia. How rewarming proceeds depends on the body temperature. Different approaches are used for patients who are mildly hypothermic (the patient's body temperature is 90–95°F [32.2–35°C]), moderately hypothermic (86–90°F [30–32.2°C]), or severely hypothermic (less than 86°F [30°C]). Other considerations, such as the patient's age or the condition of the heart, can also influence treatment choices.

Mild hypothermia is reversed with passive rewarming. This technique relies on the patient's own metabolism to rewarm the body. Once wet clothing is removed and the skin is dried, the patient is covered with blankets and placed in a warm room. The goal is to raise the patient's temperature by 0.5–2°C an hour.

Moderate hypothermia is often treated first with active external rewarming and then with passive rewarm-

ing. Active external rewarming involves applying heat to the skin, for instance by placing the patient in a warm bath or wrapping the patient in electric heating blankets.

Severe hypothermia requires active internal rewarming, which is recommended for some cases of moderate hypothermia as well. There are several types of active internal rewarming. Cardiopulmonary bypass, in which the patient's blood is circulated through a rewarming device and then returned to the body, is considered the best, and can raise body temperature by 1–2°C every 3–5 minutes. However, many hospitals are not equipped to offer this treatment. The alternative is to introduce warm oxygen or fluids into the body.

Hypothermia treatment can also include, among other things, insulin, **antibiotics**, and fluid replacement therapy. When the heart has stopped, both **cardiopulmonary resuscitation** (**CPR**) and rewarming are necessary. Once a patient's condition has stabilized, he or she may need treatment for an underlying problem such as alcoholism or thyroid disease.

Prognosis

Victims of mild or moderate hypothermia usually enjoy a complete recovery. In regard to severely hypothermic patients, the prognosis for survival varies due to differences in people's physiological responses to cold.

Prevention

People who spend time outdoors in cold weather can reduce heat loss by wearing their clothing loosely and in layers and by keeping their hands, feet, and head well covered (30–50% of body heat is lost through the head). Because water draws heat away from the body so easily, staying dry is important, and wet clothing and footwear should be replaced as quickly as possible. Wind- and water-resistant outer garments are also crucial. Alcohol should be avoided because it promotes heat loss by expanding the blood vessels that carry body heat to the skin.

Preventing hypothermia among the elderly requires vigilance on the part of family, friends, and caregivers. An elderly person's home should be properly insulated and heated, with living areas kept at a temperature of 70°F (21.1°C). Warm clothing and bedding are essential, as are adequate food, rest, and **exercise**; warming the bed and bedroom before going to sleep is also recommended. Older people who live alone should be visited regularly—at least once a day during very cold weather—to ensure that their health remains sound and that they are taking good care of themselves. For help and advice, family members and others can turn to government and social service agencies. Meals on wheels and visiting nurse programs, for instance, may be available, and it may be possible to obtain financial aid for winterizing and heating homes.

KEY TERMS

Antibiotics—Substances used against microorganisms that cause infection.

Computed tomography—A process that uses x rays to create three-dimensional images of structures inside the body.

Esophagus—A muscular tube through which food and liquids pass on their way to the stomach.

Insulin—A substance that regulates blood glucose levels. Glucose is a sugar.

Magnetic resonance imaging—The use of electromagnetic energy to create images of structures inside the body.

Metabolism—The chemical changes by which the body breaks down food and other substances and builds new substances necessary for life.

Nervous system—The system that transmits information, in the form of electrochemical impulses, throughout the body. It comprises the brain, spinal cord, and nerves.

Rectum—The lower section of the large intestine. The intestines are part of the digestive system.

Stroke—A condition involving loss of blood flow to the brain.

Thyroid—A gland (fluid-secreting structure) in the neck. It plays an important role in metabolism.

Resources

BOOKS

Danzl, Daniel F. "Disturbances Due to Cold." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Danzl, Daniel F., Robert S. Pozos, and Murray P. Hamlet. "Accidental Hypothermia." In *Wilderness Medicine: Management of Wilderness and Environmental Emergencies*, ed. Paul S. Auerbach. St. Louis: Mosby, 1995.

Mills Jr., W. J., and R. S. Pozos. "Low Temperature Effects on Humans." In *Encyclopedia of Human Biology*, ed. Renato Dulbecco. San Diego: Academic Press, 1997.

Petty, Kevin J. "Hypothermia." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Howard Baker

Hypothyroidism

Definition

Hypothyroidism, or underactive thyroid, develops when the thyroid gland fails to produce or secrete as much thyroxine (T_4) as the body needs. Because T_4 regulates such essential functions as heart rate, digestion, physical growth, and mental development, an insufficient supply of this hormone can slow life-sustaining processes, damage organs and tissues in every part of the body, and lead to life-threatening complications.

Description

Hypothyroidism is one of the most common chronic diseases in the United States. Symptoms may not appear until years after the thyroid has stopped functioning and they are often mistaken for signs of other illnesses, **menopause**, or **aging**. Although this condition is believed to affect as many as 11 million adults and children, as many as two of every three people with hypothyroidism may not know they have the disease.

Nicknamed "Gland Central" because it influences almost every organ, tissue, and cell in the body, the thyroid is shaped like a butterfly and located just below the Adam's apple. The thyroid stores iodine the body gets from food and uses this mineral to create T_4. Low T_4 levels can alter weight, appetite, sleep patterns, body temperature, sex drive, and a variety of other physical, mental, and emotional characteristics.

There are three types of hypothyroidism. The most common is primary hypothyroidism, in which the thyroid doesn't produce an adequate amount of T_4. Secondary hypothyroidism develops when the pituitary gland does not release enough of the thyroid-stimulating hormone (TSH) that prompts the thyroid to manufacture T_4. Tertiary hypothyroidism results from a malfunction of the hypothalamus, the part of the brain that controls the endocrine system. Drug-induced hypothyroidism, an adverse reaction to medication, occurs in two of every 10,000 people, but rarely causes severe hypothyroidism.

Hypothyroidism is at least twice as common in women as it is in men. Although hypothyroidism is most common in women who are middle-aged or older, the disease can occur at any age. Newborn infants are tested for congenital thyroid deficiency (cretinism) using a test that measures the levels of thyroxine in the infant's blood. Treatment within the first few months of life can prevent **mental retardation** and physical abnormalities. Older children who develop hypothyroidism suddenly stop growing.

Factors that increase a person's risk of developing hypothyroidism include age, weight, and medical history. Women are more likely to develop the disease after age 50; men, after age 60. **Obesity** also increases risk. A family history of thyroid problems or a personal history of **high cholesterol** levels or such autoimmune diseases as lupus, **rheumatoid arthritis**, or diabetes can make an individual more susceptible to hypothyroidism.

Causes and symptoms

Hypothyroidism is most often the result of Hashimoto's disease, also known as chronic **thyroiditis** (inflammation of the thyroid gland). In this disease, the immune system fails to recognize that the thyroid gland is part of the body's own tissue and attacks it as if it were a foreign body. The attack by the immune system impairs thyroid function and sometimes destroys the gland. Other causes of hypothyroidism include:

- Radiation. Radioactive iodine used to treat **hyperthyroidism** (overactive thyroid) or radiation treatments for head or neck cancers can destroy the thyroid gland.
- Surgery. Removal of the thyroid gland because of **cancer** or other thyroid disorders can result in hypothyroidism.
- Viruses and bacteria. Infections that depress thyroid hormone production usually cause permanent hypothyroidism.
- Medication. Nitroprusside, lithium, or iodides can induce hypothyroidism. Because patients who use these medications are closely monitored by their doctors, this side effect is very rare.
- Pituitary gland malfunction. This is a rare condition in which the pituitary gland fails to produce enough TSH to activate the thyroid's production of T_4.
- Congenital defect. One of every 4,000 babies is born without a properly functioning thyroid gland.
- Diet. Because the thyroid makes T_4 from iodine drawn from food, an iodine-deficient diet can cause hypothyroidism. Adding iodine to table salt and other common foods has eliminated iodine deficiency in the United States. Certain foods (cabbage, rutabagas, peanuts, peaches, soybeans, spinach) can interfere with thyroid hormone production.
- Environmental contaminants. Certain man-made chemicals-such as PCBs-found in the local environment at high levels may also cause hypothyroidism.

Hypothyroidism is sometimes referred to as a "silent" disease because early symptoms may be so mild that no one realizes anything is wrong. Untreated symptoms become more noticeable and severe, and can lead to confusion and mental disorders, breathing difficulties, heart problems, fluctuations in body temperature, and **death**.

Someone who has hypothyroidism will probably have more than one of the following symptoms:

- fatigue
- decreased heart rate
- progressive **hearing loss**
- weight gain
- problems with memory and concentration
- depression
- goiter (enlarged thyroid gland)
- muscle **pain** or weakness
- loss of interest in sex
- numb, tingling hands
- dry skin
- swollen eyelids
- dryness, loss, or premature graying of hair
- extreme sensitivity to cold
- **constipation**
- irregular menstrual periods
- hoarse voice

Hypothyroidism usually develops gradually. When the disease results from surgery or other treatment for hyperthyroidism, symptoms may appear suddenly and include severe muscle cramps in the arms, legs, neck, shoulders, and back.

It's important to see a doctor if any of these symptoms appear unexpectedly. People whose hypothyroidism remains undiagnosed and untreated may eventually develop myxedema. Symptoms of this rare but potentially deadly complication include enlarged tongue, swollen facial features, hoarseness, and physical and mental sluggishness.

Myxedema **coma** can cause unresponsiveness; irregular, shallow breathing; and a drop in blood pressure and body temperature. The onset of this medical emergency can be sudden in people who are elderly or have been ill, injured, or exposed to very cold temperatures; who have recently had surgery; or who use sedatives or antidepressants. Without immediate medical attention, myxedema coma can be fatal.

KEY TERMS

Cretinism—Severe hypothyroidism that is present at birth.

Endocrine system—The network of glands that produce hormones and release them into the bloodstream. The thyroid gland is part of the endocrine system.

Hypothalamus—The part of the brain that controls the endocrine system.

Myxedema—A condition that can result from a thyroid gland that produces too little of its hormone. In addition to a decreased metabolic rate, symptoms may include anemia, slow speech, an enlarged tongue, puffiness of the face and hands, loss of hair, coarse and thickened skin, and sensitivity to cold.

Pituitary gland—Small, oval endocrine gland attached to the hypothalamus. The pituitary gland releases TSH, the hormone that activates the thyroid gland.

Thyroid-stimulating hormone (TSH)—A hormone secreted by the pituitary gland that controls the release of T_4 by the thyroid gland.

Thyroxine (T_4)—Thyroid hormone that regulates many essential body processes.

Diagnosis

Diagnosis of hypothyroidism is based on the patient's observations, medical history, **physical examination**, and **thyroid function tests**. Doctors who specialize in treating thyroid disorders (endocrinologists) are most apt to recognize subtle symptoms and physical indications of hypothyroidism. A blood test known as a thyroid-stimulating hormone (TSH) assay, **thyroid nuclear medicine scan**, and **thyroid ultrasound** are used to confirm the diagnosis. A woman being tested for hypothyroidism should let her doctor know if she is pregnant or breastfeeding and all patients should be sure their doctors are aware of any recent procedures involving radioactive materials or contrast media.

The TSH assay is extremely accurate, but some doctors doubt the test's ability to detect mild hypothyroidism. They advise patients to monitor their basal (resting) body temperature for below-normal readings that could indicate the presence of hypothyroidism.

Treatment

Natural or synthetic **thyroid hormones** are used to restore normal (euthyroid) thyroid hormone levels. Synthetic hormones are more effective than natural substances, but it may take several months to determine the correct dosage. Patients start to feel better within 48 hours, but symptoms will return if they stop taking the medication.

Most doctors prescribe levothyroxine sodium tablets, and most people with hypothyroidism will take the med-

ication for the rest of their lives. Aging, other medications, and changes in weight and general health can affect how much replacement hormone a patient needs, and regular TSH tests are used to monitor hormone levels. Patients should not switch from one brand of thyroid hormone to another without a doctor's permission.

Regular **exercise** and a high-fiber diet can help maintain thyroid function and prevent constipation.

Alternative treatment

Alternative treatments are primarily aimed at strengthening the thyroid and will not eliminate the need for thyroid hormone medications. Herbal remedies to improve thyroid function and relieve symptoms of hypothyroidism include bladder wrack (*Fucus vesiculosus*), which can be taken in capsule form or as a tea. Some foods, including cabbage, peaches, radishes, soybeans, peanuts, and spinach, can interfere with the production of thyroid hormones. Anyone with hypothyroidism may want to avoid these foods. The Shoulder Stand **yoga** position (at least once daily for 20 minutes) is believed to improve thyroid function.

Prognosis

Thyroid **hormone replacement therapy** generally maintains normal thyroid hormone levels unless treatment is interrupted or discontinued.

Prevention

Primary hypothyroidism can't be prevented, but routine screening of adults could detect the disease in its early stages and prevent complications.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

Langer, Stephen, and James F. Scheer. *Hypothyroidism: The Unsuspected Illness*. Keats Publishing, 1995.

Rosenthal, M. Sara. *The Thyroid Sourcebook: Everything You Need to Know.* Lowell House, 1996.

Wood, Lawrence C., David S. Cooper, and E. Chester Ridgway. *Your Thyroid: A Home Reference*. Ballantine Books, 1996.

PERIODICALS

Dranov, P. "Tired? Wired? It Could Be Your Thyroid." *American Health* (May 1994): 90-93.

Drexler, Madeline. "The Disease Doctors Miss." *McCall's*, Oct. 1996, 112.

"Experts Urge Testing for Sluggish Thyroid." *Tufts University Health & Nutrition Letter* (Mar. 1997): 1.

"Recognizing and Treating Thyroid Problems." *Health After 50* (Aug. 1996): 6.

"Underactive Thyroid" *Mayo Clinic Health Letter* (Mar. 1996): 1-3.

ORGANIZATIONS

American Thyroid Association. Montefiore Medical Center, 111 E. 210th St., Bronx, NY 10467.

Endocrine Society. 4350 East West Highway, Suite 500, Bethesda, MD 20814-4410. (301) 941-0200.

Thyroid Foundation of America, Inc. Ruth Sleeper Hall, RSL 350, Boston, MA 02114-2968. (800) 832-8321 or (617) 726-8500.

Thyroid Society for Education and Research. 7515 S. Main St., Suite 545, Houston, TX 77030. (800) THYROID or (713) 799-9909.

OTHER

Haggerty, Maureen. "AACE Guidelines for the Evaluation and Treatment of Hyperthyroidism and Hypothyroidism." *A Healthy Me Page*. 13 Dec. 1997 <http://www.ahealthyme.com/topic/topic47578>.

Caroll, Linda. "Routine Screening for Thyroid Disorders Cost-Effective." 13 Dec. 1997 <http://www.pharmacy-web.com/WHP/InfoService/MedTribune/Abstract/M960723c.html>.

"EDRI Federal Project Inventory: Disruption of Thyroid Hormone Action by Environmental Agents - Impact on Brain Development." *Environmental Protection Agency.* 13 Dec. 1997 <http://www.epa.gov/epahome/index.html>.

"FAQ on Hashimoto's Thyroiditis." 13 Dec. 1997 <http://www.geocities.com/Athens/3626/hashimoto>.

"Hypothyroidism." *National Institute of Health.* 12 Dec. 1997 <http://www.cc.nih.gov>.

"Hypothyroidism." *InteliHealth Page*. 10 Dec. 1998 <http://www.intelihealth.com>.

Haggerty, Maureen. "Hypothyroidism." *A Healthy Me Page*. 14 Dec. 1997 <http://www.ahealthyme.com/topic/topic47578>.

Mickelson, Alana. "Unmasking Thyroid Disease." 13 Dec. 1997 <http://www.-med.stanford.edu/center/communications./Stanmed/Summer95/hyroid.htm>.

"Thyroid Conditions." *American Medical Women's Association Page*. 8 Dec. 1997 <http://www.amwa-doc.org/thyroid.html>.

"Thyroid Disorders." *Columbia University Health Sciences Page*. 12 Dec. 1997 <http://cpmcnet.columbia.edu>.

Maureen Haggerty

Hypotonic duodenography

Definition

Hypotonic duodenography is an x-ray procedure that produces images of the duodenum. The duodenum is the first part of the small intestine.

Purpose

Hypotonic duodenography may be ordered to detect tumors of the head of the pancreas or the area where the pancreatic and bile ducts meet the small intestine. Lesions causing upper abdominal **pain** may be demonstrated by duodenography, and the procedure can aid in the diagnosis of chronic **pancreatitis**.

Precautions

Some patients with narrowing of the tubes in the upper gastrointestinal tract should not receive duodenography. Patients with certain heart disorders and **glaucoma** are cautioned against receiving an agent called anticholinergic, which is administered during the procedure to lessen intestinal muscle spasms. A hormone called glucagon may also be used to relax the intestines, but its use is not recommended in patients with most forms of diabetes.

Description

Hypotonic duodenography is also referred to as x ray of the duodenum or simply as duodenography. The patient is seated while the radiologist places a catheter in the nose and down into the stomach. Then the patient lies down and the tube is continued to the duodenum. The radiologist is guided in this placement by a fluoroscopic image. (Fluoroscopic equipment shows an immediate x ray. In this case, the x ray shows the location of the catheter as it is moved into the stomach and duodenum.) Next, either the glucagon is administered intravenously or anticholinergic is injected into the patient to relax the muscles of the intestine.

After several minutes, the physician will administer barium through the catheter. Barium is a contrast agent that will help highlight the area on the fluoroscopy screen and x rays. After a few films are taken, some of the barium is withdrawn and air is sent in through the catheter. Additional images are acquired and the catheter is then removed. The procedure takes from 30–60 minutes.

Preparation

Patients are required to fast from midnight before the test until after the test, or about 6–12 hours. Just prior to the exam, patients should remove dentures, glasses, and other objects that may interfere with the procedure. The patient may be instructed to empty his or her bladder just prior to duodenography.

Aftercare

The barium should be expelled within two to three days. Extra fluids and/or an agent given by the physician to help encourage bowel movement may aid in barium elimination. Physicians and patients should watch for possible reactions to the anticholinergic or glucagon. If an anticholinergic is used, patients are advised to empty their bladder within a few hours after the exam and to wait two hours for clearing of vision or have someone drive them home. Patients will notice that their stools are chalky white from the barium for one to three days following the procedure.

KEY TERMS

Anticholinergic—A drug that lessens muscle spasms in the intestines, lungs, bladder, and eye muscles.

Fluoroscopic (fluoroscopy)—An x-ray procedure that produces immediate images and motion on a screen. The images look like those seen at airport baggage security stations.

Glucagon—A hormone that changes glycogen, a carbohydrate stored in muscles and the liver, into glucose. It can be used to relax muscles for a procedure such as duodenography.

Pancreas—A five-inch-long gland that lies behind the stomach and next to the duodenum. The pancreas releases glucagon, insulin and some of the enzymes which aid digestion. Pancreatitis is the swelling of the pancreas which can nausea, jaundice, and severe pain and may be fatal.

Risks

Abdominal cramping may occur when the physician instills air into the duodenum, but aside from the discomfort, there are few risks associated with this procedure. Side effects from the contrast, hormones or agents may occur. Those patients with diabetes, heart disease, or glaucoma run the highest risk of reaction and should not receive anticholinergic or glucagon, depending on their specific conditions. Elderly patients or those who are extremely ill, must be closely monitored during the procedure for possible return of fluid, or gastric reflux.

Normal results

The linings of the duodenum and surrounding tissues will look smooth and even. The shape of the head of the pancreas will appear normal and near the duodenal wall.

Abnormal results

Any masses or irregular nodules on the wall of the duodenum may indicate tumors or abnormality of tissue. Tumors of the head of the pancreas or of the opening into the intestine from the pancreatic and bile ducts may be seen. Chronic pancreatitis may be indicated on the x rays. In many instances, follow-up laboratory or imaging studies may be ordered to further study the abnormal findings and confirm a diagnosis.

Resources

BOOKS

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

ORGANIZATIONS

American College of Radiology. 1891 Preston White Drive, Reston, VA 22091. (800) 227-5463. <http://www.acr.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Teresa Norris

Hypovolemic shock *see* **Shock**

Hysterectomy

Definition

Hysterectomy is the surgical removal of the uterus. In a total hysterectomy, the uterus and cervix are removed. In some cases, the fallopian tubes and ovaries are removed along with the uterus (called hysterectomy with bilateral **salpingo-oophorectomy**). In a subtotal hysterectomy, only the uterus is removed. In a radical hysterectomy, the uterus, cervix, ovaries, oviducts, lymph nodes, and lymph channels are removed. The type of hysterectomy performed depends on the reason for the procedure. In all cases, menstruation stops and a woman loses the ability to bear children.

Purpose

Hysterectomy is the second most common operation performed in the United States. About 556,000 of these surgeries are done annually. By age 60, approximately one out of every three American women will have had a hysterectomy. Yet it's estimated that 30 percent of hysterectomies are unnecessary.

About 10% of hysterectomies are performed to treat **cancer** of the cervix, ovaries, or uterus. Women with cancer in one or more of these organs almost always have the organ(s) removed as one part of their cancer treatment.

The most frequent reason for hysterectomy in the United States is to remove fibroid tumors, accounting for 30% of these surgeries. Fibroid tumors are noncancerous (benign) growths in the uterus, which can cause pelvic and **low back pain** and heavy or lengthy menstrual periods. They occur in 30–40% of women over age 40, and are three times more likely to be present in African-American women than in Caucasian women. Fibroids do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Treatment of **endometriosis** is the reason for 20% of hysterectomies. The endometrium is the lining of the uterus. Endometriosis is a condition that occurs when the cells from the endometrium begin growing outside the uterus. The outlying endometrial cells respond to the hormones that control the menstrual cycle, bleeding each month the way the lining of the uterus does. This causes irritation of the surrounding tissue, leading to **pain** and scarring.

Another 20% percent of hysterectomies are done because of heavy or abnormal vaginal bleeding that can not be linked to any specific cause and cannot be controlled by other means. The remaining 20% of hysterectomies are performed to treat prolapsed uterus, **pelvic inflammatory disease**, and endometrial hyperplasia, a potentially precancerous condition.

Alternatives

There are several alternatives to hysterectomy today. They include:

Embolization

Uterine artery embolization is not a surgical procedure. Instead, interventional radiologists put a catherter into the artery that leads to the uterus and inject polyvinyl alcohol particles right where the artery leads to the blood vessels that nourish the fibroids. By killing off those blood vessels, the fibroids have no more blood supply, and they die off. Severe cramping and pain after the procedure is common, but serious complications are less than .5 percent and it may protect fertility.

Myomectomy

A **myomectomy** is a surgery used to remove fibroids, thus avoiding a hysterectomy. Hysteroscopic myomectomy, in which a surgical "telescope," or laparascope, is inserted into the uterus through the vagina

can be done on an outpatient basis. If there are large fibroids, however, an abdominal incision is required. Then women typically are hospitalized for two to three days, and require up to six weeks recovery. However, laparascopic myomectomies are also being done more often. They only require three small incisions in the abdomen, and have a much shorter hospitalization and recovery time.

Once the fibroids have been removed, the surgeon must repair the wall of the uterus to eliminate future bleeding or infection.

Endometrial ablation

In this surgical procedure, recommended for women with small fibroids, the entire lining of the uterus is removed. Women are no longer fertile, however. The uterine cavity is filled with fluid and a **hysteroscopy**, or telescope, inserted to provide a clear view of the uterus. Then the uterus is destroyed using a laser beam or electric voltage. The procedure is typically done under anesthesia, although women can go home the same day as the surgery. Another, newer procedure involves using a balloon, which is filled with superheated liquid and inflated until it fills the uterus. The liquid kills the lining, and after 8 minutes the balloon is removed.

Endometrial resection

Like endometrial ablation, the uterine lining is also destroyed during this procedure, only instead of a laser, an electrosurgical wire loop is used.

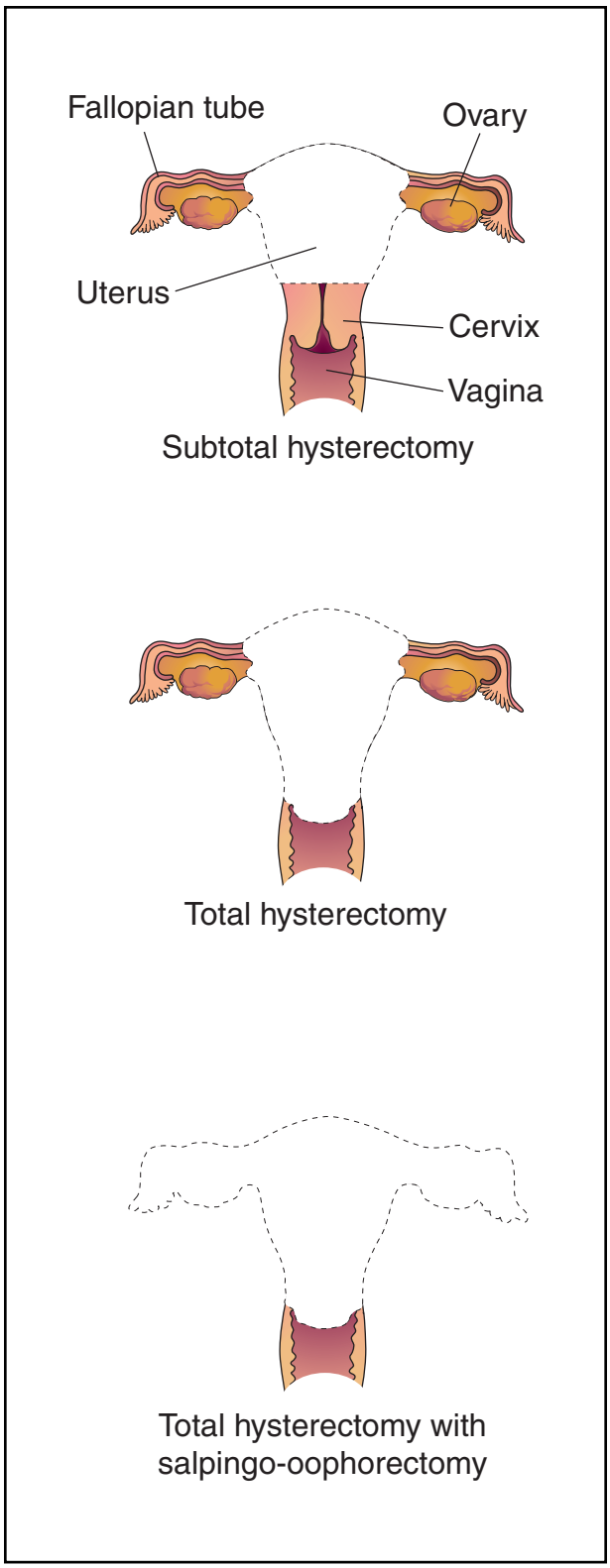
Total hysterectomy

A total hysterectomy, sometimes called a simple hysterectomy, removes the entire uterus and the cervix. The ovaries are not removed and continue to secrete hormones. Total hysterectomies are always performed in the case of uterine and **cervical cancer**. This is the most common kind of hysterectomy.

Sometimes, in addition to a total hysterectomy a procedure called a bilateral salpingo-oophorectomy is performed. This surgery removes the ovaries and the fallopian tubes. Removal of the ovaries eliminates the main source of the hormone estrogen, so **menopause** occurs immediately. Removal of the ovaries and fallopian tubes is performed in about one-third of hysterectomy operations, often to reduce the risk of **ovarian cancer**.

Subtotal hysterectomy

If the reason for the hysterectomy is to remove **uterine fibroids**, treat abnormal bleeding, or relieve pelvic



Three types of hysterectomies: subtotal, total, and total with salpingo-oophorectomy. *(Illustration by Electronic Illustrators Group.)*

pain, it may be possible to remove only the uterus and leave the cervix. This procedure, called a subtotal hysterectomy (or partial hysterectomy), removes the least amount of tissue. The opening to the cervix is left in place. Some women feel that leaving the cervix intact aids in their achieving sexual satisfaction. This procedure, which used to be rare, is now performed more frequently when requested.

Subtotal hysterectomy is easier to perform than a total hysterectomy, but leaves a woman at risk for cervical cancer. She will still need to get yearly pap smears.

Radical hysterectomy

Radical hysterectomies are performed on women with cervical cancer or **endometrial cancer** that has spread to the cervix. A radical hysterectomy removes the uterus, cervix, top part of the vagina, ovaries, fallopian tubes, lymph nodes, lymph channels, and tissue in the pelvic cavity that surrounds the cervix. This type of hysterectomy removes the most tissue and requires the longest hospital stay and longer recovery period.

Precautions

The frequency with which hysterectomies are performed in the United States has been questioned in recent years. It has been suggested that a large number of hysterectomies are performed unnecessarily. The United States has the highest rate of hysterectomies (number of hysterectomies per thousand women) of any country in the world. Also, the frequency of this surgery varies across different regions of the United States. Rates are highest in the South and Midwest, and are higher for African American women. In recent years, although the number of hysterectomies performed has declined, the number of hysterectomies performed on younger women in their 30s and 40s is increasing, and 55 percent of all hysterectomies are performed on women 35 to 49.

Women for whom a hysterectomy is recommended should discuss possible alternatives with their doctor and consider getting a second opinion, since this is major surgery with life-changing implications. Alternative treatments exist for many conditions. Whether these alternatives are appropriate for any individual woman is a decision she and her doctor should make together.

As in all major surgery, the health of the patient affects the risk of the operation. Women who have chronic heart or lung diseases, diabetes, or iron-deficiency anemia may not be good candidates for this operation. Heavy **smoking**, **obesity**, use of steroid drugs, and use of illicit drugs add to the surgical risk.

Description

There are two ways that hysterectomies can be performed. The choice of method depends on the type of hysterectomy, the doctor's experience, and the reason for the hysterectomy.

Abdominal hysterectomy

About 75% of hysterectomies performed in the United States are abdominal hysterectomies. The surgeon makes a four to six inch incision either horizontally across the pubic hair line from hip bone to hip bone or vertically from navel to pubic bone. Horizontal incisions leave a less noticeable scar, but vertical incisions give the surgeon a better view of the abdominal cavity. The blood vessels, fallopian tubes, and ligaments are cut away from the uterus, which is lifted out.

Abdominal hysterectomies take from one to three hours. The hospital stay is three to five days, and it takes four to eight weeks to return to normal activities.

The advantages of an abdominal hysterectomy are that the uterus can be removed even if a woman has internal scarring (adhesions) from previous surgery or her fibroids are large. The surgeon has a good view of the abdominal cavity and more room to work. Also, surgeons have the most experience with this type of hysterectomy. The abdominal incision is more painful than with vaginal hysterectomy and the recovery period is longer.

Vaginal hysterectomy

With a vaginal hysterectomy, the surgeon makes an incision near the top of the vagina. The surgeon then reaches through this incision to cut and tie off the ligaments, blood vessels, and fallopian tubes. Once the uterus is cut free, it is removed through the vagina. The operation takes one to two hours. The hospital stay is usually one to three days, and return to normal activities takes about four weeks.

The advantages of this procedure are that it leaves no visible scar and is less painful. The disadvantage is that it is more difficult for the surgeon to see the uterus and surrounding tissue. This makes complications more common. Large fibroids cannot be removed using this technique. It is very difficult to remove the ovaries during a vaginal hysterectomy, so this approach may not be possible if the ovaries are involved.

Vaginal hysterectomy can also be performed using a laparoscopic technique. With this surgery, a tube containing a tiny camera is inserted through an incision in the navel. This allows the surgeon to see the uterus on a video monitor. The surgeon then inserts two slender instruments through small incisions in the abdomen and

uses them to cut and tie off the blood vessels, fallopian tubes, and ligaments. When the uterus is detached, it is removed though a small incision at the top of the vagina.

This technique, called laparoscopic-assisted vaginal hysterectomy, allows surgeons to perform a vaginal hysterectomy that might be too difficult otherwise. The hospital stay is usually only one day. Recovery time is about two weeks. The disadvantage is that this operation is relatively new and requires great skill by the surgeon.

Any vaginal hysterectomy may have to be converted to an abdominal hysterectomy during surgery if complications develop.

Preparation

Before surgery the doctor will order blood and urine tests. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. On the evening before the operation, the woman should eat a light dinner and then avoid eating or drinking anything.

Aftercare

After surgery a woman will feel pain. The degree of discomfort varies, and is generally greatest in abdominal hysterectomies because of the incision. Hospital stays vary from about two days (laparoscopic-assisted vaginal hysterectomy) to five or six days (abdominal hysterectomy with bilateral salpingo-oophorectomy). During the hospital stay, the doctor will probably order more blood tests.

Return to normal activities such as driving and working takes anywhere from two to eight weeks, again depending on the type of surgery. Some women have emotional changes following a hysterectomy. Women who have had their ovaries removed will probably start taking **hormone replacement therapy**.

Risks

Hysterectomy is a relatively safe operation, although like all major surgery it carries risks. These include unanticipated reaction to anesthesia, internal bleeding, blood clots, damage to other organs such as the bladder, and post-surgery infection. The risk of **death** is about one in every 1,000 (1/1,000) women having the operation.

Other complications sometimes reported after a hysterectomy include changes in sex drive, weight gain, **constipation**, and pelvic pain. Hot flashes and other symptoms of menopause can occur if the ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for heart disease and **osteoporosis** (a condition that causes bones to be brittle). Women with a history of psychological and emotional problems before the hysterectomy are more likely to experience psychological difficulties after the operation.

KEY TERMS

Cervix—The lower part of the uterus extending into the vagina.

Fallopian tubes—Slender tubes that carry eggs (ova) from the ovaries to the uterus.

Lymph nodes—Small, compact structures lying along the channels that carry lymph, a yellowish fluid. Lymph nodes produce white blood cells (lymphocytes), which are important in forming antibodies that fight disease.

Prolapsed uterus—A uterus that has slipped out of place, sometimes protruding down through the vagina.

Normal results

Although there is some concern that hysterectomies may be performed unnecessarily, there are many conditions for which the operation improves a woman's quality of life. In the Maine Woman's Health Study, 71% of women who had hysterectomies to correct moderate or severe painful symptoms reported feeling better mentally, physically, and sexually after the operation.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Hysterectomy." In *The Harvard Guide to Women's Health,* Cambridge, MA: Harvard University Press, 1996, pp. 308-313.

Griffith, H. Winter. "Hysterectomy." In *The Complete Guide to Symptoms, Illness and Surgery,* 3rd ed. New York: Berkeley Publishing, 1995, pp. 818-825.

ORGANIZATION

American Cancer Society. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. (800) 4-CANCER. <http://www.nci.nih.gov>.

OTHER

Parker, William H. "A Gynecologist's Second Opinion." <http://www.gynsecondopinion.com>.

Debra Gordon

Hysteria

Definition

The term "hysteria" has been in use for over 2,000 years and its definition has become broader and more diffuse over time. In modern psychology and psychiatry, hysteria is a feature of hysterical disorders in which a patient experiences physical symptoms that have a psychological, rather than an organic, cause; and histrionic personality disorder characterized by excessive emotions, dramatics, and attention-seeking behavior.

Description

Hysterical disorders

Patients with hysterical disorders, such as conversion and somatization disorder experience physical symptoms that have no organic cause. Conversion disorder affects motor and sensory functions, while somatization affects the gastrointestinal, nervous, cardiopulmonary, or reproductive systems. These patients are not "faking" their ailments, as the symptoms are very real to them. Disorders with hysteric features typically begin in adolescence or early adulthood.

Histrionic personality disorder

Histrionic personality disorder has a prevalence of approximately 2–3% of the general population. It begins in early adulthood and has been diagnosed more frequently in women than in men. Histrionic personalities are typically self-centered and attention seeking. They operate on emotion, rather than fact or logic, and their conversation is full of generalizations and dramatic appeals. While the patient's enthusiasm, flirtatious behavior, and trusting nature may make them appear charming, their need for immediate gratification, mercurial displays of emotion, and constant demand for attention often alienates them from others.

Causes and symptoms

Hysterical disorders

Hysteria may be a defense mechanism to avoid painful emotions by unconsciously transferring this distress to the body. There may be a symbolic function for this, for example a rape victim may develop paralyzed legs. Symptoms may mimic a number of physical and neurological disorders which must be ruled out before a diagnosis of hysteria is made.

Histrionic personality disorder

According to the *Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition (*DSM-IV*), individuals with histrionic personality possess at least five of the following symptoms or personality features:

- a need to be the center of attention
- inappropriate, sexually seductive, or provocative behavior while interacting with others
- rapidly changing emotions and superficial expression of emotions
- vague and impressionistic speech (gives opinions without any supporting details)
- easily influenced by others
- believes relationships are more intimate than they are

Diagnosis

Hysterical disorders frequently prove to be actual medical or neurological disorders,which makes it important to rule these disorders out before diagnosing a patient with hysterical disorders. In addition to a patient interview, several clinical inventories may be used to assess the patient for hysterical tendencies, such as the Minnesota Multiphasic Personality Inventory-2 (**MMPI-2**) or the Millon Clinical Multiaxial Inventory-III (MCMI-III). These tests may be administered in an outpatient or hospital setting by a psychiatrist or psychologist.

Treatment

Hysterical disorders

For people with hysterical disorders, a supportive healthcare environment is critical. Regular appointments with a physician who acknowledges the patient's physical discomfort are important. Psychotherapy may be attempted to help the patient gain insight into the cause of their distress. Use of behavioral therapy can help to avoid reinforcing symptoms.

Histrionic personality disorder

Psychotherapy is generally the treatment of choice for histrionic personality disorder. It focuses on supporting the patient and on helping develop the skills needed to create meaningful relationships with others.

Prognosis

Hysterical disorders

The outcome for hysterical disorders varies by type. Somatization is typically a lifelong disorder, while conversion disorder may last for months or years. Symptoms of hysterical disorders may suddenly disappear, only to reappear in another form later.

Histrionic personality disorder

Individuals with histrionic personality disorder may be at a higher risk for suicidal gestures, attempts, or threats in

KEY TERMS

Conversion disorder—A psychological disorder that alters motor or sensory functions. Paralysis, blindness, anesthesia (lack of feeling), coordination or balance problems, and seizures are all common symptoms of the disorder.

Somatization disorder—The appearance of physical symptoms in the gastrointestinal system, the nervous system, the cardiopulmonary system, or the reproductive system that have no organic cause.

an effort to gain attention. Providing a supportive environment for patients with both hysterical disorders and histrionic personality disorder is key to helping these patients.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S., and Nicholas G. Ward. "Mood Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Shorter, Edward. *From Paralysis to Fatigue: A History of Psychosomatic Illness in the Modern Era*. New York: The Free Press, 1992.

Shorter, Edward. *From the Mind Into the Body: The Cultural Origins of Psychosomatic Symptoms*. New York: The Free Press, 1994.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

Paula Anne Ford-Martin

Hysterosalpingography

Definition

Hysterosalpingography is a procedure where x rays are taken of a woman's reproductive tract after a dye is injected. *Hystero* means uterus and *salpingo* means tubes, so hysterosalpingography literally means to take pictures of the uterus and fallopian tubes. This procedure may also be called hysterography (or HSG).

Purpose

Hysterosalpingography is used to determine if the fallopian tubes are open, or if there are any apparent abnormalities or defects in the uterus. It can be used to detect tumors, scar tissue, or tears in the lining of the uterus. This procedure is often used to help diagnose **infertility** in women. The fallopian tubes are the location where an egg from the ovary joins with sperm to produce a fertilized ovum. If the fallopian tubes are blocked or deformed, the egg may not be able to descend or the sperm may be blocked from moving up to meet the egg. Up to 30% of all cases of infertility are due to damaged or blocked fallopian tubes.

Precautions

This procedure should not be done on women who suspect they might be pregnant or who may have a pelvic infection. Women who have had an allergic reaction to dye used in previous x-ray procedures should inform their doctor.

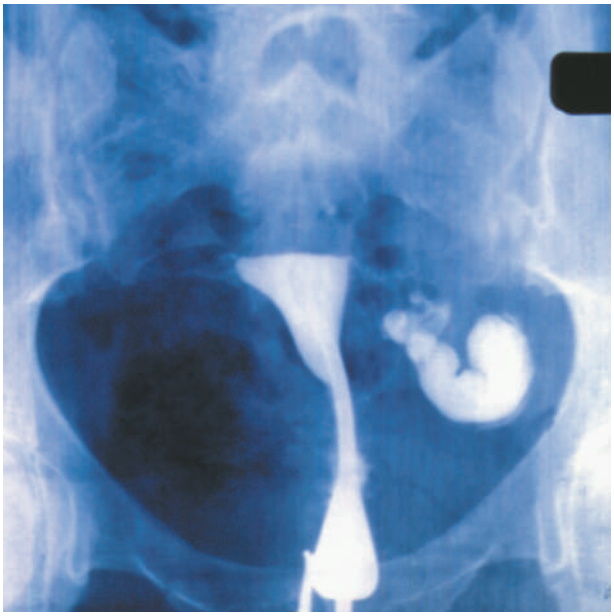
Description

As with other types of pelvic examinations, the woman will lie on her back on an examination table with her legs sometimes raised in stirrups. The x-ray equipment is placed above the abdomen.

A speculum is inserted into the vagina and a catheter (a thin tube) is inserted into the uterus through the cervix (the opening to the uterus). A small balloon in the catheter is inflated to hold it in place. A liquid water-based or oil-based dye is then injected through the catheter into the uterus. This process can cause cramping, **pain**, and uterine spasms.

As the dye spreads through the reproductive tract, the doctor may watch for blockages or abnormalities on an x-ray monitor. Several x rays will also be taken. The procedure takes approximately 15–30 minutes. The x rays will be developed while the patient waits, but the final reading and interpretation of the x rays by a radiologist (a doctor who specializes in x rays) may not be available for a few days.

Interestingly, sometimes the hysterosalpingography procedure itself can be considered a treatment. The dye used can sometimes open up small blockages in the fallopian tubes. The need for additional test procedures or surgical treatments to deal with infertility should be discussed with the doctor.



A hysterosalpingogram of the abdomen of a woman whose fallopian tubes are blocked. The fallopian tube (right on image) is blocked near the uterus, the triangular shape at center. The other fallopian tube is obstructed at a point further from the uterus where dilatation has occurred. *(Photo Researchers, Inc. Reproduced by permission.)*

KEY TERMS

Catheter—A thin tube, usually made of plastic, that is inserted into the body to allow the passage of fluid into or out of a site.

Fallopian tubes—The narrow ducts leading from a woman's ovaries to the uterus. After an egg is released from the ovary during ovulation, fertilization (the union of sperm and egg) normally occurs in the fallopian tubes.

Hysterography—Another term for the x-ray procedure of the uterus and fallopian tubes.

Hysterosalpingogram—The term for the x ray taken during a hysterosalpingography procedure.

Speculum—A plastic or stainless steel instrument that is inserted into the opening of the vagina so the cervix (the opening of the uterus) and interior of the vagina can be examined.

Preparation

This procedure is generally done in the x-ray department of a hospital or large clinic. General anesthesia is not needed. A pain reliever may be taken prior to the procedure to lessen the severity of cramping.

Aftercare

While no special aftercare is required after a hysterosalpingography, the woman may be observed for some period after the procedure to ensure that she does not have any allergic reactions to the dye. A sanitary napkin may be worn after the procedure to absorb dye that will flow out through the vaginal opening. If a blockage is seen in a tube, the patient may be given an antibiotic. A woman should notify her doctor if she experiences excessive bleeding, extensive pelvic pain, **fever**, or an unpleasant vaginal odor after the procedure. These symptoms may indicate a pelvic infection. Counseling may be necessary to interpret the results of the x rays, and to discuss any additional procedures to treat tubal blockages or uterine abnormalities found.

Risks

Cramps during the procedure are common. Complications associated with hysterosalpingography include abdominal pain, pelvic infection, and allergic reactions. It is also possible that abnormalities of the fallopian tubes and uterus will not be detected by this procedure.

Normal results

A normal hysterosalpingography will show a healthy, normally shaped uterus and unblocked fallopian tubes.

Abnormal results

Blockage of one or both of the fallopian tubes or abnormalities of the uterus may be detected.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Infertility: Hysterosalpingogram." In *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

"Hysterosalpingogram." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin Co., 1997.

PERIODICALS

Stovall, D. W. "The Role of Hysterosalpingography in the Evaluation of Infertility." *American Family Physician* 55, no. 2 (Feb. 1997): 621-628.

ORGANIZATIONS

American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216-2809. (205) 978-5000. <http://www.asrm.com>.

Altha Roberts Edgren

Hysteroscopy

Definition

Hysteroscopy is a procedure that allows a physician to look through the vagina and neck of the uterus (cervix) to inspect the cavity of the uterus. A telescope-like instrument called a hysteroscope is used. Hysteroscopy is used as both a diagnostic and a treatment tool.

Purpose

Diagnostic hysteroscopy may be used to evaluate the cause of **infertility**, to determine the cause of repeated miscarriages, or to help locate polyps and fibroids.

The procedure is also used to treat gynecological conditions, often instead of or in addition to **dilatation and curettage** (D&C). A D&C is a procedure for scraping the lining of the uterus. A D&C can be used to take a sample of the lining of the uterus for analysis. Hysteroscopy is an advance over D&C because the doctor can take tissue samples of specific areas or actually see fibroids, polyps, or structural abnormalities.

When used for treatment, the hysteroscope is used with other devices to remove polyps, fibroids, or IUDs that have become embedded in the wall of the uterus.

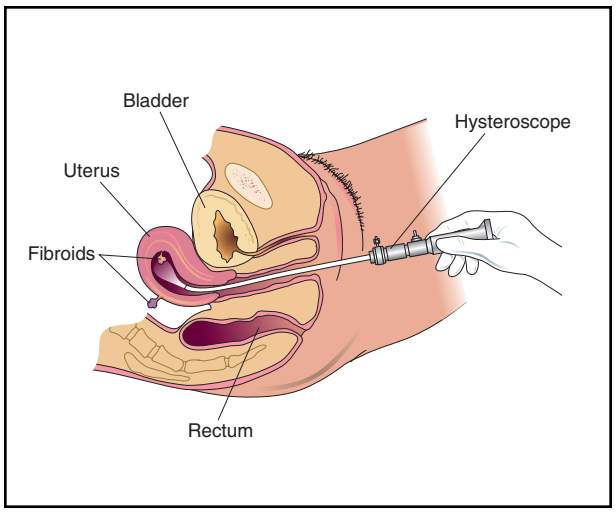
Precautions

The procedure is not performed on women with **cervical cancer**, **endometrial cancer**, or acute pelvic inflammation.

Description

Diagnostic hysteroscopy is performed in either a doctor's office or hospital. Before inserting the hysteroscope, the doctor injects a local anesthetic around the cervix. Once it has taken effect, the doctor dilates the cervix and then inserts a narrow lighted tube (the hysteroscope) through the cervix to reveal the inside of the uterus. Ordinarily, the walls of the uterus are touching each other. In order to get a better view, the uterus is inflated with carbon dioxide gas or fluid. Hysteroscopy takes about 30 minutes, and can cost anywhere from $750 to $4,000 depending on the extent of the procedure.

Treatment involving the use of hysteroscopy is usually performed as a day surgical procedure with regional or general anesthesia. Tiny surgical instruments are inserted through the hysteroscope, and are used to remove polyps or fibroids. A small sample of tissue lining the uterus is often removed for examination, especially if there is any abnormal bleeding.



Hysteroscopy is a procedure that allows inspection of the uterus by using a telescope-like instrument called a hysteroscope. *(Illustration by Electronic Illustrators Group.)*

Preparation

If the procedure is done in the doctor's office, the patient will be given a mild **pain** reliever before the procedure to ease cramping. The doctor will wash the vagina and cervix with an antiseptic solution.

If the procedure is done in the hospital under general anesthesia, the patient should not eat or drink anything (not even water) after midnight the night before the procedure.

Aftercare

Many women experience light bleeding for several days after surgical hysteroscopy. Mild cramping or pain is common after operative hysteroscopy, but usually fades away within eight hours. If carbon dioxide gas was used, there may also be some shoulder pain. Nonprescription pain relievers may help ease discomfort. Women may want to take the day off and relax after having hysteroscopy.

Risks

Diagnostic hysteroscopy is a fairly safe procedure that only rarely causes complications. The primary risk is prolonged bleeding or infection, usually following surgical hysteroscopy to remove a growth.

Very rare complications include perforation of the uterus, bowel, or bladder. Surgery under general anesthesia causes the additional risks typically associated with anesthesia.

Patients should alert their health care provider if they develop any of these symptoms:

KEY TERMS

Fibroid—A benign tumor of the uterus

Polyp—A growth that projects from the lining of the cervix, the nose, or any other mucus membrane.

Septum—A condition present at birth in which there is an extra fold of tissue down the center of the uterus that can cause infertility. This tissue can be removed with a wire electrode and a hysteroscope.

- abnormal discharge
- heavy bleeding
- fever over 101°F (38.3°C)
- severe lower abdominal pain

Normal results

A normal, healthy uterus with no fibroids or other growths.

Abnormal results

Using hysteroscopy, the doctor may find **uterine fibroids** or polyps (often the cause of abnormal bleeding) or a septum (extra fold of tissue down the center of the uterus) that can cause infertility. Sometimes, precancerous or malignant growths are discovered.

Resources

BOOKS

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1997.

PERIODICALS

Anon. "Looking Inside the Uterus." *Harvard Women's Health Watch* 4, no. 5 (Jan. 1997): 4-5.

Apgar, B. S., and D. Dewitt. "Diagnostic Hysteroscopy." *American Family Physician* 46, no. 5 (Nov. 1992): 19S-24S, 29S-32S, 35S.

Carol A. Turkington

Hysterosonography

Definition

Hysterosonography, which is also called sonohysterography, is a new noninvasive technique that involves the slow infusion of sterile saline solution into a woman's uterus during ultrasound imaging. Hysterosonography allows the doctor to evaluate abnormal growths inside the uterus; abnormalities of the tissue lining the uterus (the endometrium); or disorders affecting deeper tissue layers. Hysterosonography does not require either radiation or contrast media, or invasive surgical procedures.

Purpose

Hysterosonography is used to evaluate patients in the following groups:

- peri- or postmenopausal women with unexplained vaginal bleeding
- women whose endometrium appears abnormal during baseline ultrasound imaging
- women with fertility problems. **Infertility** is sometimes related to polyps, leiomyomas (fibroids), or adhesions inside the uterus. Adhesions are areas of tissue that have grown together to form bands or membranes across the inside of the uterus
- women receiving tamoxifen therapy for **breast cancer**

Hysterosonography is useful as a screening test to minimize the use of more invasive diagnostic procedures, such as tissue biopsies and dilation and curettage (D&C). Hysterosonography can also be used as a follow-up after uterine surgery to evaluate its success.

Precautions

Hysterosonography is difficult to perform in patients with certain abnormalities:

- Cervical stenosis. Cervical stenosis means that the lower end of the uterus is narrowed or tightened. It complicates the insertion of a tube (catheter).
- Adhesions or large fibroids. These growths sometimes block the flow of saline fluid into the uterus.

Patients with active **pelvic inflammatory disease** (PID) should not be tested with hysterosonography until the disease is brought under control. Women with chronic PID or heart problems are given **antibiotics** before the procedure.

Description

A hysterosonography is preceded by a baseline ultrasound examination performed through the vagina. This allows the doctor to detect an unsuspected **pregnancy** and to assess the thickness and possible abnormalities of the patient's endometrium. The doctor then

inserts a catheter into the uterus and injects sterile saline fluid while ultrasound imaging is recorded on film or videotape. The procedure takes about 10 to 15 minutes.

Preparation

Patients do not require special preparation apart from the timing of the procedure. Patients with fertility problems are examined during the first 10 days of the menstrual cycle. Patients who may have polyps are usually examined at a later phase in the cycle. The best time for examining women with fibroids is still under discussion.

Aftercare

Aftercare consists of advising the patient to contact her doctor in case of abnormal bleeding, **fever**, or abdominal **pain**. Some spotting or cramping is common, however, and can usually be treated with **nonsteroidal anti-inflammatory drugs**, such as ibuprofen.

Risks

The chief risks are mild spotting and cramping after the procedure.

Normal results

Normal findings include a symmetrical uterus with a normal endometrium and no visible masses or tumors.

Abnormal results

Abnormal findings include adhesions; polyps; leiomyomas; abnormal thickening of the endometrium; or tissue changes related to tamoxifen (Nolvadex), which is a drug given for breast **cancer**.

Resources

PERIODICALS

Cullinan, Joanne, et al. "Sonohysterography: A Technique for Endometrial Evaluation." *RadioGraphics* 15 (May 1995): 501-514.

Huntington, Diane K. "Invited Commentary." *RadioGraphics* 15 (May 1995): 515-516.

Yoder, Isabel C., and Deborah A. Hall. "Hysterosalpingography in the 1990s." *American Journal of Roentgenology* 157 (Oct. 1991): 675-683.

Rebecca J. Frey

KEY TERMS

Adhesion—An abnormal union or attachment of two areas of tissue.

Contrast medium—A chemical substance used to make an organ or body part opaque on x ray.

Dilation and curettage (D&C)—A surgical procedure in which the patient's cervix is widened (dilated) and the endometrium is scraped with a scoop-shaped knife (curette).

Endometrium—The tissue that lines the uterus.

Fibroid—Another word for leiomyoma.

Leiomyoma—A benign tumor composed of muscle tissue. Leiomyomas in the uterus are sometimes called fibroids.

Pelvic inflammatory disease (PID)—An inflammation of the fallopian tubes, usually caused by bacterial infection.

Polyp—A growth projecting from the lining of the uterus. Polyps can cause fertility problems or abnormal vaginal bleeding.

Saline solution—A solution of sterile water and salt used in a variety of medical procedures. In hysterosonography, saline solution is used to fill the uterus for diagnostic imaging.

Transvaginal ultrasound (US)—The diagnostic imaging procedure that serves as the baseline for a hysterosonographic examination.

I

IBS *see* **Irritable bowel syndrome**

Ibuprofen *see* **Nonsteroidal anti-inflammatory drugs**

Ichthyosis

Definition

Derived from the Greek word meaning fish disease, ichthyosis is a congenital (meaning present at birth) dermatological (skin) disease that is represented by thick, scaly skin.

Description

The ichthyoses are a group of genetic skin diseases caused by an abnormality in skin growth that results in drying and scaling. There are at least 20 types of ichthyosis. Ichthyosis can be more or less severe, sometimes accumulating thick scales and cracks that are painful and bleed. Ichthyosis is not contagious because it is inherited.

The most common form of ichthyosis is called ichthyosis vulgaris (*vulgar* is Latin for common), and occurs in approximately one person in every 250 and is inherited in an autosomal dominant manner. The most rare types of ichthyosis occur in fewer than one person in one million and are inherited in an autosomal recessive manner. Ichthyosis occurs regardless of the part of the world the child is from, or the ethnic background of the parents.

Causes and symptoms

Depending on the specific type of ichthyosis, the inheritance can be autosomal recessive, autosomal dominant, X-linked recessive, X-linked dominant, or sporadic. Autosomal recessive means that the altered gene for the disease or trait is located on one of the first 22 pairs of chromosomes, which are also called "autosomes." Males and females are equally likely to have an autosomal recessive disease or trait. Recessive means that two copies of the altered gene are necessary to express the condition. Therefore, a child inherits one copy of the altered gene from each parent, who are called carriers (because they have only one copy of the altered gene). Since carriers do not express the altered gene, parents usually do not know they carry the altered gene that causes ichthyosis until they have an affected child. Carrier parents have a 1-in-4 chance (or 25%) with each **pregnancy**, to have a child with ichthyosis.

Autosomal dominant inheritance also means that both males and females are equally likely to have the disease but only one copy of the altered gene is necessary to have the condition. An individual with ichthyosis has a 50/50 chance to pass the condition to his or her child.

The skin is made up of several layers, supported underneath by a layer of fat that is thicker or thinner depending on location. The lower layers contain blood vessels, the middle layers contain actively growing cells, and the upper layer consists of dead cells that serve as a barrier to the outside world. This barrier is nearly waterproof and highly resistant to infection. Scattered throughout the middle layers are hair follicles, oil and sweat glands, and nerve endings. The upper layer is constantly flaking off and being replaced from beneath by new tissue. In ichthyosis, the skin's natural shedding process is slowed or inhibited; and in some types, skin cells are produced too rapidly.

The abnormality in skin growth and hydration called ichthyosis may present with symptoms at birth or in early childhood. Ichthyosis can itch relentlessly, leading to such complications of scratching as lichen simplex (**dermatitis** characterized by raw patches of skin). Either the cracking or the scratching can introduce infection, bringing with it discomfort and complications.

KEY TERMS

Amniocentesis—A procedure performed at 16-18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Amniotic fluid—The fluid that surrounds a developing baby during pregnancy.

Autosomal dominant—A pattern of genetic inheritance where only one abnormal gene is needed to display the trait or disease.

Autosomal recessive inheritance—A pattern of genetic inheritance where two abnormal genes are needed to display the trait or disease.

Dermatologist—A physician that specializes in disorders of the skin.

Emollients—Petroleum or lanolin-based skin lubricants.

Keratin—A tough, nonwater-soluble protein found in the nails, hair, and the outermost layer of skin. Human hair is made up largely of keratin.

Keratinocytes—Skin cells.

Keratolytic—An agent that dissolves or breaks down the outer layer of skin (keratins).

Retinoids—A derivative of synthetic Vitamin A.

Sporadic—Isolated or appearing occasionally with no apparent pattern.

X-linked dominant inheritance—The inheritance of a trait by the presence of a single gene on the X chromosome in a male or female, passed from an affected female who has the gene on one of her X chromosomes.

X-linked recessive inheritance—The inheritance of a trait by the presence of a single gene on the X chromosome in a male, passed from a female who has the gene on one of her X chromosomes, and who is referred to as an unaffected carrier.

Diagnosis

A dermatologist will often make the diagnosis of ichthyosis, based on a clinical exam. However, a **skin biopsy**, or DNA study (from a small blood sample) is necessary to confirm the diagnosis. Evaluation for associated problems is done by a complete physical medical examination.

For some types of ichythyosis, the abnormal gene has been identified and prenatal testing is available. At present this is true for the autosomal recessive congenital ichythoses, which include: lamellar ichthyosis (LI), autosomal recessive lamellar ichthyosis (ARLI), congenital ichthyosiform erythroderm a(CIE), and non-bullous congenital ichthyosiform erythroderma (NBCIE).

There are four different genes that have been located for the autosomal recessive congenital ichthyoses; however, testing is available for only one gene called transglutaminase-1 (TGM1) located on chromosome 14. Once a couple has had a child with ichthyosis, and they have had the genetic cause identified by DNA studies (performed from a small blood sample), prenatal testing for future pregnancies may be considered. (Note that prenatal testing may not be possible if both mutations cannot be identified.) Prenatal diagnosis is available via either **chorionic villus sampling** (CVS) or **amniocentesis**. CVS is a biopsy of the placenta performed in the first trimester of pregnancy under ultrasound guidance. Ultrasound is the use of sound waves to visualize the developing fetus. The genetic makeup of the placenta is identical to the fetus and therefore the TGM1 gene can be studied from this tissue. There is approximately a one in 100 chance for **miscarriage** with CVS. Amniocentesis is a procedure done under ultrasound guidance in which a long thin needle is inserted through the mother's abdomen into the uterus, to withdraw a couple of tablespoons of amniotic fluid (fluid surrounding the developing baby) to study. The TGM1 gene can be studied using cells from the amniotic fluid. Other genetic tests, such as a chromosome analysis, may also be performed through either CVS or amniocentesis.

Treatment

Most treatments for ichthyosis are topical, which means they are applied directly to the skin, not taken internally. Some forms of ichthyosis require two forms of treatment—a reduction in the amount of scale buildup and moisturizing of the underlying skin. Several agents are available for each purpose. Reduction in the amount of scale is achieved by keratolytics. Among this class of drugs are urea, lactic acid, and salicylic acid. Petrolatum,

60% propylene glycol, and glycerin are successful moisturizing agents, as are many commercially available products. Increased humidity of the ambient air is also helpful in preventing skin dryness.

Because the skin acts as a barrier to the outside environment, medicines have a hard time penetrating, especially through the thick skin of the palms of the hands and the soles of the feet. This resistance is diminished greatly by maceration (softening the skin). Soaking hands in water macerates skin so that it looks like prune skin. Occlusion (covering) with rubber gloves or plastic wrap will also macerate skin. Applying medicines and then covering the skin with an occlusive dressing will facilitate entrance of the medicine and greatly magnify its effect.

Secondary treatments are necessary to control pruritus (**itching**) and infection. Commercial products containing camphor, menthol, eucalyptus oil, aloe, and similar substances are very effective as antipruritics. If the skin cracks deeply enough, a pathway for infection is created. Topical **antibiotics** like bacitracin are effective in prevention and in the early stages of these skin infections. Cleansing with hydrogen peroxide inhibits infection as well.

Finally, there are topical and internal derivatives of vitamin A called retinoids, that improve skin growth and are used for severe cases of **acne**, ichthyosis, and other skin conditions.

Prognosis

This condition requires continuous care throughout a lifetime. Properly treated, in most cases it is a cosmetic problem. There are a small number of lethal forms, such as harlequin fetus.

Resources

BOOKS

Sybert, Virginia P. *Genetic Skin Disorders*. Oxford Monographs on Medical Genetics. No. 33. New York: Oxford University Press, 1997.

Baden, Howard P. "Ichthyosiform Dermatoses." In *Dermatology in General Medicine*. Edited by Thomas B. Fitzpatrick, et al, 531-544. New York: McGraw-Hill, 1993.

Parker, Frank. "Skin Diseases of General Importance." In *Cecil Textbook of Medicine*. Edited by J. Claude Bennett and Fred Plum, 2204. Philadelphia: W. B. Saunders, 1996.

ORGANIZATIONS

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington, DC 20008. (202) 966-5557. Fax: (202) 966-8553. <http://www.geneticalliance.org>.

Foundation for Ichthyosis and Related Skin Types. 650 N. Cannon Ave., Suite 17, Lansdale, PA 19446. (215) 631-1411 or (800) 545-3286. Fax: (215) 631-1413. <http://www.scalyskin.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

National Registry for Ichthyosis and Related Disorders. University of Washington Dermatology Department, Box 356524, 1959 N.E. Pacific, Rm. BB1353, Seattle, WA 98195-6524. (800) 595-1265 or (206) 616-3179. <http://www.skinregistry.org>.

OTHER

Immune Deficiency Foundation Website. <www.primaryimmune.org>.

Catherine L. Tesla, MS, CGC

Icterus *see* **Jaundice**

Idiopathic hypertrophic subaortic stenosis *see* **Hypertrophic cardiomyopathy**

Idiopathic infiltrative lung diseases

Definition

The term *idiopathic* means "cause unknown." The idiopathic infiltrative lung diseases, also known as interstitial lung diseases, are a group of more than a hundred disorders seen in both adults and (less often) in children, whose cause is unknown but which tend to spread, or "infiltrate" through much or all of the lung tissue. They range from mild conditions that respond well to treatment, to progressive, nonresponsive disease states that severely limit lung function and may cause **death**.

Description

The body produces inflammatory cells in response to a variety of conditions, including a number of different diseases, pollutants, certain infections, exposure to organic dust or toxic fumes and vapors, and various drugs and poisons. When white blood cells and tissue fluid rich in protein collect in the small air sacs of the lungs, or alveoli, the sacs become inflamed (alveolitis). In time, the fluid may solidify and cause scar formation that replaces the normal lung tissue. This process is known as **pulmonary fibrosis**. In about half of all patients, no specific cause is ever found; they are said to have idiopathic pulmonary fibrosis.

Some patients have special types of interstitial lung disease that may occur in certain types of patients, or feature typical pathological changes when a sample of lung tissue is examined under a microscope. They include:

- Usual interstitial pneumonitis. Disease occurs in a patchy form throughout the lungs. Parts of the lungs can appear normal while others have dense scar tissue and lung cysts, often the end result of pulmonary fibrosis. This disease progresses quite slowly. Both children and adults may be affected.
- Desquamative interstitial pneumonitis. Similar-appearing lesions are present throughout the lungs. Both inflammatory cells and cells that have separated from the air sac linings (desquamated) are present. Some researchers believe this is an early form of usual interstitial pneumonitis.
- Lymphocytic interstitial pneumonitis. Most of the cells infiltrating the lungs are the type of white blood cells called lymphocytes. Both the breathing tubes (bronchi) and blood vessels of the lungs become thickened. In children, this condition tends to occur when the immune system is not operating properly, as occurs with **Acquired immunodeficiency syndrome** (AIDS).

Causes and symptoms

By definition, the causes of *idiopathic* infiltrative lung diseases are not known. Some forms of pulmonary fibrosis, however, do have specific causes and these may provide a clue as to what may cause idiopathic diseases. Known causes of pulmonary fibrosis include diseases that impair the body's immune function; infection by viruses and the bacterium causing **tuberculosis**; and exposure to such mineral dusts as silica or asbestos, or such organic materials as bird droppings. Other cases of pulmonary fibrosis result from exposure to fumes and vapors, radiation (in industry or medically), and certain drugs used to treat disease.

Patients with interstitial lung disease usually have labored breathing when exerting themselves. Often they **cough** and feel overly tired ("no stamina"). **Wheezing** is uncommon. When the physician listens to the patient's chest with a stethoscope, dry, crackling sounds may be heard. Some patients have vague chest **pain**. When disease progresses, the patient may breathe very rapidly, have mottled blue skin (because of getting too little oxygen), and lose weight. The fingertips may appear thick or club-shaped.

Diagnosis

Both scars in the lung and cysts (air-filled spaces) can be seen on a **chest x ray**. Up to 10% of patients, however, may have normal x rays even if their symptoms are severe. A special type of x ray, high-resolution computed tomography scan (CT scan), often is helpful in adult patients. Tests of lung function will show that the lungs cannot hold enough air with each breath, and there is too little oxygen in the blood, especially after exercising. In a procedure called bronchoalveolar lavage, a tube is placed through the nose and windpipe into the bronchi and a small amount of saline is released and then withdrawn. This fluid can then be analyzed for cells. A tiny piece of lung tissue can be sampled using the same instrument. If necessary, a larger sample (a biopsy) is taken through an incision in the chest wall and examined under a microscope.

Treatment

The first medication given, providing scarring is not too extensive, is usually a steroid drug such as prednisone. An occasional patient will improve dramatically if steroid therapy stops the inflammation. Most patients, however, improve to a limited extent. It may take 6–12 weeks for a patient to begin to respond. Patients must be watched closely for a gain in body weight, high blood pressure, and depression. Steroids can also result in diabetes, ulcer disease, and cataract. Patients treated with steroids are at risk of contracting serious infection. If steroids have not proved effective or have caused serious side effects, other anti-inflammatory drugs, such as cyclophosphamide (Cytoxan) or azathioprine (Imuran), can be tried. Cytoxan sometimes is combined with a steroid, but it carries its own risks, which include bladder inflammation and suppression of the bone marrow. Some patients will benefit from a bronchodilator drug that relaxes the airway and makes breathing easier.

Some patients with interstitial lung disease, especially children, will need oxygen therapy. Usually oxygen is given during sleep or **exercise**, but if the blood oxygen level is very low it may be given constantly. A program of conditioning, training in how to breathe efficiently, energy-saving tips, and a proper diet will help patients achieve the highest possible level of function given the state of their illness. All patients should be vaccinated each year against **influenza**. A last resort for those with very advanced disease who do not respond to medication is **lung transplantation**. This operation is being done more widely, and it is even possible to replace both lungs.

Prognosis

A scoring system based on lung function and x ray appearances has been designed to help monitor a

KEY TERMS

Bronchoalveolar lavage—A way of obtaining a sample of fluid from the airways by inserting a flexible tube through the windpipe. Used to diagnose the type of lung disease.

Desquamation—Shedding of the cells lining the insides of the air sacs. A feature of desquamative interstitial pneumonitis.

Idiopathic—A disease whose cause is unknown.

Immune system—A set of body chemicals and specialized cells that attack an invading agent (such as a virus) by forming antibodies that can engulf and destroy it.

Infiltrative—A process whereby inflammatory or other types of disease spread throughout an organ such as the lungs.

Interstitial—Refers to the connective tissue that supports the "working parts" of an organ, in the case of the lungs the air sacs.

Pulmonary fibrosis—A scarring process that is the end result of many forms of long-lasting lung disease.

patient's course. In general, idiopathic forms of interstitial lung disease cause a good deal of illness, and a significant number of deaths. A majority of patients get worse over time, although survival for many years is certainly possible. An estimated one in five affected children fail to survive. In different series, survival times average between four and ten years. Early diagnosis gives the best chance of a patient recovering or at least stabilizing. Once the lungs are badly scarred, nothing short of lung transplantation offers hope of restoring lung function. Patients with desquamative interstitial pneumonitis tend to respond well to steroid treatment, and live longer than those with other types of infiltrative lung disease.

Prevention

Since we do not understand what causes idiopathic interstitial lung diseases, there is no way to prevent them. What can be done is to prevent extensive scarring of the lungs by making the diagnosis shortly after the first symptoms develop, and trying steroids or other drugs in hope of suppressing lung inflammation. Every effort should be made to avoid exposure to dusts, gases, chemicals, and even pets. Keeping fit and learning how to breathe efficiently will help maintain lung function as long as possible.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

OTHER

"Pulmonary Medicine." *Healthweb Page*. 12 Jan. 1998 <http://healthweb.org/browse.cfm?subjectid=81>.

David A. Cramer, MD

Idiopathic primary renal hematuric/proteinuric syndrome

Definition

This syndrome includes a group of disorders characterized by blood and protein in the urine and by damage to the kidney glomeruli (filtering structures) that may lead to kidney failure.

Description

This syndrome, also known as Berger's disease or IgA nephropathy, arises when internal kidney structures called glomeruli become inflamed and injured. It can occur at any age, but the great majority of patients are 16–35 when diagnosed. Males seem to be affected more often than females, and whites are more often affected than blacks. Blood in the urine (hematuria), either indicated by a visible change in the color of the urine or detected by laboratory testing, is a hallmark of this syndrome, and it may occur continuously or sporadically. The pattern of occurrence is not indicative of the severity of kidney damage.

Causes and symptoms

The glomeruli are the kidney structures that filter the blood and extract waste, which is then excreted as urine. The barrier between the blood and the urine side of the filter mechanism is a membrane only one cell layer thick. Anything that damages the membrane will

KEY TERMS

Glomeruli (singular, glomerulus)—Filtering structures in the kidneys.

Hematuria—The presence of hemoglobin or red blood cells in the urine.

Idiopathic—Refers to a disease that arises from an obscure or unknown cause.

Nephrotic syndrome—A kidney disorder characterized by fluid retention (edema) and proteinuria. It is caused by damage to the kidney glomeruli.

Proteinuria—The presence of protein in the urine exceeding normal levels.

result in hematuria. Symptoms of idiopathic primary renal hematruic/proteinuric syndrome are caused by inflammation of the glomeruli and deposit of IgA antibodies in kidney tissue. Although a genetic basis for this syndrome is suspected, this has not been proven. Symptoms often appear 24–48 hours after an upper respiratory or gastrointestinal infection. Symptoms of the syndrome include:

- blood in the urine (hematuria)
- protein in the urine (proteinuria)
- pain in the lower back or kidney area
- elevated blood pressure (20–30% of cases)
- nephrotic syndrome (less than 10% of cases)
- swelling (occasionally)

This condition usually does not get worse with time, although renal failure occasionally results. In patients with large amounts of IgA deposits in their glomeruli, the long-term prognosis may not be favorable. The syndrome can go into remission spontaneously, although this is more common in children than in adults.

Diagnosis

One of the objectives of diagnosis is to distinguish glomerular from non-glomerular kidney diseases. Idiopathic primary hematuric/proteinuric syndrome involves the glomeruli. The presence of fragmented or distorted red blood cells in the urine is evidence of glomerular disease. A high concentration of protein in the urine is also evidence for glomerular disease. The hematuria associated with this syndrome must be distinguished from that caused by urinary tract diseases, which can also cause a loss of blood into the urine. Biopsy of the patient's kidney shows deposits of IgA antibodies. Detecting IgA-antibody deposits rules out thin membrane disease as the cause of the hematuria and proteinuria. Test values are normal for ASO, complement, rheumatoid factor, antinuclear antibodies, anti-DNase, and cryoglobulins, all of which are associated with different types of kidney disease. A diagnosis of idiopathic primary renal hematuric/proteinuric syndrome is largely made by ruling out other diseases and their causes, leaving this syndrome as the remaining possible diagnosis.

Treatment

Many patients do not need specific treatment, except for those who have symptoms indicating a poor prognosis. Oral doses of **corticosteroids** are effective in patients with mild proteinuria and good kidney function. Other treatments, such as medications to lower blood pressure, are aimed at slowing or preventing kidney damage. If kidney failure develops, dialysis or **kidney transplantation** is necessary.

Prognosis

Idiopathic primary renal hematuric/proteinuric syndrome progresses slowly and in many cases does not progress at all. Risk for progression of the disorder is considered higher if there is:

- high blood pressure
- large amounts of protein in the urine
- increased levels of urea and creatinine in the blood (indications of kidney function)

About 25–35% of patients may develop kidney failure within about 25 years.

Prevention

Since the underlying causes of this syndrome are so poorly understood, there is no known prevention.

Resources

BOOKS

Brenner, B. M. *The Kidney.* Philadelphia: W. B. Saunders Co., 1996.

Greenberg, A. *Primer on Kidney Diseases.* San Diego: Academic Press, 1998.

Schrier, R. W., and C. W. Gottschalk. *Diseases of the Kidney.* Boston: Little Brown, 1997.

ORGANIZATIONS

IgA Nephropathy Support Network. 964 Brown Ave., Huntington Valley, PA 19006. (215) 663–0536.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

John T. Lohr, PhD

Idiopathic thrombocytopenic purpura

Definition

Idiopathic thrombocytopenic purpura, or ITP, is a bleeding disorder caused by an abnormally low level of platelets in the patient's blood. Platelets are small plate-shaped bodies in the blood that combine to form a plug when a blood vessel is injured. The platelet plug then binds certain proteins in the blood to form a clot that stops bleeding. ITP's name describes its cause and two symptoms. Idiopathic means that the disorder has no apparent cause. ITP is now often called immune thrombocytopenic purpura rather than idiopathic because of recent findings that ITP patients have autoimmune antibodies in their blood. **Thrombocytopenia** is another word for a decreased number of blood platelets. Purpura refers to a purplish or reddish-brown skin rash caused by the leakage of blood from broken capillaries into the skin. Other names for ITP include purpura hemorrhagica and essential thrombocytopenia.

Description

ITP may be either acute or chronic. The acute form is most common in children between the ages of two and six years; the chronic form is most common in adult females between 20 and 40. Between 10% and 20% of children with ITP have the chronic form. ITP does not appear to be related to race, lifestyle, climate, or environmental factors.

ITP is a disorder that affects the overall *number* of blood platelets rather than their function. The normal platelet level in adults is between 150,000 and 450,000/mm3. Platelet counts below 50,000 mm3 increase the risk of dangerous bleeding from trauma; counts below 20,000/mm3 increase the risk of spontaneous bleeding.

Causes and Symptoms

In adults, ITP is considered an autoimmune disorder, which means that the body produces antibodies that damage some of its own products—in this case, blood platelets. Some adults with chronic ITP also have other immune system disorders, such as **systemic lupus erythematosus** (SLE). In children, ITP is usually triggered by a virus infection, most often **rubella**, **chickenpox**, **measles**, cytomegalovirus, or Epstein-Barr virus. It usually begins about two or three weeks after the infection.

Acute ITP

Acute ITP is characterized by bleeding into the skin or from the nose, mouth, digestive tract, or urinary tract. The onset is usually sudden. Bleeding into the skin takes the form of purpura or petechiae. Purpura is a purplish or reddish-brown rash or discoloration of the skin; petechiae are small round pinpoint hemorrhages. Both are caused by the leakage of blood from tiny capillaries under the skin surface. In addition to purpura and petechiae, the patient may notice that he or she **bruises** more easily than usual. In extreme cases, patients with ITP may bleed into the lungs, brain, or other vital organs.

Chronic ITP

Chronic ITP has a gradual onset and may have minimal or no external symptoms. The low **platelet count** may be discovered in the course of a routine blood test. Most patients with chronic ITP, however, will consult their primary care doctor because of the purpuric skin rash, nosebleeds, or bleeding from the digestive or urinary tract. Women sometimes go to their gynecologist for unusually heavy or lengthy menstrual periods.

The risk factors for the development of chronic ITP include:

- female sex
- age over 10 years at onset of symptoms
- slow onset of bruising
- presence of other autoantibodies in the blood

Diagnosis

ITP is usually considered a diagnosis of exclusion, which means that the doctor arrives at the diagnosis by a process of ruling out other possible causes. If the patient belongs to one or more of the risk groups for chronic ITP, the doctor may order a blood test for autoantibodies in the blood early in the diagnostic process.

Physical examination

If the doctor suspects ITP, he or she will examine the patient's skin for bruises, purpuric areas, or petechiae. If the patient has had nosebleeds or bleeding from the mouth or other parts of the body, the doctor will examine these areas for other possible causes of bleeding. Patients with ITP usually look and feel healthy except for the bleeding.

KEY TERMS

Autoimmune disorder—A disorder in which the patient's immune system produces antibodies that destroy some of the body's own products. ITP in adults is thought to be an autoimmune disorder.

Idiopathic—Of unknown cause. Idiopathic refers to a disease that is not preceded or caused by any known dysfunction or disorder in the body.

Petechiae—Small pinpoint hemorrhages in skin or mucous membranes caused by the rupture of capillaries.

Platelet—A blood component that helps to prevent blood from leaking from broken blood vessels. ITP is a bleeding disorder caused by an abnormally low level of platelets in the blood.

Prednisone—A corticosteroid medication that is used to treat ITP. Prednisone works by decreasing the effects of antibody on blood platelets. Long-term treatment with prednisone is thought to decrease antibody production.

Purpura—A skin discoloration of purplish or brownish red spots caused by bleeding from broken capillaries.

Splenectomy—Surgical removal of the spleen.

Thrombocytopenia—An abnormal decline in the number of platelets in the blood.

The most important features that the doctor will be looking for during the **physical examination** are the condition of the patient's spleen and the presence of **fever**. Patients with ITP do not have fever whereas patients with lupus and some other types of thrombocytopenia are usually feverish. The doctor will have the patient lie flat on the examining table in order to feel the size of the spleen. If the spleen is noticeably enlarged, ITP is not absolutely ruled out but is a less likely diagnosis.

Laboratory testing

The doctor will order a complete **blood count** (CBC), a test of clotting time, a bone marrow test, and a test for antiplatelet antibodies if it is available in the hospital laboratory. Patients with ITP usually have platelet counts below 20,000/mm^3 and prolonged **bleeding time**. The size and appearance of the platelets may be abnormal. The red blood cell count (RBC) and white blood cell count (WBC) are usually normal, although about 10% of patients with ITP are also anemic. The blood marrow test yields normal results. Detection of antiplatelet antibodies in the blood is considered to confirm the diagnosis of ITP.

Treatment

General care and monitoring

There is no specific treatment for ITP. In most cases, the disorder will resolve without medications or surgery within two to six weeks. Nosebleeds can be treated with ice packs when necessary.

General care includes explaining ITP to the patient and advising him or her to watch for bruising, petechiae, or other signs of recurrence. Children should be discouraged from rough contact sports or other activities that increase the risk of trauma. Patients are also advised to avoid using **aspirin** or ibuprofen (Advil, Motrin) as **pain** relievers because these drugs lengthen the clotting time of blood.

Emergency treatment

Patients with acute ITP who are losing large amounts of blood or bleeding into their central nervous system require emergency treatment. This includes transfusions of platelets, intravenous immunoglobulins, or prednisone. Prednisone is a steroid medication that decreases the effects of antibody on platelets and eventually lowers antibody production. If the patient has a history of ITP that has not responded to prednisone or immunoglobulins, the surgeon may remove the patient's spleen. This operation is called a **splenectomy**. The reason for removing the spleen when ITP does not respond to other forms of treatment is that the spleen sometimes keeps platelets out of the general blood circulation.

Medications and transfusions

Patients with chronic ITP can be treated with prednisone, immune globulin, or large doses of intravenous gamma globulin. Although 90% of patients respond to immunoglobulin treatment, it is very expensive. About 80% of patients respond to prednisone therapy. Platelet transfusions are not recommended for routine treatment of ITP. If the patient's platelet level does not improve within one to four months, or requires high doses of prednisone, the doctor may recommend splenectomy. All medications for ITP are given either orally or intravenously; intramuscular injection is avoided because of the possibility of causing bleeding into the skin.

Surgery

Between 80% and 85% of adults with ITP have a remission of the disorder after the spleen is removed. Splenectomy is usually avoided in children younger than five years because of the increased risk of a severe infec-

tion after the operation. In older children, however, splenectomy is recommended if the child has been treated for 12 months without improvement; if the ITP is very severe or the patient is getting worse; if the patient begins to bleed into the head or brain; and if the patient is an adolescent female with extremely heavy periods.

Prognosis

The prognosis for recovery from acute ITP is good; 80% of patients recover without special treatment. The prognosis for chronic ITP is also good; most patients experience long-term remissions. In rare instances, however, ITP can cause life-threatening hemorrhage or bleeding into the central nervous system.

Resources

BOOKS

"Blood Component Therapy: Platelet Transfusions." In *Internal Medicine On Call*, ed. Steven A. Haist, et al. Stamford: Appleton & Lange, 1991.

Hays, Taru. "Hematologic Disorders." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

"Hematology and Oncology: Immunologic Idiopathic Thrombocytopenic Purpura (ITP)." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Idiopathic Thrombocytopenic Purpura." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

Linker, Charles A. "Blood." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

McMillan, Robert. "Platelet-Mediated Bleeding Disorders." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"On-Call Problems: Thrombocytopenia." In *Internal Medicine On Call*, ed. Steven A. Haist, et al. Stamford: Appleton & Lange, 1991.

Rebecca J. Frey PhD

IHSS *see* **Hypertrophic cardiomyopathy**

Ileal conduit *see* **Urinary diversion surgery**

Ileitis *see* **Crohn's disease**

Ileostomy *see* **Enterostomy**

Ileus

Definition

Ileus is a partial or complete non-mechanical blockage of the small and/or large intestine.

Description

There are two types of **intestinal obstructions**, mechanical and non-mechanical. Mechanical obstructions occur because the bowel is physically blocked and its contents can not pass the point of the obstruction. This happens when the bowel twists on itself (volvulus) or as the result of hernias, impacted feces, abnormal tissue growth, or the presence of foreign bodies in the intestines.

Unlike mechanical obstruction, non-mechanical obstruction, called ileus or paralytic ileus, occurs because peristalsis stops. Peristalsis is the rhythmic contraction that moves material through the bowel. Ileus is most often associated with an infection of the peritoneum (the membrane lining the abdomen). It is one of the major causes of bowel obstruction in infants and children.

Another common cause of ileus is a disruption or reduction of the blood supply to the abdomen. Handling the bowel during abdominal surgery can also cause peristalsis to stop, so people who have had abdominal surgery are more likely to experience ileus. When ileus results from abdominal surgery the condition is often temporary and usually lasts only 48–72 hours.

Ileus can also be caused by kidney diseases, especially when potassium levels are decreased. Heart disease and certain **chemotherapy** drugs, such as vinblastine (Velban, Velsar) and vincristine (Oncovin, Vincasar PES, Vincrex), also can cause ileus. Infants with **cystic fibrosis** are more likely to experience meconium ileus (a dark green material in the intestine). Over all, the total rate of bowel obstruction due both to mechanical and non-mechanical causes is one in one thousand people (1/1,000).

Causes and symptoms

When the bowel stops functioning, the following symptoms occur:

- abdominal cramping
- abdominal distention
- nausea and vomiting
- failure to pass gas or stool

Diagnosis

When a doctor listens with a stethoscope to the abdomen there will be few or no bowel sounds, indicating that the intestine has stopped functioning. Ileus can be confirmed by x rays of the abdomen, **computed tomography scans** (CT scans), or ultrasound. It may be necessary to do more invasive tests, such as a **barium enema** or upper GI series, if the obstruction is mechanical. Blood tests also are useful in diagnosing paralytic ileus.

KEY TERMS

Computed tomography scan (or CT scan)—A computer enhanced x-ray study performed to detect abnormalities that do not show up on normal x rays.

Meconium—A greenish fecal material that forms the first bowel movement of an infant.

Peritoneum—The transparent membrane lining the abdominal cavity that holds organs, such as the intestines, in place.

Barium studies are used in cases of mechanical obstruction, but may cause problems by increasing pressure or intestinal contents if used in ileus. Also, in cases of suspected mechanical obstruction involving the gastrointestinal tract (from the small intestine downward) use of barium x rays are contraindicated, since they may contribute to the obstruction. In such cases a barium enema should always be done first.

Treatment

Patients may be treated with supervised bed rest in a hospital, and bowel rest—where nothing is taken by mouth and patients are fed intravenously or through the use of a nasogastric tube. A nasogastric tube is a tube inserted through the nose, down the throat, and into the stomach. A similar tube can be inserted in the intestine. The contents are then suctioned out. In some cases, especially where there is a mechanical obstruction, surgery may be necessary.

Drug therapies that promote intestinal motility (ability of the intestine to move spontaneously), such as cisapride and vasopressin (Pitressin), are sometimes prescribed.

Alternative treatment

Alternative practitioners offer few treatment suggestions, but focus on prevention by keeping the bowels healthy through eating a good diet, high in fiber and low in fat. If the case is not a medical emergency, homeopathic treatment and **traditional Chinese medicine** can recommend therapies that may help to reinstate peristalsis.

Prognosis

The outcome varies depending on the cause of ileus.

Prevention

Most cases of ileus are not preventable. Surgery to remove a tumor or other mechanical obstruction will help prevent a recurrence.

Resources

OTHER

"Intestinal Obstruction." *HealthAnswers.com.* <http://www.healthanswers.com/database/ami/converted/000260.html>.
"Bowel Paralysis." *Trigan Oncology Associates Page.* <http://www.trigan.com/ileus.htm>.

Tish Davidson

Immobilization

Definition

Immobilization refers to the process of holding a joint or bone in place with a splint, cast, or brace. This is done to prevent an injured area from moving while it heals.

Purpose

Splints, casts, and braces support and protect broken bones, dislocated joints, and such injured soft tissue as tendons and ligaments. Immobilization restricts motion to allow the injured area to heal. It can help reduce **pain**, swelling, and muscle spasm. In some cases, splints and casts are applied after surgical procedures that repair bones, tendons, or ligaments. This allows for protection and proper alignment early in the healing phase.

Precautions

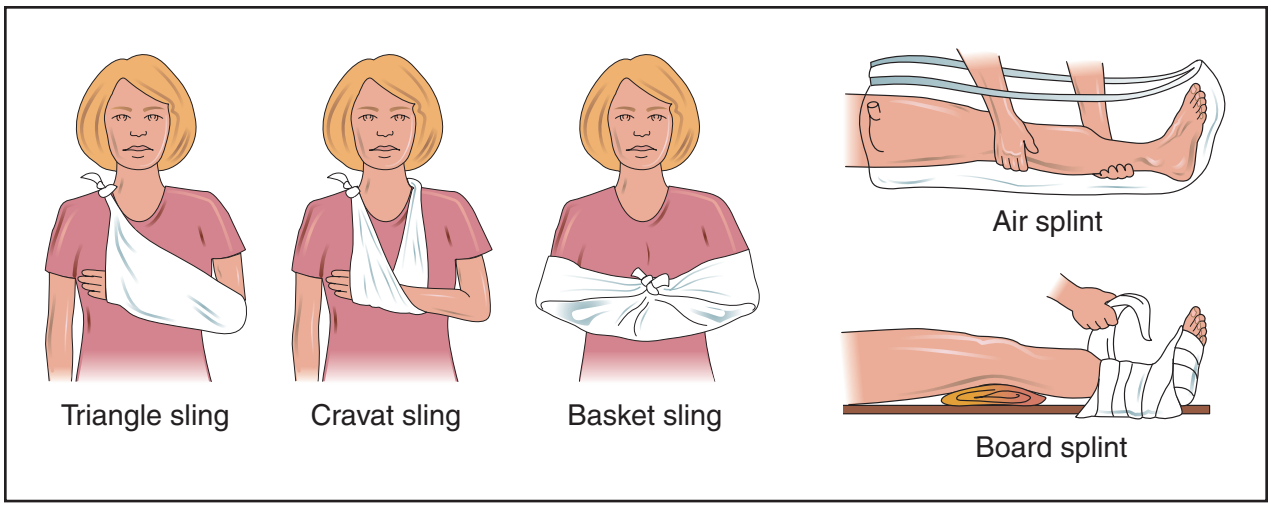
There are no special precautions for immobilization.

Description

When an arm, hand, leg, or foot requires immobilization, the cast, splint, or brace will generally extend from the joint above the injury to the joint below the injury. For example, an injury to the mid-calf requires immobilization from the knee to the ankle and foot. Injuries of the hip and upper thigh or shoulder and upper arm require a cast that encircles the body and extends down the injured leg or arm.

Casts and splints

Casts are generally used for immobilization of a broken bone. Once the doctor makes sure the two broken ends of the bone are aligned, a cast is put on to keep them in place until they are rejoined through natural healing. Casts are applied by a physician, a nurse, or an assistant. They are custom-made to fit each person, and are usually made of plaster or fiberglass. Fiberglass weighs less than plaster, is more durable, and allows the skin more ade-



Immobilization refers to the process of immobilizing or fixating the position of a joint, bone, extremity, or torso with a splint, cast, or brace. Immobilization can help reduce pain, swelling, and muscle spasms. The illustrations above feature several types of immobilization techniques. *(Illustration by Electronic Illustrators Group.)*

quate airflow than plaster. A layer of cotton or synthetic padding is first wrapped around the skin to cover the injured area and protect the skin. The plaster or fiberglass is then applied over this.

Most casts should not be gotten wet. However, some types of fiberglass casts use Gore-tex padding that is waterproof and allows the person to completely immerse the cast in water when taking a shower or bath. There are some circumstances when this type of cast material can not be used.

A splint is often used to immobilize a dislocated joint while it heals. Splints are also often used for finger injuries, such as **fractures** or baseball finger. Baseball finger is an injury in which the tendon at the end of the finger is separated from the bone as a result of trauma. Splinting also is used to immobilize an injured arm or leg immediately after an injury. Before moving a person who has injured an arm or leg some type of temporary splint should be applied to prevent further injury to the area. Splints may be made of acrylic, polyethylene foam, plaster of paris, or aluminum. In an emergency, a splint can be made from a piece of wood or rolled magazine.

Slings

Slings are often used to support the arm after a fracture or other injury. They are generally used along with a cast or splint, but sometimes are used alone as a means of immobilization. They can be used in an emergency to immobilize the arm until the person can be seen by a doctor. A triangular bandage is placed under the injured arm and then tied around the neck.

Braces

Braces are used to support, align, or hold a body part in the correct position. Braces are sometimes used after a surgical procedure is performed on an arm or leg. They can also be used for an injury. Since some braces can be easily taken off and put back on, they are often used when the person must have physical therapy or **exercise** the limb during the healing process. Many braces can also be adjusted to allow for a certain amount of movement.

Braces can be custom-made, or a ready-made brace can be used. The off-the-shelf braces are made in a variety of shapes and sizes. They generally have Velcro straps that make the brace easy to adjust, and to put on and take off. Both braces and splints offer less support and protection than a cast and may not be a treatment option in all circumstances.

Collars

A collar is generally used for neck injuries. A soft collar can relieve pain by restricting movement of the head and neck. They also transfer some of the weight of the head from the neck to the chest. Stiff collars are generally used to support the neck when there has been a fracture in one of the bones of the neck. Cervical collars are widely used by emergency personnel at the scene of injuries when there is a potential neck or **head injury**.

Traction

Immobilization may also be secured by **traction**. Traction involves using a method for applying tension to correct the alignment of two structures (such as two

KEY TERMS

Decubitus ulcers — A pressure sore resulting from ulceration of the skin occurring in persons confined to bed for long periods of time

Ligament—Ligaments are structures that hold bones together and prevent excessive movement of the joint. They are tough, fibrous bands of tissue.

Pneumonia — An acute or chronic disease characterized by inflammation of the lungs and caused by viruses, bacteria, or other microorganisms.

Tendon—Tendons are structures that attach bones to muscles and muscles to other muscles.

bones) and hold them in the correct position. For example, if the bone in the thigh breaks, the broken ends may have a tendency to overlap. Use of traction will hold them in the correct position for healing to occur. The strongest form of traction involves inserting a stainless steel pin through a bony prominence attached by a horseshoe shaped bow and rope to a pulley and weights suspended over the end of the patient's bed.

Traction must be balanced by countertraction. This is obtained by tilting the bed and allowing the patient's body to act as a counterweight. Another technique involves applying weights pulling in the opposite direction.

Traction for neck injuries may be in the form of a leather or cotton cloth halter placed around the chin and lower back of the head. For very severe neck injuries that require maximum traction, tongs that resemble ice tongs are inserted into small holes drilled in the outer skull.

All traction requires careful observation and adjustment by doctors and nurses to maintain proper balance and alignment of the traction with free suspension of the weights.

Immobilization can also be secured by a form of traction called skin traction. This is a combination of a splint and traction that is applied to the arms or legs by strips of adhesive tape placed over the skin of the arm or leg. Adhesive strips, moleskin, or foam rubber traction strips are applied on the skin. This method is effective only if a moderate amount of traction is required.

Preparation

There are many reasons for immobilization using splints, casts, and braces. Each person should understand his or her diagnosis clearly.

Aftercare

After a cast or splint has been put on, the injured arm or leg should be elevated for 24 to 72 hours. It is recommended that the person lie or sit with the injured arm or leg raised above the level of the heart. Rest combined with elevation will reduce pain and speed the healing process by minimizing swelling.

Fingers or toes can be exercised as much as can be tolerated after casting. This has been found to decrease swelling and prevent stiffness. If excessive swelling is noted, the application of ice to the splint or cast may be helpful.

After the cast, splint, or brace is removed, gradual exercise is usually performed to regain muscle strength and motion. The doctor may also recommend **hydrotherapy**, **heat treatments**, and other forms of physical therapy.

Risks

For some people, such as those in traction, immobilization will require long periods of bedrest. Lying in one position in bed for an extended period of time can result in sores on the skin (decubitus ulcers) and skin infection. Long periods of bedrest can also cause a buildup of fluid in the lungs or an infection in the lungs (**pneumonia**). Urinary infection can also be a result of extended bedrest.

People who have casts, splints, or braces on their arms or legs will generally spend several weeks not using the injured arm or leg. This lack of use can result in decreased muscle tone and shrinkage of the muscle (atrophy). Much of this loss can usually be regained, however, through **rehabilitation** after the injury has healed.

Immobility can also cause psychological **stress**. An individual restricted to a bed with a traction device may become frustrated and bored, and perhaps even depressed, irritable, and withdrawn.

There is the possibility of decreased circulation if the cast, splint, or brace fits too tightly. Excessive pressure over a nerve can cause irritation or possible damage if not corrected. If the cast, splint, or brace breaks or malfunctions, the healing process of the bone or soft tissue can be disrupted and lead to deformity.

Normal results

Normally, the surgical or injured area heals appropriately with the help of immobilization. The form of immobilization can be discontinued, which is followed by an appropriate rehabilitation program under the supervision of a physical therapist to regain range of motion and strength.

Resources

BOOKS

American Red Cross. *Community First Aid and Safety.* St. Louis: Mosby, 1993.

PERIODICALS

Gorden, Everett J. "Fractures and Dislocations: An Overview." *Trauma* 37 (Feb. 1996): 5-36.

Krock, N. "Immobilizing the Cervical Spine Using a Collar: Complications and Nursing Management." *Nursing Journal* 18 (Mar. 1997):52-55.

OTHER

"Casts & Splints." *The Center for Orthopaedics and Sports Medicine*. <http://www.arthroscopy.com>.

Griffith, H. Winter. "Dislocations or Subluxation." 1998. 25 Mar. 1998. *ThriveOnline*. <http://thriveonline.oxygen.com>.

Jeffrey P. Larson, RPT

Immune complex detection *see* **Immune complex test**

Immune complex test

Definition

These tests evaluate the immune system, whose function is to defend the body against such invaders as bacteria and viruses. The immune system also plays a role in the control of **cancer**, and is responsible for the phenomena of allergy, hypersensitivity, and rejection problems when organs or tissue are transplanted.

One of the ways the immune system protects the body is by producing proteins called antibodies. Antibodies are formed in response to another type of protein called an antigen (anything foreign or different from a natural body protein). Immune complex reactions occur when large numbers of antigen-antibody complexes accumulate in the body.

Purpose

The purpose of the immune complex test is to demonstrate circulating immune complexes in the blood, to estimate the severity of immune complex disease, and to monitor response to therapy.

Precautions

Because this test is requested when the physician suspects that a patient's immune system is not functioning properly, special care should be taken during and after blood is drawn. For example, the venipuncture site should be kept clean and dry to avoid any chance of infection.

Description

Immune complexes are normally not detected in the blood. However, when immune complexes are produced faster than they can be cleared by the system, immune complex disease may occur. Examples of such disorders are drug sensitivity, **rheumatoid arthritis**, and a disease called **systemic lupus erythematosus**, or SLE.

The method generally used for detecting immune complexes is examination of a tissue obtained by biopsy (removal and examination of tissue sample) and the subsequent use of different staining techniques with specific antibodies. However, since tissue biopsies do not provide information about the level of complexes still in the circulatory system, serum assays obtained from blood samples which indirectly detect circulating immune complexes are useful. However, due to the variability of these complexes, several test methods may be used. Also, as most immune complex assays have not been standardized, more than one test may be required to achieve accurate results.

Preparation

This test requires a blood sample. It is not necessary for the patient to be in a **fasting** (nothing to eat or drink) state before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normally, immune complexes are not detected in the blood.

Abnormal results

The presence of detectable immune complexes in the blood is important in the diagnosis of autoimmune diseases, such as SLE and rheumatoid arthritis. However, for definitive diagnosis, the results of other studies must be considered with the presence of any immune complex. For example, immune complexes are associated with high numbers of a component called antinuclear antibodies in the diagnosis of systemic lupus erythematosus. A different example are the kidneys. Because of their filter-

KEY TERMS

Antibody—A (immunogloblin) molecule that interacts with a specific antigen. Antibodies provide protection from microscopic invaders like bacteria.

Antigen—Any substance that is capable under certain circumstances of producing an immune response either from antibodies or T-cells; bacteria are often antigens.

Autoimmune disorder—A disorder caused by a reaction of an individual's immune system against the organs or tissues of the body. Autoimmune processes can have different results: slow destruction of a particular type of cell or tissue, stimulation of an organ into excessive growth, or interference in function.

Biopsy—The removal and examination, usually under a microscope, of tissue from the living body. Used for diagnosis.

Systemic lupus erythematosus—A chronic disease of the connective tissues in the body; characterized by involvement of the skin, joints, kidneys, and serosal membranes (membranes that form the outer covering of organs in the abdomen or chest).

ing functions, elements in the kidneys called renal glomeruli can be affected by immune complexes. In such cases, renal biopsy is used to provide conclusive evidence for immune complex.

Resources

BOOKS

Cahill, Matthew. *Handbook of Diagnostic Tests.* Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook.* 4th ed. New York: Lexi-Comp Inc., 1996.

Janis O. Flores

Immunodeficiency

Definition

Immunodeficiency disorders are a group of disorders in which part of the immune system is missing or defective. Therefore, the body's ability to fight infections is impaired. As a result, the person with an immunodeficiency disorder will have frequent infections that are generally more severe and last longer than usual.

Description

The immune system is the body's main system to fight infections. Any defect in the immune system decreases a person's ability to fight infections. A person with an immunodeficiency disorder may get more frequent infections, heal more slowly, and have a higher incidence of some cancers.

The normal immune system involves a complex interaction of certain types of cells that can recognize and attack "foreign" invaders, such as bacteria, viruses, and fungi. It also plays a role in fighting **cancer**. The immune system has both innate and adaptive components. Innate immunity is made up of immune protections people are born with. Adaptive immunity develops throughout life. It adapts to fight off specific invading organisms. Adaptive immunity is divided into two components: humoral immunity and cellular immunity.

The innate immune system is made up of the skin (which acts as a barrier to prevent organisms from entering the body), white blood cells called phagocytes, a system of proteins called the complement system, and chemicals called interferonso. When phagocytes encounter an invading organism, they surround and engulf it to destroy it. The complement system also attacks bacteria. The elements in the complement system create a hole in the outer layer of the target cell, which leads to the **death** of the cell.

The adaptive component of the immune system is extremely complex, and is still not entirely understood. Basically, it has the ability to recognize an organism or tumor cell as not being a normal part of the body, and to develop a response to attempt to eliminate it.

The humoral response of adaptive immunity involves a type of cell called B lymphocytes. B lymphocytes manufacture proteins called antibodies (which are also called immunoglobulins). Antibodies attach themselves to the invading foreign substance. This allows the phagocytes to begin engulfing and destroying the organism. The action of antibodies also activates the complement system. The humoral response is particularly useful for attacking bacteria.

The cellular response of adaptive immunity is useful for attacking viruses, some parasites, and possibly cancer cells. The main type of cell in the cellular response is T lymphocytes. There are helper T lymphocytes and killer T lymphocytes. The helper T lymphocytes play a role in recognizing invading organisms, and they also help killer

T lymphocytes to multiply. As the name suggests, killer T lymphocytes act to destroy the target organism.

Defects can occur in any component of the immune system or in more than one component (combined immunodeficiency). Different immunodeficiency diseases involve different components of the immune system. The defects can be inherited and/or present at birth (congenital) or acquired.

Congenital immunodeficiency disorders

Congenital immunodeficiency is present at the time of birth, and is the result of genetic defects. Even though more than 70 different types of congenital immunodeficiency disorders have been identified, they rarely occur. Congenital immunodeficiencies may occur as a result of defects in B lymphocytes, T lymphocytes, or both. They can also occur in the innate immune system.

B LYMPHOCYTE DEFICIENCIES. If there is an abnormality in either the development or function of B lymphocytes, the ability to make antibodies will be impaired. This allows the body to be susceptible to recurrent infections.

Bruton's agammaglobulinemia, also known as **X-linked agammaglobulinemia**, is one of the most common congenital immunodeficiency disorders. The defect results in a decrease or absence of B lymphocytes, and therefore a decreased ability to make antibodies. People with this disorder are particularly susceptible to infections of the throat, skin, middle ear, and lungs. It is seen only in males because it is caused by a genetic defect on the X chromosome. Since males have only one X chromosome, they always have the defect if the gene is present. Females can have the defective gene, but since they have two X chromosomes, there will be a normal gene on the other X chromosome to counter it. Women may pass the defective gene on to their male children.

Another type of B lymphocyte deficiency involves a group of disorders called selective immunoglobulin deficiency syndomes. Immunoglobulin is another name for antibody, and there are five different types of immunoglobulins (called IgA, IgG, IgM, IgD, and IgE). The most common type of immunoglobulin deficiency is selective IgA deficiency. The amounts of the other antibody types are normal. Some patients with selective IgA deficiency experience no symptoms, while others have occasional lung infections and **diarrhea**. In another immunoglobulin disorder, IgG and IgA antibodies are deficient and there is increased IgM. People with this disorder tend to get severe bacterial infections.

Common variable immunodeficiency is another type of B lymphocyte deficiency. In this disorder, the production of one or more of the immunoglobulin types is decreased and the antibody response to infections is impaired. It generally develops around the age of 10-20. The symptoms vary among affected people. Most people with this disorder have frequent infections, and some will also experience anemia and **rheumatoid arthritis**. Many people with common variable immunodeficiency develop cancer.

T LYMPHOCYTE DEFICIENCIES. Severe defects in the ability of T lymphocytes to mature results in impaired immune responses to infections with viruses, fungi, and certain types of bacteria. These infections are usually severe and can be fatal.

DiGeorge syndrome is a T lymphocyte deficiency that starts during fetal development, but it isn't inherited. Children with DiGeorge syndrome either do not have a thymus or have an underdeveloped thymus. Since the thymus is a major organ that directs the production of T-lymphocytes, these patients have very low numbers of T-lymphocytes. They are susceptible to recurrent infections, and usually have physical abnormalities as well. For example, they may have low-set ears, a small receding jawbone, and wide-spaced eyes.

In some cases, no treatment is required for DiGeorge syndrome because T lymphocyte production improves. Either an underdeveloped thymus begins to produce more T lymphocytes or organ sites other than the thymus compensate by producing more T lymphocytes.

COMBINED IMMUNODEFICIENCIES. Some types of immunodeficiency disorders affect both B lymphocytes and T lymphocytes. For example, **severe combined immunodeficiency disease** (SCID) is caused by the defective development or function of these two types of lymphocytes. It results in impaired humoral and cellular immune responses. SCID is usually recognized during the first year of life. It tends to cause a fungal infection of the mouth (thrush), diarrhea, **failure to thrive**, and serious infections. If not treated with a bone marrow transplant, a person with SCID will generally die from infections before age two.

DISORDERS OF INNATE IMMUNITY. Disorders of innate immunity affect phagocytes or the complement system. These disorders also result in recurrent infections.

Acquired immunodeficiency disorders

Acquired immunodeficiency is more common than congenital immunodeficiency. It is the result of an infectious process or other disease. For example, the human immunodeficiency virus (HIV) is the virus that causes acquired immunodeficiency syndrome (**AIDS**). However, this is not the most common cause of acquired immunodeficiency.

Acquired immunodeficiency often occurs as a complication of other conditions and diseases. For example, the most common causes of acquired immunodeficiency are **malnutrition**, some types of cancer, and infections. People who weigh less than 70% of the average weight of persons of the same age and gender are considered to be malnourished. Examples of types of infections that can lead to immunodeficiency are **chickenpox**, cytomegalovirus, German **measles**, measles, **tuberculosis**, **infectious mononucleosis** (Epstein-Barr virus), chronic hepatitis, lupus, and bacterial and fungal infections.

Sometimes, acquired immunodeficiency is brought on by drugs used to treat another condition. For example, patients who have an organ transplant are given drugs to suppress the immune system so the body will not reject the organ. Also, some **chemotherapy** drugs, which are given to treat cancer, have the side effect of killing cells of the immune system. During the period of time that these drugs are being taken, the risk of infection increases. It usually returns to normal after the person stops taking the drugs.

Causes and symptoms

Congenital immunodeficiency is caused by genetic defects, and they generally occur while the fetus is developing in the womb. These defects affect the development and/or function of one or more of the components of the immune system. Acquired immunodeficiency is the result of a disease process, and it occurs later in life. The causes, as described above, can be diseases, infections, or the side effects of drugs given to treat other conditions.

People with an immunodeficiency disorder tend to become infected by organisms that don't usually cause disease in healthy persons. The major symptoms of most immunodeficiency disorders are repeated infections that heal slowly. These chronic infections cause symptoms that persist for long periods of time. People with chronic infection tend to be pale and thin. They may have skin **rashes**. Their lymph nodes tend to be larger than normal and their liver and spleen may also be enlarged. The lymph nodes are small organs that house antibodies and lymphocytes. Broken blood vessels, especially near the surface of the skin, may be seen. This can result in black-and-blue marks in the skin. The person may lose hair from their head. Sometimes, a red inflammation of the lining of the eye (**conjunctivitis**) is present. They may have a crusty appearance in and on the nose from chronic nasal dripping.

Diagnosis

Usually, the first sign that a person might have an immunodeficiency disorder is that they don't improve rapidly when given **antibiotics** to treat an infection. Strong indicators that an immunodeficiency disorder may be present is when rare diseases occur or the patient gets ill from organisms that don't normally cause diseases, especially if the patient gets repeatedly infected. If this happens in very young children it is an indication that a genetic defect may be causing an immunodeficiency disorder. When this situation occurs in older children or young adults, their medical history will be reviewed to determine if childhood diseases may have caused an immunodeficiency disorder. Other possibilities will then be considered, such as recently acquired infections—for example, HIV, hepatitis, tuberculosis, etc.

Laboratory tests are used to determine the exact nature of the immunodeficiency. Most tests are performed on blood samples. Blood contains antibodies, lymphocytes, phagocytes, and complement components— all of the major immune components that might cause immunodeficiency. A blood cell count will determine if the number of phagocytic cells or lymphocytes is below normal. Lower than normal counts of either of these two cell types correlates with immunodeficiencies. The blood cells are also checked for their appearance. Sometimes a person may have normal cell counts, but the cells are structurally defective. If the lymphocyte cell count is low, further testing is usually done to determine whether any particular type of lymphocyte is lower than normal. A lymphocyte proliferation test is done to determine if the lymphocytes can respond to stimuli. The failure to respond to stimulants correlates with immunodeficiency. Antibody levels can be measured by a process called electrophoresis. Complement levels can be determined by immunodiagnostic tests.

Treatment

There is no cure for immunodeficiency disorders. Therapy is aimed at controlling infections and, for some disorders, replacing defective or absent components.

Patients with Bruton's agammaglobulinemia must be given periodic injections of a substance called gamma globulin throughout their lives to make up for their decreased ability to make antibodies. The gamma globulin preparation contains antibodies against common invading bacteria. If left untreated, the disease is usually fatal.

Common variable immunodeficiency also is treated with periodic injections of gamma globulin throughout life. Additionally, antibiotics are given when necessary to treat infections.

Patients with selective IgA deficiency usually do not require any treatment. Antibiotics can be given for frequent infections.

In some cases, no treatment is required for DiGeorge syndrome because T lymphocyte production improves on its own. Either an underdeveloped thymus begins to produce more T lymphocytes or organ sites other than the thymus compensate by producing more T lymphocytes. In some severe cases, a bone marrow transplant or thymus transplant can be done to correct the problem.

For patients with SCID, **bone marrow transplantation** is necessary. In this procedure, healthy bone marrow from a donor who has a similar type of tissue (usually a relative, like a brother or sister) is removed. The bone marrow is a substance that resides in the cavity of bones. It is the factory that produces blood, including some of the white blood cells that make up the immune system. The bone marrow of the person receiving the transplant is destroyed, and is then replaced with marrow from the donor.

Treatment of the HIV infection that causes AIDS consists of drugs called antivirals. These drugs attempt to inhibit the process that the virus goes through to kill T lymphocytes. Several of these drugs used in various combinations with one another can prolong the period of time before the disease becomes apparent. However, this is not a cure. Other treatments for people with AIDS are aimed at the particular infections that arise as a result of the impaired immune system.

In most cases, immunodeficiency caused by malnutrition is reversible. The health of the immune system is directly linked to the nutritional health of the patient. Among the essential nutrients required by the immune system are proteins, **vitamins**, iron, and zinc.

For people being treated for cancer, periodic relief from chemotherapy drugs can restore the function of the immune system.

In general, people with immunodeficiency disorders should maintain a healthy diet. This is because malnutrition can aggravate immunodeficiencies. They should also avoid being near people who have colds or are sick because they can easily acquire new infections. For the same reason, they should practice good personal hygiene, especially dental care. People with immunodeficiency disorders should also avoid eating undercooked food because it might contain bacteria that could cause infection. This food would not cause infection in normal persons, but in someone with an immunodeficiency, food is a potential source of infectious organisms. People with immunodeficiency should be given antibiotics at the first indication of an infection.

KEY TERMS

Agammaglobulinemia—The lack of gamma globulins in the blood. Antibodies are the main gamma globulins of interest, so this term means a lack of antibodies.

Prognosis

The prognosis depends on the type of immunodeficiency disorder. People with Bruton's agammaglobulinemia who are given injections of gamma globulin generally live into their 30s or 40s. They often die from chronic infections, usually of the lung. People with selective IgA deficiency generally live normal lives. They may experience problems if given a blood **transfusion**, and therefore they should wear a Medic Alert bracelet or have some other way of alerting any physician who treats them that they have this disorder.

SCID is the most serious of the immunodeficiency disorders. If a bone marrow transplant is not successfully performed, the child usually will not live beyond two years old.

People with HIV/AIDS are living longer than in the past because of the **antiviral drugs** that became available in the mid 1990s. However, AIDS is still a fatal disease. People with AIDS usually die of opportunistic infections, which are infections that occur because the impaired immune system is unable to fight them.

Prevention

There is no way to prevent a congenital immunodeficiency disorder. However, someone with a congenital immunodeficiency disorder might want to consider getting **genetic counseling** before having children to find out if there is a chance they will pass the defect on to their children.

Some of the infections associated with acquired immunodeficiency can be prevented or treated before they cause problems. For example, there are effective treatments for tuberculosis and most bacterial and fungal infections. HIV infection can be prevented by practicing "safe sex" and not using illegal intravenous drugs. These are the primary routes of transmitting the virus. For people who don't know the HIV status of the person with whom they are having sex, safe sex involves using a **condom**.

Malnutrition can be prevented by getting adequate **nutrition**. Malnutrition tends to be more of a problem in developing countries.

Resources

BOOKS

Abbas, A. K., A. H. Lichtman, and J. S. Pober. *Cellular and Molecular Immunology.* Philadelphia: W. B. Saunders Co., 1997.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Roitt, Ivan M. *Roitt's Essential Immunology.* Oxford, UK: Blackwell Science Ltd., 1997.

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Immunoelectrophoresis

Definition

Immunoelectrophoresis, also called gamma globulin electrophoresis, or immunoglobulin electrophoresis, is a method of determining the blood levels of three major immunoglobulins: immunoglobulin M (IgM), immunoglobulin G (IgG), and immunoglobulin A (IgA).

Purpose

Immunoelectrophoresis is a powerful analytical technique with high resolving power as it combines separation of antigens by electrophoresis with immunodiffusion against an antiserum. The increased resolution is of benefit in the immunological examination of serum proteins. Immunoelectrophoresis aids in the diagnosis and evaluation of the therapeutic response in many disease states affecting the immune system. It is usually requested when a different type of electrophoresis, called a serum **protein electrophoresis**, has indicated a rise at the immunoglobulin level. Immunoelectrophoresis is also used frequently to diagnose **multiple myeloma**, a disease affecting the bone marrow.

Precautions

Drugs that may cause increased immunoglobulin levels include therapeutic gamma globulin, hydralazine, isoniazid, phenytoin (Dilantin), procainamide, **oral contraceptives**, **methadone**, steroids, and **tetanus** toxoid and antitoxin. The laboratory should be notified if the patient has received any vaccinations or immunizations in the six months before the test. This is mainly because prior immunizations lead to the increased immunoglobulin levels resulting in false positive results.

It should be noted that, because immunoelectrophoresis is not quantitative, it is being replaced by a procedure called immunofixation, which is more sensitive and easier to interpret.

Description

Serum proteins separate in agar gels under the influence of an electric field into albumin, alpha 1, alpha 2, and beta and gamma globulins. Immunoelectrophoresis is performed by placing serum on a slide containing a gel designed specifically for the test. An electric current is then passed through the gel, and immunoglobulins, which contain an electric charge, migrate through the gel according to the difference in their individual electric charges. Antiserum is placed alongside the slide to identify the specific type of immunoglobulin present. The results are used to identify different disease entities, and to aid in monitoring the course of the disease and the therapeutic response of the patient to such conditions as immune deficiencies, autoimmune disease, chronic infections, chronic viral infections, and intrauterine fetal infections.

There are five classes of antibodies: IgM, IgG, IgA, IgE, and IgD.

IgM is produced upon initial exposure to an antigen. For example, when a person receives the first tetanus **vaccination**, antitetanus antibodies of the IgM class are produced 10–14 days later. IgM is abundant in the blood but is not normally present in organs or tissues. IgM is primarily responsible for ABO blood grouping and rheumatoid factor, yet is involved in the immunologic reaction to other infections, such as hepatitis. Since IgM does not cross the placenta, an elevation of this immunoglobulin in the newborn indicates intrauterine infection such as **rubella**, cytomegalovirus (CMV) or a sexually transmitted disease (STD).

IgG is the most prevalent type of antibody, comprising approximately 75% of the serum immunoglobulins. IgG is produced upon subsequent exposure to an antigen. As an example, after receiving a second tetanus shot, or booster, a person produces IgG antibodies in five to seven days. IgG is present in both the blood and tissues, and is the only antibody to cross the placenta from the mother to the fetus. Maternal IgG protects the newborn for the first months of life, until the infant's immune system produces its own antibodies.

IgA constitutes approximately 15% of the immunoglobulins within the body. Although it is found to some degree in the blood, it is present primarily in the secretions of the respiratory and gastrointestinal tract, in saliva, colostrum (the yellowish fluid produced by the breasts during late **pregnancy** and the first few days after **childbirth**), and in tears. IgA plays an important role in defending the body against invasion of germs through the mucous membrane-lined organs.

IgE is the antibody that causes acute allergic reactions; it is measured to detect allergic conditions. IgD, which constitutes the smallest portion of the immunoglobulins, is rarely evaluated or detected, and its function is not well understood.

Preparation

This test requires a blood sample.

Aftercare

Because this test is ordered when either very low or very high levels of immunoglobulins are suspected, the patient should be alert for any signs of infection after the test, including **fever**, chills, rash, or skin ulcers. Any bone **pain** or tenderness should also be immediately reported to the physician.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or bruising.

Normal results

Reference ranges vary from laboratory to laboratory and depend upon the method used. For adults, normal values are usually found within the following ranges (1 mg = approximately.000035 oz. and 1 dL = approximately. 33 oz.):

- IgM: 60–290 mg/dL
- IgG: 700–1,800 mg/dL
- IgA: 70–440 mg/dL

Abnormal results

Increased IgM levels can indicate Waldenström's macroglobulinemia, a malignancy caused by secretion of IgM at high levels by malignant lymphoplasma cells. Increased IgM levels can also indicate chronic infections, such as hepatitis or mononucleosis and autoimmune diseases, like **rheumatoid arthritis**.

Decreased IgM levels can be indicative of **AIDS**, immunosuppression caused by certain drugs like steroids or dextran, or leukemia.

Increased levels of IgG can indicate chronic liver disease, autoimmune diseases, hyperimmunization reactions, or certain chronic infections, such as **tuberculosis** or **sarcoidosis**.

Decreased levels of IgG can indicate **Wiskott-Aldrich syndrome**, a genetic deficiency caused by inadequate synthesis of IgG and other immunoglobulins. Decreased IgG can also be seen with AIDS and leukemia.

KEY TERMS

Antibody—A protein manufactured by the white blood cells to neutralize an antigen in the body. In some cases, excessive formation of antibodies leads to illness, allergy, or autoimmune disorders.

Antigen—A substance that can cause an immune response, resulting in production of an antibody, as part of the body's defense against infection and disease. Many antigens are foreign proteins not found naturally in the body, and include germs, toxins, and tissues from another person used in organ transplantation.

Autoimmune disorder—A condition in which antibodies are formed against the body's own tissues; for example, in some forms of arthritis.

Increased levels of IgA can indicate chronic liver disease, chronic infections, or inflammatory bowel disease.

Decreased levels of IgA can be found in ataxia, a condition affecting balance and gait, limb or eye movements, speech, and telangiectasia, an increase in the size and number of the small blood vessels in an area of skin, causing redness. Decreased IgA levels are also seen in conditions of low blood protein (hypoproteinemia), and drug immunosuppression.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Fischbach, Frances T. *A Manual of Laboratory Diagnostic Tests*. Philadelphia: Lippincott Williams & Wilkins, 1999.

Pagana, Kathleen D., and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis, MO: Mosby, Inc., 1999.

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Immunoglobulin *see* **Gammaglobulin**

Immunoglobulin deficiency syndromes

Definition

Immunoglobulin deficiency syndromes are a group of **immunodeficiency** disorders in which the patient has a reduced number of or lack of antibodies.

Description

Immunoglobulins (Ig) are antibodies. There are five major classes of antibodies: IgG, IgM, IgA, IgD, and IgE.

- IgG is the most abundant of the classes of immunoglobulins. It is the antibody for viruses, bacteria, and antitoxins. It is found in most tissues and plasma.
- IgM is the first antibody present in an immune response.
- IgA is an early antibody for bacteria and viruses. It is found in saliva, tears, and all other mucous secretions.
- IgD activity is not well understood.
- IgE is present in the respiratory secretions. It is an antibody for parasitic diseases, **Hodgkin's disease**, hay **fever**, **atopic dermatitis**, and allergic **asthma**).

All antibodies are made by B-lymphocytes (B-cells). Any disease that harms the development or function of B-cells will cause a decrease in the amount of antibodies produced. Since antibodies are essential in fighting infectious diseases, people with immunoglobulin deficiency syndromes become ill more often. However, the cellular immune system is still functional, so these patients are more prone to infection caused by organisms usually controlled by antibodies. Most of these invading germs (microbes) make capsules, a mechanism used to confuse the immune system. In a healthy body, antibodies can bind to the capsule and overcome the bacteria's defenses. The bacteria that make capsules include the streptococci, meningococci, and *Haemophilus influenzae*. These organisms cause such diseases as otitis, **sinusitis**, **pneumonia**, **meningitis**, **osteomyelitis**, septic arthritis, and **sepsis**. Patients with immunoglobulin deficiencies are also prone to some viral infections, including echovirus, enterovirus, and **hepatitis B**. They may also have a bad reaction to the attenuated version of the **polio** virus vaccine.

There are two types of immunodeficiency diseases: primary and secondary. Secondary disorders occur in normally healthy bodies that are suffering from an underlying disease. Once the disease is treated, the immunodeficiency is reversed. Immunoglobulin deficiency syndromes are primary immunodeficiency diseases, occurring because of defective B-cells or antibodies. They account for 50% of all primary immunodeficiencies, and they are, therefore, the most prevalent type of immunodeficiency disorders.

- X-linked agammaglobulinemia is an inherited disease. The defect is on the X chromosome and, consequently, this disease is seen more frequently in males than females. The defect results in a failure of B-cells to mature. Mature B-cells are capable of making antibodies and developing "memory," a feature in which the B-cell will rapidly recognize and respond to an infectious agent the next time it is encountered. All classes of antibodies are decreased in agammaglobulinemia.
- Selective IgA deficiency is an inherited disease, resulting from a failure of B-cells to switch from making IgM, the early antibody, to IgA. Although the B-cell numbers are normal, and the B-cells are otherwise normal (they can still make all other classes of antibodies), the amount of IgA produced is limited. This results in more infections of mucosal surfaces, such as the nose, throat, lungs, and intestines.
- Transient hypogammaglobulinemia of infancy is a temporary disease of unknown cause. It is believed to be caused by a defect in the development of T-helper cells (cells that recognize foreign antigens and activate T- and B-cells in an immune response). As the child ages, the number and condition of T-helper cells improves and this situation corrects itself. Hypogammaglobulinemia is characterized by low levels of **gammaglobulin** (antibodies) in the blood. During the disease period, patients have decreased levels of IgG and IgA antibodies. In lab tests, the antibodies that are present do not react well with infectious bacteria.
- Common variable immunodeficiency is a defect in both B cells and T-lymphocytes. It results in a near complete lack of antibodies in the blood.
- Ig heavy chain deletions is a genetic disease in which part of the antibody molecule isn't produced. It results in the loss of several antibody classes and subclasses including most IgG antibodies and all IgA and IgE antibodies. The disease occurs because part of the gene for the heavy chain has been lost.
- Selective IgG subclass deficiencies is a group of genetic diseases in which some of the subclasses of IgG are not made. There are four subclasses in the IgG class of antibodies. As the B-cell matures, it can switch from one subclass to another. In these diseases there is a defect in the maturation of the B-cells that results in a lack of switching.
- IgG deficiency with hyper-IgM is a disease that results when the B-cell fails to switch from making IgM to IgG. This produces an increase in the amount of IgM antibodies present and a decrease in the amount of IgGantibodies. This disease is the result of a genetic mutation.

Causes and symptoms

Immunoglobulin deficiencies are the result of congenital defects affecting the development and function of B lymphocytes (B-cells). There are two main points in the development of B-cells when defects can occur. First, B-cells can fail to develop into antibody-producing cells. X-linked agammaglobulinemia is an example of this disease. Secondly, B-cells can fail to make a particular type

KEY TERMS

Antibody—Another term for immunoglobulin. A protein molecule that specifically recognizes and attaches to infectious agents.

T-helper cell—A type of cell that recognizes foreign antigens and activates T- and B-cells in an immune response.

of antibody or fail to switch classes during maturation. Initially, when B-cells start making antibodies for the first time, they make IgM. As they mature and develop memory, they switch to one of the other four classes of antibodies. Failures in switching or failure to make a subclass of antibody leads to immunoglobulin deficiency diseases. Another mechanism that results in decreased antibody production is a defect in T-helper cells. Generally, defects in T-helper cells are listed as severe combined immunodeficiencies.

Symptoms are persistent and frequent infections, **diarrhea**, **failure to thrive**, and malabsorption (of nutrients).

Diagnosis

An immunodeficiency disease is suspected when children become ill frequently, especially from the same organisms. The profile of organisms that cause infection in patients with immunoglobulin deficiency syndrome is unique and is preliminary evidence for this disease. Laboratory tests are performed to verify the diagnosis. Antibodies can be found in the blood. Blood is collected and analyzed for the content and types of antibodies present. Depending on the type of immunoglobulin deficiency the laboratory tests will show a decrease or absence of antibodies or specific antibody subclasses.

Treatment

Immunodeficiency diseases cannot be cured. Patients are treated with **antibiotics** and immune serum. Immune serum is a source of antibodies. Antibiotics are useful for fighting bacteria infections. There are some drugs that are effective against fungi, but very few drugs that are effective against viral diseases.

Bone marrow transplantation can, in most cases, completely correct the immunodefiency.

Prognosis

Patients with immunoglobulin defiency syndromes must practice impeccable health maintenance and care, paying particular attention to optimal dental care, in order to stay in good health.

Resources

BOOKS

Abbas, A. K., A. H. Lichtman, and J. S. Pober. *Cellular and Molecular Immunology.* Philadelphia: W. B. Saunders Co., 1997.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Roitt, I. M. *Roitt's Essential Immunology.* Oxford, UK: Blackwell Science Ltd., 1997.

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Immunoglobulin electrophoresis *see* **Immunoelectrophoresis**

Immunoglobulins G, A, and M test *see* **Immunoelectrophoresis**

Immunologic therapies

Definition

Immunologic therapy is the treatment of disease using medicines that boost the body's natural immune response.

Purpose

Immunologic therapy is used to improve the immune system's natural ability to fight such diseases as **cancer**, hepatitis and **AIDS**. These drugs may also be used to help the body recover from immunosuppression resulting from such treatments as **chemotherapy** or **radiation therapy**.

Description

Most drugs in this category are synthetic versions of substances produced naturally in the body. In their natural forms, these substances help defend the body against disease. For example, aldesleukin (Proleukin) is an artificially made form of interleukin-2, which helps white blood cells work. Aldesleukin is administered to patients with kidney cancers and skin cancers that have spread to other parts of the body. Filgrastim (Neupogen) and sargramostim (Leukine) are versions of natural substances called colony stimulating factors, which drive the bone marrow to make new white blood cells. Another type of

drug, epoetin (Epogen, Procrit), is a synthetic version of human erythropoietin that stimulates the bone marrow to make new red blood cells. Thrombopoietin stimulates the production of platelets, disk-shaped bodies in the blood that are important in clotting. Interferons are substances the body produces naturally using immune cells to fight infections and tumors. The synthetic interferons carry such brand names as Alferon, Roferon or Intron A. Some of the interferons that are currently in use as drugs are Recombinant Interferon Alfa-2a, Recombinant Interferon Alfa-2b, interferon alfa-n1 and Interferon Alfa-n3. Alfa interferons are used to treat **hairy cell leukemia**, **malignant melanoma** and AIDS-related **Kaposi's sarcoma,** which is a form of cancer. In addition interferons are also used for such other conditions as laryngeal papillomatosis, **genital warts** and certain types of hepatitis.

Recommended dosage

The recommended dosage depends on the type of immunologic therapy. For some medicines, the physician will decide the dosage for each patient, taking into account a patient's weight and whether he/she is taking other medicines. Some drugs used in immunologic therapy are given only in a hospital, under a physician's supervision. For those that patients may give themselves, one should check with the physician who prescribed the medicine or the pharmacist who filled the prescription for the correct dosage.

Most of these drugs come in injectable form. These drugs are generally administered by the cancer care provider.

Precautions

Aldesleukin

This medicine may temporarily increase the chance of getting infections. It may also lower the number of platelets in the blood, and thus possibly interfering with the blood's ability to clot. Taking these precautions may reduce the chance of such problems:

- Avoid people with infections, if possible.
- Be alert to signs of infection, such as **fever**, chills, **sore throat**, **pain** in the lower back or side, **cough**, hoarseness, or painful or difficulty with urination. If any of these symptoms occur, get in touch with a physician immediately.
- Be alert to signs of bleeding problems, such as black, tarry stools, iny red spots on the skin, blood in the urine or stools, or any other unusual bleeding or bruising.
- Take care to avoid cuts or other injuries. Be especially careful when using knives, razors, nail clippers and other sharp objects. Check with a dentist for the best ways to clean the teeth and mouth without injuring the gums. Do not have dental work done without checking with a physician.
- Wash hands frequently, and avoid touching the eyes or inside of the nose unless the hands have just been washed.

Aldesleukin may make some medical conditions worse, such as **chickenpox**, **shingles** (herpes zoster), liver disease, lung disease, heart disease, underactive thyroid, **psoriasis**, immune system problems and mental problems. The medicine may increase the chance of seizures (convulsions) in people who are prone to having them. Also, the drug's effects may be greater in people with kidney disease, because their kidneys are slow to clear the medicine from their bodies.

Colony stimulating factors

Certain drugs used in treating cancer reduce the body's ability to fight infections. Although colony stimulating factors help restore the body's natural defenses, the process takes time. Getting prompt treatment for infections is important, even while taking this medicine. Call the physician at the first sign of illness or infection, such as a sore throat, fever or chills.

People with certain medical conditions could have problems if they take colony stimulating factors. People who have kidney disease, liver disease or conditions caused by inflammation or immune system problems can worsen these problems with colony stimulating factors. Those who have heart disease may be more likely to experience such side effects as water retention and heart rhythm problems while taking these drugs. Finally, patients who have lung disease might increase their chances of suffering from **shortness of breath**. Those who have any of these medical conditions should check with their personal physicians before using colony stimulating factors.

Epoetin

Epoetin is a medicine that may cause seizures (convulsions), especially in people who are prone to having them. No one who takes these drugs should drive, use machines, or do anything considered dangerous in case of a seizure.

Epoetin helps the body make new red blood cells, but it is not effective unless there is adequate iron in the body. The physician may recommend taking iron supplements or certain **vitamins** that help supply the body with iron. It is necessary to follow the physician's advice in this instance —recommendations for iron in this case, as with any supplements, should come only from a physician.

KEY TERMS

AIDS—Acquired immunodeficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, increasing vulnerability to other infections and some types of cancer.

Bone marrow—Soft tissue that fills the hollow centers of bones. Blood cells and platelets (disk-shaped bodies in the blood that are important in clotting) are produced in the bone marrow.

Chemotherapy—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs.

Clot—A hard mass that forms when blood coagulates.

Fetus—A developing baby inside the womb.

Hepatitis—Inflammation of the liver caused by a virus, chemical, or drug.

Immune response—The body's natural protective reaction to disease and infection.

Immune system—The system that protects the body against disease and infection through immune responses.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Psoriasis—A skin disease that manifests itself with itchy, scaly, red patches on the skin.

Seizure—A sudden attack, spasm, or convulsion.

Shingles—A disease caused by an infection with the Herpes zoster virus—the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

Sickle cell anemia—An inherited disorder in which red blood cells contain an abnormal form of hemoglobin, a protein that carries oxygen. The abnormal form of hemoglobin causes the red cells to become sickle-shaped. The misshapen cells may clog blood vessels, preventing oxygen from reaching tissues and leading to pain, blood clots and other problems. Sickle cell anemia is most common in people of African descent and in people from Italy, Greece, India, and the Middle East.

In studies of laboratory animals, epoetin taken during **pregnancy** caused **birth defects**, including damage to the bones and spine. However, the drug has not been reported to cause problems in human babies whose mothers take it. Women who are pregnant or who may become pregnant should check with their physicians for the most up-to-date information on the safety of taking this medicine during pregnancy.

People with certain medical conditions may have problems if they take this medicine. For example, the chance of side effects may be greater in people with high blood pressure, heart or blood vessel disease or a history of blood clots. Epoetin may not work properly in people who have bone problems or sickle cell anemia.

Interferons

Interferons can add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. Those taking interferons should check with their physicians before taking any of the above.

Some people experience **dizziness**, unusual tiredness, or become less alert than usual while being treated with these drugs. Because of these possible problems, anyone who takes these drugs should not drive, use machines or do anything else considered dangerous until they have determined how the drugs affect them.

Interferons often cause flu-like symptoms, including fever and chills. The physician who prescribes this medicine may recommend taking **acetaminophen** (Tylenol) before—and sometimes after—each dose to keep the fever from getting too high. If the physician recommends this, follow instructions carefully.

Like aldesleukin, interferons may temporarily increase the chance of getting infections and lower the number of platelets in the blood, leading to clotting problems. To help prevent these problems, follow the precautions for reducing the risk of infection and bleeding listed for aldesleukin.

People who have certain medical conditions may have problems if they take interferons. For example, the drugs may worsen some medical conditions, including heart disease, kidney disease, liver disease, lung disease, diabetes, bleeding problems and mental problems. In peo-

ple who have overactive immune systems, these drugs can even increase the activity of the immune system. People who have shingles or chickenpox, or who have recently been exposed to chickenpox, may increase their risk of developing severe problems in other parts of the body if they take interferons. People with a history of seizures or mental problems could be at risk if taking interferon?

In teenage women, interferons may cause changes in the menstrual cycle. Young women should discuss this possibility with their physicians. Older people may be more sensitive to the effects of interferons. This sensitivity may increase the chance of side effects.

These drugs are not known to cause fetal **death**, birth defects or other problems in humans when taken during pregnancy. Women who are pregnant or who may become pregnant should ask their physicians for the latest information on the safety of taking these drugs during pregnancy.

Women who are breastfeeding their babies may need to stop while taking this medicine. Whether interferons pass into breast milk is not known. Because of the chance of serious side effects to the baby, breastfeeding while taking interferon is discouraged. Check with a physician for advice.

General precautions for all types of immunologic therapy

Regular physician visits are necessary during immunologic therapy treatment. This gives the physician a chance to make sure the medicine is working and to check for unwanted side effects.

Anyone who has had unusual reactions to drugs used in immunologic therapy should let the physician know before resuming the drugs. Any **allergies** to foods, dyes, preservatives, or other substances should also be reported.

Side effects

Aldesleukin

In addition to its helpful effects, this medicine may cause serious side effects. Generally, it is given only in a hospital, where medical professionals can watch for early signs of problems. Medical tests might be performed to check for unwanted effects.

Anyone who has breathing problems, fever or chills while being given aldesleukin should check with a physician immediately.

Other side effects should be brought to a physician's attention as soon as possible:

- dizziness
- drowsiness
- confusion
- agitation
- depression
- **nausea and vomiting**
- **diarrhea**
- sores in the mouth and on the lips
- tingling of hands or feet
- decrease in urination
- unexplained weight gain of five or more pounds

Some side effects are usually temporary and do not need medical attention unless they are bothersome. These include dry skin; itchy or burning skin rash or redness followed by peeling; loss of appetite; and a general feeling of illness or discomfort.

Colony stimulating factors

As this medicine starts to work, the patient might experience mild pain in the lower back or hips. This is nothing to cause undue concern, and will usually go away within a few days. If the pain is intense or causes discomfort, the physician may prescribe a painkiller.

Other possible side effects include **headache**, joint or muscle pain and skin rash or **itching**. These side effects tend to disappear as the body adjusts to the medicine, and do not need medical treatment. If they continue, or they interfere with normal activities, check with a physician.

Epoetin

This medicine may cause flu-like symptoms, such as muscle aches, bone pain, fever, chills, shivering, and sweating, within a few hours after it is taken. These symptoms usually go away within 12 hours. If they do not, or if they are troubling, check with a physician. Other possible side effects that do not need medical attention are diarrhea, nausea or vomiting, and tiredness or weakness.

Certain side effects should be brought to a physician's attention as soon as possible. These include headache, vision problems, increased blood pressure, fast heartbeat, weight gain, and swelling of the face, fingers, lower legs, ankles or feet.

Anyone who has chest pain or seizures after taking epoetin should seek professional emergency medical attention immediately.

Interferons

This medicine may cause temporary hair loss. While upsetting, it is not a sign that something is seriously

wrong. The hair should grow back normally after treatment ends.

As the body adjusts to the medicine, many other side effects usually go away during treatment. These include flu-like symptoms, changes in taste, loss of appetite, nausea and vomiting, skin rash, and unusual tiredness. If these problems persist, or if they interfere with normal life, check with a physician.

A few more serious side effects should be brought to a physician's attention as soon as possible:

- confusion
- difficulty thinking or concentrating
- nervousness
- depression
- sleep problems
- numbness or tingling in the fingers, toes and face

General caution regarding side effects for all types of immunologic therapy

Other side effects are possible with any type of immunologic therapy. Anyone who has unusual symptoms during or after treatment with these drugs should contact the physician immediately.

Interactions

Anyone who has immunologic therapy should let the physician know all other medicines being taken. Some combinations of drugs may interact, which may increase or decrease the effects of one or both drugs or may increase the likelihood of side effects. Consultation with a physician is highly recommended to get the insight on whether the possible interactions can interfere with drug therapy or cause harmful effects.

Resources

PERIODICALS

Dale, David C. "Where Now for Colony-stimulating Factors?" *Lancet* 346 (July 15, 1995): 135.

Haynes, Barton F. "New Frontiers of Immunotherapy for HIV." *Lancet* 347 (December 7, 1996): 1531.

"Immunoprevention of Cancer: Is the Time Ripe?" *Cancer Research* 60:, May 15, 2000. (2571–2575)

MEDLINE plus Drug information *Aldesleukin (Systemic)* <http://www.nlm.nih.gov/ medlineplus/druginfo/aldesleukinsystemic202669.html>. June 1998. 29 June 2001.

MEDLINE plus Drug information. *Interferons, Alpha (Systemic)* <http://www.nlm.nih.gov/medlineplus/druginfo/interferonsalphasystemic202299.html>. July 1998; 29 June 2001.

National Cancer Institute *Treating Cancer with Vaccine therapy* <http://cancertrials.nci.nih.gov/news/features/vaccine/html/page05.htm>. 2000. 29 June 2001.

Old, Lloyd J. "Immunotherapy for Cancer." (Therapies of the Future) *Scientific American* 275 (September 1996): 136.

Ward, Darrell E. "Taking Advantage of the Body's Healing Power." *USA Today Magazine* 123 (May 1995): 68.

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Immunosuppressant drugs

Definition

Immunosuppressant drugs, also called anti-rejection drugs, are used to prevent the body from rejecting a transplanted organ.

Purpose

When an organ, such as a liver, a heart or a kidney, is transplanted from one person (the donor) into another (the recipient), the immune system of the recipient triggers the same response against the new organ it would have to any foreign material, setting off a chain of events that can damage the transplanted organ. This process is called rejection and it can occur rapidly (acute rejection), or over a long period of time (chronic rejection). Rejection can occur despite close matching of the donated organ and the transplant patient. Immunosuppressant drugs greatly decrease the risks of rejection, protecting the new organ and preserving its function. These drugs act by blocking the immune system so that it is less likely to react against the transplanted organ. A wide variety of drugs are available to achieve this aim but work in different ways to reduce the risk of rejection.

In addition to being used to prevent organ rejection, immunosuppressant drugs are also used to treat such severe skin disorders as **psoriasis** and such other diseases as **rheumatoid arthritis**, **Crohn's disease** (chronic inflammation of the digestive tract) and patchy hair loss (**alopecia** areata). Some of these conditions are termed "autoimmune" diseases, indicating that the immune system is acting against the body itself.

Description

Immunosuppressant drugs can be classified according to their specific molecular mode of action. The three main immunosuppressant drugs currently used in organ transplantations are the following:

- Cyclosporins (Neoral, Sandimmune, SangCya). These drugs act by inhibiting T-cell activation, thus preventing T-cells from attacking the transplanted organ.
- Azathioprines (Imuran). These drugs disrupt the synthesis of DNA and RNA and cell division.
- **Corticosteroids** such as prednisolone (Deltasone, Orasone). These drugs suppress the inflammation associated with transplant rejection.

Most patients are prescribed a combination of drugs after their transplant, one from each of the above main groups; for example cyclosporin, azathioprine and prednisolone. Over a period of time, the doses of each drug and the number of drugs taken may be reduced as the risks of rejection decrease. However, most patients need to take at least one immunosuppressive for the rest of their lives.

Immunosuppressants can also be classified depending on the specific transplant:

- basiliximab (Simulect) is also used, in combination with other drugs such as cyclosporin and corticosteroids, in kidney transplants
- daclizumab (Zenapax)is also used, in combination with other drugs such as cyclosporin and corticosteroids, in kidney transplants
- muromonab CD3 (Orthoclone OKT3) is used, along with cyclosporin, in kidney, liver and heart transplants
- tacrolimus (Prograf) is used in liver transplants. It is under study for kidney, bone marrow, cardiac, pancreas, pancreatic island cell, and small bowel transplantation

Some immunosuppressants are also used to treat a variety of autoimmune diseases:

- Azathioprine (Imuran) is used not only to prevent organ rejection in kidney transplants, but also in treatment of rheumatoid arthritis. It has been used to treat chronic **ulcerative colitis**, but it has been of limited value for this use.
- Cyclosporin (Sandimmune, Neoral) is used in heart, liver, kidney, pancreas, bone marrow and heart/lung transplantation. The Neoral form has been used to treat psoriasis and rheumatoid arthritis. The drug has also been used for many other conditions including **multiple sclerosis**, diabetes and myesthenia gravis.
- Glatiramer acetate (Copaxone) is used in treatment of relapsing-remitting multiple sclerosis. In one study, glatiramer reduced the frequency of multiple sclerosis attacks by 75% over a two-year period.
- Mycopehnolate (CellCept) is used, along with cyclosporin, in kidney, liver and heart transplants. It has also been used to prevent the kidney problems associated with Lupus Erythematosis.
- Sirolimus (Rapamune) is used in combination with other drugs including cyclosporin and corticosteroids, in kidney transplants. The drug is also used for the treatment of psoriasis.

Recommended dosage

Immunosuppressant drugs are available only with a physician's prescription. They come in tablet, capsule, liquid and injectable forms.

The recommended dosage depends on the type and form of immunosuppressant drug and the purpose for which it is being used. Doses may be different for different patients. The prescribing physician or the pharmacist who filled the prescription will advise on correct dosage.

Taking immunosuppressant drugs exactly as directed is very important. Smaller, larger or more frequent doses should never be taken, and the drugs should never be taken for longer than directed. The physician will decide exactly how much of the medicine each patient needs. Blood tests often are necessary to monitor the action of the drug.

The prescribing physician should be consulted before stopping an immunosuppressant drug.

Precautions

Seeing a physician regularly while taking immunosuppressant drugs is important. These regular check-ups will allow the physician to make sure the drug is working as it should and to watch for unwanted side effects. These drugs are very powerful and can cause serious side effects, such as high blood pressure, kidney problems and liver problems. Some side effects may not show up until years after the medicine is used. Anyone who has been advised to take immunosuppressant drugs should thoroughly discuss the risks and benefits with the prescribing physician

Immunosuppressant drugs lower a person's resistance to infection and can make infections harder to treat. The drugs can also increase the chance of uncontrolled bleeding. Anyone who has a serious infection or injury while taking immunosuppressant drugs should get prompt medical attention and should make sure that the treating physician knows about the immunosuppressant prescription. The prescribing physician should be immediately informed if signs of infection, such as **fever** or chills, **cough** or hoarseness, **pain** in the lower back or side, or painful or difficult urination, bruising or bleeding, blood in the urine, bloody or black, tarry stools occur. Other ways of preventing infection and injury include washing the hands frequently, avoiding sports in which injuries may occur,

KEY TERMS

Antibody—Protein produced by the immune system in response to the presence in the body of an antigen.

Antigen—Any substance or organism that is foreign to the body. Examples of antigens are: bacteria, bacterial toxins, viruses, or other cells or proteins.

Autoimmune disease—A disease in which the immune system is overactive and has lost the ability to distinguish between self and non-self.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Corticosteroids—A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

Cortisone—Glucocorticoid produced by the adrenal cortex in response to stress. Cortisone is a steroid with anti-inflammatory and immunosuppressive properties.

Inflammation—A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in such disorders as arthritis and causes harmful effects.

Inflammatory—Pertaining to inflammation.

Immune response—Physiological response of the body controlled by the immune system that involves the production of antibodies to fight off specific foreign substances or agents (antigens).

Immune system—The network of organs, cells, and molecules that work together to defend the body from foreign substances and organisms causing infection and disease such as: bacteria, viruses, fungi and parasites.

Immunosuppressant—Any chemical substance that suppresses the immune response.

Immunosuppressive—Any agent that suppresses the immune response of an individual.

Immunosuppresive cytotoxic drugs—A class of drugs that function by destroying cells and suppressing the immune response.

Lymphocyte—Lymphocytes are white blood cells that participate in the immune response. The two main groups are the B cells that have antibody molecules on their surface and T cells that destroy antigens.

Psoriasis—A skin disease characterized by itchy, scaly, red patches on the skin.

Rejection—Rejection occurs when the body recognizes a new transplanted organ as 'foreign' and turns on the immune system of the body.

T cells—Any of several lymphocytes that have specific antigen receptors, and that are involved in cell-mediated immunity and destruction of antigen-bearing cells.

Transplantation— The removal of tissue from one part of the body for implantation to another part of the body; or the removal of tissue or an organ from one individual and its implantation in another individual by surgery.

and being careful when using knives, razors, fingernail clippers or other sharp objects. Avoiding contact with people who have infections is also important. In addition, people who are taking or have been taking immunosuppressant drugs should not have immunizations, such as **smallpox** vaccinations, without checking with their physicians. Because of their low resistance to infection, people taking these drugs might get the disease that the vaccine is designed to prevent. People taking immunosuppressant drugs also should avoid contact with anyone who has taken the oral **polio** vaccine, as there is a chance the virus could be passed on to them. Other people living in their home should not take the oral polio vaccine.

Immunosuppressant drugs may cause the gums to become tender and swollen or to bleed. If this happens, a physician or dentist should be notified. Regular brushing, flossing, cleaning and gum massage may help prevent this problem. A dentist can provide advice on how to clean the teeth and mouth without causing injury.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take immunosuppressant drugs. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to immunosuppressant drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Azathioprine may cause **birth defects** if used during **pregnancy**, or if either the male or female is using it at time of conception. Anyone taking this medicine should use a barrier method of birth control, such as a diaphragm or condoms. Birth control pills should not be used without a physician's approval. Women who become pregnant while taking this medicine should check with their physicians immediately.

The medicine's effects have not been studied in humans during pregnancy. Women who are pregnant or who may become pregnant and who need to take this medicine should check with their physicians.

BREASTFEEDING. Immunosuppressant drugs pass into breast milk and may cause problems in nursing babies whose mothers take it. Breastfeeding is not recommended for women taking this medicine.

OTHER MEDICAL CONDITIONS. People who have certain medical conditions may have problems if they take immunosuppressant drugs. For example:

- People who have **shingles** (herpes zoster) or **chickenpox,** or who have recently been exposed to chickenpox, may develop severe disease in other parts of their bodies when they take these medicines.
- The medicine's effects may be greater in people with kidney disease or liver disease, because their bodies are slow to get rid of the medicine.
- The effects of oral forms of this medicine may be weakened in people with intestinal problems, because the medicine cannot be absorbed into the body.

Before using immunosuppressant drugs, people with these or other medical problems should make sure their physicians are aware of their conditions.

USE OF CERTAIN MEDICINES. Taking immunosuppressant drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Increased risk of infection is a common side effect of all the immunosuppressant drugs. The immune system protects the body from infections and when the immune system is suppressed, infections are more likely. Taking **antibiotics** such as co-trimoxazole prevents some of these infections. Immunosuppressant drugs are also associated with a slightly increased risk of **cancer** because the immune system also plays a role in protecting the body against some forms of cancer. For example, long-term use of immunosuppressant drugs carries an increased risk of developing skin cancer as a result of the combination of the drugs and exposure to sunlight.

Other side effects of immunosuppressant drugs are minor and usually go away as the body adjusts to the medicine. These include loss of appetite, nausea or vomiting, increased hair growth, and trembling or shaking of the hands. Medical attention is not necessary unless these side effects continue or cause problems.

The treating physician should be notified immediately if any of the following side effects occur:

- unusual tiredness or weakness
- fever or chills
- frequent need to urinate

Interactions

Immunosuppressant drugs may interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be greater. Other drugs may also have an adverse effect on immunosuppressant therapy. This is particularly important for patients taking cyclosporin or tacrolimus. For example, some drugs can cause the blood levels to rise, while others can cause the blood levels to fall and it is important to avoid such contraindicated combinations. Other examples are:

- The effects of azathioprine may be greater in people who take allopurinol, a medicine used to treat gout.
- A number of drugs, including female hormones (estrogens), male hormones (androgens), the antifungal drug ketoconazole (Nizoral), the ulcer drug cimetidine (Tagamet) and the **erythromycins** (used to treat infections), may increase the effects of cyclosporine.
- When sirolimus is taken at the same time as cyclosporin, the blood levels of sirolimus may be increased to a level where there are severe side effects. Although these two drugs are usually used together, the sirolimus should be taken four hours after the dose of cyclosporin.
- Tacrolimus is eliminated through the kidneys. When the drug is used with other drugs that may harm the kidneys, such as cyclosporin, the antibiotics gentamicin and amikacin, or the antifungal drug amphotericin B, blood levels of tacrolimus may be increased. Careful kidney monitoring is essential when tacrolimus is given with any drug that might cause kidney damage.
- The risk of cancer or infection may be greater when immunosuppressant drugs are combined with certain

other drugs which also lower the body's ability to fight disease and infection. These drugs include corticosteroids such as prednisone; the **anticancer drugs** chlorambucil (Leukeran), cyclophosphamide (Cytoxan) and mercaptopurine (Purinethol); and the monoclonal antibody muromonab-CD3 (Orthoclone), which also is used to prevent transplanted organ rejection.

Not every drug that may interact with immunosuppressant drugs is listed here. Anyone who takes immunosuppressant drugs should let the physician know all other medicines he or she is taking and should ask whether the possible interactions can interfere with treatment.

Resources

BOOKS

Abbas, A. K., Lichtman, A. H. *Basic Immunology: Functions and Disorders of the Immune System*. Philadelphia: W. B. Saunders Co., 2001.

Sompayrac, L. M. *How the Immune System Works*. Boston: Blackwell Science, 1999.

Travers, P. *Immunobiology : The Immune System in Health and Disease.,* 5th edition. New York: Garland Publishers, 2001.

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Immunotherapy *see* **Immunologic therapies**

Impacted tooth

Definition

An impacted tooth is any tooth that is prevented from reaching its normal position in the mouth by tissue, bone, or another tooth.

Description

The teeth that most commonly become impacted are the third molars, also called wisdom teeth. These large teeth are the last to develop, beginning to form when a person is about nine years old, but not breaking through the gum tissue until the late teens or early twenties. By this time, the jaws have stopped growing and may be too small to accommodate these four additional teeth. As the wisdom teeth continue to move, one or more may become impacted, either by running into the teeth next to them or becoming blocked within the jawbone or gum tissue. An impacted tooth can cause further dental problems, including infection of the gums, displacement of other teeth, or decay. At least one wisdom tooth becomes impacted in nine of every ten people.

KEY TERMS

Dry socket—A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket, leaving the bone underneath exposed to air and food.

Eruption—The process of a tooth breaking through the gum tissue to grow into place in the mouth.

Extraction—The removal of a tooth from its socket in the bone.

Pericoronitis—A gum condition in which irritation and inflammation are produced by the crown of an incompletely erupted tooth.

Wisdom tooth—One of the four last teeth on the top and bottom rows of teeth. Also called a third molar.

Causes and Symptoms

The movement of an erupting wisdom tooth and any subsequent impaction may produce **pain** at the back of the jaw. Pain may also be the result of infection, either from decay in any exposed portion of the tooth or from trapped food and plaque in the surrounding gum tissue. Infection typically produces an unpleasant taste when biting down and **bad breath**. Another source of pain may be pericoronitis, a gum condition in which the crown of the incompletely erupted tooth produces inflammation, redness, and tenderness of the gums. Less common symptoms of an impacted tooth are swollen lymph nodes in the neck, difficulty opening the mouth, and prolonged **headache**.

Diagnosis

Upon visual examination, the dentist may find signs of infection or swelling in the area where the tooth is present or only partially erupted. Dental x rays are necessary to confirm tooth impaction.

Treatment

Because impacted teeth may cause dental problems with few if any symptoms to indicate damage, dentists commonly recommend the removal of all wisdom teeth, preferably while the patient is still a young adult. A dentist may perform an extraction with forceps and local anesthetic if the tooth is exposed and appears to be easily removable in one piece. However, he or she may refer a difficult extraction to an oral surgeon, a specialist who administers either nitrous oxide-oxygen (commonly

called "laughing gas"), an intravenous sedative, or a general anesthetic to alleviate any pain or discomfort during the surgical procedure. Extracting an impacted tooth typically requires cutting through gum tissue to expose the tooth, and may require removing portions of bone to free the tooth. The tooth may have to be removed in pieces to minimize destruction to the surrounding structures. The extraction site may or may not require one or more stitches to help the incision heal.

Prognosis

The prognosis is very good when impacted teeth are removed from young healthy adults without complications. Potential complications include postoperative infection, temporary numbness from nerve irritation, jaw fracture, and jaw joint pain. An additional condition which may develop is called dry socket: when a blood clot does not properly form in the empty tooth socket, or is disturbed by an oral vacuum (such as from drinking through a straw or **smoking**), the bone beneath the socket is painfully exposed to air and food, and the extraction site heals more slowly.

Resources

ORGANIZATIONS

American Association of Oral and Maxillofacial Surgeons. 9700 West Bryn Mawr Ave., Rosemont, IL 60018-5701. (847) 678-6200. <http://www.aaoms.org>.

Bethany Thivierge

Impedance phlebography

Definition

Impedance phlebography is a noninvasive test that uses electrical monitoring to measure blood flow in veins of the leg. Information from this test helps a doctor to detect **deep vein thrombosis** (blood clots or **thrombophlebitis**).

Purpose

Impedance phlebography may be done in order to:

- detect blood clots lodged in the deep veins of the leg
- screen patients who are likely to have blood clots in the leg
- detect the source of blood clots in the lungs (pulmonary emboli)

Blood clots in the legs can lead to more serious problems. If a clot breaks loose from a leg vein, it may travel to the lungs and lodge in a blood vessel in the lungs. Blood clots are more likely to occur in people who have recently had leg injuries, surgery, **cancer**, or a long period of bed rest.

Precautions

Because this test is not invasive, it can be done on all patients. However, the accuracy of the results will be affected if the patient does not breathe normally or keep the leg muscles relaxed. Compression of the veins because of pelvic tumors or decreased blood flow, due to **shock** or any condition that reduces the amount of blood the heart pumps, may also change the test results.

Description

Impedance phlebography works by measuring the resistance to the transmission of electrical energy (impedance). This resistance changes depending on the volume of blood flowing through the veins. By graphing the impedance, a doctor or technician can tell whether a clot is obstructing blood flow.

Using conductive jelly, the examiner puts electrodes on the patient's calf. These electrodes are connected to an instrument called a plethysmograph, which records the changes in electrical resistance that occur during the test.

The patient lies down and raises one leg at a 30° angle, so that the calf is above the level of the heart. The examiner wraps a pressure cuff around the patient's thigh and inflates it to a pressure of 45–60 cm of water for 45 seconds. The plethysmograph records the electrical changes that correspond to changes in the volume of blood in the vein at the time the pressure is exerted and again three seconds after the cuff is deflated. This procedure is repeated several times in both legs.

This test takes 30–45 minutes. Impedance phlebography is also called an impedance test of blood flow or impedance plethysmography.

Preparation

Patients undergoing this test do not need to alter their diet, change their normal activities, or stop taking any medications. They will wear a surgical gown during the test, and be asked to urinate before the test starts. If keeping the legs elevated causes discomfort, mild **pain** medication will be given.

Aftercare

The patient may resume normal or postoperative activities after the test.

KEY TERMS

Thrombophlebitis—Inflammation of a vein, associated with the formation of a blood clot.

Risks

Impedance phlebography is painless and safe. It presents no risk to the patient.

Normal results

Normally, inflating the pressure cuff will cause a sharp rise in the pressure in the veins of the calf because blood flow is blocked. When the cuff is released, the pressure decreases rapidly as the blood flows away.

Abnormal results

If a clot is present, the pressure in the calf veins will already be high. It does not become sharply higher when the pressure cuff is tightened. When the pressure cuff is deflated, the clot blocks the flow of blood out of the calf vein. The decrease in pressure is not as rapid as when no clot is present, and the shape of the resulting graph is different.

Resources

BOOKS

"Impedance Plethysmography." In *Illustrated Guide to Diagnostic Tests*, ed. J. A. Lewis. Springhouse, PA: Springhouse Corp., 1994.

OTHER

Griffith, H. Winter. "Complete Guide to Medical Tests." *ThriveOnline*. <http://thriveonline.oxygen.com>.

Tish Davidson

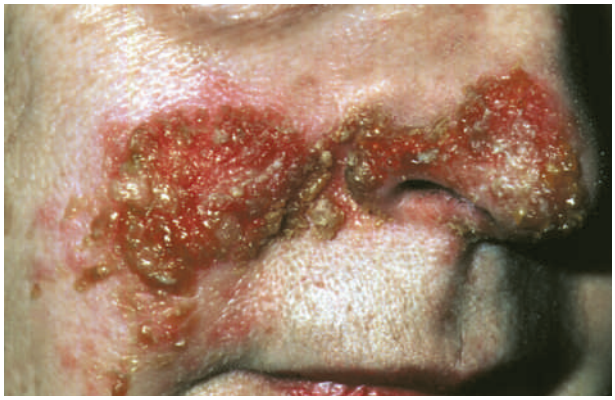
Impedance plethysmography *see* **Impedance phlebography**

Impedance test of blood flow *see* **Impedance phlebography**

Impetigo

Definition

Impetigo refers to a very localized bacterial infection of the skin. There are two types, bullous and epidemic.



Impetigo is a contagious bacterial skin infection that mostly affects the area around the nose and mouth. Usually caused by staphylococci, this person's impetigo was triggered by herpes simplex. *(Photo Researchers, Inc. Reproduced by permission.)*

Description

Impetigo is a skin infection thatwhich tends primarily to afflict children. Impetigo caused by the bacterium *Staphylococcus aureus* (also known as staph) affects children of all ages. Impetigo caused by the bacteria called group A streptococci (also know as strep) are most common in children ages two to five.

The bacteria that cause impetigo are very contagious. They can be spread by a child from one part of his or her body to another by scratching, or contact with a towel, clothing, or stuffed animal. These same methods can pass the bacteria on from one person to another.

Impetigo tends to develop in areas of the skin that have already been damaged through some other mechanism (a cut or scrape, burn, insect bite, or vesicle from **chickenpox**).

Causes and symptoms

The first sign of bullous impetigo is a large bump on the skin with a clear, fluid-filled top (called a vesicle). The bump develops a scab-like, honey-colored crust. There is usually no redness or **pain**, although the area may be quite itchy. Ultimately, the skin in this area will become dry and flake away. Bullous impetigo is usually caused by staph bacteria.

Epidemic impetigo can be caused by staph or strep bacteria, and (as the name implies) is very easily passed among children. Certain factors, such as heat and humidity, crowded conditions, and poor hygiene increase the chance that this type of impetigo will spread rapidly among large groups of children. This type of impetigo involves the formation of a small

KEY TERMS

Systemic—Involving the whole body; the opposite of localized.

Ulcer—An irritated pit in the surface of a tissue.

Vesicle—A bump on the skin filled with fluid.

vesicle surrounded by a circle of reddened skin. The vesicles appear first on the face and legs. When a child has several of these vesicles close together, they may spread to one another. The skin surface may become eaten away (ulcerated), leaving irritated pits. When there are many of these deep, pitting ulcers, with pus in the center and brownish-black scabs, the condition is called ecthyma. If left untreated, the type of bacteria causing this type of impetigo has the potential to cause a serious kidney disease called **glomerulonephritis**. Even when impetigo is initially caused by strep bacteria, the vesicles are frequently secondarily infected with staph bacteria.

Impetigo is usually an uncomplicated skin condition. Left untreated, however, it may develop into a serious disease, including **osteomyelitis** (bone infection), septic arthritis (joint infection), or **pneumonia**. If large quantities of bacteria are present and begin circulating in the bloodstream, the child is in danger of developing an overwhelming systemic infection known as **sepsis**.

Diagnosis

Characteristic appearance of the skin is the usual method of diagnosis, although fluid from the vesicles can be cultured and then examined in an attempt to identify the causative bacteria.

Treatment

Uncomplicated impetigo is usually treated with a topical antibiotic cream called mupirocin. In more serious, widespread cases of impetigo, or when the child has a **fever** or swollen glands, **antibiotics** may be given by mouth or even through a needle placed in a vein (intravenously).

Prognosis

Prognosis for a child with impetigo is excellent. The vast majority of children recover quickly, completely, and uneventfully.

Prevention

Prevention involves good hygiene. Handwashing; never sharing towels, clothing, or stuffed animals; and keeping fingernails well-trimmed are easy precautions to take to avoid spreading the infection from one person to another.

Resources

BOOKS

Darmstad, Gary L., and Al Lane. "The Skin." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Deresiewicz, Robert L., and Jeffrey Parsonnet. "Staphylococcal Infections." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Sherrill's Medical Microbiology: An Introduction to Infectious Diseases. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stevens, Dennis L. "Infections of the Skin, Muscle, and Soft Tissues." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley & Sons, 1995.

"Streptococci." In *Sherrill's Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

"Bullous Impetigo." *Archives of Pediatrics and Adolescent Medicine* 151, no. 11 (Nov. 1997): 1168+.

Huerter, Christopher, et al. "Helpful Clues to Common Rashes." *Patient Care* 31, no. 8 (30 Apr. 1997): 9+.

Squires, Sally. "What Your Child Could Catch At School This Year." *Good Housekeeping*, Sept. 1996, 138+.

Rosalyn Carson-DeWitt, MD

Implant therapy *see* **Radioactive implants**

Implantable cardioverter-defibrillator

Definition

The implantable cardioverter-defibrillator is an electronic device to treat life-threatening heartbeat irregularities. It is surgically implanted.

Purpose

The implantable cardioverter-defibrillator is used to detect and stop serious ventricular **arrhythmias** and

restore a normal heartbeat in people who are at high risk of sudden **death**. The American Heart Association recommends that implantable cardioverter-defibrillators be considered only for patients who have a life-threatening arrhythmia. A recent study by the National Heart, Lung, and Blood Institute demonstrated that implantable cardioverter-defibrillators are the treatment of choice instead of drug therapy for patients who have had a cardiac arrest or **heart attack;** and are at risk for developing **ventricular tachycardia**, which is a very rapid heartbeat; or **ventricular fibrillation**, which is an ineffective, irregular heart activity. Other studies suggest that 20% of these high-risk patients would die within two years without an implantable cardioverter-defibrillator. With the device, the five-year risk of sudden death drops to five percent.

Precautions

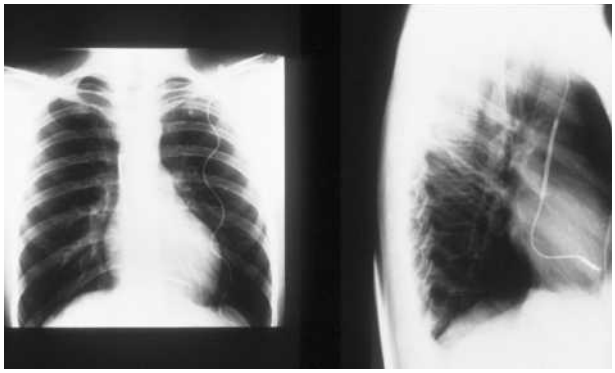
The implantable cardioverter-defibrillator should not be used on patients who faint from causes other than a known life-threatening ventricular arrhythmia; to treat slow heart rates; or during an emergency.

Description

According to the American College of Cardiology, more than 80,000 Americans currently have an implantable cardioverter-defibrillator; 17,000 of these were implanted in 1995 alone. The battery-powered device rescues the patient from a life-threatening arrhythmia by rapid pacing and/or delivering electrical shock(s) to suspend heart activity and then allow the heart to initiate a normal rhythm. Before the development of the implantable cardioverter-defibrillator, most people who experienced ventricular fibrillation and weren't near a hospital with a well-equipped emergency team died within minutes.

The implantable cardioverter-defibrillator is like a mini-computer connected to the patient's heart. Newer models weigh less than 10 ounces and can be implanted beneath the skin of the chest in the pectoral region without major surgery. A lead from the device is then inserted into the heart through a vein. The procedure is performed in an operating room under general anesthesia. Earlier versions of implantable cardioverter-defibrillators were implanted in the abdomen and required open-chest surgery to connect the electrodes to the left and right ventricles.

The implantable cardioverter-defibrillator is set above the patient's **exercise** heart rate. Once the device is in place, many tests will be conducted to ensure that the device is sensing and defibrillating properly. The newer implantable cardioverter-defibrillators last seven or eight years. Technology and procedures continue to evolve.



X ray of implanted cardioverter-dbfibrillator *(Custom Medical Stock Photo. Reproduced by permission.)*

Preparation

Before the procedure, a complete medical history and physical exam will be done. **Electrocardiography**, special electrophysiologic testing, **chest x ray**, **urinalysis**, and a blood test are usually also required.

Aftercare

The patient is monitored for arrhythmias and to ensure that the implantable cardioverter-defibrillator is working properly. The physician also watches for signs of infection. Before the patient leaves the hospital, the device is tested again. Anti-arrhythmia drug therapy is necessary in more than half of all patients with implantable cardioverter-defibrillators, but the number of drugs and the dosages are usually reduced. Any time a significant change in anti-arrhythmia medication is made, the device will be tested again.

The patient is taught how the device works, and that the shock it delivers will feel like a punch or kick in the chest. The patient is told to notify his/her physician when the implantable cardioverter-defibrillator delivers a shock, and to go to the emergency room if multiple shocks are sent within a short period of time.

Although most patients with implantable cardioverter-defibrillators are glad that they have the device and feel that it has extended their lives, they do experience fear and **anxiety**. This feeling stems from the sensation of the shock(s), the unpredictable circumstances under which shock(s) occurs, and unknown outcomes.

Risks

There can be serious complications to the implantation of a cardioverter-defibrillator. These include inflammation of the pericardium, the sac that surrounds the heart; heart attack; congestive **heart failure**; and post-operative

KEY TERMS

Arrhythmia—A variation of the normal rhythm of the heartbeat.

Cardioverter—A device to apply electric shock to the chest to convert an abnormal heartbeat into a normal heartbeat.

Defibrillation—An electronic process which helps re-establish a normal heart rhythm.

Ventricles—The two large lower chambers of the heart which pump blood to the lungs and the rest of the human body.

Ventricular fibrillation—An arrhythmia in which the heart beats very fast but blood is not pumped out to the body. Ventricular fibrillation can quickly become fatal if not corrected.

Ventricular tachycardia—An arrhythmia in which the heart rate is more than 100 beats per minute.

stroke. Serious infections can develop in the area around the device while the patient is initially hospitalized or up to several months later. Death due to the device's failure while being tested during surgery is an uncommon risk. The risk of death from the implantation procedure is about the same as that for a pacemaker—less than one percent. There are also potentially serious risks associated with the device's improper functioning once it is in place.

Resources

BOOKS

DeBakey, M. E., and A. M. Gotto. "Arrhythmias." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

Texas Heart Institute. "Arrhythmias." In *Texas Heart Institute Heart Owners Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

"Comparing Implantable Defibrillators and Drug Therapy in Patients with Life-Threatening Arrhythmias." *Modern Medicine* 65, no. 7 (July 1997): 15.

"Computer Software Aids Cardiac Implants." *USA Today*, Feb. 1998, 4.

Daneala, Gallagher, et al. "The Impact of the Implantable Cardioverter Defibrillator on Quality of Life." *American Journal of Critical Care* 6, no. 1 (Jan. 1997): 16-23.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave., Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Texas Heart Institute. Heart Information Service., PO Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Implantable Cardioverter/Defibrillator." *American Heart Association*. 30 Mar. 1998 <http://www.americanheart.org>.

"Implantable Defibrillator Can Aid People with Dangerously Irregular Heartbeats." *Cardiovascular Institute of the South Page*. 1 Apr. 1998 <http://www.cardio.com>.

"Implantable Defibrillators Prevent Sudden Death. *Reuters*. Mar. 31, 1998.

"Studies Define Role of Defibrillators for Near Future." *North American Society of Pacing and Electrophysiology Page*. 1 Apr. 1998 <http://www.naspe.org/defib2pr.html>.

Lori De Milto

Impotence

Definition

Impotence, often called erectile dysfunction, refers to the male's inability to achieve or maintain an erection long enough to engage in sexual intercourse.

Description

Under normal circumstances, when a man is sexually stimulated, his brain sends a message down the spinal cord and into the nerves of the penis. The nerve endings in the penis release chemical messengers called neurotransmitters that signal the corpora cavernosa (the two spongy rods of tissue that span the length of the penis) to relax and fill with blood. As they expand, the corpora cavernosa close off other veins that would normally drain blood from the penis. As the penis becomes engorged with blood, it enlarges and stiffens, causing an erection. Problems with blood vessels, nerves, or tissues of the penis can interfere with an erection.

Causes and symptoms

It is estimated that up to 30 million American men frequently suffer from impotence and that it strikes up to half of all men between the ages of 40 and 70. Doctors used to think that most cases of impotence were psychological in origin, but they now recognize that, at least in older men, physical causes may play a primary role in 60% or more of all cases. In men over the age of 60, the leading cause is **atherosclerosis**, or narrowing of the arteries, which can restrict the flow of blood to the penis. Injury to or disease of the connective tissue, such as **Peyronie's disease**, may prevent the corpora cavernosa from com-

pletely expanding. Damage to the nerves of the penis from certain types of surgery or neurological conditions, such as **Parkinson's disease** or **multiple sclerosis**, may also cause impotence. Men with diabetes are especially at risk for impotence because of their high risk of both atherosclerosis and a nerve disease called **diabetic neuropathy**.

Certain types of blood pressure medications, antiulcer drugs, **antihistamines**, tranquilizers (especially before intercourse), antifungals (ketoconazole), antipsychotics, **antianxiety drugs**, and antidepressants, known as **selective serotonin reuptake inhibitors** (SSRIs, including Prozac and Paxil), can interfere with erectile function. **Smoking**, excessive alcohol consumption, and illicit drug use may also contribute. In rare cases, low levels of the male hormone testosterone may contribute to erectile failure. Finally, such psychological factors as **stress**, guilt, or **anxiety** may also play a role, even when the impotence is primarily due to organic causes.

Diagnosis

The doctor also obtains a thorough medical history to find out about past pelvic surgery, diabetes, cardiovascular disease, kidney disease, and any medications the man may be taking. The **physical examination** should include a genital examination, a measurement of blood flow through the penis, hormone tests, and a glucose test for diabetes.

In some cases, nocturnal penile tumescence testing is performed to find out whether the man has erections while asleep. Healthy men usually have about four or five erections throughout the night. The man applies a device to the penis called a Rigiscan before going to bed at night, and the device can determine whether he has had erections. (If a man is able to have normal erections at night, this finding suggests a psychological cause for his impotence.)

Treatment

Years ago, the standard treatment for impotence was an implantable penile prosthesis or long-term psychotherapy. Although physical causes are now more readily diagnosed and treated, individual or marital counseling is still an effective treatment for impotence when emotional factors play a role. Fortunately, other approaches are now available to treat the physical causes of impotence.

The first line and by far the most common treatment today is the prescription drug **sildenafil citrate**, sold under the brand name Viagra. An estimated 20 million prescriptions for the pill have been filled since it was approved by the FDA in March 1998. It is also the most effective treatment, with a success rate of more than 60%. The drug boosts levels of a substance called cyclic GMP, which is responsible for widening the blood vessels of the penis. In clinical studies, Viagra produced headaches in 16% of men who took it, and other side effects included flushing, **indigestion**, and stuffy nose.

The primary drawback to Viagra, which works about an hour after it is taken, is that the FDA cautions men with heart disease or low blood pressure to be thoroughly examined by a physician before obtaining a prescription.

A second impotence drug, apomorphine, failed to receive FDA approval in 2000 after tests showed it was associated with an unacceptable risk of heart disease. At least four other impotence drugs are in development and could be on the market by 2002.

Another approach is vacuum therapy. The man inserts his penis into a clear plastic cylinder and uses a pump to force air out of the cylinder. This forms a partial vacuum around the penis, which helps to draw blood into the corpora cavernosa. The man then places a special ring over the base of the penis to trap the blood inside it. The only side effect with this type of treatment is occasional bruising if the vacuum is left on too long.

KEY TERMS

Alprostadil—A smooth muscle relaxant sometimes injected into the penis or applied to the urethral opening to treat impotence.

Atherosclerosis—A disorder in which plaques of cholesterol, lipids, and other debris build up on the inner walls of arteries, narrowing them.

Corpora cavernosa—Rods of spongy tissue found within the penis, which become engorged with blood in order to produce an erection. (The singular form of this term is corpus cavernosum.)

Neurotransmitters—Chemicals that modify or help transmit impulses between nerve synapses.

Papaverine—A smooth muscle relaxant sometimes injected into the penis as a treatment for impotence.

Peyronie's disease—A disease resulting from scarring of the corpora cavernosa, causing painful erections.

Urethra—The small tube that drains urine from the bladder, as well as serving as a conduit for semen during ejaculation.

Viagra—An orally administered drug for erectile failure first cleared for marketing in the United States in March 1998.

Injection therapy involves injecting a substance into the penis to enhance blood flow and cause an erection. The Food and Drug Administration (FDA) approved a drug called alprostadil (Caverject) for this purpose in July of 1995. Alprostadil relaxes smooth muscle tissue to enhance blood flow into the penis. It must be injected shortly before intercourse. Another, similar drug that is sometimes used is papaverine—not yet approved by the FDA for this use. Either drug may sometimes cause painful erections or **priapism** (uncomfortable, prolonged erections) that must be treated with a shot of epinephrine.

Alprostadil may also be administered into the urethral opening of the penis. In MUSE (medical urethral system for erection), the man inserts a thin tube the width of a vermicelli noodle into his urethral opening and presses down on a plunger to deliver a tiny pellet containing alprostadil into his penis. The drug takes about 10 minutes to work and the erection lasts about an hour. The main side effect is a sensation of **pain** and burning in the urethra, which can last about five to 15 minutes.

Implantable **penile prostheses** are usually considered a last resort for treating impotence. They are implanted in the corpora cavernosa to make the penis rigid without the need for blood flow. The semirigid type of prosthesis consists of a pair of flexible silicone rods that can be bent up or down. This type of device has a low failure rate but, unfortunately, it causes the penis to always be erect, which can be difficult to conceal under clothing.

The inflatable type of device consists of cylinders that are implanted in the corpora cavernosa, a fluid reservoir implanted in the abdomen, and a pump placed in the scrotum. The man squeezes the pump to move fluid into the cylinders and cause them to become rigid. (He reverses the process by squeezing the pump again.) While these devices allow for intermittent erections, they have a slightly higher malfunction rate than the silicon rods.

Men can return to sexual activity six to eight weeks after implantation surgery. Since implants affect the corpora cavernosa, they permanently take away a man's ability to have a natural erection.

In rare cases, if narrowed or diseased veins are responsible for impotence, surgeons may reroute the blood flow into the corpus cavernosa or remove leaking vessels. However, the success rate with these procedures has been very low, and they are still considered experimental.

Alternative treatment

A number of herbs have been promoted for treating impotence. The most widely touted herbs for this purpose are *Coryanthe yohimbe* (available by prescription as yohimbine, with the trade name Yocon) and gingko (*Gingko biloba*), although neither has been conclusively shown to help the condition in controlled studies. In addition, gingko carries some risk of abnormal blood clotting and should be avoided by men taking such blood thinners as coumadin. Other herbs promoted for treating impotence include true unicorn root (*Aletrius farinosa*), **saw palmetto** (*Serenoa repens*), ginseng (*Panax ginseng*), and Siberian ginseng (*Eleuthrococcus senticosus*). *Strychnos Nux vomica* has been recommended, especially when impotence is caused by excessive alcohol, cigarettes, or dietary indiscretions, but it can be very toxic if taken improperly, so it should be used only under the strict supervision of a physician trained in its use.

Prognosis

With proper diagnosis, impotence can nearly always be treated or managed successfully. Unfortunately, fewer than 10% of impotent men seek treatment.

Prevention

There is no specific treatment to prevent impotence. Perhaps the most important measure is to maintain general good health and avoid atherosclerosis by exercising regularly, controlling weight, controlling **hypertension** and **high cholesterol** levels, and avoiding smoking. Avoiding excessive alcohol intake may also help.

Resources

BOOKS

Ryan, George. *Reclaiming Male Sexuality: A Guide to Potency, Vitality, and Prowess*. New York: M. Evans and Company, 1997.

PERIODICALS

"American Urologic Association Issues Treatment Guidelines for Erectile Failure." *American Family Physician* (April 1997): 1967-69.

Burnett, Arthur L. "Erectile Dysfunction: A Practical Approach to Primary Care." *Geriatrics* (February 1998): 36-42.

Cowley, Geoffrey. "Looking Beyond Viagra." *Newsweek* (April 24, 2000): 77.

Leland, John and Andrew Murr. "A Pill for Impotence?" *Newsweek* (November 17, 1997): 62-67.

Young, Melinda G. "A Novel Strategy for Individualizing Erectile Dysfunction Treatment." *Patient Care* (Jan. 30, 2000): 91.

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 North Charles Street, Baltimore, MD 21201. (410) 468-1800.

Impotence Institute of America, Impotents Anonymous. 10400 Little Patuxent Parkway, Suite 485, Columbia, MD 21044-3502. (800) 669-1603.

National Kidney and Urologic Diseases Information Clearinghouse. 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5390.

Ken R. Wells

Impulse control disorders

Definition

Impulse control disorders are characterized by an inability to resist the impulse to perform an action that is harmful to one's self or others. This is a relatively new class of **personality disorders**. The most common of these are **intermittent explosive disorder**, kleptomania, pyromania, compulsive gambling disorder, and trichotillomania.

KEY TERMS

Compulsive gambling disorder—An impulse control disorder in which an individual cannot resist gambling despite repeated losses.

Intermittent explosive disorder—A personality disorder in which an individual is prone to intermittent explosive episodes of aggression, during which he or she causes bodily harm or destroys property.

Kleptomania—An impulse control disorder in which one steals objects that are of little or no value.

Pyromania—An impulse control disorder in which one sets fires.

Trichotillomania—An impulse or compulsion to tug or pull on one's own hair.

Description

All of these impulse control disorders involve the loss or lack of control in certain specific situations. The hallmark of these disorders is the individual's inability to control impulses that may cause harm to themselves or others. Affected individuals often feel **anxiety** or tension in considering these behaviors. This anxiety or tension is relieved or diminished once the action is performed.

Intermittent explosive disorder is more common among men, and involves aggressive outbursts that lead to assaults on others or destruction of property. These outburst are unprovoked, or seem to be out of proportion to the event that precedes them.

Kleptomania is more common among women, and involves the theft of objects that are seemingly worthless. The act of stealing relieves tension and is seen by the individually to be rewarding. The actual stealing is not preplanned, and the concept of punishment for the crime doesn't occur to these individuals—although they are aware that what they are doing is wrong.

Pyromania is more common among men, and involves setting fires in order to feel pleasure and relieve tension.

Pathological gambling occurs in roughly 1-3% of the population, and involves excessive gambling despite heavy monetary losses. These losses actually act as a motivating factor in continuing gambling in order to recoup some of what was lost.

Trichotillomania involves pulling hair from one's own scalp, face, or body, and is more common in women.

Causes and symptoms

The exact causes of impulse control disorders are still unknown. Individuals who have had serious head injuries, however, can be at a higher risk for developing impulse control disorders, as are persons with epilepsy.

Diagnosis

A diagnosis of any of these impulse control disorders can be made only after all other medical and psychiatric disorders that may cause the same symptoms have been ruled out.

Intermittent explosive disorder involves severe acts of assault or destruction of property. The aggression seen during these acts is vastly out of proportion to events that may seem to have precipitated the acts.

Kleptomania involves stealing objects that are unnecessary and of little monetary value. The act of stealing is not an expression of anger or vengeance. Again, there is an increased tension before the act is committed, and this is resolved or relieved once the object is stolen.

Pyromania is classified by the deliberate and repeated setting of fires. The individual will exhibit a fascination and attraction to fire and any objects associated with it. Before the fire is set, there is tension, with a resolving relief once the fire is set. Acts of true pyromania are not done for monetary gain, to express anger, to conceal criminal behavior, or in response to hallucination.

Pathological gambling is a disorder to gamble despite continuing losses and monetary insufficiency. This disorder typically begins in youth. Affected individuals are often competitive, easily bored, restless, and generous.

For a diagnosis of pathological gambling, five or more of the following symptoms must be present:

- a preoccupation with gambling
- a need to gamble with more money to achieve the "thrill" of winning
- repeated attempts to control or stop gambling
- irritability or restlessness due to repeated attempts at control
- gambling as an escape from stress
- lying to cover up gambling
- conducting illegal activities, such as embezzling or fraud, to finance gambling
- losing a job or personal relationship due to gambling
- borrowing money to fund gambling

Trichotillomania is the continuous pulling or tugging on one's own hair. Again, there is an increased sense of tension before pulling the hair, which is relieved once it is pulled out. Recurrent pulling out of one's hair resulting in noticeable hair loss. Affected individuals can undergo significant distress and impaired social, occupational, and functional behavior.

Treatment

A combination of psychological counseling and medication are the preferred treatments for impulse control disorders. For kleptomania, pyromania, and trichotillomania, behavior modification is usually the treatment of choice. For pathological gambling, treatment usually involves an adaptation of the model set forth by Alcoholics Anonymous. Individuals are counseled with the goal of eventual response to appropriate social limits. In the case of intermittent explosive disorder, anger management and medication may be used in extreme cases of aggression.

Prognosis

These disorders can usually be controlled with medication, although it may need to be continued long-term to help prevent further aggressive outbursts. Long-term counseling is usually necessary as well. Support groups and meetings may also help these individuals.

The prognosis for intermittent explosive disorder, kleptomania, and pyromania is fair. Little is known about the prognosis for trichotillomania, and studies have shown that the condition can disappear for long periods (months to years) without any psychological counseling. For pathological gambling, the prognosis varies greatly from person to person. While total cure for this condition is unlikely, much like **alcoholism**, long periods of abstinence or continuous abstinence are possible.

Prevention

There are no known preventive treatments or measures for impulse control disorders.

Resources

PERIODICALS

Hollander, E., A. J. Buchalter, C. M. DeCaria. "Pathological Gambling." *Psychiatric Clinics of North America* (September 2000): 629-42.

Jackson, E. A. "Hair Disorders." *Primary Care* (June 2000): 319-32.

Van Es, R. "Identifying Problem and Compulsive Gamblers." *Canadian Family Physician* (June 2000): 1323-31.

ORGANIZATIONS

Gamblers Anonymous International Service Office. PO Box 17173, Los Angeles, CA 90017. (213) 386-8789., Fax: (213) 386-0030. <http://www.gamblersanonymous.org/>.

Trichotillomania Learning Center, Inc. 1215 Mission Street, Suite 2, Santa Cruz, CA 95060. (831) 457-1004., Fax: (831) 426-4383. <http://www.trich.org>.

Liz Meszaros

In vitro fertilization

Definition

In vitro fertilization (IVF) is a procedure in which eggs (ova) from a woman's ovary are removed. They are fertilized with sperm in a laboratory procedure, and then the fertilized egg (embryo) is returned to the woman's uterus.

Purpose

IVF is one of several assisted reproductive techniques (ART) used to help infertile couples to conceive a child. If after one year of having sexual intercourse without the use of birth control a woman is unable to get pregnant, **infertility** is suspected. Some of the reasons for infertility include damaged or blocked fallopian tubes, hormonal imbalance, or **endometriosis** in the woman. In the man, low sperm count or poor quality sperm can cause infertility.

IVF is one of several possible methods to increase the chance for an infertile couple to become pregnant. Its use depends on the reason for infertility. IVF may be an option if there is a blockage in the fallopian tubes or endometriosis in the woman or low sperm count or poor quality sperm in the man. There are other possible treatments for these conditions, such as surgery for blocked tubes or endometriosis, which may be tried before IVF.

IVF will not work for a woman who is not capable of ovulating or a man who is not able to produce at least a few healthy sperm.

Precautions

The screening procedures and treatments for infertility can become a long, expensive, and sometimes disappointing process. Each IVF attempt takes at least an entire menstrual cycle and can cost $5000–$10,000, which may or may not be covered by health insurance. The **anxiety** of dealing with infertility can challenge both individuals and their relationship. The added **stress** and expense of multiple clinic visits, testing, treatments, and surgical procedures can become overwhelming. Couples may want to receive counseling and support through the process.

Description

In vitro fertilization is a procedure in which the joining of egg and sperm takes place outside the woman's body. A woman may be given fertility drugs before this procedure so that several eggs mature in the ovaries at the same time. Eggs (ova) are removed from a woman's ovaries using a long, thin needle. The physician gets access to the ovaries using one of two possible procedures. One procedure involves inserting the needle through the vagina (transvaginally). The physician guides the needle to the location of the ovaries with the help of an ultrasound machine. In the other procedure, called **laparoscopy**, a small thin tube with a viewing lens is inserted through an incision in the navel. This allows the physician to see inside the patient and locate the ovaries on a video monitor.

Once the eggs are removed, they are mixed with sperm in a laboratory dish or test tube. (This is the origin of the term *test tube baby*.) The eggs are monitored for several days. Once there is evidence that fertilization has occurred and the cells begin to divide, they are then returned to the woman's uterus.

In the procedure to remove eggs, enough may be gathered to be frozen and saved (either fertilized or unfertilized) for additional IVF attempts.

IVF has been used successfully since 1978, when the first child to be conceived by this method was born in England. Over the past 20 years, thousands of couples have used this method of ART or similar procedures to conceive.

Other types of assisted reproductive technologies might be used to achieve **pregnancy**. A procedure called intracytoplasmic sperm injection (ICSI) uses a manipulation technique that must be performed using a microscope to inject a single sperm into each egg. The fertilized eggs can then be returned to the uterus as in IVF. In gamete intrafallopian tube transfer (GIFT) the eggs and sperm are mixed in a narrow tube and then deposited in the fallopian tube, where fertilization normally takes place. Another variation on IVF is zygote intrafallopian tube transfer (ZIFT). As in IVF, the fertilization of the eggs occurs in a laboratory dish. And, similar to GIFT, the embryos are placed in the fallopian tube (rather than the uterus as with IVF).

Preparation

Once a woman is determined to be a good candidate for in vitro fertilization, she will generally be given "fertility drugs" to stimulate ovulation and the development of multiple eggs. These drugs may include gonadotropin releasing hormone agonists (GnRHa), Pergonal, Clomid, or human chorionic gonadotropin (hcg). The maturation of the eggs is then monitored with ultrasound tests and frequent blood tests. If enough eggs mature, the physician will perform the procedure to remove them. The woman may be given a sedative prior to the procedure. A local anesthetic may also be used to reduce discomfort during the procedure.

KEY TERMS

Fallopian tubes—In a woman's reproductive system, a pair of narrow tubes that carry the egg from the ovary to the uterus.

GIFT—Stands for gamete intrafallopian tube transfer. This is a process in which eggs are taken from a woman's ovaries, mixed with sperm, and then deposited into the woman's fallopian tube.

ICSI—Stands for intracytoplasmic sperm injection. This process is used to inject a single sperm into each egg before the fertilized eggs are put back into the woman's body. The procedure may be used if the male has a low sperm count.

ZIFT—Stands for zygote intrafallopian tube transfer. In this form of in vitro fertilization, the eggs are fertilized in a laboratory dish and then placed in the woman's fallopian tube.

Aftercare

After the IVF procedure is performed the woman can resume normal activities. A pregnancy test can be done approximately 12–14 days later to determine if the procedure was successful.

Risks

The risks associated with in vitro fertilization include the possibility of **multiple pregnancy** (since several embryos may be implanted) and **ectopic pregnancy** (an embryo that implants in the fallopian tube or in the abdominal cavity outside the uterus). There is a slight risk of ovarian rupture, bleeding, infections, and complications of anesthesia. If the procedure is successful and pregnancy is achieved, the pregnancy would carry the same risks as any pregnancy achieved without assisted technology.

Normal results

Success rates vary widely between clinics and between physicians performing the procedure. A couple has about a 10% chance of becoming pregnant each time the procedure is performed. Therefore, the procedure may have to be repeated more than once to achieve pregnancy.

Abnormal results

An ectopic or multiple pregnancy may abort spontaneously or may require termination if the health of the mother is at risk.

Resources

BOOKS

"Assisted Reproductive Technologies." In *The Merck Manual.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck & Co., Inc., 1992.

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

Sher, Geoffrey, V. M. Davis, and J. Stoess. *In Vitro Fertilization: The A.R.T. of Making Babies.* 1st ed. New York: Facts On File, Inc., 1995.

PERIODICALS

Blackwell, R. E. "Clinical Treatment of Infertility: A Practicable Algorithm." *Drug Benefit Trends* 8, no. 1 (1996): 17, 21-22, 38.

ORGANIZATIONS

American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216-2809. (205) 978-5000. <asrm@asrm.com>. <http://www.asrm.com>.

Center for Fertility and In Vitro Fertilization, Loma Linda University. 11370 Anderson St., Loma Linda, CA 92354. (909) 796-4851. <http://www.llu.edu/llumc/fertility>.

Resolve. 1310 Broadway, Somerville, MA 02144-1731. (617) 623-0744. <http://www.resolve.org>.

OTHER

"In vitro Fertilization: A Teacher's Guide from Newton's Apple." *PBS Page.* <http://www.pbs.org/ktca/newtons/11/invitro.html>.

"Infertility." *HealthWorld Online Page.* <http://www.healthy.net>.

Altha Roberts Edgren

Inclusion blennorrhea *see* **Inclusion conjunctivitis**

Inclusion conjunctivitis

Definition

Inclusion **conjunctivitis** is an inflammation of the conjunctiva (the membrane that lines the eyelids and covers the white part, or sclera, of the eyeball) by *Chlamydia trachomatis*. Chlamydia is a sexually transmitted organism.

Description

Inclusion conjunctivitis, known as neonatal inclusion conjunctivitis in the newborn and adult inclusion conjunctivitis in the adult, is also called inclusion blennorrhea, chlamydial conjunctivitis, or swimming pool conjunctivitis. This disease affects four of 1,000 (0.4%) live births. Approximately half of the infants born to untreated infected mothers will develop the disease.

Causes and symptoms

Inclusion conjunctivitis in the newborn results from passage through an infected birth canal and develops five to 14 days after birth. Both eyelids and conjunctivae are swollen. There may be a discharge of pus from the eyes.

Most instances of adult inclusion conjunctivitis result from exposure to infected genital secretions. It is transmitted to the eye by fingers and occasionally by the water in swimming pools, poorly chlorinated hot tubs, or by sharing makeup. In adult inclusion conjunctivitis, one eye is usually involved, with a stringy discharge of mucus and pus. There may be little bumps called follicles inside the lower eyelid and the eye is red. Occasionally, the condition damages the cornea, causing cloudy areas and a growth of new blood vessels (neovascularization).

Diagnosis

Inclusion conjunctivitis is usually considered when the patient has a follicular conjunctivitis that will not go away, even after using topical **antibiotics**. Diagnosis depends upon tests performed on the discharge from the eye. Gram stains determine the type of microorganism, while culture and sensitivity tests determine which antibiotic will kill the harmful microorganism. Conjunctival scraping determines whether chlamydia is present in cells taken from the conjunctiva.

Treatment

Treatment in the newborn consists of administration of tetracycline ointment to the conjunctiva and erythromycin orally or through intravenous therapy for fourteen days. The mother should be treated for **cervicitis** and the father for **urethritis**, even if they do not have symptoms of these diseases.

In adults, tetracycline ointment or drops should be applied to the conjunctiva and oral tetracycline, amoxacillin, or erythromycin should be taken for three weeks, or doxycycline for one week.

Patients should have weekly checkups so that the doctor can monitor the healing.

Oral tetracycline should not be administered to children whose permanent teeth have not erupted. It should also not be given to nursing or pregnant women.

Prognosis

Untreated inclusion conjunctivitis in the newborn persists for three to 12 months and usually heals; however, there may be scarring or neovascularization. In the adult, if left untreated, the disease may continue for months and cause corneal neovascularization. Even if the disease is treated, antibiotics usually do not reverse damage that may have occurred, but they may help prevent it if given early enough.

Prevention

The neonatal infection may be prevented by instilling erythromycin ointment in the conjunctival cul-de-sac at birth. It is not prevented by silver nitrate.

Chlamydia is a contagious, sexually transmitted disease. Some systemic symptoms include a history of vaginitis, **pelvic inflammatory disease**, or urethritis. Patients with symptoms of these diseases should be treated by a physician.

Resources

BOOKS

Newell, Frank W. *Ophthalmology: Principles and Concepts.* 8th ed. St. Louis: Mosby, 1996.

KEY TERMS

Cervicitis—Cervicitis is an inflammation of the cervix or neck of the uterus.

Conjunctiva—The conjunctiva is the membrane that lines the eyelids and covers the white part of the eyeball (sclera).

Cornea—The clear dome-shaped structure that covers the colored part of the eye (iris).

Neovascularization—Neovascularization is the growth of new blood vessels.

Urethritis—Urethritis is an inflammation of the urethra, the canal for the discharge of urine that extends from the bladder to the outside of the body.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, PO Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

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Incompetent cervix

Definition

A cervix (the structure at the bottom of the uterus) that is incompetent is abnormally weak, and therefore it can gradually widen during **pregnancy**. Left untreated, this can result in repeated pregnancy losses or premature delivery.

Description

Incompetent cervix is the result of an anatomical abnormality. Normally, the cervix remains closed throughout pregnancy until labor begins. An incompetent cervix gradually opens due to the pressure from the developing fetus after about the 13th week of pregnancy. The cervix begins to thin out and widen without any contractions or labor. The membranes surrounding the fetus bulge down into the opening of the cervix until they break, resulting in the loss of the baby or a very premature delivery.

KEY TERMS

Diethylstilbestrol (DES)—DES is a drug given to women a generation ago to prevent miscarriage. At that time it was not known that female children born of women who had been given DES would show a higher rate for cervical and other reproductive abnormalities, as well as a rare form of vaginal cancer, when they reached reproductive age.

Effacement—The thinning out of the cervix that normally occurs along with dilation shortly before delivery.

Preterm labor—Labor before the thirty-seventh week of pregnancy.

Causes and symptoms

Some factors that can contribute to the chance of a woman having an incompetent cervix include trauma to the cervix, physical abnormality of the cervix, or having been exposed to the drug diethylstilbestrol (DES) in the mother's womb. Some women have cervical incompetence for no obvious reason.

Diagnosis

Incompetent cervix is suspected when a woman has three consecutive spontaneous pregnancy losses during the second trimester (the fourth, fifth and sixth months of the pregnancy). The likelihood of this happening by random chance is less than 1%. Spontaneous losses due to incompetent cervix account for 20–25% of all second trimester losses. A spontaneous second trimester pregnancy loss is different from a **miscarriage**, which usually happens during the first three months of pregnancy.

The physician can check for abnormalities in the cervix by performing a manual examination or by an ultrasound test. The physician can also check to see if the cervix is prematurely widened (dilated). Because incompetent cervix is only one of several potential causes for this, the patient's past history of pregnancy losses must also be considered when making the diagnosis.

Treatment

Treatment for incompetent cervix is a surgical procedure called cervical cerclage. A stitch (suture) is used to tie the cervix shut to give it more support. It is most effective if it is performed somewhere between 14 and 16 weeks into the pregnancy. The stitch is removed near the end of pregnancy to allow for a normal birth.

Cervical cerclage can be performed under spinal, epidural, or general anesthesia. The patient will need to stay in the hospital for one or more days. The procedure to remove the suture is done without the need for anesthesia. The vagina is held open with an instrument called a speculum and the stitch is cut and removed. This may be slightly uncomfortable, but should not be painful.

Some possible risks of cerclage are premature rupture of the amniotic membranes, infection of the amniotic sac, and preterm labor. The risk of infection of the amniotic sac increases as the pregnancy progresses. For a cervix that is dilated 3 centimeters (cm), the risk is 30%.

After cerclage, a woman will be monitored for any preterm labor. The woman needs to consult her obstetrician immediately if there are any signs of contractions.

Cervical cerclage can not be performed if a woman is more than 4 cm dilated, if the fetus has already died in her uterus, or if her amniotic membranes are torn and her water has broken.

Prognosis

The success rate for cerclage correction of incompetent cervix is good. About 80–90% of the time women deliver healthy infants. The success rate is higher for cerclage done early in pregnancy.

Resources

BOOKS

Barber, Hugh R. K., David H. Fields, and Sherwin A. Kaufman. "Infertility." In *Quick Reference to OB-GYN Procedures*. Philadelphia: Lippincott, 1990.

OTHER

Weiss, Robin. "Incompetent Cervix." *The Mining Co. Guide to Pregnancy/Childbirth Page*. Mar. 1998 <http://www.pregnancy.miningco.com/library/weekly/aa011298.htm>.

Tish Davidson

Incontinence *see* **Urinary incontinence**

Indigestion

Definition

Indigestion, which is sometimes called **dyspepsia**, is a general term covering a group of nonspecific symptoms in the digestive tract. It is often described as a feeling of fullness, bloating, nausea, **heartburn**, or gassy discomfort in the chest or abdomen. The symptoms develop dur-

ing meals or shortly afterward. In most cases, indigestion is a minor problem that often clears up without professional treatment.

Description

Indigestion or dyspepsia is a widespread condition, estimated to occur in 25% of the adult population of the United States. Most people with indigestion do not feel sick enough to see a doctor; nonetheless, it is a common reason for office visits. About 3% of visits to primary care doctors are for indigestion.

Causes and symptoms

Physical causes

The symptoms associated with indigestion have a variety of possible physical causes, ranging from commonplace food items to serious systemic disorders:

- Diet. Milk, milk products, alcoholic beverages, tea, and coffee cause indigestion in some people because they stimulate the stomach's production of acid.
- Medications. Certain prescription drugs as well as over-the- counter medications can irritate the stomach lining. These medications include **aspirin**, NSAIDs, some **antibiotics**, digoxin, theophylline, **corticosteroids**, iron (ferrous sulfate), **oral contraceptives**, and tricyclic antidepressants.
- Disorders of the pancreas and gallbladder. These include inflammation of the gallbladder or pancreas, **cancer** of the pancreas, and **gallstones**.
- Intestinal parasites. Parasitic infections that cause indigestion include **amebiasis**, fluke and tapeworm infections, **giardiasis**, and strongyloidiasis.
- Systemic disorders, including diabetes, thyroid disease, collagen vascular disease.
- Cancers of the digestive tract.
- Conditions associated with women's reproductive organs. These conditions include menstrual cramps, **pregnancy**, and pelvic inflammatory disease.

Psychologic and emotional causes

Indigestion often accompanies an emotional upset, because the part of the nervous system involved in the so-called "fight-or-flight" response also affects the digestive tract. People diagnosed with **anxiety** or **somatoform disorders** frequently have problems with indigestion. Many people in the general population, however, will also experience heartburn, "butterflies in the stomach," or stomach cramps when they are in upsetting situations—such as school examinations, arguments with family members, crises in their workplace, and so on. Some people's digestive systems appear to react more intensely to emotional **stress** due to hypersensitive nerve endings in their intestinal tract.

Specific gastrointestinal disorders

In some cases, the patient's description of the symptoms suggests a specific digestive disorder as the cause of the indigestion. Some doctors classify these cases into three groups:

ESOPHAGITIS TYPE. Esophagitis is an inflammation of the tube that carries food from the throat to the stomach (the esophagus). The tissues of the esophagus can become irritated by the flow (reflux) of stomach acid backward into the lower part of the esophagus. If the patient describes the indigestion in terms of frequent or intense heartburn, the doctor will consider gastroesophageal reflux disease (GERD) as a possible cause. GERD is a common disorder in the general population, affecting about 30% of adults.

PEPTIC ULCER TYPE. Patients who smoke and are over 45 are more likely to have indigestion of the peptic ulcer type. This group also includes people who find that their indigestion is relieved by taking **antacids** or eating a small amount of food. Patients in this category are often found to have *Helicobacter pylori* infections. *H. pylori* is a rod-shaped bacterium that lives in the tissues of the stomach and causes irritation of the mucous lining of the stomach walls. Most people with *H. pylori* infections do not develop chronic indigestion, but the organism appears to cause peptic ulcer disease (PUD) in a vulnerable segment of the population.

NONULCER TYPE. Most cases of chronic indigestion—as many as 65%—fall into this third category. Nonulcer dyspepsia is sometimes called functional dyspepsia because it appears to be related to abnormalities in the way that the stomach empties its contents into the intestine. In some people, the stomach empties either too slowly or too rapidly. In others, the stomach's muscular contractions are irregular and uncoordinated. These disorders of stomach movement (motility) may be caused by hypersensitive nerve endings in the stomach tissues. Patients in this group are likely to be younger than 45 and have a history of taking medications for anxiety or depression.

Diagnosis

Patient history

Because indigestion is a nonspecific set of symptoms, patients who feel sick enough to seek medical attention are likely to go to their primary care doctor. The

history does not always point to an obvious diagnosis. The doctor can, however, use the process of history-taking to evaluate the patient's mood or emotional state in order to assess the possibility of a psychiatric disturbance. In addition, asking about the location, intensity, timing, and recurrence of the indigestion can help the doctor weigh the different diagnostic possibilities.

An important part of the history-taking is asking about symptoms that may indicate a serious illness. These warning symptoms include:

- weight loss
- persistent vomiting
- difficulty or **pain** in swallowing
- vomiting blood or passing blood in the stools
- anemia

Imaging studies

If the doctor thinks that the indigestion should be investigated further, he or she will order an endoscopic examination of the stomach. An endoscope is a slender tube-shaped instrument that allows the doctor to look at the lining of the patient's stomach. If the patient has indigestion of the esophagitis type or nonulcer type, the stomach lining will appear normal. If the patient has PUD, the doctor will be able to see breaks or ulcerated areas in the tissue. He or she may also order ultrasound imaging of the abdomen, or a radionuclide scan to evaluate the motility of the stomach.

Laboratory tests

BLOOD TESTS. If the patient is over 45, the doctor will have the patient's blood analyzed for a complete blood cell count, measurements of liver enzyme levels, electrolyte and serum calcium levels, and thyroid function.

TESTS FOR *HELICOBACTER PYLORI*. Doctors can now test patients for the presence of *H. pylori* without having to take a tissue sample from the stomach. One of these noninvasive tests is a blood test and the other is a breath test.

Treatment

Since most cases of indigestion are not caused by serious disorders, many doctors prefer to try medications and other treatment measures before ordering an endoscopy.

Diet and stress management

Many patients benefit from the doctor's reassurance that they do not have a serious or fatal disorder. Cutting out alcoholic beverages and drinks containing **caffeine** often helps. The patient may also be asked to keep a record of food intake, daily schedule, and symptom severity. Food diaries sometimes reveal psychologic or dietary factors that influence indigestion.

Medications

Patients with the esophagitis type of indigestion are often treated with H_2 antagonists. H_2 antagonists are drugs that block the secretion of stomach acid. They include ranitidine (Zantac) and famotidine (Pepcid).

Patients with motility disorders may be given prokinetic drugs. Prokinetic medications speed up the emptying of the stomach and increase intestinal motility. They include metoclopramide (Reglan) and cisapride (Propulsid). These drugs relieve symptoms in 60-80% of patients.

Removal of H. pylori

It is not clear that patients with *H. pylori* infections who have *not* developed gastric ulcers need to have the bacterium removed. Some studies indicate, however, that these patients may benefit from antibiotic therapy.

Alternative treatment

Herbal medicine

Practitioners of Chinese traditional herbal medicine might recommend medicines derived from peony (*Paeonia lactiflora*), hibiscus (*Hibiscus sabdariffa*), or hare's ear (*Bupleurum chinense*) to treat indigestion. Western herbalists are likely to prescribe fennel (*Foeniculum vulgare*), lemon balm (*Melissa officinalis*), or peppermint (*Mentha piperita*) to relieve stomach cramps and heartburn.

Homeopathy

Homeopaths tailor their remedies to the patient's overall personality profile as well as the specific symptoms. Depending on the patient's reaction to the indigestion and some of its likely causes, the homeopath might choose *Gelsemium* (*Gelsemium sempervirens*), *Carbo vegetalis*, *Nux vomica*, or *Pulsatilla* (*Pulsatilla nigricans*).

Other treatments

Some alternative treatments are aimed at lowering the patient's stress level or changing attitudes and beliefs that contribute to indigestion. These therapies and practices include **Reiki**, **reflexology**, **hydrotherapy**, therapeutic massage, **yoga**, and **meditation**.

Prognosis

Most cases of mild indigestion do not need medical treatment. For patients who consult a doctor and are

KEY TERMS

Dyspepsia—Another name for indigestion.

Endoscope—A slender tubular instrument used to examine the inside of the stomach.

Gastroesophageal reflux disease (GERD)—A disorder of the lower end of the esophagus, caused by stomach acid flowing backward into the esophagus and irritating the tissues.

H_2 antagonist—A type of drug that relieves indigestion by reducing the production of stomach acid.

Heartburn—A popular term for an uncomfortable burning sensation in the stomach and lower esophagus, sometimes caused by the reflux of small amounts of stomach acid.

Helicobacter pylori—A gram-negative rod-shaped bacterium that lives in the tissues of the stomach and causes inflammation of the stomach lining.

Motility—The movement or capacity for movement of an organism or body organ. Indigestion is sometimes caused by abnormal patterns in the motility of the stomach.

Peptic ulcer disease (PUD)—A stomach disorder marked by corrosion of the stomach lining due to the acid in the digestive juices.

Prokinetic—A drug that works to speed up the emptying of the stomach and the motility of the intestines.

Reflux—The backward flow of a body fluid or secretion. Indigestion is sometimes caused by the reflux of stomach acid into the esophagus.

given an endoscopic examination, 5–15% are diagnosed with GERD and 15–25% with PUD. About 1% of patients who are endoscoped have **stomach cancer**. Most patients with functional dyspepsia do well on either H_2 antagonists or prokinetic drugs, depending on the cause of their indigestion.

Prevention

Indigestion can often be prevented by attention to one's diet, general stress level, and ways of managing stress. Specific preventive measures include:

- stop **smoking**
- cutting down on or eliminating alcohol, tea, or coffee
- avoiding foods that are highly spiced or loaded with fat
- eating slowly and keeping mealtimes relaxed
- practicing yoga or meditation
- not taking aspirin or other medications on an empty stomach
- keeping one's weight within normal limits

Resources

OTHER

"Indigestion." *ThriveOnline.* 6 Apr. 1998 <http://thriveonline.oxygen.com>.

Rebecca J. Frey, PhD

Indinavir *see* **Protease inhibitors**

Indium scan of the body

Definition

A scanning procedure in which a patient's white blood cells are first labeled with the radioactive substance indium, and then the patient's body is scanned as a way of tracking the white blood cells at the site of possible infection.

Purpose

The procedure is used to detect inflammatory processes in the body such as infections. By labelling the leukocytes (white blood cells), radiologists or nuclear medicine specialists can then watch their migration toward an **abscess** or other infection.

Description

A nuclear medicine technologist withdraws about 50 ml. of blood. White blood cells are collected, exposed to indium, and reinjected by IV back into the patient.

The scan is scheduled for between 18 and 24 hours after the white blood cells have been labelled with indium. (In some cases, more scanning may be scheduled 48 hours after labelling).

For the scan, the patient lies on a special scanning table, as either a single camera passing underneath the table or two cameras (one above the table and one underneath) are placed as close as possible to the body, slowly scanning the person's body.

The radiologist may need extra pictures, but these take only a few minutes each.

KEY TERMS

Indium—A silvery metallic element with some nonmetallic chemical properties used to label white blood cells prior to scanning.

Leukocyte—A white blood cell that protects the body against infection and fights infection when it occurs. They are bigger than red blood cells.

While the patient must remain perfectly still during the scan, there should be no discomfort.

Aftercare

After the scan, the patient should be able to continue with normal daily activities with no problems.

Risks

The only risk during this scanning procedure could be to a patient who is pregnant, as with any type of injectable radioactive substance. If the woman is pregnant, the radiologist must be notified; if the scan is cleared, the radiologist may use a lower dosage of indium.

Normal results

The scan should reveal no infection or pathology.

Abnormal results

The scan will reveal such details as location about an infection in the patient's body.

Carol A. Turkington

Indirect Coombs' test *see* **Coombs' tests**

Induction of labor

Definition

Induction of labor involves using artificial means to assist the mother in delivering her baby.

Purpose

Labor is brought on, or induced, when the **pregnancy** has extended significantly beyond the expected delivery date and the mother shows no signs of going into labor. Generally, if the unborn baby is more than two weeks past due, labor will be induced. In most cases, a mother delivers her baby between 38 and 42 weeks of pregnancy. This usually means that labor is induced if the pregnancy has lasted more than 42 weeks. Labor is also induced if the mother is suffering from diseases (preeclampsia, chronic **hypertension**); if there is an Rh blood incompatibility between the baby and the mother; or if the mother or baby has a medical problem that requires delivery of the baby (like a premature rupture of the membranes).

Description

The uterus is the hollow female organ that supports the development and nourishment of the unborn baby during pregnancy. Sometimes labor is induced by the rupturing the amniotic membrane to release amniotic fluid. This is an attempt to mimic the normal process of "breaking water" that occurs early in the normal birth process. This method is sometimes enough stimulation to induce contractions in the mother's uterus. If labor fails to start, drugs are used.

Most labor is induced by using the drug Pitocin, a synthetic form of oxytocin. Oxytocin is a natural hormone produced in the body by the pituitary gland. During normal labor, oxytocin causes contractions. When labor does not occur naturally, the doctor may give the mother Pitocin to start the contractions. Pitocin makes the uterus contract with strength and force almost immediately. This drug is given through a vein in a steady flow that allows the doctor to control the amount the mother is given.

Sometimes vaginal gels are used to induce labor. Normally, the baby will pass through the opening of the uterus (the cervix) into the birth canal during delivery. Because of this, the cervix softens and begins to enlarge (dilate) during the early part of labor to make room for the baby to pass through. The cervix will continue to dilate, and the contractions will eventually push the baby out of the mother's body. When labor needs to be induced, the cervix is often small, hard, and not ready for the process. The doctor may need to prepare or "ripen" the cervix to induce labor. The hormone prostaglandin in a gel form may be applied high in the vagina to soften and dilate the cervix, making the area ready for labor. This may be enough to stimulate contractions on its own. More often, prostaglandin gel is used in conjunction with Pitrocin.

If all attempts to induce labor fail, a **cesarean section** is performed.

Risks

Once labor has been induced, the unborn baby is monitored to guard against a reduction in its oxygen supply, or hypoxia. The drugs used to induce labor cause vasoconstriction, which can decrease blood supply to the unborn

KEY TERMS

Cesarean section—Delivery of a baby through an incision in the mother's abdomen instead of through the vagina; also called a C-section.

Preeclampsia—Hypertension (high blood pressure) experienced during pregnancy.

Rh blood incompatibility—A blood type problem between mother (who is Rh negative) and baby (who is Rh positive), making the immune system of the mother attack her unborn baby. During delivery of the first pregnancy, the mother's immune system becomes sensitive to the Rh positive blood of the baby. The mother's system may then attack later pregnancies and cause severe illness or death to those babies.

Vasoconstriction—Constriction of a blood vessel.

baby. Throughout the process, the baby's heart rate is monitored by an electronic device placed on top of the mother's abdomen. The heart rate is one sign that the unborn baby is getting enough oxygen and remains healthy. Once the membranes are broken, prolonged labor may result in infection for either the newborn or the mother.

Normal results

Once labor is induced and the cervix has dilated, labor usually proceeds normally. When performed properly, induced labor is a safe procedure for both mother and baby.

Resources

BOOKS

Berkow, Robert, ed., et al. *The Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

"Induction of Labor." In *The American Medical Association Encylopedia of Medicine*. New York: Random House, 1989.

"Induction of Labor." In *Columbia University College of Physicians and Surgeons Complete Home Medical Guide*. New York: Random House, 1985.

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Infant massage

Definition

Infant massage refers to **massage therapy** as specifically applied to infants. In most cases, oil or lotion is used as it would be on an adult subject by a trained and licensed massage therapist. Medical professionals caring for infants might also use massage techniques on infants born prematurely, on those with motor or gastrointestinal problems, or on those who have been exposed to **cocaine** in utero.

Purpose

Research from experiments conducted at the Touch Research Institutes at the University of Miami School of Medicine and Nova Southeastern University has been cited for the clinical benefits massage has on infants and children. Tiffany Field, Ph. D., director, noted that the research "... suggests that touch is as important to infants and children as eating and sleeping. Touch therapy triggers many physiological changes that help infants and children grow and develop. For example, massage can stimulate nerves in the brain which facilitate food absorption, resulting in faster weight gain. It also lowers level of **stress** hormones, resulting in improved immune function."

The benefits of infant massage include:

- relaxation
- relief from stress
- interaction with adults
- stimulation of the nervous system

The results of several studies showed that infant massage alleviates the stress that newborns experience as a result of the enormous change that birth brings about in their lives after the six to nine months they have spent in the womb. Both premature infants and full-term babies need the relaxation that comes from massaging and moving their limbs and muscles. In infants with **colic**, massage provides the relief necessary to disperse gas, ease muscle spasm, tone the digestive system and help it work efficiently. Some techniques even help bring relief from teething and emotional stress. The stimulation an infant receives from massage can aid circulation, strengthen muscles, help digestion, and relieve **constipation**. The bonding that occurs with massage between a parent and child enhances the entire process of bonding that comes with contact through all of the senses, including touch, voice, and sight. It affords a physical experience of quality time between the parents and the child as well as with any significant others in a baby's life.

Description

Origins

The practice of massaging infants dates back to ancient times, particularly in Asian and Pacific Island

cultures; that is, massage was a component of the baby's regular bath routine among the Maoris and Hawaiians. Touch in these cultures is considered healthful both physically and spiritually. In the West, however, infant massage has received more attention in recent years in conjunction with the popularity of natural **childbirth** and midwife-assisted births. Dr. Frédéric Leboyer, a French physician who was one of the leaders of the natural childbirth movement, helped to popularize infant massage through his photojournalistic book on the Indian art of baby massage.

Infant massage was introduced formally into the United States in 1978 when Vimala Schneider McClure, a **yoga** practitioner who served in an orphanage in Northern India, developed a training program for instructors at the request of childbirth educators. An early research study by R. Rice in 1976 had showed that premature babies who were massaged surged ahead in weight gain and neurological development over those who were not massaged. From McClure's training in India, her knowledge of Swedish massage and **reflexology**, along with her knowledge of yoga postures that she had already adapted for babies, she became the foremost authority on infant massage. In 1986 she founded the International Association of Infant Massage (IAIM), which has 27 chapters worldwide as of 2000.

Various techniques are used in infant massage, with the different strokes specific to a particular therapy. Special handling is used for treating a baby with gas and colic. Some of the strokes are known as "Indian milking," which is a gentle stroking of the child's legs; and the "twist and squeeze" stroke, a gentle squeeze of the muscles in the thigh and calf. The light "feather" strokes often employed in regular Swedish massage are applied at the end of a massage. The procedure is not unlike certain forms of adult massage, but with extra care taken for the fragility of the infant.

There are also specific Chinese techniques of pediatric massage, including massage of children with special needs. In China, these forms of massage can be given by medical professionals, but parents are often taught how to do the simpler forms for home treatment of their children.

Preparations

If lotions or oils are used, care is taken to ensure their safety on a baby's delicate skin. The most important consideration is to use vegetable oils rather than mineral oils, which can clog the pores in the skin. The oil that is used should be warmed in the caregiver's hands before applying it to the baby's skin. The environment in which the massage is given to an infant should be comfortably warm, and as calm and nonthreatening as possible.

Precautions

Extreme caution is necessary when performing infant massage. Strokes are made with the greatest delicacy in order not to harm the infant in any way. Proper techniques are taught by licensed massage therapists ensuring that the infant is treated with appropriate physical touch. Anyone who is unfamiliar with handling a baby should receive appropriate instruction before beginning infant massage.

Side effects

No adverse side effects have been reported when infant massage is done properly after careful instruction, or by a licensed massage therapist who specializes in infant care.

Research and general acceptance

In addition to the study already noted regarding touch therapy, a website devoted to infant massage lists research published as early as 1969, and cites hundreds of individual projects that have been conducted throughout the world focusing on infant massage. Many of the studies are related to the benefits of massage and touch for premature infants and others born with such risk factors as drug dependence. Conclusions regarding the benefits are overwhelmingly positive. The proliferation of therapists licensed in infant massage across the United States and worldwide indicates that infant massage is increasingly recognized as a legitimate health care treatment.

Resources

BOOKS

Auckett, Amelia. *Baby Massage: Parent-Child Bonding through Touching.* Newmarket Press, 1982.

Cline, Kyle. *Chinese Massage for Infants and Children: Traditional Techniques for Alleviating Colic, Teething Pain, Earache, and Other Common Childhood Conditions.* Inner Traditions International, Limited, 1999.

Fan, Ya-Li. *Chinese Pediatric Massage Therapy: Traditional Techniques for Alleviating Colic, Colds, Earaches, and Other Common Childhood Conditions,* ed. Bob Flaws. Blue Poppy Enterprises, 1999.

Gordon, Jay, and Brenda Adderly. *Brighter Baby: Boosting Your Child's Intelligence, Health and Happiness through Infant Therapeutic Massage.* New York: Regnery Publishing, Inc. 1999.

Heinl, Tina. *The Baby Massage Book: Shared Growth through the Hands.* Sigo Press, 1991.

Leboyer, Frédéric. *Loving Hands: The Traditional Indian Art of Baby Massage.* New York: Knopf, 1976.

McClure, Vimala Schneider. *Infant Massage: A Handbook for Loving Parents*. New York: Bantam Books, 1989.
Walker, Peter. *Baby Massage: A Practical Guide to Massage and Movement for Babies and Infants*. New York: St. Martin's Press, 1996.

ORGANIZATIONS

International Association of Infant Massage. P.O. Box 1045. Oak View, CA 93022.
International Institute of Infant Massage. 605 Bledsoe Rd. NW. Albuquerque, NM 87107. (505) 341-9381. Fax: (505) 341-9386. <http://www.infantmassage.com>.

OTHER

Gentle Touch. *Gentle Touch Infant Massage Video*. Gentle Touch, Inc. 1996.

Jane Spehar

Infant respiratory distress syndrome *see* **Respiratory distress syndrome**

Infantile paralysis *see* **Polio**

Infarct avid imaging *see* **Technetium heart scan**

Infarction *see* **Stroke**

Infectious arthritis

Definition

Infectious arthritis, which is sometimes called septic arthritis or pyogenic arthritis, is a serious infection of the joints characterized by **pain**, **fever**, occasional chills, inflammation and swelling in one or more joints, and loss of function in the affected joints. It is considered a medical emergency.

Description

Infectious arthritis can occur in any age group, including newborns and children. In adults, it usually affects the wrists or one of the patient's weight-bearing joints—most often the knee—although about 20% of adult patients have symptoms in more than one joint. Multiple joint infection is common in children and typically involves the shoulders, knees, and hips.

Some groups of patients are at greater risk for developing infectious arthritis. These high-risk groups include:

- patients with chronic **rheumatoid arthritis**
- patients with certain systemic infections, including **gonorrhea** and HIV infection. Women and male homosexuals are at greater risk for gonorrheal arthritis than are male heterosexuals
- patients with certain types of **cancer**
- IV drug abusers and alcoholics
- patients with artificial (prosthetic) joints
- patients with diabetes, sickle cell anemia, or **systemic lupus erythematosus** (SLE)
- patients with recent joint injuries or surgery, or patients receiving medications injected directly into a joint

Causes and symptoms

In general, infectious arthritis is caused by the spread of a bacterial, viral, or fungal infection through the bloodstream to the joint. The disease agents may enter the joint directly from the outside as a result of an injury or a surgical procedure, or they may be carried to the joint by the blood from infections elsewhere in the body. The specific organisms vary somewhat according to age group. Newborns are most likely to acquire gonococcal infections of the joints from a mother with gonorrhea. Children may also acquire infectious arthritis from a hospital environment, often as a result of catheter placement. The organisms involved are usually either *Haemophilus influenzae* (in children under two years of age) or *Staphylococcus aureus*. In older children or adults, the infectious organisms include *Streptococcus pyogenes* and *Streptococcus viridans* as well as *Staphylococcus aureus*. *Staphylococcus epidermidis* is usually involved in joint infections related to surgery. Sexually active teenagers and adults frequently develop infectious arthritis from *Neisseria gonorrhoeae* infections. Older adults are often vulnerable to joint infections caused by gram-negative bacilli, including *Salmonella* and *Pseudomonas*.

Infectious arthritis often has a sudden onset, but symptoms sometimes develop over a period of three to 14 days. The symptoms include swelling in the infected joint and pain when the joint is moved. Infectious arthritis in the hip may be experienced as pain in the groin area that becomes much worse if the patient tries to walk. In 90% of cases, there is some leakage of tissue fluid into the affected joint. The joint is sore to the touch; it may or may not be warm to the touch, depending on how deep the infection lies within the joint. In most cases the patient will have fever and chills, although the fever may be only low-grade. Children sometimes develop **nausea and vomiting**.

Septic arthritis is considered a medical emergency because of the damage it causes to bone as well as cartilage, and its potential for creating **septic shock**, which is a potentially fatal condition. *Staphylococcus aureus* is

KEY TERMS

Arthrocentesis—A procedure in which the doctor inserts a needle into the patient's joint to withdraw fluid for diagnostic testing or to drain infected fluid from the joint.

Pyogenic arthritis—Another name for infectious arthritis. Pyogenic means that pus is formed during the disease process.

Sepsis—Invasion of the body by disease organisms or their toxins. Generalized sepsis can lead to shock and eventual death.

Septic arthritis—Another name for infectious arthritis.

Synovial fluid (SF)—A fluid secreted by tissues surrounding the joints that lubricates the joints.

capable of destroying cartilage in one or two days. Destruction of cartilage and bone in turn leads to dislocations of the joints and bones. If the infection is caused by bacteria, it can spread to the blood and surrounding tissues, causing abscesses or even blood **poisoning**. The most common complication of infectious arthritis is **osteoarthritis**.

Diagnosis

The diagnosis of infectious arthritis depends on a combination of laboratory testing with careful history-taking and **physical examination** of the affected joint. It is important to keep in mind that infectious arthritis can coexist with other forms of arthritis, **gout**, **rheumatic fever**, **Lyme disease**, or other disorders that can cause a combination of joint pain and fever. In some cases, the doctor may consult a specialist in orthopedics or rheumatology to avoid misdiagnosis.

Patient history

The patient's history will tell the doctor whether he or she belongs to a high-risk group for infectious arthritis. Sudden onset of joint pain is also important information.

Physical examination

The doctor will examine the affected joint for swelling, soreness, warmth, and other signs of infection. Location is sometimes a clue to diagnosis; infection of an unusual joint, such as the joints between the breastbone and collarbone, or the pelvic joints, often occurs in drug abusers.

Laboratory tests

Laboratory testing is necessary to confirm the diagnosis of infectious arthritis. The doctor will perform an arthrocentesis, which is a procedure that involves withdrawing a sample of synovial fluid (SF) from the joint with a needle and syringe. SF is a lubricating fluid secreted by tissues surrounding the joints. Patients should be warned that arthrocentesis is a painful procedure. The fluid sample is sent for culture in the sealed syringe. SF from infected joints is usually streaked with pus or looks cloudy and watery. Cell counts usually indicate a high level of white cells; a level higher than 100,000 cells/mm3 or a neutrophil proportion greater than 90% suggests septic arthritis. A Gram's stain of the culture obtained from the SF is usually positive for the specific disease organism.

Doctors sometimes order a biopsy of the synovial tissue near the joint if the fluid sample is negative. Cultures of other body fluids, such as urine, blood, or cervical mucus, may be taken in addition to the SF culture.

Diagnostic imaging

Diagnostic imaging is not helpful in the early stages of infectious arthritis. Destruction of bone or cartilage does not appear on x rays until 10–14 days after the onset of symptoms. Imaging studies are sometimes useful if the infection is in a deep-seated joint.

Treatment

Infectious arthritis requires usually requires several days of treatment in a hospital, with follow-up medication and physical therapy lasting several weeks or months.

Medications

Because of the possibility of serious damage to the joint or other complications if treatment is delayed, the patient will be started on intravenous **antibiotics** before the specific organism is identified. After the disease organism has been identified, the doctor may give the patient a drug that targets the specific bacterium or virus. **Nonsteroidal anti-inflammatory drugs** are usually given for viral infections.

Intravenous antibiotics are given for about two weeks, or until the inflammation has disappeared. The patient may then be given a two- to four-week course of oral antibiotics.

Surgery

In some cases, surgery is necessary to drain fluid from the infected joint. Patients who need surgical

drainage include those who have not responded to antibiotic treatment, those with infections of the hip or other joints that are difficult to reach with arthrocentesis, and those with joint infections related to gunshot or other penetrating **wounds**.

Patients with severe damage to bone or cartilage may need reconstructive surgery, but it cannot be performed until the infection is completely gone.

Monitoring and supportive treatment

Infectious arthritis requires careful monitoring while the patient is in the hospital. The doctor will drain the joint on a daily basis and remove a small sample of fluid for culture to check the patient's response to the antibiotic.

Infectious arthritis often causes intense pain. Patients are given medications to relieve pain, together with hot compresses or ice packs on the affected joint. In some cases the patient's arm or leg is put in a splint to protect the sore joint from accidental movement. Recovery can be speeded up, however, if the patient practices range-of-motion exercises to the extent that the pain allows.

Prognosis

The prognosis depends on prompt treatment with antibiotics and drainage of the infected joint. About 70% of patients will recover without permanent joint damage. However, many patients will develop osteoarthritis or deformed joints. Children with infected hip joints sometimes suffer damage to the growth plate. If treatment is delayed, infectious arthritis has a mortality rate between 5% and 30% due to septic **shock** and **respiratory failure**.

Prevention

Some cases of infectious arthritis are preventable by lifestyle choices. These include avoidance of self-injected drugs; sexual abstinence or monogamous relationships; and prompt testing and treatment for suspected cases of gonorrhea. Patients receiving corticosteroid injections into the joints for osteoarthritis may want to weigh this treatment method against the increased risk of infectious arthritis.

Resources

BOOKS

"Bedside Procedures: Joint Aspiration (Arthrocentesis)." In *Surgery On Call*, ed. Leonard G. Gomella and Alan T. Lefor. Stamford: Appleton & Lange, 1996.

Bradford, David S., et al. "Orthopedics." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Eilert, Robert E. "Bones & Joints." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Gilliland, Bruce C., and Robert G. Petersdorf. "Infectious Arthritis." In *Harrison's Principles of Internal Medicine*, ed. Eugene Braunwald, et al. New York: McGraw-Hill Book Co., 1987.

Hellman, David B., "Arthritis & Musculoskeletal Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Musculoskeletal and Connective Tissue Disorders: Infectious Arthritis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Nanagara, Ratanavadee, et al. "Septic Arthritis." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"On-Call Problems: Joint Swelling." In *Internal Medicine On Call*, ed. Steven A. Haist, et al. Stamford: Appleton & Lange, 1991.

"Septic Arthritis." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Theodosakis, Jason, et al. *The Arthritis Cure*. New York: St. Martin's Paperbacks, 1997.

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Infection control

Definition

Infection control refers to policies and procedures used to minimize the risk of spreading infections, especially in hospitals and health care facilities.

Purpose

The purpose of infection control is to reduce the occurrence of infectious diseases. These diseases are usually caused by bacteria or viruses and can be spread by human-to-human contact, animal-to-human contact, human contact with an infected surface, airborne transmission through tiny droplets of infectious agents suspended in the air, and, finally, by a common vehicle such as food or water.

Infection control in hospitals

Infections obtained in hospitals are also called nosocomial infections. They occur in approximately 5% of all hospital patients. This results in increased time spent in the hospital and, in some cases, **death**. There are many

Selected Infectious Diseases And Corresponding Treatments

Disease	Symptoms	Transmittal	Treatment
Chicken pox	Rash, low-grade fever	Person to person	None
Common cold/ Influenza	Runny nose, sore throat, cough, fever, headache, muscle aches	Person to person	None
Hepatitis	Jaundice, flu-like symptoms	Sexual contact with an infected person, contaminated blood, food, or water	None
Legionnaire's Disease	Flu-like symptoms, pneumonia, diarrhea, vomiting, kidney failure, respiratory failure	Air conditioning or water systems	Antibiotics
Measles	Skin rash, runny nose and eyes, fever, cough	Person to person	None
Meningitis	Neck pain, headache, pain caused by exposure to light, fever, nausea, drowsiness	Person to person	Antibiotics for bacterial meningitis, hospital care for viral meningitis
Mumps	Swelling of salivary glands	Person to person	Anti-inflammatory drugs
Ringworm	Skin rash	Contact with infected animal or person	Antifungal drugs applied topically
Tetanus	Lockjaw, other spasms	Soil infection of wounds	Antibiotics, antitoxins, muscle relaxers

reasons nosocomial infections are common, one of which is that many hospital patients have a weakened immune system which makes them more susceptible to infections. This weakened immune system can be caused either by the patient's diseases or by treatments given to the patient. Second, many medical procedures can increase the risk of infection by introducing infectious agents into the patient. Thirdly, many patients are admitted to hospitals because of infectious disease. These infectious agents can then be transferred from patient to patient by hospital workers or visitors.

Infection control has become a formal discipline in the United States since the 1950s, due to the spread of **staphylococcal infections** in hospitals. Because there is both the risk of health care providers acquiring infections themselves, and of their passing infections on to patients, the Centers for Disease Control and Prevention have established guidelines for infection control procedures. In addition to hospitals, infection control is important in nursing homes, clinics, child care centers, and restaurants, as well as in the home.

Threat of emerging infectious diseases

Due to constant changes in our lifestyles and environments, there are constantly new diseases that people are susceptible to, making protection from the threat of infectious disease urgent. Many new contagious diseases have been identified in the past 30 years, such as **AIDS**, Ebola, and hantavirus. Increased travel between continents makes the worldwide spread of disease a bigger concern than it once was. Additionally, many common infectious diseases have become resistant to known treatments.

Problems of antibiotic resistance

Because of the overuse of **antibiotics**, many bacteria have developed a resistance to common antibiotics. This means that newer antibiotics must continually be developed in order to treat an infection. However, further resistance seems to come about almost simultaneously. This indicates to many scientists that it might become more and more difficult to treat infectious diseases. The use of antibiotics outside of medicine also contributes to increased antibiotic resistance. One example of this is the use of antibiotics in animal husbandry. These negative trends can only be reversed by establishing a more rational use of antibiotics through treatment guidelines.

Description

The goals of infection control programs are: immunizing against preventable diseases, defining precautions that can prevent exposure to infectious agents, and restricting the exposure of health care workers to an infectious agent. An infection control practitioner is a specially trained professional, oftentimes a nurse, who oversees infection control programs.

Commonly recommended precautions to avoid and control the spread of infections include:

- vaccinate against diseases for which a vaccine is available
- wash hands often
- cook food thoroughly
- use antibiotics only as directed
- see a doctor for infections that do not heal
- avoid areas with a lot of insects

KEY TERMS

Acquired immunodeficiency syndrome (AIDS)—A disease that weakens the body's immune system. It is thought to be caused by the virus known as HIV.

Antibiotic—A substance, such as a drug, that can stop a bacterium from growing or destroy the bacterium.

Antibiotic resistance—The ability of infectious agents to change their biochemistry in such a way as to make an antibiotic no longer effective.

Ebola—The disease caused by the newly described and very deadly Ebola virus found in Africa.

Hantavirus—A group of arboviruses that cause hemorrhagic fever (characterized by sudden onset, fever, aching and bleeding in the internal organs).

Immunization—Immunity refers to the body's ability to protect itself from a certain disease after it has been exposed to that disease. Through immunization, also known as vaccination, a small amount of an infectious agent is injected into the body to stimulate the body to develop immunity.

Immunocompromised—Refers to the condition of having a weakened immune system. This can happen due to genetic factors, drugs, or disease.

Nosocomial infection—An infection that was acquired in a hospital setting.

Staphylococcal infection—An infection caused by the organism *Staphylococcus*. Infection by this agent is common and is often resistant to antibi-

- be cautious around unfamiliar animals
- do not engage in unprotected sex or in intravenous drug use
- inquire about infectious diseases when you travel

Because of the higher risk of spreading infectious disease in a hospital setting, higher levels of precautions are taken there. Typically, health care workers wear gloves with all patients, since it is difficult to know whether a transmittable disease is present or not. Patients who have a known transmittable infectious disease are isolated to decrease the risk of transmitting the infectious agent to another person. Hospital workers who come in contact with infected patients must wear gloves and gowns to decrease the risk of carrying the infectious agent to other patients. All articles of equipment that are used in an **isolation** room are decontaminated before reuse. Patients who are immunocompromised may be put in protective isolation to decrease the risk of infectious agents being brought into their room. Any hospital worker with infections, including colds, are restricted from that room.

Hospital infections can also be transmitted through the air. Thus care must be taken when handling infected materials so as to decrease the numbers of infectious agents that become airborne. Special care should also taken with hospital ventilation systems to prevent recirculation of contaminated air.

Resources

BOOKS

Edmond, Michael B., and Richard P. Wenzel. "Infection Control." In *Principles and Practice of Infectious Diseases*, ed. G. L. Mandell, J. E. Bennett, and R. Dolin. New York: Churchill Livingston, 1995.

PERIODICALS

"Plagued by Cures." *Economist*, 22 Nov. 1997, 95-97.

Williams, Rosamund J., and David L. Heymann. "Containment of Antibiotic Resistance." *Science* 279 (20 Feb. 1998): 1153-1154.

Winik, Lyric W. "Before The Next Epidemic Strikes." *Parade Magazine*, 8 Feb. 1998, 6-7.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Infectious hepatitis *see* **Hepatitis A**

Infectious mononucleosis

Definition

Infectious mononucleosis is a contagious illness caused by the Epstein-Barr virus, which can affect the liver, lymph nodes, and oral cavity. While mononucleosis is not usually a serious disease, its primary symptoms of **fatigue** and lack of energy can linger for several months.

Description

Infectious mononucleosis, frequently called "mono" or the "kissing disease," is caused by the Epstein-Barr virus (EBV) found in saliva and mucus. The virus affects a type of white blood cell called the B lymphocyte, producing characteristic atypical lymphocytes that may be useful in the diagnosis of the disease.

While anyone, even young children, can develop mononucleosis, it occurs most often in young adults between the ages of 15 and 35, and is especially common in teenagers. The mononucleosis infection rate among college students who have not previously been exposed to EBV has been estimated to be about 15%. In younger children, the illness may not be recognized.

The disease typically runs its course in four to six weeks in people with normally functioning immune systems. People with weakened or suppressed immune systems, such as **AIDS** patients or those who have had organ transplants, are particularly vulnerable to the potentially serious complications of infectious mononucleosis.

Causes and symptoms

The EBV that causes mononucleosis is related to a group of herpesviruses, including those that cause cold sores, chicken pox, and **shingles**. Most people are exposed to EBV at some point during their lives. Mononucleosis is most commonly spread by contact with virus-infected saliva through coughing, sneezing, kissing, or sharing drinking glasses or eating utensils.

In addition to general weakness and fatigue, symptoms of mononucleosis may include any or all of the following:

- **sore throat** and/or swollen tonsils
- fever and chills
- nausea and vomiting, or decreased appetite
- swollen lymph nodes in the neck and armpits
- headaches or joint **pain**
- enlarged spleen
- jaundice
- skin rash

Complications that can occur with mononucleosis include a temporarily enlarged spleen or inflamed liver. In rare instances, the spleen may rupture, producing sharp pain on the left side of the abdomen, a symptom that warrants immediate medical attention. Additional symptoms of a ruptured spleen include lightheadedness, rapidly beating heart, and difficulty breathing. Other rare, but potentially life-threatening, complications may involve the heart or brain. The infection may also cause significant destruction of the body's red blood cells or platelets.

Symptoms do not usually appear until four to seven weeks after exposure to EBV. An infected person can be contagious during this incubation time period and for as many as five months after the disappearance of symptoms. Also, the virus will be excreted in the saliva intermittently for the rest of their lives, although the individual will experience no symptoms. Contrary to popular belief, the EBV is not highly contagious. As a result, individuals living in a household or college dormitory with someone who has mononucleosis have a very small risk of being infected unless they have direct contact with the person's saliva.

Diagnosis

If symptoms associated with a cold persist longer than two weeks, mononucleosis is a possibility; however, a variety of other conditions can produce similar symptoms. If mononucleosis is suspected, a physician will typically conduct a **physical examination**, including a "Monospot" antibody blood test that can indicate the presence of proteins or antibodies produced in response to infection with the EBV. These antibodies may not be detectable, however, until the second or third weeks of the illness. Occasionally, when this test is inconclusive, other blood tests may be conducted.

Treatment

The most effective treatment for infectious mononucleosis is rest and a gradual return to regular activities. Individuals with mild cases may not require bed rest but should limit their activities. Any strenuous activity, athletic endeavors, or heavy lifting should be avoided until the symptoms completely subside, since excessive activity may cause the spleen to rupture.

The sore throat and **dehydration** that usually accompany mononucleosis may be relieved by drinking water and fruit juices. Gargling salt water or taking throat lozenges may also relieve discomfort. In addition, taking over-the-counter medications, such as **acetaminophen** or ibuprofen, may relieve symptoms, but **aspirin** should be avoided because mononucleosis has been associated with **Reye's syndrome**, a serious illness aggravated by aspirin.

While **antibiotics** do not affect EBV, the sore throat accompanying mononucleosis can be complicated by a streptococcal infection, which can be treated with antibiotics. Cortisone anti-inflammatory medications are also occasionally prescribed for the treatment of severely swollen tonsils or throat tissues.

Prognosis

While the severity and length of illness varies, most people diagnosed with mononucleosis will be able to return to their normal daily routines within two to three weeks, particularly if they rest during this time period. It may take two to three months before a person's usual

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Herpesviruses—A group of viruses that can cause cold sores, shingles, chicken pox, and congenital abnormalities. The Epstein-Barr virus which causes mononucleosis belongs to this group of viruses.

Reye's syndrome—A very serious, rare disease, most common in children, which involves an upper respiratory tract infection followed by brain and liver damage.

energy levels return. One of the most common problems in treating mononucleosis, particularly in teenagers, is that people return to their usual activities too quickly and then experience a relapse of symptoms. Once the disease has completely run its course, the person cannot be reinfected.

Prevention

Although there is no way to avoid becoming infected with EBV, paying general attention to good hygiene and avoiding sharing beverage glasses or having close contact with people who have mononucleosis or cold symptoms can help prevent infection.

Resources

BOOKS

The Merck Manual. 16th ed. Whitehouse Station, NJ: Merck & Co., 1992.

PERIODICALS

Baily, Eugene R. "Diagnosis and Treatment of Infectious Mononucleosis." *American Family Physician* (Mar. 1994): 879-887.

ORGANIZATIONS

National Institute of Allergy and Infectious Disease. Building 31, Room 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892-2520. (301) 496-5717. <http://www.niaid.nih.gov/default.htm>.

OTHER

"Mononucleosis: A Tiresome Disease." *Mayo Clinic Online*. <http://www.mayo.ivi.com/mayo/9701/htm/mono.htm>.

"Communicable Disease Fact Sheet." New York State Department of Health.

Susan J. Montgomery

Infertility

Definition

Infertility is the failure of a couple to conceive a **pregnancy** after trying to do so for at least one full year. In primary infertility, pregnancy has never occurred. In secondary infertility, one or both members of the couple have previously conceived, but are unable to conceive again after a full year of trying.

Description

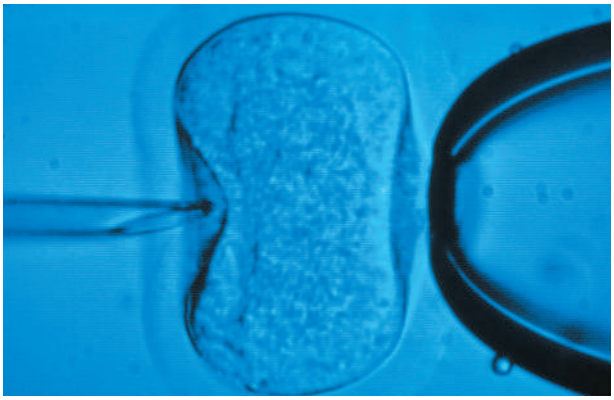
Currently, in the United States, about 20% of couples struggle with infertility at any given time. Infertility has increased as a problem over the last 30 years. Some studies pin the blame for this increase on social phenomena, including the tendency for marriage to occur at a later age, which means that couples are trying to start families at a later age. It is well known that fertility in women decreases with increasing age, as illustrated by the following statistics:

- infertility in married women ages 16–20 = 4.5%
- infertility in married women ages 35–40 = 31.8%
- infertility in married women over the age of 40 = 70%.

Nowadays, individuals often have multiple sexual partners before they marry and try to have children. This increase in numbers of sexual partners has led to an increase in **sexually transmitted diseases**. Scarring from these infections, especially from **pelvic inflammatory disease** (a serious infection of the female reproductive organs, most commonly caused by **gonorrhea**) seems to be in part responsible for the increase in infertility noted. Furthermore, the use of some forms of the contraceptive called the intrauterine device (**IUD**) contributed to an increased rate of pelvic inflammatory disease, with subsequent scarring. However, newer IUDs do not lead to this increased rate of infection.

To understand issues of infertility, it is first necessary to understand the basics of human reproduction. Fertilization occurs when a sperm from the male merges with an egg (ovum) from the female, creating a zygote that contains genetic material (DNA) from both the father and the mother. If pregnancy is then established, the zygote will develop into an embryo, then a fetus, and ultimately a baby will be born.

The male contribution to fertilization and the establishment of pregnancy is the sperm. Sperm are small cells that carry the father's genetic material. This genetic material is contained within the oval head of the sperm. The sperm are mixed into a fluid called semen, which is discharged from the penis during sexual intercourse. The



A microscopic image of a needle (left) injecting sperm cells directly into a human egg (center). The broad object at right is a pipette used to hold the ovum steady. *(Phototake NYC. Reproduced by permission.)*

whip-like tail of the sperm allows the sperm to swim up the female reproductive tract, in search of the egg it will try to fertilize.

The female makes many contributions to fertilization and the establishment of pregnancy. The ovum is the cell that carries the mother's genetic material. These ova develop within the ovaries. Once a month, a single mature ovum is produced, and leaves the ovary in a process called ovulation. This ovum enters a tube leading to the uterus (the fallopian tube). The ovum needs to meet up with the sperm in the fallopian tube if fertilization is to occur.

When fertilization occurs, the resulting cell (which now contains genetic material from both the mother and the father) is called the zygote. This single cell will divide into many other cells within the fallopian tube, and the resulting cluster of cells (called a blastocyst) will then move into the womb (uterus). The uterine lining (endometrium) has been preparing itself to receive a pregnancy by growing thicker. If the blastocyst successfully reaches the inside of the uterus and attaches itself to the wall of the uterus, then implantation and pregnancy have been achieved.

Causes and symptoms

Unlike most medical problems, infertility is an issue requiring the careful evaluation of two separate individuals, as well as an evaluation of their interactions with each other. In about 3–4% of couples, no cause for their infertility will be discovered. About 40% of the time, the root of the couple's infertility is due to a problem with the male partner; about 40% of the time, the root of the infertility is due to the female partner; and about 20% of the time, there are fertility problems with both the man and the woman.

The main factors involved in causing infertility, listing from the most to the least common, include:

- male problems: 35%
- ovulation problems: 20%
- tubal problems: 20%
- **endometriosis**: 10%
- cervical factors: 5%

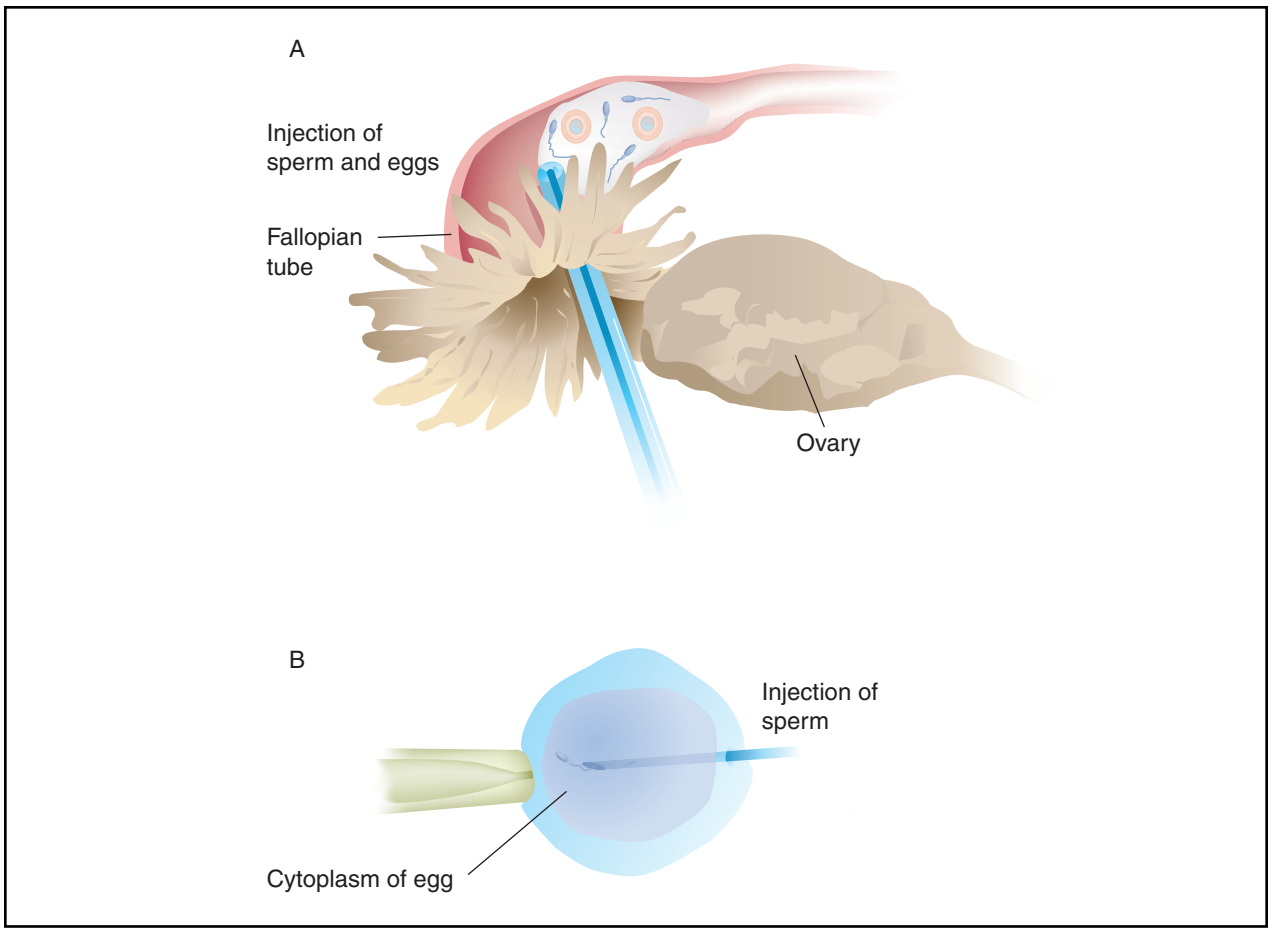
Male factors

Male infertility can be caused by a number of different characteristics of the sperm. To check for these characteristics, a sample of semen is obtained and examined under the microscope (**semen analysis**). Four basic characteristics are usually evaluated:

- Sperm count refers to the number of sperm present in a semen sample. The normal number of sperm present in just one milliliter (ml) of semen is over 20 million. An individual with only 5–20 million sperm per ml of semen is considered subfertile; an individual with less than 5 million sperm per ml of semen is considered infertile.
- Sperm are also examined to see how well they swim (sperm motility) and to be sure that most have normal structure.
- Not all sperm within a specimen of semen will be perfectly normal. Some may be immature, and some may have abnormalities of the head or tail. A normal semen sample will contain no more than 25% abnormal forms of sperm.
- Volume of the semen sample is important. An abnormal amount of semen could affect the ability of the sperm to successfully fertilize an ovum.

Another test can be performed to evaluate the ability of the sperm to penetrate the outer coat of the ovum. This is done by observing whether sperm in a semen sample can penetrate the outer coat of a guinea pig ovum; fertilization cannot occur, of course, but this test is useful in predicting the ability of the individual's sperm to penetrate a human ovum.

Any number of conditions result in abnormal findings in the semen analysis. Men can be born with testicles that have not descended properly from the abdominal cavity (where testicles develop originally) into the scrotal sac, or may be born with only one instead of the normal two testicles. Testicle size can be smaller than normal. Past infection (including **mumps**) can affect testicular function, as can a past injury. The presence of



A. An egg and sperm are injected into the fallopian tube to encourage natural fertilization in a procedure called gamete intrafallopian transfer (GIFT). B. An alternative to GIFT is the injection of sperm directly into an egg using microscopic needles. *(Illustration by Argosy Inc.)*

abnormally large veins (varicocele) in the testicles can increase testicular temperature, which decreases sperm count. History of having been exposed to various toxins, drug use, excess alcohol use, use of anabolic steroids, certain medications, diabetes, thyroid problems, or other endocrine disturbances can have direct effects on the formation of sperm (spermatogenesis). Problems with the male anatomy can cause sperm to be ejaculated not out of the penis, but into the bladder; and scarring from past infections can interfere with ejaculation.

Treatment of male infertility includes addressing known reversible factors first; for example, discontinuing any medication known to have an effect on spermatogenesis or ejaculation, as well as decreasing alcohol intake, and treating thyroid or other endocrine disease. Varicoceles can be treated surgically. Testosterone in low doses can improve sperm motility.

Other treatments of male infertility include collecting semen samples from multiple ejaculations, after which the semen is put through a process that allows the most motile sperm to be sorted out. These motile sperm are pooled together to create a concentrate that can deposited into the female partner's uterus at a time that coincides with ovulation. In cases in which the male partner's sperm is proven to be absolutely unable to cause pregnancy in the female partner, and with the consent of both partners, donor sperm may be used for this process. Depositing the male partner's sperm or donor sperm by mechanical means into the female partner are both forms of artificial insemination.

Ovulatory problems

The first step in diagnosing ovulatory problems is to make sure that an ovum is being produced each month. A woman's morning body temperature is slightly higher around the time of ovulation. A woman can measure and record her temperatures daily, and a chart can be drawn to show whether or not ovulation has occurred. Luteiniz-

KEY TERMS

Blastocyst—A cluster of cells representing multiple cell divisions that have occurred in the fallopian tube after successful fertilization of an ovum by a sperm. This is the developmental form which must leave the fallopian tube, enter the uterus, and implant itself in the uterus to achieve actual pregnancy.

Cervix—The opening from the vagina, which leads into the uterus.

Embryo—The stage of development of a baby between the second and eighth weeks after conception.

Endometrium—The lining of the uterus.

Fallopian tube—The tube leading from the ovary into the uterus. Just as there are two ovaries, there are two fallopian tubes.

Fetus—A baby developing in the uterus from the third month to birth.

Ovary—The female organ in which eggs (ova) are stored and mature.

Ovum (plural: ova)—The reproductive cell of the female, which contains genetic information and participates in the act of fertilization. Also popularly called the egg.

Semen—The fluid that contains sperm, which is ejaculated by the male.

Sperm—The reproductive cell of the male, which contains genetic information and participates in the act of fertilization of an ovum.

Spermatogenesis—The process by which sperm develop to become mature sperm, capable of fertilizing an ovum.

Zygote—The result of the sperm successfully fertilizing the ovum. The zygote is a single cell that contains the genetic material of both the mother and the father.

ing hormone (LH) is released just before ovulation. A simple urine test can be done to check if LH has been released around the time that ovulation is expected.

Treatment of ovulatory problems depends on the cause. If a thyroid or pituitary problem is responsible, simply treating that problem can restore fertility. (The thyroid and pituitary glands release hormones that also are involved in regulating a woman's menstrual cycle.) Medication can also be used to stimulate fertility. The most commonly used of these are called Clomid and Pergonal. These drugs increase the risk of multiple births (twins, triplets, etc.).

Pelvic adhesions and endometriosis

Pelvic adhesions and endometriosis can cause infertility by preventing the sperm from reaching the egg or interfering with fertilization.

Pelvic adhesions are fibrous scars. These scars can be the result of past infections, such as pelvic inflammatory disease, or infections following abortions or prior births. Previous surgeries can also leave behind scarring.

Endometriosis may lead to pelvic adhesions. Endometriosis is the abnormal location of uterine tissue outside of the uterus. When uterine tissue is planted elsewhere in the pelvis, it still bleeds on a monthly basis with the start of the normal menstrual period. This leads to irritation within the pelvis around the site of this abnormal tissue and bleeding, and may cause scarring.

Pelvic adhesions cause infertility by blocking the fallopian tubes. The ovum may be prevented from traveling down the fallopian tube from the ovary or the sperm may be prevented from traveling up the fallopian tube from the uterus.

A hysterosalpingogram (HSG) can show if the fallopian tubes are blocked. This is an x-ray exam that tests whether dye material can travel through the patient's fallopian tubes. A few women become pregnant following this x-ray exam. It is thought that the dye material in some way helps flush out the tubes, decreasing any existing obstruction. Scarring also can be diagnosed by examining the pelvic area through the use of a scope that can be inserted into the abdomen through a tiny incision made near the naval. This scoping technique is called **laparoscopy**.

Pelvic adhesions can be treated during laparoscopy. The adhesions are cut using special instruments. Endometriosis can be treated with certain medications, but may also require surgery to repair any obstruction caused by adhesions.

Cervical factors

The cervix is the opening from the vagina into the uterus through which the sperm must pass. Mucus pro-

duced by the cervix helps to transport the sperm into the uterus. Injury to the cervix or scarring of the cervix after surgery or infection can result in a smaller than normal cervical opening, making it difficult for the sperm to enter. Injury or infection can also decrease the number of glands in the cervix, leading to a smaller amount of cervical mucus. In other situations, the mucus produced is the wrong consistency (perhaps too thick) to allow sperm to travel through. In addition, some women produce antibodies (immune cells) that are specifically directed to identify sperm as foreign invaders and to kill them.

Cervical mucus can be examined under a microscope to diagnose whether cervical factors are contributing to infertility. The interaction of a live sperm sample from the male partner and a sample of cervical mucus from the female partner can also be examined. This procedure is called a postcoital test.

Treatment of cervical factors includes **antibiotics** in the case of an infection, steroids to decrease production of anti-sperm antibodies, and artificial insemination techniques to completely bypass the cervical mucus.

Treatment

Assisted reproductive techniques include **in vitro fertilization** (IVF), gamete intrafallopian transfer (GIFT), and zygote intrafallopian tube transfer (ZIFT). These are usually used after other techniques to treat infertility have failed.

In vitro fertilization involves the use of a drug to induce the simultaneous release of many eggs from the female's ovaries, which are retrieved surgically. Meanwhile, several semen samples are obtained from the male partner, and a sperm concentrate is prepared. The ova and sperm are then combined in a laboratory, where several of the ova may be fertilized. Cell division is allowed to take place up to the embryo stage. While this takes place, the female may be given drugs to ensure that her uterus is ready to receive an embryo. Three or four of the embryos are transferred to the female's uterus, and the wait begins to see if any or all of them implant and result in an actual pregnancy.

Success rates of IVF are still rather low. Most centers report pregnancy rates between 10–20%. Since most IVF procedures put more than one embryo into the uterus, the chance for a multiple birth (twins or more) is greatly increased in couples undergoing IVF.

GIFT involves retrieval of both multiple ova and semen, and the mechanical placement of both within the female partner's fallopian tubes, where one hopes that fertilization will occur. ZIFT involves the same retrieval of ova and semen, and fertilization and growth in the laboratory up to the zygote stage, at which point the zygotes are placed in the fallopian tubes. Both GIFT and ZIFT seem to have higher success rates than IVF.

Prognosis

It is very hard to obtain statistics regarding the prognosis of infertility because many different problems may exist within an individual or couple trying to conceive. In general, it is believed that of all couples who undergo a complete evaluation of infertility followed by treatment, about half will ultimately have a successful pregnancy. Of those couples who do not choose to undergo evaluation or treatment, about 5% will go on to conceive after a year or more of infertility.

Resources

BOOKS

Hornstein, Mark D., and Daniel Schust. "Infertility." In *Novak's Gynecology.* 12th ed. Ed. Jonathan S. Berek, et al. Baltimore: Lippincott, 1996.

Martin, Mary C. "Infertility" In *Current Obstetric and Gynecologic Diagnosis and Treatment*, ed. Alan H. Decherney and Martin L. Pernoll. Norwalk, CT: 1994.

PERIODICALS

Intrator, Nancy. "What To Do If You Can't Get Pregnant." *Cosmopolitan*, Dec. 1995, 154+.

Mastroianni, Luigi, et al. "Helping Infertile Patients." *Patient Care* (15 Oct. 1997): 103+.

Rosenbaum, Joshua. "Beat the Clock: Treatments for Infertility." *American Health* (Dec. 1995): 70+.

Trantham, Patricia. "The Infertile Couple." *American Family Physician* (1 Sept. 1996), 1001+.

ORGANIZATIONS

American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216-2809. (205) 978-5000. <http://www.asrm.com>.

International Center for Infertility Information Dissemination. <http://www.inciid.org>.

Rosalyn Carson-DeWitt, MD

Infertility drugs

Definition

Infertility drugs are medicines that help bring about **pregnancy**.

Purpose

Infertility is the inability of a man and woman to achieve pregnancy after at least a year of having regular

KEY TERMS

Endometriosis—A condition in which tissue like that normally found in the lining of the uterus is present outside the uterus. The condition often causes pain and bleeding.

Fetus—A developing baby inside the womb.

Fibroid tumor—A noncancerous tumor formed of fibrous tissue.

Ovary—A reproductive organ in females that produces eggs and hormones.

sexual intercourse without any type of birth control. There are many possible reasons for infertility, and finding the most effective treatment for a couple may involve many tests to find the problem. For pregnancy to occur, the woman's reproductive system must release eggs regularly—a process called ovulation. The man must produce healthy sperm that are able to reach and unite with an egg. And once an egg is fertilized, it must travel to the woman's uterus (womb), become implanted and remain there to be nourished.

If a couple is infertile because the woman is not ovulating, infertility drugs may be prescribed to stimulate ovulation. The first step usually is to try a drug such as clomiphene. If that doesn't work, human chorionic gonadotropin (HCG) may be tried, usually in combination with other infertility drugs.

Clomiphene and HCG may also be used to treat other conditions in both males and females.

Description

Clomiphene (Clomid, Serophene) comes in tablet form and is available only with a physician's prescription. Human chorionic gonadotropin is given as an injection, only under a physician's supervision.

Clomiphene citrate is used to increase the natural production of the hormones that stimulate ovulation in otherwise healthy women. When clomiphene is administered, the body produces higher levels of luteinizing hormone (LH), follicle stimulating hormone (FSH), and gonadotropins. These hormones induce ovulation.

Human chorionic gonadotropin (HCG) is sold under man brand names including Gonic, Pregnyl and Profasi. This hormone stimulates the gonads in both men and women. In men, HCG increases androgen production. In women, it increases the levels of progesterone. Human chorionic gonadotropin can help stimulate ovulation in women.

Although some people believe that HCG can help lose weight, there is no evidence that this hormone offers any benefit in weight loss programs. It should not be used for this purpose.

A number of other natural and synthetic hormones are used to induce ovulation. Urofollotropins (Fertinex) is a concentrated preparation of human hormones, while follitropin alfa (Gonal-F) and follitropin beta (Follistim) are human FSH preparations of recombinant DNA origin.

Menotropins (Pergonal, Humegon, Repronex) are given with human chorionic gonadotropin to stimulate ovulation in women and sperm production in men

Recommended dosage

The dosage may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Clomiphene must be taken at certain times during the menstrual cycle. Be sure to follow directions exactly.

Precautions

Seeing a physician regularly while taking infertility drugs is important.

Treatment with infertility drugs increases the chance of multiple births. Although this may seem like a good thing to couples who want children very badly, multiple fetuses can cause problems during pregnancy and delivery and can even threaten the babies' survival.

Having intercourse at the proper time in the woman's menstrual cycle helps increase the chance of pregnancy. The physician may recommend using an ovulation prediction test kit to help determine the best times for intercourse.

Some people feel dizzy or lightheaded, or less alert when using clomiphene. The medicine may also cause blurred vision and other vision changes. Anyone who takes clomiphene should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Questions remain about the safety of long-term treatment with clomiphene. Women should not have more than 6 courses of treatment with this drug and should ask their physicians for the most up-to-date information about its use.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take infertility drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to infertility drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Clomiphene may cause **birth defects** if taken during pregnancy. Women who think they have become pregnant while taking clomiphene should stop taking the medicine immediately and check with their physicians.

OTHER MEDICAL CONDITIONS. Infertility drugs may make some medical conditions worse. Before using infertility drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- endometriosis
- fibroid tumors of the uterus
- unusual vaginal bleeding
- ovarian cyst
- enlarged ovaries
- inflamed veins caused by blood clots
- liver disease, now or in the past
- depression

USE OF CERTAIN MEDICINES. Taking infertility drugs with certain other medicines may affect the way the drugs work or may increase the chance of side effects.

Side effects

When used in low doses for a short time, clomiphene and HCG rarely cause side effects. However, anyone who has stomach or pelvic **pain** or bloating while taking either medicine should check with a physician immediately. Infertility drugs may also cause less serious symptoms such as hot flashes, breast tenderness or swelling, heavy menstrual periods, bleeding between menstrual periods, nausea or vomiting, **dizziness**, lightheadedness, irritability, nervousness, restlessness, **headache**, tiredness, sleep problems, or depression. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they continue or they interfere with normal activities.

Other side effects are possible. Anyone who has unusual symptoms after taking infertility drugs should get in touch with a physician.

Interactions

Infertility drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes infertility drugs should let the physician know all other medicines she is taking.

Resources

PERIODICALS

Randal, Judith. "Trying to outsmart infertility." *FDA Consumer* 25 (May 1991): 22.

Nancy Ross-Flanigan

Infertility therapies

Definition

Infertility is the inability of a man and a woman to conceive a child through sexual intercourse. There are many possible reasons for the problem, which can involve the man, the woman, or both partners. Various treatments are available that enable a woman to become pregnant; the correct one will depend on the specific cause of the infertility.

Purpose

Infertility treatment is aimed at enabling a woman to have a baby by treating the man, the woman, or both partners. During normal conception of a child, the man's sperm will travel to the woman's fallopian tubes, where, if conditions are right, it will encounter an egg that has been released from the ovary. The sperm will fertilize the egg, which will enter the uterus where it implants and begins to divide, forming what's called an embryo. The embryo will develop during **pregnancy** into a baby.

Infertility treatment attempts to correct or compensate for any abnormalities in this process that prevent the fertilization of an egg or development of an embryo.

Precautions

It's important for a couple contemplating infertility treatment to examine their own ideas and feelings about the process and consider ethical objections before the woman becomes pregnant from such treatment.

Description

About 90% of women who are trying to get pregnant and use no birth control will do so within one year. If after one year of having frequent sexual intercourse with no **contraception** a couple has not conceived, they should seek the advice of a physician. Tests can be performed to look for possible infertility problems.

Treating an underlying infection or illness is the first step in infertility treatment. The physician may also suggest improving general health, dietary changes, reducing **stress**, and counseling.

Treatments

Low sperm count treatments

The most common cause of male infertility is failure to produce enough healthy sperm. For fertilization to happen, the number of sperm cells in the man's semen (the fluid ejected during sexual intercourse) must be sufficient, and the sperm cells must have the right shape, appearance, and activity (motility).

Defects in the sperm can be caused by an infection resulting from a sexually transmitted disease, a blockage caused by a varicose vein in the scrotum (varicocele), an endocrine imbalance, or problems with other male reproductive organs (such as the testicles, prostate gland, or seminal vesicles).

If a low sperm count is the problem, it's possible to restore fertility by:

- treating underlying infections
- timing sex to coincide with the time the woman is ovulating, which means that the egg is released from the ovary and is beginning to travel down the fallopian tube (the site of fertilization)
- having sex less often to build up the number of sperm in the semen
- treating any endocrine imbalance with drugs
- having a surgical procedure to remove a varicocele (varicocelectomy)

Fertility drugs

If infertility is due to a woman's failure to release eggs from the ovary (ovulate), fertility drugs can help bring hormone levels into balance, stimulating the ovaries and triggering egg production.

Surgical repair

In some women, infertility is due to blocked fallopian tubes. The egg is released from the ovary, but the sperm is prevented from reaching it because of a physical obstruction in the fallopian tube. If this is the case, surgery may help repair the damage. Microsurgery can sometimes repair the damage to scarred fallopian tubes if it is not too severe. Not all tube damage can be repaired, however, and most tubal problems are more successfully treated with **in vitro fertilization**.

Fibroid tumors in the uterus also may cause infertility, and they can be surgically treated. **Endometriosis**, a condition in which parts of the lining of the uterus become imbedded in other internal organs (such as the ovaries or fallopian tubes) may contribute to infertility. It may be necessary to surgically remove the endometrial tissue to improve fertility.

Artificial insemination

Artificial insemination may be tried if sperm count is low, the man is impotent, or the woman's vagina creates a hostile environment for the sperm. The procedure is not always successful. In this procedure, the semen is collected and placed into the woman's cervix with a small syringe at the time of ovulation. From the cervix, it can travel to the fallopian tube where fertilization takes place. If the partner's sperm count is low, it can be mixed with donor sperm before being transferred into the uterus.

If there is no sperm in the male partner's semen, then artificial insemination can be performed using a donor's sperm obtained from a sperm bank.

Assisted reproductive technologies

Some fertility treatments require removal of the eggs and/or sperm and manipulation of them in certain ways in a laboratory to assist fertilization. These techniques are called assisted reproductive technologies.

IN VITRO FERTILIZATION (IVF). When infertility can't be treated by other means or when the cause is not known, it's still possible to become pregnant through in vitro fertilization (IVF), a costly, complex procedure that achieves pregnancy 20% of the time.

In this procedure, a woman's eggs are removed by withdrawing them with a special needle. Attempts are then made to fertilize the eggs with sperm from her partner or a donor. This fertilization takes place in a petri dish in a laboratory. The fertilized egg (embryo) is then returned to the woman's uterus.

Often, three to six fertilized eggs are returned at the same time into the uterus. Usually one or two of the embryos survive and grow into fetuses, but sometimes three or more fetuses result.

A child born in this method is popularly known as a "test tube baby," but in fact the child actually develops inside the mother. Only the fertilization of the egg takes place in the laboratory.

INTRACYTOPLASMIC SPERM INJECTION (ICSI). In a variation of IVF called intracytoplasmic sperm injection (ICSI), single sperm cells are injected directly into each egg. This may be helpful for men with severe infertility.

GAMETE INTERFALLOPIAN TRANSFER (GIFT). In this technique, sperm and eggs are placed directly into the woman's fallopian tubes to encourage fertilization to occur naturally. This procedure is done with the help of **laparoscopy**. In laparoscopy, a small tube with a viewing lens at one end is inserted into the abdomen through a small incision. The lens allows the physician to see inside the patient on a video monitor.

ZYGOTE INTRAFALLOPIAN TRANSFER (ZIFT). If infertility is caused by a low sperm count, zygote intrafallopian transfer (ZIFT) can be tried. This technique combines GIFT and IVF. This procedure is also called a "tubal embryo transfer."

In this technique, in vitro fertilization is first performed, so that the actual fertilization takes place and is confirmed in the laboratory. Two days later, instead of placing the embryo in the uterus, the physician performs laparoscopy to place the embryos in the fallopian tube, much like the GIFT procedure.

A woman must have at least one functioning fallopian tube in order to participate in ZIFT.

Preparation

Couples who are having fertility problems may want to limit or avoid:

- tobacco
- alcohol
- caffeine
- stress
- tight-fitting undershorts (men)
- hot tubs, saunas and steam rooms (high temperatures can kill sperm)

Risks

Women who take fertility drugs have a higher likelihood of getting pregnant with more than one child at once. There are also rare but serious side effects to fertility drugs.

Normal results

Typically, at least half of all couples who are infertile will respond to treatment with a successful pregnancy. For those who cannot become pregnant with treatment or insemination, surrogate parenting or adopting may be a workable option.

KEY TERMS

Gamete—An egg (ovum) from the female or a mature sperm from the male.

Laparoscopy—A procedure in which a viewing tube is inserted through the abdominal wall to examine a woman's reproductive organs.

Ovulation—The release of an egg from the ovary. Fertilization can occur within a day or two of ovulation.

Zygote—A fertilized egg.

Resources

BOOKS

Berger, Gary S., et al. *The Couple's Guide to Infertility.* New York: Doubleday, 1994.

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Cunningham, F. Gary, Paul C. Macdonald, et al. *Williams Obstetrics*. 20th ed. Stamford: Appleton & Lange, 1997.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1995.

ORGANIZATIONS

American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216. (205) 978-5000.

Resolve. 1310 Broadway, Somerville, MA 02144-1731. (617) 623-0744. <http://www.resolve.org>.

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Influenza

Definition

Usually referred to as the flu or grippe, influenza is a highly infectious respiratory disease. The disease is caused by certain strains of the influenza virus. When the virus is inhaled, it attacks cells in the upper respiratory tract, causing such typical flu symptoms as **fatigue**, **fever** and chills, a hacking **cough**, and body aches. Influenza victims are also susceptible to potentially life-threatening secondary infections. Although the stomach or intestinal "flu" is commonly blamed for stomach upsets and **diarrhea**, the influenza virus rarely causes gastrointestinal symptoms. Such symptoms are most

likely due to other organisms such as rotavirus, *Salmonella*, *Shigella*, or ***Escherichia coli***.

Description

The flu is considerably more debilitating than the **common cold**. Influenza outbreaks occur suddenly, and infection spreads rapidly. The annual **death** toll attributable to influenza and its complications averages 20,000 in the United States alone. In the 1918–1919 Spanish flu pandemic, the death toll reached a staggering 20–40 million worldwide. Approximately 500,000 of these fatalities occurred in America.

Influenza outbreaks occur on a regular basis. The most serious outbreaks are pandemics, which affect millions of people worldwide and last for several months. The 1918-1919 influenza outbreak serves as the primary example of an influenza pandemic. Pandemics also occurred in 1957 and 1968 with the Asian flu and Hong Kong flu, respectively. The Asian flu was responsible for 70,000 deaths in the United States, while the Hong Kong flu killed 34,000.

Epidemics are widespread regional outbreaks that occur every two to three years and affect 5–10% of the population. The Russian flu in the winter of 1977 is an example of an epidemic. A regional epidemic is shorter lived than a pandemic, lasting only several weeks. Finally, there are smaller outbreaks each winter that are confined to specific locales.

The earliest existing descriptions of influenza were written nearly 2,500 years ago by the ancient Greek physician Hippocrates. Historically, influenza was ascribed to a number of different agents, including "bad air" and several different bacteria. It was not until 1933 that the causative agent was identified as a virus.

There are three types of influenza viruses, identified as A, B, and C. Influenza A can infect a range of species, including humans, pigs, horses, and birds, but only humans are infected by types B and C. Influenza A is responsible for most flu cases, while infection with types B and C virus are less common and cause a milder illness.

Causes and symptoms

Approximately one to four days after infection with the influenza virus, the victim is hit with an array of symptoms. "Hit" is an appropriate term, because symptoms are sudden, harsh, and unmistakable. Typical influenza symptoms include the abrupt onset of a **headache**, dry cough, and chills, rapidly followed by overall achiness and a fever that may run as high as 104°F (40°C). As the fever subsides, nasal congestion and a **sore throat** become noticeable. Flu victims feel extremely tired and weak and may not return to their normal energy levels for several days or even a couple of weeks.

Influenza complications usually arise from bacterial infections of the lower respiratory tract. Signs of a secondary respiratory infection often appear just as the victim seems to be recovering. These signs include high fever, intense chills, chest pains associated with breathing, and a productive cough with thick yellowish green sputum. If these symptoms appear, medical treatment is necessary. Other secondary infections, such as sinus or ear infections, may also require medical intervention. Heart and lung problems, and other chronic diseases, can be aggravated by influenza, which is a particular concern with elderly patients.

With children and teenagers, it is advisable to be alert for symptoms of **Reye's syndrome**, a rare but serious complication. Symptoms of Reye's syndrome are **nausea and vomiting**, and more seriously, such neurological problems as confusion or **delirium**. The syndrome has been associated with the use of **aspirin** to relieve flu symptoms.

Diagnosis

Although there are specific tests to identify the flu virus strain from respiratory samples, doctors typically rely on a set of symptoms and the presence of influenza in the community for diagnosis. Specific tests are useful to determine the type of flu in the community, but they do little for individual treatment. Doctors may administer tests, such as throat cultures, to identify secondary infections.

Treatment

Essentially, a bout of influenza must be allowed to run its course. Symptoms can be relieved with bed rest and by keeping well hydrated. A steam vaporizer may make breathing easier, and **pain** relievers will take care of the aches and pain. Food may not seem very appetizing, but an effort should be made to consume nourishing food. Recovery should not be pushed too rapidly. Returning to normal activities too quickly invites a possible relapse or complications.

Drugs

Since influenza is a viral infection, **antibiotics** are useless in treating it. However, antibiotics are frequently used to treat secondary infections.

Over-the-counter medications are used to treat flu symptoms, but it is not necessary to purchase a medication marketed specifically for flu symptoms. Any medication that is designed to relieve symptoms, such as pain and

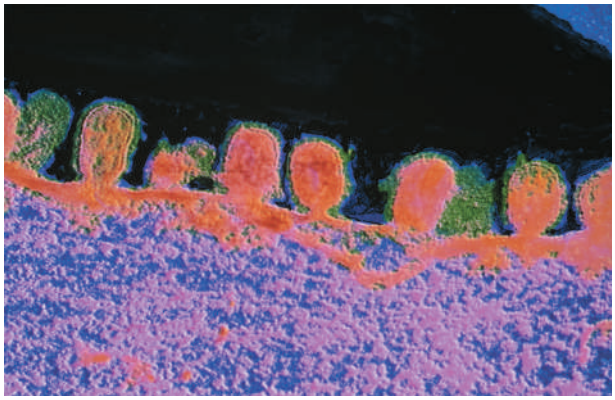
coughing, will provide some relief. Medications containing alcohol, however, should be avoided because of the dehydrating effects of alcohol. The best medicine for symptoms is simply an analgesic, such as aspirin, **acetaminophen**, or naproxen. Without a doctor's approval, aspirin is generally not recommended for people under 18 owing to its association with Reye's syndrome, a rare aspirin-associated complication seen in children recovering from the flu. To be on the safe side, children should receive acetaminophen or ibuprofen to treat their symptoms.

There are two **antiviral drugs** marketed for use in the United States. These may be useful in treating individuals who have weakened immune systems or who are at risk for developing serious complications of influenza but may be allergic to the flu vaccine. The first is amantadine hydrochloride, which is marketed under the names Symmetrel (syrup), Symadine (capsule) and Amantadine-hydrochloride (capsule and syrup). The second antiviral is rimantadine hydrochloride, trade name Flumandine (tablet and syrup). These two drugs are chemically related and are effective only against type A influenza viruses. Both drugs can cause such side effects as nervousness, **anxiety**, lightheadedness, and nausea, with side effects more likely to occur with amantadine. Severe side effects include seizures, delirium, and hallucination, but are rare and are nearly always limited to people who have kidney problems, seizure disorders, or psychiatric disorders.

Alternative treatment

There are several alternative treatments that may help in fighting off the virus and recovering from the flu, in addition to easing flu symptoms.

- **Acupuncture** and **acupressure**. Both are said to stimulate natural resistance, relieve nasal congestion and headaches, fight fever, and calm coughs, depending on the acupuncture and acupressure points used.
- Aromatherapy. Aromatherapists recommend gargling daily with one drop each of the essential oils of tea tree (*Melaleuca* spp.) and lemon mixed in a glass of warm water. If already suffering from the flu, two drops of tea tree oil in a hot bath may help ease the symptoms. Essential oils of eucalyptus (*Eucalyptus globulus*) or peppermint (*Mentha piperita*) added to a steam vaporizer may help clear chest and nasal congestion.
- Herbal remedies. Herbal remedies can be used stimulate the immune system (**echinacea**), as antivirals (*Hydrastis canadensis*) goldenseal and garlic (*Allium sativum*), or directed at whatever symptoms arise as a result of the flu. For example, an infusion of boneset (*Eupatroium perfoliatum*) may counteract aches and fever, and yarrow (*Achillea millefolium*) or elderflower tinctures may combat chills.
- Homeopathy. To prevent flu, a homeopathic remedy called *Oscillococcinum* may be taken at the first sign of flu symptoms and repeated for a day or two. Other homeopathic remedies recommended vary according to the specific flu symptoms present. *Gelsemium* (*Gelsemium sempervirens*) is recommended to combat weakness accompanied by chills, a headache, and nasal congestion. *Bryonia* (*Bryonia alba*) may be used to treat muscle aches, headaches, and a dry cough. For restlessness, chills, hoarseness, and achy joints, poison ivy (*Rhus toxicodendron*) is recommended. Finally, for achiness and a dry cough or chills, *Eupatorium perfoliatum* is suggested.
- Hydrotherapy. A bath to induce a fever will speed recovery from the flu by creating an environment in the body in which the flu virus cannot survive. The patient should take a bath as hot as he/she can tolerate and remain in the bath for 20–30 minutes. While in the bath, the patient drinks a cup of yarrow or elderflower tea to induce sweating. During the bath, a cold cloth is held on the forehead or at the nape of the neck to keep the temperature down in the brain. The patient is assisted when getting out of the bath (he/she may feel weak or dizzy) and then gets into bed and covers up with layers of blankets to induce more sweating.
- Vitamins. For adults, 2–3 grams of vitamin C daily may help prevent the flu. Increasing the dose to 5–7 grams per day during the flu can help fight the infection. (The dose should be reduced if diarrhea develops.)



A transmission electron microscopy (TEM) image of influenza viruses budding from the surface of an infected cell. *(Photo Researchers, Inc. Reproduced by permission.)*

Prognosis

Following proper treatment guidelines, healthy people under the age of 65 usually suffer no long-term con-

KEY TERMS

Common cold—A mild illness caused by upper respiratory viruses. Usual symptoms include nasal congestion, coughing, sneezing, throat irritation, and a low-grade fever.

Epidemic—A widespread regional disease outbreak.

Guillain-Barré syndrome—Also called acute idiopathic polyneuritis, this condition is a neurologic syndrome that can cause numbness in the limbs and muscle weakness following certain viral infections.

Pandemic—Worldwide outbreak of an infection, afflicting millions of victims.

sequences associated with flu infection. The elderly and the chronically ill are at greater risk for secondary infection and other complications, but they can also enjoy a complete recovery.

Most people recover fully from an influenza infection, but it should not be viewed complacently. Influenza is a serious disease, and approximately 1 in 1,000 cases proves fatal.

Prevention

The Centers for Disease Control and Prevention recommend that people get an influenza vaccine injection each year before flu season starts. In the United States, flu season typically runs from late December to early March. Vaccines should be received two to six weeks prior to the onset of flu season to allow the body enough time to establish immunity. Adults need only one dose of the yearly vaccine, but children under nine years of age who have not previously been immunized should receive two doses, with a month between each dose.

Each season's flu vaccine contains three virus strains that are the most likely to be encountered in the coming flu season. When there is a good match between the anticipated flu strains and the strains used in the vaccine, the vaccine is 70–90% effective in people under 65. Because immune response diminishes somewhat with age, people over 65 may not receive the same level of protection from the vaccine, but even if they do contract the flu, the vaccine diminishes the severity and helps prevent complications.

The virus strains used to make the vaccine are inactivated and will not cause the flu. In the past, flu symptoms were associated with vaccine preparations that were not as highly purified as modern vaccines, not to the virus itself. In 1976, there was a slightly increased risk of developing **Guillain-Barré syndrome**, a very rare disorder, associated with the swine flu vaccine. This association occurred only with the 1976 swine flu vaccine preparation and has never recurred.

Serious side effects with modern vaccines are extremely unusual. Some people experience a slight soreness at the point of injection, which resolves within a day or two. People who have never been exposed to influenza, particularly children, may experience one to two days of a slight fever, tiredness, and muscle aches. These symptoms start within six to 12 hours after the **vaccination**.

It should be noted that certain people should not receive influenza vaccine. Infants six months and younger have immature immune systems and will not benefit from the vaccine. Since the vaccines are prepared using hen eggs, people who have severe **allergies** to eggs or other vaccine components should not receive the influenza vaccine. As an alternative, they may receive a course of amantadine or rimantadine, which are also used as a protective measure against influenza. Other people who might receive these drugs are those that have been immunized after the flu season has started or who are immunocompromised, such as people with advanced HIV disease. Amantadine and rimantadine are 70-90% effective in preventing influenza.

Certain groups are strongly advised to be vaccinated because they are at risk for influenza-related complications:

- all people 65 years and older
- residents of nursing homes and chronic-care facilities, regardless of age
- adults and children who have chronic heart or lung problems, such as **asthma**
- adults and children who have such chronic metabolic diseases as diabetes and renal dysfunction, as well as severe anemia or inherited hemoglobin disorders
- children and teenagers who are on long-term aspirin therapy
- women who will be in their second or third trimester of pregnancy during flu season or women who are nursing
- anyone who is immunocompromised, including HIV-infected persons; **cancer** patients; organ transplant recipients; and patients receiving steroids, **chemotherapy**, or **radiation therapy**
- anyone in contact with the above groups, such as teachers, care givers, health care personnel, and family members
- travelers to foreign countries

An individual need not be in one of the at-risk categories listed above, however, to receive a flu vaccination. Anyone who wants to forego the discomfort and inconvenience of an influenza attack may receive the vaccine.

Resources

BOOKS

Levine, Arthur J. "The Influenza A Virus." In *Viruses*. New York: Scientific American Library, 1992.

PERIODICALS

Centers for Disease Control and Prevention. "Prevention and Control of Influenza: Recommendations of the Advisory Committee on Immunization Practices (ACIP)." *Morbidity and Mortality Weekly Report*, 46, no. 15 (25 Apr. 1997).

Novitt-Moren, Anne. "Holidays' Biggest Spoilers: Colds and Flu." *Current Health 2* 4, no. 24 (Dec. 1997): 6.

Saul, Helen. "Flu Vaccines Wanted: Dead or Alive." *New Scientist* (18 Feb. 1995): 26.

Zimmerman, Richard K., Frederick L. Ruben, and Ellen R. Ahwesh. "Influenza, Influenza Vaccine, and Amantadine/Rimantadine." *Journal of Family Practice* 45, no. 2 (Aug. 1997): 107.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Julia Barrett

Infrequent menstruation *see* **Oligomenorrhea**

Inhalation therapies

Definition

Inhalation therapies are a group of respiratory, or breathing, treatments designed to help restore or improve breathing function in patients with a variety of diseases, conditions, or injuries. The treatments range from at-home oxygen therapy for patients with chronic obstructive pulmonary disease to mechanical ventilation for patients with acute **respiratory failure**. Inhalation therapies usually include the following categories:

- oxygen therapy
- incentive spirometry
- continuous positive airway pressure (CPAP)
- oxygen chamber therapy
- mechanical ventilation
- newborn **life support**

Purpose

Inhalation therapies are ordered for various stages of diseases that are causing progressive or sudden respiratory failure. Although physicians generally follow guidelines to assign specific therapy according the type and stage of a disease, the ultimate decision is based on a number of tests indicating pulmonary function and the presence or absence of oxygen in body organs and tissues.

Oxygen therapy

Oxygen therapy is most commonly ordered to support patients with **emphysema** and other chronic obstructive pulmonary diseases (COPD). The oxygen therapy is usually ordered once decreased oxygen saturation in the blood or tissues is demonstrated. Oxygen therapy may also be used in the hospital setting to help return a patient's breathing and oxygen levels to normal.

Incentive spirometry

Spirometry is a diagnostic method for measuring gases and respiratory function. Incentive spirometry may be ordered to help patients practice and improve controlled breathing. It may be ordered after surgery to the abdomen, lungs, neck, or head.

Continuous positive airway pressure (CPAP)

Common uses of continuous positive airway pressure include **sleep apnea**, **respiratory distress syndrome** in infants, and **adult respiratory distress syndrome**. Signs of **atelectasis** (absence of gas from the lungs) or abnormalities of the lower airways may also indicate CPAP.

Oxygen chamber therapy

Oxygen chamber therapy is ordered for various causes that indicate immediate need for oxygen saturation in the blood. Divers with decompression illness, climbers at high altitude, patients suffering from severe carbon dioxide **poisoning**, and children or adults in acute respiratory distress may require oxygen chamber therapy. In recent years, physicians have also used the forced pressure of oxygen chambers to help heal **burns** and other **wounds**, since the pressure under which the oxygen is delivered can reach areas that are blocked off or suffering from poor circulation.

Mechanical ventilation

Mechanical ventilation is ordered for patients in acute respiratory distress, and is often used in an intensive care situation. In some cases, mechanical ventilation is a final attempt to continue the breathing function in a patient and may be considered "life-sustaining."

Newborn life support

Newborn babies, particularly those who were premature, may require inhalation therapies immediately upon birth, since the lungs are among the last organs to fully develop. Some newborns suffer from serious respiratory problems or birth complications, such as respiratory distress syndrome, neonatal wet lung syndrome, apnea of **prematurity** or persistent fetal circulation, which may require inhalation therapies.

Precautions

There are numerous indications for not prescribing various inhalation therapies.

Oxygen therapy

Patients and family members who smoke should not have oxygen prescribed or should avoid **smoking** in the area to prevent combustion. Sedatives should be avoided for patients on oxygen therapy.

Incentive spirometry

Patients who are unable or unwilling to properly and consistently practice incentive spirometry as prescribed should not receive this form of treatment.

Continuous positive airway pressure (CPAP)

Patients unable or unwilling to comply with the physician's instructions for use of CPAP are not likely to have it prescribed. Extremely obese patients may have less success with this form of therapy for the treatment of sleep apnea.

Oxygen chamber therapy

Complications may arise from this form of treatment and during transport to or from the oxygen chamber. Therefore, some patients may not receive enough benefit to outweigh possible complications. All patients, particularly children, must be carefully monitored.

Mechanical ventilation

Use of mechanical ventilation will be carefully weighed against benefit and possible risks. Some patients will require **sedation** to prevent fighting off the ventilator, which can increase the risk of complications.

Newborn life support

Not all infants with breathing problems will require measures as severe as mechanical ventilation. The physician will make the determination based on weight and condition of the infant. Newborns with patent ductus arteriosis, a handicap affecting the pulmonary artery, are more likely to suffer pulmonary hemorrhage from mechanical ventilation.

Description

Oxygen therapy

Once a patient shows hypoxemia, or decreased oxygen in arterial blood, supplemental oxygen may be ordered. The main purpose of the oxygen is to prevent damage to vital organs resulting from inadequate oxygen supply. The lowest possible saturation will be given to keep the patient's measurements at a minimum acceptable level. The oxygen is administered through a mask or nasal tube, or sometimes directly into the trachea. The amount of oxygen prescribed is measured in liters of flow per minute. Patients with chronic hypoxemia, most likely in late stages of COPD, will often receive long-term oxygen therapy.

Most patients will receive their long-term oxygen therapy through home oxygen use. A physician must prescribe home oxygen and levels will be monitored to ensure that the correct amount of oxygen is administered. Some patients will receive oxygen therapy only at night or when exercising.

The choice of type of home oxygen systems will vary depending on availability, cost considerations, and the mobility of the patient. Those patients who are ambulatory, especially those who work, will need a system with a small portable tank. Depending on the system chosen, frequent deliveries of oxygen and filling of portable tanks will be necessary.

In the case of respiratory distress in newborns or adults, oxygen therapy may be attempted before mechanical ventilation since it is a noninvasive and less expensive choice. Oxygen has been found effective in treating patients with such other diseases as **cystic fibrosis**, chronic congestive **heart failure**, or other lung diseases.

Incentive spirometry

Incentive spirometry is also referred to as sustained maximal inspiration. It is designed to mimic natural sighs and yawns. A device provides positive feedback when a patient inhales at a predetermined rate and sustains the breath for a specific period of time. This helps teach the patient to take long, slow, and deep breaths. A spirometer, or equipment that measures pulmonary function, is provided to the patient and a respiratory therapist will work with the patient; to demonstrate and explain the technique. Once patients show mastery of the technique, they are instructed to practice the exercises frequently on their own.

Continuous positive airway pressure (CPAP)

Patients with sleep apnea will receive continuous positive airway pressure to prevent upper airway collapse. It is usually administered through a tight-fitting mask as humidified oxygen. The pressure of flow is constant during both exhaling and inhaling and the level of pressure is determined based on each individual. Most patients undergoing CPAP in a hospital setting will receive continuous monitoring of some vital signs and periodic sampling of blood gas values.

Oxygen chamber therapy

Also known as hyperbaric oxygen chamber or hyperbaric oxygen therapy (HBO), this treatment delivers pure oxygen under pressure equal to that of two to three times normal atmospheric pressure. For years, this treatment has been especially effective on scuba divers who suffer from the "bends," or decompression illness. The patient enters the chamber, a plastic cylinder-shaped structure that is normally transparent. In most cases, just one patient will enter by being rolled into the chamber on a type of stretcher. Once inside, the oxygen will be delivered under forced pressure and the patient is free to read, nap, or listen to the radio. The therapy usually lasts one hour, although it can take up to five hours in serious decompression cases. Before exiting the chamber, the pressure will eventually be lowered to normal atmospheric level.

Mechanical ventilation

In general, mechanical ventilation replaces or supports the normal ventilatory lung function of a patient. Although normally delivered in a hospital, often to treat serious illness, mechanical ventilation may be performed at home under the order and supervision of a physician and home health agency. The patient will usually be intubated and the ventilator machine "takes over" the breathing function.

There are several modes and methods of mechanical ventilation, each offering different advantages and disadvantages. In assist/control ventilation, the oldest mode of ventilation, the physician predetermines settings and the ventilator delivers a breath each time the patient makes an effort to inhale. In synchronized intermittent mandatory ventilation, the machine senses a patient's effort to inhale and delivers the preset amount. The amount cannot be increased by the patient's effort. Pressure-control ventilation involves the physician's selection of a peak pressure; this method is most useful for patients suffering from obstructive airways disease. In cases of severe hypoventilation, an endotracheal tube must be inserted. If a patient will be on mechanical ventilation for more than two weeks, a tracheostomy, or surgical incision, will be performed for placement of the breathing tubes.

There are other modes of ventilation that may be used, including high-frequency ventilation, a newer technique that delivers 100 to 200 breaths per minute to the patient. The breaths are delivered through a humidified, high-pressure gas jet. High-frequency ventilation may be ordered when a patient does not respond to conventional mechanical ventilation or for certain conditions and circumstances.

Newborn life support

Premature infants, especially those born before the 28th week of gestation, have underdeveloped breathing muscles and immature structures within the lungs. These infants will require breathing support, often in the form of mechanical ventilation. The support delivers warm, humidified, oxygen-enriched gases either by oxygen hood or through mechanical ventilation. In serious cases, the infant may require mechanical ventilation with CPAP or positive-end expiratory pressure (PEEP) through a tightly fitting face mask or even by endotracheal intubation.

Need for continued resuscitation for newborns depends not only on gestational age, but on signs indicating ineffective breathing—including color, heart rate, and respiratory effort. CPAP will be delivered through nasal or endotracheal tubes with a continuous-flow ventilator specifically designed for infants. An alarm system alerts the neonatal staff to problems and monitoring of breathing and other vital functions will accompany the therapy. As respiratory distress syndrome begins to resolve, usually in four or five days, the type of support will be reduced accordingly and the infant may be weaned from the ventilator and moved to only CPAP or an oxygen hood.

Preparation

Preparation for any of these treatments is normally not necessary; and in fact, these therapies may be administered as a result of an emergency situation. Some of the methods, particularly incentive spirometry, or at-home oxygen or ventilation, will require education and cooperation with a home health agency or respiratory therapist. Pretreatment testing of various indicators of respiratory function and oxygen saturation will be performed to determine exact needs of individual patients.

Aftercare

Pulmonary function tests and other tests will be performed to verify that treatments have been successful or to monitor and adjust treatments. Mechanical ventilation will require weaning from the equipment and may also require care for the area surrounding the intubation.

Risks

Inhalation therapies may carry risks, complications or side effects including:

KEY TERMS

Aspiration—Accidental suction of fluids or vomit into the respiratory system.

Cannula—A tube inserted into a cavity to serve as a channel for the transport of fluid.

Endotracheal—Placed within the trachea.

Hypoventilation—Reduced ventilation in the lungs' air sacs resulting in above normal carbon dioxide pressure.

Hypoxemia—A condition in which there is deficient oxygen supply in the blood.

Hypoxia—Low levels of oxygen in blood, tissue, or air.

Intubation—Placement of a tube into a hollow organ (such as the trachea).

Pneumothorax—Presence of gas or air in the hollow space around the lungs.

Trachea—The windpipe, or main by which air passes to and from the lungs.

Oxygen therapy

At-home oxygen therapy carries risk if care is not taken to follow instructions when handling the oxygen. Patients are cautioned not to smoke near the oxygen supply and to keep the supply away from other sources that may cause electrical spark, flames, or intense heat. Patients on home oxygen therapy should avoid use of sedatives.

Incentive spirometry

The major risk associated with incentive spirometry relates to improper use. Patients must be carefully instructed in the technique and monitored periodically for compliance and improvement. Barotrauma, injury to the middle ear or sinuses caused by imbalance between the affected cavity and the outside, or ambient pressure, can result from incentive spirometry. A patient may also suffer discomfort or **fatigue**.

Continuous positive airway pressure (CPAP)

The effectiveness of CPAP may be limited if patients do not cooperate. Possible side effects of CPAP include skin abrasions from the mask, leakage from the tube or mask, nasal congestion, nasal or oral dryness, or discomfort from the pressure of delivery.

Oxygen chamber therapy

Hyperbaric oxygen therapy is painless. The only risk would be associated with improper administration of the pressure levels, which should not occur, since respiratory staff and the supervising physician should be thoroughly trained in performance of this therapy. The drawback to hyperbaric oxygen treatment is the limited availability of chambers. Many cities do not have readily available chambers.

Mechanical ventilation

The biggest risk of mechanical ventilation is sometimes considered to be a patient's dependence on the machine and the difficulty of weaning the patient. The physician will carefully select and monitor the mode of ventilation, the machine's settings, and the patient's progress to prevent this complication. A patient may therefore be left on a ventilator after sufficient progress is made to gradually wean breathing dependence.

Intubation and mechanical ventilation are frightening and uncomfortable for many patients and they may fight the ventilator. If this occurs, the physician may order a sedative to ensure cooperation and effectiveness of the therapy. Intubation often results in irritation to the trachea and larynx. Tracheostomy is associated with risk of bleeding, **pneumothorax**, local infection, and increased incidence of aspiration.

Newborn life support

Infants are continuously monitored to determine even small changes in breathing function. Mechanical ventilation can result in increases in respiratory distress or other complications. It is possible for the ventilator to be accidentally disconnected and staff is trained to watch for signs or alarms indicating disconnection. Mechanical ventilation increases risk of infection in premature babies. Complications of PEEP or CPAP may include pneumothorax or decreased cardiac output.

Normal results

Oxygen therapy

In the case of COPD, oxygen therapy does not treat the disease but can prolong life, quality of life, and onset of more serious symptoms. Effective oxygen therapy for any patient should lead to improved or sustained levels of oxygen in arterial blood.

Incentive spirometry

With proper use of incentive spirometry, the physician should observe improved pulse rate, decreased res-

piratory rate, improved respiratory muscle performance, and other indicators of improved function. Lung function following lung resection should show marked improvement following incentive spirometry.

Continuous positive airway pressure

Successful CPAP will result in reduction in apnea for those suffering from sleep apnea. A study completed in 1998 demonstrated that CPAP was effective in the majority of patients with sleep apnea, with the exception of significantly obese patients with blood gas values that were worse during waking hours at rest and at **exercise**. Hospitalized patients on CPAP therapy should show improvement in blood gas and other pulmonary measurements as expected by the treating physician.

Oxygen chamber therapy

Divers undergoing emergency treatment in a hyperbaric chamber should show immediate improvement in oxygen levels throughout the body, regardless of blood flow restrictions, after one or two treatments. Those patients receiving oxygen chamber therapy for difficult wounds may continue to receive treatments daily for several weeks before satisfactory results are reached. Patients with carbon dioxide poisoning should show improvement in or recovery of neurologic function. Results of hyperbaric chamber therapy depend largely on how quickly the patient was brought to the chamber, as well as the severity of the initial condition.

Mechanical ventilation

Successful mechanical ventilation will result in gradual decrease in dependence on the ventilator and weaning from the machine. Reduction of therapy to another form, such as CPAP or oxygen therapy, indicates that ventilation has worked as expected. In the case of COPD, exacerbation may be successfully treated with mechanical ventilation and the patient may return to home oxygen therapy. Pediatric patients will demonstrate normal growth and development as a normal result of long-term mechanical ventilation at home. Some patients, particularly those in a hospital intensive care unit, will not be able to breathe again without the ventilator; and families and physicians will face tough choices about continued life support.

Newborn life support

Neonates will be constantly monitored to measure lung function. Those measurements will help caregivers determine if and when mechanical ventilation can be reduced and CPAP or oxygen mask begun. CPAP is considered successful when the infant's respiratory rate is reduced by 30–40%, a chest radiograph shows improved lung volume and appearance, stabilization of oxygen levels is documented and caregivers observe improvement in the infant's comfort. Evidence that there is no infection from ventilation is also considered normal. In some cases, inhalation therapy, including mechanical ventilation, will not work and the infant's parents and physicians will face tough decisions about invasive procedures with associated high risks or cessation of life support.

Resources

ORGANIZATIONS

American Association for Respiratory Care. 11030 Ables Lane, Dallas, TX 75229. (972) 243-2272., Fax (972) 484-2720.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

OTHER

Hyperbaric Research and Treatment Center Page. <http://www.hyperbaricrx.com>.

Teresa Norris, RN

Inner ear infection *see* **Labyrinthitis**

Insecticide poisoning

Definition

Insecticide **poisoning** is exposure to a group of chemicals designed to eradicate insects that cause affected persons to develop clinical signs that can progress to **death**.

Description

Insecticides belong to a group of chemicals called organophosphates, used to protect against insects. Their use is popular since they are effective and do not remain in the environment, disintegrating within a few days. Organophosphates act to inhibit an enzyme in humans called acetyl cholinesterase. This enzyme functions to degrade a chemical called acetylcholine, which excites nerve cells. The resultant effect of organophosphates would be an increase in acetylcholine, thus causing initial excitation of nerve cells.

Poisoning can occur with a broad range of symptoms affecting the functioning of nerves and initial symptoms similar to the flu, such as vomiting, abdominal **pain**, **dizziness**, and **headache**. Common names for

insecticides include dichlorvos, chlorpyrifos, diazinon, fenthion, malathion, parathion, and carbamate. A special type of insecticide called paraquat is very lethal and responsible for approximately 1,000 deaths per year just in Japan. Paraquat poisoning releases oxygen free radicals that destroy lung and kidney tissues. When poisoning is suspected, a comprehensive management and assessment plan should be performed. This initial assessment should include:

- description of toxins: names of chemical(s)
- magnitude of exposure: determination of amount of exposure
- progression of symptoms: determining the progression of symptoms can provide information concerning **life support** and overall outcome
- time of exposure: knowing the time of exposure is vital since symptoms may be delayed, and it may assist to develop a management plan
- medical history: underlying diseases and therapeutic mediations may worsen toxic manifestations

Causes and symptoms

Exposure to insecticides can occur by ingestion, inhalation, or exposure to skin or eyes. The chemicals are absorbed through the skin, lungs, and gastrointestinal tract and then widely distributed in tissues. Symptoms cover a broad spectrum and affect several organ systems:

- gastrointestinal: nausea, vomiting, cramps, excess salivation, and loss of bowel control
- lungs: increases in bronchial mucous secretions, coughing, **wheezing**, difficulty breathing, and water collection in the lungs (this can progress to breathing cessation)
- skin: sweating
- eyes: blurred vision, smaller sized pupil, and increased tearing
- heart: slowed heart rate, block of the electrical conduction responsible for heartbeat, and lowered blood pressure
- urinary system: urinary frequency and lack of control
- central nervous system: convulsions, confusion, **paralysis**, and **coma**

Diagnosis

The confirmatory diagnosis for insecticide poisoning is a measurement of blood acetyl cholinesterase less than 50% of normal. The chemicals can also be detected by specific urine testing. Signs and symptoms in addition to a comprehensive poisoning assessment are essential for diagnosis. Carbamate insecticide poisoning exhibits symptoms similar to organophosphate poisoning but without central nervous system signs.

KEY TERMS

Acetylcholine— A chemical called a neurotransmitter that functions to excite nerve cells.

Acetylcholinesterase— An enzyme that breaks down acetylcholine.

Central nervous system— Consists of the brain and spinal cord and integrates and processes information.

Enzyme— A protein that speeds up a chemical reaction, but is not consumed during the process.

Oxygen free radicals— Reactive molecules containing oxygen that can cause cell damage.

Treatment

Decontaminate exposed clothing and wash with soap and water immediately. Emergency measures may focus on ventilator support and heart monitoring. If inhalation is suspected, the patient should be removed from the site of exposure. If the eyes were the entry site, they should be flushed with large amounts of water. If the chemicals were ingested, the stomach may be washed out and activated charcoal may be administered. Atropine or glycopyrrolate (Robinul) is the drug of choice for carbamate insecticide poisoning. It reverses many symptoms, but is only partially effective for such central nervous symptom effects as coma and convulsions. A medication called pralidoxime is also commonly indicated to reactivate acetylcholinesterase and to reverse typical symptoms due to organophosphate poisoning. Additionally, the patient is monitored for heart, lung, liver functioning, specific blood tests, and oxygen levels in blood.

Prognosis

Prognosis depends on the specific chemical of exposure, magnitude and time of exposure, progression of symptoms (severity), and time of onset for medical attention.

Prevention

Adherence to accepted guidelines for handling and management is the key to preventing insecticide poisoning. These may include masks, gowns, gloves, gog-

gles, respiratory breathing machines, or hazardous material suits.

Resources

BOOKS

Behrman, Richard E., et al, eds. *Nelson Textbook.* 16th ed. Philadelphia: W. B. Saunders Company, 2000.
Goldman, Lee, et al. *Cecil's Textbook of Medicine.* 21st ed. Philadelphia: W. B. Saunders Company, 2000.
Rakel, Robert E., et al. *Conn's Current Therapy.* 53rd ed. Philadelphia: W. B. Saunders Company, 2001.

PERIODICALS

Blain, P. G. "Effects of Insecticides." *Lancet* 357 (5 May 2001).
Senanayake, N. "Organophosphorus Insecticide Poisoning." *Ceylon Medical Journal* 43 (March 1998).

OTHER

Material Safety Data Sheets. <http://oshweb.me.tut.fi>.
National Toxicology Program. <http://ntp-server.niehs.nih.gov/main_Pages/NTP_ALL_STDY_PG.html>.

Laith Farid Gulli, M.D.

Insomnia

Definition

Insomnia is the inability to obtain an adequate amount or quality of sleep. The difficulty can be in falling asleep, remaining asleep, or both. People with insomnia do not feel refreshed when they wake up. Insomnia is a common symptom affecting millions of people that may be caused by many conditions, diseases, or circumstances.

Description

Sleep is essential for mental and physical restoration. It is a cycle with two separate states: rapid eye movement (REM), the stage in which most dreaming occurs; and non-REM (NREM). Four stages of sleep take place during NREM: stage I, when the person passes from relaxed wakefulness; stage II, an early stage of light sleep; stages III and IV, which are increasing degrees of deep sleep. Most stage IV sleep (also called delta sleep), occurs in the first several hours of sleep. A period of REM sleep normally follows a period of NREM sleep.

Insomnia is more common in women and older adults. People who are divorced, widowed, or separated are more likely to have the problem than those who are married, and it is more frequently reported by those of lower socioeconomic status. Short-term, or transient, insomnia is a common occurrence and usually lasts only a few days. Long-term, or chronic, insomnia lasts more than three weeks and increases the risk for injuries in the home, at the workplace, and while driving because of daytime sleepiness and decreased concentration. Chronic insomnia can also lead to **mood disorders** like depression.

Causes and symptoms

Transient insomnia is often caused by a temporary situation in a person's life, such as an argument with a loved one, a brief medical illness, or **jet lag**. When the situation is resolved or the precipitating factor disappears, the condition goes away, usually without medical treatment.

Chronic insomnia usually has different causes, and there may be more than one. These include:

- a medical condition or its treatment, including **sleep apnea**
- use of substances such as **caffeine**, alcohol, and nicotine
- psychiatric conditions such as mood or **anxiety disorders**
- **stress**, such as sadness caused by the loss of a loved one or a job
- disturbed sleep cycles caused by a change in work shift
- sleep-disordered breathing, such as **snoring**
- periodic jerky leg movements (*nocturnal myoclonus*), which happen just as the individual is falling asleep
- repeated nightmares or panic attacks during sleep

Another cause is excessive worrying about whether or not a person will be able to go to sleep, which creates so much **anxiety** that the individual's bedtime rituals and behavior actually trigger insomnia. The more one worries about falling asleep, the harder it becomes. This is called psychophysiological insomnia.

Symptoms of insomnia

People who have insomnia do not start the day refreshed from a good night's sleep. They are tired. They may have difficulty falling asleep, and commonly lie in bed tossing and turning for hours. Or the individual may go to sleep without a problem but wakes in the early hours of the morning and is either unable to go back to sleep, or drifts into a restless unsatisfying sleep. This is a common symptom in the elderly and in those suffering from depression. Sometimes sleep patterns are reversed, and the individual has difficulty staying awake during the day and takes frequent naps. The sleep at night is fitful and frequently interrupted.

KEY TERMS

Biofeedback—A training technique that enables an individual to gain some element of control over involuntary body functions.

Mood disorder—A group of mental disorders involving a disturbance of mood, along with either a full or partial excessively happy (manic) or extremely sad (depressive) syndrome not caused by any other physical or mental disorder. Mood refers to a prolonged emotion.

Sleep apnea—A condition in which a person stops breathing while asleep. These periods can last up to a minute or more, and can occur many times each hour. In order to start breathing again, the person must become semi-awake. The episodes are not remembered, but the following day the client feels tired and sleepy. If severe, sleep apnea can cause other medical problems.

Sleep disorder—Any condition that interferes with sleep. At least 84 have been identified, according to the American Sleep Disorders Association.

Diagnosis

The diagnosis of insomnia is made by a physician based on the patient's reported signs and symptoms. It can be useful for the patient to keep a daily record for two weeks of sleep patterns, food intake, use of alcohol, medications, **exercise**, and any other information recommended by the physician. If the patient has a bed partner, information can be obtained about whether the patient snores or is restless during sleep. This, together with a medical history and **physical examination**, can help confirm the doctor's assessment.

A wide variety of health care professionals can recognize and treat insomnia, but when a patient with chronic insomnia does not respond to treatment, or the condition is not adequately explained by the patient's physical, emotional, or mental circumstances, then more extensive testing by a specialist in **sleep disorders** may be warranted.

Treatment

Treatment of insomnia includes alleviating any physical and emotional problems that are contributing to the condition, and exploring changes in lifestyle that will improve the situation.

Changes in behavior

Patients can make changes in their daily routine that are simple and effective in treating their insomnia. They should go to bed only when sleepy and use the bedroom only for sleep. Other activities like reading, watching television, or snacking should take place somewhere else. If they are unable to go to sleep, they should go into another room and do something that is relaxing, like reading. Watching television should be avoided because it has an arousing effect. The person should return to bed only when they feel sleepy. Patients should set the alarm and get up every morning at the same time, no matter how much they have slept, to establish a regular sleep-wake pattern. Naps during the day should be avoided, but if absolutely necessary, then a 30-minute nap early in the afternoon may not interfere with sleep at night.

Another successful technique is called sleep-restriction therapy, which restricts the amount of time spent in bed to the actual time spent sleeping. This approach allows a slight sleep debt to build up, which increases the individual's ability to fall asleep and stay asleep. If a patient is sleeping five hours a night, the time in bed is limited to 5-5 1/2 hours. The time in bed is gradually increased in small segments,with the individual rising at the same time each morning; at least 85% of the time in bed must be spent sleeping.

Drug therapy

Medications given for insomnia include sedatives, tranquilizers, and **antianxiety drugs**. All require a doctor's prescription and may become habit-forming. They can lose effectiveness over time and can reduce alertness during the day. The medications should be taken two to four times daily for approximately three to four weeks, though this will vary with the physician and patient. If the insomnia is related to depression, then an antidepressant medication may be helpful. Over-the-counter drugs such as **antihistamines** are not very effective in bringing about sleep, and can affect the quality of sleep.

Other measures

Relaxing before going to bed will help a person fall asleep faster. Learning to substitute pleasant thoughts for unpleasant ones (imagery training) is a technique that can be very helpful in reducing worry. Another effective measure is the use of audiotapes that combine the sounds of nature with soft relaxing music. These, alone or in combination with other relaxation techniques, can safely promote sleepiness.

Changes in diet and exercise routines can also have a beneficial effect. Dietary items to be avoided include drinks that contain

caffeine, such as coffee, tea and colas' chocolate (which contains a stimulant); and alcohol, which initially makes a person sleepy but a few hours later can have the opposite effect. Maintaining a comfortable bedroom temperature, reducing noise and eliminating light are also helpful. Regularly scheduled morning or afternoon exercise can relax the body. This should be done 3-4 times a week and be sufficient to produce a light sweat.

Alternative treatments

Many alternative treatments are effective in treating both the symptom of insomnia and its underlying causes. Incorporating relaxation techniques into bedtime rituals will help a person go to sleep faster, as well as improve the quality of sleep. These methods include **meditation**; massage; breathing exercises; and a warm bath, scented with rose, lavender (*Lavendula officinalis*), marjoram, or chamomile (*Matricaria recutita*). Eating a healthy diet rich in calcium, magnesium, and the B **vitamins** is also beneficial. A high-protein snack like yogurt before going to bed is recommended, or a cup of herb tea made with chamomile, hops (*Humulus lupulus*), passionflower (*Passiflora incarnata*), or St. John's-Wort (*Hypericum perforatum*) to encourage relaxation. **Acupuncture** and **biofeedback** have also proven useful.

Prevention

Prevention of insomnia centers around promotion of a healthy lifestyle. A balance of rest, recreation and exercise in combination with stress management, regular physical examinations, and a healthy diet can do much to reduce the risk.

Resources

BOOKS

Boyd, Mary Ann, and Mary Ann Nihart. *Psychiatric Nursing: Contemporary Practice*. Philadelphia: Lippincott, 1998.

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Fife, WA: Future Medicine Publishing, 1995.

Frisch, Noreen Cavan, and Lawrence E. Frisch. *Psychiatric Mental Health Nursing*. Albany, NY: Delmar, 1988.

ORGANIZATIONS

American Sleep Disorders Association. 1610 14th St. NW, Ste. 300, Rochester, MN 55901. (507) 287-6006. <http://www.asda.org>.

OTHER

"Patient Information: Insomnia and What You Can Do to Sleep Better." *American Family Physician* 49, no. 6 (May 1, 1994) <http://home.aafp.org/afp>.

"What to Do When You Can't Sleep." *The Virtual Hospital Page*. University of Iowa. <http://www.vh.org>.

Donald G. Barstow, RN

Insulin *see* **Antidiabetic drugs**

Intelligence tests *see* **Stanford-Binet intelligence scales; Wechsler intelligence test**

Intention tremor *see* **Tremors**

Interferon *see* **Antiviral drugs; Immunologic therapies**

Interleukin-2 *see* **Immunologic therapies**

Intermittent explosive disorder

Definition

Intermittent explosive disorder (IED) is a mental disturbance that is characterized by specific episodes of violent and aggressive behavior that may involve harm to others or destruction of property. Usually, these episodes follow minor incidents and are out of proportion to the trigger.

Description

The Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) decribes intermittent explosive disorder as one of several impulse-control disorders, including kleptomania (impulsive stealing), pathological gambling, and pyromania (setting fires). There must be several instances of failure to resist aggressive or violent behaviors that result in harm to others or destruction of property. Spurred by a minor incident, these acts are grossly out of proportion to the stressor. To meet the criteria for IED, these behaviors are not caused by another mental disorder (e.g. antisocial personality disorder, **bipolar disorder**, borderline personality disorder, or **attention-deficit/hyperactivity disorder**). These impulsive acts are not caused by substance abuse or medical condition (head trauma or **Alzheimer's disease**.

Many psychiatrists do not place intermittent explosive disorder into a separate clinical category but consider it a symptom of other psychiatric and mental disorders. Future acts of violence may escalate, despite how it is defined, and treatment is essential.

IED occurs more often in men. Women do experience it and have reported it as part of **premenstrual syndrome** (PMS).

Causes and symptoms

Causes

As with other impulse-control disorders, the cause of IED has not been determined.

KEY TERMS

Kleptomania—A mental disorder characterized by impulsive stealing.

Pyromania—A mental disorder characterized by setting fires.

Serotonin—A neurotransmitter or brain chemical that is responsible for transporting nerve impulses.

Symptoms

IED causes such violent behavior as physical assault, destruction of property, and homicide or violent suicide. Violent, destructive behaviors often begin in childhood and escalate in adult life.

Diagnosis

A thorough case history of behavior and medical problems is taken. A diagnosis is made by a psychiatrist or psychologist after interviews and psychological testing. Since IED is a behavioral illness, no medical tests have been able as yet to find an organic cause. Treatment options with certain drugs may point to a relationship with bipolar disorder and serotonin (a brain chemical) conditions.

Treatment

Treatment for IED usually involves psychotherapy of some type, drugs, or **biofeedback**. Usually, a regime of therapy (behavior modification, among others) and drugs is most common. Good success has occurred with mood stabilizers and antidepressants like selective serotonin reuptake inhibitors (SSRIs) and tricyclic antidepressants. Among these drugs are Prozac, Zoloft, Neurontin, and Dilantin.

Prognosis

The outlook for IED is good with proper diagnosis, medications, and therapy. Still, more research is needed to determine the mechanisms involved in this disorder.

Prevention

There is no know way to prevent this disorder and no clinical way to diagnose it until behaviors appear.

Resources

PERIODICALS

McElroy, Susan L. "Recognition and Treatment of DSM-IV Intermittent Explosive Disorder." *Journal of Clinical Psychiatry* (1999): 12-16.

OTHER

"DSM-IV Axis I Diagnosis." Psychiatrist.com. May 7, 2001. <http://www.psychiatrist.com/suppplenet/v60s15/02v60s15.htm>.

Padgitt, Steven T. "Treating Intermittent Explosive Disorder with Neurofeedback." Behavenet.com. May 7, 2001. <http://www.behavenet.com/capsules/disorders/explosivedis.htm>.

Janie Franz

Internal fetal monitoring *see* **Electronic fetal monitoring**

Internuclear ophthalmoplegia *see* **Ophthalmoplegia**

Interpositional reconstruction *see* **Arthroplasty**

Intersex states

Definition

Intersex states are conditions in which a newborn's sex organs (genitals) look unusual, making it impossible to identify the sex of the baby from their outward appearance.

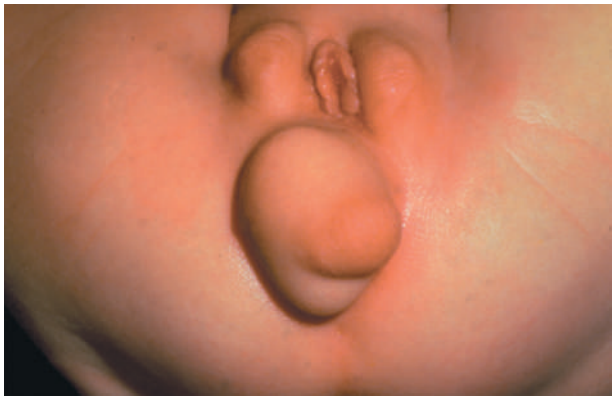
Description

All developing babies start out with external sex organs that look female. If the baby is male, the internal sex organs mature and begin to produce the male hormone testosterone. If the hormones reach the tissues correctly, the external genitals change into the scrotum and penis. Sometimes, the genetic sex (as indicated by chromosomes) may not match the appearance of the external sex organs. About one in every 2,000 births results in a baby whose sex organs are ambiguous.

Patients with intersex states can be classified as a true hermaphrodite, a female pseudohermaphrodite, or a male pseudohermaphrodite. This is determined by examining the internal and external structures of the child.

A true hermaphrodite is born with both ovaries and testicles. They also have mixed male and female external genitals. This condition is extremely rare.

A female pseudohermaphrodite is a genetic female. However, the external sex organs have been masculinized and look like a penis. This may occur if the mother takes the hormone progesterone to prevent a **miscarriage**, but more often it is caused by an overproduction of certain hormones.



This infant was born with female and male genitalia. *(Photography by Mike Peres, Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Chromosomes—Spaghetti-like structures located within the nucleus (or central portion) of each cell. Chromosomes contain the genetic information necessary to direct the development and functioning of all cells and systems in the body. They pass on hereditary traits from parents to child (like eye color) and determine whether the child will be male or female.

A male pseudohermaphrodite is a genetic male. However, the external sex organs fail to develop normally. Intersex males may have testes and a female-like vulva, or a very small penis.

Causes and symptoms

Any abnormality in chromosomes or sex hormones, or in the unborn baby's response to the hormones, can lead to an intersex state in a newborn.

Intersex states may also be caused by a condition called **congenital adrenal hyperplasia**, which occurs in about one out of every 5,000 newborns. This disease blocks the baby's metabolism and can cause a range of symptoms, including abnormal genitals.

Diagnosis

When doctors are uncertain about a newborn's sex, a specialist in infant hormonal problems is consulted as soon as possible. Ultrasound can locate a uterus behind the bladder and can determine if there is a cervix or uterine canal. Blood tests can check the levels of sex hormones in the baby's blood, and chromosome analysis (called karyotyping) can determine sex. Exploratory surgery or a biopsy of reproductive tissue may be necessary. Only after thorough testing can a correct diagnosis and determination of sex be made.

Treatment

Treatment of intersex states is controversial. Traditional treatment assigns sex according to test results; the potential for the child to identify with a sex; and the ease of genital surgery to make the organs look more normal. Treatment may then include reconstructive surgery followed by hormone therapy. Babies born with congenital adrenal hyperplasia can be treated with cortisone-type drugs and sometimes surgery.

Counseling should be given to the entire family of an intersex newborn. Families should explore all available medical and surgical options. Counseling should also be provided to the child when he or she is old enough.

Prognosis

Since the mid-1950s, doctors have typically assigned a sex to an intersex infant based on how easy reconstructive surgery would be. The American Academy of Pediatrics states that children with these types of genitals can be raised successfully as members of either sex, and recommends surgery within the first 15 months of life.

Some people are critical of this approach, including intersex adults who were operated on as children. The remolded genitals do not function sexually and can be the source of lifelong **pain**. They suggest that surgery be delayed until the patient can make informed choices about surgery and intervention.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Hermaphroditism." In *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

Cunningham, F. Gary, et al. *Williams Obstetrics.* 20th ed. Stamford: Appleton & Lange, 1997.

Johnson, Robert V., ed. *Mayo Clinic Complete Book of Pregnancy and Baby's First Year.* New York: William Morrow and Co., Inc., 1994.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. "Medical Genetics." In *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1997.

PERIODICALS

Johnson, Kate. "Doctors Asked to Delay Sex-Assignment Surgery." *Ob-Gyn News*, 1 Mar. 1997, 30.

ORGANIZATIONS

Ambiguous Genitalia Support Network. P.O. Box 313, Clements, CA 95227. (209) 727-0313.

Intersex Society. P.O. Box 31791, San Francisco, CA 94131.

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Intestinal culture *see* **Stool culture**

Intestinal lymphangiectasia *see* **Malabsorption syndrome**

Intestinal obstructions

Definition

Intestinal obstruction is the partial or complete mechanical or nonmechanical blockage of the small or large intestine.

Description

There are two types of intestinal obstructions—mechanical and nonmechanical. Mechanical obstructions occur because the bowel is physically blocked and its contents cannot get past the obstruction. Mechanical obstructions can occur for several reasons. Sometimes the bowel twists on itself (volvulus) or telescopes into itself (**intussusception**). Mechanical obstruction can also result from hernias, impacted feces, abnormal tissue growth, the presence of foreign bodies in the intestines, or inflammatory bowel disease (**Crohn's disease**). Nonmechanical obstruction, called **ileus**, occurs because the wavelike muscular contractions of the intestine (peristalsis) that ordinarily move food through the digestive tract stop.

Mechanical obstruction in infants

Infants under one year of age are most likely to have intestinal obstruction caused by meconium ileus, volvulus, and intussusception. Meconium ileus, which is the inability to pass the first fecal excretion after birth (meconium), is a disorder of newborns. It is an early clue that the infant has **cystic fibrosis**. In meconium ileus, the material that is blocking the intestine is thick and stringy, rather than the collection of mucus and bile that is passed by normal infants. The abnormal meconium must be removed with an enema or through surgery.

Volvulus is the twisting of either the small or large bowel. The twisting may cut off the blood supply to the bowel, leading to tissue **death** (**gangrene**). This development is called a strangulating obstruction.

In intussusception, the bowel telescopes into itself like a radio antenna folding up. Intussusception is most common in children between the ages of three and nine months, although it also occurs in older children. Almost twice as many boys suffer intussusception as girls. It is, however, difficult for doctors to predict which infants will suffer from intestinal obstruction.

Mechanical obstruction in adults

Obstructions in adults are usually caused by tumors, trauma, volvulus, the presence of foreign bodies such as **gallstones**, or hernias. Volvulus occurs most often in elderly adults and psychiatrically disturbed patients. Intussusception in adults is usually associated with tumors in the bowel, whether benign or malignant.

Causes and symptoms

One of the earliest signs of mechanical intestinal obstruction is abdominal **pain** or cramps that come and go in waves. Infants typically pull up their legs and cry in pain, then stop crying suddenly. They will then behave normally for as long as 15–30 minutes, only to start crying again when the next cramp begins. The cramping results from the inability of the muscular contractions of the bowel to push the digested food past the obstruction.

Vomiting is another symptom of intestinal obstruction. The speed of its onset is a clue to the location of the obstruction. Vomiting follows shortly after the pain if the obstruction is in the small intestine but is delayed if it is in the large intestine. The vomited material may be fecal in character. When the patient has a mechanical obstruction, the doctor will first hear active, high-pitched gurgling and splashing bowel sounds while listening with a stethoscope. Later these sounds decrease, then stop. If the blockage is complete, the patient will not pass any gas or feces. If the blockage is only partial, however, the patient may have **diarrhea**. Initially there is little or no **fever**.

When the material in the bowel cannot move past the obstruction, the body reabsorbs large amounts of fluid and the abdomen becomes sore to the touch and swollen. The balance of certain important chemicals (electrolytes) in the blood is upset. Persistent vomiting can cause the patient to become dehydrated. Without treatment, the patient can suffer **shock** and kidney failure.

Strangulation occurs when a loop of the intestine is cut off from its blood supply. Strangulation occurs in about 25% of cases of small bowel obstruction. It is a serious condition that can progress to gangrene within six hours.

Diagnosis

Imaging studies

If the doctor suspects intestinal obstruction based on the **physical examination** and patient history, he or she will order x rays, a computed tomography scan (CT scan), or an ultrasound evaluation of the abdomen. In many cases the patient is given a **barium enema**. Barium sulfate, which is a white powder, is inserted through the rectum and the intestinal area is photographed. Barium acts as a contrast material and allows the location of the obstruction to be pinpointed on film.

Laboratory tests

The first blood test of a patient with an intestinal obstruction usually gives normal results, but later tests indicate electrolyte imbalances. There is no way to determine if an obstruction is simple or strangulated except surgery.

Treatment

Initial assessment

All patients with suspected intestinal obstruction are hospitalized. Treatment must be rapid, because strangulating obstructions can be fatal. The first step in treatment is inserting a nasogastric tube to suction out the contents of the stomach and intestines. The patient is then given intravenous fluids to prevent **dehydration** and correct electrolyte imbalances.

Nonsurgical approaches

Surgery can be avoided for some patients. In some cases of volvulus, guiding a rectal tube into the intestines will straighten the twisted bowels. In infants, a barium enema may reverse intussusception in 50-90%. An air enema is sometimes used instead of a barium enema. This treatment successfully relieves the obstruction in many infants. The children are usually hospitalized for observation for two to three days after these procedures. In patients with only partial obstruction, a barium enema may dissolve the blockage.

Surgical treatment

If these efforts fail, surgery is necessary. Strangulated obstructions require emergency surgery. The obstructed area is removed and part of the bowel is cut away. If the obstruction is caused by tumors, polyps, or scar tissue, they are removed. Hernias, if present, are repaired. **Antibiotics** are given to reduce the possibility of infection.

Alternative treatment

Alternative practitioners offer few suggestions for treatment. They focus on preventive strategies, particularly the use of high-fiber **diets** to keep the bowels healthy through regular elimination.

KEY TERMS

Electrolytes—Salts and minerals that ionize in body fluids. Electrolytes control the body's fluid balance as well as performing other important functions.

Gangrene—The death of soft tissue in any part of the body when the blood supply is obstructed.

Ileus—Obstruction of the intestines caused by the absence of peristalsis.

Intussusception—The slipping or telescoping of one part of the intestine into the section next to it.

Meconium—A greenish fecal material that forms the first bowel movement of an infant.

Peristalsis—The waves of muscular contraction in the intestines that push the food along during the process of digestion.

Strangulated obstruction—An obstruction in which a loop of the intestine has its blood supply cut off.

Volvulus—A twisting of the intestine that causes an obstruction.

Prognosis

Mortality

Untreated intestinal obstructions can be fatal. The bowel either strangulates or perforates, causing massive infection. With prompt treatment, however, most patients recover without complications.

Recurrence

As many as 80% of patients whose volvulus is treated without surgery have recurrences. Recurrences in infants with intussusception are most likely to happen during the first 36 hours after the blockage has been cleared. The mortality rate for unsuccessfully treated infants is 1–2%.

Prevention

Most cases of intestinal obstruction are not preventable. Surgery to remove tumors, polyps, or gallstones helps prevent recurrences.

Resources

BOOKS

"Intestinal Obstruction." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

OTHER

HealthAnswers.com. "Intestinal Obstruction." <http://www.healthanswers.com/database/ami/converted/000260.html>.

"Intussusception: A Case Study for Nurses." *University of New Brunswick Nursing Faculty Page*. <http://www.unb.ca/courses/nur4284/intu.htm>.

Tish Davidson

Intestinal polyps

Definition

The word polyp refers to any overgrowth of tissue from the surface of mucous membranes. Intestinal polyps grow out of the lining of the small and large bowels. Polyps come in a variety of shapes—round, droplet, and irregular being the most common.

Description

Polyps are one of many forms of tissue overproduction that can occur in the body. Cells in many body tissues sometimes keep growing beyond their usual limits. Medical scientists call this process *neoplasia*, which means simply "new growth." An individual overgrowth is called a neoplasm. In most cases these growths are limited, and the result is a benign swelling or mass of cells called a tumor. If the new growth occurs on the surface of the tissue instead of inside an organ it is often called a polyp. **Cancer** is another type of neoplasm marked by unlimited tissue growth. The essential feature that distinguishes cancer from nonmalignant neoplasms is that it does not stop growing.

Intestinal polyps are a common form of neoplasm. All intestinal polyps arise from the inner lining of the intestinal wall. This layer of mucosal tissue does the work of digestion. About 30% of the general population will develop intestinal polyps at some point in life, with the likelihood increasing with age. Most of these polyps are never noticed during a person's lifetime because they cause no problems. They are often discovered accidentally at **autopsy**. The primary importance of intestinal polyps is that 1% of them become cancerous. Because the polyps that eventually turn malignant cannot be identified in advance, they are all suspect.

Location of intestinal polyps

The chances of a polyp's becoming cancerous depend to some extent on its location within the digestive tract.

COLON. Ninety-five percent of all intestinal polyps develop inside the large bowel. There are several hereditary diseases that produce large numbers of intestinal polyps. These disorders include:

- familial polyposis of the colon
- Gardner's syndrome
- Lynch's syndrome
- Turcot's syndrome
- Peutz-Jeghers syndrome
- juvenile polyposis

All of these disorders are inherited in what is called an autosomal dominant pattern. This pattern means that the disorders are not sex-linked and that a child can inherit the disorder from either parent. In all of these hereditary disorders, the intestinal polyps appear during or after **puberty**. The first four diseases on the list have such a high rate of cancer of the large bowel (colon)—virtually 100% by the age of 40—that persons diagnosed with any of them should have the colon removed surgically in early adulthood.

STOMACH. The stomach's lining is host to polyps of a similar appearance, but there is no agreement as to their potential for becoming **stomach cancer**.

SMALL INTESTINE. Polyps in the small bowel do not seem to have malignant potential. Instead they can produce obstruction in either of two ways. A large polyp can obstruct the bowel by its sheer size. Smaller polyps can be picked up by the rhythmic contractions (peristalsis) of the intestines and pull the part of the bowel to which they are attached into the adjoining section. The result is a telescoping of one section of bowel into another, called **intussusception**.

Causes and symptoms

Population studies of **colon cancer** suggest that diet plays an important role in the disease, and by implication in the formation of colon polyps. The most consistent interpretation of these data is that animal fats—though not vegetable fats—are the single most important dietary factor. Lack of fiber in the diet may also contribute to polyp formation. Other types of polyps are too rare to produce enough data for evaluation.

Most polyps cause no symptoms. Large ones eventually cause intestinal obstruction, which produces cramping abdominal **pain** with **nausea and vomiting**. As colon polyps evolve into cancers, they begin to produce symptoms that include bleeding and altered bowel habits.

KEY TERMS

Autosomal dominance—A pattern of heredity in which a trait is inherited without respect to sex and from either parent. The hereditary diseases associated with intestinal polyps are all autosomal dominant.

Colectomy—Surgical removal of the large bowel.

Intussusception—The slipping of one section of the intestine inside an adjoining section. Intussusception can be caused by small intestinal polyps.

Mucosal—Refers to tissues that produce mucus, such as the digestive, genital and urinary tracts.

Neoplasm—A new growth of abnormal tissue.

Peristalsis—The rhythmic contractions of muscular tubes like the intestines that carry the contents along the tube.

Sigmoid—The S-shaped curve of the large intestine where the colon joins the rectum.

Diagnosis

Routine screening for bowel cancer is recommended for everyone over the age of 40. Screening may be as simple as testing the stool for blood or as elaborate as **colonoscopy**. Colonoscopy is a procedure in which the doctor threads an instrument called a colonoscope up through the entire large bowel. Most polyps are in the lower segment of the colon, called the sigmoid colon. These polyps can be seen with a shorter scope called a sigmoidoscope. X ray imaging can also used to look for polyps. For x rays, the colon is first filled with barium, which is a white substance that shows up as a shadowed area on the film. The colon can also be filled with barium and air, which is called a double contrast study.

Because polyps take about five years to turn into cancers, routine examinations are recommended every three years.

Treatment

All polyps should be removed as preventive care. Most of them can be taken out through a colonoscope. Complications like obstruction and intussusception are surgical emergencies.

Prevention

Patients with hereditary disorders associated with polyps must undergo total colectomy early in adult life. All children of parents with these disorders should be screened early in adulthood, because half of them will have the same disease. For the bulk of the population, increased dietary fiber and decreased animal fat are the best preventives known at present. For the occasional intestinal polyp that arises in spite of good dietary habits, routine screening should prevent it from becoming cancerous.

Resources

BOOKS

Levin, Bernard. "Neoplasms of the Large and Small Intestines." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Mayer, Robert J. "Gastrointestinal Tract Cancer." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Silverstein, Fred E. "Gastrointestinal Endoscopy." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

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Intestinal strangulation *see* **Intestinal obstructions**

Intoxication confusional state *see* **Delirium**

Intracavity therapy *see* **Radioactive implants**

Intracranial abscess *see* **Brain abscess**

Intrapartum monitoring *see* **Electronic fetal monitoring**

Intrauterine device *see* **IUD**

Intrauterine growth retardation

Definition

Intrauterine growth retardation (IUGR) occurs when the unborn baby is at or below the 10th weight percentile for his or her age (in weeks).

Description

There are standards or averages in weight for unborn babies according their age in weeks. When the baby's weight is at or below the tenth percentile for his or her age, it is called intrauterine growth retardation or fetal growth restriction. These babies are smaller than they

should be for their age. How much a baby weighs at birth depends not only on how many weeks old it is, but the rate at which it has grown. This growth process is complex and delicate. There are three phases associated with the development of the baby. During the first phase, cells multiply in the baby's organs. This occurs from the beginning of development through the early part of the fourth month. During the second phase, cells continue to multiply and the organs grow. In the third phase (after 32 weeks of development), growth occurs quickly and the baby may gain as much as 7 ounces per week. If the delicate process of development and weight gain is disturbed or interrupted, the baby can suffer from restricted growth.

IUGR is usually classified as symmetrical or asymmetrical. In symmetrical IUGR, the baby's head and body are proportionately small. In asymmetrical IUGR, the baby's brain is abnormally large when compared to the liver. In a normal infant, the brain weighs about three times more than the liver. In asymmetrical IUGR, the brain can weigh five or six times more than the liver.

Causes and symptoms

Doctors think that the two types of IUGR may be linked to the time during development that the problem occurs. Symmetrical IUGR may occur when the unborn baby experiences a problem during early development. Asymmetrical IUGR may occur when the unborn baby experiences a problem during later development. While not true for all asymmetrical cases, doctors think that sometimes the placenta may allow the brain to get more oxygen and **nutrition** while the liver gets less.

There are many IUGR risk factors involving the mother and the baby. A mother is at risk for having a growth restricted infant if she:

- has had a previous baby who suffered from IUGR
- is small in size
- has poor weight gain and nutrition during **pregnancy**
- is socially deprived
- uses substances (like tobacco, narcotics, alcohol) that can cause abnormal development or **birth defects**
- has a vascular disease (like preeclampsia)
- has chronic kidney disease
- has a low total blood volume during early pregnancy
- is pregnant with more than one baby
- has an antibody problem that can make successful pregnancy difficult (antiphospholipid antibody syndrome)

Additionally, an unborn baby may suffer from IUGR if it has:

- exposure to an infection, including German **measles** (**rubella**), cytomegalovirus, **tuberculosis**, **syphilis**, or **toxoplasmosis**
- a birth defect (like a severe cardiovascular defect)
- a chromosome defect, especially trisomy 18 (**Edwards' syndrome**)
- a primary disorder of bone or cartilage
- a chronic lack of oxygen during development (hypoxia)
- placenta or umbilical cord defects
- developed outside of the uterus

Diagnosis

IUGR can be difficult to diagnose and in many cases doctors are not able to make an exact diagnosis until the baby is born. A mother who has had a growth-restricted baby is at risk of having another during a later pregnancy. Such mothers are closely monitored during pregnancy. The length in weeks of the pregnancy must be carefully determined so that the doctor will know if development and weight gain are appropriate. Checking the mother's weight and abdomen measurements can help diagnose cases when there are no other risk factors present. Measuring the girth of the abdomen is often used as a tool for diagnosing IUGR. During pregnancy, the health care provider will use a tape measure to record the height of the upper portion of the uterus (the uterine fundal height). As the pregnancy continues and the baby grows, the uterus stretches upward in the direction of the mother's head. Between 18 and 30 weeks of gestation, the uterine fundal height (in cm.) equals the weeks of gestation. If the uterine fundal height is more than 2–3 cm below normal, then IUGR is suspected. Ultrasound is used to evaluate the growth of the baby. Usually, IUGR is diagnosed after week 32 of pregnancy. This is during the phase of rapid growth when the baby should be gaining more weight. IUGR caused by genetic factors or infection may sometimes be detected earlier.

Treatment

There is no treatment that improves fetal growth, but IUGR babies who are at or near term have the best outcome if delivered promptly. If IUGR is caused by a problem with the placenta and the baby is otherwise healthy, early diagnosis and treatment of the problem may reduce the chance of a serious outcome.

Prognosis

Babies who suffer from IUGR are at an increased risk for **death**, low blood sugar (**hypoglycemia**), low

body temperature (**hypothermia**), and abnormal development of the nervous system. These risks increase with the severity of the growth restriction. The growth that occurs after birth cannot be predicted with certainty based on the size of the baby when it is born. Infants with asymmetrical IUGR are more likely to catch up in growth after birth than are infants who suffer from prolonged symmetrical IUGR. However, as of 1998, doctors cannot reliably predict an infant's future progress. Each case is unique. Some infants who have IUGR will develop normally, while others will have complications of the nervous system or intellectual problems like **learning disorders**. If IUGR is related to a disease or a genetic defect, the future of the infant is related to the severity and the nature of that disorder.

Resources

BOOKS

Cunningham, F. Gary, et al. *Williams Obstetrics*. 20th ed. Stamford, CT: Appleton & Lange, 1997.

Linda Jones

Intravenous nutrition *see* **Nutrition through an intravenous line**

Intravenous pyelography *see* **Intravenous urography**

Intravenous rehydration

KEY TERMS

Intravenous—Into a vein; a needle is inserted into a vein in the back of the hand, inside the elbow, or some other location on the body. Fluids, nutrients, and drugs can be injected.

Definition

Sterile water solutions containing small amounts of salt or sugar, are injected into the body through a tube attached to a needle that is inserted into a vein.

Purpose

Fever, vomiting, and **diarrhea** can cause a person to become dehydrated fairly quickly. Infants and children are especially vulnerable to **dehydration**. Patients can become dehydrated due to an illness, surgery, or accident. Athletes who have overexerted themselves may also require rehydration with IV fluids. An IV for rehydration can be used for several hours to several days, and is generally used if a patient cannot drink fluids.

Precautions

Patients receiving IV therapy need to be monitored to ensure that the IV solutions are providing the correct amounts of fluids and **minerals** needed. People with kidney and heart disease are at increased risk for **overhydration**, so they must be carefully monitored when receiving IV therapy.

Description

Basic IV solutions are sterile water with small amounts of sodium (salt) or dextrose (sugar) supplied in bottles or thick plastic bags that can hang on a stand mounted next to the patient's bed. Additional minerals like potassium and calcium, **vitamins**, or drugs can be added to the IV solution by injecting them into the bottle or bag with a needle.

Preparation

A doctor orders the IV solution and any additional nutrients or drugs to be added to it. The doctor also specifies the rate at which the IV will be infused. The IV solutions are prepared under the supervision of a doctor, pharmacist, or nurse, using sanitary techniques that prevent bacterial contamination. Just like a prescription, the IV is clearly labeled to show its contents and the amounts of any additives. The skin around the area where the needle is inserted is cleaned and disinfected. Once the needle is in place, it will be taped to the skin to prevent it from dislodging.

Aftercare

Patients need to take fluids by mouth before an IV solution is discontinued. After the IV needle is removed, the site should be inspected for any signs of bleeding or infection.

Risks

There is a small risk of infection at the injection site. It is possible that the IV solution may not provide all of the nutrients needed, leading to a deficiency or an imbal-

ance. If the needle becomes dislodged, it is possible that the solution may flow into tissues around the injection site rather than into the vein.

Resources

BOOKS

Josephson, Dianne. *Intravenous Therapy for Nurses*. Albany, NY: Delmar Publishers, 1998.

"Water, Electrolyte, Mineral, and Acid-Base Metabolism." In *The Merck Manual*. 16th ed. Rahway, NJ: Merck, 1992.

PERIODICALS

Castellani, J. W., et al. "Intravenous vs. Oral Rehydration: Effects on Subsequent Exercise-Heat Stress." *Journal of Applied Physiology* 82 (Mar. 1997): 799–806.

OTHER

Martinez-Bianchi, Viviana, Michelle Rejman-Peterson, and Mark A. Graber. "Pediatrics: Vomiting, Diarrhea, and Dehydration." *Family Practice Handbook*. University of Iowa. <http://www.vh.org/Providers/ClinRef/FP Handbook/Chapter10/17-10.html>.

Toth, Peter P. "Gastoenterology: Acute Diarrhea." *Family Practice Handbook*. University of Iowa. <http://www.vh.org/Providers/ClinRef/FPHandbook/Chapter04/01-4.html>.

Altha Roberts Edgren

Intravenous urography

Definition

Intravenous urography is a test that x rays the urinary system using intravenous dye for diagnostic purposes.

Of the many ways to obtain images of the urinary system, the intravenous injection of a contrast agent has been traditionally considered the best. The kidneys excrete the dye into the urine. X rays can then create pictures of every structure through which the urine passes.

The procedure has several variations and many names:

- intravenous pyelography (IVP)
- urography
- pyelography
- antegrade pyelography differentiates this procedure from "retrograde pyelography," which injects dye into the lower end of the system, therefore flowing backward or "retrograde." Retrograde pyelography is better able to define problems in the lower parts of the system and is the only way to get x rays if the kidneys are not working well.
- Nephrotomography is somewhat different in that the x rays are taken by a moving x ray source onto a film moving in the opposite direction. By accurately coordinating the movement, all but a single plane of tissue is blurred, and that plane is seen without overlying shadows.

Every method available gives good pictures of this system, and the question becomes one of choosing among many excellent alternatives. Each condition has special requirements, while each technique has distinctive benefits and drawbacks.

- Nuclear scans rely on the radiation given off by certain atoms. Chemicals containing such atoms are injected into the bloodstream. They reach the kidneys, where images are constructed by measuring the radiation emitted. The radiation is no more dangerous than standard x rays. The images require considerable training to interpret, but unique information is often available using this technology. Different chemicals can concentrate the radiation in different types of tissue. This technique may require several days for the chemical to concentrate at its destination. It also requires a special detector to create the image.
- Ultrasound is a quick, safe, simple, and inexpensive way to obtain views of internal organs. Although less detailed than other methods, it may be sufficient.
- Retrograde pyelography is better able to define problems in the lower parts of the system and is the only way to get x rays if the kidneys are not working well. Dye is usually injected through an instrument (cystoscope) passed into the bladder through the urethra.
- Computed tomography scans (CT or CAT scanning) uses the same kind of radiation used in x rays, but it collects information by computer in such a way that three-dimensional images can be constructed, eliminating interference from nearby structures. CT scanning requires a special apparatus.
- Magnetic resonance imaging (MRI) uses magnetic fields and radio frequency signals, instead of ionizing radiation, to create computerized images. This form of energy is entirely safe as long as the patient has no metal on board. The technique is far more versatile than CT scanning. MRI requires special apparatus and, because of the powerful magnets needed, even a special building all by itself. It is quite expensive.

Purpose

Most diseases of the kidneys, ureters, and bladder will yield information to this procedure, which actually has two phases. First, it requires a functioning kidney to filter the dye out of the blood into the urine. The time required for the dye to appear on x rays correlates accurately with

KEY TERMS

Contrast agent—Any substance that causes shadows on x rays; also known as contrast dye or medium.

Intravenous—Into a vein.

kidney function. The second phase gives detailed anatomical images of the urinary tract. Within the first few minutes the dye "lights up" the kidneys, a phase called the nephrogram. Subsequent pictures follow the dye down the ureters and into the bladder. A final film taken after urinating reveals how well the bladder empties.

IVPs are most often done to assess structural abnormalities or obstruction to urine flow. If kidney function is at issue, more films are taken sooner to catch the earliest phase of the process.

- Stones, tumors and congenital malformations account for many of the findings.
- Kidney cysts and cancers can be seen.
- Displacement of a kidney or ureter suggests a space-occupying lesion like a **cancer** pushing it out of the way.
- Bad valves where the ureters enter the bladder will often show up.
- Bladder cancers and other abnormalities are often outlined by the dye in the bladder.
- An **enlarged prostate** gland will show up as incomplete bladder emptying and a bump at the bottom of the bladder.

Precautions

The only serious complication of an IVP is allergy to the iodine-containing dye that is used. Such an allergy is rare, but it can be dramatic and even lethal. Emergency measures taken immediately are usually effective.

Description

IVPs are usually done in the morning. In the x ray suite, the patient will undress and lie down. There are two methods of injecting the dye. An intravenous line can be established, through which the dye will be consistently fed through the body during the procedure. The other method is to give the dye all at once through a needle that is immediately withdrawn. X rays are taken until the dye has reached the bladder, an interval of half an hour or less. The patient will be asked to empty the bladder before one last x ray.

Preparation

Emptying the bowel with **laxatives** or **enemas** prevents bowel shadows from obscuring the details of the urinary system. An empty stomach prevents the complications of vomiting, a rare effect of the contrast agent. Therefore, the night before the IVP the patient will be asked to evacuate the bowels and to drink sparingly.

Risks

Allergy to the contrast agent is the only risk. Anyone with a possible iodine allergy or a previous reaction to x ray dye must be particularly careful to inform the x ray personnel.

Resources

BOOKS

Merrill, Vinta. *Atlas of Roentgenographic Positions and Standard Radiologic Procedures*. Saint Louis: The C.V. Mosby Co., 1975.

J. Ricker Polsdorfer, MD

Intussusception

Definition

Intussusception is the enfolding of one segment of the intestine within another. It is characterized by and initially presents with recurring attacks of cramping abdominal **pain** that gradually become more painful.

Description

Intussusception occurs when part of the bowel or intestine is wrapped around itself, producing a mass-like object on the right side of the abdomen during palpation (a procedure used during a **physical examination**, when the examiner touches the abdomen with his/her hand, usually feeling for mass, pain, or discomfort). The number of new cases of intussusception is approximately 1.5 to four cases per 1,000 live births. The onset of abdominal pain is usually abrupt and severe. Just as fast as the onset of pain appears, it disappears and the child resumes activity normally. This process of sudden severe abdominal pain appearing out of the blue, then disappearing, is repeated with duration of painful attacks. The pain usually increases after approximately five hours of recurrent cycles of severe abdominal pain followed by relaxation. Vomiting and **diarrhea** occur in about 90% of cases within six to 12 hours after initial onset of symptoms.

Physical examination and palpation usually reveal a sausage-shaped mass of enfolded bowel in the right upper mid-portion of the abdomen. Within a few hours approximately 50% of cases have bloody, mucus-filled bowel movements. At about this time the child is visibly very ill with **fever**, tenderness, and distended abdomen. Intussusception is the most frequent cause of intestinal obstruction during the first two years of life and commonly affects children between three to 12 months of age. The disease is three times more common in males than in females. In about 85% of cases the cause is idiopathic (meaning that it is unknown). The remaining 15% of cases can be caused by a variety of such other diseases as tumors of the lymph nodes (lymphoma), fat tumors (lipomas), foreign bodies/objects, or from infections that mobilize immune cells to the area causing and an inflammatory reaction and intestinal blockage. Most cases of intussusception do not strangulate the affected bowel within the first 24 hours. If the disease is not treated after this time, the possibility of intestinal **gangrene**, **shock**, and **death** increases.

Causes and symptoms

The major symptom of intussusception is that a healthy child suddenly and without warning experiences severe abdominal pain that subsides and usually results in continuation of such normal activities as playing. The duration of the painful attacks increases as the hours go by. Usually, the child develops nausea, vomiting, and diarrhea soon afterwards in about 90% of all cases. The child becomes weak, exhausted, and develops a fever. The affected child may also expel bloody, mucus-like bowel movements. These blood-filled bowel movements are usually due to impaired blood flow to the obstructed area. During palpation there may be a sausage-shaped mass located on the upper right mid portion of the abdomen. If the disease progresses and is undetected, the child may develop necrosis (death) of cells within the affected area. Additionally, there may be perforation or holes in the intussusception bowel that can cause a life threatening infection in the peritoneum (a layer of tissue that protects the organs and intestines within the abdominal cavity). This infection of the peritoneum is called **peritonitis**. Some patients may exhibit altered states of consciousness or seizures.

Diagnosis

A presumed diagnosis can be made by history alone. If the clinician suspects intussusception x-ray films should be performed, which may reveal a mass in the right upper mid abdominal region. Two classical clinical signs are mucus-blood filled stools and a "coiled string" appearance in the affected bowel as visualized during an x ray with a **barium enema**. Blood chemistry analysis is not specific for intussusception. Depending on vomiting and blood loss through the stools, blood chemistry may reflect signs of **dehydration** and anemia.

Treatment

Treating intussusception by reduction (alleviating the source of blockage) is an emergency procedure. The barium examination is not only the diagnostic tool of choice, but also frequently curative. Infusion by gravity from a catheter placed in the rectum will tend to relieve pressure buildup. If this does not relieve the area, then air can be pumped into the colon to clear blockage. If these procedures are unsuccessful then surgery is required. Approximately 25% of affected children require surgical intervention. Surgery in the affected bowel is advantageous since the actual cause can be removed, and the procedure decreases the possibility of recurrences. In general, without surgical correction of the affected bowel, there is a 5–10% chance of recurrence. Recurrence usually appears within the first 24 to 48 hours after barium procedure.

Prognosis

The outcome of intussusception depends on the duration of symptoms before treatment initiation. Most infants will recover if treatment is initiated within the first 24 hours. Untreated intussusception is almost always fatal. Overall even with treatment, approximately 1–2% of affected children will die.

Prevention

Prevention of death can be accomplished with immediate medical care, within the first 24 hours. Once intussusception is suspected, emergency measures should be initiated. Untreated intussusception is almost always fatal. There is an increased chance of death if the disorder is not treated within 48 hours.

Resources

BOOKS

Behrman, Richard E., et al, eds. *Nelson Textbook of Pediatrics.* 16th ed. Philadelphia: W. B. Saunders Company, 2000.

Feldman, Mark, et al, eds. *Sleisenger & Fordtran's Gastrointestinal and Liver Disease.* 6th ed. Philadelphia: W. B. Saunders Company, 1998.

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice.* 4th ed. St. Louis: Mosby-Year Book, Inc., 1998.

Townsend, Courtney M., et al. *Sabiston Textbook of Surgery.* 16th ed. Philadelphia: W. B. Saunders Company, 2001.

PERIODICALS

Irish, M., R. Pearl, M. Caty, P. Glick. "The Approach to Common Abdominal Diagnosis in Infants and Children." *Pediatric Clinics of North America* 45 (Aug. 1998).

KEY TERMS

Barium— A chemical used in certain radiological studies to enhance visualization of anatomical structures.

Obstruction— A blockage that prevents movement.

OTHER
University of Maryland. 2001. <http://www.umm.edu>.

Laith Farid Gulli, M.D.

Intussusception *see* **Intestinal obstructions**

Iodine *see* **Antiseptics**

Iodine uptake test *see* **Thyroid nuclear medicine scan**

Ipecac

Definition

Ipecac is a medicine commonly used to induce vomiting in cases of accidental **poisoning**. It is also a homeopathic remedy.

Purpose

Treatment of poisoning

Standard medical practice uses ipecac to cause vomiting in cases of poisoning in order to remove the toxic substance from the stomach before absorption occurs. It can be used on animals as well as humans. Ipecac is safer and more effective than many other methods for inducing vomiting, such as sticking a finger down a child's throat or using salt water. There are times, however, when ipecac should not be used because it can make certain kinds of poisoning worse. Syrup of ipecac should not be used if the poison is one of the following.

- strychnine
- alkalis (lye)
- strong acids
- kerosene
- fuel oil
- gasoline
- coal oil
- paint thinner
- cleaning fluid

Poisoning is a potentially serious condition. It is best to contact a local poison control center, local hospital emergency room, or the family doctor for instructions before using syrup of ipecac.

Ipecac's reputation for inducing vomiting has encouraged some bulimics to take it on a regular basis in order to purge the contents of the stomach after an eating binge. This misuse of ipecac is extremely dangerous; it can cause heart problems, tears in the esophagus or stomach lining, vomiting blood, seizures, or even **death**.

Homeopathy

The homeopathic remedy made from ipecac is called *Ipecacuanha*. Homeopathic preparations are given for a reason completely opposite from that of standard allopathic treatment. In **homeopathy**, ipecac is given to stop vomiting rather than to induce it. According to Hahnemann's law of similars, a substance that would cause vomiting in large doses when given to a healthy person will stimulate a sick person's natural defenses when given in extremely dilute and carefully prepared doses. *Ipecacuanha* is a favorite homeopathic remedy for morning sickness associated with **pregnancy**. It is also given to stop nausea that is not relieved by vomiting; when the vomitus is slimy and white; when there is gagging and heavy salivation; when the tongue is clean despite the patient's feelings of nausea; and when the patient is not thirsty. The nausea may be accompanied by a **headache**, **cough**, or heavy menstrual bleeding. The modalities (circumstances) that suggest *Ipecacuanha* as the appropriate homeopathic remedy is that the patient feels worse lying down; in dry weather; in winter; and when exercising or moving about.

A homeopathic practitioner would not necessarily prescribe ipecac for all cases of nausea. *Arsenicum* would be given when the nausea is caused by **food poisoning** and accompanied by strong thirst, *Nux vomica* when the nausea is the result of overindulgence in food or alcohol and accompanied by gas or **heartburn**. A sick child might be given *Pulsatilla*, particularly if rich foods have been eaten.

On the other hand, a homeopathic practitioner may prescribe ipecac for any of the following conditions that are not related to **nausea and vomiting**.

- nosebleeds producing bright red blood
- dental bleeding

Ipecac plant (*Cephaelis ipecacuanha*). *(PlantaPhile Germany. Reproduced by permission.)*

- diarrhea with cramping abdominal **pain**, the stools are green with froth or foam.
- asthma of sudden onset; the patient has to sit up in order to breathe, but cannot bring up any mucus in spite of violent coughing
- hoarseness or loss of voice following a cold
- physical or mental exhaustion

Description

The medicinal effects of ipecac were recognized centuries ago by the Portuguese who settled in South America. They found a plant that can make people vomit and appropriately named it *Caephalis ipecacuanha*, meaning sick-making plant. Syrup of ipecac is now considered the safest drug to treat poisoning and is often the most effective. There are different types of ipecac preparations that vary greatly in strength. Syrup of ipecac is best for use at home to treat accidental poisoning. Ipecac fluid extract and ipecac tincture should be avoided as they are much stronger compounds and can be toxic.

Ipecacuanha is a homeopathic remedy made from ipecac by a process of dilution and succussion (shaking). In contrast to syrup of ipecac, it is given to relieve vomiting.

Recommended dosage

Syrup of ipecac

Syrup of ipecac is made from the dried roots and rhizomes (underground stems) of *Cephaelis ipecacuanha*. It is available over the counter in 0.5–1 oz bottles. Larger bottles require a doctor's prescription. The dosage for infants under 6 months old should be prescribed by the family doctor or poison control center. For children six months to one year, the usual dose is 5–10 ml or 1–2 tsp. One-half or one full glass (4–8 oz) of water should be taken immediately before or after the dose. The dose may be repeated once after 20–30 minutes if vomiting does not occur. For children one to 12 years of age, the usual dose is 15 ml (1 tbsp) to be taken with one full glass (8 oz) of water. Adults and teenagers should take 15–30 ml of ipecac with at least 1 full glass of water. Syrup of ipecac should not be taken with milk or soda drinks as these foods may prevent it from working properly. If vomiting does not occur within 20–30 minutes after the first dose, a second dose may be needed. If the second dose fails to induce vomiting, the patient should be taken to a hospital emergency room.

If both activated charcoal and syrup of ipecac are recommended to treat poison, ipecac must be used first. Activated charcoal should not be taken until 30 minutes after taking syrup of ipecac, or until the vomiting caused by ipecac stops.

Homeopathic preparations

Ipecacuanha is available as an over-the-counter remedy in 30x potency. This is a decimal potency, which means that one part of ipecac has been mixed with nine parts of alcohol or water; 30x means that this decimal dilution has been repeated 30 times. The dilute solution of ipecac is then added to sugar tablets so that the remedy can be taken in tablet form.

Precautions

Syrup of ipecac

For inducing vomiting in cases of accidental poisoning, only the syrup form of ipecac should be used. Syrup of ipecac should not be mixed with milk or carbonated drinks as they may prevent vomiting.

Syrup of ipecac should not be used in the following situations (contact poison control center or family doctor for alternative treatments).

- poisoning caused by strychnine; sustained-release theophylline; such corrosive substances as strong alkalis (lye); strong acids (such as toilet bowl cleaner); and such petroleum products as kerosene, gasoline, coal oil, fuel oil, paint thinner, or cleaning fluids
- overdoses of medications given for depression
- excessive vomiting
- a serious heart condition
- timing. Do not give ipecac more than four to six hours after the poison was ingested
- pregnancy
- very young children (less than six months old). Infants and very young children may choke on their own vomit or get vomit into their lungs

KEY TERMS

Bulimia nervosa—An eating disorder characterized by episodic binge eating followed by self-induced vomiting or laxative abuse.

Cephaeline—A chemical compound found in ipecac that irritates the stomach lining and triggers the vomiting reflex.

Fluid extract—A concentrated preparation of a drug.

Law of similars—A principle of homeopathic treatment according to which substances that cause specific symptoms in healthy people are given to sick people with similar symptoms.

Modality—A factor or circumstance that makes a patient's symptoms better or worse. Modalities include such factors as time of day, room temperature, the patient's level of activity, sleep patterns, etc.

Tincture—An alcoholic solution of a chemical or drug.

- drowsy or unconscious patients
- seizures

Homeopathic preparations

Ipecacuanha should not be given after *Arsenicum* or *Tabac* because these remedies will counteract it.

Side effects

The following side effects have been associated with the use of syrup of ipecac.

- loose bowel movements
- diarrhea
- fast irregular heartbeat
- inhaling or **choking** on vomit
- stomach cramps or pains
- coughing
- weakness
- aching
- muscle stiffness
- severe heart problems often occur in cases of ipecac abuse (because ipecac stays in the body for a long time, damage to the heart frequently occurs in persons who repeatedly take ipecac to induce vomiting)
- seizures; these are most likely to occur in patients who accidentally swallow ipecac or in ipecac abusers
- death; deaths have been reported due to ipecac abuse in bulimic persons

Homeopathic *Ipecacuanha* has been highly diluted and is relatively nontoxic.

Interactions

Ipecac should not be given together with other drugs because it can decrease their effectiveness and increase their toxicity. If both syrup of ipecac and activated charcoal are needed to treat suspected poisons, ipecac should be given first. Activated charcoal should not be given until vomiting induced by ipecac has stopped. Soda pop should also be avoided because it can cause the stomach to swell. The person should lie on the stomach or side in case vomiting occurs.

Homeopathic *Ipecacuanha* is considered complementary to *Arnica* and *Cuprum*. It is counteracted by *Arsenicum* and *Tabac*.

Resources

BOOKS

Cummings, Stephen, MD, and Dana Ullman, MPH. *Everybody's Guide to Homeopathic Medicines*. New York: G. P. Putnam's Sons, 1991.

Ellenhorn's Medical Toxicology, 2nd ed. Baltimore: Williams & Wilkins, 1997.

Hammond, Christopher. *The Complete Family Guide to Homeopathy: An Illustrated Encyclopedia of Safe and Effective Remedies*. New York: Penguin Studio, 1995.

PDR Nurse's Drug Handbook. Montvale, NJ: Delmar Publishers, 2000.

ORGANIZATIONS

American Foundation for Homeopathy. 1508 S. Garfield. Alhambra, CA 91801.

Homeopathic Educational Services. 2124B Kittredge St. Berkeley, CA 94704. (510) 649-0294. Fax: (510) 649-1955.

Mai Tran

Ipratropium *see* **Bronchodilators**

I.Q. tests *see* **Stanford-Binet intelligence scales; Wechsler intelligence test**

Iridocyclitis *see* **Uveitis**

Iritis *see* **Uveitis**

Iron-binding capacity test *see* **Iron tests**

Iron-utilization anemias *see* **Sideroblastic anemia**

Iron deficiency anemia

Definition

Anemia can be caused by iron deficiency, folate deficiency, vitamin B_{12} deficiency, and other causes. The term iron deficiency anemia means anemia that is due to iron deficiency. Iron deficiency anemia is characterized by the production of small red blood cells. When examined under a microscope, the red blood cells also appear pale or light-colored. For this reason, the anemia that occurs with iron deficiency is also called hypochromic microcytic anemia.

Description

Iron deficiency anemia is the most common type of anemia throughout the world. In the United States, iron deficiency anemia occurs to a lesser extent than in developing countries because of the higher consumption of red meat and the practice of food fortification (addition of iron to foods by the manufacturer). Anemia in the United States is caused by a variety of sources, including excessive losses of iron in menstrual fluid and excessive bleeding in the gastrointestinal tract. In developing countries located in tropical climates, the most common cause of iron deficiency anemia is infestation with hookworm.

Causes and symptoms

Infancy is a period of increased risk for iron deficiency. The human infant is born with a built-in supply of iron, which can be tapped during periods of drinking low-iron milk or formula. Both human milk and cow milk contain rather low levels of iron (0.5–1.0 mg iron/liter). However, the iron in human milk is about 50% absorbed by the infant, while the iron of cow milk is only 10% absorbed. During the first six months of life, growth of the infant is made possible by the milk in the diet and by the infant's built-in supply. However, premature infants have a lower supply of iron and, for this reason, it is recommended that preterm infants (beginning at two months of age) be given oral supplements of 7 mg iron/day, as ferrous sulfate. Iron deficiency can be provoked where infants are fed formulas that are based on unfortified cow milk. For example, unfortified cow milk is given free of charge to mothers in Chile. This practice has the fortunate result of preventing general **malnutrition**, but the unfortunate result of allowing the development of mild iron deficiency.

The normal rate of blood loss in the feces is 0.5–1.0 ml per day. These losses can increase with colorectal **cancer**. About 60% of colorectal cancers result in further blood losses, where the extent of blood loss is 2–10 ml/day. Cancer of the colon and rectum can provoke losses of blood, resulting in iron deficiency anemia. The fecal blood test is widely used to screen for the presence of cancer of the colon or rectum. In the absence of testing, colorectal cancer may be first detected because of the resulting iron deficiency anemia.

Infestation with hookworm can provoke iron deficiency and iron deficiency anemia. The hookworm is a parasitic worm. It thrives in warm climates, including the southern United States. The hookworm enters the body through the skin, through the soles of bare feet. The hookworm then migrates to the small intestines where it attaches itself to the villi (small sausage-shaped structures in the intestines that are used for the absorption of all nutrients). The hookworm damages the villi, resulting in blood loss, and they produce anti-coagulants that promote continued bleeding. Each worm can provoke the loss of up to 0.25 ml of blood per day.

Bleeding and blood losses through gastrointestinal tract can be provoked by colorectal cancer and hookworms, as mentioned above, but also by **hemorrhoids**, anal fissures, **irritable bowel syndrome**, aspirin-induced bleeding, blood clotting disorders, and diverticulosis (a condition caused by an abnormal opening from the intestine or bladder). Several genetic diseases exist that lead to bleeding disorders, and these include **hemophilia** A, hemophilia B, and von Willebrand's disease. Of these, only von Willebrand's disease leads to gastrointestinal bleeding.

The symptoms of iron deficiency anemia include weakness and **fatigue**. These symptoms result from dysfunction of the red blood cells, and the reduced ability of the red blood cells to carry iron to exercising muscles. Iron deficiency can also affect other tissues, including the tongue and fingernails. Prolonged iron deficiency can result in changes of the tongue, and it may become smooth, shiny, and reddened. This condition is called glossitis. The fingernails may grow abnormally, and acquire a spoon-shaped appearance.

Decreased iron intake is a contributing factor in iron deficiency and iron deficiency anemia. The iron content of cabbage, for example, is about 1.6 mg/kg food, while those of spinach (33 mg/kg), lima beans (15 mg/kg), potato (14 mg/kg), tomato (3 mg/kg), apples (1.5 mg/kg), raisins (20 mg/kg), whole wheat bread (43 mg/kg), eggs (20 mg/kg), canned tuna (13 mg/kg), chicken (11 mg/kg), beef (28 mg/kg), corn oil (0.6 mg/kg), and peanut butter (6.0 mg/kg), are indicated. One can see that apples, tomatoes, and vegetable oil are relatively low in iron, while whole wheat bread and beef are relatively high in iron. The assessment of whether a food is low or high in iron can also be made by comparing the amount of that food

eaten per day with the recommended dietary allowance (RDA) for iron. The RDA for iron for the adult male is 10 mg/day, while that for the adult woman is 15 mg/day. The RDA during **pregnancy** is 30 mg/day. The RDA for infants of 0–0.5 years of age is 6 mg/day, while that for infants of 0.5–1.0 years of age is 10 mg/day. The RDA values are based on the assumption that the consumer eats a mixture of plant and animal foods.

The above list of iron values alone may be deceptive, since the availability of iron in fruits, vegetables, and grains is very low, while the availability from meat is much higher. The availability of iron in plants ranges from only 1–10%, while that in meat, fish, chicken, and liver is 20–30%. The term availability means the percent of dietary iron that is absorbed via the gastrointestinal tract to the bloodstream. Non-absorbed iron is lost in the feces.

Interactions between various foods can influence the absorption of dietary iron. Vitamin C can increase the absorption of dietary iron. Orange juice is a rich source of vitamin C. Thus, if a plant food, such as rice, is consumed with orange juice, then the orange juice can enhance the absorption of the iron in the rice. Vitamin C is also added to infant formulas, and the increased use of formulas fortified with both iron and vitamin C have led to a marked decline in anemia in infants and young children in the United States (Dallman, 1989). In contrast, if rice is consumed with tea, certain chemicals in the tea (tannins) can reduce the absorption of the iron. Phytic acid is a chemical that naturally occurs in legumes, cereals, and nuts. Phytic acid, which can account for 1–5% of the weight of these foods, is a potent inhibitor of iron absorption. The increased availability of the iron in meat products is partly due to the fact that heme-iron is absorbed to a greater extent than free iron salts, and to a greater extent than iron in the phytic acid/iron complex. Nearly all of the iron in plants is nonheme-iron. Much of the iron in meat is nonheme-iron as well. The nonheme-iron in meat, fish, chicken and liver may be about 20% available. The heme-iron of meat may be close to 30% available. The most available source of iron is human milk (50% availability).

Diagnosis

Iron deficiency anemia in infants is defined as a hemoglobin level below 109 mg/ml of whole blood, and a **hematocrit** below 33%. Anemia in adult males is defined as a hemoglobin under 130 mg/ml and a hematocrit below 38%. Anemia in adult females is defined as hemoglobin under 120 mg/ml and a hematocrit below 32%. Anemia in pregnant women is defined as hemoglobin of under 110 mg/ml and hematocrit below 31%.

When an abnormally high presence of blood is found in the feces during a **fecal occult blood test**, the physician needs to examine the gastrointestinal tract to determine the cause of bleeding. Here, the diagnosis for iron deficiency anemia includes an examination using a sigmoidoscope. The sigmoidoscope is an instrument that consists of a flexible tube that permits examination of the colon to a distance of 60 cm. A **barium enema**, with an x ray, may also be used to detect abnormalities that can cause bleeding.

The diagnosis of iron deficiency anemia should include a test for oral iron absorption, where evidence suggests that oral iron supplements fail in treating anemia. The oral iron absorption test is conducted by eating 64 mg iron (325 mg ferrous sulfate) in a single dose. Blood samples are then taken after two hours and four hours. The iron content of the blood serum is then measured. The concentration of iron should rise by an increment of about 22 micromolar, where iron absorption is normal. Lesser increases in concentration mean that iron absorption is abnormal, and that therapy should involve injections or infusions of iron.

Treatment

Oral iron supplements (pills) may contain various iron salts. These iron salts include ferrous sulfate, ferrous gluconate, or ferrous fumarate. Injections and infusions of iron can be carried out with a preparation called iron dextran. In patients with poor iron absorption (by the gut), therapy with injection or infusion is preferable over oral supplements. Treatment of iron deficiency anemia sometimes requires more than therapy with iron. Where iron deficiency was provoked by hemorrhoids, surgery may prove essential to prevent recurrent iron deficiency anemia. Where iron deficiency is provoked by bleeding due to **aspirin** treatment, aspirin should be discontinued. Where iron deficiency is provoked by hookworm infections, therapy for this parasite should be used, along with protection of the feet by wearing shoes whenever walking in hookworm-infested soil.

Prognosis

The prognosis for treating and curing iron deficiency anemia is excellent. Perhaps the main problem is failure to take iron supplements. In cases of pregnant women, the health care worker may recommend taking 100–200 mg iron/day. This dose is rather high, and can lead to nausea, **diarrhea**, or abdominal **pain** in 10–20 % of women taking this dose. The reason for using this high dose is to effect a rapid cure for anemia, where the anemia is detected at a midpoint during the pregnancy. The above problems of side effects and noncompliance can be avoided by taking iron doses (100–200 mg) only once a week, where

KEY TERMS

Hematocrit—The proportion of whole blood in the body by volume that is composed of red blood cells.

Hemoglobin—Hemoglobin is an iron-containing protein that resides within red blood cells. Hemoglobin accounts for about 95% of the protein in the red blood cell.

Protoporphyrin IX—Protoporphyrin IX is a protein. The measurement of this protein is useful for the assessment of iron status. Hemoglobin consists of a complex of a protein plus heme. Heme consists of iron plus protoporphyrin IX. Normally, during the course of red blood cell formation, protoporphyrin IX acquires iron to generate heme, and the heme becomes incorporated into hemoglobin. However, in iron deficiency, protophoryrin IX builds up.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients of the diet that are required to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years.

supplements are initiated some time prior to conception, or continuously throughout the fertile period of life. The problem of compliance is not an issue where infusions are used; however, a fraction of patients treated with iron infusions experience side effects, such as flushing, **headache**, nausea, **anaphylaxis**, or seizures. A number of studies have shown that iron deficiency anemia in infancy can result in reduced intelligence, where intelligence was measured in early childhood. It is not certain if iron supplementation of children with reduced intelligence, due to iron deficiency anemia in infancy, has any influence in allowing a "catch-up" in intellectual development.

Prevention

In the healthy population, all of the mineral deficiencies can be prevented by the consumption of inorganic nutrients at levels defined by the RDA. Iron deficiency anemia in infants and young children can be prevented by the use of fortified foods. Liquid cow milk-based infant formulas are generally supplemented with iron (12 mg/L). The iron in liquid formulas is added as ferrous sulfate or ferrous gluconate. Commercial infant cereals are also fortified with iron, and here small particles of elemental iron are added. The levels used are about 0.5 gram iron/kg dry cereal. This amount of iron is about tenfold greater than that of the iron naturally present in the cereal.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

"Food and Nutrition Board." *Recommended Dietary Allowances.* Washington, DC: National Academy Press, 1989.

PERIODICALS

Pennington, J., S. Schoen, G. Salmon, B. Young, R. Johnson, and R. Marts. "Composition of core foods of the U.S. food supply, 1982-1991." *Journal of Food Composition and Analysis* 8 (1995): 129-169.

Swain, R., B. Kaplan, and E. Montgomery. "Iron Deficiency Anemia." *Postgraduate Medicine* 100 (1996): 181-193.

Walter, T., P. Pino, F. Pizarro, and B. Lozoff. "Prevention of Iron-deficiency Anemia: Comparison of High- and Low-iron Formulas in Term Healthy Infants after Six Months of Life." *Journal of Pediatrics* 132 (1998): 635-640.

Tom Brody, PhD

Iron overload *see* **Hemochromatosis**

Iron tests

Definition

Iron tests are a group of blood tests that are done to evaluate the iron level in blood serum, the body's capacity to absorb iron, and the amount of iron actually stored in the body. Iron is an essential trace element; it is necessary for the formation of red blood cells and certain enzymes. At the other extreme, high levels of iron can be poisonous.

Purpose

There are four different types of tests that measure the body's iron levels and storage. They are called iron level tests, total iron-binding capacity (TIBC) tests, ferritin tests, and transferrin tests. These tests are given for several reasons:

- to help in the differential diagnosis of different types of anemia
- to assess the severity of anemia and monitor the treatment of patients with chronic anemia
- to evaluate protein depletion and other forms of **malnutrition**

- to check for certain liver disorders
- to evaluate the possibility of chronic gastrointestinal bleeding (blood loss from the digestive tract is a common cause of **iron deficiency anemia**)
- to help diagnose certain unusual disorders, including iron **poisoning**, **thalassemia**, hemosiderosis, and **hemochromatosis**

A serum iron test can be used without the others to evaluate cases of iron poisoning.

Precautions

Patients should not have their blood tested for iron within four days of a blood **transfusion** or tests and treatments that use radioactive materials. Recent high **stress** levels or sleep deprivation are additional reasons for postponing iron tests.

Blood samples for iron tests should be taken early in the morning because serum iron levels vary during the day. This precaution is especially important in evaluating the results of iron replacement therapy.

Description

Iron tests are performed on samples of the patient's blood, withdrawn from a vein into a vacuum tube. The amount of blood taken is between 6 mL and 10 mL (1/3 of a fluid ounce). The procedure, which is called a venipuncture, takes about five minutes.

Iron level test

The iron level test measures the amount of iron in the blood serum that is being carried by a protein (transferrin) in the blood plasma.

Medications and substances that can cause *increased* iron levels include chloramphenicol, estrogen preparations, dietary iron supplements, alcoholic beverages, methyldopa, and birth control pills.

Medications that can cause *decreased* iron levels include ACTH, colchicine, deferoxamine, methicillin, and testosterone.

Total iron-binding capacity (TIBC) test

The TIBC test measures the amount of iron that the blood would carry if the transferrin were fully saturated. Since transferrin is produced by the liver, the TIBC can be used to monitor liver function and **nutrition**.

Medications that can cause *increased* TIBC levels include fluorides and birth control pills.

Medications that can cause *decreased* TIBC levels include chloramphenicol and ACTH.

Transferrin test

The transferrin test is a direct measurement of transferrin—which is also called siderophilin—levels in the blood. Some laboratories prefer this measurement to the TIBC. The saturation level of the transferrin can be calculated by dividing the serum iron level by the TIBC.

Ferritin test

The ferritin test measures the level of a protein in the blood that stores iron for later use by the body.

Medications that can cause *increased* ferritin levels include dietary iron supplements. In addition, some diseases that do not directly affect the body's iron storage can cause artificially high ferritin levels. These disorders include infections, late-stage cancers, lymphomas, and severe inflammations. Alcoholics often have high ferritin levels.

Preparation

Patient history

Before patients are tested for iron, they should be checked for any of the following factors:

- prescription medications that affect iron levels, absorption, or storage
- blood transfusion or radioactive medications within the last four days
- recent extreme stress or sleep deprivation
- recent eating habits; test results can be affected by eating large amounts of iron-rich foods shortly before the blood test

Fasting

Patients scheduled for an iron level, TIBC, or transferrin test should fast for 12 hours before the blood is drawn. They are allowed to drink water. Patients scheduled for a ferritin test do not need to fast but they should not have any alcoholic beverages before the test.

Aftercare

Aftercare consists of routine care of the area around the venipuncture.

Risks

The primary risk is the possibility of a bruise or swelling in the area of the venipuncture. The patient can apply moist warm compresses if there is any discomfort.

KEY TERMS

Anemia—A disorder marked by low hemoglobin levels in red blood cells, which leads to a deficiency of oxygen in the blood.

Ferritin—A protein found in the liver, spleen, and bone marrow that stores iron.

Hemochromatosis—A disorder of iron absorption characterized by bronze-colored skin. It can cause painful joints, diabetes, and liver damage if the iron concentration is not lowered.

Hemosiderosis—An overload of iron in the body resulting from repeated blood transfusions. Hemosiderosis occurs most often in patients with thalassemia.

Iron poisoning—A potentially fatal condition caused by swallowing large amounts of iron dietary supplements. Most cases occur in children who have taken adult- strength iron formulas. The symptoms of iron poisoning include vomiting, bloody diarrhea, convulsions, low blood pressure, and turning blue.

Plasma—The liquid part of blood.

Siderophilin—Another name for transferrin.

Thalassemia—A hereditary form of anemia that occurs most frequently in people of Mediterranean origin.

Transferrin—A protein in blood plasma that carries iron derived from food intake to the liver, spleen, and bone marrow.

Normal results

Iron level test

Normal serum iron values are as follows:

- adult males: 75–175 micrograms/dL
- adult females: 65–165 micrograms/dL
- children: 50–120 micrograms/dL
- newborns: 100–250 micrograms/dL.

TIBC test

Normal TIBC values are as follows:

- adult males: 300–400 micrograms/dL
- adult females: 300–450 micrograms/dL.

Transferrin test

Normal transferrin values are as follows:

- adult males: 200–400 mg/dL
- adult females: 200–400 mg/dL
- children: 203–360 mg/dL
- newborns: 130–275 mg/dL.

Normal transferrin saturation values are between 30-40%.

Ferritin test

Normal ferritin values are as follows:

- adult males: 20–300 ng/mL
- adult females: 20–120 ng/mL
- children (one month): 200–600 ng/mL
- children (two to five months): 50–200 ng/mL
- children (six months to 15 years): 7–140 ng/mL
- newborns: 25–200 ng/mL.

Abnormal results

Iron level test

Serum iron level is *increased* in thalassemia, hemochromatosis, severe hepatitis, liver disease, **lead poisoning**, acute leukemia, and kidney disease. It is also increased by multiple blood transfusions and intramuscular iron injections.

Iron levels above 350–500 micrograms/dL are considered toxic; levels over 1000 micrograms/dL indicate severe iron poisoning.

Serum iron level is *decreased* in iron deficiency anemia, chronic blood loss, chronic diseases (lupus, **rheumatoid arthritis**), late **pregnancy**, chronically heavy menstrual periods, and thyroid deficiency.

TIBC test

The TIBC is *increased* in iron deficiency anemia, **polycythemia vera**, pregnancy, blood loss, severe hepatitis, and the use of birth control pills.

The TIBC is *decreased* in malnutrition, severe **burns**, hemochromatosis, anemia caused by infections and chronic diseases, **cirrhosis** of the liver, and kidney disease.

Transferrin test

Transferrin is *increased* in iron deficiency anemia, pregnancy, **hormone replacement therapy** (HRT), and the use of birth control pills.

Transferrin is *decreased* in protein deficiency, liver damage, malnutrition, severe burns, kidney disease, chronic infections, and certain genetic disorders.

Ferritin test

Ferritin is *increased* in liver disease, iron overload from hemochromatosis, certain types of anemia, acute leukemia, **Hodgkin's disease**, **breast cancer**, thalassemia, infections, inflammatory diseases, and hemosiderosis. Ferritin levels may be normal or slightly above normal in patients with kidney disease.

Ferritin is *decreased* in chronic iron deficiency and severe protein depletion.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Shaw, Michael, ed. *Everything You Need to Know About Diseases*. Springhouse, PA: Springhouse Corporation, 1996.

Rebecca J. Frey, PhD

Irregular bite *see* **Malocclusion**

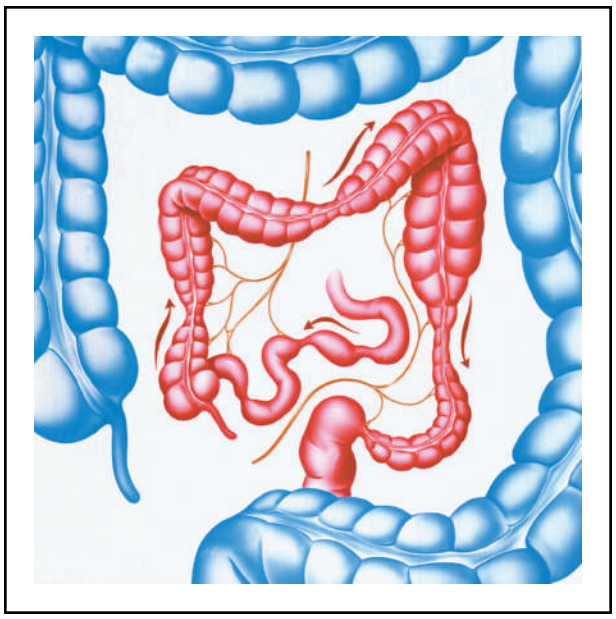
Irritable bowel syndrome

Definition

Irritable bowel syndrome (IBS) is a common intestinal condition characterized by abdominal **pain** and cramps; changes in bowel movements (**diarrhea**, **constipation**, or both); gassiness; bloating; nausea; and other symptoms. There is no cure for IBS. Much about the condition remains unknown or poorly understood; however, dietary changes, drugs, and psychological treatment are often able to eliminate or substantially reduce its symptoms.

Description

IBS is the name people use today for a condition that was once called—among other things—colitis, mucous colitis, spastic colon, nervous colon, spastic bowel, and functional bowel disorder. Some of these names reflected the now-outdated belief that IBS is a purely psychological disorder, a product of the patient's imagination. Although modern medicine recognizes that **stress** can trigger IBS attacks, medical specialists agree that IBS is a genuine physical disorder—or group of disorders—with specific identifiable characteristics.



Normal and diseased (center) colons. Areas of constriction in the colon cause constipation, while areas of distention cause diarrhea. *(John Bavosi/Science Photo Library. Custom Medical Stock Photo. Reproduced by permission.)*

No one knows for sure how many Americans suffer from IBS. Surveys indicate a range of 10-20%, with perhaps as many as 30% of Americans experiencing IBS at some point in their lives. IBS normally makes its first appearance during young adulthood, and in half of all cases symptoms begin before age 35. Women with IBS outnumber men by two to one, for reasons that are not yet understood. IBS is responsible for more time lost from work and school than any medical problem other than the **common cold**. It accounts for a substantial proportion of the patients seen by specialists in diseases of the digestive system (gastroenterologists). Yet only half—possibly as few as 15%—of IBS sufferers ever consult a doctor.

Causes and symptoms

Symptoms

The symptoms of IBS tend to rise and fall in intensity rather than growing steadily worse over time. They always include abdominal pain, which may be relieved by defecation; diarrhea or constipation; or diarrhea alternating with constipation. Other symptoms—which vary from person to person—include cramps; gassiness; bloating; nausea; a powerful and uncontrollable urge to defecate (urgency); passage of a sticky fluid (mucus) during bowel movements; or the feeling after finishing a bowel

movement that the bowels are still not completely empty. The accepted diagnostic criteria—known as the Rome criteria—require at least three months of continuous or recurrent symptoms before IBS can be confirmed. According to Christine B. Dalton and Douglas A. Drossman in the *American Family Physician,* an estimated 70% of IBS cases can be described as "mild;" 25% as "moderate;" and 5% as "severe." In mild cases the symptoms are slight. As a general rule, they are not present all the time and do not interfere with work and other normal activities. Moderate IBS occasionally disrupts normal activities and may cause some psychological problems. People with severe IBS often find living a normal life impossible and experience crippling psychological problems as a result. For some the physical pain is constant and intense.

Causes

Researchers remain unsure about the cause or causes of IBS. It is called a functional disorder because it is thought to result from changes in the activity of the major part of the large intestine (the colon). After food is digested by the stomach and small intestine, the undigested material passes in liquid form into the colon, which absorbs water and salts. This process may take several days. In a healthy person the colon is quiet during most of that period except after meals, when its muscles contract in a series of wavelike movements called peristalsis. Peristalsis helps absorption by bringing the undigested material into contact with the colon wall. It also pushes undigested material that has been converted into solid or semisolid feces toward the rectum, where it remains until defecation. In IBS, however, the normal rhythm and intensity of peristalsis is disrupted. Sometimes there is too little peristalsis, which can slow the passage of undigested material through the colon and cause constipation. Sometimes there is too much, which has the opposite effect and causes diarrhea. A Johns Hopkins University study found that healthy volunteers experienced 6–8 contractions of the colon each day, compared with up to 25 contractions a day for volunteers suffering from IBS with diarrhea, and an almost complete absence of contractions among constipated IBS volunteers. In addition to differences in the number of contractions, many of the IBS volunteers experienced powerful spasmodic contractions affecting a larger-than-normal area of the colon—"like having a Charlie horse in the gut," according to one of the investigators.

DIET. Some kinds of food and drink appear to play a key role in triggering IBS attacks. Food and drink that healthy people can ingest without any trouble may disrupt peristalsis in IBS patients, which probably explains why IBS attacks often occur shortly after meals. Chocolate, milk products, **caffeine** (in coffee, tea, colas, and other drinks), and large quantities of alcohol are some of the chief culprits. Other kinds of food have also been identified as problems, however, and the pattern of what can and cannot be tolerated is different for each person. Characteristically, IBS symptoms rarely occur at night and disrupt the patient's sleep.

STRESS. Stress is an important factor in IBS because of the close nervous system connections between the brain and the intestines. Although researchers do not yet understand all of the links between changes in the nervous system and IBS, they point out the similarities between mild digestive upsets and IBS. Just as healthy people can feel nauseated or have an upset stomach when under stress, people with IBS react the same way, but to a greater degree. Finally, IBS symptoms sometimes intensify during menstruation, which suggests that female reproductive hormones are another trigger.

Diagnosis

Diagnosing IBS is a fairly complex task because the disorder does not produce changes that can be identified during a **physical examination** or by laboratory tests. When IBS is suspected, the doctor (who can be either a family doctor or a specialist) needs to determine whether the patient's symptoms satisfy the Rome criteria. The doctor must rule out other conditions that resemble IBS, such as **Crohn's disease** and **ulcerative colitis**. These disorders are ruled out by questioning the patient about his or her physical and mental health (the medical history), performing a physical examination, and ordering laboratory tests. Normally the patient is asked to provide a stool sample that can be tested for blood and intestinal parasites. In some cases x rays or an internal examination of the colon using a flexible instrument inserted through the anus (a sigmoidoscope or colonoscope) is necessary. The doctor also may ask the patient to try a lactose-free diet for two or three weeks to see whether **lactose intolerance** is causing the symptoms.

Treatment

Dietary changes, sometimes supplemented by drugs or psychotherapy, are considered the key to successful treatment. The following approach, offered by Dalton and Drossman, is typical of the advice found in the medical literature on IBS. The authors tie their approach to the severity of the patient's symptoms:

Mild symptoms

Dalton and Drossman recommend a low-fat, high-fiber diet. Problem-causing substances such as lactose, caffeine, beans, cabbage, cucumbers, broccoli, fatty foods, alcohol, and medications should be identified and avoided. Bran or 15–25 grams a day of an over-the-

counter psyllium laxative (Metamucil or Fiberall) may also help both constipation and diarrhea. The patient can still have milk or milk products if lactose intolerance is not a problem. People with irregular bowel habits—particularly constipated patients—may be helped by establishing set times for meals and bathroom visits.

Moderate symptoms

The advice given by Dalton and Drossman in mild cases applies here as well. They also suggest that patients keep a diary of symptoms for two or three weeks, covering daily activities including meals, and emotional responses to events. The doctor can then review the diary with the patient to identify possible problem areas.

Although a high-fiber diet remains the standard treatment for constipated patients, such **laxatives** as lactulose (Chronulac) or sorbitol may be prescribed. Loperamide (Imodium) and cholestyramine (Questran) are suggested for diarrhea. Abdominal pain after meals can be reduced by taking such **antispasmodic drugs** as hyoscyamine (Anaspaz, Cystospaz, or Levsin) or dicyclomine (Bemote, Bentyl, or Di-Spaz) before eating.

Dalton and Drossman also suggest psychological counseling or behavioral therapy for some patients to reduce **anxiety** and to learn to cope with the pain and other symptoms of IBS. Relaxation therapy, hypnosis, **biofeedback**, and **cognitive-behavioral therapy** are examples of behavioral therapy.

Severe symptoms

When IBS produces constant pain that interferes with everyday life, **antidepressant drugs** can help by blocking pain transmission from the nervous system. Dalton and Drossman also underscore the importance of an ongoing and supportive doctor-patient relationship.

Alternative treatment

Alternative and mainstream approaches to IBS treatment overlap to a certain extent. Like mainstream doctors, alternative practitioners advise a high-fiber diet to reduce digestive system irritation. They also suggest avoiding alcohol, caffeine, and fatty, gassy, or spicy foods. Recommended stress management techniques include **yoga**, **meditation**, hypnosis, biofeedback, and **reflexology**. Reflexology is a technique of foot massage that is thought to relieve diarrhea, constipation, and other IBS symptoms.

Alternative medicine also emphasizes such herbal remedies as ginger (*Zingiber officinale*), buckthorn (*Rhamnus purshiana*), and enteric-coated peppermint oil. Enteric coating prevents digestion until the peppermint oil reaches the small intestine, thus avoiding irritation of the upper part of the digestive tract. Chamomile (*Matricaria recutita*), valerian (*Valeriana officinalis*), rosemary (*Rosemarinus officinalis*), lemon balm (*Melissa officinalis*), and other herbs are recommended for their antispasmodic properties. The list of alternative treatments for IBS is in fact quite long. It includes **aromatherapy**, **homeopathy**, **hydrotherapy**, juice therapy, **acupuncture**, **chiropractic**, **osteopathy**, **naturopathic medicine**, and traditional Chinese herbal medicine.

KEY TERMS

Anus—The opening at the lower end of the rectum.

Crohn's disease—A disease characterized by inflammation of the intestines. Its early symptoms may resemble those of IBS.

Defecation—Passage of feces through the anus.

Feces—Undigested food and other waste that is eliminated through the anus. Feces are also called fecal matter or stools.

Lactose—A sugar found in milk and milk products. Some people are lactose intolerant, meaning they have trouble digesting lactose. Lactose intolerance can produce symptoms resembling those of IBS.

Peristalsis—The periodic waves of muscular contractions that move food through the intestines during the process of digestion.

Ulcerative colitis—A disease that inflames and causes breaks (ulcers) in the colon and rectum, which are parts of the large intestine.

Prognosis

IBS is not a life-threatening condition. It does not cause intestinal bleeding or inflammation, nor does it cause other bowel diseases or **cancer**. Although IBS can last a lifetime, in up to 30% of cases the symptoms eventually disappear. Even if the symptoms cannot be eliminated, with appropriate treatment they can usually be brought under control to the point where IBS becomes merely an occasional inconvenience. Treatment requires a long-term commitment, however; six months or more may be needed before the patient notices substantial improvement.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Puyallup, WA: Future Medicine Publishing, 1993.

Lynn, Richard B., and Lawrence S. Friedman. "Irritable Bowel Syndrome." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Dalton, Christine B., and Douglas A. Drossman. "Diagnosis and Treatment of Irritable Bowel Syndrome." *American Family Physician* (Feb. 1997): 875+.

Hendricks, Melissa. "Bowels in an Uproar." *Johns Hopkins Magazine* (Apr. 1997).

"Irritable Bowel Syndrome: Treating the Mind to Treat the Body." *Tufts University Health & Nutrition Letter* (Sept. 1997): 4+.

Maxwell, P. R., M. A. Mendall, and D. Kumar. "Irritable Bowel Syndrome." *The Lancet* 350 (1997): 1691+.

ORGANIZATIONS

International Foundation for Functional Gastrointestinal Disorders. P.O. Box 17864, Milwaukee, WI 53217. (888) 964-2001. <http://www.iffgd.org>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Howard Baker

Ischemia

Definition

Ischemia is an insufficient supply of blood to an organ, usually due to a blocked artery.

Description

Myocardial ischemia is an intermediate condition in **coronary artery disease** during which the heart tissue is slowly or suddenly starved of oxygen and other nutrients. Eventually, the affected heart tissue will die. When blood flow is completely blocked to the heart, ischemia can lead to a **heart attack**. Ischemia can be silent or symptomatic. According to the American Heart Association, up to four million Americans may have silent ischemia and be at high risk of having a heart attack with no warning.

Symptomatic ischemia is characterized by chest **pain** called **angina** pectoris. The American Heart Association estimates that nearly seven million Americans have angina pectoris, usually called angina. Angina occurs more frequently in women than in men, and in blacks and Hispanics more than in whites. It also occurs more frequently as people age—25% of women over the age of 85 and 27% of men who are 80–84 years old have angina.

People with angina are at risk of having a heart attack. Stable angina occurs during exertion, can be quickly relieved by resting or taking nitroglycerin, and lasts from three to twenty minutes. Unstable angina, which increases the risk of a heart attack, occurs more frequently, lasts longer, is more severe, and may cause discomfort during rest or light exertion.

Ischemia can also occur in the arteries of the brain, where blockages can lead to a **stroke**. About 80-85% of all strokes are ischemic. Most blockages in the cerebral arteries are due to a blood clot, often in an artery narrowed by plaque. Sometimes, a blood clot in the heart or aorta travels to a cerebral artery. A **transient ischemic attack** (TIA) is a "mini-stroke" caused by a temporary deficiency of blood supply to the brain. It occurs suddenly, lasts a few minutes to a few hours, and is a strong warning sign of an impending stroke. Ischemia can also effect intestines, legs, feet and kidneys. Pain, malfunctions, and damage in those areas may result.

Causes and symptoms

Ischemia is almost always caused by blockage of an artery, usually due to atherosclerotic plaque. Myocardial ischemia is also caused by blood clots (which tend to form on plaque), artery spasms or contractions, or any of these factors combined. Silent ischemia is usually caused by emotional or mental **stress** or by exertion, but there are no symptoms. Angina is usually caused by increased oxygen demand when the heart is working harder than usual, for example, during **exercise**, or during mental or physical stress. According to researchers at Harvard University, physical stress is harder on the heart than mental stress. A TIA is caused by a blood clot briefly blocking a cerebral artery.

Risk factors

The risk factors for myocardial ischemia are the same as those for coronary artery disease. For TIA, coronary artery disease is also a risk factor.

- Heredity. People whose parents have coronary artery disease are more likely to develop it. African-Americans are also at higher risk.
- Sex. Men are more likely to have heart attacks than women, and to have them at a younger age.
- Age. Men who are 45 years of age and older and women who are 55 years of age and older are considered to be at risk.
- **Smoking**. Smoking increases both the chance of developing coronary artery disease and the chance of dying from it. Second hand smoke may also increase risk.

- **High cholesterol**. Risk of developing coronary artery disease increases as blood cholesterol levels increase. When combined with other factors, the risk is even greater.
- High blood pressure. High blood pressure makes the heart work harder, and with time, weakens it. When combined with **obesity**, smoking, high cholesterol, or diabetes, the risk of heart attack or stroke increases several times.
- Lack of physical activity. Lack of exercise increases the risk of coronary artery disease.
- Diabetes mellitus. The risk of developing coronary artery disease is seriously increased for diabetics.
- Obesity. Excess weight increases the strain on the heart and increases the risk of developing coronary artery disease, even if no other risk factors are present. Obesity increases blood pressure and blood cholesterol, and can lead to diabetes.
- Stress and anger. Some scientists believe that stress and anger can contribute to the development of coronary artery disease. Stress increases the heart rate and blood pressure and can injure the lining of the arteries. Angina attacks often occur after epsiodes of anger, as do many heart attacks and strokes.

Angina symptoms include:

- a tight, squeezing, heavy, burning, or choking pain that is usually beneath the breastbone—the pain may spread to the throat, jaw, or one arm
- a feeling of heaviness or tightness that isn't painful
- a feeling similar to gas or indigestion
- attacks brought on by exertion and relieved by rest

If the pain or discomfort continues or intensifies, immediate medical help should be sought, ideally within 30 minutes.

TIA symptoms include:

- sudden weakness, tingling, or numbness, usually in one arm or leg or both the arm and leg on the same side of the body, as well as sometimes in the face
- audden loss of coordination
- loss of vision or double vision
- difficulty speaking
- vertigo and loss of balance

Diagnosis

Diagnostic tests for myocardial ischemia include: resting, exercise, or ambulatory electrocardiograms; scintigraphic studies (radioactive heart scans); **echocardiography**; coronary **angiography**; and, rarely, **positron emission tomography**. Diagnostic tests for TIA include physician review of symptoms, **computed tomography scans** (CT scans), carotid artery ultrasound (**Doppler ultrasonography**), and **magnetic resonance imaging**. Angiography is the best test for ischemia of any organ.

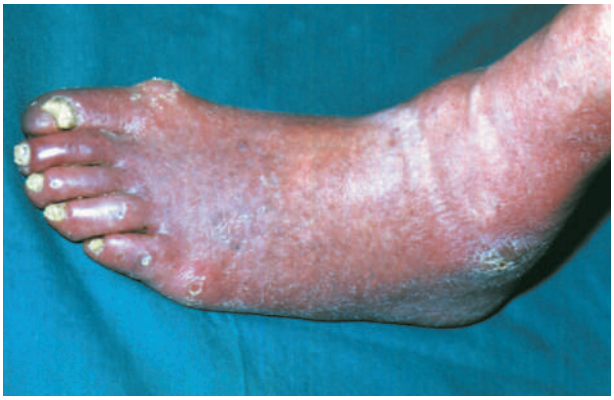
An electrocardiogram (ECG) shows the heart's activity and may reveal a lack of oxygen. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. Impulses of the heart's activity are recorded on paper. The test takes about 10 minutes and is performed in a physician's office. About 25% of patients with angina have normal electrocardiograms. Another type of electrocardiogram, the exercise **stress test**, measures response to exertion when the patient is exercising on a treadmill or a stationary bike. It is performed in a physician's office or an exercise laboratory and takes 15 to 30 minutes. This test is more accurate than a resting ECG in diagnosing ischemia. Sometimes an ambulatory ECG is ordered. For this test, the patient wears a portable ECG machine called a Holter monitor for 12, 24, or 48 hours.

Myocardial perfusion scintigraphy and radionuclide angiography are nuclear studies involving the injection of a radioactive material (e.g., thallium) that is absorbed by healthy tissue. A gamma scintillation camera displays and records a series of images of the radioactive material's movement through the heart. Both tests are usually performed in a hospital's nuclear medicine department and take about 30 minutes to an hour. A perfusion scan is sometimes performed at the end of a stress test.

An echocardiogram uses sound waves to create an image of the heart's chambers and valves. The technician applies gel to a hand-held transducer, then presses it against the patient's chest. The heart's sound waves are converted into an image on a monitor. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30 minutes to an hour. It can reveal abnormalities in the heart wall that indicate ischemia, but it doesn't evaluate the coronary arteries directly.

Coronary angiography is the most accurate diagnostic technique, but it is also the most invasive. It shows the heart's chambers, great vessels, and coronary arteries by using a contrast solution and x ray technology. A moving picture is recorded of the blood flow through the coronary arteries. The patient is awake but sedated, and connected to ECG electrodes and an intravenous line. A local anesthetic is injected. The cardiologist then inserts a catheter into a blood vessel and guides it into the heart. Coronary angiography is performed in a **cardiac catheterization** laboratory and takes from half an hour to two hours.

Positron emission tomography (**PET**) is a noninvasive nuclear test used to evaluate the heart tissue. A PET



This patient's foot is affected with ischemia. Ischemia occurs when there is an insufficient supply of blood to a specific organ or tissue. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

scanner traces high-energy gamma rays released from radioactive particles to provide three-dimensional images of the heart tissue. Performed at a hospital, it usually takes from one hour to one hour and 45 minutes. PET is very expensive and not widely available.

Computed tomography scans (CT scans) and magnetic resonance imaging (MRI) are computerized scanning methods. CT scanning uses a thin x-ray beam to show three-dimensional views of soft tissues. It is performed at a hospital or clinic and takes less than a minute. MRI uses a magnetic field to produce clear, cross-sectional images of soft tissues. The patient lies on a table that slides into a tunnel-like scanner. It is usually performed at a hospital and takes about 30 minutes.

Treatment

Angina is treated with drug therapy and surgery. Drugs such as nitrates, beta-blockers, and **calcium channel blockers** relieve chest pain, but they cannot clear blocked arteries. **Aspirin** helps prevent blood clots. Surgical procedures include percutaneous transluminal coronary **angioplasty** and **coronary artery bypass graft surgery**.

Nitroglycerin is the classic treatment for angina. It quickly relieves pain and discomfort by opening the coronary arteries and allowing more blood to flow to the heart. **Beta blockers** reduce the amount of oxygen required by the heart during stress. Calcium channel blockers help keep the arteries open and reduce blood pressure. Aspirin helps prevent blood clots from forming on plaques.

Percutaneous transluminal coronary angioplasty and coronary artery bypass graft surgery are invasive procedures that improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty is a non-surgical procedure in which a catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compressing the plaque to enlarge the blood vessel and open the blocked artery. The balloon is deflated and the catheter is removed. The procedure is performed by a cardiologist in a hospital and generally requires a two-day stay. Sometimes a metal stent is placed in the artery to prevent closing of the artery.

In coronary artery bypass graft, called bypass surgery, a detour is built around the coronary artery blockage with a healthy leg vein or chest wall artery. The healthy vein or artery then supplies oxygen-rich blood to the heart. Bypass surgery is major surgery appropriate for patients with blockages in two or three major coronary arteries or severely narrowed left main coronary arteries, as well as those who have not responded to other treatments. It is performed in a hospital under general anesthesia using a heart-lung machine to support the patient while the healthy vein or artery is attached to the coronary artery.

There are several experimental surgical procedures: **atherectomy**, in which the surgeon shaves off and removes strips of plaque from the blocked artery; laser angioplasty, in which a catheter with a laser tip is inserted to burn or break down the plaque; and insertion of a metal coil, called a stent, that can be implanted permanently to keep a blocked artery open. This stenting procedure is becoming more common. Another experimental procedure uses a laser to drill channels in the heart muscle to increase blood supply.

TIAs are treated by drugs that control high blood pressure and reduce the likelihood of blood clots and surgery. Aspirin is commonly used and anticoagulants are sometimes used to prevent blood clots. In some cases, carotid **endarterectomy** surgery is performed to help prevent further TIAs. The procedure involves removing arterial plaque from inside blood vessels.

The use of **chelation therapy**, a long-term injection by a physician of a cocktail of synthetic amino acid, ethylenediaminetetracetric acid, and anticoagulant drugs and nutrients, is controversial.

Alternative treatment

Ischemia can be life-threatening. Although there are alternative treatments for angina, traditional medical care may be necessary. Prevention of the cause of ischemia, primarily **atherosclerosis**, is primary. This becomes even more important for people with a family history of heart disease. Dietary modifications, especially the reduction or elimination of saturated fats (primarily found in meat), are essential. Increased fiber (found in fresh fruits and

vegetables, grains, and beans) can help the body eliminate excessive cholesterol through the stools. Exercise, particularly aerobic exercise, is essential for circulation health. Not smoking will prevent damage from smoke and the harmful substances it contains.

Abana, a mixture of herbs and **minerals** used in **ayurvedic medicine**, can reduce the frequency and severity of angina attacks. Western herbal medicine recommends hawthorn (*Crataegus laevigata* or *C. oxyacantha*) to relieve long-term angina, since it strengthens the contractility of the heart muscles. Nutritional supplements and botanical medicines that act as antioxidants, for example, **vitamins** C and E, selenium, gingko (*Gingko biloba*), bilberry (*Vaccinium myrtillus*), and hawthorn, can help prevent initial arterial injury that can lead to the formation of plaque deposits. Cactus (*Cactus grandiflorus*) is a homeopathic remedy used for pain relief during an attack. Mind/body relaxation techniques such as **yoga** and **biofeedback** can help control strong emotions and stress.

KEY TERMS

Atherosclerosis—A process in which the walls of the arteries thicken due to the accumulation of plaque in the blood vessels. Atherosclerosis is the cause of most coronary artery disease.

Coronary artery disease —A narrowing or blockage, due to atherosclerosis, of the arteries that provide oxygen and nutrients to the heart. When blood flow is cut-off, the result is a heart attack.

Plaque—A deposit of fatty and other substances that accumulate in the lining of the artery wall.

Stroke—A sudden decrease or loss of consciousness caused by rupture or blockage of a blood vessel by a blood clot or hemorrhage in the brain. Ischemic strokes are caused by blood clots in a cerebral artery.

Prognosis

In many cases, ischemia can be successfully treated, but the underlying disease process of atherosclerosis is usually not "cured." New diagnostic techniques enable doctors to identify ischemia earlier. New technologies and surgical procedures can prevent angina from leading to a heart attack or TIA from resulting in a stroke. The outcome for patients with silent ischemia has not been well established.

Prevention

A healthy lifestyle, including eating right, getting regular exercise, maintaining a healthy weight, not smoking, drinking in moderation, not using illegal drugs, controlling **hypertension**, and managing stress are practices that can reduce the risk of ischemia progressing to a heart attack or stroke.

A healthy diet includes a variety of foods that are low in fat, especially saturated fat; low in cholesterol; and high in fiber. Plenty of fruits and vegetables should be eaten and sodium should be limited. Fat should comprise no more than 30% of total daily calories. Cholesterol should be limited to about 300 mg and sodium to about 2,400 mg per day.

Moderate aerobic exercise lasting about 30 minutes four or more times per week is recommended for maximum heart health, according to the Centers for Disease Control and Prevention and the American College of Sports Medicine. Three 10-minute exercise periods are also beneficial. If any risk factors are present, a physician's clearance should be obtained before starting exercise.

Maintaining a desirable body weight is also important. People who are 20% or more over their ideal body weight have an increased risk of developing coronary artery disease or stroke.

Smoking has many adverse effects on the heart and arteries, so should be avoided. Heart damage caused by smoking can be improved by quitting. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within five to ten years of quitting.

Excessive drinking can increase risk factors for heart disease. Modest consumption of alcohol, however, can actually protect against coronary artery disease. The American Heart Association defines moderate consumption as one ounce of alcohol per day—roughly one cocktail, one 8-ounce glass of wine, or two 12-ounce glasses of beer.

Commonly used illegal drugs can seriously harm the heart and should never be used. Even stimulants like ephedra and **decongestants** like pseudoephedrine can be harmful to patients with hypertension or heart disease.

Treatment should be sought for hypertension. High blood pressure can be completely controlled through lifestyle changes and medication. Stress, which can increase the risk of a heart attack or stroke, should also be managed. While it cannot always be avoided, it can be controlled.

Resources

BOOKS

American Heart Association. *Heart Attack Treatment, Prevention, Recovery.* New York: Time Books, 1996.

"Angina." In *The Alternative Advisor: The Complete Guide to Natural Therapies & Alternative Treatments*. Alexandria, VA: Time-Life Books, 1997.

"Coronary Heart Disease (Arteriosclerotic Coronary Artery Disease; Ischemic Heart Disease)." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

DeBakey, Michael E. and Antonio M. Gotto Jr. "Coronary Artery Disease" and "Stroke." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

Iskandrian, A. S., and Mario S. Verani. "Scintigraphic Techniques in Acute Ischemic Syndromes." In *Nuclear Cardiac Imaging: Principles and Applications*. 2nd ed. Philadelphia: F. A. Davis, 1996.

PERIODICALS

Geraci, Ron, and Duane Swierczynski. "Short Strokes." *Men's Health*, Sept. 1997, 56.

"How Mental Stress Taxes the Heart." *Harvard Health Letter* (Mar. 1997): 2.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave., Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Transient Ischemic Attack." *American Academy of Neurology.* 1997. 25 Mar. 1998. <http://www.aan.com>.

Lori De Milto

Isocarboxazid *see* **Monoamine oxidase inhibitors**

Isolation

Definition

Isolation refers to the precautions that are taken in the hospital to prevent the spread of an infectious agent from an infected or colonized patient to susceptible persons.

Purpose

Isolation practices are designed to minimize the transmission of infection in the hospital, using current understanding of the way infections can transmit. Isolation should be done in a user-friendly, well-accepted, inexpensive way that interferes as little as possible with patient care; minimizes patient discomfort; and avoids unnecessary use.

Precautions

The types of precautions used should be viewed as a flexible scale that may range from the least to the most demanding methods of prevention. These methods should always take into account that differences exist in the way that diseases are spread. Recognition and understanding of these differences will avoid use of insufficient or unnecessary interventions.

Description

Isolation practices can include placement in a private room or with a select roommate; the use of protective barriers such as masks, gowns and gloves; a special emphasis on handwashing (which is always very important); and special handling of contaminated articles. Because of the differences among infectious diseases, more than one of these precautions may be necessary to prevent spread of some diseases but may not be necessary for others.

The Centers for Disease Control and Prevention (CDC) and the Hospital **Infection Control** Practice Advisory Committee (HICPAC) have led the way in defining the guidelines for hospital-based infection precautions. The most current system recommended for use in hospitals consists of two levels of precautions. The first level is Standard Precautions, which apply to all patients at all times because signs and symptoms of infection are not always obvious and therefore may unknowingly pose a risk for a susceptible person. The second level is known as Transmission-Based Precautions, which are intended for individuals who have a known or suspected infection with certain organisms.

Frequently, patients are admitted to the hospital without a definite diagnosis, but with clues that suggest an infection. These patients should be isolated with the appropriate precautions until a definite diagnosis is made.

Standard Precautions

Standard Precautions define all the steps that should be taken to prevent spread of infection from person to person when there is an anticipated contact with:

- blood
- body fluids
- secretions, such as phlegm
- excretions, such as urine and feces (not including sweat), whether or not they contain visible blood
- nonintact skin, such as an open wound
- mucous membranes, such as the mouth cavity

Standard Precautions includes the use of one or of combinations of the following practices. The level of use

will always depend on the nature of the anticipated contact with the patient:

- handwashing, the most important infection control method
- use of latex or other protective gloves
- masks, eye protection and/or face shield
- gowns
- proper handling of soiled patient care equipment
- proper environmental cleaning
- minimal handling of soiled linen
- proper disposal of needles and other sharp equipment such as scalpels
- placement in a private room for patients who cannot maintain appropriate cleanliness or contain body fluids

Transmission-Based Precautions

Transmission-Based Precautions may be needed in addition to Standard Precautions for selected patients who are known or suspected to harbor certain infections. These precautions are divided into three categories that reflect the differences in the way infections are transmitted. Some diseases may require more than one isolation category.

AIRBORNE PRECAUTIONS. Airborne Precautions prevent diseases that are transmitted by minute particles called droplet nuclei or contaminated dust particles. These particles, can remain suspended in the air for long periods of time because of their size; even after the infected person has left the room. Some examples of diseases requiring these precautions are **tuberculosis**, **measles**, and **chickenpox**.

A patient needing Airborne Precautions should be assigned to a private room with special ventilation requirements. The door to this room must be closed at all possible times. If a patient must move from the isolation room to another area of the hospital, the patient should be wearing a mask during the transport. Anyone entering the isolation room to provide care to the patient must wear a special mask called a respirator.

DROPLET PRECAUTIONS. Droplet Precautions prevent the spread of organisms that travel on particles much larger than the droplet nuclei. These particles do not spend much time suspended in the air, and usually do not travel beyond a several-foot range from the patient. These particles are produced when a patient coughs, talks, or sneezes. Examples of diseases requiring droplet precautions are meningococcal **meningitis** (a serious bacterial infection of the lining of the brain), **influenza**, **mumps**, and German measles (**rubella**).

KEY TERMS

Colonized—Colonization occurs when a microorganism is found on or in a person without causing a disease.

Disinfected—Decreased the number of microorganisms on or in an object.

Latex—A rubber material from which gloves and condoms are made.

Phlegm—Another word for sputum, material coughed up from a person's airway.

Stethoscope—A medical instrument for listening to a patient's heart and lungs.

Patients who require Droplet Precautions should be placed in a private room or with a roommate who is infected with the same organism. The door to the room may remain open. Health care workers will need to wear masks within 3 ft of the patient. Patients moving about the hospital away from the isolation room should wear a mask.

CONTACT PRECAUTIONS. Contact Precautions prevent spread of organisms from an infected patient through direct (touching the patient) or indirect (touching surfaces or objects that that been in contact with the patient) contact. Examples of patients who might be placed in Contact Precautions are those infected with:

- antibiotic-resistant bacteria
- hepatitis A
- scabies
- impetigo
- lice

This type of precaution requires the patient to be placed in a private room or with a roommate who has the same infection. Health care workers should wear gloves when entering the room. They should change their gloves if they touch material such as soiled dressings that contains large volumes of organisms. Prior to leaving the room, health care workers should remove the gloves and wash their hands with medicated soap. In addition, they may need to wear protective gowns if there is a chance of contact with potentially infective materials such as discharges from **diarrhea** or wound drainage that cannot be contained, or if there is likely to be extensive contact with the patient or environment.

Patient care items, such as a stethoscope, that are used for a patient in Contact Precautions should not be shared with other patients unless they are properly

cleaned and disinfected before reuse. Patients should leave the isolation room infrequently.

Resources

BOOKS

Edmond, M. "Isolation." In *A Practical Handbook for Hospital Epidemiologists*, ed. L. A. Herwaldt and M.D. Decker. Thorofare, NJ: Slack Inc., 1998.

Garner, J. S. "Universal Precautions and Isolation Systems." In *Hospital Infections*, ed. J. V. Bennett and P. S. Brachman. Boston: Little, Brown, 1992.

PERIODICALS

U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. "Draft Guideline for Isolation Precautions in Hospitals." *Federal Register* 59 (1994): 55552-55570.

Suzanne M. Lutwick

Isoniazid *see* **Antituberculosis drugs**

Isosorbide dinitrate *see* **Antiangina drugs**

Isotretinoin *see* **Antiacne drugs**

Isradipine *see* **Calcium channel blockers**

Itching

Definition

Itching is an intense, distracting irritation or tickling sensation that may be felt all over the skin's surface, or confined to just one area. The medical term for itching is "pruritus."

Description

Itching instinctively leads most people to scratch the affected area. Different people can tolerate different amounts of itching, and anyone's threshold of tolerance can be changed due to **stress**, emotions, and other factors. In general, itching is more severe if the skin is warm, and if there are few distractions. This is why people tend to notice itching more at night.

Causes and symptoms

The reason for the sensation of itching is not well understood. While itching is the most noticeable symptom in many skin diseases, it doesn't necessary mean that a person who feels itchy has a disease.

Stress and emotional upset can make itching worse, no matter what the underlying cause. If emotional problems are the primary reason for the itch, the condition is known as psychogenic itching. Some people become convinced that their itch is caused by a parasite; this conviction is often linked to burning sensations in the tongue, and may be caused by a major psychiatric disorder.

Generalized itching

Itching that occurs all over the body may indicate a medical condition such as **diabetes mellitus**, liver disease, kidney failure, **jaundice**, thyroid disorders (and rarely, **cancer**). Blood disorders such as leukemia, and lymphatic conditions such as **Hodgkin's disease** may sometimes cause itching as well.

Some people may develop an itch without a rash when they take certain drugs (such as **aspirin**, codeine, **cocaine**); others may develop an itchy red "drug rash" or **hives** because of an allergy to a specific drug.

Itching also may be caused when any of the family of hookworm larvae penetrate the skin. This includes swimmer's itch and creeping eruption caused by cat or dog hookworm, and ground itch caused by the "true" hookworm.

Many skin conditions cause an itchy rash. These include:

- atopic **dermatitis**
- chickenpox
- **contact dermatitis**
- dermatitis herpetiformis (occasionally)
- eczema
- fungus infections (such as **athlete's foot**)
- hives (urticaria)
- insect bites
- lice
- lichen planus
- neurodermatitis (**lichen simplex chronicus**)
- psoriasis (occasionally)
- scabies

On the other hand, itching all over the body can be caused by something as simple as bathing too often, which removes the skin's natural oils and may make the skin too dry and scaly.

Localized itching

Specific itchy areas may occur if a person comes in contact with soap, detergents, and wool or other rough-

textured, scratchy material. Adults who have **hemorrhoids**, anal fissure, or persistent **diarrhea** may notice itching around the anus (called "pruritus ani"). In children, itching in this area is most likely due to worms.

Intense itching in the external genitalia in women ("pruritus vulvae") may be due to **candidiasis**, hormonal changes, or the use of certain spermicides or vaginal suppositories, ointments, or deodorants.

It's also common for older people to suffer from dry, itchy skin (especially on the back) for no obvious reason. Younger people also may notice dry, itchy skin in cold weather. Itching is also a common complaint during **pregnancy**.

Diagnosis

Itching is a symptom that is quite obvious to its victim. Someone who itches all over should seek medical care. Because itching can be caused by such a wide variety of triggers, a complete physical exam and medical history will help diagnose the underlying problem. A variety of blood and stool tests may help determine the underlying cause.

Treatment

Antihistamines such as diphenhydramine (Benadryl) can help relieve itching caused by hives, but won't affect itching from other causes. Most antihistamines also make people sleepy, which can help patients sleep who would otherwise be awake from the itch.

Specific treatment of itching depends on the underlying condition that causes it. In general, itchy skin should be treated very gently. While scratching may temporarily ease the itch, in the long run scratching just makes it worse. In addition, scratching can lead to an endless cycle of itch—scratch—more itching.

To avoid the urge to scratch, a person can apply a cooling or soothing lotion or cold compress when the urge to scratch occurs. Soaps are often irritating to the skin, and can make an itch worse; they should be avoided, or used only when necessary.

Creams or ointments containing cortisone may help control the itch from insect bites, contact dermatitis or eczema. Cortisone cream should not be applied to the face unless a doctor prescribes it.

Probably the most common cause of itching is dry skin. There are a number of simple things a person can do to ease the annoying itch:

- don't wear tight clothes
- avoid synthetic fabrics
- don't take long baths
- wash the area in lukewarm water with a little baking soda
- for generalized itching, take a lukewarm shower
- try a lukewarm oatmeal (or Aveeno) bath for generalized itching
- apply bath oil or lotion (without added colors or scents) right after bathing

People who itch as a result of mental problems or stress should seek help from a mental health expert.

KEY TERMS

Atopic dermatitis—An intensely itchy inflammation often found on the face of people prone to allergies. In infants and early childhood, it's called infantile eczema.

Creeping eruption—Itchy irregular, wandering red lines on the foot made by burrowing larvae of the hookworm family and some roundworms.

Dermatitis herpetiformis—A chronic very itchy skin disease with groups of red lesions that leave spots behind when they heal. It is sometimes associated with cancer of an internal organ.

Eczema—A superficial type of inflammation of the skin that may be very itchy and weeping in the early stages; later, the affected skin becomes crusted, scaly, and thick. There is no known cause.

Hodgkin's disease—A type of cancer characterized by slowly-enlarging lymph tissue; symptoms include generalized itching.

Lichen planus—A noncancerous, chronic itchy skin disease that causes small, flat purple plaques on wrists, forearm, ankles.

Neurodermatitis —An itchy skin disease (also called lichen simplex chronicus) found in nervous, anxious people.

Psoriasis—A common chronic skin disorder that causes red patches anywhere on the body. Occasionally, the lesions may itch.

Scabies—A contagious parasitic skin disease characterized by intense itching.

Swimmer's itch—An allergic skin inflammation caused by a sensitivity to flatworms that die under the skin, causing an itchy rash.

Prognosis

Most cases of itching go away when the underlying cause is treated successfully.

Prevention

There are certain things people can do to avoid itchy skin. Patients who tend toward itchy skin should:

- avoid a daily bath
- use only lukewarm water when bathing
- use only gentle soap
- pat dry, not rub dry, after bathing, leaving a bit of water on the skin
- apply a moisture-holding ointment or cream after the bath
- use a humidifier in the home

Patients who are allergic to certain substances, medications, and so on can avoid the resulting itch if they avoid contact with the allergen. Avoiding insect bites, bee stings, poison ivy and so on can prevent the resulting itch. Treating sensitive skin carefully, avoiding overdrying of the skin, and protecting against diseases that cause itchy **rashes** are all good ways to avoid itching.

Resources

BOOKS

Donahue, Peggy Jo. *Relief from Chronic Skin Problems.* New York: Dell Publishing, 1992.

Manual of Clinical Problems in Dermatology. Ed. Susan M. Olbricht, et al. Boston: Little, Brown and Co.,1992.

Turkington, Carol A., and Jeffrey S. Dover. *Skin Deep: An A to Z of Skin Disorders, Treatments and Health.* New York: Facts on File, 1998.

PERIODICALS

Bogin, Rob. "Don't Scratch That Itch." *Rocky Mountain News*, 5 Oct. 1997, 6F.

Carol A. Turkington

IUD

Definition

An IUD is an intrauterine device made of plastic and/or copper that is inserted into the womb (uterus) by way of the vaginal canal. One type releases a hormone (progesterone), and is replaced each year. The second type is made of copper and can be left in place for five years. The most common shape in current use is a plastic "T" which is wrapped with copper wire.

Purpose

IUDs are used to prevent **pregnancy** and are considered to be 95–98% effective. It should be noted that IUDs offer no protection against the acquired **immunodeficiency** syndrome (**AIDS**) virus or other **sexually transmitted diseases** (STDs).

Precautions

IUDs are placed in the uterus by physicians. Prior to placement the doctor will take a medical history, do a **physical examination**, and take a **Pap test**. Women who have had tubal pregnancies, an abnormal Pap smear, or abnormal vaginal bleeding are generally disqualified from using this form of **contraception**. Also, women who have STDs, an allergy to copper, severe **pain** with periods (menstruation), sex with multiple partners, or who are currently pregnant are not eligible for an IUD. There are no age restrictions.

Description

There is continuing controversy over exactly how IUDs prevent pregnancy. Some researchers think pregnancy is controlled by preventing conception (fertilization), while others believe that the devices prevent embryo attachment to the uterine wall (implantation).

IUDs that release a hormone may prevent pregnancy in several ways. Since one hormonal response is a thickening of the mucus at the entrance to the uterus, it is more difficult for the sperm to gain entry. This prevents the sperm from reaching an ovum. At the same time, the lining of the uterus becomes thinner, making it more difficult for a fertilized egg to implant itself in the uterus. The copper device slowly releases copper, which is believed to weaken and perhaps kill sperm. An alternate explanation is that these objects "sweep" the uterus, dislodging any fertilized egg that attempts to implant itself. In addition, both devices tend to cause a mild inflammatory reaction in the lining of the uterus, which also has an adverse impact on implantation.

Preparation

After the physician approves the use of an IUD, the woman's genital area is washed thoroughly with soap and water in preparation of IUD insertion. The opening into the uterus (cervix) will also be cleaned with an antiseptic such as an iodine solution. Actual IUD insertion takes about five minutes, during which local anesthesia is used to reduce any discomfort associated with the proce-

KEY TERMS

Antiseptic—An antiseptic is a chemical that prevents the growth of germs.

Hormone—Hormones are chemicals that are produced in an organ or gland and then are carried by the blood to another part of the body where they produce a special effect for which they were designed.

Pap test—This is a procedure by which cells are collected from the cervix and vagina by inserting a swab into the vaginal canal. These cells are then examined under a microscope in order to detect signs of early cancer.

dure. A plastic string connected to the IUD will hang out of the uterus into the vagina. The string is used to periodically check the position of the IUD.

Aftercare

The woman will be taught to watch for the signs and symptoms of potential complications and how to check the string, which should be done at least once a week. To check the string, the woman should first wash her hands with soap and water. From a squatting position, or with one foot elevated (such as on a chair), she should gently insert her finger into the vagina until she feels the cervix. If she cannot feel the string, if the string feels longer than it should, or if she can feel part of the IUD she should notify her physician immediately. Additional information that needs to be reported includes painful intercourse and unusual discharges from the vagina.

Risks

Serious risks are rare, but include heavy bleeding, pain, infection, cramps, **pelvic inflammatory disease**, perforation of the uterus, and **ectopic pregnancy**.

Resources

BOOKS

Dickason, Elizabeth Jean, Bonnie Lang Silverman, and Judith A. Kaplan. *Maternal-Infant Nursing Care.* St. Louis: Mosby-Year Book Inc., 1998.

Gorrie, Trula Meyers, Emily Slone McKinney, and Sharon Smith Murray. *Foundations of Maternal-Newborn Nursing.* Philadelphia: W. B. Saunders Co., 1998.

Nichols, Francine H., and Elaine Zwelling. *Maternal-Newborn Nursing: Theory and Practice.* Philadelphia: W. B. Saunders Co., 1997.

Olds, Sally B., Marcia L. London, and Patricia Wieland Ladewig. *Maternal-Newborn Nursing: A Family Centered Approach.* Menlo Park, CA: Addison-Wesley, 1996.

ORGANIZATIONS

Planned Parenthood Federation of America, Inc. 810 Seventh Ave., New York, NY,10019. (800) 669-0156. <http://www.plannedparenthood.org>.

OTHER

"Intrauterine Device (IUD)." *Planned Parenthood League of Massachusetts Page.* 11 Feb. 1998 <http://www.pplm.org/iud.html>.

"The IUD (Intrauterine Device): Answers to Your Questions." *EngenderHealth Page.* 4 Feb. 1998 <http://www.engenderhealth.org>.

Donald G. Barstow, RN

Ivory bones *see* **Osteopetroses**

Ivy method *see* **Bleeding time**

J

Japanese encephalitis

Definition

Japanese **encephalitis** is an infection of the brain caused by a virus. The virus is transmitted to humans by mosquitoes.

Description

The virus that causes Japanese encephalitis is called an arbovirus, which is an arthropod-borne virus. Mosquitoes are a type of arthropod. Mosquitoes in a number of regions carry this virus and are responsible for passing it along to humans. Many of these areas are in Asia, including Japan, Korea, China, India, Thailand, Indonesia, Malaysia, Vietnam, Taiwan, and the Philippines. Areas where the disease-causing arbovirus is always present are referred to as being endemic for the disease. In such areas, blood tests will reveal that more than 70% of all adults have been infected at some point with the arbovirus.

Because the virus that causes Japanese encephalitis is carried by mosquitoes, the number of people infected increases during those seasons when mosquitoes are abundant. This tends to be in the warmest, rainiest months. In addition to humans, other animals like wild birds, pigs, and horses are susceptible to infection with this arbovirus. Because the specific type of mosquito carrying the Japanese encephalitis arbovirus frequently breeds in rice paddies, the disease is considered to be primarily a rural problem.

Causes and symptoms

The virus is transferred to a human when an infected mosquito sucks that person's blood. Once in the body, the virus travels to various glands where it multiplies. The virus can then enter the bloodstream. Ultimately, the virus settles in the brain, where it causes serious problems.

Japanese encephalitis begins with **fever**, severe **headache**, nausea, and vomiting. As the tissue covering the brain and spinal cord (the meninges) becomes infected and swollen, the patient will develop a stiff and painful neck. By day two or three, the patient begins to suffer the effects of swelling in the brain. These effects include:

- problems with balance and coordination
- paralysis of some muscle groups
- tremors
- seizures
- lapses in consciousness
- a stiff, mask-like appearance of the face

The patient becomes dehydrated and loses weight. If the patient survives the illness, the fever will decrease by about day seven and the symptoms will begin to improve by about day 14. Other patients will continue to have extremely high fevers and their symptoms will get worse. In these cases, **coma** and then **death** occur in 7-14 days. Many patients who recover have permanent disabilities due to brain damage.

Diagnosis

Most diagnostic techniques for Japanese encephalitis do not yield results very quickly. The diagnosis is made primarily on the basis of the patient's symptoms and the knowledge of the kinds of illnesses endemic to a particular geographic region.

Immunofluorescence tests, where special viral markers react with human antibodies that have been tagged with a fluorescent chemical, are used to verify the disease. However, these results tend to be unavailable until week two of the infection. Other tests involve comparing the presence and quantity of particular antibodies in the blood or spinal fluid during week one with those present during week two of the illness.

KEY TERMS

Antibody—A type of cell made by the immune system that has the ability to recognize markers (antigens) on the surface of invading organisms, like bacteria and viruses.

Encephalitis—A swelling of the brain, potentially causing serious brain damage.

Endemic—Naturally and consistently present in a certain geographical region.

Treatment

There are no treatments available to stop or slow the progression of Japanese encephalitis. Only the symptoms of each patient can be treated. Fluids are given to decrease **dehydration** and medications are given to decrease fever and **pain**. Medications are available to attempt to decrease brain swelling. Patients in a coma may require mechanical assistance with breathing.

Prognosis

While the majority of people infected with arbovirus never become sick, those who develop Japanese encephalitis become very ill. Some outbreaks have a 50% death rate. A variety of long-term problems may haunt those who recover from the illness. These problems include:

- movement difficulties where the arms, legs, or body jerks or writhes involuntarily
- shaking
- paralysis
- inability to control emotions
- loss of mental abilities
- mental disturbances, including **schizophrenia** (which may affect as many as 75% of Japanese encephalitis survivors)

Young children are most likely to have serious, long-term problems after an infection.

Prevention

A three-dose vaccine is available for Japanese encephalitis and is commonly given to young children in areas where the disease is endemic. Travelers to these regions can also receive the vaccine.

Controlling the mosquito population with insecticides is another preventive measure. Visitors to regions with high rates of Japanese encephalitis should take precautions (like using mosquito repellents and sleeping under a bed net) to avoid contact with mosquitoes.

Resources

BOOKS

Douglas, R. Gordon. "Other Arthropod-Borne Viruses." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Arthropod-Borne and Other Zoonotic Viruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Jaundice

Definition

Jaundice is a condition in which a person's skin and the whites of the eyes are discolored yellow due to an increased level of bile pigments in the blood resulting from liver disease. Jaundice is sometimes called icterus, from a Greek word for the condition.

Description

In order to understand jaundice, it is useful to know about the role of the liver in producing bile. The most important function of the liver is the processing of chemical waste products like cholesterol and excreting them into the intestines as bile. The liver is the premier chemical factory in the body—most incoming and outgoing chemicals pass through it. It is the first stop for all nutrients, toxins, and drugs absorbed by the digestive tract. The liver also collects chemicals from the blood for processing. Many of these outward-bound chemicals are excreted into the bile. One particular substance, bilirubin, is yellow. Bilirubin is a product of the breakdown of hemoglobin, which is the protein inside red blood cells. If bilirubin cannot leave the body, it accumulates and discolors other tissues. The normal total level of bilirubin in blood serum is between 0.2 mg/dL and 1.2 mg/dL. When it rises to 3 mg/dL or higher, the person's skin and the whites of the eyes become noticeably yellow.

Bile is formed in the liver. It then passes into the network of hepatic bile ducts, which join to form a single tube. A branch of this tube carries bile to the gallbladder, where it is stored, concentrated, and released on a signal from the stomach. Food entering the stomach is the signal that stimulates the gallbladder to release the bile. The tube, which is now called the common bile duct, continues to the intestines. Before the common bile duct reaches the intestines, it is joined by another duct from the pancreas. The bile and the pancreatic juice enter the intestine through a valve called the ampulla of Vater. After entering the intestine, the bile and pancreatic secretions together help in the process of digestion.

Causes and symptoms

There are many different causes for jaundice, but they can be divided into three categories based on where they start—before, in, or after the liver (pre-hepatic, hepatic and post-hepatic). When bilirubin begins its life cycle, it cannot be dissolved in water. The liver changes it so that it is soluble in water. These two types of bilirubin are called unconjugated (insoluble) and conjugated (soluble). Blood tests can easily distinguish between these two types of bilirubin.

Hemoglobin and bilirubin formation

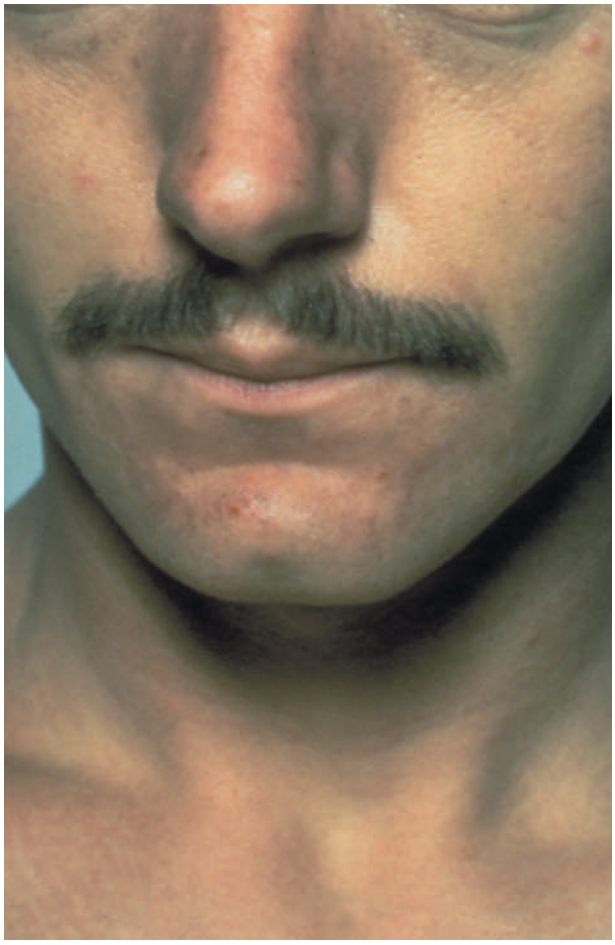
Bilirubin begins as hemoglobin in the blood-forming organs, primarily the bone marrow. If the production of red blood cells (RBCs) falls below normal, the extra hemoglobin finds its way into the bilirubin cycle and adds to the pool.

Once hemoglobin is in the red cells of the blood, it circulates for the life span of those cells. The hemoglobin that is released when the cells die is turned into bilirubin. If for any reason the RBCs die at a faster rate than usual, bilirubin can accumulate in the blood and cause jaundice.

Hemolytic disorders

Many disorders speed up the **death** of red blood cells. The process of red blood cell destruction is called hemolysis, and the diseases that cause it are called hemolytic disorders. If red blood cells are destroyed faster than they can be produced, the patient develops anemia. Hemolysis can occur in a number of diseases, disorders, conditions, and medical procedures:

- **Malaria**. The malaria parasite develops inside red blood cells. When it is mature it breaks the cell apart and swims off in the blood. This process happens to most of the parasites simultaneously, causing the intermittent symptoms of the disease. When enough cells burst at once, jaundice may result from the large amount of bilirubin formed from the hemoglobin in the dead cells. The pigment may reach the urine in sufficient quantities to cause "blackwater fever," an often lethal form of malaria.
- Side effects of certain drugs. Some common drugs can cause hemolysis as a rare but sudden side effect. These medications include some antibiotic and anti-tuberculosis medicines; drugs that regulate the heartbeat; and levodopa, a drug used to treat **Parkinson's disease**.
- Certain drugs in combination with a hereditary enzyme deficiency known as glucose-6-phosphate dehydrogenase (G6PD). G6PD is a deficiency that affects over 200 million people in the world. Some of the drugs listed above are more likely to cause hemolysis in people with G6PD. Other drugs cause hemolysis only in people with this disorder. Most important among these drugs are anti-malarial medications such as quinine, and **vitamins** C and K.



This patient suffers from obstructive jaundice, which is often caused by gallstones. *(Custom Medical Stock Photo. Reproduced by permission.)*

A newborn baby undergoes phototherapy with visible blue light to treat his jaundice. *(Photograph by Ron Sutherland, Photo Researchers, Inc. Reproduced by permission.)*

- Poisons. Snake and spider venom, certain bacterial toxins, copper, and some organic industrial chemicals directly attack the membranes of red blood cells.
- Artificial heart valves. The inflexible moving parts of heart valves damage RBCs as they flutter back and forth. This damage is one reason to recommend pig valves and valves made of other organic materials.
- Hereditary RBC disorders. There are a number of hereditary defects that affect the blood cells. There are many genetic mutations that affect the hemoglobin itself, the best-known of which is **sickle cell disease**. Such hereditary disorders as spherocytosis weaken the outer membrane of the red cell. There are also inherited defects that involve the internal chemistry of RBCs.
- Enlargement of the spleen. The spleen is an organ that is located near the upper end of the stomach and filters the blood. It is supposed to filter out and destroy only worn-out RBCs. If it has become enlarged, it filters out normal cells as well. Malaria, other infections, cancers and leukemias, some of the hereditary **anemias** mentioned above, obstruction of blood flow from the spleen—all these and many more diseases can enlarge the spleen to the point where it removes too many red blood cells.
- Diseases of the small blood vessels. Hemolysis that occurs in diseased small blood vessels is called microangiopathic hemolysis. It results from damage caused by rough surfaces on the inside of the capillaries. The RBCs squeeze through capillaries one at a time and can easily be damaged by scraping against the vessel walls.
- Immune reactions to RBCs. Several types of **cancer** and immune system diseases produce antibodies that react with RBCs and destroy them. In 75% of cases, this reaction occurs all by itself, with no underlying disease to account for it.
- Transfusions. If a patient is given an incompatible blood type, hemolysis results.
- Kidney failure and other serious diseases. Several diseases are characterized by defective blood coagulation that can destroy red blood cells.
- **Erythroblastosis fetalis**. Erythroblastosis fetalis is a disease of newborns marked by the presence of too many immature red blood cells (erythroblasts) in the baby's blood. When a baby's mother has a different blood type, antibodies from the mother may leak into the baby's circulation and destroy blood cells. This reaction can produce severe hemolysis and jaundice in the newborn. Rh factor incompatibility is the most common cause.
- High bilirubin levels in newborns. Even in the absence of blood type incompatibility, the newborn's bilirubin level may reach threatening levels.

Normal jaundice in newborns

Normal newborn jaundice is the result of two conditions occurring at the same time—a pre-hepatic and a hepatic source of excess bilirubin. First of all, the baby at birth immediately begins converting hemoglobin from a fetal type to an adult type. The fetal type of hemoglobin was able to extract oxygen from the lower levels of oxygen in the mother's blood. At birth the infant can extract oxygen directly from his or her own lungs and does not need the fetal hemoglobin any more. So fetal hemoglobin is removed from the system and replaced with adult hemoglobin. The resulting bilirubin loads the system and places demands on the liver to clear it. But the liver is not quite ready for the task, so there is a period of a week or so when the liver has to catch up. During that time the baby is jaundiced.

Hepatic jaundice

Liver diseases of all kinds threaten the organ's ability to keep up with bilirubin processing. **Starvation**, circulating infections, certain medications, hepatitis, and **cirrhosis** can all cause hepatic jaundice, as can certain hereditary defects of liver chemistry, including Gilbert's syndrome and Crigler-Najjar syndrome.

Post-hepatic jaundice

Post-hepatic forms of jaundice include the jaundices caused by failure of soluble bilirubin to reach the intestines after it has left the liver. These disorders are called obstructive jaundices. The most common cause of obstructive jaundice is the presence of **gallstones** in the ducts of the biliary system. Other causes have to do with **birth defects** and infections that damage the bile ducts; drugs; infections; cancers; and physical injury. Some drugs—and **pregnancy** on rare occasions—simply cause the bile in the ducts to stop flowing.

Symptoms and complications associated with jaundice

Certain chemicals in bile may cause **itching** when too much of them ends up in the skin. In newborns, insoluble bilirubin may get into the brain and do permanent damage. Long-standing jaundice may upset the balance of chemicals in the bile and cause stones to form. Apart from these potential complications and the discoloration of skin and eyes, jaundice by itself is inoffensive. Other symptoms are determined by the disease producing the jaundice.

Diagnosis

Physical examination

In many cases the diagnosis of jaundice is suggested by the appearance of the patient's eyes and complexion. The doctor will ask the patient to lie flat on the examining table in order to feel (palpate) the liver and spleen for enlargement and to evaluate any abdominal **pain**. The location and severity of abdominal pain and the presence or absence of **fever** help the doctor to distinguish between hepatic and obstructive jaundice.

Laboratory tests

Disorders of blood formation can be diagnosed by more thorough examination of the blood or the bone marrow, where blood is made. Occasionally a bone marrow biopsy is required, but usually the blood itself will reveal the diagnosis. The spleen can be evaluated by an ultrasound examination or a nuclear scan if the **physical examination** has not yielded enough information.

Liver disease is usually assessed from blood studies alone, but again a biopsy may be necessary to clarify less obvious conditions. A **liver biopsy** is performed at the bedside. The doctor uses a thin needle to take a tiny core of tissue from the liver. The tissue sample is sent to the laboratory for examination under a microscope.

Assessment of jaundice in newborns

Newborns are more likely to have problems with jaundice if:

- they are premature.
- they are Asian or Native Americans.
- they have been bruised during the birth process.
- they have lost too much weight during the first few days.
- they are born at high altitude.
- the mother has diabetes.
- labor had to be induced

Imaging studies

Disease in the biliary system can be identified by imaging techniques, of which there are many. X rays are taken a day after swallowing a contrast agent that is secreted into the bile. This study gives functional as well as anatomical information. There are several ways of injecting x ray dye directly into the bile ducts. It can be done through a thin needle pushed straight into the liver or through a scope passed through the stomach that can inject dye into the Ampulla of Vater. CT and MRI scans are very useful for imaging certain conditions like cancers in and around the liver or gall stones in the common bile duct.

Treatment

Jaundice in newborns

Newborns are the only major category of patients in whom the jaundice itself requires attention. Because the insoluble bilirubin can get into the brain, the amount in the blood must not go over certain levels. If there is reason to suspect increased hemolysis in the newborn, the bilirubin level must be measured repeatedly during the first few days of life. If the level of bilirubin shortly after birth threatens to go too high, treatment must begin immediately. Exchanging most of the baby's blood was the only way to reduce the amount of bilirubin until a few decades ago. Then it was discovered that bright blue light will render the bilirubin harmless. Now jaundiced babies are fitted with eye protection and placed under bright fluorescent lights. The light chemically alters the bilirubin in the blood as it passes through the baby's skin.

KEY TERMS

Ampulla of Vater—The widened portion of the duct through which the bile and pancreatic juices enter the intestine. Ampulla is a Latin word for a bottle with a narrow neck that opens into a wide body.

Anemia—A condition in which the blood does not contain enough hemoglobin.

Biliary system/Bile ducts—The gall bladder and the system of tubes that carries bile from the liver into the intestines.

Bilirubin—A reddish pigment excreted by the liver into the bile as a breakdown product of hemoglobin.

Crigler-Najjar syndrome—A moderate to severe form of hereditary jaundice.

Erythroblastosis fetalis—A disorder of newborn infants marked by a high level of immature red blood cells (erythroblasts) in the infant's blood.

Gilbert's syndrome—A mild hereditary form of jaundice.

Glucose-6-phosphate dehydrogenase (G6PD) deficiency—A hereditary disorder that can lead to episodes of hemolytic anemia in combination with certain medications.

Hemoglobin—The red chemical in blood cells that carries oxygen.

Hemolysis—The destruction or breakdown of red blood cells.

Hepatic—Refers to the liver.

Icterus—Another name for jaundice.

Microangiopathic—Pertaining to disorders of the small blood vessels.

Pancreas—The organ beneath the stomach that produces digestive juices, insulin, and other hormones.

Sickle cell disease—A hereditary defect in hemoglobin synthesis that changes the shape of red cells and makes them more fragile.

Splenectomy—Surgical removal of the spleen.

Hemolytic disorders

Hemolytic diseases are treated, if at all, with medications and blood transfusions, except in the case of a large spleen. Surgical removal of the spleen (**splenectomy**) can sometimes cure **hemolytic anemia**. Drugs that cause hemolysis or arrest the flow of bile must be stopped immediately.

Hepatic jaundice

Most liver diseases have no specific cure, but the liver is so robust that it can heal from severe damage and regenerate itself from a small remnant of its original tissue.

Post-hepatic jaundice

Obstructive jaundice frequently requires a surgical cure. If the original passageways cannot be restored, surgeons have several ways to create alternate routes. A popular technique is to sew an open piece of intestine over a bare patch of liver. Tiny bile ducts in that part of the liver will begin to discharge their bile into the intestine, and pressure from the obstructed ducts elsewhere will find release in that direction. As the flow increases, the ducts grow to accommodate it. Soon all the bile is redirected through the open pathways.

Prevention

Erythroblastosis fetalis can be prevented by giving an Rh negative mother a gamma globulin solution called RhoGAM whenever there is a possibility that she is developing antibodies to her baby's blood. G6PD hemolysis can be prevented by testing patients before giving them drugs that can cause it. Medication side effects can be minimized by early detection and immediate cessation of the drug. Malaria can often be prevented by certain precautions when traveling in tropical or subtropical countries. These precautions include staying in after dark; using prophylactic drugs such as mefloquine; and protecting sleeping quarters with mosquito nets treated with insecticides and mosquito repellents.

Resources

BOOKS

Balistreri, William F. "Manifestations of Liver Disease." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

"Jaundice." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

Kaplan, Lee M., and Kurt J. Isselbacher. "Jaundice." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

McQuaid, Kenneth R. "Alimentary Tract." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.
Scharschmidt, Bruce F. "Bilirubin Metabolism, Hyperbilirubinemia, and Approach to the Jaundiced Patient." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

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Jaw wiring

Definition

Jaw wiring, also known as maxillomandibular fixation, is a surgical procedure where metal pins and wires are anchored into the jaw bones and surrounding tissues to keep the jaw from moving.

Purpose

Sports injuries, automobile accidents, falls, or fistfights are a few of the situations where the jaw might be fractured or broken. In these cases, jaw wiring may be necessary to keep the bones aligned and stable while the jaw heals. The presence of **cancer** or other diseased tissues may make removal and reconstruction of the jaw necessary. Wiring the jaws shut has been used in the past as a weight loss aid in cases of extreme **obesity** where other treatments had failed, although this procedure is rarely used for that purpose today.

Precautions

Traumatic injuries to the face can cause damage to facial nerves and salivary glands and ducts. These injuries can also leave scars that may require additional surgery to correct.

Description

Jaw wiring surgery can be performed by an oral or maxillofacial surgeon (a specially trained dentist), or by an otolaryngologist (a doctor specializing in surgeries of the head and neck). The procedure may be done in a medical or dental office if the office is staffed and equipped to handle this type of surgery. More often, this surgery is performed in a hospital or medical center surgical area. If jaw wiring is required due to an injury, the surgeon may set the fracture immediately before swelling sets in. It is also possible to wait (up to several weeks) until the swelling goes down and some of the soft tissue injuries have healed, prior to wiring the jaw fracture.

The surgeon realigns the fractured bones. Every effort is made to restore the shape and appearance of the original jaw line. If any teeth were damaged, repair or replacement may be done at the same time. Small incisions may be made through the skin and surrounding tissue so the pins and wires can be set into the jawbone to hold the fracture together. To prevent the lower jaw from moving during healing, pins and wires may be inserted into the top jaw, as well. The upper and lower jaws are then wired together in order to stabilize the fracture.

As with other types of bone **fractures**, the jaw may take several weeks to heal. Another type of jaw **immobilization** that has been developed more recently, rigid fixation uses small metal plates and screws rather than pins and wires to secure the jaw bones. The main benefit of this technique is that the jaws do not have to be wired shut, allowing the patient to return to a more normal lifestyle sooner.

Preparation

X rays of the fractured area may be taken prior to surgery. Depending on the extent of the facial injury or condition to be corrected, the patient may receive a sedative for relaxation, a local anesthetic drug to numb the area, and/or an anesthetic agent to induce unconsciousness prior to the surgery.

Aftercare

A patient whose jaw has been wired will not be able to eat solid foods for several weeks. In order for the bone and surrounding tissues to heal, it is important to maintain adequate **nutrition**. A liquid diet that can be consumed through a straw, will be required. Soft, precooked foods can be liquefied in a blender, however, it may be difficult for the patient to consume adequate calories, protein, **vitamins**, and **minerals** with this type of diet. Liquid diet formulas may be a good alternative. The patient will also have to be taught how to care for the mouth, teeth, and injured area while the wires are in place.

Risks

It is possible that scarring may occur due to the need to make small incisions in the skin in order to insert the wires. With any surgical procedure, there are risks associated with the anesthetic drugs used and the possibility of infection. If there is a risk that the patient may vomit, the jaw wiring may pose a **choking** hazard. It may be

KEY TERMS

Oral and maxillofacial surgeon—A dentist who is trained to perform surgery to correct injuries, defects, or conditions of the mouth, teeth, jaws, and face.

Otolaryngologist—A doctor who is trained to treat injuries, defects, or conditions of the head and neck.

recommended that wire cutters be kept available in case the wires need to be cut in an emergency situation.

Resources

BOOKS

"Jaw Wiring." In *Nutrition and Diet Therapy Reference Dictionary.* 4th ed. New York: Chapman & Hall, 1996.

ORGANIZATIONS

American Association of Oral & Maxillofacial Surgeons. 9700 West Bryn Mawr Avenue; Rosemont, IL 60018-5701; (847) 678-6200.

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

OTHER

"Know the Score on Facial Sports Injuries" *The Virtual Hospital Page.* University of Iowa. <http://www.vh.org>.

"Topic: Maxillofacial Trauma." *Connecticut Maxillofacial Surgeons Page.* <http://www.cmsllc.com/toptrm.html>.

Altha Roberts Edgren

JC virus infection *see* **Progressive multifocal leukoencephalopathy**

Jejunostomy *see* **Enterostomy**

Jet lag

Definition

Jet lag is a condition marked by **fatigue**, **insomnia**, and irritability that is caused by air travel through changing time zones.

Description

Living organisms are accustomed to periods of night and day alternating at set intervals. Most of the human body's regulating hormones follow this cycle, known as circadian rhythm. The word circadian comes from the Latin, *circa*, meaning about, and *dies*, meaning day. These cycles are not exactly 24 hours long, hence the "circa." Each chemical has its own cycle of highs and lows, interacting with and influencing the other cycles. Body temperature, sleepiness, thyroid function, growth hormone, metabolic processes, adrenal hormones, and the sleep hormone melatonin all cycle with daylight. There is a direct connection between the retina (where light hits the back of the eye) and the part of the brain that controls all these hormones. Artificial light has some effect, but sunlight has much more.

When people are without clocks in a compartment that is completely closed to sunlight, most of them fall into a circadian cycle of about 25 hours. Normally, all the regulating chemicals follow one another in order like threads in a weaving pattern. Every morning the sunlight resets the cycle, stimulating the leading chemicals and thus compensating for the difference between the 24-hour day and the 25-hour innate rhythm.

When traveling through a number of time zones, most people reset their rhythms within a few days, demonstrating the adaptability of the human species. Some people, however, have upset rhythms that last indefinitely.

Causes and symptoms

Traveling through a few time zones at a time is not as disruptive to circadian rhythms as traveling around the world can be. The foremost symptom of jet lag is altered sleep pattern—sleepiness during the day, and insomnia during the night. Jet lag may also include **indigestion** and trouble concentrating. Individuals afflicted by jet lag will alternate in and out of a normal day-night cycle.

Treatment

In cases of short-term insomnia triggered by jet lag, a physician may recommend sleeping pills or prescription medication. Such medication should only be taken under the guidance of a health care professional.

Alternative treatment

Exposure to bright morning sunlight cures jet lag after a few days in most people. A few will have prolonged sleep phase difficulties. For these, there is a curious treatment that has achieved success. By forcing one's self into a 27 hour day, complete with the appropriate stimulation from bright light, all the errant chemical cycles will be able to catch up during one week.

When selecting an international flight, individuals should try to arrange an early evening arrival in their destination city. When an individual is traveling to a destination in the east, he or she can try going to bed and waking up a few hours earlier several days before their flight. If travel is to the west, going to bed and waking up later than usual can help the body start to adjust to the upcoming time change.

The following precautions taken during an international flight can help to limit or prevent jet lag:

- Stay hydrated. Drink plenty of water and juices to prevent **dehydration**. Beverages and foods with **caffeine** should be avoided because of their stimulant properties. Alcohol should also be avoided.
- Stretch and walk. As much movement as possible during a flight helps circulation, which moves nutrients and waste through the body and aids in elimination.
- Stay on time. Set watches and clocks ahead to the time in the destination city to start adjusting to the change.
- Sleep smart. Draw the shade and sleep during the evening hours in the destination city, even if it is still daylight outside of the airplane. Earplugs and sleep masks may be helpful in blocking noise and light. Many airlines provide these items on international flights.
- Dress comfortably. Wear or bring comfortable clothes and slippers that will make sleeping during the flight easier.

Once arriving in their destination city, individuals should spend as much time outdoors in the sunlight as possible during the day to reset their internal clock and lessen the symptoms of jet lag. Bedtime should be postponed until at least 10 P.M., with no daytime naps. If a daytime nap is absolutely necessary, it should be limited to no more than two hours.

To promote a restful sleeping environment in a hotel setting, individuals should request that the hotel desk hold all phone calls. Because sleeping in too late can also prolong jet lag, an early wake up call should be requested if an alarm clock is not available. If the hotel room is noisy, a portable white noise machine can help to block outside traffic and hallway noises. A room air conditioner or fan can serve the same purpose. The temperature in the room should also be adjusted for sleeping comfort.

All antioxidants help to decrease the effects of jet lag. Extra doses of **vitamins** A, C, and E, as well as zinc and selenium, two days before and two days after a flight help to alleviate jet lag. Melatonin, a hormone which helps to regulate circadian rhythms, can also help to combat jet lag. Melatonin is available as an over-the-counter supplement in most health food stores and pharmacies, but no more than 3 mg should be used in a 24-hour period.

KEY TERMS

Hormone—A chemical made in one part of the body that has an effect on another part.

Melatonin—A hormone which helps to regulate circadian rhythms.

If weather prevents an individual from spending time in the sunlight, light therapy may be beneficial in decreasing jet lag symptoms. Light therapy, or **phototherapy**, uses a device called a light box, which contains a set of fluorescent or incandescent lights in front of a reflector. Typically, the patient sits for 30 minutes next to a 10,000-lux box (which is about 50 times as bright as an ordinary indoor light). Light therapy is safe for most people, but those with eye diseases should consult a healthcare professional before undergoing the treatment.

Prognosis

Jet lag usually lasts 24–48 hours after travel has taken place. In that short time period, the body adjusts to the time change, and with enough rest and daytime exposure to sunlight, it returns to normal circadian rhythm.

Prevention

Eating a high protein diet that is low in calories before intended travel may help reduce the effects of jet lag.

Resources

BOOKS

Czeisler, Charles A., and Gary S. Richardson. "Disorders of Sleep and Circadian Rhythms." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Molitch, Mark E. "The Neuroendocrine System." In *Cecil Textbook of Medicine,* edited by J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders, 1996.

PERIODICALS

Delagrange, P., and B. Guardiola-Lemaitre. "Melatonin, Its Receptors, and Relationships with Biological Rhythm Disorders." *Clinical Neuropharmacology* 20 (December 1997): 482–510.

Garfinkel D. and N. Zisapel. "The Use of Melatonin for Sleep." *Nutrition* 14 (January 1998): 53–55.

Hastings, M.H. "Central Clocking." *Trends in Neurosciences* 20 (October 1997): 459–464.

Hastings, M.H. "Circadian Clocks." *Current Biology* 7 (November 1, 1997): R670–672.
Hinton, S.C., and W.H. Meck. "The 'Internal Clocks' of Circadian and Interval Timing." *Endeavour* 21 (1997): 82–87.
Samel, A., and H.M. Wegmann. "Bright Light: a Countermeasure for Jet Lag?" *Chronobiology International* 14 (March 1997): 173–183.
Wagner, D.R. "Disorders of the Circadian Sleep-Wake Cycle." *Neurologic Clinics* 14 (August 1996): 651–670.
Zhdanova, I.V., and R.J. Wurtman. "Efficacy of Melatonin as a Sleep-Promoting Agent." *Journal of Biological Rhythms* 12 (December 1997): 644–650.

Paula Ford-Martin

Jock itch *see* **Ringworm**

Joint aspiration *see* **Joint fluid analysis**

Joint biopsy

KEY TERMS

Joint—The point where two bones meet.

Pathology—The branch of medicine that looks at abnormal changes in cells and tissues which signal disease.

Synovial membrane—Membrane lining a joint.

Trocar—A sharp pointed tube through which a needle can be inserted.

Definition

A joint or synovial membrane biopsy refers to a procedure where a sample of the joint lining or synovial membrane is taken.

Purpose

A joint biopsy is performed to determine why a joint is painful or swollen. It is usually reserved for more difficult cases where the diagnosis is not clear. The test can be used to diagnose bacterial or fungal infections, an abnormal buildup of iron, **cancer**, or other diseases.

Precautions

The procedure must be done under very sterile conditions to reduce the risk of infection.

Description

The test is performed either in the doctor's office, clinic, or hospital by a surgeon. There are many different ways to perform this biopsy: through an incision in the joint; with a scope inserted in the joint; or, more typically, by the insertion of a sharp instrument through the skin. The procedure can be taken from any joint, but the most common joint requiring biopsy is the knee. A sharp instrument (trocar) is pushed into the joint space. A needle with an attached syringe is inserted into the joint to withdraw fluid for laboratory analysis. The surgeon may instill numbing medicine into the joint and along the needle track before the needle is withdrawn. The trocar and then the biopsy needle is inserted and specimens taken. After the specimen is taken, both the trocar and the biopsy needle are removed, a bandage is placed over the joint, and the samples are sent to pathology for analysis.

Preparation

Blood tests will be done to check that blood clots properly. A mild sedative may be given before the procedure. With the patient lying down, the skin over the joint is disinfected and a local anesthetic is injected into the skin and tissue just below the skin.

Aftercare

The joint will need rest for at least one day. Normal activity can resume if there is no increased **pain** or swelling.

Risks

There is a chance of joint swelling or tenderness. Rarely, bleeding and infection can occur in the joint, or the biopsy needle could break off or strike a nerve or blood vessel. The risk of infection is higher if the patient has an immune deficiency.

Resources

BOOKS

"Arthrocentesis, Synovial Fluid Analysis and Synovial Biopsy." In *Primer on Rheumatic Diseases*, ed. H. Ralph Schumacher. Atlanta: Arthritis Foundation, 1993.
Schumacher, H. Ralph, Jr. "Synovial Fluid Analysis and Synovial Biopsy." In *Textbook of Rheumatology*, ed. William N. Kelley, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Beaule, V. et al. "Synovial Membrane: Percutaneous Biopsy." *Radiology* 177 (1990): 581-585

Jeanine Barone, Physiologist

Joint endoscopy *see* **Arthroscopy**

Joint fluid analysis

Definition

Joint fluid analysis, also called synovial fluid analysis, or arthrocentesis, is a procedure used to assess joint-related abnormalities, such as in the knee or elbow.

KEY TERMS

Aspirate—The removal by suction of a fluid from a body cavity using a needle.

Bursae—A closed sac lined with a synovial membrane and filled with fluid, usually found in areas subject to friction, such as where a tendon passes over a bone.

Hematoma—A localized mass of blood that is confined within an organ or tissue.

Synovial fluid—A transparent lubricating fluid secreted in a sac to protect an area where a tendon passes over a bone.

Purpose

The purpose of a joint fluid analysis is to identify the cause of swelling in the joints, to relieve **pain** and distention from fluid accumulation in the joint, and to diagnose certain types of arthritis and inflammatory joint diseases. The test is also a method to determine whether an infection, either bacterial or fungal, exists within the joint.

Precautions

Joint fluid analysis should not be performed on any patient who is uncooperative, especially if the patient cannot or will not keep the joint immobile throughout the procedure. Patients with certain infections should be excluded from the procedure, particularly those who have a local infection along the proposed needle track. The joint space should be accessible. Therefore, a poorly accessible joint space, such as in hip aspiration in an obese patient, should not be subject to this procedure.

Description

The test is also called arthrocentesis, joint tap, and closed joint aspiration. Normal synovial fluid is a clear or pale-yellow fluid found in small amounts in joints, bursae (fluid-filled sac found on points of friction, like joints), and tendon sheaths. The procedure is done by passing a needle into a joint space and sucking out (aspirating) synovial fluid for diagnostic analysis. When the sample is sent to the laboratory, the fluid is analyzed for color, clarity, quantity, and chemical composition. It is also examined microscopically to check for the presence of bacteria and other cells.

The procedure takes about 10 minutes. Prior to the procedure, any risks that are involved should be explained to the patient. No intravenous pain medications or sedatives are required, although the patient will be given a local anesthetic.

The patient is asked to lie on their back and remain relaxed. The local anesthetic, typically an injection of lidocaine, is then administered. The clinician is usually seated next to the patient. Then the clinician marks exactly where the needle is to enter. As the needle enters the joint, a "pop" may be felt or heard. This is normal. Correct placement of the needle in the joint space is normally painless. At this point, the clinician slowly drains some of the fluid into the syringe. The needle is then withdrawn and adhesive tape is placed over the needle site.

Preparation

Glucose, or sugar, in the joint can be a signal of arthritis. If the clinician will be doing a glucose test, the patient will be asked to fast for 6-12 hours preceding the procedure. If not, there is no special preparation required for a joint fluid analysis.

Aftercare

Some post-procedural pain may be experienced. For this reason, the patient should arrange to be driven home by someone else. Aftercare of the joints will depend on the results of the analysis.

Risks

While joint fluid analysis is generally a safe procedure, especially when performed on a large, easily accessible joint, such as the knee, some risks are possible. Some of the complications to the procedure, although rare, include infection at the site of the needle stick, an accumulation of blood (hematoma) formation, local pain, injury to cartilage, tendon rupture, and nerve damage.

Normal results

The results of a normal joint fluid analysis include fluid of a clear or pale-yellow color and the absence of bacteria, fungus, and other cells, such as white blood cells.

Abnormal results

The results of an abnormal joint fluid analysis include fluid that is turbid, or cloudy. Also, white blood cells and other blood cells may be found, from which the clinician can make a diagnosis and arrive at a treatment for the joint problem. An abnormal result can indicate an infection caused by a bacteria, or **tuberculosis**. Or, there might be inflammation that is caused by **gout**, **rheumatoid arthritis**, or **osteoarthritis**.

Resources

BOOKS

Arnold, William J., and Robert W. Ike. "Specialized Procedures in the Management of Patients with Rheumatic Diseases." In *Cecil Textbook of Medicine*, ed. James B. Wyngaarden, et al. Philadelphia: W. B. Saunders Co., 1996.

Ron Gasbarro, PharmD

Joint infection *see* **Infectious arthritis**

Joint radiography *see* **Arthrography**

Joint replacement

Definition

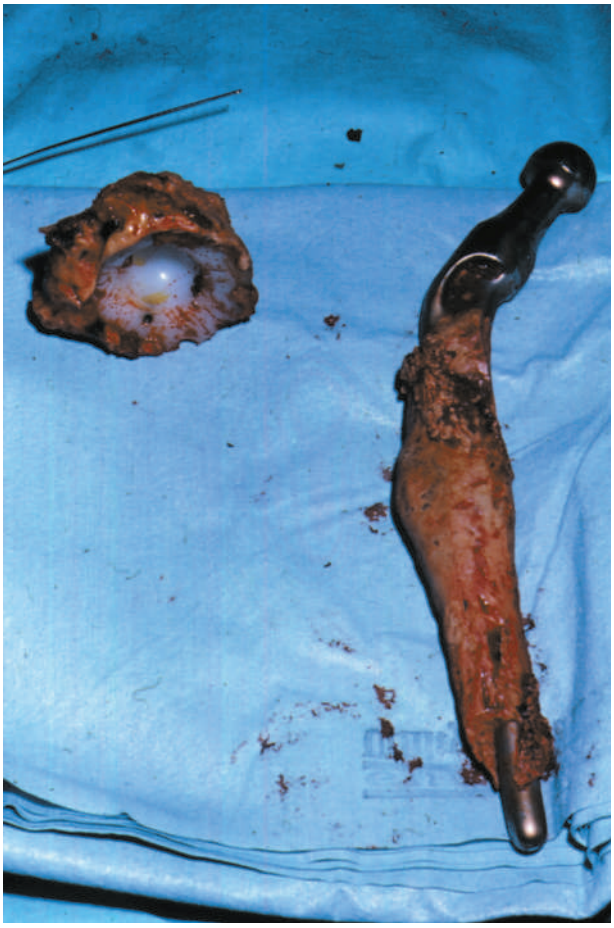
Joint replacement is the surgical replacement of a joint with an artificial prosthesis.

Purpose

Great advances have been made in joint replacement since the first hip replacement was performed in the United States in 1969. Improvements have been made in the endurance and compatibility of materials used and the surgical techniques to install artificial joints. Custom joints can be made using a mold of the original joint that duplicate the original with a very high degree of accuracy.

The most common joints to be replaced are hips and knees. There is ongoing work on elbow and shoulder replacement, but some joint problems are still treated with joint resection (the surgical removal of the joint in question) or interpositional reconstruction (the reassembly of the joint from constituent parts).

Seventy percent of joint replacements are performed because arthritis has caused the joint to stiffen and become painful to the point where normal daily activities are no longer possible. If the joint does not respond to conservative treatment like medication, weight loss, activity restriction, and use of walking aids such as a cane, joint replacement is considered appropriate.



The components of a prosthetic hip joint, removed due to loosening. On the right is the metal shaft encased in the cement which fixed it to the inside of the femur. On the left is the plastic socket. *(Custom Medical Stock Photo. Reproduced by permission.)*

Patients with **rheumatoid arthritis** or other connective tissue diseases may also be candidates for joint replacement, but the results are usually less satisfactory in those patients. Elderly people who fall and break their hip often undergo hip replacement when the probability of successful bone healing is low.

More than 170,000 hip replacements are performed in the United States each year. Since the lifetime of the artificial joint is limited, the best candidates for joint replacement are over age 60.

Precautions

Joint replacements are performed successfully on an older- than-average group of patients. People with dis-

A false color x-ray image of the human pelvis showing a prosthetic hip joint. *(Custom Medical Stock Photo. Reproduced by permission.)*

eases that interfere with blood clotting are not good candidates for joint replacement. Joint replacement surgery should not be done on patients with infection, or any heart, kidney or lung problems that would make it risky to undergo general anesthesia.

Description

Joint replacements are performed under general or regional anesthesia in a hospital by an orthopedic surgeon. Some medical centers specialize in joint replacement, and these centers generally have a higher success rate than less specialized facilities. The specific techniques of joint replacement vary depending on the joint involved.

Hip Replacement

The surgeon makes an incision along the top of the thigh bone (femur) and pulls the thigh bone away from the socket of the hip bone (the acetabulum). An artificial socket made of metal coated with polyethylene (plastic) to reduce friction is inserted in the hip. The top of the thigh bone is cut, and a piece of artificial thigh made of metal is fitted into the lower thigh bone on one end and the new socket on the other.

The artificial hip can either be held in place by a synthetic cement or by natural bone in-growth. The cement is an acrylic polymer. It assures good locking of the prosthesis to the remaining bone. However, bubbles left in the cement after it cures may act as weak spots, causing the development of cracks. This promotes loosening of the prosthesis later in life. If additional surgery is needed, all the cement must be removed before surgery can be performed.

An artificial hip fixed by natural bone in-growth requires more precise surgical techniques to assure maximum contact between the remaining natural bone and the prosthesis. The prosthesis is made so that it contains small pores that encourage the natural bone to grow into it. Growth begins 6 to 12 weeks after surgery. The short term outcome with non-cemented hips is less satisfactory, with patients reporting more thigh **pain**, but the long term outlook is better, with fewer cases of hip loosening in non-cemented hips. The trend is to use the non-cemented technique. Hospital stays last from four to eight days.

Knee Replacement

The doctor puts a tourniquet above the knee, than makes a cut to expose the knee joint. The ligaments surrounding the knee are loosened, then the shin bone and thigh bone are cut and the knee removed. The artificial knee is then cemented into place on the remaining stubs of those bones. The excess cement is removed, and the knee is closed. Hospital stays range from three to six days.

In both types of surgery, preventing infection is very important. **Antibiotics** are given intravenously and continued in pill form after the surgery. Fluid and blood loss can be great, and sometimes blood transfusions are needed.

KEY TERMS

Catheterization—Inserting a tube into the bladder so that a patient can urinate without leaving the bed.

Prosthesis—A synthetic replacement for a missing part of the body, such as a knee or a hip.

Rheumatoid arthritis—A joint disease of unknown origins that may begin at an early age causing deformity and loss of function in the joints.

Preparation

Many patients choose to donate their own blood for **transfusion** during the surgery. This prevents any blood incompatibility problems or the transmission of blood-borne diseases.

Prior to surgery, all the standard preoperative blood and urine tests are performed, and the patient meets with the anesthesiologist to discuss any special conditions that affect the administration of anesthesia. Patients receiving general anesthesia should not eat or drink for 10 hours prior to the operation.

Aftercare

Immediately after the operation the patient will be catheterized so that he or she will not have to get out of bed to urinate. The patient will be monitored for infection. Antibiotics are continued and pain medication is prescribed. Physical therapy begins (first passive exercises, then active ones) as soon as possible using a walker, cane, or crutches for additional support. Long term care of the artificial joint involves refraining from heavy activity and heavy lifting, and learning how to sit, walk, how to get out of beds, chairs, and cars so as not to dislocate the joint.

Risks

The immediate risks during and after surgery include the development of blood clots that may come loose and block the arteries, excessive loss of blood, and infection. Blood thinning medication is usually given to reduce the risk of clots forming. Some elderly people experience short term confusion and disorientation from the anesthesia.

Although joint replacement surgery is highly successful, there is an increased risk of nerve injury. Dislocation or fracture of the hip joint is also a possibility. Infection caused by the operation can occur as long as a year later and can be difficult to treat. Some doctors add antibiotics directly to the cement used to fix the replacement joint in place. Loosening of the joint is the most common cause of failure in hip joints that are not infected. This may require another joint replacement surgery in about 12% of patients within a 15-year period following the first procedure.

Normal results

Over 90% of patients receiving hip replacements achieve complete relief from pain and significant improvement in joint function. The success rate is slightly lower in knee replacements, and drops still more for other joint replacement operations.

Resources

PERIODICALS

Siopack, Jorge, and Harry Jergensen. "Total Hip Arthroplasty." In *Western Journal of Medicine* (Mar. 1995): 43-50.

Tish Davidson

Joint resection *see* **Arthroplasty**

Joint x rays *see* **Arthrography**

Juvenile arthritis

Definition

Juvenile arthritis (JA) refers to a number of different conditions, all of which strike children, and all of which have joint inflammation as their major manifestation.

Description

The skeletal system of the body is made up of different types of the strong, fibrous tissue known as connective tissue. Bone, cartilage, ligaments, and tendons are all forms of connective tissue that have different compositions, and thus different characteristics.

The joints are structures that hold two or more bones together. Some joints (synovial joints) allow for movement between the bones being joined (called articulating bones). The simplest model of a synovial joint involves two bones, separated by a slight gap called the joint cavity. The ends of each articular bone are covered by a layer of cartilage. Both articular bones and the joint cavity are surrounded by a tough tissue called the articular capsule. The articular capsule has two components: the fibrous membrane on the outside, and the synovial membrane (or synovium) on the inside. The fibrous membrane may include tough bands of fibrous tissue called ligaments, which are responsible for providing support to the joints. The synovial membrane has special cells and many capillaries (tiny blood vessels). This membrane produces a supply of synovial fluid which fills the joint cavity, lubricates it, and helps the articular bones move smoothly about the joint.

In JA, the synovial membrane becomes intensely inflamed. Usually thin and delicate, the synovium becomes thick and stiff, with numerous infoldings on its surface. The membrane becomes invaded by white blood cells, which produce a variety of destructive chemicals. The cartilage along the articular surfaces of the bones may be attacked and destroyed, and the bone, articular

capsule, and ligaments may begin to be worn away (eroded). These processes severely interfere with movement in the joint.

JA specifically refers to chronic arthritic conditions that affect a child under the age of 16 years, and that last for a minimum of three to six months. JA is often characterized by a waxing and waning course, with flares separated by periods of time during which no symptoms are noted (remission). Some literature refers to JA as juvenile **rheumatoid arthritis**, although most types of JA differ significantly from the adult disease called rheumatoid arthritis, in terms of symptoms, progression, and prognosis.

Causes and symptoms

A number of different causes have been sought to explain the onset of JA. There seems to be some genetic link, based on the fact that the tendency to develop JA sometimes runs in a particular family, and based on the fact that certain genetic markers are more frequently found in patients with JA and other related diseases. Many researchers have looked for some infectious cause for JA, but no clear connection to a particular organism has ever been made. JA is considered by some to be an autoimmune disorder. **Autoimmune disorders** occur when the body's immune system mistakenly identifies the body's own tissue as foreign, and goes about attacking those tissues, as if trying to rid the body of an invader (such as a bacteria, virus, or fungi). While an autoimmune mechanism is strongly suspected, certain markers of such a mechanism (such as rheumatoid factor, often present in adults with such disorders) are rarely present in children with JA.

Joint symptoms of arthritis may include stiffness, **pain**, redness and warmth of the joint, and swelling. Bone in the area of an affected joint may grow too quickly, or too slowly, resulting in limbs that are of different lengths. When the child tries to avoid moving a painful joint, the muscle may begin to shorten from disuse. This is called a contracture.

Symptoms of JA depend on the particular subtype. JA is classified by the symptoms that appear within the first six months of the disorder:

- Pauciarticular JA: This is the most common and the least severe type of JA, affecting about 40-60% of all JA patients. This type of JA affects fewer than four joints, usually the knee, ankle, wrist, and/or elbow. Other more general (systemic) symptoms are usually absent, and the child's growth usually remains normal. Very few children (less than 15%) with pauciarticular JA end up with deformed joints. Some children with this form of JA experience painless swelling of the joint. Some children with JA have a serious inflammation of structures within the eye, which if left undiagnosed and untreated could even lead to blindness. While many children have cycles of flares and remissions, in some children the disease completely and permanently resolves within a few years of diagnosis.
- Polyarticular JA: About 40% of all cases of JA are of this type. More girls than boys are diagnosed with this form of JA. This type of JA is most common in children up to age three, or after the age of 10. Polyarticular JA affects five or more joints simultaneously. This type of JA usually affects the small joints of both hands and both feet, although other large joints may be affected as well. Some patients with arthritis in their knees will experience a different rate of growth in each leg. Ultimately, one leg will grow longer than the other. About half of all patients with polyarticular JA have arthritis of the spine and/or hip. Some patients with polyarticular JA will have other symptoms of a systemic illness, including anemia (low red blood cell count), decreased growth rate, low appetite, low-grade **fever**, and a slight rash. The disease is most severe in those children who are diagnosed in early adolescence. Some of these children will test positive for a marker present in other autoimmune disorders, called rheumatoid factor (RF). RF is found in adults who have rheumatoid arthritis. Children who are positive for RF tend to have a more severe course, with a disabling form of arthritis which destroys and deforms the joints. This type of arthritis is thought to be the adult form of rheumatoid arthritis occurring at a very early age.
- Systemic onset JA: Sometimes called Still disease (after a physician who originally described it), this type of JA occurs in about 10-20% off all patients with JA. Boys and girls are equally affected, and diagnosis is usually made between the ages of 5-10 years. The initial symptoms are not usually related to the joints. Instead, these children have high fevers; a rash; decreased appetite and weight loss; severe joint and muscle pain; swollen lymph nodes, spleen, and liver; and serious anemia. Some children experience other complications, including inflammation of the sac containing the heart (**pericarditis**); inflammation of the tissue lining the chest cavity and lungs (pleuritis); and inflammation of the heart muscle (**myocarditis**). The eye inflammation often seen in pauciarticular JA is uncommon in systemic onset JA. Symptoms of actual arthritis begin later in the course of systemic onset JA, and they often involve the wrists and ankles. Many of these children continue to have periodic flares of fever and systemic symptoms throughout childhood. Some children will go on to develop a polyarticular type of JA.
- Spondyloarthropathy: This type of JA most commonly affects boys older than eight years of age. The arthritis

KEY TERMS

Articular bones—Two or more bones that are connected with each other via a joint.

Joint—Structures that hold two or more bones together.

Synovial joint—A particular type of joint, which allows for movement in the articular bones.

Synovial membrane—The membrane that lines the inside of the articular capsule of a joint, and produces a lubricating fluid called synovial fluid.

occurs in the knees and ankles, moving over time to include the hips and lower spine. Inflammation of the eye may occur occasionally, but usually resolves without permanent damage.

- Psoriatic JA: This type of arthritis usually shows up in fewer than four joints, but goes on to include multiple joints (appearing similar to polyarticular JA). Hips, back, fingers, and toes are frequently affected. A skin condition called **psoriasis** accompanies this type of arthritis. Children with this type of JA often have pits or ridges in their fingernails. The arthritis usually progresses to become a serious, disabling problem.

Diagnosis

Diagnosis of JA is often made on the basis of the child's collection of symptoms. Laboratory tests often show normal results. Some nonspecific indicators of inflammation may be elevated, including white blood cell count, **erythrocyte sedimentation rate**, and a marker called C-reactive protein. As with any chronic disease, anemia may be noted. Children with an extraordinarily early onset of the adult type of rheumatoid arthritis will have a positive test for rheumatoid factor.

Treatment

Treating JA involves efforts to decrease the amount of inflammation, in order to preserve movement. Medications which can be used for this include nonsteroidal anti-inflammatory agents (such as ibuprofen and naproxen). Oral (by mouth) steroid medications are effective, but have many serious side effects with long-term use. Injections of steroids into an affected joint can be helpful. Steroid eye drops are used to treat eye inflammation. Other drugs that have been used to treat JA include methotrexate, sulfasalazine, penicillamine, and hydroxychloroquine. Physical therapy and exercises are often recommended in order to improve joint mobility and to strengthen supporting muscles. Occasionally, splints are used to rest painful joints and to try to prevent or improve deformities.

Alternative treatment

Alternative treatments that have been suggested for arthritis include juice therapy, which can work to detoxify the body, helping to reduce JA symptoms. Some recommended fruits and vegetables to include in the juice are carrots, celery, cabbage, potatoes, cherries, lemons, beets, cucumbers, radishes, and garlic. Tomatoes and other vegetables in the nightshade (potatoes, eggplant, red and green peppers) are discouraged. As an adjunct therapy, **aromatherapy** preparations utilize cypress, fennel, and lemon. Massage oils include rosemary, benzoin, chamomile, camphor, juniper, and lavender. Other types of therapy which have been used include **acupuncture**, **acupressure**, and body work. Nutritional supplements that may be beneficial include large amounts of antioxidants (**vitamins** C, A, E, zinc, selenium, and flavenoids), as well as B vitamins and a full complement of **minerals** (including boron, copper, manganese). Other nutrients that assist in detoxifying the body, including methionine, cysteine, and other amino acids, may also be helpful. A number of autoimmune disorders, including JA, seem to have a relationship to food **allergies**. Identification and elimination of reactive foods may result in a decrease in JA symptoms. Constitutional **homeopathy** can also work to quiet the symptoms of JA and bring about balance to the whole person.

Prognosis

The prognosis for pauciarticular JA is quite good, as is the prognosis for spondyloarthropathy. Polyarticular JA carries a slightly worse prognosis. RF-positive polyarticular JA carries a difficult prognosis, often with progressive, destructive arthritis and joint deformities. Systemic onset JA has a variable prognosis, depending on the organ systems affected, and the progression to polyarticular JA. About 1-5% of all JA patients die of such complications as infection, inflammation of the heart, or kidney disease.

Prevention

Because so little is known about what causes JA, there are no recommendations available for how to avoid developing it.

Resources

BOOKS

Kredich, Deborah Welt. "Juvenile Rheumatoid Arthritis." In *Rudolph's Pediatric*, ed. Abraham M. Rudolph, et al. Stamford: Appleton & Lange, 1996.

Olson, Judyann C. "Rheumatic Diseases of Childhood." In *Principles and Practice of Pediatrics*, ed. Frank A. Oski, et al. Philadelphia: J. B. Lippincott Co., 1994.
Schaller, Jane Green. "Juvenile Rheumatoid Arthritis." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

ORGANIZATIONS

The American College of Rheumatology. 1800 Century Place, Suite 250, Atlanta, GA 30345. (404) 633-3777. <http://www.rheumatology.org>.
Arthritis Foundation, 1330 West Peachtree St., Atlanta, GA 30309. (404) 872-7100. <http://www.arthritis.org>.

Rosalyn Carson-DeWitt, MD

K

Kala-azar *see* **Leishmaniasis**

Kaposi's sarcoma

Definition

Kaposi's sarcoma is a form of skin **cancer** that can involve internal organs. It is most often found in patients with acquired **immunodeficiency** syndrome (**AIDS**), and can be fatal.

Description

Kaposi's sarcoma (KS) was once a very rare form of cancer, primarily affecting elderly men of Mediterranean and eastern European background, until the 1980s, when it began to appear among AIDS patients. It manifests in four distinct forms. The first form, called classic KS, was described by the Austrian dermatologist Moricz Kaposi more than a century ago. Classic KS usually affects older men of Mediterranean or eastern European backgrounds by producing tumors on the lower legs. Though at times painful and disfiguring, they are not generally life-threatening. The second form of the disease, African endemic KS, primarily affects boys and men. It can appear as classic KS, or in a more deadly form that quickly spreads to tissues below the skin, the bones and lymph system, leading to **death** within a few years of diagnosis. Another form of KS, iatrogenic KS, is observed in kidney and liver transplant patients who take immunosuppressive drugs to prevent rejection of their organ transplant. Iatrogenic KS usually reverses after the immunosuppressive drug is stopped. The fourth form of KS, AIDS- related KS, emerged as one of the first illnesses observed among those with AIDS. Unlike classic KS, AIDS-related KS, tumors generally appear on the upper body, including the head, neck, and back. The tumors also can appear on the soft palate and gum areas of the mouth, and in more advanced cases, they can be found in the stomach and intestines, the lymph nodes, and the lungs,

Kaposi's sarcoma is reported to be found in 20% of homosexual men who have HIV, 3% in heterosexual intravenous drug users, 3% in women and children, 3% in **transfusion** recipients, and 1% in hemophiliacs. Once regarded as only a defining illness for AIDS, KS has proven to be a progressive, fatal disease on its own, especially when the disease becomes systemic. Yet, involvement throughout the body is not the only factor in patient mortality. Research in 2000 found that patients with KS in oral mucosa had a higher risk of death than those with KS appearing only on the skin.

Causes and symptoms

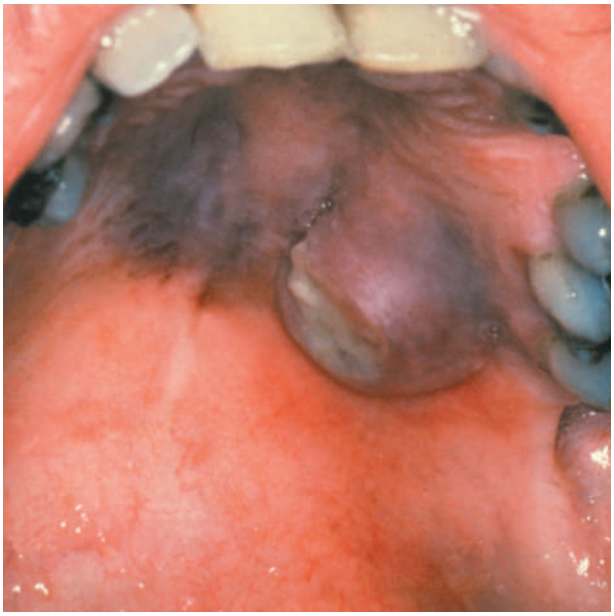
Causes

A variety of factors appear to contribute to the development of KS. One of the first avenues offered as causal agents was genetic predisposition. People with classic KS, and those who develop the tumors after transplantation, are more likely than others to possess a genetically determined immune factor called HLA-DR. Cases of KS that run in families, however, are rare.

The fact that the disease is more likely to afflict men than women suggests sex hormones, such as testosterone in men, may stimulate the growth of KS tumors, and that estrogen in women may retard their growth.

Immune suppression was the next likely cause since liver, kidney, and bone marrow patients who take immunosuppressive drugs to prevent transplant rejection frequently develop KS lesions. Similarly, KS has been observed in patients receiving systemic treatment with high- dose **corticosteroids**, which also suppresses the immune system. Immune suppression is the hallmark of AIDS.

The current theory is the discovery of an infectious agent. A number of viruses have been proposed as possible causes, including cytomegalovirus and human papilloma virus, fragments of which have been found in KS



This HIV-positive patient is afflicted with Kaposi's sarcoma inside the mouth. *(Custom Medical Stock Photo. Reproduced by permission.)*

tumor specimens. A more likely candidate, however, is a new herpes virus that has been called human herpes virus 8 (HHV-8) or KS-associated herpes virus (KSHV). Since fragments of the virus were first disclosed in KS samples in 1994, they have since been found in KS samples taken from patients with classic KS, African endemic KS, and KS in transplant patients. Fragments of HHV-8, however, have also been found in patients who have other skin diseases but who do not have KS,

Studies in 2000 showed that HHV-8 was indeed the culprit behind KS. Nevertheless, it does not work alone. In combination with a patient's altered response to cytokines (regulatory proteins that are produced by the immune system) and the HIV-1 transactivating protein Tat which promotes the growth of endothelial cells, HHV-8 can then encode interleukin 6 viral proteins, specific cytokines that stimulate cell growth in the skin. This becomes KS.

HHV-8 destroys the immune system further by directing a cell to remove the major histocompatibility complex (MHC-1) proteins that protect it from invasion. These proteins are then transferred to the interior of the cell and are destroyed. This leaves the cell unguarded and vulnerable to invaders which would normally be targeted for attack by the immune system.

Research in early 2001 showed that transmission of HHV-8 virus can be more casual than was once thought, giving rise to incidence among women and children. Women who are intravenous drug users and who also have had a sexually transmitted disease have been found to harbor HHV-8. This evidence shows that women can contract HHV-8 through blood. In addition, researchers in 2000 found that HHV-8 could be transmitted orally though kissing. This study found more HHV-8 virus in oral samples than in genital secretions. In fact, HHV-8 was difficult to find in genital samples. This may indicate why children and women who were not intravenous drug users have had KS.

Symptoms

Kaposi's sarcoma produces pink, purple, or brown tumors on the skin, mucous membranes, or internal organs.

Diagnosis

Many physicians will diagnose KS based on the appearance of the skin tumors and the patient's medical history. Unexplained **cough** or chest **pain**, as well as unexplained stomach or intestinal pain or bleeding, could suggest that the disease has moved beyond the skin. The most certain diagnosis can be achieved by taking a biopsy sample of a suspected KS lesion and examining it under high-power magnification. For suspected involvement of internal organs, physicians will use a bronchoscope to examine the lungs or an endoscope to view the stomach and intestinal tract.

Treatment

Treatment goals for KS are simple: to reduce the severity of symptoms, shrink tumors, and prevent disease progression. Unfortunately, there is no single best treatment plan that can achieve all of those goals. Treatments range from topical agents for mild disease with few tumors to more aggressive systemic **chemotherapy** for more serious KS that has spread to large areas of skin or the internal organs. Physicians will frequently combine topical, radiation, and various systemic chemotherapy drugs, depending on the sites of the body affected, the speed at which it is progressing, and the patient's overall health, among other considerations.

Local therapy

When the number of KS tumors is small and the disease appears to be progressing slowly, physicians have had great success with the application, by the patient, of a topical gel containing alitretinoin. This product is a naturally occurring retinoid (a derivative of vitamin A) that can inhibit cell growth and activate apoptosis (cell death). Patients tolerate the product well with only mild

to moderate skin irritation at the site of application in some individuals. Duration of treatment is long term, with the patient seeing results after four to eight weeks of therapy. Treatment slows the progress of the disease and reduces the size of the lesions.

Other local treatments include **cryotherapy** (using a liquid nitrogen spray or probe to freeze the tumor), injections of vinblastine (a drug also used for systemic chemotherapy) directly into the tumor, laser therapy, or **radiation therapy** targeted at the tumor sites. These methods have some success, but they also have unpleasant side effects. Vinblastine injections are about 70% effective, but they do not resolve the lesions completely.

Systemic chemotherapy

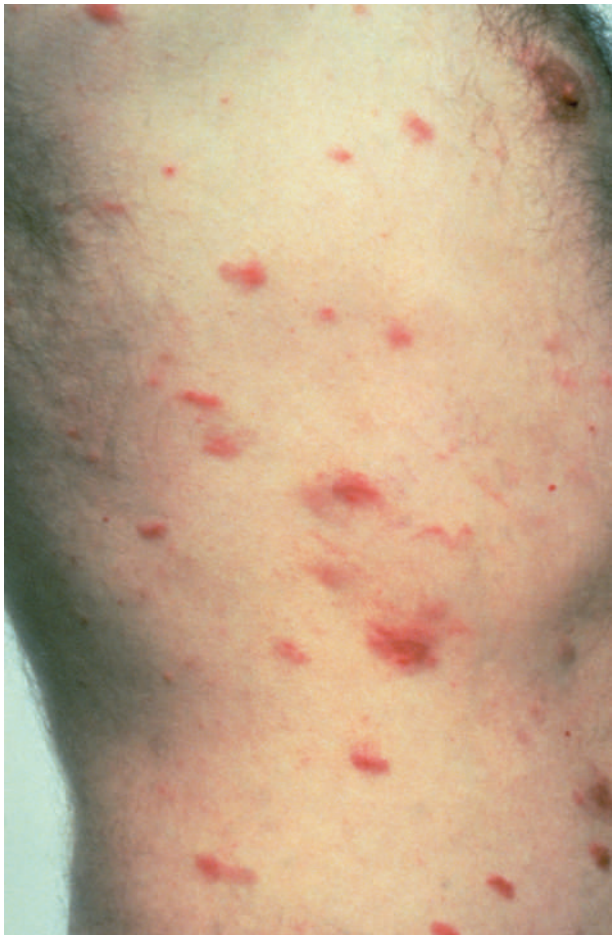
With widespread KS lesions over the body surface, or evidence of spread to other parts of the body, physicians will consider systemic chemotherapy drugs. A new class of chemotherapy drugs, called liposomal anthracyclines, appears to produce good results with fewer toxic side effects than do more conventional chemotherapy drugs. Two of these drugs, liposomal doxorubicin (Doxil) and liposomal daunorubicin (DaunoXone) have become the treatment of choice. These drugs last longer in the human body, demonstrate higher concentrations of the drug in tumors, and have fewer toxic side effects,

Paclitaxel (Taxol) is the newest drug in the KS arsenal. It has a 75% effective rate and is very effective in patients who are resistant to anthracycline drugs. The 3-hour infusion time and the incidence of bone marrow suppression, hair loss, and joint and muscle pain make it less attractive to patients.

Antiviral therapy

Evidence suggests that for some individuals, the class of AIDS drugs called **protease inhibitors**, in combination with other anti-HIV drugs, can reduce the levels of detectable HIV in the blood to nearly zero, and in some patients stabilize or reverse KS tumors. More research is needed in this area. Since the discovery of HHV-8, interest in an antiviral approach to KS has increased. There is no evidence, however, that two **antiviral drugs** commonly prescribed for herpes, acyclovir and ganciclovir, have any effect on the disease. One study of 20,000 patients with HIV and AIDS found that those who took foscarnet, another antiviral medication that works in a different way than acyclovir and ganciclovir, were less likely to develop KS tumors.

Another treatment source is interferon-alpha, which is made by the body and has powerful effects on the immune system. Investigators have tried injecting it directly into lesions, and also in combination with other anti-HIV drugs such as zidovudine, with some success. It has been used with patients who have KS limited only to the skin and who have little immunosuppression. Interferon-alpha has had poor tumor response and significant toxic effects in patients, especially those with seriously-depressed immune systems.



Kaposi's sarcoma usually appears on the lower extremities, as evidenced on this patient's hip. *(Custom Medical Stock Photo. Reproduced by permission.)*

Still other avenues of therapy being researched are sex hormones, thalidomide, SU5516 (an endothelial growth factor inhibitor), and angiogenesis inhibitors, which prevents the growth of blood vessels within a cell that supplies oxygen and nutrients. There is also some research involving the oral administration of alitretinoin.

Alternative treatment

The Bastyr University AIDS Research Study has been investigating and collecting data on treatment for KS and other opportunistic conditions that are AIDS-related. Among the treatments under investigation are

KEY TERMS

African endemic Kaposi's sarcoma—Affects men and boys; can appear like classic KS or in a more lethal form.

AIDS-related Kaposi's sarcoma—Emerged as one of the first illnesses associated with AIDS patients. These tumors usually appear on the upper body, the soft palate and gum areas, and, as the disease advances, in the lymph nodes, stomach, intestines, and lungs.

Apoptosis—Cell death.

Classic Kaposi's sarcoma—Usually affects older men of Mediterranean or eastern European backgrounds, and produces tumors on the lower legs.

Cytokines—Regulatory proteins that are produced by the immune system.

Human herpesvirus 8—Also called Kaposi's sarcoma-associated herpesvirus (KSHV). Thought to be a viral cause for KS.

Iatrogenic Kaposi's sarcoma—Develops in transplant patients who take immunosuppressive drugs to prevent rejection of their organ transplant,

MCH-1—Major histocompatibility complex proteins that protect cells from invasion.

nutritional and herbal therapies (both internal and external). Bastyr University is located in Seattle, Washington.

Prognosis

The prognosis for patients with classic KS is good. Tumors can frequently be controlled and patients frequently die of other causes before any serious spread. African endemic KS can progress rapidly and lead to premature death, despite treatment. In AIDS-related KS, milder cases can frequently be controlled; the prognosis for more advanced and rapidly progressing cases is less certain and dependent on the patient's overall medical condition. There are indications that KS can be stabilized or reversed in patients whose level of HIV in the blood is reduced to undetectable levels via antiretroviral therapy.

Prevention

Safer sex practices may help to prevent AIDS-related KS by decreasing the risk of transmission of HHV-8 through sexual means. However, the addition of avoidance of deep kissing to those precautions may be necessary. Intravenous drug users should still be urged not to share needles. Treatment with antiretrovirals may help to preserve the function of the immune system in HIV patients and delay the appearance and progression of KS lesions.

Resources

BOOKS

Fitzpatrick, Thomas B., et al, *Color Atlas and Synopsis of Clinical Dermatology.* New York: McGraw-Hill, 1997.

Sams, W. Mitchell Jr., et al, *Principles and Practice of Dermatology.* New York: Churchill Livingstone, 1996.

PERIODICALS

"Alitretinoin Gel Effective for Treating Lesions." *AIDS Weekly* (February 12, 2001).

Dezube, Bruce J. "AIDS-Related Kaposi Sarcoma." *Archives of Dermatology* (December 2000)136(2): 1554.

Henderson, Charles W. "Kissing May Spread Cause of Kaposi's Sarcoma." *Cancer Weekly* (November 21, 2000).

Mann, Arnold. "Kaposi's Lesions Benefit from Long-Term Alitretinoin Gel Use." *Family Practice News* (October 1, 2000)30(19): 12.

Rohrmus, Bettina, Eva M. Thoma-Greber, Hohannes R. Bogner, and Martin Rocken. "Outlook in Oral and Cutaneous Kaposi's Sarcoma." *The Lancet* (December 23, 2000)356(9248): 2160.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, PO Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

Gay Men's Health Crisis. 119 West 24th Street, New York, NY 10011. (212) 807-6664. <http://www.gmhc.org>.

Janie F. Franz

Kawasaki syndrome

Definition

Kawasaki syndrome is a potentially fatal inflammatory disease that affects several organ systems in the body, including the heart, circulatory system, mucous membranes, skin, and immune system. It occurs primarily in infants and children but has also been identified in adults as old as 34 years. Its cause is unknown.

Description

Kawasaki syndrome, also called mucocutaneous lymph node syndrome (MLNS), is an inflammatory disorder with potentially fatal complications affecting the heart and its larger arteries. Nearly twice as many males

are affected as females. Although persons of Asian descent are affected more frequently than either black or white individuals, there does not appear to be a distinctive geographic pattern of occurrence. Eighty percent of cases involve children under the age of four. Although the disease usually appears in individuals, it sometimes affects several members of the same family and occasionally occurs in small epidemics.

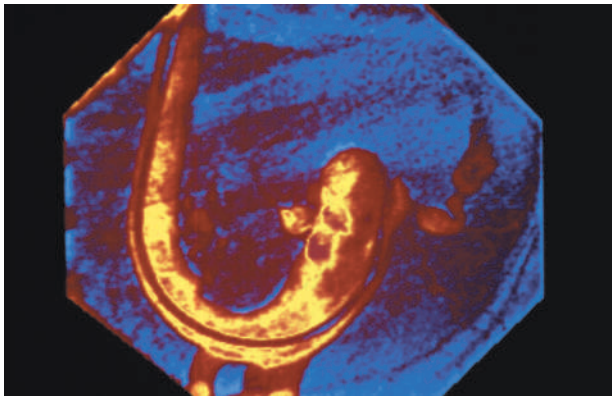
Causes and symptoms

The specific cause of Kawasaki syndrome is unknown, although the disease resembles infectious illnesses in many ways. It has been suggested that Kawasaki syndrome represents an allergic reaction or other unusual response to certain types of infections. Some researchers think that the syndrome may be caused by the interaction of an immune cell, called the T cell, with certain poisons (toxins) secreted by bacteria.

Kawasaki syndrome has an abrupt onset, with **fever** as high as 104°F (40°C) and a rash that spreads over the patient's chest and genital area. The fever is followed by a characteristic peeling of the skin beginning at the fingertips and toenails. In addition to the body rash, the patient's lips become very red, with the tongue developing a "strawberry" appearance. The palms, soles, and mucous membranes that line the eyelids and cover the exposed portion of the eyeball (conjuntivae) become purplish-red and swollen. The lymph nodes in the patient's neck may also become swollen. These symptoms may last from two weeks to three months, with relapses in some patients.

In addition to the major symptoms, about 30% of patients develop joint pains or arthritis, usually in the large joints of the body. Others develop **pneumonia**, **diarrhea**, dry or cracked lips, **jaundice**, or an inflammation of the membranes covering the brain and spinal cord (**meningitis**). A few patients develop symptoms of inflammation in the liver (hepatitis), gallbladder, lungs, or tonsils.

About 20% of patients with Kawasaki syndrome develop complications of the cardiovascular system. These complications include inflammation of the heart tissue (**myocarditis**), disturbances in heartbeat rhythm (**arrhythmias**), and areas of blood vessel dilation (aneurysms) in the coronary arteries. Other patients may develop inflammation of an artery (arteritis) in their arms or legs. Complications of the heart or arteries begin to develop around the tenth day after the illness begins, when the fever and rash begin to subside. A few patients may develop **gangrene**, or the **death** of soft tissue, in their hands and feet. The specific causes of these complications are not yet known.



An angiogram showing abnormal coronary arteries in a child suffering from Kawasaki's disease. The coronary arteries are abnormal and weakened in that they bulge into balloon shapes, or aneurysms, along their lengths. This illness afflicts children between the ages of 1-2 years. *(Photograph by Mehau Kulyk, Photo Researchers, Inc. Reproduced by permission.)*

Diagnosis

Because Kawasaki syndrome is primarily a disease of infants and young children, the disease is most likely to be diagnosed by a pediatrician. The physician will first consider the possible involvement of other diseases that cause fever and skin **rashes**, including **scarlet fever**, **measles**, **Rocky Mountain spotted fever**, **toxoplasmosis**, juvenile **rheumatoid arthritis**, and a blistering and inflammation of the skin caused by reactions to certain medications (Stevens-Johnson syndrome).

Once other diseases have been ruled out, the patient's symptoms will be compared with a set of diagnostic criteria. The patient must have a fever lasting five days or longer that does not respond to **antibiotics**, together with four of the following five symptoms:

- Inflammation of the conjunctivae of both eyes with no discharge
- At least one of the following changes in the mucous membranes of the mouth and throat: "strawberry" tongue; cracked lips; or swollen throat tissues
- At least one of the following changes in the hands or feet: swelling caused by excess fluid in the tissues; peeling of the skin; or abnormal redness of the skin
- A skin eruption or rash associated with fever (exanthem) on the patient's trunk
- Swelling of the lymph nodes in the neck to a size greater than 0.6 in (1.5 cm).

Since the cause of Kawasaki syndrome is unknown, there are no laboratory tests that can confirm the diagno-

KEY TERMS

Aneurysm—Dilation of an artery caused by thinning and weakening of the vessel wall.

Arrythmia—Abnormal heart rhythm.

Arteritis—Inflammation of an artery.

Cardiomegaly—An enlarged heart.

Conjunctivae—The mucous membranes that cover the exposed area of the eyeball and line the inner surface of the eyelids.

Exanthem—A skin eruption associated with a disease, usually one accompanied by fever as in Kawasaki syndrome.

Gangrene—The death of soft tissue in a part of the body, usually caused by obstructed circulation.

Hepatitis—Inflammation of the liver.

Meningitis—Inflammation of the membranes, called the meninges, covering the brain and spinal cord.

Mucocutaneous lymph node syndrome (MLNS)—Mucocutaneous lymph node syndrome, another name for Kawasaki syndrome. The name comes from the key symptoms of the disease, which involve the mucous membranes of the mouth and throat, the skin, and the lymph nodes.

Myocarditis—Inflammation of the heart muscle.

Stevens-Johnson syndrome—A severe inflammatory skin eruption that occurs as a result of an allergic reaction or respiratory infection.

T cell—A type of white blood cell that develops in the thymus gland and helps to regulate the immune system's response to infections or malignancy.

sis. The following test results, however, are associated with the disease:

- Blood tests show a high white blood cell count, high **platelet count**, a high level of protein in the blood serum, and mild anemia.
- Chest x ray may show enlargement of the heart (cardiomegaly).
- Urine may show the presence of pus or an abnormally high level of protein.
- An electrocardiogram may show changes in the heartbeat rhythm.

In addition to these tests, it is important to take a series of echocardiograms during the course of the illness because 20% of Kawasaki patients will develop coronary aneurysms or arteritis that will not appear during the first examination.

Treatment

Kawasaki syndrome is usually treated with a combination of **aspirin**, to control the patient's fever and skin inflammation, and high doses of intravenous immune globulin to reduce the possibility of coronary artery complications. Some patients with heart complications may be treated with drugs that reduce blood clotting or may receive corrective surgery.

Follow-up care includes two to three months of monitoring with chest x rays, **electrocardiography**, and **echocardiography**. Treatment with aspirin is often continued for several months.

Prognosis

Most patients with Kawasaki syndrome will recover completely, but about 1-2% will die as a result of blood clots forming in the coronary arteries or as a result of a **heart attack**. Deaths are sudden and unpredictable. Almost 95% of fatalities occur within six months of infection, but some have been reported as long as 10 years afterward. Long-term follow-up of patients with aneurysms indicates that about half show some healing of the aneurysm. The remaining half has a high risk of heart complications in later life.

Resources

BOOKS

Abzug, Mark J. "Infectious Diseases: Bacterial, Spirochetal, Protozoal, Metazoal, & Mycotic." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

"Childhood Infections: Kawasaki Syndrome." In *The Merck Manual of Diagnosis and Therapy.* 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

Shaffer, Elizabeth M., et al. "Heart." In *Handbook of Pediatrics*, ed. Gerald B. Merenstein, et al. Norwalk, CT: Appleton & Lange, 1994.

Shandera, Wayne X., and Maria E. Carlini. "Infectious Diseases: Viral & Rickettsial." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Wolfe, Robert R., et al. "Cardiovascular Diseases." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Keloids

Definition

Keloids are overgrowths of fibrous tissue or scars that can occur after an injury to the skin. These heavy scars are also called cheloid or hypertrophic scars. In individuals prone to keloids, even minor traumas to the skin, such as ear piercing, can cause keloids.

Description

Keloids can occur anywhere on the body, but they are most common on the earlobes, upper back, shoulders, and chest. They consist of hard, raised scars that may be slightly pink or whitish. These may itch and be painful, and some keloids can grow to be quite large.

Causes and symptoms

Although the cause of keloids is unknown, it is thought that they are due to the body's failure to turn off the healing process needed to repair skin. When this occurs, extra collagen forms at the site of the scar, and keeps forming because it is not shut off. This results in keloid formation.

Keloids occur most frequently in individuals of African-American descent and in those with darker skin. Other risk factors include a family history of keloids, surgery, **acne**, **burns**, ear piercing, vaccinations, or even insect bites. In addition, women and young people under the age of 30 are more prone to develop them.

Initially, keloids will begin as a small lump where the skin has been injured. This lump grows and can eventually become very large and cosmetically unacceptable.

Diagnosis

A dermatologist can usually make the diagnosis of a keloid based on looking at the scar. In some cases, however, a biopsy may be necessary to rule out other types of **skin lesions**, such as tumors.

Treatment

The treatment of choice for keloids is usually an injection of corticosteroid drugs such as cortisone directly into the lesion. These injections cause the keloid to become atrophic, or thinner, and are repeated every three to four weeks until the keloid has been resolved to the individual's satisfaction. Other therapies include laser treatment or **radiation therapy**, and topical treatments are undergoing study.

KEY TERMS

Atrophy —A wasting away of, becoming thinner, less strong.

Corticosteroids—Any of several steroid medications used to suppress inflammation, allergic, or immune responses of the body.

Surgery is often used in combination with corticosteroid injections. The injections are given for several weeks, and then the keloid is surgically removed. The injections are then continued for several weeks. Surgical removal of the keloid may also be used in conjunction with radiation therapy, which delivers small amounts of radiation to the affected area.

Newer approaches include silastic gel sheeting, which makes use of pressure to flatten the keloid. The gel is applied and kept securely in place with tape, cloth, or an ace bandage. The dressing is to be changed every seven to 10 days, for as long as 12 months.

Finally, researchers are now studying a type of tape that has been soaked with steroids, which are released slowly into the keloid, causing it to thin over time.

Prognosis

Although keloids are unsightly, they are not life threatening. Keloids do not have a tendency to develop into malignancies, but they can become cosmetically unacceptable. Keloids can gradually lessen after treatment, but many recur. And just as they can occur spontaneously, they can also resolve spontaneously.

Prevention

Preventive measures include avoiding any trauma to the skin, and compression pressure dressing for high-risk patients who have suffered burns to their skin. Patients with a tendency to form keloids should avoid any sort of elective surgery. Individuals who are prone to develop keloids or who have a history of keloids should immediately care for any cuts or abrasions they may sustain.

Resources

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, PO Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. Fax: (847) 330-0050 <http://www.aad.org>.

OTHER

"Keloids." Black Women's Health. <http://www.blackwomenshealth.com/Keloids.htm>.

<http://www.skinsite.com>.

Liz Meszaros

Keratitis

Definition

Keratitis is an inflammation of the cornea, the transparent membrane that covers the colored part of the eye (iris) and pupil of the eye.

Description

There are many types and causes of keratitis. Keratitis occurs in both children and adults. Organisms cannot generally invade an intact, healthy cornea. However, certain conditions can allow an infection to occur. For example, a scratch can leave the cornea open to infection. A very dry eye can also decrease the cornea's protective mechanisms.

Risk factors that increase the likelihood of developing this condition include:

- poor contact lens care; overuse of contact lenses
- illnesses or other factors that reduces the body's ability to overcome infection
- cold sores, **genital herpes**, and other viral infections
- crowded, dirty living conditions; poor hygiene
- poor **nutrition** (especially a deficiency of Vitamin A, which is essential for normal vision)

Some common types of keratitis are listed below, however there are many other forms.

Herpes simplex keratitis

A major cause of adult eye disease, herpes simplex keratitis may lead to:

- chronic inflammation of the cornea
- development of tiny blood vessels in the eye
- scarring
- loss of vision
- glaucoma

This infection generally begins with inflammation of the membrane lining the eyelid (conjunctiva) and the portion of the eyeball that comes into contact with it. It usually occurs in one eye. Subsequent infections are characterized by a pattern of lesions that resemble the veins of a leaf. These infections are called dendritic keratitis and aid in the diagnosis.

Recurrences may be brought on by **stress**, **fatigue**, or ultraviolet light (UV) exposure (e.g., skiing or boating increase the exposure of the eye to sunlight; the sunlight reflects off of the surfaces). Repeated episodes of dendritic keratitis can cause sores, permanent scarring, and numbness of the cornea.

Recurrent dendritic keratitis is often followed by disciform keratitis. This condition is characterized by clouding and deep, disc-shaped swelling of the cornea and by inflammation of the iris.

It is very important not to use topical **corticosteroids** with herpes simplex keratitis as it can make it much worse, possibly leading to blindness.

Bacterial keratitis

People who have bacterial keratitis wake up with their eyelids stuck together. There can be **pain**, sensitivity to light, redness, tearing, and a decrease in vision. This condition, which is usually aggressive, can be caused by wearing soft contact lenses overnight. One study found that overnight wear can increase risk by 10-15 times more than if wearing daily wear contact lenses. Improper lens care is also a factor. Contaminated makeup can also contain bacteria.

Bacterial keratitis makes the cornea cloudy. It may also cause abscesses to develop in the stroma, which is located beneath the outer layer of the cornea.

Fungal keratitis

Usually a consequence of injuring the cornea in a farm-like setting or in a place where plant material is present, fungal keratitis often develops slowly. This condition:

- usually affects people with weakened immune systems
- often results in infection within the eyeball
- may cause stromal abscesses

Peripheral ulcerative keratitis

Peripheral ulcerative keratitis is also called marginal keratolysis or peripheral rheumatoid ulceration. This condition is often associated with active or chronic:

- rheumatoid arthritis
- relapsing polychondritis (connective-tissue inflammation)
- wegener's granulomatosis, a rare condition characterized by kidney disease and development of nodules in the respiratory tract

Superficial punctate keratitis

Often associated with the type of viruses that cause upper respiratory infection (adenoviruses), superficial punctate keratitis is characterized by destruction of pinpoint areas in the outer layer of the cornea (epithelium). One or both eyes may be affected.

Acanthamoeba keratitis

This pus-producing condition is very painful. It is a common source of infection in people who wear soft or rigid contact lenses. It can be found in tap water, soil, and swimming pools.

Photokeratitis

Photokeratitis or snowblindness is caused by excess exposure to UV light. This can occur with sunlight, suntanning lamps, or a welding arc. It is called snowblindness because the sunlight is reflected off of the snow. It therefore can occur in water sports as well, because of the reflection of light off of the water. It is very painful and may occur several hours after exposure. It may last one to two days.

Interstitial keratitis

Also called parenchymatous keratitis, interstitial keratitis is a chronic inflammation of tissue deep within the cornea. Interstitial keratitis is rare in the United States. Interstitial keratitis affects both eyes and usually occurs as a complication of congenital or acquired **syphilis**. In congenital syphilis it can occur between age two and **puberty**. It may also occur in people with **tuberculosis**, **leprosy**, or other diseases.

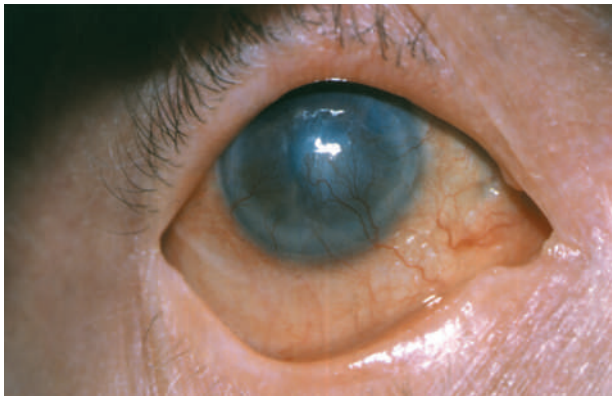
Causes and symptoms

In summary, keratitis can be caused by:

- bacterial, viral, or fungal infections
- dry eyes resulting from disorders of the eyelid or diminished ability to form tears
- exposure to very bright light
- **foreign objects** that injure or become lodged in the eye
- sensitivity or allergic reactions to eye makeup, dust, pollen, pollution, or other irritants
- vitamin A deficiency, which people with normal **diets** rarely develop

Symptoms of keratitis include, but are not limited to:

- tearing
- pain
- sensitivity to light



Close-up of a damaged cornea due to complications following cataract surgery. *(Custom Medical Stock Photo. Reproduced by permission.)*

- inflammation of the eyelid
- decrease in vision
- redness

Diagnosis

A case history will be taken and the vision will be tested. Examination with a slit lamp, an instrument that's a microscope and focuses a beam of light on the eye, is important for diagnosis. The cornea can be examined with fluorescein, a yellow dye which will highlight defects in the cornea. Deeper layers of the cornea can also be examined with the slit lamp. Infiltrates, hazy looking areas in the cornea, can be seen by the doctor and will aid in the diagnosis. Samples of infectious matter removed from the eye will be sent for laboratory analysis.

Treatment

Antibiotics, antifungals, and antiviral medication will be used to treat the appropriate organism. Broad spectrum antibiotics will be used immediately, but once the lab analysis determines the offending organism the medication may be changed. Sometimes more than one medication is necessary. It depends upon the infection, but the patient should be clear on how often and how to use the medications.

A sterile, cotton-tipped applicator may be used to gently remove infected tissue and allow the eye to heal more rapidly. **Laser surgery** is sometimes performed to destroy unhealthy cells, and some severe infections require corneal transplants.

Antifungal, antibiotic, or antiviral eyedrops or ointments are usually prescribed to cure keratitis, but they should be used only by patients under a doctor's care.

KEY TERMS

Abscess—A collection of pus.

Glaucoma—An eye disease characterized by an increase of pressure in the eye. Left untreated, blindness may result.

Infiltrate—A collection of cells not usually present in that area. In the cornea, infiltrates may be a collection of white blood cells.

Inflammation—A localized response to an injury. May include swelling, redness, and pain.

Inappropriate prescriptions or over-the-counter preparations can make symptoms more severe and cause tissue deterioration. Topical corticosteroids can cause great harm to the cornea in patients with herpes simplex keratitis.

A patient with keratitis may wear a patch to protect the healing eye from bright light, foreign objects, the lid rubbing against the cornea, and other irritants. Sometimes a patch can make it worse, so again, the patient must discuss with the doctor whether or not a patch is necessary. The patient will probably return every day to the eye doctor to check on the progress.

Although early detection and treatment can cure most forms of keratitis, the infection can cause:

- glaucoma
- permanent scarring
- ulceration of the cornea
- blindness

Prevention

Children and adults who wear contact lenses should always use sterile lens-cleaning and disinfecting solutions. Tap water is not sterile and should not be used to clean contact lenses. It is important to go for follow-up checkups because small defects in the cornea can occur without the patient being aware of it. Do not overwear contact lenses. Remove them if the eyes become red or irritated. Replace contact lenses when scheduled to do so. Proteins and other matter can deposit on the contacts, leading to an increased risk of infection. Rinse contact lens cases in hot water every night, if possible, and let them air dry. Replace contact lens cases every three months. Organisms have been cultured from contact lens cases.

Eating a well-balanced diet and wearing protective glasses when working or playing in potentially dangerous situations can reduce anyone's risk of developing keratitis. Protective goggles can even be worn mowing the lawn so that if twigs are tossed up they can't hurt the eye. Goggles or sunglasses with UV coatings can help protect against damage from UV light.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892-3655. (301) 496-5248. <http://www.nei.nih.gov>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

OTHER

"Infection-causing Organism Dictates Microbial Keratitis Treatment." Slack Inc. Page. 21 May 1998 <http://www.slackinc.com/areas.asp>.

"Keratitis." ThriveOnline. 20 May 1998 <http://thriveonline.oxygen.com>.

"Ohthalmologic Disorders." The Merck Page. 21 May 1998 <http://www.merck.com>.

"To Avoid Infection, Make RGP Patients Aware of Tap Water Risk." Slack Inc. Page. 21 May 1998 <http://www.slackinc.com/eye/pcon/199603/taph20.htm>.

Maureen Haggerty

Keratosis pilaris

Definition

Keratosis pilaris is a common skin condition that looks like small goose bumps, which are actually dead skin cells that build up around the hair follicle.

Description

Keratosis pilaris is a disorder that occurs around the hair follicles of the upper arms, thighs, and sometimes the buttocks. It presents as small, benign bumps or papules that are actually waxy build-ups of keratin. Normally skin sloughs off. However, around the hair follicle where the papules form, the keratinized skin cells slough off at a slower rate, clogging the follicles.

This is generally thought to be a genetic disorder, although the symptoms of keratosis pilaris are often seen with **ichthyosis** and allergic **dermatitis**. It can also be observed in people of all ages who have either inherited it, have a **vitamin A deficiency** or have dry skin. Keratosis pilaris is a self-limiting disorder that disappears as the person ages. It can become more severe when conditions are dry such as during the winter months or in dry climates.

Causes and symptoms

The specific causes of this disorder are unknown. Since this disorder runs in families, it is thought to be hereditary. Keratosis pilaris is not a serious disorder and is not contagious.

The symptoms of keratosis pilaris are based on the development of small white papules the size of a grain of sand on the upper arms, thighs, and occasionally the buttocks and face. The papules occur around a hair follicle and are firm and white. They feel a little like coarse sandpaper, but they are not painful and there usually is no **itching** associated with them. They are easily removed and the material inside the papule usually contains a small, coiled hair.

Diagnosis

A dermatologist or a general practicioner can easily diagnose this disorder. A **physical examination** is all that is necessary to diagnose keratosis pilaris. Special tests are not needed.

Treatment

To treat keratosis pilaris patients can try several strategies to lessen the bumps. First, the patient can supplement the natural removal of dry skin and papules by using a loofah or another type of scrub when showering or bathing. A variety of different over-the-counter (OTC) lotions, ointments, and creams can also be applied after showering while the skin is still moist and then several times a day to keep the area moist. Medicated lotions with urea, 15% alphahydroxy acids, or Retin A can also be prescribed by the dermatologist and applied one to two times daily. Systemic (oral) medications are not prescribed for keratosis pilaris. However if papules are opened and become infected, **antibiotics** may be necessary to treat the infection.

Prognosis

Unfortunately, the treatment for keratosis pilaris is often disappointing. Although extreme cases of keratosis pilaris can occasionally be unsightly, the disorder is not life threatening and usually begins to disappear as the patient ages.

KEY TERMS

Benign—Not cancerous.

Dermatologist—A physician that specializes in diseases and disorders of the skin.

Ichthyosis—A group of congenital disorders of keratinization characterized by dryness and scaling of the skin.

Keratin—The hard, waxy material that is made by the outer layer of skin cells.

Prevention

Since keratosis pilaris is thought to be a genetic disorder and is observed in several members of the same family, there is nothing that can be done to prevent this disorder. Following the treatment advice above can alleviate the outward characteristics of keratosis pilaris.

Sally C. McFarlane-Parrott

Kidney biopsy

Definition

Kidney biopsy is a medical procedure in which a small piece of tissue is removed from the kidney for microscopic examination.

Purpose

The test is usually done to diagnose kidney disease and to evaluate the extent of damage to the kidney. A biopsy is also frequently ordered to detect the reason for acute renal failure when normal office procedures and tests fail to establish the cause. In addition, information regarding the progression of the disease and how it is responding to medical treatment can be obtained from a biopsy. Occasionally a biopsy may be done to confirm a diagnosis of **kidney cancer**, to determine its aggressiveness, and decide on the mode of treatment.

Precautions

The biopsy is not recommended for patients who have any uncontrollable bleeding disorders. Platelets are blood cells that play an important role in the blood clotting process. If the bleeding disorder is caused by a low

platelet count (less than 50,000 per cubic millimeter of blood), then a platelet **transfusion** can be done just before performing the biopsy.

Description

The kidneys, a pair of organs that are shaped like beans, lie on either side of the backbone, just above the waist. The periphery (parenchyma) of the kidney is made up of tiny tubes. These tubes filter and clean the blood by taking out the waste products and making urine. The urine is collected in the central portion of the kidney. Tubes called ureters drain the urine from the kidney into the bladder, where it is held until it is voided from the body.

A kidney specialist (nephrologist) performs the biopsy. It can be done either in the doctor's office or in a local hospital. The patient may be given a calming drug before the procedure to help him relax. The skin and muscles on the back overlying the site that is to be biopsied may be numbed with local anesthesia.

The patient will be asked to lie face down and a pad or a rolled towel may be placed under the stomach. Either the left or the right kidney may be biopsied depending on the results of the imaging tests: x rays, **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), and ultrasound. The area that will be biopsied is cleaned with an antiseptic solution and sterile drapes are placed on it. The skin is numbed with local anesthesia. A small incision is made on the skin with a scalpel blade. Using a long needle, the physician injects local anesthesia into the incision so that it infiltrates down to the kidney. The biopsy needle is then advanced slowly through the incision. The patient is asked to hold his or her breath each time the needle is pushed forward. Once the wall (capsule) of the kidney has been penetrated, the patient can breathe normally. The tissue is collected for examination and the needle is withdrawn. The needle may be re-inserted into another part of the kidney so that tissue is collected from at least three different areas. The tissue samples are sent to the laboratory for examination. The entire procedure may last about an hour.

Preparation

Before performing the biopsy, the doctor should be made aware of all the medications that the patient is taking. The doctor should also be told whether the patient is allergic to any medications. The procedure and the risks of the procedure are explained to the patient and the necessary consent forms are obtained. The patient should be told that a kidney biopsy requires a 24-hour stay in the hospital after the biopsy.

Some doctors order blood tests to check for clotting problems before performing the biopsy. The patient's blood type may also be determined in case a transfusion becomes necessary.

Aftercare

Immediately after the biopsy, pulse, respiration, and temperature (vital signs) are measured. If they are stable, the patient is instructed to lie flat in bed for at least 12 hours. The pulse and blood pressure are checked at regular intervals by the nursing staff. All urine voided by the patient in the first 12-24 hours is examined in the laboratory for blood cells.

If bleeding is severe, iron levels in the blood drop significantly, or the patient complains of severe **pain** at the biopsy site, the physician should be contacted immediately. After the patient goes home, he should avoid heavy lifting, vigorous **exercise**, and contact sports for at least one or two weeks.

Risks

The risks of a kidney biopsy are very small. Severe bleeding may occur after the procedure. There is also a slight chance that an infection or a lump of blood under the skin that looks black and blue (hematoma) may develop. In most cases, the hematoma disappears by itself and does not cause any pain. However, severe pain or a drop in blood pressure and iron levels in the blood indicates that the hematoma is expanding. This condition could lead to complications and should be reported immediately to the doctor.

Very rarely, the patient may develop high blood pressure (**hypertension**), and the bleeding may be severe enough to require a transfusion. In extremely rare circumstances, the kidney may rupture, or the surrounding organs (pancreas, bowel, spleen, and liver) may be punctured. **Death** occurs in about one in 3000 cases.

Normal results

The results are normal if no abnormalities can be seen in the tissue samples with the naked eye, with an electron microscope or through staining with a fluorescent dye (immunofluorescence).

Abnormal results

Any abnormalities in the size, color, and consistency of the sample will be reported as an abnormal result. In addition, any change in the structure of the renal tubules, the presence of red blood cells, or abnormalities in the cells are considered an abnormal result. If cancerous

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Computed tomography (CT) scan—A medical procedure in which a series of x rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes in which pictures of areas inside the body can be created using a magnet linked to a computer.

Nephrologist—A doctor who specializes in the diseases and disorders of the kidneys.

Renal ultrasound—A painless and non-invasive procedure in which sound waves are bounced off the kidneys. These sound waves produce a pattern of echoes that are then used by the computer to create pictures of areas inside the kidney (sonograms).

changes are detected in the kidney cells, they are further characterized in order to determine the stage of the tumor and decide on the appropriate mode of treatment.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Sobel, David S., and T. Ferguson. *The People's Book of Medical Tests.* New York: Summit Books, 1985.

ORGANIZATIONS

National Kidney Cancer Association. 1234 Sherman Ave., Suite 203, Evanston, IL 60202-1375. (800) 850-9132.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.

Lata Cherath, PhD

Kidney cancer

Definition

Kidney **cancer** is a disease in which the cells in certain tissues of the kidney start to grow uncontrollably and form tumors. Renal cell carcinoma, which occurs in the cells lining the kidneys (epithelial cells), is the most common type of kidney cancer. Eighty-five percent of all kidney tumors are renal cell carcinomas. **Wilms' tumor** is a rapidly developing cancer of the kidney most often found in children under four years of age.

Description

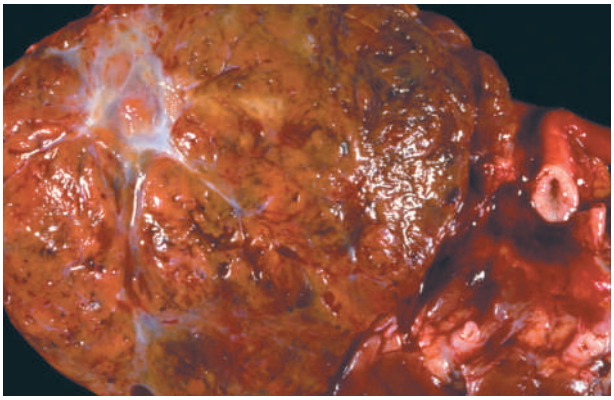
The kidneys are a pair of organs shaped like kidney beans that lie on either side of the spine just above the waist. Inside each kidney are tiny tubes (tubules) that filter and clean the blood, taking out the waste products and making urine. The urine that is made by the kidney passes through a tube called the ureter into the bladder. Urine is held in the bladder until it is discharged from the body. Renal cell carcinoma generally develops in the lining of the tubules that filter and clean the blood. Cancer that develops in the central portion of the kidney (where the urine is collected and drained into the ureters) is known as transitional cell cancer of the renal pelvis. Transitional cell cancer is similar to **bladder cancer**.

Kidney cancer accounts for 3% of all cancers. According to the American Cancer Society, approximately 30,000 new cases of kidney cancer will be found in 1998. Kidney cancer occurs most often in people between 50 and 60 years old. Men are twice as likely as women to have cancer of the kidney. Other risk factors for the development of kidney cancer include Hispanic heritage, and pre-existing von Hippel-Lindau disease.

Causes and symptoms

The causes of kidney cancer are unknown, but men seem to have twice the risk of contracting the disease. There is a strong association between cigarette **smoking** and kidney cancer. Cigarette smokers are twice as likely as non-smokers to develop kidney cancer. Working around coke ovens has been shown to increase people's risk of developing this cancer. Certain types of painkillers that contain the chemical phenacetin are associated with kidney cancer. The United States government discontinued use of **analgesics** containing phenacetin about 20 years ago. **Obesity** may be yet another risk factor for kidney cancer. Some studies show a loose association between kidney cancer and occupational exposure to cadmium, petroleum products, lead, and asbestos.

The most common symptom of kidney cancer is blood in the urine (hematuria). Other symptoms include painful urination, **pain** in the lower back or on the sides, abdominal pain, a lump or hard mass that can be felt in the kidney area, unexplained weight loss, **fever**, weakness, **fatigue**, and high blood pressure.



An extracted cancerous kidney. *(Custom Medical Stock Photo. Reproduced by permission.)*

Other symptoms may occur if the cancer has spread beyond its original location. Spread of kidney cancer most commonly occurs to the lung (55%), liver (33%), bone (33%), adrenal (20%), and opposite kidney (10%). Lymph node spread is also common, occurring in about 25% of patients.

Diagnosis

A diagnostic examination for kidney cancer includes taking a thorough medical history and making a complete **physical examination** in which the doctor will probe (palpate) the abdomen for lumps. Blood tests will be ordered to check for changes in blood chemistry caused by substances released by the tumor. Laboratory tests may show abnormal levels of iron in the blood. Either a low red blood cell count (anemia) or a high red blood cell count (erythrocytosis) may accompany kidney cancer. Occasionally, patients will have high calcium levels.

If the doctor suspects kidney cancer, an intravenous pyelogram (IVP) may be ordered. An IVP is an x-ray test in which a dye in injected into a vein in the arm. The dye travels through the body, and when it is concentrated in the urine to be discharged, it outlines the kidneys, ureters, and the urinary bladder. On an x-ray image, the dye will reveal any abnormalities of the urinary tract. The IVP may miss small kidney cancers.

Renal ultrasound is a diagnostic test in which sound waves are used to form an image of the kidneys. Ultrasound is a painless and non-invasive procedure that can be used to detect even very small kidney tumors. Imaging tests such as **computed tomography scans** (CT scans) and **magnetic resonance imaging** (MRI) can be used to evaluate the kidneys and the surrounding organs. These tests are used to check whether the tumor has spread outside the kidney to other organs in the abdomen. If the patient complains of bone pain, a special x ray called a bone scan may be ordered to rule out spread to the bones. A **chest x ray** may be taken to rule out spread to the lungs.

A **kidney biopsy** is used to positively confirm the diagnosis of kidney cancer. During this procedure, a small piece of tissue is removed from the tumor and examined under a microscope. The biopsy will give information about the type of tumor, the cells that are involved, and the aggressiveness of the tumor (tumor stage).

Treatment

Each person's treatment is different and depends on several factors. The location, size, and extent of the tumor have to be considered in addition to the patient's age, general health, and medical history.

The primary treatment for kidney cancer that has not spread to other parts of the body is surgical removal of the diseased kidney (**nephrectomy**). Because most cancers affect only one kidney, the patient can function well on the one remaining. Two types of surgical procedure are used. Radical nephrectomy removes the entire kidney and the surrounding tissue. Sometimes, the lymph nodes surrounding the kidney are also removed. Partial nephrectomy removes only part of the kidney along with the tumor. This procedure is used either when the tumor is very small or when it is not practical to remove the entire kidney. It is not practical to remove a kidney when the patient has only one kidney or when both kidneys have tumors. There is a small (5%) chance of missing some of the cancer.

Radiation therapy, which consists of exposing the cancer cells to high-energy gamma rays from an external source, generally destroys cancer cells with minimal damage to the normal tissue. Side effects are nausea, tiredness, and stomach upsets. These symptoms disappear when the treatment is over. In kidney cancer, radiation therapy has been shown to alleviate pain and bleeding, especially when the cancer is inoperable. However, it has not proven to be of much use in destroying the kidney cancer cells. Therefore radiation therapy is not used very often.

Treatment of kidney cancer with anti-cancer drugs (**chemotherapy**) has not produced good results. However, new drugs and new combinations of drugs continue to be tested in clinical trials.

Immunotherapy, a form of treatment in which the body's immune system is harnessed to help fight the cancer, is a new mode of therapy that is being tested for kidney cancer. Clinical trials with substances produced by the immune cells (interferon, interleukin-2, and lymphokine-activated cells) have shown some promise in destroying kidney cancer cells. These substances have been approved for use but they can be very toxic and pro-

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Bone scan—An x-ray study in which patients are given an intravenous injection of a small amount of a radioactive material that travels in the blood. When it reaches the bones, it can be detected by x ray to make a picture of their internal structure.

Chemotherapy—Treatment with anticancer drugs.

Computed tomography (CT) scan—A medical procedure in which a series of x-ray images are made and put together by a computer to form detailed pictures of areas inside the body.

Hematuria—Blood in the urine.

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Intravenous pyelogram (IVP)—A procedure in which a dye is injected into a vein in the arm. The dye travels through the body and concentrates in the urine to be discharged. It outlines the kidneys, ureters, and the urinary bladder. An x-ray image is then made and any abnormalities of the urinary tract are revealed.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes in which pictures of areas inside the body can be created using a magnet linked to a computer.

Nephrectomy—A medical procedure in which the kidney is surgically removed.

Radiation therapy—Treatment with high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Renal ultrasound—A painless and non-invasive procedure in which sound waves are bounced off the kidneys. These sound waves produce a pattern of echoes that are then used by the computer to create pictures of areas inside the kidney (sonograms).

duce severe side effects. The benefits derived from the treatment have to be weighed very carefully against the side effects in each case.

A procedure called renal artery embolization may be used to help decrease the patient's symptoms. In this procedure, the blood flow to the affected kidney is blocked, reducing the amount of blood received by the tumor. This starves the tumor, and may cause it to shrink.

Prognosis

Because kidney cancer is often caught early and sometimes progresses slowly, the chances of a surgical cure are good. Length of survival depends on the size of the original tumor, the aggressiveness of the specific cells making up the tumor, and whether the cancer cells spread from the kidney to surrounding or distant tissues.

Kidney cancer is also one of the few cancers for which there are well-documented cases of spontaneous remission without therapy. Unfortunately, recurrences can occur even as long as 10 years after the original diagnosis and treatment, and cancer can also crop up in the other, previously unaffected kidney.

Prevention

The exact cause of kidney cancer is not known, so it is not possible to prevent all cases. However, because a strong association between kidney cancer and tobacco has been shown, avoiding tobacco is the best way to lower one's risk of developing this cancer. Using care when working with cancer-causing agents such as asbestos and cadmium and eating a well-balanced diet may also help prevent kidney cancer.

Resources

BOOKS

Murphy, Gerald P., Lois B. Morris, and Dianne Lange. *Informed Decisions: The Complete Book of Cancer Diagnosis, Treatment and Recovery.* New York: Viking, 1997.

Quek, Marcus L. and John P. Stein. "Malignant Tumors of the Urogenital Tract." In *Conn's Current Therapy 2001* 53th ed. Philadlphia: W.B. Saunders Company, 2001.

ORGANIZATIONS

American Cancer Society (National Headquarters). 1599 Clifton Road, N.E., Atlanta, GA 30329. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute (National Headquarters). 681 Fifth Avenue, New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

National Cancer Institute. 9000 Rockville Pike, Building 31, Room 10A16, Bethesda, MD 20892. (800) 422-6237. <http://www.nci.nih.gov>.

National Kidney Cancer Association. 1234 Sherman Avenue, Suite 203, Evanston, IL 60202-1375. (800) 850-9132.

National Kidney Foundation. 30 East 33rd Street, New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

Rosalyn Carson-DeWitt

Kidney dialysis *see* **Dialysis, kidney**

Kidney failure *see* **Acute kidney failure; Chronic kidney failure**

Kidney function tests

Definition

Kidney function tests is a collective term for a variety of individual tests and procedures that can be done to evaluate how well the kidneys are functioning.

Purpose

The kidneys, the body's natural filtration system, perform many vital functions, including removing metabolic waste products from the bloodstream, regulating the body's water balance, and maintaining the pH (acidity/alkalinity) of the body's fluids. Approximately one and a half quarts of blood per minute are circulated through the kidneys, where waste chemicals are filtered out and eliminated from the body (along with excess water) in the form of urine. Kidney function tests help to determine if the kidneys are performing their tasks adequately.

Precautions

A complete history should be taken prior to kidney function tests to assess the patient's food and drug intake. A wide variety of prescription and over-the-counter medications can affect blood and urine kidney function test results, as can some food and beverages.

Description

Many conditions can affect the ability of the kidneys to carry out their vital functions. Some lead to a rapid (acute) decline in kidney function; others lead to a gradual (chronic) decline in function. Both result in a build-up of toxic waste substances in the blood. A number of clinical laboratory tests that measure the levels of substances normally regulated by the kidneys can help determine the cause and extent of kidney dysfunction. These tests are done on urine samples, as well as on blood samples.

Urine tests

There are a variety of urine tests that assess kidney function. A simple, inexpensive screening test, called a routine **urinalysis**, is often the first test administered if kidney problems are suspected. A small, randomly collected urine sample is examined physically for things like color, odor, appearance, and concentration (specific gravity); chemically for substances such as protein, glucose, and pH (acidity/ alkalinity); and microscopically for the presence of cellular elements (red blood cells, white blood cells, and epithelial cells), bacteria, crystals, and casts (structures formed by the deposit of protein, cells, and other substances in the kidneys' tubules). If results indicate a possibility of disease or impaired kidney function, one or more of the following additional tests is usually performed to more specifically diagnose the cause and the level of decline in kidney function.

- Creatinine clearance test. This test evaluates how efficiently the kidneys clear a substance called creatinine from the blood. Creatinine, a waste product of muscle energy metabolism, is produced at a constant rate that is proportional to the muscle mass of the individual. Because the body does not recycle it, all of the creatinine filtered by the kidneys in a given amount of time is excreted in the urine, making creatinine clearance a very specific measurement of kidney function.The test is performed on a timed urine specimen—a cumulative sample collected over a two to 24-hour period. Determination of the blood creatinine level is also required to calculate the urine clearance.
- Urea clearance test. Urea is a waste product that is created by protein metabolism and excreted in the urine. The urea clearance test requires a blood sample to measure the amount of urea in the bloodstream and two urine specimens, collected one hour apart, to determine the amount of urea that is filtered, or cleared, by the kidneys into the urine.
- Urine osmolality test. Urine osmolality is a measurement of the number of dissolved particles in urine. It is a more precise measurement than specific gravity for evaluating the ability of the kidneys to concentrate or dilute the urine. Kidneys that are functioning normally will excrete more water into the urine as fluid intake is increased, diluting the urine. If fluid intake is decreased, the kidneys excrete less water and the urine becomes more concentrated. The test may be done on a urine sample collected first thing in the morning, on multiple timed samples, or on a cumulative sample collected over a 24-hour period. The patient will typically be prescribed a high-protein diet for several days before the test and asked to drink no fluids the night before the test.
- Urine protein test. Healthy kidneys filter all proteins from the bloodstream and then reabsorb them, allowing

no protein, or only slight amounts of protein, into the urine. The persistent presence of significant amounts of protein in the urine, then, is an important indicator of kidney disease. A positive screening test for protein (included in a routine urinalysis) on a random urine sample is usually followed up with a test on a 24-hour urine sample that more precisely measures the quantity of protein.

Blood tests

There are also several blood tests that can aid in evaluating kidney function. These include:

- **Blood urea nitrogen test** (BUN). Urea is a by-product of protein metabolism. This waste product is formed in the liver, then filtered from the blood and excreted in the urine by the kidneys. The BUN test measures the amount of nitrogen contained in the urea. High BUN levels can indicate kidney dysfunction, but because blood urea nitrogen is also affected by protein intake and liver function, the test is usually done in conjunction with a blood creatinine, a more specific indicator of kidney function.
- Creatinine test. This test measures blood levels of creatinine, a by-product of muscle energy metabolism that, like urea, is filtered from the blood by the kidneys and excreted into the urine. Production of creatinine depends on an individual's muscle mass, which usually fluctuates very little. With normal kidney function, then, the amount of creatinine in the blood remains relatively constant and normal. For this reason, and because creatinine is affected very little by liver function, an elevated blood creatinine is a more sensitive indication of impaired kidney function than the BUN.
- Other blood tests. Measurement of the blood levels of other elements regulated in part by the kidneys can also be useful in evaluating kidney function. These include sodium, potassium, chloride, bicarbonate, calcium, magnesium, phosphorus, protein, uric acid, and glucose.

Preparation

Patients will be given specific instructions for collection of urine samples, depending on the test to be performed. Some timed urine tests require an extended collection period of up to 24 hours, during which time the patient collects all urine voided and transfers it to a specimen container. Refrigeration and/or preservatives are typically required to maintain the integrity of such urine specimens. Certain dietary and/or medication restrictions may be imposed for some of the blood and urine tests. The patient may also be instructed to avoid **exercise** for a period of time before a test.

Aftercare

If medication was discontinued prior to a urine kidney function test, it may be resumed once the test is completed.

Risks

Risks for these tests are minimal, but may include slight bleeding from a blood-drawing site, hematoma (accumulation of blood under a puncture site), or **fainting** or feeling light-headed after venipuncture. In addition, suspension of medication or dietary changes imposed in preparation for some blood or urine tests may trigger side-effects in some individuals.

Normal results

Normal values for many tests are determined by the patient's age and sex. Reference values can also vary by laboratory, but are generally within the ranges that follow.

Urine tests

- Creatinine clearance. For a 24-hour urine collection, normal results are 90-139 ml/min for adult males less than 40 years old, and 80-125 ml/min for adult females less than 40 years old. For people over 40, values decrease by 6.5 ml/min for each decade of life.
- Urea clearance. With maximum clearance, normal is 64-99 ml/min.
- Urine osmolality. With restricted fluid intake (concentration testing), osmolality should be greater than 800 mOsm/kg of water. With increased fluid intake (dilution testing), osmolality should be less than 100 mOSm/kg in at least one of the specimens collected.
- Urine protein. A 24-hour urine collection should contain no more than 150 mg of protein.

Blood tests

- blood urea nitrogen (BUN). 8-20 mg/dl
- creatinine. 0.8-1.2 mg/dl for males, and 0.6-0.9 mg/dl for females

Abnormal results

Low clearance values for creatinine and urea indicate diminished ability of the kidneys to filter these waste products from the blood and excrete them in the urine. As clearance levels decrease, blood levels of creatinine and urea nitrogen increase. Since it can be affected by other factors, an elevated BUN, by itself, is suggestive, but not diagnostic, for kidney dysfunction. An abnormally elevated blood creatinine, a more specific

KEY TERMS

Blood urea nitrogen (BUN)—The nitrogen portion of urea in the bloodstream. Urea is a waste product of protein metabolism in the body.

Creatinine—The metabolized by-product of creatine, an organic acid that assists the body in producing muscle contractions. Creatinine is found in the bloodstream and in muscle tissue. It is removed from the blood by the kidneys and excreted in the urine.

Osmolality—A measurement of urine concentration that depends on the number of particles dissolved in it. Values are expressed as milliosmols per kilogram (mOsm/kg) of water.

Urea—A by-product of protein metabolism that is formed in the liver. Because urea contains ammonia, which is toxic to the body, it must be quickly filtered from the blood by the kidneys and excreted in the urine.

and sensitive indicator of kidney disease than the BUN, is diagnostic of impaired kidney function.

Inability of the kidneys to concentrate the urine in response to restricted fluid intake, or to dilute the urine in response to increased fluid intake during osmolality testing may indicate decreased kidney function. Because the kidneys normally excrete almost no protein in the urine, its persistent presence, in amounts that exceed the normal 24-hour urine value, usually indicates some type of kidney disease as well.

Resources

BOOKS

Bock, G. H., E. J. Ruley, and M. P. Moore. *A Parent's Guide to Kidney Disorders.* Minneapolis: University of Minnesota Press, 1993.

Brenner, Barry M., and Floyd C. Rector Jr., eds. *The Kidney.* Philadelphia: W. B. Saunders Co., 1991.

Cameron, J. S. *Kidney Failure: The Facts.* New York: Oxford University Press, 1996.

Fischbach, Frances Talaska. *A Manual of Laboratory & Diagnostic Tests.* 5th ed. Philadelphia: J. B. Lippincott Co., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

ORGANIZATIONS

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.

Paula Anne Ford-Martin

Kidney nuclear medicine scan

Definition

A kidney nuclear medicine scan, or study, is a simple outpatient test that involves administering small amounts of radioactive substances, called tracers, into the body and then imaging the kidneys and bladder with a special camera. The images obtained can help in the diagnosis and treatment of certain kidney diseases.

Purpose

While many tests, such as x rays, ultrasound exams, or **computed tomography scans** (CT scans), can reveal the structure of the kidneys (its anatomy), the kidney nuclear medicine scan is unique in that it reveals how the kidneys are functioning. This is valuable information in helping a doctor make a diagnosis. Therefore, the kidney nuclear medicine scan is performed primarily to see how well the kidneys are working and, at the same time, can identify some of the various structures that make up the kidney.

Precautions

If a patient is pregnant, it is generally recommended that she not have a kidney nuclear medicine scan. The unborn baby is more sensitive to radiation than an adult. If a woman thinks she might be pregnant, she should inform her doctor of this too.

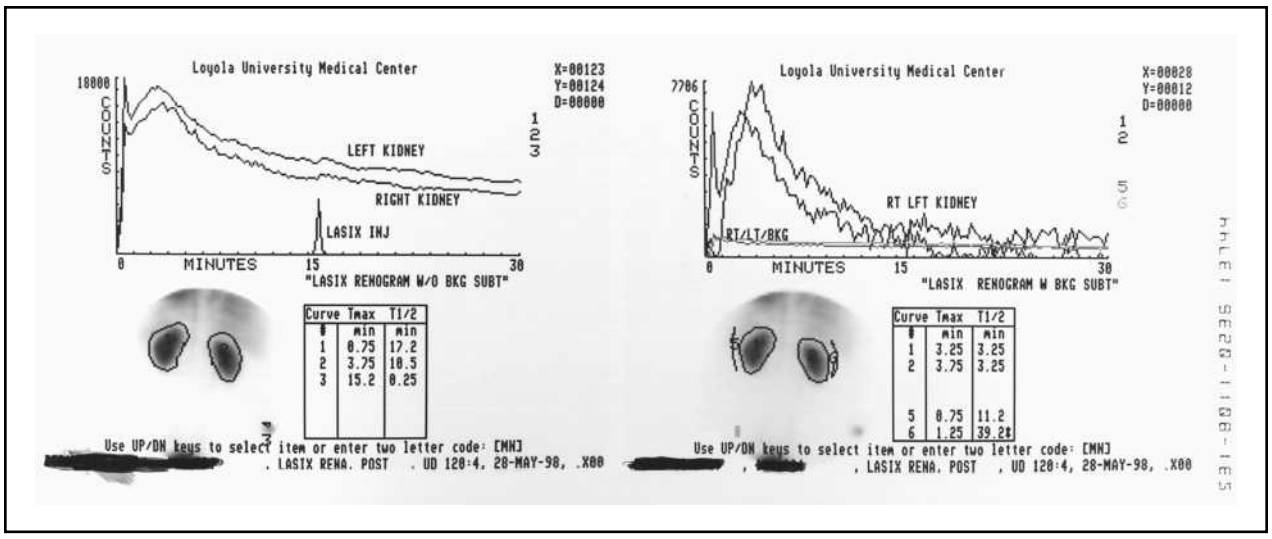
Women who are breastfeeding should also inform their doctor. The doctor may recommend the woman stop breastfeeding for a day or two after a kidney nuclear medicine scan, depending on the particular tracer that was used since the tracer can accumulate in breast milk.

Description

Nuclear medicine is a branch of radiology that uses radioactive materials to diagnose or treat various diseases. These radioactive materials (tracers) may also be called radiopharmaceuticals, and they accumulate (collect) in specific organs in the body. Radiopharmaceuticals are able to yield valuable information about the particular organ being studied.

Whether outside the body or inside the body, tracers emit radioactive signals, called gamma rays, which can be collected and counted by a special device, called a gamma camera. The images of the kidney that the camera produces are called renal scans.

The kidney nuclear medicine scan can be performed on an outpatient basis, usually by a nuclear medicine



A computer-generated time activity curve generated from a renal scan. This time activity curve looks at the radiation count over a period of time. *(Photograph by Collette Placek. Reproduced by permission.)*

technologist. The technologist helps prepare the patient for the exam by positioning him or her on an exam table or cart in the imaging area. The patient's position is usually flat on the back. The patient must lie still during imaging to prevent blurring of the images that will be taken. The technologist positions the camera as close to the kidney (or kidneys) as possible to obtain the best images.

In the next step of the procedure, the technologist injects the radiopharmaceutical into the patient. This may be done with one single injection or through an intravenous (IV) line. Immediately after the tracer is injected, imaging begins. It is important to obtain images right away because the tracer's radioactivity begins to diminish (decay). The time required for one-half of the tracer's activity to decay is called the tracer's half-life (T 1/2). The half-life is unique to each radiopharmaceutical. Also, it is important to see the kidney in its immediate state.

Serial pictures are taken with the gamma camera and may be seen on a computer or TV-like screen. The camera doesn't emit radiation, it only records it. The images then are stored on film.

A kidney nuclear medicine scan ranges from 45 minutes to three hours in length, depending on the goals of the test. But the test typically takes about an hour to an hour-and-a-half.

Once the images and curves are obtained, the nuclear medicine physician or radiologist analyzes, or reads, them. Various information can be provided to the doctor through these, depending on the test that was performed. A variety of kidney nuclear medicine studies are available for a doctor to help in making diagnoses. It is important to understand that kidney nuclear medicine scans are good at identifying when there is an abnormality, but they do not always identify the specific problem. They are very useful in providing information about how the various parts of the kidneys function, which, in turn, can assist in making a diagnosis.

Studies may be performed to determine the rate at which the kidneys are filtering a patient's blood. These studies use a radiopharmaceutical, called Technetium DTPA (Tc 99m DTPA). This radiopharmaceutical also can identify obstruction (blockage) in the collecting system. To study how well the tubules and ducts of the kidney are functioning, the radiopharmaceutical Technetium MAG3 is used. Studying tubular function is a good indicator of overall renal function. In many renal diseases, one of the first things that disappears or diminishes is the tubular function.

Candidates for a kidney nuclear medicine scan are patients who have:

- renal failure or chronic renal failure
- obstruction in their urine collection systems
- **renal artery stenosis**
- a kidney transplant

Preparation

No preparation is necessary for a kidney nuclear medicine scan. The doctor may ask the patient to refrain from certain medications, however, before the scan if the medications might interfere with the test. For example, if

KEY TERMS

Intravenous pyelogram (IVP)—X ray technique using dye to image the kidneys, ureters, and bladder.

Renal—Having to do with the kidneys.

Renal artery stenosis—Narrowing or constriction of the artery that supplies the kidney with blood.

a scan is being performed to study renal artery stenosis, the patient may have to refrain from taking medications for **hypertension**.

Aftercare

Patients can resume their normal daily activities immediately after the test. Most tracers are passed naturally from the body, though drinking fluids after a kidney nuclear medicine scan can help flush the tracer into the urine and out of the body more quickly.

Risks

Nuclear medicine procedures are very safe. Unlike some of the dyes that may be used in x-ray studies, radioactive tracers rarely cause side effects. There are no long-lasting effects of the tracers themselves, because they have no functional effects on the body's tissues.

Normal results

The test reveals normal kidney function for age and medical situation.

Abnormal results

The test reveals a change in function that may be attributable to a disease process, such as obstruction or a malfunctioning kidney. If the test is abnormal, the patient may be recalled another day for a repeat study, performed differently, to narrow the list of causes.

Resources

BOOKS

Henkin, Robert, et al. *Nuclear Medicine*. St. Louis: Mosby, 1996.

Maisey, Michael. *Clinical Nuclear Medicine*. 2nd ed. New York: Chapman and Hall, 1991.

PERIODICALS

McBiles, Mike. "Correlative Imaging of the Kidney." *Seminars in Nuclear Medicine* 24, no. 3 (July 1994): 219-233.

Taylor Jr., Andrew, and Joseph V. Nally. "Clinical Applications of Renal Scintigraphy." *American Journal of Radiology* 164 (Jan. 1995): 31-41.

ORGANIZATIONS

Society of Nuclear Medicine. 1850 Samuel Morse Dr., Reston, VA 10016. (703) 708-9000. <http://www.snm.org>.

OTHER

Interview with Robert H. Wagner, MD., Assistant Professor of Radiology, Section of Nuclear Medicine, Loyola University Medical Center. May 28, 1998 & June 5, 1998.

Collette L. Placek

Kidney removal *see* **Nephrectomy**

Kidney stones

Definition

Kidney stones are solid accumulations of material that form in the tubal system of the kidney. Kidney stones cause problems when they block the flow of urine through or out of the kidney. When the stones move along the ureter, they cause severe **pain**.

Description

Urine is formed by the kidneys. Blood flows into the kidneys, and specialized tubes (nephrons) within the kidneys allow a certain amount of fluid from the blood, and certain substances dissolved in that fluid, to flow out of the body as urine. Sometimes, a problem causes the dissolved substances to become solid again. Tiny crystals may form in the urine, meet, and cling together to create a larger solid mass called a kidney stone.

Many people do not ever find out that they have stones in their kidneys. These stones are small enough to allow the kidney to continue functioning normally, never causing any pain. These are called "silent stones." Kidney stones cause problems when they interfere with the normal flow of urine. They can block (obstruct) the flow down the tube (the ureter) that carries urine from the kidney to the bladder. The kidney is not accustomed to experiencing any pressure. When pressure builds from backed-up urine, the kidney may swell (**hydronephrosis**). If the kidney is subjected to this pressure for some time, it may cause damage to the delicate kidney structures. When the kidney stone is lodged further down the ureter, the backed-up urine may also cause the ureter to swell (hydroureter). Because the ureters are muscular tubes, the

presence of a stone will make these muscular tubes spasm, causing severe pain.

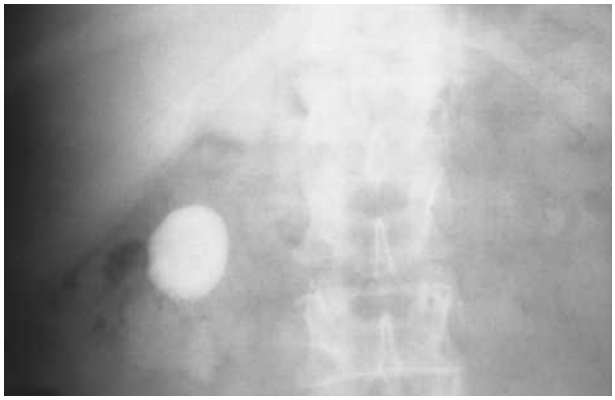
About 10% of all people will have a kidney stone in his or her lifetime. Kidney stones are most common among:

- caucasians
- males
- people over the age of 30
- people who have had kidney stones previously
- relatives of kidney stone patients

Causes and symptoms

Kidney stones can be composed of a variety of substances. The most common types of kidney stones include:

- Calcium stones. About 80% of all kidney stones fall into this category. These stones are composed of either calcium and phosphate, or calcium and oxalate. People with calcium stones may have other diseases that cause them to have increased blood levels of calcium. These diseases include primary parathyroidism, **sarcoidosis**, **hyperthyroidism**, **renal tubular acidosis**, **multiple myeloma**, hyperoxaluria, and some types of **cancer**. A diet heavy in meat, fish, and poultry can cause calcium oxalate stones.
- Struvite stones. About 10% of all kidney stones fall into this category. This type of stone is composed of magnesium ammonium phosphate. These stones occur most often when patients have had repeated urinary tract infections with certain types of bacteria. These bacteria produce a substance called urease, which increases the urine pH and makes the urine more alkaline and less acidic. This chemical environment allows struvite to settle out of the urine, forming stones.
- Uric acid stones. About 5% of all kidney stones fall into this category. Uric acid stones occur when increased amounts of uric acid circulate in the bloodstream. When the uric acid content becomes very high, it can no longer remain dissolved and solid bits of uric acid settle out of the urine. A kidney stone is formed when these bits of uric acid begin to cling to each other within the kidney, slowly growing into a solid mass. About half of all patients with this type of stone also have deposits of uric acid elsewhere in their body, commonly in the joint of the big toe. This painful disorder is called **gout**. Other causes of uric acid stones include **chemotherapy** for cancer, certain bone marrow disorders where blood cells are over-produced, and an inherited disorder called **Lesch-Nyhan syndrome**.
- Cystine stones. About 2% of all kidney stones fall into this category. Cystine is a type of amino acid, and people with this type of kidney stone have an abnormality in the way their bodies process amino acids in the diet.



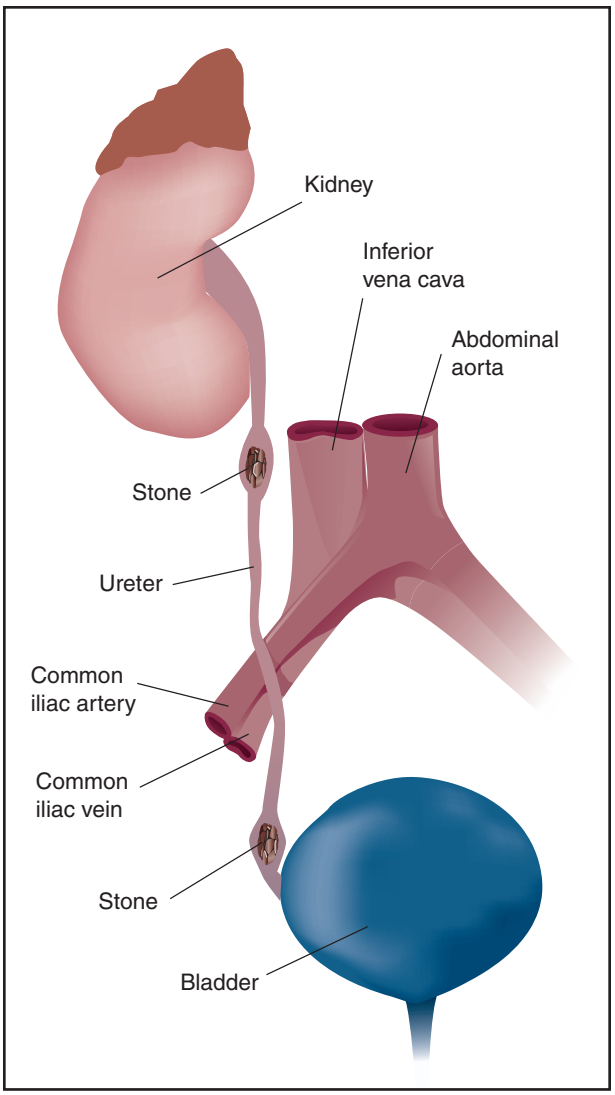
X ray of kidney stone. *(Custom Medical Stock Photo. Reproduced by permission.)*

Patients who have kidney stones usually do not have symptoms until the stones pass into the ureter. Prior to this, some people may notice blood in their urine. Once the stone is in the ureter, however, most people will experience bouts of very severe pain. The pain is crampy and spasmodic, and is referred to as "colic". The pain usually begins in the flank region, the area between the lower ribs and the hip bone. As the stone moves closer to the bladder, a patient will often feel the pain radiating along the inner thigh. In women, the pain may be felt in the vulva. In men, the pain may be felt in the testicles. Nausea, vomiting, extremely frequent and painful urination, and obvious blood in the urine are common. **Fever** and chills usually means that the ureter has become obstructed, allowing bacteria to become trapped in the kidney causing a kidney infection (**pyelonephritis**).

Diagnosis

Diagnosing kidney stones is based on the patient's history of the very severe, distinctive pain associated with the stones. Diagnosis includes laboratory examination of a urine sample and an x-ray examination. During the passage of a stone, examination of the urine almost always reveals blood. A number of x-ray tests are used to diagnose kidney stones. A plain x ray of the kidneys, ureters, and bladder may or may not reveal the stone. A series of x rays taken after injecting iodine dye into a vein is usually a more reliable way of seeing a stone. This procedure is called an intravenous pyelogram (IVP). The dye "lights up" the urinary system as it travels. In the case of an obstruction, the dye will be stopped by the stone or will only be able to get past the stone at a slow trickle.

When a patient is passing a kidney stone, it is important that all of his or her urine is strained through a spe-



Kidney stones can occur in the ureter near the bladder or kidney. *(Illustration by Argosy Inc.)*

cial sieve. This is to make sure that the stone is caught. The stone can then be sent to a special laboratory for analysis so that the chemical composition of the stone can be determined. After the kidney stone has been passed, other tests will be required in order to understand the underlying condition that may have caused the stone to form. Collecting urine for 24 hours, followed by careful analysis of its chemical makeup, can often determine a number of reasons for stone formation.

Treatment

A patient with a kidney stone will say that the most important aspect of treatment is adequate pain relief. Because the pain of passing a kidney stone is so severe, narcotic pain medications (like morphine) are usually required. It is believed that stones may pass more quickly if the patient is encouraged to drink large amounts of water (2-3 quarts per day). If the patient is vomiting or unable to drink because of the pain, it may be necessary to provide fluids through a vein. If symptoms and urine tests indicate the presence of infection, **antibiotics** will be required.

Although most kidney stones will pass on their own, some will not. Surgical removal of a stone may become necessary when a stone appears too large to pass. Surgery may also be required if the stone is causing serious obstructions, pain that cannot be treated, heavy bleeding, or infection. Several alternatives exist for removing stones. One method involves inserting a tube into the bladder and up into the ureter. A tiny basket is then passed through the tube, and an attempt is made to snare the stone and pull it out. Open surgery to remove an obstructing kidney stone was relatively common in the past, but current methods allow the stone to be crushed with shock waves (called **lithotripsy**). These shock waves may be aimed at the stone from outside of the body by passing the necessary equipment through the bladder and into the ureter. The shock waves may be aimed at the stone from inside the body by placing the instrument through a tiny incision located near the stone. The stone fragments may then pass on their own or may be removed through the incision. All of these methods reduce the patient's recovery time considerably when compared to the traditional open operation.

Alternative treatment

Alternative treatments for kidney stones include the use of herbal medicine, **homeopathy**, **acupuncture**, **acupressure**, hypnosis, or **guided imagery** to relieve pain. Starfruit (*Averrhoa carambola*) is recommended to increase the amount of urine a patient passes and to relieve pain. Dietary changes can be made to reduce the risk of future stone formation and to facilitate the resorption of existing stones. Supplementation with magnesium, a smooth muscle relaxant, can help reduce pain and facilitate stone passing. Homeopathy and herbal medicine, both western and Chinese, recommend a number of remedies that may help prevent kidney stones.

Prognosis

A patient's prognosis depends on the underlying disorder causing the development of kidney stones. In most cases, patients with uncomplicated calcium stones will recover very well. About 60% of these patients, however, will have other kidney stones. Struvite stones are particu-

larly dangerous because they may grow extremely large, filling the tubes within the kidney. These are called staghorn stones and will not pass out in the urine. They will require surgical removal. Uric acid stones may also become staghorn stones.

Prevention

Prevention of kidney stones depends on the type of stone and the presence of an underlying disease. In almost all cases, increasing fluid intake so that a person consistently drinks several quarts of water a day is an important preventative measure. Patients with calcium stones may benefit from taking a medication called a diuretic, which has the effect of decreasing the amount of calcium passed in the urine. Eating less meat, fish, and chicken may be helpful for patients with calcium oxalate stones. Other items in the diet that may encourage calcium oxalate stone formation include beer, black pepper, berries, broccoli, chocolate, spinach, and tea. Uric acid stones may require treatment with a medication called allopurinol. Struvite stones will require removal and the patient should receive an antibiotic. When a disease is identified as the cause of stone formation, treatment specific to that disease may lessen the likelihood of repeated stones.

Resources

BOOKS

Asplin, John R., et al. "Nephrolithiasis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Fishman, Mark C., et al. *Medicine*. Philadelphia: J. B. Lippincott Co., 1996.

PERIODICALS

Goshorn, Janet. "Kidney Stones: Strategies for Managing This Common, Excruciating Condition." *American Journal of Nursing* 96, no. 9 (Sept. 1996): 40+.

"New Advice Regarding the Treatment of Kidney Stones." *HealthFacts* 22, no. 11 (Nov. 1997): 2.

Squires, Sally. "New Guidelines Issued for Kidney Stones." *The Washington Post*, 7 Oct. 1997, WH7.

Trivedi, Bhairvi K. "Nephrolithiasis: How It Happens and What To Do About It." *Postgraduate Medicine* 100, no. 6 (Dec. 1996): 63+.

ORGANIZATIONS

American Foundation for Urologic Disease. 300 West Pratt St., Baltimore, MD 21201-2463. (800) 242-2383.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.

Rosalyn Carson-DeWitt, MD

Kidney transplantation

Definition

Kidney transplantation is a surgical procedure to remove a healthy, functioning kidney from a living or brain-dead donor and implant it into a patient with non-functioning kidneys.

Purpose

Kidney transplantation is performed on patients with **chronic kidney failure**, or end-stage renal disease (ESRD). ESRD occurs when a disease or disorder damages the kidneys so that they are no longer capable of adequately removing fluids and wastes from the body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream. Without long-term dialysis or a kidney transplant, ESRD is fatal.

Precautions

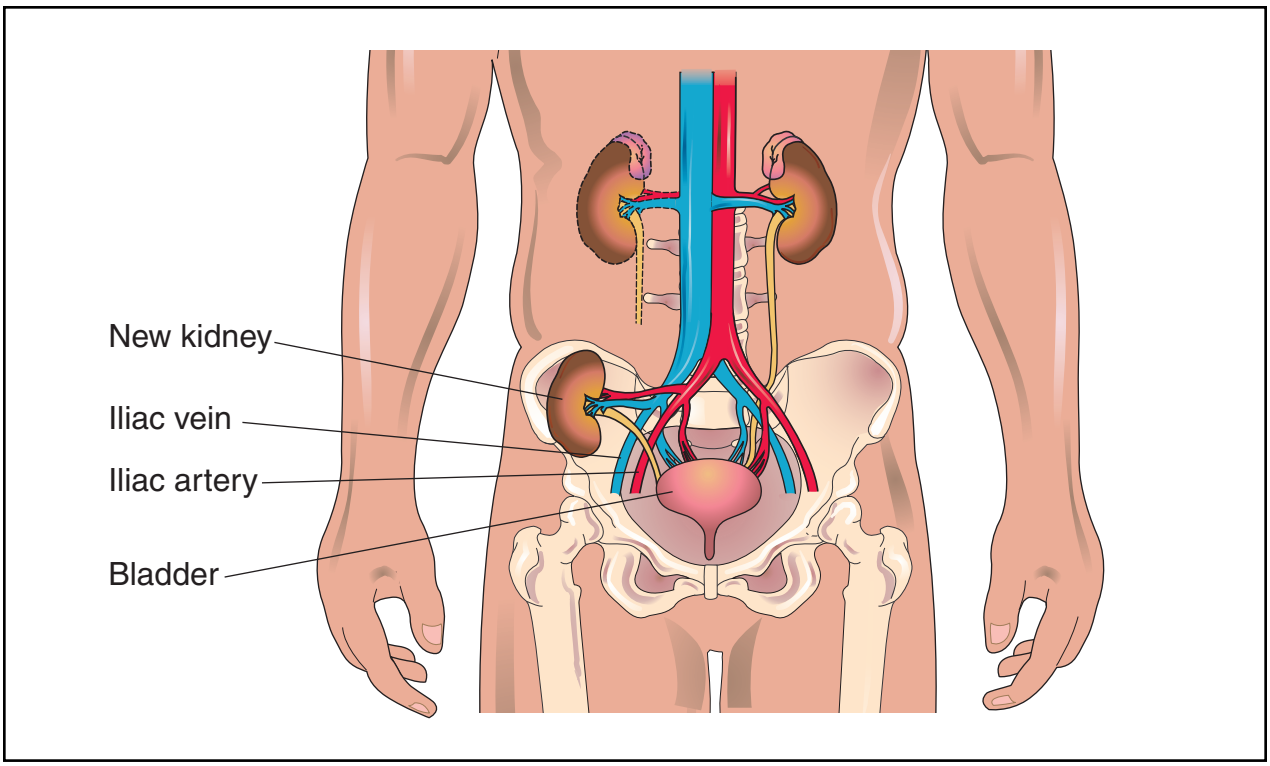
Patients with a history of heart disease, lung disease, **cancer**, or hepatitis may not be suitable candidates for receiving a kidney transplant.

Description

Kidney transplantation involves surgically attaching a functioning kidney, or graft, from a brain-dead organ donor (a cadaver transplant) or from a living donor, to a patient with ESRD. Living donors may be related or unrelated to the patient, but a related donor has a better chance of having a kidney that is a stronger biological "match" for the patient.

The surgical procedure to remove a kidney from a living donor is called a *nephrectomy*. The kidney donor is administered general anesthesia and an incision is made on the side or front of the abdomen. The blood vessels connecting the kidney to the donor are cut and clamped, and the ureter is also cut between the bladder and kidney and clamped. The kidney and an attached section of ureter is removed from the donor. The vessels and ureter in the donor are then tied off and the incision is sutured together again. A similar procedure is used to harvest cadaver kidneys, although both kidneys are typically removed at once, and blood and cell samples for **tissue typing** are also taken.

Laparoscopic **nephrectomy** is a form of minimally-invasive surgery using instruments on long, narrow rods to view, cut, and remove the donor kidney. The surgeon views the kidney and surrounding tissue with a flexible videoscope. The videoscope and surgical instruments are



Kidney transplantation involves the surgical attachment of a functioning kidney, or graft, from a donor to a patient with end-stage renal disease (ESRD). During the procedure, the surgeon makes an incision in the patient's flank and implants the new kidney above the pelvic bone and below the non-functioning kidney by suturing the kidney artery and vein to the patient's iliac artery and vein. The ureter of the new kidney is then attached directly to the bladder of the patient. *(Illustration by Electronic Illustrators Group.)*

maneuvered through four small incisions in the abdomen. Once the kidney is freed, it is secured in a bag and pulled through a fifth incision, approximately 3 in (7.6 cm) wide, in the front of the abdominal wall below the navel. Although this surgical technique takes slightly longer than a traditional nephrectomy, preliminary studies have shown that it promotes a faster recovery time, shorter hospital stays, and less post-operative **pain** for kidney donors.

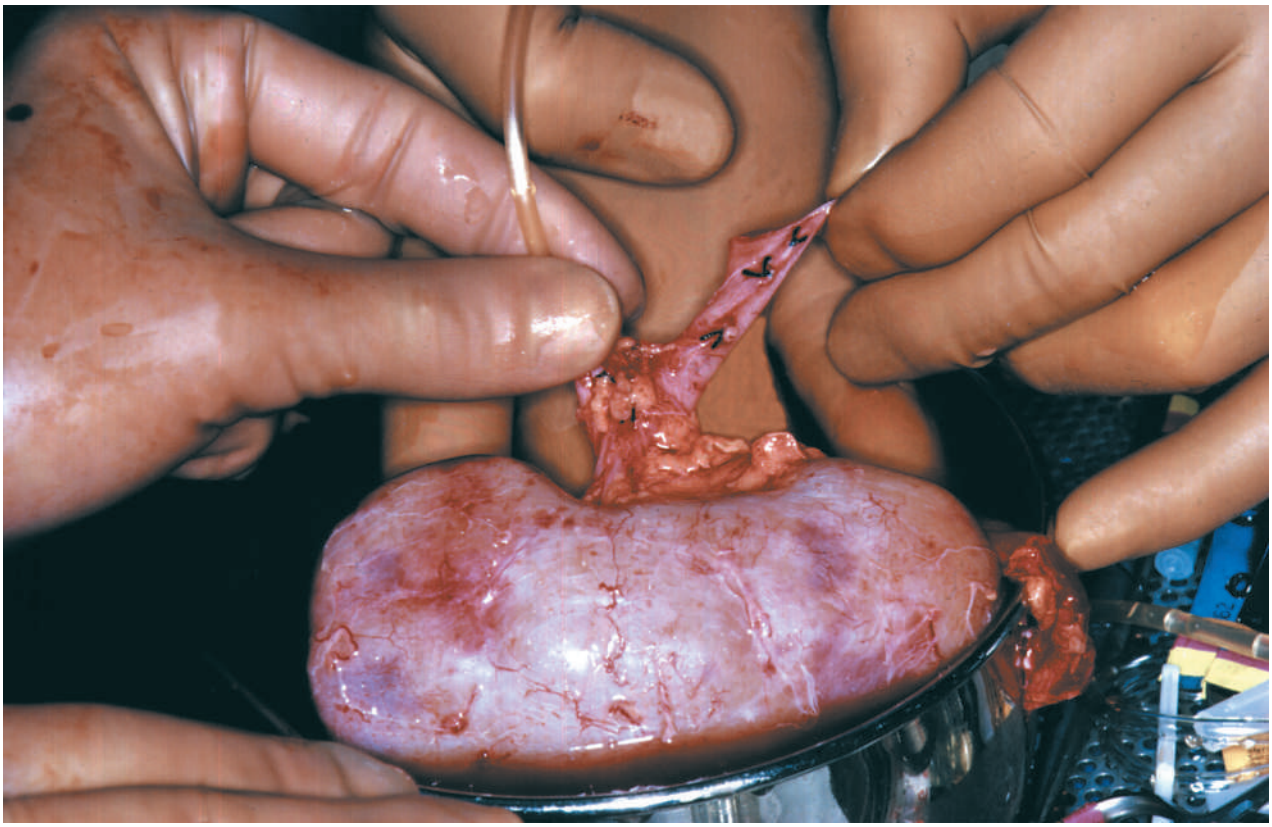
Once removed, kidneys from live donors and cadavers are placed on ice and flushed with a cold preservative solution. The kidney can be preserved in this solution for 24-48 hours until the transplant takes place. The sooner the transplant takes place after harvesting the kidney, the better the chances are for proper functioning.

During the transplant operation, the kidney recipient patient is typically under general anesthesia and administered **antibiotics** to prevent possible infection. A catheter is placed in the bladder before surgery begins. An incision is made in the flank of the patient and the surgeon implants the kidney above the pelvic bone and below the existing, non-functioning kidney by suturing the kidney artery and vein to the patient's iliac artery and vein. The ureter of the new kidney is attached directly to the bladder of the kidney recipient. Once the new kidney is attached, the patient's existing, diseased kidneys may or may not be removed, depending on the circumstances surrounding the kidney failure.

Since 1973, Medicare has picked up 80% of ESRD treatment costs, including the costs of transplantation for both the kidney donor and recipient. Medicare also covers 80% of immunosuppressive medication costs for up to three years, although federal legislation was under consideration in early 1998 that may remove the time limit on these benefits. To qualify for Medicare ESRD benefits, a patient must be insured or eligible for benefits under Social Security, or be a spouse or child of an eligible American. Private insurance and state Medicaid programs often cover the remaining 20% of treatment costs.

Preparation

Patients with chronic renal disease who need a transplant and do not have a living donor register with United Network for Organ Sharing (UNOS) will be placed on a



A human kidney is being prepped by medical personnel prior to transplantation. *(Photograph by Brad Nelson, Custom Medical Stock Photo. Reproduced by permission.)*

waiting list for a cadaver kidney transplant. UNOS is a non-profit organization that is under contract with the federal government to administer the Organ Procurement and Transplant Network (OPTN) and the national Scientific Registry of Transplant Recipients (SR). Kidney availability is based on the patient's health status. The most important factor is that the kidney be compatible to the patient's body. A human kidney has a set of six antigens, substances that stimulate the production of antibodies. (Antibodies then attach to cells they recognize as foreign and attack them.) Donors are tissue-matched for 0 to 6 of the antigens, and compatibility is determined by the number and strength of those matched pairs. Patients with a living donor who is a close relative have the best chance of a close match.

Potential kidney donors undergo a complete medical history and **physical examination** to evaluate their suitability for donation. Extensive blood tests are performed on both donor and recipient. The blood samples are used to tissue type for antigen matches, and confirm that blood types are compatible. A panel of reactive antibody (PRA) is performed by mixing white blood cells from the donor and serum from the recipient to ensure that the recipient antibodies will not have a negative reaction to the donor antigens. A urine test is performed on the donor to evaluate his kidney function. In some cases, a special dye that shows up on x rays is injected into an artery, and x rays are taken to show the blood supply of the donor kidney (a procedure called an arteriogram).

Once compatibility is confirmed and the physical preparations for kidney transplantation are complete, both donor and recipient may undergo a psychological or psychiatric evaluation to ensure that they are emotionally prepared for the transplant procedure and aftercare regimen.

Aftercare

Kidney donors and recipients will experience some discomfort in the area of the incision. Pain relievers are administered following the transplant operation. Patients may also experience numbness, caused by severed nerves, near or on the incision.

A regimen of immunosuppressive, or anti-rejection, medication is prescribed to prevent the body's immune system from rejecting the new kidney. Common immunosuppressants include cyclosporine, prednisone,

National Transplant Waiting List By Organ Type (June 2000)

Organ Needed	Number Waiting
Kidney	48,349
Liver	15,987
Heart	4,139
Lung	3,695
Kidney-Pancreas	2,437
Pancreas	942
Heart-Lung	212
Intestine	137

and azathioprine. The kidney recipient will be required to take immunosuppressants for the life span of the new kidney. Intravenous antibodies may also be administered after transplant surgery. Daclizumab, a monoclonal antibody, is a promising new therapy that can be used in conjunction with standard immunosuppressive medications to reduce the incidence of organ rejection.

Transplant recipients may need to adjust their dietary habits. Certain immunosuppressive medications cause increased appetite or sodium and protein retention, and the patient may have to adjust his or her intake of calories, salt, and protein to compensate.

Risks

As with any surgical procedure, the kidney transplantation procedure carries some risk for both a living donor and a graft recipient. Possible complications include infection and bleeding (hemorrhage). The most common complication for kidney recipients is a urine leak. In approximately 5% of kidney transplants, the ureter suffers some damage, which results in the leak. This problem is usually correctable with follow-up surgery.

The biggest risk to the recovering transplant recipient is not from the operation or the kidney itself, but from the immunosuppressive medication he or she must take. Because these drugs suppress the immune system, the patient is susceptible to infections such as cytomegalovirus (CMV) and varicella (**chickenpox**). The immunosuppressants can also cause a host of possible side effects, from high blood pressure to **osteoporosis**. Prescription and dosage adjustments can lessen side effects for some patients.

Normal results

The new kidney may start functioning immediately, or may take several weeks to begin producing urine. Living donor kidneys are more likely to begin functioning earlier than cadaver kidneys, which frequently suffer some reversible damage during the kidney transplant and storage procedure. Patients may have to undergo dialysis for several weeks while their new kidney establishes an acceptable level of functioning.

The success of a kidney transplant graft depends on the strength of the match between donor and recipient and the source of the kidney. Cadaver kidneys have a four-year survival rate of 66%, compared to an 80.9% survival rate for living donor kidneys. However, there have been cases of cadaver and living, related donor kidneys functioning well for over 25 years.

Studies have shown that after they recover from surgery, kidney donors typically have no long-term complications from the loss of one kidney, and their remaining kidney will increase its functioning to compensate for the loss of the other.

Abnormal results

A transplanted kidney may be rejected by the patient. Rejection occurs when the patient's immune system recognizes the new kidney as a foreign body and attacks the kidney. It may occur soon after transplantation, or several months or years after the procedure has taken place. Rejection episodes are not uncommon in the first weeks after transplantation surgery, and are treated with high-dose injections of **immunosuppressant drugs**. If a rejection episode cannot be reversed and kidney failure continues, the patient will typically go back on dialysis. Another transplant procedure can be attempted at a later date if another kidney becomes available.

Resources

BOOKS

Brenner, Barry M., and Floyd C. Rector Jr., eds. *The Kidney.* Philadelphia: W. B. Saunders Co., 1991.

Cameron, J. S. *Kidney Failure: The Facts.* New York: Oxford University Press, 1996.

Ross, Linda M., ed. *Kidney and Urinary Tract Diseases and Disorders Sourcebook.* Vol. 21. Health Reference Series. Detroit: Omnigraphics, Inc., 1997.

U.S. Renal Data System. *USRDS 1997 Annual Data Report.* Bethesda, MD: The National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1996.

PERIODICALS

Okie, Susan. "New Surgery Makes Kidney Donation Easier." *Washington Post*, 120, no. 154, 3 June 1997, WH5.

ORGANIZATIONS

American Association of Kidney Patients (AAKP), 100 S. Ashley Drive, Suite 280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Fund (AKF). Suite 1010, 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://www.arbon.com/kidney>.

KEY TERMS

Arteriogram—A diagnostic test that involves viewing the arteries and/or attached organs by injecting a contrast medium, or dye, into the artery and taking an x ray.

Dialysis—A blood filtration therapy that replaces the function of the kidneys, filtering fluids and waste products out of the bloodstream. There are two types of dialysis treatment—hemodialysis, which uses an artificial kidney, or dialyzer, as a blood filter; and peritoneal dialysis, which uses the patient's abdominal cavity (peritoneum) as a blood filter.

Iliac artery—Large blood vessel in the pelvis that leads into the leg.

Immunosuppressive medication—Drugs given to a transplant recipient to prevent his or her immune system from attacking the transplanted organ.

Rejection—The process in which the immune system attacks tissue it sees as foreign to the body.

Videoscope—A surgical camera.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.
United Network for Organ Sharing (UNOS). (888) 894-6361. <http://www.unos.org>.
United States Renal Data System (USRDS). The University of Michigan, 315 W. Huron, Suite 240, Ann Arbor, MI 48103. (734) 998-6611. <http://www.med.umich.edu/usrds>.

OTHER

Transweb. <http://www.transweb.org>.

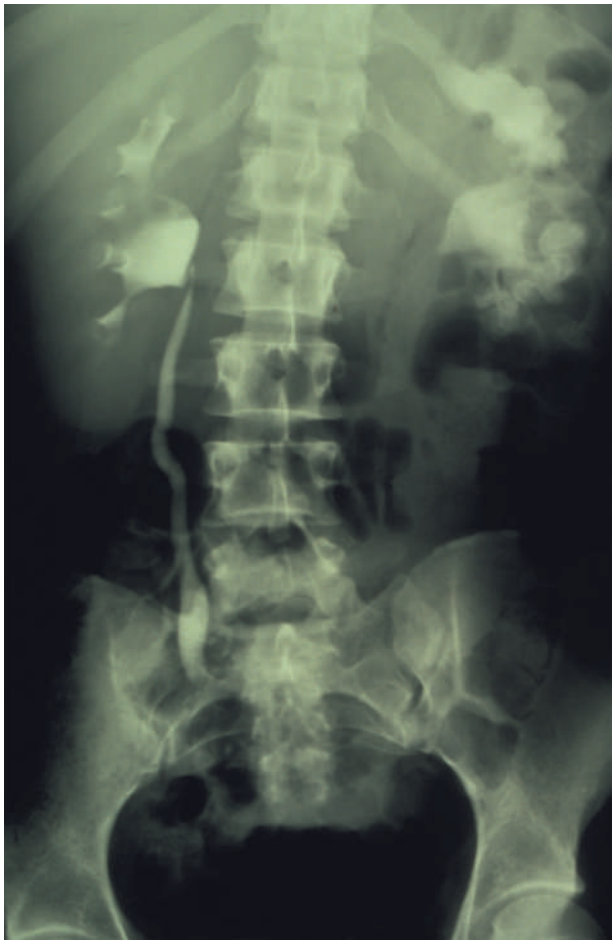
Paula Anne Ford-Martin

Kidney ultrasound *see* **Abdominal ultrasound**

Kidney, ureter, and bladder x-ray study

Definition

A kidney, ureter, and bladder (KUB) x-ray study is an abdominal x ray. Despite its name, KUB does not show the ureters and only sometimes shows the kidneys and bladder and, even then, with uncertainty.



An x-ray image of a human torso and abdomen showing a blocked ureter. *(Custom Medical Stock Photo. Reproduced by permission.)*

Purpose

The KUB study is a diagnostic test used to detect **kidney stones** and to diagnose some gastrointestinal disorders. The KUB is also used as a follow-up procedure after the placement of devices such as ureteral stents and nasogastric or nasointestinal tubes (feeding tubes) to verify proper positioning.

Precautions

Because of the risks of radiation exposure to the fetus, pregnant women are advised to avoid this x-ray procedure.

A KUB study is a preliminary screening test for kidney stones, and should be followed by a more sophisticated series of diagnostic tests (such as an **abdominal ultrasound**, **intravenous urography**, or computed tomography scan [CT scan]) if kidney stones are suspected.

KEY TERMS

Ureteral stent—A surgical device implanted in patients with damaged ureters that holds the ureter open so that urine can flow freely from the kidneys to the bladder.

Description

A KUB is typically a single x-ray procedure. The patient lies flat on his back on an x-ray table. An x-ray plate is placed underneath him near the small of the back, and the x-ray camera is aimed at his abdomen. The patient is asked to hold his breath and lie still while the x ray is taken. Sometimes a second KUB will be ordered, with the patient standing, or if unable to do so, lying on his side.

Preparation

A KUB study requires no special diet, fluid restrictions, medications, or other preparation. The patient is typically required to wear a hospital gown or similar attire and to remove all jewelry so the x-ray camera has an unobstructed view of the abdomen. A lead apron may be placed over the abdominal areas of the body not being x-rayed to shield the patient from unnecessary radiation.

Aftercare

No special aftercare treatment or regimen is required for a KUB study.

Risks

Because the KUB study is an x-ray procedure, it does involve minor exposure to radiation.

Normal results

Normal KUB x-ray films show two kidneys of a similar size and shape. A normal amount of intestinal gas is seen.

Abnormal results

Abnormal KUB films may show calculi (kidney stones). If both kidneys are visible, it may be possible to diagnose renal size discrepancies. The films may also show too much bowel gas indicating possible obstruction or soft tissue masses.

Resources

BOOKS

Kevles, Bettyann. *Naked to the Bone: Medical Imaging in the Twentieth Century.* New Brunswick, NJ: Rutgers University Press, 1997.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

Paula Anne Ford-Martin

Kinesiology, applied

Definition

Kinesiology is a series of tests that locate weaknesses in specific muscles reflecting imbalances throughout the body. Then specific massages or **acupressure** techniques are used in an attempt to rebalance what has been revealed by the kinesiology tests. Thus, kinesiology is used as both an assessment tool and as a limited therapeutic modality.

Purpose

Kinesiology claims to be a healing system that detects and corrects imbalances in the body before they develop into a disease, and which restores overall system balance and harmony. It is used to alleviate muscle, bone, and joint problems, treat all manner of aches and pains, and correct many areas of imbalance and discomfort.

Precautions

Since interpretation of the muscle tests is both complex and subjective, it should only be performed by a licensed health professional trained to look for "subclinical" symptoms (those which have not yet become a major problem). Kinesiology itself is more of a diagnostic technique and should not be thought of as a cure for any particular problem.

Description

Traditionally, the word kinesiology refers simply to the study of muscles and body movement. In 1964, however, American chiropractor George J. Goodheart founded what has become known as applied kinesiology when he linked oriental ideas about energy flow in the body with western techniques of muscle testing. First, Goodheart noted that all muscles are related to other muscles. He observed that for each movement a muscle makes, there is another muscle or group of muscles involved with that movement; one muscle contracts while another

one relaxes. So when he was presented with a painful, overly-tight muscle, he would observe and treat the opposite, and necessarily weak, muscle to restore balance. This was then a very new technique.

Further, Goodheart argued that there is a definite and real connection between muscles, glands, and organs, and that by testing the strength of certain muscles he could learn about the health or condition of the gland or organ to which it was related.

Applied kinesiology is based on the idea that the body is an interacting unit made of different parts that interconnect and affect each other. Everything we do affects the body as a whole; therefore, a problem in one area can cause trouble in another area. According to kinesiology, the muscles eventually register and reflect anything that is wrong with any part of the body, whether physical or mental. Thus, a particular digestive problem might show up in the related and corresponding muscles of the legs. By testing the strength of certain muscles, the kinesiologist claims to be able to gain access to the body's communication system, and, thus, to read the health status of each of the body's major components.

The manual testing of muscles or muscle strength is not new, and was used in the late 1940s to evaluate muscle function and strength and to assess the extent of an injury. Applied kinesiology measures whether a muscle is stuck in the "on" position, acting like a tense muscle spasm, or is stuck "off," appearing weak or flaccid. It is called manual testing because it is done without instruments, using only the kinesiologist's fingertip pressure. During the first and longest appointment which lasts about an hour, the kinesiologist conducts a complete consultation, asking about the patient's history and background. During the **physical examination**, patients sit or lie down, then the kinesiologist holds the patient's leg or arm to isolate a particular muscle. The practitioner then touches a point on the body which he believes is related to that muscle, and, with quick, gentle, and painless pressure, pushes down on the limb. Patients are asked to resist this pressure, and, if they cannot, an imbalance is suspected in the related organ, gland, or body part. This diagnostic technique uses muscles to find the cause of a problem, and is based on **traditional Chinese medicine** and its idea that the body has common energy meridians, or channels, for both organs and muscles. Kinesiologists also claim that they are able to locate muscle weaknesses that stem from a variety of causes such as **allergies**, mineral and vitamin deficiencies, as well as from problems with the lymph system. Once the exact cause is determined, the kinesiologist uses his fingertips to work the appropriate corresponding acupressure points in order to rebalance the flow of energy and restore health. Often he will recommend a complementary program of **nutrition** therapy.

KEY TERMS

Acupressure—A form of acupuncture in which certain points of the body are pressed with the fingers and hands to release energy blocks.

Alleviate—To make something easier to be endured.

Complementary—Something that serves to fill out or complete something else.

Deficiency—A shortage of something necessary for health.

Diagnostic—The art or act of identifying a disease from its signs and symptoms.

Flaccid—Flabby, limp, weak.

Meridian—In traditional Chinese medicine, the channels which run beneath the skin through which the body's energy flows.

Spasm—An involuntary, sudden, violent contraction of a muscle or a group of muscles.

Risks

There are no major risks associated with this gentle, noninvasive therapy. It is generally safe for people of all ages and has no side effects.

Normal results

If applied kinesiology does what it claims, patients should expect muscle testing to discover the cause of their physical complaint and to be told how to correct it.

Resources

BOOKS

Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Puyallup, WA: Future Medicine Publishing, Inc., 1993.

Holdway, Ann. *Kinesiology: Muscle Testing and Energy Balancing for Health and Well-Being.* Rockport, MA: Element Books Ltd., 1995.

Kastner, Mark, and Hugh Burroughs. *Alternative Healing.* New York: Henry Holt and Co., 1996.

Levy, Susan L., and Carol R. Lehr. *Your Body Can Talk.* Prescott, AZ: Hohm Press, 1996.

PERIODICALS

Gelb, Harold, and Paula M. Siegel. "Applied Kinesiology: Relieving Internal Stresses and Pain." *Science Digest* (Aug. 1980): 28-33.

ORGANIZATIONS

International College of Applied Kinesiology. P.O. Box 905. Lawrence, KS 66044-9005 (913) 542-1801.

Leonard C. Bruno, PhD

Kleine-Levin syndrome *see* **Sleep disorders**

Klinefelter syndrome

Definition

Klinefelter syndrome is a chromosome disorder in males. People with this condition are born with at least one extra X chromosome.

Description

Klinefelter syndrome is a condition where one or more extra X-chromosomes are present in a male. Boys with this condition appear normal at birth. They enter **puberty** normally, but by mid puberty have low levels of testosterone causing small testicles and the inability to make sperm. Affected males may also have learning disabilities and behavior problems such as shyness and immaturity and an increased risk for certain other health problems.

Klinefelter syndrome is one of the most common chromosomal abnormalities. About 1 in every 500 to 800 males is born with this disorder. Approximately 3% of the infertile male population have Klinefelter syndrome.

Causes and symptoms

Chromosomes are found in the cells in the body. Chromosomes contain genes, structures that tell the body how to grow and develop. Chromosomes are responsible for passing on hereditary traits from parents to child. Chromosomes also determine whether the child will be male or female. Normally, a person has a total of 46 chromosomes in each cell, two of which are responsible for determining that individual's sex. These two sex chromosomes are called X and Y. The combination of these two types of chromosomes determines the sex of a child. Females have two X chromosomes (the XX combination); males have one X and one Y chromosome (the XY combination).

In Klinefelter syndrome, a problem very early in development results in an abnormal number of chromosomes. Most commonly, a male with Klinefelter syndrome will be born with 47 chromosomes in each cell, rather than the normal number of 46. The extra chromosome is an X chromosome. This means that rather than having the normal XY combination, the male has an XXY combination. Because people with Klinefelter syndrome have a Y chromosome, they are all male.

Approximately 1/3 of all males with Klinefelter syndrome have other chromosome changes involving an extra X chromosome. Mosaic Klinefelter syndrome occurs when some of the cells in the body have an extra X chromosome and the other have normal male chromosomes. These males can have the same or milder symptoms than non-mosaic Klinefelter syndrome. Males with more than one additional extra X chromosome, such as 48,XXXY, are usually more severely affected than males with 47,XXY.

Klinefelter syndrome is not considered an inherited condition. The risk of Klinefelter syndrome reoccurring in another **pregnancy** is not increased above the general population risk.

The symptoms of Klinefelter syndrome are variable and not every affected person will have all of the features of the condition. Males with Klinefelter syndrome appear normal at birth and have normal male genitalia. From childhood, males with Klinefelter syndrome are taller than average with long limbs. Approximately 20–50% have a mild intention tremor, an uncontrolled shaking. Many males with Klinefelter syndrome have poor upper body strength and can be clumsy. Klinefelter syndrome does not cause homosexuality. Approximately 1/3 of males with Klinefelter syndrome have breast growth, some requiring **breast reduction** surgery.

Most boys enter puberty normally, though some can be delayed. The Leydig cells in the testicles usually produce testosterone. With Klinefelter syndrome, the Leydig cells fail to work properly causing the testosterone production to slow. By mid-puberty, testosterone production is decreased to approximately half of normal. This can lead to decreased facial and pubic hair growth. The decreased testosterone also causes an increase in two other hormones, follicle stimulating hormone (FSH) and luteinizing hormone (LH). Normally, FSH and LH help the immature sperm cells grow and develop. In Klinefelter syndrome, there are few or no sperm cells. The increased amount of FSH and LH cause hyalinization and fibrosis, the growth of excess fibrous tissue, in the seminiferous tubules, where the sperm are normally located. As a result, the testicles appear smaller and firmer than normal. With rare exception, men with Klinefelter syndrome are infertile because they can not make sperm.

While it was once believed that all boys with Klinefelter syndrome were mentally retarded, doctors now know that the disorder can exist without retardation.

However, children with Klinefelter syndrome frequently have difficulty with language, including learning to speak, read, and write. Approximately 50% of males with Klinefelter syndrome are dyslexic.

Some people with Klinefelter syndrome have difficulty with social skills and tend to be more shy, anxious, or immature than their peers. They can also have poor judgement and do not handle stressful situations well. As a result, they often do not feel comfortable in large social gatherings. Some people with Klinefelter syndrome can also have **anxiety**, nervousness and/or depression.

The greater the number of X-chromosomes present, the greater the disability. Boys with several extra X-chromosomes have distinctive facial features, more severe retardation, deformities of bony structures, and even more disordered development of male features.

KEY TERMS

Chromosome—A microscopic thread-like structure found within each cell of the body that consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Gonadotrophin—Hormones that stimulate the ovary and testicles.

Testosterone—Hormone produced in the testicles that is involved in male secondary sex characteristics.

Diagnosis

Diagnosis of Klinefelter syndrome is made by examining chromosomes for evidence of more than one X chromosome present in a male. This can be done in pregnancy with prenatal testing such as a **chorionic villus sampling** or **amniocentesis**. Chorionic villus sampling is a procedure done early in pregnancy (approximately 10–12 weeks) to obtain a small sample of the placenta for testing. An amniocentesis is done further along in pregnancy (from approximately 16–18 weeks) to obtain a sample of fluid surrounding the baby for testing. Both procedures have a risk of **miscarriage**. Usually these procedures are done for a reason other than diagnosing Klinefelter syndrome. For example, a prenatal diagnostic procedure may be done on an older woman to determine if her baby has **Down syndrome**. If the diagnosis of Klinefelter syndrome is suspected in a young boy or adult male, chromosome testing can also be on a small blood or skin sample after birth.

Treatment

There is no treatment available to change chromosomal makeup. Children with Klinefelter syndrome may benefit from a speech therapist for speech problems or other educational intervention for learning disabilities. Testosterone injections started around the time of puberty may help to produce more normal development including more muscle mass, hair growth and increased sex drive. Testosterone supplementation will not increase testicular size, decrease breast growth or correct **infertility**.

Prognosis

While many men with Klinefelter syndrome go on to live normal lives, nearly 100% of these men will be sterile (unable to produce a child). However, a few men with Klinefelter syndrome have been reported who have fathered a child through the use of assisted fertility services. Males with Klinefelter syndrome have an increased risk of several conditions such as **osteoporosis**, **autoimmune disorders** such as lupus and arthritis, diabetes and both breast and germ cell tumors.

Resources

BOOKS

Bock, R. *Understanding Klinefelter's Syndrome: A Guide for XXY Males and Their Families*. National Institutes of Health, USA, 1993.

Probasco, Teri, and Gretchen A. Gibbs. *Klinefelter Syndrome*. Richmond, IN: Prinit Press, 1999.

PERIODICALS

Smyth, C.M., and W.J. Bremner. "Klinefelter Syndrome." *Archives of Internal Medicine* 158(1998): 1309–1314.

Smyth, Cynthia M. "Diagnosis and Treatment of Klinefelter Syndrome." *Hospital Practice* (September 15, 1999): 111–120

Staessen, C., et al. "Preimplantation Diagnosis for X and Y Normality in Embryos from Three Klinefelter Patients." *Human Reproduction* 11, no. 8. (1996): 1650–1653.

ORGANIZATIONS

American Association for Klinefelter Syndrome Information and Support (AAKSIS) 2945 W. Farwell Ave., Chicago, IL 60645-2925. (773) 761-5298 or (888) 466-5747. Fax: (773) 761-5298. <http://www.aaksis.org aaksis@aaksis.org>.

Klinefelter Syndrome and Associates, Inc. PO Box 119, Roseville, CA 95678-0119. (916) 773-2999 or (888) 999-9428. Fax: (916) 773-1449. ksinfo@genetic.org. <http://www.genetic.org/ks>.

Klinefelter's Organization. PO Box 60, Orpington, BR68ZQ. UK <http://hometown.aol.com/KSCUK/index.htm>.

OTHER

Klinefelter Syndrome Support Group Home Page. <http://klinefeltersyndrome.org/index.html>.

Carin Lea Beltz, M.S.

Knee replacement *see* **Joint replacement**

KEY TERMS

Degenerative arthritis, or osteoarthritis—A non-inflammatory type of arthritis, usually occurring in older people, characterized by degeneration of cartilage, enlargement of the margins of the bones, and changes in the membranes in the joints.

Kneecap removal

Definition

Kneecap removal, or patellectomy, is the surgical removal of the patella, commonly called the kneecap.

Purpose

Kneecap removal is done under three circumstances:

- when the kneecap is fractured or shattered
- when the kneecap dislocates easily and repeatedly
- when degenerative arthritis of the kneecap causes extreme **pain**

A person of any age can break a kneecap in an accident. When the bone is shattered beyond repair, the kneecap is removed. No prosthesis or artificial replacement part is put in its place.

Dislocation of the kneecap is most common in young girls between the ages of 10-14. Initially, the kneecap will pop back into place of its own accord, but pain may continue. If dislocation occurs too often, or the kneecap doesn't go back into place correctly, the patella may rub the other bones in the knee, causing an arthritis-like condition. Some people are born with **birth defects** that cause the kneecap to dislocate frequently.

Degenerative arthritis of the kneecap, also called patellar arthritis or *chondromalacia patellae*, can cause enough pain that it is necessary to remove the kneecap. As techniques of **joint replacement** have improved, arthritis in the knee is more frequently treated with total knee replacement.

Precautions

People who have had their kneecap removed for degenerative arthritis and then later have to have a total knee replacement are more likely to have problems with the stability of their artificial knee than those who only have total knee replacement. This is because the realigned muscles and tendons provide less support once the kneecap is removed.

Description

Kneecap removal is performed under either general or local anesthesia at a hospital or freestanding surgical center, by an orthopedic surgeon. The surgeon makes an incision around the kneecap. Then, the muscles and tendons attached to the kneecap are cut and the kneecap is removed. Next, the muscles are sewed back together, and the skin is closed with sutures or clips that stay in place about one week. Any hospital stay is generally brief.

Preparation

Prior to surgery, x rays and other diagnostic tests are done on the knee to determine if removing the kneecap is the appropriate treatment. Pre-operative blood and urine tests are also done.

Aftercare

Pain relievers may be prescribed for a few days. The patient will initially need to use a cane, or crutches, to walk. Physical therapy exercises to strengthen the knee should be begun immediately. Driving should be avoided for several weeks. Full recovery can take months.

Risks

Risks involved with kneecap removal are similar to those that occur in any surgical procedure, mainly allergic reaction to anesthesia, excessive bleeding, and infection.

Normal results

People who have kneecap removal because of a broken bone or repeated dislocations have the best chance for complete recovery. Those who have this operation because of arthritis may have less successful results, and later need a total knee replacement.

Resources

BOOKS

"Kneecap Removal." In *The Complete Guide to Symptoms, Illness and Surgery.* 3rd ed. Ed. H. Winter Griffith, et al. New York: Berkeley Publishing, 1995.

Tish Davidson

KOH test

Definition

The KOH test takes its name from the chemical formula for potassium hydroxide (KOH), which is the substance used in the test. The test, which is also called a potassium hydroxide preparation, is done to rapidly diagnose fungal infections of the hair, skin, or nails. A sample of the infected area is analyzed under a microscope following the addition of a few drops of potassium hydroxide.

Purpose

The primary purpose of the KOH test is the differential diagnosis of infections produced by dermatophytes and *Candida albicans* from other skin disorders. Dermatophytes are a type of fungus that invade the top layer of the skin, hair, or nails, and produce an infection commonly known as **ringworm**, technically known as tinea. It can appear as "jock itch" in the groin or inner thighs (tinea cruris); on the feet (tinea pedis); on the scalp and hair (tinea capitis); and on the nails (tinea unguium). Tinea versicolor appears anywhere on the skin and produces characteristic unpigmented patches. Tinea unguium affects the nails.

Similar symptoms of redness, scaling, and **itching** can be caused by other conditions, such as eczema and **psoriasis**. The KOH test is a quick, inexpensive test—often done in a physician's office—to see if these symptoms are caused by a dermatophyte. If a dermatophyte is found, treatment is started immediately; further tests are seldom necessary.

A yeast (candidal) infection of the skin or a mucous membrane, such as the mouth, often produces a white cheesy material at the infection site. This type of infection, known as thrush, is also identified with the KOH test.

Description

The KOH test involves the preparation of a slide for viewing under the laboratory microscope. KOH mixed with a blue-black dye is added to a sample from the infected tissues. This mixture makes it easier to see the dermatophytes or yeast under the microscope. The KOH dissolves skin cells, hair, and debris; the dye adds color. The slide is gently heated to speed up the action of the KOH. Finally the slide is examined under a microscope.

Dermatophytes are easily recognized under the microscope by their long branch-like structures. Yeast cells look round or oval. The dermatophyte that causes tinea versicolor has a characteristic spaghetti-and-meatballs appearance.

KEY TERMS

Dermatophyte—A type of fungus that causes diseases of the skin, including tinea or ringworm.

KOH—The chemical formula for potassium hydroxide, which is used to perform the KOH test. The tests is also called a potassium hydroxide preparation.

Thrush—A disease of the mouth, caused by *Candida albicans* and characterized by a whitish growth and ulcers. It can be diagnosed with the KOH test.

Tinea—A superficial infection of the skin, hair, or nails, caused by a fungus and commonly known as ringworm.

If the KOH test is done in the doctor's office, the results are usually available while the person waits. If the test is sent to a laboratory, the results will be ready the same or following day. The KOH test is covered by insurance when medically necessary.

Preparation

The physician selects an infected area from which to collect the sample. Scales and cells from the area are scraped using a scalpel. If the test is to be analyzed immediately, the scrapings are placed directly onto a microscope slide. If the test will be sent to a laboratory, the scrapings are placed in a sterile covered container.

Normal results

A normal, or negative, KOH test shows no fungi (no dermatophytes or yeast).

Abnormal results

Dermatophytes or yeast seen on a KOH test indicate the person has a fungal infection. Follow-up tests are usually unnecessary.

Resources

PERIODICALS

Crissey, John Thorne. "Common Dermatophyte Infections. A Simple Diagnostic Test and Current Management." *Postgraduate Medicine* (Feb. 1998): 191-192, 197-198, 200, 205.

Nancy J. Nordenson

Korsakoff's psychosis *see* **Korsakoff's syndrome**

Korsakoff's syndrome

Definition

Korsakoff's syndrome is a memory disorder which is caused by a deficiency of vitamin B_1, also called thiamine.

Description

In the United States, the most common cause of thiamine deficiency is **alcoholism**. Other conditions that cause thiamine deficiency occur quite rarely, but can be seen in patients undergoing dialysis (a procedure used primarily for patients suffering from kidney failure, during which the patient's blood circulates outside of the body, is mechanically cleansed, and then is circulated back into the body), pregnant women with a condition called **hyperemesis gravidarum** (a condition of extreme morning sickness, during which the woman vomits up nearly all fluid and food intake), and patients after surgery who are given vitamin-free fluids for a prolonged period of time. Thiamine deficiency is an important cause of disability in developing countries where the main source of food is polished rice (rice with the more nutritious outer husk removed).

An associated disorder, Wernicke's syndrome, often precedes Korsakoff's syndrome. In fact, they so often occur together that the spectrum of symptoms produced during the course of the two diseases is frequently referred to as Wernicke-Korsakoff syndrome. The main symptoms of Wernicke's syndrome include ataxia (difficulty in walking and maintaining balance), **paralysis** of some of the muscles responsible for movement of the eyes, and confusion. Untreated Wernicke's will lead to **coma** and then **death**.

Causes

One of the main reasons that alcoholism leads to thiamine deficiency has to do with the high-calorie nature of alcohol. A person with a large alcohol intake often, in essence, substitutes alcohol for other, more nutritive calorie sources. Food intake drops off considerably, and multiple vitamin deficiencies develop. Furthermore, it is believed that alcohol increases the body's requirements for B **vitamins**, at the same time interfering with the absorption of thiamine from the intestine and impairing the body's ability to store and use thiamine. Direct neurotoxic (poisonous damage to the nerves) effects of alcohol may also play some role.

Thiamine is involved in a variety of reactions which provide energy to the neurons (nerve cells) of the brain. When thiamine is unavailable, these reactions cannot be carried out, and the important end-products of the reactions are not produced. Furthermore, certain other substances begin to accumulate, and are thought to cause damage to the vulnerable neurons. The area of the brain believed to be responsible for the symptoms of Korsakoff's syndrome is called the diencephalon, specifically the structures called the mamillary bodies and the thalamus.

Symptoms

An individual with Korsakoff's syndrome displays much difficulty with memory. The main area of memory affected is the ability to learn new information. Usually, intelligence and memory for past events is relatively unaffected, so that an individual may remember what occurred 20 years previously, but is unable to remember what occurred 20 minutes ago. This memory defect is referred to as anterograde **amnesia**, and leads to a peculiar symptom called "confabulation," in which a person suffering from Korsakoff's fills in the gaps in his or her memory with fabricated or imagined information. For instance, a person may insist that a doctor to whom he or she has just been introduced is actually an old high school classmate, and may have a lengthy story to back this up. When asked, as part of a memory test, to remember the name of three objects which the examiner listed ten minutes earlier, a person with Korsakoff's may list three entirely different objects and be completely convincing in his or her certainty. In fact, one of the hallmarks of Korsakoff's is the person's complete unawareness of the memory defect, and complete lack of worry or concern when it is pointed out.

Diagnosis

Whenever someone has a possible diagnosis of alcoholism, and then has the sudden onset of memory difficulties, it is important to seriously consider the diagnosis of Korsakoff's syndrome. While there is no specific laboratory test to diagnose Korsakoff's syndrome in a patient, a careful exam of the individual's mental state should be rather revealing. Although the patient's ability to confabulate answers may be convincing, checking the patient's retention of factual information (asking, for example, for the name of the current president of the United States), along with the patient's ability to learn new information (repeating a series of numbers, or recalling the names of three objects ten minutes after having been asked to memorize them) should point to the diagnosis. Certainly a patient known to have just begun recovery from Wernicke's syn-

drome, who then begins displaying memory difficulties, would be very likely to have developed Korsakoff's syndrome. A **physical examination** may also show signs of Wernicke's syndrome, such as **peripheral neuropathy**.

Treatment

Treatment of both Korsakoff's and Wernicke's syndromes involves the immediate administration of thiamine. In fact, any individual who is hospitalized for any reason and who is suspected of being an alcoholic, should receive thiamine. The combined Wernicke-Korsakoff syndrome has actually been precipitated in alcoholic patients hospitalized for other medical illnesses, due to the administration of thiamine-free intravenous fluids (intravenous fluids are those fluids containing vital sugars and salts which are given to the patient through a needle inserted in a vein). Also, the vitamin therapy may be impaired by the feeding of carbohydrates prior to the giving of thiamine; since carbohydrates cannot be metabolized with thiamine.

Prognosis

Fifteen to twenty percent of all patients hospitalized for Wernicke's syndrome will die of the disorder. Although the degree of ataxia nearly always improves with treatment, half of those who survive will continue to have some permanent difficulty walking. The paralysis of the eye muscles almost always resolves completely with thiamine treatment. Recovery from Wernicke's begins to occur rapidly after thiamine is given. Improvement in the symptoms of Korsakoff's syndrome, however, can take months and months of thiamine replacement. Furthermore, patients who develop Korsakoff's syndrome are almost universally memory-impaired for the rest of their lives. Even with thiamine treatment, the memory deficits tend to be irreversible, with less than 20% of patients even approaching recovery. The development of Korsakoff's syndrome often results in an individual requiring a supervised living situation.

Prevention

Prevention depends on either maintaining a diet with a sufficient intake of thiamine, or supplementing an inadequate diet with vitamin preparations. Certainly, one of the most important forms of prevention involves treating the underlying alcohol **addiction**.

Resources

BOOKS

Messing, Robert. "Nutritional Disorders of the Nervous System." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

KEY TERMS

Amnesia—Inability to remember events or experiences. Memory loss. Includes: 1) Anterograde amnesia: inability to retain the memory of events occurring after the time of the injury or disease which brought about the amnesic state. 2) Retrograde amnesia: inability to recall the memory of events which occurred prior to the time of the injury or disease which brought about the amnesic state.

Confabulation—An attempt to fill in memory gaps by fabricating information or details.

Diencephalon—A part of the brain that binds the mesencephalon to the cerebral hemispheres. Considered by some as part of the brain stem.

Rossor, Martin. "Disorders of Higher Cerebral Cortical Function and Behavioral Neurology." In *Brain's Diseases of the Nervous System*, ed. John Walton. New York: Oxford Medical Publications, 1993.

Schuckit, Marc Alan. *Educating Yourself About Drugs and Alcohol*. New York: Plenum Press, 1995.

PERIODICALS

Langlais, Philip J. "Alcohol-Related Thiamine Deficiency." *Alcohol Health and Research World* (Spring 1995): 113.

ORGANIZATIONS

National Institute on Alcoholism Abuse and Alcoholism. 6000 Executive Boulevard, Willco Building, Bethesda, Maryland 20892-7003. <http://www.niaaa.nih.gov>.

Rosalyn Carson-DeWitt, MD

KUB *see* **Kidney, ureter, and bladder x-ray study**

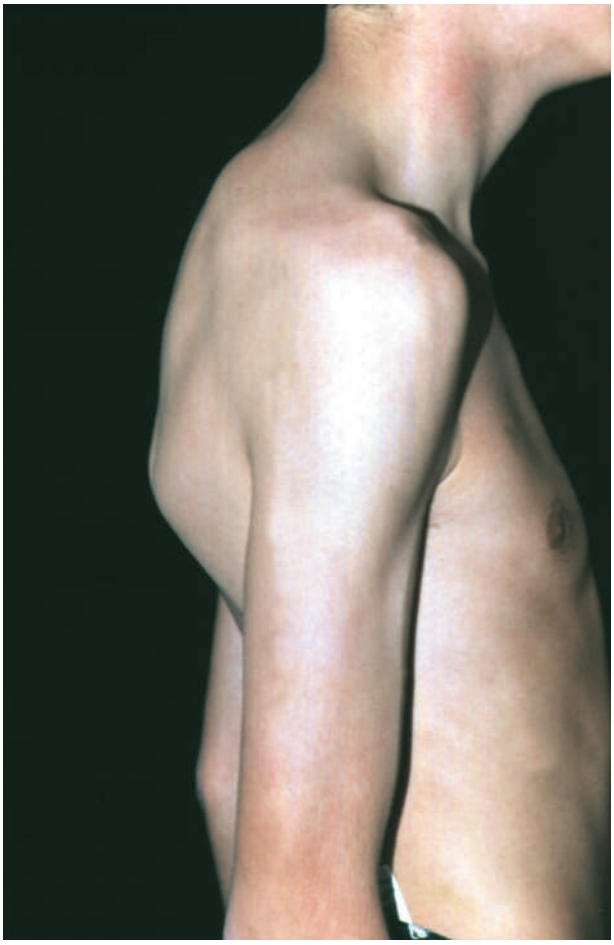
Kuru *see* **Creutzfeldt-Jakob disease**

Kwashiorkor *see* **Protein-energy malnutrition**

Kyphosis

Definition

Kyphosis is the extreme curvature of the upper back also known as a hunchback.



This patient's spine shows excessive backward curvature at the level of the upper chest. *(Custom Medical Stock Photo. Reproduced by permission.)*

Description

The upper back bone (thoracic region), is normally curved forward. If the curve exceeds 50° it is considered abnormal (kyphotic).

Causes and symptoms

Kyphosis can be divided into three ages of acquisition—birth, old age, and the time in between.

- Spinal **birth defects** can result in a fixed, exaggerated curve. Vertebrae can be fused together, shaped wrong, extraneous, or partially missing. Congenital and hereditary defects in bone growth weaken bone and result in exaggerated curves wherever gravity or muscles pull on them. Dwarfism is such a defect.
- During life, several events can distort the spine. Because the natural tendency of the thoracic spine is to curve forward, any weakness of the supporting structures will tend in that direction. A diseased thoracic vertebra (a spine bone) will ordinarily crumble its forward edge first, increasing the kyphotic curve. Conditions that can do this include **cancer**, **tuberculosis**, Scheuermann's disease, and certain kinds of arthritis. Healthy vertebrae will fracture forward with rapid deceleration injuries, such as in car crashes when the victim is not wearing a seat belt.
- Later in life, kyphosis is caused from **osteoporosis**, bone weakness, and crumbling forward.

The **stress** caused by kyphosis produces such symptoms as an increase in musculoskeletal pains, tension headaches, back aches, and joint pains.

Diagnosis

A quick look at the back will usually identify kyphosis. X rays of the spine will confirm the diagnosis and identify its cause.

Treatment

Congenital defects have to be repaired surgically. The procedures are delicate, complicated, and lengthy. Often orthopedic hardware must be placed to stabilize the back bone. At other times, a device called a Milwaukee brace can hold the back in place from the outside. Fitting Milwaukee braces comfortably is difficult because they tend to rub and cause sores.

Kyphosis acquired during the younger years requires treatment directed at the cause, such as medications for tuberculosis. Surgical reconstruction or bracing may also be necessary.

Kyphosis induced by osteoporosis is generally not treated except to prevent further bone softening.

Prognosis

Congenital kyphosis may be alleviated to some extent by surgery and bracing. Kyphosis occurring later in life may worsen over time.

Prevention

Preventing osteoporosis is within the grasp of modern medicine. Menopausal women must start early with estrogen replacement, calcium supplementation, and appropriate **exercise**. The treatment must continue through the remainder of life. Evidence suggests that a high calcium intake even during younger years delays the onset of symptomatic osteoporosis. Dairy products are the major dietary sources of calcium.

KEY TERMS

Congenital—Present at birth.

Dwarfism—A congenital disease of bone growth that results in short stature and weak bones.

Orthopedic—Refers to surgery on the supporting structures of the body—bones, joints, ligaments, muscles.

Osteoporosis—A weakening of bones due to calcium loss that affects post-menopausal women.

Scheuermann's disease—Juvenile kyphosis due to damaged bone in the spinal vertebrae.

Resources

BOOKS

Canale, S. Terry, ed. "Kyphosis." In *Campbell's Operative Orthopedics*. St. Louis: Mosby, 1998.

Finkelstein, Joel S. "Osteoporosis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Krane, Stephen M., and Alan L. Schiller. " Hyperostosis, Fibrous Dysplasia and Other Dysplasias of Bone and Cartilage." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Krane, Stephen M., and Michael F. Holick. "Metabolic Bone Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Boachie-Adjei, O., and B. Lonner. "Spinal Deformity." *Pediatric Clinics of North America* 43 (Aug. 1996): 883-897.

Boachie-Adjei, O., and R. G. Squillante. "Tuberculosis of the Spine." *Orthopedic Clinics of North America* 27 (Jan. 1996): 95-103.

Hawker, G. A. "The Epidemiology of Osteoporosis." *Journal of Rheumatology* 45 (Aug. 1996): 2-5.

Winter R. B., J. E. Lonstein, and O. Boachie-Adjei. "Congenital Spinal Deformity." *Instructional Course Lectures. Minnesota Spine Center, Minneapolis, USA* 45 (1996): 117-127.

ORGANIZATIONS

Arthritis Foundation.1300 W. Peachtree St., Atlanta, GA 30309. (800) 283-7800. <http://www.arthritis.org>.

National Osteoporosis Foundation. 1150 17th St., Suite 500 NW, Washington, DC 20036-4603. (800) 223-9994. <http://www.nof.org>.

Osteoporosis and Related Bone Diseases-National Resource Center. 1150 17th S. NW, Ste. 500, Washington, DC 20036. (800) 624-2663.

J. Ricker Polsdorfer, MD

L

Labor and delivery *see* **Childbirth**

Labor induction *see* **Induction of labor**

Labyrinthitis

Definition

Labyrinthitis is an inflammation of the inner ear that is often a complication of **otitis media**. It is caused by the spread of bacterial or viral infections from the head or respiratory tract into the inner ear.

Description

Labyrinthitis is characterized by **dizziness** or feelings of **motion sickness** caused by disturbance of the sense of balance.

Causes and symptoms

Causes

The disease agents that cause labyrinthitis may reach the inner ear by one of three routes:

- Bacteria may be carried from the middle ear or the membranes that cover the brain.
- The viruses that cause **mumps**, **measles**, **influenza**, and colds may reach the inner ear following an upper respiratory infection.
- The **rubella** virus can cause labyrinthitis in infants prior to birth.

Labyrinthitis can also be caused by toxic drugs.

Symptoms

The primary symptoms of labyrinthitis are vertigo (dizziness), accompanied by **hearing loss** and a sensation of ringing in the ears called **tinnitus**. Vertigo occurs because the inner ear controls the sense of balance as well as hearing. Some patients also experience **nausea and vomiting** and spontaneous eye movements in the direction of the unaffected ear. Bacterial labyrinthitis may produce a discharge from the infected ear.

Diagnosis

The diagnosis of labyrinthitis is based on a combination of the patient's symptoms and history—especially a history of a recent upper respiratory infection. The doctor will test the patient's hearing, and order a laboratory culture to identify the organism if the patient has a discharge.

If there is no history of a recent infection, the doctor will order extra tests in order to exclude injuries to the brain or **Meniere's disease**.

Treatment

Medication

Patients with labyrinthitis are given **antibiotics**, either by mouth or intravenously to clear up the infection. They may also be given meclizine (Antivert, Bonine) for vertigo and nausea.

Surgery

Some patients require surgery to drain the inner and middle ear.

Supportive care

Patients with labyrinthitis should rest in bed for three to five days until the acute dizziness subsides. Patients who are dehydrated by repeated vomiting may need intravenous fluid replacement. In addition, patients are advised to avoid driving or similar activities for four to six weeks after the acute symptoms subside, because they may have occasional dizzy spells during that period.

KEY TERMS

Labyrinth—The bony cavity of the inner ear.

Meniere's syndrome—A disease of the inner ear marked by recurrent episodes of vertigo and roaring in the ears lasting several hours. Its cause is unknown.

Otitis media—Inflammation of the middle ear. It can lead to labyrinthitis.

Vertigo—A sensation of dizziness marked by the feeling that one's self or surroundings are spinning or whirling.

Prognosis

Most patients with labyrinthitis recover completely, although it often takes five to six weeks for the vertigo to disappear completely and the patient's hearing to return to normal. In a few cases the hearing loss is permanent.

Prevention

The most effective preventive strategy includes prompt treatment of middle ear infections, as well as monitoring of patients with mumps, measles, influenza, or colds for signs of dizziness or hearing problems.

Resources

BOOKS

Baloh, Robert W. "Episodic Vertigo." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Borer, William Z., and Duane W. Taebel. "Nausea, Vomiting, and Dyspepsia." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Jackler, Robert K., and Michael J. Kaplan. "Ear, Nose, & Throat." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Labyrinthitis." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

"Otolaryngology: Purulent Labyrinthitis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Rowe, Lee D. "Otolaryngology— Head & Neck Surgery." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Rebecca J. Frey

Laceration repair

Definition

A laceration is a wound caused by a sharp object producing edges that may be jagged, dirty, or bleeding. Lacerations most often affect the skin, but any tissue may be lacerated, including subcutaneous fat, tendon, muscle, or bone.

Purpose

A laceration should be repaired if it:

- continues to bleed after application of pressure for ten to fifteen minutes
- is more than one-eighth to one-fourth inch deep
- exposes fat, muscle, tendon, or bone
- causes a change in function surrounding the area of the laceration
- is dirty or has visible debris in it
- is located in an area where an unsightly scar is undesirable

Precautions

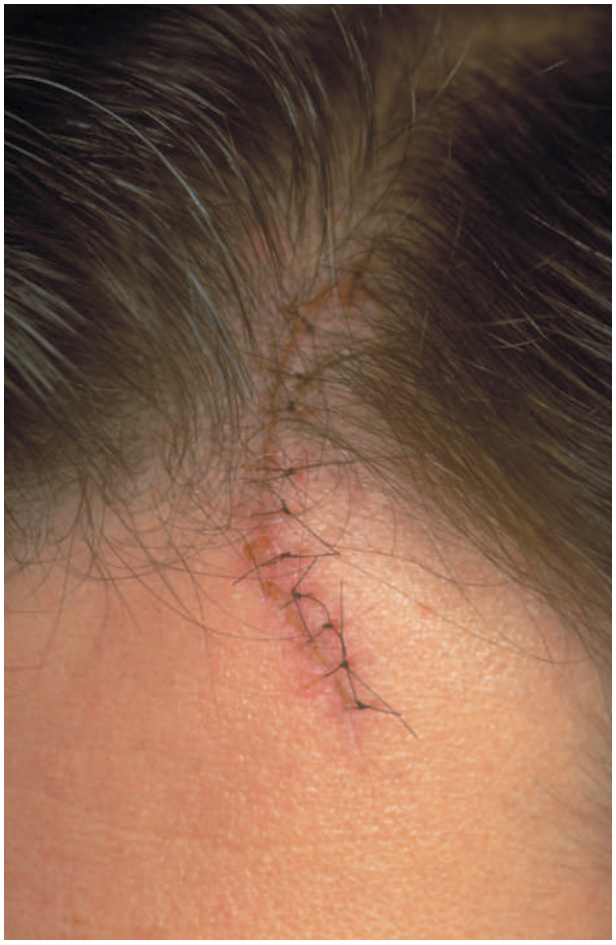
Lacerations are less likely to become infected if they are repaired soon after they occur. Many physicians will not repair a laceration that is more than eight hours old because the risk of infection is too great.

Description

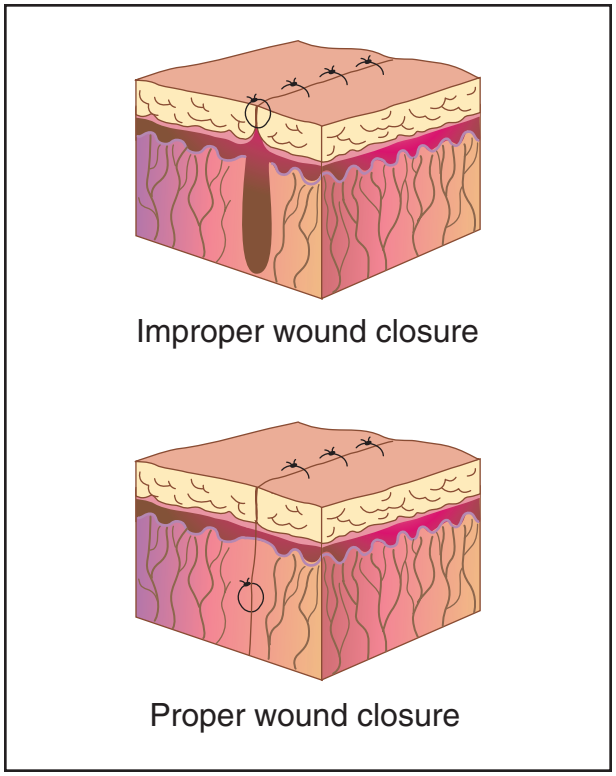
Laceration repair mends a tear in the skin or other tissue. The procedure is similar to repairing a tear in clothing. Primary care physicians, emergency room physicians, and surgeons usually repair lacerations. The four goals of laceration repair are to stop bleeding, prevent infection, preserve function, and restore appearance. Insurance companies do pay for the procedure. Cost depends upon the severity and size of the laceration.

Before repairing the laceration, the physician thoroughly examines the wound and the underlying tendons or nerves. If nerves or tendons have been injured, a surgeon may be needed to complete the repair. The laceration is cleaned by removing any foreign material or debris. Removing **foreign objects** from penetrating **wounds** can sometimes cause bleeding, so this type of wound must be cleaned very carefully. The wound is then irrigated with saline solution and a disinfectant. The disinfecting agent may be mild soap or a commercial preparation. An antibacterial agent may be applied.

Once the wound has been cleansed, the physician anesthetizes the area of the repair by injecting a local anes-



Eleven sutures are necessary to close up the laceration on this person's forehead. *(Custom Medical Stock Photo. Reproduced by permission.)*



A laceration is a traumatic break in the skin caused by a sharp object producing edges that may be jagged, dirty, or bleeding. The underlying tissue may also be severed. In such instances, the physician may place absorbable sutures in the tissue to help bring the edges together before the skin is sutured close. *(Illustration by Electronic Illustrators Group.)*

thetic. The physician may trim edges that are jagged or extremely uneven. Tissue that is too damaged to heal must be removed (**debridement**) to prevent infection. If the laceration is deep, several absorbable stitches (sutures) are placed in the tissue under the skin to help bring the tissue layers together. Suturing also helps eliminate any pockets where tissue fluid or blood can accumulate. The skin wound is closed with sutures. Suture material used on the surface of a wound is usually non-absorbable and will have to be removed later. A light dressing or an adhesive bandage is applied for 24-48 hours. In areas where a dressing is not feasible, an antibiotic ointment can be applied. If the laceration is the result of a human or animal bite, if it is very dirty, or if the patient has a medical condition that alters wound healing, oral **antibiotics** may be prescribed.

Aftercare

The laceration is kept clean and dry for at least 24 hours after the repair. Light bathing is generally permitted after 24 hours if the wound is not soaked. The physician will provide directions for any special wound care. Sutures are removed three to 14 days after the repair is completed. Timing of suture removal depends on the location of the laceration and physician preference.

The repair should be observed frequently for signs of infection, which include redness, swelling, tenderness, drainage from the wound, red streaks in the skin surrounding the repair, chills, or **fever**. If any of these occur, the physician should be contacted immediately.

Risks

The most common complication of any laceration repair is infection. Risk of infection can be minimized by cleansing the wound thoroughly. Wounds from bites or dirty objects or wounds that have a large amount of dirt in them are most likely to become infected.

All lacerations will heal with a scar. Wounds that are repaired with sutures are less likely to develop scars that are unsightly, but no one can predict how wounds will

KEY TERMS

Debridement—The act of removing any foreign material and damaged or contaminated tissue from a wound to expose surrounding healthy tissue.

heal and who will develop unsightly scars. Plastic surgery can improve the appearance of many scars.

Resources

BOOKS

Snell, George."Laceration Repair." In *Procedures for Primary Care Physicians*, ed. John L. Pfenninger and Grant C. Fowler. St. Louis: Mosby, 1994.

OTHER

"Caring for Cuts and Scrapes at Home." Mayo Clinic Online. <http://www.mayohealth.org/mayo/9611/htm/cuts_sb.htm>.

"Cuts and Scrapes." Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

"Laceration Repair." ThriveOnline. <http://thriveonline.oxygen.com>.

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Lacerations *see* **Wounds**

Lacrimal duct obstruction

Definition

A lacrimal duct obstruction is blockage of the tear duct, the thin channel that normally drains tears from the surface of the eye.

Description

The lacrimal glands, located above each eyeball, produce tears. The tears flow over the eye, then drain through the nasolacrimal ducts. A tiny hole at the inner edge of each eyelid marks the opening of the ducts, which lead to the lacrimal sacs located on the side of the nose. The tears pass from the sacs into the nasolacrimal ducts and then into the nose.

When a tear duct becomes obstructed, tears may spill over the eyelids and run down the face. Stagnant tears within the system can become infected, leading to recurrent red eyes and infections. Excessive tearing can also produce secondary skin changes on the lower eyelids.

Causes and symptoms

An obstructed lacrimal tear duct can result in inflammation and infection of the lacrimal sac. The area beneath the eyes next to the nose can become red, inflamed, and sensitive to the touch. The area usually is swollen, and there may be a mucous discharge from the opening of the nasal corner of the eye. Common complaints include **itching**, irritation, burning, redness, foreign body sensation, and tearing.

Children frequently have a congenital lacrimal duct obstruction. Six to ten percent of all children are born before their tear ducts are open.

In adults, a common cause of lacrimal duct obstruction is involution, which is progressive degeneration occurring naturally with advancing age, resulting in shrivelling of organs or tissues. Other causes include **eyelid disorders**, infections by bacteria, viruses, fungi, and parasites, inflammations, the use of eye drops or excessive nasal spray, systemic **chemotherapy**, trauma from previous surgeries, injury to the bone at the side of the nose, foreign bodies, sinus disease, **nasal polyps**, and malignant or benign tumors.

Diagnosis

If the primary symptom is excessive tearing, the first step is for the health care professional to determine if the overflow of tears is due to an increase in tear production or a decrease in tear drainage. Causes of increased tear production may include trichiasis, a disease in which the eyelashes produce constant irritation, and eyelid malpositions and diseases. If abnormal tear production is ruled out, then obstructions in tear drainage is the most likely cause of the excessive tearing. Additional observations of swollen lacrimal sac area and purulent eye discharge indicate that there may be a lacrimal duct infection present. To further define the diagnosis, the lacrimal discharge may be cultured to determine possible infective agents, while various imaging techniques may be used to detect the type of obstruction. Dye tracer tests are also used to test for blockages.

Treatment

Lacrimal duct obstructions in children often resolve spontaneously, with 95% showing resolution before the child is one year old. Daily massaging of the lacrimal sac may help open the blockage. A topical antibiotic ointment may be applied if infection is present. If the blockage is not resolved after several weeks to months of this therapy, a physician may attempt forceful irrigation. Surgical probing to open up the duct under general anesthesia is a last resort, after a year or so of less invasive treatments.

KEY TERMS

Lacrimal duct—A short canal leading from a small orifice at the medial angle of each eyelid to the lacrimal sac.

Lacrimal gland—An almond-shaped gland that secretes tears.

Lacrimal sac—The dilated upper end of the nasolacrimal duct in which the lacrimal ducts empty.

Nasolacrimal duct—A channel that transmits tears from the lacrimal sac to the nose.

Purulent—Consisting of or containing pus

Tear—A drop of the clear, salty fluid secreted by the lachrimal gland.

Trichiasis—A disease of the eye, in which the eyelashes, being turned in upon the eyeball, produce constant irritation by the motion of the lids.

In adults, conservative treatments are usually recommended. The infected or inflamed area may be massaged, with warm compresses applied to provide relief and speed the healing process. The health care provider may also massage or irrigate the infected area. Topical antibiotic ointments and oral **antibiotics** may also be used reduce infection. The use of **analgesics** such as **aspirin** may be recommended to control discomfort and reduce swelling. Severe cases may require surgical intervention to prevent future recurrences. Surgical approaches include insertion of a probe or catheter to remove an obstruction or creation of an artificial duct to bypass the obstruction.

Prognosis

If more conservative approaches fail to clear the obstruction, surgical procedures are available, with success rates greater than 90%.

Prevention

In many cases, the cause of a lacrimal duct obstruction is not known. However, in some cases, lacrimal duct obstruction may be caused by **smoking** and abuse of nasal sprays.

Resources

BOOKS

Sullivan, David A., ed. *Lacrimal Gland, Tear Film, and Dry Eye Syndromes: Basic Science and Clinical Relevance, Advances in Experimental Medicine and Biology*. New York: Plenum Press, 1994.

Sullivan, David A., Darlene A. Dartt, and Michele A. Meneray, ed. *Lacrimal Gland, Tear Film, and Dry Eye Syndromes 2: Basic Science and Clinical Relevance, Advances in Experimental Medicine and Biology*. New York: Plenum Press, 1998.

Schmidt, Eric C., and Eric E. Schmidt. *Lids and Nasolacrimal System: Clinical Procedures*. Woburn, MA: Butterworth-Heinemann Medical, 1997.

PERIODICALS

Camara, Jorge G., and Alfonso U. Bengzon. "Nasolacrimal Duct Obstruction." *eMedicine Journal* <http://www.emedicine.com/OPH/topic465.htm>. (August 24, 2000).

Judith Sims

Lacrimal sac infection *see* **Dacryocystitis**

Lactate dehydrogenase isoenzymes test

Definition

The enzyme lactate dehydrogenase (also known as lactic dehydrogenase, or LDH) is found in the cells of almost all body tissues. The enzyme is especially concentrated in the heart, liver, red blood cells, kidneys, muscles, brain, and lungs. The total LDH can be further separated into five components or fractions labeled by number: LDH-1, LDH-2, LDH-3, LDH-4, and LDH-5. Each of these fractions, called isoenzymes, is used mainly by a different set of cells or tissues in the body. For this reason, the relative amounts of a particular isoenzyme of LDH in the blood can provide valuable diagnostic information.

Purpose

The LDH isoenzymes test assists in differentiating **heart attack**, anemia, lung injury, or liver disease from other conditions that may cause the same symptoms (differential diagnosis).

Precautions

Strenuous **exercise** may raise levels of total LDH, specifically the isoenzymes LDH-1, LDH-2, and LDH-5. Alcohol, anesthetics, **aspirin**, narcotics, procainamide, fluorides, and mithramycin may also raise levels of LDH. Ascorbic acid (vitamin C) can lower levels of LDH.

Description

LDH is found in the cells of almost all body tissues. When certain conditions injure cells in tissues containing LDH, it is released into the bloodstream. Because LDH is so widely distributed throughout the body, analysis of total LDH will not help make a diagnosis of a particular disease. Because this enzyme is actually composed of five different isoenzymes, however, analysis of the different LDH isoenzyme levels in the blood can help in the diagnosis of some diseases.

The five LDH isoenzymes are: LDH-1, LDH-2, LDH-3, LDH-4, and LDH-5. In general, each isoenzyme is used mostly by the cells in a specific tissue. LDH-1 is found mainly in the heart. LDH-2 is primarily associated with the system in the body that defends against infection (reticuloendothelial system). LDH-3 is found in the lungs and other tissues, LDH-4 in the kidney, placenta, and pancreas, and LDH-5 in liver and striated (skeletal) muscle. Normally, levels of LDH-2 are higher than those of the other isoenzymes.

Certain diseases have classic patterns of elevated LDH isoenzyme levels. For example, an LDH-1 level higher than that of LDH-2 is indicative of a heart attack or injury; elevations of LDH-2 and LDH-3 indicate lung injury or disease; elevations of LDH-4 and LDH-5 indicate liver or muscle disease or both. A rise of all LDH isoenzymes at the same time is diagnostic of injury to multiple organs. For example, a heart attack with congestive **heart failure** may cause symptoms of lung and liver congestion. Advanced **cancer** and autoimmune diseases such as lupus can also cause this pattern.

One of the most important diagnostic uses for the LDH isoenzymes test is in the differential diagnosis of myocardial infarction or heart attack. The total LDH level rises within 24-48 hours after a heart attack, peaks in two to three days, and returns to normal in approximately five to ten days. This pattern is a useful tool for a delayed diagnosis of heart attack. The LDH-1 isoenzyme level, however, is more sensitive and specific than the total LDH. Normally, the level of LDH-2 is higher than the level of LDH-1. An LDH-1 level higher than that of LDH-2, a phenomenon known as "flipped LDH," is strongly indicative of a heart attack. The flipped LDH usually appears within 12-24 hours after a heart attack. In about 80% of cases, flipped LDH is present within 48 hours of the incident. A normal LDH-1/LDH-2 ratio is considered reliable evidence that a heart attack has not occurred.

It should be noted that two conditions might cause elevated LDH isoenzymes at the same time and that one may confuse the other. For example, a patient with **pneumonia** may also be having an acute heart attack. In this instance, the LDH-1 level would rise with the LDH-2 and LDH-3. Because of this complication, some laboratories measure only the LDH-1 and consider an elevated LDH level with LDH-1 higher than 40% to be diagnostic of heart damage. LDH isoenzymes test is not used much anymore for diagnosis of heart attack. Tests for the protein troponin, which is found in myocardial cells, have been found to be more accurate.

Preparation

This test requires a blood sample. The patient need not fast (nothing to eat or drink) before the test unless requested to do so by the physician.

Risks

Risks for this test are minimal. The patient may experience slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after the vein is punctured (venipuncture), or an accumulation of blood under the puncture site (hematoma).

Normal results

Reference values for normal levels of LDH isoenzymes vary from laboratory to laboratory but can generally be found within the following ranges:

- LDH-1: 17-27%
- LDH-2: 27-37%
- LDH-3: 18-25%
- LDH-4: 8-16%
- LDH-5: 6-16%

Abnormal results

Increased levels of LDH-1 are seen in myocardial infarction, red blood cell diseases like **hemolytic anemia**, kidney disease including **kidney transplantation** rejection, and testicular tumors. Increased levels of LDH-2 are found in lung diseases such as pneumonia and congestive heart failure, as well as in lymphomas and other tumors. Elevations of LDH-3 are significant in lung disease and certain tumors. Elevations of LDH-4 are greatly increased in **pancreatitis**. High levels of LDH-5 are found in liver disease, intestinal problems, and skeletal muscle disease and injury, such as **muscular dystrophy** and recent muscular trauma.

Diffuse disease or injury (for example, collagen disease, **shock**, low blood pressure) and advanced solid-tumor cancers cause significant elevations of all LDH isoenzymes at the same time.

KEY TERMS

Differential diagnosis—Comparing and contrasting the signs, symptoms, and laboratory findings of two or more diseases to determine which is causing the patient's condition.

Enzyme—A protein that regulates the rate of a chemical reaction in the body, increasing the speed at which the change occurs.

Isoenzyme—One of a group of enzymes that bring about the same reaction but are vary in their physical properties.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Lactate dehydrogenase test

Definition

Lactate dehydrogenase, also called lactic dehydrogenase, or LDH, is an enzyme found in the cells of many body tissues, including the heart, liver, kidneys, skeletal muscle, brain, red blood cells, and lungs. It is responsible for converting muscle lactic acid into pyruvic acid, an essential step in producing cellular energy.

Purpose

Lactic dehydrogenase is present in almost all body tissues, so the LDH test is used to detect tissue alterations and as an aid in the diagnosis of **heart attack**, anemia, and liver disease. Newer injury markers are becoming more useful than LDH for heart attack diagnosis.

Precautions

Because the LDH enzyme is so widely distributed throughout the body, cellular damage causes an elevation of the total serum LDH. As a result, the diagnostic usefulness of this enzyme by itself is not as valuable as determination of the five fractions that comprise the LDH. These fractions are called isoenzymes and are better indicators of disease than is the total LDH. The fractions are LDH-1, LDH-2, LDH-3, LDH-4, and LDH-5. A normal total LDH level does not mean that individual isoenzyme levels should not be measured. Individual isoenzyme ranges can help differentiate a diagnosis.

Description

When disease or injury affects tissues containing LDH, the cells release LDH into the bloodstream, where it is identified in higher than normal levels. For example, when a person has a heart attack, the LDH level begins to rise about 12 hours after the attack and usually returns to normal within five to 10 days. The LDH is also elevated in diseases of the liver, in certain types of anemia, and in cases of excessive destruction of cells, as in **fractures**, trauma, muscle damage, and **shock**.

Cancers can also elevate LDH level. Additionally, some patients have chronically elevated LDH with no identifiable cause and no apparent consequence.

Preparation

This test requires a blood sample. It is not necessary for the patient to fast (nothing to eat or drink) before the test unless the physician requests it.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges for total LDH vary from laboratory to laboratory. Normal values are also higher in childhood. For adults, in most laboratories, the range can be up to approximately 200 units/L, but is usually found within 45-90 U/L.

Abnormal results

Due to the fact that many common disease processes cause elevations in the total LDH level, a breakdown of the five different isoenzymes that make up the total LDH is often helpful for diagnosis. In certain disorders, the total LDH may be within normal limits, but individual isoenzyme elevations can indicate specific organ or tissue damage. For example, the LDH-2 fraction is normal-

KEY TERMS

Enzyme—A protein that regulates the rate of a chemical reaction in the body, increasing the speed at which the change occurs.

Isoenzyme—One of a group of enzymes that catalyze the same reaction but are differentiated by variations in physical properties.

ly greater than LDH-1 in the blood. After an acute heart attack, however, the LDH-1 rises over the LDH-2 in what is known as a "flipped LDH."

Certain diagnoses can be assisted by determination of the total LDH. One example is **infectious mononucleosis**, in which the LDH is usually more elevated than a liver enzyme called AST. Conversely, in cases of viral hepatitis, the liver enzymes AST and ALT are greatly increased over the LDH.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

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Lactation

Definition

Lactation is the medical term for breastfeeding, a natural method of feeding an infant from birth to the time he or she can eat solid food. Human milk contains the ideal amount of nutrients for the infant, and provides important protection from diseases through the mother's natural defenses.

Description

Early in a woman's **pregnancy** her milk-producing glands begin to prepare for her baby's arrival, and by the sixth month of pregnancy the breasts are ready to produce milk. Immediately after the baby is born, the placenta is delivered. This causes a hormone in the woman's body (prolactin) to activate the milk-producing glands. By the third to fifth day, the woman's breasts fill with milk.

Then, as the baby continues to suck each day, nursing triggers the continuing production of milk. The baby's sucking stimulates nerve endings in the nipple, which signal the mother's pituitary gland to release oxytocin, a hormone that causes the mammary glands to release milk to the nursing baby. This is called the "let-down reflex." While the baby's sucking is the primary stimulus for this reflex, a baby's cry, thoughts of the baby, or the sound of running water also may trigger the response. Frequent nursing will lead to increased milk production.

Breast milk cannot be duplicated by commercial baby food formulas, although both contain protein, fat, and carbohydrates. In particular, breast milk changes to meet the specific needs of a baby. The composition of breast milk changes as the baby grows, to meet the baby's changing needs. Most important, breast milk contains substances called antibodies from the mother that can protect the child against illness and **allergies**. Antibodies are part of the body's natural defense system against infections and other agents that can cause disease. Breast milk also helps a baby's own immune system mature faster. As a result, breast-fed babies have fewer ear infections, **diarrhea**, **rashes**, allergies, and other medical problems than bottle-fed babies.

There are many other benefits to breast milk. Because it is easily digested, babies do not get constipated. Breast-fed babies have fewer speech impediments, and they have good cheekbone development and jaw alignment.

Breastfeeding is also good for the mother. The act of breastfeeding releases hormones that stimulate the uterus to contract, helping it to return to normal size after delivery and reducing the risk of bleeding. The act of producing milk **burns** calories, which helps the mother to lose excess weight gained during pregnancy. Breastfeeding also may be related to a lower risk of **breast cancer**, **ovarian cancer**, or **cervical cancer**. This benefit is stronger the younger a woman is when she breastfeeds; women who breastfeed before age 20 and nurse for at least six months have a 50% drop in the risk for breast **cancer**.

In addition, breastfeeding does not involve any formulas, bottles and nipples, or sterilizing equipment. Breast milk is free, and saves money by eliminating the need to buy formula, bottles, and nipples. Because breast-fed babies are healthier, health care costs for breast-fed infants are lower.

Procedure

Breastfeeding should begin as soon as possible after birth, and should continue every two to three hours.

However, all babies are different; some need to nurse almost constantly at first, while others can go much longer between feedings. A baby should be fed at least eight to 12 times in 24 hours. Because breast milk is easily digested, a baby may be hungry again as soon as one and one-half hours after the last meal.

Mothers should wear comfortable, loose, front-opening clothes and a good nursing bra. Mothers should find a comfortable chair with lots of pillows, supporting the arm and back. Feet should rest on a low footstool, with knees raised slightly. The baby should be level with the breast. The new mother may have to experiment with different ways of holding the baby before finding one that is comfortable for both the mother and baby.

Some babies have no trouble breastfeeding, while others may need some assistance. Once the baby begins to suck, the mother should make sure that the entire dark area around the nipple is in the baby's mouth. This will help stimulate milk flow, allowing the baby to get enough milk. It will also prevent nipple soreness.

Breastfeeding mothers will usually offer the baby both breasts at each feeding. Breastfeeding takes about 15-20 minutes on each side. After stopping the feeding on one side, the mother should burp the baby before beginning the feeding on the other breast. If the baby falls asleep at the breast, the next feeding should begin with the breast that was not nursed.

Mothers can tell if the baby is getting enough milk by checking diapers; a baby who is wetting between four to six disposable diapers (six to eight cloth) and who has three or four bowel movements in 24 hours is getting enough milk.

Nursing problems

New mothers may experience nursing problems, including:

- Engorged breasts. Breasts that are too full can prevent the baby from sucking. Expressing milk manually or with a breast pump can help.
- Sore nipples. In the early weeks nipples may become sore; a nipple shield can ease discomfort.
- Infection. Soreness and inflammation on the breast surface or a **fever** in the mother, may be an indication of breast infection. **Antibiotics** and continued nursing on the affected side may solve the problem.

Prognosis

There are no rules about when to stop breastfeeding. A baby needs breast milk for at least the first year of life; as long as a baby eats age-appropriate solid food, the mother may nurse for several years.

KEY TERMS

Bromocriptine —A drug used to treat Parkinson's disease that can decrease a woman's milk supply.

Ergotamine—A drug used to prevent or treat migraine headaches. This can cause vomiting, diarrhea, and convulsions in infants.

Lithium—A drug used to treat manic depression (bipolar disorder) that can be transmitted in breast milk.

Methotrexate—An anticancer drug also used to treat arthritis that can suppress an infant's immune system when taken by a nursing mother.

Prevention

Most common illnesses can not be transmitted via breast milk. However, some viruses, including HIV (the virus that causes **AIDS**) can be passed in breast milk; for this reason, women who are HIV-positive should not breastfeed.

Many medications have not been tested in nursing women, so it is not known if these drugs can affect a breast-fed child. A nursing woman should always check with her doctor before taking any medications, including over-the-counter drugs.

These drugs are not safe to take while nursing:

- radioactive drugs for some diagnostic tests
- chemotherapy drugs for cancer
- bromocriptine
- ergotamine
- lithium
- methotrexate
- street drugs (including marijuana, heroin, amphetamines)
- tobacco

Resources

BOOKS

Cunningham, F. Gary, et al. *Williams Obstetrics*. 20th ed. Stamford: Appleton & Lange, 1997.

Franck, Irene, and David Brownstone. *The Parents' Desk Reference*. New York: Prentice Hall, 1991.

Johnson, Robert V. *Mayo Clinic Complete Book of Pregnancy and Baby's First Year.* New York: William Morrow and Co., 1994.

PERIODICALS

Newman, Jack. "How Breast Milk Protects Newborns." *Scientific American* 273 (Dec. 1995):676.

ORGANIZATIONS

International Lactation Consultants Assoc. 201 Brown Ave., Evanston, IL 60202. (708) 260-8874.

La Leche League International. 1400 North Meacham Rd., Schaumburg, IL 60173. (800) LA-LECHE.

National Alliance for Breastfeeding Advocacy. 254 Conant Rd., Weston, MA 02193. (617) 893-3553.

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Lactic acid test

Definition

Lactic acid is an acid produced by cells during chemical processes in the body that do not require oxygen (anaerobic metabolism). Anaerobic metabolism occurs only when too little oxygen is present for the more usual aerobic metabolism (oxygen requiring). Lactic acid is a contributing factor in muscle cramps. It is also produced in tissues when conditions such as **heart attack** or **shock** reduce the blood supply responsible for carrying oxygen. Normally, lactic acid is removed from the blood by the liver. When an excess of lactic acid accumulates for any reason, the result is a condition called lactic acidosis.

Purpose

The lactic acid test is used as an indirect assessment of the oxygen level in tissues and to determine the cause and course of lactic acidosis.

Precautions

During blood collection, the patient should be instructed to relax the hand. Clenching and unclenching the fist will cause a build-up of potassium and lactic acid from the hand muscles that will falsely elevate the levels.

Description

The degree of acidity is an important chemical property of blood and other body fluids. Acidity is expressed on a pH scale where 7.0 is neutral, above 7.0 is basic (alkaline), and below 7.0 is acidic. A strong acid has a very low pH (near 1.0). A strong base has a very high pH (near 14.0). Blood is normally slightly alkaline or basic. It has a pH range of 7.35-7.45. The balance of acid to base in blood is precisely controlled. Even a minor deviation from the normal range can severely affect many organs.

Lactic acid (present in the blood as lactate ion) is a product of the breakdown of glucose to generate energy. It is found primarily in muscle cells and red blood cells. The lactate ion concentration in the blood depends on the rates of energy production and metabolism. Levels may increase significantly during **exercise**.

Together, lactic acid and another chemical (pyruvate) form a reversible reaction regulated by the oxygen supply to the blood and tissues. When oxygen levels are low, pyruvate converts to lactic acid; when oxygen levels are adequate, lactic acid converts to pyruvate. When the liver fails to metabolize lactose sufficiently or when too much pyruvate converts to lactate, lactic acidosis occurs. Measurement of blood lactate levels is recommended for all patients with symptoms of lactic acidosis. Testing is generally indicated if the blood pH level falls below 7.25-7.35.

Because of the close relationship between pyruvate and lactic acid, comparison of blood levels of the two substances can provide reliable information about tissue oxidation. However, pyruvate measurement is technically difficult and seldom performed. Lactic acid is measured more often, in either venous or arterial blood samples.

Preparation

This test requires a blood sample. The patient should have nothing to eat or drink (**fasting**) from midnight the night before the test. Because lactic acid is produced by exertion, the patient should rest for at least one hour before the test.

Risks

Risks for this test are minimal. The patient may experience slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after puncture of the vein (venipuncture), or an accumulation of blood under the puncture site (hematoma).

Normal results

Reference values vary from laboratory to laboratory but can be found within the following ranges:

- Venous blood: 4.5-19.8 mg/dL
- Arterial blood: 4.5-14.4 mg/dL

KEY TERMS

Acidosis—A disturbance of the balance of acid to base in the body causing an accumulation of acid or loss of alkali (base). There are two types of acidosis: metabolic and respiratory. One of the most common causes of metabolic acidosis is an overdose of aspirin. Respiratory acidosis is caused by impaired breathing caused by conditions such as severe chronic bronchitis, bronchial asthma, or airway obstruction.

Abnormal results

High blood lactate levels, together with decreased oxygen in tissues, may be caused by strenuous muscle exercise, shock, hemorrhage, severe infection in the blood stream, heart attack, or cardiac arrest. When tissue oxygenation is low for no apparent reason, increased lactate levels may be caused by systemic disorders like diabetes, leukemia, liver disease, or kidney failure. Defects in enzymes may also be responsible, as in glycogen storage disease (von Gierke's disease). Lactate is also increased in certain instances of intestinal obstruction.

Lactic acidosis can be caused by taking large doses of **acetaminophen** and alcohol and by intravenous infusion of epinephrine, glucagon, fructose, or sorbitol. Antifreeze **poisoning** can also cause lactic acidosis. In rare instances, a diabetic medication, metformin (Glucophage), causes lactic acidosis. People with weak kidneys should not take metformin.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, Pennsylvania: Springhouse Corporation, 1995.

Jacobs, David S., ed. *Laboratory Test Handbook*. 4th ed. Hudson, Ohio: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska, and Timothy James Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Paul A. Johnson

Lactic acidosis *see* **Metabolic acidosis**

Lactogen test *see* **Prolactin test**

Lactogenic hormone test *see* **Prolactin test**

Lactose intolerance *see* **Carbohydrate intolerance**

Lactose intolerance

Definition

Lactose intolerance refers to the inability of the body to digest lactose.

Description

Lactose is the form of sugar present in milk. The enzyme lactase, which is normally produced by cells lining the small intestine, breaks down lactose into substances that can be absorbed into the bloodstream. When dairy products are ingested, the lactose reaches the digestive system and is broken down by lactase into the simpler sugars glucose and galactose. The liver changes the galactose into glucose, which then enters the bloodstream and raises the blood glucose level. Lactose intolerance occurs when, due to a deficiency of lactase, lactose is not completely broken down and the glucose level does not rise. While not usually dangerous, lactose intolerance can cause severe discomfort.

From 30 to 50 million Americans suffer from the symptoms of lactose intolerance, but not everyone who is deficient in lactase experiences symptoms. Experts believe that 75% of the adult population worldwide does not produce enough lactase and is at risk for some or all of the symptoms of lactose intolerance.

Causes and symptoms

Lactose intolerance can be caused by some diseases of the digestive system and by injuries to the small intestine that result in a decreased production of lactase. While rare, some children are also born unable to produce the enzyme. For many, however, lactase deficiency develops naturally because, after about two years of age, the body produces less lactase.

Symptoms include nausea, cramps, **diarrhea**, bloating and gas. The symptoms usually occur between 30 minutes to two hours after eating or drinking lactose-containing foods.

Diagnosis

Usually, health care professionals measure the absorption of lactose in the digestive system by using the lactose tolerance test, hydrogen breath test or stool acidity test. Each of these can be performed outpatient, through a hospital, clinic or doctor's office.

People taking the lactose tolerance test must fast before being tested. They then drink a lactose-containing liquid for the test and medical personnel take blood sam-

KEY TERMS

Galactose—Simple sugar derived from milk sugar.

Glucose—A simple sugar and the chief energy source in the

Lactase enzyme—The enzyme produced by cells that line the small intestine which allows the body to break down lactose.

Lactose—The primary sugar in milk.

ples during the next two hours to measure the patient's blood glucose level. The blood glucose level, or blood sugar level, indicates how well the body is digesting the lactose. A diagnosis of lactose intolerance is confirmed when blood glucose level does not rise. This test is not administered to infants and very young children because they are more prone to **dehydration**, which can result from diarrhea from the liquid.

Health care professionals measure the amount of hydrogen in the breath using the hydrogen breath test. Hydrogen is usually detected only in small amounts in the breath. However when undigested lactose found in the colon is fermented by bacteria, hydrogen in the breath is produced in greater quantities. The hydrogen is exhaled after being absorbed from the intestines and carried through the bloodstream to the lungs. The hydrogen breath test involves having the patient drink a lactose-containing beverage. Health care professionals monitor the breath at regular intervals to see if the hydrogen levels rise, which indicates improper lactose digestion. People taking the test who have had certain foods, medications or cigarettes before the test may get inaccurate results. While the test is available to children and adults, newborns and young children should not have it because of the risk of dehydration from drinking the beverage that can cause diarrhea in those who are lactose intolerant.

A stool acidity test measures the amount of acid in the stool. This is a safe test for newborns and young children. The test detects lactic acid and other short-chain fatty acids from undigested lactose fermented by bacteria in the colon. Glucose might also be in the stool sample, resulting form unabsorbed lactose in the colon.

Treatment

Pediatricians might recommend that parents of newborns and very young children who are suspected of having lactose intolerance simply change from cow's milk to a soya formula. Since there is no treatment that can improve the body's ability to produce lactase, lactose deficiency treatments instead, are focused on controlling the diet.

Most people affected by lactose intolerance do well if they limit their intake of lactose foods and drinks. People differ in the amounts they can handle before experiencing symptoms. Some have to stop lactose completely. People who are sensitive after ingesting small amounts of lactose can take lactase enzymes, which are available without a prescription. Using the liquid form, people can add a few drops in their milk, put the milk in the refrigerator and drink it after 24 hours, when the lactase enzymes have worked to reduce the lactose content by 70%. If the milk is heated first and double the amount of lactase liquid is added, the milk will be 90 percent lactose free. Recently, researchers have developed a chewable lactase enzyme tablet. By taking three to six tablets just before eating, the tablets help people digest lactose-containing solid foods. Supermarkets also carry lactose-reduced mild and other products, which contain the needed nutrients found in the regular products but without the lactose.

Foods that contain lactose are milk, low-fat milk, skim milk, chocolate milk, buttermilk, sweetened condensed milk, dried whole milk, instant nonfat dry milk, low-fat yogurts, frozen yogurts ice cream, ice milk, sherbet, cheese, cottage cheese, low-fat cottage cheese, cream and butter. Other foods that may contain hidden lactose are: nondairy creamers, powdered artificial sweeteners, foods containing milk power or nonfat milk solids, bread, cake, margarine, creamed soups, pancakes, waffles, processed breakfast cereals, salad dressings, lunch meats, puddings, custards, confections and some meat products.

Prognosis

Lactose intolerance is easy to manage. People of all ages however, especially children, have to replace the calcium lost by cutting back on milk products by taking supplements and eating calcium-rich foods, such as broccoli, kale, canned salmon with bones, calcium-fortified foods and tofu. Many people who suffer with lactose intolerance will be able to continue eating some milk products. The condition is not considered dangerous.

Prevention

Often, lactose intolerance is a natural occurrence that cannot be avoided. However, people can prevent symptoms by managing the condition with diet and lactase supplements.

Resources

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. National Institute of Diabetes and Digestive and Kidney

Diseases. National Institutes of Health. U.S. Department of Health and Human Services. 2 Information Way. Bethesda, MD 20892-3570. <http://www.niddk.nih.gov/health/digest/pubs/lactose/lactose.htm>.
American Dietetic Association. (800) 366-1655. <http://www.eatright.org/nfs/nfs43.html>.

OTHER

"Lactose Intolerance." Onebody.com. <http://www.onebody.com>.

Lisette Hilton

Lambliasis *see* **Giardiasis**

Laminectomy *see* **Disk removal**

Language disturbance *see* **Aphasia**

Laparoscopic cholecystectomy *see* **Cholecystectomy**

Laparoscopy

Definition

Laparoscopy is a type of surgical procedure in which a small incision is made, usually in the navel, through which a viewing tube (laparoscope) is inserted. The viewing tube has a small camera on the eyepiece. This allows the doctor to examine the abdominal and pelvic organs on a video monitor connected to the tube. Other small incisions can be made to insert instruments to perform procedures. Laparoscopy can be done to diagnose conditions or to perform certain types of operations. It is less invasive than regular open abdominal surgery (laparotomy).

Purpose

Since the late 1980s, laparoscopy has been a popular diagnostic and treatment tool. The technique dates back to 1901, when it was reportedly first used in a gynecologic procedure performed in Russia. In fact, gynecologists were the first to use laparoscopy to diagnose and treat conditions relating to the female reproductive organs: uterus, fallopian tubes, and ovaries.

Laparoscopy was first used with **cancer** patients in 1973. In these first cases, the procedure was used to observe and biopsy the liver. Laparoscopy plays a role in the diagnosis, staging, and treatment for a variety of cancers.

As of 2001, the use of laparoscopy to completely remove cancerous growths and surrounding tissues (in place of open surgery) is controversial. The procedure is being studied to determine if it is as effective as open surgery in complex operations. Laparoscopy is also being investigated as a screening tool for **ovarian cancer**.

Laparoscopy is widely used in procedures for noncancerous conditions that in the past required open surgery, such as removal of the appendix (**appendectomy**) and gallbladder removal (**cholecystectomy**).

Diagnostic procedure

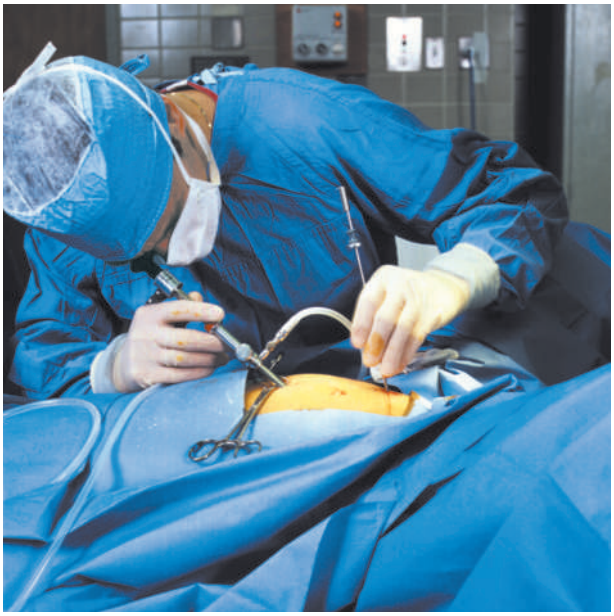
As a diagnostic procedure, laparoscopy is useful in taking biopsies of abdominal or pelvic growths, as well as lymph nodes. It allows the doctor to examine the abdominal area, including the female organs, appendix, gallbladder, stomach, and the liver.

Laparoscopy is used to determine the cause of pelvic **pain** or gynecological symptoms that cannot be confirmed by a physical exam or ultrasound. For example, **ovarian cysts**, **endometriosis**, **ectopic pregnancy**, or blocked fallopian tubes can be diagnosed using this procedure. It is an important tool when trying to determine the cause of **infertility**.

Operative procedure

While laparoscopic surgery to completely remove cancerous tumors, surrounding tissues, and lymph nodes is used on a limited basis, this type of operation is widely used in noncancerous conditions that once required open surgery. These conditions include:

- Tubal ligation. In this procedure, the fallopian tubes are sealed or cut to prevent subsequent pregnancies.
- Ectopic **pregnancy**. If a fertilized egg becomes embedded outside the uterus, usually in the fallopian tube, an operation must be performed to remove the developing embryo. This often can be done with laparoscopy.
- Endometriosis. This is a condition in which tissue from inside the uterus is found outside the uterus in other parts of (or on organs within) the pelvic cavity. This can cause cysts to form. Endometriosis is diagnosed with laparoscopy, and in some cases the cysts and other tissue can be removed during laparoscopy.
- Hysterectomy. This procedure to remove the uterus can, in some cases, be performed using laparoscopy. The uterus is cut away with the aid of the laparoscopic instruments and then the uterus is removed through the vagina.
- Ovarian masses. Tumors or cysts in the ovaries can be removed using laparoscopy.
- Appendectomy. This surgery to remove an inflamed appendix required open surgery in the past. It is now routinely performed with laparoscopy.



This surgeon is performing a laparoscopic procedure on a patient. *(Photo Researchers, Inc. Reproduced by permission.)*

- Cholecystectomy. Like appendectomy, this procedure to remove the gall bladder used to require open surgery. Now it can be performed with laparoscopy, in some cases.

In contrast to open abdominal surgery, laparoscopy usually involves less pain, less risk, less scarring, and faster recovery. Because laparoscopy is so much less invasive than traditional abdominal surgery, patients can leave the hospital sooner.

Cancer staging

Laparoscopy can be used in determining the spread of certain cancers. Sometimes it is combined with ultrasound. Although laparoscopy is a useful staging tool, its use depends on a variety of factors, which are considered for each patient. Types of cancers where laparoscopy may be used to determine the spread of the disease include:

- Liver cancer. Laparoscopy is an important tool for determining if cancer is present in the liver. When a patient has non-liver cancer, the liver is often checked to see if the cancer has spread there. Laparoscopy can identify up to 90% of malignant lesions that have spread to that organ from a cancer located elsewhere in the body. While computerized tomography (CT) can find cancerous lesions that are 0.4 in (10 mil) in size, laparoscopy is capable of locating lesions that are as small as 0.04 in (1 millimeter).
- Pancreatic cancer. Laparoscopy has been used to evaluate pancreatic cancer for years. In fact, the first reported use of laparoscopy in the United States was in a case involving pancreatic cancer.
- Esophageal and stomach cancers. Laparoscopy has been found to be more effective than **magnetic resonance imaging** (MRI) or computerized tomography (CT) in diagnosing the spread of cancer from these organs.
- **Hodgkin's disease**. Some patients with Hodgkin's disease have surgical procedures to evaluate lymph nodes for cancer. Laparoscopy is sometimes selected over laparotomy for this procedure. In addition, the spleen may be removed in patients with Hodgkin's disease. Laparoscopy is the standard surgical technique for this procedure, which is called a splenectomy.
- **Prostate cancer**. Patients with prostate cancer may have the nearby lymph nodes examined. Laparoscopy is an important tool in this procedure.

Cancer treatment

Laparoscopy is sometimes used as part of a palliative cancer treatment. This type of treatment is not a cure, but can often lessen the symptoms. An example is the feeding tube, which cancer patients may have if they are unable to take in food by mouth. The feeding tube provides **nutrition** directly into the stomach. Inserting the tube with a laparoscopy saves the patient the ordeal of open surgery.

Precautions

As with any surgury, patients should notify their physician of any medications they are taking (prescription, over-the-counter, or herbal) and of any **allergies**. Precautions vary due to the several different purposes for laparoscopy. Patients should expect to rest for several days after the procedure, and should set up a comfortable environment in their home (with items such as pain medication, heating pads, feminine products, comfortable clothing, and food readily accessible) prior to surgery.

Description

Laparoscopy is a surgical procedure that is done in the hospital under anesthesia. For diagnosis and biopsy, local anesthesia is sometimes used. In operative procedures, such as abdominal surgery, general anesthesia is required. Before starting the procedure, a catheter is inserted through the urethra to empty the bladder, and the skin of the abdomen is cleaned.

After the patient is anesthetized, a hollow needle is inserted into the abdomen in or near the navel, and carbon dioxide gas is pumped through the needle to expand

the abdomen. This allows the surgeon a better view of the internal organs. The laparoscope is then inserted through this incision to look at the internal organs. The image from the camera attached to the end of the laparoscope is seen on a video monitor.

Sometimes, additional small incisions are made to insert other instruments that are used to lift the tubes and ovaries for examination or to perform surgical procedures.

Preparation

Patients should not eat or drink after midnight on the night before the procedure.

Aftercare

After the operation, nurses will check the vital signs of patients who had general anesthesia. If there are no complications, the patient may leave the hospital within four to eight hours. (Traditional abdominal surgery requires a hospital stay of several days).

There may be some slight pain or throbbing at the incision sites in the first day or so after the procedure. The gas that is used to expand the abdomen may cause discomfort under the ribs or in the shoulder for a few days. Depending on the reason for the laparoscopy in gynecological procedures, some women may experience some vaginal bleeding. Many patients can return to work within a week of surgery and most are back to work within two weeks.

Risks

Laparoscopy is a relatively safe procedure, especially if the physician is experienced in the technique. The risk of complication is approximately 1%.

The procedure carries a slight risk of puncturing a blood vessel or organ, which could cause blood to seep into the abdominal cavity. Puncturing the intestines could allow intestinal contents to seep into the cavity. These are serious complications and major surgery may be required to correct the problem. For operative procedures, there is the possibility that it may become apparent that open surgery is required. Serious complications occur at a rate of only 0.2%.

Rare complications include:

- hemorrhage
- inflammation of the abdominal cavity lining
- abscess
- problems related to general anesthesia

Laparoscopy is generally not used in patients with certain heart or lung conditions, or in those who have some intestinal disorders, such as bowel obstruction.

KEY TERMS

Biopsy—Microscopic evaluation of a tissue sample. The tissue is closely examined for the presence of abnormal cells.

Cancer staging—Determining the course and spread of cancer.

Cyst—An abnormal lump or swelling that is filled with fluid or other material.

Palliative treatment—A type treatment that does not provide a cure, but eases the symptoms.

Tumor—A growth of tissue, benign or malignant, often referred to as a mass.

Normal results

In diagnostic procedures, normal results would indicate no abnormalities or disease of the organs or lymph nodes that were examined.

Abnormal results

A diagnostic laparoscopy may reveal cancerous or benign masses or lesions. Abnormal findings include tumors or cysts, infections (such as **pelvic inflammatory disease**), **cirrhosis**, endometriosis, fibroid tumors, or an accumulation of fluid in the cavity. If a doctor is checking for the spread of cancer, the presence of malignant lesions in areas other than the original site of malignancy is an abnormal finding.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Cunningham, F. Gary, Paul C. MacDonald, et al. *Williams Obstetrics,* 20th ed. Stamford, CT: Appleton & Lange, 1997.

Kurtz, Robert C., and Robert J. Ginsberg. "Cancer Diagnosis: Endoscopy." In *Cancer: Principles & Practice of Oncology.*, edited by Vincent T. DeVita Jr. Philadelphia: Lippincott, Williams & Wilkins, 2001, 725-27.

Lefor, Alan T. "Specialized Techniques in Cancer Management." In *Cancer: Principles & Practice of Oncology,* 6th ed., edited by Vincent T. DeVita Jr., et al. Philadelphia: Lippincott, Williams & Wilkins, 2001, 739-57.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology,* 6th ed. St. Louis: Mosby, 1997.

OTHER

Iannitti, David A. "The Role of Laparoscopy in the Management of Pancreatic Cancer." *Home Journal Library Index.*

23 March 2001. 27 June 2001 <http://bioscience.org/1998/v3/e/iannitti/e181-185.htm>.

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Laryngeal cancer

Definition

Laryngeal cancer is cancer of the larynx or voice box.

Description

The larynx is located where the throat divides into the esophagus and the trachea. The esophagus is the tube that takes food to the stomach. The trachea, or windpipe, takes air to the lungs. The area where the larynx is located is sometimes called the Adam's apple.

The larynx has two main functions. It contains the vocal cords, cartilage, and small muscles that make up the voice box. When a person speaks, small muscles tighten the vocal cords, narrowing the distance between them. As air is exhaled past the tightened vocal cords, it creates sounds that are formed into speech by the mouth, lips, and tongue.

The second function of the larynx is to allow air to enter the trachea and to keep food, saliva, and foreign material from entering the lungs. A flap of tissue called the epiglottis covers the trachea each time a person swallows. This blocks foreign material from entering the lungs. When not swallowing, the epiglottis retracts, and air flows into the trachea. During treatment for cancer of the larynx, both of these functions may be lost.

Cancers of the larynx develop slowly. About 95% of these cancers develop from thin, flat cells similar to skin cells called squamous epithelial cells. These cells line the larynx. Gradually, the squamous epithelial cells begin to change and are replaced with abnormal cells. These abnormal cells are not cancerous but are pre-malignant cells that have the potential to develop into cancer. This condition is called dysplasia. Most people with dysplasia never develop cancer. The condition simply goes away without any treatment, especially if the person with dysplasia stops smoking or drinking alcohol.

The larynx is made up of three parts, the glottis, the supraglottis, and the subglottis. Cancer can start in any of these regions. Treatment and survival rates depend on which parts of the larynx are affected and whether the cancer has spread to neighboring areas of the neck or distant parts of the body.

The glottis is the middle part of the larynx. It contains the vocal cords. Cancers that develop on the vocal cords are often diagnosed very early because even small vocal cord tumors cause hoarseness. In addition, the vocal cords have no connection to the lymphatic system. This means that cancers on the vocal cord do not spread easily. When confined to the vocal cords without any involvement of other parts of the larynx, the cure rate for this cancer is 75% to 95%.

The supraglottis is the area above the vocal cords. It contains the epiglottis, which protects the trachea from foreign materials. Cancers that develop in this region are usually not found as early as cancers of the glottis because the symptoms are less distinct. The supraglottis region has many connections to the lymphatic system, so cancers in this region tend to spread easily to the lymph nodes and may spread to other parts of the body (lymph nodes are small bean-shaped structures that are found throughout the body; they produce and store infection-fighting cells). In 25% to 50% of people with cancer in the supraglottal region, the cancer has already spread to the lymph nodes by the time they are diagnosed. Because of this, survival rates are lower than for cancers that involve only the glottis.

The subglottis is the region below the vocal cords. Cancer starting in the subglottis region is rare. When it does, it is usually detected only after it has spread to the vocal cords, where it causes obvious symptoms such as hoarseness. Because the cancer has already begun to spread by the time it is detected, survival rates are generally lower than for cancers in other parts of the larynx.

About 12,000 new cases of cancer of the larynx develop in the United States each year. Each year, about 3,900 die of the disease. Laryngeal cancer is between four and five times more common in men than in women. Almost all men who develop laryngeal cancer are over age 55. Laryngeal cancer is about 50% more common among African-American men than among other Americans.

It is thought that older men are more likely to develop laryngeal cancer than women because the two main risk factors for acquiring the disease are lifetime habits of smoking and alcohol abuse. More men are heavy smokers and drinkers than women, and more African-American men are heavy smokers than other men in the United States. However, as smoking becomes more prevalent among women, it seems likely that more cases of laryngeal cancer in females will be seen.

Causes and symptoms

Laryngeal cancer develops when the normal cells lining the larynx are replaced with abnormal cells (dys-

plasia) that become malignant and reproduce to form tumors. The development of dysplasia is strongly linked to life-long habits of smoking and heavy use of alcohol. The more a person smokes, the greater the risk of developing laryngeal cancer. It is unusual for someone who does not smoke or drink to develop cancer of the larynx. Occasionally, however, people who inhale asbestos particles, wood dust, paint or industrial chemical fumes over a long period of time develop the disease.

The symptoms of laryngeal cancer depend on the location of the tumor. Tumors on the vocal cords are rarely painful, but cause hoarseness. Anyone who is continually hoarse for more than two weeks or who has a cough that does not go away should be checked by a doctor.

Tumors in the supraglottal region above the vocal cords often cause more, but less distinct symptoms. These include:

- persistent sore throat
- pain when swallowing
- difficulty swallowing or frequent choking on food
- bad breath
- lumps in the neck
- persistent ear pain (called referred pain; the source of the pain is not the ear)
- change in voice quality

Tumors that begin below the vocal cords are rare, but may cause noisy or difficult breathing. All the symptoms above can also be caused other cancers as well as by less seriousness illnesses. However, if these symptoms persist, it is important to see a doctor and find their cause, because the earlier cancer treatment begins, the more successful it is.

Diagnosis

On the first visit to a doctor for symptoms that suggest laryngeal cancer, the doctor first takes a complete medical history, including family history of cancer and lifestyle information about smoking and alcohol use. The doctor also does a physical examination, paying special attention to the neck region for lumps, tenderness, or swelling.

The next step is examination by an otolaryngologist, or ear, nose, and throat (ENT) specialist. This doctor also performs a physical examination, but in addition will also want to look inside the throat at the larynx. Initially, the doctor may spray a local anesthetic on the back of the throat to prevent gagging, then use a long-handled mirror to look at the larynx and vocal cords. This examination is done in the doctor's office. It may cause gagging but is usually painless.

A more extensive examination involves a laryngoscopy. In a laryngoscopy, a lighted fiberoptic tube called a laryngoscope that contains a tiny camera is inserted through the patient's nose and mouth and snaked down the throat so that the doctor can see the larynx and surrounding area. This procedure can be done with a sedative and local anesthetic in a doctor's office. More often, the procedure is done in an outpatient surgery clinic or hospital under general anesthesia. This allows the doctor to use tiny clips on the end of the laryngoscope to take biopsies (tissue samples) of any abnormal-looking areas.

Laryngoscopies are normally painless and take about one hour. Some people find their throat feels scratchy after the procedure. Since laryngoscopies are done under sedation, patients should not drive immediately after the procedure, and should have someone available to take them home. Laryngoscopy is a standard procedure that is covered by insurance.

The locations of the samples taken during the laryngoscopy are recorded, and the samples are then sent to the laboratory where they are examined under the microscope by a pathologist who specializes in diagnosing diseases through cell samples and laboratory tests. It may take several days to get the results. Based on the findings of the pathologist, cancer can be diagnosed and staged.

Once cancer is diagnosed, other tests will probably be done to help determine the exact size and location of the tumors. This information is helpful in determining which treatments are most appropriate. These tests may include:

- Endoscopy. Similar to a laryngoscopy, this test is done when it appears that cancer may have spread to other areas, such as the esophagus or trachea.
- Computed tomography (CT or CAT) scan. Using x-ray images taken from several angles and computer modeling, CT scans allow parts of the body to be seen as a cross section. This helps locate and size the tumors, and provides information on whether they can be surgically removed.
- Magnetic resonance imaging (MRI). MRI uses magnets and radio waves to create more detailed cross-sectional scans than computed tomography. This detailed information is needed if surgery on the larynx area is planned.
- Barium swallow. Barium is a substance that, unlike soft tissue, shows up on x rays. Swallowed barium coats the throat and allows x-ray pictures to be made of the tissues lining the throat.
- Chest x ray. Done to determine if cancer has spread to the lungs. Since most people with laryngeal cancer are smokers, the risk of also having lung cancer or emphysema is high.

- Fine needle aspiration (FNA) biopsy. If any lumps on the neck are found, a thin needle is inserted into the lump, and some cells are removed for analysis by the pathologist.
- Additional blood and urine tests. These tests do not diagnose cancer, but help to determine the patient's general health and provide information to determine which cancer treatments are most appropriate.

Treatment

Staging

Once cancer of the larynx is found, more tests will be done to find out if cancer cells have spread to other parts of the body. This is called staging. A doctor needs to know the stage of the disease to plan treatment. In cancer of the larynx, the definitions of the early stages depend on where the cancer started.

STAGE I. The cancer is only in the area where it started and has not spread to lymph nodes in the area or to other parts of the body. The exact definition of stage I depends on where the cancer started, as follows:

- Supraglottis: The cancer is only in one area of the supraglottis and the vocal cords can move normally.
- Glottis: The cancer is only in the vocal cords and the vocal cords can move normally.
- Subglottis: The cancer has not spread outside of the subglottis.

STAGE II. The cancer is only in the larynx and has not spread to lymph nodes in the area or to other parts of the body. The exact definition of stage II depends on where the cancer started, as follows:

- Supraglottis: The cancer is in more than one area of the supraglottis, but the vocal cords can move normally.
- Glottis: The cancer has spread to the supraglottis or the subglottis or both. The vocal cords may or may not be able to move normally.
- Subglottis: The cancer has spread to the vocal cords, which may or may not be able to move normally.

STAGE III. Either of the following may be true:

- The cancer has not spread outside of the larynx, but the vocal cords cannot move normally, or the cancer has spread to tissues next to the larynx.
- The cancer has spread to one lymph node on the same side of the neck as the cancer, and the lymph node measures no more than 3 centimeters (just over 1 inch).

STAGE IV. Any of the following may be true:

- The cancer has spread to tissues around the larynx, such as the pharynx or the tissues in the neck. The lymph nodes in the area may or may not contain cancer.
- The cancer has spread to more than one lymph node on the same side of the neck as the cancer, to lymph nodes on one or both sides of the neck, or to any lymph node that measures more than 6 centimeters (over 2 inches).
- The cancer has spread to other parts of the body.

RECURRENT. Recurrent disease means that the cancer has come back (recurred) after it has been treated. It may come back in the larynx or in another part of the body.

Treatment

Treatment is based on the stage of the cancer as well as its location and the health of the individual. Generally, there are three types of treatments for cancer of the larynx. These are surgery, radiation, and chemotherapy. They can be used alone or in combination based in the stage of the caner. Getting a second opinion after the cancer has been staged can be very helpful in sorting out treatment options and should always be considered.

SURGERY. The goal of surgery is to cut out the tissue that contains malignant cells. There are several common surgeries to treat laryngeal cancer.

Stage III and stage IV cancers are usually treated with total laryngectomy. This is an operation to remove the entire larynx. Sometimes other tissues around the larynx are also removed. Total laryngectomy removes the vocal cords. Alternate methods of voice communication must be learned with the help of a speech pathologist. Laryngectomy is treated in depth as a separate entry in this volume.

Smaller tumors are sometimes treated by partial laryngectomy. The goal is to remove the cancer but save as much of the larynx (and corresponding speech capability) as possible. Very small tumors or cancer in situ are sometimes successfully treated with laser excision surgery. In this type of surgery, a narrowly-targeted beam of light from a laser is used to remove the cancer.

Advanced cancer (Stages III and IV) that has spread to the lymph nodes often requires an operation called a neck dissection. The goal of a neck dissection is to remove the lymph nodes and prevent the cancer from spreading. There are several forms of neck dissection. A radical neck dissection is the operation that removes the most tissue.

Several other operations are sometimes performed because of laryngeal cancer. A tracheotomy is a surgical procedure in which an artificial opening is made in the trachea (windpipe) to allow air into the lungs. This operation is necessary if the larynx is totally removed. A gas-

trectomy tube is a feeding tube placed through skin and directly into the stomach. It is used to give nutrition to people who cannot swallow or whose esophagus is blocked by a tumor. People who have a total laryngectomy usually do not need a gastrectomy tube if their esophagus remains intact.

RADIATION. Radiation therapy uses high-energy rays, such as x rays or gamma rays, to kill cancer cells. The advantage of radiation therapy is that it preserves the larynx and the ability to speak. The disadvantage is that it may not kill all the cancer cells. Radiation therapy can be used alone in early stage cancers or in combination with surgery. Sometimes it is tried first with the plan that if it fails to cure the cancer, surgery still remains an option. Often, radiation therapy is used after surgery for advanced cancers to kill any cells the surgeon might not have removed.

There are two types of radiation therapy. External beam radiation therapy focuses rays from outside the body on the cancerous tissue. This is the most common type of radiation therapy used to treat laryngeal cancer. With internal radiation therapy, also called brachytherapy, radioactive materials are placed directly on the cancerous tissue. This type of radiation therapy is a much less common treatment for laryngeal cancer.

External radiation therapy is given in doses called fractions. A common treatment involves giving fractions five days a week for seven weeks. Clinical trials are underway to determine the benefits of accelerating the delivery of fractions (accelerated fractionation) or dividing fractions into smaller doses given more than once a day (hyperfractionation). Side effects of radiation therapy include dry mouth, sore throat, hoarseness, skin problems, trouble swallowing, and diminished ability to taste.

CHEMOTHERAPY. Chemotherapy is the use of drugs to kill cancer cells. Unlike radiation therapy, which is targeted to a specific tissue, chemotherapy drugs are either taken by mouth or intravenously (through a vein) and circulate throughout the whole body. They are used mainly to treat advanced laryngeal cancer that is inoperable or that has metastasized to a distant site. Chemotherapy is often used after surgery or in combination with radiation therapy. Clinical trials are underway to determine the best combination of treatments for advanced cancer.

The two most common chemotherapy drugs used to treat laryngeal cancer are cisplatin and 5-fluorouracil (5-FU). There are many side effects associated with chemotherapy drugs, including nausea and vomiting, loss of appetite, hair loss, diarrhea, and mouth sores. Chemotherapy can also damage the blood-producing cells of the bone marrow, which can result in low blood cell counts, increased chance of infection, and abnormal bleeding or bruising.

KEY TERMS

Dysplasia—The abnormal change in size, shape or organization of adult cells.

Lymph—Clear, slightly yellow fluid carried by a network of thin tubes to every part of the body. Cells that fight infection are carried in the lymph.

Lymphatic system—Primary defense against infection in the body. The lymphatic system consists of tissues, organs, and channels (similar to veins) that produce, store, and transport lymph and white blood cells to fight infection.

Lymph nodes—Small, bean-shaped collections of tissue found in a lymph vessel. They produce cells and proteins that fight infection, and also filter lymph. Nodes are sometimes called lymph glands.

Metastasize—Spread of cells from the original site of the cancer to other parts of the body where secondary tumors are formed.

Malignant—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

Alternative treatment

Alternative and complementary therapies range from herbal remedies, vitamin supplements, and special diets to spiritual practices, acupuncture, massage, and similar treatments. When these therapies are used in addition to conventional medicine, they are called complementary therapies. When they are used instead of conventional medicine, they are called alternative therapies.

Complementary or alternative therapies are widely used by people with cancer. One large study published in the *Journal of Clinical Oncology* in July, 2000 found that 83% of all cancer patients studied used some form of complementary or alternative medicine as part of their cancer treatment. No specific alternative therapies have been directed toward laryngeal cancer. However, good nutrition and activities that reduce stress and promote a positive view of life have no unwanted side-effects and appear to be beneficial in boosting the immune system in fighting cancer.

Unlike traditional pharmaceuticals, complementary and alternative therapies are not evaluated by the United States Food and Drug Administration (FDA) for either safety or effectiveness. These therapies may have interactions with traditional pharmaceuticals. Patients should be wary of "miracle cures" and notify their doctors if

KEY TERMS

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they are using herbal remedies, vitamin supplements or other unprescribed treatments. Alternative and experimental treatments normally are not covered by insurance.

Prognosis

Cure rates and survival rates can predict group outcomes, but can never precisely predict the outcome for a single individual. However, the earlier laryngeal cancer is discovered and treated, the more likely it will be cured.

Cancers found in stage 0 and stage 1 have a 75% to 95% cure rate depending on the site. Late stage cancers that have metastasized have a very poor survival rate, with intermediate stages falling somewhere in between. People who have had laryngeal cancer are at greatest risk for recurrence (having cancer come back), especially in the head and neck, during the first two to three years after treatment. Check-ups during the first year are needed every other month, and four times a year during the second year. It is rare for laryngeal cancer to recur after five years of being cancer-free.

Prevention

By far, the most effective way to prevent laryngeal cancer is not to smoke. Smokers who quit smoking also significantly decrease their risk of developing the disease. Other ways to prevent laryngeal cancer include limiting the use of alcohol, eating a well-balanced diet, seeking treatment for prolonged heartburn, and avoiding inhaling asbestos and chemical fumes.

Resources

PERIODICALS

Ahmad, I., B.N. Kumar, K. Radford, J. O'Connell, and A.J. Batch. "Surgical Voice Restoration Following Ablative Surgery for Laryngeal and Hypopharyngeal Carcinoma." *Journal or Laryngology and Otolaryngology* 114 (July 2000): 522–5.

ORGANIZATIONS

American Cancer Society. National Headquarters, 1599 Clifton Rd. NE, Atlanta, GA 30329. 800 (ACS)-2345. <http://www.cancer.org>.

National Cancer Institute. Cancer Information Service. Bldg. 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800) 4-CANCER. <http://www.nci.nih.gov/cancerinfo/index.html>.

National Cancer Institute Office of Cancer Complementary and Alternative Medicine. <http://occam.nci.nih.gov>.

National Center for Complementary and Alternative Medicine. P. O. Box 8218, Silver Spring, MD 20907-8281. (888) 644-6226. <http://nccam.nih.gov>.

OTHER

"What you Need to Know About Cancer of the Larynx." CancerNet November 2000. 19 July 2001 <http://www.cancernet.nci.nih.gov>.

"Laryngeal Cancer." CancerNet 19 July 2001 <http://www.graylab.ac.uk/cancernet/201519.html#3_STAGE EXPLANATION>.

Tish Davidson, A.M.

Laryngectomy

Definition

Laryngectomy is the partial or complete surgical removal of the larynx, usually as a treatment for **cancer** of the larynx.

Purpose

Normally a laryngectomy is performed to remove tumors or cancerous tissue. In rare cases, it may be done when the larynx is badly damaged by gunshot, automobile injuries, or similar violent accidents. Laryngectomies can be total or partial. Total laryngectomies are done when cancer is advanced. The entire larynx is

removed. Often if the cancer has spread, other surrounding structures in the neck, such as lymph nodes, are removed at the same time. Partial laryngectomies are done when cancer is limited to one spot. Only the area with the tumor is removed. Laryngectomies may also be performed when other cancer treatment options, such as radiation or **chemotherapy**, fail.

Precautions

Laryngectomy is done only after cancer of the larynx has been diagnosed by a series of tests that allow the otolaryngologist (a specialist often called an ear, nose, and throat doctor) to look into the throat and take tissue samples (biopsies) to confirm and stage the cancer. People need to be in good general health to undergo a laryngectomy, and will have standard pre-operative blood work and tests to make sure they are able to safely withstand the operation.

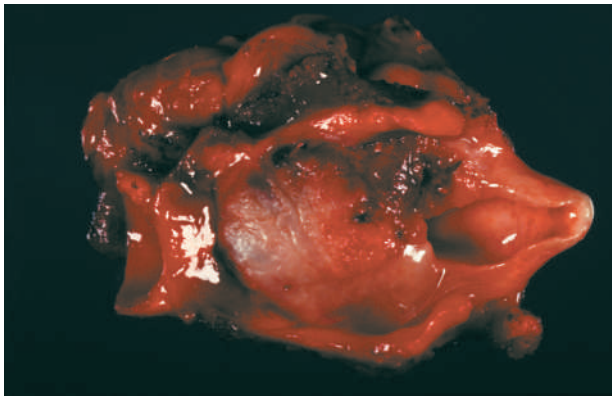
Description

The larynx is located slightly below the point where the throat divides into the esophagus, which takes food to the stomach, and the trachea (windpipe), which takes air to the lungs. Because of its location, the larynx plays a critical role in normal breathing, swallowing, and speaking. Within the larynx, vocal folds (often called vocal cords) vibrate as air is exhaled past, thus creating speech. The epiglottis protects the trachea, making sure that only air gets into the lungs. When the larynx is removed, these functions are lost.

Once the larynx is removed, air can no longer flow into the lungs. During this operation, the surgeon removes the larynx through an incision in the neck. The surgeon also performs a **tracheotomy**. He makes an artificial opening called a stoma in the front of the neck. The upper portion of the trachea is brought to the stoma and secured, making a permanent alternate way for air to get to the lungs. The connection between the throat and the esophagus is not normally affected, so after healing, the person whose larynx has been removed (called a laryngectomee) can eat normally. However, normal speech is no longer possible. Several alternate means of vocal communication can be learned with the help of a speech pathologist.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is thoroughly explained. Many patients prefer a second opinion, and some insurers require it. Blood and urine studies, along with **chest x ray** and EKG may be ordered as the doctor deems necessary. The patient also has a pre-operative meeting with an anesthesiologist. If a complete laryngectomy is planned, it may be helpful to meet with a speech pathologist and/or an established laryngectomee for discussion of post-operative expectations and support.



A pathology photograph of an extracted tumor found on the larynx. *(Custom Medical Stock Photo. Reproduced by permission.)*

Aftercare

A person undergoing a laryngectomy spends several days in intensive care (ICU) and receives intravenous (IV) fluids and medication. As with any major surgery, the blood pressure, pulse, and respirations are monitored regularly. The patient is encouraged to turn, **cough**, and deep breathe to help mobilize secretions in the lungs. One or more drains are usually inserted in the neck to remove any fluids that collect. These drains are removed after several days.

It takes two to three weeks for the tissues of the throat to heal. During this time, the laryngectomee cannot swallow food and must receive **nutrition** through a tube inserted through the nose and down the throat into the stomach. During this time, even people with partial laryngectomies are unable to speak.

When air is drawn in normally through the nose, it is warmed and moistened before it reaches the lungs. When air is drawn in through the stoma, it does not have the opportunity to be warmed and humidified. In order to keep the stoma from drying out and becoming crusty, laryngectomees are encouraged to breathe artificially humidified air. The stoma is usually covered with a light cloth to keep it clean and to keep unwanted particles from accidentally entering the lungs. Care of the stoma is extremely important, since it is the person's only way to get air to the lungs. After a laryngectomy, a healthcare professional will teach the laryngectomee and his or her caregivers how to care for the stoma.

KEY TERMS

Larynx—Also known as the voice box, the larynx is composed of cartilage that contains the apparatus for voice production. This includes the vocal cords and the muscles and ligaments that move the cords.

Lymph nodes—Accumulations of tissue along a lymph channel, which produce cells called lymphocytes that fight infection.

Tracheostomy—A surgical procedure in which an artificial opening is made in the trachea (windpipe) to allow air into the lungs.

Immediately after a laryngectomy, an alternate method of communication such as writing notes, gesturing, or pointing must be used. A partial laryngectomy patient will gradually regain some speech several weeks after the operation, but the voice may be hoarse, weak, and strained. A speech pathologist will work with a complete laryngectomee to establish new ways of communicating.

There are three main methods of vocalizing after a total laryngectomy. In esophageal speech the laryngectomee learns how to "swallow" air down into the esophagus and creates sounds by releasing the air. This method requires quite a bit of coordination and learning, and produces short bursts (seven or eight syllables) of low-volume sound.

Tracheoesophageal speech diverts air through a hole in the trachea made by the surgeon. The air then passes through an implanted artificial voice prosthesis (a small tube that makes a sound when air goes through it). Recent advances have been made in implanting voice prostheses that produce good voice quality.

The third method of artificial sound communication involves using a hand-held electronic device that translates vibrations into sounds. There are several different styles of these devices, but all require the use of at least one hand to hold the device to the throat. The choice of which method to use depends on many things including the age and health of the laryngectomee, and whether other parts of the mouth, such as the tongue, have also been removed.

Many patients resume daily activities after surgery. Special precautions must be taken during showering or shaving. Special instruction and equipment is also required for those who wish to swim or water ski, as it is dangerous for water to enter the windpipe and lungs through the stoma.

Regular follow-up visits are important following treatment for cancer of the larynx because there is a higher-than-average risk of developing a new cancer in the mouth, throat, or other regions of the head or neck. Many self-help and support groups are available to help patients meet others who face similar problems.

Risks

Laryngectomy is often successful in curing early stage cancers. However it does cause lifestyle changes. Laryngectomees must learn new ways of speaking. They must be continually concerned about the care of their stoma. Serious infections can occur if water or other foreign material enters the lungs through an unprotected stoma. Also, women who undergo partial laryngectomy or who learn some types of artificial speech will have a deep voice similar to that of a man. For some women this presents psychological challenges.

Normal results

Ideally, removal of the larynx will remove all cancerous material. The person will recover from the operation, make lifestyle adjustments, and return to an active life.

Abnormal results

Sometimes cancer has spread to surrounding tissues and it is necessary to remove lymph nodes, parts of the tongue, or other cancerous tissues. As with any major operation, post- surgical infection is possible. Infection is of particular concern to laryngectomees who have chosen to have a voice prosthesis implanted, and is one of the major reasons for having to remove the device.

Resources

BOOKS

Monahan, Frances. *Medical-Surgical Nursing*. Philadelphia: W. B. Saunders Company, 1998.

ORGANIZATIONS

American Cancer Society. National Headquarters, 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS -2345.<http://www.cancer.org>.

Cancer Information Service. National Cancer Institute, Building 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800)4-CANCER. <http://www.nci.nih.gov/cancerinfo/index.html>.

International Association of Laryngectomees(IAL). <http://www.larynxlink.com/>.

National Institute on Deafness and Other Communication Disorders. National Institutes of Health, 31 Center Drive, MSC 2320, Bethesda, MD 20892-2320. <http://www.nidcd.nih.gov>.

The Voice Center at Eastern Virginia Medical School. Norfolk, VA 23507 <http://www.voice-center.com>.

Kathleen Dredge Wright
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Laryngitis

Definition

Laryngitis is caused by inflammation of the larynx, resulting in hoarseness of the voice.

Description

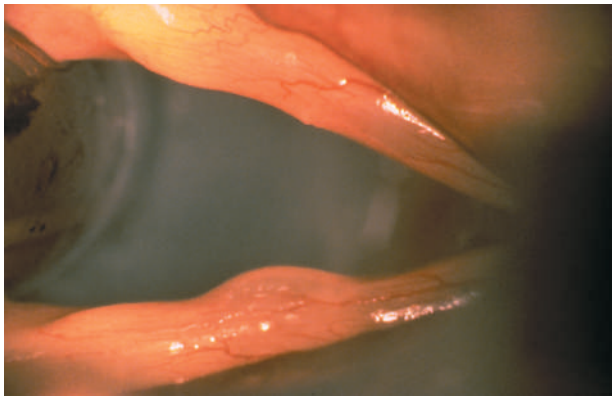
When air is breathed in (inspired), it passes through the nose and the nasopharynx or through the mouth and the oropharynx. These are both connected to the larynx, a tube made of cartilage. The vocal cords, responsible for setting up the vibrations necessary for speech, are located within the larynx. The air continues down the larynx to the trachea. The trachea then splits into two branches, the left and right bronchi (bronchial tubes). These bronchi branch into smaller air tubes which run within the lungs, leading to the small air sacs of the lungs (alveoli).

Either food, liquid, or air may be taken in through the mouth. While air goes into the larynx and the respiratory system, food and liquid are directed into the tube leading to the stomach, the esophagus. Because food or liquid in the bronchial tubes or lungs could cause a blockage or lead to an infection, the airway must be protected. The epiglottis is a leaf-like piece of cartilage extending upwards from the larynx. The epiglottis can close down over the larynx when someone is eating or drinking, preventing these substances from entering the airway.

In laryngitis, the tissues below the level of the epiglottis are swollen and inflamed. This causes swelling around the area of the vocal cords, so that they cannot vibrate normally. A hoarse sound to the voice is very characteristic of laryngitis. Laryngitis is a very common problem, and often occurs during the course of an upper respiratory tract infection (cold).

Causes and symptoms

Laryngitis is caused almost 100% of the time by a virus. The same viruses which cause the majority of simple upper respiratory infections (colds, etc.) are responsible for laryngitis. These include parainfluenzae virus, **influenza** virus, respiratory syncytial virus, rhinovirus, coronavirus, and echovirus. Extremely rarely, bacteria such as Group A streptococcus, M. catarrhalis, or that which causes **tuberculosis** may cause laryngitis. In people with faulty immune systems (particular due to acquired **immunodeficiency** syndrome, or **AIDS**), infections with fungi may be responsible for laryngitis.



An endoscopic view of a patient's vocal cords with laryngitis. *(Custom Medical Stock Photo. Reproduced by permission.)*

Symptoms usually begin along with, or following, symptoms of a cold. A sore, scratchy throat, **fever**, runny nose, achiness, and **fatigue** may all occur. Difficulty swallowing sometimes occurs with **streptococcal infections**. The patient may **cough** and wheeze. Most characteristically, the patient's voice will sound strained, hoarse, and raspy.

In extremely rare cases, the swelling of the larynx may cause symptoms of airway obstruction. This is more common in infants, because the diameter of their airways is so small. In that case, the baby may have a greatly increased respiratory rate, and exhibit loud high-pitched sounds with breathing (called **stridor**).

Diagnosis

Diagnosis is usually made by learning the history of a cold followed by hoarseness. The throat usually appears red and somewhat swollen. Listening to the chest and back with a stethoscope may reveal some harsh **wheezing** sounds with inspiration (breathing in).

In long-standing (chronic laryngitis), tuberculosis may be suspected. Using a scope called a laryngoscope, examination of the airway will show redness, swelling, small bumps of tissue called nodules, and irritated pits in the tissue called ulcerations. Special skin testing (TB testing) will reveal that the individual has been exposed to the bacteria causing TB.

Treatment

Treatment of a simple, viral laryngitis simply addresses the symptoms. Gargling with warm salt water, **pain** relievers such as **acetaminophen**, the use of vaporizers to

KEY TERMS

Epiglottis—A leaf-like piece of cartilage extending upwards from the larynx, which can close like a lid over the trachea to prevent the airway from receiving any food or liquid being swallowed.

Larynx—The part of the airway lying between the pharynx and the trachea.

Nasopharynx—The part of the airway into which the nose leads.

Oropharynx—The part of the airway into which the mouth leads.

Trachea—The part of the airway which leads into the bronchial tubes.

create moist air, and rest will help the illness resolve within a week.

In an infant who is clearly struggling for air, it may be necessary to put in an artificial airway for a short period of time. This is very rarely needed.

An individual with tubercular laryngitis is treated with a combination of medications used to treat classic TB. In people with fungal laryngitis, a variety of antifungal medications are available.

Alternative treatment

Alternative treatments include **aromatherapy** inhalations made with benzoin, lavender, frankincense, thyme, and sandalwood. Decoctions (extracts made by boiling an herb in water) or infusions (extracts made by steeping an herb in boiling water) can be made with red sage (*Salvia officinalis* var. *rubra*) and yarrow (*Achillea millefolium*) or with licorice (*Glycyrrhiza glabra*). These are used for gargling, and are said to reduce pain. **Echinacea** (*Echinacea* spp.) tincture taken in water every hour for 48 hours is recommended to boost the immune system. Antiviral herbs, including usnea (*Usnea* spp.), lomatium (*Lomatium dissectum*), and ligusticum (*Ligusticum porteri*), may help hasten recovery from laryngitis. Homeopathic remedies are recommended based on the patient's symptoms. Some people may get relief from placing cold compresses on the throat.

Prognosis

Prognosis for laryngitis is excellent. Recovery is complete, and usually occurs within a week's time.

Prevention

Prevention of laryngitis is the same as for any upper respiratory infections. The only way to even attempt to prevent such illnesses is by good handwashing, and by avoiding situations where one might come in contact with people who might be sick. However, even with relatively good hygiene practices, most people will get about five to six colds per year. It is unpredictable which of these may lead to laryngitis.

Resources

BOOKS

Durand, Marlene, et al. "Laryngitis, Croup, and Epiglottitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Orenstein, David. "Acute Inflammatory Upper Airway Obstruction." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Middle and Lower Respiratory Tract Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Rosalyn Carson-DeWitt, MD

Laryngoscopy

Definition

Laryngoscopy refers to a procedure used to view the inside of the larynx (the voice box).

Description

The purpose and advantage of seeing inside the larynx is to detect tumors, foreign bodies, nerve or structural injury, or other abnormalities. Two methods allow the larynx to be seen directly during the examination. In one, a flexible tube with a fiber-optic device is threaded through the nasal passage and down into the throat. The other method uses a rigid viewing tube passed directly from the mouth, through the throat, into the larynx. A light and lens affixed to the endoscope are used in both methods. The endoscopic tube may also be equipped to suction debris or remove material for biopsy. **Bronchoscopy** is a similar,

KEY TERMS

Endoscopic tube—a tube that is inserted into a hollow organ permitting a physician to see the inside it.

but more extensive procedure in which the tube is continued through the larynx, down into the trachea and bronchi.

Preparation

Laryngoscopy is done in the hospital with a local anesthetic spray to minimize discomfort and suppress the gag reflex. Patients are requested not to eat for several hours before the examination.

Aftercare

If the throat is sore, soothing liquids or lozenges will probably relieve any temporary discomfort.

Risks

This procedure carries no serious risks, although the patient may experience soreness of the throat or **cough** up small amounts of blood until the irritation subsides.

Normal results

A normal result would be the absence of signs of disease or damage.

Abnormal results

An abnormal finding, such as a tumor or an object lodged in the tissue, would either be removed or described for further medical attention.

Jill S. Lasker

Larynx removal *see* **Laryngectomy**

Laser-assisted in-situ keratomileusis *see* **Photorefractive keratectomy and laser-assisted in-**

Laser surgery

Definition

Laser (light amplification by stimulated emission of radiation) surgery uses an intensely hot, precisely focused beam of light to remove or vaporize tissue and control bleeding in a wide variety of non-invasive and minimally invasive procedures.

Purpose

Laser surgery is used to:

- cut or destroy tissue that is abnormal or diseased without harming healthy, normal tissue
- shrink or destroy tumors and lesions
- cauterize (seal) blood vessels to prevent excessive bleeding

Precautions

Anyone who is thinking about having laser surgery should ask his doctor to:

- explain why laser surgery is likely to be more beneficial than traditional surgery
- describe his experience in performing the laser procedure the patient is considering

Because some lasers can temporarily or permanently discolor the skin of Blacks, Asians, and Hispanics, a dark-skinned patient should make sure that his surgeon has successfully performed laser procedures on people of color.

Some types of laser surgery should not be performed on pregnant women or on patients with severe cardiopulmonary disease or other serious health problems.

Description

The first working laser was introduced in 1960. The device was initially used to treat diseases and disorders of the eye, whose transparent tissues gave ophthalmic surgeons a clear view of how the narrow, concentrated beam was being directed. Dermatologic surgeons also helped pioneer laser surgery, and developed and improved upon many early techniques and more refined surgical procedures.

Types of lasers

The three types of lasers most often used in medical treatment are the:

- Carbon dioxide (CO_2) laser. Primarily a surgical tool, this device converts light energy to heat strong enough to minimize bleeding while it cuts through or vaporizes tissue.
- Neodymium:yttrium-aluminum-garnet (Nd:YAG) laser. Capable of penetrating tissue more deeply than other lasers, the Nd:YAG makes blood clot quickly and can enable surgeons to see and work on parts of the body

that could otherwise be reached only through open (invasive) surgery.

- Argon laser. This laser provides the limited penetration needed for eye surgery and superficial skin disorders. In a special procedure known as photodynamic therapy (PDT), this laser uses light-sensitive dyes to shrink or dissolve tumors.

Laser applications

Sometimes described as "scalpels of light," lasers are used alone or with conventional surgical instruments in a diverse array of procedures that:

- improve appearance
- relieve **pain**
- restore function
- save lives

Laser surgery is often standard operating procedure for specialists in:

- cardiology
- dentistry
- dermatology
- gastroenterology (treatment of disorders of the stomach and intestines)
- gynecology
- neurosurgery
- oncology (**cancer** treatment)
- ophthalmology (treatment of disorders of the eye)
- orthopedics (treatment of disorders of bones, joints, muscles, ligaments, and tendons)
- otolaryngology (treatment of disorders of the ears, nose, and throat)
- pulmonary care (treatment of disorders of the respiratory system
- urology (treatment of disorders of the urinary tract and of the male reproductive system)

Routine uses of lasers include erasing **birthmarks**, skin discoloration, and skin changes due to **aging**, and removing benign, precancerous, or cancerous tissues or tumors. Lasers are used to stop **snoring**, remove tonsils, remove or transplant hair, and relieve pain and restore function in patients who are too weak to undergo major surgery. Lasers are also used to treat:

- angina (chest pain)
- cancerous or non-cancerous tumors that cannot be removed or destroyed
- cold and **canker sores**, gum disease, and tooth sensitivity or decay
- ectopic **pregnancy** (development of a fertilized egg outside the uterus)
- endometriosis
- fibroid tumors
- gallstones
- glaucoma, mild-to-moderate nearsightedness and **astigmatism**, and other conditions that impair sight
- migraine headaches
- non-cancerous enlargement of the prostate gland
- nosebleeds
- ovarian cysts
- ulcers
- varicose veins
- warts
- and numerous other conditions, diseases, and disorders

Advantages of laser surgery

Often referred to as "bloodless surgery," laser procedures usually involve less bleeding than conventional surgery. The heat generated by the laser keeps the surgical site free of germs and reduces the risk of infection. Because a smaller incision is required, laser procedures often take less time (and cost less money) than traditional surgery. Sealing off blood vessels and nerves reduces bleeding, swelling, scarring, pain, and the length of the recovery period.

Disadvantages of laser surgery

Although many laser surgeries can be performed in a doctor's office rather than in a hospital, the person guiding the laser must be at least as thoroughly trained and highly skilled as someone performing the same procedure in a hospital setting. The American Society for Laser Medicine and Surgery, Inc. urges that:

- all operative areas be equipped with oxygen and other drugs and equipment required for **cardiopulmonary resuscitation** (**CPR**)
- non-physicians performing laser procedures be properly trained, licensed, and insured
- a qualified and experienced supervising physician be able to respond to and manage unanticipated events or other emergencies within five minutes of the time they occur
- emergency transportation to a hospital or other acute-care facility be available whenever laser surgery is performed in a non-hospital setting

Cosmetic laser surgery in progress. The wavelengths of the laser's light can be matched to a specific target, enabling the physician to destroy the capillaries near the skin's surface without damaging the surrounding tissue. *(Photograph by Will & Deni McIntyre, Photo Researchers, Inc. Reproduced by permission.)*

Imprecisely aimed lasers can burn or destroy healthy tissue.

Preparation

Because laser surgery is used to treat so many dissimilar conditions, the patient should ask his physician for detailed instructions about how to prepare for a specific procedure. Diet, activities, and medications may not have to be limited prior to surgery, but some procedures require a **physical examination** and a medical history that:

- determines the patient's general health and current medical status
- describes how the patient has responded to other illnesses, hospital stays, and diagnostic or therapeutic procedures
- clarifies what the patient expects the outcome of the procedure to be

Aftercare

Most laser surgeries can be performed on an outpatient basis, and patients are usually permitted to leave the hospital or medical office when their vital signs have stabilized. A patient who has been sedated should not be discharged:

- until he has recovered from the anesthesia and knows who and where he is
- unless he is accompanied by a responsible adult

The doctor may prescribe analgesic (pain-relieving) medication, and should provide easy-to-understand written instructions that describe how the patient's recovery should progress and what to do in case complications or emergency arise.

Risks

Like traditional surgery, laser surgery can be complicated by:

- hemorrhage
- infection
- perforation (piercing) of an organ or tissue

Laser surgery can also involve risks that are not associated with traditional surgical procedures. Being

KEY TERMS

Argon—A colorless, odorless gas.

Astigmatism—A condition in which one or both eyes cannot filter light properly and images appear blurred and indistinct.

Canker sore—A blister-like sore on the inside of the mouth that can be painful but is not serious.

Carbon dioxide—A heavy, colorless gas that dissolves in water.

Cardiopulmonary resuscitation—An emergency procedure used to restore circulation and prevent brain death to a person who has collapsed, is unconscious, is not breathing, and has no pulse.

Cauterize—To use heat or chemicals to stop bleeding, prevent the spread of infection, or destroy tissue.

Cornea—The outer, transparent lens that covers the pupil of the eye and admits light.

Endometriosis—An often painful gynecologic condition in which endometrial tissue migrates from the inside of the uterus to other organs inside and beyond the abdominal cavity.

Glaucoma—A disease of the eye in which increased pressure within the eyeball can cause gradual loss of vision.

Invasive surgery—A form of surgery that involves making an incision in the patient's body and inserting instruments or other medical devices into it.

Nearsightedness—A condition in which one or both eyes cannot focus normally, causing objects at a distance to appear blurred and indistinct. Also called myopia.

Ovarian cyst—A benign or malignant growth on an ovary. An ovarian cyst can disappear without treatment or become extremely painful and have to be surgically removed.

Vaporize—To dissolve solid material or convert it into smoke or gas.

Varicose veins—Swollen, twisted veins, usually occurring in the legs, that occur more often in women than in men.

careless or not practicing safe surgical techniques can severely burn the patient's lungs or even cause them to explode. Patients must wear protective eye shields while undergoing laser surgery on any part of the face near the eyes or eyelids, and the United States Food and Drug Administration (FDA) has said that both doctors and patients must use special protective eyewear whenever a CO2 laser is used.

Laser beams can burn or destroy healthy tissue, cause injuries that are painful and sometimes permanent, and actually compound problems they are supposed to solve. Errors or inaccuracies in laser surgery can worsen a patient's vision, for example, and lasers can scar and even change the skin color of some patients.

Normal results

The nature and severity of the problem, the skill of the surgeon performing the procedure, and the patient's general health and realistic expectations are among the factors that influence the outcome of laser surgery. Successful procedures can enable patients to:

- feel better
- look younger
- enjoy longer, fuller, more active lives

A patient who is considering any kind of laser surgery should ask his doctor to provide detailed information about what the outcome of the surgery is expected to be, what the recovery process will involve, and how long it will probably be before he regains a normal appearance and can resume his normal activities.

Abnormal results

A person who is considering any type of laser surgery should ask his doctor to provide specific and detailed information about what could go wrong during the procedure and what the negative impact on the patient's health or appearance might be.

Lighter or darker skin may appear, for example, when a laser is used to remove sun damage or age spots from an olive-skinned or dark-skinned individual. This abnormal pigmentation may or may not disappear in time.

Scarring or rupturing of the cornea is uncommon, but laser surgery on one or both eyes can:

- increase sensitivity to light or glare
- reduce night vision

- permanently cloud vision, or cause sharpness of vision to decline throughout the day

Signs of infection following laser surgery include:

- burning
- crusting of the skin
- itching
- pain
- scarring
- severe redness
- swelling

Resources

BOOKS

Carlson, Karen J., et al. *The Harvard Guide to Women's Health*. Cambridge, Massachusetts: Harvard University Press, 1996.

PERIODICALS

"Laser Procedures for Nearsightedness." *FDA Consumer* (Jan./Feb. 1996): 2.
"Laser Resurfacing Slows the Hands of Time." *Harvard Health Letter* (Aug. 1996): 4-5.
"Lasers." *Mayo Clinic Health Letter* (July 1994): 1-3.
"Lasers: Bright Lights of the Medical World." *Cosmopolitan*, May 1995, 262-265.
"Lasers for Skin Surgery." *Harvard Women's Health Watch* (Mar. 1997): 2-3.
"Lasers — Hope or Hype?" *American Health* (June 1994): 68-72, 103.
"The Light Fantastic." *Helix* (Winter 1989): 3-9.
"New Cancer Therapies That Ease Pain, Extend Life." *Cancer Smart* (June 1997): 8-10.
"New Laser Surgery for Angina." *HealthNews* (6 May 1997): 3-4.
"Saving Face." *Essence*, Aug. 1997, 24, 26, 28.
"Under the Gun." *Mirabella*, Jan./Feb. 1996, 108-110.
"What a Laser Can and Cannot Do." *San Jose Mercury News*, Feb. 1994, 22, 24.

ORGANIZATIONS

American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asds-net.org>.
American Society for Laser Medicine and Surgery. 2404 Stewart Square, Wausau, WI 54401.(715) 845-9283. <http://www.aslms.org>.
Cancer Information Service. (800) 422-6237.
National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

OTHER

Haggerty, Maureen. "ASLMS Guidelines for Office-Based Laser Procedures." A Healthy Me Page. 19 Mar. 1998 <http://www.ahealthyme.com/topic/topic100587070>.
"Facts About Laser Surgery." Glaucoma Research Foundation Page. 12 Mar. 1998 <http://www.glaucoma.org/fs-laser-sur.html>.
"Refractive Eye Surgery." Mayo Clinic Online. 15 Mar. 1998 <http://www.mayohealth.org/mayo/9707/htm/refract.htm>.
"What is Laser?" The American Society for Dermatologic Surgery Page. 19 Mar. 1998 <http://www.asds-net.org>.

Maureen Haggerty

LASIK *see* **Photorefractive keratectomy and laser-assisted in-**

Lassa fever *see* **Hemorrhagic fevers**

Laxatives

Definition

Laxatives are products that promote bowel movements.

Purpose

Laxatives are used to treat constipation—the passage of small amounts of hard, dry stools, usually fewer than three times a week. Before recommending use of laxatives, differential diagnosis should be performed. Prolonged **constipation** may be evidence of a significant problem, such as localized **peritonitis** or diverticulitis. Complaints of constipation may be associated with **obsessive-compulsive disorder**. Use of laxatives should be avoided in these cases. Patients should be aware that patterns of defecation are highly variable, and may vary from two to three times daily to two to three times weekly.

Laxatives may also be used prophylacticly for patients, such as those recovering from a myocardial infarction or those who have had recent surgery, who should not strain during defecation.

Description

Laxatives may be grouped by mechanism of action.

Saline cathartics include dibasic sodium phosphate (Phospo-Soda), magnesium citrate, magnesium hydroxide (milk of magnesia), magnesium sulfate (Epsom salts), sodium biphosphate, and others. They act by attracting and holding water in the intestinal lumen, and may produce a watery stool. Magnesium sulfate is the most potent of the laxatives in this group.

Stimulant and irritant laxatives increase the peristaltic movement of the intestine. Examples include cas-

KEY TERMS

Carbohydrates—Compounds, such as cellulose, sugar, and starch, that contain only carbon, hydrogen, and oxygen, and are a major part of the diets of people and other animals.

Cathartic colon— A poorly functioning colon, resulting from the chronic abuse of stimulant cathartics.

Colon—The large intestine.

Diverticulitis—Inflammation of the part of the intestine known as the diverticulum.

Fiber—Carbohydrate material in food that cannot be digested.

Hyperosmetic—Hypertonic, containing a higher concentration of salts or other dissolved materials than normal tissues.

Osteomalacia—A disease of adults, characterized by softening of the bone. Similar to Rickets which is seen in children.

Pregnancy category— A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Steatorrhea— An excess of fat in the stool.

Stool—The solid waste that is left after food is digested. Stool forms in the intestines and passes out of the body through the anus.

cara and bisadocyl (Dulcolax.) Castor oil works in a similar fashion.

Bulk producing laxatives increase the volume of the stool, and will both soften the stool and stimulate intestinal motility. Psyillium (Metamucil, Konsil) and methylcellulose (Citrucel) are examples of this type. The overall effect is similar to that of eating high-fiber foods, and this class of laxative is most suitable for regular use.

Docusate (Colace) is the only representative example of the stool softener class. It holds water within the fecal mass, providing a larger, softer stool. Docusate has no effect on acute constipation, since it must be present before the fecal mass forms to have any effect, but may be useful for prevention of constipation in patients with recurrent problems, or those who are about to take a constipating drug, such as narcotic **analgesics**.

Mineral oil is an emollient laxative. It acts by retarding intestinal absorption of fecal water, thereby softening the stool.

The hyperosmotic laxatives are glycerin and lactulose (Chronulac, Duphalac), both of which act by holding water within the intestine. Lactulose may also increase peristaltic action of the intestine.

Recommended dosage

See specific products.

Precautions

Short term use of laxatives is generally safe except in **appendicitis**, fecal impaction, or intestinal obstruction. Lactulose is composed of two sugar molecules; galactose and fructose, and should not be administered to patients who require a low galactose diet.

Chronic use of laxatives may result in fluid and electrolyte imbalances, steatorrhea, osteomalacia, **diarrhea**, cathartic colon, and liver disease. Excessive intake of mineral oil may cause impaired absorption of oil soluble **vitamins**, particularly A and D. Excessive use of magnesium salts may cause hypermanesemia.

Lactulose and magnesium sulfate are **pregnancy** category B. Casanthranol, cascara sagrada, danthron, docusate sodium, docusate calcium, docusate potassium, mineral oil and senna are category C. Casanthranol, cascara sagrada and danthron are excreted in breast milk, resulting in a potential increased incidence of diarrhea in the nursing infant.

Interactions

Mineral oil and docusate should not be used in combination. Docusate is an emulsifying agent which will increase the absorption of mineral oil.

Bisacodyl tablets are enteric coated, and so should not be used in combination with **antacids**. The antacids will cause premature rupture of the enteric coating.

Resources

PERIODICALS

"Constipation, Laxatives and Dietary Fiber." *HealthTips* (April 1993): 9.

"Overuse Hazardous: Laxatives Rarely Needed." (Includes related article on types of laxatives.) *FDA Consumer* (April 1991): 33.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. nddic@aerie.com. <http://www.niddk.nih.gov/Brochures/NDDIC.htm.

Samuel D. Uretsky, PharmD

Lazy eye *see* **Amblyopia**

LCM *see* **Lymphocytic choriomeningitis**

LDH isoenzymes test *see* **Lactate dehydrogenase isoenzymes test**

LDH test *see* **Lactate dehydrogenase test**

Lead poisoning

Definition

Lead **poisoning** occurs when a person swallows or inhales lead in any form. The result can be damage to the brain, nerves, and many other parts of the body. Acute lead poisoning, which is relatively rare, occurs when a large amount of lead is taken into the body over a short period of time. Chronic lead poisoning, which is a common problem in children, occurs when small amounts of lead are taken in over a longer period.

Description

Lead can damage almost every system in the human body, and it can also cause high blood pressure (**hypertension**). It is particularly harmful to the developing brain of fetuses and young children. The higher the level of lead in a child's blood, and the longer this elevated level lasts, the greater the chance of ill effects. Over the long term, lead poisoning in a child can lead to learning disabilities, behavior problems, and even **mental retardation**. At very high levels, lead poisoning can cause seizures, **coma**, and even **death**.

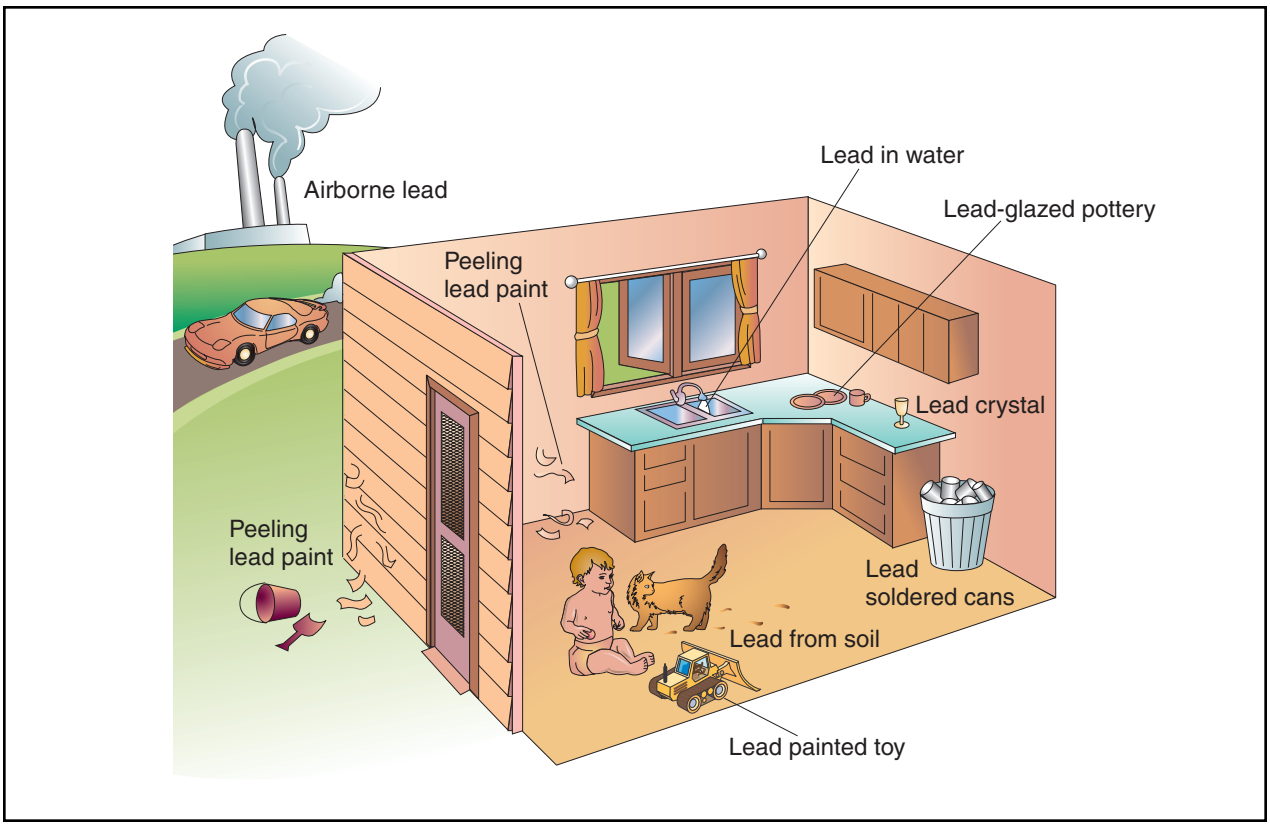
About one out of every six children in the United States has a high level of lead in the blood, according to the Agency for Toxic Substances and Disease Registry. Many of these children are exposed to lead through peeling paint in older homes. Others are exposed through dust or soil that has been contaminated by old paint or past emissions of leaded gasoline. Since children between the ages of 12-36 months are apt to put things in their mouths, they are more likely than older children to take in lead. Pregnant women who come into contact with lead can pass it along to the fetus.

Over 80% of American homes built before 1978 have lead-based paint in them, according to the Centers for Disease Control and Prevention (CDC). The older the home, the more likely it is to contain lead paint, and the higher the concentration of lead in the paint is apt to be. Some homes also have lead in the water pipes or plumbing. People may have lead in the paint, dust, or soil around their homes or in their drinking water without knowing it, since lead can't be seen, smelled, or tasted. Because lead doesn't break down naturally, it can continue to cause problems until it is removed.

Causes and symptoms

Before scientists knew how harmful it could be, lead was widely used in paint, gasoline, water pipes, and many other products. Today house paint is almost lead-free, gasoline is unleaded, and household plumbing is no longer made with lead materials. Still, remnants of the old hazards remain. Following are some sources of lead exposure:

- Lead-based paint. This is the most common source of exposure to large amounts of lead among preschoolers. Children may eat paint chips from older homes that have fallen into disrepair. They may also chew on painted surfaces such as windowsills. In addition, paint may be disturbed during remodeling.
- Dust and soil. These can be contaminated with lead from old paint or past emissions of leaded gasoline. In addition, pollution from operating or abandoned industrial sites and smelters can find its way into the soil, resulting in soil contamination.
- Drinking water. Exposure may come from lead water pipes, found in many homes built before 1930. Even newer copper pipes may have lead solder. Also, some new homes have brass faucets and fittings that can leach lead.
- Jobs and hobbies. A number of activities can expose participants to lead. These include making pottery or stained glass, refinishing furniture, doing home repairs, and using indoor firing ranges. When adults take part in such activities, they may inadvertently expose children to lead residue that is on their clothing or on scrap materials.



Continuous exposure to lead can damage nearly every system in the human body and is particularly harmful to the developing brain of fetuses and young children. Common sources of lead exposure include lead-based paint, dust and soil, drinking water, food from cans, and eating utensils, such as plates and drinking glasses, that are lead-based. *(Illustration by Electronic Illustrators Group.)*

- Food. Imported food cans often have lead solder. Also, lead is found in leaded crystal glassware and some imported or old ceramic dishes. In addition, food may be contaminated by lead in the water or soil.
- Folk medicines. Certain folk medicines (for example, alarcon, alkohl, azarcon, bali goli, coral, ghasard, greta, liga, pay-loo-ah, and rueda) and traditional cosmetics (kohl, for example) contain large amounts of lead.

Chronic lead poisoning

New evidence suggests that lead may be harmful to children even at low levels that were once thought to be safe, and the risk of damage rises as blood levels of lead increase. The symptoms of chronic lead poisoning take time to develop, however. Children can appear healthy despite having high levels of lead in their blood. Over time, though, problems such as the following may arise:

- learning disabilities
- hyperactivity
- mental retardation
- slowed growth
- hearing loss
- headaches

Lead poisoning is also harmful to adults, in whom it can cause high blood pressure, digestive problems, nerve disorders, memory loss, and muscle and joint **pain**. In addition, it can lead to difficulties during **pregnancy**, as well as cause reproductive problems in both men and women.

Acute lead poisoning

Acute lead poisoning, while less common, shows up more quickly and can be fatal. Symptoms such as the following may occur:

- severe abdominal pain
- diarrhea
- nausea and vomiting
- weakness of the limbs
- seizures
- coma

Diagnosis

A high level of lead in the blood can be detected with a simple blood test. In fact, testing is the only way to know for sure if children without symptoms have been exposed to lead, since they can appear healthy even as long-term damage occurs. The CDC recommends testing all children at 12 months of age and, if possible, again at 24 months. Testing should start at six months for children at risk for lead poisoning. Based on these test results and a child's risk factors, the doctor will then decide whether further testing is needed and how often. In some states, more frequent testing is required by law.

Children at risk

Children with an increased risk of lead poisoning include those who:

- live in or regularly visit a house built before 1978 in which chipped or peeling paint is present
- live in or regularly visit a house that was built before 1978 where remodeling is planned or underway
- have a brother or sister, housemate, or playmate who has been diagnosed with lead poisoning
- live with an adult whose job or hobby involves exposure to lead
- live near an active lead smelter, battery-recycling plant, or other industry that can create lead pollution

Adults at risk

Testing is also important for adults whose job or hobby puts them at risk for lead poisoning. This includes people who take part in the following activities:

- glazed pottery or stained glass making
- furniture refinishing
- home renovation
- target shooting at indoor firing ranges
- battery reclamation
- precious metal refining
- radiator repair
- art restoration

Treatment

The first step in treating lead poisoning is to avoid further contact with lead. For adults, this usually means making changes at work or in hobbies. For children, it means finding and removing sources of lead in the home. In most states, the public health department can help assess the home and identify lead sources.

KEY TERMS

Chelation therapy—Treatment with chemicals that bind to a poisonous metal and help the body pass it in urine at a faster rate.

Dimercaprol (BAL)—A chemical agent used to remove excess lead from the body.

Edetate calcium disodium (EDTA calcium)—A chemical agent used to remove excess lead from the body.

Penicillamine (Cuprimine, Depen)—A drug used to treat medical problems (such as excess copper in the body and rheumatoid arthritis) and to prevent kidney stones. It is also sometimes prescribed to remove excess lead from the body.

Succimer (Chemet)—A drug used to remove excess lead from the body.

If the problem is lead paint, a professional with special training should remove it. This is not a do-it-yourself project. Scraping or sanding lead paint creates large amounts of dust that can poison people in the home. This dust can stay around long after the work is completed. In addition, heating lead paint can release lead into the air. For these reasons, lead paint should only be removed by someone who knows how to do the job safely and has the equipment to clean up thoroughly. Occupants, especially children and pregnant women, should leave the home until the cleanup is finished.

Chelation therapy

If blood levels of lead are high enough, the doctor may also prescribe **chelation therapy**. This refers to treatment with chemicals that bind to the lead and help the body pass it in urine at a faster rate. There are four chemical agents that may be used for this purpose, either alone or in combination. Edetate calcium disodium (EDTA calcium) and dimercaprol (BAL) are given through an intravenous line or in shots, while succimer (Chemet) and penicillamine (Cuprimine, Depen) are taken by mouth. (Although many doctors prescribe penicillamine for lead poisoning, this use of the drug has not been approved by the Food and Drug Administration.)

Alternative treatment

Changes in diet are no substitute for medical treatment. However, getting enough calcium, zinc, and protein may help reduce the amount of lead the body

absorbs. Iron is also important, since people who are deficient in this nutrient absorb more lead. Garlic and thiamine, a B-complex vitamin, have been used to treat lead poisoning in animals. However, their usefulness in humans for this purpose has not been proved. Nutritional, botanical, and homeopathic medicines can be administered once the source is removed, to help correct any imbalances brought on by lead toxicity.

Prognosis

If acute lead poisoning reaches the stage of seizures and coma, there is a high risk of death. Even if the person survives, there is a good chance of permanent brain damage. The long-term effects of lower levels of lead can also be permanent and severe. However, if chronic lead poisoning is caught early, these negative effects can be limited by reducing future exposure to lead and getting proper medical treatment.

Prevention

Many cases of lead poisoning can be prevented. These steps can help:

- Keep the areas where children play as clean and dust-free as possible.
- Wash pacifiers and bottles when they fall to the floor, and wash stuffed animals and toys often.
- Make sure children wash their hands before meals and at bedtime.
- Mop floors and wipe windowsills and other chewable surfaces, such as cribs, twice a week with a solution of powdered dishwasher detergent in warm water.
- Plant bushes next to an older home with painted exterior walls to keep children at a distance.
- Plant grass or another ground cover in soil that is likely to be contaminated, such as soil around a home built before 1960 or located near a major highway.
- Have household tap water tested to find out if it contains lead.
- Use only water from the cold-water tap for drinking, cooking, and making baby formula, since hot water is likely to contain higher levels of lead.
- If the cold water hasn't been used for six hours or more, run it for several seconds, until it becomes as cold as it will get, before using it for drinking or cooking. The more time water has been sitting in the pipes, the more lead it may contain.
- If you work with lead in your job or hobby, change your clothes before you go home.
- Do not store food in open cans, especially imported cans.
- Do not store or serve food in pottery meant for decorative use.

Resources

BOOKS

Centers for Disease Control and Prevention. *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials*. Atlanta: CDC, 1997.

Upton, Arthur C., and Eden Graber, eds. *Staying Healthy in a Risky Environment: The New York University Medical Center Family Guide*. New York: Simon & Schuster, 1993.

PERIODICALS

Centers for Disease Control and Prevention. "Adult Blood Lead Epidemiology and Surveillance—United States, Second Quarter, 1995." *Morbidity and Mortality Weekly Report* 44 (27 Oct.1995): 801-803.

Committee on Drugs, American Academy of Pediatrics. "Treatment Guidelines for Lead Exposure in Children." *Pediatrics* 96 (July 1995): 155-160.

Krucoff, Carol. "Lead Alert." *Child* (Aug. 1996): 64-65, 67.

Trachtenbarg, David E. "Getting the Lead Out." *Postgraduate Medicine* 99 (Mar. 1996): 201-202, 207-208, 211-214, 216, 218.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Lead Information Center, National Safety Council. 1025 Connecticut Ave. N.W., Suite 1200, Washington, DC 20036. (800) 532-3394. <http://www.nsc.org/ehc/lead.htm>.

Office of Water Resources Center, Environmental Protection Agency. Mail Code (4100), Room 2615 East Tower Basement, 401 M St. S.W., Washington, DC 20460. (800) 426-4791. <http://www.epa.gov/ow>.

Linda Wasmer Smith

Learning disorders

Definition

Learning disorders are academic difficulties experienced by children and adults of average to above-average intelligence. People with learning disorders have difficulty with reading, writing, mathematics, or a combination of the three. These difficulties significantly interfere with academic achievement or daily living.

Description

Learning disorders, or disabilities, affect approximately 2 million children between the ages of 6-17 (5%

of public school children). These children have specific impairments in acquiring, retaining, and processing information. Standardized tests place them well below their IQ range in their area of difficulty. The three main types of learning disorders are reading disorders, mathematics disorders, and disorders of written expression.

Reading disorders

Reading disorders are the most common type of learning disorder. Children with reading disorders have difficulty recognizing and interpreting letters and words (**dyslexia**). They aren't able to recognize and decode the sounds and syllables (phonetic structure) behind written words and language in general. This condition lowers accuracy and comprehension in reading.

Mathematics disorders

Children with mathematics disorders (dyscalculia) have problems recognizing and counting numbers correctly. They have difficulty using numbers in everyday settings. Mathematics disorders are typically diagnosed in the first few years of elementary school when formal teaching of numbers and basic math concepts begins. Children with mathematics disorders usually have a coexisting reading disorder, a disorder of written expression, or both.

Disorders of written expression

Disorders of written expression typically occur in combination with reading disorders or mathematics disorders or both. The condition is characterized by difficulty with written compositions (dysgraphia). Children with this type of learning disorder have problems with spelling, punctuation, grammar, and organizing their thoughts in writing.

Causes and symptoms

Learning disorders are thought to be caused by neurological abnormalities that trigger impairments in the regions of the brain that control visual and language processing and attention and planning. These traits may be genetically linked. Children from families with a history of learning disorders are more likely to develop disorders themselves. Learning difficulties may also be caused by medical conditions such as a traumatic brain injury or brain infections such as **encephalitis** or **meningitis**.

The defining symptom of a learning disorder is academic performance that is markedly below a child's age and grade capabilities and measured IQ. Children with a reading disorder may confuse or transpose words or letters and omit or add syllables to words. The written homework of children with disorders of written expression is filled with grammatical, spelling, punctuation, and organizational errors. The child's handwriting is often extremely poor. Children with mathematical disorders are often unable to count in the correct sequence, to name numbers, and to understand numerical concepts.

Diagnosis

Problems with vision or hearing, mental disorders (depression, **attention-deficit/hyperactivity disorder**), **mental retardation**, cultural and language differences, and inadequate teaching may be mistaken for learning disorders or complicate a diagnosis. A comprehensive medical, psychological, and educational assessment is critical to making a clear and correct diagnosis.

A child thought to have a learning disorder should undergo a complete medical examination to rule out an organic cause. If none is found, a psychoeducational assessment should be performed by a psychologist, psychiatrist, neurologist, neuropsychologist, or learning specialist. A complete medical, family, social, and educational history is compiled from existing medical and school records and from interviews with the child and the child's parents and teachers. A series of written and verbal tests are then given to the child to evaluate his or her cognitive and intellectual functioning. Commonly used tests include the Wechsler Intelligence Scale for Children (WISC-III), the Woodcock-Johnson Psychoeducational Battery, the Peabody Individual Achievement Test-Revised (PIAT-R) and the California Verbal Learning Test (CVLT). Federal legislation mandates that this testing is free of charge within the public school system.

Treatment

Once a learning disorder has been diagnosed, an individual education plan (IEP) is developed for the child in question. IEPs are based on psychoeducational test findings. They provide for annual retesting to measure a child's progress. Learning-disordered students may receive special instruction within a regular general education class or they may be taught in a special education or learning center for a portion of the day.

Common strategies for the treatment of reading disorders focus first on improving a child's recognition of the sounds of letters and language through phonics training. Later strategies focus on comprehension, retention, and study skills. Students with disorders of written expression are often encouraged to keep journals and to write with a computer keyboard instead of a pencil. Instruction for students with mathematical disorders emphasizes real-world uses of math, such as balancing a checkbook or comparing prices.

KEY TERMS

IQ—Intelligence quotient; a measure of intellectual functioning determined by performance on standardized intelligence tests.

Phonics—A system to teach reading by teaching the speech sounds associated with single letters, letter combinations, and syllables.

Prognosis

The high school dropout rate for children with learning disabilities is almost 40%. Children with learning disabilities that go undiagnosed or are improperly treated may never achieve functional literacy. They often develop serious behavior problems as a result of their frustration with school. The key to helping these students reach their fullest potential is early detection and the implementation of an appropriate individualized education plan. The prognosis is good for a large percentage of children with reading disorders that are identified and treated early. Learning disorders continue into adulthood, but with proper educational and vocational training, an individual can complete college and pursue a challenging career.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Church, Robin P., M. E. B. Lewis, and Mark L. Batshaw. "Learning Disabilities." In *Children with Disabilities*. 4th ed. Ed. Mark L. Batshaw. Baltimore: Paul H. Brookes, 1997.

Hallowell, Edward. *When You Worry About the Child You Love*. New York: Simon & Schuster, 1996.

Osman, Betty B. *Learning Disabilities and ADHD: A Family Guide to Living and Learning Together.* New York: John Wiley & Sons, 1997.

PERIODICALS

Baringa, Marcia. "Learning Defect Identified in Brain." *Science* 273 (Aug. 1996): 867-868.

Stage, Frances K., and Nancy V. Milne. "Invisible Scholars: Students With Learning Disabilities." *Journal of Higher Education* 67 (July/Aug. 1996): 426-45.

ORGANIZATIONS

National Center for Learning Disabilities (NCLD). 381 Park Avenue South, Suite 1401, New York, NY 10016. (410) 296-0232. <http://www.ncld.org>.

Learning Disabilities Association of America. 4156 Library Road, Pittsburg, PA 15234. (412) 341-1515. <http://www.ldanatl.org>.

The National Adult Literacy and Learning Disabilities Center (National ALLD Center). 1875 Connecticut Ave., NW, Washington, DC 20009-1202. (800) 953-2553. <http://www.nifl.gov/nalldtop.htm>.

OTHER

LD Online Page. <http://www.ldonline.org>.

Paula Anne Ford-Martin

Leeches

Definition

Leeches are bloodsucking worms with segmented bodies. They belong to the same large classification of worms as earthworms and certain oceanic worms.

Leeches can primarily be found in freshwater lakes, ponds, or rivers. They range in size from 0.2 in (5 mm) to nearly 18 in (45 cm) and have two characteristic suckers located at either end of their bodies. Leeches consume the blood of a wide variety of animal hosts, ranging from fish to humans. To feed, a leech first attaches itself to the host using the suckers. One of these suckers surrounds the leech's mouth, which contains three sets of jaws that bite into the host's flesh, making a Y-shaped incision. As the leech begins to feed, its saliva releases chemicals that dilate blood vessels, thin the blood, and deaden the **pain** of the bite. Because of the saliva's effects, a person bitten by a leech may not even be aware of it until afterwards, when he or she sees the incision and the trickle of blood that is difficult to stop.

For centuries, leeches were a common tool of doctors, who believed that many diseases were the result of "imbalances" in the body that could be stabilized by releasing blood. For example, leeches were sometimes attached to veins in the temples to treat headaches. Advances in medical knowledge led doctors to abandon bloodletting and the use of leeches in the mid-nineteenth century. In recent years, however, doctors have found a new purpose for leeches—helping to restore blood circulation to grafted or severely injured tissue.

Purpose

There are many occasions in medicine, mostly in surgery and trauma care, when blood accumulates and causes trouble. Leeches can be used to reduce the swelling of any tissue that is holding too much blood. This problem is most likely to occur in two situations:

- Trauma. Large blood clots resulting from trauma can threaten tissue survival by their size and pressure. Blood clots can also obstruct the patient's airway.

- Surgical procedures involving reattachment of severed body parts or tissue reconstruction following **burns**. In these situations it is difficult for the surgeon to make a route for blood to leave the affected part and return to the circulation. The hardest part of reattaching severed extremities like fingers, toes and ears is to reconnect the tiny veins. If the veins are not reconnected, blood will accumulate in the injured area. A similar situation occurs when plastic surgeons move large flaps of skin to replace skin lost to burns, trauma or radical surgery. The skin flaps often drain blood poorly, get congested, and begin to die. Leeches have come to the rescue in both situations.

Precautions

It is important to use only leeches that have been raised in the laboratory under sterile conditions in order to protect patients from infection. Therapeutic leeches belong to one of two species—*Hirudo michaelseni* or *Hirudo medicinalis*.

Description

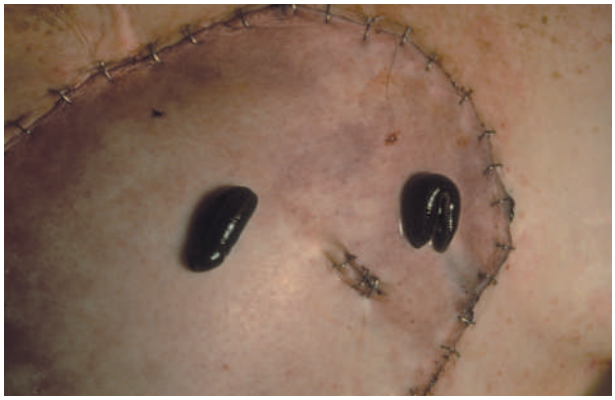
One or more leeches are applied to the swollen area, depending on the size of the graft or injury, and left on for several hours. The benefits of the treatment lie not in the amount of blood that the leeches ingest, but in the anti-bloodclotting (anticoagulant) enzymes in the saliva that allow blood to flow from the bite for up to six hours after the animal is detached, effectively draining away blood that could otherwise accumulate and cause tissue **death**. Leech saliva has been described as a better anticoagulant than many currently available to treat strokes and heart attacks. Active investigation of the chemicals in leech saliva is currently under way, and one anticoagulant drug, hirudin, is derived from the tissues of *Hirudo medicinalis*.

Aftercare

The leeches are removed by pulling them off or by loosening their grip with **cocaine**, heat, or acid. The used leeches are then killed by placing them in an alcohol solution and disposed of as a biohazard. Proper care of the patient's sore is important, as is monitoring the rate at which it bleeds after the leech is removed. Any clots that form at the wound site during treatment should be removed to ensure effective blood flow.

Risks

Infection is a constant possibility until the sore heals. It is also necessary to monitor the amount of blood that the leeches have removed from the patient, since a drop in red blood cell counts could occur in rare cases of prolonged bleeding.



These leeches are being used to reduce venous congestion, or excessive amounts of blood in the blood vessels. *(Photograph by Michael English, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

Resources

PERIODICALS

Adams, J. F., and L. F. Lassen. "Leech Therapy for Venous Congestion Following Myocutaneous Pectoralis Flap Reconstruction." *ORL - Head & Neck Nursing* 13, no. 1 (Winter 1995): 12-14.

Daane, S., et al. "Clinical Use of Leeches in Reconstructive Surgery." *American Journal of Orthopedics* 26, no. 8 (Aug. 1997): 528-532.

de Chalain, T., et al. "Successful Use of Leeches in the Treatment of Purpura Fulminans." *Annals of Plastic Surgery* 35, no. 3 (Sept. 1995): 300-306.

de Chalain, T. M. "Exploring the Use of the Medicinal Leech: A Clinical Risk-Benefit Analysis." *Source Journal of Reconstructive Microsurgery* 12, no. 3 (Apr. 1996): 165-172.

de Chalain, T., and G. Jones. "Replantation of the Avulsed Pinna: 100 Percent Survival with a Single Arterial Anastomosis and Substitution of Leeches for a Venous Anastomosis." *Plastic & Reconstructive Surgery* 95, no. 7 (June 1995): 1275-1279.

Godfrey, K. "Uses of Leeches and Leech Saliva in Clinical Practice." *Nursing Times* 93, no. 9 (26 Feb. 1997): 62-63.

Goessl, C., et al. "Leech Therapy for Massive Scrotal Mematoma Following Percutaneous Transluminal Angioplasty." *Journal of Urology* 158, no. 2 (Aug. 1997): 545.

Haycox, C. L., et al. "Indications and Complications of Medicinal Leech Therapy." *Journal of the American Academy of Dermatology* 33, no. 6 (Dec. 1995): 1053-1055.

Iafolla, A. K. "Medicinal Leeches in the Postoperative Care of Bladder Exstrophy." *Journal of Perinatology* 15, no. 2 (Mar./Apr. 1995): 135-138.

Lee, N. J., and N. S. Peckitt. "Treatment of a Sublingual Hematoma with Medicinal Leeches: Report of Case."

KEY TERMS

Anemia—A blood disorder marked by low hemoglobin levels in red blood cells, which leads to a deficiency of oxygen in the blood.

Anticoagulant—A chemical or medication that prevents blood from clotting.

Journal of Oral & Maxillofacial Surgery 54, no. 1 (Jan. 1996): 101-103.

Pantuck, A. J., et al. "Penile Replantation Using the Leech Hirudo medicinalis." *Urology* 48, no. 6 (Dec. 1996): 953-956.

Piascik, P. "Medicinal Leeches: Ancient Therapy Is a Source of Biotech Drugs." *Journal of the American Pharmaceutical Association* NS37, no. 3 (1997): 285-286.

Smeets, I. M., and I. Engelberts. "The Use of Leeches in a Case of Post-Operative Life-Threatening Macroglossia." *Journal of Laryngology & Otology* 109, no. 5 (May 1995): 442-444.

Van Wingerden, J. J., and J. H. Oosthuizen. "Use of the Local Leech Hirudo michaelseni in Reconstructive Plastic and Hand Surgery." *South African Journal of Surgery* 35, no. 1 (Feb. 1997): 29-31.

Wallis, R. B. "Hirudins: From Leeches to Man." *Seminars in Thrombosis & Hemostasis* 22, no. 2 (1996): 185-196.

J. Ricker Polsdorfer, MD

Left ventricular failure *see* **Heart failure**

Leg veins x ray *see* **Venography**

Legg-Calvé *see* **Osteochondroses**

Legionella pneumophila infection *see* **Legionnaires' disease**

Legionellosis *see* **Legionnaires' disease**

Legionnaires' disease

Definition

Legionnaires' disease is a type of **pneumonia** caused by *Legionella* bacteria. The bacterial species responsible for Legionnaires' disease is *L. pneumophila*. Major symptoms include **fever**, chills, muscle aches, and a **cough** that is initially nonproductive. Definitive diagnosis relies on specific laboratory tests for the bacteria, bacterial antigens, or antibodies produced by the body's immune system. As with other types of pneumonia, Legionnaires' disease poses the greatest threat to people who are elderly, ill, or immunocompromised.

Description

Legionella bacteria were first identified as a cause of pneumonia in 1976, following an outbreak of pneumonia among people who had attended an American Legion convention in Philadelphia, Pennsylvania. This eponymous outbreak prompted further investigation into *Legionella* and it was discovered that earlier unexplained pneumonia outbreaks were linked to the bacteria. The earliest cases of Legionnaires' disease were shown to have occurred in 1965, but samples of the bacteria exist from 1947.

Exposure to the *Legionella* bacteria doesn't necessarily lead to infection. According to some studies, an estimated 5-10% of the American population show serologic evidence of exposure, the majority of whom do not develop symptoms of an infection. *Legionella* bacteria account for 2-15% of the total number of pneumonia cases requiring hospitalization in the United States.

There are at least 40 types of *Legionella* bacteria, half of which are capable of producing disease in humans. A disease that arises from infection by *Legionella* bacteria is referred to as legionellosis. The *L. pneumophila bacterium*, the root cause of Legionnaires' disease, causes 90% of legionellosis cases. The second most common cause of legionellosis is the *L. micdadei* bacterium, which produces the Philadelphia pneumonia-causing agent.

Approximately 10,000-40,000 people in the United States develop Legionnaires' disease annually. The people who are the most likely to become ill are over age 50. The risk is greater for people who suffer from health conditions such as malignancy, diabetes, lung disease, or kidney disease. Other risk factors include immunosuppressive therapy and cigarette **smoking**. Legionnaires' disease has occurred in children, but typically it has been confined to newborns receiving respiratory therapy, children who have had recent operations, and children who are immunosuppressed. People with HIV infection and **AIDS** do not seem to contract Legionnaires' disease with any greater frequency than the rest of the population, however, if contracted, the disease is likely to be more severe compared to other cases.

Cases of Legionnaires' disease that occur in conjunction with an outbreak, or epidemic, are more likely to be diagnosed quickly. Early diagnosis aids effective and successful treatment. During epidemic outbreaks, fatalities have ranged from 5% for previously healthy individuals

to 24% for individuals with underlying illnesses. Sporadic cases (that is, cases unrelated to a wider outbreak) are harder to detect and treatment may be delayed pending an accurate diagnosis. The overall fatality rate for sporadic cases ranges from 10-19%. The outlook is bleaker in severe cases that require respiratory support or dialysis. In such cases, fatality may reach 67%.

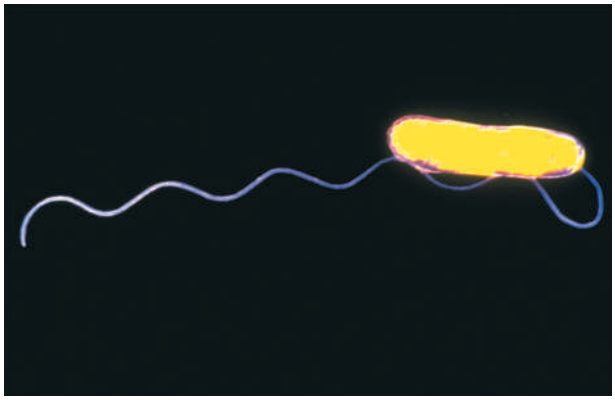
Causes and symptoms

Legionnaires' disease is caused by inhaling *Legionella* bacteria from the environment. Typically, the bacteria are dispersed in aerosols of contaminated water. These aerosols are produced by devices in which warm water can stagnate, such as air-conditioning cooling towers, humidifiers, shower heads, and faucets. There have also been cases linked to whirlpool spa baths and water misters in grocery store produce departments. Aspiration of contaminated water is also a potential source of infection, particularly in hospital-acquired cases of Legionnaires' disease. There is no evidence of person-to-person transmission of Legionnaires' disease.

Once the bacteria are in the lungs, cellular representatives of the body's immune system (alveolar macrophages) congregate to destroy the invaders. The typical macrophage defense is to phagocytose the invader and demolish it in a process analogous to swallowing and digesting it. However, the *Legionella* bacteria survive being phagocytosed. Instead of being destroyed within the macrophage, they grow and replicate, eventually killing the macrophage. When the macrophage dies, many new *Legionella* bacteria are released into the lungs and worsen the infection.

Legionnaires' disease develops two to 10 days after exposure to the bacteria. Early symptoms include lethargy, headaches, fever, chills, muscle aches, and a lack of appetite. Respiratory symptoms such as coughing or congestion are usually absent. As the disease progresses, a dry, hacking cough develops and may become productive after a few days. In about a third of Legionnaires' disease cases, blood is present in the sputum. Half of the people who develop Legionnaires' disease suffer **shortness of breath** and a third complain of breathing-related chest **pain**. The fever can become quite high, reaching 104°F (40°C) in many cases, and may be accompanied by a decreased heart rate.

Although the pneumonia affects the lungs, Legionnaires' disease is accompanied by symptoms that affect other areas of the body. About half the victims experience **diarrhea** and a quarter have **nausea and vomiting** and abdominal pain. In about 10% of cases, acute renal failure and scanty urine production accompany the disease. Changes in mental status, such as disorientation, confusion, and **hallucinations**, also occur in about a quarter of cases.



A transmission electron microscopy (TEM) image of *Legionella pneumophila,* the bacteria which causes Legionnaires' disease. *(Custom Medical Stock Photo. Reproduced by permission.)*

In addition to Legionnaires' disease, *L. pneumophila* legionellosis also includes a milder disease, Pontiac fever. Unlike Legionnaires' disease, Pontiac fever does not involve the lower respiratory tract. The symptoms usually appear within 36 hours of exposure and include fever, **headache**, muscle aches, and lethargy. Symptoms last only a few days and medical intervention is not necessary.

Diagnosis

The symptoms of Legionnaires' disease are common to many types of pneumonia and diagnosis of sporadic cases can be difficult. The symptoms and chest x rays that confirm a case of pneumonia are not useful in differentiating between Legionnaires' disease and other pneumonias. If a pneumonia case involves multisystem symptoms, such as diarrhea and vomiting, and an initially dry cough, laboratory tests are done to definitively identify *L. pneumophila* as the cause of the infection.

If Legionnaires' disease is suspected, several tests are available to reveal or indicate the presence of *L. pneumophila* bacteria in the body. Since the immune system creates antibodies against infectious agents, examining the blood for these indicators is a key test. The level of immunoglobulins, or antibody molecules, in the blood reveals the presence of infection. In microscopic examination of the patient's sputum, a fluorescent stain linked to antibodies against *L. pneumophila* can uncover the presence of the bacteria. Other means of revealing the bacteria's presence from patient sputum samples include **isolation** of the organism on culture media or detection of the bacteria by DNA probe. Another test detects *L. pneumophila* antigens in the urine.

KEY TERMS

Antibody—A molecule created by the immune system in response to the presence of an antigen. It serves to recognize the invader and help defend the body from infection.

Antigen—A molecule, such as a protein, which is associated with a particular infectious agent. The immune system uses this molecule as the identifying characteristic of the infectious invader.

Culture—A laboratory system for growing bacteria for further study.

DNA probe—An agent that binds directly to a predefined sequence of nucleic acids.

Immunocompromised—Refers to conditions in which the immune system is not functioning properly and cannot adequately protect the body from infection.

Immunoglobulin—The protein molecule that serves as the primary building block of antibodies.

Immunosuppressive therapy—Medical treatment in which the immune system is purposefully thwarted. Such treatment is necessary, for example, to prevent organ rejection in transplant cases.

Legionellosis—A disease caused by infection with a Legionella bacterium.

Media—Substance which contains all the nutrients necessary for bacteria to grow in a culture.

Phagocytosis—The "ingestion" of a piece of matter by a cell.

Treatment

Most cases of *Legionella* pneumonia show improvement within 12-48 hours of starting antibiotic therapy. The antibiotic of choice has been erythromycin, sometimes paired with a second antibiotic, rifampin. Tetracycline, alone or with rifampin, is also used to treat Legionnaires' disease, but has had more mixed success in comparison to erythromycin. Other **antibiotics** that have been used successfully to combat *Legionella* include doxycycline, clarithromycin, fluorinated quinolones, and trimethoprim/sulfamethoxazole.

The type of antibiotic prescribed by the doctor depends on several factors including the severity of infection, potential **allergies**, and interaction with previously prescribed drugs. For example, erythromycin interacts with warfarin, a blood thinner. Several drugs, such as **penicillins** and **cephalosporins**, are ineffective against the infection. Although they may be deadly to the bacteria in laboratory tests, their chemical structure prevents them from being absorbed into the areas of the lung where the bacteria are present.

In severe cases with complications, antibiotic therapy may be joined by respiratory support. If renal failure occurs, dialysis is required until renal function is recovered.

Prognosis

Appropriate medical treatment has a major impact on recovery from Legionnaires' disease. Outcome is also linked to the victim's general health and absence of complications. If the patient survives the infection, recovery from Legionnaires' disease is complete. Similar to other types of pneumonia, severe cases of Legionnaires' disease may cause scarring in the lung tissue as a result of the infection. Renal failure, if it occurs, is reversible and renal function returns as the patient's health improves. Occasionally, **fatigue** and weakness may linger for several months after the infection has been successfully treated.

Prevention

Since the bacteria thrive in warm stagnant water, regularly disinfecting ductwork, pipes, and other areas that may serve as breeding areas is the best method for preventing outbreaks of Legionnaires' disease. Most outbreaks of Legionnaires' disease can be traced to specific points of exposure, such as hospitals, hotels, and other places where people gather. Sporadic cases are harder to determine and there is insufficient evidence to point to exposure in individual homes.

Resources

BOOKS

Edelstein, Paul H., and Richard D. Meyer. "Legionella Pneumonias." In *Respiratory Infections: Diagnosis and Management.* 3rd ed. Ed. James E. Pennington. New York: Raven Press, Ltd., 1994.

Johnson, Caroline C., and Sydney M. Finegold. "Pyogenic Bacterial Pneumonia, Lung Abscess, and Empyema." In *Textbook of Respiratory Medicine.* 2nd ed. Vol. 1. Ed. John F. Murray and Jay A. Nadel. Philadelphia: W. B. Saunders Co., 1994.

PERIODICALS

Shuman, H. A., et al. "Intracellular Multiplication of Legionella pneumophila: Human Pathogen of Accidental Tourist?" *Current Topics in Microbiology and Immunology* 225 (1998): 99.

Stout, Janet E., and Victor L. Yu. "Legionellosis," *The New England Journal of Medicine* 337 (4 Sept. 1997): 682.

Julia Barrett

Leiomyomas *see* **Uterine fibroids**

Leishmaniasis

Definition

Leishmaniasis refers to several different illnesses caused by infection with an organism called a protozoan.

Description

Protozoa are considered to be the most simple organisms in the animal kingdom. They are all single-celled. The types of protozoa which cause leishmaniasis are carried by the blood-sucking sandfly. The sandfly is referred to as the disease vector, simply meaning that the infectious agent (the protozoan) is carried by the sandfly and passed on to other animals or humans in whom the protozoan will set up residence and cause disease. The animal or human in which the protozoan then resides is referred to as the host.

Once the protozoan is within the human host, the human's immune system is activated to try to combat the invader. Specialized immune cells called macrophages work to swallow up the protozoa. Usually, this technique kills a foreign invader, but these protozoa can survive and flourish within macrophages. The protozoa multiply within the macrophages, ultimately causing the macrophage to burst open. The protozoa are released, and take up residence within other neighboring cells.

At this point, the course of the disease caused by the protozoa is dependent on the specific type of protozoa, and on the type of reaction the protozoa elicits from the immune system. There are several types of protozoa which cause leishmaniasis, and they cause different patterns of disease progression.

At any one time, about 20 million people throughout the world are infected with leishmaniasis. While leishmaniasis exists as a disease in 88 countries around the globe, some countries are hit harder than others. These include Bangladesh, India, Nepal, Sudan, Afghanistan, Brazil, Iran, Peru, Saudi Arabia, and Syria. Other areas which harbor the causative protozoa include China, many countries throughout Africa, Mexico, Central and South America, Turkey, and Greece. Although less frequent, cases have occurred in the United States, in Texas.

In some areas of southern Europe, leishmaniasis is becoming an important disease which infects people with weakened immune systems. In particular, individuals with acquired **immunodeficiency** syndrome (**AIDS**) are at great risk of this infection.

Causes and symptoms

There are a number of types of protozoa which can cause leishmaniasis. Each type exists in specific locations, and there are different patterns to the kind of disease each causes. The overall species name is Leishmania (commonly abbreviated L.). The specific types include: *L. Donovani, L. Infantum, L. Chagasi, L. Mexicana, L. Amazonensis, L. Tropica, L. Major, L. Aethiopica, L. Brasiliensis, L. Guyaensis, L. Panamensis, L. Peruviana*. Some of the names are reflective of the locale in which the specific protozoa is most commonly found, or in which it was first discovered.

Localized cutaneous leishmaniasis

This type of disease occurs most commonly in China, India, Asia Minor, Africa, the Mediterranean Basin, and Central America. It has occurred in an area ranging from northern Argentina all the way up to southern Texas. It is called different names in different locations, including chiclero ulcer, bush **yaws**, uta, oriental sore, Aleppo boil, and Baghdad sore.

This is perhaps the least drastic type of disease caused by any of the Leishmania. Several weeks or months after being bitten by an infected sandfly, the host may notice an itchy bump (lesion) on an arm, leg, or face. Lymph nodes in the area of this bump may be swollen. Within several months, the bump develops a crater (ulceration) in the center, with a raised, reddened ridge around it. There may be several of these lesions near each other, and they may spread into each other to form one large lesion. Although localized cutaneous leishmaniasis usually heals on its own, it may take as long as year. A depressed, light-colored scar usually remains behind. Some lesions never heal, and may invade and destroy the tissue below. For example, lesions on the ears may slowly, but surely, invade and destroy the cartilage which supports the outer ear.

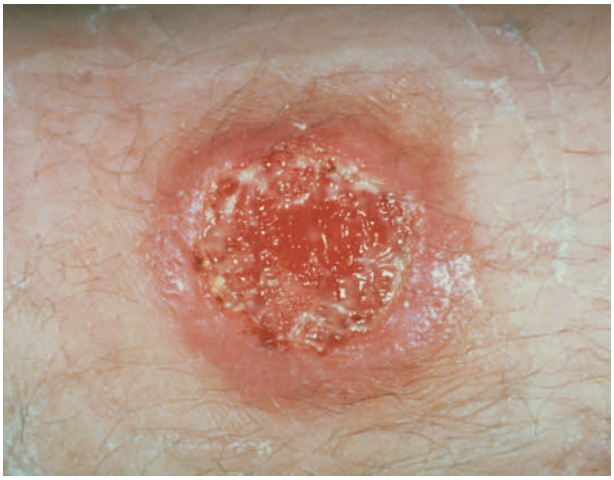
Diffuse cutaneous leishmaniasis

This type of disease occurs most often in Ethiopia, Brazil, Dominican Republic, and Venezuela.

The lesions of diffuse cutaneous leishmaniasis are very similar to those of localized cutaneous leishmaniasis, except they are spread all over the body. The body's immune system apparently fails to battle the protozoa, which are free to spread throughout. The characteristic lesions resemble those of the dread biblical disease, **leprosy**.

Mucocutaneous leishmaniasis

This form of leishmaniasis occurs primarily in the tropics of South America. The disease begins with the



This condition, also called an oriental sore, is caused by the bacterium *L. tropica*. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission.)*

same sores noted in localized cutaneous leishmaniasis. Sometimes these primary lesions heal, other times they spread and become larger. Some years after the first lesion is noted (and sometimes several years after that lesion has totally healed), new lesions appear in the mouth and nose, and occasionally in the area between the genitalia and the anus (the perineum). These new lesions are particularly destructive and painful. They erode underlying tissue and cartilage, frequently eating through the septum (the cartilage which separates the two nostrils). If the lesions spread to the roof of the mouth and the larynx (the part of the wind pipe which contains the vocal cords), they may prevent speech. Other symptoms include **fever**, weight loss, anemia (low red blood cell count). There is always a large danger of bacteria infecting the already open sores.

Visceral leishmaniasis

This type of leishmaniasis occurs India, China, the southern region of Russia, and throughout Africa, the Mediterranean, and South and Central America. It is frequently called Kala-Azar or Dumdum fever.

In this disease, the protozoa uses the bloodstream to travel to the liver, spleen, lymph nodes, and bone marrow. Fever may last for as long as eight weeks, disappear, and then reappear again. The lymph nodes, spleen, and liver are often quite enlarged. Weakness, **fatigue**, loss of appetite, **diarrhea**, and weight loss are common. Kala-azar translates to mean "black fever." The name kala-azar comes from a characteristic of this form of leishmaniasis. Individual with light-colored skin take on a darker, grayish skin tone, particularly of their face and hands. A variety of lesions appear on the skin.

Diagnosis

Diagnosis for each of these types of leishmaniasis involves taking a scraping from a lesion, preparing it in a laboratory, and examining it under a microscope to demonstrate the causative protozoan. Other methods that have been used include culturing a sample piece of tissue in a laboratory to allow the protozoa to multiply for easier microscopic identification; injecting a mouse or hamster with a solution made of scrapings from a patient's lesion to see if the animal develops a leishmaniasis-like disease; and demonstrating the presence in macrophages of the characteristic-appearing protozoan, called Leishman-Donovan bodies.

In some forms of leishmaniasis, a skin test (similar to that given for TB) may be used. In this test, a solution containing a small bit of the protozoan antigen (cell markers which cause the human immune system to react) is injected or scratched into a patient's skin. In a positive reaction, cells from the immune system will race to this spot, causing a characteristic skin lesion. Not all forms of leishmaniasis cause a positive skin test, however.

Treatment

The treatment of choice for all forms of leishmaniasis is a type of drug containing the element antimony. These include sodium sitogluconate, and meglumin antimonate. When these types of drugs do not work, other medications with anti-protozoal activity are utilized, including amphotericin B, pentamidine, flagyl, and allopurinol.

Prognosis

The prognosis for leishmaniasis is quite variable, and depends on the specific strain of infecting protozoan, as well as the individual patient's immune system response to infection. Localized cutaneous leishmaniasis may require no treatment. Although it may take many months, these lesions usually heal themselves completely. Only rarely do these lesions fail to heal and become more destructive.

Disseminated cutaneous leishmaniasis may smolder on for years without treatment, ultimately causing **death** when the large, open lesions become infected with bacteria.

Mucocutaneous leishmaniasis is often relatively resistant to treatment. Untreated visceral leishmaniasis has a 90% death rate, but only a 10% death rate with treatment.

Prevention

Prevention involves protecting against sandfly bites. Insect repellents used around homes, on clothing, on

KEY TERMS

Host—The organism (such as a monkey or human) in which another organism (such as a virus or bacteria) is living.

Larynx—The part of the airway lying between the pharynx and the trachea.

Leishman-Donovan body—A body of a (trypanosomatid) protozoa at a particular and characteristic stage in its life cycle; the infectious (trypanosomatid) protozoa can cause leishmaniasis, and is relatively easy to identify at that stage.

Lesion—A disruption of the normal structure and function of a tissue by some disease process.

Macrophage—A cell of the immune system which engulfs and digests foreign invaders such as bacteria and viruses in an attempt to stop them from causing disease within the body.

Protozoa—A group of organisms which are the smallest members of the animal kingdom, consisting of a single cell.

Ulceration—An area of pitting and irritation.

Vector—A carrier organism (such as a fly or mosquito) which serves to deliver a virus (or other agent of infection) to a host.

skin, and on bednets (to protect people while sleeping) are effective measures.

Reducing the population of sandflies is also an important preventive measure. In areas where leishmaniasis is very common, recommendations include clearing the land of trees and brush for at least 984 ft (300 m) around all villages, and regularly spraying the area with insecticides. Because rodents often carry the protozoan which causes leishmaniasis, careful rodent control should be practiced. Dogs, which also carry the protozoan, can be given a simple blood test and then either treated or put to sleep.

Resources

BOOKS

Herwaldt, Barbara. "Leishmaniasis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Plorde, James J. "Flagellate Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Plorde, James J. "Introduction to Pathogenic Parasites." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Ablon, Glynis R., and Ted Rosen. "Protozoan Skin Infections: The World Traveler and the Unwanted Companion." *Consultant* 35 (Apr. 1995): 461+.

Farley, Dixie. "Treating Tropical Diseases." *FDA Consumer* 31 (Jan./Feb. 1997): 26+.

Farley, Dixie. "Tropical Diseases: Travelers Take Note." *Consumer Research Magazine*, May 1997, 27+.

Gradoni, L., et al. "Treatment of Mediterranean Visceral Leishmaniasis." *World Health Organization* 73 (Mar./Apr. 1995): 191+.

Hashim, Faisal A. "Neurologic Changes in Visceral Leishmaniasis." *The Journal of the American Medical Association"* 274 (5 July 1995): 6E.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Leprosy

Definition

Leprosy is a slowly progressing bacterial infection that affects the skin, peripheral nerves in the hands and feet, and mucous membranes of the nose, throat, and eyes. Destruction of the nerve endings causes the the affected areas to lose sensation. Occasionally, because of the loss of feeling, the fingers and toes become mutilated and fall off, causing the deformities that are typically associated with the disease.

Description

Leprosy is also known as Hansen's disease after G. A. Hansen who in 1878 identified the bacillus *Mycobacterium leprae* that caused the disease.

The infection is characterized by abnormal changes of the skin. These changes, called lesions, are at first flat and red. Upon enlarging, they have irregular shapes and a characteristic appearance. The lesions are typically darker in color around the edges with discolored pale centers. Because the organism grows best at lower temperatures the leprosy bacillus has a preference for the skin, the mucous membranes and the nerves. Infection in and destruction of the nerves leads to sensory loss. The loss

of sensation in the fingers and toes increases the risk of injury. Inadequate care causes infection of open **wounds**. **Gangrene** may also follow, causing body tissue to die and become deformed.

Because of the disabling deformities associated with it, leprosy has been considered one of the most dreaded diseases since biblical times, though much of what was called leprosy in the Old Testament most likely was not the same disease. Its victims were often shunned by the community, kept at arm's length, or sent to a leper colony. Many people still have misconceptions about the disease. Contrary to popular belief, it is not highly communicable and is extremely slow to develop. Household contacts of most cases and the medical personnel caring for Hansen's disease patients are not at particular risk. It is very curable, although the treatment is long-term, requiring multiple medications.

The World Health Organization (WHO) puts the number of identified leprosy cases in the world, at the beginning of 1997, at about 890,000. Seventy percent of all cases are found in just three countries: India, Indonesia, and Myanamar (Burma). The infection can be acquired, however, in the Western Hemisphere as well. Cases also occur in some areas of the Caribbean and even in southern Texas and Louisiana.

Causes and symptoms

The organism that causes leprosy is a rod-shaped bacterium called *Mycobacterium leprae*. This bacterium is related to *Mycobacterium tuberculosis*, the causative agent of **tuberculosis**. Because special staining techniques involving acids are required to view these bacteria under the microscope, they are referred to as acid-fast bacilli (AFB).

When *Mycobacterium leprae* invades the body, one of two reactions can take place. In tuberculoid leprosy (TT), the milder form of the disease, the body's immune cells attempt to seal off the infection from the rest of the body by surrounding the offending pathogen. Because this response by the immune system occurs in the deeper layers of the skin, the hair follicles, sweat glands, and nerves can be destroyed. As a result, the skin becomes dry and discolored and loses its sensitivity. Involvement of nerves on the face, arms, or legs can cause them to enlarge and become easily felt by the doctor. This finding is highly suggestive of TT. The scarcity of bacteria in this type of leprosy leads to it being referred to as paucibacillary (PB) leprosy. Seventy to eighty percent of all leprosy cases are of the tuberculoid type.

In lepromatous (LL) leprosy, which is the second and more contagious form of the disease, the body's immune system is unable to mount a strong response to the invading organism. Hence, the organism multiplies freely in the skin. This type of leprosy is also called the multibacillary (MB) leprosy, because of the presence of large numbers of bacteria. The characteristic feature of this disease is the appearance of large nodules or lesions all over the body and face. Occasionally, the mucous membranes of the eyes, nose, and throat may be involved. Facial involvement can produce a lion-like appearance (leonine facies). This type of leprosy can lead to blindness, drastic change in voice, or mutilation of the nose. Leprosy can strike anyone; however, children seem to be more susceptible than adults.

Well-defined **skin lesions** that are numb are the first symptoms of tuberculoid leprosy. Lepromatous leprosy is characterized by a chronic stuffy nose due to invasion of the mucous membranes, and the presence of nodules and lesions all over the body and face.

The incubation period varies anywhere from six months to ten years. On an average, it takes four years for the symptoms of tuberculoid leprosy to develop. Probably because of the slow growth of the bacillus, lepromatous leprosy develops even more slowly, taking an average of eight years for the initial lesions to appear.

It is not very clear how the leprosy bacillus is transmitted from person to person. Inhaling bacteria that are present in dust is thought to be one of the modes of transmission. However, even among people who live in the same household as the patient and are in close contact, only 5% get leprosy. It is obviously not a highly communicable disease. The incidence of leprosy is highest in the poverty belt of the globe. Therefore, environmental factors such as unhygienic living conditions, overpopulation, and **malnutrition** may also be contributing factors favoring the infection. The nine-banded armadillo is susceptible to this disease but it is still unclear if human infection is related to exposure to this animal.

Diagnosis

One of the hallmarks of leprosy is the presence of AFB in smears taken from the skin lesions, nasal scrapings, or tissue secretions. In patients with LL leprosy, the bacilli are easily detected; however, in TT leprosy the bacteria are very few and almost impossible to find. In such cases, a diagnosis is made based on the clinical signs and symptoms, the type and distribution of skin lesions, and history of having lived in an endemic area.

The signs and symptoms characteristic of leprosy can be easily identified by a health worker after a short training period. There is no need for a laboratory investigation to confirm a leprosy diagnosis, except in very rare circumstances.

In an endemic area, if smears from an individual show the presence of AFB, or if he has typical skin lesions, he should definitely be regarded as having leprosy. Usually, there is slight discoloration of the skin and loss of skin sensitivity. Thickened nerves accompanied by weakness of muscles supplied by the affected nerve are very typical of the disease. One characteristic occurrence is a foot drop where the foot cannot be flexed upwards, affecting the ability to walk.

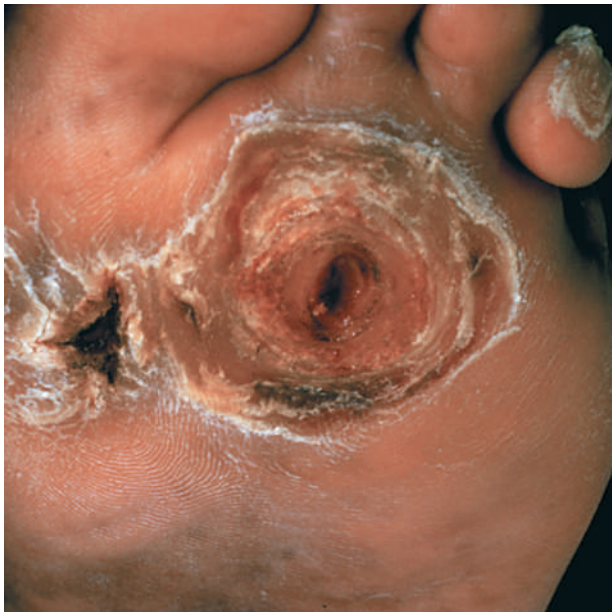
Treatment

The most widely used drug for leprosy is dapsone. However, emergence of dapsone-resistant strains prompted the introduction of multi-drug therapy. The multi-drug therapy includes dapsone, refampin (also known as rifampicin), and clofazimine, all of which are powerful antibacterial drugs. Patients with MB leprosy are usually treated with all three drugs, while patients with PB leprosy are only given refampin and dapsone. Usually three months after starting treatment, a patient ceases being infectious, though not everyone with this disease is necessarily infectious before treatment. Depending on the type of leprosy, the time required for treatment may vary from six months to two years or more.

Each of the drugs have minor side effects. Dapsone can cause nausea, **dizziness**, **palpitations**, **jaundice** and rash. A doctor should be contacted immediately if a rash develops. Dapsone also interacts with the second drug, refampin. Refampin increases the metabolizing of dapsone in the body, requiring an adjustment of the dapsone dosage. Refampin may also cause muscle cramps, or nausea. If jaundice, flu-like symptoms or a rash appear, a doctor should be contacted immediately. The third drug, clofazimine may cause severe abdominal **pain** and **diarrhea**, as well as discoloration of the skin. Red to brownish black discoloration of the skin and bodily fluids, including sweat, may persist for months to years after use.

Thalidomide, the most famous agent of **birth defects** in the 20th century, is now being used to treat complications of leprosy and similar diseases. Thalidomide regulates the immune response by suppressing a protein, tumor necrossi factor alpha.

Leprosy patients should be aware that treatment itself can cause a potentially serious immune system response called a lepra reaction. When **antibiotics** kill *M. leprae,* antigens (the proteins on the surface of the organism that initiate the body's immune system response) are released from the dying bacteria. In some people, when the antigens combine with the antibodies to *M. Leprae* in the bloodstream, a reaction called **erythema nodosum** leprosum may occur, resulting in new lesions and peripheral nerve damage. Cortisone-type medications and, increasingly, thalidomide are used to minimize the effects of lepra reactions.



Lesions such as these are characteristic of leprosy. *(Phototake NYC. Reproduced by permission.)*

Prognosis

Leprosy is curable; however, the deformities and nerve damage associated with leprosy are often irreversible. Preventions or rehabilition of these defects is an integral part of management of the disease. Reconstructive surgery, aimed at preventing and correcting deformities, offers the greatest hope for disabled patients. Sometimes, the deformities are such that the patients will not benefit from this type of surgery.

Comprehensive care involves teaching patients to care for themselves. If the patients have significant nerve damage or are at high risk of developing deformities, they must be taught to take care of their insensitive limbs, similar to diabetics with lower leg nerve damage. Lacking the sensation of pain, the patients should constantly check themselves to identify cuts and **bruises**. If adequate care is not taken, these wounds become festering sores and a source of dangerous infection. Physiotherapy exercises are taught to the patients to maintain a range of movement in finger joints and prevent the deformities from worsening. Prefabricated standardized splints are available and are extremely effective in correcting and preventing certain common deformities in leprosy. Special kinds of footwear have been designed for patients with insensitive feet in order to prevent or minimize the progression of foot ulcers.

KEY TERMS

Endemic area—A geographical area where a particular disease is prevalent.

Gangrene—Death of tissue due to loss of blood supply followed by bacterial invasion and putrefaction.

Incubation period—The time it takes for symptoms to develop after initial exposure to a disease-causing organism.

Lesion—Any visible, local abnormality of the tissues of the skin, such as a wound, sore, rash, or boil.

Mucous membranes—The inner tissue that covers or lines body cavities or canals open to the outside, such as nose and mouth. These membranes secrete mucus and absorb water and salts.

Nasal scraping—Pathological material obtained for clinical study by scratching the inner surface of the nose with a clinical instrument.

Nodules—A small mass of tissue in the form of a protuberance or a knot that is solid and can be detected by touch.

Pathogen—Any disease-producing agent or microorganism.

Smear—A specimen prepared for microscopic study by spreading the material across a slide and treating it with a specific stain.

Prevention

By early diagnosis and appropriate treatment of infected individuals, even a disease as ancient as leprosy can be controlled. People who are in immediate contact with the leprosy patient should be tested for leprosy. Annual examinations should also be conducted on these people for a period of five years following their last contact with an infectious patient. Some physicians have advocated dapsone treatment for people in close household contact with leprosy patients.

The WHO Action Program for the Elimination of Leprosy has adopted a resolution calling for the reduction of leprosy's prevalence to less than one case per 10,000 people by the year 2000. In order to make this possible, educating people about the disease and raising their awareness is of utmost importance. The tuberculosis BCG vaccine, used in many areas of the world, may have an effect in decreasing the incidence of leprosy.

Resources

BOOKS

"Bacterial and Mycotic Infections: Leprosy." In *Microbiology.* 3rd ed. Ed. B. D. Davis, et al. New York: Harper & Row Publishers, 1980.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Zinsser, Hans. *Zinsser Microbiology.* 19th ed. Ed. Wolfgang K. Joklik, et al. Stamford: Appleton Lange, 1988.

PERIODICALS

Binford, Chapman, et al. "Leprosy." *Journal of the American Medical Association* 247 (23 Apr. 1982): 2283-2292.

ORGANIZATIONS

American Leprosy Missions. 1 ALM Way, Greenville, SC 29601. (1-800-LEPROSY).

British Leprosy Relief Association, LEPRA. Fairfax House, Causton Road, Colchester, Essex CO1 1PU, UK.

INFOLEP, Leprosy Information Services. Postbus 95005,1090 HA, Amsterdam, Netherlands. <Infolep@antenna.nl>.

WHO/LEP, Action Programme for the Elimination of Leprosy. 20 Avenue Appia CH-1211, Geneva 27, Suisse. (http://www.who.ch/programmes/lep/lep_home.htm).

OTHER

National Institutes of Health. <http://www.nih.gov>.

Cherath, Lata. "Leprosy." A Healthy Me Page. <http://www.ahealthyme.com/topic/topic100587076>.

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Leptospirosis

Definition

Leptospirosis is a febrile disease (**fever**) caused by infection with the bacteria *Leptospira interrogans*. The disease can range from very mild and symptomless to a more serious, even life threatening form, that may be associated with kidney (renal) failure.

Description

An infection by the bacterium *Leptospira interrogans* goes by different names in different regions. Alternate names for leptospirosis include mud fever, swamp fever, sugar cane fever, and Fort Bragg fever. More severe cases of leptospirosis are called Weil's syndrome or icterohemorrhagic fever. This disease is commonly found in tropical and subtropical climates but occurs worldwide.

As of the mid 1980s, there were 35-60 cases of leptospirosis reported in the United States each year. Most

cases occur in Hawaii, followed by the south Atlantic, Gulf, and Pacific coastal states. However, because of the nonspecific symptoms of leptospirosis, it is believed that the occurrence in the United States is actually much higher. Leptospirosis occurs year-round in the United States, but about half of the cases occur between July and October.

Leptospirosis is a disease of animals and can be a very serious problem in the livestock industry. *Leptospira* bacteria have been found in dogs, rats, livestock, mice, voles, rabbits, hedgehogs, skunks, possums, frogs, fish, snakes, and certain birds and insects. Infected animals will pass the bacteria in their urine for months, or even years. In the United States, rats and dogs are more commonly linked with human leptospirosis than other animals.

Humans are considered "accidental hosts" and become infected with *Leptospira interrogans* by coming into contact with urine from infected animals. This is either through direct contact with urine, or through contact with soil, water, or plants that have been contaminated by animal urine. *Leptospira interrogans* can survive for as long as six months outdoors under favorable conditions. Leptospira bacteria can enter the body through cuts or other skin damage or through mucous membranes (such as the inside of the mouth and nose). It is believed that the bacteria may be able to pass through intact skin, but this is not known.

Once past the skin barrier, the bacteria enter the blood stream and rapidly spread throughout the body. The infection causes damage to the inner lining of blood vessels. The liver, kidneys, heart, lungs, central nervous system, and eyes may be affected.

There are two stages in the disease process. The first stage is during the active Leptospira infection and is called the "bacteremic," or "septicemic," phase. The bacteremic phase lasts from three to seven days and presents as typical flu-like symptoms. During this phase, bacteria can be found in the patient's blood and cerebrospinal fluid. The second stage, or "immune phase," occurs either immediately after the bacteremic stage or after a one to three day symptom-free period. The immune phase can last up to one month. During the immune phase, symptoms are milder but **meningitis** (inflammation of spinal cord and brain tissues) is common. Bacteria can be isolated only from the urine during this second phase.

Causes and symptoms

Leptospirosis is caused by an infection with the bacterium *Leptospira interrogans*. The bacteria are spread through contact with urine from infected animals. Persons at an increased risk for leptospirosis include farmers, miners, animal health care workers, fish farmers and processors, sewage and canal workers, cane harvesters, and soldiers. High risk activities include care of pets, hunting, trail biking, freshwater swimming, rafting, canoeing, kayaking, and participating in sports in muddy fields.

Symptoms of *Leptospira* infection occur within seven to 12 days following exposure to the bacteria. Because the symptoms can be nonspecific, most people who have antibodies to *Leptospira* do not remember having had an illness. Eighty-five to 90% of the cases are not serious and clear up on their own. Symptoms of the first stage of leptospirosis last three to seven days and are: fever (100-105°F [37.8-40.6°C]), severe **headache**, muscle **pain**, stomach pain, chills, nausea, vomiting, back pain, joint pain, neck stiffness, and extreme exhaustion. **Cough** and body rash sometimes occur.

Following the first stage of disease, a brief symptom-free period occurs for most patients. The symptoms of the second stage vary in each patient. Most patients have a low grade fever, headache, vomiting, and rash. Aseptic meningitis is common in the second stage, symptoms of which include headache and **photosensitivity** (sensitivity of the eye to light). *Leptospira* can affect the eyes and make them cloudy and yellow to orange colored. Vision may be blurred.

Ten percent of the persons infected with *Leptospira* develop a serious disease called Weil's syndrome. The symptoms of Weil's syndrome are more severe than those described above and there is no distinction between the first and second stages of disease. The hallmark of Weil's syndrome is liver, kidney, and blood vessel disease. The signs of severe disease are apparent after three to seven days of illness. In addition to those listed above, symptoms of Weil's syndrome include **jaundice** (yellow skin and eyes), decreased or no urine output, **hypotension** (low blood pressure), rash, anemia (decreased number of red blood cells), **shock**, and severe mental status changes. Red spots on the skin, "blood shot" eyes, and bloody sputum signal that blood vessel damage and hemorrhage have occurred.

Diagnosis

Leptospirosis can be diagnosed and treated by doctors who specialize in infectious diseases. During the bacteremic phase of the disease, the symptoms are relatively nonspecific. This often causes an initial misdiagnosis because many diseases have similar symptoms to leptospirosis. The later symptoms of jaundice and kidney failure together with the bacteremic phase symptoms suggest leptospirosis. Blood samples will be tested to look for antibodies to *Leptospira interrogans*. Blood samples taken over a period of a few days would show an increase in the number of antibodies. Isolating *Leptospira* bacteria from blood, cerebrospinal fluid (performed

KEY TERMS

Hemodialysis—The removal of waste products from the blood stream in patients with kidney failure. Blood is removed from a vein, passed through a dialysis machine, and then put back into a vein.

Jarisch-Herxheimer reaction—A rare reaction to the dead bacteria in the blood stream following antibiotic treatment.

Meningitis—Inflammation of tissues in the brain and spinal cord. Aseptic meningitis refers to meningitis with no bacteria present in the cerebral spinal fluid.

by spinal tap), and urine samples is diagnostic of leptospirosis. It make take six weeks for *Leptospira* to grow in laboratory media. Most insurance companies would cover the diagnosis and treatment of this infection.

Treatment

Leptospirosis is treated with **antibiotics**, penicillin (Bicillin, Wycillin), doxycycline (Monodox), ibramycin, or erythromycin (E-mycin, Ery-Tab). As of early 1998, the timing of antibiotic treatment is controversial. It is generally agreed that antibiotic treatment during the first few days of illness is helpful. However, leptospirosis is often not diagnosed until the later stages of illness. The benefit of antibiotic treatment in the later stages of disease is controversial. A rare complication of antibiotic therapy for leptospirosis is the occurrence of the Jarisch-Herxheimer reaction, which is characterized by fever, chills, headache, and muscle pain.

Patients with severe illness will require hospitalization for treatment and monitoring. Medication or other treatment for pain, fever, vomiting, fluid loss, bleeding, mental changes, and low blood pressure may be provided. Patients with kidney failure will require hemodialysis to remove waste products from the blood.

Prognosis

The majority of patients infected with *Leptospira interrogans* experience a complete recovery. Ten percent of the patients will develop eye inflammation (**uveitis**) up to one year after the illness. In the United States, about one out of every 100 patients will die from leptospirosis. **Death** is usually caused by kidney failure, but has also been caused by **myocarditis** (inflammation of heart tissue), **septic shock** (reduced blood flow to the organs because of the bacterial infection), organ failure, and/or poorly functioning lungs.

Prevention

Persons who are at an extremely high risk (such as soldiers who are training in wetlands) can be pretreated with 200 mg of doxycycline once a week. As of early 1998, there were no vaccines available to prevent leptospirosis.

There are many ways to decrease the chances of being infected by *Leptospira*. These include:

- avoid swimming or wading in freshwater ponds and slowly moving streams, especially those located near farms.
- do not conduct canoe or kayak capsizing drills in freshwater ponds. Use a swimming pool instead.
- boil or chemically treat pond or stream water before drinking it or cooking with it.
- control rats and mice around the home.
- have pets and farm animals vaccinated against *Leptospira*.
- wear protective clothing (gloves, boots, long pants, and long-sleeved shirts) when working with wet soil or plants

Resources

BOOKS

Cook, G. C. *Manson's Tropical Diseases*. 20th ed. London: W. B. Saunders Co., 1996.

Gorbach, Samuel L., John G. Bartlett, and Neil R. Blacklow. *Infectious Diseases*. 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Farr, R. Wesley. "Leptospirosis." *Clinical Infectious Diseases* 21 (1995): 1-8.

OTHER

Centers for Disease Control. 20 Apr. 1998 <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

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Lesch-Nyhan syndrome

Definition

Lesch-Nyhan syndrome is a rare genetic disorder that affects males. Males with this syndrome develop physical handicaps, **mental retardation**, and kidney

problems. It is caused by a total absence of an enzyme. Self injury is a classic feature of this genetic disease.

Description

Lesch-Nyhan syndrome was first described in 1964 by Dr. Michael Lesch and Dr. William Nyhan. The syndrome is caused by a severe change (mutation) in the HPRT gene. This gene is responsible for the production the enzyme called hypoxanthine-guanine phosphoribosyltransferase(HPRT). HPRT catalyzes a reaction that is necessary to prevent the buildup of uric acid. A severe mutation in the HPRT gene leads to an absence of HPRT enzyme activity which, in turn, leads to markedly elevated uric acid levels in the blood(hyperuricemia). This buildup of uric acid is toxic to the body and is related to the symptoms associated with the disease. Absence of the HPRT enzyme activity is also thought to alter the chemistry of certain parts of the brain, such as the basal ganglia, affecting neurotransmitters (chemicals used for communication between nerve cells), acids, and other chemicals. This change in the nervous system is also related to the symptoms associated with Lesch-Nyhan syndrome.

Males with Lesch-Nyhan syndrome develop neurologic problems during infancy. Infants with Lesch-Nyhan syndrome have weak muscle tone (hypotonia) and are unable to develop normally. Affected males develop uncontrollable writhing movements (athetosis) and muscle stiffness (spasticity) over time. Lack of speech is also a common feature of Lesch-Nyhan syndrome. The most dramatic symptom of Lesch-Nyhan syndrome is the compulsive self-injury seen in 85% of affected males. This self injury involves the biting of their own lips, tongue, and finger tips, as well as head banging. This behavior leads to serious injury and scarring.

Lesch-Nyhan syndrome affects approximately one in 380,000 live births. It occurs evenly among races. Almost always, only male children are affected. Women carriers usually do not have any symptoms. Women carriers can occasionally develop inflammation of the joints (gout)as they get older.

Causes and symptoms

Severe changes(mutations)in the HPRT gene completely halt the activity of the enzyme HPRT. There have been many different severe mutations identified in the HPRT gene. These mutations may be different between families. The HPRT gene is located on the X chromosome. Since the HPRT gene is located on the X chromosome, Lesch-Nyhan syndrome is considered X-liked. This means that it only affects males.

A person's sex is determined by their chromosomes. Males have one X chromosome and one Y chromosome. Females, on the other hand, have two X chromosomes. Males who possess a severe mutation in their HPRT gene will develop Lesch-Nyhan syndrome. Females who possess a severe mutation in their HPRT gene will not. They are considered to be carriers. This is because females have another X chromosome without the mutation that prevents them from getting this disease. If a woman is a carrier, she has a 50% risk with any **pregnancy** to pass on her X chromosome with the mutation. Therefore, with every male pregnancy she has a 50% risk to have an affected son, and with every female pregnancy she has a 50% risk to have a daughter who is a carrier.

At birth, males with Lesch-Nyhan syndrome appear completely normal. Development is usually normal for the first few months. Symptoms develop between three to six months of age. Sand-like crystals of uric acid in the diapers may be one of the first symptoms of the disease. The baby may be unusually irritable. Typically, the first sign of nervous system impairment is the inability to lift their head or sit up at an appropriate age. Many patients with Lesch-Nyhan will never learn to walk. By the end of the first year, writhing motions (athetosis), and spasmodic movements of the limbs and facial muscles (chorea) are clear evidence of defective motor development.

The compulsive self-injury associated with Lesch-Nyhan syndrome begins, on average, at three years. The self-injury begins with biting of the lips and tongue. As the disease progresses, affected individuals frequently develop finger biting and head banging. The self-injury can increase during times of **stress**.

Males with Lesch-Nyhan disease may also develop kidney damage due to **kidney stones**. Swollen and tender joints(gout)is another common problem.

Diagnosis

The diagnosis of Lesch-Nyhan syndrome is based initially on the distinctive pattern of symptoms. Measuring the amount of uric acid in a person's blood or urine can not definitively diagnose Lesch-Nyhan syndrome. It is diagnosed by measuring the activity of the HPRT enzyme through a blood test. When the activity of the enzyme is very low it is diagnostic of Lesch-Nyhan syndrome. It can also be diagnosed by DNA testing. This is also a blood test. DNA testing checks for changes (mutations) in the HPRT gene. Results from DNA testing are helpful in making the diagnosis and also if the family is interested in prenatal testing for future pregnancies.

Prenatal diagnosis is possible by DNA testing of fetal tissue drawn by **amniocentesis** or **chorionic villus sampling** (CVS). Fetuses should be tested if the mother is a carrier of a change (mutation) in her HPRT gene. A woman is at risk of being a carrier if she has a son with

KEY TERMS

Amniocentesis—A procedure performed at 16-18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Athetosis—A condition marked by slow, writhing, involuntary muscle movements.

Basal ganglia—A section of the brain responsible for smooth muscular movement.

Chorea—Involuntary, rapid, jerky movements.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10-12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Neurotransmitter—Chemical in the brain that transmits information from one nerve cell to another.

Palsy—Uncontrolable tremors.

Spasticity—Increased mucle tone, or stiffness, which leads to uncontrolled, awkward movements.

Lesch-Nyhan syndrome or someone in her family has Lesch-Nyhan syndrome. Any woman at risk of being a carrier should have DNA testing through a blood test.

Treatment

There are no known treatments for the neurological defects of Lesch-Nyhan. The medication Allopurinol can lower blood uric acid levels. This medication does not correct many of the symptoms. Some patients with Lesch-Nyhan syndrome have their teeth removed to prevent self-injury. Restraints are recommended to reduce self-destructive behaviors.

Prognosis

With strong supportive care, infants born with Lesch-Nyhan can live into adulthood with symptoms continuing throughout life.

At present, there are no preventive measures for Lesch-Nyhan syndrome. However, recent studies have indicated that this genetic disorder may be a good candidate for treatment with gene replacement therapy. Unfortunately, the technology necessary to implement this therapy has not yet been perfected.

Resources

BOOKS

Jinnah, H.A., and Theodore Friedmann. "Lesch-Nyhan Disease and Its Variants." *The Metabolic and Molecular Bases of Inherited Disease*. New York: McGraw-Hill, 2001.

PERIODICALS

Lesch, M., and W.L. Nyhan. "A Familial Disorder of Uric Acid Metabolism and Central Nervous System Function." *American Journal of Medicine* 36 (1964): 561–570.

Mak, B.S., et al. "New Mutations of the HPRT Gene in Lesch-Nyhan Syndrome." *Pediatric Neurology* (October 2000): 332–335.

Visser, J.E., et al. "Lesch-Nyhan Disease and the Basal Ganglia." *Brain Research Reviews* (November 1999): 450–469.

ORGANIZATIONS

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington, DC 20008. (202) 966-5557. Fax: (202) 966-8553. <http://www.geneticalliance.org>.

International Lesch-Nyhan Disease Association. 114 Winchester Way, Shamong, NJ 08088-9398. (215) 677-4206.

Lesch-Nyhan Syndrome Registry. New York University School of Medicine, Department of Psychiatry, 550 First Ave., New York, NY 10012. (212) 263-6458.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

OTHER

GeneClinics <http://www.geneclinics.org/profiles/lns/details.html>.

Pediatric Database(PEDBASE) <http://www.icondata.com/health/pedbase/files/LESCH-NY.HTM>.

Holly Ann Ishmael

Leukemia stains

Definition

Leukemia stains are laboratory tests done on bone marrow or blood samples to help diagnose specific types of leukemia.

Purpose

Leukemia stains are done to diagnose and classify leukemia. Blood contains red cells, several varieties of white cells, and platelets. Cancerous overproduction of any one type of cell produces one of many types of leukemia. A patient's specific type of leukemia must be classified in order to provide the best treatment and most accurate prognosis.

The type and maturity of the cells involved are identified by analyzing blood and bone marrow under a microscope. Often, however, the abnormality or immaturity of the cells make it difficult to identify the cell types with certainty. Special leukemia stains help to distinguish one cell type from another.

Description

Special stains are added to bone marrow or blood that has been smeared on a microscope slide. Cell types react differently to the chemicals in the stains.

If the patient has few white cells, a buffy coat smear is made. A tube of blood is spun in a centrifuge. Red cells fall, plasma rises, and white cells settle in a thin middle layer called the buffy coat. The smear is made from this layer.

Sudan black B stain

This stain distinguishes between acute lymphoblastic leukemia (cells stain positive) and acute myeloblastic leukemia (cells stain negative).

Periodic acid-Schiff stain (PAS)

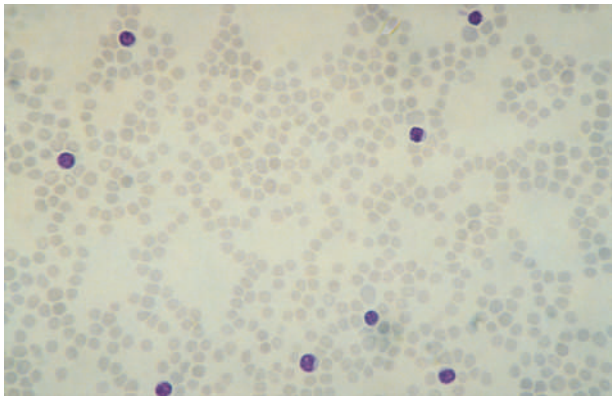
The PAS stain is primarily used to identify erythroleukemia, a leukemia of immature red blood cells. These cells stain a bright fuchsia.

Terminal deoxynucleotidyl transferase stain (TdT)

The TdT stain differentiates between acute lymphoblastic leukemia (cells stain positive) and acute myelogenous leukemia (cells stain negative).

Leukocyte alkaline phosphatase (LAP)

The LAP stain is used to determine if an increase of cells is due to chronic myelogenous leukemia or a noncancerous reaction to an infection or similar conditions. Cells from a noncancerous reaction stain positive with many intense blue granules; cells from chronic myelogenous leukemia have few blue granules.



A magnified stain of chronic lymphocytic leukemia cells. *(Custom Medical Stock Photo. Reproduced by permission.)*

Tartrate-resistant acid phosphatase stain (TRAP)

The TRAP stain is primarily used to identify **hairy cell leukemia** cells. These cells stain with purple to dark red granules.

Myeloperoxidase stain

The myeloperoxidase stain distinguishes between the immature cells in acute myeloblastic leukemia (cells stain positive) and those in acute lymphoblastic leukemia (cells stain negative).

Leukocyte specific esterase

This stain identifies granulocytes, which show red granules.

Leukocyte nonspecific esterase

Nonspecific esterase stain identifies monocytes and immature platelets (megakaryocytes), which show positive black granules.

Preparation

Leukemia stains are done on smears of blood or bone marrow. To collect blood, a healthcare worker draws blood from a vein in the inner elbow region. Collection of the sample takes only a few minutes.

When bone marrow is needed, the person is given local anesthesia. Then the physician inserts a needle

KEY TERMS

Bone marrow—The spongy tissue inside large bones where blood cells are formed.

Buffy coat—The thin layer of concentrated white blood cells that forms when a tube of blood is spun in a centrifuge.

Leukemia—Any of several cancers of the bone marrow characterized by the abnormal increase of a type of blood cell.

Leukemia stains—Special stains added to smears of blood or bone marrow, performed to diagnose and classify leukemia.

through the skin and into the bone—usually the breast bone or hip bone—and 0.5-2 mL of bone marrow is withdrawn. This procedure takes approximately 30 minutes.

Aftercare

Patients sometimes feel discomfort or bruising at the puncture site after blood collection. They may also become dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Collection of bone marrow is done under a physician's supervision. The patient is asked to rest after the procedure and is watched for weakness and signs of bleeding.

Normal results

A normal blood or bone marrow smear shows no evidence of leukemic cells. The expected reaction of cells varies with the type of stain.

Abnormal results

Leukemia stain results that help diagnosis and classify leukemia are supported by the results of other laboratory tests and the person's clinical condition.

Resources

BOOKS

Fischbach, Francis. *Manual of Laboratory and Diagnostic Tests*. Philadelphia: Lippincott, 1996.

Nancy J. Nordenson

Leukemias, acute

Definition

Leukemia is a **cancer** that starts in the organs that make blood, namely the bone marrow and the lymph system. Depending on their characteristics, leukemias can be divided into two broad types. Acute leukemias are the rapidly progressing leukemias, while the chronic leukemias progress more slowly. The vast majority of the childhood leukemias are of the acute form.

Description

The cells that make up blood are produced in the bone marrow and the lymph system. The bone marrow is the spongy tissue found in the large bones of the body. The lymph system includes the spleen (an organ in the upper abdomen), the thymus (a small organ beneath the breastbone), and the tonsils (an organ in the throat). In addition, the lymph vessels (tiny tubes that branch like blood vessels into all parts of the body) and lymph nodes (pea-shaped organs that are found along the network of lymph vessels) are also part of the lymph system. The lymph is a milky fluid that contains cells. Clusters of lymph nodes are found in the neck, underarm, pelvis, abdomen, and chest.

The cells found in the blood are the red blood cells (RBCs), which carry oxygen and other materials to all tissues of the body; white blood cells (WBCs) that fight infection; and the platelets, which play a part in the clotting of the blood. The white blood cells can be further subdivided into three main types: granulocytes, monocytes, and lymphocytes.

The granulocytes, as their name suggests, have particles (granules) inside them. These granules contain special proteins (enzymes) and several other substances that can break down chemicals and destroy microorganisms, such as bacteria. Monocytes are the second type of white blood cell. They are also important in defending the body against pathogens.

The lymphocytes form the third type of white blood cell. There are two main types of lymphocytes: T lymphocytes and B lymphocytes. They have different functions within the immune system. The B cells protect the body by making "antibodies." Antibodies are proteins that can attach to the surfaces of bacteria and viruses. This "attachment" sends signals to many other cell types to come and destroy the antibody-coated organism. The T cells protect the body against viruses. When a virus enters a cell, it produces certain proteins that are projected onto the surface of the infected cell. The T cells recognize these proteins and make certain chemicals that are

capable of destroying the virus-infected cells. In addition, the T cells can destroy some types of cancer cells.

The bone marrow makes stem cells, which are the precursors of the different blood cells. These stem cells mature through stages into either RBCs, WBCs, or platelets. In acute leukemias, the maturation process of the white blood cells is interrupted. The immature cells (or "blasts") proliferate rapidly and begin to accumulate in various organs and tissues, thereby affecting their normal function. This uncontrolled proliferation of the immature cells in the bone marrow affects the production of the normal red blood cells and platelets as well.

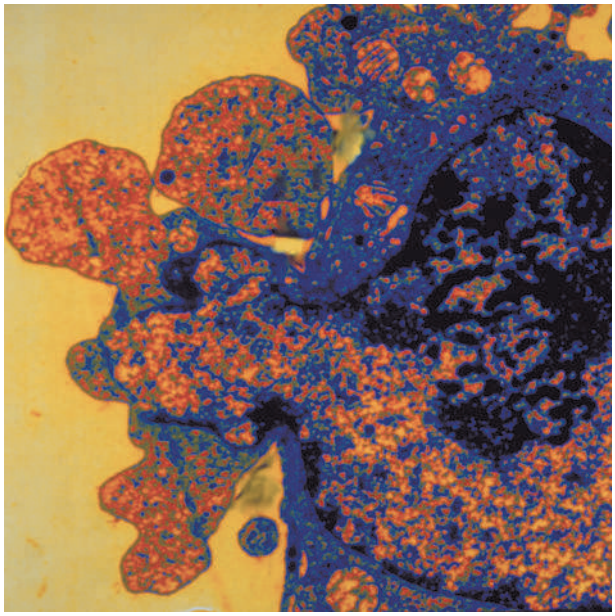
Acute leukemias are of two types: acute lymphocytic leukemia and acute myelogenous leukemia. Different types of white blood cells are involved in the two leukemias. In acute lymphocytic leukemia (ALL), it is the T or the B lymphocytes that become cancerous. The B cell leukemias are more common than T cell leukemias. Acute myelogenous leukemia, also known as acute nonlymphocytic leukemia (ANLL), is a cancer of the monocytes and/or granulocytes.

Leukemias account for 2% of all cancers. Because leukemia is the most common form of childhood cancer, it is often regarded as a disease of childhood. However, leukemias affect nine times as many adults as children. Half of the cases occur in people who are 60 years of age or older. The incidence of acute and chronic leukemias is about the same. According to the estimates of the American Cancer Society (ACS), approximately 29,000 new cases of leukemia will be diagnosed in 1998.

Causes and symptoms

Leukemia strikes both sexes and all ages. The human T-cell leukemia virus (HTLV-I) is believed to be the causative agent for some kinds of leukemias. However, the cause of most leukemias is not known. Acute lymphoid leukemia (ALL) is more common among Caucasians than among African-Americans, while acute myeloid leukemia (AML) affects both races equally. The incidence of acute leukemia is slightly higher among men than women. People with Jewish ancestry have a higher likelihood of getting leukemia. A higher incidence of leukemia has also been observed among persons with **Down syndrome** and some other genetic abnormalities.

Exposure to ionizing radiation and to certain organic chemicals, such as benzene, is believed to increase the risk of getting leukemia. Having a history of diseases that damage the bone marrow, such as **aplastic anemia**, or a history of cancers of the lymphatic system puts people at a high risk for developing acute leukemias. Similarly, the use of anticancer medications, immunosuppressants, and the antibiotic chloramphenicol are also considered risk factors for developing acute leukemias.



An enhanced transmission electron microscopy (TEM) image of acute myelogenous leukemia cells. *(Photograph by Robert Becker, Ph.D., Custom Medical Stock Photo. Reproduced by permission.)*

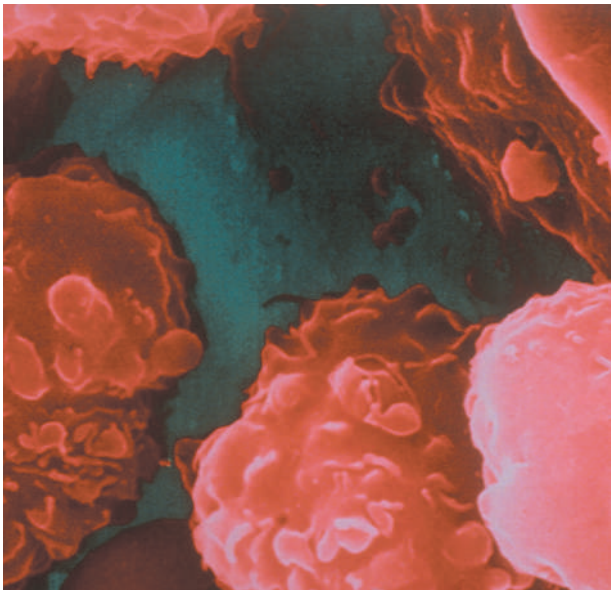
The symptoms of leukemia are generally vague and non-specific. A patient may experience all or some of the following symptoms:

- weakness or chronic **fatigue**
- fever of unknown origin
- weight loss that is not due to dieting or **exercise**
- frequent bacterial or viral infections
- headaches
- skin rash
- non-specific bone **pain**
- easy bruising
- bleeding from gums or nose
- blood in urine or stools
- enlarged lymph nodes and/or spleen
- abdominal fullness

Diagnosis

Like all cancers, acute leukemias are best treated when found early. There are no screening tests available.

If the doctor has reason to suspect leukemia, he or she will conduct a very thorough **physical examination** to look for enlarged lymph nodes in the neck, underarm,



An enhanced scanning electron microscopy (SEM) image of acute myelogenous leukemia cells. *(Photograph by Robert Becker, Ph.D., Custom Medical Stock Photo. Reproduced by permission.)*

and pelvic region. Swollen gums, enlarged liver or spleen, **bruises**, or pinpoint red **rashes** all over the body are some of the signs of leukemia. Urine and blood tests may be ordered to check for microscopic amounts of blood in the urine and to obtain a complete differential **blood count**. This count will give the numbers and percentages of the different cells found in the blood. An abnormal blood test might suggest leukemia; however, the diagnosis has to be confirmed by more specific tests.

The doctor may perform a bone marrow biopsy to confirm the diagnosis of leukemia. During the biopsy, a cylindrical piece of bone and marrow is removed. The tissue is generally taken out of the hipbone. These samples are sent to the laboratory for examination. In addition to diagnosis, the biopsy is also repeated during the treatment phase of the disease to see if the leukemia is responding to therapy.

A spinal tap (lumbar puncture) is another procedure that the doctor may order to diagnose leukemia. In this procedure, a small needle is inserted into the spinal cavity in the lower back to withdraw some cerebrospinal fluid and to look for leukemic cells.

Standard imaging tests, such as x rays, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) may be used to check whether the leukemic cells have invaded other areas of the body, such as the bones, chest, kidneys, abdomen, or brain. A gallium scan or bone scan is a test in which a radioactive chemical is injected into the body. This chemical accumulates in the areas of cancer or infection, allowing them to be viewed with a special camera.

Treatment

There are two phases of treatment for leukemia. The first phase is called "induction therapy." As the name suggests, during this phase, the main aim of the treatment is to reduce the number of leukemic cells as far as possible and induce a remission in the patient. Once the patient shows no obvious signs of leukemia (no leukemic cells are detected in blood tests and bone marrow biopsies), the patient is said to be in remission. The second phase of treatment is then initiated. This is called continuation or maintenance therapy, and the aim in this case is to kill any remaining cells and to maintain the remission for as long as possible.

Chemotherapy is the use of drugs to kill cancer cells. It is usually the treatment of choice and is used to relieve symptoms and achieve long-term remission of the disease. Generally, combination chemotherapy, in which multiple drugs are used, is more efficient than using a single drug for the treatment. Some drugs may be administered intravenously through a vein in the arm; others may be given by mouth in the form of pills. If the cancer cells have invaded the brain, then chemotherapeutic drugs may be put into the fluid that surrounds the brain through a needle in the brain or back. This is known as intrathecal chemotherapy.

Because leukemia cells can spread to all the organs via the blood stream and the lymph vessels, surgery is not considered an option for treating leukemias.

Radiation therapy, which involves the use of x rays or other high-energy rays to kill cancer cells and shrink tumors, may be used in some cases. For acute leukemias, the source of radiation is usually outside the body (external radiation therapy). If the leukemic cells have spread to the brain, radiation therapy can be given to the brain.

Bone marrow transplantation is a process in which the patient's diseased bone marrow is replaced with healthy marrow. There are two ways of doing a bone marrow transplant. In an allogeneic bone marrow transplant, healthy marrow is taken from a donor whose tissue is either the same as or very closely resembles the patient's tissues. The donor may be a twin, a brother or sister (sibling), or a person who is not related at all. First, the patient's bone marrow is destroyed with very high doses of chemotherapy and radiation therapy. Healthy marrow from the donor is then given to the patient through a needle in a vein to replace the destroyed marrow.

In the second type of bone marrow transplant, called an autologous bone marrow transplant, some of the

KEY TERMS

Antibodies—Proteins made by the B lymphocytes in response to the presence of infectious agents, such as bacteria or viruses, in the body.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Chemotherapy—Treatment with drugs that act against cancer.

Computerized tomography (CT) scan—A series of x rays put together by a computer in order to form detailed pictures of areas inside the body.

Cytokines—Chemicals made by the cells that act on other cells to stimulate or inhibit their function. Cytokines that stimulate growth are called "growth factors."

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Lumbar puncture—A procedure in which the doctor inserts a small needle into the spinal cavity in the lower back to withdraw some spinal fluid for testing. Also known as a "spinal tap."

Magnetic resonance imaging (MRI)—A medical procedure using a magnet linked to a computer to picture areas inside the body.

Maturation—The process by which stem cells transform from immature cells without a specific function into a particular type of blood cell with defined functions.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Remission—A disappearance of a disease as a result of treatment. Complete remission means that all disease is gone. Partial remission means that the disease is significantly improved by treatment, but residual traces of the disease are still present.

patient's own marrow is taken out and treated with a combination of **anticancer drugs** to kill all the abnormal cells. This marrow is then frozen to save it. The marrow remaining in the patient's body is destroyed with high-dose chemotherapy and radiation therapy. The marrow that was frozen is then thawed and given back to the patient through a needle in a vein. This mode of bone marrow transplant is currently being investigated in clinical trials.

Biological therapy or immunotherapy is a mode of treatment in which the body's own immune system is harnessed to fight the cancer. Substances that are routinely made by the immune system (such as growth factors, hormones, and disease-fighting proteins) are either synthetically made in a laboratory or their effectiveness is boosted and they are then put back into the patient's body. This treatment mode is also being investigated in clinical trials all over the country at major cancer centers.

Prognosis

Like all cancers, the prognosis for leukemia depends on the patient's age and general health. According to statistics, more than 60% of the patients with leukemia survive for at least a year after diagnosis. Acute myelocytic leukemia (AML) has a poorer prognosis rate than acute lymphocytic leukemias (ALL) and the chronic leukemias. In the last 15 to 20 years, the five-year survival rate for patients with ALL has increased from 38% to 57%.

Interestingly enough, since most childhood leukemias are of the ALL type, chemotherapy has been highly successful in their treatment. This is because chemotherapeutic drugs are most effective against actively growing cells. Due to the new combinations of anticancer drugs being used, the survival rates among children with ALL have improved dramatically. Eighty percent of the children diagnosed with ALL now survive for five years or more, as compared to 50% in the late 1970s.

Prevention

Most cancers can be prevented by changes in lifestyle or diet, which will reduce the risk factors. However, in leukemias, there are no such known risk factors. Therefore, at the present time, no way is known to prevent leukemias from developing. People who are at an increased risk for developing leukemia because of proven exposure to ionizing radiation or exposure to the toxic liquid benzene, and people with Down syndrome, should undergo periodic medical checkups.

Resources

BOOKS

Berkow, Robert, ed., et al. *Merck Manual of Diagnosis and Therapy.* 17th ed. Merck Research Laboratories, 1997.

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Morra, Marion E., and Eve Potts. *Choices: The New, Most Up-To-Date Sourcebook for Cancer Information.* New York: Avon Books, 1994.

Murphy, Gerald P. *Informed Decisions: The Complete Book of Cancer Diagnosis, Treatment and Recovery.* American Cancer Society, 1997.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute. 681 Fifth Ave., New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Leukemia Society of America, Inc. 600 Third Ave., New York, NY 10016. (800) 955-4572. <http://www.leukemia.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Oncolink. University of Pennsylvania Cancer Center. <http://cancer.med.upenn.edu>.

Lata Cherath, PhD

Leukemias, chronic

Definition

Chronic leukemia is a disease in which too many white blood cells are made in the bone marrow. Depending on the type of white blood cell that is involved, chronic leukemia can be classified as chronic lymphocytic leukemia or chronic myeloid leukemia.

Description

Chronic leukemia is a **cancer** that starts in the blood cells made in the bone marrow. The bone marrow is the spongy tissue found in the large bones of the body. The bone marrow makes precursor cells called "blasts" or "stem cells" that mature into different types of blood cells. Unlike acute leukemias, in which the process of maturation of the blast cells is interrupted, in chronic leukemias, the cells do mature and only a few remain as immature cells. However, even though the cells appear normal, they do not function as normal cells.

The different types of cells that are produced in the bone marrow are red blood cells (RBCs), which carry oxygen and other materials to all tissues of the body; white blood cells (WBCs), which fight infection; and platelets, which play a part in the clotting of the blood. The white blood cells can be further subdivided into three main types: the granulocytes, monocytes, and the lymphocytes.

The granulocytes, as their name suggests, have granules (particles) inside them. These granules contain special proteins (enzymes) and several other substances that can break down chemicals and destroy microorganisms such as bacteria.

Monocytes are the second type of white blood cell. They are also important in defending the body against pathogens.

The lymphocytes form the third type of white blood cell. There are two main types of lymphocytes: T lymphocytes and B lymphocytes. They have different functions within the immune system. The B cells protect the body by making "antibodies." Antibodies are proteins that can attach to the surfaces of bacteria and viruses. This attachment sends signals to many other cell types to come and destroy the antibody-coated organism. The T cell protects the body against viruses. When a virus enters a cell, it produces certain proteins that are projected onto the surface of the infected cell. The T cells can recognize these proteins and produce certain chemicals (cytokines) that are capable of destroying the virus-infected cells. In addition, the T cells can destroy some types of cancer cells.

Chronic leukemias develop very gradually. The abnormal lymphocytes multiply slowly, but in a poorly regulated manner. They live much longer and thus their numbers build up in the body. The two types of chronic leukemias can be easily distinguished under the microscope. Chronic lymphocytic leukemia (CLL) involves the T or B lymphocytes. B cell abnormalities are more common than T cell abnormalities. T cells are affected in only 5% of the patients. The T and B lymphocytes can be differentiated from the other types of white blood cells based on their size and by the absence of granules inside them. In chronic myelogenous leukemia (CML), the cells that are affected are the granulocytes.

Chronic lymphocytic leukemia (CLL) often has no symptoms at first and may remain undetected for a long time. Chronic myelogenous leukemia (CML), on the other hand, may progress to a more acute form.

Chronic leukemias account for 1.2% of all cancers. Because leukemia is the most common form of childhood cancer, it is often regarded as a disease of childhood. However, leukemias affect nine times as many adults as children. In chronic lymphoid leukemia, 90% of the cases are seen in people who are 50 years or older, with the average age at diagnosis being 65. The incidence of the disease increases with age. It is almost never seen in children. Chronic myeloid leukemias are generally seen in people in their mid-40s. It accounts for about 4% of childhood leukemia cases. According to the estimates of the American Cancer Society (ACS), approximately 29,000 new cases of leukemia will be diagnosed in 1998.

KEY TERMS

Antibodies—Proteins made by the B lymphocytes in response to the presence of infectious agents, such as bacteria or viruses, in the body.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Chemotherapy—Treatment with drugs that act against cancer.

Computerized tomography (CT) scan—A series of x rays put together by a computer in order to form detailed pictures of areas inside the body.

Cytokines—Chemicals made by the cells that act on other cells to stimulate or inhibit their function. Cytokines that stimulate growth are called "growth factors."

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Lumbar puncture—A procedure in which the doctor inserts a small needle into the spinal cavity in the lower back to withdraw some spinal fluid for testing. Also known as a "spinal tap."

Magnetic resonance imaging (MRI)—A medical procedure using a magnet linked to a computer to picture areas inside the body.

Maturation—The process by which stem cells transform from immature cells without a specific function into a particular type of blood cell with defined functions.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Remission—A disappearance of a disease as a result of treatment. Complete remission means that all disease is gone. Partial remission means that the disease is significantly improved by treatment, but residual traces of the disease are still present.

Causes and symptoms

Leukemia strikes both sexes and all ages. Although the cause is unknown, chronic leukemia is linked to genetic abnormalities and environmental factors. For example, exposure to ionizing radiation and to certain organic chemicals, such as benzene, is believed to increase the risks for getting leukemia. Chronic leukemia occurs in some people who are infected with two human retroviruses (HTLV-I and HTLV-II). An abnormal chromosome known as the Philadelphia chromosome is seen in 90% of those with CML. The incidence of chronic leukemia is slightly higher among men than women.

The symptoms of chronic leukemia are generally vague and non-specific. In chronic lymphoid leukemia (CLL), a patient may experience all or some of the following symptoms:

- swollen lymph nodes
- an enlarged spleen, which could make the patient complain of abdominal fullness
- chronic **fatigue**
- a general feeling of ill-health
- fever of unknown origin
- night sweats
- weight loss that is not due to dieting or **exercise**
- frequent bacterial or viral infections

In the early stages of chronic myeloid leukemia (CML), the symptoms are more or less similar to CLL. In the later stages of the disease, the patient may experience these symptoms:

- non-specific bone **pain**
- bleeding problems
- mucus membrane irritation
- frequent infections
- a pale color due to a low red blood cell count (anemia)
- swollen lymph glands
- fever
- night sweats

Diagnosis

There are no screening tests available for chronic leukemias. The detection of these diseases may occur by chance during a routine **physical examination**.

If the doctor has reason to suspect leukemia, he or she will conduct a very thorough physical examination to look for enlarged lymph nodes in the neck, underarm, and pelvic region. Swollen gums, an enlarged liver or spleen, **bruises**, or pinpoint red **rashes** all over the

body are some of the signs of leukemia. Urine and blood tests may be ordered to check for microscopic amounts of blood in the urine and to obtain a complete differential **blood count**. This count will give the numbers and percentages of the different cells found in the blood. An abnormal blood test might suggest leukemia; however, the diagnosis has to be confirmed by more specific tests.

The doctor may perform a bone marrow biopsy to confirm the diagnosis of leukemia. During the bone marrow biopsy, a cylindrical piece of bone and marrow is removed. The tissue is generally taken out of the hipbone. These samples are sent to the laboratory for examination. In addition to diagnosis, bone marrow biopsy is also done during the treatment phase of the disease to see if the leukemia is responding to therapy.

Standard imaging tests such as x rays, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) may be used to check whether the leukemic cells have invaded other organs of the body, such as the bones, chest, kidneys, abdomen, or brain.

Treatment

The treatment depends on the specific type of chronic leukemia and its stage. In general, **chemotherapy** is the standard approach to both CLL and CML. **Radiation therapy** is occasionally used. Because leukemia cells can spread to all the organs via the blood stream and the lymph vessels, surgery is not considered an option for treating leukemias.

Bone marrow transplantation (BMT) is becoming the treatment of choice for CML because it has the possibility of curing the illness. BMT is generally not considered an option in treating CLL because CLL primarily affects older people, who are not considered to be good candidates for the procedure.

In BMT, the patient's diseased bone marrow is replaced with healthy marrow. There are two ways of doing a bone marrow transplant. In an allogeneic bone marrow transplant, healthy marrow is taken from another person (donor) whose tissue is either the same or very closely resembles the patient's tissues. The donor may be a twin, a sibling, or a person who is not related at all. First, the patient's bone marrow is destroyed with very high doses of chemotherapy and radiation therapy. To replace the destroyed marrow, healthy marrow from the donor is given to the patient through a needle in the vein.

In the second type of bone marrow transplant, called an autologous bone marrow transplant, some of the patient's own marrow is taken out and treated with a combination of **anticancer drugs** to kill all the abnormal cells. This marrow is then frozen to save it. The marrow remaining in the patient's body is then destroyed with high dose chemotherapy and radiation therapy. Following that, the patient's own marrow that was frozen is thawed and given back to the patient through a needle in the vein. This mode of bone marrow transplant is currently being investigated in clinical trials.

In chronic lymphoid leukemia (CLL), chemotherapy is generally the treatment of choice. Depending on the stage of the disease, single or multiple drugs may be given. Drugs commonly prescribed include steroids, chlorambucil, fludarabine, and cladribine. Low dose radiation therapy may be given to the whole body, or it may be used to alleviate the symptoms and discomfort due to an enlarged spleen and lymph nodes. The spleen may be removed in a procedure called a **splenectomy**.

In chronic myeloid leukemia (CML), the treatment of choice is bone marrow transplantation. During the slow progress (chronic phase) of the disease, chemotherapy may be given to try to improve the cell counts. Radiation therapy, which involves the use of x rays or other high-energy rays to kill cancer cells and shrink tumors, may be used in some cases to reduce the discomfort and pain due to an enlarged spleen. For chronic leukemias, the source of radiation is usually outside the body (external radiation therapy). If the leukemic cells have spread to the brain, radiation therapy can be directed at the brain. As the disease progresses, the spleen may be removed in an attempt to try to control the pain and to improve the blood counts.

In the acute phase of CML, aggressive chemotherapy is given. Combination chemotherapy, in which multiple drugs are used, is more efficient than using a single drug for the treatment. The drugs may either be administered intravenously through a vein in the arm or by mouth in the form of pills. If the cancer cells have invaded the central nervous system (CNS), chemotherapeutic drugs may be put into the fluid that surrounds the brain through a needle in the brain or back. This is known as intrathecal chemotherapy.

Biological therapy or immunotherapy is a mode of treatment in which the body's own immune system is harnessed to fight the cancer. Substances that are routinely made by the immune system (such as growth factors, hormones, and disease-fighting proteins) are either synthetically made in a laboratory, or their effectiveness is boosted and they are then put back into the patient's body. This treatment mode is also being investigated in clinical trials all over the country at major cancer centers.

Prognosis

The prognosis for leukemia depends on the patient's age and general health. According to statistics, in chronic lymphoid leukemia, the overall survival for all stages of the disease is nine years. Most of the deaths in people with CLL are due to infections or other illnesses that occur as a result of the leukemia.

In CML, if bone marrow transplantation is performed within one to three years of diagnosis, 50-60% of the patients survive three years or more. If the disease progresses to the acute phase, the prognosis is poor. Less than 20% of these patients go into remission.

Prevention

Most cancers can be prevented by changes in lifestyle or diet, which will reduce the risk factors. However, in leukemias, there are no known risk factors. Therefore, at the present time, there is no way known to prevent the leukemias from developing. People who are at an increased risk for developing leukemia because of proven exposure to ionizing radiation, the organic liquid benzene, or people who have a history of other cancers of the lymphoid system (Hodgkin's lymphoma) should undergo periodic medical checkups.

Resources

BOOKS

Berkow, Robert, ed., et al. *Merck Manual of Diagnosis and Therapy.* 17th ed. Merck Research Laboratories, 1997.

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Morra, Marion E., and Eve Potts. *Choices: The New, Most Up-To-Date Sourcebook for Cancer Information.* New York: Avon Books, 1994.

Murphy, Gerald P. *Informed Decisions: The Complete Book of Cancer Diagnosis, Treatment and Recovery.* American Cancer Society, 1997.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute. 681 Fifth Ave., New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Leukemia Society of America, Inc. 600 Third Ave., New York, NY 10016. (800) 955 4572. <http://www.leukemia.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Oncolink. University of Pennsylvania Cancer Center. <http://cancer.med.upenn.edu>.

Lata Cherath, PhD

Leukocytosis

Definition

Leukocytosis is a condition characterized by an elevated number of white cells in the blood.

Description

Leukocytosis is a condition that affects all types of white blood cells. Other illnesses, such as neutrophilia, lymphocytosis, and granulocytosis, target specific types of white blood cells. Normal white blood cell counts are 4,300-10,800 white blood cells per microliter. Leukocyte or white blood cell levels are considered elevated when they are between 15,000-20,000 per microliter. The increased number of leukocytes can occur abnormally as a result of an infection, **cancer**, or drug intake; however, leukocytosis can occur normally after eating a large meal or experiencing **stress**.

Causes and symptoms

Leukemias can cause white blood cell counts to increase to as much as 100,000. Each kind of white cell can produce a leukemia. Apart from leukemias, nearly all leukocytosis is due to one type of white blood cell, the polymorphonuclear leukocyte (PMN). These conditions are more accurately referred to as neutrophilia.

The most common and important cause of neutrophilia is infection, and most infections cause neutrophilia. The degree of elevation often indicates the severity of the infection. Tissue damage from other causes raises the white count for similar reasons. **Burns**, infarction (cutting off the blood supply to a region of the body so that it dies), crush injuries, inflammatory diseases, poisonings, and severe diseases, like kidney failure and **diabetic ketoacidosis**, all cause neutrophilia.

Counts almost as high occur in leukemoid (leukemia-like) reactions caused by infection and non-infectious inflammation.

Drugs can also cause leukocytosis. Cortisone-like drugs (prednisone), lithium, and NSAIDs are the most common offenders.

Non-specific stresses also cause white blood cells to increase in the blood. Extensive testing of medical students reveals that neutrophilia accompanies every examination. Vigorous **exercise** and intense excitement also cause elevated white blood cell counts.

Diagnosis

A complete **blood count** (CBC) is one of the first tests obtained in any medical setting. More than 11,000

KEY TERMS

Biopsy—Surgical removal of tissue for examination.

Inflammation—Heat, swelling, redness, and pain caused by tissue injury.

Ketoacidosis—A severe stage of diabetes where acids and ketones accumulate in the body.

NSAID—Non-steroidal anti-inflammatory drug such as ibuprofen.

white cells in a cubic millimeter of blood is considered high. Bone marrow biopsy may help clarify the cause.

Treatment

Relieving the underlying cause returns the count to normal.

Prognosis

By treating the underlying condition, white blood cell counts usually return to normal

Resources

BOOKS

Baehner, Robert L. "Neutrophilia." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Dale, David C. "Neutrophilia." In *Williams Hematology*, ed. Ernest Beutler, et al. New York: McGraw-Hill, Inc. 1995.

Holland, Steven M., and John I. Gallin. "Disorders of Granulocytes and Monocytes." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Levodopa *see* **Antiparkinson drugs**

Levothyroxine *see* **Thyroid hormones**

LGV *see* **Lymphogranuloma venereum**

Lice infestation

Definition

Lice infestations (pediculosis) are infections of the skin, hair, or genital region caused by lice living directly on the body or in hats or other garments. Lice are small wingless insect-like parasites with sucking mouthparts that feed on human blood and lay their eggs on body hairs or in clothing. The name pediculosis comes from the Latin word for louse (singular) or lice (plural).

Description

Lice infestations are not dangerous infections by themselves. It is, however a serious public health problem because some lice can carry organisms that cause other diseases, including **relapsing fever**, **trench fever**, and epidemic **typhus**. Although trench **fever** is self-limiting, the other two diseases have mortality rates of 5%-10%. Pubic lice are often associated with other **sexually transmitted diseases** (STDs) but do not spread them.

Lice infestations are frequent occurrences in areas of overcrowding or inadequate facilities for bathing and laundry. They are often associated with homelessness in the general population or with military, refugee, or prisoner camps in war-torn areas. All humans are equally susceptible to louse infestation; the elderly, however, are more vulnerable to typhus and other diseases carried by lice.

Causes and symptoms

The symptoms of lice infestations vary somewhat according to body location, although all are characterized by intense **itching**, usually with injury to the skin caused by scratching or scraping. The itching is an allergic reaction to a toxin in the saliva of the lice. Repeated bites can lead to a generalized skin eruption or inflammation.

Head lice

This type of infestation is caused by *Pediculosis humanus capitis*, the head louse. Head lice can be transmitted from one person to another by the sharing of hats, combs, or hair brushes. Epidemics of head lice are common among school-age children from all class backgrounds in all parts of the United States. The head louse is about 1/16 of an inch in length. The adult form may be visible on the patient's scalp, especially around the ears; or its grayish-white nits (eggs) may be visible at the base of the hairs close to the scalp. It takes between three and 14 days for the nits to hatch. After the nits hatch, the louse must feed on blood within a day or die.

Head lice can spread from the scalp to the eyebrows, eyelashes, and beard in adults, although they are more often limited to the scalp in children. The itching may be intense, and may be followed by bacterial infection of skin that has been scratched open. Another common complication is swelling or inflammation of the neck glands. Head lice do not spread typhus or other systemic diseases.

Body lice

Infestations of body lice are caused by *Pediculosis humanus corporis*, an organism that is similar in size to head lice. Body lice, however, are rarely seen on the skin itself because they come to the skin only to feed. They should be looked for in the seams of the patient's clothing. This type of infestation is associated by wearing the same clothing for long periods of time without laundering, as may happen in wartime or in cold climates; or with poor personal hygiene. It can be spread by close personal contact or shared bedding.

Patients with body lice often have intense itching with deep scratches around the upper shoulders, flanks, or neck. The bites first appear as small red pimples but may cause a generalized skin rash. If the infestation is not treated, the patient may develop complications that include **headache**, fever, and bacterial infection with scarring. Body lice can spread systemic typhus or other infections.

Pubic lice

Pubic lice are sometimes called "crabs." This type of infestation is caused by *Phthirus pubis* and is commonly spread by intimate contact. People can also get public lice from using the bedding, towels, or clothes of an infected person.

Pubic lice usually appear first on pubic hair, but may spread to other parts of the body, particularly if the patient is very hairy. Pubic lice are also sometimes seen on the eyelashes of children born to infected mothers. It is usually easier for the doctor to see marks from the patient's scratching than the bites from the lice, but pubic lice sometimes produce small bluish spots called maculae ceruleae on the patient's trunk or thighs. Pubic lice also sometimes leave small dark brown specks from their own excreted matter on the parts of the patient's underwear that cover the anal or genital areas.

Diagnosis

Doctors can diagnose lice infestations from looking closely at the parts of the body where the patient has been scratching. Lice are large enough to be easily seen with the naked eye or a magnifying glass. The eggs of pubic lice as well as head lice can often be found by looking at the base of the patient's hairs. Pediatricians are most likely to diagnose lice in school-age children.

It is important for doctors to rule out other diseases that can cause scratching and skin inflammation because the medications used to kill lice are very strong and can have bothersome side effects. The doctor will need to distinguish between head lice and dandruff; between body lice and **scabies** (a disease caused by skin mites); and between pubic lice and eczema. Blood tests or other laboratory tests are not useful in diagnosing lice infestations.

This woman's eyelashes are infested with nits, or eggs, of a body louse. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Lice infestations are treated with externally applied medications that either kill the lice or prevent them from feeding. Cases of head lice are usually treated with shampoos or rinses containing either lindane (Kwell) or permethrin (Nix). Because lindane is absorbed through the skin, the person giving the application should wear rubber gloves and rinse the patient's hair or body completely after use. Following the treatment, nits should be removed from the hair with a fine-toothed comb or tweezers. Lindane is also effective for treating infestations of body or pubic lice, but it should not be used by pregnant women. In most cases one treatment is sufficient, but the medication can be reapplied a week later if living lice have reappeared.

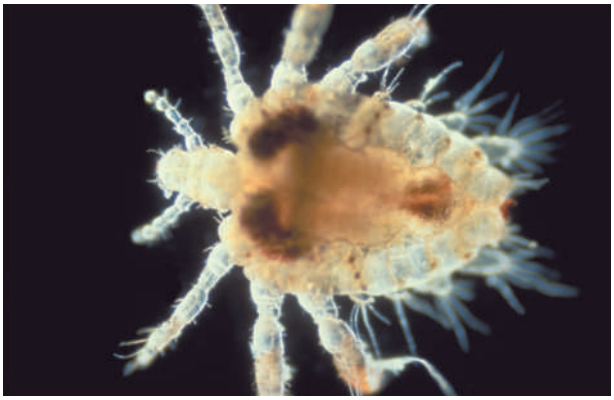
Infestations of body lice can also be treated by washing the patient's clothes or bedding in boiling water, ironing seams with an iron on a high setting, or treating the clothes with 1% malathion powder or 10% DDT powder.

If the patient's eyelashes have been infested, the only safe treatments are either a thick coating of petroleum jelly (Vaseline) applied twice daily for eight days, or 1% yellow oxide of mercury applied four times a day for two weeks. Any remaining nits should be removed with tweezers.

Patients with pubic lice should be examined and tested for other STDs.

Alternative treatment

For pubic lice, some practitioners of **holistic medicine** recommend a mixture of 25% oil of pennyroyal (*Mentha pulegium*), 25% garlic (*Allium sativum*) oil, and



A close-up view of a body louse. *(Custom Medical Stock Photo. Reproduced by permission.)*

50% distilled water applied three times in a three-day period, followed by removal of dormant eggs to prevent reinfestation.

Prognosis

Lice can be successfully eradicated in almost all cases, although some cases of lindane-resistant lice have been reported. In general, patients are more at risk from typhus and other diseases spread by lice than from the lice themselves.

Prevention

There are no vaccines or skin treatments that will protect a person against lice prior to contact. In addition, lice infestation does not provide immunity against reinfection; recurrences are in fact quite common. Prevention depends on adequate personal hygiene at the individual level and the following public health measures:

- teaching school-age children the basics of good personal hygiene, including the importance of not lending or borrowing combs, brushes, or hats
- notifying and treating an adult patient's close personal and sexual contacts
- examining homeless people, elderly patients incapable of self-care, and other high-risk individuals prior to hospital admission for signs of louse infestation. This measure is necessary to protect other hospitalized people from the spread of lice

Resources

BOOKS

Berger, Timothy G. "Skin and Appendages." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

"Dermatologic Disorders: Parasitic Infections of the Skin." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Lindane." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

McCarthy, James S., and Thomas B. Nutman. "Parasitic Diseases of the Skin." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Millikin, Larry E. "Flies, Lice, Mites, and Bites." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Morelli, Joseph G., and William L. Weston. "Skin." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

"Permethrin." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

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KEY TERMS

Crabs—An informal or slang term for pubic lice.

Lindane—A benzene compound that is used to kill body and pubic lice. Lindane works by being absorbed into the louse's central nervous system, causing seizures and death.

Maculae ceruleae—Bluish or blue-grey skin eruptions often seen on the trunk or thighs of patients with pubic lice. The Latin words mean blue spots.

Malathion—An insecticide that can be used in 1% powdered form to disinfect the clothes of patients with body lice.

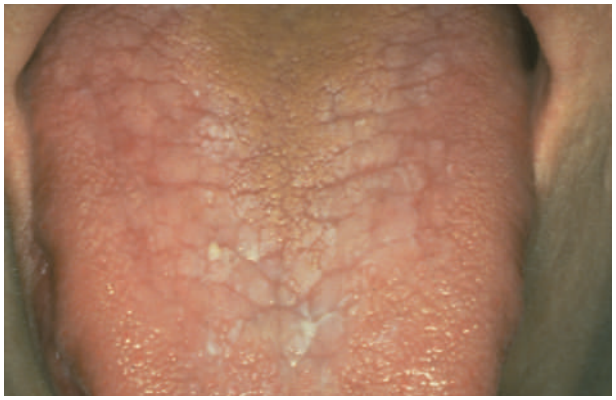
Nits—The eggs produced by head or pubic lice, usually grayish-white in color and visible at the base of hair shafts.

Permethrin—A medication used to rid the scalp of head lice. Permethrin works by paralyzing the lice, so that they cannot feed after hatching within the 24 hours required for survival.

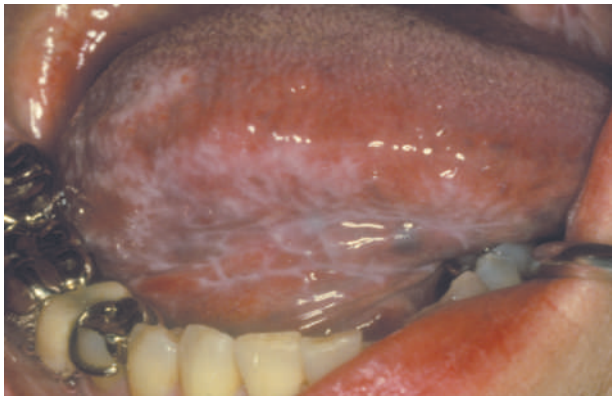
Lichen planus

Definition

Lichen planus is a skin condition of unknown origin that produces small, shiny, flat-topped, itchy pink or purple raised spots on the wrists, forearms or lower legs, especially in middle-aged patients.



One example of lichen planus on the tongue. *(Custom Medical Stock Photo. Reproduced by permission.)*



Lichen planus appearing under the tongue. *(Custom Medical Stock Photo. Reproduced by permission.)*

Description

Lichen planus affects between 1-2% of the population, most of whom are middle-aged women. The condition is less common in the very young and the very old. The lesions are found on the skin, genitals, and in the mouth. Most cases resolve spontaneously within two years. Lichen planus is found throughout the world and is equally distributed among races.

Causes and symptoms

No one knows what causes lichen planus, although some experts suspect that it is an abnormal immune reaction following a viral infection, probably aggravated by **stress**. The condition is similar to symptoms caused by exposure to arsenic, bismuth, gold, or developers used in color photography. Occasionally, lichen planus in the mouth appears to be an allergic reaction to medications, filling material, dental hygiene products, chewing gum or candy.

Symptoms can appear suddenly, or they may gradually develop, usually on the arms or legs. The lesions on the skin may be preceded by a dryness and metallic taste or burning in the mouth.

Once the lesions appear, they change over time into flat, glistening, purple lesions marked with white lines or spots. Mild to severe **itching** is common. White, lacy lesions are usually painless, but eroded lesions often burn and can be painful. As the lesions clear up, they usually leave a brown discoloration behind, especially in dark skinned people.

Lichen planus in the mouth occurs in six different forms with a variety of symptoms, appearing as lacy-white streaks, white plaques, or eroded ulcers. Often the gums are affected, so that the surface of the gum peels off, leaving the gums red and raw.

KEY TERMS

PUVA—A type of phototherapy that combines the oral or topical photosensitizing chemical psoralen, plus long-wave ultraviolet light-A (UVA).

Diagnosis

A doctor can probably diagnose the condition simply from looking at the characteristic lesions, but a **skin biopsy** may be needed to confirm the diagnosis.

Treatment

Treatment is aimed at easing symptoms. Itching can be treated with steroid creams and oral **antihistamines**. Severe lesions can be treated with **corticosteroids** by mouth, or combinations of photochemotherapy (PUVA) and griseofulvin.

Patients with lesions in the mouth may find that regular professional cleaning of the teeth and conscientious dental care improve the condition. Using milder toothpastes instead of tartar control products also seems to lessen the number of ulcers and makes them less sensitive.

Prognosis

While lichen planus can be annoying, it is usually fairly benign and clears up on its own. It may take months to reach its peak, but it usually clears up within 18 months.

Resources

BOOKS

Manual of Clinical Problems in Dermatology. Ed. Susan M. Olbricht, et al. Boston: Little, Brown and Co.,1992.

PERIODICALS

Burkhart, N. W., E. J. Burkes, and E. J. Burker. "Meeting the Educational Needs of Patients with Oral Lichen Planus." *General Dentistry* 45 (1997): 126-132.

OTHER

Lichen Planus Self-Help. Baylor College of Dentistry. <http://www.tambcd.edu/lichen>.

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KEY TERMS

Antihistamine—A chemical that interferes with the action of histamine. Histamine is part of an inflammatory response and helps to cause itching.

Callus—Thickened skin due to chronic rubbing or irritation.

Lesion—Abnormal change in tissue caused by localized disease.

Lichen simplex chronicus

Definition

Lichen simplex chronicus is a chronic inflammation of the skin (**dermatitis**) characterized by small, round itchy spots that thicken and become leathery as a result of scratching.

Description

Also termed neurodermatis, lichen simplex chronicus is the result of chronic skin irritation. It occurs in 4-5 out of every thousand people. Initial irritation causes **itching**, and in turn, itching causes scratching. Scratching leads to further irritation, which damages the skin. The possibility of infection is greatly increased when the outer layer of protective skin is broken. Skin usually repairs itself quickly; however, in the case of lichen simplex chronicus, healing skin causes more itching and more scratching causes a thickening of the skin (lichen). The small skin patches are usually 1–10 in (2.54–25.4 cm) in diameter.

Causes and symptoms

Lichen simplex chronicus is often caused by constant rubbing of the skin. The rubbing begins the chain of events that leads from itching to scratching and then to the presence of leather-like skin patches.

Symptoms are chronic itching which is often accompanied by nervous tension. The appearance of scratch marks and the leathery skin patches can be found anywhere on the body. A prolonged lichen simplex chronicus can result in brown-colored pigmentation at the site of irritation.

Diagnosis

A dermatologist, a physician specializing in the study and treatment of skin disorders, can make a diagnosis after a visual exam.

Treatment

Treatment of the itching is necessary to stop the scratching and resulting skin damage. There are a number of ways to stop itching. Perhaps the most important is to cut fingernails very short. Ice can substitute for the relief of scratching. Heat and fuzzy clothing worsen itching; cold and smooth clothing pacify it. If the itching is persistent, dressings may be applied to the affected areas.

Among the topical medications that relieve itching are a number of commercial preparations containing menthol, camphor, eucalyptus oil, and aloe. Topical cortisone is also available without a prescription. Some preparations also contain **antihistamines**, which penetrate intact skin poorly. All these medicines work better under occlusion, which means putting a waterproof barrier like a rubber glove or plastic wrap over them. For broken skin, topical **antibiotics** like bacitracin help prevent infection. These should be used early to forestall further damage to the skin.

Reducing the buildup of thick skin may require medicines that dissolve or melt keratin, the major chemical in skin's outer layer. These keratolytics include urea, lactic acid, and salicylic acid.

Resistant cases of lichen simplex chronicus will often respond to cortisone-like drugs injected directly into the lesions.

Sedatives or tranquilizers may be prescribed to combat the nervous tension and **anxiety** that often accompanies the condition.

Prognosis

Diligent adherence to treatment is usually rewarded with a resolution of the condition. The original cause of itching may be gone, or it may reappear. Preventive treatment in its early stages will arrest the process.

Prevention

Early, gentler substitutes for scratching can entirely prevent lichen simplex chronicus.

Resources

BOOKS

Habif, Thomas P. "Lichen Simplex Chronicus." In *Clinical Dermatology: A Color Guide to Diagnosis and Therapy.* St. Louis: Mosby, 1995.

Parker, Frank. "Skin Diseases of General Importance." *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Swerlick, Robert A., and Thomas J. Lawley. "Eczema, Psoriasis, Cutaneous Infections, Acne, and Other Common Skin Disorders." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Life support

Definition

Life support refers to a spectrum of techniques used to maintain life after the failure of one or more vital organs.

Purpose

A patient requires life support when one or more vital organs fail, due to causes such as trauma, infection, **cancer**, **heart attack**, or chronic disease. Among the purposes of life support are to:

- establish and maintain the ABC's of resuscitation—airway, breathing, and circulation
- restore the patient's homeostasis—the internal chemical and physical balance of the body
- protect the patient from complications of the underlying disease and its treatment

Precautions

Patients and families need to recognize that life support is an extremely painful, expensive, and emotionally wrenching experience. Life support exposes a patient to vast risks of further medical complications, and offers no guarantee of a positive outcome. Even in successful cases, recovery may be slow and frustrating.

Description

Successful life support begins with establishing the ABC's of resuscitation—airway, breathing, and circulation.

The airway refers to a clear passageway for air to enter the lungs from outside the body. The patient's airway may become blocked by:

- foreign body obstruction, as by food or dentures
- injury-related damage and swelling, as from a wound or surgery
- loss of protective reflexes due to **coma** of any origin

Life support may begin with basic **cardiopulmonary resuscitation** (**CPR**), as in cases of cardiac arrest. Thereafter, the most common technique used to create a secure airway is insertion of an endotracheal (ET) tube through the mouth or nose into the windpipe (trachea). An alternative method of securing an airway is by **tracheotomy**, a surgical procedure in which a tube is inserted into the trachea through an incision made in the base of the throat. Of the two options, placement of an ET tube is usually quicker and more convenient, and thus occurs much more commonly. Doctors perform a tracheotomy when they cannot establish an ET airway, or when the patient will require an artificial airway for more than a week or two.

Breathing refers to the movement of air in and out of the lungs. Inadequate breathing may result from:

- heart disease, as in congestive heart failure
- primary disease of the lungs, such as **pneumonia**, **asthma**, or emphysema
- coma of any cause, such as narcotic overdose or stroke
- muscle **fatigue** or neuromuscular disease (**spinal cord injury** or polio)
- pain, from rib **fractures** or surgery on the chest

When the patient cannot breathe sufficiently, the physician will use a ventilator, a machine that pumps air in and out of the patient's lungs. For many doctors and members of the public, the term "life support" calls up the image of an ET tube and ventilator.

Circulation refers to the flow of blood around the body from the heart to vital organs. Circulation can fail due to:

- primary disease of the heart (heart attack)
- blood loss (trauma or internal bleeding of any cause)
- severe infection (sepsis)
- drug reactions or overdoses
- extreme allergic reaction
- severe **dehydration** (**gastroenteritis** or heat-related illness)

In order to ensure adequate circulation, the patient will require one or more intravenous (IV) tubes (catheters). The IVs may include both the short needle and tube commonly used in the hand or forearm, and longer catheters inserted into the larger and more central veins of the body. Catheters inserted into these larger

veins are known as central lines. Through the IVs the patient receives fluids, drugs, and blood transfusions as needed to support the circulation.

Once the ABC's are secure, life support is directed at maintaining homeostasis, the body's delicate chemical and physical balance. In a healthy person, the body keeps precise control over many components of its makeup, such as its fluids, nutrients, and pressures. When vital organs fail, the body can no longer regulate these components, and the doctor must take steps to restore the normal state.

Preserving the body's internal equilibrium requires careful monitoring of innumerable indicators of the patient's well-being. These indicators include:

- vital signs (heartbeats per minute, breaths per minute, blood pressure, body temperature, and weight)
- fluids (input and output of the body)
- blood cell counts
- chemical substances of the body (sodium, potassium, sugar, and many others)
- pressures in the circulation, lungs, and perhaps even the brain
- presence of germs (bacteria, fungi) causing infection in body systems (lungs, blood, urine)

This intensive monitoring usually takes place in an intensive care unit (ICU) or critical care unit (CCU) and requires:

- specialized physicians, such as cardiologists, intensivists, and surgeons
- highly-skilled nursing care, often one nurse per patient around-the-clock
- extensive support staff, such as respiratory therapists, laboratory technicians, radiology technicians, dieticians, and pharmacists
- constant measurement of basics such as pulse, heart rhythm, and oxygen level in the blood
- frequent inspection of the patient's alertness, color, and level of pain
- use of catheters in the veins and arteries to withdraw blood samples and measure pressures in the circulation
- use of tubes in the bladder (Foley catheter), stomach (nasogastric tube), and other body cavities
- frequent laboratory tests on blood, urine, drainage from **wounds**, and other body specimens
- x-ray, ultrasound, computerized tomography (CT), and other imaging procedures
- electrocardiograms

The treatments of life support include:

- oxygen
- intravenous fluids with sugar and basic salts
- drugs to improve circulation and other body functions
- antibiotics
- transfusions
- surgery
- nutritional supplements by vein or stomach tube
- tubes in body cavities (chest or abdomen) to relieve fluid buildup
- dialysis
- pacemaker
- electrical defibrillation
- various machines to assist heart or lung function
- transplantation of organs or mechanical substitutes (artificial heart)
- sedation or even temporary **paralysis** to enable the patient to tolerate these procedures

Preparation

The need for life support may arise suddenly and with little warning. All people should discuss in advance with family and doctor their wishes for the use of life support should a medical crisis develop. The doctor will note the preferences in the patient's record. Patients should sign documents such as an Advance Directive and Durable Power of Attorney for Health Care to express their wishes and designate a surrogate decision-maker in case of incapacitation.

Physicians and medical care providers must anticipate the possibility that a patient will require life support, perhaps suddenly. In preparation, doctors and medical staff must:

- receive training in resuscitation skills
- monitor patients carefully
- maintain proper supplies and equipment
- discuss in advance with patients and patients' families whether or not to begin life support

Aftercare

If a patient survives life support treatments, doctors will cautiously try to wean the patient from the support systems. Being able to breathe adequately without the ventilator is one major hurdle. Patients commonly fail in their first attempts to breathe on their own, often tiring out after

KEY TERMS

Cardiopulmonary—Relating to the heart and lungs.

Central line—A tube placed by needle into a large, central vein of the body.

Coma—Unconsciousness.

Defibrillation—Use of an electric shock to restore a normal heartbeat.

Endotracheal tube—A tube placed into the windpipe through the nose or mouth.

Foley catheter—A tube that drains urine from the bladder.

Homeostasis—The internal chemical and physical balance of the body.

Nasogastric tube—A tube placed through the nose into the stomach.

Neuromuscular—Relating to nerves and muscles.

Resuscitation—Treatments to restore an adequate airway, breathing, and circulation.

Sepsis—An overwhelming infection with effects throughout the body.

Tracheotomy—A surgical procedure in which a tube is inserted into the trachea through an incision made in the base of the throat.

Trauma—Serious physical injury.

Ventilator—A machine that pumps air in and out of the lungs.

Vital signs—Basic indicators of body function, usually meaning heartbeats per minute, breaths per minute, blood pressure, body temperature, and weight.

a few hours. Thus, the doctor will reconnect the ventilator, give the patient a rest, and try again in a day or two.

As the patient regains organ function, there is less need for monitors, tests, and treatments that require an intensive care setting. The doctor may transfer the patient to a lower level of hospital care, a skilled nursing facility (SNF), or perhaps directly to home. Physical and occupational therapists may help the patient improve strength and endurance. The patient will receive continuing care from the primary doctor and specialists as needed. The patient may require prescription drugs, assist devices, and psychological therapists.

Risks

The risks and consequences of life support are enormous. These risks include:

- physical dangers
- emotional suffering
- financial costs
- societal discord

The physical dangers of life support encompass all the hazards of the patient's underlying disease and treatments. Among these risks are:

- permanent damage to the brain, kidneys, and other vital organs caused by poor circulation or low oxygen content of the blood
- direct damage to organs from use of medical instruments and procedures
- infections, often with organisms that are highly resistant to antibiotics
- abnormal blood clots
- skin ulcers from lying immobilized for long periods
- extreme pain
- exposure of medical personnel to communicable diseases

The emotional consequences of life support touch patients, families, and medical caregivers. These repercussions arise from:

- the frightening environment of an ICU
- the need to make life-and-death decisions
- the anger, guilt, and grief that relate to life-threatening illness
- the fact that many lengthy and difficult treatments will end in failure

The financial costs of life support are huge. A single day of life support costs many thousands of dollars. These expenses fall on individual payers, insurance companies, health plans, and governments. All such payers face difficult decisions regarding the allotment of money for such treatment, especially in cases that are likely to be futile.

Society as a whole faces difficult decisions surrounding life support. Some governments have enacted regulations that establish priorities for the spending of health care resources. Patients who do not receive treatment under such rules may feel victimized by society's choices.

Resources

BOOKS

Irwin, Richard S., Frank B. Cerra, and James M. Rippe, ed. *Irwin and Rippe's Intensive Care Medicine*. Philadelphia: Lippincott-Raven, 1999.

Luce, John M., "Approach to the Patient In a Critical Care Setting." In *Textbook of Medicine*, edited by Goldman, Lee and J. Claude Bennett. 21st ed. Vol. 1. Philadelphia: W.B. Saunders Company, 2000, pp. 483-4.

Tintinalli, Judith E., et al, ed. *Emergency Medicine: a comprehensive study guide*. New York: McGraw-Hill, 2000.

Isaac R. Berniker

Light sensitivity *see* **Photosensitivity**

Light therapy *see* **Phototherapy**

Light treatment *see* **Ultraviolet light treatment**

Lipase test

Definition

The lipase test is a blood test performed to determine the serum level of a specific protein (enzyme) involved in digestion. Lipase is an enzyme produced by the pancreas, which is a large gland situated near the stomach. Lipase works to break down a certain type of blood lipid (triglycerides) into fatty acids.

Lipase appears in the blood together with another enzyme called amylase following damage to or diseases affecting the pancreas. It was once thought that abnormally high lipase levels were associated only with diseases of the pancreas. Other conditions are now known to be associated with high lipase levels, especially kidney failure and intestinal obstruction. Diseases involving the pancreas, however, produce much higher lipase levels than diseases of other organs. Lipase levels in pancreatic disorders are often five to 10 times higher than normal.

Purpose

The lipase test is most often used in evaluating inflammation of the pancreas (**pancreatitis**), but it is also useful in diagnosing kidney failure, intestinal obstruction, **mumps**, and peptic ulcers. Doctors often order amylase and lipase tests at the same time to help distinguish pancreatitis from ulcers and other disorders in the abdomen. If the patient has acute (sudden onset) pancreatitis, the lipase level usually rises somewhat later than the amylase level—about 24-48 hours after onset of symptoms—and remains abnormally high for five to seven days. Because the lipase level peaks later and remains elevated longer, its determination is more useful in late diagnosis of acute pancreatitis. Conversely, however, lipase levels are not as useful in diagnosing chronic pancreatic disease.

Precautions

Patients should be asked whether they are taking certain prescription drugs that can affect the accuracy of the lipase test. Drugs that can cause elevated lipase levels include bethanechol, cholinergics, codeine, indomethacin, meperidine, methacholine, and morphine. Drugs that may decrease levels include calcium ions.

Description

A lipase test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

Preparation

The patient should have nothing to eat or drink for 12 hours before the lipase test.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, a small bruise or swelling in the area, **fainting**, or feeling lightheaded.

Normal results

Reference values for lipase determination are laboratory- and method-specific. In general, normal results are usually less than 200 units/L (triolein methods by titration or turbidimetry).

Abnormal results

Increased lipase levels are found in acute pancreatitis, chronic relapsing pancreatitis, and pancreatic **cancer**. High lipase levels also occur in certain liver diseases, kidney failure, bowel obstruction, peptic ulcer disease, and tumors or inflammation of the salivary glands.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

KEY TERMS

Amylase—A digestive enzyme that breaks down starch.

Lipid—A greasy organic compound that cannot be dissolved in water. Triglycerides, which are broken down by lipase, are one type of blood lipid.

Pancreas—An elongated gland situated across the back of the abdomen behind the stomach. It secretes both digestive enzymes and hormones. Pancreatic hormones regulate the level of sugar in the blood.

Pancreatitis—Inflammation of the pancreas, frequently caused by gallstones, alcohol abuse, viral infection, or injury.

Turbidimetry—A technique of measurement that analyzes the amount of sediment in a liquid.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Lipidoses

Definition

Lipidoses are heredity disorders, passed from parents to their children, characterized by defects of the digestive system that impair the way the body uses fat from the diet. When the body is unable to properly digest fats, lipids accumulate in body tissues in abnormal amounts.

Description

The digestion, storage, and use of fats from foods is a complex process that involves hundreds of chemical reactions in the body. In most people, the body is already programmed by its genetic code to produce all of the enzymes and chemicals necessary to carry out these functions. These genetic instructions are passed from parents to their offspring during reproduction.

People with lipidoses are born without the genetic codes needed to tell their bodies how to complete a particular part of the fat digestion process. In most of these disorders, the body does not produce a certain enzyme or chemical. Over 30 different disorders of fat metabolism are related to genetic defects. Although the defects are passed from parents to children, the parents often do not have the disorders themselves.

The symptoms, available treatments, and long-term consequences of these conditions vary greatly. Some of the conditions become apparent shortly after the infant is born; in others, symptoms may not develop until adulthood. For most of the lipidoses, diagnosis is suspected based on the symptoms and family history. Blood tests, urine tests, and tissue tests can be used to confirm the diagnosis. **Genetic testing** can be used, in some cases, to identify the defective gene. Some of these disorders can be controlled with changes in the diet, medications, or enzyme supplements. For many, no treatment is available. Some may cause **death** in childhood or contribute to a shortened life expectancy. Some of the most common or most serious lipidoses are discussed below.

Causes and symptoms

Fabry's disease

Approximately one in every 40,000 males is born with Fabry's disease. This condition has an X-linked, recessive pattern of inheritance, meaning that the defective gene is carried on the X chromosome. A female who carries a defective recessive gene on one of her two X chromosomes has a 50% chance of passing the defective gene to her sons who will develop the disorder associated with the defective gene (a male receives one X chromosome from his mother and one Y chromosome from his father). She also has a 50% chance of passing the defective recessive gene to her daughters who will be carries of the disorder (like their mother). Some female carries of Fabry's disease show mild signs of the disorder, especially cloudiness of the cornea.

The gene that is defective in Fabry's disease causes a deficiency of the enzyme alpha-galactosidase A. Without this enzyme, fatty compounds starts to line the blood vessels. The collection of fatty deposits eventually affects blood vessels in the skin, heart, kidneys, and nervous system. The first symptoms in childhood are **pain** and discomfort in the hands and feet brought on by **exercise**, **fever**, **stress**, or changes in the weather. A raised rash of dark red-purple spots is common, especially on skin between the waistline and the knees. Other symptoms include a decreased ability to sweat and changes in the cornea or outer layer of the eye. Although the disease begins in childhood, it progresses very slowly. Kidney and heart problems develop in adulthood.

Gaucher disease

Gaucher (pronounced go-shay) disease is the most common of the lipid storage disorders. It is found in pop-

ulations all over the world (20,00 to 40,000 people have a type of the disease), and it occurs with equal frequency in males and females. **Gaucher disease** has a recessive pattern of inheritance, meaning that a person must inherit a copy of the defective gene from both parents in order to have the disease. The genetic defect causes a deficiency of the enzyme glucocerebrosidase that is responsible for breaking down a certain type of fat and releasing it from fat cells. These fat cells begin to crowd out healthy cells in the liver, spleen, bones, and nervous system. Symptoms of Gaucher disease can start in infancy, childhood, or adulthood.

Three types of Gaucher disease have been identified, but there are many variations in how symptoms develop. Type 1 is the most common and affects both children and adults. It occurs much more often in people of Eastern European and Russian Jewish (Ashkenazi) ancestry, affecting one out of every 450 live births. The first signs of the disease include an enlarged liver and spleen, causing the abdomen to swell. Children with this condition may be shorter than normal. Other symptoms include tiredness, pain, bone deterioration, broken bones, anemia, and increased bruising. Type 2 Gaucher disease is more serious, beginning within the first few months after birth. Symptoms, which are similar to those in Type 1, progress rapidly, but also include nervous system damage. Symptoms of Type 3 Gaucher disease begin during early childhood with symptoms like Type 1. Unlike Type 2, the progress of the disease is slower, although it also includes nervous system damage.

Krabbe's disease

Krabbe's disease is caused by a deficiency of the enzyme galactoside beta-galactosidase. It has a recessive pattern of inheritance and is believed to occur in 1 of 40,000 births in the United States. This condition, which is also called globoid cell leukodystrophy or Krabbe leukodystrophy, is characterized by acute nervous system degeneration. It develops in early infancy with initial symptoms of irritability, vomiting and episodes of partial unconsciousness. Symptoms progress rapidly to seizures, difficulty swallowing, blindness, deafness, **mental retardation**, and **paralysis**.

Niemann-pick disease

At least five different forms of Niemann-Pick disease (NPD) have been identified. The different types seem to be related to the activity level of the enzyme sphingomyelinase. In patients with Types A and B NPD, there is a build up of sphingomyelin in cells of the brain, liver, spleen, kidney and lung. Type A is the most common form of NPD and the most serious, with death usually occurring by the age of 18 months. Symptoms develop within the first few months of life and include poor appetite, failure to grow, enlarged liver and spleen, and the appearance of cherry red spots in the retina of the eye. Type B develops in infancy or childhood with symptoms of mild liver or spleen enlargement and lung problems. Some adults with this form (Type E) may also show a loss of muscle coordination. Types C or D NPD are related to cholesterol transfer out of cells. Children with Types C or D grow normally in early childhood, but eventually develop difficulty in walking and loss of muscle coordination. Ultimately, the nervous system becomes severely damaged and these patients die. Type C occurs in any population, while Type D has been identified only in patients from Nova Scotia, Canada.

Refsum's disease

Refsum's disease has a recessive pattern of inheritance and affects populations from Northern Europe, particularly Scandinavians most frequently. It is due to a deficiency of phytanic acid hydroxylase, an enzyme that breaks down a fatty acid called phytanic acid. This condition affects the nervous system, eyes, bones, and skin. Symptoms, which usually appear by age 20, include vision problems [retinitis pigmentosa and rhythmic eye movements (nystagmus)], loss of muscle coordination, loss of sense of smell (**anosmia**), pain, numbness, and elevated protein in the cerebrospinal fluid.

Tay-sachs disease

Tay-Sachs disease (TSD) is a fatal condition caused by a deficiency of the enzyme hexosaminidase A (Hex-A). The defective gene that causes this disorder is found in roughly 1 in 250 people in the general population. However, certain populations have significantly higher rates of TSD. French-Canadians living near the St. Lawrence River and in the Cajun regions of Louisiana are at higher risk of having a child with TSD. The highest risk seems to be in people of Eastern European and Russian Jewish (Ashkenazi) descent. Tay-Sachs disease has a recessive pattern of inheritance, and approximately 1 in every 27 people of Jewish ancestry in the United States carries the TSD gene. Symptoms develop in infancy and are due to the accumulation of a fatty acid compound in the nervous system. Early symptoms include loss of vision and physical coordination, seizures, and mental retardation. Eventually, the child develops problems with breathing and swallowing. Blindness, paralysis, and death follow.

Wolman's disease

Wolman's disease is caused by a genetic defect (with a recessive pattern of inheritance) that results in deficien-

cy of an enzyme that breaks down cholesterol. This causes large amounts of fat to accumulate in body tissues. Symptoms begin in the first few weeks of life and include an enlarged liver and spleen, adrenal calcification (hardening of adrenal tissue due to deposits of calcium salts), and fatty stools.

Diagnosis

Fabry's disease

The diagnosis can be confirmed by a blood test to measure for alpha-galactosidase A. Women who are carries of the defective gene can also be identified by a blood test.

Gaucher disease

Gaucher disease may be suspected based on symptoms and is confirmed with a blood test for levels of the enzyme. Samples of tissue from an affected area may also be used to confirm a diagnosis of the disease.

Niemann-Pick disease

Diagnosis is confirmed by analyzing a sample of tissue. Prenatal diagnosis of Types A and B of NPD can be done with *amniocentesis* or *chorionic villus sampling*

Tay-Sachs disease

Carriers of the Tay-Sachs related gene can be identified with a blood test. Amniocentesis or chorionic villi sampling can be used to determine if the fetus has Tay-Sachs disease.

Treatment

Fabry's disease

Treatment focuses on prevention of symptoms and long-term complications. Daily doses of diphenylhydantoin (Dilantin) or carbamazapine (Tegretol) can prevent or reduce the severity of pain in the hands and feet associated with the condition. A low sodium, low protein diet may be beneficial to those patients who have some kidney complications. If kidney problems progress, **kidney dialysis** or **kidney transplantation** may be required. Enzyme replacement therapy is currently being explored.

Gaucher disease

The symptoms of Gaucher disease can be stopped and even reversed by treatment with injections of enzyme replacements. Two enzyme drugs currently available are alglucerase (Ceredase) and imiglucerase (Cerezyme). Other treatments address specific symptoms such as anemia, broken bones, or pain.

Krabbe's disease

No treatment is available.

Niemann-pick disease

Treatment consists of supportive care to deal with symptoms and the development of complications. **Bone marrow transplantation** is being investigated as a possible treatment. Low-cholesterol **diets** may be helpful for patients with Types C and D.

Refsum's disease

A diet free of phytanic acid (found in dairy products, tuna, cod, haddock, lamb, stewed beef, white bread, white rice, boiled potatoes, and egg yolk) can reduce some of the symptoms. **Plasmapheresis**, a process where whole blood is removed from the body, processed through a filtering system, and then return to the body, may be used to filter phytanic acid from the blood.

Tay-Sachs disease

There is no treatment for Tay-Sachs disease. Parents who are identified as carriers may want to seek **genetic counseling**. If a fetus is identified as having TSD, parents may consider termination of the **pregnancy**.

Wolman's disease

No treatment is currently available.

Prognosis

Fabry's disease

Although patients with Fabry's disease usually survive to adulthood, they are at increased risk for **stroke**, heart attacks, and kidney damage.

Gaucher disease

The pain and deformities associated with symptoms can make coping with this illness very challenging for individuals and families. With treatment and control of symptoms, people with Type 1 Gaucher disease may lead fairly long and normal lives. Most infants with Type 2 die before the age of 2. Children with Type 3 Gaucher disease may survive to adolescence and early adulthood.

Krabbe's disease

Children born with Krabbe's disease die in infancy.

KEY TERMS

Amniocentesis—A procedure where a needle is inserted through the abdomen into the uterus of a pregnant woman to remove a small amount of the fluid that surrounds the developing fetus. This test can be preformed at about week 16 of the pregnancy. Cells from the fetus can be tested for genetic defects.

Chorionic villi sampling—A procedure to remove a small tissue sample of the placenta, the sac that surrounds the developing fetus. This test can be performed as early as week 10 of the pregnancy. The tissue can be tested for genetic defects.

Lipids—Organic compounds not soluble in water, but soluble in fat solvents such as alcohol. Lipids are stored in the body as energy reserves and are also important components of cell membranes.

Recessive—Refers to an inherited characteristic or trait that is expressed only when two copies of the gene responsible for it are present.

X-linked—Refers to a gene carried on the X chromosome, one of the two sex chromosomes.

Niemann-Pick disease

Patients with Type A NPD usually die within the first year and a half of life. Type B patients generally live to adulthood but suffer from significant liver and lung problems. With Types C and D NPD, there is significant nervous system damage leading to severe muscle spasms, seizures, and eventually, to **coma** and death. Some patients with Types C and D die in childhood, while less severely affected patients may survive to adulthood.

Tay-Sachs disease

Children born with Tay-Sachs disease become increasingly debilitated; most die by about age four.

Wolman's disease

Death generally occurs before six months of age.

Prevention

Couples who have family histories of genetic defects can undergo genetic testing and counseling to see if they are at risk for having a child with one of the lipidoses disorders. During pregnancy, cell samples can be collected from the fetus using amniocentesis or chorionic villi sampling. The results of these test can indicate if the developing fetus has a lipidosis disorder. Termination of the pregnancy may be considered in some cases.

Resources

BOOKS

"Lipid Storage Diseases." In *Internal Medicine*. 5th ed. Ed. Jay H. Stein. St. Louis: Mosby, 1998.

McGovern, Margaret M., and Robert J. Desnick. "Lysosomal Storage Diseases." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

The Metabolic and Molecular Bases of Inherited Disease. 7th ed. Ed. Charles R. Scriver, et al. New York: McGraw-Hill, Inc., 1995.

ORGANIZATIONS

International Center for Fabry Disease. Department of Human Genetics, Mount Sinai School of Medicine, Box 1497, Fifth Avenue and 100th St., New York, NY 10029. (212) 241-6944. <http://www.mssm.edu/crc/fabry/brochure.html>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

National Niemann-Pick Foundation. 3734 E. Olive Ave., Gilbert, AZ 85234. (602) 497-6638.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

National Tay-Sachs and Allied Diseases Association. 2001 Beacon St., Suite 204, Brookline, MA 02146. (800) 906-8723. <http://www.ntsad.org>.

OTHER

Gaucher Disease Treatment Program. <http://gaucher.mgh.harvard.edu>.

Rare Genetic Diseases In Children: An Internet Resource Gateway. <http://mcrcr2.med.nyu.edu/murphp01/homenew. htm>.

Altha Roberts Edgren

Lipoproteins test

Definition

Lipoproteins are the "packages" in which cholesterol and triglycerides travel throughout the body. Measuring the amount of cholesterol carried by each type of lipoprotein helps determine a person's risk for cardiovascular disease (disease that affects the heart and blood vessels, also called CVD).

Purpose

Cholesterol and triglycerides are fat-like substances called lipids. Cholesterol is used to build cell membranes and hormones. The body makes cholesterol and gets it from food. Triglycerides provide a major source of energy to the body tissues. Both cholesterol and triglycerides are vital to body function, but an excess of either one, especially cholesterol, puts a person at risk of cardiovascular disease.

Because cholesterol and triglycerides can't dissolve in watery liquid, they must be transported by something that can dissolve in blood serum. Lipoproteins contain cholesterol and triglycerides at the core and an outer layer of protein, called apolipoprotein.

There are four major classes of lipoproteins: chylomicrons, very low-density lipoproteins (VLDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL). There are also less commonly measured classes such as lipoprotein(a) and subtypes of the main classes. Each lipoprotein has characteristics that make the cholesterol it carries a greater or lesser risk. Measuring each type of lipoprotein helps determine a person's risk for cardiovascular disease more accurately than cholesterol measurement alone. When a person is discovered to be at risk, treatment by diet or medication can be started and his or her response to treatment monitored by repeated testing.

Description

Chylomicrons

Chylomicrons are made in the intestines from the triglycerides in food. They contain very little cholesterol. Chylomicrons circulate in the blood, getting smaller as they deposit the triglycerides in fatty tissue. Twelve hours after a meal, they are gone from circulation. Serum collected from a person directly after eating will form a creamy layer on the top if left undisturbed and refrigerated overnight. This creamy layer is the chylomicrons.

Very low-density lipoproteins (VLDL)

VLDL are formed in the liver by the combination of cholesterol, triglycerides formed from circulating fatty acids, and apolipoprotein. This lipoprotein particle is smaller than a chylomicron, and contains less triglyceride but more cholesterol (10-15% of a person's total cholesterol). As the VLDL circulates in the blood, triglycerides are deposited and the particle gets smaller, eventually becoming a low-density lipoprotein (LDL). Serum from a person with a large amount of VLDL will be cloudy.

Low-density lipoproteins (LDL)

LDL, often called "bad" cholesterol, is formed primarily by the breakdown of VLDL. LDL contains little triglycerides and a large amount of cholesterol (60-70% of a person's total cholesterol). Although the particles are much smaller than chylomicrons and VLDL, LDL particles can vary in size and chemical structure. These variations represent subclasses within the LDL class. Serum from a person with a large amount of LDL will be clear.

LDL carries cholesterol in the blood and deposits it in body tissues and in the walls of blood vessels, a condition known as **atherosclerosis**. The amount of LDL in a person's blood is directly related to his or her risk of cardiovascular disease. The higher the LDL level, the greater the risk. LDL is the lipoprotein class most used to trigger and monitor cholesterol lowering therapy.

High-density lipoproteins (HDL)

HDL is often called "good" cholesterol. HDL removes excess cholesterol from tissues and vessel walls and carries it to the liver, where it is removed from the blood and discarded. The amount of HDL in a person's blood is inversely related to his or her risk of cardiovascular disease. The lower the HDL level, the greater the risk; the higher the level, the lower the risk. The smallest lipoprotein, it contains 20-30% of a person's total cholesterol and can be separated into two major subclasses.

Lipoprotein(a)

Lipoprotein(a) is found in lower concentrations than other lipoproteins, yet it carries a unique and significant risk for cardiovascular disease. Because of its similarity to LDL, test methods often don't measure it separately, but include it within the LDL class. Testing specifically for this class may uncover why a person is not responding to standard cholesterol-lowering treatment. High lipoprotein(a) levels may not respond to treatment aimed at high LDL.

Measurement guidelines

The Expert Panel of the National Cholesterol Education Program (NCEP) sponsored by the National Institutes of Health has published guidelines for the detection of **high cholesterol** in adults. The NCEP panel recommends that adults over the age of 20 be tested for cholesterol and HDL every five years. If the cholesterol is high, the HDL is low (below 35 mg/dl), or other risk factors are present, a complete lipoprotein profile that includes total cholesterol, triglycerides, HDL, and calculated LDL should be done.

Measurement methods

There are a variety of methods to measure the lipoprotein classes. All require separation of the classes

before they can be measured. One way to separate them is by spinning serum (the yellow, watery liquid that separates from the cells when blood clots) for a long time in a high-speed centrifuge (called ultracentrifugation). The most dense classes will settle towards the bottom, the least dense towards the top. Following centrifugation, the most complete measurement of all the lipoprotein classes is done using electrophoresis. This procedure measures the quantity of each lipoprotein class based on its movement in an electrical field.

Other, less extensive procedures are also used. For example, if only HDL is to be measured, a chemical is added to the serum that will clump the other classes, leaving HDL free in the serum to be measured by a chemical method. LDL often is not measured directly but its level is calculated based on the measurements of total cholesterol, HDL, and triglycerides. The formula is called the Friedewald formula: LDL = total cholesterol - HDL - (triglycerides/5). The calculated result will be inaccurate in a person with high triglycerides. Results are usually available the same or following day.

Preparation

The patient must fast for 12 hours before the test, eating nothing and drinking only water. The person should not have alcohol for 24 hours before the test. There should be a stable diet and no illnesses occurring in the preceding two weeks.

A lipoproteins test requires 5 mL (milliliters) of blood. A person's physical position while having blood collected affects the results. Values from blood drawn while a person is sitting may be different from those while the person is standing. If repeated testing is done, the person should be in same position each time.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

People with HDL levels between 45 mg/dl and 59 mg/dl carry an average risk for cardiovascular disease. People with HDL levels above 60 mg/dl have a negative risk factor and appear to be protected from cardiovascular disease.

LDL levels below 130 mg/dl are desirable.

Some people have normal variations in their lipoprotein and total cholesterol levels. Repeat testing may be necessary, especially if a value is at a borderline risk category point.

KEY TERMS

Atherosclerosis—Disease of blood vessels caused by deposits of cholesterol on the inside walls of the vessels.

Cardiovascular disease—Disease that affects the heart and blood vessels.

Cholesterol—A fat-like substance called a lipid. It is used to build cell membranes and hormones. The body makes cholesterol and gets it from food.

Lipoproteins—The packages in which cholesterol and triglycerides travel throughout the body.

Abnormal results

People with HDL levels 36-44 mg/dl have a moderate risk of cardiovascular disease. HDL levels below 35 mg/dl are a major risk.

LDL levels 130-159 mg/dl place a person at a borderline high risk of cardiovascular disease; levels above 160 mg/dl place a person at high risk. Relative proportions between HDL and LDL are important also.

Resources

BOOKS

Bachorik, Paul S., Basil M. Rafkind, and Peter O. Kwiterovich. "Lipids and Dyslipoproteinemia." In *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

Rifai, Nader, G. Russell Warnick, and Marek H. Dominiczak. *Handbook of Lipoprotein Testing*. Washington, DC: American Association of Clinical Chemistry (AACC) Press, 1997.

PERIODICALS

O'Brien, Timothy, and Tu T. Nguyen. "Lipids and Lipoproteins in Women." *Mayo Clinic Proceedings* (Mar. 1997) 235-244.

Stein, James H, and Robert S. Rosenson. "Lipoprotein Lp(a) Excess and Coronary Heart Disease." *Archives of Internal Medicine* (9 June 1997): 1170-1176.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

OTHER

National Cholesterol Education Program: Second Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol In Adults. NIH Publication No. 93-3096, Bethesda, Maryland. August 1996.

Nancy J. Nordenson

Liposuction

Definition

Liposuction, also known as lipoplasty or suction-assisted lipectomy, is cosmetic surgery performed to remove unwanted deposits of fat from under the skin. The doctor sculpts and recontours the patient's body by removing excess fat deposits that have been resistant to reduction by diet or **exercise**. The fat is permanently removed from under the skin with a suction device.

Purpose

Liposuction is intended to reduce and smooth the contours of the body and improve the patient's appearance. Its goal is cosmetic improvement. It is the most commonly performed cosmetic procedure in the United States.

Liposuction does not remove large quantities of fat and is not intended as a weight reduction technique. The average amount of fat removed is about a liter, or a quart. Although liposuction is not intended to remove cellulite (lumpy fat), some doctors believe that it improves the appearance of cellulite areas (thighs, hips, buttocks, abdomen, and chin).

A new technique called liposhaving shows more promise at reducing cellulite.

Precautions

Liposuction is most successful on patients who have firm, elastic skin and concentrated pockets of fat in cellultite areas. To get good results after fat removal, the skin must contract to conform to the new contours without sagging. Older patients have less elastic skin and therefore may not be good candidates for this procedure. Patients with generalized fat distribution, rather than localized pockets, are not good candidates.

Patients should be in good general health and free of heart or lung disease. Patients with poor circulation or who have had recent surgery at the intended site of fat reduction are not good candidates.

"Before" photo of patient undergoing liposuction. *(Photograph by I. Richard Toranto, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

Description

Most liposuction procedures are performed under local anesthesia (loss of sensation without loss of consciousness) by the tumescent or wet technique. In this technique, large volumes of very dilute local anesthetic (a substance that produces anesthesia) are injected under the patient's skin, making the tissue swollen and firm. Epinephrine is added to the solution to reduce bleeding, and make possible the removal of larger amounts of fat.

The doctor first numbs the skin with an injection of local anesthetic. After the skin is desensitized, the doctor makes a series of tiny incisions, usually 0.12-0.25 in (3-6 mm) in length. The area is then flooded with a larger amount of local anesthetic. Fat is then extracted with suction through a long, blunt hollow tube called a cannula. The doctor repeatedly pushes the cannula through the fat layers in a radiating pattern creating tun-

"After" photo of same patient following liposuction. *(Photograph by I. Richard Toranto, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

nels, removing fat, and recontouring the area. Large quantities of intravenous fluid (IV) is given during the procedure to replace lost body fluid. Blood transfusions are possible.

Some newer modifications to the procedure involve the use of a cutting cannula called a liposhaver, or the use of ultrasound to help break up the fat deposits. The patient is awake and comfortable during these procedures.

The length of time required to perform the procedure varies with the amount of fat that is to be removed and the number of areas to be treated. Most operations take from 30 minutes to two hours, but extensive procedures can take longer. The length of time required also varies with the manner in which the anesthetic is injected.

The cost of liposuction can vary depending upon the standardized fees in the region of the country where it is performed, the extent of the area being treated, and the person performing the procedure. Generally, small areas, such as the chin or knees, can be done for as little as $500, while more extensive treatment, such as when hips, thighs, and abdomen are done simultaneously, can cost as much as $10,000. These procedures are cosmetic and are not covered by most insurance policies.

Preparation

The doctor will do a physical exam and may order blood work to determine clotting time and hemoglobin level for transfusions should the need arise. The patient may be placed on **antibiotics** immediately prior to surgery to ward off infection.

Aftercare

After the surgery, the patient will need to wear a support garment continuously for two to three weeks. If ankles or calves were treated, support hose will need to be worn for up to six weeks. The support garments can be removed during bathing 24 hours after surgery. A drainage tube, under the skin in the area of the procedure, may be inserted to prevent fluid build-up.

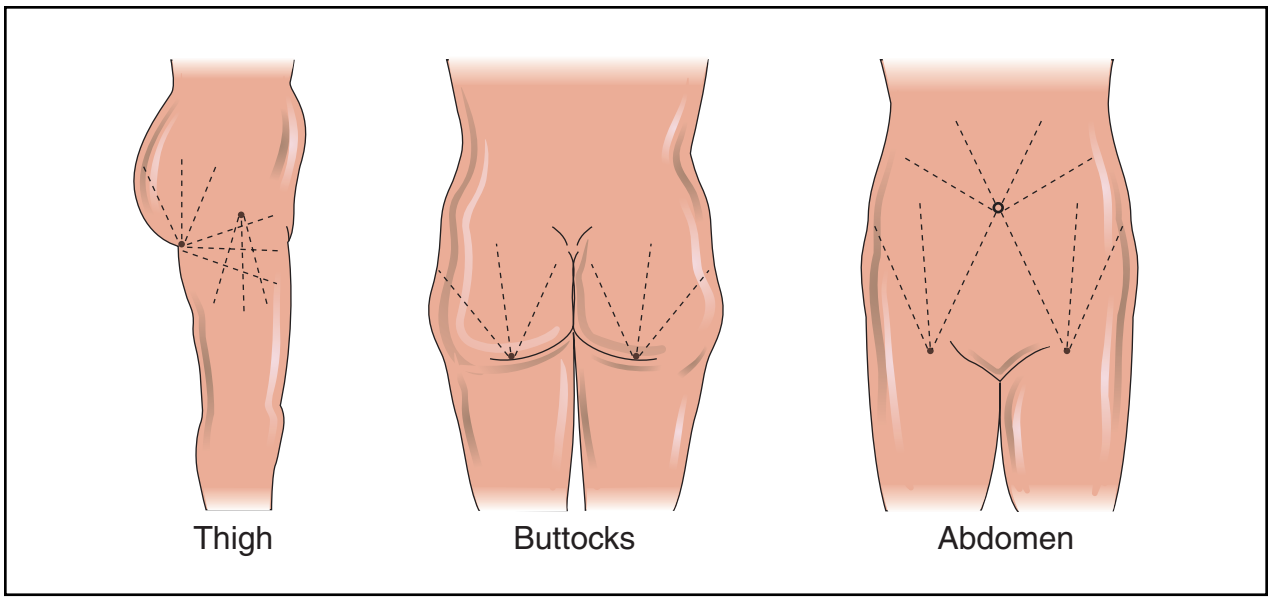
Mild side effects can include a burning sensation at the site of the surgery for up to one month. The patient should be prepared for swelling of the tissues below the operated site for 6-8 weeks after surgery. Wearing the special elastic garments will help reduce this swelling and help to achieve the desired final results.

The incisions involved in this procedure are tiny, but the surgeon may close them with stitches or staples. These will be removed the day after surgery. However, three out of eight doctors use no sutures. Minor bleeding or seepage through the incision site is common after this procedure. Wearing the elastic bandage or support garment helps reduce fluid loss.

This operation is virtually painless. However, for the first postoperative day, there may be some discomfort which will require light **pain** medication. Soreness or aching may persist for several days. The patient can usually return to normal activity within a week. Postoperative bruising will go away by itself within 10-14 days. Postoperative swelling begins to go down after a week. It may take three to six months for the final contour to be reached.

Risks

Liposuction under local anesthesia using the tumescent technique is exceptionally safe. A 1995 study of 15,336 patients showed no serious complications or deaths. Another study showed a 1% risk factor. However,



Common entry sites for liposuction procedures. *(Illustration by Electronic Illustrators Group.)*

as with any surgery, there are some risks and serious complications. **Death** is possible.

The main hazards associated with this surgery involve migration of a blood clot or fat globule to the heart, brain, or lungs. Such an event can cause a **heart attack**, **stroke**, or serious lung damage. However, this complication is rare and did not occur even once in the study of 15,336 patients. The risk of blood clot formation is reduced with the wearing of special girdle-like compression garments after the surgery, and with the resumption of normal mild activity soon after surgery.

Staying in bed increases the risk of clot formation, but not getting enough rest can result in increased swelling of the surgical area. Such swelling is a result of excess fluid and blood accumulation, and generally comes from not wearing the compression garments. If necessary, this excess fluid can be drained off with a needle in the doctor's office.

Infection is another complication, but this rarely occurs. If the physician is skilled and works in a sterile environment, infection should not be a concern.

If too much fat is removed, the skin may peel in that area. Smokers are at increased risk for shedding skin because their circulation is impaired. Another and more serious hazard of removing too much fat is that the patient may go into **shock**. Fat tissue has an abundant blood supply and removing too much of it at once can cause shock if the fluid is not replaced.

A rare complication is perforation or puncture of an organ. The procedure involves pushing a cannula vigorously through the fat layer. If the doctor pushes too hard or if the tissue gives way too easily under the force, the blunt hollow tube can go too far and injure internal organs.

Liposuction can damage superficial nerves. Some patients lose sensation in the area that has been suctioned, but feeling usually returns with time.

Normal results

The loss of fat cells is permanent, and the patient should have smoother, more pleasing body contours without excessive bulges. However, if the patient overeats, the remaining fat cells will grow in size. Although the patient may gain weight back, the body should retain the new proportions and the suctioned area should remain proportionally smaller.

Tiny scars about 0.25-0.5 in (6-12 mm) long at the site of incision are normal. The doctor usually makes the incisions in places where the scars are not likely to show.

In some instances, the skin may appear rippled, wavy, or baggy after surgery. Pigmentation spots may develop. The recontoured area may be uneven. This unevenness is common, occurring in 5-20% of the cases, and can be corrected with a second procedure that is less extensive than the first.

Resources

BOOKS

Hetter, Gregory P. *Lipoplasty: The Theory and Practice of Blunt Suction Lipectomy.* Little, Brown and Co., 1990.

KEY TERMS

Cellulite—Cellulite is dimply skin caused by uneven fat deposits beneath the surface.

Epinephrine—Epinephrine is a drug that causes blood vessels to constrict or narrow. It is used in local anesthetics to reduce bleeding.

Hemoglobin—Hemoglobin is the component of blood that carries oxygen to the tissues.

Liposhaving—Liposhaving involves removing fat that lies closer to the skins surface by using a needle-like instrument that contains a sharp-edged shaving device.

Tumescent technique—The tumescent technique of liposuction involves swelling, or tumescing, the tissue with large volumes of dilute anesthetic.

Pitman, Gerald H. *Liposuction & Aesthetic Surgery.* Quality Medical Publishing, Inc., 1993.

Stegman, Samuel J., Theodore A. Tromovitch, and Richard G. Glogau. *Cosmetic Dermatologic Surgery.* Year Book Medical Publishers, Inc., 1990.

Wilson, Joleen. *The American Society of Plastic and Reconstructive Surgeon's Guide to Cosmetic Surgery.* Simon & Schuster, 1992.

PERIODICALS

"Downsize Your Thighs." *Good Housekeeping*, May 1997, 69-75.

Hanke, C. W., G. Bernstein, and S. Bullock. "Safety of Tumescent Liposuction in 15,336 Patients." *Dermatologic Surgery* 21 (May 1995): 459-462.

Murray, Louann. "Tumescent Liposuction Technique is Great Improvement." *Dermatology Times* (Sept. 1995): 4.

Murray, Louann. "What is the Best Approach to Liposuction?" *Dermatology Times* (Sept. 1995): 24-25.

"Sound Waves Help Break Up Fat." *USA Today*, Oct. 1997, 15-16.

Taylor, Mia, Lloyd A. Hoffman, and Michael Lieberman. "Intestinal Perforation after Suction Lipoplasty: A Case Report and Review of the Literature." *Annals of Plastic Surgery* 38. No. 2: 169-172.

Van Ness, David. "The Skinny on Liposuction." *Muscle and Fitness*, Nov. 1997, 128-132, 201.

ORGANIZATIONS

American Society of Aesthetic Plastic Surgery. (888) 272-7711.

American Society of Plastic and Reconstructive Surgery. (800) 635-0635. <http://:www.plasticsurgery.org>.

Lipoplasty Society of North America. (800) 848-1991.

Louann W. Murray, PhD

Listeria monocytogenes infection *see* **Listeriosis**

Listeriosis

Definition

Listeriosis is an illness caused by the bacterium *Listeria monocytogenes* that is acquired by eating contaminated food. The organism can spread to the blood stream and central nervous system. During **pregnancy**, listeriosis often causes **miscarriage** or **stillbirth**.

Description

Listeriosis is caused by an infection with the bacterium *Listeria monocytogenes*. This bacteria can be carried by many animals and birds, and it has been found in soil, water, sewage, and animal feed. Five out of every 100 people carry *Listeria monocytogenes* in their intestines. Listeriosis is considered a "food-borne illness" because most people are probably infected after eating food contaminated with *Listeria monocytogenes*. However, a woman can pass the bacteria to her baby during pregnancy. In addition, there have been a few cases where workers have developed *Listeria* skin infections by touching infected calves or poultry.

In the 1980s, the United States government began taking measures to decrease the occurrence of listeriosis. Processed meats and dairy products are now tested for the presence of *Listeria monocytogenes*. The Food and Drug Administration (FDA) and the Food Safety and Inspection Service (FSIS) can legally prevent food from being shipped, or order food recalls, if they detect any *Listeria* bacteria. These inspections, in combination with the public education regarding the proper handling of uncooked foods, appear to be working. In 1989, there were 1,965 cases of listeriosis with 481 deaths. In 1993, the numbers fell to 1,092 cases with 248 deaths.

In 1996, the Centers for Disease Control and Prevention (CDC) began a nationwide food-borne disease surveillance program called "FoodNet," in which seven states were participating by January 1997. Results from the program indicated that, in 1996, one person out of every 200,000 people got listeriosis. FoodNet also revealed that the hospitalization rate was higher for listeriosis (94%) than for any other food-borne illness. In addition, FoodNet found that the *Listeria* bacteria reached the blood and cerebrospinal fluid in 89% of cases, a higher percentage than in any other food-borne illness.

Persons at particular risk for listeriosis include the elderly, pregnant women, newborns, and those with a weakened immune system (called "immunocompromised"). Risk is increased when a person suffers from diseases such as **AIDS**, **cancer**, kidney disease, **diabetes mellitus**, or by the use of certain medications. Infection

is most common in babies younger than one month old and adults over 60 years of age. Pregnant women account for 27% of the cases and immunocompromised persons account for almost 70%. Persons with AIDS are 280 times more likely to get listeriosis than others.

Causes and symptoms

As noted, persons become infected with *Listeria monocytogenes* by eating contaminated food. *Listeria* has been found on raw vegetables, fish, poultry, raw (unpasteurized) milk, fresh meat, processed meat (such as deli meat, hot dogs, and canned meat), and certain soft cheeses. Listeriosis outbreaks in the United States since the 1980s have been linked to cole slaw, milk, Mexican-style cheese, undercooked hot dogs, undercooked chicken, and delicatessen foods. Unlike most other bacteria, *Listeria monocytogenes* does not stop growing when food is in the refrigerator—its growth is merely slowed. Fortunately, typical cooking temperatures and the pasteurization process do kill this bacteria.

Listeria bacteria can pass through the wall of the intestines, and from there they can get into the blood stream. Once in the blood stream, they can be transported anywhere in the body, but are commonly found the central nervous system (brain and spinal cord); and in pregnant women they are often found in the placenta (the organ which connects the baby's umbilical cord to the uterus). *Listeria monocytogenes* live inside specific white blood cells called macrophages. Inside macrophages, the bacteria can hide from immune responses and become inaccessible to certain **antibiotics**. *Listeria* bacteria are capable of multiplying within macrophages, and then may spread to other macrophages.

After consuming food contaminated with this bacteria, symptoms of infection may appear anywhere from 11-70 days later. Most people do not get any noticeable symptoms. Scientists are unsure, but they believe that *Listeria monocytogenes* can cause upset stomach and intestinal problems just like other food-borne illnesses. Persons with listeriosis may develop flu-like symptoms such as **fever**, **headache**, **nausea and vomiting**, tiredness, and **diarrhea**.

Pregnant women experience a mild, flu-like illness with fever, muscle aches, upset stomach, and intestinal problems. They recover, but the infection can cause miscarriage, **premature labor**, early rupture of the birth sac, and stillbirth. Unfortunately, half of the newborns infected with *Listeria* will die from the illness.

There are two types of listeriosis in the newborn baby: early-onset disease and late-onset disease. Early-onset disease refers to a serious illness that is present at birth and usually causes the baby to be born prematurely. Babies infected during the pregnancy usually have a blood infection (**sepsis**) and may have a serious, whole body infection called granulomatosis infantisepticum. When a full-term baby becomes infected with *Listeria* during **childbirth**, that situation is called late-onset disease. Commonly, symptoms of late-onset listeriosis appear about two weeks after birth. Babies with late-term disease typically have **meningitis** (inflammation of the brain and spinal tissues); yet they have a better chance of surviving than those with early-onset disease.

Immunocompromised adults are at risk for a serious infection of the blood stream and central nervous system (brain and spinal cord). Meningitis occurs in about half of the cases of adult listeriosis. Symptoms of listerial meningitis occur about four days after the flu-like symptoms and include fever, personality change, uncoordinated muscle movement, **tremors**, muscle contractions, seizures, and slipping in and out of consciousness.

Listeria monocytogenes causes **endocarditis** in about 7.5% of the cases. Endocarditis is an inflammation of heart tissue due to the bacterial infection. Listerial endocarditis causes **death** in about half of the patients. Other diseases which have been caused by *Listeria monocytogenes* include **brain abscess**, eye infection, hepatitis (liver disease), **peritonitis** (abdominal infection), lung infection, joint infection, arthritis, heart disease, bone infection, and gallbladder infection.

Diagnosis

Listeriosis may be diagnosed and treated by infectious disease specialists and internal medicine specialists. The diagnosis and treatment of this infection should be covered by most insurance providers.

The only way to diagnose listeriosis is to isolate *Listeria monocytogenes* from blood, cerebrospinal fluid, or stool. A sample of cerebrospinal fluid is removed from the spinal cord using a needle and syringe. This procedure is commonly called a spinal tap. The amniotic fluid (the fluid which bathes the unborn baby) may be tested in pregnant women with listeriosis. This sample is obtained by inserting a needle through the abdomen into the uterus and withdrawing fluid. *Listeria* grows well in laboratory media and test results can be available within a few days.

Treatment

Listeriosis is treated with the antibiotics ampicillin (Omnipen) or sulfamethoxazole-trimethoprim (Bactrim, Septra). Because the bacteria live within macrophage cells, treatment may be difficult and the treatment periods may vary. Usually, pregnant women are treated for two weeks; newborns, two to three weeks; adults with mild disease, two to four weeks; persons with meningitis,

three weeks; persons with brain abscesses, six weeks; and persons with endocarditis, four to six weeks.

Patients are often hospitalized for treatment and monitoring. Other drugs may be provided to relieve **pain** and fever and to treat other reactions to the infection.

Prognosis

The overall death rate for listeriosis is 26%. This high death rate is due to the serious illness suffered by newborns, the elderly, and immunocompromised persons. Healthy adults and older children have a low death rate. Complications of *Listeria* infection include: meningitis, sepsis, miscarriage, stillbirth, **pneumonia**, **shock**, endocarditis, **abscess** (localized infection) formation, and eye inflammation.

Prevention

The United States government has already done much to prevent listeriosis. Persons at extremely high risk (pregnant women, immunocompromised persons, etc.) must use extra caution. High risk persons should: avoid soft cheeses, such as Mexican cheese, feta, Brie, Camembert, and blue cheese (cottage cheese is safe), thoroughly cook leftovers and ready-to-eat foods (such as hot-dogs), and avoid foods from the deli.

For all people, the risk of listeriosis can be reduced by taking these precautions:

- completely cook all meats and eggs
- carefully wash raw vegetables before eating
- keep raw meat away from raw vegetables and prepared foods. After cutting raw meat, wash the cutting board with detergent before using it for vegetables
- avoid drinking unpasteurized milk or foods made from such milk
- wash hands thoroughly after handling raw meat
- follow the instructions on food labels. Observe food expiration dates and storage conditions

Resources

BOOKS

Gorbach, Samuel L., John G. Bartlett, and Neil R. Blacklow. *Infectious Diseases*. 2nd ed. Philadelphia: W. B. Saunders Co., 1998.

Lorber, Bennett. "Listeriosis." In *Infectious Diseases*. Philadelphia: Temple University School of Medicine and Hospital, 1996.

PERIODICALS

Calder, Jennifer. "Listeria Meningitis in Adults." *Lancet* 350 (1997): 307.

Farr, R. Wesley. "Leptospirosis." *Clinical Infectious Diseases* 21 (1995): 1-8.

KEY TERMS

Abscess—An accumulation of pus caused by localized infection in tissues or organs. *Listeria monocytogenes* can cause abscesses in many organs including the brain, spleen, and liver.

Immunocompromised—To have a poor immune system due to disease or medication. Immunocompromised persons are at risk for developing infections because they can't fight off microorganisms like healthy persons can.

Macrophages—White blood cells whose job is to destroy invading microorganisms. *Listeria monocytogenes* avoids being killed and can multiply within the macrophage.

Meningitis—An inflammation of the tissues that surround the brain and spinal cord. It can be caused by a bacterial infection.

Sepsis—The presence of bacteria in the blood stream, a normally sterile environment.

Schlech, Walter F. "Listeria Gastroenteritis — Old Syndrome, New Pathogen." *New England Journal of Medicine* 336 (June 1997): 130-131.

OTHER

"Preventing Foodborne Illness: Listeriosis." Centers for Disease Control. <http://www.cdc.gov/ncidad/diseases/foodborn/lister.htm>.

"Listeriosis." HealthAnswers.com 12 Apr. 1998 <http://www.ahealthyme.com/topic/topic100587088>.

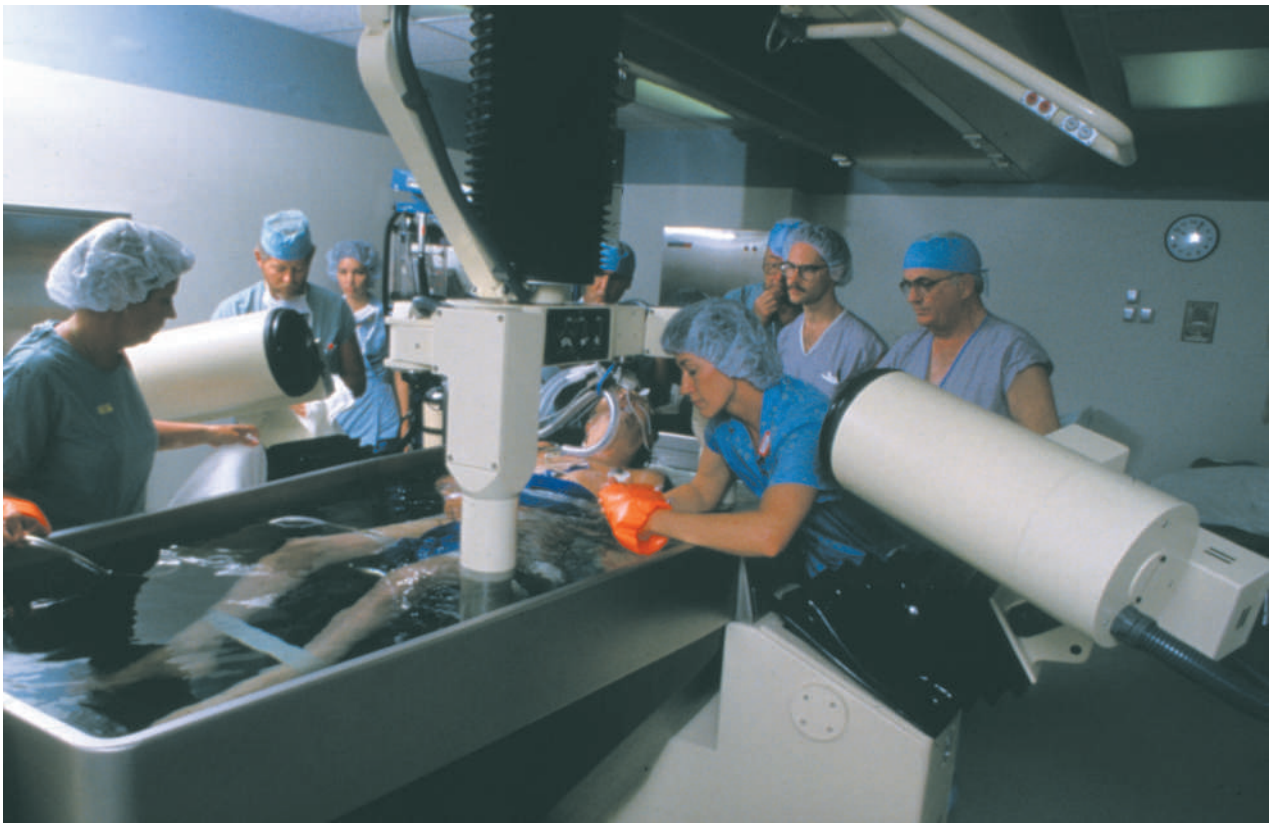
"Preventing Foodborne Listeriosis." A Healthy Me Page. 12 Apr. 1998 <http://www.ahealthyme.com/topic/topic100587088>.

Belinda Rowland, PhD

Lithotripsy

Definition

Lithotripsy is the use of high-energy shock waves to fragment and disintegrate **kidney stones**. The shock wave, created by using a high-voltage spark or an electromagnetic impulse, is focused on the stone. This shock wave shatters the stone and this allows the fragments to pass through the urinary system. Since the shock wave is generated outside the body, the procedure is termed extracorporeal shock wave lithotripsy, or ESWL.



A lithotriptor in use by patient in tub. This noninvasive method crushes kidney stones through shock waves. *(Photo Researchers, Inc. Reproduced by permission.)*

Purpose

ESWL is used when a kidney stone is too large to pass on its own, or when a stone becomes stuck in a ureter (a tube which carries urine from the kidney to the bladder) and will not pass. Kidney stones are extremely painful and can cause serious medical complications if not removed.

Precautions

ESWL should not be considered for patients with severe skeletal deformities, patients weighing over 300 lb (136 kg), patients with abdominal aortic aneurysms, or patients with uncontrollable bleeding disorders. Patients who are pregnant should not be treated with ESWL. Patients with cardiac **pacemakers** should be evaluated by a cardiologist familiar with ESWL. The cardiologist should be present during the ESWL procedure in the event the pacemaker needs to be overridden.

Description

Lithotripsy uses the technique of focused shock waves to fragment a stone in the kidney or the ureter. The patient is placed in a tub of water or in contact with a water-filled cushion, and a shock wave is created which is focused on the stone. The wave shatters and fragments the stone. The resulting debris, called gravel, then passes through the remainder of the ureter, through the bladder, and through the urethra during urination. There is minimal chance of damage to skin or internal organs because biologic tissues are resilient, not brittle, and because the the shock waves are not focused on them.

Preparation

Prior to the lithotripsy procedure, a complete **physical examination** is done, followed by tests to determine the number, location, and size of the stone or stones. A test called an intravenous pyelogram, or IVP, is used to locate the stones. An IVP involves injecting a dye into a vein in the arm. This dye, which shows up on x ray, travels through the bloodstream and is excreted by the kidneys. The dye then flows down the ureters and into the bladder. The dye surrounds the stones, and x rays are then used to evaluate the stones and the anatomy of the urinary system. (Some people are allergic to the dye material, so it cannot be used. For these people, focused sound waves, called ultrasound,

KEY TERMS

Aneurysm—A dilation of the wall of an artery which causes a weak area prone to rupturing.

Bladder—Organ in which urine is stored prior to urination.

Bleeding disorder—Problems in the clotting mechanism of the blood.

Cardiologist—A physician who specializes in problems of the heart.

EKG—A tracing of the electrical activity of the heart.

ESWL (Extracorporeal shock wave lithotripsy)—The use of focused shock waves, generated outside the body, to fragment kidney stones.

Gravel—The debris which is formed from a fragmented kidney stone.

IVP (Intravenous pyelogram)—The use of a dye, injected into the veins, used to locate kidney stones. Also used to determine the anatomy of the urinary system.

Kidney stone—A hard mass that forms in the urinary tract and which can cause pain, bleeding, obstruction, or infection. Stones are primarily made up of calcium.

Stent—A plastic tube placed in the ureter prior to the ESWL procedure which facilitates the passage of gravel and urine

Ultrasound—Sound waves used to determine the internal structures of the body

Ureter—A tube which carries urine from the kidney to the bladder.

Urethra—A tube through which urine passes during urination.

Urologist—A physician who specializes in problems of the urinary system.

can be used to see where the stones are located.) Blood tests are done to determine if any potential bleeding problems exist. For women of childbearing age, a **pregnancy** test is done to make sure the patient isn't pregnant; and elderly patients have an EKG done to make sure no potential heart problems exist. Some patients may have a stent placed prior to the lithotripsy procedure. A stent is a plastic tube placed in the ureter which allows the passage of gravel and urine after the ESWL procedure is completed.

Aftercare

Most patients have a lot of blood in their urine after the ESWL procedure. This is normal and should clear after several days to a week or so. Lots of fluids should be taken to encourage the flushing of any gravel remaining in the urinary system. The patient should follow up with the urologist in about two weeks to make sure that everything is going as planned. If a stent has been inserted, it is normally removed at this time. Patients may return to work whenever they feel able.

Risks

Abdominal **pain** is not uncommon after ESWL, but it is usually not cause to worry. However, persistent or severe abdominal pain may imply unexpected internal injury. Colicky renal pain is very common as gravel is still passing. Other problems may include perirenal hematomas (blood clots near the kidneys) in 66% of the cases; nerve palsies; **pancreatitis** (inflammation of the pancreas); and obstruction by stone fragments. Occasionally, stones may not be completely fragmented during the first ESWL treatment and further ESWL procedures may be required.

Resources

BOOKS

Tanagho, Emil, and Jack McAninch, eds. *Smith's General Urology.* 14th ed. Norwalk, CT: Appleton & Lange Publishers, 1995.

ORGANIZATIONS

American Urological Association. 1120 North Charles St., Baltimore, MD 21201-5559. (410) 727-1100. <http://www.auanet.org/index_hi.cfm>.

Joseph Knight, PA

Live cell therapy *see* **Cell therapy**

Liver-spleen scan *see* **Liver nuclear medicine scan**

Liver biopsy

Definition

A liver biopsy is a medical procedure performed to obtain a small piece of liver tissue for diagnostic testing.

Liver biopsies are sometimes called percutaneous liver biopsies, because the tissue sample is obtained by going through the patient's skin.

Purpose

A liver biopsy is usually done to diagnose a tumor, or to evaluate the extent of damage that has occurred to the liver because of chronic disease. Biopsies are often performed to identify abnormalities in liver tissues after imaging studies have failed to yield clear results.

A liver biopsy may be ordered to evaluate any of the following conditions or disorders:

- jaundice
- **cirrhosis**
- hemochromatosis, which is a condition of excess iron in the liver
- repeated abnormal results from liver function tests
- unexplained swelling or enlargement of the liver
- primary cancers of the liver, such as hepatomas, cholangiocarcinomas, and angiosarcomas
- metastatic cancers of the liver

Precautions

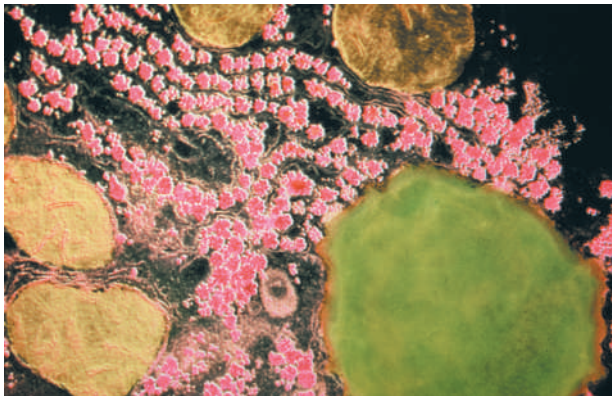
Some patients should not have percutaneous liver biopsies. They include patients with any of the following conditions:

- a **platelet count** below 60,000
- a longer-than-normal **prothrombin time**
- a liver tumor that contains a large number of blood vessels
- a history of unexplained bleeding
- a watery (hydatid) cyst
- an infection in either the cavity around the lungs, or the diaphragm

Description

Percutaneous liver biopsy is done with a special hollow needle, called a Menghini needle, attached to a suction syringe. Doctors who specialize in the digestive system or liver will sometimes perform liver biopsies. But in most cases, a radiologist (a doctor who specializes in x rays and imaging studies) performs the biopsy. The radiologist will use computed tomography scan (CT scan) or ultrasound to guide the choice of the site for the biopsy.

An hour or so before the biopsy, the patient may be given a sedative to help relaxation. He or she is then asked to lie on the back with the right elbow to the side and the right hand under the head. The patient is instructed to lie as still as possible during the procedure. He or she is warned to expect a sensation resembling a punch in the right shoulder, but to hold still in spite of the momentary feeling.



A false color image of hepatocyte cells of the liver that secrete bile. *(Custom Medical Stock Photo. Reproduced by permission.)*

The doctor marks a spot on the skin where the needle will be inserted and thoroughly cleanses the right side of the upper abdomen with an antiseptic solution. The patient is then given an anesthetic at the biopsy site.

The needle with attached syringe is inserted into the patient's chest wall. The doctor then draws the plunger of the syringe back to create a vacuum. At this point the patient is asked to take a deep breath, exhale the air and hold their breath at the point of complete exhalation. The needle is inserted into the liver and withdrawn quickly, usually within two seconds or less. The negative pressure in the syringe draws or pulls a sample of liver tissue into the biopsy needle. As soon as the needle is withdrawn, the patient can breathe normally. Pressure is applied at the biopsy site to stop any bleeding, and a bandage will be placed over it. The entire procedure takes 10 to 15 minutes. Test results are usually available within a day.

Preparation

Aspirin and non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen are known to thin the blood and interfere with clotting. These medications should be avoided for at least a week before the biopsy. Four to eight hours before the biopsy, patients should stop eating and drinking.

The patient's blood will be tested prior to the biopsy to make sure that it is clotting normally. Tests will include a platelet count and a prothrombin time. Doctors will also ensure that the patient is not taking any other medications, such as blood thinners like Coumadin, that might affect blood clotting.

Aftercare

Liver biopsies are outpatient procedures in most hospitals. After the biopsy, patients are usually instructed to lie on their right side for about two hours. This provides pressure to the biopsy site and helps prevent bleeding. A nurse will check the patient's vital signs at regular intervals. If there are no complications, the patient is sent home within about four to eight hours.

Patients should arrange to have a friend or relative take them home after discharge. Bed rest for a day is recommended, followed by a week of avoiding heavy work or strenuous **exercise**. The patient can resume eating a normal diet.

Some mild soreness in the area of the biopsy is normal after the anesthetic wears off. Irritation of the muscle that lies over the liver can also cause mild discomfort in the shoulder for some patients. Tylenol can be taken for minor soreness, but aspirin and NSAIDs are best avoided. Patients should call their doctor if they have severe **pain** in the abdomen, chest or shoulder, difficulty breathing, or persistent bleeding. These signs may indicate that there has been leakage of bile into the abdominal cavity, or that air has been introduced into the cavity around the lungs.

Risks

The risks of a liver biopsy are usually very small. When complications do occur, over 90% are apparent within 24 hours after the biopsy. The most significant risk is internal bleeding. Bleeding is most likely to occur in elderly patients, in patients with cirrhosis, or in patients with a tumor that has many blood vessels. Other complications from percutaneous liver biopsies include the leakage of bile or the introduction of air into the chest cavity (**pneumothorax**). There is also a small chance that an infection may occur, or an internal organ such as the lung, gall bladder, or kidney could be punctured.

Normal results

After the biopsy, the liver sample is sent to the pathology laboratory for study under a microscope. A normal (negative) result would find no evidence of **cancer** or other disease in the tissue sample.

Abnormal results

Changes in liver tissue that are visible under the microscope indicate abnormal results. Possible causes for the abnormality include the presence of a tumor, or a disease such as hepatitis.

KEY TERMS

Biopsy—A procedure where a piece of tissue is removed from a patient for diagnostic testing.

Menghini needle—A special needle used to obtain a sample of liver tissue.

Percutaneous biopsy—A biopsy in which a needle is inserted and a tissue sample removed through the skin.

Prothrombin time—A blood test that determines how quickly a person's blood will clot.

Vital signs—A person's essential body functions, usually defined as the pulse, body temperature, and breathing rate.

Resources

BOOKS

Brown, Kyle E., et al. "Liver Biopsy: Indications, Technique, Complications and Interpretation" In *Liver Disease. Diagnosis and Management,* edited by Bacon, Bruce R., and Adrian M. Di Bisceglie. Philadelphia, PA: Churchill Livingstone, 2000.

Cahill, Matthew, et al., eds. *Everything You Need To Know About Medical Tests.* Springhouse, PA: Springhouse Corporation, 1996.

Reddy, K. Rajender, and Lennox J. Jeffers. "Evaluation of the Liver. Liver Biopsy and Laparoscopy." In *Schiff's Diseases of the Liver,* edited by Eugene R. Schiff, et al. Philadelphia, PA: Lippincott-Raven, 1999.

PERIODICALS

Bravo, Arturo A., et al. "Liver Biopsy" *New England Journal of Medicine* 344, no. 7 (February 15, 2001): 495-500.

WEB SITES

"Diagnostic Tests." The National Digestive Diseases Information Clearinghouse (National Institutes of Health). <http://www.www.niddk.nih.gov/health/digest/pubs/diagtest/indexhtm>.

Lata Cherath

Liver cancer

Definition

Liver cancer is a form of **cancer** with a high mortality rate. Liver cancers can be classified into two types. They are either primary, when the cancer starts in the

liver itself, or metastatic, when the cancer has spread to the liver from some other part of the body.

Description

Primary liver cancer

Primary liver cancer is a relatively rare disease in the United States, representing about 2% of all malignancies and 4% of newly diagnosed cancers. Hepatocellular carcinoma is one of the top eight most common cancers in the world. It is, however, much more common outside the United States, representing 10% to 50% of malignancies in Africa and parts of Asia. Rates of HCC in men are at least two to three times higher than for women. In high-risk areas (East and Southeast Asia, sub-Saharan Africa), men are even more likely to have HCC than women.

TYPES OF PRIMARY LIVER CANCER. In adults, most primary liver cancers belong to one of two types: hepatomas, or hepatocellular carcinomas (HCC), which start in the liver tissue itself; and cholangiomas, or cholangiocarcinomas, which are cancers that develop in the bile ducts inside the liver. About 80% to 90% of primary liver cancers are hepatomas. In the United States, about five persons in every 200,000 will develop a hepatoma (70% to 75% of cases of primary liver cancers are HCC). In Africa and Asia, over 40 persons in 200,000 will develop this form of cancer (more than 90% of cases of primary liver are HCC). Two rare types of primary liver cancer are mixed-cell tumors and Kupffer cell sarcomas.

One type of primary liver cancer, called a hepatoblastoma, usually occurs in children younger than four years of age and between the ages of 12 and 15. Unlike liver cancers in adults, hepatoblastomas have a good chance of being treated successfully. Approximately 70% of children with hepatoblastomas experience complete cures. If the tumor is detected early, the survival rate is over 90%.

Metastatic liver cancer

The second major category of liver cancer, metastatic liver cancer, is about 20 times as common in the United States as primary liver cancer. Because blood from all parts of the body must pass through the liver for filtration, cancer cells from other organs and tissues easily reach the liver, where they can lodge and grow into secondary tumors. Primary cancers in the colon, stomach, pancreas, rectum, esophagus, breast, lung, or skin are the most likely to metastasize (spread) to the liver. It is not unusual for the metastatic cancer in the liver to be the first noticeable sign of a cancer that started in another organ. After cirrhosis, metastatic liver cancer is the most common cause of fatal liver disease.

Causes and symptoms

Risk factors

The exact cause of primary liver cancer is still unknown. In adults, however, certain factors are known to place some individuals at higher risk of developing liver cancer. These factors include:

- Male sex.
- Age over 60 years.
- Exposure to substances in the environment that tend to cause cancer (carcinogens). These include: a substance produced by a mold that grows on rice and peanuts (aflatoxin); thorium dioxide, which was once used as a contrast dye for x rays of the liver; vinyl chloride, used in manufacturing plastics; and cigarette smoking.
- Use of oral estrogens for birth control.
- Hereditary hemochromatosis. This is a disorder characterized by abnormally high levels of iron storage in the body. It often develops into cirrhosis.
- Cirrhosis. Hepatomas appear to be a frequent complication of cirrhosis of the liver. Between 30% and 70% of hepatoma patients also have cirrhosis. It is estimated that a patient with cirrhosis has 40 times the chance of developing a hepatoma than a person with a healthy liver.
- Exposure to hepatitis viruses: Hepatitis B (HBV), Hepatitis C (HCV), Hepatitis D (HDV), or Hepatitis G (HGV). It is estimated that 80% of worldwide HCC is associated with chronic HBV infection. In Africa and most of Asia, exposure to hepatitis B is an important factor; in Japan and some Western countries, exposure to hepatitis C is connected with a higher risk of developing liver cancer. In the United States, nearly 25% of patients with liver cancer show evidence of HBV infection. Hepatitis is commonly found among intravenous drug abusers. The 70% increase in HCC incidence in the United States is thought to be due to increasing rates of HBV and HCV infections due to increased sexual promiscuity and illicit drug needle sharing. The association between HDV and HGV and HCC is unclear at this time.

Symptoms of liver cancer

The early symptoms of primary, as well as metastatic, liver cancer are often vague and not unique to liver disorders. The long period between the beginning of the tumor's growth and the first signs of illness is the major reason why the disease has such a high mortality rate. At the time of diagnosis, patients are often fatigued, with fever, abdominal pain, and loss of appetite. They may look emaciated and generally ill. As the tumor enlarges, it stretches the membrane surrounding the liver (the capsule), causing pain in the upper abdomen on the right

side. The pain may extend into the back and shoulder. Some patients develop a collection of fluid, known as ascites, in the abdominal cavity. Others may show signs of bleeding into the digestive tract. In addition, the tumor may block the ducts of the liver or the gall bladder, leading to jaundice. In patients with jaundice, the whites of the eyes and the skin may turn yellow, and the urine becomes dark–colored.

Diagnosis

Physical examination

If the doctor suspects a diagnosis of liver cancer, he or she will check the patient's history for risk factors and pay close attention to the condition of the patient's abdomen during the physical examination. Masses or lumps in the liver and ascites can often be felt while the patient is lying flat on the examination table. The liver is usually swollen and hard in patients with liver cancer; it may be sore when the doctor presses on it. In some cases, the patient's spleen is also enlarged. The doctor may be able to hear an abnormal sound (bruit) or rubbing noise (friction rub) if he or she uses a stethoscope to listen to the blood vessels that lie near the liver. The noises are caused by the pressure of the tumor on the blood vessels.

Laboratory tests

Blood tests may be used to test liver function or to evaluate risk factors in the patient's history. Between 50% and 75% of primary liver cancer patients have abnormally high blood serum levels of a particular protein (alpha-fetoprotein or AFP). The AFP test, however, cannot be used by itself to confirm a diagnosis of liver cancer, because cirrhosis or chronic hepatitis can also produce high alpha–fetoprotein levels. Tests for alkaline phosphatase, bilirubin, lactic dehydrogenase, and other chemicals indicate that the liver is not functioning normally. About 75% of patients with liver cancer show evidence of hepatitis infection. Again, however, abnormal liver function test results are not specific for liver cancer.

Imaging studies

Imaging studies are useful in locating specific areas of abnormal tissue in the liver. Liver tumors as small as an inch across can now be detected by ultrasound or computed tomography scan (CT scan). Imaging studies, however, cannot tell the difference between a hepatoma and other abnormal masses or lumps of tissue (nodules) in the liver. A sample of liver tissue for biopsy is needed to make the definitive diagnosis of a primary liver cancer. CT or ultrasound can be used to guide the doctor in selecting the best location for obtaining the biopsy sample.

Chest x rays may be used to see whether the liver tumor is primary or has metastasized from a primary tumor in the lungs.

Liver biopsy

Liver biopsy is considered to provide the definite diagnosis of liver cancer. A sample of the liver or tissue fluid is removed with a fine needle and is checked under a microscope for the presence of cancer cells. In about 70% of cases, the biopsy is positive for cancer. In most cases, there is little risk to the patient from the biopsy procedure. In about 0.4% of cases, however, the patient develops a fatal hemorrhage from the biopsy because some tumors are supplied with a large number of blood vessels and bleed very easily.

Laparoscopy

The doctor may also perform a laparoscopy to help in the diagnosis of liver cancer. First, the doctor makes a small cut in the patient's abdomen and inserts a small, lighted tube called a laparoscope to view the area. A small piece of liver tissue is removed and examined under a microscope for the presence of cancer cells.

Clinical staging

Currently, the pathogenesis of HCC is not well understood. It is not clear how the different risk factors for HCC affect each other. In addition, the environmental factors vary from region to region.

Treatment

Treatment of liver cancer is based on several factors, including the type of cancer (primary or metastatic); stage (early or advanced); the location of other primary cancers or metastases in the patient's body; the patient's age; and other coexisting diseases, including cirrhosis. For many patients, treatment of liver cancer is primarily intended to relieve the pain caused by the cancer but cannot cure it.

Surgery

Few liver cancers in adults can be cured by surgery because they are usually too advanced by the time they are discovered. If the cancer is contained within one lobe of the liver, and if the patient does not have either cirrhosis, jaundice, or ascites, surgery is the best treatment option. Patients who can have their entire tumor removed have the best chance for survival. Unfortunately, only about 5% of patients with metastatic cancer (from primary tumors in the colon or rectum) fall into this group. If

the entire visible tumor can be removed, about 25% of patients will be cured. The operation that is performed is called a partial hepatectomy, or partial removal of the liver. The surgeon will remove either an entire lobe of the liver (a lobectomy) or cut out the area around the tumor (a wedge resection).

Chemotherapy

Some patients with metastatic cancer of the liver can have their lives prolonged for a few months by chemotherapy, although cure is not possible. If the tumor cannot be removed by surgery, a tube (catheter) can be placed in the main artery of the liver and an implantable infusion pump can be installed. The pump allows much higher concentrations of the cancer drug to be carried to the tumor than is possible with chemotherapy carried through the bloodstream. The drug that is used for infusion pump therapy is usually floxuridine (FUDR), given for 14-day periods alternating with 14-day rests. Systemic chemotherapy can also be used to treat liver cancer. The medications usually used are 5-fluorouracil (Adrucil, Efudex) or methotrexate (MTX, Mexate). Systemic chemotherapy does not, however, significantly lengthen the patient's survival time.

Radiation therapy

Radiation therapy is the use of high-energy rays or x-rays to kill cancer cells or to shrink tumors. Its use in liver cancer, however, is only to give short-term relief from some of the symptoms. Liver cancers are not sensitive to radiation, and radiation therapy will not prolong the patient's life.

Liver transplantation

Removal of the entire liver (total hepatectomy) and liver transplantation can be used to treat liver cancer. However, there is a high risk of tumor recurrence and metastases after transplantation.

Other therapies

Other therapeutic approaches include:

- hepatic artery embolization with chemotherapy (chemoembolization)
- alcohol ablation via ultrasound-guided percutaneous injection
- ultrasound-guided cryoablation
- immunotherapy with monoclonal antibodies tagged with cytotoxic agents
- gene therapy with retroviral vectors containing genes expressing cytotoxic agents

KEY TERMS

Aflatoxin—A substance produced by molds that grow on rice and peanuts. Exposure to aflatoxin is thought to explain the high rates of primary liver cancer in Africa and parts of Asia.

Alpha-fetoprotein—A protein in blood serum that is found in abnormally high concentrations in most patients with primary liver cancer.

Cirrhosis—A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

Hepatitis—A viral disease characterized by inflammation of the liver cells (hepatocytes). People infected with hepatitis B or hepatitis C virus are at an increased risk for developing liver cancer.

Metastatic cancer—A cancer that has spread to an organ or tissue from a primary cancer located elsewhere in the body.

Alternative treatment

Many patients find that alternative and complementary therapies help to reduce the stress associated with illness, improve immune function, and boost spirits. While there is no clinical evidence that these therapies specifically combat disease, activities such as biofeedback, relaxation, therapeutic touch, massage therapy and guided imagery have no side effects and have been reported to enhance well-being.

Several other healing therapies are sometimes used as supplemental or replacement cancer treatments, such as antineoplastons, cancell, cartilage (bovine and shark), laetrile, and mistletoe. Many of these therapies have not been the subject of safety and efficacy trials by the National Cancer Institute (NCI). The NCI has conducted trials on cancell, laetrile, and other alternative therapies and found no anticancer activity. These treatments have varying effectiveness and safety considerations. Patients using any alternative remedy should first consult their doctor in order to prevent harmful side effects or interactions with traditional cancer treatment.

Prognosis

Liver cancer has a very poor prognosis because it is often not diagnosed until it has metastasized. Fewer than 10% of patients survive three years after the initial diagnosis; the overall five-year survival rate for patients with

hepatomas is around 4%. Most patients with primary liver cancer die within several months of diagnosis. Patients with liver cancers that metastasized from cancers in the colon live slightly longer than those whose cancers spread from cancers in the stomach or pancreas.

Prevention

There are no useful strategies at present for preventing metastatic cancers of the liver. Primary liver cancers, however, are 75% to 80% preventable. Current strategies focus on widespread vaccination for **hepatitis B**, early treatment of hereditary hemochromatosis, and screening of high-risk patients with alpha–fetoprotein testing and ultrasound examinations.

Lifestyle factors that can be modified in order to prevent liver cancer include avoidance of exposure to toxic chemicals and foods harboring molds that produce aflatoxin. Most important, however, is avoidance of alcohol and drug abuse. Alcohol abuse is responsible for 60% to 75% of cases of cirrhosis, which is a major risk factor for eventual development of primary liver cancer. Hepatitis is a widespread disease among persons who abuse intravenous drugs.

Resources

BOOKS

Berkow, Robert, et al., eds. "Hepatic and Biliary Disorders: Neoplasms of the Liver." In *The Merck Manual of Diagnosis and Therapy.* Rahway, NJ: Merck Research Laboratories, 1997.

Dollinger, Malin. *Everyone's Guide to Cancer Therapy.* Kansas City: Somerville House Books Limited, 1994.

Friedman, Lawrence S. "Liver, Biliary Tract, & Pancreas." In *Current Medical Diagnosis & Treatment 1998.* Stamford, CT: Appleton & Lange, 1997.

Isselbacher, K.J., and J.L. Dienstag. "Tumors of the Liver and Biliary Tract." In *Harrison's Principles of Internal Medicine.* Fauci, Anthony S., et al., eds. New York: McGraw–Hill, 1998.

Loeb, Stanley, et al., eds. "Liver Cancer." In *Professional Guide to Diseases.* Springhouse, PA: Springhouse Corporation, 1991.

Morra, Marion E. *Choices.* New York: Avon Books, October 1994.

Rudolph, Rebecca E., and Kris V. Kowdley. "Cirrhosis of the Liver." In *Current Diagnosis 9.* Conn, Rex B., et al., eds. Philadelphia: W. B. Saunders Company, 1997.

Way, Lawrence W. "Liver." In *Current Surgical Diagnosis & Treatment.* Stamford, CT: Appleton & Lange, 1994.

PERIODICALS

El-Serag, H.B. "Epidemiology of Hepatocellular Carcinoma" *Clinics in Liver Disease* (February 2001): 87–107.

Macdonald, G.A. "Pathogenesis of Hepatocellular Carcinoma" *Clinical Liver Disease* (February 2001): 69–85.

Yu, M.C., et al. "Epidemiology of Hepatocellular Carcinoma" *Canadian Journal of Gastroenterology* (September 2000): 703–9.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329. (800) 227-2345. <http://www.cancer.org>.

American Institute for Cancer Research (AICR). 1759 R St. NW, Washington, DC 20009. (800) 843-8114. <http://www.aicr.org>.

American Liver Foundation. 908 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179.

Cancer Care, Inc. 275 Seventh Ave., New York, NY 10001.(800) 813-HOPE. <http://www.cancercare.org>.

Cancer Hope Network. Suite A., Two North Rd., Chester, NJ 07930. (877) HOPENET. <http://www.cancerhope network.org>.

Hospicelink. Hospice Education Institute, 190 Westbrook Rd., Essex, CT, 06426-1510. (800) 331-1620. <http://www.hospiceworld.com>.

National Cancer Institute (National Institutes of Health). 9000 Rockville Pike, Bethesda, MD 20892. (800) 422-6237. <http://www.nci.nih.gov>.

The Wellness Community. Suite 412, 35 E. Seventh St., Cincinnati, OH 45202. (888) 793-9355. <http://www.wellness-community.org>.

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Liver cirrhosis *see* **Cirrhosis**

Liver encephalopathy

Definition

Liver encephalopathy is a potentially life-threatening disease in which toxic substances accumulate in the blood. Also known as hepatic encephalopathy or hepatic **coma**, this condition can cause confusion, disorientation, abnormal neurological signs, loss of consciousness, and **death**.

Description

A normally functioning liver metabolizes and detoxifies substances formed in the body during the digestive process. Impaired liver function allows substances like ammonia (formed when the body digests protein), some fatty acids, phenol, and mercaptans to escape into the bloodstream. From there, they may penetrate the blood-brain barrier, affect the central nervous system (CNS), and lead to hepatic coma.

Hepatic coma is most common in patients with chronic liver disease. It occurs in 50-70% of all those with **cirrhosis**.

Causes and symptoms

The cause of hepatic coma is unknown, but the condition is frequently associated with the following conditions:

- acute or chronic liver disease
- gastrointestinal bleeding
- azotemia, the accumulation of nitrogen-containing compounds (such as urea) in the blood
- inherited disorders that disrupt the process by which nitrogen is decomposed and excreted
- the use of shunts (devices implanted in the body to redirect the flow of fluid from one vessel to another)
- electrolyte imbalances, including low levels of potassium (**hypokalemia**) and abnormally alkaline blood pH (alkalosis). These imbalances may result from the overuse of sedatives, **analgesics**, or **diuretics**; reduced levels of oxygen (hypoxia), or withdrawal of excessive amounts of body fluid (hypovolemia)
- constipation, which may increase the body's nitrogen load
- surgery
- infection
- acute liver disease

Binge drinking and acute infection are common causes of hepatic coma in patients with long-standing liver disease.

Symptoms of hepatic encephalopathy range from almost unnoticeable changes in personality, energy levels, and thinking patterns to deep coma.

Inability to reproduce a star or other simple design (apraxia) and deterioration of handwriting are common symptoms of early encephalopathy. Decreased brain function can also cause inappropriate behavior, lack of interest in personal grooming, mood swings, and uncharacteristically poor judgment.

The patient may be less alert than usual and develop new sleep patterns. Movement and speech may be slow and labored.

As the disease progresses, patients become confused, drowsy, and disoriented. The breath and urine acquires a sweet, musky odor. The hands shake, the outstretched arms flap (asterixis or "liver flap"), and the patient may lapse into unconsciousness. As coma deepens, reflexes may be heightened (hyperreflexia). The toes sometimes splay when the sole of the foot is stroked (Babinski reflex).

Agitation occasionally occurs in children and in adults who suddenly develop severe symptoms. Seizures are uncommon.

Diagnosis

The absence of sensitive, reliable tests for encephalopathy make the physician's personal observations and professional judgment the most valuable diagnostic tools.

Confusion, disorientation, and other indications of impaired brain function strongly suggest encephalopathy in patients known to have liver disease. CAT scans and examination of spinal fluid don't provide diagnostic clues. Elevated arterial ammonia levels are almost always present in hepatic coma, but levels are not necessarily correlated with the severity or extent of the disease.

Magnetic resonance imaging (MRI) can show severe brain swelling that often occurs prior to coma, and **electroencephalography** (EEG) detects abnormal brain waves even in patients with early, mild symptoms. Blood and urine analyses can provide important information about the cause of encephalopathy in patients suspected of taking large quantities of sedatives or other drugs.

Treatment

This condition may disappear if the cause of symptoms is eliminated. In other cases, treatment is designed to improve liver function as much as possible; remove or relieve factors that worsen symptoms; and decrease the body's production of poisonous substances.

All non-essential medications are discontinued. Soft restraints are recommended in place of sedatives for patients who become agitated.

Enemas or **laxatives** are used to stimulate expulsion of toxic intestinal products. All or most protein is eliminated from the diet, and supplemental feeding may be necessary to replenish lost calories. Regular doses of neomycin (Neobiotic), taken orally or administered to comatose patients in liquid form through a tube, may be used to decrease production of protein-digesting bacteria in the bowel.

Lactulose, a synthetic sugar, changes the characteristics of intestinal bacteria, decreases the amount of ammonia accumulated in the body, and has laxative properties. The patient is given hourly doses of lactulose syrup until **diarrhea** occurs, then dosage is adjusted to maintain regular bowel function. Lactulose and dietary-protein restrictions may be used to control chronic encephalopathy.

KEY TERMS

Cirrhosis—A serious disease of the liver caused by chronic damage to its cells and the eventual formation of scar tissue (fibrosis).

Coma—A condition of deep unconsciousness from which the person cannot be aroused

Electrolytes—Substances that conduct electricity when they are in solution. In the body, electrolytes in the blood and tissues enable nerve impulses to flow normally.

Encephalopathy—A dysfunction of the brain. Hepatic encephalopathy is brain dysfunction that occurs because the liver isn't removing harmful substances from the blood.

Prognosis

Encephalopathy may be reversible if the responsible factor is identified and removed or treated. Patients whose condition is the result of chronic liver disease may recover completely after the underlying cause is corrected.

Despite intensive treatment, encephalopathy caused by acute liver inflammation (fulminant hepatitis) is fatal for as many as 80% of patients. Those with chronic liver failure often die in hepatic coma.

Resources

BOOKS

Bennet, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck & Co., Inc., 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

OTHER

"Hepatic and Biliary Disorders." The Merck Page. 12 May 1998 <http://www.merck.com>.

Haggerty, Maureen. "Treatment of Hepatic Encephalopathy." Building Better Health Page. 12 May 1998 <http://www.buildingbetterhealth.com/article/gale/100083634>.

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Liver fluke infections *see* **Fluke infections**

Liver function tests

Definition

Liver function tests, or LFTs, include tests for bilirubin, a breakdown product of hemoglobin, and ammonia, a protein byproduct that is normally converted into urea by the liver before being excreted by the kidneys. LFTs also commonly include tests to measure levels of several enzymes, which are special proteins that help the body break down and use (metabolize) other substances. Enzymes that are often measured in LFTs include gamma-glutamyl transferase (GGT); alanine aminotransferase (ALT or SGPT); aspartate aminotransferase (AST or SGOT); and alkaline phosphatase (ALP). LFTs also may include **prothrombin time** (PT), a measure of how long it takes for the blood to clot.

Purpose

Liver function tests are used to aid in the differential diagnosis of liver disease and injury, and to help monitor response to treatment.

Precautions

Bilirubin: Drugs that may cause increased blood levels of total bilirubin include anabolic steroids, **antibiotics**, antimalarials, ascorbic acid, Diabinese, codeine, **diuretics**, epinephrine, **oral contraceptives**, and vitamin A.

Ammonia: Muscular exertion can increase ammonia levels, while cigarette **smoking** produces significant increases within one hour of inhalation. Drugs that may cause increased levels include alcohol, **barbiturates**, narcotics, and diuretics. Drugs that may decrease levels include broad-spectrum antibiotics, levodopa, lactobacillus, and potassium salts.

ALT: Drugs that may increase ALT levels include **acetaminophen**, ampicillin, codeine, dicumarol, indomethacin, methotrexate, oral contraceptives, **tetracyclines**, and verapamil. Previous intramuscular injections may cause elevated levels.

GGT: Drugs that may cause increased GGT levels include alcohol, phenytoin, and phenobarbital. Drugs that may cause decreased levels include oral contraceptives.

Description

The liver is one of the most important organs in the body. As the body's "chemical factory," it regulates the levels of most of the main blood chemicals and acts with the kidneys to clear the blood of drugs and toxic substances. The liver metabolizes these products, alters their

chemical structure, makes them water soluble, and excretes them in bile.

Liver function tests are used to determine if the liver has been damaged or its function impaired. Elevations of certain liver tests in relation to others aids in that determination. For example, aminotransferases (which include ALT and AST) are notably elevated in liver damage caused by liver cell disease (hepatocellular disease). However, in intrahepatic obstructive disease—which may be caused by some drugs or biliary cirrhosis—the alkaline phosphatases are most abnormal.

Alanine aminotransferase

Alanine aminotransferase (ALT), formerly called serum glutamate pyruvate transaminase, or SGPT, is an enzyme necessary for energy production. It is present in a number of tissues, including the liver, heart, and skeletal muscles, but is found in the highest concentration in the liver. Because of this, it is used in conjunction with other liver enzymes to detect liver disease, especially hepatitis or **cirrhosis** without **jaundice**. Additionally, in conjunction with the **aspartate aminotransferase test** (AST), it helps to distinguish between heart damage and liver tissue damage.

Aspartate aminotransferase

Aspartate aminotransferase (AST), formerly called serum glutamic-oxaloacetic transaminase, or SGOT, is another enzyme necessary for energy production. It, too, may be elevated in liver and heart disease. In liver disease, the AST increase is usually less than the ALT increase. However, in liver disease caused by alcohol use, the AST increase may be two or three times greater than the ALT increase.

Alkaline phosphatase

Alkaline phosphatase (ALP) levels usually include two similar enzymes (isoenzymes) that mainly come from the liver and bone and from the placenta in pregnant women. In some cases, doctors may order a test to differentiate between the alkaline phosphatase that originates in the liver and the alkaline phosphatase originating in bone. If a person has elevated ALP, does not have bone disease and is not pregnant, he or she may have a problem with the biliary tract, the system that makes and stores bile. (Bile is made in the liver, then passes through ducts to the gall bladder, where it is stored.)

Gamma-glutamyl transferase

Gamma-glutamyl transferase (GGT), sometimes called gamma-glutamyl transpeptidase (GGPT), is an enzyme that is compared with ALP levels to distinguish between skeletal disease and liver disease. Because GGT is not increased in bone disorders, as is ALP, a normal GGT with an elevated ALP would indicate bone disease. Conversely, because the GGT is more specifically related to the liver, an elevated GGT with an elevated ALP would strengthen the diagnosis of liver or bile-duct disease. The GGT has also been used as an indicator of heavy and chronic alcohol use, but its value in these situations has been questioned recently. It is also commonly elevated in patients with **infectious mononucleosis**.

Bilirubin

Bilirubin, a breakdown product of hemoglobin, is the predominant pigment in a substance produced by the liver called bile. Excess bilirubin causes yellowing of body tissues (jaundice). There are two tests for bilirubin: direct-reacting (conjugated) and indirect-reacting (unconjugated). Differentiating between the two is important diagnostically, as elevated levels of indirect bilirubin are usually caused by liver cell dysfunction (e.g. hepatitis), while elevations of direct bilirubin typically result from obstruction either within the liver (intrahepatic) or a source outside the liver (e.g. **gallstones** or a tumor blocking the bile ducts). Bilirubin measurements are especially valuable in newborns, as extremely elevated levels of unconjugated bilirubin can accumulate in the brain, causing irreparable damage.

Ammonia

Analysis of blood ammonia aids in the diagnosis of severe liver diseases and helps to monitor the course of these diseases. Together with the AST and the ALT, ammonia levels are used to confirm a diagnosis of **Reye's syndrome** (a rare disorder usually seen in children and associated with **aspirin** intake), which is characterized by brain and liver damage following an upper respiratory tract infection, **chickenpox**, or **influenza**. Ammonia levels are also helpful in the diagnosis and treatment of hepatic encephalopathy, a serious brain condition caused by the accumulated toxins that result from liver disease and liver failure.

Preparation

Preparation requirements for all these tests vary from laboratory to laboratory, so it is generally considered best that the patient be in a **fasting** state (nothing to eat or drink) after midnight the day before the test(s).

Aftercare

Because many patients with liver disease have prolonged clotting times, it is important to monitor the puncture site for bleeding after blood is drawn (venipuncture).

KEY TERMS

Cirrhosis—A serious disease of the liver caused by chronic damage to its cells and the eventual formation of scar tissue (fibrosis). The most common symptoms are mild jaundice, fluid collection in the tissues, mental confusion, and vomiting of blood. If left untreated, cirrhosis lead to liver failure and death.

Hemolytic disease of the newborn—Also known as erythroblastosis neonatorum, this is a condition in which a newborn's red blood cells are destroyed by antibodies that have crossed the placenta from the mother's blood. (Hemolytic disease begins in the fetus, in whom the disease is called erythroblastosis fetalis). Severe anemia caused by hemolytic disease is treated in the same way as other anemias, but when jaundice appears due to increased bilirubin, the jaundice is treated by exposing the infant to bright lights. In severe cases, exchange transfusion is required or brain damage may result.

Hepatitis—An inflammation of the liver, with accompanying liver cell damage or cell death, caused most frequently by viral infection, but also by certain drugs, chemicals, or poisons. May be either acute (of limited duration) or chronic (continuing). Symptoms include jaundice, nausea, vomiting, loss of appetite, tenderness in the right upper abdomen, aching muscles, and joint pain. In severe cases, liver failure may result.

Hepatic encephalopathy—Also called liver encephalopathy or hepatic coma, this is a disorder in which brain function deteriorates because toxic substances, which would normally be removed by the liver, accumulate in the bloodstream due to liver damage or disease. Early symptoms include subtle changes in logical thinking, personality and behavior. As the disorder progresses, signs of drowsiness and confusion increase until eventually the patient loses consciousness and lapses into coma.

Reye's syndrome—A rare disorder characterized by brain and liver damage following an upper respiratory tract infection, chickenpox, or influenza, almost entirely confined to children under age 15, and often related to aspirin ingestion for a viral infection. Symptoms include uncontrollable vomiting, often with lethargy, memory loss, disorientation, or delirium. Swelling of the brain may cause seizures, coma, and in severe cases, death.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges vary from laboratory to laboratory and also depend upon the method used. However, normal values can generally be found within the following ranges, unless specified differently.

- ALT: 5-35 IU/L (values for the elderly may be slightly higher, and values also may be higher in men and in African-Americans)
- AST: 0-35 IU/L
- ALP: 30-120 IU/L
- GGT: Normal values for this test vary widely, depending on the laboratory performing the test, and the age and sex of the patient. For example, females less than 45 years old have lower values than both males and females over 45 years of age. Values in the newborn can be as much as five times higher than in adults.
- Bilirubin: (Adult, elderly, and child) Total bilirubin: 0.1-1.0 mg/dL; indirect bilirubin: 0.2-0.8 mg/dL; direct bilirubin: 0.1-0.3 mg/dL. (Newborn) Total bilirubin: 1-12 mg/dL. Note: critical values for adult: greater than 1.2 mg/dL. Critical values for newborn (requiring immediate treatment): greater than 15 mg/dL.
- Ammonia: Normal values for this test vary widely, depending upon the laboratory performing the test, the age of the patient, and the type of specimen. For example, values are somewhat higher in arterial than in venous blood.
- PT: 9-12 seconds.

Abnormal results

ALT: Values are significantly increased in cases of hepatitis, and moderately increased in cirrhosis, liver tumor, obstructive jaundice, and severe **burns**. Values are mildly increased in **pancreatitis**, **heart attack**, infectious mononucleosis, and **shock**. Most useful when compared with ALP levels.

- AST: High levels may indicate liver cell damage, hepatitis, heart attack, **heart failure**, or gall stones.
- ALP: Elevated levels occur in diseases that impair bile formation (**cholestasis**). ALP may also be elevated in

many other liver disorders, as well as some lung cancers (bronchogenic carcinoma) and Hodgkin's lymphoma. However, elevated ALP levels may also occur in otherwise healthy people, especially among older people.

GGT: Increased levels are diagnostic of hepatitis, cirrhosis, liver tumor or metastasis, as well as injury from drugs toxic to the liver. Although the causes are unclear, GGT levels may increase with alcohol ingestion, heart attack, pancreatitis, infectious mononucleosis, and Reye's syndrome.

Bilirubin: Increased *indirect* or total bilirubin levels can indicate various serious **anemias**, including hemolytic disease of the newborn and **transfusion** reaction. Increased *direct* bilirubin levels can be diagnostic of bile duct obstruction, gallstones, cirrhosis, or hepatitis. It is important to note that if total bilirubin levels in the newborn reach or exceed critical levels, exchange transfusion is necessary to avoid kernicterus, a condition that causes brain damage.

Ammonia: Increased levels are seen in primary liver cell disease, Reye's syndrome, severe heart failure, hemolytic disease of the newborn, and hepatic encephalopathy.

PT: Elevated in acute liver injury, vitamin K deficiencies, and disorders with impair the absorption of vitamin K, including cholestasis.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Liver nuclear medicine scan

Definition

A liver scan is a diagnostic procedure to evaluate the liver for suspected disease. A radioactive substance that concentrates in the liver is injected intravenously and the image of its distribution in the body is analyzed to diagnose certain abnormalities.

Purpose

In the past, liver scans were used to evaluate the liver in a wide variety of situations. It was considered a useful study to detect abnormalities, but was often not able to establish a specific diagnosis. In the 1990s, radionuclide imaging of the liver (use of a radioactive form of cobalt or iodine) evolved into a more specialized study, used to identify individual diseases or conditions. This is accomplished by using different radioisotopes precisely designed to further evaluate a particular case. Isotopes are different forms of the same substance, such as radioactive iodine, that are injected into the body. This allows the physician to trace the process of the substance throughout the part of the body that is being tested for disease.

A liver scan is usually ordered after blood studies and other imaging procedures have shown a liver abnormality. It is most often used to further evaluate masses or tumors. These may be benign growths in the liver, or **cancer** which has developed in the liver or has spread (or metastasized) from another organ.

A liver scan may also be helpful in diagnosing specific disorders, by detecting features which are characteristic of a disorder, such as **cirrhosis** of the liver. This study may also be part of the battery of tests used to evaluate potential candidates for liver transplant.

Precautions

Women who are pregnant or breast feeding should not have this test.

Description

This test can be performed in an outpatient setting or a hospital x-ray department. The patient usually lies down while a radioactive substance (radioactive isotope) which accumulates in the liver is injected through a vein in the arm. Scanning times may vary, depending on the specific radioisotope used. It most often begins within minutes after injection. The radionuclide scanner, sometimes called a gamma camera or scintillation camera, is positioned above the upper abdomen and may lightly touch the patient. It is important for the patient to lie quietly. Position changes and brief periods of breath holding may be required. The test usually takes approximately one hour.

A specialized liver scan used to assess blood flow is frequently used. It may be referred to as a radionuclide blood pool or volume study, a labeled red cell scintigram, or some combination of these terms. Other studies may be named for the radioisotope used. This test may also be called a liver-spleen scan.

Preparation

No physical preparation is required. A liver scan should be performed before doing any study that uses

KEY TERMS

Radioisotope—A radioactive, or radiation-emitting form of an element.

Radionuclide—A substance which emits radiation that can be detected by a scanner as the substance disintegrates.

iodinated or barium-containing contrast agents, to prevent inaccurate results.

The patients should understand that there is no danger of radioactive exposure to themselves or others. Only small amounts of radionuclide are used. The total amount of radiation absorbed is often less than the dose received from ordinary x rays. The scanner does not emit any radiation, but detects and records it from the patient.

Aftercare

No special precautions are needed.

Normal results

A normal scan will show a liver of normal size, shape, and position.

Abnormal results

An abnormal liver scan may result from a mass. Depending on the radioisotope and technique used, the scan may identify particular types of tumors or certain cancers. Too much radioisotope in the spleen and bones, compared to the liver, can indicate potential **hypertension** or cirrhosis. Liver diseases such as cirrhosis or hepatitis may also cause an abnormal scan, but are rarely diagnosed from the information revealed by this study alone.

Resources

BOOKS

Vitti, Richard A., and Leon S. Malmud. "Gastrointestinal System." In *Nuclear Medicine*, ed. Donald R. Bernier, et al. St. Louis: Mosby, 1997.

PERIODICALS

Drane, Walter E. "Scintigraphic Techniques for Hepatic Imaging." *Radiologic Clinics of North America* 36 (Mar. 1998): 309-318.

Ellen S. Weber, MSN

Liver transplantation

Definition

Liver transplantation is a surgery that removes a diseased liver and replace it with a healthy donor liver.

Purpose

The liver is the body's principle chemical factory. It receives all nutrients, drugs, and toxins absorbed from the intestines and performs the final stages of digestion, converting food into energy and replacement parts for the body. The liver also filters the blood of all waste products, removes and detoxifies poisons and excretes many of these into the bile. It processes other chemicals for excretion by the kidneys. The liver is also an energy storage organ, changing food energy to a chemical called glycogen that can be rapidly converted to fuel.

As the liver fails, all of its functions diminish. **Nutrition** suffers, toxins build up, and waste products accumulate. Scar tissue builds up on the liver if disease is of long duration. As the liver scars, blood flow is progressively restricted in the portal vein, which carries blood from the stomach and abdominal organs to the liver. The resulting high blood pressure (**hypertension**) causes swelling of and bleeding from the blood vessels of the esophagus. Severe **jaundice**, fluid accumulation in the abdomen (**ascites**), and deterioration of mental function, due to the build-up of toxins in the blood (**liver encephalopathy**), eventually occur, leading to **death**.

Among the many causes of liver failure that bring patients to transplant surgery are:

- progressive hepatitis (mostly due to virus infection) accounts for more than a third
- alcohol damage brings in about 20%
- scarring or abnormality of the biliary system accounts for roughly another 20%
- the remainder comes from selected cancers, other uncommon diseases, and a situation called fulminant liver failure

Fulminant liver failure most commonly happens during acute viral hepatitis, but it is also the result of **mushroom poisoning** by *Amanita phalloides* and toxic reactions to some medicines, like an overdose of **acetaminophen**. This is a special category of candidates for liver transplant because of the speed of their disease and the immediate need of treatment.

The first human liver transplant was performed in 1963, and since then, thousands of liver transplants are done every year. Since the introduction of of

cyclosporine (a drug that suppresses the immune response that rejects the donor organ), success rates for liver transplantation have reached 85%.

Precautions

Patients with advanced heart and lung disease, who are HIV positive, and who abuse drugs and alcohol are poor candidates for liver tranplantation. Their ability to survive the surgery and the difficult recovery period, as well as their longterm prognosis, is hindered by their conditions.

Description

There are three types of liver transplantation methods. They include:

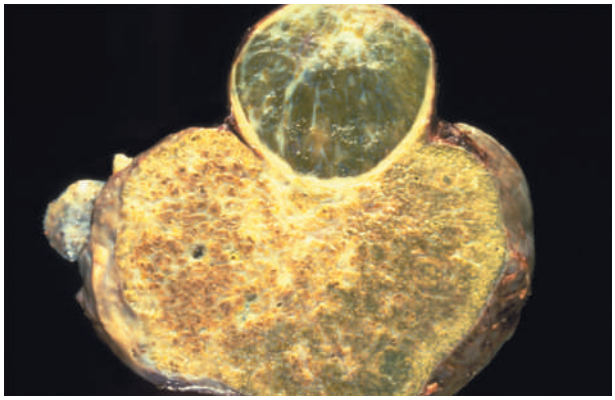
- Orthotopic transplantation is the replacement of a whole diseased liver with a healthy donor liver.
- Heterotopic transplantation is the addition of a donor liver at another site, while the diseased liver is left intact.
- Reduced-size liver transplantation is the replacement of a whole diseased liver with a portion of a healthy donor liver. Reduced-size liver transplants are most often performed on children.

When an orthotopic transplantation is performed, a segment of the inferior vena cava attached to the liver is taken from the donor as well. The same parts are removed from the recipient and replaced by connecting the inferior vena cava, the hepatic artery, the portal vein and the bile ducts.

When there is a possibility that the afflicted liver may recover, a heterotopic tranplantation is performed. The donor liver is placed in a different site, but it still has to have the same connections. It is usually attached very near the original liver, and if the original liver recovers, the donor shrivels away. If the original liver does not recover, it will shrivel, leaving the donor in place.

Reduced-size liver transplantation tranplants part of a donor liver into a patient. It is possible to divide the liver into eight pieces, each supplied by a different set of blood vessels. Two of these pieces have been enough to save a patient in liver failure, especially if the patient is a child. It is therefore possible to transplant one liver into at least two patients and to transplant part of a liver from a living donor and have both donor and recipient survive. Liver tissue grows to accommodate its job so long as there is initially enough of the organ to use. Patients have survived with only 15-20% of their original liver, provided that 15-20% was healthy.

Availability of organs for transplant is a current crisis in the transplantation business. In October 1997, a national distribution system was established that gives priority to the sickest patients closest in location to the donor liver, but makes livers available nationally. It is now possible to preserve a liver out of the body for 10-20 hours by flushing it with cooled solutions of special chemicals and nutrients, so it can be transported across the country.



The diseased liver of a patient ready for transplantation. *(Custom Medical Stock Photo. Reproduced by permission.)*

Preparation

Before transplantation takes place, the patient is first determined to be a good candidate for transplantation by going through rigorous medical examination. A suitable candidate boosts their nutritional intake in order to ensure that they are as healthy as possible before surgery. Drugs are administered that will decrease rejection after surgery. Consultation with the patient, as well as any family, is conducted to explain the surgery and its complications. Psychological counciling is recommended.

Aftercare

In order to prevent organ rejection, immunosuppressive drugs will be taken. Hospitalization ranges from four weeks to five months, depending on the rate of recovery.

Successfully receiving a transplanted liver is only the beginning of a life-long process. Patients with transplanted livers have to stay on **immunosuppressant drugs** for the rest of their lives to prevent organ rejection. Although many can reduce the dosage after the initial few months, virtually none can discontinue drugs altogether. Prednisone, azathioprine, and tacrolimus are often combined with cyclosporine for better results. Newer immunosuppressive agents are coming that promise even better results. In spite of immunosuppressants, rejection occurs most of the time and requires additional medication. In some cases it cannot be reversed, and retransplantation becomes necessary.

National Transplant Waiting List By Organ Type (June 2000)

Organ Needed	Number Waiting
Kidney	48,349
Liver	15,987
Heart	4,139
Lung	3,695
Kidney-Pancreas	2,437
Pancreas	942
Heart-Lung	212
Intestine	137

Risks

Early failure of the transplant occurs once in four surgeries and has to be repeated. Some transplants never work, some succumb to infection, and some suffer immune rejection. Primary failure is apparent within one or two days. Infections happen in half the patients and often appear during the first week. Rejection usually starts at the end of the first week. The surgery itself may need revision because of narrowing, leaking, or blood clots at the connections.

There are potential social and economic problems, psychological problems, and a vast array of possible medical and surgical complications. Close medical surveillance must continue for the rest of the patient's life. Infections are a constant risk while on immunosuppressive agents, because the immune system is supposed to prevent them. A way has not yet been devised to control rejection without hampering immune defenses against infections. Not only do ordinary infections pose a threat, but because of the impaired immunity, transplant patients are susceptible to the same "opportunistic" infections that threaten **AIDS** patients—pneumocystis **pneumonia**, herpes and cytomegalovirus infections, fungi, and a host of bacteria.

Immunosuppression also hinders the body's ability to resist **cancer**. All the drugs used to prevent rejection increase the risk of leukemias and lymphomas.

There is also a risk of the original disease returning. Hepatitis virus still inhabits the patient, as does the urge to drink alcohol. Newer **antiviral drugs** hold out promise for dealing with hepatitis, and Alcoholics Anonymous (AA) is the most effective treatment known for **alcoholism**.

Drug reactions are also a continuing threat. Every drug used to suppress the immune system has potential problems.

Resources

BOOKS

Dienstag, Jules. "Liver Transplantation." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Gartner, J. Carleton. "Liver Transplantation." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Roberts, John P. "Liver Transplantation." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Butler, A., and P. J. Friend. "Novel Strategies for Liver Support in Acute Liver Failure." *British Medical Bulletin* 53 (1997): 719-729.

Cao, S., C. O. Esquivel, and E. B. Keeffe. "New Approaches to Supporting the Failing Liver." *Annual Review of Medicine* 49 (1998): 85-94.

Lanza, R. P and D. K. Cooper "Xenotransplantation of Cells and Tissues: Application to a Range of Diseases, from Diabetes to Alzheimer's." *Molecular Medicine Today* 4 (Jan. 1998): 39-45.

Luxon, B. A. "Liver Transplantation: Who Should Be Referred—And When?" *Postgraduate Medicine* 102 (Dec. 1997): 103-108, 113.

Rao, V. K. "Posttransplant Medical Complications" *Surgical Clinics of North America* 78 (Feb. 1998):113-132.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

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KEY TERMS

Acetaminophen—A common pain reliever (Tylenol).

Antigen—Any chemical that provokes an immune response.

Bile ducts—Tubes carrying bile from the liver to the intestines.

Biliary system—The tree of tubes that carries bile.

Hepatic artery—The blood vessel supplying arterial blood to the liver.

Inferior vena cava—The biggest vein in the body, returning blood to the heart from the lower half of the body.

Leukemia—A cancer of the white blood cells.

Lymphoma—A cancer of lymphatic tissue.

Portal vein—The blood vessel carrying venous blood from the abdominal organs to the liver.

Ller-Christi *see* **Histiocytosis X**

Loaiasis *see* **Filariasis**

Lobectomy *see* **Lung surgery**

Lobotomy *see* **Psychosurgery**

Local anesthetic *see* **Anesthesia, local**

Localized scratch dermatitis *see* **Lichen simplex chronicus**

Lockjaw *see* **Tetanus**

Loperamide *see* **Antidiarrheal drugs**

Loratadine *see* **Antihistamines**

Lou Gehrig's disease *see* **Amyotrophic lateral sclerosis**

Louis-Bar syndrome *see* **Ataxia-telangiectasia**

Low potassium blood level *see* **Hypokalemia**

Low back pain

Definition

Low back **pain** is a common musculoskeletal symptom that may be either acute or chronic. It may be caused by a variety of diseases and disorders that affect the lumbar spine. Low back pain is often accompanied by **sciatica**, which is pain that involves the sciatic nerve and is felt in the lower back, the buttocks, and the backs of the thighs.

Description

Low back pain is a symptom that affects 80% of the general United States population at some point in life with sufficient severity to cause absence from work. It is the second most common reason for visits to primary care doctors, and is estimated to cost the American economy $75 billion every year.

Low back pain may be experienced in several different ways:

- Localized. In localized pain the patient will feel soreness or discomfort when the doctor palpates, or presses on, a specific surface area of the lower back.
- Diffuse. Diffuse pain is spread over a larger area and comes from deep tissue layers.
- Radicular. The pain is caused by irritation of a nerve root. Sciatica is an example of radicular pain.
- Referred. The pain is perceived in the lower back but is caused by inflammation elsewhere—often in the kidneys or lower abdomen.

Causes and Symptoms

Acute pain

Acute pain in the lower back that does not extend to the leg is most commonly caused by a sprain or muscle tear, usually occurring within 24 hours of heavy lifting or overuse of the back muscles. The pain is usually localized, and there may be muscle spasms or soreness when the doctor touches the area. The patient usually feels better when resting.

Chronic pain

Chronic low back pain has several different possible causes:

MECHANICAL. Chronic strain on the muscles of the lower back may be caused by **obesity**; **pregnancy**; or job-related stooping, bending, or other stressful postures.

MALIGNANCY. Low back pain at night that is not relieved by lying down may be caused by a tumor in the cauda equina (the roots of the spinal nerves controlling sensation in and movement of the legs), or a **cancer** that has spread to the spine from the prostate, breasts, or lungs. The risk factors for the spread of cancer to the lower back include a history of **smoking**, sudden weight loss, and age over 50.

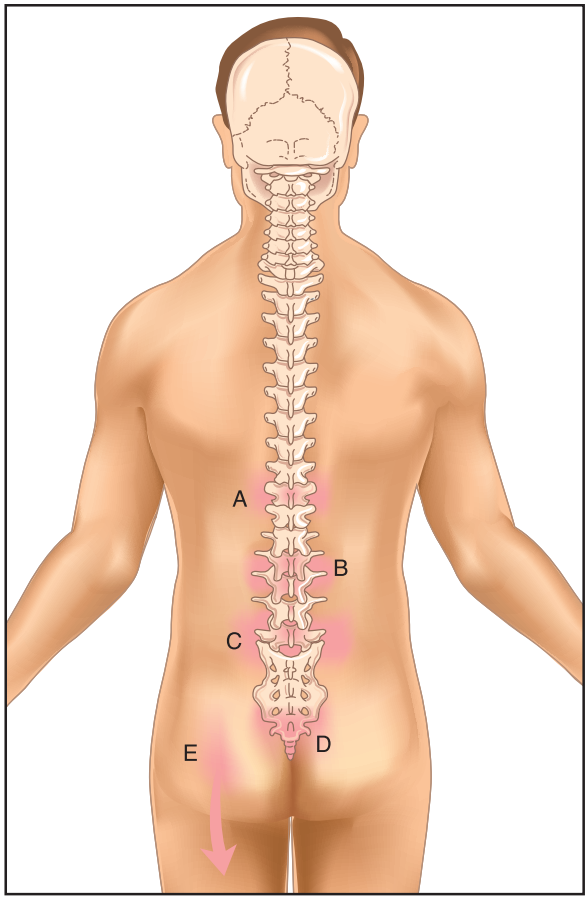
ANKYLOSING SPONDYLITIS. Ankylosing spondylitis is a form of arthritis that causes chronic pain in the lower back. The pain is made worse by sitting or lying down and improves when the patient gets up. It is most commonly seen in males between 16 and 35. Ankylosing spondylitis is often confused with mechanical back pain in its early stages.

HERNIATED SPINAL DISK. Disk herniation is a disorder in which a spinal disk begins to bulge outward between the vertebrae. Herniated or ruptured disks are a common cause of chronic low back pain in adults.

PSYCHOGENIC. Back pain that is out of proportion to a minor injury, or that is unusually prolonged, may be associated with a somatoform disorder or other psychiatric disturbance.

Low back pain with leg involvement

Low back pain that radiates down the leg usually indicates involvement of the sciatic nerve. The nerve can be pinched or irritated by herniated disks, tumors of the cauda equina, abscesses in the space between the spinal



Sites of low back pain. Pain anywhere along the spine (A) can be caused by osteoarthritis. Pain along one or the other side of the spine may be (B) a kidney infection. Trauma to back muscles, joints, or disks (C) causes low back pain. Damage to the coccyx (D) can occur during a fall. Sciatica (E) can cause pain to run down from the back and buttocks area down a leg. *(Illustration by Electronic Illustrators Group.)*

cord and its covering, **spinal stenosis**, and compression **fractures**. Some patients experience numbness or weakness of the legs as well as pain.

Diagnosis

The diagnosis of low back pain can be complicated. Most cases are initially evaluated by primary care physicians rather than by specialists.

Initial workup

PATIENT HISTORY. The doctor will ask the patient specific questions about the location of the pain, its characteristics, its onset, and the body positions or activities that make it better or worse. If the doctor suspects that the pain is referred from other organs, he or she will ask about a history of diabetes, peptic ulcers, **kidney stones**, urinary tract infections, or **heart murmurs**.

PHYSICAL EXAMINATION. The doctor will examine the patient's back and hips to check for conditions that require surgery or emergency treatment. The examination includes several tests that involve moving the patient's legs in specific positions to test for nerve root irritation or disk herniation. The flexibility of the lumbar vertebrae may be measured to rule out ankylosing spondylitis.

Imaging studies

Imaging studies are not usually performed on patients whose history and **physical examination** suggest routine muscle strain or overuse. X rays are ordered for patients whose symptoms suggest cancer, infection, inflammation, pelvic or abdominal disease, or bone fractures. MRIs are usually ordered only for patients with certain types of masses or tumors.

It is important to know that the appearance of some abnormalities on imaging studies of the lower back does not necessarily indicate that they cause the pain. Many patients have minor deformities that do not create symptoms. The doctor must compare the results of imaging studies very carefully with information from the patient's history and physical examination.

Treatment

All forms of treatment of low back pain are aimed either at symptom relief or to prevent interference with the processes of healing. None of these methods appear to speed up healing.

Acute pain

Acute back pain is treated with **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as ibuprofen, **muscle relaxants**, or **aspirin**. Applications of heat or cold compresses are also helpful to most patients. If the patient has not experienced some improvement after several weeks of treatment, the doctor will reinvestigate the cause of the pain.

Chronic pain

Patients with chronic back pain are treated witha combination of medications, physical therapy, andoccupational or lifestyle modification. The medicationsgiven are usually NSAIDs, although patients withhypertension, kidney problems, or stomach ulcers should not take these drugs. Patients who take NSAIDs for longer than six weeks should be monitored periodically for complications.

Physical therapy for chronic low back pain usually includes regular **exercise** for fitness and flexibility, and massage or application of heat if necessary.

Lifestyle modifications include giving up smoking, weight reduction (if necessary), and evaluation of the patient's occupation or other customary activities.

Patients with herniated disks are treated surgically if the pain does not respond to medication.

Patients with chronic low back pain sometimes benefit from **pain management** techniques, including **biofeedback**, **acupuncture**, and **chiropractic** manipulation of the spine.

Psychotherapy is recommended for patients whose back pain is associated with a somatoform, **anxiety**, or depressive disorder.

Low back pain with leg involvement

Treatment of sciatica and other disorders that involve the legs may include NSAIDs. Patients with long-standing sciatica or spinal stenosis that do not respond to NSAIDs are treated surgically. Although some doctors use cortisone injections to relieve the pain, this form of treatment is still debated.

Alternative treatment

A thorough differential diagnosis is important before any treatment is considered. There are times when alternative therapies are the most beneficial, and other times when more invasive treatments are needed.

Chiropractic

Chiropractic treats patients by manipulating or adjusting sections of the spine. It is one of the most popular forms of alternative treatment in the United States for relief of back pain caused by straining or lifting injuries. Some osteopathic physicians, physical therapists, and naturopathic physicians also use spinal manipulation to treat patients with low back pain.

Traditional Chinese medicine

Practitioners of **traditional Chinese medicine** treat low back pain with acupuncture, *tui na* (push-and-rub) massage, and the application of herbal poultices.

Herbal medicine

Herbal medicine can utilize a variety of antispasmodic herbs in combination to help relieve low back pain due to spasm. Lobelia (*Lobelia inflata*) and myrrh (*Commiphora molmol*) are two examples of antispasmodic herbs.

Homeopathy

Homeopathic treatment for acute back pain consists of applications of *Arnica* oil to the sore area or oral doses of *Arnica* or *Rhus toxicodendron*. *Bellis perennis* is recommended for deep muscle injuries. Other remedies may be recommended based on the symptoms presented by the patient.

Body work and yoga

Massage and the numerous other body work techniques can be very effective in treating low back pain. **Yoga**, practiced regularly and done properly, can be most useful in preventing future episodes of low back pain.

Prognosis

The prognosis for most patients with acute low back pain is excellent. About 80% of patients recover com-

KEY TERMS

Ankylosing spondylitis—A type of arthritis that causes gradual loss of flexibility in the spinal column. It occurs most commonly in males between 16 and 35.

Cauda equina—The roots of the spinal nerves controlling movement and sensation in the legs. These nerve roots are located in the lower spine and resemble a horse's tail (*cauda equina* in Latin).

Chiropractic—A method of treatment based on the interactions of the spine and the nervous system. Chiropractors adjust or manipulate segments of the patient's spinal column in order to relieve pain.

Lumbar spine—The segment of the human spine above the pelvis that is involved in low back pain. There are five vertebrae, or bones, in the lumbar spine.

Radicular—Pain that is caused by the root of a nerve.

Referred pain—Pain that is experienced in one part of the body but originates in another organ or area. The pain is referred because the nerves that supply the damaged organ enter the spine in the same segment as the nerves that supply the area where the pain is felt.

Sciatica—Pain caused by irritation of the sciatic nerve. Sciatica is felt in the lower back, the buttocks, and the backs of the upper legs.

Spinal stenosis—A form of sciatica that is caused by a narrowing of the spinal canal in the lumbar vertebrae. The narrowing puts pressure on the roots of the sciatic nerve.

pletely in four to six weeks. The prognosis for recovery from chronic pain depends on the underlying cause.

Prevention

Low back pain due to muscle strain can be prevented by lifestyle choices, including regular physical exercise and weight control, avoiding smoking, and learning the proper techniques for lifting and moving heavy objects. Exercises designed to strengthen the muscles of the lower back, and chairs or car seats with lumbar supports are also recommended.

Resources

BOOKS

Esses, Stephen I. "Low Back Pain." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Hellman, David B. "Arthritis & Musculoskeletal Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

McKenzie, Robin. *Treat Your Own Back*. Waikanae, New Zealand: Spinal Publications New Zealand Ltd., 1997.

"Musculoskeletal and Connective Tissue Disorders: Low Back Pain and Sciatica." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Theodosakis, Jason, et al. *The Arthritis Cure*. New York: St. Martin's Paperbacks, 1997.

Rebecca J. Frey

Low blood magnesium *see* **Magnesium imbalance**

Low blood phosphate level *see* **Phosphorus imbalance**

Low blood pressure *see* **Hypotension; Orthostatic hypotension**

Low blood sugar *see* **Hypoglycemia**

Low calcium blood level *see* **Hypocalcemia**

Low sodium blood level *see* **Hyponatremia**

Lower esophageal ring

Definition

Lower esophageal ring is a condition in which there is a ring of tissue inside the lower part of the esophagus (the tube connecting the throat with the stomach). This tissue causes narrowing and partial blockage of the esophagus. Lower esophageal ring can also refer to the ring itself.

Description

Lower esophageal ring (also called Schatzki's ring and B-ring) affects about 10-14% of the population. Normally, the lower part of the esophagus, near where the esophagus meets the stomach, has an inside diameter of 1.5-2 inches (3.8-5 cm). The diameter of this part of the esophagus is less when lower esophageal ring is present, and diameters as small as one-eighth inch (0.3 cm) have been seen. When the inside diameter is less than about three-fourths of an inch, intermittent difficulty with swallowing can result. About 96% of people with lower esophageal ring have no symptoms.

Causes and symptoms

Causes

Lower esophageal ring seems to result from infoldings of tissue near the bottom of the esophagus, but the underlying cause is unknown. Although some specialists speculate they are due to a congenital defect, most people do not develop symptoms until they reach their forties or later. Although lower esophageal ring is generally associated with hiatal **hernia**, and sometimes with **heartburn**, the cause/effect relationship is unclear.

Symptoms

Intermittent difficulty swallowing solid food is the primary symptom of this condition. The degree of difficulty in swallowing is directly related to the degree the esophagus is narrowed. Certain foods, especially tough or fibrous foods like meat, are more likely to cause swallowing difficulties.

Diagnosis

Gastroenterologists and internists are best equipped to diagnose and treat lower esophageal ring. The diagnosis is based on the patient's history of swallowing difficulties and a barium x ray of the upper gastrointestinal tract. For a barium x ray, the patient swallows a liquid containing barium, a substance that is opaque to x rays. Subsequent x-ray photography reveals the shape of the esophagus and any narrow regions present.

The presence of a lower esophageal ring can also be shown with a test called an esophagoscopy. This procedure visualizes the inside of the esophagus with an insert-

ed, thin, flexible tube. However, this test is less sensitive for lower esophageal ring and costs about five times as much as barium x ray. However, if the findings of a barium x ray are not definitive, esophagoscopy should be done. Biopsies can then be done on questionable areas.

Treatment

Dietary change

Swallowing difficulties due to lower esophageal ring can often be relieved by chewing food more thoroughly. Soft foods and liquids may also be recommended.

Dilation

Lower esophageal rings can be corrected by passing a bougie (a cylindrical, mercury-filled dilator) through the esophagus. This procedure, called bougienage, is effective most of the time, but may need to be repeated every few years. Complications and adverse reactions are extremely rare.

Surgery

If bougienage is unsuccessful, lower esophageal ring tissue can be surgically removed.

Prognosis

The probability of a favorable outcome is high. Swallowing difficulties can be alleviated in almost every case, and the rate of complications from bougienage or surgery is less than 1%.

Prevention

Since the cause of lower esophageal ring is not known, there are no definitive preventive measures. Nevertheless, anyone with lower esophageal ring who also suffers from heartburn would be wise to prevent or treat the heartburn. It is possible that the stomach acid in the esophagus associated with heartburn contributes to esophageal ring.

Resources

BOOKS

Castell, Donald O., ed. *The Esophagus.* 2nd ed. Boston: Little, Brown, 1995.

Groher, Michael E., ed. *Dysphagia: Diagnosis and Management.* 3rd ed. Boston: Butterworth-Heinemann, 1997.

ORGANIZATIONS

The American College of Gastroenterology (ACG). P.O. Box 3099, Alexandria, VA 22302. (800) 432-2876. <http://www.healthtouch.com>.

KEY TERMS

Bougie—A mercury-filled dilator in the shape of a cylinder or tapered cylinder. Bougies come in a range of different sizes.

Bougienage—The procedure of dilating tubal organs, like the esophagus, with a bougie or bougies.

Congenital—Existing at birth.

Dysphagia—Difficulty swallowing.

Esophagoscopy (also esophagoendoscopy)—Examination of the inside of the esophagus using a flexible tube that transmits video images.

Esophagus —The tube connecting the throat to the stomach, which is about ten inches long in adults. It is coated with mucus and surrounded by muscles, and pushes food to the stomach by sequential waves of contraction. It functions to transport food from the throat to the stomach and to keep the contents of the stomach in the stomach.

Heartburn—A burning sensation in the chest that can extend to the neck, throat, and face, caused by the movement of stomach acid into the esophagus.

Hiatal hernia—A condition where part of the stomach extends through the diaphragm into the chest cavity.

The American Gastroenterological Association (AGA). 7910 Woodmont Ave., 7th Floor, Bethesda, MD 20814. (310) 654-2055. aga001@aol.com. <http://www.gastro.org/index.html>.

American Society for Gastrointestinal Endoscopy. 13 Elm St., Manchester, MA 01944. (508) 526-8330. <http://www.asge.org/doc/201>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Lorraine Lica, PhD

Lower GI exam *see* **Barium enema**

LSD *see* **Lysergic acid diethylamide**

Lues *see* **Syphilis**

Lumbar puncture *see* **Cerebrospinal fluid (CSF) analysis**

Lumbar stenosis *see* **Spinal stenosis**

Lumbosacral radiculopathy *see* **Sciatica**

Lumpectomy

Definition

A lumpectomy is a type of surgery for **breast cancer**. It is considered "breast-conserving" surgery because in a lumpectomy, only the malignant tumor and a surrounding margin of normal breast tissue are removed. Lymph nodes in the armpit (axilla) may also be removed. This procedure is called lymph node dissection.

Purpose

Lumpectomy is a surgical treatment for newly diagnosed breast **cancer**. It is estimated that at least 50% of women with breast cancer are good candidates for this procedure. The location, size, and type of tumor are of primary importance when considering breast cancer surgery options. The size of the breast is another factor the surgeon considers when recommending surgery. The patient's psychological outlook, as well as her lifestyle and preferences, should also be taken into account when treatment decisions are made.

The extent and severity of a cancer is evaluated or "staged" according to a fairly complex system. Staging considers the size of the tumor and whether the cancer has spread directly to adjacent tissues, such as the chest wall, the lymph nodes, and/or to distant parts of the body. Women with early stage breast cancers are usually better candidates for lumpectomy. In most cases, a course of **radiation therapy** after surgery is part of the treatment. **Chemotherapy** or hormone treatment may also be prescribed.

Many studies have compared the survival rates of women who have had removal of a breast (**mastectomy**) with those who have undergone lumpectomy and radiation therapy. The data clearly demonstrate that for women with comparable stages of breast cancer, survival rates are equal between the two groups.

In some instances, women with later stage breast cancer may be able to have lumpectomy. Chemotherapy may be administered before surgery to decrease tumor size and the chance of spread in selected cases.

Precautions

There are a number of factors that may prevent or prohibit a breast cancer patient from having a lumpectomy. The tumor itself may be too large or located in an area where it would be difficult to remove with good cosmetic results. Sometimes several areas of cancer are found in one breast, so the tumor cannot be removed as a single lump. A cancer that has already attached itself to nearby structures, such as the skin or the chest wall, needs more extensive surgery.

Certain medical or physical circumstances may also eliminate lumpectomy as a treatment option. Sometimes lumpectomy may be attempted, but the surgeon is unable to remove the tumor with a sufficient amount of normal tissue surrounding it. This may be termed "persistently positive margins," or "lack of clear margins," referring to the margin of unaffected tissue around the tumor. Lumpectomy is not used for women who have had a previous lumpectomy and have a recurrence of the breast cancer.

Because of the need for radiation therapy after lumpectomy, this surgery may be medically unacceptable. A breast cancer discovered during **pregnancy** is not amenable to lumpectomy, due to the need for radiation therapy as part of the treatment. Radiation therapy cannot be administered to pregnant women because it may injure the fetus. If, however, delivery would be completed prior to the need for radiation, pregnant women may undergo lumpectomy. Women with collagen vascular disease, such as lupus erythematosus or **scleroderma**, would experience scarring and damage to their connective tissue if exposed to radiation treatments. A woman who has already had therapeutic radiation to the chest area for other reasons cannot have additional exposure for breast cancer therapy.

Some women may choose not to have a lumpectomy for other reasons. They may strongly fear a recurrence of breast cancer, and may consider a lumpectomy too risky. Others feel uncomfortable with a breast that has had a cancer, and they experience more peace of mind with the entire breast removed.

The need for radiation therapy may also be a barrier due to non-medical concerns. Some women simply fear this type of treatment and choose more extensive surgery so that radiation will not be required. The commitment of time, usually five days a week for six weeks, may not be acceptable for others. This may be due to financial, personal, or job-related constraints. Finally, in geographically isolated areas, a course of radiation therapy may require lengthy travel, and perhaps unacceptable amounts of time away from family and other responsibilities.

Description

Lumpectomy is an imprecise term. Any amount of tissue, from 1% to 50% of the breast, may be removed

and called a lumpectomy. Other names are no more definite in their meaning, although some idea of the scope of tissue removal may be implied. Breast conservation surgery is a frequently-used synonym for lumpectomy. Partial mastectomy, quadrantectomy, segmental excision, wide excision, and tylectomy are other, less commonly used names for this procedure.

A lumpectomy is frequently done in a hospital setting (especially if lymph nodes are to be removed at the same time), but specialized outpatient facilities are sometimes preferred. The surgery is usually done while the patient is under general anesthetic. Local anesthetic with additional **sedation** may be used for some patients. The tumor and surrounding margin of tissue is removed and sent to the pathologist. The surgical site is closed.

If axillary lymph nodes were not removed before, a second incision is made in the armpit. The fat pad that contains lymph nodes is removed from this area and is also sent to the pathologist for analysis. This portion of the procedure is called an axillary lymph node dissection; it is critical for determining the stage of the cancer. Typically, 10 to 15 nodes are removed, but the number may vary. Surgical drains may be left in place in either location to prevent fluid accumulation. The surgery may last from one to three hours.

The patient may stay in the hospital one or two days, or return home the same day. This generally depends on the extent of the surgery, the medical condition of the patient, and physician and patient preferences. A woman usually goes home with a small bandage. The inner part of the surgical site usually has dissolvable stitches. The skin may be sutured or stitched; or the skin edges may be held together with steristrips, which are special thin, clear pieces of tape.

Preparation

Routine preoperative preparations, such as having nothing to eat or drink the night before surgery, are typically ordered for a lumpectomy. Information about expected outcomes and potential complications is also part of preparation for lumpectomy, as it is for any surgical procedure. It is especially important that women know about sensations they might experience after the operation, so the sensations are not misinterpreted as signs of further cancer or poor healing.

If the tumor is not able to be felt (not palpable), a pre-operative localization procedure is needed. A fine wire, or other device, is placed at the tumor site, using x ray or ultrasound for guidance. This is usually done in the radiology department of a hospital. The woman is most often sitting up and awake, although some sedation may be administered.

Aftercare

After a lumpectomy, patients are usually cautioned against lifting anything which weighs over five pounds for several days. Other activities may be restricted (especially if the axillary lymph nodes were removed) according to individual needs. **Pain** is often enough to limit inappropriate motion. Women are often instructed to wear a well-fitting support bra both day and night for approximately one week after surgery.

Pain is usually well controlled with prescribed medication. If it is not, the patient should contact the surgeon, as severe pain may be a sign of a complication, which needs medical attention. A return visit to the surgeon is normally scheduled approximately ten days to two weeks after the operation.

Radiation therapy is usually started as soon as feasible after lumpectomy. Other additional treatments, such as chemotherapy or hormone therapy, may also be prescribed. The timing of these is specific to each individual patient.

Risks

The risks are similar to those associated with any surgical procedure. Risks include bleeding, infection, asymmetry, anesthesia reaction, or unexpected scarring. A lumpectomy may also cause loss of sensation in the breast. The size and shape of the breast will be affected by the operation. Fluid can accumulate in the area where tissue was removed, requiring drainage.

If lymph node dissection is performed, there are several potential complications. A woman may experience decreased feeling in the back of her armpit. She may also experience other sensations, including numbness, tingling, or increased skin sensitivity. An inflammation of the arm vein, called phlebitis, can occur. There may be injury to the nerves controlling arm motion.

Approximately 2% to 10% of patients develop **lymphedema** (swelling of the arm) after axillary lymph node dissection. This swelling of the arm can range from mild to very severe. It can be treated with elastic bandages and specialized physical therapy, but it is a chronic condition, requiring continuing care. Lymphedema can arise at any time, even years after surgery.

A new technique that may eliminate the need for removing many axillary lymph nodes is being tested. Sentinel lymph node mapping and biopsy is based on the idea that the condition of the first lymph node in the network, which drains the affected area, can predict whether the cancer may have spread to the rest of the nodes. It is thought that if this first, or sentinel, node is cancer-free, then there is no need to look further. Many patients with early-stage breast cancers may be spared the risks and

KEY TERMS

Lymph node—A small mass of tissue in the form of a knot or protuberance. They are the primary source of lymph fluid, which serves in the body's defense by removing toxic fluids and bacteria.

complications of axillary lymph node dissection as the use of this approach continues to increase.

Normal results

When lumpectomy is performed, it is anticipated that it will be the definitive surgical treatment for breast cancer. Other forms of therapy, especially radiation, are often prescribed as part of the total treatment plan. The expected outcome is no recurrence of the breast cancer.

Abnormal results

An unforeseen outcome of lumpectomy may be recurrence of the breast cancer, either locally or distally (in a part of the body far from the original site). Recurrence may be discovered soon after lumpectomy or years after the procedure. For this reason, it is important for patients to be regularly and closely monitored by their physicians.

Resources

BOOKS

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book,* 2nd ed. Reading, MA: Addison-Wesley, 1995.

Robinson, Rebecca Y. and Jeanne A. Petrek. *A Step-by-Step Guide to Dealing With Your Breast Cancer.* New York: Carol Publishing Group, 1994.

PERIODICALS

Winchester, David P., and James D. Cox. "Standards for Diagnosis and Management of Invasive Breast Carcinoma." *CA-A Cancer Journal for Clinicians* 48 (March/April 1998): 83-107.

ORGANIZATION

American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Information about surgeons and institutions participating in clinical trials of sentinel node biopsy is available at the <http://cancertrials.nci.nih.gov/types/breast/treatment/sentnode>. (800) 4-CANCER.

National Lymphedema Network. 2211 Post St., Suite 404, San Francisco, CA 94115-3427. (800) 541-3259 or (415) 921-1306. <http://www.wenet.net/~lymphnet>.

Ellen S. Weber

Lumpy breasts *see* **Fibrocystic condition of the breast**

Lumpy jaw *see* **Actinomycosis**

Lung abscess

Definition

Lung **abscess** is an acute or chronic infection of the lung, marked by a localized collection of pus, inflammation, and destruction of tissue.

Description

Lung abscess is the end result of a number of different disease processes ranging from fungal and bacterial infections to **cancer**. It can affect anyone at any age. Patients who are most vulnerable include those weakened by cancer and other chronic diseases; patients with a history of substance abuse, diabetes, epilepsy, or poor dental hygiene; patients who have recently had operations under anesthesia; and **stroke** patients. In children, the most vulnerable patients are those with weakened immune systems, **malnutrition**, or blunt injuries to the chest.

Causes and symptoms

The immediate cause of most lung abscesses is infection caused by bacteria. About 65% of these infections are produced by anaerobes, which are bacteria that do not need air or oxygen to live. The remaining cases are caused by a mixture of anaerobic and aerobic (air breathing) bacteria. When the bacteria arrive in the lung, they are engulfed or eaten by special cells called phagocytes. The phagocytes release chemicals that contribute to inflammation and eventual necrosis, or **death**, of a part of the lung tissue. There are several different ways that bacteria can get into the lung.

Aspiration

Aspiration refers to the accidental inhalation of material from the mouth or throat into the airway and lungs. It is responsible for about 50% of cases of lung abscess. The human mouth and gums contain large numbers of anaerobic bacteria; patients with **periodontal disease** or poor **oral hygiene** have higher concentrations of these organisms. Aspiration is most likely to occur in patients who are unconscious or semi-conscious due to anesthesia, seizures, alcohol and drug abuse, or stroke. Patients who have problems swallowing or coughing, or

who have nasogastric tubes in place are also at risk of aspiration.

Bronchial obstruction

The bronchi are the two branches of the windpipe that lead into the lungs. If they are blocked by tissue swelling, cancerous tumors, or **foreign objects**, a lung abscess may form from infection trapped behind the blockage.

Spread of infection

About 20% of cases of **pneumonia** that cause the death of lung tissue (necrotizing pneumonia) will develop into lung abscess. Lung abscess can also be caused by the spread of other infections from the liver, abdominal cavity, or open chest **wounds**. Rarely, **AIDS** patients can develop lung abscess from *Pneumocystis carinii* and other organisms that take advantage of a weakened immune system.

Lung abscess is usually slow to develop. It may take about two weeks after aspiration or bronchial obstruction for an abscess to produce noticeable symptoms. The patient may be acutely ill for two weeks to three months. In the beginning, the symptoms of lung abscess are difficult to distinguish from those of severe pneumonia. Adults will usually have moderate **fever** (101-102°F/38-39°C), chills, chest **pain**, and general weakness. Children may or may not have chest pain, but usually suffer weight loss and high fevers. As the illness progresses, about 75% of patients will **cough** up foul or musty-smelling sputum; some also cough up blood.

Lung abscess can lead to serious complications, including **emphysema**, spread of the abscess to other parts of the lung, hemorrhage, **adult respiratory distress syndrome**, rupture of the abscess, inflammation of the membrane surrounding the heart, or chronic inflammation of the lung.

Diagnosis

The diagnosis is made on the basis of the patient's medical history (especially recent operations under general anesthesia) and general health as well as imaging studies. Smears and cultures taken from the patient's sputum are not usually very helpful because they will be contaminated with bacteria from the mouth. The doctor will first use a bronchoscope (lighted tube inserted into the windpipe) to rule out the possibility of lung cancer. In some cases of serious infection, the doctor can use a fiberoptic bronchoscope with a protected specimen brush to take material directly from the patient's lungs, for identification of the organism. This technique is time- consuming and expensive, and requires the patient to be taken off **antibiotics** for 48 hours. It is usually used only to evaluate severely ill patients with weakened immune systems.

In most cases, the doctor will use the results of a **chest x ray** to help distinguish lung abscess from **empyema**, cancer, **tuberculosis**, or cysts. In patients with lung abscess, the x ray will show a thick-walled unified clear space or cavity surrounded by solid tissue. There is often a visible air-fluid level. The doctor may also order a CT scan of the chest, in order to have a clearer picture of the exact location of the abscess.

Blood tests cannot be used to make a diagnosis of lung abscess, but they can be useful in ruling out other conditions. Patients with lung abscess usually have abnormally high white blood cell counts (**leukocytosis**) when their blood is tested, but this condition is not unique to lung abscess.

Treatment

Lung abscess is treated with a combination of antibiotic drugs, oxygen therapy, and surgery. The antibiotics that are usually given for lung abscess are penicillin G, penicillin V, and clindamycin. They are given intravenously until the patient shows signs of improvement, and then continued in oral form. The patient may need to take antibiotics for a month or longer, until the chest x ray indicates that the abscess is healing. Oxygen may be given to patients who are having trouble breathing.

Surgical treatment

Most patients with lung abscess will not need surgery. About 5% of patients—usually those who do not respond to antibiotics or are coughing up large amounts of blood (500 mL or more)—may have emergency surgery for removal of the diseased part of the lung or for insertion of a tube to drain the abscess. Antibiotic treatment is considered to have failed if fever and other symptoms continue after 10-14 days of treatment; if chest x rays indicate that the abscess is not shrinking; or if the patient has pneumonia that is spreading to other parts of the lung.

Supportive care

Because lung abscess is a serious condition, patients need quiet and bed rest. Hospital care usually includes increasing the patient's fluid intake to loosen up the secretions in the lungs, and physical therapy to strengthen the patient's breathing muscles.

Follow-up

Patients with lung abscess need careful follow-up care after the acute infection subsides. Follow-up usually

KEY TERMS

Abscess—An area of injured body tissue that fills with pus, as in lung abscess.

Anaerobe—A type of bacterium that does not require air or oxygen to live. Anaerobic bacteria are frequent causes of lung abscess.

Aspiration—Inhalation of fluid or foreign bodies into the airway or lungs. Aspiration often happens after vomiting.

Bronchoscope—A lighted, flexible tube inserted into the windpipe to view the bronchi or withdraw fluid samples for testing. Bronchoscopy with a protected brush can be used in the diagnosis of lung abscess in severely ill patients.

Bronchus—One of the two large tubes connecting the windpipe and the lungs.

Leukocytosis—An increased level of white cells in the blood. Leukocytosis is a common reaction to infections, including lung abscess.

Necrotizing pneumonia—Pneumonia that causes the death of lung tissue. It often precedes the development of lung abscess.

Sputum—The substance that is brought up from the lungs and airway when a person coughs or spits. It is usually a mixture of saliva and mucus, but may contain blood or pus in patients with lung abscess or other diseases of the lungs.

includes a series of chest x rays to make sure that the infection has cleared up. Treatment with antibiotics may continue for as long as four months, to prevent recurrence.

Prognosis

About 95% of lung abscess patients can be treated successfully with antibiotics alone. Patients who need surgical treatment have a mortality rate of 10-15%.

Prevention

Some of the conditions that make people more vulnerable to lung abscess concern long-term lifestyle behaviors, such as substance abuse and lack of dental care. Others, however, are connected with chronic illness and hospitalization. Aspiration can be prevented with proper care of unconscious patients, which includes suctioning of throat secretions and positioning patients to promote drainage. Patients who are conscious can be given physical therapy to help them cough up material in their lungs and airways. Patients with weakened immune systems can be isolated from patients with pneumonia or fungal infections.

Resources

BOOKS

D'Esopo, Nicholas D. "Primary Lung Abscess." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Larsen, Gary L., et al. "Respiratory Tract & Mediastinum." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Stauffer, John L. "Lung." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Turley, Kevin. "Thoracic Wall, Pleura, Mediastinum, & Lung." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Vincent, Miriam T., and Stephan L. Kamholz. "Anaerobic Lung Infections." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Rebecca J. Frey, Ph.D.

Lung biopsy

Definition

Lung biopsy is a medical procedure performed to obtain a small piece of lung tissue for examination under a microscope. Biopsy examinations are usually performed by pathologists, who are doctors with special training in tissue abnormalities and other signs of disease.

Purpose

Lung biopsies are useful, first of all, in confirming a diagnosis of **cancer**, especially if malignant cells are detected in the patient's sputum. A lung biopsy may be ordered to examine other abnormalities that appear on chest x rays, such as lumps (nodules). It is also helpful in diagnosing symptoms such as coughing up bloody sputum, **wheezing** in the chest, or difficult breathing. In addition to evaluating lung tumors and their associated symptoms, lung biopsies can be used in the diagnosis of lung infections, especially **tuberculosis**, drug reactions, and such chronic diseases of the lung as **sarcoidosis**.

A lung biopsy can be used for treatment as well as diagnosis. **Bronchoscopy**, which is a type of lung biopsy performed with a long slender instrument called a bronchoscope, can be used to clear a patient's air passages of secretions and to remove blockages from the airways.

Precautions

As with any other biopsy, lung biopsies should not be performed on patients who have problems with blood clotting because of low platelet counts. Platelets are small blood cells that play a role in the blood clotting process. If the patient has a **platelet count** lower than 50,000/cubic mm, he or she can be given a platelet **transfusion** as a temporary relief measure, and a biopsy can then be performed.

Description

Overview

The lungs are a pair of cone-shaped organs that lie in the chest cavity. An area known as the mediastinum separates the right and the left lungs from each other. The heart, the windpipe (trachea), the lymph nodes, and the tube that brings the food to the stomach (the esophagus) lie in this mediastinal cavity. Lung biopsies may involve entering the mediastinum, as well as the lungs themselves.

Types of lung biopsies

Lung biopsies can be performed using a variety of techniques. A bronchoscopy is ordered if a patch that looks suspicious on the x ray seems to be located deep in the chest. If the area lies close to the chest wall, a needle biopsy is often done. If both these methods fail to diagnose the problem, an open surgical biopsy may be carried out. If there are indications that the lung cancer has spread to the lymph nodes in the mediastinum, a **mediastinoscopy** is performed.

NEEDLE BIOPSY. When a needle biopsy is to be done, the patient will be given a sedative about an hour before the procedure, to help relaxation. The patient sits in a chair with arms folded on a table in front of him or her. X rays are then taken to identify the location of the suspicious areas. Small metal markers are placed on the overlying skin to mark the biopsy site. The skin is thoroughly cleansed with an antiseptic solution, and a local anesthetic is injected to numb the area.

The doctor then makes a small cut (incision) about half an inch in length. The patient is asked to take a deep breath and hold it while the doctor inserts the special biopsy needle through the incision into the lung. When enough tissue has been obtained, the needle is withdrawn. Pressure is applied at the biopsy site and a sterile bandage is placed over the cut. The entire procedure takes between 30 and 45 minutes.

The patient may feel a brief sharp **pain** or some pressure as the biopsy needle is inserted. Most patients, however, do not experience severe pain.

OPEN BIOPSY. Open biopsies are performed in a hospital under general anesthesia. As with needle biopsies, patients are given sedatives before the procedure. An intravenous line is placed in the arm to give medications or fluids as necessary. A hollow tube, called an endotracheal tube, is passed through the throat, into the airway leading to the lungs. It is used to convey the general anesthetic.

Once the patient is under the influence of the anesthesia, the surgeon makes an incision over the lung area. Some lung tissue is removed and the cut closed with stitches. The entire procedure usually takes about an hour. A chest tube is sometimes placed with one end inside the lung and the other end protruding through the closed incision. Chest tube placement is done to prevent the lungs from collapsing by removing the air from the lungs. The tube is removed a few days after the biopsy.

A **chest x ray** is done following an open biopsy, to check for lung collapse. The patient may experience some grogginess for a few hours after the procedure. He or she may also experience tiredness and muscle aches for a day or two, because of the general anesthesia. The throat may be sore because of the placement of the hollow endotracheal tube. The patient may also have some pain or discomfort at the incision site, which can be relieved by medication.

MEDIASTINOSCOPY. The preparation for a mediastinoscopy is similar to that for an open biopsy. The patient is sedated and prepared for general anesthesia. The neck and the chest will be cleansed with an antiseptic solution.

After the patient has been put to sleep, an incision about two or three inches (5 or 8 cm) long is made at the base of the neck. A thin, hollow, lighted tube, called a mediastinoscope, is inserted through the cut into the space between the right and the left lungs. The doctor examines the space thoroughly and removes any lymph nodes or tissues that look abnormal. The mediastinoscope is then removed, and the incision stitched up and bandaged. A mediastinoscopy takes about an hour.

Preparation

Before scheduling any lung biopsy, the doctor will check to see if the patient is taking any prescription medications, if he or she has any medication **allergies**, and if there is a history of bleeding problems. Blood tests may be performed before the procedure to check for clotting problems and blood type, in case a transfusion becomes necessary.

If an open biopsy or a mediastinoscopy is being performed, the patient will be asked to sign a consent form.

Since these procedures are done under general anesthesia, the patient will be asked to refrain from eating or drinking anything for at least 12 hours before the biopsy.

Aftercare

Needle biopsy

Following a needle biopsy, the patient is allowed to rest comfortably. He or she will be checked by a nurse at two-hour intervals. If there are no complications after four hours, the patient can go home. Patients are advised to rest at home for a day or two before resuming regular activities, and to avoid strenuous activities for a week after the biopsy.

Open biopsy or mediastinoscopy

After an open biopsy or a mediastinoscopy, patients are taken to a recovery room for observation. If no other complications develop, they are taken back to the hospital room. Stitches are usually removed after seven to 14 days.

If the patient has extreme pain, light-headedness, difficulty breathing, or develops a blue tinge to the skin after an open biopsy, the doctor should be notified immediately. The sputum may be slightly bloody for a day or two after the procedure. If, however, the bleeding is heavy or persistent, it should be brought to the attention of the doctor.

Risks

Needle biopsy

Needle biopsy is a less risky procedure than an open biopsy, because it does not involve general anesthesia. Very rarely, the lung may collapse because of air that leaks in through the hole made by the biopsy needle. If the lung collapses, a tube will have to be inserted into the chest to remove the air. Some coughing up of blood occurs in 5% of needle biopsies. Prolonged bleeding or infection may also occur, although these are very rare.

Open biopsy

Possible complications of an open biopsy include infection or lung collapse. **Death** occurs in about one in 3,000 cases. If the patient has very severe breathing problems before the biopsy, breathing may be slightly impaired following the operation. If the person's lungs were functioning normally before the biopsy, the chances of any respiratory problems are very small.

Mediastinoscopy

Complications due to mediastinoscopy are rare; death occurs in fewer than one in 3,000 cases. More common complications include lung collapse or bleeding caused by damage to the blood vessels near the heart. Injury to the esophagus or voice box (larynx) may sometimes occur. If the nerves leading to the larynx are injured, the patient may be left with a permanently hoarse voice. All of these complications are very rare.

KEY TERMS

Bronchoscopy—A medical test that enables the doctor to see the breathing passages and the lungs through a hollow, lighted tube.

Endotracheal tube—A hollow tube that is inserted into the windpipe to administer anesthesia.

Lymph nodes—Small, bean-shaped structures scattered along the lymphatic vessels which serve as filters. Lymph nodes retain any bacteria or cancer cells that are traveling through the system.

Mediastinoscopy—A medical procedure that allows the doctor to see the organs in the mediastinal space using a thin, lighted, hollow tube (a mediastinoscope).

Mediastinum—The area between the lungs, bounded by the spine, breastbone, and diaphragm.

Sputum—Mucus or phlegm that is coughed up from the passageways (bronchial tubes) in the lungs.

Normal results

Normal results of a needle biopsy and an open biopsy include the absence of any evidence of infection in the lungs. No lumps or nodules will be detected in the lungs and the cells will not show any cancerous abnormalities. Normal results from the mediastinoscopy will show the lymph nodes to be free of cancer.

Abnormal results

Abnormal results may be associated with diseases other than cancer. Nodules in the lungs may be due to active infections such as tuberculosis, or may be scars from a previous infection. The lung cells on microscopic examination do not resemble normal cells, and show certain abnormalities that point to cancer. In a third of biopsies using a mediastinoscope, the lymph nodes that are biopsied prove to be cancerous. Abnormal results should always be considered in the context of the patient's medical history, **physical examination**, and other tests such as sputum examination, chest x rays, etc. before a final diagnosis is made.

Resources

BOOKS

"Bronchoscopy." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Sobel, David S., and Tom Ferguson. *The People's Book of Medical Tests*. New York: Summit Books, 1985.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Cancer Research Institute. 681 Fifth Ave., New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Lata Cherath, PhD

Lung cancer, non-small cell

Definition

Non-small cell lung **cancer** is a disease in which the cells of the lung tissues grow uncontrollably and form tumors.

Description

There are two kinds of lung cancers, primary and secondary. Primary lung cancer starts in the lung itself, and is divided into small cell lung cancer and non-small cell lung cancer. Small cell lung cancers are shaped like an oat and called oat-cell cancers; they are aggressive, spread rapidly, and represent 20% of lung cancers. Non-small cell lung cancer represents almost 80% of all primary lung cancers. Secondary lung cancer is cancer that starts somewhere else in the body (for example, the breast or colon) and spreads to the lungs.

The lungs

The lungs are located along with the heart in the chest cavity. The lungs are not simply hollow balloons but have a very organized structure consisting of hollow tubes, blood vessels and elastic tissue. The hollow tubes, called bronchi, are highly branched, becoming smaller and more numerous at each branching. They end in tiny, blind sacs made of elastic tissue called alveoli. These sacs are where the oxygen a person breathes in is taken up into the blood, and where carbon dioxide moves out of the blood to be breathed out.

Normal, healthy lungs are continually secreting mucus that not only keeps the lungs moist, but also protects the lungs by trapping foreign particles like dust and dirt in breathed air. The inside of the lungs is covered with small hairlike structures called cilia. The cilia move in such a way that mucus is swept up out of the lungs and into the throat.

Lung cancer

Most lung cancers start in the cells that line the bronchi, and can take years to develop. As they grow larger they prevent the lungs from functioning normally. The tumor can reduce the capacity of the lungs, or block the movement of air through the bronchi in the lungs. As a result, less oxygen gets into the blood and patients feel short of breath. Tumors may also block the normal movement of mucus up into the throat. As a result, mucus builds up in the lungs and infection may develop behind the tumor. Once lung cancer has developed it frequently spreads to other parts of the body.

The speed at which non-small cell tumors grow depends on the type of cells that make up the tumor. The following three types account for the vast majority of non-small cell tumors:

- Adenocarcinomas are the most common and often cause no symptoms. Frequently they are not found until they are advanced.
- Squamous cell carcinomas usually produce symptoms because they are centrally located and block the lungs.
- Undifferentiated large cell and giant cell carcinomas tend to grow rapidly, and spread quickly to other parts of the body.

Worldwide, lung cancer is the most common cancer in males, and the fifth most common cancer in women. The worldwide mortality rate for patients with lung cancer is 86%. In the United States, lung cancer is the leading cause of **death** from cancer among both men and women. The World Health Organization estimates that the worldwide mortality from lung cancer will increase to three million by the year 2025. Of those three million deaths, almost two and a half million will result from non-small cell lung cancer.

The incidence of lung cancer is beginning to fall in developed countries. This may be a result of antismoking campaigns. In developing countries, however, rates continue to rise, which may be a consequence of both industrialization and the increasing use of tobacco products.

Causes and symptoms

Causes

Tobacco **smoking** accounts for nearly 90% of all lung cancers. Giving up tobacco can prevent most lung

cancers. Smoking marijuana cigarettes is considered another risk factor for cancer of the lung. Second hand smoke also contributes to the development of lung cancer among nonsmokers.

Certain hazardous materials that people may be exposed to in their jobs have been shown to cause lung cancer. These include asbestos, coal products, and radioactive substances. Air pollution may also be a contributing factor. Exposure to radon, a colorless, odorless gas that sometimes accumulates in the basement of homes, may cause lung cancer in a tiny minority of patients. In addition, patients whose lungs are scarred from other lung conditions may have an increased risk of developing lung cancer.

Symptoms

Lung cancers tend to spread very early, and only 15% are detected in their early stages. The chances of early detection, however, can be improved by seeking medical care at once if any of the following symptoms appear:

- a **cough** that does not go away
- chest **pain**
- **shortness of breath**
- recurrent lung infections, such as **bronchitis** or pneumonia
- bloody or brown-colored spit or phlegm (sputum)
- persistent hoarseness
- significant weight loss that is not due to dieting or vigorous **exercise**; **fatigue** and loss of appetite
- unexplained fever

Although these symptoms may be caused by diseases other than lung cancer, it is important to consult a doctor to rule out the possibility of lung cancer.

If lung cancer has spread to other organs, the patient may have other symptoms such as headaches, bone **fractures**, pain, bleeding, or blood clots.

Diagnosis

Physical examination and diagnostic tests

The doctor will first take a detailed medical history and assess risk factors. During a complete **physical examination** the doctor will examine the patient's throat to rule out other possible causes of hoarseness or coughing, and will listen to the patient's breathing and chest sounds.

If the doctor has reason to suspect lung cancer, particularly if the patient has a history of heavy smoking or occupational exposure to irritating substances, a **chest x ray** may be ordered to see if there are any masses in the lungs. Special imaging techniques, such as computed tomography (CT) scans or **magnetic resonance imaging** (MRI), may provide more precise information about the size, shape, and location of any tumors.

Sputum analysis

Sputum analysis is a noninvasive test that involves microscopic examination of cells that are coughed up from the lungs. This test can diagnose at least 30% of lung cancers, even if tumors are not visible on chest x rays. In addition, the test can detect cancer in its very early stages, before it spreads to other regions. The sputum test does not provide any information about the location of the tumor.

Lung biopsy

Lung biopsy is the most definitive diagnostic tool for cancer. It can be performed in three different ways. **Bronchoscopy** involves the insertion of a slender, lighted tube, called a bronchoscope, down the patient's throat and into the lungs. This test allows the doctor to see the tubes inside the lungs, and to obtain samples of lung tissue. If a needle biopsy is to be performed, the location of the tumor is first identified using a computerized tomography (CT) scan or magnetic resonance imaging (MRI). The doctor then inserts a needle through the chest wall and collects a sample of tissue from the tumor. In the third procedure, known as surgical biopsy, the chest wall is opened up and a part of the tumor, or all of it, is removed. A doctor who specializes in the study of diseased tissue (a pathologist) examines the tumor to identify the cancer's type and stage.

Treatment

Staging

Treatment for non-small cell lung cancer depends primarily on the stage of the cancer. Staging is a process that tells the doctor if the cancer has spread and the extent of its spread. The most commonly used treatments are surgery, **radiation therapy**, and **chemotherapy**.

Non-small cell lung cancer has six stages:

- Occult carcinoma. Cancer cells have been found in the sputum, but no tumor has yet been found.
- Stage 0. A small group of cancerous cells have been found in one location.
- Stage I. The cancer is only in the lung and has not spread anywhere else.
- Stage II. The cancer has spread to nearby lymph nodes.

- Stage III. The cancer has spread to more distant lymph nodes, and/or other parts of the chest like the diaphragm.
- Stage IV. The cancer has spread to other parts of the body.

Surgery

Surgery is the standard treatment for the earlier stages of non-small cell lung cancer. The surgeon will decide on the type of surgery, depending on how much of the lung is affected. There are three different types of surgical procedures:

- Wedge resection is the removal of a small part of the lung.
- Lobectomy is the removal of one lobe of the lung. (The right lung has three lobes and the left lung has two lobes.)
- Pneumonectomy is the removal of an entire lung.

Lung surgery is a major procedure and patients can expect to experience pain, weakness in the chest, and shortness of breath. Air and fluid collect in the chest after surgery. As a result, patients will need help to turn over, cough, and breath deeply. Patients should be encouraged to perform these activities because they help get rid of the air and fluid and speed up recovery. It can take patients several months before they regain their energy and strength.

Radiotherapy

Patients whose cancer has progressed too far for surgery (Stages III and IV) may receive radiotherapy. Radiotherapy involves the use of high-energy rays to kill cancer cells. It is used either by itself or in combination with surgery or chemotherapy. The amount of radiation used depends on the size and the location of the tumor.

Radiation therapy may produce such side effects as tiredness, skin **rashes**, upset stomach, and **diarrhea**. Dry or sore throats, difficulty in swallowing, and loss of hair in the treated area are all minor side effects of radiation. These may disappear either during the course of the treatment or after the treatment is over.

Chemotherapy

Chemotherapy is also given to patients whose cancer has progressed too far for surgery. Chemotherapy is medication that is usually given intravenously to kill cancer cells. These drugs enter the bloodstream and travel to all parts of the body, killing cancer cells that have spread to different organs. Chemotherapy is used as the primary treatment for cancers that have spread beyond the lung and cannot be removed by surgery. It can also be used in addition to surgery or radiation therapy.

KEY TERMS

Bronchi—The tubes that carry air into the lungs.

Lymph—Clear fluid containing white blood cells that is collected from the tissues of the body and flows in vessels called the lymphatic system.

Lymph node—Small, oval shaped filters in the lymphatic system that trap bacteria and other unwanted particles to ensure their removal from the body.

Respiratory distress—A condition where patients with lung disease are not able to get enough oxygen.

Chemotherapy is tailored to each patient's needs. Most patients are given a combination of several different drugs. Because these drugs also harm normal cells, doses are carefully adjusted. Chemotherapy often has severe side effects, including **nausea and vomiting**, hair loss, anemia, weakening of the immune system, and sometimes **infertility**. Most of these side effects end when the treatment is over. Other medications can be given to lessen the unpleasant side effects of chemotherapy.

Alternative treatment

Because non-small cell lung cancer has a poor prognosis with conventional medical treatment, many patients are willing to try complementary and alternative therapies. These therapies are used to try to reduce **stress**, ease side effects and symptoms, or control disease. Two treatments sometimes used are shark cartilage and mistletoe. Although shark cartilage is thought to interfere with the tumor's blood supply, clinical trials have so far been inconclusive. Mistletoe is a poisonous plant that has been shown to kill cancer cells in the laboratory. Again, however, clinical trials with cancer patients have been inconclusive.

Patients who decide to try complementary and alternative therapies should tell their doctor. Some of these therapies may interfere with conventional treatment.

Prognosis

The prognosis for non-small cell lung cancer is better if the disease is found early, and removed surgically. For patients whose disease is caught in Stage I, the survival rate five years after surgery ranges from 60% to 80%. Up to 55% of Stage II patients are alive

after five years, but only about 30% of Stage III patients make it to five years. Unfortunately, 85% of patients already have at least Stage III cancer by the time they are diagnosed. Many of these patients have disease that is too advanced for surgery. Despite treatment with radiotherapy and chemotherapy, the five-year survival for patients with inoperable disease is extremely low.

Prevention

The best way to prevent lung cancer is not to start smoking or to quit smoking. Secondhand smoke from other people's tobacco should also be avoided. Appropriate precautions should be taken when working with cancer-causing substances (carcinogens). Testing houses for the presence of radon gas, and removing asbestos from buildings have also been suggested as preventive strategies.

Resources

BOOKS

Brambilla, Christian, and Elisabeth Brambilla, ed. *Lung Tumors. Fundamental Biology and Clinical Management*. New York: Marcel Dekker, 1999.

Skarin, Harry S., ed. *Multimodality Treatment of Lung Cancer.* New York: Marcel Dekker, 2000.

PERIODICALS

Carney, Desmond N., and Heine H. Hansen. "Non-Small-Cell Lung Cancer: Stalemate or Progress?" *New England Journal of Medicine* 343, no. 17 (26 October 2000): 1261–3.

Deslauriers, Jean, and Jocelyn Gregoire. "Clinical and Surgical Staging of Non-Small Cell Lung Cancer." *Chest* 117, no. 4, supplement 1 (April 2000): 96S–103S.

Hoffman, Phillip C., et al. "Lung Cancer." *The Lancet* (355) (5 February 2000): 479–85.

Johnson, David H. "Locally Advanced, Unresectable Non-Small Cell Lung Cancer. New Treatment Strategies." *Chest* 117, no.4, supplement 1 (April 2000): 123S–126S.

ORGANIZATIONS

Alliance for Lung Cancer Advocacy, Support and Education. PO Box 849 Vancouver, WA 98666. (800) 298-2436. <http://www.alcase.org>.

American Lung Association. (800) 586-4872. <http://www.lungusa.org>.

National Cancer Institute (National Institutes of Health). 9000 Rockville Pike, Bethesda, MD 20892. (800) 422-6237. <http://www.nci.nih.gov>.

National Center for Complementary and Alternative Medicine (National Institutes of Health). PO Box 8218, Silver Spring, MD 20907-8218. (888) 644-6226. <http://nccam.nih.gov>.

Lata Cherath
Alison McTavish, M.Sc.

Lung cancer, small cell

Definition

Small cell lung **cancer** is a disease in which the cells of the lung tissues grow uncontrollably and form tumors.

Description

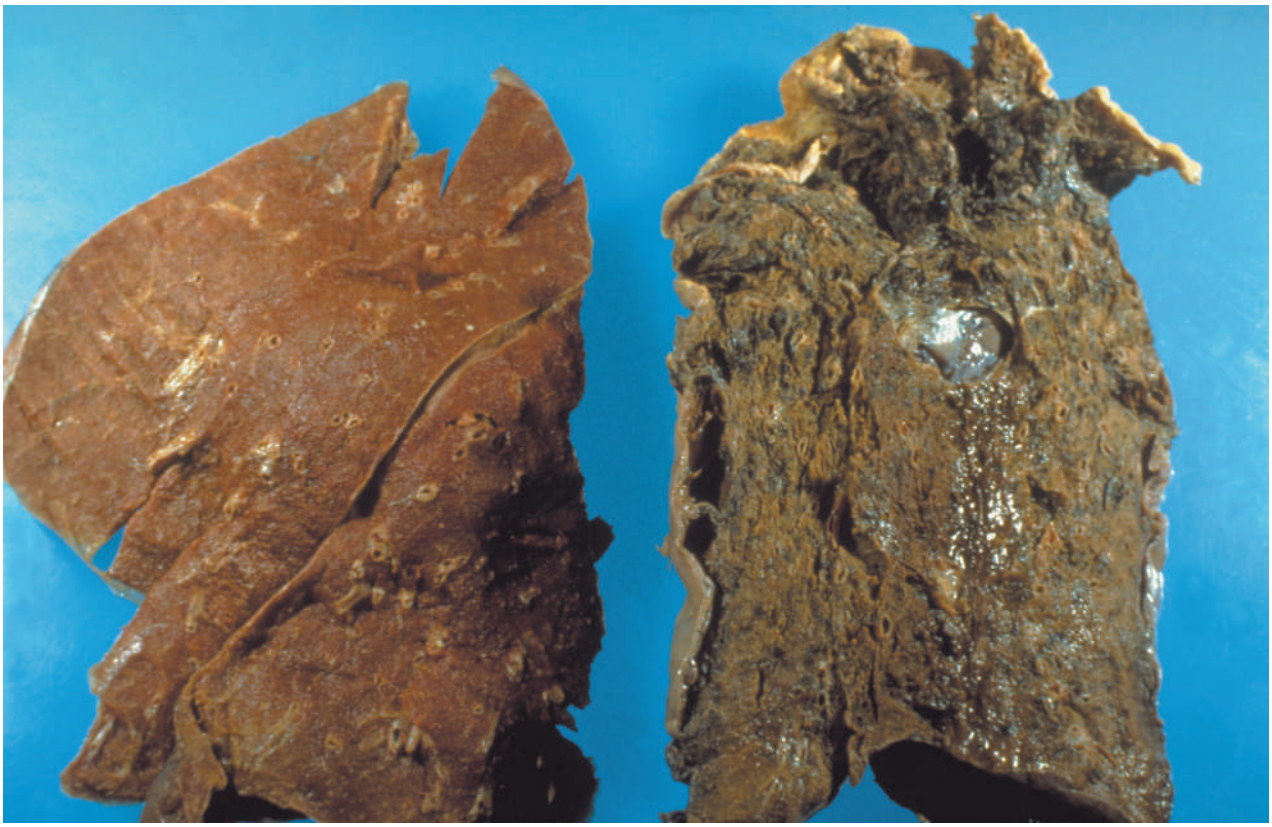
Lung cancer is divided into two main types: small cell and non-small cell. Small cell lung cancer is the least common of the two, accounting for only about 20% of all lung cancers. In the past, the disease was called oat cell cancer because, when viewed under a microscope, the cancer cells resemble oats. This type of lung cancer grows quickly and is more likely to spread to other organs in the body.

The lungs are located along with the heart in the chest cavity. The lungs are not simply hollow balloons, but have a very organized structure consisting of hollow tubes, blood vessels, and elastic tissue. The hollow tubes, called bronchi, are multi-branched, becoming smaller and more numerous at each branching. They end in tiny, blind sacs made of elastic tissue called alveoli. These sacs are where the oxygen a person breathes in is taken up into the blood, and where carbon dioxide moves out of the blood to be breathed out.

Normal, healthy lungs are continually secreting mucus that not only keeps the lungs moist, but also protects the lungs by trapping foreign particles like dust and dirt in breathed air. The inside of the lungs is covered with small, hair-like structures called cilia. The cilia move in such a way that mucus is swept up out of the lungs and into the throat.

Small cell lung tumors usually start to develop in the central bronchi. They grow quickly and prevent the lungs from functioning at their full capacity. Tumors may block the movement of air through the bronchi in the lungs. As a result, less oxygen gets into the blood and patients feel short of breath. Tumors may also block the normal movement of mucus into the throat. As a result, mucus builds up in the lungs and infection may develop behind the tumor.

Lung cancer is a growing global epidemic. Worldwide, lung cancer is the second most common cancer among both men and women and is the leading cause of cancer **death** in both sexes. The worldwide mortality rate for patients with lung cancer is 86%. Of the 160,000 deaths from lung cancer that occur annually in the United States, about 40,000 are caused by small cell lung cancer. Although there are differences in mortality rates between ethnic groups, this is mainly due to differences in **smoking** habits.



A normal lung (left) and the lung of a cigarette smoker (right). *(Photograph by A. Glauberman, Photo Researchers, Inc. Reproduced by permission.)*

Causes and symptoms

Causes

Tobacco smoking accounts for nearly 90% of all lung cancers. The risk of developing lung cancer is increased for smokers who start at a young age, and for those who have smoked for a long time. The risk also increases as more cigarettes are smoked, and when cigarettes with higher tar content are smoked. Smoking marijuana cigarettes is also a risk factor for lung cancer. These cigarettes have a higher tar content than tobacco cigarettes.

Certain hazardous materials that people may be exposed to in their jobs have been shown to cause lung cancer. These include asbestos, coal products, and radioactive substances. Air pollution may also be a contributing factor. Exposure to radon, a colorless, odorless gas that sometimes accumulates in the basement of homes, may cause lung cancer in some patients. In addition, patients whose lungs are scarred from other lung conditions may have an increased risk of developing lung cancer.

Although the exact cause of lung cancer is not known, people with a family history of lung cancer appear to have a slightly higher risk of contracting the disease.

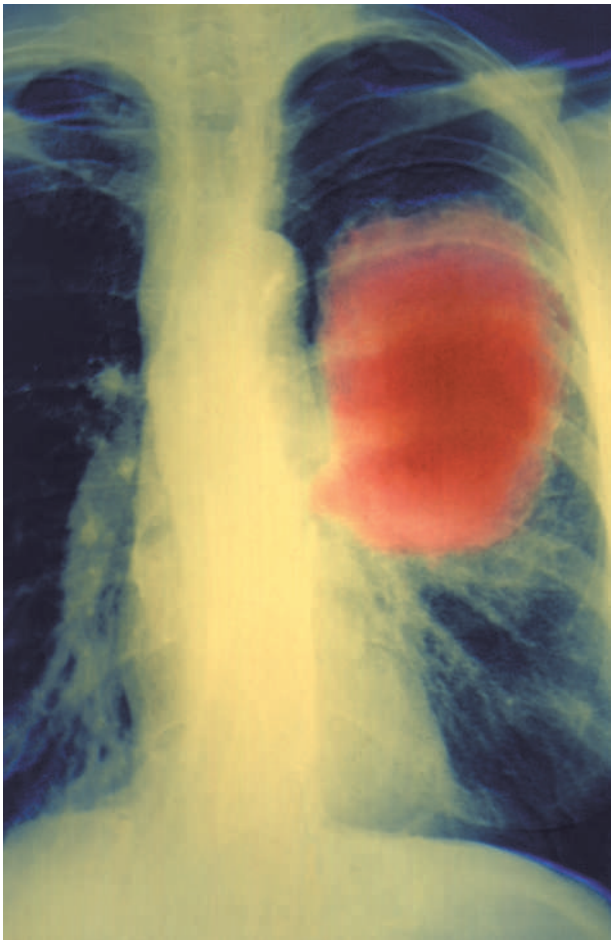
Symptoms

Small cell lung cancer is an aggressive disease that spreads quickly. Symptoms depend on the tumor's location within the lung, and on whether the cancer has spread to other parts of the body. More than 80% of small cell lung cancer patients have symptoms for only three months or less, and few cases are detected early. The following symptoms are the most commonly reported by small cell lung cancer patients at the time of their diagnosis:

- a **cough** that does not go away
- chest **pain**
- **shortness of breath** and wheezing
- persistent hoarseness
- fatigue and loss of appetite

Although some patients may experience bloody spit or phlegm, this symptom is more commonly seen in patients with other types of lung cancer.

Small cell tumors often press against a large blood vessel near the lungs called the superior vena cava (SVC), causing a condition known as SCV syndrome. This condi-



An x-ray image showing an oval-shaped carcinoma in the left lung (right of image). *(Custom Medical Stock Photo. Reproduced by permission.)*

tion may cause patients to retain water, cough, and have shortness of breath. Because small cell lung cancer often spreads quickly to the bones and central nervous system, patients may also have bone pain, headaches, and seizures.

Diagnosis

If lung cancer is suspected, the doctor will take a detailed medical history that checks both symptoms and risk factors. During a complete **physical examination**, the doctor will examine the patient's throat to rule out other possible causes of hoarseness or coughing, and listen to the patient's breathing and the sounds made when the patient's chest and upper back are tapped. A **chest x ray** may be ordered to check for masses in the lungs. Special imaging techniques, such as computed tomography (CT) scans or **magnetic resonance imaging** (MRI), may provide more precise information about the size, shape, and location of any tumors.

Sputum analysis involves microscopic examination of the cells that are either coughed up from the lungs, or are collected through a special instrument called a bronchoscope. The sputum test does not, however, provide any information about the location of the tumor and must be followed by other tests.

Lung biopsy is the most definitive diagnostic tool for cancer. It can be performed in several different ways. The doctor can perform a **bronchoscopy**, which involves the insertion of a slender, lighted tube, called a bronchoscope, down the patient's throat and into the lungs. In addition to viewing the passageways of the lungs, the doctor can use the bronchoscope to obtain samples of the lung tissue. In another procedure known as a needle biopsy, the location of the tumor is first identified using a CT scan or MRI. The doctor then inserts a needle through the chest wall and collects a sample of tissue from the tumor. In the third procedure, known as surgical biopsy, the chest wall is opened up and a part of the tumor, or all of it, is removed for examination.

Treatment

Staging

Staging procedures are important in lung cancer because they tell doctors whether patients have disease only in their lungs, or whether the cancer has spread to other parts of the body. To establish the cancer stage, doctors have to perform various tests. These may include **bone marrow aspiration and biopsy**, CT scans of the chest and abdomen, MRI scans of the brain, and radionuclide bone scans. All of these tests determine the extent to which the cancer has spread. Once the stage is determined, doctors can decide on a course of treatment, and can have a better idea of the patient's prognosis.

Unlike other types of lung cancer, the staging of small cell lung cancer is relatively simple. This is because approximately 70% of patients already have metastatic disease when they are diagnosed, and small differences in the amount of tumor found in the lungs do not change the prognosis. Small cell lung cancer is usually divided into three stages:

- Limited stage: The cancer is found only in one lung and in lymph nodes close to the lung.
- Extensive stage: The cancer has spread beyond the lungs to other parts of the body.
- Recurrent stage: The cancer has returned following treatment.

Without treatment, small cell lung cancer has the most aggressive clinical course of any type of pulmonary tumor, with median survival from diagnosis of only 2–4

months. Compared with other cell types of lung cancer, small cell lung cancer has a greater tendency to be widely disseminated by the time of diagnosis, but is much more responsive to **chemotherapy** and irradiation.

Treatment of small cell lung cancer depends on whether the patient has limited, extensive, or recurrent disease. Treatment usually involves radiotherapy and chemotherapy. Surgery is rarely used for this type of lung cancer because the tumor is usually too advanced.

Patients with limited-stage disease are usually treated with chemotherapy. Combinations of two or more drugs have a better effect than treatment with a single drug. Up to 90% of patients with this stage of disease will respond to chemotherapy. The chemotherapy most commonly prescribed is a combination of the drugs etoposide (Vepesid) and cisplatin (Platinol). Combining chemotherapy with chest radiotherapy and/or occasionally surgery has also prolonged survival for limited-stage patients.

In addition to chest radiotherapy, some patients are also treated with **radiation therapy** to the brain, even if no cancer is found there. This treatment, called prophylactic cranial irradiation (PCI), is given to prevent tumors from forming in the brain. The combination of etoposide and cisplatin chemotherapy with chest radiation therapy and PCI has increased the two-year survival of limited-stage small cell lung cancer patients to almost 50%.

Combinations of different chemotherapy agents are also used for treating extensive-stage small cell lung cancer. However, compared with limited-stage patients, the percentage of extensive-stage patients who respond to therapy is lower. Commonly used drug combinations include cyclophosphamide (Cytoxan), doxorubicin (Adriamycin), and vincristine (Oncovin), or etoposide and cisplatin. The addition of radiation therapy to chemotherapy does not improve survival in these patients. However, radiation therapy is used for the palliative (pain relief) treatment of symptoms of metastatic lung cancer, particularly brain and bone tumors.

Patients who have recurrent small cell lung cancer often become resistant to chemotherapy. These patients are treated with palliative radiotherapy. Their doctor may also recommend that they take part in a clinical trial of a new therapy. Patients whose relapse occurs more than six months after their initial treatment, however, may still respond to traditional chemotherapy.

Alternative treatment

Many cancer patients have tried using shark cartilage to treat their disease. Shark cartilage is thought to interfere with the tumor's blood supply. A clinical trial using this treatment in lung cancer patients is ongoing. Information on this and other alternative treatments is available on the Internet from the National Center for Complementary and Alternative Medicine.

Patients who decide to try complementary and alternative therapies should tell their doctor. Some of these therapies may interfere with conventional treatment.

KEY TERMS

Bronchi—Hollow tubes that carry air into the lungs.

PCI—A type of radiotherapy that is used to prevent tumors from growing in the brain.

Radionuclide bone scan—A test that tells if cancer has spread to the bones.

Superior vena cava (SVC) syndrome—A condition seen in lung cancer patients where the tumor presses against a large blood vessel and causes various symptoms.

Prognosis

Small cell lung cancer is a very aggressive disease. Without treatment, limited-stage patients will survive for three to six months, while extensive-stage patients will survive six to 12 weeks. However, small cell lung cancer is much more responsive to chemotherapy and radiation therapy than other types of lung cancer. Among patients treated with chemotherapy, 70–90% have a major response to treatment.

Survival in patients responding to therapy is four to five times longer than in patients without treatment. In addition, two years after the start of therapy, about 10% of patients remain free of disease. In general, women tend to have a better prognosis than men. Patients whose disease has spread to the central nervous system or liver have a much worse prognosis. Although the overall survival at five years is 5% to 10%, survival is higher in patients with limited stage disease. About 70% of patients who are disease free after two years do not relapse. After five to 10 disease-free years, relapses are rare.

Prevention

The best way to prevent lung cancer is either not start smoking, or quit smoking. Secondhand smoke from other people's tobacco should also be avoided. Appropriate precautions should be taken when working with substances that can cause cancer (carcinogens). Testing houses for the presence of radon gas, and removing

asbestos from buildings have also been suggested as preventive strategies.

Resources

BOOKS

Pass, Harvey I. et al. *Lung Cancer Principles and Practice.* Philadelphia: Lippincott Williams and Wilkins, 2000.

PERIODICALS

Adjei, Alex A. et al. "Current Guidelines for the Management of Small Cell Lung Cancer." *Mayo Clinic Proceedings* 74 (August 1999): 809-16.

Sandler, Alan. "Extensive Small Cell Lung Cancer: A Treatment Overview." *Oncology* 14, no. 7, supplement 5 (July 2000): 49-55.

Tamura, Tomohide. "New State of the Art in Small Cell Lung Cancer." *Oncology* 15, no. 1, supplement 1 (January 2001): 8-10.

ORGANIZATIONS

Alliance for Lung Cancer Advocacy, Support, and Education. P.O. Box 849, Vancouver, WA 98666. (800) 298-2436. <http://www.alcase.org>.

American Lung Association. (800) 586-4872. <http://www.lungusa.org>.

National Cancer Institute (National Institutes of Health). 9000 Rockville Pike, Bethesda, MD 20892. (800) 422-6237. <http://www.nci.nih.gov>.

National Center for Complementary and Alternative Medicine (National Institutes of Health). P.O. Box 8218, Silver Spring, MD 20907-8218. (888) 644-6226. <http://nccam.nih.gov>.

Lata Cherath
Alison McTavish, M.Sc.

Lung diseases due to gas or chemical exposure

Definition

Lung diseases due to gas or chemical exposure are conditions that can be acquired from indoor and outdoor air pollution and from ingesting tobacco smoke.

Description

The lungs are susceptible to many airborne poisons and irritants. Mucus present in the airways blocks foreign particles of a certain size, however it is unable to filter all airborne particulates. There are hundreds of substances that can pollute air and harm lungs. Harmful gases and chemicals are just one type of airborne pollutant that can adversely effect the lungs. They include:

- vehicle exhaust
- localized pollutants such as arsenic, asbestos, lead, and mercury
- outdoor pollutants caused by industry and intensified by weather conditions
- household heating, such as wood-burning stoves
- household chemical products
- tobacco smoke

Lungs respond to irritants in four ways, each of which can occur separately or, more often, trigger other responses.

- **Asthma** occurs when irritation causes the smooth muscles surrounding the airways to constrict.
- Increased mucus comes from irritated mucus glands lining the airway. Excess mucus clogs the airway and prevents air from circulating.
- Constriction of the lungs results from scarring when the supporting tissues are damaged.
- **Cancer** is caused by certain irritants, like asbestos and tobacco smoke.

The major categories that airborne irritants fall into are allergic, organic, inorganic, and poisonous, with many agents occupying more than one category.

- Allergic irritants bother only people who are sensitive to them. Cat hair, insect parts, and pollen are common allergens. Chemicals called sulfites, which are widely used as food preservatives, also cause asthma.
- There are many organic dusts that irritate the lungs. Most of them occur on the job and cause occupational lung disease. Grain dust causes silo filler's disease. Cotton and other textile dusts cause **byssinosis**. Mold spores in hay cause farmer's lung.
- Inorganic dusts and aerosolized chemicals are also found mostly on the job. Classic among them are asbestos and coal dust. Many metals (cadmium, arsenic, chromium, and phosphorus), various other fine particles (cement, mica, rock), acid fumes, ammonia, ozone, and automobile and industrial emissions are part of a very long list.
- Most intentional poisons (cyanide, nerve gas) that enter through the lungs pass through and damage other parts of the body. Mustard gas, used during World War I and banned since, directly and immediately destroys lungs.
- Tobacco use scars the lungs and causes **emphysema** and **lung cancer.**

Causes and symptoms

Lung disease generates three major symptoms—coughing, **wheezing**, and **shortness of breath**. It also

predisposes the lungs to infections such as **bronchitis** and **pneumonia**. Cancer is a late effect, requiring prolonged exposure to an irritant. In the case of tobacco, an average of a pack of cigarettes a day for forty years, or two packs a day for twenty years, will greatly increase the risk of lung cancer.

Diagnosis

A history of exposure combined with a **chest x ray** and lung function studies completes the diagnostic evaluation in most cases. Lung function measures the amount of air breathed in and out, the speed it moves, and the effectiveness of oxygen exchange with the blood. If the cause is still unclear, a **lung biopsy** reveals the answer.

Treatment

Eliminating the offending irritant and early **antibiotics** for infection are primary. There are many techniques available to remove excess mucus from the lungs. Respiratory therapists are experts in these methods. Finally, there are several machines available to enrich the oxygen content of breathed air.

A new surgical treatment called "lung reduction surgery" is just emerging from the experimental stage. It promises substantial return of lung function for selected patients with advanced emphysema.

Prognosis

Many of these diseases are progressive, because the irritants stay in the lungs forever. Others remain stable after the offensive agents are removed from the environment. Lungs do not heal from destructive damage, but they can clean out infection and excess mucus, and function better.

Prevention

Industrial air filters, adequate ventilation, and respirators in polluted work sites are now mandatory. Tobacco smoke is the world's leading cause of lung disease and many other afflictions. **Smoking** cessation programs are widely available.

Resources

BOOKS

Beckett, William S., W. Morgan, and C. Keith. "Byssinosis and Respiratory Disease Caused by Vegetable Dusts." In *Textbook of Pulmonary Diseases*, ed. Gerald L. Baum, et al. Philadelphia: Lippincott-Raven, 1997.

Graham, David R. "Noxious Gases and Fumes." In *Textbook of Pulmonary Diseases*, ed. Gerald L. Baum, et al. Philadelphia: Lippincott-Raven, 1997.

Kelley, Jason. "Occupational Lung Diseases Caused by Asbestos, Silica, and Other Silicates." In *Textbook of Pulmonary Diseases*, ed. Gerald L. Baum, et al. Philadelphia: Lippincott-Raven, 1997.

Looney, R. John, and Mark J. Utell. "Occupational Asthma and Industrial Bronchitis." In *Textbook of Pulmonary Diseases*, ed. Gerald L. Baum, et al. Philadelphia: Lippincott-Raven, 1997.

Morgan, W., and C. Keith. "Occupational Lung Diseases: Coal Workers' Beryllium, and Other Pneumoconioses." In *Textbook of Pulmonary Diseases*, ed. Gerald L. Baum, et al. Philadelphia: Lippincott-Raven, 1997.

PERIODICALS

Rogers, R. M., F. C. Sciurba, and R. J. Keenan. "Lung Reduction Surgery in Chronic Obstructive Lung Disease." *Medical Clinics of North America* 80 (May 1996): 623-44.

Sciurba, F. C., and R.M. Rogers. "Lung Reduction Surgery for Emphysema." *Current Opinion In Pulmonary Medicine* 2 (Mar. 1996): 97-103.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

J. Ricker Polsdorfer, MD

KEY TERMS

Allergen—A substance that causes an allergic reaction in those who are sensitive to it.

Asthma—Temporary airway narrowing that causes wheezing and shortness of breath due to allergies.

Bronchitis—Infection in the bronchi (breathing tubes).

Pneumonia—Infection or inflammation in the lung itself.

Lung fluke infections *see* **Fluke infections**

Lung function tests *see* **Pulmonary function test**

Lung perfusion and ventilation scan

Definition

A lung perfusion scan is a nuclear medicine test that produces a picture of blood flow to the lungs. A lung

ventilation scan measures the ability of the lungs to take in air and uses radiopharmaceuticals to produce a picture of how air is distributed in the lungs.

Purpose

Lung perfusion scans and lung ventilation scans are usually performed in the same session. They are done to detect pulmonary embolisms, determine how much blood is flowing to lungs, determine which areas of the lungs are capable of ventilation, and assess how well the lungs are functioning after surgery. These tests are called by different names, including perfusion lung scan, aerosol lung scan, radionucleotide ventilation lung scan, ventilation lung scan, xenon lung scan, ventilation/perfusion scanning (VPS), pulmonary scintiphotography, or, most commonly, V/Q scan.

Precautions

The amount of radioactivity a person is exposed to during these tests is very low and is not harmful. However, if the patient has had other recent radionuclear tests, it may be necessary to wait until other radiopharmaceuticals have been cleared from the body so that they do not interfere with these tests.

Description

In a lung perfusion scan, a small amount of the protein labeled with a radioisotope is injected into the patient's hand or arm vein. The patient is positioned under a special camera that can detect radioactive material, and a series of photographs are made of the chest. When these images are projected onto a screen (oscilloscope), they show how the radioactive protein has been distributed by the blood vessels running through the lungs.

In a lung ventilation scan, a mask is placed over the nose and mouth, and the patient is asked to inhale and exhale a combination of air and radioactive gas. Pictures are then taken that show the distribution of the gas in the lungs. Each test takes 15-30 minutes.

Preparation

There is little preparation needed for these tests. The patient may eat and drink normally before the procedure. Tests to check for **pulmonary embolism** are often performed on an emergency basis.

Aftercare

No special aftercare is needed. The patient may resume normal activities immediately.

KEY TERMS

Pulmonary embolism—A blood clot in the arteries going to the lungs.

Risks

There are practically no risks associated with these tests.

Normal results

Normal results in both tests show an even distribution of radioactive material in all parts of the lungs.

Abnormal results

In the lung perfusion scan, an absence of radioactive marker material suggests decreased blood flow to that part of the lung, and possibly a pulmonary **embolism**. However, **pneumonia**, **emphysema**, or lung tumors can create readings on the lung perfusion scan that falsely suggest a pulmonary embolism is present.

In the lung ventilation scan, absence of marker material when the lung perfusion scan for the area is normal suggests lung disease.

Certain combinations of abnormalities in lung perfusion and ventilation scans suggest pulmonary embolism.

Resources

BOOKS

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

"Scanning Tests." In *Illustrated Guide to Diagnostic Tests*, ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

"Lung Scan." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Tish Davidson

Lung surgery

Definition

Lung surgery includes a variety of procedures used to diagnose or treat diseases of the lungs. Biopsies are performed to extract a small amount of tissue for diagnosis, resections remove a portion of lung tissue, and other

surgeries are aimed at reducing the volume of the lungs, removing cancerous tumors, or improving lung function.

Purpose

The type of lung surgery performed will depend upon the underlying disease or condition, as well as other factors.

- Pneumonectomy usually refers to the removal of a lung, or sometimes one or more lobes (sections containing lung tissue, air sacs, ducts, and respiratory bronchiole). It is most commonly indicated in certain forms and stages of lung **cancer**.
- Thoracotomy, or surgical incision of the chest wall, is used primarily as a diagnostic tool when other procedures have failed to provide adequate diagnostic information.
- Lobectomy is the term used to describe removal of one lobe of a lung. It is most commonly indicated for lung cancer, but may also be used for **cystic fibrosis** patients if other treatments have failed.
- Other surgical procedures include segmental resection or wedge resection. A resection is the removal of a part of the lung, often in order to remove a tumor. Wedge resection is removal of a wedge-shaped portion of lung tissue.
- Volume reduction surgery is a newer surgery used to help relieve **shortness of breath** and increase tolerance for **exercise** in patients with chronic obstructive pulmonary disease, such as **emphysema**.
- Other surgeries are continuously improved upon to make biopsy less invasive and surgery more effective, such as video-assisted lobectomy. Other purposes for lung surgery may include severe **abscess**, areas of long-term infection, or permanently enlarged or collapsed lung tissue.

Precautions

Thoracotomy should not be performed on patients whose general health status will not tolerate major surgery. Any surgery carries with it risks associated with general anesthesia and possibility of infection. Patients whose risk for these complications outweighs benefit may not be considered candidates for lung surgery. Each individual patient's condition will be reviewed prior to the treatment decision.

Description

Lung surgery procedures will vary depending on the underlying cause of the surgical test or intervention. A patient will be placed under general anesthesia during the surgery. An incision is made to examine the lungs. Diseased tissue is removed and may be sent for biopsy. Following the surgery, drainage tubes may be placed in the chest to drain fluids, blood, and air from the chest cavity. Tubes will most likely remain in place for one to two days, depending on the surgery and the patient's condition. The chest cavity, ribs, and skin are closed and the incision will be sutured. Hospital stay averages from three to 10 days.

Pneumonectomy consists of removal of all of one lung. It may often be indicated only when a lobectomy does not successfully remove the cancerous or damaged tissue. Thoracotomy consists of reaching the lung tissue through incision and obtaining tissue for a biopsy. The biopsy is used to diagnose or stage cancer, and thoracotomy may be avoided until other less invasive methods have failed. Volume reduction surgery involves incision and removal of those parts of the lung or lungs that are the most destroyed, in order to allow for full function of the remaining lung structure. This procedure is still being studied.

Lobectomy is performed in the same general manner as other lung surgeries, but will involve removal of an entire lobe of the lung. Most patients with Stage I or II **non-small cell lung cancer** will receive this treatment for their disease, or a less extensive resection. Lobectomy may only be performed if a wedge or segmental resection is ineffective, but is generally preferred as treatment for primary lung cancer in any patient who can tolerate the procedure. Wedge and segmental resections are still major surgery, but remove less tissue and may be the first choice for some patients, such as those with Stage I and Stage II non-small cell lung cancer. Patients who do not have enough pulmonary function to undergo a lobectomy will receive a wedge or segmental resection instead. This may lead to a higher recurrence rate of cancer. In general, the surgery method chosen will depend on specific circumstances and consideration of benefit versus risk.

Preparation

Preparation for lung surgery is much like that for any major surgery. Patients will receive instructions from a physician concerning limit of food or water intake prior to the surgery, as well as risks and expected recovery. Patients should continue to follow treatment for the underlying condition, unless instructed otherwise by the physician, and should discuss medications and changes in condition with their physician prior to the surgery.

Aftercare

The chest tube inserted at the end of surgery will remain in place until the lung has fully expanded. Patients will be carefully monitored in the hospital for complications and infection. Deep breathing is recommended to

help lessen the risk of **pneumonia** and infection. Breathing exercises will also help expand the lung. After discharge from the hospital, the patient may still receive some **pain** or infection-fighting medications and should recover within one to three months of the operation.

Risks

Risks of lung surgery follows those of any major surgery involving general anesthesia. These risks include reactions to anesthetics or medications, bleeding, infection, and problems restoring breathing. Lung surgery, in particular, offers the risk of pneumonia and blood clots. Thoracotomy, as a biopsy procedure, offers greater risk than most biopsy procedures.

Normal results

Outcome for any lung surgery depends on many factors and the severity of disease. In general, the predicted benefits, which justified the surgery, are normal expected results. Thoracotomy results in a definitive diagnosis in more than 90% of patients. Volume reduction surgery has been shown to result in relief of some symptoms and improvement in quality of life for selected patients with severe emphysema and have shown short-term promise.

Mortality from lung surgery improves as procedures move from the more complete pneumonectomy to lobectomy, and the lowest rate for segmental resection.

Resources

PERIODICALS

Norman, M., et al. "Improved Lung Function and Quality of Life Following Increased Elastic Recoil After Lung Volume Reduction Surgery in Emphysema." *Respiratory Medicine* 92 (1998): 653-658.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris, RN

Lung transplantation

Definition

Lung transplantation involves removal of one or both diseased lungs from a patient and the replacement of the lungs with healthy organs from a donor. Lung transplantation may refer to single, double, or even heart-lung transplantation.

National Transplant Waiting List By Organ Type (June 2000)

Organ Needed	Number Waiting
Kidney	48,349
Liver	15,987
Heart	4,139
Lung	3,695
Kidney-Pancreas	2,437
Pancreas	942
Heart-Lung	212
Intestine	137

Purpose

The purpose of lung transplantation is to replace a lung that no longer functions, or is cancerous, with a healthy lung. In order to qualify for lung transplantation, a patient must suffer from severe lung disease which limits activities of daily living. There should be potential for rehabilitated breathing function. Attempts at other medical treatments should be exhausted before transplantion is considered. Many candidates for this procedure have end-stage fibrotic lung disease, are dependent on oxygen therapy, and are likely to die of their disease in 12-18 months.

Patients with **emphysema** or chronic obstructive pulmonary disease (COPD) should be under 60 years of age, have a life expectancy without transplantation of two years or less, progressive deterioration, and emotional stability in order to be considered for lung transplantation. Young patients with end-stage **silicosis** (a progressive lung disease) may be candidates for lung or heart-lung transplantation. Patients with Stage III or Stage IV **sarcoidosis** (a chronic lung disease) with **cor pulmonale** should be considered as early as possible for lung transplantation. Other indicators of lung transplantation include pulmonary vascular disease and chronic pulmonary infection.

Precautions

Patients who have diseases or conditions which may make them more susceptible to organ rejection should not receive a lung transplant. This includes patients who are acutely ill and unstable; who have uncontrolled or untreatable pulmonary infection; significant dysfunction of other organs, particularly the liver, kidney, or central nervous system; and those with significant coronary disease or left ventricular dysfunction. Patients who actively smoke ciga-

rettes or are dependent on drugs or alcohol may not be selected. There are a variety of protocols that are used to determine if a patient will be placed on a transplant recipient list, and criteria may vary depending on location.

Description

Once a patient has been selected as a possible organ recipient, the process of waiting for a donor organ match begins. The donor organ must meet clear requirements for tissue match in order to reduce the chance of organ rejection. It is estimated that it takes an average of one to two years to receive a suitable donor lung, and the wait is made less predictable by the necessity for tissue match. Patients on a recipient list must be available and ready to come to the hospital immediately when a donor match is found, since the life of the lungs outside the body is brief.

Single lung transplantation is performed via a standard thoracotomy (incision in the chest wall) with the patient under general anesthesia. Cardiopulmonary bypass (diversion of blood flow from the heart) is not always necessary for a single lung transplant. If bypass is necessary, it involves re-routing of the blood through tubes to a heart-lung bypass machine. Double lung transplantation involves implanting the lungs as two separate lungs, and cardiopulmonary bypass is usually required. The patient's lung or lungs are removed and the donor lungs are stitched into place. Drainage tubes are inserted into the chest area to help drain fluid, blood, and air out of the chest. They may remain in place for several days. Transplantation requires a long hospital stay and recovery can last up to six months.

Heart-lung transplants always require the use of cardiopulmonary bypass. An incision is made through the middle of the sternum. The heart, lung, and supporting structures are transplanted into the recipient at the same time.

Preparation

In addition to tests and criteria for selection as a candidate for transplantation, patients will be prepared by discussing the procedure, risks, and expected prognosis at length with their doctor. Patients should continue to follow all therapies and medications for treatment of the underlying disease unless otherwise instructed by their physician. Since lung transplantation takes place under general anesthesia, normal surgical and anesthesia preparation should be taken when possible. These include no food or drink from midnight before the surgery, discussion of current medications with the physician, and informing the physician of any changes in condition while on the recipient waiting list.

KEY TERMS

Pulmonary—Refers to the respiratory system, or breathing function and system.

Sarcoidosis—A chronic disease with unknown cause that involves formation of nodules in bones, skin, lymph nodes, and lungs.

Silicosis—A progressive disease that results in impairment of lung function and is caused by inhalation of dust containing silica.

Aftercare

Careful monitoring will take place in a recovery room immediately following the surgery and in the patient's hospital room. Patients must take immunosuppression, or anti-rejection, drugs to reduce the risk of rejection of the transplanted organ. The body considers the new organ an invader and will fight its presence. The anti-rejection drugs lower the body's immune function in order to improve acceptance of the new organs. This also makes the patient more susceptible to infection.

Frequent check-ups with a physician, including x ray and blood tests, will be necessary following surgery, probably for a period of several years.

Risks

Lung transplantation is a complicated and risky procedure, partly because of the organs and systems involved, and also because of the risk of rejection by the recipient's body. Acute rejection most often occurs within the first four months following surgery, but may occur years later. Infection is a substantial risk for organ recipients. An early complication of the surgery can be poor healing of the bronchial and tracheal openings created during the surgery. A late complication and risk is chronic rejection. This can result in inflammation of the bronchial tubes or in late infection from the prolonged use of **immunosuppressant drugs** to fight rejection. Overall, lung transplant recipients have demonstrated average one and two-year survival rates of more than 70%.

Normal results

The outcome of lung transplantation can be measured in survival rates, and also in improved quality of life for recipients. Studies have reported improved quality of life after lung and heart-lung transplants. One study showed that at the two-year follow-up period, 86% of

studied recipients reported no limitation to their activity. Demonstration of normal results for patients may include quality of life measurements, as well as testing to ensure lack of infection and rejection.

Resources

BOOKS

Maurer, Janet R., Ronald F. Grossman, and Noel Zamel. "Lung Transplantation." In *Textbook of Respiratory Medicine*. 2nd ed. Ed. John F. Murray and Jay A. Nadel. Philadelphia: W. B. Saunders Co., 1994.

ORGANIZATIONS

Children's Organ Transplant Association, Inc. 2501 COTA Drive, Bloomington, IN 47403. (800) 366-2682. <http://www.cota.org>.

Second Wind Lung Transplant Association, Inc. 9030 West Lakeview Court, Crystal River, FL 34428. (888) 222-2690. <http://www.arthouse.com/secondwind>.

Teresa Norris, RN

Lupus erythematosus *see* **Systemic lupus erythematosus**

Luque rod *see* **Spinal instrumentation**

Luteinizing hormone test

Definition

The luteinizing hormone (LH) test is a test of the blood or urine to measure the level of luteinizing hormone (lutropin). This hormone level is highest immediately before a woman ovulates during her menstrual cycle.

Purpose

The LH test is frequently used to determine the timing of ovulation. Couples who are trying to become pregnant may use information about the timing of ovulation to improve their chance of conception. The LH test and other hormone tests may be used during **infertility** screening to chart a woman's menstrual cycle. It may also be used during preparation for **in vitro fertilization**, to determine when eggs are mature and ready to be removed from the ovary.

Description

Lutenizing hormone is a hormone released by the pituitary gland, a small gland at the base of the brain. The hormone stimulates the ovaries to produce and release eggs each month during the menstrual cycle. The level of LH in the blood is highest before ovulation. This increase in hormone level is sometimes called a "surge." A urine or blood sample can be analyzed by a laboratory for the level of LH present. An LH test may be used as part of an infertility screening to determine if there is a hormonal imbalance that might make it difficult to become pregnant. If fertility drugs are given to stimulate ovulation, an LH test can help determine the best time for sexual intercourse. The LH test may also be used to determine when eggs are mature enough to be surgically removed from the ovary as part of the in vitro fertilization process. LH tests may also aid in the diagnoses of polycystic ovary disease, premature ovarian failure, and **menopause**.

A urine LH detection kit is also available for use at home. These are sometimes called "ovulation tests" and are similar to home **pregnancy** test kits. A sample of the woman's first morning urine is tested with the materials provided in the kit. These home tests are often used by women who want to become pregnant. By monitoring levels of LH and watching for the "surge," they can time sexual intercourse to coincide with ovulation, increasing the chance that the egg will be fertilized.

Preparation

If a blood sample is taken, the skin around the vein where the needle will be inserted is swabbed with an antiseptic. No special preparation is necessary for collection of a urine sample.

Aftercare

No special aftercare is required. If the blood is tested, as with any blood sampling, the area where the needle was inserted should be kept clean.

Risks

There are no significant risks associated with either the blood or urine test for LH.

Normal results

The level of LH in the blood or urine will vary depending on when the sample was taken during the menstrual cycle. LH levels will be highest around the time of ovulation, about halfway between a woman's menstrual periods. Levels will be lower during the rest of the month. Women who have already experienced menopause will normally have lower LH levels.

Abnormal results

LH levels that remain low throughout the menstrual cycle may indicate a hormonal imbalance that could pre-

KEY TERMS

Lutropin—Another term for luteinizing hormone, this hormone stimulates the development and release of the egg from the ovary.

vent ovulation. Additional testing may be required if this test is done as part of an infertility screening.

Resources

BOOKS

"Pituitary Disorders." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Sher, G., V. M. Davis, and J. Stoess. *In Vitro Fertilization: The A.R.T. of Making Babies*. New York: Facts On File, 1995.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Altha Roberts Edgren

Lyme borreliosis *see* **Lyme disease**

Lyme disease

Definition

Lyme disease is an infection transmitted by the bite of ticks carrying the spiral-shaped bacterium *Borrelia burgdorferi*. The disease was named for Lyme, Connecticut, the town where it was first diagnosed in 1975 after a puzzling outbreak of arthritis. The organism was named for its discoverer, Willy Burgdorfer. The effects of this disease can be long-term and disabling unless it is recognized and treated properly with **antibiotics**.

Description

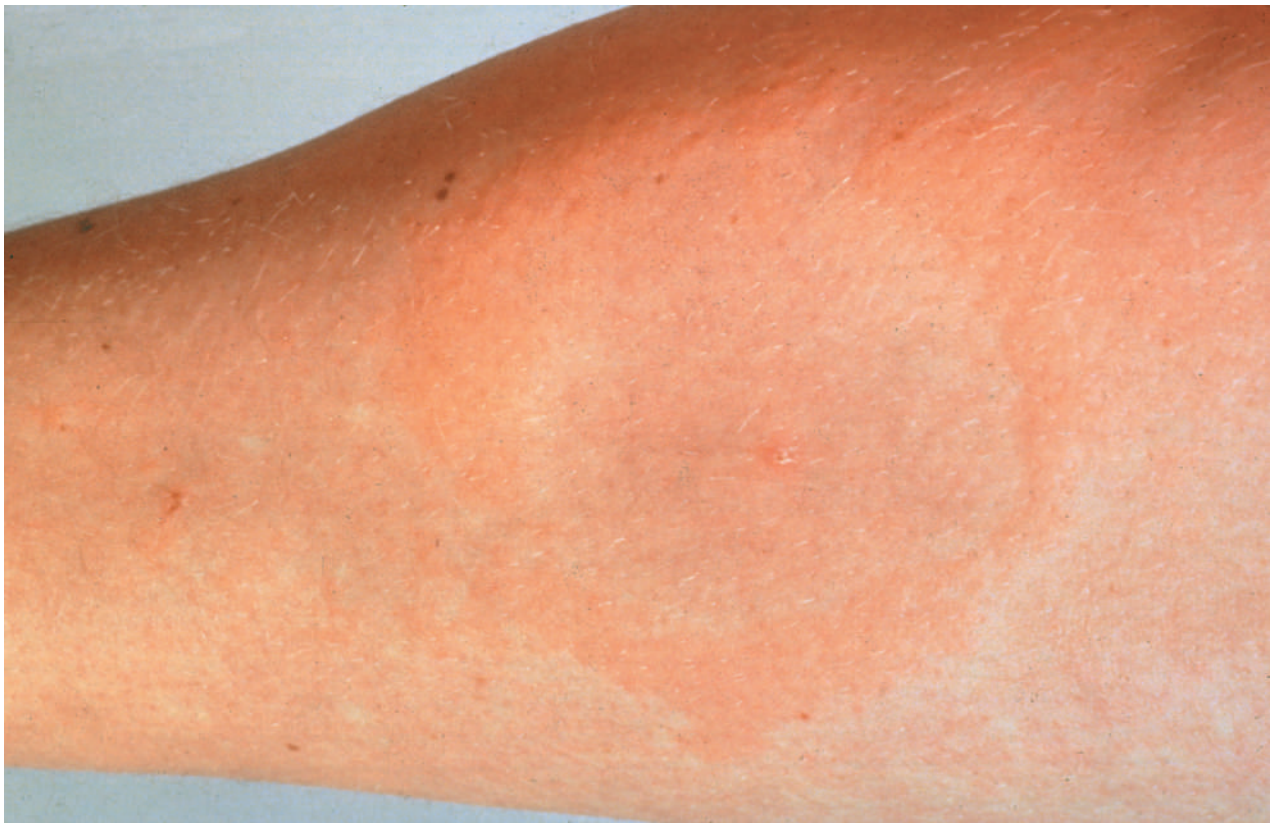
Lyme disease, which is also called Lyme borreliosis, is a vector-borne disease. This term means that it is delivered from one host to another. In this case, a tick bearing the *Borrelia burgdorferi* organism literally inserts it into a host's bloodstream when it bites the host to feed on its blood. It is important to note that neither *Borrelia burgdorferi* nor Lyme disease can be transmitted directly from one person to another, or from pets to humans.

In the United States, Lyme disease accounts for more than 90% of all reported vector-borne illnesses. It is a significant public health problem and continues to be diagnosed in significant numbers. More than 99,000 cases were reported between 1982 and 1996. When the numbers for 1996 Lyme disease cases reported were tallied, there were 16,455 *new cases*, a record high following a drop in reported cases from 1994 (13,043 cases) to 1995 (11,700 cases). Controversy clouds the true incidence of Lyme disease because no test is definitively diagnostic for the disease, and the broad spectrum of Lyme disease's symptoms mimic those of so many other diseases. Originally, public health specialists thought Lyme disease was limited geographically in the United States to the East Coast. We now know it occurs in most states, with the highest number of cases in the eastern third of the country and a strip along the West Coast that includes California and Oregon. As of 2001, Lyme disease is also found across Europe, in the countries of the former Soviet Union, and in China and Japan.

The risk for acquiring Lyme disease varies, depending on what stage in its life cycle a tick has reached. A tick passes through three stages of development—larva, nymph, and adult—each of which is dependent on a live host for food. In the United States, *Borrelia burgdorferi* is borne by ticks of several species in the genus *Ixodes*, which usually feed on the white-footed mouse and deer (and are often called deer ticks). In the summer, the larval ticks hatch from eggs laid in the ground and feed by attaching themselves to small animals and birds. At this stage they are not a problem for humans. It is the next stage—the nymph—that causes most cases of Lyme disease. Nymphs are very active from spring through early summer, at the height of outdoor activity for most people. Because they are still quite small (less than 2 mm), they are difficult to spot, giving them ample opportunity to transmit *Borrelia burgdorferi* while feeding. Although far more adult ticks than nymphs carry *Borrelia burgdorferi*, the adult ticks are much larger, more easily noticed, and more likely to be removed before the 24 hours or more of continuous feeding needed to transmit *Borrelia burgdorferi*.

Causes and symptoms

Lyme disease is caused by *Borrelia burgdorferi*. Once *Borrelia burgdorferi* gains entry to the body through a tick bite, it can move through the bloodstream quickly. Only 12 hours after entering the bloodstream, *Borrelia burgdorferi* can be found in cerebrospinal fluid (which means it can affect the nervous system). Treating Lyme disease early and thoroughly is important because lyme disease can hide for long periods within the body in a clinically latent state. That ability explains why symptoms can recur in cycles and can flare up after months or years, even over decades. It is important to note, howev-



The first sign of Lyme disease is usually an itchy rash around the site of the tick bite. *(Science Photo Library. Custom Medical Stock Photo. Reproduced by permission.)*

er, that not many people who are exposed to *Borrelia burgdorferi* develops the disease.

Lyme disease is usually described in terms of length of infection (time since the person was bitten by a tick infected with lyme disease) and whether *Borrelia burgdorferi* is localized or disseminated (spread through the body by fluids and cells carrying *Borrelia burgdorferi*). Furthermore, when and how symptoms of Lyme disease appear can vary widely from patient to patient. People who experience recurrent bouts of symptoms over time are said to have chronic lyme disease.

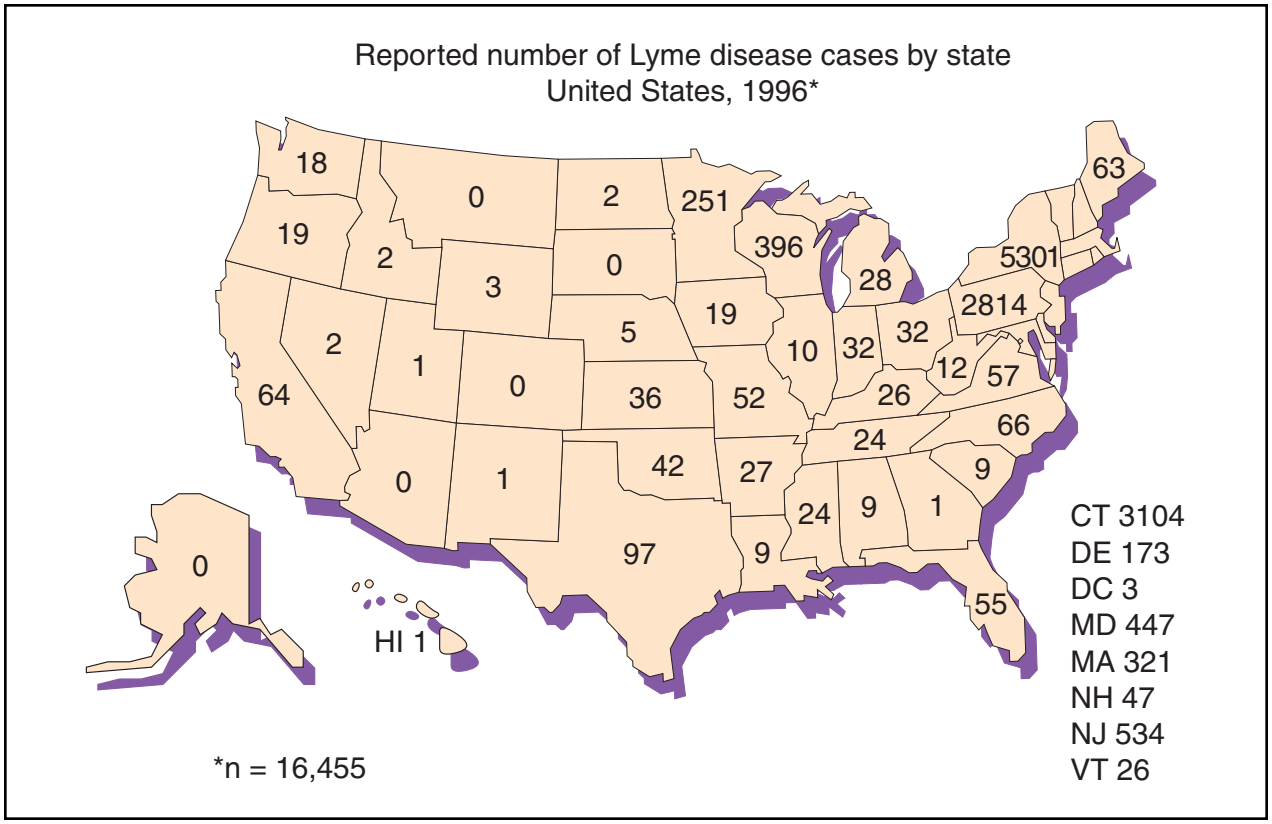
Early, localized Lyme disease

The most recognizable indicator of Lyme disease is a rash around the site of the tick bite. Often, the tick exposure has not been recognized. The eruption might be warm or itch. The rash—erythema migrans (EM)-generally develops within three to 30 days and usually begins as a round, red patch that expands outward. About 75% of patients with Lyme disease develop EM. Clearing may take place from the center out, leaving a bull's-eye effect; in some cases, the center gets redder instead of clearing. The rash may look like a bruise on people with dark skin. Of those who develop lyme disease, about 50% notice flu-like symptoms, including **fatigue**, **headache**, chills and **fever**, muscle and joint **pain**, and lymph node swelling. However, a rash at the site can also be an allergic reaction to the tick saliva rather than an indicator of lyme disease, particularly if the rash appears in *less* than three days and disappears only days later.

Late, disseminated disease and chronic Lyme disease

Weeks, months, or even years after an untreated tick bite, symptoms can appear in several forms, including:

- fatigue, forgetfulness, confusion, mood swings, irritability, numbness
- neurologic problems, such as pain (unexplained and not triggered by an injury), **Bell's palsy** (facial **paralysis**, usually one-sided but may be on both sides), and a mimicking of the inflammation of brain membranes known as **meningitis** (fever, severe headache)
- arthritis (short episodes of pain and swelling in joints) and other musculoskeletal complaints. Arthritis eventu-



Lyme disease accounts for more than 90% of all reported vector-borne illnesses in the United States. It is caused by an infection transmitted by the bite of ticks carrying the *Borrelia burgdorferi* bacterium. *Data taken from the Centers for Disease Control. Illustration by Electronic Illustrators Group.)*

ally develops in about 60% of patients with untreated lyme disease

Less common effects of Lyme disease are heart abnormalities (such as irregular rhythm or cardiac block) and eye abnormalities (such as swelling of the cornea, tissue, or eye muscles and nerves).

Diagnosis

A clear diagnosis of Lyme disease can be difficult, and relies on information the patient provides and the doctor's clinical judgment, particularly through elimination of other possible causes of the symptoms. Lyme disease may mimic other conditions, including **chronic fatigue syndrome** (CFS), **multiple sclerosis** (MS), and other diseases with many symptoms involving multiple body systems. Differential diagnosis (distinguishing kyme disease from other diseases) is based on clinical evaluation with laboratory tests used for clarification when necessary. A two-test approach is common to confirm the results. Because of the potential for misleading results (false-positive and false-negative), laboratory tests alone cannot establish the diagnosis.

In February 1999 the Food and Drug Administration (FDA) approved a new blood test for Lyme disease called PreVue. The test, which searches for antigens (substances that stimulate the production of antibodies) produced by *Borrelia burgdorferi*, gives results within one hour in the doctor's office. A positive result from the PreVue test is confirmed by a second blood test known as the Western blot, which must be done in a laboratory.

Doctors generally know which disease-causing organisms are common in their geographic area. The most helpful piece of information is whether a tick bite or rash was noticed and whether it happened locally or while traveling. Doctors may not consider Lyme disease if it is rare locally, but will take it into account if a patient mentions vacationing in an area where the disease is commonly found.

Treatment

The treatment for Lyme disease is antibiotic therapy; however, overprescribing of antibiotics can lead to serious problems, so the decision to treat must be made

with care. Disease organisms can develop resistance to families of medications over time, rendering the drugs useless. Furthermore, testing and treatments can be expensive. If a patient has strong indications of Lyme disease (symptoms and medical history), the doctor will probably begin treatment on the presumption of this disease. The American College of Physicians recommends treatment for a patient with a rash resembling EM or who has arthritis, a history of an EM-type rash, and a previous tick bite.

The benefits of treating early must be weighed against the risks of over treatment. The longer a patient is ill with lyme disease before treatment, the longer the course of therapy must be, and the more aggressive the treatment. The development of opportunistic organisms may produce other symptoms. For example, after long-term antibiotic therapy, patients can become more susceptible to yeast infections. Treatment may also be associated with adverse drug reactions.

For most patients, oral antibiotics (doxycycline or amoxicillin) are prescribed for 21 days. When symptoms indicate nervous system involvement or a severe episode of Lyme disease, intravenous antibiotic (ceftriaxone) may be given for 14-30 days. Some physicians consider intravenous ceftriaxone the best therapy for any late manifestation of disease, but this is controversial. **Corticosteroids** (oral) may be prescribed if eye abnormalities occur, but they should not be used without first consulting an eye doctor.

The doctor may have to adjust the treatment regimen or change medications based on the patient's response. Treatment can be difficult because *Borrelia burgdorferi* comes in several strains (some may react to different antibiotics than others) and may even have the ability to switch forms during the course of infection. Also, *Borrelia burgdorferi* can shut itself up in cell niches, allowing it to hide from antibiotics. Finally, antibiotics can kill *Borrelia burgdorferi* only while it is active rather than dormant.

Alternative treatment

Supportive therapies may minimize symptoms of LD or improve the immune response. These include vitamin and nutritional supplements, mostly for chronic fatigue and increased susceptibility to infection. For example, yogurt and *Lactobacillus acidophilus* preparations help fight yeast infections, which are common in people on long-term antibiotic therapy. In addition, botanical medicine and **homeopathy** can be considered to help bring the body's systems back to a state of health and well being. A Western herb, spilanthes (*Spilanthes* spp.), may be effective in treating diseases like LD that are caused by spirochetes (spiral-shaped bacteria).

Prognosis

If aggressive antibiotic therapy is given early, and the patient cooperates fully and sticks to the medication schedule, recovery should be complete. Only a small percentage of lyme disease patients fail to respond or relapse (have recurring episodes). Most long-term effects of the disease result when diagnosis and treatment is delayed or missed. Co-infection with other infectious organisms spread by ticks in the same areas as *Borrelia burgdorferi* (**babesiosis** and **ehrlichiosis**, for instance) may be responsible for treatment failures or more severe symptoms. Lyme disease has been responsible for deaths, but they are rare.

Prevention

Get vaccinated

A vaccine against Lyme disease was approved by the FDA in 1999. The vaccine, called LYMErix, appears to work by stimulating the production of antibodies in human blood that kill Lyme disease spirochetes in the gut of the tick when the tick feeds on a vaccinated person. The vaccine is given in three doses over a one-year period; the first dose is followed by a second dose one month later, and a third dose a year after the first. The doses should be timed so that the second and third doses are given several weeks before the beginning of spring. It is not known how long the vaccine protects people against Lyme disease.

Household pets can get lyme disease and develop the same joint pains and fever as humans, but dogs at least can also be protected by **vaccination**. As of 1999, there are three lyme vaccines available for dogs, called LymeVax, Galaxy Lyme, and Canine Recombinant lyme. Healthy dogs nine weeks or older can be vaccinated. There is no vaccine available as yet for cats.

Although LYMErix protects most people, it is not 100% effective against Lyme disease. It should not be considered a substitute for other preventive measures. The best prevention strategy is through minimizing risk of exposure to ticks and using personal protection precautions.

Minimize risk of exposure

Precautions to avoid contact with ticks include moving leaves and brush away from living quarters. Most important are personal protection techniques when outdoors, such as:

- spraying tick repellent on clothing and exposed skin.
- wearing light-colored clothing to maximize ability to see ticks

- tucking pant legs into socks or boot top
- checking children and pets frequently for ticks

In highly tick-populated areas, each individual should be inspected at the end of the day to look for ticks.

Minimize risk of disease

The two most important factors are removing the tick quickly and carefully, and seeking a doctor's evaluation at the first sign of symptoms of Lyme disease. When in an area that may be tick-populated:

- check for ticks, particularly in the area of the groin, underarm, behind ears, and on the scalp
- stay calm and grasp the tick as near to the skin as possible, using a tweezer
- to minimize the risk of squeezing more bacteria into the bite, pull straight back steadily and slowly
- do not try to make the tick back out by using vaseline, alcohol, or a lit match
- place the tick in a closed container (for species identification later, should symptoms develop) or dispose of it by flushing
- see a physician for any sort of rash or patchy discoloration that appears three to 30 days after a tick bite

Medical studies to date do not support the preventative use of antibiotics after a tick bite, even if the tick has been identified as a deer tick. The risk of Lyme disease after a deer tick exposure appears to be quite low.

Resources

BOOKS

"Bacterial Diseases: Lyme Disease." In *The Merck Manual of Diagnosis and Therapy*, edited by Mark H. Beers, MD, and Robert Berkow, MD. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

Territo, J., and D. V. Lang. *Coping With Lyme Disease: A Practical Guide to Dealing With Diagnosis and Treatment*. Henry Holt, 1997.

Vanderhoof-Forschne, K. *Everything You Need to Know About Lyme Disease and Other Tick-Borne Disorders*. New York: John Wiley & Sons, 1997.

PERIODICALS

American College of Physicians/American Society of Internal Medicine. "Lyme Disease: A Patient's Guide." ACP/ASIP, 1996-2001. <http://www.acponline.org/lyme/patient>.

"Breakthrough of the Year: The Runners-Up." *Science* 278(December 19, 1997): 2039.

Lewis, Carol. "New Vaccine Targets Lyme Disease." *FDA Consumer Magazine* May-June 1999. FDA Publication No. 99-1304.

KEY TERMS

Blood-brain barrier—A blockade of cells separating the circulating blood from elements of the central nervous system (CNS); it acts as a filter, preventing many substances from entering the central nervous system.

Cerebrospinal fluid—Clear fluid found around the brain and spinal cord and in the ventricles of the brain.

Erythema migrans (EM)—A red skin rash that is one of the first signs of Lyme disease in about 75% of patients.

Lyme borreliosis—Another name for Lyme disease.

Spirochete—A bacterium shaped like a loosely coiled spiral. The organism that causes Lyme disease is a spirochete.

Vector-borne—Delivered from one host to another, as in an insect or tick bearing an organism causing an infectious disease.

ORGANIZATIONS

American Lyme Disease Foundation, Inc. Mill Pond Offices, 293 Route 100, Suite 204, Somers, NY 10589. 800-876-LYME. <http://www.w2.com/docs2/d5/lyme.html>.

Centers for Disease Control, Washington, DC. Lyme Disease Information Voice Information System. (404) 332-4555. <http://www.cdc.gov/ncidod/dvbid/lymeinfo.htm>.

The Lyme Disease Network of NJ, Inc. 43 Winton Road, East Brunswick, NJ 08816. <http://www.lymenet.org>.

National Institutes of Health Lyme Lines, National Institute of Allergy and Infectious Diseases. Box AMS, 9000 Rockville Pike, Bethesda, MD 20891. <http://www.medlineplus.nlm.nih.gov/medlineplus/lymedisease.html>.

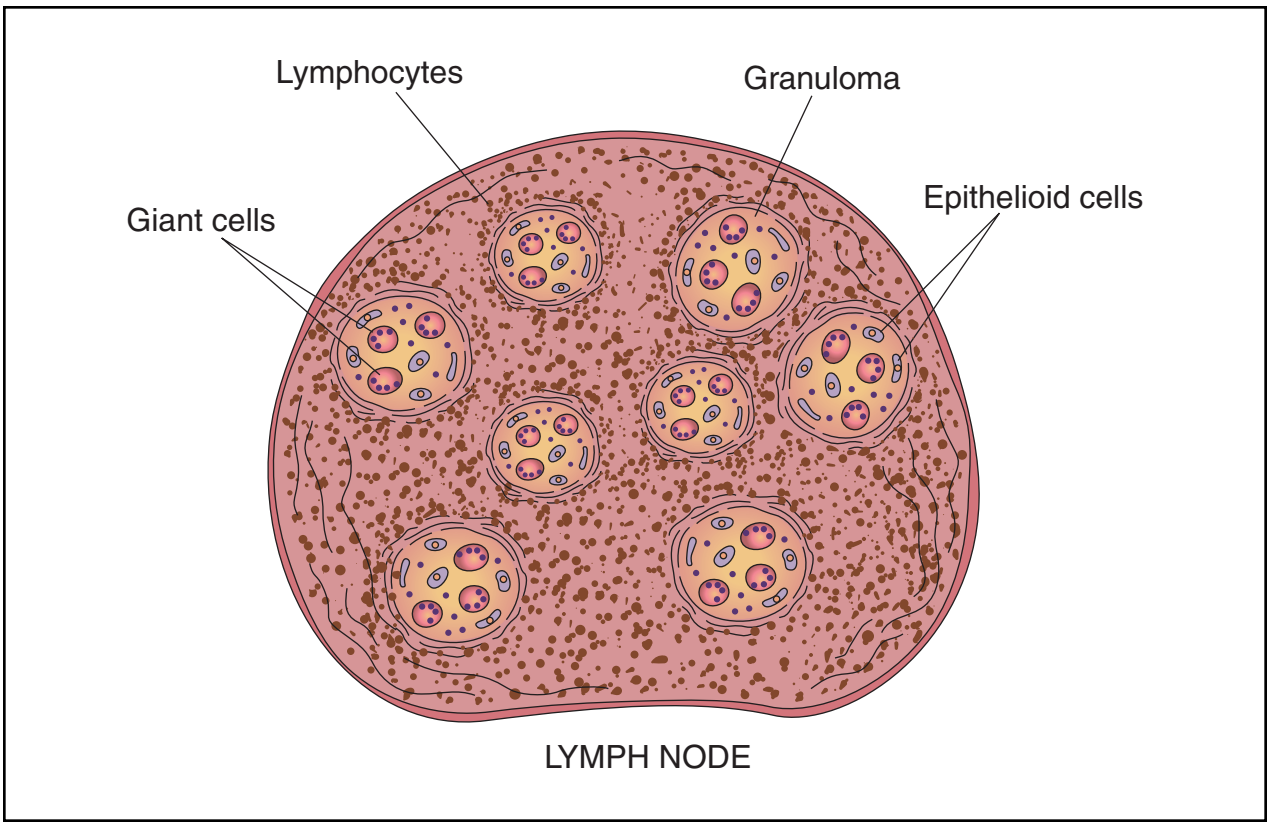
Rebecca J. Frey, PhD

Lymph node angiogram *see* **Lymphangiography**

Lymph node biopsy

Definition

A lymph node biopsy is a procedure in which all or part of a lymph node is removed and examined to determine if there is **cancer** within the node.



Lymph node biopsy is a procedure in which a sample of lymph node tissue is removed for laboratory analysis. It is generally performed on an outpatient basis. *(Illustration by Electronic Illustrators Group.)*

Purpose

The lymph system is the body's primary defense against infection. It consists of the spleen, tonsils, thymus, lymph nodes, lymph vessels, and the clear, slightly yellow fluid called lymph. These components produce and transport white blood cells called lymphocytes and macrophages that rid the body of infection. The lymph system is also involved in the production of antibodies. Antibodies are proteins that fight bacteria, viruses, and other foreign materials that enter the body.

The lymph vessels are similar to veins, only instead of carrying blood as veins do, they circulate lymph to most tissues in the body. Lymph nodes are about 600 small, bean-shaped collections of tissue found along the lymph vessel. They produce cells and proteins that fight infection, and clean and filter lymph. Lymph nodes are sometimes called lymph glands, although they are not true glands. When someone talks about having swollen glands, they are actually referring to lymph nodes.

Normal lymph glands are no larger than 0.5 in (1.3 cm) in diameter and are difficult to feel. However, lymph nodes can enlarge to greater than 2.5 in (6 cm) and can become sore. Most often the swelling is caused by an infection, but it can also be caused by cancer.

Cancers can metastasize (spread) through the lymph system from the site of the original tumor to distant parts of the body where secondary tumors are formed. The purpose of a lymph node biopsy is to determine the cause of the swelling and/or to see if cancer has begun to spread through the lymph system. This information is important in staging the cancer and devising a treatment plan.

Precautions

Women who are pregnant should inform their doctor before a lymph node biopsy, although **pregnancy** will not affect the results.

Description

There are three kinds of lymph node biopsy. Sentinel lymph node mapping and biopsy is a promising new technique that is discussed in its own entry. Fine needle aspiration (FNA) biopsy, often just called needle biopsy, is done when the lymph node of interest is near the surface of the body. A hematologist (a doctor who special-

izes in blood diseases) usually performs the test. In FNA biopsy, a needle is inserted through the skin and into the lymph node, and a sample of tissue is drawn out of the node. This material is preserved and sent to the laboratory for examination.

Advantages of a needle biopsy are that the test is minimally invasive. Only a local anesthetic is used, the procedure generally takes less than half an hour, and there is little **pain** afterwards. The disadvantage is that cancer may not be detected in the small sample of cells removed by the needle.

Open lymph node biopsy is a surgical procedure. It is done by a surgeon under general anesthesia on lymph nodes in the interior of the body and under local anesthesia on surface lymph nodes where FNA biopsy is considered inadequate. Once there is adequate anesthesia, the surgeon makes a small cut and removes either the entire lymph node or a slice of tissue that is then sent to the laboratory for examination. Results in both kinds of biopsies take one to three days.

Open biopsy can be advantageous in that it is easier to detect and identify the type of cancer in a large piece of tissue. Also, lymph nodes deep in the body can be sampled. Disadvantages include a longer recovery time, soreness at the biopsy site for several days, and the use of deeper anesthesia, increasing the risks to the patient. The procedure is done in a hospital or outpatient surgery center and takes about an hour, with additional time to recover from general anesthesia.

Preparation

No particular preparation is necessary for a needle biopsy. For an open biopsy, patients need standard preoperative blood tests and other tests to evaluate general health. The doctor should be informed about any medications (prescription, non-prescription, or herbal) the patient is taking, as well as past bleeding problems or **allergies** to medication or anesthesia.

Aftercare

Little aftercare is needed in a needle biopsy other than a bandage to keep the biopsy site clean. Patients who have general anesthesia for an open biopsy often feel drowsy and tired for several days following the procedure, and should not plan to drive home after biopsy. The incision site must be kept clean and dry, and a follow-up visit to check on healing is usually necessary.

Risks

There are few risks associated with lymph node biopsy. The main risks are excessive bleeding (usually only in people with blood disorders) and allergic reaction to general anesthesia (rare). Occasionally the biopsy site becomes infected.

KEY TERMS

Lymph nodes—Small, bean-shaped organs located throughout the lymphatic system. The lymph nodes store special cells that can trap cancer cells or bacteria that are traveling through the body in lymph. Also called lymph glands.

Lymphocytes—Small white blood cells that bear the major responsibility for carrying out the activities of the immune system; they number about 1 trillion.

Malignant—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

Spleen—An organ located at the left side of the stomach that acts as a reservoir for blood cells and produces lymphocytes and other products involved in fighting infection.

Thymus—An organ near the base of the neck that produces cells that fight infection. It is at its largest at puberty, then declines in size and function during adult life.

Tonsils—Small masses of tissue at the back of the throat.

Normal results

Normal lymph nodes are small and flat. When examined under the microscope, they show no signs of cancer or infection.

Abnormal results

Abnormal lymph nodes are usually enlarged and contain cancerous (malignant) cells and/or show signs of infection.

Resources

BOOKS

Ioachim, H. *Lymph Node Pathology.* Philadelphia: Lippincott Williams & Wilkins, 1993.

ORGANIZATIONS

American Cancer Society. National Headquarters, 1599 Clifton Road NE, Atlanta, GA 30329. 800(ACS)-2345).<http://www.cancer.org>.

Cancer Information Service. National Cancer Institute, Building 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800)4-CANCER. <http://www.nci.nih.gov/cancerinfo>.

OTHER

ThriveOnline; 12 June 2001 <http://thriveonline.oxygen.com/medical/library/article/003933.html>.

Tish Davidson

Lymphadenitis

Definition

Lymphadenitis is the inflammation of a lymph node. It is often a complication of a bacterial infection of a wound, although it can also be caused by viruses or other disease agents. Lymphadenitis may be either generalized, involving a number of lymph nodes; or limited to a few nodes in the area of a localized infection. Lymphadenitis is sometimes accompanied by lymphangitis, which is the inflammation of the lymphatic vessels that connect the lymph nodes.

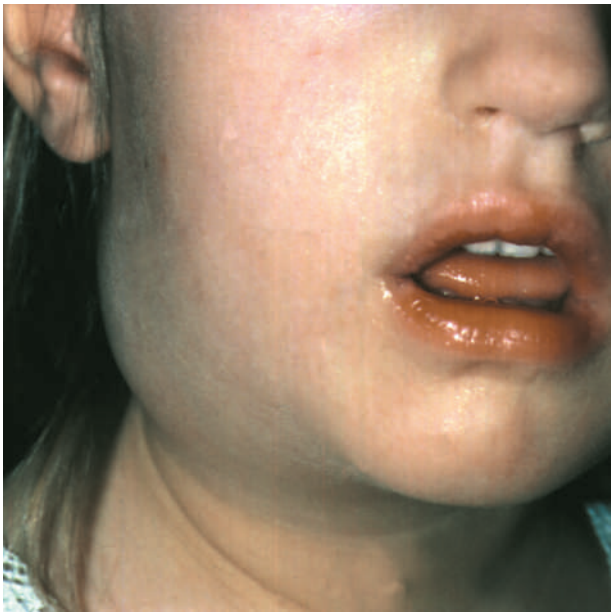
Description

Lymphadenitis is marked by swollen lymph nodes that are painful, in most cases, when the doctor touches them. If the lymphadenitis is related to an infected wound, the skin over the nodes may be red and warm to the touch. If the lymphatic vessels are also infected, there will be red streaks extending from the wound in the direction of the lymph nodes. In most cases, the infectious organisms are hemolytic *Streptococci* or *Staphylococci*. Hemolytic means that the bacteria produce a toxin that destroys red blood cells.

The extensive network of lymphatic vessels throughout the body and their relation to the lymph nodes helps to explain why bacterial infection of the nodes can spread rapidly to or from other parts of the body. Lymphadenitis in children often occurs in the neck area because these lymph nodes are close to the ears and throat, which are frequent locations of bacterial infections in children.

Causes and symptoms

Streptococcal and staphylococcal bacteria are the most common causes of lymphadenitis, although viruses, protozoa, rickettsiae, fungi, and the **tuberculosis** bacillus can also infect the lymph nodes. Diseases or disorders that involve lymph nodes in specific areas of the body include rabbit **fever** (**tularemia**), **cat-scratch disease**, **lymphogranuloma venereum**, **chancroid**, **genital herpes**, infected **acne**, dental abscesses, and bubonic **plague**. In children, **tonsillitis** or bacterial sore throats are the most common causes of lymphadenitis in the neck area. Diseases that involve lymph nodes throughout the body include mononucleosis, **cytomegalovirus infection**, **toxoplasmosis**, and **brucellosis**.



Swollen lymph node glands in a young girl's neck. *(Custom Medical Stock Photo. Reproduced by permission.)*

The early symptoms of lymphadenitis are swelling of the nodes caused by a buildup of tissue fluid and an increased number of white blood cells resulting from the body's response to the infection. Further developments include fever, often as high as 101-102°F (38-39°C) together with chills, loss of appetite, heavy perspiration, a rapid pulse, and general weakness.

Diagnosis

Physical examination

The diagnosis of lymphadenitis is usually based on a combination of the patient's history, the external symptoms, and laboratory cultures. The doctor will press (palpate) the affected lymph nodes to see if they are sore or tender. Swollen nodes without soreness are often caused by cat-scratch disease. In children, the doctor will need to rule out **mumps**, tumors in the neck region, and congenital cysts that resemble swollen lymph nodes.

Although lymphadenitis is usually diagnosed in lymph nodes in the neck, arms, or legs, it can also occur

in lymph nodes in the chest or abdomen. If the patient has acutely swollen lymph nodes in the groin, the doctor will need to rule out a **hernia** in the groin that has failed to reduce (incarcerated inguinal hernia). Hernias occur in 1% of the general population; 85% of patients with hernias are male.

Laboratory tests

The most significant tests are a white blood cell count (WBC) and a **blood culture** to identify the organism. A high proportion of immature white blood cells indicates a bacterial infection. Blood cultures may be positive, most often for a species of staphylococcus or streptococcus. In some cases, the doctor may order a biopsy of the lymph node.

Treatment

Medications

The medications given for lymphadenitis vary according to the bacterium or virus that is causing it. If the patient also has lymphangitis, he or she will be treated with **antibiotics**, usually penicillin G (Pfizerpen, Pentids), nafcillin (Nafcil, Unipen), or **cephalosporins**. Erythromycin (Eryc, E-Mycin, Erythrocin) is given to patients who are allergic to penicillin.

Supportive care

Supportive care of lymphadenitis includes resting the affected limb and treating the area with hot moist compresses.

Surgery

Cellulitis associated with lymphadenitis should *not* be treated surgically because of the risk of spreading the infection. Pus is drained only if there is an **abscess** and usually after the patient has been started on antibiotic treatment. In some cases, a biopsy of an inflamed lymph node is necessary if no diagnosis has been made and no response to treatment has occurred.

Prognosis

The prognosis for recovery is good if the patient is treated promptly with antibiotics. In most cases, the infection can be brought under control in three or four days. Patients with untreated lymphadenitis may develop blood **poisoning** (septicemia), which is sometimes fatal.

Prevention

Prevention of lymphadenitis depends on prompt treatment of bacterial and viral infections.

KEY TERMS

Hemolytic—Able to break down or dissolve red blood cells. The bacteria that cause lymphadenitis are hemolytic.

Hernia—The bulging of a part of the intestine or other organ through its surrounding wall of tissue. Most hernias are in the abdominal cavity. An inguinal hernia is located in the groin area.

Lymph nodes—The glandlike masses of tissue in the lymphatic system that contain lymphocytes. The lymph nodes also filter lymph, which is a clear yellowish tissue fluid that carries lymphocytes and fats throughout the body.

Lymphangitis—Inflammation of the lymphatic vessels. It often occurs together with lymphadenitis.

Septicemia—The presence of bacteria and their toxins in the bloodstream. Septicemia is sometimes called blood poisoning.

Staphylococcus—Any of several species of spherical bacteria that occur in groups of four or irregular clusters. *Staphylococci* frequently cause skin infections.

Streptococcus—Any of several species of bacteria that are spherical in shape and form pairs or chains. *Streptococci* cause scarlet fever, tonsillitis, and pneumonia, and are often involved in lymphadenitis.

Resources

BOOKS

Berman, Stephen, and Ken Chan. "Ear, Nose, & Throat." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Grossi, Carlo E., and Peter M. Lydyard. "Lymph Nodes." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Hall, Joseph G. "Lymphatic System." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

"Infectious Disease: Superficial Infections." In *The Merck Manual of Diagnosis and Therapy.* 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

"Blood Vessels & Lymphatics." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Lymphangiography

Definition

Lymphangiography, or lymph node angiogram, is a test which utilizes x-ray technology, along with the injection of a contrast agent, to view lymphatic circulation and lymph nodes for diagnostic purposes.

Purpose

The lymphatic system is a one way circulation that channels tissue fluid back into the heart. The watery fluid called lymph seeps out of the blood into tissues, and while journeying back to the heart, it picks up germs, **cancer** cells, and some waste products. Lymph passes through the lymph nodes, which are major arsenals of immune defense that attack germs carried in the lymph. Cancer cells are also subject to attack in lymph nodes.

Cancers of the lymph system, such as **Hodgkin's disease** and non-Hodgkin's lymphomas, spread throughout the body. Treatment often depends upon finding all the disease and directing radiation to each location. Planning other kinds of treatment, such as surgery or **chemotherapy**, may also require that the full extent of the disease be known.

The lymphatic circulation may become clogged by infection, injury, or several other types of cancer that have spread through lymphatic channels. Swelling, sometimes massive, can result from blocked lymphatics. The most outstanding example of this is the tropical disease **filariasis**, which results in the swelling of the legs termed elephangiasis.

Lymphangiography gives precise information on the extent and location of lymph vessels and lymph nodes. Oftentimes, it is performed to evaluate the extent of a lymphatic cancer. Rarely, it is a tool, which aids surgeons attempting to reconstruct the lymphatics.

Precautions

Lymphangiography should not be performed on patients with dye or shellfish **allergies** or on patients with chronic lung disease, kidney disease, heart disease, or liver disease.

Description

A lymphangiogram begins by injecting a blue dye into a hand or foot. The lymph system picks up dye, which in turn will highlight the lymph vessels. This process may take a full day. When the lymphatic channel is clearly visible, the radiologist will insert an even tinier needle into that vessel and inject a contrast agent. X rays outline the journey of the contrast agent as it travels to the heart through lymph vessels and nodes.

KEY TERMS

Contrast agent—A substance that makes shadows on x rays.

Filariasis—A tropical disease caused by worms that live in lymph channels.

Hodgkin's disease—A cancer of the lymphatic system.

Lymphoma—A type of lyphatic cancer.

Preparation

Unless a dye allergy is suspected, no special preparation is need. If an allergy is suspected, a non-ionic contrast agent can be administered instead.

Aftercare

Prior to suture removal seven to 10 days after the procedure, the patient should watch for any sign of infection around the site.

Risks

Lipid **pneumonia** can occur if the contrast agent penetrates the thoracic duct. An allergic reaction to the contrast agent is possible, causing a range of symptoms that can range from innocuous to life threatening.

Resources

BOOKS

Merrill, Vinta. "Lymphangiography." In *Atlas of Roentgenographic Positions and Standard Radiologic Procedures*. Saint Louis: The C. V. Mosby Co., 1975.

J. Ricker Polsdorfer, MD

Lymphedema

Definition

Lymphedema is the swelling of tissues (**edema**), usually the feet and legs, due to lymphatic obstruction.

Description

Lymphatic fluid seeps out of the blood circulation into the tissues. It returns to the heart through separate channels called lymphatics, carrying waste products and germs. On its way to the heart, it passes through lymph nodes, where infecting germs (including some cancers) are attacked by the body's defense mechanisms.

If lymphatic channels are obstructed or inadequate, fluid backs up and causes edema. Tissue fluid can also return to the circulation through tissues, without using the lymphatics, but gravity hinders this flow. So lymphedema is usually confined to the feet and legs.

Causes and symptoms

There are several types of congenital abnormalities associated with other **birth defects** of the lymphatics, which cause this condition. One in 10,000 people have this type of lymphedema.

Lymphatics can be damaged or obstructed by many different agents. Repeated bouts of blood **poisoning** can scar the vessels. Surgery to remove cancerous lymph nodes or **radiation therapy** can damage them. **Cancer** itself, as it invades the lymph system, as well as several other infectious and inflammatory conditions, can result in blockage of lymph flow. The most common worldwide cause of lymphedema is a group of worms known as filaria. Filaria can be found in most of the developing regions of the world. They enter humans through insect bites, mostly mosquitoes, and take up residence in lymphatic channels, irritating them enough to scar them and impair their ability to carry lymph. Long-standing lymphatic **filariasis** can cause massive swelling of the legs, earning the name **elephantiasis**.

Diagnosis

Since other types of swelling may look similar to lymphedema, precise diagnostic tools must be used. Ultrasound, **computed tomography scans** (CT), and **magnetic resonance imaging** (MRI) scans may help with diagnosis. **Lymphangiography** may be needed to clarify the cause.

Treatment

Physical activity can pump some of the fluid out of the tissues. Compression stockings are of some value, as are devices that actively squeeze fluid out of tissues. **Diuretics** may alleviate some of the edema. Because the ability of the skin to defend itself is hampered by the swelling, infections are more common. It is therefore important to care for **wounds** and to treat infections early.

KEY TERMS

Blood poisoning—Infection that has escaped local defenses and spread into the circulation.

When caused by infection, lymphedema can be treated by eliminating the underlying infection with **antibiotics**.

Reconstructing lymphatic channels using microvascular surgery has recently achieved some success.

Prognosis

If congenital, lymphedema is a progressive and lifelong condition. If secondary or caused by an underlying disease or infection, lymphedema can be treated by treating the disease.

Prevention

When traveling in regions known to have filaria, avoidance of insect bites is crucial. Prompt and effective treatment of the infection will prevent the consequences.

Resources

BOOKS

Creager, Mark A., and Victor A. Dzau. "Vascular Diseases of the Extremities." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Kontos, Hermes A. "Vascular Diseases of the Limbs." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

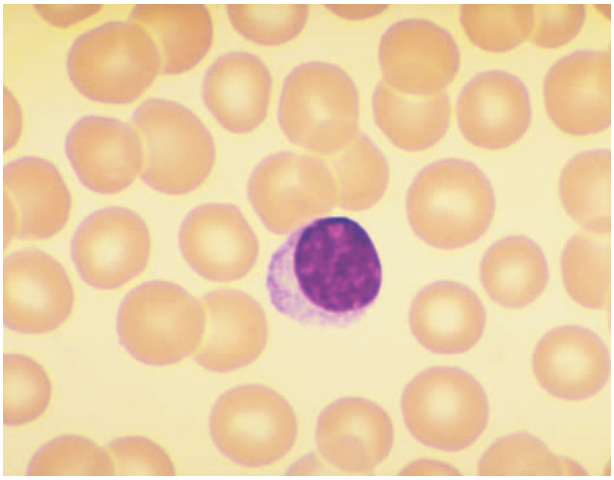
Nutman, Thomas B., and Peter F. Weller. "Filariasis and Related Infections." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Lymphocyte typing

Definition

Lymphocyte typing focuses on identifying the numbers and relative percentages of lymphocytes in an individual's bloodstream. Lymphocytes, primarily T cells and B cells, are types of white blood cells, the underlying supports of the immune system in the bloodstream.



A lymphocyte cell. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission.)*

Purpose

Determining the numbers and relative percentages of T cells and B cells provides information on the state of a person's immune system. By comparing these values to normal numbers and percentages, the presence of disease and the side effects of certain drugs can be revealed. Lymphocyte typing can also show whether a person has been exposed to certain poisonous substances.

Description

To do a white blood cell count, a small amount of blood is drawn from a vein. The total number of white blood cells is calculated, either through microscopic examination of a blood smear or by using automated counting equipment. For a white blood cell count with differential, 100 white blood cells are counted and the proportion of each type is calculated. Since T cells and B cells have similar appearances, a differential can only give the proportion of lymphocytes in the blood, not the proportion of specific lymphocyte types.

For more specific information on B cells and T cells, it is necessary to divide the blood into its separate components. In this procedure, a tube of blood is placed in a centrifuge, a piece of equipment that spins the tube in circles at high speed. The force generated by the spinning causes the various elements in the bloodstream to settle at different levels of the tube.

The lymphocytes are extracted from the tube and treated with special dyes, or stains. Each stain is equipped with an antibody portion that adheres to a specific type of lymphocyte, such as a B cell or a T cell. The stains make the cells visible to an automated counting machine, called a flow cytometer. Based on the number of times the machine detects a particular stain, it can calculate the number of the associated cell type. This procedure can also be used to classify T cells and B cells into their subtypes.

Preparation

If possible, a person should avoid eating a heavy meal within hours of the test or engaging in strenuous **exercise** for the 24 hours preceding the blood test.

Normal results

In general, normal levels of white blood cells vary slightly by age and gender. Normal values are lower in children under the age of 15 and in young adults between the ages of 20 and 30. After age 30, men have slightly higher levels of white blood cells than women.

Normal adult levels of white blood cells are 4,500-11,000 cells per microliter of blood. Lymphocytes account for approximately 25-45% of the total white blood cell count; the normal range is 1,000-4,800 lymphocytes per microliter of blood. Of the total lymphocytes, 60-80% are T cells and approximately 15% are B cells. (There are two other types of lymphocytes; natural killer and K-type; that constitute a minor proportion of the total lymphocyte numbers.)

Abnormal results

A higher-than-normal level of lymphocytes is called lymphocytosis. Lymphocytosis occurs if a person has a viral, bacterial, or other type of infection. It can also occur with certain blood disorders, such as leukemia.

Lower-than-normal levels of lymphocytes is called lymphopenia. Lymphopenia can be an indicator of certain cancers, bone marrow failure, or immune system deficiency. Medical treatments, such as **chemotherapy** and **radiation therapy**, can also deplete the body's supply of lymphocytes, as can exposure to poisonous substances.

Resources

BOOKS

Corbett, Jane Vincent. *Laboratory Tests & Diagnostic Procedures with Nursing Diagnoses*. 4th ed. Stamford: Appleton & Lange, 1996.

Janeway, Charles A., and Paul Travers. *Immunobiology: The Immune System in Health and Disease*. 2nd ed. New York: Garland Publishing, Inc., 1996.

Malarkey, Louise M., and Mary Ellen McMorrow. *Nurse's Manual of Laboratory Tests and Diagnostic Procedures*. Philadelphia: W. B. Saunders Co., 1996.

KEY TERMS

Immune system—The body's system of defenses against infectious diseases.

Lymphocytosis—A condition in which the number of lymphocytes increases above normal levels.

Lymphopenia—A condition in which the number of lymphocytes falls below normal levels.

White blood cell—A class of cells in the blood that form the foundation of the body's immune system.

Turgeon, Mary Louise. *Immunology & Serology in Laboratory Medicine*. St. Louis: Mosby-Year Book, Inc., 1996.

Julia Barrett

Lymphocytic choriomeningitis

Definition

Lymphocytic choriomeningitis (LCM) is a viral infection of the membranes surrounding the brain and spinal cord and of the cerebrospinal fluid.

Description

Lymphocytic choriomeningitis virus infection is relatively rare and recovery usually occurs spontaneously within a couple of weeks. Many cases are probably not even identified because the symptoms range from extremely mild to those resembling severe flu. A few patients develop symptoms of **meningitis**. In some rare cases, the LCM viral infection can spread throughout the central nervous system, and may even be fatal.

Causes and symptoms

LCM is caused by an arenavirus, which is an RNA virus and is a mild cousin in the family containing the much more threatening arenaviruses that cause hemmorrhagic **fever**. Humans acquire LCM virus from infected rodents by coming in contact with the animals or their excretions. Exposure to the virus is not as unlikely to occur as it seems, because the viral hosts can be common house mice and even pets, such as hamsters and chinchillas. Most cases of LCM occur in fall and winter, when mice seek warmth inside dwellings. Food and dust can become contaminated by the excretions of rodents infected with LCM virus. In 1997, French scientists alerted physicians to suspect LCM viral infection in people who had contact with Syrian hamsters.

KEY TERMS

Prodrome—Symptom(s) experienced prior to the onset of a disease. For example, visual disturbances may precede and signal the onset of a migraine headache.

The symptoms of LCM occur in two phases. The first (prodrome) stage can produce fever, chills, muscle aches, **cough**, and vomiting. In the second phase, characteristic meningitis symptoms of **headache**, stiff neck, listlessness, and **nausea and vomiting** may occur. In adults, complications are rare and recovery may even occur before the second phase.

The virus is not spread from person to person, except through **pregnancy**. LCM virus is one of the few viruses that can cross the placenta from mother to child during pregnancy and may be an underrecognized cause of congenital infection in newborns. Infection with cytomegalovirus, *Toxoplasma gondii*, or LCM virus can appear similar enough in infants to be confused when diagnosed. In cases that have been recognized among infants, LCM viral infection has a high mortality rate (about one-third of the babies studied died).

Diagnosis

LCM can be distinguished from bacterial meningitis by the history of prodrome symptoms and the period of time before meningitis symptoms begin, which is about 15-21 days for LCM.

Treatment

No antiviral agents exist for LCM virus. Treatment consists of supporting the patient and treating the symptoms until the infection subsides, generally within a few weeks.

Jill S. Lasker

Lymphocytic leukemia, acute *see* **Leukemias, acute**

Lymphocytic leukemia, chronic *see* **Leukemias, chronic**

Lymphocytopenia

Definition

Lymphocytopenia is a condition marked by an abnormally low level of lymphocytes in the blood. Lymphocytes are a specific type of white blood cell with important functions in the immune system.

Description

Lymphocytes normally account for 15-40% of all white cells in the bloodstream. They help to protect the body from infections caused by viruses or fungi. They also coordinate the activities of other cells in the immune system. In addition, lymphocytes fight **cancer** and develop into antibody-producing cells that neutralize the effect of foreign substances in the blood.

Lymphocytopenia is the result of abnormalities in the way lymphocytes are produced, make their way through the bloodstream, or are lost or destroyed. These conditions can result from congenital or drug-induced decreases in the body's ability to recognize and attack invaders.

Causes and symptoms

Lymphocytopenia has a wide range of possible causes:

- **AIDS** and other viral, bacterial, and fungal infections
- chronic failure of the right ventricle of the heart (This chamber of the heart pumps blood to the lungs.)
- hodgkin's disease and cancers of the lymphatic system
- a leak or rupture in the thoracic duct (The thoracic duct removes lymphatic fluid from the legs and abdomen.)
- leukemia
- side effects of prescription medications
- malnutrition (**Diets** that are low in protein and overall calorie intake may cause lymphocytopenia.)
- radiation therapy
- high **stress** levels
- trauma

The symptoms of lymphocytopenia vary. Lymphocytes constitute only a fraction of the body's white blood cells, and a decline in their number may not produce any symptoms. A patient who has lymphocytopenia may have symptoms of the condition responsible for the depressed level of lymphocytes.

Diagnosis

Lymphocytopenia is most often detected when blood tests are performed to diagnose other diseases.

KEY TERMS

B lymphocyte—A type of lymphocyte that circulates in the blood and lymph and produces antibodies when it encounters specific antigens. B lymphocytes are also called B cells.

Lymph—A clear yellowish fluid circulated by the lymphatic system. The lymph carries mostly lymphocytes and fats.

Lymphocyte—A specific type of white blood cell that is important in the production of antibodies.

Treatment

Treatment for lymphocytopenia is designed to identify and correct the underlying cause of the condition.

Drug-depressed lymphocyte levels usually return to normal a few days after the patient stops taking the medication.

A deficiency of B lymphocytes, which mature into antibody-producing plasma cells, can result in abnormally low lymphocyte levels. When the number of B lymphocytes is low, the patient may be treated with **antibiotics**, antifungal medications, antiviral agents, or a substance containing a high concentration of antibodies (gamma globulin) to prevent infection.

It is not usually possible to restore normal lymphocyte levels in AIDS patients. Drugs like AZT (azidothymidine, sold under the trade name Retrovir) can increase the number of helper T cells, which help other cells wipe out disease organisms.

Prognosis

Very low levels of lymphocytes make patients vulnerable to life-threatening infection. Researchers are studying the effectiveness of transplanting bone marrow and other cells to restore normal lymphocyte levels. **Gene therapy**, which uses the body's own resources or artificial substances to counter diseases or disorders, is also being evaluated as a treatment for lymphocytopenia.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Merck Manual of Medical Information: Home Edition. Ed. Robert Berkow, et al. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Maureen Haggerty

Lymphogranuloma venereum

Definition

Lymphogranuloma venereum (LGV) is a sexually transmitted systemic disease (STD) caused by a parasitic organism closely related to certain types of bacteria. It affects the lymph nodes and rectal area, as well as the genitals, in humans. The name comes from two Latin words that mean a swelling of granulation tissue in the lymph nodes resulting from sexual intercourse. Granulation tissue is tissue that forms during wound or ulcer healing that has a rough or lumpy surface.

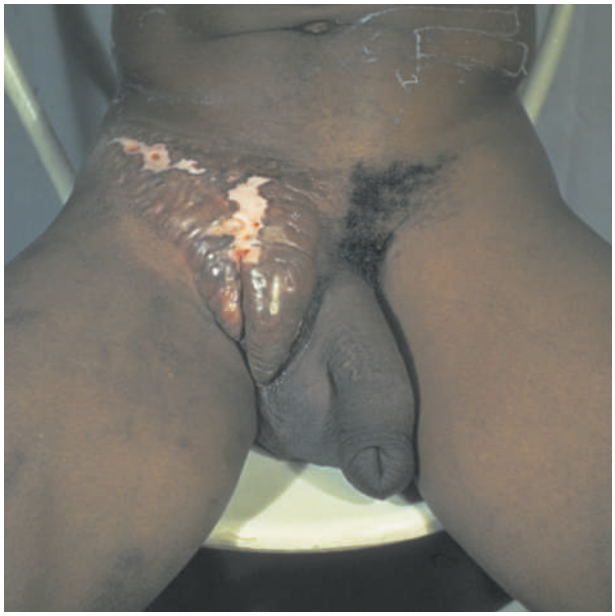
Description

Although LGV is easily treated in its early stages, it can produce serious complications in its later stages. LGV is most likely to occur among people living in tropical or subtropical countries and among military personnel or tourists in countries or large cities with high rates of the disease. Prostitutes play a major role in carrying and transmitting LGV, as was documented during an outbreak in Florida in the late 1980s. There are about 1,000 documented cases of LGV in the United States in an average year.

Causes and symptoms

LGV is caused by *Chlamydia trachomatis*, a globe-shaped parasitic organism that reproduces only inside of living cells. *C. trachomatis* has 17 subtypes and is responsible for a wide range of infections in both men and women; however, only subtypes L1, L2, and L3 cause lymphogranuloma venereum. The parasite has a two-part lifecycle. In the first stage, it is inert and can survive outside of cells. In its second stage, it lacks a cell wall and actively reproduces after gaining entry to a cell. As the chlamydia organism reproduces inside the cell, it pushes the nucleus aside and forms an inclusion that can be identified with tissue staining. LGV differs from other diseases caused by *C. trachomatis* in that it affects the body's lymphatic system and not just the moist tissues of the genital region. In humans, the chlamydia organism is transmitted through vaginal or anal intercourse, oral sex, or contact with fluid from open ulcers or infected tissues.

Lymphogranuloma venereum has three stages. In its primary stage, the disease is more likely to be detected in men; it may go unnoticed in women. After an incubation period of four to 30 days, a small painless ulcer or blister develops in the genital area. Second-stage LGV develops between one and six weeks later. In this stage, the infection spreads to the lymphatic system, forming buboes (swellings) in the lymph nodes of the groin area.



This man suffers from lymphogranuloma venereum, a venereal disease that is caused by the bacterium *Chlamydia trachomatis.* *(Photograph by Milton Reisch, M.D., Corbis Images. Reproduced by permission.)*

The buboes often merge, soften, and rupture, forming sinuses and fistulas (hollow passages and ducts) that carry an infectious bloody discharge to the outside of the body. Patients with second-stage LGV may also have **fever**, nausea, headaches, pains in their joints, skin **rashes**, and enlargement of the spleen or liver. Third-stage LGV, which is sometimes called anogenitorectal syndrome, develops in about 25% of patients. In men, this stage is usually seen in homosexuals. Third-stage LGV is marked by rectal **pain**, **constipation**, a discharge containing pus or bloody mucus, and the development of strictures (narrowing or tightening of a body passage) in the rectum or vagina.

LGV can have a number of serious complications. *C. trachomatis* infections of any subtype are associated with long-term fertility problems in women. Strictures in the rectum can completely close off the lower bowel, producing eventual rupture of the bowel and inflammation of the abdominal cavity. The patient can develop chronic abscesses or fistulae in the anal area or in the vagina in women. Long-term blockages in the lymph nodes can produce **elephantiasis**, a condition in which the patient's upper legs and groin area become greatly enlarged. Patients with chronic LGV infection have a higher risk of developing **cancer** in the inflamed areas.

Chronic LGV can be reactivated in patients who become infected with the **AIDS** virus. These patients develop open ulcers in the groin that are difficult to treat.

Diagnosis

The diagnosis of LGV is usually made on the basis of the patient's history, careful examination of the genital area and lymph nodes, and blood tests or cultures to confirm the diagnosis. In the early stages of the disease, the doctor will need to distinguish between LGV and such other STDs as **syphilis** and herpes. If the patient has developed buboes, the doctor will need to rule out **tuberculosis**, **cat-scratch disease**, bubonic **plague**, or **tularemia** (a disease similar to plague that is carried by rabbits and squirrels). If the patient has developed rectal strictures, the doctor will need to rule out tumors or colitis.

There are several blood tests that can be used to confirm the diagnosis of LGV. The most commonly used are the complement fixation (CF) test and the microimmunofluorescence (micro-IF) tests. Although the micro-IF test is considered more sensitive than the CF test, it is less widely available. An antibody titer (concentration) of 1:64 or greater on the CF test or 1:512 or greater on the micro-IF test is needed to make the diagnosis of LGV. In some cases, the diagnosis can be made from culturing *C. trachomatis* taken from samples of tissue fluid from ulcers or buboes, or from a tissue sample from the patient's rectum.

Treatment

LGV is treated with oral **antibiotics**, usually tetracycline or doxycycline for 10-20 days, or erythromycin or trimethoprim sulfamethoxazole for 14 days. Pregnant women are usually treated with erythromycin rather than the **tetracyclines**, because this class of medications can harm the fetus.

Patients who have developed second- and third-stage complications may need surgical treatment. The doctor can treat buboes by withdrawing fluid from them through a hollow needle into a suction syringe. This procedure is called aspiration. Fistulas and abscesses also can be treated surgically. Patients who develop elephantiasis are usually treated by plastic surgeons. Patients with rectal strictures may need surgery to prevent bowel obstruction and rupture into the abdomen.

Prognosis

The prognosis for recovery for most patients is good, with the exception of AIDS patients. Prompt treatment of the early stages of LGV is essential to prevent transmission of the disease as well as fertility problems and other serious complications of the later stages.

Prevention

Prevention of lymphogranuloma venereum has four important aspects:

KEY TERMS

Anogenitorectal syndrome—Another name for third-stage LGV.

Aspiration—A procedure in which pus or other fluid is removed from a body cavity through a hollow needle connected to a syringe.

Bubo—An inflamed swelling inside a lymph node, characteristic of second-stage LGV.

Elephantiasis—Abnormal enlargement of the legs and groin area caused by blockage of the lymphatic system, as a complication of LGV.

Fistula—A passageway formed by a disease or injury that drains fluid from an infected area to the outside or to other parts of the body.

Lymph—A clear yellowish fluid that circulates throughout the body, carrying white blood cells and fats. The system that produces and circulates lymph is called the lymphatic system; it includes lymph vessels, lymph nodes, the thymus gland, and the spleen.

Proctitis—Inflammation of the anus and rectum.

Stricture—An abnormal narrowing or tightening of a body passage. LGV can cause strictures to form in the patient's rectum, or in the vagina of female patients.

- Avoidance of casual sexual contacts, particularly with prostitutes, in countries with high rates of the disease.
- Observance of proper safeguards by health professionals. Doctors and other healthcare workers should wear gloves when touching infected areas of the patient's body or handling soiled dressings and other contaminated items. All contaminated materials and instruments should be double-bagged before disposing.
- Tracing and examination of an infected person's recent sexual contacts.
- Monitoring the patient for recurring symptoms for a period of six months after antibiotic treatment.

Resources

BOOKS

Chambers, Henry F. "Infectious Diseases: Bacterial & Chlamydial." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Chapel, Thomas A., and Johanna Chapel. "Lymphogranuloma Venereum." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.
Hill, Edward C. "Gynecology." In *Current Surgical Diagnosis and Treatment.* 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.
"Infectious Disease: Sexually Transmitted Diseases." In *The Merck Manual of Diagnosis and Therapy.* 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.
Thomas, Isabelle, et al. "Lymphogranuloma Venereum." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Rebecca J. Frey

Lymphomas *see* **Hodgkin's disease**
Lymphopenia *see* **Lymphocytopenia**
Lymphosarcomas *see* **Malignant lymphomas**

Lysergic acid diethylamide

Definition

Lysergic acid diethylamide (LSD), also known as "acid," belongs to a class of drugs known as hallucinogens, which distort perceptions of reality. LSD is the most potent mood- and perception-altering drug known: doses as small as 30 micrograms can produce effects lasting six to 12 hours.

Purpose

In the United States, LSD has no accepted medical use and its manufacture is illegal.

Description

LSD is produced synthetically from a fungus that grows on rye grass. This odorless, colorless, and slightly bitter-tasting chemical is generally ingested orally and absorbed from the gastrointestinal system. Manufacturers commonly distribute LSD in small squares of absorbent paper soaked with the drug, which users chew and swallow. Use of LSD and other hallucinogens by secondary school students has decreased since 1998, but has increased among older teens and young adults attending dance clubs and all-night raves, according to the National Institute on Drug Abuse.

LSD alters perceptions by disrupting the action of the neurotransmitter serotonin, although precisely how it does this is unclear. Studies suggest LSD acts on certain groups of serotonin receptors, and that its effects are most prominent in two brain regions: the cerebral cortex and the locus ceruleus. The cerebral cortex is involved in mood and perception, and the locus ceruleus receives sensory signals from all areas of the body. Natural hallucinogens resembling LSD, such as mescaline and psilocybin, have been used in social and religious rituals for thousands of years.

After its discovery in 1938, LSD was used experimentally to treat neuroses, narcotic **addiction**, **autism**, **alcoholism**, and terminally ill **cancer** patients, and to study the mechanisms of psychotic diseases like **schizophrenia**. Nearly 30 years after its discovery, manufacture, possession, sale, and use of LSD was restricted in the United States under the Drug Abuse Control Amendment of 1965.

LSD's effects generally begin within an hour of taking the drug and last for up to 12 hours. The drug is absorbed from the gastrointestinal tract, and circulated throughout the body and to the brain. It is metabolized in the liver and excreted in the urine about 24 hours after ingestion. Physical effects of LSD may include loss of appetite, sleeplessness, pupil dilation, **dry mouth**, salivation, **palpitations**, perspiration, nausea, **dizziness**, blurred vision, and **anxiety**, as well as increased body temperature, heartbeat, blood pressure, and blood sugar.

The major effects of LSD are emotional and sensory. Emotions may shift instantaneously from euphoria to confusion and despair, and users may feel as if they are experiencing several emotions simultaneously. Colors, smells, and sounds may be highly intensified, and time may appear to move very slowly. Sensory perceptions may blend in a phenomenon known as synesthesia, in which a person sees sounds, or smells colors, for example. Users may have out-of-body sensations, or may perceive their body has changed shape or merged with another person or object.

Precautions

Unlike **cocaine**, amphetamines, heroin, alcohol, and nicotine, LSD is not considered addictive, but it is considered dangerous; users are at risk for several short- and long-term side effects. LSD's effects are unpredictable and may vary with the amount ingested and the user's personality, mood, expectations, and surroundings. Users may experience enjoyable sensations on some "trips," and terrifying feelings of anxiety and despair on others. Most LSD-related deaths stem not from the LSD's physical effects on the body, but from the panicked reactions ensuing from intense LSD-triggered illusions.

KEY TERMS

Cerebral cortex—Brain region responsible for reasoning, mood, and perception.

Hallucinogen—A drug that distorts sensory perceptions and disturbs emotion, judgment, and memory.

Hallucinogen persisting perception disorder (HPPD)—The recurrence of LSD effects after the drug experience has ended.

Locus ceruleus—Brain region that processes sensory signals from all areas of the body.

Neurotransmitter—Chemical compound in the brain that transmits signals from one nerve cell to another.

Serotonin—A neurotransmitter that modulates the actions of other neurotransmitters in the brain.

Side Effects

Two long-term effects are associated with LSD use: **psychosis**, and hallucinogen persisting perception disorder (HPPD), also known as "flashbacks." The exact causes of these effects, including the mechanism by which LSD may cause them, is unknown. Chronic hallucinogen users or individuals with underlying personality problems are most vulnerable to these effects, but individuals with no history of psychological disorders have also experienced them. LSD-induced psychosis may include dramatic mood swings, loss of cognitive and communication skills, and **hallucinations**. Flashbacks generally involve seeing bright flashes, or halos or trails attached to moving objects after the LSD "trip" has ended. Flashbacks can last a few seconds or even several hours.

According to the Drug Abuse Warning Network (DAWN), the number of LSD-related hospital emergencies is low compared to those related to cocaine, heroin, **marijuana,** methamphetamine, and other illicit drugs. One reason for this trend may be that LSD currently sold on the black market is less potent than in the past. LSD dose strengths tend to range from 20 to 80 micrograms today, compared to 100 to 200 micrograms reported during the 1960s and early 1970s.

Interactions

LSD flashbacks can be spurred by use of drugs such as marijuana. Preliminary evidence suggests serotonin reuptake inhibitors like Prozac and Zoloft may also exacerbate the LSD flashback syndrome.

Resources

PERIODICALS

Aghajanian, G. K. and G. J. Marek. "Serotonin and Hallucinogens." *Neuropsychopharmacology* (1999): 16S-23S

Markel, H., A. Lee, R. Holmes, and E. Domino. "LSD Flashback Syndrome Exacerbated By Selective Serotonin Reuptake Inhibitor Antidepressants In Adolescents." *Journal of Pediatrics* (November 1994): 817-819.

ORGANIZATIONS

National Clearinghouse for Alcohol and Drug Information. 11426 Rockville Pike, Suite 200, Rockville, MD. 20852. (800) 729-6686. <http:\\www.health.org>.

National Institute on Drug Abuse. P.O. Box 30652, Bethesda, MD. 20824-0652. (888) 644-6432. <http:\\www.drug abuse.gov>.

U.S. Department of Justice, Drug Enforcement Administration. 2401 Jefferson Davis Highway, Alexandria, VA 22301. (888) 644-6432. <http:\\www.usdoj.gov/dea>.

Ann Quigley

M

Macular degeneration

Definition

Macular degeneration is the progressive deterioration of a critical region of the retina called the macula. The macula is a 3-5 mm area in the retina that is responsible for central vision. This disorder leads to irreversible loss of central vision, although peripheral vision is retained. In the early stages, vision may be gray, hazy, or distorted.

Description

Macular degeneration is the most common cause of legal blindness in people over 60, and accounts for approximately 11.7% of blindness in the United States. About 28% of the population over age 74 is affected by this disease.

Age-related macular degeneration (ARMD) is the most common form of macular degeneration. It is also known as age-related maculopathy (ARM), aged macular degeneration, and senile macular degeneration. Approximately 10 million Americans have some vision loss that is due to ARMD.

ARMD is subdivided into a dry (atrophic) and a wet (exudative) form. The dry form is more common and accounts for 70-90% of cases of ARMD. It progresses more slowly than the wet form and vision loss is less severe. In the dry form, the macula thins over time as part of the **aging** process and the pigmented retinal epithelium (a dark-colored cell layer at the back of the eye) is gradually lost. Words may appear blurred or hazy and colors may appear dim or gray.

In the wet form of ARMD, new blood vessels grow underneath the retina and distort the retina. These blood vessels can leak, causing scar tissue to form on the retina. The wet form may cause visual distortion and make straight lines appear wavy. A central blind spot develops. The wet type progresses more rapidly and vision loss is more pronounced. Treatments are available for some, but not most, cases of the wet form.

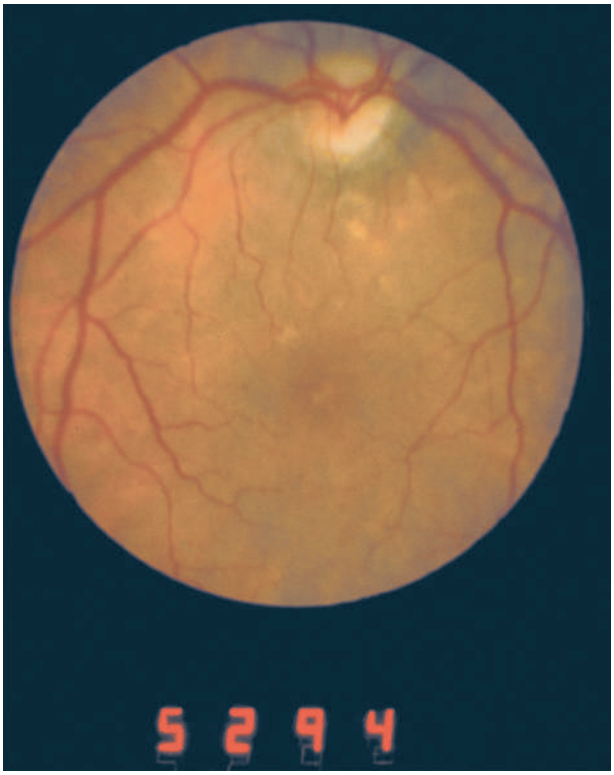
Other less common forms of macular degeneration include:

- Cystoid macular degeneration. Loss of vision in the macula due to fluid-filled areas (cysts) in the macular region. This may be a result of other disorders, such as aging, inflammation, or high myopia.
- Diabetic macular degeneration. Deterioration of the macula due to diabetes.
- Senile disciform degeneration (also known as Kuhnt-Junius macular degeneration). A specific and severe type of the wet form of ARMD that involves leaking blood vessels (hemorrhaging) in the macular region. It usually occurs in people over 40 years old.

Causes and symptoms

Age-related macular degeneration is part of the aging process. There may be a hereditary component. Having a family member with ARMD increases a person's risk for developing it. There is a slightly higher incidence in females. Whites and Asians are more susceptible to developing ARMD than blacks, in whom the disorder is rare.

ARMD is thought to be caused by hardening and blocking of the arteries (arteriosclerosis) in the blood vessels supplying the retina. Some of the same things that are bad for the heart are thought to contribute to the development of macular degeneration. These risk factors include **smoking** and a diet that is rich in saturated fat. Smokers have a risk of developing ARMD that is approximately 2.4-3 times that of non-smokers. Smoking increases the risk of developing wet-type ARMD, and may increases the risk of developing dry-type as well. Dietary fat also increase the risk. In one study of older (age 45-84) Americans, signs of early ARMD were 80% more common in the group who ate the most saturated fat compared to those who ate the least. Low consump-



A slit-lamp view showing macular degeneration of the eye. *(Custom Medical Stock Photo. Reproduced by permission.)*

tion of antioxidants, such as foods rich in vitamin A, is associated with a higher risk for developing ARMD. Consumption of moderate amounts of red wine and foods rich in vitamin A is associated with a lower risk. It is generally believed that exposure to ultraviolet (UV) light may contribute to disease development, but this has not been proven.

The main symptom of macular degeneration is a change in central vision. The patient may notice blurred central vision or a blank spot on the page when reading. The patient may notice visual distortion such as bending of straight lines. Images may appear smaller. Some patients notice a change in color perception and some experience abnormal light sensations. These symptoms may come on suddenly and become progressively more troublesome. Sudden onset of symptoms, particularly vision distortion, is an indication for immediate evaluation by an ophthalmologist.

Diagnosis

To make the diagnosis of macular degeneration, the doctor dilates the pupil with eye drops and examines the interior of the eye, looking at the retina for the presence of yellow bumps called drusen and for gross changes in the macula such as thinning. The doctor also administers a visual field test, looking for blank spots in the central vision. The doctor may call for fluorescein **angiography** (intravenous injection of fluorescent dye followed by visual examination and photography of the back of the eye) to determine if blood vessels in the retina are leaking.

A central visual field test called an Amsler grid is usually given to patients who are suspected of having ARMD. It is a grid printed on a sheet of paper (so it is easy to take home). When looking at a central dot on the page, the patient should call the doctor right away if any of the lines appear to be wavy or missing. This may be an indication of fluid and the onset of wet ARMD. Patients may also be asked to come in for more frequent checkups.

Treatment

While loss of vision cannot be reversed, early detection is important because treatments are available that may halt or slow the progression of the wet form of ARMD. Treatment for the dry form is not available as of 1998, but cell transplantation studies are under study.

In wet-type ARMD and in senile disciform macular degeneration, new capillaries grow in the macular region and leak. This leaking of blood and fluid causes a portion of the retina to detach. Blood vessel growth, called neovascularization, can be treated with laser photocoagulation in some cases, depending upon the location and extent of the growth. Argon or krypton lasers can destroy the new tissue and flatten the retina. This treatment is effective in about half the cases but results may be temporary. A concern with laser therapy is that the laser also destroys the photoreceptors in the treated area. If the blood vessels have grown into the fovea (a region of the macula responsible for fine vision), treatment may not be possible. Because capillaries can grow very quickly, this form of macular degeneration should be handled as an emergency and treated quickly. Patients who are experiencing visual distortion should seek help immediately.

Another form of treatment for the wet form of ARMD is **radiation therapy** with either x rays or a proton beam. Blood vessels that are proliferating (growing) are sensitive to treatment with low doses of ionizing radiation. Nerve cells in the retina are not growing and are insensitive, so they are not harmed by this treatment. External beam radiation treatment has shown promising results at slowing progression in limited, early trials. An alternative treatment is internal beam radiation therapy. For this treatment, the patient is given a local anesthetic and an applicator containing strontium 90 is inserted into the affected eye. This brief and localized radiation therapy prevents the growth of blood vessels.

Other therapies that are under study include treatment with alpha-interferon, thalidomide, and other drugs that slow the growth of blood vessels. Subretinal surgery also has shown promise in rapid-onset cases of wet ARMD. This surgery carries the risk of **retinal detachment**, hemorrhage, and acceleration of cataract formation. Other experimental treatments include photodynamic therapy (PDT). For this treatment, a photosensitizing dye is injected, followed by irradiation of the area of new blood vessel growth with a special, low-intensity diode laser. This treatment damages the cells in the blood vessel walls and causes them to stop growing.

A controversial treatment called rheotherapy involves pumping the patient's blood through a device that removes some proteins and fats. As of 1998, this had not been proven to be safe or effective.

Alternative treatment

Consumption of a diet rich in antioxidants (beta carotene and the mixed carotenoids that are precursors of vitamin A, **vitamins** C and E, selenium, and zinc), or taking antioxidant nutritional supplements, may help prevent macular degeneration, particularly if started early in life. Good dietary sources of antioxidants include citrus fruits, cauliflower, broccoli, nuts, seeds, orange and yellow vegetables, cherries, blackberries, and blueberries. Research has shown that nutritional therapy can prevent ARMD or slow its progression once established. Some doctors recommend taking beta carotene and zinc as a precautionary measure. Some vitamins are marketed specifically for the eyes.

Prognosis

The dry form of ARMD is self-limiting and eventually stabilizes. The loss of vision is permanent. The vision of patients with the wet form of ARMD often stabilizes or improves even without treatment, at least temporarily. However, after a few years, patients with the wet form of ARMD are usually left with only coarse peripheral vision remaining.

Many patients with macular degeneration lose their central vision permanently and may become legally blind. However, macular degeneration rarely causes total loss of vision. Peripheral vision is retained. The patient can compensate, to some extent, for the loss of central vision, even though macular degeneration may render them legally blind. Improved lighting and special low-vision aids may help even if sharpness of vision (visual acuity) is poor. Vision aids include special magnifiers that allow the patient to read and telescopic aids for long-distance vision. The use of these visual aids plus the retained peripheral vision usually allow the patient to remain independent. Registration as a legally blind person will enable a patient to obtain special services and considerations.

KEY TERMS

Drusen—Tiny yellow dots on the retina that can be soft or hard and that usually do not interfere with vision.

Fovea—A tiny pit in the macula that is responsible for sharp vision.

Neovascularization—Growth of new capillaries.

Photoreceptors—Specialized nerve cells (rods and cones) in the retina that are responsible for vision.

Retina—The light-sensitive membrane at the back of the eye that images are focused on. The retina sends the images to the brain via the optic nerve.

Prevention

Avoiding the risk factors for macular degeneration may help prevent it. This includes avoiding tobacco smoke and eating a diet low in saturated fat. Some other behaviors that may help reduce the risk of wet-type ARMD are eating a diet rich in green, leafy vegetables and yellow vegetables such as carrots, sweet potatoes, and winter squash; drinking moderate amounts of alcohol, such as one or two glasses of red wine a day; and taking an antioxidant vitamin supplement, especially vitamin A. Some vitamins may be toxic in large doses, so patients should speak with their doctors. Vitamins C and E have not been shown to reduce risk, nor did selenium in one large study. The use of zinc is controversial: some studies showed a benefit, others showed no benefit, and one actually showed an increased risk of ARMD with increased levels of zinc in the blood. Some doctors suggest that wearing UV-blocking sunglasses reduces risk. Use of estrogen in postmenopausal women is associated with a lower risk of developing ARMD.

Resources

BOOKS

Caird, F. I., and John Williamson. *The Eye and Its Disorders in the Elderly.* Bristol, England: Wright, 1986.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Eden, John. *The Physician's Guide to Cataracts, Glaucoma, and Other Eye Problems.* Yonkers, New York: Consumer Reports Books, a division of Consumers Union, 1992.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

PERIODICALS

"All the Better to See You." *Harvard Health Letter* 21, no. 3 (Jan. 1996): 8.

"Macular Degeneration." *Mayo Clinic Health Letter* 15, no. 6 (June, 1997): 4.

O'Shea, John. "Age-related Macular Degeneration: A Leading Cause of Blindness." *Medical Journal of Australia* 165, no. 10 (18 Nov. 1996): 561-4.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

Louann W. Murray, PhD

Macule *see* **Skin lesions**

Mad cow disease *see* **Creutzfeldt-Jakob disease**

Madura foot *see* **Mycetoma**

Maduromycosis *see* **Mycetoma**

Magnesium hydroxide *see* **Antacids**

Magnesium imbalance

Definition

A mineral found in the fluid that surrounds cells, magnesium (Mg) is an essential component of more than 300 enzymes that regulate many body functions. Imbalances occur when the blood contains more or less magnesium than it should.

Description

Magnesium is necessary for the formation and functioning of healthy bones, teeth, muscles, and nerves. It converts food into energy, builds proteins, and is instrumental in maintaining adequate levels of calcium in the blood. Magnesium helps prevent cardiovascular disease and irregular heartbeat, reduces the risk of bone loss (**osteoporosis**), and increases an individual's chance of surviving a **heart attack**. It may also help prevent **stroke** and lessen the effects of existing osteoporosis.

Fish, dairy products, leafy green vegetables, legumes, nuts, seeds, and grains are especially good sources of magnesium, but varying amounts of this mineral are found in all foods. Some is stored in the kidneys, and excess amounts are excreted in the urine or stools.

Magnesium deficiency (hypomagnesemia) or excess (hypermagnesemia) is rare, but either condition can be serious.

Causes and symptoms

Hypomagnesemia

Magnesium deficiency most often occurs in people who have been fed intravenously for a long time, whose diet doesn't contain enough magnesium, or who are unable to absorb and excrete the mineral properly.

Secreting too much aldosterone (the hormone that regulates the body's salt-fluid balance), ADH (a hormone that inhibits urine production), or thyroid hormone can cause hypomagnesemia.

Other factors associated with hypomagnesemia include:

- loss of body fluids as a result of stomach suctioning or chronic **diarrhea**
- cisplatin (a **chemotherapy** drug)
- long-term diuretic therapy
- hypercalcemia (abnormally high levels of calcium in the blood)
- diabetic acidosis (a condition in which the body's tissues have a higher-than-normal acid content)
- complications of bowel surgery
- chronic **alcoholism**
- malnutrition
- starvation
- severe **dehydration**

People who have hypomagnesemia usually experience loss of weight and appetite, bloating, and muscle **pain**, and they pass stools that have a high fat content. Also, they may be listless, disoriented, confused, and very irritable. Other symptoms of hypomagnesemia are:

- nausea
- vomiting
- muscle weakness
- tremor
- irregular heart beat
- delusions and **hallucinations**
- leg and foot cramps

- muscle twitches
- changes in blood pressure

Severe magnesium deficiency can cause seizures, especially in children.

Neonatal hypomagnesemia can occur in premature babies and in infants who have genetic parathyroid disorders or who have had blood transfusions. This condition also occurs in babies born to magnesium-deficient mothers or to women who have:

- diabetes mellitus.
- hyperparathyroidism (overactive parathyroid glands)
- toxemia (a pregnancy-related condition characterized by high blood pressure and fluid retention)

Hypermagnesemia

Hypermagnesemia is most common in patients whose kidneys cannot excrete the magnesium they derive from food or take as medication. This condition can also develop in patients who take magnesium salts, or in healthy people who use large quantities of magnesium-containing **antacids**, **laxatives**, or **analgesics** (pain relievers).

Magnesium **poisoning** can cause severe diarrhea in young people, and mask the symptoms of other illnesses. Very high overdoses can lead to **coma**. The risk of complications of magnesium poisoning is greatest for:

- elderly people with inefficient kidney function
- patients with kidney problems or intestinal disorders
- people who use **antihistamines**, **muscle relaxants**, or narcotics

Severe dehydration or an overdose of supplements taken to counteract hypomagnesemia can also cause this condition.

People who have hypermagnesemia may feel flushed and drowsy, perspire heavily, and have diarrhea. Breathing becomes shallow, reflexes diminish, and the patient becomes unresponsive. Muscle weakness and hallucinations are common. The patient's heart beat slows dramatically and blood pressure plummets. Extreme toxicity, which can lead to coma and cardiac arrest, can be fatal.

Diagnosis

Blood tests are used to measure magnesium levels.

Treatment

The goal of treatment is to identify and correct the cause of the imbalance. Oral magnesium supplements or injections are usually prescribed to correct mild magnesium deficiency. If the deficiency is more severe or does not respond to treatment, magnesium sulfate or magnesium chloride may be administered intravenously.

KEY TERMS

Hypermagnesemia—An abnormally high concentration of magnesium in the blood.

Hypomagnesemia—An abnormally low concentration of magnesium in the blood.

Doctors usually prescribe **diuretics** (urine-producing drugs) for patients with hypermagnesemia and advise them to drink more fluids to flush the excess mineral from the body. Patients whose magnesium levels are extremely high may need mechanical support to breathe and to circulate blood throughout their bodies.

Intravenously administered calcium gluconate may reverse damage caused by excess magnesium. Intravenous furosemide (Lasix) or ethacrynic acid (Edecrin) can increase magnesium excretion in patients who get enough fluids and whose kidneys are functioning properly.

In an emergency, dialysis can provide temporary relief for patients whose kidney function is poor or who are unable to excrete excess **minerals**.

Prognosis

Because imbalances may recur if the underlying condition is not eliminated, monitoring of magnesium levels should continue after treatment has been completed.

Prevention

Most people consume adequate amounts of magnesium in the food they eat. Dietary supplements can be used safely, but should only be used under a doctor's supervision.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments.* Alexandria, VA: Time Life, Inc., 1996.

Shaw, Michael, ed. *Everything You Need to Know About Diseases.* Springhouse, PA: Springhouse Corporation, 1996.

Slupnik, Ramona, ed. *American Medical Association Complete Guide to Women's Health.* New York: Random House, Inc., 1996.

OTHER

"Hypermagnesemia." The Merck Page. 2 May 1998 <http://www.merck.com>.

"Hypomagnesemia Etiology and Pathogenesis." The Merck Page. 1 May 1998 <http://www.merck.com>.

"Mineral Guide." CNN Page. 2 May 1998 <http://www.cnn.com/HEALTH>.

"Report Says Excessive Antacid Use Can Cause Poisoning." CNN Page. 30 Aug. 1995. 2 May 1998 <http://www.cnn.com/HEALTH/9508/magnesium/index.html>.

Maureen Haggerty

Magnetic field therapy

Definition

Magnetic therapy is the use of magnets to relieve **pain** in various areas of the body.

Purpose

Some of the benefits that magnetic therapy claims to provide include:

- pain relief
- reduction of swelling
- improved tissue alkalinization
- more restful sleep
- increased tissue oxygenation
- relief of stress
- increased levels of cellular oxygen
- improved blood circulation
- anti-infective activity

Description

Origins

Magnetic therapy dates as far back as the ancient Egyptians. Magnets have long been believed to have healing powers associated with muscle pain and stiffness. Chinese healers as early as 200 B.C. were said to use magnetic lodestones on the body to correct unhealthy imbalances in the flow of *qi,* or energy. The ancient Chinese medical text known as *The Yellow Emperor's Canon of Internal Medicine* describes this procedure. The *Vedas*, or ancient Hindu scriptures, also mention the treatment of diseases with lodestones. The word "lodestone" or leading stone, came from the use of these stones as compasses. The word "magnet" probably stems from the Greek *Magnes lithos*, or "stone from Magnesia," a region of Greece rich in magnetic stones. The Greek phrase later became *magneta* in Latin.

Sir William Gilbert's 1600 treatise, *De Magnete*, was the first scholarly attempt to explain the nature of magnetism and how it differed from the attractive force of static electricity. Gilbert allegedly used magnets to relieve the arthritic pains of Queen Elizabeth I. Contemporary American interest in magnetic therapy began in the 1990s, as several professional golfers and football players offered testimony that the devices seemed to cure their nagging aches and injuries.

Many centuries ago, the earth was surrounded by a much stronger magnetic field than it is today. Over the past 155 years, scientists have been studying the decline of this magnetic field and the effects it has had on human health. When the first cosmonauts and astronauts were going into space, physicians noted that they experienced bone calcium loss and muscle cramps when they were out of the Earth's magnetic field for any extended period of time. After this discovery was made, artifical magnetic fields were placed in the space capsules.

There are two theories that are used to explain magnetic therapy. One theory maintains that magnets produce a slight electrical current. When magnets are applied to a painful area of the body, the nerves in that area are stimulated, thus releasing the body's natural painkillers. The other theory maintains that when magnets are applied to a painful area of the body, all the cells in that area react to increase blood circulation, ion exchange, and oxygen flow to the area. Magnetic fields attract and repel charged particles in the bloodstream, increasing blood flow and producing heat. Increased oxygen in the tissues and blood stream is thought to make a considerable difference in the speed of healing.

Preparations

There are no special preparations for using magnetic therapy other than purchasing a product that is specific for the painful area being treated. Products available in a range of prices include necklaces and bracelets; knee, back, shoulder and wrist braces; mattress pads; gloves; shoe inserts; and more.

Precautions

The primary precaution involved with magnetic therapy is to recognize the expense of this therapy. Magnets have become big business; they can be found in mail-order catalogs and stores ranging from upscale department stores to specialty stores. As is the case with many popular self-administered therapies, many far-fetched claims are being made about the effectiveness of

magnetic therapy. Consumers should adopt a "let the buyer beware" approach to magnetic therapy. Persons who are interested in this form of treatment should try out a small, inexpensive item to see if it works for them before investing in the more expensive products.

Side effects

There are very few side effects from using magnetic therapy. Generally, patients using this therapy find that it either works for them or it does not. Patients using transcranial magnetic stimulation for the treatment of depression reported mild **headache** as their only side effect.

Research and general acceptance

Magnetic therapy is becoming more and more widely accepted as an alternative method of pain relief. Since the late 1950s, hundreds of studies have demonstrated the effectiveness of magnetic therapy. In 1997, a group of physicians at Baylor College of Medicine in Houston, Texas studied the use of magnetic therapy in 50 patients who had developed **polio** earlier in life. These patients had muscle and joint pain that standard treatments failed to manage. In this study, 29 of the patients wore a magnet taped over a trouble spot, and 21 others wore a nonmagnetic device. Neither the researchers nor the patients were told which treatment they were receiving (magnetic or nonmagnetic). As is the case with most studies involving a placebo, some of the patients responded to the nonmagnetic therapy, but 75% of those using the magnetic therapy reported feeling much better.

In another study at New York Medical College in Valhalla, New York, a neurologist tested magnetic therapy on a group of 19 men and women complaining of moderate to severe burning, tingling, or numbness in their feet. Their problems were caused by diabetes or other conditions present such as **alcoholism**. This group of patients wore a magnetic insole inside one of their socks or shoes for 24 hours a day over a two-month period, except while bathing. They wore a nonmagnetic insert in their other sock or shoe. Then for two months they wore magnetic inserts on both feet. By the end of the study, nine out of ten of the diabetic patients reported relief, while only three of nine nondiabetic patients reported relief. The neurologist in charge of the study believes that this study opens the door to additional research into magnetic therapy for diabetic patients. He plans a larger follow-up study in the near future.

As of 2000, a federally funded study is underway at the University of Virginia. This study is evaluating the effectiveness of magnetic mattress pads in easing the muscle pain, stiffness and **fatigue** associated with **fibromyalgia**.

KEY TERMS

Fibromyalgia—A chronic syndrome characterized by fatigue, widespread muscular pain, and pain at specific points on the body.

Lodestone—A variety of magnetite that possesses magnetic polarity.

Transcranial magnetic stimulation—A procedure used to treat patients with depression.

Magnetic therapy is also being studied in the treatment of depression in patients with **bipolar disorder**. A procedure called repeated transcranial magnetic stimulation has shown promise in treating this condition. In this particular study, patients with depression had a lower relapse rate than did those using **electroconvulsive therapy**. Unlike electroconvulsive therapy, patients using magnetic therapy did not suffer from seizures, memory lapses, or impaired thinking.

Training and certification

There is no training or certification required for administering magnetic therapy. Magnetic therapy can be self-administered.

Resources

BOOKS

Lawrence, Ron, and Paul Rosch. *Magnet Therapy Book: The Pain Cure Alternative*. New York: Prima Publications, 1998.

PERIODICALS

"Magnets for Pain Relief: Attractive but Unproven." *Tufts University Health and Nutrition Letter* (1999): 3.

Vallbona, C. "Evolution of Magnetic Therapy from Alternative to Traditional Medicine." *Physical Medicine Rehabilitation Clinics of North America*, 1999: 729-54.

Kim Sharp

Magnetic resonance imaging

Definition

Magnetic resonance imaging (MRI) is the newest, and perhaps most versatile, medical imaging technology available. Doctors can get highly refined images of the

body's interior without surgery, using MRI. By using strong magnets and pulses of radio waves to manipulate the natural magnetic properties in the body, this technique makes better images of organs and soft tissues than those of other scanning technologies. MRI is particularly useful for imaging the brain and spine, as well as the soft tissues of joints and the interior structure of bones. The entire body is visible to the technique, which poses few known health risks.

Purpose

MRI was developed in the 1980s. The latest additions to MRI technology are **angiography** (MRA) and spectroscopy (MRS). MRA was developed to study blood flow, while MRS can identify the chemical composition of diseased tissue and produce color images of brain function. The many advantages of MRI include:

- Detail. MRI creates precise images of the body based on the varying proportions of magnetic elements in different tissues. Very minor fluctuations in chemical composition can be determined. MRI images have greater natural contrast than standard x rays, computed tomography scan (CT scan), or ultrasound, all of which depend on the differing physical properties of tissues. This sensitivity lets MRI distinguish fine variations in tissues deep within the body. It also is particularly useful for spotting and distinguishing diseased tissues (tumors and other lesions) early in their development. Often, doctors prescribe an MRI scan to more fully investigate earlier findings of the other imaging techniques.
- Scope. The entire body can be scanned, from head to toe and from the skin to the deepest recesses of the brain. Moreover, MRI scans are not obstructed by bone, gas, or body waste, which can hinder other imaging techniques. (Although the scans can be degraded by motion such as breathing, heartbeat, and normal bowel activity.) The MRI process produces cross-sectional images of the body that are as sharp in the middle as on the edges, even of the brain through the skull. A close series of these two-dimensional images can provide a three-dimensional view of a targeted area.
- Safety. MRI does not depend on potentially harmful ionizing radiation, as do standard x-ray and CT scans. There are no known risks specific to the procedure, other than for people who might have metal objects in their bodies.

Given all the advantages, doctors would undoubtedly prescribe MRI as frequently as ultrasound scanning, but the MRI process is complex and costly. The process requires large, expensive, and complicated equipment; a highly trained operator; and a doctor specializing in radiology. Generally, MRI is prescribed only when serious symptoms and/or negative results from other tests indicate a need. Many times another test is appropriate for the type of diagnosis needed.

Doctors may prescribe an MRI scan of different areas of the body.

- Brain and head. MRI technology was developed because of the need for brain imaging. It is one of the few imaging tools that can see through bone (the skull) and deliver high quality pictures of the brain's delicate soft tissue structures. MRI may be needed for patients with symptoms of a **brain tumor**, **stroke**, or infection (like **meningitis**). MRI also may be needed when cognitive and/or psychological symptoms suggest brain disease (like Alzheimer's or Huntington's diseases, or **multiple sclerosis**), or when developmental retardation suggests a birth defect. MRI can also provide pictures of the sinuses and other areas of the head beneath the face.
- Spine. Spinal problems can create a host of seemingly unrelated symptoms. MRI is particularly useful for identifying and evaluating degenerated or herniated spinal discs. It can also be used to determine the condition of nerve tissue within the spinal cord.
- Joint. MRI scanning is most commonly used to diagnose and assess joint problems. MRI can provide clear images of the bone, cartilage, ligament, and tendon that comprise a joint. MRI can be used to diagnose joint injuries due to sports, advancing age, or arthritis. MRI can also be used to diagnose shoulder problems, like a torn rotator cuff. MRI can also detect the presence of an otherwise hidden tumor or infection in a joint, and can be used to diagnose the nature of developmental joint abnormalities in children.
- Skeleton. The properties of MRI that allow it to see though the skull also allow it to view the inside of bones. It can be used to detect bone **cancer**, inspect the marrow for leukemia and other diseases, assess bone loss (**osteoporosis**), and examine complex **fractures**.
- The rest of the body. While CT and ultrasound satisfy most chest, abdominal, and general body imaging needs, MRI may be needed in certain circumstances to provide better pictures or when repeated scanning is required. The progress of some therapies, like **liver cancer** therapy, needs to be monitored, and the effect of repeated x-ray exposure is a concern.

Precautions

MRI scanning should not be used when there is the potential for an interaction between the strong MRI magnet and metal objects that might be imbedded in a patient's body. The force of magnetic attraction on certain types of metal objects (including surgical steel)

could move them within the body and cause serious injury. Metal may be imbedded in a person's body for several reasons.

- Medical. People with implanted cardiac **pacemakers**, metal aneurysm clips, or who have had broken bones repaired with metal pins, screws, rods, or plates must tell their radiologist prior to having an MRI scan. In some cases (like a metal rod in a reconstructed leg) the difficulty may be overcome.
- Injury. Patients must tell their doctors if they have bullet fragments or other metal pieces in their body from old **wounds**. The suspected presence of metal, whether from an old or recent wound, should be confirmed before scanning.
- Occupational. People with significant work exposure to metal particles (working with a metal grinder, for example) should discuss this with their doctor and radiologist. The patient may need prescan testing—usually a single, regular x ray of the eyes to see if any metal is present.

Chemical agents designed to improve the picture and/or allow for the imaging of blood or other fluid flow during MRA may be injected. In rare cases, patients may be allergic to or intolerant of these agents, and these patients should not receive them. If these chemical agents are to be used, patients should discuss any concerns they have with their doctor and radiologist.

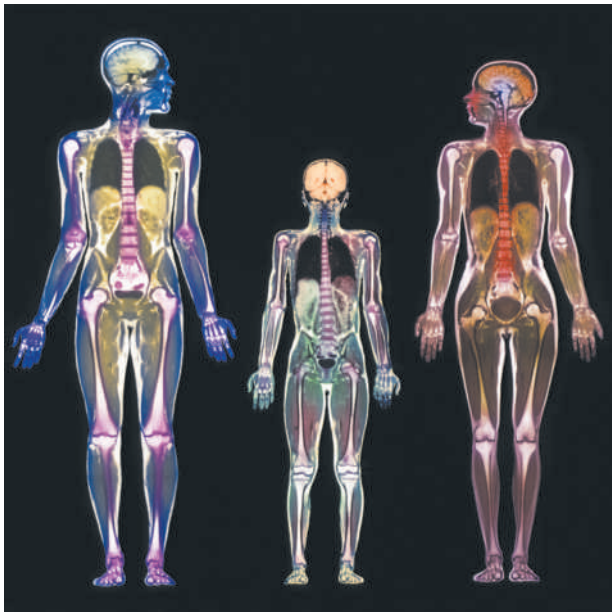
The potential side effects of magnetic and electric fields on human health remain a source of debate. In particular, the possible effects on an unborn baby are not well known. Any woman who is, or may be, pregnant should carefully discuss this issue with her doctor and radiologist before undergoing a scan.

As with all medical imaging techniques, **obesity** greatly interferes with the quality of MRI.

Description

In essence, MRI produces a map of hydrogen distribution in the body. Hydrogen is the simplest element known, the most abundant in biological tissue, and one that can be magnetized. It will align itself within a strong magnetic field, like the needle of a compass. The earth's magnetic field is not strong enough to keep a person's hydrogen atoms pointing in the same direction, but the superconducting magnet of an MRI machine can. This comprises the "magnetic" part of MRI.

Once a patient's hydrogen atoms have been aligned in the magnet, pulses of very specific radio wave frequencies are used to knock them back out of alignment. The hydrogen atoms alternately absorb and emit radio wave energy, vibrating back and forth between their resting (magnetized) state and their agitated (radio pulse) state. This comprises the "resonance" part of MRI.



MRI body scans of a man, woman, and child. *(Simon Fraser, Photo Researchers. Reproduced by permission.)*

The MRI equipment records the duration, strength, and source location of the signals emitted by the atoms as they relax and translates the data into an image on a television monitor. The state of hydrogen in diseased tissue differs from healthy tissue of the same type, making MRI particularly good at identifying tumors and other lesions. In some cases, chemical agents such as gadolinium can be injected to improve the contrast between healthy and diseased tissue.

A single MRI exposure produces a two-dimensional image of a slice through the entire target area. A series of these image slices closely spaced (usually less than half an inch) makes a virtual three-dimensional view of the area.

Magnetic resonance spectroscopy (MRS) is different from MRI because MRS uses a continuous band of radio wave frequencies to excite hydrogen atoms in a variety of chemical compounds other than water. These compounds absorb and emit radio energy at characteristic frequencies, or spectra, which can be used to identify them. Generally, a color image is created by assigning a color to each distinctive spectral emission. This comprises the "spectroscopy" part of MRS. MRS is still experimental and is available in only a few research centers.

Doctors primarily use MRS to study the brain and disorders, like epilepsy, **Alzheimer's disease**, brain tumors, and the effects of drugs on brain growth and

metabolism. The technique is also useful in evaluating metabolic disorders of the muscles and nervous system.

Magnetic resonance angiography (MRA) is another variation on standard MRI. MRA, like other types of angiography, looks specifically at fluid flow within the blood (vascular) system, but does so without the injection of dyes or radioactive tracers. Standard MRI cannot make a good picture of flowing blood, but MRA uses specific radio pulse sequences to capture usable signals. The technique is generally used in combination with MRI to obtain images that show both vascular structure and flow within the brain and head in cases of stroke, or when a blood clot or aneurysm is suspected.

Regardless of the exact type of MRI planned, or area of the body targeted, the procedure involved is basically the same and occurs in a special MRI suite. The patient lies back on a narrow table and is made as comfortable as possible. Transmitters are positioned on the body and the cushioned table that the patient is lying on moves into a long tube that houses the magnet. The tube is as long as an average adult lying down, and the tube is narrow and open at both ends. Once the area to be examined has been properly positioned, a radio pulse is applied. Then a two-dimensional image corresponding to one slice through the area is made. The table then moves a fraction of an inch and the next image is made. Each image exposure takes several seconds and the entire exam will last anywhere from 30-90 minutes. During this time, the patient is not allowed to move. If the patient moves during the scan, the picture will not be clear.

Depending on the area to be imaged, the radio-wave transmitters will be positioned in different locations.

- For the head and neck, a helmet-like hat is worn.
- For the spine, chest, and abdomen, the patient will be lying on the transmitters.
- For the knee, shoulder, or other joint, the transmitters will be applied directly to the joint.

Additional probes will monitor vital signs (like pulse, respiration, etc.).

The process is very noisy and confining. The patient hears a thumping sound for the duration of the procedure. Since the procedure is noisy, music supplied via earphones is often provided. Some patients get anxious or panic because they are in the small, enclosed tube. This is why vital signs are monitored and the patient and medical team can communicate between each other. If the chest or abdomen are to be imaged, the patient will be asked to hold his/her breath as each exposure is made. Other instructions may be given to the patient, as needed. In many cases, the entire examination will be performed by an MRI operator who is not a doctor. However, the supervising radiologist should be available to consult as necessary during the exam, and will view and interpret the results sometime later.

Preparation

In some cases (such as for MRI brain scanning or an MRA), a chemical designed to increase image contrast may be given by the radiologist immediately before the exam. If a patient suffers from **anxiety** or claustrophobia, drugs may be given to help the patient relax.

The patient must remove all metal objects (watches, jewelry, eye glasses, hair clips, etc). Any magnetized objects (like credit and bank machine cards, audio tapes, etc.) should be kept far away from the MRI equipment because they can be erased. The patient cannnot bring their wallet or keys into the MRI machine. The patient may be asked to wear clothing without metal snaps, buckles, or zippers, unless a medical gown is worn during the procedure. The patient may be asked to remove any hair spray, hair gel, or cosmetics that may interfere with the scan.

Aftercare

No aftercare is necessary, unless the patient received medication or had a reaction to a contrast agent. Normally, patients can immediately return to their daily activities. If the exam reveals a serious condition that requires more testing and/or treatment, appropriate information and counseling will be needed.

Risks

MRI poses no known health risks to the patient and produces no physical side effects. Again, the potential effects of MRI on an unborn baby are not well known. Any woman who is, or may be, pregnant, should carefully discuss this issue with her doctor and radiologist before undergoing a scan.

Normal results

A normal MRI, MRA, or MRS result is one that shows the patient's physical condition to fall within normal ranges for the target area scanned.

Abnormal results

Generally, MRI is prescribed only when serious symptoms and/or negative results from other tests indicate a need. There often exists strong evidence of a condition that the scan is designed to detect and assess. Thus, the results will often be abnormal, confirming the earlier diagnosis. At that point, further testing and appro-

KEY TERMS

Angiography—Any of the different methods for investigating the condition of blood vessels, usually via a combination of radiological imaging and injections of chemical tracing and contrasting agents.

Gadolinium—A very rare metallic element useful for its sensitivity to electromagnetic resonance, among other things. Traces of it can be injected into the body to enhance the MRI pictures.

Hydrogen—The simplest, most common element known in the universe. It is composed of a single electron (negatively charged particle) circling a nucleus consisting of a single proton (positively charged particle). It is the nuclear proton of hydrogen that makes MRI possible by reacting resonantly to radio waves while aligned in a magnetic field.

Ionizing radiation—Electromagnetic radiation that can damage living tissue by disrupting and destroying individual cells. All types of nuclear decay radiation (including x rays) are potentially ionizing. Radio waves do not damage organic tissues they pass through.

Magnetic field—The three-dimensional area surrounding a magnet, in which its force is active. During MRI, the patient's body is permeated by the force field of a superconducting magnet.

Radio waves— Electromagnetic energy of the frequency range corresponding to that used in radio communications, usually 10,000 cycles per second to 300 billion cycles per second. Radio waves are the same as visible light, x rays, and all other types of electromagnetic radiation, but are of a higher frequency.

priate medical treatment is needed. For example, if the MRI indicates the presence of a brain tumor, an MRS may be prescribed to determine the type of tumor so that aggressive treatment can begin immediately without the need for a surgical biopsy.

Resources

BOOKS

Edelman, Robert R., et al., eds. *Clinical Magnetic Resonance Imaging.* Philadelphia: Saunders Co., 1990.

Haaga, John R., et al., eds. *Computed Tomography and Magnetic Resonance Imaging of the Whole Body.* St. Louis: Mosby, 1994.

Kevles, Bettyann Holtzmann. *Naked to the Bone: Medical Imaging in the Twentieth Century.* New Brunswick, NJ: Rutgers University Press, 1997.

Shtasel, Philip. *Medical Tests and Diagnostic Procedures: A Patient's Guide to Just What the Doctor Ordered.* New York: Harper & Row, 1991.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

Doria, John J. "A Primer on Imaging." *Alcohol Health & Research World* 19 (Dec. 1995): 261-265.

Fein, George, Dieter J. Meyerhoff, and Michael W. Weiner. "Magnetic Resonance Spectroscopy of the Brain in Alcohol Abuse." *Alcohol Health & Research World* 19 (Dec. 1995): 306-314.

Kevles, Bettyann. "Body Imaging." *Newsweek*, Winter 1997/1998, 74-76.

ORGANIZATIONS

American College of Radiology. 1891 Preston White Drive, Reston, VA 22091. (800) 227-5463. <http://www.acr.org>.

American Society of Radiologic Technologists. 15000 Central Ave. SE, Albuquerque, NM 87123-3917. (505) 298-4500. <http://www.asrt.org>.

Center for Devices and Radiological Health. United States Food and Drug Administration. 1901 Chapman Ave., Rockville, MD 20857. (301) 443-4109. <http://www.fda.gov/cdrh>.

Kurt Richard Sternlof

Magnetic resonance spectroscopy *see* **Magnetic resonance imaging**

Major depression *see* **Depressive disorders**

Major tranquilizers *see* **Antipsychotic drugs**

Malabsorption syndrome

Definition

Malabsorption syndrome is an alteration in the ability of the intestine to absorb nutrients adequately into the bloodstream.

Causes and symptoms

Protein, fats, and carbohydrates (macronutrients) normally are absorbed in the small intestine; the small

bowel also absorbs about 80% of the eight to ten liters of fluid ingested daily. There are many different conditions that affect fluid and nutrient absorption by the intestine. A fault in the digestive process may result from failure of the body to produce the enzymes needed to digest certain foods. Congenital structural defects or diseases of the pancreas, gall bladder, or liver may alter the digestive process. Inflammation, infection, injury, or surgical removal of portions of the intestine may also result in absorption problems; reduced length or surface area of intestine available for fluid and nutrient absorption can result in malabsorption. **Radiation therapy** may injure the mucosal lining of the intestine, resulting in **diarrhea** that may not become evident until several years later. The use of some **antibiotics** can also affect the bacteria that normally live in the intestine and affect intestinal function.

Risk factors for malabsorption syndrome include:

- family history of malabsorption or **cystic fibrosis**
- use of certain drugs, such as mineral oil or other **laxatives**
- travel to foreign countries
- intestinal surgery
- excess alcohol consumption

The most common symptoms of malabsorption include:

- anemia, with weakness and **fatigue** due to inadequate absorption of vitamin B_{12}, iron, and **folic acid**
- diarrhea, steatorrhea (excessive amount of fat in the stool), and abdominal distention with cramps, bloating, and gas due to impaired water and carbohydrate absorption, and irritation from unabsorbed fatty acids. The individual may also report explosive diarrhea with greasy, foul-smelling stools.
- **edema** (fluid retention in the body's tissues) due to decreased protein absorption
- malnutrition and weight loss due to decreased fat, carbohydrate, and protein absorption. Weight may be 80-90% of usual weight despite increased oral intake of nutrients.
- muscle cramping due to decreased vitamin D, calcium, and potassium levels
- muscle wasting and atrophy due to decreased protein absorption and metabolism
- perianal skin burning, **itching**, or soreness due to frequent loose stools

Irregular heart rhythms may also result from inadequate levels of potassium and other electrolytes. Blood clotting disorders may occur due to a **vitamin K deficiency**. Children with malabsorption syndrome often exhibit a failure to grow and thrive.

Several disorders can lead to malabsorption syndrome, including cystic fibrosis, chronic **pancreatitis**, **lactose intolerance**, and gluten enteropathy (non-tropical sprue.)

Tropical sprue is a malabsorptive disorder that is uncommon in the United States, but seen more often in people from the Caribbean, India, or southeast Asia. Although its cause is unknown, it is thought to be related to environmental factors, including infection, intestinal parasites, or possibly the consumption of certain food toxins. Symptoms often include a sore tongue, anemia, weight loss, along with diarrhea and passage of fatty stools.

Whipple's disease is a relatively rare malabsorptive disorder, affecting mostly middle-aged men. The cause is thought to be related to bacterial infection, resulting in nutritional deficiencies, chronic low-grade **fever**, diarrhea, joint **pain**, weight loss, and darkening of the skin's pigmentation. Other organs of the body may be affected, including the brain, heart, lungs, and eyes.

Short bowel syndromes—which may be present at birth (congenital) or the result of surgery—reduce the surface area of the bowel available to absorb nutrients and can also result in malabsorption syndrome.

Diagnosis

The diagnosis of malabsorption syndrome and identification of the underlying cause can require extensive diagnostic testing. The first phase involves a thorough medical history and **physical examination** by a physician, who will then determine the appropriate laboratory studies and x rays to assist in diagnosis. A 72-hour stool collection may be ordered for fecal fat measurement; increased fecal fat in the stool collected indicates malabsorption. A biopsy of the small intestine may be done to assist in differentiating between malabsorption syndrome and small bowel disease. Ultrasound, computed tomography scan (CT scan), **magnetic resonance imaging** (MRI), **barium enema**, or other x rays to identify abnormalities of the gastrointestinal tract and pancreas may also be ordered.

Laboratory studies of the blood may include:

- Serum cholesterol. May be low due to decreased fat absorption and digestion.
- Serum sodium, potassium, and chloride. May be low due to electrolyte losses with diarrhea.
- Serum calcium. May be low due to vitamin D and amino acid malabsorption.
- Serum protein and albumin. May be low due to protein losses.
- Serum vitamin A and carotene. May be low due to bile salt deficiency and impaired fat absorption.

- D-xylose test. Decreased excretion may indicate malabsorption.
- Schilling test. May indicate malabsorption of vitamin B_{12}.

Treatment

Fluid and nutrient monitoring and replacement is essential for any individual with malabsorption syndrome. Hospitalization may be required when severe fluid and electrolyte imbalances occur. Consultation with a dietitian to assist with nutritional support and meal planning is helpful. If the patient is able to eat, the diet and supplements should provide bulk and be rich in carbohydrates, proteins, fats, **minerals**, and **vitamins**. The patient should be encouraged to eat several small, frequent meals throughout the day, avoiding fluids and foods that promote diarrhea. Intake and output should be monitored, along with the number, color, and consistency of stools.

The individual with malabsorption syndrome must be monitored for **dehydration**, including dry tongue, mouth and skin; increased thirst; low, concentrated urine output; or feeling weak or dizzy when standing. Pulse and blood pressure should be monitored, observing for increased or irregular pulse rate, or **hypotension** (low blood pressure). The individual should also be alert for signs of nutrient, vitamin, and mineral depletion, including nausea or vomiting; fissures at corner of mouth; fatigue or weakness; dry, pluckable hair; easy bruising; tingling in fingers or toes; and numbness or burning sensation in legs or feet. Fluid volume excess, as a result of diminished protein stores, may require fluid intake restrictions. The physician should also be notified of any **shortness of breath**.

Other specific medical management for malabsorption syndrome is dependent upon the cause. Treatment for tropical sprue consists of folic acid supplements and long-term antibiotics. Depending on the severity of the disorder, this treatment may be continued for six months or longer. Whipple's disease also may require long-term use of antibiotics, such as tetracycline. Management of some individuals with malabsorption syndrome may require injections of vitamin B_{12} and oral iron supplements. The doctor may also prescribe enzymes to replace missing intestinal enzymes, or antispasmodics to reduce abdominal cramping and associated diarrhea. People with cystic fibrosis and chronic pancreatitis require pancreatic supplements. Those with lactose intolerance or gluten enteropathy (non-tropical sprue) will have to modify their **diets** to avoid foods that they cannot properly digest.

Prognosis

The expected course for the individual with malabsorption syndrome varies depending on the cause. The onset of symptoms may be slow and difficult to diagnose. Treatment may be long, complicated, and changed often for optimal effectiveness. Patience and a positive attitude are important in controlling or curing the disorder. Careful monitoring is necessary to prevent additional illnesses cause by nutritional deficiencies.

KEY TERMS

Anemia—A decrease in the number of red blood cells in the bloodstream, characterized by pallor, loss of energy, and generalized weakness.

Atrophy—A wasting away of a tissue or organ, often because of insufficient nutrition.

Biopsy—A tissue sample removed from the body for examination under the microscope.

Cystic fibrosis—A hereditary genetic disorder that occurs most often in Caucasians. Thick, sticky secretions from mucus-producing glands cause blockages in the pancreatic ducts and the airways.

Edema—From the Greek word meaning swelling, an excessive accumulation of fluid in the tissue spaces. Excessive generalized edema may also be referred to as ascites.

Gluten enteropathy—A hereditary malabsorption disorder caused by sensitivity to gluten, a protein found in wheat, rye, barley, and oats. Also called non-tropical sprue or celiac disease.

Intestines—The intestines, also known as the bowels, are divided into the large and small intestines. They extend from the stomach to the anus.

Short bowel syndrome—A condition in which the bowel is not as long as normal, either because of surgery or because of a congenital defect. Because the bowel has less surface area to absorb nutrients, it can result in malabsorption syndrome.

Steatorrhea—An excessive amount of fat in the stool.

Resources

BOOKS

Brunner, Lillian, and Doris Suddarth. *The Lippincott Manual of Nursing Practice*. Philadelphia: J. B. Lippincott Co., 1991.

Doughty, Dorothy. *Gastrointestinal Disorders*. St. Louis: Mosby-Yearbook, Inc., 1993.

Griffith, H. Winter. *Complete Guide to Pediatric Symptoms, Illness and Medications*. New York: Putnam Berkley Group, Inc., 1989.

Monahan, Frances, and Marianne Neighbors. *Medical-Surgical Nursing: Foundations for Clinical Practice*. Philadelphia: W. B. Saunders Co., 1998.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

"Malabsorption." ThriveOnline. 24 Apr. 1998 <http://thriveonline.oxygen.com>.

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Malaria

Definition

Malaria is a serious, infectious disease spread by certain mosquitoes. It is most common in tropical climates. It is characterized by recurrent symptoms of chills, **fever**, and an enlarged spleen. The disease can be treated with medication, but it often recurs. Malaria is endemic (occurs frequently in a particular locality) in many third world countries. Isolated, small outbreaks sometimes occur within the boundaries of the United States.

Description

Malaria is not a serious problem in the United States. Within the last 10 years, only about 1,200 cases have been reported each year in this country, mostly by people who were infected elsewhere. Locally transmitted malaria has occurred in California, Florida, Texas, Michigan, New Jersey, and New York City. While malaria can be transmitted in blood, the American blood supply is not screened for malaria. Widespread malarial epidemics are far less likely to occur in the United States, but small, localized epidemics could return to the western world.

The picture is far more bleak outside the territorial boundaries of the United States. A recent government panel warned that disaster looms over Africa from the disease. Malaria infects between 300 and 500 million people every year in Africa, India, southeast Asia, the Middle East, Oceania, and Central and South America. About 2 million of the infected die each year. Most of the cases and almost all of the deaths occur in sub-Saharan Africa. At the present time, malaria kills about twice as many people as does **AIDS**. As many as half a billion people worldwide are left with chronic anemia due to malaria infection. In some parts of Africa, people battle up to 40 or more separate episodes of malaria in their lifetimes. The spread of malaria is becoming even more serious as the parasites that cause malaria develop resistance to the drugs used to treat the condition.

Causes and symptoms

Human malaria is caused by four different species of a parasite called plasmodium: *Plasmodium falciparum* (the most deadly), *P.vivax*, *P. malariae,* and *P. ovale*. The last two are fairly uncommon. Many animals can get malaria but human malaria does not spread to animals. In turn, animal malaria does not spread to humans.

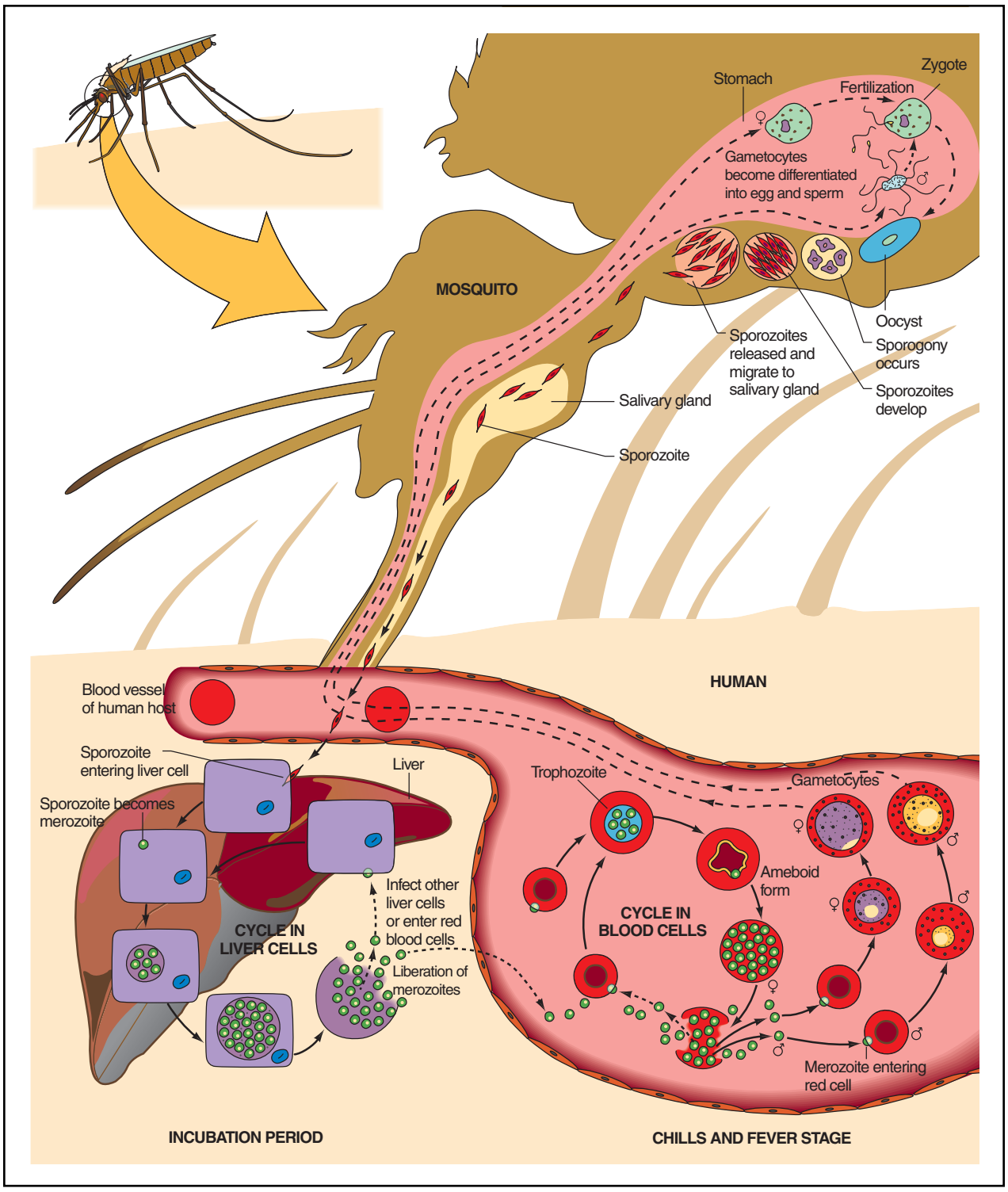
A person gets malaria when bitten by a female mosquito who is looking for a blood meal and is infected with the malaria parasite. The parasites enter the blood stream and travel to the liver, where they multiply. When they re-emerge into the blood, symptoms appear. By the time a patient shows symptoms, the parasites have reproduced very rapidly, clogging blood vessels and rupturing blood cells.

Malaria cannot be casually transmitted directly from one person to another. Instead, a mosquito bites an infected person and then passes the infection on to the next human it bites. It is also possible to spread malaria via contaminated needles or in blood transfusions. This is why all blood donors are carefully screened with questionnaires for possible exposure to malaria.

The amount of time between the mosquito bite and the appearance of symptoms varies, depending on the strain of parasite involved. The incubation period is usually between 8 and 12 days for falciparum malaria, but it can be as long as a month for the other types. Symptoms from some strains of *P.vivax* may not appear until eight to 10 months after the mosquito bite occurred.

The primary symptom of all types of malaria is the "malaria ague" (chills and fever). In most cases, the fever has three stages, beginning with uncontrollable shivering for an hour or two, followed by a rapid spike in temperature (as high as 106°F), which lasts three to six hours. Then, just as suddenly, the patient begins to sweat profusely, which will quickly bring down the fever. Other symptoms may include **fatigue**, severe **headache**, or **nausea and vomiting**. As the sweating subsides, the patient typically feels exhausted and falls asleep. In many cases, this cycle of chills, fever, and sweating occurs every other day, or every third day, and may last for between a week and a month. Those with the chronic form of malaria may have a relapse as long as 50 years after the initial infection.

Falciparum malaria is far more severe than other types of malaria because the parasite attacks all red blood cells, not just the young or old cells, as do other types. It



The life cycle of *Plasmodium vivax,* the parasite that causes malaria. *(Illustration by Hans & Cassady.)*

causes the red blood cells to become very "sticky." A patient with this type of malaria can die within hours of the first symptoms. The fever is prolonged. So many red blood cells are destroyed that they block the blood vessels in vital organs (especially the kidneys), and the spleen becomes enlarged. There may be brain damage, leading to **coma** and convulsions. The kidneys and liver may fail.

Malaria in **pregnancy** can lead to premature delivery, **miscarriage**, or **stillbirth**.

Certain kinds of mosquitoes (called anopheles) can pick up the parasite by biting an infected human. (The more common kinds of mosquitoes in the United States do not transmit the infection.) This is true for as long as that human has parasites in his/her blood. Since strains of malaria do not protect against each other, it is possible to be reinfected with the parasites again and again. It is also possible to develop a chronic infection without developing an effective immune response.

Diagnosis

Malaria is diagnosed by examining blood under a microscope. The parasite can be seen in the blood smears on a slide. These blood smears may need to be repeated over a 72-hour period in order to make a diagnosis. Antibody tests are not usually helpful because many people developed antibodies from past infections, and the tests may not be readily available.

Anyone who becomes ill with chills and fever after being in an area where malaria exists must see a doctor and mention their recent travel to endemic areas. A person with the above symptoms who has been in a high-risk area should insist on a blood test for malaria. The doctor may believe the symptoms are just the common flu virus. Malaria is often misdiagnosed by North American doctors who are not used to seeing the disease. Delaying treatment of falciparum malaria can be fatal.

Treatment

Falciparum malaria is a medical emergency that must be treated in the hospital. The type of drugs, the method of giving them, and the length of the treatment depend on where the malaria was contracted and how sick the patient is.

For all strains except falciparum, the treatment for malaria is usually chloroquine (Aralen) by mouth for three days. Those falciparum strains suspected to be resistant to chloroquine are usually treated with a combination of quinine and tetracycline. In countries where quinine resistance is developing, other treatments may include clindamycin (Cleocin), mefloquin (Lariam), or sulfadoxone/pyrimethamine (Fansidar). Most patients receive an antibiotic for seven days. Those who are very ill may need intensive care and intravenous (IV) malaria treatment for the first three days.

Anyone who acquired falciparum malaria in the Dominican Republic, Haiti, Central America west of the Panama Canal, the Middle East, or Egypt can still be cured with chloroquine. Almost all strains of falciparum malaria in Africa, South Africa, India, and southeast Asia are now resistant to chloroquine. In Thailand and Cambodia, there are strains of falciparum malaria that have some resistance to almost all known drugs.

A patient with falciparum malaria needs to be hospitalized and given **antimalarial drugs** in different combinations and doses depending on the resistance of the strain. The patient may need IV fluids, red blood cell transfusions, **kidney dialysis**, and assistance breathing.

A drug called primaquine may prevent relapses after recovery from *P. vivax* or *P. ovale*. These relapses are caused by a form of the parasite that remains in the liver and can reactivate months or years later.

Another new drug, halofantrine, is available abroad. While it is licensed in the United States, it is not marketed in this country and it is not recommended by the Centers for Disease Control and Prevention in Atlanta.

Alternative treatment

The Chinese herb qiinghaosu (the western name is artemisinin) has been used in China and southeast Asia to fight severe malaria, and became available in Europe in 1994. Because this treatment often fails, it is usually combined with another antimalarial drug (mefloquine) to boost its effectiveness. It is not available in the United States and other parts of the developed world due to fears of its toxicity, in addition to licensing and other issues.

A western herb called wormwood (*Artemesia annua*) that is taken as a daily dose can be effective against malaria. Protecting the liver with herbs like goldenseal (*Hydrastis canadensis*), Chinese goldenthread (*Coptis chinensis*), and milk thistle (*Silybum marianum*) can be used as preventive treatment. Preventing mosquitoes from biting you while in the tropics is another possible way to avoid malaria.

Prognosis

If treated in the early stages, malaria can be cured. Those who live in areas where malaria is epidemic, however, can contract the disease repeatedly, never fully recovering between bouts of acute infection.

Prevention

Several researchers are currently working on a malarial vaccine, but the complex life cycle of the malaria parasite makes it difficult. A parasite has much more genetic material than a virus or bacterium. For this reason, a successful vaccine has not yet been developed.

Malaria is an especially difficult disease to vaccinate against because the parasite goes through several separate stages. One recent, promising vaccine appears to

KEY TERMS

Arteminisinins—An antimalarial family of products derived from an ancient Chinese herbal remedy. Two of the most popular varieties are artemether and artesunate, used mainly in southeast Asia in combination with mefloquine.

Chloroquine—This antimalarial drug was first used in the 1940s, until the first evidence of quinine resistance appeared in the 1960s. It is now ineffective against falciparum malaria almost everywhere. However, because it is inexpensive, it is still the antimalarial drug most widely used in Africa. Native individuals with partial immunity may have better results with chloroquine than a traveler with no previous exposure.

Mefloquine—An antimalarial drug that was developed by the United States Army in the early 1980s. Today, malaria resistance to this drug has become a problem in some parts of Asia (especially Thailand and Cambodia).

Quinine—One of the first treatments for malaria, quinine is a natural product made from the bark of the Cinchona tree. It was popular until being superseded by the development of chloroquine in the 1940s. In the wake of widespread chloroquine resistance, however, it has become popular again. It or its close relative quinidine can be given intravenously to treat severe falciparum malaria.

Sulfadoxone/pyrimethamine (Fansidar)—This antimalarial drug developed in the 1960s is the first drug tried in some parts of the world where chloroquine resistance is widespread. It has been associated with severe allergic reactions due to its sulfa component.

have protected up to 60% of people exposed to maleria. This was evident during field trials for the drug that were conducted in South America and Africa. It is not yet commercially available.

The World Health Association (WHO) has been trying to eliminate malaria for the past 30 years by controlling mosquitoes. Their efforts were successful as long as the pesticide DDT killed mosquitoes and antimalarial drugs cured those who were infected. Today, however, the problem has returned a hundredfold, especially in Africa. Because both the mosquito and parasite are now extremely resistant to the insecticides designed to kill them, governments are now trying to teach people to take antimalarial drugs as a preventive medicine and avoid getting bitten by mosquitoes.

Travelers to high-risk areas should use insect repellant containing DEET for exposed skin. Because DEET is toxic in large amounts, children should not use a concentration higher than 35%. DEET should not be inhaled. It should not be rubbed onto the eye area, on any broken or irritated skin, or on children's hands. It should be thoroughly washed off after coming indoors.

Those who use the following preventive measures get fewer infections than those who do not:

- between dusk and dawn, remain indoors in well-screened areas
- sleep inside pyrethrin or permethrin repellent-soaked mosquito nets
- wear clothes over the entire body

Anyone visiting endemic areas should take antimalarial drugs starting a day or two before they leave the United States. The drugs used are usually chloroquine or mefloquine. This treatment is continued through at least four weeks after leaving the endemic area. However, even those who take antimalarial drugs and are careful to avoid mosquito bites can still contract malaria.

International travelers are at risk for becoming infected. Most Americans who have acquired falciparum malaria were visiting sub-Saharan Africa; travelers in Asia and South America are less at risk. Travelers who stay in air conditioned hotels on tourist itineraries in urban or resort areas are at lower risk than backpackers, missionaries, and Peace Corps volunteers. Some people in western cities where malaria does not usually exist may acquire the infection from a mosquito carried onto a jet. This is called airport or runway malaria.

Resources

BOOKS

Desowitz, Robert S. *The Malaria Capers: More Tales of Parasites and People, Research and Reality.* New York: W. W. Norton, 1993.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Illnesses.* New York: John Wiley & Sons, 1995.

PERIODICALS

Kristof, Nicholas D. "Malaria Makes a Comeback, Deadlier Than Ever." *The New York Times*, 8 Jan. 1997.

Mack, Alison. "Collaborative Efforts Under Way to Combat Malaria." *The Scientist* 10 (12 May 1997): 1, 6.
Shell, Ellen Ruppel. "Resurgence of a Deadly Disease." *The Atlantic Monthly* 280 (Aug. 1997).

ORGANIZATIONS

Centers for Disease Control Malaria Hotline. (770) 332-4555.
Centers for Disease Control Travelers Hotline. (770) 332-4559.

OTHER

Malaria Foundation Page. <http://www.malaria.org>.

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Malaya *see* **Elephantiasis**

Male breast enlargement *see* **Gynecomastia**

Male condom *see* **Condom**

Male infertility *see* **Infertility**

Male pattern baldness *see* **Alopecia**

Malignant lymphomas

Definition

Lymphomas are a group of cancers in which cells of the lymphatic system become abnormal and start to grow uncontrollably. Because there is lymph tissue in many parts of the body, lymphomas can start in almost any organ of the body.

Description

The lymph system is made up of ducts or tubules that carry lymph to all parts of the body. Lymph is a milky fluid that contains the lymphocytes or white blood cells. These are the infection- fighting cells of the blood. Small pea-shaped organs are found along the network of lymph vessels. These are called the lymph nodes, and their main function is to make and store the lymphocytes. Clusters of lymph nodes are found in the pelvis region, underarm, neck, chest, and abdomen. The spleen (an organ in the upper abdomen), the tonsils, and the thymus (a small organ found beneath the breastbone) are part of the lymphatic system.

The lymphocyte is the main cell of the lymphoid tissue. There are two main types of lymphocytes: the T lymphocyte and the B lymphocyte. Lymphomas develop from these two cell types. B cell lymphomas are more common among adults, while among children, the incidence of T and B cell lymphomas are almost equal.

The T and the B cell perform different jobs within the immune system. When an infectious bacterium enters the body, the B cell makes proteins called "antibodies." These antibodies attach themselves to the bacteria, and flag them for destruction by other immune cells. The T cells help protect the body against viruses. When a virus enters the cell, it generally produces certain proteins that are projected on the surface of the infected cell. T cells recognize these proteins and produce certain substances (cytokines) that destroy the infected cells. Some of the cytokines made by the T cells attract other cell types, which are capable of digesting the virus-infected cell. The T cells can also destroy some types of cancerous cells.

Lymphomas can be divided into two main types: Hodgkin's lymphoma or **Hodgkin's disease**, and non-Hodgkin's lymphomas. There are at least 10 types of non-Hodgkin's lymphomas. They are grouped (staged) by how aggressively they grow; slow growing (low grade), intermediate growing, and rapidly growing (high grade); and how far they spread.

A majority of non-Hodgkin's lymphomas begin in the lymph nodes. About 20% start in other organs, such as the lungs, liver or the gastrointestinal tract. Malignant lymphocytes multiply uncontrollably and do not perform their normal functions. Hence, the body's ability to fight infections is affected. In addition, these malignant cells may crowd the bone marrow, and, depending on the stage, prevent the production of normal red blood cells, white blood cells, and platelets. A low red blood cell count causes anemia, while a reduction in the number of platelets makes the person susceptible to excessive bleeding. Cancerous cells can also invade other organs through the circulatory system of the lymph, causing those organs to malfunction.

Causes and symptoms

The exact cause of non-Hodgkin's lymphomas is not known. However, the incidence has increased significantly in recent years. Part of the increase is due to the **AIDS** epidemic. Individuals infected with the AIDS virus have a higher likelihood of developing non-Hodgkin's lymphomas. In general, males are at a higher risk for having non-Hodgkin's lymphomas than are females. The risk increases with age. Though it can strike people as young as 40, people between the ages of 60 and 69 are at the highest risk.

People exposed to certain pesticides and ionizing radiation have a higher than average chance of developing this disease. For example, an increased incidence of lymphomas has been seen in survivors of the atomic bomb explosion in Hiroshima, and in people who have undergone aggressive **radiation therapy**. People who

suffer from immune-deficient disorders, as well as those who have been treated with immune suppressive drugs for heart or kidney transplants, and for conditions such as **rheumatoid arthritis** and autoimmune diseases, are at an increased risk for this disease.

There have been some studies that have shown a loose association between retroviruses, such as HTLV-I, and some rare forms of lymphoma. The Epstein-Barr virus has been linked to Burkitt's lymphoma in African countries. However, a direct cause-and-effect relationship has not been established.

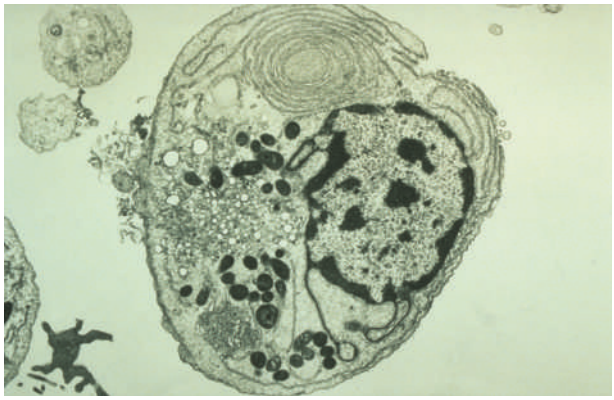
The symptoms of lymphomas are often vague and non-specific. Patients may experience loss of appetite, weight loss, nausea, vomiting, abdominal discomfort, and **indigestion**. The patient may complain of a feeling of fullness, which is a result of enlarged lymph nodes in the abdomen. Pressure or **pain** in the lower back is another symptom. In the advanced stages, the patient may have bone pain, headaches, constant coughing, and abnormal pressure and congestion in the face, neck, and upper chest. Some may have fevers and night sweats. In most cases, patients go to the doctor because of the presence of swollen glands in the neck, armpits, or groin area. Since all the symptoms are common to many other illnesses, it is essential to seek medical attention if any of the conditions persist for two weeks or more. Only a qualified physician can correctly diagnose if the symptoms are due to lymphoma or some other ailment.

Diagnosis

Like all cancers, lymphomas are best treated when found early. However, it is often difficult to diagnose lymphomas. There are no screening tests available, and, since the symptoms are non-specific, lymphomas are rarely recognized in their early stages. Detection often occurs by chance during a routine **physical examination**.

When the doctor suspects lymphoma, a complete medical history is taken, and a thorough physical examination is performed. Enlargement of the lymph nodes, liver, or spleen may suggest lymphomas. Blood tests will determine the cell counts and obtain information on how well the organs, such as the kidney and liver, are functioning.

A biopsy of the enlarged lymph node is the most definitive diagnostic tool for staging purposes. The doctor may perform a bone marrow biopsy. During the biopsy, a cylindrical piece of bone and marrow fluid is removed. They are generally taken out of the hipbone. These samples are sent to the laboratory for examination. In addition to diagnosis, the biopsy may also be repeated during the treatment phase of the disease to see if the lymphoma is responding to therapy.



A malignant lymph cell. *(Custom Medical Stock Photo. Reproduced by permission.)*

Once the exact form of lymphoma is known, it is then staged to determine how aggressive it is, and how far it has spread. Staging is necessary to plan appropriate treatment.

Conventional imaging tests, such as x rays, **computed tomography scans** (CT scans), **magnetic resonance imaging**, and abdominal sonograms, are used to determine the extent of spread of the disease.

Lymphangiograms are x rays of the lymphatic system. In this procedure, a special dye is injected into the lymphatic channels through a small cut (incision) made in each foot. The dye is injected slowly over a period of three to four hours. This dye clearly outlines the lymphatic system and allows it to stand out. Multiple x rays are then taken and any abnormality, if present, is revealed.

Rarely, a lumbar puncture or a spinal tap is performed to check if malignant cells are present in the fluid surrounding the brain. In this test, the physician inserts a needle into the epidural space at the base of the spine and collects a small amount of spinal fluid for microscopic examination.

Treatment

Treatment options for lymphomas depend on the type of lymphoma and its present stage. In most cases, treatment consists of **chemotherapy**, radiotherapy, or a combination of the two methods.

Chemotherapy is the use of anti-cancer drugs to kill **cancer** cells. In non-Hodgkin's lymphomas, combination therapy, which involves the use of multiple drugs, has been found more effective than single drug use. The treatment may last about six months, but in some cases may last as long as a year. The drugs may either be administered intravenously (through a vein) in the arm or given orally in the form of pills. If cancer cells have invaded the central nervous system, then chemotherapeu-

KEY TERMS

Antibodies—Proteins made by the B lymphocytes in response to the presence of infectious agents such as bacteria or viruses in the body.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Growth factors (cytokines)—Chemicals made by the cells that act on other cells to stimulate or inhibit their function. Cytokines that stimulate growth are called "growth factors."

tic drugs may be instilled, through a needle in the brain or back, into the fluid that surrounds the brain. This procedure is known as intrathecal chemotherapy.

Radiation therapy, where high-energy ionizing rays are directed at specific portions of the body, such as the upper chest, abdomen, pelvis, or neck, is often used for treatment of lymphomas. External radiation therapy, where the rays are directed from a source outside the body, is the most common mode of radiation treatment.

Bone marrow transplantation is used in cases where the lymphomas do not respond to conventional therapy, or in cases where the patient has had a relapse or suffers from recurrent lymphomas.

There are two ways of doing bone marrow transplantation. In a procedure called "allogeneic bone marrow transplant," a donor is found whose marrow matches that of the patient. The donor can be a twin (best match), a sibling, or a person who is not related at all. High-dose chemotherapy or radiation therapy is given to eradicate the lymphoma. The donor marrow is then given to replace the marrow destroyed by the therapy.

In "autologous bone marrow transplantation," some of the patient's own bone marrow is harvested, chemically purged, and frozen. High-dose chemotherapy and radiation therapy are given. The marrow that was harvested, purged, and frozen is then thawed and put back into the patient's body to replace the destroyed marrow.

A new treatment option for patients with lymphoma is known as "peripheral stem cell transplantation." In this treatment approach, cells that normally circulate in the blood are collected when the patient has normal blood counts taken, and these cells are saved via a process called "pheresis." Researchers are exploring whether these cells can be used to restore the normal function and development of blood cells, rather than using a bone marrow transplant.

Prognosis

Like all cancers, the prognosis for lymphoma depends on the stage of the cancer, and the patient's age and general health. When all the different types and stages of lymphoma are considered together, only 50% of patients survive 5 years or more after initial diagnosis. This is because some types of lymphoma are more aggressive than others.

The survival rate among children is definitely better than among older people. About 90% of the children diagnosed with early stage disease survive 5 years or more, while only 60-70% of adults diagnosed with low grade lymphomas survive for 5 years or more. The survival rate for children with the more advanced stages is about 75-85%, while among adults it is 40-60%.

Prevention

Although many cancers may be prevented by making diet and lifestyle changes which reduce risk factors, there is currently no known way to prevent lymphomas. Protecting oneself from developing AIDS, which may be a risk factor for lymphomas, is the only preventive measure that can be practiced.

At present, there are no special tests that are available for early detection of non-Hodgkin's lymphomas. Paying prompt attention to the signs and symptoms of this disease, and seeing a doctor if the symptoms persist, are the best strategies for an early diagnosis of lymphoma. Early detection affords the best chance for a cure.

Resources

BOOKS

Berkow, Robert, et al., eds. *Merck Manual of Diagnosis and Therapy.* 17th ed. St. Louis: Merck Research Laboratories, 1997.

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Morra, Marion E., and Eve Potts. *Choices: The New, Most Up-To-Date Sourcebook for Cancer Information.* New York: Avon Books, 1994.

Murphy, Gerald P. *Informed Decisions: The Complete Book of Cancer Diagnosis, Treatment and Recovery.* New York: American Cancer Society, 1997.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Cancer Research Institute. 681 Fifth Ave., New York, N.Y. 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Leukemia Society of America, Inc. 600 Third Ave., New York, NY 10016 (800) 955 4572. <http://www.leukemia.org>.

Lymphoma Research Foundation. 8800 Venice Boulevard, Suite 207, Los Angeles, CA 90034. (310) 204 7040.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.
Oncolink. University of Pennsylvania Cancer Center. <http://cancer.med.upenn.edu>.

OTHER

"1998 Cancer Facts and Figures." American Cancer Society Page. 12 May 1998 <http://www.cancer.orgl>.
"Hodgkin's Disease" and Non-Hodgkin's Lymphoma." The Leukemia Society. <http://www.leukemia-lymphoma.org/hm_lls>.
"Adults Non-Hodgkin's Lymphoma." National Cancer Institute Page. <http://www.nci.nih.gov>.
"Childhood Non-Hodgkin's Lymphoma." National Cancer Institute Page. <http://www.nci.nih.gov>.

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Malignant melanoma

Definition

Malignant Melanoma is a type of **cancer** arising from the melanocyte cells of the skin. The melanocytes are cells in the skin that produce the pigment melanin. Malignant melanoma develops when the melanocytes no longer respond to normal control mechanisms of cellular growth and are capable of invasion locally or spread to other organs in the body (metastasis), where again they invade and compromise the function of that organ.

Description

Melanocytes, embryologically derived from the neural crest, are distributed in the epidermis and thus are found throughout the skin. They produce a brown pigment known as melanin and are responsible for racial variation in skin color and also the color of **moles**. Malignant degeneration of the melanocyte gives rise to the tumor, melanoma, of which there are four subtypes. These are: superficial spreading, nodular, lentigo maligna, and acral lentiginous melanomas, accounting for 70%, 15% to 30%, 4% to 10%, and 2% to 8% of cases, respectively. Malignant melanoma may develop anywhere on the body. In men, it is most common on the trunk. In women, it is most common on the back or legs. The subtype also may influence where the tumor develops; lentigo melanoma is more common on the face while acral lentiginous melanoma is more common on the palms of the hand, soles of the feet, or in the nail beds.

The locally invasive characteristic of this tumor involves vertical penetration through the skin and into the dermis and subcutaneous (under-the-skin) tissues of the malignant melanocytes. With the exception of the nodular variety of melanoma, there is often a phase of radial or lateral growth associated with these tumors. Since it is the vertical growth that characterizes the malignancy, the nodular variant of melanoma carries the worst prognosis. Fortunately, the superficial spreading type is most common.

The primary tumor begins in the skin, often from the melanocytes of a pre-existing mole. Once it becomes invasive, it may progress beyond the site of origin to the regional lymph nodes or travel to other organ systems in the body and become systemic in nature.

The lymph is the clear, protein-rich fluid that bathes the cells throughout our body. Lymph will work its way back to the bloodstream via small channels known as lymphatics. Along the way, the lymph is filtered through cellular stations known as nodes, thus they are called lymph nodes. Nearly all organs in the body have a primary lymph node group filtering the tissue fluid, or lymph, that comes from that organ. Different areas of the skin have different primary nodal stations. For the leg, they are in the groin. For the arm, the armpit or axilla. For the face, it is the neck. Depending where on the torso the tumor develops, it may drain into one groin or armpit, or both.

Cancer, as it invades in its place of origin, may also work its way into blood vessels. If this occurs, it provides yet another route for the cancer to spread to other organs of the body. When the cancer spreads elsewhere in the body, it has become systemic in extent and the tumor growing elsewhere is known as a metastasis.

Untreated, malignant melanoma follows a classic progression. It begins and grows locally, penetrating vertically. It may be carried via the lymph to the regional nodes, known as regional metastasis. It may go from the lymph to the bloodstream or penetrate blood vessels, directly allowing it a route to go elsewhere in the body. When systemic disease or distant metastasis occur, melanoma commonly involves the lung, brain, liver, or occasionally bone. The malignancy causes **death** when its uncontrolled growth compromises vital organ function.

Of the anticipated new cases of cancer for the year 2001 in the United States, malignant melanoma will account for 5% of malignancies in men and 4% in women, being the sixth most common cancer in men and the seventh in women. It is estimated there will be 553,400 total cancer deaths in the United States in 2001. Malignant melanoma will account for 7,800 for an incidence of 1.5% of total deaths related to cancer.

The incidence of primary cutaneous malignant melanoma has been steadily increasing, possibly related to increase of sun exposure. Currently, the risk is about

13 per 100,000 of the population. It affects all age groups but is most commonly seen in patients between 30 and 60 years of age.

Sun exposure definitely increases risk of developing melanoma. The melanocytes are part of the integument's photoprotective mechanism; in response to sunlight, they produce melanin that has a protective role from the sun's ultraviolet rays. For Caucasians, the amount of melanin present in the skin is directly related to sun exposure. However, it is not so much the total sun exposure that seems important, rather it is the history of **sunburn**, (especially if severe or at an early age), that correlates with the increased risk. On this basis populations of fair-skinned people living in areas of high sun exposure such as the southwest United States or Australia are subject to increased risk. Malignant melanoma also affects non-Caucasians—though sun exposure probably does not play a role—at a rate of 10% that of Caucasians.

Malignant melanoma may arise in the skin anywhere on the body. It is estimated that 50% to 70% develop spontaneously while the remainder start in a pre-existing mole.

Causes and symptoms

The predisposing causes to the development of malignant melanoma are environmental and genetic. The environmental factor is excessive sun exposure. There are also genetically transmitted familial syndromes with alterations in the CDKN2A gene, which encodes for the tumor-suppressing proteins p16 and p19.

As mentioned previously, melanin production in fair-skinned people is induced by sun exposure. An exposure substantial enough to result in a mild sunburn will be followed by melanin producing a tan that may last a few weeks. Both ultraviolet radiation and damaging oxygen radicals caused by sun exposure may damage cells, particularly their DNA. It is suspected that this damage induces mutations that result in the development of malignant melanoma. Though these mutations are alterations of the genome causing the melanoma, they are environmentally induced and account for sporadic or spontaneous cases of this disease.

A positive family history of one or two first-degree relatives having had melanoma substantially increases the risk on a genetic basis. A family tendency is observed in 8% to 12% of patients. There is a syndrome known as the dysplasic (atypical), nevus syndrome that is characterized by atypical moles with bothersome clinical features in children under age 10. Such individuals have to be observed closely for the development of malignant melanoma. Chromosome 9p has been identified as being involved in familial predisposition. There are mutations in up to 50% of familial melanoma patients of the tumor-suppressing gene CDKN2A. The actual number of moles increases risk, but the size of the moles needs be considered. Those with 10 larger moles of over 1 cm (0.4 in.) are at more risk than those with a higher number (50-99) of smaller moles. Finally, when a child is born with a large congenital mole, careful observation for change is appropriate because of increased risk.

An excellent way of identifying changes of significance in a mole is the ABCD rule:

- assymetry
- border irregularity
- color variegation
- diameter exceeding 6 mm (0.24 in)

Notice that three of the criteria refer to variability of the lesion (color variegation refers to areas of light color and black scattered within the mole). Thus small, uniform regular lesions have less cause for concern. It is important to realize that change in a mole or the rapid development of a new one are very important symptoms.

Another summary of important changes in a mole is the Glasgow 7-point scale. The symptoms and signs below can occur anywhere on the skin, including the palms of the hands, soles of the feet, and also the nail beds:

- change in size
- change in shape
- change in color
- inflammation
- crusting and bleeding
- sensory change
- diameter more than 7 mm (0.28 in)

In this scheme, change is emphasized along with size. Bleeding and sensory changes are relatively late symptoms.

Symptoms related to the presence of regional disease are mostly those of nodules or lumps in the areas containing the lymph nodes draining the area. Thus nodularity can be found in the armpit, the groin, or the neck if regional nodes are involved. There is also a special type of metastasis that can occur regionally with malignant melanoma; it is known as an in-transit metastasis. If the melanoma is spreading through the lymph system, some of the tumor may grow there, resulting in a nodule part way between the primary site and the original lymph node. These in-transit metastases are seen both at the time of original presentation or later after primary treatment has been rendered, the latter being a type of recurrence.

Finally, in those who either present with or progress to widespread or systemic disease, symptoms and signs

are related to the affected organ. Thus neurologic problems, lung problems, or liver problems develop depending on the organ involved.

Diagnosis

None of the clinical signs or symptoms discussed above are absolute indications that a patient has malignant melanoma. The actual diagnosis is accomplished by biopsy, a procedure that removes tissue to examine under a microscope. It is important that the signs and symptoms are used to develop a suspicion of the diagnosis because the way the biopsy is performed for melanoma may be different than for other lesions of the skin.

When dealing with an early malignant melanoma, it is very important to establish the exact thickness of penetration of the primary tumor. Any biopsy that doesn't remove the full vertical extent of the primary is inadequate. Therefore, if a skin lesion is suspicious, full thickness excisional biopsy is the approach recommended. Shave biopsies and biopsies that remove only a portion of the suspect area are inappropriate. Often, in an early case, the excision involves just the suspicious lesion with minimal normal skin, but it should be a full vertical excision of the skin. If a melanoma is diagnosed, further treatment of this area will often be necessary but doesn't compromise outcome (prognosis). In some special areas of the body, minor modifications may be necessary about initial total excision, but full thickness excision should always be the goal. (See staging, below.)

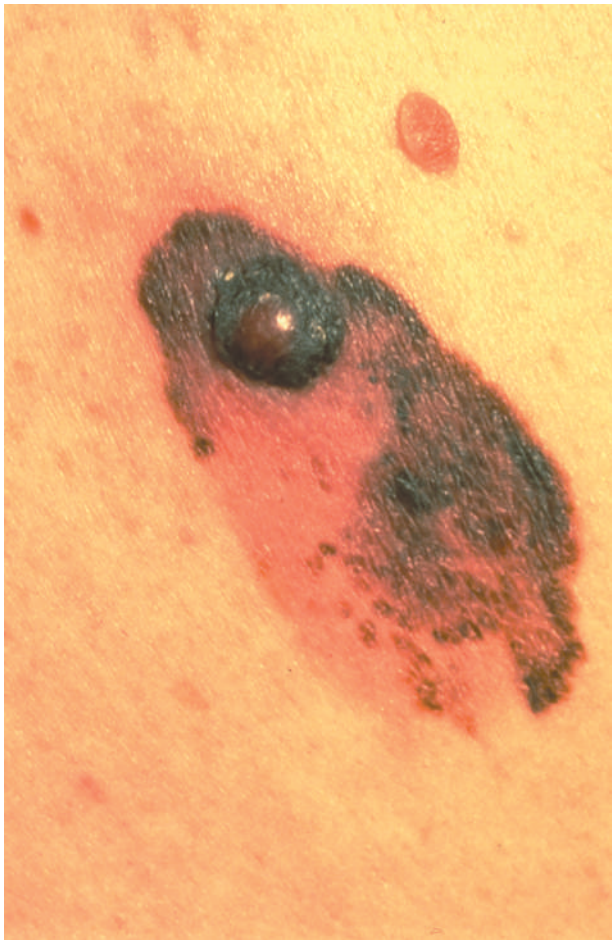
Once the diagnosis is obtained, careful examination of the patient for regional lymph node involvement should be done. A careful review to uncover any symptoms of widespread disease is also appropriate.

The more common patient has an early melanoma, and extensive testing is not usually warranted. Routine testing in this situation involves a complete **blood count**, a **chest x ray**, and determinations of blood enzymes including lactic dehydrogenase and alkaline phosphatase.

If the patient has signs or symptoms of more advanced disease, or if the lesion's depth of penetration is sizeable, further imaging studies may be appropriate. These would involve CAT scans of the abdomen, the chest, or regional nodal areas, or a CT or MRI of the brain.

Treatment

The key to successful treatment is early diagnosis. Patients identified with localized, thin, small lesions (typified by superficial spreading subtype) nearly always survive. For those with advanced lesions, the outcome is poor in spite of progress in systemic therapy.



A close-up image of a malignant melanoma on a patient's back. *(Custom Medical Stock Photo. Reproduced by permission.)*

Clinical staging

Malignant melanoma is locally staged based on the depth of penetration through the skin and its appendages. There are two ways of looking at the depth of penetration. The Clarke system utilizes the layers of the dermis and the skin appendages present at that layer to identify the depth of penetration. The Breslow system uses the absolute measurement of depth. Though useful conceptually, the Clarke system is used less frequently because of the fact that skin is of different thickness in different regions of the body. The depth of penetration is much greater when the tumor reaches the subcutaneous fat when the skin involved is the back as opposed to the face. It turns out that the Breslow measurement is more reproducible and thus more useful; therefore, for purposes here, depth of penetration by absolute measurement (Breslow) is used in local staging.

Stage I and stage II have no involvement of the regional lymph nodes and are thus localized to the site of

KEY TERMS

Adjuvant therapy—Therapy administered to patients who are at risk of having microscopic untreated disease present but have no manifestations.

Dermis—The deeper portion or layer of the skin.

Dysplastic nevus syndrome—A familial syndrome characterized by the presence of multiple atypical appearing moles, often at a young age.

Epidermis—The superficial layer of the skin.

Genome—Composed of DNA, the genome is the genetic makeup of the cell.

Immunotherapy—Therapy using biologic agents that either enhance or stimulate normal immune function.

Integument—The skin.

Lymph node dissection—Surgical removal of an anatomic group of lymph nodes.

Lymphedema—Swelling of an extremity following surgical removal of the lymph nodes draining that extremity.

Melanocyte—Cells derived from the neural crest that are in the skin and produce the protein pigment melanin.

Metastasis—A tumor growth or deposit that has spread via lymph or blood to an area of the body remote from the primary tumor.

Nevus—A mole.

Resection—The act of removing something surgically.

Skin appendages—Structures related to the integument such as hair follicles and sweat glands.

Systemic disease—Used to refer to a patient who has distant metastasis.

Variegation—Patchy variation.

origin. These stages are subdivided on the basis of penetration. Stage Ia is 0.75 mm or less (1 mm = 0.04 in), and Stage Ib is 0.75 mm to 1.5 mm penetration. Stage IIa is 1.5 mm to 4.0 mm and Stage IIb is over 4.0 mm or into the subcutaneous fat. In stage III and IV, there is disease beyond the primary site. Stage III is defined by the presence of in-transit or regional nodal metastasis or both. Stage IV is defined by the presence of distant metastasis.

Once the diagnosis of malignant melanoma has been established by biopsy and the stage has been identified using the results of the examination and studies, a treatment plan is developed. Melanoma is not cured unless it is diagnosed at a stage when it can be isolated and removed surgically. Considerations revolve around the extent of the local and regional nodal surgery for stages I through III. For stage IV patients, or those that are treated and then develop recurrence at distant sites, **chemotherapy** or immunotherapy is planned. Studies are in progress to improve the results from traditional chemotherapeutic regimens. Adjuvant therapy (auxiliary drug treatment used to make possibility of relapse less for those at high risk) is also considered.

Surgical therapy for the primary site is that of wide local removal of the skin including subcutaneous tissue surrounding the lesion. In the past, wide excisions were large and encompassed 2 in (5 cm) of tissue in all directions wherever feasible. It has been shown that such wide local excisions are not necessary and the issue has become: how wide is enough? Studies from the World Health Organization Melanoma Group and by the Melanoma Intergroup Committee in the United States have provided general guidelines based on the depth of penetration of the melanoma. These guidelines and anatomic considerations need to be kept in mind by the surgeon.

The next issue in primary management is whether or not the patient needs to have the regional lymph nodes removed in addition to treatment of the primary tumor. The problems associated with the resection of regional lymph nodes are those of lifelong **edema** or swelling in the extremity. Though it does not occur in all patients (5% to 20%, depending on the extremity and extent of the dissection), it can be a disabling symptom. Certainly, if it could be ascertained that there was disease in the nodes, resection (removal) would be appropriate. However, if there was no disease, the risk of edema should be avoided. In patients with no signs of regional disease, depth of penetration of the primary tumor helps guide the decision. If the tumor penetrates less than 1mm, dissection is not usually done. If it is 1-2 mm, node dissection may be done at the time of primary treatment or the patient may be observed and only undergo lymph node dissection if the area later shows signs of disease. If the patient has enlarged lymph nodes or the depth of the tumor has led to the evaluation by CAT scan showing enlarged nodes, resection of the nodes will be considered. In the latter case, more exten-

sive imaging of the lung, liver, or brain may be appropriate to be sure the patient doesn't already have stage IV disease.

Questions related to which patients should have resection of regional lymph nodes have led to an intermediary procedure known as sentinel node mapping and biopsy. Intermediate thickness melanomas between 1 and 4 mm deep (0.04 and 0.16 in) may have nodal involvement even if the exam and any other studies done are normal. If a radioisotope tracer or blue dye is injected into the area of the primary tumor, very shortly it will travel to the lymph nodes draining that area. These sentinel nodes are thus identifiable and are the most likely to harbor any regional metastatic disease. If these nodes alone are biopsied and are normal, the rest of the lymph node group can be spared. If they show microscopic deposits of tumor, then the full resection of the lymph node group may be completed. This procedure allows selection of those patients with intermediate thickness melanoma who will benefit from the regional lymph node dissection.

Patients with metastatic melanoma who do not respond well to other therapies may be candidates for treatment with aldesleukin. Aldesleukin is a form of interleukin, a specific kind of biological response modifier that promotes the development of T-cells. These cells are part of the lymphatic system and can directly interact with and fight cancer cells. Although aldesleukin is produced naturally in the body, its therapeutic form is developed via biotechnology in a laboratory setting. Treatment is considered palliative, which means that it provides comfort but does not produce a cure. Side effects, however, can be severe, and range from flu-like symptoms to whole-body infection (**sepsis**) and **coma**.

Some patients, such as those with IIb or stage III melanoma, are at high risk for the development of recurrence after treatment. Although these patients are clinically free of disease after undergoing primary treatment, they are more likely to have some microscopic disease in the body that studies have not yet been able to identify. In an effort to decrease the rate of relapse, adjuvant therapy may be considered. Interferon alpha 2a is an agent that stimulates the immune system. This adjuvant therapy may slightly increase the duration of a patient's disease-free state and lengthen overall survival. However, interferon alpha 2a has high toxicity and patients may not tolerate the side effects.

Unfortunately, treatment for those patients who present with or go on to develop systemic disease usually fails. The chemotherapeutic agent dacarbazine, or DTIC, seems to be the most active agent. Overall responses are noted in about 20% of patients, and they last only two to six months. Combination therapy may be an option. The regimen of DTIC + BCNU (carmustine) + cisplatin + tamoxifen delivers a response rate of 40%. Combining biologic or immunologic agents such as interferon with standard chemotherapeutic agents is under study and showing improved response rates. However, toxicity is substantial and only healthier, younger patients tolerate the treatment.

Alternative treatment

Though **radiation therapy** has a minimal role in the primary treatment of malignant melanoma, for patients who have metastatic disease, radiation may be helpful. This is true in patients who have developed tumor deposits in areas such as the brain or the bone.

Prognosis

Almost all patients survive stage Ia malignant melanoma, and the suvivorship for stage I overall is more than 90%. Survival drops in stage IIa to about 65% at five years and is worse yet for stage IIb at slightly over 50%. Stage III has a survival rate at 5 years of 10% to 47%, depending on the size and number of regional nodes involved. Stage IV malignant melanoma is almost always a fatal disease.

Coping with cancer treatment

For those with familial tendencies for malignant melanoma, **genetic counseling** may be appropriate. Psychological counseling may be appropriate for anyone having trouble coping with a potentially fatal disease. Local cancer support groups may be helpful and are often identified by contacting local hospitals or the American Cancer Society.

Prevention

Though it is difficult to prove that **sunscreens** statistically reduce the frequency of malignant melanoma at this time, most authorities recommend use as protection from ultraviolet light (considered a major factor in the development of melanoma.) Avoidance of severe sunburns is recommended.

Resources

BOOKS

Abeloff, Armitage, Lichter, and Niederhuber. *Clinical Oncology Library,* 2nd ed. London: Churchill Livingstone, 1999.

Schwartz, Shires, Daly, et al, ed. *Principles of Surgery.* New York: McGraw Hill, 1999.

PERIODICALS

Agarwala, Sanjiv S., and John M. Kirkwood. "Adjuvant Therapy of Melanoma." *Seminars in Surgical Oncology* 14, no. 4 (June 1998): 302-10.

Averbrook, Bruce J., Leo J. Russo, and Edward G. Mansour. "A Long-Term Analysis of 620 Patients with Malignant Melanoma at a Major Referral Center." *Surgery* 124 (October 1998): 739

Cascinelli, Natale. "Margin of Resection in the Management of Primary Melanoma." *Seminars in Surgical Oncology* 14, no. 4 (June 1998): 272-75.

Gilchrest, B.A., et al. "The Pathogenesis of Melanoma Induced by Ultraviolet Radiation." *New England Journal of Medicine* 340 (29 April, 1999): 17.

Grin, Caron M., and Marti Rothe. "Pigmented Lesions: Innocent or Deadly?" *Consultant* 40 (February 2000): 304.

Joseph, Emmanuella, et. al. "Results of Complete Lymph Node Dissection in 83 Melanoma Patients with Positive Sentinel Nodes." *Annals of Surgical Oncology* 5, no. 2 (Mar. 1998): 119-25.

Karakousis, Constantine P., "Therapeutic Node Dissections in Malignant Melanoma." *Seminars in Surgical Oncology* 5, no. 6 (Sept. 1998): 473-82.

Langley, Richard G.B., and Arthur J. Sober. "Clinical Recognition of Melanoma and its Precursors" *Hematology/Oncology Clinics of North America* 12, no. 4 (August 1998).

Nathan, Faith E., and Michael J. Mastrangelo. "Systemic Therapy in Melanoma" *Seminars in Surgical Oncology* 14, no. 4 (June 1998): 319-27.

Weinstock, Martin A. "Early Detection of Melanoma." *JAMA, The Journal of the American Medical Association* 284 (16 August 2000): 886.

OTHER

Cancer Resource Center American Cancer Society. 20 June 2001 <http://www3.cancer.org/cancerinfo>.

Melanoma Patient's Information Page 20 June 2001 <http://www.mpip.org>.

National Cancer Institute. 13 June 2001 <http://rex.nci.nih.gov/PATIENTS/INFO_PEOPL_DOC.html>.

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Malignant plasmacytoma *see* **Multiple myeloma**

Malingering

Definition

In the context of medicine, malingering is the act of intentionally feigning or exaggerating physical or psychological symptoms for personal gain.

Description

People may feign physical or psychological illness for any number of reasons. Faked illness can get them out of work, military duty, or criminal prosecution. It can also help them obtain financial compensation through insurance claims, lawsuits, or workers' compensation. Feigned symptoms may also be a way of getting the doctor to prescribe certain drugs.

According to the American Psychiatric Association, patients who malinger are different from people who invent symptoms for sympathy (factitious diseases). Patients who malinger clearly have something tangible to gain. People with factitious diseases appear to have a need to play the "sick" role. They may feign illness for attention or sympathy.

Malingering may take the form of complaints of chronic **whiplash pain** from automobile accidents. Whiplash claims are controversial. Although some people clearly do suffer from whiplash injury, others may be exaggerating the pain for insurance claims or lawsuits. Some intriguing scientific studies have shown that chronic whiplash pain after automobile accidents is almost nonexistent in Lithuania and Greece. In these countries, the legal systems do not encourage personal injury lawsuits or financial settlements. The psychological symptoms experienced by survivors of disaster (**post-traumatic stress disorder**) are also faked by malingerers.

Causes and symptoms

People malinger for personal gain. The symptoms may vary. Generally malingerers complain of psychological disorders such as **anxiety**. They may also complain of chronic pain for which objective tests such as x rays can find no physical cause. Because it is often impossible to determine who is malingering and who is not, it is impossible to know how frequently malingering occurs.

Diagnosis

Malingering may be suspected:

- when a patient is referred for examination by an attorney
- when the onset of illness coincides with a large financial incentive, such as a new disability policy
- when objective medical tests do not confirm the patient's complaints
- when the patient does not cooperate with the diagnostic work-up or prescribed treatment
- when the patient has antisocial attitudes and behaviors (antisocial personality)

The diagnosis of malingering is a challenge for doctors. On the one hand, the doctor does not want to overlook a treatable disease. On the other hand, he or she does not want to continue ordering tests and treatments if the symptoms are faked. Malingering is difficult to dis-

KEY TERMS

Antisocial personality—A personality characterized by attitudes and behaviors at odds with society's customs and moral standards, including illegal acts.

Factitious diseases—Conditions in which symptoms are deliberately manufactured by patients in order to gain attention and sympathy. Patients with factitious diseases do not fake symptoms for obvious financial gain or to evade the legal system.

Post traumatic stress disorder (PTSD)—A disorder that occurs among survivors of severe environmental stress such as a tornado, an airplane crash, or military combat. Symptoms include anxiety, insomnia, flashbacks, and nightmares. Patients with PTSD are unnecessarily vigilant; they may experience survivor guilt, and they sometimes cannot concentrate or experience joy.

tinguish from certain legitimate **personality disorders**, such as factitious diseases or post-traumatic distress syndrome. In legal cases, malingering patients may be referred to a psychiatrist. Psychiatrists use certain written tests to try to determine whether the patient is faking the symptoms.

Treatment

In a sense, malingering cannot be treated because the American Psychiatric Association does not recognize it as a personality disorder. Patients who are purposefully faking symptoms for gain do not want to be cured. Often, the malingering patient fails to report any improvement with treatment, and the doctor may try many treatments without success.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Resnick, Phillip J. "Malingered Psychosis." In *Clinical Assessment of Malingering and Deception*. 2nd ed. Ed. Richard Rogers. New York: Gilford Publications, 1997.

PERIODICALS

Klass, Peri. "How Sick Is It to Want to Be Sick?" *Discover* 78 (Jan. 1986): 20-21.

Resnick, Phillip J. "Defrocking the Fraud." *Israel Journal of Psychiatry and Related Sciences* 30 (1993): 93-101.

Schrader, H., et al. "Natural Evolution of Late Whiplash Syndrome Outside the Medicolegal Context." *The Lancet* 347 (4 May 1996): 1207-1211.

"Two New Studies Question Basis for Whiplash Claims." *The Back Letter* 12 (Dec. 1997): 133-34.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

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Mallet finger

Definition

Mallet finger refers to the involuntary flexion of the distal phalanx of a finger caused by the disruption or tearing of its extensor tendon.

Description

Tendons are the strong "cables" between muscles and bones that help control movements of the body. They consist of white, glistening, fibrous cords, of various length and thickness, either round or flattened, and lacking in elasticity. In mallet finger, which often occurs as a sports-related injury, the tendon on the back of the finger becomes damaged or torn near the outermost joint. Without the support provided by the tendon, the short bone at the tip of the finger drops downward at an awkward angle. This bone, referred to as the "distal phalanx" of a finger, is the one furthest from the palm. In addition to tendon damage, mallet finger may involve a fracture of the distal phalanx. Mallet finger is sometimes called baseball finger.

Causes and symptoms

Mallet finger usually occurs while playing a sport that involves a ball—for example, reaching out to catch a hard pass in basketball or bare-handing a baseball. Instead of landing on the palm of the hand, the ball accidentally hits the tip of an extended (or partially extended) finger. This straight-on impact causes instantaneous stretch of the tendon, which may overextend or tear away. Mallet finger can also result from hitting the hand against a hard object or receiving a cut from a sharp edge such as a knife.

Symptoms of mallet finger include **pain** and swelling around the top part of the finger, near the outermost joint. These symptoms occur right after the injury. Redness and swelling develop soon afterward. The tip of the finger has an abnormal-looking downward droop, and it may be difficult to fully extend the finger.

KEY TERMS

Distal Phalanx—The outermost bone of any finger or toe.

Fracture—A break in bone.

Orthopedist—A doctor who specializes in disorders of the musculoskeletal system.

Phalanx—Any of the digital bones of the hand or foot. Humans have three phalanxes to each finger and toe with the exception of the thumb and big toe which have only two each.

Tendon—A tough cord of dense white fibrous connective tissue that connects a muscle with some other part, especially a bone, and transmits the force which the muscle exerts.

Diagnosis

Mallet finger is usually diagnosed after a relatively brief **physical examination** conducted by an emergency care physician or by an orthopedist, the type of doctor who specializes in such injuries. The downward droop of the fingertip is the major indication of mallet finger, along with the tenderness and pain that occurs in the affected area. X rays will be taken to determine if the bone at the top of the finger has been fractured. Mallet finger is typically covered by medical insurance.

Treatment

If symptoms of mallet finger appear, the affected individual should consult a physician or seek emergency care. In the meantime, ice (wrapped in a towel or cloth) can be applied to the affected area to help reduce swelling and alleviate pain.

Treatment usually involves wearing a splint around the top of the affected finger in order to keep it extended and allow the injury to heal. The splint must be worn at all times for six to eight weeks, though it may be briefly removed to wash the finger, but with extreme care so as not to allow the fingertip to bend. For the next six to eight weeks after that, the splint need only be worn during sleep or athletic activities.

If the bone at the top of the finger has sustained a large fracture, surgery may be necessary. If the tendon was damaged due to a cut, stitches may be required both to repair the tendon and to adequately close the wound.

Over-the-counter (OTC) or prescription pain medication can be used to alleviate pain.

Alternative treatment

Acupuncture, therapeutic massage, and **yoga** are believed by some practitioners of alternative medicine to have generalized pain-relieving effects. Any of these therapies may provide additional comfort while the finger heals.

Prognosis

With proper treatment, most people regain full use of the affected finger.

Prevention

Caution should be used when playing ball sports or using knives or other sharp implements.

Resources

BOOKS

Brukner, Peter, et al. *Clinical Sports Medicine* McGraw-Hill, 2000.

PERIODICALS

Lester B, et al. "A simple effective splinting technique for the mallet finger." *American Journal of Orthopedics* (March 2000): 202-6.

Takami H, et al. "Operative treatment of mallet finger due to intra-articular fracture of the distal phalanx." *Archives of Orthopaedic and Trauma Surgery* 120 (2000): 9-13.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018-4262. (800) 346-AAOS. <http://www.aaos.org>.

Greg Annussek

Mallory-Weiss syndrome

Definition

Mallory-Weiss syndrome is bleeding from an arterial blood vessel in the upper gastrointestinal tract, caused by a mucosal gastric tear at or near the point where the esophagus and stomach join.

Description

Mallory-Weiss syndrome causes about 5% of all upper gastrointestinal bleeding. The condition was originally diagnosed in alcoholics and is associated with heavy alcohol use, although it can also be found in patients who are not alcoholics. Earlier episodes of heavy

hiccupping, vomiting, and retching are reported by about half the patients who are diagnosed with Mallory-Weiss syndrome. It is thought that the tear or laceration occurs when there is a sudden increase in intra-abdominal pressure. Patients with increased pressure in the vein leading into the liver (portal **hypertension**) are more likely to bleed heavily from an esophageal laceration than those whose blood pressure is normal.

Causes and symptoms

In Mallory-Weiss syndrome, a tear occurs in the gastric mucosa, near where the esophagus and stomach join. About 10% of the tears are in the esophagus. Most are either right at the junction of the esophagus and stomach or in the stomach just slightly below the junction.

Bleeding from the tear causes a disruption in fluid and electrolyte balance of the body. The patient often produces vomit tinged with either fresh blood or older, blackish blood. Blood loss can be considerable.

Diagnosis

A Mallory-Weiss syndrome tear is not visible on standard upper gastrointestinal x rays. A tear about one-eighth to one and one-half inches long (0.5-4 cm) is revealed by endoscopy. Endoscopy also shows that in 35% of patients there is another potential cause for gastrointestinal bleeding, such as peptic ulcer, erosive **gastritis**, or esophageal varices.

Treatment

The patient is resuscitated and stabilized with blood transfusions and intravenous fluids to restore the fluid and electrolyte balance. Most of the time, esophageal bleeding stops spontaneously. When bleeding does not stop, patients are treated with an injection of epinephrine (adrenaline) and/or the bleeding artery is cauterized with heat. If these treatments fail, surgery is performed to stop the bleeding.

Prognosis

In 90-95% of patients whose bleeding does not stop spontaneously, cauterization without surgery will stop the bleeding. Patients at highest risk for a recurrence of bleeding are those with portal hypertension.

Prevention

Mallory-Weiss syndrome is associated with **alcoholism**. Limiting alcohol intake may help prevent the disorder.

KEY TERMS

Electrolytes—Salts and minerals that can conduct electrical impulses in the body. Common human electrolytes are sodium chloride, potassium, calcium, and sodium bicarbonate. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost every major biochemical reaction in the body.

Endoscopy—A procedure in which an instrument containing a camera and a light source is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

Esophageal varix—An enlarged vein of the esophagus. (Plural: esophageal varices.)

Portal hypertension —High blood pressure in the portal vein, which carries blood from the abdominal organs to the liver.

Resources

BOOKS

"Esophageal Laceration and Rupture." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Mallory-Weiss Syndrome." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Tish Davidson

Malnutrition

Definition

Malnutrition is the condition that develops when the body does not get the right amount of the **vitamins**, **minerals**, and other nutrients it needs to maintain healthy tissues and organ function.

Description

Undernutrition

Malnutrition occurs in people who are either undernourished or over-nourished. Undernutrition is a consequence of consuming too few essential nutrients or using or excreting them more rapidly than they can be replaced.

Infants, young children, and teenagers need additional nutrients. So do women who are pregnant or

breastfeeding. Nutrient loss can be accelerated by **diarrhea**, excessive sweating, heavy bleeding (hemorrhage), or kidney failure. Nutrient intake can be restricted by age-related illnesses and conditions, excessive dieting, severe injury, serious illness, a lengthy hospitalization, or substance abuse.

The leading cause of **death** in children in developing countries is **protein-energy malnutrition**. This type of malnutrition is the result of inadequate intake of calories from proteins, vitamins, and minerals. Children who are already undernourished can suffer from protein-energy malnutrition when rapid growth, infection, or disease increases the need for protein and essential minerals.

Overnutrition

In the United States, nutritional deficiencies have generally been replaced by dietary imbalances or excesses associated with many of the leading causes of death and disability. Overnutrition results from eating too much, eating too many of the wrong things, not exercising enough, or taking too many vitamins or other dietary replacements.

Risk of overnutrition is also increased by being more than 20% overweight, consuming a diet high in fat and salt, and taking high doses of:

- nicotinic acid (niacin) to lower elevated cholesterol levels
- vitamin B_6 to relieve **premenstrual syndrome**
- vitamin A to clear up skin problems
- iron or other trace minerals not prescribed by a doctor

Nutritional disorders can affect any system in the body and the senses of sight, taste, and smell. Malnutrition begins with changes in nutrient levels in blood and tissues. Alterations in enzyme levels, tissue abnormalities, and organ malfunction may be followed by illness and death.

Causes and symptoms

Poverty and lack of food are the primary reasons why malnutrition occurs in the United States. Ten percent of all members of low income households do not always have enough healthful food to eat, and malnutrition affects one in four elderly Americans. Protein-energy malnutrition occurs in 50% of surgical patients and in 48% of all other hospital patients.

There is an increased risk of malnutrition associated with chronic diseases, especially disease of the intestinal tract, kidneys, and liver. Patients with chronic diseases like **cancer**, **AIDS**, and intestinal disorders may lose weight rapidly and become susceptible to undernourishment because they cannot absorb valuable vitamins, calories, and iron.

People with drug or alcohol dependencies are also at increased risk of malnurtrition. These people tend to maintain inadequate **diets** for long periods of time and their ability to absorb nutrients is impaired by the alcohol or drug's affect on body tissues, particularly the liver, pancreas, and brain.

Unintentionally losing 10 pounds or more may be a sign of malnutrition. People who are malnourished may be skinny or bloated. Their skin is pale, thick, dry, and **bruises** easily. **Rashes** and changes in pigmentation are common.

Hair is thin, tightly curled, and pulls out easily. Joints ache and bones are soft and tender. The gums bleed. The tongue may be swollen or shriveled and cracked. Visual disturbances include night blindness and increased sensitivity to light and glare.

Other symptoms of malnutrition include:

- anemia
- diarrhea
- disorientation
- goiter (enlarged thyroid gland)
- loss of reflexes and lack of coordination
- muscle twitches
- scaling and cracking of the lips and mouth

Malnourished children may be short for their age, thin, listless, and have weakened immune systems.

Diagnosis

Overall appearance, behavior, body-fat distribution, and organ function can alert a family physician, internist, or **nutrition** specialist to the presence of malnutrition. Patients may be asked to record what they eat during a specific period. X rays can determine bone density and reveal gastrointestinal disturbances, and heart and lung damage.

Blood and urine tests are used to measure levels of vitamins, minerals, and waste products. Nutritional status can also be determined by:

- comparing a patient's weight to standardized charts
- calculating body mass index (BMI) according to a formula that divides height into weight
- measuring skin-fold thickness or the circumference of the upper arm

Treatment

Normalizing nutritional status starts with a nutritional assessment. This process enables a clinical nutritionist

or registered dietician to confirm the presence of malnutrition, assess the effects of the disorder, and formulate diets that will restore adequate nutrition.

Patients who cannot or will not eat, or who are unable to absorb nutrients taken by mouth, may be fed intravenously (parenteral nutrition) or through a tube inserted into the gastrointestinal (GI) tract (enteral nutrition).

Tube feeding is often used to provide nutrients to patients who have suffered **burns** or who have inflammatory bowel disease. This procedure involves inserting a thin tube through the nose and carefully guiding it along the throat until it reaches the stomach or small intestine. If long-term tube feeding is necessary, the tube may be placed directly into the stomach or small intestine through an incision in the abdomen.

Tube feeding cannot always deliver adequate nutrients to patients who:

- are severely malnourished
- require surgery
- are undergoing **chemotherapy** or radiation treatments
- have been seriously burned
- have persistent diarrhea or vomiting
- whose gastrointestinal tract is paralyzed

Intravenous feeding can supply some or all of the nutrients these patients need.

Prognosis

Up to 10% of a person's body weight can be lost without side effects, but if more than 40% is lost, the situation is almost always fatal. Death usually results from **heart failure**, electrolyte imbalance, or low body temperature. Patients with semiconsciousness, persistent diarrhea, **jaundice**, or low blood sodium levels have a poorer prognosis.

Some children with protein-energy malnutrition recover completely. Others have many health problems throughout life, including **mental retardation** and the inability to absorb nutrients through the intestinal tract. Prognosis for all patients with malnutrition seems to be dependent on the age of the patient, and the length and severity of the malnutrition, with young children and the elderly having the highest rate of long-term complications and death.

Prevention

Breastfeeding a baby for at least six months is considered the best way to prevent early-childhood malnutrition. The United States Department of Agriculture and Health and Human Service recommend that all Americans over the age of two:

- consume plenty of fruits, grains, and vegetables
- eat a variety of foods that are low in fats and cholesterols and contain only moderate amounts of salt, sugars, and sodium
- engage in moderate physical activity for at least 30 minutes, at least several times a week
- achieve or maintain their ideal weight
- use alcohol sparingly or avoid it altogether

Every patient admitted to a hospital should be screened for the presence of illnesses and conditions that could lead to protein-energy malnutrition. Patients with higher-than-average risk for malnutrition should be more closely assessed and reevaluated often during long-term hospitalization or nursing-home care.

Resources

BOOKS

Andersen, Jean, and Barbara Deskins. *The Nutrition Bible*. New York: William Morrow and Co., 1995.

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck Research Laboratories, Inc., 1997.

The Surgeon General's Report on Nutrition and Health. Rocklin, CA: Prima Publishing and Communications, 1988.

ORGANIZATIONS

American College of Nutrition. 722 Robert E. Lee Drive, Wilmington, NC 20412-0927. (919) 452-1222.

American Institute of Nutrition. 9650 Rockville Pike, Bethesda, MD 20814-3990. (301) 530-7050.

Food and Nutrition Information Center. 10301 Baltimore Boulevard, Room 304, Beltsville, MD 20705-2351. <http://www.nalusda.gov/fnic>.

OTHER

"Malnutrition." Nutrition Page. Uppsala University. 3 May 1998 <http://www.nutrition.uu.se>.

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

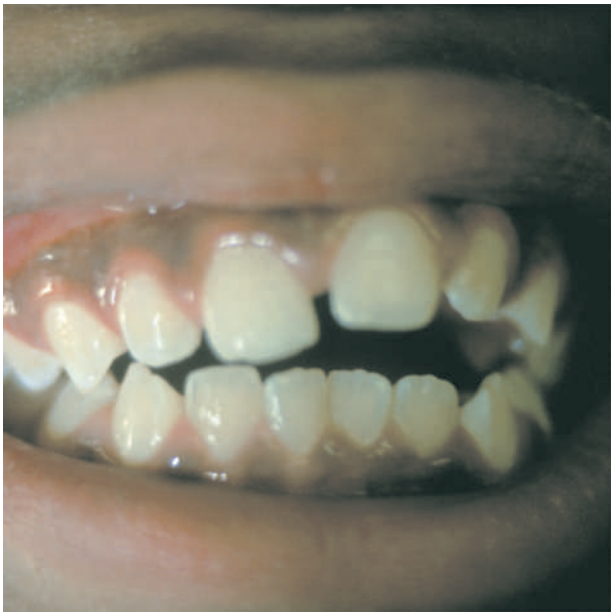
Mary K. Fyke

Malocclusion

Definition

Malocclusion is a problem in the way the upper and lower teeth fit together in biting or chewing. The word malocclusion literally means "bad bite." The condition

Orthodontia treatments usually include the use of braces and retainers. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission).*



This patient's teeth are misarranged because of excessive thumb sucking. *(Custom Medical Stock Photo. Reproduced by permission.)*

may also be referred to as an irregular bite, crossbite, or overbite.

Description

Malocclusion may be seen as crooked, crowded, or protruding teeth. It may affect a person's appearance, speech, and/or ability to eat.

Causes and symptoms

Malocclusions are most often inherited, but may be acquired. Inherited conditions include too many or too few teeth, too much or too little space between teeth, irregular mouth and jaw size and shape, and atypical formations of the jaws and face, such as a cleft palate. Malocclusions may be acquired from habits like finger or thumb sucking, tongue thrusting, premature loss of teeth from an accident or dental disease, and medical conditions such as enlarged tonsils and adenoids that lead to mouth breathing.

Malocclusions may be symptomless or they may produce **pain** from increased **stress** on the oral structures. Teeth may show abnormal signs of wear on the chewing surfaces or decay in areas of tight overlap. Chewing may be difficult.

Diagnosis

Malocclusion is most often found during a routine dental examination. A dentist will check a patient's occlusion by watching how the teeth make contact when the patient bites down normally. The dentist may ask the patient to bite down with a piece of coated paper between the upper and lower teeth; this paper will leave colored marks at the points of contact. When malocclusion is suspected, photographs and x rays of the face and mouth may be taken for further study. To confirm the presence and extent of malocclusion, the dentist makes plaster, plastic, or artificial stone models of the patient's teeth from impressions. These models duplicate the fit of the teeth and are very useful in treatment planning.

Treatment

Malocclusion may be remedied by orthodontic treatment; orthodontics is a specialty of dentistry that manages the growth and correction of dental and facial structures. Braces are the most commonly used orthodontic appliances in the treatment of malocclusion. At any given time, approximately 4 million people in the United States are wearing braces, including 800,000 adults.

Braces apply constant gentle force to slowly change the position of the teeth, straightening them and properly aligning them with the opposing teeth. Braces consist of brackets cemented to the surface of each tooth and wires of stainless steel or nickel titanium alloy. When the wires are threaded through the brackets, they exert pressure against the teeth, causing them to gradually move.

Braces are not removable for daily tooth brushing, so the patient must be especially diligent about keeping the mouth clean and removing food particles which become easily trapped, to prevent **tooth decay**. Foods that are crunchy should be avoided to minimize the risk of breaking the appliance. Hard fruits, vegetables, and breads must be cut into bite-sized pieces before eating. Foods that are sticky, including chewing gum, should be avoided because they may pull off the brackets or weaken the cement. Carbonated beverages may also weaken the cement, as well as contribute to tooth decay. Teeth should be brushed immediately after eating sweet foods. Special floss threaders are available to make flossing easier.

If overcrowding is creating malocclusion, one or more teeth may be extracted (surgically removed), giving the others room to move. If a tooth has not yet erupted or is prematurely lost, the orthodontist may insert an appliance called a space maintainer to keep the other teeth from moving out of their natural position. In severe cases of malocclusion, surgery may be necessary and the patient would be referred to yet another specialist, an oral or maxillofacial surgeon.

Once the teeth have been moved into their new position, the braces are removed and a retainer is worn until the teeth stabilize in that position. Retainers do not move teeth, they only hold them in place.

Orthodontic treatment is the only effective treatment for malocclusion not requiring surgery. However, depending on the cause and severity of the condition, an orthodontist may be able to suggest other appliances as alternatives to braces.

Alternative treatment

There are some techniques of **craniosacral therapy** that can alter structure. This therapy may allow correction of some cases of malocclusion. If surgery is required, pre- and post-surgical care with homeopathic remedies, as well as vitamin and mineral supplements, can enhance recovery. Night guards are sometimes recommended to ease the strain on the jaw and to limit teeth grinding.

Prognosis

Depending on the cause and severity of the malocclusion and the appliance used in treatment, a patient may expect correction of the condition to take 2 or more years. Patients typically wear braces 18-24 months and a retainer for another year. Treatment is faster and more successful in children and teens whose teeth and bones are still developing. The length of treatment time is also affected by how well the patient follows orthodontic instructions.

KEY TERMS

Braces—An orthodontic appliance consisting or brackets cemented to the surface of each tooth and wires of stainless steel or nickel titanium alloy. Braces are used to treat malocclusion by changing the position of the teeth.

Impression—An imprint of the upper or lower teeth made in a pliable material that sets. When this material has hardened, it may be filled with plaster, plastic, or artificial stone to make an exact model of the teeth.

Occlusion—The way the upper and lower teeth fit together in biting or chewing.

Retainer—An orthodontic appliance that is worn to stabilize teeth in a new position.

Space maintainer—An orthodontic appliance that is worn to prevent adjacent teeth from moving into the space left by an unerupted or prematurely lost tooth.

Prevention

In general, malocclusion is not preventable. It may be minimized by controlling habits such as finger or thumb sucking. An initial consultation with an orthodontist before a child is 7 years old may lead to appropriate management of the growth and development of the child's dental and facial structures, circumventing many of the factors contributing to malocclusion.

Resources

ORGANIZATIONS

American Association of Oral and Maxillofacial Surgeons. 9700 West Bryn Mawr Ave., Rosemont, IL 60018-5701. (847) 678-6200. <http://www.aaoms.org>.

American Association of Orthodontists. 401 North Lindbergh Boulevard, St. Louis, MO 63141-7816. (314) 993-1700. <http://www.aaortho.org>.

Bethany Thivierge

MALT lymphoma

Definition

MALT lymphomas are solid tumors that originate from cancerous growth of immune cells that are recruited

to secretory tissue such as the gastrointestinal tract, salivary glands, lungs, and the thyroid gland.

Description

The digestive tract is generally not associated with lymphoid tissue, with the exception of small collections of lymphocytes such as Peyer's patches. A specific kind of white blood cell, B-lymphocytes, can accumulate in response to infections of the digestive tract and other secretory tissues, or as a result of autoimmune conditions such as Sj"gren's syndrome. When the growth of these lymphocytes is maintained through continued infection or autoimmune disease, a malignant cell can arise and replace the normal lymphocytes. These lymphomas, derived from mucosa-associated lymphoid tissue (MALT), most commonly arise in the stomach. Their growth seems to be dependent upon continuous stimulation of the immune system by an infectious agent, such as H. pylori, or some other entity, termed an antigen, that the body recognizes as foreign. This antigen-driven growth permits these tumors to be treated by eliminating the stimulus that generated the original, normal immune response. In the stomach they are associated, in greater than 90% of all cases, with the bacteria called Helicobacter pylori (H. pylori). This bacteria is also associated with peptic stomach irritation, ulcers, and gastric **cancer**. MALT lymphomas are generally indolent, that is, they grow slowly and cause little in the way of symptoms. Those MALT lymphomas that arise in the stomach in response to H. pylori infections are generally successfully treated with **antibiotics**, which eliminate the bacteria.

Demographics

MALT lymphomas occur at a frequency of about 1.5 per 100,000 people per year in the United States and account for about 10% of all non-Hodgkin's lymphomas. The frequency varies among different populations. For example, in parts of Italy the frequency of MALT lymphomas is as high as 13 per 100,000 people per year. This can in part be attributed to different rates of infection with H. pylori. However, other hereditary, dietary, or environmental factors are almost certainly involved.

Causes and symptoms

The majority of MALT lymphomas appear to be the result of infectious agents, most commonly H. pylori in the stomach. It is not known if infectious agents also cause MALT lymphomas outside of the stomach. In some cases, such as in the thyroid, MALT lymphomas seem to arise in patients who have autoimmune diseases, which make their immune systems treat their own tissue as foreign or antigenic. It is believed that there must be additional factors, in addition to infection or autoimmunity, that influence the development of MALT lymphomas. For example, in the United States, where infections with H. pylori are quite common, less than 1 in 30,000 people who have H. pylori in their stomachs develop MALT lymphomas. In addition, individuals who develop MALT lymphomas are more likely to develop other forms of cancer. This would suggest that there might be genetic factors predisposing individuals to develop MALT lymphomas or other tumors in response to environmental or infectious agents.

In general, patients have stomach **pain**, ulcers, or other localized symptoms, but rarely do they suffer from systemic complaints such as **fatigue** or **fever**.

Diagnosis

The indolent nature of most MALT lymphomas means that the majority of patients are diagnosed at early stages with relatively nonspecific symptoms. In the case of gastric MALT lymphomas, the physician will then have a gastroenterologist perform an endoscopy to examine the interior of the stomach. MALT lymphomas are then recognized as areas of inflammation or ulceration within the stomach. It is unusual for masses recognizable as tumors to be seen upon examination. Definitive diagnosis of MALT lymphoma requires a biopsy, in which a bit of tissue is removed from the stomach or other involved site. Examination of this tissue by a pathologist is the first step in distinguishing among the possible diagnoses of inflammation, indolent lymphoma, or a more aggressive form of cancer, such as gastric cancer or a rapidly growing non-Hodgkin's lymphoma. The pathologist evaluates the type of lymphoid cells that are present in the biopsy to establish the nature of the lesion. In addition, it is essential that the pathologist determine whether or not the lymphoma has grown beyond the borders of the mucosa, which lines the stomach or other gland.

Treatment

The best staging system to employ for MALT lymphomas is still the subject of discussion. However, it is standard practice that patients presenting with MALT lymphomas should be evaluated in a similar manner to individuals with nodal lymphomas, the more common type of lymphoma that originates at sites within the lymphoid system. These procedures include a complete history and physical, blood tests, chest x rays, and bone marrow biopsy. This evaluation will permit the oncologist to determine if the disease is localized or if it has spread to other sites within the body.

In general, the prognosis for patients with MALT lymphomas is good, with overall five-year survival rates

that are greater than 80%. The features that are most closely related to the outlook for newly diagnosed individual patients are: whether the primary site is in the stomach or is extra-gastric; if the disease has spread beyond the initial location; and whether the histologic evaluation of the initial tumor biopsies is consistent with a low-grade, slowly growing lesion, as compared to a high-grade lesion that is more rapidly growing. In general, the histologic grade is the most important feature, with high-grade lesions requiring the most aggressive treatment.

Treatment of MALT lymphomas differs from that of most lymphomas. In the most common type of MALT lymphomas—low-grade lesions originating in the stomach—treatment with antibiotics to eliminate H. pylori leads to complete remissions in the majority of patients. The effectiveness of this treatment is indistinguishable from surgery, **chemotherapy**, **radiation therapy**, or a combination of surgery with drugs or irradiation. Approximately one-third of patients in this group have evidence of disseminated disease, where lymphoma cells are detected at sites in addition to the gastric mucosa. The response of these patients to antibiotic treatment is not significantly different from that for individuals with localized disease. For both groups a complete remission is achieved in about 75% of patients, who remain, on average, free of disease for about 5 years.

KEY TERMS

Antigen—A foreign substance that leads to an immune response, including the production of antibodies by B cells.

Autoimmune disease—A condition in which an individual's immune system reacts to their own tissues, viewing self components as if they were foreign antigens.

Bone marrow biopsy—A procedure in which cellular material is removed from the pelvis or breastbone and examined under a microscope to look for the presence of abnormal blood cells characteristic of specific forms of leukemia and lymphoma.

Indolent lymphoma (also called low-grade)—Cancerous growths of lymphoid tissue that progress slowly to more aggressive forms of cancer.

Lymphoid tissue—Sites within the body that produce cells of the immune system, including lymph nodes, bone marrow, and the thymus.

Prognosis

Patients with MALT lymphomas arising outside of the digestive tract also have good prognoses. Effective treatment for these lymphomas has been achieved with local radiation, chemotherapy, and/or interferon. Surgery followed by chemotherapy or radiation is also effective with nongastrointestinal MALT lymphomas. Overall these patients have five-year survival rates greater than 90%.

While the outlook for patients with MALT lymphomas is good, difficulties in diagnosis and staging have left the optimal treatment a matter of continued study. This is an especially open question for those patients who fail to respond to antibiotic therapy, or whose disease recurs. It may be the case that in these patients, the MALT lymphoma may have already progressed to a point where high-grade lesions, not observed in the original biopsies, were resistant to the initial treatment. The best treatment for these patients remains to be established. In general, these patients are treated with chemotherapy in a similar manner to patients with other types of lymphoma. Given the success of antibiotics, and the good prognosis for gastric MALT lymphomas in general, no sufficient body of evidence exists to determine the best chemotherapy for patients who fail to achieve a complete and lasting remission upon initial treatment. At present, a chemotherapeutic regime designated CHOP includes the anti-cancer drugs cyclophosphamide, doxorubicin, vincristine, and prednisone. Similar drug combinations are being used for patients whose MALT lymphomas do not respond to antibiotic treatment.

Clinical trials are underway and mostly concentrate upon optimizing treatment of gastric MALT lymphomas that involve H. pylori. The aspects of treatment being addressed are the most effective antibiotics and the use of **antacids** to modulate irritation in the stomach. These protocols have been designed to follow the natural history of gastric lymphomas and to establish the biological features that predict treatment response to antibiotics and duration of remission.

Prevention

There are currently no commonly accepted means to prevent MALT lymphomas. While the H. pylori infections are associated with this and other gastric disease, the eradication of H. pylori in asymptomatic individuals is not currently recommended for prevention of MALT lymphomas or gastric cancer.

Resources

BOOKS

Fauci, Anthony S., et al., ed. *Harrison's Principles of Internal Medicine* New York: McGraw-Hill, 1998.

PERIODICALS

Thieblemont, C., et al. "Mucosa-associated Lymphoid Tissue Lymphoma is a Disseminated Disease in One-third of 158 Patients Analyzed." *Blood* 95 (February 2000): 802-6.

Zucca, E., et al. "The Gastric Marginal Zone Lymphoma of MALT Type." *Blood* 96 (July 2000): 410-19.

OTHER

"Low-Grade Non-Hodgkin's Lymphoma: A Year 2000 Perspective." Medscape June 2000. <http://www.medscape.com/medscape/oncology/clinicalmgmt/CM.v03/public/index-CM.v03.html>.

Warren Maltzman, Ph.D.

Malta fever *see* **Brucellosis**

Mammogram screening *see* **Mammography**

Mammography

Definition

Mammography is the study of the breast using x ray. The actual test is called a mammogram. There are two types of mammograms. A screening mammogram is ordered for women who have no problems with their breasts. It consists of two x-ray views of each breast. A diagnostic mammogram is for evaluation of new abnormalities or of patients with a past abnormality requiring follow-up (i.e. a woman with **breast cancer** treated with **lumpectomy**). Additional x rays from other angles or special views of certain areas are taken.

Purpose

The purpose of screening mammography is breast **cancer** detection. A screening test, by definition, is used for patients without any signs or symptoms in order to detect disease as early as possible. Many studies have shown that having regular mammograms increases a woman's chances of finding breast cancer in an early stage, when it is more likely to be curable. It has been estimated that a mammogram may find a cancer as much as two years before it can be felt. The American Cancer Society, American College of Radiology, American College of Surgeons and American Medical Association recommend annual mammograms for every woman beginning at age 40.

Screening mammograms are not usually recommended for women under age 40 who have no special risk factors and a normal physical breast examination. Below age 40, breasts tend to be "radiographically dense," which means it is difficult to see many details. But some differences of opinion exist about the usefulness of screening women between the ages of 40-50. While screening mammograms at 40 can detect cancers in an early stage, some health care providers worry about the increased negative (benign) biopsy rate in this age group.

Some women are at increased risk for developing breast cancer, such as those with multiple relatives who have the disease. Beginning screening mammography at a younger age—generally 10 years younger than the youngest affected relative, but not less than 35 years of age—may be recommended for these women.

Diagnostic mammography is used to evaluate an existing problem, such as a lump, discharge from the nipple, or unusual tenderness in one area. The cause of the problem may be definitively diagnosed from this study, but further investigation using other methods may be necessary. This test is also used to evaluate findings from screening mammography tests.

Description

A mammogram may be offered in a variety of settings. Hospitals, outpatient clinics, physician's offices, or other facilities may have mammography equipment. In the United States, since October 1, 1994, only places certified by the Food and Drug Administration (FDA) are legally permitted to perform, interpret, or develop mammograms.

In addition to the usual paperwork, a woman will be asked to fill out a form seeking information relevant to her risk of breast cancer and special mammography needs. The woman is asked about personal and family history of cancer, details about menstruation, child bearing, birth control, **breast implants**, other breast surgery, age, and **hormone replacement therapy**. Information about Breast Self Examination (BSE) and other breast health issues are usually available at no charge.

At some centers, a technologist may perform a **physical examination** of the breasts before the mammogram. Whether or not this is done, it is essential for the patient to tell the technologist about any lumps, nipple discharge, breast **pain**, or other concerns.

Clothing from the waist up is removed and a hospital gown or similar covering is put on. The woman stands facing the mammography machine. The technologist exposes one breast and places it on a plastic or metal film holder about the size of a placemat. The breast is compressed as flat as possible between the film holder and a rectangle of plastic (called a paddle), which presses down onto the breast from above. The compression should only last a few seconds, just enough to take the x

ray. Good compression can be uncomfortable, but it is necessary to ensure the clearest view of all breast tissues.

Next, the woman is positioned with her side toward the mammography unit. The film holder is tilted so the outside of the breast rests against it, and a corner touches the armpit. The paddle again holds the breast firmly as the x ray is taken. This procedure is repeated for the other breast. A total of four x rays, two of each breast, are taken for a screening mammogram. Additional x rays, using special paddles, different breast positions, or other techniques are usually taken for a diagnostic mammogram.

The mammogram may be seen and interpreted by a radiologist right away, or it may not be reviewed until later. If there are any questionable areas or an abnormality, extra x rays may be recommended. These may be taken during the same appointment. More commonly, especially for screening mammograms, the woman is called back on another day for these additional films.

A screening mammogram usually takes approximately 15 to 30 minutes. A woman having a diagnostic mammogram can expect to spend up to an hour at the mammography facility.

The cost of mammography varies widely. Many mammography facilities accept "self referral." This means women can schedule themselves without a physician's referral. However, some insurance policies do require a doctor's prescription to ensure payment. Medicare will pay for annual screening mammograms for all women with Medicare who are age 40 or older and a baseline mammogram for those age 35 to 39.

A digital mammogram is performed in the same way as a traditional exam, but in addition to the image being recorded on film, it is viewed on a computer monitor and stored as a digital file.

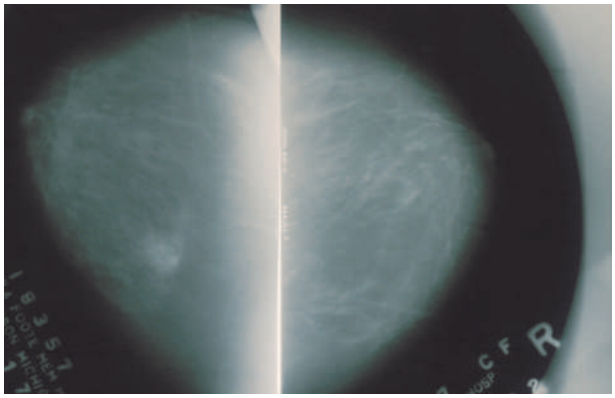
Preparation

The compression or squeezing of the breast necessary for a mammogram is a concern of many women. Mammograms should be scheduled when a woman's breasts are least likely to be tender. One week after the menstrual period is usually best.

Women should not put deodorant, powder, or lotion on their upper body on the day the mammogram is performed. Particles from these products can get on the breast or film holder and may look like abnormalities on the mammogram film.

Aftercare

No special aftercare is required.



Comparison of two mammograms— cancerous tissue is shown on left and normal tissue on right. *(Custom Medical Stock Photo. Reproduced by permission.)*

Risks

The risk of radiation exposure from a mammogram is considered virtually nonexistent. Experts are unanimous that any negligible risk is far outweighed by the potential benefits of mammography.

Some breast cancers do not show up on mammograms, or "hide" in dense breast tissue. A normal (or negative) study is not a guarantee that a woman is cancer-free. Mammograms find about 85% to 90% of breast cancers.

"False positive" readings are also possible, and 5% to 10% of mammogram results indicate the need for additional testing, most of which confirms that no cancer is present.

Normal results

A mammography report describes details about the x-ray appearance of the breasts. It also rates the mammogram according to standardized categories, as part of the Breast Imaging Reporting and Data System (BIRADS) created by the American College of Radiology (ACR). A normal mammogram may be rated as BIRADS 1 or negative, which means no abnormalities were seen. A normal mammogram may also be rated as BIRADS 2 or benign findings. This means that one or more abnormalities were found but are clearly benign (not cancerous), or variations of normal. Some kinds of calcification, lymph nodes, or implants in the breast might generate a BIRADS 2 rating. A BIRADS 0 rating indicates that the mammogram is incomplete and requires further assessment.

Abnormal results

Many mammograms are considered borderline or indeterminate in their findings. BIRADS 3 means an abnormality is present and probably (but not definitely)

KEY TERMS

Breast biopsy—A procedure in which suspicious tissue is removed and examined by a pathologist for cancer or other disease. The breast tissue may be obtained by open surgery or through a needle.

Radiographically dense—Difficult to see details of breast tissue on x ray.

benign. A follow-up mammogram within a short interval of six months is suggested. This helps to ensure that the abnormality is not changing, or is "stable." This stability in the abnormality indicates that a cancer is probably not present. If the abnormality were a cancer, it would have grown in the interval between mammograms. Some women are uncomfortable or anxious about waiting and may want to consult with their doctor about having a biopsy. BIRADS 4 means suspicious for cancer. A biopsy is usually recommended in this case. BIRADS 5 means an abnormality is highly suggestive of cancer. The suspicious area should be biopsied.

Resources

BOOKS

Henderson, Craig. *Mammography & Beyond. Developing Technologies for the Early Detection of Breast Cancer: A Nontechnical Summary.* Washington, DC: National Academy Press, 2001.

Love, Susan M., with Karen Lindsey. *Dr. Susan Love's Breast Book,* 3rd ed. Boulder, CO: Perseus Book Group, 2000.

PERIODICALS

Letich, A., et al. "American Cancer Society Guidelines for the Early Detection of Breast Cancer: Update 1997." *CA: A Cancer Journal for Clinicians* 47 (May/June 1997): 150-53.

"The Mammography Muddle." *Harvard Women's Health Watch* 7 (March 1997): 4-5.

Weber, Ellen. "Questions and Answers About Breast Cancer Diagnosis." *American Journal of Nursing* (October 1997): 34-8.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., Atlanta, GA 30329. (800) ACS-2345. <http://www.cancer.org.>.

Federal Drug Administration. 5600 Fishers lane, Rockville, MD 20857. (800) 532-4440. <http://www.fda.gov.>.

National Cancer Institute. Office of Cancer Communications, Bldg. 31, Room 10A31, Bethesda, MD 20892. NCI/Cancer Information Service: (800) 4-CANCER. <http://cancernet.nci.nih.gov.>.

Ellen S. Weber

Manganese excess *see* **Mineral toxicity**

Mania

Definition

Mania is an abnormally elated mental state, typically characterized by feelings of euphoria, lack of inhibitions, racing thoughts, diminished need for sleep, talkativeness, risk taking, and irritability. In extreme cases, mania can induce **hallucinations** and other psychotic symptoms.

Description

Mania typically occurs as a symptom of **bipolar disorder** (a mood disorder characterized by both manic and depressive episodes). Individuals experiencing a manic episode often have feelings of self-importance, elation, talkativeness, sociability, and a desire to embark on goal-oriented activities, coupled with the less desirable characteristics of irritability, impatience, impulsiveness, hyperactivity, and a decreased need for sleep. (Note: Hypomania is a term applied to a condition resembling mania. It is characterized by persistent or elevated expansive mood, hyperactivity, inflated self esteem, etc., but of less intensity than mania.) Severe mania may have psychotic features.

Causes and symptoms

Mania can be induced by the use or abuse of stimulant drugs such as **cocaine** and amphetamines. It is also the predominant feature of bipolar disorder, or manic depression, an affective mental illness that causes radical emotional changes and mood swings.

The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (*DSM-IV*), the diagnostic standard for mental health professionals in the U.S., describes a manic episode as an abnormally elevated mood lasting at least one week that is distinguished by at least three of the following symptoms: inflated self-esteem, decreased need for sleep, talkativeness, racing thoughts, distractibility, increase in goal-directed activity, or excessive involvement in pleasurable activities that have a high potential for painful consequences. If the mood of the patient is irritable and not elevated, four of these symptoms are required.

Diagnosis

Mania is usually diagnosed and treated by a psychiatrist and/or a psychologist in an outpatient setting. However, most severely manic patients require hospitaliza-

tion. In addition to an interview, several clinical inventories or scales may be used to assess the patient's mental status and determine the presence and severity of mania. An assessment commonly includes the Young Mania Rating Scale (YMRS). The Mini-Mental State Examination (MMSE) may also be given to screen out other illnesses such as **dementia**.

Treatment

Mania is primarily treated with drugs. The following mood-stabilizing agents are commonly prescribed to regulate manic episodes:

- Lithium (Cibalith-S, Eskalith, Lithane) is one of the oldest and most frequently prescribed drugs available for the treatment of mania. Because the drug takes four to seven days to reach a therapeutic level in the bloodstream, it is sometimes prescribed in conjunction with neuroleptics (**antipsychotic drugs**) and/or **benzodiazepines** (tranquilizers) to provide more immediate relief of mania.
- Carbamazepine (Tegretol, Atretol) is an anticonvulsant drug usually prescribed in conjunction with other mood-stabilizing agents. The drug is often used to treat bipolar patients who have not responded well to lithium therapy. As of early 1998, carbamazepine was not approved for the treatment of mania by the FDA.
- Valproate (divalproex sodium, or Depakote; valproic acid, or Depakene) is an anticonvulsant drug prescribed alone or in combination with carbamazepine and/or lithium. For patients experiencing "mixed mania," or mania with features of depression, valproate is preferred over lithium.

Clozapine (Clozaril) is an atypical antipsychotic medication used to control manic episodes in patients who have not responded to typical mood-stabilizing agents. The drug has also been a useful preventative treatment in some bipolar patients. Other new anticonvulsants (lamotrigine, gubapentin) are being investigated for treatment of mania and bipolar disorder.

Prognosis

Patients experiencing mania as a result of bipolar disorder will require long-term care to prevent recurrence; bipolar disorder is a chronic condition that requires lifelong observation and treatment after diagnosis. Data show that almost 90% of patients who experience one manic episode will go on to have another.

Prevention

Mania as a result of bipolar disorder can only be prevented through ongoing pharmacologic treatment. Patient education in the form of therapy or self-help groups is crucial for training patients to recognize signs of mania and to take an active part in their treatment program. Psychotherapy is an important adjunctive treatment for patients with bipolar disorder.

KEY TERMS

Hypomania—A less severe form of elevated mood state that is a characteristic of bipolar type II disorder.

Mixed mania—A mental state in which symptoms of both depression and mania occur simultaneously.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S., and Nicholas G. Ward. "Mood Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Whybrow, Peter C. *A Mood Apart*. New York: HarperCollins, 1997.

PERIODICALS

Biederman, Joseph A. "Is There a Childhood Form of Bipolar Disorder?" *Harvard Mental Health Letter* 13 (Mar. 1997): 8.

Daly, Ian. "Seminar: Mania." *The Lancet* 349 (1997): 1157-60.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Depressive and Manic-Depressive Association (NDMDA). 730 N. Franklin St., Suite 501, Chicago, IL 60610. (800) 826-3632. <http://www.ndmda.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

OTHER

Bowden, Charles L. "Choosing the Appropriate Therapy for Bipolar Disorder." *Medscape Today* 2, no. 8 (1997) <http://www.medscape.com>.

Sachs, Gary. "Adolescent Mania: Underdiagnosed and Undertreated." *Medscape Today* May 1997 <http://www.medscape.com>.

Paula Anne Ford-Martin

Manic depression *see* **Bipolar disorder**

Manic episode *see* **Mania**

MAO inhibitors *see* **Monoamine oxidase inhibitors**

Marasmus *see* **Protein-energy malnutrition**

Marble bones *see* **Osteopetroses**

Marburg virus infection *see* **Hemorrhagic fevers**

Marfan syndrome

Definition

Marfan syndrome is an inherited disorder of the connective tissue that causes abnormalities of the patient's eyes, cardiovascular system, and musculoskeletal system. It is named for the French pediatrician, Antoine Marfan (1858–1942), who first described it in 1896. Marfan syndrome is sometimes called arachnodactyly, which means "spider-like fingers" in Greek, since one of the characteristic signs of the disease is disproportionately long fingers and toes. It is estimated that one person in every 3,000-5,000 has Marfan syndrome, or about 50,000 people in the United States. Marfan syndrome is one of the more common inheritable disorders.

Description

Marfan syndrome affects three major organ systems of the body: the heart and circulatory system, the bones and muscles, and the eyes. The genetic mutation responsible for Marfan was discovered in 1991. It affects the body's production of fibrillin, which is a protein that is an important part of connective tissue. Fibrillin is the primary component of the microfibrils that allow tissues to stretch repeatedly without weakening. Because the patient's fibrillin is abnormal, his or her connective tissues are looser than usual, which weakens or damages the support structures of the entire body.

The most common external signs associated with Marfan syndrome include excessively long arms and legs, with the patient's arm span being greater than his or her height. The fingers and toes may be long and slender, with loose joints that can be bent beyond their normal limits. This unusual flexibility is called hypermobility. The patient's face may also be long and narrow, and he or she may have a noticeable curvature of the spine. It is important to note, however, that Marfan patients vary widely in the external signs of their disorder and in their severity; even two patients from the same family may look quite different. Most of the external features of Marfan syndrome become more pronounced as the patient gets older, so that diagnosis of the disorder is often easier in adults than in children. In many cases, the patient may have few or very minor outward signs of the disorder, and the diagnosis may be missed until the patient develops vision problems or cardiac symptoms.

Marfan syndrome by itself does not affect a person's intelligence or ability to learn. There is, however, some clinical evidence that children with Marfan have a slightly higher rate of hyperactivity and attention-deficit disorder (ADD) than the general population. In addition, a child with undiagnosed nearsightedness related to Marfan may have difficulty seeing the blackboard or reading printed materials, and thus do poorly in school.

Marfan syndrome affects males and females equally, and appears to be distributed equally among all races and ethnic groups. The rate of mutation of the fibrillin gene, however, appears to be related to the age of the patient's father; older fathers are more likely to have new mutations appear in chromosome 15.

Causes and symptoms

Marfan syndrome is caused by a single gene for fibrillin on chromosome 15, which is inherited in most cases from an affected parent. Between 15 and 25% of cases result from spontaneous mutations. Mutations of the fibrillin gene (FBNI) are unique to each family affected by Marfan, which makes rapid genetic diagnosis impossible, given present technology. The syndrome is an autosomal dominant disorder, which means that someone who has it has a 50% chance of passing it on to any offspring.

Another important genetic characteristic of Marfan syndrome is variable expression. This term means that the mutated fibrillin gene can produce a variety of symptoms of very different degrees of severity, even in members of the same family.

Cardiac and circulatory abnormalities

The most important complications of Marfan are those affecting the heart and major blood vessels; some are potentially life-threatening. About 90% of Marfan patients will develop cardiac complications.

- Aortic enlargement. This is the most serious potential complication of Marfan syndrome. Because of the abnormalities of the patient's fibrillin, the walls of the aorta (the large blood vessel that carries blood away from the heart) are weaker than normal and tend to

stretch and bulge out of shape. This stretching increases the likelihood of an **aortic dissection**, which is a tear or separation between the layers of tissue that make up the aorta. An aortic dissection usually causes severe **pain** in the abdomen, back, or chest, depending on the section of the aorta that is affected. Rupture of the aorta is a medical emergency requiring immediate surgery and medication.

- Aortic regurgitation. A weakened and enlarged aorta may allow some blood to leak back into the heart during each heartbeat; this condition is called aortic regurgitation. Aortic regurgitation occasionally causes **shortness of breath** during normal activity. In serious cases, it causes the left ventricle of the heart to enlarge and may eventually lead to heart failure.
- **Mitral valve prolapse**. Between 75 and 85% of Marfan patients have loose or "floppy" mitral valves, which are the valves that separate the chambers of the heart. When these valves do not cover the opening between the chambers completely, the condition is called mitral valve prolapse. Complications of mitral valve prolapse include **heart murmurs** and **arrhythmias**. In rare cases, mitral valve prolapse can cause sudden death.
- Infective **endocarditis**. Infective endocarditis is an infection of the endothelium, the tissue that lines the heart. In patients with Marfan, it is the abnormal mitral valve that is most likely to become infected.
- Other complications. Some patients with Marfan develop cystic disease of the lungs or recurrent spontaneous **pneumothorax**, which is a condition in which air accumulates in the space around the lungs. Many will also eventually develop **emphysema**.

Musculoskeletal abnormalities

Marfan syndrome causes an increase in the length of the patient's bones, with decreased support from the ligaments that hold the bones together. As a result, the patient may develop various deformities of the skeleton or disorders related to the relative looseness of the ligaments.

Disorders of the spine

- **Scoliosis**. Scoliosis, or curvature of the spine, is a disorder in which the vertebrae that make up the spine twist out of line from side to side into an S-shape or a spiral. It is caused by a combination of the rapid growth of children with Marfan, and the looseness of the ligaments that help the spine to keep its shape.
- **Kyphosis** is an abnormal outward curvature of the spine at the back, sometimes called hunch back when it occurs in the upper back. Marfan patients may develop kyphosis either in the upper (thoracic) spine or the lower (lumbar) spine.
- Spondylolisthesis. Spondylolisthesis is the medical term for a forward slippage of one vertebra on the one below it. It produces an ache or stiffness in the lower back.
- Dural ectasia. The dura is the tough, fibrous outermost membrane covering the brain and the spinal cord. The weak dura in Marfan patients swells or bulges under the pressure of the spinal fluid. This swelling is called ectasia. In most cases, dural ectasia occurs in the lower spine, producing low back ache, a burning feeling, or numbness or weakness in the legs.

Disorders of the chest and lower body

- Pectus excavatum. Pectus excavatum is a malformation of the chest in which the patient's breastbone, or sternum, is sunken inward. It can cause difficulties in breathing, especially if the heart, spine, and lung have been affected by Marfan. It also usually causes concerns about appearance.
- Pectus carinatum. In other patients with Marfan the sternum is pushed outward and narrowed. Although pectus carinatum does not cause breathing difficulties, it can cause embarassment about appearance. A few patients with Marfan may have a pectus excavatum on one side of their chest and a pectus carinatum on the other.
- Foot disorders. Patients with Marfan are more likely to develop pes planus (flat feet) or so-called "claw" or "hammer" toes than people in the general population. They are also more likely to suffer from chronic pain in their feet.
- Protrusio acetabulae. The acetabulum is the socket of the hip joint. In patient's with Marfan, the acetabulum becomes deeper than normal during growth, for reasons that are not yet understood. Although protrusio acetabulae does not cause problems during childhood and adolescence, it can lead to a painful form of arthritis in adult life.

Disorders of the eyes and face

Although the visual problems that are related to Marfan syndrome are rarely life-threatening, they are important in that they may be the patient's first indication of the disorder. Eye disorders related to the syndrome include the following:

- Myopia (nearsightedness). Most patients with Marfan develop nearsightedness, usually in childhood.
- Ectopia lentis. Ectopia lentis is the medical term for dislocation of the lens of the eye. Between 65 and 75%

of Marfan patients have dislocated lenses. This condition is an important indication for diagnosis of the syndrome because there are relatively few other disorders that produce it.

- **Glaucoma**. This condition is much more prevalent in patients with Marfan syndrome than in the general population.
- **Cataracts**. Patients with Marfan are more likely to develop cataracts, and to develop them much earlier in life, sometimes as early as 40 years of age.
- **Retinal detachment**. Patients with Marfan are more vulnerable to this disorder because of the weakness of their connective tissues. Untreated retinal detachment can cause blindness. The danger of retinal detachment is an important reason for patients to avoid contact sports or other activities that could cause a blow on the head or being knocked to the ground.
- Other facial problems. Patients with Marfan sometimes develop dental problems related to crowding of the teeth caused by a high-arched palate and a narrow jaw.

Other disorders

- Striae. Striae are stretch marks in the skin caused by rapid weight gain or growth; they frequently occur in pregnant women, for example. Marfan patients often develop striae over the shoulders, hips, and lower back at an early age because of rapid bone growth. Although the patient may be self-conscious about the striae, they are not a danger to health.
- Obstructive **sleep apnea**. Obstructive sleep apnea refers to partial obstruction of the airway during sleep, causing irregular breathing and somet imes **snoring**. In patients with Marfan, obstructive sleep apnea is caused by the unusual flexibility of the tissues lining the patient's airway. This disturbed breathing pattern increases the risk of aortic dissection.

Diagnosis

Presently, there is no objective diagnostic test for Marfan syndrome, in part because the disorder does not produce any measurable biochemical changes in the patient's blood or body fluids, or cellular changes that could be detected from a tissue sample. Although researchers in molecular biology are currently investigating the FBNI gene through a process called mutational analysis, it is presently not useful as a diagnostic test because there is evidence that there can be mutations in the fibrillin gene that do not produce Marfan. Similarly, there is no reliable prenatal test, although some physicians have used ultrasound to try to determine the length of fetal limbs in at-risk pregnancies.

The diagnosis is made by taking a family history and a thorough examination of the patient's eyes, heart, and bone structure. The examination should include an echocardiogram taken by a cardiologist, a slit-lamp **eye examination** by an ophthalmologist, and a work-up of the patient's spinal column by an orthopedic specialist. In terms of the cardiac examination, a standard electrocardiogram (EKG) is not sufficient for diagnosis; only the echocardiogram can detect possible enlargement of the aorta. The importance of the slit-lamp examination is that it allows the doctor to detect a dislocated lens, which is a significant indication of the syndrome.

The symptoms of Marfan syndrome in some patients resemble the symptoms of homocystinuria, which is an inherited disorder marked by extremely high levels of homocystine in the patient's blood and urine. This possibility can be excluded by a urine test.

In other cases, the diagnosis remains uncertain because of the mildness of the patient's symptoms, the absence of a family history of the syndrome, and other variables. These borderline conditions are sometimes referred to as marfanoid syndromes.

Treatment

The treatment and management of Marfan is tailored to the specific symptoms of each patient. Some patients find that the syndrome has little impact on their overall lifestyle; others have found their lives centered on the disorder.

Cardiovascular system

After a person has been diagnosed with Marfan, he or she should be monitored with an echocardiogram every six months until it is clear that the aorta is not growing larger. After that, the patient should have an echocardiogram once a year. If the echocardiogram does not allow the physician to visualize all portions of the aorta, CT (computed tomography) or MRI (**magnetic resonance imaging**) may be used. In cases involving a possible aortic dissection, the patient may be given a TEE (transesophageal echocardiogram).

Medications. A Marfan patient may be given drugs called beta-blockers to slow down the rate of aortic enlargement and decrease the risk of dissection by lowering the blood pressure and decreasing the forcefulness of the heartbeat. The most commonly used beta-blockers in Marfan patients are propranolol (Inderal) and atenolol (Tenormin). Patients who are allergic to beta-blockers may be given a calcium blocker such as verapamil.

Because Marfan patients are at increased risk for infective endocarditis, they must take a prophylactic dose

of an antibiotic before having dental work or minor surgery, as these procedures may allow bacteria to enter the bloodstream. Penicillin and amoxicillin are the **antibiotics** most often used.

Surgical treatment. Surgery may be necessary if the width of the patient's aorta increases rapidly or reaches a critical size (about 2 inches). As of 2000, the most common surgical treatment involves replacing the patient's aortic valve and several inches of the aorta itself with a composite graft, which is a prosthetic heart valve sewn into one end of a Dacron tube. This surgery has been performed widely since about 1985; most patients who have had a composite graft have not needed additional surgery.

Patients who have had a valve replaced must take an anticoagulant medication, usually warfarin (Coumadin), in order to minimize the possibility of a clot forming on the prosthetic valve.

Musculoskeletal system

Children diagnosed with Marfan should be checked for scoliosis by their pediatricians at each annual **physical examination**. The doctor simply asks the child to bend forward while the back is examined for changes in the curvature. In addition, the child's spine should be x-rayed in order to measure the extent of scoliosis or kyphosis. The curve is measured in degrees by the angle between the vertebrae as seen on the x ray. Curves of 20° or less are not likely to become worse. Curves between 20 and 40 degrees are likely to increase in children or adolescents. Curves of 40 degrees or more are highly likely to worsen, even in an adult, because the spine is so badly imbalanced that the force of gravity will increase the curvature.

Scoliosis between 20 and 40 degrees in children is usually treated with a back brace. The child must wear this appliance about 23 hours a day until growth is complete. If the spinal curvature increases to 40 or 50 degrees, the patient may require surgery in order to prevent lung problems, back pain, and further deformity. Surgical treatment of scoliosis involves straightening the spine with metal rods and fusing the vertebrae in the straightened position.

Spondylolisthesis is treated with a brace in mild cases. If the slippage is more than 30 degrees, the slipped vertebra may require surgical realignment.

Dural ectasia can be distinguished from other causes of back pain on an MRI. Mild cases are usually not treated. Medication or spinal shunting to remove some of the spinal fluid are used to treat severe cases.

Pectus excavatum and pectus carinatum can be treated by surgery. In pectus excavatum, the deformed breastbone and ribs are raised and straightened by a metal bar. After four to six months, the bar is removed in an outpatient procedure.

Protrusio acetabulae may require surgery in adult life to provide the patient with an artificial hip joint, if the arthritic pains are severe.

Pain in the feet or limbs is usually treated with a mild analgesic such as **acetaminophen**. Patients with Marfan should consider wearing shoes with low heels, special cushions, or orthotic inserts. Foot surgery is rarely necessary.

Visual and dental concerns

Patients with Marfan should have a thorough eye examination, including a slit-lamp examination, to test for dislocation of the lens as well as nearsightedness. Dislocation can be treated by a combination of special glasses and daily use of one percent atropine sulfate ophthalmic drops, or by surgery.

Because patients with Marfan are at increased risk of glaucoma, they should have the fluid pressure inside the eye measured every year as part of an eye examination. Glaucoma can be treated with medications or with surgery.

Cataracts are treated with increasing success by implant surgery. It is important, however, to seek treatment at medical centers with eye surgeons familiar with the possible complications of **cataract surgery** in patients with Marfan syndrome.

All persons with Marfan should be taught to recognize the signs of retinal detachment (sudden blurring of vision in one eye becoming progressively worse without pain or redness) and to seek professional help immediately.

Children with Marfan should be evaluated by their dentist at each checkup for crowding of the teeth and possible misalignment, and referred to an orthodontist if necessary.

Athletic activities and occupational choice. People with Marfan should avoid sports or occupations that require heavy weight lifting, rough physical contact, or rapid changes in atmospheric pressure (e.g., scuba diving). Weight lifting increases blood pressure, which in turn may enlarge the aorta. Rough physical contact may cause retinal detachment. Sudden changes in air pressure may produce pneumothorax. Regular noncompetitive physical **exercise**, however, is beneficial for Marfan patients. Good choices include brisk walking, shooting baskets, and slow-paced tennis.

KEY TERMS

Arachnodactyly—A condition characterized by abnormally long and slender fingers and toes.

Ectopia lentis—Dislocation of the lens of the eye. It is one of the most important single indicators in diagnosing Marfan syndrome.

Fibrillin—A protein that is an important part of the structure of the body's connective tissue. In Marfan's syndrome, the gene responsible for fibrillin has mutated, causing the body to produce a defective protein.

Hypermobility—Unusual flexibility of the joints, allowing them to be bent or moved beyond their normal range of motion.

Kyphosis—An abnormal outward curvature of the spine, with a hump at the upper back.

Pectus carinatum—An abnormality of the chest in which the sternum (breastbone) is pushed outward. It is sometimes called "pigeon breast."

Pectus excavatum—An abnormality of the chest in which the sternum (breastbone) sinks inward; sometimes called "funnel chest."

Scoliosis—An abnormal, side-to-side curvature of the spine.

Social and lifestyle issues

Smoking. Smoking is particularly harmful for Marfan patients because it increases their risk of emphysema.

Pregnancy. Until very recently, women with Marfan were advised not to become pregnant because of the risk of aortic enlargement or dissection. The development of beta-blockers and echocardiograms, however, allows doctors now to monitor patients throughout pregnancy. It is recommended that patients have an echocardiogram during each of the three trimesters of pregnancy. Normal, vaginal delivery is not necessarily more stressful than a Caesarian section, but patients in prolonged labor may be given a Caesarian to reduce strain on the heart. A pregnant woman with Marfan should also receive **genetic counseling** regarding the 50% risk of having a child with the syndrome.

Appearance and Social Concerns. Children and adolescents with Marfan may benefit from supportive counseling regarding appearance, particularly if their symptoms are severe and causing them to withdraw from social activities. In addition, families may wish to seek counseling regarding the effects of the syndrome on relationships within the family. Many people respond with guilt, fear, or blame when a genetic disorder is diagnosed in the family, or they may overprotect the affected member. Support groups are often good sources of information about Marfan; they can offer helpful suggestions about living with it as well as emotional support.

Prognosis

The prognosis for patients with Marfan has improved markedly in recent years. As of 1995, the life expectancy of people with the syndrome has increased to 72 years, up from 48 years in 1972. This dramatic improvement is attributed to new surgical techniques, improved diagnosis, and new techniques of medical treatment.

The most important single factor in improving the patient's prognosis is early diagnosis. The earlier that a patient can benefit from the new techniques and lifestyle modifications, the more likely he or she is to have a longer life expectancy.

Resources

BOOKS

Beers, Mark H., and Robert Berkow, eds. *Pediatrics*. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

Pyeritz, Reed E., and Cheryll Gasner. *The Marfan Syndrome*. New York: National Marfan Syndrome, 1999.

Thoene, Jess G. "Marfan Syndrome." In *Physician's Guide to Rare Diseases*. 2nd ed. Montvale, NJ: Dowden Publishing Company, Inc., 1995.

Wynbrandt, James, and Mark D. Ludman. "Marfan Syndrome." In *The Encyclopedia of Genetic Disorders and Birth Defects*. New York and Oxford: Facts on File, 1991.

PERIODICALS

DePaepe, A., et al. "Revised diagnostic criteria for the Marfan syndrome." *American Journal of Medical Genetics* 62 (1996): 417–26.

Shores, J., et al. "Chronic (-adrenergic blockade protects the aorta in the Marfan syndrome: a prospective, randomized trial of propranolol." *New England Journal of Medicine* 330 (1994): 1335–41.

Silverman, D., et al. "Life expectancy in the Marfan syndrome." *American Journal of Cardiology* 75 (1995): 157–60.

ORGANIZATION

National Marfan Foundation, 382 Main Street, Port Washington, NY, 11050, 516/ 883-8712, <http:www.marfan.org>.

Alliance of Genetic Support Groups, 4301 Connecticut Avenue, Washington, DC, 20008, 202/ 652-5553, <http: www.geneticalliance.org>.

Rebecca J. Frey, PhD

Marie-Strümpell disease *see* **Ankylosing spondylitis**

Marijuana

Definition

Marijuana (marihuana) *Cannabis sativa L.*, also known as Indian hemp, is a member of the Cannabaceae or hemp family, thought to have originated in the mountainous districts of India, north of the Himalayan mountains.

Description

The herb was referred to as "hempe" in A.D. 1000 and listed in a dictionary under that English name. Supporters of the notorious Pancho Villa first used the name marijuana in 1895 in Sonora, Mexico. They called the mood-altering herb they smoked marijuana. The term hashish, is derived from the name for the Saracen soldiers, called *hashashins*, who ingested the highly potent cannabis resin before being sent out to assassinate enemies.

Two related species of cannabis are *C. ruderalis*, and *C. indica*, a variety known as Indian hemp. Indian hemp grows to a height of about 4 ft (1.2 m) and the seed coats have a marbled appearance.

The species *C. sativa L.* has many variations, depending on the soil, temperature, and light conditions, and the origin of the parent seed. These factors also affect the relative amounts of THC (tetra-hydrocannabinol) and cannabidiol, the chemicals present in varying amounts in cannabis that determine if the plant is primarily a fiber type or an intoxicant. Generally the species grown at higher elevations and in hotter climates exudes more of the resin and is more medicinally potent.

Marijuana is a somewhat weedy plant and may grow as high as 18 ft (5.4 m). The hairy leaves are arranged opposite one another on the erect and branching stem. Leaves are palmate and compound, deeply divided into five to seven narrow, toothed and pointed leaflets. Male and female flowers are small and greenish in color and grow on separate plants. Male flowers grow in the leaf axils in elongated clusters. The female flowers grow in spike-like clusters. The resinous blossoms have five sepals and five petals. The male and female blossoms can be distinguished at maturity. The male plant matures first, shedding its pollen and dying after flowering. Female plants die after dropping the mature seeds. Marijuana produces an abundance of quickly germinating seeds. This hardy annual is wind pollinated and has escaped from cultivation to grow wild along roadsides, trails, stream banks, and in wayside places throughout the world. The plant matures within three to five months after the seed has been sown.

History

Marijuana has been cultivated for thousands of years. Cannabis was first described for its therapeutic use in the first known Chinese pharmacopoeia, the *Pen Ts'ao*. (A pharmacopoeia is a book containing a list of medicinal drugs, and their descriptions of preparation and use.) Cannabis was called a "superior" herb by the Emperor Shen-Nung (2737–2697 B.C.), who is believed to have authored the work. Cannabis was recommended as a treatment for numerous common ailments. Around that same period in Egypt, cannabis was used as a treatment for sore eyes. The herb was used in India in cultural and religious ceremonies, and recorded in Sanskrit scriptural texts around 1,400 B.C. Cannabis was considered a holy herb and was characterized as the "soother of grief," "the sky flyer," and "the poor man's heaven." Centuries later, around 700 B.C., the Assyrian people used the herb they called *Qunnabu,* for incense. The ancient Greeks used cannabis as a remedy to treat inflammation, earache, and edema (swelling of a body part due to collection of fluids). Shortly after 500 B.C. the historian and geographer Herodotus recorded that the peoples known as Scythians used cannabis to produce fine linens. They called the herb *kannabis* and inhaled the "intoxicating vapor" that resulted when it was burned. By the year 100 B.C. the Chinese were using cannabis to make paper.

Cannabis use and cultivation migrated with the movement of various traders and travelers, and knowledge of the herb's value spread throughout the Middle East, Eastern Europe, and Africa. Around 100, Dioscorides, a surgeon in the Roman Legions under the Emperor Nero, named the herb *Cannabis sativa* and recorded numerous medicinal uses. In the second century, the Chinese physician Hoa-Tho used cannabis in surgical procedures, relying on its analgesic properties. In ancient India, around 600, Sanskrit writers recorded a recipe for "pills of gaiety," a combination of hemp and sugar. By 1150, Moslems were using cannabis fiber in Europe's first paper production. This use of cannabis as a durable and renewable source of paper fiber continued for the next 750 years.

By the 1300s, government and religious authorities, concerned about the psychoactive effects on citizens consuming the herb, were placing harsh restrictions on its use. The Emir Soudon Sheikhouni of Joneima outlawed cannabis use among the poor. He destroyed the crops and ordered that offenders' teeth be pulled out. In 1484, Pope Innocent VIII outlawed the use of hashish, a concentrat-

ed form of cannabis. Cannabis cultivation continued, however, because of its economic value. A little more than a century later, the English Queen Elizabeth I issued a decree commanding that landowners holding 60 acres or more must grow hemp or pay a fine. Commerce in hemp, which was primarily valued for the strength and versatility of its fibers, was profitable and thriving. Hemp ropes and sails were crossing the sea to North America with the explorers. By 1621, the British were growing cannabis in Virginia where cultivation of hemp was mandatory. In 1776, the Declaration of Independence was drafted on hemp paper. Both President George Washington and President Thomas Jefferson were advocates of hemp as a valuable cash crop. Jefferson urged farmers to grow the crop in lieu of tobacco. By the 1850s, hemp had become the third largest agricultural crop grown in North America. The U. S. Census of that year recorded 8,327 hemp plantations, each with 2,000 or more acres in cultivation. But the invention of the cotton gin was already bringing many changes, and cotton was becoming a prime and profitable textile fiber. More change came with the introduction of the sulfite and chlorine processes used to turn trees into paper. Restrictions on the personal use of cannabis as a mood-altering, psychoactive herb, were soon to come.

Controversy

The 1856 edition of the *Encyclopedia Britannica*, in its lengthy entry on hemp, noted that the herb "produces inebriation and delirium of decidedly hilarious character, inducing violent laughter, jumping and dancing." This inebriating effect of marijuana use has fueled the controversy and led to restrictions that have surrounded marijuana use throughout history in many cultures and regions of the world. Cannabis use has been criminalized in some parts of the United States since 1915. Utah was the first state to criminalize it, then California and Texas. By 1923, Louisiana, Nevada, Oregon, and Washington had legal restrictions on the herb. New York prohibited cannabis use in 1927. Despite the restrictions, cannabis use was woven into the cultural and social fabric in some communities, and widespread use persisted, particularly among the Mexican, Asian, and African American populations.

In 1937, the federal government passed the Marihuana Tax Act, prohibiting the cultivation and farming of marijuana. This bill was introduced to Congress by then Secretary of the Treasury Andrew Mellon, who was also a banker for the DuPont Corporation. That same year, the DuPont Chemical Company filed a patent for nylon, plastics, and a new bleaching process for paper. The 1937 Marijuana Transfer Tax Bill prohibited industrial and medical use of marijuana and classified the flowering tops as narcotic, and restrictions on the cultivation and use of cannabis continued. Marijuana was categorized as an illegal narcotic, in the company of LSD and heroin, cocaine, and morphine. Illegal use continued. The FBI publication, *Uniform Crime Reports for The United States, 1966* reported that 641,642 Americans were arrested for marijuana offenses that year, with as many as 85% of these arrests for simple possession, rather than cultivation or commerce.

In a reversal of the state-by-state progression of criminalizing marijuana that led to the 1937 Marijuana Transfer Tax Bill, there is a movement underway, state by state, to endorse the legalized use of medical marijuana. By 1992, 35 states in the United States had endorsed referenda for medical marijuana. A growing body of scientific research and many thousands of years of folk use support the importance of medical marijuana in treatment of a variety of illnesses, and the economic value of hemp in the textile, paper, and cordage industries has a long history.

The controversy and misinformation persists around this relatively safe and non-toxic herb. The World Health Organization, in a 1998 study, stated that the risks from cannabis use were unlikely to seriously compare to the public health risks of the legal drugs, alcohol and tobacco. And despite thousands of years of human consumption, not one death has been directly attributed to cannabis use. According to Lester Grinspoon, MD, and James B. Bakalar, JD, in a 1995 *Journal of the American Medical Association* article, "Marihuana is also far less addictive and far less subject to abuse than many drugs now used as muscle relaxants, hypnotics, and analgesics. The chief legitimate concern is the effect of smoking on the lungs. Cannabis smoke carries even more tars and other particulate matter than tobacco smoke. But the amount smoked is much less, especially in medical use, and once marihuana is an openly recognized medicine, solutions may be found."

Purpose

The whole cannabis plant, including buds, leaves, seeds, and root, have all been utilized throughout the long history of this controversial herb. Despite persistent legal restrictions and severe criminal penalties for illicit use, marijuana continues to be widely used in the United States, and throughout the world, both for its mood-altering properties and its proven medicinal applications. The conflicting opinions on the safety and effectiveness of cannabis in a climate of prohibition make any discussion of its beneficial uses politically charged. Marijuana has analgesic, anti-emetic, anti-inflammatory, sedative, anticonvulsive, and laxative actions. Clinical studies have demonstrated its effectiveness in relieving **nausea and vomiting** following chemotherapy treatments for cancer. The herb has also been shown to reduce intra-ocular

pressure in the eye by as much as 45%, a beneficial action in the treatment for glaucoma. Cannabis has proven anticonvulsive action, and may be helpful in treating epilepsy. Other research has documented an in-vitro tumor inhibiting effect of THC. Marijuana also increases appetite and reduces nausea and has been used with **AIDS** patients to counter weight loss and "wasting" that may result from the disease. Several chemical constituents of cannabis displayed antimicrobial action and antibacterial effects in research studies. The components CBC and d-9-tetrahydrocannabinol have been shown to destroy and inhibit the growth of streptococci and staphylococci bacteria.

Cannabis contains chemical compounds known as cannabinoids. Different cannabinoids seem to exert different effects on the body after ingestion. Scientific research indicates that these substances have potential therapeutic value for **pain** relief, control of nausea and vomiting, and appetite stimulation. The primary active agent identified to date is 9-tetrahydrocannabinol, known as THC. This chemical may constitute as much as 12% of the active chemicals in the herb, and is said to be responsible for as much as 70–100% of the euphoric action, or "high," experienced when ingesting the herb. The predominance of this mental lightness or "euphoria" depends on the balance of other active ingredients and the freshness of the herb. THC degrades into a component known as cannabinol, or CBN. This relatively inactive chemical predominates in marijuana that has been stored too long prior to use. Another chemical component, cannabidiol, known as CBD, has a sedative and mildly analgesic effect, and contributes to a somatic heaviness sometimes experienced by marijuana users.

Before prohibition, cannabis was recommended for treatment of gonorrhea, angina pectoris (constricting pain in the chest due to insufficient blood to the heart), and choking fits. It was also used for **insomnia**, **neuralgia**, rheumatism, gastrointestinal disorders, cholera, **tetanus**, **epilepsy**, strychnine **poisoning**, **bronchitis**, **whooping cough**, and **asthma**. Other phytotherapeutic (plant-based therapeutic) uses include treatment of ulcers, **cancer**, **emphysema**, **migraine**, and **anxiety**.

The United States federal government policy prohibits physicians from prescribing marijuana, even for seriously ill patients because of possible adverse effects, and the disputed belief that cannabis is dangerously addictive. U. S. Attorney General Janet Reno warned that physicians in any state who prescribed marijuana could lose the privilege of writing prescriptions, be excluded from Medicare and Medicaid reimbursement, and even be prosecuted for a federal crime, according to a 1997 editorial in the *New England Journal of Medicine*.

Preparations

Cannabis extracts, prepared for medicinal application, are prohibited in the United States. Marijuana is ingested by **smoking**, which quickly delivers the active ingredients to the blood system. The dried herb is also variously prepared for eating. The essential oil consists of beta caryophyllenes, humules, caryophyllene oxide, alpha-pinenes, beta-pinenes, limonene, myrcene, and betaocimene. The oil expressed from the seeds is used for massage and in making salves used to relieve muscle strain.

Precautions

Marijauna is considered a Class I narcotic and its use has been restricted by federal law since 1937. Penalties include fines and imprisonment. The National Commission on Marihuana and Drug Abuse concluded in 1972 that, "A careful search of the literature and testimony of the nation's health officials has not revealed a single human fatality in the United States proven to have resulted solely from ingestion of marijuana."

Research has shown that cannabis acts to increase heart frequency by as much as 40 beats per minute. A study reported by The American Heart Association in February 2000, concluded that smoking marijuana can precipitate a heart attack in persons with pre-existing heart conditions. One hour after smoking marijuana, the likelihood of having a **heart attack** is four and one-half times greater than if the person had not smoked, according to the research.

An additional health concern is the effect that marijuana smoking has on the lungs. Cannabis smoke carries more tars and other particulate matter than tobacco smoke.

Side effects

The *PDR For Herbal Medicine* reports, "No health hazards or side effects are known in conjunction with the proper administration of designated therapeutic dosages." Smoking the herb, however, "leads almost at once to euphoric states (pronounced gaiety, laughing fits)," according to the PDR, and "long term usage leads to a clear increase in tolerance for most of the pharmacological effects." The ability to safely operate automobiles and machinery can be impaired for up to eight hours after ingesting the herb. Chronic abuse results in "laryngitis, bronchitis, apathy, psychic decline, and disturbances of genital functions," according to the PDR.

Some people may be hypersensitive to marijuana. They may experience paranoia or be allergic or sensitive to the plant. Chronic sinus fungal infections have been linked to chronic marijuana smoking.

Interactions

Marijauna use may mask the perceived effects of alcohol and **cocaine** when the drugs are consumed together. Marijuana is said to exert a synergistic effect with other medicinal agents. When used with nitrous oxide it may enhance the effect.

Resources

BOOKS

Foster, Steven, and James A. Duke. *Peterson Field Guides, Eastern/Central Medicinal Plants*. Boston-New York: Houghton Mifflin Company, 1990.

Lust, John. *The Herb Book*. New York: Bantam Books, 1974.

Magic and Medicine of Plants. The Reader's Digest Association, Inc. 1986.

PDR for Herbal Medicines. New Jersey: Medical Economics Company, 1998.

PERIODICALS

Grinspoon, Lester, M.D. and James B. Bakalar, JD. *The Journal of the American Medical Association* 273, No. 23 (21 June 1995):1875-1876.

Kassirer, Jerome P. M.D. "Federal Foolishness and Marijuana." *Massachusetts Medical Society, New England Journal of Medicine* 336, no. 5 (30 January 1997): 366-367.

OTHER

Campaign to Legalise Cannabis International Association. *Cannabis Campaigner's Guide, Up-to-Date Chronology of Cannabis Hemp*. <http://www.paston.co.uk/users/webbooks/chronol.html>.

Center for Cardiovascular Education, Inc. *Smoking Marijuana Increases Heart Attack Risk*. Heart Information Network. 6/14/00. <http://www.heartinfo.org/news2000/marijuana061400.htm>.

Deerman, Dixie, RN. *The Best Herb You're Not Using That Could Add Years to Your Life!* North Carolina: Community of Compassion, 2000.

Goddard, Ian Williams. *Proven: Cannabis Is Safe Medicine*. <http://sers.erols.com/igoddard/hempsafe.htm>.

Lewin, Louis. *Phantastica, Hallucinating Substances, Indian Hemp: Cannabis Indica*. <http://users.lycaeum.org/~sputnik/Ludlow/Texts/phantastica.html>.

Report of the US National Commission on Marihuana and Drug Abuse, 1972. *II. Biological Effects of Marihuana, Botanical and Chemical Considerations*. <http://www.druglibrary.org/schaffer/Library/studies/nc/nclc.htm>.

Report of the US National Commission on Marihuana and Drug Abuse, 1972. *History of Marihuana Use: Medical and Intoxicant*. <http://www.druglibraryorg/schaffer/Library/Studies/nc/ncla.htm>.

Taima in Japan. *Drug War Facts: Marijuana*. <http://taima.org/drugfacts/mj.htm>.

Clare Hanrahan

Marriage counseling

Definition

Marriage counseling is a type of psychotherapy for a married couple or established partners that tries to resolve problems in the relationship. Typically, two people attend counseling sessions together to discuss specific issues.

Purpose

Marriage counseling is based on research that shows that individuals and their problems are best handled within the context of their relationships. Marriage counselors are trained in psychotherapy and family systems, and focus on understanding their clients' symptoms and the way their interactions contribute to problems in the relationship.

Description

Marriage counseling is usually a short-term therapy that may take only a few sessions to work out problems in the relationship. Typically, marriage counselors ask questions about the couple's roles, patterns, rules, goals, and beliefs. Therapy often begins as the couple analyzes the good and bad aspects of the relationship. The marriage counselor then works with the couple to help them understand that, in most cases, both partners are contributing to problems in the relationship. When this is understood, the two can then learn to change how they interact with each other to solve problems. The partners may be encouraged to draw up a contract in which each partner describes the behavior he or she will be trying to maintain.

Marriage is not a requirement for two people to get help from a marriage counselor. Anyone person wishing to improve his or her relationships can get help with behavioral problems, relationship issues, or with mental or emotional disorders. Marriage counselors also offer treatment for couples before they get married to help them understand potential problem areas. A third type of marriage counseling involves postmarital therapy, in which divorcing couples who share children seek help in working out their differences. Couples in the midst of a divorce find that marriage therapy during separation can help them find a common ground as they negotiate interpersonal issues and child custody.

Choosing a therapist

A marriage counselor is trained to use different types of therapy in work with individuals, couples, and groups. American Association of Marriage and **Family Therapy**

(AAMFT) training includes supervision by experienced therapists, a minimum of a master's degree (including specific training in marriage and family therapy), and specific graduate training in marriage and family therapy.

When looking for a marriage counselor, a couple should find out the counselor's training and educational background, professional associations, such as AAMFT, and state licensure, and whether the person has experience in treating particular kinds of problem. Also, questions should be asked concerning fees, insurance coverage, the average length of therapy, and so on.

Normal results

Marriage counseling helps couples learn to deal more effectively with problems, and can help prevent small problems from becoming serious. Research shows that marriage counseling, when effective, tends to improve a person's physical as well as mental health, in addition to improving the relationship.

Resources

PERIODICALS

Johnson, S. M., and E. Talitman. "Predictors of Success in Emotionally- Focused Marital Therapy." *Journal of Marital and Family Therapy* 23 (1997): 135-152.

Lee, M. "A Study of Solution-Focused Brief Family Therapy: Outcomes and Issues." *The American Journal of Family Therapy* 25 (1997): 3-17.

ORGANIZATIONS

American Association of Marriage and Family Therapy. 1133 Fifteenth St. NW, Ste. 300, Washington, DC 20005. (202) 452-0109.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

Carol A. Turkington

Marshall-Marchetti-Krantz procedure

Definition

The Marshall-Marchetti-Krantz procedure surgically reinforces the bladder neck in order to prevent unintentional urine loss.

Purpose

The Marshall-Marchetti-Krantz procedure is performed to correct **stress** incontinence in women, a common result of **childbirth** and/or **menopause**. Incontinence also occurs when an individual involuntarily loses urine after pressure is placed on the abdomen (like during **exercise**, sexual activity, sneezing, coughing, laughing, or hugging).

Precautions

In some women, stress incontinence may be controlled through nonsurgical means, such as:

- kegel exercises (exercises that tighten pelvic muscles)
- biofeedback (monitors temperature and muscle contractions in the vagina to help incontinent patients control their pelvic muscles)
- **bladder training** (behavioral modification program used to treat stress incontinence)
- medication
- inserted incontinence devices

Each patient should undergo a full diagnostic workup to determine the best course of treatment.

Description

The Marshall-Marchetti-Krantz procedure, also known as retropubic suspension or bladder neck suspension surgery, is performed by a surgeon in a hospital setting. The patient is placed under general anesthesia, and a long, thin, flexible tube (catheter) is inserted into the bladder through the narrow tube (urethra) that drains the body's urine. An incision is made across the abdomen, and the bladder is exposed. The bladder is separated from surrounding tissues. Stitches (sutures) are placed in these tissues near the bladder neck and urethra. The urethra is then lifted, and the sutures are attached to the pubic bone itself, or to tissue (fascia) behind the pubic bone. The sutures support the bladder neck, helping the patient gain control over urine flow.

Preparation

A complete evaluation to determine the cause of incontinence is critical to proper treatment. A thorough medical history and general **physical examination** should be performed on candidates for the Marshall-Marchetti-Krantz procedure. Diagnostic testing may include x rays, ultrasound, urine tests, and examination of the pelvis. It may also include a series of urodynamic testing exams that measure bladder pressure and capacity, and urinary flow.

Patients undergoing a Marshall-Marchetti-Krantz procedure must not eat or drink for eight hours prior to the surgery.

KEY TERMS

Biofeedback—Biofeedback training monitors temperature and muscle contractions in the vagina to help incontinent patients control their pelvic muscles.

Bladder training—A behavioral modification program used to treat stress incontinence. Bladder training involves putting the patient on a toilet schedule, and gradually increasing the time interval between urination.

Catheter—A long, thin, flexible tube. A catheter is used to drain the bladder of urine during a Marshall-Marchetti-Krantz procedure.

Kegel exercises—Exercises that tighten the pelvic floor muscles. Kegel exercises can assist some women in controlling their stress incontinence.

Urethra—The narrow tube, leading from the bladder that drains the body's urine.

Aftercare

Recovery from a Marshall-Marchetti-Krantz procedure requires two to six days of hospitalization. The catheter will be removed from the patient's bladder once normal bladder function resumes. Patients are advised to refrain from heavy lifting for four to six weeks after the procedure.

Patients should contact their physician immediately if they experience **fever**, **dizziness**, or extreme nausea, or if their incision site becomes swollen, red, or hard.

Risks

The Marshall-Marchetti-Krantz procedure is an invasive surgical procedure and, as such, it carries risks of infection, internal bleeding, and hemorrhage. There is also a possibility of permanent damage to the bladder or urethra. The urethra may become scarred, causing a permanent narrowing, or stricture.

Normal results

Approximately 85% of women who undergo the Marshall-Marchetti-Krantz procedure are cured of their stress incontinence.

Resources

BOOKS

Blaivas, Jerry. *Conquering Bladder and Prostate Problems: The Authoritative Guide for Men and Women.* New York: Plenum, 1998.

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 North Charles St., Baltimore, MD 21201. (800) 242-2383. <http://www.afud.org>.

National Association for Continence. P.O. Box 8310, Spartanburg, SC 29305-8310. (800) 252-3337. <http://www.nafc.org>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

Paula Anne Ford-Martin

Massage therapy

Definition

Massage therapy is the scientific manipulation of the soft tissues of the body for the purpose of normalizing those tissues and consists of manual techniques that include applying fixed or movable pressure, holding, and/or causing movement of or to the body.

Purpose

Generally, massage is known to affect the circulation of blood and the flow of blood and lymph, reduce muscular tension or flaccidity, affect the nervous system through stimulation or **sedation**, and enhance tissue healing. These effects provide a number of benefits:

- reduction of muscle tension and stiffness
- relief of muscle spasms
- greater flexibility and range of motion
- increase of the ease and efficiency of movement
- relief of **stress** and aide of relaxation
- promotion of deeper and easier breathing
- improvement of the circulation of blood and movement of lymph
- relief of tension-related conditions, such as headaches and eyestrain
- promotion of faster healing of soft tissue injuries, such as pulled muscles and sprained ligaments, and reduction in **pain** and swelling related to such injuries
- reduction in the formation of excessive scar tissue following soft tissue injuries
- enhancement in the health and nourishment of skin
- improvement in posture through changing tension patterns that affect posture

- reduction in stress and an excellent stress management tool
- creation of a feeling of well-being
- reduction in levels of **anxiety**
- increase in awareness of the mind-body connection
- promotion of a relaxed state of mental awareness

Massage therapy also has a number of documented clinical benefits. For example, massage can reduce anxiety, improve pulmonary function in young **asthma** patients, reduce psycho-emotional distress in persons suffering from chronic inflammatory bowel disease, increase weight and improve motor development in premature infants, and may enhance immune system functioning. Some medical conditions that massage therapy can help are: **allergies**, anxiety and stress, arthritis, asthma and **bronchitis**, **carpal tunnel syndrome** and other repetitive motion injuries, chronic and temporary pain, circulatory problems, depression, digestive disorders, **tension headache**, **insomnia**, myofascial pain, **sports injuries**, and temporomandibular joint dysfunction.

Description

Origins

Massage therapy is one of the oldest health care practices known to history. References to massage are found in Chinese medical texts more than 4,000 years old. Massage has been advocated in Western health care practices at least since the time of Hippocrates, the "Father of Medicine." In the fourth century B.C. Hippocrates wrote, "The physician must be acquainted with many things and assuredly with rubbing" (the ancient Greek term for massage was rubbing).

The roots of modern, scientific massage therapy go back to Per Henrik Ling (1776–1839), a Swede, who developed an integrated system consisting of massage and active and passive exercises. Ling established the Royal Central Gymnastic Institute in Sweden in 1813 to teach his methods.

Modern, scientific massage therapy was introduced in the United States in the 1850s by two New York physicians, brothers George and Charles Taylor, who had studied in Sweden. The first clinics for massage therapy in the United States were opened by two Swedish physicians after the Civil War period. Doctor Baron Nils Posse operated the Posse Institute in Boston and Doctor Hartwig Nissen opened the Swedish Health Institute near the Capitol in Washington, D.C.

Although there were periods when massage fell out of favor, in the 1960s it made a comeback in a different way as a tool for relaxation, communication, and alternative healing. Today, massage is one of the most popular healing modalities. It is used by conventional, as well as alternative, medical communities and is now covered by some health insurance plans.

Massage therapy is the scientific manipulation of the soft tissues of the body for the purpose of normalizing those tissues and consists of a group of manual techniques that include applying fixed or movable pressure, holding, and/or causing movement of or to the body. While massage therapy is applied primarily with the hands, sometimes the forearms or elbows are used. These techniques affect the muscular, skeletal, circulatory, lymphatic, nervous, and other systems of the body. The basic philosophy of massage therapy embraces the concept of *vis Medicatrix naturae*, which is aiding the ability of the body to heal itself, and is aimed at achieving or increasing health and well-being.

Touch is the fundamental medium of massage therapy. While massage can be described in terms of the type of techniques performed, touch is not used solely in a mechanistic way in massage therapy. One could look at a diagram or photo of a massage technique that depicts where to place one's hands and what direction the stroke should go, but this would not convey everything that is important for giving a good massage. Massage also has an artistic component.

Because massage usually involves applying touch with some degree of pressure and movement, the massage therapist must use touch with sensitivity in order to determine the optimal amount of pressure to use for each person. For example, using too much pressure may cause the body to tense up, while using too little may not have enough effect. Touch used with sensitivity also allows the massage therapist to receive useful information via his or her hands about the client's body, such as locating areas of muscle tension and other soft tissue problems. Because touch is also a form of communication, sensitive touch can convey a sense of caring—an essential element in the therapeutic relationship—to the person receiving massage.

In practice, many massage therapists use more than one technique or method in their work and sometimes combine several. Effective massage therapists ascertain each person's needs and then use the techniques that will meet those needs best.

Swedish massage uses a system of long gliding strokes, kneading, and friction techniques on the more superficial layers of muscles, generally in the direction of blood flow toward the heart, and sometimes combined with active and passive movements of the joints. It is used to promote general relaxation, improve circulation and range of motion, and relieve muscle tension. Swedish massage is the most commonly used form of massage.

Deep tissue massage is used to release chronic patterns of muscular tension using slow strokes, direct pressure, or friction directed across the grain of the muscles. It is applied with greater pressure and to deeper layers of muscle than Swedish, which is why it is called deep tissue and is effective for chronic muscular tension.

Sports massage uses techniques that are similar to Swedish and deep tissue, but are specially adapted to deal with the effects of athletic performance on the body and the needs of athletes regarding training, performing, and recovery from injury.

Neuromuscular massage is a form of deep massage that is applied to individual muscles. It is used primarily to release trigger points (intense knots of muscle tension that refer pain to other parts of the body), and also to increase blood flow. It is often used to reduce pain. Trigger point massage and myotherapy are similar forms.

Acupressure applies finger or thumb pressure to specific points located on the **acupuncture** meridians (channels of energy flow identified in Asian concepts of anatomy) in order to release blocked energy along these meridians that causes physical discomforts, and re-balance the energy flow. **Shiatsu** is a Japanese form of acupressure.

The cost of massage therapy varies according to geographic location, experience of the massage therapist, and length of the massage. In the United States, the average range is from $35-60 for a one-hour session. Massage therapy sessions at a client's home or office may cost more due to travel time for the massage therapist. Most sessions are one hour. Frequency of massage sessions can vary widely. If a person is receiving massage for a specific problem, frequency can vary widely based on the condition, though it usually will be once a week. Some people incorporate massage into their regular personal health and fitness program. They will go for massage on a regular basis, varying from once a week to once a month.

The first appointment generally begins with information gathering, such as the reason for getting massage therapy, physical condition and medical history, and other areas. The client is asked to remove clothing to one's level of comfort. Undressing takes place in private, and a sheet or towel is provided for draping. The massage therapist will undrape only the part of the body being massaged. The client's modesty is respected at all times. The massage therapist may use an oil or cream, which will be absorbed into the skin in a short time.

To receive the most benefit from a massage, generally the person being massaged should give the therapist accurate health information, report discomfort of any kind (whether it's from the massage itself or due to the room temperature or any other distractions), and be as receptive and open to the process as possible.

Insurance coverage for massage therapy varies widely. There tends to be greater coverage in states that license massage therapy. In most cases, a physician's prescription for massage therapy is needed. Once massage therapy is prescribed, authorization from the insurer may be needed if coverage is not clearly spelled out in one's policy or plan.

Preparations

Going for a massage requires little in the way of preparation. Generally, one should be clean and should not eat just before a massage. One should not be under the influence of alcohol or non-medicinal drugs. Massage therapists generally work by appointment and usually will provide information about how to prepare for an appointment at the time of making the appointment.

Precautions

Massage is comparatively safe; however it is generally contraindicated, i.e., it should not be used, if a person has one of the following conditions: advanced heart diseases, **hypertension** (high blood pressure), phlebitis, thrombosis, **embolism**, kidney failure, **cancer** if massage would accelerate metastasis (i.e., spread a tumor) or damage tissue that is fragile due to **chemotherapy** or other treatment, infectious diseases, contagious skin conditions, acute inflammation, infected injuries, unhealed **fractures**, dislocations, frostbite, large hernias, torn ligaments, conditions prone to hemorrhage, and **psychosis**.

Massage should not be used locally on affected areas (i.e., avoid using massage on the specific areas of the body that are affected by the condition) for the following conditions: **rheumatoid arthritis** flare up, eczema, **goiter**, and open **skin lesions**. Massage may be used on the areas of the body that are not affected by these conditions.

In some cases, precautions should be taken before using massage for the following conditions: **pregnancy**, high fevers, **osteoporosis**, diabetes, recent postoperative cases in which pain and muscular splinting (i.e., tightening as a protective reaction) would be increased, apprehension, and mental conditions that may impair communication or perception. In such cases, massage may or may not be appropriate. The decision on whether to use massage must be based on whether it may cause harm. For example, if someone has osteoporosis, the concern is whether bones are strong enough to withstand the pressure applied. If one has a health condition and has any hesitation about whether massage therapy would be appropriate, a physician should be consulted.

Side effects

Massage therapy does not have side effects. Sometimes people are concerned that massage may leave them too relaxed or too mentally unfocused. To the contrary, massage tends to leave people feeling more relaxed and alert.

Research and general acceptance

Before 1939, more than 600 research studies on massage appeared in the main journals of medicine in English. However, the pace of research was slowed by medicine's disinterest in massage therapy.

Massage therapy research picked up again in the 1980s, as the growing popularity of massage paralleled the growing interest in complementary and alternative medicine. Well designed studies have documented the benefits of massage therapy for the treatment of acute and chronic pain, acute and chronic inflammation, chronic **lymphedema**, nausea, muscle spasm, various soft tissue dysfunctions, anxiety, depression, insomnia, and psycho-emotional stress, which may aggravate mental illness.

Premature infants treated with daily massage therapy gain more weight and have shorter hospital stays than infants who are not massaged. A study of 40 low-birthweight babies found that the 20 massaged babies had a 47% greater weight gain per day and stayed in the hospital an average of six days less than 20 infants who did not receive massage, resulting in a cost savings of approximately $3,000 per infant. Cocaine-exposed, preterm infants given massage three times daily for a 10-day period showed significant improvement. Results indicated that massaged infants had fewer postnatal complications and exhibited fewer stress behaviors during the 10-day period, had a 28% greater daily weight gain, and demonstrated more mature motor behaviors.

A study comparing 52 hospitalized depressed and adjustment disorder children and adolescents with a control group that viewed relaxation videotapes, found massage therapy subjects were less depressed and anxious, and had lower saliva cortisol levels (an indicator of less depression).

Another study showed massage therapy produced relaxation in 18 elderly subjects, demonstrated in measures such as decreased blood pressure and heart rate and increased skin temperature.

A combination of massage techniques for 52 subjects with traumatically induced spinal pain led to significant improvements in acute and chronic pain and increased muscle flexibility and tone. This study also found massage therapy to be extremely cost effective, with cost savings ranging from 15-50%. Massage has also been shown to stimulate the body's ability to naturally control pain by stimulating the brain to produce endorphins. **Fibromyalgia** is an example of a condition that may be favorably affected by this effect.

A pilot study of five subjects with symptoms of tension and anxiety found a significant response to massage therapy in one or more psycho-physiological parameters of heart rate, frontalis and forearm extensor electromyograms (EMGs) and skin resistance, which demonstrate relaxation of muscle tension and reduced anxiety.

Lymph drainage massage has been shown to be more effective than mechanized methods or diuretic drugs to control lymphedema secondary to radical **mastectomy**, consequently using massage to control lymphedema would significantly lower treatment costs. A study found that massage therapy can have a powerful effect upon psycho-emotional distress in persons suffering from chronic inflammatory bowel disease. Massage therapy was effective in reducing the frequency of episodes of pain and disability in these patients.

Massage may enhance the immune system. A study suggests an increase in cytotoxic capacity associated with massage. A study of **chronic fatigue syndrome** subjects found that a group receiving massage therapy had lower depression, emotional distress, and somatic symptom scores, more hours of sleep, and lower epinephrine and cortisol levels than a control group.

Resources

BOOKS

Beck, Mark F. *Milady's Theory and Practice of Therapeutic Massage*. Milady Publishing, 1994.

Capellini, Steve. *Massage Therapy Career Guide for Hands-On Success*. Milady Publishing, 1998.

Downing, George. *The Massage Book*. New York: Random House, 1998.

Loving, Jean E. *Massage Therapy: Theory and Practice*. Appleton & Lange, 1998.

PERIODICALS

Field, T., W. Sunshine, M. Hernandez-Reif, and O. Quintino. "Chronic fatigue syndrome: massage therapy effects on depression and somatic symptoms in chronic fatigue syndrome." *J Chronic Fatigue Syndrome* (1997):43-51.

Ironson, G., T. Field, F. Scafidi, and M. Hashimoto. "Massage therapy is associated with enhancement of the immune system's cytotoxic capacity." *Int J Neuroscience* (February 1996):205-217.

Joachim, G. "The effects of two stress management techniques on feelings of well-being in patients with inflammatory bowel disease." *Nursing Papers* (1983):4, 5-18.

Kaarda, B., and O. Tosteinbo. "Increase of plasma beta- endorphins in connective tissue massage." *Gen pharmacology* (1989): 487-489.

Scafidi, F., T. Field, A. Wheeden, S. Schanberg, C. Kuhn, R. Symanski, E. Zimmerman, and E.S. Bandstra. "Cocaine exposed preterm neonates show behavioral and hormonal differences." *Pediatrics* (June 1996):851-855.

Weintraub, M. "Shiatsu, Swedish muscle massage, and trigger point suppression in spinal pain syndrome." *Am Massage Therapy J* Summer 1992; 31:3; 99-1 09.

ORGANIZATIONS

American Massage Therapy Association. <http://www.amtamassage.org>.

Elliot Greene

Mastectomy

Definition

Mastectomy is the surgical removal of the breast for the treatment or prevention of **breast cancer**.

Purpose

Mastectomy is performed as a surgical treatment for breast **cancer**. The severity of a breast cancer is evaluated according to a complex system called staging. This takes into account the size of the tumor and whether it has spread to the lymph nodes, adjacent tissues, and/or distant parts of the body. A mastectomy is usually the recommended surgery for more advanced breast cancers. Women with earlier stage breast cancers, who might also have breast-conserving surgery (**lumpectomy**), may choose to have a mastectomy. In the United States, approximately 50,000 women a year undergo mastectomy.

The size, location, and type of tumor are important considerations when choosing the best surgery to treat breast cancer. The size of the breast is also an important factor. A woman's psychological concerns and lifestyle choices should also be considered when making a decision.

There are many factors that make a mastectomy the treatment of choice for a patient. Large tumors are difficult to remove with good cosmetic results. This is especially true if the woman has small breasts. Sometimes multiple areas of cancer are found in one breast, making removal of the whole breast necessary. The surgeon is sometimes unable to remove the tumor with a sufficient amount, or margin, of normal tissue surrounding it. In this situation, the entire breast needs to be removed. Recurrence of breast cancer after a lumpectomy is another indication for mastectomy.

Radiation therapy is almost always recommended following a lumpectomy. If a woman is unable to have radiation, a mastectomy is the treatment of choice. Pregnant women cannot have radiation therapy for fear of harming the fetus. A woman with certain collagen vascular diseases, such as **systemic lupus erythematosus** or **scleroderma**, would experience unacceptable scarring and damage to her connective tissue from radiation exposure. Any woman who has had therapeutic radiation to the chest area for other reasons cannot tolerate additional exposure for breast cancer therapy.

The need for radiation therapy after breast conserving surgery may make mastectomy more appealing for nonmedical reasons. Some women fear radiation and choose the more extensive surgery so radiation treatment will not be required. The commitment of time, usually five days a week for six weeks, may not be acceptable for other women. This may be due to financial, personal, or job-related factors. In geographically isolated areas, a course of radiation therapy may require lengthy travel and perhaps unacceptable amounts of time away from family or other responsibilities.

Some women choose mastectomy because they strongly fear recurrence of the breast cancer, and lumpectomy seems too risky. Keeping a breast that has contained cancer may feel uncomfortable for some patients. They prefer mastectomy, so the entire breast will be removed.

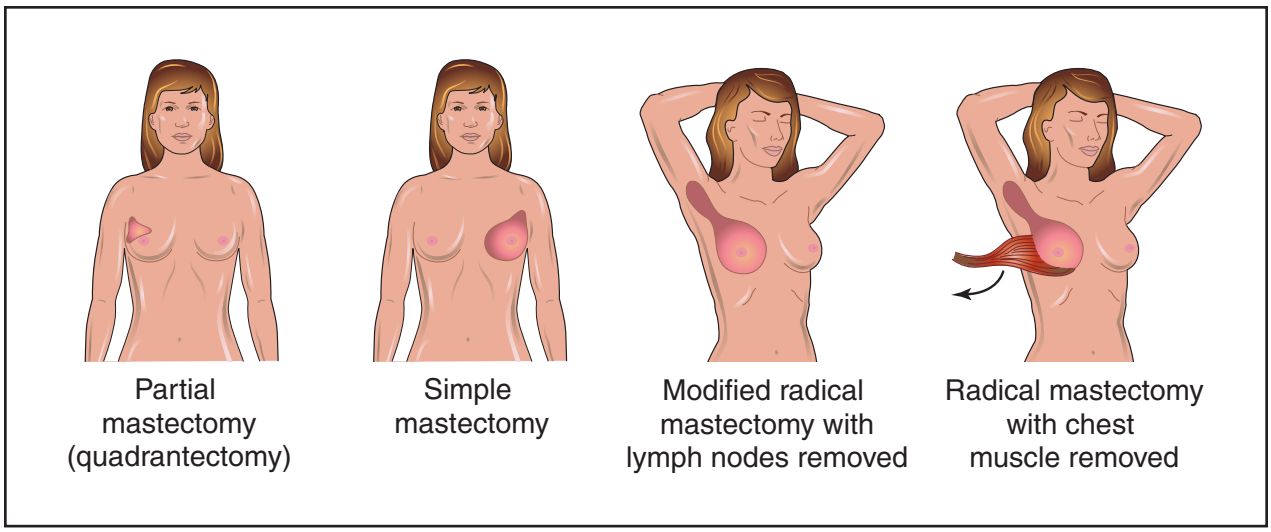
The issue of prophylactic mastectomy, or removal of the breast to prevent future breast cancer, is controversial. Women with a strong family history of breast cancer and/or who test positive for a known cancer-causing gene may choose to have both breasts removed. Patients who have had certain types of breast cancers that are more likely to recur may elect to have the unaffected breast removed. Although there is some evidence that this procedure can decrease the chances of developing breast cancer, it is not a guarantee. It is not possible to be certain that all breast tissue has been removed. There have been cases where breast cancers have occurred after both breasts have been removed. However, a 1999 survey of over 500 women found that 70% of women who chose prophylactic mastectomy were satisfied with the procedure.

Precautions

The decision to have mastectomy or lumpectomy should be carefully considered. It is important that the woman be fully informed of all the potential risks and benefits of each surgical treatment before making a choice.

Description

There are several types of mastectomies. The radical mastectomy, also called the Halsted mastectomy, is very rarely performed today. It was developed in the late



There are four types of mastectomies: partial mastectomy, or lumpectomy, in which the tumor and surrounding tissue is removed; simple mastectomy, where the entire breast and some axillary lymph nodes are removed; modified radical mastectomy, in which the entire breast and all axillary lymph nodes are removed; and the radical mastectomy, where the entire breast, axillary lymph nodes, and chest muscles are removed. *(Illustration by Electronic Illustrators Group.)*

1800s, when it was thought that more extensive surgery was most likely to cure cancer. A radical mastectomy involves removal of the breast, all surrounding lymph nodes up to the collarbone, and the underlying chest muscle. Women were often left disfigured and disabled, with a large defect in the chest wall requiring **skin grafting**, and significantly decreased arm sensation and motion. Unfortunately, and inaccurately, it is still the operation many women picture when the word mastectomy is mentioned.

Surgery that removes breast tissue, nipple, an ellipse of skin, and some axillary or underarm lymph nodes, but leaves the chest muscle intact, is usually called a modified radical mastectomy. This is the most common type of mastectomy performed today. The surgery leaves a woman with a more normal chest shape than the older radical mastectomy procedure, and a scar that is not visible in most clothing. It also allows for immediate or delayed **breast reconstruction**.

In a simple mastectomy, only the breast tissue, nipple, and a small piece of overlying skin is removed. If a few of the axillary lymph nodes closest to the breast are also taken out, the surgery may be called an extended simple mastectomy.

There are other variations on the term mastectomy. A skin-sparing mastectomy uses special techniques that preserve the patient's breast skin for use in reconstruction, although the nipple is still removed. Total mastectomy is a confusing expression, as it may be used to refer to a modified radical mastectomy or a simple mastectomy.

Many women choose to have breast reconstruction performed in conjunction with the mastectomy. The reconstruction can be done using a woman's own abdominal tissue, or using saline-filled artificial expanders, which leave the breast relatively flat but partially reconstructed. Additionally, there are psychological benefits to coming out of the surgery with the first step to a reconstructed breast. Immediate reconstruction will add time and cost to the mastectomy procedure, but the patient can avoid the physical impact of a later surgery.

A mastectomy is typically performed in a hospital setting, but specialized outpatient facilities are sometimes used. The surgery is done under general anesthesia. The type and location of the incision may vary according to plans for reconstruction or other factors, such as old scars. As much breast tissue as possible is removed. Approximately 10 to 20 axillary lymph nodes are usually removed. All tissue is sent to the pathology laboratory for analysis. If no immediate reconstruction is planned, surgical drains are left in place to prevent fluid accumulation. The skin is sutured and bandages are applied.

The surgery may take from two to five hours. Patients usually stay at least one night in the hospital, although outpatient mastectomy is increasingly performed for about 10% of all patients. Insurance usually covers the cost of mastectomy. If immediate reconstruction is performed, the length of stay, recovery period, insurance reimbursement, and fees will vary from mastectomy alone. In 1998, the Women's Health and Cancer Rights Act required insurance plans to cover the

cost of breast reconstruction in conjunction with a mastectomy procedure.

Preparation

Routine preoperative preparations, such as not eating or drinking the night before surgery, are typically ordered for a mastectomy. On rare occasions, the patient may also be asked to donate blood in case a blood **transfusion** is required during surgery. The patient should advise the surgeon of any medications she is taking. Information regarding expected outcomes and potential complications should also be a part of preparation for a mastectomy, as for any surgical procedure. It is especially important that women know about sensations they might experience after surgery, so they are not misinterpreted as a sign of poor wound healing or recurrent cancer.

Aftercare

In the past, women often stayed in the hospital at least several days. Now many patients go home the same day or within a day or two after their mastectomies. Visits from home care nurses can sometimes be arranged, but patients need to learn how to care for themselves before discharge from the hospital. Patients may need to learn to change bandages and/or care for the incision. The surgical drains must be attended to properly; this includes emptying the drain, measuring fluid output, moving clots through the drain, and identifying problems that need attention from the doctor or nurse. If the drain becomes blocked, fluid or blood may collect at the surgical site. Left untreated, this accumulation may cause infection and/or delayed wound healing.

After a mastectomy, activities such as driving may be restricted according to individual needs. **Pain** is usually well controlled with prescribed medication. Severe pain may be a sign of complications, and should be reported to the physician. A return visit to the surgeon is usually scheduled 7 to 10 days after the procedure.

Exercises to maintain shoulder and arm mobility may be prescribed as early as 24 hours after surgery. These are very important in restoring strength and promoting good circulation. However, intense **exercise** should be avoided for a time after surgery in order to prevent injury. The specific exercises suggested by the physician will change as healing progresses. Physical therapy is an integral part of care after a mastectomy, aiding in the overall recovery process.

Emotional care is another important aspect of recovery from a mastectomy. A mastectomy patient may feel a range of emotions including depression, negative self-image, grief, fear and **anxiety** about possible recurrence of the cancer, anger, or guilt. Patients are advised to seek counseling and/or support groups and to express their emotions to others, whether family, friends, or therapists. Assistance in dealing with the psychological effects of the breast cancer diagnosis, as well as the surgery, can be invaluable for women.

Measures to prevent injury or infection to the affected arm should be taken, especially if axillary lymph nodes were removed. There are a number of specific instructions, all directed toward avoiding pressure or constriction of the arm. Extra care must be exercised to avoid injury, to treat it properly if it occurs, and to seek medical attention promptly when appropriate.

Additional treatment for breast cancer may be necessary after a mastectomy. Depending on the type of tumor, lymph node status, and other factors, **chemotherapy**, radiation therapy, and/or hormone therapy may be prescribed.

Risks

Risks that are common to any surgical procedure include bleeding, infection, anesthesia reaction, or unexpected scarring. After mastectomy and axillary lymph node dissection, a number of complications are possible. A woman may experience decreased feeling in the back of her armpit or other sensations including numbness, tingling, or increased skin sensitivity. Some women report phantom breast symptoms, experiencing **itching**, aching, or other sensations in the breast that has been removed. There may be scarring around where the lymph nodes were removed, resulting in decreased arm mobility and requiring more intense physical therapy.

Approximately 10% to 20% of patients develop **lymphedema** after axillary lymph node removal. This swelling of the arm, caused by faulty lymph drainage, can range from mild to very severe. It can be treated with elevation, elastic bandages, and specialized physical therapy. Lymphedema is a chronic condition that requires continuing treatment. This complication can arise at any time, even years after surgery. A new technique called sentinel lymph node mapping and biopsy, which may eliminate the need for removing many lymph nodes, is being tested.

Normal results

A mastectomy is performed as the definitive surgical treatment for breast cancer. The goal of the procedure is that the breast cancer is completely removed and does not recur.

Abnormal results

An abnormal result of a mastectomy is the incomplete removal of the breast cancer or a recurrence of the

KEY TERMS

Axillary—Located in or near the armpit.

Lymphedema—Swelling caused by an accumulation of fluid from faulty lymph drainage.

Mastectomy, modified radical— Total mastectomy with axillary lymph node dissection, but with preservation of the pectoral muscles.

Mastectomy, radical—Removal of the breast, pectoral muscles, axillary lymph nodes, and associated skin and subcutaneous tissue.

Mastectomy, simple—Removal of only the breast tissue, nipple and a small portion of the overlying skin

cancer. Other abnormal results include long-lasting (chronic) pain or impairment that does not improve after several months of physical therapy.

Resources

BOOKS

Berger, Karen J., and John Bostwick III. *A Woman's Decision: Breast Care, Treatment and Reconstruction*. St. Louis, MO: Quality Medical Publishing, 1998.

Robinson, Rebecca Y., and Jeanne A. Petrek. *A Step-by-Step Guide to Dealing With Your Breast Cancer.* New York: Carol Publishing Group, 1994.

Zuckweiler, Rebecca. *Living in the Postmastectomy Body: Learning to Live in and Love Your Body Again*. Point Roberts, WA: Hartley and Marks, 1998.

PERIODICALS

Frost, Marlene, et al. "Long-term Satisfaction and Psychological and Social Function Following Bilateral Prophylactic Mastectomy." *Journal of the American Medical Association* (20 July 2000): 319-24.

Lynden, Patricia. "Your Breasts or Your Life." *American Health for Women* (16 June 1997): 29-31.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Lymphedema Network. 2211 Post St., Suite 404, San Francisco, CA 94115-3427. (800) 541-3259 or (415) 921-1306. <http://www.wenet.net/~lymphnet/>.

Y-ME National Organization for Breast Cancer Information and Support. 18220 Harwood Ave., Homewood, IL 60430. 24-hour hotlines: (800) 221-2141 or (708) 799-8228.

OTHER

ibreast.org 15 Apr. 2001. <http://www.breastcancer.org> (12 June 2001).

Living Beyond Breast Cancer 15 Apr. 2001. <http://www.lbbc.org> (12 June 2001).

Ellen S. Weber

Mastitis

Definition

Mastitis is an infection of the breast. It usually only occurs in women who are breastfeeding their babies.

Description

Breastfeeding is the act of allowing a baby to suckle at the breast, in order to drink the mother's milk. In the process, unaccustomed to the vigorous pull and tug of the infant's suck, the nipples may become sore, cracked, or slightly abraded. This creates a tiny opening in the breast, through which bacteria can enter. The presence of milk, with high sugar content, gives the bacteria an excellent source of **nutrition**. Under these conditions, the bacteria are able to multiply, until they are plentiful enough to cause an infection within the breast.

Mastitis usually begins more than two to four weeks after delivery of the baby. It is a relatively uncommon complication of breastfeeding mothers, occurring in only approximately 2% of women.

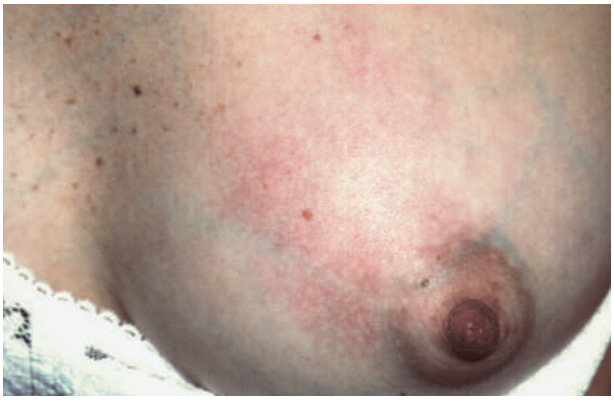
Causes and symptoms

The most common bacteria causing mastitis is called *Staphylococcus aureus*. In 25-30% of people, this bacteria is present on the skin lining normal, uninfected nostrils. It is probably this bacteria, clinging to the baby's nostrils, that is available to create infection when an opportunity (crack in the nipple) presents itself.

Usually, only one breast is involved. An area of the affected breast becomes swollen, red, hard, and painful. Other symptoms of mastitis include **fever**, chills, and increased heart rate.

Diagnosis

Diagnosis involves obtaining a sample of breast milk from the infected breast. The milk is cultured, allowing colonies of bacteria to grow. The causative bacteria can then be specially prepared for identification under a microscope. At the same time, tests can be performed to determine what type of antibiotic would be most effective against that particular bacteria.



Mastitis is usually caused by a bacterial infection through a nipple damaged during breastfeeding. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

Treatment

The **antibiotics** dicloxacillin and erythromycin are both used to treat mastitis. Breastfeeding should be continued, because the rate of **abscess** formation (an abscess is a persistent pocket of pus) in the infected breast goes up steeply among women who stop breastfeeding during a bout with mastitis. Most practitioners allow women to take **acetaminophen** while nursing, to relieve both fever and **pain**. As always, breastfeeding women need to make sure that any medication they take is also safe for the baby, since almost all drugs they take appear in the breastmilk. Warm compresses applied to the affected breast can be soothing.

Prognosis

Prognosis for uncomplicated mastitis is excellent. About 10% of women with mastitis will end up with an abscess within the affected breast. An abscess is a collection of pus within the breast. This complication will require a surgical procedure to drain the pus.

Prevention

The most important aspect of prevention involves good handwashing to try to prevent the infant from acquiring the *Staphylococcus aureus* bacteria in the first place.

Resources

BOOKS

Current Obstetric & Gynecologic Diagnosis & Treatment. Ed. Alan H. DeCherney. Norwalk, CT: Appleton & Lange, 1994.

Williams Obstetrics. Ed. F. Gary Cunningham, et al. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

LaLeche League International. 1400 N. Meacham Rd., Schaumburg, IL 60173-4048. (800) 525-3243. <http://www.lalecheleague.org>.

Rosalyn Carson-DeWitt, MD

Mastocytosis

Definition

Mastocytosis is a disease characterized by the presence of too many mast cells in various organs and tissues.

Description

The body has a variety of free-roaming cell populations that function as immunogenic agents. Most immunogenic cells fall into the category of white blood cells, but some remain in tissues and are not found in the blood. Mast cells are such a group.

Mast cells are found primarily in the skin and digestive system, including the liver and spleen, and produce histamine, a chemical most famous for its ability to cause **itching**. Histamine also causes acid **indigestion**, **diarrhea**, flushing, heart pounding, headaches, and can even cause the blood pressure to drop suddenly.

Mastocytosis comes in three forms. Most cases produce symptoms but do not shorten life expectancy. The three forms are:

- mastocytoma, a benign skin tumor
- urticaria pigmentosa, small collections of mast cells in the skin that manifest as salmon or brown-colored patches
- systemic mastocytosis, the collection of mast cells in the skin, lymph nodes, liver, spleen, gastrointestinal tract, and bones

Causes and symptoms

The cause of mastocytosis is unknown. People with systemic mastocytosis have bone and joint **pain**. Peptic ulcers are frequent because of the increased stomach acid stimulated by histamine. Many patients with systemic mastocytosis also develop urticaria pigmentosa. These **skin lesions** itch when stroked and may become fluid-filled.

Diagnosis

A biopsy of the skin patches aids diagnosis. An elevated level of histamine in the urine or blood is also indicative of mastocytosis.

KEY TERMS

Non-steroidal anti-inflammatory drugs (NSAIDs)—Aspirin, ibuprofen, naproxen, and many others.

Peptic ulcer—Ulcers in the stomach and upper duodenum (first portion of the small intestine) caused by stomach acid and a bacterium called *Helicobacter pylori*.

Treatment

Mastocytoma usually occurs in childhood and clears up on its own. Urticaria pigmentosa (present alone without systemic disease) also dramatically clears or improves as adolescence approaches.

Several medications are helpful in relieving symptoms of systemic mastocytosis. **Antihistamines** and drugs that reduce stomach acid are frequently needed. Headaches respond to migraine treatment. A medicine called cromolyn helps with the bowel symptoms. Several other standard and experimental medications have been used.

Prognosis

Mastocytoma and urticaria pigmentosa rarely if ever, develop into systemic mastocytosis, and both spontaneously improve over time. Systemic mastocytosis is only symptomatically treated. There is no known treatment that decreases the number of mast cells within tissue.

Resources

BOOKS

Austen, K. Frank. "Diseases of Immediate Type Hypersensitivity." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Metcalfe, Dean D. "Mastocytosis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Mastoid tympanoplasty *see* **Mastoidectomy**

Mastoidectomy

Definition

Mastoidectomy is a surgical procedure to remove an infected portion of the bone behind the ear when medical treatment is not effective. This surgery is rarely needed today because of the widespread use of **antibiotics**.

Purpose

Mastoidectomy is performed to remove infected air cells within the mastoid bone caused by **mastoiditis**, ear infection, or an inflammatory disease of the middle ear (cholesteatoma). The cells are open spaces containing air that are located throughout the mastoid bone. They are connected to a cavity in the upper part of the bone, which is in turn connected to the middle ear. As a result, infections in the middle ear can sometimes spread through the mastoid bone. When antibiotics can't clear this infection, it may be necessary to remove the infected air cells by surgery. Mastoidectomies are also performed sometimes to repair paralyzed facial nerves.

Description

Mastoidectomy is performed less often today because of the widespread use of antibiotics to treat ear infections.

There are several different types of mastoidectomy:

- Simple (or closed). The operation is performed through the ear or through a cut (incision) behind the ear. The surgeon opens the mastoid bone and removes the infected air cells. The eardrum is cut (incised) to drain the middle ear. Topical antibiotics are then placed in the ear.
- Radical mastoidectomy. The eardrum and most middle ear structures are removed, but the innermost small bone (the stapes) is left behind so that a hearing aid can be used later to offset the **hearing loss**.
- Modified radical mastoidectomy. The eardrum and the middle ear structures are saved, which allows for better hearing than is possible after a radical operation.

The wound is then stitched up around a drainage tube, which is removed a day or two later. The procedure usually takes between two and three hours.

Preparation

The doctor will give the patient a thorough ear, nose, and throat examination as well as a detailed hearing test before surgery. Patients are given an injection before surgery to make them drowsy.

Aftercare

Painkillers are usually needed for the first day or two after the operation. The patient should drink fluids freely. After the stitches are removed, the bulky mastoid dressing can be replaced with a smaller dressing if the ear is still draining. The patient is given antibiotics for several days.

KEY TERMS

Cholesteatoma—A rare but chronic inflammatory disease in which skin cells and debris collect in the middle ear, usually as a result of an ear infection.

Mastoid bone—The prominent bone behind the ear that projects from the temporal bone of the skull.

Mastoiditis—An inflammation of the bone behind the ear (the mastoid bone) caused by an infection spreading from the middle ear to the cavity in the mastoid bone.

The patient should tell the doctor if any of the following symptoms occur:

- bright red blood on the dressing
- stiff neck or disorientation. These may be signs of **meningitis**
- facial **paralysis**, drooping mouth, or problems swallowing

Risks

Complications don't often occur, but they may include:

- persistent ear drainage
- infections, including meningitis or brain abscesses
- hearing loss
- facial nerve injury, this is a rare complication
- temporary **dizziness**
- temporary loss of taste on the side of the tongue

Resources

BOOKS

Turkington, Carol A. *The Hearing Loss Sourcebook*. New York: Plume/Signet, 1997.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

American Hearing Research Foundation. 55 E. Washington St., Suite 2022, Chicago, IL 60602. (312) 726-9670. <http://www.american-hearing.org/>.

Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684-3391.

Carol A. Turkington

Mastoiditis

Definition

Mastoiditis is an infection of the spaces within the mastoid bone. It is almost always associated with **otitis media**, an infection of the middle ear. In the most serious cases, the bone itself becomes infected.

Description

The mastoid is a part of the side (temporal bone) of the skull. It can be felt as a bony bump just behind and slightly above the level of the earlobe. The mastoid has been described as resembling a "honeycomb" of tiny partitioned-off airspaces. The mastoid is connected with the middle ear, so that when there is a collection of fluid in the middle ear, there is usually also a slight collection of fluid within the airspaces of the mastoid.

Mastoiditis can range from a simple case of some fluid escaping into the mastoid air cells during a middle ear infection, to a more complex infection which penetrates through to the lining of the mastoid bone, to a very severe and destructive infection of the mastoid bone itself.

Causes and symptoms

Mastoiditis is caused by the same types of bacteria which cause middle ear infections (*Streptococcus pneumoniae* and *Haemophilus influenzae*), as well as by a variety of other bacteria (*Staphylococcus aureus*, *Pseuodomonas aeruginosa*, *Klebsiella*, ***Escherichia coli***, *Proteus*, *Prevotella*, *Fusobacterium*, *Porphyromonas*, and *Bacteroides*). Mastoiditis may occur due to the progression of an untreated, or undertreated, middle ear infection.

Symptoms of mastoiditis may at first be the same as symptoms of an early middle ear infection. With progression, however, the swollen mastoid may push the outer ear slightly forward and away from the head. The area behind the ear will appear red and swollen, and will be very sore. There may be drainage of pus from the infected ear. In some cases, the skin over the mastoid may develop an opening through which pus drains. **Fever** is common.

Diagnosis

Mastoiditis is usually suspected when a severe middle ear infection is accompanied by redness, swelling, and **pain** in the mastoid area. A computed tomography scan (CT scan) will show inflammation and fluid within the airspaces of the mastoid, as well as the erosion of the little walls of bone that should separate the air spaces. If there is any fluid draining from the ear or mastoid, this can be

KEY TERMS

Abscess—A pocket of infection, usually including a collection of pus.

Meningitis—Inflammation and infection of the tissues covering the brain and spinal cord (the meninges).

Otitis or oteitis—An infection of the middle ear; marked by an enlargement of bone, tenderness and dull aching pain.

collected and processed in a laboratory to allow identification of the causative organism. If there is no fluid available, a tiny needle can be used to obtain a sample of the fluid which has accumulated behind the eardrum.

Treatment

Identification of the causative organism guides the practitioner's choice of antibiotic. Depending on the severity of the infection, the antibiotic can be given initially through a needle in the vein (intravenously or IV), and then (as the patient improves) by mouth.

In the case of a very severe infection of the mastoid bone itself, with a collection of pus (**abscess**), an operation to remove the mastoid part of the temporal bone is often necessary (**mastoidectomy**).

Prognosis

With early identification of mastoiditis, the prognosis is very good. When symptoms are not caught early enough, however, a number of complications can occur. These include an infection of the tissues covering the brain and spinal cord (**meningitis**), a pocket of infection within the brain (abscess), or an abscess within the muscles of the neck. All of these complications have potentially more serious prognoses.

Prevention

Prevention of mastoiditis involves careful and complete treatment of any middle ear infections.

Resources

BOOKS

Duran, Marlene, et al. "Infections of the Upper Respiratory Tract." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Otitis Media and its Complications." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Eye, Ear, and Sinus Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Rosalyn Carson-DeWitt, MD

Maternal serum alpha-fetoprotein test *see* **Alpha-fetoprotein test**

Mathematics disorder *see* **Learning disorders**

Maxillofacial trauma

Definition

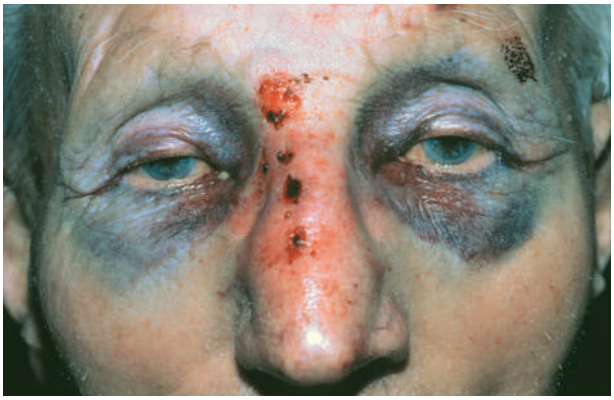
Maxillofacial trauma refers to any injury to the face or jaw caused by physical force, **foreign objects**, or **burns**.

Description

Maxillofacial trauma includes injuries to any of the bony or fleshy structures of the face.

Any part of the face may be affected. Teeth may be knocked out or loosened. The eyes and their muscles, nerves, and blood vessels may be injured as well as the eye socket (orbit), which can be fractured by a forceful blow. The lower jaw (mandible) may be dislocated by force. Although anchored by strong muscles for chewing, the jaw is unstable in comparison with other bones and is easily dislocated from the temporomandibular joints that attach it to the skull. A fractured nose or jaw may affect the ability to breathe or eat. Any maxillofacial trauma may also prevent the passage of air or be severe enough to cause a **concussion** or more serious brain injury.

Athletes are particularly at risk of maxillofacial injuries. Boxers suffer repeated blows to the face and occasional knockouts (traumatic brain injury). Football, basketball, hockey, and soccer players, and many other athletes are at risk for milder forms of brain injury called concussions. There are an estimated 300,000 cases every year. Overall, there are one million new traumatic brain



Face of an elderly woman suffering from maxillofacial trauma. *(Photo Researchers. Reproduced by permission.)*

injuries every year, causing 50,000 deaths. Of the rest, 7–9% are left with long-term disability.

Burns to the face are also categorized as maxillofacial trauma.

Causes and symptoms

There are no reliable statistics on the incidence of maxillofacial trauma because there are so many types and many are not reported. Automobile accidents are a major cause, as well as participation in sports, fights, and other violent acts, and being hit by an object accidentally, for instance being hit by a baseball while watching a game. People most at risk are athletes, anyone who drives a vehicle or rides in one, and those who do dangerous work or engage in aggressive types of behavior.

One study reported in August 2000 that 42% of all facial **fractures** resulted from sports activity.

The major symptoms of most facial injuries are **pain**, swelling, bleeding, and bruising, although a fractured jaw also prevents the person from working his jaw properly, and symptoms of a fractured nose also include black eyes and possible blockage of the airway due to swelling and bleeding.

Symptoms of eye injury or orbital fracture can include blurred or double vision, decreased mobility of the eye, and numbness in the area of the eye. In severe injuries there can be temporary or permanent loss of vision.

Burn symptoms are pain, redness, and possibly blisters, **fever**, and **headache**. Extensive burns can cause the victim to go into **shock**. In that situation, he will have low blood pressure and a rapid pulse.

Symptoms of traumatic brain injury include problems with thinking, memory, and judgement as well as mood swings, and difficulty with coordination and balance. These symptoms linger for weeks or months, and in severe cases can be permanent. Double vision for months after the injury is not uncommon.

Diagnosis

Trauma is usually diagnosed in an emergency room or physician's office by **physical examination** and/or x ray. Some injuries require diagnosis by a specialist. A detailed report of how the injury occurred is also taken. In some cases, diagnosis cannot be made until swelling subsides.

Treatment

Treatment varies, depending on the type and extent of the injury.

Dislocation of the jaw can be treated by a primary care physician by exerting pressure in the proper manner. If muscle spasm prevents the jaw from moving back into alignment, a sedative is administered intravenously (IV) to relax the muscles. Afterward, the patient must avoid opening the jaw wide as he will be prone to repeat dislocations.

A jaw fracture may be minor enough to heal with simple limitation of movement and time. More serious fractures require complicated, multi-step treatment. The jaw must be surgically immobilized by a qualified oral or maxillofacial surgeon or an otolaryngologist. The jaw is properly aligned and secured with metal pins and wires. Proper alignment is necessary to ensure that the bite is correct. If the bite is off, the patient may develop a painful disorder called temporomandibular joint syndrome.

During the weeks of healing the patient is limited to a liquid diet sipped through a straw and must be careful not to choke or vomit since he cannot open his mouth to expel the vomitus. The surgeon will prescribe pain relievers and perhaps **muscle relaxants**. Healing time varies according to the patient's overall health, but will take at least several weeks.

Another common maxillofacial fracture is a broken nose. The bones that form the bridge of the nose may be fractured, but cartilage may also be damaged, particularly the nasal septum which divides the nose. If hit from the side, the bones and cartilage are displaced to the side, but if hit from the front, they are splayed out. Severe swelling can inhibit diagnosis and treatment. Mild trauma to the nose can sometimes heal without the person being aware of the fracture unless there is obvious deformity. The nose will be tender for at least three weeks.

Either before the swelling begins or after it subsides, some 10 days after the injury, the doctor can assess the extent of the damage. Physical examination of the inside using a speculum and the outside, in addition to a

detailed history of how the injury occurred will determine appropriate treatment. The doctor should be informed of any previous nasal fractures, nasal surgery, or chronic disease such as **osteoporosis**. Sometimes an x ray is useful, but it is not always required.

A primary care physician may treat a nasal fracture himself, but if there is extensive damage or the air passage is blocked, he will refer the patient to an otolaryngologist or a plastic surgeon for treatment. Initially the nose may be packed to control bleeding and hold the shape. It is reset under anesthesia. A protective shield or bandage may be placed over it while the fracture heals.

In the case of orbital fractures, there is great danger of permanent damage to vision. Double vision and decreased mobility of the eye are common complications. Surgical reconstruction may be required if the fracture changes the position of the eye or there is other facial deformity. Treatment requires a maxillofacial surgeon.

When the eyes have been exposed to chemicals, they must be washed out for 15 minutes with clear water. Contact lenses may be removed only after rinsing the eyes. The eyes should then be kept covered until the person can be evaluated by a primary care physician or ophthalmologist.

When a foreign object is lodged in the eye, the person should not rub the eye or put pressure on it which would further injure the eyeball. The eye should be covered to protect it until medical attention can be obtained.

Several kinds of traumatic injuries can occur to the mouth. A person can suffer a laceration (cut) to the lips or tongue, or loosening of teeth, or have teeth knocked out. Such injuries often accompany a jaw fracture or other facial injury. **Wounds** to the soft tissues of the mouth bleed freely, but the plentiful blood supply that leads to this heavy bleeding also helps healing. It is important to clean the wound thoroughly with salt water or hydrogen peroxide rinse to prevent infection. Large cuts may require sutures, and should be done by a maxillofacial surgeon for a good cosmetic result, particularly when the laceration is on the edge of the lip line (vermilion). The doctor will prescribe an antibiotic because there is normally a large amount of bacteria present in the mouth.

Any injury to the teeth should be evaluated by a dentist for treatment and prevention of infection. Implantation of a tooth is sometimes possible if it has been handled carefully and protected. The tooth should be held by the crown, not the root, and kept in milk, saline, or contact lens fluid. The patient's dentist can refer him to a specialist in this field.

For first degree burns, put a cold-water compress on the area or run cold water on it. Put a clean bandage on it for protection. Second and third degree burn victims must be taken to the hospital for treatment.

Fluids are replaced there through an IV. This is vital since a patient in shock will die unless those lost fluids are replaced quickly. **Antibiotics** are given to combat infection since the burns make the body vulnerable to infection.

Treatment for a **head injury** requires examination by a primary care physician unless symptoms point to a more serious injury. In that case, the victim must seek emergency care. A concussion is treated with rest and avoidance of contact sports. Very often athletes who have suffered a concussion are allowed to play again too soon, perhaps in the mistaken impression that the injury isn't so bad if the player didn't lose consciousness. Anyone who has had one concussion is at increased risk of another one.

Danger signs that the injury is more serious include worsening headaches, vomiting, weakness, numbness, unsteadiness, change in the appearance of the eyes, seizures, slurred speech, confusion, agitation, or the victim won't wake up. These signs require immediate transport to the hospital. A neurologist will evaluate the situation, usually with a CT scan. A stay in a **rehabilitation** facility may become necessary.

Alternative treatments

Fractures, burns, and deep lacerations require treatment by a doctor but alternative treatments can help the body withstand injury and assist the healing process. Calcium, **minerals**, **vitamins**, all part of a balanced and nutrient-rich diet, as well as regular **exercise**, build strong bones that can withstand force well. After an injury, **craniosacral therapy** may help healing and ease the headaches that follow a concussion or other head trauma. A physical therapist can offer ultrasound that raises temperature to ease pain, or **biofeedback** in which the patient learns how to tense and relax muscles to relieve pain. **Hydrotherapy** may ease the **stress** of recovering from trauma. Chinese medicine seeks to reconnect the chi along the body's meridians and thus aid healing. Homeopathic physicians may prescribe natural medicines such as Arnica or Symphytum to enhance healing.

Prognosis

When appropriate treatment is obtained quickly after an injury, the prognosis can be excellent. However, if the victim of trauma has osteoporosis or a debilitating chronic disease, healing is more problematic. Healing also depends upon the extent of the injury. An automobile accident or a gunshot wound, for example, can cause severe facial trauma that may require multiple surgical

KEY TERMS

Corneal abrasion—A scratch on the surface of the eyeball.

Mandible—The lower jaw, a U-shaped bone attached to the skull at the temporomandibular joints.

Maxilla—The bone of the upper jaw which serves as a foundation of the face and supports the orbits.

Orbit—The eye socket which contains the eyeball, muscles, nerves, and blood vessels that serve the eye.

Otolaryngologist—Ear, nose and throat specialist.

Shock—A reduction of blood flow in the body caused by loss of blood and/or fluids. Can be fatal if not treated quickly.

Temporomandibular joint—The mandible attaches to the temporal bone of the skull and works like a hinge.

Temporomandibular joint syndrome—TMJ Syndrome refers to an incorrect alignment of the lower jaw to the skull which causes the bite to be off line. It causes chronic headaches, nausea, and other symtoms.

Nasal septum—The cartilage which divides the nose in half.

Vermilion border—The line between the lip and the skin.

procedures and a considerable amount of time to heal. Burns and lacerations cause scarring that might be improved by plastic surgery.

Prevention

Safety equipment is vital to preventing maxillofacial trauma from automobile accidents and sports. Here is a partial list of equipment people should always use:

- seatbelts
- automobile air bags
- approved child safety seats
- helmets for riding motorcycles or bicycles, skateboarding, snowboarding, and other sports
- safety glasses for the job, yard work, sports
- other approved safety equipment for sports such as mouthguards, masks, and goggles

Resources

PERIODICALS

Roberts, Graham. "Dental Emergencies (ABC of Oral Health)." *British Medical Journal* (September 2, 2000).

Perkins, Stephen W. "The Incidence of Sports-Related Facial Trauma in Children." *Ear, Nose and Throat Journal* (August 2000).

ORGANIZATIONS

Brain Injury Association, Inc. 105 N. Alfred St., Alexandria, VA 22314. (703) 236-6000. <http://www.biausa.org.>.

American Association of Oral & Maxillofacial Surgeons. 9700 W. Bryn Mawr Ave., Rosemont, IL 60018. (847) 678-6200.

OTHER

"Broken Nose." <http://www.intelihealth.com>.

"Burns: Take Them Seriously." Virtual Hospital. <http://www.vh.org/Patients/IHB/HealthProse/Family medicine/burns.html>.

"Fractured Jaw." <http://www.cbshealthwatch.com/cx/view article/150454>.

"Major Domains of Complementary & Alternative Medicine." National Institutes of Health. <http://nccam.nih.gov/fcp/classify/>.

Barbara J. Mitchell

MCS syndrome *see* **Multiple chemical sensitivity**

MD *see* **Muscular dystrophy**

Measles

Definition

Measles is an infection, caused by a virus, which causes an illness displaying a characteristic skin rash. Measles is also sometimes called rubeola, 5-day measles, or hard measles.

Description

Measles infections appear all over the world. Prior to the current effective immunization program, large-scale measles outbreaks occurred on a two to three-year cycle, usually in the winter and spring. Smaller outbreaks occurred during the off-years. Babies up to about eight months of age are usually protected from contracting measles, due to immune cells they receive from their mothers in the uterus. Once someone has had measles infection, he or she can never get it again.

Causes and symptoms

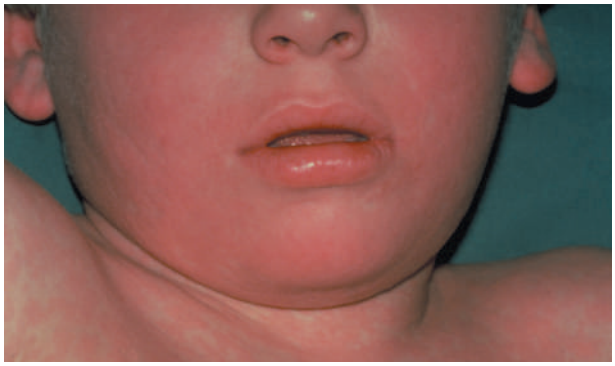
Measles is caused by a type of virus called a paramyxovirus. It is an extremely contagious infection, spread through the tiny droplets that may spray into the air when an individual carrying the virus sneezes or coughs. About 85% of those people exposed to the virus will become infected with it. About 95% of those people infected with the virus will develop the illness called measles. Once someone is infected with the virus, it takes about 7-18 days before he or she actually becomes ill. The most contagious time period is the three to five days before symptoms begin through about four days after the characteristic measles rash has begun to appear.

The first signs of measles infection are **fever**, extremely runny nose, red, runny eyes, and a **cough**. A few days later, a rash appears in the mouth, particularly on the mucous membrane which lines the cheeks. This rash consists of tiny white dots (like grains of salt or sand) on a reddish bump. These are called Koplik's spots, and are unique to measles infection. The throat becomes red, swollen, and sore.

A couple of days after the appearance of the Koplik's spots, the measles rash begins. It appears in a characteristic progression, from the head, face, and neck, to the trunk, then abdomen, and next out along the arms and legs. The rash starts out as flat, red patches, but eventually develops some bumps. The rash may be somewhat itchy. When the rash begins to appear, the fever usually climbs higher, sometimes reaching as high as 105°F (40.5°C). There may be nausea, vomiting, **diarrhea**, and multiple swollen lymph nodes. The cough is usually more problematic at this point, and the patient feels awful. The rash usually lasts about five days. As it fades, it turns a brownish color, and eventually the affected skin becomes dry and flaky.

Many patients (about 5-15%) develop other complications. Bacterial infections, such as ear infections, sinus infections, and **pneumonia** are common, especially in children. Other viral infections may also strike the patient, including **croup**, **bronchitis**, **laryngitis**, or viral pneumonia. Inflammation of the liver, appendix, intestine, or lymph nodes within the abdomen may cause other complications. Rarely, inflammations of the heart or kidneys, a drop in **platelet count** (causing episodes of difficult-to-control bleeding), or reactivation of an old **tuberculosis** infection can occur.

An extremely serious complication of measles infection is swelling of the brain. Called **encephalitis**, this can occur up to several weeks after the basic measles symptoms have resolved. About one out of every 1,000 patients develops this complication, and about 10-15% of these patients die. Symptoms include fever, **headache**, sleepiness, seizures, and **coma**. Long-term problems following recovery from measles encephalitis may include seizures and **mental retardation**.



Measles on child's face. *(Custom Medical Stock Photo. Reproduced by permission.)*

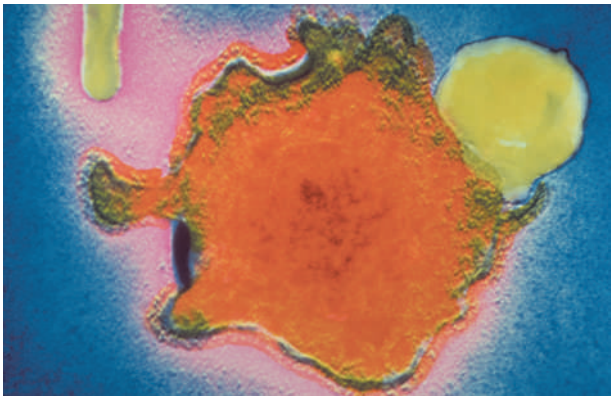
A very rare complication of measles can occur up to 10 years following the initial infection. Called **subacute sclerosing panencephalitis**, this is a slowly progressing, smoldering swelling and destruction of the entire brain. It is most common among people who had measles infection prior to the age of two years. Symptoms include changes in personality, decreased intelligence with accompanying school problems, decreased coordination, involuntary jerks and movements of the body. The disease progresses so that the individual becomes increasingly dependent, ultimately becoming bedridden and unaware of his or her surroundings. Blindness may develop, and the temperature may spike (rise rapidly) and fall unpredictably as the brain structures responsible for temperature regulation are affected. **Death** is inevitable.

Diagnosis

Measles infection is almost always diagnosed based on its characteristic symptoms, including Koplik's spots, and a rash which spreads from central body structures out towards the arms and legs. If there is any doubt as to the diagnosis, then a specimen of body fluids (mucus, urine) can be collected and combined with fluorescent-tagged measles virus antibodies. Antibodies are produced by the body's immune cells that can recognize and bind to markers (antigens) on the outside of specific organisms, in this case the measles virus. Once the fluorescent antibodies have attached themselves to the measles antigens in the specimen, the specimen can be viewed under a special microscope to verify the presence of measles virus.

Treatment

There are no treatments available to stop measles infection. Treatment is primarily aimed at helping the



A transmission electron microscopy (TEM) image of a single measles virion. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Antibodies—Cells made by the immune system which have the ability to recognize foreign invaders (bacteria, viruses), and thus stimulate the immune system to kill them.

Antigens—Markers on the outside of such organisms as bacteria and viruses, which allow antibodies to recognize foreign invaders.

Encephalitis—Swelling, inflammation of the brain.

Koplik's spots—Tiny spots occurring inside the mouth, especially on the inside of the cheek. These spots consist of minuscule white dots (like grains of salt or sand) set onto a reddened bump. Unique to measles.

patient to be as comfortable as possible, and watching carefully so that **antibiotics** can be started promptly if a bacterial infection develops. Fever and discomfort can be treated with **acetaminophen**. Children with measles should never be given **aspirin**, as this has caused the fatal disease **Reye's syndrome** in the past. A cool-mist vaporizer may help decrease the cough. Patients should be given a lot of liquids to drink, in order to avoid **dehydration** from the fever.

Some studies have shown that children with measles encephalitis benefit from relatively large doses of vitamin A.

Alternative treatment

Botanical immune enhancement (with **echinacea**, for example) can assist the body in working through this viral infection. Homeopathic support also can be effective throughout the course of the illness. Some specific alternative treatments to soothe patients with measles include the Chinese herbs bupleurum (*Bupleurum chinense*) and peppermint (*Mentha piperita*), as well as a preparation made from empty cicada (*Cryptotympana atrata*) shells. The itchiness of the rash can be relieved with witch hazel (*Hamamelis virginiana*), chickweed (*Stellaria media*), or oatmeal baths. The eyes can be soothed with an eyewash made from the herb eyebright (*Euphrasia officinalis*). Practitioners of **ayurvedic medicine** recommend ginger or clove tea.

Prognosis

The prognosis for an otherwise healthy, well-nourished child who contracts measles is usually quite good. In developing countries, however, death rates may reach 15-25%. Adolescents and adults usually have a more difficult course. Women who contract the disease while pregnant may give birth to a baby with hearing impairment. Although only 1 in 1,000 patients with measles will develop encephalitis, 10-15% of those who do will die, and about another 25% will be left with permanent brain damage.

Prevention

Measles is a highly preventable infection. A very effective vaccine exists, made of live measles viruses which have been treated so that they cannot cause actual infection. The important markers on the viruses are intact, however, which causes an individual's immune system to react. Immune cells called antibodies are produced, which in the event of a future infection with measles virus will quickly recognize the organism, and kill it off. Measles vaccines are usually given at about 15 months of age; because prior to that age, the baby's immune system is not mature enough to initiate a reaction strong enough to insure long-term protection from the virus. A repeat injection should be given at about 10 or 11 years of age. Outbreaks on college campuses have occurred among unimmunized or incorrectly immunized students.

Resources

BOOKS

Gershon, Anne. "Measles (Rubeola)." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Ray, C. George. "Pathogenic Viruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Borton, Dorothy. "Keeping Measles at Bay: Use These Four Techniques to Stop the Spread." *Nursing* 27,no. 12 (Dec. 1997): 26.

Chavez, Gilberto F., and Arthur A. Ellis. "Pediatric Hospital Admissions for Measles: Lessons from the 1990 Epidemic." *The Western Journal of Medicine* 165, no.1-2 (July/Aug. 1996): 20+.

Hussey, Greg. "Managing Measles: Integrated Case Management Reduces Disease Severity." *British Medical Journal* 314, no. 7077 (1 Feb. 1997): 316+.

Klass, Perri. "Rash Decision." *American Health* 14, no. 4 (May 1995): 102+.

"Progress Toward Global Measles Control and Elimination, 1990-1996." *The Journal of the American Medical Association* 278, no. 17 (5 Nov. 1997): 1396+.

Ramsey, Alison. "Childhood Diseases Are Back." *Reader's Digest* 148, no. 886 (Feb. 1996): 73+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Mebendazole *see* **Antihelminthic drugs**

Mechanical debridement *see* **Debridement**

Mechanical ventilation *see* **Inhalation therapies**

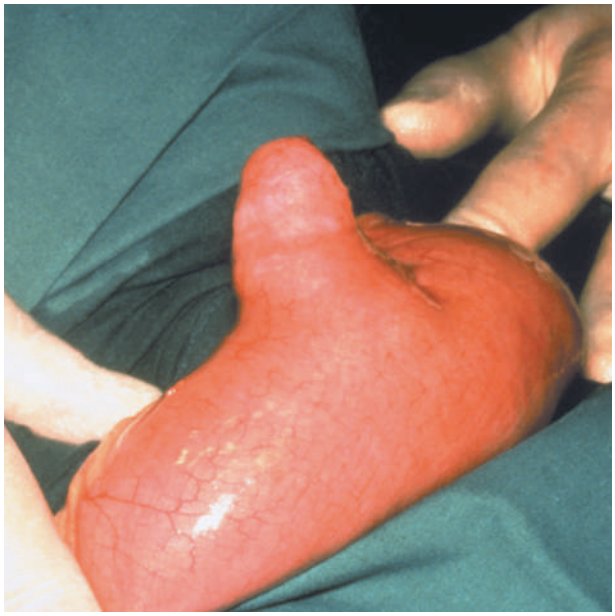
Meckel's diverticulum

Definition

Meckel's diverticulum is a congenital pouch (diverticulum) approximately two inches in length and located at the lower (distal) end of the small intestine. It was named for Johann F. Meckel, a German anatomist who first described the structure.

Description

The diverticulum is most easily described as a blind pouch that is a remnant of the omphalomesenteric duct or yolk sac that nourished the early embryo. It contains all layers of the intestine and may have ectopic tissue present from either the pancreas or stomach.



A close-up image of a patient's small intestine with a protruding sac. This condition, called Meckel's diverticulum, is a congenital abnormality occurring in 2% of the population, usually males. *(Custom Medical Stock Photo. Reproduced by permission.)*

The rule of 2s is the classical description. It is located about 2 ft from the end of the small intestine, is often about 2 in in length, occurs in about 2% of the population, is twice as common in males as females, and can contain two types of ectopic tissue—stomach or pancreas. Many who have a Meckel's diverticulum never have trouble but those that do present in the first two decades of life and often in the first two years.

There are three major complications that may result from the development of Meckel's diverticulum. The most common problem is inflammation or infection that mimics **appendicitis**. This diagnosis is defined at the time of surgery for suspected appendicitis. Bleeding caused by ectopic stomach tissue that results in a bleeding ulcer is the second most frequent problem. Bleeding may be brisk or massive. The third potential complication is obstruction due to **intussusception**, or a twist around a persistent connection to the abdominal wall. This problem presents as a small bowel obstruction, however, the true cause is identified at the time of surgical exploration.

Meckel's diverticulum is a developmental defect that is present in about 2% of people, but does not always cause symptoms. Meckel's diverticula (plural of diverticulum) are found twice as frequently in men as in women. Complications occur three to five times more frequently in males.

KEY TERMS

Appendectomy—The procedure to surgically remove an appendix.

Appendicitis—Inflammation of the appendix.

Appendix—A portion of intestine attached to the cecum.

Cecum—The first part of the large bowel.

Congenital—Refers to a disorder which is present at birth.

Distal—Away from the point of origin.

Ectopic—Tissue found in an abnormal location.

Intussusception—One piece of bowel inside another, causing obstruction.

Isotope—Any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior but with differing atomic mass and physical properties.

Peptic ulcer—A wound in the bowel that can be caused by stomach acid or a bacterium called *Helicobacter pylori.*

Volvulus—A twisted loop of bowel, causing obstruction.

Causes and symptoms

Meckel's diverticulum is not hereditary. It is a vestigial remnant of the omphalomesenteric duct, an embryonic structure that becomes the intestine. As such, there is no genetic defect or abnormality.

Symptoms usually occur in children under 10 years of age. There may be bleeding from the rectum, **pain** and vomiting, or simply tiredness and weakness from unnoticed blood loss. It is common for a Meckel's diverticulum to be mistaken for the much more common disease appendicitis. If there is obstruction, the abdomen will distend and there will be cramping pain and vomiting.

Diagnosis

The situation may be so acute that surgery is needed on an emergency basis. This is often the case with bowel obstruction. With heavy bleeding or severe pain, whatever the cause, surgery is required. The finer points of diagnosis can be accomplished when the abdomen is open for inspection during a surgical procedure. This situation is called an acute abdomen.

If there is more time (not an emergency situation), the best way to diagnose Meckel's diverticulum is with a nuclear scan. A radioactive isotope injected into the bloodstream will accumulate at sites of bleeding or in stomach tissue. If a piece of stomach tissue or a pool of blood shows up in the lower intestine, Meckel's diverticulum is indicated.

Treatment

A Meckel's diverticulum that is causing discomfort, bleeding, or obstruction must be surgically removed. This procedure is very similar to an **appendectomy**.

Prognosis

The outcome after surgery is usually excellent. The source of bleeding, pain, or obstruction is removed so the symptoms also disappear. A Meckel's diverticulum will not return.

Resources

BOOKS

Aspinall, Richard J., and Simon T. Taylor-Robinson. *Mosby's Color Atlas & Text of Gastroenterology.* St. Louis: Mosby-Year Book, 2001.

Cousins, Claire, and Ralph Boulton. *A Color Handbook of Gastroenterology.* New York: McGraw-Hill, 1999.

Isselbacher, Kurt J., and Alan Epstein. "Diverticular, Vascular, and Other Disorders of the Intestine and Peritoneum." In *Harrison's Principals of Internal Medicine.* New York: McGraw Hill, pp. 1648-1655, 1998.

Lipsky, Martin S., and Richard Sadovsky. *Gastrointestinal Problems.* Philadelphia: Lippincott Williams & Wilkins Publishers, 2000.

Sanderson, Ian R., and W. Allan Walker. *Development of the Gastrointestinal Tract.* Hamilton, Ontario, Canada: B. C. Decker, 1999.

Stringer, David A., and Paul S. Babyn. *Pediatric Gastrointestinal Imaging and Intervention,* 2nd edition. Hamilton, Ontario, Canada: B. C. Decker, 2000.

PERIODICALS

al Mahmeed, T., J. K. MacFarlane, and D. Filipenko. "Ischemic Meckel's diverticulum and acute appendicitis." *Canadian Journal of Surgery* 43, no. 2 (2000): 146-47.

Arnio, P., and I. S. Salonen. "Abdominal disorders arising from 71 Meckel's diverticulum." *Annals of Surgery and Gynecology* 89, no. 4 (2000): 281-84.

Heider, R., D. M. Warshauer, and K. E. Behrns. "Inverted Meckel's diverticulum as a source of chronic gastrointestinal blood loss." *Surgery* 128, no. 1 (2000): 107-08.

Martin, J. P., P. D. Connor, and K. Charles. "Meckel's diverticulum." *American Family Physician* 61, no. 4 (2000): 1037-42.

Nagler, J., J. L. Clarke, and S. A. Albert. "Meckel's diverticulitis in an elderly man diagnosed by computed tomography." *Journal of Clinical Gastroenterology* 30, no. (2000): 87-88.

ORGANIZATIONS

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000. <http://www.aafp.org/>., fp@aafp.org>.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000. Fax: (847) 434-8000. kidsdoc@aap.org. <http://www.aap.org/default.htm>.

American College of Gastroenterology. 4900 B South 31st Street, Arlington, VA 22206. (703) 820-7400. Fax: (703) 931-4520. <http://www.acg.gi.org>.

American College of Surgeons. 633 North St. Clair St., Chicago, IL 60611-32311. (312) 202-5000. Fax: (312) 202-5001. postmaster@facs.org. <http://www.facs.org/>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http://www.ama-assn.org/>.

OTHER

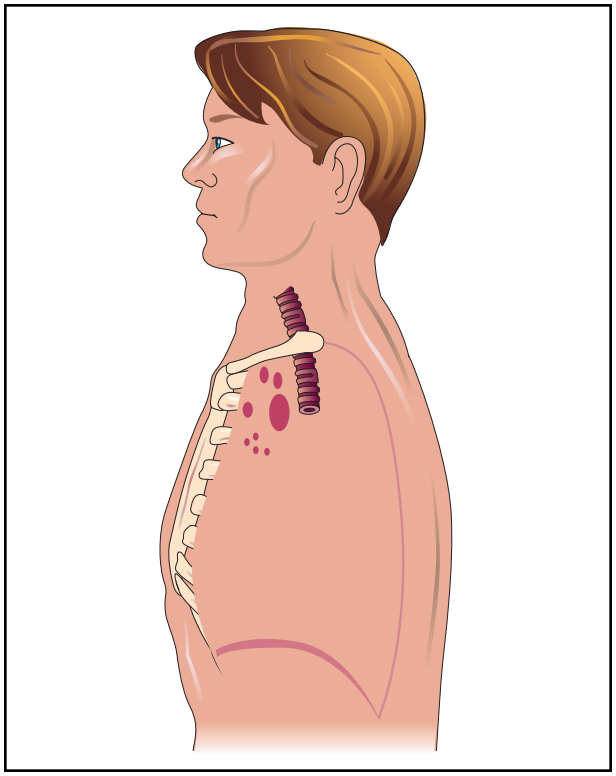
American Academy of Family Physicians. <http://www.aafp.org/afp/20000215/1037.html>.

"Meckel's Diverticulum." *Merck Manual*. <http://www.merck.com/pubs/mmanual/section19/chapter268/268d.htm>.

"Gastroenterology: Meckel's Diverticulum." Vanderbilt University Medical Center, 1998. <http://www.mc.vanderbilt.edu/peds/pidl/gi/meckel.htm>.

L. Fleming Fallon, Jr., MD, DrPH

Median nerve entrapment *see* **Carpal tunnel syndrome**



Mediastinoscopy is a surgical procedure used to detect or stage lymphoma or lung cancer. In this procedure, the surgeon makes an incision below the neck and inserts a mediastinoscope (a narrow, hollow tube with an attached light) through it to reach the area behind the breastbone. The surgeon can then insert tools through the scope to collect tissue for laboratory analysis. *(Illustration by Electronic Illustrators Group.)*

Mediastinoscopy

Definition

Mediastinoscopy is a surgical procedure that allows physicians to view areas of the mediastinum, the cavity behind the breastbone that lies between the lungs. The organs in the mediastinum include the heart and its vessels, the lymph nodes, trachea, esophagus, and thymus.

Mediastinoscopy is most commonly used to detect or stage **cancer**. It is also ordered to detect infection, and to confirm diagnosis of certain conditions and diseases of the respiratory organs. The procedure involves insertion of an endotracheal (within the trachea) tube, followed by a small incision in the chest. A mediastinoscope is inserted through the incision. The purpose of this equipment is to allow the physician to directly see the organs inside the mediastinum, and to collect tissue samples for laboratory study.

Purpose

Mediastinoscopy is often the diagnostic method of choice for detecting lymphoma, including Hodgkin's disease. The diagnosis of **sarcoidosis** (a chronic lung disease) and the staging of lung cancer can also be accomplished through mediastinoscopy. Lung cancer staging involves the placement of the cancer's progression into stages, or levels. These stages help a physician study cancer and provide consistent definition levels of cancer and corresponding treatments. The lymph nodes in the mediastinum are likely to show if lung cancer has spread beyond the lungs. Mediastinoscopy allows a physician to observe and extract a sample from the nodes for further study. Involvement of these lymph nodes indicates diagnosis and stages of lung cancer.

Mediastinoscopy may also be ordered to verify a diagnosis that was not clearly confirmed by other methods, such as certain radiographic and laboratory studies. Mediastinoscopy may also aid in certain surgical biopsies of nodes or cancerous tissue in the mediastinum. In fact, the surgeon may immediately perform a surgical procedure if a malignant tumor is confirmed while the patient is undergoing mediastinoscopy, thus combining

KEY TERMS

Endotracheal—Placed within the trachea, also known as the windpipe.

Hodgkin's disease—A malignancy of lymphoid tissue found in the lymph nodes, spleen, liver, and bone marrow.

Lymph nodes—Small round structures located throughout the body; contain cells that fight infections.

Pleural space—Space between the layers of the pleura (membrane lining the lungs and thorax).

Sarcoidosis—A chronic disease characterized by nodules in the lungs, skin, lymph nodes and bones; however, any tissue or organ in the body may be affected.

Thymus—An unpaired organ in the mediastinal cavity that is important in the body's immune response.

the diagnostic exam and surgical procedure into one operation when possible.

Although still performed in 2001, advancements in computed tomography (CT) and **magnetic resonance imaging** (MRI) techniques, as well as the new developments in ultrasonography, have led to a decline in the use of mediastinoscopy. In addition, better results of fine-needle aspiration (drawing out fluid by suction) and core-needle biopsy (using a needle to obtain a small tissue sample) investigations, along with new techniques in **thoracoscopy** (examination of the thoracic cavity with a lighted instrument called a thoracoscope) offer additional options in examining mediastinal masses. Mediastinoscopy may be required, however, when these other methods cannot be used or when the results they provide are inconclusive.

Precautions

Because mediastinoscopy is a surgical procedure, it should only be performed when the benefits of the exam's findings outweigh the risks of surgery and anesthesia. Patients who previously had mediastinoscopy should not receive it again if there is scarring present from the first exam.

Several other medical conditions, such as impaired cerebral circulation, obstruction or distortion of the upper airway, or thoracic **aortic aneurysm** (abnormal dilation of the thoracic aorta) may also preclude mediastinoscopy. Anatomic structures that can be compressed by the mediastinoscope may complicate these pre-existing medical conditions.

Description

Mediastinoscopy is usually performed in a hospital under general anesthesia. An endotracheal tube is inserted first, after local anesthesia is applied to the throat. Once the patient is under general anesthesia, a small incision is made usually just below the neck or at the notch at the top of the breastbone. The surgeon may clear a path and feel the patient's lymph nodes first to evaluate any abnormalities within the nodes. Next, the physician will insert the mediastinoscope through the incision. The scope is a narrow, hollow tube with an attached light that allows the surgeon to see inside the area. The surgeon can insert tools through the hollow tube to help perform biopsies. A sample of tissue from the lymph nodes or a mass can be extracted and sent for study under a microscope or on to a laboratory for further testing.

In some cases, analysis of the tissue sample which shows malignancy will suggest the need for immediate surgery while the patient is already prepared and under anesthesia. In other cases, the surgeon will complete the visual study and tissue extraction and stitch the small incision closed. The patient will remain in the surgery recovery area until it is determined that the effects of anesthesia have lessened and it is safe for the patient to leave the area. The entire procedure should take about an hour, not counting preparation and recovery time. Studies have shown that mediastinoscopy is a safe, thorough, and cost-effective diagnostic tool with less risk than some other procedures.

Preparation

Patients are asked to sign a consent form after having reviewed the risks of mediastinoscopy and known risks or reactions to anesthesia. The physician will normally instruct the patient to fast from midnight before the test until after the procedure is completed. A physician may also prescribe a sedative the night before the exam and before the procedure. Often a local anesthetic will be applied to the throat to prevent discomfort during placement of the endotracheal tube.

Aftercare

Following mediastinoscopy, patients will be carefully monitored to watch for changes in vital signs or indications of complications of the procedure or the anesthesia. A patient may have a **sore throat** from the endotracheal tube, temporary chest **pain**, and soreness or tenderness at the site of incision.

Risks

Complications from the actual mediastinoscopy procedure are relatively rare—the overall complication rate in various studies has been 1.3–3.0%. However, the following complications, in decreasing order of frequency, have been reported:

- hemorrhage
- pneumothorax (air in the pleural space)
- recurrent laryngeal nerve injury, causing hoarseness
- infection
- tumor implantation in the wound
- phrenic nerve injury (injury to a thoracic nerve)
- esophageal injury
- chylothorax (chyle—a milky lymphatic fluid—in the pleural space)
- air **embolism** (air bubble)
- transient hemiparesis (**paralysis** on one side of the body)

The usual risks associated with general anesthesia also apply to this procedure.

Normal results

In the majority of procedures performed to diagnose cancer, a normal result involves evidence of small, smooth, normal-appearing lymph nodes and no abnormal tissue, growths, or signs of infection. In the case of lung cancer staging, results are related to the severity and progression of the cancer.

Abnormal results

Abnormal findings may indicate lung cancer, **tuberculosis**, the spread of disease from one body part to another, sarcoidosis (a disease that causes nodules, usually affecting the lungs), lymphoma (abnormalities in the lymph tissues), and Hodgkin's disease.

Resources

BOOKS

Fischbach, Frances Talaska. *A Manual of Laboratory and Diagnostic Tests,* 6th ed. Philadelphia: Lippincott Williams and Wilkins, 2000.

Pagana, Kathleen Deska, and Timothy James Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis, MO: Mosby, 1998.

Schull, Patricia, ed. *Illustrated Guide to Diagnostic Tests,* 2nd ed. Springhouse, PA: Springhouse Corporation, 1998.

PERIODICALS

Tahara R. W., et al. "Is There a Role for Routine Mediastinoscopy in Patients With Peripheral T1 Lung Cancers?" *American Journal of Surgery* (December 2000): 488–491.

Deslauriers, Jean, and Jocelyn Gregoire. "Clinical and Surgical Staging of Non-Small Cell Lung Cancer." *Chest,* (April 2000 supplement): 96S–103S.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329. 800–ACS–2345 <http://www.cancer.org>.

American Lung Association. 1740 Broadway, New York, NY 10019–4374. 800–LUNG–USA (800–586–4872). <http://www.lungusa.org>.

Alliance for Lung Cancer Advocacy, Support, and Education. P.O. Box 849, Vancouver, WA 98666. 800–298–2436. <http://www.alcase.org>.

Teresa G. Norris

Meditation

Definition

Meditation is a practice of concentrated focus upon a sound, object, visualization, the breath, movement, or attention itself in order to increase awareness of the present moment, reduce **stress**, promote relaxation, and enhance personal and spiritual growth.

Purpose

Meditation benefits people with or without acute medical illness or stress. People who meditate regularly have been shown to feel less **anxiety** and depression. They also report that they experience more enjoyment and appreciation of life and that their relationships with others are improved. Meditation produces a state of deep relaxation and a sense of balance or equanimity. According to Michael J. Baime, "Meditation cultivates an emotional stability that allows the meditator to experience intense emotions fully while simultaneously maintaining perspective on them." Out of this experience of emotional stability, one may gain greater insight and understanding about one's thoughts, feelings, and actions. This insight in turn offers the possibility to feel more confident and in control of life. Meditation facilitates a greater sense of calmness, empathy, and acceptance of self and others.

Meditation can be used with other forms of medical treatment and is an important complementary therapy for both the treatment and prevention of many stress-related conditions. Regular meditation can reduce the number of symptoms experienced by patients with a wide range of illnesses and disorders. Based upon clinical evidence as well as theoretical understanding, meditation is considered to be one of the better therapies for **panic disorder**, **generalized anxiety disorder**, substance dependence

and abuse, ulcers, colitis, chronic **pain**, **psoriasis**, and dysthymic disorder. It is considered to be a valuable adjunctive therapy for moderate **hypertension** (high blood pressure), prevention of cardiac arrest (**heart attack**), prevention of **atherosclerosis** (hardening of arteries), arthritis (including **fibromyalgia**), **cancer**, **insomnia**, migraine, and prevention of **stroke**. Meditation may also be a valuable complementary therapy for **allergies** and **asthma** because of the role stress plays in these conditions. Meditative practices have been reported to improve function or reduce symptoms in patients with some neurological disorders as well. These include people with **Parkinson's disease**, people who experience **fatigue** with **multiple sclerosis**, and people with epilepsy who are resistant to standard treatment.

Overall, a 1995 report to the National Institutes of Health on alternative medicine concluded that, "More than 30 years of research, as well as the experience of a large and growing number of individuals and health care providers, suggests that meditation and similar forms of relaxation can lead to better health, higher quality of life, and lowered health care costs..."

Description

Origins

Meditation techniques have been practiced for millennia. Originally, they were intended to develop spiritual understanding, awareness, and direct experience of ultimate reality. The many different religious traditions in the world have given rise to a rich variety of meditative practices. These include the contemplative practices of Christian religious orders, the Buddhist practice of sitting meditation, and the whirling movements of the Sufi dervishes. Although meditation is an important spiritual practice in many religious and spiritual traditions, it can be practiced by anyone regardless of their religious or cultural background to relieve stress and pain.

As Western medical practitioners begin to understand the mind's role in health and disease, there has been more interest in the use of meditation in medicine. Meditative practices are increasingly offered in medical clinics and hospitals as a tool for improving health and quality of life. Meditation has been used as the primary therapy for treating certain diseases; as an additional therapy in a comprehensive treatment plan; and as a means of improving the quality of life of people with debilitating, chronic, or terminal illnesses.

Sitting meditation is generally done in an upright seated position, either in a chair or cross-legged on a cushion on the floor. The spine is straight yet relaxed. Sometimes the eyes are closed. Other times the eyes are open and gazing softly into the distance or at an object. Depending on the type of meditation, the meditator may be concentrating on the sensation of the movement of the breath, counting the breath, silently repeating a sound, chanting, visualizing an image, focusing awareness on the center of the body, opening to all sensory experiences including thoughts, or performing stylized ritual movements with the hands.

Movement meditation can be spontaneous and free-form or involve highly structured, choreographed, repetitive patterns. Movement meditation is particularly helpful for those people who find it difficult to remain still.

Generally speaking, there are two main types of meditation. These types are concentration meditation and mindfulness meditation. Concentration meditation practices involve focusing attention on a single object. Objects of meditation can include the breath, an inner or external image, a movement pattern (as in **tai chi** or **yoga**), or a sound, word, or phrase that is repeated silently (mantra). The purpose of concentrative practices is to learn to focus one's attention or develop concentration. When thoughts or emotions arise, the meditator gently directs the mind back to the original object of concentration.

Mindfulness meditation practices involve becoming aware of the entire field of attention. The meditator is instructed to be aware of all thoughts, feelings, perceptions or sensations as they arise in each moment. Mindfulness meditation practices are enhanced by the meditator's ability to focus and quiet the mind. Many meditation practices are a blend of these two forms.

The study and application of meditation to health care has focused on three specific approaches: 1. transcendental meditation (TM); 2. The "relaxation response," a general approach to meditation developed by Dr. Herbert Benson; and 3. mindfulness meditation, specifically the program of mindfulness-based **stress reduction** (MBSR) developed by Jon Kabat-Zinn.

Transcendental meditation

TM has its origins in the Vedic tradition of India and was introduced to the West by Maharishi Mahesh Yogi. TM has been taught to somewhere between two and four million people. It is one of the most widely practiced forms of meditation in the West. TM has been studied many times; these studies have produced much of the information about the physiology of meditation. In TM, the meditator sits with closed eyes and concentrates on a single syllable or word (mantra) for 20 minutes at a time, twice a day. When thoughts or feelings arise, the attention is brought back to the mantra. According to Charles Alexander, an important TM researcher, "During TM, ordinary waking mental activity is said to settle down,

MAHARISHI MAHESH YOGI (1911–)

(Archive. Reproduced by permission.)

Maharishi Mahesh Yogi is one of the most recognized spiritual leaders of the world. Almost single-handedly, the Maharishi (meaning great sage) brought Eastern culture into Western consciousness. He emerged in the late 1950s in London and the United States as a missionary in the cause of Hinduism, the philosophy of which is called Vedanta—a belief that "holds that God is to be found in every creature and object, that the purpose of human life is to realize the godliness in oneself and that religious truths are universal."

By 1967, the Maharishi became a leader among flower-children and an anti-drug advocate. The Maharishi's sudden popularity was helped along by such early fans as the Beatles, Mia Farrow, and Shirley MacLaine. These people, and many others, practiced Transcendental Meditation (TM), a Hindu-influenced procedure that endures in America to this day.

When the 1960s drew to a close, the Maharishi began to fade from public view. The guru still had enough followers, though, to people the Maharishi International University, founded in 1971. One of the main draws of Maharishi International University was the study of TM-Sidha, an exotic form of Transcendental Meditation. Sidhas believe that group meditation can elicit the maharishi effect—a force strong enough to conjure world peace.

until even the subtlest thought is transcended and a completely unified wholeness of awareness...is experienced. In this silent, self-referential state of pure wakefulness, consciousness is fully awake to itself alone..." TM supporters believe that TM practices are more beneficial than other meditation practices.

The relaxation response

The relaxation response involves a similar form of mental focusing. Dr. Herbert Benson, one of the first Western doctors to conduct research on the effects of meditation, developed this approach after observing the profound health benefits of a state of bodily calm he calls "the relaxation response." In order to elicit this response in the body, he teaches patients to focus upon the repetition of a word, sound, prayer, phrase, or movement activity (including swimming, jogging, yoga, and even knitting) for 10–20 minutes at a time, twice a day. Patients are also taught not to pay attention to distracting thoughts and to return their focus to the original repetition. The choice of the focused repetition is up to the individual. Instead of Sanskrit terms, the meditator can choose what is personally meaningful, such as a phrase from a Christian or Jewish prayer.

Mindfulness meditation

Mindfulness meditation comes out of traditional Buddhist meditation practices. Psychologist Jon Kabat-Zinn has been instrumental in bringing this form of meditation into medical settings. In formal mindfulness practice, the meditator sits with eyes closed, focusing the attention on the sensations and movement of the breath for approximately 45–60 minutes at a time, at least once a day. Informal mindfulness practice involves bringing awareness to every activity in daily life. Wandering thoughts or distracting feelings are simply noticed without resisting or reacting to them. The essence of mindfulness meditation is not what one focuses on but rather the quality of awareness the meditator brings to each moment. According to Kabat-Zinn, "It is this investigative, discerning observation of whatever comes up in the present moment that is the hallmark of mindfulness and differentiates it most from other forms of meditation. The goal of mindfulness is for you to be more aware, more in touch with life and whatever is happening in your own body and mind at the time it is happening— that is, the present moment." The MBSR program consists of a series of classes involving meditation, movement, and group process. There are

Girl in meditation. *(Photograph by Robert J. Huffman. Field Mark Publications. Reproduced by permission.)*

over 240 MBSR programs offered in health care settings around the world.

Meditation is not considered a medical procedure or intervention by most insurers. Many patients pay for meditation training themselves. Frequently, religious groups or meditation centers offer meditation instruction free of charge or for a nominal donation. Hospitals may offer MBSR classes at a reduced rate for their patients and a slightly higher rate for the general public.

Precautions

Meditation appears to be safe for most people. There are, however, case reports and studies noting some adverse effects. Thirty-three to 50% of the people participating in long silent meditation retreats (two weeks to three months) reported increased tension, anxiety, confusion, and depression. On the other hand, most of these same people also reported very positive effects from their meditation practice. Kabat-Zinn notes that these studies fail to differentiate between serious psychiatric disturbances and normal emotional mood swings. These studies do suggest, however, that meditation may not be recommended for people with psychotic disorders, severe depression, and other severe **personality disorders** unless they are also receiving psychological or medical treatment.

Side effects

There are no reported side effects from meditation except for positive benefits.

Research and general acceptance

The scientific study of the physiological effects of meditation began in the early 1960s. These studies prove that meditation affects metabolism, the endocrine system, the central nervous system, and the autonomic nervous system. In one study, three advanced practitioners of Tibetan Buddhist meditation practices demonstrated the ability to increase "inner heat" as much as 61%. During a different meditative practice they were able to dramatically slow down the rate at which their bodies consumed oxygen. Preliminary research shows that mindfulness meditation is associated with increased levels of melatonin. These findings suggest a potential role for meditation in the treatment and prevention of breast and prostate cancer.

Despite the inherent difficulties in designing research studies, there is a large amount of evidence of the medical benefits of meditation. Meditation is particularly effective as a treatment for chronic pain. Studies have shown meditation reduces symptoms of pain and pain-related drug use. In a four-year follow-up study, the majority of patients in a MBSR program reported "moderate to great improvement" in pain as a result of participation in the program.

Meditation has long been recommended as a treatment for high blood pressure; however, there is a debate over the amount of benefit that meditation offers. Although most studies show a reduction in blood pressure with meditation, medication is still more effective at lowering high blood pressure.

Meditation may also be an effective treatment for **coronary artery disease**. A study of 21 patients practicing TM for eight months showed increases in their amount of **exercise** tolerance, amount of workload, and a delay in the onset of ST-segment depression. Meditation is also an important part of Dean Ornish's program, which has been proven to reverse coronary artery disease.

Research also suggests that meditation is effective in the treatment of chemical dependency. Gelderloos and others reviewed 24 studies and reported that all of them showed that TM is helpful in programs to stop **smoking** and also in programs for drug and alcohol abuse.

Studies also imply that meditation is helpful in reducing symptoms of anxiety and in treating anxiety-related disorders. Furthermore, a study in 1998 of 37 psoriasis patients showed that those practicing mindful-

KEY TERMS

Dervish—A member of the Sufi order. Their practice of meditation involves whirling ecstatic dance.

Mantra—A sacred word or formula repeated over and over to concentrate the mind.

Transcendental meditation (TM)—A meditation technique based on Hindu practices that involves the repetition of a mantra.

ness meditation had more rapid clearing of their skin condition, with standard UV light treatment, than the control subjects. Another study found that meditation decreased the symptoms of fibromyalgia; over half of the patients reported significant improvement. Meditation was one of several stress management techniques used in a small study of HIV-positive men. The study showed improvements in the T-cell counts of the men, as well as in several psychological measures of well-being.

Resources

BOOKS

Astin, John A., et al. "Meditation" in *Clinician's Complete Reference to Complementary and Alternative Medicine*, ed. Donald Novey. St. Louis, MO: Mosby, 2000.

Baime, Michael J. "Meditation and Mindfulness" in *Essentials of Complementary and Alternative Medicine*, ed. Wayne B. Jonas and Jeffrey S. Levin. New York: Lippencott, Williams and Wilkins, 1999.

Benson, Herbert, M.D. *The Relaxation Response.* New York: William Morrow, 1975.

Kabat-Zinn, John. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness.* New York: Dell, 1990.

Roth, Robert. *TM Transcendental Meditation: A New Introduction to Maharishi's Easy, Effective and Scientifically Proven Technique for Promoting Better Health.* Donald I Fine, 1994.

ORGANIZATIONS

The Center for Mindfulness in Medicine, Health Care and Society. Stress Reduction Clinic. University of Massachusetts Memorial Health Care. 55 Lake Avenue North, Worcester, MA 01655. (508) 856-2656. Fax (508) 856-1977. E-mail: jon.kabat-zinn@banyan@ummed.edu. <http://www.mbst.com>.

Insight Meditation Society. 1230 Pleasant, St. Barre, MA 01005. (978) 355-4378. FAX: (978) 355-6398. <http://www.dharma.org>.

Mind-Body Medical Institute. Beth Israel Deaconess Medical Center. One Deaconess Road, Boston, MA 02215. (617) 632-9525. <http://www.mindbody.harvard.edu>.

OTHER

Videos are available from the organizations listed above.

Linda Chrisman

Medullary sponge kidney

Definition

Medullary sponge kidney is a congenital defect of the kidneys where the kidneys fill with pools of urine.

Description

One of every 100 to 200 people have some form of this disease. The kidneys filter urine from the blood and direct it down tiny collecting tubes toward the ureters (ducts that carry urine from the kidney to the bladder). These tiny tubes gradually join together until they reach the renal pelvis, where the ureters begin. As the tubes join, they are supposed to get progressively bigger as they get fewer in number. In medullary sponge kidney, the tubes are irregular in diameter, forming pools of urine along the way. These pools encourage stone formation and infection.

Causes and symptoms

Although some cases of this disorder seem to be inherited, usually the cause is not known.

The symptoms associated with medullary sponge kidney are those related to infection and stone passage. Infection causes **fever**; back and flank **pain**; cloudy, frequent, and burning urine; and general discomfort. Stones cause pain in the flank or groin as they pass. They usually cause some bleeding. The bleeding may not be visible in the urine, but it is apparent under a microscope.

Diagnosis

Recurring kidney infections, bleeding, or stones will prompt x rays of the kidneys. The appearance of medullary sponge kidney on an intravenous pyelogram (x rays of the upper urinary system) is characteristic.

Treatment

Many people never have trouble with this disorder. For those that do, infections and stones will need periodic treatment. Infections should be treated with **antibiotics** early in order to prevent kidney damage. Stones may need to be surgically removed. Often, removal can be accomplished without an incision but rather by reach-

KEY TERMS

Congenital— Present at birth.

Intravenous pyelogram—X rays of the upper urinary system using a contrast agent that is excreted by the kidneys into the urine.

Thiazide diuretic—A particular class of medication that encourages urine production.

ing up with instruments through the lower urinary tract to grab the stones. There is also a method of stone treatment called shock wave **lithotripsy**. A special machine delivers a focused blast of shock waves that breaks stones into sand so that they will pass out naturally. It is considered reasonably safe and usually effective.

Prognosis

Ignoring symptoms can result in progressive damage to the kidneys and ultimate kidney failure, but attentive early treatment will preserve kidney function.

Prevention

Diligent monitoring for infection at regular intervals and at the first symptom will give the best long-term results. By drinking extra liquids, most stones can be prevented. The most common kind of stones, calcium stones, can be deterred by regularly taking a medication that encourages urine production (thiazide diuretic).

Resources

BOOKS

Asplin, John R., and Frederic L. Coe. "Hereditary Tubular Disorders." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Martin, Thomas V., and R. Earnest Sosa. "Shock Wave Lithotripsy." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Saklayen, M. G. "Medical Management of Nephrolithiasis." *Medical Clinics of North America* 81 (May 1997): 785-799.

ORGANIZATIONS

American Association of Kidney Patients. 100 S. Ashley Dr., #280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Foundation. 6110 Executive Boulevard, #1010, Rockville, Maryland 20852. 800-638-8299.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.

J. Ricker Polsdorfer, MD

Medulloblastoma *see* **Brain tumor**

Mefloquine *see* **Antimalarial drugs**

Megalencephaly *see* **Congenital brain defects**

Melanoma *see* **Malignant melanoma**

Melioidosis

Definition

Melioidosis is an infectious disease of humans and animals caused by a gram-negative bacillus found in soil and water. It has both acute and chronic forms.

Description

Melioidosis, which is sometimes called *Pseudomonas pseudomallei* infection, is endemic (occurring naturally and consistently) in Southeast Asia, Australia, and parts of Africa. It was rare in the United States prior to recent immigration from Southeast Asia. Melioidosis is presently a public health concern because it is most common in **AIDS** patients and intravenous drug users.

Causes and symptoms

Melioidosis is caused by *Pseudomonas pseudomallei,* a bacillus that can cause disease in sheep, goats, pigs, horses, and other animals, as well as in humans. The organism enters the body through skin abrasions, **burns**, or **wounds** infected by contaminated soil; inhalation of dust; or by eating food contaminated with *P. pseudomallei*. Person-to-person transmission is unusual. Drug addicts acquire the disease from shared needles. The incubation period is two to three days.

Chronic melioidosis is characterized by **osteomyelitis** (inflammation of the bone) and pus-filled abscesses in the skin, lungs, or other organs. Acute melioidosis takes one of three forms: a localized skin infection that may spread to nearby lymph nodes; an infection of the lungs associated with high **fever** (102°F/38.9°C), **headache**, chest **pain**, and coughing; and septicemia (blood **poisoning**) characterized by disorientation, difficulty breathing, severe headache, and an eruption of pimples on the head or trunk. The third form is most common among drug addicts and may be rapidly fatal.

Diagnosis

Melioidosis is usually suspected based on the patient's history, especially travel, occupational exposure

KEY TERMS

Osteomyelitis—An inflammation of bone or bone marrow, often caused by bacterial infections. Chronic melioidosis may cause osteomyelitis.

Septicemia—Bacterial infection of the bloodstream. One form of melioidosis is an acute septicemic infection.

to infected animals, or a history of intravenous drug use. Diagnosis must then be confirmed through laboratory tests. *P. pseudomallei* can be cultured from samples of the patient's sputum, blood, or tissue fluid from abscesses. Blood tests, including complement fixation (CF) tests and hemagglutination tests, also help to confirm the diagnosis. In acute infections, chest x rays and **liver function tests** are usually abnormal.

Treatment

Patients with mild or moderate infections are given a course of trimethoprim-sulfamethoxazole (TMP/SMX) and ceftazidime by mouth. Patients with acute melioidosis are given a lengthy course of ceftazidime followed by TMP/SMX. In patients with acute septicemia, a combination of **antibiotics** is administered intravenously, usually tetracycline, chloramphenicol, and TMP/SMX.

Prognosis

The mortality rate in acute cases of pulmonary melioidosis is about 10%; the mortality rate for the septicemic form is significantly higher (slightly above 50%). The prognosis for recovery from mild infections is excellent.

Prevention

There is no form of immunization for melioidosis. Prevention requires prompt cleansing of scrapes, burns, or other open wounds in areas where the disease is common and avoidance of needle sharing among drug addicts.

Resources

BOOKS

"Bacterial Diseases: Melioidosis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Ceftazidime." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

Pollock, Matthew. "Infections Due to Pseudomonas Species and Related Organisms." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Trimethoprim-sulfamethoxazole." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

Rebecca J. Frey

Membranous glomerulopathy *see* **Nephrotic syndrome**

Memory loss *see* **Amnesia**

Meniere's disease

Definition

Meniere's disease is a condition characterized by recurring vertigo (**dizziness**), **hearing loss**, and **tinnitus** (a roaring, buzzing or ringing sound in the ears).

Description

Meniere's disease was named for the French physician Prosper Meniere who first described the illness in 1861. It is an abnormality within the inner ear. A fluid called endolymph moves in the membranous labyrinth or semicircular canals within the bony labyrinth inside the inner ear. When the head or body moves, the endolymph moves, causing nerve receptors in the membranous labyrinth to send signals to the brain about the body's motion. A change in the volume of the endolymph fluid, or swelling or rupture of the membranous labyrinth is thought to result in Meniere's disease symptoms.

Causes and symptoms

The cause of Meniere's disease is unknown; however, scientists are studying several possible causes including noise pollution, viral infections, or other biological factors. The symptoms are associated with a change in fluid volume within the labyrinth of the inner ear.

Symptoms include severe dizziness or vertigo, tinnitus, hearing loss, and the sensation of **pain** or pressure in the affected ear. Symptoms appear suddenly, last up to several hours, and can occur as often as daily to as infrequently as once a year. A typical attack includes vertigo, tinnitus and hearing loss; however, some individuals with Meniere's disease may experience a single symptom, like an occasional bout of slight dizziness or periodic, intense ringing in the ear. Attacks of severe vertigo can force the sufferer to have to sit or lie down, and may be accompa-

nied by **headache**, nausea, vomiting, or **diarrhea**. Hearing tends to recover between attacks, but becomes progressively worse over time.

Meniere's disease usually starts between the ages of 20 and 50 years and affects men and women in equal numbers. In most patients, only one ear is affected, but in about 15% of patients, both ears are involved.

Diagnosis

An estimated 3 to 5 million people in the United States have Meniere's disease, and almost 100,000 new cases are diagnosed each year. Diagnosis is based on medical history, **physical examination**, hearing and balance tests, and medical imaging with **magnetic resonance imaging** (MRI).

Several types of tests may be used to diagnose the disease and to evaluate the extent of hearing loss. In patients with Meniere's disease, audiometric tests (hearing tests) usually indicate a sensory type of hearing loss in the affected ear. Speech discrimination or the ability to distinguish between words that sound alike is often diminished. In about 50% of patients, the balance function is reduced in the affected ear. An electronystagnograph (ENG) may be used to evaluate balance. Since the eyes and ears work together through the nervous system to coordinate balance, measurement of eye movements can be used to test the balance system. For this test, the patient is seated in a darkened room and recording electrodes, similar to those used with a heart monitor, are placed near the eyes. Warm and cool water or air are gently introduced into the each ear canal and eye movements are recorded.

Another test that may be used is an electrocochleograph (EcoG), which can measure increased inner ear fluid pressure.

Treatment

There is no cure for Meniere's disease, but medication, surgery, and dietary and behavioral changes, can help control or improve the symptoms.

Medications

Symptoms of Meniere's disease may be treated with a variety of oral or injectable medications. **Antihistamines**, like diphenhydramine, meclizine, and cyclizine can be prescribed to sedate the vestibular system. A barbiturate medication like pentobarbital may be used to completely sedate the patient and relieve the vertigo. Anticholinergic drugs, like atropine or scopolamine, can help minimize **nausea and vomiting**. Diazepam has been found to be particularly effective for relief of vertigo and nausea in Meniere's disease.

There have been some reports of successful control of vertigo after **antibiotics** (gentamicin or streptomycin) or a steroid medication (dexamethasone) are injected directly into the inner ear. This procedure is done in the doctor's office and is less expensive and less invasive than a surgical procedure.

Surgical procedures

Surgical procedures may be recommended if the vertigo attacks are frequent, severe, or disabling and cannot be controlled by other treatments. The most common surgical treatment is insertion of a small tube or shunt to drain some of the fluid from the canal. This treatment usually preserves hearing and controls vertigo in about one-half to two-thirds of cases, but it is not a permanent cure in all patients.

The vestibular nerve leads from the inner ear to the brain and is responsible for conducting nerve impulses related to balance. A vestibular neurectomy is a procedure where this nerve is cut so the distorted impulses causing dizziness no longer reach the brain. This procedure permanently cures the majority of patients and hearing is preserved in most cases. There is a slight risk that hearing or facial muscle control will be affected.

A labyrinthectomy is a surgical procedure in which the balance and hearing mechanism in the inner ear are destroyed on one side. This procedure is considered when the patient has poor hearing in the affected ear. Labyrinthectomy results in the highest rates of control of vertigo attacks, however, it also causes complete deafness in the affected ear.

Alternative treatment

Changes in diet and behavior are sometimes recommended. Eliminating **caffeine**, alcohol, and salt may relieve the frequency and intensity of attacks in some people with Meniere's disease. Reducing **stress** levels and eliminating tobacco use may also help.

Prognosis

Meniere's disease is a complex and unpredictable condition for which there is no cure. The vertigo associated with the disease can generally be managed or eliminated with medications and surgery. Hearing tends to become worse over time, and some of the surgical procedures recommended, in fact, cause deafness.

Prevention

Since the cause of Meniere's disease is unknown, there are no current strategies for its prevention. Research continues on the environmental and biological factors that

KEY TERMS

Tinnitus—A roaring, buzzing or ringing sound in the ears.

Vertigo—Dizziness or a spinning sensation.

may cause Meniere's disease or induce an attack, as well as on the physiological components of the fluid and labyrinth system involved in hearing and balance. Preventive strategies and more effective treatment should become evident once these mechanisms are better understood.

Resources

BOOKS

"Meniere's Disease." In *The Merck Manual of Diagnosis and Therapy.* 17th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

PERIODICALS

Cohen H., L. R. Ewell, and H. A. Jenkins. "Disability in Meniere's Disease." *Archives of Otolaryngology, Head and Neck Surgery* 121 (Jan. 1995): 29-33.

Driscoll, C. L., et al. "Low-Dose Gentamicin and the Treatment of Meniere's Disease: Preliminary Results." *Laryngoscope* 107 (Jan. 1997): 83-89.

Filipo, R., and M. Barbara. "Natural Course of Meniere's Disease in Surgically-Selected Patients." *Ear, Nose & Throat Journal* 73 (Apr. 1994): 254-257.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

The Meniere's Network. 2000 Church St., P.O. Box 111, Nashville, TN 37236. (800) 545-4327. <http://www.healthy.net/pan/cso/cioi/mn.htm>.

On-Balance, A Support Group for People with Meniere's Disease. <http://www.midwestear.com/onbal.htm>.

Vestibular Disorders Association. P.O. Box 4467, Portland, OR 97208-4467. (800)837-8428.

Altha Roberts Edgren

Meningioma *see* **Brain tumor**

Meningitis

Definition

Meningitis is a potentially fatal inflammation of the meninges, the thin, membranous covering of the brain and the spinal cord. Meningitis is most commonly caused by infection (by bacteria, viruses, or fungi), although it can also be caused by bleeding into the meninges, **cancer**, diseases of the immune system, and an inflammatory response to certain types of **chemotherapy** or other chemical agents. The most serious and difficult-to-treat types of meningitis tend to be those caused by bacteria.

Description

Meningitis is a particularly dangerous infection because of the very delicate nature of the brain. Brain cells are some of the only cells in the body that, once killed, will not regenerate themselves. Therefore, if enough brain tissue is damaged by an infection, serious, life-long handicaps will remain.

In order to learn about meningitis, it is important to have a basic understanding of the anatomy of the brain. The meninges are three separate membranes, layered together, which encase the brain and spinal cord:

- The dura is the toughest, outermost layer, and is closely attached to the inside of the skull.
- The middle layer, the arachnoid, is important because of its involvement in the normal flow of the cerebrospinal fluid (CSF), a lubricating and nutritive fluid that bathes both the brain and the spinal cord.
- The innermost layer, the pia, helps direct blood vessels into the brain.
- The space between the arachnoid and the pia contains CSF, which helps insulate the brain from trauma. Many blood vessels course through this space.

CSF, produced within specialized chambers deep inside the brain, flows over the surface of the brain and spinal cord. This fluid serves to cushion these relatively delicate structures, as well as supplying important nutrients for brain cells. CSF is reabsorbed by blood vessels located within the meninges. A careful balance between CSF production and reabsorption is important to avoid the accumulation of too much CSF.

Because the brain is enclosed in the hard, bony case of the skull, any disease that produces swelling will be damaging to the brain. The skull cannot expand at all, so when the swollen brain tissue pushes up against the skull's hard bone, the brain tissue becomes damaged and may ultimately die. Furthermore, swelling on the right side of the brain will not only cause pressure and damage to that side of the brain, but by taking up precious space within the tight confines of the skull, the left side of the brain will also be pushed up against the hard surface of the skull, causing damage to the left side of the brain as well.

Another way that infections injure the brain involves the way in which the chemical environment of the brain changes in response to the presence of an infection. The cells of the brain require a very well-regulated environment. Careful balance of oxygen, carbon dioxide, sugar (glucose), sodium, calcium, potassium, and other substances must be maintained in order to avoid damage to brain tissue. An infection upsets this balance, and brain damage can occur when the cells of the brain are either deprived of important nutrients or exposed to toxic levels of particular substances.

The cells lining the brain's tiny blood vessels (capillaries) are specifically designed to prevent many substances from passing into brain tissue. This is commonly referred to as the blood-brain barrier. The blood-brain barrier prevents various substances that could be poisonous to brain tissue (toxins), as well as many agents of infection, from crossing from the blood stream into the brain tissue. While this barrier is obviously an important protective feature for the brain, it also serves to complicate treatment in the case of an infection by making it difficult for medications to pass out of the blood and into the brain tissue where the infection is located.

Causes and symptoms

The most common infectious causes of meningitis vary according to an individual's age, habits, living environment, and health status. While nonbacterial types of meningitis are more common, bacterial meningitis is the more potentially life-threatening. Three bacterial agents are responsible for about 80% of all bacterial meningitis cases. These bacteria are *Haemophilus influenzae* type b, *Neisseria meningitidis* (causing meningococcal meningitis), and *Streptococcus pneumoniae* (causing pneumococcal meningitis).

In newborns, the most common agents of meningitis are those that are contracted from the newborn's mother, including Group B streptococci (becoming an increasingly common infecting organism in the newborn period), ***Escherichia coli***, and *Listeria monocytogenes*. The highest incidence of meningitis occurs in babies under a month old, with an increased risk of meningitis continuing through about two years of age.

Older children are more frequently infected by the bacteria *Haemophilus influenzae*, *Neisseria meningitidis*, and *Streptococci pneumoniae*.

Adults are most commonly infected by either *S. pneumoniae* or *N. meningitidis*, with pneumococcal meningitis the more common. Certain conditions predispose to this type of meningitis, including **alcoholism** and chronic upper respiratory tract infections (especially of the middle ear, sinuses, and mastoids).

N. meningitidis is the only organism that can cause epidemics of meningitis. In particular, these have occurred when a child in a crowded day-care situation or a military recruit in a crowded training camp has fallen ill with meningococcal meningitis.

Viral causes of meningitis include the herpes simplex virus, the **mumps** and **measles** viruses (against which most children are protected due to mass immunization programs), the virus that causes chicken pox, the **rabies** virus, and a number of viruses that are acquired through the bites of infected mosquitoes.

A number of medical conditions predispose individuals to meningitis caused by specific organisms. Patients with **AIDS** (acquired **immunodeficiency** syndrome) are more prone to getting meningitis from fungi, as well as from the agent that causes **tuberculosis**. Patients who have had their spleens removed, or whose spleens are no longer functional (as in the case of patients with **sickle cell disease**) are more susceptible to other infections, including meningococcal and pneumococcal meningitis.

The majority of meningitis infections are acquired by blood-borne spread. A person may have another type of infection (of the lungs, throat, or tissues of the heart) caused by an organism that can also cause meningitis. If this initial infection is not properly treated, the organism will continue to multiply, find its way into the blood stream, and be delivered in sufficient quantities to invade past the blood brain barrier. Direct spread occurs when an organism spreads to the meninges from infected tissue next to or very near the meninges. This can occur, for example, with a severe, poorly treated ear or sinus infection.

Patients who suffer from skull **fractures** possess abnormal openings to the sinuses, nasal passages, and middle ears. Organisms that usually live in the human respiratory system without causing disease can pass through openings caused by such fractures, reach the meninges, and cause infection. Similarly, patients who undergo surgical procedures or who have had foreign bodies surgically placed within their skulls (such as tubes to drain abnormal amounts of accumulated CSF) have an increased risk of meningitis.

Organisms can also reach the meninges via an uncommon but interesting method called intraneural spread. This involves an organism invading the body at a considerable distance away from the head, spreading along a nerve, and using that nerve as a kind of ladder into the skull, where the organism can multiply and cause meningitis. Herpes simplex virus is known to use this type of spread, as is the rabies virus.

The most classic symptoms of meningitis (particularly of bacterial meningitis) include **fever**, **headache**, vomiting, sensitivity to light (photophobia), irritability,

HATTIE ALEXANDER (1901–1968)

(Betmann/CORBIS. Reproduced by permission.)

Hattie Alexander, a dedicated pediatrician, medical educator, and researcher in microbiology, won international recognition for deriving a serum to combat influenzal meningitis, a common disease that previously had been nearly always fatal to infants and young children. Alexander subsequently investigated microbiological genetics and the processes whereby bacteria, through genetic mutation, acquire resistance to antibiotics. In 1964, as president of the American Pediatric Society, she became one of the first women to head a national medical association.

As an intern at the Harriet Lane Home of Johns Hopkins Hospital from 1930 to 1931, Alexander became interested in influenzal meningitis. The source of the disease was *Hemophilus influenzae*, a bacteria that causes inflammation of the meninges, the membranes surrounding the brain and spinal cord. In 1931, Alexander began a second internship at the Babies Hospital of the Columbia-Presbyterian Medical Center in New York City. There, she witnessed first-hand the futility of medical efforts to save babies who had contracted influenzal meningitis.

Alexander's early research focused on deriving a serum (the liquid component of blood, in which antibodies are contained) that would be effective against influenzal meningitis. Serums derived from animals that have been exposed to a specific disease-producing bacterium often contain antibodies against the disease and can be developed for use in immunizing humans against it. Alexander knew that the Rockefeller Institute in New York City, however, had been able to prepare a rabbit serum for the treatment of pneumonia, another bacterial disease. Alexander therefore experimented with rabbit serums, and by 1939 was able to announce the development of a rabbit serum effective in curing infants of influenzal meningitis.

In the early 1940s, Alexander experimented with the use of drugs in combination with rabbit serum in the treatment of influenzal meningitis. Within the next two years, she saw infant deaths due to the disease drop by eighty percent.

severe **fatigue** (lethargy), stiff neck, and a reddish purple rash on the skin. Untreated, the disease progresses with seizures, confusion, and eventually **coma**.

A very young infant may not show the classic signs of meningitis. Early in infancy, a baby's immune system is not yet developed enough to mount a fever in response to infection, so fever may be absent. Some infants with meningitis have seizures as their only identifiable symptom. Similarly, debilitated elderly patients may not have fever or other identifiable symptoms of meningitis.

Damage due to meningitis occurs from a variety of phenomena. The action of infectious agents on the brain tissue is one direct cause of damage. Other types of damage may be due to the mechanical effects of swelling and compression of brain tissue against the bony surface of the skull. Swelling of the meninges may interfere with the normal absorption of CSF by blood vessels, causing accumulation of CSF and damage from the resulting pressure on the brain. Interference with the brain's carefully regulated chemical environment may cause damaging amounts of normally present substances (carbon dioxide, potassium) to accumulate. Inflammation may cause the blood-brain barrier to become less effective at preventing the passage of toxic substances into brain tissue.

Diagnosis

A number of techniques are used when examining a patient suspected of having meningitis to verify the diagnosis. Certain manipulations of the head (lowering the head, chin towards chest, for example) are difficult to perform and painful for a patient with meningitis.

The most important test used to diagnose meningitis is the lumbar puncture (commonly called a spinal tap). Lumbar puncture (LP) involves the insertion of a thin nee-

KEY TERMS

Blood-brain barrier—An arrangement of cells within the blood vessels of the brain that prevents the passage of toxic substances, including infectious agents, from the blood and into the brain. It also makes it difficult for certain medications to pass into brain tissue.

Cerebrospinal fluid (CSF)—Fluid made in chambers within the brain which then flows over the surface of the brain and spinal cord. CSF provides nutrition to cells of the nervous system, as well as providing a cushion for the nervous system structures. It may accumulate abnormally in some disease processes, causing pressure on and damage to brain structures.

Lumbar puncture (LP)—A medical test in which a very narrow needle is inserted into a specific space between the vertebrae of the lower back in order to draw off a sample of CSF for further examination.

Meninges—The three-layer membranous covering of the brain and spinal cord, composed of the dura, arachnoid, and pia. It provides protection for the brain and spinal cord, as well as housing many blood vessels and participating in the appropriate flow of CSF.

dle into a space between the vertebrae in the lower back and the withdrawal of a small amount of CSF. The CSF is then examined under a microscope to look for bacteria or fungi. Normal CSF contains set percentages of glucose and protein. These percentages will vary with bacterial, viral, or other causes of meningitis. For example, bacterial meningitis causes a greatly lower than normal percentage of glucose to be present in CSF, as the bacteria are essentially "eating" the host's glucose, and using it for their own **nutrition** and energy production. Normal CSF should contain no infection-fighting cells (white blood cells), so the presence of white blood cells in CSF is another indication of meningitis. Some of the withdrawn CSF is also put into special lab dishes to allow growth of the infecting organism, which can then be identified more easily. Special immunologic and serologic tests may also be used to help identify the infectious agent.

In rare instances, CSF from a lumbar puncture cannot be examined because the amount of swelling within the skull is so great that the pressure within the skull (intracranial pressure) is extremely high. This pressure is always measured immediately upon insertion of the LP needle. If it is found to be very high, no fluid is withdrawn because doing so could cause herniation of the brain stem. Herniation of the brain stem occurs when the part of the brain connecting to the spinal cord is thrust through the opening at the base of the skull into the spinal canal. Such herniation will cause compression of those structures within the brain stem that control the most vital functions of the body (breathing, heart beat, consciousness). **Death** or permanent debilitation follows herniation of the brain stem.

Treatment

Antibiotic medications (forms of penicillin and **cephalosporins**, for example) are the most important element of treatment against bacterial agents of meningitis. Because of the effectiveness of the blood-brain barrier in preventing the passage of substances into the brain, medications must be delivered directly into the patient's veins (intravenously, or by IV), at very high doses. **Antiviral drugs** (acyclovir) may be helpful in shortening the course of viral meningitis, and antifungal medications are available as well.

Other treatments for meningitis involve decreasing inflammation (with steroid preparations) and paying careful attention to the balance of fluids, glucose, sodium, potassium, oxygen, and carbon dioxide in the patient's system. Patients who develop seizures will require medications to halt the seizures and prevent their return.

Prognosis

Viral meningitis is the least severe type of meningitis, and patients usually recover with no long-term effects from the infection. Bacterial infections, however, are much more severe, and progress rapidly. Without very rapid treatment with the appropriate antibiotic, the infection can swiftly lead to coma and death in less than a day's time. While death rates from meningitis vary depending on the specific infecting organism, the overall death rate is just under 20%.

The most frequent long-term effects of meningitis include deafness and blindness, which may be caused by the compression of specific nerves and brain areas responsible for the senses of hearing and sight. Some patients develop permanent seizure disorders, requiring life-long treatment with anti-seizure medications. Scarring of the meninges may result in obstruction of the normal flow of CSF, causing abnormal accumulation of CSF. This may be a chronic problem for some patients, requiring the installation of shunt tubes to drain the accumulation regularly.

Prevention

Prevention of meningitis primarily involves the appropriate treatment of other infections an individual may acquire, particularly those that have a track record of seeding to the meninges (such as ear and sinus infections). Preventive treatment with **antibiotics** is sometimes recommended for the close contacts of an individual who is ill with meningococcal or *H. influenzae* type b meningitis. A meningococcal vaccine exists, and is sometimes recommended to individuals who are traveling to very high risk areas. A vaccine for *H. influenzae* type b is now given to babies as part of the standard array of childhood immunizations.

Resources

BOOKS

Ray, C. George. "Central Nervous System Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

Swartz, Morton N. "Bacterial Meningitis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Meissner, Judith W. "Caring for Patients With Meningitis." *Nursing* (July 1995): 50+.

Schuchat, Anne, et al. "Bacterial Meningitis in the United States in 1995." *New England Journal of Medicine* (2 Oct. 1997).

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Meningitis Foundation of America. 7155 Shadeland Station, Suite 190, Indianapolis, IN 46256-3922. (800) 668-1129. <http://www.musa.org/welcome.htm>.

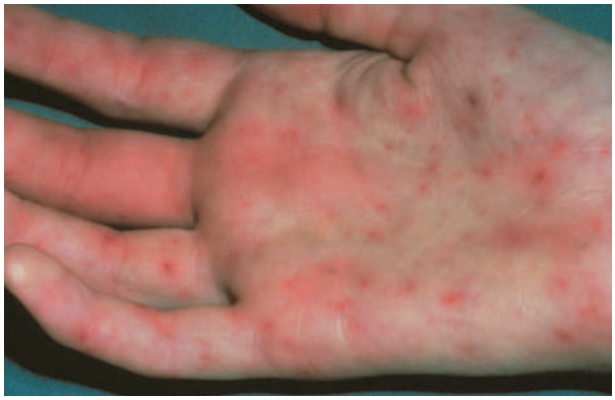
Rosalyn Carson-DeWitt, MD

Meningocele *see* **Spina bifida**

Meningococcemia

Definition

Meningococcemia is the presence of meningococcus in the bloodstream. Meningococcus, a bacteria formally called *Neisseria meningitidis*, can be one of the most dramatic and rapidly fatal of all infectious diseases.



A close-up image of a person's hand with meningococcemia. This disease is caused by the presence of meningococcus (*Neisseria meningitidis*) in the bloodstream. The organism can cause multiple illnesses and can damage small blood vessels. *(Custom Medical Stock Photo. Reproduced by permission.)*

Causes and symptoms

Meningococcemia, a relatively uncommon infection, occurs most commonly in children and young adults. In susceptible people, it may cause a very severe illness that can produce **death** within hours. The bacteria, which can spread from person to person, usually first causes a colonization in the upper airway, but without symptoms. From there, it can penetrate into the bloodstream to the central nervous system and cause **meningitis** or develop into a full-blown bloodstream infection (meningococcemia). Fortunately in most colonized people, this does not happen and the result of this colonization is long-lasting immunity against the particular strain.

After colonization is established, symptoms can develop within one day to one to two weeks. After a short period of time (one hour up to one to two days) when the patient complains of **fever** and muscle aches, more severe symptoms can develop. Unfortunately during this early stage, a doctor cannot tell this illness from any other illness, such as a viral infection like **influenza**. Unless the case is occurring in a person known to have been exposed to or in the midst of an epidemic of meningococcal disease, there may be no specific symptoms or signs found that help the doctor diagnose the problem. Rarely, a low-grade bloodstream infection called chronic meningococcemia can occur.

After this initial period, the patient will often complain of continued fever, shaking chills, overwhelming weakness, and even a feeling of impending doom. The organism is multiplying in the bloodstream, unchecked by the immune system. The severity of the illness and its dire complications are caused by the damage the organism does to the small blood vessel walls. This damage is called

KEY TERMS

Blood culture—A procedure where blood is collected from a vein and is placed in a small bottle that contains a special liquid; the liquid will make any organisms that are present in the blood sample grow. These organisms can then be grown and identified in the laboratory so that the proper antibiotic can be given to the patient.

Colonization—The presence of bacteria on a body surface (like on the skin, mouth, intestines or airway) without causing disease in the person.

Complement—One of several proteins in the blood that acts with other proteins to assist in killing bacteria.

Meningitis—Inflammation of the membranes of the brain or spinal cord.

a **vasculitis**, an inflammation of a blood vessel. Damage to the small vessels causes them to become leaky. The first signs of the infection's severity are small bleeding spots seen on the skin (petechiae). A doctor should always suspect meningococcemia when he/she finds an acutely ill patient with fever, chills, and petechiae.

Quickly (within hours), the blood vessel damage increases and large bleeding areas on the skin (purpura) are seen. The same changes are taking place in the affected person's internal organs. The blood pressure is often low and there may be signs of bleeding from other organs (like coughing up blood, nose bleeds, blood in the urine). The organism not only damages the blood vessels by causing them to leak, but also causes clotting inside the vessels. If this clotting occurs in the larger arteries, it results in major tissue damage. Essentially, large areas of skin, muscle, and internal organs die from lack of blood and oxygen. Even if the disease is quickly diagnosed and treated, the patient has a high risk of dying.

Diagnosis

The diagnosis of meningococcemia can be made by the growth of the organism from blood cultures. Treatment should begin when the diagnosis is suspected and should not be delayed waiting for positive cultures. Obtaining fluid from a petechial spot and staining it in the laboratory can assist in quickly seeing the organism.

Treatment

Immediate treatment of a suspected case of meningococcemia begins with **antibiotics** that work against the organism. Possible choices include penicillin G, ceftriaxone (Rocephin), cefotaxime (Claforan), or trimethoprim/sulfamethoxazole (Bactrim, Septra). If the patient is diagnosed in a doctor's office, antibiotics should be given immediately if possible, even before transfer to the hospital and even if cultures cannot be obtained before treatment. It is most likely that the speed of initial treatment will affect the ultimate outcome.

Prognosis

As many as 15-20% of patients with meningococcemia will die as a result of the acute infection. A significant percentage of the survivors will have tissue damage that requires surgical treatment. This treatment may consist of skin grafts, or even partial or full amputations of an arm or leg. Certain people with immune system defects (particularly those with defects in the complement system) may have recurrent episodes of meningococcemia. These patients, however, seem to have a less serious outcome.

Prevention

Although a vaccine is available for meningococcus, it is still difficult at this time to produce a vaccine for the type B organism, the most common one in the United States. Because of this and the short time that the vaccine seems to offer protection, the product has not been routinely used in the United States. It can be used for travelers going to areas where meningococcal disease is more common or is epidemic. Recently, the vaccine has been suggested for use in incoming college freshman, particularly those living in dormitories. These students appear to have a somewhat higher risk of meningococcal infections.

It is, however, recommended that all people take certain antibiotics if they have had contact (like at home or in a daycare) with a person who has meningococcal infection. The most common antibiotics given are rifampin (Rifadin) or ciprofloxacin (Cipro). These medicines are usually taken by mouth twice a day for two days. This treatment will decrease the risk of infection in these people who have been exposed. However, the overall risk to people who have been exposed, even without antibiotic use, is probably no more than 1-2%.

Resources

PERIODICALS

Centers for Disease Control. "Recommendation of the Immunization Practices Advisory Committee (ACIP): Meningococcal Vaccines." *Morbidity and Mortality Weekly Report* 34(May 10, 1985): 255-259.

Devine, L. F., et al. "Rifampin: Effect of Two-Day Treatment on the Meningococcal Carrier State and the Relationship

to the Levels of Drug in Sera and Saliva." *American Journal of the Medical Sciences* 261(February 1971): 79-83.
McCormick, Joseph B., and John V. Bennett. "Public Health Considerations in the Management of Meningococcal Disease." *Annals of Internal Medicine* 83(December 1975): 883-886.
Salzman, Mark B., and Lorry G. Rubin. "Meningococcemia." *Infectious Disease Clinics of North America* 10(December 1996): 709-725.

Larry I. Lutwick, MD

Meningomyelocele *see* **Spina bifida**

Menkes' syndrome *see* **Mineral deficiency**

Menopause

Definition

Menopause represents the end of menstruation. While technically it refers to the final period, it is not an abrupt event, but a gradual process. Menopause is not a disease that needs to be cured, but a natural life-stage transition. However, women have to make important decisions about "treatment," including the use of **hormone replacement therapy** (HRT).

Description

Many women have irregular periods and other problems of "pre-menopause" for years. It's not easy to predict when menopause begins, although doctors agree it is complete when a woman has not had a period for a year. Eight out of every 100 women stop menstruating before age 40. At the other end of the spectrum, five out of every 100 continue to have periods until they are almost 60. The average age of menopause is 51.

There's no mathematical formula to figure out when the ovaries will begin to scale back either, but a woman can get a general idea based on her family history, body type, and lifestyle. Women who began menstruating early will not necessarily stop having periods early as well. It is true that a woman will likely enter menopause at about the same age as her mother. Menopause may occur later than average among smokers.

Causes and symptoms

Once a woman enters **puberty**, each month her body releases one of the more than 400,000 eggs that are stored in her ovaries, and the lining of the womb (uterus) thickens in anticipation of receiving a fertilized egg. If the egg isn't fertilized, progesterone levels drop and the uterine lining sheds and bleeds.

By the time a woman reaches her late 30s or 40s, her ovaries begin to shut down, producing less estrogen and progesterone and releasing eggs less often. The gradual decline of estrogen causes a wide variety of changes in tissues that respond to estrogen—including the vagina, vulva, uterus, bladder, urethra, breasts, bones, heart, blood vessels, brain, skin, hair, and mucous membranes. Over the long run, the lack of estrogen can make a woman more vulnerable to **osteoporosis** (which can begin in the 40s) and heart disease.

As the levels of hormones fluctuate, the menstrual cycle begins to change. Some women may have longer periods with heavy flow followed by shorter cycles and hardly any bleeding. Others will begin to miss periods completely. During this time, a woman also becomes less able to get pregnant.

The most common symptom of menopause is a change in the menstrual cycle, but there are a variety of other symptoms as well, including:

- hot flashes
- night sweats
- **insomnia**
- mood swings/irritability
- memory or concentration problems
- vaginal dryness
- heavy bleeding
- **fatigue**
- depression
- hair changes
- headaches
- heart **palpitations**
- sexual disinterest
- urinary changes
- weight gain

Diagnosis

The clearest indication of menopause is the absence of a period for one year. It is also possible to diagnose menopause by testing hormone levels. One important test measures the levels of follicle-stimulating hormone (FSH).

However, as a woman first enters menopause, her hormones often fluctuate wildly from day to day. For example, if a woman's estrogen levels are high and progesterone is low, she may have mood swings, irritability,

and other symptoms similar to **premenstrual syndrome** (PMS). As hormone levels shift and estrogen level falls, hot flashes occur. Because of these fluctuations, a normal hormone level when the blood is tested may not necessarily mean the levels were normal the day before or will be the day after.

If it has been at least three months since a woman's last period, an FSH test might be more helpful in determining whether menopause has occurred. Most doctors believe that the FSH test alone can't be used as proof that a woman has entered early menopause. A better measure of menopause is a test that checks the levels of estrogen, progesterone, testosterone and other hormones at midcycle, in addition to FSH.

Treatment

When a woman enters menopause, her levels of estrogen drop and symptoms (such as hot flashes and vaginal dryness) begin. Hormone replacement therapy can treat these symptoms by boosting the estrogen levels enough to suppress symptoms while also providing protection against heart disease and osteoporosis, which causes the bones to weaken. Experts disagree on whether HRT increases or decreases the risk of developing **breast cancer**. A Harvard study concluded that short-term use of hormones carries little risk, while HRT used for more than five years among women 55 and over seems to increase the risk of breast **cancer**.

There are two types of hormone treatments: hormone replacement therapy (HRT) and estrogen replacement therapy (ERT). HRT is the administration of estrogen and progesterone; ERT is the administration of estrogen alone. Only women who have had a **hysterectomy** (removal of the uterus) can take estrogen alone, since taking this "unopposed" estrogen can cause uterine cancer. The combination of progesterone and estrogen in HRT eliminates the risk of uterine cancer.

Most physicians do not recommend HRT until a woman's periods have stopped completely for one year. This is because women in early menopause who still have an occasional period are still producing estrogen; HRT would then provide far too much estrogen.

Most doctors believe that every woman (except those with certain cancers) should take hormones as they approach menopause because of the protection against heart disease, osteoporosis, and uterine cancer and the relatively low risk of breast cancer. Heart disease and osteoporosis are two of the leading causes of disability and **death** among post-menopausal women.

Critics say the benefit of taking hormonal drugs to ease symptoms isn't worth the risk of breast cancer. Since menopause isn't a disease, many argue that women shouldn't take hormones to cure what is actually a natural process of **aging**. Advocates of HRT contend that the purpose of taking hormones is not to "treat" menopause but to prevent the development of other diseases.

There are risks with HRT and there are risks without it. In order to decide whether to take HRT, a woman should balance her risk of getting breast cancer against her risk of getting heart disease, and decide how bad her menopause symptoms are. Most doctors agree that short-term use of estrogen for those women with symptoms of hot flashes or night sweats is a sensible choice as long as they don't have a history of breast cancer.

For a woman who has no family history of cancer and a high risk of dying from heart disease, for example, the low risk of cancer might be worth the protective benefit of avoiding heart disease. Certainly, for Caucasian women aged 50 to 94, the risk of dying from heart disease is far greater than the risk of dying of breast cancer.

Women are poor candidates for hormone replacement therapy if they have:

- had breast or **endometrial cancer**
- a close relative (mother, sister, grandmother) who died of breast cancer or have two relatives who got breast cancer before age 40
- had endometrial cancer
- had gallbladder or liver disease
- blood clots or phlebitis

Some women with liver or gallbladder disease, or who have clotting problems, may be able to go on HRT if they use a patch to administer the hormones through the skin, bypassing the liver.

Women would make a good candidate for HRT if they:

- need to prevent osteoporosis
- have had their ovaries removed
- need to prevent heart disease
- have significant symptoms

Taking hormones can almost immediately eliminate hot flashes, vaginal dryness, **urinary incontinence** (depending on the cause), insomnia, moodiness, memory problems, heavy irregular periods, and concentration problems. Side effects of treatment include bloating, breakthrough bleeding, headaches, vaginal discharge, fluid retention, swollen breasts, or nausea. Up to 20% of women who try hormone replacement stop within nine months because of these side effects. However, some side effects can be lessened or prevented by changing the HRT regimen.

KEY TERMS

Endometrium—The lining of the uterus that is shed with each menstrual period.

Estrogen—Female hormone produced by the ovaries and released by the follicles as they mature. Responsible for female sexual characteristics, estrogen stimulates and triggers a response from at least 300 tissues, and may help some types of breast cancer to grow. After menopause, the production of the hormone gradually stops.

Estrogen replacement therapy (ERT)—A treatment for menopause in which estrogen is given in pill, patch, or cream form.

Follicle-stimulating hormone (FSH)—The pituitary hormone that stimulates the ovary to mature egg capsules (follicles). It is linked with rising estrogen production throughout the cycle. An elevated FSH (above 40) indicates menopause.

Hormone—A chemical messenger secreted by a gland that is released into the blood, and that travels to distant cells where it exerts an effect.

Hormone replacement therapy (HRT)—The use of estrogen and progesterone to replace hormones that the ovary no longer supplies.

Hot flash—A wave of heat that is one of the most common perimenopausal symptoms, triggered by the hypothalamus' response to estrogen withdrawal.

Hysterectomy—Surgical removal of the uterus.

Ovary—One of the two almond-shaped glands in the female reproductive system responsible for producing eggs and the hormones estrogen and progesterone.

Ovulation—The monthly release of an egg from the ovary.

Pituitary gland—The "master gland" at the base of the brain that secretes a number of hormones responsible for growth, reproduction, and other activities. Pituitary hormones stimulate the ovaries to release estrogen and progesterone.

Progesterone—The hormone that is produced by the ovary after ovulation to prepare the uterine lining for a fertilized egg.

Testosterone—Male hormone produced by the testes and (in small amounts) in the ovaries. Testosterone is responsible for some masculine secondary sex characteristics such as growth of body hair and deepening voice.

Uterus—The female reproductive organ that contains and nourishes a fetus from implantation until birth. Also known as the womb.

Vagina—The tube-like passage from the vulva (a woman's external genital structures) to the cervix (the portion of the uterus that projects into the vagina).

The decision should be made by a woman and her doctor after taking into consideration her medical history and situation. Women who choose to take hormones should have an annual mammogram, breast exam, and **pelvic exam** and should report any unusual vaginal bleeding or spotting (a sign of possible uterine cancer).

Anti-estrogens

A new type of hormone therapy offers some of the same protection against heart disease and bone loss as estrogen, but without the increased risk of breast cancer. This new class of drugs are known as anti-estrogens. The best known of these anti-estrogens is raloxifene, which mimics the effects of estrogen in the bones and blood, but blocks some of its negative effects elsewhere. It's called an anti-estrogen because for a long time these drugs had been used to counter the harmful effects of estrogen that caused breast cancer. Oddly enough, in other parts of the body these drugs mimic estrogen, protecting against heart disease and osteoporosis without putting a woman at risk for breast cancer.

Like estrogen, raloxifene works by attaching to an estrogen "receptor," much like a key fits into a lock. When raloxifene clicks into the estrogen receptors in the breast and uterus, it blocks estrogen at these sites. This is the secret of its cancer-fighting property. Many tumors in the breast are fueled by estrogen; if the estrogen cannot get in the cell, then the cancer stops growing.

Women may prefer to take raloxifene instead of hormone replacement because the new drug doesn't boost the breast cancer risk and doesn't have side effects like uterine bleeding, bloating, or breast soreness. Unfortunately, the drug may worsen hot flashes. Raloxifene is basically a treatment to prevent osteoporosis. It doesn't help with common symptoms and it is unclear if it has the same protective effect against heart disease as estrogen does.

Testosterone replacement

The ovaries also produce a small amount of male hormones, which decreases slightly as a woman enters menopause. The vast majority of women never need testosterone replacement, but it can be important if a woman has declining interest in sex. Testosterone can improve the libido, and decrease **anxiety** and depression; adding testosterone especially helps women who have had hysterectomies. Testosterone also eases breast tenderness and helps prevent bone loss. However, testosterone does have side effects. Some women experience mild **acne** and some facial hair growth, but because only small amounts of testosterone are prescribed, most women don't appear to have extreme masculine changes.

Birth control pills

Women who are still having periods but who have annoying menopausal symptoms may take low-dose birth control pills to ease the problems; this treatment has been approved by the FDA for perimenopausal symptoms in women under age 55. HRT is the preferred treatment for menopause, however, because it uses lower doses of estrogen.

Alternative treatment

Some women also report success in using natural remedies to treat the unpleasant symptoms of menopause. Not all women need estrogen and some women can't take it. Many doctors don't want to give hormones to women who are still having their periods, however erratically. Indeed, only a third of menopausal women in the United States try HRT and of those who do, eventually half of them drop the therapy. Some are worried about breast cancer, some can't tolerate the side effects, some don't want to medicate what they consider to be a natural occurrence.

Herbs

Herbs have been used to relieve menopausal symptoms for centuries. In general, most herbs are considered safe, and there is no substantial evidence that herbal products are a major source of toxic reactions. But because herbal products aren't regulated in the United States, contamination or accidental overdose is possible. Herbs should be bought from a recognized company or through a qualified herbal practitioner.

Women who choose to take herbs for menopausal symptoms should learn as much as possible about herbs and work with a qualified practitioner (an herbalist, a traditional Chinese doctor, or a naturopathic physician). Pregnant women should avoid herbs because of unknown effects on a developing fetus.

The following list of herbs include those that herbalists most often prescribe to treat menstrual complaints:

- black cohosh (*Cimicifuga racemosa*): hot flashes and other menstrual complaints
- black currant: breast tenderness
- chaste tree/chasteberry (*Vitex agnus-castus*): hot flashes, excessive menstrual bleeding, fibroids, and moodiness
- evening primrose oil (*Oenothera biennis*): mood swings, irritability, and breast tenderness
- fennel (*Foeniculum vulgare*): hot flashes, digestive gas, and bloating
- flaxseed (linseed): excessive menstrual bleeding, breast tenderness, and other symptoms, including dry skin and vaginal dryness
- gingko (*Gingko biloba*): memory problems
- ginseng (*Panax ginseng*): hot flashes, fatigue and vaginal thinning.
- hawthorn (*Crataegus laevigata*): memory problems, fuzzy thinking
- lady's mantle: excessive menstrual bleeding
- mexican wild yam (*Dioscorea villosa*) root: vaginal dryness, hot flashes and general menopause symptoms
- motherwort (*Leonurus cardiaca*): night sweats, hot flashes
- oat (*Avena sativa*) straw : mood swings, anxiety
- red clover (*Trifolium pratense*): hot flashes
- sage (*Salvia officinalis*): mood swings, headaches, night sweats
- valerian (*Valeriana officinalis*): insomnia

Natural estrogens (phytoestrogens)

Proponents of plant estrogens (including soy products) believe that plant estrogens are better than synthetic estrogen, but science has not yet proven this. The results of smaller preliminary trials suggest that the estrogen compounds in soy products can indeed relieve the severity of hot flashes and lower cholesterol. But no one yet has proven that soy can provide all the benefits of synthetic estrogen without its negative effects.

It is true that people in other countries who eat foods high in plant estrogens (especially soy products) have lower rates of breast cancer and report fewer "symptoms" of menopause. While up to 80% of menopausal women in the United States complain of hot flashes, night sweats, and vaginal dryness, only 15% of Japanese women have similar complaints. When all other things are equal, a soy-based diet may make a difference (and soy is very high in plant estrogens).

The study of phytoestrogens is so new that there aren't very many recommendations on how much a woman can consume. Herbal practitioners recommend a dose based on a woman's history, body size, lifestyle, diet, and reported symptoms. Research has indicated that some women were able to ease their symptoms by eating a large amount of fruits, vegetables, and whole grains, together with four ounces of tofu four times a week.

What concerns some critics of other alternative remedies is that many women think that "natural" or "plant-based" means "harmless." In large doses, phytoestrogens can promote the abnormal growth of cells in the uterine lining. Unopposed estrogen of any type can lead to endometrial cancer, which is why women on conventional estrogen-replacement therapy usually take progesterone (progestin) along with their estrogen. However, a plant-based progesterone product can sometimes be effective alone, without estrogen, in assisting the menopausal woman in rebalancing her hormonal action throughout this transition time.

Yoga

Many women find that **yoga** (the ancient meditation/exercise developed in India 5,000 years ago) can ease menopausal symptoms. Yoga focuses on helping women unite the mind, body, and spirit to create balance. Because yoga has been shown to balance the endocrine system, some experts believe it may affect hormone-related problems. Studies have found that yoga can reduce **stress**, improve mood, boost a sluggish metabolism, and slow the heart rate. Specific yoga positions deal with particular problems, such as hot flashes, mood swings, vaginal and urinary problems, and other pains.

Exercise

Exercise helps ease hot flashes by lowering the amount of circulating FSH and LH and by raising endorphin levels that drop while having a hot flash. Even exercising 20 minutes three times a week can significantly reduce hot flashes.

Elimination

Regular, daily bowel movements to eliminate waste products from the body can be crucial in maintaining balance through menopause. The bowels are where circulating hormones are gathered and eliminated, keeping the body from recycling them and causing an imbalance.

Acupuncture

This ancient Asian art involves placing very thin needles into different parts of the body to stimulate the system and unblock energy. It is usually painless and has been used for many menopausal symptoms, including insomnia, hot flashes, and irregular periods. Practitioners believe that **acupuncture** can facilitate the opening of blocked energy channels, allowing the life force energy (chi) to flow freely. This allows the menopausal woman to keep her energy moving. Blocked energy usually increases the symptoms of menopause.

Acupressure and massage

Therapeutic massage involving **acupressure** can bring relief from a wide range of menopause symptoms by placing finger pressure at the same meridian points on the body that are used in acupuncture. There are more than 80 different types of massage, including foot **reflexology**, **Shiatsu** massage, or Swedish massage, but they are all based on the idea that boosting the circulation of blood and lymph benefits health.

Biofeedback

Some women have been able to control hot flashes through **biofeedback**, a painless technique that helps a person train her mind to control her body. A biofeedback machine provides information about body processes (such as heart rate) as the woman relaxes her body. Using this technique, it is possible to control the body's temperature, heart rate, and breathing.

Prognosis

Menopause is a natural condition of aging. Some women have no problems at all with menopause, while others notice significant unpleasant symptoms. A wide array of treatments, from natural to hormone replacement, mean that no woman needs to suffer through this time of her life.

Prevention

Menopause is a natural part of the aging process and not a disease that needs to be prevented. Most doctors recommend HRT for almost all post-menopausal women, usually for a few years. When HRT is then stopped, symptoms should be mild or non existent. But HRT is not only useful in lessening the symptoms of menopause; it also protects against heart disease and osteoporosis.

Resources

BOOKS

Carlson, Karen J., Stephanie Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Goroll, Allan H., et al. *Primary Care Medicine*. 4th ed. Lippincott Williams & Wilkins, 2000.
Goldman, Lee, et al., eds. *Cecil Textbook of Medicine*. 21st ed. W. B. Saunders, 2000.
Jacobowitz, Ruth S. *150 Most-Asked Questions About Menopause*. New York: William Morrow, 1993.
Notelovitz, Morris, and Diana Tonnessen. *Estrogen: Yes or No?* New York: St. Martin's Press, 1993.
Notelovitz, Morris, and Diana Tonnessen. *Menopause and Midlife Health*. New York: St. Martin's Press, 1993.
Perry, Susan, and Kate O'Hanlan. *Natural Menopause: The Complete Guide*. Reading, MA: Addison-Wesley, 1997.
Sachs, Judith. *What Women Should Know About Menopause*. New York: Dell Publishing, 1991.
Teaff, Nancy Lee, and Kim Wright Wiley. *Perimenopause: Preparing for the Change*. Prima Publishing, 1996.
Turkington, Carol A. *The Perimenopause Sourcebook*. New York: Contemporary Books, 1998.

PERIODICALS

Adami, H. O., and I. Persson. "Hormone Replacement and Breast Cancer: A Remaining Controversy?" *Journal of the American Medical Association* 274 (1995): 178-9.
Nash, J. Madeleine. "Early Flash Points: Beset by Symptoms Caused by Ebbing Hormones, Women in Midlife Turn to Herbs and Health Foods to Smooth Out the Rocky Road to Menopause." *Time* 146 (21 Apr. 1997).
Seachrist, Lia. "What Risk Hormones? Conflicting Studies Reveal Problems in Pinning Down Breast Cancer Risks." *Science News* 148 (5 Aug. 1995): 94-95.
Shute, Nancy. "Menopause is No Disease." *U.S. News & World Report* 122 (24 Mar. 1997): 71.
Stampfer, M. J, et al. "Postmenopausal Estrogen Therapy and Cardiovascular Disease: Ten Year Follow Up From the Nurses' Health Study." *New England Journal of Medicine* 325 (12 Sept. 1991): 756-762.
Stanford, J. L., N. S. Weiss, et al. "Combined Estrogen and Progestin Hormone Replacement Therapy in Relation to Risk of Breast Cancer." *Journal of the American Medical Association* 274 (12 July 1995): 137-142.
Wallis, Claudia. "The Estrogen Dilemma." *Time* 145 (26 June 1995).
Wright, Karen, "Menopause, Naturally." *Health*, Jan./Feb. 1996, 75-79.

ORGANIZATIONS

American Menopause Foundation, Inc. Empire State Bldg., 350 Fifth Ave., Ste. 2822, New York, NY 10118. (212) 714-2398.
Federation of Feminist Women's Health Centers. 633 East 11th Ave., Eugene, OR 97401. (503) 344-0966.
Hysterectomy Educational Resources and Services Foundation (HERS). 422 Bryn Mawr Ave., Bala Cynwyd, PA 19004. (215) 667-7757.
National Women's Health Network. 1325 G St. NW, Washington, DC 20005. (202) 347-1140.
North American Menopause Society. PO Box 94527, Cleveland, OH 44101. (216) 844-8748. <http:www.menopause.org>.
Resources for Midlife and Older Women. 226 E. 70 St., Ste. 1C, New York, NY 10021. (212) 439-1913.

OTHER

Meno Times Online. <http://www.aimnet.com/~hyperion/meno/menotimes.index.html>.
Menopause Online Page. <http://www.menopause-online.com/links.htm>.
Menopause Page. <http://www.howdyneighbor.com/menopause>.

Laith Farid Gulli, M.D.

Menorrhagia *see* **Dysfunctional uterine bleeding**

Men's health

Definition

Men's health is concerned with identifying, preventing, and treating conditions that are most common or specific to men.

Purpose

Men live on average seven years less than women; life expectancy in the United States is 72 years for men and 79 years for women. The reasons for this discrepancy are not completely understood. Men may have some genetic predisposition for lower life expectancy, as women tend to outlive men in most areas throughout the world. But men also have different lifestyle patterns that increase the wear and tear on their bodies. Studies have shown that men tend to drink and smoke more than women, men obtain medical care less frequently than women, and men generally have more stressful habits. It is clear to health professionals that men can benefit from increased knowledge of male medical issues and by understanding how lifestyle choices impact health.

According to the Centers for Disease Control (CDC), the 10 leading causes of **death** for men in the United States are:

- heart disease
- **cancer**
- **stroke**
- accidents
- lung disease (including **emphysema** and chronic bronchitis)
- pneumonia
- diabetes
- suicide

• liver disease

• homicides

Men also suffer regularly from conditions as diverse as **sexually transmitted diseases** (STDs), mental illness, arthritis, urinary tract infections, athletic injuries, hair and skin problems, and digestive disorders. The field of men's health strives to reduce the risks and incidence of men's conditions by researching preventative practices, designing testing procedures for early detection, and recommending specialized courses of treatment.

Description

Prevention

Preventative practices for men's health emphasize diet, **exercise** and **stress** management, as well as the elimination of risky behaviors like **smoking** and excessive drinking. Four of the leading causes of death for American men are related to diet—heart disease, cancer, stroke, and diabetes. In addition men are more likely than women to suffer from diet-related conditions including **high cholesterol**, high blood pressure, and **obesity**, all of which increase the risk of certain diseases and premature death.

For American men, dietary problems are usually not the result of getting too little nourishment but of eating too much fat, sugar, and overall calories. The dietary change most likely to improve the health of males is reduced intake of fats, particularly cholesterol and saturated fats. Cholesterol and saturated fats are found mainly in meat and dairy products. Calories from fat should amount to no more than 30% of total daily calories. Eating adequate protein is generally not a problem for American men, so replacing some dairy and meat consumption with high fiber vegetable proteins such as beans and soy would be beneficial. Complex carbohydrates should provide the bulk of daily calories, such as those from whole grains and legumes, while sugar intake should be significantly reduced, such as in soft drinks, desserts and processed foods. Increasing dietary fiber is recommended by eating plenty of fresh fruits, vegetables, whole grains and legumes. Other principles of a healthy diet are avoiding artificial and processed foods, eating food that is as fresh and natural as possible, drinking plenty of water, and avoiding hydrogenated or partially hydrogenated oils, which contain unhealthy substances called trans-fatty acids. Overeating should be avoided as should snacking between meals, and alcohol intake should be limited to one or two glasses per day.

Exercise

The health of men has been affected as work patterns have shifted. Physical labor has been replaced by machines and office work. Studies have estimated that over 30% of Americans are now obese, which means that nearly one out of three people is significantly overweight. Obesity poses many risks including increasing the chances of heart disease, diabetes, and some cancers. Effective exercise programs help men control weight, reduce stress, increase energy levels, improve self-esteem, reduce **pain** and injuries, and improve sleep. Exercise programs should emphasize flexibility and stretching as well as plenty of aerobic activities, such as running and swimming that exercise the heart and lungs and burn excess calories. Men may also choose anaerobic activities such as weight training to add muscles and increase strength. Routines should begin with warm-ups to reduce the chances of injuries and end with cool-down exercises to speed recovery.

Stress reduction

Stress is a silent killer; chronic (long-term) stress is a risk factor in many of the major diseases affecting men's mortality rates. Prolonged stress may also cause ulcers, **sleep disorders**, addictions, depression, **anxiety**, and other conditions. Reduction of stress may require changes in both activities and attitudes. Exercise is recommended, as is reducing dependence on alcohol and nicotine. Men with extreme job-related stress may choose to spend more time with their families or in enjoyable activities. Men with stress levels that lead to destructive behaviors may need to pursue psychotherapy or significant lifestyle changes. **Nutrition**, social support, and healthy sleep patterns also reduce stress.

Alternative therapies may help with **stress reduction**. Their use has been adopted by many leading health centers. **Biofeedback** utilizes machines that monitor user's stress levels, so people can learn to control stress levels. **Meditation** and other mind/body techniques are taught to enable the relaxation response, which has the opposite effects of stress in the body.

Testing

Routine physical examinations performed by physicians are recommended every three years for men in their twenties and thirties, every two years for men in their forties, and every year for men over 50. Physicians may order several screening tests as well, depending on the age and condition of the patient. Blood tests screen for diabetes, high cholesterol, cancer, infections, and HIV. The prostate-specific antigen (PSA) test is a blood screen for **prostate cancer**. The digital rectal exam is used to manually check the prostate gland for enlargement or irregularities. Urine tests check for infections, kidney problems, and diabetes. The **fecal occult blood test**

examines the stool for indications of ulcers or cancer. A **sigmoidoscopy** checks the health of the rectum and lower colon. Electrocardiograms (ECGs) check the status of the heart. Older men may consult an opthalmologist (eye specialist) every two years for vision and **glaucoma** testing.

Men may perform self-tests as preventative measures. During a skin cancer self-exam, the entire skin is checked closely for irregular or changing **moles**, lesions, or blemishes, usually red, white or blue in color. Abnormal findings should be reported to a physician. Like some forms of skin cancer, **testicular cancer** tends to spread rapidly and early detection is crucial. The testicular self-exam is best performed in the shower or bath, because warm water relaxes the scrotum. The testicles are gently rolled and massaged between the fingers and thumb to feel for bumps, swelling, tenderness, or irregularities. Some self-test kits are available in pharmacies, including ones for blood pressure, high cholesterol, colorectal cancer, and blood glucose tests for diabetes. These do not take the place of proper medical care, and physicians should be consulted before their use.

Heart disease

Heart disease is the major cause of death among men. It claims nearly half a million lives every year in the United States and is more likely in men than women. Heart disease can take several forms but the most prevalent is coronary heart disease, in which the blood vessels that supply the heart with oxygen become blocked and the heart muscle becomes increasingly stressed. Arteriosclerosis, a major factor, is the hardening of arteries due to the accumulation of fats and other substances. **Hypertension**, or high blood pressure also poses major risks for both heart disease and stroke. **Angina** pectoris is the chest pain associated with the early stages of heart disease; over three million American men suffer from it. When the blockage of blood supply to the heart becomes severe, a myocardial infarction (**heart attack**) may occur, which can be fatal.

The main symptom of angina pectoris is sharp pain on the left side of the chest that may radiate throughout the upper body. Other symptoms include **shortness of breath**, **dizziness**, **fatigue**, and swelling in the legs and ankles. Angina may be triggered by physical or emotional stress and lasts up to 30 minutes. Heart attacks have similar symptoms but with longer and more intense pain in the chest and upper body and may be accompanied by cold sweats and vomiting.

The American Heart Association lists the main risk factors for heart disease as being male, old age, having family history of the disease, smoking, high cholesterol, high blood pressure, diabetes, **alcoholism**, obesity, physical inactivity and stress. Clearly, lifestyle habits such as diet, exercise and stress control play major roles in the development and prevention of heart disease in men.

Cancer

The American Cancer Society (ACS) estimates that over 1.2 million cases of cancer were reported in 2000. Men have a slightly higher risk for cancer than women. The World Health Organization (WHO) estimates that the number of cancer cases in most countries will double in the next 25 years, while men's prostate cancer is expected to go up 40% worldwide. The most common cancers in men are skin, prostate, lung, colorectal (colon and rectum), lymphoma (lymph glands), oral (mouth and throat), and testicular cancer. The ACS lists seven warning signs of cancer:

- unusual bleeding or discharge
- changes in bowel or bladder patterns
- persistent sores
- lumps or irregularities on the body
- difficulty swallowing or indigestion
- changes in **warts** or moles
- persistent **cough** or hoarseness in the throat

Although the causes of cancer are incompletely understood, there are several risk factors that increase its chances: family history of cancer, smoking, poor diet (high in fat, low in fiber), excessive alcohol consumption, skin damage from sunlight, and exposure to radiation, chemicals, and environmental pollutants.

The prostate gland is a walnut-sized organ in the male reproductive system, located near the rectum below the bladder. The ACS reported that there were nearly 185,000 new cases of prostate cancer in 1998, causing 40,000 deaths, making prostate cancer the second most fatal cancer for men behind lung cancer. Worldwide studies have shown that about 12% of men in Western countries get prostate cancer, while 50% have enlarged prostates. Benign prostatic hyperplasia (BPH) is the enlargement of the prostate gland, called benign when it is non-cancerous although growth can be rapid.

With early detection, 98% of men with prostate cancer survive for five years. Many cases of prostate cancer grow so slowly that they don't require treatment. Symptoms of prostate cancer include difficulty in stopping or starting urination, frequent nighttime urination (nocturia), weak urine flow, and blood in the urine or semen.

Testicular cancer is most common in men between the ages of 15 and 34. The ACS estimated that there were 7,600 cases of testicular cancer in 1998.

Stroke

Strokes occur when the blood supply to the brain is interrupted and brain function becomes impaired due to lack of oxygen. Ischemic strokes occur due to blood vessels becoming blocked while hemorrhagic strokes are the result of broken blood vessels in or near the brain. Ischemic strokes account for about 80% of all strokes. The American Heart Association estimates that over 600,000 Americans suffer from strokes each year, with men having a 20% higher risk of stroke than women, although more women die from strokes. Other risk factors are hypertension (high blood pressure), previous heart attacks, age, family history, high cholesterol, smoking, obesity, alcoholism, and physical inactivity. African-Americans have 60 percent greater chances for strokes than whites.

Symptoms of stroke include sudden weakness or numbness, blurring or loss of vision, difficulty speaking or understanding, sudden severe **headache**, and dizziness or falling. Stroke victims should receive immediate emergency care.

Male urinary tract problems

The urinary system includes the kidneys and bladder, the ureters between the kidneys and bladder, and the urethra, the tube through which urine flows from the bladder. Symptoms of urinary tract problems include frequent urination, excessive urination at night, painful or burning urination, weak urination, blood in the urine, or incontinence (involuntary loss of urine). **Urethritis** is infection of the urethra, which is a major symptom of sexually transmitted diseases (STDs). **Kidney stones** (nephrolithiasis) are the most common urinary tract problems, accounting for nearly one out of every 100 hospital admissions in the United States. Eighty percent of kidney stone patients are men. About 12% of American men will develop kidney stones during their lifetimes. Kidney stones cause extreme pain when they move from the kidneys into the ureters. Ten percent of kidney stone cases require surgery. The best prevention for kidney stones is drinking plenty of fluids daily.

The male reproductive system

The male reproductive system includes the penis, testicles, scrotum, prostate and other organs. Problems include **orchitis**, or infection of the testicles, and hydrocele, the buildup of fluid on the testicles. **Epididymitis** is inflammation of the tube that transports sperm from the testicles, and can cause severe pain, swelling, and **fever**. A varicocele is a group of **varicose veins** in the scrotum that can cause swelling and damage sperm. **Peyronie's disease** is the abnormal curvature of the penis caused by accumulated scar tissue. **Testicular torsion** is considered a medical emergency, when a testicle becomes twisted and blood supply is cut off. This condition can lead to permanent damage if not treated quickly. It is most common in males between the ages of 12 and 18. **Prostatitis** is infection or inflammation of the prostate gland.

Sexually transmitted diseases include **genital warts**, chlamydia, **gonorrhea**, **syphilis**, **genital herpes**, hepatitis and HIV (human **immunodeficiency** virus). HIV is the leading cause for death for American men between the ages of 25 and 45. Symptoms of STDs include discharge of fluid from the penis; painful urination; sores, lesions, **itching**, or **rashes** in the genital area; and swelling of the lymph nodes in the groin. Prevention of STDs begins with safe sexual behavior: wearing condoms, limiting the number of sexual partners, not mixing sexual encounters with alcohol, and avoiding sexual contact with infected people, prostitutes and intravenous drug users. Men who engage in risky behaviors should have frequent HIV tests and medical examinations.

Male sexual health

Erectile dysfunction (ED), also called **impotence**, is a man's inability to maintain an erection for sexual intercourse. It is estimated that half of all men over 40 experience ED occasionally and 20 million American men are chronic sufferers, particularly older men as ED increases with age. Up to 80% of ED is caused by physical problems, while 20% of cases are psychogenic, or psychological in origin. Causes of ED include hormonal problems, injuries, nerve damage, diseases, infections, diabetes, stress, depression, anxiety, drug abuse and interactions with prescription drugs.

A self-test men can perform to determine whether ED is physical or psychological is the stamp test, or nocturnal penile tumescence test. Physically healthy men experience several prolonged erections during sleep. The stamp test is done by attaching a strip of stamps around the penis before bedtime; if the stamps are torn in the morning, it generally indicates that nocturnal (nightly) erections have occurred and thus ED is not physiological. Men with ED should see urologists for further diagnosis and discussion of the several treatment options available including drugs, hormone injections and surgical repair or implants.

Infertility occurs when men lack an adequate supply of sperm to cause **pregnancy**. As many as 15% of American couples are affected by infertility in one or both partners, or over five million Americans. A World Health Organization (WHO) project found that in about 20% of infertile couples, the problem was due to the man, while in another 27% of couples both partners had

KEY TERMS

Emphysema—Disease of severe lung deterioration and impairment.

Obesity—Condition defined as being overweight by 30 percent of normal limits.

Sigmoidoscopy—Test procedure using an optical instrument to view the internal rectum and colon.

Urologist—Physician specializing in male reproductive and urinary systems.

infertility problems. Injuries, **birth defects**, infections, environmental pollutants, chronic stress, drug abuse and hormonal problems may account for male infertility, while one in four cases has no apparent cause and is termed idiopathic infertility. Declining sperm counts have been observed in industrialized countries, and possible explanations for this decrease are as diverse as increased environmental pollutants to the use of plastic diapers, which a German study claims damages infant testicles by keeping in excess heat. Male infertility can be diagnosed by sperm analysis, blood tests, radiographic scans of the testicles and other tests.

Other types of **sexual dysfunction** include **premature ejaculation**, in which men cannot sustain intercourse long enough to bring their partners to climax, and retarded ejaculation (also called male orgasmic disorder) when male orgasm becomes difficult. Some men have periods of inadequate sexual desire (hypoactive sexual desire disorder), while sexual aversion disorder (SAD) is fear and repulsion of sexual activity. Dyspareunia is painful intercourse, and should be reported to physicians as it may indicate STDs or infections. In addition to medical care, sexual dysfunction may be treated by **sex therapy** or psychotherapy depending on its causes.

Vasectomies, a form of male birth control, are surgical operations that sever the tubes that transport sperm from the testicles. Vasectomies can be reversed but ten percent of men become infertile due to the surgery. **Circumcision** is the surgical removal of the foreskin of the penis, for religious and medical reasons, performed on 60% of newborn males in the United States. Increasing controversy surrounds this procedure. Advocates of circumcision claim it prevents infections (called **balanitis**) on the head of the penis and reduces chances of **penile cancer**. Opponents of circumcision claim that the outdated procedure affords no medical benefits, that it causes unnecessary pain for infants, and that the lack of a foreskin may reduce sexual pleasure and performance.

Men's emotional health

Depression is a mood disorder marked by sadness, emotional pain, and the inability to feel pleasure. At least 10% of men will experience an episode of major depression at least once in their lives. Men with depression are five times more likely to commit suicide, a major cause of mortality in men. Men are half as likely to seek psychological help than women. Men may suffer depression and emotional problems between the ages of 50 and 65, called the midlife crisis as men face the major transition into retirement and older age.

Panic attacks have symptoms of overwhelming fear, chest pain, shortness of breath, numbness, and increased heart rate. Men may mistake them as heart attacks. Men are also plagued by addictions to nicotine, alcohol, and other drugs, which are often the unhealthy escape routes from deeper emotional issues. Studies have estimated that as many as one third of Americans have suffered from sleep disorders, which may be psychological in origin and related to anxiety, stress and lifestyle.

Mental illness can be particularly difficult for men because in our society men are taught to withhold rather than express emotions and feelings. Emotional problems can be strong signals for men to communicate and confront deeper issues. Help can be found from physicians, psychotherapists, and spiritual or religious counselors.

Resources

BOOKS

Bauman, Alisa, Brian Kaufman, and Men's Health Books, eds. *Symptom Solver: Understanding and Treating the Most Common Male Health Concerns*. Emmaus, PA: Rodale, 1997.

Inlander, Charles, and the People's Medical Society, eds. *The People's Medical Society Men's Health and Wellness Encylopedia*. New York: Macmillan, 1998.

Weil, Andrew, M.D. *Natural Health, Natural Medicine: A Comprehensive Manual for Wellness and Self-Care*. Boston: Houghton Mifflin, 1998.

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 N. Charles St., Baltimore, MD 21201. (401) 468-1800. <http://www.afud.org>.

Center for Holistic Urology. 161 Fort Washington Ave., New York, NY 10032. (212) 305-0347. <http://www.holistic-urology.com>.

OTHER

A Man's Life Online Magazine. <http://www.manslife.com>.

The Prostate Cancer Infolink. <http://www.comed.com/prostate>.

Douglas Dupler, MA

Menstrual disorders

Definition

Anything that interferes with the normal menstrual cycle, causing **pain**, unusually heavy or light bleeding, or missed periods.

Description

Typically, a woman of childbearing age should menstruate every 28 days or so unless she's pregnant or moving into **menopause**. But numerous things can wrong with the normal menstrual cycle, some the result of physical causes, others emotional. These include **amenorrhea**, or the cessation of menstruation, menorrhagia, or heavy bleeding, and **dysmenorrhea**, or severe menstrual cramps. Nearly every woman will experience one or more of these menstrual irregularities at some time in her life.

Amenorrhea

There are two types of amenorrhea: primary and secondary. Overall, they affect 2 to 5 percent of childbearing women, a number that is considerably higher among female athletes (possibly as high as 66 percent).

Primary amenorrhea occurs when a girl of at least 16 is not menstruating. Young girls may not have regular periods for their first year or two, or their periods may be very light, a condition known as **oligomenorrhea**. This is nothing to worry about. But if the period hasn't begun at all by age 16, there may be something wrong. It's most common in girls who are severely underweight and/or **exercise** intensely, both of which affect the amount of body fat necessary to trigger the release of hormones that, in turn, begins **puberty**.

Secondary amenorrhea occurs in women of childbearing age after a period of normal menstruation and is diagnosed when menstruation has stopped for three months. It can occur in women of any age.

Dysmenorrhea

Characterized by menstrual cramps or painful periods, dysmenorrhea, which is Greek for "painful menstruation," affects nearly every woman at some point in her life. It's the most common reproductive problem in women, resulting in numerous days absent from school, work and other activities. There are two types: primary and secondary.

Primary, or normal cramps, affects up to 90 percent of all women, usually occurring in women about three years after they start menstruating and continuing through their mid-twenties or until they have a child. About 10 percent of women who have this type of dysmenorrhea can't work, attend school, or participate in their normal activities. It may be accompanied by backache, **dizziness**, **headache**, nausea, vomiting, **diarrhea** and tenseness. The symptoms typically start a day or two before menstruation, usually ending when menstruation actually begins.

Secondary dysmenorrhea has an underlying physical cause and primarily affects older women, although it may also occur immediately after a woman begins menstruation, however.

Menorrhagia

Menorrhagia, or heavy bleeding, most commonly occurs in the years just before menopause or just after women start menstruating. It occurs in 9 to 14 percent of all women.

Causes and symptoms

Amenorrhea

The only symptom of primary amenorrhea is delayed menstruation. In addition to low body weight or excessive exercise, other causes of primary amenorrhea include Turner's Syndrome, a birth defect related to the reproductive system, or ovarian problems. In secondary amenorrhea, the primary symptom is the ceasing of menstruation for at least three months. Causes include **pregnancy** or breastfeeding, sudden weight loss or gain, intense exercise, **stress**, endocrine disorders affecting the thyroid, pituitary or adrenal glands, including **Cushing's Syndrome** and **hyperthyroidism**, problems with or surgery on the ovaries, including removal of the ovaries, cysts or ovarian tumors.

Dysmenorrhea

Primary dysmenorrhea is related to the production of prostaglandins, natural chemicals the body makes that cause an inflammatory reaction. They also cause the muscles of the uterus to contract, thus helping the uterus shed the lining built up during the first part of a woman's cycle. Women with severe menstrual pain have higher levels of prostaglandin in their menstrual blood than women who don't have such pain. In some women, prostaglandins can cause some of the smooth muscles in the gastrointestinal tract to contract, resulting in the nausea, vomiting and diarrhea some women experience. Prostaglandins also cause the arteries and veins to expand, so that blood collects in them rather than flowing freely through them, causing pain and heaviness. Yet another reason for severe cramps, particularly in women who haven't yet had a baby, is that the flow of the blood and clots through the

tiny cervical opening is painful. After a woman has a baby, however, the cervix opening is larger.

Secondary dysmenorrhea is more serious and is related to some underlying cause. The pain may feel like regular menstrual cramps, but may last longer than normal and occur throughout the month. It may be stronger on one side than the other. Possible causes include:

- a tipped uterus
- endometriosis, in which the lining of the uterus grows outside the uterus
- adenomyosis, in which the endometrial lining grows into the muscle of the uterus
- fibroids
- **pelvic inflammatory disease** (PID)
- an **IUD**
- a uterine, ovarian, bowel or bladder tumor
- uterine polyps
- inflammatory bowel disease
- scarring or adhesions from earlier surgery

Menorrhagia

Heavy bleeding during menstruation is usually related to a hormonal imbalance, although other causes include fibroids, cervical or endometrial polyps, the autoimmune disease lupus, pelvic inflammatory disease (PID), blood platelet disorder, or, possibly, some reproductive cancers. Thus, menorrhagia is actually a symptom of an underlying condition rather than a disease itself. It may also be related to the use of an IUD.

Women with menorrhagia experience not only significant inconvenience, including basically being trapped in their homes during the first day or two of their periods, but may feel very tired due to the loss of iron-rich blood. It is usually diagnosed when a woman soaks through a tampon or pad every hour for several hours or has a period lasting more than 7 days. Clots are not related to menorrhagia, although women with heavy cycles may pass clots. They are typically a normal part of menstruation, more common when a woman has been sitting or in a stationary position for a while

Diagnosis

Women should seek care from a gynecologist, family practitioner or internist for menstrual irregularities. Depending on the problem, various tests and procedures will be performed, but the one common to any menstrual problem is a **pelvic exam**. This should be scheduled when women are not menstruating, simply for convenience sake.

Male doctors typically have a female nurse or assistant in the room. The exam begins by checking the external genitalia for any sores or irregularities. Then the doctor inserts a speculum (a metal duckbill-shaped device that holds open the vagina) into the vagina and peers throughout the opening to evaluate the health of the cervix (opening of the uterus), and inside the vagina, looking for growths or any other abnormalities.

The doctor will also manually examine the woman, inserting two fingers into the vagina while pressing on the abdomen, again feeling for any lumps or other abnormalities, checking the size and shape of the reproductive organs, and watching for any signs of infection, such as tenderness or pain. The exam is typically covered by insurance and takes about 10 minutes.

Other tests that will be done for menstrual irregularities include:

- A pregnancy test. The nurse takes some blood from a woman's arm and it is tested for the presence of certain hormones that indicate a pregnancy has occurred.
- Ultrasound. Typically performed by a trained ultrasound technician, it involves using sound waves to get an image of the reproductive system. It is used to look for fibroids and other ovarian abnormalities that may cause heavy bleeding or cramps. Typically, the technician will smear a jelly over the woman's stomach, then place a probe on her stomach and watch the images appear on a computer screen. It is painless. Women may be asked not to urinate for several hours prior to the test, as a full bladder makes it easier to see the other internal organs. The test takes about 20 minutes.
- Endometrial biopsy. Used to check the health of uterine tissue in women who have unusually heavy bleeding, this test should be performed by the physician. Women should take a pain reliever like Motrin or Aleve prior to the procedure, as there may be some cramping. The woman lies back on the table with her feet in stirrups and the doctor inserts a speculum, then opens the cervix slightly with an instrument called a tenaculum. Then the doctor slides a small, hollow catheter into the uterus and sucks a small piece of tissue from the uterine lining out. The tissue is then examined for any abnormalities in a laboratory. The test takes about 30 minutes and is typically covered by insurance. Some bleeding may result afterwards.
- Blood, stool and urine tests may also be conducted to check for levels of various hormones, blood cells, and other chemicals.
- Dilation and curettage (D&C): During this minor surgical procedure, the cervix is opened and the lining of the uterus scraped for a tissue sample.
- Laparascopy and **hysteroscopy**: in some instances, these surgical procedures, in which a small camera is

KEY TERMS

Adenomyosis—Uterine thickening caused when endometrial tissue, which normally lines the uterus, extends outward into the fibrous and muscular tissue of the uterus.

Cervical polyps—Growths originating from the surface of the cervix or endocervical canal. These small, fragile growths hang from a stalk and protrude through the cervical opening (the os).

Cushing's Syndrome—A group of conditions caused by increased production of cortisol hormones or by the administration of glucocorticoid hormones (cortisone-like hormones).

Endometriosis—A condition in which the tissue that normally lines the uterus (endometrium) grows in other areas of the body, causing pain, irregular bleeding, and frequently, infertility.

Fibroids—Benign tumors of muscle and connective tissue that develop within or are attached to the uterine wall.

Hyperthyroidism—An imbalance in metabolism that occurs from overproduction of thyroid hormone.

Inflammatory bowel disease—A chronic inflammatory disease that can affect any part of the gastrointestinal tract but most commonly affects the ileum.

Lupus—A chronic inflammatory autoimmune disorder that may affect many organ systems including the skin, joints, and internal organs.

Pelvic inflammatory disease (PID)—A general term referring to infection involving the lining of the uterus, the Fallopian tubes, or the ovaries.

Turner's Syndrome—A disorder in women caused by an inherited chromosomal defect. This disorder inhibits sexual development and causes infertility. A symptom is absence of menstruation.

inserted into the woman to view the inside of the pelvis, abdomen or uterus.

Treatment

Amenorrhea

For primary amenorrhea with no underlying problem, no treatment is necessary, and a wait-and-see approach is often adopted. If women have genetic or hormonal abnormalities, amenorrhea is often treated with **oral contraceptives** that contain combinations of estrogen and progestin. Side effects include bloating, weight gain and **acne**, although some birth control pills actually improve acne. Progestins, or synthetic progesterone, are also used alone to "jump start" a woman's period. They include medroxyprogesterone (Provera, Amen, Depo-Provera), norethindrone acetate (Aygestin, Norlutate), and norgestrel (Ovrel).If the amenorrhea is due to a physical problem, such as a closed vagina, surgery may be required.

With secondary amenorrhea, treatment depends on the cause. Hormonal imbalances are treated with supplemental hormones. Tumors or cysts may require surgery, **obesity** may require a diet and exercise regimen, while amenorrhea resulting from too much dieting or exercise necessitates lifestyle changes.

Dysmenorrhea

Primary dysmenorrhea is typically treated with nonsteroidal anti-inflammatory medications like ibuprofen and naproxen, which studies show help 64 to 100 percent of women. Birth control pills relieve pain and symptoms in about 90 percent of women by suppressing ovulation and reducing the amount of menstrual blood. It may take up to three cycles before a woman feels relief. Heat, whether a heating pad or hot bath, can also help relieve pain.

Treatment for secondary dysmenorrhea depends on the underlying cause of the condition.

Menorrhagia

If there are no other problems, and the bleeding is due to hormonal imbalances, birth control pills are often prescribed to bring the bleeding under control and regulate menstruation. Medications, such as ibuprofen and naproxen, can also help reduce the bleeding and any cramping associated with it. In severe cases, doctors may recommend removing the uterus during a **hysterectomy**, or performing some form of endometrial ablation, which removes the lining of the uterus. These are typically only offered to women who are finished having children.

Alternative treatment

Amenorrhea

There are several herbal remedies that can bring on menstruation, including: black cohosh, cramp bark,

chasteberry, celery, turmeric, and marsh mallow. Numerous relaxation techniques, such as **meditation**, deep breathing, and **yoga** can help reduce stress and its affects on menstruation.

Dysmenorrhea

Numerous alternative treatments may help relieve the menstrual pain. These include:

- Transcutaneous **electrical nerve stimulation** (TENS), which several studies found, relieved pain in 42 to 60 percent of participants, working faster than naproxen in one study.
- **Acupuncture**: One study of 43 patients followed for a year found that 90 percent of those who had acupuncture once a week for three menstrual cycles had less pain, and 43 percent used less pain medication.
- Omega-3 fatty acids: Often sold as fish oil supplements, they are a known anti-inflammatory, working against the effects of prostaglandins. Studies found that women with low amounts of omega-3 fatty acids in their **diets** were more likely to have menstrual carmps; those who took supplements had less pain.
- Vitamin B-1: One large study found that symptoms disappeared in 87 percent of women who took 100 mg a day for 90 days.
- Magnesium supplements: One study of 30 women who took 4.5 milligrams of oral magnesium three times daily for part of the month decreased their symptoms up to 84 percent.

Menorrhagia

Herbs used to treat menorrhagia include yarrow, nettles and shepherd's purse, as well as agrimony, particularly used in Chinese medicine, ladies mantle, vervain and red raspberry, which are thought to strengthen the uterus. Vitex is another herb recommended for a variety of menstrual disorders ranging from menorrhagia to PMS. Women may want to make sure they're taking an iron supplement to replace the iron lost during the heavy bleeding, although they should check with their doctor to make sure they don't suffer from a condition of having too much iron. Helpful **vitamins** include vitamin A, because women with heavy bleeding typically have lower levels of Vitamin A, K, which aids in clotting, and C and bioflavinoids which help strengthen veins and capillaries. Zinc may also help.

Prognosis

The prognosis for all menstrual irregularities is good once treatment is initiated.

Prevention

Amenorrhea

Simply following a healthy exercise and nutritional program can help prevent amenorrhia, as can reducing stress and learning relaxation techniques. Also, avoiding excessive alcohol intake and quitting **smoking** may prevent missed periods.

Dysmenorrhea

Prevention includes certain dietary supplements and vitamins described above. Exercise may also help.

Menorrhagia

There's little women can do to prevent this menstrual irregularity other than discovering the root cause. One thing they can do, however, is stop using an IUD, which can often cause heavier bleeding.

Resources

BOOKS

Dan , Alice J. (Editor), Linda L. Lewis (Editor) *Menstrual Health in Women's Lives* Univ of Illinois Press, 1991.

Flaws, Robert S. Honora L. Wolfe *A Handbook of Menstrual Diseases in Chinese Medicine* Blue Poppy Press, 1999.

Francis-Cheung, Theresa. *A Break in Your Cycle : The Medical and Emotional Causes and Effects of Amenorrhea* John Wiley & Sons, 1998.

Owen, Lara. *Honoring Menstruation : A Time of Self-Renewal* Crossing Press, 1998.

Trickey, Ruth. *Women Hormones and the Menstrual Cycle : Herbal and Medical Solutions from Adolescence to Menopause* Allen & Unwin, 1998.

ORGANIZATIONS

Advancement of Women's Health Research, 1828 L Street, N.W., Suite 625 Washington, D.C. 20036, 202-223-8224 <www.womens-health.org>.

National Women's Health Resource Center, 120 Albany Street Suite 820 New Brunswick, NJ 08901, 877-986-9472 <www.healthywomen.org>.

Debra Gordon

Menstrual disorders *see* **Dysmenorrhea**

Menstrual pain *see* **Dysmenorrhea**

Mental retardation

Definition

Mental retardation is a developmental disability that first appears in children under the age of 18. It is defined

as an intellectual functioning level (as measured by standard tests for intelligence quotient) that is well below average and significant limitations in daily living skills (adaptive functioning).

Description

Mental retardation occurs in 2.5-3% of the general population. About 6-7.5 million mentally retarded individuals live in the United States alone. Mental retardation begins in childhood or adolescence before the age of 18. In most cases, it persists throughout adulthood. A diagnosis of mental retardation is made if an individual has an intellectual functioning level well below average and significant limitations in two or more adaptive skill areas. Intellectual functioning level is defined by standardized tests that measure the ability to reason in terms of mental age (intelligence quotient or IQ). Mental retardation is defined as IQ score below 70-75. Adaptive skills are the skills needed for daily life. Such skills include the ability to produce and understand language (communication); home-living skills; use of community resources; health, safety, leisure, self-care, and social skills; self-direction; functional academic skills (reading, writing, and arithmetic); and work skills.

In general, mentally retarded children reach developmental milestones such as walking and talking much later than the general population. Symptoms of mental retardation may appear at birth or later in childhood. Time of onset depends on the suspected cause of the disability. Some cases of mild mental retardation are not diagnosed before the child enters preschool. These children typically have difficulties with social, communication, and functional academic skills. Children who have a neurological disorder or illness such as **encephalitis** or **meningitis** may suddenly show signs of cognitive impairment and adaptive difficulties.

Mental retardation varies in severity. *The Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition (*DSM-IV*) is the diagnostic standard for mental healthcare professionals in the United States. The *DSM-IV* classifies four different degrees of mental retardation: *mild, moderate, severe*, and *profound*. These categories are based on the functioning level of the individual.

Mild mental retardation

Approximately 85% of the mentally retarded population is in the mildly retarded category. Their IQ score ranges from 50-75, and they can often acquire academic skills up to the 6th grade level. They can become fairly self-sufficient and in some cases live independently, with community and social support.

Moderate mental retardation

About 10% of the mentally retarded population is considered moderately retarded. Moderately retarded individuals have IQ scores ranging from 35-55. They can carry out work and self-care tasks with moderate supervision. They typically acquire communication skills in childhood and are able to live and function successfully within the community in a supervised environment such as a group home.

Severe mental retardation

About 3-4% of the mentally retarded population is severely retarded. Severely retarded individuals have IQ scores of 20-40. They may master very basic self-care skills and some communication skills. Many severely retarded individuals are able to live in a group home.

Profound mental retardation

Only 1-2% of the mentally retarded population is classified as profoundly retarded. Profoundly retarded individuals have IQ scores under 20-25. They may be able to develop basic self-care and communication skills with appropriate support and training. Their retardation is often caused by an accompanying neurological disorder. The profoundly retarded need a high level of structure and supervision.

The American Association on Mental Retardation (AAMR) has developed another widely accepted diagnostic classification system for mental retardation. The AAMR classification system focuses on the capabilities of the retarded individual rather than on the limitations. The categories describe the level of support required. They are: *intermittent support, limited support, extensive support*, and *pervasive support*. To some extent, the AAMR classification mirrors the *DSM-IV* classification. Intermittent support, for example, is support needed only occasionally, perhaps during times of **stress** or crisis. It is the type of support typically required for most mildly retarded individuals. At the other end of the spectrum, pervasive support, or life-long, daily support for most adaptive areas, would be required for profoundly retarded individuals.

Causes and symptoms

Low IQ scores and limitations in adaptive skills are the hallmarks of mental retardation. Aggression, self-injury, and **mood disorders** are sometimes associated with the disability. The severity of the symptoms and the age at which they first appear depend on the cause. Children who are mentally retarded reach developmental milestones significantly later than expected, if at all. If retardation is caused by chromosomal or other genetic

KEY TERMS

Amniocentesis—A test usually done between 16 and 20 weeks of pregnancy to detect any abnormalities in the development of the fetus. A small amount of the fluid surrounding the fetus (amniotic fluid) is drawn out through a needle inserted into the mother's womb. Laboratory analysis of this fluid can detect various genetic defects, such as Down syndrome, or neural tube defects.

Developmental delay—The failure to meet certain developmental milestones, such as sitting, walking, and talking, at the average age. Developmental delay may indicate a problem in development of the central nervous system.

Down syndrome—A disorder caused by an abnormality at the 21st chromosome. One symptom of Down syndrome is mental retardation.

Extensive support—Ongoing daily support required to assist an individual in a specific adaptive area, such as daily help with preparing meals.

Hib disease—An infection caused by *Haemophilus influenza* type b (Hib). This disease mainly affects children under the age of five. In that age group, it is the leading cause of bacterial meningitis, pneumonia, joint and bone infections, and throat inflammations.

Inborn error of metabolism—A rare enzyme deficiency; children with inborn errors of metabolism do not have certain enzymes that the body requires to maintain organ functions. Inborn errors of metabolism can cause brain damage and mental retardation if left untreated. Phenylketonuria is an inborn error of metabolism.

Limited support—A predetermined period of assistance required to deal with a specific event, such as training for a new job.

Phenylketonuria (PKU)—An inborn error in metabolism that prevents the body from using phenylalanine, an amino acid necessary for normal growth and development.

Trisomy—An abnormality in chromosomal development. Chromosomes are the structures within a cell that carry its genetic information. They are organized in pairs. Humans have 23 pairs of chromosomes. In a trisomy syndrome, an extra chromosome is present so that the individual has three of a particular chromosome instead of the normal pair. An extra chromosome 18 (trisomy 18) causes mental retardation.

Ultrasonography—A process that uses the reflection of high-frequency sound waves to make an image of structures deep within the body. Ultrasonography is routinely used to detect fetal abnormalities.

disorders, it is often apparent from infancy. If retardation is caused by childhood illnesses or injuries, learning and adaptive skills that were once easy may suddenly become difficult or impossible to master.

In about 35% of cases, the cause of mental retardation cannot be found. Biological and environmental factors that can cause mental retardation include:

Genetics

About 5% of mental retardation is caused by hereditary factors. Mental retardation may be caused by an inherited abnormality of the genes, such as **fragile X syndrome**. Fragile X, a defect in the chromosome that determines sex, is the most common inherited cause of mental retardation. Single gene defects such as **phenylketonuria** (PKU) and other inborn errors of metabolism may also cause mental retardation if they are not found and treated early. An accident or mutation in genetic development may also cause retardation. Examples of such accidents are development of an extra chromosome 18 (trisomy 18) and **Down syndrome**. Down syndrome, also called mongolism or trisomy 21, is caused by an abnormality in the development of chromosome 21. It is the most common genetic cause of mental retardation.

Prenatal illnesses and issues

Fetal alcohol syndrome affects one in 600 children in the United States. It is caused by excessive alcohol intake in the first twelve weeks (trimester) of **pregnancy**. Some studies have shown that even moderate alcohol use during pregnancy may cause learning disabilities in children. Drug abuse and cigarette **smoking** during pregnancy have also been linked to mental retardation.

Maternal infections and illnesses such as glandular disorders, **rubella**, **toxoplasmosis**, and **cytomegalovirus infection** may cause mental retardation. When the mother has high blood pressure (**hypertension**) or blood **poi-**

soning (toxemia), the flow of oxygen to the fetus may be reduced, causing brain damage and mental retardation.

Birth defects that cause physical deformities of the head, brain, and central nervous system frequently cause mental retardation. Neural tube defect, for example, is a birth defect in which the neural tube that forms the spinal cord does not close completely. This defect may cause children to develop an accumulation of cerebrospinal fluid on the brain (**hydrocephalus**). Hydrocephalus can cause learning impairment by putting pressure on the brain.

Childhood illnesses and injuries

Hyperthyroidism, **whooping cough**, **chickenpox**, **measles**, and Hib disease (a bacterial infection) may cause mental retardation if they are not treated adequately. An infection of the membrane covering the brain (meningitis) or an inflammation of the brain itself (encephalitis) cause swelling that in turn may cause brain damage and mental retardation. Traumatic brain injury caused by a blow or a violent shake to the head may also cause brain damage and mental retardation in children.

Environmental factors

Ignored or neglected infants who are not provided the mental and physical stimulation required for normal development may suffer irreversible learning impairments. Children who live in poverty and suffer from **malnutrition**, unhealthy living conditions, and improper or inadequate medical care are at a higher risk. Exposure to lead can also cause mental retardation. Many children have developed **lead poisoning** by eating the flaking lead-based paint often found in older buildings.

Diagnosis

If mental retardation is suspected, a comprehensive **physical examination** and medical history should be done immediately to discover any organic cause of symptoms. Conditions such as hyperthyroidism and PKU are treatable. If these conditions are discovered early, the progression of retardation can be stopped and, in some cases, partially reversed. If a neurological cause such as brain injury is suspected, the child may be referred to a neurologist or neuropsychologist for testing.

A complete medical, family, social, and educational history is compiled from existing medical and school records (if applicable) and from interviews with parents. Children are given intelligence tests to measure their learning abilities and intellectual functioning. Such tests include the Stanford-Binet Intelligence Scale, the Wechsler Intelligence Scales, the Wechsler Preschool and Primary Scale of Intelligence, and the Kaufmann Assessment Battery for Children. For infants, the Bayley Scales of Infant Development may be used to assess motor, language, and problem-solving skills. Interviews with parents or other caregivers are used to assess the child's daily living, muscle control, communication, and social skills. The Woodcock-Johnson Scales of Independent Behavior and the Vineland Adaptive Behavior Scale (VABS) are frequently used to test these skills.

Treatment

Federal legislation entitles mentally retarded children to free testing and appropriate, individualized education and skills training within the school system from ages 3-21. For children under the age of three, many states have established early intervention programs that assess, recommend, and begin treatment programs. Many day schools are available to help train retarded children in basic skills such as bathing and feeding themselves. Extracurricular activities and social programs are also important in helping retarded children and adolescents gain self-esteem.

Training in independent living and job skills is often begun in early adulthood. The level of training depends on the degree of retardation. Mildly retarded individuals can often acquire the skills needed to live independently and hold an outside job. Moderate to profoundly retarded individuals usually require supervised community living.

Family therapy can help relatives of the mentally retarded develop coping skills. It can also help parents deal with feelings of guilt or anger. A supportive, warm home environment is essential to help the mentally retarded reach their full potential.

Prognosis

Individuals with mild to moderate mental retardation are frequently able to achieve some self-sufficiency and to lead happy and fulfilling lives. To reach these goals, they need appropriate and consistent educational, community, social, family, and vocational supports. The outlook is less promising for those with severe to profound retardation. Studies have shown that these individuals have a shortened life expectancy. The diseases that are usually associated with severe retardation may cause the shorter life span. People with Down syndrome will develop the brain changes that characterize **Alzheimer's disease** in later life and may develop the clinical symptoms of this disease as well.

Prevention

Immunization against diseases such as measles and Hib prevents many of the illnesses that can cause mental

retardation. In addition, all children should undergo routine developmental screening as part of their pediatric care. Screening is particularly critical for those children who may be neglected or undernourished or may live in disease-producing conditions. Newborn screening and immediate treatment for PKU and hyperthyroidism can usually catch these disorders early enough to prevent retardation.

Good prenatal care can also help prevent retardation. Pregnant women should be educated about the risks of drinking and the need to maintain good **nutrition** during pregnancy. Tests such as **amniocentesis** and ultrasonography can determine whether a fetus is developing normally in the womb.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Batshaw, Mark L., and Bruce K. Shapiro. "Mental Retardation." In *Children with Disabilities*. 4th ed. Ed. Mark L. Batshaw. Baltimore: Paul H. Brookes, 1997.

Maxmen, Jerrold S., and Nicholas G. Ward. "Disorders Usually First Diagnosed in Infancy, Childhood, or Adolescence." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

PERIODICALS

Martin, Barry A. "Primary Care of Adults with Mental Retardation Living in the Community." *American Family Physician* 56 (Aug. 1997): 485-494.

ORGANIZATIONS

American Association on Mental Retardation (AAMR). 444 North Capitol St., NW, Suite 846, Washington, D.C. 20001-1512 (800) 424-3688. <http://www.aamr.org>.

The Arc. 900 Varnum Street NE, Washington, D.C. 20017. (202) 636-2950. <http://thearc.org>.

OTHER

Americans With Disabilities Act (ADA) Page. <http://www.usdoj.gov/crt/ada/adahom1.htm>.

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Mental status examination

Definition

A mental status examination (MSE) is an assessment of a patient's level of cognitive (knowledge-related) ability, appearance, emotional mood, and speech and thought patterns at the time of evaluation. It is one part of a full neurologic (nervous system) examination and includes the examiner's observations about the patient's attitude and cooperativeness as well as the patient's answers to specific questions. The most commonly used test of cognitive functioning per se is the so-called Folstein Mini-Mental Status Examination (MMSE), developed in 1975.

Purpose

The purpose of a mental status examination is to assess the presence and extent of a person's mental impairment. The cognitive functions that are measured during the MSE include the person's sense of time, place, and personal identity; memory; speech; general intellectual level; mathematical ability; insight or judgment; and reasoning or problem-solving ability. Complete MSEs are most commonly given to elderly people and to other patients being evaluated for **dementia** (including AIDS-related dementia). Dementia is an overall decline in a person's intellectual function— including difficulties with language, simple calculations, planning or decision-making, and motor (muscular movement) skills as well as loss of memory. The MSE is an important part of the differential diagnosis of dementia and other psychiatric symptoms or disorders. The MSE results may suggest specific areas for further testing or specific types of required tests. A mental status examination can also be given repeatedly to monitor or document changes in a patient's condition.

Precautions

A MSE cannot be given to a patient who cannot pay attention to the examiner, for example as a result of being in a **coma** or unconscious; or is completely unable to speak (aphasic); or is not fluent in the language of the examiner.

Description

The MMSE of Folstein evaluates five areas of mental status, namely, orientation, registration, attention and calculation, recall and language. A complete MSE is more comprehensive and evaluates the following 10 areas of functioning:

- Appearance. The examiner notes the person's age, race, sex, civil status, and overall appearance. These features are significant because poor personal hygiene or grooming may reflect a loss of interest in self-care or physical inability to bathe or dress oneself.
- Movement and behavior. The examiner observes the person's gait (manner of walking), posture, coordination, eye contact, facial expressions, and similar behaviors. Problems with walking or coordination may reflect a disorder of the central nervous system.

KEY TERMS

Aphasia—The loss of the ability to speak, or to understand written or spoken language. A person who cannot speak or understand language is said to be aphasic.

Cognition—The act or process of knowing or perceiving.

Coma—A state of prolonged unconsciousness in which a person cannot respond to spoken commands or mildly painful physical stimuli.

Delusion—A belief that is resistant to reason or contrary to actual fact. Common delusions include delusions of persecution, delusions about one's importance (sometimes called delusions of grandeur), or delusions of being controlled by others.

Dementia—A decline in a person's level of intellectual functioning. Dementia includes memory loss as well as difficulties with language, simple calculations, planning or decision-making, and motor (muscular movement) skills.

Dissociation—The splitting off of certain mental processes from conscious awareness. Specific symptoms of dissociation include feelings of unreality, depersonalization, and confusion about one's identity.

Hallucination—A sensory experience, usually involving either sight or hearing, of something that does not exist outside the mind.

Illusion—A false visual perception of an object that others perceive correctly. A common example is the number of sightings of "UFOs" that turn out to be airplanes or weather balloons.

Obsession—Domination of thoughts or feelings by a persistent idea, desire, or image.

Organic brain disorder—An organic brain disorder refers to impaired brain function due to damage or deterioration of brain tissue.

- Affect. Affect refers to a person's outwardly observable emotional reactions. It may include either a lack of emotional response to an event or an overreaction.
- Mood. Mood refers to the underlying emotional "atmosphere" or tone of the person's answers.
- Speech. The examiner evaluates the volume of the person's voice, the rate or speed of speech, the length of answers to questions, the appropriateness and clarity of the answers, and similar characteristics.
- Thought content. The examiner assesses what the patient is saying for indications of **hallucinations**, **delusions**, obsessions, symptoms of dissociation, or thoughts of suicide. Dissociation refers to the splitting-off of certain memories or mental processes from conscious awareness. Dissociative symptoms include feelings of unreality, depersonalization, and confusion about one's identity.
- Thought process. Thought process refers to the logical connections between thoughts and their relevance to the main thread of conversation. Irrelevant detail, repeated words and phrases, interrupted thinking (thought blocking), and loose, illogical connections between thoughts, may be signs of a thought disorder.
- Cognition. Cognition refers to the act or condition of knowing. The evaluation assesses the person's orientation (ability to locate himself or herself) with regard to time, place, and personal identity; long- and short-term memory; ability to perform simple arithmetic (counting backward by threes or sevens); general intellectual level or fund of knowledge (identifying the last five Presidents, or similar questions); ability to think abstractly (explaining a proverb); ability to name specified objects and read or write complete sentences; ability to understand and perform a task (showing the examiner how to comb one's hair or throw a ball); ability to draw a simple map or copy a design or geometrical figure; ability to distinguish between right and left.
- Judgment. The examiner asks the person what he or she would do about a commonsense problem, such as running out of a prescription medication.
- Insight. Insight refers to a person's ability to recognize a problem and understand its nature and severity.

The length of time required for a mental status examination depends on the patient's condition. It may take as little as five minutes to examine a healthy person. Patients with speech problems or intellectual impairments, dementia, or other organic brain disorders may require 15 or 20 minutes. The examiner may choose to spend more time on certain portions of the MSE and less time on others, depending on the patient's condition and answers.

Preparation

Preparation for a mental status examination includes a careful medical and psychiatric history of the patient. The history helps the examiner to interpret the patient's appearance and answers with greater accuracy, because some physical illnesses may produce psychiatric symptoms or require medications that influence the patient's mood or attentiveness. The psychiatric history should include a family history as well as the patient's personal history of development, behavior patterns, and previous treatment for mental disorders (if any). Symptoms of dissociation, for example, often point to a history of childhood **abuse**, rape, or other severe emotional traumas in adult life. The examiner should also include information about the patient's occupation, level of education, marital status, and right- or left-handedness. Information about occupation and education helps in evaluating the patient's use of language, extent of memory loss, reasoning ability, and similar functions. Handedness is important in determining which half of the patient's brain is involved in writing, picking up a pencil, or other similar tasks that he or she may be asked to perform during the examination.

Aftercare

Depending on the examiner's specific observations, the patient may be given additional tests for follow-up. These tests might include blood or urine samples to test for drug or alcohol abuse, anemia, diabetes, disorders of the liver or kidneys, vitamin or thyroid deficiencies, medication side effects, or **syphilis** and **AIDS**. Brain imaging (CT, MRI, or **PET** scans) may be used to look for signs of seizures, strokes, head trauma, brain tumors, or other evidence of damage to specific parts of the brain. A spinal tap may be performed if the doctor thinks the patient may have an infection of the central nervous system.

Normal results

Normal results for a mental status examination depend to some extent on the patient's history, level of education, and recent life events. For example, a depressed mood is appropriate in the context of a recent **death** or other sad event in the patient's family but inappropriate in the context of a recent pay raise. Speech patterns are often influenced by racial or ethnic background as well as by occupation or schooling. In general, however, the absence of obvious delusions, hallucinations, or thought disorders together with the presence of insight, good judgment, and socially appropriate appearance and behavior are considered normal results. A normal numerical score for the MMSE is between 28 and 30.

Abnormal results

Abnormal results for a mental status examination include:

- any evidence of organic brain damage
- evidence of thought disorders
- a mood or affect that is clearly inappropriate to its context
- thoughts of suicide
- disturbed speech patterns
- dissociative symptoms
- delusions or hallucinations

A score below 27 on the MMSE usually indicates an organic brain disorder.

Resources

BOOKS

Campbell, Robert Jean, MD. *Psychiatric Dictionary*, 7th edition. New York and Oxford: Oxford University Press, 1996.

Eisendrath, Stuart J., MD, and Jonathan E. Lichtmacher, MD. "Psychiatric Disorders: Psychiatric Assessment." In *Current Medical Diagnosis & Treatment 2001*, 40th edition, ed. L. M. Tierney, Jr., MD, et al. New York: Lange Medical Books/McGraw-Hill, 2001.

Mabbett, P. D. *Delmar's Instant Nursing Assessment: Mental Health*. Albany, NY: Delmar Publishers, 1996-1998.

"Neurologic Disorders: Neurologic Examination." In *The Merck Manual of Diagnosis and Therapy*, 17th edition, edited by Mark H. Beers, MD, and Robert Berkow, MD. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

PERIODICALS

Folstein MF et al., "Mini-mental state: A practical method for grading the cognitive state of patients for the clinician." *Journal of Psychiatric Research* 12 (1975): 189-198.

ORGANIZATION

American Psychiatric Association. 1400 K Street, NW. Washington, DC 20005. (202) 682-6220. <http://www.psych.org>.

National Institute of Mental Health. 5600 Fishers Lane, Rockville, MD 20857. (301) 443-4513. FAX: (301) 443-4513. <http://www.nimh.nih.gov>.

National Institute of Neurological Disorders and Stroke (NINDS). Building 31, Room 8A06, 9000 Rockville Pike, Bethesda, MD 20892. (301) 496-5751. <http://www.ninds.nih.gov>.

National Institute on Aging Information Center. P.O. Box 8057, Gaithersburg, MD 20898. (800) 222-2225 or (301) 496-1752. <http://www.nih.gov/nia>.

Rebecca J. Frey, PhD

Metabolic acidosis

Definition

Metabolic acidosis is a pH imbalance in which the body has accumulated too much acid and does not have enough bicarbonate to effectively neutralize the effects of the acid.

Description

Metabolic acidosis, as a disruption of the body's acid/base balance, can be a mild symptom brought on by a lack of insulin, a **starvation** diet, or a gastrointestinal disorder like vomiting and **diarrhea**. Metabolic acidosis can indicate a more serious problem with a major organ like the liver, heart, or kidneys. It can also be one of the first signs of **drug overdose** or **poisoning**.

Causes and symptoms

Metabolic acidosis occurs when the body has more acid than base in it. Chemists use the term "pH" to describe how acidic or basic a substance is. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly basic (alkaline), with a normal range of 7.36-7.44.

Acid is a natural by-product of the breakdown of fats and other processes in the body; however, in some conditions, the body does not have enough bicarbonate, an acid neutralizer, to balance the acids produced. This can occur when the body uses fats for energy instead of carbohydrates. Conditions where metabolic acidosis can occur include chronic **alcoholism**, **malnutrition**, and **diabetic ketoacidosis**. Consuming a diet low in carbohydrates and high in fats can also produce metabolic acidosis. The disorder may also be a symptom of another condition like kidney failure, liver failure, or severe diarrhea. The build-up of lactic acid in the blood due to such conditions as **heart failure**, **shock**, or **cancer**, induces metabolic acidosis. Some poisonings and overdoses (**aspirin**, methanol, or ethylene glycol) also produce symptoms of metabolic acidosis.

In mild cases of metabolic acidosis, symptoms include **headache**, lack of energy, and sleepiness. Breathing may become fast and shallow. Nausea, vomiting, diarrhea, **dehydration**, and loss of appetite are also associated with metabolic acidosis. Diabetic patients with symptoms of metabolic acidosis may also have breath that smells fruity. The patient may lose consciousness or become disoriented. Severe cases can produce **coma** and **death**.

KEY TERMS

Diabetic ketoacidosis—A condition caused by low insulin levels where the amount of sugar and ketones in the blood is high.

pH—A measurement of the acidity or alkalinity of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkaline (basic) with a normal range of 7.36-7.44.

Diagnosis

Metabolic acidosis is suspected based on symptoms, but is usually confirmed by laboratory tests on blood and urine samples. Blood pH below 7.35 confirms the condition. Levels of other blood components, including potassium, glucose, ketones, or lactic acid, may also be above normal ranges. The level of bicarbonate in the blood will be low, usually less than 22 mEq/L. Urine pH may fall below 4.5 in metabolic acidosis.

Treatment

Treatment focuses first on correcting the acid imbalance. Usually, sodium bicarbonate and fluids will be injected into the blood through a vein. An intravenous line may be started to administer fluids and allow for the quick injection of other drugs that may be needed. If the patient is diabetic, insulin may be administered. Drugs to regulate blood pressure or heart rate, to prevent seizures, or to control **nausea and vomiting** might be given. Vital signs like pulse, respiration, blood pressure, and body temperature will be monitored. The underlying cause of the metabolic acidosis must also be diagnosed and corrected.

Prognosis

If the metabolic acidosis is recognized and treated promptly, the patient may have no long-term complications, however, the underlying condition that caused the acidosis needs to be corrected or managed. Severe metabolic acidosis that is left untreated will lead to coma and death.

Prevention

Diabetic patients need to routinely test their urine for sugar and acetone, strictly follow their appropriate

diet, and take any medications or insulin to prevent metabolic acidosis. Patients receiving **tube feedings** or intravenous feedings must be monitored to prevent dehydration or the accumulation of ketones or lactic acid.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. "Acid-Base Disturbances." In *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

DuBose Jr., Thomas D. "Acidosis and Alkalosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Fluid, Electrolyte, and Acid-Base Disorders." In *Family Medicine Principles and Practices*. 5th ed. New York: Springer-Verlag, 1998.

"Fluid & Electrolyte Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Altha Roberts Edgren

Metabolic alkalosis

Definition

Metabolic alkalosis is a pH imbalance in which the body has accumulated too much of an alkaline substance, such as bicarbonate, and does not have enough acid to effectively neutralize the effects of the alkali.

Description

Metabolic alkalosis, as a disturbance of the body's acid/base balance, can be a mild condition, brought on by vomiting, the use of steroids or diuretic drugs, or the overuse of **antacids** or **laxatives**. Metabolic alkalosis can also indicate a more serious problem with a major organ such as the kidneys.

Causes and symptoms

Metabolic alkalosis occurs when the body has more base than acid in the system. Chemists use the term "pH" to decribe how acidic or alkaline (also called basic) a substance is. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is alkaline; the higher the number, the stronger the alkali. Blood pH is slightly alkaline, with a normal range of 7.36-7.44. Conditions that lead to a reduced amount of fluid in the body, like vomiting or excessive urination due to use of diuretic drugs, change the balance of fluids and salts. The blood levels of potassium and sodium can decrease dramatically, causing symptoms of metabolic alkalosis.

In cases of metabolic alkalosis, slowed breathing may be an initial symptom. The patient may have episodes of apnea (not breathing) that may go on 15 seconds or longer. **Cyanosis**, a bluish or purplish discoloration of the skin, may also develop as a sign of inadequate oxygen intake. Nausea, vomiting, and **diarrhea** may also occur. Other symptoms can include irritability, twitching, confusion, and picking at bedclothes. Rapid heart rate, irregular heart beats, and a drop in blood pressure are also symptoms. Severe cases can lead to convulsions and **coma**.

Diagnosis

Metabolic alkalosis may be suspected based on symptoms, but often may not be noticeable. The condition is usually confirmed by laboratory tests on blood and urine samples. Blood pH above 7.45 confirms the condition. Levels of other blood components, including salts like potassium, sodium, and chloride, fall below normal ranges. The level of bicarbonate in the blood will be high, usually greater than 29 mEq/L. Urine pH may rise to about 7.0 in metabolic alkalosis.

Treatment

Treatment focuses first on correcting the imbalance. An intravenous line may be started to administer fluids (generally normal saline, a salt water solution) and allow for the quick injection of other drugs that may be needed. Potassium chloride will be administered. Drugs to regulate blood pressure or heart rate, or to control **nausea and vomiting** might be given. Vital signs like pulse, respiration, blood pressure, and body temperature will be monitored. The underlying cause of the metabolic alkalosis must also be diagnosed and corrected.

Prognosis

If metabolic alkalosis is recognized and treated promptly, the patient may have no long-term complications; however, the underlying condition that caused the alkalosis needs to be corrected or managed. Severe metabolic alkalosis that is left untreated will lead to convulsions, **heart failure**, and coma.

Prevention

Patients receiving **tube feedings** or intravenous feedings must be monitored to prevent an imbalance of fluids and salts, particularly potassium, sodium, and chloride. Overuse of some drugs, including **diuretics**, laxatives, and antacids, should be avoided.

KEY TERMS

pH—A measurement of the acidity or alkalinity of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkaline (basic) with a normal range of 7.36-7.44.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. "Acid-Base Disturbances." In *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

DuBose Jr., Thomas D. "Acidosis and Alkalosis" In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Fluid, Electrolyte, and Acid-Base Disorders." In *Family Medicine Principles and Practices*. 5th ed. New York: Springer-Verlag, 1998.

"Fluid & Electrolyte Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Altha Roberts Edgren

Metabolic encephalopahty *see* **Delirium**

Meth *see* **Muscle relaxants**

Methadone

Definition

Methadone is a powerful narcotic drug in the same class as heroin. This class is known as the opioids.

Purpose

Methadone, formerly known as dolophine, is a psychoactive drug, meaning that it affects the mind or behavior. It belongs to the class of opioids, drugs that share some of the analgesic properties, and mimic the action of some of the body's naturally occurring chemicals called peptides, such as endorphins and enkephalines.

Methadone is used to relieve chronic **pain** in **cancer** patients and as a maintenance drug to control withdrawal symptoms in people undergoing treatment for opiate **addiction**.

In opiate addiction treatment, methadone blocks the opioid receptors of the brain that bind opiates such as heroin. The blocking of these receptors leads to two major effects:

- because these chemical receptors remain blocked by methadone for up to 24 hours, even if a person addicted to heroin takes heroin after the administration of methadone, this person is not likely to feel the same effects of the heroin as he or she previously felt;
- because the action of methadone is associated with slower and less intense withdrawal symptoms than those of heroin, the patient can experience milder opiate effects while the addiction is being treated and avoid the unpleasant withdrawal symptoms associated with heroin.

Methadone has also been shown to reduce cravings for heroin while not altering a person's mood.

Precautions

Methadone magnifies the effects of alcohol and other central nervous system depressants, such as **antihistamines**, cold medicines, sedatives, tranquilizers, other prescription and over-the-counter (OTC) pain medications, **barbiturates**, seizure medications, **muscle relaxants**, and certain anesthetics including some dental anesthetics. Alcohol and other central nervous system depressants should not be taken or consumed while methadone is being taken.

Methadone is a powerful narcotic. It can cause some people to feel drowsy, dizzy, or light-headed. People taking methadone should not drive a car or operate machinery.

Intentional or accidental overdose of methadone can lead to unconsciousness, **coma**, or **death**. The signs of methadone overdose include confusion, difficulty speaking, seizures, severe nervousness or restlessness, severe **dizziness**, severe drowsiness, and/or slow or troubled breathing. These symptoms are increased by alcohol or other central nervous system (CNS) depressants. Anyone who feels that he or she, or someone else, may have overdosed on methadone, or a combination of methadone and other central nervous system depressants, should seek emergency medical attention for that person at once.

Description

A typical adult dosage for methadone is 5-20 mg as an oral solution, 2.5-10 mg as an oral tablet or injection, every four to eight hours as necessary for pain. When used for **detoxification**, methadone is initially given in a

KEY TERMS

Analgesic—Any agent that relieves pain.

Central nervous system (CNS) depressant—Any drug that tends to reduce the activity of the central nervous system. The major drug categories included in this classification are: alcohol, anesthetics, antianxiety medications, antihistamines, antipsychotics, hypnotics, narcotics, sedatives, and tranquilizers.

Endorphins—Any of several opiate peptides naturally produced in the brain that bind to certain neuron receptors and have the effect of relieving pain.

Enkephalines—Peptides produced by the body that have analgesic properties.

Morphine—Morphine is the naturally occurring opioid in the opium poppy, Papaver somniferum. It is a powerful narcotic analgesic, and its primary clinical use is in the management of moderately severe to severe pain. After heroin, morphine has the greatest potential for addiction of all narcotic analgesics.

Narcotic—Any drug that produces insensibility or stupor and/or generally causes effects similar to those caused by morphine.

Opiate—Any narcotic analgesic derived from a natural source, such as morphine from the opium poppy.

Opioid receptors—Receptors located in the brain and various organs that bind opiates or opioid substances.

Opioids—One of the major classes of semi or fully synthetic psychoactive drugs that includes methadone.

Psychoactive drugs—Any drug that affects the mind or behavior. There are five main classes of psychoactive drugs: opiates and opioids (e.g. heroin and methadone); stimulants (e.g. cocaine, nicotine), depressants (e.g. tranquilizers, antipsychotics, alcohol), hallucinogens (e.g. LSD), and marijuana and hashish.

Receptor—A molecular structure on the surface that selectively binds a specific substance resulting in a specific physiological effect.

dose of 15-100 mg per day as an oral solution. This dose is then decreased until the patient no longer requires the medication. The injection form of methadone is only used for detoxification in patients who are unable to take the medication by mouth.

Preparation

No preparation is generally necessary prior to the intake of methadone as a pain reliever. In cases of maintenance treatments, it is important to be sure that the patient is not currently intoxicated by alcohol, heroin, other opioids, or taking other central nervous system depressants.

Aftercare

Patients receiving methadone should be monitored for adverse reactions to this drug, and/or possible accidental overdose.

Risks

Methadone can interfere with or exacerbate certain medical conditions. For these reasons, it is important that the prescribing physician be informed of any current case, or history of:

- alcohol abuse
- brain disease or head injury
- colitis
- drug dependency, particularly of narcotics
- emotional problems
- emphysema, **asthma**, or other chronic lung disease
- enlarged prostate
- gallstones or gallbladder disease
- heart disease
- kidney disease
- liver disease
- problems with urination
- seizures
- underactive thyroid

Side effects

The most common side effects of methadone include:

- constipation
- dizziness

- drowsiness
- itching
- nausea
- urine retention
- vomiting

Less common side effects of methadone include:

- abnormally fast or slow heartbeat
- blurred or double vision
- cold, clammy skin
- depression or other mood changes
- dry mouth
- fainting
- hallucinations
- hives
- loss of appetite
- nightmares or unusual dreams
- pinpoint pupils of the eyes
- redness or flushing of the face
- restlessness
- rigid muscles
- ringing or buzzing in the ears
- seizure
- severe drowsiness
- skin reaction at the site of injection
- stomach cramps or pain
- sweating
- trouble sleeping (insomnia)
- yellowing of the skin or whites of the eyes

Normal results

Normal results after the administration of methadone to treat chronic pain is the alleviation of that patient's pain, at least to the point where the pain is bearable.

The normal result of methadone treatment to control heroin addiction is that the patient reduces heroin intake almost immediately upon starting methadone treatments, followed by complete abstinence, usually within two weeks after starting treatment.

Resources

BOOKS

Preston, Andrew. *The Methadone Briefing* London: ISDD, 1996.

Ward, Jeff, Richard P. Mattick, and Wayne Hall (eds). *Methadone Maintenance Treatment and Other Opioid Replacement Therapies*. Amsterdam, Netherlands: Harwood Academic Publishing, 1997.

PERIODICALS

Dole, Vincent P. "What Have We Learned from Three Decades of Methadone Maintenance Treatment?" *Drug and Alcohol Review* 13 (1994):3-4.

Sadovsky, Richard. "Methadone Maintenance Therapy." *American Family Physician* (15 July 2000).

ORGANIZATIONS

National Alliance of Methadone Advocates (NAMA). 435 Second Avenue, New York, NY, 10010. (212) 595-6262. <http://www.methadone.org/>.

National Clearinghouse for Alcohol and Drug Information. 11426-28 Rockville Pike, Suite 200, Rockville, MD 20852. (800) 729-6686. <http://www.health.org/>.

Paul A. Johnson

Methemoglobinemia

Definition

When excessive hemoglobin in the blood is converted to another chemical that cannot deliver oxygen to tissues, called methemoglobin.

Description

The molecule hemoglobin in the blood is responsible for binding oxygen to give to the body. When hemoglobin is oxidized to methemoglobin its structure changes and it is no longer able to bind oxygen. Hemoglobin is constantly under oxidizing stresses: however, normally less than 1% of a person's hemoglobin is in the methemoglobin state. This is due to the body's systems that reduce methemoglobin back to hemoglobin. Infants have a higher risk of acquiring methemoglobinemia because infant hemoglobin is more prone to be oxidized to methemoglobin.

Causes and symptoms

Methemoglobinemia can either be congenital or acquired.

There are two causes of the congenital form. One cause is a defect in the body's systems to reduce methemoglobin to hemoglobin. The other cause is a mutant form of hemoglobin called hemoglobin M that cannot bind to oxygen. Both of these forms are typically benign.

Acquired methemoglobinemia is caused by an external source, usually a drug or medication. Some of these medications include benzocaine, lidocaine and prilocaine. These medications can inhibit the body's systems

KEY TERMS

Cyanosis—When the body does not receive enough oxygen.

Oxidation—When a chemical element or compound loses an electron.

Reduction—When a chemical element or compound gains an electron.

of reducing methemoglobin to hemoglobin resulting in methemoglobinemia.

With a methemoglobin level of 3-15% skin can turn to a pale gray or blue (**cyanosis**). With levels above 25% the following symptoms may be present:

- cyanosis unaffected by oxygen administration
- blood that is dark or chocolate in color that won't change to red in the presence of oxygen
- headache
- weakness
- confusion
- chest pain

When methemoglobin levels are above 70% **death** may result if not treated immediately.

Diagnosis

Diagnosis is based on the symptoms and history. If these are indicative of methemoglobinemia blood tests are performed to confirm the presence and level of methemoglobin.

Treatment

For acquired methemoglobinemia the typical treatment is with methylene blue. This is administered with an IV over a five-minute period and results are typically seen within 20 minutes. Methylene blue reduces methemoglobin back to hemoglobin.

Though congenital methemoglobinemia is usually benign, the form due to a defective reducing system can be treated with ascorbic acid (vitamin C) taken daily. The other congenital form due to hemoglobin M has no treatment as of late.

Alternative Treatment

There are not any known alternative treatments for methemoglobinemia. Methylene blue, or a similar treatment, is needed to reduce methemoglobin to hemoglobin.

Prognosis

If found early, acquired methemoglobinemia can be easily treated with no side effects. After treatment with methylene blue the patient can expect a full recovery.

Congenital methemoglobinemia is typically benign and should be observed. If methemoglobinemia symptoms occur the person should be taken to the hospital for treatment.

Prevention

If a person gets methemoglobinemia from a certain medication that medication should be avoided at all costs in the future. For people with congenital methemoglobinemia medications or other things that are known to oxidize hemoglobin should be avoided.

Resources

BOOKS

Beutler, Ernest. "Methemoglobinemia and Other Causes of Cyanois." In *Williams Hematology* New York: McGraw-Hill, 2001, 6th Edition, pp.611-17.

PERIODICALS

Wright, Lewander and Woolf. "Methemoglobinemia: Etiology, Pharmacology, and Clinical Management." *Annals of Emergency Medicine* (November 1999): 646-56.

Wilburn-Goo, Dawn and Lloyd. "When Patients Become Cyanotic: Acquired Methemoglobinemia." *Journal of the American Dental Association* (June 1999): 826-31.

OTHER

eMedicine. Website. 2001. <http://www.emedicine.com>.

Thomas Scott Eagan
Ronald Watson, PhD

Methylphenidate *see* **Central nervous system stimulants**

Metoprolol *see* **Beta blockers**

Metronidazole *see* **Antiprotozoal drugs**

Micronaz *see* **Antifungal drugs, topical**

Microphthalmia and anophthalmia

Definition

Anophthalmia is the complete absence of an eye. Microphthalmia is an eye that has an abnormal smallness.

Description

Anophthalmia is caused by a defect in embryonic development. The total absence of an eye is extremely rare and often a clinical sign associated with a broad range of genetic disorders or, more commonly, a sporadic mutation. Sporadic transmission occurs in the affected individual due to a genetic abnormality. It is not passed on from the parents, but usually due to a combination of environmental and genetic influences. More commonly anophthalmia clinically presents as a small cyst. The defect, which causes anophthalmia, is an absence of the optic vesicle, a structure important for eye development. The genetic abnormality usually occurs during weeks one to three after conception. It is estimated that the incidence of microphthalmia occurs 0.22 times per 1,000 live births. Anophthalmia can occur during adult life but not associated with a genetic cause.

Microphthalmia refers to an abnormally small eye. This clinical sign is often associated with autosomal dominant or recessively transmitted genetic disorders. Most disorders dominantly inherited with microphthalmia are associated with some visual capabilities in infancy and early childhood. Microphthalmia may be isolated (the only presenting sign) or associated with a range of ocular or systemic abnormalities. Isolated cases of microphthalmia may be sporadic or inherited. There is a variable degree of **visual impairment**. Microphthalmia occurs due to autosomal recessive transmission and is part of a syndrome associated with abnormalities in the retina or systemic lesions. Microphthalmia results from a developmental defect after formation of the optic vesicle. The developmental abnormality causes the optic vesicle to fold inwards, resulting in the formation of a cyst. The cyst will progressively swell from birth, and it may be situated along the optic nerve. The cyst may also be situated along other important eye structures.

Causes and symptoms

Microphthalmia and anophthalmia can be caused by sporadic or genetic mutations. Anophthalmia is characterized by a total absence of an eye. Anophthalmia in an adult is usually caused by trauma, infection, tumor, or advanced eye disease.

Diagnosis

Microscope examination confirms the diagnosis of true anophthalmia. The clinician examines a piece of tissue taken from the eye and notes eviscerated tissue. For microphthalmia the confirmation can be established by eye measurements. Eyes that have an axial length <21 mm in an adult, or <19 mm in a one-year-old child are described as having microphthalmia.

KEY TERMS

Axial— A straight line passing through a spherical body between its two poles and about which the body may revolve.

Eviserated— Removal of eye contents.

Prostheses— A synthetic object that resembles a missing anatomical part.

Retina— A major portion of the eye responsible for reception of visual light rays.

Treatment

Large cysts causing microphthalmia should be aspirated or removed surgically. There is no known cure for anophthalmia or microphthalmia. For anophthalmia a prosthetic eye can be fitted which may involve surgery. Treatment for microphthalmia depends on the complexity of eye involvement.

Prognosis

For anophthalmia, prosthetic eyes should be seen by a specialist two to three times per year to assess fit, mobility, and smoothness. They are usually well tolerated and have good appearance and mobility. The clinical course for microphthalmia depends on the extent of smallness, but usually patients progress favorably without major treatment. Since the smallness is distinctly noticeable, there may be individual cosmetic considerations.

Prevention

There is no known prevention for either, since these clinical signs are commonly associated with genetic inheritance.

Resources

BOOKS

Yanoff, Myron, et al, eds. *Ophthalmology.* 1st ed. Mosby International Ltd., 1999.

PERIODICALS

Mills, M. "The Eye in Childhood." *American Family Physician* 60 (Sept. 1999).

ORGANIZATIONS

The American Society of Human Genetics. Administrative Office. 9650 Rockville Pike Bethesda, Maryland 20814-3998. (301) 571-1825. 2001. <http://www.faseb.org/genetics/ashg/moreinfo.htm>.

Laith Farid Gulli, M.D.

Middle ear infection *see* **Otitis media**

Mifeprex *see* **Mifepristone**

Mifepristone

Definition

Mifepristone is a pill that can be taken as an alternative to a surgical abortion.

Purpose

This medication is best-suited for ending early pregnancies.

Precautions

Women who are more than seven weeks pregnant (or 49 days since their last menstrual period) should not take mifepristone. Other reasons to avoid mifepristone include: use of an intrauterine device (**IUD**), **ectopic pregnancy**, use of blood thinners, bleeding disorders, use of steroid medications, **allergies** to mifepristone or similar drugs and lack of access to medical help within two weeks after the treatment.

Description

Mifepristone, sold commercially under the name Mifeprex, also is known as RU-486, the abortion pill, the early option pill or medical abortion. While it has been used for many years in Europe, mifepristone has only been available for use in the United States since the U.S. Food and Drug Administration (FDA) approved it in 2000 for use in abortion.

This drug causes **pregnancy** to end by blocking the female hormone progesterone. The lack of progesterone makes the uterus shed its lining, which causes bleeding similar to a menstrual period. Three days after taking mifepristone, women are given a second drug, misprostol, to cause uterine contractions that expel the contents of the uterus. Most women are able to remain in their own home while they pass the fetus, and many prefer to have this privacy.

Preparation

Before taking mifepristone, healthcare providers likely will give the woman a urine or blood test to be sure that she is, in fact, pregnant. They also may give her some counseling and support. Once she has made the decision to use mifepristone, they will ask her to sign a written statement that she has decided to end her pregnancy.

Aftercare

Using mifepristone and misoprostol causes heavy bleeding and cramping. Doctors can offer **pain** medicine, such as Motrin, to ease the cramps. For two weeks after treatment with mifepristone, healthcare providers likely will ask patients to abstain from sexual intercourse, heavy lifting and strenuous **exercise**. They also may advise against breastfeeding, since scientists are not sure if the drug is present in breast milk.

Physicians require patients to come in for a follow-up visit 14 days after their first dose of mifepristone to verify that they are no longer pregnant and that they are properly healing.

Risks

Other common side effects include: **fatigue**, headaches, **dizziness**, nausea, vomiting, **diarrhea** and low-back pain.

Since pregnancy hormones are in flux after a medical abortion, many women have emotional side-effects, such as mood swings, depression or a mild case of the blues. These feelings usually subside when hormones stabilize a few weeks later. For those who feel stuck in their grief or anger about the situation, counseling or support groups may offer relief.

Normal results

Most women feel better after about two weeks. Bleeding and spotting usually occurs for nine to 16 days, but may last for a month.

Abnormal results

In some cases, mifepristone does not completely end the pregnancy. If the fetus is still left inside the uterus, a doctor may recommend a surgical abortion, or a procedure called dilation and curettage (D and C). About five to eight out of 100 women who take mifepristone go on to have a surgical abortion, according to the FDA. During a D and C, which usually is done at a hospital or clinic under a local anesthetic, a physician dilates the cervix, then uses an instrument to scrape any residual tissue away from the walls of the uterus. This allows the heavy bleeding to eventually stop so a woman can return to her normal cycle sooner.

Resources

BOOKS

Lader, Lawrence and Eleanor Smeal. *A Private Matter: RU 486 and the Abortion Crisis*. New York: Prometheus Books, 1995.

PERIODICALS

"The Abortion Pill's Grim Progress." *Mother Jones* 24(January 1, 1999).

ORGANIZATION

Post Abortion Stress Syndrome Support Site. For information and online support groups. <http://www.afterabortion.com>.

U.S. Food and Drug Administration Center for Drug Evaluation and Research 5600 Fishers Lane, Rockville MD 20857-0001. Mifepristone fact sheets available: 1-888-463-6332. <http://www.fda.gov/cder>.

Melissa Knopper

Migraine headache

Definition

Migraine is a type of **headache** marked by severe head **pain** lasting several hours or more.

Description

Migraine is an intense, often debilitating type of headache. Migraines affect as many as 24 million people in the United States, and are responsible for billions of dollars in lost work, poor job performance, and direct medical costs. Approximately 18% of women and 6% of men experience at least one migraine attack per year. More than three million women and one million men have one or more severe headaches every month. Migraines often begin in adolescence, and are rare after age 60.

Two types of migraine are recognized. Eighty percent of migraine sufferers experience "migraine without aura," formerly called common migraine. In "migraine with aura," formerly called classic migraine, pain is preceded or accompanied by visual or other sensory disturbances, including **hallucinations**, partial obstruction of the visual field, numbness or tingling, or a feeling of heaviness. Symptoms are often most prominent on one side of the body, and may begin as early as 72 hours before the onset of pain.

Causes and symptoms

Causes

The physiological basis of migraine has proved difficult to uncover. Genetics appear to play a part for many, but not all, people with migraine. There are a multitude of potential triggers for a migraine attack, and recognizing one's own set of triggers is the key to prevention.

PHYSIOLOGY. The most widely accepted hypothesis of migraine suggests that a migraine attack is precipitated when pain-sensing nerve cells in the brain (called nociceptors) release chemicals called neuropeptides. At least one of the neurotransmitters, substance P, increases the pain sensitivity of other nearby nociceptors.

Other neuropeptides act on the smooth muscle surrounding cranial blood vessels. This smooth muscle regulates blood flow in the brain by relaxing or contracting, thus constricting the enclosed blood vessels and stimulating adjacent pain receptors. At the onset of a migraine headache, neuropeptides are thought to cause muscle relaxation, allowing vessel dilation and increased blood flow. Other neuropeptides increase the leakiness of cranial vessels, allowing fluid leak, and promote inflammation and tissue swelling. The pain of migraine is thought to result from this combination of increased pain sensitivity, tissue and vessel swelling, and inflammation. The aura seen during a migraine may be related to constriction in the blood vessels that dilate in the headache phase.

GENETICS. Susceptibility to migraine may be inherited. A child of a migraine sufferer has as much as a 50% chance of developing migraine. If both parents are affected, the chance rises to 70%. However, the gene or genes responsible have not been identified, and many cases of migraine have no obvious familial basis. It is likely that whatever genes are involved set the stage for migraine, and that full development requires environmental influences as well.

TRIGGERS. A wide variety of foods, drugs, environmental cues, and personal events are known to trigger migraines. It is not known how most triggers set off the events of migraine, nor why individual migraine sufferers are affected by particular triggers but not others.

Common food triggers include:

- cheese
- alcohol
- **caffeine** products, and caffeine withdrawal
- chocolate
- intensely sweet foods
- dairy products
- fermented or pickled foods
- citrus fruits
- nuts
- processed foods, especially those containing nitrites, sulfites, or monosodium glutamate (msg)

Environmental and event-related triggers include:

- **stress** or time pressure

- menstrual periods, **menopause**
- sleep changes or disturbances, oversleeping
- prolonged overexertion or uncomfortable posture
- hunger or **fasting**
- odors, smoke, or perfume
- strong glare or flashing lights

Drugs which may trigger migraine include:

- oral contraceptives
- estrogen replacement therapy
- nitrates
- theophylline
- reserpine
- nifedipine
- indomethicin
- cimetidine
- decongestant overuse
- analgesic overuse
- benzodiazepine withdrawal

Symptoms

Migraine without aura may be preceded by elevations in mood or energy level for up to 24 hours before the attack. Other pre-migraine symptoms may include **fatigue**, depression, and excessive yawning.

Aura most often begins with shimmering, jagged arcs of white or colored light progressing over the visual field in the course of 10-20 minutes. This may be preceded or replaced by dark areas or other visual disturbances. **Numbness and tingling** is common, especially of the face and hands. These sensations may spread, and may be accompanied by a sensation of weakness or heaviness in the affected limb.

The pain of migraine is often present only on one side of the head, although it may involve both, or switch sides during attacks. The pain is usually throbbing, and may range from mild to incapacitating. It is often accompanied by nausea or vomiting, painful sensitivity to light and sound, and intolerance of food or odors. Blurred vision is common.

Migraine pain tends to intensify over the first 30 minutes to several hours, and may last from several hours to a day or longer. Afterward, the affected person is usually weary, and sensitive to sudden head movements.

Diagnosis

Migraine is diagnosed by a careful medical history. Lab tests and imaging studies such as computed tomography (CT scan) or **magnetic resonance imaging** (MRI) scans have not been useful for identifying migraine. However, for some patients, those tests may be needed to rule out a **brain tumor** or other structural causes of migraine headache.

Treatment

Once a migraine begins, the person will usually seek out a dark, quiet room to lessen painful stimuli. Several drugs may be used to reduce the pain and severity of the attack.

Nonsteroidal anti-inflammatory drugs (NSAIDs) are helpful for early and mild headache. NSAIDs include **acetaminophen**, ibuprofen, naproxen, and others. A recent study concluded that a combination of acetaminophen, **aspirin**, and caffeine could effectively relieve symptoms for many migraine patients. One such over-the-counter preparation is available as Exedrin Migraine.

More severe or unresponsive attacks may be treated with drugs that act on serotonin receptors in the smooth muscle surrounding cranial blood vessels. Serotonin, also known as 5-hydroxytryptamine, constricts these vessels, relieving migraine pain. Drugs that mimic serotonin and bind to these receptors have the same effect. The oldest of them is ergotamine, a derivative of a common grain fungus. Ergotamine and dihydroergotamine are used for both acute and preventive treatment. Derivatives with fewer side effects have come onto the market in the past decade, including sumatriptan (Imitrex). Some of these drugs are available as nasal sprays, intramuscular injections, or rectal suppositories for patients in whom vomiting precludes oral administration. Other drugs used for acute attacks include meperidine and metoclopramide.

Studies are showing that rizatriptan is a promising drug for the treatment of migraines. One study showed that 10mg of rizatriptan provided relief to 90% of the patients in the study group and kept 50% of them pain-free 2 hours after taking the medication. Sumatriptan has been on the market since 1993, while rizatriptan became available in 1998.

Continued use of some anti-migraine drugs can lead to “rebound headache,” marked by frequent or chronic headaches, especially in the early morning hours. Rebound headache is avoided by using anti-migraine drugs under a doctor’s supervision, with the minimum dose necessary to treat symptoms. Patients with frequent migraines may need preventive therapy.

Alternative treatment

Alternative treatments are aimed at prevention of migraine. Migraine headaches are often linked with food

allergies or intolerances. Identification and elimination of the offending food or foods can decrease the frequency of migraines and/or alleviate these headaches altogether. Herbal therapy with feverfew (*Chrysanthemum parthenium*) may lessen the frequency of attacks. Learning to increase the flow of blood to the extremities through **biofeedback** training may allow a patient to prevent some of the vascular changes once a migraine begins. During a migraine, keep the lights low; put the feet in a tub of hot water and place a cold cloth on the occipital region (the back of the head). This draws the blood to the feet and decreases the pressure in the head.

Prognosis

Most people with migraines can bring their attacks under control through recognizing and avoiding triggers, and by use of appropriate drugs when migraine occurs. Some people with severe migraines do not respond to preventive or drug therapy. Migraines usually wane in intensity by age 60 and beyond.

Prevention

The frequency of migraine may be lessened by avoiding triggers. It is useful to keep a headache journal, recording the particulars and noting possible triggers for each attack. Specific measures which may help include:

- eating at regular times, and not skipping meals
- reducing the use of caffeine and pain relievers
- restricting physical exertion, especially on hot days
- keeping regular sleep hours, but not oversleeping
- managing time to avoid stress at work and home

Some drugs can be used for migraine prevention, including specific members of these drug classes:

- beta blockers
- tricyclic antidepressants
- calcium channel blockers
- anticonvulsants
- prozac
- monoamine oxidase inhibitors (mao)
- serotonin antagonists

For most patients, preventive drug therapy is not an appropriate option, since it requires continued use of powerful drugs. However, for women whose migraines coincide with the menstrual period, limited preventive treatment may be effective. Since these drugs are appropriate for patients with other medical conditions, the decision to prescribe them for migraine may be influenced by expected benefit elsewhere.

Resources

BOOKS

Larson, David E. *Mayo Clinic Family Health Book*. New York: William Morrow and Company, 1996.

Rakel, Robert. *Conn's Current Therapy: Latest Approved Methods of Treatment for the Practicing Physician*. Philadelphia: W.B. Saunders Company, 2001.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment*. Los Altos: Lange Medical Publications, 2001.

PERIODICALS

Block, GA, et. al. "Efficacy and Safety of Rizatriptan Versus Standard Care During Long-Term Treatment for Migraine. Rizatriptan Multicenter Study Groups." *Headache* (November-December 1998):764-771.

"Clinical Trials Show New Drug Offers Faster Relief from Migraine Pain." *Geriatrics* (June 1998): 95

"Drug Treatment of Migraine: Part I." *American Family Physician* (November 15, 1997): 2039-2048.

"Drug Treatment of Migraine: Part II." *American Family Physician* (December, 1997): 2279-2286.

Meadows, Michelle. "Wellness: No More Migraines." *Essence* (May 1999):52.

OTHER

American Medical Association. "Migraine." <http://www.ama-assn.org/special/migraine/>.

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Miliaria *see* **Prickly heat**

Mineral deficiency

Definition

The term mineral deficiency means a condition where the concentration of any one of the **minerals** essential to human health is abnormally low in the body. In some cases, an abnormally low mineral concentration is defined as that which leads to an impairment in a function dependent on the mineral. In other cases, the convention may be to define an abnormally low mineral concentration as a level lower than that found in a specific healthy population.

The mineral nutrients are defined as all the inorganic elements or inorganic molecules that are required for life. As far as human **nutrition** is concerned, the inorganic nutrients include water, sodium, potassium, chloride, calcium, phosphate, sulfate, magnesium, iron, copper, zinc, manganese, iodine, selenium, and molybdenum. Some of the inorganic nutrients, such as water, do not occur as single atoms, but occur as molecules. Other inorganic nutri-

ents that are molecules include phosphate, sulfate, and selenite. Phosphate contains an atom of phosphorus. Sulfate contains an atom of sulfur. We do not need to eat sulfate, since the body can acquire all the sulfate it needs from protein. Selenium occurs in foods as selenite and selenate.

There is some evidence that other inorganic nutrients, such as chromium and boron, play a part in human health, but their role is not well established. Fluoride has been proven to increase the strength of bones and teeth, but there is little or no reason to believe that is needed for human life.

The mineral content of the body may be measured by testing samples of blood plasma, red blood cells, or urine. In the case of calcium and phosphate deficiency, the diagnosis may also involve taking x rays of the skeleton. In the case of iodine deficiency, the diagnosis may include examining the patient's neck with the eyes and hands. In the case of iron deficiency, the diagnosis may include the performance of a stair-stepping test by the patient. Since all the minerals serve strikingly different functions in the body, the tests for the corresponding deficiency are markedly different from each other.

Description

Laboratory studies with animals have revealed that severe deficiencies in any one of the inorganic nutrients can result in very specific symptoms, and finally in **death**, due to the failure of functions associated with that nutrient. In humans, deficiency in one nutrient may occur less often than deficiency in several nutrients. A patient suffering from **malnutrition** is deficient in a variety of nutrients. In the United States, malnutrition is most often found among severe alcoholics. In part, this is because the alcohol consumption may supply half of the energy requirement, resulting in a mineral and vitamin intake of half the expected level. Deficiencies in one nutrient do occur, for example, in human populations living in iodine-poor regions of the world, and in iron deficient persons who looses excess iron by abnormal bleeding.

Inorganic nutrients have a great variety of functions in the body. Water, sodium, and potassium deficiencies are most closely associated with abnormal nerve action and cardiac **arrhythmias**. Deficiencies in these nutrients tend to result not from a lack of content in the diet, but from excessive losses due to severe **diarrhea** and other causes. Iodine deficiency is a global public health problem. It occurs in parts of the world with iodine-deficient soils, and results in **goiter**, which involves a relatively harmless swelling of the neck, and cretinism, a severe birth defect. The only use of iodine in the body is for making thyroid hormone. However, since thyroid hormone has a variety of roles in development of the embryo, iodine deficiency during **pregnancy** results in a number of **birth defects**.

Calcium deficiency due to lack of dietary calcium occurs only rarely. However, calcium deficiency due to **vitamin D deficiency** can be found among certain populations. Vitamin D is required for the efficient absorption of calcium from the diet, and hence vitamin D deficiency in growing infants and children can result in calcium deficiency.

Dietary phosphate deficiency is rare because phosphate is plentiful in plant and animal foods, but also because phosphate is efficiently absorbed from the diet into the body. Iron deficiency causes anemia (lack of red blood cells), which results in tiredness and **shortness of breath**.

Dietary deficiencies in the remaining inorganic nutrients tend to be rare. Magnesium deficiency is uncommon, but when it occurs it tends to occur in chronic alcoholics, in persons taking diuretic drugs, and in those suffering from severe and prolonged diarrhea. Magnesium deficiency tends to occur with the same conditions that provoke deficiencies in sodium and potassium. Zinc deficiency is rare, but it has been found in impoverished populations in the Middle East, who rely on unleavened whole wheat bread as a major food source. Copper deficiency is also rare, but dramatic and health-threatening changes in copper metabolism occur in two genetic diseases, Wilson's disease and Menkes' disease.

Selenium deficiency may occur in regions of the world where the soils are poor in selenium. Low-selenium soils can produce foods that are also low in selenium. Premature infants may also be at risk for selenium deficiency. Manganese deficiency is very rare. Experimental studies with humans fed a manganese deficient diet have revealed that the deficiency produces a scaly, red rash on the skin of the upper torso. Molybdenum deficiency has probably never occurred, but indirect evidence suggests that if molybdenum deficiency could occur, it would result in **mental retardation** and death.

Causes and symptoms

Sodium deficiency (**hyponatremia**) and water deficiency are the most serious and widespread deficiencies in the world. These deficiencies tend to arise from excessive losses from the body, as during prolonged and severe diarrhea or vomiting. Diarrheal diseases are a major world health problem, and are responsible for about a quarter of the 10 million infant deaths that occur each year. Nearly all of these deaths occur in impoverished parts of Africa and Asia, where they result from contamination of the water supply by animal and human feces.

The main concern in treating diarrheal diseases is **dehydration**, that is, the losses of sodium and water which deplete the fluids of the circulatory system (the heart, veins, arteries, and capillaries). Severe losses of the fluids of the circulatory system result in **shock**. Shock nearly always occurs when dehydration is severe enough to produce a 10% reduction in body weight. Shock, which is defined as inadequate supply of blood to the various tissues of the body, results in a lack of oxygen to all the cells of the body. Although diarrheal fluids contain a number of electrolytes, the main concern in avoiding shock is the replacement of sodium and water.

Sodium deficiency and potassium deficiency also frequently result during treatment with drugs called **diuretics**. Diuretics work because they cause loss of sodium from the body. These drugs are used to treat high blood pressure (**hypertension**), where the resulting decline in blood pressure reduces the risk for cardiovascular disease. However, diuretics can lead to sodium deficiency, resulting in low plasma sodium levels. A side effect of some diuretics is excessive loss of potassium, and low plasma potassium (**hypokalemia**) may result.

Iodine deficiency tends to occur in regions of the world where the soil is poor in iodine. Where soil used in agriculture is poor in iodine, the foods grown in the soil will also be low in iodine. An iodine intake of 0.10-0.15 mg/day is considered to be nutritionally adequate, while iodine deficiency occurs at below 0.05 mg/day. Goiter, an enlargement of the thyroid gland (located in the neck), results from iodine deficiency. Goiter continues to be a problem in eastern Europe, parts of India and South America, and in Southeast Asia. Goiter has been eradicated in the United States because of the fortification of foods with iodine. Iodine deficiency during pregnancy results in cretinism in the newborn. Cretinism involves mental retardation, a large tongue, and sometimes deafness, muteness, and lameness.

Iron deficiency occurs due to periods of dietary deficiency, rapid growth, and excessive loss of the body's iron. Human milk and cow milk both contains low levels of iron. Infants are at risk for acquiring iron deficiency because their rapid rate of growth needs a corresponding increased supply of dietary iron, for use in making blood and muscles. Human milk is a better source of iron than cow milk, since about half of the iron in human breast milk is absorbed by the infant's digestive tract. In contrast, only 10% of the iron in cow milk is absorbed by the infant. Surveys of lower-income families in the United States have revealed that about 6% of the infants are anemic indicating a deficiency of iron in their **diets**. Blood loss that occurs with menstruation in women, as well as with a variety of causes of intestinal bleeding is a major cause of iron deficiency. The symptoms of iron deficiency are generally limited to anemia, and the resulting tiredness, weakness, and a reduced ability to perform physical work.

Calcium and phosphate are closely related nutrients. About 99% of the calcium and 85% of the phosphate in the body occur in the skeleton, where they exist as crystals of solid calcium phosphate. Both of these nutrients occur in a great variety of foods. Milk, eggs, and green, leafy vegetables are rich in calcium and phosphate. Whole cow milk, for example, contains about 1.2 g calcium and 0.95 g phosphorus per kg of food. Broccoli contains 1.0 g calcium and 0.67 g phosphorus per kg food. Eggs supply about one third of the calcium and phosphate of the overall population of the United States. Dietary deficiencies in calcium (**hypocalcemia**) or phosphate are extremely rare throughout the world. Vitamin D deficiency can be found among young infants, the elderly, and others who may be shielded from sunshine for prolonged periods of time. Vitamin D deficiency impairs the absorption of calcium from the diet, and in this way can provoke calcium deficiency even when the diet contains adequate calcium.

Zinc deficiency has been found among peasant populations in rural areas of the Middle East. Unleavened whole wheat bread can account for 75% of the energy intake in these areas. This diet, which does not contain meat, does contain zinc, but it also contains phytic acid at a level of about 3 g/day. The phytic acid, which naturally occurs in wheat, inhibits zinc absorption. The yeast used to leaven bread produces enzymes that inactivate the phytic acid. Unleavened bread does not contain yeast, and therefore, contains intact phytic acid. The symptoms of zinc deficiency include lack of sexual maturation, lack of pubic hair, and small stature. The amount of phytic acid in a typical American diet cannot provoke zinc deficiency.

Zinc deficiency is relatively uncommon in the United States, but it may occur in adults with **alcoholism** or intestinal malabsorption problems. Low plasma zinc has been found in patients with alcoholic **cirrhosis**, **Crohn's disease**, and **celiac disease**. Experimental studies with humans have shown that the signs of zinc deficiency are detectable after two to five weeks of consumption of the zinc-free diet. The signs include a rash and diarrhea. The rash occurs on the face, groin, hands, and feet. These symptoms can easily be reversed by administering zinc. An emerging concern is that increased calcium intake can interfere with zinc absorption or retention. Hence, there is some interest in the question of whether persons taking calcium to prevent **osteoporosis** should also take zinc supplements.

Severe alterations in copper metabolism occur in two genetic diseases, Wilson's disease and Menkes' dis-

KEY TERMS

Recommended Dietary Allowance—The Recommended Dietary Allowances (RDAs) are quantities of nutrients that are required each day to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient.

ease. Both of these diseases are rare and occur in about one in 100,000 births. Both diseases involve mutations in copper transport proteins, that is, in special channels that allow the passage of copper ions through cell membranes. Menkes' disease is a genetic disease involving mental retardation and death before the age of three years. The disease also results in steely or kinky hair. The hair is tangled, grayish, and easily broken. Menkes' disease involves a decrease in copper levels in the serum, liver, and brain, and increases in copper in the cells of the intestines and kidney.

Selenium deficiency may occur in premature infants, since this population naturally tends to have low levels of plasma selenium. Full term infants have plasma selenium levels of about 0.001-0.002 mM, while premature infants may have levels about one third this amount. Whether these lower levels result in adverse consequences is not clear. Selenium deficiency occurs in regions of the world containing low-selenium soils. These regions include Keshan Province in China, New Zealand, and Finland. In Keshan Province, a disease (Keshan disease) occurs which results in deterioration of regions of the heart and the development of fibers in these regions. Keshan disease, which may be fatal, is thought to result from a combination of selenium deficiency and a virus.

Diagnosis

The diagnosis of deficiencies in water, sodium, potassium, iron, calcium, and phosphate involve chemical testing of the blood plasma, urine, and red blood cells.

Iodine deficiency can be diagnosed by measuring the concentration of iodine in the urine. A urinary level greater than 0.05 mg iodine per gram creatinine means adequate iodine status. Levels under 0.025 mg iodine/g creatinine indicate a serious risk.

Normal blood serum magnesium levels are 1.2-2.0 mM. Magnesium deficiency results in hypomagnesemia, which is defined as serum magnesium levels below 0.8 mM. Magnesium levels below 0.5 mM provoke a decline in serum calcium levels. Hypomagnesemia can also result in low serum potassium. Some of the symptoms of hypomagnesemia, which include twitching and convulsions, actually result from the hypocalcemia. Other symptoms of hypomagnesemia, such as cardiac arrhythmias, result from the low potassium levels.

There is no reliable test for zinc deficiency. When humans eat diets containing normal levels of zinc (16 mg/day), the level of urinary zinc is about 0.45 mg/day, while humans consuming low-zinc diets (0.3 mg/day) may have urinary levels of about 0.150 mg/day. Plasma zinc levels tend to be maintained during a dietary deficiency in zinc. Plasma and urinary zinc levels can be influenced by a variety of factors, and for this reason cannot provide a clear picture of zinc status.

Selenium deficiency may be diagnosed by measuring the selenium in plasma (70 ng/mL) or red blood cells (90 ng/mL), where the normal values are indicated. There is also some interest in measuring the activity of an enzyme in blood platelets, in order to assess selenium status. This enzyme is glutathione peroxidase. Platelets are small cells of the bloodstream which are used mainly to allow the clotting of blood after an injury.

Treatment

The treatment of deficiencies in sodium, potassium, calcium, phosphate, and iron usually involves intravenous injections of the deficient mineral.

Iodine deficiency can be easily prevented and treated by fortifying foods with iodine. Table salt is fortified with 100 mg potassium iodide per kg sodium chloride. Goiter was once common in the United States in areas from Washington State to the Great Lakes region, but this problem has been eliminated by iodized salt. Public health programs in impoverished countries have involved injections of synthetic oils containing iodine. Goiter is reversible but, cretinism is not.

Magnesium deficiency can be treated with a magnesium rich diet. If magnesium deficiency is due to a prolonged period of depletion, treatment may include injections of magnesium sulfate (2.0 mL of 50% $MgSO_4$). Where magnesium deficiency is severe enough to provoke convulsions, magnesium needs to be administered by injections or infusions. For infusion, 500 mL of a 1% solution (1 gram/100 mL) of magnesium sulfate is gradually introduced into a vein over the course of about five hours.

Zinc deficiency and copper deficiency are quite rare, but when they are detected or suspected, they can be treated by consuming zinc or copper, on a daily basis, at levels defined by the RDA.

Selenium deficiency in adults can be treated by eating 100 mg selenium per day for a week, where the selenium is supplied as selenomethionine. The incidence of Keshan disease in China has been reduced by supplementing children with 1.0 mg sodium selenite per week.

Prognosis

In iodine deficiency, the prognosis for treating goiter is excellent, however cretinism cannot be reversed. The effects of iron deficiency are not life-threatening and can be easily treated. The prognosis for treating magnesium deficiency is excellent. The symptoms may be relieved promptly or, at most, within two days of starting treatment. In cases of zinc deficiency in Iran and other parts of the Middle East, supplementation of affected young adults with zinc has been found to promote the growth of pubic hair and enlargement of genitalia to a normal size within a few months.

Prevention

In the healthy population, all mineral deficiencies can be prevented by the consumption of inorganic nutrients at levels defined by the Recommended Dietary Allowances (RDA). Where a balanced diet is not available, government programs for treating individuals, or for fortifying the food supply, may be used. Government sponsored programs for the prevention of iron deficiency and iodine deficiency are widespread throughout the world. Selenium treatment programs have been used in parts of the world where selenium deficiency exists. Attention to potassium status, and to the prevention of potassium deficiency, is an issue mainly in patients taking diuretic drugs. In many cases of mineral deficiency, the deficiency occurs because of disease, and individual medical attention, rather than preventative measures, is used. The prevention of calcium deficiency is generally not an issue or concern, however calcium supplements are widely used with the hope of preventing osteoporosis. The prevention of deficiencies in magnesium, zinc, copper, manganese, or molybdenum are not major health issues in the United States. Ensuring an adequate intake of these minerals, by eating a balanced diet or by taking mineral supplements, is the best way to prevent deficiencies.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

Tom Brody, PhD

Mineral excess *see* **Mineral toxicity**

Mineral toxicity

Definition

The term mineral toxicity means a condition where the concentration in the body of any one of the **minerals** is abnormally high, and where there is an adverse effect on health.

Description

In general, mineral toxicity results when there is an accidental consumption of too much of any mineral, as with drinking ocean water (sodium toxicity) or with overexposure to industrial pollutants, household chemicals, or certain drugs. Mineral toxicity may also apply to toxicity that can be the result of certain diseases or injuries. For example, **hemochromatosis** leads to iron toxicity; Wilson's disease results in copper toxicity; severe trauma can lead to **hyperkalemia** (potassium toxicity).

The mineral nutrients are defined as all the inorganic elements or inorganic molecules that are required for life. As far as human **nutrition** is concerned, the inorganic nutrients include water, sodium, potassium, chloride, calcium, phosphate, sulfate, magnesium, iron, copper, zinc, manganese, iodine, selenium, and molybdenum.

The mineral content of the body may be measured by testing samples of blood plasma, red blood cells, and urine.

Causes and symptoms

An increase in the concentrations of sodium in the bloodstream can be toxic. The normal concentration of sodium in the blood plasma is 136-145 mM, while levels over 152 mM can result in seizures and **death**. Increased plasma sodium, which is called **hypernatremia**, causes various cells of the body, including those of the brain, to shrink. Shrinkage of the brain cells results in confusion, **coma**, **paralysis** of the lung muscles, and death. Death has occurred where table salt (sodium chloride) was accidently used, instead of sugar, for feeding infants. Death due to sodium toxicity has also resulted when baking soda (sodium bicarbonate) was used during attempted therapy of excessive **diarrhea** or vomiting. Although a variety of processed foods contain high levels of sodium chloride, the levels used are not enough to result in sodium toxicity.

The normal level of potassium in the bloodstream is in the range of 3.5-5.0 mM, while levels of 6.3-8.0 mM

(severe hyperkalemia) result in cardiac **arrhythmias** or even death due to cardiac arrest. Potassium is potentially quite toxic, however toxicity or death due to potassium **poisoning** is usually prevented because of the vomiting reflex. The consumption of food results in mild increases in the concentration of potassium in the bloodstream, but levels of potassium do not become toxic because of the uptake of potassium by various cells of the body, as well as by the action of the kidneys transferring the potassium ions from the blood to the urine. The body's regulatory mechanisms can easily be overwhelmed, however, when potassium chloride is injected intravenously, as high doses of injected potassium can easily result in death.

Iodine toxicity can result from an intake of 2.0 mg of iodide per day. The toxicity results in impairment of the creation of thyroid hormone, resulting in lower levels of thyroid hormone in the bloodstream. The thyroid gland enlarges, as a consequence, and **goiter** is produced. This enlargement is also called **hyperthyroidism**. Goiter is usually caused by iodine deficiency. In addition to goiter, iodine toxicity produces ulcers on the skin. This condition has been called "kelp acne," because of its association with eating kelp, an ocean plant, which contains high levels of iodine. Iodine toxicity occurs in Japan, where large amounts of seaweed are consumed.

Iron toxicity is not uncommon, due to the wide distribution of iron pills. A lethal dose of iron is in the range of 200-250 mg iron/kg body weight. Hence, a child who accidently eats 20 or more iron tablets may die as a result of iron toxicity. Within six hours of ingestion, iron toxicity can result in vomiting, diarrhea, abdominal **pain**, seizures, and possibly coma. A latent period, where the symptoms appear to improve, may occur but it is followed by **shock**, low blood glucose, liver damage, convulsions, and death, occuring 12-48 hours after toxic levels of iron are ingested.

Nitrite poisoning should be considered along with iron toxicity, since nitrite produces its toxic effect by reacting with the iron atom of hemoglobin. Hemoglobin is an iron-containing protein that resides within the red blood cells. This protein is responsible for the transport of nearly all of the oxygen, acquired from the lungs, to various tissues and organs of the body. Hemoglobin accounts for the red color of our red blood cells. A very small fraction of our hemoglobin spontaneously oxidizes per day, producing a protein of a slightly different structure, called methemoglobin. Normally, the amount of methemoglobin constitutes less than 1% of the total hemoglobin. Methemoglobin can accumulate in the blood as a result of nitrite poisoning. Infants are especially susceptible to poisoning by nitrite.

Nitrate, which is naturally present in green leafy vegetables and in the water supply is rapidly converted to nitrite by the naturally occurring bacteria residing on our tongue, as well as in the intestines, and then absorbed into the bloodstream. The amount of nitrate that is supplied by leafy vegetables and in drinking water is generally about 100-170 mg/day. The amount of nitrite supplied by a typical diet is much less, that is, than 0.1 mg nitrite/day. Poisoning by nitrite, or nitrate after its conversion to nitrite, results in the inability of hemoglobin to carry oxygen throughout the body. This condition can be seen by the blue color of the skin. Adverse symptoms occur when over 30% of the hemoglobin has been converted to methemoglobin, and these symptoms include cardiac arrhythmias, **headache**, **nausea and vomiting**, and in severe cases, seizures.

Calcium and phosphate are closely related nutrients. Calcium toxicity is rare, but overconsumption of calcium supplements may lead to deposits of calcium phosphate in the soft tissues of the body. Phosphate toxicity can occur with overuse of **laxatives** or **enemas** that contain phosphate. Severe phosphate toxicity can result in **hypocalcemia**, and in various symptoms resulting from low plasma calcium levels. Moderate phosphate toxicity, occurring over a period of months, can result in the deposit of calcium phosphate crystals in various tissues of the body.

Zinc toxicity is rare, but it can occur in metal workers who are exposed to fumes containing zinc. Excessive dietary supplements of zinc can result in nausea, vomiting, and diarrhea. The chronic intake of excessive zinc supplements can result in copper deficiency, as zinc inhibits the absorption of copper.

Severe alterations in copper metabolism occur in two genetic diseases, Wilson's disease and Menkes' disease. Both of these diseases are rare and occur in about one in 100,000 births. Both diseases involve mutations in the proteins that transport copper, that is, in special channels that allow the passage of copper ions through cell membranes. Wilson's disease tends to occur in teenagers and in young adults, and then remain for the lifetime. Copper accumulates in the liver, kidney, and brain, resulting in damage to the liver and nervous system. Wilson's disease can be successfully controlled by lifelong treatment with d-penicillamine. Treatment also involves avoiding foods that are high in copper, such as liver, nuts, chocolate, and mollusks. After an initial period of treatment with penicillamine, Wilson's disease may be treated with zinc (150 mg oral Zn/day). The zinc inhibits the absorption of dietary copper.

Selenium toxicity occurs in regions of the world, including some parts of China, where soils contain high levels of selenium. A daily intake of 0.75-5.0 mg selenium may occur in these regions, due to the presence of

selenium in foods and water. Early signs of selenium toxicity include nausea, weakness, and diarrhea. With continued intake of selenium, changes in fingernails and hair loss results, and damage to the nervous system occurs. The breath may acquire a garlic odor, as a result of the increased production of dimethylselenide in the body, and its release via the lungs.

Manganese toxicity occurs in miners in manganese mines, where men breathe air containing dust bearing manganese at a concentration of 5-250 mg/cubic meter. Manganese toxicity in miners has been documented in Chile, India, Japan, Mexico, and elsewhere. Symptoms of manganese poisoning typically occur within several months or years of exposure. These symptoms include a mental disorder resembling **schizophrenia**, as well as hyperirritability, violent acts, **hallucinations**, and difficulty in walking.

Diagnosis

The initial diagnosis of mineral toxicity involves questioning the patient in order to determine any unusual aspects of the diet, unusual intake of drugs and chemicals, and possible occupational exposure. Diagnosis of mineral toxicities also involves measuring the metal concentration in the plasma or urine. Concentrations that are above the normal range can confirm the initial, suspected diagnosis.

Treatment

Iron toxicity is treated by efforts to remove remaining iron from the stomach, by use of a solution of 5% sodium bicarbonate. Where plasma iron levels are above 0.35 mg/dL, the patient is treated with deferoxamine. Treatment of manganese toxicity involves removal of the patient from the high manganese environment, as well as lifelong doses of the drug L-dopa. The treatment is only partially successful. Treatment of nitrite or nitrate toxicity involves inhalation of 100% oxygen for several hours. If oxygen treatment is not effective, then methylene blue may be injected, as a 1.0% solution, in a dose of 1.0 mg methylene blue/kg body weight.

Prognosis

The prognosis for treating toxicity due to sodium, potassium, calcium, and phosphate is usually excellent. Toxicity due to the deposit of calcium phosphate crystals is not usually reversible. The prognosis for treating iodine toxicity is excellent. For any mineral overdose that causes coma or seizures, the prognosis for recovery is often poor, and death results in a small fraction of patients. For any mineral toxicity that causes nerve damage, the prognosis is often fair to poor.

Prevention

When mineral toxicity results from the excessive consumption of mineral supplements, toxicity can be prevented by not using supplements. In the case of manganese, toxicity can be prevented by avoiding work in manganese mines. In the case of iodine, toxicity can be prevented by avoiding overconsumption of seaweed or kelp. In the case of selenium toxicity that arises due to high-selenium soils, toxicity can be prevented by relying on food and water acquired from a low-selenium region.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

O'Dell, B., and R. A. Sunde. *Handbook of Nutritionally Essential Mineral Elements.* New York: Marcel Dekker, 1997.

PERIODICALS

Johnson, C., et al. "Fatal Outcome of Methemoglobinemia in an Infant." *Journal of the American Medical Association* 257 (1987): 2796-2797.

Tom Brody, PhD

Minerals

Definition

The minerals (inorganic nutrients) that are relevant to human **nutrition** include water, sodium, potassium, chloride, calcium, phosphate, sulfate, magnesium, iron, copper, zinc, manganese, iodine, selenium, and molybdenum. Cobalt is a required mineral for human health, but it is supplied by vitamin B_{12}. Cobalt appears to have no other function, aside from being part of this vitamin. There is some evidence that chromium, boron, and other inorganic elements play some part in human nutrition, but the evidence is indirect and not yet convincing. Fluoride seems not to be required for human life, but its presence in the diet contributes to long term dental health. Some of the minerals do not occur as single atoms, but occur as molecules. These include water, phosphate, sulfate, and selenite (a form of selenium). Sulfate contains an atom of sulfur. We do not need to eat sulfate, since the body can acquire all the sulfate it needs from protein.

The statement that various minerals, or inorganic nutrients, are required for life means that their continued supply in the diet is needed for growth, maintenance of

body weight in adulthood, and for reproduction. The amount of each mineral that is needed to support growth during infancy and childhood, to maintain body weight and health, and to facilitate **pregnancy** and **lactation**, are listed in a table called the Recommended Dietary Allowances (RDA). This table was compiled by the Food and Nutrition Board, a committee that serves the United States government. All of the values listed in the RDA indicate the daily amounts that are expected to maintain health throughout most of the general population. The actual levels of each inorganic nutrient required by any given individual is likely to be less than that stated by the RDA. The RDAs are all based on studies that provided the exact, minimal requirement of each mineral needed to maintain health. However, the RDA values are actually greater than the minimal requirement, as determined by studies on small groups of healthy human subjects, in order to accomodate the variability expected among the general population.

The RDAs for adult males are 800 mg of calcium, 800 mg of phosphorus, 350 mg of magnesium, 10 mg of iron, 15 mg of zinc, 0.15 mg of iodine, and 0.07 mg of selenium. The RDA for sodium is expressed as a range (0.5-2.4 g/day). The minimal requirement for chloride is about 0.75 g/day, and the minimal requirement for potassium is 1.6-2.0 g/day, though RDA values have not been set for these nutrients. The RDAs for several other minerals has not been determined, and here the estimated safe and adequate daily dietary intake has been listed by the Food and Nutrition Board. These values are listed for copper (1.5-3.0 mg), manganese (2-5 mg), fluoride (1.5-4.0 mg), molybdenum (0.075-0.25 mg), and chromium (0.05-0.2 mg). In noting the appearance of chromium in this list, one should note that the function of chromium is essentially unknown, and evidence for its necessity exists only for animals, and not for human beings. In considering the amount of any mineral used for treating **mineral deficiency**, one should compare the recommended level with the RDA for that mineral. Treatment at a level that is one tenth of the RDA might not be expected to be adequate, while treatment at levels ranging from 10-1,000 times the RDA might be expected to exert a toxic effect, depending on the mineral. In this way, one can judge whether any claim of action, for a specific mineral treatment, is likely to be adequate or appropriate.

Purpose

People are treated with minerals for several reasons. The primary reason is to relieve a mineral deficiency, when a deficiency has been detected. Chemical tests suitable for the detection of all mineral deficiencies are available. The diagnosis of the deficiency is often aided by tests that do not involve chemical reactions, such as the **hematocrit** test for the red blood cell content in blood for iron deficiency, the visual examination of the neck for iodine deficiency, or the examination of bones by densitometry for calcium deficiency. Mineral treatment is conducted after a test and diagnosis for iron-deficiency anemia, in the case of iron, and after a test and diagnosis for hypomagnesemia, in the case of magnesium, to give two examples.

A second general reason for mineral treatment is to prevent the development of a possible or expected deficiency. Here, minerals are administered when tests for possible mineral deficiency are not given. Examples include the practice of giving young infants iron supplements, and of the food industry's practice of supplementing infant formulas with iron. The purpose here is to reduce the risk for **iron deficiency anemia**. Another example is the practice of many women of taking calcium supplements, with the hope of reducing the risk of **osteoporosis**.

Most minerals are commercially available at supermarkets, drug stores, and specialty stores. There is reason to believe that the purchase and consumption of most of these minerals is beneficial to health for some, but not all, of the minerals. Potassium supplements are useful for reducing blood pressure, in cases of persons with high blood pressure. The effect of potassium varies from person to person. The consumption of calcium supplements is likely to have some effect on reducing the risk for osteoporosis. The consumption of selenium supplements is expected to be of value only for residents of Keshan Province, China, because of the established association of selenium deficiency in this region with "Keshan disease."

Precautions

During emergency treatment of sodium deficiency (**hyponatremia**), potassium deficiency (**hypokalemia**), and calcium deficiency (**hypocalcemia**) with intravenous injections, extreme caution must be taken to avoid producing toxic levels of each of these minerals (**hypernatremia**, **hyperkalemia**, and **hypercalcemia**), as **mineral toxicity** can be life-threatening in some instances. The latter three conditions can be life threatening. Selenium is distinguished among most of the nutrients in that dietary intakes at levels only ten times that of the RDA can be toxic. Hence, one must guard against any overdose of selenium. Calcium and zinc supplements, when taken orally, are distinguished among most of the other minerals in that their toxicity is relatively uncommon.

Description

Minerals are used in treatments by three methods, namely, by replacing a poor diet with a diet that supplies

the RDA, by consuming oral supplements, or by injections or infusions. Injections are especially useful for infants, for mentally disabled persons, or where the physician wants to be totally sure of compliance. Infusions, as well as injections, are essential for medical emergencies, as during mineral deficiency situations like hyponatremia, hypokalemia, hypocalcemia, and hypomagnesemia. Oral mineral supplements are especially useful for mentally alert persons who otherwise cannot or will not consume food that is a good mineral source, such as meat. For example, a vegetarian who will not consume meat may be encouraged to consume oral supplements of iron, as well as supplements of vitamin B_{12}.

Iron treatment is used for young infants, given as supplements of 7 mg of iron per day to prevent anemia. Iron is also supplied to infants via the food industry's practice of including iron at 12 mg/L in cow milk-based infant formulas, as well as adding powdered iron at levels of 50 mg iron per 100 g dry infant cereal.

Calcium supplements, along with estrogen and calcitonin therapy, are commonly used in the prevention and treatment of osteoporosis. Estrogen and calcitonin are naturally occurring hormones. Bone loss occurs with **diets** supplying under 400 mg Ca/day. Bone loss can be minimized with the consumption of the RDA for calcium. There is some thought that all postmenopausal women should consume 1,000–1,500 mg of calcium per day. These levels are higher than the RDA. There is some evidence that such supplementation can reduce bone losses in some bones, such as the elbow (ulna), but not in other bones. Calcium absorption by the intestines decreases with **aging**, especially after the age of 70. The regulatory mechanisms of the intestines that allow absorption of adequate calcium (500 mg Ca/day or less) may be impaired in the elderly. Because of these changes, there is much interest in increasing the RDA for calcium for older women.

Fluoride has been proven to reduce the rate of **tooth decay**. When fluoride occurs in the diet, it is incorporated into the structure of the teeth, and other bones. The optimal range of fluoride in drinking water is 0.7-1.2 mg/L. This level results in a reduction in the rate of tooth decay by about 50%. The American Dental Association recommends that persons living in areas lacking fluoridated water take fluoride supplements. The recommendation is 0.25 mg F/day from the ages of 0-2 years, 0.5 mg F/day for 2-3 years, and 1.0 mg F/day for ages 3-13 years.

Magnesium is often used to treat a dangerous condition, called eclampsia, that occasionally occurs during pregnancy. In this case, magnesium is used as a drug, and not to relieve a deficiency. High blood pressure is a fairly common disorder during pregnancy, affecting 1-5% of pregnant mothers. **Hypertension** during pregnancy can result in increased release of protein in the urine. In pregnancy, the combination of hypertension with increased urinary protein is called preeclampsia. Preeclampsia is a concern during pregnancies as it may lead to eclampsia. Eclampsia involves convulsions and possibly **death** to the mother. Magnesium sulfate is the drug of choice for preventing the convulsions of eclampsia.

Treatment with cobalt, in the form of vitamin B_{12}, is used for relieving the symptoms of **pernicious anemia**. Pernicious anemia is a relatively common disease that tends to occur in persons older than 40 years. Free cobalt is never used for the treatment of any disease.

Preparation

Evaluation of a patient's mineral levels requires a blood sample, and the preparation of plasma or serum from the blood sample. An overnight fast is usually recommended as preparation prior to drawing the blood and chemical analysis. The reason for this is that any mineral present in the food consumed at breakfast may artificially boost the plasma mineral content beyond the normal **fasting** level, and thereby mask a mineral deficiency. In some cases, red blood cells are used for the mineral status assay.

Aftercare

The healthcare provider assesses the patient's response to mineral treatment. A positive response confirms that the diagnosis was correct. Lack of response indicates that the diagnosis was incorrect, that the patient had failed to take the mineral supplement, or that a higher dose of mineral was needed. The response to mineral treatment can be monitored by chemical tests, by an examination of red blood cells or white blood cells, or by physiological tests, depending on the exact mineral deficiency.

Risks

There are few risks associated with mineral treatment. In treating emergency cases of hyponatremia, hypokalemia, or hypocalcemia by intravenous injections, there exists a very real risk that giving too much sodium, potassium, or calcium, can result in hypernatremia, hyperkalemia, or hypercalcemia, respectively. Risk for toxicity is rare where treatment is by dietary means. This is because the intestines act as a barrier, and absorption of any mineral supplement is gradual. The gradual passage of any mineral through the intestines, especially when the mineral supplement is taken with food, allows the various organs of the body to acquire the mineral. Gradual passage of the mineral into the bloodstream also allows the kidneys to excrete the mineral in the urine, should levels of the mineral rise to toxic levels in the blood.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

Sibai, B. M. "Treatment of Hypertension in Pregnant Women." *New England Journal of Medicine* 335 (1996): 227-265.

Tom Brody, PhD

Minnesota multiphasic personality inventory (MMPI-2)

Definition

The Minnesota Multiphasic Personality Inventory (MMPI-2; MMPI-A) is a written psychological assessment, or test, used to diagnose mental disorders.

Purpose

The MMPI is used to screen for personality and **psychosocial disorders** in adults and adolescents. It is also frequently administered as part of a neuropsychological test battery to evaluate cognitive functioning.

Precautions

The MMPI should be administered, scored, and interpreted by a clinical professional trained in its use, preferably a psychologist or psychiatrist. The MMPI is only one element of psychological assessment, and should never be used alone as the sole basis for a diagnosis. A detailed history of the test subject and a review of psychological, medical, educational, or other relevant records are required to lay the groundwork for interpreting the results of any psychological measurement.

Cultural and language differences in the test subject may affect test performance and may result in inaccurate MMPI results. The test administrator should be informed before psychological testing begins if the test taker is not fluent in English and/or has a unique cultural background.

Description

The original MMPI was developed at the University of Minnesota and introduced in 1942. The current standardized version for adults 18 and over, the MMPI-2, was released in 1989, with a subsequent revision of certain test elements in early 2001. The MMPI-2 has 567 items, or questions, and takes approximately 60 to 90 minutes to complete. There is a short form of the test that is comprised of the first 370 items on the long-form MMPI-2. There is also a version of the inventory for adolescents age 14 to 18, the MMPI-A.

The questions asked on the MMPI are designed to evaluate the thoughts, emotions, attitudes, and behavioral traits that comprise personality. The results of the test reflect an individual's personality strengths and weaknesses, and may identify certain disturbances of personality (psychopathologies) or mental deficits caused by neurological problems.

There are six validity scales and ten basic clinical or personality scales scored in the MMPI-2, and a number of supplementary scales and subscales that may be used with the test. The validity scales are used to determine whether the test results are actually valid (i.e., if the test-taker was truthful, answered cooperatively and not randomly) and to assess the test-taker's response style (i.e., cooperative, defensive). Each clinical scale uses a set or subset of MMPI-2 questions to evaluate a specific personality trait. The MMPI should always be administered in a controlled environment by a psychologist or other qualified mental health professional trained in its use.

Preparation

The administrator should provide the test subject with information on the nature of the test and its intended use, complete standardized instructions to taking the MMPI (including any time limits, and information on the confidentiality of the results).

Normal results

The MMPI should be scored and interpreted by a trained professional. When interpreting test results for test subjects, the test administrator will review what the test evaluates, its precision in evaluation and any margins of error involved in scoring, and what the individual scores mean in the context of overall norms for the test and the background of the test subject.

Resources

BOOKS

Graham, John R. *MMPI-2: Assessing Personality and Psychopathology.* 3rd edition. New York: Oxford University Press, 1999.

KEY TERMS

Neuropsychological testing—Tests used to evaluate patients who have experienced a traumatic brain injury, brain damage, or organic neurological problems (e.g., dementia). It may also be used to evaluate the progress of a patient who has undergone treatment or rehabilitation for a neurological injury or illness.

Norms—Normative or mean score for a particular age group.

Psychopathology—A mental disorder or illness, such as schizophrenia, personality disorder, or major depressive disorder.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

ORGANIZATIONS

The American Psychological Association. Testing and Assessment Office of the Science Directorate. 750 First St., N.E., Washington, DC 20002-4242. (202)336-6000. <http://www.apa.org/science/testing.html>.

The ERIC Clearinghouse on Assessment and Evaluation. 1131 Shriver Laboratory Bldg 075, University of Maryland, College Park, MD 20742. (800) 464-3742. <http://www.ericae.net>.

Paula Anne Ford-Martin

Minor tranquilizers *see* **Antianxiety drugs**

Minority health

Definition

Minority health addresses the special medical and/or health needs associated with specific ethnic groups.

Description

The United States, as well as many other countries, experiences cultural diversity. This poses specific health issues that are specific to ethnic groups. Additionally, the propensity for certain diseases or illnesses is of concern in certain minority groups. These specific health issues include infant mortality rates, **cancer**, cardiovascular disease, diabetes, HIV infection, and immunizations.

Infant mortality rates

Infant mortality rates (IMRs) in the United States and in all countries worldwide are an accurate indicator of health status. They provide information concerning programs about **pregnancy** education and counseling, technological advances, and procedures and aftercare. IMRs vary among racial groups. African Americans had an IMRs of 14.2 per 1,000 live births in 1996, approximately 2.5 times higher than Caucasians. The IMRs among American Native Indian groups varies greatly, with some communities possessing IMRs about two times more than national rates. Additionally Hispanic IMRs (7.6 per 1,000 live births) are also diverse for separate groups, since the IMRs, for example, among Puerto Ricans is higher (8.9 per 1,000 live births).

Cancer

Cancer is a serious national, worldwide, and minority health concern. It is the second cause of **death** in the United States, claiming over half a million lives each year. Approximately 50% of persons who develop cancer will die. There is great disparity among the cancer rates in minority groups. Across genders, cancer death rates for African Americans are 35% higher when compared to statistics for Caucasians. The death rates for **prostate cancer** (two times more) and lung cancer (27 times more) are disproportionately higher when compared to Caucasians. There are also gender differences among ethnic groups and specific cancers. Lung cancers in African American and Hawaiian men are elevated compared with caucasian males. Vietnamese females who live in the United States have five times more new cases of **cervical cancer** when compared to Caucasian women. Hispanic females also have a greater incidence of cervical cancer than Caucasian females. Additionally, Alaskan native men and women have a greater propensity for cancers in the rectum and colon than do Caucasians.

Cardiovascular disease

Cardiovascular disease is the leading cause of disability and death rates, about equal to death from all other diseases combined. Cardiovascular disease can affect the patient's lifestyle and function in addition to having an impact on family members. The financial costs are very high. Among ethnic and racial groups cardiovascular disease is the leading cause of death. **Stroke** is the leading cause of cardiovascular related death, which occurs in higher numbers for Asian-American males when compared to Caucasian men. Mexican-American men and women and African American males have a higher incidence of **hypertension**. African American women have higher rates of being overweight, which is a major risk factor of cardiovascular disease.

DR. ANTONIA NOVELLO (1944–)

(Gamma Liaison. Reproduced by permission.)

Born Antonia Coello was born in Fajardo, Puerto Rico, on August 23, 1944, the oldest of three children. At eight years old, she suffered two blows that she would carry all of her life. Her father, Antonio Coello, died, leaving her mother, Ana Delia Flores Coello, to raise her children alone until she later remarried Ramon Flores, an electrician. Novello was also diagnosed with a chronic condition called congenital megacolon, an illness in which her colon was overly large and not functioning properly, which required regular hospitalization. Although an operation would have helped Novello, it was not performed until she was 18 years old, and even after the surgery, complications followed her for years. Because of her childhood illness, Novello grew up wanting to be a doctor.

On October 17, 1989, President George Bush officially nominated Novello for Surgeon General. The fourteenth United States Surgeon General, Novello was sworn in on March 9, 1990. She remarked that "the American dream is well and alive...today the West Side Story comes to the West Wing." Novello was the first woman and the first Hispanic to be appointed Surgeon General of the United States. Noted for her philosophy of "good science, good sense" and for her approachability, Novello was dedicated to the prevention of AIDS, substance abuse, and smoking, as well as to the education of the American public. Her special concerns were for women, children, and Hispanics—populations often overlooked by public health services.

Diabetes

Diabetes—a serious health problem in Americans and ethnic groups—is the seventh leading cause of death in the United States. The prevalence of diabetes in African Americans is about 70% higher than Caucasians.

HIV

HIV infection/AIDS is the most common cause of death for all persons age 25 to 44 years old. Ethnic groups account for 25% of the United States population and 54% of all **AIDS** cases. In addition to sexual transmission there is an increase in HIV among ethnic groups related to intravenous drug usage.

Immunizations

Immunization, the reduction of preventable disease by **vaccination**, was lower in 1996, but there has been a rapid increase in African Americans taking vaccinations. The coverage for immunization among African Americans and Hispanics for persons age 65 and over is currently below the general population. This may increase the death rates due to respiratory infections.

Causes and symptoms

IMRs are correlated with prenatal care. Women who receive adequate prenatal care tend to have better pregnancy outcomes when compared to little or no care. Women who receive inadequate prenatal care also have increased chances of delivering a very low birth weight (VLBW) infant, which is linked to risk of early death.

Cancer is related to several preventable lifestyle choices. Tobacco use, diet, and exposure to sun (skin cancer) can be prevented by lifestyle modifications. Additionally many cancers can occur due to lack of interest and/or lack of availability for screening and educational programs.

Cardiovascular diseases are higher among persons with high blood cholesterol and high blood pressure. Certain lifestyle choices may increase the chance for heart disease includes lack of **exercise**, overweight, and cigarette **smoking**. Cardiovascular disease is responsible for over 50% of the deaths in persons with diabetes.

HIV occurs at a higher frequency among homosexuals (the number of African Americans males who have AIDS through sex with men has increased). Additional-

ly, unprotected sexual intercourse and sharing used needles for IV drug injection are strongly correlated with infection.

Vaccinations are an effective method of preventing certain disease such as **polio**, **tetanus**, pertussis, **diphtheria**, **influenza**, **hepatitis b**, and pneumococcal infections. Approximately 90% of influenza related mortality is associated with persons aged 65 and older. This is mostly due to neglect of vaccinations. About 45,000 adults each year die of diseases related to hepatitis B, pneumococcal, and influenza infections.

Diagnosis

The diagnosis of VLBW is by weight. Infants who weigh 1,500 g are at high risk for death. For cancer, the diagnosis can be made through screening procedures such as **mammography** (for **breast cancer**), PAP smear (for cervical cancer), and lifestyle modifications such as avoidance of sun and cigarette smoking. Balanced **diets** and adequate **nutrition** also help. Other specific screening tests (PSA, prostate surface antigen) are helpful for diagnosing prostate cancer. Cardiovascular diseases can be detected by medical check-up. Blood pressure and cholesterol levels can be measured. **Obesity** can be diagnosed by assessing a person's weight relative to height. Diabetes and its complications can be detected by blood tests, in-depth eye examinations and studies that assess the flow of blood through blood vessels in legs. HIV can be detected through a careful history/physical examination and analysis of blood using a special test called a western blot. Infections caused by lack of immunizations can be detected by careful **physical examination** and culturing the specific microorganism in the laboratory.

Treatment

Treatment is directed at the primary causes(s) that minorities have increased chances of developing disease(s). Cancer may require treatment utilizing surgery, radiotherapy, or **chemotherapy**. Cardiovascular diseases may require surgical procedures for establishing a diagnosis and initiating treatment. Depending on the extent of disease, cardiovascular management can become complicated requiring medications and daily lifestyle modifications. Treatment usually includes medications, dietary modifications, and—if complications arise—specific interventions tailored to alleviating the problem. HIV can be treated with specific medications and more often than not with symptomatic treatment as reported complications arise. Diseases caused by lack of immunizations are treated based on the primary disease. The best method of treatment is through prevention and generating public awareness through educational awareness.

KEY TERMS

Prevalence— Number of existing cases relative to time.

Propensity— A greater risk for developing a disease.

Alternative treatment

Alternative therapies do exist, but more research is needed to substantiate present data. The diseases that relate to minority health are best treated with nationally accepted standards of care.

Prognosis

Generally the prognosis is related to the diagnosis, patient's state of health, age, and if there is another disease or complication in addition to the presenting problem. The course for IMR's is related to educational programs and prenatal care, which includes medical and psychological treatments. The prognosis for chronic diseases such as cardiovascular problems, high blood pressure, cancer, and diabetes is variable. These diseases are not cured and control is achieved by standardized treatment options. Eventually complications, even with treatment, can potentially occur. For HIV the clinical course at present is death even though this process may take years. Educational programs with an emphasis on disease prevention can potentially improve outcomes concerning pediatric and geriatric diseases.

Prevention

Prevention is accomplished best through educational programs specific to target populations. IMRs can be prevented by increasing awareness, interest, and accessibility for prenatal care that address a comprehensive approach for the needs of each patient. Regular physicals and special screening tests ca potentially prevent certain cancers in high-risk groups. Educational programs concerning lifestyle modifications, diet, exercise, and testing may prevent the development of cardiovascular disease and diabetes. Educational programs assemble to illicit IV drug abusers and persons who engage in unprotected sexual intercourse may decrease the incidence of HIV infection.

Resources

BOOKS

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Year Book, Inc., 1998.

ORGANIZATIONS

Office of Minority Health. 2001. <http://www.omhrc.gov/rah/3rdpgBlue/Cardio/3pgGoalsCardio.htm>.

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Minoxidil

Definition

Minoxidil is a drug available in two forms to treat different conditions. Oral minoxidil is used to treat high blood pressure and the topical solution form is used to treat hair loss and baldness.

Purpose

Minoxidil was the first drug approved by the FDA for the treatment of androgenetic **alopecia** (hair loss). Before that, minoxidil had been used as a vasodilator drug prescribed as oral tablet to treat high blood pressure, with side effects that included hair growth and reversal of male baldness. In the 1980s, UpJohn Corporation came out with a topical solution of 2% minoxidil, called Rogaine, for the specific treatment of androgenetic alopecia. Since the 1990s, numerous generic forms of minoxidil have become available to treat hair loss while the oral form is still used to treat high blood pressure.

The popularity of hair loss treatment is due to the general preference in the overall population for the cosmetic appearance of a full head of hair. Minoxidil is used to stimulate hair growth in areas of the scalp that have stopped growing hair. As of early 2001, the exact mechanism of action of minoxidil is not known.

Precautions

People who have had a prior unusual or allergic reaction to either minoxidil or propylene glycol, a nonactive chemical in the Rogaine solution, should not use topical minoxidil. People who have had a previous allergic reaction to preservatives or dyes may also be at risk for having an allergic reaction to minoxidil.

People who are using cortisone, or cortisone-like drugs (**corticosteroids**), petroleum jelly (Vaseline), or tretinoin (Retin-A) on their scalps should consult their doctors prior to using minoxidil. The use of any of these products in conjunction with minoxidil may cause excessive minoxidil absorption into the body and increase the risk of side effects.

Also, people who have skin problems or irritations of the scalp, including **sunburn**, may absorb too much minoxidil and increase their risk of side effects.

As for oral minoxidil, the form prescribed for high blood pressure, patients should use minoxidil only under medical supervision to ensure that excessive amounts of the drug are not absorbed into their bodies. Large amounts of minoxidil may increase the severity of the symptoms and side effects of **hypertension**.

Minoxidil may pass from mother to child through breast milk. Therefore, women who are breastfeeding should not use minoxidil.

Description

For the treatment of hair loss, minoxidil is available as a topical solution that is generally either 2% or 5% minoxidil in propylene glycol. The propylene glycol ensures that the applied minoxidil is evenly spread across the affected area and easily absorbed through the skin. As of early 2001, the 5% solution is only approved by the FDA for use on men. Approximately 1 milliliter of minoxidil solution is applied to the scalp once a day using the fingertips or a pump spray. It should be applied from the center of the area being treated outward.

In the treatment of high blood pressure, oral minoxidil is usually prescribed when other medications have failed to treat the condition. Dosage is usually 2.5-100 mg per day as a single dose for adults and 200 micrograms to 1 mg per kg of body weight for children.

Preparation

Before using topical minoxidil, the hair and scalp should be clean and dry before the minoxidil solution is applied.

Aftercare

Hands, and any other areas of the body where hair growth is not desired that may have come into contact with topical minoxidil, should be washed immediately after applying the minoxidil solution on the scalp. Once applied, topical minoxidil should be allowed to air-dry for at least two to four hours before clothing is pulled on or off over the head, a hat is worn, or the patient goes to bed. Prior to this, the minoxidil solution may stain clothing, hats, or bed linens; or, it may be accidentally transferred from the patient's head to one of these objects,

then back to other parts of the patient's body where hair growth is not desired. A blow dryer, or other drying methods, should not be used to speed the drying of the minoxidil as this may interfere with the absorption of the medicine. People using minoxidil should also not shampoo, wash, or rinse their hair for at least four hours after minoxidil is applied.

Risks

The most common side effects of topical minoxidil use are **itching** and skin irritation of the treated area of the scalp. Unwanted hair growth may also occur adjacent to treated areas or in areas where the medicine has been inadvertently transferred several times. This unwanted hair growth adjacent to the treatment area may be particularly distressing to women when the face is involved. The itching and irritation usually subside after the drug has been used for approximately two weeks. If symptoms persist after this time, minoxidil use should be halted until a physician has been consulted.

Extremely rare side effects that may occur if too much topically or orally administered minoxidil is being absorbed in the body include:

- changes in vision, most commonly blurred vision
- chest pain
- very low blood pressure
- decreased sexual desire
- fast or irregular heartbeat
- flushing of the skin
- headache
- lightheadedness
- numbness or tingling in the hands, feet, or face
- partial, or complete, impotence
- rapid weight gain
- swelling of the hands, feet, lower legs, or face

Normal results

Topical minoxidil is much more effective at treating baldness that occurs on the top, or crown, of the head than it is at causing hair growth on other parts of the head. Minoxidil does not work for everyone and there is no predictor, in early 2001, of whether or not it will be effective in any particular person. Clinical tests on the effectiveness of topical minoxidil in men with baldness on the top of the head showed that 48% of men who had used minoxidil for one year reported moderate to dense re-growth of hair within the treated area. Thirty-six percent reported minimal re-growth; while 16% reported no re-growth. Similar percentages have been reported in women.

In both men and women, hair re-growth generally does not begin until the medicine has been used for at least four months. The first signs that minoxidil may be effective in a particular person usually occur after approximately 90 days of treatment, when the patient notices that he or she is losing (shedding) much less hair than prior to beginning treatment.

When new growth begins, the first hairs may be soft and barely visible. For some patients, this is the extent to the effectiveness of this medication. For others, this down-like hair develops into hair of the same color and thickness as the other hairs on their heads.

Minoxidil is a treatment for hair loss, it is not a cure. Once a patient stops taking minoxidil, he or she will most likely lose all of the re-grown hair within 90 days of stopping the medication and no further hair growth will occur.

KEY TERMS

Androgenetic alopecia—Hair loss that develops into baldness and affects both men and women.

Hypertension—Persistently high arterial blood pressure.

Scalp—That part of the head that is usually covered with hair.

Topical drug—Drug or medication applied to a specific area of the skin and affecting only the area to which it is applied.

Vasodilation—The increase in the diameter of a blood vessel resulting from relaxation of smooth muscle within the wall of the vessel. Vasodilation activates the blood flow.

Vasodilators—Drugs or substances that cause vasodilation.

Resources

BOOKS

Saito, H. (ed.) *Progress in Hypertension : Antihypertensive Drugs Today.* Philadelphia: Coronet Books, 1992.

PERIODICALS

Barone, Jeanine. "Coping with Hair Loss." *Better Homes and Gardens* (September 1997): 102-108.

Bowser, Andrew. "Treatments Abound for Female Hair Loss." *Dermatology Times* (June 1999).

Scow, Dean Thomas. "Medical Treatments for Balding in Men." *American Family Physician* (15 April 1999).

ORGANIZATIONS

American Hair Loss Council. 30 Grassy Plain Road, Bethel, CT 06801. (888) 873-9719. <http://www.ahlc.org/>.

American Academy of Dermatology. 930 N. Meacham Road, PO Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. Fax: 847-330-0050. <http://www.aad.org/>.

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Miscarriage

Definition

Miscarriage means loss of an embryo or fetus before the 20th week of **pregnancy**. Most miscarriages occur during the first 14 weeks of pregnancy. The medical term for miscarriage is spontaneous abortion.

Description

Miscarriages are very common. Approximately 20% of pregnancies (one in five) end in miscarriage. The most common cause is a genetic abnormality of the fetus. Not all women realize that they are miscarrying and others may not seek medical care when it occurs.

A miscarriage is often a traumatic event for both partners, and can cause feelings similar to the loss of a child or other member of the family. Fortunately, 90% of women who have had one miscarriage subsequently have a normal pregnancy and healthy baby; 60% are able to have a healthy baby after two miscarriages. Even a woman who has had three miscarriages in a row still has more than a 50% chance of having a successful pregnancy the fourth time.

Causes and symptoms

There are many reasons why a woman's pregnancy ends in miscarriage. Often the cause is not clear. However, more than half the miscarriages that occur in the first eight weeks of pregnancy involve serious chromosomal abnormalities or **birth defects** that would make it impossible for the baby to survive. These are different from inherited genetic diseases. They probably occur during development of the specific egg or sperm, and therefore are not likely to occur again.

In about 17% of cases, miscarriage is caused by an abnormal hormonal imbalance that interferes with the ability of the uterus to support the growing embryo. This is known as luteal phase defect. In another 10% of cases, there is a problem with the structure of the uterus or cervix. This can especially occur in women whose mothers used diethylstilbestrol (DES) when pregnant with them.

The risk of miscarriage is increased by:

- **smoking** (up to a 50% increased risk)
- infection
- exposure to toxins (such as arsenic, lead, formaldehyde, benzene, and ethylene oxide)
- multiple pregnancies
- poorly-controlled diabetes

The most common symptom of miscarriage is bleeding from the vagina, which may be light or heavy. However, bleeding during early pregnancy is common and is not always serious. Many women have slight vaginal bleeding after the egg implants in the uterus (about 7-10 days after conception), which can be mistaken for a threatened miscarriage. A few women bleed at the time of their monthly periods through the pregnancy. However, any bleeding in the first three months of pregnancy (first trimester) is considered a threat of miscarriage.

Women should not ignore vaginal bleeding during early pregnancy. In addition to signaling a threatened miscarriage, it could also indicate a potentially life-threatening condition known as **ectopic pregnancy**. In an ectopic pregnancy, the fetus implants at a site other than the inside of the uterus. Most often this occurs in the fallopian tube.

Cramping is another common sign of a possible miscarriage. The cramping occurs because the uterus attempts to push out the pregnancy tissue. If a pregnant woman experiences both bleeding and cramping the possibility of miscarriage is more likely than if only one of these symptoms is present.

If a woman experiences any sign of impending miscarriage, she should be examined by a practitioner. The doctor or nurse will perform a **pelvic exam** to check if the cervix is closed as it should be. If the cervix is open, miscarriage is inevitable and nothing can preserve the pregnancy. Symptoms of an inevitable miscarriage may include dull relentless or sharp intermittent **pain** in the lower abdomen or back. Bleeding may be heavy. Clotted material and tissue (the placenta and embryo) may pass from the vagina.

A situation in which only some of the products in the uterus have been expelled is called an incomplete miscarriage. Pain and bleeding may continue and become severe. An incomplete miscarriage requires medical attention.

A "missed abortion" occurs when the fetus has died but neither the fetus nor placenta is expelled. There may not be any bleeding or pain, but the symptoms of pregnancy will disappear. The physician may suspect a missed abortion if the uterus does not continue to grow. The physician will diagnose a missed abortion with an ultrasound examination.

A woman should contact her doctor if she experiences any of the following:

- any bleeding during pregnancy
- pain or cramps during pregnancy
- passing of tissue
- fever and chills during or after miscarriage

Diagnosis

If a woman experiences any sign of impending miscarriage she should see a doctor or nurse for a pelvic examination to check if the cervix is closed, as it should be. If the cervix is open, miscarriage is inevitable.

An ultrasound examination can confirm a missed abortion if the uterus has shrunk and the patient has had continual spotting with no other symptoms.

Treatment

Threatened miscarriage

For women who experience bleeding and cramping, bed rest is often ordered until symptoms disappear. Women should not have sex until the outcome of the threatened miscarriage is determined. If bleeding and cramping are severe, women should drink fluids only.

Miscarriage

Although it may be psychologically difficult, if a woman has a miscarriage at home she should try to collect any material she passes in a clean container for analysis in a laboratory. This may help determine why the miscarriage occurred.

An incomplete miscarriage or missed abortion may require the removal of the fetus and placenta by a D&C (**dilatation and curettage**). In this procedure the contents of the uterus are scraped out. It is performed in the doctor's office or hospital.

After miscarriage, a doctor may prescribe rest or **antibiotics** for infection. There will be some bleeding from the vagina for several days to two weeks after miscarriage. To give the cervix time to close and avoid possible infection, women should not use tampons or have sex for at least two weeks. Couples should wait for one to three normal menstrual cycles before trying to get pregnant again.

Prognosis

A miscarriage that is properly treated is not life-threatening, and usually does not affect a woman's ability to deliver a healthy baby in the future.

Feelings of grief and loss after a miscarriage are common. In fact, some women who experience a miscarriage suffer from major depression during the six months after the loss. This is especially true for women who don't have any children or who have had depression in the past. The emotional crisis can be similar to that of a woman whose baby has died after birth.

Prevention

The majority of miscarriages cannot be prevented because they are caused by severe genetic problems determined at conception. Some doctors advise women who have a threatened miscarriage to rest in bed for a day and avoid sex for a few weeks after the bleeding stops. Other experts believe that a healthy woman (especially early in the pregnancy) should continue normal activities instead of protecting a pregnancy that may end in miscarriage later on, causing even more profound distress.

If miscarriage was caused by a hormonal imbalance (luteal phase defect), this can be treated with a hormone called progesterone to help prevent subsequent miscarriages. If structural problems have led to repeated miscarriage, there are some possible procedures to treat these problems. Other possible ways to prevent miscarriage are to treat genital infections, eat a well-balanced diet, and refrain from smoking and using recreational drugs.

Resources

BOOKS

Allen, Marie, and Shelly Marks. *Miscarriage: Women Sharing From the Heart*. New York: John Wiley & Sons, 1993.

Friedman, Lynn, Irene Daria, and Laurie Abkemeier. *A Woman Doctor's Guide to Miscarriage*. New York: Hyperion, 1996.

Hinton, Clara H. *Silent Grief; Miscarriage—Finding Your Way Through the Darkness*. Green Forest, AK: New Leaf Press, 1998.

Ingram, Kristen J., and Christine O. Lafser. *Always Precious in our Memory: Reflections After Miscarriage, Stillbirth, or Neonatal Death*. Anaheim, CA: Acta Publications, 1997.

Lachelin, Gillian C. L. *Miscarriage: The Facts*. New York: Oxford Medical Publications, 1996.

Vredevelt, Pam W. *Empty Arms: Emotional Support for Those Who Have Suffered Miscarriage or Stillbirth*. New York: Questar Publications, 1995.

PERIODICALS

"Aftermath of Loss." *U.S. News and World Report* 122, no. 6 (17 Feb. 1997): 66.

KEY TERMS

Diethylstilbestrol (DES)—This is a synthetic estrogen drug that is used to treat a number of hormonal conditions. However, it causes problems in developing fetuses and should not be taken during pregnancy. From about 1938 to 1971, DES was given to pregnant women because it was thought to prevent miscarriage. Children of women who took the drug during pregnancy are at risk for certain health problems.

Dilation and curettage (D&C)—A procedure in which the neck of the womb (cervix) is expanded and the lining of the uterus is scraped to remove pregnancy tissue or abnormal tissue.

Embryo—An unborn child in the first eight weeks after conception. After the eighth week until birth, the baby is called a fetus.

Bennetts, L. "Preventing Miscarriage." *Parents*, Feb. 1994, 64-66.

Petterson, S. "Miscarriage Myths." *Your Health*, 25 Jan. 1994, 23-24.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

Hygeia Foundation, Inc. P.O. Box 3943 New Haven, CT 06525. (203) 387-3589. <http://www.hygeia.org>.

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Mitral incompetence *see* **Mitral valve insufficiency**

Mitral regurgitation *see* **Mitral valve insufficiency**

Mitral stenosis *see* **Mitral valve stenosis**

Mitral valve insufficiency

Definition

Mitral valve insufficiency is a term used when the valve between the upper left chamber of the heart (atrium) and the lower left chamber (ventricle) doesn't close well enough to prevent back flow of blood when the ventricle contracts. Mitral valve insufficiency is also known as mitral valve regurgitation or mitral valve incompetence.

Description

Normally, blood enters the left atrium of the heart from the lungs and is pumped through the mitral valve into the left ventricle. The left ventricle contracts to pump the blood forward into the aorta. The aorta is a large artery that sends oxygenated blood through the circulatory system to all of the tissues in the body. If the mitral valve is leaky due to mitral valve insufficiency, it allows some blood to get pushed back into the atrium. This extra blood creates an increase in pressure in the atrium, which then increases blood pressure in the vessels that bring the blood from the lungs to the heart. Increased pressure in these vessels can result in increased fluid buildup in the lungs.

Causes and symptoms

In the past, **rheumatic fever** was the most common cause of mitral valve insufficiency. However, the increased use of **antibiotics** for **strep throat** has made rheumatic **fever** rare in developed countries. In these countries, mitral valve insufficiency caused by rheumatic fever is seen mostly in the elderly. In countries with less developed health care, rheumatic fever is still common and is often a cause of mitral valve insufficiency.

Heart attacks that damage the structures that support the mitral valve are a common cause of mitral valve insufficiency. Myxomatous degeneration can cause a "floppy" mitral valve that leaks. In other cases, the valve simply deteriorates with age and becomes less efficient.

People with mitral valve insufficiency may not have any symptoms at all. It is often discovered during a doctor's visit when the doctor listens to the heart sounds.

Both the left atrium and left ventricle tend to get a little bigger when the mitral valve does not work properly. The ventricle has to pump more blood so it gets bigger to increase the force of each beat. The atrium gets bigger to hold the extra blood. An enlarged ventricle can cause **palpitations**. An enlarged atrium can develop an erratic rhythm (atrial fibrillation), which reduces its efficiency and can lead to blood clots forming in the atrium.

Diagnosis

When the doctor listens to the heart sounds, mitral valve insufficiency is generally recognized by the sound the blood makes as it leaks backward. It sounds like a regurgitant murmur. The next step is generally a **chest x ray** and an electrocardiogram (ECG) to see if the heart is enlarged. The most definitive noninvasive test is **echocardiography**, a test that uses sound waves to make an image of the heart. This test gives a picture of the valve in action and shows the severity of the problem.

KEY TERMS

Aorta—A large artery beginning at the base of the left ventricle.

Atrium—One of the two upper chambers of the heart.

Rheumatic fever—An illness that sometimes follows a streptococcal infection of the throat.

Ventricle—One of the two lower chambers of the heart.

Treatment

A severely impaired valve needs to be repaired or replaced. Either option will require surgery. Repairing the valve can fix the problem completely or reduce it enough to make it bearable and prevent damage to the heart. Valves can be replaced with either a mechanical valve or one that is partly mechanical and partly from a pig's heart.

Mechanical valves are effective but can increase the incidence of blood clots. To prevent blood clots from forming, the patient will need to take drugs that prevent abnormal blood clotting (anticoagulants). The valves made partly from a pigs heart don't have as great a risk of blood clots but don't last as long as fully mechanical valves. If a valve wears out, it must be replaced again.

Damaged heart valves are easily infected. Anytime a procedure is contemplated that might allow infectious organisms to enter the blood, the person with mitral valve insufficiency should take antibiotics to prevent possible infection.

Prognosis

The diagnostic, medical and surgical procedures available to the person with mitral valve insufficiency are all likely to produce good results.

Prevention

The only possible way to prevent mitral valve insufficiency is to prevent rheumatic fever. This can be done by evaluating sore throats for the presence of the bacteria that causes strep throat. Strep throat is easily treated with antibiotics.

Resources

BOOKS

McGoon, Michael D., *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health.* New York: William Morrow and Co., Inc., 1993.

PERIODICALS

Ling, Lieng H., et al. "Clinical Outcome of Mitral Regurgitation Due to Flail Leaflet." *New England Journal of Medicine* 335 (7 Nov. 1996): 1417+

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

OTHER

The Merck Page. <http://www.merck.com>.

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Mitral valve prolapse

Definition

Mitral valve prolapse (MVP) is a ballooning of the support structures of the mitral heart valve into the left upper collection chamber of the heart.

Description

Other names for MVP include floppy valve and Barlow's syndrome. The mitral valve is located on the left side of the heart between the top chamber (left atrium) and the bottom chamber (left ventricle). The valve opens and closes according to the heartbeat and the pressure that is exerted upon it from the blood in both chambers.

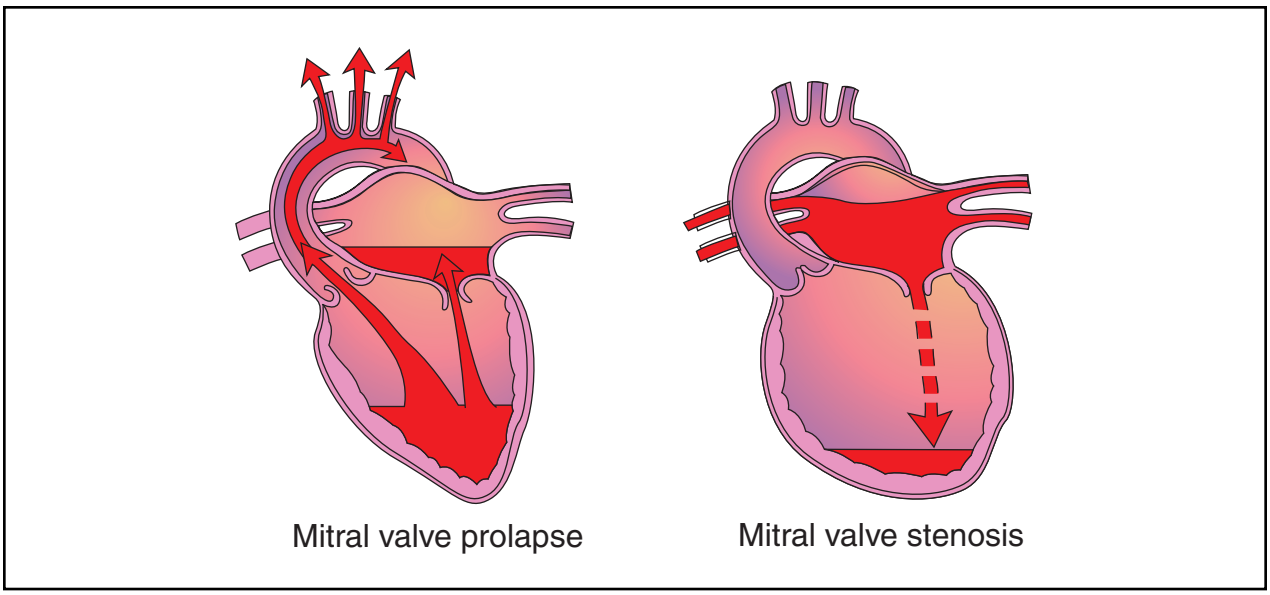
The valve has supporting structures that attach to the heart muscle to help it open and close properly. When these structures weaken or lengthen abnormally, the valve may balloon into the left atrium. Sometimes this can cause the mitral valve to leak blood backward.

This condition may be inherited and occurs in approximately 10% of the population. It affects more women than men and often peaks after the age of 40.

Causes and symptoms

MVP may occur due to rheumatic heart disease but is usually found in healthy people. Changes that occur in the valve are caused by rapid multiplication of cells in the middle layer that presses on the outer layer. The outer layer weakens, causing a prolapse of the valve toward the left atrium.

Most persons do not have symptoms. Those that do may experience sharp, left-sided chest **pain**. Some complain of **fatigue**, or a pounding feeling in the chest. Others can have an irregular heart beat and even pass out. Some persons may experience difficulty breathing, ankle swelling



Mitral valve prolapse occurs when the mitral valve does not open and close properly. When this happens, the valve may balloon into the left atrium of the heart, causing the mitral valve to leak blood backward. Mitral valve stenosis refers to the narrowing of the mitral valve, in which the flow of blood from the atrium to the ventricle becomes restricted. *(Illustration by Electronic Illustrators Group.)*

and fluid in the lungs. Other symptoms may include **anxiety**, headaches, morning tiredness and constantly cold hands and feet. **Death** from this condition is rare.

Diagnosis

The diagnosis of MVP is based on symptoms and physical exam. During the exam, the physician may hear a click and/or heart murmur with a stethoscope.

The best diagnostic test for MVP is the echocardiogram. The test reflects sound waves through the chest wall to give two-dimensional color flow pictures of the heart, its size, position, motion, chambers, and valves. Unfortunately, during the early 1980s, this diagnosis was often made excessively from faulty echocardiographic criteria prevalent at that time.

Any person with symptoms or family history of MVP should consider having an echocardiogram. The test takes 15-20 minutes and is done in doctors' offices and hospitals. It is performed by trained technicians and is read by cardiologists. Family physicians, internists, cardiologists, and nurse practitioners can treat MVP. Echocardiograms are recommended periodically depending on the extent of valve leakage.

Treatment

Persons who experience certain types of an irregular heartbeat with MVP should be treated. Propranolol (Inderal) or other **beta blockers** or digoxin (Lanoxin) are often helpful. Persons who develop moderate to severe symptoms with a leaky mitral valve may require repair or replacement of the mitral valve with an artificial heart valve. Persons with MVP and a leaky valve need to protect themselves from heart or heart valve infections. **Antibiotics** should be taken before any surgical, dental or oral procedures according to the American Heart Association recommendations.

Other treatments include drinking lots of fluids during strenuous activity and hot weather. Water pills, **caffeine** and donating blood may aggravate the symptoms of MVP.

KEY TERMS

Heart murmur—Sound during the heartbeat caused by a heart valve that does not close properly.

Rheumatic heart disease—A condition caused by a streptococcus infection which can result in permanent heart damage.

Prognosis

MVP is usually not a serious condition. However, dangerous, untreated irregular heartbeats may rarely cause sudden death. These persons should be carefully monitored.

Resources

BOOKS

LeDoux, Denise."Acquired Valvular Heart Disease." In *Cardiac Nursing*, ed. Susan Woods, et al. Philadelphia: J. B. Lippincott Co., 1995.

PERIODICALS

McGrath, Dicey. "Mitral Valve Prolapse." *American Journal of Nursing* (May 1997): 40-41.

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KEY TERMS

Atrium—One of the two upper chambers of the heart.

Beta blocker—A drug that can be used to reduce blood pressure.

Rheumatic fever—An illness which sometimes follows a streptococcal infection of the throat.

Ventricle—One of the two lower chambers of the heart.

Mitral valve stenosis

Definition

The term stenosis means an abnormal narrowing of an opening. Mitral valve stenosis refers to a condition in the heart in which one of the valve openings has become narrow and restricts the flow of blood from the upper left chamber (left atrium) to the lower left chamber (left ventricle).

Description

In the heart, the valve that regulates the flow of blood between the left atrium and the left ventricle is called the mitral valve. If the mitral valve is abnormally narrow, due to disease or birth defect, blood flow from the atrium to the ventricle is restricted. This restricted flow leads to an increase in the pressure of blood in the left atrium. Over a period of time, this back pressure causes fluid to leak into the lungs. It can also lead to an abnormal heart rhythm (atrial fibrillation), which further decreases the efficiency of the pumping action of the heart.

Causes and symptoms

Mitral valve stenosis is almost always caused by **rheumatic fever**. As a result of rheumatic **fever**, the leaflets that form the opening of the valve are partially fused together. Mitral valve stenosis can also be present at birth. Babies born with this problem usually require surgery if they are to survive. Sometimes, growths or tumors can block the mitral valve, mimicking mitral valve stenosis.

If the restriction is severe, the increased blood pressure can lead to **heart failure**. The first symptoms of heart failure, which are **fatigue** and **shortness of breath**, usually appear only during physical activity. As the condition gets worse, symptoms may also be felt even during rest. A person may also develop a deep red coloring in the cheeks.

Diagnosis

Mitral valve stenosis is usually detected by a physician listening to heart sounds. Normal heart valves open silently to permit the flow of blood. A stenotic valve makes a snapping sound followed by a "rumbling" murmur. The condition can be confirmed with a **chest x ray** and an electrocardiogram, both of which will show an enlarged atrium. **Echocardiography**, which produces images of the heart's structure, is also helpful in making the diagnosis. If surgery is necessary, **cardiac catheterization** may be done to fully evaluate the heart before the operation.

Treatment

Drug therapy may help to slow the heart rate, strengthen the heart beat, and control abnormal heart rhythm. Drugs such as **beta blockers**, **calcium channel blockers**, and digoxin may be prescribed. A drug that prevents abnormal blood clotting (anticoagulant) called warfarin (Coumadin) may be recommended. If drug therapy does not produce satisfactory results, valve repair or replacement may be necessary.

Repair can be accomplished in two ways. In the first method, **balloon valvuloplasty**, the doctor will try to stretch the valve opening by threading a thin tube (catheter) with a balloon tip through a vein and into the heart. Once the catheter is positioned in the valve, the balloon is inflated, separating the fused areas. The second method involves opening the heart and surgically separating the fused areas.

If the valve is damaged beyond repair, it can be replaced with a mechanical valve or one that is partly mechanical and partly made from a pig's heart.

Prognosis

Procedures available to treat mitral valve stenosis, whether medical or surgical, all produce effective results.

Prevention

The only possible way to prevent mitral valve stenosis is to prevent rheumatic fever. This can be done by evaluating sore throats for the presence of the bacteria that causes **strep throat**. Strep throat is easily treated with **antibiotics**.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

PERIODICALS

"Opening Mitral Valves Without Surgery." *Harvard Heart Letter* 6 (Nov. 1995): 5+.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

OTHER

The Merck Page. <http://www.merck.com>.

Dorothy Elinor Stonely

Molar pregnancy *see* **Hydatidiform mole**

Moles

Definition

A mole (nevus) is a pigmented (colored) spot on the outer layer of the skin (epidermis).

Description

Moles can be round, oval, flat, or raised. They can occur singly or in clusters on any part of the body. Most moles are brown, but colors can range from pinkish flesh tones to yellow, dark blue, or black.

Everyone has at least a few moles. They generally appear by the time a person is 20 and look, at first, like freckles. A mole's color and shape don't usually change. Changes in hormone levels that occur during **puberty** and **pregnancy** can make moles larger and darker. New moles may also appear during this period.

A mole usually lasts about 50 years before beginning to fade. Some moles disappear completely, and some never lighten at all. Some moles develop stalks that raise them above the skin's surface; these moles eventually drop off.

Types of moles

About 1-3% of all babies have one or more moles when they are born. Moles that are present at birth are called congenital nevi.

Other types of moles include:

- junctional moles, which are usually brown and may be flat or slightly raised
- compound moles, which are slightly raised, range in color from tan to dark brown, and involve pigment-producing cells (melanocytes) in both the upper and lower layers of the skin (epidermis and dermis)
- dermal moles, which range from flesh-color to brown, are elevated, most common on the upper body, and may contain hairs
- sebaceous moles, which are produced by over-active oil glands and are yellow and rough-textured
- blue moles, which are slightly raised, colored by pigment deep within the skin, and most common on the head, neck, and arms of women

Most moles are benign, but atypical moles (dysplastic nevi) may develop into **malignant melanoma**, a potentially fatal form of skin **cancer**. Atypical moles are usually hereditary. Most are bigger than a pencil eraser, and the shape and pigmentation are irregular.

Congenital nevi are more apt to become cancerous than moles that develop after birth, especially if they are more than eight inches in diameter. Lentigo maligna (melanotic freckle of Hutchinson), most common on the face and after the age of 50, first appears as a flat spot containing two or more shades of tan. It gradually becomes larger and darker. One in three of these moles develop into a form of skin cancer known as lentigo maligna melanoma.

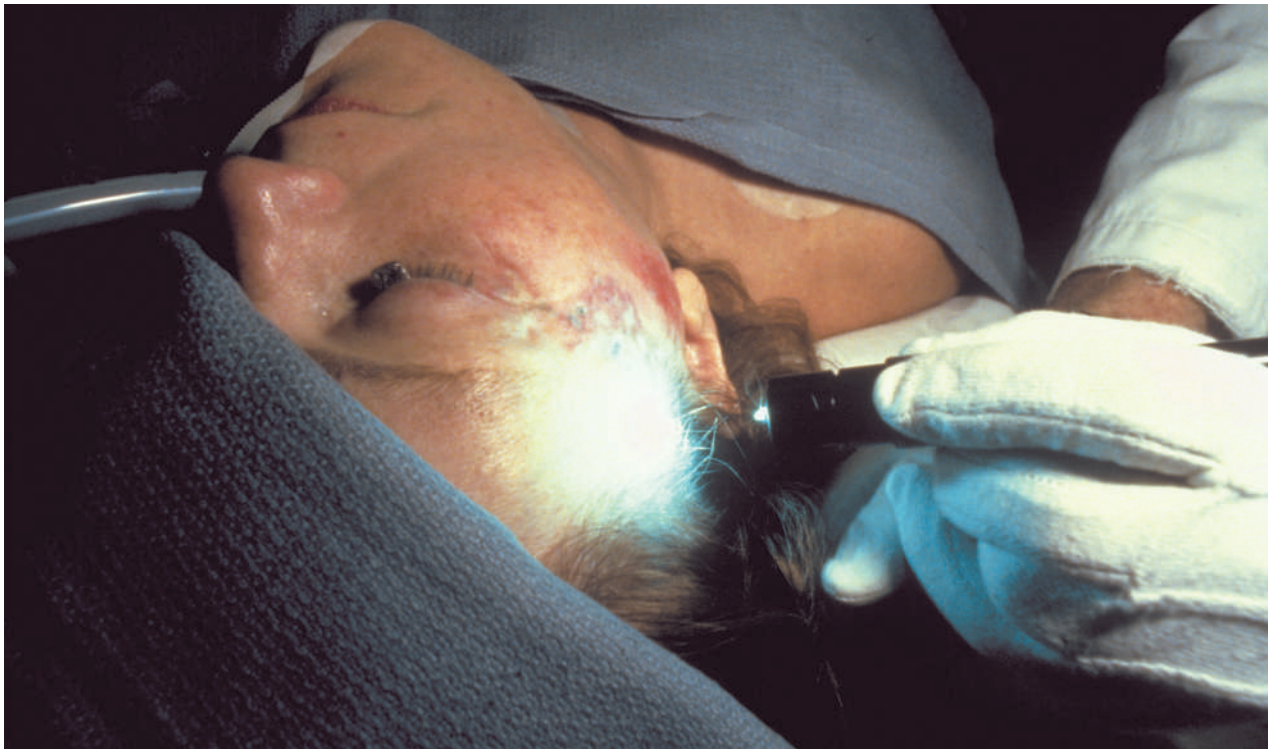
Causes and symptoms

The cause of moles is unknown, although atypical moles seem to run in families and result from exposure to sunlight.

Diagnosis

Only a small percentage of moles require medical attention. A mole that has the following symptoms should be evaluated by a dermatologist (a physician spealizing in skin diseases).

- appears after the age of 20
- bleeds
- itches
- looks unusual or changes in any way



Woman's birthmark being removed by laser. *(Photograph by Alexander Tsiaras, Photo Researchers, Inc. Reproduced by permission.)*

A doctor who suspects skin cancer will remove all or part of the mole for microscopic examination. This procedure, which is usually performed in a doctor's office, is simple, relatively painless, and doesn't take more than a few minutes. It does leave a scar.

Treatment

If laboratory analysis confirms that a mole is cancerous, the dermatologist will remove the rest of the mole. Patients should realize that slicing off a section of a malignant mole will not cause the cancer to spread.

Removing a mole for cosmetic reasons involves numbing the area and using scissors or a scalpel to remove the elevated portion. The patient is left with a flat mole the same color as the original growth. Cutting out parts of the mole above and beneath the surface of the skin can leave a scar more noticeable than the mole.

Scissors or a razor can be used to temporarily remove hair from a mole. Permanent hair removal requires electrolysis or surgical removal of the mole.

Prognosis

Moles are rarely cancerous and, once removed, unlikely to recur. A dermatologist should be consulted if a mole reappears after being removed.

Prevention

Wearing a sunscreen and limiting sun exposure may prevent some moles. Anyone who has moles should examine them every month and see a dermatologist if changes in size, shape, color, or texture occur or if new moles appear.

Anyone with a family history of melanoma should see a dermatologist for an annual skin examination. Everyone should know the ABCDs of melanoma:

- A: Asymmetry, which occurs when the two halves of the mole are not identical
- B: Borders that are irregular or indistinct
- C: Color that varies in a single mole
- D: Diameter, which should be no larger than the eraser on a pencil.

A mole exhibiting any of these characteristics should be evaluated by a dermatologist.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

KEY TERMS

Malignant melanoma—Most moles are benign, but atypical moles (called dysplastic nevi) may develop into malignant melanoma, a potentially fatal form of skin cancer. Atypical moles are usually hereditary. Most are bigger than a pencil eraser, and the shape and pigmentation are irregular.

Nevus Outreach, Inc. 1601 Madison Blvd., Bartesville, OK 74006. (877) 426-3887. <http://www.nevus.org>.

OTHER

"Atypical Moles." The Skin Site. 8 Apr. 1998 <http://www.skinsite.com/info_atypical moles.htm>.

"Moles." American Academy of Dermatology. 7 Apr. 1998 <http://www.aad.org>.

"Moles." The Skin Site. 8 Apr. 1998 <http://www.skinsite.com/info_moles.htm>.

Maureen Haggerty

Molybdenum excess *see* **Mineral toxicity**

Mometasone *see* **Corticosteroids**

Moncytic ehrlichiosis *see* **Ehrlichiosis**

Mongolism *see* **Down syndrome**

Moniliasis *see* **Candidiasis**

Monkeypox

Definition

Certain African squirrels and primates carry a virus that causes monkeypox in humans. This virus is related to the **smallpox** virus, but it usually produces a less severe illness with fewer fatalities. However, symptoms are similar: **fever**, pus-filled blisters all over the body, and respiratory problems.

Description

Most monkeypox cases have been diagnosed in remote areas of central and west Africa. Contact with infected animals is unusual because they are isolated in forests, away from humans. However, between February 1996 and October 1997, there were 511 suspected cases of monkeypox in the Democratic Republic of the Congo (DRC, formerly Zaire). This outbreak, the largest ever, raised fears that the virus had mutated and become more infectious.

In late 1997, the U.S. Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) announced that this relatively large outbreak was likely due to human behavior, rather than virus mutation. During the outbreak, the DRC was embroiled in civil war. Food shortages increased reliance on hunting and raised chances that people would come into contact with infected animals.

Monkeypox is less severe than smallpox and can sometimes be confused with **chickenpox**. It seems partly preventable with smallpox **vaccination**, but vaccination programs were discontinued in the late 1970s. (Barring samples stored in laboratories, smallpox has been eradicated.) People under the age of 16—those born after smallpox vaccination ended—seem the most susceptible to monkeypox. During the 1996-97 outbreak, approximately 85% of the cases were in this age group.

This outbreak also seemed to indicate high person-to-person transmission. Initial reports claimed as many as 78% of suspected cases were transmitted person to person rather than animal to person. However, according to WHO and the CDC, further study revealed that about 8% of cases were transmitted this way.

Causes and symptoms

The monkeypox virus is transmitted to humans through an infected animal's blood or by its bite. Initial symptoms are a fever and a bodywide rash of pus-filled blisters. These symptoms can be accompanied by **diarrhea**, swollen lymph nodes, a **sore throat**, and mouth sores. In some cases, a victim may experience trouble breathing. Symptoms are at their worst for 3-7 days, after which the fever lessens and blisters begin to form crusts.

Diagnosis

Since the symptoms resemble other pox diseases, definitive diagnosis may require laboratory testing to uncover the virus or evidence that it is present.

Treatment

Like most viruses, monkeypox cannot be resolved with medication. The only treatment option is symptomatic—that is, patients are made as comfortable as possible. In March 1998, the U.S. Army Medical Research Institute for Infectious Diseases reported that an antiviral drug called cidofovir may combat monkeypox infection. The drug has worked successfully in primates, but further research is needed to determine its effectiveness in humans.

Prognosis

Children are more likely to contract the disease and have the highest **death** rate. Monkeypox is not as lethal as smallpox, but the death rate among young children may reach 2-10%. In some cases, hospitalization is required. Recovery is good among survivors, although some scarring may result from the blisters.

Prevention

Although smallpox vaccination may protect against monkeypox, experts do not generally recommend getting a smallpox vaccine simply to guard against monkeypox. This vaccine carries risks, including severe, potentially fatal complications. For most people, the risk posed by the smallpox vaccine far outweighs the odds that they might come in contact with the monkeypox virus.

Resources

BOOKS

Fenner, Frank. "Human Monkeypox, a Newly Discovered Virus Disease." In *Emerging Viruses*, ed. Stephen S. Morse. Oxford University Press, 1993.

PERIODICALS

Cohen, Jon. "Is an Old Virus Up to New Tricks?" *Science* 277 (18 July 1997): 312.

OTHER

World Health Organization. 7 June 1998 <http://www.who.int/home-page/index.en.shtml>.

Julia Barrett

Monoamine oxidase inhibitors

Definition

Monoamine oxidase inhibitors (MAO inhibitors) are medicines that relieve certain types of mental depression.

Purpose

MAO inhibitors are a type of antidepressant and are used to treat mental depression. Like other **antidepressant drugs**, MAO inhibitors help reduce the extreme sadness, hopelessness, and lack of interest in life that are typical in people with depression. MAO inhibitors are especially useful in treating people whose depression is combined with other problems such as **anxiety**, panic attacks, **phobias**, or the desire to sleep too much.

KEY TERMS

Antiviral—Refers to a drug that can destroy viruses and help treat illnesses caused by them.

Mutation—A change in an organism's genetic code that causes it to develop new characteristics.

Symptomatic—Refers to treatment that addresses the symptoms of an illness, but not its underlying cause.

Description

Discovered in the 1950s, MAO inhibitors work by correcting chemical imbalances in the brain. Normally, natural chemicals called neurotransmitters carry signals from one brain cell to another. Some neurotransmitters, such as serotonin and norepinephrine, play important roles in controlling mood. But other substances in the brain may interfere with mood control by breaking down these neurotransmitters. Researchers believe that MAO inhibitors work by blocking the chemicals that break down serotonin and norepinephrine. This gives the neurotransmitters more time to do their important work.

Because MAO inhibitors also affect other chemicals throughout the body, these drugs may produce many unwanted side effects. They can be especially dangerous when taken with certain foods, beverages and medicines. Anyone taking these drugs should ask his or her physician or pharmacist for a list of products to avoid.

MAO inhibitors are available only with a physician's prescription. They are sold in tablet form. Some commonly used MAO inhibitors are isocarboxazid (Marplan), phenelzine (Nardil), and tranylcypromine (Parnate).

Recommended dosage

The recommended dosage depends on the type of MAO inhibitor and the type of depression for which it is being taken. Dosages may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take MAO inhibitors exactly as directed by your physician. Never take larger or more frequent doses, and do not take the drug for longer than directed. See the physician regularly while taking this medicine, especially in the first few months of treatment. The physician will check to make sure the medicine is working as it should and will note unwanted side effects. The physician may also need to adjust the dosage during this period.

Several weeks may be needed for the effects of this medicine to be felt. Be sure to keep taking it as directed, even if it does not seem to be helping.

Do not stop taking this medicine suddenly. Tapering the dose may be necessary to reduce the chance of withdrawal symptoms. If it is necessary to stop taking the drug, check with the physician who prescribed it for instructions on how to stop.

MAO inhibitors may be taken with or without food, on a full or empty stomach. Check package directions or ask the physician or pharmacist for instructions on how to take the medicine. Remember that some foods and beverages must be avoided during treatment with MAO inhibitors.

Precautions

The effects of this medicine may continue for two weeks or more after patients stop taking it. All precautions should be observed during this period, as well as throughout treatment with MAO inhibitors.

MAO inhibitors may cause serious and possibly life-threatening reactions, such as sudden high blood pressure, when taken with certain foods, beverages, or medicines. The dangerous reactions may not begin until several hours after consuming these items. Aged cheeses, red wines, smoked or pickled meats, chocolate, caffeinated beverages, and foods containing monosodium glutamate (MSG) are among the foods and drinks to be avoided. Be sure to get a complete list from the physician who prescribed the medicine or the pharmacist who filled the prescription.

Do not drink any alcoholic beverages or reduced-alcohol or alcohol-free beer or wine while taking this medicine.

Anyone who is taking MAO inhibitors should not use any other medicine unless it has been approved or prescribed by a physician who knows that they are taking MAO inhibitors. This includes nonprescription (over-the-counter) medicines such as sleep aids; medicines for colds, **cough**, hay **fever**, or **asthma** (including nose drops or sprays); medicines to increase alertness or keep from falling asleep; and appetite control products.

Because MAO inhibitors work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking MAO inhibitors should check with his or her physician before taking any of the above.

MAO inhibitors may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking MAO inhibitors should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some people feel drowsy, dizzy, lightheaded, or less alert when using MAO inhibitors. The drugs may also cause blurred vision. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

These medicines also make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible.

Older people may be especially sensitive to the effects of MAO inhibitors. This may increase the chance of side effects, such as **dizziness** or lightheadedness.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take MAO inhibitors. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to MAO inhibitors in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Studies suggest that taking MAO inhibitors during **pregnancy** may increase the risk of **birth defects** or problems in the newborn after birth. Women who are pregnant or who may become pregnant should check with their physicians before using MAO inhibitors.

BREASTFEEDING. MAO inhibitors may pass into breast milk, but no problems have been reported in nursing babies whose mothers took the medicine. Women who are breastfeeding their babies should check with their physicians before using this medicine.

DIABETES. MAO inhibitors may affect blood sugar levels. Persons with diabetes who are taking this medicine and notice changes in their blood or urine tests should check with their physicians.

ANGINA. MAO inhibitors may make people feel unusually energetic and healthy. People with **angina** (chest pain) should be careful not to overexert themselves and should check with their physicians before increasing their levels of activity or **exercise**.

OTHER MEDICAL CONDITIONS. Before using MAO inhibitors, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcohol abuse
- high blood pressure
- recent **heart attack** or **stroke**
- heart or blood vessel disease
- liver disease
- kidney disease
- frequent or severe headaches
- epilepsy
- parkinson's disease
- current or past mental illness
- asthma or **bronchitis**
- overactive thyroid
- pheochromocytoma (a tumor of the adrenal gland)

USE OF CERTAIN MEDICINES. Taking MAO inhibitors with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are dizziness, lightheadedness, drowsiness, tiredness, weakness, blurred vision, shakiness or trembling, restlessness, sleep problems or twitching during sleep, increased appetite (especially for sweets), weight gain, decreased sexual ability, decreased amount of urine, and mild **headache**. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they interfere with normal activities.

More serious side effects may occur. If any of the following side effects occur, stop taking the medicine and get emergency medical attention immediately:

- severe chest pain
- severe headache
- stiff, sore neck
- enlarged pupils
- increased sensitivity of eyes to light
- fast or slow heartbeat
- sweating, with or without fever or cold, clammy skin
- nausea and vomiting

Other side effects may occur. Anyone who has unusual or troublesome symptoms after taking MAO inhibitors should get in touch with his or her physician.

KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Central nervous system—The brain and spinal cord.

Depression—A mental condition in which people feel extremely sad and lose interest in life. People with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Neurotransmitter—A chemical that carries messages from one nerve cell to another.

Phobia—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

Interactions

MAO inhibitors may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. *Anyone who takes MAO inhibitors must check with his or her physician before taking any other prescription or nonprescription (over-the-counter) medicine*. Among the drugs that may interact with MAO inhibitors are:

- central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; **barbiturates**; and anesthetics.
- medicine for high blood pressure
- other antidepressants, including tricyclic antidepressants (such as Tofranil and Norpramin), antidepressants that raise serotonin levels (such as Prozac and Zoloft), and bupropion (Wellbutrin)
- diabetes medicines taken by mouth
- insulin
- water pills (diuretics)

The list above does not include every drug that may interact with MAO inhibitors. Check with a physician or

pharmacist before combining MAO inhibitors with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Mononucleosis *see* **Infectious mononucleosis**

Montezuma's revenge *see* **Traveler's diarrhea**

Mood disorders

Definition

Mood disorders are mental disorders characterized by periods of depression, sometimes alternating with periods of elevated mood.

Description

While many people go through sad or elated moods from time to time, people with mood disorders suffer from severe or prolonged mood states that disrupt their daily functioning. Among the general mood disorders classified in the fourth edition (1994) of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*) are major depressive disorder, **bipolar disorder**, and dysthymia.

In classifying and diagnosing mood disorders, doctors determine if the mood disorder is unipolar or bipolar. When only one extreme in mood (the depressed state) is experienced, this type of depression is called unipolar. Major depression refers to a single severe period of depression, marked by negative or hopeless thoughts and physical symptoms like **fatigue**. In major depressive disorder, some patients have isolated episodes of depression. In between these episodes, the patient does not feel depressed or have other symptoms associated with depression. Other patients have more frequent episodes.

Bipolar depression or bipolar disorder (sometimes called manic depression) refers to a condition in which people experience two extremes in mood. They alternate between depression (the "low" mood) and **mania** or hypomania (the "high" mood). These patients go from depression to a frenzied, abnormal elevation in mood. Mania and hypomania are similar, but mania is usually more severe and debilitating to the patient.

Dysthymia is a recurrent or lengthy depression that may last a lifetime. It is similar to major depressive disorder, but dysthymia is chronic, long-lasting, persistent, and mild. Patients may have symptoms that are not as severe as major depression, but the symptoms last for many years. It seems that a mild form of the depression is always present. In some cases, people may also experience a major depressive episode on top of their dysthymia, a condition sometimes referred to as a "double depression."

Causes and symptoms

Mood disorders tend to run in families. These disorders are associated with imbalances in certain chemicals that carry signals between brain cells (neurotransmitters). These chemicals include serotonin, norepinephrine, and dopamine. Women are more vulnerable to unipolar depression than are men. Major life stressors (like divorce, serious financial problems, **death** of a family member, etc.) will often provoke the symptoms of depression in susceptible people.

Major depression is more serious than just feeling "sad" or "blue." The symptoms of major depression may include:

- loss of appetite
- a change in the sleep pattern, like not sleeping (**insomnia**) or sleeping too much
- feelings of worthlessness, hopelessness, or inappropriate guilt
- fatigue
- difficulty in concentrating or making decisions
- overwhelming and intense feelings of sadness or grief
- disturbed thinking. The person may also have physical symptoms like stomachaches or headaches

Bipolar disorder includes mania or hypomania. Mania is an abnormal elevation in mood. The person may be excessively cheerful, have grandiose ideas, and may sleep less. They may talk nonstop for hours, have unending enthusiasm, and demonstrate poor judgement. Sometimes the elevation in mood is marked by irritability and hostility rather than cheerfulness. While the person may at first seem normal with an increase in energy, others who know the person well see a marked difference in behavior. The patient may seem to be in a frenzy and will often make poor, bizarre, or dangerous choices in his/her personal and professional lives. Hypomania is not as severe as mania and does not cause the level of impairment in work and social activities that mania can.

Diagnosis

Doctors diagnose mood disorders based on the patient's description of the symptoms as well as the

patient's family history. The length of time the patient has had symptoms is also important. Generally patients are diagnosed with dysthymia if they feel depressed more days than not for at least two years. The depression is mild but long lasting. In major depressive disorder, the patient is depressed almost all day nearly every day of the week for at least two weeks. The depression is severe. Sometimes laboratory tests are performed to rule out other causes for the symptoms (like thyroid disease). The diagnosis may be confirmed when a patient responds well to medication.

Treatment

The most effective treatment for mood disorders is a combination of medication and psychotherapy. The four different classes of drugs used in mood disorders are:

- heterocyclic antidepressants (HCAs), like amitriptyline (Elavil)
- selective serotonin reuptake inhibitors (SSRI inhibitors), like fluoxetine (Prozac), paroxetine (Paxil), and sertraline (Zoloft)
- monoamine oxidase inhibitors (MAOI inhibitors), like phenelzine sulfate (Nardil) and tranylcypromine sulfate (Parnate)
- mood stabilizers, like lithium carbonate (Eskalith) and valproate, often used in people with bipolar mood disorders

A number of psychotherapy approaches are useful as well. Interpersonal psychotherapy helps the patient recognize the interaction between the mood disorder and interpersonal relationships. **Cognitive-behavioral therapy** explores how the patient's view of the world may be affecting his or her mood and outlook.

When depression fails to respond to treatment or when there is a high risk of suicide, **electroconvulsive therapy** (ECT) is sometimes used. ECT is believed to affect neurotransmitters like the medications do. Patients are anesthetized and given **muscle relaxants** to minimize discomfort. Then low-level electric current is passed through the brain to cause a brief convulsion. The most common side effect of ECT is mild, short-term memory loss.

Alternative treatment

There are many alternative therapies that may help in the treatment of mood disorders, including **acupuncture**, botanical medicine, **homeopathy**, **aromatherapy**, constitutional **hydrotherapy**, and light therapy. The therapy used is an individual choice. Short-term clinical studies have shown that the herb **St. John's wort** (*Hypericum perforatum*) can effectively treat some types of depression. Though it appears very safe, the herb may have some side effects and its long-term effectiveness has not been proven. It has not been tested in patients with bipolar disorder. St. John's wort and **antidepressant drugs** should not be taken simultaneously, so patients should tell their doctor if they are taking St. John's wort.

KEY TERMS

Cognitive therapy—Psychotherapy technique designed to help people change their attitudes, perceptions, and patterns of thinking.

Electroconvulsive therapy (ECT)—Therapy for mood disorders that involves passing electrical current through the brain in order to create a brief convulsion.

Neurotransmitter—A chemical that aids or alters the transmission of impulses between the points that connect nerves.

Serotonin—A chemical messenger in the brain thought to play a role in mood regulation.

Prognosis

Most cases of mood disorders can be successfully managed if properly diagnosed and treated.

Prevention

People can take steps to improve mild depression and keep it from becoming worse. They can learn **stress** management (like relaxation training or breathing exercises), **exercise** regularly, and avoid drugs or alcohol.

Resources

BOOKS

Gold, Mark S. *The Good News About Depression: Cures and Treatments in the New Age of Psychiatry.* New York: Bantam Books, 1995.

Kramer, Peter D. *Listening to Prozac: A Psychiatrist Explores Antidepressants and the Remaking of Self.* New York: Viking Penguin, 1993.

"Mood Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, 1994.

PERIODICALS

Jamison, Kay Redfield. "Manic-Depressive Illness and Creativity." *Scientific American* (Feb. 1995): 62-67.

Michels, Robert, and Peter M. Marzuk. "Progress in Psychiatry." *The New England Journal of Medicine* 329 (26 Aug. 1993): 628-38.

Price, Lawrence H., and George R. Heninger. "Lithium in the Treatment of Mood Disorders." *The New England Journal of Medicine* 331 (1 Sept. 1994): 591-98.

Whybrow, Peter C. "Making Sense of Mania & Depression." *Psychology Today* (May/June 1997): 35-38, 71-72.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

National Depressive and Manic Depressive Association. 730 N. Franklin St., Ste. 501, Chicago, IL 60610. (800) 826-3632. <http://www.ndmda.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Robert Scott Dinsmoor

Morning after pill *see* **Mifepristone**

Motion sickness

Definition

Motion sickness is the uncomfortable **dizziness**, nausea, and vomiting that people experience when their sense of balance and equilibrium is disturbed by constant motion. Riding in a car, aboard a ship or boat, or riding on a swing all cause stimulation of the vestibular system and visual stimulation that often leads to discomfort. While motion sickness can be bothersome, it is not a serious illness, and can be prevented.

Description

Motion sickness is a common problem with nearly 80% of the population enduring its affects at one time in their lives. While it may occur at any age, motion sickness most often afflicts children over the age of two, with the majority outgrowing this susceptibility.

When looking at why motion sickness occurs, it is helpful to understand the role of the sensory organs. The sensory organs control a body's sense of balance by telling the brain what direction the body is pointing, the direction it is moving, and if it is standing still or turning. These messages are relayed by the inner ears (or labyrinth); the eyes; the skin pressure receptors, such as in those in the feet; the muscle and joint sensory receptors, which track what body parts are moving; and the central nervous system (the brain and spinal cord), which is responsible for processing all incoming sensory information.

Motion sickness and its symptoms surface when conflicting messages are sent to the central nervous system. An example of this is reading a book in the back seat of a moving car. The inner ears and skin receptors sense the motion, but the eyes register only the stationary pages of the book. This conflicting information may cause the usual motion sickness symptoms of dizziness, **nausea and vomiting**.

Causes and symptoms

While all five of the body's sensory organs contribute to motion sickness, excess stimulation to the vestibular system within the inner ear (the body's "balance center") has been shown to be one of the primary reasons for this condition. Balance problems, or vertigo, are caused by a conflict between what is seen and how the inner ear perceives it, leading to confusion in the brain. This confusion may result in higher heart rates, rapid breathing, nausea and sweating, along with dizziness and vomiting.

Pure optokinetic motion sickness is caused solely by visual stimuli, or what is seen. The optokinetic system is the reflex that allow the eyes to move when an object moves. Many people suffer when what they view is rotating or swaying, even if they are standing still.

Additional factors that may contribute to the occurrence of motion sickness include:

- Poor ventilation.
- Anxiety or fear. Both have been found to lower a person's threshold for experiencing motion sickness symptoms.
- Food. It is recommended that a heavy meal of spicy and greasy foods be avoided before and during a trip.
- Alcohol. A drink is often thought to help calm the nerves, but in this case it could upset the stomach further. A hangover for the next morning's trip may also lead to motion sickness.
- Genetic predisposition. Research suggests that some people are predisposed to motion sickness symptoms partly due to a hereditary link.

Often viewed as a minor annoyance, some travelers are temporarily immobilized by motion sickness, and a few continue to feel its effects for hours and even days after a trip (the "mal d'embarquement" syndrome).

Diagnosis

Most cases of motion sickness are mild and self-treatable disorders. If symptoms such as dizziness become chronic, a doctor may be able to help alleviate

the discomfort by looking further into a patient's general health. Questions regarding medications, head injuries, recent infections, and other questions about the ear and neurological system will be asked. An examination of the ears, nose, and throat, as well as tests of nerve and balance function, may also be completed.

Severe cases of motion sickness symptoms, and those that become progressively worse, may require additional, specific tests. Diagnosis in these situations deserves the attention and care of a doctor with specialized skills in diseases of the ear, nose, throat, equilibrium, and neurological system.

Treatment

There are a variety of medications to help ease the symptoms of motion sickness, and most of these are available without a prescription. Known as over-the-counter (OTC) medications, it is recommended that these be taken 30-60 minutes before traveling to prevent motion sickness symptoms, as well as during an extended trip.

Drugs

The following OTC drugs consist of ingredients that have been considered safe and effective for the treatment of motion sickness by the Food and Drug Administration:

- Marezine (and others). Includes the active ingredient cyclizine and is not for use in children under age 6.
- Benadryl (and others). Includes the active ingredient diphenhydramine and is not for use in children under age 6.
- Dramamine (and others). Includes the active ingredient dimenhydrinate and is not for use in children under age 2.
- Bonine (and others). Includes the active ingredient meclizine and is not for use in children under age 12.

Each of the active ingredients listed above are **antihistamines** whose main side effect is drowsiness. Caution should be used when driving a vehicle or operating machinery, and alcohol should be avoided when taking any drug for motion sickness. Large doses of OTC drugs for motion sickness may also cause **dry mouth** and occasional blurred vision.

The Food and Drug Administration recommends that people with **emphysema**, chronic **bronchitis**, **glaucoma**, or difficulty urinating due to an **enlarged prostate** do not use OTC drugs for motion sickness unless directed by their doctor.

Longer trips may require a prescription medication called scopolamine (Transderm Scop). Formerly used in the transdermal skin patch (now discontinued), travelers must now ask their doctor to prescribe it in the form of a gel. In gel form, scopolamine is most effective when smeared on the arm or neck and covered with a bandage.

Alternative treatment

Alternative treatments for motion sickness have become widely accepted as a standard means of care. Ginger (*Zingiber officinale*) in its various forms is often used to calm the stomach, and it is now known that the oils it contains (gingerols and shogaols) appear to relax the intestinal tract in addition to mildly depressing the central nervous system. Some of the most effective forms of ginger include the powdered, encapsulated form; ginger tea prepared from sliced ginger root; or candied pieces. All forms of ginger should be taken on an empty stomach.

Placing manual pressure on the Neiguan or Pericardium-6 **acupuncture** point (located about three finger-widths above the wrist on the inner arm), either by acupuncture, **acupressure**, or a mild, electrical pulse, has shown to be effective against the symptoms of motion sickness. Elastic wristbands sold at most drugstores are also used as a source of relief due to the pressure it places in this area. Pressing the small intestine 17 (just below the earlobes in the indentations behind the jawbone) may also help in the functioning of the ear's balancing mechanism.

There are several homeopathic remedies that work specifically for motion sickness. They include *Cocculus*, *Petroleum*, and *Tabacum*.

Prognosis

While there is no cure for motion sickness, its symptoms can be controlled or even prevented. Most people respond successfully to the variety of treatments, or avoid the unpleasant symptoms through prevention methods.

Prevention

Because motion sickness is easier to prevent than treat once it has begun, the best treatment is prevention. The following steps may help deter the unpleasant symptoms of motion sickness before they occur:

- Avoid reading while traveling, and do not sit in a backward facing seat.
- Always ride where the eyes may see the same motion that the body and inner ears feel. Safe positions include the front seat of the car while looking at distant scenery; the deck of a ship where the horizon can be seen; and sitting by the window of an airplane. The least motion on an airplane is in a seat over the wings.
- Maintain a fairly straight-ahead view.

KEY TERMS

Acupressure—Often described as acupuncture without needles, acupressure is a traditional Chinese medical technique based on theory of *qi* (life energy) flowing in energy meridians or channels in the body. Applying pressure with the thumb and fingers to acupressure points can relieve specific conditions and promote overall balance and health.

Acupuncture—Based on the same traditional Chinese medical foundation as acupressure, acupuncture uses sterile needles inserted at specific points to treat certain conditions or relieve pain.

Neurological system—The tissue that initiates and transmits nerve impulses including the brain, spinal cord, and nerves.

Optokinetic —A reflex that causes a person's eyes to move when their field of vision moves.

Vertigo—The sensation of moving around in space, or objects moving around a person. It is a disturbance of equilibrium.

Vestibular system—The brain and parts of the inner ear that work together to detect movement and position.

- Eat a light meal before traveling, or if already nauseated, avoid food altogether.
- Avoid watching or talking to another traveler who is having motion sickness.
- Take motion sickness medicine at least 30-60 minutes before travel begins, or as recommended by a physician.
- Learn to live with the condition. Even those who frequently endure motion sickness can learn to travel by anticipating the conditions of their next trip. Research also suggests that increased exposure to the stimulation that causes motion sickness may help decrease its symptoms on future trips.

Resources

BOOKS

Blakely, Brian W., and Mary-Ellen Siegel. "Peripheral Vestibular Disorders." In *Feeling Dizzy: Understanding and Treating Dizziness, Vertigo, and Other Balance Disorders*. New York: Macmillan, 1995.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

PERIODICALS

"Acupuncture Effective In Combating Nausea." *Executive Health's Good Health Report* 33 (June 1997): 5.

Brown, Edwin W. "Ginger Not Just For Ale And Cookies." *Medical Update* 20 (Dec. 1996): 5.

Farley, Dixie. "Taming Tummy Turmoil." *FDA Consumer* (June 1995).

Gannon, Robert. "How To Prevent Motion Sickness." *Popular Science* 246 (Mar. 1995): 98.

Mowrey, Daniel B. "Ginger Root—A Blessing For The Gastrointestinal Tract." *Health News & Review* (Spring 1995): 18.

Munson, Marty and Greg Gutfeld with Beth Higbee and Teresa Yeykal. "A Soothing Shock: A Little Electricity Helps Ease Nausea." *Prevention Magazine*, Jan. 1994, 26.

Purcell, Lauren. "How To Cure Motion Sickness." *Health*, Jan. 1997, 26.

"Traveler's Advisory: A Glob Of Scop Is Good News For The Nauseated." *Prevention Magazine*, Aug. 1997, 22.

ORGANIZATIONS

Vestibular Disorders Association. P.O. Box 4467, Portland, OR 97208-4467. (800) 837-8428. <http://www.teleport.com/~veda>.

Beth A. Kapes

Mountain sickness *see* **Altitude sickness**

Mouth cancer *see* **Head and neck cancer**

Movement disorders

Definition

Movement disorders are a group of diseases and syndromes affecting the ability to produce and control movement.

Description

Though it seems simple and effortless, normal movement in fact requires an astonishingly complex system of control. Disruption of any portion of this system can cause a person to produce movements that are too weak, too forceful, too uncoordinated, or too poorly controlled for the task at hand. Unwanted movements may occur at rest. Intentional movement may become impossible. Such conditions are called movement disorders.

Abnormal movements themselves are symptoms of underlying disorders. In some cases, the abnormal movements are the only symptoms. Disorders causing abnormal movements include:

- **Parkinson's disease**

- Parkinsonism caused by drugs or poisons
- Parkinson-plus syndromes (**progressive supranuclear palsy**, multiple system atrophy, and cortical-basal ganglionic degeneration)
- Huntington's disease
- Wilson's disease
- inherited ataxias (**Friedreich's ataxia**, Machado-Joseph disease, and spinocerebellar ataxias)
- **tourette syndrome** and other tic disorders
- essential tremor
- restless leg syndrome
- dystonia
- stroke
- **cerebral palsy**
- encephalopathies
- intoxication
- poisoning by carbon monoxide, cyanide, methanol, or manganese

Causes and symptoms

Causes

Movement is produced and coordinated by several interacting brain centers, including the motor cortex, the cerebellum, and a group of structures in the inner portions of the brain called the basal ganglia. Sensory information provides critical input on the current position and velocity of body parts, and spinal nerve cells (neurons) help prevent opposing muscle groups from contracting at the same time.

To understand how movement disorders occur, it is helpful to consider a normal voluntary movement, such as reaching to touch a nearby object with the right index finger. To accomplish the desired movement, the arm must be lifted and extended. The hand must be held out to align with the forearm, and the forefinger must be extended while the other fingers remain flexed.

THE MOTOR CORTEX. Voluntary motor commands begin in the motor cortex located on the outer, wrinkled surface of the brain. Movement of the right arm is begun by the left motor cortex, which generates a large volley of signals to the involved muscles. These electrical signals pass along upper motor neurons through the midbrain to the spinal cord. Within the spinal cord, they connect to lower motor neurons, which convey the signals out of the spinal cord to the surface of the muscles involved. Electrical stimulation of the muscles causes contraction, and the force of contraction pulling on the skeleton causes movement of the arm, hand, and fingers.

Damage to or **death** of any of the neurons along this path causes weakness or **paralysis** of the affected muscles.

ANTAGONISTIC MUSCLE PAIRS. This picture of movement is too simple, however. One important refinement to it comes from considering the role of opposing, or antagonistic, muscle pairs. Contraction of the biceps muscle, located on the top of the upper arm, pulls on the forearm to flex the elbow and bend the arm. Contraction of the triceps, located on the opposite side, extends the elbow and straightens the arm. Within the spine, these muscles are normally wired so that willed (voluntary) contraction of one is automatically accompanied by blocking of the other. In other words, the command to contract the biceps provokes another command within the spine to prevent contraction of the triceps. In this way, these antagonist muscles are kept from resisting one another. Spinal cord or brain injury can damage this control system and cause involuntary simultaneous contraction and spasticity, an increase in resistance to movement during motion.

THE CEREBELLUM. Once the movement of the arm is initiated, sensory information is needed to guide the finger to its precise destination. In addition to sight, the most important source of information comes from the "position sense" provided by the many sensory neurons located within the limbs (proprioception). Proprioception is what allows you to touch your nose with your finger even with your eyes closed. The balance organs in the ears provide important information about posture. Both postural and proprioceptive information are processed by a structure at the rear of the brain called the cerebellum. The cerebellum sends out electrical signals to modify movements as they progress, "sculpting" the barrage of voluntary commands into a tightly controlled, constantly evolving pattern. Cerebellar disorders cause inability to control the force, fine positioning, and speed of movements (ataxia). Disorders of the cerebellum may also impair the ability to judge distance so that a person under- or over-reaches the target (dysmetria). Tremor during voluntary movements can also result from cerebellar damage.

THE BASAL GANGLIA. Both the cerebellum and the motor cortex send information to a set of structures deep within the brain that help control involuntary components of movement (basal ganglia). The basal ganglia send output messages to the motor cortex, helping to initiate movements, regulate repetitive or patterned movements, and control muscle tone.

Circuits within the basal ganglia are complex. Within this structure, some groups of cells begin the action of other basal ganglia components and some groups of cells

block the action. These complicated feedback circuits are not entirely understood. Disruptions of these circuits are known to cause several distinct movement disorders. A portion of the basal ganglia called the substantia nigra sends electrical signals that block output from another structure called the subthalamic nucleus. The subthalamic nucleus sends signals to the globus pallidus, which in turn blocks the thalamic nuclei. Finally, the thalamic nuclei send signals to the motor cortex. The substantia nigra, then, begins movement and the globus pallidus blocks it.

This complicated circuit can be disrupted at several points. For instance, loss of substantia nigra cells, as in Parkinson's disease, increases blocking of the thalamic nuclei, preventing them from sending signals to the motor cortex. The result is a loss of movement (motor activity), a characteristic of Parkinson's.

In contrast, cell loss in early Huntington's disease decreases blocking of signals from the thalamic nuclei, causing more cortex stimulation and stronger but uncontrolled movements.

Disruptions in other portions of the basal ganglia are thought to cause tics, **tremors**, dystonia, and a variety of other movement disorders, although the exact mechanisms are not well understood.

Some movement disorders, including Huntington's disease and inherited ataxias, are caused by inherited genetic defects. Some diseases that cause sustained muscle contraction limited to a particular muscle group (focal dystonia) are inherited, but others are caused by trauma. The cause of most cases of Parkinson's disease is unknown, although genes have been found for some familial forms.

Symptoms

Abnormal movements are broadly classified as either hyperkinetic—too much movement—or hypokinetic—too little movement. Hyperkinetic movements include:

- Dystonia. Sustained muscle contractions, often causing twisting or repetitive movements and abnormal postures. Dystonia may be limited to one area (focal) or may affect the whole body (general). Focal dystonias may affect the neck (cervical dystonia or **torticollis**), the face (one-sided or hemifacial spasm, contraction of the eyelid or blepharospasm, contraction of the mouth and jaw or oromandibular dystonia, simultaneous spasm of the chin and eyelid or Meige syndrome), the vocal cords (laryngeal dystonia), or the arms and legs (writer's cramp, occupational cramps). Dystonia may be painful as well as incapacitating.
- Tremor. Uncontrollable (involuntary) shaking of a body part. Tremor may occur only when muscles are relaxed or it may occur only during an action or holding an active posture.
- Tics. Involuntary, rapid, nonrhythmic movement or sound. Tics can be controlled briefly.
- Myoclonus. A sudden, shock-like muscle contraction. Myoclonic jerks may occur singly or repetitively. Unlike tics, myoclonus cannot be controlled even briefly.
- Chorea. Rapid, nonrhythmic, usually jerky movements, most often in the arms and legs.
- Ballism. Like chorea, but the movements are much larger, more explosive and involve more of the arm or leg. This condition, also called ballismus, can occur on both sides of the body or on one side only (hemiballismus).
- Akathisia. Restlessness and a desire to move to relieve uncomfortable sensations. Sensations may include a feeling of crawling, **itching**, stretching, or creeping, usually in the legs.
- Athetosis. Slow, writhing, continuous, uncontrollable movement of the arms and legs.

Hypokinetic movements include:

- Bradykinesia. Slowness of movement.
- Freezing. Inability to begin a movement or involuntary stopping of a movement before it is completed.
- Rigidity. An increase in muscle tension when an arm or leg is moved by an outside force.
- Postural instability. Loss of ability to maintain upright posture caused by slow or absent righting reflexes.

Diagnosis

Diagnosis of movement disorders requires a careful medical history and a thorough physical and neurological examination. Brain imaging studies are usually performed. Imaging techniques include computed tomography scan (CT scan), **positron emission tomography** (**PET**), or **magnetic resonance imaging** (MRI) scans. Routine blood and urine analyses are performed. A lumbar puncture (spinal tap) may be necessary. Video recording of the abnormal movement is often used to analyze movement patterns and to track progress of the disorder and its treatment. **Genetic testing** is available for some forms of movement disorders.

Treatment

Treatment of a movement disorder begins with determining its cause. Physical and occupational therapy may help make up for lost control and strength. Drug therapy can help compensate for some imbalances of the basal

KEY TERMS

Botulinum toxin—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*. The toxins cause muscle paralysis, and thus force the relaxation of a muscle in spasm.

Cerebral palsy—A movement disorder caused by a permanent brain defect or injury present at birth or shortly after. It is frequently associated with premature birth. Cerebral palsy is not progressive.

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Encephalopathy—An abnormality in the structure or function of tissues of the brain.

Essential tremor—An uncontrollable (involuntary) shaking of the hands, head, and face. Also called familial tremor because it is sometimes inherited, it can begin in the teens or in middle age. The exact cause is not known.

Fetal tissue transplantation—A method of treating Parkinson's and other neurological diseases by grafting brain cells from human fetuses onto the basal ganglia. Human adults cannot grow new brain cells but developing fetuses can. Grafting fetal tissue stimulates the growth of new brain cells in affected adult brains.

Hereditary ataxia—One of a group of hereditary degenerative diseases of the spinal cord or cerebellum. These diseases cause tremor, spasm, and wasting of muscle.

Huntington's disease—A rare hereditary condition that causes progressive chorea (jerky muscle movements) and mental deterioration that ends in dementia. Huntington's symptoms usually appear in patients in their 40s. There is no effective treatment.

Levodopa (L-dopa)—A substance used in the treatment of Parkinson's disease. Levodopa can cross the blood-brain barrier that protects the brain. Once in the brain, it is converted to dopamine and thus can replace the dopamine lost in Parkinson's disease.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Parkinson's disease—A slowly progressive disease that destroys nerve cells in the basal ganglia and thus causes loss of dopamine, a chemical that aids in transmission of nerve signals (neurotransmitter). Parkinson's is characterized by shaking in resting muscles, a stooping posture, slurred speech, muscular stiffness, and weakness.

Positron emission tomography (PET)—A diagnostic technique in which computer-assisted x rays are used to track a radioactive substance inside a patient's body. PET can be used to study the biochemical activity of the brain.

Progressive supranuclear palsy—A rare disease that gradually destroys nerve cells in the parts of the brain that control eye movements, breathing, and muscle coordination. The loss of nerve cells causes palsy, or paralysis, that slowly gets worse as the disease progresses. The palsy affects ability to move the eyes, relax the muscles, and control balance.

Restless legs syndrome—A condition that causes an annoying feeling of tiredness, uneasiness, and itching deep within the muscle of the leg. It is accompanied by twitching and sometimes pain. The only relief is in walking or moving the legs.

Tourette syndrome—An abnormal condition that causes uncontrollable facial grimaces and tics and arm and shoulder movements. Tourette syndrome is perhaps best known for uncontrollable vocal tics that include grunts, shouts, and use of obscene language (coprolalia).

Wilson's disease—An inborn defect of copper metabolism in which free copper may be deposited in a variety of areas of the body. Deposits in the brain can cause tremor and other symptoms of Parkinson's disease.

ganglionic circuit. For instance, levodopa (L-dopa) or related compounds can substitute for lost dopamine-producing cells in Parkinson's disease. Conversely, blocking normal dopamine action is a possible treatment in some hyperkinetic disorders, including tics. Oral medications can also help reduce overall muscle tone. Local injections of botulinum toxin can selectively weaken overactive muscles in dystonia and spasticity. Destruction of periph-

eral nerves through injection of phenol can reduce spasticity. All of these treatments may have some side effects.

Surgical destruction or inactivation of basal ganglionic circuits has proven effective for Parkinson's disease and is being tested for other movement disorders. Transplantation of fetal cells into the basal ganglia has produced mixed results in Parkinson's disease.

Alternative treatment

There are several alternative therapies that can be useful when treating movement disorders. The progress made will depend on the individual and his/her condition. Among the therapies that may be helpful are **acupuncture**, **homeopathy**, touch therapies, postural alignment therapies, and **biofeedback**.

Prognosis

The prognosis for a patient with a movement disorder depends on the specific disorder.

Prevention

Prevention depends on the specific disorder.

Resources

BOOKS

Martini, Frederic. *Fundamentals of Anatomy and Physiology.* Englewood Cliffs, NJ: Prentice Hall, 1989.

Watts, Ray L., and William C. Koller, eds. *Movement Disorders: Neurologic Principles and Practice*. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Worldwide Education and Awareness for Movement Disorders. One Gustave L. Levy Place, Box 1052, New York, NY 10029. (800) 437-6683. <http://www.wemove.org>.

Richard Robinson

Movement therapy

Definition

Movement therapy refers to a broad range of Eastern and Western movement approaches used to promote physical, mental, emotional, and spiritual well-being.

Purpose

The physical benefits of movement therapy include greater ease and range of movement, increased balance, strength and flexibility, improved muscle tone and coordination, joint resiliency, cardiovascular conditioning, enhanced athletic performance, stimulation of circulation, prevention of injuries, greater longevity, **pain** relief, and relief of rheumatic, neurological, spinal, **stress**, and respiratory disorders. Movement therapy can also be used as a **meditation** practice to quiet the mind, foster self-knowledge, and increase awareness. In addition, movement therapy is beneficial in alleviating emotional distress that is expressed through the body. These conditions include eating disorders, excessive clinging, and **anxiety** attacks. Since movements are related to thoughts and feelings, movement therapy can also bring about changes in attitude and emotions. People report an increase in self-esteem and self-image. Communication skills can be enhanced and tolerance of others increased. The physical openness facilitated by movement therapy leads to greater emotional openness and creativity.

Description

Origins

Movement is fundamental to human life. In fact movement is life. Contemporary physics tells us that the universe and everything in it is in constant motion. We can move our body and at the most basic level our body is movement. According to the somatic educator Thomas Hanna, "The living body is a moving body—indeed, it is a constantly moving body." The poet and philosopher Alan Watts eloquently states a similar view, "A living body is not a fixed thing but a flowing event, like a flame or a whirlpool." Centuries earlier, the great Western philosopher Socrates understood what modern physics has proven, "The universe is motion and nothing else."

Since the beginning of time, indigenous societies around the world have used movement and dance for individual and community healing. Movement and song were used for personal healing, to create community, to ensure successful crops, and to promote fertility. Movement is still an essential part of many healing traditions and practices throughout the world.

Western movement therapies generally developed out of the realm of dance. Many of these movement approaches were created by former dancers or choreographers who were searching for a way to prevent injury, attempting to recover from an injury, or who were curious about the effects of new ways of moving. Some movement therapies arose out of the fields of physical therapy, psychology, and bodywork. Other movement therapies were developed as way to treat an incurable disease or condition.

Eastern movement therapies, such as **yoga**, **qigong**, and t'ai chi began as a spiritual or self-defense practices

and evolved into healing therapies. In China, for example, Taoist monks learned to use specific breathing and movement patterns in order to promote mental clarity, physical strength, and support their practice of meditation. These practices, later known as qigong and t'ai chi eventually became recognized as ways to increase health and prolong life.

There are countless approaches to movement therapy. Some approaches emphasize awareness and attention to inner sensations. Other approaches use movement as a form of psychotherapy, expressing and working through deep emotional issues. Some approaches emphasize alignment with gravity and specific movement sequences, while other approaches encourage spontaneous movement. Some approaches are primarily concerned with increasing the ease and efficiency of bodily movement. Other approaches address the reality of the body "as movement" instead of the body as only something that runs or walks through space.

The term movement therapy is often associated with dance therapy. Some dance therapists work privately with people who are interested in personal growth. Others work in mental health settings with autistic, brain injured and learning disabled children, the elderly, and disabled adults.

Laban movement analysis (LMA), formerly known as Effort-Shape is a comprehensive system for discriminating, describing, analyzing, and categorizing movements. LMA can be applied to dance, athletic coaching, fitness, acting, psychotherapy, and a variety of other professions. Certified movement analysts can "observe recurring patterns, note movement preferences, asses physical blocks and dysfunctional movement patterns, and then suggest new movement patterns." As a student of Rudolf Laban, Irmgard Bartenieff developed his form of movement analysis into a system of body training or reeducation called Bartenieff fundamentals (BF). The basic premise of this work is that once the student experiences a physical foundation, emotional, and intellectual expression become richer. BF uses specific exercises that are practiced on the floor, sitting, or standing to engage the deeper muscles of the body and enable a greater range of movement.

Authentic movement (AM) is based upon Mary Starks Whitehouse's understanding of dance, movement, and depth psychology. There is no movement instruction in AM, simply a mover and a witness. The mover waits and listens for an impulse to move and then follows or "moves with" the spontaneous movements that arise. These movements may or may not be visible to the witness. The movements may be in response to an emotion, a dream, a thought, pain, joy, or whatever is being experienced in the moment. The witness serves as a compassionate, non judgmental mirror and brings a "special quality of attention or presence." At the end of the session the mover and witness speak about their experiences together. AM is a powerful approach for self development and awareness and provides access to preverbal memories, creative ideas, and unconscious movement patterns that limit growth.

Gabrielle Roth (5 Rhythms movement) and Anna Halprin have both developed dynamic movement practices that emphasize personal growth, awareness, expression, and community. Although fundamentally different forms, each of these movement/dance approaches recognize and encourage our inherent desire for movement.

Several forms of movement therapy grew out of specific bodywork modalities. **Rolfing** movement integration (RMI) and Rolfing rhythms are movement forms which reinforce and help to integrate the structural body changes brought about by the hands-on work of Rolfing (structural integration). RMI uses a combination of touch and verbal directions to help develop greater awareness of one's vertical alignment and habitual movement patterns. RMI teacher Mary Bond says, "The premise of Rolfing Movement Integration... is that you can restore your structure to balance by changing the movement habits that perpetuate imbalance." Rolfing rhythms is a series of lively exercises designed to encourage awareness of the Rolfing principles of ease, length, balance, and harmony with gravity.

The movement education component of **Aston-Patterning** bodywork is called neurokinetics. This movement therapy teaches ways of moving with greater ease throughout every day activities. These movement patterns can also be used to release tension in the body. Aston fitness is an **exercise** program which includes warm-up techniques, exercises to increase muscle tone and stability, stretching, and cardiovascular fitness.

Rosen method movement (an adjunct to Rosen method bodywork) consists of simple fun movement exercises done to music in a group setting. Through gentle swinging, bouncing, and stretching every joint in the body experiences a full range of movement. The movements help to increase balance and rhythm and create more space for effortless breathing.

The movement form of **Trager psychophysical Integration** bodywork, Mentastics, consists of fun, easy swinging, shaking, and stretching movements. These movements, developed by Dr. Milton Trager, create an experience of lightness and freedom in the body, allowing for greater ease in movement. Trager also worked successfully with **polio** patients.

Awareness through movement, the movement therapy form of the **Feldenkrais method**, consists of specific

structured movement experiences taught as a group lesson. These lessons reeducate the brain without tiring the muscles. Most lessons are done lying down on the floor or sitting. Moshe Feldenkrais designed the lessons to "improve ability... turn the impossible into the possible, the difficult into the easy, and the easy into the pleasant."

Ideokinesis is another movement approach emphasizing neuromuscular reeducation. Lulu Sweigart based her work on the pioneering approach of her teacher Mabel Elsworth Todd. Ideokinesis uses imagery to train the nervous system to stimulate the right muscles for the intended movement. If one continues to give the nervous system a clear mental picture of the movement intended, it will automatically select the best way to perform the movement. For example, to enhance balance in standing, Sweigart taught people to visualize "lines of movement" traveling through their bodies. Sweigart did not train teachers in ideokinesis but some individuals use ideokinetic imagery in the process of teaching movement.

The Mensendieck system of functional movement techniques is both corrective and preventative. Bess Mensendieck, a medical doctor, developed a series of exercises to reshape, rebuild and revitalize the body. A student of this approach learns to use the conscious will to relax muscles and release tension. There are more than 200 exercises that emphasize correct and graceful body movement through everyday activities. Unlike other movement therapy approaches this work is done undressed or in a bikini bottom, in front of mirrors. This allows the student to observe and feel where a movement originates. Success has been reported with many conditions including **Parkinson's disease**, muscle and joint injuries, and repetitive strain injuries.

The **Alexander technique** is another functional approach to movement therapy. In this approach a teacher gently uses hands and verbal directions to subtly guide the student through movements such as sitting, standing up, bending and walking. The Alexander technique emphasizes balance in the neck-head relationship. A teacher lightly steers the students head into the proper balance on the tip of the spine while the student is moving in ordinary ways. The student learns to respond to movement demands with the whole body, in a light integrated way. This approach to movement is particularly popular with actors and other performers.

Pilates or physical mind method is also popular with actors, dancers, athletes, and a broad range of other people. Pilates consists of over 500 exercises done on the floor or primarily with customized exercise equipment. The exercises combine sensory awareness and physical training. Students learn to move from a stable, central core. The exercises promote strength, flexibility, and balance. Pilates training is increasingly available in sports medicine clinics, fitness centers, dance schools, spas, and physical therapy offices.

Many approaches to movement therapy emphasize awareness of internal sensations. Charlotte Selver, a student of somatic pioneer Elsa Gindler, calls her style of teaching sensory awareness (SA). This approach has influenced the thinking of many innovators, including Fritz Perls, who developed **gestalt therapy**. Rather than suggesting a series of structured movements, visualizations, or body positions, in SA the teacher outlines experiments in which one can become aware of the sensations involved in any movement. A teacher might ask the student to feel the movement of her breathing while running, sitting, picking up a book, etc. This close attunement to inner sensory experience encourages an experience of body-mind unity in which breathing becomes less restricted and posture, coordination, flexibility, and balance are improved. There may also be the experience of increased energy and aliveness.

Gerda Alexander Eutony (GAE) is another movement therapy approach that is based upon internal awareness. Through GAE one becomes a master of self-sensing and knowing which includes becoming sensitive to the external environment, as well. For example, while lying on the floor sensing the breath, skin or form of the body, one also senses the connection with the ground. GAE is taught in group classes or private lessons which also include hands-on therapy. In 1987, after two years of observation in clinics throughout the world, GAE became the first mind-body discipline accepted by the World Health Organization (WHO) as an alternative healthcare technique.

Kinetic awareness developed by dancer-choreographer Elaine Summers, emphasizes emotional and physical inquiry. Privately or in a group, a teacher sets up situations for the student to explore the possible causes of pain and movement restrictions within the body. Rubber balls of various sizes are used as props to focus attention inward, support the body in a stretched position and massage a specific area of the body. The work helps one to deal with chronic pain, move easily again after injuries and increase energy, flexibility, coordination, and comfort.

Body-mind centering (BMC) was developed by Bonnie Bainbridge Cohen and is a comprehensive educational and therapeutic approach to movement. BMC practitioners use movement, touch, **guided imagery**, developmental repatterning, dialogue, music, large balls, and other props in an individual session to meet the needs of each person. BMC encourages people to develop a sensate awareness and experience of the ligaments, nerves, muscles, skin, fluids, organs, glands, fat, and fas-

cia that make up one's body. It has been effective in preventing and rehabilitating from chronic injuries and in improving neuromuscular response in children with **cerebral palsy** and other neurological disorders.

Continuum movement has also been shown to be effective in treating neurological disorders including spinal chord injury. Developed by Emilie Conrad and Susan Harper, continuum movement is an inquiry into the creative flux of our body and all of life. Sound, breath, subtle and dynamic movements are explored that stimulate the brain and increase resonance with the fluid world of movement. The emphasis is upon unpredictable, spontaneous or spiral movements rather than a linear movement pattern. According to Conrad, "Awareness changes how we physically move. As we become more fluid and resilient so do the mental, emotional, and spiritual movements of our lives."

Eastern movement therapies such as yoga, t'ai chi, and qigong are also effective in healing and preventing a wide range of physical disorders, encouraging emotional stability, and enhancing spiritual awareness. There are a number of different approaches to yoga. Some emphasize the development of physical strength, flexibility, and alignment. Other forms of yoga emphasize inner awareness, opening, and meditation.

Precautions

People with acute injuries and chronic physical and mental conditions need to be careful when choosing a form of movement therapy. It is best to consult with a knowledgeable physician, physical therapist, or mental health therapist.

Research and general acceptance

Although research has documented the effects of dance therapy, qigong, t'ai chi, yoga, Alexander technique, awareness through movement (Feldenkrais), and Rolfing movement, other forms of movement therapy have not been as thoroughly researched.

Resources

BOOKS

Halprin, Anna. *Dance as a Healing Art: Returning to Health Through Movement and Imagery.* Life Rhythm, 1999.

Hartley, Linda. *Wisdom of the Body Moving: An Introduction to Body-Mind Centering.* Berkeley, CA: North Atlantic Press, 1995.

Knaster, Mirka. *Discovering the Body's Wisdom.* New York, NY: Bantam Books, 1996.

PERIODICALS

Cottingham, John T., and Jeffrey Maitland. "Integrating Manual and Movement Therapy With Philosophical Counseling for Treatment of a Patient With Amyotrophic Lateral Sclerosis: A Case Study That Explores the Principles of Holistic Intervention." *Alternative Therapies Journal* (March 2000): 120-128.

Linda Chrisman

Mpell disease *see* **Ankylosing spondylitis**

MR *see* **Magnetic resonance imaging**

MRI *see* **Magnetic resonance imaging**

MS *see* **Multiple sclerosis**

M's disease *see* **Waldenström's macroglobulinemia**

Mucopolysaccharidoses

Definition

Mucopolysaccharidosis (MPS) is a general term for a number of inherited diseases that are caused by the accumulation of mucopolysaccharides, resulting in problems with an individual's development. With each condition, mucopolysaccharides accumulate in the cells and tissues of the body because of a deficiency of a specific enzyme. The specific enzyme that is deficient or absent is what distinguishes one type of MPS from another. However, before these enzymes were identified, the MPS disorders were diagnosed by the signs and symptoms that an individual expressed. The discovery of these enzymes resulted in a reclassification of some of the MPS disorders. These conditions are often referred to as MPS I, MPS II, MPS III, MPS IV, MPS VI, MPS VII, and MPS IX. However, these conditions are also referred to by their original names, which are Hurler, Hurler-Scheie, Scheie (all MPS I), Hunter (MPS II), Sanfilippo (MPS III), Morquio (MPS IV), Maroteaux-Lamy (MPS VI), Sly (MPS VII), and Hyaluronidase deficiency (MPS IX).

Description

Mucopolysaccharides are long chains of sugar molecules that are essential for building the bones, cartilage, skin, tendons, and other tissues in the body. Normally, the human body continuously breaks down and builds mucopolysaccharides. Another name for mucopolysaccharides is glycosaminoglycans (GAGs). There are many different types of GAGs and specific GAGs are unable to be broken down in each of the MPS conditions. There are several enzymes involved in breaking down each GAG and a deficiency or absence of any of the essential

enzymes can cause the GAG to not be broken down completely and result in its accumulation in the tissues and organs in the body. In some MPS conditions, in addition to the GAG being stored in the body, some of the incompletely broken down GAGs can leave the body via the urine. When too much GAG is stored, organs and tissues can be damaged or not function properly.

Genetic profile

Except for MPS II, the MPS conditions are inherited in an autosomal recessive manner. MPS conditions occur when both of an individual's genes that produce the specific enzyme contain a mutation, causing them to not work properly. When both genes do not work properly, either none or a reduced amount of the enzyme is produced. An individual with an autosomal recessive condition inherits one of those non-working genes from each parent. These parents are called "carriers" of the condition. When two people are known carriers for an autosomal recessive condition, they have a 25% chance with each **pregnancy** to have a child affected with the disease. Some individuals with MPS do have children of their own. Children of parents who have an autosomal recessive condition are all carriers of that condition. These children are not at risk to develop the condition unless the other parent is a carrier or affected with the same autosomal recessive condition.

Unlike the other MPS conditions, MPS II is inherited in an X-linked recessive manner. This means that the gene causing the condition is located on the X chromosome, one of the two sex chromosomes. Since a male has only one X chromosome, he will have the disease if the X chromosome inherited from his mother carries the defective gene. Females, because they have two X chromosomes, are called "carriers" of the condition if only one of their X chromosomes has the gene that causes the condition, while the other X chromosome does not.

Causes and symptoms

Each type of MPS is caused by a deficiency of one of the enzymes involved in breaking down GAGs. It is the accumulation of the GAGs in the tissues and organs in the body that cause the wide array of symptoms characteristic of the MPS conditions. The accumulating material is stored in cellular structures called lysosomes, and these disorders are also known as lysosomal storage diseases.

MPS I

MPS I is caused by a deficiency of the enzyme alpha-L-iduronidase. Three conditions, Hurler, Hurler-Scheie, and Scheie syndromes, all are caused by a deficiency of this enzyme. Initially, these three conditions were felt to be separate because each were associated with different physical symptoms and prognoses. However, once the underlying cause of these conditions was identified, it was realized that these three conditions were all variants of the same disorder. The gene involved with MPS I is located on chromosome 4p16.3.

MPS I H (HURLER SYNDROME). It has been estimated that approximately one baby in 100,000 will be born with Hurler syndrome. Individuals with Hurler syndrome tend to have the most severe form of MPS I. Symptoms of Hurler syndrome are often evident within the first year or two after birth. Often these infants begin to develop as expected, but then reach a point where they begin to loose the skills that they have learned. Many of these infants may initially grow faster than expected, but their growth slows and typically stops by age three. Facial features also begin to appear "coarse." They develop a short nose, flatter face, thicker skin, and a protruding tongue. Additionally, their heads become larger and they develop more hair on their bodies with the hair becoming coarser. Their bones are also affected, with these children usually developing joint **contractures** (stiff joints), **kyphosis** (a specific type of curve to the spine), and broad hands with short fingers. Many of these children experience breathing difficulties, and respiratory infections are common. Other common problems include heart valve dysfunction, thickening of the heart muscle (cardiomyopathy), enlarged spleen and liver, clouding of the cornea, **hearing loss**, and **carpal tunnel syndrome**. These children typically do not live past age 12.

MPS I H/S (HURLER-SCHEIE SYNDROME). Hurler-Scheie syndrome is felt to be the intermediate form of MPS I, meaning that the symptoms are not as severe as those in individuals who have MPS I H but not as mild as those in MPS I S. Approximately one baby in 115,000 will be born with Hurler-Scheie syndrome. These individuals tend to be shorter than expected, and they can have normal intelligence, however, some individuals with MPS I H/S will experience learning difficulties. These individuals may develop some of the same physical features as those with Hurler syndrome, but usually they are not as severe. The prognosis for children with MPS I H/S is variable with some individuals dying during childhood, while others live to adulthood.

MPS I S (SCHEIE SYNDROME). Scheie syndrome is considered the mild form of MPS I. It is estimated that approximately one baby in 500,000 will be born with Scheie syndrome. Individuals with MPS I S usually have normal intelligence, but there have been some reports of individuals with MPS I S developing psychiatric problems. Common physical problems include corneal clouding, heart abnormalities, and orthopedic difficulties

involving their hands and back. Individuals with MPS I S do not develop the facial features seen with MPS I H and usually these individuals have a normal life span.

MPS II (Hunter syndrome)

Hunter syndrome is caused by a deficiency of the enzyme iduronate-2-sulphatase. All individuals with Hunter syndrome are male, because the gene that causes the condition is located on the X chromosome, specifically Xq28. Like many MPS conditions, Hunter syndrome is divided into two groups, mild and severe. It has been estimated that approximately 1 in 110,000 males are born with Hunter syndrome, with the severe form being three times more common than the mild form. The severe form is felt to be associated with progressive **mental retardation** and physical disability, with most individuals dying before age 15. In the milder form, most of these individuals live to adulthood and have normal intelligence or only mild mental impairments. Males with the mild form of Hunter syndrome develop physical differences similar to the males with the severe form, but not as quickly. Men with mild Hunter syndrome can have a normal life span and some have had children. Most males with Hunter syndrome develop joint stiffness, chronic **diarrhea**, enlarged liver and spleen, heart valve problems, hearing loss, kyphosis, and tend to be shorter than expected. These symptoms tend to progress at a different rate depending on if an individual has the mild or severe form of MPS II.

MPS III (Sanfilippo syndrome)

MPS III, like the other MPS conditions, was initially diagnosed by the individual having certain physical characteristics. It was later discovered that the physical symptoms associated with Sanfilippo syndrome could be caused by a deficiency in one of four enzymes. Each type of MPS III is now subdivided into four groups, labeled A-D, based on the specific enzyme that is deficient. All four of these enzymes are involved in breaking down the same GAG, heparan sulfate. Heparan sulfate is mainly found in the central nervous system and accumulates in the brain when it cannot be broken down because one of those four enzymes are deficient or missing.

MPS III is a variable condition with symptoms beginning to appear between ages two and six years of age. Because of the accumulation of heparan sulfate in the central nervous system, the central nervous system is severely affected. In MPS III, signs that the central nervous system is degenerating usually are evident in most individuals between ages six and 10. Many children with MPS III will develop seizures, sleeplessness, thicker skin, joint contractures, enlarged tongues, cardiomyopathy, behavior problems, and mental retardation. The life expectancy in MPS III is also variable. On average, individuals with MPS III live until they are teenagers, with some living longer and others not that long.

MPS IIIA (SANFILIPPO SYNDROME TYPE A). MPS IIIA is caused by a deficiency of the enzyme heparan N-sulfatase. Type IIIA is felt to be the most severe of the four types, in which symptoms appear and **death** occurs at an earlier age. A study in British Columbia estimated that one in 324,617 live births are born with MPS IIIA. MPS IIIA is the most common of the four types in Northwestern Europe. The gene that causes MPS IIIA is located on the long arm of chromosome 17 (location 17q25).

MPS IIIB (SANFILIPPO SYNDROME TYPE B). MPS IIIB is due to a deficiency in N-acetyl-alpha-D-glucosaminidase (NAG). This type of MPS III is not felt to be as severe as Type IIIA and the characteristics vary. Type IIIB is the most common of the four in southeastern Europe. The gene associated with MPS IIIB is also located on the long arm of chromosome 17 (location 17q21).

MPS IIIC (SANFILIPPO SYNDROME TYPE C). A deficiency in the enzyme acetyl-CoA-alpha-glucosaminide acetyltransferase causes MPS IIIC. This is considered a rare form of MPS III. The gene involved in MPS IIIC is believed to be located on chromosome 14.

MPS IIID (SANFILIPPO SYNDROME TYPE D). MPS IIID is caused by a deficiency in the enzyme N-acetyl-glucosamine-6-sulfatase. This form of MPS III is also rare. The gene involved in MPS IIID is located on the long arm of chromosome 12 (location 12q14).

MPS IV (Morquio syndrome)

As with several of the MPS disorders, Morquio syndrome was diagnosed by the presence of particular signs and symptoms. However, it is now known that the deficiency of two different enzymes can cause the characteristics of MPS IV. These two types of MPS IV are called MPS IV A and MPS IV B. MPS IV is also variable in its severity. The intelligence of individuals with MPS IV is often completely normal. In individuals with a severe form, skeletal abnormalities can be extreme and include dwarfism, kyphosis (backward-curved spine), prominent breastbone, flat feet, and knock-knees. One of the earliest symptoms seen in this condition usually is a difference in the way the child walks. In individuals with a mild form of MPS IV, limb stiffness, and joint **pain** are the primary symptoms. MPS IV is one of the rarest MPS disorders, with approximately one baby in 300,000 born with this condition.

MPS IV A (MORQUIO SYNDROME TYPE A). MPS IV A is the "classic" or the severe form of the condition and

KEY TERMS

Cardiomyopathy—A thickening of the heart muscle.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Joint contractures—Stiffness of the joints that prevents full extension.

Kyphosis—An abnormal outward curvature of the spine, with a hump at the upper back.

Lysosome—Membrane-enclosed compartment in cells, containing many hydrolytic enzymes; where large molecules and cellular components are broken down.

Mucopolysaccharide—A complex molecule made of smaller sugar molecules strung together to form a chain. Found in mucous secretions and intercellular spaces.

Recessive gene—A type of gene that is not expressed as a trait unless inherited by both parents.

X-linked gene—A gene carried on the X chromosome, one of the two sex chromosomes.

is caused by a deficiency in the enzyme galactosamine-6-sulphatase. The gene involved with MPS IV A is located on the long arm of chromosome 16 (location 16q24.3).

MPS IV B (MORQUIO SYNDROME TYPE B). MPS IV B is considered the milder form of the condition. The enzyme, beta-galactosidase, is deficient in MPS IV B. The location of the gene that produces beta-galactosidase is located on the short arm of chromosome 3 (location 3p21).

MPS VI (Maroteaux-Lamy syndrome)

MPS VI, which is another rare form of MPS, is caused by a deficiency of the enzyme N-acetylglucosamine-4-sulphatase. This condition is also variable; individuals may have a mild or severe form of the condition. Typically, the nervous system or intelligence of an individual with MPS VI is not affected. Individuals with a more severe form of MPS VI can have airway obstruction, develop **hydrocephalus** (extra fluid accumulating in the brain) and have bone changes. Additionally, individuals with a severe form of MPS VI are more likely to die while in their teens. With a milder form of the condition, individuals tend to be shorter than expected for their age, develop corneal clouding, and live longer. The gene involved in MPS VI is believed to be located on the long arm of chromosome 5 (approximate location 5q11-13).

MPS VII (Sly syndrome)

MPS VII is an extremely rare form of MPS and is caused by a deficiency of the enzyme beta-glucuronidase. It is also highly variable, but symptoms are generally similar to those seen in individuals with Hurler syndrome. The gene that causes MPS VII is located on the long arm of chromosome 7 (location 7q21).

MPS IX (Hyaluronidase deficiency)

MPS IX is a condition that was first described in 1996 and has been grouped with the other MPS conditions by some researchers. MPS IX is caused by the deficiency of the enzyme hyaluronidase. In the few individuals described with this condition, the symptoms are variable, but some develop soft-tissue masses (growths under the skin). Also, these individuals are shorter than expected for their age. The gene involved in MPS IX is believed to be located on the short arm of chromosome 3 (possibly 3p21.3-21.2)

Many individuals with an MPS condition have problems with airway constriction. This constriction may be so serious as to create significant difficulties in administering general anesthesia. Therefore, it is recommended that surgical procedures be performed under local anesthesia whenever possible.

Diagnosis

While a diagnosis for each type of MPS can be made on the basis of the physical signs described above, several of the conditions have similar features. Therefore, enzyme analysis is used to determine the specific MPS disorder. Enzyme analysis usually cannot accurately determine if an individual is a carrier for a MPS condition. This is because the enzyme levels in individuals who are not carriers overlaps the enzyme levels seen in those individuals who are carrier for a MPS. With many of the MPS conditions, several mutations have been found in each gene involved that can cause symptoms of each condition. If the specific mutation is known in a family, DNA analysis may be possible.

Once a couple has had a child with an MPS condition, prenatal diagnosis is available to them to help determine if a fetus is affected with the same MPS as their other child. This can be accomplished through testing samples using procedures such as an **amniocentesis** or **chorionic villus sampling** (CVS). Each of these procedures has its own risks, benefits, and limitations.

Treatment

There is no cure for mucopolysaccharidosis. There are several types of experimental therapies that are being investigated. Typically, treatment involves trying to relieve some of the symptoms. For MPS I and VI, **bone marrow transplantation** has been attempted as a treatment option. In those conditions, bone marrow transplantation has sometimes been found to help slow down the progression or reverse some symptoms of the disorder in some children. The benefits of a bone marrow transplantation are more likely to be noticed when performed on children under two years of age. However it is not certain that a bone marrow transplant can prevent further damage to certain organs and tissues, including the brain. Furthermore, bone marrow transplantation is not felt to be helpful in some MPS disorders and there are risks, benefits, and limitations with this procedure. In 2000, 10 individuals with MPS I received recombinant human alpha-L-iduronidase every week for one year. Those individuals showed an improvement with some of their symptoms. Additionally, there is ongoing research involving gene replacement therapy (the insertion of normal copies of a gene into the cells of patients whose gene copies are defective).

Prevention

No specific preventive measures are available for genetic diseases of this type. For some of the MPS diseases, biochemical tests are available that will identify healthy individuals who are carriers of the defective gene, allowing them to make informed reproductive decisions. There is also the availability of prenatal diagnosis for all MPS disease to detect affected fetuses.

Resources

PERIODICALS

Bax, Martin C.O. and Gillian A. Colville. "Behaviour in mucopolysaccharide disorders." *Arch Dis Child* 73 (1995): 77–81.

Caillud, C. and L. Poenaru. "Gene therapy in lysosomal diseases." *Biomed & Pharmacother* 54 (2000): 505–512.

Dangle, J. H. "Cardiovascular changes in children with mucopolysaccharide storage diseases and related disorders-clinical and echocardiographic findings in 64 patients." *European Journal of Pediatrics* 157 (1998): 534–538.

Kakkis, E. D. et al. "Enzyme-Replacement Therapy in Mucopolysaccharidosis I." *The New England Journal of Medicine* 344 (2001): 182–188.

Wraith, J.E. "The Mucopolysaccharidoses: A Clinical Review and Guide to Management." *Archives of Disease in Childhood* 72 (1995): 263–267.

ORGANIZATIONS

Canadian Society for Mucopolysaccharide and Related Diseases. PO Box 64714, Unionville, ONT L3R-OM9. Canada (905) 479-8701 or (800) 667-1846. <http://www.mpssociety.ca>.

Children Living with Inherited Metabolic Diseases. The Quadrangle, Crewe Hall, Weston Rd., Crewe, Cheshire, CW1-6UR. UK 127 025 0221. Fax: 0870-7700-327. <http://www.climb.org.uk>.

Metabolic Information Network. PO Box 670847, Dallas, TX 75367-0847. (214) 696-2188 or (800) 945-2188.

National MPS Society. 102 Aspen Dr., Downingtown, PA 19335. (610) 942-0100. Fax: (610) 942-7188. info@mpssociety.org. <http://www.mpssociety.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

Society for Mucopolysaccharide Diseases. 46 Woodside Rd., Amersham, Buckinghamshire, HP6 6AJ. UK +44 (01494) 434156. <http://www.mpssociety.co.uk>.

Zain Hansen MPS Foundation. 23400 Henderson Rd., Covelo, CA 95420. (800) 767-3121.

OTHER

National Library of Medicine. National Institutes of Health. <http://www.nlm.nih.gov/>.

"NINDS Mucopolysaccharidoses Information Page." The National Institute of Neurological Disorders and Stroke. National Institutes of Health. <http://www.ninds.nih.gov/health_and_medical/disorders/mucopolysaccharidoses.htm>.

Online Mendelian Inheritance in Man (OMIM). National Center for Biotechnology Information. <http://www.ncbi.nlm.nih.gov/Omim/>.

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Mucormycosis

Definition

Mucormycosis is a rare but often fatal disease caused by certain fungi. It is sometimes called zygomycosis or phycomycosis. Mucormycosis is an opportunistic infection that typically develops in patients with weakened immune systems, diabetes, kidney failure, organ transplants, or **chemotherapy**.

Description

In the United States, mucormycosis is most likely to develop in the patient's nasal area or in the lungs.

Rhinocerebral mucormycosis

Rhinocerebral mucormycosis is an infection of the nose, eyes, and brain. The fungus destroys the tissue of the nasal passages, sinuses, or hard palate, producing a black discharge and visible patches of dying tissue. The

KEY TERMS

Amphotericin B—An antibiotic used to treat mucormycosis and other severe fungal infections.

Opportunistic infection—An infection that develops only when a person's immune system is weakened.

Orbit—The bony cavity or socket surrounding the eye.

Zygomycosis—Another term for mucormycosis. The fungi that cause mucormycosis belong to a group called Zygomycetes.

fungus then invades the tissues around the eye socket and eventually the brain.

Pulmonary mucormycosis

Most patients with the pulmonary form of the disease are being treated for leukemia. The fungus enters the patient's lungs, where it eventually invades a major blood vessel, causing the patient to **cough** up blood or hemorrhage into the lungs.

Causes and symptoms

Mucormycosis is caused by fungi of several different species, including *Mucor*, *Rhizopus*, *Absidia*, and *Rhizomucor*. When these organisms gain access to the mucous membranes of the patient's nose or lungs, they multiply rapidly and invade the nearby blood vessels. The fungi destroy soft tissue and bone, as well as the walls of blood vessels.

The early symptoms of rhinocerebral mucormycosis include **fever**, sinus **pain**, **headache**, and **cellulitis**. As the fungus reaches the eye tissues, the patient develops dilated pupils, drooping eyelids, a bulging eye, and eventually hemorrhage of the blood vessels in the brain—causing convulsions, partial **paralysis**, and **death**.

The symptoms of pulmonary mucormycosis include fever and difficulty breathing, with eventual bleeding from the lungs.

Diagnosis

Diagnosis is usually based on a combination of the patient's medical history and a visual examination of the nose and throat. The doctor will take a tissue sample for biopsy, or a PAS, potassium hydroxide (KOH), or Calcofluor stain in order to make a tentative diagnosis. Confirmation requires a laboratory culture.

Imaging studies are not needed to make the diagnosis. If the patient has mucormycosis, however, **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT scans) will usually show the destruction of soft tissue or bone in patients with advanced disease. Chest x rays will sometimes show a cavity in the lung or an area filled with tissue fluid if the patient has pulmonary mucormycosis.

Treatment

Treatment is usually begun without waiting for laboratory reports because of the rapid spread and high mortality rate of the disease. It includes intravenous amphotericin B (Fungizone); surgical removal of infected tissue; and careful monitoring of the disorder or condition that is responsible for the patient's vulnerability.

Prognosis

The prognosis for recovery from mucormycosis is poor. The mortality rate is 30%-50% of patients with the rhinocerebral form, and even higher for patients with pulmonary mucormycosis. The disease is almost 100% fatal for patients with **AIDS**.

Prevention

Prevention depends on protecting high-risk patients from contact with sugary foods, decaying plants, moldy bread, manure, and other breeding grounds for fungi.

Resources

BOOKS

Beavis, Kathleen G. "Systemic Mycoses." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Hamill, Richard J. "Infectious Diseases: Mycotic." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Infectious Disease: Systemic Fungal Diseases." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Jackler, Robert K., and Michael J. Kaplan. "Ear, Nose, & Throat." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

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Mucoviscidosis *see* **Cystic fibrosis**

MUGA scan *see* **Multiple-gated acquisition (MUGA) scan**

Multiple-gated acquisition (MUGA) scan

Definition

The multiple-gated acquisition (MUGA) scan is a non-invasive nuclear test that uses a radioactive isotope called technetium to evaluate the functioning of the heart's ventricles.

Purpose

The MUGA scan is performed to determine if the heart's left and right ventricles are functioning properly and to diagnose abnormalities in the heart wall. It can be ordered in the following patients:

- with known or suspected **coronary artery disease**, to diagnose the disease and predict outcomes
- with lesions in their heart valves
- who have recently had a **heart attack**, to assess damage to heart tissue and predict the likelihood of future cardiac events
- with congestive **heart failure**
- who have undergone percutaneous transluminal coronary **angioplasty**, **coronary artery bypass graft surgery**, or medical therapy, to assess the efficacy of the treatment
- with low cardiac output after open-heart surgery
- who are undergoing **chemotherapy**

Precautions

Pregnant women and those who are breastfeeding should not be exposed to technetium.

Description

The MUGA scan measures the heart's function and the flow of blood through it. The strongest chamber in the heart is the left ventricle, which serves as the main pump of blood through the body. The left ventricular is assessed by measuring the amount of blood pumped with each heartbeat (the ejection fraction), ventricle filling, and the blood flow into the pumping chamber. A normal ejection fraction is 50% or more. The heart's ejection fraction is one of the most important measures of its performance. The right ventricle's ability to pump blood to the lungs is also assessed, and any abnormalities in the heart wall are identified. The MUGA scan is the most accurate, non-invasive test available to assess the heart's ventricles.

MUGA is a nuclear heart scan, which means that it involves the use of a radioactive isotope that targets the heart and a radionuclide detector that traces the absorption of the radioactive isotope. The isotope is injected into a vein and absorbed by healthy tissue at a known rate during a certain time period. The radionuclide detector, in this case a gamma scintillation camera, picks up the gamma rays emitted by the isotope.

During the MUGA scan, electrodes are placed on the patient's body so that an electrocardiogram (ECG) can be conducted. The imaging equipment and computer are synchronized with the ECG so that images of the heart can be recorded without motion or blur. Then a small amount of a mildly radioactive isotope called technetium Tc99m stannous pyrophosphate, usually called technetium, is injected, usually into an arm vein. While the patient lies motionless on the test table, a gamma scintillation camera follows the movement of the technetium through the blood circulating in the heart. The camera, which looks like an x-ray machine and is suspended above the table, moves back and forth over the patient. It displays multiple images of the heart in motion and records them on a computer for later analysis.

The MUGA scan is usually performed in a hospital's nuclear medicine department, but it can also be performed in an outpatient facility or at the patient's bedside if equipment is available. The scan is done immediately after injection of the technetium and usually takes about 30 minutes to one hour. It is also called multigated graft acquisition, multigated acquisition scan, cardiac blood-pool imaging, and equilibrium radionuclide **angiography**. Test results can be affected by patient movement during the test, electrocardiogram abnormalities, an irregular heartbeat, or long-acting nitrates.

The MUGA scan can be done with the patient at rest or exercising (called a **stress** MUGA). The stress MUGA is often performed in patients who have or are suspected of having coronary artery disease. The resting MUGA is compared to the stress MUGA and changes in the heart's pumping performance are analyzed. In some cases, the rest MUGA is compared to a nitroglycerin MUGA, in which a strong heart drug called nitroglycerin is administered to the patient before the scan. For the nitroglycerin MUGA, a cardiologist should be present.

The MUGA scan is not dangerous. The technetium is completely gone from the body within a few days of the test. The scan itself exposes the patient to about the same amount of radiation as a **chest x ray**. The patient can resume normal activities immediately after the test.

Normal results

If the patient's heart is normal, the technetium will appear to be evenly distributed in the scans. In a stress

KEY TERMS

Ejection fraction—The fraction of all blood in the ventricle that is ejected at each heartbeat. One of the main advantages of the MUGA scan is its ability to measure ejection fraction, one of the most important measures of the heart's performance.

Electrocardiogram—A test in which electronic sensors called electrodes are placed on the body to record the heart's electrical activities.

Heart attack—A cardiac emergency that occurs when a clot blocks blood flow in one or more of the heart's arteries. Oxygen supply to the heart muscle is cut off, resulting in the death of heart tissue in the affected area.

Ischemia—A decreased supply of oxygenated blood to a body part or organ, often marked by pain and organ dysfunction, as in ischemic heart disease.

Non-invasive—A procedure that does not penetrate the body.

Radioactive isotope—One of two or more atoms with the same number of protons but a different number of neutrons with a nuclear composition. In nuclear scanning, radioactive isotopes are used as a diagnostic agent.

Technetium—A radioactive isotope frequently used in radionuclide scanning of the heart and other organs. It is produced during nuclear fission reactions.

Ventricles—The heart's lower chambers are called the left and right ventricles. They send blood to the lungs and throughout the body. The MUGA scan is performed to evaluate the ventricles.

MUGA, patients with normal hearts will exhibit an increase in ejection fraction or no change.

Abnormal results

An uneven distribution of technetium in the heart indicates that the patient has coronary artery disease, a cardiomyopathy, or blood shunting within the heart. Abnormalities in a resting MUGA usually indicate a heart attack, while those that occur during **exercise** usually indicate **ischemia**. In a stress MUGA, patients with coronary artery disease may exhibit a decrease in ejection fraction.

Resources

BOOKS

DeBakey, Michael E., and Antonio M. Gotto Jr. "Noninvasive Diagnostic Procedures." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

"Radionuclide Angiography." In *Cardiac Stress Testing & Imaging*, ed. Thomas H. Marwick. New York: Churchill Livingstone, 1996.

Raizner, Albert E. "Nuclear Cardiology Testing." *Indications for Diagnostic Procedures: Topics in Clinical Cardilogy.* Tokyo: Igaku-Shon, 1997.

Texas Heart Institute. "Diagnosing Heart Diseases." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996, p. 333.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

OTHER

"Tests To Diagnose Heart Disease." *American Heart Association*. 3 Mar. 1998 <http://www.americanheart.org>.

Lori De Milto

Multiple chemical sensitivity

Definition

Multiple chemical sensitivity, also known as MCS syndrome or simply MCS, is a disorder in which a person develops symptoms from exposure to chemicals in the environment. With each incidence of exposure, lower levels of the chemical will trigger a reaction and the person becomes increasingly vulnerable to reactions triggered by other chemicals.

Description

Multiple chemical sensitivity typically begins with one high-dose exposure to a chemical, but it may also develop with long-term exposure to a low level of a chemical. Chemicals most often connected with MCS include: formaldehyde; pesticides; solvents; petrochemical fuels such as diesel, gasoline, and kerosene; waxes, detergents, and cleaning products; latex; tobacco smoke;

perfumes and fragrances; and artificial colors, flavors, and preservatives. People who develop MCS are commonly exposed in one of the following situations: on the job as an industrial worker; residing or working in a poorly ventilated building; or living in conditions of high air or water pollution. Others may be exposed in unique incidents.

Because MCS is difficult to diagnose, estimates vary as to what percentage of the population develops MCS. However, most MCS patients are female. The median age of MCS patients is 40 years old, and most experienced symptoms before they were 30 years old.

Causes and symptoms

Chemical exposure is often a result of indoor air pollution. Buildings which are tightly sealed for energy conservation may cause a related illness called sick building syndrome, in which people develop symptoms from chronic exposure to airborne environmental chemicals such as formaldehyde from the furniture, carpet glues, and latex caulking. A person moving into a newly constructed building, which has not had time to degas, may experience the initial high-dose exposure that leads to MCS.

The symptoms of MCS vary from person to person and are not chemical-specific. Symptoms are not limited to one physiological system, but primarily affect the respiratory and nervous systems. Symptoms commonly reported are **headache**, **fatigue**, weakness, difficulty concentrating, short-term memory loss, **dizziness**, irritability and depression, **itching**, numbness, burning sensation, congestion, **sore throat**, hoarseness, **shortness of breath**, **cough**, and stomach pains.

Diagnosis

Multiple chemical sensitivity is a twentieth-century disorder, becoming more prevalent as more man-made chemicals are introduced into the environment in greater quantities. It is especially difficult to diagnose because it presents no consistent or measurable set of symptoms and has no single diagnostic test or marker. Physicians are often unaware of MCS as a condition. They may be unable to diagnose it, or may misdiagnose it as another degenerative disease, or may label it as a psychosomatic illness (a physical illness that is caused by emotional problems). Their lack of understanding generates frustration, **anxiety**, and distrust in patients already struggling with MCS. However, a new specialty of medicine is evolving to address MCS and related illnesses: occupational and environmental medicine. A physician looking for MCS will take a complete patient history and try to identify chemical exposures.

KEY TERMS

Degas—To release and vent gases. New building materials often give off gases and odors and the air should be well circulated to remove them.

Sick building syndrome—An illness related to MCS in which a person develops symptoms in response to chronic exposure to airborne environmental chemicals found in a tightly sealed building.

Treatment

While doctors may recommend **antihistamines**, **analgesics**, and other medications to combat the symptoms, the most effective treatment is to avoid those chemicals which trigger the symptoms. This becomes increasingly difficult as the number of offending chemicals increases, and people with MCS often remain at home where they are able to control the chemicals in their environment. This **isolation** often limits their abilities to work and socialize, so supportive counseling may also be appropriate.

Alternative treatment

Some MCS patients find relief with **detoxification** programs of **exercise** and sweating, and chelation of heavy metals. Others support their health with nutritional regimens and immunotherapy vaccines. Some undergo food-allergy testing and testing for accumulated pesticides in the body to learn more about their condition and what chemicals to avoid. **Homeopathy** and **acupuncture** can give added support to any treatment program for MCS patients. Botanical medicine can help to support the liver and other involved organs.

Prognosis

Once MCS sets in, sensitivity continues to increase and a person's health continues to deteriorate. Strictly avoiding exposure to triggering chemicals for a year or more may improve health.

Prevention

Multiple chemical sensitivity is difficult to prevent because even at high-dose exposures, different people react differently. Ensuring adequate ventilation in situations with potential for acute high-dose or chronic low-dose chemical exposure, as well as wearing the proper protective equipment in industrial situations, will minimize the risk.

Resources

BOOKS

Hu, Howard, and Frank E. Speizer. "Specific Environmental and Occupational Hazards." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Sparks, P. J., et al. "Multiple Chemical Sensitivity Syndrome: A Clinical Perspective." *Journal of Occupational Medicine* 36 (1994): 718.

ORGANIZATIONS

American Academy of Environmental Medicine. P.O. Box CN 1001-8001, New Hope, PA 18938. (215) 862-4544.

Bethany Thivierge

Multiple endocrine adenomatosis *see* **Multiple endocrine neoplasia syndromes**

Multiple endocrine neoplasia syndromes

Definition

The multiple endocrine neoplasia (MEN) syndromes are three related disorders affecting the thyroid and other hormonal (endocrine) glands of the body. MEN has previously been known as familial endocrine adenomatosis.

Description

The three forms of MEN are MEN1 (Wermer's syndrome), MEN2A (Sipple syndrome), and MEN2B (previously known as MEN3). Each is an autosomal dominant genetic condition which predisposes to hyperplasia (excessive growth of cells) and tumor formation in a number of endocrine glands.

Causes and symptoms

MEN1 patients experience hyperplasia or tumors of several endocrine glands, including the parathyroids, the pancreas, and the pituitary. The most frequent symptom of MEN1 is **hyperparathyroidism**. Overgrowth of the parathyroid glands leads to oversecretion of parathyroid hormone, which leads to elevated blood calcium levels, **kidney stones**, weakened bones, and nervous system depression. Almost all MEN1 patients show parathyroid symptoms by age 40.

Tumors of the pancreas known as gastrinomas are also common in MEN1. Excessive secretion of gastrin (a hormone secreted into the stomach to aid in digestion) by these tumors can cause upper gastrointestinal ulcers. The anterior pituitary and the adrenal glands can also be affected. Unlike MEN2, the thyroid gland is rarely involved in MEN1 symptoms.

Patients with MEN2A and MEN2B experience two main symptoms, medullary **thyroid cancer** (MTC) and a tumor of the adrenal gland medulla known as **pheochromocytoma**. MTC is a slow-growing **cancer**, but one that can be cured in less than 50% of cases. Pheochromocytoma is usually a benign tumor that causes excessive secretion of adrenal hormones, which, in turn, can cause life-threatening **hypertension** and cardiac arrhythmia.

The two forms of MEN2 are distinguished by additional symptoms. MEN2A patients have a predisposition to increase in size (hypertrophy) and to develop tumors of the parathyroid gland. Although similar to MEN1, less than 20% of MEN2A patients will show parathyroid involvement.

MEN2B patients show a variety of additional conditions: a characteristic facial appearance with swollen lips; tumors of the mucous membranes of the eye, mouth, tongue, and nasal cavity; enlarged colon; and skeletal abnormalities. Symptoms develop early in life (often under five years of age) in cases of MEN2B and the tumors are more aggressive. MEN2B is about 10-fold less common than MEN2A.

MEN1 is caused by mutation at the PYGM gene. PYGM is one of a group of genes known as tumor suppressor genes. A patient who inherits one defective copy of a tumor suppressor gene from either parent has a strong predisposition to the disease because of the high probability of incurring a second mutation in at least one dividing cell. That cell no longer possesses even one normal copy of the gene. When both copies are defective, tumor suppression fails and tumors develop.

Both types of MEN2 are caused by mutations in another gene, known as RET. A mutation in only one copy of the RET gene is sufficient to cause disease. A number of different mutations can lead to MEN2A, but only one specific genetic alteration leads to MEN2B.

For all types of MEN, the children of an affected individual have a 50% chance of inheriting the defective gene.

Diagnosis

Classical diagnosis of MEN is based on clinical features and on testing for elevated hormone levels. For MEN1, the relevant hormone is parathyroid hormone. For both types of MEN2, the greatest concern is devel-

opment of medullary thyroid cancer. MTC can be detected by measuring levels of the thyroid hormone, calcitonin. Numerous other hormone levels can be measured to assess the involvement of the various other endocrine glands.

Diagnosis of MEN2B can be made by **physical examination** alone. However, MEN2A shows no distinct physical features and must be identified by measuring hormone levels or by finding endocrine tumors.

Since 1994, genetic screening using DNA technology has been available for both MEN1 and MEN2. This new methodology allows diagnosis prior to the onset of symptoms.

In the past, there was no way of definitively identifying which children had inherited the defective gene. As a result, all children had to be considered at risk. In the case of MEN2A and MEN2B, children would undergo frequent calcitonin testing. Molecular techniques now allow a positive distinction to be made between children who are and are not actually at risk.

Children who are identified as carriers of the RET gene can be offered total **thyroidectomy** on a preventative (prophylactic) basis to prevent the development of MTC.

Treatment

No comprehensive treatment is available for genetic conditions such as MEN. However, some of the consequences of MEN can be symptomatically treated.

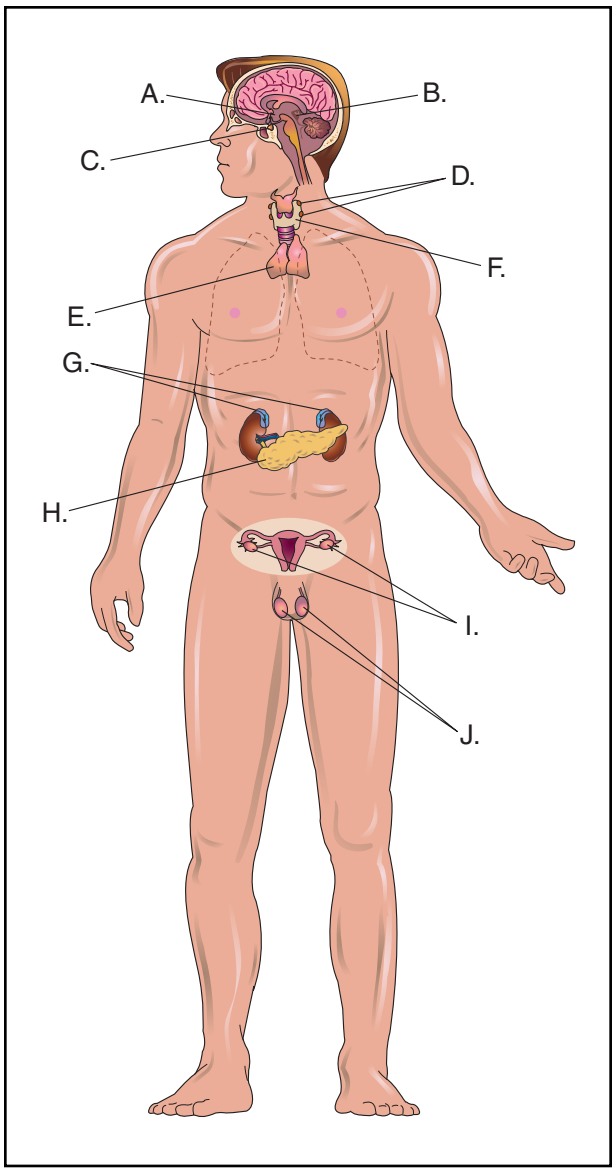
Pheochromocytoma in both types of MEN 2 can be cured by surgical removal of this slow growing tumor.

Treatment of MTC is by surgical removal of the thyroid, although doctors may disagree at what stage to remove the thyroid. After thyroidectomy, the patient will receive normal levels of thyroid hormone orally or by injection.

Even when surgery is performed early, metastatic spread of the cancer may have already occurred. Since this cancer is slow growing, metastasis may not be obvious. Metastasis is very serious in MTC because **chemotherapy** and **radiation therapy** are not effective in controlling its spread.

Prognosis

Diagnosed early, the prognosis for the MEN diseases is reasonably good, even for MEN2B, the most dangerous of the three forms. Even in the absence of treatment, a few individuals with MEN2A mutations will never show any symptoms at all. Analysis of at-risk family members using molecular genetic techniques will lead to earlier treatment and improved outcomes.



The human endocrine system: A. Hypothalamus. B. Pineal. C. Pituitary. D. Parathyroid. E. Thymus. F. Thyroid. G. Adrenals. H. Pancreas. I. Ovaries (female). J. Testes (male). *(Illustration by Electronic Illustrators Group.)*

Prevention

One of the most serious consequences of MEN is MTC, which can be prevented by thyroidectomy. There is no preventive measure to block the occurrence of genetic mutations such as those that cause MEN.

Resources

PERIODICALS

Gardner, David G. "Recent Advances in Multiple Endocrine Neoplasia Syndromes." *Advances in Internal Medicine* (1997): 597-625.

KEY TERMS

Endocrine—A term used to describe the glands that produce hormones in the body.

Hyperplasia—An overgrowth of normal cells within an organ or tissue.

Medullary thyroid cancer (MTC)—A slow-growing tumor associated with MEN.

Neoplasm—An abnormal formation of tissue; for example, a tumor.

Pheochromocytoma—A tumor of the medullary of the adrenal gland.

Moley, Jeffrey F. "The Molecular Genetics of Multiple Endocrine Neoplasia Type 2A and Related Syndromes." *Annual Review of Medicine* 48 (1997): 409-420.

ORGANIZATIONS

Canadian MEN Society. P.O. Box 100, Meola, Saskatchewan SOM 1XO. (306) 892-2080.

Victor Leipzig, PhD

Multiple myeloma

Definition

Multiple myeloma is a **cancer** in which antibody-producing plasma cells grow in an uncontrolled and invasive (malignant) manner.

Description

Multiple myeloma, also known as plasma cell myeloma, is the second-most common cancer of the blood. It is the most common type of plasma cell neoplasm. Multiple myeloma accounts for approximately 1% of all cancers and 2% of all deaths from cancer. Multiple myeloma is a disease in which malignant plasma cells spread through the bone marrow and hard outer portions of the large bones of the body. These myeloma cells may form tumors called plasmacytomas. Eventually, multiple soft spots or holes, called osteolytic lesions, form in the bones.

Bone marrow is the spongy tissue within the bones. The breastbone, spine, ribs, skull, pelvic bones, and the long bone of the thigh all are particularly rich in marrow. Bone marrow is a very active tissue that is responsible for producing the cells that circulate in the blood. These include the red blood cells that carry oxygen, the white blood cells that develop into immune system cells, and platelets, which cause blood to clot.

Plasma cells and immunoglobulins

Plasma cells develop from B-lymphocytes or B-cells, a type of white blood cell. B-cells, like all blood cells, develop from unspecialized stem cells in the bone marrow. Each B-cell carries a specific antibody that recognizes a specific foreign substance called an antigen. Antibodies are large proteins called immunoglobulins (Igs), which recognize and destroy foreign substances and organisms such as bacteria. When a B-cell encounters its antigen, it begins to divide rapidly to form mature plasma cells. These plasma cells are all identical (monoclonal). They produce large amounts of identical antibody that are specific for the antigen.

Malignant plasma cells

Multiple myeloma begins when the genetic material (DNA) is damaged during the development of a stem cell into a B-cell in the bone marrow. This causes the cell to develop into an abnormal or malignant plasmablast, a developmentally early form of plasma cell. Plasmablasts produce adhesive molecules that allow them to bond to the inside of the bone marrow. A growth factor, called interleukin-6, promotes uncontrolled growth of these myeloma cells in the bone marrow and prevents their natural **death**. Whereas normal bone marrow contains less than 5% plasma cells, bone marrow of an individual with multiple myeloma contains over 10% plasma cells.

In most cases of multiple myeloma, the malignant plasma cells all make an identical Ig. Igs are made up of four protein chains that are bonded together. Two of the chains are light and two are heavy. There are five classes of heavy chains, corresponding to five types of Igs with different immune system functions. The Igs from myeloma cells are nonfunctional and are called paraproteins. All of the paraproteins from any one individual are monoclonal (identical) because the myeloma cells are identical clones of a single plasma cell. Thus, the paraprotein is a monoclonal protein or M-protein. The M-proteins crowd out the functional Igs and other components of the immune system. They also cause functional antibodies, which are produced by normal plasma cells, to rapidly break down. Thus, multiple myeloma depresses the immune system.

In about 75% of multiple myeloma cases, the malignant plasma cells also produce monoclonal light chains, or incomplete Igs. These are called Bence-Jones proteins and are secreted in the urine. Approximately 1% of multiple myelomas are called nonsecretors because they do not produce any abnormal Ig.

Osteolytic lesions

About 70% of individuals with multiple myeloma have soft spots or lesions in their bones. These lesions can vary from quite small to grapefruit-size. In part, these lesions occur because the malignant plasma cells rapidly outgrow the normal bone-forming cells. In addition, malignant myeloma cells produce factors that affect cells called osteoclasts. These are the cells that normally destroy old bone, so that new bone can be produced by cells called osteoblasts. The myeloma cell factors increase both the activation and the growth of osteoclasts. As the osteoclasts multiply and migrate, they destroy healthy bone and create lesions. **Osteoporosis**, or widespread bone weakness, may develop.

There are more than 40,000 multiple myeloma patients in the United States. The American Cancer Society predicts an additional 14,400 new cases in 2001. About 11,200 Americans will die of the disease in 2001. Multiple myeloma is one of the leading causes of cancer deaths among African-Americans.

In Western industrialized countries, approximately four people in 100,000 develop multiple myeloma. The incidence of multiple myeloma among African- Americans is 9.5 per 100,000, about twice that of Caucasians. Asians have a much lower incidence of the disease. In China, for example, the incidence of multiple myeloma is only one in 100,000. The offspring and siblings of individuals with multiple myeloma are at a slightly increased risk for the disease.

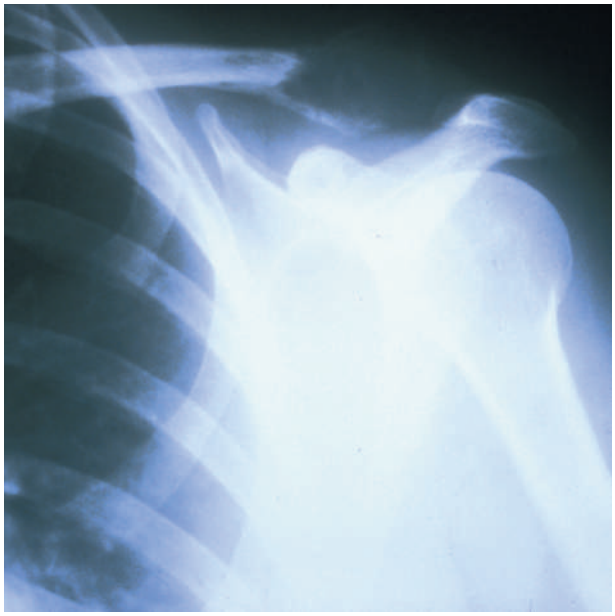
At diagnosis, the average age of a multiple myeloma patient is 68 to 70. Although the average age at onset is decreasing, most multiple myelomas still occur in people over 40. This cancer is somewhat more prevalent in men than in women.

Causes and symptoms

Associations

The cause of multiple myeloma has not been determined. However, a number of possible associations have been identified:

- decreased immune system function; the immune systems of older individuals may be less efficient at detecting and destroying cancer cells
- genetic (hereditary) factors, suggested by the increased incidence in some ethnic groups and among family members
- occupational factors, suggested by the increased incidence among agricultural, petroleum, wood, and leather workers, and cosmetologists



This x ray of the patient's left clavicle indicates an occurrence of myelomas in the bone. *(Custom Medical Stock Photo. Reproduced by permission.)*

- long-term exposure to herbicides, pesticides, petroleum products, heavy metals, plastics, and dusts such as asbestos
- radiation exposure, as among Japanese atomic bomb survivors, nuclear weapons workers, and medical personnel such as radiologists
- Kaposi's sarcoma-associated herpes virus (also called human herpes virus-8 or HHV-8), found in the blood and bone marrow cells of many multiple myeloma patients

Early symptoms

The accumulation of malignant plasma cells can result in tiny cracks or **fractures** in bones. Malignant plasma cells in the bone marrow can suppress the formation of red and white blood cells and platelets. About 80% of individuals with multiple myeloma are anemic due to low red blood cell formation. Low white blood cell formation results in increased susceptibility to infection, since new, functional antibodies are not produced. In addition, normal circulating antibodies are rapidly destroyed. Low platelet formation can result in poor blood clotting. It is rare, however, that insufficient white blood cell and platelet formations are presenting signs of multiple myeloma.

These factors cause the early symptoms of multiple myeloma:

- **pain** in the lower back or ribs

- fatigue and paleness due to anemia (low red blood cell count)
- frequent and recurring infections, including bacterial **pneumonia**, urinary-tract and kidney infections, and shingles
- bleeding

Bone destruction

Bone pain, particularly in the backbone, hips, and skull, is often the first symptom of multiple myeloma. As malignant plasma cells increase in the bone marrow, replacing normal marrow, they exert pressure on the bone. As overly-active osteoclasts (large cells responsible for the breakdown of bone) remove bone tissue, the bone becomes soft. Fracture and spinal cord compression may occur.

Plasmacytomas (malignant tumors of plasma cells) may weaken bones, causing fractures. Fractured bones or weak or collapsed spinal bones, in turn, may place unusual pressure on nearby nerves, resulting in nerve pain, burning, or numbness and muscle weakness. Proteins produced by myeloma cells also may damage nerves.

Calcium from the destroyed bone enters the blood and urine, causing **hypercalcemia**, a medical condition in which abnormally high concentrations of calcium compounds exist in the bloodstream. High calcium affects nerve cell and kidney function. The symptoms of hypercalcemia include:

- weakness and fatigue
- depression
- mental confusion
- constipation
- increased thirst
- icreased urination
- nausea and vomiting
- kidney pain
- kidney failure

Hypercalcemia affects about one-third of multiple myeloma patients.

Serum proteins

The accumulation of M-proteins in the serum (the liquid portion of the blood) may cause additional complications, such as hyperviscosity syndrome, or thickening of the blood (though rare in multiple myeloma patients). Symptoms of hyperviscosity include:

- fatigue
- headaches
- shortness of breath
- mental confusion
- chest pain
- kidney damage and failure
- vision problems
- Raynaud's phenomenon

Poor blood circulation, or Raynaud's phenomenon, can affect any part of the body, but particularly the fingers, toes, nose, and ears.

Cryoglobulinemia occurs when the protein in the blood forms particles under cold conditions. These particles can block small blood vessels and cause pain and numbness in the toes, fingers, and other extremities during cold weather.

Amyloidosis is a rare complication of multiple myeloma. It usually occurs in individuals whose plasma cells produce only Ig light chains. These Bence-Jones proteins combine with other serum proteins to form amyloid protein. This starchy substance can invade tissues, organs, and blood vessels. In particular, amyloid proteins can accumulate in the kidneys, where they block the tiny tubules that are the kidney's filtering system. Indicators of amyloidosis include:

- carpal tunnel syndrome
- kidney failure
- liver failure
- heart failure

Diagnosis

Blood and urine tests

Often, the original diagnosis of multiple myeloma is made from routine blood tests that are performed for other reasons. Blood tests may indicate:

- anemia
- abnormal red blood cells
- high serum protein levels
- how levels of normal antibody
- high calcium levels
- high blood urea nitrogen (BUN) levels
- high creatinine levels

Urea and creatinine normally are excreted in the urine. High levels of urea and creatinine in the blood indicate that the kidneys are not functioning properly to eliminate these substances.

Protein electrophoresis is a laboratory technique that uses an electrical current to separate the different proteins in the blood and urine on the basis of size and

KEY TERMS

Amyloidosis—A complication of multiple myeloma in which amyloid protein accumulates in the kidneys and other organs, tissues, and blood vessels.

Anemia—Any condition in which the red blood cell count is below normal.

Antibody—Immunoglobulin produced by immune system cells that recognizes and binds to a specific foreign substance (antigen).

Antigen—Foreign substance that is recognized by a specific antibody.

B-cell (B-lymphocyte)—Type of white blood cell that produces antibodies.

Bence-Jones protein—Light chain of an immunoglobulin that is overproduced in multiple myeloma and is excreted in the urine.

Beta 2-microglobulin—Protein produced by B-cells; high concentrations in the blood are indicative of multiple myeloma.

Cryoglobulinemia—Condition in which protein in the blood forms particles in the cold, blocking blood vessels, leading to pain and numbness of the extremities.

Electrophoresis—Use of an electrical field to separate proteins in a mixture (such as blood or urine), on the basis of the size and electrical charge of the proteins.

Hemoglobin—Protein in red blood cells that carries oxygen.

Hypercalcemia—Abnormally high levels of calcium in the blood.

Hyperviscosity—Thick, viscous blood, caused by the accumulation of large proteins, such as immunoglobulins, in the serum.

Immunoglobulin (Ig)—Antibody; large protein produced by B-cells that recognizes and binds to a specific antigen.

M-protein—Monoclonal or myeloma protein; paraprotein; abnormal antibody found in large amounts in the blood and urine of individuals with multiple myeloma.

Malignant—A characteristic of cancer cells that grow uncontrollably and invade other tissues.

Monoclonal—Identical cells or proteins; cells (clones) derived from a single, genetically-distinct cell, or proteins produced by these cells.

Monoclonal gammopathy of undetermined significance (MGUS)—Common condition in which M-protein is present, but there are no tumors or other symptoms of disease.

Neoplasm—Tumor or abnormal tissue, made up of rapidly growing cells.

Osteoblast—Bone-forming cell.

Osteoclast—Cell that absorbs bone.

Osteolytic lesion—Soft spot or hole in bone caused by cancer cells.

Osteoporosis—Condition in which the bones become weak and porous, due to loss of calcium and destruction of cells.

Paraprotein—M-protein; abnormal immunoglobulin produced in multiple myeloma.

Plasma cell—Type of white blood cell that produces antibodies; derived from an antigen-specific B-cell.

Platelet—Cell that is involved in blood clotting.

Stem cell—Undifferentiated cell that retains the ability to develop into any one of numerous cell types.

charge. Since all of the multiple myeloma M-proteins in the blood and urine are identical, electrophoresis of blood and urine from a patient with multiple myeloma shows a large M-protein spike, corresponding to the high concentration of monoclonal Ig. Electrophoresis of the urine also can detect Bence-Jones proteins.

Bones

A bone marrow aspiration utilizes a very thin, long needle to remove a sample of marrow from the hip bone. Alternatively, a bone marrow biopsy with a larger needle removes solid marrow tissue. The marrow is examined under the microscope for plasma cells and tumors. If 10% to 30% of the cells are plasma cells, multiple myeloma is the usual diagnosis.

X rays are used to detect osteoporosis, osteolytic lesions, and fractures. Computer-assisted tomography (CAT or CT) scans can detect lesions in both bone and soft tissue. **Magnetic resonance imaging** (MRI) may give a more detailed image of a certain bone or a region of the body.

Treatment

Related disorders

Monoclonal gammopathy of undetermined significance (MGUS) is a common condition in which a monoclonal Ig is detectable. However, there are no tumors or other symptoms of multiple myeloma. MGUS occurs in about 1% of the general population and in about 3% of those over age 70. Over a period of years, about 16% to 20% of those with MGUS will develop multiple myeloma or a related cancer called malignant lymphoma.

Occasionally, only a single plasmacytoma develops, either in the bone marrow (isolated plasmacytoma of the bone) or other tissues or organs (extramedullary plasmacytoma). Some individuals with solitary plasmacytoma may develop multiple myeloma.

Clinical stages

The Durie-Salmon system is used to stage multiple myeloma. Stage I multiple myeloma requires all of the following (1 gram = approx. 0.02 pints, 1 deciliter = approx. 0.33 ounces):

- hemoglobin (the oxygen-transporting molecule of red blood cells) above 10 grams/deciliter (g/dl)
- serum calcium below 12 mg/dl
- normal bone structure or only isolated plasmacytoma
- low M-protein, based on established guideline levels of Ig protein chains

Approximately 5% of multiple myeloma cases are not progressing at diagnosis, and may not progress for months or years. This is called smoldering myeloma. These patients have stage I blood chemistry but no symptoms.

Stage II multiple myeloma fits neither stage I nor stage III. Stage III multiple myeloma meets one or more of the following criteria:

- hemoglobin below 8.5 g/dl
- serum calcium above 12 mg/dl
- advanced bone lesions
- high M-protein

Each stage is subclassified as A or B, based on serum creatinine indicators of normal or abnormal kidney function. Most patients have stage III multiple myeloma at diagnosis.

Prognostic indicators

Prognostic indicators for multiple myeloma may be used instead of, or in addition to, the staging system described above. Prognostic indicators are laboratory tests that help to define the stage of the disease at diagnosis, and its progression during treatment. These indicators are:

- plasmablastic multiple myeloma (presence of plasmablasts, the precursor malignant plasma cells)
- plasma cell labeling index (the percentage of plasma cells that are actively dividing)
- beta 2-microglobulin, a protein secreted by B-cells that correlates with the myeloma cell mass (also indicates kidney damage)

Since multiple myeloma often progresses slowly, and since the treatments can be toxic, the disease may not be treated until M-protein levels in the blood are quite high. In particular, MGUS and smoldering myeloma may be followed closely but not treated. Solitary plasmacytomas are treated with radiation and/or surgery and followed closely with examinations and laboratory tests.

Chemotherapy

Chemotherapy, or treatment with anti-cancer drugs, is used for multiple myeloma. MP, a combination of the drugs melphalan and prednisone, is the standard treatment. Usually, the drugs are taken by mouth every 3 to 4 weeks for 6 to 9 months or longer, until the M-protein levels in the blood stop decreasing. MP usually results in a 50% reduction in M-protein.

Dexamethasone, a corticosteroid, sometimes is used to treat the elderly or those in poor health. It can drop the M-protein levels by 40% in untreated individuals and by 20% to 40% in patients who have not responded to previous treatment. Other chemotherapy drugs, including cyclophosphamide, carmustine, doxorubicin, vincristine, and chlorambucil, may be used as well.

Multiple myeloma usually recurs within a year after the end of chemotherapy. Although the chemotherapy can be repeated after each recurrence, it is progressively less responsive to treatment.

Side effects of chemotherapy may include:

- anemia
- hair loss
- nausea
- vomiting
- diarrhea
- mood swings
- swelling
- acne

These side effects disappear after treatment is discontinued.

Other drug treatments

Bisphosphonates are drugs that inhibit the activity of osteoclasts. These drugs can slow the progression of bone disease, reduce pain, and help prevent bone fractures. Different types of bisphosphonates inhibit osteoclasts in different ways. They also reduce the production of interleukin-6 by bone marrow cells. Laboratory studies suggest that bisphosphonates may kill or inhibit the growth of multiple myeloma cells. Pamidronate is the most common bisphosphonate for treating multiple myeloma.

The drug thalidomide appears to have several anti-myeloma activities. Thalidomide affects the immune system in various ways and it appears to inhibit myeloma cells, both directly and indirectly. It also inhibits the growth of new blood vessels that are needed by tumors. However, if thalidomide is taken during **pregnancy**, it can cause severe **birth defects** or death of the fetus.

The drug allopurinol may be used to reduce high blood levels of uric acid that result from kidney dysfunction. **Diuretics** can improve kidney function. Infections require prompt treatment with **antibiotics**.

BONE AND PERIPHERAL BLOOD STEM CELL TRANSPLANTATION. Bone marrow or peripheral blood stem cell transplantations (PBSCT) are used to replace the stem cells of the bone marrow following high-dosage chemotherapy. Chemotherapy destroys the bone marrow stem cells that are necessary to produce new blood cells. In an autologous transplant, the patient's bone marrow stem cells or peripheral blood stem cells (immature bone marrow cells found in the blood) are collected, treated with drugs to kill any myeloma cells, and frozen prior to chemotherapy. Growth factors are used to increase the number of peripheral stem cells prior to collection. A procedure called apheresis is used to collect the peripheral stem cells. Following high-dosage chemotherapy, the stem cells are reinjected into the individual. In an allogeneic transplant, the donor stem cells come from a genetically-related individual such as a sibling.

Other treatments

Blood transfusions may be required to treat severe anemia.

Plasmapheresis, or plasma exchange **transfusion**, may be used to thin the blood to treat hyperviscosity syndrome. In this treatment, blood is removed and passed through a machine that separates the plasma, containing the M-protein, from the red and white blood cells and platelets. The blood cells are transfused back into the patient, along with a plasma substitute or donated plasma.

Multiple myeloma may be treated with high-energy x rays directed at a specific region of the body. **Radiation therapy** is used for treating bone pain.

Alternative treatment

Interferon alpha, an immune-defense protein that is produced by some white blood cells and bone marrow cells, can slow the growth of myeloma cells. It usually is given to patients following chemotherapy, to prolong their remission. However, interferon may have toxic effects in older individuals with multiple myeloma.

Once multiple myeloma is in remission, calcium and vitamin D supplements can improve bone density. It is important not to take these supplements when the myeloma is active. Individuals with multiple myeloma must drink large amounts of fluid to counter the effects of hyperviscous blood.

Prognosis

The prognosis for individuals with MGUS or solitary plasmacytoma is very good. Most do not develop multiple myeloma. However, approximately 15% of all patients with multiple myeloma die within three months of diagnosis. About 60% respond to treatment and live for an average of two and a half to three years following diagnosis. Approximately 23% of patients die of other illnesses associated with advanced age.

The prognosis for a given individual may be based on the prognostic indicators described above. The median survival for those without plasmablasts, and with a low plasma cell labeling index (PCLI) and low beta 2-microglobulin, is 5.5 years. The median survival for patients with plasmablastic multiple myeloma, or with a high PCLI (1% or greater) and high beta 2-microglobulin (4 or higher), is 1.9 and 2.4 years, respectively. Many multiple myeloma patients are missing part or all of chromosome 13. The deletion of this chromosome, along with high beta 2-microglobulin, leads to a poor prognosis.

With treatment, multiple myeloma may go into complete remission. This is defined as:

- M-protein absent from the blood and urine
- myeloma cells not detectable in the bone marrow
- no clinical symptoms
- negative laboratory tests

However, with very sensitive testing, a few myeloma cells are usually detectable and eventually lead to a recurrence of the disease, in the bone or elsewhere in the body.

Prevention

There are no clearly-established risk factors for multiple myeloma and it is possible that a combination of factors interact to cause the disease. Thus, there is no method for preventing multiple myeloma.

Resources

BOOKS

Drum, David. *Making the Chemotherapy Decision,* 2nd ed. Los Angeles: Lowell House, 1996.

Holland, Jimmie C., and Sheldon Lewis. *The Human Side of Cancer: Living with Hope, Coping with Uncertainty.* New York: HarperCollins, 2000.

Longo, Dan L. "Plasma Cell Disorders." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Malpas, James S., D. E. Bergsagel, R. A. Kyle, et al, eds. *Myeloma: Biology and Management,* 2nd ed. Oxford: Oxford University Press, 1998.

ORGANIZATIONS

International Myeloma Foundation. 12650 Riverside Dr., Suite 206, North Hollywood, CA 91607. (800) 452-CURE. (818) 487-7455. <http://www.myeloma.org>. Information and support for patients and families and the scientific and medical communities.

The Leukemia and Lymphoma Society. 600 Third Avenue, New York, NY 10016. (800) 955-4572. (914) 949-5213. <http://www.leukemia-lymphoma.org>. Information, support, and guidance for patients and health care professionals.

Multiple Myeloma Research Foundation. 11 Forest Street, New Canaan, CT 06840. (203) 972-1250. <http://www.multiplemyeloma.org>. Information and research funding.

OTHER

"About Myeloma." *Multiple Myeloma Research Foundation.* 16 Apr. 2001. 15 June 2001 <http://www.multiplemyeloma.org/aboutmyeloma.html>.

Complementary and Alternative Therapies for Leukemia, Lymphoma, Hodgkin's Disease and Myeloma. The Leukemia and Lymphoma Society. 27 Mar. 2001. 15 June 2001 <http://www.leukemia-lymphoma.org>.

Facts and Statistics About Leukemia, Lymphoma, Hodgkin's Disease and Myeloma. The Leukemia and Lymphoma Society. 27 Mar. 2001. 15 Mar. 2001. <http://www.leukemia-lymphoma.org>.

"Multiple Myeloma." *Cancer Resource Center.* American Cancer Society. 16 Apr. 2001. 15 June 2001 <http://www3.cancer.org/cancerinfo>.

"Multiple Myeloma and Other Plasma Cell Neoplasms." *CancerNet* National Cancer Institute. Mar. 2001. 16 Apr. 2001. <http://cancernet.nci.nih.gov>.

Margaret Alic, Ph.D.

Multiple personality disorder

Definition

Multiple personality disorder, or MPD, is a mental disturbance classified as one of the **dissociative disorders** in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*). It has been renamed dissociative identity disorder (DID). MPD or DID is defined as a condition in which "two or more distinct identities or personality states" alternate in controlling the patient's consciousness and behavior. Note: "Split personality" is not an accurate term for DID and should not be used as a synonym for **schizophrenia**.

Description

The precise nature of DID (MPD) as well as its relationship to other mental disorders is still a subject of debate. Some researchers think that DID may be a relatively recent development in western society. It may be a culture-specific syndrome found in western society, caused primarily by both childhood **abuse** and unspecified long-term societal changes. Unlike depression or **anxiety disorders**, which have been recognized, in some form, for centuries, the earliest cases of persons reporting DID symptoms were not recorded until the 1790s. Most were considered medical oddities or curiosities until the late 1970s, when increasing numbers of cases were reported in the United States. Psychiatrists are still debating whether DID was previously misdiagnosed and underreported, or whether it is currently over-diagnosed. Because childhood trauma is a factor in the development of DID, some doctors think it may be a variation of **post-traumatic stress disorder** (PTSD). DID and PTSD are conditions where dissociation is a prominent mechanism. The female to male ratio for DID is about 9:1, but the reasons for the gender imbalance are unclear. Some have attributed the imbalance in reported cases to higher rates of abuse of female children; and some to the possibility that males with DID are underreported because they might be in prison for violent crimes.

The most distinctive feature of DID is the formation and emergence of alternate personality states, or "alters." Patients with DID experience their alters as distinctive individuals possessing different names, histories, and personality traits. It is not unusual for DID patients to have alters of different genders, sexual orientations, ages, or nationalities. Some patients have been reported with alters that are not even human; alters have been animals, or even aliens from outer space. The average DID patient has between two and 10 alters, but some have been reported with over one hundred.

Causes and symptoms

The severe dissociation that characterizes patients with DID is currently understood to result from a set of causes:

- an innate ability to dissociate easily
- repeated episodes of severe physical or sexual abuse in childhood

KEY TERMS

Alter—An alternate or secondary personality in a patient with DID.

Amnesia—A general medical term for loss of memory that is not due to ordinary forgetfulness. Amnesia can be caused by head injuries, brain disease, or epilepsy as well as by dissociation.

Depersonalization—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

Derealization—A dissociative symptom in which the external environment is perceived as unreal.

Dissociation—A psychological mechanism that allows the mind to split off traumatic memories or disturbing ideas from conscious awareness.

Dissociative identity disorder (DID)—Term that replaced Multiple Personality Disorder (MPD). A condition in which two or more distinctive identities or personality states alternate in controlling a person's consciousness and behavior.

Hypnosis—An induced trance state used to treat the amnesia and identity disturbances that occur in dissociative identity disorder (DID).

Multiple personality disorder (MPD)—The former, though often still used, term for dissociative identity disorder (DID).

Primary personality—The core personality of a DID patient. In women, the primary personality is often timid and passive, and may be diagnosed as depressed.

Trauma—A disastrous or life- threatening event that can cause severe emotional distress. DID is associated with trauma in a person's early life or adult experience.

- the lack of a supportive or comforting person to counteract abusive relative(s)
- the influence of other relatives with dissociative symptoms or disorders

The relationship of dissociative disorders to childhood abuse has led to intense controversy and lawsuits concerning the accuracy of childhood memories. The brain's storage, retrieval, and interpretation of childhood memories are still not fully understood.

The major dissociative symptoms experienced by DID patients are **amnesia**, depersonalization, derealization, and identity disturbances.

Amnesia

Amnesia in DID is marked by gaps in the patient's memory for long periods of their past, in some cases, their entire childhood. Most DID patients have amnesia, or "lose time," for periods when another personality is "out." They may report finding items in their house that they can't remember having purchased, finding notes written in different handwriting, or other evidence of unexplained activity.

Depersonalization

Depersonalization is a dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving. Some DID patients experience depersonalization as feeling to be outside of their body, or as watching a movie of themselves.

Derealization

Derealization is a dissociative symptom in which the patient perceives the external environment as unreal. Patients may see walls, buildings, or other objects as changing in shape, size, or color. DID patients may fail to recognize relatives or close friends.

Identity disturbances

Identity disturbances in DID result from the patient's having split off entire personality traits or characteristics as well as memories. When a stressful or traumatic experience triggers the reemergence of these dissociated parts, the patient switches — usually within seconds — into an alternate personality. Some patients have histories of erratic performance in school or in their jobs caused by the emergence of alternate personalities during examinations or other stressful situations. Patients vary with regard to their alters' awareness of one another.

Diagnosis

The diagnosis of DID is complex and some physicians believe it is often missed, while others feel it is over-diagnosed. Patients have been known to have been treated under a variety of other psychiatric diagnoses for a long time before being re-diagnosed with DID. The

average DID patient is in the mental health care system for six to seven years before being diagnosed as a person with DID. Many DID patients are misdiagnosed as depressed because the primary or "core" personality is subdued and withdrawn, particularly in female patients. However, some core personalities, or alters, may genuinely be depressed, and may benefit from antidepressant medications. One reason misdiagnoses are common is because DID patients may truly meet the criteria for **panic disorder** or somatization disorder.

Misdiagnoses include schizophrenia, borderline personality disorder, and, as noted, somatization disorder and panic disorder. DID patients are often frightened by their dissociative experiences, which can include losing awareness of hours or even days of time, meeting people who claim to know them by another name, or feeling "out of body." Persons with the disorder may go to emergency rooms or clinics because they fear they are going insane.

When a doctor is evaluating a patient for DID, he or she will first rule out physical conditions that sometimes produce amnesia, depersonalization, or derealization. These conditions include head injuries; brain disease, especially seizure disorders; side effects from medications; substance abuse or intoxication; **AIDS dementia** complex; or recent periods of extreme physical **stress** and sleeplessness. In some cases, the doctor may give the patient an electroencephalograph (EEG) to exclude epilepsy or other seizure disorders. The physician also must consider whether the patient is **malingering** and/or offering fictitious complaints.

If the patient appears to be physically normal, the doctor will next rule out psychotic disturbances, including schizophrenia. Many patients with DID are misdiagnosed as schizophrenic because they may "hear" their alters "talking" inside their heads. If the doctor suspects DID, he or she can use a screening test called the Dissociative Experiences Scale (DES). If the patient has a high score on this test, he or she can be evaluated further with the Dissociative Disorders Interview Schedule (DDIS) or the Structured Clinical Interview for *DSM-IV* Dissociative Disorders (SCID-D). The doctor may also use the Hypnotic Induction Profile (HIP) or a similar test of the patient's hypnotizability.

Treatment

Treatment of DID may last for five to seven years in adults and usually requires several different treatment methods.

Psychotherapy

Ideally, patients with DID should be treated by a therapist with specialized training in dissociation. This specialized training is important because the patient's personality switches can be confusing or startling. In addition, many patients with DID have hostile or suicidal alter personalities. Most therapists who treat DID patients have rules or contracts for treatment that include such issues as the patient's responsibility for his or her safety. Psychotherapy for DID patients typically has several stages: an initial phase for uncovering and "mapping" the patient's alters; a phase of treating the traumatic memories and "fusing" the alters; and a phase of consolidating the patient's newly integrated personality.

Most therapists who treat multiples, or DID patients, recommend further treatment after personality integration, on the grounds that the patient has not learned the social skills that most people acquire in adolescence and early adult life. In addition, **family therapy** is often recommended to help the patient's family understand DID and the changes that occur during personality reintegration.

Many DID patients are helped by group as well as individual treatment, provided that the group is limited to people with dissociative disorders. DID patients sometimes have setbacks in mixed therapy groups because other patients are bothered or frightened by their personality switches.

Medications

Some doctors will prescribe tranquilizers or antidepressants for DID patients because their alter personalities may have **anxiety** or **mood disorders**. However, other therapists who treat DID patients prefer to keep medications to a minimum because these patients can easily become psychologically dependent on drugs. In addition, many DID patients have at least one alter who abuses drugs or alcohol, substances which are dangerous in combination with most tranquilizers.

Hypnosis

While not always necessary, hypnosis is a standard method of treatment for DID patients. Hypnosis may help patients recover repressed ideas and memories. Further, hypnosis can also be used to control problematic behaviors that many DID patients exhibit, such as **self-mutilation**, or eating disorders like **bulimia nervosa**. In the later stages of treatment, the therapist may use hypnosis to "fuse" the alters as part of the patient's personality integration process.

Alternative treatment

Alternative treatments that help to relax the body are often recommended for DID patients as an adjunct to psychotherapy and/or medication. These treatments include **hydrotherapy**, botanical medicine (primarily herbs that help the nervous system), therapeutic massage, and **yoga**.

Homeopathic treatment can also be effective for some people. **Art therapy** and the keeping of journals are often recommended as ways that patients can integrate their past into their present life. **Meditation** is usually discouraged until the patient's personality has been reintegrated.

Prognosis

Some therapists believe that the prognosis for recovery is excellent for children and good for most adults. Although treatment takes several years, it is often ultimately effective. As a general rule, the earlier the patient is diagnosed and properly treated, the better the prognosis.

Prevention

Prevention of DID requires intervention in abusive families and treating children with dissociative symptoms as early as possible.

Resources

BOOKS

"Dissociative Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Napier, Nancy J. *Getting Through The Day: Strategies for Adults Hurt as Children*. New York: W. W. Norton & Co., 1994.

Nemiah, John C. "Psychoneurotic Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

Noll, Richard. *The Encyclopedia of Schizophrenia and the Psychotic Disorders*. New York: Facts On File, 1992.

Pascuzzi, Robert M., and Mary C. Weber. "Conversion Disorders, Malingering, and Dissociative Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

van der Kolk, Bessel A., and Onno van der Hart. "The Intrusive Past: The Flexibility of Memory and the Engraving of Trauma." In *Trauma: Explorations in Memory*, ed. Cathy Caruth. Baltimore: The Johns Hopkins University Press, 1995.

Rebecca J. Frey

Multiple pregnancy

Definition

Multiple **pregnancy** is a pregnancy where more than one fetus develops simultaneously in the womb.

KEY TERMS

Amniotic membranes—A thin membrane surrounding the fetus and containing serous fluid.

Genes—Hereditary determinants of identifying characteristics.

Gestational—Refers to pregnancy.

Ovulate—To release a mature egg for fertilization.

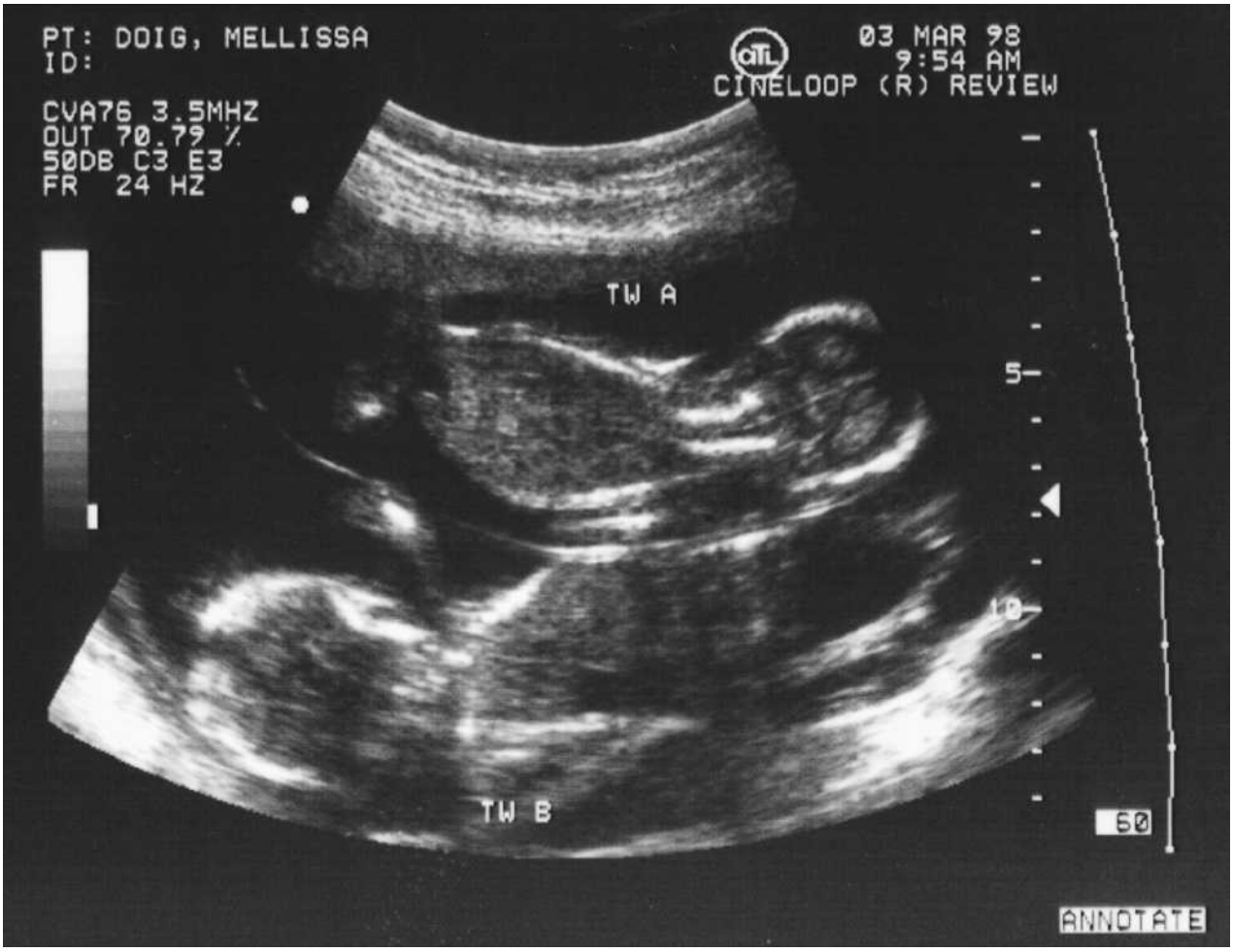
Zygote—The earliest stage of a fertilized egg.

Description

Twins happen naturally about one in every 100 births. There are two types of twinning—identical and fraternal. Identical twins represent the splitting of a single fertilized zygote (union of two gametes or male/female sex cells that produce a developing fetus) into two separate individuals. They usually, but not always, have identical genes. When they do not separate completely, the result is Siamese (or conjoined) twins. Fraternal twins are three times as common as identical twins. They occur when two eggs are fertilized by separate sperm. Each has a different selection of its parents' genes. The natural incidence of multiple pregnancy has been upset by advances in fertility treatments, resulting in higher rates of multiple births in the United States. All these children are fraternal; they each arose from a separate egg and a separate sperm. Cloning produces identical twins.

The human female is designed to release one egg every menstrual cycle. A hormone called progesterone, released by the first egg to be produced, prevents any other egg from maturing during that cycle. When this control fails, fertilization of more than one egg is possible. Fertility drugs inhibit these controls, allowing multiple pregnancy to occur. Multiple pregnancy is more difficult and poses more health risks than single pregnancy. Premature birth is greater with each additional fetus.

The problem with multiple births is that there is only so much room in even the most accommodating womb (uterus). Babies need to reach a certain size and gestational age before they can survive outside the uterus. **Prematurity** is the constant threat of multiple pregnancies. Twins have five times the **death** rate of single births. Triplets and higher die even more often. The principle threat of prematurity is that the lungs are not fully developed. A disease called hyaline membrane disease afflicts premature infants. Their lungs do not stay open after their first breath because they lack a chemical called surfactant. Survival of premature infants was greatly improved when



An ultrasound image of identical twin male fetuses. The distortion is due to "twin B" being closer to the monitor. *(Courtesy of Melissa Walsh Doig.)*

surfactant was finally synthesized in a form that could be of benefit to premature babies. Tiny babies also have trouble regulating their body temperature.

Causes and symptoms

Fertility drugs prevent the normal process of single ovulation by permitting more than one egg at a time to mature and ovulate (move from the ovary to the uterus in anticipation of fertilization). This happens naturally to produce fraternal twins. The first drug to accomplish this was clomiphene. Subsequently, two natural hormones—follicle stimulating hormone and chorionic gonadotrophin—were developed and used.

Diagnosis

Multiple pregnancies cause the uterus to grow faster than usual. Obstetricians can detect this unusually rapid growth as the pregnancy progresses. Before birth, an ultrasound will also detect multiple babies in the uterus. After birth, physical appearance or a careful examination of the placenta and amniotic membranes will usually reveal whether the babies were in the same water bag or separate ones. One bag means identical twins.

A multiple pregnancy almost always means increased monitoring and surveillance for complications. This often means more frequent visits to the healthcare provider, serial ultrasounds to make sure that the babies are growing adequately, **amniocentesis** to check for lung development, and close monitoring for preterm labor.

Treatment

Mothers may be put on bedrest during a multiple pregnancy, in order to try to prevent pre-term labor and delivery. If preterm labor is impossible to control at home, the mother may be hospitalized, and medication may be used to attempt to control contractions and dilata-

tion of the cervix. Multiple pregnancies more often end in cesarean deliveries than singleton pregnancies.

Babies from multiple pregnancies are often born early, and may require longer-than-normal hospitalization. The babies may need assistance with breathing, careful control of body temperature within an incubator, and surveillance for other complications that frequently beset pre-term babies. While premature babies are fragile in many other ways, modern methods of intensive care have successfully stabilized babies as small as one pound.

Alternative treatment

There are no specific treatments to alleviate medical difficulties caused by multiple pregnancies, however there are supportive measures that may help both mother and children recover from the birthing process. There are treatments to encourage breast milk production and to combat postpartum difficulties. Various homeopathic remedies and massage can be helpful to both mother and children during the early adjustment period after birth.

Prognosis

With modern medical advances and excellent prenatal care, many multiple pregnancies reach fruition without difficulties. If the babies are born prematurely, immediate medical care increases the chance of survival without any complications.

Resources

BOOKS

Chitkara, Usha and Richard L. Berkowitz. "Multiple Gestations." In *Obstetrics - Normal and Problem Pregnancies*. New York: Churchill Livingstone, 1996.

Cunningham, F. Gary, et al., eds. *Williams Obstetrics*. Stamford, CT: Appleton & Lange, 1997.

PERIODICALS

Evans, M.I., et al. "Selective Reduction For Multifetal Pregnancy. Early Opinions Revisited." *Journal of Reproductive Medicine* 42(December 1997): 771-777.

Evans, M.I., et al. "What Are The Ethical And Technical Problems Associated With Multifetal Pregnancy Reduction." *Clinical Obstetrics and Gynecology* 41(March 1998): 46-54.

Hecht, B.R., and M.W. Magoon. "Can The Epidemic Of Iatrogenic Multiples Be Conquered?" *Clinical Obstetrics and Gynecology* 41(March 1998): 126-137.

Kok, J.H., et al. "Outcome Of Very Preterm Small For Gestational Age Infants: The First Nine Years Of Life." *British Journal of Obstetrics and Gynaecology* 105(February 1998): 162-168.

Kousta, E., D.M. White, and S. Franks. "Modern Use Of Clomiphene Citrate In Induction Of Ovulation." *Human Reproduction Update* 3(July 1997): 359-365.

Styrcula, L. "Code Seven: The Birth Of The Septuplets." *Nursing Spectrum* 9(February 1998):14-15.

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Multiple sclerosis

Definition

Multiple sclerosis (MS) is a chronic autoimmune disorder affecting movement, sensation, and bodily functions. It is caused by destruction of the myelin insulation covering nerve fibers (neurons) in the central nervous system (brain and spinal cord).

Description

MS is a nerve disorder caused by destruction of the insulating layer surrounding neurons in the brain and spinal cord. This insulation, called myelin, helps electrical signals pass quickly and smoothly between the brain and the rest of the body. When the myelin is destroyed, nerve messages are sent more slowly and less efficiently. Patches of scar tissue, called plaques, form over the affected areas, further disrupting nerve communication. The symptoms of MS occur when the brain and spinal cord nerves no longer communicate properly with other parts of the body. MS causes a wide variety of symptoms and can affect vision, balance, strength, sensation, coordination, and bodily functions.

Multiple sclerosis affects more than a quarter of a million people in the United States. Most people have their first symptoms between the ages of 20 and 40; symptoms rarely begin before 15 or after 60. Women are almost twice as likely to get MS as men, especially in their early years. People of northern European heritage are more likely to be affected than people of other racial backgrounds, and MS rates are higher in the United States, Canada, and Northern Europe than in other parts of the world. MS is very rare among Asians, North and South American Indians, and Eskimos.

Causes and symptoms

Causes

Multiple sclerosis is an autoimmune disease, meaning its cause is an attack by the body's own immune system. For unknown reasons, immune cells attack and destroy the myelin sheath that insulates neurons in the brain and spinal cord. This myelin sheath, created by other brain cells called glia, speeds transmission and prevents electri-

cal activity in one cell from short-circuiting to another cell. Disruption of communication between the brain and other parts of the body prevent normal passage of sensations and control messages, leading to the symptoms of MS. The demyelinated areas appear as plaques, small round areas of gray neuron without the white myelin covering. The progression of symptoms in MS is correlated with development of new plaques in the portion of the brain or spinal cord controlling the affected areas. Because there appears to be no pattern in the appearance of new plaques, the progression of MS can be unpredictable.

Despite considerable research, the trigger for this autoimmune destruction is still unknown. At various times, evidence has pointed to genes, environmental factors, viruses, or a combination of these.

The risk of developing MS is higher if another family member is affected, suggesting the influence of genetic factors. In addition, the higher prevalence of MS among people of northern European background suggests some genetic susceptibility.

The role of an environmental factor is suggested by studies of the effect of migration on the risk of developing MS. Age plays an important role in determining this change in risk—young people in low-risk groups who move into countries with higher MS rates display the risk rates of their new surroundings, while older migrants retain the risk of their original home country. One interpretation of these studies is that an environmental factor, either protective or harmful, is acquired in early life; the risk of disease later in life reflects the effects of the early environment.

These same data can be used to support the involvement of a slow-acting virus, one that is acquired early on but begins its destructive effects much later. Slow viruses are known to cause other diseases, including **AIDS**. In addition, viruses have been implicated in other autoimmune diseases. Many claims have been made for the role of viruses, slow or otherwise, as the trigger for MS, but as of 2001 no strong candidate has emerged.

How a virus could trigger the autoimmune reaction is also unclear. There are two main models of virally induced autoimmunity. The first suggests the immune system is actually attacking a virus (one too well-hidden for detection in the laboratory), and the myelin damage is an unintentional consequence of fighting the infection. The second model suggests the immune system mistakes myelin for a viral protein, one it encountered during a prior infection. Primed for the attack, it destroys myelin because it resembles the previously-recognized viral invader.

Either of these models allows a role for genetic factors, since certain genes can increase the likelihood of autoimmunity. Environmental factors as well might change the sensitivity of the immune system or interact with myelin to provide the trigger for the secondary immune response. Possible environmental triggers that have been invoked in MS include viral infection, trauma, electrical injury, and chemical exposure, although controlled studies do not support a causative role.

Symptoms

The symptoms of multiple sclerosis may occur in one of three patterns:

- The most common pattern is the "relapsing-remitting" pattern, in which there are clearly defined symptomatic attacks lasting 24 hours or more, followed by complete or almost complete improvement. The period between attacks may be a year or more at the beginning of the disease, but may shrink to several months later on. This pattern is especially common in younger people who develop MS.
- In the "primary progressive" pattern, the disease progresses without remission or with occasional plateaus or slight improvements. This pattern is more common in older people.
- In the "secondary progressive" pattern, the person with MS begins with relapses and remissions, followed by more steady progression of symptoms.

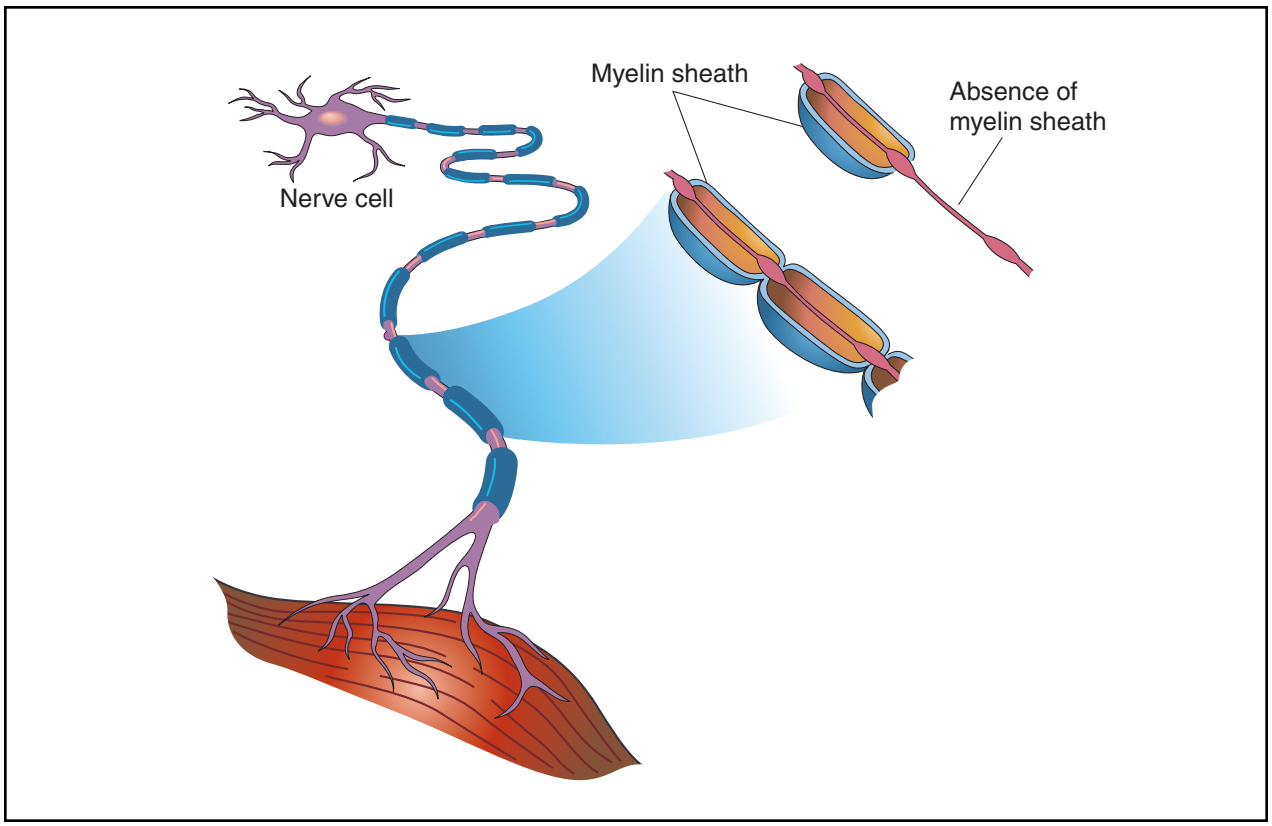
Between 10–20% of people have a benign type of MS, meaning their symptoms progress very little over the course of their lives.

Because plaques may form in any part of the central nervous system, the symptoms of MS vary widely from person-to-person and from stage-to-stage of the disease. Initial symptoms often include:

- muscle weakness, causing difficulty walking
- loss of coordination or balance
- numbness, "pins and needles," or other abnormal sensations
- visual disturbances, including blurred or double vision

Later symptoms may include:

- **fatigue**
- muscle spasticity and stiffness
- tremors
- paralysis
- **pain**
- vertigo
- speech or swallowing difficulty
- loss of bowel and bladder control
- incontinence, **constipation**
- sexual dysfunction



Multiple sclerosis (MS) is an autoimmune disease in which immune cells attack and destroy the myelin sheath which stimulates neurons in the brain and spinal cord. When the myelin is destroyed, nerve messages are sent more slowly and less efficiently. Scar tissue then forms over the affected areas, disrupting nerve communication. MS symptoms occur when the brain and spinal cord nerves cease to communicate properly with other parts of the body. *(Illustration by Electronic Illustrators Group.)*

• cognitive changes

Weakness in one or both legs is common, and may be the first symptom noticed by a person with MS. Muscle spasticity, or excessive tightness, is also common and may be more disabling than weakness.

Double vision or eye tremor (**nystagmus**) may result from involvement of the nerve pathways controlling movement of the eye muscles. Visual disturbances result from involvement of the optic nerves (optic neutritis) and may include development of blind spots in one or both eyes, changes in color vision, or blindness. **Optic neuritis** usually involves only one eye at a time and is often associated with movement of the affected eye.

More than half of all people affected by MS have pain during the course of their disease, and many experience chronic pain, including pain from spasticity. Acute pain occurs in about 10% of cases. This pain may be a sharp, stabbing pain especially in the face, neck, or down the back. Facial numbness and weakness are also common.

Cognitive changes, including memory disturbances, depression, and personality changes, are found in people affected by MS, though it is not entirely clear whether these changes are due primarily to the disease or to the psychological reaction to it. Depression may be severe enough to require treatment in up to 25% of those with MS. A smaller number of people experience disease-related euphoria, or abnormally elevated mood, usually after a long disease duration and in combination with other psychological changes.

Symptoms of MS may be worsened by heat or increased body temperature, including **fever**, intense physical activity, or exposure to sun, hot baths, or showers.

Diagnosis

There is no single test that confirms the diagnosis of multiple sclerosis, and there are a number of other diseases with similar symptoms. While one person's diagnosis may be immediately suggested by her symptoms and history, another's may not be confirmed without multiple tests and prolonged observation. The distribution of symptoms is important: MS affects multiple areas of the body over time. The pattern of symptoms is also

critical, especially evidence of the relapsing- remitting pattern, so a detailed medical history is one of the most important parts of the diagnostic process. A thorough search to exclude other causes of a patient's symptoms is especially important if the following features are present: 1) family history of neurologic disease, 2) symptoms and findings attributable to a single anatomic location, 3) persistent back pain, 4) age of onset over 60 or under 15 years of age, or 5) progressively worsening disease.

In addition to the medical history and a standard neurological exam, several lab tests are used to help confirm or rule out a diagnosis of MS:

- Magnetic resonance imaging (MRI) can reveal plaques on the brain and spinal cord. Gadolinium enhancement can distinguish between old and new plaques, allowing a correlation of new plaques with new symptoms. Plaques may be seen in several other diseases as well, including encephalomyelitis, neurosarcoidosis, and cerebral lupus. Plaques on MRI may be difficult to distinguish from small strokes, areas of decreased blood flow, or changes seen with trauma or normal **aging**.
- A lumbar puncture, or spinal tap, is done to measure levels of immune proteins, which are usually elevated in the cerebrospinal fluid of a person with MS. This test may not be necessary if other tests are diagnostic.
- Evoked potential tests, electrical tests of conduction speed in the nerves, can reveal reduced speeds consistent with the damage caused by plaques. These tests may be done with small electrical charges applied to the skin (somatosensory evoked potential), with light patterns flashed on the eyes (visual evoked potential), or with sounds presented to the ears (auditory evoked potential).

The clinician making the diagnosis, usually a neurologist, may classify the disease as "definite MS," meaning the symptoms and test results all point toward MS as the cause. "Probable MS" and "possible MS" reflect less certainty and may require more time to pass to observe the progression of the disease and the distribution of symptoms.

Treatment

The three major drugs previously approved for the treatment of MS affect the course of the disease. None of these drugs is a cure, but they can slow disease progression in many patients.

Known as the ABC drugs, Avonex and Betaseron are forms of the immune system protein beta interferon, while Copaxone is glatiramer acetate (formerly called copolymer-1). All three have been shown to reduce the rate of relapses in the relapsing-remitting form of MS. Different measurements from tests of each have demonstrated other benefits as well: Avonex may slow the progress of physical impairment, Betaseron may reduce the severity of symptoms, and Copaxone may decrease disability. All three drugs are administered by injection.

Two major clinical studies were recently completed that focused on the question of whether disease-modifying therapy known to slow the disease, can postpone the development of clinically definitive MS in high risk patients. Data presented at the annual meeting of the American Academy of Neurology in May, 2000, highlighted the different effects of interferon therapy when it was initiated at the earliest recognizable stages of MS versus later. Previous studies with interferon beta-1b (Betaseron) and interferon beta-1a (Avonex, Rebif) clearly demonstrated benefits in patients with relapsing forms of MS. Moreover, previous treatment with high-dose **corticosteroids** also delays, but does not prevent the ultimate development of MS. The encouraging message from the CHAMPS study in the United states and the ETOMS study in Europe is that early intervention can reduce the probability of developing clinically definitive MS.

Although the ABC drugs stop relapses and may keep patients in relatively good health for the short-term, their long-term success has not been proven and they don't work well for patients who have reached a steadily progressive stage of MS. In the meantime, new approaches to using current therapies are being researched especially using combinations of different types of agents when one agent alone is not effective. Clinical trials are now evaluating the safety and efficacy of combining cyclophosphamide (Cytoxan) and methylprednisolone (Medrol) in patients who do not respond to the ABC drus, and of adding mitoxantrone (Novantrone), prednisone (Prelone), azathioprine (Imuran), or methotrexate (Rheumatrex) to beta-interferon for further benefit.

In addition, Miloxzantrone HCI (novantrone), a drug approved for **cancer** treatment, has been approved for treating patients with advanced or chronic multiple sclereosis.In clinical trials, mitoxantrone reduced the number of relapse episodes and slowed down the disease. Reserved for progressive forms of MS, it is given intravenously by a doctor to help maintain mobility and reduce the number of flare-ups. However, there are serious side effects with the drug including heart problems, nausea, and hair thinning.

As reported in the Spring, 2001, Volume 19, No 2 issue of InsideMS, the FDA recently approved the Copaxone Autoject and the Mixject vial adapters to help people using Copaxone self administer the drug. The autoject keeps the syringe steady and hides the needle. The same syringe may be used for both mixing and injecting with the Mixject vial adapters. A similar device is available for

patients using Betassseron. Some patients are using the needlefree Biojector 2000 which uses a CO@ cartridge to deliver doses of medication through the skin. The FDA has not approved its use and patients should discuss this with their physician for its use with either Copaxone or Betaseron. Avonex must be injected in the muscle.

Immunosuppressant drugs have been used for many years to treat acute exacerbations (relapses). Drugs used include corticosteroids such as prednisone and methylprednisone; the hormone adrenocorticotropic hormone (ACTH); and azathioprine. Recent studies indicate that several days of intravenous methylprednisone may be more effective than other immunosuppressant treatments for acute symptoms. This treatment may require hospitalization.

MS causes a large variety of symptoms, and the treatments for these are equally diverse. Most symptoms can be treated and complications avoided with good care and attention from medical professionals. Good health and **nutrition** remain important preventive measures. **Vaccination** against **influenza** can prevent respiratory complications, and contrary to earlier concerns, is not associated with worsening of symptoms. Preventing complications such as **pneumonia**, bed sores, injuries from falls, or urinary infection requires attention to the primary problems which may cause them. Shortened life spans with MS are almost always due to complications rather than primary symptoms themselves.

Physical therapy helps the person with MS to strengthen and retrain affected muscles; to maintain range of motion to prevent muscle stiffening; to learn to use assistive devices such as canes and walkers; and to learn safer and more energy-efficient ways of moving, sitting, and transferring. **Exercise** and stretching programs are usually designed by the physical therapist and taught to the patient and caregivers for use at home. Exercise is an important part of maintaining function for the person with MS. Swimming is often recommended, not only for its low-impact workout, but also because it allows strenuous activity without overheating.

Occupational therapy helps the person with MS adapt to her environment and adapt the environment to her. The occupational therapist suggests alternate strategies and assistive devices for activities of daily living, such as dressing, feeding, and washing, and evaluates the home and work environment for safety and efficiency improvements that may be made.

Training in bowel and bladder care may be needed to prevent or compensate for incontinence. If the urge to urinate becomes great before the bladder is full, some drugs may be helpful, including propantheline bromide (Probanthine), oxybutynin chloride (Ditropan), or imipramine (Tofranil). Baclofen (Lioresal) may relax the sphincter muscle, allowing full emptying. Intermittent catheterization is effective in controlling bladder dysfunction. In this technique, a catheter is used to periodically empty the bladder.

Spasticity can be treated with oral medications, including baclofen and diazepam (Valium), or by injection with botulinum toxin (Botox). Spasticity relief may also bring relief from chronic pain. Other more acute types of pain may respond to carbamazepine (Tegretol) or diphenylhydantoin (Dilantin). **Low back pain** is common from increased use of the back muscles to compensate for weakened legs. Physical therapy and over-the-counter pain relievers may help.

Fatigue may be partially avoidable with changes in the daily routine to allow more frequent rests. Amantadine (Symmetrel) and pemoline (Cylert) may improve alertness and lessen fatigue. Visual disturbances often respond to corticosteroids. Other symptoms that may be treated with drugs include seizures, vertigo, and tremor.

Myloral, an oral preparation of bovine myelin, has recently been tested in clinical trials for its effectiveness in reducing the frequency and severity of relapses. Preliminary data indicate no difference between it and placebo.

Alternative treatment

Bee venom has been suggested as a treatment for MS, but no studies or objective reports support this claim.

In British studies, marijuana has been shown to have variable effects on the symptoms of MS. Improvements have been documented for tremor, pain, and spasticity, and worsening for posture and balance. Side effects have included weakness, dizziness,relaxation, and incoordination, as well as euphoria. As a result, marijuana is not recommended as an alternative treatment.

Some studies support the value of high doses of **vitamins**, **minerals**, and other dietary supplements for controlling disease progression or improving symptoms. Alpha-linoleic and linoleic acids, as well as selenium and vitamin E, have shown effectiveness in the treatment of MS. The selenium and vitamin E act as antioxidants. In addition, the Swank diet (low in saturated fats), maintained over a long period of time, may retard the disease process.

Removal of mercury fillings has been touted as a possible cure, but is of no proven benefit.

Studies have also shown that t'ai chi can be an effective therapy for MS because it works to improve balance and increase strength.

There are conflicting views about **Echinacea** and its benefit to MS. Some medicine books recommend Echi-

KEY TERMS

Clinical trial—All new drugs undergo clinical trials before approval. Clinical trials are carefully conducted tests in which effectiveness and side effects are studied, with the placebo effect eliminated.

Evoked potentials—Tests that measure the brain's electrical response to stimulation of sensory organs (eyes or ears) or peripheral nerves (skin). These tests may help confirm the diagnosis of multiple sclerosis.

Myelin—A layer of insulation that surrounds the nerve fibers in the brain and spinal cord.

Plaque—Patches of scar tissue that form where the layer of yelin covering the nerve fibers is destroyed by the multiple sclerosis disease process.

Primary progressive—A pattern of symptoms of multiple sclerosis in which the disease progresses without remission, or with occasional plateaus or slight improvements.

Relapsing-remitting—A pattern of symptoms of multiple sclerosis in which symptomatic attacks occur that last 24 hours or more, followed by complete or almost complete improvement.

Secondary progressive—A pattern of symptoms of multiple sclerosis in which there are relapses and remissions, followed by more steady progression of symptoms.

nacea for people with MS. However, Echinacea appears to stimulate different parts of the immune system, particularly immune cells known as macrophages. In MS these cells are very active already and further stimulation could worsen the disease.

Prognosis

It is difficult to predict how multiple sclerosis will progress in any one person. Most people with MS will be able to continue to walk and function at their work for many years after their diagnosis. The factors associated with the mildest course of MS are being female, having the relapsing-remitting form, having the first symptoms at a younger age, having longer periods of remission between relapses, and initial symptoms of decreased sensation or vision rather than of weakness or incoordination.

Less than 5% of people with MS have a severe progressive form, leading to **death** from complications within five years. At the other extreme, 10-20% have a benign form, with a very slow or no progression of their symptoms. The most recent studies show that about seven out of 10 people with MS are still alive 25 years after their diagnosis, compared to about nine out of 10 people of similar age without disease. On average, MS shortens the lives of affected women by about six years, and men by 11 years. Suicide is a significant cause of death in MS, especially in younger patients.

The degree of disability a person experiences five years after onset is, on average, about three-quarters of the expected disability at 10–15 years. A benign course for the first five years usually indicates the disease will not cause marked disability.

Prevention

There is no known way to prevent multiple sclerosis. Until the cause of the disease is discovered, this is unlikely to change. Good nutrition; adequate rest; avoidance of **stress**, heat, and extreme physical exertion; and good bladder hygiene may improve quality of life and reduce symptoms.

Resources

BOOKS

Holland, Nancy, T. Jock Murray, and Stephen Reingold. *Multiple Sclerosis: A Guide for the Newly Diagnosed*. Demos Vermande, 1996.

Kraft, Georg H. and Catanzaro, Marci. *Living with Multiple Sclerosis: A Wellness Approach*. Demos Medical Publishing, 2000.

Matthews, Bryan. *Multiple Sclerosis: The Facts*. New York: Oxford University Press, 993.

Sibley, William. *Therapeutic Claims in Multiple Sclerosis: A Guide to Treatments*. 4th ed. Demos Vermande, 1996.

Swank, R.L., and M.H. Pullen. *The Multiple Sclerosis Diet Book*. Garden City, NY: Doubleday, 1977.

ORGANIZATION

ABLEDATA Adaptive Equipment Center. 8455 Colesville Road, Suite 935, Silver Spring, MD 20910-3319. (800) 227-0216.

International MS Support foundation, PO Box 90154, Tucson, Arizona. <http://www.imssf.org>.

Multiple Sclerosis Foundation, Inc., 6350 North Andrews Ave., Fort Lauderdale, Florida 33309. 800-441-7055. <http://www.msfacts.org>.

The National Multiple Sclerosis Society. 733 Third Avenue, New York, NY 10017. (800) FIGHT-MS (800-344-4867). <http://www.nmss.org>.

Ruthan Brodsky

Mumps

Definition

Mumps is a relatively mild, short-term viral infection of the salivary glands that usually occurs during childhood. Typically, mumps is characterized by a painful swelling of both cheek areas, although the person could have swelling on one side or no perceivable swelling at all. The salivary glands are also called the parotid glands, therefore, mumps is sometimes referred to as an inflammation of the parotid glands (epidemic parotitis). The word mumps comes from an old English dialect, meaning lumps or bumps within the cheeks.

A young child with mumps. *Photo Researchers. Reproduced by permission.)*

Description

Mumps is a very contagious infection that spreads easily in highly populated areas, such as schools. Although not as contagious as **measles** or **chickenpox**, mumps was once quite common. Prior to the release of a mumps vaccine in the United States in 1967, approximately 92% of all children had been exposed to mumps by the age of 15. In these pre-vaccine years, most children contracted mumps between the ages of four and seven. Mumps epidemics came in two to five year cycles. The greatest mumps epidemic was in 1941 when approximately 250 cases were reported for every 100,000 people. In 1968, the year after the live mumps vaccine was released, only 76 cases were reported for every 100,000 people. By 1985, less than 3,000 cases of mumps were reported throughout the entire United States, which works out to about 1 case per 100,000 people. The reason for the decline in mumps was the increased usage of the mumps vaccine. However, 1987 noted a five-fold increase in the incidence of the disease because of the reluctance of some states to adopt comprehensive school immunization laws. Since then, state-enforced school entry requirements have achieved student immunization rates of nearly 100% in kindergarten and first grade. In 1996, the Centers for Disease Control and Prevention (CDC) reported only 751 cases of mumps nationwide, or, in other words, about one case for every five million people.

Causes and symptoms

The virus that causes mumps is harbored in the saliva and is spread by sneezing, coughing, and other direct contact with another person's infected saliva. Once the person is exposed to the virus, symptoms generally occur in 14-24 days. Initial symptoms include chills, **headache**, loss of appetite, and a lack of energy. However, an infected person may not experience these initial symptoms. Swelling of the salivary glands in the face (parotitis) generally occurs within 12-24 hours of the above symptoms. Accompanying the swollen glands is **pain** on chewing or swallowing, especially with acidic beverages, such as lemonade. A **fever** as high as 104°F (40°C) is also common. Swelling of the glands reaches a maximum on about the second day and usually disappears by the seventh day. Once a person has contracted mumps, they become immune to the disease, despite how mild or severe their symptoms may have been.

While the majority of cases of mumps are uncomplicated and pass without incident, some complications can occur. Complications are, however, more noticeable in adults who get the infection. In 15% of cases, the covering of the brain and spinal cord becomes inflamed (**meningitis**). Symptoms of meningitis usually develop within four or five days after the first signs of mumps. These symptoms include a stiff neck, headache, vomiting, and a lack of energy. Mumps meningitis is usually resolved within seven days, and damage to the brain is exceedingly rare.

The mumps infection can spread into the brain causing inflammation of the brain (**encephalitis**). Symptoms of mumps encephalitis include the inability to feel pain, seizures, and high fever. Encephalitis can occur during the parotitis stage or one to two weeks later. Recovery from mumps encephalitis is usually complete, although complications, such as seizure disorders, have been noted. Only about 1 in 100 with mumps encephalitis dies from the complication.

About one-quarter of all post-pubertal males who contract mumps can develop a swelling of the scrotum (**orchitis**) about seven days after the parotitis stage. Symptoms include marked swelling of one or both testicles, severe pain, fever, nausea, and headache. Pain and swelling usually subside after five to seven days, although the testicles can remain tender for weeks.

KEY TERMS

Asymptomatic—Persons who carry a disease and may be capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Encephalitis—Inflammation of the brain.

Meningitis—Inflammation of the membranes covering the brain and spinal cord.

Orchitis—Inflammation or swelling of the scrotal sac containing the testicles.

Parotitis—Inflammation and swelling of the salivary glands.

Post-pubertal—After puberty, in males approximately after the age of 14 years.

Diagnosis

When mumps reaches epidemic proportions, diagnosis is relatively easy, because swollen salivary glands are so characteristic of the infection. With so many people vaccinated today, a case of mumps must be properly diagnosed in the event the salivary glands are swollen for reasons other than viral infection. For example, in persons with poor **oral hygiene**, the salivary glands can be infected with bacteria. In these cases, **antibiotics** are necessary. Also in rare cases, the salivary glands can become blocked, develop tumors, or swell due to the use of certain drugs, such as iodine. A test can be performed to determine whether the person with swelling of the salivary glands actually has the mumps virus.

Treatment

When mumps does occur, the illness is usually allowed to run its course. The symptoms, however, are treatable. Because of difficulty swallowing, the most important challenge is to keep the patient fed and hydrated. The individual should be provided a soft diet, consisting of cooked cereals, mashed potatoes, broth-based soups, prepared baby foods, or foods put through a home food processor. **Aspirin**, **acetaminophen**, or ibuprofen can relieve some of the pain due to swelling, headache, and fever. Avoid fruit juices and other acidic foods or beverages that can irritate the salivary glands. Avoid dairy products that can be hard to digest. In the event of complications, a physician should be contacted at once. For example, if orchitis occurs, a physician should be called. Also, supporting the scrotum in a cotton bed on an adhesive-tape bridge between the thighs can minimize tension. Ice packs are also helpful.

Alternative treatment

Acupressure can be used effectively to relieve pain caused by swollen glands. The patient can, by using the middle fingers, gently press the area between the jawbone and the ear for two minutes while breathing deeply.

A number of homeopathic remedies can be differentiated for the treatment of mumps. For example, belladonna may be useful for flushing, redness, and swelling. Bryonia (wild hops) may be useful for irritability, lack of energy, or thirst. Phytolacca (poke root) may be prescribed for extremely swollen glands. A homeopathic physician should always be consulted for appropriate doses for children, and remedies that do not work within one day should be stopped. A homeopathic preparation of the mumps virus can also be used prophylactically or as a treatment for the disease.

Several herbal remedies may be useful in helping the body recover from the infection or may help alleviate the discomfort associated with the disease. Echinacea (*Echinacea* spp.) can be used to boost the immune system and help the body fight the infection. Other herbs taken internally, such as cleavers (*Galium aparine*), calendula (*Calendula officinalis*), and phytolacca (poke root), target the lymphatic system and may help to enhance the activity of the body's internal filtration system. Since phytolacca can be toxic, it should only be used by patients under the care of a skilled practitioner. Topical applications are also useful in relieving the discomfort of mumps. A cloth dipped in a heated mixture of vinegar and cayenne (*Capsicum frutescens*) can be wrapped around the neck several times a day. Cleavers or calendula can also be combined with vinegar, heated, and applied in a similar manner.

Prognosis

When mumps is uncomplicated, prognosis is excellent. However, in rare cases, a relapse occurs after about two weeks. Complications can also delay complete recovery.

Prevention

A vaccine exists to protect against mumps. The vaccine preparation (MMR) is usually given as part of a combination injection that helps protect against measles, mumps, and **rubella**. MMR is a live vaccine administered in one dose between the ages of 12-15 months, four to six years, or 11-12 years. Persons who are unsure of their mumps history and/or mumps **vaccination** history should be vaccinated. Susceptible health care workers, especially those who work in hospitals, should be vaccinated. Because mumps is still prevalent throughout the world, susceptible persons over age one who are traveling abroad would benefit from receiving the mumps vaccine.

The mumps vaccine is extremely effective, and virtually everyone should be vaccinated against this disease. There are, however, a few reasons why people should NOT be vaccinated against mumps:

- Pregnant women who contract mumps during **pregnancy** have an increased rate of **miscarriage**, but not **birth defects**. As a result, pregnant women should not receive the mumps vaccine because of the possibility of damage to the fetus. Women who have had the vaccine should postpone pregnancy for three months after vaccination.
- Unvaccinated persons who have been exposed to mumps should not get the vaccine, as it may not provide protection. The person should, however, be vaccinated if no symptoms result from the exposure to mumps.
- Persons with minor fever-producing illnesses, such as an upper respiratory infection, should not get the vaccine until the illness has subsided.
- Because mumps vaccine is produced using eggs, individuals who develop **hives**, swelling of the mouth or throat, **dizziness**, or breathing difficulties after eating eggs should not receive the mumps vaccine.
- Persons with immune deficiency diseases and/or those whose immunity has been suppressed with anti-cancer drugs, **corticosteroids**, or radiation should not receive the vaccine. Family members of immunocompromised people, however, should get vaccinated to reduce the risk of mumps.
- The CDC recommends that all children infected with human **immunodeficiency** disease (HIV) who are asymptomatic should receive the MMR vaccine at 15 months of age.

Ron Gasbarro, PharmD

Munchausen syndrome

Definition

Munchausen syndrome is a psychiatric disorder that causes an individual to self-inflict injury or illness or to fabricate symptoms of physical or mental illness, in order to receive medical care or hospitalization. In a variation of the disorder, Munchausen by proxy (MSBP), an individual, typically a mother, intentionally causes or fabricates illness in a child or other person under her care.

Description

Munchausen syndrome takes its name from Baron Karl Friederich von Munchausen, an 18th century German military man known for his tall tales. The disorder first appeared in psychiatric literature in the early 1950s when it was used to describe patients who sought hospitalization by inventing symptoms and complicated medical histories, and/or inducing illness and injury in themselves. Categorized as a factitious disorder (a disorder in which the physical or psychological symptoms are under voluntary control), Munchausen's syndrome seems to be motivated by a need to assume the role of a patient. Unlike **malingering**, there does not seem to be any clear secondary gain (e.g., money) in Munchausen syndrome.

Individuals with Munchausen by proxy syndrome use their child (or another dependent person) to fulfill their need to step into the patient role. The disorder most commonly victimizes children from birth to 8 years old. Parents with MSBP may only exaggerate or fabricate their child's symptoms, or they may deliberately induce symptoms through various methods, including **poisoning**, suffocation, **starvation**, or infecting the child's bloodstream.

Causes and symptoms

The exact cause of Munchausen syndrome is unknown. It has been theorized that Munchausen patients are motivated by a desire to be cared for, a need for attention, dependency, an ambivalence toward doctors, or a need to suffer. Factors that may predispose an individual to Munchausen's include a serious illness in childhood or an existing personality disorder.

The Munchausen patient presents a wide array of physical or psychiatric symptoms, usually limited only by their medical knowledge. Many Munchausen patients are very familiar with medical terminology and symptoms. Some common complaints include fevers, **rashes**, abscesses, bleeding, and vomiting. Common Munchausen by proxy symptoms include apnea (cessation of breathing), **fever**, vomiting, and **diarrhea**. In both Munchausen and MSBP syndromes, the suspected illness does not respond to a normal course of treatment. Patients or parents may push for invasive diagnostic procedures and display an extraordinary depth of knowledge of medical procedures.

Diagnosis

Because Munchausen sufferers often go from doctor to doctor, gaining admission into many hospitals along the way, diagnosis can be difficult. They are typically detected rather than diagnosed. During a course of treatment, they may be discovered by a hospital employee who encountered them during a previous hospitalization. Their caregivers may also notice that symptoms such as high fever occur only when the patient is left unattended. Occasionally, unprescribed medication used to induce symptoms is found with the patient's belongings. When the patient is confronted, they often react with outrage

KEY TERMS

Apnea—A cessation of breathing.

Factitious disorder—A disorder in which the physical or psychological symptoms are under voluntary control.

and check out of the hospital to seek treatment at another facility with a new caregiver.

Treatment

There is no clearly effective treatment for Munchausen syndrome. Extensive psychotherapy may be helpful with some Munchausen patients. If Munchausen syndrome co-exists with other mental disorders, such as a personality disorder, the underlying disorder is typically treated first.

Prognosis

The infections and injuries Munchausen patients self-inflict can cause serious illness. Patients often undergo countless unnecessary surgeries throughout their lifetimes. In addition, because of their frequent hospitalizations, they have difficulty holding down a job. Further, their chronic health complaints may damage interpersonal relationships with family and friends. Children victimized by sufferers of MSBP are at a real risk for serious injury and possible **death**. Those who survive physically unscathed may suffer developmental problems later in life.

Prevention

Because the cause of Munchausen syndrome is unknown, formulating a prevention strategy is difficult. Some medical facilities and healthcare practitioners have attempted to limit hospital admissions for Munchausen patients by sharing medical records. While these attempts may curb the number of hospital admissions, they do not treat the underlying disorder and may endanger Munchausen sufferers that have made themselves critically ill and require treatment. Children who are found to be victims of persons with Munchausen by proxy syndrome should be immediately removed from the care of the abusing parent or guardian.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Feldman, Marc, and Charles Ford. *Patient or Pretender: Inside the Strange World of Factitious Disorders*. New York: John Wiley and Sons, 1994.

Goodman, Berney. *When the Body Speaks Its Mind: A Psychiatrist Probes the Mysteries of Hypochondria and Munchausen's Syndrome*. New York: Putnam, 1994.

PERIODICALS

Murray, John B. "Munchausen Syndrome/Munchausen Syndrome by Proxy." *The Journal of Psychology* 131, no. 3 (May 1997): 343-52.

Rosenberg, Janice. "Patient by Proxy." *American Medical News* 39, no. 47 (Dec. 1996): 18-23.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Paula Anne Ford-Martin

Mupirocin *see* **Antibiotics, topical**

Murine (endemic) typhus *see* **Typhus**

Muscle cramps *see* **Muscle spasms and cramps**

Muscle relaxants

Definition

Skeletal muscle relaxants are drugs that relax striated muscles (those that control the skeleton). They are a separate class of drugs from the muscle relaxant drugs used during intubations and surgery to reduce the need for anesthesia and facilitate intubation.

Purpose

Skeletal muscle relaxants may be used for relief of spasticity in neuromuscular diseases, such as **multiple sclerosis**, as well as for **spinal cord injury** and **stroke**. They may also be used for **pain** relief in minor strain injuries and control of the muscle symptoms of **tetanus**. Dantrolene (Dantrium) has been used to prevent or treat malignant hyperthermia in surgery.

Description

Although the muscle relaxants may be divided into only two groups, centrally acting and peripherally acting, the centrally acting group, which appears to act on the central nervous system, contains 10 drugs which are chemically different, while only dantrolene has a direct action at the level of the nerve-muscle connection.

Baclofen (Lioresal) may be administered orally or intrathecally for control of spasticity due to neuromuscular disease.

Carisoprodol (Soma), chlorphenesin (Maolate), chlorzoxazone (Paraflex), cyclobenzaprine (Flexeril), diazepam (Valium), metaxalone (Skelaxin), methocarbamol (Robaxin), and orphenadrine (Norflex) are used primarily as an adjunct for rest in management of acute muscle spasms associated with sprains. Muscle relaxation may also be an adjunct to physical therapy in **rehabilitation** following stroke, spinal cord injury, or other musculoskeletal conditions.

Diazepam and methocarbamol are also used by injection for relief of tetanus.

Recommended dosage

Dose varies with the drug, route of administration, and purpose. There may be individual variations in absorption that require doses higher than those usually recommended, particularly with methocarbamol. Consult specific references for further information.

Precautions

All drugs in this class may cause **sedation**. Baclofen, when administered intrathecally, may cause severe central nervous system (CNS) depression with cardiovascular collapse and **respiratory failure**.

Diazepam may be addictive. It is a controlled substance under federal law.

Dantrolene has a potential for hepatotoxicity. The incidence of symptomatic hepatitis is dose related, but may occur even with a short period of doses at or above. Even short periods of doses at or above 800 mg per day greatly increases the risk of serious liver injury. Overt hepatitis has been most frequently observed between the third and twelfth months of therapy. Risk of hepatic injury appears to be greater in women, in patients over 35 years of age and in patients taking other medications in addition to dantrolene.

Tizanidine may cause low blood pressure, but this may be controlled by starting with a low dose and increasing it gradually. The drug may rarely cause liver damage.

KEY TERMS

Central nervous system—The brain and spinal cord.

Intrathecal—Introduced into or occurring in the space under the arachnoid membrane which covers the brain and spinal cord.

Pregnancy category— A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Sedative—Medicine used to treat nervousness or restlessness.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles.

Tranquilizer (minor)—A drug that has a calming effect and is used to treat anxiety and emotional tension.

Methocarbamol and chlorzoxazone may cause harmless color changes in urine—orange or reddish-purple with chlorzoxazone and purple, brown, or green with methocarbamol. The urine will return to its normal color when the patient stops taking the medicine.

Most drugs in this class are well tolerated.

Not all drugs in this group have been evaluated for safety in **pregnancy** and breast feeding.

Baclofen is pregnancy category C. It has caused fetal abnormalities in rats at doses 13 times above the human dose. Baclofen passes into breast milk, and breast feeding while taking baclofen is not recommended.

Diazepam is category D. All **benzodiazepines** cross the placenta. Although the drugs appear to be safe for use during the first trimester of pregnancy, use later in pregnancy may be associated with **cleft lip and palate**. Diazepam should not be taken while breast feeding. Infants who were breast fed while their mothers took diazepam were excessively sleepy and lethargic.

Dantrolene is category C. In animal studies it has reduced the rate of survival of the newborn when given in doses seven times the normal human dose. Mothers should not breast feed while receiving dantrolene.

Interactions

Skeletal muscle relaxants have many potential drug interactions. Individual references should be consulted.

Because these drugs cause sedation, they should be used with caution with other drugs that may also cause drowsiness.

The activity of diazepam may be increased by drugs that inhibit its metabolism in the liver. These include: Cimetidine, oral contraceptives, Disulfiram, Fluoxetine, Isoniazid, Ketoconazole, Metoprolol, Propoxyphene, Propranolol, and Valproic acid.

Dantrolene may have an interaction with estrogens. Although no interaction has been demonstrated, the rate of liver damage in women over the age of 35 who were taking estrogens is higher than in other groups.

Samuel D. Uretsky, PharmD

Muscle spasms and cramps

Definition

Muscle spasms and cramps are spontaneous, often painful muscle contractions.

Description

Most people are familiar with the sudden **pain** of a muscle cramp. The rapid, uncontrolled contraction, or spasm, happens unexpectedly, with either no stimulation or some trivially small one. The muscle contraction and pain last for several minutes, and then slowly ease. Cramps may affect any muscle, but are most common in the calves, feet, and hands. While painful, they are harmless, and in most cases, not related to any underlying disorder. Nonetheless, cramps and spasms can be manifestations of many neurological or muscular diseases.

The terms cramp and spasm can be somewhat vague, and they are sometimes used to include types of abnormal muscle activity other than sudden painful contraction. These include stiffness at rest, slow muscle relaxation, and spontaneous contractions of a muscle at rest (fasciculation). Fasciculation is a type of painless muscle spasm, marked by rapid, uncoordinated contraction of many small muscle fibers. A critical part of diagnosis is to distinguish these different meanings and to allow the patient to describe the problem as precisely as possible.

Causes and symptoms

Causes

Normal voluntary muscle contraction begins when electrical signals are sent from the brain through the spinal cord along nerve cells called motor neurons. These include both the upper motor neurons within the brain and the lower motor neurons within the spinal cord and leading out to the muscle. At the muscle, chemicals released by the motor neuron stimulate the internal release of calcium ions from stores within the muscle cell. These calcium ions then interact with muscle proteins within the cell, causing the proteins (actin and myosin) to slide past one another. This motion pulls their fixed ends closer, thereby shortening the cell and, ultimately, the muscle itself. Recapture of calcium and unlinking of actin and myosin allows the muscle fiber to relax.

Abnormal contraction may be caused by abnormal activity at any stage in this process. Certain mechanisms within the brain and the rest of the central nervous system help regulate contraction. Interruption of these mechanisms can cause spasm. Motor neurons that are overly sensitive may fire below their normal thresholds. The muscle membrane itself may be over-sensitive, causing contraction without stimulation. Calcium ions may not be recaptured quickly enough, causing prolonged contraction.

Interuption of brain mechanisms and overly sensitive motor neurons may result from damage to the nerve pathways. Possible causes include **stroke**, **multiple sclerosis**, **cerebral palsy**, neurodegenerative diseases, trauma, **spinal cord injury**, and nervous system poisons such as strychnine, **tetanus**, and certain insecticides. Nerve damage may lead to a prolonged or permanent muscle shortening called contracture.

Changes in muscle responsiveness may be due to or associated with:

- Prolonged **exercise**. Curiously, relaxation of a muscle actually requires energy to be expended. The energy is used to recapture calcium and to unlink actin and myosin. Normally, sensations of pain and **fatigue** signal that it is time to rest. Ignoring or overriding those warning signals can lead to such severe energy depletion that the muscle cannot be relaxed, causing a cramp. The familiar advice about not swimming after a heavy meal, when blood flow is directed away from the muscles, is intended to avoid this type of cramp. Rigor mortis, the stiffness of a corpse within the first 24 hours after **death**, is also due to this phenomenon.

- **Dehydration** and salt depletion. This may be brought on by protracted vomiting or **diarrhea**, or by copious sweating during prolonged exercise, especially in high temperatures. Loss of fluids and salts—especially sodium, potassium, magnesium, and calcium—can disrupt ion balances in both muscle and nerves. This can prevent them from responding and recovering normally, and can lead to cramp.
- Metabolic disorders that affect the energy supply in muscle. These are inherited diseases in which particular muscle enzymes are deficient. They include deficiencies of myophosphorylase (McArdle's disease), phosphorylase b kinase, phosphofructokinase, phosphoglycerate kinase, and lactate dehydrogenase.
- Myotonia. This causes stiffness due to delayed relaxation of the muscle, but does not cause the spontaneous contraction usually associated with cramps. However, many patients with myotonia do experience cramping from exercise. Symptoms of myotonia are often worse in the cold. Myotonias include **myotonic dystrophy**, myotonia congenita, paramyotonia congenita, and neuromyotonia.

Fasciculations may be due to fatigue, cold, medications, metabolic disorders, nerve damage, or neurodegenerative disease, including **amyotrophic lateral sclerosis**. Most people experience brief, mild fasciculations from time to time, usually in the calves.

Symptoms

The pain of a muscle cramp is intense, localized, and often debilitating. Coming on quickly, it may last for minutes and fade gradually. **Contractures** develop more slowly, over days or weeks, and may be permanent if untreated. Fasciculations may occur at rest or after muscle contraction, and may last several minutes.

Diagnosis

Abnormal contractions are diagnosed through a careful medical history, physical and neurological examination, and **electromyography** of the affected muscles. Electromyography records electrical activity in the muscle during rest and movement.

Treatment

Most cases of simple cramps require no treatment other than patience and stretching. Gently and gradually stretching and massaging the affected muscle may ease the pain and hasten recovery.

More prolonged or regular cramps may be treated with drugs such as carbamazepine, phenytoin, or quinine. Fluid and salt replacement, either orally or intravenously, is used to treat dehydration. Treatment of underlying metabolic or neurologic disease, where possible, may help relieve symptoms.

KEY TERMS

Motor neuron—Nerve cells within the central nervous system that carry nerve impulses controlling muscle movement.

Alternative treatment

Cramps may be treated or prevented with Gingko (*Ginkgo biloba*) or Japanese quince (*Chaenomeles speciosa*). Supplements of vitamin E, niacin, calcium, and magnesium may also help. Taken at bedtime, they may help to reduce the likelihood of night cramps.

Prognosis

Occasional cramps are common, and have no special medical significance.

Prevention

The likelihood of developing cramps may be reduced by eating a healthy diet with appropriate levels of **minerals**, and getting regular exercise to build up energy reserves in muscle. Avoiding exercising in extreme heat helps prevent heat cramps. Heat cramps can also be avoided by taking salt tablets and water before prolonged exercise in extreme heat. Taking a warm bath before bedtime may increase circulation to the legs and reduce the incidence of nighttime leg cramps.

Resources

BOOKS

Bradley, Walter G., et al. *Neurology in Clinical Practice*. 2nd ed. Woburn, MA: Butterworth-Heinemann, 1995.

Richard Robinson

Muscular dystrophy

Definition

Muscular dystrophy is the name for a group of inherited disorders in which strength and muscle bulk gradually decline. Nine types of muscular dystrophies are generally recognized.

Description

The muscular dystrophies include:

- Duchenne muscular dystrophy (DMD): DMD affects young boys, causing progressive muscle weakness, usually beginning in the legs. It is the most severe form of muscular dystrophy. DMD occurs in about 1 in 3,500 male births, and affects approximately 8,000 boys and young men in the United States. A milder form occurs in very few female carriers.
- Becker muscular dystrophy (BMD): BMD affects older boys and young men, following a milder course than DMD. BMD occurs in about 1 in 30,000 male births.
- Emery-Dreifuss muscular dystrophy (EDMD): EDMD affects young boys, causing **contractures** and weakness in the calves, weakness in the shoulders and upper arms, and problems in the way electrical impulses travel through the heart to make it beat (heart conduction defects). Fewer than 300 cases of EDMD have been identified.
- Limb-girdle muscular dystrophy (LGMD): LGMD begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles around the hips and shoulders. It is the most variable of the muscular dystrophies, and there are several different forms of the disease now recognized. Many people with suspected LGMD have probably been misdiagnosed in the past, and therefore the prevalence of the disease is difficult to estimate. The number of people affected in the United States may be in the low thousands.
- Facioscapulohumeral muscular dystrophy (FSH): FSH, also known as Landouzy-Dejerine disease, begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles of the face, shoulders, and upper arms. The hips and legs may also be affected. FSH occurs in about 1 out of every 20,000 people, and affects approximately 13,000 people in the United States.
- **Myotonic dystrophy**: also known as Steinert's disease, affects both men and women, causing generalized weakness first seen in the face, feet, and hands. It is accompanied by the inability to relax the affected muscles (myotonia). Symptoms may begin from birth through adulthood. It is the most common form of muscular dystrophy, affecting more than 30,000 people in the United States.
- Oculopharyngeal muscular dystrophy (OPMD): OPMD affects adults of both sexes, causing weakness in the eye muscles and throat. It is most common among French Canadian families in Quebec, and in Spanish-American families in the southwestern United States.
- Distal muscular dystrophy (DD): DD begins in middle age or later, causing weakness in the muscles of the feet and hands. It is most common in Sweden, and rare in other parts of the world.
- Congenital muscular dystrophy (CMD): CMD is present from birth, results in generalized weakness, and usually progresses slowly. A subtype, called Fukuyama CMD, also involves **mental retardation**. Both are rare; Fukuyama CMD is more common in Japan.

Causes and symptoms

Causes

Several of the muscular dystrophies, including DMD, BMD, CMD, and most forms of LGMD, are due to defects in the genes for a complex of muscle proteins. This complex spans the muscle cell membrane to unite a fibrous network on the interior of the cell with a fibrous network on the outside. Current theory holds that by linking these two networks, the complex acts as a "shock absorber," redistributing and evening out the forces generated by contraction of the muscle, thereby preventing rupture of the muscle membrane. Defects in the proteins of the complex lead to deterioration of the muscle. Symptoms of these diseases set in as the muscle gradually exhausts its ability to repair itself. Both DMD and BMD are caused by flaws in the gene for the protein called dystrophin. The flaw leading to DMD prevents the formation of any dystrophin, while that of BMD allows some protein to be made, accounting for the differences in severity and onset between the two diseases. Differences among the other diseases in the muscles involved and the ages of onset are less easily explained.

The causes of the other muscular dystrophies are not as well understood:

- One form of LGMD is caused by defects in the gene for a muscle enzyme, calpain. The relationship between this defect and the symptoms of the disease is unclear.
- EDMD is due to a defect in the gene for a protein called emerin, which is found in the membrane of a cell's nucleus, but whose exact function is unknown.
- Myotonic dystrophy is linked to gene defects for a protein that may control the flow of charged particles within muscle cells. This gene defect is called a triple repeat, meaning it contains extra triplets of DNA code. It is possible that this mutation affects nearby genes as well, and that the widespread symptoms of myotonic dystrophy are due to a range of genetic disruptions.
- The gene for OPMD appears to also be mutated with a triple repeat. The function of the affected protein may involve translation of genetic messages in a cell's nucleus.

- The cause of FSH is unknown. Although the genetic region responsible for it has been localized on its chromosome, the identity and function of the gene or genes involved had not been determined as of 1997.
- The gene responsible for DD has not yet been found.

Genetics and patterns of inheritance

The muscular dystrophies are genetic diseases, meaning they are caused by defects in genes. Genes, which are linked together on chromosomes, have two functions: They code for the production of proteins, and they are the material of inheritance. Parents pass along genes to their children, providing them with a complete set of instructions for making their own proteins.

Because both parents contribute genetic material to their offspring, each child carries two copies of almost every gene, one from each parent. For some diseases to occur, both copies must be flawed. Such diseases are called autosomal recessive diseases. Some forms of LGMD and DD exhibit this pattern of inheritance, as does CMD. A person with only one flawed copy, called a carrier, will not have the disease, but may pass the flawed gene on to his children. When two carriers have children, the chances of having a child with the disease is one in four for each **pregnancy**.

Other diseases occur when only one flawed gene copy is present. Such diseases are called autosomal dominant diseases. Other forms of LGMD exhibit this pattern of inheritance, as do DM, FSH, OPMD, and some forms of DD. When a person affected by the disease has a child with someone not affected, the chances of having an affected child is one in two.

Because of chromosomal differences between the sexes, some genes are not present in two copies. The chromosomes that determine whether a person is male or female are called the X and Y chromosomes. A person with two X chromosomes is female, while a person with one X and one Y is male. While the X chromosome carries many genes, the Y chromosome carries almost none. Therefore, a male has only one copy of each gene on the X chromosome, and if it is flawed, he will have the disease that defect causes. Such diseases are said to be X-linked. X-linked diseases include DMD, BMD, and EDMD. Women aren't usually affected by X-linked diseases, since they will likely have one unaffected copy between the two chromosomes. Some female carriers of DMD suffer a mild form of the disease, probably because their one unaffected gene copy is shut down in some of their cells.

Women carriers of X-linked diseases have a one in two chance of passing the flawed gene on to each child born. Daughters who inherit the disease gene will be carriers. A son born without the disease gene will be free of the disease and cannot pass it on to his children. A son born with the defect will have the disease. He will pass the flawed gene on to each of his daughters, who will then be carriers, but to none of his sons (because they inherit his Y chromosome).

Not all genetic flaws are inherited. As many as one third of the cases of DMD are due to new mutations that arise during egg formation in the mother. New mutations are less common in other forms of muscular dystrophy.

Symptoms

All of the muscular dystrophies are marked by muscle weakness as the major symptom. The distribution of symptoms, age of onset, and progression differ significantly. **Pain** is sometimes a symptom of each, usually due to the effects of weakness on joint position.

DMD. A boy with Duchenne muscular dystrophy usually begins to show symptoms as a pre-schooler. The legs are affected first, making walking difficult and causing balance problems. Most patients walk three to six months later than expected and have difficulty running. Later on, the boy with DMD will push his hands against his knees to rise to a standing position, to compensate for leg weakness. About the same time, his calves will begin to swell, though with fibrous tissue rather than with muscle, and feel firm and rubbery; this condition gives DMD one of its alternate names, pseudohypertrophic muscular dystrophy. He will widen his stance to maintain balance, and walk with a waddling gait to advance his weakened legs. Contractures (permanent muscle tightening) usually begin by age five or six, most severely in the calf muscles. This pulls the foot down and back, forcing the boy to walk on tip-toes, called equinus, and further decreases balance. Frequent falls and broken bones are common beginning at this age. Climbing stairs and rising unaided may become impossible by age nine or ten, and most boys use a wheelchair for mobility by the age of 12. Weakening of the trunk muscles around this age often leads to **scoliosis** (a side-to-side spine curvature) and **kyphosis** (a front-to-back curvature).

The most serious weakness of DMD is weakness of the diaphragm, the sheet of muscles at the top of the abdomen that perform the main work of breathing and coughing. Diaphragm weakness leads to reduced energy and stamina, and increased lung infection because of the inability to **cough** effectively. Young men with DMD often live into their twenties and beyond, provided they have mechanical ventilation assistance and good respiratory hygiene.

About one third of boys with DMD experience specific learning disabilities, including trouble learning by

ear rather than by sight and trouble paying attention to long lists of instructions. Individualized educational programs usually compensate well for these disabilities.

BMD. The symptoms of BMD usually appear in late childhood to early adulthood. Though the progression of symptoms may parallel that of DMD, the symptoms are usually milder and the course more variable. The same pattern of leg weakness, unsteadiness, and contractures occur later for the young man with BMD, often allowing independent walking into the twenties or early thirties. Scoliosis may occur, but is usually milder and progresses more slowly. Heart muscle disease (cardiomyopathy), occurs more commonly in BMD. Problems may include irregular heartbeats (**arrhythmias**) and congestive **heart failure**. Symptoms may include **fatigue**, **shortness of breath**, chest pain, and **dizziness**. Respiratory weakness also occurs, and may lead to the need for mechanical ventilation.

EDMD. This type of muscular dystrophy usually begins in early childhood, often with contractures preceding muscle weakness. Weakness affects the shoulder and upper arm originally, along with the calf muscles, leading to foot-drop. Most men with EDMD survive into middle age, although a defect in the heart's rhythm (**heart block**) may be fatal if not treated with a pacemaker.

LGMD. While there are at least a half-dozen genes that cause the various types of LGMD, two major clinical forms of LGMD are usually recognized. A severe childhood form is similar in appearance to DMD, but is inherited as an autosomal recessive trait. Symptoms of adult-onset LGMD usually appear in a person's teens or twenties, and are marked by progressive weakness and wasting of the muscles closest to the trunk. Contractures may occur, and the ability to walk is usually lost about 20 years after onset. Some people with LGMD develop respiratory weakness that requires use of a ventilator. Lifespan may be somewhat shortened. (Autosomal dominant forms usually occur later in life and progress relatively slowly.)

FSH. FSH varies in its severity and age of onset, even among members of the same family. Symptoms most commonly begin in the teens or early twenties, though infant or childhood onset is possible. Symptoms tend to be more severe in those with earlier onset. The disease is named for the regions of the body most severely affected by the disease: muscles of the face (facio-), shoulders (scapulo-), and upper arms (humeral). Hips and legs may be affected as well. Children with FSH often develop partial or complete deafness.

The first symptom noticed is often difficulty lifting objects above the shoulders. The weakness may be greater on one side than the other. Shoulder weakness also causes the shoulder blades to jut backward, called scapular winging. Muscles in the upper arm often lose bulk sooner than those of the forearm, giving a "Popeye" appearance to the arms. Facial weakness may lead to loss of facial expression, difficulty closing the eyes completely, and inability to drink through a straw, blow up a balloon, or whistle. A person with FSH may not develop strong facial wrinkles. Contracture of the calf muscles may cause foot-drop, leading to frequent tripping over curbs or rough spots. People with earlier onset often require a wheelchair for mobility, while those with later onset rarely do.

MYOTONIC DYSTROPHY. Symptoms of Myotonic dystrophy include facial weakness and a slack jaw, drooping eyelids (**ptosis**), and muscle wasting in the forearms and calves. A person with this dystrophy has difficulty relaxing his grasp, especially if the object is cold. Myotonic dystrophy affects heart muscle, causing arrhythmias and heart block, and the muscles of the digestive system, leading to motility disorders and **constipation**. Other body systems are affected as well: Myotonic dystrophy may cause **cataracts**, retinal degeneration, low IQ, frontal balding, skin disorders, testicular atrophy, **sleep apnea**, and insulin resistance. An increased need or desire for sleep is common, as is diminished motivation. Severe disability affects most people with this type of dystrophy within 20 years of onset, although most do not require a wheelchair even late in life.

OPMD. OPMD usually begins in a person's thirties or forties, with weakness in the muscles controlling the eyes and throat. Symptoms include drooping eyelids, difficulty swallowing (dysphagia), and weakness progresses to other muscles of the face, neck, and occasionally the upper limbs. Swallowing difficulty may cause aspiration, or the introduction of food or saliva into the airways. **Pneumonia** may follow.

DD. DD usually begins in the twenties or thirties, with weakness in the hands, forearms, and lower legs. Difficulty with fine movements such as typing or fastening buttons may be the first symptoms. Symptoms progress slowly, and the disease usually does not affect life span.

CMD. CMD is marked by severe muscle weakness from birth, with infants displaying "floppiness" and very little voluntary movement. Nonetheless, a child with CMD may learn to walk, either with or without some assistive device, and live into young adulthood or beyond. In contrast, children with Fukuyama CMD are rarely able to walk, and have severe mental retardation. Most children with this type of CMD die in childhood.

Diagnosis

Diagnosis of muscular dystrophy involves a careful medical history and a thorough physical exam to deter-

KEY TERMS

Autosomal dominant—Diseases that occur when a person inherits only one flawed copy of the gene.

Autosomal recessive —Diseases that occur when a person inherits two flawed copies of a gene—one from each parent.

Becker muscular dystrophy (BMD)—A type of muscular dystrophy that affects older boys and men, and usually follows a milder course than DMD.

Contractures—A permanent shortening (as of muscle, tendon, or scar tissue) producing deformity or distortion.

Distal muscular dystrophy (DD) —A form of muscular dystrophy that usually begins in middle age or later, causing weakness in the muscles of the feet and hands.

Duchenne muscular dystrophy (DMD)—The most severe form of muscular dystrophy, DMD usually affects young boys and causes progressive muscle weakness, usually beginning in the legs.

Dystrophin—A protein that helps muscle tissue repair itself. Both DMD and BMD are caused by flaws in the gene that instructs the body how to make this protein.

Facioscapulohumeral muscular dystrophy (FSH)—This form of muscular dystrophy, also known as Landouzy-Dejerine disease, begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles of the face, shoulders, and upper arms.

Limb-girdle muscular dystrophy (LGMD)—This form of muscular dystrophy begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles around the hips and shoulders.

Myotonic dystrophy—This type of muscular dystrophy, also known as Steinert's disease, affects both men and women, causing generalized weakness first seen in the face, feet, and hands. It is accompanied by the inability to relax the affected muscles (myotonia).

Oculopharyngeal muscular dystrophy (OPMD)—This type of muscular dystrophy affects adults of both sexes, causing weakness in the eye muscles and throat.

mine the distribution of symptoms and to rule out other causes. Family history may give important clues, since all the muscular dystrophies are genetic conditions (though no family history will be evident in the event of new mutations).

Lab tests may include:

- Blood level of the muscle enzyme creatine kinase (CK). CK levels rise in the blood due to muscle damage, and may be seen in some conditions even before symptoms appear.
- Muscle biopsy, in which a small piece of muscle tissue is removed for microscopic examination. Changes in the structure of muscle cells and presence of fibrous tissue or other aberrant structures are characteristic of different forms of muscular dystrophy. The muscle tissue can also be stained to detect the presence or absence of particular proteins, including dystrophin.
- Electromyogram (EMG). This electrical test is used to examine the response of the muscles to stimulation. Decreased response is seen in muscular dystrophy. Other characteristic changes are seen in DM.
- Genetic tests. Several of the muscular dystrophies can be positively identified by testing for the presence of the mutated gene involved. Accurate genetic tests are available for DMD, BMD, DM, several forms of LGMD, and EDMD.
- Other specific tests as necessary. For EDMD and BMD, for example, an electrocardiogram may be needed to test heart function, and hearing tests are performed for children with FSH.

For most forms of muscular dystrophy, accurate diagnosis is not difficult when done by someone familiar with the range of diseases. There are exceptions, however. Even with a muscle biopsy, it may be difficult to distinguish between FSH and another muscle disease, **polymyositis**. Childhood-onset LGMD is often mistaken for the much more common DMD, especially when it occurs in boys. BMD with an early onset appears very similar to DMD, and a genetic test may be needed to accurately distinguish them. The muscular dystrophies may be confused with diseases involving the motor neurons, such as spinal muscular atrophy; diseases of the neuromuscular junction, such as **myasthenia gravis**; and

other muscle diseases, as all involve generalized weakening of varying distribution.

Treatment

Drugs

There are no cures for any of the muscular dystrophies. Prednisone, a corticosteroid, has been shown to delay the progression of DMD somewhat, for reasons that are still unclear. Prednisone is also prescribed for BMD, though no controlled studies have tested its benefit. A related drug, deflazacort, appears to have similar benefits with fewer side effects. It is available and is prescribed in Canada and Mexico, but is unavailable in the United States. Albuterol, an adrenergic agonist, has shown some promise for FSH in small trials; larger trials are scheduled for 1998. No other drugs are currently known to have an effect on the course of any other muscular dystrophy.

Treatment of muscular dystrophy is mainly directed at preventing the complications of weakness, including decreased mobility and dexterity, contractures, scoliosis, heart defects, and respiratory insufficiency.

Physical therapy

Physical therapy, in particular regular stretching, is used to maintain the range of motion of affected muscles and to prevent or delay contractures. Braces are used as well, especially on the ankles and feet to prevent equinus. Full-leg braces may be used in DMD to prolong the period of independent walking. Strengthening other muscle groups to compensate for weakness may be possible if the affected muscles are few and isolated, as in the earlier stages of the milder muscular dystrophies. Regular, nonstrenuous **exercise** helps maintain general good health. Strenuous exercise is usually not recommended, since it may damage muscles further.

Surgery

When contractures become more pronounced, tenotomy surgery may be performed. In this operation, the tendon of the contractured muscle is cut, and the limb is braced in its normal resting position while the tendon regrows. In FSH, surgical fixation of the scapula can help compensate for shoulder weakness. For a person with OPMD, surgical lifting of the eyelids may help compensate for weakened muscular control. For a person with DM, sleep apnea may be treated surgically to maintain an open airway. Scoliosis surgery is often needed in DMD, but much less often in other muscular dystrophies. Surgery is recommended at a much lower degree of curvature for DMD than for scoliosis due to other conditions, since the decline in respiratory function in DMD makes surgery at a later time dangerous. In this surgery, the vertebrae are fused together to maintain the spine in the upright position. Steel rods are inserted at the time of operation to keep the spine rigid while the bones grow together.

When any type of surgery is performed in patients with muscular dystrophy, anesthesia must be carefully selected. People with MD are susceptible to a severe reaction, known as malignant hyperthermia, when given halothane anesthetic.

Occupational therapy

The occupational therapist suggests techniques and tools to compensate for the loss of strength and dexterity. Strategies may include modifications in the home, adaptive utensils and dressing aids, compensatory movements and positioning, wheelchair accessories, or communication aids.

Nutrition

Good **nutrition** helps to promote general health in all the muscular dystrophies. No special diet or supplement has been shown to be of use in any of the conditions. The weakness in the throat muscles seen especially in OPMD and later DMD may necessitate the use of a **gastrostomy** tube, inserted in the stomach to provide nutrition directly.

Cardiac care

The arrhythmias of EDMD and BMD may be treatable with antiarrhythmia drugs such as mexiletine or nifedipine. A pacemaker may be implanted if these do not provide adequate control. Heart transplants are increasingly common for men with BMD.

Respiratory care

People who develop weakness of the diaphragm or other ventilatory muscles may require a mechanical ventilator to continue breathing deeply enough. Air may be administered through a nasal mask or mouthpiece, or through a tracheostomy tube, which is inserted through a surgical incision through the neck and into the windpipe. Most people with muscular dystrophy do not need a tracheostomy, although some may prefer it to continual use of a mask or mouthpiece. Supplemental oxygen is not needed. Good hygiene of the lungs is critical for health and longterm survival of a person with weakened ventilatory muscles. Assisted cough techniques provide the strength needed to clear the airways of secretions; an assisted cough machine is also available and provides excellent results.

Experimental treatments

Two experimental procedures aiming to cure DMD have attracted a great deal of attention in the past decade. In myoblast transfer, millions of immature muscle cells are injected into an affected muscle. The goal of the treatment is to promote the growth of the injected cells, replacing the defective host cells with healthy new ones. Despite continued claims to the contrary by a very few researchers, this procedure is widely judged a failure. Modifications in the technique may change that in the future.

Gene therapy introduces good copies of the dystrophin gene into muscle cells. The goal is to allow the existing muscle cells to use the new gene to produce the dystrophin it cannot make with its flawed gene. Problems have included immune rejection of the virus used to introduce the gene, loss of gene function after several weeks, and an inability to get the gene to enough cells to make a functional difference in the affected muscle. Nonetheless, after a number of years of refining the techniques in mice, researchers are beginning human trials in 1998.

Prognosis

The expected lifespan for a male with DMD has increased significantly in the past two decades. Most young men will live into their early or mid-twenties. Respiratory infections become an increasing problem as their breathing becomes weaker, and these infections are usually the cause of **death**.

The course of the other muscular dystrophies is more variable; expected life spans and degrees of disability are hard to predict, but may be related to age of onset and initial symptoms. Prediction is made more difficult because, as new genes are discovered, it is becoming clear that several of the dystrophies are not uniform disorders, but rather symptom groups caused by different genes.

People with dystrophies with significant heart involvement (BMD, EDMD, Myotonic dystrophy) may nonetheless have almost normal life spans, provided that cardiac complications are monitored and treated aggressively. The respiratory involvement of BMD and LGMD similarly require careful and prompt treatment.

Prevention

There is no way to prevent any of the muscular dystrophies in a person who has the genes responsible for these disorders. Accurate genetic tests, including prenatal tests, are available for some of the muscular dystrophies. Results of these tests may be useful for purposes of family planning.

Resources

BOOKS

Brooke, Michael H. *A Clinician's View of Neuromuscular Diseases*. 2nd ed. Williams & Wilkins, 1986.

Emery, Alan. *Muscular Dystrophy: The Facts*. Oxford, England: Oxford Medical Publications, 1994.

Swash, Michael, and Martin Schwartz. *Neuromuscular Diseases: A Practical Approach to Diagnosis and Management*. 3rd ed. Springer, 1997.

ORGANIZATIONS

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (800) 572-1717. <http://www.mdausa.org>.

Richard Robinson

Mushroom poisoning

Definition

Mushroom **poisoning** refers to the severe and often deadly effects of various toxins that are found in certain types of mushrooms. One type known as *Amanita phalloides*, appropriately called "death cap," accounts for the majority of cases. The toxins initially cause severe abdominal cramping, vomiting, and watery **diarrhea**, and then lead to liver and kidney failure.

Description

The highest reported incidences of mushroom poisoning occur in western Europe, where a popular pastime is amateur mushroom hunting. Since the 1970s, the United States has seen a marked increase in mushroom poisoning due to an increase in the popularity of "natural" foods, the use of mushrooms as recreational hallucinogens, and the gourmet qualities of wild mushrooms. About 90% of the deaths due to mushroom poisoning in the United States and western Europe result from eating *Amanita phalloides*. This mushroom is recognized by its metallic green cap (the color may vary from light yellow to greenish brown), white gills (located under the cap), white stem, and bulb-shaped structure at the base of the stem. A pure white variety of this species also occurs. Poisoning results from ingestion of as few as one to three mushrooms. Higher **death** (mortality) rates of more than 50% occur in children less than 10 years of age.

Causes and symptoms

Poisonous mushrooms contain at least two different types of toxins, each of which can cause death if taken in large enough quantities. Some of the toxins found in poi-

A poisonous mushroom, *Amanita muscaria* *(Photo Researchers. Reproduced by permission.)*

sonous mushrooms are among the most potent ever discovered. One group of poisons, known as amatoxins, blocks the production of DNA, the basis of cell reproduction. This leads to the death of many cells, especially those that reproduce frequently such as in the liver, intestines, and kidney. Other mushroom poisons affect the proteins needed for muscle contraction, and therefore reduce the ability of certain muscle groups to perform.

Symptoms of *Amanita* poisoning occur in different stages or phases. These include:

- First phase. Abdominal cramping, nausea, vomiting, and severe watery diarrhea occur anywhere from 6-24 hours after eating the mushroom and last for about 24 hours. These intestinal symptoms can lead to **dehydration** and low blood pressure (hypotension).
- Second phase. A period of remission of symptoms that lasts 1-2 days. During this time, the patient feels better, but blood tests begin to show evidence of liver and kidney damage.
- Third phase. Liver and kidney failure develop at this point and either lead to death within about a week or recovery within two to three weeks.

Other symptoms are due to either a decrease in blood clotting factors that leads to internal bleeding or reduced muscle function, with the development of weakness and **paralysis**.

Diagnosis

In most cases, the fact that the patient has recently eaten wild mushrooms is the clue to the cause of symptoms. Moreover, the identification of any remaining mushrooms by a qualified mushroom specialist (mycologist) can be a key to diagnosis. When in doubt, the toxin known as alpha-amantin can be found in the blood, urine, or stomach contents of an individual who has ingested poisonous *Amanita* mushrooms.

Treatment

It is important to remember that there is no specific antidote for mushroom poisoning. However, several advances in therapy have decreased the death rate over the last several years. Early replacement of lost body fluids has been a major factor in improving survival rates.

Therapy is aimed at decreasing the amount of toxin in the body. Initially, attempts are made to remove toxins from the upper gastrointestinal tract by inducing vomiting or by gastric lavage (stomach pumping). After that continuous aspiration of the upper portion of the small intestine through a nasogastric tube is done and oral charcoal (every four hours for 48 hours) is given to prevent absorption of toxin. These measures work best if started within six hours of ingestion.

In the United States, early removal of mushroom poison by way of an artificial kidney machine (dialysis) has become part of the treatment program. This is combined with the correction of any imbalances of salts (electrolytes) dissolved in the blood, such as sodium or potassium. An enzyme called thioctic acid and **corticosteroids** also appear to be beneficial, as well as high doses of penicillin. In Europe, a chemical taken from the milk thistle plant, *Silybum marianum* , is also part of treatment. When liver failure develops, **liver transplantation** may be the only treatment option.

Prognosis

The mortality rate has decreased with improved and rapid treatment. However, according to some medical reports death still occurs in 20-30% of cases, with a higher mortality rate of 50% in children less than 10 years old.

Prevention

The most important factor in preventing mushroom poisoning is to avoid eating wild or noncultivated mushrooms. For anyone not expert in mushroom identification, there are generally no easily recognizable differences

between nonpoisonous and poisonous mushrooms. It is also important to remember that most mushroom poisons are not destroyed or deactivated by cooking, canning, freezing, drying, or other means of food preparation.

Resources

BOOKS

Gitlin, Norman. "Clinical Aspects of Liver Disease Caused by Industrial and Environmental Toxins." In *Hepatology A Textbook of Liver Disease*, ed. David Zakim, et al. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

"Amanita phalloides Mushroom Poisoning—Northern California, Jan. 1997." *Morbidity and Mortality Weekly Report* 46 (6 June 1997): 489-492

O'Brien, Barbara L., and Linh Khuu. "A Fatal Sunday Brunch: Amanita Mushroom Poisoning in a Gulf Coast Family." *American Journal of Gastroenterology* 91 (1996): 581-583.

OTHER

"Alerts from the CDC." *Experience Lab Page*. <http://www.medsitenavigator.com>.

"Cyclopeptide-Containing Mushroom Toxicity." *The Toxikon Multimedia Project Page*. <http://toxikon.er.uic.edu/mushroo.htm>.

"Mushroom Poisoning in Children." *American Association of Family Physicians*. <http://www.aafp.org/patientinfo/mushroom.html>.

Mushroom Toxins from the FDA. <http://vm.cfsan.fda.gov/~mow/chap40.html.

David Kaminstein, MD

Music therapy

Definition

Music therapy is a technique of complementary medicine that uses music prescribed in a skilled manner by trained therapists. Programs are designed to help patients overcome physical, emotional, intellectual, and social challenges. Applications range from improving the well being of geriatric patients in nursing homes to lowering the **stress** level and **pain** of women in labor. Music therapy is used in many settings, including schools, **rehabilitation** centers, hospitals, hospice, nursing homes, community centers, and sometimes even in the home.

Purpose

Music can be beneficial for anyone. Although it can be used therapeutically for people who have physical, emotional, social, or cognitive deficits, even those who are healthy can use music to relax, reduce stress, improve mood, or to accompany **exercise**. There are no potentially harmful or toxic effects. Music therapists help their patients achieve a number of goals through music, including improvement of communication, academic strengths, attention span, and motor skills. They may also assist with behavioral therapy and **pain management**.

Physical effects

Brain function physically changes in response to music. The rhythm can guide the body into breathing in slower, deeper patterns that have a calming effect. Heart rate and blood pressure are also responsive to the types of music that are listened to. The speed of the heartbeat tends to speed or slow depending on the volume and speed of the auditory stimulus. Louder and faster noises tend to raise both heart rate and blood pressure; slower, softer, and more regular tones produce the opposite result. Music can also relieve muscle tension and improve motor skills. It is often used to help rebuild physical patterning skills in rehabilitation clinics. Levels of endorphins, natural pain relievers, are increased while listening to music, and levels of stress hormones are decreased. This latter effect may partially explain the ability of music to improve immune function. A 1993 study at Michigan State University showed that even 15 minutes of exposure to music could increase interleukin-1 levels, a consequence which also heightens immunity.

Mental effects

Depending on the type and style of sound, music can either sharpen mental acuity or assist in relaxation. Memory and learning can be enhanced, and this is used with good results in children with learning disabilities. This effect may also be partially due to increased concentration that many people have while listening to music. Better productivity is another outcome of an improved ability to concentrate. The term "Mozart effect" was coined after a study showed that college students performed better on math problems when listening to classical music.

Emotional effects

The ability of music to influence human emotion is well known, and is used extensively by moviemakers. A variety of musical moods may be used to create feelings of calmness, tension, excitement, or romance. Lullabies have long been popular for soothing babies to sleep. Music can also be used to express emotion nonverbally, which can be a very valuable therapeutic tool in some settings.

Description

Origins

Music has been used throughout human history to express and affect human emotion. In biblical accounts,

King Saul was reportedly soothed by David's harp music, and the ancient Greeks expressed thoughts about music having healing effects as well. Many cultures are steeped in musical traditions. It can change mood, have stimulant or sedative effects, and alter physiologic processes such as heart rate and breathing. The apparent health benefits of music to patients in Veterans Administration hospitals following World War II lead to it being studied and formalized as a complementary healing practice. Musicians were hired to continue working in the hospitals. Degrees in music therapy became available in the late 1940s, and in 1950, the first professional association of music therapists was formed in the United States. The National Association of Music Therapy merged with the American Association of Music Therapy in 1998 to become the American Music Therapy Association.

Goals

Music is used to form a relationship with the patient. The music therapist sets goals on an individual basis, depending on the reasons for treatment, and selects specific activities and exercises to help the patient progress. Objectives may include development of communication, cognitive, motor, emotional, and social skills. Some of the techniques used to achieve this are singing, listening, instrumental music, composition, creative movement, **guided imagery**, and other methods as appropriate. Other disciplines may be integrated as well, such as dance, art, and psychology. Patients may develop musical abilities as a result of therapy, but this is not a major concern. The primary aim is to improve the patient's ability to function.

Techniques

Learning to play an instrument is an excellent musical activity to develop motor skills in individuals with developmental delays, brain injuries, or other motor impairment. It is also an exercise in impulse control and group cooperation. Creative movement is another activity that can help to improve coordination, as well as strength, balance, and gait. Improvisation facilitates the nonverbal expression of emotion. It encourages socialization and communication about feelings as well. Singing develops articulation, rhythm, and breath control. Remembering lyrics and melody is an exercise in sequencing for **stroke** victims and others who may be intellectually impaired. Composition of words and music is one avenue available to assist the patient in working through fears and negative feelings. Listening is an excellent way to practice attending and remembering. It may also make the patient aware of memories and emotions that need to be acknowledged and perhaps talked about. Singing and discussion is a similar method, which is used with some patient populations to encourage dialogue. Guided Imagery and Music (GIM) is a very popular technique developed by music therapist Helen Bonny. Listening to music is used as a path to invoke emotions, picture, and symbols from the patient. This is a bridge to the exploration and expression of feelings.

Music and children

The sensory stimulation and playful nature of music can help to develop a child's ability to express emotion, communicate, and develop rhythmic movement. There is also some evidence to show that speech and language skills can be improved through the stimulation of both hemispheres of the brain. Just as with adults, appropriately selected music can decrease stress, **anxiety**, and pain. Music therapy in a hospital environment with those who are sick, preparing for surgery, or recovering postoperatively is appropriate and beneficial. Children can also experience improved self-esteem through musical activities that allow them to succeed.

Newborns may enjoy an even greater benefit of music. Those who are premature experience more rapid weight gain and hospital discharge than their peers who are not exposed to music. There is also anecdotal evidence of improved cognitive function.

Music and rehabilitation

Patients with brain damage from stroke, traumatic brain injury, or other neurologic conditions have been shown to exhibit significant improvement as a result of music therapy. This is theorized to be partially the result of entrainment, which is the synchronization of movement with the rhythm of the music. Consistent practice leads to gains in motor skill ability and efficiency. Cognitive processes and language skills often benefit from appropriate musical intervention.

Music and the elderly

The geriatric population can be particularly prone to anxiety and depression, particularly in nursing home residents. Chronic diseases causing pain are also not uncommon in this setting. Music is an excellent outlet to provide enjoyment, relaxation, relief from pain, and an opportunity to socialize and reminisce about music that has had special importance to the individual. It can have a striking effect on patients with **Alzheimer's disease**, even sometimes allowing them to focus and become responsive for a time. Music has also been observed to decrease the agitation that is so common with this disease. One study shows that elderly people who play a

musical instrument are more physically and emotionally fit as they age than their nonmusical peers are.

Music and the mentally ill

Music can be an effective tool for the mentally or emotionally ill. **Autism** is one disorder that has been particularly researched. Music therapy has enabled some autistic children to relate to others and have improved learning skills. Substance abuse, **schizophrenia**, **paranoia**, and disorders of personality, anxiety, and affect are all conditions that may be benefited by music therapy. In these groups, participation and social interaction are promoted through music. Reality orientation is improved. Patients are helped to develop coping skills, reduce stress, and express their feelings.

Music and hospice

Pain, anxiety, and depression are major concerns with patients who are terminally ill, whether they are in hospice or not. Music can provide some relief from pain, through release of endorphins and promotion of relaxation. It can also provide an opportunity for the patient to reminisce and talk about the fears that are associated with **death** and dying. Music may help regulate the rapid breathing of a patient who is anxious, and soothe the mind. The Chalice of Repose project, headquartered at St. Patrick Hospital in Missoula, Montana, is one organization that attends and nurtures dying patients through the use of music, in a practice they called music-thanatology by developer Therese Schroeder-Sheker. Practitioners in this program work to relieve suffering through music prescribed for the individual patient.

Music and labor

Research has proven that mothers require less pharmaceutical pain relief during labor if they make use of music. Using music that is familiar and associated with positive imagery is the most helpful. During early labor, this will promote relaxation. Maternal movement is helpful to get the baby into a proper birthing position and dilate the cervix. Enjoying some "music to move by" can encourage the mother to stay active for as long as possible during labor. The rhythmic auditory stimulation may also prompt the body to release endorphins, which are a natural form of pain relief. Many women select different styles of music for each stage of labor, with a more intense, or faster piece feeling like a natural accompaniment to the more difficult parts of labor. Instrumental music is often preferred.

Precautions

Patients making use of music therapy should not discontinue medications or therapies prescribed by other health providers without prior consultation.

KEY TERMS

Entrainment—The patterning of body processes and movements to the rhythm of music

Physiologic—Characteristic of normal, healthy functioning

Research and general acceptance

There is little disagreement among physicians that music can be of some benefit for patients, although the extent to which it can have physical effects is not as well acknowledged in the medical community. Research has shown that listening to music can decrease anxiety, pain, and recovery time. There is also good data for the specific subpopulations discussed. A therapist referral can be made through the AMTA.

Resources

BOOKS

Campbell, Don. *The Mozart Effect*. Avon Books, 1997.

Cassileth, Barrie. *The Alternative Medicine Handbook*. W. W. Norton & Co., Inc., 1998.

Dillard, James, and Terra Ziporyn. *Alternative Medicine for Dummies*. IDG Books Worldwide, Inc., 1998.

Sears, William, and Martha Sears. *The Birth Book*. Little, Brown & Co., 1994.

Woodham, Anne, and David Peters. *Encyclopedia of Healing Therapies*. DK Publishing, Inc., 1997.

ORGANIZATIONS

American Music Therapy Association, Inc. 8455 Colesville Road, Suite 1000 Silver Spring, ML 20910. (301) 589-3300. <http://www.musictherapy.org>.

The Chalice of Repose Project at St. Patrick Hospital, 312 East Pine Street, Missoula, MT 59802. (406)329-2810 Fax: (406)329-5614 <http://www.saintpatrick.org/chalice/.

Judith Turner

Mutism

Definition

Mutism is a rare childhood condition characterized by a consistent failure to speak in situations where talking is expected. The child has the ability to converse normally, and does so, for example, in the home, but consistently fails to speak in specific situations such as at

KEY TERMS

Behavior modification—A form of therapy that uses rewards to reinforce desired behavior. An example would be to give a child a piece of chocolate for grooming themselves appropriately.

school or with strangers. It is estimated that one in every 1,000 school-age children are affected.

Description

Experts believe that this problem is associated with **anxiety** and fear in social situations such as in school or in the company of adults. It is therefore often considered a type of social phobia. This is not a communication disorder because the affected children can converse normally in some situations. It is not a developmental disorder because their ability to talk, when they choose to do so, is appropriate for their age level. This problem has been linked to anxiety, and one of the major ways in which both children and adults attempt to cope with anxiety is by avoiding whatever provokes the anxiety.

Affected children are typically shy, and are especially so in the presence of strangers and unfamiliar surroundings or situations. However, the behaviors of children with this condition go beyond shyness.

Causes and symptoms

Mutism is believed to arise from anxiety experienced in social situations where the child may be called upon to speak. Refusing to speak, or speaking in a whisper, spares the child from the possible humiliation or embarrassment of "saying the wrong thing." When asked a direct question by teachers, for example, the affected child may act as if they are unable to answer.Some children may communicate via gestures, nodding, or very brief utterances. Additional features may include excessive shyness, oppositional behavior, and impaired learning at school.

Diagnosis

The diagnosis of mutism is fairly easy to make because the signs amd symptoms are clear-cut and easily observable. However, other social disorders effecting social speech, such as **autism** or **schizophrenia**, must be considered in the diagnosis.

Treatment

There are two recommended treatments for mutism: behavior modification therapy and antidepressant medication. Treatment is most effective when individualized to each patient. It has been suggested that speech pathologists may also be able to help these children.

Prognosis

The prognosis for mutism is good. Sometimes it disappears suddenly on its own. The negative impact on learning and school activities may, however, persist into adult life.

Prevention

Mutism cannot be prevented because the cause is not known. However, family conflict or problems at school contribute to the seriousness of the symptoms.

Resources

BOOKS

Diagnostic and Statistical Manual of Mental Disorders. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Donald G. Barstow, RN

MVP *see* **Mitral valve prolapse**

Myasthenia gravis

Definition

Myasthenia gravis is an autoimmune disease that causes muscle weakness.

Description

Myasthenia gravis (MG) affects the neuromuscular junction, interrupting the communication between nerve and muscle, and thereby causing weakness. A person with MG may have difficulty moving their eyes, walking, speaking clearly, swallowing, and even breathing, depending on the severity and distribution of weakness. Increased weakness with exertion, and improvement with rest, is a characteristic feature of MG.

About 30,000 people in the United States are affected by MG. It can occur at any age, but is most common in women who are in their late teens and early twenties, and in men in their sixties and seventies.

Causes and symptoms

Myasthenia gravis is an autoimmune disease, meaning it is caused by the body's own immune system. In

MG, the immune system attacks a receptor on the surface of muscle cells. This prevents the muscle from receiving the nerve impulses that normally make it respond. MG affects "voluntary" muscles, which are those muscles under conscious control responsible for movement. It does not affect heart muscle or the "smooth" muscle found in the digestive system and other internal organs.

A muscle is stimulated to contract when the nerve cell controlling it releases acetylcholine molecules onto its surface. The acetylcholine lands on a muscle protein called the acetylcholine receptor. This leads to rapid chemical changes in the muscle which cause it to contract. Acetylcholine is then broken down by acetylcholinesterase enzyme, to prevent further stimulation.

In MG, immune cells create antibodies against the acetylcholine receptor. Antibodies are proteins normally involved in fighting infection. When these antibodies attach to the receptor, they prevent it from receiving acetylcholine, decreasing the ability of the muscle to respond to stimulation.

Why the immune system creates these self-reactive "autoantibodies" is unknown, although there are several hypotheses:

- During fetal development, the immune system generates many B cells that can make autoantibodies, but B cells that could harm the body's own tissues are screened out and destroyed before birth. It is possible that the stage is set for MG when some of these cells escape detection.
- Genes controlling other parts of the immune system, called MHC genes, appear to influence how susceptible a person is to developing autoimmune disease.
- Infection may trigger some cases of MG. When activated, the immune system may mistake portions of the acetylcholine receptor for portions of an invading virus, though no candidate virus has yet been identified conclusively.
- About 10% of those with MG also have thymomas, or benign tumors of the thymus gland. The thymus is a principal organ of the immune system, and researchers speculate that thymic irregularities are involved in the progression of MG.

Some or all of these factors (developmental, genetic, infectious, and thymic) may interact to create the autoimmune reaction.

The earliest symptoms of MG often result from weakness of the extraocular muscles, which control eye movements. Symptoms involving the eye (ocular symptoms) include double vision (diplopia), especially when not gazing straight ahead, and difficulty raising the eyelids (**ptosis**). A person with ptosis may need to tilt their head back to see. Eye-related symptoms remain the only symptoms for about 15% of MG patients. Another common early symptom is difficulty chewing and swallowing, due to weakness in the bulbar muscles, which are in the mouth and throat. **Choking** becomes more likely, especially with food that requires extensive chewing.

Weakness usually becomes more widespread within several months of the first symptoms, reaching their maximum within a year in two-thirds of patients. Weakness may involve muscles of the arms, legs, neck, trunk, and face, and affect the ability to lift objects, walk, hold the head up, and speak.

Symptoms of MG become worse upon exertion, and better with rest. Heat, including heat from the sun, hot showers, and hot drinks, may increase weakness. Infection and **stress** may worsen symptoms. Symptoms may vary from day to day and month to month, with intervals of no weakness interspersed with a progressive decline in strength.

"Myasthenic crisis" may occur, in which the breathing muscles become too weak to provide adequate respiration. Symptoms include weak and shallow breathing, **shortness of breath**, pale or bluish skin color, and a racing heart. Myasthenic crisis is an emergency condition requiring immediate treatment. In patients treated with anticholinesterase agents, myasthenic crisis must be differentiated from cholinergic crisis related to overmedication.

Pregnancy worsens MG in about one third of women, has no effect in one third, and improves symptoms in another third. About 12% of infants born to women with MG have "neonatal myasthenia," a temporary but potentially life-threatening condition. It is caused by the transfer of maternal antibodies into the fetal circulation just before birth. Symptoms include weakness, floppiness, feeble cry, and difficulty feeding. The infant may have difficulty breathing, requiring the use of a ventilator. Neonatal myasthenia usually clears up within a month.

Diagnosis

Myasthenia gravis is often diagnosed accurately by a careful medical history and a neuromuscular exam, but several tests are used to confirm the diagnosis. Other conditions causing worsening of bulbar and skeletal muscles must be considered, including drug-induced myasthenia, thyroid disease, Lambert-Eaton myasthenic syndrome, **botulism**, and inherited muscular dystrophies.

MG causes characteristic changes in the electrical responses of muscles that may be observed with an electromyogram, which measures muscular response to electrical stimulation. Repetitive nerve stimulation leads to

KEY TERMS

Antibody—An immune protein normally used by the body for combating infection and which is made by B cells.

Autoantibody—An antibody that reacts against part of the self.

Autoimmune disease—A disease caused by a reaction of the body's immune system.

Bulbar muscles—Muscles that control chewing, swallowing, and speaking.

Neuromuscular junction—The site at which nerve impulses are transmitted to muscles.

Pyridostigmine bromide (Mestinon)—An anticholinesterase drug used in treating myasthenia gravis.

Tensilon test—A test for diagnosing myasthenia gravis. Tensilon is injected into a vein and, if the person has MG, their muscle strength will improve for about five minutes.

Thymus gland—A small gland located just above the heart, involved in immune system development.

reduction in the height of the measured muscle response, reflecting the muscle's tendency to become fatigued.

Blood tests may confirm the presence of the antibody to the acetylcholine receptor, though up to a quarter of MG patients will not have detectable levels. A **chest x ray** or chest computed tomography scan (CT scan) may be performed to look for **thymoma**.

Treatment

While there is no cure for myasthenia gravis, there are a number of treatments that effectively control symptoms in most people.

Edrophonium (Tensilon) blocks the action of acetylcholinesterase, prolonging the effect of acetylcholine and increasing strength. An injection of edrophonium rapidly leads to a marked improvement in most people with MG. An alternate drug, neostigmine, may also be used.

Pyridostigmine (Mestinon) is usually the first drug tried. Like edrophonium, pyridostigmine blocks acetylcholinesterase. It is longer-acting, taken by mouth, and well-tolerated. Loss of responsiveness and disease progression combine to eventually make pyridostigmine ineffective in tolerable doses in many patients.

Thymectomy, or removal of the thymus gland, has increasingly become standard treatment for MG. Up to 85% of people with MG improve after thymectomy, with complete remission eventually seen in about 30%. The improvement may take months or even several years to fully develop. Thymectomy is not usually recommended for children with MG, since the thymus continues to play an important immune role throughout childhood.

Immune-suppressing drugs are used to treat MG if response to pyridostigmine and thymectomy are not adequate. Drugs include **corticosteroids** such as prednisone, and the non-steroids azathioprine (Imuran) and cyclosporine (Sandimmune).

Plasma exchange may be performed to treat myasthenic crisis or to improve very weak patients before thymectomy. In this procedure, blood plasma is removed and replaced with purified plasma free of autoantibodies. It can produce a temporary improvement in symptoms, but is too expensive for long-term treatment. Another blood treatment, intravenous immunoglobulin therapy, is also used for myasthenic crisis. In this procedure, large quantities of purified immune proteins (immunoglobulins) are injected. For unknown reasons, this leads to symptomatic improvement in up to 85% of patients. It is also too expensive for long-term treatment.

People with weakness of the bulbar muscles may need to eat softer foods that are easier to chew and swallow. In more severe cases, it may be necessary to obtain **nutrition** through a feeding tube placed into the stomach (**gastrostomy** tube).

Prognosis

Most people with MG can be treated successfully enough to prevent their condition from becoming debilitating. In some cases, however, symptoms may worsen even with vigorous treatment, leading to generalized weakness and disability. MG rarely causes early **death** except from myasthenic crisis.

Prevention

There is no known way to prevent myasthenia gravis. Thymectomy improves symptoms significantly in many patients, and relieves them entirely in some. Avoiding heat can help minimize symptoms.

Some drugs should be avoided by people with MG because they interfere with normal neuromuscular function.

Drugs to be avoided or used with caution include:

- many types of **antibiotics**, including erythromycin, streptomycin, and ampicillin

- some cardiovascular drugs, including Verapamil, betaxolol, and propranolol
- some drugs used in psychiatric conditions, including chlorpromazine, clozapine, and lithium.

Many other drugs may worsen symptoms as well, so patients should check with the doctor who treats their MG before taking any new drugs.

A Medic-Alert card or bracelet provides an important source of information to emergency providers about the special situation of a person with MG. They are available from health care providers.

Resources

BOOKS

Swash, Michael, and Martin Schwarz. *Neuromuscular Diseases: A Practical Approach to Diagnosis and Management*. Springer, 1997.

PERIODICALS

Drachman, D. B. "Myasthenia Gravis." *New England Journal of Medicine* 330 (1994): 1797-1810.

Robinson, Richard. "The Body At War with Itself." *Quest* 4, no. 3 (1997): 20-24.

ORGANIZATIONS

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (800) 572-1717. <http://www.mdausa.org>.

Myasthenia Gravis Foundation of America. 222 S. Riverside Plaza, Suite 1540, Chicago, IL 60606. (800) 541-5454. <http://www.med.unc.edu>.

Richard Robinson

Mycetoma

Definition

Mycetoma, or maduromycosis, is a slow-growing bacterial or fungal infection focused in one area of the body, usually the foot. For this reason—and because the first medical reports were from doctors in Madura, India—an alternate name for the disease is Madura foot. The infection is characterized by an abnormal tissue mass beneath the skin, formation of cavities within the mass, and a fluid discharge. As the infection progresses, it affects the muscles and bones; at this advanced stage, disability may result.

Description

Although the bacteria and fungi that cause mycetoma are found in soil worldwide, the disease occurs mainly in tropical areas in India, Africa, South America, Central America, and southeast Asia. Mycetoma is an uncommon disease, affecting an unknown number of people annually.

There are more than 30 species of bacteria and fungi that can cause mycetoma. Bacteria or fungi can be introduced into the body through a relatively minor skin wound. The disease advances slowly over months or years, typically with minimal **pain**. When pain is experienced, it is usually due to secondary infections or bone involvement.Although it is rarely fatal, mycetoma causes deformities and potential disability at its advanced stage.

Causes and symptoms

Owing to a wound, bacteria or fungi gain entry into the skin. Approximately one month or more after the injury, a nodule forms under the skin surface. The nodule is painless, even as it increases in size over the following months. Eventually, the nodule forms a tumor, or mass of abnormal tissue. The tumor contains cavities—called sinuses—that discharge blood- or pus-tainted fluid. The fluid also contains tiny grains, less than two thousandths of an inch in size. The color of these grains depends on the type of bacteria or fungi causing the infection.

As the infection continues, surrounding tissue becomes involved, with an accumulation of scarring and loss of function. The infection can extend to the bone, causing inflammation, pain, and severe damage. Mycetoma may be complicated by secondary infections, in which new bacteria become established in the area and cause an additional set of problems.

Diagnosis

The primary symptoms of a tumor, sinuses, and grain-flecked discharge often provide enough information to diagnose mycetoma. In the early stages, prior to sinus formation, diagnosis may be more difficult and a biopsy, or microscopic examination of the tissue, may be necessary. If bone involvement is suspected, the area is x-rayed to determine the extent of the damage. The species of bacteria or fungi at the root of the infection is identified by staining the discharge grains and inspecting them with a microscope.

Treatment

Combating mycetoma requires both surgery and drug therapy. Surgery usually consists of removing the tumor and a portion of the surrounding tissue. If the infection is extensive, **amputation** is sometimes necessary. Drug therapy is recommended in conjunction with surgery. The specific prescription depends on the type of bacteria or fungi causing the disease. Common medicines include antifungal drugs, such as ketoconazole and **antibiotics** (streptomycin sulfate, amikacin, sulfamethoxazole, penicillin, and rifampin).

KEY TERMS

Biopsy—A medical procedure in which a small piece of tissue is surgically removed for microscopic examination.

Grains—Flecks of hardened material such as bacteria or fungi spores.

Nodule—A hardened area or knot sometimes associated with infection.

Secondary infection—Illness caused by new bacteria, viruses, or fungi becoming established in the wake of an initial infection.

Sinuses—Cavities or hollow areas.

Tumor—A mass or clump of abnormal tissue, not necessarily caused by a cancer.

Prognosis

Recovery from mycetoma may take months or years, and the infection recurs after surgery in at least 20% of cases. Drug therapy can reduce the chances of a re-established infection. The extent of deformity or disability depends on the severity of infection; the more deeply entrenched the infection, the greater the damage. By itself, mycetoma is rarely fatal, but secondary infections can be fatal.

Prevention

Mycetoma is a rare condition that is not contagious.

Resources

PERIODICALS

Fahal, A. H., and M. A. Hassan. "Mycetoma." *British Journal of Surgery* 79 (Nov. 1992): 1138.

McGinnis, Michael R. "Mycetoma." *Dermatologic Clinics* 14, no. 1 (Jan. 1996): 97.

Welsh, Oliverio. "Mycetoma." *Seminars in Dermatology* 12, no. 4 (Dec. 1993): 290.

Julia Barrett

Mycobacterial infections, atypical

Definition

Atypical mycobacterial infections are infections caused by several types of mycobacteria similar to the germ that causes **tuberculosis**. These atypical mycobacterial infections are a frequent complication in patients with human **immunodeficiency** virus (HIV) infection or **AIDS**.

Description

Mycobacteria are a group of rod-shaped bacteria that cause several diseases, among them **leprosy** and tuberculosis. For some time, scientists have known of bacteria that are similar to *Mycobacterium tuberculosis,* the cause of tuberculosis, but that grow and act differently. When tuberculosis was a much more widespread problem and microbiology was much less able to tell the difference between similar microbes, these atypical mycobacteria were ignored. Today, they have been classified more precisely as members of the same species and called atypical (or nontuberculosis) mycobacteria.

Although the medical profession has known about these atypical infections for a long time, they were not considered a serious problem until the early 1980s. It was then that many of these atypical infections were noticed among homosexuals and intravenous drug users in New York City. These bacteria rarely cause infection in humans other than those with HIV or AIDS.

Causes and symptoms

Although there are more than a dozen species of atypical mycobacteria, the two most common are *Mycobacterium kansasii* and *M. avium-intracellulare*. These microbes are found in many places in the environment: tap water, fresh and ocean water, milk, bird droppings, soil, and house dust. The manner in which these bacteria are transmitted is not completely understood. There is no evidence that they are transmitted from person to person.

M. avium-intracellulare (MAC or MAI) is a rare cause of lung disease in otherwise healthy humans but a frequent cause of infection among those whose resistance has been lowered by another disorder (opportunistic infection). According to some experts, MAC infection is an almost inevitable complication of HIV. The infection is caused by one of two similar organisms, *M. avium* and *M. intracellulare*.

AIDS patients are almost always attacked by these mycobacteria. Once inside the body, the atypical mycobacterial organisms colonize and grow in the lungs like tuberculosis. Because AIDS patients have a poorly functioning immune system, the microbes multiply because they aren't stopped by the body's normal response to infection. Once they have colonized the lungs, the organisms enter the bloodstream and spread throughout the body, affecting almost every organ. These devastating

infections can invade the lymph nodes, liver, spleen, bone marrow, gastrointestinal tract, skin, and brain.

Symptoms include **shortness of breath**, **fever**, night sweats, weight loss, appetite loss, **fatigue**, and progressively severe **diarrhea**, stomach **pain**, **nausea and vomiting**. If the infection spreads to the brain, the patient may experience weakness, headaches, vision problems, and loss of balance.

MAC and *M. kansasii* sometimes cause lung infections in middle-aged and elderly people with chronic lung conditions. MAC, *M. kansasii*, and *M. scrofulaceum* may cause inflammation of the lymph nodes in otherwise healthy young children. *M. fortuitum* and *M. chelonae* cause skin and wound infections and abscesses after trauma or surgical procedures. *M. marinum* causes a nodular inflammation, usually on the arms and legs. This infection is called "swimming pool granuloma" because it is associated with swimming pools, fish tanks, and other bodies of water. *M. ulcerans* infection causes chronic skin ulcerations, usually on an arm or leg. Atypical mycobacteria infections can also occur without causing any symptoms. In such cases, a **tuberculin skin test** may be positive.

Diagnosis

The diagnosis is made from the patient's symptoms and organisms grown in culture from the site of infection. In cases of lung infection, a diagnostic workup will include a **chest x ray** and tests on discharges from the respiratory passages (sputum).

Treatment

These nontypical mycobacteria are not easy to treat in any patient and the problem is complicated when the person has AIDS. **Antibiotics** aren't particularly effective, although rifabutin (a cousin of the anti-tuberculosis drug rifampin) and clofazimine (an anti-leprosy drug) have helped some patients. It is also possible to contain the infection to some degree by combining different drugs, including ethionamide, cycloserine, ethambutol, and streptomycin.

Prognosis

Because drug therapy is not easily effective, the overwhelming infections caused by these mycobacteria in AIDS patients can be fatal.

Prevention

People with HIV infection can prevent or delay the onset of MAC by taking disease-preventing drugs such as rifabutin.

KEY TERMS

Culture—A test in which a sample of body fluid, such as prostatic fluid, is placed on materials specially formulated to grow microorganisms. A culture is used to learn what type of bacterium is causing infection.

Human immunodeficiency virus (HIV)—The virus that causes AIDS.

AIDS patients and persons with tissue damage, such as skin **wounds** or pulmonary disease, can make a number of lifestyle changes to help prevent MAC infection. Since these mycobacteria are found in most city water systems, in hospital water supplies, and in bottled water, at-risk persons should boil drinking water. Persons at risk should also avoid raw foods, especially salads, root vegetables, and unpasteurized milk or cheese. Fruits and vegetables should be peeled and rinsed thoroughly. Conventional cooking (baking, boiling or steaming) destroys mycobacteria, which are killed at 176°F (80°C).

Finally, at-risk patients should avoid contact with animals, especially birds and bird droppings. Pigeons in particular can transmit MAC.

Resources

BOOKS

Gong, Victor, and Norman Rudnick, eds. *AIDS: Facts and Issues*. New Brunswick: Rutgers University Press, 1996.

PERIODICALS

Rochell, Anne. "Hope and a Reality Check: Although a Cure Is Still a Distant Dream, New AIDS Treatments Invite Optimism." *Atlanta Journal and Constitution* 6 (July 1996): D1.

Wilson, Billie Ann. "Understanding Strategies for Treating HIV." *Medical Surgical Nursing* 6 (1 Apr. 1997): 109-111.

ORGANIZATIONS

National AIDS Treatment Advocacy Project. 580 Broadway, Ste. 403, New York, NY 10012. (888) 266-2827. <http://www.natap.org>.

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Mycobacterium leprae infection *see* **Leprosy**

Mycobacterium tuberculosis see **Tuberculosis**

Mycoplasma infections

Definition

Mycoplasma are the smallest of the free-living organisms. (Unlike viruses, mycoplasma can reproduce outside of living cells.) Many species within the genus *Mycoplasma* thrive as parasites in human, bird, and animal hosts. Some species can cause disease in humans.

Description

Mycoplasma are found most often on the surfaces of mucous membranes. They can cause chronic inflammatory diseases of the respiratory system, urogenital tract, and joints. The most common human illnesses caused by mycoplasma are due to infection with *M. pneumoniae,* which is responsible for 10-20% of all pneumonias. This type of **pneumonia** is also called atypical pneumonia, walking pneumonia, or community-acquired pneumonia. Infection moves easily among people in close contact because it is spread primarily when infected droplets circulate in the air (that is, become aerosolized), usually due to coughing, spitting, or sneezing.

Causes and symptoms

Atypical pneumonias can affect otherwise healthy people who have close contact with one another. Pneumonia caused by *M.pneumoniae* may start out with symptoms of an upper respiratory infection, probably a **sore throat** progressing to a dry **cough** within a few days. Gradually, **fever**, **fatigue**, muscle aches, and a cough that produces thin sputum (spit or phlegm) will emerge. Nonrespiratory symptoms may occur too: abdominal **pain**, **headache**, and **diarrhea**; about 20% of patients may have ear pain.

Another mycoplasma species, *M. hominis*, is common in the mucous membranes of the genital area (including the cervix), and can cause infection in both males and females. Its presence doesn't always result in symptoms.

Diagnosis

Usually, mycoplasma pneumonia will be identified after other common diagnoses are set aside. For example, a type of antibiotic known as a beta-lactam might be prescribed for a respiratory infection producing fever and cough. If symptoms do not improve in 3-5 days, the organism causing the disease is not a typical one and not susceptible to these **antibiotics**. If a Gram's stain (a common test done on sputum) does not indicate a gram-positive pathogen, the doctor will suspect a gram-negative organism, such as mycoplasma. The actual underlying organism may not be identified (it isn't in almost 50% of cases of atypical pneumonia). Although it is rare, a rash may appear along with pneumonia symptoms.This should trigger suspicion of mycoplasma pneumonia, even if laboratory tests are inconclusive.

Standard x rays may reveal a patchy material that has entered the tissue; this can be evident for months. Laboratory tests include cold agglutinins, complement fixation, culture, and enzyme immunoassay. The presence of infection with *M. pneumoniae* would be indicated by a fourfold rise in *M. pneumoniae*-specific antibody in serum, during the illness or convalescence. Highly sophisticated and specific polymerase chain reaction methods (PCR) have been developed for many respiratory pathogens, including *M. pneumoniae*. They are not readily available and are very expensive.

KEY TERMS

Community-acquired—Refers to an infectious disease that is passed among individuals who have close contact with one another.

Treatment

A 2-3 week course of certain antibiotics (erythromycin, azithromycin, clarithromycin, dirithromycin, or doxycycline) is generally prescribed for atypical pneumonia. This disease is infectious for weeks, even after the patient starts antibiotics. A persistent cough may linger for 6 weeks.

Prognosis

Mycoplasma pneumonia may be involved in the onset of **asthma** in adults; other rare complications include meningoencephalitis, **Guillain-Barré syndrome**, mononeuritis multiplex, **myocarditis**, or **pericarditis**. This may increase the risk of acute **arrhythmias** leading to **sudden cardiac death**. However, with proper treatment and rest, recovery should be complete.

Prevention

At this time, there are no vaccines for mycoplasma infection. It is difficult to control its spread, especially in a group setting. The best measures are still the simplest ones. Avoid exposure to people with respiratory infections whenever possible. A person who has a respiratory infection should cover the face while coughing or sneezing.

Resources

BOOKS

Cassell, Gail H., Gregory G. Gray, and K. B. Waites. "Mycoplasma Infections." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Mycoplasma Pneumonia." In *The Merck Manual*. 16th ed. Ed. Robert Berkow. Rahyway, NJ: Merck Research Laboratories, Merck & Co., Inc., 1992.

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Mycoplasmal pneumonia *see* **Mycoplasma infections**

Myelocytic leukemia, acute *see* **Leukemias, acute**

Myelodysplastic syndrome

Definition

Myelodysplastic syndrome (MDS) is a disease that is associated with decreased production of blood cells. Blood cells are produced in the bone marrow, and the blood cells of people with MDS do not mature normally. There are three major types of blood cells —red blood cells, white blood cells and platelets. Patients with MDS can have decreased production of one, two, or all three types of blood cells.

Description

Blood cells are used in the body for many different and important functions, such as carrying oxygen (red blood cells), fighting infection (white blood cells), and controlling bleeding (platelets). Blood cells are formed and stored in the bone marrow, which is the spongy tissue inside large bones. Stem cells, or immature blood cells, are stored in the bone marrow and have the ability to develop into all three types of mature blood cells. When the body needs a specific type of blood cell, the bone marrow uses its stockpile of stem cells to produce the kind of mature cells needed for that particular situation.

In patients who have MDS, blood cells fail to mature normally. In other words, the bone marrow is unable to develop a normal amount of mature blood cells, and is also not able to increase blood cell production when mature cells are needed. Sometimes, even the cells that are produced do not function normally. The marrow eventually becomes filled with the immature cells and there is not room for the normal cells to grow and develop. MDS therefore causes a shortage of functional blood cells.

Subtypes of MDS

MDS is divided into five different subtypes that are classified according to the number and appearance of blast cells in the bone marrow. It is important for doctors to know the type of MDS a patient has, because each subtype affects patients differently and requires specific treatment. The International Prognostic Scoring System (IPSS) can help the doctor to determine the best treatment for an individual patient. The subtypes are as follows:

- Refractory anemia (RA). Bone marrow with less than 5% blast cells and abnormal red blood cell blasts
- Refractory anemia with ring sideroblasts (RARS). Bone marrow with less than 5% blasts and characteristic abnormalities in red blood cells
- Refractory anemia with excess blasts (RAEB). Bone marrow with 5-20% blast cells, and higher risk of changing into acute leukemia over time
- Refractory anemia with excess blasts in transformation (RAEBT). Bone marrow with 21-30% blast cells. This form is most likely to change into acute leukemia.
- Chronic myelomonocytic leukemia (CMMoL). Marrow with 5-20% blasts and excess monocytes (a specific type of white blood cell).

Approximately 15,000 new cases are diagnosed annually in the United States. The average age at diagnosis is 70. The most common types are RA and RARS. It is rare to have MDS before age 50. MDS is slightly more common in males than in females.

Causes and symptoms

Causes

There is no clear cause for the majority of MDS cases, which is referred to as primary or *de novo* myelodysplastic syndrome. In some cases, however, MDS results from earlier **cancer** treatments such as radiation and/or **chemotherapy**. This type of MDS is called secondary or treatment related MDS, is often seen 3 to 7 years after the exposure, and usually occurs in younger people.

Other possible causative agents for MDS include exposure to radiation, cigarette smoke or toxic chemicals such as benzene. Children with pre-existing chromosomal abnormalities such as **Down syndrome** have a higher risk of developing MDS. MDS does not appear to run in families, nor can it be spread to other individuals.

Symptoms

MDS symptoms are related to the type of blood cells that the body is lacking. The earliest symptoms are usually due to anemia, which results from a shortage of mature red blood cells. Anemia causes patients to feel tired and out of breath because there is a lack of cells transporting oxygen throughout the body. MDS may also lead to a shortage of white blood cells resulting in an increased likelihood of infections. Another symptom of MDS is increased bleeding (e.g. blood in stool, nose bleeds, increased **bruises** or bleeding gums) which is due to a low level of platelets. These symptoms can occur in any combination, depending on a given patient's specific subtype of MDS.

Diagnosis

Blood tests

People who have MDS usually visit their primary care doctor first, with symptoms of **fatigue**, and are then referred to a hematologist (a physician who specializes in diseases of the blood). The diagnosis of MDS requires a complete analysis of the patient's blood and bone marrow, which is done by the hematologist. A complete **blood count** (CBC) is done to determine the number of each blood cell type within the sample. Low numbers of red blood cells, white blood cells, and or platelets are signs that a patient has MDS. Numerous other medical problems such as bleeding, nutritional deficiencies, or adverse reaction to a medication can also cause low blood counts. The hematologist will investigate other causes for low blood counts before assigning a diagnosis of MDS. Blood cells in patients with MDS can also be abnormal when viewed under the microscope.

Bone marrow aspiration and biopsy

A bone marrow biopsy is required to confirm the diagnosis of MDS and determine the correct MDS subtype. This procedure involves a needle used to take a sample of marrow from inside the bone. The area of the skin where the needle is inserted is numbed and sometimes the patient is also sedated. Patients may experience some discomfort but the procedure is safe and is over fairly quickly. Marrow samples are usually taken from the back of the hip bone (iliac crest). A sample of the marrow, known as an aspirate, and a small piece of bone are both removed with the needle.

A hematologist or a pathologist (a specialist in diagnosing diseases through cell examination) will carefully examine the bone marrow sample through a microscope. Microscopic examination allows the doctor to determine the number and type of blast cells (immature cells) within the marrow in order to identify the MDS subtype. Cells from the bone marrow are also sent for cytogenetic testing, which analyzes the cells' chromosomes. Forty to seventy percent of MDS patients have abnormal bone marrow chromosomes as a result of the disease. The pattern of these abnormalities can be used to predict how a patient will respond to a particular treatment. Thus, the full set of information provided by a bone marrow biopsy and CBC will ultimately allow the doctor to recommend the most effective treatment plan.

International Prognostic Scoring System (IPSS) for MDS

Once a diagnosis of MDS is established, the doctor will calculate the IPSS score for each individual patient. The bone marrow blast percentage, chromosomal abnormalities and number of different blood types that are reduced determine the score. A score of 0 to 3.5 is assigned to each patient. Patients with lower score have a better prognosis and usually should not undertake treatment upon initial diagnosis. Patients with a higher score have more aggressive disease and should consider more aggressive treatment.

Treatments

Supportive care

Treatment for MDS is tailored to the patient's age, general health, specific MDS subtype, and IPSS score. Treatment varies for each patient, but most treatment strategies are designed to control the symptoms of MDS. This approach is called supportive care and aims to improve the patient's quality of life.

Supportive care for MDS patients commonly includes red blood cell transfusions to relieve symptoms related to anemia. Red cell transfusions are relatively safe and the physician will review risks and benefits with this approach. Transfusions of any type only last a certain amount of time and therefore need to be repeated at certain intervals. Platelet transfusions can also be a way to control excessive bleeding. The doctor will decide with each individual patient when it is appropriate to give a **transfusion**. **Antibiotics** are used when needed to combat infections that can occur more frequently in patients with low white blood cell counts.

Bone marrow transplantation

Bone marrow transplantation (BMT) is a type of treatment that attempts to provide MDS patients with a cure. This strategy requires the patient to be in fairly good health and is therefore more likely to be used in younger patients. Bone marrow transplantation (BMT)

has been found to be a successful treatment for MDS patients under the age of 50 (and some over 50 in good health). Following BMT, many patients are able to achieve long-term, disease-free survival. Unfortunately, most MDS patients cannot receive a traditional bone marrow transplant because of older age or because they do not have a suitable donor. Bone marrow donors are usually siblings or are obtained from the national bone marrow registry. "Mini"-bone marrow transplants use less intense chemotherapy, and are currently being tested in older patients who would otherwise not be candidates for traditional bone marrow transplants.

Chemotherapy

Chemotherapy has been used to treat some MDS patients; however, the disease often recurs after a period of time. This type of therapy uses cell-killing drugs that may also damage healthy cells in the body. Most chemotherapy drugs are associated with some side effects. For these reasons, chemotherapy is generally not used until the MDS becomes more aggressive or the patient has a high IPSS score.

Growth factors

Growth factors are natural proteins that the body normally uses to control blood production. These substances stimulate the patient's bone marrow to produce healthy blood cells. Growth factors that stimulate white cell production are G-CSF (also called neupogen or filgrastim) and GMCSF (Leukine, sargramostim). In order to increase red cell production another growth factor, erythropoietin (Procrit) is used. These growth factors are safe with few side effects and are available only in the injectable form. The physician will decide if this treatment is appropriate for an individual patient.

Alternative treatment

There are no alternative therapies that have been proven to successfully treat MDS. Some of the available alternative drugs can have adverse side effects and therefore a physician should be informed if they are being used.

Prognosis

The prognosis for MDS patients depends on the subtype of their disease and the IPSS score. Patients with RA, RARS or low IPSS score rarely develop leukemia and may live with disease for some years. The higher-risk patients including those with RAEB, RAEBt, CMMoL or high IPSS scores progress more rapidly, and require intensive therapy to control the disease.

Managing MDS requires frequent doctor appointments to monitor disease progression and to evaluate the response to treatment. Fortunately for many patients, recent advances in therapy have significantly enhanced their ability to cope with MDS. Experimental drugs and a better understanding of the disease are likely to improve the overall prognosis in the future.

Prevention

MDS is usually impossible to prevent. Being careful about daily activities and avoiding the use of aspirin-like products that thin the blood may prevent secondary complications of MDS such as bruising and bleeding. Practicing good hygiene and avoiding crowds or people with infections can sometimes prevent infections. A well balanced diet is recommended to increase overall energy.

Resources

BOOKS

Aguayo, Alvaro, Jorge Cortes, and Hagop Kantarjian. "Myelodysplastic Syndromes," In *Cancer Management: A Mulitdisciplinary Approach,* Fourth Edition, edited by Richard Pazdur, et al. PRR, Inc, 2000.

ORGANIZATIONS

Aplastic Anemia Foundation of America. P.O. Box 613, Annapolis, MD 21404. (800)747-2820. < <http://www.aplastic.org>.

Leukemia Society of America. 600 Third Avenue, New York, NY 10016. (800)955-4LSA. <http://www.leukemia.org>.

Myelodysplastic Syndromes Foundation. 464 Main Street, P.O. Box 477, Crosswicks, NJ 08515. (800) MDS-0839. <www.mds-foundation.org>.

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Myelofibrosis

Definition

Myelofibrosis is a rare disease of the bone marrow in which collagen builds up fibrous scar tissue inside the marrow cavity. This is caused by the uncontrolled growth of a blood cell precursor, which results in the accumulation of scar tissue in bone marrow. Myelofibrosis goes by many names including idiopathic myelofibrosis, agnogenic myeloid metaplasia, chronic myelosclerosis, aleukemic megakaryocytic myelosis, and leukoerythroblastosis.

Description

Myelofibrosis can be associated with many other conditions including **breast cancer**, **prostate cancer**,

Hodgkin's disease, non-Hodgkin's lymphoma, acute myeloid leukemia, acute lymphocytic leukemia, **hairy cell leukemia**, **multiple myeloma**, myeloproliferative diseases, **tuberculosis**, Gaucher's disease, and **Paget's disease of bone**. Myelofibrosis typically becomes progressively worse and can cause **death**.

In myelofibrosis, abnormal cells (hematopoietic stem cells) grow out of control and begin to produce both immature blood cells and excess scar (fibrous) tissue. The fibrous tissue builds up (fibrosis) primarily in the bone marrow, the place where blood cells are produced. The fibrous tissue interferes with the production of normal blood cells. The outcome of this is that the blood made by the bone marrow is of poor quality. To compensate for this, blood cell production occurs in other parts of the body (extramedullary hematopoiesis), but most notably in the spleen and liver. This causes enlargement of the spleen (splenomegaly) and the liver (hepatomegaly). Extramedullary hematopoiesis is not effective and, combined with the reduced production of blood cells by the bone marrow, a condition called anemia results.

The abnormal stem cells can spread throughout the body, settle in other organs, and form tumors that produce more abnormal blood cells and fibrous tissue. These tumors are most commonly found in the adrenals, kidneys, lymph nodes, breast, lungs, skin, bowel, thymus, thyroid, prostate, and urinary tract.

Most patients with myelofibrosis are over 50 years old; the average age at diagnosis is 65 years. However, myelofibrosis can occur at any age. Myelofibrosis occurs with equal frequency in women and men, but in children it affects girls twice as often as it does boys.

Causes and symptoms

Myelofibrosis is caused by an abnormality in a single stem cell, which causes it to grow out of control. Myelofibrosis tumors that have originated from a single cell are called monoclonal. The cause of the stem cell abnormality is unknown. Persons who were exposed to benzene or high doses of radiation have developed myelofibrosis. There may be an association between myelofibrosis and autoimmune diseases, such as **systemic lupus erythematosus** and **scleroderma**, in which the immune system treats certain molecules of the body as foreign invaders.

Symptoms usually appear slowly over a long period of time. About one quarter of all patients with myelofibrosis have no symptoms (asymptomatic). An enlarged spleen discovered at an annual medical examination may be the first clue. Symptoms of myelofibrosis include:

- fatigue
- weight loss
- paleness
- fever
- sweating
- weakness
- heart palpitations
- shortness of breath
- itchiness
- feeling full after eating a small amount of food
- stomach **pain** or discomfort
- pain in the left shoulder or upper left portion of the body
- unexpected bleeding
- bone pain, especially in the legs

Diagnosis

Because symptoms are similar to other diseases (mostly leukemias), myelofibrosis is not easy to diagnose. The doctor would use his or her hands to feel (palpate) for enlargement of the spleen and liver. Blood tests and urine tests would be performed. **Bone marrow aspiration and biopsy** can help make a diagnosis, but they often fail because of the fibrosis. X-ray imaging and **magnetic resonance imaging** (MRI) may be performed.

Treatment

Many asymptomatic patients, if stable, do not require treatment. There is no cure for myelofibrosis, although **bone marrow transplantation** is curative in some cases. Treatment is aimed at reducing symptoms and improving quality of life.

Medications

Male hormones (androgens) can be used to treat anemia but, in women, these drugs can cause the development of male characteristics (e.g., hair growth on the face and body). Glucocorticoid therapy is also an effective treatment of anemia and can improve myelofibrosis in children. Nutrients that stimulate blood formation (hematinics), such as iron, **folic acid**, and vitamin B_{12}, may reduce anemia. **Cancer chemotherapy** (usually hydroxyurea) can decrease splenomegaly and hepatomegaly, reduce symptoms of myelofibrosis, lessen anemia, and sometimes reduce bone marrow fibrosis. The bone marrow of myelofibrosis patients is often not strong enough to withstand the harsh chemotherapy drugs, so this treatment is not always an option. Interferon-alpha has been shown to reduce spleen size, reduce bone pain,

and, in some cases, increase the number of blood platelets (structures involved in blood clotting).

Other treatments

In certain cases, the enlarged spleen may be removed (**splenectomy**). Conditions that warrant splenectomy include spleen pain, the need for frequent blood **transfusion**, very low levels of platelets (**thrombocytopenia**), and extreme pressure in the blood vessels of the liver (portal **hypertension**).

Radiation therapy is used to treat splenomegaly, spleen pain, bone pain, tumors in certain places such as next to the spinal cord, and fluid accumulation inside the abdomen (**ascites**). Patients who are not strong enough to undergo splenectomy are often treated with radiation therapy.

Bone marrow transplantation may be used to treat some patients with myelofibrosis. This procedure may be performed on patients who are less than 50 years old, have a poor life expectancy, and have a brother or sister with blood-type similarities.

Patients with severe anemia may require blood transfusions.

Prognosis

Similar to leukemias, myelofibrosis is progressive and often requires therapy to control the disease. Myelofibrosis can progress to acute lymphocytic leukemia or lymphoma. Although a number of factors to predict the survival time have been proposed, advanced age or severe anemia are consistently associated with a poor prognosis. The average survival rate of patients diagnosed with myelofibrosis is five years. Death is usually caused by infection, bleeding, complications of splenectomy, **heart failure**, or progression to leukemia. Spontaneous remission is rare.

Prevention

Persons who have been exposed to radiation, benzene, or radioactive thorium dioxide (a chemical used during certain diagnostic radiological procedures) are at risk for myelofibrosis.

Resources

BOOKS

Lichtman, Marshall. "Idiopathic Myelofibrosis (Agnogenic Myeloid Metaplasia)." In *Williams Hematology*, edited by Ernest Beutler et al. New York: McGraw Hill, 2001, pp.1125-36.

Mavroudis, Dimitrios and John Barrett. "Myelofibrosis (Agnogenic Myeloid Metaplasia)." In *Bone Marrow Failure Syndromes*, edited by Neal Young. Philadelphia: W.B. Saunders Company, 2000, pp.122-34.

Peterson, Powers. "Myelofibrosis." In *Practical Diagnosis of Hematologic Disorders*, edited by Carl Kjeldsberg. Chicago: ASCP Press, 2000, pp.477-9.

PERIODICALS

Reilly, J.T. "Idiopathic Myelofibrosis: Pathogenesis, Natural History and Management." *Blood Reviews* 11 (1997): 233-42.

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KEY TERMS

Anemia—Low numbers of red blood cells in the blood.

Benzene—A colorless volatile flammable toxic liquid hydrocarbon used as a solvent and as a motor fuel.

Biopsy—Surgical removal of tissue for microscopic examination.

Fibrosis—Buildup of scar tissue.

Glucocorticoid therapy—Treatment using corticoids that are anti-inflammatory and immunosuppressive.

Leukemia—Cancer of white blood cells.

Portal hypertension—Extreme pressure on the blood vessels of the liver.

Stem cell—A cell that has the ability to become many different specialized cells.

Myelogram *see* **Myelography**

Myelography

Definition

Myelography is an x-ray examination of the spinal canal. A contrast agent is injected through a needle into the space around the spinal cord to display the spinal cord, spinal canal, and nerve roots on an x ray.

Purpose

The purpose of a myelogram is to evaluate the spinal cord and/or nerve roots for suspected compression. Pres-

sure on these delicate structures causes **pain** or other symptoms. A myelogram is performed when precise detail about the spinal cord is needed to make a definitive diagnosis. In most cases, myelography is used after other studies, such as **magnetic resonance imaging** (MRI) or a computed tomography scan (CT scan), have not yielded enough information to be sure of the disease process. Sometimes myelography followed by CT scan is an alternative for patients who cannot have an MRI scan, because they have a pacemaker or other implanted metallic device.

A herniated or ruptured intervertebral disc, popularly known as a slipped disc, is one of the most common causes for pressure on the spinal cord or nerve roots. Discs are pads of fiber and cartilage that contain rubbery tissue. They lie between the vertebrae, or individual bones, which make up the spine. Discs act as cushions, accommodating strains, shocks, and position changes. A disc may rupture suddenly, due to injury, or a sudden straining with the spine in an unnatural position. In other cases, the problem may come on gradually as a result of progressive deterioration of the discs with **aging**. The lower back is the most common area for this problem, but it sometimes occurs in the neck, and rarely in the upper back. A myelogram can help accurately locate the disc or discs involved.

Myelography may be used when a tumor is suspected. Tumors can originate in the spinal cord, or in tissues surrounding the cord. Cancers that have started in other parts of the body may spread or metastasize in the spine. It is important to precisely locate the mass causing pressure, so effective treatment can be undertaken. Patients with known **cancer** who develop back pain may require a myelogram for evaluation.

Other conditions that may be diagnosed using myelography include arthritic bony growths, known as spurs, narrowing of the spinal canal, called **spinal stenosis**, or malformations of the spine.

Precautions

Patients who are unable to lie still or cooperate with positioning should not have this examination. Severe congenital spinal abnormalities may make the examination technically difficult to carry out. Patients with a history of severe allergic reaction to contrast material (x-ray dye) should report this to their physician. Pretreatment with medications to minimize the risk of severe reaction may be recommended.

Description

Myelograms can be performed in a hospital x-ray department or in an outpatient radiology facility. The patient lies on the x-ray table on his or her stomach. The radiologist first looks at the spine under fluoroscopy, where the images appear on a monitor screen. This is done to find the best location to position the needle. The skin is cleaned, then numbed with local anesthetic. The needle is inserted. Occasionally, a small amount of cerebrospinal fluid, the clear fluid that surrounds the spinal cord and brain, may be withdrawn through the needle and sent for laboratory studies. Then contrast material is injected. The contrast material (dye) is a liquid that shows up on x rays.

The x-ray table is tilted slowly. This allows the contrast material to reach different levels in the spinal canal. The flow is observed under fluoroscopy, then x rays are taken with the table tilted at various angles. A footrest and shoulder straps or supports will keep the patient from sliding.

In many instances, a CT scan of the spine will be performed immediately after a myelogram, while the contrast material is still in the spinal canal. This helps outline internal structures most clearly.

A myelogram takes approximately 30-60 minutes. A CT scan adds about another hour to the examination. If the procedure is done as an outpatient exam, some facilities prefer the patient to stay in a recovery area for up to four hours.

Preparation

Patients should be well hydrated at the time of a myelogram. Increasing fluids the day before the study is usually recommended. All food and fluid intake should be stopped approximately four hours before the myelogram.

Certain medications may need to be stopped for one to two days before myelography is performed. These include some antipsychotics, antidepressants, blood thinners, and diabetic medications. Patients should consult with their physician and/or the facility where the study is to be done.

Patients who smoke may be asked to stop the day before the test. This helps decrease the chance of nausea or headaches after the myelogram. Immediately before the examination, patients should empty their bowels and bladder.

Aftercare

After the examination is completed, the patient usually rests for several hours, with the head elevated. Extra fluids are encouraged, to help eliminate the contrast material and prevent headaches. A regular diet and routine medications may be resumed. Strenuous physical

activities, especially any which involve bending over, may be discouraged for one or two days. The doctor should be notified if a **fever**, excessive **nausea and vomiting**, severe **headache**, or stiff neck develop.

Risks

Headache is a common complication of myelography. It may begin several hours to several days after the examination. The cause is thought to be changes in cerebrospinal fluid pressure, not a reaction to the dye. The headache may be mild and easily alleviated with rest and increased fluids. Sometimes, nonprescription medicines are recommended. In some instances, the headache may be more severe and require stronger medication or other measures for relief. Many factors influence whether the patient develops this problem. These include the type of needle used and the age and sex of the patient. Patients with a history of chronic or recurrent headache are more likely to develop a headache after a myelogram.

The chance of reaction to the contrast material is a very small, but potentially significant risk with myelography. It is estimated that only 5-10% of patients experience any effect from contrast exposure. The vast majority of reactions are mild, such as sneezing, nausea, or **anxiety**. These usually resolve by themselves. A moderate reaction, like **wheezing** or **hives**, may be treated with medication, but is not considered life threatening. Severe reactions, such as heart or **respiratory failure**, happen very infrequently. These require emergency medical treatment.

Rare complications of myelography include injury to the nerve roots from the needle, or from bleeding into the spaces around the roots. Inflammation of the delicate covering of the spinal cord, called arachnoiditis, or infections, can also occur. Seizures are another very uncommon complication reported after myelography.

Normal results

A normal myelogram would show a spinal canal of normal width, with no areas of constriction or obstruction.

Abnormal results

A myelogram may reveal a **herniated disk**, tumor, bone spurs, or narrowing of the spinal canal (spinal stenosis).

Resources

BOOKS

Daffner, Richard. *Clinical Radiology, The Essentials.* Baltimore: Williams and Wilkins, 1993.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

KEY TERMS

Contrast agent—Also called a contrast medium, this is usually a barium or iodine dye that is injected into the area under investigation. The dye makes the interior body parts more visible on an x-ray film.

Torres, Lillian. *Basic Medical Techniques and Patient Care in Imaging Technology.* Philadelphia: Lippincott, 1997.

ORGANIZATIONS

The Spine Center. 1911 Arch St., Philadelphia, PA 19103. (215) 665-8300. <http://www.thespinecenter.com>.

Ellen S. Weber, MSN

Myeloma *see* **Multiple myeloma**

Myers-Briggs type indicator

Definition

The Myers-Briggs Type Indicator (MBTI) is a widely-used personality inventory, or test, employed in vocational, educational, and psychotherapy settings to evaluate personality type in adolescents and adults age 14 and older.

Purpose

In an educational setting, the MBTI may be performed to assess student learning style. Career counselors use the test to help others determine what occupational field they might be best suited for, and it is also used in organizational settings to assess management skills and facilitate teamwork and problem solving. Because the MBTI is also a tool for self-discovery, mental health professionals may administer the test in counseling sessions to provide their patients with insight into their behavior.

Precautions

The MBTI should only be administered, scored, and interpreted by a professional trained in its use. Cultural and language differences in the test subject may affect performance and may result in inaccurate test results. The test administrator should be informed before testing begins if the test taker is not fluent in English and/or he has a unique cultural background.

KEY TERMS

Multi-tasking—Performing multiple duties or taking on multiple responsibilities and roles simultaneously.

Vocational—Relating to an occupation, career, or job.

Description

In 2000, an estimated two million people took the MBTI, making it the most frequently used personality inventory available. The test was first introduced in 1942, the work of mother and daughter Katharine C. Myers Briggs and Isabel Briggs. There are now several different versions of the test available. Form M, which contains 93 items, is the most commonly used.

The Myers-Briggs inventory is based on Carl Jung's theory of types, outlined in his 1921 work *Psychological Types*. Jung's theory holds that human beings are either *introverts* or *extraverts*, and their behavior follows from these inborn psychological types. He also believed that people take in and process information different ways, based on their personality traits.

The Myers-Briggs evaluates personality type and preference based on the four Jungian psychological types:

- extraversion (E) or introversion (I)
- sensing (S) or intuition (N)
- thinking (T) or feeling (F)
- judging (J) or perceiving (P)

Preparation

Prior to the administration of the MBTI, the test subject should be fully informed about the nature of the test and its intended use. He or she should also receive standardized instructions for taking the test and any information on the confidentiality of the results.

Normal results

Myers-Briggs results are reported as a four-letter personality type (e.g., ESTP, ISFJ). Each letter corresponds to an individual's preference in each of the four pairs of personality indicators (i.e., E or I, S or N, T or F, and J or P). There are a total of sixteen possible combinations of personality types on the MBTI.

Letter One: E or I

Extraverts focus more on people and things, introverts on ideas.

Letter Two: S or N

Sensing dominant personalities prefer to perceive things through sight, sound, taste, touch, and smell, while intuition dominant types look to past experience and are more abstract in their thinking.

Letter Three: T or F

The third subtype is a measure of how people use judgement. Thinking types use logic to judge the world, while feeling types tend to view things on the basis of what emotions they invoke.

Letter Four: J or P

Everyone judges and perceives, but those who are judging dominant are said to be more methodical and results-oriented, while perceiving dominant personalities are good at multi-tasking and are flexible.

Resources

BOOKS

Quenck, Naomi. *Essentials of Myers-Briggs Type Indicator Assessment*. New York: John Wiley & Sons, 1999.

PERIODICALS

"Identifying How We Think: The Myers-Briggs Type Indicator and the Hermann Brian Dominance Instrument." *The Harvard Business Review.* (July-August 1997) 75, no. 4: 114.

ORGANIZATION

American Psychological Association. Testing and Assessment Office of the Science Directorate. 750 First St., N.E., Washington, DC 20002-4242. (202)336-6000. <http://www.apa.org/science/testing.html>.

ERIC Clearinghouse on Assessment and Evaluation. 1131 Shriver Laboratory Bldg 075, University of Maryland, College Park, MD 20742. (800) 464-3742. <http://www.ericae.net>.

Paula Anne Ford-Martin

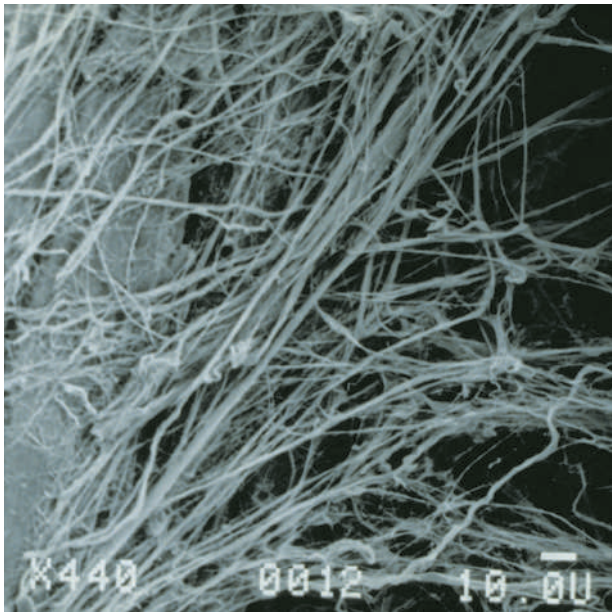
Myocardial biopsy

Definition

Myocardial biopsy is a procedure wherein a small portion of tissue is removed from the heart muscle for testing. This test is also known as endomyocardial biopsy.

Purpose

The main reason for a biopsy is to secure tissue samples that will be useful in the diagnosis, treatment, and



Once the catheter is threaded up into the heart, the surgeon will take several small samples of muscle for laboratory analysis. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Anticoagulant—Medication that thins the blood and slows clot formation.

Aplastic anemia—A greatly decreased production of all of the formed elements of the blood caused by a failure of the cell-generating capacity of the bone marrow.

Electrocardiography—A test that uses electrodes attached to the chest with an adhesive gel to transmit the electrical impulses of the heart muscle to a recording device.

Leukemia—A disease characterized by an increasing number of abnormal cells in the blood.

care of heart muscle disorders. The test is also used to detect rejection after a **heart transplantation** procedure.

Precautions

This procedure is not used when the patient is taking blood-thinning medication (anticoagulant therapy). It should not be done when the patient has leukemia and **aplastic anemia** or if there is a blood clot on the interior wall of the heart.

Description

A long, flexible tube, called a catheter, is inserted into a vein and threaded up into the heart. The doctor can guide the catheter by watching its movement on a TV monitor showing an x-ray image of the area. The tip of the catheter is fitted with tiny jaws that the doctor can open and close. Once the catheter is in place, the doctor will take several small snips of muscle for microscopic examination.

Preparation

Preparation for myocardial biopsy is quite extensive. The patient will be asked not to eat for several hours before the procedure. A technician will shave the hair from the area of the incision and will also insert an intravenous line in the arm. The patient will be given a sedative to relax but will not be fully anesthetized. The patient will be connected to an electrocardiograph (ECG) to monitor the heart, and a blood-pressure cuff will be placed. Finally, the patient will be covered with sterile drapes, so that the area of the biopsy is kept free of germs. The cardiologist will numb the area where the catheter will be inserted.

Aftercare

At the end of the biopsy, the catheter will be removed and pressure will be applied at the site where it entered the blood vessel in order to encourage healing. The patient will then be taken to the recovery room. It is advisable to remain flat and not to move about for 6-8 hours. After that time, most people begin walking around. Swelling and bruising at the puncture site are common and usually go away without need for further attention.

Risks

The risks involved with myocardial biopsy are small because the patient is monitored closely and attended by well-trained staff. Racing of the heart (**palpitations**) and quivering of the heart muscles (atrial fibrillation) are both possible during the procedure.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Myocardial infarction *see* **Heart attack**

Myocardial resection

Definition

Myocardial resection is a surgical procedure in which a portion of the heart muscle is removed.

Purpose

Myocardial resection is done to improve the stability of the heart function or rhythm. Also known as endocardial resection, this open-heart surgery is done to destroy or remove damaged areas of the heart that cause life-threatening heart rhythms. This procedure is often performed in people who have had a **heart attack**, in order to prevent future rapid heart rates. It is also used in people who have **Wolff-Parkinson-White syndrome** (a condition resulting in abnormal heart rhythm).

Precautions

This is major surgery and should be the treatment of choice only after medications have failed and the use of an **implantable cardioverter-defibrillator** (a device that delivers electrical shock to control heart rhythm) has been ruled out.

Description

After receiving a general anesthetic, an incision will be made in the chest to expose the heart. When the exact source of the abnormal rhythm is identified, it is removed. If there are areas around the source that may contribute to the problem, they can be frozen with a special probe to further ensure against dangerous heart rates. The amount of tissue removed is so small, usually only 2 or 3 millimeters, that there is no damage to the structure of the heart. On some occasions, aneurysms of the heart wall are removed as well.

Preparation

Prior to surgery, the physician will explain the procedure, routine blood tests will be completed, and consent forms will be signed.

Aftercare

Immediately after surgery, the patient will be moved to a recovery room until the effects of anesthesia have worn off. The patient will then be transferred to the intensive care unit for further recovery. In the intensive care unit, the heart will be monitored for any disturbances in rhythm and the patient will be watched for any signs of post-operative problems.

KEY TERMS

Implantable cardioverter-defibrillator—A device placed in the body to deliver an electrical shock to the heart in response to a serious abnormal rhythm.

Wolff-Parkinson-White syndrome—An abnormal, rapid heart rhythm, due to an extra pathway for the electrical impulses to travel from the atria to the ventricles.

Risks

The risks of myocardial resection are based in large part on the person's underlying heart condition and, therefore, vary greatly. The procedure involves opening the heart, so the person is at risk for the complications associated with major heart surgery such as **stroke**, shock, infection, and hemorrhage.

Normal results

Anywhere from 5-25% of post-heart attack patients do not survive open-heart surgery. The survivors have a 90% arrhythmia-free one-year survival rate, (arrthymia is an irregular heart beat).

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Myocarditis

Definition

Myocarditis is an inflammatory disease of the heart muscle (myocardium) that can result from a variety of

causes. While most cases are produced by a viral infection, an inflammation of the heart muscle may also be instigated by toxins, drugs, and hypersensitive immune reactions. Myocarditis is a rare but serious condition that affects both males and females of any age.

Description

Most cases of myocarditis in the United States originate from a virus, and the disease may remain undiagnosed by doctors due to its general lack of initial symptoms. The disease may also present itself as an acute, catastrophic illness that requires immediate treatment. Although the inflammation or degeneration of the heart muscle that myocarditis causes may be fatal, this disease often goes undetected. It may also disguise itself as ischemic, valvular, or hypertensive heart disease.

An inflammation of the heart muscle may occur as an isolated disorder or be the dominating feature of a systemic disease (one that affects the whole body, like **systemic lupus erythematosus**).

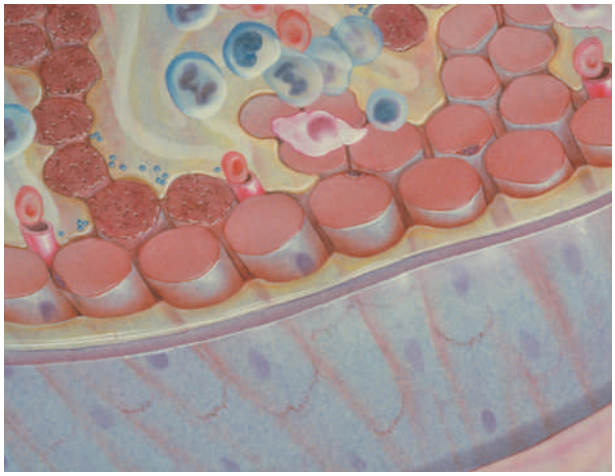
Causes and symptoms

While there are several contributing factors that may lead to myocarditis, the primary cause is viral. Myocarditis usually results from the Coxsackie B virus, and may also result from **measles**, **influenza**, chicken pox, hepatitis virus, or the adenovirus in children. If an acute onset of severe myocarditis occurs, a patient may display the following symptoms:

- rhythm disturbances of the heart
- rapid heartbeat (**Ventricular tachycardia**)
- left or right ventricular enlargement
- **shortness of breath** (Dyspnea)
- pulmonary **edema** (the accumulation of fluid in the lungs due to left-sided **heart failure**)
- swollen legs

Additional causes of myocarditis include:

- bacterial infections, such as **tetanus**, **gonorrhea**, or **tuberculosis**
- parasite infections, such as **Chagas' disease** (which is caused by an insect-borne protozoan most commonly seen in Central and South America)
- rheumatic **fever**
- surgery on the heart
- radiation therapy for **cancer** that is localized in the chest, such as breast or lung cancer
- certain medications



This illustration depicts the inflammation of the myocarditis, the middle muscular layer of the heart wall. *(Custom Medical Stock Photo. Reproduced by permission.)*

As of 1996, research has shown that illegal drugs and toxic substances may also produce acute or chronic injury to the myocardium. These studies also indicate an increase in the incidence of toxic results from the use of **cocaine**. This illegal drug causes coronary artery spasm, myocardial infarction (**heart attack**), and **arrhythmias**, as well as myocarditis.

Further studies conducted in 1996 indicate that **malnutrition** encourages the Coxsackie B virus to flourish, leading to the potential development of myocarditis. Human **immunodeficiency** virus (HIV) is also now recognized as a cause of myocarditis, though its prevalence is not known.

Symptoms of myocarditis may start as **fatigue**, shortness of breath, fever and aching of the joints, all characteristic of a flu-like illness. In contrast to this type of mild appearance, myocarditis may also appear suddenly in the form of heart failure, or **sudden cardiac death** without any prior symptoms. If an inflammation of the heart muscle leads to congestive heart failure, symptoms such as swollen feet and ankles, distended neck veins, a rapid heartbeat, and difficulty breathing while reclining may all appear.

Diagnosis

The best way to diagnose myocarditis may be through a person's observation of his or her own symptoms, followed by a thorough medical history and physical exam conducted by a doctor. Further tests usually include laboratory blood studies and **echocardiography**. An electrocardiogram (ECG) is also routinely used due to its ability to detect a mild case of the disease. **Cardiac catheterization** and **angiography** are additional diagnostic tests used

KEY TERMS

Adenovirus—One type of virus that can cause upper respiratory tract infections.

Angiography—A procedure which uses x ray after injecting a radiopaque substance to examine the blood vessels and lymphatics.

Arrhythmia—An irregular heartbeat or action.

Cardiac catheterization—A diagnostic procedure that gives a comprehensive examination of how the heart and its blood vessels function; performed by inserting one or more catheters through a peripheral blood vessel in the arm or leg.

Coxsackie B virus—A mild virus belonging to a group of viruses (coxsackievirus) that may produce a variety of illnesses, including myocarditis.

Echocardiography—A noninvasive diagnostic procedure that uses ultrasound to examine internal cardiac structures.

Electrocardiogram—A record of the electrical activity of the heart, with each wave being labeled as P, Q, R, S, and T waves. Often used in the diagnosis of cases of abnormal cardiac rhythm and myocardial damage.

Hypertensive heart disease—High blood pressure resulting in a disease of the heart.

Ischemic heart disease—Insufficient blood supply to the heart muscle (myocardium).

Valvular heart disease—A disease of any one of the four valves that controls blood flow into, through, and out of the heart.

Ventricular tachycardia— An abnormally rapid heartbeat. It includes a series of at least three beats arising from a ventricular area at a rate of more than 100 beats per minute, usually ranging from 150-200 beats per minute.

to determine the presence of myocarditis, or to rule out other possible heart diseases that may lead to heart failure.

Another measure used to diagnosis myocarditis is the endomyocardial biopsy procedure. This invasive catheterization procedure examines a biopsied, or "snipped," piece of the endocardium (the lining membrane of the inner surface of the heart). The tissue sample is examined to verify the presence of the disease, as well as to try to determine the infective cause. An approach used only with a patient's consent, this procedure may also confirm acute myocarditis, allowing close monitoring of potential congestive heart failure.

Treatment

While myocarditis is a serious condition, there is no medical treatment necessary if it results from a general viral infection. The only steps to recovery include rest and avoidance of physical exertion. Adequate rest becomes more important to recovery if the case is severe myocarditis with signs of dilated cardiomyopathy (disease of the heart muscles). In this case, medical treatment for congestive heart failure may include the following medications: angiotensin converting enzyme (ACE) inhibitors, **diuretics** to reduce fluid retention, digitalis to stimulate a stronger heartbeat, and low-dose beta-blockers.

If myocarditis is caused by a bacterial infection, the disease is treated with **antibiotics** to fight the infection. If severe rhythm disturbances are involved, cardiac assist devices, an "artificial heart," or **heart transplantation** may be the only option for complete recovery.

Prognosis

The outlook for a diagnosed case of myocarditis caused by a viral infection is excellent, with many cases healing themselves spontaneously. Severe or acute myocarditis may be controlled with medication to prevent heart failure. Because this disease may be mild or may be extreme and cause serious arrhythmias, the prognosis varies. Cases of myocarditis may vary from complete healing (with or without significant scarring), to severe congestive heart failure leading to **death** or requiring a heart transplant.

Inflammation of the myocardium may also cause acute **pericarditis** (inflammation of the outer lining of the heart). Due to the potential effects of the disease, including sudden death, it is imperative that proper medical attention is obtained.

Prevention

Although myocarditis is an unpredictable disease, the following measures may help prevent its onset. Individuals should:

- take extra measures to avoid infections, and obtain appropriate treatment for infections

- limit alcohol consumption to no more than one or two drinks a day, if any
- maintain current immunizations against **diphtheria**, tetanus, measles, **rubella**, and **polio**
- avoid anything that may cause the abnormal heart to work too hard, including salt and vigorous exercise

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

Griffith, H. Winter. "Myocarditis." In *Complete Guide To Symptoms, Illness & Surgery.* New York: The Putnam Berkley Group, Inc., 1995.

"Myocarditis & The Cardiomyopathies." In *Currrent Medical Diagnosis & Treatment*. 35th ed. Ed. Lawrence M. Tierney Jr., Stephen J. McPhee, and Maxine A. Papdakis. Stamford: Appleton & Lange, 1996.

PERIODICALS

"Viral Myocarditis." *Physician and Sportsmedicine* 23 (July 1995): 63-66, 68.

Zeppilli, Paolo, et al. "Role of Myocarditis in Athletes with Minor Arrhythmias and/or Echocardiographic Abnormalities." *Chest* 106 (Aug. 1994): 373.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Beth A. Kapes

Myoglobin test

Definition

Myoglobin is a protein found in muscle. Myoglobin tests are done to evaluate a person who has symptoms of a **heart attack** (myocardial infarction) or other muscle damage.

Purpose

Myoglobin holds oxygen inside heart and skeletal muscle (muscles that attach to and move bones). It is continually released into the blood in small amounts due to normal turnover of muscle cells. Kidneys discard the myoglobin into urine.

When muscle is damaged, as in a heart attack, larger amounts of myoglobin are released and blood levels rise rapidly. Myoglobin is one of the first tests done to determine if a person with chest **pain** is having a heart attack, as it may be one of the first blood tests to become abnormal.

Damage or injury to skeletal muscle also causes myoglobin to be released into the blood.

Description

Heart attack must be diagnosed quickly. Medications to prevent heart damage are effective only within a limited number of hours. Yet, because of their risk for excessive bleeding, these medications are given only after a diagnosis of heart attack is made.

Myoglobin is one of several cardiac markers used to make the diagnosis. Cardiac markers are substances in blood whose levels rise in the hours following a heart attack. Increased levels help diagnose a heart attack; persistent normal levels rule it out.

Each cardiac marker rises, peaks, and returns to a normal level according to its own timeline, or diagnostic window. Myoglobin is useful because it has the earliest diagnostic window. It is the first marker to rise after chest pain begins. Myoglobin levels rise within two to three hours, and sometimes as early as 30 minutes. They peak after six to nine hours. The levels return to normal within 24-36 hours.

Although a rise in myoglobin supports a diagnosis of heart attack, it is not conclusive. Simultaneous skeletal muscle damage could also cause the increase. Myoglobin rules out, rather than proves, a diagnosis in the following way. If myoglobin levels have not risen after more than five hours, a heart attack is unlikely. Normal levels in the first two to three hours do not rule out an infarction.

The myoglobin test is sometimes repeated every one to two hours to watch for the rise and peak. Results are available within 30 minutes.

Myoglobin in large amounts is toxic to the kidney. When a person has high amounts of myoglobin in the blood, kidney function must be monitored.

Preparation

This test requires 5 ml of blood. Collection of the sample takes only a few minutes. A urine myoglobin test requires 1 ml of urine collected into a urine collection cup.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

KEY TERMS

Cardiac marker—A substance in the blood that rises following a heart attack.

Diagnostic window—A cardiac marker's timeline for rising, peaking, and returning to normal after a heart attack.

Myoglobin—A protein that holds oxygen in heart and skeletal muscle. It rises after damage to either of these muscle types.

Normal results

Normal results vary based on the laboratory and method used.

Abnormal results

Myoglobin levels and levels of other cardiac markers are usually considered before finally confirming a diagnosis of heart attack. A level that has doubled after one to two hours, even if the level is still in the normal range, indicates a significant rise that may be due to heart attack.

Increased levels are also found with skeletal muscle damage or disease, such as an injury, **muscular dystrophy**, or **polymyositis**. Myoglobin levels also rise during renal failure because kidneys lose their ability to clear myoglobin from blood.

Resources

BOOKS

Wu, Alan, ed. *Cardiac Markers*. Washington, DC: American Association of Clinical Chemistry (AACC) Press, 1998.

PERIODICALS

Chesebro, Marcia J. "Using Serum Markers in the Early Diagnosis of Myocardial Infarction." *American Family Physician* (June 1997): 2667-2674.

Keffer, Joseph. "Myocardial Markers of Injury. Evolution and Insights." *American Journal of Clinical Pathology* (Mar. 1996): 305-320.

Mercer, Donald W. "Role of Cardiac Markers in Evaluation of Suspected Heart attack. Selecting the Most Clinically Useful Indicators." *Postgraduate Medicine* (Nov. 1997): 113-117, 121-122.

Nancy J. Nordenson

Myomas *see* **Uterine fibroids**

Myomectomy

Definition

Myomectomy is the removal of fibroids (noncancerous tumors) from the wall of the uterus. Myomectomy is the preferred treatment for symptomatic fibroids in women who want to keep their uterus. Larger fibroids must be removed with an abdominal incision, but small fibroids can be taken out using **laparoscopy** or **hysteroscopy**.

Purpose

A myomectomy can remove **uterine fibroids** that are causing symptoms. It is an alternative to surgical removal of the whole uterus (**hysterectomy**). The procedure can relieve fibroid-induced menstrual symptoms that have not responded to medication. Myomectomy also may be an effective treatment for **infertility** caused by the presence of fibroids.

Precautions

There is a risk that removal of the fibroids may lead to such severe bleeding that the uterus itself will have to be removed. Because of the risk of blood loss during a myomectomy, patients may want to consider banking their own blood before surgery.

Description

Usually, fibroids are buried in the outer wall of the uterus and abdominal surgery is required. If they are on the inner wall of the uterus, uterine fibroids can be removed using hysteroscopy. If they are on a stalk (pedunculated) on the outer surface of the uterus, laparoscopy can be performed.

Removing fibroids through abdominal surgery is a more difficult and slightly more risky operation than a hysterectomy. This is because the uterus bleeds from the sites where the fibroids were, and it may be difficult or impossible to stop the bleeding. This surgery is usually performed under general anesthesia, although some patients may be given a spinal or epidural anesthesia.

The incision may be horizontal (the "bikini" incision) or a vertical incision from the navel downward. After separating the muscle layers underneath the skin, the surgeon makes an opening in the abdominal wall. Next, the surgeon makes an incision over each fibroid, grasping and pulling out each growth.

Every opening in the uterine wall is then stitched with sutures. The uterus must be meticulously repaired in

order to eliminate potential sites of bleeding or infection. Then, the surgeon sutures the abdominal wall and muscle layers above it with absorbable stitches, and closes the skin with clips or nonabsorbable stitches.

When appropriate, a laparoscopic myomectomy may be performed. In this procedure, the surgeon removes fibroids with the help of a viewing tube (laparoscope) inserted into the pelvic cavity through an incision in the navel. The fibroids are removed through a tiny incision under the navel that is much smaller than the 4 or 5 inch opening required for a standard myomectomy.

If the fibroids are small and located on the inner surface of the uterus, they can be removed with a thin telescope-like device called a hysteroscope. The hysteroscope is inserted into the vagina through the cervix and into the uterus. This procedure does not require any abdominal incision, so hospitalization is shorter.

Preparation

Surgeons often recommend hormone treatment with a drug called leuprolide (Lupron) two to six months before surgery in order to shrink the fibroids. This makes the fibroids easier to remove. In addition, Lupron stops menstruation, so women who are anemic have an opportunity to build up their **blood count**. While the drug treatment may reduce the risk of excess blood loss during surgery, there is a small risk that temporarily-smaller fibroids might be missed during myomectomy, only to enlarge later after the surgery is completed.

Aftercare

Patients may need four to six weeks of recovery following a standard myomectomy before they can return to normal activities. Women who have had laparoscopic or hysteroscopic myomectomies, however, can leave the hospital the day after surgery and usually recovery completely within two to three days to one to three weeks.

Risks

The risks of a myomectomy performed by a skilled surgeon are about the same as hysterectomy (one of the most common and safest surgeries). Removing multiple fibroids is more difficult and slightly more risky.

Possible complications include:

- infection
- blood loss
- the wall of the uterus may be weakened if the removal of a large fibroid leaves a wound that extends the complete thickness of the wall. Special precautions may be needed in future pregnancies. For example, the delivery may need to be performed surgically (Caesarean section)
- adverse reactions to anesthesia
- internal scarring (and possible infertility)

Since fibroids tend to appear and grow as a woman ages (until **menopause**), it is possible that new fibroids will appear after myomectomy.

KEY TERMS

Epidural anesthesia—A method of pain relief for surgery in which local anesthetic is injected into the epidural space in the middle and lower back.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

OTHER

Toaff, Michael E. "Myomectomy." *Alternatives to Hysterectomy Page*. <http://www.netreach.net/~hysterectomyedu/myomecto.htm>.

Carol A. Turkington

Myopathies

Definition

Myopathies are diseases of skeletal muscle which are not caused by nerve disorders. These diseases cause the skeletal or voluntary muscles to become weak or wasted.

Description

There are many different types of myopathies, some of which are inherited, some inflammatory, and some caused by endocrine problems. Myopathies are rare and not usually fatal. Typically, effects are mild, largely causing muscle weakness and movement problems, and many are transitory. Only rarely will patients become dependent on a wheelchair. However, **muscular dystrophy** (which

is technically a form of myopathy) is far more severe. Some types of this disease are fatal in early adulthood.

Causes and symptoms

Myopathies are usually degenerative, but they are sometimes caused by drug side effects, chemical **poisoning**, or a chronic disorder of the immune system.

Genetic myopathies

Among their many functions, genes are responsible for overseeing the production of proteins important in maintaining healthy cells. Muscle cells produce thousands of proteins. With each of the inherited myopathies, a genetic defect is linked to a lack of, or problem with, one of the proteins needed for normal muscle cell function.

There are several different kinds of myopathy caused by defective genes:

- central core disease
- centronuclear (myotubular) myopathy
- myotonia congenita
- nemaline myopathy
- paramyotonia congenita
- periodic **paralysis** (hypokalemic and hyperkalemic forms)
- mitochondrial myopathies

Most of these genetic myopathies are dominant, which means that a child needs to inherit only one copy of the defective gene from one parent in order to have the disease. The parent with the defective gene also has the disorder, and each of this parent's children has a 50% chance of also inheriting the disease. Male and female children are equally at risk.

However, one form of myotonia congenita and some forms of nemaline myopathy must be inherited from both parents, each of whom carry a recessive defective gene but who don't have symptoms of the disease. Each child of such parents has a 25% chance of inheriting both genes and showing signs of the disease, and a 50% chance of inheriting one defective gene from only one parent. If the child inherited just one defective gene, he or she would be a carrier but would not show signs of the disease.

A few forms of centronuclear myopathy develop primarily in males. Females who inherit the defective gene are usually carriers without symptoms, like their mothers, but they can pass on the disease to their sons. Mitochondrial myopathies are inherited through the mother, since sperm don't contain mitochondria. (Mitochondria play a key role in energy production in the body's cells.)

The major symptoms associated with the genetic myopathies include:

- Central core disease: mild weakness of voluntary muscles, especially in the hips and legs; hip displacement; delays in reaching developmental motor milestones; problems with running, jumping, and climbing stairs develop in childhood
- Centronuclear myopathy: weakness of voluntary muscles including those on the face, arms, legs, and trunk; drooping upper eyelids; facial weakness; foot drop; affected muscles almost always lack reflexes
- Myotonia congenita: voluntary muscles of the arms, legs, and face are stiff or slow to relax after contracting (myotonia); stiffness triggered by **fatigue**, **stress**, cold, or long rest periods, such as a night's sleep; stiffness can be relieved by repeated movement of the affected muscles
- Nemaline myopathy: moderate weakness of voluntary muscles in the arms, legs, and trunk; mild weakness of facial muscles; delays in reaching developmental motor milestones; decreased or absent reflexes in affected muscles; long, narrow face; high-arched palate; jaw projects beyond upper part of the face
- Paramyotonia congenita: stiffness (myotonia) of voluntary muscles in the face, hands, and forearms; attacks spontaneous or triggered by cold temperatures; stiffness made worse by repeated movement; episodes of stiffness last longer than those seen in myotonia congenita
- Periodic paralysis: attacks of temporary muscle weakness (muscles work normally between attacks); in the hypokalemic (low calcium) form, attacks triggered by vigorous **exercise**, heavy meals (high in carbohydrates), insulin, stress, alcohol, infection, **pregnancy**; in the hyperkalemic (normal/high calcium) form, attacks triggered by vigorous exercise, stress, pregnancy, missing a meal, steroid drugs, high potassium intake
- Mitochondrial myopathies: symptoms vary quite widely with the form of the disease and may include progressive weakness of the eye muscles (ocular myopathy), weakness of the arms and legs, or multisystem problems primarily involving the brain and muscles

Endocrine-related myopathies

In some cases, myopathies can be caused by a malfunctioning gland (or glands), which produces either too much or too little of the chemical messengers called hormones. Hormones are carried by the blood and one of their many functions is to regulate muscle activity. Problems in producing hormones can lead to muscle weakness.

Hyperthyroid myopathy and hypothyroid myopathy affect different muscles in different ways. Hyperthyroid

myopathy occurs when the thyroid gland produces too much thyroxine, leading to muscle weakness, some muscle wasting in hips and shoulders, and, sometimes, problems with eye muscles. The hypothyroid type occurs when too little hormone is produced, leading to stiffness, cramps, and weakness of arm and leg muscles.

Inflammatory myopathies

Some myopathies are inflammatory, leading to inflamed, weakened muscles. Inflammation is a protective response of injured tissues characterized by redness, increased heat, swelling, and/or **pain** in the affected area. Examples of this type include **polymyositis**, dermatomyositis, and myositis ossificans.

Dermatomyositis is a disease of the connective tissue that also involves weak, tender, inflamed muscles. In fact, muscle tissue loss may be so severe that the person may be unable to walk. Skin inflammation is also present. The cause is unknown, but viral infection and **antibiotics** are associated with the condition. In some cases, dermatomyositis is associated with rheumatologic disease or **cancer**. Polymyositis involves inflammation of many muscles usually accompanied by deformity, swelling, sleeplessness, pain, sweating, and tension. It, too, may be associated with cancer. Myositis ossificans is a rare inherited disease in which muscle tissue is replaced by bone, beginning in childhood.

Muscular dystrophy

While considered to be a separate group of diseases, the muscular dystrophies also technically involve muscle wasting and can be described as myopathies. These relatively rare diseases appear during childhood and adolescence, and are caused by muscle destruction or degeneration. They are a group of genetic disorders caused by problems in the production of key proteins.

The forms of muscular dystrophy (MD) differ according to the way they are inherited, the age of onset, the muscles they affect, and how fast they progress. The most common type is Duchenne MD, affecting one or two in every 10,000 boys. Other types of MD include Becker's, **myotonic dystrophy**, limb-girdle MD, and facioscapulohumeral MD.

Diagnosis

Early diagnosis of myopathy is important so that the best possible care can be provided as soon as possible. An experienced physician can diagnose a myopathy by evaluating a person's medical history and by performing a thorough physical exam. Diagnostic tests can help differentiate between the different types of myopathy, as well as between myopathy and other neuromuscular disorders. If the doctor suspects a genetic myopathy, a thorough family history will also be taken.

Diagnostic tests the doctor may order include:

- measurements of potassium in the blood
- muscle biopsy
- electromyogram (EMG)

KEY TERMS

Electromyogram (EMG)—A diagnostic test that records the electrical activity of muscles. In the test, small electrodes are placed on or in the skin; the patterns of electrical activity are projected on a screen or over a loudspeaker. This procedure is used to test for muscle disorders, including muscular dystrophy.

Inflammation—A protective response of injured tissues characterized by redness, increased heat, swelling, and/or pain in the affected area.

Voluntary muscles—Muscles producing voluntary movement.

Treatment

Treatment depends on the specific type of myopathy the person has:

- periodic paralysis: medication and dietary changes
- hyperthyroid or hypothyroid myopathy: treatment of the underlying thyroid abnormality
- myositis ossificans: medication may prevent abnormal bone formation, but there is no cure following onset
- central core disease: no treatment
- nemaline myopathy: no treatment
- centronuclear (myotubular) myopathy: no treatment
- paramyotonia congenita: treatment often unnecessary
- myotonia congenita: drug treatment (if necessary), but drugs don't affect the underlying disease, and attacks may still occur

Prognosis

The prognosis for patients with myopathy depends on the type and severity of the individual disease. In most cases, the myopathy can be successfully treated and the patient returned to normal life.

Muscular dystrophy, however, is generally a much more serious condition. Duchenne's MD is usually fatal by the late teens; Becker's MD is less serious and may not be fatal until the 50s.

Resources

BOOKS

Knowles, Anne. *Under the Shadow.* New York: Harper & Row, 1983.

ORGANIZATIONS

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (800) 572-1717. <http://www.mdausa.org>.

OTHER

Facts About Myopathies. Tucson, AZ: Muscular Dystrophy Association, 1993.

Carol A. Turkington

Myopia

Definition

Myopia is the medical term for nearsightedness. People with myopia see objects more clearly when they are close to the eye, while distant objects appear blurred or fuzzy. Reading and close-up work may be clear, but distance vision is blurry.

Description

To understand myopia it is necessary to have a basic knowledge of the main parts of the eye's focusing system: the cornea, the lens, and the retina. The cornea is a tough, transparent, dome-shaped tissue that covers the front of the eye (not to be confused with the white, opaque sclera). The cornea lies in front of the iris (the colored part of the eye). The lens is a transparent, double-convex structure located behind the iris. The retina is a thin membrane that lines the rear of the eyeball. Light-sensitive retinal cells convert incoming light rays into electrical signals that are sent along the optic nerve to the brain, which then interprets the images.

In people with normal vision, parallel light rays enter the eye and are bent by the cornea and lens (a process called refraction) to focus precisely on the retina, providing a crisp, clear image. In the myopic eye, the focusing power of the cornea (the major refracting structure of the eye) and the lens is too great with respect to the length of the eyeball. Light rays are bent too much, and they converge in front of the retina. This inaccuracy is called a refractive error. In other words, an overfocused fuzzy image is sent to the brain.

There are many types of myopia. Some common types include:

- physiologic
- pathologic
- acquired

By far the most common form, physiologic myopia develops in children sometime between the ages of 5-10 years and gradually progresses until the eye is fully grown. Physiologic myopia may include refractive myopia (the cornea and lens-bending properties are too strong) and axial myopia (the eyeball is too long). Pathologic myopia is a far less common abnormality. This condition begins as physiologic myopia, but rather than stabilizing, the eye continues to enlarge at an abnormal rate (progressive myopia). This more advanced type of myopia may lead to degenerative changes in the eye (degenerative myopia). Acquired myopia occurs after infancy. This condition may be seen in association with uncontrolled diabetes and certain types of **cataracts**. **Antihypertensive drugs** and other medications can also affect the refractive power of the lens.

Genetic profile

Eyecare professionals have debated the role of genetics in the development of myopia for many years. Some believe that a tendency toward myopia may be inherited, but the actual disorder results from a combination of environmental and genetic factors. Environmental factors include close work; work with computer monitors or other instruments that emit some light (electron microscopes, photographic equipment, lasers, etc.); emotional **stress**; and eye strain.

A variety of genetic patterns for inheriting myopia have been suggested, ranging from a recessive pattern with complete penetrance in people who are homozygotic for myopia to an autosomal dominant pattern; an autosomal recessive pattern; and various mixtures of these patterns. One explanation for this lack of agreement is that the genetic profile of high myopia (defined as a refractive error greater than -6 diopters) may differ from that of low myopia. Some researchers think that high myopia is determined by genetic factors to a greater extent than low myopia.

Another explanation for disagreement regarding the role of heredity in myopia is the sensitivity of the human eye to very small changes in its anatomical structure. Since even small deviations from normal structure cause significant refractive errors, it may be difficult to single out any specific genetic or environmental factor as their cause.

Genetic markers and gene mapping

Since 1992, genetic markers that may be associated with genes for myopia have been located on human chromosomes 1, 2, 12, and 18. There is some genetic information on the short arm of chromosome 2 in highly myopic people. Genetic information for low myopia appears to be located on the short arm of chromosome 1, but it is not known whether this information governs the structure of the eye itself or vulnerability to environmental factors.

In 1998 a team of American researchers presented evidence that a gene for familial high myopia with an autosomal dominant transmission pattern could be mapped to human chromosome 18 in eight North American families. The same group also found a second locus for this form of myopia on human chromosome 12 in a large German/Italian family. In 1999 a group of French researchers found no linkage between chromosome 18 and 32 French families with familial high myopia. These findings have been taken to indicate that more than one gene is involved in the transmission of the disorder.

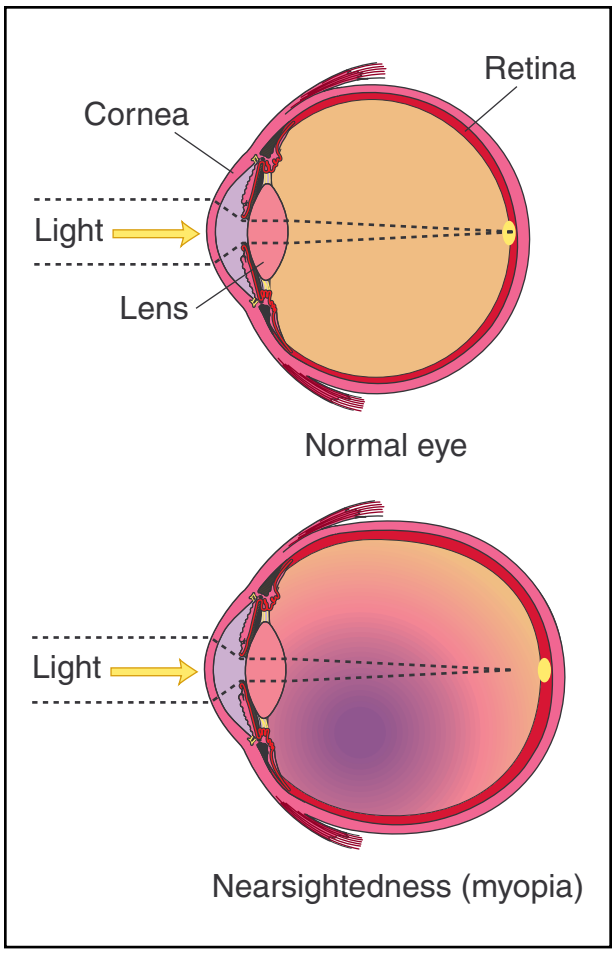
Family studies

It has been known for some years that a family history of myopia is one of the most important risk factors for developing the condition. Only 6%-15% of children with myopia come from families in which neither parent is myopic. In families with one myopic parent, 23%-40% of the children develop myopia. If both parents are myopic, the rate rises to 33%-60% for their children. One American study found that children with two myopic parents are 6.42 times as likely to develop myopia themselves as children with only one or no myopic parents. The precise interplay of genetic and environmental factors in these family patterns, however, is not yet known.

One multigenerational study of Chinese subjects indicated that subjects in the third generation had a higher risk of developing myopia even if their parents were not myopic. The researchers concluded that, at least in China, the genetic factors in myopia have remained constant over the past three generations while the environmental factors have intensified. The increase in the percentage of people with myopia over the last 50 years in the United States has led American researchers to the same conclusion.

Myopia is the most common eye disorder in humans around the world. It affects between 25% and 35% of the adult population in the United States and the developed countries, but is thought to affect as much as 40% of the population in some parts of Asia. Some researchers have found slightly higher rates of myopia in women than in men.

The age distribution of myopia in the United States varies considerably. Five-year-olds have the lowest rate of myopia (less than 5%) of any age group. The prevalence of myopia rises among children and adolescents in school until it reaches the 25%-35% mark in the young adult population. It declines slightly in the over-45 age group; about 20% of 65-year-olds have myopia. The figure drops to 14% for Americans over 70.



Myopia, or nearsightedness, is a condition of the eye in which objects are seen more clearly when close to the eye while distant objects appear blurred or fuzzy. *(Illustration by Electronic Illustrators Group.)*

Other factors that affect the demographic distribution of myopia are income level and education. The prevalence of myopia is higher among people with above-average incomes and educational attainments. Myopia is also more prevalent among people whose work requires a great deal of close focusing, including work with computers.

Causes and symptoms

Myopia is said to be caused by an elongation of the eyeball. This means that the oblong (as opposed to nor-

mal spherical) shape of the myopic eye causes the cornea and lens to focus at a point in front of the retina. A more precise explanation is that there is an inadequate correlation between the focusing power of the cornea and lens and the length of the eye.

People are generally born with a small amount of **hyperopia** (farsightedness), but as the eye grows this decreases and myopia does not become evident until later. This change is one reason why some researchers think that myopia is an acquired rather than an inherited trait.

The symptoms of myopia are blurred distance vision, eye discomfort, squinting, and eye strain.

Diagnosis

The diagnosis of myopia is typically made during the first several years of elementary school when a teacher notices a child having difficulty seeing the chalkboard, reading, or concentrating. The teacher or school nurse often recommends an **eye examination** by an ophthalmologist or optometrist. An ophthalmologist—M.D. or D.O. (Doctor of Osteopathy)—is a medical doctor trained in the diagnosis and treatment of eye problems. Ophthalmologists also perform eye surgery. An optometrist (O.D.) diagnoses and manages and/or treats eye and visual disorders. In many states, optometrists are licensed to use diagnostic and therapeutic drugs.

A patient's distance vision is tested by reading letters or numbers on a chart posted a set distance away (usually 20 ft). The doctor asks the patient to view images through a variety of lenses to obtain the best correction. The doctor also examines the inside of the eye and the retina. An instrument called a slit lamp is used to examine the cornea and lens. The eyeglass prescription is written in terms of diopters (D), which measure the degree of refractive error. Mild to moderate myopia usually falls between -1.00D and -6.00D. Normal vision is commonly referred to as 20/20 to describe the eye's focusing ability at a distance of 20 ft from an object. For example, 20/50 means that a myopic person must stand 20 ft away from an eye chart to see what a normal person can see at 50 ft. The larger the bottom number, the greater the myopia.

Treatment

People with myopia have three main options for treatment: eyeglasses, contact lenses, and for those who meet certain criteria, refractive eye surgery.

Eyeglasses

Eyeglasses are the most common method used to correct myopia. Concave glass or plastic lenses are placed in frames in front of the eyes. The lenses are ground to the thickness and curvature specified in the eyeglass prescription. The lenses cause the light rays to diverge so that they focus further back, directly on the retina, producing clear distance vision.

Contact lenses

Contact lenses are a second option for treatment. Contact lenses are extremely thin round discs of plastic that are worn on the eye in front of the cornea. Although there may be some initial discomfort, most people quickly grow accustomed to contact lenses. Hard contact lenses, made from a material called PMMA, are virtually obsolete. Rigid gas permeable lenses (RGP) are made of plastic that holds its shape but allows the passage of some oxygen into the eye. Some believe that RGP lenses may halt or slow the progression of myopia because they maintain a constant, gentle pressure that flattens the cornea. As of 2001, the National Eye Institute is conducting an ongoing study of RGP lenses called the Contact Lens and Myopia Progression (CLAMP) Study, with results to be published in 2003.

A procedure called orthokeratology acts on this principle of "corneal molding." However, when contact lenses are discontinued for a period of time, the cornea will generally go back to its original shape. Rigid gas permeable lenses offer crisp, clear, sight. Soft contact lenses are made of flexible plastic and can be up to 80% water. Soft lenses offer increased comfort and the advantage of extended wear; some can be worn continuously for up to one week. While oxygen passes freely through soft lenses, bacterial contamination and other problems can occur, requiring replacement of lenses on a regular basis. It is very important to follow the cleaning and disinfecting regimens prescribed because protein and lipid buildup can occur on the lenses, causing discomfort or increasing the risk of infection. Contact lenses offer several benefits over glasses, including: better vision, less distortion, clear peripheral vision, and cosmetic appeal. In addition, contacts don't steam up from perspiration or changes in temperature.

Refractive eye surgery

For people who find glasses and contact lenses inconvenient or uncomfortable, and who meet selection criteria regarding age, degree of myopia, general health, etc., refractive eye surgery is a third treatment alternative. There are three types of corrective surgeries available as of 2001: 1) **radial keratotomy** (RK), 2) photorefractive keratectomy (PRK), and 3) laser-assisted in-situ keratomileusis (LASIK), which is still under clinical evaluation by the Food and Drug Administration (FDA). Refrac-

KEY TERMS

Accommodation—The ability of the lens to change its focus from distant to near objects. It is achieved through the action of the ciliary muscles that change the shape of the lens.

Cornea—The transparent structure of the eye over the lens that is continous with the sclera in forming the outermost, protective, layer of the eye.

Diopter (D)—A unit of measure for describing refractive power.

Laser-assisted in-situ keratomileusis (LASIK)—A procedure that uses a cutting tool and a laser to modify the cornea and correct moderate to high levels of myopia.

Lens—The transparent, elastic, curved structure behind the iris (colored part of the eye) that helps focus light on the retina.

Ophthalmologist—A physician specializing in the medical and surgical treatment of eye disorders.

Optic nerve—A bundle of nerve fibers that carries visual messages from the retina in the form of electrical signals to the brain.

Optometrist—A medical professional who examines and tests the eyes for disease and treats visual disorders by prescribing corrective lenses and/or vision therapy. In many states, optometrists are licensed to use diagnostic and therapeutic drugs to treat certain ocular diseases.

Orthokeratology—A method of reshaping the cornea using a contact lens. It is not considered a permanent method to reduce myopia.

Peripheral vision—The ability to see objects that are not located directly in front of the eye. Peripheral vision allows people to see objects located on the side or edge of their field of vision.

Photorefractive keratectomy (PRK)—A procedure that uses an excimer laser to make modifications to the cornea and permanently correct myopia. As of early 1998, only two lasers have been approved by the FDA for this purpose.

Radial keratotomy (RK)—A surgical procedure involving the use of a diamond-tipped blade to make several spoke-like slits in the peripheral (non-viewing) portion of the cornea to improve the focus of the eye and correct myopia by flattening the cornea.

Refraction—The bending of light rays as they pass from one medium through another. Used to describe the action of the cornea and lens on light rays as they enter the eye. Also used to describe the determination and measurement of the eye's focusing system by an optometrist or ophthalmologist.

Refractive eye surgery—A general term for surgical procedures that can improve or correct refractive errors by permanently changing the shape of the cornea.

Retina—The light-sensitive layer of tissue in the back of the eye that receives and transmits visual signals to the brain through the optic nerve.

Visual acuity—The ability to distinguish details and shapes of objects.

tive eye surgery improves myopic vision by permanently changing the shape of the cornea so that light rays focus properly on the retina. These procedures are performed on an outpatient basis and generally take 10-30 minutes.

RADIAL KERATOTOMY. Radial keratotomy (RK), the first of these procedures made available, has a high associated risk. It was first developed in Japan and the Soviet Union, and introduced into the United States in 1978. The surgeon uses a delicate diamond-tipped blade, a microscope, and microscopic instruments to make several spoke-like "radial" incisions in the non-viewing (peripheral) portion of the cornea. As the incisions heal, the slits alter the curve of the cornea, making it more flat, which may improve the focus of images onto the retina.

PHOTOREFRACTIVE KERATECTOMY. Photorefractive keratectomy (PRK) involves the use of a computer to measure the shape of the cornea. Using these measurements, the surgeon applies a computer-controlled laser to make modifications to the cornea. The PRK procedure flattens the cornea by vaporizing small amounts of tissue from the cornea's surface. As of early 2001, only two excimer lasers are approved by the FDA for PRK, although other lasers have been used. It is important to make sure the laser being used is FDA approved. Photorefractive keratectomy can be used to treat mild to moderate forms of myopia. The cost is approximately $2,000 per eye.

LASER-ASSISTED IN-SITU KERATOMILEUSIS. Laser-assisted in-situ keratomileusis (LASIK) is the newest of

these procedures. It is recommended for moderate to severe cases of myopia. A variation on the PRK method, LASIK uses lasers and a cutting tool called a microkeratome to cut a circular flap on the cornea. The flap is flipped back to expose the inner layers of the cornea. The cornea is treated with a laser to change the shape and focusing properties, then the flap is replaced.

Risks

All of these surgical procedures carry risks, the most serious being corneal scarring, corneal rupture, infection, cataracts, and loss of vision. In addition, a study published in March 2001 warns that mountain climbers who have had LASIK surgery should be aware of possible changes in their vision at high altitudes. The lack of oxygen at high altitudes causes temporary changes in the thickness of the cornea.

Since refractive eye surgery doesn't guarantee 20/20 vision, it is important to have realistic expectations before choosing this treatment. In a 10-year study conducted by the National Eye Institute between 1983 and 1993, over 50% of people with radial keratotomy gained 20/20 vision, and 85% passed a driving test (requiring 20/40 vision) after surgery, without glasses or contact lenses. Even if the patient gains near-perfect vision, however, there are potentially irritating side effects, such as postoperative **pain**, poor night vision, variation in visual acuity, light sensitivity and glare, and optical distortion. Refractive eye surgeries are considered elective procedures and are rarely covered by insurance plans.

Myopia treatments under research include corneal implants and permanent surgically placed contact lenses.

Alternative treatments

Some eye care professionals recommend treatments to help improve circulation, reduce eye strain, and relax the eye muscles. It is possible that by combining exercises with changes in behavior, the progression of myopia may be slowed or prevented. Alternative treatments include: visual therapy (also referred to as **vision training** or eye exercises); discontinuing close work; reducing eye strain (taking a rest break during periods of prolonged near vision tasks); and wearing bifocals to decrease the need to accommodate when doing close-up work.

Prognosis

Glasses and contact lenses can (but not always) correct the patient's vision to 20/20. Refractive surgery can make permanent improvements for the right candidates.

While the genetic factors that influence the transmission and severity of myopia cannot be changed, some environmental factors can be modified. They include reducing close work; reading and working in good light; taking frequent breaks when working at a computer or microscope for long periods of time; maintaining good **nutrition**; and practicing visual therapy (when recommended).

Eye strain can be prevented by using sufficient light for reading and close work, and by wearing corrective lenses as prescribed. Everyone should have regular eye examinations to see if their prescription has changed or if any other problems have developed. This is particularly important for people with high (degenerative) myopia who are at a greater risk of developing **retinal detachment**, retinal degeneration, **glaucoma**, or other problems.

Resources

BOOKS

Birnbaum, Martin H. *Optometric Management of Nearpoint Vision Disorders*. Boston: Butterworth-Heinemann, 1993.

Curtin, Brian J. *The Myopias: Basic Science and Clinical Management*. Philadelphia: Harper & Row, 1985.

Rosanes-Berrett, Marilyn B. *Do You Really Need Eyeglasses?* Barrytown, NY: Station Hill Press, 1990.

Zinn, Walter J., and Herbert Solomon. *Complete Guide to Eyecare, Eyeglasses, and Contact Lenses*. Hollywood, FL: Lifetime Books, 1996.

PERIODICALS

Edwards MH. "Effect of parental myopia on the development of myopia in Hong Kong Chinese." *Ophthalmic Physiologic Optometry* 18 (November 1998): 477-483.

Naiglin L et al. "Familial high myopia: evidence of an autosomal dominant mode of inheritance and genetic heterogeneity." *Annals of Genetics* 42 (3) (1999): 140-146.

"Nine Ways to Look Better: If You Want to Improve Your Vision—Or Just Protect What You Have—Try These Eye Opening Moves." *Men's Health* 13 (Jan.-Feb. 1998): 50.

Pacella R et al. "Role of genetic factors in the etiology of juvenile-onset myopia based on a longitudinal study of refractive error." *Optometry and Visual Science* 76 (June 1999): 381-386.

Saw SM et al. "Myopia: gene-environment interaction." *Annals of the Academy of Medicine of Singapore* 29 (May 2000): 290-297.

Wu MM, and MH Edwards. "The effect of having myopic parents: an analysis of myopia in three generations." *Optometry and Visual Science* 76 (June 1999): 341-342.

Young TL et al. "Evidence that a locus for familial high myopia maps to chromosome 18p." *American Journal of Human Genetics* 63 (July 1998): 109-119.

Young TL et al. "A second locus for familial high myopia maps to chromosome 12q." *American Journal of Human Genetics* 63 (November 1998): 1419-1424.

ORGANIZATIONS

American Academy of Ophthalmology. PO Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

International Myopia Prevention Association. RD No. 5, Box 171, Ligonier, PA 15658. (412) 238-2101.

Myopia International Research Foundation. 1265 Broadway, Room 608, New York, NY 10001. (212) 684-2777.

National Eye Institute. Bldg. 31 Rm 6A32, 31 Center Dr., MSC 2510, Bethesda, MD 20892-2510. (301) 496-5248. 2020 @nei.nih.gov. <http://www.nei.nih.gov>.

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Myositis *see* **Myopathies**

Myotonia atrophica *see* **Myotonic dystrophy**

Myotonic dystrophy

Definition

Myotonic dystrophy is a progressive disease in which the muscles are weak and are slow to relax after contraction.

Description

Myotonic dystrophy (DM), also called dystrophia myotonica, myotonia atrophica, or Steinert disease, is a common form of **muscular dystrophy**. DM is an inherited disease, affecting males and females approximately equally. About 30,000 people in the United States are affected. Symptoms may appear at any time from infancy to adulthood. DM causes general weakness, usually beginning in the muscles of the hands, feet, neck, or face. It slowly progresses to involve other muscle groups, including the heart. DM affects a wide variety of other organ systems as well.

A severe form of DM, congenital myotonic dystrophy, may appear in newborns of mothers who have DM. Congenital means that the condition is present from birth.

DM occurs in about 1 of 20,000 people and has been described in people from all over the world.

Causes and symptoms

The most common type of DM is called DM1 and is caused by a mutation in a gene called myotonic dystrophy protein kinase (DMPK). The DMPK gene is located on chromosome 19. When there is a mutation in this gene, a person develops DM1. The specific mutation that causes DM1 is called a trinucleotide repeat expansion.

Some families with symptoms of DM do not have a mutation in the DMPK gene. As of early 2001, scientists have found that the DM in many of these families is caused by a mutation in a gene on chromosome 3. However the specific gene and mutation have not yet been identified. These families are said to have DM2.

Trinucleotide repeats

In the DMPK gene, there is a section of the genetic code where the three letters CTG are repeated a certain number of times. In people who have DM1, this word is repeated too many times—more than the normal number of 37 times—and thus this section of the gene is too big. This enlarged section of the gene is called a trinucleotide repeat expansion.

People who have repeat numbers in the normal range will not develop DM1 and cannot pass it to their children. Having more than 50 repeats causes DM1. People who have 38–49 repeats have a premutation and will not develop DM1, but can pass DM1 onto their children. Having repeats numbers greater than 1,000 causes congenital myotonic dystrophy.

In general, the more repeats in the affected range that someone has, the earlier the age of onset of symptoms and the more severe the symptoms. However, this is a general rule. It is not possible to look at a person's repeat number and predict at what age they will begin to have symptoms or how their condition will progress.

Exactly how the trinucleotide repeat expansion causes myotonia, the inability to relax muscles, is not yet understood. The disease somehow blocks the flow of electrical impulses across the muscle cell membrane. Without proper flow of charged particles, the muscle cannot return to its relaxed state after it has contracted.

Anticipation

Sometimes when a person who has repeat numbers in the affected or premutation range has children, the expansion grows larger. This is called anticipation. A larger expansion can result in an earlier age of onset in children than in their affected parent. Anticipation happens more often when a mother passes DM1 onto her children then when it is passed from the father. Occasionally repeat sizes stay the same or even get smaller when they are passed to a person's children.

Inheritance

DM is inherited through autosomal dominant inheritance. This means that equal numbers of males and females are affected. It also means that only one gene in the pair needs to have the mutation in order for

a person to be affected. Since a person only passes one copy of each gene onto their children, there is a 50% or one in two chance that a person who has DM will pass it onto each of their children. This percentage is not changed by results of other pregnancies. A person with a premutation also has a 50%, or one in two, chance of passing the altered gene on to each of their children. However, whether or not their children will develop DM1 depends on whether the trinucleotide repeat becomes further expanded. A person who has repeat numbers in the normal range cannot pass DM1 onto their children.

There is a range in the severity of symptoms in DM and not everyone will have all of the symptoms listed here.

Myotonic dystrophy causes weakness and delayed muscle relaxation called myotonia. Symptoms of DM include facial weakness and a slack jaw, drooping eyelids called **ptosis**, and muscle wasting in the forearms and calves. A person with DM has difficulty relaxing his or her grasp, especially in the cold. DM affects the heart muscle, causing irregularities in the heartbeat. It also affects the muscles of the digestive system, causing **constipation** and other digestive problems. DM may cause **cataracts**, retinal degeneration, low IQ, frontal balding, skin disorders, atrophy of the testicles, and diabetes. It can also cause sleep apnea—a condition in which normal breathing is interrupted during sleep. DM increases the need for sleep and decreases motivation. Severe disabilities do not set in until about 20 years after symptoms begin. Most people with myotonic dystrophy maintain the ability to walk, even late in life.

A severe form of DM, congenital myotonic dystrophy, may appear in newborns of mothers who have DM1. Congenital myotonic dystrophy is marked by severe weakness, poor sucking and swallowing responses, respiratory difficulty, delayed motor development, and **mental retardation**. **Death** in infancy is common in this type.

Some people who have a trinucleotide repeat expansion in their DMPK gene do not have symptoms or have very mild symptoms that go unnoticed. It is not unusual for a woman to be diagnosed with DM after she has an infant with congenital myotonic dystrophy.

Predictive testing

It is possible to test someone who is at risk for developing DM1 before they are showing symptoms to see whether they inherited an expanded trinucleotide repeat. This is called predictive testing. Predictive testing cannot determine the age of onset that someone will begin to have symptoms, or the course of the disease.

Diagnosis

Diagnosis of DM is not difficult once the disease is considered. However, the true problem may be masked because symptoms can begin at any age, can be mild or severe, and can occur with a wide variety of associated complaints. Diagnosis of DM begins with a careful medical history and a thorough physical exam to determine the distribution of symptoms and to rule out other causes. A family history of DM or unexplained weakness helps to establish the diagnosis.

A definitive diagnosis of DM1 is done by **genetic testing**, usually by taking a small amount of blood. The DNA in the blood cells is examined and the number of repeats in the DMPK gene is determined. Various other tests may be done to help establish the diagnosis, but only rarely would other testing be needed. An electromyogram (EMG) is a test used to examine the response of the muscles to stimulation. Characteristic changes are seen in DM that helps distinguish it from other muscle diseases. Removing a small piece of muscle tissue for microscopic examination is called a muscle biopsy. DM is marked by characteristic changes in the structure of muscle cells that can be seen on a muscle biopsy. An electrocardiogram could be performed to detect characteristic abnormalities in heart rhythm associated with DM. These symptoms often appear later in the course of the disease.

Prenatal testing

Testing a **pregnancy** to determine whether an unborn child is affected is possible if genetic testing in a family has identified a DMPK mutation. This can be done at 10–12 weeks gestation by a procedure called **chorionic villus sampling** (CVS) that involves removing a tiny piece of the placenta and analyzing DNA from its cells. It can also be done by **amniocentesis** after 14 weeks gestation by removing a small amount of the amniotic fluid surrounding the baby and analyzing the cells in the fluid. Each of these procedures has a small risk of **miscarriage** associated with it and those who are interested in learning more should check with their doctor or genetic counselor.

There is also another procedure, called preimplantation diagnosis that allows a couple to have a child that is unaffected with the genetic condition in their family. This procedure is experimental and not widely available. Those interested in learning more about this procedure should check with their doctor or genetic counselor.

Treatment

Myotonic dystrophy cannot be cured, and no treatment can delay its progression. However, many of the

symptoms it causes can be treated. Physical therapy can help preserve or increase strength and flexibility in muscles. Ankle and wrist braces can be used to support weakened limbs. Occupational therapy is used to develop tools and techniques to compensate for loss of strength and dexterity. A speech-language pathologist can provide retraining for weakness in the muscles controlling speech and swallowing.

Irregularities in the heartbeat may be treated with medication or a pacemaker. A yearly electrocardiogram is usually recommended to monitor the heartbeat. **Diabetes mellitus** in DM is treated in the same way that it is in the general population. A high-fiber diet can help prevent constipation. **Sleep apnea** may be treated with surgical procedures to open the airways or with nighttime ventilation. Treatment of sleep apnea may reduce drowsiness. Lens replacement surgery is available when cataracts develop. Pregnant women should be followed by an obstetrician familiar with the particular problems of DM because complications can occur during pregnancy, labor and delivery.

Wearing a medical bracelet is advisable. Some emergency medications may have dangerous effects on the heart rhythm in a person with DM. Adverse reactions to general anesthesia may also occur.

Prognosis

The course of myotonic dystrophy varies. When symptoms appear earlier in life, disability tends to become more severe. Occasionally people with DM may require a wheelchair later in life. Children with congenital DM usually require special educational programs and physical and occupational therapy. For both types of DM, respiratory infections pose a danger when weakness becomes severe.

Resources

PERIODICALS

The International Myotonic Dystrophy Consortium (IDMC). "New nomenclature and DNA testing guidelines for myotonic dystrophy type 1 (DM1)." *Neurology* 54(2000): 1218–1221.

Meola, Giovanni. "Myotonic Dystrophies." *Current Opinion in Neurology* 13 (2000): 519–525.

ORGANIZATIONS

Muscular Dystrophy Association. 3300 East Sunrise Dr., Tucson, AZ 85718. (520) 529-2000 or (800) 572-1717. <http://www.mdausa.org>.

OTHER

Myotonic Dystrophy Website. <http://www.umd.necker.fr/myotonic_dystrophy.html>.

NCBI Genes and Disease Web Page. <http://www.ncbi.nlm.nih. gov/disease/Myotonic.html>.

Smith, Corrine O'Sullivan. "Myotonic Dystrophy: Making an Informed Choice About Genetic Testing." University of Washington. <http://www.depts.washington.edu/neurogen/Myotonic.pdf>.

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KEY TERMS

Electrocardiogram (ECG, EKG)—A test that uses electrodes attached to the chest with an adhesive gel to transmit the electrical impulses of the heart muscle to a recording device.

Electromyography (EMG)—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

Muscular dystrophy—A group of inherited diseases characterized by progressive wasting of the muscles.

Sleep apnea—Temporary cessation of breathing while sleeping.

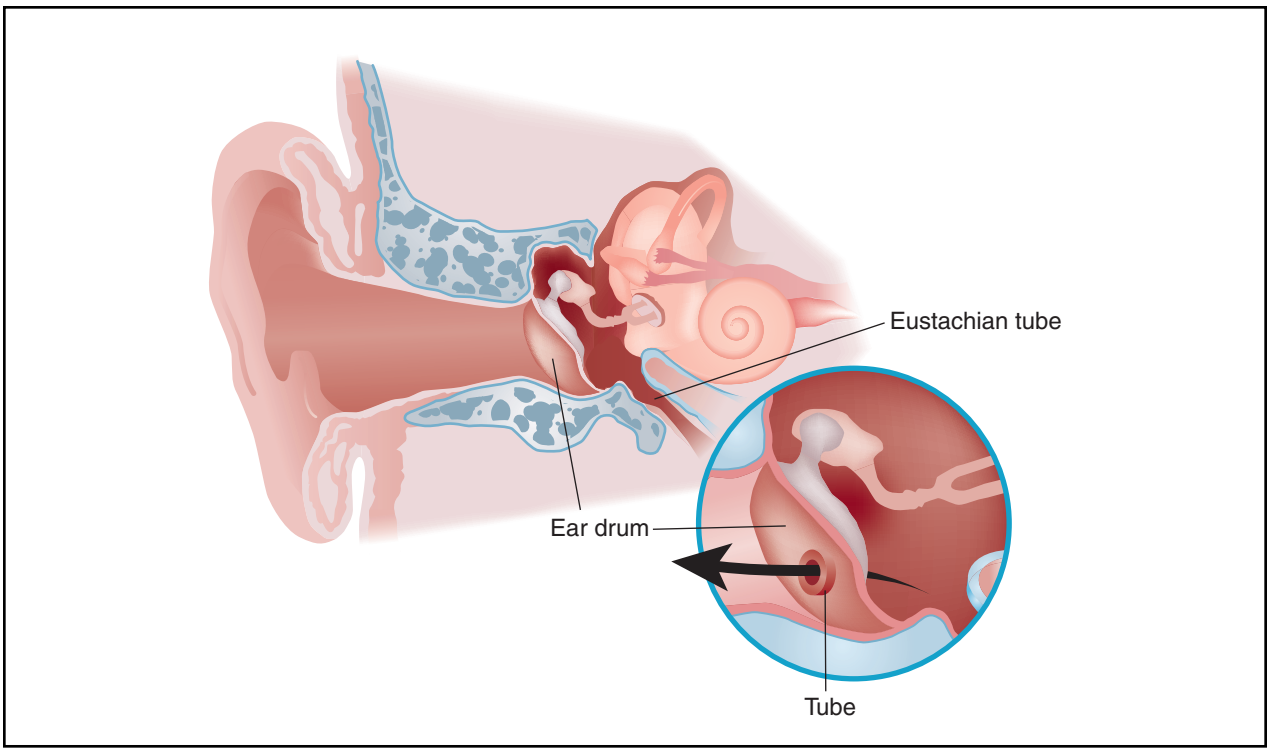
Trinucleotide repeat expansion—A sequence of three nucleotides that is repeated too many times in a section of a gene.

Myringotomy and ear tubes

Definition

Myringotomy is a surgical procedure in which a small incision is made in the eardrum (the tympanic membrane), usually in both ears. The word comes from *myringa,* modern Latin for drum membrane, and *tomē,* Greek for cutting. It is also called myringocentesis, tympanotomy, tympanostomy, or **paracentesis** of the tympanic membrane. Fluid in the middle ear can be sucked out through the incision.

Ear tubes, or tympanostomy tubes, are small tubes, open at both ends, that are inserted into the incisions in the eardrums during myringotomy. They come in various shapes and sizes and are made of plastic, metal, or both. They are left in place until they fall out by themselves or until they are removed by a doctor.



The insertion of ear tubes in the eardrum helps to alleviate chronic middle ear infections. *(Illustration by Argosy, Inc.)*

Purpose

Myringotomy with the insertion of ear tubes is an optional treatment for inflammation of the middle ear with fluid collection (effusion), also called glue ear, that lasts more than three months (chronic **otitis media** with effusion) and does not respond to drug treatment. It is the recommended treatment if the condition lasts four to six months. Effusion is the collection of fluid that escapes from blood vessels or the lymphatic system. In this case, the fluid collects in the middle ear.

Initially, acute inflammation of the middle ear with effusion is treated with one or two courses of **antibiotics**. **Antihistamines** and **decongestants** have been used, but they have not been proven effective unless there is also hay **fever** or some other allergic inflammation that contributes to the problem. Myringotomy with or without the insertion of ear tubes is NOT recommended for initial treatment of otherwise healthy children with middle ear inflammation with effusion.

In about 10% of children, the effusion lasts for three months or longer, when the disease is considered chronic. In children with chronic disease, systemic steroids may help, but the evidence is not clear, and there are risks.

When medical treatment doesn't stop the effusion after three months in a child who is one to three years old, is otherwise healthy, and has **hearing loss** in both ears, myringotomy with insertion of ear tubes becomes an option. If the effusion lasts for four to six months, myringotomy with insertion of ear tubes is recommended.

The purpose of myringotomy is to relieve symptoms, to restore hearing, to take a sample of the fluid to examine in the laboratory in order to identify any microorganisms present, or to insert ear tubes.

Ear tubes can be inserted into the incision during myringotomy and left there. The eardrum heals around them, securing them in place. They usually fall out on their own in 6-12 months or are removed by a doctor.

While they are in place, they keep the incision from closing, keeping a channel open between the middle ear and the outer ear. This allows fresh air to reach the middle ear, allowing fluid to drain out, and preventing pressure from building up in the middle ear. The patient's hearing returns to normal immediately and the risk of recurrence diminishes.

Parents often report that children talk better, hear better, are less irritable, sleep better, and behave better after myringotomy with the insertion of ear tubes.

Description

The procedure is usually done in an ambulatory surgical unit under general anesthesia, although some physi-

cians do it in the office with **sedation** and local anesthesia, especially in older children. The ear is washed, a small incision made in the eardrum, the fluid sucked out, a tube inserted, and the ear packed with cotton to control bleeding.

There has been an effort to design ear tubes that are easier to insert or to remove, and to design tubes that stay in place longer. Therefore, ear tubes come in various shapes and sizes.

Preparation

The child may not have food or water for four to six hours before anesthesia. Antibiotics are usually not needed.

Aftercare

Use of antimicrobial drops is controversial. Water should be kept out of the ear canal until the eardrum is intact. A doctor should be notified if the tubes fall out.

Risks

The risks include:

- cutting the outer ear
- formation at the myringotomy site of granular nodes due to inflammation
- formation of a mass of skin cells and cholesterol in the middle ear that can grow and damage surrounding bone (cholesteatoma)
- permanent perforation of the eardrum

The risk of persistent discharge from the ear (otorrhea) is 13%.

If the procedure is repeated, structural changes in the eardrum can occur, such as loss of tone (flaccidity), shrinkage or retraction, or hardening of a spot on the eardrum (typmanosclerosis). The risk of hardening is 51%; its effects on hearing aren't known, but they are probably insignificant.

It is possible that the incision won't heal properly, leaving a permanent hole in the eardrum, which can cause some hearing loss and increases the risk of infection.

It is also possible that the ear tube will move inward and get trapped in the middle ear, rather than move out into the external ear, where it either falls out on its own or can be retrieved by a doctor. The exact incidence of tubes moving inward is not known, but it could increase the risk of further episodes of middle-ear inflammation, inflammation of the eardrum or the part of the skull directly behind the ear, formation of a mass in the middle ear, or infection due to the presence of a foreign body.

KEY TERMS

Acute otitis media—Inflammation of the middle ear with signs of infection lasting less than three months.

Chronic otitis media—Inflammation of the middle ear with signs of infection lasting three months or longer.

Effusion—The escape of fluid from blood vessels or the lymphatic system and its collection in a cavity, in this case, the middle ear.

Middle ear—The cavity or space between the eardrum and the inner ear. It includes the eardrum, the three little bones (hammer, anvil, and stirrup) that transmit sound to the inner ear, and the eustachian tube, which connects the inner ear to the nasopharynx (the back of the nose).

Tympanic membrane—The eardrum. A thin disc of tissue that separates the outer ear from the middle ear.

Tympanostomy tube—Ear tube. A small tube made of metal or plastic that is inserted during myringotomy to ventilate the middle ear.

The surgery may not be a permanent cure. As many as 30% of children undergoing myringotomy with insertion of ear tubes need to undergo another procedure within five years.

The other risks include those associated with sedatives or general anesthesia.

An additional element of post-operative care is the recommendation by many doctors that the child use ear plugs to keep water out of the ear during bathing or swimming, to reduce the risk of infection and discharge.

Resources

BOOKS

Lim, David J., ed., et al. *Recent Advances in Otitis Media: Proceedings of the Sixth International Symposium, June 4-8, 1995, Marriott Harbot Beach, Ft. Lauderdale, Florida.* Hamilton, Ontario: B. C. Decker Inc., 1996.

Wiet, Richard J., Steven A. Harvey, and George P. Bauer. "Management of Complications of Chronic Otitis Media." In *Otologic Surgery*, ed. Derald E. Brackmann, Clough Shelton, and Moises A. Arriaga. Philadelphia: W. B. Saunders Co., 1994.

PERIODICALS

Terris, Mark H., Anthony E. Magit, and Terence M. Davidson. "Otitis media with effusion in infants and children: Prima-

ry care concerns addressed from an otolaryngologist's perspective." *Postgraduate Medicine* 97, no. 1 (Jan. 1995): 137-151.

Mary Zoll, PhD

Myxedema *see* **Hypothyroidism**

Myxoma

Definition

A myxoma is a rare, usually noncancerous, primary tumor (a new growth of tissue) of the heart. It is the most common of all benign heart tumors.

Description

Myxoma is an intracardiac tumor; it is found inside the heart. Seventy five percent of all myxomas are found in the left atrium, and almost all other myxomas are found in the right atrium. It is very rare for a myxoma to be found in either of the ventricles. The tumor takes one of two general shapes: a round, firm mass, or an irregular shaped, soft, gelatinous mass. They are attached to the endocardium, the inside lining of the heart. The cells that make up the tumor are spindle-shaped cells and are embedded in a matrix rich in mucopolysaccharides (a group of carbohydrates). Myxomas may contain calcium, which shows up on x rays. The tumor gets its blood supply from capillaries that bring blood from the heart to the tumor. Thrombi (blood clots) may be attached to the outside of the myxoma.

There are three major syndromes linked to myxomas: embolic events, obstruction of blood flow, and constitutional syndromes. Embolic events happen when fragments of the tumor, or the thrombi attached to the outside of the tumor, are released and enter the blood stream. Gelatinous myxomas are more likely to embolize than the more firm form of this tumor.

Myxomas may also obstruct blood flow in the heart, usually at a heart valve. The mitral valve is the heart valve most commonly affected. Blood flow restrictions can lead to pulmonary congestion and heart valve disease. Embolization can lead to severe consequences. In cases of left atrial myxoma, 40-50% of patients experience embolization. Emboli usually end up in the brain, kidneys, and extremities.

The third syndrome linked to myxomas are called constitutional syndromes, nonspecific symptoms caused by the myxoma.

KEY TERMS

Embolus—A piece of tissue, blood clot, etc. that travels through the blood system and can lodge in smaller blood vessels anywhere in the body.

Metastasis—The spread of a cancer or infectious agent from the site of origin to other areas of the body.

Raynaud's phenomenon—Intermittant ischemia (deficient blood flow) of the fingers or toes, sometimes also affecting the ears and nose.

Causes and symptoms

There is no known causative agent for myxoma. The main symptoms, if any, produced by myxoma are generic and not specific. These include **fever**, weight loss, anemia, elevated white blood cell (WBC) count, decreased **platelet count** and Raynaud's phenomenon. Most patients with myxoma are between 30-60 years of age.

Diagnosis

Diagnosis is made following a suspicion that a myxoma might be present, and can usually be confirmed by echocardiogram.

Treatment

Surgery is used to remove the tumor. Myxomas can regrow if they are not completely removed. The survival rate for this operation is excellent.

Prognosis

Successful removal of the tumor rids the patient of this disease. Emboli from a myxoma may survive in other areas of the body. However, there is no evidence that myxoma is truly metastatic (able to transfer disease from one area to another), causing tumors in other areas of the body.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York, McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

OTHER

"Myxoma, Intracardiac." *OMIM Home Page, Online Mendelian Inheritance in Man.* <http://www.ncbi.nlm.nih.gov/Omim>.

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CONTENTS

PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Medicine 2* is a medical reference product designed to inform and educate readers about a wide variety of disorders, conditions, treatments, and diagnostic tests. The Gale Group believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioner. While the Gale Group has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, the Gale Group makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of medical opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their health care provider.

INTRODUCTION

The *Gale Encyclopedia of Medicine 2 (GEM2)* is a one-stop source for medical information on nearly 1,700 common medical disorders, conditions, tests, and treatments, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart attack. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 2* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

SCOPE

Almost 1,700 full-length articles are included in the *Gale Encyclopedia of Medicine 2*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses, eg. acetaminophen (Tylenol). Throughout the *Gale Encyclopedia of Medicine 2*, many prominent individuals are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Description	Purpose
Causes and symptoms	Precautions
Diagnosis	Description
Treatment	Preparation
Alternative treatment	Aftercare
Prognosis	Risks
Prevention	Normal/Abnormal results
Resources	Resources
Key terms	Key terms

In recent years there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 2* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies.

INCLUSION CRITERIA

A preliminary list of diseases, disorders, tests and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM2* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale Group editor.

ABOUT THE CONTRIBUTORS

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM2* medical advisors reviewed the completed essays to insure that they are appropriate, up-to-date, and medically accurate.

HOW TO USE THIS BOOK

The *Gale Encyclopedia of Medicine 2* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.

- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms are also cross-referenced.
- A list of **key terms** are provided where appropriate to define unfamiliar terms or concepts.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix contains an extensive list of organizations arranged in alphabetical order.
- **Resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

GRAPHICS

The *Gale Encyclopedia of Medicine 2* is enhanced with over 675 color images, including photos, charts, tables, and customized line drawings.

ADVISORY BOARD

A number of experts in the library and medical communities provided invaluable assistance in the formulation of this encyclopedia. Our advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. The editor would like to express her appreciation to them.

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Nail infections *see* **Onychomycosis**

Nail-patella syndrome

Definition

Nail-patella syndrome, is a genetic disease of the connective tissue that produces defects in the fingernails, knee caps, and kidneys.

Description

Nail-patella syndrome is also known as Fong Disease, Hereditary Onycho-Osteodysplasia (H.O.O.D.), Iliac Horn Disease, and Turner-Kieser syndrome. Patients who have nail-patella syndrome may show a variety of physical defects. The hallmark features of this syndrome are poorly developed fingernails, toenails, and patellae (kneecaps). Other common abnormalities include elbow deformities, abnormally shaped pelvis bone (hip bone), and kidney (renal) disease.

Less common medical findings include defects of the upper lip, the roof of the mouth, and unusual skeletal abnormalities. Skeletal abnormalities may include poorly developed scapulae (shoulder blades), sideways bent fingers (clinodactyly), **clubfoot**, **scoliosis**, and unusual neck bones. There are also other effects, such as thickening of the basement membrane in the skin and of the tiny clusters of capillaries (glomeruli) in the kidney. Scientists have recognized an association between nail-patella syndrome and **colon cancer**. Nail-patella syndrome is associated with open-angle **glaucoma**, which, if untreated, may lead to blindness. Patients may also have **cataracts**, drooping eyelids (**ptosis**), or corneal problems such as glaucoma.

People with nail-patella syndrome may display only a few or many of the recognized signs of this disease. Symptoms vary widely from person to person. Signs even vary within a single family with multiple affected members.

The incidence of nail-patella syndrome is approximately one in 50,000 births. This disorder affects males and females equally. It is found throughout the world and occurs in all ethnic groups. The strongest risk factor for nail-patella syndrome is a family history of the disease.

Causes and symptoms

Nail-patella syndrome has been recognized as an inherited disorder for over 100 years. It is caused by mutations in a gene known as LIM Homeobox Transcription Factor 1-Beta (LMX1B), located on the long arm of chromosome 9.

The LMX1B gene codes for a protein that is important in organizing embryonic limb development. Mutations in this gene have been detected in many unrelated people with nail-patella syndrome. Scientists have also been able to interrupt this gene in mice to produce defects similar to those seen in human nail-patella syndrome.

Nail-patella syndrome is inherited in an autosomal dominant manner. This means that possession of only one copy of the defective gene is enough to cause disease. When a parent has nail-patella syndrome each of their children has a 50% chance to inherit the disease-causing mutation.

A new mutation causing nail-patella syndrome can also occur, causing disease in a person with no family history. This is called a sporadic occurrence and accounts for approximately 20% of cases of nail-patella syndrome. The children of a person with sporadic nail-patella syndrome are also at a 50% risk of developing signs of the disorder.

Medical signs of nail-patella syndrome vary widely between patients. Some patients with this disorder do not display symptoms. These patients are discovered to have the nail-patella syndrome only when genetic studies trace their family history. Scientists are now working to learn what causes different people to display such different symptoms of nail-patella syndrome.

The most obvious sign associated with nail-patella syndrome is absent, poorly developed, or unusual fingernails. Fingernail abnormalities are found in over 80% of patients with this disorder. Abnormalities may be found in one or more fingernails. Only rarely are all fingernails affected. This disease most commonly affects the fingernails of the thumbs and index fingers. The pinky fingernail is least likely to be affected. Fingernails may be small and concave with pitting, ridges, splits, and/or discoloration. Toenails are less often affected. The lunulae, or light-colored crescent moons, at the base of the fingernail bed next to the cuticle are sometimes triangularly-shaped in people with nail-patella syndrome.

Kneecap abnormalities are the second most common sign associated with this disorder. Either or both kneecaps may be missing or poorly formed. If present, kneecaps are likely to be dislocated. The knees of people with nail-patella syndrome may have a square appearance. Besides the kneecap, other support structures including bones, ligaments, and tendons may also be malformed. These support structures stabilize the knee, therefore patients with some leg malformations may have difficulty in walking.

The hip bones of approximately 80% of patients with nail-patella syndrome have unusual bony projections called posterior iliac horns. These bony projections, or spurs, are internal and not obvious unless they are detected on x ray. This unusual pelvic anatomy is not associated with any other disease.

Kidney disease is present in at least 30% of people with nail-patella syndrome. Biopsy shows lesions that resemble those of inflammation of the clusters of capillaries in the kidneys (**glomerulonephritis**), but without any infection present. Kidney failure is the most dangerous consequence of nail-patella syndrome. It occurs in about 30% of patients who have kidney involvement. An early sign of kidney involvement is the presence of protein or blood in the urine (chronic, benign proteinuria and hematuria.) Kidney involvement is progressive, so early diagnosis and treatment of renal disease is important. Kidney disease has been reported in children with nail-patella syndrome, but renal involvement more commonly develops during adulthood.

Various skeletal symptoms may occur. Patients with nail-patella syndrome may not be able to fully straighten their arms at the elbow. This may create a webbed appearance at the elbow joint. Patients may have sideways bent fingers, poorly developed shoulder blades, clubfoot, hip dislocation, unusual neck bones, or scoliosis.

Eye problems may be present and vary from person to person. Nail-patella syndrome is associated with open angle glaucoma. Open angle glaucoma is caused by fluid blocked into the front chamber of the eye. This blocked fluid builds increasing pressure into the eye. If untreated, this increased pressure may lead to permanent damage of the optic nerve and irreversible blindness. Some patients with nail-patella syndrome have ptosis, or drooping eyelids. Nail-patella syndrome has also been associated with abnormalities of the cornea, cataracts, and **astigmatism**. Additionally, the irises of the eye may be multicolored, possibly displaying a clover-shaped pattern of color.

Diagnosis

As of early 2001, **genetic testing** for nail-patella syndrome is available only through research institutions that are working to further characterize this disorder. Genetic testing cannot predict which signs of the disease will develop. Nor can genetic testing predict the severity of disease symptoms. Improved genetic testing for nail-patella syndrome is anticipated in the future.

Diagnosis of this disease is most often made on visual medical clues such as the characteristic abnormalities of the fingernails and kneecaps. Diagnosis is confirmed by x-ray images of the affected bones and, when indicated, **kidney biopsy**. The bony pelvic spurs found in 80% of patients with nail-patella syndrome are not associated with any other disease.

Prenatal diagnosis for nail-patella syndrome by third-trimester ultrasound was documented in 1998. Prenatal diagnosis via genetic testing of cells obtained by **chorionic villus sampling** was reported the same year. As of 2001, prenatal genetic testing for nail-patella syndrome is not yet widely available. There is controversy surrounding the use of prenatal testing for such a variable disorder. Prenatal testing cannot predict the extent of an individual's disease.

Treatment

Treatment is usually not necessary. Treatment, when required, depends on each patient's specific symptoms. Severe kidney disease is treated with dialysis or a kidney transplant. Patients receiving kidney transplant do not develop nail-patella type renal complications in their new kidney.

A wheelchair may be required if walking becomes painful due to bone, tendon, ligament, or muscle defects. **Orthopedic surgery** may be necessary for congenital clubfoot deformity. Manipulation or surgery may be required to correct hip dislocation. Cataracts are also surgically treated. Medical treatment at early signs of glaucoma prevents progression of the disease to blindness.

Genetic counseling is offered to persons who have the disease. Parents with this disease have a 50% chance of passing it to each of their children. As of 2001, current

KEY TERMS

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Glomeruli—Tiny clusters of capillaries in the kidney.

Hematuria—The presence of blood in the urine.

Patella—The kneecap.

Proteinuria—Excess protein in the urine.

genetic testing technology cannot predict the severity or scope of an individual's symptoms.

Because many possible manifestations of nail-patella syndrome exist, patients are advised to pursue extra medical care including regular **urinalysis** and special eye exams. Children with nail-patella syndrome should be screened for scoliosis.

Prognosis

Survival among patients with nail-patella syndrome is not decreased unless a they exhibit renal complications. It is estimated that 8% of individuals with nail-patella syndrome who come to medical attention eventually die of kidney disease.

Resources

BOOKS

Berkow, R., M. H. Beers, A. J. Fletcher, and R. M. Bogin. *The Merck Manual of Medical Information - Home Edition.* McGraw-Hill, 2000.

OTHER

Gene Clinics. <http://www.geneclinics.org>.
OMIM—Online Mendelian Inheritance in Man. <http://www3.ncbi.nlm.nih.gov/Omim>.

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Nail removal

Definition

Nail removal is a form of treatment that is sometimes necessary following traumatic injuries or recurrent infections in the area of the nail. There are nonsurgical as well as surgical methods of nail removal.

Purpose

Nails are removed only when necessary to allow the skin beneath the nail (the nail bed) to heal or in some cases, to remove a nail that has been partially pulled out in an accident. In the case of toenails, it is occasionally necessary to remove the nail of the large toe due to a chronic condition caused by badly fitted shoes. In general, however, doctors prefer to try other forms of treatment before removing the nail. Depending on the cause, nail disorders are usually treated with oral medications; applying medicated gels or creams directly to the skin around the nail; avoiding substances that irritate the nail folds; surgical lancing of abscesses around the nail; or injecting **corticosteroids** under the nail fold.

The most common causes of nail disorders include:

- Trauma. The nails can be damaged by nail biting, using the fingernails as tools, and incorrect use of nail files and manicure scissors as well as by accidents and **sports injuries**.
- Infections. These include fungal infections under the nails, bacterial infections of cuts or breaks in the nail folds, or infections of the nails themselves caused by *Candida albicans*. Inflammation of the nail folds is called paronychia.
- Exposure to harsh detergents, industrial chemicals, hot water, and other irritants. People who work as dishwashers are especially vulnerable to separation of the nail itself from the nail bed (onycholysis).
- Systemic diseases and disorders. These include **psoriasis**, anemia, and certain congenital disorders.
- Allergic reactions to nail polish, polish remover, or the glue used to attach false nails.

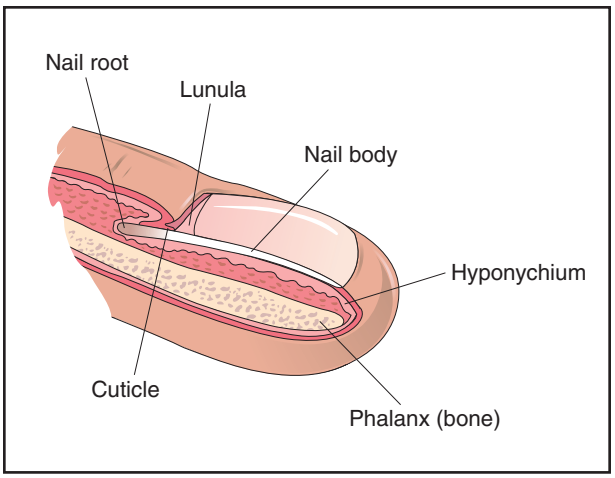
Precautions

In the case of infections, it is necessary to distinguish between fungal, bacterial, and candidal infections before removing the nail. Cultures can usually be obtained from pus or tissue fluid from the affected nail.

Description

Surgical nail removal

If necessary, the surgeon can remove the nail at its base with an instrument called a needlepoint scalpel. In a few cases, the nail may need to be pulled out (avulsed) from its matrix.



The physiology of the human fingernail. The most common causes of nail disorders include trauma, infections, exposure to harsh detergents, hot water and other irritants, systemic diseases and disorders, and allergic reactions to nail polish, nail polish remover, and nail glue. *(Illustration by Electronic Illustrators Group.)*

Nonsurgical nail removal

Nails can be removed by applying a mixture of 40% urea, 20% anhydrous lanolin, 5% white wax, 25% white petroleum jelly, and silica gel type H.

Preparation

For nonsurgical nail removal, the nail fold is treated with tincture of benzoin and covered with adhesive tape. The nail itself is thickly coated with the urea mixture, followed by a layer of plastic film and adhesive tape. The mixture is left on the nail for five to 10 days, after which the nail itself can be removed.

Aftercare

Aftercare of surgical removal is similar to the care of any minor surgical procedure. Aftercare of the urea paste method includes applying medication for the specific infection that is being treated.

Risks

Risks from either procedure are minimal.

Normal results

Normal results include the successful removal of the infected or damaged nail.

KEY TERMS

Avulse—To pull or tear away forcibly. In some cases, a surgeon must remove a nail by avulsing it from its matrix.

Matrix—The tissue at the base of the nail, from which the nail grows.

Nail bed—The layer of tissue underneath the nail.

Onycholysis—The separation of a nail from its underlying bed. Onycholysis is a common symptom of candidal infections of the nail or of exposure to harsh chemicals and detergents.

Paronychia—Inflammation of the folds of skin that surround a nail.

Resources

BOOKS

Baden, Howard P. "Diseases of the Nails." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Berger, Timothy G. "Skin and Appendages." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Kilgore, Eugene S., et al. "Hand Surgery." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

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Nalidixic acid *see* **Urinary anti-infectives**

Narcissistic personality disorder *see* **Personality disorders**

Narcolepsy

Definition

Narcolepsy is a disorder marked by excessive daytime sleepiness, uncontrollable sleep attacks, and cataplexy (a sudden loss of muscle tone, usually lasting up to half an hour).

Description

Narcolepsy is the second-leading cause of excessive daytime sleepiness (after obstructive **sleep apnea**). Per-

sistent sleepiness and sleep attacks are the hallmarks of this condition. The sleepiness has been compared to the feeling of trying to stay awake after not sleeping for two or three days.

People with narcolepsy fall asleep suddenly—anywhere, at any time, maybe even in the middle of a conversation. These sleep attacks can last from a few seconds to more than an hour. Depending on where they occur, they may be mildly inconvenient or even dangerous to the individual. Some people continue to function outwardly during the sleep episodes, such as talking or putting things away. But when they wake up, they have no memory of the event.

Narcolepsy is related to the deep, dreaming part of sleep known as rapid eye movement (REM) sleep. Normally when people fall asleep, they experience 90 minutes of non-REM sleep, which is then followed by REM sleep. People with narcolepsy, however, enter REM sleep immediately. In addition, REM sleep occurs inappropriately throughout the day.

There has been debate over the incidence of narcolepsy. It is thought to affect between one in every 1,000 to 2,000 Americans. The known prevalence in other countries varies, from one in 600 in Japan to one in 500,000 in Israel. Reasons for these differences are not clear.

Causes and symptoms

In 1999 researchers identified the gene that causes narcolepsy. The gene allows cells in the hypothalamus (the part of the brain that regulates sleep behavior) to receive messages from other cells. When this gene is abnormal, cells cannot communicate properly, and abnormal sleeping patterns develop.

The disorder sometimes runs in families, but most people with narcolepsy have no relatives with the disorder. Researchers believe that the inheritance of narcolepsy is similar to that of heart disease. In heart disease, several genes play a role in being susceptible to the disorder, but it usually does not develop without an environmental trigger of some sort.

While the symptoms of narcolepsy usually appear during the teens or 20s, the disease may not be diagnosed for many years. Most often, the first symptom is an overwhelming feeling of **fatigue**. After several months or years, cataplexy and other symptoms appear.

Cataplexy is the most dramatic symptom of narcolepsy. It affects 75% of people with the disorder. During attacks, the knees buckle and the neck muscles go slack. In extreme cases, the person may become paralyzed and fall to the floor. This loss of muscle tone is temporary, lasting from a few seconds to half an hour, but frightening. The attacks can occur at any time but are often triggered by strong emotions, such as anger, joy, or surprise.

Other symptoms of narcolepsy include:

- sleep attacks: short, uncontrollable sleep episodes throughout the day
- sleep **paralysis**: a frightening inability to move shortly after awakening or dozing off
- auditory or visual **hallucinations**: intense, sometimes terrifying experiences at the beginning or end of a sleep period
- disturbed nighttime sleep: tossing and turning, nightmares, and frequent awakenings during the night

Diagnosis

If a person experiences both excessive daytime sleepiness and cataplexy, a diagnosis may be made on the patient history alone. Laboratory tests, however, can confirm a diagnosis. These may include an overnight polysomnogram—a test in which sleep is monitored with **electrocardiography**, video, and respiratory parameters. A Multiple Sleep Latency Test, which measures sleep latency (onset) and how quickly REM sleep occurs, may be used. People who have narcolepsy usually fall asleep in less than five minutes.

If a diagnosis is in question, a genetic blood test can reveal the existence of certain substances in people who have a tendency to develop narcolepsy. Positive test results suggest, but do not prove, the existence of narcolepsy.

Narcolepsy is a complex disorder, and it is often misdiagnosed. It takes 14 years, on average, for an individual to be correctly diagnosed.

Treatment

There is no cure for narcolepsy. It is not progressive, and it is not fatal, but it is chronic. The symptoms can be managed with medication or lifestyle adjustment. Amphetamine-like stimulant drugs are often prescribed to control drowsiness and sleep attacks. Patients who do not like taking high doses of stimulants may choose to take smaller doses and "manage" their lifestyles, such as by napping every couple of hours, to relieve daytime sleepiness. Antidepressants are often effective in treating symptoms of abnormal REM sleep.

With the recent discovery of the gene that causes narcolepsy, researchers are hopeful that therapies can be designed to relieve the symptoms of the disorder.

KEY TERMS

Cataplexy—A symptom of narcolepsy in which there is a sudden episode of muscle weakness triggered by emotions. The muscle weakness may cause the person's knees to buckle, or the head to drop. In severe cases, the patient may become paralyzed for a few seconds to minutes.

Hypnagogic hallucinations—Dream-like auditory or visual hallucinations that occur while falling asleep.

Hypothalamus—A part of the forebrain that controls heartbeat, body temperature, thirst, hunger, body temperature and pressure, blood sugar levels, and other functions.

Sleep paralysis—An abnormal episode of sleep in which the patient cannot move for a few minutes, usually occurring on falling asleep or waking up. Often found in patients with narcolepsy.

Prognosis

Narcolepsy is not a degenerative disease, and patients do not develop other neurologic symptoms. However, narcolepsy can interfere with a person's ability to work, play, drive, and perform other daily activities. In severe cases, the disorder prevents people from living a normal life, leading to depression and a loss of independence.

Resources

PERIODICALS

Mignot, E. "Genetics of Narcolepsy and Other Sleep Disorders." *American Journal of Human Genetics* 60 (1997): 1289-1302.

Siegel, Jeremy M. "Narcolepsy." *Scientific American* (January 2000). <http://www.sciam.com/2000/0100issue/0100siegel.html>.

ORGANIZATIONS

American Sleep Disorders Association. 1610 14th St. NW, Suite 300, Rochester, MN 55901. (507) 287-6006.

Narcolepsy Network. PO Box 42460, Cincinnati, OH 45242. (973) 276-0115.

National Center on Sleep Disorders Research. Two Rockledge Centre, 6701 Rockledge Dr., Bethesda, MD 20892. (301) 435-0199.

National Sleep Foundation. 1367 Connecticut Ave. NW, Suite 200, Washington, DC 20036. (202) 785-2300.

Stanford Center for Narcolepsy. 1201 Welch Rd-Rm P-112, Stanford, CA 94305. (415) 725-6517.

University of Illinois Center for Narcolepsy Research. 845 S. Damen Ave., Chicago, IL 60612. (312) 996-5176.

OTHER

"Stanford Researchers Nab Narcolepsy Gene For Sleep Disorders." *Stanford University Medical Center*. [August 5, 1999]. <http://www.stanford.edu/%7Edement/ngene.html>.

Michelle Lee Brandt

Narcotics *see* **Analgesics, opioid**

Nasal culture *see* **Nasopharyngeal culture**

Nasal irrigation

Definition

Nasal irrigation is the practice of flushing the nasal cavity with a sterile solution. The solution may contain **antibiotics**.

Purpose

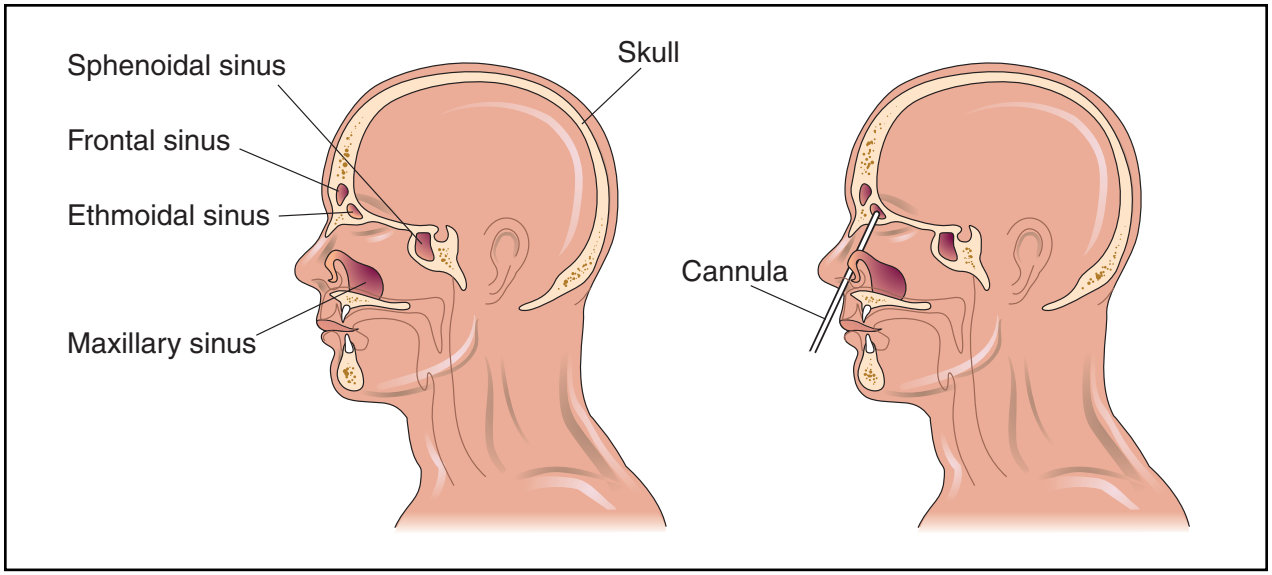
Nasal irrigation is used to clear infected sinuses or may be performed after surgery to the nose region. It may be performed by adding antibiotics to the solution to treat **nasal polyps**, nasal septal deviation, allergic nasal inflammation, chronic sinus infection, and swollen mucous membranes. Irrigation may also be used to treat long-term users of inhalants, such as illicit drugs (**cocaine**), or occupational toxins, like paint fumes, sawdust, pesticides, or coal dust.

Precautions

Nasal irrigation should not be performed on people who have frequent nosebleeds; have recently had nasal surgery; or whose gag reflex is impaired, as fluid may enter the windpipe.

Description

Nasal irrigation can be performed by the patient at home, or by a medical professional. A forced-flow instrument, such as a syringe, is filled with a warm saline solution. The solution can be commercially prepared (Ayr, NaSal) or can be prepared by the patient, using one half teaspoon salt with each eight ounces of warm water. Occasionally, antibiotics are added to the solution, to kill bacteria and aid healing of irritated membrane. The syringe is then directed into the nostril. The irrigation solution loosens encrusted material in the nasal passage, and drainage takes place through the nose. The patient leans over a catch basin during irrigation, into which the debris flows. Irrigation continues until all debris is



Because surgery in the nasal area has a high incidence rate for contamination with pathogenic bacteria, nasal irrigation is performed to remove loose tissue and prevent infection. The illustration (right) shows a cannula in place while the sinus passages are being flushed. *(Illustration by Electronic Illustrators Group.)*

cleared from the passage. Nasal irrigation can be performed up to twice daily, unless the irrigation irritates the mucous membrane.

Preparation

Before nasal irrigation, the patient is instructed not to open his or her mouth or swallow during the procedure. Opening the mouth or swallowing could cause infectious material to move from the nasal passage into the sinuses or the ear.

Risks

Complications of nasal irrigation include irritation of the nasal passage due to extreme temperature of the irrigation solution. Rarely, irrigation fluid may enter the windpipe, in people with a poor gag reflex.

Resources

BOOKS

Brackmann, D. E., D. Shelton, and M. A. Arriaga. *Otologic Surgery.* Philadelphia: W. B. Saunders Co., 1994.

Everything You Need to Know About Medical Treatments. Ed. Matthew Cahill. Springhouse, PA: Springhouse Corporation, 1996.

Schuller, D. E., and A. J. Schleuning II. *DeWeese and Saunder's Otolaryngology-Head and Neck Surgery.* St. Louis: Mosby, 1994.

Mary K. Fyke

KEY TERMS

Saline—A solution made from salt and water.

Nasal packing

Definition

Nasal packing is the application of gauze or cotton packs to the nasal chambers.

Purpose

The most common purpose of nasal packing is to control bleeding following surgery to the septum or nasal reconstruction and to treat chronic nosebleeds. Packing is also used to provide support to the septum after surgery.

Description

Packing is the placement of gauze or cotton into the nasal area. Packing comes in three forms, gauze, cotton balls, and preformed cotton wedges. Packing is usually coated with **antibiotics** and, sometimes, petrolatum. The end of the nose may be taped to keep the packings in place or to prevent the patient from pulling them out. In cases of surgery, packings are frequently removed within

24–48 hours following surgery. In the case of nosebleeds, packing is left in for extended periods of time to promote healing and to prevent the patient from removing scar tissue which might reopen the wound. If both sides of the nose are packed, the patient must breathe through his or her mouth while the packs are in place.

In patients who are chronic nose pickers, frequent bleeding is common and ulceration of nasal tissue is possible. To promote healing and to prevent nose picking, both sides of the nose are packed with cotton that contains antibiotics. The nose is taped shut with surgical tape to prevent the packing from being removed. The packing is left in the nose for seven to 10 days. If the wound is high up in the nasal cavity, gauze strips treated with petrolatum and antibiotics are used. The strips are placed into the nose one layer at a time, folding one layer on top of the other until the area is completely packed.

Local packing is a procedure used when only a small part of the nose must be packed. Typically, this occurs when one blood vessel is prone to bleeding, and there is no need to block breathing through the nose. Local packing is used when the pack can remain in place by itself. This situation can be found at the turbinates. Turbinates are folds of tissue on the insides of the nose. The folds are sufficiently firm to support packing. A small piece of gauze or cotton is wedged in between the turbinates where the blood vessel being treated is located. Local packing is left in place for up to 48 hours and then removed. The main advantage to this type of packing is that it enables the patient to breathe through his or her nose. Local packing is also more comfortable than complete packing, although the patient will still experience a sensation that something is in the nasal cavity. The patient must be instructed not to interfere with or probe the packing while it is in place.

A postnasal pack is used to treat bleeding in the postnasal area. This is difficult area to pack. Packs used in this area are made from cotton balls or gauze that have been tied into a tubular shape with heavy gauge suture or umbilical tape. Long lengths of suture or tape are left free. The lengths of suture or tape are used to help position the pack during installation and to remove it. An alternative is to cut a vaginal tampon and reposition the strings. Balloons have been tried as a method to replace postnasal packing, but have not proved effective. After being tied, the pack is soaked with an antibiotic ointment. Generally, packs are formed larger than needed, so that they completely block the nasal passage. A catheter is passed through the nose and pulled out through the mouth. Strings from one end of the pack are tied to the catheter and the pack pulled into place by passing through the mouth and up the back of the nasal cavity. The pack is removed in a similar manner. Complications may occur if a pack compresses the Eustachian tube, causing ear problems. The ear should be examined to ensure that infection is not developing.

Packing of the anterior (front) part of the nose is also performed following surgery such as **septoplasty** and **rhinoplasty**. In these operations, the surgeon cuts through the skin flap covering cartilage and bone in the center, top, and bottom of the nose to correct the shape of the nose. At the conclusion of the surgery, the skin flap is sutured back into place. The purposes of packing is to absorb any drainage from the incision and mucus produced by nasal tissue, and to support the skin flap and cartilage. The packing used is either gauze or preformed adsorbent wedges of cotton. Both are usually treated with antibiotic to reduce the chance of infections at the incision site. Generally, there is little bleeding following septoplasty and rhinoplasty, and the incisions heal normally. These packs are left in place for 24 to 48 hours and then removed.

Aftercare

Ice chips or mouthwash can be used to moisten the mouth while packing is in place, as the mouth may be dry from breathing through it. Humidifiers may also help with breathing. After nasal packing, the nose should not be blown for two to three days.

Since one of the major reasons that packing is performed is to heal damage to nasal blood vessels from nose-picking, follow-up examination should be done to ensure that the patient is no longer practicing this habit. If the patient has restarted nose-picking, therapy to alter this behavior should be pursued. When the packing completely blocks the nasal cavity and prevents breathing through the nose, the patient should adjust to breathing through the mouth. In elderly patients, adjustment may be more difficult. This leads to a drop in the blood oxygen content and an increase in blood carbon dioxide levels (CO_2). This, in turn, can cause respiratory and cardiac complications, including a racing pulse.

Risks

Nasal packing could cause a lack of oxygen in those who have difficulty breathing through their mouths. Rarely, sinus infection or middle ear infection may occur.

Resources

BOOKS

Bluestone, C. D., S. E. Stool, and M. A. Kenna. *Pediatric Otolaryngology.* Philadelphia: W. B. Saunders Co., 1996.

Cohen, M., and R.M. Goldwyn. *Mastery of Plastic and Reconstructive Surgery.* Boston: Little, Brown and Co., 1994.

KEY TERMS

Turbinate—Ridge-shaped cartilage or soft bony tissue inside the nose.

Ulcer—A sore on the skin or mucous tissue that produces pus and in which tissue is destroyed.

Schuller, D. E., and A. J. Schleuning II. *DeWeese and Saunder's Otolaryngology-Head and Neck Surgery.* St. Louis: Mosby, 1994.

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Nasal papillomas

Definition

Nasal papillomas are **warts** located inside the nose.

Description

Two types of tumors can grow inside the nose: polyps and papillomas. By far the most common are polyps, which have smooth surfaces. On the contrary, papillomas have irregular surfaces and are, in fact, warts. Papillomas may be caused by the same viruses that cause warts elsewhere on the body. They are inside the nose, more often on the side near the cheek, and, because of their internal structure, they are much more likely to bleed than polyps.

There is a special type of nasal papilloma called an inverting papilloma because of its unique appearance. About 10 or 15% of these are or can become cancers.

Causes and symptoms

Like polyps, papillomas can plug up the nose and disable the sense of smell. Unlike polyps, papillomas often bleed.

Diagnosis

A **physical examination** with special instruments will detect these tumors.

Treatment

Because of the possibility of **cancer**, all nasal papillomas must be removed surgically and sent to the laboratory for analysis. If a cancer is present, further surgery may be necessary to guarantee that all of the cancer has been removed. The initial surgery can be done in an office setting by a specialist in head and neck surgery, also known as otorhinolaryngology and popularly abbreviated ENT (ear, nose, and throat). Cancer surgery is more extensive and often requires hospitalization.

Prognosis

For benign (non-cancerous) lesions, removal is curative, although they tend to recur, just like warts elsewhere. The cancerous papillomas may occasionally escape complete surgical removal and spread to adjacent or distant sites. The prognosis is then much more complex.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of the Nose, Throat, Ear, Head, and Neck.* Philadelphia: Lea & Febiger, 1996.

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

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KEY TERMS

Polyp—A tumor commonly found in the nasal cavity or intestine.

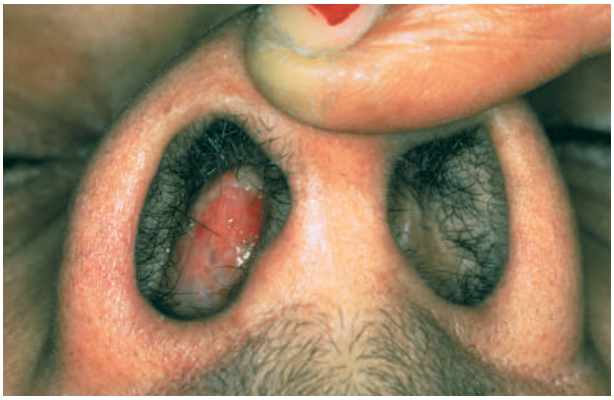
Nasal polyps

Definition

A polyp is any overgrowth of tissue from a surface. Polyps come in all shapes—round, droplet, and irregular being the most common.

Description

Nasal polyps tend to occur in people with respiratory **allergies**. Hay **fever** (**allergic rhinitis**) is an irritation of the membranes of the nose by airborne particles or chemicals. These membranes make mucus. When irritated, they can also grow polyps. The nose is not only a passageway for air to reach the lungs; it also provides the connection between the sinuses and the outside world.



A nasal polyp inside patient's right nostril. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Allergen—Any substance that irritates only those who are sensitive (allergic) to it.

Asthma—Wheezing (labored breathing) due to allergies or irritation of the lungs.

Decongestant—Medicines that shrink blood vessels and consequently mucus membranes. Pseudoephedrine, phenylephrine, and phenylpropanolamine are the most common.

Sinus—Air-filled cavities surrounding the eyes and nose are lined with mucus-producing membranes. They cleanse the nose, add resonance to the voice, and partially determine the structure of the face.

Sinuses are lined with mucus membranes, just like the nose. Polyps can easily obstruct the drainage of mucus from the sinuses. When any fluid in the body is trapped so it cannot flow freely, it becomes infected. The result, **sinusitis**, is a common complication of allergic **rhinitis**.

Causes and symptoms

Some people who are allergic to **aspirin** develop both **asthma** and nasal polyps.

Nasal polyps often plug the nose, usually one side at a time. People with allergic rhinitis are so used to having a stopped up nose they may not notice the difference when a polyp develops. Other polyps may be closer to a sinus opening, so airflow is not obstructed, but mucus becomes trapped in the sinus. In this case, there is a feeling of fullness in the head, no sense of smell, and perhaps a **headache**. The trapped mucus will eventually get infected, adding **pain**, fever, and perhaps bloody discharge from the nose.

Diagnosis

A **physical examination** will identify most polyps. Small polyps located higher up or further back may be hidden from view, but they will be detected with more sophisticated medical instruments. The otorhinolaryngologist is equipped to diagnose nasal polyps. In order to perform the exam, medicine must be applied to decongest the membranes. Cotton balls soaked with one of these agents and left in the nostrils for a few minutes provide adequate shrinkage.

Treatment

Most polyps can be removed by the head and neck surgeon as an office procedure called a nasal polypectomy. Bleeding, the only complication, is usually easy to control. Nose and sinus infections can be treated with **antibiotics** and **decongestants**, but if airflow is restricted, the infection will reoccur.

Prognosis

Polyps reappear as long as the allergic irritation continues.

Prevention

If aspirin is the cause, all aspirin containing medications must be avoided.

Since most nasal polyps are the result of allergic rhinitis, they can be prevented by treating this condition. New treatments have greatly improved control of hay fever. There are now several spray medicines that are quite effective. Spray cortisone-like drugs are the most popular. Over-the-counter nasal decongestants have an irritating effect similar to the allergy they are supposed to be treating. Continued use can bring more trouble than relief and result in an **addiction** to nose sprays. The resulting disease, rhinitis medicamentosa, is more difficult to treat than allergic rhinitis.

Allergists and ENT surgeons both treat allergic rhinitis with a procedure called desensitization. After identifying suspect allergens using one of several methods, they will give the patient increasing doses of those allergens in order to produce blocking antibodies that will impede the allergic reaction. This is effective in a number of patients, but the treatment may take a period of months to years.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of the Nose, Throat, Ear, Head, and Neck*. Philadelphia: Lea & Febiger, 1996.
Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

J. Ricker Polsdorfer, MD

Nasal trauma

Definition

Nasal trauma is defined as any injury to the nose or related structure that may result in deformity, decreased inhalation due to obstruction, or an impaired sense of smell (olfaction).

Description

The nose is composed of bone, soft tissue, and cartilage. It functions to serve as a passageway for air from the environment to flow into the lower respiratory tract and lungs, at the same time warming and humidify air.

The nasal bones are the most frequently fractured facial bones due to their foremost position on the face. Although not life threatening, **fractures** may lead to aesthetic and functional deformities. Children have a more cartilaginous nose than adults and are more resilient to trauma due to force.

Fractures of the nose vary with the type and direction of force that has been inflicted. Fractures resulting from trauma to the nose may involve the bones of the septum as well as bones surrounding the orbit including the nasal, maxilla, lacrimal, and frontal bones. Fractures and other trauma may also damage the membranes that line the nasal passages. Damage to these membranes is serious since it can lead to obstruction, increased secretion, or an impaired sense of olfaction.

Causes and symptoms

Nasal trauma results from fractures, dislocations, foreign bodies such as digits, chemical irritants, **burns**; or may be iatrogenic in which complications of a physician's exam or surgical treatment result in injury. Most injuries are caused by auto accidents, **sports injuries**, fights, work related accidents, or leisure activities. Falls are a more common cause of nasal injury in children. Trauma can also occur to neonates as a result of birth. There is also an increased incidence of fractures following **rhinoplasty**, or plastic surgery, performed on the nose.

All severe blows to the nose may result in a nasal fracture. After such a blow, the nose may appear slightly deformed as well as shifted laterally or depressed. Other symptoms include:

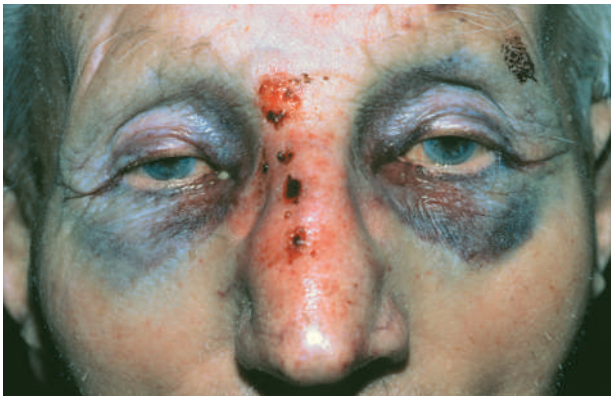
- **pain**
- swelling
- airway obstruction
- epistaxis (profuse bleeding from the nose)
- crepitance (the crackling heard and the sensation felt when broken bones are moved over each other)
- ecchymosis (a purplish area of the nose resulting from fracture and caused by extravasation of blood into the skin)
- septal hematoma (a mass of extravasated blood that confined within the nasal septum)
- **rhinitis** (an inflammation of the mucous membranes that line the nasal passages)
- nasal vestibular stenosis (a narrowing of the nasal passages)

In addition to fracture, trauma may be caused by chemical inhalation. This is normally due to repetitive inhalation of toxic materials that may, in addition to irritating the nasal passages, cause damage to the lower respiratory tract and lungs. Irritant gases may cause damage by direct contact with membranes and a proceeding chemical reaction can result in a release of free radicals causing membrane damage.

Initial symptoms of chemical irritation may include rhinorrhea or runny nose, pain, and/or nasal congestion. Certain chemical irritants may also cause burning of the mucous membranes of the nose. Irritation may also cause redness of the eyes, coughing, sneezing, **itching**, and a deficit in olfaction and taste.

Some common irritants that may be encountered in the home and workplace include:

- cleaning solutions and powders
- ammonia
- environmental tobacco smoke
- bleach
- metalworking fluids
- ozone
- sulfur dioxide
- paint thinners
- arsenic



Fractured nose of an elderly patient. *(Photograph byDr. P Marazzi. Photo Researchers. Reproduced by permission.)*

- chromic acid
- copper dust and mists

Sequelae following exposure to these chemicals are based not only on the concentration of the irritant but also on factors specific to the individual. Reactions vary among persons, even with similar exposures.

Diagnosis

Diagnosis of a fracture is normally based on a history of nasal trauma and clinical presentation. Epistaxis may or may not be present. An intranasal examination is performed in order to look for a septal hematoma that may result in serious consequences such as **death** of the septal cartilaginous tissue. The nose is also checked for tenderness, mobility, stability, and crepitance.

X rays are normally not indicated, however, in more severe fractures involving multiple bones a computed tomography (CT) scan may be required. The physician should look for associated injuries such as periorbital (surrounding the eye) ecchymosis, watery eyes, or diplopia (double vision) that may indicate orbital injuries. In addition, dental fractures and a cerebrospinal fluid (CSF) leak should be looked for. CSF leaks indicate a more severe injury possibly involving an ethmoid bone fracture.

The physician may also ask for photographs taken prior to the injury in order to determine the extent of deformity. Photographs may also be taken to document the injury in regards to possible legal actions.

In order to diagnose trauma sustained by a chemical injury, a history of exposure to potentially toxic chemicals should be ascertained. In addition, the patient should also bring information related to the types of chemicals that he or she has been exposed to. If injury occurs in the workplace, Material Safety Data Sheets should be available in the employer's poison control center that list the chemical components of commercial materials. Measurements of air from the patient's work area may also be obtained. Symptomatic improvement on off-days followed by a subsequent return of symptoms when returning to work confirms that the illness is work related. The physician should perform an intranasal examination to determine the extent of the chemical injury. A **chest x ray** as well as a **pulmonary function test** may be ordered to determine if there is any subsequent lower respiratory tract involvement.

Treatment

Treatment of nasal fractures is aimed at restoring nasal function and reestablishing the aesthetic appearance of the nose. Treatment is best performed during the first three hours after the injury. If this is impossible, management of a nasal fracture should be done within three to seven days. Timing is of utmost importance when treating nasal fractures since delays longer than seven to 10 days may result in significant bone healing and possibly require surgical intervention including rhinoplasty.

The treatment options depend upon the extent of the injury. Reductions, or restorations, can be performed under local or general anesthesia. A closed reduction involves manipulation without a skin incision. This type of reduction will be performed for unilateral or bilateral fractures of the nasal bones, or if the fracture of the nasal-septal complex is insignificant. If there is a persistent deformity following treatment an open reduction may be needed.

Open reductions are performed for more complex nasal fractures. This involves manipulating the bones back to their original location after an incision in the skin has been made. This procedure is done for fractures involving dislocation of the nasal bones and the septum. In addition, an open reduction is indicated for a septal hematoma or for open fractures in which the skin has been perforated. If a septal hematoma is present, it should be drained and packed to prevent subsequent accumulation of blood. The patient should be given **antibiotics** and may be referred to an otolaryngologist or a plastic surgeon for further evaluation.

Complications can arise following treatment and therefore follow-up is necessary. Problems that may occur resemble symptoms of nasal fractures. Others include infection, CSF leakage, scar tissue build-up, and a saddle nose deformity where the bridge of the nose is markedly depressed.

Treatment for trauma caused by irritant inhalation involves removing the patient from the contaminated area or decreasing exposure time. Other measures include using a saline nasal spray or topical steroids. For acute injuries oxygen or supportive treatment for any subsequent lower respiratory tract involvement may be administered.

If the injury is occupation related, changes should be made in order to eliminate future incidents. This may include having the patient wear a respiratory protection device while working. In addition, the employer should be made aware of the situation and employ measures to prevent future incidents.

Prognosis

Most patients who sustain nasal trauma recover following treatment. Prognosis can be improved with patient compliance with any antibiotics prescribed and follow-up visits with their physician.

Prevention

Although most cases of nasal trauma happen inadvertently, some measures can be employed in order to prevent injury. Patients should be aware of the symptoms of nasal fracture and should seek medical attention as soon as possible to prevent more invasive reductions. Protective equipment should also be worn when playing sports. Employees should also be aware of irritating chemicals in their workplace and appropriate measures should be taken to avoid exposure.

Resources

BOOKS

Bailey, Byron J., and Luke K. S. Tan. "Nasal and Frontal Sinus Fractures." In *Head and Neck Surgery-Otolaryngology*, ed. Byron J. Bailey. Lippencott-Raven Publishers, Philadelphia, 1998.

Cantrill, Stephen V. "Facial Trauma." In *Rosen Emergency Medicine, Concepts and Clinical Practice*, 4th ed. Ed. Peter Rosen, et al. Mosby-Year Books, St. Louis, 1998.

Jackler, Robert K., and Michael J. Kaplan. "Ear, Nose, and Throat." In *Current Medical Diagnosis and Treatment*, ed. Lawrence M. Tierney Jr., et al. New York: Lange Medical Books/McGraw-Hill, 2001.

PERIODICALS

Balkissoon, Ron, and Dennis J. Shusterman. "Occupational Upper Airway Disorders." *Seminars in Respiratory and Critical Care Medicine*. 20 (1999): 569.

Beckett, William S. "Current Concepts: Occupational Respiratory Diseases." *The New England Journal of Medicine*. 342 (10 Feb. 2000): 406.

Jablon, Jeffrey H, and John F. Hoffman. "Birth Trauma Causing Nasal Vestibular Stenosis." *Archives of Otolaryngology-Head and Neck Surgery.* 123 (Sept. 1997): 1004.

Karen, Matthew, et al. "Auricular Composite Grafting to Repair Nasal Vestibular Stenosis." *Otolaryngology Head and Neck Surgery.* 122 (2000): 529.

Prudhomme, Janice C., et al. "Acute-onset Persistent Olfactory Deficit Resulting From Multiple Overexposures to Ammonia Vapor at Work." *The Journal of the American Board of Family Practice*. 11 (Jan./Feb. 1998): 66.

KEY TERMS

Anosmia—A loss or a decrease sense of smell (olfaction).

Closed reduction—Fracture repair that is performed without an incision being made.

Crepitance—This is the crackling heard and the sensation felt when the broken bones are moved over each other.

Diplopia—This term is used to describe double vision.

Epistaxis—The medical term used to describe a bleeding from the nose.

Iatrogenic—The term used to describe a response to medical treatment. This is normally denotes an unfavorable result.

Olfaction—The sense of smelling.

Open Reduction—Fracture repair that includes making an incision in the skin.

Rhinitis—An inflammation of the mucous membranes that line the nasal passages.

Rhinoplasty—Plastic surgery of the nose to repair or change the shape of the nose.

Septal hematoma—A mass of extravasated blood that is confined within the nasal septum.

Rubinstein, Brian, and Bradley E. Strong. "Management of Nasal Fractures." *Archives of Family Medicine*. 9 (Aug. 2000): 738.

Segal, S., et al. "Vasomotor Rhinitis following Trauma to the Nose." *Annals of Otology, Rhinology & Laryngology.* 108 (1999): 208.

Smedsaas-Lofvenberg, A. "Nasal Deformities at a UK Hospital." *Archives of Disease in Childhood and Neonatal Edition*. 78 (Mar. 1998): 158.

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Nasogastric suction

Definition

Nasogastric suction involves removing solids, liquids, or gasses from the stomach or small intestine by inserting a tube through the nose and suctioning the gastrointestinal material through the tube.

Purpose

Nasogastric suction may be done in the following situations:

- to decompress the stomach or small intestine when intestinal obstruction (**ileus**) is suspected
- prior to gastrointestinal operations
- to obtain a sample of the gastric contents for analysis
- to remove toxic substances
- to flush the stomach during gastrointestinal bleeding or poisonings

Nasogastric intubation, the insertion of a tube through the nose into the stomach or small intestine, is also done to temporarily feed certain patients. In this case, material is not suctioned out.

Precautions

Nasogastric tubes cannot be placed in patients who have blockages in their esophagus, enlarged esophageal veins or arteries that might bleed, or severe damage to the jaws and face. The tube cannot be inserted in a patient who is having convulsions, or who is losing or has lost consciousness unless a tube has been inserted into his or her airway (intubation).

Description

The patient sits upright while a lubricated tube is slipped through the nose and down the throat. The patient may be asked to sip water at a certain point in the procedure to facilitate the passage of the tube. If the tube is to be placed into the small intestine, the doctor may use an endoscope to help see where the tube is going. Once the tube is in place, material can be removed from the stomach or intestines with gentle suction.

There are several different types of nasogastric tubes, each with a different purpose. Tubes used for **stomach flushing** are called orogastric tubes and are the largest in diameter. Tubes that are threaded through the lower opening of the stomach (pylorus) and into the small intestine are stiffer and have a balloon tip. Other specialized tubes are used for long-term and short-term feeding.

Preparation

Little preparation is necessary for this procedure other than educating the patient as to what will happen. The patient should remove dental appliances before the nasogastric tube is inserted.

KEY TERMS

Endoscope—A piece of equipment with a camera and a light source in a thin tube that can be threaded through the nose into the gastrointestinal system so that the doctor can make a real-time visual examination.

Pylorus—The ring of muscle that controls the passage of material from the stomach into the small intestine.

Aftercare

After the tube is removed, no special care is needed. The patient's throat may feel irritated from the presence of the tube.

Risks

The most serious risk is that the patient will inhale some of the stomach contents into the lungs (aspiration). This may lead to bronchial infections and aspiration **pneumonia**. There is also the chance that the tube will be misplaced in the windpipe (trachea), causing violent coughing. Irritation to the throat and esophagus can cause bleeding.

Normal results

Nasogastric suctioning is normally well tolerated by patients and is a temporary treatment, performed in conjunction with other therapies.

Resources

BOOKS

Berkow, Robert, ed. "Nasogastric or Intestinal Intubation." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Tish Davidson

Nasopharyngeal culture

Definition

A nasopharyngeal culture is used to identify pathogenic (disease causing) organisms present in the nasal cavity that may cause upper respiratory tract symptoms.

Purpose

Some organisms that cause upper respiratory infections are carried primarily in the nasopharynx, or back of the nose. The person carrying these pathogenic bacteria may have no symptoms, but can still infect others with the pathogen and resulting illness. The most serious of these organisms is *Neisseriea meningitidis*, which causes **meningitis** or blood stream infection in infants. By culturing a sample from the nasopharynx, the physician can identify this organism, and others, in the asymptomatic carrier. The procedure can also be used as a substitute for a **throat culture** in infants, the elderly patient, the debilitated patient, or in cases where a throat culture is difficult to obtain.

Precautions

The person taking the specimen should wear gloves, to prevent spreading infectious organisms. The patient should not be taking **antibiotics**, as this may influence the test results.

Description

The patient should **cough** before collection of the specimen. Then, as the patient tilts his or her head backwards, the caregiver will inspect the back of the throat using a penlight and tongue depressor. A swab on a flexible wire is inserted into the nostril, back to the nasal cavity and upper part of the throat. The swab is rotated quickly and then removed. Next, the swab is placed into a sterile tube with culture fluid in it for transport to the microbiology laboratory. To prevent contamination, the swab should not touch the patient's tongue or side of the nostrils.

When the sample reaches the lab, the swab will be spread onto an agar plate and the agar plate incubated for 24-48 hours, to allow organisms present to grow. These organisms will be identified and any pathogenic organisms may also be tested for susceptibility to specific antibiotics. This allows the treating physician to determine which antibiotics will be effective.

Alternative Procedures

In most cases of upper respiratory tract infections, a throat culture is more appropriate than a nasopharyngeal culture. However, the nasopharyngeal culture should be used in cases where throat cultures are difficult to obtain or to detect the carrier states of *Harmophilus influenzae* and meningococcal disease.

Preparation

The procedure should be described to the patient, as there is a slight discomfort associated with the procedure. Other than that, no special preparation is necessary.

KEY TERMS

Antibiotic—A drug given to stop the growth of bacteria. Antibiotics are ineffective against viruses.

Nasopharynx—The back wall of the nasal cavity where it meets the throat.

Aftercare

None

Risks

There is little to no risk involved in a nasopharyngeal culture.

Normal results

Bacteria that normally grow in the nose cavity will be identified by a nasopharyngeal culture. These include nonhemolytic streptococci, alpha-hemolytic streptococci, some *Neisseria* species, and some types of staphylococci.

Abnormal results

Pathogenic organisms that might be identified by this culture include

- Group A beta-hemolytic streptococci
- *Bordetella pertussis*, the causative agent of **whooping cough**
- *Corynebacterium diptheriae*, the causative agent of diptheria
- *Staphylococcus aureus*, the causative agent of many Staph infections.

Additional bacteria are abnormal if they are found in large amounts. These include

- *Haemophilus influenzae*, a causative agent for certain types of meningitis and chronic pulmonary disease.
- *Streptococci pneumonlae*, a causative agent of **pneumonia**
- *Candida albicans*, the causative agent of thrush.

Resources

BOOKS

Byrne, J., D. F. Saxton, P. K. Pelikan, and P. M. Nugent. *Laboratory Tests, Implication for Nursing Care.* 2nd ed. Menlo Park, CA: Addison-Wesley Publishing Company.

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Cindy L. A. Jones, PhD

Native American health *see* **Minority health**

Naturopathic medicine

Definition

Naturopathic medicine is a branch of medicine in which a variety of natural medicines and treatments are used to heal illness. It uses a system of medical diagnosis and therapeutics based on the patterns of chaos and organization in nature. It is founded on the premise that people are naturally healthy, and that healing can occur through removing obstacles to a cure and by stimulating the body's natural healing abilities. The foundations of health in natural medicine are diet, **nutrition**, **homeopathy**, physical manipulation, **stress** management, and **exercise**.

Naturopaths are general practitioners who treat a wide variety of illnesses. They believe in treating the "whole person"—the spirit as well as the physical body—and emphasize preventive care. They often recommend changes in diet and lifestyle to enhance the health of their patients.

Purpose

Naturopathic medicine is useful for treating chronic as well as acute diseases. It is sometimes used in conjunction with allopathic care to enhance wellness and relieve chronic symptoms, such as **fatigue** and **pain**. A naturopath treats a wide range of health problems, ranging from back pain to depression.

A naturopathic physician will spend extra time interviewing and examining the patient to find the underlying cause for a medical problem. Emotional and spiritual symptoms and patterns are included in the assessment. The naturopath often spends more time educating patients in preventive health, lifestyle, and nutrition than most M.D.s.

Description

Origins

People have always seen a connection to diet and disease, and many therapies are built around special **diets**. Naturopathy began in the eighteenth and nineteenth centuries, as the industrial revolution brought about unhealthy lifestyles, and the European custom of "taking the cure" at natural spas became popular. Benedict Lust, who believed deeply in natural medicine, organized naturopathy as a formal system of healthcare in the 1890s. By the early 1900s, it was flourishing.

The first naturopaths in the United States emphasized the healing properties of a nutritious diet, as did a number of their contemporaries. In the early twentieth century, for instance, John Kellogg, a physician and vegetarian, opened a sanitarium which used healing methods such as **hydrotherapy**, often prescribed by today's naturopaths. His brother Will produced health foods, such as corn flakes and shredded wheat. The Post brothers helped make naturopathic ideas popular and emphasized the value of whole grains over highly refined ones. Together with one of their employees, C.W. Post, they eventually went on to start the cereal companies that bear their names.

In the early 1900s, most states licensed naturopaths as physicians. There were 20 medical schools of naturopathic medicine. From early on, naturopathic physicians were considered "eclectic," since they drew on a variety of natural therapies and traditions for treating their patients.

In the 1930s, naturopathy dramatically declined for several reasons. Allopathic medicine finally stopped using therapies such as bloodletting and **heavy metal poisoning** as curatives. New therapies were more effective and less toxic. Allopathic medical schools became increasingly well-funded by foundations with links to the emerging drug industry. Also, allopathic physicians became much more organized and wielded political clout. Naturopathy has experienced a resurgence over the last 20 years, however. The lay public is aware of the connection between a healthy diet and lifestyle and avoiding chronic disease. In addition, conventional medicine is often unable to treat these chronic diseases. Patients are now health care consumers, and will seek their own resolution to health problems that cannot be resolved by conventional physicians. As a result, even medical groups which once considered naturopathy ineffective are now beginning to accept it.

Naturopathic medicine modalities include a variety of healing treatments, such as diet and clinical nutrition, homeopathy, botanical medicine, soft tissue and spinal manipulation, ultrasound, and therapeutic exercise. A naturopath provides complete diagnostic and treatment services in sciences such as obstetrics, pediatrics and obstetrics. Some are also licensed midwives.

Naturopaths consider health to be not just the absence of disease, but complete physical, mental and social well being. Naturopathic physicians often say that

diseases must be healed not just by suppressing symptoms, but by rooting out the true cause. Symptoms are actually viewed as the body's natural efforts to heal itself and restore balance.

A typical office visit to a naturopath takes an hour. During the first visit, the doctor will ask detailed questions about the patient's symptoms, lifestyle, history of illness, and state of his or her emotions. The naturopath will take a complete medical history, and may order lab tests such as urine and blood tests. A naturopath may talk with the patient about the possible causes for an illness—poor diet, life stresses, occupational dangers, and mental, emotional, and spiritual problems. Naturopaths believe that even widely varying symptoms can sometimes be traced to one underlying cause. Often environmental or metabolic toxins or serious stress bring on an illness.

In some states, naturopaths prescribe pharmaceuticals. In these cases, naturopaths might prescribe natural medicines, such as natural hormones, glandular **thyroid hormones**, herbal extracts, **vitamins**, etc.

As with most doctors, treatment by a naturopath can range from one office visit to many. Some acute illnesses can be alleviated with one or two visits. Other chronic diseases need regular weekly or monthly attention. Clinical care provided by naturopathic physicians are covered by insurance in a number of states in the United States.

Preparations

There are about 3,000 naturopathic physicians in the United States. Consumers can find naturopaths by contacting the American Association of Naturopathic Physicians (AANP) or logging on to their Web site. Naturopaths recommended by the AANP have met requirements for state licensure and have taken a national exam that qualifies them to practice. Qualified naturopaths can also be found through the local branch of the national or state association of naturopathic physicians. It is sometimes useful to request names from another health care provider who knows naturopathic practitioners in the community.

Precautions

A good naturopath is always willing to work with the patient's other physicians or health care providers. To avoid drug interactions and to coordinate care, it is important for a patient to inform his or her allopathic doctor about supplements prescribed by a naturopath.

Many naturopaths give childhood vaccinations, but some do not. If a parent is concerned about this, it is best to go to an allopathic doctor for vaccinations.

Naturopaths are not licensed to perform major surgery, or prescribe narcotics and **antidepressant drugs**. They must involve an oncologist when treating a **cancer** patient.

Side effects

Although naturopathic remedies are from natural sources and pose much less risk than traditional drugs do, there are some side effects with the use of some. One problem they can pose is the interaction with prescription medicines. It is important for a patient to inform his or her allopathic physician about any natural remedies or herbs prescribed by a naturopath.

It is also important to note that the U.S. Food and Drug Administration considers medicinal herbs as dietary supplements, not drugs, and so are not subject to the same regulations as drugs are. Because they come from natural sources, the active ingredients may not always be in the same concentration from bottle to bottle, since plants naturally vary. To guard against using too little or too much of a natural remedy, use herbs and supplements recommended by a naturopath or those produced by well-respected companies.

Research and general acceptance

Medical research in naturopathy has increased dramatically in the United States within the last 10 years. Naturopathic research often employs case histories, summaries of practitioners' clinical observations, and medical records. Some U.S. studies have also met today's scientific gold standard; they were double-blind and placebo-controlled. Much naturopathic research has also been done in Germany, France, England, India, and China.

Research in naturopathy tends to focus on single treatments used by naturopaths, rather than naturopathy as a whole. In 1998, an extensive review of such single treatment studies found that naturopathic healing methods were effective for 15 different medical conditions, including **osteoarthritis**, **asthma**, and middle ear infections. A study of 8,341 men in with damaged heart muscles in 1996 revealed that supplementation with niacin, a B vitamin, was associated with an 11% reduced risk of mortality over 15 years. In 1996, a study showed **St. John's wort** was as effective as prescription antidepressants in relieving depression, and had fewer side effects.

Studies have also demonstrated benefits in the arena of **women's health** issues. In one classic 1993 study, women with cervical dysplasia or abnormal Pap smears were treated by naturopaths with topical applications of herbs and dietary supplements. These medications included Bromelian, an enzyme from the pineapple; bloodroot; marigold; and zinc chloride; and suppositories made from herbal and nutritional ingredients, such as

KEY TERMS

Clinical nutrition—The use of diet and nutritional supplements as a way to enhance health prevent disease.

Cryosurgery—The exposure of body tissue to extremely cold temperatures, often by applying a probe containing liquid nitrogen.

Herb—In naturopathy, a plant or plant derivative or extract prescribed for health or healing.

Homeopathy—The use of diluted remedies that have energetic rather than chemical properties. They are prescribed according to the axiom that "like cures like."

Hydrotherapy—The use of water as baths, poultices, and steams to heal.

Physical manipulation—The use of deep massage, spinal alignment, and joint manipulation to stimulate tissues.

Ultrasound—A therapy employing high frequency sound waves.

echinacea, vitamin A, and vitamin E. Thirty eight of the 43 women in the study had normal Pap smears and normal tissue biopsies after treatment. The study concluded that these protocols might benefit the health of patients undergoing more traditional treatments for cervical dysplasia, such as cryosurgery.

Other more recent research has documented the benefits of nutritional foods such as soy in relieving hot flashes and vaginal dryness. Nutritional supplements prescribed by naturopaths to enhance women's health during **menopause** have also proven effective. Research shows vitamin E supplements are helpful for 50% of postmenopausal women with thinning vaginal tissue. Studies also reveal that bioflavonoids with vitamin C and gamma-oryzanol, a substance taken from rice bran oil, can relieve hot flashes.

Resources

BOOKS

Better Homes and Gardens. *Smart Choices in Alternative Medicine*. Meredith Books, 1999.

Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Future Medicine Publishing Inc., 1995.

Pelletier, Dr. Kenneth R. *The Best Alternative Medicine*. Simon and Schuster, 2000.

PERIODICALS

"Naturopathic Medicine." *Alternative Medicine: The Definitive Guide*. Future Medicine Publishing, Inc. 1995.

Hudson, Tori, N.D. "Six Paths to Menopausal Wellness." *Herbs for Health* (Jan/Feb 2000): 47-50.

Kurtzweil, Paula. *An FDA Guide to Dietary Supplements*. FDA Consumer, 1998.

Lee, A.C., and K.J. Kemper. "Homeopathy and Naturopathy: Practice Characteristics and Pediatric Care." *Archives of Pediatric and Adolescent Medicine* (Jan 2000) 154 (1):75-80.

ORGANIZATIONS

The American Association of Naturopathic Physicians. 601 Valley Street, Suite 105, Seattle, WA 98109. (206) 298-0126. <http://www.naturopathic.org>.

Barbara Boughton

Naturopathy *see* **Naturopathic medicine**

Nausea and vomiting

Definition

Nausea is the sensation of being about to vomit. Vomiting, or emesis, is the expelling of undigested food through the mouth.

Description

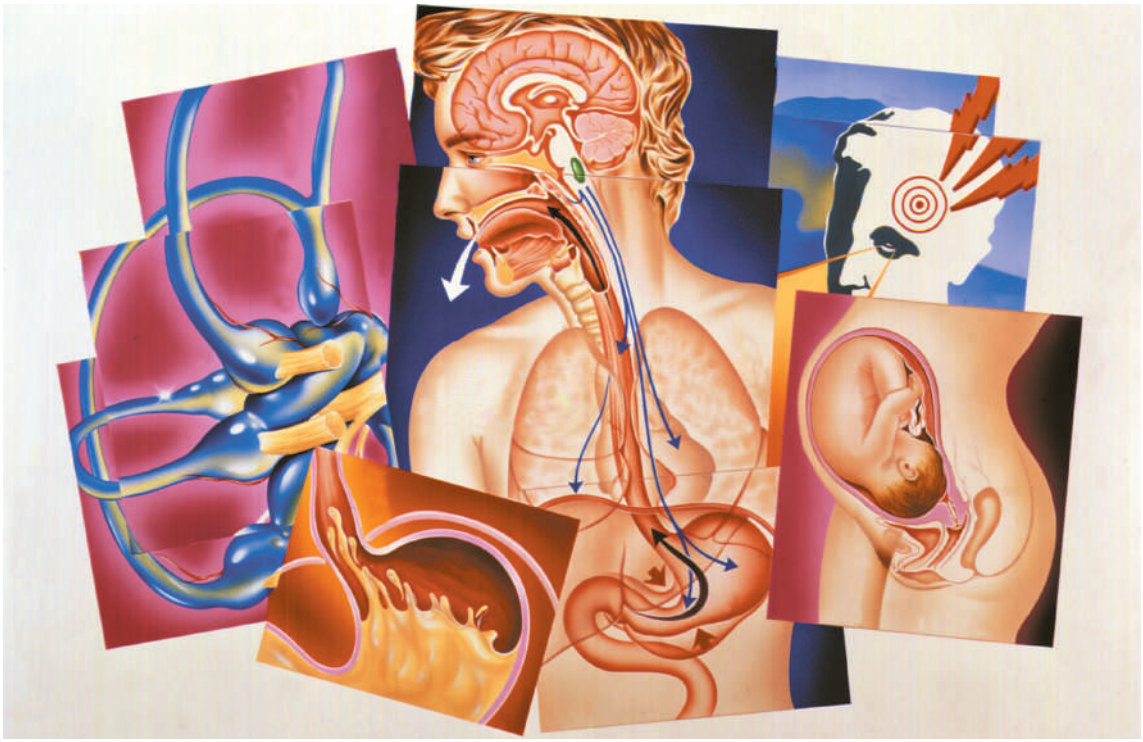
Nausea is a reaction to a number of causes that include overeating, infection, or irritation of the throat or stomach lining. Persistent or recurrent nausea and vomiting should be checked by a doctor.

A doctor should be called if nausea and vomiting occur:

- after eating rich or spoiled food or taking a new medication
- repeatedly or for 48 hours or longer
- following intense **dizziness**

It is important to see a doctor if nausea and vomiting are accompanied by:

- yellowing of the skin and whites of the eyes
- **pain** in the chest or lower abdomen
- trouble with swallowing or urination
- **dehydration** or extreme thirst
- drowsiness or confusion
- constant, severe abdominal pain



These illustrations depict the mechanism and causes of vomiting in the human body. An impulse from the brain stimulates the vomiting center (top center) in the brain stem. Nerve impulses sent to the stomach, diaphragm, and abdominal wall (bottom center) result in stomach's contents being expelled. Other causes of vomiting include raised pressure in the skull due to injury or tumor (upper right), and hormonal changes during pregnancy. *(Illustration by John Bavosi, Custom Medical Stock Photo. Reproduced by permission.)*

• a fruity breath odor.

A doctor should be notified if vomiting is heavy and/or bloody, if the vomitus looks like feces, or if the patient has been unable to keep food down for 24 hours.

An ambulance or emergency response number should be called immediately if:

• diabetic **shock** is suspected
• nausea and vomiting continue after other symptoms of viral infection have subsided
• the patient has a severe headach.
• the patient is sweating and having chest pain and trouble breathing
• nausea, vomiting, and breathing problems occur after exposure to a known allergen.

Causes and symptoms

Persistent, unexplained, or recurring nausea and vomiting can be symptoms of a variety of serious illnesses. It can be caused by simply over-eating or drinking too much alcohol. It can be due to **stress**, medication, or illness. Morning sickness is a consequence of pregnancy-related hormone changes. **Motion sickness** can be induced by traveling in a vehicle, plane, or on a boat. Many patients experience nausea after eating spoiled food or foods to which they are allergic. Patients who suffer **migraine headache** often experience nausea. **Cancer** patients on **chemotherapy** are nauseated. **Gallstones**, **gastroenteritis** and stomach ulcer may cause nausea and vomiting. These symptoms should be evaluated by a physician.

Diagnosis

Diagnosis is based on the severity, frequency, and duration of symptoms, and other factors that could indicate the presence of a serious illness.

Treatment

Getting a breath of fresh air or getting away from whatever is causing the nausea can solve the problem.

KEY TERMS

Dehydration—Loss of fluid and minerals following vomiting, prolonged diarrhea, or excessive sweating.

Diabetic coma—Reduced level of consciousness that requires immediate medical attention.

Eating olives or crackers or sucking on a lemon can calm the stomach by absorbing acid and excess fluid. Coke syrup is another proven remedy.

Vomiting relieves nausea right away but can cause dehydration. Sipping clear juices, weak tea, and some sports drinks help replace lost fluid and **minerals** without irritating the stomach. Food should be reintroduced gradually, beginning with small amounts of dry, bland food like crackers and toast.

Meclizine (Bonine), a medication for motion sickness, also diminishes the feeling of queasiness in the stomach. Dimenhydrinate (Dramamine), another motion-sickness drug, is not effective on other types of nausea and may cause drowsiness.

Alternative treatment

Advocates of alternative treatments suggest **biofeedback**, **acupressure** and the use of herbs to calm the stomach. Biofeedback uses **exercise** and deep relaxation to control nausea. Acupressure (applying pressure to specific areas of the body) can be applied by wearing a special wristband or by applying firm pressure to:

- the back of the jawbone
- the webbing between the thumb and index finger
- the top of the foot
- the inside of the wrist
- the base of the rib cage

Chamomile (*Matricaria recutita*) or lemon balm (*Melissa officinalis*) tea may relieve symptoms. Ginger (*Zingiber officinale*), another natural remedy, can be drunk as tea or taken as candy or powered capsules.

Prevention

Massage, **meditation**, **yoga**, and other relaxation techniques can help prevent stress-induced nausea. Anti-nausea medication taken before traveling can prevent motion sickness. Sitting in the front seat, focusing on the horizon, and traveling after dark can also minimize symptoms.

Food should be fresh, properly prepared, and eaten slowly. Overeating, tight-fitting clothes, and strenuous activity immediately after a meal should be avoided.

Resources

BOOKS

The Doctors Book of Home Remedies. Emmaus, PA: Rodale Press, 1990.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

OTHER

"Nutrition Tips for Managing Nausea and Vomiting." *Mayo Clinic Online*. 5 Mar. 1998 <http://www.mayohealth.org/mayo/9709/htm/eating5.htm>.

Maureen Haggerty

Nberg disease *see* **Osteopetroses**

NCV *see* **Electromyography**

Near-drowning

Definition

Near-drowning is the term for survival after suffocation caused by submersion in water or another fluid. Some experts exclude from this definition cases of temporary survival that end in **death** within 24 hours, which they prefer to classify as drownings.

Description

An estimated 15,000–70,000 near-drownings occur in the United States each year (insufficient reporting prevents a better estimate). The typical victim is young and male. Nearly half of all drownings and near-drownings involve children less than four years old. Home swimming pools pose the greatest risk for children, being the site of 60–90% of drownings in the 0–4 age group. Teenage boys also face a heightened risk of drowning and near-drowning, largely because of their tendency to behave recklessly and use drugs and alcohol (drugs and alcohol are implicated in 40–50% of teenage drownings). Males, however, predominate even in the earliest age-groups, possibly because young boys are often granted more freedom from supervision than young girls enjoy, making it more likely that they will stumble into danger and less likely that they

will attract an adult's attention in time for a quick rescue. Roughly four out of five drowning victims are males.

Causes and symptoms

The circumstances leading to near-drownings (and drownings also) cannot be reduced to a single scenario involving nonswimmers accidentally entering deep water. On many occasions, near-drownings are secondary to an event such as a **heart attack** that causes unconsciousness or a head or spinal injury that prevents a diver from resurfacing. Near-drownings, moreover, can occur in shallow as well as deep water. Small children have drowned or almost drowned in bathtubs, toilets, industrial-size cleaning buckets, and washing machines. Bathtubs are especially dangerous for infants six months to one year old, who can sit up straight in a bathtub but may lack the ability to pull themselves out of the water if they slip under the surface.

A reduced concentration of oxygen in the blood (hypoxemia) is common to all near-drownings. Human life, of course, depends on a constant supply of oxygen-laden air reaching the blood by way of the lungs. When drowning begins, the larynx (an air passage) closes involuntarily, preventing both air and water from entering the lungs. In 10–15% of cases, hypoxemia results because the larynx stays closed. This is called "dry drowning." Hypoxemia also occurs in "wet drowning," the 85–90% of cases where the larynx relaxes and water enters the lungs. The physiological mechanisms that produce hypoxemia in wet drowning are different for freshwater and saltwater, but only a small amount of either kind of water is needed to damage the lungs and interfere with the body's oxygen intake. All of this happens very quickly: within three minutes of submersion most people are unconscious, and within five minutes the brain begins to suffer from lack of oxygen. Abnormal heart rhythms (cardiac dysrhythmias) often occur in near-drowning cases, and the heart may stop pumping (cardiac arrest). An increase in blood acidity (acidosis) is another consequence of near-drowning, and under some circumstances near-drowning can cause a substantial increase or decrease in the volume of circulating blood. Many victims experience a severe drop in body temperature (**hypothermia**).

The signs and symptoms of near-drowning can differ widely from person to person. Some victims are alert but agitated, while others are comatose. Breathing may have stopped, or the victim may be gasping for breath. Bluish skin (**cyanosis**), coughing, and frothy pink sputum (material expelled from the respiratory tract by coughing) are often observed. Rapid breathing (tachypnea), a rapid heart rate (tachycardia), and a low-grade **fever** are common during the first few hours after rescue. Conscious victims may appear confused, lethargic, or irritable.

Diagnosis

Diagnosis relies on a **physical examination** of the victim and on a wide range of tests and other procedures. Blood is taken to measure oxygen levels and for many other purposes. Pulse oximetry, another way of assessing oxygen levels, involves attaching a device called a pulse oximeter to the patient's finger. An electrocardiograph is used to monitor heart activity. X rays can detect head and neck injuries and excess tissue fluid (**edema**) in the lungs.

Treatment

Treatment begins with removing the victim from the water and performing **cardiopulmonary resuscitation** (**CPR**). One purpose of CPR—which, of course, should be attempted only by people trained in its use—is to bring oxygen to the lungs, heart, brain, and other organs by breathing into the victim's mouth. When the victim's heart has stopped, CPR also attempts to get the heart pumping again by pressing down on the victim's chest. After CPR has been performed and emergency medical help has arrived on the scene, oxygen is administered to the victim. If the victim's breathing has stopped or is otherwise impaired, a tube is inserted into the windpipe (trachea) to maintain the airway (this is called endotracheal intubation). The victim is also checked for head, neck, and other injuries, and fluids are given intravenously. Hypothermia cases require careful handling to protect the heart.

In the emergency department, victims continue receiving oxygen until blood tests show a return to normal. About one-third are intubated and initially need mechanical support to breathe. Rewarming is undertaken when hypothermia is present. Victims may arrive needing treatment for cardiac arrest or cardiac dysrhythmias. Comatose patients present a special problem: although various treatment approaches have been tried, none have proved beneficial. Patients can be discharged from the emergency department after four to six hours if their blood oxygen level is normal and no signs or symptoms of near-drowning are present. But because lung problems can arise 12 or more hours after submersion, the medical staff must first be satisfied that the patients are willing and able to seek further medical help if necessary. Admission to a hospital for at least 24 hours for further observation and treatment is a must for patients who do not appear to recover fully in the emergency department.

Prognosis

Neurological damage is the major long-term concern in the treatment of near-drowning victims. Patients who arrive at an emergency department awake and alert usually survive with brain function intact, as do about 90% of those who arrive mentally impaired (lethargic, confused,

and so forth) but not comatose. Death or permanent neurological damage is very likely when patients arrive comatose. Early rescue of near-drowning victims (within five minutes of submersion) and prompt CPR (within less than 10 minutes of submersion) seem to be the best guarantees of a complete recovery. An analysis of 715 patients admitted to emergency departments in 1971–81 revealed that 69% recovered completely, 25% died, and 6% survived but suffered permanent neurological damage.

Prevention

Prevention depends on educating parents, other adults, and teenagers about water safety.

Parents must realize that young children who are left in or near water without adult supervision even for a short time can easily get into trouble, not just at the beach or next to a swimming pool, but in bathtubs and around toilets, buckets, washing machines, and other household articles where water can collect. Research on swimming pool drownings involving young children shows that the victims have usually been left unattended less than five minutes before the accident. Experts consider putting up a fence around a home swimming pool an essential precaution, and estimate that 50-90% of child drownings and near-drownings could be prevented if fences were widely adopted. The fence should be at least five feet high and unclimbable, have a self-closing and self-locking gate, and completely surround the pool.

Pool owners—and, indeed, all other adults—should consider learning CPR. Everyone, of course, should follow the rules for safe swimming and boating. Those who have a medical condition that can cause a seizure or otherwise threaten safety in the water are advised always to swim with a partner. And of course, people need to be aware that alcohol and drug use substantially increase the chances of an accident.

The danger of alcohol and drug use around water is a point that requires special emphasis where teenagers are concerned. Teenagers can also benefit from CPR training and safe swimming and boating classes.

Resources

BOOKS

Modell, Jerome H. "Drowning and Near-Drowning." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Piantadosi, Claude A. "Physical, Chemical, and Aspiration Injuries of the Lung." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Bross, Michael H., and Jacquelyn L. Clark. "Near-Drowning." *American Family Physician* 51 (May 1995): 1545+.

Weinstein, Michael D., and Bruce P. Krieger. "Near-Drowning: Epidemiology, Pathophysiology, and Initial Treatment." *Journal of Emergency Medicine* 14 (1996): 461-467.

Howard Baker

Necrotizing enterocolitis

Definition

Necrotizing enterocolitis is a serious bacterial infection in the intestine, primarily of sick or premature newborn infants. It can cause the **death** (necrosis) of intestinal tissue and progress to blood **poisoning** (septicemia).

Description

Necrotizing enterocolitis develops in approximately 10% of newborns weighing less than 800 g (under 2 lb). It is a serious infection that can produce complications in the intestine itself—such as ulcers, perforations (holes) in the intestinal wall, and tissue necrosis—as well as progress to life-threatening septicemia. Necrotizing enterocolitis most commonly affects the lower portion of the small intestine (ileum). It is less common in the colon and upper small bowel.

Causes and symptoms

The cause of necrotizing enterocolitis is not clear. It is believed that the infection usually develops after the bowel wall has already been weakened or damaged by a lack of oxygen, predisposing it to bacterial invasion. Bacteria proliferate in the bowel and cause a deep infection that can kill bowel tissue and spread to the bloodstream.

Necrotizing enterocolitis almost always occurs in the first month of life. Infants who require **tube feedings** may have an increased risk for the disorder. A number of other conditions also make newborns susceptible, including **respiratory distress syndrome**, congenital heart problems, and episodes of apnea (cessation of breathing). The primary risk factor, however, is **prematurity**. Not only is the immature digestive tract less able to protect itself, but premature infants are subjected to many stresses on the body in their attempt to survive.

Early symptoms of necrotizing enterocolitis include an intolerance to formula, distended and tender abdomen, vomiting, and blood (visible or not) in the

stool. One of the earliest signs may also be the need for mechanical support of the infant's breathing. If the infection spreads to the bloodstream, infants may develop lethargy, fluctuations in body temperature, and periodically stop breathing.

Diagnosis

The key to reducing the complications of this disease is early suspicion by the physician. A series of x rays of the bowel often reveals the progressive condition, and blood tests confirm infection.

Treatment

Over two-thirds of infants can be treated without surgery. Aggressive medical therapy is begun as soon as the condition is diagnosed or even suspected. Tube feedings into the gastrointestinal tract (enteral **nutrition**) are discontinued, and tube feedings into the veins (parenteral nutrition) are used instead until the condition has resolved. Intravenous fluids are given for several weeks while the bowel heals.

Some infants are placed on a ventilator to help them breathe, and some receive transfusions of platelets, which help the blood clot when there is internal bleeding. **Antibiotics** are usually given intravenously for at least 10 days. These infants require frequent evaluations by the physician, who may order multiple abdominal x rays and blood tests to monitor their condition during the illness.

Sometimes, necrotizing enterocolitis must be treated with surgery. This is often the case when an infant's condition does not improve with medical therapy or there are signs of worsening infection.

The surgical treatment depends on the individual patient's condition. Patients with infection that has caused serious damage to the bowel may have portions of the bowel removed. It is sometimes necessary to create a substitute bowel by making an opening (**ostomy**) into the abdomen through the skin, from which waste products are discharged temporarily. But many physicians are avoiding this and operating to remove diseased bowel and repair the defect at the same time.

Postoperative complications are common, including wound infections and lack of healing, persistent **sepsis** and bowel necrosis, and a serious internal bleeding disorder known as disseminated intravascular coagulation.

Prognosis

Necrotizing enterocolitis is the most common cause of death in newborns undergoing surgery. The average mortality is 30–40%, even higher in severe cases.

KEY TERMS

Enteral nutrition—Liquid nutrition provided through tubes that enter the gastrointestinal tract, usually through the mouth or nose.

Necrosis—The death of cells, a portion of tissue, or a portion of an organ due to permanent damage of some sort, such as a lack of oxygen supply to the tissues.

Parenteral nutrition—Liquid nutrition provided through tubes that are placed in the veins.

Sepsis—The presence of pus-forming or other disease-causing organisms in the blood or tissues. Septicemia, commonly known as blood poisoning, is a common type of sepsis.

Early identification and treatment are critical to improving the outcome for these infants. Aggressive nonsurgical support and careful timing of surgical intervention have improved overall survival; however, this condition can be fatal in about one-third of cases. With the resolution of the infection, the bowel may begin functioning within weeks or months. But infants need to be carefully monitored by a physician for years because of possible future complications.

About 10–35% of all survivors will eventually develop a stricture, or narrowing, of the intestine that occurs with healing. This can create an intestinal obstruction that will require surgery. Infants may also be more susceptible to future bacterial infections in the gastrointestinal tract and to a delay in growth. Infants with severe cases may also suffer neurological impairment.

The most serious long-term gastrointestinal complication associated with necrotizing enterocolitis is short-bowel, or short-gut, syndrome. This refers to a condition that can develop when a large amount of bowel must be removed, making the intestines less able to absorb certain nutrients and enzymes. These infants gradually evolve from tube feedings to oral feedings, and medications are used to control the malabsorption, **diarrhea**, and other consequences of this condition.

Prevention

In very small or sick premature infants, the risk for necrotizing enterocolitis may be diminished by beginning parenteral nutrition and delaying enteral feedings for several days to weeks.

KEY TERMS

Enteral nutrition—Liquid nutrition provided through tubes that enter the gastrointestinal tract, usually through the mouth or nose.

Necrosis—The death of cells, a portion of tissue, or a portion of an organ due to permanent damage of some sort, such as a lack of oxygen supply to the tissues.

Parenteral nutrition—Liquid nutrition provided through tubes that are placed in the veins.

Sepsis—The presence of pus-forming or other disease-causing organisms in the blood or tissues. Septicemia, commonly known as blood poisoning, is a common type of sepsis.

Some have suggested that breast milk provides substances that may be protective, but there is no evidence that this reduces the risk of infection. A large multicenter trial showed that steroid drugs given to women in preterm labor may protect their offspring from necrotizing enterocolitis.

Sometimes necrotizing enterocolitis occurs in clusters, or outbreaks, in hospital newborn (neonatal) units. Because there is an infectious element to the disorder, infants with necrotizing enterocolitis may be isolated to avoid infecting other infants. Persons caring for these infants must also employ strict measures to prevent spreading the infection.

Resources

BOOKS

"Pediatrics and Genetics: Disturbances in Newborns and Infants." In *The Merck Manual*. Whitehouse Station, NJ: Merck & Co., Inc., 1992.

OTHER

Neonatology on the Web. <http://www.neonatology.org>.

Caroline A. Helwick

Nearsightedness *see* **Myopia**

Necrotizing fasciitis *see* **Flesh-eating disease**

Neisseria gonorrheae infection *see* **Gonorrhea**

Neisseria meningitidis bacteremia *see* **Meningococcemia**

Nelfinavir *see* **Protease inhibitors**

Neonatal jaundice

Definition

Neonatal **jaundice** (or hyperbilirubinemia) is a higher-than-normal level of bilirubin in the blood. Bilirubin is a by-product of the breakdown of red blood cells. This condition can cause a yellow discoloration of the skin and the whites of the eyes called jaundice.

Description

Bilirubin, a by-product of the breakdown of hemoglobin (the oxygen-carrying substance in red blood cells), is produced when the body breaks down old red blood cells. Normally, the liver processes the bilirubin and excretes it in the stool. Hyperbilirubinemia means there is a high level of bilirubin in the blood. This condition is particularly common in newborn infants. Before birth, an infant gets rid of bilirubin through the mother's blood and liver systems. After birth, the baby's liver has to take over processing bilirubin on its own. Almost all newborns have higher than normal levels of bilirubin. In most cases, the baby's systems continue to develop and can soon process bilirubin. However, some infants may need medical treatment to prevent serious complications which can occur due to the accumulation of bilirubin.

Causes and symptoms

In newborn infants, the liver and intestinal systems are immature and cannot excrete bilirubin as fast as the body produces it. This type of hyperbilirubinemia can cause jaundice to develop within a few days after birth. About one-half of all newborns develop jaundice, while premature infants are much more likely to develop it. Hyperbilirubinemia is also more common in some populations, such as Native American and Asian. All infants with jaundice should be evaluated by a health care provider to rule out more serious problems.

Hyperbilirubinemia and jaundice can also be the result of other diseases or conditions. Hepatitis, **cirrhosis** of the liver, and mononucleosis are diseases that can affect the liver. **Gallstones**, a blocked bile duct, or the use of drugs or alcohol can also cause jaundice.

Extremely high levels of bilirubin in infants may cause kernicterus, a form of brain damage. Signs of severe hyperbilirubinemia include listlessness, high-pitched crying, apnea (periods of not breathing), arching of the back, and seizures. If severe hyperbilirubinemia is not treated, it can cause **mental retardation**, **hearing loss**, behavior disorders, **cerebral palsy**, or **death**.

A newborn baby undergoes phototherapy with visible blue light to treat his jaundice. *(Photograph by Ron Sutherland. Photo Researchers, Inc. Reproduced by permission.)*

KEY TERMS

Bilirubin—A yellowish-brown substance in the blood that forms as old red blood cells are broken down.

Hemoglobin—A protein, an oxygen-carrying pigment of the erythrocyte (red blood cell) formed in the bone marrow.

Jaundice—A yellow discoloration of the skin and whites of the eyes.

Kernicterus—A serious condition where high bilirubin levels cause brain damage in infants.

Diagnosis

The initial diagnosis of hyperbilirubinemia is based on the appearance of jaundice at **physical examination**. The child is often placed by an open window so he/she may be checked in natural light. Blood samples may be taken to determine the bilirubin level in the blood.

Treatment

Most cases of newborn jaundice resolve without medical treatment within two to three weeks, but should be checked by the health care provider. It is important that the infant is feeding regularly and having normal bowel movements. If bilirubin levels are extremely high, the infant may be treated with **phototherapy**—exposure of the baby's skin to fluorescent light. The bilirubin in the baby's skin absorbs the light and is changed to a substance that can be excreted in the urine. This treatment can be done in the hospital and is often done at home with special lights which parents can rent for the treatment. Treatment may be needed for several days before bilirubin levels in the blood return to normal. The baby's eyes are shielded to prevent the optic nerves from absorbing too much light. Another type of treatment uses a special fiberoptic blanket. There is no need to shield the baby's eyes with this treatment, and it can be done at home. In rare cases, where bilirubin levels are extremely high, the baby may need to receive a blood **transfusion**.

Prognosis

Most infants with hyperbilirubinemia and associated jaundice recover without medical treatment. Phototherapy is very effective in reducing bilirubin levels in the majority of infants who need it. There are usually no long-term effects on the child from the hyperbilirubinemia or the phototherapy. It is very rare that a baby may need a blood transfusion for treatment of this condition.

Prevention

There is no way to predict which infants will be affected by hyperbilirubinemia. Newborns should be breastfed or given formula frequently, and feedings should begin as soon as possible after delivery to increase activity of the baby's digestive system.

Resources

BOOKS

"Hyperbilirubinemia." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

OTHER

D'Alessandro, Hellen Anne. *Biliary Atresia.The Virtual Hospital Page*. University of Iowa. <http://www.vh.org/Providers/Textbooks/ElectricGiNucs/Text/BiliaryAtresia.html>.

"Jaundice in Newborn (Hyperbilirubinemia)." <http://www.ivillage.com>.
"Jaundice/Hyperbilirubinemia." <http://www2.medsch.wisc.edu/ 1childrenshosp/Parents_of_Preemies/jaundice.html>.
Neonatology on the Web. <http://www.neonatology.org>.
"Neonatal Jaundice." <http://www.gi.vghtc.gov.tw/Teaching/Biliary/Jaundice/s13.htm>.

Altha Roberts Edgren

Nephrectomy

Definition

Nephrectomy is the surgical procedure of removing a kidney or section of a kidney.

Purpose

Nephrectomy, or kidney removal, is performed on patients with **cancer** of the kidney (renal cell carcinoma); a disease in which cysts (sac-like structures) displace healthy kidney tissue (**polycystic kidney disease**); and serious kidney infections. It is also used to remove a healthy kidney from a donor for the purposes of **kidney transplantation**.

Precautions

Because the kidney is responsible for filtering wastes and fluid from the bloodstream, kidney function is critical to life. Nephrectomy candidates suffering from serious kidney disease, cancer, or infection usually have few treatment choices but to undergo the procedure. However, if kidney function is lost in the remaining kidney, the patient will require chronic dialysis treatments or transplantation of a healthy kidney to sustain life.

Description

Nephrectomy may involve removing a small portion of the kidney or the entire organ and surrounding tissues. In partial nephrectomy, only the diseased or infected portion of the kidney is removed. Radical nephrectomy involves removing the entire kidney, a section of the tube leading to the bladder (ureter), the gland that sits atop the kidney (adrenal gland), and the fatty tissue surrounding the kidney. A simple nephrectomy performed for transplant purposes requires removal of the kidney and a section of the attached ureter. A similar procedure is used to harvest cadaver kidneys, although both kidneys are typically removed at once (bilateral nephrectomy) and blood and cell samples for **tissue typing** are also taken.

The nephrectomy patient is administered general anesthesia and the surgeon makes an incision on the side or front of the abdomen. Muscle, fat, and tissue are cut away to reveal the kidney. The blood vessels connecting the kidney to the circulation are cut and clamped. Depending on the type of nephrectomy procedure being performed, the ureter, adrenal gland, and/or surrounding tissue may also be cut. The vessels and the ureter in the patient are then tied off and the incision is sewn up (sutured). The surgical procedure can take up to three hours, depending on the type of nephrectomy being performed.

Laparoscopic nephrectomy is a form of minimally-invasive surgery that utilizes instruments on long, narrow rods to view, cut, and remove the kidney. The surgeon views the kidney and surrounding tissue with a flexible videoscope. The videoscope and surgical instruments are maneuvered through four small incisions in the abdomen. Once the kidney is freed, it is secured in a bag and pulled through a fifth incision, approximately 3 in (7.6 cm) wide, in the front of the abdominal wall below the navel. Although this surgical technique takes slightly longer than a traditional nephrectomy, preliminary studies have shown that it promotes a faster recovery time, shorter hospital stays, and less post-operative **pain** for kidney donors.

Preparation

Prior to surgery, blood samples will be taken from the patient to type and crossmatch in case **transfusion** is required during surgery. A catheter will also be inserted into the patient's bladder. The surgical procedure will be described to the patient, along with the possible risks.

Aftercare

Nephrectomy patients may experience considerable discomfort in the area of the incision. Patients may also experience numbness, caused by severed nerves, near or on the incision. Pain relievers are administered following the surgical procedure and during the recovery period on an as-needed basis. Although deep breathing and coughing may be painful due to the proximity of the incision to the diaphragm, breathing exercises are encouraged to prevent **pneumonia**. Patients should not drive an automobile for a minimum of two weeks.

Risks

Possible complications of a nephrectomy procedure include infection, bleeding (hemorrhage), and post-operative pneumonia. There is also the risk of kidney failure in a patient with impaired function or disease in the remaining kidney.

KEY TERMS

Cadaver kidney—A kidney from a brain-dead organ donor used for purposes of kidney transplantation.

Polycystic kidney disease—A hereditary kidney disease that causes fluid- or blood-filled pouches of tissue called cysts to form on the tubules of the kidneys. These cysts impair normal kidney function.

Renal cell carcinoma—Cancer of the kidney.

Normal results

Normal results of a nephrectomy are dependent on the purpose of the procedure and the type of nephrectomy performed. Immediately following the procedure, it is normal for patients to experience pain near the incision site, particularly when coughing or breathing deeply. Renal function of the patient is monitored carefully after nephrectomy surgery. If the remaining kidney is healthy, it will increase its functioning over time to compensate for the loss of the removed kidney.

Length of hospitalization depends on the type of nephrectomy procedure. Patients undergoing a laparoscopic radical nephrectomy may be released within two to four days after surgery. Traditional open nephrectomy patients are typically hospitalized for about a week. Recovery time will also vary, on average from three to six weeks.

Resources

BOOKS

Brenner, Barry M., and Floyd C. Rector Jr., eds. *The Kidney.* Philadelphia: W. B. Saunders Co., 1991.

Cameron, J. S. *Kidney Failure: The Facts*. New York: Oxford University Press, 1996.

Ross, Linda M., ed. *Kidney and Urinary Tract Diseases and Disorders Sourcebook*. Vol. 21. Detroit: Omnigraphics, Inc., 1997.

PERIODICALS

McDougall, Elspeth. "Laparoscopic Radical Nephrectomy for Renal Tumor: The Washington University Experience." *The Journal of the American Medical Association* 275, no. 24 (June 1996): 1180-5.

ORGANIZATIONS

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

United Network for Organ Sharing (UNOS). 1100 Boulders Pkwy, Suite 500, P.O. Box 13770,

Paula Anne Ford-Martin

Nephritic syndrome *see* **Glomerulonephritis**

Nephritis

Definition

Nephritis is inflammation of the kidney.

Description

The most prevalent form of acute nephritis is **glomerulonephritis**. This condition affects children and teenagers far more often than it affects adults. It is inflammation of the glomeruli, or small round filters located in the kidney. **Pyelonephritis** affects adults more than children, and is recognized as inflammation of the kidney and upper urinary tract. A third type of nephritis is hereditary nephritis, a rare inherited condition.

Causes and symptoms

Acute glomerulonephritis usually develops a few weeks after a strep infection of the throat or skin. Symptoms of glomerulonephritis include **fatigue**, high blood pressure, and swelling. Swelling is most notable in the hands, feet, ankles and face.

Pyelonephritis usually occurs suddenly, and the acute form of this disease is more common in adult women. The most common cause of this form of bacterial nephritis is the backward flow of infected urine from the bladder into the upper urinary tract. Its symptoms include **fever** and chills, fatigue, burning or frequent urination, cloudy or bloody urine, and aching **pain** on one of both sides of the lower back or abdomen.

Hereditary nephritis can be present at birth. The rare disease presents in many different forms and can be responsible for up to 5% of end-stage renal disease in men.

Diagnosis

Diagnosis of nephritis is based on:

- the patient's symptoms and medical history
- physical examination
- laboratory tests
- kidney function tests
- imaging studies such as ultrasound or x rays to determine blockage and inflammation

Urinalysis can reveal the presence of:

- albumin and other proteins

• red and white blood cells

• pus, blood, or bacteria in the urine

Treatment

Treatment of glomerulonephritis normally includes drugs such as cortisone or cytotoxic drugs (those that are destructive to certain cells or antigens). **Diuretics** may be prescribed to increase urination. If high blood pressure is present, drugs may be prescribed to decrease the **hypertension**. Iron and vitamin supplements may be recommended if the patient becomes anemic.

Acute pyelonephritis may require hospitalization for severe illness. **Antibiotics** will be prescribed, with the length of treatment based on the severity of the infection. In the case of chronic pyelonephritis, a six-month course of antibiotics may be necessary to rid the infection. Surgery is sometimes necessary.

Treatment of hereditary nephritis depends of the variety of the disease and severity at the time of treatment.

Alternative treatment

Alternative treatment of nephritis should be used as a complement to medical care and under the supervision of a licensed practitioner. Some herbs thought to relieve symptoms of nephritis include cleavers (*Galium* spp.) and wild hydrangea.

Prognosis

Prognosis for most cases of glomerulonephritis is generally good. Ninety percent of children recover without complications. With proper medical treatment, symptoms usually subside within a few weeks, or at the most, a few months.

Pyelonephritis in the acute form offers a good prognosis if diagnosed and treated early. Follow-up urinalysis studies will determine if the patient remains bacteria-free. If the infection is not cured or continues to recur, it can lead to serious complications such as **bacteremia** (bacterial invasion of the bloodstream), hypertension, chronic pyelonephritis and even permanent kidney damage.

If hereditary nephritis is not detected or treated, it can lead to complications such as eye problems, deafness or kidney failure.

Prevention

Streptococcal infections that may lead to glomerulonephritis can be prevented by avoiding exposure to strep infection and obtaining prompt medical treatment for **scarlet fever** or other infection.

Pyelonephritis can best be avoided if those with a history of urinary tract infections take care to drink plenty of fluids, urinate frequently, and practice good hygiene following urination.

Hereditary nephritis can not be prevented, but research to combat the disease continues.

Resources

ORGANIZATIONS

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

OTHER

"Cleavers." *HealthWorld Online Page*. 14 June 1998 <http://www.healthy.net/hwlibrarybooks/hoffman/materiamedica/cleavers.htm>.

"Glomerulonephritis." *ThriveOnline*. 6 June 1998 <http://thriveonline.oxygen.com>.

"Glomerulonephritis." *National Institute of Diabetes and Digestive and Kidney Disease*. <http://www.niddk.nih.gov>.

"Hereditary nephritis." University of Utah. 6 June 1998 <http://www.cc.utah.edu>.

"Hydrangea." *HealthWorld Online Page*. 14 June 1998 <http://www.healthy.net/hwlibrarybooks/hoffman/materiamedica/hydrangea.htm>.

Maureen Haggerty

Nephroblastoma *see* **Wilms' tumor**

Nephrocarcinoma *see* **Kidney cancer**

Nephrotic syndrome

Definition

Nephrotic syndrome is a collection of symptoms which occur because the tiny blood vessels (the glomeruli) in the kidney become leaky. This allows protein (normally never passed out in the urine) to leave the body in large amounts.

Description

The glomeruli (a single one is called a glomerulus) are tiny tufts of capillaries (the smallest type of blood vessels). Glomeruli are located in the kidneys, where they allow a certain amount of water and waste products to leave the blood, ultimately to be passed out of the body in the form of urine. Normally, proteins are unable

to pass through the glomerular filter. Nephrotic syndrome, however, occurs when this filter becomes defective, allowing large quantities of protein to leave the blood circulation, and pass out or the body in the urine.

Patients with nephrotic syndrome are from all age groups, although in children there is an increased risk of the disorder between the ages of 18 months and four years. In children, boys are more frequently affected; in adults, the ratio of men to women is closer to equal.

Causes and symptoms

Nephrotic syndrome can be caused by a number of different diseases. The common mechanism which seems to cause damage involves the immune system. For some reason, the immune system seems to become directed against the person's own kidney. The glomeruli become increasingly leaky as various substances from the immune system are deposited within the kidney.

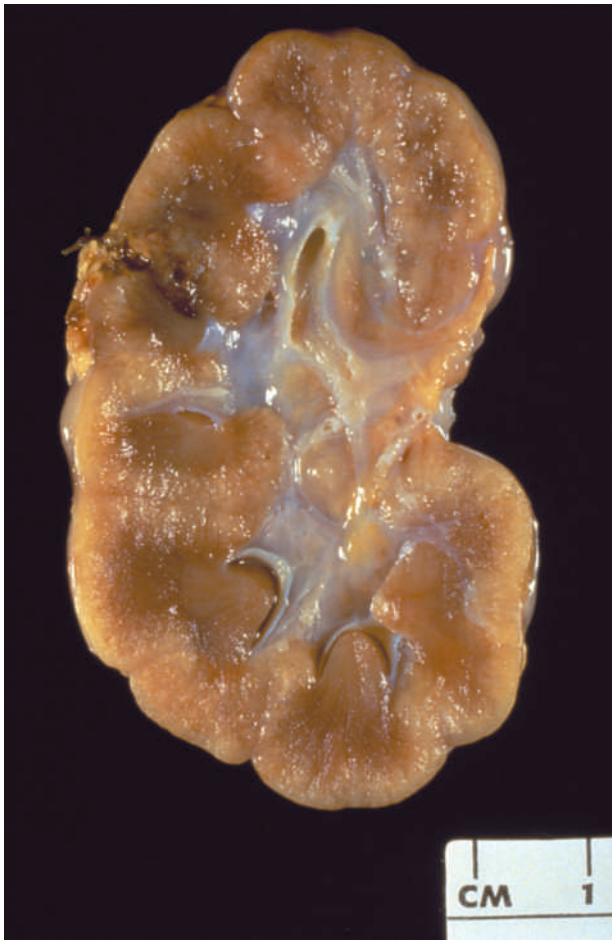
A number of different kidney disorders are associated with nephrotic syndrome, including:

- minimal change disease or MCD (responsible for about 80% of nephrotic syndrome in children, and about 20% in adults) MCD is a disorder of the glomeruli
- focal glomerulosclerosis
- membranous glomerulopathy
- membranoproliferative glomerulonephropathy

Other types of diseases can also result in nephrotic syndrome. These include diabetes, sickle-cell anemia, **amyloidosis**, **systemic lupus erythematosus**, **sarcoidosis**, leukemia, lymphoma, **cancer** of the breast, colon, and stomach, reactions to drugs (including **nonsteroidal anti-inflammatory drugs**, lithium, and street heroine), allergic reactions (to insect stings, snake venom, and poison ivy), infections (**malaria**, various bacteria, **hepatitis B**, herpes zoster, and the virus which causes **AIDS**), and severe high blood pressure.

The first symptom of nephrotic syndrome is often foamy urine. As the syndrome progresses, swelling (**edema**) is noticed in the eyelids, hands, feet, knees, scrotum, and abdomen. The patient feels increasingly weak and fatigued. Appetite is greatly decreased. Over time, the loss of protein causes the muscles to become weak and small (called muscle wasting). The patient may note abdominal **pain** and difficulty breathing. Because the kidneys are involved in blood pressure regulation, abnormally low or abnormally high blood pressure may develop.

Over time, the protein loss occurring in nephrotic syndrome will result in a generally malnourished state. Hair and nails become brittle, and growth is stunted. Bone becomes weak, and the body begins to lose other important nutrients (sugar, potassium, calcium). Infection is a serious and frequent complication, as are disorders of blood clotting. **Acute kidney failure** may develop.



A specimen of a nephrotic human kidney. *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

Diagnosis is based first on the laboratory examination of the urine and the blood. While the urine will reveal significant quantities of protein, the blood will reveal abnormally low amounts of circulating proteins. Blood tests will also reveal a high level of cholesterol. In order to diagnose one of the kidney disorders which cause nephrotic syndrome, a small sample of the kidney (biopsy) will need to be removed for examination. This biopsy can be done with a long, very thin needle which is inserted through the skin under the ribs.

Treatment

Treatment depends on the underlying disorder which has caused nephrotic syndrome. Medications which

KEY TERMS

Glomeruli—Tiny tufts of capillaries which carry blood within the kidneys. The blood is filtered by the glomeruli. The blood then continues through the circulatory system, but a certain amount of fluid and specific waste products are filtered out of the blood, to be removed from the body in the form of urine.

Immune system—The complex system within the body which serves to fight off harmful invaders, such as bacteria, viruses, fungi.

Kidney failure—The inability of the kidney to excrete toxic substances from the body.

dampen down the immune system are a mainstay of treatment. The first choice is usually a steroid drug (such as prednisone). Some conditions may require even more potent medications, such as cyclophosphamide or cyclosporine. Treating the underlying conditions (lymphoma, cancers, heroine use, infections) which have led to nephrotic syndrome will often improve the symptoms of nephrotic syndrome as well. Some patients will require the use of specific medications to control high blood pressure. Occasionally, the quantity of fluid a patient is allowed to drink is restricted. Some patients benefit from the use of **diuretics** (which allow the kidney to produce more urine) to decrease swelling.

Prognosis

Prognosis depends on the underlying disorder. Minimal change disease has the best prognosis of all the kidney disorders, with 90% of all patients responding to treatment. Other types of kidney diseases have less favorable outcomes, with high rates of progression to kidney failure. When nephrotic syndrome is caused by another, treatable disorder (infection, allergic or drug reaction), the prognosis is very good.

Resources

BOOKS

Brady, Hugh R., et al. "Nephrotic Syndrome." In *Qof Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Griffith, H. W. "Nephrotic Syndrome." In *Instructions for Patients*. Philadelphia: W. B. Saunders Co., 1994.

Kaysen, G. A. "Nephrotic Syndrome: Nutritional Consequences and Dietary Management." In *Nutrition and the Kidney*, ed. W. E. Mitch and S. Klahr. Boston: Little, Brown and Co., 1993.

PERIODICALS

Tune, B. M., and S. A. Mendoza. "Treatment of the Idiopathic Nephrotic Syndrome: Regimens and Outcomes in Children and Adults." *Journal of the American Society of Nephrology* 8 (May 1997): 824+.

ORGANIZATIONS

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

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Nephrotoxic injury

Definition

Nephrotoxic injury is damage to one or both of the kidneys that results from exposure to a toxic material, usually through ingestion.

Description

The kidneys are the primary organs of the urinary system, which purifies the blood by removing wastes from it and excreting them from the body in urine. Every day, the kidneys filter about 45 gal (180 l) of blood, about four times as much as the amount that passes through any other organ. Because of this high volume, the kidneys are more often exposed to toxic substances in the blood and are very vulnerable to injury from those sources.

Each kidney contains over one million structures called nephrons. Each nephron consists of two parts: the renal corpuscle and the renal tubule. The renal corpuscle is where the blood is filtered. It is made up of a network of capillaries (the glomerulus) and the structure that surrounds these capillaries (Bowman's capsule). Blood flows into the glomerulus, where the liquid part of the blood (plasma) passes through the walls of the capillaries and into Bowman's capsule (blood cells and some proteins are too big to pass through and therefore remain in the blood vessels). The plasma, now called filtrate, contains substances that the body needs, such as water, glucose, and other nutrients, as well as wastes, excess salts, and excess water. When the filtrate moves from Bowman's capsule into the renal tubules, about 99% of it is taken back up as the action of the tubules allows beneficial substances to be reabsorbed into the blood stream. The remaining filtrate is then passed to the bladder as urine.

When the kidneys are exposed to a toxic agent, either accidentally or intentionally (as in a suicide attempt), dam-

age can occur in a number of different ways, depending upon the agent. One toxin may directly affect the glomerulus or the renal tubules, causing the cells of these structures to die. Another toxin may create other substances or conditions that result in the same cell **death**. Nephrotoxic injury can lead to acute renal failure, in which the kidneys suddenly lose their ability to function, or chronic renal failure, in which kidney function slowly deteriorates. If unchecked, renal failure can result in death.

Causes and symptoms

Several different substances can be toxic to the kidneys. These include:

- **antibiotics**, primarily **aminoglycosides**, sulphonamides, amphotericin B, polymyxin, neomycin, bacitracin, rifampin, trimethoprim, cephaloridine, methicillin, aminosalicylic acid, oxy- and chlorotetracyclines
- **analgesics**, including **acetaminophen** (Tylenol), all **nonsteroidal anti-inflammatory drugs** (e.g. **aspirin**, ibuprofen), all prostaglandin synthetase inhibitors
- contrast agents used in some diagnostic tests, such as sodium iodide
- heavy metals, such as lead, mercury, arsenic, and uranium
- anti-cancer drugs, such as cyclosporin, cisplatin, and cyclophosphamide
- methemoglobin-producing agents
- solvents and fuels, such as carbon tetrachloride, methanol, amyl alcohol, and ethylene glycol
- herbicides and pesticides
- overproduction of uric acid

Nephrotoxic injury is most commonly caused by drugs, primarily antibiotics, analgesics, and contrast agents. In some cases, such as with aminoglycosides and amphotericin B, the drug itself will damage the kidneys. In others, such as with methicillin, sulphonamides, and some contrast agents, the drug provokes an allergic reaction that destroys the kidneys. Some chemicals found in certain drugs and industrial agents damage the kidneys by converting the hemoglobin of red blood cells into methemoglobin, thereby interfering with the blood's transport of oxygen. In hospitals, the most common form of nephrotoxic injury is antibiotic nephropathy, which usually occurs when antibiotics are given to patients with already weakened kidneys. Analgesic nephropathy is another common form of nephrotoxic injury and occurs as a result of long-term abuse of analgesics, usually NSAIDs (e.g., ibuprofen). Analgesic nephropathy is most prevalent in women over 30. Lead nephropathy, arising from **lead poisoning**, and nephropathy, from ingestion of the solvent carbon tetrachloride, are also more common forms of nephrotoxic injury. Uric acid nephropathy is one form of nephropathy that is not caused by exposure to an external toxin; instead, it arises from the body's overproduction of uric acid, usually in persons with diseases of the lymph nodes or bone marrow.

Risk factors for nephrotoxic injury include:

- Age. The elderly are more likely to overdose on antibiotics or analgesics.
- Underlying kidney disease. Kidneys already weakened by conditions such as diabetes can be particularly susceptible to nephrotoxic injury.
- Severe **dehydration**.
- Prolonged exposure to heavy metals or solvents on the job or in the home.
- Presence of diseases that cause the overproduction of uric acid.

Symptoms of nephrotoxic injury are wide ranging and, in some cases, depend upon the type of toxin involved. In general, symptoms are similar to those of renal failure and include excess urea in the blood (azotemia), anemia, increased hydrogen ion concentration in the blood (acidosis), excess fluids in the body (**overhydration**), and high blood pressure (**hypertension**). Blood or pus may be present in the urine, as may uric acid crystals. A decrease in urinary output may also occur. If the toxin's effect on the kidneys remains unchecked, more serious symptoms of kidney failure may occur, including seizures and **coma**.

Diagnosis

Damage to the kidneys is assessed through a combination of **physical examination**, blood tests, urine tests, and imaging procedures. Diagnosis of nephrotoxic injury as the underlying cause results from a thorough investigation of the patient's history. Information regarding preexisting conditions, current prescriptions, and environmental exposures to toxins aid the physician in determining what toxin, if any, has caused the kidneys to malfunction.

Treatment

Treatment of nephrotoxic injury takes place in the hospital and focuses on removing the toxin from the patient's system, while maintaining kidney function. Removal methods are targeted to specific toxins and may include the use of **diuretics** or chelates to enhance excretion of the toxin in urine, or, in extreme cases, the direct removal of toxins from the blood via hemodialysis or passing the blood over an absorbent substance such as

KEY TERMS

Bowman's capsule—The structure surrounding the glomerulus.

Chelate—A chemical that binds to heavy metals in the blood, thereby helping the body to excrete them in urine.

Contrast agent—Substance ingested so as to highlight anatomical structures in x-ray imaging tests.

Diuretic—A drug that promotes the excretion of urine.

Glomerulus—A network of capillaries located in the nephron where wastes are filtered from the blood.

Methemoglobin—A compound formed from hemoglobin by oxidation.

Nephron—Basic functional unit of the kidney.

Nephrotoxin—Substance that is poisonous to the kidneys.

Renal failure—Disorder characterized by the kidney's inability to filter wastes from the blood. It may be acute (occuring suddenly and usually reversable) or chronic (developing slowly over time as a result of permanent damage).

charcoal. Support of kidney function depends on the extent of damage to the organs and ranges from monitoring fluid levels to dialysis.

Prognosis

The outcome of nephrotoxic injury is determined by the cause and severity of the damage. In cases where damage has not progressed beyond acute renal failure, kidney function can be fully restored once the toxin is removed from the system and equilibrium restored. However, if permanent damage has resulted in chronic renal failure, lifelong dialysis or a kidney transplant may be required.

Prevention

Exposure to nephrotoxins can be minimized several different ways. When taking antibiotics or analgesics, recommended dosages should be strictly followed. Also, elderly patients on these medications (for example, those taking aspirin for heart problems or NSAIDs for arthritis) should be closely monitored to prevent accidental overdose. Health care workers should be aware of any underlying conditions, such as diabetes or **allergies** to antibiotics, that may heighten the effect of a potential nephrotoxin. When using solvents or handling heavy metals, procedures regarding their safe use should be employed.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010.<http://www.kidney.org>.

OTHER

Analgesic Nephropathy. *HealthAnswers.com.* <http://www.healthanswers.com/database/ami/converted/000482.html>. (16 June 1998).

Injury to the Kidney and Ureter. *HealthAnswers.com.* <http://www.healthanswers.com/database/ami/converted/001065.html>. (7 June 1998).

Bridget Travers

Nerve conduction velocity testing *see* **Electromyography**

Neural hearing loss *see* **Hearing loss**

Neuralgia

Definition

Neuralgia is defined as an intense burning or stabbing **pain** caused by irritation of or damage to a nerve. The pain is usually brief but may be severe. It often feels as if it is shooting along the course of the affected nerve.

Description

Different types of neuralgia occur depending on the reason the nerve has been irritated. Neuralgia can be triggered by a variety of causes, including **tooth decay**, eye strain, or **shingles** (an infection caused by the herpes zoster virus). Pain is usually felt in the part of the body that is supplied by the irritated nerve.

KEY TERMS

Desensitization—A technique of pain reduction in which the painful area is stimulated with whatever is causing the pain.

Dorsal root entry zone (DREZ)—A type of nerve surgery for postherpetic neuralgia that is occasionally used when the patient can get no other pain relief. The surgery destroys the area where damaged nerves join the central nervous system, thereby interfering with inappropriate pain messages from nerves to the brain.

Glossopharyngeal neuralgia—Sharp recurrent pain deep in the throat that extends to the area around the tonsils and possibly the ear. It is triggered by swallowing or chewing.

Migraine neuralgia—A variant of migraine pain, also called cluster headache, in which severe attacks of pain affect the eye and forehead on one side of the face.

Occipital neuralgia—Pain on one side of the back of the head caused by entrapment or pinching of an occipital nerve.

Postherpetic neuralgia—Persistent pain that occurs as a complication of a herpes zoster infection. Although the pain can be treated, the response is variable.

Shingles—A painful rash with blisters that appears along the course of a nerve. It is caused by infection with herpes zoster virus.

TENS—The abbreviation for transcutaneous electrical nerve stimulation, a technique used to control chronic pain. Electrodes placed over the painful area deliver a mild electrical impulse to nearby nerve pathways, thereby easing pain.

Trigeminal neuralgia—Brief episodes of severe shooting pain on one side of the face caused by inflammation of the root of the trigeminal nerve. Also referred to as tic douloureux.

Causes and symptoms

Neuralgia is caused by irritation or nerve damage from systemic disease, inflammation, infection, and compression or physical irritation of a nerve. The location of the pain depends on the underlying condition that is irritating the nerve or the location of the particular nerve that is being irritated.

Neuralgia can result from tooth decay, poor diet, eye strain, nose infections, or exposure to damp and cold. Postherpetic neuralgia is an intense debilitating pain felt at the site of a previous attack of shingles. **Trigeminal neuralgia** (also called tic douloureux, the most common type of neuralgia), causes a brief, searing pain along the trigeminal nerve, which supplies sensation to the face. The facial pain of migraine neuralgia lasts between 30 minutes and an hour and occurs at the same time on successive days. The cause is not known.

Glossopharyngeal neuralgia is an intense pain felt at the back of the tongue, in the throat, and in the ear—all areas served by the glossopharyngeal nerve. The pain may occur spontaneously, or it can be triggered by talking, eating, or swallowing (especially cold foods such as ice cream). Its cause is not known.

Occipital neuralgia is caused by a pinched occipital nerve. There are two occipital nerves, each located at the back of the neck, each supplying feeling to the skin over half of the back of the head. These nerves can be pinched due to factors ranging from arthritis to injury, but the result is the same: numbness, pain, or tingling over half the base of the skull.

Diagnosis

Neuralgia is a symptom of an underlying disorder; its diagnosis depends on finding the cause of the condition creating the pain.

To diagnose occipital neuralgia, a doctor can inject a small amount of anesthetic into the region of the occipital nerve. If the pain temporarily disappears, and there are no other physical reasons for the pain, the doctor may recommend surgery to deal with the pinched nerve.

Treatment

Glossopharyngeal, trigeminal, and postherpetic neuralgias sometimes respond to **anticonvulsant drugs**, such as carbamazepine or phenytoin, or to painkillers, such as **acetaminophen**. Trigeminal neuralgia may also be relieved by surgery in which the nerve is cut or decompressed. In some cases, compression neuralgia (including occipital neuralgia) can be relieved by surgery.

People with shingles should see a doctor within three days of developing the rash, since aggressive treat-

ment of the blisters that appear with the rash can ease the severity of the infection and minimize the risk of developing postherpetic neuralgia. However, it is not clear whether the treatment can prevent postherpetic neuralgia.

If postherpetic neuralgia develops, a variety of treatments can be tried, since their effectiveness varies from person-to-person.

- antidepressants such as amitriptyline (Elavil)
- anticonvulsants (phenytoin, valproate, or carbamazepine)
- capsaicin (Xostrix), the only medication approved by the FDA for treatment of postherpetic neuralgia
- topical painkillers
- desensitization
- TENS (transcutaneous **electrical nerve stimulation**)
- dorsal root zone (DREZ) surgery (a treatment of last resort)

Alternative treatment

B-complex **vitamins**, primarily given by intramuscular injection, can be an effective treatment. A whole foods diet with adequate protein, carbohydrates, and fats that also includes yeast, liver, wheat germ, and foods that are high in B vitamins may be helpful. **Acupuncture** is a very effective treatment, especially for postherpetic neuralgia. Homeopathic treatment can also be very effective when the correct remedy is used. Some botanical medicines may also be useful. For example, black cohosh (*Cimicifuga racemosa*) appears to have anti-inflammatory properties based on recent research.

Prognosis

The effectiveness of the treatment depends on the cause of the neuralgia, but many cases respond to pain relief.

Trigeminal neuralgia tends to come and go, but successive attacks may be disabling. Although neuralgia is not fatal, the patient's fear of being in pain can seriously interfere with daily life.

Some people with postherpetic neuralgia respond completely to treatment. Most people, however, experience some pain after treatment, and a few receive no relief at all. Some people live with this type of neuralgia for the rest of their lives, but for most, the condition gradually fades away within five years.

Resources

BOOKS

Loeser, J. "Cranial Neuralgias." In *The Management of Pain.* 2nd ed. Philadelphia: Lea & Febiger, 1990.

PERIODICALS

Fields, H. "Treatment of Trigeminal Neuralgia." *The New England Journal of Medicine* 334 (Apr. 1996): 1125-1126.

ORGANIZATIONS

American Chronic Pain Association. P.O. Box 850, Rocklin, CA 95677-0850. (916) 632-0922. <http://members.tripod.com/~widdy/ACPA.html>.

National Chronic Pain Outreach. P.O. Box 274, Millboro, VA 24460. (540) 997-5004.

Trigeminal Neuralgia/Tic Douloureux Association. P.O. Box 340, Barnegat Light, NJ 08006. (609) 361-1014.

Carol A. Turkington

Neuroblastoma

Definition

Neuroblastoma is a type of **cancer** that usually originates either in the tissues of the adrenal gland or in the ganglia of the abdomen or in the ganglia of the nervous system. (Ganglia are masses of nerve tissue or groups of nerve cells.) Tumors develop in the nerve tissue in the neck, chest, abdomen, or pelvis.

Description

Neuroblastoma is one of the few cancer types known to secrete hormones. It occurs most often in children, and it is the third most common cancer that occurs in children. Approximately 7.5% of the childhood cancers diagnosed in 2001 were neuroblastomas, affecting one in 80,000 to 100,000 children in the United States. Close to 50% of cases of neuroblastoma occur in children younger than two years old. The disease is sometimes present at birth, but is usually not noticed until later. By the time the disease is diagnosed, it has often spread to the lymph nodes, liver, lungs, bones, or bone marrow. Approximately one-third of neuroblastomas start in the adrenal glands.

Demographics

According to some reports, African-American children develop the disease at a slightly higher rate than Caucasian children (8.7 per million compared to 8.0 per million cases diagnosed).

Causes and symptoms

The causes of neuroblastoma are not precisely known. Current research holds that neuroblastomas develop when cells produced by the fetus (neuroblast

cells) fail to mature into normal nerve or adrenal cells and keep growing and proliferating. The first symptom of a neuroblastoma is usually an unusual growth or lump, found in most cases in the abdomen of the child, causing discomfort or a sensation of fullness and **pain**. Other symptoms such as numbness and **fatigue**, arise because of pressure caused by the tumor. Bone pain also occurs if the cancer has spread to the bone. If it has spread to the area behind the eye, the cancer may cause protruding eyes and dark circles around the eyes. Or **paralysis** may result from compression of the spinal cord. **Fever** is also reported in one case out of four. High blood pressure, persistent **diarrhea**, rapid heartbeat, reddening of the skin and sweating occur occasionally. Some children may also have uncoordinated or jerky muscle movements, or uncontrollable eye movements, but these symptoms are rare. If the disease spreads to the skin, blue or purple patches are observed.

Diagnosis

A diagnosis of neuroblastoma usually requires blood and urine tests to investigate the nature and quantity of chemicals (neurotransmitters) released by the nerve cells. These are broken down by the body and released in urine. Additionally, scanning techniques are used to confirm the diagnosis of neuroblastoma. These techniques produce images or pictures of the inside of the body and they include computed tomography scan (CT scan) and **magnetic resonance imaging** (MRI). To confirm the diagnosis, the physician will surgically remove some of the tissue from the tumor or bone marrow (biopsy), and examine the cells under the microscope.

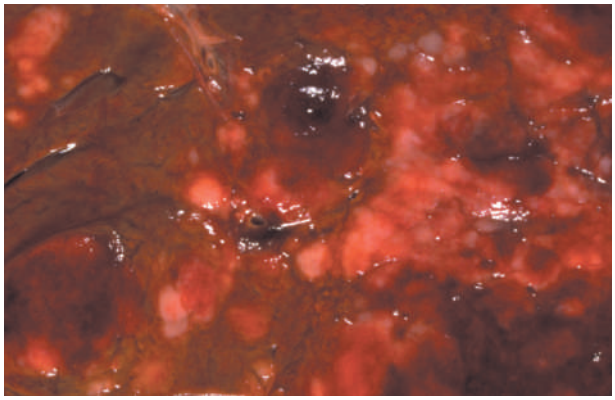
Treatment team

The treatment team usually consists of an oncologist specialized in the treatment of neuroblastoma, a surgeon to perform biopsies and possibly attempt surgical removal of the tumor, a **radiation therapy** team and, if indicated, a **bone marrow transplantation** team.

Treatment

Staging

Once neuroblastoma has been diagnosed, the physician will perform more tests to determine if the cancer has spread to other tissues in the body. This process, called staging, is important for the physician to determine how to treat the cancer and check liver and kidney function. The staging system for neuroblastoma is based on how far the disease has spread from its original site to other tissues in the body.



A neuroblastoma appearing at the surface of the liver. *(Custom Medical Stock Photo. Reproduced by permission.)*

Localized resectable (able to be cut out) neuroblastoma is confined to the site of origin, with no evidence that it has spread to other tissues, and the cancer can be surgically removed. Localized unresectable neuroblastoma is confined to the site of origin, but the cancer cannot be completely removed surgically. Regional neuroblastoma has extended beyond its original site, to regional lymph nodes, and/or surrounding organs or tissues, but has not spread to distant sites in the body. Disseminated neuroblastoma has spread to distant lymph nodes, bone, liver, skin, bone marrow, and/or other organs. Stage 4S (or IVS, or "special") neuroblastoma has spread only to liver, skin, and/or, to a very limited extent, bone marrow. Recurrent neuroblastoma means that the cancer has come back, or continued to spread after it has been treated. It may come back in the original site or in another part of the body.

Treatments are available for children with all stages of neuroblastoma. More than one of these treatments may be used, depending on the stage of the disease. The four types of treatment used are:

- surgery (removing the tumor in an operation)
- radiation therapy (using high-energy x-rays to kill cancer cells)
- **chemotherapy** (using drugs to kill cancer cells)
- bone marrow transplantation (replacing the patient's bone marrow cells with those from a healthy person)

Surgery is used whenever possible, to remove as much of the cancer as possible, and can generally cure the disease if the cancer has not spread to other areas of the body. Before surgery, chemotherapy may be used to shrink the tumor so that it can be more easily removed during surgery; this is called neoadjuvant chemotherapy. Radiation therapy is often used after surgery; high-energy rays (radiation) are used to kill as

KEY TERMS

Adjuvant chemotherapy—Treatment of the tumor with drugs after surgery to kill as many of the remaining cancer cells as possible.

Adrenal gland—Gland located above each kidney consisting of an outer wall (cortex) that produces steroid hormones and an inner section (medulla) that produces other important hormones, such as adrenaline and noradrenaline.

Alternative therapy—A therapy is generally called alternative when it is used instead of conventional cancer treatments.

Biopsy—A small sample of tissue removed from the site of the tumor to be examined under a microscope.

Conventional therapy—Treatments that are widely accepted and practiced by the mainstream medical community.

Complementary therapy—A therapy is called complementary when it is used in addition to conventional cancer treatments.

Disseminated—Spread to other tissues.

Hormone—A substance produced by specialized cells that affects the way the body carries out the biochemical and energy-producing processes required to maintain health (metabolism.

Localized—Confined to a small area.

Neoadjuvant chemotherapy—Treatment of the tumor with drugs before surgery to reduce the size of the tumor.

Neuroblast cells—Cells produced by the fetus which mature into nerve cells and adrenal medulla cells.

Monoclonal antibody—A protein substance which is produced in the laboratory by a single population of cells. They are being tested as a possible form of cancer treatment.

Resectable cancer—A tumor that can be surgically removed.

Staging system—A system based on how far the cancer has spread from its original site, developed to help the physician determine how best to treat the disease.

Unresectable cancer—A tumor that cannot be completely removed by surgery.

many of the remaining cancer cells as possible. Chemotherapy (called adjuvant chemotherapy) may also be used after surgery to kill remaining cells. Bone marrow transplantation is used to replace bone marrow cells killed by radiation or chemotherapy. In some cases the patient's own bone marrow is removed prior to treatment and saved for transplantation later. Other times the bone marrow comes from a "matched" donor, such as a sibling.

Alternative treatment

No alternative therapy has yet been reported to substitute for conventional neuroblastoma treatment. Complementary therapies—such as retinoic acid therapy—have been shown to be beneficial to patients when administered after a conventional course of chemotherapy or transplantation.

Prognosis

The chances of recovery from neuroblastoma depend on the stage of the cancer, the age of the child at diagnosis, the location of the tumor, and the state and nature of the tumor cells evaluated under the microscope. Infants have a higher rate of cure than do children over one year of age, even when the disease has spread. In general, the prognosis for a young child with neuroblastoma is good: the predicted five-year survival rate is approximately 85% for children who had the onset of the disease in infancy, and 35% for those whose disease developed later.

Prevention

Neuroblastoma may be a genetic disease passed down from the parents. There is currently no known method for its prevention.

Special concerns

After completion of a course of treatment for neuroblastoma, physicians sometimes recommend that the child undergo an investigative operation. This procedure allows the treatment team to evaluate how effective treatment has been, and may offer an opportunity to remove more of the tumor if it is still present.

Resources

BOOKS

Alexander, F. "Neuroblastoma." *Urol. Clin. North. Am.* 27 (August 2000):383-92,.

Raghaven, Derek, et al, eds. *Principles and Practice of Genitourinary Oncology.* Philadelphia: Lippincott-Raven Publishers, 1997.

PERIODICALS

Berthold, F., B. Hero. "Neuroblastoma: current drug therapy recommendations as part of the total treatment approach." *Drugs* 59 (June 2000):1261-77

Grosfeld, J. L. "Risk-based management of solid tumors in children." *American Journal of Surgery* 180 (November 2000):322-7

Herrera, J. M., A. Krebs, P. Harris, F. Barriga. "Childhood tumors." *Surg. Clin. North. Am.* 80 (April 2000):747-60

Hoefnagel, C. A. "Nuclear medicine therapy of neuroblastoma." *Quartely Journal of Nuclear Medicine* 43 (December 1999):336-43.

Pinkerton, C., R. Blanc, M. P. Vincent, C. Bergeron, B. Fervers, T. Philip. "Induction chemotherapy in metastatic neuroblastoma—does dose influence response? A critical review of published data standards, options and recommendations (SOR) project of the National Federation of French Cancer Centres (FNCLCC)." *European Journal of Cancer* 36 (September 2000):1808-15

ORGANIZATIONS

The American Cancer Society. "After Diagnosis: A Guide for Patients and Families," "Caring for the Patient with Cancer at Home,""Understanding Chemotherapy: A Guide for Patients and Families," "Understanding Radiation Therapy: A Guide for Patients and Families." <http://www.cancer.org>.

National Cancer Institute. Office of Cancer Communications, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. 800-422-6237. <http://cancernet.nci.nih.gov/clinpdq/pif/Neuroblastoma_Patient.html.>.

National Institutes of Health & National Cancer Institute *Young People With Cancer: A Handbook for Parents* <http://www.cancernet.nci.nih.gov/young_people/yngconts.html>.

Lisa Christenson
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Neuroendocrine tumors

Definition

Neuroendocrine tumor refers to the type of cell that a tumor grows from rather than where that tumor is located. Neuroendocrine cells produce hormones or regulatory proteins, and so tumors of these cells usually have symptoms that are related to the specific hormones that they produce.

Description

Neuroendocrine cells have roles both in the endocrine system and the nervous system. They produce and secrete a variety of regulatory hormones, or neuropeptides, which include neurotransmitters and growth factors. When these cells become cancerous, they grow and overproduce their specific neuropeptide. Neuroendocrine tumors are generally rare. One type of neuroendocrine tumor is a carcinoid tumor. This type of tumor can occur in the intestinal tract, appendix, rectum, bronchial tubes, or ovary. Most carcinoid tumors secrete serotonin. When the blood concentration of this hormone is high enough, it causes carcinoid syndrome. This syndrome refers to a variety of symptoms that are caused by the excessive amount of hormone secreted rather than the tumor itself.

Causes and symptoms

Many of the symptoms of carcinoid tumor are due to the hormones that the tumor secretes. These hormones can affect the whole body and cause what is referred to as carcinoid syndrome. The most common symptom of carcinoid syndrome is flushing, a sudden appearance of redness and warmth in the face and neck that can last from minutes to hours. Other symptoms of carcinoid syndrome are **diarrhea**, asthma-like symptoms and heart problems. Since most carcinoid tumors are found in the appendix, the symptoms are often similar to **appendicitis**, primarily **pain** in the abdomen. When these tumors are found in the small intestine, they can cause abdominal pain that is often initially diagnosed as bowel obstruction. Many patients have no symptoms and the carcinoids are found during routine endoscopy of the intestines.

Diagnosis

The diagnosis of carcinoid syndrome is made by the measurement of 5–hydroxy indole acetic acid (5–HIAA) in the urine. 5–HIAA is a breakdown (waste) product of serotonin. If the syndrome is diagnosed, the presence of carcinoid tumor is a given. When the syndrome is not present, diagnosis may be delayed, due to the vague symptoms present. Diagnosis can sometimes take up to two years. It is made by performing a number of tests, and the specific test used depends on the tumor's suspected location. The tests that may be performed include gastrointestinal endoscopy, **chest x ray**, computed tomography scan (CT scan), **magnetic resonance imaging**, or ultrasound. A biopsy of the tumor is performed for diagnosis. A variety of hormones can be measured in the blood as well to indicate the presence of a carcinoid.

KEY TERMS

Appendicitis—Inflammation of the appendix.

Growth factor—A local hormone produced by some cells that initiates growth.

Metastasis—The spread of disease from one part of the body to another, as when cancer cells appear in parts of the body remote from the site of the primary tumor.

Neurotransmitter—A chemical messenger used to transmit information in the nervous system.

Treatment

The only treatment for carcinoid tumor is surgical removal of the tumor. Although **chemotherapy** is sometimes used when metastasis has occurred, it is rarely effective. The treatment for carcinoid syndrome is typically meant to decrease the symptoms. Patients should avoid **stress** as well as foods that bring on the syndrome. If this does not work, there are a few medications that can help alleviate the symptoms.

Prognosis

The prognosis of carcinoid tumors is related to the specific growth patterns of that tumor, as well as its location. For localized disease the five-year survival rate can be 94%, whereas for patients where metastasis has occurred, the average five-year survival rate is 18%.

Prevention

Neuroendocrine tumors such as carcinoid tumors are rare, and no information consequently is yet available on cause or prevention.

Resources

BOOKS

Jensen, R. T., and J. A. Norton. "Carcinoid Tumors and the Carcinoid Syndrome." In *Cancer, Principles and Practice of Oncology*, ed. V. T. DeVita, S. Hellman, and S. A. Rosenberg. Philadelphia: Lippincott-Raven, 1997.

PERIODICALS

Modlin, I. M. "Gastric Carcinoids: The Yale Experience." *The Journal of the American Medical Association* 274 (23 Aug. 1995): 594.

ORGANIZATIONS

The Carcinoid Cancer Foundation, Inc. 1751 York Ave., New York, NY 10128. (212) 722-3132. <http://www.carcinoid.org>.

Cindy L. A. Jones, PhD

Neurofibromatosis

Definition

Neurofibromatosis (NF), or von Recklinghausen disease, is a genetic disease in which patients develop multiple soft tumors (neurofibromas). These tumors occur under the skin and throughout the nervous system.

Description

Neural crest cells are primitive cells which exist during fetal development. These cells eventually turn into:

- cells which form nerves throughout the brain, spinal cord, and body
- cells which serve as coverings around the nerves that course through the body
- pigment cells, which provide color to structures
- the meninges, the thin, membranous coverings of the brain and spinal cord
- cells which ultimately develop into the bony structures of the head and neck

In neurofibromatosis, a genetic defect causes these neural crest cells to develop abnormally. This results in numerous tumors and malformations of the nerves, bones, and skin.

Neurofibromatosis occurs in about one of every 4,000 births. Two types of NF exist, NF-1 (90% of all cases), and NF-2 (10% of all cases).

Causes and symptoms

Both forms of neurofibromatosis are caused by a defective gene. NF-1 is due to a defect on chromosome 17; NF-2 results from a defect on chromosome 22. Both of these disorders are inherited in a dominant fashion. This means that anybody who receives just one defective gene will have the disease. However, a family pattern of NF is only evident for about half of all cases of NF. The other cases of NF occur due to a spontaneous mutation (a permanent change in the structure of a specific gene). Once such a spontaneous mutation has been established in an individual, however, it is then possible to be passed on to any offspring. The chance of a person with NF passing on the NF gene to a child is 50%.

NF-1 has a number of possible signs and can be diagnosed if any two of the following are present:

- The presence of café-au-lait (French for coffee-with-milk) spots. These are patches of tan or light brown skin, usually about 5-15 mm in diameter. Nearly all patients with NF-1 will display these spots.

- Multiple freckles in the armpit or groin area.
- Ninty percent of patients with NF-1 have tiny tumors called Lisch nodules in the iris (colored area) of the eye.
- Neurofibromas. These soft tumors are the hallmark of NF-1. They occur under the skin, often located along nerves or within the gastrointestinal tract. Neurofibromas are small and rubbery, and the skin overlying them may be somewhat purple in color.
- Skeletal deformities, such as a twisted spine (**scoliosis**), curved spine (humpback), or bowed legs.
- Tumors along the optic nerve, which cause vision disturbance in about 20% of patients.
- The presence of NF-1 in a patient's parent, child, or sibling.

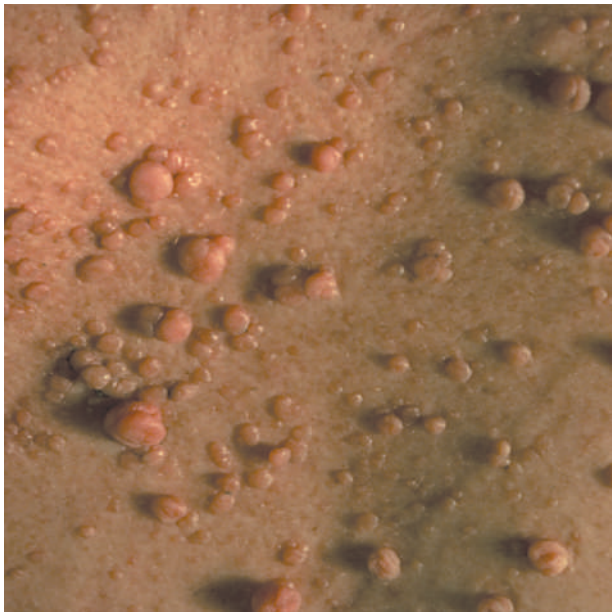
There are very high rates of speech impairment, learning disabilities, and attention deficit disorder in children with NF-1. Other complications include the development of a **seizure disorder**, or the abnormal accumulation of fluid within the brain (**hydrocephalus**). A number of cancers are more common in patients with NF-1. These include a variety of types of malignant brain tumors, as well as leukemia, and cancerous tumors of certain muscles (rhabdomyosarcoma), the adrenal glands (**pheochromocytoma**), or the kidneys (**Wilms' tumor**).

Patients with NF-2 do not necessarily have the same characteristic skin symptoms (café-au-lait spots, freckling, and neurofibromas of the skin) that appear in NF-1. The characteristic symptoms of NF-2 are due to tumors along the acoustic nerve. Interfering with the function of this nerve results in the loss of hearing; and the tumor may spread to neighboring nervous system structures, causing weakness of the muscles of the face, **headache**, **dizziness**, poor balance, and uncoordinated walking. Cloudy areas on the lens of the eye (called **cataracts**) frequently develop at an unusually early age. As in NF-1, the chance of brain tumors developing is unusually high.

Diagnosis

Diagnosis is based on the symptoms outlined above. Diagnosis of NF-1 requires that at least two of the listed signs are present. Diagnosis of NF-2 requires the presence of either a mass on the acoustic nerve or another distinctive nervous system tumor. An important diagnostic clue for either NF-1 or NF-2 is the presence of the disorder in a patient's parent, child, or sibling.

Monitoring the progression of neurofibromatosis involves careful testing of vision and hearing. X-ray studies of the bones are frequently done to watch for the development of deformities. CT scans and MRI scans are performed to track the development/progression of tumors in the brain and along the nerves. Auditory evoked potentials (the electric response evoked in the cerebral cortex by stimulation of the acoustic nerve) may be helpful to determine involvement of the acoustic nerve, and EEG (electroencephalogram, a record of electrical currents in the brain) may be needed for patients with suspected seizures.



This person's skin has multiple soft tumors, or neurofibromas. Such tumors develop underneath the skin. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

There are no available treatments for the disorders which underlie either type of neurofibromatosis. To some extent, the symptoms of NF-1 and NF-2 can be treated individually. Skin tumors can be surgically removed. Some brain tumors, and tumors along the nerves, can be surgically removed, or treated with drugs (**chemotherapy**) or x-ray treatments (**radiation therapy**). Twisting or curving of the spine and bowed legs may require surgical treatment, or the wearing of a special brace.

Prognosis

Prognosis varies depending on the types of tumors which an individual develops. As tumors grow, they begin to destroy surrounding nerves and structures. Ultimately, this destruction can result in blindness, deafness, increasingly poor balance, and increasing difficulty with the coordination necessary for walking. Deformities of the bones and spine can also interfere with walking and movement. When cancers develop, prognosis worsens according to the specific type of **cancer**.

KEY TERMS

Chromosome—A structure within the nucleus of every cell, which contains genetic information governing the organism's development.

Mutation—A permanent change to the genetic code of an organism. Once established, a mutation can be passed on to offspring.

Neurofibroma—A soft tumor usually located on a nerve.

Tumor—An abnormally multiplying mass of cells.

Prevention

There is no known way to prevent the approximately 50% of all NF cases which occur due to a spontaneous change in the genes (mutation). New cases of inherited NF can be prevented with careful **genetic counseling**. A person with NF can be made to understand that each of his or her offspring has a 50% chance of also having NF. When a parent has NF, and the specific genetic defect causing the parent's disease has been identified, tests can be performed on the fetus (developing baby) during **pregnancy**. **Amniocentesis** or **chorionic villus sampling** are two techniques which allow small amounts of the baby's cells to be removed for examination. The tissue can then be examined for the presence of the parent's genetic defect. Some families choose to use this information in order to prepare for the arrival of a child with a serious medical problem. Other families may choose not to continue the pregnancy.

Resources

BOOKS

Haslam, Robert H. A. "Neurocutaneous Syndromes." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

"Health Supervision for Children with Neurofibromatosis." *Pediatrics* 96, no. 2 (Aug. 1995): 368+.

Levy, Charles E. "Physiatry and Care of Patients with Neurofibromatosis." *The Journal of the American Medical Association* 278, no. 18 (12 Nov. 1997): 1493+.

Waller, Amy L., and James E. Baumgartner. "Current Concepts in the Management of Neurofibromatosis Type 1." *Physician Assistant* 21, no. 8 (Aug. 1997): 103+.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

The National Neurofibromatosis Foundation, Inc., 95 Pine St., 16th Floor, New York, NY 10005. (800) 323-7938. <http://nf.org>.

Neurofibromatosis, Inc., 8855 Annapolis Rd., #110, Lanham, MD 20706-2924. (800) 942-6825.

Rosalyn Carson-DeWitt, MD

Neurogenic arthropathy *see* **Charcot's joints**

Neurogenic bladder

Definition

Neurogenic bladder is a dysfunction that results from interference with the normal nerve pathways associated with urination.

Description

Normal bladder function is dependent on the nerves that sense the fullness of the bladder (sensory nerves) and on those that trigger the muscle movements that either empty it or retain urine (motor nerves). The reflex to urinate is triggered when the bladder fills to 300-500 ml. The bladder is then emptied when the contraction of the bladder wall muscles forces urine out through the urethra. The bladder, internal sphincters, and external sphincters may all be affected by nerve disorders that create abnormalities in bladder function.

There are two categories of neurogenic bladder dysfunction: overactive (spastic or hyper-reflexive) and underactive (flaccid or hypotonic). An overactive neurogenic bladder is characterized by uncontrolled, frequent expulsion of urine from the bladder. There is reduced bladder capacity and incomplete emptying of urine. An underactive neurogenic bladder has a capacity that is extremely large (up to 2000 ml). Due to a loss of the sensation of bladder filling, the bladder does not contract forcefully, and small amounts of urine dribble from the urethra as the bladder pressure reaches a breakthrough point.

Causes and symptoms

There are numerous causes for neurogenic bladder dysfunction and symptoms vary depending on the cause. An overactive bladder is caused by interruptions in the nerve pathways to the bladder occurring above the sacrum (five fused spinal vertebrae located just above the tailbone or **coccyx**). This nerve damage results in a loss of sensation and motor control and is often seen in

KEY TERMS

Anticholinergic—An agent that blocks certain nerve impulses.

Catheterization—Insertion of a slender, flexible tube into the bladder to drain urine.

Compliance—A term used to describe how well a patient's behavior follows medical advice.

Cystometry—A test of bladder function in which pressure and volume of fluid in the bladder are measured during filling, storage, and voiding.

Cystoscopy—A direct method of bladder study and visualization using a cystoscope (self-contained optical lens system). The cystoscope can be manipulated to view the entire bladder, with a guide system to pass it up into the ureters (tubes leading from the kidneys to the bladder).

Glans penis—The bulbous tip of the penis.

Motor nerves—Nerves that cause movement when stimulated.

Parasympathomimetic—An agent whose effects mimic those resulting from stimulation of the parasympathetic nerves.

Perineal—The diamond-shaped region of the body between the pubic arch and the anus.

Reflex—An involuntary response to a particular stimulus.

Sensory nerves—Nerves that convey impulses from sense organs to the higher parts of the nervous system, including the brain.

Sphincter—A band of muscles that surrounds a natural opening in the body; these muscles can open or close the opening by relaxing or contracting.

Ureter—A tube leading from one of the kidneys to the bladder.

Urethra—The tube that leads from the bladder to the outside of the body.

Urostomy—A diversion of the urinary flow away from the bladder, resulting in output through the abdominal wall. The most common method involves use of a portion of intestine to conduct the urine out through the abdomen and into an external pouch worn for urine collection.

stroke, **Parkinson's disease**, and most forms of spinal-cord injuries. An underactive bladder is the result of interrupted bladder stimulation at the level of the sacral nerves. This may result from certain types of surgery on the spinal cord, sacral spinal tumors, or congenital defects. It also may be a complication of various diseases, such as **syphilis**, **diabetes mellitus**, or **polio**.

Diagnosis

Neurogenic bladder is diagnosed by carefully recording fluid intake and urinary output and by measuring the quantity of urine remaining in the bladder after voiding (residual urine volume). This measurement is done by draining the bladder with a small rubber tube (catheter) after the person has urinated. Kidney function also is evaluated by regular laboratory testing of the blood and urine. **Cystometry** may be used to estimate the capacity of the bladder and the pressure changes within it. These measurements can help determine changes in bladder compliance in order to assess the effectiveness of treatment. Doctors may use a cystoscope to look inside the bladder and tubes that lead to it from the kidneys (ureters). **Cystoscopy** may be used to assess the loss of muscle fibers and elastic tissues and, in some cases, for removing small pieces of tissue for biopsy.

Treatment

Doctors using begin treating neurogenic bladder by attempting to reduce bladder stretching (distension) through intermittent or continuous catheterization. In intermittent catheterization, a small rubber catheter is inserted at regular intervals (four to six times per day) to approximate normal bladder function. This avoids the complications that may occur when a catheter remains in the bladder's outside opening (urethra) continuously (an indwelling catheter). Intermittent catheterization should be performed using strict sterile technique (asepsis) by skilled personnel, and hourly fluid intake and output must be recorded. Patients who can use their arms may be taught to catheterize themselves.

Indwelling catheters avoid distension by emptying the bladder continuously into a bedside drainage collector. Individuals with indwelling catheters are encouraged to maintain a high fluid intake in order to prevent bacteria from accumulating and growing in the urine. Increased fluid intake also decreases the concentration of calcium in the

urine, minimizing urine crystallization and the subsequent formation of stones. Moving around as much as possible and a low calcium diet also help to reduce stone formation.

Drugs may be used to control the symptoms produced by a neurogenic bladder. The unwanted contractions of an overactive bladder with only small volumes of urine may be suppressed by drugs that relax the bladder (anticholinergics) such as propantheline (Pro-Banthine) and oxybutynin (Ditropan). Contraction of an underactive bladder with normal bladder volumes may be stimulated with parasympathomimetics (drugs that mimic the action resulting from stimulation of the parasympathetic nerves) such as bethanechol (Urecholine).

Long-term management for the individual with an overactive bladder is aimed at establishing an effective spontaneous reflex voiding. The amount of fluid taken in is controlled in measured amounts during the waking hours, with sips only toward bedtime to avoid bladder distension. At regular intervals during the day (every four to six hours when fluid intake is two to three liters per 24 hours), the patient attempts to void using pressure over the bladder (Crede maneuver). The patient may also stimulate reflex voiding by abdominal tapping or stretching of the anal sphincter. The **Valsalva maneuver**, involving efforts similar to those used when straining to pass stool, produces an increase in intra-abdominal pressure that is sometimes adequate to completely empty the bladder. The amount of urine remaining in the bladder (residual volume) is estimated by a comparison of fluid intake and output. The patient also may be catheterized immediately following the voiding attempt to determine residual urine. Catheterization intervals are lengthened as the residual urine volume decreases and catheterization may be discontinued when urine residuals are at an acceptable level to prevent urinary tract infection.

For an underactive bladder, the patient may be placed on a similar bladder routine with fluid intake and output adjusted to prevent bladder distension. If an adequate voiding reflex cannot be induced, the patient may be maintained on clean intermittent catheterization.

Some individuals who are unable to control urine output (**urinary incontinence**) due to deficient sphincter tone may benefit from perineal exercises. Although this is a somewhat dated technique, male patients with extensive sphincter damage may be helped by the use of a Cunningham clamp. The clamp is applied in a horizontal fashion behind the glans of the penis and must be removed approximately every four hours for bladder emptying to prevent bacteria from growing in the urine and causing an infection. Alternation of the Cunningham clamp with use of a **condom** collection device will reduce the skin irritation sometimes caused by the clamp.

Surgery is another treatment option for incontinence. Urinary diversion away from the bladder may involve creation of a urostomy or a continent diversion. The surgical implantation of an inflatable sphincter is another option for certain patients. An indwelling urinary catheter is sometimes used when all other methods of incontinence management have failed. The long-term use of an indwelling catheter almost inevitably leads to some urinary tract infections, and contributes to the formation of urinary stones (calculi). Doctors may prescribe **antibiotics** preventively to reduce recurrent urinary tract infection.

Alternative treatment

The cause of the bladder problem must be determined and treated appropriately. If nerve damage is not permanent, **homeopathy** and **acupuncture** may help restore function.

Prognosis

Individuals with an overactive bladder caused by spinal cord lesions at or above the seventh thoracic vertebra, are at risk for sympathetic dysreflexia, a life-threatening condition which can occur when the bladder (and/or rectum) becomes overly full. Initial symptoms include sweating (particularly on the forehead) and **headache**, with progression to slow heart rate (bradycardia) and high blood pressure (**hypertension**). Patients should notify their physician promptly if symptoms do not subside after the bladder (or rectum) is emptied, or if the bladder (or rectum) is full and cannot be emptied.

Resources

BOOKS

Agency for Health Care Policy and Research. *Urinary Incontinence in Adults: Acute and Chronic Management*. Rockville, MD: U.S. Department of Health and Human Services, 1996.

Doughty, Dorothy B. *Urinary and Fecal Incontinence*. St. Louis: Mosby-Year Book, 1991.

Monaham, Frances D., and Marianne Neighbors. *Medical-Surgical Nursing: Foundations for Clinical Practice*. Philadelphia: W. B. Saunders Co., 1998.

Suddarth, Doris S. *The Lippincott Manual of Nursing Practice*. Philadelphia: J. B. Lippincott Co., 1991.

ORGANIZATIONS

Bladder Health Council, American Foundation for Urologic Disease. 300 West Pratt St., Suite 401, Baltimore, MD 21201. (800) 242-2383 or (410) 727- 2908.

National Association for Continence. P.O. Box 8310, Spartanburg, SC 29305-8310. (800) 252-3337. <http://www.nafc. org>.

Simon Foundation for Continence. Box 835, Wilmette, IL 60091.

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Neuroleptics *see* **Antipsychotic drugs**

Neurolinguisitic programming

Definition

Neurolinguistic programming (NLP) is aimed at enhancing the healing process by changing the conscious and subconscious beliefs of patients about themselves, their illnesses, and the world. These limiting beliefs are "reprogrammed" using a variety of techniques drawn from other disciplines including **hypnotherapy** and psychotherapy.

Purpose

Neurolinguistic programming has been used to change the limiting beliefs of patients about their prospects of recovery from a wide variety of medical conditions including **Parkinson's disease**, **AIDS**, migraines, arthritis, and **cancer**. Practitioners claim to be able to cure most **phobias** in less than one hour, and to help in making lifestyle changes regarding **exercise**, diet, **smoking**, etc. NLP has also been used to treat **allergies**. In other fields, claimed benefits include improved relationships, communication, motivation, and business performance.

Description

Origins

NLP was originally developed during the early 1970s by linguistics professor John Grinder and psychology and mathematics student Richard Bandler, both of the University of California at Santa Cruz.

Studying the well-known psychotherapist Virginia Satir, the hypnotherapist Milton Erickson, the anthropologist Gregory Bateson, and others whom they considered "charismatic superstars" in their fields, Grinder and Bandler identified psychological, linguistic and behavioral characteristics that they said contributed to the greatness of these individuals. On the other hand, they found that persons experiencing emotional difficulties could be similarly identified by posture, breathing pattern, choice of words, voice tone, eye movements, body language, and other characteristics.

Grinder and Bandler then focused on using these indicators to analyze and alter patterns of thought and behavior. After publishing their findings in two books in 1975, Grinder and Bandler parted company with themselves, with a number of other collaborators, and with the University of California, continuing their work on NLP outside the formal world of academia. As a result, NLP split into a number of competing schools.

Popularized by television "infomercial" personality Anthony Robbins and others, NLP was quickly adopted in management and self-improvement circles. During the 1990s, there was growing interest in NLP's healing potential.

In a health-care context, practitioners of neurolinguistic programming first seek to identify the negative attitudes and beliefs with which a client has been "programmed" since birth. This is accomplished by asking questions and observing physical responses such as changes in skin color, muscle tension, etc. Then, a wide variety of techniques is employed to "reprogram" limiting beliefs. For example, clients with chronic illness such as AIDS or cancer might be asked to displace the despair and loss of identity caused by the disease by visualizing themselves in vigorous health. Treatment by NLP practitioners is often of shorter duration than that of other alternative practitioners, but NLP self-help seminars and courses can be quite expensive.

For those who wish to try self-treatment with NLP, a wide variety of books, audio tapes, and videos are available.

Precautions

NLP is particularly popular in the self-improvement and career-development fields, and some trainers and practitioners have little experience in its use for healing. Practitioners should be specifically asked about this.

Because NLP is intended to enhance the healing process, it should not be used independently of other healing methods. In all cases of serious illness, a physician should be consulted.

Side effects

NLP is believed to be generally free of harmful side effects.

Research and general acceptance

Although some physicians and mental health practitioners employ principles of neurolinguistic programming, the field is generally considered outside of mainstream medical practice and academic thinking.

Resources

ORGANIZATIONS

Association for NLP. PO Box 78, Stourbridge, UK DY8 2YP.

Australian Association of Professional Hypnotherapists and NLP Practitioners, Inc. PO BOX 1526, Southport, Gold

Coast, Queensland 4215, Australia. <http://www.members.tripod.com/~aaphan/index.html>.
International NLP Trainers Association, Ltd. Coombe House, Mill Road, Fareham, Hampshire, UK PO16 0TN. (044) 01489 571171.
Society of Neuro-Lingustic Programming. PO Box 424, Hopatcong, NJ 07843. (201) 770-3600.

David Helwig

Neurologic bladder dysfunction *see* **Neurogenic bladder**

Neurologic exam

Definition

A neurological examination is an essential component of a comprehensive **physical examination**. It is a systematic examination that surveys the functioning of nerves delivering sensory information to the brain and caring motor commands (Peripheral nervous system) and impulses back to the brain for processing and coordinating (Central nervous system).

Purpose

A careful neurological evaluation can help to determine the cause of impairment since a clinician can begin localizing the problem. Symptoms that occur unexpectedly suggest a blood vessel or seizure problem. Those that are not so sudden suggest a possible tumor. Symptoms that have a waning course with recurrences and worsen over time suggest a disease that destroys nerve cells. Others that are chronic and progressive indicate a degenerative disorder. In cases of trauma, symptoms may be evident upon inspection and causes may be explained by third party witnesses. Some patients may require extensive neurological screening examination (NSE) and/or neurological examination (NE) to determine the cause. The NH will assist the clinician to diagnose illnesses such as seizure disorders, **narcolepsy**, migraine disorders, **dizziness**, and **dementia**.

Description

A neurological screening is an essential component of every comprehensive physical examination. In cases of neurological trauma, disease, or psychological disorders patients are usually given a very in-depth neurological examination. The examination is best performed in a systematic manner, which means that there is a recommended order for procedures.

Neurological screening examination

The NSE is basic procedure especially in patients who have a general neurological complaint or symptoms. The NSE consists of six areas of assessment:

- mental status: assessing normal orientation to time, place, space, and speech
- cranial nerves: checking the eyes with a special light source (ophthalmoscope), and also assessment of facial muscles strength and functioning
- motor: checking for tone, drift, heal, and toe and walking
- sensory: cold and vibration tests
- coordination: observing the patient walk and finger to nose testing
- reflexes: using a special instrument the clinician taps an area above a nerve to emit a reflex (usually movement of muscle groups)

Neurological examination

The NE should be performed on a patient suspected of having neurological trauma, neurological, or psychological diseases. The NE is performed in a systematic and comprehensive manner. The NE consists of several comprehensive and in-depth assessments of mental status, cranial nerves, motor examination, reflexes, sensory examination, and posture and walking (gait) analysis.

MENTAL STATUS EXAMINATION (MSE). There are two types of MSE, informal and formal. The informal MSE is usually done when clinicians are obtaining historical information from a patient. The formal MSE is performed in a patient suspected of a neurological problem. The patient is commonly asked his/her name, the location, the day, and date. Retentive memory capability and immediate recall can be assessed by determining the number of digits that can be repeated in sequence. Recent memory is typically examined by testing recall potential of a series of objects after defined times, usually within five and 15 minutes. Remote memory can be assessed by asking the patient to review in a coherent and chronological fashion, his or her illness or personal life events that the patient feels comfortable talking about. Patient recall of common historical or current events can be utilized to assess general knowledge. Higher functioning (referring to brain processing capabilities) can be assessed by spontaneous speech, repetition, reading, naming, writing, and comprehension. The patient may be asked to perform further tasks such as identification of fingers, whistling, saluting, brushing teeth motions,

combing hair, drawing, and tracing figures. These procedures will assess the intactness of what is called dominant (left-sided brain) functioning or higher cortical function referring to the portion of the brain that regulates these activities.

The MSE is particularly important in the specialty of psychotherapy. Psychotherapists recommend an in-depth MSE to all patients with possible organic (referring to the body) or psychotic disorders. This examination is also performed in a systematic and orderly manner. It is divided into several categories:

- Appearance: This assessment determines the patient's presentation, i.e. how the patient looks (clothes posture, grooming, and alertness).
- Behavior: This assesses the patient's motor (movements) activity such as walking, gestures, muscular twitching, and impulse control.
- Speech: the patient's speech can be examined concerning volume, rate of speech and coherence. Patients who exhibit latent or delayed speech can indicate depression, while a rapid or pressured speech may suggest possible **mania** or **anxiety**.
- Mood and affect: Normal mood is term euthymia. There is variation in mood presentations and patients may display a flat, labile, blunted, constructed or inappropriate mood. The patient can also be euphoric (elevated) or dysphoric (on the down side).
- Thought processes and content: This category is typically assessed by determining word usage (can indicate brain disease), thought stream (whether thoughts are slow, restricted, blocked, or overabundant), continuity of thought (referring to associations among ideas), and content of thought (delusional thoughts).
- Perception: This assessment examines the patient's ability to hear, see, touch, taste, and smell. Certain psychological states may cause hearing and visual **hallucinations**. Impairments of smell and touch are usually caused by medical (organic) causes or as side effects from certain medications.
- Attention and concentration: This clinician assesses the patient's ability to focus on a specific task or activity. Abnormalities in attention and concentration can indicate problems related to anxiety or hallucinations.
- Orientation: The patient is examined for orientation to time, place, and identification of self (asking the patient his/her name). Disturbances in orientation can be due to a medical condition (other than psychological), substance abuse, or as a side effect of certain medications such as those used to treat depression, anxiety or **psychosis** (since these medications usually have a sedative affect).
- Memory: Patients are examined for remote, recent, and immediate memory capabilities. Remote and recent memory can be assessed by the patient's ability to recall historical and current events. Immediate memory can be tested by naming three objects and asking the patient to repeat the named objects immediately, then after five and 15 minute intervals.
- Judgment: This category evaluates the patient's ability to exercise appropriate judgment. It also determines whether the patient has an understanding of consequences associated with their actions.
- Intelligence and information: The only precise measurement for this category can be obtained by administering specialized intelligence tests, However a preliminary assessment of intelligence can be made based on the patient's fund of information, general knowledge, awareness of current events, and the ability for abstract thinking (thinking of unique concepts).
- Insight: Insight in the MSE pertains to the patient's awareness of their problem that prompted them to seek professional examination. Insight concerning the present illness can range from denial to fleeting admission of current illness.

CRANIAL NERVES (CN). Cranial nerves are specialized nerves that originate in the brain and connect to specialized structures such as the nose, eyes, muscles in the face, scalp, ear, and tongue.

- CNI: This nerve checks for visual capabilities. Patients are usually given the Snellen Chart (a chart with rows of large and small letters). Patients read letters with one eye at a time.
- CN III, IV, and VI: These nerves examine the pupillary (the circular center structure of the eye that light rays enter) reaction. The pupils get smaller, normally when exposed to the light. The eyelids are also examined for drooping or retraction. The eyeball is also checked for abnormalities in movement.
- CNV: The clinician can assess the muscles on both sides of the scalp muscles (the temporalis muscle). Additionally the jaw can be tested for motion resistance, opening, protrusion, and side-to-side mobility. The cornea located is a transparent tissue covering the eyeball and could be tested for intactness by lightly brushing a wisp of cotton directly on the outside of the eye.
- CNVII: Examination of CNVII assesses asymmetry of the face at rest and during spontaneous movements. The patient is asked to raise eyebrows, wrinkle forehead, close eyes, frown, smile, puff cheeks, purse lips, whistle, and contract chin muscles. Taste for the front and middle portions of the tongue can also be examined.

- CNVIII: Testing for this CN deals with hearing. The clinician usually uses a special instrument called a tuning fork and tests for air conduction and structural problems which can occur inside the ear.
- CN IX and X: These tests will evaluate certain structures in the mouth. The clinician will usually ask the patient to say "aah" and can detect abnormal positioning of certain structures such as the palatel-uvula. The examiner will also assess the sensation capabilities of the pharynx, by stimulating the area with a wooden tongue depressor, causing a gag reflex.
- CNXI: This nerve is usually examined by asking the patient to shrug shoulders (testing a muscle called the trapezius) and rotating the head to each side (testing a muscle called the sternocleidomastoid). These muscles are responsible for movement of the shoulders and neck. The test is usually done with resistance, meaning the examiner holds the area while the patient is asked to move. This is done to assess patient's strength in these areas.
- CNXII: This nerve tests the bulk and power of the tongue. The examiner looks for tongue protrusion and/or abnormal movements.

MOTOR EXAMINATION. The motor examination assesses the patient's muscle strength, tone, and shape. Muscles could be abnormally larger than expected (hypertrophy) or small due to tissues destruction (atrophy). It is important to assess if there is evidence of twitching or abnormal movements. Involuntary movements due to tics or myoclonus can be observed. Additionally, movements can be abnormal during maintained posture in neurological disorders such as **Parkinson's disease**. Muscle tone is usually tested by applying resistance to passive motion of a relaxed limb. Power is assessed for movements at each joint. Decreases or increases in muscle tone can help the examiner localize the affected area.

REFLEXES. The patient's reflexes are tested by using a special instrument that looks like a little hammer. The clinician will tap the rubber triangular shaped end in several different areas in the arms, knee, and Achilles heal area. The clinician will ask the patient to relax and gently tap the area. If there is a difference in response from the left to right knee, then there may be an underlying problem that merits further evaluation. A difference in reflexes between the arms and legs usually indicates of a lesion involving the spinal cord. Depressed reflexes in only one limb, while the other limb demonstrates a normal response usually indicates a peripheral nerve lesion.

SENSORY EXAMINATION. Although a very essential component of the NE, the sensory examination is the least informative and least exacting since it requires patient concentration and cooperation. Five primary sensory categories are assessed: vibration (using a tuning fork), joint position (examiner moves the limb side-to-side and in a downward position), light touch, pinprick, and temperature. Patients who have sensory abnormalities may have a lesion above the thalamus. Spinal cord lesions or disease can possibly be detected by pinprick and temperature assessment.

COORDINATION. The patient is asked to repetitively touch his nose using his index finger and then to touch the clinician's outstretched finger. Coordination can also be assessed by asking the patient to alternate tapping the palm then the back of one hand on the thigh. For coordination in the lower extremities on legs, the patient lies on his or her back and is asked to slide the heel of each foot from the knee down the shin of the opposite leg and to raise the leg and touch the examiners index finger with the great toe.

WALKING (GAIT). Normal walking is a complex process and requires usage of multiple systems such as power, coordination and sensation working together in a coordinated fashion. The examination of gait can detect a variety of disease states. Decreased arm swinging on one side is indicative of corticospinal tract disease. A stooped down posture and short-stepped gait may suggest Parkinson's syndrome. A high stepped, slapping gait may be the result of a peripheral nerve disease.

Preparation

The MSE is the first step in a continuous assessment to determine the diagnosis a psychotherapist should take a detailed medical history in the process of ruling out a general medical condition. If a general medical disease is suspected, referral is indicated to rule out this category. Once a medical condition has been fully excluded the therapist can then localize the components of an abnormal MSE to determine the underlying psychological disorder. Once this is determined treatment may included, but is not limited to therapy sessions and/or medication. For neurological diseases the clinician will use information gained from the NE for ordering further tests. These tests may include a complete blood analysis, **liver function tests**, **kidney function tests**, hormone tests, and a lumbar puncture to determine abnormalities in cerebrospinal fluid. In cases a trauma (car accident, sports injury) the NE is a quick and essential component of emergency assessment. One a diagnosis is determined emergency measures may include further tests and/or surgery.

Aftercare

Care is usually specific once the final diagnosis has been determined. In psychological cases the treatment may include therapy and/or medication. In causes of an

KEY TERMS

Corticospinal tract—A tract of nerve cells that carries motor commands from the brain to the spinal cord.

Gait—Referring to walking motions.

Reflex—A response, usually a movement, elicited by tapping on the nerve with a special hammer-like instrument.

Thalamus—A part of the brain that filters incoming sensory information.

acute insult such as **stroke** or trauma, the patient is usually admitted to the hospital for appropriate treatment. Some neurological diseases are chronic and require conservative (medical) treatment and frequent follow-up visits for monitoring and stability or progression of the disease state. The MSE and NE are good diagnostic tools. Further testing using advanced technological procedures are usually required for definitive diagnosis and initiation of disease-specific treatment.

The outcome depends ultimately on the final diagnosis. Neurological diseases typically follow a chronic course. Situations that present as trauma may require surgical intervention and intensive care with an outcome usually proportional to extent of injuries. Psychological disorders may require long term (chronic) treatment and/or medication(s). Most neurological conditions require follow-up and periodic monitoring.

Resources

BOOKS

Behrman, Richard E., et al, eds. *Nelson Textbook of Pediatrics* 16th ed. W. B. Saunders Company, 2000.

Goldman, Lee, et al. *Cecil's Textbook of Medicine*. 21st ed. W. B. Saunders Company, 2000.

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Year Book, Inc., 1998.

PERIODICALS

Sturmann, K. "Neurologic Emergencies: The Neurologic Examination." *Emergency Medicine Clinics of North America* 15 (Aug. 1997).

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Neuromuscular junction disease *see* **Myasthenia gravis**

Neuropathic bladder *see* **Neurogenic bladder**

Neutropenia

Definition

Neutropenia is an abnormally low level of neutrophils in the blood. Neutrophils are white blood cells (WBCs) produced in the bone marrow that ingest bacteria. Neutropenia is sometimes called agranulocytosis or granulocytopenia because neutrophils make up about 60% of WBCs and have granules inside their cell walls. Neutropenia is a serious disorder because it makes the body vulnerable to bacterial and fungal infections.

Description

The normal level of neutrophils in human blood varies slightly by age and race. Infants have lower counts than older children and adults, and African Americans have lower counts than Caucasians or Asians. The average adult level is 1500 cells/mm^3 of blood. Neutrophil counts (in cells/mm^3) are interpreted as follows:

- greater than 1000. Normal protection against infection.
- 500–1000. Some increased risk of infection.
- 200–500. Great risk of severe infection.
- lower than 200. Risk of overwhelming infection; requires hospital treatment with **antibiotics**.

Causes and symptoms

Causes

Neutropenia may result from three processes:

DECREASED WBC PRODUCTION. Lowered production of white blood cells is the most common cause of neutropenia. It can result from:

- medications that affect the bone marrow, including **cancer** drugs, chloramphenicol (Chloromycetin), anticonvulsant medications, and **antipsychotic drugs** (Thorazine, Prolixin, and other phenothiazines)
- hereditary and congenital disorders that affect the bone marrow, including familial neutropenia, cyclic neutropenia, and infantile agranulocytosis
- cancer, including certain types of leukemia
- radiation therapy
- exposure to pesticides
- vitamin B_{12} and folate (**folic acid**) deficiency

DESTRUCTION OF WBCS. WBCs are used up at a faster rate by:

- acute bacterial infections in adults
- infections in newborns
- certain **autoimmune disorders**, including **systemic lupus erythematosus** (SLE)
- penicillin, phenytoin (Dilantin), and sulfonamide medications (Benemid, Bactrim, Gantanol)

SEQUESTRATION AND MARGINATION OF WBCS. Sequestration and margination are processes in which neutrophils are removed from the general blood circulation and redistributed within the body. These processes can occur because of:

- hemodialysis
- felty's syndrome or **malaria**, the neutrophils accumulate in the spleen.
- bacterial infections, the neutrophils remain in the infected tissues without returning to the bloodstream.

Symptoms

Neutropenia has no specific symptoms except the severity of the patient's current infection. In severe neutropenia, the patient is likely to develop **periodontal disease**, oral and rectal ulcers, **fever**, and bacterial **pneumonia**. Fever recurring every 19–30 days suggests cyclical neutropenia.

Diagnosis

Diagnosis is made on the basis of a **white blood cell count and differential**. The cause of neutropenia is often difficult to establish and depends on a combination of the patient's history, genetic evaluation, bone marrow biopsy, and repeated measurements of the WBC.

Treatment

Treatment of neutropenia depends on the underlying cause.

Medications

Patients with fever and other signs of infection are treated for seven to 10 days with antibiotics. Nutritional deficiencies are corrected by green vegetables to supply folic acid, and by vitamin B supplements.

Medications known to cause neutropenia are stopped. Neutropenia related to pesticide exposure is treated by removing the patient from the contaminated environment.

KEY TERMS

Cyclical neutropenia—A rare genetic blood disorder in which the patient's neutrophil level drops below 500/mm^3 for six to eight days every three weeks.

Differential—A blood cell count in which the percentages of cell types are calculated as well as the total number of cells.

Felty's syndrome—An autoimmune disorder in which neutropenia is associated with rheumatoid arthritis and an enlarged spleen.

Granulocyte—Any of several types of white blood cells that have granules in their cell substance. Neutrophils are the most common type of granulocyte.

Neutrophil—A granular white blood cell that ingests bacteria, dead tissue cells, and foreign matter.

Sargramostim—A medication made from yeast that stimulates WBC production. It is sold under the trade names Leukine and Prokine.

Sequestration and margination—The removal of neutrophils from circulating blood by cell changes that trap them in the lungs and spleen.

Patients receiving **chemotherapy** for cancer may be given a blood growth factor called sargramostim (Leukine, Prokine) to stimulate WBC production.

Surgery

Patients with Felty's syndrome who have repeated infections may have their spleens removed.

Prognosis

The prognosis for mild or chronic neutropenia is excellent. Recovery from acute neutropenia depends on the severity of the patient's infection and the promptness of treatment.

Resources

BOOKS

Baehner, Robert L. "Neutropenia." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Hematology and Oncology: Leukopenia; Neutropenia." In *The Merck Manual of Diagnosis and Therapy.* 16th ed.

Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.
"Infectious Diseases: Neonatal Sepsis." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.
Lane, Peter A., et al. "Hematologic Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.
Linker, Charles A. "Blood." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.
Pearson, Starr P., and Stanley J. Russin. "Quantitative Disorders of Granulocytes." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.
Physicians' Guide to Rare Diseases. Ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Co., Inc., 1995.

Rebecca J. Frey

Nevirapine *see* **Non-nucleoside reverse transcriptase inhibitors**

Nevus *see* **Moles**

Newborn life support *see* **Extracorporeal membrane oxygenation**

Niacin deficiency *see* **Pellagra**

Nicotine *see* **Smoking; Smoking-cessation drugs**

Nicotinic acid deficiency *see* **Pellagra**

Niemann-Pick disease *see* **Lipidoses**

Nifedipine *see* **Calcium channel blockers**

Night blindness *see* **Vitamin A deficiency**

Night terrors

Definition

Night terrors are a sleep disorder characterized by **anxiety** episodes with extreme panic, often accompanied by screaming, flailing, fast breathing, and sweating and that usually occur within a few hours after going to sleep.

Description

Night terrors occur most commonly in children between the ages of four and 12 but can also occur at all ages. Affected individuals usually suffer these episodes within a few hours after going to sleep. They appear to bolt up suddenly, and wake up screaming, sweating and panicked. The episode may last anywhere from five to 20 minutes. During this time, the individual is actually asleep, although the eyes may open. Quite often, nothing can be done to comfort the affected person. Very often, the person has no memory of the episode upon waking the next day.

Night terrors are differentiated from nightmares in that they have been shown to occur during Stage 4 of sleep, or in REM sleep, while nightmares can occur anytime throughout the sleep cycle.

Causes and symptoms

Suffering from night terrors seems to run in families. Extreme tension or **stress** can increase the incidence of the episodes. In adults, the use of alcohol also contributes to an increased incidence of night terrors. Episodes sometimes occur after an accident involving **head injury**. Other factors thought to contribute to episodic night terrors, but not actually cause them, include:

- medications
- excessive tiredness at bedtime
- eating a heavy meal prior to bedtime
- drug **abuse**

Diagnosis

Night terrors are primarily diagnosed by observing the person suffering from an episode. The following symptoms are characteristic of a person suffering from a night terror:

- panic
- sweating
- gasping, moaning, crying or screaming during sleep
- little or no recollection of the episode upon awakening

Treatment

In most cases, the individual will still be asleep as the night terror episode happens and will prove difficult to awaken. The goal should be to help the affected person go back into a calm state of sleep. The lights should be turned on, and soothing comments should be directed at the person, avoiding brusque gestures such as shaking the person or shouting to startle them out of the episode. Any form of stress should be avoided.

Individuals affected by night terrors should be evaluated by a physician if they are really severe and occur frequently. A physician can recommend the best treat-

KEY TERMS

Benzodiazepines—A class of drugs that suppresses Stage 4 of sleep.

REM sleep—Rapid Eye Movement phase of sleep, a mentally active period during which dreaming occurs.

Sleep disorder—Any disorder that keep a person from falling asleep or staying asleep.

ment for the particular circumstances of the night terrors. In some severe cases, the physician may prescribe a benzodiazepine tranquilizer, such as Diazepam, known to suppress Stage 4 of sleep. The physician may also refer the affected person for further evaluation by a sleep disorder specialist. It should be noted that episodic night terrors in children are normal and do not suggest the presence of psychological problems. In adults, night terrors are more likely to be related to a significant stress-related or emotional problem.

Prognosis

In children, night terror episodes in children usually end by the age of 12.

Prevention

If a child seems to have a regular pattern of night terror episodes, he should be gently awakened about 15 minutes before the episode usually happens. The child should be kept awake and out of the bed for a short period of time and then allowed to return to bed.

Since sleep deprivation is a strong trigger for night terror episodes, children should not be allowed to become overtired. Having children take a nap during the day may be useful.

Adults affected by night terror episodes should avoid stress, the consumption of alcohol and stimulants before going to sleep.

Resources

BOOKS

Berkow, Robert. *The Merck Manual of Medical Information.* Whitehouse Station: Merck Research Laboratories, 1997.

Larson, David E. *Mayo Clinic Family Health Book.* New York: William Morrow and Company, 1996.

PERIODICALS

Laberge, Luc, et. al. "Development of Parasomnias from Childhood to Early Adolescence." *Pediatrics* (July 2000): 67-74.

American Academy of Family Physicians. "Nightmares and Night Terrors in Children." October 2000.

ORGANIZATIONS

American Sleep Disorders Association, 6301 Bandel Road Suite 101, Rochester, MN 55901. (507) 287-6008. <http://www.asda.org>.

National Foundation for Sleep and Related Disorders in Children, 4200 W. Peterson Suite 109, Chicago, IL 60646. (708) 971-1086.

Kim Sharp, MLn

Nitrates *see* **Antiangina drugs**

Nitrofurantoin *see* **Urinary anti-infectives**

Nitrogen narcosis

Definition

Nitrogen narcosis is a condition that occurs in divers breathing compressed air. When divers go below depths of approximately 100 ft, increase in the partial pressure of nitrogen produces an altered mental state similar to alcohol intoxication.

Description

Nitrogen narcosis, commonly referred to as "rapture of the deep," typically becomes noticeable at 100 ft underwater and is incapacitating at 300 ft, causing stupor, blindness, unconsciousness, and even **death**. Nitrogen narcosis is also called "the martini effect" because divers experience an effect comparable to that from one martini on an empty stomach for every 50 ft of depth beyond the initial 100 ft.

Causes and symptoms

Nitrogen narcosis is caused by gases in the body acting in a manner described by Dalton's Law of partial pressures: the total pressure of a gas mixture is equal to the sum of the partial pressures of gases in the mixture. As the total gas pressure increases with increasing dive depth, the partial pressure of nitrogen increases and more nitrogen becomes dissolved in the blood. This high nitrogen concentration impairs the conduction of nerve impulses and mimics the effects of alcohol or narcotics.

Symptoms of nitrogen narcosis include: wooziness; giddiness; euphoria; disorientation; loss of balance; loss of manual dexterity; slowing of reaction time; fixation of ideas; and impairment of complex reasoning. These

effects are exacerbated by cold, **stress**, and a rapid rate of compression.

Diagnosis

A diagnosis must be made on circumstantial evidence of atypical behavior, taking into consideration the depth of the dive and the rate of compression. Nitrogen narcosis may be differentiated from toxicity of oxygen, carbon monoxide, or carbon dioxide by the absence of such symptoms as **headache**, seizure, and bluish color of the lips and nail beds.

Treatment

The effects of nitrogen narcosis are totally reversed as the gas pressure decreases. They are typically gone by the time the diver returns to a water depth of 60 ft. Nitrogen narcosis has no hangover or lasting effects requiring further treatment. However, a doctor should be consulted whenever a diver has lost consciousness.

Prognosis

When a diver returns to a safe depth, the effects of nitrogen narcosis disappear completely. Some evidence exists that certain divers may become partially acclimated to the effects of nitrogen narcosis with frequency—the more often they dive, the less the increased nitrogen seems to affect them.

Prevention

Helium may be used as a substitute for nitrogen to dilute oxygen for deep water diving. It is colorless, odorless, tasteless, and chemically inert. However, it is more expensive than nitrogen and drains body heat from a diver. In diving with rapid compression, the helium-oxygen mixture may produce nausea, **dizziness**, and trembling, but these adverse reactions are less severe than nitrogen narcosis.

Nitrogen narcosis can be avoided by limiting the depth of dives. The risk of nitrogen narcosis may also be minimized by following safe diving practices, including proper equipment maintenance, low work effort, proper buoyancy, maintenance of visual cues, and focused thinking. In addition, no alcohol should be consumed within 24 hours of diving.

Resources

BOOKS

Martin, Lawrence. *Scuba Diving Explained: Questions and Answers of Physiology and Medical Aspects of Scuba Diving*. Flagstaff, AZ: Best Publishing, 1997.

KEY TERMS

Compressed air—Air that is held under pressure in a tank to be breathed by underwater divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

Compression—An increase in pressure from the surrounding water that occurs with increasing diving depth.

Partial pressure—The pressure exerted by one of the gases in a mixture of gases. The partial pressure of the gas is proportional to its concentration in the mixture. The total pressure of the gas mixture is the sum of the partial pressures of the gases in it (Dalton's Law) and as the total pressure increases, each partial pressure increases proportionally.

ORGANIZATIONS

American College of Hyperbaric Medicine. P.O. Box 25914-130, Houston, Texas 77265. (713) 528-0657. <http://www.hyperbaricmedicine.org>.

Divers Alert Network. The Peter B. Bennett Center, 6 West Colony Place, Durham, NC 27705. (800) 446-2671. <http://www.diversalertnetwork.org>.

Undersea and Hyperbaric Medical Society. 10531 Metropolitan Ave., Kensington, MD 20895. (301) 942-2980. <http://www.uhms.org>.

Bethany Thivierge

Nitroglycerin *see* **Antiangina drugs**

Nlein purpura *see* **Allergic purpura**

NMR *see* **Magnetic resonance imaging**

Nocardia asteroides infection *see* **Nocardiosis**

Nocardiosis

Definition

Nocardiosis is a serious infection caused by a fungus-like bacterium that begins in the lungs and can spread to the brain.

Description

Nocardiosis is found throughout the world among people of all ages, although it is most common in older

people and males. While people with poor immunity are vulnerable to this infection, it sometimes strikes individuals with no history of other diseases. Nocardiosis is rare in **AIDS** patients. It is not transmitted by person-to-person contact.

Causes and symptoms

Nocardiosis is caused by a bacterium of the *Nocardia* species—usually *N. asteroides*, an organism that is normally found in the soil. The incubation period is not known, but is probably several weeks.

The bacteria can enter the human body when a person inhales contaminated dust. Less often, people can pick up the bacteria in contaminated puncture **wounds** or cuts.

Symptoms

The infection causes a **cough** similar to **pneumonia** or **tuberculosis**, producing thick, sometimes bloody, sputum. Other symptoms include chills, night sweats, chest **pain**, weakness, loss of appetite and weight loss. Nocardiosis does not, however, respond to short-term **antibiotics**.

Complications

In about one-third of patients, the infection spreads from the blood into the brain, causing brain abscesses. This complication can trigger a range of symptoms including severe **headache**, confusion, disorientation, **dizziness**, nausea and seizures, and problems in walking. If a **brain abscess** ruptures, it can lead to **meningitis**.

About a third of patients with nocardiosis also have abscesses in the skin or directly underneath the skin. They may also have lesions in other organs, such as the kidneys, liver, or bones.

Diagnosis

Nocardia is not easily identified from cultures of sputum or discharge. A doctor can diagnose the condition using special staining techniques and taking a thorough medical history. Lung biopsies or x rays also may be required. Up to 40% of the time, however, a diagnosis can't be made until an **autopsy** is done.

Treatment

Treatment of nocardiosis includes bed rest and high doses of medication for a period of 12 to 18 months, including sulfonamide drugs or a combination of trimethoprim-sulfamethoxazole (Bactrim, Septra). If the patient doesn't respond to these drugs, antibiotics such as ampicillin (Amcill, Principen) or erythromycin (E-Mycin, Eryc) may be tried.

The abscesses may need to be drained and dead tissue cut away. Other symptoms are treated as necessary.

KEY TERMS

Abscess—A localized area of infection in a body tissue. Abscesses in the brain or skin are possible complications of nocardiosis.

Meningitis—An infection of the outer covering of the brain (meninges) that can be caused by either bacteria or a virus.

Prognosis

Nocardiosis is a serious disease with a high mortality rate. If it has been diagnosed early and caught before spreading to the brain, the prognosis is better. Even with appropriate treatment, however, the **death** rate is still 50%. Once the infection reaches the brain, the death rate is above 80%. This outcome is most commonly seen in patients with a weakened immune system.

Resources

BOOKS

Handbook of Diseases. Ed. June Norris. Springhouse, PA: Springhouse Corp., 1996.

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Nodule *see* **Skin lesions**

Non-A, non-B hepatitis *see* **Hepatitis C**

Non-Hodgkin's lymphomas *see* **Malignant lymphomas**

Non-melanoma skin cancer *see* **Skin cancer, non-melanoma**

Non-nucleoside reverse transcriptase inhibitors

Definition

This type of drug interferes with an enzyme that is key to the replication (reproduction) of the human

immunodeficiency virus (HIV). The drug is designed to help suppress the growth of HIV, but does not eliminate it.

Purpose

This medication is used to treat patients with the HIV virus and **AIDS** in combination with one or more other AIDS drugs. Combining NRTIs with older drugs improves their ability to lower the levels of HIV in the bloodstream, and strengthens the immune system.

HIV becomes rapidly resistant to this class of drugs when they are used alone. However, in combination with older drugs, they can interfere with the virus's ability to become resistant because they attack the virus on several fronts. As the virus tries to evade one drug, another attacks. This combination can lower the level of HIV in the blood to undetectable levels.

Precautions

Patients should not discontinue this drug even if symptoms improve without consultation with a physician.

Description

Nucleoside analogues, the first class of HIV drugs to be developed, worked by incorporating themselves into the virus's DNA, making the DNA incomplete and therefore unable to create new a virus. Non-nucleoside inhibitors work at the same stage as nucleoside analogues, but act in a completely different way, preventing the conversion of RNA to DNA.

This class of drugs includes nevirapine (Viramune) and delavirdine (Rescriptor). It may take several weeks or months before the full benefits are apparent.

Depending on the drug prescribed, doses may start with a lower amount and be increased after a short period of time.

Risks

A mild skin rash is common; a severe skin rash can be a life threatening reaction. Other possible side effects include **fever**, blistering skin, mouth sores, aching joints, eye inflammation, **headache**, nausea, and tiredness.

Because the drug passes into breast milk, breastfeeding mothers should avoid the drug, or not nurse until the treatment is completed.

Resources

BOOKS

Griffith, H. Winter. *1998 Edition: Complete Guide to Prescription and Nonprescription Drugs*. New York: Berkeley Publishing Group, 1998.

KEY TERMS

Human immunodeficiency virus (HIV)—The virus that causes AIDS.

PERIODICALS

Fox, Maggie. "Doctors grapple with huge pool of AIDS drugs." *Reuters* (4 Feb. 1998).

Rochell, Anne. "Hope and a Reality Check: Although a Cure is Still a Distant Dream, New AIDS Treatments Invite Optimism." *Atlanta Journal and Constitution*, 6 July 1996, D1.

Wilson, Billie Ann. "Understanding strategies for treating HIV." *Medical Surgical Nursing* 6 (1 Apr. 1997): 109-111.

ORGANIZATIONS

National AIDS Treatment Advocacy Project. 580 Broadway, Ste. 403, New York, NY 10012. (888) 266-2827. <http://www.natap.org>.

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Non-small cell lung cancer *see* **Lung cancer, non-small cell**

Non-tuberculous *see* **Mycobacterial infections, atypical**

Nonbacterial regional lymphaden *see* **Cat-scratch disease**

Noncholera vibrio infections *see* **Vibriosis**

Noneros *see* **Gastritis**

Nongonococcal urethritis

Definition

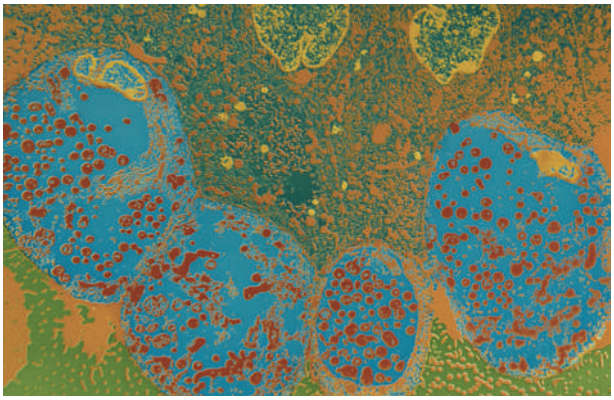
Any inflammation of the urethra not due to **gonorrhea**, almost always contracted through sexual intercourse and found far more often in men.

Description

Men between the ages of 15 and 30 who have multiple sex partners are most at risk for nongonococcal **urethritis** (NGU), which is believed to be the most common sexually transmitted disease in the United States.

Causes and symptoms

NGU is spread almost exclusively via sexual contact, and appears most often in men because a woman's



A microscopic image of non-specific urethritis. This sexually transmitted disease is usually caused by a bacterium of the genus *Chlamydia.* *(Custom Medical Stock Photo. Reproduced by permission.)*

urethra is less easily infected during sex. The infection is most often due to *Chlamydia trachomatis*, the organism that causes chlamydia. Those that aren't caused by *Chlamydia trachomatis* are usually due to another bacterium, *Ureaplasma urealyticum*. In 10% to 20% of NGU cases, the cause is unknown.

Symptoms appear within one to five weeks after infection, and include a slight clear discharge (the color of the discharge can vary from one patient to the next), and **itching** or burning during or after urination.

However, some men never develop symptoms, and women almost never show signs of infection. However, it's possible that symptoms of burning or itching in or around the vagina may be due to NGU.

The disease is communicable from the time of first infection until the patient is cured. Past infection doesn't make a person immune.

Diagnosis

Nongonococcal urethritis is diagnosed by excluding other causes, since inflammation that is not caused by gonorrhea is classified as NGU. A microscopic and/or culture test of the discharge or urine can reveal the infection.

Since many people are infected with both NGU and **syphilis** at the same time, infected patients also should have a test for syphilis before treatment for NGU begins, and three months after treatment ends.

Treatment

Antibiotics such as tetracycline or azithromycin will cure NGU; both sexual partners should be treated at the same time.

KEY TERMS

Chlamydia—One of the most common sexually transmitted diseases in the United States. It causes discharge, inflammation and burning during urination. About half of the cases of nongonococcal urethritis are due to chlamydia.

Gonorrhea—A sexually transmitted disease that affects the genital mucous membranes of men and women.

Urethra—The tube that carries urine from the bladder through the outside of the body.

Patients taking tetracycline should avoid milk or milk products and take the medication at least one hour before or two hours after meals. On the last day of treatment, a male should have a urine test to make sure the infection has cleared. If it hasn't, he should take a second course of therapy. Men should use a **condom** during treatment and for several months after treatment is completed.

If urine tests indicate the infection is gone but symptoms persist, the doctor will check for signs of prostate inflammation.

Prognosis

NGU is completely curable with proper antibiotic treatment. Untreated, NGU can lead to sterility in both men and women, inflammation of the mouth of the uterus, and infections of the woman's internal sexual organs. An infection during **pregnancy** may lead to **pneumonia** or eye infections in the newborn child. Untreated men may develop swelling of the testicles and an infected prostate gland.

Prevention

People can prevent the spread of NGU by:

- using a condom
- limiting the number of sex partners
- washing the genital area after sex
- if infected, avoid sexual contact; take antibiotics, notify all partners

Resources

BOOKS

Ross, Linda M., and Peter Dresser, eds. *Sexually Transmitted Diseases Sourcebook: Basic Information about Herpes,*

Chlamydia, Gonorrhea, Hepatitis, Nongonococcal Urethritis, Pelvic Inflammatory Disease. Detroit: Omnigraphics, 1997.

PERIODICALS

Stamm, W. E., C. B. Hicks, and D.H. Martin, et al. "Azithromycin for Empirical Treatment of Nongonococcal Urethritis Syndrome in Men." *Journal of the American Medical Association* 274 (16 Aug. 1995): 545-9.

ORGANIZATIONS

American Social Health Association. P.O. Box 13827, Research Triangle Park, NC 27709. (800) 227-8922. <http://www.ashastd.org>.

OTHER

Sexually Transmitted Diseases Hotline. (800) 227-8922.

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Nonsteroidal anti-inflammatory drugs

Definition

Nonsteroidal anti-inflammatory drugs are medicines that relieve **pain**, swelling, stiffness, and inflammation.

Purpose

Nonsteroidal anti-inflammatory drugs (NSAIDs) are prescribed for a variety of painful conditions, including arthritis, **bursitis**, **tendinitis**, **gout**, menstrual cramps, sprains, strains, and other injuries.

Description

Nonsteroidal anti-inflammatory drugs relieve pain, stiffness, swelling, and inflammation, but they do not cure the diseases or injuries responsible for these problems. Two drugs in this category, ibuprofen and naproxen, also reduce **fever**. Some nonsteroidal anti-inflammatory drugs can be bought over the counter; others are available only with a prescription from a physician or dentist.

Among the drugs in this group are diclofenac (Voltaren), etodolac (Lodine), flurbiprofen (Ansaid), ibuprofen (Motrin, Advil, Rufen), ketorolac (Toradol), nabumetone (Relafen), naproxen (Naprosyn); naproxen sodium (Aleve, Anaprox, Naprelan); and oxaprozin (Daypro). They are sold as tablets, capsules, caplets, liquids, and rectal suppositories and some are available in chewable, extended-release, or delayed-release forms.

Recommended dosage

Recommended doses vary, depending on the patient, the type of nonsteroidal anti-inflammatory drug prescribed, the condition for which the drug is prescribed, and the form in which it is used. Always take nonsteroidal anti-inflammatory drugs exactly as directed. If using nonprescription (over-the-counter) types, follow the directions on the package label. For prescription types, check with the physician who prescribed the medicine or the pharmacist who filled the prescription. Never take larger or more frequent doses, and do not take the drug for longer than directed. Patients who take nonsteroidal anti-inflammatory drugs for severe arthritis must take them regularly over a long time. Several weeks may be needed to feel the results, so it is important to keep taking the medicine, even if it does not seem to be working at first.

When taking nonsteroidal anti-inflammatory drugs in tablet, capsule, or caplet form, always take them with a full, 8-ounce glass of water or milk. Taking these drugs with food or an antacid will help prevent stomach irritation.

Precautions

Nonsteroidal anti-inflammatory drugs can cause a number of side effects, some of which may be very serious (See Side effects). These side effects are more likely when the drugs are taken in large doses or for a long time or when two or more nonsteroidal anti-inflammatory drugs are taken together. Health care professionals can help patients weigh the risks of benefits of taking these medicines for long periods.

Do not take **acetaminophen**, **aspirin**, or other salicylates along with other nonsteroidal anti-inflammatory drugs for more than a few days unless directed to do so by a physician. Do not take ketorolac (Toradol) while taking other nonsteroidal anti-inflammatory drugs unless directed to do so by a physician.

Because older people are more sensitive than younger adults to nonsteroidal anti-inflammatory drugs, they may be more likely to have side effects. Some side effects, such as stomach problems, may also be more serious in older people.

Serious side effects are especially likely with one nonsteroidal anti-inflammatory drug, phenylbutazone. Patients age 40 and over are especially at risk of side effects from this drug, and the likelihood of serious side effects increases with age. Because of these potential problems, it is especially important to check with a physician before taking this medicine. Never take it for anything other than the condition for which it was prescribed, and never share it—or any other prescription drug—with another person.

Some nonsteroidal anti-inflammatory drugs can increase the chance of bleeding after surgery (including dental surgery), so anyone who is taking the drugs should alert the physician or dentist before surgery. Avoiding the medicine or switching to another type in the days prior to surgery may be necessary.

Some people feel drowsy, dizzy, confused, lightheaded, or less alert when using these drugs. Blurred vision or other vision problems also are possible side effects. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Nonsteroidal anti-inflammatory drugs make some people more sensitive to sunlight. Even brief exposure to sunlight can cause severe **sunburn**, **rashes**, redness, **itching**, blisters, or discoloration. Vision changes also may occur. To reduce the chance of these problems, avoid direct sunlight, especially from mid-morning to mid-afternoon; wear protective clothing, a hat, and sunglasses; and use a sunscreen with a skin protection factor (SPF) rating of at least 15. Do not use sunlamps, tanning booths or tanning beds while taking these drugs.

Special conditions

People with certain medical conditions and people who are taking some other medicines can have problems if they take nonsteroidal anti-inflammatory drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Let the physician know about any **allergies** to foods, dyes, preservatives, or other substances. Anyone who has had reactions to nonsteroidal anti-inflammatory drugs in the past should also check with a physician before taking them again.

PREGNANCY. Women who are pregnant or who plan to become pregnant should check with their physicians before taking these medicines. Whether nonsteroidal anti-inflammatory drugs cause **birth defects** in people is unknown, but some do cause birth defects in laboratory animals. If taken late in **pregnancy**, these drugs may prolong pregnancy, lengthen labor time, cause problems during delivery, or affect the heart or blood flow of the fetus.

BREASTFEEDING. Some nonsteroidal anti-inflammatory drugs pass into breast milk. Women who are breastfeeding should check with their physicians before taking these drugs.

OTHER MEDICAL CONDITIONS. A number of medical conditions may influence the effects of nonsteroidal anti-inflammatory drugs. Anyone who has any of the conditions listed below should tell his or her physician about the condition before taking nonsteroidal anti-inflammatory drugs.

- stomach or intestinal problems, such as colitis or **Crohn's disease**
- liver disease
- current or past kidney disease; current or past **kidney stones**
- heart disease
- high blood pressure
- blood disorders, such as anemia, low **platelet count**, low white blood cell count
- bleeding problems
- diabetes mellitus
- hemorrhoids, rectal bleeding, or rectal irritation
- asthma
- parkinson's disease
- epilepsy
- systemic lupus erythematosus
- diseases of the blood vessels, such as **polymyalgia rheumatica** and **temporal arteritis**
- fluid retention
- alcohol abuse
- mental illness

People who have sores or white spots in the mouth should tell the physician about them before starting to take nonsteroidal anti-inflammatory drugs. Sores or white spots that appear while taking the drug can be a sign of serious side effects.

SPECIAL DIETS. Some nonsteroidal anti-inflammatory drugs contain sugar or sodium, so anyone on a low-sugar or low-sodium diet should be sure to tell his or her physician.

SMOKING. People who smoke cigarettes may be more likely to have unwanted side effects from this medicine.

USE OF CERTAIN MEDICINES. Taking nonsteroidal anti-inflammatory drugs with certain other drugs may affect the way the drugs work or increase the risk of unwanted side effects. (See Interactions.)

Side effects

The most common side effects are stomach pain or cramps, nausea, vomiting, **indigestion**, **diarrhea**, **heartburn**, **headache**, **dizziness** or lightheadedness, and

drowsiness. As the patient's body adjusts to the medicine, these symptoms usually disappear. If they do not, check with the physician who prescribed the medicine.

Serious side effects are rare, but do sometimes occur. If any of the following side effects occur, stop taking the medicine and get emergency medical care immediately:

- swelling or puffiness of the face
- swelling of the hands, feet, or lower legs
- rapid weight gain
- fainting
- breathing problems
- fast or irregular heartbeat
- tightness in the chest

Other side effects do not require emergency medical care, but should have medical attention. If any of the following side effects occur, stop taking the medicine and call the physician who prescribed the medicine as soon as possible:

- severe pain, cramps, or burning in the stomach or abdomen
- convulsions
- fever
- severe nausea, heartburn, or indigestion
- white spots or sores in the mouth or on the lips
- rashes or red spots on the skin
- any unusual bleeding, including nosebleeds, spitting up or vomiting blood or dark material
- black, tarry stool
- chest pain
- unusual bruising
- severe headaches

A number of less common, temporary side effects are also possible. They usually do not need medical attention and will disappear once the body adjusts to the medicine. If they continue or interfere with normal activity, check with the physician. Among these side effects are:

- gas, bloating, or **constipation**
- bitter taste or other taste changes
- sweating
- restlessness, irritability, **anxiety**
- trembling or twitching

Interactions

Nonsteroidal anti-inflammatory drugs may interact with a variety of other medicines. When this happens, the effects of the drugs may change, and the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with nonsteroidal anti-inflammatory drugs are:

- blood thinning drugs, such as warfarin (Coumadin)
- other nonsteroidal anti-inflammatory drugs
- heparin
- tetracyclines
- cyclosprorine
- digitalis drugs
- lithium
- phenytoin (Dilantin)
- zidovudine (AZT, Retrovir)

Nancy Ross-Flanigan

KEY TERMS

Anemia—A lack of hemoglobin — the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Bursitis—Inflammation of the tissue around a joint

Colitis—Inflammation of the colon (large bowel)

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

Tendinitis—Inflammation of a tendon—a tough band of tissue that connects muscle to bone.

Nontropical sprue *see* **Celiac disease**

Nonvenereal syphilis *see* **Bejel**

Norfloxac *see* **Fluoroquinolones**

Norplant *see* **Depo-Provera/Norplant**

Norwalk virus infection *see* **Gastroenteritis**

Nose injuries *see* **Nasal trauma**

Nose irrigation *see* **Nasal irrigation**

Nose job *see* **Rhinoplasty**

Nose packing *see* **Nasal packing**

Nose papillomas *see* **Nasal papillomas**

Nose polyps *see* **Nasal polyps**

Nosebleed

Definition

A nosebleed is bleeding from the nose called epistaxis.

Description

Unexpected bleeding from anywhere is cause for alarm. Persistent bleeding should always be investigated because it may be the earliest sign of **cancer**. Fortunately, nosebleeds are rarely a sign of cancer. A much more common cause of nosebleeds is injury from picking or blowing or fisticuffs. People with hay **fever** have swollen membranes that are fragile and more likely to bleed.

Nosebleeds most often come from the front of the septum, that plane of cartilage that separates the nostrils. It has a mass of blood vessels on either side called Kiesselbach's plexus that is easy to injure. Nosebleeds from the more remote reaches of the nose are less common and much harder to manage.

Causes and symptoms

Cancers are an uncommon cause of nosebleeds, but by far the most serious. Injury from fists, fingers, and over zealous nose blowing leads the list. Tumors from the front of the brain may break through into the sinuses or the back of the nose. Bleeding may be a trickle or a flood.

Treatment

The first treatment is to pinch the nostrils together, sit forward and stay that way for 5-10 minutes. Bleeding that continues will be from the back of the nose and will flow down the throat. If that happens, emergency intervention is needed.

As an emergency procedure, the nose will be packed front and/or back with cotton cloth and a rubber balloon. This is not comfortable. Having no place to flow, the blood should clot, giving the ear, nose and throat specialists (otorhinolaryngologists) a chance to find the source and permanently repair it. If the packing has to remain for any length of time, **antibiotics** and **pain** medication will be necessary—antibiotics because the sinuses will be plugged up and prone to infection. Nose packing may so interfere with breathing that the patient will need supplemental oxygen.

Many bleeds are from small exposed blood vessels with no other disease. They can be destroyed by cautery (burning with electricity or chemicals). Larger vessels may not respond to cautery. The surgeon may have to tie them off.

Alternative treatment

Estrogen cream, the same preparation used to revitalize vaginal tissue, can toughen fragile blood vessels in the anterior septum and forestall the need for cauterization. Botanical medicines known as stiptics, which slow down and can stop bleeding, may be taken internally or applied topically. Some of the plants used are achillea (yarrow), trillium, geranium, and shepard's purse (*capsella-bursa*). Homeopathic remedies can be one of the quickest and most effective treatments for epistaxis. One well known remedy for nosebleeds is phosphorus.

Prevention

Both before and after a nosebleed, blow gently and do not pick. Treatment of hay fever helps reduce the fragility of the tissues.

Resources

BOOKS

Ballenger, John Jacob. *Disorders Of The Nose, Throat, Ear, Head, and Neck*. Philadelphia: Lea & Febiger, 1991.

Jackler, Robert K., and Michael J. Kaplan. "Ear, Nose And Throat." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

J. Ricker Polsdorfer, MD

Nosocomial infections *see* **Hospital-acquired infections**

NS *see* **Nephrotic syndrome**

NSAIDs *see* **Nonsteroidal anti-inflammatory drugs**

Nther's disease *see* **Porphyrias**

Nuclear magnetic resonance *see* **Magnetic resonance imaging**

Nucleoside analogs *see* **Antiretroviral drugs**

Nummular dermatitis *see* **Dermatitis**

Numbness and tingling

Definition

Numbness and tingling are decreased or abnormal sensations caused by altered sensory nerve function.

Description

The feeling of having a foot "fall asleep" is a familiar one. This same combination of numbness and tingling can occur in any region of the body and may be caused by a wide variety of disorders. Sensations such as these, which occur without any associated stimulus, are called paresthesias. Other types of paresthesias include feelings of cold, warmth, burning, **itching**, and skin crawling.

Causes and symptoms

Causes

Sensation is carried to the brain by neurons (nerve cells) running from the outer parts of the body to the spinal cord in bundles called nerves. In the spinal cord, these neurons make connections with other neurons that run up to the brain. Paresthesias are caused by disturbances in the function of neurons in the sensory pathway. This disturbance can occur in the central nervous system (the brain and spinal cord), the nerve roots that are attached to the spinal cord, or the peripheral nervous system (nerves outside the brain and spinal cord).

Peripheral disturbances are the most common cause of paresthesias. "Falling asleep" occurs when the blood supply to a nerve is cut off—a condition called **ischemia**. Ischemia usually occurs when an artery is compressed as it passes through a tightly flexed joint. Sleeping with the arms above the head or sitting with the legs tightly crossed frequently cause numbness and tingling.

Direct compression of the nerve also causes paresthesias. Compression can be short-lived, as when a heavy backpack compresses the nerves passing across the shoulders. Compression may also be chronic. Chronic nerve compression occurs in entrapment syndromes. The most common example is **carpal tunnel syndrome**. Carpal tunnel syndrome occurs when the median nerve is compressed as it passes through a narrow channel in the wrist. Repetitive motion or prolonged vibration can cause the lining of the channel to swell and press on the nerve. Chronic nerve root compression, or radiculopathy, can occur in disk disease or spinal arthritis.

Other causes of paresthesias related to disorders of the peripheral nerves include:

- Metabolic or nutritional disturbances. These disturbances include diabetes, **hypothyroidism** (a condition caused by too little activity of the thyroid gland), **alcoholism**, **malnutrition**, and vitamin B_{12} deficiency.
- Trauma. Trauma includes injuries that crush, sever, or pull on nerves.
- Inflammation.
- Connective tissue disease. These diseases include arthritis, **systemic lupus erythematosus** (a chronic inflammatory disease that affects many systems of the body, including the nervous system), polyarteritis nodosa (a vascular disease that causes widespread inflammation and ischemia of small and medium-size arteries), and **Sjögren's syndrome** (a disorder marked by insufficient moisture in the tear ducts, salivary glands, and other glands).
- Toxins. Toxins include heavy metals (metallic elements such as arsenic, lead, and mercury which can, in large amounts, cause **poisoning**), certain **antibiotics** and **chemotherapy** agents, solvents, and overdose of pyridoxine (vitamin B_6).
- Malignancy.
- Infections. Infections include **Lyme disease**, human **immunodeficiency** virus (HIV), and leprosy.
- Hereditary disease. These diseases include **Charcot-Marie-Tooth disease** (a hereditary disorder that causes wasting of the leg muscles, resulting in malformation of the foot), porphyria (a group of inherited disorders in which there is abnormally increased production of substances called porphyrins), and Denny-Brown's syndrome (a hereditary disorder of the nerve root).

Paresthesias can also be caused by central nervous system disturbances, including **stroke**, TIA (**transient ischemic attack**), tumor, trauma, **multiple sclerosis**, or infection.

Symptoms

Sensory nerves supply or innervate particular regions of the body. Determining the distribution of symptoms is an important way to identify the nerves involved. For instance, the median nerve innervates the thumb, the first two fingers, half of the ring finger, and the part of the hand to which they connect. The ulnar nerve innervates the other half of the ring finger, the little finger, and the remainder of the hand. Distribution of symptoms may also aid diagnosis of the underlying disease. Diabetes usually causes a symmetrical "glove and stocking" distribution in the hands and feet. Multiple sclerosis may cause symptoms in several, widely separated areas.

Other symptoms may accompany paresthesias, depending on the type and severity of the nerve disturbance. For instance, weakness may accompany damage to nerves that carry both sensory and motor neurons. (Motor neurons are those that carry messages outward from the brain.)

Diagnosis

A careful history of the patient is needed for a diagnosis of paresthesias. The medical history should focus

on the onset, duration, and location of symptoms. The history may also reveal current related medical problems and recent or past exposure to drugs, toxins, infection, or trauma. The family medical history may suggest a familial disorder. A work history may reveal repetitive motion, chronic vibration, or industrial chemical exposure.

The physical and neurological examination tests for distribution of symptoms and alterations in reflexes, sensation, or strength. The distribution of symptoms may be mapped by successive stimulation over the affected area of the body.

Lab tests for paresthesia may include blood tests and **urinalysis** to detect metabolic or nutritional abnormalities. Other tests are used to look for specific suspected causes. Nerve conduction velocity tests, **electromyography**, and imaging studies of the affected area may be employed. Nerve biopsy may be indicated in selected cases.

Treatment

Treatment of paresthesias depends on the underlying cause. For limbs that have "fallen asleep," restoring circulation by stretching, exercising, or massaging the affected limb can quickly dissipate the numbness and tingling. If the paresthesia is caused by a chronic disease such as diabetes or occurs as a complication of treatments such as chemotherapy, most treatments are aimed at relieving symptoms. Anti-inflammatory drugs such as **aspirin** or ibuprofen are recommended if symptoms are mild. In more difficult cases, **antidepressant drugs** such as amitriptyline (Elavil) are sometimes prescribed. These drugs are given at a much lower dosage for this purpose than for relief of depression. They are thought to help because they alter the body's perception of **pain**. In severe cases, opium derivatives such as codeine can be prescribed. Currently trials are being done to determine whether treatment with human nerve growth factor will be effective in regenerating the damaged nerves.

Alternative treatment

Several alternative treatments are available to help relieve symptoms of paresthesia. Nutritional therapy includes supplementation with B complex **vitamins**, especially vitamin B_{12} (intramuscular injection of vitamin B_{12} is most effective). Vitamin supplements should be used cautiously however. Overdose of Vitamin B_6 is one of the causes of paresthesias. People experiencing paresthesia should also avoid alcohol. **Acupuncture** and massage are said to relieve symptoms. Self-massage with aromatic oils is sometimes helpful. The application of topical ointments containing capsaicin, the substance that makes hot peppers hot, provides relief for some. It may also be helpful to wear loosely fitting shoes and clothing. None of these alternatives should be used in place of traditional therapy for the underlying condition.

KEY TERMS

Electromyography—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

Motor nerve—Motor or efferent nerve cells carry impulses from the brain to muscle or organ tissue.

Nerve conduction velocity test—A test that measures the time it takes a nerve impulse to travel a specific distance over the nerve after electronic stimulation.

Nerve growth factor—A protein resembling insulin that affects growth and maintenance of nerve cells

Peripheral nervous system—The part of the nervous system that is outside the brain and spinal cord. Sensory, motor, and autonomic nerves are included.

Sensory nerves—Sensory or afferent nerves carry impulses of sensation from the periphery or outward parts of the body to the brain. Sensations include feelings, impressions, and awareness of the state of the body.

Prognosis

Treating the underlying disorder may reduce the occurrence of paresthesias. Paresthesias resulting from damaged nerves may persist throughout or even beyond the recovery period. The overall prognosis depends on the cause.

Prevention

Preventing the underlying disorder may reduce the incidence of paresthesias. For those with frequent paresthesias caused by ischemia, changes in posture may help.

Resources

BOOKS

Bradley, Walter G., ed., et al. *Neurology in Clinical Practice*. 2nd ed. Boston: Butterworth-Heinemann, 1996.

PERIODICALS

McKnight, Jerry T., and Bobbi B. Adcock. "Paresthesias: A Practical Diagnostic Approach." *American Family Physician* 56 (Dec. 1997): 2253-2260.

Richard Robinson

Nutrition

Definition

Good nutrition can help prevent disease and promote health. There are six categories of nutrients that the body needs to acquire from food: protein, carbohydrates, fat, fibers, **vitamins** and **minerals**, and water.

Proteins

Protein supplies amino acids to build and maintain healthy body tissue. There are 20 amino acids considered essential because the body must have all of them in the right amounts to function properly. Twelve of these are manufactured in the body but the other eight amino acids must be provided by the diet. Foods from animal source such as milk or eggs often contain all these essential amino acids while a variety of plant products must be taken together to provide all these necessary protein components.

Fat

Fat supplies energy and transports nutrients. There are two families of fatty acids considered essential for the body: the omega-3 and omega-6 fatty acids. Essential fatty acids are required by the body to function normally. They can be obtained from canola oil, flaxseed oil, cold-water fish, or fish oil, all of which contain omega-3 fatty acids, and primrose or black currant seed oil, which contains omega-6 fatty acids. The American diet often contains excess of omega-6 fatty acids and insufficient amount of omega-3 fats. Increased consumption of omega-3 oils are recommended to help reduce risk of cardiovascular diseases and **cancer** and alleviate symptoms of **rheumatoid arthritis**, **premenstrual syndrome**, **dermatitis**, and inflammatory bowel disease.

Carbohydrates

Carbohydrates are the body's main source of energy and should be the major part of total daily intake. There are two types of carbohydrates: simple carbohydrates (such as sugar or honey) or complex carbohydrates (such as grains, beans, peas, or potatoes). Complex carbohydrates are preferred because these foods are more nutritious yet have fewer calories per gram compared to fat and cause fewer problems with overeating than fat or sugar. Complex carbohydrates are also preferred over simple carbohydrates by diabetics because they allow better blood glucose control.

Fiber

Fiber is the material that gives plant texture and support. Although it is primarily made up of carbohydrates, it does not have a lot of calories and usually is not broken down by the body for energy. Dietary fiber is found in plant foods such as fruits, vegetables, legumes, nuts, and whole grains.

There are two types of fiber: soluble and insoluble. Insoluble fiber, as the name implies, does not dissolve in water because it contains high amount of cellulose. Insoluble fiber can be found in the bran of grains, the pulp of fruit and the skin of vegetables. Soluble fiber is the type of fiber that dissolves in water. It can be found in a variety of fruits and vegetables such as apples, oatmeal and oat bran, rye flour, and dried beans.

Although they share some common characteristics such as being partially digested in the stomach and intestines and have few calories, each type of fiber has its own specific health benefits. Insoluble fiber speeds up the transit of foods through the digestive system and adds bulk to the stools, therefore, it is the type of fiber that helps treat **constipation** or **diarrhea** and prevents **colon cancer**. On the other hand, only soluble fiber can lower blood cholesterol levels. This type of fiber works by attaching itself to the cholesterol so that it can be eliminated from the body. This prevents cholesterol from recirculating and being reabsorbed into the bloodstream.

Vitamins and minerals

Vitamins are organic substances present in food and required by the body in a minute amount for regulation of metabolism and maintenance of normal growth and functioning. The most commonly known vitamins are A, B_1 (thiamine), B_2 (riboflavin), B_3 (niacin), B_5 (pantothenic acid), B_6 (pyridoxine), B_7 (biotin), B_9 (**folic acid**), B_{12} (cobalamin), C (ascorbic acid), D, E, and K. The B and C vitamins are water-soluble, excess amounts of which are excreted in the urine. The A, D, E, and K vitamins are fat-soluble and will be stored in the body fat.

Minerals are vital to our existence because they are the building blocks that make up muscles, tissues, and bones. They also are important components of many life-supporting systems, such as hormones, oxygen transport, and enzyme systems.

There are two kinds of minerals: the major (or macro) minerals and the trace minerals. Major minerals are the minerals that the body needs in large amount. The following minerals are classified as major: calcium, phosphorus, magnesium, sodium, potassium, sulfur, and chloride. They are needed to build muscles, blood, nerve cells, teeth, and bones. They are also essential electrolytes that the body requires to regulate blood volume and acid-base balance.

Unlike the major minerals, trace minerals are needed only in tiny amounts. Even though they can be found in

the body in exceedingly small amounts, they are also very important to the human body. These minerals participate in most chemical reactions in the body. They are also needed to manufacture important hormones. The following are classified as trace minerals: iron, zinc, iodine, copper, manganese, fluoride, chromium, selenium, molybdenum, and boron.

Many vitamins (such as vitamins A, C, and E) and minerals (such as zinc, copper, selenium, or manganese) act as antioxidants. They protect the body against the damaging effects of free radicals. They scavenge or mop up these highly reactive radicals and change them into inactive, less harmful compounds. In so doing, these essential nutrients help prevent cancer and many other degenerative diseases, such as premature **aging**, heart disease, autoimmune diseases, arthritis, **cataracts**, **Alzheimer's disease**, and **diabetes mellitus**.

Water

Water helps to regulate body temperature, transports nutrients to cells, and rids the body of waste materials.

Origins

Unlike plants, human beings cannot manufacture most of the nutrients that they need to function. They must eat plants and/or other animals. Although nutritional therapy came to the forefront of the public's awareness in the late twentieth century, the notion that food affects health is not new. John Harvey Kellogg was an early health-food pioneer and an advocate of a high-fiber diet. An avowed vegetarian, he believed that meat products were particularly detrimental to the colon. In the 1870s, Kellogg founded the Battle Creek Sanitarium, where he developed a diet based on nut and vegetable products.

Purpose

Good nutrition helps individuals achieve general health and well-being. In addition, dietary modifications might be prescribed for a variety of complaints including **allergies**, anemia, arthritis, colds, depressions, **fatigue**, gastrointestinal disorder, high or low blood pressure, **insomnia**, headaches, **obesity**, **pregnancy**, premenstrual syndrome (PMS), respiratory conditions, and **stress**.

Nutritional therapy may also be involved as a complement to the allopathic treatments of cancer, diabetes, and **Parkinson's disease**. Other specific dietary measures include the elimination of food additives for attention deficit hyperactivity disorder (**ADHD**), gluten-free **diets** for **schizophrenia**, and dairy-free for chronic respiratory diseases.

A high-fiber diet helps prevent or treat the following health conditions:

- High cholesterol levels. Fiber effectively lowers blood cholesterol levels. It appears that soluble fiber binds to cholesterol and moves it down the digestive tract so that it can be excreted from the body. This prevents the cholesterol from being reabsorbed into the bloodstream.
- Constipation. A high-fiber diet is the preferred non-drug treatment for constipation. Fiber in the diet adds more bulk to the stools, making them softer and shortens the time foods stay in the digestive tract.
- Hemorrhoids. Fiber in the diet adds more bulk and softens the stool, thus, reducing painful hemorrhoidal symptoms.
- Diabetes. Soluble fiber in the diet slows down the rise of blood sugar levels following a meal and helps control diabetes.
- Obesity. Dietary fiber makes a person feel full faster.
- Cancer. Insoluble fiber in the diet speeds up the movement of the stools through the gastro-intestinal tract. The faster food travels through the digestive tract, the less time there is for potential cancer-causing substances to work. Therefore, diets high in insoluble fiber help prevent the accumulation of toxic substances that cause cancer of the colon. Because fiber reduces fat absorption in the digestive tract, it may also prevent **breast cancer**.

A diet low in fat also promotes good health and prevents many diseases. Low-fat diet can help treat or control the following conditions:

- Obesity. High fat consumption often leads to excess caloric and fat intake, which increases body fat.
- Coronary artery disease. High consumption of saturated fats is associated with coronary artery disease.
- Diabetes. People who are overweight tend to develop or worsen existing diabetic condition due to decreased insulin sensitivity.
- Breast cancer. A high dietary consumption of fat is associated with an increased risk of breast cancer.

Description

The four basic food groups, as outlined by the United States Department of Agriculture (USDA) are:

- dairy products (such as milk and cheese)
- meat and eggs (such as fish, poultry, pork, beef, and eggs)
- grains (such as bread cereals, rice, and pasta)
- fruits and vegetables

The USDA recommendation for adults is that consumption of meat, eggs, and dairy products should not exceed 20% of total daily caloric intake. The rest (80%) should be devoted to vegetables, fruits, and grains. For children age two or older, 55% of their caloric intake should be in the form of carbohydrates, 30% from fat, and 15% from proteins. In addition, saturated fat intake should not exceed 10% of total caloric intake. This low-fat, high-fiber diet is believed to promote health and help prevent many diseases, including heart disease, obesity, and cancer.

Allergenic and highly processed foods should be avoided. Highly processed foods do not contain significant amounts of essential trace minerals. Furthermore, they contain lots of fat and sugar as well as preservatives, artificial sweeteners and other additives. High consumption of these foods causes build up of these unwanted chemicals in the body and should be avoided. Food allergy causes a variety of symptoms including food cravings, weight gain, bloating, water retention. It may also worsen chronic inflammatory conditions such as arthritis.

Preparations

An enormous body of research exists in the field of nutrition. Mainstream Western medical practitioners point to studies that show that a balanced diet, based on the USDA Food Guide Pyramid, provides all of the necessary nutrients.

The Food Guide Pyramid recommends the following daily servings in six categories:

- grains: six or more servings
- vegetables: five servings
- fruits: two to four servings
- meat: two to three servings
- dairy: two to three servings
- fats and oils: use sparingly

Precautions

Individuals should not change their diets without the advice of nutritional experts or health care professionals. Certain individuals especially children, pregnant and lactating women, and chronically ill patients should only change their diets under professional supervision.

Side effects

It is best to obtain vitamins and minerals through food sources. Excessive intake of vitamins and mineral supplements can cause serious physiological problems.

The following is a list of possible side effects resulting from excessive doses of vitamins and minerals:

- vitamin A: **birth defects**, irreversible bone and liver damage
- vitamin B_1: deficiencies in B_2 and B_6
- vitamin B_6: damage to the nervous system
- vitamin C: affects the absorption of copper; diarrhea
- vitamin D: **hypercalcemia** (abnormally high concentration of calcium in the blood)
- phosphorus: affects the absorption of calcium
- zinc: affects absorption of copper and iron; suppresses the immune system

Research and general acceptance

Due to large volume of scientific evidence demonstrating the benefits of the low-fat, high-fiber diet in disease prevention and treatment, this diet has been accepted and advocated by both complementary and allopathic practitioners.

Resources

BOOKS

Bruce, Debra Fulghum, and Harris H. McIlwain. *The Unofficial Guide to Alternative Medicine*. New York: Macmillan, 1998.

Cassileth, Barrie R. *The Alternative Medicine Handbook*. New York: W.W. Norton, 1998.

Credit, Larry P., Sharon G. Hartunian, and Margaret J. Nowak. *Your Guide to Complementary Medicine*. Garden City Park, New York: Avery Publishing Group, 1998.

U.S. Preventive Services Task Force Guidelines. "Counseling to Promote a Healthy Diet." *Guide to Clinical Preventive Services, 2nd edition*. <http://cpmcnet.columbia.edu/texts/gcps/gcps0066.html>.

Winick, Myron. *The Fiber Prescription*. New York: Random House, Inc., 1992.

PERIODICALS

Halbert, Steven C. "Diet and Nutrtion in Primary Care: From Antioxidants to Zinc." *Primary Care: Clinics in Office Practice* (December 1997): 825-843.

Turner, Lisa. "Good 'n Plenty." *Vegetarian Times* (February 1999):48

Vickers, Andrew, and Catherine Zollman. "Unconventional approaches to nutritional medicine." *British Medical Journal* (November 27, 1999): 1419.

ORGANIZATIONS

American Association of Nutritional Consultants. 810 S. Buffalo Street, Warsaw, IN 46580. (888) 828-2262.

American Dietetic Association. 216 W. Jackson boulevard, Suite 800, Chicago, IL 60606-6995. (800) 366-1655. <http://www.eatright.org/>.

Mai Tran

Nutrition through an intravenous line

Definition

Sterile solutions containing some or all of the nutrients necessary to support life, are injected into the body through a tube attached to a needle, which is inserted into a vein, either temporarily or for long-term treatment.

Purpose

Patients who cannot consume enough nutrients or who cannot eat at all due to an illness, surgery, or accident, can be fed through an intravenous (IV) line or tube. An IV can be used for as little as a few hours, to provide fluids to a patient during a short surgical procedure, or to rehydrate a patient after a viral illness.

Patients with more serious and long term illnesses and conditions may require months or even years of intravenous therapy to meet their nutritional needs. These patients may require a central **venous access** port. A specialized catheter (Silastic Broviac or Hickman) is inserted beneath the skin and positioned below the collarbone. Fluids can then be injected directly into the bloodstream for long periods of time. X rays are taken to ensure that the move permanent catheter is properly positioned.

Precautions

Patients receiving IV therapy need to be monitored to ensure that the IV solutions are providing the correct amounts of fluids, **minerals**, and other nutrients needed.

Description

There are two types of IV, or parenteral, **nutrition**. Parenteral nutrition is that which is delivered through a system other than the digestive system. In this case, the nutrition is delivered through a vein. Partial parenteral nutrition (PPN) is given for short periods of time, to replace some of the nutrients required daily and only supplements a normal diet. Total parenteral nutrition (TPN) is given to someone who cannot eat anything and must receive all nutrients required daily through an intravenous line. Both of these types of nutrition can be performed in a medical facility or at the patient's home. Home parenteral nutrition (HPN) usually required a central venous catheter, which must first be inserted in a fully equiped medical facility. After it is inserted, therapy can continue at home.

Basic IV solutions are sterile water with small amounts of sodium (salt) or dextrose (sugar) supplied in bottles or thick plastic bags that can hang on a stand mounted next to the patient's bed. Additional minerals, like potassium and calcium, **vitamins**, or drugs can be added to the IV solution by injecting them into the bottle or bag with a needle. These simple sugar and salt solutions can provide fluids, calories, and electrolytes necessary for short periods of time. If a patient requires intravenous feeding for more than a few days, additional nutrients like proteins and fats will be included. The amounts of each of the nutrients to be added will depend on the patient's age, medical condition, and particular nutritional requirements.

Preparation

A doctor orders the IV solution and any additional nutrients or drugs to be added to it. The doctor also specifies the rate at which the IV will be infused. The IV solutions are prepared under the supervision of a doctor, pharmacist, or nurse, using sanitary techniques that prevent bacterial contamination. Just like a prescription, the IV is clearly labeled to show its contents and the amounts of any additives. The skin around the area where the needle is inserted is cleaned and sanitized. Once the needle is in place, it will be taped to the skin to prevent it from dislodging.

In the case of HPN, the IV solution is delivered to the patient's home on a regular basis and should be kept refrigerated. Each bag will have an expiration date, by which time the bag should be used. The solution should be allowed to be warmed to room temperature before intravenous nutrition begins.

Aftercare

Patients who have been on IV therapy for more than a few days may need to have foods reintroduced gradually to give the digestive tract time to start working again. After the IV needle is removed, the site should be inspected for any signs of bleeding or infection.

When using HPN, the catheter should be kept clean at all times. The dressings around the site should be changed at least once a week and the catheter site should be monitored closely for signs of redness, swelling, and drainage. The patient's extremities should be watched for swelling, which is a sign of nutritional imbalance.

Risks

There is a risk of infection at the injection site, and for patients on long term IV therapy, the risk of an infection spreading to the entire body is fairly high. It is possible that the IV solution may not provide all of the nutri-

KEY TERMS

Home parenteral nutrition (HPN)—Long-term parenteral nutrition, given through a central venous catheter and administered in the patient's home.

Intravenous—Into a vein; a needle is inserted into a vein in the back of the hand, inside the elbow, or some other location on the body. Fluids, nutrients, and drugs can be injected.

Parenteral—Not in or through the digestive system. Parenteral nutrition is given through the veins of the circulatory system, rather than through the digestive system.

Partial parenteral nutrition (PPN)—A solution, containing some essentail nutrients, is injected into a vein to supplement other means of nutrition, usually a partially normal diet of food.

Total parenteral nutrition (TPN)—A solution containing all the required nutrients including protein, fat, calories, vitamins, and minerals, is injected over the course of several hours, into a vein. TPN provides a complete and balanced source of nutrients for patients who cannot consume a normal diet.

ents needed, leading to a deficiency or an imbalance. If the needle becomes dislodged, it is possible that the solution may flow into tissues around the injection site rather than into the vein. The patient should be monitored regularly, particulary if receiving HPN, as intravenous nutrition can potentially cause infection at the site of the catheter, high blood sugar, and low blood potassium, which can all be life-threatening.

Resources

BOOKS

Howard, Lyn. "Enteral and Parenteral Nutrition Therapy." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Parenteral Nutrition." In *The Encyclopedia of Nutrition and Good Health*. New York: Facts On File, Inc., 1997.

"Parenteral Nutrition." In *The Merck Manual*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, Merck & Co., Inc., 1992.

OTHER

"Clinical Management: Parenteral Nutrition" In *Revised Intravenous Nursing Standards of Practice*. <http://www.ins1.org>.

Altha Roberts Edgren

Nystagmus

Definition

Rhythmic, oscillating motions of the eyes are called nystagmus. The to-and-fro motion is generally involuntary. Vertical nystagmus occurs much less frequently than horizontal nystagmus and is often, but not necessarily, a sign of serious brain damage. Nystagmus can be a normal physiological response or a result of a pathologic problem.

Description

The eyes play a critical role in maintaining balance. They are directly connected to other organs of equilibrium, most important of which is the inner ear. Paired structures called the semicircular canals deep in the skull behind the ears sense motion and relay that information to balance control centers in the brain. The eyes send visual information to the same centers. A third set of sensors consists of nerve endings all over the body, particularly in joints, that detect position. All this information is integrated to allow the body to navigate in space and gravity.

It is possible to fool this system or to overload it with information so that it malfunctions. A spinning ride at the amusement park is a good way to overload it with information. The system has adapted to the spinning, expects it to go on forever, and carries that momentum for some time after it is over. Nystagmus is the lingering adjustment of the eyes to tracking the world as it revolves around them.

Nystagmus can be classified depending upon the type of motion of the eyes. In pendular nystagmus the speed of motion of the eyes is the same in both directions. In jerk nystagmus there is a slow and fast phase. The eyes move slowly in one direction and then seem to jerk back in the other direction.

Nystagmus can be present at birth (congenital) or acquired later on in life. A certain type of acquired nystagmus, called spasmus nutans, includes a head tilt and head bobbing and generally occurs between four to 12 months of age. It may last a few months to a few years, but generally goes away by itself.

Railway nystagmus is a physiological type of nystagmus. It happens when someone is on a moving train (thus the term railway) and is watching a stationary object which appears to be going by. The eyes slowly follow the object and then quickly jerk back to start over. Railway nystagmus (also called optokinetic nystagmus) is a type of jerk nystagmus. This phenomenon can be used to check vision in infants. Nystagmus can also be induced by fooling the semicircular canals. Caloric stim-

KEY TERMS

Binocular fixation—Both eye pointed to and looking at the same object.

Cataract—A clouding of the lens of the eye.

Optic atrophy—Degeneration of the optic nerve.

Semicircular canals—Structures of the inner ear that help in maintaining balance.

Vertigo—A sense of spinning usually accompanied by unsteadiness and nausea.

ulation refers to a medical method of testing their connections to the brain, and therefore to the eyes. Cold or warm water flushed into the ear canal will generate motion signals from the inner ear. The eyes will respond to this signal with nystagmus if the pathways are intact.

Causes and symptoms

There are many causes of nystagmus. Nystagmus may be present at birth. It may be a result of the lack of development of normal binocular fixation early on in life. This can occur if there is a cataract at birth or a problem is some other part of the visual system. Some other conditions that nystagmus may be associated with include:

- Albinism. This condition is caused by a decrease in pigmentation and may affect the eyes.
- Disorders of the eyes. This may include **optic atrophy**, **color blindness**, very high nearsightedness (**myopia**) or severe **astigmatism**, or opacities in the structures of the eyes.
- Acute **labyrinthitis**. This is an inflammation in the inner ear. The patient may have **dizziness** (vertigo), **nausea and vomiting**, and nystagmus.
- Brain lesions. Disease in many parts of the brain can result in nystagmus.
- Alcohol and drugs. Alcohol and some medications (e.g., anti-epilepsy medications) can induce or exaggerate nystagmus.
- Multiple sclerosis. A disease of the central nervous system.

Diagnosis

Nystagmus is a sign, not a disease. If abnormal, it indicates a problem in one of the systems controlling it. An ophthalmologist and/or neuro-ophthalmologist should be consulted.

Treatment

There is one kind of nystagmus that seems to occur harmlessly by itself. The condition, benign positional vertigo, produces vertigo and nystagmus when the head is moved in certain directions. It can arise spontaneously or after a **concussion**. **Motion sickness** medicines sometimes help. But the reaction will dissipate if continuously evoked. Each morning a patient is asked to produce the symptom by moving his or her head around until it no longer happens. This prevents it from returning for several hours or the entire day.

Prisms, contact lenses, eyeglasses, or **eye muscle surgery** are some possible treatments. These therapies may reduce the nystagmus but may not alleviate it. Again, because nystagmus may be a symptom, it is important to determine the cause.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Horton, Jonathan C. "Disorders of the Eye." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

J. Ricker Polsdorfer, MD

O

Obesity

Definition

Obesity is an abnormal accumulation of body fat, usually 20% or more over an individual's ideal body weight. Obesity is associated with increased risk of illness, disability, and **death**.

Description

Obesity traditionally has been defined as a weight at least 20% above the weight corresponding to the lowest death rate for individuals of a specific height, gender, and age (ideal weight). Twenty to forty percent over ideal weight is considered mildly obese; 40–100% over ideal weight is considered moderately obese; and 100% over ideal weight is considered severely, or morbidly, obese. More recent guidelines for obesity use a measurment called BMI (body mass index) which is the individual's weight multiplied by 703 and then divided by twice the height in inches. BMI of 25.9–29 is considered overweight; BMI over 30 is considered obese. Measurements and comparisons of waist and hip circumference can also provide some information regarding risk factors associated with weight. The higher the ratio, the greater the chance for weight-associated complications. Calipers can be used to measure skin-fold thickness to determine whether tissue is muscle (lean) or adipose tissue (fat).

Much concern has been generated about the increasing incidence of obesity among Americans. Some studies have noted an increase from 12% to 18% occurring between 1991 and 1998. Other studies have actually estimated that a full 50% of all Americans are overweight. The World Health Organization terms obesity a worldwide epidemic, and the diseases which can occur due to obesity are becoming increasingly prevalent.

Excessive weight can result in many serious, potentially life-threatening health problems, including **hypertension**, Type II **diabetes mellitus** (non-insulin dependent diabetes), increased risk for coronary disease, increased unexplained **heart attack**, hyperlipidemia, **infertility**, and a higher prevalence of colon, prostate, endometrial, and, possibly, **breast cancer**. Approximately 300,000 deaths a year are attributed to obesity, prompting leaders in public health, such as former Surgeon General C. Everett Koop, M.D., to label obesity "the second leading cause of preventable deaths in the United States."

Causes and symptoms

The mechanism for excessive weight gain is clear—more calories are consumed than the body **burns**, and the excess calories are stored as fat (adipose) tissue. However, the exact cause is not as clear and likely arises from a complex combination of factors. Genetic factors significantly influence how the body regulates the appetite and the rate at which it turns food into energy (metabolic rate). Studies of adoptees confirm this relationship—the majority of adoptees followed a pattern of weight gain that more closely resembled that of their birth parents than their adoptive parents. A genetic predisposition to weight gain, however, does not automatically mean that a person will be obese. Eating habits and patterns of physical activity also play a significant role in the amount of weight a person gains. Recent studies have indicated that the amount of fat in a person's diet may have a greater impact on weight than the number of calories it contains. Carbohydrates like cereals, breads, fruits, and vegetables and protein (fish, lean meat, turkey breast, skim milk) are converted to fuel almost as soon as they are consumed. Most fat calories are immediately stored in fat cells, which add to the body's weight and girth as they expand and multiply. A sedentary lifestyle, particularly prevalent in affluent societies, such as in the United States, can contribute to weight gain. Psychological factors, such as depression and low self-esteem may, in some cases, also play a role in weight gain.

At what stage of life a person becomes obese can effect his or her ability to lose weight. In childhood,

excess calories are converted into new fat cells (hyperplastic obesity), while excess calories consumed in adulthood only serve to expand existing fat cells (hypertrophic obesity). Since dieting and **exercise** can only reduce the size of fat cells, not eliminate them, persons who were obese as children can have great difficulty losing weight, since they may have up to five times as many fat cells as someone who became overweight as an adult.

Obesity can also be a side-effect of certain disorders and conditions, including:

- cushing's syndrome, a disorder involving the excessive release of the hormone cortisol
- hypothyroidism, a condition caused by an underactive thyroid gland
- neurologic disturbances, such as damage to the hypothalamus, a structure located deep within the brain that helps regulate appetite
- consumption of certain drugs, such as steroids or antidepressants

The major symptoms of obesity are excessive weight gain and the presence of large amounts of fatty tissue. Obesity can also give rise to several secondary conditions, including:

- arthritis and other orthopedic problems, such as lower back pain
- hernias
- heartburn
- adult-onset asthma
- gum disease
- high cholesterol levels
- gallstones
- high blood pressure
- menstrual irregularities or cessation of menstruation (amenorhhea)
- decreased fertility, and **pregnancy** complications
- shortness of breath that can be incapacitating
- sleep apnea and sleeping disorders
- skin disorders, arising from the bacterial breakdown of sweat and cellular material in thick folds of skin or from increased friction between folds
- emotional and social problems

Diagnosis

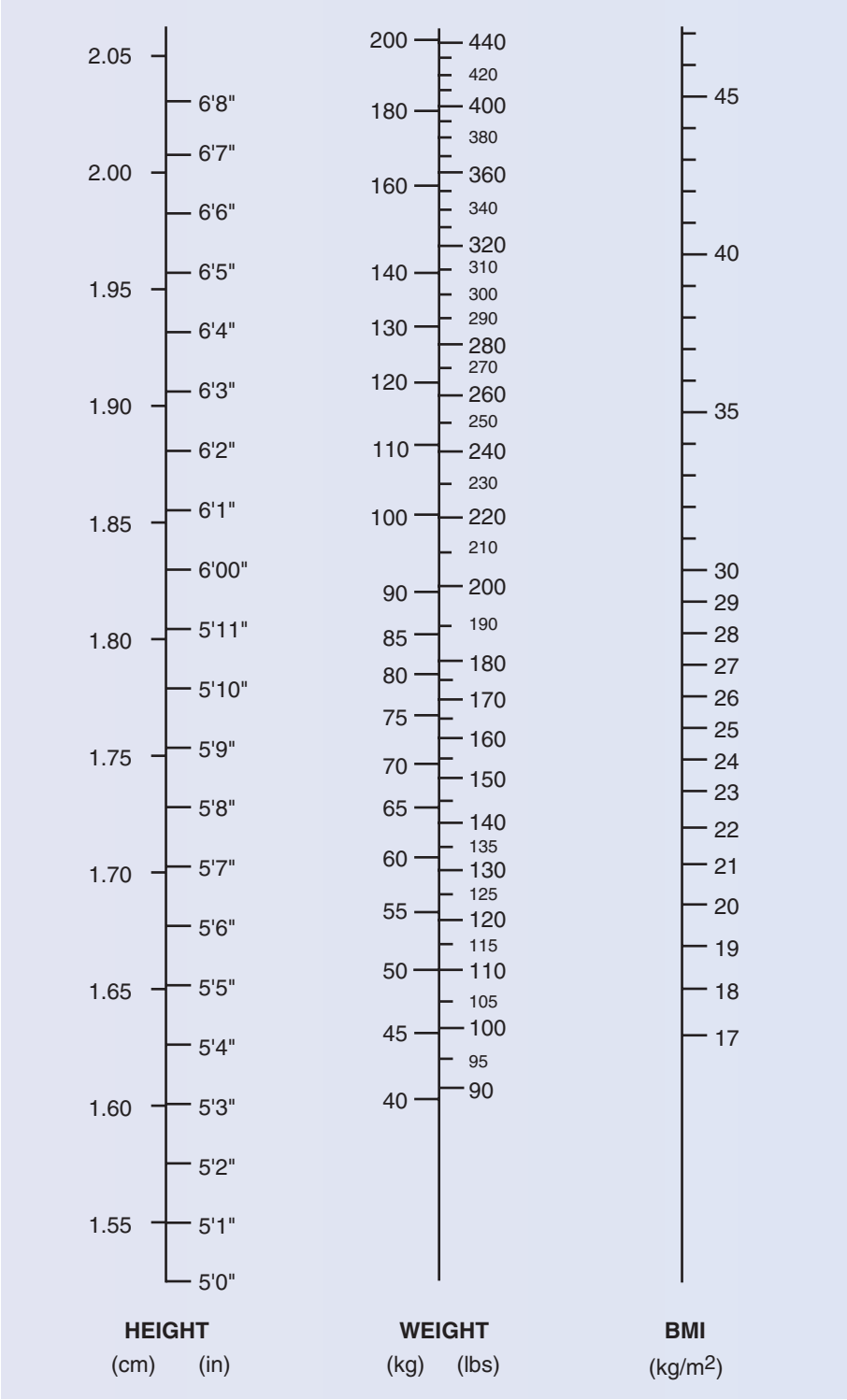
Diagnosis of obesity is made by observation and by comparing the patient's weight to ideal weight charts. Many doctors and obesity researchers refer to the body mass index (BMI), which uses a height-weight relationship to calculate an individual's ideal weight and personal risk of developing obesity-related health problems. Physicians may also obtain direct measurements of an individual's body fat content by using calipers to measure skin-fold thickness at the back of the upper arm and other sites. The most accurate means of measuring body fat content involves immersing a person in water and measuring relative displacement; however, this method is very impractical and is usually only used in scientific studies requiring very specific assessments. Women whose body fat exceeds 30% and men whose body fat exceeds 25% are generally considered obese.

Doctors may also note how a person carries excess weight on his or her body. Studies have shown that this factor may indicate whether or not an individual has a predisposition to develop certain diseases or conditions that may accompany obesity. "Apple-shaped" individuals who store most of their weight around the waist and abdomen are at greater risk for **cancer**, heart disease, **stroke**, and diabetes than "pear-shaped" people whose extra pounds settle primarily in their hips and thighs.

Treatment

Treatment of obesity depends primarily on how overweight a person is and his or her overall health. However, to be successful, any treatment must affect lifelong behavioral changes rather than short-term weight loss. "Yo-yo" dieting, in which weight is repeatedly lost and regained, has been shown to increase a person's likelihood of developing fatal health problems than if the weight had been lost gradually or not lost at all. Behavior-focused treatment should concentrate on:

- What and how much a person eats. This aspect may involve keeping a food diary and developing a better understanding of the nutritional value and fat content of foods. It may also involve changing grocery-shopping habits (e.g. buying only what is on a prepared list and only going on a certain day), timing of meals (to prevent feelings of hunger, a person may plan frequent, small meals), and actually slowing down the rate at which a person eats.
- How a person responds to food. This may involve understanding what psychological issues underlie a person's eating habits. For example, one person may binge eat when under **stress**, while another may always use food as a reward. In recognizing these psychological triggers, an individual can develop alternate coping mechanisms that do not focus on food.
- How they spend their time. Making activity and exercise an integrated part of everyday life is a key to achieving and maintaining weight loss. Starting slowly



Body/mass index can be calculated by locating your height and weight on the chart and drawing a diagonal line between the two. Where the line crosses over the third bar is the approximate BMI. *(Illustration by Argosy Inc.)*

and building endurance keeps individuals from becoming discouraged. Varying routines and trying new activities also keeps interest high.

For most individuals who are mildly obese, these behavior modifications entail life-style changes they can make independently while being supervised by a family physician. Other mildly obese persons may seek the help of a commercial weight-loss program (e.g. Weight Watchers). The effectiveness of these programs is difficult to assess, since programs vary widely, drop-out rates are high, and few employ members of the medical community. However, programs that emphasize realistic goals, gradual progress, sensible eating, and exercise can be very helpful and are recommended by many doctors. Programs that promise instant weight loss or feature severely restricted **diets** are not effective and, in some cases, can be dangerous.

For individuals who are moderately obese, medically supervised behavior modification and weight loss are required. While doctors will put most moderately obese patients on a balanced, low-calorie diet (1200–1500 calories a day), they may recommend that certain individuals follow a very-low-calorie liquid protein diet (400–700 calories) for as long as three months. This therapy, however, should not be confused with commercial liquid protein diets or commercial weight-loss shakes and drinks. Doctors tailor these diets to specific patients, monitor patients carefully, and use them for only a short period of time. In addition to reducing the amount and type of calories consumed by the patient, doctors will recommend professional therapists or psychiatrists who can help the individual effectively change his or her behavior in regard to eating.

For individuals who are severely obese, dietary changes and behavior modification may be accompanied by surgery to reduce or bypass portions of the stomach or small intestine. Such **obesity surgery**, however, can be risky, and it is only performed on patients for whom other strategies have failed and whose obesity seriously threatens their health. Other surgical procedures are not recommended, including **liposuction**, a purely cosmetic procedure in which a suction device is used to remove fat from beneath the skin, and **jaw wiring**, which can damage gums and teeth and cause painful muscle spasms.

Appetite-suppressant drugs are sometimes prescribed to aid in weight loss. These drugs work by increasing levels of serotonin or catecholamine, which are brain chemicals that control feelings of fullness. Appetite suppressants, though, are not considered truly effective, since most of the weight lost while taking them is usually regained after stopping them. Also, suppressants containing amphetamines can be potentially abused by patients. While most of the immediate side-effects of these drugs are harmless, the long-term effects of these drugs, in many cases, is unknown. Two drugs, dexfenfluramine hydrochloride (Redux) and fenfluramine (Pondimin) as well as a combination fenfluramine-phentermine (Fen/Phen) drug, were taken off the market when they were shown to cause potentially fatal heart defects. In November 1997, the United States Food and Drug Administration (FDA) approved a new weight-loss drug, sibutramine, (Meridia). Available only with a doctor's prescription, Meridia can significantly elevate blood pressure and cause **dry mouth**, **headache**, **constipation**, and **insomnia**. This medication should not be used by patients with a history of congestive **heart failure**, heart disease, stroke, or uncontrolled high blood pressure.

Other weight-loss medications available with a doctor's prescription include:

- diethylpropion (Tenuate, Tenuate dospan)
- mazindol (Mazanor, Sanorex)
- phendimetrazine (Bontril, Plegine, Prelu-2, X-Trozine)
- phentermine (Adipex-P, Fastin, Ionamin, Oby-trim)

Phenylpropanolamine (Acutrim, Dextarim) is the only nonprescription weight-loss drug approved by the FDA These over-the-counter diet aids can boost weight loss by 5%. Combined with diet and exercise and used only with a doctor's approval, prescription anti-obesity medications enable some patients to lose 10% more weight than they otherwise would. Most patients regain lost weight after discontinuing use of either prescription medications or nonprescription weight-loss products.

Prescription medications or over-the-counter weight-loss products can cause:

- constipation
- dry mouth
- headache
- irritability
- nausea
- nervousness
- sweating

None of them should be used by patients taking monoamine oxidate inhibitors (MAO inhibitors).

Doctors sometimes prescribe fluoxetine (Prozac), an antidepressant that can increase weight loss by about 10%. Weight loss may be temporary and side effects of this medication include **diarrhea**, **fatigue**, insomnia, nausea, and thirst. Weight-loss drugs currently being developed or tested include ones that can prevent fat absorption or digestion; reduce the desire for food and prompt the body to burn calories more quickly; and regu-

Height And Weight Goals

Men

Height	Small Frame	Medium Frame	Large Frame
5'2" 5'3" 5'4"	128–134 lbs. 130–136 132–138	131–141 lbs. 133–143 135–145	138–150 lbs. 140–153 142–153
5'5" 5'6" 5'7"	134–140 136–142 138–145	137–148 139–151 142–154	144–160 146–164 149–168
5'8" 5'9" 5'10"	140–148 142–151 144–154	145–157 148–160 151–163	152–172 155–176 158–180
5'11" 6'0" 6'1"	146–157 159–160 152–164	154–166 157–170 160–174	161–184 164–188 168–192
6'2" 6'3" 6'4"	155–168 158–172 162–176	164–178 167–182 171–187	172–197 176–202 181–207

Women

Height	Small Frame	Medium Frame	Large Frame
4'10" 4'11" 5'0"	102–111 lbs. 103–113 104–115	109–121 lbs. 111–123 113–126	118–131 lbs. 120–134 112–137
5'1" 5'2" 5'3"	106–118 108–121 111–124	115–129 118–132 121–135	125–140 128–143 131–147
5'4" 5'5" 5'6"	114–127 117–130 120–133	124–141 127–141 130–144	137–151 137–155 140–159
5'7" 5'8" 5'9"	123–136 126–139 129–142	133–147 136–150 139–153	143–163 146–167 149–170
5'10" 5'11" 6'0"	132–145 135–148 138–151	142–156 145–159 148–162	152–176 155–176 158–179

late the activity of substances that control eating habits and stimulate overeating.

Alternative treatment

The Chinese herb ephedra (*Ephedra sinica*), combined with **caffeine**, exercise, and a low-fat diet in physician-supervised weight-loss programs, can cause at least a temporary increase in weight loss. However, the large doses of ephedra required to achieve the desired result can also cause:

- anxiety
- heart **arrhythmias**
- heart attack
- high blood pressure
- insomnia
- irritability
- nervousness
- seizures
- strokes
- death

Ephedra should not be used by anyone with a history of diabetes, heart disease, or thyroid problems.

Diuretic herbs, which increase urine production, can cause short-term weight loss but cannot help patients achieve lasting weight control. The body responds to heightened urine output by increasing thirst to replace lost fluids, and patients who use **diuretics** for an extended period of time eventually start retaining water again anyway. In moderate doses, psyllium, a mucilaginous herb available in bulk-forming **laxatives** like Metamucil, absorbs fluid and makes patients feel as if they've eaten enough. Red peppers and mustard help patients lose weight more quickly by accelerating the metabolic rate. They also make people more thirsty, so they crave water instead of food. Walnuts contain serotonin, the brain chemical that tells the body it has eaten enough. Dandelion (*Taraxacum officinale*) can raise metabolism and counter a desire for sugary foods.

Acupressure and **acupuncture** can also suppress food cravings. Visualization and **meditation** can create and reinforce a positive self-image that enhances the patient's determination to lose weight. By improving physical strength, mental concentration, and emotional serenity, **yoga** can provide the same benefits. Also, patients who play soft, slow music during meals often find that they're eating less food but enjoying it more.

Getting the correct ratios of protein, carbohydrates, and good-quality fats can help in weight loss via enhancement of the metabolism. Support groups that are informed about healthy, nutritious, and balanced diets can offer an individual the support he or she needs to maintain this type of eating regimen.

Prognosis

As many as 85% of dieters who do not exercise on a regular basis regain their lost weight within two years. In five years, the figure rises to 90%. Repeatedly losing and regaining weight (yo yo dieting) encourages the body to store fat and may increase a patient's risk of developing heart disease. The primary factor in achieving and maintaining weight loss is a life-long commitment to regular exercise and sensible eating habits.

Prevention

Obesity experts suggest that a key to preventing excess weight gain is monitoring fat consumption

KEY TERMS

Adipose tissue—Fat tissue.

Appetite suppressant—Drug that decreases feelings of hunger. Most work by increasing levels of serotonin or catecholamine, chemicals in the brain that control appetite.

Hyperlipidemia—Abnormally high levels of lipids in blood plasma.

Hyperplastic obesity—Excessive weight gain in childhood, characterized by the creation of new fat cells.

Hypertension—High blood pressure.

Hypertrophic obesity—Excessive weight gain in adulthood, characterized by expansion of already existing fat cells.

Ideal weight—Weight corresponding to the lowest death rate for individuals of a specific height, gender, and age.

rather than counting calories, and the National Cholesterol Education Program maintains that only 30% of calories should be derived from fat. Only one-third of those calories should be contained in saturated fats (the kind of fat found in high concentrations in meat, poultry, and dairy products). Because most people eat more than they think they do, keeping a detailed food diary is a useful way to assess eating habits. Eating three balanced, moderate-portion meals a day—with the main meal at mid-day—is a more effective way to prevent obesity than **fasting** or crash diets. Exercise increases the metabolic rate by creating muscle, which burns more calories than fat. When regular exercise is combined with regular, healthful meals, calories continue to burn at an accelerated rate for several hours. Finally, encouraging healthful habits in children is a key to preventing childhood obesity and the health problems that follow in adulthood.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative & Conventional Treatments*. Alexandria, VA: Time Life, Inc. 1996.

Harris, Dan R., ed. *Diet and Nutrition Sourcebook*. Detroit, MI: Omnigraphics, 1996.

Pi-Sunyer, F. Xavier. "Obesity." In *Cecil Textbook of Medicine*, edited by Russel L. Cecil et al. Philadelphia: W.B. Saunders Company, 2000.

Slupik, Ramona I., ed. *American Medical Association Complete Guide to Women's Health*. New York: Random House, 1996.

ORGANIZATIONS

HCF Nutrition Research Foundation, Inc. P.O. Box 22124, Lexington, KY 40522. (606) 276-3119.

National Institute of Diabetes and Digestive and Kidney Diseases. 31 Center Drive, USC2560, Building 31, Room 9A-04, Bethesda, MD 20892-2560. (301) 496-3583. <http://www. niddk.nih/gov>.

National Obesity Research Foundation. Temple University, Weiss Hall 867, Philadelphia, PA 19122.

The Weight-Control Information Network. 1 Win Way, Bethesda, MD 20896-3665. (301) 951-1120. <http://www.navigator.tufts.edu/special/win.html>.

Rosalyn Carson-DeWitt

Obesity surgery

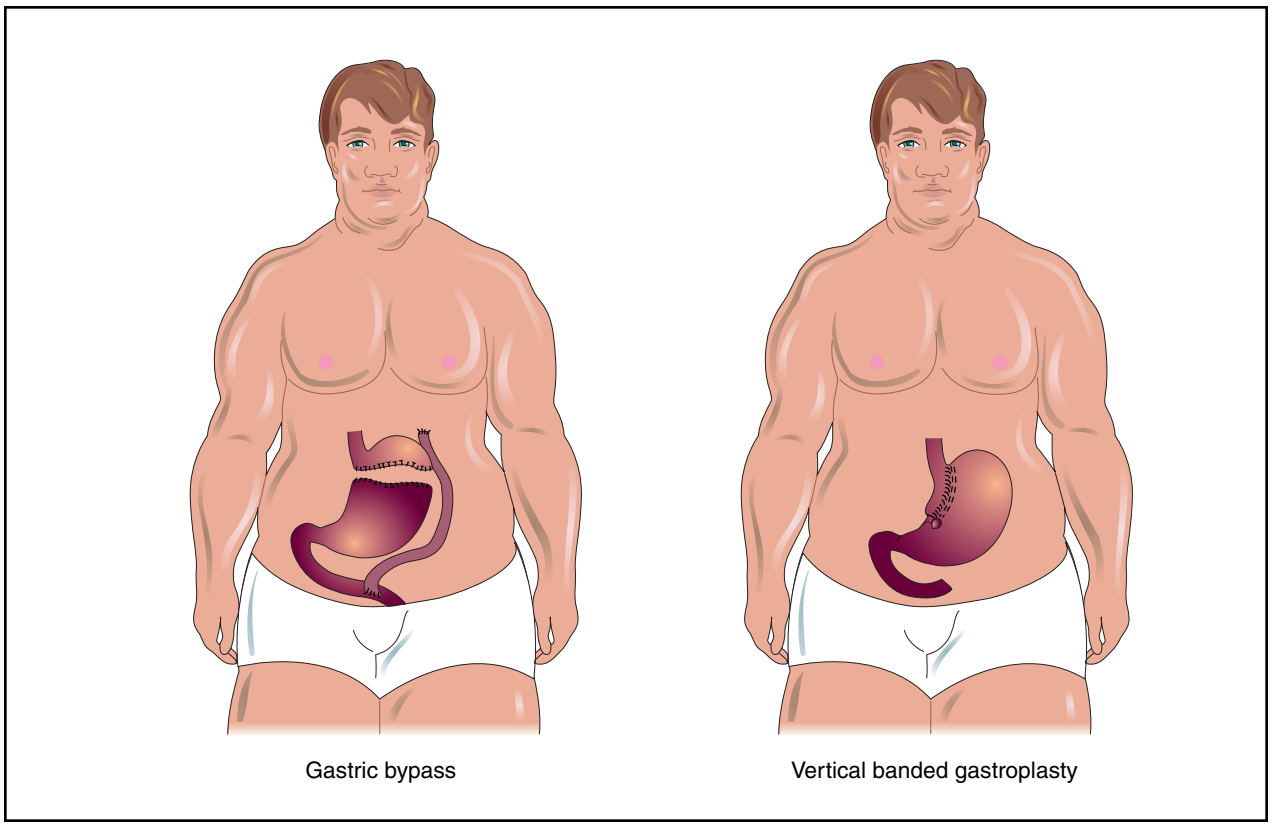
Definition

Obesity surgery is an operation that reduces or bypasses the stomach or small intestine so that severely overweight people can achieve significant and permanent weight loss.

Purpose

Obesity surgery, also called bariatric surgery, is performed only on severely overweight people who are more than twice their ideal weight. This level of obesity often is refered to as morbid obesity since it can result in many serious, and potentially deadly, health problems, including hypertenison, Type II **diabetes mellitus** (non-insulin dependent diabetes), increased risk for coronary disease, increased unexplained **heart attack**, hyperlipidemia, and a higher prevalence of colon, prostate, endometrial, and, possibly, **breast cancer**. Therefore, this surgery is performed on people whose risk of complications of surgery is outweighed by the need to lose weight to prevent health complications, and for whom supervised weight loss and **exercise** programs have repeatedly failed. Obesity surgery, however, does not make people thin. Most people lose about 60% of their excess weight through this treatment. Changes in diet and exercise are still required to maintain a normal weight.

The theory behind obesity surgery is that if the volume the stomach holds is reduced and the entrance into the intestine is made smaller to slow stomach emptying, or part of the small intestine is bypassed or shortened, people will not be able to consume and/or absorb as



The purpose of obesity surgery is to reduce the size of the stomach and slow the stomach emptying process by narrowing the entrance into the intestine. With this surgery, the volume of food the stomach can hold is reduced from approximately 4 cups to approximately one-half a cup. There are two types of procedures used for obesity surgery: gastric bypass surgery, and vertical banded gastroplasty, as shown in the illustration above. *(Illustration by Electronic Illustrators Group.)*

many calories. With obesity surgery the volume of food the stomach can hold is reduced from about four cups to about 1/2 a cup.

Insurers may consider obesity surgery elective surgery and not cover it under their policy. Documentation of the necessity for surgery and approval from the insurer should be sought before this operation is performed.

Precautions

Obesity surgery should not be performed on people who are less than twice their ideal weight. It is also not appropriate for people who have substance addictions or who have psychological disorders. Other considerations in choosing candidates for obesity surgery include the general health of the person and his or her willingness to comply with follow-up treatment.

Description

Obesity surgery is usually performed in a hospital by a surgeon who has experience with obesity surgery or at a center that specializes in the procedure. General anesthesia is used, and the operation takes 2–3 hours. The hospital stay lasts about a week.

Three procedures are currently used for obesity surgery:

- Gastric bypass surgery. Probably the most common type of obesity surgery, gastric bypass surgery has been performed in the United States for about 25 years. In this procedure, the volume of the stomach is reduced by four rows of stainless steel staples that separate the main body of the stomach from a small, newly created pouch. The pouch is attached at one end to the esophagus. At the other end is a very small opening into the small intestine. Food flows though this pouch, bypassing the main portion of the stomach and emptying slowly into the small intestine where it is absorbed.
- Vertical banded gastroplasty. In this procedure an artificial pouch is created using staples in a different section of the stomach. Plastic mesh is sutured into part of the pouch to prevent it from dilating. In both surgeries the food enters the small intestine farther along that it

would enter if exiting the stomach normally. This reduces the time available for absorption of nutrients.

- Jejuoileal bypass. Now a rarely performed procedure, jejuoileal bypass involves shortening the small intestine. Because of the high occurance of serious complications involving chronic **diarrhea** and liver disease, it has largely been abandoned for the other, safer procedures

Preparation

After patients are carefully selected as appropriate for obesity surgery, they receive standard preoperative blood and urine tests and meet with an anesthesiologist to discuss how their health may affect the administration of anesthesia. Pre-surgery counseling is done to help patients anticipate what to expect after the operation.

Aftercare

Immediately after the operation, most patients are restricted to a liquid diet for two to three weeks; however, some may remain on it for up to 12 weeks. Patients then move on to a diet of pureed food for about a month, and, after about two months, most can tolerate solid food. High fat food is restricted because it is hard to digest and causes diarrhea. Patients are expected to work on changing their eating and exercise habits to assist in weight loss. Most people eat three to four small meals a day once they return to solid food. Eating too quickly or too much after obestity surgery can cause **nausea and vomiting** as well as intestinal "dumping," a condition in which undigested food is shunted too quickly into the small intestine, causing **pain**, diarrhea, weakness, and **dizziness**.

Risks

As in any abdominal surgery, there is always a risk of excessive bleeding, infection, and allergic reaction to anesthesia. Specific risks associated with obesity surgery include leaking or stretching of the pouch and loosening of the gastric staples. Although the average **death** rate associated with this procedure is less than one percent, the rate varies from center to center, ranging from 0–4%. Long term failure rates can reach 50%, sometimes making additional surgery necessary. Other complications of obesity surgery include an intolerance to foods high in fats, **lactose intolerance**, bouts of vomiting, diarrhea, and intestinal discomfort

Normal results

Many people lose about 60% of the weight they need to reach their ideal weight through obesity surgery. However, surgery is not a magic weight-loss operation, and success also depends on the patient's willingness to exercise and eat low-calorie foods.

Resources

PERIODICALS

Gallager, Sharon, and R. Armour Forse. "Gastric Bypass." *Diabetes Forecast* 47 (Dec. 1994): 52.

Sadovsky, Richard. "Surgical Treatments for Obesity: Selection of Patients." *American Family Physician* 56 (Dec. 1997): 2320.

Tish Davidson

Obsessive-compulsive disorder

Definition

Obsessive-compulsive disorder (OCD) is a type of **anxiety** disorder. Anxiety disorder is the experience of prolonged, excessive worry about circumstances in one's life. OCD is characterized by distressing repetitive thoughts, impulses or images that are intense, frightening, absurd, or unusual. These thoughts are followed by ritualized actions that are usually bizarre and irrational. These ritual actions, known as compulsions, help reduce anxiety caused by the individual's obsessive thoughts. Often described as the "disease of doubt," the sufferer usually knows the obsessive thoughts and compulsions are irrational but, on another level, fears they may be true.

Description

Almost one out of every 40 people will suffer from obsessive-compulsive disorder at some time in their lives. The condition is two to three times more common than either **schizophrenia** or manic depression, and strikes men and women of every ethnic group, age and social level. Because the symptoms are so distressing, sufferers often hide their fears and rituals but cannot avoid acting on them. OCD sufferers are often unable to decide if their fears are realistic and need to be acted upon.

Most people with obsessive-compulsive disorder have both obsessions and compulsions, but occasionally a person will have just one or the other. The degree to which this condition can interfere with daily living also varies. Some people are barely bothered, while others find the obsessions and compulsions to be profoundly traumatic and spend much time each day in compulsive actions.

Obsessions are intrusive, irrational thoughts that keep popping up in a person's mind, such as "my hands are

dirty, I must wash them again." Typical obsessions include fears of dirt, germs, contamination, and violent or aggressive impulses. Other obsessions include feeling responsible for others' safety, or an irrational fear of hitting a pedestrian with a car. Additional obsessions can involve excessive religious feelings or intrusive sexual thoughts. The patient may need to confess frequently to a religious counselor or may fear acting out the strong sexual thoughts in a hostile way. People with obsessive-compulsive disorder may have an intense preoccupation with order and symmetry, or be unable to throw anything out.

Compulsions usually involve repetitive rituals such as excessive washing (especially handwashing or bathing), cleaning, checking and touching, counting, arranging or hoarding. As the person performs these acts, he may feel temporarily better, but there is no long-lasting sense of satisfaction or completion after the act is performed. Often, a person with obsessive-compulsive disorder believes that if the ritual isn't performed, something dreadful will happen. While these compulsions may temporarily ease **stress**, short-term comfort is purchased at a heavy price—time spent repeating compulsive actions and a long-term interference with life.

The difference between OCD and other compulsive behavior is that while people who have problems with gambling, overeating or with substance abuse may appear to be compulsive, these activities also provide pleasure to some degree. The compulsions of OCD, on the other hand, are never pleasurable.

OCD may be related to some other conditions, such as the continual urge to pull out body hair (trichotillomania); fear of having a serious disease (**hypochondriasis**) or preoccupation with imagined defects in personal appearance disorder (body dysmorphia). Some people with OCD also have **Tourette syndrome**, a condition featuring tics and unwanted vocalizations (such as swearing). OCD is often linked with depression and other **anxiety disorders**.

Causes and symptoms

While no one knows for sure, research suggests that the tendency to develop obsessive-compulsive disorder is inherited. There are several theories behind the cause of OCD. Some experts believe that OCD is related to a chemical imbalance within the brain that causes a communication problem between the front part of the brain (frontal lobe) and deeper parts of the brain responsible for the repetitive behavior. Research has shown that the orbital cortex located on the underside of the brain's frontal lobe is overactive in OCD patients. This may be one reason for the feeling of alarm that pushes the patient into compulsive, repetitive actions. It is possible that people with OCD experience overactivity deep within the brain that causes the cells to get "stuck," much like a jammed transmission in a car damages the gears. This could lead to the development of rigid thinking and repetitive movements common to the disorder. The fact that drugs which boost the levels of serotonin, a brain messenger substance linked to emotion and many different anxiety disorders, in the brain can reduce OCD symptoms may indicate that to some degree OCD is related to levels of serotonin in the brain.

Recently, scientists have identified an intriguing link between childhood episodes of **strep throat** and the development of OCD. It appears that in some vulnerable children, strep antibodies attack a certain part of the brain. Antibodies are cells that the body produces to fight specific diseases. That attack results in the development of excessive washing or germ **phobias**. A phobia is a strong but irrational fear. In this instance the phobia is fear of disease germs present on commonly handled objects. These symptoms would normally disappear over time, but some children who have repeated infections may develop full-blown OCD. Treatment with **antibiotics** has resulted in lessening of the OCD symptoms in some of these children.

If one person in a family has obsessive-compulsive disorder, there is a 25% chance that another immediate family member has the condition. It also appears that stress and psychological factors may worsen symptoms, which usually begin during adolescence or early adulthood.

Diagnosis

People with obsessive-compulsive disorder feel ashamed of their problem and often try to hide their symptoms. They avoid seeking treatment. Because they can be very good at keeping their problem from friends and family, many sufferers don't get the help they need until the behaviors are deeply ingrained habits and hard to change. As a result, the condition is often misdiagnosed or underdiagnosed. All too often, it can take more than a decade between the onset of symptoms and proper diagnosis and treatment.

While scientists seem to agree that OCD is related to a disruption in serotonin levels, there is no blood test for the condition. Instead, doctors diagnose OCD after evaluating a person's symptoms and history.

Treatment

Obsessive-compulsive disorder can be effectively treated by a combination of **cognitive-behavioral therapy** and medication that regulates the brain's serotonin levels. Drugs that are approved to treat obsessive-compulsive dis-

order include fluoxetine (Prozac), fluvoxamine (Luvox), paroxetine (Paxil), and sertraline (Zoloft), all **selective serotonin reuptake inhibitors** (SSRI's) that affect the level of serotonin in the brain. Older drugs include the antidepressant clomipramine (Anafranil), a widely-studied drug in the treatment of OCD, but one that carries a greater risk of side effects. Drugs should be taken for at least 12 weeks before deciding whether or not they are effective.

Cognitive-behavioral therapy (CBT) teaches patients how to confront their fears and obsessive thoughts by making the effort to endure or wait out the activities that usually cause anxiety without compulsively performing the calming rituals. Eventually their anxiety decreases. People who are able to alter their thought patterns in this way can lessen their preoccupation with the compulsive rituals. At the same time, the patient is encouraged to refocus attention elsewhere, such as on a hobby.

In a few severe cases where patients have not responded to medication or behavioral therapy, brain surgery may be tried as a way of relieving the unwanted symptoms. Surgery can help up to a third of patients with the most severe form of OCD. The most common operation involves removing a section of the brain called the cingulate cortex. The serious side effects of this surgery for some patients include seizures, personality changes and less ability to plan.

Alternative treatment

Because OCD sometimes responds to SSRI antidepressants, a botanical medicine called **St. John's wort** (*Hypericum perforatum*) might have some beneficial effect as well, according to herbalists. Known popularly as "Nature's Prozac," St. John's wort is prescribed by herbalists for the treatment of anxiety and depression. They believe that this herb affects brain levels of serotonin in the same way that SSRI antidepressants do. Herbalists recommend a dose of 300 mg., three times per day. In about one out of 400 people, St. John's wort (like Prozac) may initially increase the level of anxiety. Homeopathic constitutional therapy can help rebalance the patient's mental, emotional, and physical well-being, allowing the behaviors of OCD to abate over time.

Prognosis

Obsessive-compulsive disorder is a chronic disease that, if untreated, can last for decades, fluctuating from mild to severe and worsening with age. When treated by a combination of drugs and behavioral therapy, some patients go into complete remission. Unfortunately, not all patients have such a good response. About 20% of people cannot find relief with either drugs or behavioral therapy. Hospitalization may be required in some cases.

KEY TERMS

Anxiety disorder—This is the experience of prolonged, excessive worry about circumstances in one's life. It disrupts daily life.

Cognitive-behavior therapy—A form of psychotherapy that seeks to modify behavior by manipulating the environment to change the patient's response.

Compulsion—A rigid behavior that is repeated over and over each day.

Obsession—A recurring, distressing idea, thought or impulse that feels "foreign" or alien to the individual.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvex, and Paxil.

Serotonin—One of three major neurotransmitters found in the brain that is related to emotion, and is linked to the development of depression and obsessive-compulsive disorder.

Despite the crippling nature of the symptoms, many successful doctors, lawyers, business people, performers and entertainers function well in society despite their condition. Nevertheless, the emotional and financial cost of obsessive-compulsive disorder can be quite high.

Resources

BOOKS

Dumont, Raeann. *The Sky is Falling: Understanding and Coping with Phobias, Panic and Obsessive-Compulsive Disorders*. New York: W. W. Norton & Co., 1996.

Foa, E., and R. Wilson. *Stop Obsessing! How to Overcome Your Obsessions and Compulsions*. New York: Bantam, 1991.

Schwartz, Jeffrey. *Brain Lock*. New York: HarperCollins, 1996.

Schwartz, Jeffrey. *Free Yourself from Obsessive-Compulsive Behavior: A Four-Step Self-Treatment Method to Change Your Brain Chemistry.* New York: HarperCollins, 1996.

Swedo, S. E., and H. L. Leonard. *It's Not All In Your Head.* New York: HarperCollins, 1996.

PERIODICALS

Hiss, H., E. B. Foa, and M. J. Kozak. "Relapse Prevention Program for Treatment of Obsessive-Compulsive Disorder." *Journal of Consulting and Clinical Psychology* 62 (1994): 801-808.

"How Do Treatments for Obsessive-Compulsive Disorder Compare?" *Harvard Mental Health Letter* (July 1995).
Jenike, Michael A., and Scott L. Rauch. "Managing the Patient with Treatment-Resistant Obsessive-Compulsive Disorder." *Journal of Clinical Psychiatry* 55, no. 3 (1994): 11-17.
Talan, Jamie. "A Link to Strep, Behavior: The Infection May Trigger Obsessive-Compulsive Symptoms." *Newsday*, 21 May 1996, B31.

ORGANIZATIONS

Anxiety Disorders Association of America. 11900 Park Lawn Drive, Ste. 100, Rockville, MD 20852. (800) 545-7367. <http://www.adaa.org>.
National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.
National Anxiety Foundation. 3135 Custer Dr., Lexington, KY 40517. (606) 272-7166. <http://www.lexington-on-line.com/naf.html>.
National Institutes of Mental Health (NIMH). 6001 Executive Boulevard, Rm. 8184, MSC 9663
National Mental Health Association. 1021 Prince St., Alexandria, VA 22314. (703) 684-7722. <http://www.nmha.org>.
Obsessive-Compulsive Anonymous. P.O. Box 215, New Hyde Park, NY 11040. (516) 741-4901. <west24th@aol.com>. <http://members.aol.com/west24th/index.html>.
Obsessive-Compulsive Foundation. P.O. Box 70, Milford, CT 06460. (203) 874-3843. <JPHS28A@Prodigy.com>. <http://pages.prodigy.com/alwillen/ocf.html>.

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Obsessive compulsive personality disorder *see* **Personality disorders**

Obstetric sonogram *see* **Pelvic ultrasound**

Obstetrical emergencies

Definition

Obstetrical emergencies are life-threatening medical conditions that occur in **pregnancy** or during or after labor and delivery.

Description

There are a number of illnesses and disorders of pregnancy that can threaten the well-being of both mother and child. Obstetrical emergencies may also occur during active labor, and after delivery (postpartum).

Obstetrical emergencies of pregnancy

ECTOPIC PREGNANCY. An ectopic, or tubal, pregnancy occurs when the fertilized egg implants itself in the fallopian tube rather than the uterine wall. If the pregnancy is not terminated at an early stage, the fallopian tube will rupture, causing internal hemorrhaging and potentially resulting in permanent **infertility**.

PLACENTAL ABRUPTION. Also called *abruptio placenta*, **placental abruption** occurs when the placenta separates from the uterus prematurely, causing bleeding and contractions. If over 50% of the placenta separates, both the fetus and mother are at risk.

PLACENTA PREVIA. When the placenta attaches to the mouth of the uterus and partially or completely blocks the cervix, the position is termed *placenta previa* (or low-lying placenta). **Placenta previa** can result in premature bleeding and possible postpartum hemorrhage.

PREECLAMPSIA/ECLAMPSIA. Preeclampsia (toxemia), or pregnancy-induced high blood pressure, causes severe **edema** (swelling due to water retention) and can impair kidney and liver function. The condition occurs in approximately 5% of all United States pregnancies. If it progresses to eclampsia, toxemia is potentially fatal for mother and child.

PREMATURE RUPTURE OF MEMBRANES (PROM). **Premature rupture of membranes** is the breaking of the bag of waters (amniotic fluid) before contractions or labor begins. The situation is only considered an emergency if the break occurs before thirty-seven weeks and results in significant leakage of amniotic fluid and/or infection of the amniotic sac.

Obstetrical emergencies during labor and delivery

AMNIOTIC FLUID EMBOLISM. A rare but frequently fatal complication of labor, this condition occurs when amniotic fluid embolizes from the amniotic sac and through the veins of the uterus and into the circulatory system of the mother. The fetal cells present in the fluid then block or clog the pulmonary artery, resulting in **heart attack**. This complication can also happen during pregnancy, but usually occurs in the presence of strong contractions.

INVERSION OR RUPTURE OF UTERUS. During labor, a weak spot in the uterus (such as a scar or a uterine wall that is thinned by a **multiple pregnancy**) may tear, resulting in a uterine rupture. In certain circumstances, a portion of the placenta may stay attached to the wall and will pull the uterus out with it during delivery. This is called uterine inversion.

PLACENTA ACCRETA. *Placenta accreta* occurs when the placenta is implanted too deeply into the uterine wall, and will not detach during the late stages of **childbirth**, resulting in uncontrolled bleeding.

PROLAPSED UMBILICAL CORD. A prolapse of the umbilical cord occurs when the cord is pushed down into the cervix or vagina. If the cord becomes compressed, the oxygen supply to the fetus could be diminished, resulting in brain damage or possible **death**.

SHOULDER DYSTOCIA. Shoulder dystocia occurs when the baby's shoulder(s) becomes wedged in the birth canal after the head has been delivered.

Obstetrical emergencies postpartum

POSTPARTUM HEMORRHAGE OR INFECTION. Severe bleeding or uterine infection occurring after delivery is a serious, potentially fatal situation.

Causes and symptoms

Obstetrical emergencies can be caused by a number of factors, including **stress**, trauma, genetics, and other variables. In some cases, past medical history, including previous pregnancies and deliveries, may help an obstetrician anticipate the possibility of complications.

Signs and symptoms of an obstetrical emergency include, but are not limited to:

- Diminished fetal activity. In the late third trimester, fewer than ten movements in a two hour period may indicate that the fetus is in distress.
- Abnormal bleeding. During pregnancy, brown or white to pink vaginal discharge is normal, bright red blood or blood containing large clots is not. After delivery, continual blood loss of over 500 ml indicates hemorrhage.
- Leaking amniotic fluid. Amniotic fluid is straw-colored and may easily be confused with urine leakage, but can be differentiated by its slightly sweet odor.
- Severe abdominal **pain**. Stomach or lower back pain can indicate preeclampsia or an undiagnosed **ectopic pregnancy**. Postpartum stomach pain can be a sign of infection or hemorrhage.
- Contractions. Regular contractions before 37 weeks of gestation can signal the onset of preterm labor due to obstetrical complications.
- Abrupt and rapid increase in blood pressure. **Hypertension** is one of the first signs of toxemia.
- Edema. Sudden and significant swelling of hands and feet caused by fluid retention from toxemia.
- Unpleasant smelling vaginal discharge. A thick, malodorous discharge from the vagina can indicate a postpartum infection.
- **Fever**. Fever may indicate an active infection.
- Loss of consciousness. **Shock** due to blood loss (hemorrhage) or amniotic **embolism** can precipitate a loss of consciousness in the mother.
- Blurred vision and headaches. Vision problems and **headache** are a possible symptom of preeclampsia.

Diagnosis

Diagnosis of an obstetrical emergency typically takes place in a hospital or other urgent care facility. A specialist will take the patient's medical history and perform a pelvic and general **physical examination**. The mother's vital signs are taken, and if preeclampsia is suspected, blood pressure may be monitored over a period of time. The fetal heartbeat is assessed with a doppler stethoscope, and diagnostic blood and urine tests of the mother may also be performed, including laboratory analysis for protein and/or bacterial infection. An **abdominal ultrasound** may aid in the diagnosis of any condition that involves a malpositioned placenta, such as placenta previa or placenta abruption.

In cases where an obstetrical complication is suspected, a fetal heart monitor is positioned externally on the mother's abdomen. If the fetal heart rate is erratic or weak, or if it does not respond to movement, the fetus may be in distress. A biophysical profile (BPP) may also be performed to evaluate the health of the fetus. The BPP uses data from an ultrasound examination to analyze the fetus size, movement, heart rate, and surrounding amniotic fluid.

If the mother's membranes have ruptured and her cervix is partially dilated, an internal fetal scalp electrode can be inserted through the vagina to assess heart rate. A fetal oximetry monitor that measures the oxygen saturation levels of the fetus may also be attached to the scalp.

Treatment

Obstetrical emergencies of pregnancy

ECTOPIC PREGNANCY. Treatment of an ectopic pregnancy is laparoscopic surgical removal of the fertilized ovum. If the fallopian tube has burst or been damaged, further surgery will be necessary.

PLACENTAL ABRUPTION. In mild cases of placental abruption, bed rest may prevent further separation of the placenta and stem bleeding. If a significant abruption (over 50%) occurs, the fetus may have to be delivered immediately and a blood **transfusion** may be required.

PLACENTA PREVIA. Hospitalization or highly restricted at-home bed rest is usually recommended if placenta previa is diagnosed after the twentieth week of pregnancy. If the

fetus is at least 36 weeks old and the lungs are mature, a **cesarean section** is performed to deliver the baby.

PREECLAMPSIA/ECLAMPSIA. Treatment of preeclampsia depends upon the age of the fetus and the acuteness of the condition. A woman near full term who has only mild toxemia may have labor induced to deliver the child as soon as possible. Severe preeclampsia in a woman near term also calls for immediate delivery of the child, as this is the only known cure for the condition. However, if the fetus is under 28 weeks, the mother may be hospitalized and steroids may be administered to try to hasten lung development in the fetus. If the life of the mother or fetus appears to be in danger, the baby is delivered immediately, usually by cesarean section.

PREMATURE RUPTURE OF MEMBRANES (PROM). If PROM occurs before 37 weeks and/or results in significant leakage of amniotic fluid, a course of intravenous **antibiotics** is started. A culture of the cervix may be taken to analyze for the presence of bacterial infection. If the fetus is close to term, labor is typically induced if contractions do not start within 24 hours of rupture.

KEY TERMS

Amniotic fluid—The liquid in the placental sac that cushions the fetus and regulates temperature in the placental environment. Amniotic fluid also contains fetal cells.

Cesarean section—The surgical delivery of a fetus through an incision in the uterus.

Embolism—Blood vessel obstruction by a blood clot or other substance (i.e., air, cell matter).

Episiotomy—Incision of the perineum, the area between the vulva and the anus, to assist delivery and avoid severe tearing of the perineum.

Postpartum—After childbirth.

Laparoscopic—A minimally-invasive surgical or diagnostic procedure that uses a flexible endoscope (laparoscope) to view and operate on structures in the abdomen.

Obstetrical emergencies during labor and delivery

AMNIOTIC FLUID EMBOLISM. The stress of contractions can cause this complication, which has a high mortality rate. Administering steroids to the mother and delivering the fetus as soon as possible is the standard treatment.

INVERSION OR RUPTURE OF UTERUS. An inverted uterus is either manually or surgical replaced to the proper position. A ruptured uterus is repaired if possible, although if the damage is extreme, a **hysterectomy** (removal of the uterus) may be performed. A blood transfusion may be required in either case if hemorrhaging occurs.

PLACENTA ACCRETA. Women who experience placenta accreta will typically need to have their placenta surgically removed after delivery. Hysterectomy is necessary in some cases.

PROLAPSED UMBILICAL CORD. Saline may be infused into the vagina to relieve the compression. If the cord has prolapsed out the vaginal opening, it may be replaced, but immediate delivery by cesarean section is usually indicated.

Obstetrical emergencies postpartum

POSTPARTUM HEMORRHAGE OR INFECTION. The source of the hemorrhage is determined, and blood transfusion and IV fluids are given as necessary. Oxytocic drugs may be administered to encourage contraction of the uterus. Retained placenta is a frequent cause of persistent bleeding, and surgical removal of the remaining fragments (curettage) may be required. Surgical repair of lacerations to the birth canal or uterus may be required. Drugs that encourage coagulation (clotting) of the blood may be administered to stem the bleeding. Infrequently, hysterectomy is required.

In cases of infection, a course of intravenous antibiotics is prescribed. Most postpartum infections occur in the endometrium, or lining of the uterus, and may be also caused by a piece of retained placenta. If this is the case, it will also require surgical removal.

SHOULDER DYSTOCIA. The mother is usually positioned with her knees to her chest, known as the McRoberts maneuver, in an effort to free the child's shoulder. An **episiotomy** is also performed to widen the vaginal opening. If the shoulder cannot be dislodged from the pelvis, the baby's clavicle (collarbone) may have to be broken to complete the delivery before a lack of oxygen causes brain damage to the infant.

Prognosis

If a fetus is close to full-term (37 weeks) and the complication is detected early enough, the prognosis is usually good for mother and child. With advances in neonatal care, approximately 85% of infants weighing less than 3 lbs 5 oz survive, and these infants are being delivered at 28 weeks and younger. However, preterm infants have a greater chance of serious medical problems, and develop-

mental disabilities occur in 25–50%. They also have a higher incidence of **learning disorders**, and are four to six times more likely to be diagnosed with attention-deficit hyperactivity disorder (**ADHD**).

Prevention

Proper prenatal care is the best prevention for obstetrical emergencies. When complications of pregnancy do arise, pregnant women who see their OB/GYN on a regular basis are more likely to get an early diagnosis, and with it, the best chance for fast and effective treatment. In addition, eating right and taking prenatal **vitamins** and supplements as recommended by a physician will also contribute to the health of both mother and child.

Resources

BOOKS

Pearlman, Mark D and Judith Tintinalli, eds. *Emergency Care of the Woman*. New York: McGraw-Hill, 1998.

PERIODICALS

Chamberlain, Geoffrey and Phillip Steer. "Obstetric Emergencies." *British Medical Journal*. 318, no.7194(May 1999):1342.

"Women's Lives at Risk: Preventable Deaths, Avoidable Injuries." *Population Reports*. 25, no.1(Sept 1997):3.

ORGANIZATIONS

National Institute of Child Health and Human Development (NICHD) Clearinghouse. Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD 20892-2425. (800) 370-2943. <http://www.nichd.nih.gov/publications/health.htm>.

Occupational asthma

Definition

Occupational **asthma** is a form of lung disease in which the breathing passages shrink, swell, or become inflamed or congested as a result of exposure to irritants in the workplace.

Description

As many as 15% of all cases of asthma may be related to on-the-job exposure to:

- animal hair
- dander
- dust composed of bacteria, protein, or organic matter like cereal, grains, cotton, and flax
- fumes created by metal soldering

Occupations Associated With Asthma

Animal Handling
Bakeries
Health Care
Jewelry Making
Laboratory Work
Manufacturing Detergents
Nickel Plating
Soldering
Snow Crab and Egg Processing
Tanneries

- insulation and packaging materials
- mites and other insects
- paints

Hundreds of different types of jobs involve exposure to substances that could trigger occupational asthma, but only a small fraction of people who do such work develop this disorder. Occupational asthma is most apt to affect workers who have personal or family histories of **allergies** or asthma, or who are often required to handle or breathe dust or fumes created by especially irritating material.

Causes and symptoms

More than 240 causes of occupational asthma have been identified. Even short-term exposure to low levels of one or more irritating substances can cause a very sensitive person to develop symptoms of occupational asthma. A person who has occupational asthma has one or more symptoms, including coughing, **shortness of breath**, tightness in the chest, and **wheezing**. Symptoms may appear less than 24 hours after the person is first exposed to the irritant or develop two or three years later.

At first, symptoms appear while the person is at work or several hours after the end of the workday. Symptoms disappear or diminish when the person spends time away from the workplace and return or intensify when exposure is renewed.

As the condition becomes more advanced, symptoms sometimes occur even when the person is not in the workplace. Symptoms may also develop in response to minor sources of lung irritation.

Diagnosis

An allergist, occupational medicine specialist, or a doctor who treats lung disease performs a thorough **physical examination** and takes a medical history that explores:

- the kind of work the patient has done
- the types of exposures the patient may have experienced

ALICE HAMILTON (1869–1970)

(AP/Wide World Photos. Reproduced by permission.)

Alice Hamilton was born on February 27, 1869, in New York City, the second of five children born to Montgomery Hamilton, a wholesale grocer,and Gertrude (Pond) Hamilton. She earned a medical degree from the University of Michigan in 1893, without having completed an undergraduate degree and taking surprisingly few science courses. Realizing that she wanted to pursue research rather than medical practice, Hamilton went on to do further studies both in the United States and abroad: from 1895–1896 at Leipzig and Munich; 1896–1897 at Johns Hopkins; and 1902 in Paris at the Pasteur Institute. In 1897 she accepted a post as professor of pathology at the Women's Medical College at Northwestern University in Chicago.

In Chicago Hamilton became a resident of Hull House, the pioneering settlement designed to give care and advice to the poor of Chicago. Here, under the influence of Jane Addams, the founder of Hull House, Hamilton saw the effects of poverty up close, leading her to a lifelong career focused on industrial medicine.

Alice Hamilton was a pioneer in correcting the medical problems caused by industrialization, awakening the country in the early twentieth century to the dangers of industrial poisons and hazardous working conditions. Through her untiring efforts, toxic substances in the lead, mining, painting,pottery, and rayon industries were exposed and legislation passed to protect workers. She was also a champion of worker's compensation laws, and was instrumental in bringing about this type of legislation in the state of Illinois. A medical doctor and researcher, she was the first woman of faculty status at Harvard University, and was a consultant on governmental commissions, both domestic and foreign.

- what symptoms the patient has had
- when, how often, and how severely they have occurred

Performed before and after work, pulmonary function tests can show how job-related exposures affect the airway. Laboratory analysis of blood and sputum may confirm a diagnosis of workplace asthma. To pinpoint the cause more precisely, the doctor may ask the patient to inhale specific substances and monitor the body's response to them. This is called a challenge test.

Treatment

The most effective treatment for occupational asthma is to reduce or eliminate exposure to symptom-producing substances.

Medication may be prescribed for workers who can't prevent occasional exposure. Medication, physical therapy, and breathing aids may all be needed to relieve symptoms of advanced occupational asthma involving airway damage.

A patient who has occupational asthma should learn what causes symptoms and how to control them, and what to do when an asthma attack occurs.

Because asthma symptoms and the substances that provoke them can change, a patient who has occupational asthma should be closely monitored by a family physician, allergist, or doctor who specializes in occupational medicine or lung disease.

Prognosis

Occupational asthma is usually reversible. However, continued exposure to the symptom-producing substance can cause permanent lung damage.

In time, occupational asthma can cause asthma-like symptoms to occur when the patient is exposed to tobacco smoke, household dust, and other ordinary irritants.

Smoking aggravates symptoms of occupational asthma. Patients who eliminate workplace exposure and stop smoking are more apt to recover fully than those who change jobs but continue to smoke.

Prevention

Industries and environments whose employees have a heightened exposure to substances known to cause occupational asthma can take measures to diminish or eliminate the amount of pollution in the atmosphere or decrease the number of workers exposed to it.

Regular medical screening of workers in these environments may enable doctors to diagnose occupational asthma before permanent lung damage takes place.

Resources

ORGANIZATIONS

American College of Allergy, Asthma & Immunology. 85 West Algonquin Road, Suite 550, Arlington Heights, IL 60005. (847) 427-1200.

OTHER

"Occupational Asthma." *American Lung Association Page.* 16 May 1998 <http://www.lungusa.org>.

"On-Job Exposure Triggers Asthma." *The Detroit News* 15 Dec. 1997. 16 May 1998 <http://detnews.com/1997/discover/9712/16/12150021.htm>.

Maureen Haggerty

Occupational therapy *see* **Rehabilitation**

Ocular myopathy *see* **Ophthalmoplegia**

Ocular rosacea *see* **Rosacea**

Ofloxacin *see* **Fluoroquinolones**

Ohio Valley disease *see* **Histoplasmosis**

Oligomenorrhea

Definition

Medical dictionaries define oligomenorrhea as infrequent or very light menstruation. But physicians typically apply a narrower definition, restricting the diagnosis of oligomenorrhea to women whose periods were regularly established before they developed problems with infrequent flow. With oligomenorrhea, menstrual periods occur at intervals of greater than 35 days, with only four to nine periods in a year.

Description

True oligomenorrhea can not occur until menstrual periods have been established. In the United States, 97.5% of women have begun normal menstrual cycles by age 16. The complete absence of menstruation, whether menstrual periods never start or whether they stop after having been established, is called **amenorrhea**. Oligomenorrhea can become amenorrhea if menstruation stops for six months or more.

It is quite common for women at the beginning and end of their reproductive lives to miss or have irregular periods. This is normal and is usually the result of imperfect coordination between the hypothalamus, the pituitary gland, and the ovaries. For no apparent reason, a few women menstruate (with ovulation occurring) on a regular schedule as infrequently as once every two months. For them that schedule is normal and not a cause for concern.

Women with **polycystic ovary syndrome** (PCOS) are also likely to suffer from oligomenorrhea. PCOS is a condition in which the ovaries become filled with small cysts. Women with PCOS show menstrual irregularities that range from oligomenorrhea and amenorrhea on the one hand to very heavy, irregular periods on the other. The condition affects about 6% of premenopausal women and is related to excess androgen production.

Other physical and emotional factors also cause a woman to miss periods. These include:

- emotional **stress**
- chronic illness
- poor **nutrition**
- eating disorders such as **anorexia nervosa**
- excessive **exercise**
- estrogen-secreting tumors
- illicit use of anabolic steriod drugs to enhance athletic performance

Serious ballet dancers, gymnasts, and ice skaters are especially at risk because they combine heavy activity with a diet intended to keep their weight down. One study at the University of California San Francisco found that 11% of female ultramarathon runners had amenorrhea or oligomenorrhea. This is a much higher rate than in the general population. Women's coaches are becoming more aware of the problem and are encouraging female athletes to seek medical advice. A gynecologist is the doctor most experienced in diagnosing and treating oligomenorrhea.

Causes and symptoms

Symptoms of oligomenorrhea include:

- menstrual periods at intervals of more than 35 days
- irregular menstrual periods with unpredictable flow
- some women with oligomenorrhea may have difficulty conceiving

Oligomenorrhea that occurs in adolescents is often caused by immaturity or lack of synchronization between

the hypothalamus, pituitary gland, and ovaries. The hypothalamus is part of the brain that controls body temperature, cellular metabolism, and basic functions such as eating, sleeping, and reproduction. It secretes hormones that regulate the pituitary gland.

The pituitary gland is then stimulated to produce hormones that affect growth and reproduction. At the beginning and end of a woman's reproductive life, some of these hormone messages may not be synchronized, causing menstrual irregularities.

In PCOS, oligomenorrhea is probably caused by inappropriate levels of both female and male hormones. Male hormones are produced in small quantities by all women, but in women with PCOS, levels of male hormone (androgens) are slightly higher than in other women.

In athletes, models, actresses, dancers, and women with anorexia nervosa, oligomenorrhea occurs because the ratio of body fat to weight drops too low.

Diagnosis

Diagnosis of oligomenorrhea begins with the patient informing the doctor about infrequent periods. Women should seek medical treatment after three missed periods. The doctor will ask for a detailed description of the problem and take a history of how long it has existed and any patterns the patient has observed. A woman can assist the doctor in diagnosing the cause of oligomenorrhea by keeping a record of the time, frequency, length, and quantity of bleeding. She should also tell the doctor about any illnesses including longstanding conditions like **diabetes mellitus**. The doctor may also inquire about her diet, exercise patterns, sexual activity, contraceptive use, current medications, or past surgical procedures.

Laboratory tests

After taking the woman's history, the gynecologist or family practitioner does a pelvic examination and **Pap test**. To rule out specific causes of oligomenorrhea, the doctor may also do a **pregnancy** test and blood tests to check the level of thyroid hormone. Based on the initial test results, the doctor may want to do tests to determine the level of other hormones that play a role in reproduction.

Treatment

Treatment of oligomenorrhea depends on the cause. In adolescents and women near **menopause**, oligomenorrhea usually needs no treatment. For athletes, changes in training routines and eating habits may be enough to return the woman to a regular menstrual cycle.

Most patients suffering from oligomenorrhea are treated with birth control pills. Other women, including those with PCOS, are treated with hormones. Prescribed hormones depend on which particular hormones are deficient or out of balance. When oligomenorrhea is caused by a chronic underlying disorder or disease, such as anorexia nervosa, the underlying condition must be treated for oligomenorrhea to improve.

Alternative treatment

As with conventional medicial treatments, alternative treatments are based on the cause of the condition. If a hormonal imbalance is revealed by laboratory testing, hormone replacements that are more "natural" for the body (including tri-estrogen and natural progesterone) are recommended. Glandular therapy can assist in bringing about a balance in the glands involved in the reproductive cycle, including the hypothalmus, pituitary, thyroid, ovarian, and adrenal glands. Since **homeopathy** and **acupuncture** work on deep, energetic levels to rebalance the body, these two modalities may be helpful in treating oligomenorrhea. Western and Chinese herbal medicines also can be very effective. Herbs used to treat oligomenorrhea include dong quai (*Angelica sinensis*), black cohosh (*Cimicifuga racemosa*), and chaste tree (*Vitex agnus-castus*). Diet and adequate nutrition, including adequate protein, essential fatty acids, whole grains, and fresh fruits and vegetables, are important for every woman, especially if deficiencies are present or if she regularly exercises very strenuously. For some women, **meditation**, **guided imagery**, and visualization can play a key role in the treatment of oligomenorrhea.

Prognosis

Many women, including those with PCOS, are successfully treated with hormones for oligomenorrhea. They have more frequent periods and begin ovulating during their menstrual cycle, restoring their fertility.

For women who do not respond to hormones or who continue to have an underlying condition that causes oligomenorrhea, the outlook is less positive. Women who have oligomenorrhea may have difficulty conceiving children and may receive fertility drugs. The absence of adequate estrogen increases risk for bone loss (**osteoporosis**) and cardiovascular disease. Women who do not have regular periods also are more likely to develop uterine **cancer**. Oligomenorrhea can become amenorrhea at any time, increasing the chance of having these complications.

Prevention

Oligomenorrhea is preventable only in women whose low body fat to weight ratio is keeping them from maintaining a regular menstrual cycle. Adequate nutrition and a less vigorous training schedules will normally prevent

KEY TERMS

Anorexia nervosa—A disorder of the mind and body in which people starve themselves in a desire to be thin, despite being of normal or below normal body weight for their size and age.

Cyst—An abnormal sac containing fluid or semi-solid material.

Osteoporosis—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily. Women who are not menstruating are especially vulnerable to this condition because estrogen, a hormone that protects bones against calcium loss, decreases drastically after menopause.

oligomenorrhea. When oligomenorrhea is caused by hormonal factors, it is not preventable, but it is often treatable.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Menstrual Cycle Disorders." In *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

ORGANIZATIONS

Polycystic Ovarian Syndrome Association. P.O. Box 80517, Portland, OR 7280. (877) 775-7267. <http://www.pcosupport.org>.

OTHER

Clinical Research Bulletin. vol. 1, no. 14. <http://www.herbsinfo.com.

Maxwell, Tracey. "Polycystic Ovarian Syndrome." Ivanhoe Broadcast News. 1997. <http://www.ivanhoe.com>.

Tish Davidson

Omeprazole *see* **Antiulcer drugs**

Omphalocele *see* **Abdominal wall defects**

Onchocerciasis *see* **Filariasis**

Onychomycosis

Definition

Onychomycosis is a fungal infection of the fingernails or toenails. The actual infection is of the bed of the nail and of the plate under the surface of the nail.

Description

Onychomycosis is the most common of all diseases of the nails in adults. In North America, the incidence falls roughly between 2–13%. The incidence of onychomycosis is also greater in older adults, and up to 90% of the elderly may be affected. Men are more commonly infected than women.

Individuals who are especially susceptible include those with chronic diseases such as diabetes and circulatory problems and those with diseases that suppress the immune system. Other risk factors include a family history, previous trauma to the nails, warm climate, occlusive or tight footwear.

Causes and symptoms

Onychomycosis is caused by three types of fungi, called dermatophytes, yeasts, and nondermatophyte molds. Fungi are simple parasitic plant organisms that don't need sunlight to grow. Toenails are especially susceptible because fungi prefer dark damp places. Swimming pools, locker rooms, and showers typically harbor fungi. Chronic diseases such as diabetes, problems with the circulatory system, or immune deficiency disease are risk factors. A history of **athlete's foot** and excess perspiration are also risk factors.

Onychomycosis can be present for years without causing **pain** or disturbing symptoms. Typically, the nail becomes thicker and changes to a yellowish-brown. Foul smelling debris may collect under the nail. The infection can spread to the surrounding nails and even the skin.

Diagnosis

To make a diagnosis of onychomycosis, the clinician must collect a specimen of the nail in which infection is suspected. A clipping is taken from the nail plate, and a sample of the debris from underneath the nail bed is also taken, usually with a sharp curette. Debris from the nail surface may also be taken. These will be sent for microscopic analysis to a laboratory, as well as cultured to determine what types of fungus are growing there.

Treatment

Onychomycosis is very difficult and sometimes impossible to treat, and therapy is often long-term. Therapy consists of topical treatments that are applied directly to the nails, as well as two systemic drugs, griseofulvin and ketoconazole. Topical therapy is reserved for only the mildest cases. The use of griseofulvin and ketoconazole is problematic, and there are typically high relapse rates of 50–85%. In addition, treatment must be continued for a

long duration (10–18 months for toenails), with monthly laboratory monitoring for several side effects, including liver toxicity. Individuals taking these medications must also abstain from alcohol consumption.

In the past few years, newer oral antifungal agents have been developed, and include itraconazole (Sporanox), terbinafine (Lamisil), and fluconazole (Diflucan). These agents, when taken orally for as little as 12 weeks, bring about better cure rates and fewer side effects than either griseofulvin or ketoconazole. The most common side effect is stomach upset. Patients taking oral antifungal therapy must have a complete **blood count** and liver enzyme workup every four to six weeks. Terbinafine in particular has markedly less toxicity to the liver, one of the more severe side effects of the older agents, griseofulvin and ketoconazole.

Treatment should be continued until microscopic exam or culture shows no more fungal infection. Nails may, however, continue to look damaged even after a clinical cure is achieved. Nails may take up to a full year to return to normal. If the nail growth slows or stops, additional doses of antifungal therapy should be taken.

Nail **debridement** is another treatment option, but it is considered by many to be primitive compared with topical or systemic treatment. Clinicians perform nail debridement in their offices. The nail is cut and then thinned using surgical tools or chemicals, and then the loose debris under the nail is removed. The procedure is painless, and often improves the appearance of the nails immediately. In addition, it helps whatever medication being used to penetrate the newly thinned nail. Patients with very thickened nails will sometimes undergo chemical removal of a nail. A combination of oral, topical, and surgical removal can increase the chances of curing the infection.

Alternative treatment

For controlling onychomycosis, as opposed to curing it, some experts advocate using Lotrimin cream, available over the counter. The cream should be thoroughly rubbed into the nail daily in order to control the infection.

In general, **nutrition** may also play a role in promoting good nail health and thus preventing nail disease. Adequate protein and **minerals**, in the form of nuts, seeds, whole grains, legumes, fresh vegetables, and fish, should be consumed. Sugars, alcohol, and **caffeine** should be avoided. Certain supplements may also be beneficial, including vitamin A (10,000 IU per day), zinc (15–30 mg per day), iron (ferrous glycinate 100 mg per day, vitamin B_{12} (1,000 mcg per day), and essential fatty acids in the form of flax, borage, or evening primrose oil (1,000–1,5000 mg twice daily).

KEY TERMS

Curette—Spoon-shaped instrument for removing debris, growths, or infected nail matter.

Dermatophytes, yeasts, and nondermatophyte molds—Three types of fungi responsible for fungal infections of the nails.

Herbal remedies may also relieve some of the symptoms of onychomycosis. A combination of coneflower, oregano, spilanthes, usnea, Oregon grape root, and myrrh can be used as a tincture (20 drops four times daily).

Undiluted grapefruit seed extract and tea tree oil are also said to be beneficial when applied topically to the infected nails.

Prognosis

Onychomycosis is typically quite difficult to cure completely. Even if a clinical cure is achieved after long therapy with either topical or oral drugs, normal regrowth takes four to six months in the fingernails, and eight to 12 months in the toenails, which grow more slowly. Relapse is common, and often, the nail or nail bed is permanently damaged. For toenails infected with onychomycosis, terbinafine seems to offer the highest cure rate (35–50%). Itraconazole cure rates typically range from 25–40%, and those with fluconazole, which was recently approved in the United States, have not been documented by long-term trials

Prevention

Keeping the feet clean and dry, and washing with soap and water and drying thoroughly are important preventive steps to take to prevent onychomycosis. Other preventive measures include keeping the nails cut short and wearing shower shoes whenever walking or showering in public places. Daily changes of shoes, socks, or hosiery are also helpful. Excessively tight hose or shoes promote moisture, which in turn, provides a wonderful environment for onychomycotic infections. To prevent this, individuals should wear only socks made of synthetic fibers, which can absorb moisture more quickly than those made of cotton or wools. Manicure and pedicure tools should be disinfected after each use. Finally, nail polish should not be applied to nails that are infected, as this causes the water or moisture that collects under the surface of the nail to not evaporate and be trapped.

Resources

PERIODICALS

Harrell T. K., et al. "Onychomycosis: Improved Cure Rates with Itraconazole and Terbinafine." *Journal of the American Board of Family Practitioners* (July-August 2001):268- 73.

Scher Robert K. "Novel Treatment Strategies for Superficial Mycoses." *Journal of the American Academy of Dermatology* (1999).

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, PO Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. Fax:(847) 330-0050. <http://www.aad.org>.

OTHER

<http://www.nailfungus.org/about.html>.
<http://www.emedicine.com/derm/topic200.htm>.

Liz Meszaros

Oophorectomy

Definition

Oophorectomy is the surgical removal of one or both ovaries. It is also called ovariectomy. If one ovary is removed, a woman may continue to menstruate and have children. If both ovaries are removed, menstruation stops and a woman loses the ability to have children.

Purpose

Oophorectomy is performed to:

- remove cancerous ovaries
- remove the source of estrogen that stimulates some cancers
- remove a large ovarian cyst
- excise an abscess
- treat endometriosis

In an oophorectomy one or a portion of one ovary may be removed or both ovaries may be removed. When oophorectomy is done to treat **ovarian cancer** or other spreading cancers, both ovaries are always removed. This is called a bilateral oophorectomy. Oophorectomies are sometimes performed on pre-menopausal women who have estrogen-sensitive **breast cancer** in an effort to remove the main source of estrogen from their bodies. This procedure has become less common than it was in the 1990s. Today, **chemotherapy** drugs are available that alter the production of estrogen and tamoxifen blocks any of the effects any remaining estrogen may have on **cancer** cells.

Until the 1980s, women over age 40 having hysterectomies (surgical removal of the uterus) routinely had healthy ovaries and fallopian tubes removed at the same time. This operation is called a bilateral **salpingo-oophorectomy**. Many physicians reasoned that a woman over 40 was approaching **menopause** and soon her ovaries would stop secreting estrogen and releasing eggs. Removing the ovaries would eliminate the risk of ovarian cancer and only accelerate menopause by a few years.

In the 1990s, the thinking about routine oophorectomy began to change. The risk of ovarian cancer in women who have no family history of the disease is less than 1%. Meanwhile, removing the ovaries increases the risk of cardiovascular disease and accelerates **osteoporosis** unless a woman takes prescribed hormone replacements.

Under certain circumstances, oophorectomy may still be the treatment of choice to prevent breast and ovarian cancer in certain high-risk women. A study done at the University of Pennsylvania and released in 2000 showed that healthy women who carried the BRCA1 or BRCA2 genetic mutations that pre-disposed them to breast cancer had their risk of breast cancer drop from 80% to 19% when their ovaries were removed before age 40. Women between the ages of 40 and 50 showed less risk reduction, and there was no significant reduction of breast cancer risk in women over age 50.

Overall, ovarian cancer still ranks low on a woman's list of health concerns: It accounts for only 4% of all cancers in women. But the lifetime risk for developing ovarian cancer in women who have mutations in BRCA1 is significantly increased over the general population and may cause an ovarian cancer risk of 30% by age 60. For women at increased risk, oophorectomy may be considered after the age of 35 if childbearing is complete.

The value of ovary removal in preventing both breast and ovarian cancer has been documented. However, there are disagreements within the medical community about when and at what age this treatment should be offered. Preventative oophorectomy, called preventative bilateral oophorectomy (PBO), is not always covered by insurance. One study conducted in 2000 at the University of California at San Francisco found that only 20% of insurers paid for PBO. Another 25% had a policy against paying for the operation, and the remaining 55% said that they would decide about payment on an individual basis.

Precautions

There are situations in which oophorectomy is a medically wise choice for women who have a family history of breast or ovarian cancer. However, women with healthy ovaries who are undergoing **hysterectomy** for

reasons other than cancer should discuss with their doctors the benefits and disadvantages of having their ovaries removed at the time of the hysterectomy.

KEY TERMS

Cyst—An abnormal sac containing fluid or semi-solid material.

Endometriosis—A benign condition that occurs when cells from the lining of the uterus begin growing outside the uterus.

Fallopian tubes—Slender tubes that carry ova from the ovaries to the uterus.

Hysterectomy—Surgical removal of the uterus.

Osteoporosis—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily.

Description

Oophorectomy is done under general anesthesia. It is performed through the same type of incision, either vertical or horizontal, as an abdominal hysterectomy. Horizontal incisions leave a less noticeable scar, but vertical incisions give the surgeon a better view of the abdominal cavity.

After the incision is made, the abdominal muscles are pulled apart, not cut, so that the surgeon can see the ovaries. Then the ovaries, and often the fallopian tubes, are removed.

Oophorectomy can sometimes be done with a laparoscopic procedure. With this surgery, a tube containing a tiny lens and light source is inserted through a small incision in the navel. A camera can be attached that allows the surgeon to see the abdominal cavity on a video monitor. When the ovaries are detached, they are removed though a small incision at the top of the vagina. The ovaries can also be cut into smaller sections and removed.

The advantages of abdominal incision are that the ovaries can be removed even if a woman has many adhesions from previous surgery. The surgeon gets a good view of the abdominal cavity and can check the surrounding tissue for disease. A vertical abdominal incision is mandatory if cancer is suspected. The disadvantages are that bleeding is more likely to be a complication of this type of operation. The operation is more painful than a laparoscopic operation and the recovery period is longer. A woman can expect to be in the hospital two to five days and will need three to six weeks to return to normal activities.

Preparation

Before surgery, the doctor will order blood and urine tests, and any additional tests such as ultrasound or x rays to help the surgeon visualize the woman's condition. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. A colon preparation may be done, if extensive surgery is anticipated.

On the evening before the operation, the woman should eat a light dinner, then take nothing by mouth, including water or other liquids, after midnight.

Aftercare

After surgery a woman will feel discomfort. The degree of discomfort varies and is generally greatest with abdominal incisions, because the abdominal muscles must be stretched out of the way so that the surgeon can reach the ovaries.

When both ovaries are removed, women who do not have cancer are started on **hormone replacement therapy** to ease the symptoms of menopause that occur because estrogen produced by the ovaries is no longer present. If even part of one ovary remains, it will produce enough estrogen that a woman will continue to menstruate, unless her uterus was removed in a hysterectomy. **Antibiotics** are given to reduce the risk of post-surgery infection.

Return to normal activities takes anywhere from two to six weeks, depending on the type of surgery. When women have cancer, chemotherapy or radiation are often given in addition to surgery. Some women have emotional trauma following an oophorectomy, and can benefit from counseling and support groups.

Risks

Oophorectomy is a relatively safe operation, although, like all major surgery, it does carry some risks. These include unanticipated reaction to anesthesia, internal bleeding, blood clots, accidental damage to other organs, and post-surgery infection.

Complications after an oophorectomy include changes in sex drive, hot flashes, and other symptoms of menopause if both ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for cardiovascular disease and osteoporosis. Women with a history of psychological and emotional problems before an oophorectomy are more likely to experience psychological difficulties after the operation.

Normal results

If the surgery is successful, the ovaries will be removed without complication, and the underlying problem resolved. In the case of cancer, all the cancer will be removed.

Abnormal results

Complications may arise if the surgeon finds that cancer has spread to other places in the abdomen. If the cancer cannot be removed by surgery, it must be treated with chemotherapy and radiation.

Resources

PERIODICALS

"Removing Ovaries Lowers Risk for Women at High Risk of Breast, Ovarian Cancer." *ACS News Today* 8 November 2000. <http://www.cancer.org>.

ORGANIZATIONS

American Cancer Society National Headquarters. 1599 Clifton Road NE, Atlanta, GA 30329. (800)ACS-2345. <http://www.cancer.org>.

Cancer Information Service, National Cancer Institute. Building 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800)4-CANCER. <http://www.nci.nih.gov/cancerinfo/index.html>.

Tish Davidson, A.M.

Open fracture reduction *see* **Fracture repair**

Ophthalmic antibiotics *see* **Antibiotics, ophthalmic**

Ophthalmoplegia

Definition

Ophthalmoplegia is a **paralysis** or weakness of one or more of the muscles that control eye movement. The condition can be caused by any of several neurologic disorders. It may be myopathic, meaning that the muscles controlling eye movement are directly involved, or neurogenic, meaning that the nerve pathways controlling eye muscles are affected. Diseases associated with ophthalmoplegia are ocular myopathy, which affects muscles, and internuclear ophthalmoplegia, a disorder caused by **multiple sclerosis**, a disease which affects nerves.

Description

Because the eyes do not move together in ophthalmoplegia, patients may complain of double vision. Double vision is especially troublesome if the ophthalmoplegia comes on suddenly or affects each eye differently. Because ophthalmoplegia is caused by another, underlying disease, it is often associated with other neurologic symptoms, including limb weakness, lack of coordination, and numbness.

Causes and symptoms

Ocular myopathy is also known as mitochondrial encephalomyelopathy with ophthalmoplegia or progressive external ophthalmoplegia. Because it is so often associated with diseases affecting many levels of the neurologic system, it is often referred to as "ophthalmoplegia plus." The main feature is progressive limitation of eye movements, usually with drooping of the eyelids (**ptosis**). Ptosis may occur years before other symptoms of ophthalmoplegia. Because both eyes are equally involved and because ability to move the eyes lessens gradually over the course of years, double vision is rare. On examination, the eyelids may appear thin. This disease usually begins in childhood or adolescence but may start later.

When ophthalmoplegia is caused by muscle degeneration (myopathic), muscle biopsy, in which a small piece of muscle is surgically removed and examined microscopically, will find characteristic abnormal muscle fibers called ragged red fibers. In this form of ophthalmoplegia, the patient may experience weakness of the face, the muscles involved in swallowing, the neck, or the limbs.

Progressive external ophthalmoplegia is sometimes associated with specific neurologic syndromes. These syndromes include familial forms of spastic paraplegia, spinocerebellar disorders, or sensorimotor **peripheral neuropathy**. Kearns-Sayre syndrome causes ophthalmoplegia along with loss of pigment in the retina, the light-sensitive membrane lining the eye. In addition, the disease may cause **heart block** that must be corrected with a pacemaker, increased protein in the cerebrospinal fluid, and a progressively disabling lack of muscular coordination (cerebellar syndrome). Symptoms of the disease appear before age 15.

Some of the progressive external ophthalmoplegia syndromes are unusual in that inheritance is controlled by DNA in the mitochondria. The mitochondria are rod-shaped structures within a cell that convert food to usable energy. Most inherited diseases are passed on by DNA in the cell nucleus, the core that contains the hereditary material. Mitochondrial inheritance tends to be passed on by the mother. Other forms of progressive external ophthalmoplegia are not inherited but occur sporadically with no clear family history. It is not known why some forms are neurogenic and others are myopathic. In the

forms inherited through mitochondrial DNA, it is not known which gene product is affected.

Internuclear ophthalmoplegia in multiple sclerosis is caused by damage to a bundle of fibers in the brainstem called the medial longitudinal fasciculus. In this syndrome, the eye on the same side as the damaged medial longitudinal fasciculus is unable to look outward (that is, the left eye cannot look left). The other eye exhibits jerking movements (**nystagmus**) when the patient tries to look left. Internuclear ophthalmoplegia may be seen rarely without multiple sclerosis in patients with certain types of **cancer** or with Chiari type II malformation.

Eye **movement disorders** and ophthalmoplegia can also be seen with **progressive supranuclear palsy**, thyroid disease, **diabetes mellitus**, brainstem tumors, migraine, basilar artery **stroke**, pituitary stroke, **myasthenia gravis**, **muscular dystrophy**, and the Fisher variant of **Guillain-Barré syndrome**. A tumor or aneurysm in the cavernous sinus, located behind the eyes, can cause painful ophthalmoplegia. Painful ophthalmoplegia can also be caused by an inflammatory process in the same area, called Tolosa-Hunt syndrome.

Diagnosis

The patient's medical and family history and the examination findings will usually help differentiate the various syndromes associated with ophthalmoplegia. In addition, each syndrome is associated with characteristic features, such as nystagmus or ptosis. All patients with progressive external ophthalmoplegia should have a muscle biopsy to look for ragged red fibers or changes suggesting muscular dystrophy. A sample should be sent for analysis of mitochondrial DNA. Electromyogram (EMG), measurement of electrical activity in the muscle, helps diagnose myopathy.

Computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scans of the brain may be needed to rule out **brain tumor**, stroke, aneurysm, or multiple sclerosis. When multiple sclerosis is suspected, evoked potential testing of nerve response may also be helpful. Analysis of cerebrospinal fluid may show changes characteristic of multiple sclerosis or Kearns-Sayre syndrome. Other tests that may be helpful in Kearns-Sayre include electrocardiogram (measuring electrical activity of the heart muscles), retinal examination, and a hearing test (audiogram). For possible myasthenia gravis, the Tensilon (edrophonium) test should be done. Tests should also be done to measure activity of the cell-surface receptors for acetylcholine, a chemical that helps pass electrical impulses along nerve cells in the muscles. Thyroid disease and diabetes mellitus should be excluded by appropriate blood work.

KEY TERMS

Cerebellar—Involving the cerebellum, which controls walking, balance, and coordination.

Cerebrospinal fluid—Fluid bathing the brain and spinal cord.

Heart block—A problem with electrical conduction in the heart muscle that may lead to irregular heart beat and require a pacemaker for treatment.

Mitochondria—Spherical or rod shaped parts of the cell. Mitochondria contain genetic material (DNA and RNA) and are responsible for converting food to energy.

Treatment

There are no specific cures for ocular myopathy or progressive external ophthalmoplegia. Vitamin E therapy has been used to treat Kearns-Sayre syndrome. Coenzyme Q (ubiquinone), a naturally occurring substance similar to vitamin K, is widely used to treat other forms of progressive external ophthalmoplegia, but the degree of success varies. Specific treatments are available for multiple sclerosis, myasthenia gravis, diabetes mellitus, and thyroid disease. Symptoms of ophthalmoplegia can be relieved by mechanical treatment. Surgical procedures can lift drooping eyelids or a patch over one eye can be used to relieve double vision. Because there is no blink response, a surgically lifted eyelid exposes the cornea of the eye so that it may become dry or be scratched. These complications must be avoided by using artificial tears and wearing eyepatches at night. In Kearns-Sayre syndrome, a pacemaker may be needed.

Prognosis

The prognosis of progressive external ophthalmoplegia depends on the associated neurological problems; in particular, whether there is severe limb weakness or cerebellar symptoms that may be mild or disabling. As with most chronic neurologic diseases, mortality increases with disability. Progressive external ophthalmoplegia itself is not a life-threatening condition. Kearns-Sayre syndrome is disabling, probably shortens the life span, and few if any patients have children. Overall life expectancy for multiple sclerosis patients is seven years less than normal; **death** rates are higher for women than for men.

Prevention

There is no way to prevent ophthalmoplegia.

Resources

BOOKS

Hirano, M., and S. DiMauro. "Clinical Features of Mitochondrial Myopathies and Encephalomyopathies." In *Handbook of Muscle Disease*, ed. R. J. M. Lane. New York: Marcel Dekker, 1994.

Tome, F. M. S., and M. Fardeau. "Ocular Myopathies." In *Myology: Basic and Clinical*, ed. A. G. Engel and B. Q. Banker. New York: McGraw-Hill, 1986.

PERIODICALS

Rowland, L. P. "Progressive External Ophthalmoplegia and Ocular Myopathies." *Handbook of Clinical Neurology* 48 (1992): 287-329.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Laurie Barclay, MD

Ophthalmoscopic examination *see* **Eye examination**

Opiate withdrawal *see* **Withdrawal syndromes**

Opioid analgesics *see* **Analgesics, opioid**

Oppositional defiant disorder

Definition

Oppositional defiant disorder is a recurring pattern of negative, hostile, disobedient, and defiant behavior in a child or adolescent, lasting for at least six months without serious violation of the basic rights of others.

Description

The behavior disturbances cause clinically significant problems in social, school, or work functioning. The course of oppositional defiant disorder varies among patients. In males, the disorder is more common among those who had problem temperaments or high motor activity in the preschool years. During the school years, patients may have low self-esteem, changing moods, and a low frustration tolerance. Patients may swear and use alcohol, tobacco, or illicit drugs at an early age. There are often conflicts with parents, teachers, and peers.

Children with this disorder show their negative and defiant behaviors by being persistently stubborn and resisting directions. They may be unwilling to compromise, give in, or negotiate with adults. Patients may deliberately or persistently test limits, ignore orders, argue, and fail to accept blame for misdeeds. Hostility is directed at adults or peers and is shown by verbal aggression or deliberately annoying others.

Causes and symptoms

Oppositional defiant disorder is more common in boys than girls and the disorder typically begins by age eight. Although the specific causes of the disorder are unknown, parents who are overly concerned with power and control may cause an eruption to occur. Symptoms often appear at home, but over time may appear in other settings as well. Usually the disorder occurs gradually over months or years. Several theories about the causes of oppositional defiant disorder are being investigated. Oppositional defiant disorder may be related to:

- the child's temperament and the family's response to that temperament
- an inherited predisposition to the disorder in some families
- a neurological cause, like a head injury
- a chemical imbalance in the brain (especially with the brain chemical serotonin)

Oppositional defiant disorder appears to be more common in families where at least one parent has a history of a mood disorder, **conduct disorder**, attention deficit/hyperactivity disorder, antisocial personality disorder, or a substance-related disorder. Additionally, some studies suggest that mothers with a depressive disorder are more likely to have children with oppositional behavior. However, it is unclear to what extent the mother's depression results from or causes oppositional behavior in children.

Symptoms include a pattern of negative, hostile, and defiant behavior lasting at least six months. During this time four or more specific behaviors must be present. These behaviors include the child who:

- often loses his/her temper
- often argues with adults
- often actively defies or refuses to comply with adults' requests or rules
- often deliberately annoys people
- often blames others for his/her mistakes or misbehavior
- is often touchy or easily annoyed by others
- is often angry and resentful
- is often spiteful or vindictive
- misbehaves

- swears or uses obscene language
- has a low opinion of him/herself

The diagnosis of oppositional defiant disorder is not made if the symptoms occur exclusively in psychotic or **mood disorders**. Criteria are not met for conduct disorder, and, if the child is 18 years old or older, criteria are not met for antisocial personality disorder. In other words, a child with oppositional defiant disorder does not show serious aggressive behaviors or exhibit the physical cruelty that is common in other disorders.

Additional problems may be present, including:

- learning problems
- a depressed mood
- hyperactivity (although attention deficit/hyperactivity disorder must be ruled out)
- substance abuse or dependence
- dramatic and erratic behavior

The patient with oppositional defiant disorder is moody, easily frustrated, and may abuse drugs.

Diagnosis

While psychological testing may be needed, the doctor must examine and talk with the child, talk with the parents, and review the medical history. Oppositional defiant disorder rarely travels alone. Children with attention/deficit hyperactive disorder will also have oppositional defiant disorder 50% of the time. Children with depression/anxiety will have oppositional defiant disorder 10–29% of the time. Because all of the features of this disorder are usually present in conduct disorder, oppositional defiant disorder is not diagnosed if the criteria are met for conduct disorder.

A diagnosis of oppositional defiant disorder should be considered only if the behaviors occur more frequently and have more serious consequences than is typically observed in other children of a similar developmental stage. Further, the behavior must lead to significant impairment in social, school, or work functioning.

Treatment

Treatment of oppositional defiant disorder usually consists of group, individual and/or **family therapy**, and education. Of these, individual therapy is the most common. Therapy can provide a consistent daily schedule, support, consistent rules, discipline, and limits. It can also help train patients to get along with others and modify behaviors. Therapy can occur in residential, day treatment, or medical settings. Additionally, having a healthy role model as an example is important for the patient.

KEY TERMS

Attention deficit/hyperactivity disorder— A persistent pattern of inattention, hyperactivity and/or impulsiveness; the pattern is more frequent and severe than is typically observed in people at a similar level of development.

Conduct disorder—A repetitive and persistent pattern of behavior in which the basic rights of others are violated or major age-appropriate rules of society are broken.

Parent management training focuses on teaching the parents specific and more effective techniques for handling the child's opposition and defiance. Research has shown that parent management training is more effective than family therapy.

Whether involved in therapy or working on this disorder at home, the patient must work with his or her parents' guidance to make the fullest possible recovery. According to the New York Hospital/Cornell Medical Center, the patients must:

- use self timeouts
- identify what increases anxiety
- talk about feelings instead of acting on them
- find and use ways to calm themselves
- frequently remind themselves of their goals
- get involved in tasks and physical activities that provide a healthy outlet for energy
- learn how to talk with others
- develop a predictable, consistent, daily schedule of activity
- develop ways to obtain pleasure and feel good
- learn how to get along with other people
- find ways to limit stimulation
- learn to admit mistakes in a matter-of-fact way

Stimulant medication is used only when oppositional defiant disorder coexists with attention deficit/hyperactivity disorder. Currently no research is currently available on the use of other psychiatric medications in the treatment of oppositional defiant disorder.

Prognosis

The outcome varies. In some children the disorder evolves into a conduct disorder or a mood disorder. Later

in life, oppositional defiant disorder can develop into passive aggressive personality disorder or antisocial personality disorder. Some children respond well to treatment and some do not. Generally, with treatment, reasonable adjustment in social settings and in the workplace can be made in adulthood.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Howe, James W., ed., et. al. *Neurobiological Disorders in Children and Adolescents*. San Francisco: Jossey–Bass, 1992.

Kendall, Philip C., and Julian D. Norton-Ford. *Clinical Psychology: Scientific and Professional Dimensions*. John Wiley & Sons, 1982.

PERIODICALS

Cohen P., et al. "Diagnostic Predictors of Treatment Patterns in a Cohort of Adolescents." *Journal of the American Academy of Child & Adolescent Psychiatry* 30 (1991): 989-93.

Frick P. J., et al. "Familial Risk Factors to Oppositional Defiant Disorder and Conduct Disorder: Parental Psychopathology and Maternal Parenting." *Journal of Consulting & Clinical Psychology* 60 (1992): 49-55.

ORGANIZATIONS

Families Anonymous. Weschester County, Westchester, NY. (212) 354-8525.

David James Doermann

Optic atrophy

Definition

Optic atrophy can be defined as damage to the optic nerve resulting in a degeneration or destruction of the optic nerve. Optic atrophy may also be referred to as optic nerve head pallor because of the pale appearance of the optic nerve head as seen at the back of the eye. Possible causes of optic atrophy include: **optic neuritis**, Leber's hereditary optic atrophy, toxic or nutritional optic neuropathy, **glaucoma**, vascular disorders, trauma, and other systemic disorders.

Description

The process of vision involves light entering the eye and triggering chemical changes in the retina, a pigmented layer lining the back of the eye. Nerve impulses created by this process travel to the brain via the optic nerve. Using a hand-held instrument called an ophthalmoscope, the doctor can see the optic nerve head (optic disc) which is the part of the optic nerve that enters at the back of the eyeball. In optic atrophy, the disc is pale and has fewer blood vessels than normal.

Causes and symptoms

Symptoms of optic atrophy are a change in the optic disc and a decrease in visual function. This change in visual function can be a decrease in sharpness and clarity of vision (visual acuity) or decreases in side (peripheral) vision. Color vision and contrast sensitivity can also be affected.

There are many possible causes of optic atrophy. The causes can range from trauma to systemic disorders. Some possible causes of optic atrophy include:

- Optic neuritis. Optic neuritis is an inflammation of the optic nerve. It may be associated with eye **pain** worsened by eye movement. It is more common in young to middle-aged women. Some patients with optic neuritis may develop **multiple sclerosis** later on in life.
- Leber's hereditary optic neuropathy. This is a disease of young men (late teens, early 20s), characterized by an onset over a few weeks of painless, severe, central visual loss in one eye, followed weeks or months later by the same process in the other eye. At first the optic disc may be slightly swollen, but eventually there is optic atrophy. The visual loss is generally permanent. This condition is hereditary. If a patient knows that Leber's runs in the family, **genetic counseling** should be considered.
- Toxic optic neuropathy. Nutritional deficiencies and poisons can be associated with gradual vision loss and optic atrophy, or with sudden vision loss and optic disc swelling. Toxic and nutritional optic neuropathies are uncommon in the United States, but took on epidemic proportions in Cuba in 1992–1993. The most common toxic optic neuropathy is known as tobacco-alcohol **amblyopia**, thought to be caused by exposure to cyanide from tobacco **smoking**, and by low levels of vitamin B_{12} because of poor **nutrition** and poor absorption associated with drinking alcohol. Other possible toxins included ethambutol, methyl alcohol (moonshine), ethylene glycol (antifreeze), cyanide, lead, and carbon monoxide. Certain medications have also been implicated. Nutritional optic neuropathy may be caused by deficiencies of protein, or of the B **vitamins** and folate, associated with **starvation**, malabsorption, or **alcoholism**.
- Glaucoma. Glaucoma may be caused by an increase of pressure inside the eye. This increased pressure may eventually affect the optic nerve if left untreated.
- Compressive optic neuropathy. This is the result of a tumor or other lesion putting pressure on the optic

nerve. Another possible cause is enlargement of muscles involved in eye movement seen in **hyperthyroidism** (Graves' disease).

- Retinitis pigmentosa. This is a hereditary ocular disorder.
- Syphilis. Left untreated, this disease may result in optic atrophy.

Diagnosis

Diagnosis involves recognizing the characteristic changes in the optic disc with an ophthalmoscope, and measuring visual acuity, usually with an eye chart. Visual field testing can test peripheral vision. Color vision and contrast sensitivity can also be tested. Family history is important in the diagnosis of inherited conditions. Exposure to poisons, drugs, and even medications should be determined. Suspected **poisoning** can be confirmed through blood and urine analysis, as can vitamin deficiency.

Brain **magnetic resonance imaging** (MRI) may show a tumor or other structure putting pressure on the optic nerve, or may show plaques characteristic of multiple sclerosis, which is frequently associated with optic neuritis. However, similar MRI lesions may appear in Leber's hereditary optic neuropathy. Mitochondrial DNA testing can be done on a blood sample, and can identify the mutation responsible for Leber's.

Visual evoked potentials (VEP), which measure speed of conduction over the nerve pathways involved in sight, may detect abnormalities in the clinically unaffected eye in early cases of Leber's. Fluorescein **angiography** gives more detail about blood vessels in the retina.

Treatment

Treatment of optic neuritis with steroids is controversial. Currently, there is no known treatment for Leber's hereditary optic neuropathy. Treatment of other causes of optic atrophy varies depending upon the underlying disease.

Prognosis

Many patients with optic neuritis eventually develop multiple sclerosis. Most patients have a gradual recovery of vision after a single episode of optic neuritis, even without treatment. Prognosis for visual improvement in Leber's hereditary optic neuropathy is poor, with the specific rate highly dependent on which mitochondrial DNA mutation is present. If the cause of toxic or nutritional deficiency optic neuropathy can be found and treated early, such as stopping smoking and taking vitamins in tobacco-alcohol amblyopia, vision generally returns to near normal over several months' time. However, visual loss is often permanent in cases of long-standing toxic or nutritional deficiency optic neuropathy.

KEY TERMS

Atrophy—A destruction or dying of cells, tissues, or organs.

Cerebellar—Involving the part of the brain (cerebellum), which controls walking, balance, and coordination.

Mitochondia—A structure in the cell responsible for producing energy. A defect in the DNA in the mitochondria is involved in Leber's optic neuropathy.

Neuritis—An inflammation of the nerves.

Neuropathy—A disturbance of the nerves, not caused by an inflammation. For example, the cause may be toxins, or unknown.

Prevention

People noticing a decrease in vision (central and/or side vision) should ask their eye care practitioner for a check up. Patients should also go for regular vision exams. Patients should ask their doctor how often that should be, as certain conditons may warrant more frequent exams. Early detection of inflammations or other problems lessens the chance of developing optic atrophy.

As of mid 1998, there are no preventive measures that can definitely abort Leber's hereditary optic neuropathy in those genetically at risk, or in those at risk based on earlier involvement of one eye. However, some doctors recommend that their patients take vitamin C, vitamin E, coenzyme Q_{10}, or other antioxidants, and that they avoid the use of tobacco or alcohol. Patients should ask their doctors about the use of vitamins. Avoiding toxin exposure and nutritional deficiency should prevent toxic or nutritional deficiency optic neuropathy.

Resources

PERIODICALS

Cullom, M. E., et al. "Leber's Hereditary Optic Neuropathy Masquerading as Tobacco-Alcohol Amblyopia." *Archives of Ophthalmology* 111 (1993): 1482-5.

Funakawa, I., et al. "Cerebellar Ataxia in Patients with Leber's Hereditary Optic Neuropathy." *Journal of Neurology* 242 (1995): 75-7.

Goldnick, K. C., and E. R. Schaible. "Folate-Responsive Optic Neuropathy." In *Journal of Neuroophthalmology* 14 (1994):163-9.

Newman, N. J. "Optic Neuropathy." *Neurology* 46, no. 2 (1996): 315-22.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

Laurie Barclay, MD

Optic neuritis

Definition

Optic neuritis is a vision disorder characterized by inflammation of the optic nerve.

Description

Optic neuritis occurs when the optic nerve, the pathway that transmits visual information to the brain, becomes inflamed and the myelin sheath that surrounds the nerve is destroyed (a process known as demyelination). It typically occurs in one eye at a time (70%), and the resulting vision loss is rapid and progressive, but only temporary. Thirty percent of patients experience occurrence in both eyes. Optic neuritis tends to afflict young adults with an average age in their 30s. Seventy-five percent of patients with optic neuritis are women.

Nerve damage that occurs in the section of the optic nerve located behind the eyeball, is called *retrobulbar neuritis*, and is most often associated with **multiple sclerosis**. Optic nerve inflammation and **edema** (swelling) caused by intracranial pressure at the place where the nerve enters the eyeball is termed *papillitis*.

Causes and symptoms

Symptoms of optic neuritis include one or more of the following:

- blurred or dimmed vision
- blind spots, particularly with central vision
- pain with eye movement
- **headache**
- sudden color blindness
- impaired night vision
- impaired contrast sensitivity

Optic neuritis is most commonly associated with multiple sclerosis (MS). Other causes include viral or fungal infections, encephalomyelitis, autoimmune diseases, or pressure on the nerve from tumors or vascular diseases (i.e., **temporal arteritis**). Some toxins, such as methanol and lead, can also damage the optic nerve, as can long-term abuse of alcohol and tobacco. Patients with non-MS related optic neuritis are usually immunocompromised in some way.

Diagnosis

An ophthalmologist, a physician trained in diseases of the eye, will typically make a diagnosis of optic neuritis. A complete visual exam, including a visual acuity test, color vision test, and examination of the retina and optic disc with an ophthalmoscope, will be performed. Clinical signs such as impaired pupil response may be apparent during an eye exam, but in some cases the eye may appear normal. A medical history will also be performed to determine if exposure to toxins such as lead may have caused the optic neuritis.

Further diagnostic testing such as **magnetic resonance imaging** (MRI) may be necessary to confirm a diagnosis of optic neuritis. An MRI can also reveal signs of multiple sclerosis.

Treatment

Treatment of optic neuritis depends on the underlying cause of the condition. Vision loss resulting from a viral condition usually resolves itself once the virus is treated, and optic neuritis resulting from toxin damage may improve once the source of the toxin is removed.

A course of intravenous **corticosteroids** (steroids) followed by oral steroids has been found to be helpful in restoring vision quickly to patients with MS-related episodes of optic neuritis, but its efficacy in preventing relapse is debatable. The Optic Neuritis Treatment Trial (ONTT) has shown that IV steroids may be effective in reducing the onset of MS for up to two years, but further studies are necessary. Oral prednisone has been found to increase the likelihood of recurrent episodes of optic neuritis, and is not recommended for treating the disorder.

Prognosis

The vision loss associated with optic neuritis is usually temporary. Spontaneous remission occurs in two to eight weeks. Sixty-five to eighty percent of patients can expect 20/30 or better vision after recovery. Long-term prognosis depends on the underlying cause of the condition. If a viral infection has triggered the episode, it frequently resolves itself with no after effects. If optic neuritis is associated with multiple sclerosis, future episodes are not uncommon. Thirty-three percent of optic neuritis cases recur within five years. Each recurrence results in less recovery and worsening vision. There is a strong association between optic neu-

KEY TERMS

Atrophy—Cell wasting or death.

Multiple sclerosis—An autoimmune disease of the central nervous system characterized by damage to the myelin sheath that covers nerves.

Temporal arteritis—Also known as giant cell arteritis. Inflammation of the large arteries located in the temples which is marked by the presence of giant cells and symptoms of headache and facial pain.

Visual acuity test—An eye examination that determines sharpness of vision, typically performed by identifying objects and/or letters on an eye chart.

ritis and MS. In those without multiple sclerosis, half who experience an episode of vision loss related to optic neuritis will develop the disease within 15 years.

Prevention

Regular annual eye exams are critical to maintaining healthy vision. Early treatment of vision problems can prevent permanent optic nerve damage (atrophy).

Resources

BOOKS

Leitman, Mark. *Manual for Eye Examination and Diagnosis, 5th ed*. Boston: Blackwell Science, 2001.

PERIODICALS

Cohen, Joyce Render, et al. "Living with Low Vision." *Inside MS* 1(2001):46.

ORGANIZATIONS

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.prevent-blindness.org>.

Paula Ford-Martin

Oral cancer *see* **Head and neck cancer**

Oral cholecystography *see* **Gallbladder x rays**

Oral contraceptives

Definition

Oral contraceptives are medicines taken by mouth to help prevent **pregnancy**. They are also known as the Pill, OCs, or birth control pills.

Purpose

Oral contraceptives, also known as birth control pills, contain artificially made forms of two hormones produced naturally in the body. These hormones, estrogen and progestin, regulate a woman's menstrual cycle. When taken in the proper amounts, following a specific schedule, oral contraceptives are very effective in preventing pregnancy. Studies show that less than one of every one hundred women who use oral contraceptives correctly becomes pregnant during the first year of use.

These pills have several effects that help prevent pregnancy. For pregnancy to occur, an egg must become mature inside a woman's ovary, be released, and travel to the fallopian tube. A male sperm must also reach the fallopian tube, where it fertilizes the egg. Then the fertilized egg must travel to the woman's uterus (womb), where it lodges in the uterus lining and develops into a fetus. The main way that oral contraceptives prevent pregnancy is by keeping an egg from ripening fully. Eggs that do not ripen fully cannot be fertilized. In addition, birth control pills thicken mucus in the woman's body through which the sperm has to swim. This makes it more difficult for the sperm to reach the egg. Oral contraceptives also change the uterine lining so that a fertilized egg cannot lodge there to develop.

Birth control pills may cause good or bad side effects. For example, a woman's menstrual periods are regular and usually lighter when she is taking oral contraceptives, and the pills may reduce the risk of **ovarian cysts**, breast lumps, **pelvic inflammatory disease**, and other medical problems. However, taking birth control pills increases the risk of **heart attack**, **stroke**, and blood clots in certain women. Serious side effects such as these are more likely in women over 35 years of age who smoke cigarettes and in those with specific health problems such as high blood pressure, diabetes, or a history of breast or uterine **cancer**. A woman who wants to use oral contraceptives should ask her physician for the latest information on the risks and benefits of all types of birth control and should consider her age, health, and medical history when deciding what to use.

Precautions

No form of birth control (except not having sex) is 100% effective. However, oral contraceptives can be highly effective when used properly. Discuss the options with a health care professional.

Oral contraceptives do not protect against **AIDS** or other **sexually transmitted diseases**. For protection against such diseases, use a latex **condom**.

Oral contraceptives are not effective immediately after a woman begins taking them. Physicians recom-

mend using other forms of birth control for the first 1–3 weeks. Follow the instructions of the physician who prescribed the medicine.

Smoking cigarettes while taking oral contraceptives greatly increases the risk of serious side effects. *Women who take oral contraceptives should not smoke cigarettes.*

Seeing a physician regularly while taking this medicine is very important. The physician will note unwanted side effects. Follow his or her advice on how often you should be seen.

Anyone taking oral contraceptives should be sure to tell the health care professional in charge before having any surgical or dental procedures, laboratory tests, or emergency treatment.

This medicine may increase sensitivity to sunlight. Women using oral contraceptives should avoid too much sun exposure and should not use tanning beds, tanning booths, or sunlamps until they know how the medicine affects them. Some women taking oral contraceptives may get brown splotches on exposed areas of their skin. These usually go away over time after the women stop taking birth control pills.

Oral contraceptives may cause the gums to become tender and swollen or to bleed. Careful brushing and flossing, gum massage, and regular cleaning may help prevent this problem. Check with a physician or dentist if gum problems develop.

Women who have certain medical conditions or who are taking certain other medicines may have problems if they take oral contraceptives. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to estrogens or progestins in the past should let her physician know before taking oral contraceptives. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who become pregnant or think they may have become pregnant while taking birth control pills should stop taking them immediately and check with their physicians. Women who want to start taking oral contraceptives again after pregnancy should not refill their old prescriptions without checking with their physicians. The physician may need to change the prescription.

BREASTFEEDING. Women who are breastfeeding should check with their physicians before using oral contraceptives. The hormones in the pills may reduce the amount of breast milk and may cause other problems in breastfeeding. They may also cause **jaundice** and enlarged breasts in nursing babies whose mothers take the medicine.

OTHER MEDICAL CONDITIONS. Oral contraceptives may improve or worsen some medical conditions. The possibility that they may make a condition worse does not necessarily mean they cannot be used. In some cases, women may need only to be tested or followed more closely for medical problems while using oral contraceptives. Before using oral contraceptives, women with any of these medical problems should make sure their physicians are aware of their conditions:

- Female conditions such as menstrual problems, **endometriosis**, or fibroid tumors of the uterus. Birth control pills usually make these problems better, but may sometimes make them worse or more difficult to diagnose.
- Heart or circulation problems; recent or past blood clots or stroke. Women who already have these problems may be at greater risk of developing blood clots or circulation problems if they use oral contraceptives. However, healthy women who do not smoke may lower their risk of circulation problems and heart disease by taking the pills.
- Breast cysts, lumps, or other noncancerous breast problems. Oral contraceptives generally protect against these conditions, but physicians may recommend more frequent breast exams for women taking the pills.
- **Breast cancer** or other cancer (now or in the past, or family history). Oral contraceptives may make some existing cancers worse. Women with a family history of breast cancer may need more frequent screening for the disease if they decide to take birth control pills.
- Migraine headaches. This condition may improve or may get worse with the use of birth control pills.
- Diabetes. Blood sugar levels may increase slightly when oral contraceptives are used. Usually this increase is not enough to affect the amount of diabetes medicine needed. However, blood sugar will need to be monitored closely while taking oral contraceptives.
- Depression. This condition may worsen in women who already have it or may (rarely) occur again in women who were depressed in the past.
- Gallbladder disease, **gallstones**, high blood cholesterol, or chorea gravidarum (a nervous disorder). Oral contraceptives may make these conditions worse.
- Epilepsy, high blood pressure, heart or circulation problems. By increasing fluid build-up, oral contraceptives may make these conditions worse.

Description

Oral contraceptives (birth control pills) come in a wide range of estrogen-progestin combinations. The pills in use today contain much lower doses of estrogen

than those available in the past, and this change has reduced the likelihood of serious side effects. Some pills contain only progestin. These are prescribed mainly for women who need to avoid estrogens and may not be as effective in preventing pregnancy as the estrogen-progestin combinations.

These medicines come in tablet form, in containers designed to help women keep track of which tablet to take each day. The tablets are different colors, indicating amounts of hormones they contain. Some may contain no hormones at all. These are included simply to help women stay in the habit of taking a pill every day, as the hormone combination needs to be taken only on certain days of the menstrual cycle. Keeping the tablets in their original container and taking them exactly on schedule is very important. They will not be as effective if they are taken in the wrong order or if doses are missed.

Oral contraceptives are available only with a physician's prescription. Some commonly used brands are Demulen, Desogen, Loestrin, Lo/Ovral, Nordette, Ortho-Novum, Ortho-Tri-Cyclen, Estrostep, Ortho-cept, Alesse, Levlite and Ovcon.

The dose schedule depends on the type of oral contraceptive. The two basic schedules are a 21-day schedule and a 28-day schedule. On the 21-day schedule, take 1 tablet a day for 21 days, then skip 7 days and repeat the cycle. On the 28-day schedule, take one tablet a day for 28 days; then repeat the cycle. Be sure to carefully follow the instructions provided with the medicine. For additional information or explanations, check with the physician who prescribed the medicine or the pharmacist who filled the prescription.

Taking doses more than 24 hours apart may increase the chance of side effects or pregnancy. Try to take the medicine at the same time every day. Take care not to run out of pills. If possible, keep an extra month's supply on hand and replace it every month with the most recently filled prescription.

Try not to miss a dose, as this increases the risk of pregnancy. If a dose is missed, follow the package directions or check with the physician who prescribed the medicine for instructions. It may be necessary to use another form of birth control for some time after missing a dose.

Taking this medicine with food or at bedtime will help prevent nausea, a side effect that sometimes occurs during the first few weeks. This side effect usually goes away as the body adjusts to the medicine.

Taking oral contraceptives may have several benefits outside of their ability to prevent pregnancy. Research indicates that with 10 to 12 years of oral contraceptive use, a woman's risk of **ovarian cancer** is reduced by up to 80%. There may also be an approximate 50% decrease in the rate of endometrial cancers in women. One other well-known, noncontraceptive benefit of oral contraceptives is an improvement in **acne**. The combination oral contraceptive ethinyl estradiol/norgestimate has been approved by the Food and Drug Administration for the treatment of acne. Another positive effect of oral contraceptive use is improvement in abnormal uterine bleeding. Older women may also benefit from using oral contraceptives, because the pills can increase bone mass as women enter their menopausal years, when **osteoporosis** is a growing concern.

Oral contraceptives may also be used on an emergency basis as a means of preventing pregnancy in women who have had unprotected intercourse. Two products specifically designed for this purpose are Preven and Plan B. In 2001, the American College of Obstetricians and Gynecologists (ACOG) recommended that emergency oral contraceptives be available as an over-the-counter medicine. The Food and Drug Administration, however, has not yet approved any measures that would allow this to happen.

Risks

Taking oral contraceptives with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side Effects

Serious side effects are rare in healthy women who do not smoke cigarettes. In women with certain health problems, however, oral contraceptives may cause problems such as **liver cancer**, noncancerous liver tumors, blood clots, or stroke. Health care professionals can help women weigh the benefits of being protected against unwanted pregnancy against the risks of possible health problems.

The most common minor side effects are nausea; vomiting; abdominal cramping or bloating; breast **pain**, tenderness or swelling; swollen ankles or feet; tiredness; and acne. These problems usually go away as the body adjusts to the drug and do not need medical attention unless they continue or they interfere with normal activities.

Other side effects should be brought to the attention of the physician who prescribed the medicine. Check with the physician as soon as possible if any of the following side effects occur:

- menstrual changes, such as lighter periods or missed periods, longer periods, or bleeding or spotting between periods

- headaches
- vaginal infection, **itching**, or irritation
- increased blood pressure

Women who have any of the following symptoms should get emergency help right away. These symptoms may be signs of blood clots:

- sudden changes in vision, speech, breathing, or coordination
- severe or sudden **headache**
- coughing up blood
- sudden, severe, or continuing pain in the abdomen or stomach
- pain in the chest, groin, or leg (especially in the calf)
- weakness, numbness, or pain in an arm or leg

Oral contraceptives may continue to affect the menstrual cycle for some time after a woman stops taking them. Women who miss periods for several months after stopping this medicine should check with their physicians.

Other rare side effects may occur. Anyone who has unusual symptoms while taking oral contraceptives should get in touch with her physician.

Interactions

Oral contraceptives may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes oral contraceptives should let the physician know all other medicines she is taking and should ask whether the possible interactions can interfere with drug therapy.

These drugs may make oral contraceptives less effective in preventing pregnancy. Anyone who takes these drugs should use an additional birth control method for the entire cycle in which the medicine is used:

- ampicillin
- penicillin V
- rifampin (Rifadin)
- tetracyclines
- griseofulvin (Gris-PEG, Fulvicin)
- corticosteroids
- barbiturates
- carbamazepine (Tegretol)
- phenytoin (Dilantin)
- primidone (Mysoline)
- ritonavir (Norvir)

KEY TERMS

Cyst—An abnormal sac or enclosed cavity in the body, filled with liquid or partially solid material.

Endometriosis—A condition in which tissue like that normally found in the lining of the uterus is present outside the uterus. The condition often causes pain and bleeding.

Fallopian tube—One of a pair of slender tubes that extend from each ovary to the uterus. Eggs pass through the fallopian tubes to reach the uterus.

Fetus—A developing baby inside the womb.

Fibroid tumor—A noncancerous tumor formed of fibrous tissue.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Jaundice—Yellowing of the eyes and skin due to the build up of a bile pigment (bilirubin) in the blood.

Migraine—A throbbing headache that usually affects only one side of the head. Nausea, vomiting, increased sensitivity to light, and other symptoms often accompany migraine.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Ovary—A reproductive organ in females that produces eggs and hormones.

Pelvic inflammatory disease—Inflammation of the female reproductive tract, caused by any of several microorganisms. Symptoms include severe abdominal pain, high fever, and vaginal discharge. Severe cases can result in sterility. Also called PID.

Uterus—A hollow organ in a female in which a fetus develops until birth.

In addition, taking these medicines with oral contraceptives may increase the risk of side effects or interfere with the medicine's effects:

- theophylline—effects of this medicine may increase, along with the chance of unwanted side effects
- cyclosporine—effects of this medicine may increase, along with the chance of unwanted side effects
- troleandomycin (TAO)—chance of liver problems may increase. Effectiveness of oral contraceptive may also decrease, raising the risk of pregnancy

The list above does not include every drug that may interact with oral contraceptives. Be sure to check with a physician or pharmacist before combining oral contraceptives with any other prescription or nonprescription (over-the-counter) medicine.

As with any medication, the benefits and risks should be discussed with a physician.

Resources

BOOKS

Beers, Mark H. and Robert Berkow, eds. *The Merck Manual of Diagnosis and Therapy, 17th ed.* Whitehouse Station, NJ: Merck and Company, Inc., 1999.

PERIODICALS

"Physician Group Supports Safety, Availability of Over-the-Counter Emergency Option" *Medical Letter on the CDC and FDA* (March 18, 2001).

"Current Perspectives on OC Formulations" *Family Practice News* (January 15, 2001): 2.

OTHER

Medline Plus Health Information, U.S. National Library of Medicine. <http://www.nlm.nih.gov/medlineplus>.

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Oral herpes *see* **Cold sore**

Oral hygiene

Definition

Oral hygiene is the practice of keeping the mouth clean and healthy by brushing and flossing to prevent **tooth decay** and gum disease.

Purpose

The purpose of oral hygiene is to prevent the build-up of plaque, the sticky film of bacteria and food that forms on the teeth. Plaque adheres to the crevices and fissures of the teeth and generates acids that, when not removed on a regular basis, slowly eat away, or decay, the protective enamel surface of the teeth, causing holes (cavities) to form. Plaque also irritates gums and can lead to gum disease (**periodontal disease**) and tooth loss. Toothbrushing and flossing remove plaque from teeth, and antiseptic mouthwashes kill some of the bacteria that help form plaque. Fluoride—in toothpaste, drinking water, or dental treatments—also helps to protect teeth by binding with enamel to make it stronger. In addition to such daily oral care, regular visits to the dentist promote oral health. Preventative services that he or she can perform include fluoride treatments, sealant application, and scaling (scraping off the hardened plaque, called tartar). The dentist can also perform such diagnostic services as x-ray imaging and oral **cancer** screening as well as such treatment services as fillings, crowns, and bridges.

Precautions

Maintaining oral hygiene should be a lifelong habit. An infant's gums and, later, teeth should be kept clean by wiping them with a moist cloth or a soft toothbrush. However, only a very small amount (the size of a pea) of toothpaste containing fluoride should be used since too much fluoride may be toxic to infants.

An adult who has partial or full dentures should also maintain good oral hygiene. Bridges and dentures must be kept clean to prevent gum disease. Dentures should be relined and adjusted by a dentist as necessary to maintain proper fit so the gums do not become red, swollen, and tender.

Brushing and flossing should be performed thoroughly but not too vigorously. Rough mechanical action may irritate or damage sensitive oral tissues. Sore or bleeding gums may be experienced for the first few days after flossing is begun. However, bleeding continuing beyond one week should be brought to the attention of a dentist. As a general rule, any sore or abnormal condition that does not disappear after 10 days should be examined by a dentist.

Description

Brushing

Brushing should be performed with a toothbrush and a fluoride toothpaste at least twice a day and preferably after every meal and snack. Effective brushing must clean each outer tooth surface, inner tooth surface, and the flat chewing surfaces of the back teeth. To clean the outer and inner surfaces, the toothbrush should be held at a 45-degree angle against the gums and moved back and forth in short strokes (no more than one toothwidth distance). To clean the inside surfaces of the front teeth, the toothbrush should be held vertically and the bristles at the tip (called the toe of the brush) moved gently up and down against each tooth. To clean the chewing surfaces of the large back teeth, the brush should be held flat and moved back and forth. Finally, the tongue should also be brushed using a back-to-front sweeping motion to remove food particles and bacteria that may sour the breath.

Toothbrushes wear out and should be replaced every three months. Consumers should look for toothbrushes

with soft, nylon, rounded bristles in a size and shape that allows them to reach all tooth surfaces easily.

Holding a toothbrush may be difficult for people with limited use of their hands. The toothbrush handle may be modified by inserting it into a rubber ball for easier gripping.

Flossing

Flossing once a day helps prevent gum disease by removing food particles and plaque at and below the gumline as well as between teeth. To begin, most of an 18-in (45-cm) strand of floss is wrapped around the third finger of one hand. A 1-in (2.5-cm) section is then grasped firmly between the thumb and forefinger of each hand. The floss is eased between two teeth and worked gently up and down several times with a rubbing motion. At the gumline, the floss is curved first around one tooth and then the other with gentle sliding into the space between the tooth and gum. After each tooth contact is cleaned, a fresh section of floss is unwrapped from one hand as the used section of floss is wrapped around the third finger of the opposite hand. Flossing proceeds between all teeth and behind the last teeth. Flossing should also be performed around the abutment (support) teeth of a bridge and under any artificial teeth using a device called a floss threader.

Dental floss comes in many varieties (waxed, unwaxed, flavored, tape) and may be chosen on personal preference. For people who have difficulty handling floss, floss holders and other types of interdental (between the teeth) cleaning aids, such as brushes and picks, are available.

Risks

Negative consequences arise from improper or infrequent brushing and flossing. The five major oral health problems are plaque, tartar, gingivitis, periodontitis, and tooth decay.

Plaque is a soft, sticky, colorless bacterial film that grows on the hard, rough surfaces of teeth. These bacteria use the sugar and starch from food particles in the mouth to produce acid. Left to accumulate, this acid destroys the outer enamel of the tooth, irritates the gums to the point of bleeding, and produces foul breath. Plaque starts forming again on teeth four to 12 hours after brushing, so brushing a minimum of twice a day is necessary for adequate oral hygiene.

When plaque is not regularly removed by brushing and flossing, it hardens into a yellow or brown mineral deposit called tartar or calculus. This formation is crusty and provides additional rough surfaces for the growth of plaque. When tartar forms below the gumline, it can lead to periodontal (gum) disease.

KEY TERMS

Calculus—A hardened yellow or brown mineral deposit from unremoved plaque; also called tartar.

Cavity—A hole or weak spot in the tooth surface caused by decay.

Gingivitis—Inflammation of the gums, seen as painless bleeding during brushing and flossing.

Interdental—Between the teeth.

Periodontal—Pertaining to the gums.

Periodontitis—A gum disease that destroys the structures supporting the teeth, including bone.

Plaque—A thin, sticky, colorless film of bacteria that forms on teeth.

Tartar—A hardened yellow or brown mineral deposit from unremoved plaque; also called calculus.

Gingivitis is an early form of periodontal disease, characterized by inflammation of the gums with painless bleeding during brushing and flossing. This common condition is reversible with proper dental care but if left untreated, it will progress into a more serious periodontal disease, periodontitis.

Periodontitis is a gum disease that destroys the structures supporting the teeth, including bone. Without support, the teeth will loosen and may fall out or have to be removed. To diagnose periodontitis, a dentist looks for gums that are red, swollen, bleeding, and shrinking away from the teeth, leaving widening spaces between teeth and exposed root surfaces vulnerable to decay.

Tooth decay, also called dental caries or cavities, is a common dental problem that results when the acid produced by plaque bacteria destroys the outer surface of a tooth. A dentist will remove the decay and fill the cavity with an appropriate dental material to restore and protect the tooth; left untreated, the decay will expand, destroying the entire tooth and causing significant **pain**.

Normal results

With proper brushing and flossing, oral hygiene may be maintained and oral health problems may be avoided. Older adults may no longer assume that they will lose all of their teeth in their lifetime. Regular oral care preserves speech and eating functions, thus prolonging the quality of life.

Resources

ORGANIZATIONS

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

American Dental Hygienists' Association. 444 North Michigan Ave., Chicago, IL 60611. (800) 847-6718.

OTHER

Healthtouch Online Page. <http://www.healthtouch.com>.

Bethany Thivierge

Oral hypoglycemics *see* **Antidiabetic drugs**

Orbital and periorbital cellulitis

Definition

Periorbital **cellulitis** is an inflammation and infection of the eyelid and the skin surrounding the eye. Orbital cellulitis affects the eye socket (orbit) as well as the skin closest to it.

Description

Inside the eyelid is a septum. The septum divides the eyelid into outer and inner areas. This orbital septum helps prevent the spread of infection to the eye socket. Periorbital and orbital cellulitis are more common in children than in adults. Periorbital cellulitis, which accounts for 85–90% of all ocular cellulitis, usually occurs in children under the age of five. Responsible for the remaining 10–15% of these infections, orbital cellulitis is most common in children over the age of five.

These conditions usually begin with swelling or inflammation of one eye. Infection spreads rapidly and can cause serious problems that affect the eye or the whole body.

Causes and symptoms

Orbital and periorbital cellulitis are usually caused by infection of the sinuses near the nose. Insect bites or injuries that break the skin cause about one-third of these cellulitis infections. Orbital and periorbital cellulitis may also occur in people with a history of dental infections.

The blood of about 33 of every 100 patients with orbital or periorbital cellulitis contains bacteria known to cause:

- acute ear infections
- inflammation of the epiglottis (the cartilage flap that covers the opening of the windpipe during swallowing)
- **meningitis** (inflammation of the membranes that enclose and protect the brain)
- pneumonia
- sinus infection

People with periorbital cellulitis will have swollen, painful lids and redness, but probably no **fever**. About one child in five has a runny nose, and 20% have **conjunctivitis**. Conjunctivitis, also called pinkeye, is an inflammation of the mucous membrane that lines the eyelid and covers the front white part of the eye. It can be caused by allergy, irritation, or bacterial or viral infection.

As well as a swollen lid, other symptoms of orbital cellulitis include:

- bulging or displacement of the eyeball (proptosis)
- chemosis (swelling of the mucous membrane of the eyeball and eyelid as a result of infection, injury, or systemic disorders like anemia or kidney disease)
- diminished ability to see clearly
- eye **pain**
- fever
- paralysis of nerves that control eye movements (**ophthalmoplegia**)

Diagnosis

An eye doctor may use special instruments to open a swollen lid in order to:

- examine the position of the eyeball
- evaluate eye movement
- test the patient's vision

If the source of infection is not apparent, the position of the eyeball may suggest its location. **Computed tomography scans** (CT scans) can indicate which sinuses and bones are involved or whether abscesses have developed.

Treatment

A child who has orbital or periorbital cellulitis should be hospitalized without delay. **Antibiotics** are used to stop the spread of infection and prevent damage to the optic nerve, which transmits visual images to the brain.

Symptoms of optic-nerve damage or infection that has spread to sinus cavities close to the brain include:

- very limited ability to move the eye
- impaired response of the pupil to light and other stimulus
- loss of visual acuity

• papilledema (swelling of the optic disk—where the optic nerve enters the eye)

One or both eyes may be affected, and eye sockets or sinus cavities may have to be drained. These surgical procedures should be performed by an ophthalmologist or otolaryngologist.

Prognosis

If diagnosed promptly and treated with antibiotics, most orbital and periorbital cellulitis can be cured. These conditions are serious and need prompt treatment.

Infections that spread beyond the eye socket can cause:

• abscesses in the brain or in the protective membranes that enclose it

• bacterial meningitis

• blood clots

• vision loss

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. < ://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

OTHER

"Periorbital and Orbital Cellulitis." *The Meck Page*. May 20 1998 <http://www.merck.com>.

Mary Jane Tenerelli, MS

Orchiectomy *see* **Testicular surgery**

Orchiopexy *see* **Testicular surgery**

Orchitis

Definition

Orchitis is an inflammation of one or both testis, accompanied by swelling, **pain**, **fever**, and a sensation of heaviness in the affected area.

Description

Viral **mumps** is the most common cause of orchitis. Bacterial infections associated with the disorder are **tuberculosis**, **syphilis**, **gonorrhea**, and chlamydia. A mechanical injury to the groin area may also cause orchitis. Fifteen to twenty-five percent of males past the age of **puberty** with mumps develop orchitis. Epididymo-orchitis (inflammation of both testis and part of the spermatic duct) is the most common bacterial type of Orchitis. This form of the condition occurs most often in sexually active males fifteen years and older, and in men over 45 with enlarged prostates.

Causes and symptoms

The people most susceptible to orchitis are those with inadequate mumps inoculation and, in the case of sexually transmitted orchitis, those who practice unsafe sex or have a history of sexually transmitted disease. Inadequate protection of the groin area during contact sports or other potentially harmful physical activities may result in injury leading to orchitis. Symptoms of orchitis include swelling of one or both testicles, tenderness in the groin area, fever, **headache**, and nausea. Symptoms may also include bloody discharge from the penis, and pain during urination, intercourse, or ejaculation.

Diagnosis

In most cases, Orchitis can be diagnosed by an urologist, general practitioner, or emergency room physician. Diagnosis is usually based on the results of a **physical examination** and patient history. Other testing may include a **urinalysis** and **urine culture**, screening for chlamydia and gonorrhea, ultrasound imaging, or blood tests.

Treatment

Elevation and support of the scrotum, and the application of cold packs to the groin area give some relief from the pain of orchitis. Medication for pain such as codeine and meperidine may be given. Only the symptoms of viral mumps orchitis are treated. **Antibiotics** are used to alleviate orchitis that is bacterial in origin. Sexually transmitted orchitis (especially when resultant from chlamydia or gonorrhea) is often treated with the antibiotic Ceftriaxone in conjunction with azithromycin or doxycycline.

Alternative treatment

For relief from swelling, the drinking of dandelion tea is recommended in **traditional Chinese medicine** (TCM). Another traditional Chinese treatment for swelling is the application of a poultice of ground dandelion and aloe to

KEY TERMS

Atrophy—A wasting away or withering.

Epididymo-orchitis—Inflammation of both the testis and a part of the spermatic duct system.

Unilateral—Affecting only one side.

the affected area. Homeopathic remedies to reduce swelling include apis mel, belladonna, and pulsatilla. Consult a homeopathic physician before taking or administering these remedies to ensure safe and correct dosage.

Prognosis

Orchitis is usually unilateral and lasts between one and two weeks. Atrophy of the scrotum occurs in 60% of orchitis cases. However, hormonal function is not affected and resulting sterility is rare from mumps.

Prevention

Keeping mumps inoculations current and diligently practicing safe sex are the best ways to prevent orchitis from occurring. For males involved in contact sports or other potentially harmful physical activities, the wearing of a protective cup over the genitals will help guard against mechanical injuries that could lead to orchitis.

Resources

BOOKS

Center for Disease Control, Prevention Staff and U.S. Department of Health and Human Services. *1998 Guidelines for Treatment of Sexually Transmitted Diseases.* McLean, VA: International Medical Publishing, Inc., 1998.

Zand, Janet, Allan N. Spreen, and James B. LaValle. "Mumps" In *Smart Medicine for Healthier Living*. Garden City Park, NY: Avery Publishing Group, 1998.

PERIODICALS

Casella, R., B. Leibundgut, K. Lehman, et al. "Mumps Orchitis: Report of a Mini-Epidemic." *Journal of Urology* (December 1997).

Rodriguez, Rod. "Acute Scrotum Due to Epididymo-Orchitis in Male Children." *Impotence & Male Health Weekly Plus* (February 1999).

OTHER

Mycyck, Mark, MD. "Orchitis from Emergency Medicine/Genitourinary." *Emedicine, Instant Access to the Minds of Medicine.* February 2001. <http://www.emedicine.com/emerg/topic344.htm>.

Maureen Haggerty

Organophosphates *see* **Insecticide poisoning**

Oriental sore *see* **Leishmaniasis**

Ornithosis *see* **Parrot fever**

Oroya fever *see* **Bartonellosis**

Orthopedic surgery

Definition

Orthopedic (sometimes spelled orthopaedic) surgery is surgery performed by a medical specialist, such as an orthopedist or orthopedic surgeon, trained to deal with problems that develop in the bones, joints, and ligaments of the human body.

Purpose

Orthopedic surgery corrects problems that arise in the skeleton and its attachments, the ligaments and tendons. It may also deal with some problems of the nervous system, such as those that arise from injury of the spine. These problems can occur at birth, through injury, or as the result of **aging**. They may be acute, as in injury, or chronic, as in many aging-related problems.

Orthopedics comes from two Greek words, *ortho*, meaning straight and *pais,* meaning child. Originally orthopedic surgeons dealt with bone deformities in children, using braces to straighten the child's bones. With the development of anesthesia and an understanding of the importance of aseptic technique in surgery, orthopedic surgeons extended their role to include surgery involving the bones and related nerves and connective tissue.

The terms orthopedic surgeon and orthopedist are used interchangeably today to indicate a medical doctor with special certification in orthopedics.

Many orthopedic surgeons maintain a general practice, while some specialize in one particular aspect of orthopedics, such as hand surgery, joint replacements, or disorders of the spine. Orthopedics treats both acute and chronic disorders. Some orthopedists specialize in trauma medicine and can be found in emergency rooms and trauma centers treating injuries. Others find their work overlapping with plastic surgeons, geriatric specialists, pediatricians, or podiatrists (**foot care** specialists). A rapidly growing area of orthopedics is sports medicine, and many sports medicine doctors are board certified orthopedists.

Precautions

Choosing an orthopedist is an important step in obtaining appropriate treatment. Patients looking for a qualified orthopedist should inquire if they are "board certified" by their accrediting organization.

Description

The range of treatments done by orthopedists is enormous. It can cover anything from **traction** to **amputation**, hand reconstruction to spinal fusion or joint replacements. They also treat broken bones, strains and sprains, and dislocations. Some specific procedures done by orthopedic surgeons are listed as separate entries in this book, including **arthroplasty**, **arthroscopic surgery**, **bone grafting**, **fasciotomy**, **fracture repair**, **kneecap removal**, and traction.

In general orthopedists are attached to a hospital, medical center, trauma center, or free-standing surgical center where they work closely with a surgical team including an anesthesiologist and surgical nurse. Orthopedic surgery can be performed under general, regional, or local anesthesia.

Much of the work of the surgeon involves adding foreign material to the body in the form of screws, wires, pins, tongs, and prosthetics to hold damaged bones in their proper alignment or to replace damaged bone or connective tissue. Great improvements have been made in the development of artificial limbs and joints, and in the materials available to repair damage to bones and connective tissue. As developments occur in the fields of metallurgy and plastics, changes will take place in orthopedic surgery that will allow the surgeon to more nearly duplicate the natural functions of the bones, joints, and ligaments, and to more accurately restore damaged parts to their original range of motion.

Preparation

Patients are usually referred to an orthopedic surgeon by a general physical or family doctor. Prior to any surgery, the patient undergoes extensive testing to determine the proper corrective procedure. Tests may include x rays, **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), myelograms, diagnostic arthroplasty, and blood tests. The orthopedist will determine the history of the disorder and any treatments that were tried previously. A period of rest to the injured part may be recommended before surgery is prescribed.

Patients undergo standard blood and urine tests before surgery and, for major surgery, may be given an electrocardiogram or other diagnostic tests prior to the operation.

KEY TERMS

Arthroplasty—The surgical reconstruction or replacement of a joint.

Prosthesis—A synthetic replacement for a missing part of the body, such as a knee or a hip.

Range of motion—The normal extent of movement (flexion and extension) of a joint.

Patients may choose to give some of their own blood to be held in reserve for their use in major surgery, such as knee replacement, where heavy bleeding is common.

Aftercare

Rehabilitation from orthopedic injuries can be a long, arduous task. The doctor will work closely with physical therapists to assure that the patient is receiving treatment that will enhance the range of motion and return function to the affected part.

Risks

As with any surgery, there is always the risk of excessive bleeding, infection, and allergic reaction to anesthesia. Risks specifically associated with orthopedic surgery include inflammation at the site where foreign material (pins, prosthesis) is introduced into the body, infection as the result of surgery, and damage to nerves or to the spinal cord.

Normal results

Thousands of people have successful orthopedic surgery each year to recover from injuries or restore lost function. The degree of success in individual recoveries depends on the age and general health of the patient, the medical problem being treated, and the patient's willingness to comply with rehabilitative therapy after the surgery.

Resources

BOOKS

Walton, John, Paul Beeson, and Ronald B. Scott, eds. "Orthopaedics." In *The Oxford Companion to Medicine*. Vol. 2. Oxford, England: Oxford University Press, 1986.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018-4262. (800) 823-8125. <http://www.AAOS.org>.

American Osteopathic Board of Orthopedic Surgery. <http://www.netincom.com/aobos/about.html>.

OTHER

Orthogate. <http://owl.orthogate.org/>.

Tish Davidson

Orthopedic x rays *see* **Bone x rays**

Orthostatic hypotension

Definition

Orthostatic **hypotension** is an abnormal decrease in blood pressure when a person stands up. This may lead to **fainting**.

Description

When a person stands upright, a certain amount of blood normally pools in the veins of the ankles and legs. This pooling means that there is slightly less blood for the heart to pump and causes a drop in blood pressure. Usually, the body responds to this drop so quickly, a person is unaware of the change. The brain tells the blood vessels to constrict so they have less capacity to carry blood, and at the same time tells the heart to beat faster and harder. These responses last for a very brief time. If the body's response to a change in vertical position is slow or absent, the result is orthostatic hypotension. It is not a true disease, but the inability to regulate blood pressure quickly.

Causes and symptoms

Orthostatic hypotension has many possible causes. The most common cause is medications used to treat other conditions. **Diuretics** reduce the amount of fluid in the body which reduces the volume of blood. Medicines used to expand the blood vessels increase the vessel's ability to carry blood and so lower blood pressure.

If there is a severe loss of body fluid from vomiting, **diarrhea**, untreated diabetes, or even excessive sweating, blood volume will be reduced enough to lower blood pressure. Severe bleeding can also result in orthostatic hypotension.

Any disease or **spinal cord injury** that damages the nerves which control blood vessel diameter can cause orthostatic hypotension.

Symptoms of orthostatic hypotension include faintness, **dizziness**, confusion, or blurry vision, when standing up quickly. An excessive loss of blood pressure can cause a person to pass out.

Diagnosis

When a person experiences any of the symptoms above, a physician can confirm orthostatic hypotension if the person's blood pressure falls significantly on standing up and returns to normal when lying down. The physician will then look for the cause of the condition.

Treatment

When the cause of orthostatic hypotension is related to medication, it is often possible to treat it by reducing dosage or changing the prescription. If it is caused by low blood volume, an increase in fluid intake and retention will solve the problem.

Medications designed to keep blood pressure from falling can be used when they will not interfere with other medical problems.

When orthostatic hypotension cannot be treated, the symptoms can be significantly reduced by remembering to stand up slowly or by wearing elastic stockings.

Prognosis

The prognosis for people who have orthostatic hypotension depends on the underlying cause of the problem.

Prevention

There is no way to prevent orthostatic hypotension, since it is usually the result of another medical condition.

Resources

PERIODICALS

Godbey, Susan Flagg, and Stephen George. "Up, Not Out, Flexing Checks Dizziness and Fainting." *Prevention Magazine* 49, no. 2 (Feb. 1997): 38+.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Dorothy Elinor Stonely

Orthotopic transplantation *see* **Liver transplantation**

Osgood-Schlatter disease *see* **Osteochondroses**

Osteitis deformans *see* **Paget's disease of bone**

Osteoarthritis

Definition

Osteoarthritis (OA), which is also known as osteoarthrosis or degenerative joint disease (DJD), is a progressive disorder of the joints caused by gradual loss of cartilage and resulting in the development of bony spurs and cysts at the margins of the joints. The name osteoarthritis comes from three Greek words meaning bone, joint, and inflammation.

Description

OA is one of the most common causes of disability due to limitations of joint movement, particularly in people over 50. It is estimated that 2% of the United States population under the age of 45 suffers from osteoarthritis; this figure rises to 30% of persons between 45 and 64, and 63–85% in those over 65. About 90% of the American population will have some features of OA in their weight-bearing joints by age 40. Men tend to develop OA at earlier ages than women.

OA occurs most commonly after 40 years of age and typically develops gradually over a period of years. Patients with OA may have joint **pain** on only one side of the body and it primarily affects the knees, hands, hips, feet, and spine.

Causes and symptoms

Osteoarthritis results from deterioration or loss of the cartilage that acts as a protective cushion between bones, particularly in weight-bearing joints such as the knees and hips. As the cartilage is worn away, the bone forms spurs, areas of abnormal hardening, and fluid-filled pockets in the marrow known as subchondral cysts. As the disorder progresses, pain results from deformation of the bones and fluid accumulation in the joints. The pain is relieved by rest and made worse by moving the joint or placing weight on it. In early OA, the pain is minor and may take the form of mild stiffness in the morning. In the later stages of OA, inflammation develops; the patient may experience pain even when the joint is not being used; and he or she may suffer permanent loss of the normal range of motion in that joint.

Until the late 1980s, OA was regarded as an inevitable part of **aging**, caused by simple "wear and tear" on the joints. This view has been replaced by recent research into cartilage formation. OA is now considered to be the end result of several different factors contributing to cartilage damage, and is classified as either primary or secondary.

Primary osteoarthritis

Primary OA results from abnormal stresses on weight-bearing joints or normal stresses operating on weakened joints. Primary OA most frequently affects the finger joints, the hips and knees, the cervical and lumbar spine, and the big toe. The enlargements of the finger joints that occur in OA are referred to as Heberden's and Bouchard's nodes. Some gene mutations appear to be associated with OA. **Obesity** also increases the pressure on the weight-bearing joints of the body. Finally, as the body ages, there is a reduction in the ability of cartilage to repair itself. In addition to these factors, some researchers have theorized that primary OA may be triggered by enzyme disturbances, bone disease, or liver dysfunction.

Secondary osteoarthritis

Secondary OA results from chronic or sudden injury to a joint. It can occur in any joint. Secondary OA is associated with the following factors:

- trauma, including sports injuries
- repetitive **stress** injuries associated with certain occupations (like the performing arts, construction or assembly line work, computer keyboard operation, etc.)
- repeated episodes of **gout** or septic arthritis
- poor posture or bone alignment caused by developmental abnormalities
- metabolic disorders

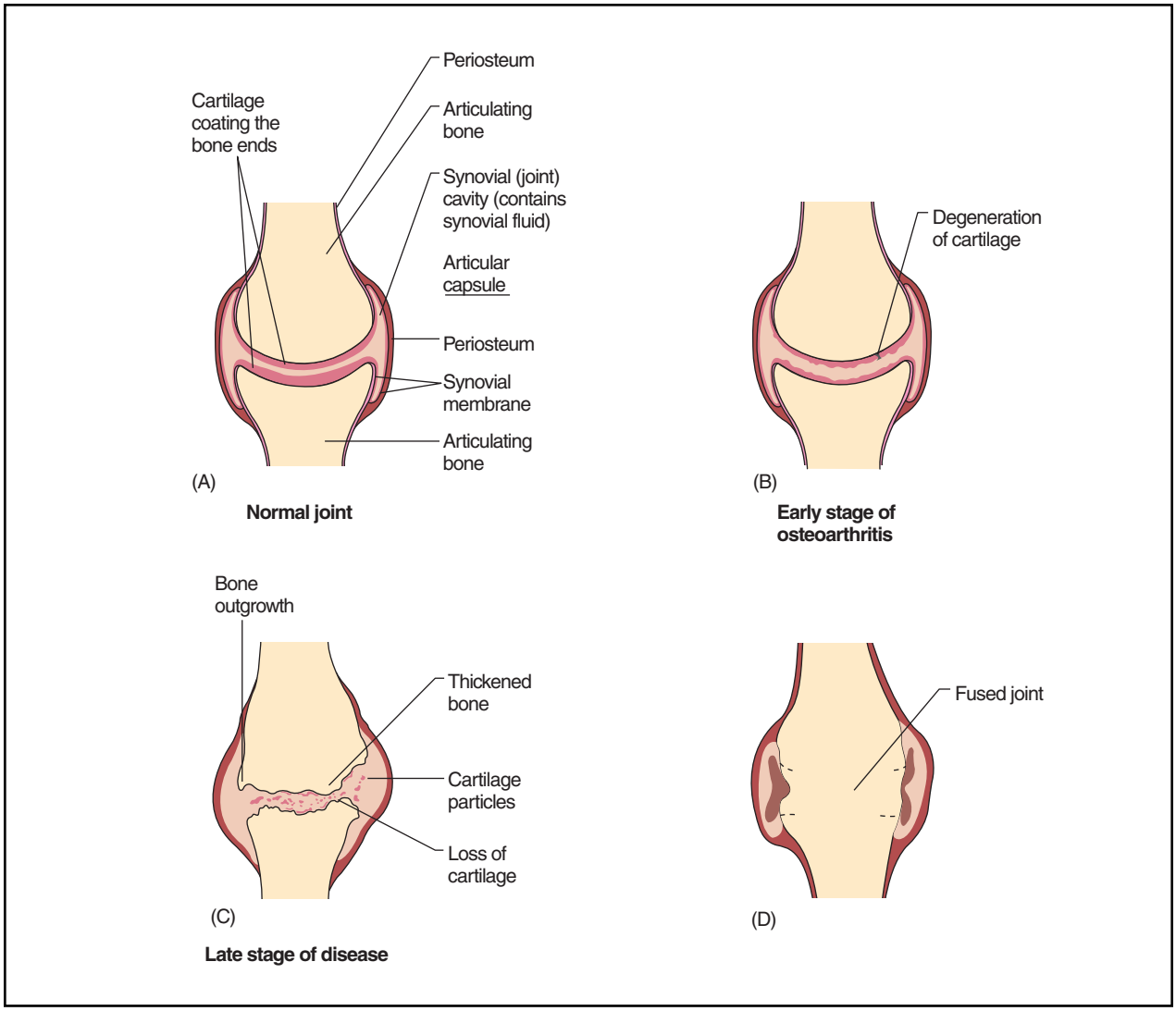
Diagnosis

History and physical examination

The two most important diagnostic clues in the patient's history are the pattern of joint involvement and the presence or absence of **fever**, rash, or other symptoms outside the joints. As part of the **physical examination**, the doctor will touch and move the patient's joint to evaluate swelling, limitations on the range of motion, pain on movement, and crepitus (a cracking or grinding sound heard during joint movement).

Diagnostic imaging

There is no laboratory test that is specific for osteoarthritis. Treatment is usually based on the results of diagnostic imaging. In patients with OA, x rays may



The progression of osteoarthritis. *(Illustration by Hans & Cassady.)*

indicate narrowed joint spaces, abnormal density of the bone, and the presence of subchondral cysts or bone spurs. The patient's symptoms, however, do not always correlate with x ray findings. **Magnetic resonance imaging** (MRI) and **computed tomography scans** (CT scans) can be used to determine more precisely the location and extent of cartilage damage.

Treatment

Treatment of OA patients is tailored to the needs of each individual. Patients vary widely in the location of the joints involved, the rate of progression, the severity of symptoms, the degree of disability, and responses to specific forms of treatment. Most treatment programs include several forms of therapy.

Patient education and psychotherapy

Patient education is an important part of OA treatment because of the highly individual nature of the disorder and its potential impacts on the patient's life. Patients who are depressed because of changes in employment or recreation usually benefit from counseling. The patient's family should be involved in discussions of coping, household reorganization, and other aspects of the patient's disease and treatment regimen.

Medications

Patients with mild OA may be treated only with pain relievers such as **acetaminophen** (Tylenol). Most patients with OA, however, are given **nonsteroidal anti-inflammatory drugs**, or NSAIDs. These include com-

pounds such as ibuprofen (Motrin, Advil), ketoprofen (Orudis), and flurbiprofen (Ansaid). The NSAIDs have the advantage of relieving inflammation as well as pain. They also have potentially dangerous side effects, including stomach ulcers, sensitivity to sun exposure, kidney disturbances, and nervousness or depression.

Some OA patients are treated with **corticosteroids** injected directly into the joints to reduce inflammation and slow the development of Heberden's nodes. Injections should not be regarded as a first-choice treatment and should be given only two or three times a year.

Most recently, a new class of NSAIDs, known as the cyclo-oxygenase-2 (COX-2) inhibitors have been studied and approved for the treatment of OA. These COX-2 inhibitors work to block the enzyme COX-2, which stimulates inflammatory responses in the body. They work to decrease both the inflammation and joint pain of OA, but without the high risk of gastrointestinal ulcers and bleeding seen with the traditional NSAIDs. This is due to the fact that they do not block COX-1, which is another enzyme that has protective effects on the stomach lining. The COX-2 inhibitors included celecoxib (Celebrex) and rofecoxib (Vioxx). Celecoxib is taken once or twice daily, and rofecoxib once daily.

Physical therapy

Patients with OA are encouraged to **exercise** as a way of keeping joint cartilage lubricated. Exercises that increase balance, flexibility, and range of motion are recommended for OA patients. These may include walking, swimming and other water exercises, **yoga** and other stretching exercises, or isometric exercises.

Physical therapy may also include massage, moist hot packs, or soaking in a hot tub.

Surgery

Surgical treatment of osteoarthritis may include the replacement of a damaged joint with an artificial part or appliance; surgical fusion of spinal bones; scraping or removal of damaged bone from the joint; or the removal of a piece of bone in order to realign the bone.

Protective measures

Depending on the location of the affected joint, patients with OA may be advised to use neck braces or collars, crutches, canes, hip braces, knee supports, bed boards, or elevated chair and toilet seats. They are also advised to avoid unnecessary knee bending, stair climbing, or lifting of heavy objects.

New treatments

Since 1997, several new methods of treatment for OA have been investigated. Although they are still being developed and tested, they appear to hold promise. They include:

- Disease-modifying drugs. These compounds may be useful in assisting the body to form new cartilage or improve its repair of existing cartilage.
- Hyaluronic acid. Injections of this substance may help to lubricate and protect cartilage, thereby promoting flexibility and reduced pain. These agents include hyaluronan (Hyalgan) and hylan G-F20 (Synvisc).
- Cartilage transplantation. This technique is presently used in Sweden.

Alternative treatment

Diet

Food intolerance can be a contributing factor in OA, although this is more significant in **rheumatoid arthritis**. Dietary suggestions that may be helpful for people with OA include emphasizing high-fiber, complex-carbohydrate foods, while minimizing fats. Plants in the Solanaceae family, such as tomatoes, eggplant, and potatoes, should be avoided, as should refined and processed foods. Foods that are high in bioflavonoids (berries as well as red, orange, and purple fruits and vegetables) should be eaten often.

Nutritional supplements

In the past several years, a combination of glucosamine and chondroitin sulfate has been proposed as a dietary supplement that helps the body maintain and repair cartilage. Studies conducted in Europe have shown the effectiveness of this treatment in many cases. These substances are nontoxic and do not require prescriptions. Other supplements that may be helpful in the treatment of OA include the antioxidant **vitamins** and **minerals** (vitamins A, C, E, selenium, and zinc) and the B vitamins, especially vitamins B_6 and B_5.

Naturopathy

Naturopathic treatment for OA includes **hydrotherapy**, diathermy (deep-heat therapy), nutritional supplements, and botanical preparations, including yucca, devil's claw (*Harpagophytum procumbens*), and hawthorn (*Crataegus laevigata*) berries.

Traditional Chinese medicine (TCM)

Practitioners of Chinese medicine treat arthritis with suction cups, massage, moxibustion (warming an area of skin by burning a herbal wick a slight distance above the skin), the application of herbal poultices, and internal doses of Chinese herbal formulas.

KEY TERMS

Bouchard's nodes—Swelling of the middle joint of the finger.

Cartilage—Elastic connective tissue that covers and protects the ends of bones.

Heberden's nodes—Swelling or deformation of the finger joints closest to the fingertips.

Primary osteoarthritis—OA that results from hereditary factors or stresses on weight-bearing joints.

Secondary osteoarthritis—OA that develops following joint surgery, trauma,or repetitive joint injury.

Subchondral cysts—Fluid-filled sacs that form inside the marrow at the ends of bones as part of the development of OA.

Other alternatives

Recently, several alternative treatments for OA have received considerable attention and study. These include:

- transcutaneous **electrical nerve stimulation** (TENS)
- magnet therapy
- therapeutic touch
- acupuncture
- yoga

Prognosis

OA is a progressive disorder without a permanent cure. In some patients, the rate of progression can be slowed by weight loss, appropriate exercise, surgical treatment, and the use of alternative therapies.

Resources

BOOKS

Fauci, A.S., et al, eds. *Harrison's Principles of Internal Medicine*. 14th ed. New York, NY: McGraw-Hill, 1998:1935-41.

Hellman, David B. "Arthritis & Musculoskeletal Disorders." In *Current Medical Diagnosis & Treatment 1998,* edited by Lawrence M. Tierney, Jr., et al. Stamford, CT: Appleton & Lange, 1998.

Neustadt, David H. "Osteoarthritis." In *Conn's Current Therapy,* edited by Robert E. Rakel. Philadelphia: W. B. Saunders Company, 1998.

Theodosakis, Jason, et al. *The Arthritis Cure*. New York: St. Martin's, 1997.

PERIODICALS

Berger, R. G. "Intelligent Use of NSAIDs: Where Do We Stand." *Expert Opinions in Pharmacotherapy* no. 2(1) (January 2001):19-30.

Brandt, K. D. "The Role of Analgesics in the Management of Osteoarthritis." *American Journal of Therapeutics* (March 2000):75-90.

Little, C. V., T. Parsons. "Herbal Therapy for Treating Osteoarthritis." *Cochrane Database System Review* (2001): 1.

Pavelka, K. "Treatment of Pain in Osteoarthritis." *European Journal of Pain* (2000):23-30.

Schnitzer, T. J. "Osteoarthritis Management: The Role of Cyclooxygenase-2-selective Inhibitors." *Clinical Therapeutics* (March 2001):313-26.

Towheed, T. E. et al. "Glucosamine Therapy for Treating Osteoarthritis." *Cochrane Database System Review* (2001):1.

Liz Meszaros

Osteoarthrosis *see* **Osteoarthritis**

Osteochondroses

Definition

Osteochondroses is a group of diseases of children and adolescents in which localized tissue **death** (necrosis) occurs, usually followed by full regeneration of healthy bone tissue. The singular term is osteochondrosis.

Description

During the years of rapid bone growth, blood supply to the growing ends of bones (epiphyses) may become insufficient resulting in necrotic bone, usually near joints. The term avascular necrosis is used to describe osteochondrosis. Since bone is normally undergoing a continuous rebuilding process, the necrotic areas are most often self-repaired over a period of weeks or months.

Osteochondrosis can affect different areas of the body and is often categorized by one of three locations: articular, non-articular, and physeal.

Physeal osteochondrosis is known as Scheuermann's disease. It occurs in the spine at the intervertebral joints (physes), especially in the chest (thoracic) region.

Articular disease occurs at the joints (articulations). One of the more common forms is Legg-Calvé-Perthes disease, occurring at the hip. Other forms include Köhler's disease (foot), Freiberg's disease (second toe), and Panner's disease (elbow). Freiberg's disease is the one

type of osteochondrosis that is more common in females than in males. All others affect the sexes equally.

Non-articular osteochondrosis occurs at any other skeletal location. For instance, Osgood-Schlatter disease of the tibia (the large inner bone of the leg between the knee and ankle) is relatively common.

Osteochondritis dissecans is a form of osteochondrosis in which loose bone fragments may form in a joint.

Causes and symptoms

Many theories have been advanced to account for osteochondrosis, but none has proven fully satisfactory. **Stress** and **ischemia** (reduced blood supply) are two of the most commonly mentioned factors. Athletic young children are often affected when they overstress their developing limbs with a particular repetitive motion. Many cases are idiopathic, meaning that no specific cause is known.

The most common symptom for most types of osteochondrosis is simply **pain** at the affected joint, especially when pressure is applied. Locking of a joint or limited range of motion at a joint can also occur.

Scheuermann's disease can lead to serious **kyphosis** (hunchback condition) due to erosion of the vertebral bodies. Usually, however, the kyphosis is mild, causing no further symptoms and requiring no special treatment.

Diagnosis

Diagnosis can be confirmed by x-ray findings.

Treatment

Conservative treatment is usually attempted first. In many cases, simply resting the affected body part for a period of days or weeks will bring relief. A cast may be applied if needed to prevent movement of a joint.

Surgical intervention may be needed in some cases of osteochondritis dissecans to remove abnormal bone fragments in a joint.

Prognosis

Accurate prediction of the outcome for individual patients is difficult with osteochondrosis. Some patients will heal spontaneously. Others will heal with little treatment other than keeping weight or stress off the affected limb. The earlier the age of onset, the better the prospects for full recovery. Surgical intervention is often successful in osteochondritis dissecans.

Prevention

No preventive measures are known.

Resources

BOOKS

Eilert, Robert E., and Gaia Geogopoulos. "Orthopedics." In *Current Pediatric Diagnosis and Treatment*, ed. W. W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Sherry, Eugene. *Sports Medicine Colour Guide*. Churchill Livingstone, 1997.

Victor Leipzig, PhD

Osteogenesis imperfecta

Definition

Osteogenesis imperfecta (OI) is a group of genetic diseases of collagen in which the bones are formed improperly, making them fragile and prone to breaking.

Description

Collagen is a fibrous protein material. It serves as the structural foundation of skin, bone, cartilage, and ligaments. In osteogenesis imperfecta, the collagen produced is abnormal and disorganized. This results in a number of abnormalities throughout the body, the most notable being fragile, easily broken bones.

There are four forms of OI, Types I through IV. Of these, Type II is the most severe, and is usually fatal within a short time after birth. Types I, III, and IV have some overlapping and some distinctive symptoms, particularly weak bones.

Evidence suggests that OI results from abnormalities in the collagen gene COL1A1 or COL1A2, and possibly abnormalities in other genes. In OI Type I, II, and III, the gene map locus is 17q21.31-q22, 7q22.1, and in OI Type IV, the gene map locus is 17q21.31-q22.

In OI, the genetic abnormality causes one of two things to occur. It may direct cells to make an altered collagen protein and the presence of this altered collagen causes OI Type II, III, or IV. Alternately, the dominant altered gene may fail to direct cells to make any collagen protein. Although some collagen is produced by instructions from the normal gene, an overall decrease in the total amount of collagen produced results in OI Type I.

A child with only one parent who is a carrier of a single altered copy of the gene has no chance of actually having the disease, but a 50% chance of being a carrier.

If both parents have OI caused by an autosomal dominant gene change, there is a 75% chance that the child will inherit one or both OI genes. In other words,

there is a 25% chance the child will inherit only the mother's OI gene (and the father's unaffected gene), a 25% chance the child will inherit only the father's OI gene (and the mother's unaffected gene), and a 25% chance the child will inherit both parents' OI genes. Because this situation has been uncommon, the outcome of a child inheriting two OI genes is hard to predict. It is likely that the child would have a severe, possibly lethal, form of the disorder.

About 25% of children with OI are born into a family with no history of the disorder. This occurs when the gene spontaneously mutates in either the sperm or the egg before the child's conception. No triggers for this type of mutation are known. This is called a new dominant mutation. The child has a 50% chance of passing the disorder on to his or her children. In most cases, when a family with no history of OI has a child with OI, they are not at greater risk than the general population for having a second child with OI, and unaffected siblings of a person with OI are at no greater risk of having children with OI than the general population.

In studies of families into which infants with OI Type II were born, most of the babies had a new dominant mutation in a collagen gene. In some of these families, however, more than one infant was born with OI. Previously, researchers had seen this recurrence as evidence of recessive inheritance of this form of OI. More recently, however, researchers have concluded that the rare recurrence of OI to a couple with a child with autosomal dominant OI is more likely due to gonadal mosaicism. Instead of mutation occurring in an individual sperm or egg, it occurs in a percentage of the cells that give rise to a parent's multiple sperm or eggs. This mutation, present in a percentage of his or her reproductive cells, can result in more than one affected child without affecting the parent with the disorder. An estimated 2%–4% of families into which an infant with OI Type II is born are at risk of having another affected child because of gonadal mosaicism.

Demographics

OI affects equal numbers of males and females. It occurs in about one of every 20,000 births.

Causes and symptoms

OI is usually inherited as an autosomal dominant condition. In autosomal dominant inheritance, a single abnormal gene on one of the autosomal chromosomes (one of the first 22 "non-sex" chromosomes) from either parent can cause the disease. One of the parents will have the disease (since it is dominant) and is the carrier. Only one parent needs to be a carrier in order for the child to inherit the disease. A child who has one parent with the disease has a 50% chance of also having the disease.

Type I

This is the most common and mildest type. Among the common features of Type I are the following:

- bones are predisposed to fracture, with most **fractures** occurring before **puberty**, people with OI type I typically have about 20–40 fractures before puberty
- stature is normal or near-normal
- joints are loose and muscle tone is low
- usually sclera (whites of the eyes) have blue, purple, or gray tint
- face shape is triangular
- tendency toward **scoliosis** (a curvature of the spine)
- bone deformity is absent or minimal
- dentinogenesis imperfecta may occur, causing brittle teeth
- hearing loss is a possible symptom, often beginning in early 20s or 30s
- structure of collagen is normal, but the amount is less than normal

Type II

Sometimes called the lethal form, Type II is the most severe form of OI. Among the common features of Type II are the following:

- frequently, OI Type II is lethal at or shortly after birth, often as a result of respiratory problems
- fractures are numerous and bone deformity is severe
- stature is small with underdeveloped lungs
- collagen is formed improperly

Type III

Among the common features of Type III are the following:

- bones fracture easily (fractures are often present at birth, and x rays may reveal healed fractures that occurred before birth; people with OI Type III may have more than 100 fractures before puberty)
- stature is significantly shorter than normal
- sclera (whites of the eyes) have blue, purple, or gray tint
- joints are loose and muscle development is poor in arms and legs

- rib cage is barrel-shaped
- face shape is triangular
- scoliosis (a curvature of the spine) is present
- respiratory problems are possible
- bones are deformed and deformity is often severe
- dentinogenesis imperfecta may occur, causing brittle teeth
- hearing loss is possible
- collagen is formed improperly

Type IV

OI Type IV falls between Type I and Type III in severity. Among the common features of Type IV are the following:

- bones fracture easily, with most fractures occurring before puberty
- stature is shorter than average
- sclera (whites of the eyes) are normal in color, appearing white or near-white
- bone deformity is mild to moderate
- scoliosis (curvature of the spine) is likely
- rib cage is barrel-shaped
- face is triangular in shape
- dentinogenesis imperfecta may occur, causing brittle teeth
- hearing loss is possible
- collagen is formed improperly

Diagnosis

It is often possible to diagnose OI solely on clinical features and x-ray findings. Collagen or DNA tests may help confirm a diagnosis of OI. These tests generally require several weeks before results are known. Approximately 10–15% of individuals with mild OI who have collagen testing, and approximately 5% of those who have **genetic testing**, test negative for OI despite having the disorder.

Diagnosis is usually suspected when a baby has bone fractures after having suffered no apparent injury. Another indication is small, irregular, isolated bones in the sutures between the bones of the skull (wormian bones). Sometimes the bluish sclera serves as a diagnostic clue. Unfortunately, because of the unusual nature of the fractures occurring in a baby who cannot yet move, some parents have been accused of **child abuse** before the actual diagnosis of osteogenesis imperfecta was reached.

Prenatal diagnosis

Testing is available to assist in prenatal diagnosis. Women with OI who become pregnant, or women who conceive a child with a man who has OI, may wish to explore prenatal diagnosis. Because of the relatively small risk (2–4%) of recurrence of OI Type II in a family, families may opt for ultrasound studies to determine if a developing fetus has the disorder.

Ultrasound is the least invasive procedure for prenatal diagnosis, and carries the least risk. Using ultrasound, a doctor can examine the fetus's skeleton for bowing of the leg or arm bones, fractures, shortening, or other bone abnormalities that may indicate OI. Different forms of OI may be detected by ultrasound in the second trimester. The reality is that when it occurs as a new dominant mutation, it is found inadvertantly on ultrasound, and it may be difficult to know the diagnosis until after delivery since other genetic conditions can cause bowing and/or fractures prenatally.

Chorionic villus sampling is a procedure to obtain chorionic villi tissue for testing. Examination of fetal collagen proteins in the tissue can reveal information about the quantitative or qualitative collagen defects that leads to OI. When a parent has OI, it is necessary for the affected parent to have the results of his or her own collagen test available. Chorionic villus sampling can be performed at 10–12 weeks of **pregnancy**.

Amniocentesis is a procedure that involves inserting a thin needle into the uterus, into the amniotic sac, and withdrawing a small amount of amniotic fluid. DNA can be extracted from the fetal cells contained in the amniotic fluid and tested for the specific mutation known to cause OI in that family. This technique is useful only when the mutation causing OI in a particular family has been identified through previous genetic testing of affected family members, including previous pregnancies involving a baby with OI. Amniocentesis is performed at 16–18 weeks of pregnancy.

Treatment

There are no treatments available to cure OI, nor to prevent most of its complications. Most treatments are aimed at treating the fractures and bone deformities caused by OI. Splints, casts, braces, and rods are all used. Rodding refers to a surgical procedure in which a metal rod is implanted within a bone (usually the long bones of the thigh and leg). This is done when bowing or repeated fractures of these bones has interfered with a child's ability to begin to walk.

Other treatments include **hearing aids** and early capping of teeth. Patients may require the use of a walker or

wheelchair. **Pain** may be treated with a variety of medications. **Exercise** is encouraged as a means to promote muscle and bone strength. Swimming is a form of exercise that puts a minimal amount of strain on muscles, joints, and bones. Walking is encouraged for those who are able.

Smoking, excessive alcohol and **caffeine** consumption, and steroid medications may deplete bone and exacerbate bone fragility.

Alternative treatment such as **acupuncture**, naturopathic therapies, hypnosis, relaxation training, visual imagery, and **biofeedback** have all been used to try to decrease the constant pain of fractures.

Prognosis

Lifespan for people with OI Type I, III, and IV is not generally shortened. The prognosis for people with these types of OI is quite variable, depending on the severity of the disorder and the number and severity of the fractures and bony deformities.

Fifty percent of all babies with OI Type II are stillborn. The rest of these babies usually die within a very short time after birth. In recent years, some people with Type II have lived into young adulthood.

Resources

BOOKS

Hall, Bryan D. "Inherited Osteoporoses." In *Nelson Textbook of Pediatrics,* edited by Richard Behrman. Philadelphia: W.B. Saunders Co., 1996.

PERIODICALS

Kocher, M. S., and F. Shapiro. "Osteogenesis imperfecta." *Journal of the American Academy of Orthopedic Surgery* 6 (July-August 1998): 225+.

Kocher, M. S., and J. R. Kasser. "Orthopaedic aspects of child abuse." *Journal of the American Academy of Orthopedic Surgery* 8 (January-February 2000):10+.

Marini, Joan C. "Osteogenesis imperfecta: Managing brittle bones." *New England Journal of Medicine* 339 (October 1, 1998): 986+.

Niyibizi, C., et al. "Potential of gene therapy for treating osteogenesis imperfecta." *Clinical Orthopedics* 379 (October 2000): S126+.

Paterson, Colin, et al. "Life Expectancy in Osteogenesis Imperfecta." *British Medical Journal* 312 (February 10, 1997): 351.

Smith, R. "Severe osteogenesis imperfecta: new therapeutic options?" *British Medical Journal* 322 (January 13, 2001): 63+.

Wacaster, Priscilla. "Osteogenesis Imperfecta." *Exceptional Parent* 30 (April 2000): 94+.

ORGANIZATIONS

Children's Brittle Bone Foundation. 7701 95th St., Pleasant Prairie, WI 53158. (847) 433-498. <http://www.cbbf.org>.

KEY TERMS

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Ligament—A type of connective tissue that connects bones or cartilage and provides support and strength to joints.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Sclera—The tough white membrane that forms the outer layer of the eyeball.

Scoliosis—An abnormal, side-to-side curvature of the spine.

OTHER

"Osteogenesis Imperfecta. " *National Institutes of Health Osteoporosis and Related Bone Diseases–National Resource Center*. <http://www.osteo.org/oi.html>.

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Osteogenic sarcoma *see* **Sarcomas**

Osteomalacia *see* **Vitamin D deficiency**

Osteomyelitis

Definition

Osteomyelitis refers to a bone infection, almost always caused by a bacteria. Over time, the result can be destruction of the bone itself.

Description

Bone infections may occur at any age. Certain conditions increase the risk of developing such an infection, including sickle cell anemia, injury, the presence of a foreign body (such as a bullet or a screw placed to hold together a broken bone), intravenous drug use (such as heroin), diabetes, **kidney dialysis**, surgical procedures to bony areas, untreated infections of tissue near a bone (for example, extreme cases of untreated sinus infections have led to osteomyelitis of the bones of the skull).

Causes and symptoms

Staphylococcus aureus, a bacterium, is the most common organism involved in osteomyelitis. Other types of organisms include the mycobacterium which causes **tuberculosis**, a type of Salmonella bacteria in patients with sickle cell anemia, *Pseudomonas aeurginosa* in drug addicts, and organisms which usually reside in the gastrointestinal tract in the elderly. Extremely rarely, the viruses which cause **chickenpox** and **smallpox** have been found to cause a viral osteomyelitis.

There are two main ways that infecting bacteria find their way to bone, resulting in the development of osteomyelitis. These include:

- Spread via the bloodstream; 95% of these types of infections are due to *Staphylococcus aureus*. In this situation, the bacteria travels through the bloodstream to reach the bone. In children, the most likely site of infection is within one of the long bones, particularly the thigh bone (femur), one of the bones of the lower leg (tibia), or the bone of the upper arm (humerus). This is because in children these bones have particularly extensive blood circulation, making them more susceptible to invasion by bacteria. Different patterns of blood circulation in adults make the long bones less well-served by the circulatory system. These bones are therefore unlikely to develop osteomyelitis in adult patients. Instead, the bones of the spine (vertebrae) receive a lot of blood flow. Therefore, osteomyelitis in adults is most likely to affect a vertebra. Drug addicts may have osteomyelitis in the pubic bone or clavicle.
- Spread from adjacent infected soft tissue; about 50% of all such cases are infected by *Staphylococcus aureus*. This often occurs in cases where recent surgery or injury has result in a soft tissue infection. The bacteria can then spread to nearby bone, resulting in osteomyelitis. Patients with diabetes are particularly susceptible to this source of osteomyelitis. The diabetes interferes with both nerve sensation and good blood flow to the feet. Diabetic patients are therefore prone to developing poorly healing **wounds** to their feet, which can then spread to bone, causing osteomyelitis.

Acute osteomyelitis refers to an infection which develops and peaks over a relatively short period of time. In children, acute osteomyelitis usually presents itself as **pain** in the affected bone, tenderness to pressure over the infected area, **fever** and chills. Patients who develop osteomyelitis, due to spread from a nearby area of soft tissue infection, may only note poor healing of the original wound or infection.

Adult patients with osteomyelitis of the spine usually have a longer period of dull, aching pain in the back, and no fever. Some patients note pain in the chest, abdomen, arm, or leg. This occurs when the inflammation in the spine causes pressure on a nerve root serving one of these other areas. The lower back is the most common location for osteomyelitis. When caused by tuberculosis, osteomyelitis usually affects the thoracic spine (that section of the spine running approximately from the base of the neck down to where the ribs stop).

When osteomyelitis is not properly treated, a chronic (long-term) type of infection may occur. In this case, the infection may wax and wane indefinitely, despite treatment during its active phases. An abnormal opening in the skin overlaying the area of bone infection (called a sinus tract) may occasionally drain pus. This type of smoldering infection may also result in areas of dead bone, called sequestra. These areas occur when the infection interferes with blood flow to a particular part of the bone. Such sequestra lack cells called osteocytes, which in normal bone are continuously involved in the process of producing bony material.

Diagnosis

Diagnosis of osteomyelitis involves several procedures. Blood is usually drawn and tested to demonstrate an increased number of the infection-fighting white blood cells (particularly elevated in children with acute osteomyelitis). Blood is also cultured in a laboratory, a process which allows any bacteria present to multiply. A specimen from the culture is then specially treated, and examined under a microscope to try to identify the causative bacteria.

Injection of certain radioactive elements into the bloodstream, followed by a series of x-ray pictures, called a scan (radionuclide scanning), will reveal areas of bone inflammation. Another type of scan used to diagnose osteomyelitis is called **magnetic resonance imaging**, or MRI

When pockets of pus are available, or overlaying soft tissue infection exists, these can serve as sources for samples which can be cultured to allow identification of bacteria present. A long, sharp needle can be used to obtain a specimen of bone (biopsy), which can then be tested to attempt to identify any bacteria present.

Treatment

Antibiotics are medications used to kill bacteria. These medications are usually given through a needle in a vein (intravenously) for at least part of the time. In children, these antibiotics can be given by mouth after initial treatment by vein. In adults, four to six weeks of intravenous antibiotic treatment is usually recommended, along with bed-rest for part or all of that time. Occasionally, a patient will have such extensive ostemyelitis that

surgery will be required to drain any pockets of pus, and to clean the infected area.

Alternative treatment

General recommendations for the treatment of infections include increasing vitamin supplements, such as **vitamins** A and C. Liquid garlic extract is sometimes suggested. **Guided imagery** can help induce relaxation and improve pain, both of which are considered to improve healing. Herbs such as **echinacea** (*Echinacea* spp.), goldenseal (*Hydrastis canadensis*), Siberian ginseng (*Eleutherococcus senticosus*), and myrrh (*Commiphora molmol*) are all suggested for infections. Juice therapists recommend drinking combinations of carrot, celery, beet, and cantaloupe juices. A variety of homeopathic remedies may be helpful, especially those used to counter inflammation.

Prognosis

Prognosis varies depending on how quickly an infection is identified, and what other underlying conditions exist to complicate the infection. With quick, appropriate treatment, only about 5% of all cases of acute osteomyelitis will eventually become chronic osteomyelitis. Patients with chronic osteomyelitis may require antibiotics periodically for the rest of their lives.

Prevention

About the only way to have any impact on the development of osteomyelitis involves excellent care of any wounds or injuries.

Resources

BOOKS

Maguire, James H. "Osteomyelitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Ray, C. George. "Bone and Joint Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Calhoun, Jason H., et al. "Osteomyelitis: Diagnosis, Staging, Management." *Patient Care* 32 (30 Jan. 1998): 93+.

Lew, Daniel P. "Osteomyelitis." *The New England Journal of Medicine* 336 (3 Apr. 1997): 999+.

Nelson, John D. "Toward Simple but Safe Management of Osteomyelitis." *Pediatrics* 99 (June 1997): 883+.

KEY TERMS

Abscess—A pus-filled pocket of infection.

Femur—The thighbone.

Humerus—The bone of the upper arm.

Thoracic—Pertaining to the area bounded by the rib cage.

Tibia—One of the two bones of the lower leg.

Peltola, Heikki, et al. "Simplified Treatment of Acute Staphylococcal Osteomyelitis of Childhood." *Pediatrics* 99 (June 1997): 846+.

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Osteopathic medicine *see* **Osteopathy**

Osteopathy

Definition

Osteopathy is a system and philosophy of health care that separated from traditional (allopathic) medical practice about a century ago. It places emphasis on the musculoskeletal system, hence the name—osteo refers to bone and path refers to disease. Osteopaths also believe strongly in the healing power of the body and do their best to facilitate that strength. During this century, the disciplines of osteopathy and allopathic medicine have been converging.

Purpose

Osteopathy shares many of the same goals as traditional medicine, but places greater emphasis on the relationship between the organs and the musculoskeletal system as well as on treating the whole individual rather than just the disease.

Precautions

Pain is the chief reason patients seek musculoskeletal treatment. Pain is a symptom, not a disease by itself. Of critical importance is first to determine the cause of the pain. Cancers, brain or spinal cord disease, and many other causes may be lying beneath this symptom. Once it is clear that the pain is originating in the musculoskeletal system, treatment that includes manipulation is appropriate.

Osteopathic physician demonstrating the articulation of a foot. *(Photo Researchers, Inc. Reproduced by permission.)*

Description

History

Osteopathy was founded in the 1890s by Dr. Andrew Taylor, who believed that the musculoskeletal system was central to health. The primacy of the musculoskeletal system is also fundamental to **chiropractic**, a related health discipline. The original theory behind both approaches presumed that energy flowing through the nervous system is influenced by the supporting structure that encase and protect it—the skull and vertebral column. A defect in the musculoskeletal system was believed to alter the flow of this energy and cause disease. Correcting the defect cured the disease. Defects were thought to be misalignments—parts out of place by tiny distances. Treating misalignments became a matter of restoring the parts to their natural arrangement by adjusting them.

As medical science advanced, defining causes of disease and discovering cures, schools of osteopathy adopted modern science, incorporated it into their curriculum, and redefined their original theory of disease in light of these discoveries. Near the middle of the 20th century the equivalance of medical education between osteopathy and allopathic medicine was recognized, and the D.O. degree (Doctor of Osteopathy) was granted official parity with the M.D. (Doctor of Medicine) degree. Physicians could adopt either set of initials.

However, osteopaths have continued their emphasis on the musculoskeletal system and their traditional focus on "whole person" medicine. As of 1998, osteopaths constitute 5.5% of American physicians, approximately 45,000. They provide 100 million patient visits a year. From its origins in the United States, osteopathy has spread to countries all over the world.

Practice

Osteopaths, chiropractors, and physical therapists are the experts in manipulations (adjustments). The place of manipulation in medical care is far from settled, but millions of patients find relief from it. Particularly backs, but also necks, command most of the attention of the musculoskeletal community. This community includes orthopedic surgeons, osteopaths, general and family physicians, orthopedic physicians, chiropractors, physical therapists, massage therapists, specialists in orthotics and prosthetics, and even some dentists and podiatrists. Many types of headaches also originate in the musculoskeletal system. Studies comparing different methods of treating musculoskeletal back, head, and neck pain have not reached a consensus, in spite of the huge numbers of people that suffer from it.

The theory behind manipulation focuses on joints, mostly those of the vertebrae and ribs. Some believe there is a very slight offset of the joint members—a subluxation. Others believe there is a vacuum lock of the joint surfaces, similar to two suction cups stuck together. Such a condition would squeeze joint lubricant out and produce abrasion of the joint surfaces with movement. Another theory focuses on weakness of the ligaments that support the joint, allowing it freedom to get into trouble. Everyone agrees that the result produces pain, that pain produces **muscle spasms and cramps**, which further aggravates the pain.

Some, but not all, practitioners in this field believe that the skull bones can also be manipulated. The skull is, in fact, several bones that are all moveable in infants. Whether they can be moved in adults is controversial. Other practitioners manipulate peripheral joints to relieve arthritis and similar afflictions.

Manipulation returns the joint to its normal configuration. There are several approaches. Techniques vary among practitioners more than between disciplines. Muscle relaxation of some degree is often required for the manipulation to be successful. This can be done with heat or medication. Muscles can also be induced to relax by gentle but persistent stretching. The manipulation is

KEY TERMS

Orthotics—Mechanical devices that assist function.

Prosthetics—Mechanical devices that replace missing body parts.

most often done by a short, fast motion called a thrust, precisely in the right direction. A satisfying "pop" is evidence of success. Others prefer steady force until relaxation permits movement.

Return of the joint to its normal status may be only the first step in treating these disorders. There is a reason for the initial event. It may be a fall, a stumble, or a mild impact, in which case the manipulation is a cure. On the other hand, there may be a postural misalignment (such as a short leg), a limp, or a stretched ligament that permits the joint to slip back into dysfunction. Tension, as well as pain, for emotional reasons causes muscles to tighten. If the pain has been present for any length of time, there will also be muscle deterioration. The osteopathic approach to the whole person takes all these factors into account in returning the patient to a state of health.

Other repairs may be needed. A short leg is thought by some to be a subluxation in the pelvis that may be manipulated back into position. Other short legs may require a lift in one shoe. Long-standing pain requires additional methods of physical therapy to rehabilitate muscles, correct posture, and extinguish habits that arose to compensate for the pain. Medications that relieve muscle spasm and pain are usually part of the treatment. Psychological problems may need attention and medication.

Risks

Manipulation has rarely caused problems. Once in a while too forceful a thrust has damaged structures in the neck and caused serious problems. The most common adverse event, though, is misdiagnosis. Cancers have been missed; surgical back disease has been ignored until spinal nerves have been permanently damaged.

Normal results

Many patients find that one or a series of manipulations cures long-standing pain. Other patients need repeated treatments. Some do not respond at all. It is always a good idea to reassess any treatment that is not producing the expected results.

Resources

PERIODICALS

Bonner, T. N. "Searching for Abraham Flexner." *Academic Medicine* 73 (Feb. 1998): 160-166.

ORGANIZATIONS

American Association of Colleges of Osteopathic Medicine. 5550 Friendship Blvd., Suite 310, Chevy Chase, MD 20815-7231. (301) 968-4100. <http://www.aacom.org>.
American Osteopathic Association. <osteomed@wwa.com>. <http://www.am-osteo-assn.org>.

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Osteopetroses

Definition

Osteopetrosis (plural osteopetroses) is a rare hereditary disorder that makes bones increase in both density and fragility. A potentially fatal condition that can deform bone structure and distort the appearance, osteopetrosis is also called chalk bones, ivory bones, or marble bones.

Description

Osteopetrosis occurs when bones are spongy or porous, or new bone is repeatedly added to calcified cartilage (hardened connective tissue).

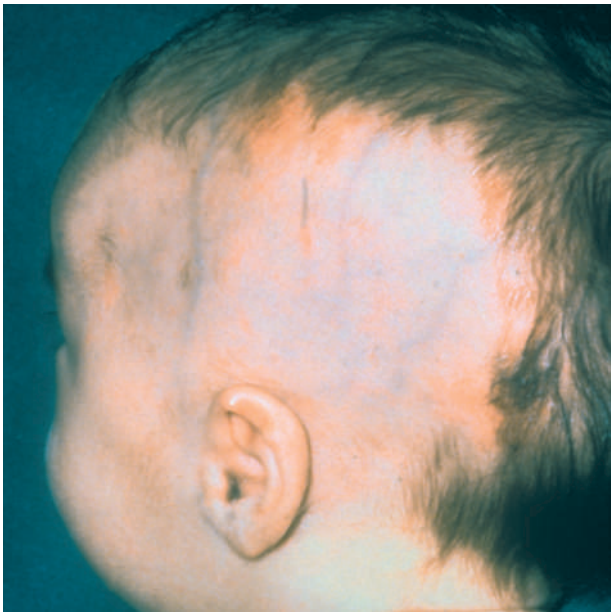
Bone density begins to increase at birth or earlier, but symptoms may not become evident until adulthood. In mild cases, bone density increases at gradual, irregular intervals until full adult height is attained. Some bones are not affected.

More severe osteopetrosis progresses at a rapid pace and destroys bone structure. This condition involves bones throughout the body, but the lower jaw is never affected.

Types of osteopetroses

Early-onset osteopetrosis can be fatal. The ends of the long bones of the arms and legs appear clubbed (widened and thickened) at birth, and bone density continues to increase sporadically or without pause. Children with early-onset osteopetroses usually die before the age of two.

Malignant infantile osteopetrosis is usually discovered by the time a baby is a few months old. Nearly one-third of all children with malignant infantile osteopetroses die before the age of 10.



This infant has osteopetrosis, a condition which thickens and hardens the bone. *(Custom Medical Stock Photo. Reproduced by permission.)*

Intermediate osteopetrosis generally appears in children under 10. This condition, usually less severe than early-onset or malignant infantile osteopetrosis, is not life-threatening.

Symptoms of adult or delayed-onset osteopetrosis may not become evident until the child becomes a teenager or adult.

Relatively common in many parts of the world, Albers-Schönberg disease is a mild form of this condition. People who have this disease are born with normal bone structure. Bone density increases as they age but does not affect appearance, health, intelligence, or life span.

Causes and symptoms

Osteopetrosis is the result of a genetic defect that causes the body to add new bone more rapidly than existing bone disintegrates.

When fibrous or bony tissue invades bone marrow and displaces red blood cells, the patient may develop anemia. Infection results when excess bone impairs the immune system, and hemorrhage can occur when platelet production is disrupted. When the skeleton grows so thick that nerves are unable to pass between bones, the patient may have a **stroke** or become blind or deaf.

Other symptoms associated with osteopetrosis include:

- bones that break easily and don't heal properly
- bruising
- convulsions
- enlargement of the liver, lymph glands, or spleen
- failure to thrive (delayed growth, weight gain, and development)
- hydrocephalus (fluid on the brain)
- macrocephaly (abnormal enlargement of the head)
- paralysis or loss of control of muscles in the face or eyes

Diagnosis

Osteopetrosis is usually diagnosed when x rays reveal abnormalities or increases in bone density. **Bone biopsy** can confirm the presence of osteopetrosis, but additional tests may be needed to distinguish one type of the disorder from another.

Treatment

High doses of vitamin D can stimulate cells responsible for disintegration of old bone and significantly alleviate symptoms of severe disease. Experimental interferon gamma 1-b therapy has been shown to reduce the risk of infection experienced by patients who are severely ill.

When bone overgrowth deforms the shape of the skull, surgery may be required to relieve pressure on the brain. Orthodontic treatment is sometimes necessary to correct **malocclusion** (a condition that shifts the position of the teeth and makes closing the mouth impossible).

Professional counseling can help patients cope with the emotional aspects of deformed features.

Bone marrow transplants (BMT) have cured some cases of early-onset and malignant infantile osteopetrosis. Because 30–60% of children who undergo BMT do not survive, this procedure is rarely performed.

Prognosis

The severity of anemia seems to determine the course of an individual's osteopetrosis. When pronounced symptoms are present at the time of birth, the child's condition deteriorates rapidly. **Death** usually occurs within two years. When mild or moderate disease develops in older children or adults and symptoms can be controlled, the patient is likely to survive.

Resources

BOOKS

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck & Co., Inc., 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.
Turek, Samuel L. *Orthopaedics: Principles and Their Application*. Philadelphia: J. B. Lippincott Co., 1984.

ORGANIZATIONS

Osteoporosis and Related Bone Diseases-National Resource Center. 1150 17th S. NW, Ste. 500, Washington, DC 20036. (800) 624-2663.

Maureen Haggerty

Osteoporosis

Definition

The word osteoporosis literally means "porous bones." It occurs when bones lose an excessive amount of their protein and mineral content, particularly calcium. Over time, bone mass, and therefore bone strength, is decreased. As a result, bones become fragile and break easily. Even a sneeze or a sudden movement may be enough to break a bone in someone with severe osteoporosis.

Description

Osteoporosis is a serious public health problem. Some 28 million people in the United States are affected by this potentially debilitating disease, which is responsible for 1.5 million **fractures** (broken bones) annually. These fractures, which are often the first sign of the disease, can affect any bone, but the most common locations are the hip, spine, and wrist. Breaks in the hip and spine are of special concern because they almost always require hospitalization and major surgery, and may lead to other serious consequences, including permanent disability and even **death**.

To understand osteoporosis, it is helpful to understand the basics of bone formation. Bone is living tissue that's constantly being renewed in a two-stage process (resorption and formation) that occurs throughout life. In the resorption stage, old bone is broken down and removed by cells called osteoclasts. In the formation stage, cells called osteoblasts build new bone to replace the old. During childhood and early adulthood, more bone is produced than removed, reaching its maximum mass and strength by the mid-30s. After that, bone is lost at a faster pace than it's formed, so the amount of bone in the skeleton begins to slowly decline. Most cases of osteoporosis occur as an acceleration of this normal **aging** process. That's referred to as primary osteoporosis. The condition can also be caused by other disease processes or prolonged use of certain medications that result in bone loss—if so, it's called secondary osteoporosis.

Osteoporosis occurs most often in older people and in women after **menopause**. It affects nearly half of all those, men and women, over the age of 75. Women, however, are five times more likely than men to develop the disease. They have smaller, thinner bones than men to begin with, and they lose bone mass more rapidly after menopause (usually around age 50), when they stop producing a bone-protecting hormone called estrogen. In the five to seven years following menopause, women can lose about 20% of their bone mass. By age 65 or 70, though, men and women lose bone mass at the same rate. As an increasing number of men reach an older age, there's more awareness that osteoporosis is an important health issue for them as well.

Causes and symptoms

A number of factors increase the risk of developing osteoporosis. They include:

- Age. Osteoporosis is more likely as people grow older and their bones lose tissue.
- Gender. Women are more likely to have osteoporosis because they are smaller and so start out with less bone. They also lose bone tissue more rapidly as they age. While women commonly lose 30–50% of their bone mass over their lifetimes, men lose only 20–33% of theirs.
- Race. Caucasian and Asian women are most at risk for the disease, but African American and Hispanic women can get it too.
- Figure type. Women with small bones and those who are thin are more liable to have osteoporosis.
- Early menopause. Women who stop menstruating early because of heredity, surgery or lots of physical **exercise** may lose large amounts of bone tissue early in life. Conditions such as anorexia and bulimia may also lead to early menopause and osteoporosis.
- Lifestyle. People who smoke or drink too much, or don't get enough exercise have an increased chance of getting osteoporosis.
- Diet. Those who don't get enough calcium or protein may be more likely to have osteoporosis. That's why people who constantly diet are more prone to the disease.

Osteoporosis is often called the "silent" disease, because bone loss occurs without symptoms. People often don't know they have the disease until a bone breaks, frequently in a minor fall that wouldn't normally cause a fracture. A common occurrence is compression fractures of the spine. These can happen even after a

seemingly normal activity, such as bending or twisting to pick up a light object. The fractures can cause severe back **pain**, but sometimes they go unnoticed—either way, the vertebrae collapse down on themselves, and the person actually loses height. The hunchback appearance of many elderly women, sometimes called "dowager's" hump or "widow's" hump, is due to this effect of osteoporosis on the vertebrae.

Diagnosis

Certain types of doctors may have more training and experience than others in diagnosing and treating people with osteoporosis. These include a geriatrician, who specializes in treating the aged; an endocrinologist, who specializes in treating diseases of the body's endocrine system (glands and hormones); and an orthopedic surgeon, who treats fractures, such as those caused by osteoporosis.

Before making a diagnosis of osteoporosis, the doctor usually takes a complete medical history, conducts a physical exam, and orders x rays, as well as blood and urine tests, to rule out other diseases that cause loss of bone mass. The doctor may also recommend a **bone density test**. This is the only way to know for certain if osteoporosis is present. It can also show how far the disease has progressed.

Several diagnostic tools are available to measure the density of a bone. The ordinary x ray is one, though it's the least accurate for early detection of osteoporosis, because it doesn't reveal bone loss until the disease is advanced and most of the damage has already been done. Two other tools that are more likely to catch osteoporosis at an early stage are **computed tomography scans** (CT scans) and machines called densitometers, which are designed specifically to measure bone density.

The CT scan, which takes a large number of x rays of the same spot from different angles, is an accurate test, but uses higher levels of radiation than other methods. The most accurate and advanced of the densitometers uses a technique called DEXA (dual energy x-ray absorptiometry). With the DEXA scan, a double x-ray beam takes pictures of the spine, hip, or entire body. It takes about 20 minutes to do, is painless, and exposes the patient to only a small amount of radiation—about one-fiftieth that of a **chest x ray**.

Doctors don't routinely recommend the test, partly because access to densitometers is still not widely available. People should talk to their doctors about their risk factors for osteoporosis and if, and when, they should get the test. Ideally, women should have bone density measured at menopause, and periodically afterward, depending on the condition of their bones. Men should be tested around age 65. Men and women with additional risk factors, such as those who take certain medications, may need to be tested earlier.

Treatment

There are a number of good treatments for primary osteoporosis, most of them medications. Two new medications, alendronate and calcitonin (in nose spray form), have been approved by the FDA (Food and Drug Administration). They provide people who have osteoporosis with a variety of choices for treatment. For people with secondary osteoporosis, treatment may focus on curing the underlying disease.

Drugs

For most women who've gone through menopause, the best treatment for osteoporosis is **hormone replacement therapy** (HRT), also called estrogen replacement therapy. Many women participate in HRT when they undergo menopause, to alleviate symptoms such as hot flashes, but hormones have other important roles as well. They protect women against heart disease, the number one killer of women in the United States, and they help to relieve and prevent osteoporosis. HRT increases a woman's supply of estrogen, which helps build new bone, while preventing further bone loss.

Some women, however, do not want to take hormones, because some studies show they are linked to an increased risk of **breast cancer** or uterine **cancer**. Other studies reveal the risk is due to increasing age. (Breast cancer tends to occur more often as women age.) Whether or not a woman takes hormones is a decision she should make carefully with her doctor. Women should talk to their doctors about personal risks for osteoporosis, as well as their risks for heart disease and breast cancer. Most women take estrogen along with a synthetic form of progesterone, another female hormone.The combination helps protect against cancer of the uterus.

For people who can't or won't take estrogen, two other medications can be good choices. These are alendronate and calcitonin. Alendronate and calcitonin both stop bone loss, help build bone, and decrease fracture risk by as much as 50%. Alendronate (sold under the name Fosamax) is the first nonhormonal medication for osteoporosis ever approved by the FDA. It attaches itself to bone that's been targeted by bone-eating osteoclasts. It protects the bone from these cells. Osteoclasts help your body break down old bone tissue.

Calcitonin is a hormone that's been used as an injection for many years. A new version is on the market as a nasal spray. It too slows down bone-eating osteoclasts.

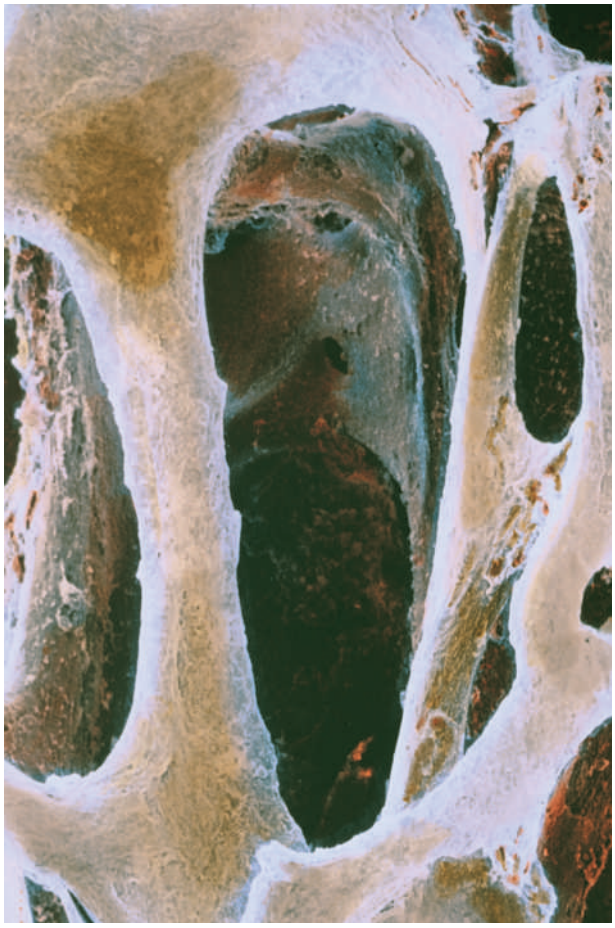
Side effects of these drugs are minimal, but calcitonin builds bone by only 1.5% a year, which may not be enough for some women to recover the bone they lose. Fosamax has proven safe in very large, multi-year studies, but not much is known about the effects of its long-term use. That's why estrogen medications may still be the medicine of choice for a few years, as researchers continue to study other drugs. Several medications under study include other biphosphonates that slow bone breakdown (like alendronate), sodium fluoride, vitamin D metabolites, and selective estrogen receptor modulators. Some of these treatments are already being used in other countries, but have not yet been approved by the FDA for use in the United States.

Surgery

Unfortunately, much of the treatment for osteoporosis is for fractures that result from advanced stages of the disease. For complicated fractures, such as broken hips, hospitalization and a surgical procedure are required. In hip replacement surgery, the broken hip is removed and replaced with a new hip made of plastic, or metal and plastic. Though the surgery itself is usually successful, complications of the hip fracture can be serious. Those individuals have a 5–20% greater risk of dying within the first year following that injury than do others in their age group. A large percentage of those who survive are unable to return to their previous level of activity, and many end up moving from self-care to a supervised living situation or nursing home. That's why getting early treatment and taking steps to reduce bone loss are vital.

Alternative treatment

Alternative treatments for osteoporosis focus on maintaining or building strong bones. A healthy diet low in fats and animal products and containing whole grains, fresh fruits and vegetables, and calcium-rich foods (such as dairy products, dark-green leafy vegetables, sardines, salmon, and almonds), along with nutritional supplements (such as calcium, magnesium, and vitamin D), and weight-bearing exercises are important components of both conventional prevention and treatment strategies and alternative approaches to the disease. In addition, alternative practitioners recommend a variety of botanical medicines or herbal supplements. Herbal supplements designed to help slow bone loss emphasize the use of calcium-containing plants, such as horsetail (*Equisetum arvense*), oat straw (*Avena sativa*), alfalfa (*Medicago sativa*), licorice (*Glycyrrhiza galbra*), marsh mallow (*Althaea officinalis*), and yellow dock (*Rumex crispus*). Homeopathic remedies focus on treatments believed to help the body absorb calcium. These remedies are likely to include such substances as *Calcarea carbonica* (calcium carbonate) or silica. In **traditional Chinese medicine**, practitioners recommend herbs thought to slow or prevent bone loss, including dong quai (*Angelica sinensis*) and Asian ginseng (*Panax ginseng*). Natural hormone therapy, using plant estrogens (from soybeans) or progesterone (from wild yams), may be recommended for women who cannot or choose not to take synthetic hormones.



A scanning electron microscopy (SEM) image of cancellous (spongy) bone from an osteoporosis patient. Osteoporosis is characterized by increased brittleness of the bones and a greater risk of fractures. This is reflected here in the thin appearance of the bony network of the cancellous bone that forms the core of the body's long bones. *(Photograph by Professor P. Motta, Photo Researchers, Inc. Reproduced by permission.)*

Prognosis

There is no cure for osteoporosis, but it can be controlled. Most people who have osteoporosis fare well once they get treatment. The medicines available now build bone, protect against bone loss, and halt the progress of this disease.

KEY TERMS

Alendronate—A nonhormonal drug used to treat osteoporosis in postmenopausal women.

Anticonvulsants—Drugs used to control seizures, such as in epilepsy.

Biphosphonates—Compounds (like alendronate) that slow bone loss and increase bone density.

Calcitonin—A hormonal drug used to treat postmenopausal osteoporosis

Estrogen—A female hormone that also keeps bones strong. After menopause, a woman may take hormonal drugs with estrogen to prevent bone loss.

Glucocorticoids—Any of a group of hormones (like cortisone) that influence many body functions and are widely used in medicine, such as for treatment of rheumatoid arthritis inflammation.

Hormone replacement therapy (HRT)—Also called estrogen replacement therapy, this controversial treatment is used to relieve the discomforts of menopause. Estrogen and another female hormone, progesterone, are usually taken together to replace the estrogen no longer made by the body. It has the added effect of stopping bone loss that occurs at menopause.

Menopause—The ending of a woman's menstrual cycle, when production of bone-protecting estrogen decreases.

Osteoblasts—Cells in the body that build new bone tissue.

Osteoclasts—Cells that break down and remove old bone tissue.

Selective estrogen receptor modulator— A hormonal preparation that offers the beneficial effects of hormone replacement therapy without the increased risk of breast and uterine cancer associated with HRT.

Prevention

Building strong bones, especially before the age of 35, and maintaining a healthy lifestyle are the best ways of preventing osteoporosis. To build as much bone mass as early as possible in life, and to help slow the rate of bone loss later in life:

Get calcium in foods

Experts recommend 1,500 milligrams (mg) of calcium per day for adolescents, pregnant or breast-feeding women, older adults (over 65), and postmenopausal women not using hormone replacement therapy. All others should get 1,000 mg per day. Foods are the best source for this important mineral. Milk, cheese, and yogurt have the highest amounts. Other foods that are high in calcium are green leafy vegetables, tofu, shellfish, Brazil nuts, sardines, and almonds.

Take calcium supplements

Many people, especially those who don't like or can't eat dairy foods, don't get enough calcium in their **diets** and may need to take a calcium supplement. Supplements vary in the amount of calcium they contain. Those with calcium carbonate have the most amount of useful calcium. Supplements should be taken with meals and accompanied by six to eight glasses of water a day.

Get vitamin D

Vitamin D helps the body absorb calcium. People can get vitamin D from sunshine with a quick (15–20 minute) walk each day or from foods such as liver, fish oil, and vitamin-D fortified milk. During the winter months it may be necessary to take supplements. Four hundred mg. daily is usually the recommended amount.

Avoid smoking and alcohol

Smoking reduces bone mass, as does heavy drinking. To reduce risk, do not smok and limit alcoholic drinks to no more than two per day. An alcoholic drink is one-and-a-half ounces of hard liquor, 12 ounces of beer, or five ounces of wine.

Exercise

Exercising regularly builds and strengthens bones. Weight-bearing exercises—where bones and muscles work against gravity—are best. These include aerobics, dancing, jogging, stair climbing, tennis, walking, and lifting weights. People who have osteoporosis may want to attempt gentle exercise, such as walking, rather than jogging or fast-paced aerobics, which increase the chance of falling. Try to exercise three to four times per week for 20–30 minutes each time.

Resources

BOOKS

Bonnick, Sydney Lou. *The Osteoporosis Handbook*. Taylor Publishing, 1994.

Brown, Susan E. *Better Bones, Better Body: A Comprehensive Self-Help Program for Preventing, Halting and Overcoming Osteoporosis*. New Canaan, CT.: Keats Publishing, 1996.

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Fife, WA: Future Medicine Publishing, 1995.

Krane, Stephen M., and Michael F. Holick. "Metabolic Bone Disease: Osteoporosis." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. 14th ed. New York: McGraw-Hill, 1998.

Notelovits, Morris, with Marsha Ware and Diana Tonnessen. *Stand Tall! Every Woman's Guide to Preventing and Treating Osteoporosis*. 2nd ed. Gainesville, FL: Triad Publishing Co., 1998.

PERIODICALS

Bilger, Burkhard. "Bone Medicine." *Health Magazine* (May/June 1996): 125-128.

"Bone Density Testing: Should You Be Checked?" *Mayo Clinic Health Newsletter* 15(June 1997): 6.

Braun, Wendy. "Do Your Bones Pass the Test?" *Saturday Evening Post* (March/April 1997): 18-22+.

Kessenich, Cathy R."Preventing and Managing Osteoporosis." *American Journal of Nursing* 97(January 1997): 16B+.

ORGANIZATION

Arthritis Foundation. 1330 W. Peachtree St., PO Box 7669, Atlanta, GA 30357-0669. (800) 283-7800. <http://www.arthritis.org>.

National Osteoporosis Foundation. 1150 17th Street, Suite 500 NW, Washington, DC 20036-4603. (800) 223-9994. <http://www.nof.org>.

Osteoporosis and Related Bone Diseases-National Resource Center. 1150 17th St., NW, Ste. 500, Washington, DC 20036-4603. (800) 624-BONE. <http://www.osteo.org>.

Barbara Boughton

Osteosarcoma *see* **Sarcomas**

Ostomy

Definition

A surgical procedure creating an opening in the body for the discharge of body wastes.

Purpose

Certain diseases of the bowel or urinary tract involve removing all or part of the intestine or bladder. This creates a need for an alternate way for feces or urine to leave the body. An opening is surgically created in the abdomen for body wastes to pass through. The surgical procedure is called an ostomy. The opening that is created at the end of the bowel or ureter is called a stoma, which is pulled through the abdominal wall.

Description

Different types of ostomy are performed depending on how much and what part of the intestines or bladder is removed.

The three most common types of ostomies are:

- **colostomy**
- ileostomy
- urostomy

Colostomy

A colostomy is a when a small portion of the colon (large intestine) is brought to the surface of the abdominal wall to allow stool to be eliminated. A colostomy may be temporary or permanent. A permanent colostomy usually involves the loss of the rectum.

A colostomy might be performed due to **cancer**, diverticulitis, imperforate anus, **Hirschsprung's disease**, or trauma to the affected area.

Ileostomy

An ileostomy is an opening created in the small intestine to bypass the colon for stool elimination. The end of the ileum, which is the lowest part of the small intestine, is brought through the abdominal wall to form a stoma.

Ileoanal reservoir surgery is an alternative to a permanent ileostomy. It requires two surgical procedures. The first removes the colon and rectum and a temporary ileostomy is created. The second procedure creates an internal pouch from a portion of the small intestine to hold stool. This is then attached to the anus. Since the muscle of the rectum is left in place, there is control over bowel movements.

An ileostomy might be performed due to **ulcerative colitis**, **Crohn's disease**, or **familial polyposis**.

Urostomy

A urostomy is a surgical procedure that diverts urine away from a diseased or defective bladder. Among several methods to create the urostomy, the most common method is called an ileal or cecal conduit. Either a section at the end of the small intestine (ileum) or at the

beginning of the large intestine (cecum) is relocated surgically to form a stoma for urine to pass out of the body. Other common names for this procedure are ileal loop or colon conduit.

A urostomy may be performed due to **bladder cancer**, spinal cord injuries, malfunction of the bladder, and **birth defects** such as **spina bifida**.

Since colostomy, ileostomy, and usotomy bypass the sphincter muscle there is no voluntary control over bowel movements and an external pouch must be worn to catch the discharge.

Preparation

Aftercare

The skin around the stoma, called the peristomal skin, must be protected from direct contact with discharge. The discharge can be irritating to the stoma since it is very high in digestive enzymes. The peristomal skin should be cleansed with plain soap and rinsed with water at each change of the pouch.

The stoma can change in size due to weight gain/loss or several other situations. To ensure proper fit of discharge pouch the stoma should be measured each time supplies are purchased.

Risks

People with ostomies can be prone to certain types of skin infections. Skin irritations or **rashes** around the stoma may be caused by leakage from around the pouch due to an improperly fitted pouch. Correctly fitting the pouch and carefully cleaning the skin around the stoma after each change are the best ways of preventing skin irritation.

Urinary tract infections are common among people who have urostomies. Preventative measures include drinking plenty of fluids, emptying the pouch regularly and using a pouch with an anti-reflux valve to prohibit the discharge from moving back into the stoma.

Normal results

Most ostomy pouches are inconspicuous and can be worn under almost any kind of clothing. There are typically no restrictions of activity, sport, or travel with an ostomy. Certain contact sports would warrant special protection for the stoma.

After recovery from surgery, most people with ostomies can resume a balanced diet.

Ostomy surgery does not generally interfere with a person's sexual or reproductive capacities.

KEY TERMS

Crohn's disease—A chronic inflammatory disease, primarily involving the small and large intestine, but which can affect other parts of the digestive system as well.

Diverticulitis—Inflammation of the diverticula (small outpouchings) along the wall of the colon, the large intestine.

Familial polyposis—An inherited condition in which several hundred polyps develop in the colon and rectum.

Hirschsprung disease—Hirschsprung disease is a congenital abnormality (birth defect) of the bowel in which there is absence of the ganglia (nerves) in the wall of the bowel. Nerves are missing starting at the anus and extending a variable distance up the bowel. This results in megacolon (massive enlargement of the bowel) above the point where the nerves are missing. (The nerves are needed to assist in the natural movement of the muscles in the lining of the bowels that move bowel contents through.)

Ileum—The lowest part of the small intestine, located beyond the duodenum and jejunum, just before the large intestine (the colon).

Imperforate anus—A congenital malformation (a birth defect) in which the rectum is a blind alley (a cul-de-sac) and there is no anus.

Spina bifida—A birth defect (a congenital malformation) in which there is a bony defect in the vertebral column so that part of the spinal cord, which is normally protected within the vertebral column, is exposed. People with spina bifida can suffer from bladder and bowel incontinence, cognitive (learning) problems and limited mobility.

Abnormal results

After an ileostomy, water and electrolyte loss may occur. It may be necessary to drink a significant amount of fluid or fruit juice each day to prevent **dehydration**.

After any type of ostomy surgery digestion and absorbtion of medications may also be affected.

High-fiber foods can cause blockages in the ileum, especially after surgery. Chewing food well helps break fiber into smaller pieces and makes it less likely to accumulate at a narrow point in the bowel. Drinking plenty of fluids can also help.

Resources

ORGANIZATIONS

Crohn's & Colitis Foundation of America, Inc. 386 Park Avenue South 17th Floor New York, NY 10016-8804. (800) 932-2423 or (212) 685-3440.

International Foundation for Functional Gastrointestinal Disorders. P.O. Box 17864 Milwaukee, WI 53217. (414) 964-1799.

National Digestive Diseases Clearinghouse. 2 Information Way Bethesda, MD 20892-3570. <http://www.niddk.nih.gov/>.

United Ostomy Association. 19772 MacArthur Boulevard, Suite 200 Irvine, CA 92612-2405. (800) 826-0826 or (949) 660-8624.

Gary A. Gilles

Otitis externa

Definition

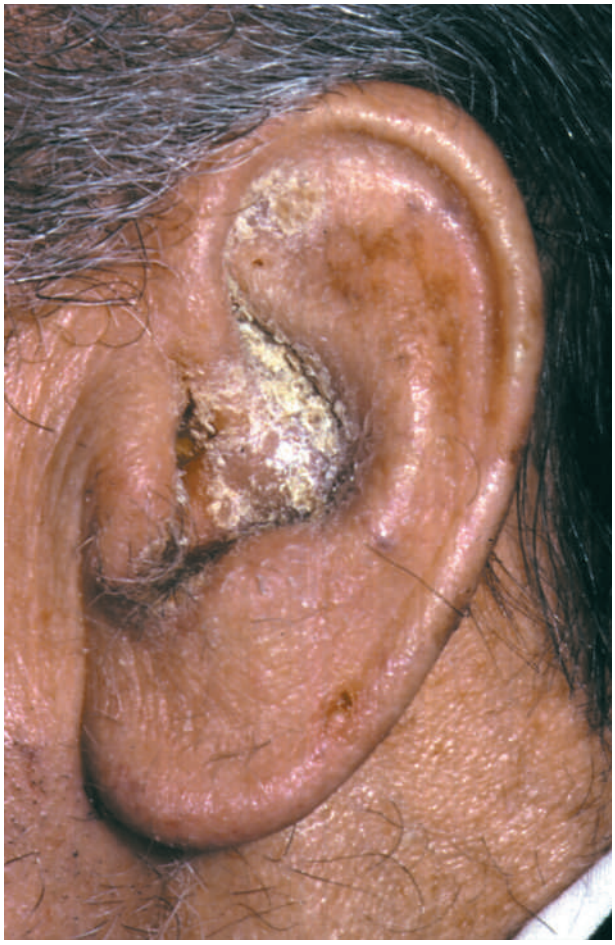
Otitis externa refers to an infection of the ear canal, the tube leading from the outside opening of the ear in towards the ear drum.

Description

The external ear canal is a tube approximately 1 in (2.5 cm) in length. It runs from the outside opening of the ear to the start of the middle ear, designated by the ear drum or tympanic membrane. The canal is partly cartilage and partly bone. In early childhood, the first two-thirds of the canal is made of cartilage, and the last one-third is made of bone. By late childhood, and lasting throughout all of adulthood, this proportion is reversed, so that the first one-third is cartilage, and the last two-thirds is bone. The lining of the ear canal is skin, which is attached directly to the covering of the bone. Glands within the skin of the canal produce a waxy substance called cerumen (popularly called earwax). Cerumen is designed to protect the ear canal, repel water, and keep the ear canal too acidic to allow bacteria to grow.

Causes and symptoms

Bacteria, fungi, and viruses have all been implicated in causing ear infections called otitis externa. The most common cause of otitis externa is bacterial infection. The usual offenders include *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, and bacteria of the family called Streptococci. Occasionally, fungi may cause otitis externa. These include *Candida* and *Aspergillus*. Two types of viruses, called herpesvirus hominis and varicella-zoster virus, have also been identified as causing otitis externa.



A close-up image of the ear of an elderly man suffering from non-infectious otitis externa. The skin in the ear canal and outer ear is scaly. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

Otitis externa occurs most often in the summer months, when people are frequenting swimming pools and lakes. Continually exposing the ear canal to moisture may cause significant loss of cerumen. The delicate skin of the ear canal, unprotected by cerumen, retains moisture and becomes irritated. Without cerumen, the ear canal stops being appropriately acidic, which allows bacteria the opportunity to multiply. Thus, the warm, moist, dark environment of the ear canal becomes a breeding ground for bacteria.

Other conditions predisposing to otitis externa include the use of cotton swabs to clean the ear canals. This pushes cerumen and normal skin debris back into the ear canal, instead of allowing the ear canal's normal cleaning mechanism to work, which would ordinarily

move accumulations of cerumen and debris out of the ear. Also, putting other items into the ear can scratch the canal, making it more susceptible to infection.

The first symptom of otitis externa is often **itching** of the ear canal. Eventually, the ear begins to feel extremely painful. Any touch, movement, or pressure on the outside structure of the ear (auricle) may cause quite severe **pain**. This is because of the way in which the skin lining the ear canal is directly attached to the covering of the underlying bone. If the canal is sufficiently swollen, hearing may become muffled. The canal may appear swollen and red, and there may be evidence of greenish-yellow pus.

In severe cases, otitis externa may have an accompanying **fever**. Often, this indicates that the outside ear structure (auricle) has become infected as well. It will become red and swollen, and there may be enlarged and tender lymph nodes in front of, or behind, the auricle.

A serious and life-threatening otitis externa is called malignant otitis externa. This is an infection which most commonly affects patients who have diabetes, especially the elderly. It can also occur in other patients who have weakened immune systems. In malignant otitis externa, a patient has usually had minor symptoms of otitis externa for some months, with pain and drainage. The causative bacteria is usually *Pseudomonas aeruginosa*. In malignant otitis externa, this bacteria spreads from the external canal into all of the nearby tissues, including the bones of the skull. Swelling and destruction of these tissues may lead to damage of certain nerves, resulting in spasms of the jaw muscles or **paralysis** of the facial muscles. Other, more severe, complications of this very destructive infection include **meningitis** (swelling and infection of the coverings of the spinal cord and brain), brain infection, or **brain abscess** (the development of a pocket of infection with pus).

Diagnosis

Diagnosis of uncomplicated otitis externa is usually quite simple. The symptoms alone, of ear pain worsened by any touch to the auricle, are characteristic of otitis externa. Attempts to examine the ear canal will usually reveal redness and swelling. It may be impossible (due to pain and swelling) to see much of the ear canal, but this inability itself is diagnostic.

If there is any confusion about the types of organisms causing otitis externa, the canal can be gently swabbed to obtain a specimen. The organisms present in the specimen can then be cultured (allowed to multiply) in a laboratory, and then viewed under a microscope to allow identification of the causative organisms.

If the rare disease malignant otitis externa is suspected, computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scans will be performed to determine how widely the infection has spread within bone and tissue. A swab of the external canal will not necessarily reveal the actual causative organism, so some other tissue sample (biopsy) will need to be obtained. The CT or MRI will help the practitioner decide where the most severe focus of infection is located, in order to guide the choice of a biopsy site.

Treatment

Antibiotics which can be applied directly to the skin of the ear canal (topical antibiotics) are usually excellent for treatment of otitis externa. These are often combined in a preparation which includes a steroid medication. The steroid helps cut down on the inflammation and swelling within the ear canal. Some practitioners prefer to insert a cotton wick into the ear canal, leaving it there for about 48 hours. The medications are applied directly to the wick, enough times per day to allow the wick to remain continuously saturated. After the wick is removed, the medications are then put directly into the ear canal three to four times each day.

In malignant otitis externa, antibiotics will almost always need to be given through a needle in the vein (intravenously or IV). If the CT or MRI scan reveals that the infection has spread extensively, these IV antibiotics will need to be continued for six to eight weeks. If the infection is in an earlier stage, two weeks of IV antibiotics can be followed by six weeks of antibiotics by mouth.

Prognosis

The prognosis is excellent for otitis externa. It is usually easily treated, although it may tend to recur in certain susceptible individuals. Left untreated, malignant otitis externa may spread sufficiently to cause **death**.

Prevention

Keeping the ear dry is an important aspect of prevention of otitis externa. Several drops of a mixture of alcohol and acetic acid can be put into the ear canal after swimming to insure that it dries adequately.

The most serious complications of malignant otitis externa can be avoided by careful attention to early symptoms of ear pain and drainage from the ear canal. Patients with conditions that put them at higher risk for this infection (diabetes, conditions which weakened the immune system) should always report new symptoms immediately.

KEY TERMS

Auricle—The external structure of the ear.

Biopsy—The removal and examination, usually under a microscope,of tissue from the living body. Used for diagnosis.

Cerumen—Earwax.

Resources

BOOKS

Duran, Marlene, et al. "Infections of the Upper Respiratory Tract." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"External Otitis." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Eye, Ear, and Sinus Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

"Keep Your Ears Dry." *Consumer Reports on Health* 7, no. 7 (July 1995): 80+.

Mirza, Natasha. "Otitis Externa: Management in the Primary Care Office." *Postgraduate Medicine* 99, no. 5 (May 1996): 153+.

Moss, Richard. "Swimmers Ear." *Pediatrics for Parents* 17, no. 4 (Apr. 1996): 3+.

Ostrowski, Vincent B., and Richard J. Wiet. "Pathologic Conditions of the External Ear and Auditory Canal." *Postgraduate Medicine* 100, no. 3 (Sept. 1996): 223+.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Rosalyn Carson-DeWitt, MD

Otitis media

Definition

Otitis media is an infection of the middle ear space, behind the eardrum (tympanic membrane).

Description

A little knowledge of the basic anatomy of the middle ear will be helpful for understanding the development of otitis media. The external ear canal is that tube which leads from the outside opening of the ear to the structure called the tympanic membrane. Behind the tympanic membrane is the space called the middle ear. Within the middle ear are three tiny bones, called ossicles. Sound (in the form of vibration) causes movement in the eardrum, and then the ossicles. The ossicles transmit the sound to a structure within the inner ear, which sends it to the brain for processing.

The nasopharynx is that passageway behind the nose which takes inhaled air into the breathing tubes leading to the lungs. The eustachian tube is a canal which runs between the middle ear and the nasopharynx. One of the functions of the eustachian tube is to keep the air pressure in the middle ear equal to that outside. This allows the eardrum and ossicles to vibrate appropriately, so that hearing is normal.

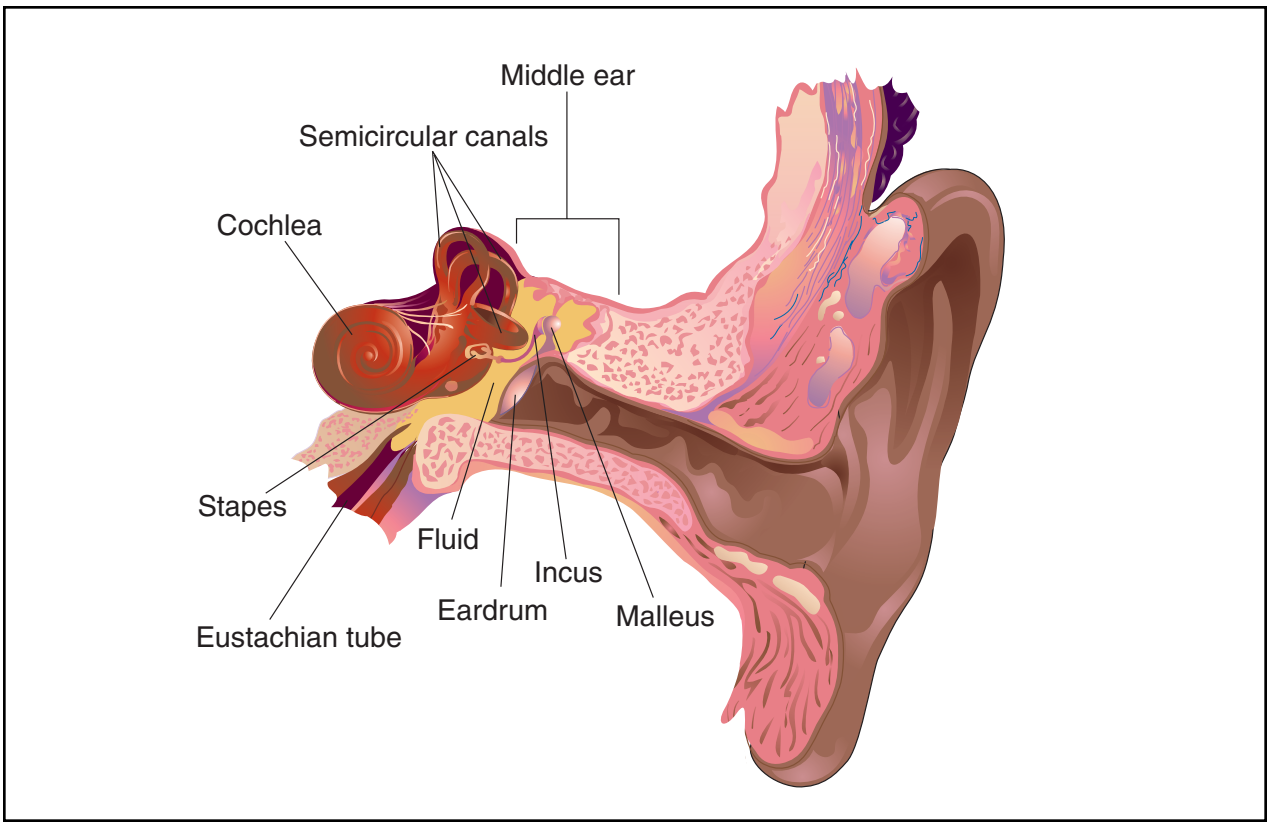
By age three, almost 85% of all children will have had otitis media at least once. Babies and children between the ages of six months and six years are most likely to develop otitis media. Children at higher risk factors for otitis media include boys, children from poor families, Native Americans, Native Alaskans, children born with cleft palate or other defects of the structures of the head and face, and children with **Down syndrome**. Exposure to cigarette smoke significantly increases the risk of otitis media as well as other problems affecting the respiratory system. Also, children who enter daycare at an early age have more upper respiratory infections (URIs or colds), and thus more cases of otitis media. The most usual times of year for otitis media to strike are in winter and early spring (the same times URIs are most common).

Otitis media is an important problem, because it often results in fluid accumulation within the middle ear (effusion). The effusion can last for weeks to months. Effusion within the middle ear can cause significant hearing impairment. When such hearing impairment occurs in a young child, it may interfere with the development of normal speech.

Causes and symptoms

The first thing necessary for the development of otitis media is exposure to an organism capable of causing the infection. These include a variety of viruses, as well as such bacteria as *Streptococcus pneumoniae* (causes about 35% of all acute ear infections), *Haemophilus influenzae* (causes about 23% of all acute ear infections), or *Moraxella catarrhalis* (causes about 14% of all acute ear infections).

There are other factors which make the development of an ear infection more likely. Because the eustachian



Otitis media is an ear infection in which fluid accumulates within the middle ear. A common condition occurring in childhood, it is estimated that 85% of all American children will develop otitis media at least once. *(Illustration by Electronic Illustrators Group.)*

tube has a more horizontal orientation and is considerably shorter in early childhood, material from the nasopharynx (including infection-causing organisms) is better able to reach the middle ear. Children also have a lot of lymph tissue (commonly called the adenoids) in the area of the eustachian tube. These adenoids may enlarge with repeated respiratory tract infections (colds), ultimately blocking the eustachian tubes. When the eustachian tube is blocked, the middle ear is more likely to fill with fluid. This fluid, then, increases the risk of infection, and the risk of **hearing loss** and delayed speech development.

Most cases of acute otitis media occur during the course of a URI. Symptoms include **fever**, ear **pain**, and problems with hearing. Babies may have difficulty feeding. When significant fluid is present within the middle ear, pain may increase depending on position. Lying down may cause an increase in painful pressure within the middle ear, so that babies may fuss if not held upright. If the fluid build-up behind the eardrum is sufficient, the eardrum may develop a hole (perforate), causing bloody fluid or greenish-yellow pus to drip from the ear. Although pain may be significant leading up to such a perforation, the pain is usually relieved by the reduction of pressure brought on by a perforation.

Diagnosis

Diagnosis is usually made simply by looking at the eardrum through a special lighted instrument called an otoscope. The eardrum will appear red and swollen, and may appear either abnormally drawn inward, or bulging outward. Under normal conditions, the ossicles create a particular pattern on the eardrum, referred to as "landmarks." These landmarks may be obscured. Normally, the light from the otoscope reflects off of the eardrum in a characteristic fashion. This is called the "cone of light." In an infection, this cone of light may be shifted or absent.

A special attachment to the otoscope allows a puff of air to be blown lightly into the ear. Normally, this should cause movement of the eardrum. In an infection, or when there is fluid behind the eardrum, this movement may be decreased or absent.

If fluid or pus is draining from the ear, it can be collected. This sample can then be processed in a laboratory to allow any organisms present to multiply sufficiently

(cultured) to permit the organisms to be viewed under a microscope and identified.

Treatment

Antibiotics are the treatment of choice for ear infections. Different antibiotics are used depending on the type of bacteria most likely to be causing the infection. This decision involves knowledge of the types of antibiotics that have worked on other ear infections occurring within a particular community at a particular time. Options include sulfa-based antibiotics, as well as a variety of **penicillins** and **cephalosporins**.

Some controversy exists regarding whether overuse of antibiotics is actually contributing to the development of bacteria, which may evolve and become able to avoid being killed by antibiotics. Research is being done to try to help determine whether there may be some ear infections which would resolve without antibiotic treatment. In the meantime, the classic treatment of an ear infection continues to involve a seven to 10 day course of antibiotic medication.

Some medical practitioners prescribe the use of special nosedrops, **decongestants**, or **antihistamines** to improve the functioning of the eustachian tube.

In a few rare cases, a procedure to drain the middle ear of pus may be performed. This procedure is called myringotomy.

Alternative treatment

Some practitioners believe that food **allergies** may increase the risk of ear infections, and they suggest eliminating suspected food allergens from the diet. The top food allergens are wheat, dairy products, corn, peanuts, citrus fruits, and eggs. Elimination of sugar and sugar products can allow the immune system to work more effectively. A number of herbal treatments have been recommended, including ear drops made with goldenseal (*Hydrastis canadensis*), mullein (*Verbascum thapsus*), **St. John's wort** (*Hypericum perforatum*), and **echinacea** (*Echinacea* spp.). Among the herbs often recommended for oral treatment of otitis media are echinacea and cleavers (*Galium aparine*), or black cohosh (*Cimicifuga racemosa*) and ginkgo (*Ginkgo biloba*). Homeopathic remedies that may be prescribed include aconite (*Acontium napellus*), *Ferrum phosphoricum,* belladonna, chamomile, *Lycopodium,* pulsatilla (*Pulsatilla nigricans*), or silica. **Craniosacral therapy** uses gentle manipulation of the bones of the skull to relieve pressure and improve eustachian tube function.

Prognosis

With treatment, the prognosis for acute otitis media is very good. However, long-lasting accumulations of fluid within the middle ear are a risk both for difficulties with hearing and speech, and for the repeated development of ear infections. Furthermore, without treatment, otitis media can lead to an infection within the nearby mastoid bone, called **mastoiditis**.

KEY TERMS

Adenoid—A collection of lymph tissue located in the nasopharynx.

Effusion—A collection of fluid which has leaked out into some body cavity or tissue.

Eustachian tube—A small tube which runs between the middle ear space and the nasopharynx.

Nasopharynx—The part of the airway into which the nose leads.

Ossicles—Tiny bones located within the middle ear which are responsible for conveying the vibrations of sound through to the inner ear.

Perforation—A hole.

Prevention

Although otitis media seems somewhat inevitable in childhood, some measures can be taken to decrease the chance of repeated infections and fluid accumulation. Breastfeeding provides some protection against URIs, which in turn protects against the development of otitis media. If a child is bottle-fed, parents should be advised to feed him or her upright, rather than allowing the baby to lie down with the bottle. General good hygiene practices (especially handwashing) help to decrease the number of upper respiratory infections in a household or daycare center.

After a child has completed treatment for otitis media, a return visit to the practitioner should be scheduled. This visit should occur after the antibiotic has been completed, and allows the practitioner to evaluate the patient for the persistent presence of fluid within the middle ear. In children who have a problem with recurrent otitis media, a small daily dose of an antibiotic may prevent repeated full attacks of otitis media. In children who have persistent fluid, a procedure to place tiny tubes within the eardrum may help equalize pressure between the middle ear and the outside, thus preventing further fluid accumulation.

Resources

BOOKS

Duran, Marlene, et al. "Infections of the Upper Respiratory Tract." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Otitis Media and Its Complications." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Eye, Ear, and Sinus Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Berman, Stephen. "Otitis Media in Children." *The New England Journal of Medicine* 332 (8 June 1995): 1560+.

Daly, Kathleen A., et al. "Knowledge and Attitudes About Otitis Media Risk: Implications for Prevention." *Pediatrics* 100 (Dec. 1997): 931+.

Dowell, Scott F., et al. "Otitis Media: Principles of Judicious Use of Antimicrobial Agents." *Pediatrics* 101 (Jan. 1998): 165+.

Lary, Marvis J. "Otitis Media: Current Concepts." *Physician Assistant* 21 (July 1997): 26+.

Pizzuto, Michael. "Let's Hear A Little More About Antibiotics and Otitis Media." *Consultant* 37 (Mar. 1997): 502+.

ORGANIZATIONS

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Otosclerosis

Definition

Otosclerosis is an excessive growth in the bones of the middle ear which interferes with the transmission of sound.

Description

The middle ear consists of the eardrum and a chamber which contains three bones called the hammer, the anvil, and the stirrup (or stapes). Sound waves passing through the ear cause the ear drum to vibrate. This vibration is transmitted to the inner ear by the three bones. In the inner ear, the vibrations are changed into impulses which are carried by the nerves, to the brain. If excessive bone growth interferes with the stapes ability to vibrate and transmit sound waves, **hearing loss** will result.

Otosclerosis is classified as a conductive disorder because it involves the bones of the ear, which conduct the sound to the nerve. If a person has hearing loss classified as neural, the nerve conducting the impulses to the brain is involved.

Otosclerosis is a common hereditary condition. About 10% of the caucasion population has some form of otosclerosis, however, it is rare among other ethnic backgrounds. Women are more likely than men to suffer from otosclerosis. It is the most common cause of conductive hearing loss between the ages of 15–50, but if the bony growth affects only the hammer or anvil, there are no symptoms and the condition goes undetected. Disease affecting the stapes is also associated with progressive hearing loss.

KEY TERMS

Tinnitus—Tinnitus is noise originating in the ear not in the environment. The noise can range from faint ringing to roaring.

Causes and symptoms

Otosclerosis is hereditary. Acquired illness and accidents have no relationship to its development.

The primary symptom of otosclerosis is loss of hearing. In addition, many people experience **tinnitus** (noice originating inside the ear). The amount of tinnitus is not necessarily related to the kind or severity of hearing loss.

Diagnosis

Hearing loss due to otosclerosis is usually first noticed in the late teens or early twenties. Hearing loss usually occurs in the low frequencies first, followed by high frequencies, then middle frequencies. Extensive hearing tests will confirm the diagnosis.

Treatment

People with otosclerosis often benefit from a properly fitted hearing aid.

The surgical replacement of the stapes has become a common procedure to improve conductive hearing problems. During this operation, called a **stapedectomy**, the stapes is removed and replaced with an artificial device. The operation is performed under local anesthesia and is usually an outpatient procedure. Surgery is done on only one ear at a time, with a one year wait between procedures. The degree of hearing improvement reaches its maximum about four months after the surgery. Over 80% of these procedures successfully improve or restore hearing.

Prognosis

People with otosclerosis almost never become totally deaf, and will usually be able to hear with a hearing

aid or with surgery plus a hearing aid. In older people, the tendency for additional hearing loss is diminished due to the hardening of the bones.

Prevention

Otosclerosis cannot be prevented.

Resources

BOOKS

Schuller, David E., and Alexander J. Schleuning II. *DeWeese and Saunders' Otolaryngology-Head and Neck Surger.* 8th ed. St. Louis: Mosby-Year Book, Inc., 1994.

ORGANIZATIONS

American Tinnitus Association. P.O. Box 5, Portland, OR 97207. (503) 248-9985. <http://www.ata.org>.

NIDCD Hereditary Hearing Impairment Resource Registry. c/o Boys Town National Research Hospital. 555 N. 30th St., Omaha NE 68131. (800) 320-1171.

National Association of the Deaf. 814 Thayer Ave., Silver Spring, MD, 20910. (301) 587-1788. <http://www.nad.org>.

Self Help for Hard of Hearing People, Inc. 7800 Wisconsin Ave., Bethesda, MD 20814. (301) 657-2248. <http://www.shhh.org>.

Dorothy Elinor Stonely

Otoscopic examination *see* **Ear exam with an otoscope**

Ototoxicity

Definition

Ototoxicity is damage to the hearing or balance functions of the ear by drugs or chemicals.

Description

Ototoxicity is drug or chemical damage to the inner ear. This section of the ear contains both the hearing mechanism and the vestibulocochlear nerve, the nerve that sends hearing and balance information to the brain. Because of this, ototoxic drugs may cause lack of hearing, and loss of sense of balance.

The extent of ototoxicity varies with the drug, the dose, and other conditions. In some cases, there is full recovery after the drug has been discontinued. In other cases, the extent of damage is limited, and may even be too small to be noticed. This may occur in high frequency **hearing loss**, where the damage to the ear makes it difficult to hear high pitched musical notes, but does not affect the ability to hear the spoken word, or carry on a conversation. In extreme cases, there may be permanent and complete deafness.

Although ototoxicity is undersirable, the ear damage can actually be used to help people with **Meniere's disease**. This is a disease of no known cause that is marked by sudden episodes of **dizziness** and vertigo. Other symptoms include a feeling of "fullness" in the ears, roaring in the ears, and ringing in the ears. While most people with this condition can be controlled with medication, about 10% require surgery. However, use of some ototoxic drugs can actually improve this condition, while causing less damage to the hearing mechanism than traditional treatments.

Causes and symptoms

Many drugs can cause ototoxicity.

Antibiotics

- amikacin (Amikin)
- streptomycin
- neomycin
- gentamicin (Garamycin)
- erythromycin (E-Mycin, Eryc)
- kanamycin (Kantrex
- tobramycin (Nebcin)
- netilmycin (Netromycin)
- vancomycin (Vancocin)

Anti-cancer drugs

- cisplatin (Platinol AQ
- bleomycin (Blenoxane)
- vincristine (Oncovin)

Diuretics

- acetazolamide (Diamox)
- furosemide (Lasix)
- bumetanide (Bumex)
- ethacrynic acid (Edecrine)

A number of other drugs and chemicals may also cause ototoxicity. **Aspirin** overdose causes ringing in the ears. The **antimalarial drugs** quinine and chloroquine may also cause ear damage. Among the environmental chemicals that can cause ear damage are tin, lead, mer-

cury, carbon monoxide, and carbon disulfide. This list is not complete, and many other drugs and chemicals, such as industrial solvents, may cause ear problems.

Diagnosis

Ototoxicity often goes undiagnosed. This occurs when the hearing loss is slight, or when it is restricted to the higher frequencies. Patients may notice a change in their hearing, but it may not be significant enough to report.

In other cases, the loss of hearing may be very significant, or the ototoxicity may take the form of ringing in the ears, or other sensations.

When physicians are administering medications that are known to cause hearing loss, it is often recommended that the patient receive regular hearing tests. By monitoring hearing on a regular basis, it may be possible to discontinue the medication, or reduce the dose so that no further damage is done.

Ototoxicity that causes loss of balance may be even more difficult to diagnose. These changes may take place gradually, over time, and may be confused with the effects of the condition the drugs are meant to treat. If ototoxicity is suspected, balance tests are available, including a platform balance test, and a rotary chair. These, and other tests, determine how a patient responds to motion and changes in body position.

Treatment

There are no current treatments to reverse the effects of ototoxicity.

People who suffer permanent hearing loss may elect to use **hearing aids**, or, when appropriate, receive a cochlear implant. For those who have balance problems, physical therapy may often be helpful. Physical therapists can help people with balance problems learn to rely more on vision and the sensations from muscles to achieve balance.

Prognosis

The prognosis depends on the drugs that caused the ototoxicity, and their dose.

The aminoglycoside **antibiotics**, gentamicin, kanamycin, netilmycin and tobramycin all cause hearing loss to varying degrees. These drugs may be used to treat life-threatening infections that are resistant to other classes of drugs, and so there may be no choice but to use them. Careful dosing can minimize, but not eliminate the risk. It is estimated that the chances of recovery are 10-15%. The hearing loss usually begins at the higher frequencies, and is usually not recognized immediately.

KEY TERMS

Antibiotic—Drugs that kill or inhibit the growth of bacteria.

Cochlea—A division of the inner ear.

Diuretic—A drug that increases water loss through increased urination.

Meniere's disease—A disorder of the membranous labyrinth of the inner ear that is marked by recurrent attacks of dizziness, tinnitus, and deafness—also called Ménière's syndrome. It is named after Prosper Ménière(1799–1862), a French physician who was among the first people to study diseases of the ear, nose, and throat.

Tinnitus—Ringing sounds in the ears.

Erythromycin may cause hearing loss that affects all frequencies. This hearing loss usually reverses itself over time.

Aspirin and the non-steroidal anti-inflammatory drugs (NSAIDS) may cause ringing in the ears (**tinnitus**). This stops when the drug is discontinued.

The **diuretics** may cause a hearing loss with a rapid onset. This will usually, but not always, reverse itself when the drugs are stopped.

In some cases, the prognosis isn't really clear. Vancomycin appears to cause hearing loss, but this may only occur when vancomycin is used at the same time as other ototoxic drugs, such as gentamicin or erythromycin.

Prevention

Since most ototoxicity occurs when the harmful drugs are used in high doses, careful dose calculations are the best method of prevention. Sometimes it is possible to replace the ototoxic drugs with drugs that have less severe adverse effects.

Resources

BOOKS

CRC Handbook of Ototoxicity. Elkins Park : Franklin-Book-Company-Incorporated, December 1985.

Ototoxicity: Basic Science and Clinical Application. New York: New-York-Academy-of-Sciences, June 1999.

PERIODICALS

Fausti, S.A., R. H. Frey, J. A. Henry, D. J. Olson, and H. I. Schaffer. "High-frequency Testing Techniques and Instrumentation for Early Detection of Ototoxicity." *Journal of Rehabilitation Research and Development* (1993).

Sloan, Richard W. "Aminoglycosides: Once-daily Dosing Regimen." *American Family Physician* (April 1996): 1513.

ORGANIZATIONS

Deafness Research Foundation. 1225 I St. NW, No. 500 Washington, DC 20005.

Ear Research Foundation. 1901 Floyd St. Sarasota, FL 34239-2909.

National Institute on Deafness and Other Communication Disorders. NIH Bldg. 10, Rm. 5C-306 9000 Rockville Park, Bethesda, MD 20892.

Sam Uretsky, PharmD

Ova & parasites collection *see* **Stool O & P test**

Ovarian cancer

Definition

Ovarian **cancer** is cancer of the ovaries, the egg-releasing and hormone-producing organs of the female reproductive tract. Cancerous, or malignant, cells divide and multiply in an abnormal fashion.

Description

The ovaries are small, almond-shaped organs, located in the pelvic region, one on either side of the uterus. When a woman is in her childbearing years, the ovaries alternate to produce and release an egg each month during the menstrual cycle. The released egg is picked up by the adjacent fallopian tube, and continues down toward the uterus. The ovaries also produce and secrete the female hormones estrogen and progesterone, which regulate the menstrual cycle and **pregnancy**, as well as support the development of the secondary female sexual characteristics (breasts, body shape, and body hair). During pregnancy and when women take certain medications, such as **oral contraceptives**, the ovaries are given a rest from their usual monthly duties.

Types of ovarian cancers

Ninety percent of all ovarian cancers develop in the cells lining the surface, or epithelium, of the ovaries and so are called epithelial cell tumors. About 15% of epithelial cancers are considered low malignant potential or LMP tumors. These tumors occur more often in younger women, and are more likely to be caught early, so prognosis is good.

Germ cell tumors develop in the egg-producing cells of the ovary, and comprise about 5% of ovarian tumors. These tumors are usually found in teenage girls or young women. The prognosis is good if found early, but as with other ovarian cancers, early detection is difficult.

Primary peritoneal carcinoma (PPC) is a cancer of the peritoneum, the lining of the abdominal cavity where the internal organs are located. Although it is a distinct disease, it is linked with ovarian cancer. This is because the ovarian and peritoneal cells have the same embryonic origin. This means that the very early cells of the embryo that will ultimately develop into the ovaries and the peritoneum share a common origin. The term "primary" means that the cancer started first in the peritoneum, as opposed to the cancer starting in the ovary and then moving, or metastasizing, into the peritoneum.

Ovarian cancer can develop at any age, but is most likely to occur in women who are 50 years or older. More than half the cases are among women who are aged 65 years and older. Industrialized countries have the highest incidence of ovarian cancer. Caucasian women, especially of Ashkenazi Jewish descent, are at somewhat higher risk; African-American and Asian women are at a slightly lower risk. The risk of developing the disease increases with age. Ovarian cancer is the fifth most common cancer among women in the United States, and the second most common gynecologic cancer. It accounts for 4% of all cancers in women. However, because of poor early detection, the **death** rate for ovarian cancer is higher than for that of any other cancer among women. The American Cancer Society estimates about 24,000 new cases of ovarian cancer in 2000 in the United States, and about 14,000 deaths.

Only 50% of the women who are diagnosed with ovarian cancer will survive five years after initial diagnosis. This is due to the cancer being at an advanced stage at the time of diagnosis. With early detection, however, survival at five years post diagnosis may be 95%.

Causes and symptoms

Causes

The actual cause of ovarian cancer remains unknown, but several factors are known to increase one's chances of developing the disease. These are called risk factors. Women at a higher risk than average of developing ovarian cancer include women who:

- have never been pregnant or had children,
- are Caucasian, especially of Northern European or Askenazi Jewish descent,
- are over 50 (half of all diagnosed cases are in women over 65),

- have a family history of breast, ovarian, endometrial (uterine), prostate, or colon cancer,
- have had **breast cancer,**
- have a first-degree relative (mother, daughter, sister) who has had ovarian cancer. (The risk is greater if two or more first-degree relatives had the disease. Having a grandmother, aunt or cousin with ovarian cancer also puts a woman at higher-than-average risk.)
- have the genetic mutation BRCA1 or BRCA2. (Not all women with these genetic breast cancer mutations will develop ovarian cancer. By age 70, a woman who has the BRCA1 mutation carries about a 40–60% risk of developing ovarian cancer. Women with the genetic mutation BRCA2 have a 15% increased risk of developing ovarian cancer. However, heredity only plays a role in about 5–10% of cases of ovarian cancer.)

Women who have a strong familial history may benefit from **genetic counseling** to better understand their risk factors.

In addition to the above risk factors, the following factors appear to play a role in affecting a women's chances of developing ovarian cancer.

Reproduction and hormones. Early menstruation (before age 12) and late **menopause** seem to put women at a higher risk for ovarian cancer. This appears to be because the longer, or more often, a woman ovulates, the higher her risk for ovarian cancer. As mentioned above, women who were never pregnant have a higher risk of developing the disease than women with one or more pregnancies. It is not yet clear from research studies whether a pregnancy that ends in **miscarriage** or **stillbirth** lowers the risk factor to the same degree as the number of term pregnancies. The use of post-menopausal estrogen supplementation for 10 years or more may double a woman's risk of ovarian cancer. Short-term use does not seem to alter one's risk factor.

Infertility drug-stimulated ovulation. Research studies have reported mixed findings on this issue. It appears that women who take medications to stimulate ovulation, yet do not become pregnant, are at higher risk of developing ovarian cancer. Women who do become pregnant after taking fertility drugs do not appear to be at higher risk. One study reported that the use of the fertility drug clomiphene citrate for more than a year increased the risk of developing LMP tumors. LMP tumors respond better to treatment than other ovarian tumors.

Talc. The use of talcum powder in the genital area has been implicated in ovarian cancer in many studies. It may be because talc contains particles of asbestos, a known carcinogen. Female workers exposed to asbestos had a higher-than-normal risk of developing ovarian cancer. Genital deodorant sprays may also present an increased risk. Not all studies have brought consistent results.

Fat. A high-fat diet has been reported in some studies to increase the risk of developing ovarian cancer. In one study the risk level increased with every 10 grams of saturated fat added to the diet. This may be because of its effect on estrogen production.

Symptoms

Most of the literature on ovarian cancer states that there are usually no early warning symptoms for the disease. Ovarian cancer is often referred to as a silent killer, because women either are unaware of having it, or have symptoms that are not accurately diagnosed until the disease is in an advanced state. However, a November 2000 study reported in the medical journal *Cancer* analyzed more than 1,700 questionnaires completed by women with stage III and stage IV ovarian cancer. The researchers found that 95% of the women reported having had early symptoms that they brought to their doctors. Most symptoms were somewhat vague and either abdominal or gastrointestinal in nature, and consequently were either not properly diagnosed or were recognized as being ovarian in nature only after a significant length of time had passed.

The following symptoms are warning signs of ovarian cancer, but could also be due to other causes. Symptoms that persist for two to three weeks, or symptoms that are unusual for the particular woman should be evaluated by a doctor right away.

- digestive symptoms, such as gas, **indigestion**, **constipation**, or a feeling of fullness after a light meal
- bloating, distention or cramping
- abdominal or low-back discomfort
- pelvic pressure or frequent urination
- unexplained changes in bowel habits
- nausea or vomiting
- **pain** or swelling in the abdomen
- loss of appetite
- **fatigue**
- unexplained weight gain or loss
- pain during intercourse
- vaginal bleeding in post-menopausal women

Diagnosis

In the best-case scenario a woman is diagnosed with ovarian cancer while it is still contained in just one ovary.

Early detection can bring five-year survival to near 95%. Unfortunately, about 75% of women (3 out of 4) have advanced ovarian cancer at the time of diagnosis. (Advanced cancer is at stage III or stage IV when it has already spread to other organs.) Five-year survival for women with stage IV ovarian cancer may be less than 5%.

Diagnostic tests and techniques

If ovarian cancer is suspected, several of the following tests and examinations will be necessary to make a diagnosis:

- a complete medical history to assess all the risk factors
- a thorough bi-manual pelvic examination
- CA-125 assay
- one or more various imaging procedures
- a lower GI series, or **barium enema**
- diagnostic laparoscopy

BI-MANUAL PELVIC EXAMINATION. The exam should include feeling the following organs for any abnormalities in shape or size: the ovaries, fallopian tubes, uterus, vagina, bladder, and rectum. Because the ovaries are located deep within the pelvic area, it is unlikely that a manual exam will pick up an abnormality while the cancer is still localized. However, a full examination provides the practitioner with a more complete picture. An enlarged ovary does not confirm cancer, as the ovary may be large because of a cyst or **endometriosis**. While women should have an annual **Pap test**, this test screens for **cervical cancer**. Cancerous ovarian cells, however, might be detected on the slide. Effectiveness of using Pap smears for ovarian cancer detection is about 10-30%.

CA-125 ASSAY. This is a blood test to determine the level of CA-125, a tumor marker. A tumor marker is a measurable protein-based substance given off by the tumor. A series of CA-125 tests may be done to see if the amount of the marker in the blood is staying stable, increasing or decreasing. A rising CA-125 level usually indicates cancer, while a stable or declining value is more characteristic of a cyst. The CA-125 level should never be used alone to diagnose ovarian cancer. It is elevated in about 80% of women with ovarian cancer, but in 20% of cases is not. In addition, it could be elevated because of a non-ovarian cancer, or it can be elevated with non-malignant gynecologic conditions, such as endometriosis or **ectopic pregnancy**. During menstruation the CA-125 level may be elevated, so the test is best done when the woman is not in her menses.

IMAGING. There are several different imaging techniques used in ovarian cancer evaluation. A fluid-filled structure such as a cyst creates a different image than does a solid structure, such as a tumor. An ultrasound uses high-frequency sound waves that create a visual pattern of echoes of the structures at which they are aimed. It is painless, and is the same technique used to check the developing fetus in the womb. Ultrasound may be done externally through the abdomen and lower pelvic area, or with a transvaginal probe.

Other painless imaging techniques are computed tomography (CT) and **magnetic resonance imaging** (MRI). Color Doppler analysis provides additional contrast and accuracy in distinguishing masses. It remains unclear whether Doppler is effective in reducing the high number of false-positives with transvaginal ultrasonography. These imaging techniques allow better visualization of the internal organs and can detect abnormalities without having to perform surgery.

LOWER GI SERIES. A lower GI series, or barium enema, uses a series of x rays to highlight the colon and rectum. To provide contrast, the patient drinks a chalky liquid containing barium. This test might be done to see if the cancer had spread to these areas.

DIAGNOSTIC LAPAROSCOPY. This technique uses a thin, hollow, lighted instrument inserted through a small incision in the skin near the belly button to visualize the organs inside of the abdominal cavity. If the ovary is believed to be malignant, the entire ovary is removed (**oophorectomy**) and its tissue sent for evaluation to the pathologist, even though only a small piece of the tissue is needed for evaluation. If cancer is present, great care must be taken not to cause the rupture of the malignant tumor, as this would cause spreading of the cancer to adjacent organs. If the cancer is completely contained in the ovary, its removal functions also as the treatment. If the cancer has spread or is suspected to have spread, then a saline solution may be instilled into the cavity and then drawn out again. This technique is called peritoneal lavage. The aspirated fluid will be evaluated for the presence of cancer cells. If peritoneal fluid is present, called **ascites**, a sample of this will also be drawn and examined for malignant cells. If cancer cells are present in the peritoneum, then treatment will be directed at the abdominal cavity as well.

Treatment

Clinical staging

Staging is the term used to determine if the cancer is localized or has spread, and if so, how far and to where. Staging helps define the cancer, and will determine the course of suggested treatment. Staging involves examining any tissue samples that have been taken from the ovary, nearby lymph nodes, as well as from any nearby organs or structures where metastasis was suspected.

This may include the diaphragm, lungs, stomach, intestines and omentum (the tissue covering internal organs), and any fluid as described above.

The National Cancer Institute Stages for ovarian cancer are:

- Stage I: Cancer is confined to one or both ovaries.
- Stage II: Cancer is found in one or both ovaries and/or has spread to the uterus, fallopian tubes, and/or other body parts within the pelvic cavity.
- Stage III: Cancer is found in one or both ovaries and has spread to lymph nodes or other body parts within the abdominal cavity, such as the surfaces of the liver or intestines.
- Stage IV: Cancer is found in one or both ovaries and has spread to other organs such as the liver or lung.

The individual stages are also further broken down in detail, such as Ia, Ib, etc. Accurate staging is important for several reasons. Treatment plans are based on staging, in part because of trying to duplicate the best results achieved in prior research trials. When staging is inconsistent, it becomes more difficult to know how different research studies compare, so the results themselves cannot be relied upon.

Treatment offered will primarily depend on the stage of the cancer and the woman's age. It is always appropriate to consider getting a second opinion, especially when treatment involves surgery, **chemotherapy**, and possible radiation. Before the patient makes her decision as to which course of treatment to take, she should feel that she has the information necessary with which to make an informed decision. The diagnostic tools mentioned above are used to determine the course of treatment. However, the treatment plan may need to be revised if the surgeon sees that the tumor has spread beyond the scope of what was seen during diagnostic tests.

Surgery

Surgery is done to remove as much of the tumor as possible (called tissue debulking), utilizing chemotherapy and/or radiation to target cancer cells that have remained in the body, without jeopardizing the woman's health. This can be hard to balance once the cancer has spread. Removal of the ovary is called oophorectomy, and removal of both ovaries is called bi-lateral oophorectomy. Unless it is very clear that the cancer has not spread, the fallopian tubes are usually removed as well (**salpingo-oophorectomy**). Removal of the uterus is called **hysterectomy**.

If the woman is very young, all attempts will be made to spare the uterus. It is crucial that a woman discuss with her surgeon her childbearing plans prior to surgery. Unfortunately, ovarian cancer spreads easily and often swiftly throughout the reproductive tract. It may be necessary to remove all reproductive organs as well as part of the lining of the peritoneum to provide the woman with the best possible chance of long-term survival. Fertility-sparing surgery can be successful if the ovarian cancer is caught very early.

Side effects of the surgery will depend on the extent of the surgery, but may include pain and temporary difficulty with bladder and bowel function, as well as reaction to the loss of hormones produced by the organs removed. A hormone replacement patch may be applied to the woman's skin in the recovery room to help with the transition. An emotional side effect may be the feeling of loss stemming from the removal of reproductive organs.

Chemotherapy

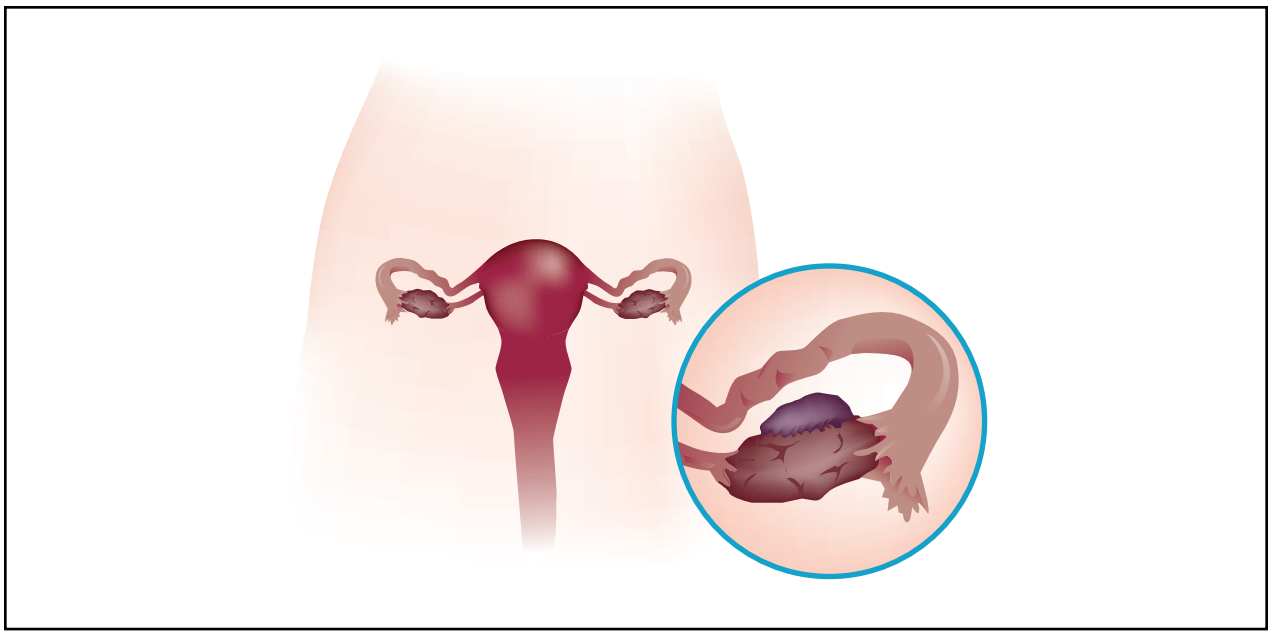
Chemotherapy is used to target cells that have traveled to other organs, and throughout the body via the lymphatic system or the blood stream. Chemotherapy drugs are designed to kill cancer cells, but may also be harmful to healthy cells as well. Chemotherapy may be administered through a vein in the arm (intravenous, IV), may be taken in tablet form, and/or may be given through a thin tube called a catheter directly into the abdominal cavity (intraperitoneal). IV and oral chemotherapy drugs travel throughout the body; intraperitoneal chemotherapy is localized in the abdominal cavity.

Side effects of chemotherapy can vary greatly depending on the drugs used. Currently, chemotherapy drugs are often used in combinations to treat advanced ovarian cancer, and usually the combination includes a platinum-based drug (such as cisplatin) with a taxol agent, such as paclitaxel. Some of the combinations used or being studied include: carboplatin/paclitaxel, cisplatin/paclitaxel, cisplatin/topotecan, and cisplatin/carboplatin. As new drugs are evaluated and developed, the goal is always for maximum effectiveness with minimum side effects. Side effects include **nausea and vomiting**, **diarrhea**, decreased appetite and resulting weight loss, fatigue, headaches, loss of hair, and **numbness and tingling** in the hands or feet. Managing these side effects is an important part of cancer treatment.

After the full course of chemotherapy has been given, the surgeon may perform a "second look" surgery to examine the abdominal cavity again to evaluate the success of treatment.

Radiation

Radiation uses high-energy, highly focused x rays to target very specific areas of cancer. This is done using a



A stage I tumor of the ovary. *(Illustration by Argosy Inc.)*

machine that generates an external beam. Very careful measurements are taken so that the targeted area can be as focused and small as possible. Another form of radiation uses a radioactive liquid that is administered into the abdominal cavity in the same fashion as intraperitoneal chemotherapy. Radiation is usually given on a daily Monday though Friday schedule and for several weeks continuously. Radiation is not painful, but side effects can include skin damage at the area exposed to the external beam, and extreme fatigue. The fatigue may hit suddenly in the third week or so of treatment, and may take a while to recover even after treatments have terminated. Other side effects may include nausea, vomiting, diarrhea, loss of appetite, weight loss and urinary difficulties. For patients with incurable ovarian cancer, radiation may be used to shrink tumor masses to provide pain relief and improve quality of life.

Once the full course of treatment has been undertaken, it is important to have regular follow-up care to monitor for any long-term side effects as well as for future relapse or metastases.

Alternative treatment

The term alternative therapy refers to therapy utilized instead of conventional treatment. By definition, these treatments have not been scientifically proven or investigated as thoroughly and by the same standards as conventional treatments. The terms complementary or integrative therapies denote practices used in conjunction with conventional treatment. Regardless of the therapies chosen, it is key for patients to inform their doctors of any alternative or complementary therapies being used or considered. (Some alternative and complementary therapies adversely affect the effectiveness of conventional treatments.) Some common complementary and alternative medicine techniques and therapies include:

- prayer and faith healing
- **meditation**
- mind/body techniques such as support groups, visualization, **guided imagery** and hypnosis
- energy work such as **therapeutic touch** and Reiki
- **acupuncture** and Chinese herbal medicine
- body work such as **yoga**, massage and T'ai Chi
- vitamins and herbal supplements
- diets such as **vegetarianism** and macrobiotic

Mind/body techniques along with meditation, prayer, yoga, T'ai Chi and acupuncture have been shown to reduce **stress** levels, and the relaxation provided may help boost the body's immune system. The effectiveness of other complementary and alternative treatments is being studied by the National Institutes of Health's National Center for Complementary and Alternative Medicine (NCCAM). For a current list of the research studies occurring, results of recent studies, or publications available, patients can visit the NCCAM web site or call at (888) 644-6226.

Prognosis

Prognosis for ovarian cancer is very dependent on the stage at which it is first diagnosed. While stage I cancer may have a 95% success rate, stages III and IV may have a survival rate of 17-30% at five years post-diagnosis. Early detection remains an elusive, yet hopeful, goal of research. Also, clinical trials are addressing new drug and treatment combinations to prolong survival in women with more advanced disease. Learning one's family history may assist in early detection, and genetic studies may clarify who is at greater risk for the disease.

Research studies are usually designed to compare a new treatment method against the standard method, or the effectiveness of a drug against a placebo (an inert substance that would be expected to have no effect on the outcome). Since the research is experimental in nature, there are no guarantees about the outcome. New drugs being used may have harmful, unknown side effects. Some people participate to help further knowledge about their disease. For others, the study may provide a possible treatment that is not yet available otherwise. If one participates in a study and is in the group receiving the standard care or the placebo, and the treatment group gets clear benefit, it may be possible to receive the experimental treatment once one's original participation role is over. Participants will have to meet certain criteria before being admitted into the study. It is important to fully understand one's role in the study, and weigh the potential risks versus benefits when deciding whether or not to participate.

Prevention

Since the cause of ovarian cancer is not known, it is not possible to fully prevent the disease. However, there are ways to reduce one's risks of developing the disease.

Decrease ovulation. Pregnancy gives a break from ovulation, and multiple pregnancies appear to further reduce the risk of ovarian cancer. The research is not clear as to whether the pregnancy must result in a term delivery to have full benefit. Women who breast-feed their children also have a lower risk of developing the disease. Since oral contraceptives suppress ovulation, women who take birth control pills (BCPs), even for as little as 3 to 6 months have a lower incidence of the disease. It appears that the longer a woman takes BCPs, the lower her risk for ovarian cancer. Also, this benefit may last for up to 15 years after a woman has stopped taking them. However, since BCPs alter a woman's hormonal status, her risk for other hormonally related cancers may change. For this reason it is very important to discuss all the risks and benefits with one's health care provider.

Genetic testing. Tests are available which can help to determine whether a woman who has a family history of breast, endometrial, or ovarian cancer has inherited the mutated BRCA gene that predisposes her to these cancers. If the woman tests positive for the mutation, then she may be able to choose to have her ovaries removed. Even without testing for the mutated gene, some women with strong family histories of ovarian cancer may consider having their ovaries removed as a preventative measure (prophylactic oophorectomy). This procedure diminishes but does not completely remove the risk of cancer, as some women may still develop primary peritoneal carcinoma after oophorectomy.

Surgery. Procedures such as **tubal ligation** (in which the fallopian tubes are blocked or cut off) and hysterectomy (in which the uterus is removed) appear to reduce the risk of ovarian cancer. However, any removal of the reproductive tract organs has surgical as well as hormonal side effects.

Screening. There are no definitive tests or screening procedures to detect ovarian cancer in its early stages. Women at high risk should consult with their physicians about regular screenings, which may include transvaginal ultrasound and the blood test for the CA-125 protein.

The American Cancer Society recommends annual pelvic examinations for all women after age 40, in order to increase the chances of early detection of ovarian cancer.

Resources

BOOKS

Coleman, C. Norman. *Understanding Cancer.* Baltimore: The Johns Hopkins University Press, 1998.

Libov, Charlotte. *Beat Your Risk Factors*. New York: Plume Books, Penguin Putnam, Inc., 1999.

McGinn, Kerry A. and Pamela J. Haylock. *Women's Cancers,* 2nd ed. Alameda, CA: Hunter House Publishers, 1998.

Murphy, Gerald P., Lois B. Morris and Dianne Lange. *The American Cancer Society: Informed Decisions, the Complete Book of Cancer Diagnosis, Treatment, and Recovery.* New York: Viking Press, 1997.

Runowicz, Carolyn D., Jeanne A. Petrek and Ted S. Gansler. *American Cancer Society: Women and Cancer.* New York: Villard Books/Random House, 1999.

Teeley, Peter and Philip Bashe. *The Complete Cancer Survival Guide*. New York: Doubleday, 2000.

ORGANIZATIONS

The American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.

Cancer Research Institute. 681 Fifth Avenue, New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

The Gilda Radner Familial Ovarian Cancer Registry. Roswell Park Cancer Institute. Elm and Carlton Streets. Buffalo,

KEY TERMS

Gynecologic oncologist—A physician specializing in the treatment of cancers of the female reproductive tract.

Lymphatic system— A connected network of nodes, or glands, that carry lymph throughout the body. Lymph is a fluid that contains the infection-fighting white blood cells that form part of the body's immune system. Because the network goes throughout the body, cancer cells that enter the lymphatic system can travel to and be deposited at any point into the tissues and organs and form new tumors there.

Pathologist—The pathologist is a doctor specializing in determining the presence and type of disease by looking at cells and tissue samples.

NY 14263-0001. (800) OVARIAN. (800) 682-7426. <http://www.ovariancancer.com>.

Johns Hopkins Medical Center Ovarian Cancer Web Site. <http://www.ovariancancer.jhmi.edu>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (301) 435-3848. <http://www.nci.nih.gov>.

National Cancer Institute Cancer Trials Web Site. <http://cancertrials.nci.nih.gov/system>. <http://www.cancertrials.com>.

National Center for Complementary and Alternative Medicine. NCCAM Clearinghouse, P.O. Box 8218, Silver Spring, MD 20907-8218. (888) 644-6226. <http://nccam.nih.gov>.

Oncolink at the University of Pennsylvania. <http://www.oncolink.upenn.edu>.

Women's Cancer Network. c/o Gynecologic Cancer Foundation, 401 N. Michigan Avenue, Chicago, IL 60611. (312) 644-6610. <http://www.wcn.org>.

OTHER

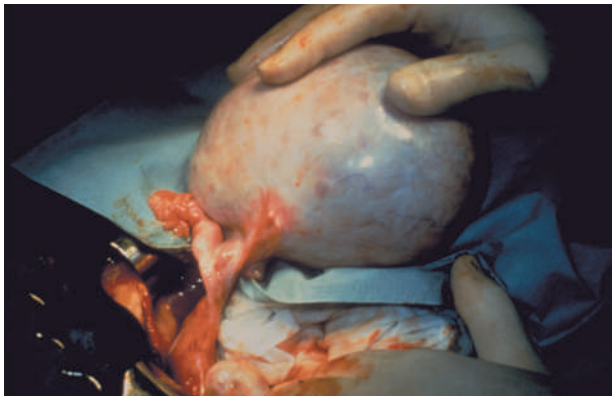
"Ovarian Cancer." *OncoLink:University of Pennsylvania Cancer Center.* 5 July 2001. 6 July 2001. <http://cancer.med.upenn.edu/specialty/gyn_onc/ovarian/>.

Esther Csapo Rastegari, R.N., B.S.N., Ed.M.

Ovarian cysts

Definition

Ovarian cysts are sacs containing fluid or semisolid material that develop in or on the surface of an ovary.



An ovarian cyst is being surgically removed from a 25-year-old female patient. *(Photograph by Art Siegel, Custom Medical Stock Photo. Reproduced by permission.)*

Description

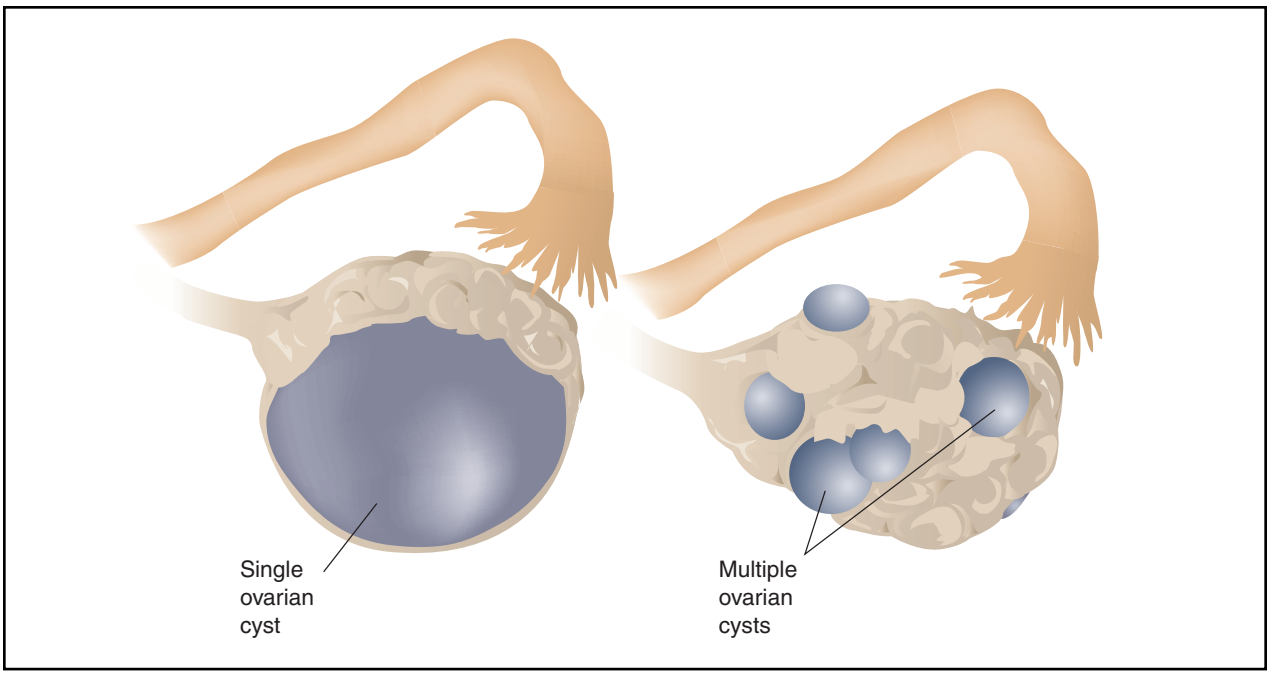
Ovarian cysts are common and the vast majority are harmless. Because they cause symptoms that may be the same as ovarian tumors that may be cancerous, ovarian cysts should always be checked out. The most common types of ovarian cysts are follicular and corpus luteum, which are related to the menstrual cycle. Follicular cysts occur when the cyst-like follicle on the ovary in which the egg develops does not burst and release the egg. They are usually small and harmless, disappearing within two to three menstrual cycles. Corpus luteum cysts occur when the corpus luteum—a small, yellow body that secretes hormones—doesn't dissolve after the egg is released. They usually disappear in a few weeks but can grow to more than 4 in (10 cm) in diameter and may twist the ovary.

Ovarian cysts can develop any time from **puberty** to **menopause**, including during **pregnancy**. Follicular cysts occur frequently during the years when a woman is menstruating, and are non-existent in postmenopausal women or any woman who is not ovulating. Corpus luteum cysts occur occasionally during the menstrual years and during early pregnancy. (Dermoid cysts, which may contain hair, teeth, or skin derived from the outer layer of cells of an embryo, are also occasionally found in the ovary.)

Causes and symptoms

Follicular cysts are caused by the formation of too much fluid around a developing egg. Corpus luteum cysts are caused by excessive accumulation of blood during the menstrual cycle, hormone therapy, or other types of ovarian tumors.

Many ovarian cysts have no symptoms. When the growth is large or there are multiple cysts, the patient may experience any of the following symptoms:



(Illustration by Argosy Inc.)

- Fullness or heaviness in the abdomen.
- Pressure on the rectum or bladder.
- Pelvic **pain** that is a constant dull ache and may spread to the lower back and thighs, occurs shortly before the beginning or end of menstruation, or occurs during intercourse.

Diagnosis

Non-symptomatic ovarian cysts are often felt by a doctor examining the ovaries during a routine **pelvic exam**. Symptomatic ovarian cysts are diagnosed through a pelvic exam and ultrasound. Ultrasonography is a painless test that uses a hand-held wand to send and receive sound waves to create images of the ovaries on a computer screen. The images are photographed for later analysis. It takes about 15 minutes and is usually done in a hospital or a physician's office.

Treatment

Many follicular and corpus luteum cysts require no treatment and disappear on their own. Often the physician will wait and re-examine the patient in four to six weeks before taking any action. Follicular cysts don't require treatment, but birth control pills may be taken if the cysts interfere with the patient's daily activities.

Surgery is usually indicated for patients who haven't reached puberty and have an ovarian mass and in postmenopausal patients. Surgery is also indicated if the growth is larger than 4 in (10 cm), complex, growing, persistent, solid and irregularly shaped, on both ovaries, or causes pain or other symptoms. Ovarian cysts are curable with surgery but often recur without it.

Surgical options include removal of the cyst or removal of one or both ovaries. More than 90% of benign ovarian cysts can be removed using **laparoscopy**, a minimally invasive outpatient procedure. In laparoscopic **cystectomy**, the patient receives a general or local anesthetic, then a small incision is made in the abdomen. The laparoscope is inserted into the incision and the cyst or the entire ovary is removed. Laparoscopic cystectomy enables the patient to return to normal activities within two weeks. Surgical cystectomy to remove cysts and/or ovaries is performed under general anesthesia in a hospital and requires a stay of five to seven days. After an incision is made in the abdomen, the muscles are separated and the membrane surrounding the abdominal cavity (peritoneum) is opened. Blood vessels to the ovaries are clamped and tied. The cyst is located and removed. The peritoneum is closed, and the abdominal muscles and skin are closed with sutures or clips. Recovery takes four weeks.

Alternative treatment

Alternative treatments for ovarian problems—herbal therapies, **nutrition** and diet, and homeopathy—should be used to supplement, not replace, conventional treat-

ment. General herbal tonics for female reproductive organs that can be taken in tea or tincture (an alcohol-based herbal extract) form include blue cohosh (*Caulophylum thalictroides*) and false unicorn root (*Chamaelirium luteum*). Recommendations to help prevent and treat ovarian cysts include a vegan diet (no dairy or animal products) that includes beets, carrots, dark-green leafy vegetables, and lemons; anitoxidant supplements including zinc and **vitamins** A, E, and C; as well as black currant oil, borage oil, and evening primrose oil (*Oenothera biennis*) supplements. Homeopathic treatments—tablets, powders, and liquids prepared from plant, mineral, and animal extracts—may also be effective in treating ovarian cysts. Castor oil packs can help reduce inflammation. **Hydrotherapy** applied to the abdomen can help prevent rupture of the cyst and assist its reabsorption.

Prognosis

The prognosis for non-cancerous ovarian cysts is excellent.

Prevention

Ovarian cysts cannot be prevented.

Resources

BOOKS

Hernandez, Enrique H., and Barbara F. Atkinson. "The Ovary: Normal, Physiologic Changes, Endometriosis, and Metastatic Tumors." In *Clinical Gynecologic Pathology.* Philadelphia: W.B. Saunders Co., 1996.

The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments. Alexandria, VA: Time Life, Inc., 1996.

"Ovarian Tumors." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Rock, John A., and John D. Thompson. "Ovarian Cystectomy" and "Surgery for Benign Disease of the Ovary." In *TeLinde's Operative Gynecology.* 8th ed. Philadelphia: Lippincott-Raven, 1997.

Williams Obstetrics. 20th ed. Stamford: Appleton & Lange, 1997.

PERIODICALS

Audebert, Alain J. M. "Laparoscopic Surgery for Ovarian Cysts." *Current Opinions in Obstetrics and Gynecology* 8 (1996): 261-265.

Martin, Dan C. "Cancer and Endometriosis: Do We Need to be Concerned?" *Seminars in Reproductive Endocrinology* 15 (1997): 319-323.

"Ovarian Cysts-Surgery Not Always Necessary." *Health Facts* 21 (1 Dec. 1996): 5.

Tsakiris, A. A. "Successful Removal of Large Ovarian Cysts Using Endoscopic Techniques in the Second Trimester of Pregnancy." *Journal of Obstetrics and Gynecology* 17 (July 1997): 356.

KEY TERMS

Corpus luteum—A small, yellow structure that forms in the ovary after an egg has been released.

Cycstectomy—Surgical removal of a cyst.

Endocrine—Internal secretions, usually in the systemic circulation.

Follicular—Relating to one of the round cells in the ovary that contain an ovum.

OTHER

"A Homeopathic Perspective on Women's Health." *HealthWorld Page*. 1995. 29 Apr. 1998 <http://www.healthy.net/library/articles/Ullman/WOMEN.HTM#4>.

"Ovarian Cysts and Tumors." *Mayo Clinic Online*. 29 Apr. 1998 <http://www.mayohealth.org/mayo/9612/htm/ovarian.htm>.

Parker, William H. "If You Have Ovarian Cysts." *A Gynecologist's Second Opinion Page*. 29 Apr. 1998 <http://www.gynsecondopinion.com/OvarianCysts.html>.

Lori De Milto

Ovarian torsion

Definition

Ovarian torsion is the twisting of the ovary due to the influence of another condition or disease. This results in extreme lower abdominal **pain**.

Description

Ovarian torsion occurs infrequently only in females. In can occur in women of all ages, but most women that experience this are younger. Approximately 70-75% of cases occur in women under 30 years old. About 20% of all reported cases are in pregnant women. It is the fifth most common gynecological emergency which can include surgical intervention.

Ovarian torsion usually arises in only one ovary at a time. They can occur in either normal or enlarged ovaries and fallopian tubes, and occasionally they develop in both.

Causes and symptoms

There are a variety of conditions that can cause torsion of the ovary ranging from changes in normal ovaries

KEY TERMS

Congenital—condition present at birth

Laparoscopy—endoscope used to observe structures in the abdomen

Mesosalpinx—a ligament connected to the fallopian tube

Ovary—female reproductive gland that contains the ova (eggs)

Tachycardia—rapidly beating heart

Torsion—the action of twisting

to congenital and developmental abnormalities or even a disease that affects the tube or ovary. Normal ovaries that experience spasms or changes in the blood vessels in the mesosalpinx can become twisted. For example, if the veins in the mesosolpinx become congested, the ovaries will undergo torsion.

Developmental abnormalities of the fallopian tube such as extremely longer-than-normal tubes or a missing mesosalpinx will cause ovarian torsion. Diseases such as **ovarian cysts** or fibromas, tumor of the ovary or tubes, and trauma to either the ovaries or the tubes will also cause ovarian torsion.

The characteristic symptom of ovarian torsion is the sudden onset of extreme lower abdominal pain that radiates to the back, side and thigh. Nausea, vomiting, **diarrhea**, and **constipation** can accompany the pain. The patient may also experience tenderness in the lower abdominal area, a mild **fever** and tachycardia.

Diagnosis

The diagnosis of ovarian torsions usually occurs in an emergency room due to the suddenness of extreme pain. Emergency room physicians may consult with another physician specializing in obstetrics and gynecology. Since 20% of ovarian torsions occur in pregnant women, physicians will order a **pregnancy** test. Visualization with an ultrasound and CT scan (computed tomography) will help pinpoint the ovarian structures and allow physicians to diagnose. Diagnosis is often confirmed through **laparoscopy**.

Treatment

Ovarian torsions need to be repaired. This is done through surgery, and for less severe cases laparoscopic surgery is used. Medications such as NSAIDs are given to control pain.

Prognosis

If ovarian torsions are diagnosed and treated early, then the prognosis is favorable. However, if diagnosis is delayed, the torsions can worsen and cut off arterial blood flow into and venous blood flow out of the ovary. This results in necrosis (**death**) of the ovarian tissue. Delayed diagnosis can also result in problems when trying to conceive due to **infertility**.

Prevention

Currently, there are no known methods for prevention of ovarian torsion.

Sally C. McFarlane-Parrott

Ovary and fallopian tube removal *see* **Salpingo-oophorectomy**

Ovary removal *see* **Oophorectomy**

Overhydration

Definition

Overhydration, also called water excess or water intoxication, is a condition in which the body contains too much water.

Description

Overhydration occurs when the body takes in more water than it excretes and its normal sodium level is diluted. This can result in digestive problems, behavioral changes, brain damage, seizures, or **coma**. An adult whose heart, kidneys, and pituitary gland are functioning properly would have to drink more than two gallons of water a day to develop water intoxication. This condition is most common in patients whose kidney function is impaired and may occur when doctors, nurses, or other healthcare professionals administer greater amounts of water-producing fluids and medications than the patient's body can excrete. Overhydration is the most common electrolyte imbalance in hospitals, occurring in about 2% of all patients.

Infants seem to be at greater risk for developing overhydration. The Centers for Disease Control and Pre-

vention has declared that babies are especially susceptible to oral overhydration during the first month of life, when the kidneys' filtering mechanism is too immature to excrete fluid as rapidly as older infants do. Breast milk or formula provide all the fluids a healthy baby needs. Water should be given slowly, sparingly, and only during extremely hot weather. Overhydration, which has been cited as a hazard of infant swimming lessons, occurs whenever a baby drinks too much water, excretes too little fluid, or consumes and retains too much water.

Causes and symptoms

Drinking too much water rarely causes overhydration when the body's systems are working normally. People with heart, kidney, or liver disease are more likely to develop overhydration because their kidneys are unable to excrete water normally. It may be necessary for people with these disorders to restrict the amount of water they drink and/or adjust the amount of salt in their **diets**.

Since the brain is the organ most susceptible to overhydration, a change in behavior is usually the first symptom of water intoxication. The patient may become confused, drowsy, or inattentive. Shouting and **delirium** are common. Other symptoms of overhydration may include blurred vision, muscle cramps and twitching, **paralysis** on one side of the body, poor coordination, **nausea and vomiting**, rapid breathing, sudden weight gain, and weakness. The patient's complexion is normal or flushed. Blood pressure is sometimes higher than normal, but elevations may not be noticed even when the degree of water intoxication is serious.

Overhydration can cause acidosis (a condition in which blood and body tissues have an abnormally high acid content), anemia, **cyanosis** (a condition that occurs when oxygen levels in the blood drop sharply), hemorrhage, and **shock**. The brain is the organ most vulnerable to the effects of overhydration. If excess fluid levels accumulate gradually, the brain may be able to adapt to them and the patient will have only a few symptoms. If the condition develops rapidly, confusion, seizures, and coma are likely to occur.

Risk factors

Chronic illness, **malnutrition**, a tendency to retain water, and kidney diseases and disorders increase the likelihood of becoming overhydrated. Infants and the elderly seem to be at increased risk for overhydration, as are people with certain mental disorders or **alcoholism**.

Diagnosis

Before treatment can begin, a doctor must determine whether a patient's symptoms are due to overhydration, in which excess water is found within and outside cells, or excess blood volume, in which high sodium levels prevent the body from storing excess water inside the cells. Overhydration is characterized by excess water both within and around the body's cells, while excess blood volume occurs when the body has too much sodium and can't move water to reservoirs within the cells. In cases of overhydration, symptoms of fluid accumulation don't usually occur. On the other hand, in cases of excess blood volume, fluid tends to accumulate around cells in the lower legs, abdomen, and chest. Overhydration can occur alone or in conjunction with excess blood volume, and differentiating between these two conditions may be difficult.

Treatment

Mild overhydration can generally be corrected by following a doctor's instructions to limit fluid intake. In more serious cases, **diuretics** may be prescribed to increase urination, although these drugs tend to be most effective in the treatment of excess blood volume. Identifying and treating any underlying condition (such as impaired heart or kidney function) is a priority, and fluid restrictions are a critical component of every treatment plan.

In patients with severe neurologic symptoms, fluid imbalances must be corrected without delay. A powerful diuretic and fluids to restore normal sodium concentrations are administered rapidly at first. When the patient has absorbed 50% of the therapeutic substances, blood levels are measured. Therapy is continued at a more moderate pace in order to prevent brain damage as a result of sudden changes in blood chemistry.

Prognosis

Mild water intoxication is usually corrected by drinking less than a quart of water a day for several days. Untreated water intoxication can be fatal, but this outcome is quite rare.

Resources

BOOKS

Gillenwater, Jay Y., ed., et al. *Adult and Pediatric Urology.* St. Louis: Mosby, 1997.

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. McPhee, Stephen, et al., eds. Stamford: Appleton & Lange, 1997.

Maureen Haggerty

Oxycodo *see* **Analgesics, opioid**

Oxygen inhalation therapy *see* **Oxygen/ozone therapy**

Oxygen/ozone therapy

Definition

Oxygen/ozone therapy is a term that describes a number of different practices in which oxygen, ozone, or hydrogen peroxide are administered via gas or water to kill disease microorganisms, improve cellular function, and promote the healing of damaged tissues. The rationale behind bio-oxidative therapies, as they are sometimes known, is the notion that as long as the body's needs for antioxidants are met, the use of certain oxidative substances will stimulate the movement of oxygen atoms from the bloodstream to the cells. With higher levels of oxygen in the tissues, bacteria and viruses are killed along with defective tissue cells. The healthy cells survive and multiply more rapidly. The result is a stronger immune system.

Ozone itself is a form of oxygen, O_3, produced when ultraviolet light or an electric spark passes through air or oxygen. It is a toxic gas that creates free radicals, the opposite of what antioxidant **vitamins** do. Oxidation, however, is good when it occurs in harmful foreign organisms that have invaded the body. Ozone inactivates many disease bacteria and viruses.

Purpose

Oxygen and ozone therapies are thought to benefit patients in the following ways:

- stimulating white blood cell production
- killing viruses (ozone and hydrogen peroxide)
- improving the delivery of oxygen from the blood stream to the tissues of the body
- speeding up the breakdown of petrochemicals
- increasing the production of interferon and tumor necrosis factor, thus helping the body to fight infections and cancers
- increasing the efficiency of antioxidant enzymes
- increasing the flexibility and efficiency of the membranes of red blood cells
- speeding up the citric acid cycle, which in turn stimulates the body's basic metabolism

Description

Origins

The various forms of oxygen and ozone therapy have been in use since the late nineteenth century. The earliest recorded use of oxygen to treat a patient was by Dr. J. A. Fontaine in 1879. In the 1950s, hyperbaric oxygen treatment was used by **cancer** researchers. The term hyperbaric means that the oxygen is given under pressure higher than normal air pressure. Recently, oxygen therapy has also been touted as a quick purification treatment for mass-market consumers. Oxygen bars can be found in airports and large cities, and provide pure oxygen in 20-minute sessions for approximately $16. While proponents claim that breathing oxygen will purify the body, most medical doctors do not agree. What is more, oxygen can be harmful to people with severe lung diseases, and these people should never self-treat with oxygen.

Ozone has been used since 1856 to disinfect operating rooms in European hospitals, and since 1860 to purify the water supplies of several large German cities. Ozone was not, however, used to treat patients until 1915, when a German doctor named Albert Wolff began to use it to treat skin diseases. During World War I, the German Army used ozone to treat **wounds** and **anaerobic infections**. In the 1950s, several German physicians used ozone to treat cancer alongside mainstream therapeutic methods. It is estimated that as of the late 1990s, about 8,000 practitioners in Germany were using ozone in their practices. This figure includes medical doctors as well as naturopaths and homeopaths.

Hydrogen peroxide is familiar to most people as an over-the-counter preparation that is easily available at supermarkets as well as pharmacies, and is used as an antiseptic for cleansing minor cuts and scrapes. It was first used as an intravenous infusion in 1920 by a British physician in India, T. H. Oliver, to treat a group of 25 Indian patients who were critically ill with **pneumonia**. Oliver's patients had a mortality rate of 48%, compared to the standard mortality rate of 80% for the disease. In the 1920s, an American physician named William Koch experimented with hydrogen peroxide as a treatment for cancer. He left the United States after a legal battle with the FDA. In the early 1960s, researchers at Baylor University studied the effects of hydrogen peroxide in removing plaque from the arteries as well as its usefulness in treating cancer, but their findings were largely ignored.

Oxygen, ozone, and hydrogen peroxide are used therapeutically in a variety of different ways.

Hyperbaric oxygen therapy (HBO)

Hyperbaric oxygen therapy (HBO) involves putting the patient in a pressurized chamber in which he or she breathes pure oxygen for a period of 90 minutes to two hours. HBO may also be administered by using a tight-fitting mask, similar to the masks used for anesthesia. A nasal catheter may be used for small children.

Ozone therapy

Ozone therapy may be administered in a variety of ways.

- Intramuscular injection: A mixture of oxygen and ozone is injected into the muscles of the buttocks.
- Rectal insufflation: A mixture of oxygen and ozone is introduced into the rectum and absorbed through the intestines.
- Autohemotherapy: Between 10–15 mL of the patient's blood is removed, treated with a mixture of oxygen and ozone and reinjected into the patient.
- Intra-articular injection: Ozone-treated water is injected into the patient's joints to treat arthritis, rheumatism and other joint diseases.
- Ozonated water: Ozone is bubbled through water that is used to cleanse wounds, **burns**, and skin infections, or to treat the mouth after dental surgery.
- Ozonated oil: Ozone is bubbled through olive or safflower oil, forming a cream that is used to treat fungal infections, insect bites, **acne**, and skin problems.
- Ozone bagging: Ozone and oxygen are pumped into an airtight bag that surrounds the area to be treated, allowing the body tissues to absorb the mixture.

Hydrogen peroxide

Hydrogen peroxide may be administered intravenously in a 0.03% solution. It is infused slowly into the patient's vein over a period of one to three hours. Treatments are given about once a week for chronic illness but may be given daily for such acute illnesses as pneumonia or **influenza**. A course of intravenous hydrogen peroxide therapy may range from one to 20 treatments, depending on the patient's condition and the type of illness being treated. Injections of 0.03% hydrogen peroxide have also been used to treat rheumatoid and **osteoarthritis**. The solution is injected directly into the inflamed joint.

Hydrogen peroxide is also used externally to treat stiff joints, **psoriasis**, and fungal infections. The patient soaks for a minimum of 20 minutes in a tub of warm water to which 1 pint of 35% food-grade hydrogen peroxide (a preparation used by the food industry as a disinfectant) has been added.

Preparations

Oxygen is usually delivered to the patient as a gas; ozone as a gas mixed with oxygen or bubbled through oil or water; and hydrogen peroxide as an 0.03% solution for intravenous injection or a 35% solution for external **hydrotherapy**.

KEY TERMS

Autohemotherapy—A form of ozone therapy in which a small quantity of the patient's blood is withdrawn, treated with a mixture of ozone and oxygen, and reinfused into the patient.

Hydrogen peroxide—A colorless, unstable compound of hydrogen and oxygen (H_2O_2). An aqueous solution of hydrogen peroxide is used as an antiseptic and bleaching agent.

Hyperbaric oxygen therapy (HBO)—A form of oxygen therapy in which the patient breathes oxygen in a pressurized chamber.

Ozone—A form of oxygen with three atoms in its molecule (O_3), produced by an electric spark or ultraviolet light passing through air or oxygen. Ozone is used therapeutically as a disinfectant and oxidative agent.

Precautions

Patients interested in oxygen/ozone therapies must consult with a physician before receiving treatment. Hyperbaric oxygen treatment should not be given to patients with untreated **pneumothorax**, a condition in which air or gas is present in the cavity surrounding the lungs. Patients with a history of pneumothorax, chest surgery, **emphysema**, middle **ear surgery**, uncontrolled high fevers, upper respitory infections, seizures, or disorders of the red blood cells are not suitable candidates for oxygen/ozone therapy. In addition, patients should be aware that oxygen is highly flammable. If treatments are administered incorrectly or by an unskilled person, there is a risk of fire.

Side effects

Typical side effects of oxygen or ozone therapy can include elevated blood pressure and ear pressure similar to that experienced while flying. Side effects may also include **headache**, numbness in the fingers, temporary changes in the lens of the eye, and seizures.

Research and general acceptance

Oxygen/ozone therapies are far more widely accepted in Europe than in the United States. The most intensive research in these therapies is presently being conducted in the former Soviet Union and in Cuba. In the United States, the work of the Baylor researchers was not followed up. As of 2000, however, the Office of Alterna-

tive Medicine of the National Institutes of Health has indicated interest in conducting clinical trials of oxygen/ozone therapies.

Resources

BOOKS

Altman, Nathaniel. *Oxygen Healing Therapies*. Rochester, VT: Healing Arts Press, 1995.

Woodman, Anne, and Dr. David Peters. *Dorling Kindersley Encyclopedia of Healing Therapies*. New York: Dorling Kindersley, 1997.

ORGANIZATIONS

International Bio-Oxidative Medicine Foundation (IBOMF). P.O. Box 891954. Oklahoma City, OK 73109. (405) 634-7855. Fax (405) 634-7320.

International Ozone Association, Ind. Pan American Group. 31 Strawberry Hill Ave., Stamford, CT 06902. (203) 348-3542. Fax (203) 967-4845.

NIH National Center for Complementary and Alternative Medicine (NCCAM). NCCAM Clearinghouse. P. O. Box 8218. Silver Spring, MD 20907-8218. TTY/TDY: (888) 644-6226.

OTHER

Oxygen and Ozone Therapies. <http://www.oxytherapy.com>.

Amy Cooper

Oxymetazoline *see* **Decongestants**

Oxytocin *see* **Drugs used in labor**

Ozone therapy *see* **Oxygen/ozone therapy**

P

PAC *see* **Atrial ectopic beats**

Pacemaker implantation *see* **Pacemakers**

Pacemakers

Definition

A pacemaker is a surgically-implanted electronic device that regulates a slow or erratic heartbeat.

Purpose

Pacemakers are implanted to regulate irregular contractions of the heart (arrhythmia). They are most frequently prescribed to speed the heartbeat of patients who have a heart rate well under 60 beats per minute (severe symptomatic bradycardia). They are also used in some cases to slow a fast heart rate (tachycardia).

Precautions

The symptoms of **fatigue** and lightheadedness that are characteristic of bradycardia can also be caused by a number of other medical conditions, including anemia. Certain prescription medications can also slow the heart rate. A doctor should take a complete medical history and perform a full physical work-up to rule out all non-cardiac causes of bradycardia.

Patients with cardiac pacemakers should not undergo a **magnetic resonance imaging** (MRI) procedure. Devices that emit electromagnetic waves (including magnets) may alter pacemaker programming or functioning. A 1997 study found that cellular phones often interfere with pacemaker programming and cause irregular heart rhythm. However, advances in pacemaker design and materials have greatly reduced the risk of pacemaker interference from electromagnetic fields.

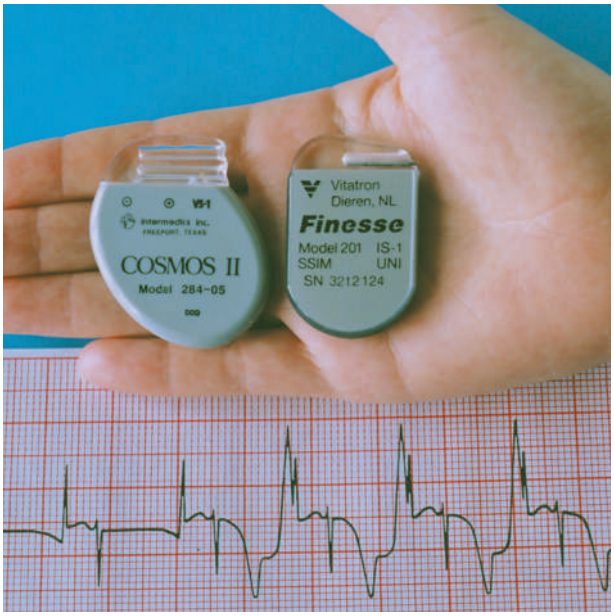
Description

Approximately 500,000 Americans have an implantable permanent pacemaker device. A pacemaker implantation is performed under local anesthesia in a hospital by a surgeon assisted by a cardiologist. An insulated wire called a lead is inserted into an incision above the collarbone and guided through a large vein into the chambers of the heart. Depending on the configuration of the pacemaker and the clinical needs of the patient, as many as three leads may be used in a pacing system. Current pacemakers have a double, or bipolar, electrode attached to the end of each lead. The electrodes deliver an electrical charge to the heart to regulate heartbeat. They are positioned on the areas of the heart that require stimulation. The leads are then attached to the pacemaker device, which is implanted under the skin of the patient's chest.

Patients undergoing surgical pacemaker implantation usually stay in the hospital overnight. Once the procedure is complete, the patient's vital signs are monitored and a **chest x ray** is taken to ensure that the pacemaker and leads are properly positioned.

Modern pacemakers have sophisticated programming capabilities and are extremely compact. The smallest weigh less than 13 grams (under half an ounce) and are the size of two stacked silver dollars. The actual pacing device contains a pulse generator, circuitry programmed to monitor heart rate and deliver stimulation, and a lithiumiodide battery. Battery life typically ranges from seven to 15 years, depending on the number of leads the pacemaker is configured with and how much energy the pacemaker uses. When a new battery is required, the unit can be exchanged in a simple outpatient procedure.

A temporary pacing system is sometimes recommended for patients who are experiencing irregular heartbeats as a result of a recent **heart attack** or other acute medical condition. The implantation procedure for the pacemaker leads is similar to that for a permanent pacing system, but the actual pacemaker unit housing the pulse generator remains outside the patient's body. Tem-



Pacemakers like these are usually implanted under the skin below the collarbone. The pacemaker is connected to the heart by a wire inserted into a major vein in the neck and guided down into the heart. *(Photograph by Eamonn McNulty, Photo Researchers, Inc. Reproduced by permission.)*

porary pacing systems may be replaced with a permanent device at a later date.

Preparation

Patients being considered for pacemaker implantation will undergo a full battery of cardiac tests, including an electrocardiogram (ECG) or an electrophysiological study or both to fully evaluate the bradycardia or tachycardia.

Patients are advised to abstain from eating 6-8 hours before the surgical procedure. The patient is usually given a sedative to help him or her relax for the procedure. An intravenous (IV) line will also be inserted into a vein in the patient's arm before the procedure begins in case medication or blood products are required during the insertion.

Aftercare

Pacemaker patients should schedule a follow-up visit with their cardiologist approximately six weeks after the surgery. During this visit, the doctor will make any necessary adjustments to the settings of the pacemaker. Pacemakers are programmed externally with a handheld electromagnetic device. Pacemaker batteries must be checked regularly. Some pacing systems allow patients to monitor battery life through a special telephone monitoring service that can read pacemaker signals.

KEY TERMS

Electrocardiogram (ECG)—A recording of the electrical activity of the heart. An ECG uses externally attached electrodes to detect the electrical signals of the heart.

Electrophysiological study—A test that monitors the electrical activity of the heart in order to diagnose arrhythmia. An electrophysiological study measures electrical signals through a cardiac catheter that is inserted into an artery in the leg and guided up into the atrium and ventricle of the heart.

Embolism—A blood clot, air bubble, or clot of foreign material that blocks the flow of blood in an artery. When an embolism blocks the blood supply to a tissue or organ, the tissue the artery feeds dies (infarction). Without immediate and appropriate treatment, an embolism can be fatal.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Risks

Because pacemaker implantation is an invasive surgical procedure, internal bleeding, infection, hemorrhage, and **embolism** are all possible complications. Infection is more common in patients with temporary pacing systems. Antibiotic therapy given as a precautionary measure can reduce the risk of pacemaker infection. If infection does occur, the entire pacing system may have to be removed.

The placing of the leads and electrodes during the implantation procedure also presents certain risks for the patient. The lead or electrode could perforate the heart or cause scarring or other damage. The electrodes can also cause involuntary stimulation of nearby skeletal muscles.

A complication known as *pacemaker syndrome* develops in approximately 7% of pacemaker patients with single-chamber pacing systems. The syndrome is characterized by the low blood pressure and **dizziness** that are symptomatic of bradycardia. It can usually be corrected by the implantation of a dual-chamber pacing system.

Normal results

Pacemakers that are properly implanted and programmed can correct a patient's arrhythmia and resolve related symptoms.

Resources

BOOKS

DeBakey, Michael E., and Antonio Gotto Jr. *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

PERIODICALS

Gillyatt, Peta. "Keeping the Beat: Cardiac Pacemakers." *Harvard Health Letter* 20 (June 1995): 1-4.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Paula Anne Ford-Martin

Packed cell volume *see* **Hematocrit**

Packed red blood cell volume *see* **Hematocrit**

Paget's disease of bone

Definition

Paget's disease of bone (*osteitis deformans*) is the abnormal formation of bone tissue that results in weakened and deformed bones.

Description

Named for Sir James Paget (1814–1899), this disease affects 1–3% of people over 50 years of age, but affects over 10% of people over 80 years of age. Paget's disease can affect one or more bones in the body. Most often, the pelvis, bones in the skull, the long bones (the large bones that make up the arms and legs), and the collarbones are affected by Paget's disease. In addition, the joints between bones (the knees or elbows, for example) can develop arthritis because of this condition.

Paget's disease is characterized by changes in the normal mechanism of bone formation. Bone is a living material made by the body through the continual processes of formation and breakdown (resorption). The combination of these two actions is called remodeling and is used by the body to build bone tissue that is strong and healthy. Strong bones are formed when bone tissue is made up of plate-shaped crystals of **minerals** called hydroxyapatite. Normal wear and tear on the skeletal system is repaired throughout life by the ongoing process of remodeling. In fact, the entire human skeleton is remodeled every five years.

Healthy bone tissue has an ordered structure that gives the bone its strength. Bones affected by Paget's disease, however, have a structure that is disorganized. This disorganized structure weakens the diseased bone and makes people suffering from this disease more likely to have **fractures**. These fractures are slow to heal.

Paget's disease of bone is most commonly found in Europe, England, Australia, New Zealand, and North America. In these areas, up to 3% of all people over 55 years of age are affected with the disease. It is interesting to note that Paget's disease is rare in Asia, possibly showing that this disease may affect some ethnic groups and geographic areas more than others.

Causes and symptoms

The cause of Paget's disease is not known. Various viruses have been suggested to be involved in this disease, but the relationship between viral infections and Paget's disease remains uncertain. There also may to be a genetic component to this disease since it may appear in more than one person within the same family.

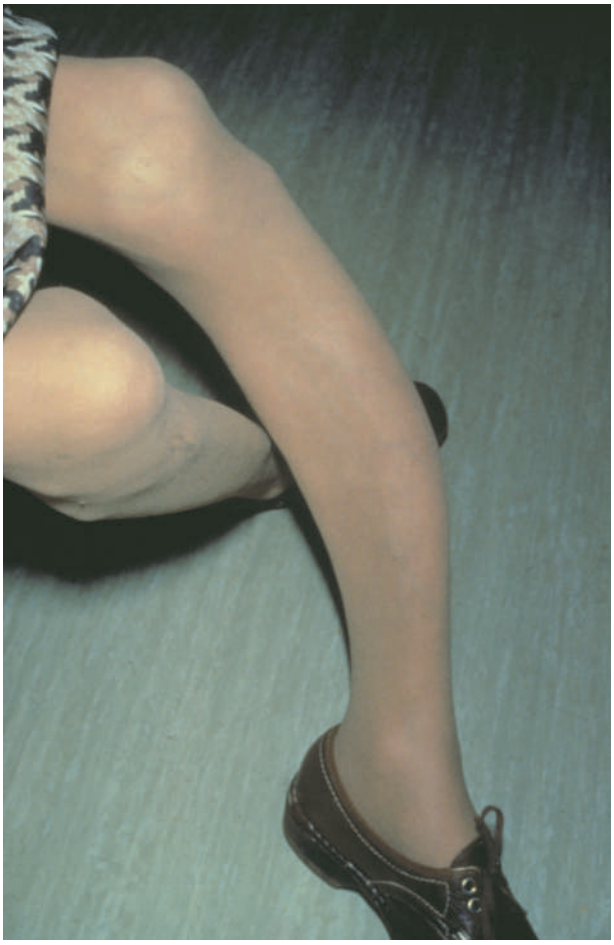
Paget's disease usually begins without any symptoms. And, in its early stages, the symptoms that do occur are often confused with symptoms of arthritis. However, as the disease progresses, bone and joint **pain** develop. A unique feature of Paget's disease is the enlargement of areas of affected bone. This type of enlargement is clearly identifiable on an x ray.

If the bones of the skull are affected by Paget's disease, enlargement of the skull can occur and may result in a loss of hearing. When the long bones in the legs are affected, they can become bent under the body's weight because of their weakness. Little or no injury to a bone can cause fractures in the weakened bones. Fractures that occur when no traumatic injury is present are known as spontaneous fractures.

Although rare, bone **cancer** occurs in less than 1% of patients with Paget's disease. Such cancer is often accompanied by an abrupt increase in the intensity of pain at the diseased site. Unfortunately, this type of cancer has a poor prognosis; the average survival time from the onset of symptoms is generally one to three years.

Diagnosis

Paget's disease is often found when an individual is having x rays taken for medical reasons unrelated to this bone disease. A diagnosis of Paget's disease can also be made when higher than normal levels of a chemical called alkaline phosphatase are found in the blood. Alkaline phosphatase is a substance involved in the bone formation process, so if its levels are abnormally high this indicates that the balance between bone formation and resorption is upset.



This woman's legs are bowed due to Paget's disease. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Treatment, given only when symptoms are present, consists of the following types:

Drugs

Paget's disease is most often treated with drug therapy, with bone pain lessening within weeks of starting the treatment. While non-steroidal anti-inflammatory drugs can reduce bone pain, two additional categories of drugs are used to treat this disease.

HORMONE TREATMENT. Calcitonin, a hormone which is made naturally by the thyroid gland, is used to treat Paget's disease. This chemical rapidly decreases the amount of bone breakdown or loss (resorption). After approximately two to three weeks of treatment with extra calcitonin, bone pain lessens and new bone tissue forms. Calcitonin is commonly given as daily injections for one month, followed by three injections each week for several additional months. The total dose of calcitonin given to an individual depends upon the amount of disease present and how well the individual's condition responds to the treatment.

Although calcitonin is effective in slowing the progression of Paget's disease, the favorable effects of the drug do not continue for very long once administration of the drug is stopped. In addition, some temporary side effects can occur with this drug. Nausea and flushing are the most common side effects and have been found in 20-30% of individuals taking calcitonin. Vomiting, **diarrhea**, and abdominal pain can also occur, but these effects are also temporary. A form of calcitonin taken nasally causes fewer side effects, but requires higher doses because less of the drug reaches the diseased bone.

BISPHOSPHONATES. The bisphosphonate group of drugs are drugs that bind directly to bone minerals because of their specific chemical structure. Once bound to the bone, these drugs inhibit bone loss by reducing the action of bone cells that normally degrade bone during the remodeling process. Unlike treatment with calcitonin, the positive effects of increased bone formation and reduced pain can continue for many months or even years after bisphosphonate treatment is stopped. Bisphosphonates are considered the treatment of choice for Paget's disease and are usually given for 3-6 months at a time.

Bisphosphonate drugs suitable for the treatment of Paget's disease are alendronate, clodronate, etidronate, pamidronate, risedronate, and tiludronate. The main side effects of these drugs include a flu-like reaction (pamidronate), gastrointestinal disturbances (alendronate, clodronate), and abnormal bone formation (etidronate, when taken in high doses). Risedronate is the newest of these drugs. It is about 1,000 times more potent than etidronate and 3 to 5 times more potent than alendronate. Because of the greater potency of this drug, lower doses and a shorter duration of treatment are required. This leads to fewer side effects with similar, or better, clinical results in the patient.

Surgery

Treatment of Paget's disease usually begins with drug therapy. However, various surgical treatments can also be used to treat skeletal conditions that occur in patients with Paget's disease.

In patients with severe arthritis of the hip or knee, a **joint replacement** operation can be beneficial. However, in addition to the malformation of bone tissue caused by this condition, there are greater numbers of blood vessels that form in the diseased bone relative to a healthy bone. This makes surgery on bones affected with Paget's disease more difficult.

KEY TERMS

Bisphosphonate—A class of drugs used to treat Paget's disease. These drugs bind to the minerals in bone tissue and lessen the amount of bone loss associated with Paget's disease.

Calcitonin—A naturally occurring hormone made by the thyroid gland that can be used as a drug to treat Paget's disease.

Remodeling—The ongoing process of bone formation and breakdown that results in healthy bone development.

Prognosis

There is no cure for Paget's disease. However, the development of potent bisphosphonate drugs like risedronate has resulted in the ability to slow the progress of the disease.

Resources

BOOKS

Krane, Stephen M. "Paget's Disease of Bone." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw Hill, 1998, pp. 2266-2269.

PERIODICALS

"Bone Pain in the Elderly." *Generations* 20 (Winter 96/97): 39.

Delmas, Pierre D., and Pierre J.Meunier. "The Management of Paget's Disease of Bone." *New England Journal of Medicine* 336 (February 20, 1997): pp. 558-566.

"Paget's Disease: Skeletal Deformity with or without Pain." *Geriatrics* 51 (June 1996): 50.

Sadovsky, Richard. "Paget's Disease of the Bone: Bisphosphonate Treatment." *American Family Physician* 55 (March 1997): 1400.

ORGANIZATION

The Paget Foundation. 120 Wall St., Suite 1602, New York, NY 10005-4001. (212) 509-5335.

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Paget's disease of the breast

Definition

Paget's disease of the breast is a rare form of **breast cancer** which makes up approximately 1 to 4 percent of all breast tumors. While sharing its name with **Paget's disease of bone**, these are two medically unrelated conditions. They are simply named after the same doctor who first described them.

Description

Paget's disease of the breast is generally associated with an underlying breast **cancer**. It is generally seen in people between the ages of 40 and 80 years. Cases in men have been identified, but they are extremely rare.

Paget's disease of the breast may also be called mammary Paget's disease (MPD). There is a much rarer form of this disease called extramammary Paget's disease (EMPD). MPD affects the breast nipple and is also called Paget's disease of the nipple. EMPD can affect the skin of the external genital tissues in both women and men, as well as the skin of the eyelids and external ear canal. MPD is believed to develop from a tumor growth within the milk ducts of the breast. EMPD may represent a spreading (metastasis) of MPD to other parts of the body.

Causes and symptoms

The cause of Paget's disease of the breast is unknown, but it is usually associated with an underlying cancer of the breast.

The symptoms of Paget's disease of the breast include:

- red scaly patches of skin on the nipple and sometimes also on the dark area of skin around the nipple (areola)
- crusting, bleeding, or ulceration of the skin of the affected area
- a discharge of fluid from the nipple
- a turning inward (inversion) of the nipple

In approximately 30–40% of cases of Paget's disease of the breast, there is also a detectable lump in the breast.

Diagnosis

Paget's disease of the breast is often confused with other skin conditions, such as eczema, **dermatitis**, or **psoriasis**. These misdiagnoses often lead to delays in appropriate treatment. Misdiagnosis is more common when both breast are affected and no lump in the breast is detected. When only one breast is affected, or when the presence of a lump in the breast is also detected, a correct initial diagnosis is more likely to occur.

Once Paget's disease of the breast is suspected, it can be definitively confirmed by biopsy of the affected

tissue. In this procedure, a small piece of the affected skin and the underlying tissue is removed and sent to a laboratory for examination under a microscope. The shape and other characteristics of the cells in the biopsied sample will allow the laboratory personnel to determine if the sample is affected with Paget's disease of the breast, or some other condition.

Topical steroid creams are usually used to treat eczema, dermatitis, and psoriasis. These creams will have no effect on the skin conditions caused by Paget's disease of the breast.

Treatment

Surgery is the main treatment for Paget's disease of the breast. Removal of the breast (**mastectomy**) may be recommended if the cancer is seen in a wide area away from the nipple or appears to be deep into the breast tissue. Breast conservation surgery, aimed at keeping as much of the breast as possible, may be recommended in cases where the disease is diagnosed early enough and the cancer has not spread far from the surface of the nipple.

Some people will require further treatment after surgery. This treatment may include **radiation therapy**, **chemotherapy**, or a combination of both. Radiation therapy involves using high-energy x rays to destroy any cancer cells that may remain after surgical removal of the primary tumor. Radiation therapy is most common after breast conservation surgery. Chemotherapy involves the use of medicinal drugs to destroy the growth of any cancer cells that may remain after removal of the primary cancer. Chemotherapy treatments are most common after mastectomy.

Alternative treatment

Alternative treatments for Paget's disease of the breast include: the use of cartilage from cows or sharks; a diet known as Gerson therapy; administration of the chemicals hydrazine sulfate or laetrile; and, the injection of solutions derived from the mistletoe plant.

Prognosis

The prognosis for Paget's disease of the breast depends on the underlying cancer that is causing this condition and whether or not this cancer has spread (metastasized) to other parts of the body.

Prevention

Because the cause of Paget's disease of the breast is not known, prevention of this disease is not possible.

KEY TERMS

Metastasis—The spread of a cancer from one part of the body (where the cancer originated) to another part of the body.

Ulceration—The formation of an ulcer, a patch of tissue that is discontinuous with the surrounding tissue because the tissue within the ulcer has decayed or died and been swept away.

In instances where this conditions arises from other underlying cancers of the breast, it may be possible to prevent Paget's disease of the breast from occurring if the underlying cause is diagnosed and successfully treated prior to the development of Paget's disease of the breast.

Resources

BOOKS

Love, Susan M., and Karen Lindsey. *Dr. Susan Love's Breast Book, 3rd edition.* Reading, MA: Perseus Book Group, 2000.

PERIODICALS

Desai, D.C., E.J. Brennan, Jr., and N.Z. Carp. "Paget's Disease of the Male Breast." *American Surgeon* 62 (December 1996): 1068-72.

Kollmorgen, D.R. et al. "Paget's Disease of the Breast: A 33-year Experience." *Journal of the American College of Surgeons* 187 (August 1998): 171-7.

Sheen-Chen, S.M. et al. "Paget Disease of the Breast - an Easily Overlooked Disease?" *Journal of Surgical Oncology* 76 (April 2001): 261-5.

ORGANIZATIONS

American Cancer Society, Inc. 1599 Clifton Road NE, Atlanta, GA 30329. 800-227-2345. <http://www.cancer.org/>.

National Alliance of Breast Cancer Organizations. 9 East 37th Street, 10th Floor, New York, NY 10016. 888-806-2226. Fax 212-689-1213. <http://www. nabco.org/>.

National Breast Cancer Coalition. 1707 L Street Northwest, Suite 1060, Washington, DC 20036. 800-622-2838. Fax 202-265-6854. <http://www.natlbcc.org/>.

OTHER

Paget's Disease of the Breast: The CancerBACUP Factsheet. <http://www.cancerbacup.org.uk/info/paget.htm>. (12 May 2001)

Ruth, Laura. *Paget's Disease: A Rare Form of Breast Cancer.* <http://users.cnmnetwork.com/~lrs1/paget.htm>. (12 May 2001)

Paul A. Johnson

Pain

Definition

Pain is an unpleasant feeling that is conveyed to the brain by sensory neurons. The discomfort signals actual or potential injury to the body. However, pain is more than a sensation, or the physical awareness of pain; it also includes perception, the subjective interpretation of the discomfort. Perception gives information on the pain's location, intensity, and something about its nature. The various conscious and unconscious responses to both sensation and perception, including the emotional response, add further definition to the overall concept of pain.

Description

Pain arises from any number of situations. Injury is a major cause, but pain may also arise from an illness. It may accompany a psychological condition, such as depression, or may even occur in the absence of a recognizable trigger.

Acute pain

Acute pain often results from tissue damage, such as a skin burn or broken bone. Acute pain can also be associated with headaches or muscle cramps. This type of pain usually goes away as the injury heals or the cause of the pain (stimulus) is removed.

To understand acute pain, it is necessary to understand the nerves that support it. Nerve cells, or neurons, perform many functions in the body. Although their general purpose, providing an interface between the brain and the body, remains constant, their capabilities vary widely. Certain types of neurons are capable of transmitting a pain signal to the brain.

As a group, these pain-sensing neurons are called nociceptors, and virtually every surface and organ of the body is wired with them. The central part of these cells is located in the spine, and they send threadlike projections to every part of the body. Nociceptors are classified according to the stimulus that prompts them to transmit a pain signal. Thermoreceptive nociceptors are stimulated by temperatures that are potentially tissue damaging. Mechanoreceptive nociceptors respond to a pressure stimulus that may cause injury. Polymodal nociceptors are the most sensitive and can respond to temperature and pressure. Polymodal nociceptors also respond to chemicals released by the cells in the area from which the pain originates.

Nerve cell endings, or receptors, are at the front end of pain sensation. A stimulus at this part of the nociceptor unleashes a cascade of neurotransmitters (chemicals that transmit information within the nervous system) in the spine. Each neurotransmitter has a purpose. For example, substance P relays the pain message to nerves leading to the spinal cord and brain. These neurotransmitters may also stimulate nerves leading back to the site of the injury. This response prompts cells in the injured area to release chemicals that not only trigger an immune response, but also influence the intensity and duration of the pain.

Chronic and abnormal pain

Chronic pain refers to pain that persists after an injury heals, **cancer** pain, pain related to a persistent or degenerative disease, and long-term pain from an unidentifiable cause. It is estimated that one in three people in the United States will experience chronic pain at some point in their lives. Of these people, approximately 50 million are either partially or completely disabled.

Chronic pain may be caused by the body's response to acute pain. In the presence of continued stimulation of nociceptors, changes occur within the nervous system. Changes at the molecular level are dramatic and may include alterations in genetic transcription of neurotransmitters and receptors. These changes may also occur in the absence of an identifiable cause; one of the frustrating aspects of chronic pain is that the stimulus may be unknown. For example, the stimulus cannot be identified in as many as 85% of individuals suffering lower back pain.

Other types of abnormal pain include allodynia, hyperalgesia, and phantom limb pain. These types of pain often arise from some damage to the nervous system (neuropathic). Allodynia refers to a feeling of pain in response to a normally harmless stimulus. For example, some individuals who have suffered nerve damage as a result of viral infection experience unbearable pain from just the light weight of their clothing. Hyperalgesia is somewhat related to allodynia in that the response to a painful stimulus is extreme. In this case, a mild pain stimulus, such as a pin prick, causes a maximum pain response. Phantom limb pain occurs after a limb is amputated; although an individual may be missing the limb, the nervous system continues to perceive pain originating from the area.

Causes and symptoms

Pain is the most common symptom of injury and disease, and descriptions can range in intensity from a mere ache to unbearable agony. Nociceptors have the ability to convey information to the brain that indicates the location, nature, and intensity of the pain. For example, stepping on a nail sends an information-packed mes-

sage to the brain: the foot has experienced a puncture wound that hurts a lot.

Pain perception also varies depending on the location of the pain. The kinds of stimuli that cause a pain response on the skin include pricking, cutting, crushing, burning, and freezing. These same stimuli would not generate much of a response in the intestine. Intestinal pain arises from stimuli such as swelling, inflammation, and distension.

Diagnosis

Pain is considered in view of other symptoms and individual experiences. An observable injury, such as a broken bone, may be a clear indicator of the type of pain a person is suffering. Determining the specific cause of internal pain is more difficult. Other symptoms, such as **fever** or nausea, help narrow down the possibilities. In some cases, such as lower back pain, a specific cause may not be identifiable. Diagnosis of the disease causing a specific pain is further complicated by the fact that pain can be referred to (felt at) a skin site that does not seem to be connected to the site of the pain's origin. For example, pain arising from fluid accumulating at the base of the lung may be referred to the shoulder.

Since pain is a subjective experience, it may be very difficult to communicate its exact quality and intensity to other people. There are no diagnostic tests that can determine the quality or intensity of an individual's pain. Therefore, a medical examination will include a lot of questions about where the pain is located, its intensity, and its nature. Questions are also directed at what kinds of things increase or relieve the pain, how long it has lasted, and whether there are any variations in it. An individual may be asked to use a pain scale to describe the pain. One such scale assigns a number to the pain intensity; for example, 0 may indicate no pain, and 10 may indicate the worst pain the person has ever experienced. Scales are modified for infants and children to accommodate their level of comprehension.

Treatment

There are many drugs aimed at preventing or treating pain. Nonopioid **analgesics**, narcotic analgesics, **anticonvulsant drugs**, and tricyclic antidepressants work by blocking the production, release, or uptake of neurotransmitters. Drugs from different classes may be combined to handle certain types of pain.

Nonopioid analgesics include common over-the-counter medications such as **aspirin**, **acetaminophen** (Tylenol), and ibuprofen (Advil). These are most often used for minor pain, but there are some prescription-strength medications in this class.

Narcotic analgesics are only available with a doctor's prescription and are used for more severe pain, such as cancer pain. These drugs include codeine, morphine, and **methadone**. Contrary to earlier beliefs, **addiction** to these painkillers is not common; people who genuinely need these drugs for pain control typically do not become addicted. However, narcotic use should be limited to patients thought to have a short life span (such as people with terminal cancer) or patients whose pain is only expected to last for a short time (such as people recovering from surgery).

Anticonvulsants, as well as **antidepressant drugs**, were initially developed to treat seizures and depression, respectively. However, it was discovered that these drugs also have pain-killing applications. Furthermore, in cases of chronic or extreme pain, it is not unusual for an individual to suffer some degree of depression; therefore, antidepressants may serve a dual role. Commonly prescribed anticonvulsants for pain include phenytoin, carbamazepine, and clonazepam. Tricyclic antidepressants include doxepin, amitriptyline, and imipramine.

Intractable (unrelenting) pain may be treated by injections directly into or near the nerve that is transmitting the pain signal. These root blocks may also be useful in determining the site of pain generation. As the underlying mechanisms of abnormal pain are uncovered, other pain medications are being developed.

Drugs are not always effective in controlling pain. Surgical methods are used as a last resort if drugs and local anesthetics fail. The least destructive surgical procedure involves implanting a device that emits electrical signals. These signals disrupt the nerve and prevent it from transmitting the pain message. However, this method may not completely control pain and is not used frequently. Other surgical techniques involve destroying or severing the nerve, but the use of this technique is limited by side effects, including unpleasant numbness.

Alternative treatment

Both physical and psychological aspects of pain can be dealt with through alternative treatment. Some of the most popular treatment options include **acupressure** and **acupuncture**, massage, **chiropractic**, and relaxation techniques, such as **yoga**, hypnosis, and **meditation**. Herbal therapies are gaining increased recognition as viable options; for example, capsaicin, the component that makes cayenne peppers spicy, is used in ointments to relieve the joint pain associated with arthritis. Contrast **hydrotherapy** can also be very beneficial for pain relief.

Lifestyles can be changed to incorporate a healthier diet and regular **exercise**. Regular exercise, aside from

KEY TERMS

Acute pain—Pain in response to injury or another stimulus that resolves when the injury heals or the stimulus is removed.

Chronic pain—Pain that lasts beyond the term of an injury or painful stimulus. Can also refer to cancer pain, pain from a chronic or degenerative disease, and pain from an unidentified cause.

Neuron—A nerve cell.

Neurotransmitters—Chemicals within the nervous system that transmit information from or between nerve cells.

Nociceptor—A neuron that is capable of sensing pain.

Referred pain—Pain felt at a site different from the location of the injured or diseased part of the body. Referred pain is due to the fact that nerve signals from several areas of the body may "feed" the same nerve pathway leading to the spinal cord and brain.

Stimulus—A factor capable of eliciting a response in a nerve.

relieving **stress**, has been shown to increase endorphins, painkillers naturally produced in the body.

Prognosis

Successful pain treatment is highly dependent on successful resolution of the pain's cause. Acute pain will stop when an injury heals or when an underlying problem is treated successfully. Chronic pain and abnormal pain are more difficult to treat, and it may take longer to find a successful resolution. Some pain is intractable and will require extreme measures for relief.

Prevention

Pain is generally preventable only to the degree that the cause of the pain is preventable; diseases and injuries are often unavoidable. However, increased pain, pain from surgery and other medical procedures, and continuing pain are preventable through drug treatments and alternative therapies.

Resources

BOOKS

Adams, Raymond D., Maurice Victor, and Allan H. Ropper. *Principles of Neurology.* 6th ed. New York: McGraw-Hill, 1997.

Tollison, C. David, John R. Satterthwaite, and Joseph W. Tollison, eds. *Handbook of Pain Management.* 2nd ed. Baltimore: Williams & Wilkins, 1994.

PERIODICALS

Iadarola, Michael J., and Robert M. Caudle. "Good Pain, Bad Pain: Neuroscience Research." *Science* 278 (1997): 239.

Markenson, Joseph A. "Mechanisms of Chronic Pain." *The American Journal of Medicine* 101 (supplement 1A/1996): 6S.

Sykes, J., R. Johnson, and G. W. Hanks. "Difficult Pain Problems: ABC of Palliative Care." *British Medical Journal* 315 (1997): 867.

ORGANIZATIONS

American Chronic Pain Association. P.O. Box 850, Rocklin, CA 95677-0850. (916) 632-0922. <http://members.tripod.com/~widdy/ACPA.html>.

American Pain Society. 4700 W. Lake Ave., Glenview, IL 60025. (847) 375-4715. <http://www.ampainsoc.org>.

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Pain management

Definition

Pain management encompasses pharmacological, nonpharmacological, and other approaches to prevent, reduce, or stop pain sensations.

Purpose

Pain serves as an alert to potential or actual damage to the body. The definition for damage is quite broad; pain can arise from injury as well as disease. After the message is received and interpreted, further pain can be counter-productive. Pain can have a negative impact on a person's quality of life and impede recovery from illness or injury. Unrelieved pain can become a syndrome in its own right and cause a downward spiral in a person's health and outlook. Managing pain properly facilitates recovery, prevents additional health complications, and improves an individual's quality of life.

Description

What is pain?

Before considering pain management, a review of pain definitions and mechanisms may be useful. Pain is the means by which the peripheral nervous system (PNS) warns the central nervous system (CNS) of injury or potential injury to the body. The CNS comprises the brain and spinal cord, and the PNS is composed of the

nerves that stem from and lead into the CNS. PNS includes all nerves throughout the body except the brain and spinal cord.

A pain message is transmitted to the CNS by special PNS nerve cells called nociceptors. Nociceptors are distributed throughout the body and respond to different stimuli depending on their location. For example, nociceptors that extend from the skin are stimulated by sensations such as pressure, temperature, and chemical changes.

When a nociceptor is stimulated, neurotransmitters are released within the cell. Neurotransmitters are chemicals found within the nervous system that facilitate nerve cell communication. The nociceptor transmits its signal to nerve cells within the spinal cord, which conveys the pain message to the thalamus, a specific region in the brain.

Once the brain has received and processed the pain message and coordinated an appropriate response, pain has served its purpose. The body uses natural pain killers, called endorphins, that are meant to derail further pain messages from the same source. However, these natural pain killers may not adequately dampen a continuing pain message. Also, depending on how the brain has processed the pain information, certain hormones, such as prostaglandins, may be released. These hormones enhance the pain message and play a role in immune system responses to injury, such as inflammation. Certain neurotransmitters, especially substance P and calcitonin gene- related peptide, actively enhance the pain message at the injury site and within the spinal cord.

Pain is generally divided into two categories: acute and chronic. Nociceptive pain, or the pain that is transmitted by nociceptors, is typically called acute pain. This kind of pain is associated with injury, headaches, disease, and many other conditions. It usually resolves once the condition that precipitated it is resolved.

Following some disorders, pain does not resolve. Even after healing or a cure has been achieved, the brain continues to perceive pain. In this situation, the pain may be considered chronic. The time limit used to define chronic pain typically ranges from three to six months, although some healthcare professionals prefer a more flexible definition, and consider chronic pain as pain that endures beyond a normal healing time. The pain associated with **cancer**, persistent and degenerative conditions, and neuropathy, or nerve damage, is included in the chronic category. Also, unremitting pain that lacks an identifiable physical cause, such as the majority of cases of **low back pain**, may be considered chronic. The underlying biochemistry of chronic pain appears to be different from regular nociceptive pain.

It has been hypothesized that uninterrupted and unrelenting pain can induce changes in the spinal cord. In the past, intractable pain has been treated by severing a nerve's connection to the CNS. However, the lack of any sensory information being relayed by that nerve can cause pain transmission in the spinal cord to go into overdrive, as evidenced by the phantom limb pain experienced by amputees. Evidence is accumulating that unrelenting pain or the complete lack of nerve signals increases the number of pain receptors in the spinal cord. Nerve cells in the spinal cord may also begin secreting pain-amplifying neurotransmitters independent of actual pain signals from the body. Immune chemicals, primarily cytokines, may play a prominent role in such changes.

Managing pain

Considering the different causes and types of pain, as well as its nature and intensity, management can require an interdisciplinary approach. The elements of this approach include treating the underlying cause of pain, pharmacological and nonpharmacological therapies, and some invasive (surgical) procedures.

Treating the cause of pain underpins the idea of managing it. Injuries are repaired, diseases are diagnosed, and certain encounters with pain can be anticipated and treated prophylactically (by prevention). However, there are no guarantees of immediate relief from pain. Recovery can be impeded by pain and quality of life can be damaged. Therefore, pharmacological and other therapies have developed over time to address these aspects of disease and injury.

PHARMACOLOGICAL OPTIONS. Pain-relieving drugs, otherwise called **analgesics**, include **nonsteroidal anti-inflammatory drugs** (NSAIDs), **acetaminophen**, narcotics, antidepressants, anticonvulsants, and others. NSAIDs and acetaminophen are available as over-the-counter and prescription medications, and are frequently the initial pharmacological treatment for pain. These drugs can also be used as adjuncts to the other drug therapies, which might require a doctor's prescription.

NSAIDs include **aspirin**, ibuprofen (Motrin, Advil, Nuprin), naproxen sodium (Aleve), and ketoprofen (Orudis KT). These drugs are used to treat pain from inflammation and work by blocking production of pain-enhancing neurotransmitters, such as prostaglandins. Acetaminophen is also effective against pain, but its ability to reduce inflammation is limited.

NSAIDs and acetaminophen are effective for most forms of acute (sharp, but of a short course) pain, but moderate and severe pain may require stronger medication. Narcotics handle intense pain effectively, and are used for cancer pain and acute pain that does not respond to NSAIDs and acetaminophen. Narcotics are classified as either opiates or opioids, and are available only with a

doctor's prescription. Opiates include morphine and codeine, which are derived from opium, a substance naturally found in some poppy species. Opioids are synthetic drugs based on the structure of opium. This drug class includes drugs such as oxycodon, **methadone**, and meperidine (Demerol).

Narcotics may be ineffective against some forms of chronic pain, especially since changes in the spinal cord may alter the usual pain signaling pathways. Furthermore, narcotics are usually not recommended for long-term use because the body develops a tolerance to narcotics, reducing their effectiveness over time. In such situations, pain can be managed with antidepressants and anticonvulsants, which are also only available with a doctor's prescription.

Although **antidepressant drugs** were developed to treat depression, it has been discovered that they are also effective in combating chronic headaches, cancer pain, and pain associated with nerve damage. Antidepressants that have been shown to have analgesic (pain reducing) properties include amitriptyline (Elavil), trazodone (Desyrel), and imipramine (Tofranil). **Anticonvulsant drugs** share a similar background with antidepressants. Developed to treat epilepsy, anticonvulsants were found to relieve pain as well. Drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol) are prescribed to treat the pain associated with nerve damage.

Other prescription drugs are used to treat specific types of pain or specific pain syndromes. For example, **corticosteroids** are very effective against pain caused by inflammation and swelling, and sumatriptan (Imitrex) was developed to treat migraine headaches.

Drug administration depends on the drug type and the required dose. Some drugs are not absorbed very well from the stomach and must be injected or administered intravenously. Injections and intravenous administration may also be used when high doses are needed or if an individual is nauseous. Following surgery and other medical procedures, patients may have the option of controlling the pain medication themselves. By pressing a button, they can release a set dose of medication into an intravenous solution. This procedure has also been employed in other situations requiring pain management. Another mode of administration involves implanted catheters that deliver pain medication directly to the spinal cord. Delivering drugs in this way can reduce side effects and increase the effectiveness of the drug.

NONPHARMACOLOGICAL OPTIONS. Pain treatment options that do not use drugs are often used as adjuncts to, rather than replacements for, drug therapy. One of the benefits of non-drug therapies is that an individual can take a more active stance against pain. Relaxation techniques, such as **yoga** and **meditation**, are used to decrease muscle tension and reduce **stress**. Tension and stress can also be reduced through **biofeedback**, in which an individual consciously attempts to modify skin temperature, muscle tension, blood pressure, and heart rate.

Participating in normal activities and exercising can also help control pain levels. Through physical therapy, an individual learns beneficial exercises for reducing stress, strengthening muscles, and staying fit. Regular **exercise** has been linked to production of endorphins, the body's natural pain killers.

Acupuncture involves the insertion of small needles into the skin at key points. **Acupressure** uses these same key points, but involves applying pressure rather than inserting needles. Both of these methods may work by prompting the body to release endorphins. Applying heat or being massaged are very relaxing and help reduce stress. Transcutaneous **electrical nerve stimulation** (TENS) applies a small electric current to certain parts of nerves, potentially interrupting pain signals and inducing release of endorphins. To be effective, use of TENS should be medically supervised.

INVASIVE PROCEDURES. There are three types of invasive procedures that may be used to manage or treat pain: anatomic, augmentative, and ablative. These procedures involve surgery, and certain guidelines should be followed before carrying out a procedure with permanent effects. First, the cause of the pain must be clearly identified. Next, surgery should be done only if noninvasive procedures are ineffective. Third, any psychological issues should be addressed. Finally, there should be a reasonable expectation of success.

Anatomic procedures involve correcting the injury or removing the cause of pain. Relatively common anatomic procedures are decompression surgeries, such as repairing a **herniated disk** in the lower back or relieving the nerve compression related to **carpal tunnel syndrome**. Another anatomic procedure is neurolysis, also called a nerve block, which involves destroying a portion of a peripheral nerve.

Augmentative procedures include electrical stimulation or direct application of drugs to the nerves that are transmitting the pain signals. Electrical stimulation works on the same principle as TENS. In this procedure, instead of applying the current across the skin, electrodes are implanted to stimulate peripheral nerves or nerves in the spinal cord. Augmentative procedures also include implanted drug-delivery systems. In these systems, catheters are implanted in the spine to allow direct delivery of drugs to the CNS.

KEY TERMS

Acute—Referring to pain in response to injury or other stimulus that resolves when the injury heals or the stimulus is removed.

Chronic—Referring to pain that endures beyond the term of an injury or painful stimulus. Can also refer to cancer pain, pain from a chronic or degenerative disease, and pain from an unidentified cause.

CNS or central nervous system—The part of the nervous system that includes the brain and the spinal cord.

Iatrogenic—Resulting from the activity of the physician.

Neuropathy—Nerve damage.

Neurotransmitter—Chemicals within the nervous system that transmit information from or between nerve cells.

Nociceptor—A nerve cell that is capable of sensing pain and transmitting a pain signal.

Nonpharmacological—Referring to therapy that does not involve drugs.

Pharmacological—Referring to therapy that relies on drugs.

PNS or peripheral nervous system—Nerves that are outside of the brain and spinal cord.

Stimulus—A factor capable of eliciting a response in a nerve.

Ablative procedures are characterized by severing a nerve and disconnecting it from the CNS. However, this method may not address potential alterations within the spinal cord. These changes perpetuate pain messages and do not cease even when the connection between the sensory nerve and the CNS is severed. With growing understanding of neuropathic pain and development of less invasive procedures, ablative procedures are used less frequently. However, they do have applications in select cases of **peripheral neuropathy**, cancer pain, and other disorders.

Preparation

Prior to beginning management, pain is thoroughly evaluated. Pain scales or questionnaires are used to attach an objective measure to a subjective experience. Objective measurements allow health care workers a better understanding of the pain being experienced by the patient. Evaluation also includes physical examinations and diagnostic tests to determine underlying causes. Some evaluations require assessments from several viewpoints, including neurology, psychiatry and psychology, and physical therapy. If pain is due to a medical procedure, management consists of anticipating the type and intensity of associated pain and managing it preemptively.

Risks

Owing to toxicity over the long term, some drugs can only be used for acute pain or as adjuncts in chronic pain management. NSAIDs have the well-known side effect of causing gastrointestinal bleeding, and long-term use of acetaminophen has been linked to kidney and liver damage. Other drugs, especially narcotics, have serious side effects, such as **constipation**, drowsiness, and nausea. Serious side effects can also accompany pharmacological therapies; mood swings, confusion, bone thinning, cataract formation, increased blood pressure, and other problems may discourage or prevent use of some analgesics.

Nonpharmacological therapies carry little or no risk. However, it is advised that individuals recovering from serious illness or injury consult with their health care providers or physical therapists before making use of adjunct therapies. Invasive procedures carry risks similar to other surgical procedures, such as infection, reaction to anesthesia, iatrogenic (injury as a result of treatment) injury, and failure.

A traditional concern about narcotics use has been the risk of promoting **addiction**. As narcotic use continues over time, the body becomes accustomed to the drug and adjusts normal functions to accommodate to its presence. Therefore, to elicit the same level of action, it is necessary to increase dosage over time. As dosage increases, an individual may become physically dependent on narcotic drugs.

However, physical dependence is different from psychological addiction. Physical dependence is characterized by discomfort if drug administration suddenly stops, while psychological addiction is characterized by an overpowering craving for the drug for reasons other than pain relief. Psychological addiction is a very real and necessary concern in some instances, but it should not interfere with a genuine need for narcotic pain relief. However, caution must be taken with people with a history of addictive behavior.

Normal results

Effective application of pain management techniques reduces or eliminates acute or chronic pain. This treatment can improve an individual's quality of life and aid in recovery from injury and disease.

Resources

BOOKS

Salerno, Evelyn, and Joyce S. Willens, eds. *Pain Management Handbook: An Interdisciplinary Approach*. St. Louis: Mosby, 1996.

Tollison, C. David, John R. Satterthwaite, and Joseph W. Tollison, eds. *Handbook of Pain Management*. 2nd ed. Baltimore: Williams & Wilkins, 1994.

PERIODICALS

Garcia, Jose, and Roy D. Altman. "Chronic Pain States: Pathophysiology and Medical Therapy." *Seminars in Arthritis and Rheumatism* 27 (Aug. 1997): 1.

Montauk, Susan Louisa, and Jill Martin. "Treating Chronic Pain." *American Family Physician* 55 (Mar. 1997): 1151.

ORGANIZATIONS

American Chronic Pain Association. P.O. Box 850, Rocklin, CA 95677-0850. (916) 632-0922. <http://members.tripod.com/~widdy/ACPA.html>.

American Pain Society. 4700 West Lake Ave., Glenview, IL 60025. (847) 375-4715. <http://www.ampainsoc.org>.

National Chronic Pain Outreach Association, Inc. P.O. Box 274, Millboro, VA 24460- 9606. (540) 997-5004.

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Pain relievers *see* **Analgesics**

Painful menstruation *see* **Dysmenorrhea**

Palliative cancer therapy *see* **Cancer therapy, palliative**

Palpitations

Definition

A sensation in which a person is aware of an irregular, hard, or rapid heartbeat.

Description

Palpitations mean that the heart is not behaving normally. It can appear to skip beats, beat rapidly, beat irregularly, or thump in the chest. Although palpitations are very common and often harmless, they can be frightening to the person, who is usually unaware of his or her heartbeat.

Palpitations can also be a sign of serious heart trouble. Palpitations that are caused by certain types of abnormal heart rhythms (**arrhythmias**) can be serious, and even fatal if left untreated. Recognizable arrhythmias are present in a small number of patients who have palpitations. Immediate medical attention should be sought for palpitations that feel like a very fast series of heartbeats, last more than two or three minutes, and are unrelated to strenuous physical activity, obvious fright, or anger. Medical attention should also be sought if palpitations are accompanied by chest **pain**, **dizziness**, **shortness of breath**, or an overall feeling of weakness.

Most people have experienced a skipped or missed heartbeat, which is really an early beat and not a skipped beat at all. After a premature heartbeat, the heart rests for an instant then beats with extra force, making the person feel as if the heart has skipped a beat. This type of palpitation is nothing to worry about unless it occurs frequently. Severe palpitations feel like a thudding or fluttering sensation in the chest. After chest pain, palpitations are the most common reason that people are referred for cardiology evaluation.

Causes and symptoms

Palpitations can be caused by **anxiety**, arrhythmias, **caffeine**, certain medications, **cocaine** and other amphetamines, emotional **stress**, overeating, panic, somatization, and vigorous **exercise**. There may be no other symptoms. But, anxiety, dizziness, shortness of breath, and chest pain may be signs of more severe arrhythmias.

Diagnosis

Palpitations are diagnosed through a medical history, a **physical examination**, an electrocardiogram (ECG), and screening for psychiatric disorders. It is often difficult to distinguish palpitations from **panic disorder**, a common problem in which the person experiences frequent and unexplained "fight-or-flight" responses, which is the body's natural physical reaction to extreme danger or physical exertion, but without the obvious external stimulus.

To accurately diagnose palpitations, one of the irregular heartbeats must be "captured" on an EKG, which shows the heart's activity. Electrodes covered with a type of gel that conducts electrical impulses are placed on the patient's chest, arms, and legs. These electrodes send impulses of the heart's activity to a recorder, which traces them on paper. This **electrocardiography** test takes about 10 minutes and is performed in a physician's office or hospital. Because the palpitations are unlikely to occur during a standard EKG, **Holter monitoring** is often performed. In this procedure, the patient wears a small, portable tape recorder that is attached to a belt or shoulder strap and connected to electrode disks on his or her chest. The Holter monitor records the heart's rhythm during normal activities. Some medical centers are now using event recorders that the patient can carry for weeks or months. When the palpitations occur, the patient

KEY TERMS

Arrhythmia—Any variation from the normal heartbeat. Some arrhythmias are harmless, while others, such as ventricular tachycardia, ventricular fibrillation, and ventricular standstill, can be fatal.

Somatization—Anxiety converted into physical symptoms. Somatization is a sign of panic disorder.

presses a button on the device, which captures the information about the palpitations for physician evaluation. Later the recording can be transmitted over the telephone line for analysis.

Treatment

Most palpitations require no treatment. Persistent palpitations can be treated with small doses of a beta blocker. **Beta blockers** are drugs that tend to lower blood pressure. They slow the heart rate and decrease the force with which the heart pumps. If the cause of the palpitations is determined to be an arrhythmia, medical or surgical treatment may be prescribed, although surgery is rarely needed.

Alternative treatment

Alternative treatments for palpitations should be used only as a complement to traditional medicine. Alternative treatments include: **aromatherapy**, Chinese herbs, herbal therapies, homeopathic medicine, exercise, mind/body medicine, and diet and **nutrition**. In aromatherapy, adding citrus oils to bath water may help with minor palpitations. Some Chinese herbs can also help, but others can worsen arrhythmias, so a qualified herbalist should be consulted. Herbal therapies such as hawthorn (*Crataegus laevigata*) and motherwort (*Leonurus cardiaca*) can help with palpitations. Homeopathic remedies such as *Lachesis, Digitalis,* and *Aconite* (*Aconitum nnapellus*) may be used to control palpitations but should be taken only when prescribed by a homeopathic physician. Mind/body medicine such as **meditation** and **yoga** can help the person relax, eliminating or reducing palpitations caused by anxiety or stress. Reducing or eliminating tea, cola, coffee, and chocolate, and consuming adequate amounts of the **minerals** calcium, magnesium, and potassium can help reduce or eliminate palpitations.

Prognosis

Most palpitations are harmless, but some can be a sign of heart trouble, which could be fatal if left untreated.

Prevention

Palpitations not caused by arrhythmias can be prevented by reducing or eliminating anxiety and emotional stress, and reducing or eliminating consumption of tea, cola, coffee, and chocolate. Exercise can also help, but a treadmill **stress test** performed by a physician should be considered first to make sure the exercise is safe.

Resources

BOOKS

"Heart Palpitations." In *New Choices in Natural Healing*, ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

"Palpitations." In *Mayo Clinic Practice of Cardiology.* 3rd ed. Ed. Emilio R. Giuliani, et al. St. Louis: Mosby, 1996.

"Palpitations, Dizziness, Syncope." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Texas Heart Institute. "Palpitations." In *Texas Heart Institute Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

"The Cause of Palpitations Can be Easily Determined in Most Patients." *Modern Medicine* 64 (June 1996): 51.

Karas, Barry J., and Blair P. Grubb. "Reentrant Tachycardias: A Look at Where Treatment Stands Today." *Postgraduate Medicine* 103 (Jan. 1998): 84-98.

Lee, Thomas H. "By the Way, Doctor..." *Harvard Heart Letter* 8 (Mar. 1998): 8.

Mayou, Richard. "Chest Pain, Palpitations, and Panic." *Journal of Psychosomatic Research* 44 (1998): 53-70.

"New Test Catches Causes of Palpitations." *Harvard Heart Letter* 6 (July 1996): 8.

"Simple Evaluation Identifies the Cause of Palpitations in Most Patients." *Modern Medicine* 64 (1 May 1996): 24.

"The Supreme Bean." *Body Bulletin* (Apr. 1997): 2.

"Ten-Question Survey Helps Differentiate Between Palpitations and Panic Disorder." *Modern Medicine* 65 (Sept. 1997): 50.

Lori De Milto

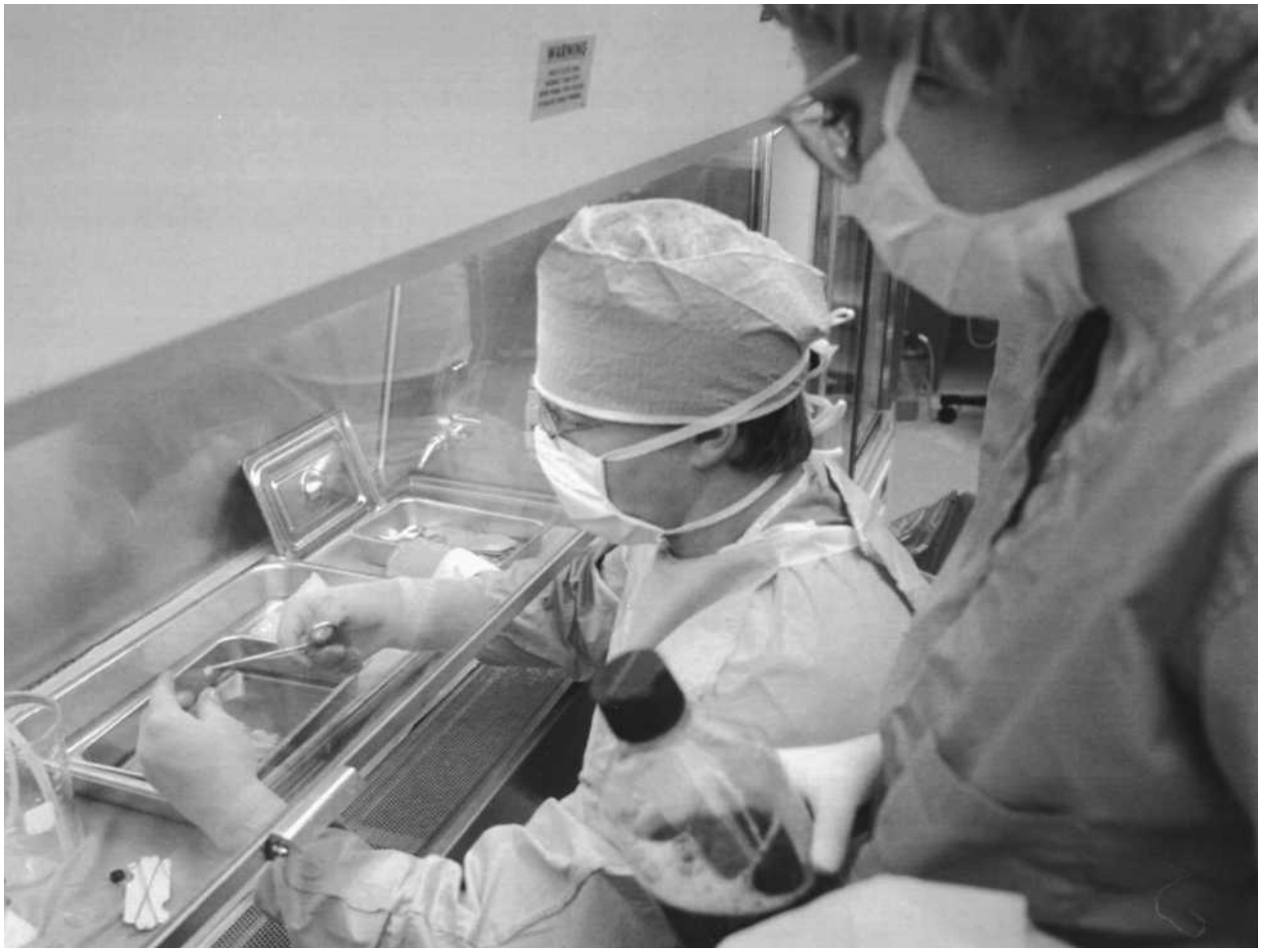
Panax quinquefolius see **Ginseng**

Pancreas removal *see* **Pancreatectomy**

Pancreas transplantation

Definition

Pancreas transplantation is a surgical procedure in which a diseased pancreas is replaced with a healthy pancreas that has been obtained immediately after **death** from an immunologically compatible donor.



A surgeon harvests the islets of Langerhans from a donor pancreas. *(Photograph by Daniel Portnoy. AP/Wide World Photo. Reproduced by permission.)*

Purpose

The pancreas secretes insulin to regulate glucose (sugar) metabolism. Failure to regulate glucose levels leads to diabetes. Over one million patients in the United States have insulin dependent (type I) **diabetes mellitus**. Successful pancreas transplantation allows the body to make and secrete its own insulin, and establishes insulin independence for these patients.

Pancreas transplantation is major surgery that requires suppression of the immune system to prevent the body from rejecting the transplanted pancreas. Immunosuppressive drugs have serious side effects. Because of these side effects, in 1996, 85% of pancreas transplants were performed simultaneously with kidney transplants, 10% after a kidney transplant, and only 5% were performed as a pancreas transplant alone.

The rationale for this is that patients will already be receiving immunosuppressive treatments for the kidney transplant, so they might as well receive the benefit of a pancreas transplant as well. Patients considering pancreas transplantation alone must decide with their doctors whether life-long treatment with immunosuppressive drugs is preferable to life-long insulin dependence.

The best candidates for pancreas transplantation are:

- between the ages of 20–40
- those who have extreme difficulty regulating their glucose levels
- those who have few secondary complications of diabetes
- those who are in good cardiovascular health.

Precautions

Many people with diabetes are not good candidates for a pancreas transplant. Others do not have tissue compatibility with the donor organ. People who are success-

National Transplant Waiting List By Organ Type (June 2000)

Organ Needed	Number Waiting
Kidney	48,349
Liver	15,987
Heart	4,139
Lung	3,695
Kidney-Pancreas	2,437
Pancreas	942
Heart-Lung	212
Intestine	137

fully controlling their diabetes with insulin injections are usually not considered for pancreas transplants.

Description

Once a donor pancreas is located, the patient is prepared for surgery. Since only about 1,000 pancreas transplants are performed each year in the United States, the operation usually occurs at a hospital where surgeons have special expertise in the procedure.

The surgeon makes an incision under the ribs and locates the pancreas and duodenum. The pancreas and duodenum (part of the small intestine) are removed. The new pancreas and duodenum are then connected to the patient's blood vessels.

Replacing the duodenum allows the pancreas to drain into the gastrointestinal system. The transplant can also be done creating a bladder drainage. Bladder drainage makes it easier to monitor organ rejection. Once the new pancreas is in place, the abdomen and skin are closed. This surgery is often done at the same time as kidney transplant surgery.

Preparation

After the patient and doctor have decided on a pancreas transplant, a complete immunological study is done to match the patient to a donor. All body functions are evaluated. The timing of surgery depends on the availability of a donated organ.

Aftercare

Patients receiving a pancreas transplantation are monitored closely for organ rejection, and all vital body functions are monitored also. The average hospital stay is three weeks. It takes about six months to recover from surgery. Patients will take immunosuppressive drugs for the rest of their lives.

KEY TERMS

Duodenum—The section of the small intestine immediately after the stomach.

Risks

Diabetes and poor kidney function greatly increase the risk of complications from anesthesia during surgery. Organ rejection, excessive bleeding, and infection are other major risks associated with this surgery.

Normal results

During a nine year period from 1987 to 1996, the patient survival rate for all types of pancreas transplants (with or without associated kidney transplant) was 92% after one year and 86% after three years. In a successful transplant, the pancreas begins producing insulin, bringing the regulation of glucose back under normal body control. Natural availability of insulin prevents the development of additional damage to the kidneys and blindness associated with diabetes. Many patients report an improved quality of life.

Resources

PERIODICALS

Stratta, R. J. "Vascularized Pancreas Transplantation: The Ultimate Treatment for Insulin Dependent Diabetes." *British Medical Journal* 21 (Sept. 1996): 703-704.

Sutherland, David, and Rainer Gruessner. "Current Status of Pancreas Transplantation for the Treatment of Type I Diabetes Mellitus." *Clinical Diabetes* (July/Aug. 1997): 152-157.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

Tish Davidson

Pancreatectomy

Definition

Pancreatectomy is the surgical removal of the pancreas. Pancreatectomy may be total, in which case the whole organ is removed, or partial, referring to the removal of part of the pancreas.

Purpose

Pancreatectomy is the most effective treatment for **cancer** of the pancreas, an abdominal organ that secretes digestive enzymes, insulin, and other hormones. The thickest part of the pancreas near the duodenum (small intestine) is called the head, the middle part is called the body, and the thinnest part adjacent to the spleen is called the tail.

While surgical removal of tumors in the pancreas is preferred, it is only possible in the 10-15% of patients who are diagnosed early enough for a potential cure. Patients who are considered suitable for surgery usually have small tumors in the head of the pancreas (close to the duodenum, or first part of the small intestine), have **jaundice** as their initial symptom, and have no evidence of metastatic disease (spread of cancer to other sites).

Pancreatectomy is sometimes necessary when the pancreas has been severely injured by trauma, especially injury to the body and tail of the pancreas. While such surgery removes normal pancreatic tissue as well, the long-term consequences of this surgery are minimal, with virtually no effects on the production of insulin, digestive enzymes, and other hormones.

Chronic **pancreatitis** is another condition for which pancreatectomy is occasionally performed. Chronic pancreatitis—or continuing inflammation of the pancreas that results in permanent damage to this organ—can develop from long-standing, recurring episodes of acute (periodic) pancreatitis. This painful condition usually results from alcohol abuse or the presence of **gallstones**. In most patients with alcohol-induced disease, the pancreas is widely involved, therefore, surgical correction is almost impossible.

Precautions

Pancreatectomy is only performed when surgery provides a clear benefit. Patients who have tumors that are obviously not operable should be carefully excluded from consideration.

Description

Pancreatectomy sometimes entails removal of the entire pancreas, called a total pancreatectomy, but more often involves removal of part of the pancreas, which is called a subtotal pancreatectomy, or distal pancreatectomy, when the body and tail of the pancreas are removed. When the duodenum is removed along with all or part of the pancreas, the procedure is called a pancreaticoduodenectomy, which surgeons sometimes refer to as "Whipple's procedure." Pancreaticoduodenectomy is being used increasingly for treatment of a variety of malignant and benign diseases of the pancreas.

Regional lymph nodes are usually removed during pancreaticoduodenectomy. In distal pancreatectomy, the spleen may also be removed.

Preparation

Patients with symptoms of a pancreatic disorder usually undergo a number of tests before surgery is even considered. These can include ultrasonography, x-ray examinations, computed tomography scans (CT scan), and **endoscopic retrograde cholangiopancreatography** (ERCP), an x-ray imaging technique. Tests may also include **angiography**, an x-ray technique for visualizing the arteries feeding the pancreas, and needle aspiration cytology, in which cells are drawn from areas suspected to contain cancer. Such tests aid in the diagnosis of the pancreatic disorder and in the planning of the operation.

Since many patients with pancreatic cancer are undernourished, appropriate nutritional support, sometimes by **tube feedings**, may be required prior to surgery.

Some patients with pancreatic cancer deemed suitable for pancreatectomy will undergo **chemotherapy** and/or **radiation therapy**. This treatment is aimed at shrinking the tumor, which will improve the chances for successful surgical removal. Sometimes, patients who are not initially considered surgical candidates may respond so well to chemoradiation that surgical treatment becomes possible. Radiation therapy may also be applied during the surgery (intraoperatively) to improve the patient's chances of survival, but this treatment is not yet in routine use. Some studies have shown that intraoperative radiation therapy extends survival by several months.

Patients undergoing distal pancreatectomy that involves removal of the spleen may receive preoperative medication to decrease the risk of infection.

Aftercare

Pancreatectomy is major surgery. Therefore, extended hospitalization is usually required. Some studies report an average hospital stay of about two weeks.

Some cancer patients may also receive combined chemotherapy and radiation therapy after surgery. This additional treatment has been clearly shown to enhance survival from pancreatic cancer.

Removal of all or part of the pancreas can lead to a condition called pancreatic insufficiency, in which food cannot be normally processed by the body, and insulin secretion may be inadequate. These conditions can be treated with pancreatic enzyme replacement therapy, to supply digestive enzymes, and insulin injections, to supply insulin.

KEY TERMS

Chemotherapy—A treatment of the cancer with synthetic drugs that destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Computed tomography (CT) scan—A medical procedure where a series of x rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes where pictures of areas inside the body can be created using a magnet linked to a computer.

Pancreas—A large gland located on the back wall of the abdomen, extending from the duodenum (first part of the small intestine) to the spleen. The pancreas produces enzymes essential for digestion, and the hormones insulin and glucagon, which play a role in diabetes.

Pancreaticoduodenectomy—Removal of all or part of the pancreas along with the duodenum. Also known as "Whipple's procedure" or "Whipple's operation".

Pancreatitis—Inflammation of the pancreas, either acute (sudden and episodic) or chronic, usually caused by excessive alcohol intake or gallbladder disease.

Radiation therapy—A treatment using high energy radiation from x-ray machines, cobalt, radium, or other sources.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms or pictures of areas inside the body.

Risks

The mortality rate for pancreatectomy has improved in recent years to 5–10%, depending on the extent of the surgery and the experience of the surgeon. A study of 650 patients at Johns Hopkins Medical Institution, Baltimore, found that only nine patients, or 1.4%, died from complications related to surgery.

There is still, however, a fairly high risk of complications following any form of pancreatectomy. The Johns Hopkins study documented complications in 41% of cases. The most devastating complication is postoperative bleeding, which increases the mortality risk to 20-50%. In cases of postoperative bleeding, the patient may be returned to surgery to find the source of hemorrhage, or may undergo other procedures to stop the bleeding.

One of the most common complications from a pancreaticoduodenectomy is delayed gastric emptying, a condition in which food and liquids are slow to leave the stomach. This complication occurred in 19% of patients in the Johns Hopkins study. To manage this problem, many surgeons insert feeding tubes at the original operation site, through which nutrients can be fed directly into the patient's intestines. This procedure, called enteral **nutrition**, maintains the patient's nutrition if the stomach is slow to recover normal function. Certain medications, called promotility agents, can help move the nutritional contents through the gastrointestinal tract.

The other most common complication is pancreatic anastomotic leak. This is a leak in the connection that the surgeon makes between the remainder of the pancreas and the other structures in the abdomen. Most surgeons handle the potential for this problem by assuring that there will be adequate drainage from the surgical site.

Normal results

Unfortunately, pancreatic cancer is the most lethal form of gastrointestinal malignancy. However, for a highly selective group of patients, pancreatectomy offers a chance for cure, especially when performed by experienced surgeons. The overall five-year survival rate for patients who undergo pancreatectomy for pancreatic cancer is about 10%; patients who undergo pancreaticoduodenectomy have a 4–5% survival at five years. The risk for tumor recurrence is thought to be unaffected by whether the patient undergoes a total pancreatectomy or a pancreaticoduodenectomy, but is increased when the tumor is larger than 3 cm and the cancer has spread to the lymph nodes or surrounding tissue.

After total pancreatectomy, the body loses the ability to secrete insulin, enzymes, and other substances, therefore, certain medications will be required to compensate for this. In some cases of pancreatic disease, the pancreas ceases to function normally, then total pancreatectomy may be preferable to other less radical forms of the operation.

When pancreatectomy is performed for chronic pancreatitis, the majority of patients obtain some relief from **pain**. Some studies report that one half to three quarters of patients become free of pain.

Resources

BOOKS

Bastidas, J. Augusto, and John E. Niederhuber. "The Pancreas." In *Fundamentals of Surgery*, ed. John E. Niederhuber. Stamford: Appleton & Lange, 1998.

Mayer, Robert J. "Pancreatic Cancer." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Yeo, C. J., et al. "Six Hundred Fifty Consecutive Pancreaticoduodenectomies in the 1990s: Pathology, Complications, and Outcomes." *Annals of Surgery 226* (Sept. 1997): 248-257.

Caroline A. Helwick

Pancreatic cancer, endocrine

Definition

Endocrine pancreatic cancer is a disease in which cancerous cells originate within the tissues of the pancreas that produce hormones.

Description

The pancreas is a 6–8 in (15–20 cm) long, slipper-shaped gland located in the abdomen. It lies behind the stomach, within a loop formed by the small intestine. Other nearby organs include the gallbladder, spleen, and liver. The pancreas has a wide end (head), a narrow end (tail), and a middle section (body). A healthy pancreas is important for normal food digestion and plays a critical role in the body's metabolic processes. The pancreas has two main functions, each performed by distinct types of tissue. The exocrine tissue secretes fluids into the other organs of the digestive system, while the endocrine tissue secretes substances that are circulated in the bloodstream. The exocrine pancreas makes up the vast majority of the gland; it produces pancreatic juices containing enzymes that help break down proteins and fatty food. The endocrine tissue of the pancreas makes up only 2% of the gland's total mass. It consists of small patches of cells that produce hormones (like insulin) that control how the body stores and uses nutrients. These patches are called islets (islands) of Langerhans or islet cells and are interspersed evenly throughout the pancreas. Each islet contains approximately 1,000 endocrine cells and a dense network of capillaries (tiny blood vessels), which allows immediate entry of hormones into the circulatory system.

Pancreatic tumors are classified as either exocrine or endocrine tumors depending on which type of tissue they arise from within the gland. Endocrine tumors of the pancreas are very rare, accounting for only 5% of all pancreatic cancers. The majority of endocrine pancreatic tumors are functional adenocarcinomas that overproduce a specific hormone. There are several types of islet cells and each produces its own hormone or peptide (small protein molecule). Functional endocrine tumors are named after the hormone they secrete. Insulinoma is the most common tumor of the endocrine pancreas. Patients with this disease usually develop hypoglycemia due to increased insulin production that leads to abnormally low blood sugar levels. Gastrinoma, a disease in which gastrin (hormone that stimulates stomach acid production) is overproduced, causes multiple ulcers in the upper gastrointestinal (GI) tract. Gastrinoma was first described in patients with a rare form of severe peptic ulcer disease known as Zollinger-Ellison syndrome (ZES). The less common glucagonoma causes mild diabetes due to excess glucagon (hormone that stimulates glucose production) secretion. Other rare islet cell tumors include vipoma (vasoactive intestinal peptide) and somatostatinoma. Nonfunctional pancreatic endocrine tumors are not associated with an excess production of any hormone and can be difficult to distinguish from exocrine pancreatic cancer. Cancers of the endocrine pancreas are relatively slow-growing compared to the more common ductal adenocarcinomas of the exocrine pancreas.

Between one and four cases of insulinoma occur per million people per year, and 90% of these tumors are benign. They occur mostly between the ages of 50 and 60 and affect men and women equally. Less than three cases of gastrinoma per million people are diagnosed each year, but it is the most common functional islet cell tumor in patients with multiple endocrine tumors, a condition known as multiple endocrine neoplasia (MEN) syndrome. Vipoma and glucagonoma are even rarer and they occur more frequently in women. Somatostatinoma is exceedingly uncommon, and less than 100 cases have been reported worldwide. Nonfunctional islet cell cancers account for approximately one-third of all cancers of the endocrine pancreas, and the majority of these are malignant.

Causes and symptoms

There are no known causes of islet cell cancer, but a small percentage of cases occur due to hereditary syndromes such as MEN. This is a condition that frequently

causes more than one tumor in several endocrine glands, such as the parathyroid and pituitary, in addition to the islet cells of the pancreas. Twenty-five percent of gastrinomas and less than 10% of insulinomas occur in MEN patients. Von Hippel-Lindau (VHL) syndrome is another genetic disorder that causes multiple tumors, and 10–15% of VHL patients will develop islet cell cancer.

Symptoms vary among the different islet cell cancer types. Insulinoma causes repeated episodes of hypoglycemia, sweating, and tremors, while patients with gastrinoma have inflammation of the esophagus, epigastric pain, multiple ulcers, and possibly diarrhea. Symptoms of glucagonoma include a distinctive skin rash, inflammation of the stomach, glucose intolerance, weight loss, weakness, and anemia (less common). Patients with vipoma have episodes of profuse, watery diarrhea, even after fasting. Somatostatinoma causes mild diabetes, diarrhea/steatorrhea (fatty stools), weight loss, and gallbladder disease. Nonfunctional endocrine tumors frequently produce the same symptoms as cancer of the exocrine pancreas such as abdominal pain, jaundice, and weight loss.

Diagnosis

A thorough physical exam is usually performed when a patient presents with the above symptoms, however, functional endocrine tumors of the pancreas tend to be small and are not detected by palpating the abdomen. Once other illnesses such as infection are ruled out, the doctor will order a series of blood and urine tests. The functional endocrine tumors can be identified through increased levels of hormone in the bloodstream.

Functional endocrine tumors can occur in multiple sites in the pancreas and are often small (less than 1 cm), making them difficult to diagnose. Nonfunctional tumors tend to be larger, which makes them difficult to distinguish from tumors of the exocrine pancreas. Methods such as computed tomography (CT) scan and magnetic resonance imaging (MRI) are used to take pictures of the internal organs and allow the doctor to determine whether a tumor is present. Somatostatin receptor scintigraphy (trade name OctreoScan) is an imaging system used to localize endocrine tumors, especially gastrinomas and somatostatinomas. Endoscopic ultrasound (EUS) is a more sensitive technique that may be used if a CT scan fails to detect a tumor. Endocrine tumors usually have many blood vessels, so angiography may be useful in the doctor's assessment and staging of the tumor. Surgical exploration is sometimes necessary in order to locate very small tumors that occur in multiple sites. These techniques also help the doctor evaluate how far the tumor has spread. A biopsy can be taken to confirm diagnosis, but more often, doctors look at the size and local invasion of the tumor in order to plan a treatment strategy.

Treatment

Staging

The staging system for islet cell cancer is still evolving, but the tumors typically fall into three categories: cancers that arise in one location within the pancreas, cancers that arise in several locations within the pancreas, and cancers that have spread to nearby lymph nodes or to other organs in the body.

Surgery is the only curative method for islet cell cancers, and studies have shown that an aggressive surgical approach can improve survival and alleviate symptoms of the disease. As with most forms of cancer, the earlier it is diagnosed, the greater the chance for survival. With the exception of insulinoma, the majority of islet cell tumors are malignant at the time of diagnosis, and more than half are metastatic. However, surgery and chemotherapy have been shown to improve the outcome of patients even if they have metastatic disease. Surgery may include partial or total removal of the pancreas, and in patients with gastrinoma, the stomach may be removed as well. Streptozotocin, doxorubicin, and 5-fluorouracil (5-FU) are chemotherapeutic agents commonly used in the treatment of islet cell cancer. Patients may experience nausea and vomiting as well as kidney toxicity from streptozotocin, and bone marrow suppression from doxorubicin. Hormone therapy is used to relieve the symptoms of functional tumors by inhibiting excess hormone production. Other techniques may be used to block blood flow to the liver in an attempt to kill the cancer cells that have spread there. Abdominal pain, nausea, vomiting and fever may result from this type of treatment. Radiation has little if any role in the treatment of islet cell cancer.

Prognosis

Islet cell cancers overall have a more favorable prognosis than cancers of the exocrine pancreas, and the median survival from diagnosis is three and a half years. This is mainly due to their slow-growing nature. Insulinomas have a five-year survival rate of 80% and gastrinomas have 65%. When malignant, islet cell cancers do not generally respond well to chemotherapy, and the treatment is mainly palliative. Most patients with metastasis do not survive five years. Islet cell cancer tends to spread to the surrounding lymph nodes, stomach, small intestine, and liver.

Prevention

There are no known risk factors associated with sporadic islet cell cancer. Therefore, it is not clear how to prevent its occurrence. Individuals with MEN syndrome or VHL, however, have a genetic predisposition to devel-

KEY TERMS

Adenocarcinoma—A malignant tumor that arises within the tissues of a gland and retains its glandular structure.

Angiography—Diagnostic technique used to study blood vessels in a tumor.

Biopsy—Removal and microscopic examination of cells to determine whether they are cancerous.

Chemotherapy— Drug treatment administered to kill cancerous cells.

Endocrine—Refers to glands that secrete hormones circulated in the bloodstream.

Endoscopic ultrasonography (EUS)—Diagnostic imaging technique where an ultrasound probe is inserted down a patient's throat to determine if a tumor is present.

Gastrinoma—Tumor that arises from the gastrin-producing cells in the pancreas.

Insulinoma—Tumor that arises from the insulin-producing cells in the pancreas.

Islets of Langerhans—Clusters of cells in the pancreas that make up the endocrine tissue.

oping islet cell cancer and should be screened regularly in an effort to catch the disease early.

Resources

BOOKS

Beger, Hans G., et al., ed. *The Pancreas*. Oxford: Blackwell Science Ltd., 1998.

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy.* Kansas City: Andrews McMeel, 1997.

Neoptolemos, John P., and Nicholas R. Lemoine. *Pancreatic Cancer: Molecular and Clinical Advances*. Oxford: Blackwell Science Ltd., 1996.

PERIODICALS

Anderson, M.A., et. al. "Endoscopic Ultrasound is Highly Accurate and Directs Management of Patients With Neuroendocrine Tumors of the Pancreas." *American Journal of Gastroenterology* 95, no. 9 (September 2000): 2271–7.

Hellman, Per, et. al. "Surgical Strategy for Large or Malignant Endocrine Pancreatic Tumors." *World Journal of Surgery* 24 (2000): 1353–60.

ORGANIZATIONS

National Cancer Institute. 9000 Rockville Pike, Bldg.31, Rm. 10A16, Bethesda, MD, 20892 (800) 422-6237. <http://www.nci.nih.gov>.

National Familial Pancreas Tumor Registry. The Johns Hopkins Hospital. 600 North Wolfe St., Baltimore, MD 21287-6417. (410) 377-7450.

National Organization for Rare Disorders. 100 Route 37, PO Box 8923. New Fairfield, CT 06812. (203) 746-6518. <http://www.nord-rdb.com/~orphan>.

OTHER

"Islet Cell Carcinoma." *CancerNet PDQ* May 2001. 19 July 2001 <http://www.cancernet.nci.nih.gov>.

Pancreatic Cancer Home Page Johns Hopkins Medical Institutions. 19 July 2001 <http://www.path.jhu.edu/pancreas>.

Elizabeth Pulcini, M.Sc.

Pancreatic cancer, exocrine

Definition

Exocrine pancreatic cancer is a disease in which cancerous cells originate within the tissues of the pancreas that produce digestive juices.

Description

The pancreas is a 6–8 in (15–20 cm) long, slipper-shaped gland located in the abdomen. It lies behind the stomach, within a loop formed by the small intestine. Other nearby organs include the gallbladder, spleen, and liver. The pancreas has a wide end (head), a narrow end (tail), and a middle section (body). A healthy pancreas is important for normal food digestion and also plays a critical role in the body's metabolic processes. The pancreas has two main functions, and each are performed by distinct types of tissue. The exocrine tissue makes up the vast majority of the gland and secretes fluids into the other organs of the digestive system. The endocrine tissue secretes hormones (like insulin) that are circulated in the bloodstream, and these substances control how the body stores and uses nutrients. The exocrine tissue of the pancreas, comprised mostly of acinar cells and ductal cells, produces pancreatic (digestive) juices. These juices contain several enzymes that help break down proteins and fatty foods. The exocrine pancreas forms an intricate system of channels or ducts, which are tubular structures that carry pancreatic juices to the small intestine where they are used for digestion.

Pancreatic tumors are classified as either exocrine or endocrine tumors depending on which type of tissue they arise from within the gland. Ninety-five percent of pancreatic cancers occur in the tissues of the exocrine pancreas. Ductal adenocarcinomas arise in the cells that line the ducts of the exocrine pancreas and account for 80% to

90% of all tumors of the pancreas. Unless specified, nearly all reports on pancreatic cancer refer to ductal adenocarcinomas. Less common types of pancreatic exocrine tumors include acinar cell carcinoma, cystic tumors that are typically benign but may become cancerous, and papillary tumors that grow within the pancreatic ducts. Pancreatoblastoma is a very rare disease that primarily affects young children. Two-thirds of pancreatic tumors occur in the head of the pancreas, and tumor growth in this area can lead to the obstruction of the nearby common bile duct that empties bile fluid into the small intestine. When bile cannot be passed into the intestine, patients may develop yellowing of the skin and eyes (jaundice) due to the buildup of bilirubin (a component of bile) in the bloodstream. Tumor blockage of bile or pancreatic ducts may also cause digestive problems since these fluids contain critical enzymes in the digestive process. Depending on their size, pancreatic tumors may cause abdominal pain by pressing on the surrounding nerves. Because of its location deep within the abdomen, pancreatic cancer often remains undetected until it has spread to other organs such as the liver or lung. Pancreatic cancer tends to rapidly spread to other organs, even when the primary (original) tumor is relatively small.

Though pancreatic cancer accounts for only 3% of all cancers, it is the fifth most frequent cause of cancer deaths. In 2001, an estimated 29,200 new cases of pancreatic cancer will be diagnosed in the United States. Pancreatic cancer is primarily a disease associated with advanced age, with 80% of cases occurring between the ages of 60 and 80. Men are almost twice as likely to develop this disease than women. Countries with the highest frequencies of pancreatic cancer include the United States, New Zealand, Western European nations, and Scandinavia. The lowest occurrences of the disease are reported in India, Kuwait, and Singapore. African-Americans have the highest incidence of pancreatic cancer of any ethnic group worldwide. Whether this difference is due to diet or environmental factors remains unclear.

Causes and symptoms

Although the exact cause for pancreatic cancer is not known, several risk factors have been shown to increase susceptibility to this particular cancer, the greatest of which is cigarette smoking. Approximately one-third of pancreatic cancer cases occur among smokers. People who have diabetes develop pancreatic cancer twice as often as non-diabetics. Numerous studies suggest that a family history of pancreatic cancer is another strong risk factor for developing the disease, particularly if two or more relatives in the immediate family have the disease. Other risk factors include chronic (long-term) inflammation of the pancreas (pancreatitis), diets high in fat, and occupational exposure to certain chemicals such as petroleum.

Pancreatic cancer often does not produce symptoms until it reaches an advanced stage. Patients may then present with the following signs and symptoms:

- upper abdominal and/or back pain
- jaundice
- weight loss
- loss of appetite
- diarrhea
- weakness
- nausea

These symptoms may also be caused by other illnesses; therefore, it is important to consult a doctor for an accurate diagnosis.

Diagnosis

Pancreatic cancer is difficult to diagnose, especially in the absence of symptoms, and there is no current screening method for early detection. The most sophisticated techniques available often do not detect very small tumors that are localized (have not begun to spread). At advanced stages where patients show symptoms, a number of tests may be performed to confirm diagnosis and to assess the stage of the disease. Approximately half of all pancreatic cancers are metastatic (have spread to other sites) at the time of diagnosis.

The first step in diagnosing pancreatic cancer is a thorough medical history and complete physical examination. The abdomen will be palpated to check for fluid accumulation, lumps, or masses. If there are signs of jaundice, blood tests will be performed to rule out the possibility of liver diseases such as hepatitis. Urine and stool tests may be performed as well.

Non-invasive imaging tools such as computed tomography (CT) scans and magnetic resonance imaging (MRI) can be used to produce detailed pictures of the internal organs. CT is the tool most often used to diagnose pancreatic cancer, as it allows the doctor to determine if the tumor can be removed by surgery or not. It is also useful in staging a tumor by showing the extent to which the tumor has spread. During a CT scan, patients receive an intravenous injection of a contrast dye so the organs can be visualized more clearly. MRI may be performed instead of CT if a patient has an allergy to the CT contrast dye. In some cases where the tumor is impinging on blood vessels or nearby ducts, MRI may be used to generate an image of the pancreatic ducts.

If the doctor suspects pancreatic cancer and no visible masses are seen with a CT scan, a patient may under-

KEY TERMS

Acinar cell carcinoma—A malignant tumor arising from the acinar cells of the pancreas.

Angiography—Diagnostic technique used to study blood vessels in a tumor.

Biopsy—Removal and microscopic examination of cells to determine whether they are cancerous.

Cancer vaccines—A treatment that uses the patient's immune system to attack cancer cells.

Chemotherapy—Drug treatment administered to kill cancerous cells.

Ductal adenocarcinoma—A malignant tumor arising from the duct cells within a gland.

Endoscopic retrograde cholangiopancreatography (ERCP)—Diagnostic technique used to obtain a biopsy. Also a surgical method of relieving biliary obstruction caused by a tumor.

Endoscopic ultrasonography (EUS)—Diagnostic imaging technique in which an ultrasound probe is inserted down a patient's throat to determine if a tumor is present.

Exocrine—Refers to glands which secrete their products through a duct.

Laparoscopic surgery—Minimally invasive surgery in which a camera and surgical instruments are inserted through a small incision.

Pancreatectomy—Partial or total surgical removal of the pancreas.

Radiation therapy—Use of radioisotopes to kill tumor cells. Applied externally through a beam of x rays, intraoperatively (during surgery), or deposited internally by implanting radioactive seeds in tumor tissue.

Whipple procedure—Surgical removal of the head of the pancreas, part of the small intestine, and some surrounding tissue.

go a combination of invasive tests to confirm the presence of a pancreatic tumor. Endoscopic ultrasound (EUS) involves the use of an ultrasound probe at the end of a long, flexible tube that is passed down the patient's throat and into the stomach. This instrument can detect a tumor mass through high frequency sound waves and echoes. EUS can be accompanied by fine needle aspiration (FNA), where a long needle, guided by the ultrasound, is inserted into the tumor mass in order to take a biopsy sample. Endoscopic retrograde cholangiopancreatography (ERCP) is a technique often used in patients with severe jaundice because it enables the doctor to relieve blockage of the pancreatic ducts. The doctor, guided by endoscopy and x rays, inserts a small metal or plastic stent into the duct to keep it open. During ERCP, a biopsy can be done by collecting cells from the pancreas with a small brush. The cells are then examined under the microscope by a pathologist, who determines the presence of any cancerous cells.

In some cases, a biopsy may be performed during a type of surgery called laparoscopy, which is done under general anesthesia. Doctors insert a small camera and instruments into the abdomen after a minor incision is made. Tissue samples are removed for examination under the microscope. This procedure allows a doctor to determine the extent to which the disease has spread and decide if the tumor can be removed by further surgery.

An angiography is a type of test that studies the blood vessels in and around the pancreas. This test may be done before surgery so that the doctor can determine the extent to which the tumor invades and interacts with the blood vessels within the pancreas. The test requires local anesthesia and a catheter is inserted into the patient's upper thigh. A dye is then injected into blood vessels that lead into the pancreas, and x rays are taken.

As of April 2001, doctors at major cancer research institutions such as Memorial Sloan-Kettering Cancer Center in New York are investigating CT angiography, an imaging technique that is less invasive than angiography alone. CT angiography is similar to a standard CT scan, but allows doctors to take a series of pictures of the blood vessels that support tumor growth. A dye is injected as in a CT scan (but at rapid intervals) and no catheter or sedation is required. A computer generates 3D images from the pictures that are taken, and the information is gathered by the surgical team who will develop an appropriate strategy if the patient's disease can be operated on.

Treatment

Staging

After cancer of the pancreas has been diagnosed, doctors typically use a TNM staging system to classify the tumor based on its size and the degree to which it has

spread to other areas in the body. T indicates the size and local advancement of the primary tumor. Since cancers often invade the lymphatic system before spreading to other organs, regional lymph node involvement (N) is an important factor in staging. M indicates whether the tumor has metastasized (spread) to distant organs. In stage I, the tumor is localized to the pancreas and has not spread to surrounding lymph nodes or other organs. Stage II pancreatic cancer has spread to nearby organs such as the small intestine or bile duct, but not the surrounding lymph nodes. Stage III indicates lymph node involvement, whether the cancer has spread to nearby organs or not. Stage IVA pancreatic cancer has spread to organs near the pancreas such as the stomach, spleen, or colon. Stage IVB is a cancer that has spread to distant sites (liver, lung). If pancreatic cancer has been treated with success and then appears again in the pancreas or in other organs, it is referred to as recurrent disease.

Treatment of pancreatic cancer will depend on several factors, including the stage of the disease and the patient's age and overall health status. A combination of therapies is often employed in the treatment of this disease to improve the patient's chances for survival. Surgery is used whenever possible and is the only means by which cancer of the pancreas can be cured. However, less than 15% of pancreatic tumors can be removed by surgery. By the time the disease is diagnosed (usually at stage III), therapies such as radiation and chemotherapy or both are used in addition to surgery to relieve a patient's symptoms and enhance quality of life. For patients with metastatic disease, chemotherapy and radiation are used mainly as palliative (pain alleviating) treatments.

Surgery

Three types of surgery are used in the treatment of pancreatic cancer, depending on what section of the pancreas the tumor is located in. A Whipple procedure removes the head of the pancreas, part of the small intestine and some of the surrounding tissues. This procedure is most common since the majority of pancreatic cancers occur in the head of the organ. A total pancreatectomy removes the entire pancreas and the organs around it. Distal pancreatectomy removes only the body and tail of the pancreas. Chemotherapy and radiation may precede surgery (neoadjuvant therapy) or follow surgery (adjuvant therapy). Surgery is also used to relieve symptoms of pancreatic cancer by draining fluids or bypassing obstructions. Side effects from surgery can include pain, weakness, fatigue, and digestive problems. Some patients may develop diabetes or malabsorption as a result of partial or total removal of the pancreas.

Radiation therapy

Radiation therapy is sometimes used to shrink a tumor before surgery or to remove remaining cancer cells after surgery. Radiation may also be used to relieve pain or digestive problems caused by the tumor if it cannot be removed by surgery. External radiation therapy refers to radiation applied externally to the abdomen using a beam of high-energy x rays. High-dose intraoperative radiation therapy is sometimes used during surgery on tumors that have spread to nearby organs. Internal radiation therapy refers to the use of small radioactive seeds implanted in the tumor tissue. The seeds emit radiation over a period of time to kill tumor cells. Radiation treatment may cause side effects such as fatigue, tender or itchy skin, nausea, vomiting, and digestive problems.

Chemotherapy

Chemotherapeutic agents are powerful drugs that are used to kill cancer cells. They are classified according to the mechanism by which they induce cancer cell death. Multiple agents are often used to increase the chances of tumor cell death. Gemcitabine is the standard drug used to treat pancreatic cancers and can be used alone or in combination with other drugs, such as 5-flourouracil (5-FU). Other drugs are being tested in combination with gemcitabine in several ongoing clinical trials, specifically irinotecan (CPT-11) and oxaliplatin. Chemotherapy may be administered orally or intravenously in a series of doses over several weeks. During treatment, patients may experience fatigue, nausea, vomiting, hair loss, and mouth sores, depending on which drugs are used.

Biological treatments

Numerous vaccine treatments are being developed in an effort to stimulate the body's immune system into attacking cancer cells. This is also referred to as immunotherapy. Another type of biological treatment involves using a targeted monoclonal antibody to inhibit the growth of cancer cells. The antibody is thought to bind to and neutralize a protein that contributes to the growth of the cancer cells. Investigational treatments such as these may be considered by patients with metastatic disease who would like to participate in a clinical trial. Biological treatments typically cause flu-like symptoms (chills, fever, loss of appetite) during the treatment period.

Alternative treatment

Acupuncture or hypnotherapy may be used in addition to standard therapies to help relieve the pain associated with pancreatic cancer. Because of the poor prognosis associated with pancreatic cancer, some patients may

try special diets with vitamin supplements, certain exercise programs, or unconventional treatments not yet approved by the FDA. Patients should always inform their doctors of any alternative treatments they are using as they could interfere with standard therapies. As of the year 2000, the National Cancer Institute (NCI) is funding phase III clinical trials of a controversial treatment for pancreatic cancer that involves the use of supplemental pancreatic enzymes (to digest cancerous cells) and coffee enemas (to stimulate the liver to detoxify the cancer). These theories remain unproven and the study is widely criticized in the medical community. It remains to been seen whether this method of treatment has any advantage over the standard chemotherapeutic regimen in prolonging patient survival or improving quality of life.

Prognosis

Unfortunately, cancer of the pancreas is often fatal, and median survival from diagnosis is less than six months, while the five-year survival rate is 4%. This is mainly due to the lack of screening methods available for early detection of the disease. Yet, even when localized tumors can be removed by surgery, patient survival after five years is only 10% to 15%. These statistics demonstrate the aggressive nature of most pancreatic cancers and their tendency to recur. Pancreatic cancers tend to be resistant to radiation and chemotherapy and these modes of treatment are mainly used to relieve pain and tumor burden.

Prevention

Although the exact cause of pancreatic cancer is not known, there are certain risk factors that may increase a person's chances of developing the disease. Quitting smoking will certainly reduce the risk for pancreatic cancer and many other cancers. The American Cancer Society recommends a diet rich in fruits, vegetables, and dietary fiber in order to reduce the risk of pancreatic cancer. According to the NCI, workers who are exposed to petroleum and other chemicals may be at greater risk for developing the disease and should follow their employer's safety precautions. People with a family history of pancreatic cancer are at greater risk than the general population, as a small percentage of pancreatic cancers are considered hereditary.

Resources

BOOKS

Beger, Hans G., et al., ed. *The Pancreas*. 2 vols. Oxford: Blackwell Science Ltd., 1998.

Reber, Howard A., ed. *Pancreatic Cancer: Pathogenesis, Diagnosis, and Treatment*. Totowa: Humana Press, 1998.

Teeley, Peter, and Philip Bashe. *The Complete Cancer Survival Guide*. New York: Doubleday, 2000.

PERIODICALS

Bornman, P. C., and I. J. Beckingham. "ABC of Diseases of Liver, Pancreas, and Biliary System. Pancreatic Tumours." *British Medical Journal* 322, no. 7288 (24 March 2001): 721–3.

Haut, E., A. Abbas, and A. Schuricht. "Pancreatic Cancer: The Role of the Primary Care Physican." *Consultant* 39, no. 12 (December 1999): 3329.

Parks, R. W., and O. J. Garden. "Ensuring Early Diagnosis in Pancreatic Cancer." *Practitioner* 244, no. 1609 (April 2000): 336–8, 340–1, 343.

ORGANIZATIONS

CancerNet. National Cancer Institute, 9000 Rockville Pike, Bldg.31, Rm.10A16, Bethesda, Maryland, 20892. (800) 422-6237. <http://wwwicic.nci.nih.gov>.

Hirshberg Foundation for Pancreatic Cancer Research. 375 Homewood Rd., Los Angeles, CA 90049. (310) 472-6310. <http://www.pancreatic.org>.

National Pancreas Foundation. PO Box 935, Wexford, PA 15090-0935. <http://www.pancreasfoundation.org>.

Pancreatic Cancer Action Network. PO Box 1010, Torrance, CA 90505. (877) 272-6226. <http://www.pancan.org>.

OTHER

Johns Hopkins Medical Institutions. 20 July 2001 <http://www.path.jhu.edu/pancreas>.

Memorial Sloan-Kettering Cancer Center. Patient Information on Pancreatic Cancer. 20 July 2001 <http://www.mskcc.org/patients_n_public/about_cancer_and_treatment/cancer_information_by_type/pancreatic_cancer/index.html>.

University of Texas MD Anderson Cancer Center. Pancreatic Tumor Study Group. 20 July 2001 <http://www.mdanderson.org/DEPARTMENTS/pancreatic/>.

"What You Need To Know About Cancer of the Pancreas." National Cancer Institute. December 12, 2000. 20 July 2001 <http://cancernet.nci.nih.gov/wyntk_pubs/pancreas.htm>.

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Pancreatitis

Definition

Pancreatitis is an inflammation of the pancreas, an organ that is important in digestion. Pancreatitis can be acute (beginning suddenly, usually with the patient recovering fully) or chronic (progressing slowly with continued, permanent injury to the pancreas).

Description

The pancreas is located in the midline of the back of the abdomen, closely associated with the liver, stomach, and duodenum (the first part of the small intestine). The

pancreas is considered a gland. A gland is an organ whose primary function is to produce chemicals that pass either into the main blood circulation (called an endocrine function), or pass into another organ (called an exocrine function). The pancreas is unusual because it has both endocrine and exocrine functions. Its endocrine function produces three hormones. Two of these hormones, insulin and glucagon, are central to the processing of sugars in the diet (carbohydrate metabolism or breakdown). The third hormone produced by the endocrine cells of the pancreas affects gastrointestinal functioning. This hormone is called vasoactive intestinal polypeptide (VIP). The pancreas' exocrine function produces a variety of digestive enzymes (trypsin, chymotrypsin, lipase, and amylase, among others). These enzymes are passed into the duodenum through a channel called the pancreatic duct. In the duodenum, the enzymes begin the process of breaking down a variety of food components, including, proteins, fats, and starches.

Acute pancreatitis occurs when the pancreas suddenly becomes inflamed but improves. Patients recover fully from the disease, and in almost 90% of cases the symptoms disappear within about a week after treatment. The pancreas returns to its normal architecture and functioning after healing from the illness. After an attack of acute pancreatitis, tissue and cells of the pancreas return to normal. With chronic pancreatitis, damage to the pancreas occurs slowly over time. Symptoms may be persistent or sporadic, but the condition does not disappear and the pancreas is permanently impaired. Pancreatic tissue is damaged, and the tissue and cells function poorly.

Causes and symptoms

There are a number of causes of acute pancreatitis. The most common, however, are gallbladder disease and **alcoholism**. These two diseases are responsible for more than 80% of all hospitalizations for acute pancreatitis. Other factors in the development of pancreatitis include:

- certain drugs
- infections
- structural problems of the pancreatic duct and bile ducts (channels leading from the gallbladder to the duodenum)
- injury to the abdomen resulting in injury to the pancreas (including injuries occurring during surgery)
- abnormally high levels of circulating fats in the bloodstream
- malfunction of the parathyroid gland, with high blood levels of calcium
- complications from kidney transplants
- a hereditary tendency toward pancreatitis

Pancreatitis caused by drugs accounts for about 5% of all cases. Some drugs that are definitely related to pancreatitis include:

- azathioprine, 6-mercaptopurine (Imuran)
- dideoxyinosine (Videx)
- estrogens (birth control pills)
- furosemide (Lasix)
- pentamidine (NebuPent)
- sulfonamides (Urobak, Azulfidine)
- tetracycline
- thiazide **diuretics** (Diuril, Enduron)
- valproic acid (Depakote)

Some drugs that are probably related to pancreatitis include:

- acetaminophen (Tylenol)
- angiotensin-converting enzyme (ACE) inhibitors (Capoten, Vasotec)
- erythromycin
- methyldopa (Aldomet)
- metronidazole (Flagyl, Protostat)
- nitrofurantoin (Furadantin, Furan)
- nonsteroidal anti-inflammatory drugs (NSAIDs) (Aleve, Naprosyn, Motrin)
- salicylates (aspirin)

All of these causes of pancreatitis seem to have a similar mechanism in common. Under normal circumstances, many of the extremely potent enzymes produced by the pancreas are not active until they are passed into the duodenum, where contact with certain other chemicals allow them to function. In pancreatitis, something allows these enzymes to become prematurely activated, so that they actually begin their digestive functions within the pancreas. The pancreas, in essence, begins digesting itself. A cycle of inflammation begins, including swelling and loss of function. Digestion of the blood vessels in the pancreas results in bleeding. Other active pancreatic chemicals cause blood vessels to become leaky, and fluid begins leaking out of the normal circulation into the abdominal cavity. The activated enzymes also gain access to the bloodstream through leaky, eroded blood vessels, and begin circulating throughout the body.

Pain is a major symptom in pancreatitis. The pain is usually quite intense and steady, located in the upper right hand corner of the abdomen, and often described as "boring." This pain is also often felt all the way through to the patient's back. The patient's breathing may

become quite shallow because deeper breathing tends to cause more pain. Relief of pain by sitting up and bending forward is characteristic of pancreatic pain. **Nausea and vomiting**, and abdominal swelling are all common as well. A patient will often have a slight **fever**, with an increased heart rate and low blood pressure.

Classic signs of **shock** may appear in more severely ill patients. Shock is a very serious syndrome that occurs when the volume (quantity) of fluid in the blood is very low. In shock, a patient's arms and legs become extremely cold, the blood pressure drops dangerously low, the heart rate is quite fast, and the patient may begin to experience changes in mental status.

In very severe cases of pancreatitis (called necrotizing pancreatitis), the pancreatic tissue begins to die, and bleeding increases. Due to the bleeding into the abdomen, two distinctive signs may be noted in patients with necrotizing pancreatitis. Turner's sign is a reddish-purple or greenish-brown color to the flank area (the area between the ribs and the hip bone). Cullen's sign is a bluish color around the navel.

Some of the complications of pancreatitis are due to shock. When shock occurs, all of the body's major organs are deprived of blood (and, therefore, oxygen), resulting in damage. Kidney, respiratory, and **heart failure** are serious risks of shock. The pancreatic enzymes that have begun circulating throughout the body (as well as various poisons created by the abnormal digestion of the pancreas by those enzymes) have severe effects on the major body systems. Any number of complications can occur, including damage to the heart, lungs, kidneys, lining of the gastrointestinal tract, liver, eyes, bones, and skin. As the pancreatic enzymes work on blood vessels surrounding the pancreas, and even blood vessels located at a distance, the risk of blood clots increases. These blood clots complicate the situation by blocking blood flow in the vessels. When blood flow is blocked, the supply of oxygen is decreased to various organs and the organ can be damaged.

The pancreas may develop additional problems, even after the pancreatitis decreases. When the entire organ becomes swollen and suffers extensive cell death (pancreatic necrosis), the pancreas becomes extremely susceptible to serious infection. A local collection of pus (called a pancreatic **abscess**) may develop several weeks after the illness subsides, and may result in increased fever and a return of pain. Another late complication of pancreatitis, occurring several weeks after the illness begins, is called a pancreatic pseudocyst. This occurs when dead pancreatic tissue, blood, white blood cells, enzymes, and fluid leaked from the circulatory system accumulate. In an attempt to enclose and organize this abnormal accumulation, a kind of wall forms from the dead tissue and the growing scar tissue in the area. Pseudocysts cause additional abdominal pain by putting pressure on and displacing pancreatic tissue (resulting in more pancreatic damage). Pseudocysts also press on other nearby structures in the gastrointestinal tract, causing more disruption of function. Pseudocysts are life-threatening when they become infected (abscess) and when they rupture. Simple rupture of a pseudocyst causes death 14% of the time. Rupture complicated by bleeding causes death 60% of the time.

As the pancreatic tissue is increasingly destroyed in chronic pancreatitis, many digestive functions become disturbed. The quantity of hormones and enzymes normally produced by the pancreas begins to seriously decrease. Decreases in the production of enzymes result in the inability to appropriately digest food. Fat digestion, in particular, is impaired. A patient's stools become greasy as fats are passed out of the body. The inability to digest and use proteins results in smaller muscles (wasting) and weakness. The inability to digest and use the nutrients in food leads to **malnutrition**, and a generally weakened condition. As the disease progresses, permanent injury to the pancreas can lead to diabetes.

Diagnosis

Diagnosis of pancreatitis can be made very early in the disease by noting high levels of pancreatic enzymes circulating in the blood (amylase and lipase). Later in the disease, and in chronic pancreatitis, these enzyme levels will no longer be elevated. Because of this fact, and because increased amylase and lipase can also occur in other diseases, the discovery of such elevations are helpful but not mandatory in the diagnosis of pancreatitis. Other abnormalities in the blood may also point to pancreatitis, including increased white blood cells (occurring with inflammation and/or infection), changes due to **dehydration** from fluid loss, and abnormalities in the blood concentration of calcium, magnesium, sodium, potassium, bicarbonate, and sugars.

X rays or ultrasound examination of the abdomen may reveal **gallstones**, perhaps responsible for blocking the pancreatic duct. The gastrointestinal tract will show signs of inactivity (**ileus**) due to the presence of pancreatitis. Chest x rays may reveal abnormalities due to air trapping from shallow breathing, or due to lung complications from the circulating pancreatic enzyme irritants. **Computed tomography scans** (CT scans) of the abdomen may reveal the inflammation and fluid accumulation of pancreatitis, and may also be useful when complications like an abscess or a pseudocyst are suspected.

In the case of chronic pancreatitis, a number of blood tests will reveal the loss of pancreatic function that

KEY TERMS

Abscess—A pocket of infection; pus.

Acute—Of short and sharp course. Illnesses that are acute appear quickly and can be serious or life-threatening. The illness ends and the patient usually recovers fully.

Chronic—Of long duration and slow progression. Illnesses that are chronic develop slowly over time, and do not end. Symptoms may be continual or intermittent, but the patient usually has the condition for life.

Diabetes—A disease characterized by an inability to process sugars in the diet, due to a decrease in or total absence of insulin production. May require injections of insulin before meals to aid in the metabolism of sugars.

Duodenum—The first section of the small intestine that receives partly digested material from the stomach.

Endocrine—A system of organs that produces chemicals that go into the bloodstream to reach other organs whose functioning they affect.

Enzyme—A chemical that speeds up or makes a particular chemical reaction more efficient. In the digestive system, enzymes are involved in breaking down large food molecules into smaller molecules that can be processed and utilized by the body.

Exocrine—A system of organs that produces chemicals that go through a duct (or tube) to reach other organs whose functioning they affect.

Gland—Collections of tissue that produce chemicals needed for chemical reactions elsewhere in the body.

Hormone—A chemical produced in one part of the body that travels to another part of the body in order to exert an effect.

occurs over time. Blood sugar (glucose) levels will rise, eventually reaching the levels present in diabetes. The levels of various pancreatic enzymes will fall, as the organ is increasingly destroyed and replaced by non-functioning scar tissue. Calcification of the pancreas can also be seen on x rays. **Endoscopic retrograde cholangiopancreatography** (ERCP) may be used to diagnose chronic pancreatitis in severe cases. In this procedure, the doctor uses a medical instrument fitted with a fiber-optic camera to inspect the pancreas. A magnified image of the area is shown on a television screen viewed by the doctor. Many endoscopes also allow the doctor to retrieve a small sample (biopsy) of pancreatic tissue to examine under a microscope. A contrast product may also be used for radiographic examination of the area.

Treatment

Treatment of pancreatitis involves quickly and sufficiently replacing lost fluids by giving the patient new fluids through a needle inserted in a vein (intravenous or IV fluids). These IV solutions need to contain appropriate amounts of salts, sugars, and sometimes even proteins, in order to correct the patient's disturbances in blood chemistry. Pain is treated with a variety of medications. In order to decrease pancreatic function (and decrease the discharge of more potentially harmful enzymes into the bloodstream), the patient is not allowed to eat. A thin, flexible tube (nasogastric tube) may be inserted through the patient's nose and down into his or her stomach. The nasogastric tube can empty the stomach of fluid and air, which may accumulate due to the inactivity of the gastrointestinal tract. Oxygen may need to be administered by nasal prongs or by a mask.

The patient will need careful monitoring in order to identify complications that may develop. Infections (often occurring in cases of necrotizing pancreatitis, abscesses, and pseudocysts) will require **antibiotics** through the IV. Severe necrotizing pancreatitis may require surgery to remove part of the dying pancreas. A pancreatic abscess can be drained by a needle inserted through the abdomen and into the collection of pus (percutaneous needle aspiration). If this is not sufficient, an abscess may also require surgical removal. Pancreatic pseudocysts may shrink on their own (in 25–40% of cases) or may continue to expand, requiring needle aspiration or surgery. When diagnostic exams reveal the presence of gallstones, surgery may be necessary for their removal. When a patient is extremely ill from pancreatitis, however, such surgery may need to be delayed until any infection is treated, and the patient's condition stabilizes.

Because chronic pancreatitis often includes repeated flares of acute pancreatitis, the same kinds of basic treatment are necessary. Patients cannot take solids or fluids by mouth. They receive IV replacement fluids, receive

pain medication, and are monitored for complications. Treatment of chronic pancreatitis caused by alcohol consumption requires that the patient stop drinking alcohol entirely. As chronic pancreatitis continues and insulin levels drop, a patient may require insulin injections in order to be able to process sugars in his or her diet. Pancreatic enzymes can be replaced with oral medicines, and patients sometimes have to take as many as eight pills with each meal. As the pancreas is progressively destroyed, some patients stop feeling the abdominal pain that was initially so severe. Others continue to have constant abdominal pain, and may even require a surgical procedure for relief. Drugs can be used to reduce the pain, but when narcotics are used for pain relief there is danger of the patient becoming addicted.

Prognosis

A number of systems have been developed to help determine the prognosis of an individual with pancreatitis. A very basic evaluation of a patient will allow some prediction to be made based on the presence of dying pancreatic tissue (necrosis) and bleeding. When necrosis and bleeding are present, as many as 50% of patients may die.

More elaborate systems have been created to help determine the prognosis of patients with pancreatitis. The most commonly used system identifies 11 different signs (Ranson's signs) that can be used to determine the severity of the disease. The first five categories are evaluated when the patient is admitted to the hospital:

- age over 55 years
- blood sugar level over 200 mg/Dl
- serum lactic dehydrogenase over 350 IU/L (increased with increased breakdown of blood, as would occur with internal bleeding, and with heart or liver damage)
- AST over 250 µ (a measure of liver function, as well as a gauge of damage to the heart, muscle, brain, and kidney)
- white **blood count** over 16,000 µL

The next six of Ranson's signs are reviewed 48 hours after admission to the hospital. These are:

- greater than 10% decrease in **hematocrit** (a measure of red blood cell volume)
- increase in BUN greater than 5 mg/dL (blood urea nitrogen, an indicator of kidney function)
- blood calcium less than 8 mg/dL
- PaO2 less than 60 mm Hg (a measure of oxygen in the blood)
- base deficit greater than 4 mEg/L (a measure of change in the normal acidity of the blood)
- fluid sequestration greater than 6 L (an estimation of the quantity of fluid that has leaked out of the blood circulation and into other body spaces)

Once a doctor determines how many of Ranson's signs are present and gives the patient a score, the doctor can better predict the risk of death. The more signs present, the greater the chance of fatal complications. A patient with less than three positive Ranson's signs has a 95% survival rate. A patient with three to four positive Ranson's signs has a 80-85% survival rate.

The results of a CT scan can also be used to predict the severity of pancreatitis. Slight swelling of the pancreas indicates mild illness. Significant swelling, especially with evidence of destruction of the pancreas and/or fluid build-up in the abdominal cavity, indicates more severe illness. With severe illness, there is a worse prognosis.

Prevention

Alcoholism is essentially the only preventable cause of pancreatitis. Patients with chronic pancreatitis must stop drinking alcohol entirely. The drugs that cause or may cause pancreatitis should also be avoided.

Resources

BOOKS

Greenberger, Norton J., Phillip P. Toskes, and Kurt J. Isselbacher. "Acute and Chronic Pancreatitis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Amann, Stephen, et al. "Pancreatitis: Diagnostic and Therapeutic Interventions." *Patient Care* 31, no. 11 (15 June 1997): 200+.

Apte, Minoti V., et al. "Alcohol-Related Pancreatic Damage: Mechanisms and Treatment." *Alcohol Health and Research World* 21, no. 1 (Winter 1997): 13+.

Baillie, John. "Treatment of Acute Biliary Pancreatitis." *The New England Journal of Medicine* 336, no. 4 (23 Jan. 1997): 286+.

Meissner, Judith E. "Caring for Patients with Pancreatitis." *Nursing* 27, no. 10 (Oct. 1997): 50+.

Ruth-Sahd, Lisa A. "Acute Pancreatitis: How to Stop This Pathologic Process Before Systemic Complications Occur." *American Journal of Nursing* 96, no. 6 (June 1996): 38+.

Steer, Michael L., et al. "Chronic Pancreatitis." *The New England Journal of Medicine* 332, no. 22 (June 1, 1995): 1482+.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892-3570. (800) 891-5389. <http://www.niddk.nih.gov/health/digest/nddic.htm>.

Rosalyn Carson-DeWitt, MD

Panic attack *see* **Panic disorder**

Panic disorder

Definition

A panic attack is a sudden, intense experience of fear coupled with an overwhelming feeling of danger, accompanied by physical symptoms of **anxiety**, such as a pounding heart, sweating, and rapid breathing. A person with panic disorder may have repeated panic attacks (at least several a month) and feel severe anxiety about having another attack.

Description

Each year, panic disorder affects one out of 63 Americans. While many people experience moments of anxiety, panic attacks are sudden and unprovoked, having little to do with real danger.

Panic disorder is a chronic, debilitating condition that can have a devastating impact on a person's family, work, and social life. Typically, the first attack strikes without warning. A person might be walking down the street, driving a car, or riding an escalator when suddenly panic strikes. Pounding heart, sweating palms, and an overwhelming feeling of impending doom are common features. While the attack may last only seconds or minutes, the experience can be profoundly disturbing. A person who has had one panic attack typically worries that another one may occur at any time.

As the fear of future panic attacks deepens, the person begins to avoid situations in which panic occurred in the past. In severe cases of panic disorder, the victim refuses to leave the house for fear of having a panic attack. This fear of being in exposed places is often called **agoraphobia**.

People with untreated panic disorder may have problems getting to work or staying on the job. As the person's world narrows, untreated panic disorder can lead to depression, substance abuse, and in rare instances, suicide.

Causes and symptoms

Scientists are not sure what causes panic disorder, but they suspect the tendency to develop the condition can be inherited. Some experts think that people with panic disorder may have a hypersensitive nervous system that unnecessarily responds to nonexistent threats. Research suggests that people with panic disorder may not be able to make proper use of their body's normal stress-reducing chemicals.

People with panic disorder usually have their first panic attack in their 20s. Four or more of the following symptoms during panic attacks would indicate panic disorder if no medical, drug-related, neurologic, or other psychiatric disorder is found:

- pounding, skipping or palpitating heartbeat
- shortness of breath or the sensation of smothering
- dizziness or lightheadedness
- nausea or stomach problems
- chest pains or pressure
- choking sensation or a "lump in the throat"
- chills or hot flashes
- sweating
- fear of dying
- feelings of unreality or being detached
- tingling or numbness
- shaking and trembling
- fear of losing control or going crazy

A panic attack is often accompanied by the urge to escape, together with a feeling of certainty that **death** is imminent. Others are convinced they are about to have a **heart attack**, suffocate, lose control, or "go crazy." Once people experience a panic attack, they tend to worry so much about having another attack that they avoid the place or situation associated with the original episode.

Diagnosis

Because its physical symptoms are easily confused with other conditions, panic disorder often goes undiagnosed. A thorough **physical examination** is needed to rule out a medical condition. Because the physical symptoms are so pronounced and frightening, panic attacks can be mistaken for a heart problem. Some people experiencing a panic attack go to an emergency room and endure batteries of tests until a diagnosis is made.

Once a medical condition is ruled out, a mental health professional is the best person to diagnose panic attack and panic disorder, taking into account not just the actual episodes, but how the patient feels about the attacks, and how they affect everyday life.

Most health insurance policies include some limited amount of mental health coverage, although few completely cover outpatient mental health care.

Treatment

Most patients with panic disorder respond best to a combination of **cognitive-behavioral therapy** and med-

ication. Cognitive-behavioral therapy usually runs from 12–15 sessions. It teaches patients:

- how to identify and alter thought patterns so as not to misconstrue bodily sensations, events, or situations as catastrophic,
- how to prepare for the situations and physical symptoms that trigger a panic attack,
- how to identify and change unrealistic self-talk (such as "I'm going to die!") that can worsen a panic attack,
- how to calm down and learn breathing exercises to counteract the physical symptoms of panic,
- how to gradually confront the frightening situation step by step until it becomes less terrifying,
- how to "desensitize" themselves to their own physical sensations, such as rapid heart rate.

At the same time, many people find that medications can help reduce or prevent panic attacks by changing the way certain chemicals interact in the brain. People with panic disorder usually notice whether or not the drug is effective within two months, but most people take medication for at least six months to a year.

Several kinds of drugs can reduce or prevent panic attacks, including:

- selective serotonin reuptake inhibitor (SSRI) antipressants like paroxetine (Paxil) or fluoxetine (Prozac), are approved specifically for the treatment of panic,
- tricyclic antidepressants such as clomipramine (Anafranil),
- **benzodiazepines** such as alprazolam (Xanax) and clonazepam (Klonopin)

Finally, patients can make certain lifestyle changes to help keep panic at bay, such as eliminating **caffeine** and alcohol, **cocaine**, amphetamines, and marijuana.

Alternative treatment

One approach used in several medical centers focuses on teaching patients how to accept their fear instead of dreading it. In this method, the therapist repeatedly stimulates a person's body sensations (such as a pounding heartbeat) that can trigger fear. Eventually, the patient gets used to these sensations and learns not to be afraid of them. Patients who respond report almost complete absence of panic attacks.

A variety of other atlernative therapies may be helpful in treating panic attacks. Neurolinguistic programming and **hypnotherapy** can be beneficial, since these techniques can help bring an awareness of the root cause of the attacks to the conscious mind. Herbal remedies, including lemon balm (*Melissa officinalis*), oat straw (*Avena sativa*), passionflower (*Passiflora incarnata*), and skullcap (*Scutellaria lateriflora*), may help significantly by strengthening the nervous system. Homeopathic medicine, nutritional supplementation (especially with B **vitamins**, magnesium, and antioxidant vitamins), creative visualization, **guided imagery**, and relaxation techniques may help some people experiencing from panic attacks. Hydrotherapies, especially hot epsom salt baths or baths with essential oil of lavender (*Lavandula officinalis*), can help patients relax.

Prognosis

While there may be occasional periods of improvement, the episodes of panic rarely disappear on their own. Fortunately, panic disorder responds very well to treatment; panic attacks decrease in up to 90% of people after 6-8 weeks of a combination of cognitive-behavioral therapy and medication.

Unfortunately, many people with panic disorder never get the help they need. If untreated, panic disorder can last for years and may become so severe that a normal life is impossible. Many people who struggle with untreated panic disorder and try to hide their symptoms end up losing their friends, family, and jobs.

Prevention

There is no way to prevent the initial onset of panic attacks. **Antidepressant drugs** or benzodiazepines can prevent future panic attacks, especially when combined with cognitive-behavioral therapy. There is some suggestion that avoiding stimulants (including caffeine, alcohol, or over-the-counter cold medicines) may help prevent attacks as well.

Resources

BOOKS

Bassett, Lucinda. *From Panic to Power: Proven Techniques to Calm Your Anxieties, Conquer Your Fears and Put You In Control of Your Life*. New York: HarperCollins, 1995.

Bemis, Judith, and Amr Barrada. *Embracing the Fear: Learning to Manage Anxiety and Panic Attacks*. Center City, MN: Hazelden, 1994.

Greist, J., and James Jefferson. *Anxiety and Its Treatment*. New York: Warner Books, 1986.

Peurifoy, Reneau Z. *Anxiety, Phobias and Panic: A Step by Step Program for Regaining Control of Your Life*. New York: Warner Books, 1996.

Sheehan, Elaine. *Anxiety, Phobias and Panic Attacks: Your Questions Answered*. New York: Element, 1996.

Wilson, Robert R. *Don't Panic: Taking Control of Anxiety Attacks*. New York: HarperCollins, 1996.

KEY TERMS

Agoraphobia—Fear of open spaces.

Benzodiazepines—A class of drugs that have a hypnotic and sedative action, used mainly as tranquilizers to control symptoms of anxiety or panic.

Cognitive-behavioral therapy—A type of psychotherapy used to treat anxiety disorders (including panic disorder) that emphasizes behavioral change together with alteration of negative thought patterns.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants used to treat panic that affects mood by boosting the levels of the brain chemical serotonin.

Tricyclic antidepressants—A class of antidepressants named for their three-ring structure that increase the levels of serotonin and other brain chemicals. They are used to treat depression and anxiety disorders, but have more side effects than the newer class of antidepressants called SSRIs.

Zuercher-White, Elke. *An End to Panic: Breakthrough Techniques for Overcoming Panic Disorder.* Oakland, CA: New Harbinger Publications, 1995.

PERIODICALS

"Cognitive Therapy and Panic Attacks." *Harvard Mental Health Letter* (Nov. 1994).

Grewal, Harinder. "Panic Attack!" *Total Health*, Oct. 1992, 57-58.

Katerndahl, David A. "Panic Attacks and Panic Disorder." *Journal of Family Practice* 43 (Sept. 1996): 275- 283.

Kram, Mark, and Melissa Meyers Gotthardt. "Night of the Living Dread." *Men's Health*, Apr. 1997, 68-70.

Wiltz, Teresa. "Is It Stress?" *Essence*, Apr. 1992, 24-25.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

Anxiety Disorders Association of America. 11900 Park Lawn Drive, Ste. 100, Rockville, MD 20852. (800) 545-7367. <http://www.adaa.org>.

Freedom From Fear. 308 Seaview Ave., Staten Island, NY 10305. (718) 351-1717.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Anxiety Foundation. 3135 Custer Dr., Lexington, KY 40517. (606) 272-7166. <http://www.lexington-on-line.com/naf.html>.

National Institute of Mental Health, Panic Campaign. Rm 15C-05, 5600 Fishers Lane, Rockville, MD 20857. (800) 647-2642. <http://www.nimh.nih.gov>.

National Mental Health Association. 1021 Prince St., Alexandria, VA 22314. (703) 684-7722. <http://www.nmha.org>.

OTHER

The Anxiety and Panic Internet Resource. <http://www.algy.com/anxiety>.

Anxiety Network Page. <http://www.anxietynetwork.com>.

"Panic Disorder." *Internet Mental Health Page*. <http://www.mentalhealth.com>.

National Institute of Mental Health Page. <http://www.nimh.nih.gov>.

Carol A. Turkington

Pap test

Definition

The Pap test is a procedure in which a physician scrapes cells from the cervix or vagina to check for **cervical cancer**, vaginal cancer, or abnormal changes that could lead to **cancer**.

Purpose

The Pap test is used to detect abnormal growth of cervical cells at an early stage so that treatment can be started when the condition is easiest to treat. This microscopic analysis of cells can detect cervical cancer, precancerous changes, inflammation (vaginitis), infections, and some **sexually transmitted diseases** (STDs). The Pap test can occasionally detect endometrial (uterine) cancer or **ovarian cancer**, although it was not designed for this purpose.

Women should begin to have Pap tests at the age of 18 or whenever they become sexually active. Young people are more likely to have multiple sex partners, which increases their risk of certain diseases that can cause cancer, such as human papillomavirus (HPV), but the American Cancer Society suggests the test benefits women of every age. Doctors have varying opinions about how often a woman should have a Pap test. The American Cancer Society states that after three consecutive negative examinations, a doctor may decide that a woman without symptoms of gynecologic problems may be examined less frequently, usually every three years. Many other doctors, however, recommend annual Pap tests for all their patients.

Women with certain risk factors should always have yearly tests. Those at highest risk for cervical cancer are

women who started having sex before age 18, those with many sex partners (especially if they did not use condoms, which protect against STDs), those who have had STDs such as **genital herpes** or **genital warts**, and those who smoke. Women older than 40 should also have the test yearly, especially in the event of bleeding after **menopause**. Women who have had a positive test result in the past may need screening every six months. Women who have had cervical cancer or precancer should have regular Pap smears.

Other women also benefit from the Pap test. Women over age 65 account for 25% of all cases of cervical cancer and 41% of deaths from this disease. Women over age 65 who have never had a Pap smear benefit the most from a Pap smear. Even a woman who has had a **hysterectomy** (removal of the uterus) should continue to have regular Pap tests at the discretion of the woman and the provider. If the surgery was for cancer, she may need to be examined more often than once a year. (Some women have the cervix left in place after hysterectomy.) Finally, a pregnant woman should have a Pap test as part of her first prenatal examination.

The Pap test is a screening test. It identifies women who are at increased risk of cervical dysplasia (abnormal cells) or cervical cancer. Only an examination of the cervix with a special lighted instrument (**colposcopy**) and samples of cervical tissue (biopsies) can actually diagnose these problems.

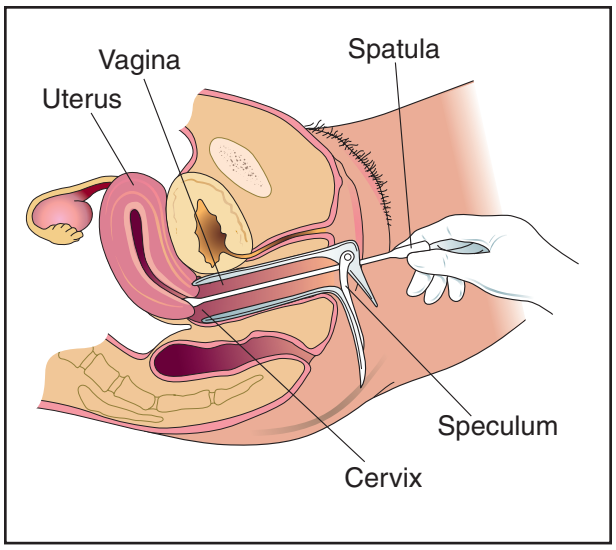
Precautions

The Pap test is usually not done during the menstrual period because of the presence of blood cells. The best time is in the middle of the menstrual cycle.

Description

The Pap test is an extremely cost-effective and beneficial test. Cervical cancer used to be a leading cause of cancer deaths in American women, but widespread use of this diagnostic procedure reduced the death rate from this disease by 74% between 1955 and 1992. The Pap test detects about 95% of cervical cancer.

The Pap test, sometimes called a cervical smear, is the microscopic examination of cells scraped from both the outer cervix and the cervical canal. (The cervix is the opening between the vagina and the uterus, or womb.) It is called the "Pap" test after its developer, Dr. George N. Papanicolaou. This simple procedure is performed during a gynecologic examination and is usually covered by insurance. For those with coverage, Medicare will pay for one screening Pap smear every three years.



The Pap test is a procedure used to detect abnormal growth of cervical cells which may be a precursor to cancer of the cervix. It is administered by a physician who inserts a speculum into the vagina to open and separate the vaginal walls. A spatula is then inserted to scrape cells from the cervix. These cells are transferred onto glass slides for laboratory analysis. The Pap test may also identify vaginitis, some sexually transmitted diseases, and cancers of the uterus and ovaries. *(Illustration by Electronic Illustrators Group.)*

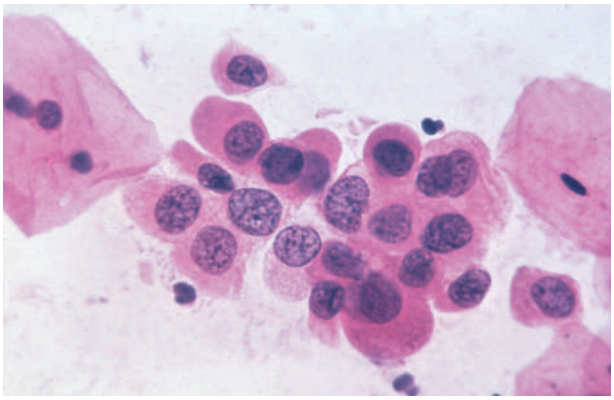
During the pelvic examination, an instrument called a speculum is inserted into the vagina to open it. The doctor then uses a tiny brush, or a cotton-tipped swab and a small spatula to wipe loose cells off the cervix and to scrape them from the inside of the cervix. The cells are transferred or "smeared" onto glass slides, the slides are treated to stabilize the cells, and the slides are sent to a laboratory for microscopic examination. The entire procedure is usually painless and takes five to 10 minutes at most.

Preparation

The Pap test may show abnormal results when a woman is healthy or normal results in women with cervical abnormalities as much as 25% of the time. It may even miss up to 5% of cervical cancers. Some simple preparations may help to ensure that the results are reliable. Among the measures that may help increase test reliability are:

- avoiding sexual intercourse for two days before the test
- not using douches for two or three days before the test
- avoid use of tampons, vaginal creams, or birth control foams or jellies for two to three days before the test
- scheduling the Pap smear when not menstruating

However, most women are not routinely advised to make any special preparations for a Pap test.



These malignant cells were taken from a woman's cervix during a Pap test. *(Photograph by Parviz M. Pour, Photo Researchers, Inc. Reproduced by permission.)*

If possible, women may want to ensure that their test is performed by an experienced gynecologist, physician, or provider and sent to a reputable laboratory. The physician should be confident in the accuracy of the chosen lab.

Before the exam, the physician will take a complete sexual history to determine a woman's risk status for cervical cancer. Questions may include date and results of the last Pap test, any history of abnormal Pap tests, date of last menstrual period and any irregularity, use of hormones and birth control, family history of gynecologic disorders, and any vaginal symptoms. These topics are relevant to the interpretation of the Pap test, especially if any abnormalities are detected. Immediately before the Pap test, the woman should empty her bladder to avoid discomfort during the procedure.

Aftercare

Harmless cervical bleeding is possible immediately after the test; a woman may need to use a sanitary napkin. She should also be sure to comply with her doctor's orders for follow-up visits.

Risks

No appreciable health risks are associated with the Pap test. However, abnormal results (whether valid or due to technical error) can cause significant **anxiety**. Women may wish to have their sample double-checked, either by the same laboratory or by the new technique of computer-assisted rescreening. The Food and Drug Administration (FDA) has approved the use of AutoPap and PAPNET to doublecheck samples that have been examined by technologists. AutoPap may also be used to perform initial screening of slides, which are then checked by a technologist. Any abnormal Pap test should be followed by colposcopy and not by double checking the pap test.

Normal results

Normal (negative) results from the laboratory exam mean that no atypical, dysplastic, or cancer cells were detected, and the cervix is normal.

Abnormal results

Terminology

Abnormal cells found on the Pap test may be described using two different grading systems. Although this can be confusing, the systems are quite similar. The Bethesda system is based on the term squamous intraepithelial lesion (SIL). Precancerous cells are classified as atypical squamous cells of undetermined significance (ASCUS), low-grade SIL, or high-grade SIL. Low-grade SIL includes mild dysplasia (abnormal cell growth) and abnormalities caused by HPV; high-grade SIL includes moderate or severe dysplasia and carcinoma in situ (cancer that has not spread beyond the cervix).

Another term that may be used is "cervical intraepithelial neoplasia" (CIN). In this classification system, mild dysplasia is called CIN I, moderate is CIN II, and severe dysplasia or carcinoma in situ is CIN III.

Regardless of terminology, it is important to remember that an abnormal (positive) result does not necessarily indicate cancer. Results may be falsely abnormal after infection or irritation of the cervix. Up to 40% of mild dysplasia reverts to normal tissue without treatment, and only 1% of mild abnormalities ever develop into cancer.

Changes of unknown cause

ASCUS or LSIL cells are found in 5–10% of all Pap tests. The most common abnormality is atypical squamous cells of undetermined significance, which are found in 4% of all Pap tests. Sometimes these results are described further as either reactive or precancerous. Reactive changes suggest that the cervical cells are responding to inflammation, such as from a yeast infection. These women may be treated for infection and then undergo repeat Pap testing in three to six months. If those results are negative, no further treatment is necessary. This category may also include atypical "glandular" cells, which could imply a more severe type of cancer and requires repeat testing and further evaluation.

Dysplasia

The next most common finding (in about 25 of every 1,000 tests) is low-grade SIL, which includes mild dys-

plasia or CIN I and changes caused by HPV. Unlike cancer cells, these cells do not invade normal tissues. Women are most susceptible to cervical dysplasia between the ages of 25 and 35. Typically, dysplasia causes no symptoms, although women may experience abnormal vaginal bleeding. Because dysplasia is precancerous, it should be treated if it is moderate or severe.

Treatment of dysplasia depends on the degree of abnormality. In women with no other risk factors for cervical cancer, mild precancerous changes may be simply observed over time with repeat testing, perhaps every four to six months. This strategy works only if women are diligent about keeping later appointments. Premalignant cells may remain that way without causing cancer for five to ten years, and may never become malignant.

In women with positive results or risk factors, the gynecologist must perform colposcopy and biopsy. A colposcope is an instrument that looks like binoculars, with a light and a magnifier, used to view the cervix. Biopsy, or removal of a small piece of abnormal cervical or vaginal tissue for analysis, is usually done at the same time.

High-grade SIL (found in three of every 50 Pap tests) includes moderate to severe dysplasia or carcinoma in situ (CIN II or III). After confirmation by colposcopy and biopsy, it must be removed or destroyed to prevent further growth. Several outpatient techniques are available: conization (removal of a cone-shaped piece of tissue), **laser surgery**, **cryotherapy** (freezing), or the "loop electrosurgical excision procedure." Cure rates are nearly 100% after prompt and appropriate treatment of carcinoma in situ. Of course, frequent checkups are then necessary.

Cancer

HPV, the most common STD in the United States, may be responsible for many cervical cancers. Cancer may be manifested by unusual vaginal bleeding or discharge, bowel and bladder problems, and **pain**. Women are at greatest risk of developing cervical cancer between the ages of 30 and 40 and between the ages of 50 and 60. Most new cancers are diagnosed in women between 50 and 55. Although the likelihood of developing this disease begins to level off for Caucasian women at the age of 45, it increases steadily for African-Americans for another 40 years. Biopsy is indicated when any abnormal growth is found on the cervix, even if the Pap test is negative.

Doctors have traditionally used **radiation therapy** and surgery to treat cervical cancer that has spread within the cervix or throughout the pelvis. In severe cases, postoperative radiation is administered to kill any remaining cancer cells, and **chemotherapy** may be used if cancer has spread to other organs. Recent studies have shown that giving chemotherapy and radiation at the same time improves a patient's chance of survival. The National Cancer Institute has urged physicians to strongly consider using both chemotherapy and radiation to treat patients with invasive cervical cancer. The survival rate at five years after treatment of early invasive cancer is 91%; rates are below 70% for more severe invasive cancer. That is why prevention, risk reduction, and frequent Pap tests are the best defense for a woman's gynecologic health.

KEY TERMS

Carcinoma in situ—Malignant cells that are present only in the outer layer of the cervix.

Cervical intraepithelial neoplasia (CIN)—A term used to categorize degrees of dysplasia arising in the epithelium, or outer layer, of the cervix.

Dysplasia—Abnormal changes in cells.

Human papillomavirus (HPV)—The most common STD in the United States. Various types of HPV are known to cause cancer.

Neoplasia—Abnormal growth of cells, which may lead to a neoplasm, or tumor.

Squamous intraepithelial lesion (SIL)—A term used to categorize the severity of abnormal changes arising in the squamous, or outermost, layer of the cervix.

Resources

BOOKS

Berek, Jonathan S., Eli Y. Adashi, and Paula A. Hillard. *Novak's Gynecology.* 12th ed. Baltimore: Williams & Wilkins, 1996.

Hoffman, Eileen. *Our Health, Our Lives: A Revolutionary Approach to Total Health Care for Women.* New York: Pocket Books, 1995.

Illustrated Guide to Diagnostic Tests. 2nd ed. Springhouse, PA: Springhouse Corporation, 1998.

Slupik, Ramona I., ed. *American Medical Association Complete Guide to Women's Health.* New York: Random House, 1996.

PERIODICALS

Brotzman, Gregory L., and Thomas M. Julian. "The Minimally Abnormal Papanicolaou Smear." *American Family Physician* 53 (March 1996): 1154-62, 1165-66.

Morgan, Peggy, and Linda Rao. "Abnormal Pap? What to Do Next." *Prevention* 48 (November 1996): 90-6.

Nuovo, Jim, Joy Melnikow, and Mary Palieschekey. "Management of Patients with Atypical and Low-Grade Pap Smear Abnormalities." *American Family Physician* 52 (December 1995): 2243-50.

Perlmutter, Cathy, and Toby Hanlon. "The Smart Pap: How to Wage a Successful Smear Campaign to Improve the Accuracy of Your Results." *Prevention* 48 (October 1996): 82-5,155-7.

ORGANIZATION

American College of Obstetricians and Gynecologists. 409 12th St. SW, PO Box 96920, Washington, DC 20090-6920. (202) 863-2518. <http://www.acog.com>.

National Cancer Institute, Office of Communications. 31 Center Dr., MSC 2580, Bethesda, MD 20892-2580. (800) 4-CANCER. <http://cancernet.nci.nih.gov/>.

OTHER

"Pap Smears: The simple test that can save your life." 29 Jan. 2001. 26 Apr. 2001. 28 June 2001 <www.mayohealth.org/home?id=HQ01178>.

"Pap smear: Simple, life-saving test." 29 Apr. 1999. 26 Apr. 2001. 28 June 2001. <www.mayohealth.org/home?id=HQ01177>.

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Papanicolaou test *see* **PAP test**

Papilledema

Definition

Papilledema is a swelling of the optic nerve, at the point where this nerve joins the eye, that is caused by an increase in fluid pressure within the skull (intracranial pressure). Swelling of the optic nerve due to other causes such as infection or inflammatory disease is not called papilledema.

Description

The optic nerve is the nerve that transmits signals from the eye to the brain. Papilledema is a swelling of this nerve where it meets the eye (the optic disc) caused by an increase in intracranial pressure. Almost all cases of papilledema are bilateral (affect both eyes). Papilledema can be observed in people of any age, but is relatively uncommon in infants because the bones of the skull are not fully fused together at this age.

Causes and symptoms

Papilledema is caused by an increase in the pressure of the fluid (cerebrospinal fluid) that is present between the brain and the skull, inside the head. This increase in intracranial pressure may be caused by any of a variety of conditions within the skull, brain, or spinal cord. The most common causes of papilledema are:

- tumor of the brain, spinal cord, skull, spinal column, or optic nerve
- abscess (the accumulation of pus within a confined space)
- craniosynostosis (an abnormal closure of the bones of the skull)
- hemorrhage (bleeding)
- hydrocephalus (an accumulation of cerebrospinal fluid within the skull)
- intracranial infection (any infection within the skull such as **meningitis** and encephalitis)
- head injury

The symptoms of papilledema include:

- headaches, which are usually worse upon awakening and exacerbated by coughing, holding the breath, or other maneuvers that tend to increase intracranial pressure
- nausea and vomiting
- changes in vision, such as temporary and transient blurring, graying, flickering, or double vision

Diagnosis

A diagnosis of papilledema is achieved by visual examination of the eye with an ophthalmoscope. This instrument shines light through the pupil of the eye and illuminates the retina while the clinician looks through it. Eye drops to dilate the pupils are used to insure a thorough examination.

Treatment

Treatment of papilledema is generally aimed at the treatment of the underlying disorder that is causing papilledema.

Diuretic drugs combined with a weight reduction program may be useful in cases of papilledema that are caused by an abnormally high production of cerebrospinal fluid.

Corticosteroids have been shown to be effective in relieving the symptoms in some patients with papilledema caused by inflammatory disorders.

Alternative treatment

Alternative treatments for conditions that cause the occurrence of papilledema include **acupuncture**, **aromatherapy**, **hydrotherapy**, massage, and herbal remedies.

KEY TERMS

Craniosynostosis—A premature closure of one or more of the joints (fissures) between the bones of the skull, which causes an abnormally shaped skull.

Hydrocephalus—The accumulation of cerebrospinal fluid within the skull.

Ophthalmoscope—A medical instrument that shines a light through the pupil of the patient's eye and illuminates the retina (back of the eye), allowing a visual examination of the interior of the eye.

Prognosis

With prompt medical care to treat the underlying cause of papilledema, a person affected with papilledema will not have permanent damage to his or her eyesight. However, prolonged papilledema can result in permanent damage to the optic nerve which could lead to blindness.

Prevention

Preventing papilledema is only possible if the underlying condition causing the papilledema can be found. Treatment of this underlying condition may prevent recurrences of papilledema.

Resources

BOOKS

Rhee, Douglas J., and Mark F. Pyfer. *The Wills Eye Manual, Third Edition*. Philadelphia, PA: Lippincott Williams and Wilkins, 1999.

PERIODICALS

Agarwal, A. K., et al. "Papilledema." *Journal of the Indian Academy of Clinical Medicine* 1 (October-December 2000): 270-277.

ORGANIZATIONS

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892-3655. (301) 496-5248. <http://www.nei.nih.gov/>.

OTHER

Giovannini, Joseph, and Georgia Chrousos. "Papilledema." *eMedicine*. <http://www.emedicine.com/OPH/topic187.htm>. (12 May 2001).

Paul A. Johnson

Papillomavirus infection *see* **Genital warts**

Papule *see* **Skin lesions**

Paracentesis

Definition

Paracentesis is a procedure during which fluid from the abdomen is removed through a needle.

Purpose

There are two reasons to take fluid out of the abdomen. One is to analyze it. The other is to relieve pressure.

Liquid that accumulates in the abdomen is called **ascites**. Ascites seeps out of organs for several reasons related either to disease in the organ or fluid pressures that are changing.

Liver disease

All the blood flowing through the intestines passes through the liver on its way back to the heart. When progressive disease such as alcohol damage or hepatitis destroys enough liver tissue, the scarring that results shrinks the liver and constricts the blood flow. Such scarring of the liver is called **cirrhosis**. Pressure builds up in the intestinal circulation, slowing flow and pushing fluid into the tissues. Slowly the fluid accumulates in areas with the lowest pressure and greatest capacity. The free space around abdominal organs receives most of it. This space is called the peritoneal space because it is enclosed by a thin membrane called the peritoneum. The peritoneum wraps around nearly every organ in the abdomen, providing many folds and spaces for the fluid to gather.

Infections

Peritonitis is an infection of the peritoneum. Infection changes the dynamics of body fluids, causing them to seep into tissues and spaces. Peritonitis can develop in several ways. Many abdominal organs contain germs that do not belong elsewhere in the body. If they spill their contents into the peritoneum, infection is the result. The gall bladder, the stomach, any part of the intestine, and most especially the appendix—all cause peritonitis when they leak or rupture. **Tuberculosis** can infect many organs in the body; it is not confined to the lungs. Tuberculous peritonitis causes ascites.

Other inflammations

Peritoneal fluid is not just produced by infections. The pancreas can cause a massive sterile peritonitis when it leaks its digestive enzymes into the abdomen.

Cancer

Any **cancer** that begins in or spreads to the abdomen can leak fluid. One particular tumor of the ovary that

leaks fluid, the resulting presentation of the disease, is Meigs' syndrome.

Kidney disease

Since the kidneys are intimately involved with the body's fluid balance, diseases of the kidney often cause excessive fluid to accumulate. Nephrosis and **nephrotic syndrome** are the general terms for diseases that cause the kidneys to retain water and provoke its movement into body tissues and spaces.

Heart failure

The ultimate source of fluid pressure in the body is the heart, which generates blood pressure. All other pressures in the body are related to blood pressure. As the heart starts to fail, blood backs up waiting to be pumped. This increases back pressure upstream, particularly below the heart where gravity is also pulling blood away from the heart. The extra fluid from **heart failure** is first noticed in the feet and ankles, where gravitational effects are most potent. In the abdomen, the liver swells first, then it and other abdominal organs start to leak.

Pleural fluid

The other major body cavity is the chest. The tissue in the chest corresponding to the peritoneum is called the pleura, and the space contained within the pleura, between the ribs and the lungs, is called the pleural space. Fluid is often found in both cavities, and fluid from one cavity can find its way into the other.

Fluid that accumulates in the abdomen creates abnormal pressures on organs in the abdomen. Digestion is hindered; blood flow is slowed. Pressure upward on the chest compromises breathing. The kidneys function poorly in the presence of such external pressures and may even fail with tense, massive ascites.

Description

During paracentesis, special needles puncture the abdominal wall, being careful not to hit internal organs. If fluid is needed only for analysis, just a bit is removed. If pressure relief is an additional goal, many quarts may be removed. Rapid removal of large amounts of fluid can cause blood pressure to drop suddenly. For this reason, the physician will often leave a tube in place so that fluid can be removed slowly, giving the circulation time to adapt.

A related procedure called culpocentesis removes ascitic fluid from the very bottom of the abdominal cavity through the back of the vagina. This is used mostly to diagnose female genital disorders like **ectopic pregnancy** that bleed or exude fluid into the peritoneal space.

KEY TERMS

Ectopic pregnancy—A pregnancy occurring outside the womb that often ruptures and requires surgical removal.

Fluid is sent to the laboratory for testing, where cancer and blood cells can be detected, infections identified, and chemical analysis can direct further investigations.

Aftercare

An adhesive bandage and perhaps a single stitch close the hole. Nothing more is required.

Risks

Risks are negligible. It is remotely possible that an organ could be punctured and bleed or that an infection could be introduced.

Normal results

A diagnosis of the cause and/or relief from accumulated fluid pressure are the expected results.

Abnormal results

Fluid will continue to accumulate until the cause is corrected. Repeat procedures may be needed.

Resources

BOOKS

Glickman, Robert M. "Abdominal Swelling and Ascites." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Lucey, Michael R. "Diseases of the Peritoneum, Mesentery and Omentum." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

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Paracoccidioidomycosis *see* **South American blastomycosis**

Paragonamiasis *see* **Fluke infections**

Paralysis

Definition

Paralysis is defined as complete loss of strength in an affected limb or muscle group.

Description

The chain of nerve cells that runs from the brain through the spinal cord out to the muscle is called the motor pathway. Normal muscle function requires intact connections all along this motor pathway. Damage at any point reduces the brain's ability to control the muscle's movements. This reduced efficiency causes weakness, also called paresis. Complete loss of communication prevents any willed movement at all. This lack of control is called paralysis. Certain inherited abnormalities in muscle cause **periodic paralysis**, in which the weakness comes and goes.

The line between weakness and paralysis is not absolute. A condition causing weakness may progress to paralysis. On the other hand, strength may be restored to a paralyzed limb. Nerve regeneration or regrowth is one way in which strength can return to a paralyzed muscle. Paralysis almost always causes a change in muscle tone. Paralyzed muscle may be flaccid, flabby, and without appreciable tone, or it may be spastic, tight, and with abnormally high tone that increases when the muscle is moved.

Paralysis may affect an individual muscle, but it usually affects an entire body region. The distribution of weakness is an important clue to the location of the nerve damage that is causing the paralysis. Words describing the distribution of paralysis use the suffix "-plegia," from the Greek word for "stroke." The types of paralysis are classified by region:

- monoplegia, affecting only one limb
- diplegia, affecting the same body region on both sides of the body (both arms, for example, or both sides of the face)
- hemiplegia, affecting one side of the body
- paraplegia, affecting both legs and the trunk
- quadriplegia, affecting all four limbs and the trunk

Causes and symptoms

Causes

The nerve damage that causes paralysis may be in the brain or spinal cord (the central nervous system) or it may be in the nerves outside the spinal cord (the peripheral nervous system). The most common causes of damage to the brain are:

- **stroke**
- tumor
- trauma (caused by a fall or a blow)
- **multiple sclerosis** (a disease that destroys the protective sheath covering nerve cells)
- **cerebral palsy** (a condition caused by a defect or injury to the brain that occurs at or shortly after birth)
- metabolic disorder (a disorder that interferes with the body's ability to maintain itself)

Damage to the spinal cord is most often caused by trauma, such as a fall or a car crash. Other conditions that may damage nerves within or immediately adjacent to the spine include:

- tumor
- herniated disk (also called a ruptured or slipped disk)
- spondylosis (a disease that causes stiffness in the joints of the spine)
- rheumatoid arthritis of the spine
- neurodegenerative disease (a disease that damages nerve cells)
- multiple sclerosis

Damage to peripheral nerves may be caused by:

- trauma
- compression or entrapment (such as carpal tunnel syndrome)
- **Guillain-Barré syndrome** (a disease of the nerves that sometimes follows **fever** caused by a viral infection or immunization)
- chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) (a condition that causes **pain** and swelling in the protective sheath covering nerve cells)
- radiation
- inherited demyelinating disease (a condition that destroys the protective sheath around the nerve cell)
- toxins or poisons

Symptoms

The distribution of paralysis offers important clues to the site of nerve damage. Hemiplegia is almost always caused by brain damage on the side opposite the paralysis, often from a stroke. Paraplegia occurs after injury to the lower spinal cord, and quadriplegia occurs after damage to the upper spinal cord at the level of the shoulders or higher (the nerves controlling the arms leave the spine at that level). Diplegia usually indicates brain damage, most often from cerebral palsy. Monoplegia may be caused by isolated damage to either the central or the peripheral nervous system. Weakness or paralysis that occurs only in the arms and legs may indicate demyelinating disease. Fluctuating symptoms in different parts of the body may be caused by multiple sclerosis.

Sudden paralysis is most often caused by injury or stroke. Spreading paralysis may indicate degenerative

disease, inflammatory disease such as Guillain-Barré syndrome or CIDP, metabolic disorders, or inherited demyelinating disease.

Other symptoms often accompany paralysis from any cause. These symptoms may include **numbness and tingling**, pain, changes in vision, difficulties with speech, or problems with balance. **Spinal cord injury** often causes loss of function in the bladder, bowel, and sexual organs. High spinal cord injuries may cause difficulties in breathing.

Diagnosis

Careful attention should be paid to any events in the patient's history that might reveal the cause of the paralysis. The examiner should look for incidents such as falls or other traumas, exposure to toxins, recent infections or surgery, unexplained **headache**, preexisting metabolic disease, and family history of weakness or other neurologic conditions. A neurologic examination tests strength, reflexes, and sensation in the affected area and normal areas.

Imaging studies, including **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI) scans, or **myelography** may reveal the site of the injury. **Electromyography** and nerve conduction velocity tests are performed to test the function of the muscles and peripheral nerves.

Treatment

The only treatment for paralysis is to treat its underlying cause. The loss of function caused by long-term paralysis can be treated through a comprehensive **rehabilitation** program. Rehabilitation includes:

- Physical therapy. The physical therapist focuses on mobility. Physical therapy helps develop strategies to compensate for paralysis by using those muscles that still have normal function, helps maintain and build any strength and control that remain in the affected muscles, and helps maintain range of motion in the affected limbs to prevent muscles from shortening (contracture) and becoming deformed. If nerve regrowth is expected, physical therapy is used to retrain affected limbs during recovery. A physical therapist also suggests adaptive equipment such as braces, canes, or wheelchairs.
- Occupational therapy. The occupational therapist focuses on daily activities such as eating and bathing. Occupational therapy develops special tools and techniques that permit self-care and suggests ways to modify the home and workplace so that a patient with an impairment may live a normal life.
- Other specialties. The nature of the impairment may mean that the patient needs the services of a respiratory therapist, vocational rehabilitation counselor, social worker, speech-language pathologist, nutritionist, special education teacher, recreation therapist, or clinical psychologist.

KEY TERMS

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Electromyography—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Myelin—The insulation covering nerve cells. Demyelinating disease causes a breakdown of myelin.

Myelography—An x-ray process that uses a dye or contrast medium injected into the space around the spine.

Nerve conduction velocity test—A test that measures the time it takes a nerve impulse to travel a specific distance over the nerve after electronic stimulation.

Prognosis

The likelihood of recovery from paralysis depends on what is causing it and how much damage has been done to the nervous system.

Prevention

Prevention of paralysis depends on prevention of the underlying causes. Risk of stroke can be reduced by controlling high blood pressure and cholesterol levels. Seatbelts, air bags, and helmets reduce the risk of injury from motor vehicle accidents and falls. Good prenatal care can help prevent premature birth, which is a common cause of cerebral palsy.

Resources

BOOKS

Bradley, Walter G., et al., eds. *Neurology in Clinical Practice*. 2nd ed. Boston: Butterworth-Heinemann, 1996.

Yarkony, Gary M., ed. *Spinal Cord Injury: Medical Management and Rehabilitation*. Gaithersburg, MD: Aspen Publishers, 1994.

Richard Robinson

Paralysis agitans *see* **Parkinson's disease**

Paralytic shellfish poisoning *see* **Fish and shellfish poisoning**

Paranoia

Definition

Paranoia is an unfounded or exaggerated distrust of others, sometimes reaching delusional proportions. Paranoid individuals constantly suspect the motives of those around them, and believe that certain individuals, or people in general, are "out to get them."

Description

Paranoid perceptions and behavior may appear as features of a number of mental illnesses, including depression and **dementia**, but are most prominent in three types of psychological disorders: paranoid **schizophrenia**, delusional disorder (persecutory type), and paranoid personality disorder (PPD).

Individuals with paranoid schizophrenia and persecutory delusional disorder experience what is known as persecutory **delusions**: an irrational, yet unshakable, belief that someone is plotting against them. Persecutory delusions in paranoid schizophrenia are bizarre, sometimes grandiose, and often accompanied by auditory **hallucinations**. Delusions experienced by individuals with delusional disorder are more plausible than those experienced by paranoid schizophrenics; not bizarre, though still unjustified. Individuals with delusional disorder may seem offbeat or quirky rather than mentally ill, and, as such, may never seek treatment.

Persons with paranoid personality disorder tend to be self-centered, self-important, defensive, and emotionally distant. Their paranoia manifests itself in constant suspicions rather than full-blown delusions. The disorder often impedes social and personal relationships and career advancement. Some individuals with PPD are described as "litigious," as they are constantly initiating frivolous law suits. PPD is more common in men than in women, and typically begins in early adulthood.

Causes and symptoms

The exact cause of paranoia is unknown. Potential causal factors may be genetics, neurological abnormalities, changes in brain chemistry, and **stress**. Paranoia is also a possible side effect of drug use and abuse (for example, alcohol, marijuana, amphetamines, **cocaine**, PCP). Acute, or short term, paranoia may occur in some individuals overwhelmed by stress.

The *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM-IV*), the diagnostic standard for mental health professionals in the United States, lists the following symptoms for paranoid personality disorder:

- suspicious; unfounded suspicions; believes others are plotting against him/her
- preoccupied with unsupported doubts about friends or associates
- reluctant to confide in others due to a fear that information may be used against him/her
- reads negative meanings into innocuous remarks
- bears grudges
- perceives attacks on his/her reputation that are not clear to others, and is quick to counterattack
- maintains unfounded suspicions regarding the fidelity of a spouse or significant other

Diagnosis

Patients with paranoid symptoms should undergo a thorough **physical examination** and patient history to rule out possible organic causes (such as dementia) or environmental causes (such as extreme stress). If a psychological cause is suspected, a psychologist will conduct an interview with the patient and may administer one of several clinical inventories, or tests, to evaluate mental status.

Treatment

Paranoia that is symptomatic of paranoid schizophrenia, delusional disorder, or paranoid personality disorder should be treated by a psychologist and/or psychiatrist. Antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), or risperidone (Risperdal) may be prescribed, and cognitive therapy or psychotherapy may be employed to help the patient cope with their paranoia and/or persecutory delusions. Antipsychotic medication, however, is of uncertain benefit to individuals with paranoid personality disorder and may pose long-term risks.

KEY TERMS

Persecutory delusion—A fixed, false, and inflexible belief that others are engaging in a plot or plan to harm an individual.

If an underlying condition, such as depression or drug abuse, is found to be triggering the paranoia, an appropriate course of medication and/or psychosocial therapy is employed to treat the primary disorder.

Prognosis

Because of the inherent mistrust felt by paranoid individuals, they often must be coerced into entering treatment. As unwilling participants, their recovery may be hampered by efforts to sabotage treatment (for example, not taking medication or not being forthcoming with a therapist), a lack of insight into their condition, or the belief that the therapist is plotting against them. Albeit with restricted lifestyles, some patients with PPD or persecutory delusional disorder continue to function in society without treatment.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S., and Nicholas G. Ward. "Personality Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Maxmen, Jerrold S., and Nicholas G. Ward. "Schizophrenia and Related Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Siegel, Ronald K. *Whispers: The Voices of Paranoia*. New York: Crown, 1994.

PERIODICALS

Manschreck, Theo C. "Delusional Disorder: The Recognition and Management of Paranoia." *Journal of Clinical Psychiatry* 57, supplement 3 (1996): 32-38.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Paula Anne Ford-Martin

Parapharyngeal abscess *see* **Abscess**

Paraphilias *see* **Sexual perversions**

Paraplegia *see* **Paralysis**

Parasomnia *see* **Sleep disorders**

Parathyroid gland removal *see* **Parathyroidectomy**

Parathyroid hormone test

Definition

The parathyroid hormone (PTH) test is a blood test performed to determine the serum levels of a hormone secreted by the parathyroid gland in response to low blood calcium levels. PTH works together with vitamin D to maintain healthy bones. The parathyroid glands are small paired glands located near the thyroid gland at the base of the neck.

Purpose

The PTH level is measured to evaluate the level of blood calcium. It is routinely monitored in patients with a kidney disorder called chronic renal failure (CRF). Because PTH is one of the major factors affecting calcium metabolism, the PTH test helps to distinguish nonparathyroid from parathyroid causes of too much calcium in the blood (**hypercalcemia**).

Differential diagnosis of hyperparathyroidism

PTH is also useful in the differential diagnosis of overactive parathyroid glands (**hyperparathyroidism**). Primary hyperparathyroidism is most often caused by a benign tumor in one or more of the parathyroid glands. It is rarely caused by parathyroid **cancer**. Patients with this condition have high PTH and calcium levels.

Secondary hyperparathyroidism is often seen in patients with chronic renal failure (CRF). The kidneys fail to excrete sufficient phosphate, and the parathyroid gland secretes PTH in an effort to lower calcium levels to balance the calcium-phosphate ratio. Because of the constant stimulation of the parathyroid, CRF patients have high PTH and normal or slightly low calcium levels.

Tertiary hyperparathyroidism occurs when CRF causes a severe imbalance in the calcium-phosphate ratio, leading to very high PTH production that results in hypercalcemia. Patients with this condition have high PTH and high calcium levels.

Specific PTH assays

PTH is broken down in the body into three different molecular forms: the intact PTH molecule and several smaller fragments which include an amino acid or N-terminal, a midregion or midmolecule, and a carboxyl or C-terminal. Two tests are currently used to measure intact PTH and its terminal fragments. While both tests are used to diagnose hyper-or **hypoparathyroidism**, each test also has specific applications as well. The C-terminal PTH assay is used to diagnose the ongoing disturbances in PTH metabolism that occur with secondary and tertiary hyperparathyroidism. The assay for intact PTH and the N-terminal fragment, which are both measured at the same time, is more accurate in detecting sudden changes in the PTH level. For this reason, the N-terminal PTH assay is used to monitor a patient's response to therapy.

Precautions

Drug interactions

Some prescription drugs affect the results of PTH tests. Drugs that *increase* PTH levels include phosphates, anticonvulsants, steroids, isoniazid, lithium, and rifampin. Drugs that *decrease* PTH include cimetidine and propranolol.

Timing

PTH levels are subject to daily variation, ranging from a peak around 2:00 A.M. to a low point around 2:00 P.M. Specimens are usually drawn at 8:00 A.M. The laboratory should be notified if the patient works a night shift so that this difference in biological rhythm can be taken into account.

Other serum level tests

Due to the relationship between PTH and calcium, calcium levels should be tested at the same time as PTH. Most laboratories have established reference values to indicate what PTH level is normal for a particular calcium level. In addition, the effects of PTH on kidney function and bone strength indicate that serum calcium, phosphorus, and creatinine levels should be measured together with PTH. The **creatinine test** measures kidney function and aids in the diagnosis of parathyroid dysfunction.

KEY TERMS

Assay—An analysis of the chemical composition or strength of a substance.

Hypercalcemia—Abnormally high levels of blood calcium.

Hyperparathyroidism—Overactivity of the parathyroid glands. Symptoms include generalized aches and pains, depression, and abdominal pain.

Hypoparathyroidism—Insufficient production of parathyroid hormone, which results in low levels of blood calcium.

Description

The PTH test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

Preparation

The patient should have nothing to eat or drink from midnight of the day of the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, a small bruise or swelling in the area, or **fainting** or feeling lightheaded.

Normal results

Reference ranges for PTH tests vary somewhat depending on the laboratory, and must be interpreted in association with calcium results. The following ranges are typical:

- Intact PTH: 10–65 pg/mL
- PTH N-terminal (includes intact PTH): 8–24 pg/mL
- PTH C-terminal (includes C-terminal, intact PTH, and midmolecule): 50–330 pg/mL

Abnormal results

When measured with serum calcium levels, abnormally *high* PTH values may indicate primary, secondary, or tertiary hyperparathyroidism, chronic renal failure, **malabsorption syndrome**, and **vitamin D deficiency**. Abnormally *low* PTH levels may indicate hypoparathyroidism, hypercalcemia, and certain malignancies.

Resources

BOOKS

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Janis O. Flores

Parathyroid scan

Definition

A parathyroid scan is sometimes called a parathyroid localization scan or parathyroid scintigraphy. This scan uses radioactive pharmaceuticals that are readily taken up by cells in the parathyroid glands to obtain an image of the glands and any abnormally active areas within them.

Purpose

The parathyroid glands, embedded in the thyroid gland in the neck, but separate from the thyroid in function, control calcium metabolism in the body. The parathyroid glands produce parathyroid hormone (PTH). PTH regulates the level of calcium in the blood.

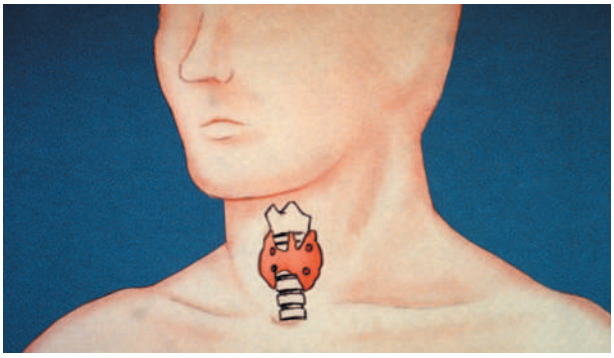
Calcium is critical to cellular metabolism, as well as being the main component of bones. If too much PTH is secreted, the bones release calcium into the bloodstream. Over time, the bones become brittle and more likely to break. A person with levels of calcium in the blood that are too high feels tired, run down, irritable, and has difficulty sleeping. Additional signs of too much calcium in the blood are **nausea and vomiting**, frequent urination, **kidney stones** and bone **pain**. A parathyroid scan is administered when the parathyroid appears to be overactive and a tumor is suspected.

Precautions

Parathyroid scans are not recommended for pregnant women because of the potential harm to the developing fetus. People who have had another recent nuclear medicine procedure or an intravenous contrast test may need to wait until the earlier radioactive markers have been eliminated from their system in order to obtain accurate results from the parathyroid scan.

Description

A parathyroid scan is a non-invasive procedure that uses two radiopharmaceuticals (drugs with a radioactive marker) to obtain an image of highly active areas of the parathyroid glands. The test can be done in two ways.



The parathyroid glands, embedded in the thyroid gland in the neck but separate from the thyroid gland in function, control calcium metabolism in the body by producing parathyroid hormone, or PTH. *(Custom Medical Stock Photo. Reproduced by permission.)*

Immediate scan

If the test is to be performed immediately, the patient lies down on an imaging table with his head and neck extended and immobilized. The patient is injected with the first radiopharmaceutical. After waiting 20 minutes, the patient is positioned under the camera for imaging. Each image takes five minutes. It is essential that the patient remain still during imaging.

After the first image, the patient is injected with a second radiopharmaceutical, and imaging continues for another 25 minutes. Total time for the test is about one hour: injection 10 minutes, waiting period 20 minutes, and imaging 30 minutes.

Another way to do this test is as follows. After the first images are acquired, the patient returns two hours later for additional images. Time for this procedure totals about three hours: injection 10 minutes, waiting period two hours and 20 minutes, and imaging 30 minutes.

Delayed scan

In a delayed parathyroid scan, the patient is asked to swallow capsules containing the first radiopharmaceutical. The patient returns after a four hour waiting period, and the initial image is made. Then the patient is injected with the second radiopharmaceutical. Imaging continues for another 25 minutes. The total time is about four hours and 40 minutes: waiting period four hours, injection 10 minutes, and imaging 30 minutes.

Preparation

No special preparations are necessary for this test. It is not necessary to fast or maintain a special diet. The

KEY TERMS

Cyst—An abnormal sac containing fluid or semi-solid material.

Goiter—Chronic enlargement of the thyroid gland.

Neoplasm—An uncontrolled growth of new tissue.

patient should wear comfortable clothing and no metal jewelry around the neck.

Aftercare

The patient should not feel any adverse effects of the test and can resume normal activities immediately.

Risks

The only risk associated with this test is to the fetus of a pregnant woman.

Normal results

Normal results will show no unusual activity in the parathyroid glands.

Abnormal results

A concentration of radioactive materials in the parathyroid gland beyond background levels suggests excessive activity and the presence of a tumor. False positive results sometimes result from the presence of multinodular **goiter**, neoplasm, or cysts. False positive tests are tests that interpret the results as abnormal when this is not true.

Resources

OTHER

"Parathyroid Scan." *HealthGate Page*. 13 June 1998 <http://www.healthgate.com>.

Tish Davidson

Parathyroidectomy

Definition

Parathyroidectomy is the removal of one or more of the parathyroid glands. The parathyroid glands are usually four in number, although the exact number may vary from three to seven. They are located in the neck in front of the Adam's apple and are closely linked to the thyroid gland. The parathyroid glands regulate the balance of calcium in the body.

Purpose

Parathyroidectomy is usually done to treat **hyperparathyroidism** (abnormal over-functioning of the parathyroid glands).

Precautions

Parathyroidectomy should only be done when other non-operative methods have failed to control the patient's hyperparathyroidism.

Description

Parathyroidectomy is an operation done most commonly by a general surgeon, or occasionally by an otolaryngologist, in the operating room of a hospital. The operation begins when the anesthesiologist anesthetizes or puts the patient to sleep. The surgeon makes an incision in the front of the neck where a tight-fitting necklace would rest. All of the parathyroid glands are identified. The surgeon then identifies the gland or glands with the disease and confirms the diagnosis by sending a piece of the gland(s) to the pathology department for immediate microscopic examination. The glands are then removed and the incision is closed and a dressing is placed over the incision.

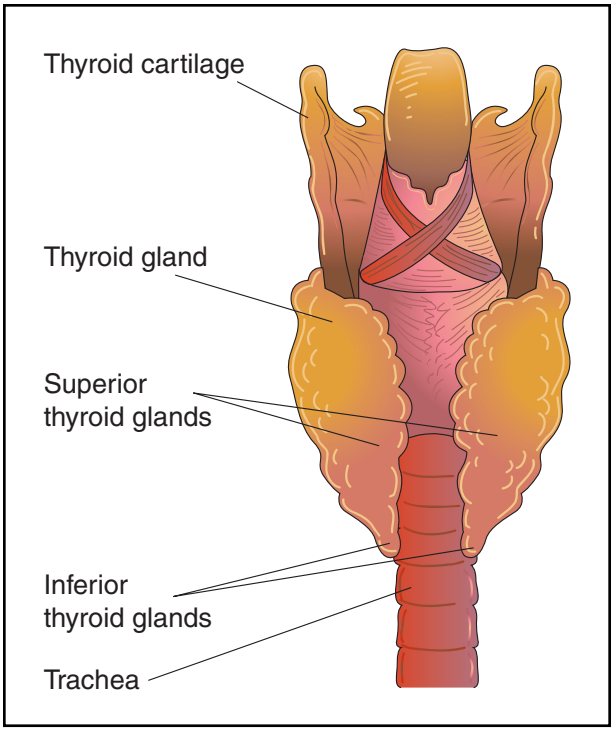
Patients generally stay overnight in the hospital after completion of the operation and may remain for one or two additional days. These procedures are reimbursed by insurance companies. Surgeon's fees typically range from $1,000–$2,000. Anesthesiologists charge for their services based on the medical status of the patient and the length of the operative procedure. Hospitals charge for use of the operating suite, equipment, lab and diagnostic tests, and medications.

Preparation

Prior to the operation, the diagnosis of hyperparathyroidism should be confirmed using lab tests. Occasionally, physicians order **computed tomography scans** (CT scans), ultrasound exams, and/or **magnetic resonance imaging** (MRI) tests to determine the total number of parathyroid glands and their location prior to the procedure.

Aftercare

The incision should be watched for signs of infection. In general, no specific wound care is required.



Parathyroidectomy refers to the surgical removal of one or more of the parathyroid glands due to hyperparathyroidism (an abnormal over-functioning of the parathyroid glands). It is usually done after other non-operative methods have failed to control or correct this condition. *(Illustration by Electronic Illustrators Group.)*

The level of calcium in the body should be monitored during the first 48 hours after the operation by obtaining frequent blood samples for laboratory analysis.

Risks

The major risk of parathyroidectomy is injury to the recurrent laryngeal nerve (a nerve that lies very near the parathyroid glands and serves the larynx or voice box). If this nerve is injured, the voice may become hoarse or weak.

Occasionally, too much parathyroid tissue is removed, and the patient may develop **hypoparathyroidism** (underfunctioning of the parathyroid glands). If this occurs, the patient will require daily calcium supplements.

Sometimes not all of the parathyroid glands are found in the initial operation. A fifth or sixth gland may be located in an aberrant location such as the chest (ectopic parathroid). If this occurs, the patient's hyperparathyroidism may not be corrected, and a second procedure may be required to find the other gland(s).

Hematoma formation (collection of blood under the incision) is a possible complication of any operative procedure. However, in procedures that involve the neck it is of particular concern, because a rapidly enlarging hematoma can obstruct the airway.

Infection of the surgical incision may occur, as with any operative procedure, but this is not common.

Normal results

Most patients require only two or three days of hospitalization to recover from the operation. They usually can resume most of their normal activities within one to two weeks.

KEY TERMS

Anesthesiologist—A physician who specializes in anesthetizing patients for operations.

Ectopic parathyroid tissue—A condition where the thyroid tissue is located in an abnormal place.

Hyperparathyroidism—Abnormal over-functioning of the parathyroid glands.

Hypoparathyroidism—Abnormal under-functioning of the parathyroid glands.

Otolaryngologist—A surgeon who treats people with abnormalities in the head and neck regions of the body.

Resources

BOOKS

Kaplan, Edwin. "Thyroid and Parathyroid." In *Principles of Surgery.* 6th ed. Ed. Seymour I. Schwartz, et al. New York: McGraw-Hill, 1994.

"Parathyroidectomy." In *The American Medical Association Encyclopedia of Medicine*, ed. Charles B. Claymon. New York: Random House, 1989.

OTHER

"Parathyroidectomy." *ThriveOnline.* <http://thriveonline.oxygen.com>.

Mary Jeanne Krob, MD, FACS

Paratyphoid fever

Definition

Paratyphoid fever, which is sometimes called *Salmonella paratyphi* infection, is a serious contagious disease

caused by a gram-negative bacterium. It is also grouped together with **typhoid fever** under the name enteric fever.

Description

Enteric fever is increasingly rare in the United States. Of the 500 cases reported in an average year, about 60% are infections acquired during travel in Mexico, India, or South America.

Paratyphoid fever has three stages: an early stage marked by high fever; a toxic stage with abdominal **pain** and intestinal symptoms, and a long period of recovery from fever (defervescence). In adults, these three phases may cover a period of four to six weeks; in children, they are shorter and may cover 10 days to two weeks. During the toxic stage there is a 1–10% chance of intestinal perforation or hemorrhage.

Causes and symptoms

Paratyphoid fever is caused by any of three strains of *Salmonella paratyphi*: *S. paratyphi A*; *S. schottmuelleri* (also called *S. paratyphi B*); or *S. hirschfeldii* (also called *S. paratyphi C*). It can be transmitted from animals or animal products to humans or from person to person. The incubation period is one to two weeks but is often shorter in children. Symptom onset may be gradual in adults but is often sudden in children.

Paratyphoid fever is marked by high fever, **headache**, loss of appetite, vomiting, and **constipation** or **diarrhea**. The patient typically develops an enlarged spleen. About 30% of patients have rose spots on the front of the chest during the first week of illness. The rose spots develop into small hemorrhages that may be hard to see in African or Native Americans.

Patients with intestinal complications have symptoms resembling those of **appendicitis**: intense cramping pain with soreness in the right lower quadrant of the abdomen.

Diagnosis

The diagnosis is usually made on the basis of a history of recent travel and culturing the paratyphoid organism. Because the disease is unusual in the United States, the doctor may not consider paratyphoid in the diagnosis unless the patient has the classic symptoms of an enlarged spleen and rose spots. The doctor will need to rule out other diseases with high fevers, including **typhus**, **brucellosis**, **tularemia** (rabbit fever), psittacosis (**parrot fever**), mononucleosis, and **Kawasaki syndrome**. *S. paratyphi* is easily cultured from samples of blood, stool, urine, or bone marrow.

Treatment

Medications

Paratyphoid fever is treated with **antibiotics** over a two- to three-week period with trimethoprim-sulfamethoxazole (Bactrim, Septra); amoxicillin (Amoxil, Novamoxin); and ampicillin (Amcill). Third-generation **cephalosporins** (ceftriaxone [Rocephin], cefotaxime [Claforan], or cefixime [Suprax]) or chloramphenicol (Chloromycetin) may be given if the specific strain is resistant to other antibiotics.

Surgery

Patients with intestinal perforation or hemorrhage may need surgery if the infection cannot be controlled by antibiotics.

Supportive care

Patients with paratyphoid fever need careful monitoring for signs of complications as well as bed rest and nutritional support. Patients with severe infections may require fluid replacement or blood transfusions.

Prognosis

Most patients with paratyphoid fever recover completely, although intestinal complications can result in **death**. With early treatment, the mortality rate is less than 1%.

Prevention

Immunization

Vaccination against paratyphoid fever is not necessary within the United States but is recommended for travel to countries with high rates of enteric fever.

Hygienic measures

Travelers in countries with high rates of paratyphoid fever should be careful to wash hands before eating and to avoid meat, egg, or poultry dishes unless they have been thoroughly cooked.

Resources

BOOKS

"Chloramphenicol." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hormaeche, Carlos E. "Salmonella, Infection and Immunity." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

KEY TERMS

Defervescence—Return to normal body temperature after high fever.

Enteric fever—A term that is sometimes used for either typhoid or paratyphoid fever.

Rose spots—Small slightly raised reddish pimples that are a distinguishing feature of typhoid or paratyphoid infection.

Hull, Anne E. "Salmonellae." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Ogle, John W. "Infections: Bacterial and Spirochetal." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Paresthesias *see* **Numbness and tingling**

Parkinson's disease

Definition

Parkinson's disease (PD) is a progressive movement disorder marked by **tremors**, rigidity, slow movements (bradykinesia), and posture instability. It occurs when cells in one of the movement-control centers of the brain begin to die for unknown reasons. PD was first noted by British physician James Parkinson in the early 1800s.

Description

Usually beginning in a person's late fifties or early sixties, Parkinson disease causes a progressive decline in movement control, affecting the ability to control initiation, speed, and smoothness of motion. Symptoms of PD are seen in up to 15% of those ages 65–74, and almost 30% of those ages 75–84.

Most cases of PD are sporadic. This means that there is a spontaneous and permanent change in nucleotide sequences (the building blocks of genes). Sporadic mutations also involve unknown environmental factors in combination with genetic defects. The abnormal gene (mutated gene) will form an altered end-product or protein. This will cause abnormalities in specific areas in the body where the protein is used. Some evidence suggests that the disease is transmitted by autosomal dominant inheritance. This implies that an affected parent has a 50% chance of transmitting the disease to any child. This type of inheritance is not commonly observed. The most recent evidence is linking PD with a gene that codes for a protein called alpha-synuclein. Further research is attempting to fully understand the relationship with this protein and nerve cell degeneration.

PD affects approximately 500,000 people in the United States, both men and women, with as many as fifty thousand new cases each year.

Causes and symptoms

The immediate cause of PD is degeneration of brain cells in the area known as the substantia nigra, one of the movement control centers of the brain. Damage to this area leads to the cluster of symptoms known as "parkinsonism." In PD, degenerating brain cells contain Lewy bodies, which help identify the disease. The cell death leading to parkinsonism may be caused by a number of conditions, including infection, trauma, and **poisoning**. Some drugs given for **psychosis**, such as haloperidol (Haldol) or chlorpromazine (thorazine), may cause parkinsonism. When no cause for nigral cell degeneration can be found, the disorder is called idiopathic parkinsonism, or Parkinson disease. Parkinsonism may be seen in other degenerative conditions, known as the "parkinsonism plus" syndromes, such as **progressive supranuclear palsy**.

The substantia nigra, or "black substance," is one of the principal movement control centers in the brain. By releasing the neurotransmitter known as dopamine, it helps to refine movement patterns throughout the body. The dopamine released by nerve cells of substantia nigra stimulates another brain region, the corpus striatum. Without enough dopamine, the corpus striatum cannot control its targets, and so on down the line. Ultimately, the movement patterns of walking, writing, reaching for objects, and other basic programs cannot operate properly, and the symptoms of parkinsonism are the result.

There are some known toxins that can cause parkinsonism, most notoriously a chemical called MPTP, found as an impurity in some illegal drugs. Parkinsonian symptoms appear within hours of ingestion, and are permanent. MPTP may exert its effects through generation of toxic molecular fragments called free radicals, and reducing free radicals has been a target of several experimental treatments for PD using antioxidants.

It is possible that early exposure to some as-yet-unidentified environmental toxin or virus leads to undetected nigral cell death, and PD then manifests as normal age-related decline brings the number of functioning nigral cells below the threshold needed for normal move-

ment. It is also possible that, for genetic reasons, some people are simply born with fewer cells in their substantia nigra than others, and they develop PD as a consequence of normal decline.

Symptoms

The identifying symptoms of PD include:

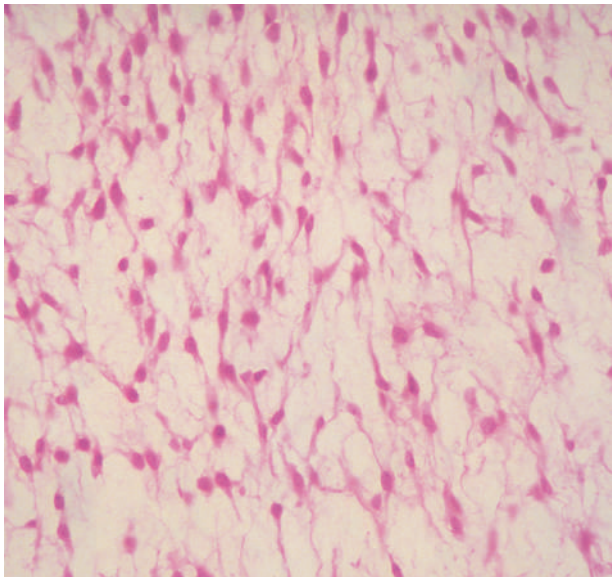
- Tremors, usually beginning in the hands, often occuring on one side before the other. The classic tremor of PD is called a "pill-rolling tremor," because the movement resembles rolling a pill between the thumb and forefinger. This tremor occurs at a frequency of about three per second.
- Slow movements (bradykinesia) occur, which may involve slowing down or stopping in the middle of familiar tasks such as walking, eating, or shaving. This may include freezing in place during movements (akinesia).
- Muscle rigidity or stiffness, occuring with jerky movements replacing smooth motion.
- Postural instability or balance difficulty occurs. This may lead to a rapid, shuffling gait (festination) to prevent falling.
- In most cases, there is a "masked face," with little facial expression and decreased eye-blinking.

In addition, a wide range of other symptoms may often be seen, some beginning earlier than others:

- depression
- speech changes, including rapid speech without inflection changes
- problems with sleep, including restlessness and nightmares
- emotional changes, including fear, irritability, and insecurity
- incontinence
- **constipation**
- handwriting changes, with letters becoming smaller across the page (micrographia)
- progressive problems with intellectual function (**dementia**)

Diagnosis

The diagnosis of Parkinson's disease involves a careful medical history and a neurological exam to look for characteristic symptoms. There are no definitive tests for PD, although a variety of lab tests may be done to rule out other causes of symptoms, especially if only some of the identifying symptoms are present. Tests for other causes of parkinsonism may include brain scans, blood tests, lumbar puncture, and x rays.



A sample of fetal nigral cells. Transplantation of these cells to treat Parkinson's disease is a highly experimental and controversial procedure. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

There is no cure for Parkinson's disease. Most drugs treat the symptoms of the disease only, although one drug, selegiline (Eldepryl), may slow degeneration of the substantia nigra.

Exercise, nutrition, and physical therapy

Regular, moderate **exercise** has been shown to improve motor function without an increase in medication for a person with PD. Exercise helps maintain range of motion in stiff muscles, improve circulation, and stimulate appetite. An exercise program designed by a physical therapist has the best chance of meeting the specific needs of the person with PD. A physical therapist may also suggest strategies for balance compensation and techniques to stimulate movement during slowdowns or freezes.

Good **nutrition** is important to maintenance of general health. A person with PD may lose some interest in food, especially if depressed, and may have nausea from the disease or from medications, especially those known as dopamine agonists. Slow movements may make it difficult to eat quickly, and delayed gastric emptying may lead to a feeling of fullness without having eaten much. Increasing fiber in the diet can improve constipation, soft foods can reduce the amount of needed chewing, and a prokinetic drug such as cisapride (Propulsid) can increase the movement of food through the digestive system.

People with PD may need to limit the amount of protein in their **diets**. The main drug used to treat PD, L-dopa, is an amino acid, and is absorbed by the digestive system by the same transporters that pick up other amino acids broken down from proteins in the diet. Limiting protein, under the direction of the physician or a nutritionist, can improve the absorption of L-dopa.

No evidence indicates that vitamin or mineral supplements can have any effect on the disease other than in the improvement of the patient's general health. No antioxidants used to date have shown promise as a treatment except for selegiline, an MAO-B inhibitor which is discussed in the Drugs section. A large, carefully controlled study of vitamin E demonstrated that it could not halt disease progression.

Drugs

The pharmacological treatment of Parkinson disease is complex. While there are a large number of drugs that can be effective, their effectiveness varies with the patient, disease progression, and the length of time the drug has been used. Dose-related side effects may preclude using the most effective dose, or require the introduction of a new drug to counteract them. There are five classes of drugs currently used to treat PD.

DRUGS THAT REPLACE DOPAMINE. One drug that helps replace dopamine, levodopa (L-dopa), is the single most effective treatment for the symptoms of PD. L-dopa is a derivative of dopamine, and is converted into dopamine by the brain. It may be started when symptoms begin, or when they become serious enough to interfere with work or daily living.

L-dopa therapy usually remains effective for five years or longer. Following this, many patients develop motor fluctuations, including peak-dose "dyskinesias" (abnormal movements such as tics, twisting, or restlessness), rapid loss of response after dosing (known as the "on-off" phenomenon), and unpredictable drug response. Higher doses are usually tried, but may lead to an increase in dyskinesias. In addition, side effects of L-dopa include **nausea and vomiting**, and low blood pressure upon standing (**orthostatic hypotension**), which can cause **dizziness**. These effects usually lessen after several weeks of therapy.

ENZYME INHIBITORS. Dopamine is broken down by several enzyme systems in the brain and elsewhere in the body, and blocking these enzymes is a key strategy to prolonging the effect of dopamine. The two most commonly prescribed forms of L-dopa contain a drug to inhibit the amino acid decarboxylase (an AADC inhibitor), one type of enzyme that breaks down dopamine. These combination drugs are Sinemet (L-dopa plus carbidopa) and Madopar (L-dopa plus benzaseride). Controlled-release formulations also aid in prolonging the effective interval of an L-dopa dose.

The enzyme monoamine oxidase B (MAO-B) inhibitor selegiline may be given as add-on therapy for L-dopa. Research indicates selegiline may have a neuroprotective effect, sparing nigral cells from damage by free radicals. Because of this, and the fact that it has few side effects, it is also frequently prescribed early in the disease before L-dopa is begun. Entacapone and tolcapone, two inhibitors of another enzyme system called catechol-O-methyltransferase (COMT), may soon reach the market as early studies suggest that they effectively treat PD symptoms with fewer motor fluctuations and decreased daily L-dopa requirements.

DOPAMINE AGONISTS. Dopamine works by stimulating receptors on the surface of corpus striatum cells. Drugs that also stimulate these cells are called dopamine agonists, or DAs. DAs may be used before L-dopa therapy, or added on to avoid requirements for higher L-dopa doses late in the disease. DAs available in the United States as of early 1998, include bromocriptine (Permax, Parlodel), pergolide (Permax), and pramipexole (Mirapex). Two more, cabergoline (Dostinex) and ropinirole (Requip), are expected to be approved soon. Other dopamine agonists in use elsewhere include lisuride (Dopergine) and apomorphine. Side effects of all the DAs are similar to those of dopamine, plus confusion and **hallucinations** at higher doses.

ANTICHOLINERGIC DRUGS. Anticholinergics maintain dopamine balance as levels decrease. However, the side effects of anticholinergics (**dry mouth**, constipation, confusion, and blurred vision) are usually too severe in older patients or in patients with dementia. In addition, anticholinergics rarely work for very long. They are often prescribed for younger patients who have predominant shaking. Trihexyphenidyl (Artane) is the drug most commonly prescribed.

DRUGS WHOSE MODE OF ACTION IS UNCERTAIN. Amantadine (Symmetrel) is sometimes used as an early therapy before L-dopa is begun, and as an add-on later in the disease. Its anti-parkinsonian effects are mild, and are not seen in many patients. Clozapine (Clozaril) is effective especially against psychiatric symptoms of late PD, including psychosis and hallucinations.

Surgery

Two surgical procedures are used for treatment of PD that cannot be controlled adequately with drug therapy. In PD, a brain structure called the globus pallidus

(GPi) receives excess stimulation from the corpus striatum. In a pallidotomy, the GPi is destroyed by heat, delivered by long thin needles inserted under anesthesia. Electrical stimulation of the GPi is another way to reduce its action. In this procedure, fine electrodes are inserted to deliver the stimulation, which may be adjusted or turned off as the response dictates. Other regions of the brain may also be stimulated by electrodes inserted elsewhere. In most patients, these procedures lead to significant improvement for some motor symptoms, including peak-dose dyskinesias. This allows the patient to receive more L-dopa, since these dyskinesias are usually what causes an upper limit on the L-dopa dose.

A third procedure, transplant of fetal nigral cells, is still highly experimental. Its benefits to date have been modest, although improvements in technique and patient selection are likely to change that.

Alternative treatment

Currently, the best treatments for PD involve the use of conventional drugs such as levodopa. Alternative therapies, including **acupuncture**, massage, and **yoga**, can help relieve some symptoms of the disease and loosen tight muscles. Alternative practitioners have also applied herbal and dietary therapies, including amino acid supplementation, antioxidant (**vitamins** A, C, E, selenium, and zinc) therapy, B vitamin supplementation, and calcium and magnesium supplementation, to the treatment of PD. Anyone using these therapies in conjunction with conventional drugs should check with their doctor to avoid the possibility of adverse interactions. For example, vitamin B_6 (either as a supplement or from foods such as whole grains, bananas, beef, fish, liver, and potatoes) can interfere with the action of L-dopa when the drug is taken without carbidopa.

Prognosis

Despite medical treatment, the symptoms of Parkinson disease worsen over time, and become less responsive to drug therapy. Late-stage psychiatric symptoms are often the most troubling, including difficulty sleeping, nightmares, intellectual impairment (dementia), hallucinations, and loss of contact with reality (psychosis).

Prevention

There is no known way to prevent Parkinson disease.

KEY TERMS

AADC inhibitors—Drugs that block the amino acid decarboxylase; one type of enzyme that breaks down dopamine. Also called DC inhibitors, they include carbidopa and benserazide.

Akinesia—A loss of the ability to move; freezing in place.

Bradykinesia—Extremely slow movement.

COMT inhibitors—Drugs that block catechol-O-methyltransferase, an enzyme that breaks down dopamine. COMT inhibitors include entacapone and tolcapone.

Dopamine—A neurochemical made in the brain that is involved in many brain activities, including movement and emotion.

Dyskinesia—Impaired ability to make voluntary movements.

MAO-B inhibitors—Inhibitors of the enzyme monoamine oxidase B. MAO-B helps break down dopamine; inhibiting it prolongs the action of dopamine in the brain. Selegiline is an MAO-B inhibitor.

Orthostatic hypotension—A sudden decrease in blood pressure upon sitting up or standing. May be a side effect of several types of drugs.

Substantia nigra—One of the movement control centers of the brain.

Resources

BOOKS

Biziere, Kathleen, and Matthias Kurth. *Living With Parkinson Disease*. New York: Demos Vermande, 1997.

PERIODICALS

"An Algorithm for the Management of Parkinson Disease." *Neurology* 44/supplement 10 (December 1994): 12. <http://neuro-chief-e.mgh.harvard.edu/parkinsonsweb/Main/Drugs/ManPark1.html>.

ORGANIZATIONS

National Parkinson Foundation. 1501 NW Ninth Ave., Bob Hope Road, Miami, FL 33136. <http://www.parkinson.org>.

Parkinson Disease Foundation. 710 West 168th St. New York, NY 10032. (800) 457-6676. <http://www.apdaparkinson.com>.

Worldwide Education and Awareness for Movement Disorders (WE MOVE). Mt. Sinai Medical Center, 1 Gustave Levy Place, New York, NY 10029. (800) 437-MOV2. <http://www.wemove.org>.

OTHER

AWAKENINGS. <http://www.parkinsonsdisease.com>.

Laith Farid Gulli, MD

Parkinsonism *see* **Parkinson's disease**
Parotid gland removal *see* **Parotidectomy**
Parotid gland scan *see* **Salivary gland scan**

Parotidectomy

Definition

Parotidectomy is the removal of the parotid gland, a salivary gland near the ear.

Purpose

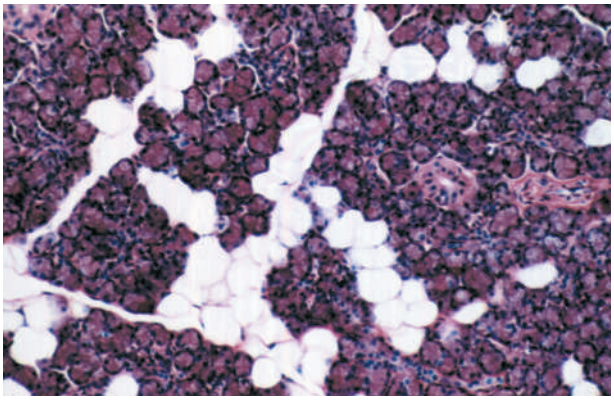
The main purpose of parotidectomy is to remove cancerous tumors in the parotid gland. A number of tumors can develop in the parotid gland. Many of these are tumors that have spread from other areas of the body, entering the parotid gland by way of the lymphatic system. Among the tumors seen in the parotid gland are lymphoma, melanoma, and squamous cell carcinoma.

Description

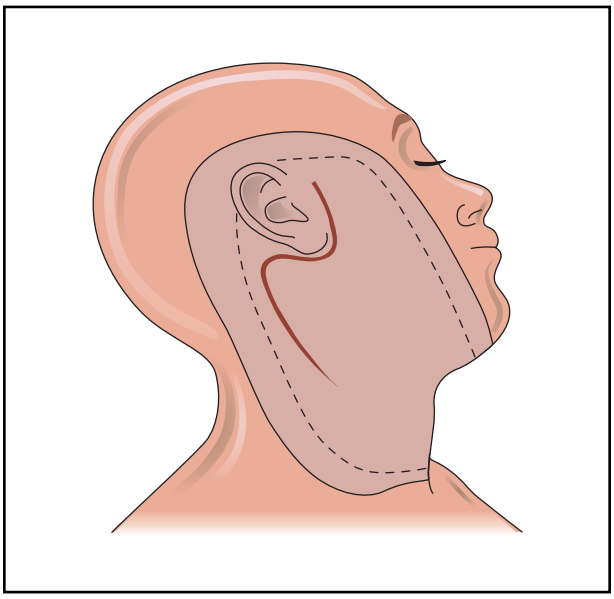
The parotid gland is the largest of the salivary glands. There are two parotid glands, one on each side of the face. They lie just in front of the ears and a duct runs from each to the inside of the cheek. Each parotid gland has several lobes. Surgery is recommend as part of the treatment for all cancers in the parotid gland. Superficial or localized parotidectomy is recommended by some authorities, unless a lipoma or Warthin's tumor is present. One of the advantages to this approach is that nerves to facial muscles are left intact. Many facial nerves run through the same area as the parotid gland and can be damaged during more complete parotidectomies. Most authorities recommend total parotidectomy, especially if **cancer** is found in both the superficial and deep lobes of the parotid gland. If the tumor has spread to involve the facial nerve, the operation is expanded to include parts of bone behind the ear (mastoid) to remove as much tumor as possible. Some authorities recommend post-surgery radiation as follow-up treatment for cancer.

Aftercare

After surgery, the patient will remain in the hospital for one to three days. The site of incision will be watched closely for signs of infection and heavy bleeding (hemorrhage). The incision site should be kept clean and dry until it is completely healed. The patient should not wash their hair until the stitches have been removed. If the patient has difficulty smiling, winking, or drinking fluids, the physician should be contacted immediately. These are signs of facial nerve damage.



A micrograph of a normal human parotid gland. One of the salivary glands, the parotid consists of acini arranged in lobes. This image shows a junction between several lobes; the clear spaces represent the interlobular connective tissue. The masses of secretory cells produce a watery secretion which is passed to the intralobular. *(Photograph by Astrid and Hanns-Frieder Michler, Custom Medical Stock Photo. Reproduced by permission.)*



Parotidectomy is a surgical procedure performed to remove cancerous tumors in the parotid gland, a salivary gland near the ear. Among the tumors seen in the parotid gland are lymphoma, melanoma, and squamous cell carcinoma. The illustration above shows the facial incision sites for this procedure. *(Illustration by Electronic Illustrators Group.)*

KEY TERMS

Fistula—An abnormal opening or duct through tissue that results from injury, disease, or other trauma.

Salivary gland—Three pairs of glands that secrete into the mouth and aid digestion.

Risks

There are a number of complications that follow parotidectomy. Facial nerve **paralysis** after minor surgery should be minimal. During surgery, it is possible to repair cut nerves. After major surgery, a graft is attempted to restore nerve function to facial muscles. Salivary fistulas can occur when saliva collects in the incision site or drains through the incision. Reoccurrence of cancer is the single most important consideration for patients who have undergone parotidectomy. Long term survival rates are largely dependent on the tumor types and the stage of tumor development at the time of the operation.

Other risks include blood clots (hematoma) and infection. The most common long-term complication of parotidectomy is redness and sweating in the cheek, known as Frey's syndrome. Rarely, paralysis may extend throughout all the branches of the facial nervous system.

Resources

BOOKS

Bentz, M. L. *Pediatric Plastic Surgery.* Stamford: Appleton & Lange, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Lee, K. J. *Essential Otolaryngology.* Norwalk: Appleton & Lange, 1995.

Mary K. Fyke

Parotitis, epidemic *see* **Mumps**

Paroxetine *see* **Selective serotonin reuptake inhibitors**

Paroxysmal atrial tachycardia

Definition

A period of very rapid and regular heart beats that begins and ends abruptly. The heart rate is usually between 160 and 200 beats per minute. This condition is also known as paroxysmal supraventricular tachycardia.

Description

The term paroxysmal means that the event begins suddenly, without warning and ends abruptly. Atrial tachycardia means that the upper chambers of the heart are beating abnormally fast. Paroxysmal atrial tachycardia can occur without any heart disease being present. It is usually more annoying than dangerous.

Causes and symptoms

Paroxysmal atrial tachycardia may be caused by several different things. The fast rate may be triggered by a premature atrial beat that sends an impulse along an abnormal electrical path to the ventricles. Other causes stem from **anxiety**, stimulants, overactive thyroid, and in some women, the onset of menstruation.

Though seldom life-threatening, paroxysmal atrial tachycardia produces annoying symptoms which can include lightheadedness, chest **pain**, **palpitations**, anxiety, sweating, and **shortness of breath**.

Diagnosis

Diagnosis is not always easy, because the event is usually over by the time the patient sees a doctor. A careful description of the episode will aid the doctor in his diagnosis. If the rapid heart rate is still occurring, an electrocardiograph (ECG) will show the condition. If the event is over, physicians often recommend a period of ambulatory electrocardiographic monitoring (called **Holter monitoring**) to confirm the diagnosis.

Treatment

The doctor may suggest that during an episode of paroxysmal atrial tachycardia the following practice may help. Briefly hold the nose and mouth closed and breathe out, or by bearing down, as though straining at a bowel movement. The doctor may try to stop the episode by gently massaging an area in the neck called the carotid sinus.

If these conservative measures don't work, an injection of the drug verapamil or adenosine should stop the episode quickly.

In rare cases, the drugs do not work and electrical shock (**cardioversion**) may be necessary, particularly if serious symptoms are also present with the tachycardia.

Prognosis

Paroxysmal atrial tachycardia is not a disease, and is seldom life-threatening. The episodes are usually more

KEY TERMS

Premature atrial beat—A beat that occurs before it would normally be expected.

Supraventricular—A term for an event that occurs in the upper chambers (atria) of the heart.

unpleasant than they are dangerous, and the prognosis is generally good.

Prevention

Frequent episodes are usually cause for medication. In rare cases, the doctor may recommend a procedure called **catheter ablation**, which will remove (or ablate) the precise area of the heart responsible for triggering the fast heart rate.

In a catheter ablation procedure, the doctor will place a special catheter against the area of the heart responsible for the problem. Radio-frequency energy is then passed to the tip of the catheter, so that it heats up and destroys the target area. Catheter ablation is considered a non-surgical technique.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health.* New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Paroxysmal supraventricular tachycardia *see* **Paroxysmal atrial tachycardia**

Parrot fever

Definition

Parrot fever is a rare infectious disease that causes **pneumonia** in humans. It is transmitted from pet birds or poultry. The illness is caused by a chlamydia, which is a type of intracellular parasite closely related to bacteria. Parrot fever is also called chlamydiosis, psittacosis, or ornithosis.

Description

Parrot fever, which is referred to as avian psittacosis when it infects birds, is caused by *Chlamydia psittaci*. Pet birds in the parrot family, including parrots, parakeets, macaws, and cockatiels, are the most common carriers of the infection. Other birds that may also spread *C. psittaci* include pigeons, doves, mynah birds, and turkeys. Birds that are carrying the organism may appear healthy, but can shed it in their feces. The symptoms of avian psittacosis include inactivity, loss of appetite and ruffled feathers, **diarrhea**, runny eyes and nasal discharge, and green or yellow-green urine. Sick birds can be treated with **antibiotics** by a veterinarian.

C. psittaci is usually spread from birds to humans through exposure to infected bird feces during cage cleaning or by handling infected birds. In humans, parrot fever can range in severity from minor flu-like symptoms to severe and life-threatening pneumonia.

Causes and symptoms

Parrot fever is usually transmitted by inhaling dust from dried bird droppings or by handling infected birds. Humans can also spread the disease by person-to-person contact, but that is very rare. The symptoms usually develop within five to 14 days of exposure and include **fever**, **headache**, chills, loss of appetite, **cough**, and tiredness. In the most severe cases of parrot fever, the patient develops pneumonia. People who work in pet shops or who keep pet birds are the most likely to become infected.

Diagnosis

Only 100–200 cases of parrot fever are reported each year in the United States. It is possible, however, that the illness is more common since it is easily confused with other types of **influenza** or pneumonia. Doctors are most likely to consider a diagnosis of parrot fever if the patient has a recent history of exposure to birds. The diagnosis can be confirmed by blood tests for antibodies, usually complement fixation or immunofluorescence tests. The organism is difficult to culture. A **chest x ray** may also be used to diagnose the pneumonia caused by *C. psittaci*.

Treatment

Psittacosis is treated with an antibiotic, usually tetracycline (Achromycin, Sumycin); doxycycline (Doxy, Vibramycin); or erythromycin (Eryc, Ilotycin). Oral medication is typically prescribed for at least 10–14 days. Severely ill patients may be given intravenous antibiotics for the first few days of therapy.

KEY TERMS

Avian chlamydiosis—An illness in pet birds and poultry caused by *Chlamydia psittaci*. It is also known as parrot fever in birds.

Chlamydia psittaci—An organism related to bacteria that infects some types of birds and can be transmitted to humans to cause parrot fever.

Chlamydiosis, psittacosis, or ornithosis—Other names for parrot fever in humans.

Prognosis

The prognosis for recovery is excellent; with antibiotic treatment, more than 99% of patients with parrot fever will recover. Severe infections, however, may be fatal to the elderly, untreated persons, and persons with weak immune systems.

Prevention

As of 1998, there is no vaccine that is effective against parrot fever. Birds that are imported into the country as pets should be quarantined to ensure that they are not infected before they can be sold. Health authorities recommend that breeders and importers feed imported birds a special blend of feed mixed with antibiotics for 45 days to ensure that any *C. psittaci* organisms are destroyed. In addition, bird cages and food and water bowls should be cleaned daily.

Resources

BOOKS

"Psittacosis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

PERIODICALS

"Compendium of Psittacosis (Chlamydiosis) Control, 1997." *Morbidity & Mortality Weekly Report* 46 (18 July 1997): 1-13.

Gregory, D. W., and W. Schaffner. "Psittacosis." *Seminars in Respiratory Infection* 12, no. 1 (Mar. 1997): 7-11.

Huges, C., et al. "Possible nosocomial transmission of psittacosis." *Infection Control Hospital Epidemiology* 18, no. 3 (Mar. 1997): 165-168.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Psittacosis (Parrot Fever; Ornithosis)." *ThriveOnline*. <http://thriveonline.oxygen.com>.

Altha Roberts Edgren

Partial birth abortion *see* **Abortion, partial birth**

Partial thromboplastin time

Definition

The partial thromboplastin time (PTT) test is a blood test that is done to investigate bleeding disorders and to monitor patients taking an anticlotting drug (heparin).

Purpose

Diagnosis

Blood clotting (coagulation) depends on the action of substances in the blood called clotting factors. Measuring the partial thromboplastin time helps to assess which specific clotting factors may be missing or defective.

Monitoring

Certain surgical procedures and diseases cause blood clots to form within blood vessels. Heparin is used to treat these clots. The PTT test can be used to monitor the effect of heparin on a patient's coagulation system.

Precautions

Certain medications besides heparin can affect the results of the PPT test. These include **antihistamines**, vitamin C (ascorbic acid), **aspirin**, and chlorpromazine (Thorazine).

Description

When a body tissue is injured and begins to bleed, it starts a sequence of clotting factor activities called the coagulation cascade, which leads to the formation of a blood clot. The cascade has three pathways: extrinsic, intrinsic, and common. Many of the thirteen known clotting factors in human blood are shared by both pathways; several are found in only one. The PTT test evaluates the factors found in the intrinsic and common pathways. It is usually done in combination with other tests, such as the prothrombin test, which evaluate the factors of the extrin-

KEY TERMS

Activated partial thromboplastin time—Partial thromboplastin time test that uses activators to shorten the clotting time, making it more useful for heparin monitoring.

Clotting factors—Substances in the blood that act in sequence to stop bleeding by forming a clot.

Coagulation—The process of blood clotting.

Coagulation cascade—The sequence of biochemical activities, involving clotting factors, that stop bleeding by forming a clot.

Common pathway—The pathway that results from the merging of the extrinsic and intrinsic pathways. The common pathway includes the final steps before a clot is formed.

Extrinsic pathway—One of three pathways in the coagulation cascade.

Heparin—A medication that prevents blood clots.

Intrinsic pathway—One of three pathways in the coagulation cascade.

Partial thromboplastin time—A test that checks the clotting factors of the intrinsic pathway.

Plasma—The fluid part of blood, as distinguished from blood cells.

sic pathway. The combination of tests narrows the list of possible missing or defective factors.

Heparin prevents clotting by blocking certain factors in the intrinsic pathway. The PTT test allows a doctor to check that there is enough heparin in the blood to prevent clotting, but not so much as to cause bleeding. The test is done before the first dose of heparin or whenever the dosage level is changed; and again when the heparin has reached a constant level in the blood. The PTT test is repeated at scheduled intervals.

The PTT test uses blood to which a chemical has been added to prevent clotting before the test begins. About 5 mL of blood are drawn from a vein in the patient's inner elbow region. Collection of the sample takes only a few minutes. The blood is spun in a centrifuge, which separates the pale yellow liquid part of blood (plasma) from the cells. Calcium and activating substances are added to the plasma to start the intrinsic pathway of the coagulation cascade. The partial thromboplastin time is the time it takes for a clot to form, measured in seconds.

The test can be done without activators, but they are usually added to shorten the clotting time, making the test more useful for monitoring heparin levels. When activators are used, the test is called activated partial thromboplastin time or APTT.

Test results can be obtained in less than one hour. The test is usually covered by insurance.

Preparation

The doctor should check to see if the patient is taking any of the medications that may influence the test results. If the patient is on heparin therapy, the blood sample is drawn one hour before the next dose of heparin.

Aftercare

Aftercare includes routine care of the puncture site. In addition, patients on heparin therapy must be watched for signs of spontaneous bleeding. The patient should not be left alone until the doctor or nurse is sure that bleeding has stopped. Patients should also be advised to watch for bleeding gums, bruising easily, and other signs of clotting problems; to avoid activities that might cause minor cuts or **bruises**; and to avoid using aspirin.

Risks

The patient may develop a bruise or swelling around the puncture site, which can be treated with moist warm compresses. People with coagulation problems may bleed for a longer period than normal.

Normal results

Normal results vary based on the method and activators used. Normal APTT results are usually between 25–40 seconds; PTT results are between 60–70 seconds. APTT results for a patient on heparin should be 1.5–2.5 times normal values. An APTT longer than 100 seconds indicates spontaneous bleeding.

Abnormal results

Increased levels in a person with a bleeding disorder indicate a clotting factor may be missing or defective. Further tests are done to identify the factor involved. Liver disease decreases production of factors, increasing the PTT.

Low levels in a patient on heparin indicate too little heparin is in the blood to prevent clots. High levels indicate too much heparin is present, placing the person at risk of excessive bleeding.

Resources

BOOKS

Miller, Jonathan L. "Blood Coagulation and Fibrinolysis." In *Clinical Diagnosis and Management by Laboratory Methods*, ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Berry, Brian R., and Stephen Nantel. "Heparin Therapy: Current Regimens and Principles of Monitoring." *Postgraduate Medicine* 99 (June 1996): 64-76.

Nancy J. Nordenson
Altha Roberts Edgren

Parvovirus B19 infection *see* **Fifth disease**

Pasteurellosis *see* **Animal bite infections**

Patau syndrome

Definition

Patau syndrome, also called trisomy 13, is a congenital (present at birth) disorder associated with the presence of an extra copy of chromosome 13. The extra chromosome 13 causes numerous physical and mental abnormalities, especially heart defects. Patau syndrome is named for Dr. Klaus Patau, who reported the syndrome and its association with trisomy in 1960.

Description

Children normally inherit 23 chromosomes from each parent, for a total of 46 chromosomes. A typical human being has 46 chromosomes: 22 pairs of non-sex linked chromosomes and one pair of sex-linked chromosomes, that determine that child's sex. Sometimes a child may end up with more than 46 chromosomes because of problems with the father's sperm or the mother's egg; or, because of mutations that occurred after the sperm and the egg fused to form the embryo (conception).

Normally, there are two copies of each of the 23 chromosomes: one from each parent. A condition called trisomy occurs when three, instead of two, copies of a chromosome are present in a developing human embryo. An extra copy of a particular chromosome can come either from the egg or sperm, or because of mutations that occur after conception.

The most well-known trisomy-related disorder is **Down syndrome** (trisomy 21), in which the developing embryo has an extra copy of chromosome 21. Patau syndrome is trisomy 13, in which the developing embryo has three copies of chromosome 13.

An extra copy of chromosome 13 is not the only cause of Patau syndrome. Other changes in chromosome 13, such as mispositioning (translocation), can also result in the characteristics classified as Patau syndrome. In these cases, an error occurs that causes a portion of chromosome 13 to be exchanged for a portion of another chromosome. There is no production of extra chromosomes; but, a portion of each affected chromosome is "misplaced" (translocated) to another chromosome.

Patau syndrome causes serious physical and mental abnormalities including: heart defects; incomplete brain development; unusual facial features such as a sloping forehead, a smaller than average head (microcephaly), small or missing eyes, low set ears, and cleft palate or hare lip; extra fingers and toes (polydactyly); abnormal genitalia; spinal defects; seizures; gastrointestinal hernias, particularly at the navel (omphalocele); and **mental retardation**. Due to the severity of these conditions, fewer than 20% of those affected with Patau syndrome survive beyond infancy.

Genetic profile

When an extra copy (trisomy) of a chromosome is made, it may either be a total trisomy (in which an extra copy of the entire chromosome is made), or partial trisomy (in which only one part of the chromosome is made an extra time).

In most cases of trisomy, errors in chromosome duplication occur at conception because of problems with the egg or the sperm that are coming together to produce an offspring. In these cases, every cell in the body of the offspring has an extra copy of the affected chromosome. However, errors in chromosome duplication may also occur during the rapid cell division that takes place immediately after conception. In these cases, only some cells of the body have the extra chromosome error. The condition in which only some of the cells in the body have the extra chromosome is called mosaicism.

Seventy-five to 80 percent of the cases of Patau syndrome are caused by a trisomy of chromosome 13. Some of these cases are the result of a total trisomy, while others are the result of a partial trisomy. Partial trisomy generally causes less severe physical symptoms than full trisomy. Ten percent of these cases are of the mosaic type, in which only some of the body's cells have the extra chromosome. The physical symptoms of the mosaic form of Patau syndrome depends on the number and type of cells that carry the trisomy.

Most cases of trisomy are not passed on from one generation to the next. Usually they result from a malfunction in the cell division (mitosis) that occurs after

conception. At least 75% of the cases of Patau syndrome are caused by errors in chromosome replication that occur after conception. The remaining 25% are caused by the inheritance of translocations of chromosome 13 with other chromosomes within the parental chromosomes. In these cases, a portion of another chromosome switches places with a portion of chromosome 13. This leads to errors in the genes on both chromosome 13 and the chromosome from which the translocated portion originated.

Patau syndrome occurs in approximately one in 10,000 live births. In many cases, spontaneous abortion (**miscarriage**) occurs and the fetus does not survive to term. In other cases, the affected individual is stillborn. As appears to be the case in all trisonomies, the risks of Patau syndrome seem to increase with the mother's age, particularly if she is over 30 when pregnant. Male and female children are equally affected, and the syndrome occurs in all races.

Causes and symptoms

The severity and symptoms of Patau syndrome vary with the type of chromosomal anomaly, from extremely serious conditions to nearly normal appearance and functioning. Full trisomy 13, which is present in the majority of the cases, results in the most severe and numerous internal and external abnormalities. Commonly, the forebrain fails to divide into lobes or hemispheres (holoprosencephaly) and the entire head is unusually small (microcephaly). The spinal cord may protrude through a defect in the vertebrae of the spinal column (myelomeningocele). Children who survive infancy have profound mental retardation and may experience seizures.

Incomplete development of the optic (sight) and olfactory (smell) nerves often accompany the brain defects described above. The eyes may be unusually small (microphthalmia) or one eye may be absent (anophthalmia). The eyes are sometimes set close together (hypotelorism) or even fused into a single structure. Incomplete development of any structures in the eye (coloboma) or failure of the retina to develop properly (retinal dysplasia) will also produce vision problems. Patau syndrome affected individuals may be born either partially or totally deaf and many are subject to recurring ear infections.

The facial features of many Patau syndrome affected individuals appear flattened. The ears are generally malformed and lowset. Frequently, a child with trisomy 13 has a cleft lip, a cleft palate, or both. Other physical characteristics include loose folds of skin at the back of the neck, extra fingers or toes (polydactyly), permanently flexed (closed) fingers (camptodactyly), noticeably prominent heels, "rocker-bottom foot," and missing ribs. Genital malformations are common in individuals affected with Patau syndrome and include undescended testicles (cryptorchidism), an abnormally developed scrotum, and ambiguous genitalia in males, or an abnormally formed uterus (bicornuate uterus) in females.

In nearly all cases, Patau syndrome affected infants have respiratory difficulties and heart defects, including atrial and ventricular septal defects (holes between chambers of the heart); malformed ducts that cause abnormal direction of blood flow (**patent ductus arteriosus**); holes in the valves of the lungs and the heart (pulmonary and aortic valves); and misplacement of the heart in the right, rather than the left, side of the chest (dextrocardia). The kidneys and gastrointestinal system may also be affected with cysts similar to those seen in **polycystic kidney disease**. These defects are frequently severe and life-threatening.

Partial trisomy of the distal segment of chromosome 13 results in generally less severe, but still serious, symptoms and a distinctive facial appearance including a short upturned nose, a longer than usual area between the nose and upper lip (philtrum), bushy eyebrows, and tumors made up of blood capillaries on the forehead (frontal capillary hemangiomata). Partial trisomy of the proximal segment of chromosome 13 is much less likely to be fatal and has been associated with a variety of facial features including a large nose, a short upper lip, and a receding jaw. Both forms of partial trisomy also result in severe mental retardation.

Beyond one month of age, other symptoms that are seen in individuals with Patau syndrome are: feeding difficulties and **constipation**, reflux disease, slow growth rates, curvature of the spine (**scoliosis**), irritability, sensitivity to sunlight, low muscle tone, high blood pressure, sinus infections, urinary tract infections, and ear and eye infections.

Diagnosis

Patau syndrome is detectable during **pregnancy** through the use of ultrasound imaging, **amniocentesis**, and **chorionic villus sampling** (CVS). At birth, the newborn's numerous malformations indicate a possible chromosomal abnormality. Trisomy 13 is confirmed by examining the infant's chromosomal pattern through karyotyping or another procedure. Karyotyping involves the separation and isolation of the chromosomes present in cells taken from an individual. These cells are generally extracted from cells found in a blood sample. The 22 non-sex linked chromosomes are identified by size, from largest to smallest, as chromosomes 1 through 22. The sex determining chromosomes are also identified. Patau syndrome is confirmed by the presence of three, rather than the normal two, copies of the thirteenth largest chromosome.

KEY TERMS

Aminocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the fetus. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the and consisting of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Karyotyping—A laboratory procedure in which chromosomes are separated from cells, stained, and arranged so that their structure can be studied under the microscope.

Mosaicism—A genetic condition resulting from a mutation, crossing over, or nondisjunction of chromosomes during cell division, causing a variation in the number of chromosomes in the cells.

Translocation—The transfer of one part of a chromosome to another chromosome during cell division. A balanced translocation occurs when pieces from two different chromosomes exchange places without loss or gain of any chromosome material. An unbalanced translocation involves the unequal loss or gain of genetic information between two chromosomes.

Trisomy—The condition of having three identical chromosomes, instead of the normal two, in a cell.

Ultrasound—An imaging technique that uses sound waves to help visualize internal structures in the body.

Treatment and management

Some infants born with Patau syndrome have severe and incurable **birth defects**. However, children with better prognoses require medical treatment to correct structural abnormalities and associated complications. For feeding problems, special formulas, positions, and techniques may be used. Tube feeding or the placement of a gastric tube (**gastrostomy**) may be required. Structural abnormalities such as cleft lip and cleft palate can be corrected through surgery. Special **diets**, **hearing aids**, and vision aids can be used to mitigate the symptoms of Patau syndrome. Physical therapy, speech therapy, and other types of developmental therapy will help the child reach his or her potential.

Since the translocation form of Patau syndrome is genetically transmitted, **genetic counseling** for the parents should be part of the management of the disease.

Prognosis

Approximately 45% of trisomy 13 babies die within their first month of life; up to 70% in the first six months; and over 70% by one year of age. Survival to adulthood is very rare. Only one adult is known to have survived to age 33.

Most survivors have profound mental and physical disabilities; however, the capacity for learning in children with Patau syndrome varies from case to case. Older children may be able to walk with or without a walker. They may also be able to understand words and phrases, follow simple commands, use a few words or signs, and recognize and interact with others.

Resources

BOOKS

Gardner, R. J. McKinlay, and Grant R. Sutherland. *Chromosome Abnormalities and Genetic Counseling*. New York: Oxford University Press, 1996.

Jones, Kenneth Lyons. *Smith's Recognizable Patterns of Human Malformation*. 5th ed. Philadelphia: W.B. Saunders Company, 1997.

PERIODICALS

Baty, Bonnie J., Brent L. Blackburn, and John C. Carey. "Natural History of Trisomy 18 and Trisomy 13: I. Growth, Physical Assessment, Medical Histories, Survival, and Recurrence Risk." *American Journal of Medical Genetics* 49 (1994): 175–87.

Baty, Bonnie J., et al. "Natural History of Trisomy 18 and Trisomy 13: II. Psychomotor Development." *American Journal of Medical Genetics* 49 (1994): 189–94.

Delatycki, M. and Gardner, R. "Three cases of trisomy 13 mosaicism and a review of the literature." *Clinical Genetics* (June 1997): 403–7.

ORGANIZATIONS

Rainbows Down Under—A Trisomy 18 and Trisomy 13 Resource. SOFT Australia, 198 Oak Rd., Kirrawee, NSW 2232. Australia 02-9521-6039. <http://members.optushome.com.au/karens>.

Support Organization for Trisomy 18, 13, and Related Disorders (SOFT). 2982 South Union St., Rochester, NY 14624. (800) 716-SOFT. <http://www.trisomy.org>.

OTHER

Pediatric Database (PEDBASE) Homepage. <http://www.icondata.com/health/pedbase/files/TRISOMY1.HTM>. (09 February 2001).

"Trisomy 13." *WebMD* <http://my.webmd.com/content/asset/adam_disease_trisomy_13>. (09 February 2001).

Paul A. Johnson

Patent ductus arteriosus

Definition

Patent ductus arteriosus (PDA) is a heart defect that occurs when the ductus arteriosus (the temporary fetal blood vessel that connects the aorta and the pulmonary artery) does not close at birth.

Description

The ductus arteriosus is a temporary fetal blood vessel that connects the aorta and the pulmonary artery before birth. The ductus arteriosus should be present and open before birth while the fetus is developing in the uterus. Since oxygen and nutrients are received from the placenta and the umbilical cord instead of the lungs, the ductus arteriosus acts as a "short cut" that allows blood to bypass the deflated lungs and go straight out to the body. After birth, when the lungs are needed to add oxygen to the blood, the ductus arteriosus normally closes. The closure of the ductus arteriosus ensures that blood goes to the lungs to pick up oxygen before going out to the body. Closure of the ductus arteriosus usually occurs at birth as levels of certain chemicals, called prostagladins, change and the lungs fill with air. If the ductus arteriosus closes correctly, the blood pumped from the heart goes to the lungs, back into the heart, and then out to the body through the aorta. The blood returning from the lungs and moving out of the aorta carries oxygen to the cells of the body.

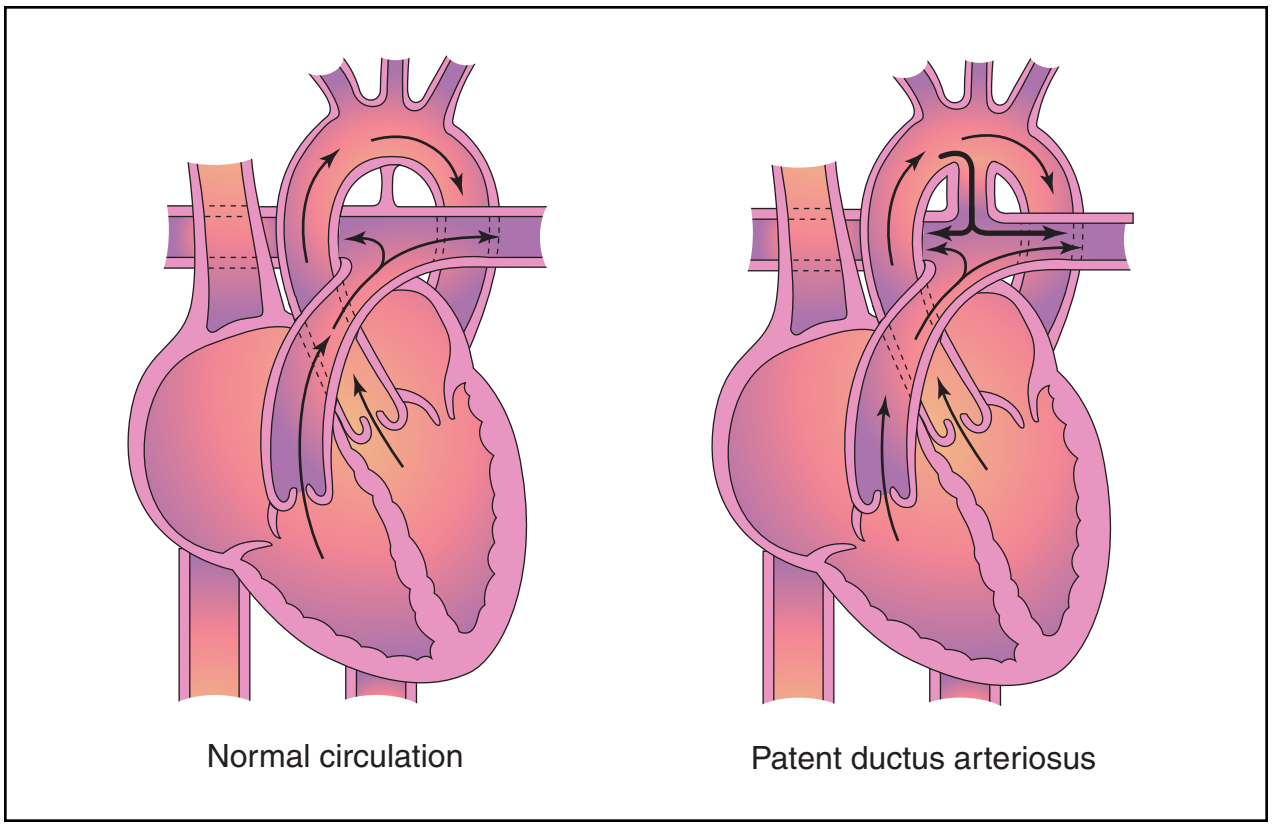
In some infants, the ductus arteriosus remains open (or patent) and the resulting heart defect is known as patent ductus arteriosus. In most cases, a small PDA does not result in physical symptoms. If the PDA is larger, health complications may occur.

In an average individual's body, the power of blood being pumped by the heart and other forces leads to a certain level of pressure between the heart and lungs. The pressure between the heart and lungs of an individual affected by PDA causes some of the oxygenated blood that should go out to the body (through the aorta) to return back through the PDA into the pulmonary artery. The pulmonary artery takes the blood immediately back to the lungs. The recycling of the already oxygenated blood forces the heart to work harder as it tries to supply enough oxygenated blood to the body. In this case, usually the left side of the heart grows larger as it works harder and must contain all of the extra blood moving back into the heart. This is know as a left-to-right or aortic-pulmonary shunt.

As noted, the size of the PDA determines how much harder the heart has to work and how much bigger the heart becomes. If the PDA is large, the bottom left side of the heart is forced to pump twice as much blood because it must supply enough blood to recycle back to the lungs and move out to the body. As the heart responds to the increased demands for more oxygenated blood by pumping harder, the pulmonary artery has to change in size and shape in order to adapt to the increased amount and force of the blood. In some cases, the increase in size and shape changes the pressure in the pulmonary artery and lungs. If the pressure in the lungs is higher than that of the heart and body, blood returning to the heart will take the short cut back into the aorta from the pulmonary artery through the PDA instead of going to the lungs. This backward flowing of blood does not carry much oxygen. If blood without much oxygen is being delivered to the body, the legs and toes will turn blue or cyanotic. This is called a shunt reversal.

When a PDA results in a large amount of blood being cycled in the wrong order, either through a left-to-right shunt or shunt reversal, the overworked, enlarged heart may stop working (congestive **heart failure**) and the lungs can become filled with too much fluid (**pulmonary edema**). At this time, there is also an increased risk for a bacterial infection that can inflame the lining of the heart (**endocarditis**). These three complications are very serious.

PDA is a very common heart defect. Though an exact incidence of PDA is difficult to determine, one review in 1990 found that approximately 8% of live births were found to be affected by PDA. PDA can occur in full- term



Patent ductus arteriosus (PDA) is the failure of the ductus arteriosus to close after birth, allowing blood to inappropriately flow from the aorta into the pulmonary artery. *(Illustration by Electronic Illustrators Group.)*

infants, but it seen most frequently in preterm infants, infants born at a high altitude, and babies whose mothers were affected by the German measles (**rubella**) during **pregnancy**. PDA is two to three times more common in females than males. PDA occurs in individuals of every ethnic origin and does not occur more frequently in any one country or ethnic population.

Causes and symptoms

PDA can be a result of an environmental exposure before birth, inheriting a specific changed or mutated gene or genes, a symptom of a genetic syndrome, or be caused by a combination of genetic and environmental factors (multifactorial).

Environmental exposures that can increase the chance for a baby to be affected by PDA include fetal exposure to rubella before birth, preterm delivery, and birth at a high altitude location.

PDA can be an inherited condition running in families as isolated PDA or part of a genetic syndrome. In either case, there are specific gene changes or mutations which lead to a defect in the elastic tissue forming the walls of the ductus arteriosus. The genes causing isolated PDA have not been identified, but it is known that PDA can be inherited through a family in an autosomal dominant pattern or an autosomal recessive pattern.

Every person has approximately 30,000 genes, which tell our bodies how to grow and develop correctly. Each gene is present in pairs since one is inherited from our mother, and one is inherited from our father. In an autosomal dominant condition, only one specific changed or mutated copy of the gene for PDA is necessary for a person to have PDA. If a parent has an autosomal dominant form of PDA, there is a 50% chance for each child to have the same or similar condition.

PDA can also be inherited in an autosomal recessive manner. A recessive condition occurs when a child receives two changed or mutated copies of the gene for a particular condition, such as PDA (one copy from each parent). Individuals with a single changed or mutated copy of a gene for a recessive condition, are known as "carriers," and have no health problems related to the condition. In fact, each of us carries between five and 10 genes for harmful, recessive conditions. However, when two people who each carry a changed or mutated copy of the same

KEY TERMS

Aorta—The main artery located above the heart which pumps oxygenated blood out into the body. Many congenital heart defects affect the aorta.

Catheterization—The process of inserting a hollow tube into a body cavity or blood vessel.

Ductus arteriosus—The temporary channel or blood vessel between the aorta and pulmonary artery in the fetus.

Echocardiograph—A record of the internal structures of the heart obtained from beams of ultrasonic waves directed through the wall of the chest.

Electrocardiogram (ECG, EKG)—A test used to measure electrical impulses coming from the heart in order to gain information about its structure or function.

Endocarditis—A dangerous infection of the heart valves caused by certain bacteria.

Oxygenated blood—Blood carrying oxygen through the body.

Pulmonary artery—An artery that carries blood from the heart to the lungs.

Pulmonary edema—A problem caused when fluid backs up into the veins of the lungs. Increased pressure in these veins forces fluid out of the vein and into the air spaces (alveoli). This interferes with the exchange of oxygen and carbon dioxide in the alveoli.

gene for a recessive condition meet, there is a chance, with each pregnancy, for the child to inherit the two changed or mutated copies from each parent. In this case, the child would have PDA. For two known carriers, there is a 25% risk with each child to have a child with PDA, a 50% chance to have a child who is a carrier, and a 25% chance to have a child who is neither affected nor a carrier.

Most cases of PDA occur as the result of multifactorial inheritance which is caused by the combination of genetic factors and environmental factors. The combined factors lead to isolated defects in the elastic tissue forming the walls of the ductus arteriosus. Family studies can provide different recurrence risks depending on the family member affected by multifactorial PDA. If an individual is affected by isolated, multifactorial PDA, they have a 2–4% chance of having a child affected by PDA. If a couple has one child with isolated, multifactorial PDA, there is a 3% chance that another of their children could be affected by PDA. If a couple has two children affected by isolated, multifactorial PDA, there is a 10–25% chance that they could have another child affected by PDA.

Unless a specific pattern of inheritance, preterm delivery, or known exposure is found through the examination of a detailed pregnancy and family history, the multifactorial family studies are used to estimated the possible risk of recurrence of PDA in a family.

The main sign of PDA is a constant heart murmur that sounds like the hum of a refrigerator or other machinery. This murmur is usually heard by the doctor using a stethoscope. Otherwise, there are no specific symptoms of PDA, unless the ductus arteriosus size is large. Children and adults with a large ductus arteriosus can show difficulty in breathing during moderate physical **exercise**, an enlarged heart, and failure to gain weight. In some cases, heart failure and pulmonary congestion can indicate a PDA.

Diagnosis

Diagnosis is most often made by detecting the characteristic "machinery" heart murmur heard by a doctor through a stethoscope. Tests such as a **chest x ray**, echocardiograph, and ECG are used to support the initial diagnosis. Other indications of PDA include failure to gain weight, frequent chest infections, heavy breathing during mild physical exertion, congestive heart failure, and pulmonary **edema**. Prenatal ultrasounds are unable to detect PDA because the heart defect does not occur until the time of birth.

Treatment

The treatment and management of PDA depends upon the size of the PDA and symptoms being experienced by the affected individual. In some cases, a PDA can correct itself in the first months of life. In preterm infants experiencing symptoms, the first step in correcting a PDA is treatment through medications such as indomethacin. In preterm infants whose PDA is not closed through medication, full term infants affected by PDA, and adults, surgery is an option for closing the ductus arteriosus. In 2000 and 2001, medicine has developed and reviewed alternatives to surgical closure such as interventional **cardiac catheterization** and video-assisted thorascopic surgical repair. A cardiologist can help individuals determine the best method for treatment based on their physical symptoms and medical history.

Prognosis

Adults and children can survive with a small opening remaining in the ductus arteriosus. Treatment, includ-

ing surgery, of a larger PDA is usually successful and frequently occurs without complications. Proper treatment allows children and adults to lead normal lives.

Resources

BOOKS

Alexander, R.W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York: McGraw-Hill, 1998.

Jaworski, Anna Marie, ed. *The Heart of A Mother.* Temple, Tex.: Baby Hearts Press, 1999.

Kleinman, Mary. *What Your Doctor Didn't Tell you About Congenital Heart Disease.* Salt Lake City: Northwest Publishing Inc., 1993.

Neill, Catherine. *The Heart of A Child.* Baltimore: Johns Hopkins University, 1992.

ORGANIZATIONS

CHASER (Congenital Heart Anomalies Support, Education, and Resources). 2112 North Wilkins Rd., Swanton, OH 43558. (419) 825-5575. <http://www.csun.edu/~hfmth006/chaser>.

Kids with Heart. 1578 Careful Dr., Green Bay, WI 54304. (800) 538-5390. <http://www.execpc.com/~kdswhrt>.

OTHER

Berger, Sheri. The Congenital Heart Defects Resource Page. <http://www.csun.edu/~hfmth006/chaser/>. (updated 6 January, 2000).

"Congenital Cardiovascular Disease." *American Heart Association* <http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/conghd.html>. 2000.

"Heart Disorders." *Family Village* <http://www.familyvillage.wisc.edu/index.html>. (updated 24 March, 2000).

Dawn A. Jacob. M.S., C.G.C.

PCV *see* **Hematocrit**

Pediculosis *see* **Lice infestation**

Pedophilia *see* **Sexual perversions**

Pellagra

Definition

Pellagra is a disorder brought on by a deficiency of the nutrient called niacin or nicotinic acid, one of the B-complex **vitamins**.

Description

Nicotinic acid plays a crucial role in the cellular process called respiration. Respiration is the process by which nutrients (specifically sugar, or glucose) and oxygen are taken in, chemical reactions take place, energy is produced and stored, and carbon monoxide and wastes are given off. This process is absolutely central to basic cell functioning, and thus the functioning of the body as a whole.

Niacin is a B vitamin found in such foods as yeast, liver, meat, fish, whole-grain cereals and breads, and legumes. Niacin can also be produced within the body from the essential amino acid called tryptophan. Dietary requirements for niacin depend on the age, gender, size, and activity level of the individual. Niacin requirements range from 5 mg in infants up to 20 mg in certain adults.

Causes and symptoms

Pellagra can be either primary or secondary. Primary pellagra results when the diet is extremely deficient in niacin-rich foods. A classic example occurs in geographic locations where Indian corn (maize) is the dietary staple. Maize does contain niacin, but in a form which cannot be absorbed from the intestine (except when it has been treated with alkali, as happens in the preparation of tortillas). People who rely on maize as their major food source often develop pellagra. Pellagra can also occur when a hospitalized patient, unable to eat for a very prolonged period of time, is given fluids devoid of vitamins through a needle in the vein (intravenous or IV fluids).

Secondary pellagra occurs when adequate quantities of niacin are present in the diet, but other diseases or conditions interfere with its absorption and/or processing. This is seen in various diseases that cause prolonged **diarrhea**, with **cirrhosis** of the liver and **alcoholism**, with long-term use of the anti-tuberculosis drug called isoniazid, in patients with malignant carcinoid tumor, and in patients suffering from **Hartnup disease** (an inherited disorder which results in disordered absorption of amino acids from the intestine and kidney).

Pellagra causes a variety of symptoms affecting the skin; mucous membranes (moist linings of the mouth, organs, etc.); central nervous system (including the brain and nerves); and the gastrointestinal system. The classic collection of symptoms includes redness and swelling of the mouth and tongue, diarrhea, skin rash, and abnormal mental functioning, including memory loss. While early patients may simply have a light skin rash, over time the skin becomes increasingly thickened, pigmented, and may slough off in places. Areas of the skin may become prone to bacterial infection. The mouth and tongue, and sometimes the vagina, become increasingly thick, swollen, and red. Abdominal **pain** and bloating occur, with **nausea and vomiting**, and

KEY TERMS

Niacinamide—A form of niacin, which is usually used as a dietary supplement for people with insufficient niacin.

Respiration—Respiration is the process by which nutrients (specifically sugar, or glucose) and oxygen are taken in to a cell; chemical reactions take place; energy is produced and stored; and carbon monoxide and wastes are given off.

bloody diarrhea to follow. Initial mental changes appear as inability to sleep (**insomnia**), **fatigue**, and a sense of disconnectedness (apathy). These mental changes progress to memory loss, confusion, depression, and **hallucinations** (in which the individual sees sights or hears sounds that do not really exist). The most severe states include stiffness of the arms and legs, with resistance to attempts to move the limbs; variations in level of consciousness; and the development of involuntary sucking and grasping motions. This collection of symptoms is called "encephalopathic syndrome."

Diagnosis

Diagnosis is purely based on the patient's collection of symptoms, together with information regarding the patient's diet. When this information points to niacin deficiency, replacement is started, and the diagnosis is then partly made by evaluating the patient's response to increased amounts of niacin. There are no chemical tests available to definitively diagnose pellagra.

Treatment

Treatment of pellagra usually involves supplementing the individual's diet with a form of niacin called niacinamide (niacin itself in pure supplementation form causes a number of unpleasant side effects, including sensations of **itching**, burning, and flushing). The niacinamide can be given by mouth (orally) or by injection (when diarrhea would interfere with its absorption). The usual oral dosage is 300–500 mg each day; the usual dosage of an injection is 100–250 mg, administered two to three times each day. When pellagra has progressed to the point of the encephalopathic syndrome, a patient will require 1,000 mg of niacinamide orally, and 100-250 mg of niacinamide by injection. Once the symptoms of pellagra have subsided, a maintenance dose of niacin can be calculated, along with attempting (where possible) to make appropriate changes in the diet. Because many B-complex vitamin deficiencies occur simultaneously, patients will usually require the administration of other B-complex vitamins as well.

Prognosis

Untreated pellagra will continue progressing over the course of several years, and is ultimately fatal. Often, death is due to complications from infections, massive **malnutrition** brought on by continuous diarrhea, blood loss due to bleeding from the gastrointestinal tract, or severe encephalopathic syndrome.

Prevention

Prevention of pellagra is completely possible; what is required is either a diet adequate in niacin-rich foods, or appropriate supplementation. However, in many geographic locations in the world such foods are unavailable to the general population, and pellagra becomes an unavoidable complication of poverty.

Resources

BOOKS

Beal, M. Flint, and Joseph B. Martin. "Pellagra." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Duyff, Roberta Larson. *The American Dietetic Association's Complete Food and Nutrition Guide*. Chicago: Chronimed, 1996.

Wilson, Jean D. "Deficiency States." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Dietetic Association, 216 W. Jackson Blvd., Chicago, IL 60606-6995. (800) 745-0775. <http://www.eatright.org/cdr.html>.

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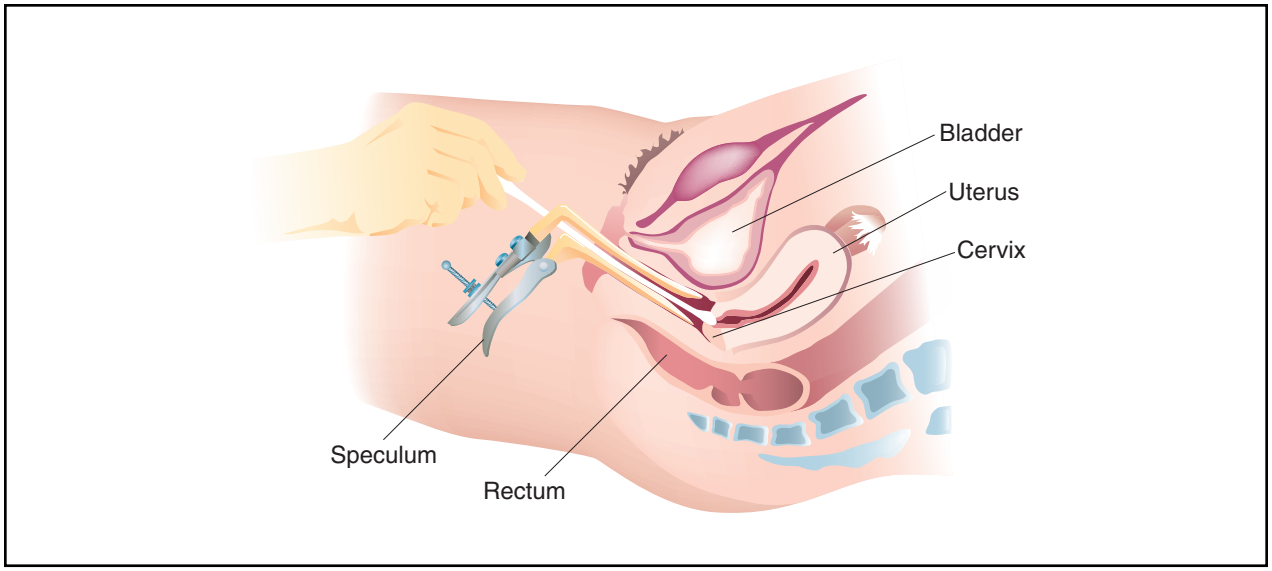
Pelvic endoscopy *see* **Laparoscopy**

Pelvic exam

Definition

A pelvic examination is a routine procedure used to assess the well being of the female patients' lower genito-urinary tract. This is done as part of a usual health screening and prevention tool, and is an element of the total health care for the female patient.



During a pelvic exam, cells from the cervix are scraped on a spatula and are tested for abnormalacies. *(Illustration by Argosy Inc.)*

Purpose

Pelvic exams are useful as a screening tool for **sexually transmitted diseases** such as **gonorrhea**, chlamydia, **genital warts**, herpes, and **syphilis**. In addition, exams detect some forms of **cancer** that may affect the genitalia. By analyzing the cervical region with a Papanicolaou or Pap smear, clinicians are able to look for signs of **cervical cancer**. The American Cancer Society and The American College of Obstetricians and Gynecologists recommend pelvic exams with Pap smears for women starting at age 18. It is also recommended that exams start earlier if the teenager requests oral **contraception**. Pap smears should continue once yearly for three years and at the physicians discretion following this time. Various groups differ in opinions on when to discontinue screening for cervical cancer, however, the United States Preventative Services Task Force recommends screening continue until age 65 if the patient has not had previous abnormal results. Women who have undergone a total **hysterectomy** for reasons other than cervical cancer do not need to be screened.

Precautions

Pelvic examinations are safe procedures, thus no precautions are necessary.

Description

The first part of the examination involves visual inspection and palpation of the external genitalia. The examiner will note the characteristics of the labia majora, labia minora, clitoris, urethral orifice, and the Skene's and Bartholin's glands. In addition, the perineum and anus will be checked. The clinician will be examining these areas for any indication of swelling, inflammation, abnormal discharge, polyps, abnormal odor, or other lesions.

The next part involves examining the internal genitalia. The examiner will first insert a gloved finger into the vagina in order to palpate the cervix—the vaginal walls. Next an instrument called a speculum is inserted. This device is made of plastic or metal and used to open the vaginal cavity in order for the examiner to be able to view the vaginal walls and cervix. Any lesions, bleeding, or abnormal discharge can be visualized with the speculum in place. If indicated, a Pap smear will then be performed. With the speculum still in place, the examiner gently scrapes the patient's cervix with a wooden or plastic spatula as well as a cylindrical-type brush. The spatula collects cells from the outer surface of the cervix, while the brush is used to collect cells from the inner-cervix. The collected cells are then spread on a glass slide, sprayed with a fixative, and sent to a laboratory for analysis. The examiner may then insert a cotton or Dacron swab into the cervix. This will be held in place for 10–30 seconds and when withdrawn spread on a plastic plate or into a tube containing a reagent for the specimen. This procedure may be repeated again with the anus. Such swab tests are used to check for gonorrhea and chlamydia, or bacterial vaginitis, which is a bacterial infection resulting in inflammation of the vagina.

Following the Pap smear is the bimanual examination during which the examiner will place an index and

KEY TERMS

Bacterial vaginitis—This is the term for inflammation of the vagina due to a bacterial infection.

Bartholin's glands—These glands are embedded in the vestibule of the vagina and function to maintain moisture.

Cervical dysplasia—Dysplasia is the abnormal growth of the epithelial cells. This is what a Pap smear will detect in the cervix.

Colposcopy—This procedure is done when a Pap smear reveals abnormal results. With an endoscope placed through the vagina and into the cervix, a physician can determine exactly where lesions of the cervix are.

Hematoma—Hematomas are masses of blood (or clotted blood) that accumulate in tissues and may result from trauma.

Myoma—These are benign (non-malignant) tumors of the uterus.

Papanicolaou or Pap smear—This is a screening test for cancer of the cervix. Cells are scraped from the cervix, smeared on a glass plate, and sent to a laboratory to examine for any abnormal cells or dysplasia. This test may also detect other cells seen in certain vaginal infections.

Skene's glands—These are the glands of the female urethra.

Speculum—A speculum is an instrument that is used during the internal genitalia examination. It can be made of plastic or metal and is used to open up the vaginal cavity in order for the examiner to view the walls of the vagina and the cervix.

Urethral meatus—This is the external opening of the urethra.

middle finger into the vagina to first examine the vaginal walls for any irregularities or tenderness. The cervix will then be palpated in order to note its shape, consistency, mobility, and any tenderness. The examiner will then place his or her other hand on the abdomen and gently push down while pushing the cervix up. This is done to assess the size and shape of the uterus, and also to note any tenderness or abnormal lesions. During this time, the ovaries are also checked for any masses, or tenderness.

The last part of the pelvic exam is the rectovaginal examination. This allows the clinician to better examine the pelvic organs and structures. The examiner will place their index finger into the vagina and a lubricated, gloved middle finger against the anus. During this part, the patient may feel an urgency to have a bowel movement. However, this is a natural feeling and a bowel movement will not occur. The patient will then be asked to strain down in order for the anal sphincter to relax. As relaxation occurs the examiner will insert the middle finger into the rectum, enabling the position and shape of the uterus to be better assessed. In addition, any masses or tenderness can be evaluated at this point. The anal canal and rectum can also be examined for any polyps, or other lesions at this time. After the rectovaginal exam, the patient will be allowed clean off any excess lubricant and get dressed. The examiner will then discuss the procedure and any findings with the patient.

Preparation

Pelvic exams require the patient to void prior to starting, as a full bladder can add to discomfort and make palpation difficult for the examiner. Even though some tests cannot be done on a menstruating patient, an examination can still be performed. Any tampons should be removed prior to the exam. Douching is not recommended before an exam due to the hazard of washing away cells that are needed for examination. If a Pap smear is to be done, the patients should also refrain from sexual intercourse or using vaginal suppositories for 24 to 48 hours prior to the exam. The patient will be asked to undress and put on a gown. The examiner will instruct the patient to lie on the examination table on her back and may assist her in putting her feet in stirrups. The buttocks are then slid to the edge of the table in order for a full view of the area to be examined.

Aftercare

Even with the invasiveness of this procedure, the patient should be able to immediately resume normal daily activities.

Risks

Other than minor discomfort, there are no risks associated with a routine pelvic examination.

Normal results

No significant findings by the examiner indicate a normal pelvic examination. The external and internal genitalia will be free of any lesions or abnormal discharge. The Pap smear will not reveal cervical dysplasia or abnormal tissue development, and there will not be any abnormal masses or tenderness upon palpation.

Abnormal results

The examiner may discover abnormal lesions during the course of the exam that may require additional tests. Ulcerations, bumps, sores, blisters, or vesicles on the external genitalia may be signs of a sexually transmitted disease. Some of the sexually transmitted diseases that may cause lesions to the external genitalia include venereal **warts**, syphilis, and **genital herpes**. Gonorrhea or chlamydia may also cause inflammation to the urethral meatus or the external opening of the urethra. These, in addition to bacterial infections, can also cause inflammation of the Skene's glands, Bartholin's glands, and vulva. Infections may result in an irritating discharge. Discharge may also be noted in yeast infections. Other abnormal findings of the external genitalia include carcinomas, vulvar tumors, or hematomas. Hematomas are masses of accumulated blood that appears as a bluish swelling of the labium that may occur following trauma to this area. Examination of the internal genitalia may reveal similar findings in regards to sexually transmitted diseases and carcinomas. Cervical abnormalities can also be found and may include lacerations, infections, ulcers, cysts, and polyps. All of these will require further evaluation in order to determine the underlying cause.

Since Pap smears screen for cervical cancer, abnormal results require special attention. Due to the incidence of false-positives or false-negatives, the test may be repeated or the physician may choose to have the patient undergo a **colposcopy**. This procedure uses an endoscope and will examine the vagina and cervix in more depth. This will identify 100% of lesions present. A biopsy may then be taken of the lesion in order to determine the exact type of abnormality. Several new techniques are now available that improve the accuracy of the Pap smear including automated analysis machines. Bimanual and rectovaginal exams may reveal abnormalities of the uterus or other pelvic structures. One commonly encountered finding is a myoma, which is a benign uterine tumor. In addition, the uterus may be positioned abnormally by being angled too far forward or backward. **Ovarian cysts** and tumors, as well as some disorders of the fallopian tubes, can be findings of these two exams.

Resources

BOOKS

Bates, Barbara, et al. *A Guide to Physical Examination and History Taking*. 6th ed. Philadelphia: J.B Lippincott Company, 1995.

DeGowin, Richard L., and Donald D. Brown. *DeGowin's Diagnostic Examination*. 7th ed. New York: McGraw-Hill, 2000.

Johnson, Bruce E., et al. *Women's Health Care Handbook*. 2nd ed. Philadelphia: Hanley and Belfus, Inc., 2000.

Seidel, Henry M., et al. *Mosby's Guide to Physical Examination*. 4th ed. St. Louis: Mosby Inc., 1999.

PERIODICALS

Russo, Joseph F. "Controversies in the Management of Abnormal Pap Smears." *Current Opinion in Obstetrics and Gynecology* 12 (Oct. 2000): 339.

Sawya, George F., et al. "Current Approaches to Cervical-Cancer Screening." *New England Journal of Medicine* 344 (May 2001): 1603.

Stewart, Felicia H., et al. "Clinical Breast and Pelvic Examination Requirements for Hormonal Contraception: Current Practice vs. Evidence." *Journal of the American Medical Association* 285 (May 2001): 2232.

OTHER

"Screening for Cervical Cancer." 2001. <http://my.webmd.com/content/article/1680.50756>.

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Robert Ramirez, B.S.

Pelvic fracture

Definition

A pelvic fracture is a break in one or more bones of the pelvis.

Description

The pelvis is a butterfly-shaped group of bones located at the base of the spine. The pelvis consists of the pubis, ilium, and ischium bones (among others) held together by tough ligaments. With a cavity in its center, the pelvis forms one major ring and two smaller rings of bone that support and protect internal organs such as the bladder, intestines, and rectum. In women, the pelvis also surrounds the uterus and vagina. The pelvis is wider and has a larger cavity in females than in males because it must accommodate **childbirth**.

Fractures of the pelvis are uncommon, accounting for only 0.3–6% of all fractures. Pelvic rings often break in more than one place. Pelvic fractures range widely in

severity. Disruption of the major ring is usually a severe injury while disruption of a minor ring is often not serious. A mild fracture (for example, one that occurs due to the impact of jogging) may heal in several weeks without surgery. However, a serious pelvic fracture can be a life-threatening event requiring emergency medical care and lengthy **rehabilitation**. The latter type of injury may involve damage to nearby internal organs.

Pelvic fractures are classified as stable or unstable, and as open or closed. A stable fracture is one in which the pelvis remains stable and involves one break-point in the pelvic ring with minimal hemorrhage. An unstable fracture is one in which the pelvis is unstable with two or more break-points in the pelvic ring with moderate to severe hemorrhage. All types of pelvic fractures are further divided into 'open' or 'closed,' depending on whether open skin **wounds** are present or not in the lower abdomen.

Causes and symptoms

Most pelvic fractures occur during high-speed accidents (such as car or motorcycle crashes) or falls from great heights. The greater the force, the greater the opportunity for a severe fracture. Pelvic fractures can also occur spontaneously or after minor falls in people with bone-weakening diseases such as **osteoporosis**. Less commonly, pelvic fractures may occur during athletic activities such as football, hockey, skiing, and long-distance running.

The primary symptom of a pelvic fracture is **pain** in the groin, hip, or lower back, which may worsen when walking or moving the legs. Other symptoms may include abdominal pain; numbness/tingling in the groin or legs; bleeding from the vagina, urethra (urine tube), or rectum; difficulty urinating; and difficulty walking or standing. A stress fracture that occurs while jogging may cause pain in the thigh or buttock.

Diagnosis

A pelvic fracture is typically diagnosed by an emergency physician looking for bone tenderness, limitations of movement, difficulty walking, and any loss of nerve function in the lower part of the body. In addition, the physician looks for signs of injury to nearby organs of the intestinal or genitourinary systems. This search may include checking the rectum, vagina, and urethra for signs of bleeding. The physician will order a plain x ray of the pelvis; this will usually detect the presence of a fracture. Blood and urine tests may also be done. A computed tomography (CT) scan will be performed in complicated cases. Depending on the severity of the fracture, other imaging procedures may be required as well, such as contrasting studies involving the injection of a radioactive dye; the pictures can be used to evaluate organs and structures in the pelvic area, such as the urethra, bladder, and blood vessels.

Treatment

In the case of a potentially serious pelvic fracture (such as that occurring after an accident or high fall), emergency assistance should be summoned. The person with the injury should be covered with a blanket or jacket (to maintain body heat), and should not be moved by non-trained personnel, especially if there is severe pain or signs of possible nerve injury.

Treatment depends on the severity of the injury. In the case of a minor fracture, treatment may consist of bed rest and over-the-counter (OTC) or prescription pain killers. Physical therapy, the use of crutches, and surgery may also be recommended. Healing can take anywhere from a few weeks to several months.

Severe injuries to the pelvis (such as those involving more than one break) can be life threatening, resulting in **shock**, extensive internal bleeding, and damage to internal organs. In these situations, the immediate goal is to control the bleeding and stabilize the injured person's condition. Resuscitation procedures may be required as well as large amounts of intravenous fluids and blood transfusions if internal bleeding is present. These injuries often require extensive surgery as well as lengthy rehabilitation.

Alternative treatment

To speed up the healing process, some practitioners of alternative medicine recommend **magnetic field therapy**, hydrogen peroxide therapy, calcium, vitamin D, vitamin B complex, and zinc.

Prognosis

The prognosis for minor pelvic fractures is excellent, with most people gaining full mobility in a matter of weeks or months. Severe pelvic fractures can be fatal due to internal bleeding or damage to nearby organs, or result in chronic pain and physical disabilities.

Prevention

People with bone-weakening conditions such as osteoporosis or **cancer**, or tendencies to fall are more vulnerable to bone fractures. They should follow their treatment regimens and make use of canes and other walking aids as well as safety devices in the home (bars, non skidding mats) and avoid climbing up, even on a small stool.

KEY TERMS

Fracture—A break in a bone.

Computed tomography (CT) scan—An imaging procedure that produces a series of thin x-ray slices of internal body organs or structures.

Orthopedist—A doctor who specializes in disorders of the musculoskeletal system.

Osteoporosis—A decrease in the amount of bone mass, leading to fractures.

Shock—A condition of profound physiological disturbance characterized by failure of the circulatory system to maintain adequate blood supply to vital organs.

Stress fracture—A crack in a bone (usually the result of overuse).

Resources

BOOKS

Dee, Roger, et al. *Principles of Orthopaedic Practice* New York: McGraw-Hill, 1997.

PERIODICALS

Brenneman, F. D., et al. "Long-term outcomes in open pelvic fractures." *The Journal of Trauma* (May 1997): 773-7.

Korovessis, P., et al. "Medium- and long-term results of open reduction and internal fixation for unstable pelvic ring fractures." *Orthopedics* (November 2000): 1165-71.

Malavaud, B., et al. "Evaluation of male sexual function after pelvic trauma by the International Index of Erectile Function." *Urology* (June 2000): 842-6.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018-4262. (800) 346-AAOS. <http://www.aaos.org>.

Greg Annussek

Pelvic gynecologic sonogram *see* **Pelvic ultrasound**

Pelvic inflammatory disease

Definition

Pelvic inflammatory disease (PID) is a term used to describe any infection in the lower female reproductive tract that spreads to the upper female reproductive tract. The lower female genital tract consists of the vagina and the cervix. The upper female genital tract consists of the body of the uterus, the fallopian or uterine tubes, and the ovaries.

Description

PID is the most common and the most serious consequence of infection with **sexually transmitted diseases** (STD) in women. Over one million cases of PID are diagnosed annually in the United States, and it is the most common cause for hospitalization of reproductive-age women. Sexually active women aged 15–25 are at highest risk for developing PID. The disease can also occur, although less frequently, in women having monogamous sexual relationships. The most serious consequences of PID are increased risk of **infertility** and **ectopic pregnancy**.

To understand PID, it is helpful to understand the basics of inflammation. Inflammation is the body's response to disease-causing (pathogenic) microorganisms. The affected body part may swell due to accumulation of fluid in the tissue or may become reddened due to an excessive accumulation of blood. A discharge (pus) may be produced that consists of white blood cells and dead tissue. Following inflammation, scar tissue may form by the proliferation of scar-forming cells and is called fibrosis. Adhesions of fibrous tissue form and cause organs or parts of organs to stick together.

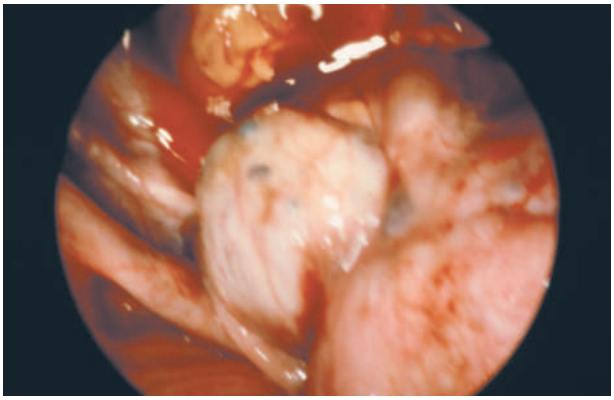
PID may be used synonymously with the following terms:

- salpingitis (Inflammation of the fallopian tubes)
- endometritis (Inflammation of the inside lining of the body of the uterus)
- tubo-ovarian abscesses (Abscesses in the tubes and ovaries)
- pelvic **peritonitis** (Inflammation inside of the abdominal cavity surrounding the female reproductive organs)

Causes and symptoms

A number of factors affect the risk of developing PID. They include:

- Age. The incidence of PID is very high in younger women and decreases as a woman ages.
- Race. The incidence of PID is 8–10 times higher in nonwhites than in whites.
- Socioeconomic status. The higher incidence of PID in women of lower socioeconomic status is due in part to



Laparoscopic view of pelvic inflammatory disease. *(Custom Medical Stock Photo. Reproduced by permission.)*

a woman's lack of education and awareness of health and disease and her accessibility to medical care.

- Contraception. Induced abortion, use of an **IUD**, nonuse of barrier contraceptives such as condoms, and frequent douching are all associated with a higher risk of developing PID.
- Lifestyle. High risk behaviors, such as drug and alcohol abuse, early age of first intercourse, number of sexual partners, and **smoking** all are associated with a higher risk of developing PID.
- Types of sexual practices. Intercourse during menses and frequent intercourse may offer more opportunities for the admission of pathogenic organisms to the inside of the uterus.
- Disease. Sixty to 75% of cases of PID are associated with STDs. A prior episode of PID increases the chances of developing subsequent infections.

The two major causes of STDs are the organisms *Neisseria gonorrhoeae* and *Chlamydia trachomatis*. The main symptom of *N. gonorrheae* infection (**gonorrhea**) is a vaginal discharge of mucus and pus. Sometimes bacteria from the colon normally in the vaginal cavity may travel upward to infect the upper female genital organs, facilitated by the infection with gonorrhea. Infections with *C. trachomatis* and other nongonoccal organisms are more likely to have mild or no symptoms.

Normally, the cervix produces mucus which acts as a barrier to prevent disease-causing microorganisms, called pathogens, from entering the uterus and moving upward to the tubes and ovaries. This barrier may be breached in two ways. A sexually transmitted pathogen, usually a single organism, invades the lining cells, alters them, and gains entry. Another way for organisms to gain entry happens when trauma or alteration to the cervix occurs. **Childbirth**, spontaneous or induced abortion, or use of an intrauterine contraceptive device (IUD) are all conditions that may alter or weaken the normal lining cells, making them susceptible to infection, usually by several organisms. During menstruation, the cervix widens and may allow pathogens entry into the uterine cavity.

Recent evidence suggests that bacterial vaginosis (BV), a bacterial infection of the vagina, may be associated with PID. BV results from the alteration of the balance of normal organisms in the vagina, by douching, for example. While the balance is altered, conditions are formed that favor the overgrowth of anaerobic bacteria, which thrive in the absence of free oxygen. A copious discharge is usually present. Should some trauma occur in the presence of anaerobic bacteria, such as menses, abortion, intercourse, or childbirth, these organisms may gain entrance to the upper genital organs.

The most common symptom of PID is pelvic **pain**. However, many women with PID have symptoms so mild that they may be unaware that an infection exists.

In acute salpingitis, a common form of PID, swelling of the fallopian tubes may cause tenderness on **physical examination**. **Fever** may be present. Abscesses may develop in the tubes, ovaries, or in the surrounding pelvic cavity. Infectious discharge may leak into the peritoneal cavity and cause peritonitis, or abscesses may rupture causing a life-threatening surgical emergency.

Chronic salpingitis may follow an acute attack. Subsequent to inflammation, scarring and resulting adhesions may result in chronic pain and irregular menses. Due to blockage of the tubes by scar tissue, women with chronic salpingitis are at high risk of having an ectopic **pregnancy**. The fertilized ovum is unable to travel down the fallopian tube to the uterus and implants itself in the tube, on the ovary, or in the peritoneal cavity. This condition can also be a life-threatening surgical emergency.

IUD

IUD usage has been strongly associated with the development of PID. Bacteria may be introduced to the uterine cavity while the IUD is being inserted or may travel up the tail of the IUD from the cervix into the uterus. Uterine tissue in association with the IUD shows areas of inflammation that may increase its susceptibility to pathogens.

Susceptibility to STDs

Susceptibility to STDs involves many factors, some of which are not known. The ability of the organism to produce disease and the circumstances that place the organism in the right place at a time when a trauma or alteration to the lining cells has occurred are factors. The

individual's own immune response also helps to determine whether infection occurs.

Diagnosis

If PID is suspected, the physician will take a complete medical history and perform an internal pelvic examination. Other diseases that may cause pelvic pain, such as **appendicitis** and **endometriosis**, must be ruled out. If pelvic examination reveals tenderness or pain in that region, or tenderness on movement of the cervix, these are good physical signs that PID is present.

Specific diagnosis of PID is difficult to make because the upper pelvic organs are hard to reach for samplings. The physician may take samples directly from the cervix to identify the organisms that may be responsible for infection. Two blood tests may help to establish the existence of an inflammatory process. A positive C-reactive protein (CRP) and an elevated **erythrocyte sedimentation rate** (ESR) indicate the presence of inflammation. The physician may take fluid from the cavity surrounding the ovaries called the *cul de sac*; this fluid may be examined directly for bacteria or may be used for culture. Diagnosis of PID may also be done using a laparoscope, but **laparoscopy** is expensive, and it is an invasive procedure that carries some risk for the patient.

Treatment

The goals of treatment are to reduce or eliminate the clinical symptoms and abnormal physical findings, to get rid of the microorganisms, and to prevent long term consequences such as infertility and the possibility of ectopic pregnancy. If acute salpingitis is suspected, treatment with **antibiotics** should begin immediately. Early intervention is crucial to keep the fallopian tubes undamaged. The patient is usually treated with at least two broad spectrum antibiotics that can kill both *N. gonorrhoeae* and *C. trachomatis* plus other types of bacteria that may have the potential to cause infection. Hospitalization may be required to ensure compliance. Treatment for chronic PID may involve **hysterectomy**, which may be helpful in some cases.

If a woman is diagnosed with PID, she should see that her sexual partner is also treated to prevent the possibility of reinfection.

Alternative treatment

Alternative therapy should be complementary to antibiotic therapy. For pain relief, an experienced practitioner may apply castor oil packs, or use **acupressure** or **acupuncture**. Some herbs, such as *Echinacea* (*Echinacea* spp.) and calendula (*Calendula officinalis*) are believed to have antimicrobial activity and may be taken to augment the action of prescribed antibiotics. General tonic herbs, as well as good **nutrition** and rest, are important in recovery and strengthening after an episode of PID. Blue cohosh (*Caulophyllum thalictroides*) and false unicorn root (*Chamaelirium luteum*) are recommended as tonics for the general well-being of the female genital tract.

KEY TERMS

Adhesion—The joining or sticking together of parts of an organ that are not normally joined together.

C-reactive protein (CRP)—A protein present in blood serum in various abnormal states, like inflammation.

Ectopic—Located away from normal position; ectopic pregnancy results in the attachment and growth of the fertilized egg outside of the uterus, a life-threatening condition.

Endometriosis—The presence and growth of functioning endometrial tissue in places other than the uterus; often results in severe pain and infertility.

Erythrocyte sedimentation rate (ESR)—The rate at which red blood cells settle out in a tube of unclotted blood, expressed in millimeters per hour; elevated sedimentation rates indicate the presence of inflammation.

Fibrosis—The formation of fibrous, or scar, tissue which may follow inflammation and destruction of normal tissue.

Hysterectomy—Surgical removal of the uterus.

Laparoscope—A thin flexible tube with a light on the end that is used to examine the inside of the abdomen; the tube is inserted into the abdomen by way of a small incision just below the navel.

Prognosis

PID can be cured if the initial infection is treated immediately. If infection is not recognized, as frequently happens, the process of tissue destruction and scarring that results from inflammation of the tubes results in irreversible changes in the tube structure that cannot be restored to normal. Subsequent bouts of PID increase a woman's risks manyfold. Thirty to forty percent of cases of female infertility are due to acute salpingitis.

With modern antibiotic therapy, **death** from PID is almost nonexistent. In rare instances, death may occur

from the rupture of tubo-ovarian abscesses and the resulting infection in the abdominal cavity. One recent study has linked infertility, a consequence of PID, with a higher risk of **ovarian cancer**.

Prevention

The prevention of PID is a direct result of the prevention and prompt recognition and treatment of STDs or of any suspected infection involving the female genital tract. The main symptom of infection is an abnormal discharge. To distinguish an abnormal discharge from the mild fluctuations of normal discharge associated with the menstrual cycle takes vigilance and self-awareness. Sexually active women must be able to detect symptoms of lower genital tract disease. Ideally these women will be able to have a frank dialogue regarding their sexual history, risks for PID, and treatment options with their physicians. Also, these women should have open discussions with their sexual partners regarding disclosure of significant symptoms of possible infection.

Lifestyle changes should be geared to preventing the transfer of organisms when the body's delicate lining cells are unprotected or compromised. Barrier contraceptives, such as condoms, diaphragms, and cervical caps should be used. Women in monogamous relationships should use barrier contraceptives during menses and take their physician's advice regarding intercourse following abortion, childbirth, or biopsy procedures.

Resources

BOOKS

Kurman, Robert J., ed. *Blaustein's Pathology of the Female Genital Tract*. New York: Springer-Verlag, 1994.

Landers, D. V., and R. L. Sweet, eds. *Pelvic Inflammatory Disease*. New York: Springer, 1997.

OTHER

"Pelvic Inflammatory Disease." Fact Sheet (November 1997). *National Institute of Allergy and Infectious Diseases*. National Institutes of Health, Bethesda, MD 20892. <http://www.niaid.nih.gov/factsheets/stpid.htm (8 Dec. 1997).

"Pelvic Inflammatory Disease." *Onhealth* (1997). <http://www.healthnet.ivi.com (17 Dec. 1997).

Karen J. Wells

Pelvic relaxation

Definition

Pelvic relaxation is a weakening of the supportive muscles and ligaments of the pelvic floor. This condition, which affects women and is usually caused by childbirth, aging, and problems with support, causes the pelvic floor to sag and press into the wall of the vagina.

Description

The pelvic floor normally holds the uterus and the bladder in position above the vagina. When the pelvic floor becomes stretched and damaged, these organs can sag into the vagina, sometimes bulging out through the vaginal opening. A sagging uterus is referred to as a uterine prolapse, pelvic floor **hernia**, or pudendal hernia. A sagging bladder is referred to as a bladder prolapse, or cystocele. Other organs, such as the rectum and intestine, can also sag into the vagina as a result of a weakened pelvic floor.

Causes and symptoms

Childbirth increases the risk of pelvic relaxation. Other causes include **constipation**, a chronic **cough**, **obesity**, and heavy lifting. Some women develop the condition after **menopause**, when the body loses the estrogen that helps maintain muscle tone. Mild pelvic relaxation may cause no symptoms. More severe pelvic relaxation can cause the following symptoms:

- an aching sensation in the vagina, lower abdomen, groin or lower back
- heaviness or pressure in the vaginal area, as if something is about to "fall out" of the vagina
- bladder control problems that worsen with heavy lifting, coughing, or sneezing
- frequent urinary tract infections
- difficulty having a bowel movement

Diagnosis

A thorough **pelvic exam** can help diagnose pelvic relaxation, as can tests of bladder function.

Treatment

Exercises called Kegel exercises can strengthen pelvic floor muscles and lessen the symptoms of pelvic relaxation. These exercises involve squeezing the muscles that stop the flow of urine. The pelvic floor can also be strengthened by estrogen supplements. Physicians sometimes prescribe the insertion of a supportive ring-shaped device called a pessary into the vagina, to prevent the uterus and bladder from pressing into the vagina. Sometimes surgery is recommended to repair a sagging bladder or uterus, and sometimes surgical removal of the uterus (**hysterectomy**) is recommended. Patients are often advised to adhere to a high-fiber diet to reduce the

KEY TERMS

Cystocele—Bulging of the bladder into the vagina.

Cystourethrocele—Bulging of the bladder neck into the vagina.

Enterocele—Bulging of the intestine into the upper part of the vagina.

Kegel exercises—Pelvic muscle exercises that strengthen bladder and bowel control.

Pessary—A device inserted into the vagina to support sagging organs.

Rectocele—Bulging of the rectum into the vaginal wall.

Uterine prolapse—Bulging of the uterus into the vagina.

Vaginal prolapse—Bulging of the top of the vagina into the lower vagina or outside the opening of the vagina.

strain of bowel movements, maintain a moderate weight, and avoid activities that strain the pelvic floor. They are sometimes prescribed medications to help control urination and prevent leakage.

Prognosis

Mild cases of pelvic relaxation can sometimes be reversed through Kegal exercises, while severe cases usually do not respond to **exercise** or estrogen therapy, but usually require pessary support or surgery.

Prevention

To limit **stress** on the pelvic support system, women are advised to maintain a normal body weight, limit heavy lifting, and avoid unnecessary straining to have bowel movements.

Resources

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 North Charles Street, Baltimore, MD 21201. (800) 242-2383. <http://www.afud.org>.

American College of Obstetricians and Gynecologists. 409 12th St., SW, Washington, DC 20090-6920. (202) 863-2518. <http://www.acog.org>.

National Association For Continence. P.O. Box 8310, Spartanburg, SC 29305-8310. (800) BLADDER. <http://www.nafc.org>.

National Kidney and Urologic Diseases Information Clearinghouse. 3 Information Way, Bethesda, MD, 20892. NIH Publication No. 97-4195. (800) 891-5390. <http://www.niddk.nih.gov/health/kidney/nkudic.htm>.

Ann Quigley

Pelvic ultrasound

Definition

Pelvic ultrasound is a procedure where harmless, high-frequency sound waves are projected into the abdomen. These waves reflect off of the internal structures and create shadowy black and white pictures on a display screen.

Purpose

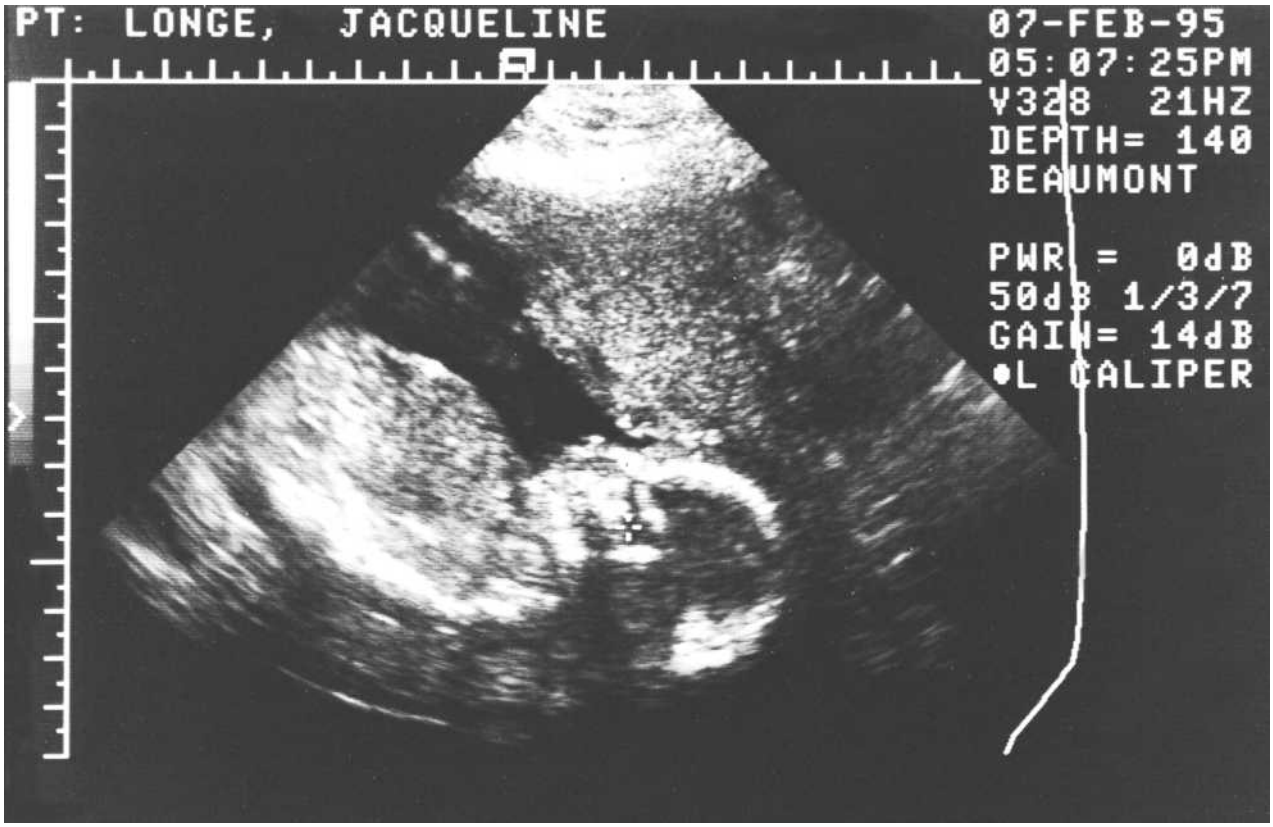
Ultrasound is performed routinely during **pregnancy**. Early in the pregnancy (at about seven weeks), it might be used to determine the size of the uterus or the fetus, to detect multiple or **ectopic pregnancy**, to confirm that the fetus is alive (or viable), or to confirm the due date. Toward the middle of the pregnancy (at about 16–20 weeks), ultrasound may be used to confirm fetal growth, to reveal defects in the anatomy of the fetus, and to check the placenta. Toward the end of pregnancy, it may be used to evaluate fetal size, position, growth, or to check the placenta. Doctors may use ultrasound during diagnostic procedures like **amniocentesis** and **chorionic villus sampling**. Both of these tests use long needles inserted through the mother's abdomen into the uterus or placenta to gather cells. Ultrasound can also be used in men or women to examine other internal organs, such as the liver, gallbladder, kidney, and heart. The procedure can be useful in detecting cysts, tumors, and **cancer** of the uterus, ovaries, and breasts.

Precautions

There are no special precautions recommended before an ultrasound examination. Unlike x rays, ultrasound does not produce any harmful radiation and does not pose a risk to the mother or the fetus. While many woman have an ultrasound as part of their prenatal care, there may be no medical need to perform the procedure.

Description

Ultrasound examinations can be done in a doctor's office, clinic, or hospital setting. Typically, the pregnant



An ultrasound image of Anabelle Ashlyn Longe at 20 weeks. *(Courtesy of Jacqueline Longe.)*

woman will lie on an examination table with her abdomen exposed. Gel or oil is applied to the area. The doctor or technician will move a hand-held scanner (called a transducer) over the abdomen. The transducer emits high-frequency sound waves (usually in the range of 3.5–7.0 megahertz) into the abdomen. The waves are reflected back to the transducer and the wave patterns are shown as an image on a display screen. An ultrasound scan reveals the shapes, densities, and even movements of organs and tissues. Although the pictures transmitted by an ultrasound scan appear gray and grainy, a trained technician can identify the fetus within the uterus, monitor its heartbeat, and sometimes determine its sex. Using computerized tools, the technician can measure various structures shown on the screen. For example, the length of the upper thigh bone (femur) or the distance between the two sides of the skull can indicate the age of the fetus.

Ultrasound technology has been used safely in medical settings for over 30 years, and several significant improvements have been made to the procedure. A specially designed transducer probe can be placed in the vagina to provide better ultrasound images. This transvaginal or endovaginal scan is particularly useful in early pregnancy or in cases where ectopic pregnancy is suspected. Doppler ultrasound uses enhanced sound waves to monitor subtle events, like the flow of fetal blood through the heart and arteries. Color imaging is a recent addition to ultrasound technology. With this process, color can be assigned to the various shades of gray for better visualization of subtle tissue details. A new technology under development is three-dimensional ultrasound, which has the potential for detecting even very subtle fetal defects.

Preparation

Before undergoing a pelvic ultrasound, a woman may be asked to drink several glasses of water and to avoid urinating for about one hour before the examination. When the bladder is full, the uterus and fetus are easier to see. A lubricating gel or mineral oil may be applied to the area to make moving the transducer easier.

Aftercare

The lubricating jelly or oil applied to the abdomen is wiped off at the end of the procedure. After an ultrasound examination, a patient can immediately resume normal activities.

KEY TERMS

Amniocentesis—A procedure where a needle is inserted through the pregnant mother's abdomen and into the uterus to draw off some of the amniotic fluid surrounding the fetus.

Chorionic villus sampling—A procedure where a needle is inserted into the placenta to draw off some of the placenta's inner wall cells surrounding the fetus.

Ectopic pregnancy—A pregnancy where the fertilized egg becomes implanted somewhere other than in the uterus. A tubal pregnancy is when the fertilized egg implants in the fallopian tube.

Fetus—A term for an unborn baby, usually from the end of week eight to the moment of birth.

Placenta—The organ that allows interchange between the fetus and the mother. Blood from the fetus and the mother do not directly mix, but the thin placental membrane allows the fetus to absorb nutrients and oxygen from the mother. Waste products from the fetus can exit through the placenta.

Ultrasonography—Another term for ultrasound.

Risks

There are no known risks, to either the mother or the fetus, associated with the use of ultrasound.

Normal results

The reliability of ultrasound readings depends on the skill of the technician or doctor performing the scan. Patients should be aware that fetal abnormalities cannot be detected with 100% accuracy using ultrasound. A normal ultrasound result does not necessarily guarantee that the fetus will be normal.

Abnormal results

Ultrasound examinations in obstetrics may detect abnormalities or defects in the fetus. This information may reveal that the fetus cannot survive on its own after birth or that it will require extensive treatment or care. Some surgical procedures can be performed to correct defects while the fetus is still in the uterus. Parents faced with information regarding possible **birth defects** may require counseling to consider their choice to either continue or end the pregnancy.

The diagnostic use of ultrasound may reveal the presence of cysts, tumors, or cancer in internal organs.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Ultrasound." In *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

"Ultrasound Studies." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

"Ultrasonography (US)." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

ORGANIZATIONS

American Institute of Ultrasound in Medicine. 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707-5906. (800) 638-5352. <http://www.aium.org>.

Altha Roberts Edgren

Penicillin V *see* **Penicillins**

Penicillins

Definition

Penicillins are medicines that kill bacteria or prevent their growth.

Purpose

Penicillins are **antibiotics** (medicines used to treat infections caused by microorganisms). There are several types of penicillins, each used to treat different kinds of infections, such as skin infections, dental infections, ear infections, respiratory tract infections, urinary tract infections, **gonorrhea**, and other infections caused by bacteria. These drugs will *not* work for colds, flu, and other infections caused by viruses.

Description

Examples of penicillins are penicillin V (Beepen-VK, Pen-Vee K, V-cillin K, Veetids) and amoxicillin (Amoxil, Polymox, Trimox, Wymox). Penicillins are sometimes combined with other ingredients called beta-lactamase inhibitors, which protect the penicillin from bacterial enzymes that may destroy it before it can do its work. The drug Augmentin, for example, contains a combination of amoxicillin and a beta-lactamase inhibitor, clavulanic acid.

Penicillins are available only with a physician's prescription. They are sold in capsule, tablet (regular and chewable), liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of penicillin, the strength of the medicine, and the medical problem for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take penicillins exactly as directed. Never take larger, smaller, more frequent, or less frequent doses. To make sure the infection clears up completely, take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve. This is important with all types of infections, but it is especially important with "strep" infections, which can lead to serious heart problems if they are not cleared up completely.

Take this medicine only for the infection for which it was prescribed. Different kinds of penicillins cannot be substituted for one another. Do not save some of the medicine to use on future infections. It may not be the right treatment for other kinds of infections, even if the symptoms are the same.

Penicillins work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses.

Some penicillins, notably penicillin V, should be taken on an empty stomach, but others may be taken with food. Check package directions or ask the physician or pharmacist for instructions on how to take the medicine.

Precautions

Symptoms should begin to improve within a few days of beginning to take this medicine. If they do not, or if they get worse, check with the physician who prescribed the medicine.

Penicillins may cause **diarrhea**. Certain diarrhea medicines may make the problem worse. Check with a physician before using any diarrhea medicine to treat diarrhea caused by taking penicillin. If diarrhea is severe, check with a physician as soon as possible. This could be a sign of a serious side effect.

Penicillins may change the results of some medical tests. Before having medical tests, patients who are taking penicillin should be sure to let the physician in charge know that they are taking this medicine.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take penicillins. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. People who have hay **fever**, **asthma**, eczema, or other general **allergies** (or who have had such allergies in the past) may be more likely to have severe reactions to penicillins. They should be sure their health care provider knows about their allergies.

Anyone who has had unusual reactions to penicillins or **cephalosporins** in the past should let his or her physician know before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

LOW-SODIUM DIET. Some penicillin medicines contain large enough amounts of sodium to cause problems for people on low-sodium **diets**. Anyone on such a diet should make sure that the physician treating the infection knows about the special diet.

DIABETES. Penicillins may cause false positive results on urine sugar tests for diabetes. People with diabetes should check with their physicians to see if they need to change their diet or the doses of their diabetes medicine.

PHENYLKETONURIA. Some formulations of Augmentin contain phenylalanine. People with **phenylketonuria** (PKU) should consult a physician before taking this medicine.

OTHER MEDICAL CONDITIONS. Before using penicillins, people with any of these medical problems should make sure their physicians are aware of their conditions:

- bleeding problems
- congestive **heart failure**
- cystic fibrosis
- kidney disease
- mononucleosis ("mono")
- stomach or intestinal problems, especially ulcerative colitis

USE OF CERTAIN MEDICINES. Taking penicillins with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are mild diarrhea, **headache**, vaginal **itching** and discharge, sore mouth or

KEY TERMS

Enzyme—A type of protein that brings about or speeds up chemical reactions.

Microorganism—An organism that is too small to be seen with the naked eye.

Mononucleosis—An infectious disease with symptoms that include severe fatigue, fever, sore throat, and swollen lymph nodes in the neck and armpits. Also called "mono."

tongue, or white patches in the mouth or on the tongue. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they continue or they are bothersome.

More serious side effects are not common, but may occur. If any of the following side effects occur, get emergency medical help immediately:

- breathing problems, such as **shortness of breath** or fast or irregular breathing
- fever
- sudden lightheadedness or faintness
- joint **pain**
- skin rash, **hives**, itching, or red, scaly skin
- swelling or puffiness in the face

Other rare side effects may occur. Anyone who has unusual symptoms after taking penicillin should get in touch with his or her physician.

Interactions

Birth control pills may not work properly when taken at the same time as penicillin. To prevent **pregnancy**, use additional methods of birth control while taking penicillin, such as latex condoms or spermicide.

Penicillins may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes penicillin should let the physician know all other medicines he or she is taking. Among the drugs that may interact with penicillins are:

- Acetaminophen (Tylenol) and other medicines that relieve pain and inflammation
- medicine for overactive thyroid
- male hormones (androgens)
- female hormones (estrogens)
- other antibiotics
- blood thinners
- disulfiram (Antabuse), used to treat alcohol abuse
- antiseizure medicines such as Depakote and Depakene
- blood pressure drugs such as Capoten, Monopril, and Lotensin

The list above does not include every drug that may interact with penicillins. Be sure to check with a physician or pharmacist before combining penicillins with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Penile cancer

Definition

Penile **cancer** is the growth of malignant cells on the external skin and in the tissues of the penis.

Description

Penile cancer is a disease in which cancerous cells appear on the penis. If left untreated, this cancer can grow and spread from the penis to the lymph nodes in the groin and eventually to other parts of the body.

Demographics

Penile cancer is a rare form of cancer that develops in about one out of 100,000 men per year in the United States. Penile cancer is more common in other parts of the world, particularly Africa and Asia. In Uganda, penile cancer is the most common form of cancer for men.

Causes and symptoms

The cause of penile cancer is unknown. The most common symptoms of penile cancer are:

- a tender spot, an open sore, or a wart-like lump on the penis
- unusual liquid discharges from the penis
- pain or bleeding in the genital area

Diagnosis

In order to diagnose penile cancer, the doctor examines the patient's penis for lumps or other abnormalities.

A tissue sample, or biopsy, may be ordered to distinguish cancerous cells from **syphilis** and penile **warts**. If the results confirm a diagnosis of cancer, additional tests are done to determine whether the disease has spread to other parts of the body.

Treatment

In Stage I penile cancer, malignant cells are found only on the surface of the head (glans) and on the foreskin of the penis. If the cancer is limited to the foreskin, treatment may involve wide local excision and **circumcision**. Wide local excision is a form of surgery that removes only cancer cells and a small amount of normal tissue adjacent to them. Circumcision is removal of the foreskin.

If the Stage I cancer is only on the glans, treatment may involve the use of a fluorouracil cream (Adrucil, Efudex), and/or microsurgery. Microsurgery removes cancerous tissue and the smallest possible amount of normal tissue. During microsurgery, the doctor uses a special instrument that provides a comprehensive view of the area where cancer cells are located and makes it possible to determine that all malignant cells have been removed.

In Stage II, the penile cancer has spread to the surface of the glans, tissues beneath the surface, and the shaft of the penis. The treatment recommended may be **amputation** of all or part of the penis (total or partial penectomy). If the disease is diagnosed early enough, surgeons are often able to preserve enough of the organ for urination and sexual activity. Treatment may also include microsurgery and external **radiation therapy**, in which a machine provides radiation to the affected area. **Laser surgery** is an experimental treatment for Stage II cancers. Laser surgery uses an intense precisely focused beam of light to dissolve or burn away cancer cells.

In Stage III, malignant cells have spread to lymph nodes in the groin, where they cause swelling. The recommended treatment may include amputation of the penis and removal of the lymph nodes on both sides. Radiation therapy may also be suggested. More advanced disease requires systemic treatments using drugs (**chemotherapy**). In chemotherapy, medicines are administered intravenously or taken by mouth. These drugs enter the bloodstream and kill cancer cells that have spread to any part of the body.

In Stage IV, the disease has spread throughout the penis and lymph nodes in the groin, or has traveled to other parts of the body. Treatments are similar to that for Stage III cancer.

Recurrent penile cancer is disease that recurs in the penis or develops in another part of the body after treatment has eradicated the original cancer cells.

KEY TERMS

Circumcision—Surgical removal of the foreskin of the penis. It is usually performed shortly after birth.

Fluorouracil—A cell-killing (cytotoxic) medication that can be applied in cream form to treat cancer of the penis.

Cure rates are high for cancers diagnosed in Stage I or II, but much lower for Stages III and IV, by which time cancer cells have spread to the lymph nodes.

Alternative treatment

In addition to the treatments previously described, biological therapy is another treatment that is currently being studied. Biological therapy is a type of treatment that is sometimes called biological response modifier (BRM) therapy. It uses natural or artificial substances to boost, focus, or reinforce the body's disease-fighting resources.

Prevention

Conditions which increase a person's chance of getting penile cancer include:

- infection with **genital warts** (human papillomavirus, or HPV)
- a skin disease called psoriasis
- a condition called phimosis, in which the foreskin becomes difficult to retract
- other conditions that result in repeated irritation of the penis
- a history of smoking

There appears to be a connection between development of the disease and lack of personal hygiene. Failure to regularly and thoroughly cleanse the part of the penis covered by the foreskin increases the risk of developing the disease. Penile cancer is also more common in uncircumcised men.

Resources

BOOKS

Ernstoff, Marc S., John A. Heaney, and Richard E. Peschel, eds. *Testicular and Penile Cancer.* Oxford: Blackwell Science Limited, 1998.

PERIODICALS

Lindegaard, J., et al. "A Retrospective Analysis of 82 Cases of Cancer of the Penis." *British Journal of Urology* (June 1996): 883-90.

ORGANIZATIONS

The Cancer Group Institute. 17620 9th Ave. NE, North Miami Beach, Florida 33162. (305) 493-1980. <http://www.cancergroup.com>.

American Cancer Society. (800) ACS-2345. <http://www.cancer.org/>.

OTHER

CancerNet: Penile Cancer. 25 Mar. 2001. 28 June 2001 <http://www.cancernet.nci.nih.gov/cancer_types/penile_cancer.shtml>.

Maureen Haggerty
Paul A. Johnson

Penile implant surgery *see* **Penile prostheses**

Penile prostheses

Definition

Penile prostheses are semirigid or inflatable devices that are implanted into penises to alleviate **impotence**.

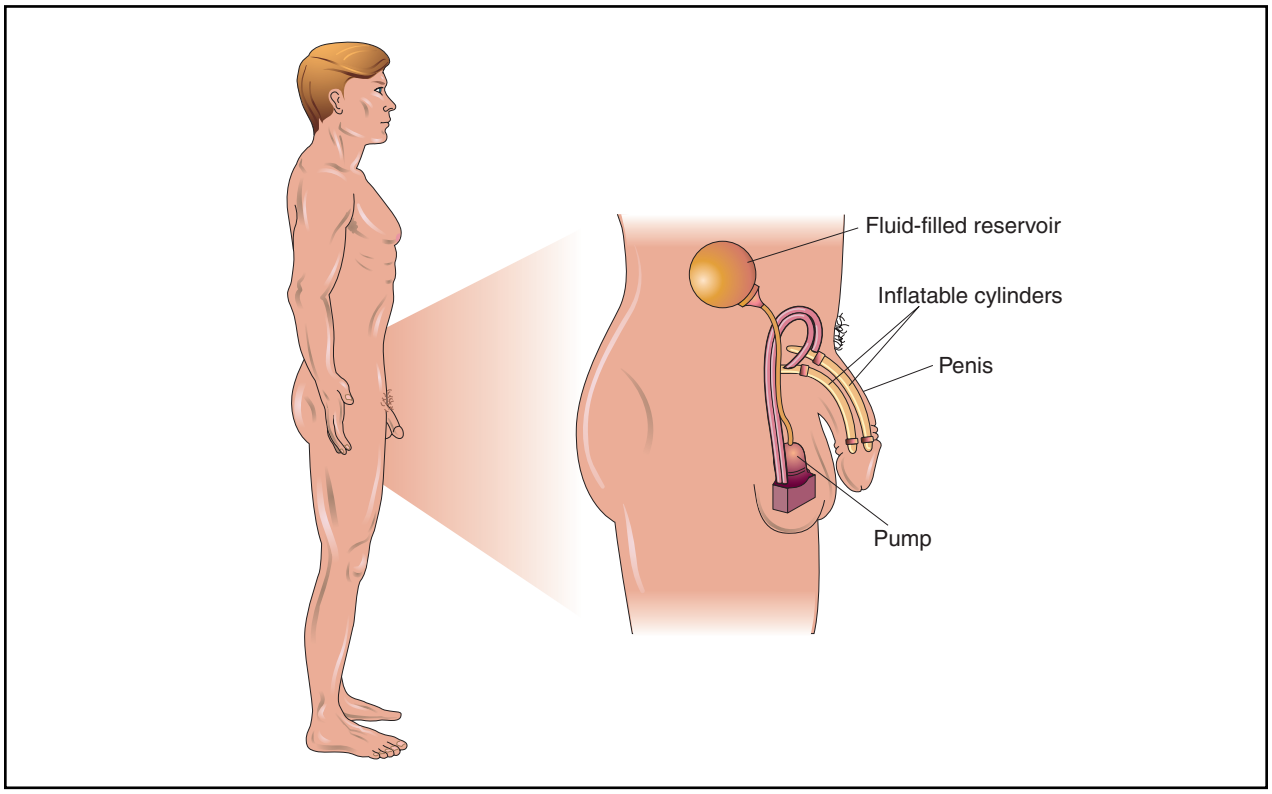
Purpose

The penis is composed of one channel for urine and semen and three compartments with tough, fibrous walls containing "erectile tissue." With appropriate stimulation, the blood vessels that lead out of these compartments constrict, trapping blood. Blood pressure fills and hardens the compartments producing an erection of sufficient firmness to perform sexual intercourse. Additional stimulation leads to ejaculation, where semen is pumped out of the urethra. When this system fails, impotence (failure to create and maintain an erection) occurs.

Impotence can be caused by a number of conditions, including diabetes, **spinal cord injury**, prolonged drug abuse, and removal of a prostate gland. If the medical condition is irreversible, a penile prosthesis may be considered. Patients whose impotence is caused by psychological problems are not recommended for implant surgery.

Description

Penile implant surgery is conducted on patients who have exhausted all other areas of treatment. The semirigid device consists of two rods that are easier and less



The inflatable implant is a common penile prostheses. This device connects through a tube to a flexible fluid reservoir and a pump. The pump is shaped like a testicle and inserted in the scrotum. When the pump is squeezed, the fluid is forced into the inflatable cylinders implanted inside the penis, producing an erection. *(Illustration by Electronic Illustrators Group.)*

KEY TERMS

General anesthesia—Deep sleep induced by a combination of medicines that allows surgery to be performed.

Genital—Sexual organ.

Perineum—Area between the anus and genitals.

Scrotum—The external pouch containing the male reproductive glands (testes) and part of the spermatic cord.

expensive to implant than the inflatable cylinders. Once implanted, the semirigid device needs no follow-up adjustments, however it produces a penis which constantly remains semi-erect. The inflatable cylinders produce a more natural effect. The patient is able to simulate an erection by using a pump located in the scrotum.

With the patient asleep under general anesthesia, the device is inserted into the erectile tissue of the penis through an incision in the fibrous wall. In order to implant the pump for the inflatable implant, incisions are made in the abdomen and the perineum (area between the anus and the genitals). A fluid reservoir is inserted into the groin and the pump is placed in the scrotum. The cylinders, reservoir, and pump are connected by tubes and tested before the incisions are closed.

Preparation

Surgery always requires an adequately informed patient, both as to risks and benefits. In this case, the sexual partner should also be involved in the discussion. Prior to surgery, antibacterial cleansing occurs and the surrounding areas are shaved.

Aftercare

To minimize swelling, ice packs are applied to the penis for the first 24 hours following surgery. The incision sites are cleansed daily to prevent infection. **Pain** relievers may be taken.

Risks

With any implant, there is a slightly greater risk of infection. The implant may irritate the penis and cause continuous pain. The inflatable prosthesis may need follow-up surgery to repair leaks in the reservoir or to reconnect the tubing.

Resources

BOOKS

Jordan, Gerald H., et al. "Surgery of the Penis and Urethra." In *Campbell's Urology,* ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Lewis, Ronald. "Surgery for Erectile Dysfunction." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

J. Ricker Polsdorfer, MD

Pentoxifylline *see* **Blood-viscosity reducing drugs**

Peptic ulcer disease *see* **Heliobacteriosis**

Percutaneous renal biopsy *see* **Kidney biopsy**

Percutaneous transhepatic cholangiography

Definition

Percutaneous transhepatic cholangiography (PTHC) is an x-ray test used to identify obstructions either in the liver or bile ducts that slow or stop the flow of bile from the liver to the digestive system.

Purpose

Because the liver and bile ducts are not normally seen on x rays, the doctor injects the liver with a special dye that will show up on the resulting picture. This dye distributes evenly to fill the whole liver drainage system. If the dye does not distribute evenly, this is indicative of a blockage, which may be caused by a gallstone or a tumor in the liver, bile ducts, or pancreas.

Precautions

Patients should report allergic reactions to:

- anesthetics
- dyes used in medical tests
- iodine
- shellfish

PTHC should not be performed on anyone who has **cholangitis** (inflammation of the bile duct), massive **ascites**, a severe allergy to iodine, or a serious uncorrectable or uncontrollable bleeding disorder. Patients who have diabetes should inform their doctor.

Description

PTHC is performed in a hospital, doctor's office, or outpatient surgical or x-ray facility. The patient lies on a movable x-ray table and is given a local anesthetic. The patient will be told to hold his or her breath, and a doctor, nurse, or laboratory technician will inject a special dye into the liver as the patient exhales.

The patient may feel a twinge when the needle penetrates the liver, a pressure or fullness, or brief discomfort in the upper right side of the back. Hands and feet may become numb during the 30–60 minute procedure.

The x-ray table will be rotated several times during the test, and the patient helped to assume a variety of positions. A special x-ray machine called a fluoroscope will track the dye's movement through the bile ducts and show whether the fluid is moving freely or if its passage is obstructed.

PTHC costs about $1,600. The test may have to be repeated if the patient moves while x rays are being taken.

KEY TERMS

Ascites—Abnormal accumulation of fluid in the abdomen.

Bile ducts—Tubes that carry bile, a thick yellowish-green fluid that is made by the liver, stored in the gallbladder, and helps the body digest fats.

Cholangitis—Inflammation of the bile duct.

Fluoroscope—An x-ray machine that projects images of organs.

Granulomatous disease—Characterized by growth of tiny blood vessels and connective tissue.

Jaundice—Disease that causes bile to accumulate in the blood, causing the skin and whites of the eyes to turn yellow. Obstructive jaundice is caused by blockage of bile ducts, while non-obstructive jaundice is caused by disease or infection of the liver.

Preparation

An intravenous antibiotic may be given every four to six hours during the 24 hours before the test. The patient will be told to fast overnight. Having an empty stomach is a safety measure in case of complications, such as bleeding, that might require emergency repair surgery. Medications such as **aspirin**, or non-steroidal anti-inflammatory drugs that thin the blood, should be stopped three to seven days prior to taking the PRHC test. Patients may also be given a sedative a few minutes before the test begins.

Aftercare

A nurse will monitor the patient's vital signs and watch for:

- itching
- flushing
- nausea and vomiting
- sweating
- excessive flow of saliva
- possible serious allergic reactions to contrast dye

The patient should stay in bed for at least six hours after the test, lying on the right side to prevent bleeding from the injection site. The patient may resume normal eating habits and gradually resume normal activities. The doctor should be informed right away if **pain** develops in the right abdomen or shoulder or in case of **fever**, **dizziness**, or a change in stool color to black or red.

Risks

Septicemia (blood **poisoning**) and bile **peritonitis** (a potentially fatal infection or inflammation of the membrane covering the walls of the abdomen) are rare but serious complications of this procedure. Dye occasionally leaks from the liver into the abdomen, and there is a slight risk of bleeding or infection.

Normal results

Normal x rays show dye evenly distributed throughout the bile ducts. **Obesity**, gas, and failure to fast can affect test results.

Abnormal results

Enlargement of bile ducts may indicate:

- obstructive or non-obstructive **jaundice**
- cholelithiasis (gallstones)
- hepatitis (inflammation of the liver)
- cirrhosis (chronic liver disease)
- granulomatous disease
- pancreatic cancer
- bile duct or gallbladder cancers

Resources

BOOKS

Komaroff, A. L. *The Harvard Medical School Family Health Guide*. New York: Simon & Schuster, 1999.

PERIODICALS

Cieszanowski, A. et al. "Imaging Techniques in Patients with Biliary Obstruction." *Medical Science Monitor* 6 (November-December 2000): 1197-202.

OTHER

Percutaneous Transhepatic Cholangiography. <http://207.25.144.143/health/Library/medtests/>.

Percutaneous Transhepatic Cholangiography (PTHC). <http://www.uhs.org/frames/health/test/test3554.htm>.

Test Universe Site: Percutaneous Transhepatic Cholangiography. <http://www.testuniverse.com/mdx/MDX-3055.html>.

Maureen Haggerty

Perforated eardrum

Definition

A perforated eardrum exists when there is a hole or rupture in the eardrum, the thin membrane that separates the outer ear canal from the middle ear. A perforated eardrum may cause temporary **hearing loss** and occasional discharge.

Description

The eardrum (tympanic membrane) is a thin wall that separates the outer ear from the middle ear, vibrating when sound waves strike the membrane. The middle ear is connected to the nose by the Eustachian tube.

In addition to conducting sound, the eardrum also protects the middle ear from bacteria. When it is perforated, bacteria can more easily get into this part of the ear, causing ear infections.

In general, the larger the hole in the eardrum, the greater the temporary loss of hearing. The location of the perforation also affects the degree of hearing loss. Severe hearing loss may follow a skull fracture that disrupts the bones in the middle ear. Eardrum perforation caused by a loud noise may result in ringing in the ear (**tinnitus**), in addition to a temporary hearing loss. Over time, this hearing loss improves and the ringing usually fades in a few days.

Causes and symptoms

The eardrum can become damaged by a direct injury. It is possible to perforate the eardrum:

- with a cotton-tipped swab or another foreign object
- by hitting the ear with an open hand
- after a skull fracture
- after a loud explosion or other loud noise

In addition, an ear infection can rupture the eardrum as pressure within the middle ear rises when fluid builds up. If the eardrum is punctured by pressure from an ear infection, there may be infected or bloody drainage from the ear.

Rarely, a small hole may remain in the eardrum after a pressure-equalizing tube falls out or is removed by a doctor.

Symptoms include an earache or **pain** in the ear, which may be severe, or a sudden decrease in ear pain, followed by ear drainage of clear, bloody, or pus-filled fluid, hearing loss, or ear noise/buzzing.

KEY TERMS

Eustachian tube—The air duct that connects the area behind the nose to the middle ear.

Otoscope—An instrument used to examine the ear, to inspect the outer ear canal and the eardrum, and to detect diseases in the middle ear.

Diagnosis

A doctor can diagnose a perforated eardrum by direct inspection with an otoscope. Hearing tests may reveal a hearing loss.

Treatment

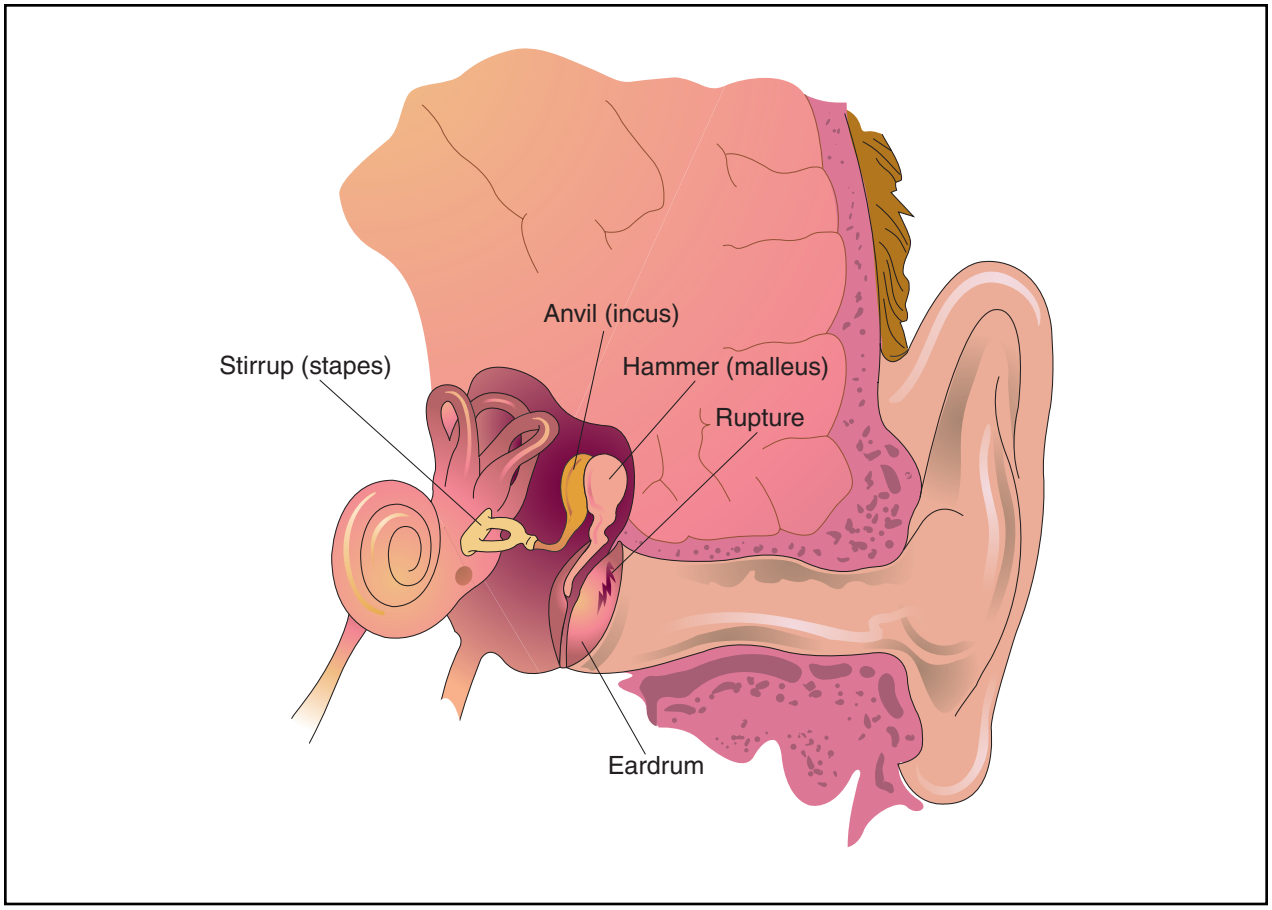
A perforated eardrum usually heals by itself within two months. **Antibiotics** may be given to prevent infection or to treat an existing ear infection. Painkillers can relieve any ear pain.

Sometimes, a paper patch is placed over the eardrum until the membrane heals. Three or four patches may be needed before the perforation closes completely. If the eardrum does not heal on its own, surgical repair (tympanoplasty) may be necessary.

The ear should be kept clean and dry while the eardrum heals; patients should insert cotton balls into the ear when showering or shampooing to block any water from getting into the ear. Pain in the ear may be eased by applying warm compresses.

Prognosis

While a perforated eardrum may be uncomfortable, it usually heals on its own. Any hearing loss that accompanies the perforation is usually temporary.



A perforated eardrum is caused by a hole or rupture in the eardrum, the thin membrane that separates the outer ear canal from the middle ear. It may result in temporary hearing loss and occasional discharge. *(Illustration by Electronic Illustrators Group.)*

Prevention

A perforated eardrum can be prevented by avoiding insertion of any object into the ear to clean it. If a foreign object becomes lodged in the ear, only a doctor should try to remove it.

Promptly treating all ear infections is another way to guard against a ruptured eardrum.

Resources

BOOKS

Turkington, Carol A. *The Hearing Loss Sourcebook*. New York: Plume/Penguin, 1997.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684-3391.

Carol A. Turkington

Perforated septum

Definition

A perforated septum is a hole in the nasal septum, the vertical plane of tissue that separates the nostrils.

Description

The nasal septum is a thin structure in the middle of the nose. In front, it is cartilage, further back it is bone. On either side, it is covered with mucus membranes. The cartilage depends upon the blood vessels in the mucus membranes on either side for its **nutrition**. If that blood supply is shut off, the cartilage dies, producing a hole or perforation.

Causes and symptoms

There are several causes of a perforated septum.

- Wearing ornaments in the nose. To hang an ornament from the middle of the nose requires that the tissue

KEY TERMS

Systemic lupus erythematosus—A collagen-vascular disease in the autoimmune category that causes damage to many different parts of the body.

directly in front of the septal cartilage be pierced or perforated.

- Sniffing **cocaine**. Cocaine is a potent vasoconstrictor, which means that it causes small blood vessels to close. It is used in nose surgery because it shrinks mucus membranes, permitting better visualization and access into the nose. Used continuously, tissues are deprived of blood and die. The nasal septum is the most vulnerable to this effect of sniffing cocaine.
- Getting the septum cauterized. Nosebleeds usually come from the front part of the nasal septum, which is rich in blood vessels. Uncontrolled repeated bleeding from these vessels may require cautery—burning the vessels with electricity or chemicals to close them off. Injudicious cautery of both sides of the septum has in the past led to death of tissue and consequent perforation.
- More and more people are having cosmetic surgery done on their nose. The procedure, called **rhinoplasty**, occasionally damages the septum's blood supply.
- Contracting certain diseases. Several diseases—typhoid, **syphilis**, **systemic lupus erythematosus**, and tuberculosis—can infect this tissue and destroy it.
- Being exposed to harmful vapors. Toxic air pollutant-like acid fumes, phosphorus, and copper vapor—and sometimes even cortisone sprays—can destroy nasal tissue.

Perforation is not serious. It causes irritation, mostly complaints of dryness and crusting. Sometimes air blowing past it whistles. Picking at the crusts can cause bleeding.

Treatment

Surgical repair is not difficult. The surgeon may devise a plastic button that fits exactly into the defect and stays in place like a collar button.

Alternative treatment

Saline nasal sprays may be sufficient to control symptoms and prevent the need for surgery.

Prevention

Nosebleeds from the septum can usually be controlled with pinching. Vaginal estrogen cream has also been used successfully to toughen the blood vessels.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of The Nose, Throat, Ear, Head, and Neck*. Philadelphia: Lea & Febiger, 1991.

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Pericardiocentesis

Definition

Pericardiocentesis is the removal by needle of pericardial fluid from the sac surrounding the heart for diagnostic or therapeutic purposes.

Purpose

The pericardium, the sac (or membrane) that surrounds the heart muscle, normally contains a small amount of fluid that cushions and lubricates the heart as the heart expands and contracts. When too much fluid gathers in the pericardial cavity, the space between the pericardium and the outer layers of the heart, a condition known as pericardial effusion occurs. Abnormal amounts of fluid may result from:

- **pericarditis** (caused by infection, inflammation)
- trauma (producing blood in the pericardial sac)
- surgery or other invasive procedures performed on the heart
- **cancer** (producing malignant effusions)
- myocardial infarction, congestive heart failure
- renal failure

Possible causes of pericarditis include chest trauma, systemic infection (bacterial, viral, or fungal), myocardial infarction (**heart attack**), or **tuberculosis**. When pericarditis is suspected, pericardiocentesis may be advisable in order to obtain a fluid sample for laboratory analysis to identify the underlying cause of the condition.

Pericardiocentesis is also used in emergency situations to remove excessive accumulations of blood or fluid from the pericardial sac, such as with **cardiac tamponade**. When fluid builds up too rapidly or excessively in the pericardial cavity, the resulting compression on the heart impairs the pumping action of the vascular system. Cardiac tamponade is a life-threatening condition that requires immediate treatment.

Precautions

Whenever possible, an echocardiogram (ultrasound test) should be performed to confirm the presence of the

pericardial effusion and to guide the pericardiocentesis needle during the procedure. Because of the risk of accidental puncture to major arteries or organs in pericardiocentesis, surgical drainage may be a preferred treatment option for pericardial effusion in non-emergency situations.

Description

The patient's vital signs are monitored throughout the procedure, and an ECG tracing is continuously run. If time allows, **sedation** is administered, the puncture site is cleaned with an antiseptic iodine solution, and a local anesthetic is injected into the skin to numb the area. The patient is instructed to remain still. The physician performing pericardiocentesis will insert a syringe with an attached cardiac needle slowly into the chest wall until the needle tip reaches the pericardial sac. The patient may experience a sensation of pressure as the needle enters the membrane. When the needle is in the correct position, the physician will aspirate, or withdraw, fluid from the pericardial sac.

When the procedure is performed for diagnostic purposes, the fluid will be collected into specimen tubes for laboratory analysis. If the pericardiocentesis is performed to treat a cardiac tamponade or other significant fluid build-up, a pericardial catheter may be attached to the needle to allow for continuous drainage.

After the cardiac needle is removed, pressure is applied to the puncture site for approximately five minutes, and the site is then bandaged.

Preparation

Prior to pericardiocentesis, the test procedure is explained to the patient, along with the risks and possible complications involved, and the patient is asked to sign an informed consent form. If the patient is incapacitated, the same steps are followed with a family member.

No special diet or **fasting** is required for the test. After the patient changes into a hospital gown, an intravenous line is inserted into a vein in the arm. The IV will be used to administer sedation, and any required medications or blood products. Leads for an electrocardiogram (ECG) tracing are attached to the patient's right and left arms and legs, and the fifth lead is attached to the cardiac needle used for the procedure. The patient is instructed to lie flat on the table, with the upper body elevated to a 60 degree angle.

Aftercare

The site of the puncture and any drainage catheter should be checked regularly for signs of infection such as redness and swelling. Blood pressure and pulse are also monitored following the procedure. Patients who experience continued bleeding or abnormal swelling of the puncture site, sudden **dizziness**, difficulty breathing, or chest pains in the days following a pericardiocentesis procedure should seek immediate medical attention.

KEY TERMS

Cardiac tamponade—Compression and restriction of the heart that occurs when the pericardium fills with blood or fluid. This increase in pressure outside the heart interferes with heart function and can result in shock and/or death.

Catheter—A long, thin, flexible tube used to drain or administer fluids.

Echocardiogram—An imaging test using high-frequency sound waves to obtain pictures of the heart and surrounding tissues.

Electrocardiogram—A cardiac test that measures the electrical activity of the heart.

Myocardium—The middle layer of the heart wall.

Pericardium—A double membranous sac that envelops and protects the heart.

Risks

Pericardiocentesis is an invasive procedure, and infection of the puncture site or pericardium is always a risk. Possible complications include perforation of a major artery, lung, or liver. The myocardium, the outer muscle layer of the heart, could also be damaged if the cardiac needle is inserted too deeply.

Normal results

Normal pericardial fluid is clear to straw-colored in appearance with no bacteria, blood, cancer cells or pathogens. There is typically a minimal amount of the fluid (10–50 ml) in the pericardial cavity.

Abnormal results

A large volume of pericardial fluid (over 50 ml) indicates the presence of pericardial effusion. Laboratory analysis of the fluid can aid in the diagnosis of the cause of pericarditis. The presence of an infectious organism such as *staphylococcus aureus* is a sign of bacterial pericarditis. Excessive protein is present in cases of **systemic**

lupus erythematosus or myocardial infarction (heart attack). An elevated white **blood count** may point to a fungal infection. If the patient has a hemorrhage, a cardiac rupture, or cancer, there may be blood in the pericardial fluid.

Resources

BOOKS

Weinstock, Doris et al. eds. "Body System Tests: Cardiovascular System." In *Illustrated Guide to Diagnostic Tests, 2nd edition*. Springhouse, PA: Springhouse Corporation, 1998.

ORGANIZATION

The American Heart Association. National Center. 7272 Greenville Avenue, Dallas, Texas 75231. (800) AHA-USA1. <http://www.americanheart.org>.

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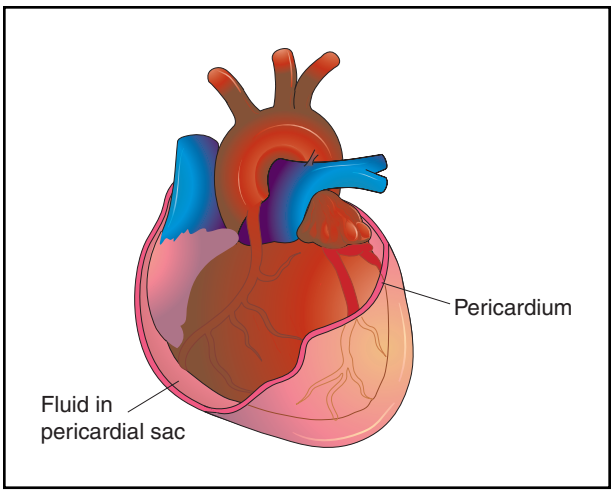

Cardiac tamponade occurs when fluid collects in the pericardial sac between the heart and the surrounding pericardium. A medical emergency, cardiac tamponade deprives the body of oxygen and requires immediate treatment. *(Illustration by Electronic Illustrators Group.)*

Pericarditis

Definition

Pericarditis is an inflammation of the two layers of the thin, sac-like membrane that surrounds the heart. This membrane is called the pericardium, so the term pericarditis means inflammation of the pericardium.

Description

Pericarditis is fairly common. It affects approximately one in 1,000 people. The most common form is caused by infection with a virus. People in their 20s and 30s who have had a recent upper respiratory infection are most likely to be affected, along with men aged 20–50. One out of every four people who have had pericarditis will get it again, but after two years these relapses are less likely.

Causes and symptoms

The viruses that cause pericarditis include those that cause **influenza**, **polio**, and **rubella** (German **measles**). In children, the most common viruses that cause pericarditis are the adenovirus and the cocksackievirus (which is most likely to affect children during warmer weather).

Although pericarditis is usually caused by a virus, it also can be caused by an injury to the heart or it can follow a **heart attack**. It may also be caused by certain inflammatory diseases such as **rheumatoid arthritis** or **systemic lupus erythematosus**. Bacteria, fungi, parasites, **tuberculosis**, **cancer** or kidney failure may also affect the pericardium. Sometimes the cause is unknown.

There are several forms of pericarditis, depending on the cause.

Acute pericarditis

This is caused by infection with a virus, bacteria, or fungus—usually in the lungs and upper respiratory tract. This form of the disease causes a sharp, severe **pain** that starts in the region of the breastbone. If the pericarditis is caused by a bacteria, it is called bacterial or purulent pericarditis.

Cardiac tamponade

Sometimes fluid collects between the heart and the pericardium. This is called pericardial effusion, and may lead to a condition called **cardiac tamponade**. When the fluid accumulates, it can squeeze the heart and prevent it from filling with blood. This keeps the rest of the body from getting the necessary supply of oxygen and can cause dangerously low blood pressure. A cardiac tamponade can happen when the chest is injured during surgery, **radiation therapy**, or an accident. Cardiac tamponade is a serious medical emergency and must be treated immediately.

Constrictive pericarditis

When the pericardium is scarred or thickened, the heart has difficulty contracting. This is because the pericardium has shrunken or tightened around the heart, constricting the muscle's heart movement. This usually occurs as a result of tuberculosis, which now is rarely

found in the United States, except in immigrant, **AIDS**, and prison populations.

Symptoms of pericarditis

Symptoms likely to be associated with pericarditis include:

- rapid breathing
- breathlessness
- dry **cough**
- fever and chills
- weakness
- broken blood vessels (hemorrhages) in the mucus membrane of the eyes, the back, the chest, fingers, and toes
- feelings of anxiety
- A sharp or dull pain that starts in the front of the chest under the breastbone and radiates to the left side of the neck, upper abdomen, and left shoulder (the pain is less intense when the patient sits up or leans forward and worsens when lying down; it may worsen with a deep breath, like **pleurisy**, which may accompany pericarditis)

In cardiac tamponade, neck veins may be swollen and blood pressure may be very low.

Diagnosis

The heart of a person with pericarditis is likely to produce a grating sound (friction rub) when heard through a stethoscope. This sound occurs because the roughened pericardium surfaces are rubbing against each other.

The following tests will also help diagnose pericarditis and what is causing it:

- electrocardiograph (ECG) and echocardiogram to distinguish between pericarditis and a heart attack
- x ray to show the traditional "water bottle" shadow around the heart that is often seen in pericarditis where there is sufficient fluid buildup
- computed tomography scan (CT scan) of the chest
- heart catheterization to view the heart's chambers and valves
- **pericardiocentesis** to test for viruses, bacteria, fungus, cancer, and tuberculosis
- blood tests such as LDH and CPK to measure cardiac enzymes and distinguish between a heart attack and pericarditis, as well as a complete **blood count** (CBC) to look for infection

KEY TERMS

Computed tomography (CT) scan—A CT scan uses x rays to scan the body from many angles. A computer compiles the x rays into a picture of the area being studied. The images are viewed on a monitor and printed-out.

Echocardiogram—An echocardiogram bounces sound waves off the heart to create a picture of its chambers and valves.

Electrocardiogram (ECG)—An ECG is a test to measure electrical activity in the heart.

Heart catheterization—A heart catheterization is used to view the heart's chamber and valves. A tube (catheter) is inserted into an artery, usually in the groin. A dye is then put into the artery through the tube. The dye makes its way to the heart to create an image of the heart on x-ray film. The image is photographed and stored for further examination.

Pericardiocentesis—Pericardiocentesis is a procedure used to test for viruses, bacteria, and fungus. The physician puts a small tube through the skin, directly into the pericardial sac, and withdraws fluid. The fluid then is tested for viruses, bacteria, and fungus.

Pericardium—The pericardium is the thin, sac-like membrane that surrounds the heart. It has two layers: the serous pericardium and the fibrous pericardium.

Treatment

Since most pericarditis is caused by a virus and will heal naturally, there is no specific, curative treatment. Ordinary **antibiotics** do not work against viruses. Pericarditis that comes from a virus usually clears up in two weeks to three months. Medications may be used to reduce inflammation, however. They include **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as ibuprofen and **aspirin**. **Corticosteroids** are helpful if the pericarditis was caused by a heart attack or systemic lupus erythematosus. **Analgesics** (painkillers such as aspirin or **acetaminophen**) also may be given.

If the pericarditis recurs, removal of all or part of the pericardium (pericardiectomy) may be necessary. In the case of constrictive pericarditis, the pericardiectomy may be necessary to remove the stiffened parts of the pericardium that are preventing the heart from beating correctly.

If a cardiac tamponade is present, it may be necessary to drain excess fluid from the pericardium. Pericardiocentesis, the same procedure used for testing, will be used to withdraw the fluid.

For most people, home care with rest and medications to relieve pain are sufficient. A warm heating pad or compress also may help relieve pain. Sitting in an upright position and bending forward helps relieve discomfort. A person with pericarditis may also be kept in bed, with the head of the bed elevated to reduce the heart's need to work hard as it pumps blood. Along with painkillers and antibiotics, diuretic drugs ("water pills") to reduce fluids may also be used judiciously.

Prognosis

Prognosis is good. Most people recover within three weeks to several months and do not need any additional treatment.

Prevention

There is no way to prevent pericarditis, but a healthy lifestyle with proper **nutrition** and **exercise** will help keep the body's immune system strong and more likely to fight off invading microorganisms.

Resources

PERIODICALS

Dugan, Kathleen. "Caring for Patients with Pericarditis." *Nursing* 28, no.3 (Mar. 1998): 50-52.

Houghton, J. L. "Pericarditis and Myocarditis." *Postgraduate Medicine* 91 (1 Feb. 1992): 273-278, 281-282.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

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Perinatal infection

Definition

An infection caused by a bacteria or virus that can be passed from a mother to her baby during **pregnancy** or delivery is called a perinatal infection.

Description

Perinatal infections include bacterial or viral illnesses that can be passed from a mother to her baby either while the baby is still in the uterus, during the delivery process, or shortly after birth. Maternal infection can, in some cases, cause complications at birth. The mother may or may not experience active symptoms of the infection during the pregnancy. The most serious and most common perinatal infections, and the impact of these diseases on the mother and infant, are discussed below in alphabetical order. It is important to note that men can become infected and can transmit many of these infections to other women. The sexual partners of women who have these infections should also seek medical treatment.

Causes and symptoms

Chlamydia

Chlamydia trachomatis is the most common bacterial sexually transmitted disease in the United States, causing more than 4 million infections each year. The majority of women with chlamydial infection experience no obvious symptoms. The infection affects the reproductive tract and causes **pelvic inflammatory disease**, **infertility**, and **ectopic pregnancy** (the fertilized egg implants somewhere other than in the uterus). This infection can cause premature rupture of the membranes and early labor. It can be passed to the infant during delivery and can cause ophthalmia neonatorum (an eye infection) within the first month of life and **pneumonia** within one to three months of age. Symptoms of **chlamydial pneumonia** are a repetitive **cough** and rapid breathing. **Wheezing** is rare and the infant does not develop a **fever**.

Cytomegalovirus

Cytomegalovirus (CMV) is a very common virus in the herpes virus family. It is found in saliva, urine, and other body fluids and can be spread through sexual contact or other more casual forms of physical contact like kissing. In adults, CMV may cause mild symptoms of swollen lymph glands, fever, and **fatigue**. Many people who carry the virus experience no symptoms at all. Infants can become infected with CMV while still in the uterus if the mother becomes infected or develops a recurrence of the infection during pregnancy. Most infants exposed to CMV before birth develop normally and do not show any symptoms. As many as 6,000 infants who were exposed to CMV before birth are born with serious complications each year. CMV interferes with normal fetal development and can cause **mental retardation**, blindness, deafness, or epilepsy in these infants.

Genital herpes

Genital herpes, which is usually caused by herpes simplex virus type 2 (HSV-2), is a sexually transmitted

disease that causes painful sores on the genitals. Women who have their first outbreak of genital herpes during pregnancy are at high risk of **miscarriage** or delivering a low birth weight baby. The infection can be passed to the infant at the time of delivery if the mother has an active sore. The most serious risk to the infant is the possibility of developing HSV-2 **encephalitis**, an inflammation of the brain, with symptoms of irritability and poor feeding.

Hepatitis B

Hepatitis B is a contagious virus that causes liver damage and is a leading cause of chronic liver disease and **cirrhosis**. Approximately 20,000 infants are born each year to mothers who test positive for the hepatitis B virus. These infants are at high risk for developing hepatitis B infection through exposure to their mothers blood during delivery.

Human immunodeficiency virus (HIV)

Human **immunodeficiency** virus (HIV) is a serious, contagious virus which causes acquired immunodeficiency syndrome (**AIDS**). About one-fourth of pregnant women with HIV pass the infection on to their newborn infants. An infant with HIV usually develops AIDS and dies before the age of two.

Human papillomavirus

Human papillomavirus (HPV) is a sexually transmitted disease that causes **genital warts** and can increase the risk of developing some cancers. HPV appears to be transferred from the mother to the infant during the birth process.

Rubella (German measles)

Rubella is a virus that causes German measles, an illness that includes rash, fever, and symptoms of an upper respiratory tract infection. Most people are exposed to rubella during childhood and develop antibodies to the virus so they will never get it again. Rubella infection during early pregnancy can pass through the placenta to the developing infant and cause serious **birth defects** including heart abnormalities, mental retardation, blindness, and deafness.

Streptococcus

Group B streptococcus (GBS) infection is the most common bacterial cause of infection and **death** in newborn infants. In women, GBS can cause vaginitis and urinary tract infections. Both infections can cause premature birth and the bacteria can be transferred to the infant in the uterus or during delivery. GBS causes pneumonia, **meningitis**, and other serious infections in infants.

Syphilis

Syphilis is a sexually transmitted bacterial infection that can be transferred from a mother to an infant through the placenta before birth. Up to 50% of infants born to mothers with syphilis will be premature, stillborn, or will die shortly after birth. Infected infants may have severe birth defects. Those infants who survive infancy may develop symptoms of syphilis up to two years later.

Diagnosis

Chlamydia

Chlamydial bacteria can be diagnosed by taking a cotton swab sample of the cervix and vagina during the third trimester of the pregnancy. Chlamydial cell cultures take three to seven days to grow but many laboratories are not equipped to run the tests necessary to confirm the diagnosis.

Ctyomegalovirus

Past or recent infection with CMV can be identified by antibody tests and CMV can be grown from body fluids.

Genital herpes

The appearance of a genital sore is enough to suspect an outbreak of genital herpes. The sore can be cultured and tested to confirm that HSV-2 is present.

Hepatitis B

A blood test can be used to screen pregnant women for the hepatitis B surface antigen (HBsAg) in prenatal health programs.

Human immunodeficiency virus (HIV)

HIV can be detected using a blood test and is part of most prenatal screening programs.

Human papillomavirus

HPV causes the growth of **warts** in the genital area. The wart tissue can be removed with a scalpel and tested to determine what type of HPV virus caused the infection.

Rubella (German measles)

Pregnant women are usually tested for antibodies to rubella, which would indicate that they have been previously exposed to the virus and therefore would not develop infection during pregnancy if exposed.

Streptococcus

GBS can be detected by a vaginal or rectal swab culture, and sometimes from a **urine culture**. Blood tests can be used to confirm GBS infection in infants who exhibit symptoms.

Syphilis

Pregnant women are usually tested for syphilis as part of the prenatal screening.

Treatment

Chlamydia

Pregnant women can be treated during the third trimester with oral erythromycin, for seven to 14 days depending on the dose used. Newborn infants can be treated with erythromycin liquid for 10–14 days at a dosage determined by their body weight.

Ctyomegalovirus

No drugs or vaccines are currently available for prevention or treatment of CMV.

Genital herpes

The **antiviral drugs** acyclovir or famciclovir can be administered to the mother during pregnancy. Little is known about the risks of these drugs to the fetus, however, the risk of birth defects does not seem to be any higher than for women who do not take these medications. Infants with suspected HSV-2 can be treated with acyclovir. Delivery of the infant by **cesarean section** is recommended if the mother has an active case of genital herpes.

Hepatitis B

Infants born to mothers who test positive to the HBsAg test should be treated with hepatitis B immune globulin at birth to give them immediate protection against developing hepatitis B. These infants, as well as all infants, should also receive a series of three hepatitis B vaccine injections as part of their routine immunizations.

Human immunodeficiency virus (HIV)

Pregnant women with HIV should be treated as early in the pregnancy as possible with zidovudine (AZT). Other newer drugs designed to treat HIV/AIDS may also be used during pregnancy with the knowledge that these drugs may have unknown effects on the infant. The risks and benefits of such treatments need to be discussed. Infants born with HIV should receive aggressive drug treatment to prevent development of AIDS.

Human papillomavirus

Genital warts are very difficult to treat and frequently reoccur even after treatment. They can be removed by **cryotherapy** (freezing), laser or electrocauterization (burning), or surgical excision (cutting) of the warts. Some medications (imiquimod 5% cream, podophyllin, trichloroacetic acid or topical 5-fluorouracil) can be applied to help dissolve genital warts. Cesarean delivery rather than vaginal delivery seems to reduce the risk of transmission of HPV from mothers to infants.

Rubella (German measles)

No treatment is available. Some health care providers may recommend giving the mother an injection of immune globulin (to boost the immune system to fight off the virus) if she is exposed to rubella early in the pregnancy. However, no evidence to support the use of these injections exists. Exposure to rubella early in pregnancy poses a high risk that the infant will have serious birth defects. Termination of the pregnancy may be considered. Women who have not been previously exposed to rubella will usually be vaccinated immediately after the first pregnancy to protect infants of future pregnancies.

Streptococcus

Pregnant women diagnosed with GBS late in the pregnancy should be treated with **antibiotics** injected intravenously to prevent **premature labor**. If transmission of GBS to the newborn infant is suspected or if the baby develops symptoms of infection, infants can be treated with antibiotics.

Syphilis

Antibiotic therapy, usually penicillin, given early in the pregnancy can be used to treat the infection and may prevent transmission to the infant.

Prognosis

Chlamydia

Without treatment, the most serious consequences of chlamydial infection are related to complications of premature delivery. Treatment of the mother with antibiotics during the third trimester can prevent premature delivery and the transfer of the infection to the baby. Infants treated with antibiotics for eye infection or pneumonia generally recover.

Ctyomegalovirus

The chance for recovery after exposure to CMV is very good for both the mother and the infant. Exposure

to CMV can be very serious and even life threatening for mothers and infants whose immune systems are compromised, for example those receiving **chemotherapy** or who have AIDS/HIV infections. Those infants who develop birth defects after CMV exposure may have serious and life long complications.

Genital herpes

Once a woman or infant is infected, outbreaks of genital herpes sores can reoccur at any time during their lifetimes.

Hepatitis B

Infants treated at birth with the immune globulin and the series of vaccinations will be protected from development of hepatitis B infection. Infants infected with hepatitis B develop a chronic, mild form of hepatitis and are at increased risk for developing liver disease.

Human immunodeficiency virus (HIV)

Treatment with AZT during pregnancy significantly reduces the chance that the infant will be infected with HIV from the mother.

Human papillomavirus

Once infected with HPV, there is a life-long risk of developing warts and an increased risk of some cancers.

Rubella (German measles)

Infants exposed to rubella virus in the uterus are at high risk for severe birth defects including heart defects, blindness, and deafness.

Streptococcus

Infection of the urinary tract or genital tract of pregnant women can cause premature birth. Infants infected with GBS can develop serious and life threatening infections.

Syphilis

Premature birth, birth defects, or the development of serious syphilis symptoms is likely to occur in untreated pregnant women.

Prevention

Use of a barrier method of contraceptive (**condom**) can prevent transmission of some of the infections. Intravenous drug use and sexual intercourse with infected partners increases the risks of exposure to most of these infections. Pregnant women can be tested for many of the bacterial or viral infections described; however, effective treatment may not be available to protect the infant.

KEY TERMS

Cesarean section—A surgical procedure in which an incision is made in a woman's abdomen to deliver the infant from the uterus.

Ectopic pregnancy—A condition that ends in miscarriage, in which the fertilized ovum attaches somewhere other than in the uterus (for example in the fallopian tube or abdomen).

Encephalitis—Inflammation or swelling of the brain.

Perinatal—The period of time around the time of pregnancy and delivery.

Pneumonia—An infection and inflammation of the lungs that usually causes shortness of breath, cough, fever, and chest pain.

Resources

BOOKS

Toth, Peter P., and A. Jothivijayarani. "Obstetrics: Group B Streptococcal Infection" In *University of Iowa Family Practice Handbook*. 3rd ed. Mosby-Year Book, 1997.

PERIODICALS

"Program to Prevent Perinatal Hepatitis B Virus Transmission in a Health Maintenance Organization: Northern California, 1990-1995." *Morbidity & Mortality Weekly Report* 46 (1997): 378-380.

Schuchat, Anne. "Prevention of Perinatal Group B Streptococcal Disease: A Public Health Perspective." *Morbidity & Mortality Weekly Report* 45 (1996).

"Update: Perinatally Acquired HIV/AIDS: United States, 1997." *Morbidity & Mortality Weekly Report* 46 (1997): 1086-1092.

OTHER

Larkin, Julie A., et al. "Recognizing and Treating Syphilis in Pregnancy." *Medscape Today* 3 (1998) <http://www.medscape.com>.

McGregor, James A., and Janice I. French. "Preterm Birth: The Role of Infection and Inflammation." *Medscape Today* 2 (1997) <http://www.medscape.com>.

Toney, John F., and Julie Larkin. "Contemporary Strategies for Detecting Chlamydial Infection in Women." *Medscape Today* 1 (1996) <http://www.medscape.com>.

Woolley, Paul. "Genital Herpes: Treatment Guidelines." *Medscape Today* 2, (1997) <http://www.medscape.com>.

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Periodic paralysis

Definition

Periodic **paralysis** (PP) is the name for several rare, inherited muscle disorders marked by temporary weakness, especially following rest, sleep, or **exercise**.

Description

Periodic paralysis disorders are genetic disorders that affect muscle strength. There are two major forms, hypokalemic and hyperkalemic, each caused by defects in different genes.

In hypokalemic PP, the level of potassium in the blood falls in the early stages of a paralytic attack, while in hyperkalemic PP, it rises slightly or is normal. (The root of both words, "kali," refers to potassium.) Hyperkalemic PP is also called potassium-sensitive PP.

Causes and symptoms

Causes

Both forms of PP are caused by inheritance of defective genes. Both genes are dominant, meaning that only one copy of the defective gene is needed for a person to develop the disease. A parent with the gene has a 50% chance of passing it along to each offspring, and the likelihood of passing it on is unaffected by the results of previous pregnancies.

The gene for hypokalemic PP is present equally in both sexes, but leads to noticeable symptoms more often in men than in women. The normal gene is responsible for a muscle protein controlling the flow of calcium during muscle contraction.

The gene for hyperkalemic PP affects virtually all who inherit it, with no difference in male-vs.-female expression. The normal gene is responsible for a muscle protein controlling the flow of sodium during muscle contraction.

Symptoms

The attacks of weakness in hypokalemic PP usually begin in late childhood or early adolescence and often become less frequent during middle age. The majority of patients develop symptoms before age 16. Since they begin in the school years, the symptoms of hypokalemic PP are often first seen during physical education classes or after-school sports, and may be mistaken for laziness, or lack of interest on the part of the child.

Attacks are most commonly brought on by:

- strenuous exercise followed by a short period of rest
- large meals, especially ones rich in carbohydrates or salt
- emotional **stress**
- alcohol use
- infection
- **pregnancy**

The weakness from a particular attack may last from several hours to as long as several days, and may be localized to a particular limb, or might involve the entire body.

The attacks of weakness of hyperkalemic PP usually begin in infancy or early childhood, and may become less severe later in life. As in the hypokalemic form, attacks are brought on by stress, pregnancy, and exercise followed by rest. In contrast, though, hyperkalemic attacks are not associated with a heavy meal but rather with missing a meal, with high potassium intake, or use of glucocorticoid drugs such as prednisone. (Glucocorticoids are a group of steroids that regulate metabolism and affect muscle tone.)

Weakness usually lasts less than three hours, and often persists for only several minutes. The attacks are usually less severe, but more frequent, than those of the hypokalemic form. Weakness usually progresses from the lower limbs to the upper, and may involve the facial muscles as well.

Diagnosis

Diagnosis of either form of PP begins with a careful medical history and a complete physical and neurological exam. A family medical history may reveal other affected relatives. Blood and urine tests done at the onset of an attack show whether there are elevated or depressed levels of potassium. Electrical tests of muscle and a muscle biopsy show characteristic changes.

Challenge tests, to aid in diagnosis, differ for the two forms. In hypokalemic PP, an attack of weakness can be brought on by administration of glucose and insulin, with exercise if necessary. An attack of hyperkalemic PP can be induced with administration of potassium after exercise during **fasting**. These tests are potentially hazardous and require careful monitoring.

Genetic tests are available at some research centers and are usually recommended for patients with a known family history. However, the number of different possible mutations leading to each form is too great to allow a single comprehensive test for either form, thus limiting the usefulness of **genetic testing**.

KEY TERMS

Gene—A biologic unit of heredity transmitted from parents to offspring.

Treatment

Severe respiratory weakness from hypokalemic PP may require intensive care to ensure adequate ventilation. Potassium chloride may be given by mouth or intravenously to normalize blood levels.

Attacks requiring treatment are much less common in hyperkalemic PP. Glucose and insulin may be prescribed. Eating carbohydrates may also relieve attacks.

Prognosis

Most patients learn to prevent their attacks well enough that no significant deterioration in the quality of life occurs. Strenuous exercise must be avoided, however. Attacks often lessen in severity and frequency during middle age. Frequent or severe attacks increase the likelihood of permanent residual weakness, a risk in both forms of periodic paralysis.

Prevention

There is no way to prevent the occurrence of either disease in a person with the gene for the disease. The likelihood of an attack of either form of PP may be lessened by avoiding the triggers (the events or combinations of circumstances which cause an attack) for each.

Hypokalemic PP attacks may be prevented with use of acetazolamide (or another carbonic anhydrase inhibitor drug) or a diuretic to help retain potassium in the bloodstream. These attacks may also be prevented by avoiding such triggers as salty food, large meals, a high-carbohydrate diet, and strenuous exercise.

Attacks of hyperkalemic PP may be prevented with frequent small meals high in carbohydrates, and the avoidance of foods high in potassium such as orange juice or bananas. Acetazolamide or thiazide (a diuretic) may be prescribed.

Resources

BOOKS

Greenberg, David A., et al. *Clinical Neurology.* 2nd ed. Norwalk, CT: Appleton & Lange, 1993.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (800) 572-1717. <http://www.mdausa.org>.

The Periodic Paralysis Association. 5225 Canyon Crest Drive #71-351, Riverside, CA 92507. (909) 781-4401. <http://www.periodicparalysis.org>.

Richard Robinson

Periodontal disease

Definition

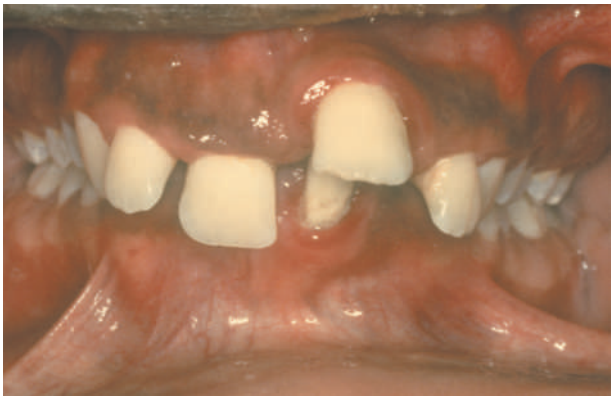
Periodontal diseases are a group of diseases that affect the tissues that support and anchor the teeth. Left untreated, periodontal disease results in the destruction of the gums, alveolar bone (the part of the jaws where the teeth arise), and the outer layer of the tooth root.

Description

Periodontal disease is usually seen as a chronic inflammatory disease. An acute infection of the periodontal tissue may occur, but is not usually reported to the dentist. The tissues that are involved in periodontal diseases are the gums, which include the gingiva, periodontal ligament, cementum, and alveolar bone. The gingiva is a pink-colored mucus membrane that covers parts of the teeth and the alveolar bone. The periodontal ligament is the main part of the gums. The cementum is a calcified structure that covers the lower parts of the teeth. The alveolar bone is a set of ridges from the jaw bones (maxillary and mandible) in which the teeth are embedded. The main area involved in periodontal disease is the gingival sulcus, a pocket between the teeth and the gums. Several distinct forms of periodontal disease are known. These are gingivitis, acute necrotizing ulcerative gingivitis, adult periodontitis, and localized juvenile periodontitis. Although periodontal disease is thought to be widespread, serious cases of periodontitis are not common. Gingivitis is also one of the early signs of leukemia in some children.

Gingivitis

Gingivitis is an inflammation of the outermost soft tissue of the gums. The gingivae become red and inflamed, loose their normal shape, and bleed easily. Gingivitis may remain a chronic disease for years without affecting other periodontal tissues. Chronic gingivitis may lead to a deepening of the gingival sulcus. Acute necrotizing ulcerative gingivitis is mainly seen in young adults. This form of gingivitis is characterized by painful,



An extreme case of juvenile periodontitis. *(Custom Medical Stock Photo. Reproduced by permission.)*

bleeding gums, and death (necrosis) and erosion of gingival tissue between the teeth. It is thought that **stress**, **malnutrition**, **fatigue**, and poor **oral hygiene** are among the causes for acute necrotizing ulcerative gingivitis.

Adult periodontitis

Adult periodontitis is the most serious form of the periodontal diseases. It involves the gingiva, periodontal ligament, and alveolar bone. A deep periodontal pocket forms between the teeth, the cementum, and the gums. Plaque, calculus, and debris from food and other sources collect in the pocket. Without treatment, the periodontal ligament can be destroyed and resorption of the alveolar bone occurs. This allows the teeth to move more freely and eventually results in the loss of teeth. Most cases of adult periodontitis are chronic, but some cases occur in episodes or periods of tissue destruction.

Localized juvenile periodontitis

Localized juvenile periodontitis is a less common form of periodontal disease and is seen mainly in young people. Primarily, localized juvenile periodontitis affects the molars and incisors. Among the distinctions that separate this form of periodontitis are the low incidence of bacteria in the periodontal pocket, minimal plaque formation, and mild inflammation.

Herpetic gingivostomatitis

Herpes infection of the gums and other parts of the mouth is called herpetic gingivostomatitis and is frequently grouped with periodontal diseases. The infected areas of the gums turn red in color and have whitish herpetic lesions. There are two principal differences between this form of periodontal diseases and most other forms. Herpetic gingivostomatitis is caused by a virus, Herpes simplex, not by bacteria, and the viral infection tends to heal by itself in approximately two weeks. Also, herpetic gingivostomatitis is infectious to other people who come in contact with the herpes lesions or saliva that contains virus from the lesion.

Pericoronitis

Pericoronitis is a condition found in children who are in the process of producing molar teeth. The disease is seen more frequently in the lower molar teeth. As the molar emerges, a flap of gum still covers the tooth. The flap of gum traps bacteria and food, leading to a mild irritation. If the upper molar fully emerges before the lower one, it may bite down on the flap during chewing. This can increase the irritation of the flap and lead to an infection. In bad cases, the infection can spread to the neck and cheeks.

Desquamative gingivitis

Desquamative gingivitis occurs mainly in postmenopausal women. The cause of the disease is not understood. The outer layers of the gums slough off, leaving raw tissue and exposed nerves.

Trench mouth

Trench mouth is an acute, necrotizing (causing tissue death), ulcerating (causing open sores) form of gingivitis. It causes **pain** in the affected gums. **Fever** and fatigue are usually present also. Trench mouth, also known as Vincent's disease, is a complication of mild cases of gingivitis. Frequently, poor oral hygiene is the main cause. Stress, an unbalanced diet, or lack of sleep are frequent cofactors in the development of trench mouth. This form of periodontal disease is more common in people who smoke. The term "trench mouth" was created in World War I, when the disease was common in soldiers who lived in the trenches. Symptoms of trench mouth appear suddenly. The initial symptoms include painful gums and foul breath. Gum tissue between teeth becomes infected and dies, and starts to disappear. Often, what appears to be remaining gum is dead tissue. Usually, the gums bleed easily, especially when chewing. The pain can increase to the point where eating and swallowing become difficult. Inflammation or infection from trench mouth can spread to nearby tissues of the face and neck.

Periodontitis

Periodontitis is a condition in which gingivitis has extended down around the tooth and into the supporting bone structure. Periodontitis is also called pyorrhea. Plaque and tarter buildup sometimes lead to the formation of large pockets between the gums and teeth. When this happens, anaerobic bacteria grow in the pockets. The pockets even-

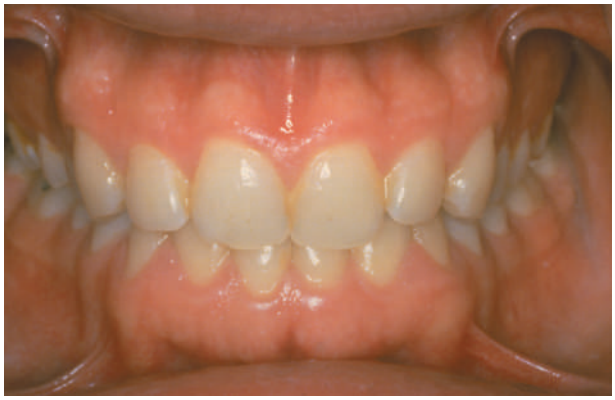
tually extend down around the roots of the teeth where the bacteria cause damage to the bone structure supporting the teeth. The teeth become loose and tooth loss can result. Some medical conditions are associated with an increased likelihood of developing periodontitis. These diseases include diabetes, **Down syndrome**, Cohn's disease, **AIDS**, and any disease that reduces the number of white blood cells in the body for extended periods of time.

Causes and symptoms

Several factors play a role in the development of periodontal disease. The most important are age and oral hygiene. The number and type of bacteria present on the gingival tissues also play a role in the development of periodontal diseases. The presence of certain species of bacteria in large enough numbers in the gingival pocket and related areas correlates with the development of periodontal disease. Also, removal of the bacteria correlates with reduction or elimination of disease. In most cases of periodontal disease, the bacteria remain in the periodontal pocket and do not invade surrounding tissue.

The mechanisms by which bacteria in the periodontal pocket cause tissue destruction in the surrounding region are not fully understood. Several bacterial products that diffuse through tissue are thought to play a role in disease formation. Bacterial endotoxin is a toxin produced by some bacteria that can kill cells. Studies show that the amount of endotoxin present correlates with the severity of periodontal disease. Other bacterial products include proteolytic enzymes, molecules that digest protein found in cells, thereby causing cell destruction. The immune response has also been implicated in tissue destruction. As part of the normal immune response, white blood cells enter regions of inflammation to destroy bacteria. In the process of destroying bacteria, periodontal tissue is also destroyed.

Gingivitis usually results from inadequate oral hygiene. Proper brushing of the teeth and flossing decreases plaque buildup. The bacteria responsible for causing gingivitis reside in the plaque. Plaque is a sticky film that is largely made from bacteria. Tartar is plaque that has hardened. Plaque can turn into tartar in as little as three days if not brushed off. Tartar is difficult to remove by brushing. Gingivitis can be aggravated by hormones, and sometimes becomes temporarily worse during **pregnancy**, **puberty**, and when the patient is taking birth control pills. Interestingly, some drugs used to treat other conditions can cause an overgrowth of the gingival tissue that can result in gingivitis because plaque builds up more easily. Drugs associated with this condition are phenytoin, used to treat seizures; cyclosporin, given to organ transplant patients to reduce the likelihood of organ rejection; and calcium blockers, used to treat several different heart conditions. **Scurvy**, a vitamin C deficiency and **pellagra**, a niacin deficiency, can also lead to bleeding gums and gingivitis.



Gingivitis, an inflammation of the gums, is a common periodontal disease. *(Photograph by Edward H. Gill, Custom Medical Stock Photo. Reproduced by permission.)*

The initial symptoms of periodontitis are bleeding and inflamed gums, and **bad breath**. Periodontitis follows cases of gingivitis, which may not be severe enough to cause a patient to seek dental help. Although the symptoms of periodontitis are also seen in other forms of periodontal diseases, the key characteristic in periodontitis is a large pocket that forms between the teeth and gums. Another characteristic of periodontitis is that pain usually does not develop until late in the disease, when a tooth loosens or an **abscess** forms.

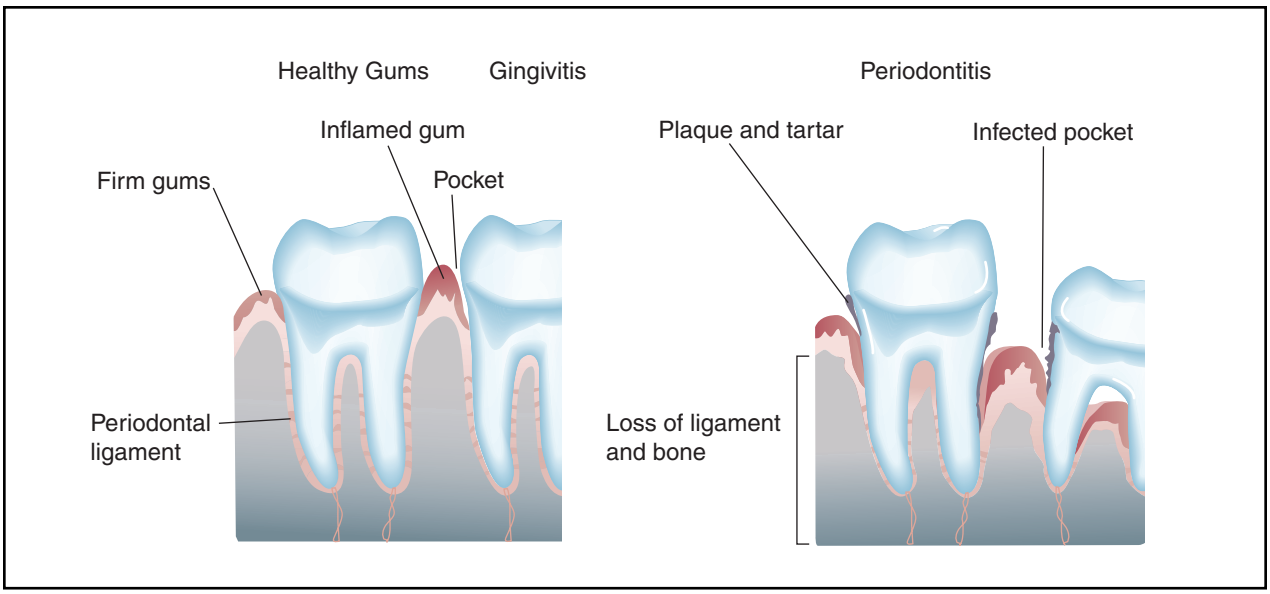
Diagnosis

Diagnosis is made by observation of infected gums. Usually, a dentist is the person to diagnose and characterize the various types of periodontal disease. In cases such as acute herpetic gingivostomatitis, there are characteristic herpetic lesions. Many of the periodontal diseases are distinguished based on the severity of the infection and the number and type of tissues involved.

Diagnosis of periodontitis includes measuring the size of the pockets formed between the gums and teeth. Normal gingival pockets are shallow. If periodontal disease is severe, jaw bone loss will be detected in x-ray images of the teeth. If too much bone is lost, the teeth become loose and can change position. This will also be seen in x-ray images.

Treatment

Tartar can only be removed by professional dental treatment. Following treatment, periodontal tissues usually heal quickly. Gingivitis caused by vitamin deficiencies is treated by administering the needed vitamin. There are



Healthy gums support the teeth. When gingivitis goes untreated, the gums become weak and pockets form around the teeth. Plaque and tartar build up in the pockets, the gum receeds, and periodontitis occurs. *(Illustration by Argosy Inc.)*

no useful drugs to treat herpetic gingivostomatitis. Because of the pain associated with the herpes lesions, patients may not brush their teeth while the lesions are present. Herpes lesions heal by themselves without treatment. After the herpetic lesions have disappeared, the gums usually return to normal if good oral hygiene is resumed. Pericoronitis is treated by removing debris under the flap of gum covering the molar. This operation is usually performed by a dentist. Surgery is used to remove molars that are not likely to form properly.

Treatment for trench mouth starts with a complete cleaning of the teeth, removal of all plaque, tartar, and dead tissue on the gums. For the first few days after cleaning, the patient uses hydrogen peroxide mouth washes instead of brushing. After cleaning, the gum tissue will be very raw and rinsing minimizes damage to the gums that might be caused by the toothbrush. For the first few days, the patient should visit the dentist daily for checkups and then every second or third day for the next two weeks. Occasionally, antibiotic treatment is used to supplement dental cleaning of the teeth and gums. Surgery may be needed if the damage to the gums is extensive and they do not heal properly.

Treatment of periodontitis requires professional dental care. The pockets around the teeth must be cleaned, and all tartar and plaque removed. In periodontitis, tartar and plaque can extend far down the tooth root. Normal dental hygiene, brushing and flossing, cannot reach deep enough to be effective in treating periodontitis. In cases where pockets are very deep (more than 0.25 in (0.64 cm) deep), surgery is required to clean the pocket. This is performed in a dental office. Sections of gum that are not likely to reattach to the teeth may be removed to promote healing by healthy sections of gum. Abscesses are treated with a combination of **antibiotics** and surgery. The antibiotics may be delivered directly to the infected gum and bone tissues to ensure that high concentrations of the antibiotic reach the infected area. Abscess infections, especially of bone, are difficult to treat and require long term antibiotic treatments to prevent a reoccurrence of infection.

Prognosis

Periodontal diseases can be easily treated. The gums usually heal and resume their normal shape and function. In cases where they do not, prostheses or surgery can restore most of the support for proper functioning of the teeth.

Prevention

Most forms of periodontal disease can be prevented with good dental hygiene. Daily use of a toothbrush and flossing is sufficient to prevent most cases of periodontal disease. Tartar control toothpastes help prevent tartar formation, but do not remove tartar once it has formed.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

KEY TERMS

Anaerobic bacteria—Microorganisms that grow in the absence of oxygen.

Inflammation—A painful redness and swelling of an area of tissue in response to infection or injury.

Gorbach, S. L., J. G. Bartlett, and N. R. Blacklow. *Infectious Diseases.* 2nd ed. Philadelphia: W. B. Saunders Co., 1998.
Shulman, S. T., et al. *Infectious Diseases.* 5th ed. Philadelphia: W. B. Saunders Co., 1997.

John T. Lohr, PhD

Periodontitis *see* **Periodontal disease**

Periorbital cellulitis *see* **Orbital and periorbital cellulitis**

Peripheral arterial disease *see* **Peripheral vascular disease**

Peripheral neuritis *see* **Peripheral neuropathy**

Peripheral neuropathy

Definition

The term peripheral neuropathy encompasses a wide range of disorders in which the nerves outside of the brain and spinal cord—peripheral nerves—have been damaged. Peripheral neuropathy may also be referred to as peripheral neuritis, or if many nerves are involved, the terms polyneuropathy or polyneuritis may be used.

Description

Peripheral neuropathy is a widespread disorder, and there are many underlying causes. Some of these causes are common, such as diabetes, and others are extremely rare, such as acrylamide **poisoning** and certain inherited disorders. The most common worldwide cause of peripheral neuropathy is **leprosy**. Leprosy is caused by the bacterium *Mycobacterium leprae*, which attacks the peripheral nerves of affected people. According to statistics gathered by the World Health Organization, an estimated 1.15 million people have leprosy worldwide.

Leprosy is extremely rare in the United States, where diabetes is the most commonly known cause of peripheral neuropathy. It has been estimated that more than 17 million people in the United States and Europe have diabetes-related polyneuropathy. Many neuropathies are idiopathic, meaning that no known cause can be found. The most common of the inherited peripheral neuropathies in the United States is **Charcot-Marie-Tooth disease**, which affects approximately 125,000 persons.

Another of the better known peripheral neuropathies is **Guillain-Barré syndrome**, which arises from complications associated with viral illnesses, such as cytomegalovirus, Epstein-Barr virus, and human **immunodeficiency** virus (HIV), or bacterial infection, including *Campylobacter jejuni* and **Lyme disease**. The worldwide incidence rate is approximately 1.7 cases per 100,000 people annually. Other well-known causes of peripheral neuropathies include chronic **alcoholism**, infection of the varicella-zoster virus, **botulism**, and poliomyelitis. Peripheral neuropathy may develop as a primary symptom, or it may be due to another disease. For example, peripheral neuropathy is only one symptom of diseases such as amyloid neuropathy, certain cancers, or inherited neurologic disorders. Such diseases may affect the peripheral nervous system (PNS) and the central nervous system (CNS), as well as other body tissues.

To understand peripheral neuropathy and its underlying causes, it may be helpful to review the structures and arrangement of the PNS.

Nerve cells and nerves

Nerve cells are the basic building block of the nervous system. In the PNS, nerve cells can be threadlike—their width is microscopic, but their length can be measured in feet. The long, spidery extensions of nerve cells are called axons. When a nerve cell is stimulated, by touch or **pain**, for example, the message is carried along the axon, and neurotransmitters are released within the cell. Neurotransmitters are chemicals within the nervous system that direct nerve cell communication.

Certain nerve cell axons, such as the ones in the PNS, are covered with a substance called myelin. The myelin sheath may be compared to the plastic coating on electrical wires—it is there both to protect the cells and to prevent interference with the signals being transmitted. Protection is also given by Schwann cells, special cells within the nervous system that wrap around both myelinated and unmyelinated axons. The effect is similar to beads threaded on a necklace.

Nerve cell axons leading to the same areas of the body may be bundled together into nerves. Continuing the comparison to electrical wires, nerves may be compared to an electrical cord—the individual components

are coated in their own sheaths and then encased together inside a larger protective covering.

Peripheral nervous system

The nervous system is classified into two parts: the CNS and the PNS. The CNS is made up of the brain and the spinal cord, and the PNS is composed of the nerves that lead to or branch off from the CNS.

The peripheral nerves handle a diverse array of functions in the body. This diversity is reflected in the major divisions of the PNS—the afferent and the efferent divisions. The afferent division is in charge of sending sensory information from the body to the CNS. When afferent nerve cell endings, called receptors, are stimulated, they release neurotransmitters. These neurotransmitters relay a signal to the brain, which interprets it and reacts by releasing other neurotransmitters.

Some of the neurotransmitters released by the brain are directed at the efferent division of the PNS. The efferent nerves control voluntary movements, such as moving the arms and legs, and involuntary movements, such as making the heart pump blood. The nerves controlling voluntary movements are called motor nerves, and the nerves controlling involuntary actions are referred to as autonomic nerves. The afferent and efferent divisions continually interact with each other. For example, if a person were to touch a hot stove, the receptors in the skin would transmit a message of heat and pain through the sensory nerves to the brain. The message would be processed in the brain and a reaction, such as pulling back the hand, would be transmitted via a motor nerve.

Neuropathy

NERVE DAMAGE. When an individual has a peripheral neuropathy, nerves of the PNS have been damaged. Nerve damage can arise from a number of causes, such as disease, physical injury, poisoning, or **malnutrition**. These agents may affect either afferent or efferent nerves. Depending on the cause of damage, the nerve cell axon, its protective myelin sheath, or both may be injured or destroyed.

CLASSIFICATION. There are hundreds of peripheral neuropathies. Reflecting the scope of PNS activity, symptoms may involve sensory, motor, or autonomic functions. To aid in diagnosis and treatment, the symptoms are classified into principal neuropathic syndromes based on the type of affected nerves and how long symptoms have been developing. Acute development refers to symptoms that have appeared within days, and subacute refers to those that have evolved over a number of weeks. Early chronic symptoms are those that take months to a few years to develop, and late chronic symptoms have been present for several years.

The classification system is composed of six principal neuropathic syndromes, which are subdivided into more specific categories. By narrowing down the possible diagnoses in this way, specific medical tests can be used more efficiently and effectively. The six syndromes and a few associated causes are listed below:

- Acute motor **paralysis**, accompanied by variable problems with sensory and autonomic functions. Neuropathies associated with this syndrome are mainly accompanied by motor nerve problems, but the sensory and autonomic nerves may also be involved. Associated disorders include Guillain-Barré syndrome, diphtheritic polyneuropathy, and porphyritic neuropathy.
- Subacute sensorimotor paralysis. The term sensorimotor refers to neuropathies that are mainly characterized by sensory symptoms, but also have a minor component of motor nerve problems. Poisoning with heavy metals (e.g., lead, mercury, and arsenic), chemicals, or drugs are linked to this syndrome. Diabetes, Lyme disease, and malnutrition are also possible causes.
- Chronic sensorimotor paralysis. Physical symptoms may resemble those in the above syndrome, but the time scale of symptom development is extended. This syndrome encompasses neuropathies arising from cancers, diabetes, leprosy, inherited neurologic and metabolic disorders, and **hypothyroidism**.
- Neuropathy associated with mitochondrial diseases. Mitochondria are organelles—structures within cells—responsible for handling a cell's energy requirements. If the mitochondria are damaged or destroyed, the cell's energy requirements are not met and it can die.
- Recurrent or relapsing polyneuropathy. This syndrome covers neuropathies that affect several nerves and may come and go, such as Guillain-Barré syndrome, porphyria, and chronic inflammatory demyelinating polyneuropathy.
- Mononeuropathy or plexopathy. Nerve damage associated with this syndrome is limited to a single nerve or a few closely associated nerves. Neuropathies related to physical injury to the nerve, such as **carpal tunnel syndrome** and **sciatica**, are included in this syndrome.

Causes and symptoms

Typical symptoms of neuropathy are related to the type of affected nerve. If a sensory nerve is damaged, common symptoms include numbness, tingling in the area, a prickling sensation, or pain. Pain associated with neuropa-

KEY TERMS

Afferent—Refers to peripheral nerves that transmit signals to the spinal cord and the brain. These nerves carry out sensory function.

Autonomic—Refers to peripheral nerves that carry signals from the brain and that control involuntary actions in the body, such as the beating of the heart.

Autosomal dominant or autosomal recessive—Refers to the inheritance pattern of a gene on a chromosome other than X or Y. Genes are inherited in pairs—one gene from each parent. However, the inheritance may not be equal, and one gene may overshadow the other in determining the final form of the encoded characteristic. The gene that overshadows the other is called the dominant gene; the overshadowed gene is the recessive one.

Axon—A long, threadlike projection that is part of a nerve cell.

Central nervous system (CNS)—The part of the nervous system that includes the brain and the spinal cord.

Efferent—Refers to peripheral nerves that carry signals away from the brain and spinal cord. These nerves carry out motor and autonomic functions.

Electromyography—A medical test that assesses nerve signals and muscle reactions. It can determine if there is a disorder with the nerve or if the muscle is not capable of responding.

Inheritance pattern—Refers to dominant or recessive inheritance.

Motor—Refers to peripheral nerves that control voluntary movements, such as moving the arms and legs.

Myelin—The protective coating on axons.

Nerve biopsy—A medical test in which a small portion of a damaged nerve is surgically removed and examined under a microscope.

Nerve conduction—The speed and strength of a signal being transmitted by nerve cells. Testing these factors can reveal the nature of nerve injury, such as damage to nerve cells or to the protective myelin sheath.

Neurotransmitter—Chemicals within the nervous system that transmit information from or between nerve cells.

Peripheral nervous system (PNS)—Nerves that are outside of the brain and spinal cord.

Sensory—Refers to peripheral nerves that transmit information from the senses to the brain.

thy can be quite intense and may be described as cutting, stabbing, crushing, or burning. In some cases, a nonpainful stimulus may be perceived as excruciating or pain may be felt even in the absence of a stimulus. Damage to a motor nerve is usually indicated by weakness in the affected area. If the problem with the motor nerve has continued over a length of time, muscle shrinkage (atrophy) or lack of muscle tone may be noticeable. Autonomic nerve damage is most noticeable when an individual stands upright and experiences problems such as light-headedness or changes in blood pressure. Other indicators of autonomic nerve damage are lack of sweat, tears, and saliva; **constipation**; urinary retention; and **impotence**. In some cases, heart beat irregularities and respiratory problems can develop.

Symptoms may appear over days, weeks, months, or years. Their duration and the ultimate outcome of the neuropathy are linked to the cause of the nerve damage. Potential causes include diseases, physical injuries, poisoning, and malnutrition or alcohol abuse. In some cases, neuropathy is not the primary disorder, but a symptom of an underlying disease.

Disease

Diseases that cause peripheral neuropathies may either be acquired or inherited; in some cases, it is difficult to make that distinction. The diabetes-peripheral neuropathy link has been well established. A typical pattern of diabetes-associated neuropathic symptoms includes sensory effects that first begin in the feet. The associated pain or pins-and-needles, burning, crawling, or prickling sensations form a typical "stocking" distribution in the feet and lower legs. Other diabetic neuropathies affect the autonomic nerves and have potentially fatal cardiovascular complications.

Several other metabolic diseases have a strong association with peripheral neuropathy. Uremia, or **chronic kidney failure**, carries a 10–90% risk of eventually developing neuropathy, and there may be an association between liver failure and peripheral neuropathy. Accumulation of lipids inside blood vessels (**atherosclerosis**) can choke-off blood supply to certain peripheral nerves. Without oxygen and nutrients, the nerves slowly die.

Mild polyneuropathy may develop in persons with low thyroid hormone levels. Individuals with abnormally enlarged skeletal extremities (acromegaly), caused by an overabundance of growth hormone, may also develop mild polyneuropathy.

Neuropathy can also result from severe vasculitides, a group of disorders in which blood vessels are inflamed. When the blood vessels are inflamed or damaged, blood supply to the nerve can be affected, injuring the nerve.

Both viral and bacterial infections have been implicated in peripheral neuropathy. Leprosy is caused by the bacteria *M. leprae*, which directly attack sensory nerves. Other bacterial illness may set the stage for an immune-mediated attack on the nerves. For example, one theory about Guillain-Barré syndrome involves complications following infection with *Campylobacter jejuni*, a bacterium commonly associated with **food poisoning**. This bacterium carries a protein that closely resembles components of myelin. The immune system launches an attack against the bacteria; but, according to the theory, the immune system confuses the myelin with the bacteria in some cases and attacks the myelin sheath as well. The underlying cause of neuropathy associated with Lyme disease is unknown; the bacteria may either promote an immune-mediated attack on the nerve or inflict damage directly.

Infection with certain viruses is associated with extremely painful sensory neuropathies. A primary example of such a neuropathy is caused by **shingles**. After a case of **chickenpox**, the causative virus, varicella-zoster virus, becomes inactive in sensory nerves. Years later, the virus may be reactivated. Once reactivated, it attacks and destroys axons. Infection with HIV is also associated with peripheral neuropathy, but the type of neuropathy that develops can vary. Some HIV-linked neuropathies are noted for myelin destruction rather than axonal degradation. Also, HIV infection is frequently accompanied by other infections, both bacterial and viral, that are associated with neuropathy.

Several types of peripheral neuropathies are associated with inherited disorders. These inherited disorders may primarily involve the nervous system, or the effects on the nervous system may be secondary to an inherited metabolic disorder. Inherited neuropathies can fall into several of the principal syndromes, because symptoms may be sensory, motor, or autonomic. The inheritance patterns also vary, depending on the specific disorder. The development of inherited disorders is typically drawn out over several years and may herald a degenerative condition—that is, a condition that becomes progressively worse over time. Even among specific disorders, there may be a degree of variability in inheritance patterns and symptoms. For example, Charcot-Marie-Tooth disease is usually inherited as an autosomal dominant disorder, but it can be autosomal recessive or, in rare cases, linked to the X chromosome. Its estimated frequency is approximately one in 2,500 people. Age of onset and sensory nerve involvement can vary between cases. The main symptom is a degeneration of the motor nerves in legs and arms, and resultant muscle atrophy. Other inherited neuropathies have a distinctly metabolic component. For example, in familial amyloid polyneuropathies, protein components that make up the myelin are constructed and deposited incorrectly.

Physical injury

Accidental falls and mishaps during sports and recreational activities are common causes of physical injuries that can result in peripheral neuropathy. The common types of injuries in these situations occur from placing too much pressure on the nerve, exceeding the nerve's capacity to stretch, blocking adequate blood supply of oxygen and nutrients to the nerve, and tearing the nerve. Pain may not always be immediately noticeable, and obvious signs of damage may take a while to develop.

These injuries usually affect one nerve or a group of closely associated nerves. For example, a common injury encountered in contact sports such as football is the "burner," or "stinger," syndrome. Typically, a stinger is caused by overstretching the main nerves that span from the neck into the arm. Immediate symptoms are numbness, tingling, and pain that travels down the arm, lasting only a minute or two. A single incident of a stinger is not dangerous, but recurrences can eventually cause permanent motor and sensory loss.

Poisoning

The poisons, or toxins, that cause peripheral neuropathy include drugs, industrial chemicals, and environmental toxins. Neuropathy that is caused by drugs usually involves sensory nerves on both sides of the body, particularly in the hands and feet, and pain is a common symptom. Neuropathy is an unusual side effect of medications; therefore, most people can use these drugs safely. A few of the drugs that have been linked with peripheral neuropathy include metronidazole, an antibiotic; phenytoin, an anticonvulsant; and simvastatin, a cholesterol-lowering medication.

Certain industrial chemicals have been shown to be poisonous to nerves (neurotoxic) following work-related exposures. Chemicals such as acrylamide, allyl chloride, and carbon disulfide have all been strongly linked to development of peripheral neuropathy. Organic compounds, such as N-hexane and toluene, are also encoun-

tered in work-related settings, as well as in glue-sniffing and solvent abuse. Either route of exposure can produce severe sensorimotor neuropathy that develops rapidly.

Heavy metals are the third group of toxins that cause peripheral neuropathy. Lead, arsenic, thallium, and mercury usually are not toxic in their elemental form, but rather as components in organic or inorganic compounds. The types of metal-induced neuropathies vary widely. Arsenic poisoning may mimic Guillain-Barré syndrome; lead affects motor nerves more than sensory nerves; thallium produces painful sensorimotor neuropathy; and the effects of mercury are seen in both the CNS and PNS.

Malnutrition and alcohol abuse

Burning, stabbing pains and numbness in the feet, and sometimes in the hands, are distinguishing features of alcoholic neuropathy. The level of alcohol consumption associated with this variety of peripheral neuropathy has been estimated as approximately 3 L of beer or 300 mL of liquor daily for three years. However, it is unclear whether alcohol alone is responsible for the neuropathic symptoms, because chronic alcoholism is strongly associated with malnutrition.

Malnutrition refers to an extreme lack of nutrients in the diet. It is unknown precisely which nutrient deficiencies cause peripheral neuropathies in alcoholics and famine and **starvation** patients, but it is suspected that the B **vitamins** have a significant role. For example, thiamine (vitamin B_1) deficiency is the cause of **beriberi**, a neuropathic disease characterized by **heart failure** and painful polyneuropathy of sensory nerves. **Vitamin E deficiency** seems to have a role in both CNS and PNS neuropathy.

Diagnosis

Clinical symptoms can indicate peripheral neuropathy, but an exact diagnosis requires a combination of medical history, medical tests, and possibly a process of exclusion. Certain symptoms can suggest a diagnosis, but more information is commonly needed. For example, painful, burning feet may be a symptom of alcohol abuse, diabetes, HIV infection, or an underlying malignant tumor, among other causes. Without further details, effective treatment would be difficult.

During a **physical examination**, an individual is asked to describe the symptoms very carefully. Detailed information about the location, nature, and duration of symptoms can help exclude some causes or even pinpoint the actual problem. The person's medical history may also provide clues as to the cause, because certain diseases and medications are linked to specific peripheral neuropathies. A medical history should also include information about diseases that run in the family, because some peripheral neuropathies are genetically linked. Information about hobbies, recreational activities, alcohol consumption, and work place activities can uncover possible injuries or exposures to poisonous substances.

The physical examination also includes blood tests, such as those that check levels of glucose and creatinine to detect diabetes and kidney problems, respectively. A **blood count** is also done to determine levels of different blood cell types. Iron, vitamin B_{12}, and other factors may be measured as well, to rule out malnutrition. More specific tests, such as an assay for heavy metals or poisonous substances, or tests to detect **vasculitis**, are not typically done unless there is reason to suspect a particular cause.

An individual with neuropathy may be sent to a doctor that specializes in nervous system disorders (neurologist). By considering the results of the physical examination and observations of the referring doctor, the neurologist may be able to narrow down the possible diagnoses. Additional tests, such as nerve conduction studies and **electromyography**, which tests muscle reactions, can confirm that nerve damage has occurred and may also be able to indicate the nature of the damage. For example, some neuropathies are characterized by destruction of the myelin. This type of damage is shown by slowed nerve conduction. If the axon itself has suffered damage, the nerve conduction may be slowed, but it will also be diminished in strength. Electromyography adds further information by measuring nerve conduction and muscle response, which determines whether the symptoms are due to a neuropathy or to a muscle disorder.

In approximately 10% of peripheral neuropathy cases, a nerve biopsy may be helpful. In this test, a small part of the nerve is surgically removed and examined under a microscope. This procedure is usually the most helpful in confirming a suspected diagnosis, rather than as a diagnostic procedure by itself.

Treatment

Treat the cause

Attacking the underlying cause of the neuropathy can prevent further nerve damage and may allow for a better recovery. For example, in cases of bacterial infection such as leprosy or Lyme disease, **antibiotics** may be given to destroy the infectious bacteria. Viral infections are more difficult to treat, because antibiotics are not effective against them. Neuropathies associated with drugs, chemicals, and toxins are treated in part by stopping exposure to the damaging agent. Chemicals such as ethylenediaminetetraacetic acid (EDTA) are used to help the body concentrate and excrete some toxins. Diabetic neuropathies may

be treated by gaining better control of blood sugar levels, but chronic kidney failure may require dialysis or even kidney transplant to prevent or reduce nerve damage. In some cases, such as compression injury or tumors, surgery may be considered to relieve pressure on a nerve.

In a crisis situation, as in the onset of Guillain-Barré syndrome, plasma exchange, intravenous immunoglobulin, and steroids may be given. Intubation, in which a tube is inserted into the trachea to maintain an open airway, and ventilation may be required to support the respiratory system. Treatment may focus more on symptom management than on combating the underlying cause, at least until a definitive diagnosis has been made.

Supportive care and long-term therapy

Some peripheral neuropathies cannot be resolved or require time for resolution. In these cases, long-term monitoring and supportive care is necessary. Medical tests may be repeated to chart the progress of the neuropathy. If autonomic nerve involvement is a concern, regular monitoring of the cardiovascular system may be carried out.

Because pain is associated with many of the neuropathies, a **pain management** plan may need to be mapped out, especially if the pain becomes chronic. As in any chronic disease, narcotics are best avoided. Agents that may be helpful in neuropathic pain include amitriptyline, carbamazepine, and capsaicin cream. Physical therapy and physician-directed exercises can help maintain or improve function. In cases in which motor nerves are affected, braces and other supportive equipment can aid an individual's ability to move about.

Prognosis

The outcome for peripheral neuropathy depends heavily on the cause. Peripheral neuropathy ranges from a reversible problem to a potentially fatal complication. In the best cases, a damaged nerve regenerates. Nerve cells cannot be replaced if they are killed, but they are capable of recovering from damage. The extent of recovery is tied to the extent of the damage and a person's age and general health status. Recovery can take weeks to years, because neurons grow very slowly. Full recovery may not be possible and it may also not be possible to determine the prognosis at the outset.

If the neuropathy is a degenerative condition, such as Charcot-Marie-Tooth disease, an individual's condition will become worse. There may be periods of time when the disease seems to reach a plateau, but cures have not yet been discovered for many of these degenerative diseases. Therefore, continued symptoms, potentially worsening to disabilities are to be expected.

A few peripheral neuropathies are eventually fatal. Fatalities have been associated with some cases of **diphtheria**, botulism, and others. Some diseases associated with neuropathy may also be fatal, but the ultimate cause of **death** is not necessarily related to the neuropathy, such as with **cancer**.

Prevention

Peripheral neuropathies are preventable only to the extent that the underlying causes are preventable. Steps that a person can take to prevent potential problems include vaccines against diseases that cause neuropathy, such as **polio** and diphtheria. Treatment for physical injuries in a timely manner can help prevent permanent or worsening damage to nerves. Precautions when using certain chemicals and drugs are well advised in order to prevent exposure to neurotoxic agents. Control of chronic diseases such as diabetes may also reduce the chances of developing peripheral neuropathy.

Although not a preventive measure, genetic screening can serve as an early warning for potential problems. Genetic screening is available for some inherited conditions, but not all. In some cases, presence of a particular gene may not mean that a person will necessarily develop the disease, because there may be environmental and other components involved.

Resources

BOOKS

Adams, Raymond D., Maurice Victor, and Allan H. Ropper. "Diseases of the Peripheral Nerves." In *Principles of Neurology.* 6th ed. New York: McGraw-Hill, 1997.

PERIODICALS

Chalk, Colin H. "Acquired Peripheral Neuropathy." *Neurologic Clinics* 15, no. 3 (Aug. 1997): 501.

Feinberg, Joseph H., Scott F. Nalder, and Lisa S. Krivickas. "Peripheral Nerve Injuries in the Athlete." *Sports Medicine* 24, no. 6 (Dec. 1997): 385.

Morgenlander, Joel C. "Recognizing Peripheral Neuropathy: How to Read the Clues to an Underlying Cause." *Postgraduate Medicine* 102, no. 3 (Sept. 1997): 71.

Pascuzzi, Robert M., and James D. Fleck. "Acute Peripheral Neuropathy in Adults." *Neurologic Clinics* 15, no. 3 (Aug. 1997): 529.

Perkins, A. Thomas, and Joel C. Morgenlander. "Endocrinologic Causes of Peripheral Neuropathy." *Postgraduate Medicine* 102, no. 3 (Sept. 1997): 81.

ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

Charcot-Marie-Tooth Association. Crozer Mills Enterprise Center. 2700 Chestnut Parkway, Chester, PA 19013. (800) 606-CMTA. <http://www.charcotmarie-tooth.org>.

Guillain-Barré Syndrome Foundation International. P.O. Box 262, Wynnewood, PA 19096. (610) 667-0131. (610) 667-0131. <http://www.webmast.com/gbs>.

The Myelin Project Headquarters. Suite 225, 2001 Pennsylvania Ave., N.W., Washington, D.C. 20006-1850. (202) 452-8994. <http://www.myelin.org>.

The Neuropathy Association. 60 E. 42nd St., Suite 942, New York, NY 10165. (800) 247-6968. <http://www.neuropathy.org/association.html>.

Julia Barrett

KEY TERMS

Embolism—The blockage of a blood vessel by air, blood clot, or other foreign body.

Plaque—A deposit, usually of fatty material, on the inside wall of a blood vessel.

Peripheral vascular disease

Definition

Peripheral vascular disease is a narrowing of blood vessels that restricts blood flow. It mostly occurs in the legs, but is sometimes seen in the arms.

Description

Peripheral vascular disease includes a group of diseases in which blood vessels become restricted or blocked. Typically, the patient has peripheral vascular disease from **atherosclerosis**. Atherosclerosis is a disease in which fatty plaques form in the inside walls of blood vessels. Other processes, such as blood clots, further restrict blood flow in the blood vessels. Both veins and arteries may be affected, but the disease is usually arterial. All the symptoms and consequences of peripheral vascular disease are related to restricted blood flow. Peripheral vascular disease is a progressive disease that can lead to **gangrene** of the affected area. Peripheral vascular disease may also occur suddenly if an **embolism** occurs or when a blot clot rapidly develops in a blood vessel already restricted by an atherosclerotic plaque, and the blood flow is quickly cut off.

Causes and symptoms

There are many causes of peripheral vascular disease. One major risk factor is **smoking** cigarettes. Other diseases predispose patients to develop peripheral vascular disease. These include diabetes, **Buerger's disease**, **hypertension**, and **Raynaud's disease**. The main symptom is **pain** in the affected area. Early symptoms include an achy, tired sensation in the affected muscles. Since this disease is seen mainly in the legs, these sensations usually occur when walking. The symptoms may disappear when resting. As the disease becomes worse, symptoms occur even during light exertion and, eventually, occur all the time, even at rest. In the severe stages of the disease the leg and foot may be cold to the touch and will feel numb. The skin may become dry and scaly. If the leg is even slightly injured, ulcers may form because, without a good blood supply, proper healing can not take place. At the most severe stage of the disease, when the blood flow is greatly restricted, gangrene can develop in those areas lacking blood supply. In some cases, peripheral vascular disease occurs suddenly. This happens when an embolism rapidly blocks blood flow to a blood vessel. The patient will experience a sharp pain. followed by a loss of sensation in the affected area. The limb will become cold and numb, and loose color or turn bluish.

Diagnosis

Peripheral vascular disease can be diagnosed by comparing blood pressures taken above and below the point of pain. The area below the pain (downstream from the obstruction) will have a much lower or undetectable blood pressure reading. **Doppler ultrasonography** and **angiography** can also be used to diagnose and define this disease.

Treatment

If the person is a smoker, they should stop smoking immediately. **Exercise** is essential to treating this disease. The patient should walk until pain appears, rest until the pain disappears, and then resume walking. The amount of walking a patient can do should increase gradually as the symptoms improve. Ideally, the patient should walk 30–60 minutes per day. Infections in the affected area should be treated promptly. Surgery may be required to attempt to treat clogged blood vessels. Limbs with gangrene must be amputated to prevent the **death** of the patient.

Prognosis

The prognosis depends on the underlying disease and the stage at which peripheral vascular disease is discovered. Removal of risk factors, such as smoking, should be done immediately. In many cases, peripheral vascular disease can be treated successfully but coexisting cardiovascular problems may ultimately prove to be fatal.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

John T. Lohr, PhD

Peritoneal dialysis *see* **Dialysis, kidney**

Peritoneal endoscopy *see* **Laparoscopy**

Peritonitis

Definition

Peritonitis is an inflammation of the membrane which lines the inside of the abdomen and all of the internal organs. This membrane is called the peritoneum.

Description

Peritonitis may be primary (meaning that it occurs spontaneously, and not as the result of some other medical problem) or secondary (meaning that it results from some other condition). It is most often due to infection by bacteria, but may also be due to some kind of a chemical irritant (such as spillage of acid from the stomach, bile from the gall bladder and biliary tract, or enzymes from the pancreas during the illness called **pancreatitis**). Peritonitis has even been seen in patients who develop a reaction to the cornstarch used to powder gloves worn during surgery. Peritonitis with no evidence of bacteria, chemical irritant, or foreign body has occurred in such diseases as **systemic lupus erythematosus**, porphyria, and **familial Mediterranean fever**. When the peritoneum is contaminated by blood, the blood can both irritate the peritoneum and serve as a source of bacteria to cause an infection. Blood may leak into the abdomen due to a burst tubal **pregnancy**, an injury, or bleeding after surgery.

Causes and symptoms

Primary peritonitis usually occurs in people who have an accumulation of fluid in their abdomens (**ascites**). Ascites is a common complication of severe **cirrhosis** of the liver (a disease in which the liver grows increasingly scarred and dysfunctional). The fluid that accumulates creates a good environment for the growth of bacteria.

Secondary peritonitis most commonly occurs when some other medical condition causes bacteria to spill into the abdominal cavity. Bacteria are normal residents of a healthy intestine, but they should have no way to escape and enter the abdomen, where they could cause an infection. Bacteria can infect the peritoneum due to conditions in which a hole (perforation) develops in the stomach (due to an ulcer eating its way through the stomach wall) or intestine (due to a large number of causes, including a ruptured appendix or a ruptured diverticulum). Bacteria can infect the peritoneum due to a severe case of **pelvic inflammatory disease** (a massive infection of the female organs, including the uterus and fallopian tubes). Bacteria can also escape into the abdominal cavity due to an injury that causes the intestine to burst, or an injury to an internal organ which bleeds into the abdominal cavity.

Symptoms of peritonitis include **fever** and abdominal **pain**. An acutely ill patient usually tries to lie very still, because any amount of movement causes excruciating pain. Often, the patient lies with the knees bent, to decrease strain on the tender peritoneum. There is often **nausea and vomiting**. The usual sounds made by the active intestine and heard during examination with a stethoscope will be absent, because the intestine usually stops functioning. The abdomen may be rigid and board-like. Accumulations of fluid will be notable in primary peritonitis due to ascites. Other signs and symptoms of the underlying cause of secondary peritonitis may be present.

Diagnosis

A diagnosis of peritonitis is usually based on symptoms. Discovering the underlying reason for the peritonitis, however, may require some work. A blood sample will be drawn in order to determine the white blood cell count. Because white blood cells are produced by the body in an effort to combat foreign invaders, the white blood cell count will be elevated in the case of an infection. A long, thin needle can be used to take a sample of fluid from the abdomen in an effort to diagnose primary peritonitis. The types of immune cells present are usually characteristic in this form of peritonitis. X-ray films may be taken if there is some suspicion that a perforation exists. In the case of a perforation, air will have escaped into the abdomen and will be visible on the picture. When a cause for peritonitis cannot be found, an open exploratory operation on the abdomen (laparotomy) is considered to be a crucial diagnostic procedure, and at the same time provides the opportunity to begin treatment.

Treatment

Treatment depends on the source of the peritonitis, but an emergency laparotomy is usually performed. Any

KEY TERMS

Ascites—An accumulation of fluid within the abdominal cavity.

Cirrhosis—A progressive liver disease in which the liver grows increasingly more scarred. The presence of scar tissue then interferes with liver function.

Diverticulum—An outpouching of the intestine.

Laparotomy—An open operation on the abdomen.

Pancreatitis—An inflammation of the pancreas.

Perforation—A hole.

Peritoneum—The membrane that lines the inside of the abdominal cavity, and all of the internal organs.

perforated or damaged organ is usually repaired at this time. If a clear diagnosis of pelvic inflammatory disease or pancreatitis can be made, however, surgery is not usually performed. Peritonitis from any cause is treated with **antibiotics** given through a needle in the vein, along with fluids to prevent **dehydration**.

Prognosis

Prognosis for untreated peritonitis is poor, usually resulting in **death**. With treatment, the prognosis is variable, dependent on the underlying cause.

Prevention

There is no way to prevent peritonitis, since the diseases it accompanies are usually not under the voluntary control of an individual. However, prompt treatment can prevent complications.

Resources

BOOKS

Isselbacher, Kurt J., and Alan Epstein. "Diverticular, Vascular, and Other Disorders of the Intestine and Peritoneum." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Podolsky, Daniel K., and Kurt J. Isselbacher. "Major Complications of Cirrhosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Zaleznik, Dori F., and Dennis L. Kasper. "Intraabdominal Infections and Abscesses." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

"Evaluation and Management of Secondary Peritonitis." *American Family Physician* 54 (Oct. 1996): 1724+.

"Subacute Bacterial Peritonitis: Diagnosis and Treatment." *American Family Physician* 52 (Aug. 1995): 645.

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Peritoneal fluid analysis *see* **Paracentesis**

Permanent pacemakers *see* **Pacemakers**

Pernicious anemia

Definition

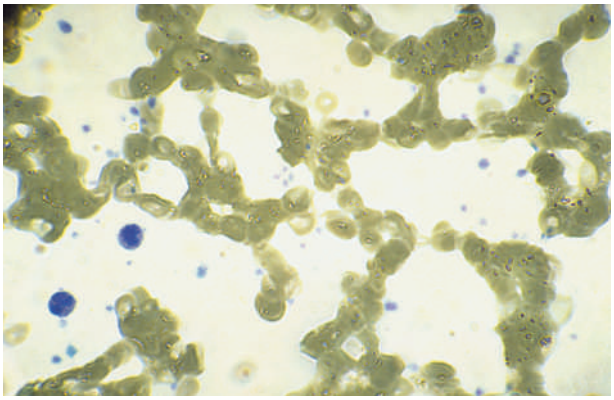
Pernicious anemia is a disease in which the red blood cells are abnormally formed, due to an inability to absorb vitamin B_{12}. True pernicious anemia refers specifically to a disorder of atrophied parietal cells leading to absent intrinsic factor, resulting in an inability to absorb B_{12}.

Description

Vitamin B_{12}, or cobalamin, plays an important role in the development of red blood cells. It is found in significant quantities in liver, meats, milk and milk products, and legumes. During the course of the digestion of foods containing B_{12}, the B_{12} becomes attached to a substance called intrinsic factor. Intrinsic factor is produced by parietal cells which line the stomach. The B_{12}-intrinsic factor complex then enters the intestine, where the vitamin is absorbed into the bloodstream. In fact, B_{12} can only be absorbed when it is attached to intrinsic factor.

In pernicious anemia, the parietal cells stop producing intrinsic factor. The intestine is then completely unable to absorb B_{12}. So, the vitamin passes out of the body as waste. Although the body has significant amounts of stored B_{12}, this will eventually be used up. At this point, the symptoms of pernicious anemia will develop.

Pernicious anemia is most common among people from northern Europe and among African Americans. It is far less frequently seen among people from southern Europe and Asia. Pernicious anemia occurs in equal numbers in both men and women. Most patients with pernicious anemia are older, usually over 60. Occasionally, a child will have an inherited condition which results in defective intrinsic factor. Pernicious anemia seems to run in families, so that anyone with a relative diagnosed with the disease has a greater likelihood of developing it as well.



A smear of red blood cells indicating folic acid (vitamin B_{12}) deficiency. *(Custom Medical Stock Photo. Reproduced by permission.)*

Causes and symptoms

Intrinsic factor is produced by specialized cells within the stomach called parietal cells. When these parietal cells shrink in size (atrophy), they produce less and less intrinsic factor. Eventually, the parietal cells stop functioning altogether. Other important products of parietal cells are also lessened, including stomach acid, and an enzyme involved in the digestion of proteins.

People with pernicious anemia seem to have a greater chance of having certain other conditions. These conditions include **autoimmune disorders**, particularly those affecting the thyroid, parathyroid, and adrenals. It is thought that the immune system, already out of control in these diseases, incorrectly becomes directed against the parietal cells. Ultimately, the parietal cells seem to be destroyed by the actions of the immune system.

As noted, true pernicious anemia refers specifically to a disorder of atrophied parietal cells leading to absent intrinsic factor, resulting in an inability to absorb B_{12}. However, there are other related conditions which result in decreased absorption of B_{12}. These conditions cause the same types of symptoms as true pernicious anemia. Other conditions that interfere with either the production of intrinsic factor, or the body's use of B_{12}, include conditions that require surgical removal of the stomach, or poisonings with corrosive substances which destroy the lining of the stomach. Certain structural defects of the intestinal system can result in an overgrowth of normal bacteria. These bacteria then absorb B_{12} themselves, for use in their own growth. Intestinal worms (especially one called fish tapeworm) may also use B_{12}, resulting in anemia. Various conditions that affect the first part of the intestine (the ileum), from which B_{12} is absorbed, can also cause anemia due to B_{12} deficiency. These ilium related disorders include tropical sprue, Whipple's disease, **Crohn's disease**, **tuberculosis**, and the Zollinger-Ellison syndrome.

Symptoms of pernicious anemia and decreased B_{12} affect three systems of the body: the system that is involved in the formation of blood cells (hematopoietic system); the gastrointestinal system; and the nervous system.

The hematopoietic system is harmed because B_{12} is required for the proper formation of red blood cells. Without B_{12}, red blood cell production is greatly reduced. Those red blood cells that are produced are abnormally large and abnormal in shape. Because red blood cells are responsible for carrying oxygen around the body, decreased numbers (termed anemia) result in a number of symptoms, including **fatigue**, **dizziness**, ringing in the ears, pale or yellowish skin, fast heart rate, enlarged heart with an abnormal heart sound (murmur) evident on examination, and chest **pain**.

Symptoms that affect the gastrointestinal system include a sore and brightly red tongue, loss of appetite, weight loss, **diarrhea**, and abdominal cramping.

The nervous system is severely affected when pernicious anemia goes untreated. Symptoms include numbness, tingling, or burning in the arms, legs, hands, and feet; muscle weakness; difficulty and loss of balance while walking; changes in reflexes; irritability, confusion, and depression.

Diagnosis

Diagnosis of pernicious anemia is suggested when a blood test reveals abnormally large red blood cells. Many of these will also be abnormally shaped. The earliest, least mature forms of red blood cells (reticulocytes) will also be low in number. White blood cells and platelets may also be decreased in number. Measurements of the quantity of B_{12} circulating in the bloodstream will be low.

Once these determinations are made, it will be important to diagnose the cause of the anemia. True pernicious anemia means that the parietal cells of the stomach are atrophied, resulting in decreased production of intrinsic factor. This diagnosis is made by the Schilling test. In this test, a patient is given radioactive B_{12} under two different sets of conditions: once alone, and once attached to intrinsic factor. Normally, large amounts of B_{12} are absorbed through the intestine, then circulate through the blood, and enter the kidneys, where a certain amount of B_{12} is then passed out in the urine. When a patient has pernicious anemia, the dose of B_{12} given by itself will not be absorbed by the intestine, so it will not pass into the urine. Therefore, levels of B_{12} in the urine will be low. When the B_{12} is given along with intrinsic

KEY TERMS

Anemia—A condition in which those elements of the blood responsible for oxygen delivery throughout the body (red blood cells, hemoglobin) are decreased in quantity or defective in some way.

Atrophy—Refers to the shrinking in size of an organ or cell.

Autoimmune disorder—A disorder in which the immune system, (responsible for fighting off such foreign invaders as bacteria and viruses), begins to attack and damage a part of the body as if it were foreign.

Hematopoietic system—The system in the body which is responsible for the production of blood cells.

Intrinsic factor—A substance produced by the parietal cells of the stomach. In order to be absorbed by the intestine, vitamin B_{12} must form a complex with intrinsic factor.

Parietal cells—Specialized cells lining the inside of the stomach. These cells are responsible for producing intrinsic factor, acid, and pepsin.

Reticulocyte—An early, immature form of a red blood cell. Over time, the reticulocyte develops to become a mature, oxygen-carrying red blood cell.

factor, the intestine is able to absorb the vitamin. Urine levels of B_{12} will therefore be higher.

Treatment

Treatment of pernicious anemia requires the administration of lifelong injections of B_{12}. Vitamin B_{12} given by injection enters the bloodstream directly, and does not require intrinsic factor. At first, injections may need to be given several times a week, in order to build up adequate stores of the vitamin. After this, the injections can be given on a monthly basis. Other substances required for blood cell production may also need to be given, such as iron and vitamin C.

Prognosis

Prognosis is generally good for patients with pernicious anemia. Many of the symptoms improve within just a few days of beginning treatment, although some of the nervous system symptoms may take up to 18 months to improve. Occasionally, when diagnosis and treatment have been delayed for a long time, some of the nervous system symptoms may be permanent.

Because an increased risk of **stomach cancer** has been noted in patients with pernicious anemia, careful monitoring is necessary, even when all the symptoms of the original disorder have improved.

Resources

BOOKS

Babior, Bernard M., and H. Franklin Bunn. "Megaloblastic Anemias." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Babior, Bernard M. "The Megaloblastic Anemias." In *Williams' Hematology*, ed. E. Beutler, et al. New York: McGraw-Hill, 1995.

PERIODICALS

Hawley, Kelly. "Pernicious Anemia: How to Recognize and Manage This Insidious Condition." *American Journal of Nursing* 96, no. 11 (Nov. 1996): 52+.

Toh, Ban-Hock, et al. "Pernicious Anemia." *The New England Journal of Medicine* 337, no. 20 (13 Nov. 1997): 52+.

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Peroneal muscular atrophy *see* **Charcot-Marie-Tooth disease**

Peroxisomal disorders

Definition

Peroxisomal disorders are a group of congenital diseases characterized by the absence of normal peroxisomes in the cells of the body. Peroxisomes are organelles within a cell that contain enzymes responsible for critical cellular processes, including oxidation of fatty acids, biosynthesis of membrane phospholipids (plasmalogens), cholesterol, and bile acids, conversion of amino acids into glucose, reduction of hydrogen peroxide by catalase, and prevention of excess synthesis of oxalate (which can form crystals with calcium, resulting in **kidney stones**). Peroxisomal disorders are subdivided into two major categories: those disorders resulting from a failure to form intact, normal peroxisomes, resulting in multiple metabolical abnormalities, which are referred to as peroxisome biogenesis disorders (PBD) or as generalized peroxisomal disorders; and those disorders resulting from the deficiency of a single peroxisomal enzyme. There are about 25 peroxisomal disorders known, although the number of diseases that are considered to be

separate, distinct peroxisomal disorders varies among researchers and health care practitioners.

Description

A cell can contain several hundred peroxisomes, which are round or oval bodies with diameters of about 0.5 micron, that contain proteins that function as enzymes in metabolic processes. By definition, a peroxisome must contain catalase, which is an enzyme that breaks down hydrogen peroxide.

Approximately fifty different biochemical reactions occur entirely or partially within a peroxisome. Some of the processes are anabolic, or constructive, resulting in the synthesis of essential biochemical compounds, including bile acids, cholesterol, plasmalogens, and docosahexanoic acid (DHA), which is a long chain fatty acid that is a component of complex lipids, including the membranes of the central nervous system. Other reactions are catabolic, or destructive, and lead to the destruction of some fatty acids, including very long chain fatty acids (VLCFAs, fatty acids with more than 22 carbon atoms in their chains), phytanic acid, pipecolic acid, and the prostoglandins.The peroxisome is involved in breaking down VLCFAs to lengths that the body can use or get rid of.

When VLCFAs accumulate due to abnormal functioning of the peroxisomes, they are disruptive to the structure and stability of certain cells, especially those associated with the central nervous system and the myelin sheath, which is the fatty covering of nerve fibers. The peroxisomal disorders that include effects on the growth of the myelin sheath are considered to be part of a group of genetic disorders referred to as leukodystrophies.

There are many other metabolic deficiencies that can occur in those who have peroxisomal disorders, which result in other types of detrimental effects, and together result in the abnormalities associated with the peroxisomal disorders. Unfortunately, it is not known how these abnormalities, and combinations of abnormalities, cause the disabilities seen in those afflicted with the disease.

Peroxisomal disorders form a heterogeneous disease group, with different degrees of severity. Included in the group referred to as PBD are:

- Zellweger syndrome (ZS), which is usually fatal within the first year of life,
- neonatal **adrenoleukodystrophy** (NALD), which is usually fatal within the first ten years,
- infantile Refsum disease (IRD), which is not as devastating as ZS and NALD, as the children with this disorder with time and patience can develop some degree of motor, cognitive, and communication skills, although **death** generally occurs during the second decade of life,
- rhizomelic chondrodysplasia punctata (RCDP), which in its most severe form is fatal within the first year or two of life; however, survival into the teens has been known to occur. It is characterized by shortening of the proximal limbs (i.e., the legs from knee to foot, and the arms from elbow to hand) and,
- Zellweger-like syndrome, which is fatal in infancy, and is known to be a defect of three particular enzymes.

The differences among these disorders are continuous, with overlap between abnormalities. The range of disease abnormalities may be a result of a corresponding range of peroxisome failure; that is, in severe cases of ZS, the failure is nearly complete, while in IRD, there is some degree of peroxisome activity.

In peroxisomal single-enzyme disorders, the peroxisome is intact and functioning, but there is a defect in only one enzymatic process, with only one corresponding biochemical abnormality. However, these disorders can be as severe as those in which peroxisomal activity is nearly or completely absent.

X-linked adrenoleukodystrophy (X-ALD) is the most common of the peroxisomal disorders, affecting about one in 20,000 males. It is estimated that there are about 1,400 people in the United States with the disorder. In X-ALD there is a deficiency in the enzyme that breaks down VLCFAs, which then accumulate in the myelin and adrenal glands. Onset of X-ALD-related neurological symptoms occurs at about 5–12 years of age, with death occurring within one to 10 years after onset of symptoms. In addition to physical abnormalities seen in other types of peroxisomal disorders, common symptoms of X-ALD also include behavioral changes such as abnormal withdrawal or aggression, poor memory, **dementia**, and poor academic performance. Other symptoms are muscle weakness and difficulties with hearing, speech, and vision. As the disease progresses, muscle tone deteriorates, swallowing becomes difficult and the patient becomes comatose. Unless treated with a diet that include's Lorenzo's oil, the disease will result in **paralysis**, **hearing loss**, blindness, **vegetative state**, and death. There are also milder forms of X-ALD: an adult on-set ALD that typically begins between the ages of 21 and 35, and a form that is occasionally seen in women who are carriers of the disorder. In addition to X-ALD, there are at least ten other single-enzyme peroxisomal disorders, each with its own specific abnormalities.

Causes and symptoms

Most peroxisomal disorders are inherited autosomal recessive diseases, with X-ALD as an exception. They occur in all countries, among all races and ethnic groups. They are extremely rare, with frequencies reported at one in 30,000 to one in 150,000, although these numbers are only estimates.

In general, developmental delay, **mental retardation**, and vision and hearing impairment are common in those who have these disorders. Acquisition of speech appears to be especially difficult, and because of the reduced communication abilities, **autism** is common in those who live longer. Peroxisomal disorder patients have decreased muscle tone (hypotonia), which in the most severe cases is generalized, while in less severe cases, is usually restricted to the neck and trunk muscles. Sometimes this lack of control is only noticeable by a curved back in the sitting position. Head control and independent sitting is delayed, with most patients unable to walk independently.

Failure to thrive is a common characteristic of patients with peroxisomal disorder, along with an enlarged liver, abnormalities in liver enzyme function, and loss of fats in stools (steatorrhea).

Peroxisomal disorders are also associated with facial abnormalities, including high forehead, frontal bossing (swelling), small face, low set ears, and slanted eyes. These characteristics may not be prominent in some children, and are especially difficult to identify in an infant.

Diagnosis

Since hearing and vision deficiencies may be difficult to identify in infants, peroxisomal disorders are usually detected by observations of failure to thrive, hypotonia, mental retardation, widely open fontanel, abnormalities in liver enzymes, and an enlarged liver. If peroxisomal disorders are suspected, blood plasma assays for VLCFAs, phytanic acid, and pipecolic acid are conducted. Additional tests include plasmalogen biosynthesis potential.

Treatment

For many of the peroxisomal disorders, there is no standard course of treatment, with supportive treatment strategies focusing on alleviation of complications and symptoms. In general, most treatments that are attempted are dietary, whereby attempts are made to artificially correct biochemical abnormalities associated with the disorders. Therapies include supplementation of the diet with antioxidant **vitamins**, or limitation of intake of fatty acids, especially VLCFAs.

Another area of dietary therapy that is being investigated is the supplementation of the diet with pure DHA, given as early in life as possible, in conjunction with a normal well-balanced diet. Some results have indicated that if given soon enough during development, DHA therapy may prevent some of the devastating consequences of peroxisomal disorders, including the loss of vision and brain damage.

Other treatment strategies include addition of important missing chemicals. For example, in disorders where there is faulty adrenal function, replacement adrenal hormone therapy is used.

Any dietary changes should be monitored biochemically to determine if the supplements are having their desired effects and are not causing additional adverse effects.

A treatment for a specific type of peroxisomal disorder includes bone marrow transplants for X-ALD, which may be effective if used early in the course of the childhood form of the disease.

Physical and psychological therapies are important for all types of peroxisomal disorders.

Alternative treatment

Patients with peroxisomal disorders, and particularly X-ALD, have been treated with a mixture of glycerol trioleate-glycerol trieucate (4:1 by volume), prepared from olive and rapeseed oils, and referred to as Lorenzo's oil (developed by parents of a son, Lorenzo, who had X-ALD, whose story was documented in the 1992 movie, *Lorenzo's Oil*), to decrease the levels of VLCFA. Other **diets** that have been tried include dietary supplementation with plasmalogen precursors to increase plasmalogen levels and with cholic acid to normalize bile acids. However, there has been only little success demonstrated with the use of these treatments. More research is needed to determine the long-term safety and effectiveness of these treatment strategies.

Prognosis

Peroxisomal disorders range from life-threatening to cases in which people may function with some degree of mental and motor retardation. As of 2001, there is not yet a cure. Enzyme replacement therapies, including enzyme infusion, transplantation, and **gene therapy**, may hold promise for future advances in the treatment of these disorders. Research is being conducted to increase scientific understanding of these disorders and to find ways to prevent, treat, and cure them.

Prevention

Unfortunately not enough is yet known about these diseases to develop comprehensive strategies for prevention. **Genetic counseling** is recommended for known or

KEY TERMS

Autosome—A chromosome not involved in sex determination.

Autosomal recessive inheritance—Two copies of an altered gene located on one of the autosomes must be present for an individual to be affected with the trait or condition determined by that gene:

- an affected individual (homozygote) has two parents who are unaffected but each parent carries the altered gene (heterozygote).
- the risk of two heterozygotes, or carriers, having an affected child is 25%, one in four, for each child that they have; similarly, there is a three in four chance that each child will not be affected.
- males and females are at equal risk for being affected.
- two affected individuals usually produce children, all of whom are affected as well.

Fontanel—One of the membranous intervals between the uncompleted angles of the parietal and neighboring bones of a fetal or young skull; so called because it exhibits a rhythmical pulsation.

Organelle—Specialized structure within a cell, which is separated from the rest of the cell by a membrane composed of lipids and proteins, where chemical and metabolic functions take place.

suspected carriers. As genes are identified that result in the disorders, **genetic testing** is being developed to identify carriers, who then can manage their reproduction to avoid the possibility of children being born with these deficiencies. As the genetic bases for the disorders is defined, prenatal diagnosis and identification of carriers will be facilitated. For example, for X-ALD, diagnosis can be made from cultured skin fibroblasts or amniotic fluid cells. This allows prenatal diagnosis and carrier identification in 90% of those affected. More recently it has been shown that biochemical diagnosis can be performed through chorionic villi biopsy, a procedure performed very early in the first trimester of **pregnancy**.

Animal models of ZS and X-ADL have been developed and are providing researchers with methods to define pathogenic mechanisms and to evaluate new therapies.

Resources

BOOKS

Reddy, Janardan K., Tetsuya Suga, and Guy P. Mannaerts, eds. *Peroxisomes: Biology and Role in Toxicology and Disease,* *Annals of the New York Academy of Sciences,* Vol. 804. New York: New York Academy of Sciences, 1996.

PERIODICALS

Martinez, Manuela. "The Fundamental and Practice of Docosahexanoic Acid Therapy in Peroxisomal Disorders." *Current Opinion in Clinical Nutrition and Metabolic Care*, 3 (2000): 101-108, 2000.

Martinez, M., E. Vazquez, M.T. Garcia Silva, J. Manzanares, J.M. Bertran, F. Castello, and I. Mougan. "Therapeutic Effects of Docosahexanoic Acid in Patients with Generalized Peroxisomal Disorders." *American Journal of Clinical Nutrition* 71 (2000): 376s - 385s.

Moser, H.W., and G.V. Raymond. "Genetic Peroxisomal Disorders: Why, When, and How to Test." *Annals of Neurology* 44 (November 1998): 713- 715.

Moser, Hugo W. "Molecular Genetics of Peroxisomal Disorders." *Frontiers in Bioscience*, 5 (March 1, 2001): 298-306.

Raymond, G.V. "Peroxisomal Disorders." *Current Opinion in Pediatrics* 11 (December 1999): 572-576.

ORGANIZATIONS

National Organization for Rare Disorders P.O. Box 8923, New Fairfield, CT 06812- 8923 <http://rarediseases.org>.

The National Institute of Neurological Disorders and Stroke, National Institutes of Health.

OTHER

The Peroxisome Website. <http://www.ninds.nih.gov>.

Judith Sims

Persantine-thallium heart scan *see* **Thallium heart scan**

Personality disorders

Definition

Personality disorders are a group of mental disturbances defined by the fourth (1994) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*) as "enduring pattern[s] of inner experience and behavior" that are sufficiently rigid and deep-seated to bring a person into repeated conflicts with his or her social and occupational environment. *DSM-IV* specifies that these dysfunctional patterns must be regarded as non-conforming or deviant by the person's culture, and cause significant emotional pain and/or difficulties in relationships and occupational performance. In addition, the patient usually sees the disorder as being consistent with his or her self image (ego-syntonic) and may blame others.

Description

To meet the diagnosis of personality disorder, which is sometimes called character disorder, the patient's problematic behaviors must appear in two or more of the following areas:

- perception and interpretation of the self and other people
- intensity and duration of feelings and their appropriateness to situations
- relationships with others
- ability to control impulses

Personality disorders have their onset in late adolescence or early adulthood. Doctors rarely give a diagnosis of personality disorder to children on the grounds that children's personalities are still in the process of formation and may change considerably by the time they are in their late teens. But, in retrospect, many individuals with personality disorders could be judged to have shown evidence of the problems in childhood.

It is difficult to give close estimates of the percentage of the population that has personality disorders. Patients with certain personality disorders, including antisocial and borderline disorders, are more likely to get into trouble with the law or otherwise attract attention than are patients whose disorders chiefly affect their capacity for intimacy. On the other hand, some patients, such as those with narcissistic or obsessive-compulsive personality disorders, may be outwardly successful because their symptoms are useful within their particular occupations. It has, however, been estimated that about 15% of the general population of the United States has a personality disorder, with higher rates in poor or troubled neighborhoods. The rate of personality disorders among patients in psychiatric treatment is between 30% and 50%. It is possible for patients to have a so-called dual diagnosis; for example, they may have more than one personality disorder, or a personality disorder together with a substance-abuse problem.

By contrast, *DSM-IV* classifies personality disorders into three clusters based on symptom similarities:

- Cluster A (paranoid, schizoid, schizotypal): Patients appear odd or eccentric to others.
- Cluster B (antisocial, borderline, histrionic, narcissistic): Patients appear overly emotional, unstable, or self-dramatizing to others.
- Cluster C (avoidant, dependent, obsessive-compulsive): Patients appear tense and anxiety-ridden to others.

The *DSM-IV* clustering system does not mean that all patients can be fitted neatly into one of the three clusters. It is possible for patients to have symptoms of more than one personality disorder or to have symptoms from different clusters.

Since the criteria for personality disorders include friction or conflict between the patient and his or her social environment, these syndromes are open to redefinition as societies change. Successive editions of *DSM* have tried to be sensitive to cultural differences, including changes over time, when defining personality disorders. One category that had been proposed for *DSM-III-R,* self-defeating personality disorder, was excluded from *DSM-IV* on the grounds that its definition reflected prejudice against women. *DSM-IV* recommends that doctors take a patient's background, especially recent immigration, into account before deciding that he or she has a personality disorder. One criticism that has been made of the general category of personality disorder is that it is based on Western notions of individual uniqueness. Its applicability to people from cultures with different definitions of human personhood is thus open to question. Furthermore, even within a culture, it can be difficult to define the limits of "normalcy."

The personality disorders defined by *DSM-IV* are as follows:

Paranoid

Patients with paranoid personality disorder are characterized by suspiciousness and a belief that others are out to harm or cheat them. They have problems with intimacy and may join cults or groups with paranoid belief systems. Some are litigious, bringing lawsuits against those they believe have wronged them. Although not ordinarily delusional, these patients may develop psychotic symptoms under severe **stress**. It is estimated that 0.5–2.5% of the general population meet the criteria for paranoid personality disorder.

Schizoid

Schizoid patients are perceived by others as "loners" without close family relationships or social contacts. Indeed, they are aloof and really do prefer to be alone. They may appear cold to others because they rarely display strong emotions. They may, however, be successful in occupations that do not require personal interaction. About 2% of the general population has this disorder. It is slightly more common in men than in women.

Schizotypal

Patients diagnosed as schizotypal are often considered odd or eccentric because they pay little attention to their clothing and sometimes have peculiar speech man-

nerisms. They are socially isolated and uncomfortable in parties or other social gatherings. In addition, people with schizotypal personality disorder often have oddities of thought, including "magical" beliefs or peculiar ideas (for example, a belief in telepathy) that are outside of their cultural norms. It is thought that 3% of the general population has schizotypal personality disorder. It is slightly more common in males. Schizotypal disorder should not be confused with **schizophrenia**, although there is some evidence that the disorders are genetically related.

Antisocial

Patients with antisocial personality disorder are sometimes referred to as sociopaths or psychopaths. They are characterized by lying, manipulativeness, and a selfish disregard for the rights of others; some may act impulsively. People with antisocial personality disorder are frequently chemically dependent and sexually promiscuous. It is estimated that 3% of males in the general population and 1% of females have antisocial personality disorder.

Borderline

Patients with borderline personality disorder (BPD) are highly unstable, with wide mood swings, a history of intense but stormy relationships, impulsive behavior, and confusion about career goals, personal values, or sexual orientation. These often highly conflictual ideas may correspond to an even deeper confusion about their sense of self (identity). People with BPD frequently cut or burn themselves, or threaten or attempt suicide. Many of these patients have histories of severe childhood **abuse** or neglect. About 2% of the general population have BPD; 75% of these patients are female.

Histrionic

Patients diagnosed with this disorder impress others as overly emotional, overly dramatic, and hungry for attention. They may be flirtatious or seductive as a way of drawing attention to themselves, yet they are emotionally shallow. Histrionic patients often live in a romantic fantasy world and are easily bored with routine. About 2–3% of the population is thought to have this disorder. Although historically, in clinical settings, the disorder has been more associated with women, there may be bias toward diagnosing women with the histrionic personality disorder.

Narcissistic

Narcissistic patients are characterized by self-importance, a craving for admiration, and exploitative attitudes toward others. They have unrealistically inflated views of their talents and accomplishments, and may become extremely angry if they are criticized or outshone by others. Narcissists may be professionally successful but rarely have long-lasting intimate relationships. Fewer than 1% of the population has this disorder; about 75% of those diagnosed with it are male.

Avoidant

Patients with avoidant personality disorder are fearful of rejection and shy away from situations or occupations that might expose their supposed inadequacy. They may reject opportunities to develop close relationships because of their fears of criticism or humiliation. Patients with this personality disorder are often diagnosed with dependent personality disorder as well. Many also fit the criteria for social phobia. Between 0.5–1.0% of the population have avoidant personality disorder.

Dependent

Dependent patients are afraid of being on their own and typically develop submissive or compliant behaviors in order to avoid displeasing people. They are afraid to question authority and often ask others for guidance or direction. Dependent personality disorder is diagnosed more often in women, but it has been suggested that this finding reflects social pressures on women to conform to gender stereotyping or bias on the part of clinicians.

Obsessive-compulsive

Patients diagnosed with this disorder are preoccupied with keeping order, attaining perfection, and maintaining mental and interpersonal control. They may spend a great deal of time adhering to plans, schedules, or rules from which they will not deviate, even at the expense of openness, flexibility, and efficiency. These patients are often unable to relax and may become "workaholics." They may have problems in employment as well as in intimate relationships because they are very "stiff" and formal, and insist on doing everything their way. About 1% of the population has obsessive-compulsive personality disorder; the male/female ratio is about 2:1.

Causes and symptoms

Personality disorders are thought to result from a bad interface, so to speak, between a child's temperament and character on one hand and his or her family environment on the other. Temperament can be defined as a person's innate or biologically shaped basic disposition. Human infants vary in their sensitivity to light or noise, their level of physical activity, their adaptability to schedules, and similar traits. Even traits such as "shyness" and "novelty-seeking" may be, at least in part, determined by the biology of the brain and the genes one inherits.

Character is defined as the set of attitudes and behavior patterns that the individual acquires or learns over time. It includes such personal qualities as work and study habits, moral convictions, neatness or cleanliness, and consideration of others. Since children must learn to adapt to their specific families, they may develop personality disorders in the course of struggling to survive psychologically in disturbed or stressful families. For example, nervous or high-strung parents might be unhappy with a baby who is very active and try to restrain him or her at every opportunity. The child might then develop an avoidant personality disorder as the outcome of coping with constant frustration and parental disapproval. As another example, **child abuse** is believed to play a role in shaping borderline personality disorder. One reason that some therapists use the term developmental damage instead of personality disorder is that it takes the presumed source of the person's problems into account.

Some patients with personality disorders come from families that appear to be stable and healthy. It has been suggested that these patients are biologically hypersensitive to normal family stress levels. Levels of the brain chemical (neurotransmitter) dopamine may influence a person's level of novelty-seeking, and serotonin levels may influence aggression.

Diagnosis

Diagnosis of personality disorders is complicated by the fact that affected persons rarely seek help until they are in serious trouble or until their families (or the law) pressure them to get treatment. The reason for this slowness is that the problematic traits are so deeply entrenched that they seem normal (ego-syntonic) to the patient. Diagnosis of a personality disorder depends in part on the patient's age. Although personality disorders originate during the childhood years, they are considered adult disorders. Some patients, in fact, are not diagnosed until late in life because their symptoms had been modified by the demands of their job or by marriage. After retirement or the spouse's **death**, however, these patients' personality disorders become fully apparent. In general, however, if the onset of the patient's problem is in mid- or late-life, the doctor will rule out substance abuse or personality change caused by medical or neurological problems before considering the diagnosis of a personality disorder. It is unusual for people to develop personality disorders "out of the blue" in mid-life.

There are no tests that can provide a definitive diagnosis of personality disorder. Most doctors will evaluate a patient on the basis of several sources of information collected over a period of time in order to determine how long the patient has been having difficulties, how many areas of life are affected, and how severe the dysfunction is. These sources of information may include:

Interviews

The doctor may schedule two or three interviews with the patient, spaced over several weeks or months, in order to rule out an adjustment disorder caused by job loss, bereavement, or a similar problem. An office interview allows the doctor to form an impression of the patient's overall personality as well as obtain information about his or her occupation and family. During the interview, the doctor will note the patient's appearance, tone of voice, body language, eye contact, and other important non-verbal signals, as well as the content of the conversation. In some cases, the doctor may contact other people (family members, employers, close friends) who know the patient well in order to assess the accuracy of the patient's perception of his or her difficulties. It is quite common for people with personality disorders to have distorted views of their situations, or to be unaware of the impact of their behavior on others.

Psychologic testing

Doctors use psychologic testing to help in the diagnosis of a personality disorder. Most of these tests require interpretation by a professional with specialized training. Doctors usually refer patients to a clinical psychologist for this type of test.

PERSONALITY INVENTORIES. Personality inventories are tests with true/false or yes/no answers that can be used to compare the patient's scores with those of people with known personality distortions. The single most commonly used test of this type is the **Minnesota Multiphasic Personality Inventory**, or MMPI. Another test that is often used is the Millon Clinical Multiaxial Inventory, or MCMI.

PROJECTIVE TESTS. Projective tests are unstructured. Unstructured means that instead of giving one-word answers to questions, the patient is asked to talk at some length about a picture that the psychologist has shown him or her, or to supply an ending for the beginning of a story. Projective tests allow the clinician to assess the patient's patterns of thinking, fantasies, worries or anxieties, moral concerns, values, and habits. Common projective tests include the Rorschach, in which the patient responds to a set of ten inkblots; and the **Thematic Apperception Test** (TAT), in which the patient is shown drawings of people in different situations and then tells a story about the picture.

Treatment

At one time psychiatrists thought that personality disorders did not respond very well to treatment. This

opinion was derived from the notion that human personality is fixed for life once it has been molded in childhood, and from the belief among people with personality disorders that their own views and behaviors are correct, and that others are the ones at fault. More recently, however, doctors have recognized that humans can continue to grow and change throughout life. Most patients with personality disorders are now considered to be treatable, although the degree of improvement may vary. The type of treatment recommended depends on the personality characteristics associated with the specific disorder.

Hospitalization

Inpatient treatment is rarely required for patients with personality disorders, with two major exceptions: borderline patients who are threatening suicide or suffering from drug or alcohol withdrawal; and patients with paranoid personality disorder who are having psychotic symptoms.

Psychotherapy

Psychoanalytic psychotherapy is suggested for patients who can benefit from insight-oriented treatment. These patients typically include those with dependent, obsessive-compulsive, and avoidant personality disorders. Doctors usually recommend individual psychotherapy for narcissistic and borderline patients, but often refer these patients to therapists with specialized training in these disorders. Psychotherapeutic treatment for personality disorders may take as long as three to five years.

Insight-oriented approaches are not recommended for patients with paranoid or antisocial personality disorders. These patients are likely to resent the therapist and see him or her as trying to control or dominate them.

Supportive therapy is regarded as the most helpful form of psychotherapy for patients with schizoid personality disorder.

Cognitive-behavioral therapy

Cognitive-behavioral approaches are often recommended for patients with avoidant or dependent personality disorders. Patients in these groups typically have mistaken beliefs about their competence or likableness. These assumptions can be successfully challenged by cognitive-behavioral methods.

Group therapy

Group therapy is frequently useful for patients with schizoid or avoidant personality disorders because it helps them to break out of their social **isolation**. It has also been recommended for patients with histrionic and antisocial personality disorders. These patients tend to act out, and pressure from peers in group treatment can motivate them to change. Because patients with antisocial personality disorder can destabilize groups that include people with other disorders, it is usually best if these people meet exclusively with others who have APD (in "homogeneous" groups).

Family therapy

Family therapy may be suggested for patients whose personality disorders cause serious problems for members of their families. It is also sometimes recommended for borderline patients from overinvolved or possessive families.

Medications

Medications may be prescribed for patients with specific personality disorders. The type of medication depends on the disorder.

ANTIPSYCHOTIC DRUGS. **Antipsychotic drugs**, such as haloperidol (Haldol), may be given to patients with paranoid personality disorder if they are having brief psychotic episodes. Patients with borderline or schizotypal personality disorder are sometimes given antipsychotic drugs in low doses; however, the efficacy of these drugs in treating personality disorder is less clear than in schizophrenia.

MOOD STABILIZERS. Carbamazepine (Tegretol) is a drug that is commonly used to treat seizures, but is also helpful for borderline patients with rage outbursts and similar behavioral problems. Lithium and valproate may also be used as mood stabilizers, especially among people with borderline personality disorder.

ANTIDEPRESSANTS AND ANTI-ANXIETY MEDICATIONS. Medications in these categories are sometimes prescribed for patients with schizoid personality disorder to help them manage **anxiety** symptoms while they are in psychotherapy. Antidepressants are also commonly used to treat people with borderline personality disorder.

Treatment with medications is not recommended for patients with avoidant, histrionic, dependent, or narcissistic personality disorders. The use of potentially addictive medications should be avoided in people with borderline or antisocial personality disorders. However, some avoidant patients who also have social phobia may benefit from **monoamine oxidase inhibitors** (MAO inhibitors), a particular class of antidepressant.

Prognosis

The prognosis for recovery depends in part on the specific disorder. Although some patients improve as

KEY TERMS

Character—An individual's set of emotional, cognitive, and behavioral patterns learned and accumulated over time.

Character disorder—Another name for personality disorder.

Developmental damage—A term that some therapists prefer to personality disorder, on the grounds that it is more respectful of the patient's capacity for growth and change.

Ego-syntonic—Consistent with one's sense of self, as opposed to ego-alien or dystonic (foreign to one's sense of self). Ego-syntonic traits typify patients with personality disorders.

Neuroleptic—Another name for older antipsychotic medications, such as haloperidol. The term does not apply to newer "atypical" agents, such as clozapine (Clozaril).

Personality—The organized pattern of behaviors and attitudes that makes a human being distinctive. Personality is formed by the ongoing interaction of temperament, character, and environment.

Projective tests—Psychological tests that probe into personality by obtaining open-ended responses to such materials as pictures or stories. Projective tests are often used to evaluate patients with personality disorders.

Rorschach—A well-known projective test that requires the patient to describe what he or she sees in each of 10 inkblots. It is named for the Swiss psychiatrist who invented it.

Temperament—A person's natural or genetically determined disposition.

they grow older and have positive experiences in life, personality disorders are generally life-long disturbances with periods of worsening (exacerbations) and periods of improvement (remissions). Others, particularly schizoid patients, have better prognoses if they are given appropriate treatment. Patients with paranoid personality disorder are at some risk for developing delusional disorders or schizophrenia. The personality disorders with the poorest prognoses are the antisocial and the borderline. Borderline patients are at high risk for developing substance abuse disorders or bulimia. About 80% of hospitalized borderline patients attempt suicide at some point during treatment, and about 5% succeed in committing suicide.

Prevention

The most effective preventive strategy for personality disorders is early identification and treatment of children at risk. High-risk groups include abused children, children from troubled families, children with close relatives diagnosed with personality disorders, children of substance abusers, and children who grow up in cults or political extremist groups.

Resources

BOOKS

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Gunderson, John G. "Personality Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. London: The Belknap Press of Harvard University Press, 1988.

Oldham, John M., and Andrew E. Skodol. "Personality Disorders." In *The Columbia University College of Physicians and Surgeons Complete Home Guide to Mental Health*, ed. Frederic I. Kass, et al. New York: Henry Holt and Co., 1992.

"Personality Disorders." In *Diagnostic and Statistical Manual of Mental Disorders.* 4th ed. Washington, DC: The American Psychiatric Association, 1994.

"Psychiatric Disorders: Personality Disorders." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Rebecca J. Frey

Perthes disease *see* **Osteochondroses**

Pertussis *see* **Whooping cough**

Pervasive developmental disorders

Definition

Pervasive developmental disorders include five different conditions: Asperger's syndrome, autistic disorder,

childhood disintegrative disorder (CDD), pervasive developmental disorder not otherwise specified (PDDNOS), and Rett's syndrome. They are grouped together because of the similarities between them. The three most common shared problems involve communication skills, motor skills, and social skills. Since there are no clear diagnostic boundaries separating these conditions it is sometimes difficult to distinguish one from the other for diagnostic purposes.

Asperger's syndrome, autistic disorder, and childhood disintegrative disorder are four to five times more common in boys, and Rett's syndrome has been diagnosed primarily in girls. All of these disorders are rare.

Description

Asperger's syndrome

Children afflicted with Asperger's syndrome exhibit difficulties in social relationships and communication. They are reluctant to make eye contact, do not respond to social or emotional contacts, do not initiate play activities with peers, and do not give or receive attention or affection. To receive this diagnosis the individual must demonstrate normal development of language, thinking and coping skills. Due to an impaired coordination of muscle movements, they appear to be clumsy. They usually become deeply involved in a very few interests which tend to occupy most of their time and attention.

Autistic disorder

Autistic disorder is frequently evident within the first year of life, and must be diagnosed before age three. It is associated with moderate **mental retardation** in three out of four cases. These children do not want to be held, rocked, cuddled or played with. They are unresponsive to affection, show no interest in peers or adults and have few interests. Other traits include avoidance of eye contact, an expressionless face and the use of gestures to express needs. Their actions are repetitive, routine and restricted. Rocking, hand and arm flapping, unusual hand and finger movements, and attachment to objects rather than pets and people are common. Speech, play, and other behaviors are repetitive and without imagination. They tend to be overactive, aggressive, and self-injurious. They are often highly sensitive to touch, noise, and smells and do not like changes in routine.

Childhood disintegrative disorder

Childhood disintegrative disorder is also called Heller's disease and most often develops between two and ten years of age. Children with CDD develop normally until two to three years of age and then begin to disintegrate rapidly. Signs and symptoms include deterioration of the ability to use and understand language to the point where they are unable to carry on a conversation. This is accompanied by the loss of control of the bladder and bowels. Any interest or ability to play and engage in social activities is lost. The behaviors are nearly identical with those that are characteristic of autistic disorder. However, childhood disintegrative disorder becomes evident later in life and results in developmental regression, or loss of previously attained skills, whereas autistic disorder can be detected as early as the first month of life and results in a failure to progress.

Pervasive developmental disorder not otherwise specified

The term pervasive developmental disorder not otherwise specified (PDDNOS) is also referred to as atypical personality development, atypical PDD, or atypical autism. Individuals with this disorder share some of the same signs and symptoms of **autism** or other conditions under the category of pervasive developmental disorders, but do not meet all of the criteria for diagnosis for any of the four syndromes included in this group of diseases. Because the children diagnosed with PDDNOS do not all exhibit the same combination of characteristics, it is difficult to do research on this disorder, but the limited evidence available suggests that patients are seen by medical professionals later in life than is the case for autistic children, and they are less likely to have intellectual deficits.

Rett's syndrome

Rett's syndrome was first described in 1966 and is found almost exclusively in girls. It is a disease in which cells in the brain experience difficulty in communicating with each other. At the same time the growth of the head falls behind the growth of the body so that these children are usually mentally retarded. These conditions are accompanied by deficits in movement (motor) skills and a loss of interest in social activities.

The course of the illness has been divided into four stages. In stage one the child develops normally for six to 18 months. In stage two, development slows down and stops. Stage three is characterized by a loss of the speech and motor skills already acquired. Typically this happens between nine months and three years of age. Stage four begins with a return to learning which will continue across the lifespan, but at a very slow rate. Problems with coordination and walking are likely to continue and even worsen. Other conditions that can occur with Rett's syndrome are convulsions, **constipation**, breathing problems, impaired circulation in the feet and legs, and difficulty chewing or swallowing.

Causes and symptoms

The causes of these disorders is unknown although brain structure abnormalities, genetic mutation, and alterations in brain function are believed to all play a role. Still, no single brain abnormality or location has been connected to a cause. Rett's syndrome demonstrates the strongest evidence that it is caused by the mutation of a gene. Research with twins has indicated that genetics may also play a role in the cause of autism. A number of neurological conditions, such as convulsions, are commonly found to accompany these disorders.

Diagnosis

The diagnosis of pervasive developmental disorder is made by medical specialists based on a thorough examination of the patient, including observing behavior and gathering information from parents and caregivers. Because many symptoms are common to more than one condition, distinctions between conditions must be carefully made. The following summary describes the distinction between three common disorders.

PDDNOS:

- impairment of two-way social interaction
- repetitive and predictable behavior patterns and activities

Autism:

- all listed for PDDNOS
- severe impairment in communication
- abnormal social interaction and use of language for social communication or imaginative play before age of three
- not better accounted for by another psychiatric order.

Asperger's disorder:

- all listed for PDDNOS
- clinically significant impairment in social, occupational, or other areas of functioning
- no general delay in language
- no delay in cognitive development, self-help skills, or adaptive behavior
- not better accounted for by another pervasive developmental disorder or schizophrenia

Rett's syndrome:

- a period of normal development between 6–18 months
- normal head circumference at birth, followed by a slowing of head growth
- retardation
- repetitive hand movements

CDD:

- normal development for at least two years
- loss of skills in at least two of the following areas: language, social skills, bowel or bladder control, play, movement skills
- abnormal functioning in at least two of the following areas: social interaction, communication, behavior patterns
- not better accounted for by another PDD or mental illness

Treatment

Treatment for children with pervasive developmental disorders is limited. Those who can be enrolled in educational programs will need a highly structured learning environment, a teacher-student ratio of not more than 1:2, and a high level of parental involvement that provides consistent care at home. Psychotherapy and social skills training can prove helpful to some. There is no specific medication available for treating the core symptoms of any of these disorders, though research is promising. Some psychiatric medications may be helpful in controlling particular behavior difficulties, such as agitation, mood instability, and self-injury. Music, massage, and **hydrotherapy** may exert a calming effect on behavior. Treatment may also include physical and occupational therapy.

Prognosis

In general, the prognosis in all of these conditions is tied to the severity of the illness.

The prognosis for Asperger's syndrome is more hopeful than that for other diseases in this cluster. These children are likely to grow up to be functional independent adults, but will always have problems with social relationships. They are also at greater risk for developing serious mental illness than the general population.

The prognosis for autistic disorder is not as good, although great strides have been made in recent years in its treatment. The higher the patient's IQ (intelligence quotient) and ability to communicate, the better the prognosis. However, many patients will always need some level of custodial care. In the past, most of these individuals were confined to institutions, but many are now able to live in group homes or supervised apartments. The prognosis for childhood disintegrative disorder is even less favorable. These children will require intensive and long-term care. Children diagnosed with PDDNOS have a better prognosis because their initial symptoms are usually milder, IQ scores are higher, and language development is stronger.

KEY TERMS

Hydrotherapy—This term literally means "water treatment" and involves the use of water in physical therapy as well as treatment of physical and emotional illness.

Mutation—A mutation is a change in a gene. Since genes determine how a body is structured and functions, any change in a gene will produce some change in these areas.

Neurological conditions—A condition that has its origin in some part of the patient's nervous system.

Psychotherapy—Literally means mind treatment; one method that mental health care specialists use to help patients overcome mental and emotional illness.

Prevention

The causes of pervasive developmental disorders are not understood, although research efforts are getting closer to understanding the problem. Until the causes are discovered, it will remain impossible to prevent these conditions.

Resources

BOOKS

Boyd, Mary Ann, and Mary Ann Nihart. *Psychiatric Nursing: Contemporary Practice*. Philadelphia: Lippincott, 1998.

Mauk, Joyce E. "Autism and Pervasive Developmental Disorders." In *Pediatric Clinics of North America*, ed. Mark L. Batshaw. Philadelphia: W. B. Saunders Co., 1993.

ORGANIZATIONS

Autism Society of America. 7910 Woodmont Avenue, Suite 300, Bethesda, MD 20814-3067. (800) 328-8476. <http://www.autism-society.org>.

The International Rett Syndrome Association. 9121 Piscataway Road, Suite 2B, Clinton, MD 20735. (800) 818-7388. <http://www.rettsyndrome.org>.

Learning Disabilities Association of America. 4156 Library Road, Pittsburg, PA 15234. (412) 341-1515. <http://www.ldanatl.org>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

OTHER

"Asperger's Syndrome." Oct. 1996. 1998 <http://www.mhsource.com/hy/asperger.html>.

Boyle, Thomas D. "Diagnosing Autism and Other Pervasive Personality Disorders." *INJersye.com Page*. <http://www.injersey.com>.

"Childhood Disintegrative Disorder." *HealthAnswers.com*. <http://www.healthanswers.com/database/ami/converted/001535.html>.

"Information on Childhood Disintegrative Disorder." *Yale-New Haven Medical Center Page*. <http://info.med.yale.edu>.

The International Rett Syndrome Association. 9121 Piscataway Road, Suite 2B, Clinton, MD 20735. (800) 818-7388 <http://www.rettsyndrome.org>.

Koenig, Kathy. "Frequently Asked Questions." *Yale-New Haven Medical Center Page*. <http://info.med.yale.edu>.

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PET scan *see* **Positron emission tomography (PET)**

Pet therapy

Definition

Animal-assisted therapy (AAT), also known as pet therapy, utilizes trained animals and handlers to achieve specific physical, social, cognitive, and emotional goals with patients.

Purpose

Studies have shown that physical contact with a pet can lower high blood pressure, and improve survival rates for **heart attack** victims. There is also evidence that petting an animal can cause endorphins to be released. Endorphins are chemicals in the body that suppress the **pain** response. These are benefits that can be enjoyed from pet ownership, as well as from visiting therapeutic animals.

Many skills can be learned or improved with the assistance of a therapy animal. Patient **rehabilitation** can be encouraged by such activities as walking or running with a dog, or throwing objects for the animal to retrieve. Fine motor skills may be developed by petting, grooming, or feeding the animal. Patient communication is encouraged by the response of the animal to either verbal or physical commands. Activities such as writing or talking about the therapy animals or past pets also develop cognitive skills and communication. Creative inclusion of an animal in the life or therapy of a patient can make a major difference in the patient's comfort, progress, and recovery.

Description

Origins

The enjoyment of animals as companions dates back many centuries, perhaps even to prehistoric times. The first

This autistic child is encouraged to interact with the guinea pig in an effort to improve his social interaction. *(Helen B. Senisi. Photo Researchers, Inc. Reproduced by permission.)*

known therapeutic use of animals started in Gheel, Belgium in the ninth century. In this town, learning to care for farm animals has long been an important part of an assisted living program designed for people with disabilities.

Some of the earliest uses of animal-assisted healing in the United States were for psychiatric patients. The presence of the therapy animals produced a beneficial effect on both children and adults with mental health issues. It is only in the last few decades that AAT has been more formally applied in a variety of therapeutic settings, including schools and prisons, as well as hospitals, hospices, nursing homes, and outpatient care programs.

The way in which AAT is undertaken depends on the needs and abilities of the individual patient. Dogs are the most common visiting therapy animals, but cats, horses, birds, rabbits, and other domestic pets can be used as long as they are appropriately screened and trained.

For patients who are confined, small animals can be brought to the bed if the patient is willing and is not allergic to the animal. A therapeutic plan may include a simple interaction aimed at improving communication and small motor skills, or a demonstration with educational content to engage the patient cognitively.

If the patient is able to walk or move around, more options are available. Patients can walk small animals outside, or learn how to care for farm animals. Both of these activities develop confidence and motor abilities. Horseback riding has recently gained great therapeutic popularity. It offers an opportunity to work on balance, trunk control, and other skills. Many patients who walk with difficulty, or not at all, get great emotional benefit from interacting with and controlling a large animal.

One advantage of having volunteers provide this service is that cost and insurance are not at issue.

Precautions

AAT does not involve just any pet interacting with a patient. Standards for the training of the volunteers and their animals are crucial in order to promote a safe, positive experience for the patient. Trained volunteers will understand how to work with other medical professionals to set goals for the patient and keep records of progress. Animals that have been appropriately trained are well

KEY TERMS

Endorphins—A group of chemicals resembling opiates that are released in the body in response to trauma or stress. Endorphins react with opiate receptors in the brain to reduce pain sensations.

socialized to people, other animals, and medical equipment. They are not distracted by the food and odors that may be present in the therapy environment and will not chew inappropriate objects or mark territory.

Animals participating in AAT should be covered by some form of liability insurance.

Research and general acceptance

While the research evidence supporting the efficacy of AAT is slim, the anecdotal support is vast. Although it may not be given much credence by medical personnel as a therapy with the potential to assist the progress of the patients, some institutions do at least allow it as something that will uplift the patients or distract them from their discomforts.

Resources

BOOKS

Burch, Mary. *Volunteering With Your Pet*. New York: Howell Book House, 1996.

ORGANIZATIONS

Delta Society. <http://www.deltasociety.org/>.

Judith Turner

Peyronie's disease

Definition

Peyronie's disease is a condition characterized by a bent penis.

Description

The cause of Peyronie's disease is unknown and the disease is often difficult to treat. For some reason, a thick scar develops in the penis and bends it. Almost a third of patients with Peyronie's disease also have similar contracting scars on their hands, a disease called Dupuytren's **contractures**. Some cases are associated with diabetes, and others appear after prostate surgery. Because prostate surgery always requires a catheter in the bladder, there is some suspicion that catheters can cause the scarring. However, many cases of Peyronie's disease arise without any use of a catheter. There is also a congenital form of penile deviation, again with no known cause. Most of the scars are located in the mid-line, therefore most of the angulations are either up or down.

Causes and symptoms

Peyronie's disease occurs in about 1% of men, most of them between 45-60 years old. Although there is no good research data to back it up, the suspicion exists that Peyronie's disease is the result of injury. If not a catheter, then sudden, forceful bending during sexual intercourse could easily tear the supporting tissues and lead to scarring.

The symptom is bending of an erect penis, sometimes with **pain**. It often interferes with sexual intercourse. Erectile failure associated with the angulation often precedes it.

Treatment

Attempts have been made to reduce the angulation with injections of cortisone-like drugs directly into the scar, but they are rarely successful. Surgery seems to be the better answer. After the scar is removed, plastic repair of the penis is attempted, often with a graft of tissue from somewhere else on the body. The Nesbit procedure is one of the more successful methods of doing this. The other surgical approach is to implant a penile prosthesis that overcomes the angulation mechanically. Results with these procedures are reported to be 60–80% satisfactory, including the return of orgasm.

Prognosis

Sometimes the condition disappears spontaneously. A careful look for other causes of **impotence** should be done before surgery.

Resources

BOOKS

Jordan, Gerald H., et al. "Surgery of the Penis and Urethra." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Lewis, Ronald. "Surgery for Erectile Dysfunction." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Carrier, S., G. Brock, N. W. Kour, and T. F. Lue. "Pathophysiology of Erectile Dysfunction." *Urology* 42 (Oct. 1993): 468-481.

KEY TERMS

Catheter—A flexible tube placed into a body vessel or cavity.

Congenital—Present at birth.

Plastic surgery—The restoring and reshaping of the skin and its appendages to improve their function and appearance.

Prostate—A gland that surrounds the outlet to the male bladder.

Prosthesis—Artificial substitute for a body part.

Morganstern, S. L. "Long-term Experience with the AMS 700CX Inflatable Penile Prosthesis in the Treatment of Peyronie's Disease." *Techniques in Urology* 3 (1997): 86-88.

Poulsen, J., and H. J. Kirkeby. "Treatment of Penile Curvature—a Retrospective Study of 175 Patients Operated with Plication of the Tunica Albuginea or with the Nesbit Procedure." *British Journal of Urology* 75 (Mar. 1995): 370-374.

Vatne, V., and P. A. Hoeisaeter. "Functional Results after Operations of Penile Deviations: an Institutional Experience." *Scandanavian Journal of Urology and Hephrology Nephrol* 179 (1996): 151-154.

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Pharyngeal pouch *see* **Esophageal pouches**

Pharmacogenetics

Definition

Pharmacogenetics is the study of how the actions of and reactions to drugs vary with the patient's genes.

Description

Genes are the portions of chromosomes that determine many of the traits in every living thing. In humans, genes influence race, hair and eye color, gender, height, weight, aspects of behavior, and even the likelihood of developing certain diseases. Although some traits are a combination of genetics and environment, researchers are still discovering new ways in which people are affected by their genes.

Pharmacogenetics is the study of how people respond to drug therapy. Although this science is still new, there have been many useful discoveries. It has long been known that genes influence the risk of developing certain diseases, or that genes could determine traits such as hair and eye color. Genes can also alter the risk of developing different diseases. It has long been known that people of African descent were more likely to have sickle cell anemia than people of other races. People of Armenian, Arab, and Turkish heritage are more prone to familiar Mediterranean **fever** than people of other nationalities. More recently, discoveries have shown that genes can determine other aspects of each individual, down to the level of the enzymes produced in the liver. Since these enzymes determine how quickly a drug is removed from the body, they can make major differences in the way people respond to drugs. Some of the most basic work concerns the way race and gender influence drug reactions—and race and gender are genetically determined.

Women often respond differently than men to drugs at the same dose levels. For example, women are more likely to have a good response to the **antidepressant drugs** that act as serotonin specific reuptake inhibitors (SSRIs, the group that includes Prozac and Paxil) than they are to the older group of tricyclic antidepressants (the group that includes Elavil and Tofranil). Women have a greater response to some narcotic **pain** reliving drugs than do men, but get less relief from some non-narcotic pain medications. Women may show a greater response to some steroid hormones than men do, but have a lower level of response to some anti-anxiety medications than men.

Race may also affect the way people respond to some medications. In this case, race implies specific genetic factors that are generally, but not always, found among members of specific ethnic groups. For example, the angiotensin II inhibitor enalopril (Vasotec), which is used to lower blood pressure, works better in Caucasians than in Blacks. Carvedilol (Coreg), a beta-adrenergic blocking agent that is also used to lower blood pressure, is more effective than other drugs in the same class when used to treat Black patients. Black patients with **heart failure** appear to respond better to a combination of hydralazine and isosorbide than do Caucasian patients using the same medication.

More specific research has identified individual genes than may influence drugs response, without relying on group information such as gender and race. Specific genes have been identified that may determine how patients will respond to specific drugs. For example, some genes may determine whether people will get pain relief from codeine, or how well they will respond to drugs used to treat **cancer**.

Causes and symptoms

Genes alter responses to drugs because the genes influence many parts of the body iteself. One of the

simplest examples is the gene that influences body weight. Since many drugs are soluble in body fat, people with large amounts of fat will have these drug deposited into their fat stores. This means that there are lower levels of the drug that can reach the actual organs on which they work.

In the case of gender responses to antidepressants, women show greater response to serotonin specific antidepressants because women naturally have lower levels of serotonin than men do. This makes women more likely to develop a type of depression marked by low serotonin levels, but it also means that women will respond better to replacement of serotonin.

Because people of the same race carry similar genes, studies based on race were the earliest types of pharmacogenetic studies. One study evaluated the levels of alcohol dehydrogenase in people of different nationalities. This is an enzyme involved in the metabolism of alcohol. When people with high levels of this enzyme, or people in whom the enzyme acts more rapidly than in other people, drink alcohol, they are subject to facial flushing and slowing of the heartbeat. The activity of this enzyme is determined by genetics, and different levels can be seen in different races because these people belong to the same gene pools. Among Asiatic people, 85% have high levels of this enzyme, compared to 20% of Swiss people, and only 5–10% of British people.

Another trait that is influenced by genes is a liver enzyme, CYP2D6. This enzyme metabolizes some drugs by converting them to a form that can be removed from the body. Genes determine the level of this enzyme in the liver. People with low levels of CYP2D6 will metabolize drugs slowly. Slow metabolism means the drugs will act for a longer peiod of time. Slow metabolizers reaspond to smaller doses of medications that are eliminated by this enzyme, while fast metabolizers, people who have a lot of the enzyme, will need larger drug doses to get the same effects. At the same time, low levels of CYP2D6 means that people taking the drugs that are metabolized by this enzyme will have higher drug levels, and are more likely to have unwanted side effects.

Another enzyme that can be important in drug dosing is called 2C9, and this enzyme is responsible for metabolizing the anticoagulant drug warfarin (Coumadin). Most people take warfarin in a dose of about 5 milligrams a day, but people who have low levels of 2C9 normally require a dose of only 1-5 milligrams a week.

Yet another mechanism of drug activity is the presence or absence of a specific drug receptor sites. Drugs act by binding to specific chemicals, receptor sites, within body cells. Genes may help determine how many of these cells there are. The action of the widely used antipsychotic drug haloperidol (Haldol) depends on its ability to bind to the dopamine (D2) receptor site. The number of these sites are determined by genetics. In one study, 63% of patients whose genes caused a large number of these receptor sites had a response to treatment with haloperidol, while only about 29% of patients with a smaller number of dopamine (D2) receptor sites did well on the drug.

Other genetic studies indicate that genes may affect how people respond to foods as well as to drugs. An Australian study of **osteoporosis** (softening of the bones that often occurs in elderly people) reported that separate genes may affect response to vitamin D, calcium, and estrogens.

Implications

Although the study is still new, pharmacogenetics promises to offer great benefits in drug effectiveness and safety.

At the present time, most drug treatment is done by trial and error. Physicians prescribe medication, and the patient tries the drug. The drug may work, or it may not. It may cause adverse effects, or it may be safe. If the drug does not work, the dose is increased. If it causes harmful or unpleasant effects, a new drug is tried until, finally, the right drug is found. In some cases this procedure may take weeks or even months.

In other cases, drugs are carefully tested, and appear to be safe and effective. Only after they are approved for general use are reports of serious adverse effects that did not appear in the initial studies documented. This can occur if there is a rare gene that affects the way in which the drug acts, or the way in which the drug is metabolized.

With increasing understanding of how genes determine the way people respond to drugs, it will be possible to select drugs and doses based on a greater understanding of each individual patient. This promises more effective drug therapy, with greater safety and fewer treatment failures.

Physicians may be able to compare the person's genetic make-up with the properties of specific drugs, and make informed decisions about which drug in a group will work most effectively or most safely.

Resources

BOOKS

From genome to therapy: Integrating new technologies with drug development. New York: John Wiley, 2000.

Pharmacogenetics of Drug Metabolism. New York: Pergamon Press, 1992.

KEY TERMS

Enzyme—Proteins produced by living cells that help produce specific biochemical reactions in the body.

Metabolism—The process by which foods and drugs are broken down for use and removal from the body.

Sickle cell anemia—A severe, inheritable disease, most common among people of African descent, marked by deformation and destruction of red blood cells, and by adherence of blood cells to the walls of blood vessels.

PERIODICALS

"A DNA tragedy." *Fortune* (October 30, 2000).

"Screening for genes." *Newsweek* (February 8, 1999).

ORGANIZATIONS

National Institute of General Medical Sciences Division of Pharmacology, Physiology, and Biological Chemistry. 45 Center Dr., MSC 6200 Bethesda, MD 20892-6200.

University of California, Los Angeles Harbor-UCLA Medical Center Research and Education Institute 1124 W Carson St., B-4 South Torrance, CA 90502.

Sam Uretsky

Pharyngitis *see* **Sore throat**

Phenelzine *see* **Monoamine oxidase inhibitors**

Phenobarbital *see* **Barbiturates**

Phenol *see* **Antiseptics**

Phenolphthalein *see* **Laxatives**

Phenylalaninemia *see* **Phenylketonuria**

Phenylketonuria

Definition

Phenylketonuria (PKU) is a rare, inherited, metabolic disorder that can result in **mental retardation** and other neurological problems. People with this disease have difficulty breaking down and using (metabolizing) the amino acid phenylalanine. PKU is sometimes called Folling's disease in honor of Dr. Asbjorn Folling who first described it in 1934.

Description

Phenylalanine is an essential amino acid. These substances are called "essential" because the body must get them from food to build the proteins that make up its tissues and keep them working. Therefore, phenylalanine is required for normal development. Phenylalanine is a common amino acid and is found in all natural foods. However, natural foods contain more phenylalanine than required for normal development. This level is too high for patients with PKU, making a special low-phenylalanine diet a requirement.

The incidence of PKU is approximately one in every 15,000 births (1/15,000). There are areas in the world where the incidence is much higher, particularly Ireland and western Scotland. In Ireland the incidence of PKU is 1/4,500 births. This is the highest incidence in the world and supports a theory that the genetic defect is very old and of Celtic origin. Countries with very little immigration from Ireland or western Scotland tend to have low rates of PKU. In Finland, the incidence is less than 1/100,000 births. Caucasians in the United States have a PKU incidence of 1/8,000, whereas Blacks have an incidence of 1/50,000.

Related diseases:

Maternal phenylketonuria is a condition in which a high level of phenylalanine in a mother's blood causes mental retardation in her child when in the womb. A woman who has PKU and is not using a special low-phenylalanine diet will have high levels of phenylalanine in her blood. Her high phenylalanine levels will cross the placenta and affect the development of her child. The majority of children born from these pregnancies are mentally retarded and have physical problems, including small head size (microcephaly) and **congenital heart disease**. Most of these children do not have PKU. There is no treatment for maternal phenylketonuria. Control of maternal phenylalanine levels is thought to limit the effects of maternal phenylketonuria.

Hyperphenylalaninemia is a condition in which patients have high levels of phenylalanine in their blood, but not as high as seen in patients with classical PKU. There are two forms of hyperphenylalaninemia: mild and severe. In the mild form of the disease, patients have phenylalanine blood levels of less than 10 mg/dl, even when eating a normal diet (0.6–1.5 mg/dl is considered the normal range). There are few effects from the mild form of the disease. In the severe form of the hyperphenylalaninemia, patients have higher levels of phenylalanine in their blood. The severe form is distinguished from classical PKU by testing for the presence of phenylalanine hydroxylase (an enzyme that breaks down

phenylalanine) in the liver. Classic PKU patients lack this enzyme in their liver, while patients with severe hyperphenylalaninemia have some enzyme activity, but at greatly reduced levels compared with normal persons. Patients with severe hyperphenylalaninemia are treated with the same diet as classical PKU patients.

Tyrosinemia is characterized by high levels of two amino acids in the blood, phenylalanine and tyrosine. Patients with this disease have many of the same symptoms as seen in classical PKU, including mental retardation. Treatment consists of a special diet similar to the diet for PKU. The main difference between the two **diets** is that patients with tyrosinemia must eat a diet that is low in both phenylalanine and tyrosine.

Tetrahydrobiopterin deficiency disease is another metabolic disorder. Patients with this disease also have high levels of phenylalanine in their blood. Although phenylalanine levels can be controlled by diet, these patients still have mental retardation because they do not make enough of the neurotransmitters dopamine and serotonin, which are essential for proper neurologic function.

Causes and symptoms

The underlying cause of PKU is mutation in the gene that tells the body to make the enzyme phenylalanine hydroxylase. This enzyme allows the body to break down phenylalanine and ultimately use it to build proteins. Normally, the first step in phenylalanine metabolism is conversion to tyrosine, another amino acid. The genetic mutations result in no enzyme or poor quality enzyme being made. As a consequence, phenylalanine is not converted and builds up in the body. The high levels of phenylalanine can be detected in the blood and urine.

PKU is an autosomal recessive genetic disease. A child must inherit abnormal genes from both parents to develop PKU. A person with one abnormal gene and one good gene will develop normally because the good gene will make sufficient phenylalanine hydroxylase. People with one good gene are called carriers because they do not have the disease, but are capable of passing the abnormal gene on to their children.

If both parents are carriers of abnormal phenylalanine hydroxylase genes, then the chances of their child having PKU is one in four or 25%. The chances that their child will be a carrier is two in four, or 50%. These percentages hold for each **pregnancy**.

The gene for phenylalanine hydroxylase is found on chromosome 12. There are many different mutation sites on the gene for phenylalanine hydroxylase. The mutations lead to a range of errors in the enzyme, including lack of the enzyme. The exact mechanism by which excess phenylalanine causes mental retardation is not known.

Children with PKU appear normal at birth, but develop irreversible mental retardation unless treated early. Treatment consists of a special diet that contains very little phenylalanine. This diet must be used throughout the patient's life. Untreated newborns develop disease symptoms at age three to five months. At first they appear to be less attentive and may have problems eating. By one year of age, they are mentally retarded.

Patients with PKU tend to have lighter colored skin, hair, and eyes than other family members. They are also likely to have eczema and seizures. PKU patients have a variety of neurologic symptoms. Approximately 75-90% of PKU patients have abnormal electrocardiograms (ECGs), which measure the activity of their heart. Their sweat and urine may have a "mousy" smell that is caused by phenylacetic acid, a byproduct of phenylalanine metabolism. Untreated PKU children tend to be hyperactive and demonstrate loss of contact with reality (**psychosis**).

Diagnosis

PKU must be detected shortly after birth. Although children with PKU appear normal at birth, they already have high phenylalanine levels. Screening is the only way to detect PKU before symptoms start to develop. In many areas of the world, screening newborns for PKU is performed routinely. The test is typically performed between one and seven days after birth. Blood is obtained by pricking the heel of the newborn and analyzing it for phenylalanine concentration. Very high levels of phenylalanine indicate that there is a problem with phenylalanine hydroxylase. There is no established level of phenylalanine that is considered diagnostic for PKU. Blood levels above 20 mg/dl are generally associated with classical PKU. The generally accepted upper limit for normal in newborns is 2 mg/dl, with most unaffected children having levels below 1 mg/dl. Patients with high blood levels of phenylalanine are tested further to distinguish between classic PKU and related diseases.

The Guthrie Inhibition Assay is usually used to test for blood phenylalanine levels. (An assay compares samples from the body to a reference standard of known concentration to determine the relative strength of the substance in the samples.) The test uses a special strain of the bacterium *Bacillus subtilis* that requires phenylalanine for growth. The bacterium is grown on the surface of a special medium that lacks phenylalanine. Paper disks containing blood samples and testing standards are placed on top of the agar plate, and the bacteria are allowed to grow. The amount of growth around each disk is proportional to the amount of phenylalanine in the

disk. A second assay detects high levels of phenylalanine metabolites in the urine. (These metabolites are the products of phenylalanine when it's broken down and used by the body.) These metabolites first appear four to six weeks after birth and are detected by the addition of a few drops of a 10% ferric chloride solution to a urine sample. If the metabolites are present, a deep bluish green color develops. Color development indicates that the patient has PKU.

Prenatal diagnosis can be done for families with a history of PKU. The test is performed by collecting amniotic fluid or chorionic villus cells and analyzing the DNA for the presence of genetic mutations indicative of PKU. Amniotic fluid cells are collected by inserting a needle through a woman's abdomen and womb and withdrawing some of the amniotic fluid that surrounds the fetus. Chorionic villus cells are obtained by inserting a catheter through the cervix and into the outer membrane that surrounds the uterus.

Treatment

The only treatment for persons with PKU is to limit the amount of phenylalanine in their diet. PKU patients should eat a special diet that is low in phenylalanine. The diet has small amounts of phenylalanine because it is essential for normal growth and development. The diet should be started before the fourth week of life to prevent mental retardation. If started early enough, the diet is 75% effective in preventing severe mental retardation. Many natural foods, including breast milk, must be avoided because they contain more phenylalanine than PKU patients can tolerate. However, low protein, natural foods, including fruits, vegetables, and some cereals, are acceptable on the diet. Monitoring of blood phenylalanine levels must be done to ensure that normal levels are maintained.

Patients who make a small amount of phenylalanine hydroxylase can eat a limited amount of regular food if their phenylalanine levels remain within an acceptable range. Low-phenylalanine and phenylalanine-free foods are available commercially. The special diet must be used throughout the patient's life. At one time it was thought acceptable to stop the diet when the brain was fully developed. However, reports of decreases in IQ and development of learning and behavior problems in patients who stopped the diet have essentially ended this practice.

Resources

OTHER

"Education of Students with Phenylketonuria (PKU)." *National Institutes of Health*. <http://www.nih.gov>.

"Endocrine and Metabolic Disorders." *The Meck Page*. 13 Apr. 1998 <http://www.merck.com>.

KEY TERMS

Amino acids—The building blocks of protein.

Metabolism—The sum of the many processes by which the body uses food and energy to build tissues and carry out the functions of life.

Phenylalanine—One of the amino acids that the body must take in through food in order to build the proteins needed for normal growth and functioning.

OMIM Home Page, Online Mendelian Inheritance in Man. <http://www.ncbi.nlm.nih.gov/Omim>.

John T. Lohr, PhD

Phenylpropanolamine *see* **Decongestants**

Phenytoin *see* **Anticonvulsant drugs**

Pheochromocytoma

Definition

Pheochromocytoma is a tumor of special cells (called chromaffin cells), most often found in the middle of the adrenal gland.

Description

Because pheochromocytomas arise from chromaffin cells, they are occasionally called chromaffin tumors. Most (90%) are benign tumors so they do not spread to other parts of the body. However, these tumors can cause many problems and if they are not treated and can result in **death**.

Pheochromocytomas can be found anywhere chromaffin cells are found. They may be found in the heart and in the area around the bladder, but most (90%) are found in the adrenal glands. Every individual has two adrenal glands that are located above the kidneys in the back of the abdomen. Each adrenal gland is made up of two parts: the outer part (called the adrenal cortex) and the inner part (called the adrenal medulla). Pheochromocytomas are found in the adrenal medulla. The adrenal medulla normally secretes two substances, or hormones, called norepinephrine and epinephrine. These two substances, when considered together, are known as adrenaline. Adrenaline is released from the adrenal gland, enters the bloodstream

and helps to regulate many things in the body including blood pressure and heart rate. Pheochromocytomas cause the adrenal medulla to secrete too much adrenaline, which in turn causes high blood pressure. The high blood pressure usually causes the other symptoms of the disease.

Pheochromocytomas are rare tumors. They have been reported in babies as young as five days old as well as adults 92 years old. Although they can be found at any time during life, they usually occur in adults between 30 and 40 years of age. Pheochromocytomas are somewhat more common in women than in men.

Causes and symptoms

The cause of most pheochromocytomas is not known. A small minority (about 10-20%) of pheochromocytomas arise because a person has an inherited susceptibility to them. Inherited pheochromocytomas are associated with four separate syndromes: Multiple Endocrine Neoplasia, type 2A (MEN2A), Multiple Endocrine Neoplasia, type 2B (MEN2B), von Hippel-Lindau disease (VHL) and **Neurofibromatosis** type 1 (NF1).

Individuals with pheochromocytomas as part of any of these four syndromes usually have other medical conditions as well. People with MEN2A often have **cancer** (usually **thyroid cancer**) and other hormonal problems. Individuals with MEN2B can also have cancer and hormonal problems, but also have other abnormal physical features. Both MEN2A and MEN2B are due to genetic alterations or mutations in a gene called RET, found at chromosome 10q11.2. Individuals with VHL often have other benign tumors of the central nervous system and pancreas, and can sometimes have renal cell cancer. This syndrome is caused by a mutation in the VHL gene, found at chromosome 3p25-26. Individuals with NF1 often have neurofibromas (benign tumors of the peripheral nervous system). NF1 is caused by mutations in the NF1 gene, found at chromosome 17q11.

All of these disorders are inherited in an autosomal dominant inheritance pattern. With autosomal dominant inheritance, men and women are equally likely to inherit the syndrome. In addition, children of individuals with the disease are at 50% risk of inheriting it. **Genetic testing** is available for these four syndromes (MEN2A, MEN2B, VHL and NF1) but, due to the complexity, **genetic counseling** should be considered before testing.

Most people (90%) with pheochromocytoma have **hypertension**, or high blood pressure. The other symptoms of the disease are extremely variable. These symptoms usually occur in episodes (or attacks) called paroxysms and include:

- headaches
- excess sweating
- racing heart
- rapid breathing
- anxiety/nervousness
- nervous shaking
- pain in the lower chest or upper abdomen
- nausea
- heat intolerance

The episodes can occur as often as 25 times a day or, as infrequently as once every few months. They can last a few minutes, several hours, or days. Usually, the attacks occur several times a week and last for about 15 minutes. After the episode is over, the person feels exhausted and fatigued.

Between the attacks, people with pheochromocytoma can experience the following:

- increased sweating
- cold hands and feet
- weight loss
- constipation

Diagnosis

If a pheochromocytoma is suspected, urine and/or a blood test are usually recommended. A test called "24-hour urinary catacholamines and metanephrines" will be done. This test is designed to look for adrenaline and the break-down products of adrenaline. Since the body gets rid of these hormones in the urine, those testing will need to collect their urine for 24 hours. The laboratory will determine whether or not the levels of hormones are too high. This test is very good at making the diagnosis of pheochromocytoma. Another test called "serum catacholamines" measures the level of adrenaline compounds in the blood. It is not as sensitive as the 24-hour urine test, but can still provide some key information if it shows that the level of adrenaline compounds is too high.

One of the difficulties with these tests is that a person needs to have an attack of symptoms either during the 24-hour urine collection time period or shortly before the blood is drawn for a serum test to ensure the test's accuracy. If a person did not have an episode during that time, the test can be a "false negative". If a doctor suspects the patient has had a "false negative" test, additional tests called "pharmacologic tests" can be ordered. During these tests, a specific drug is given to the patient (usually through an IV) and the levels of hormones are monitored from the patient's blood. These types of tests are only done rarely.

Once a person has been diagnosed with a pheochromocytoma, he or she will undergo tests to identify exactly where in the body the tumor is located. The imaging techniques used are usually computed tomography scan (CT scan) and magnetic resonsance imaging (MRI). A CT scan creates pictures of the interior of the body from computer-analyzed differences in x rays passing through the body. CT scans are performed at a hospital or clinic and take only a few minutes. An MRI is a computerized scanning method that creates pictures of the interior of the body using radio waves and a magnet. An MRI is usually performed at a hospital and takes about 30 minutes.

KEY TERMS

Adrenal medulla—The central core of the adrenal gland.

Laparoscope—An instrument used to examine body cavities during certain types of surgery; for example, surgeries to remove fibroid tumors or gall bladders are often performed through the navel rather than cutting into the body.

Paroxysm—A sudden attack of symptoms.

Treatment

Once a pheochromocytoma is found, more tests will be done to see if the tumor is benign (not cancer) or malignant (cancer). If the tumor is malignant, tests will be done to see how far the cancer has spread. There is no accepted staging system for pheochromocytoma; but an observation of the tumor could provide one of these four indications:

- Localized benign pheochromocytoma means that the tumor is found only in one area, is not cancer, and cannot spread to other tissues of the body.
- Regional pheochromocytoma means that the tumor is malignant and has spread to the lymph nodes around the original cancer. Lymph nodes are small structures found all over the body that make and store infection-fighting cells.
- Metastatic pheochromocytoma means that the tumor is malignant and has spread to other, more distant parts of the body.
- Recurrent pheochromocytoma means that a malignant tumor that was removed has come back.

Treatment in all cases begins with surgical removal of the tumor. Before surgery, medications such as alpha-adrenergic blockers are given to block the effect of the hormones and normalize blood pressure. These medications are usually started seven to 10 days prior to surgery. The surgery of choice is laparoscopic laparotomy, which is a minimally invasive outpatient procedure performed under general or local anesthesia. A small incision is made in the abdomen, the laparoscope is inserted, and the tumor is removed. The patient can usually return to normal activities within two weeks. If a laparoscopic laparotomy cannot be done, a traditional laparotomy will be performed. This is a more invasive surgery done under spinal or general anesthesia and requires five to seven days in the hospital. Usually patients are able to return to normal activities after four weeks. After surgery, blood and urine tests will be done to make sure hormone levels return to normal. If the hormone levels are still above normal, it may mean that some tumor tissue was not removed. If not all tumor can be removed (as in malignant pheochromocytoma, for example) drugs will be given to control high blood pressure.

If a pheochromocytoma is malignant, **radiation therapy** and/or **chemotherapy** may be used. Radiation therapy uses high-energy x rays to kill cancer cells and shrink tumors. Because there is no evidence that radiation therapy is effective in the treatment of malignant pheochromocytoma, it is not often used for treatment. However, it is useful in the treatment of painful bone metastases if the tumor has spread to the bones. Chemotherapy uses drugs to kill cancer cells. Like radiation therapy, it has not been shown to be effective in the treatment of malignant pheochromocytoma. Chemotherapy, therefore, is only used in rare instances.

Untreated pheochromocytoma can be fatal due to complications of the high blood pressure. In the vast majority of cases, when the tumor is surgically removed, pheochromocytoma is cured. In the minority of cases (10%) where pheochromocytoma is malignant, prognosis depends on how far the cancer has spread, and the patient's age and general health. The overall median five-year survival from the initial time of surgery and diagnosis is approximately 43%.

Prevention

Unfortunately, little is known about environmental and other causes of pheochromocytoma. Some of the tumors are due to inherited predisposition. Because of these factors, pheochromocytoma can not be prevented.

Resources

BOOKS

Goldfien, Alan. "Adrenal Medulla." In *Basic and Clinical Endocrinology*, ed. Francis Greenspan and David Gard-

ner. New York: Lange Medical Books/McGraw-Hill, 2001, 399–421.
Keiser, Harry R. "Pheochromocytoma and Related Tumors." In *Endocrinology.* 4th Ed. Ed. Leslie J DeGroot and J. Larry Jameson. New York: W.B. Saunders Company, 2001, 1862–1883.

PERIODICALS

Baker, Joanne. "Adrenal Disorders: A Primary Care Approach." *Lippincott's Primary Care Practice* 1(5) (November/December 1997): 527–536.
Barzon, Luisa, and Marco Boscaro. "Diagnosis and Management of Adrenal Incidentalomas." *The Journal of Urology* 163 (February 2000):398–407.
Young, William F. "Management Approaches to Adrenal Incidentaloma." *Endocrinology and Metabolism Clinics of North America* 29 (March 2000): 159–185.

OTHER

"Pheochromocytoma" *National Cancer Institute CancerWeb* <http://www.graylab.ac.uk/cancernet/202494.html>. 29 June 2001.

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Phlebitis *see* **Thrombophlebitis**

Phlebotomy

Definition

Phlebotomy is the act of drawing or removing blood from the circulatory system through a cut (incision) or puncture in order to obtain a sample for analysis and diagnosis. Phlebotomy is also done as part of the patient's treatment for certain blood disorders.

Purpose

Treatment

Phlebotomy that is part of treatment (therapeutic phlebotomy) is performed to treat **polycythemia vera**, a condition that causes an elevated red blood cell volume (**hematocrit**). Phlebotomy is also prescribed for patients with disorders that increase the amount of iron in their blood to dangerous levels, such as **hemochromatosis**, **hepatitis B**, and **hepatitis C**. Patients with **pulmonary edema** may undergo phlebotomy procedures to decrease their total blood volume.

Diagnosis

Phlebotomy is also used to remove blood from the body during blood donation and for analysis of the substances contained within it.

Precautions

Patients who are anemic or have a history of cardiovascular disease may not be good candidates for phlebotomy.

Description

Phlebotomy, which is also known as venesection, is performed by a nurse or a technician known as a phlebotomist. Blood is usually taken from a vein on the back of the hand or inside of the elbow. Some blood tests, however, may require blood from an artery. The skin over the area is wiped with an antiseptic, and an elastic band is tied around the arm. The band acts as a tourniquet, slowing the blood flow in the arm and making the veins more visible. The patient is asked to make a fist, and the technician feels the veins in order to select an appropriate one. When a vein is selected, the technician inserts a needle into the vein and releases the elastic band. The appropriate amount of blood is drawn and the needle is withdrawn from the vein. The patient's pulse and blood pressure may be monitored during the procedure.

For some tests requiring very small amounts of blood for analysis, the technician uses a finger stick. A lance, or small needle, makes a small cut in the surface of the fingertip, and a small amount of blood is collected in a narrow glass tube. The fingertip may be squeezed to get additional blood to surface.

The amount of blood drawn depends on the purpose of the phlebotomy. Blood donors usually contribute a unit of blood (500 mL) in a session. The volume of blood needed for laboratory analysis varies widely with the type of test being conducted. Therapeutic phlebotomy removes a larger amount of blood than donation and blood analysis require. Phlebotomy for treatment of hemochromatosis typically involves removing a unit of blood—or 250 mg of iron—once a week. Phlebotomy sessions are required until iron levels return to a consistently normal level, which may take several months to several years. Phlebotomy for polycythemia vera removes enough blood to keep the patient's hematocrit below 45%. The frequency and duration of sessions depends on the patient's individual needs.

Preparation

Patients having their blood drawn for analysis may be asked to discontinue medications or to avoid food (to fast) for a period of time before the blood test. Patients donating blood will be asked for a brief medical history, have their blood pressure taken, and have their hematocrit checked with a finger stick test prior to donation.

Aftercare

After blood is drawn and the needle is removed, pressure is placed on the puncture site with a cotton ball

KEY TERMS

Finger stick—A technique for collecting a very small amount of blood from the fingertip area.

Hemochromatosis—A genetic disorder known as iron overload disease. Untreated hemochromatosis may cause osteoporosis, arthritis, cirrhosis, heart disease, or diabetes.

Thrombocytosis—A vascular condition characterized by high blood platelet counts.

Tourniquet—Any device that is used to compress a blood vessel to stop bleeding or as part of collecting a blood sample. Phlebotomists usually use an elastic band as a tourniquet.

Venesection—Another name for phlebotomy.

to stop bleeding, and a bandage is applied. It is not uncommon for a patient to feel dizzy or nauseated during or after phlebotomy. The patient may be encouraged to rest for a short period once the procedure is completed. Patients are also instructed to drink plenty of fluids and eat regularly over the next 24 hours to replace lost blood volume. Patients who experience swelling of the puncture site or continued bleeding after phlebotomy should get medical help at once.

Risks

Most patients will have a small bruise or mild soreness at the puncture site for several days. Therapeutic phlebotomy may cause **thrombocytosis** and chronic iron deficiency (anemia) in some patients. As with any invasive procedure, infection is also a risk. This risk can be minimized by the use of prepackaged sterilized equipment and careful attention to proper technique.

Normal results

Normal results include obtaining the needed amount of blood with the minimum of discomfort to the patient.

Resources

PERIODICALS

Messinezy, Maria, and T. C. Pearson. "Polycythaemia, Primary (Essential) Thrombocythaemia and Myelofibrosis (ABC of Clinical Haematology)." *British Medical Journal* 314 (22 Feb. 1997): 587-90.

Wolfe, Yun Lee. "Case of the Ceaseless Fatigue." *Prevention Magazine* (July 1997): 88-94.

Paula Anne Ford-Martin

Phobias

Definition

A phobia is an intense, unrealistic fear, which can interfere with the ability to socialize, work, or go about everyday life, that is brought on by an object, event or situation.

Description

Just about everyone is afraid of something—an upcoming job interview or being alone outside after dark. But about 18% of all Americans are tormented by irrational fears that interfere with their daily lives. They aren't "crazy"—they know full well their fears are unreasonable—but they can not control the fear. These people have phobias.

Phobias belong to a large group of mental problems known as "anxiety disorders" that include **obsessive-compulsive disorder** (OCD), **panic disorder**, and **post-traumatic stress disorder**. Phobias themselves can be divided into three specific types:

- specific phobias (formerly called "simple phobias")
- social phobia
- **agoraphobia**

Specific phobias

As its name suggests, a specific phobia is the fear of a particular situation or object, including anything from airplane travel to dentists. Found in one out of every 10 Americans, specific phobias seem to run in families and are roughly twice as likely to appear in women. If the person rarely encounters the feared object, the phobia does not cause much harm. However, if the feared object or situation is common, it can seriously disrupt everyday life. Common examples of specific phobias, which can begin at any age, include fear of snakes, flying, dogs, escalators, elevators, high places, or open spaces.

Social phobia

People with social phobia have deep fears of being watched or judged by others and being embarrassed in public. This may extend to a general fear of social situations—or be more specific or "circumscribed," such as a fear of giving speeches or of performing (stage fright). More rarely, people with social phobia may have trouble using a public restroom, eating in a restaurant, or signing their name in front of others.

Social phobia is not the same as shyness. Shy people may feel uncomfortable with others, but they don't expe-

rience severe **anxiety**, they don't worry excessively about social situations beforehand, and they don't avoid events that make them feel self-conscious. On the other hand, people with social phobia may not be shy—they may feel perfectly comfortable with people except in specific situations. Social phobias may be only mildly irritating, or they may significantly interfere with daily life. It is not unusual for people with social phobia to turn down job offers or avoid relationships because of their fears.

Agoraphobia

Agoraphobia is the intense fear of feeling trapped and having a panic attack in a public place. It usually begins between ages 15 and 35, and affects three times as many women as men—about 3% of the population.

An episode of spontaneous panic is usually the initial trigger for the development of agoraphobia. After an initial panic attack, the person becomes afraid of experiencing a second one. Patients literally "fear the fear," and worry incessantly about when and where the next attack may occur. As they begin to avoid the places or situations in which the panic attack occurred, their fear generalizes. Eventually the person completely avoids public places. In severe cases, people with agoraphobia can no longer leave their homes for fear of experiencing a panic attack.

Causes and symptoms

Experts don't really know why phobias develop, although research suggests the tendency to develop phobias may be a complex interaction between heredity and environment. Some hypersensitive people have unique chemical reactions in the brain that cause them to respond much more strongly to **stress**. These people also may be especially sensitive to **caffeine**, which triggers certain brain chemical responses.

While experts believe the tendency to develop phobias runs in families and may be hereditary, a specific stressful event usually triggers the development of a specific phobia or agoraphobia. For example, someone predisposed to develop phobias who experiences severe turbulence during a flight might go on to develop a phobia about flying. What scientists don't understand is why some people who experience a frightening or stressful event develop a phobia and others do not.

Social phobia typically appears in childhood or adolescence, sometimes following an upsetting or humiliating experience. Certain vulnerable children who have had unpleasant social experiences (such as being rejected) or who have poor social skills may develop social phobias. The condition also may be related to low self-esteem, unassertive personality, and feelings of inferiority.

A person with agoraphobia may have a panic attack at any time, for no apparent reason. While the attack may last only a minute or so, the person remembers the feelings of panic so strongly that the possibility of another attack becomes terrifying. For this reason, people with agoraphobia avoid places where they might not be able to escape if a panic attack occurs. As the fear of an attack escalates, the person's world narrows.

While the specific trigger may differ, the symptoms of different phobias are remarkably similar: e.g., feelings of terror and impending doom, rapid heartbeat and breathing, sweaty palms, and other features of a panic attack. Patients may experience severe anxiety symptoms in anticipating a phobic trigger. For example, someone who is afraid to fly may begin having episodes of pounding heart and sweating palms at the mere thought of getting on a plane in two weeks.

Diagnosis

A mental health professional can diagnose phobias after a detailed interview and discussion of both mental and physical symptoms. Social phobia is often associated with other **anxiety disorders**, depression, or substance abuse.

Treatment

People who have a specific phobia that is easy to avoid (such as snakes) and that doesn't interfere with their lives may not need to get help. When phobias do interfere with a person's daily life, a combination of psychotherapy and medication can be quite effective. While most health insurance covers some form of mental health care, most do not cover outpatient care completely, and most have a yearly or lifetime maximum.

Medication can block the feelings of panic, and when combined with **cognitive-behavioral therapy**, can be quite effective in reducing specific phobias and agoraphobia.

Cognitive-behavioral therapy adds a cognitive approach to more traditional behavioral therapy. It teaches patients how to change their thoughts, behavior, and attitudes, while providing techniques to lessen anxiety, such as deep breathing, muscle relaxation, and refocusing.

One cognitive-behavioral therapy is "desensitization" (also known as "exposure therapy"), in which people are gradually exposed to the frightening object or event until they become used to it and their physical symptoms decrease. For example, someone who is afraid of snakes might first be shown a photo of a snake. Once the person can look at a photo without anxiety, he might then be shown a video of a snake. Each step is repeated

until the symptoms of fear (such as pounding heart and sweating palms) disappear. Eventually, the person might reach the point where he can actually touch a live snake. Three fourths of patients are significantly improved with this type of treatment.

Another more dramatic cognitive-behavioral approach is called "flooding," which exposes the person immediately to the feared object or situation. The person remains in the situation until the anxiety lessens.

Several drugs are used to treat specific phobias by controlling symptoms and helping to prevent panic attacks. These include anti-anxiety drugs (**benzodiazepines**) such as alprazolam (Xanax) or diazepam (Valium). Blood pressure medications called "beta blockers," such as propranolol (Inderal) and atenolol (Tenormin), appear to work well in the treatment of circumscribed social phobia, when anxiety gets in the way of performance, such as public speaking. These drugs reduce overstimulation, thereby controlling the physical symptoms of anxiety.

In addition, some antidepressants may be effective when used together with cognitive-behavioral therapy. These include the **monoamine oxidase inhibitors** (MAO inhibitors) phenelzine (Nardil) and tranylcypromine (Parnate), as well as **selective serotonin reuptake inhibitors** (SSRIs) like fluoxetine (Prozac), paroxetine (Paxil), sertraline (Zoloft) and fluvoxamine (Luvox).

In all types of phobias, symptoms may be eased by lifestyle changes, such as:

- eliminating caffeine
- cutting down on alcohol
- eating a good diet
- getting plenty of **exercise**
- reducing stress

Treating agoraphobia is more difficult than other phobias because there are often so many fears involved, such as open spaces, traffic, elevators, and escalators. Treatment includes cognitive-behavioral therapy with antidepressants or anti-anxiety drugs. Paxil and Zoloft are used to treat panic disorders with or without agoraphobia.

Prognosis

Phobias are among the most treatable mental health problems; depending on the severity of the condition and the type of phobia, most properly treated patients can go on to lead normal lives. Research suggests that once a person overcomes the phobia, the problem may not return for many years—if at all.

Untreated phobias are another matter. Only about 20% of specific phobias will go away without treatment, and agoraphobia will get worse with time if untreated. Social phobias tend to be chronic, and will not likely go away without treatment. Moreover, untreated phobias can lead to other problems, including depression, **alcoholism**, and feelings of shame and low self-esteem.

While most specific phobias appear in childhood and subsequently fade away, those that remain in adulthood often need to be treated. Unfortunately, most people never get the help they need; only about 25% of people with phobias ever seek help to deal with their condition.

Prevention

There is no known way to prevent the development of phobias. Medication and cognitive-behavioral therapy may help prevent the recurrence of symptoms once they have been diagnosed.

Resources

BOOKS

Ashley, Joyce. *Overcoming Stage Fright in Everyday Life*. Clarkson Potter, 1996.

Beck, Aaron T., Gary Emery, and Ruth Greenberg. *Anxiety Disorders and Phobias: A Cognitive Perspective*. New York: Basic Books, 1990.

Bourne, K. Edmund J. *The Anxiety and Phobia Workbook*. New Harbinger Publications, 1995.

Dowling, Colette. *You Mean I Don't Have to Feel This Way? New Help for Depression, Anxiety and Addiction*. New York: Bantam Doubleday Dell, 1993.

Greist, J., and James Jefferson. *Anxiety and Its Treatment*. New York: Warner Books, 1986.

Peurifoy, Reneau Z. *Anxiety, Phobias and Panic: A Step by Step Program for Regaining Control of Your Life*. New York: Warner Books, 1996.

Schneier, Franklin, and Lawrence Welkowitz. *The Hidden Face of Shyness: Understanding and Overcoming Social Anxiety*. New York: Avon Books, 1996.

Sheehan, Elaine. *Anxiety, Phobias and Panic Attacks: Your Questions Answered*. New York: Element, 1996.

Stern, Richard. *Mastering Phobias: Cases, Causes and Cures*. New York: Penguin USA, 1996.

PERIODICALS

Hall, Lynne L. "Fighting Phobias: The Things That Go Bump in the Mind." *FDA Consumer* (Mar. 1997): 12-15.

Modica, Peter. "Social Phobia may Run in the Family." *American Journal of Psychiatry* 155 (1998): 90-97.

Schneier, Franklin. "Social Phobia." *Psychiatric Annals* 21 (6 June 1991): 349-353.

ORGANIZATIONS

Agoraphobics Building Independent Lives. 3805 Cutshaw Avenue, Suite 415, Dept. W, Richmond, VA 23230. (804) 353-3964. <http://www.anxietysupport.org>.

KEY TERMS

Agoraphobia—An intense fear of being trapped in a crowded, open, or public space where it may be hard to escape, combined with the dread of having a panic attack.

Benzodiazepine—A class of drugs that have a hypnotic and sedative action, used mainly as tranquilizers to control symptoms of anxiety.

Beta blockers—A group of drugs that are usually prescribed to treat heart conditions, but that also are used to reduce the physical symptoms of anxiety and phobias, such as sweating and palpitations.

Monoamine oxidase inhibitors (MAO inhibitors)—A class of antidepressants used to treat social phobia.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in the brain, raising the levels of serotonin. SSRIs include Prozac, Zoloft, and Paxil.

Serotonin—One of three major types of neurotransmitters found in the brain that is linked to emotions.

Social phobia—Fear of being judged or ridiculed by others; fear of being embarrassed in public.

Agoraphobic Foundation of Canada. P.O. Box 132, Chomedey, Laval, Quebec. H7W 4K2, Canada.

Agoraphobics In Motion. 605 W. 11 Mile Rd., Royal Oak, MI 48067. (248) 547-0400.

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

Anxiety Disorders Association of America. 11900 Parklawn Dr., Ste. 100, Rockville, MD 20852. (301) 231-9350. <http://www.adaa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Anxiety Foundation. 3135 Custer Dr., Lexington, KY 40517. (606) 272-7166. <http://www.lexington-on-line.com/naf.html>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

National Mental Health Association. 1021 Prince St., Alexandria, VA 22314. (703) 684-7722. <http://www.nmha.org>.

Phobics Anonymous. P.O. Box 1180, Palm Springs, CA 92263. (619) 322- COPE.

Social Phobia/Social Anxiety Association. 4643 East Thomas Rd., Ste. 6-A, Phoenix, AZ 85018.

OTHER

Anxiety Network Page. <http://www.anxietynetwork.com>.

The Anxiety and Panic Internet Resource. <http://www.algy.com/anxiety>.

National Institute of Mental Health Page. <http://www.nimh.nih.gov>.

National Mental Health Association. <http://www.nmha.org>.

Social Phobia/Social Anxiety Association Home Page. <http://www.socialphobia.org/>.

Carol A. Turkington

Phospholipidosis *see* **Pulmonary alveolar proteinosis**

Phosphorus imbalance

Definition

Phosphorus imbalance refers to conditions in which the element phosphorus is present in the body at too high a level (hyperphosphatemia) or too low a level (hypophosphatemia).

Description

Almost all of the phosphorus in the body occurs as phosphate (phosphorus combined with four oxygen atoms), and most of the body's phosphate (85%) is located in the skeletal system, where it combines with calcium to give bones their hardness. The remaining amount (15%) exists in the cells of the body, where it plays an important role in the formation of key nucleic acids, such as DNA, and in the process by which the body turns food into energy (metabolism). The body regulates phosphate levels in the blood through the controlled release of parathyroid hormone (PTH) from the parathyroid gland and calcitonin from the thyroid gland. PTH keeps phosphate levels from becoming too high by stimulating the excretion of phosphate in urine and causing the release of calcium from bones (phosphate blood levels are inversely proportional to calcium blood levels). Calcitonin keeps phosphate blood levels in check by moving phosphates out of the blood and into the bone matrix to form a mineral salt with calcium.

Most phosphorus imbalances develop gradually and are the result of other conditions or disorders, such as **malnutrition**, poor kidney function, or a malfunctioning gland.

Causes and symptoms

Hypophosphatemia

Hypophosphatemia (low blood phosphate) has various causes. **Hyperparathyroidism**, a condition in which the parathyroid gland produces too much PTH, is one primary cause. Poor kidney function, in which the renal tubules do not adequately reabsorb phosphorus, can result in hypophosphatemia, as can overuse of **diuretics**, such as theophylline, and **antacids** containing aluminum hydroxide. Problems involving the intestinal absorption of phosphate, such as chronic **diarrhea** or a deficiency of vitamin D (needed by the intestines to properly absorb phosphates) can cause the condition. Malnutrition due to chronic **alcoholism** can result in an inadequate intake of phosphorus. Recovery from conditions such as **diabetic ketoacidosis** or severe **burns** can provoke hypophosphatemia, since the body must use larger-than-normal amounts of phosphate. Respiratory alkylosis, brought on by hyperventilation, can also result in temporary hypophosphatemia.

Symptoms generally occur only when phosphate levels have decreased profoundly. They include muscle weakness, tingling sensations, **tremors**, and bone weakness. Hypophosphatemia may also result in confusion and memory loss, seizures, and **coma.**

Hyperphosphatemia

Hyperphosphatemia (high blood phosphate) also has various causes. It is most often caused by a decline in the normal excretion of phosphate in urine as a result of kidney failure or impaired function. **Hypoparathyroidism**, a condition in which the parathyroid gland does not produce enough PTH, or pseudoparathyroidism, a condition in which the kidneys lose their ability to respond to PTH, can also contribute to decreased phosphate excretion. Hyperphosphatemia can also result from the overuse of **laxatives** or **enemas** that contain phosphate. **Hypocalcemia** (abnormally low blood calcium) can cause phosphate blood levels to increase abnormally. A side-effect of hyperphosphatemia is the formation of calcium-phosphate crystals in the blood and soft tissue.

Hyperphosphatemia is generally asymptomatic; however, it can occur in conjunction with hypocalcemia, the symptoms of which are **numbness and tingling** in the extemities, muscle cramps and spasms, depression, memory loss, and convulsions. When calcium-phosphate crystals build up in the blood vessels, they can cause arteriosclerosis, which can lead to heart attacks or strokes. When the crystals build up in the skin, they can cause severe **itching**.

Diagnosis

Disorders of phosphate metabolism are assessed by measuring serum or plasma levels of phosphate and calcium. Hypophosphatemia is diagnosed if the blood phosphate level is less than 2.5 milligrams per deciliter of blood. Hyperphosphatemia is diagnosed if the blood phosphate level is above 4.5 milligrams per deciliter of blood. Appropriate tests are also used to determine if the underlying cause of the imbalance, including assessments of kidney function, dietary intake, and appropriate hormone levels.

Treatment

Treatment of phosphorus imbalances focuses on correcting the underlying cause of the imbalance and restoring equilibrium. Treating the underlying condition may involve surgical removal of the parathyroid gland in the case of hypophosphatemia caused by hyperparathyroidism; initiating hormone therapy in cases of hyperphosphatemia caused by hypoparathyroidism; ceasing intake of drugs or medications that contribute to phosphorus imbalance; or instigating measures to restore proper kidney function.

Restoring phosphorus equilibrium in cases of mild hypophosphatemia may include drinking a prescribed solution that is rich in phosphorus; however, since this solution can cause diarrhea, many doctors recommend that patients drink 1 qt (0.9 L) of skim milk per day instead, since milk and other diary products are significant sources of phosphate. Other phosphate-rich foods include green, leafy vegetables; peas and beans; nuts; chocolate; beef liver; turkey; and some cola drinks. Severe hypophosphatemia may be treated with the administration of an intravenous solution containing phosphate.

Restoring phosphorus equilibrium in cases of mild hyperphosphatemia involves restricting intake of phosphorus-rich foods and taking a calcium-based antacid that binds to the phosphate and blocks its absorption in the intestines. In cases of severe hyperphosphatemia, an intravenous infusion of calcium gluconate may be administered. Dialysis may also be required in severe cases to help remove excess phosphate from the blood.

Prognosis

The prognosis for treating hyperphosphatemia and hypophosphatemia are excellent, though in cases where these problems are due to genetic disease, life-long hormone treatment may be necessary.

Prevention

Phosphorus imbalances caused by hormonal disorders or other genetically determined conditions cannot be prevented. Hypophosphatemia resulting from poor dietary intake can be prevented by eating foods rich in phosphates, and hypophosphatemia caused by overuse of

diuretics or antacids can be prevented by strictly following instructions concerning proper dosages, as can hyperphosphatemia due to excessive use of enemas or laxative. Finally, patients on dialysis or who are being fed intravenously should be monitored closely to prevent phosphorus imbalances.

Resources

BOOKS

Bales, C. W., and M. K. Drezner. "Divalent Ion Homeostasis: Calcium and Phosphorus Metabolism." In *Textbook of Internal Medicine*, ed. W. N. Kelley. New York: J. B. Lippincott Co., 1992.

Knochel, J. P. "Disorders of Phosphorus Metabolism." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Barcia, J. P., C. F. Strife, and C. B. Langman. "Infantile Hypophosphatemia: Treatment Options to Control Hypercalcemia, Hypercalciuria, and Chronic Bone Demineralization." *Journal of Pediatrics* 130 (1997): 825-828.

Tom Brody, PhD

Photoallergy *see* **Photosensitivity**

Photokeratitis *see* **Keratitis**

Photorefractive keratectomy and laser-assisted in-situ keratomileusis

Definition

Photorefractive keratectomy (PRK) and laser-assisted in-situ keratomileusis (LASIK) are two similar surgical techniques that use an excimer laser to correct nearsightedness (**myopia**) by reshaping the cornea. The cornea is the clear outer structure of the eye that lies in front of the colored part of the eye (iris). PRK and LASIK are two forms of vision-correcting (refractive) surgery. The two techniques differ in how the surface layer of the cornea is treated. As of mid 1998, two eximer lasers (Summit and Visx) had been approved for laser vision correction (refractive surgery using a laser) in the PRK procedure. Since then, Visx, Summit, and other lasers have received approval by the Food and Drug Administration (FDA) for use in LASIK procedures.

Purpose

The purpose of both LASIK and PRK is to correct nearsightedness in persons who don't want to, or can't, wear eye glasses or contact lenses. Most patients are able to see well enough to pass a driver's license exam without glasses or contact lenses after the operation. After approximately age 40, the lens in the eye stiffens making it harder to focus up close. Because laser vision correction only affects the cornea, the procedures do not eliminate the need for reading glasses. Patients should be wary of any ads that "guarantee" 20/20 vision. Patients should also make sure that the laser being used is approved by the FDA.

Precautions

Patients should be over 18 years of age, have healthy corneas, and have vision that has been stable for the past year. People who may not be good candidates for these procedures are pregnant women or women who are breastfeeding (vision may not be stable); people with scarred corneas or macular disease; people with autoimmune diseases (i.e., **systemic lupus erythematosus** or **rheumatoid arthritis**); or people with diabetes. Patients with **glaucoma** should not have LASIK because the intraocular pressure (IOP) of the eye is raised during the procedure. A patient with persistent lid infections (i.e., blepharitis) may not be a good candidate because of an increased risk of infection. An ophthalmologist who specializes in laser vision correction can determine who would be likely to benefit from the operation and suggest which of the two operations might be more appropriate for any given patient.

If a patient is thinking of having **cataract surgery**, they should discuss it with the doctor. During cataract surgery an intracocular lens (IOL) will be inserted and that alone may correct distance vision.

Description

PRK and LASIK are both performed with an excimer laser, which uses a cold beam of ultraviolet light to sculpt or reshape the cornea so that light will focus properly on the retina. The cornea is the major focusing structure of the eye. The retina sends the image focused on it to the brain. In myopia, the cornea is either too steep or the eye is too long for a clear image to be focused on the retina. PRK and LASIK flatten out the cornea so that the image will focus more precisely on the retina.

In PRK, the surface of the cornea is removed by the laser. In LASIK, the outer layer of the cornea is sliced, lifted, moved aside while the cornea is reshaped with the laser, then replaced to speed healing. Both procedures cause the cornea to become flatter, which corrects the nearsighted vision.

At least one laser has been approved to treat mild **astigmatism** as of 2000. Correcting farsightedness (**hyperopia**) may be possible in the future.

These laser vision-correcting procedures are rapidly replacing **radial keratotomy** (RK), an earlier form of refractive surgery that involved cutting the cornea with a scalpel in a pattern of radiating spokes. RK has declined in popularity since the approval of the excimer laser in 1995, falling from a high of 250,000 procedures performed per year in 1994 to 50,000 in 1997.

For both LASIK and PRK, the patient's eye is numbed with anesthetic drops. No injections are necessary. The patient is awake and relaxed during the procedure.

LASIK is sometimes referred to as a "flap and zap" procedure because a thin flap of tissue is temporarily removed from the surface of the cornea and the underlying cornea is then "zapped" with a laser. Prior to the surgery, the surface of the cornea is marked with a dye marker so that the flap of cornea can be precisely aligned when it is replaced. The doctor places a suction ring on the eye to hold it steady. During this part of the operation, which lasts only a few seconds, the patient is not able to see. A surgical instrument called a microkeratome is passed over the cornea to create a very thin flap of tissue. The IOP is increased at this time which is why it is contraindicated in patients with glaucoma. This thin tissue layer is folded back. The cornea is reshaped with the laser beam and the cell layer is replaced. Because the cell layer is not permanently removed, patients have a faster recovery time and experience far less discomfort than with PRK. An antibiotic drop is put in and the eye is patched until the following day's checkup.

In PRK, a small area of the surface layer of the cornea is vaporized. It takes about three days for the surface cells to grow back and vision will be blurred. Some patients describe it as "looking through Vaseline." PRK is generally recommended for patient's with mild to moderate myopia (usually under -5.00 diopters).

With both PRK and LASIK, there is a loud tapping sound from the laser and a burning smell as the cornea is reshaped. The surgery itself is painless and takes only a minute or two. Patients are usually able to return home immediately after surgery. Most patients wait (up to six months) before they have the second one done. This allows the first eye to heal and to see if there were complications from the surgery.

The cost of these procedures can vary with geographic area and the doctor. In general, the procedure costs $1,350–$2,500 per eye for PRK and about $500 more per eye for LASIK. PRK and LASIK are generally not covered by insurance. However, insurance may cover these procedures for people in certain occupations, such as police officers and firefighters.

Preparation

If a patient wears contact lenses, they should not be worn for a few weeks prior to surgery. It also is important to discontinue contact lens wear prior to the visual exams to make sure vision is stable. The doctor should be advised of contact lens wear.

Upon arrival at the doctor's office on the day of surgery, patients are given some eye drops and a sedative, such as Valium, to relax them. Their vision is tested. They rest while waiting for the sedative to take effect. Immediately before the surgery, patients are given local anesthetic eye drops.

Aftercare

After surgery, antibiotic drops are placed in the eye and the eye may be patched. The patient returns for a follow-up visit the next day. The patient is usually given a prescription for eyedrops (usually antibiotic and anti-inflammatory). Patients who have had PRK usually feel mild discomfort for one to three days after the procedure. They may need a bandage contact lens. Patients who have had LASIK generally have less, or even no discomfort after the surgery. After LASIK, antibiotic and anti-inflammatory drops are generally necessary for one week. After PRK, steroidal eye drops may be necessary for months. Because steroids may increase the possibility of glaucoma or **cataracts**, it is a big drawback to the procedure. The patient should speak with the doctor to see how long follow-up medications will be necessary.

Most patients return to work within one to three days after the procedure, although visual recovery from PRK may take as long as four weeks. An eye shield may be used for about one week at night and patients may be sensitive to bright light for a few days. Patients may be asked by their doctor to keep water out of their eye for a week and to avoid mascara or eyeliner during this period.

Risks

There is a risk of under- or over-correction with either of these procedures. If vision is under-corrected, a second procedure can be performed to achieve results that may be closer to 20/20 vision. About 5–10% of PRK patients return for an adjustment, as do 10–25% of LASIK patients. People with higher degrees of myopia have vision that is harder to correct and usually have LASIK surgery rather than PRK. This may account for the higher incidence of adjustments for LASIK patients. Patients with very high myopia (over -15.00 diopters) may experience improvement after LASIK, but they are not likely to achieve 20/40 vision without glasses. However, their glasses will not need to be as thick or heavy after the

KEY TERMS

Blepharitits— An inflammation of the eyelid.

Cataract—A condition in which the lens of the eye turns cloudy and interferes with vision.

Cornea—The clear, curved tissue layer in front of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the center of the iris (pupil).

Diopter (D)—A unit of measure of the power or strength of a lens.

Excimer laser—An instrument that is used to vaporize tissue with a cold, coherent beam of light with a single wavelength in the ultraviolet range.

Intraocular lens (IOL) implant—A small, plastic device (IOL) that is usually implanted in the lens capsule of the eye to correct vision after the lens of the eye is removed. This is the implant is used in cataract surgery.

Macular degeneration—A condition usually associated with age in which the area of the retina called the macula is impaired due to hardening of the arteries (arteriosclerosis). This condition interferes with vision.

Microkeratome—A precision surgical instrument that can slice an extremely thin layer of tissue from the surface of the cornea.

Myopia—A vision problem in which distant objects appear blurry. Myopia results when the cornea is too steep or the eye is too long and the light doesn't focus properly on the retina. People who are myopic or nearsighted can usually see near objects clearly, but not far objects.

Refractive surgery—A surgical procedure that corrects visual defects.

Retina—The sensory tissue in the back of the eye that is responsible for collecting visual images and sending them to the brain.

surgery. However, most patients, especially those with less extreme myopia, do not need glasses after the surgery.

Haze is another possible side effect. Although hazy vision is unlikely, it is more likely to occur after PRK than after LASIK. This haze usually clears up. Corneal scarring, halos, or glare at night, or an irritating bump on the cornea are other possible side effects. As with any eye surgery, infection is possible, but rare. Loss of vision is possible with these procedures, but this complication is extremely rare.

Most complications from LASIK are related to the creation and realignment of the flap. The microkeratome must be in good-working order and sharp. LASIK requires a great deal of skill on the part of the surgeon and the complication rate is related to the experience level of the surgeon. In one study, the rate of LASIK complications declined from 3% for surgeons during their first three months using this technique, to 1% after a year's experience in the technique, to 0% after 18 months experience.

Normal results

Most patients experience improvement in their vision immediately after the operation and about half of LASIK patients are able to see 20/30 within one day of the surgery. Vision tends to become sharper over the next few days and then stabilizes; however, it is possible to have shifts in myopia for the next few months. Vision clears and stabilizes faster after LASIK than after PRK. Final vision is achieved within three to six months with LASIK and six to eight months with PRK. The vast majority of patients (95% for people with low to moderate myopia and 75% for people with high levels of myopia) are able to see 20/40 after either of these procedures and are able to pass a driver's license test without glasses or contact lenses.

LASIK is more complicated than PRK because of the addition of the microkeratome procedure. However, LASIK generally has faster recovery time, less **pain**, and less chance of halos and scarring than PRK. LASIK can treat higher degrees of myopia (-5.00– -25.00 diopters). LASIK also requires less use of steroids. Patients need to speak with qualified, experienced eye surgeons to help in choosing the procedure that is right for them.

Resources

PERIODICALS

Bell, Jarrett. "Eye Operation Clears Path for NFL Runner." *USA Today* (27 June 1996).

Blau, Melinda. "I Can See Clearly Now." *New York* (10 Mar. 1997): 33-37.

Charters, Lynda. "Experts Discuss Options for High Myopia." *Ophthalmology Times* (1 Mar. 1998): 20- 25.

Chynn, Emil William. "Refractive Business. No Time Like the Present." *Ophthalmology Times* (15 Feb. 1998): 11-12.

Gorman, David, and Arthur M. Cotliar. "Refractive Surgery Options: RK vs PRK vs LASIK." *Newsweek* (16 June 1997): S38.
Moadel, Ken, George O. Waring III, Tarek Salah, and Akef Maghraby. "In Skillful Hands, LASIK is a Plus." *Ophthalmology Times* (17 July 1995): 14.
Murray, Louann. "Surgeons Switching from PRK to LASIK." *Ophthalmology Times* (24 Apr. 1995): 28.
Murray, Louann. "The Magic of LASIK Surgery." *Ophthalmology Times* (20 Nov. 1995): 11.
Oldham, Jennifer. "Seeing the Light." *Los Angeles Times* (13 Jan. 1997).
Vinals, Antonio. "No Regression Seen 2 Years After LASIK." *Ophthalmology Times* (1 Mar. 1998): 1, 34.
Vinals, Antonio. "Study Documents LASIK Learning Curve." *Ophthalmology Times* (1 Mar. 1998): 1, 35.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.
American Society of Cataract and Refractive Surgery. 4000 Legato Road, Suite 850, Fairfax, VA 22033-4055. (703) 591-2220. <http://www.ascrs.org>.

Louann W. Murray, PhD

Photosensitivity

Definition

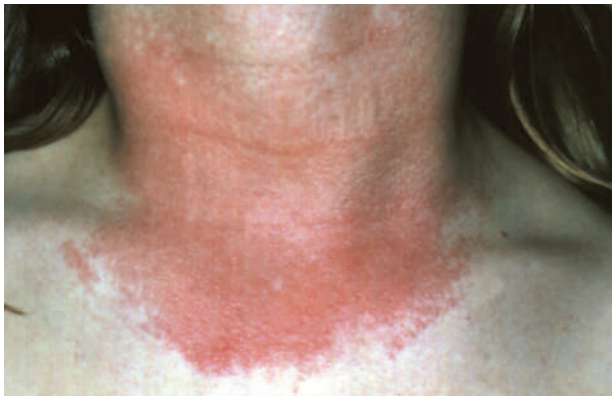
Photosensitivity is any increase in the reactivity of the skin to sunlight.

Description

The skin is a carefully designed interface between our bodies and the outside world. It is infection-proof when intact, nearly waterproof, and filled with protective mechanisms. Sunlight threatens the health of the skin. Normal skin is highly variable in its ability to resist sun damage. Natural skin pigmentation is its main protection. The term photosensitivity refers to any increase beyond what is considered normal variation.

Causes and symptoms

There are over three dozen diseases, two dozen drugs, and several perfume and cosmetic components that can cause photosensitivity. There are also several different types of reaction to sunlight—phototoxicity, photoallergy, and polymorphous light eruption. In addition, prolonged exposure to sunlight, even in normal skin, leads to skin aging and **cancer**. These effects are accelerated in patients who have photosensitivity.



A skin rash on the front of a woman's neck caused by a photosensitive reaction to sunlight. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

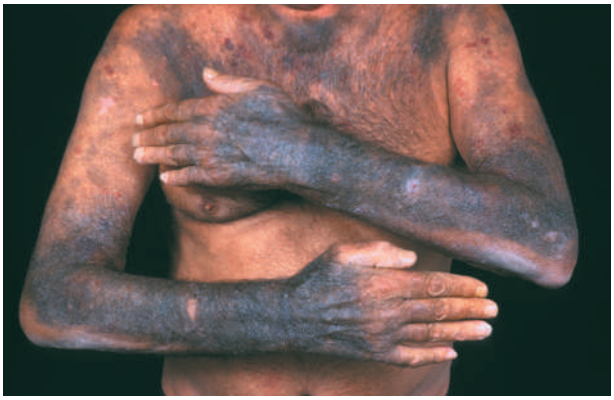
Phototoxicity is a severely exaggerated reaction to sunlight caused by a new chemical in the skin. The primary symptom is **sunburn**, which is rapid and can be severe enough to blister (a second degree burn). The chemicals associated with phototoxicity are usually drugs. The list includes several common antibiotics—quinolones, **sulfonamides**, and **tetracyclines**; **diuretics** (water pills); major tranquilizers; oral diabetes medication; and cancer medicines. There are also some dermatologic drugs, both topical and oral, that can sensitize skin.

Photoallergy produces an intense **itching** rash on exposure to sunlight. Patients develop chronic skin changes (lichen simplex) as a result of scratching. Some of the agents that cause phototoxicity can also cause photoallergy. Some cosmetic and perfume ingredients, including one of the most common sunscreens—para-amino benzoic acid (PABA)—can do this.

Polymorphous light eruption resembles photoallergy in its production of intensely itching **rashes** in sunlight. However, this condition lessens with continued light exposure, and so is seen mostly in the spring. Also, there does not seem to be an identifiable chemical involved.

Diseases of several kinds increase skin sensitivity.

- A hereditary disease called xeroderma pigmentosum includes a defect in repair mechanisms that greatly accelerates skin damage from sunlight.
- A family of metabolic diseases called **porphyrias** produce chemicals (porphyrins) that absorb sunlight in the skin and thereby cause damage.
- Albinos lack skin pigment through a genetic defect and are thus very sensitive to light.
- Malnutrition, specifically a deficiency of niacin known as **pellagra**, sensitizes the skin.



This person had a phototoxic reaction after taking an antibiotic drug. *(Photo Researchers, Inc. Reproduced by permission.)*

KEY TERMS

Biopsy—Surgical removal of tissue for examination.

- Several diseases like **acne**, **systemic lupus erythematosus**, and herpes simple (fever blisters) decrease the resistance of the skin to sun damage.

Diagnosis

The pattern of appearance on the skin, a history of drug or chemical exposure, and the timing of the symptoms often suggests a diagnosis. A **skin biopsy** may be needed for further clarification.

Treatment

Removal of the offending drug or chemical is primary. Direct sunlight exposure should be limited. Some people must avoid sunlight altogether, while others can tolerate some direct sunlight with the aid of **sunscreens**.

Prevention

A sunscreen with an SPF of 15 or greater protects most skin from damage. Protective clothing such as hats are highly recommended in addition.

Resources

BOOKS

Bickers, David R. "Photosensitivity and Other Reactions to Light." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Harber, Leonard C. "Abnormal Responses to Ultraviolet Radiation: Drug Induced Photosensitivity." In *Dermatology in General Medicine*, ed. Thomas B. Fitzpatrick, et al. New York: McGraw-Hill, 1993.

J. Ricker Polsdorfer, MD

Phototherapy

Definition

Phototherapy, or light therapy, is the administration of doses of bright light in order to normalize the body's internal clock and/or relieve depression.

Purpose

Phototherapy is prescribed primarily to treat **seasonal affective disorder** (SAD), a mood disorder characterized by depression in the winter months, and is occasionally employed to treat **insomnia** and **jet lag**. The exact mechanisms by which the treatment works are not known, but the bright light employed in phototherapy may act to readjust the body's circadian (daily) rhythms, or internal clock. Other popular theories are that light triggers the production of serotonin, a neurotransmitter believed to be related to **depressive disorders**, or that it influences the body's production of melatonin, a hormone derived from serotonin that may be related to circadian rhythms.

Precautions

Patients with eye problems should see an ophthalmologist regularly, both before and during phototherapy. Because some ultraviolet rays are emitted by the light boxes used in phototherapy, patients taking photosensitizing medications (medications making the skin more sensitive to light) and those who have sun-sensitive skin should consult with their physician before beginning treatment. Patients with medical conditions that make them sensitive to ultraviolet rays should also be seen by a physician before starting phototherapy. Patients who have a history of mood swings or **mania** should be monitored closely, since phototherapy may cause excessive mood elevation in some individuals.

Description

Phototherapy is generally administered at home. The most commonly used phototherapy equipment is a portable lighting device known as a light box. The box may be mounted upright to a wall, or slanted downwards towards a table. The patient sits in front of the box for a prescribed period of time (anywhere from 15 minutes to several hours). Some patients with SAD undergo phototherapy sessions two or three times a day, others only

once. The time of day and number of times treatment is administered depend on the physical needs and lifestyle of the individual patient. If phototherapy has been prescribed for the treatment of SAD, it typically begins in the fall months as the days begin to shorten, and continues throughout the winter and possibly the early spring.

The light from a slanted light box is designed to focus on the table it sits upon, so patients may look down to read or do other sedentary activities during therapy. Patients using an upright light box must face the light source (although they need not look directly into the light). The light sources in these light boxes typically range from 2,500–10,000 lux. (In contrast, average indoor lighting is 300–500 lux; a sunny summer day is about 100,000 lux).

Phototherapy prescribed for the treatment of SAD may be covered by insurance. Individuals requiring phototherapy should check with their insurance company to see if the cost of renting or purchasing a light box is covered.

Aftercare

Patients beginning light therapy for SAD may need to adjust the length, frequency, and timing of their phototherapy sessions to achieve the maximum benefit. These patients should keep their doctor informed of their progress and the status of their depressive symptoms. Occasionally, antidepressants and/or psychotherapy may be recommended as an adjunct to phototherapy.

Risks

An abnormally elevated or expansive mood (hypomania) may occur, but it is usually temporary. Some patients undergoing phototherapy treatment report side effects of eyestrain, headaches, insomnia, **fatigue**, **sunburn**, and dry eyes or nose. Most of these effects can be managed by adjusting the timing and duration of the phototherapy sessions. A strong sun block and eye and nose drops can alleviate the other problems. Long-term studies have shown no negative effects to the eye function of individuals undergoing phototherapy treatments.

Normal results

Patients with SAD typically report an alleviation of depressive symptoms within two to 14 days after beginning phototherapy.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Rosenthal, Norman E. *Winter Blues: Seasonal Affective Disorder—What It Is and How to Overcome It*. New York: Guilford Press, 1993.

PERIODICALS

Andersen, Janis L., and Gabrielle I. Weiner. "Seasonal Depression." *Harvard Health Letter* 21, no. 4 (Feb. 1996): 7-9.

Rosenthal, Norman E. "Light and Biological Rhythms in Psychiatry." *Harvard Mental Health Letter* 11, no. 9 (Mar. 1995): 5-6.

Zal, H. Michael. "Seasonal Affective Disorder: How to Lighten the Burden of 'Winter Depression'." *Consultant* 37, no. 3 (Mar. 1997): 641-6.

ORGANIZATIONS

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Society for Light Treatment and Biological Rhythms. P.O. Box 591687, 174 Cook St., San Francisco, CA 94159-1687. <http://www.websciences.org/sltbr>.

Paula Anne Ford-Martin

KEY TERMS

Circadian rhythm—The rhythmic repetition of certain phenomena in living organisms at about the same time each day.

Lux—A standard unit of measure for illumination.

Neurotransmitter—A chemical in the brain that transmits messages between neurons, or nerve cells.

Photosensitivity—An abnormally heightened reaction to light.

Seasonal affective disorder (SAD)—A mood disorder characterized by depression during the winter months. An estimated 11 million Americans experience SAD.

Phototoxic reaction *see* **Photosensitivity**

Phycomycosis *see* **Mucormycosis**

Physical allergy

Definition

Physical **allergies** are allergic reactions to cold, sunlight, heat, or minor injury.

Description

The immune system is designed to protect the body from harmful invaders such as germs. Occasionally, it goes awry and attacks harmless or mildly noxious agents, doing more harm than good. This event is termed allergy if the target is from the outside—like pollen or bee venom—and autoimmunity if it is caused by one of the body's own components.

The immune system usually responds only to certain kinds of chemicals, namely proteins. However, non-proteins can trigger the same sort of response, probably by altering a protein to make it look like a target. Physical allergy refers to reactions in which a protein is not the initial inciting agent.

Sometimes it takes a combination of elements to produce an allergic reaction. A classic example is drugs that are capable of sensitizing the skin to sunlight. The result is phototoxicity, which appears as an increased sensitivity to sunlight or as localized skin **rashes** on sun-exposed areas.

Causes and symptoms

- Minor injury, such as scratching, causes itchy welts to develop in about 5% of people. The presence of itchy welts (urticaria) is a condition is called dermographism.
- Cold can change certain proteins in the blood so that they induce an immune reaction. This may indicate that there are abnormal proteins in the blood from a disease of the bone marrow. The reaction may also involve the lungs and circulation, producing **wheezing** and **fainting**.
- Heat allergies can be caused by **exercise** or even strong emotions in sensitive people.
- Sunlight, even without drugs, causes immediate urticaria in some people. This may be a symptom of porphyria—a genetic metabolic defect.
- Elements like nickel and chromium, although not proteins, commonly cause skin rashes, and iodine allergy causes skin rashes and sores in the mouth in allergic individuals.
- Pressure or vibration can also cause urticaria.
- Water contact can cause aquagenic urticaria, presumably due to chlorine or some other trace chemical in the water, although distilled water has been known to cause this reaction.

When the inflammatory reaction involves deeper layers of the skin, urticaria becomes angioedema. The skin, especially the lips and eyelids, swells. The tongue, throat, and parts of the digestive tract may also be involved. Angioedema may be due to physical agents. Often the cause remains unknown.

KEY TERMS

Antihistamine—Drugs that block histamine, a major cause of itching.

Hemolysis—Destruction of red blood cells.

Inflammation—Heat, redness, swelling, and pain caused by an immune response.

Diagnosis

Visual examination of the symptoms usually diagnoses the reaction. Further skin tests and review of the patient's **photosensitivity** may reveal a cause.

Treatment

Removing the offending agent is the first step to treatment. If sun is involved, shade and **sunscreens** are necessary. The reaction can usually be controlled with epinephrine, **antihistamines**, or cortisone-like drugs. **Itching** can be controlled with cold packs or commercial topical agents that contain menthol, camphor, eucalyptus oil, aloe, antihistamines, or cortisone preparations.

Prognosis

If the causative agent has been diagnosed, avoidance of or protection against the allergen cures the allergy. Usually, allergies can be managed through treatment.

Resources

BOOKS

Bolognia, Jean L., and Irwin M. Braverman. "Skin Manifestations of Internal Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Frank, Michael M. "Urticaria and Angioedema." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Physical examination

Definition

A physical examination is an evaluation of the body and its functions using inspection, palpation (feeling

with the hands), percussion (tapping with the fingers), and auscultation (listening). A complete health assessment also includes gathering information about a person's medical history and lifestyle, doing laboratory tests, and screening for disease.

Purpose

The annual physical examination has been replaced by the periodic health examination. How often this is done depends on the patient's age, sex, and risk factors for disease. The United States Preventative Services Task Force (USPSTF) has developed guidelines for preventative health examinations that health care professionals widely follow. Organizations that promote detection and prevention of specific diseases, like the American Cancer Society, generally recommend more intensive or frequent examinations.

A comprehensive physical examination provides an opportunity for the health care professional to obtain baseline information about the patient for future use, and to establish a relationship before problems happen. It provides an opportunity to answer questions and teach good health practices. Detecting a problem in its early stages can have good long-term results.

Precautions

The patient should be comfortable and treated with respect throughout the examination. As the examination procedes, the examiner should explain what he or she is doing and share any relevant findings.

Description

A complete physical examination usually starts at the head and proceeds all the way to the toes. However, the exact procedure will vary according to the needs of the patient and the preferences of the examiner. An average examination takes about 30 minutes. The cost of the examination will depend on the charge for the professional's time and any tests that are done. Most health plans cover routine physical examinations including some tests.

The examination

First, the examiner will observe the patient's appearance, general health, and behavior, along with measuring height and weight. The vital signs—including pulse, breathing rate, body temperature, and blood pressure—are recorded.

With the patient sitting up, the following systems are reviewed:

- Skin. The exposed areas of the skin are observed; the size and shape of any lesions are noted.
- Head. The hair, scalp, skull, and face are examined.
- Eyes. The external structures are observed. The internal structures can be observed using an ophthalmoscope (a lighted instrument) in a darkened room.
- Ears. The external structures are inspected. A lighted instrument called an otoscope may be used to inspect internal structures.
- Nose and sinuses. The external nose is examined. The nasal mucosa and internal structures can be observed with the use of a penlight and a nasal speculum.
- Mouth and pharynx. The lips, gums, teeth, roof of the mouth, tongue, and pharynx are inspected.
- Neck. The lymph nodes on both sides of the neck and the thyroid gland are palpated (examined by feeling with the fingers).
- Back. The spine and muscles of the back are palpated and checked for tenderness. The upper back, where the lungs are located, is palpated on the right and left sides and a stethoscope is used to listen for breath sounds.
- Breasts and armpits. A woman's breasts are inspected with the arms relaxed and then raised. In both men and women, the lymph nodes in the armpits are felt with the examiner's hands.While the patient is still sitting, movement of the joints in the hands, arms, shoulders, neck, and jaw can be checked.

Then while the patient is lying down on the examining table, the examination includes:

- Breasts. The breasts are palpated and inspected for lumps.
- Front of chest and lungs. The area is inspected with the fingers, using palpation and percussion. A stethoscope is used to listen to the internal breath sounds.

The head should be slightly raised for:

- Heart. A stethoscope is used to listen to the heart's rate and rhythm. The blood vessels in the neck are observed and palpated.

The patient should lie flat for:

- Abdomen. Light and deep palpation is used on the abdomen to feel the outlines of internal organs including the liver, spleen, kidneys, and aorta, a large blood vessel.
- Rectum and anus. With the patient lying on the left side, the outside areas are observed. An internal digital examination (using a finger), is usually done if the patient is over 40 years old. In men, the prostate gland is also palpated.
- Reproductive organs. The external sex organs are inspected and the area is examined for hernias. In men,

KEY TERMS

Auscultation—The process of listening to sounds that are produced in the body. Direct auscultation uses the ear alone, such as when listening to the grating of a moving joint. Indirect auscultation involves the use of a stethoscope to amplify the sounds from within the body, like a heartbeat.

Hernia—The bulging of an organ, or part of an organ, through the tissues normally containing it; also called a rupture.

Inspection—The visual examination of the body using the eyes and a lighted instrument if needed. The sense of smell may also be used.

Ophthalmoscope—Lighted device for studying the interior of the eyeball.

Otoscope—An instrument with a light for examining the internal ear.

Palpation—The examination of the body using the sense of touch. There are two types: light and deep.

Percussion—An assessment method in which the surface of the body is struck with the fingertips to obtain sounds that can be heard or vibrations that can be felt. It can determine the position, size, and consistency of an internal organ. It is done over the chest to determine the presence of normal air content in the lungs, and over the abdomen to evaluate air in the loops of the intestine.

Reflex—An automatic response to a stimulus.

Speculum—An instrument for enlarging the opening of any canal or cavity in order to facilitate inspection of its interior.

Stethoscope—A Y-shaped instrument that amplifies body sounds such as heartbeat, breathing, and air in the intestine. Used in auscultation.

Varicose veins—The permanent enlargement and twisting of veins, usually in the legs. They are most often seen in people with occupations requiring long periods of standing, and in pregnant women.

the scrotum is palpated. In women, a pelvic examination is done using a speculum and a Papamnicolaou test (**Pap test**) may be taken.

- Legs. With the patient lying flat, the legs are inspected for swelling, and pulses in the knee, thigh, and foot area are found. The groin area is palpated for the presence of lymph nodes. The joints and muscles are observed.
- Musculoskeletel system. With the patient standing, the straightness of the spine and the alignment of the legs and feet is noted.
- Blood vessels. The presence of any abnormally enlarged veins (varicose), usually in the legs, is noted.

In addition to evaluating the patient's alertness and mental ability during the initial conversation, additional inspection of the nervous system may be indicated:

- Neurologic screen. The patient's ability to take a few steps, hop, and do deep knee bends is observed. The strength of the hand grip is felt. With the patient sitting down, the reflexes in the knees and feet can be tested with a small hammer. The sense of touch in the hands and feet can be evaluated by testing reaction to **pain** and vibration.
- Sometimes additional time is spent examining the 12 nerves in the head (cranial) that are connected directly to the brain. They control the sense of smell, strength of muscles in the head, reflexes in the eye, facial movements, gag reflex, and muscles in the jaw. General muscle tone and coordination, and the reaction of the abdominal area to stimulants like pain, temperature, and touch would also be evaluated.

Preparation

Before visiting the health care professional, the patient should write down important facts and dates about his or her own medical history, as well as those of family members. He or she should have a list of all medications with their doses or bring the actual bottles of medicine along. If there are specific concerns about anything, writing them down is a good idea.

Before the physical examination begins, the bladder should be emptied and a urine specimen can be collected in a small container. For some blood tests, the patient may be told ahead of time not to eat or drink after midnight.

The patient usually removes all clothing and puts on a loose-fitting hospital gown. An additional sheet is provided to keep the patient covered and comfortable during the examination.

Aftercare

Once the physical examination has been completed, the patient and the examiner should review what laboratory tests have been ordered and how the results will be shared with the patient. The medical professional should

discuss any recommendations for treatment and follow-up visits. Special instructions should be put in writing. This is also an opportunity for the patient to ask any remaining questions about his or her own health concerns.

Normal results

Normal results of a physical examination correspond to the healthy appearance and normal functioning of the body. For example, appropriate reflexes will be present, no suspicious lumps or lesions will be found, and vital signs will be normal.

Abnormal results

Abnormal results of a physical examination include any findings that indicated the presence of a disorder, disease, or underlying condition. For example, the presence of lumps or lesions, **fever**, muscle weakness or lack of tone, poor reflex response, heart arhythmia, or swelling of lymph nodes will point to a possible health problem.

Resources

BOOKS

Bates, Barbara. *A Guide to Physical Examination and History Taking*. Philadelphia: Lippincott Co., 1995.

Talking with Your Doctor: A Guide for Older People. Bethesda, MD: National Institute on Aging, National Institutes of Health, 1994.

Karen Ericson, RN

Physical therapy *see* **Rehabilitation**

Pica

Definition

Pica is the persistent craving and compulsive eating of non-food substances.

Description

The puzzling phenomenon of pica has been recognized and described since ancient times. Pica has been observed in ethnic groups worldwide, in both primitive and modernized cultures, in both sexes, and in all age groups. The word pica comes from the Latin name for magpie, a bird known for its unusual and indiscriminate eating habits. In addition to humans, pica has been observed in other animals, including the chimpanzee.

Pica in humans has many different subgroups, defined by the substance that is ingested. Some of the most commonly described types of pica are eating earth, soil or clay (geophagia), ice (pagophagia) and starch (amylophagia). However, pica involving dozens of other substances, including cigarette butts and ashes, hair, paint chips, and paper have also been reported.

Although pica can occur in individuals of any background, a higher incidence of pica is associated with:

- **pregnancy**
- developmental delay and **mental retardation**
- psychiatric disease and **autism**
- early childhood
- poor **nutrition** or low blood levels of iron and other **minerals**
- certain cultural or religious traditions

Causes and symptoms

Evidence suggests that there may be several causes of pica. One widely held theory points to iron deficiency as a major cause of pica. Several reports have described pica in individuals with documented iron deficiency, although there has been uncertainty as to whether the iron deficiency was a cause of pica or a result of it. Because some substances, such as clay, are believed to block the absorption of iron into the bloodstream, it was thought that low blood levels of iron could be the direct result of pica. However, some studies have shown that pica cravings in individuals with iron deficiency stop once iron supplements are given to correct the deficiency. Another study looked specifically at the rate of iron absorption during pica conditions and normal dietary behavior, and showed that the iron absorption was not decreased by pica. In addition, low blood levels of iron commonly occur in pregnant women and those with poor nutrition, two populations at higher risk for pica. Such findings offer strong support of iron deficiency as a cause, rather than result, of pica.

Other reports suggest that pica may have a psychological basis and may even fall into the spectrum of **obsessive-compulsive disorder**. Pica has a higher incidence in populations with an underlying diagnosis involving mental functioning. These diagnoses include psychiatric conditions like **schizophrenia**, developmental disorders including autism, and conditions with mental retardation. These conditions are not characterized by iron deficiency, which supports a psychological component in the cause of pica.

Cultural and religious traditions may also play a role in pica behavior. In some cultures, non-food substances

are believed to have positive health or spiritual effects. Among some African Americans in the south, ingesting a particular kind of white clay is believed to promote health and reduce morning sickness during pregnancy. Other cultures practice pica out of belief that eating a particular substance may promote fertility or bring good luck.

The hallmark feature of pica, consistently consuming non-food substances, often does not present publicly. People may be embarrassed to admit to these unusual eating habits, and may hide it from their family and physician. In other cases, an individual may not report the pica to a physician simply because of a lack of knowledge of pica's potential medical significance.

Because the eating behaviors of pica are not usually detected or reported, it is the complications of the behavior that bring it to attention. Complications vary, depending on the type of pica. Geophagia has potential side effects that most commonly affect the intestine and bowel. Complications can include **constipation**, cramping, **pain**, obstruction caused by formation of an indigestible mass, perforation from sharp objects like rocks or gravel, and contamination and infection from soil-dwelling parasites.

Amylophagia usually involves the consumption of cornstarch and, less frequently, laundry starch. The high caloric content of starch can cause excessive weight gain, while at the same time leading to **malnutrition**, as starch contributes "empty" calories lacking **vitamins** and minerals. Amylophagia during pregnancy can mimic **gestational diabetes** in its presentation and even in its potential harmful effects on the fetus.

Pica involving the ingestion of substances such as lead-based paint or paper containing mercury can cause symptoms of toxic **poisoning**. Compulsive consumption of even a seemingly harmless substance like ice (pagophagia) can have negative side effects, including decreased absorption of nutrients by the gut.

Diagnosis

In order for the diagnosis of pica to be made, there must be a history of persistent consumption of a non-food substance continuing for a minimum period of one month. Infants and toddlers are typically excluded from this diagnosis since mouthing objects is a normal developmental behavior at that age. Individuals with mental retardation who function at or below an approximate cognitive level of 18 months may also be exempt form this diagnosis.

Pica is most often diagnosed when a report of such behaviors can be provided by the patient or documented by another individual. In other cases, pica is diagnosed after studies have been performed to assess the presenting symptoms. For example, imaging studies ordered to assess severe gastrointestinal complaints may reveal intestinal blockage with an opaque substance; such a finding is suggestive of pica. Biopsy of intestinal contents can also reveal findings, such as parasitic infection, consistent with pica. Pica may also be suspected if abnormal levels of certain minerals or chemicals are detected in the blood.

Treatment

Treatment of pica will often depend on the cause and type of pica. Conventional medical treatment may be appropriate in certain situations. For example, supplementation with iron-containing vitamins has been shown to cause the unusual cravings to subside in some iron-deficient patients.

Medical complications and health threats, including high lead levels, bowel perforation or intestinal obstruction, will require additional medical management, beyond addressing the underlying issue of pica.

Alternative treatment

Because most cases of pica do not have an obvious medical cause, treatment with counseling, education, and nutritional management is often more successful and more appropriate than treatment with medication. Some therapists specializing in eating disorders may have expertise in treating pica.

Prognosis

The prognosis for individuals with pica varies greatly, according to the type and amount of substance ingested, the extent of presenting side effects, and the success of treatment. Many of the side effects and complications of pica can be reversed once the behavior is stopped, while other complications, including infection and bowel perforation, pose significant health threats and if not successfully treated may result in **death**.

When seen in children, pica behavior tends to lessen with age. However, individuals with a history of pica are more likely to experience it again. Counseling and nutritional education can reduce the risk of recurrence.

Prevention

There are no known methods of preventing pica. However, once pica is known or suspected, measures can be taken to reduce further ingestion of non-food substances. Removing the particular substance from readily accessible areas can be helpful. Close observation of the individual with pica may limit inappropriate eating behaviors.

KEY TERMS

Amylophagia—The compulsive eating of purified starch, typically cornstarch or laundry starch.

Geophagia—The compulsive eating of earth substances, including sand, soil, and clay.

Pagophagia—The compulsive eating of ice.

Resources

PERIODICALS

Grigsby, R. Kevin, et al. "Chalk Eating in Middle Georgia: A Culture-Bound Syndrome of Pica?" *Southern Medical Journal* 92, no. 2 (February 1999): 190-192.

Hunter, Beatrice T. "Eating Disorders: Perilous Complications." *Consumers' Research Magazine* 80, no. 9 (September 1997): 10-15.

Jackson, W. Clay. "Amylophagia Presenting as Gestational Diabetes." *Archives of Family Medicine* 9, no. 7 (July 2000): 649-652.

Kirschner, Jeffrey. "Management of Pica: A Medical Enigma." *American Family Physician* 63, no. 6 (15 March 2001): 1169. <http://www.aafp.org/afp/20010315/tips/9.html>.

Rose, Edward A, John H. Porcerelli, and Anne V. Neale. "Pica: Common but Commonly Missed." *Journal of the American Board of Family Practice* 13, no. 5 (September-October 2000): 353-388. <http://www.familypractice.com/references/referencesframe.htm?main=/journal/2000/v13.n05/1305.05/art-1305.05.htm>.

Warshall, Peter. "Eating Earth." *Whole Earth* 96 (Spring 1999): 41.

OTHER

"Pica." KidsHealth. The Nemours Foundation, 2001. <http://kidshealth.org/parent/emotions/behavior/pica.html>.

"Pica: Dirt Eating or 'Geophagy'." Support, Concern and Resources For Eating Disorders, 2000. <http://www.eating-disorder.org/pica.html>.

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Pickwickian syndrome

Definition

A group of symptoms that generally accompany massive **obesity**.

Description

Pickwickian syndrome is a complex of symptoms that primarily affect patients with extreme obesity. The syndrome is named after a character in a Charles Dickens novel, *The Pickwick Papers*, who seemed to show some of the traits of this disease.

The major health problem that occurs in patients with this disease is **sleep apnea**. This is caused in part by the excess amounts of fatty tissue surrounding the chest muscles. This excess fat places a strain on the heart, lungs, and diaphragm of the patient, making it difficult to breathe.

Causes and symptoms

The major cause of Pickwickian syndrome is extreme obesity. This obesity places an excessive load on the pulmonary system. The role of genetics is also being studied. Symptoms of Pickwickian syndrome include excessive daytime sleepiness, **shortness of breath** due to elevated blood carbon dioxide pressure, disturbed sleep at night, and flushed face. The skin can also have a bluish tint, and the patient may have high blood pressure, an enlarged liver, and an abnormally high red blood cell count.

Diagnosis

Some tests that can be used to diagnose this condition include **echocardiography** to determine heart enlargement or **pulmonary hypertension**. Giving the patient multiple sleep latency tests can help give an objective measurement of daytime sleepiness. **Magnetic resonance imaging** (MRI), computed tomography (CT) scans, or fiberoptic evaluation of the upper airway may also be used.

Treatment

The primary treatment for Pickwickian syndrome is focused on weight loss and increased physical activity. Also, medroxyprogesterone may help improve the condition.

Prognosis

Pickwickian sydnrome is entirely reversible if it is diagnosed and treated properly. If the problem goes undiagnosed, the outcome can be fatal.

Prevention

Prevention of Pickwickian syndrome can be achieved by maintaining a healthy body weight and getting the proper amount of **exercise**. For prevention of the sleep apnea that generally accompanies Pickwickian syndrome, there are several possible treatments. If the sleep apnea is only present when the patient is flat on their

KEY TERMS

Latency—The period of inactivity between the time a stimulus is provided and the time a response occurs.

Obesity—Exceeding one's normal weight by 20%. A person suffering from extreme obesity would exceed their normal weight by a much higher percentage.

Pulmonary system—Lungs and respiratory system of the body.

back, a tennis ball can be sewn into the sleep clothes to remind the patient not to sleep on their back. For more severe cases of sleep apnea, a tonsillectomy or the use of dental appliances may be recommended.

Resources

BOOKS

Dambro, Mark R. *The 5-Minute Clinical Consult*. Baltimore: Williams & Wilkins, 2001.

Dictionary of Medical Syndromes. Philadelphia: Lippincott-Raven, 4th ed.,1997.

Tierney, Lawrence, et. al. *Current Medical Diagnosis and Treatment*. Los Altos: Lange Medical Publications, 2001.

PERIODICALS

"'Apples' and 'Pears': Defining the Shape of the Problem." *FP Report* 6 (November 2000).

Kushner, Robert F. and Roland L. Weinsier. "Evlauation of the Obese Patient." *Medical Clinics of North America* 84 (March 2000)

Kim Sharp, M.Ln.

PID *see* **Pelvic inflammatory disease**

Piercing and tattoos

Definition

Body piercing and tattoos are a popular form of body art that have been practiced throughout history by various cultures.

Description

Various cultures have embraced adorning their bodies with piercings and tattoos throughout history. In

Tattoo artist Michael Wilson displaying his own tattoos and piercings. *(Photograph bySusan Mc Cartney, Photo Researchers. Reproduced by permission.*

1992, the 4,000-year-old body of a tattooed man was discovered in a glacier on the Austrian border, and historical research has shown that Egyptians identified tattooing with fertility and nobility in the period from 4000–2000 B.C. Similar to tattooing, body piercing also has a rich history, which includes being used as a symbol of royalty and courage. In some hunting and gathering societies, body piercing and tattoos have long been used in initiation rites and as socialization/enculturation symbols.

In today's industrialized cultures, tattoos and piercing are a popular art form shared by people of all ages. They are also indicative of a psychology of **self-mutilation**, defiance, independence, and belonging, as for example in prison or gang cultures.

Popular piercing sites include the ear, nasal septum, eyebrow, tongue, cheek, navel, labia, and penis. Tattoos permanently mark various areas on the body.

Piercing is performed quickly and without anesthesia by either a spring-loaded ear-piercing gun or piercing needles, with the needle diameter varying from six to 18 gauge. The skin is cleaned, then the needle and jewelry are inserted through the tissue in one swift motion. A piercing is done without anesthesia and is typically completed in tattoo or beauty parlors.

Originating from the Tahitian word tattau, meaning "to mark," tattoos are relatively permanent marks or designs on the skin. An electric needle injects colored pigment into small deep holes made in the skin to form the tattoo. Prison tattoo techniques are usually very crude, in marked contrast to the highly skilled art practiced in Japan and also performed in America and Europe.

Causes and symptoms

While piercing and tattooing are popular, both present definite health risks. Tattoos can lead to the transmission of infectious diseases, such as **hepatitis B** and C, and theoretically HIV, when proper sterilization and safety procedures are not followed. Body piercing also presents the risk of chronic infection, scarring, hepatitis B and C, **tetanus**, and skin **allergies** to the jewelry that is used.

Body piercing and tattooing are unregulated in most United States states, but illegal in some. The American Dental Association (ADA) opposes oral (tongue, lip or cheek) piercing, and the American Academy of Dermatology is against all forms of body piercing except ear lobe piercing.

Diagnosis

Some of the signs of an infection from either piercing or tattoos are obvious, such as inflammation of the pierced or tattooed area, while the symptoms of **hepatitis C**, the most common blood-borne infection in the United States, may not be so obvious. Allergic responses to tattoos may occur due to the pigment compounds used, such as oxides of iron, mercury, chromium, cadmium, and cobalt and synthetic organic dyes. Symptoms of an allergic reaction include swelling, redness and severe **itching**.

Most infections from piercing are due to the use of non-sterile techniques. The skin pathogens streptococcus and staphylococcus are most frequently involved in skin infections from piercing. The fleshy tissue around the pierced area may weaken and tear, leading for example, to a badly disfigured earlobe. Other common complications include **contact dermatitis** and scars. Piercing can result in **endocarditis**, urethral rupture, and a serious infection of the penis foreskin leading to severe disability or even **death**.

Treatment

Treatment of a local infection from piercing includes warm compresses and antibacterial ointment for local infections, to a five-day course of oral antibiotic therapy. If hepatitis B or C is confirmed, then a series of diet and lifestyle changes, such as the elimination of alcohol, is recommended to control the disease.

There are four methods to remove tattoos, including: surgical removal that involves cutting the tattoo away; sanding the skin with a wire brush to remove the epidermis and dermis layers in a process called dermabrasion; using a salt solution to soak the tattooed skin (salabrasion); and scarification, removing the tattoo with an acid solution to form a scar in its place.

Prognosis

Depending on the type of infection resulting from either piercing or tattoos, the treatment and prognosis vary. Minor infections respond well to antibiotic therapy, while blood borne diseases such as hepatitis B and C cause life-altering results. Disfigurement may or may not be fully correctable by later plastic surgery.

Prevention

The best way to prevent infection from piercing or tattoos is not to get one in the first place. Procedures should be performed in a sterile environment by an experienced professional. An autoclave (a heat machine regulated by the Food and Drug Administration) should be available on the premises to clean needles and tubes after each customer, and people performing the procedure should wear latex gloves when applying the tattoo.

Piercing should be completed with smoothly polished jewelry made of 14 or 18 carat gold, titanium, surgical steel or niobium. An allergic reaction can result with the use of jewelry made of brass plate or containing a nickel alloy. Healing time from a piercing range from six months to two years. A piercing should be completed in a sterile environment that uses every precaution to reduce the risk of infection. Excessive force, such as exerting a strong pull, should never be applied to jewelry inserted into pierced body parts to avoid tearing and injuring the tissues.

KEY TERMS

Endocarditis—Infection of a valve inside the heart.

Hepatitis—Inflammation of the liver.

Socialization—Process by which new members of a social group are integrated in the group.

Resources

PERIODICALS

Abbasi, Kamran. "Body Piercing" *British Medical Journal* (April 14, 2001): 936.

Brown, Kelli McCormack, Paula Perlmutter, and Robert J. McDermott. "Youth and Tattoos: What School Health Personnel Should Know." *Journal of School Health* (November 2000): 355.

Edy, Carolyn. "Body Piercing Woes: One More Reason to Think Twice Before Getting Your Navel Pierced." *Yoga Journal* (June 30, 2000): 36.

Weir, Erica. "Navel Gazing: A Clinical Glimpse at Body Piercing." *Canadian Medical Association Journal* (March 2001): 864.

Beth Kapes

Pilates

Definition

Pilates or Physical mind method, is a series of non-impact exercises designed by Joseph Pilates to develop strength, flexibility, balance, and inner awareness.

Purpose

Pilates is a form of strength and flexibility training that can be done by someone at any level of fitness. The exercises can also be adapted for people who have limited movement or who use wheel chairs. It is an engaging **exercise** program that people want to do. Pilates promotes a feeling of physical and mental well-being and also develops inner physical awareness. Since this method strengthens and lengthens the muscles without creating bulk, it is particularly beneficial for dancers and actors. Pilates is also helpful in preventing and rehabilitating from injuries, improving posture, and increasing flexibility, circulation, and balance. Pregnant women who do these exercises can develop body alignment, improve concentration, and develop body shape and tone after **pregnancy**. According to Joseph Pilates, "You will feel better in 10 sessions, look better in 20 sessions and have a completely new body in 30 sessions."

Description

Origins

Joseph Pilates, the founder of the Pilates method (also simply referred to as "the method") was born in Germany in 1880. As a frail child with rickets, **asthma**, and **rheumatic fever**, he was determined to become stronger. He dedicated himself to building both his body and his mind through practices which included **yoga**, zen, and ancient Roman and Greek exercises. His conditioning regime worked and he became an accomplished gymnast, skier, boxer, and diver.

While interned in England during World War I for being a German citizen, Pilates became a nurse. During this time, he designed a unique system of hooking springs and straps to a hospital bed in order to help his disabled and immobilized patients regain strength and movement. It was through these experiments that he recognized the importance of training the core abdominal and back muscles to stabilize the torso and allow the entire body to move freely. This experimentation provided the foundation for his style of conditioning and the specialized exercise equipment associated with the Pilates method.

Pilates emigrated to the United States in 1926 after the German government invited him to use his conditioning methods to train the army. That same year he opened the first Pilates studio in New York City. Over the years, dancers, actors, and athletes flocked to his studio to heal, condition, and align their bodies.

Joseph Pilates died at age 87 in a fire at his studio. Although his strength enabled him to escape the flames by hanging from the rafters for over an hour, he died from **smoke inhalation**. He believed that ideal fitness is "the attainment and maintenance of a uniformly developed body with a sound mind fully capable of naturally, easily, and satisfactorily preforming our many and varied daily tasks with spontaneous zest and pleasure."

During the initial meeting, an instructor will analyze the client's posture and movement and design a specific training program. Once the program has been created, the sessions usually follow a basic pattern. A session generally begins with mat work and passive and active stretching. In passive stretching, the instructor moves and presses the client's body to stretch and elongate the muscles. During the active stretching period, the client preforms the stretches while the instructor watches their form and breathing. These exercises warm up the muscles in preparation for the machine work. The machines help the client to maintain the correct positioning required for each exercise.

There are 500 exercises that were developed by Joseph Pilates. "Classical" exercises, according to the Pilates Studio in New York involve several principles. These include concentration, centering, flowing movement, and breath. Some instructors teach only the classical exercises originally taught by Joseph Pilates. Others design new exercises that are variations upon these classical forms in order to make the exercises more accessible for a specific person.

There are two primary exercise machines used for Pilates, the Universal Reformer and the Cadillac, and several smaller pieces of equipment. The Reformer resembles a single bed frame and is equipped with a carriage that slides back and forth and adjustable springs that are used to regulate tension and resistance. Cables, bars, straps, and pulleys allow the exercises to be done from a variety of positions. Instructors usually work with their clients on the machines for 20–45 minutes. During this time, they are observing and giving feedback about alignment, breathing, and precision of movement. The exercises are done slowly and carefully so that the movements are smooth and flowing. This requires focused concentration and muscle control. The session ends with light stretching and a cool-down period.

Once the basics are learned from an instructor, from either one-on-one lessons or in a class, it is possible to train at home using videos. Exercise equipment for use at home is also available and many exercises can be preformed on a mat.

A private session costs between $45–75 dollars, depending on the part of the country one is in. This method is not specifically covered by insurance although it may be covered when the instructor is a licensed physical therapist.

Precautions

Pilates is not a substitute for good physical therapy. People with chronic injuries are advised to see a physician.

Research and general acceptance

There are no scientific research studies on Pilates. However, Pilates appeals to a wide population. Dancers and actors originally embraced it as a form of strength training that did not create muscle bulk. Professional and amateur athletes also use these exercises to prevent reinjury. Sedentary people find Pilates to be a gentle, non-impact approach to conditioning. Pilates equipment and classes can be found in hospitals, health clubs, spas, and gyms.

Resources

BOOKS

Knaster, Mirka. *Discovering the Body's Wisdom*. New York: Bantam Books, 1996.

Pilates, Joseph H., et al. *The Complete Writings of Joseph Pilates: Return to Life Through Contrology and Your Health*. New York: Bantam Doubleday, 2000.

Robinson, Lynne, et al. *Body Control: Using the Techniques Developed by Joseph Pilates*. Trans-Atlantic Publications, 1998.

KEY TERMS

Yoga—A system of physical, mental, and breathing exercises developed in India.

Zen—A form of meditation that emphasizes direct experience.

Siler, Brooke. *The Pilates Body: The Ultimate At-Home Guide to Strengthening, Lengthening and Toning Your Body-Without Machines*. New York: Bantam Doubleday, 2000.

PERIODICALS

Argo, Carol. "The Pilates Method for a Balanced Body." *American Fitness* (March/April 1999): 52-54.

Chang, Yahlin. "Grace Under Pressure." *Newsweek Magazine* (February 28, 2000).

ORGANIZATIONS

Physical Mind Institute. 1807 Second Street, Suite 15/16, Santa Fe, New Mexico 87505. (505) 988-1990 or (800) 505-1990. Fax: (505) 988-2837. <themethod@trail.com>. <http:\\www.the-method.com>.

The Pilates Studio. 2121 Broadway, Suite 201, New York, New York, 10023-1786. (800)474-5283 or (888) 474-5283 or (212)875-0189. Fax: (212) 769-2368. <http:\\www.pilates-studio.com>.

Linda Chrisman

Piles *see* **Hemorrhoids**

Pinguecula and pterygium

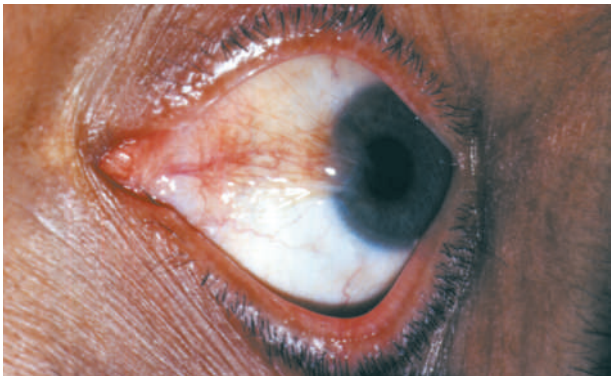
Definition

Pinguecula and pterygium are both non-malignant, slow-growing proliferations of conjunctival connective tissue in the eye. Pterygia, but not pingueculae, extend over the cornea.

Description

The outer layer of the eyeball consists of the tough white sclera and the transparent cornea. The cornea lies in front of the colored part of the eye (iris). Overlying the sclera is a transparent mucous membrane called the conjunctiva. The conjunctiva lines the inside of the lids (palpebral conjunctiva) and covers the sclera (bulbar conjunctiva).

Pinguecula and pterygia are common in adults, and their incidence increases with age. Pterygia are less common than pingueculae.



Pterygium, an overgrowth of the cornea, is usually on the inner side of the eye by thickened and degenerative conjunctiva. *(Photo Researchers, Inc. Reproduced by permission.)*

Pingueculae are seen as small, raised, thickenings of the conjunctiva. They may be yellow, gray, white, or colorless. They are almost always to one side of the iris—not above or below—and usually on the side closest to the nose. A pinguecula may develop into a pterygium.

Pterygia are conjunctival thickenings that may have blood vessels associated with them. They often have a triangular-shaped appearance. The pterygia may also grow over the cornea and may therefore affect vision.

Causes and symptoms

Causes

The cause or causes of these disorders are unknown, but they are more frequent in people who live in sunny and windy climates and people whose jobs expose them to ultraviolet (UV) light (for example, farmers and arc welders). Pingueculae and pterygia also occur in older people. It is thought these growths are the result of UV or infrared light and irritation. It is also believed that prolonged exposure to these risk factors (that is, UV light) increases the chances of occurrence.

Symptoms

Although some people with pinguecula constantly feel like they have a foreign body in their eye, most are asymptomatic. Because the lids can no longer spread the tears over a smooth area, dry areas may result. Some people with a pterygium are also asymptomatic; some feel like they have a foreign body in their eye. Because a pterygium can stretch and distort the cornea, some people acquire **astigmatism** from a pterygium.

Diagnosis

An eye doctor (ophthalmologist or optometrist) can usually diagnose pingueculae and pterygia by external observation, generally using an instrument called a slit lamp. A slit lamp is a microscope with a light source and magnifies the structures of the eye for the examiner. However, because pingueculae and pterygia can sometimes look similar to more serious eye growths, it is important for people to have them checked by an eye care professional.

Treatment

Usually, no treatment is needed. Artificial tears can be used to relieve the sensation of a foreign body in the eye and to protect against dryness. Surgery to remove the pinguecula or pterygium is advisable when the effect on the cornea causes visual defects or when the thickening is causing excessive and recurrent discomfort or inflammation. Sometimes surgical removal is also performed for cosmetic reasons. However, healing from this type of surgery, although usually painless, takes many weeks, and there is a high rate of recurrence (as high as 50–60% in some regions). Accordingly, surgery is avoided unless problems due to the pinguecula or pterygium are significant.

Several methods have been used to attempt to reduce the recurrence of the pinguecula or pterygium after surgery. One method that should be abandoned is beta radiation. Although it is effective at slowing the regrowth of pingueculae and pterygia, it can cause **cataracts**. A preferable method is the topical application of the anticancer drug, mitomycin-C.

Prognosis

Most pingueculae and pterygia grow slowly and almost never cause significant damage, so the prognosis is excellent. Again, a diagnosis must be made to rule out other more serious disorders.

Prevention

There is nothing that has been clearly shown to prevent these disorders, or to prevent a pinguecula from progressing to a pterygium. However, the presence of pingueculae and pterygia have been linked to exposure to UV radiation. For that reason, UV exposure should be reduced. The American Optometric Association (AOA) suggests that sunglasses should block 99–100% of UV-A and UV-B rays. Patients should speak to their eye care professionals about protective coatings on sunglasses or regular spectacles. Protecting the eyes from sunlight, dust, and other environmental irritants is a good idea.

Resources

BOOKS

Gayton, Johnny L., and Jan R. Ledford. *The Crystal Clear Guide to Sight for Life*. Lancaster: Starburst, 1996.

KEY TERMS

Astigmatism—Asymetric vision problems due to irregularities in the cornea.

Beta radiation—Streams of electrons emitted by beta emitters like carbon-14 and radium.

Conjuctiva—The mucous membrane that covers the white part of the eyes and lines the eyelids.

Cornea—The clear outer covering of the front of the eye. It is in front of the colored part of the eye (iris) and the iris's central black hole (pupil).

Newell, Frank W. *Ophthalmology: Principles and Concepts.* 8th ed. St. Louis: Mosby, 1996.

ORGANIZATIONS

New York University (NYU), Department of Ophthalmology. 550 First Ave., New York, NY 10016. (212) 263-6433. <http://ophth-www.med.nyu.edu/Ophth>.

OTHER

Chang, W. Jerry. "Are Pingueculas in Your Future?" *Healthline Magazine* Dec. 1995. 7 June 1998 <http://www.healthline.com>.

Lorraine Lica, PhD

Pinkeye *see* **Conjunctivitis**

Pinta

Definition

A bacterial infection of the skin which causes red to bluish-black colored spots.

Description

Pinta is a skin infection caused by the bacterium *Treponema carateum*, a relative of the bacterium which causes **syphilis**. The word "pinta" comes from the Spanish and means "painted." Pinta is also known as "azula" (blue), and "mal de pinto" (pinto sickness). It is one of several infections caused by different *Treponema* bacteria, which are called "endemic" or "non-venereal" treponematoses.

Pinta is primarily found in rural, poverty-stricken areas of northern South America, Mexico, and the Caribbean. The disease is usually acquired during childhood and is spread from one person to another by direct skin-to-skin contact. The bacteria enter the skin through a small cut, scratch, or other skin damage. Once inside the skin, the warmth and moisture allow the bacteria to multiply. The bacterial infection causes red, scaly lesions on the skin.

Causes and symptoms

Pinta is caused by an infection with the bacterium *Treponema carateum*. Persons at risk for pinta are those who live in rural, poverty-stricken, overcrowded regions of South America, Mexico, and the Caribbean. Symptoms of pinta occur within two to four weeks after exposure to the bacteria. The first sign of infection is a red, scaly, slowly enlarging bump on the skin. This is called the "primary lesion." The primary lesion usually appears at the site where the bacteria entered the skin. This is often on the arms, legs, or face. The smaller lesions which form around the primary lesion are called "satellite lesions." Lymph nodes located near the infected area will become enlarged, but are painless.

The second stage of pinta occurs between one and 12 months after the primary lesion stage. Many flat, red, scaly, itchy lesions called "pintids" occur either near the primary lesion, or scattered around the body. Pintid lesions progress through a range of color changes, from red to bluish-black. The skin of older lesions will become depigmented (loss of normal color).

Diagnosis

Pinta can be diagnosed by dermatologists (doctors who specialize in skin diseases) and infectious disease specialists. The appearance of the lesions helps in the diagnosis. A blood sample will be taken from the patient's arm to test for antibodies to *Treponema carateum*. A scraping of a lesion will be examined under the microscope to look for *Treponema* bacteria. The results of these tests should be available within one to two days.

Treatment

Pinta is treated with benzathine penicillin G (Bicillin), given as a single injection.

Prognosis

Treatment will result in a complete cure but will not undo any skin damage caused by the late stages of disease. Spread of pinta to the eyes can cause eyelid deformities.

KEY TERMS

Lesion—An abnormal change in skin due to disease.

Prevention

Good personal hygiene and general health may help prevent infections. In general, avoid physical contact with persons who have **skin lesions**.

Resources

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Belinda Rowland, PhD

Pinworm infection *see* **Enterobiasis**

Pituitary adenoma *see* **Pituitary tumors**

Pituitary dwarfism

Definition

Dwarfism is a condition in which the growth of the individual is very slow or delayed. There are many forms of dwarfism. The word pituitary is in reference to the pituitary gland in the body. This gland regulates certain chemicals (hormones) in the body. Therefore, pituitary dwarfism is decreased bodily growth due to hormonal problems. The end result is a proportionate little person, because the height as well as the growth of all other structures of the individual are decreased.

Description

Pituitary dwarfism is caused by problems arising in the pituitary gland. The pituitary gland is also called the hypophysis. The pituitary gland is divided into two halves: the anterior (front) and posterior (back) halves. The anterior half produces six hormones: growth hormone, adrenocorticotropin (corticotropin), thyroid stimulating homone (thyrotropin), prolactin, follicle stimulating hormone, and lutenizing hormone. The posterior pituitary gland only produces two hormones. It produces antidiuretic hormone (vasopressin) and oxytocin.

Most forms of dwarfism are a result of decreased production of hormones from the anterior half of the pituitary gland. The most common form is due to decreases of growth hormone which will be discussed here. These decreases during childhood cause the individual's arms, legs, and other structures to develop normal proportions for their bodies, but at a decreased rate.

When all of the hormones of the anterior pituitary gland are not produced, this is called panhypopituitarism. Another type of dwarfism occurs when only the growth hormone is decreased. Dwarfism can also result from a lack of somatomedin C (also called insulin like growth factor, IGF-1) production. Somatomedin C is a hormone produced in the liver that increases bone growth when growth hormone is present. The African pygmy and the Levi-Lorain dwarfs lack the ability to produce somatomedin C in response to growth hormone. All causes of dwarfism lead to a proportionate little person.

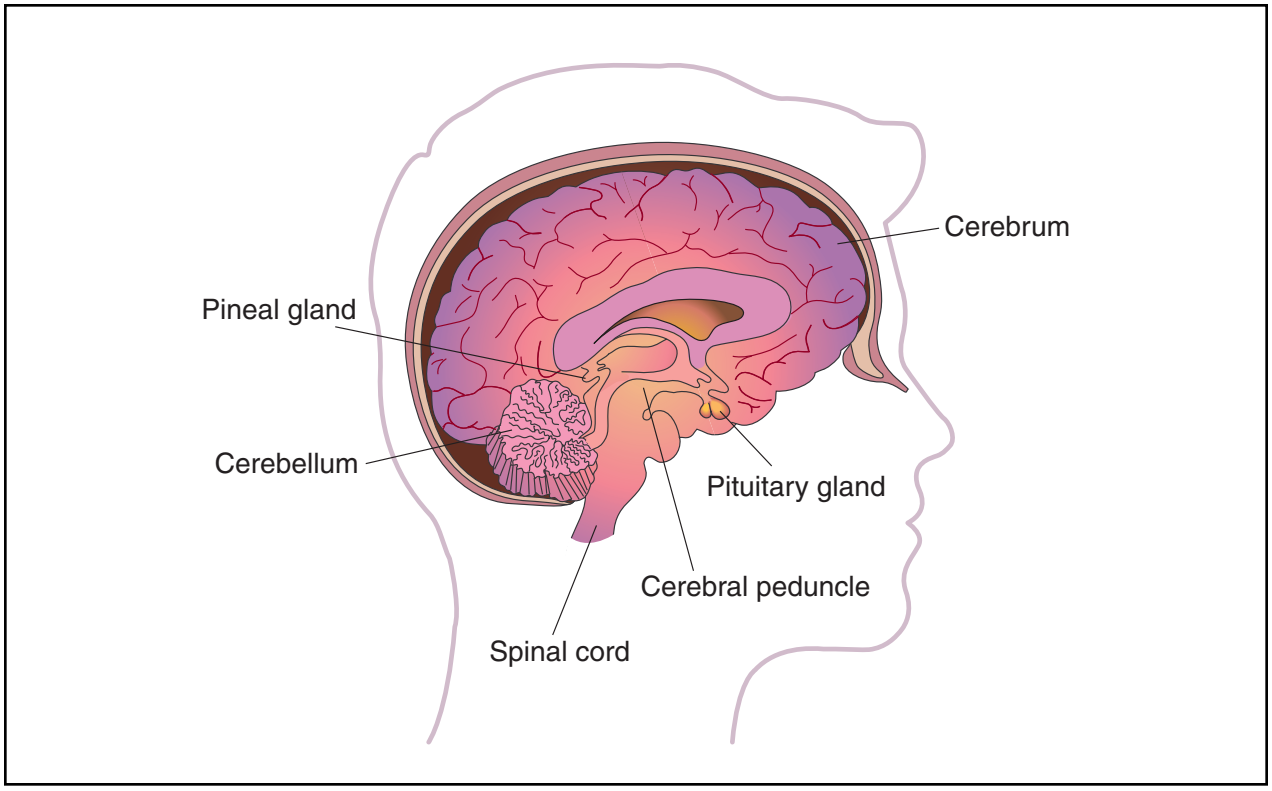
Growth is the body's response to different hormones. The forebrain contains a small organ called the hypothalamus, which is responsible for releasing hormones in response to the body's needs for purposes of regulation. Growth hormone is produced in the anterior pituitary gland when growth hormone-releasing hormone (GHRH), is released by the hypothalamus. Growth hormone is then released and stimulates the liver to produce IGF-1. In return, IGF-1 stimulates the long bones to grow in length. Thus, growth can be slowed down or stopped if there is a problem making any of these hormones or if there is a problem with the cells receiving these hormones.

Some estimates show that there are between 10,000 and 15,000 children in the United States who have growth problems due to a deficiency of growth hormone.

Causes and symptoms

Pituitary dwarfism has been shown to run in families. New investigations are underway to determine the specific cause and location of the gene responsible for dwarfism. The human cell contains 46 chromosomes arranged in 23 pairs. Most of the genes in the two chromosomes of each pair are identical or almost identical with each other. However, with dwarfism, there appears to be disruption on different areas of chromosome 3 and 7. Some studies have isolated defects for the production of pituitary hormones to the short arm (the "p" end) of chromosome 3 at a specific location of 3p11. Other studies have found changes on the short arm of chromosome 7.

A child with a growth hormone deficiency is often small with an immature face and chubby body build. The child's growth will slow down and not follow the normal growth curve patterns. In cases of tumor, most commonly craniopharyngioma (a tumor near the pituitary gland),



Pituitary dwarfism is a condition of growth retardation characterized by patients who are very short but have normal body proportions. It is caused by a dysfunction of the pituitary gland, the pea-sized mass of tissue located at the base of the brain. *(Illustration by Electronic Illustrators Group.)*

children and adolescents may present with neurological symptoms such as headaches, vomiting, and problems with vision. The patient may also have symptoms of double vision. Symptoms such as truly bizarre and excessive drinking behaviors (polydipsia) and sleep disturbances may be common.

Diagnosis

The primary symptom of pituitary dwarfism is lack of height. Therefore, a change in the individual's growth habits will help lead to a diagnosis. Another diagnostic technique uses an x ray of the child's hand to determine the child's bone age by comparing this to the child's actual chronological age. The bone age in affected children is usually two years or more behind the chronological age. This means that if a child is ten years old, his or her bones will look like they are those of an eight-year-old child. The levels of growth hormone and somatomedin C must also be measured with blood tests.

Hypopituitarism may be gained or acquired following birth for several reasons. It could be due to trauma to the pituitary gland such as a fall or following surgery to the brain for removal of a tumor. It may also be due to the child's environment (deprivational dwarfism).

On examination by the doctor there may be optic nerve atrophy, if the dwarfism is due to a type of tumor. X rays of the area where the pituitary gland is located (sella turcica) or more advanced imaging such as **magnetic resonance imaging** (MRI) or computed tomography (CT) may show changes of the pituitary gland itself. Computed tomography is an advanced form of x ray that will help determine the integrity of the bone and how much calcification the tumor is producing. Magnetic resonance imaging will also help in the diagnosis. MRI is a type of imaging device that can visualize soft tissues such as muscle and fat.

If the dwarfism is due to environmental and emotional problems, the individual may be hospitalized to monitor hormone levels. Following a few days of hospitalization, hormone levels may become normal due to avoidance of the original environment.

Treatment

The main course of therapy is growth **hormone replacement therapy** when there is lack of growth hormone in the body. A pediatric endocrinologist, a doctor specializing in the hormones of children, usually admin-

KEY TERMS

Adrenocorticotropin (corticotrophin)—A hormone that acts on cells of the adrenal cortex, causing them to produce male sex hormones and hormones that control water and mineral balance in the body.

Antidiuretic hormone (vasopressin)—A hormone that acts on the kidneys to regulate water balance.

Craniopharyngioma—A tumor near the pituitary gland in the craniopharyngeal canal that often results in intracranial pressure.

Deprivational dwarfism—A condition where emotional disturbances are associated with growth failure and abnormalities of pituitary function.

Follicle-stimulating hormone (FSH)—A hormone that in females stimulates estrogen and in males stimulates sperm production.

Growth hormone—A hormone that eventually stimulates growth. Also called somatotropin.

Hormone—A chemical messenger produced by the body that is involved in regulating specific bodily functions such as growth, development, and reproduction.

Lutenizing hormone—A hormone secreted by the pituitary gland that regulates the menstrual cycle and triggers ovulation in females. In males it stimulates the testes to produce testosterone.

Oxytocin—A hormone that stimulates the uterus to contract during child birth and the breasts to release milk.

Panhypopituitarism—Generalized decrease of all of the anterior pituitary hormones.

Prolactin—A hormone that helps the breast prepare for milk production during pregnancy.

Puberty—Point in development when the gonads begin to function and secondary sexual characteristics begin to appear.

Thyroid stimulating hormone (thyrotropin)—A hormone that stimulates the thyroid gland to produce hormones that regulate metabolism.

isters this type of therapy before a child's growth plates have fused or joined together. Once the growth plates have fused, GH replacement therapy is rarely effective.

Growth hormone used to be collected from recently deceased humans. However, frequent disease complications resulting from human growth hormone collected from deceased bodies lead to the banning of this method. In the mid-1980s, techniques were discovered that could produce growth hormones in the lab. Now, the only growth hormone used for treatment is that made in a laboratory.

A careful balancing of all of the hormones produced by the pituitary gland is necessary for patients with panhypopituitarism. This form of dwarfism is very difficult to manage.

Prognosis

The prognosis for each type of dwarfism varies. A panhypopituitarism dwarf does not pass through the initial onset of adult sexual development (**puberty**) and never produces enough gonadotropic hormones to develop adult sexual function. These individuals also have several other medical conditions. Dwarfism due to only growth hormone deficiency has a different prognosis. These individuals do pass through puberty and mature sexually, however, they remain proportionately small in stature.

If the individual is lacking only growth hormone then growth hormone replacement therapy can be administered. The success of treatment with growth hormone varies however. An increase in height of 4–6 in (10–15 cm) can occur in the first year of treatment. Following this first year, the response to the hormone is not as successful. Therefore the amount of growth hormone administered must be tripled to maintain this rate. Long-term use is considered successful if the individual grows at least 0.75 in (2 cm) per year more than they would without the hormone. However, if the growth hormone treatment is not administered before the long bones—such as the legs and arms—fuse, then the individual will never grow. This fusion is completed by adult age.

Improvement for individuals with dwarfism due to other causes such as a tumor, varies greatly. If the dwarfism is due to deprevational causes, then removing a child from that environment should help to alleviate the problem.

Resources

BOOKS

Guyton, Arthur C., and John E. Hall. "The Pituitary Hormones and Their Control by the Hypothalamus." *Textbook of*

Medical Physiology, 9th ed. Philadelphia: W.B. Saunders Company, 1996.
"Pituitary Dwarfism." In *Merck Manual*. Ed. Mark H. Beers, Robert Berkow, and Mark Burs, 2378–80. Rahway, NJ: Merck & Co., Inc., 1999.
Rogol, Alan D. "Hypothalamic and Pituitary Disorders in Infancy and Childhood." In *Principles and Practice of Endocrinology and Metabolism,* 2nd ed. Ed. Kenneth L. Becker, et. al., 180–88. Philadelphia: J.B. Lippencott Company, 1995.

PERIODICALS

Maheshwari, H. G., et. al. "Phenotype and Genetic Analysis of a Syndrome Caused by an Inactivating Mutation in the Growth Hormone-Releasing Hormone Receptor: Dwarfism of Sindh." *Journal of Clinical Endocrinology and Metabolism* 83, no. 11 (1998): 4065–81.
Nagel, B. H. P. "Magnetic Resonance Images of 91 children with Different Causes of Short Stature: Pituitary Size Reflects Growth Hormone Secretion." *European Journal of Pediatrics* 156 (1997): 758–63.
Raskin, S., et. al. "Genetic Mapping of the Human Pituitary-Specific Transcriptional Factor Gene and Its Analysis in Familial Panhypopituitary Dwarfism." *Human Genetics* 98 (1996): 703–5.

ORGANIZATIONS

Human Growth Foundation. 997 Glen Cove Ave., Glen Head, NY 11545. (800) 451-6434. Fax: (516) 671-4055. <http://www. hgf1@hgfound.org>.
Little People of America, Inc. National Headquarters, PO Box 745, Lubbock, TX 79408. (806) 737-8186 or (888) LPA-2001. <lpadatabase@juno.com>. <http://www.lpaonline.org>.
MAGIC Foundation for Children's Growth. 1327 N. Harlem Ave., Oak Park, IL 60302. (708) 383-0808 or (800) 362-4423. Fax: (708) 383-0899. <mary@magicfoundation.org>. <http://www.magicfoundation.org/ghd.html>.

OTHER

"Clinical Growth Charts by the National Center for Health Statistics." *Center for Disease Control.* <http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/clinical_charts.htm>.
"Entry 312000: Panhypopituitarism; PHP." *OMIM—Online Mendelian Inhericance in Man*. National Institutes of Health. <http://www.ncbi.nlm.nih.gov/htbin-post/Omim/dispmim?312000>.
Hill, Mark. "Development of the Endocrine System—Pituitary." *The University of New South Wales, Sydney, Australia—Department of Embryology* <http://anatomy.med.unsw.edu.au/CBL/Embryo/OMIMfind/endocrine/pitlist.htm>.

Jason S. Schliesser, DC

Pituitary gland removal *see* **Hypophysectomy**

Pituitary tumors

Definition

Pituitary tumors are abnormal growths on the pituitary gland. Some tumors secrete hormones normally made by the pituitary gland.

Description

Located in the center of the brain, the pituitary gland manufactures and secretes hormones that regulate growth, sexual development and functioning, and the fluid balance of the body. About 10% of all cancers in the skull are pituitary tumors. Pituitary adenomas (adenomas are tumors that grow from gland tissues) and pituitary tumors in children and adolescencents (craniopharyngiomas) are the most common types of pituitary tumors. They are usually benign and grow slowly. Even malignant pituitary tumors rarely spread to other parts of the body.

Pituitary adenomas do not secrete hormones but are likely to be larger and more invasive than tumors that do. Craniopharyngiomas are benign tumors that are extremely difficult to remove. Radiation does not stop them from spreading throughout the pituitary gland. Craniopharyngiomas account for less than 5% of all brain tumors. Pituitary tumors usually develop between the ages of 30 and 40, but half of all craniopharyngiomas occur in children, with symptoms most often appearing between the ages of five and ten.

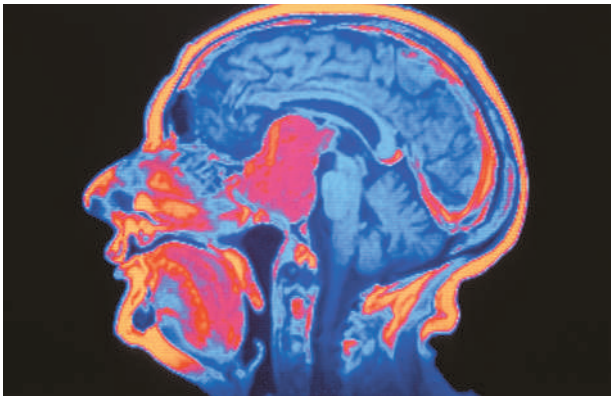
Causes and symptoms

The cause of pituitary tumors is not known, but may be genetic. Symptoms related to tumor location, size, and pressure on neighboring structures include:

- persistent **headache** on one or both sides, or in the center of the forehead
- blurred or double vision; loss of peripheral vision
- drooping eyelid caused by pressure on nerves leading to the eye
- seizures

Symptoms related to hormonal imbalance include:

- excessive sweating
- loss of appetite
- loss of interest in sex
- inability to tolerate cold temperatures
- nausea
- high levels of sodium in the blood
- menstrual problems



Colorized MRI showing large pituitary tumor at center in pink. *(Mehau Kulyk, Photo Researchers. Reproduced by permission.)*

- excessive thirst
- frequent urination
- dry skin
- constipation
- premature or delayed **puberty**
- delayed growth in children
- galactorrea (milk secretion in the absence of **pregnancy** or breast feeding)
- low blood pressure
- low blood sugar

Diagnosis

As many as 40% of all pituitary tumors do not release excessive quantities of hormones into the blood. Known as clinically nonfunctioning, these tumors are difficult to distinguish from tumors that produce similar symptoms. They may grow to be quite large before they are diagnosed.

Endocrinologists and neuroendocrinologists base the diagnosis of pituitary tumors on:

- the patient's own observations and medical history
- physical examination
- laboratory studies of the patient's blood and cerebrospinal fluid
- x rays of the skull and other studies that provide images of the inside of the brain (CT, MRI)
- vision tests
- urinalysis

Treatment

Some pituitary tumors stabilize without treatment, but a neurosurgeon will operate at once to remove the tumor (adenectomy) or pituitary gland (**hypophysectomy**) of a patient whose vision is deteriorating rapidly. Patients who have pituitary apoplexy may experience very severe headaches, have symptoms of stiff neck, and sensitivity to light. This condition is considered an emergency. **Magnetic resonance imaging** (MRI) is the best imaging technique for patients with these symptoms. If the tumor is small, surgery may be done through the nose. If the tumor is large, it may require opening the skull for **tumor removal**. Selected patients do well with proton beam radiosurgery (the use of high energy particles in the form of a high energy beam to destroy an overactive gland).

Treatment is determined by the type of tumor and by whether it has invaded tissues adjacent to the pituitary gland. Hormone-secreting tumors can be successfully treated with surgery, radiation, bromocriptine (Parlodel), Sandostatin (Octreotide), or other somatostatin analogues (drugs similar to somatostatin). Surgery is usually used to remove all or part of a tumor within the gland or the area surrounding it, and may be combined with **radiation therapy** to treat tumors that extend beyond the pituitary gland. Removal of the pituitary gland requires life-long **hormone replacement therapy**.

Radiation therapy can provide long-term control of the disease if it recurs after surgery, and radioactive pellets can be implanted in the brain to treat craniopharyngiomas. CV205-502, a new dopamine agonist (a drug that increases the effect of another, in this instance dopamine) can control symptoms of patients who do not respond to bromocriptine.

Prognosis

Pituitary tumors are usually curable. Following surgery, adults may gradually resume their normal activities, and children may return to school when the effects of the operation have diminished, and appetite and sense of well-being have returned. Patients should wear medical identification tags identifying their condition and the hormonal replacement medicines they take.

KEY TERMS

Agonist—A drug that increases the effectiveness of another drug.

Analogue—A drug that is similar to the drug from which it is derived.

Resources

BOOKS

Daly, Stephen, ed. *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corporation, 1996.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Shaw, Michael, ed. *Everything You Need to Know About Diseases*. Springhouse, PA: Springhouse Corporation, 1996.

ORGANIZATIONS

American Brain Tumor Association. 2770 River Road, Des Plaines, IL 60018. (800) 886-2289. <http://www.abta.org>.

Brain Tumor Information Services. Box 405, Room J341, University of Chicago Hospitals, 5841 S. Maryland Ave., Chicago, IL 60637. (312) 684-1400.

Maureen Haggerty

Pityriasis rosea

Definition

Pityriasis rosea is a mild, noncontagious skin disorder common among children and young adults, and characterized by a single round spot on the body, followed later by a rash of colored spots on the body and upper arms.

Description

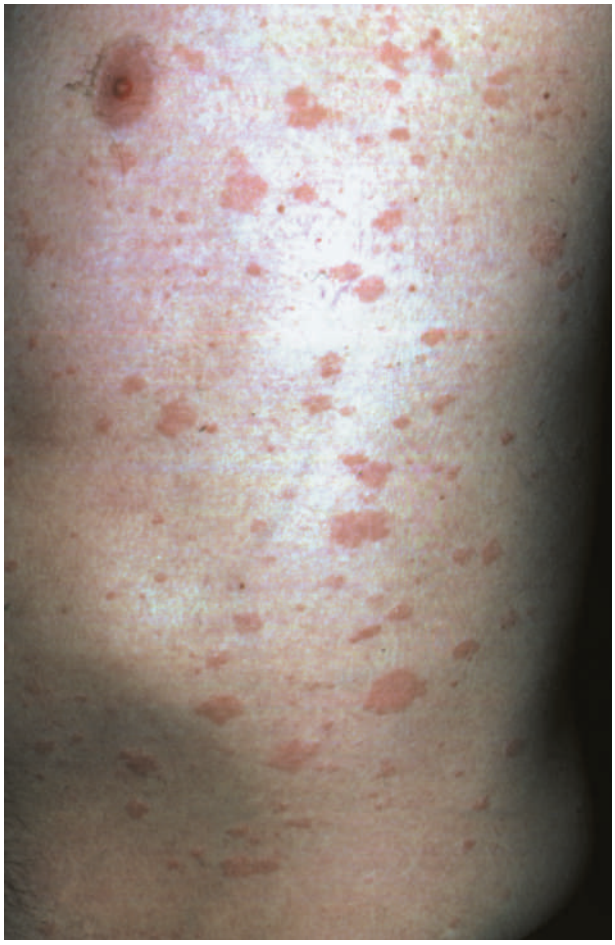
Pityriasis rosea is most common in young adults, and appears up to 50% more often in women. Its cause is unknown; however, some scientists believe that the rash is an immune response to some type of infection in the body.

Causes and symptoms

Doctors do not think that pityriasis rosea is contagious, but the cause is unknown. Some experts suspect the rash, which is most common in spring and fall, may be triggered by a virus, but no infectious agent has ever been found.

It is not sexually transmitted, and does not appear to be contagious from one person to the next.

Sometimes, before the symptoms appear, people experience preliminary sensations including **fever**, malaise, **sore throat**, or **headache**. Symptoms begin with a single, large round spot called a "herald patch" on the body, followed days or weeks later by slightly raised, scaly-edged round or oval pink-copper colored spots on the trunk and upper arms. The spots, which have a wrinkled center and a sharp border, sometimes resemble a Christmas tree. They may be mild to severely itchy, and they can spread to other parts of the body.



The torso of a man covered with pityriasis rosea. The cause of this disorder is thought to be due to a viral infection. It often appears on the torso and upper parts of the limbs of young people and may be contagious. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

Diagnosis

A physician can diagnose the condition with blood tests, skin scrapings, or a biopsy of the lesion.

Treatment

The rash usually clears up on its own, although a physician should rule out other conditions that may cause a similar rash (such as **syphilis**).

Treatment includes external and internal medications for **itching** and inflammation. Mild inflammation and itching can be relieved with antihistamine drugs or calamine lotion, zinc oxide, or other mild lubricants or anti-itching creams. Gentle, soothing strokes should be

KEY TERMS

Antihistamines—A group of drugs that block the effects of histamine, a chemical released during an allergic reaction.

Steroids—A group of drugs that includes the corticosteroids, similar to hormones produced by the adrenal glands, and used to relieve inflammation and itching.

used to apply the ointments, since vigorous rubbing may cause the lesions to spread. More severe itching and inflammation is treated with topical steroids. Moderate exposure to sun or ultraviolet light may help heal the lesions, but patients should avoid being sunburned.

Soap makes the rash more uncomfortable; patients should bathe or shower with plain lukewarm water, and apply a thin coating of bath oil to freshly-dried skin afterwards.

Prognosis

These spots, which may be itchy, last for 3-12 weeks. Symptoms rarely recur.

Resources

BOOKS

Orkin, Milton, Howard Maibach, and Mark Dahl. *Dermatology.* Norwalk, CT: Appleton & Lange, 1991.

PERIODICALS

Pellman, Harry. "A Rash Pot Pourri." *Pediatrics for Parents* 16 (1 Nov. 1995): 4-5.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

Carol A. Turkington

PKU *see* **Phenylketonuria**

Placenta previa

Definition

Placenta previa is a condition that occurs during **pregnancy** when the placenta is abnormally placed, and partially or totally covers the cervix.

Description

The uterus is the muscular organ that contains the developing baby during pregnancy. The lowest segment of the uterus is a narrowed portion called the cervix. This cervix has an opening (the os) that leads into the vagina, or birth canal. The placenta is the organ that attaches to the wall of the uterus during pregnancy. The placenta allows nutrients and oxygen from the mother's blood circulation to pass into the developing baby (the fetus) via the umbilical cord.

During labor, the muscles of the uterus contract repeatedly. This allows the cervix to begin to grow thinner (called effacement) and more open (dilatation). Eventually, the cervix will become completely effaced and dilated, and the baby can leave the uterus and enter the birth canal. Under normal circumstances, the baby will emerge through the mother's vagina during birth.

In placenta previa, the placenta develops in an abnormal location. Normally, the placenta should develop relatively high up in the uterus, on the front or back wall. In about one in 200 births, the placenta will be located low in the uterus, partially or totally covering the os. This causes particular problems in late pregnancy, when the lower part of the uterus begins to take on a new formation in preparation for delivery. As the cervix begins to efface and dilate, the attachments of the placenta to the uterus are damaged, resulting in bleeding.

Causes and symptoms

While the actual cause of placenta previa is unknown, certain factors increase the risk of a woman developing the condition. These factors include:

- having abnormalities of the uterus
- being older in age
- having had other babies
- having a prior delivery by **cesarean section**
- smoking cigarettes

When a pregnancy involves more than one baby (twins, triplets, etc.), the placenta will be considerably larger than for a single pregnancy. This also increases the chance of placenta previa.

Placenta previa may cause a number of problems. It is thought to be responsible for about 5% of all miscarriages. It frequently causes very light bleeding (spotting) early in pregnancy. Sometime after 28 weeks of pregnancy (most pregnancies last about 40 weeks), placenta previa can cause episodes of significant bleeding. Usually, the bleeding occurs suddenly and is bright red. The woman rarely experiences any accompanying **pain**,

although about 10% of the time the placenta may begin separating from the uterine wall (called abruptio placentae), resulting in pain. The bleeding usually stops on its own. About 25% of such patients will go into labor within the next several days. Sometimes, placenta previa does not cause bleeding until labor has already begun.

Placenta previa puts both the mother and the fetus at high risk. The mother is at risk of severe and uncontrollable bleeding (hemorrhage), with dangerous blood loss. If the mother's bleeding is quite severe, this puts the fetus at risk of becoming oxygen deprived. The fetus' only source of oxygen is the mother's blood. The mother's blood loss, coupled with certain changes that take place in response to that blood loss, decreases the amount of blood going to the placenta, and ultimately to the fetus. Furthermore, placenta previa increases the risk of preterm labor, and the possibility that the baby will be delivered prematurely.

Diagnosis

Diagnosis of placenta previa is suspected whenever bright red, painless vaginal bleeding occurs during the course of a pregnancy. The diagnosis can be confirmed by performing an ultrasound examination. This will allow the location of the placenta to be evaluated.

While many conditions during pregnancy require a pelvic examination, in which the health care provider's fingers are inserted into the patient's vagina, such an examination should never be performed if there is any suspicion of placenta previa. Such an examination can disturb the already susceptible placenta, resulting in hemorrhage.

Sometimes placenta previa is found early in a pregnancy, during an ultrasound examination performed for another reason. In these cases, it is wise to have a repeat ultrasound performed later in pregnancy (during the last third of the pregnancy, called the third trimester). A large percentage of these women will have a low-lying placenta, but not a true placenta previa where some or all of the os is covered.

Treatment

Treatment depends on how far along in the pregnancy the bleeding occurs. When the pregnancy is less than 36 weeks along, the fetus is not sufficiently developed to allow delivery without a high risk of complications. Therefore, a woman with placenta previa is treated with bed rest, blood transfusions as necessary, and medications to prevent labor. After 36 weeks, the baby can be delivered via cesarean section. This is almost always the preferred method of delivery in order to avoid further bleeding from the low-lying placenta.

KEY TERMS

Cesarean section—Delivery of a baby through an incision in the mother's abdomen instead of through the vagina.

Labor—The process during which the uterus contracts and the cervix opens to allow the passage of a baby into the vagina.

Placenta—The organ that provides oxygen and nutrition from the mother to the baby during pregnancy. The placenta is attached to the wall of the uterus and leads to the baby via the umbilical cord.

Umbilical cord—The blood vessels that allow the developing baby to receive nutrition and oxygen from its mother; the blood vessels also eliminate the baby's waste products. One end of the umbilical cord is attached to the placenta and the other end is attached to the baby's navel (umbilicus).

Vagina—The birth canal; the passage from the cervix of the uterus to the opening leading outside of a woman's body.

Prognosis

In cases of placenta previa, the prognosis for the mother is very good. However, there is a 15–20% chance the infant will not survive. This is 10 times the death rate associated with normal pregnancies. About 60% of these deaths occur because the baby delivered was too premature to survive.

Prevention

There are no known ways to insure the appropriate placement of the placenta in the uterus. However, careful treatment of the problem can result in the best chance for a good outcome for both mother and baby.

Resources

BOOKS

Cunningham, F. Gary, et al. "Obstetrical Hemorrhage." In *Williams Obstetrics*. 20th ed. Stamford: Appleton & Lange, 1997.

Pernoll, Martin L. "Third-Trimester Hemorrhage." In *Current Obstetric & Gynecologic Diagnosis & Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Lavery, J. P. "Placenta Previa." *Clinical Obstetrics and Gynecology* 33 (Sept. 1990): 414+.

Mabie, W. C. "Placenta Previa." *Clinical Perinatology* 19 (June 1992): 425+.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920, Washington, DC 20090-6920. <http://www.acog.org>.

Rosalyn Carson-DeWitt, MD

Placental abruption

Definition

Placental abruption occurs when the placenta separates from the wall of the uterus prior to the birth of the baby. This can result in severe, uncontrollable bleeding (hemorrhage).

Description

The uterus is the muscular organ that contains the developing baby during **pregnancy**. The lowest segment of the uterus is a narrowed portion called the cervix. This cervix has an opening (the os) that leads into the vagina, or birth canal. The placenta is the organ that attaches to the wall of the uterus during pregnancy. The placenta allows nutrients and oxygen from the mother's blood circulation to pass into the developing baby (the fetus) via the umbilical cord.

During labor, the muscles of the uterus contract repeatedly. This allows the cervix to begin to grow thinner (called effacement) and more open (dilatation). Eventually, the cervix will become completely effaced and dilated, and the baby can leave the uterus and enter the birth canal. Under normal circumstances, the baby will go through the mother's vagina during birth.

During a normal labor and delivery, the baby is born first. Several minutes to 30 minutes later, the placenta separates from the wall of the uterus and is delivered. This sequence is necessary because the baby relies on the placenta to provide oxygen until he or she begins to breathe independently.

Placental abruption occurs when the placenta separates from the uterus before the birth of the baby. Placental abruption occurs in about one out of every 200 deliveries. African-American and Latin-American women have a greater risk of this complication than do Caucasian women. It was once believed that the risk of placental abruption increased in women who gave birth to many children, but this association is still being researched.

Causes and symptoms

The cause of placental abruption is unknown. However, a number of risk factors have been identified. These factors include:

- older age of the mother
- history of placental abruption during a previous pregnancy
- high blood pressure
- certain disease states (diabetes, collagen vascular diseases)
- the presence of a type of uterine tumor called a leiomyoma
- twins, triplets, or other multiple pregnancies
- cigarette **smoking**
- heavy alcohol use
- **cocaine** use
- malformations of the uterus
- malformations of the placenta
- injury to the abdomen (as might occur in a car accident)

Symptoms of placental abruption include bleeding from the vagina, severe **pain** in the abdomen or back, and tenderness of the uterus. Depending on the severity of the bleeding, the mother may experience a drop in blood pressure, followed by symptoms of organ failure as her organs are deprived of oxygen. Sometimes, there is no visible vaginal bleeding. Instead, the bleeding is said to be "concealed." In this case, the bleeding is trapped behind the placenta, or there may be bleeding into the muscle of the uterus. Many patients will have abnormal contractions of the uterus, particularly extremely hard, prolonged contractions. Placental abruption can be total (in which case the fetus will almost always die in the uterus), or partial.

Placental abruption can also cause a very serious complication called consumptive coagulopathy. A series of reactions begin that involve the elements of the blood responsible for clotting. These clotting elements are bound together and used up by these reactions. This increases the risk of uncontrollable bleeding and may contribute to severe bleeding from the uterus, as well as causing bleeding from other locations (nose, urinary tract, etc.).

Placental abruption is risky for both the mother and the fetus. It is dangerous for the mother because of blood loss, loss of clotting ability, and oxygen deprivation to her organs (especially the kidneys and heart). This condition is dangerous for the fetus because of oxygen deprivation, too, since the mother's blood is the

fetus' only source of oxygen. Because the abrupting placenta is attached to the umbilical cord, and the umbilical cord is an extension of the fetus' circulatory system, the fetus is also at risk of hemorrhaging. The fetus may die from these stresses, or may be born with damage due to oxygen deprivation. If the abruption occurs well before the baby was due to be delivered, early delivery may cause the baby to suffer complications of premature birth.

Diagnosis

Diagnosis of placental abruption relies heavily on the patient's report of her symptoms and a **physical examination** performed by a health care provider. Ultrasound can sometimes be used to diagnose an abruption, but there is a high rate of missed or incorrect diagnoses associated with this tool when used for this purpose. Blood will be taken from the mother and tested to evaluate the possibility of life-threatening problems with the mother's clotting system.

Treatment

The first line of treatment for placental abruption involves replacing the mother's lost blood with blood transfusions and fluids given through a needle in a vein. Oxygen will be administered, usually by a mask or through tubes leading to the nose. When the placental separation is severe, treatment may require prompt delivery of the baby. However, delivery may be delayed when the placental separation is not as severe, and when the fetus is too immature to insure a healthy baby if delivered. The baby is delivered vaginally when possible. However, a **cesarean section** may be performed to deliver the baby more quickly if the abruption is quite severe or if the baby is in distress.

Prognosis

The prognosis for cases of placental abruption varies, depending on the severity of the abruption. The risk of **death** for the mother ranges up to 5%, usually due to severe blood loss, **heart failure**, and kidney failure. In cases of severe abruption, 50–80% of all fetuses die. Among those who survive, nearly half will have lifelong problems due to oxygen deprivation in the uterus and premature birth.

Prevention

Some of the causes of placental abruption are preventable. These include cigarette smoking, alcohol abuse, and cocaine use. Other causes of abruption may not be avoidable, like diabetes or high blood pressure.

KEY TERMS

Cesarean section—Delivery of a baby through an incision in the mother's abdomen, instead of through the vagina.

Labor—The process during which the uterus contracts, and the cervix opens to allow the passage of a baby into the vagina.

Placenta—The organ that provides oxygen and nutrition from the mother to the baby during pregnancy. The placenta is attached to the wall of the uterus and leads to the baby via the umbilical cord.

Umbilical cord—The blood vessels that allow the developing baby to receive nutrition and oxygen from its mother; the blood vessels also eliminate the baby's waste products. One end of the umbilical cord is attached to the placenta and the other end is attached to the baby's belly button (umbilicus).

Uterus—The muscular organ that contains the developing baby during pregnancy.

Vagina—The birth canal; the passage from the cervix of the uterus to the opening leading outside of a woman's body.

These diseases should be carefully treated. Patients with conditions known to increase the risk of placental abruption should be carefully monitored for signs and symptoms of this complication.

Resources

BOOKS

Cunningham, F. Gary, et al. "Obstetrical Hemorrhage." In *Williams Obstetrics*. 20th ed. Stamford:Appleton & Lange, 1997.

Pernoll, Martin L. "Third-Trimester Hemorrhage." In *Current Obstetric & Gynecologic Diagnosis & Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Bougere, M. H. "Abruptio Placentae." *Nursing* 28 (Feb. 1998): 47+.

Lowe, T. W., and F. G. Cunningham. "Placental Abruption." *Clinical Obsetrics and Gynecology* 33 (Sept. 1990): 406+.

ORGANIZATIONS

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Rosalyn Carson-DeWitt, MD

Plague

Definition

Plague is a serious, potentially life-threatening infectious disease that is usually transmitted to humans by the bites of rodent fleas. It was one of the scourges of our early history. There are three major forms of the disease: bubonic, septicemic, and pneumonic.

Description

Plague has been responsible for three great world pandemics, which caused millions of deaths and significantly altered the course of history. A pandemic is a disease occurring in epidemic form throughout the entire population of a country, a people, or the world. Although the cause of the plague was not identified until the third pandemic in 1894, scientists are virtually certain that the first two pandemics were plague because a number of the survivors wrote about their experiences and described the symptoms.

The first great pandemic appeared in A.D. 542 and lasted for 60 years. It killed millions of citizens, particularly along the Mediterranean Sea. This sea was the busiest, coastal trade route at that time and connected what is now southern Europe, northern Africa, and parts of coastal Asia.

The second pandemic occurred during the fourteenth century, and was called "Black Death" because its main symptom was the appearance of black patches (caused by bleeding) on the skin. It was also a subject found in many European paintings, drawings, plays, and writings of that time. The connections between large, active trading ports, rats coming off the ships, and the severe outbreaks of the plague was known by the people. This was the most severe of the three, beginning in the mid-1300s with an origin in central Asia and lasting for 400 years. About a fourth of the entire European population died within a few years after plague was first introduced.

The final pandemic began in northern China, reaching Canton and Hong Kong by 1894. From there, it spread to all continents, killing millions.

The great pandemics of the past occurred when wild rodents spread the disease to rats in cities, and then to humans when the rats died. Another route for infection came from rats coming off ships that had traveled from heavily infected areas. Generally, these were busy coastal or inland trade routes. Plague was introduced into the United States during this pandemic and it spread from the West towards the Midwest and became endemic in the Southwest of the United States.

Between 10 and 50 Americans living in the southwestern United States contract plague each year during the spring and summer. The last rat-borne epidemic in the United States occurred in Los Angeles in 1924–25. Since then, all plague cases in this country have been sporadic, acquired from wild rodents or their fleas. Plague can also be acquired from ground squirrels and prairie dogs in parts of Arizona, New Mexico, California, Colorado, and Nevada. Around the world, there are between 1,000 and 2,000 cases of plague each year. Recent outbreaks in humans occurred in Africa, South America, and Southeast Asia.

Some people and/or animals with bubonic plague go on to develop **pneumonia** (pneumonic plague). This can spread to others via infected droplets during coughing or sneezing.

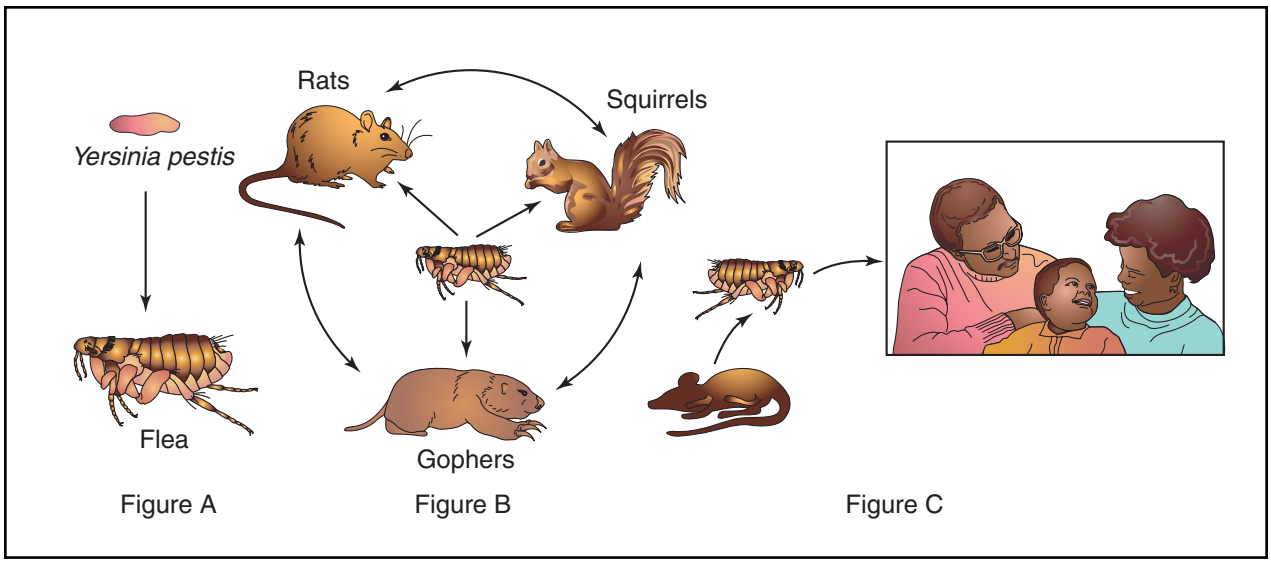
Plague is one of three diseases still subject to international health regulations. These rules require that all confirmed cases be reported to the World Health Organization (WHO) within 24 hours of diagnosis. According to the 1998 regulations, passengers on an international voyage who have been to an area where there is an epidemic of pneumonic plague must be placed in isolation for six days before being allowed to leave.

While plague is found in several countries, there is little risk to United States travelers within endemic areas (limited locales where a disease is known to be present) if they restrict their travel to urban areas with modern hotel accommodations.

Over the past few years, this infection primarily of inantiquity has become a modern issue. This change has occurred because of the concerns about the use of plague as a weapon of biological warfare or terrorism. Along with **anthrax** and **smallpox**, plague is considered to be a significant risk. In this scenario, the primary manifestation is likely to be pneumonic plague transmitted by clandestine aerosols. It has been reported that during World War II the Japanese dropped "bombs" containing plague-infected fleas in China as a form of biowarfare.

Causes and symptoms

Fleas carry the bacterium *Yersinia pestis*. When a flea bites an infected rodent, it swallows the plague bacteria. The bacteria is passed on when the fleas, in turn, bite a human. Interestingly, the plague bacterium grows in the gullet of the flea, obstructing it and not allowing the flea to eat. Transmission occurs during abortive feeding with regurgitation of bacteria into the feeding site. Humans also may become infected if they have a break or cut in the skin and come in direct contact with body fluids or tissues of infected animals.



Plague is a serious infectious disease transmitted by the bites of rat fleas. There are three major forms of plague: bubonic, pneumonic, and septicemic. As illustrated above, fleas carry the bacterium *Yersinia pestis*. When a flea bites an infected rodent, it becomes a vector and then passes the plague bacteria when it bites a human. *(Illustration by Electronic Illustrators Group.)*

More than 100 species of fleas have been reported to be naturally infected with plague; in the western United States, the most common source of plague is the Golden-manteled ground squirrel flea.

Since 1924, there have been no documented cases in the United States of human-to-human spread of plague from droplets. All but one of the few pneumonic cases have been associated with handling infected cats. While dogs and cats can become infected, dogs rarely show signs of illness and are not believed to spread disease to humans. However, plague has been spread from infected coyotes (wild dogs) to humans.

Bubonic plague

Two to five days after infection, patients experience a sudden **fever**, chills, seizures, and severe headaches, followed by the appearance of swellings or "buboes" in armpits, groin, and neck. The most commonly affected sites are the lymph glands near the site of the first infection. As the bacteria multiply in the glands, the lymph node becomes swollen. As the nodes collect fluid, they become extremely tender. Occasionally, the bacteria will cause an ulcer at the point of the first infection.

Septicemic plague

Bacteria that invade the bloodstream directly (without involving the lymph nodes) causes septicemic plague. (Bubonic plague also can progress to septicemic plague if not treated appropriately.) Septicemic plague that does not involve the lymph glands is particularly dangerous because it can be hard to diagnose the disease. The bacteria usually spread to other sites, including the liver, kidneys, spleen, lungs, and sometimes the eyes, or the lining of the brain. Symptoms include fever, chills, prostration, abdominal **pain**, **shock**, and bleeding into the skin and organs.

Pneumonic plague

Pneumonic plague may occur as a direct infection (primary) or as a result of untreated bubonic or septicemic plague (secondary). Primary pneumonic plague is caused by inhaling infective drops from another person or animal with pneumonic plague. Symptoms, which appear within one to three days after infection, include a severe, overwhelming pneumonia, with **shortness of breath**, high fever, and blood in the phlegm. If untreated, half the patients will die; if blood **poisoning** occurs as an early complication, patients may die even before the buboes appear.

Life-threatening complications of plague include shock, high fever, problems with blood clotting, and convulsions.

Diagnosis

Plague should be suspected if there are painful buboes, fever, exhaustion, and a history of possible exposure to rodents, rabbits, or fleas in the western states. The patient should be isolated. Chest x rays are taken, as well

as blood cultures, antigen testing, and examination of lymph node specimens. Blood cultures should be taken 30 minutes apart, before treatment.

Treatment

As soon as plague is suspected, the patient should be isolated, and local and state departments notified. Drug treatment reduces the risk of **death** to less than 5%. The preferred treatment is streptomycin administered as soon as possible. Alternatives include gentamicin, chloramphenicol, tetracycline, or trimethoprim/sulfamethoxazole.

Prognosis

Plague can be treated successfully if it is caught early. Untreated pneumonic plague is almost always fatal, however, and the chances of survival are very low unless specific antibiotic treatment is started within 15–18 hours after symptoms appear. The presence of plague bacteria in a blood smear is a grave sign, and indicates septicemic plague.

Prevention

Anyone who has come in contact with a plague pneumonia victim should be given **antibiotics**, since untreated pneumonic plague patients can pass on their illness to close contacts throughout the course of the illness. All plague patients should be isolated for 48 hours after antibiotic treatment begins. Pneumonic plague patients should be completely isolated until sputum cultures show no sign of infection.

Residents of areas where plague is found should keep rodents out of their homes. Anyone working in a rodent-infested area should wear insect repellent on skin and clothing. Pets can be treated with insecticidal dust and kept indoors. Handling sick or dead animals (especially rodents and cats) should be avoided.

Plague vaccines have been used with varying effectiveness since the late nineteenth century. Experts believe that **vaccination** lowers the chance of infection and the severity of the disease. However, the effectiveness of the vaccine against pneumonic plague is not clearly known.

Vaccinations against plague are not required to enter any country. Because immunization requires multiple doses over a six to 10 month period, plague vaccine is not recommended for quick protection during outbreaks. Moreover, its unpleasant side effects make it a poor choice unless there is a substantial long-term risk of infection. The safety of the vaccine for those under age 18 has not been established. Pregnant women should not be vaccinated unless the need for protection is greater than the risk to the unborn child. Even those who receive the vaccine may not be completely protected. This is why it is important to protect against rodents, fleas, and people with plague.

KEY TERMS

Buboes—Smooth, oval, reddened, and very painful swellings in the armpits, groin, or neck that occur as a result of infection with the plague.

Endemic—A disease that occurs naturally in a geographic area or population group.

Epidemic—A disease that occurs throughout part of the population of a country.

Pandemic—A disease that occurs throughout a regional group, the population of a country, or the world.

Septicemia—The medical term for "blood poisoning," in which bacteria has invaded the bloodstream and circulates throughout the body.

Resources

BOOKS

Bannister, Barbara A., Norman T. Begg, and Stephen H. Gillespie. *Infectious Disease*. Oxford, England: Blackwell Scientific, Inc., 1996.

Giblin, James Cross. *When Plague Strikes: The Black Death, Smallpox, and AIDS*. New York: HarperCollins Juvenile, 1997.

Kohn, George C. *The Encyclopedia of Plague and Pestilence*. New York: Facts on File, Inc., 1996.

Van De Graaff, Kent. *Survey of Infectious and Parasitic Diseases*. New York: McGraw Hill, 1996.

Wilks, David, Mark Farrington, and David Rubenstein. *The Infectious Diseases Manual*. Oxford, England: Blackwell Scientific, Inc., 1995.

PERIODICALS

"Bubonic blockage." *Discover* 17, no. 11 (November 1996): 18.

"Plague still a world killer, WHO warns." *Journal of Environmental Health*. 58, no. 8 (April 1996): 30.

Richardson, Sarah. "The return of the plague." *Discover* 16, no. 1 (January 1995): 69-70.

Wise, Jacqui. "Plague shows signs of multidrug resistance." *British Medical Journal* 315, no. 7109 (September 13, 1997): 623.

ORGANIZATIONS

Centers for Disease Control. 1600 Clifton Rd., NE, Atlanta, GA 30333. (404) 639-3311.

National Institute of Allergies and Infectious Diseases, Division of Microbiology and Infectious Diseases. Bldg. 31, Rm. 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892.
World Health Organization. Division of Emerging and Other Communicable Diseases Surveillance and Control. 1211 Geneva 27, Switzerland.

OTHER

Bacterial Diseases (Healthtouch). <http://www.healthtouch.com/level1/leaflets/105825/105826.htm>.
Bug Bytes. <http://www.isumc.edu/bugbytes/>.
Centers for Disease Control. <http://www.cdc.gov/travel/travel.html>.
CDC editors. *Plague*. CDC website. <http://www.cdc.gov/travel/yellowbook/page143b.htm>.
Emerging Infectious Diseases Journal, National Center for Infectious Diseases. <http://www.cdc.gov/ncidod/EID/eidtext.htm>.
Infectious Diseases Weblink. <http://pages.prodigy.net/pdeziel/>.
International Society of Travel Medicine. <http://www.istm.org>.
World Health Organization. <http://www.who.ch/>.

Arnold Cua, MD

Plaque *see* **Skin lesions**

Plasma cell myeloma *see* **Multiple myeloma**

Plasma renin activity

Definition

Renin is an enzyme released by the kidney to help control the body's sodium-potassium balance, fluid volume, and blood pressure.

Purpose

Plasma renin activity (PRA), also called plasma renin assay, may be used to screen for high blood pressure (**hypertension**) of kidney origin, and may help plan treatment of essential hypertension, a genetic disease often aggravated by excess sodium intake. PRA is also used to further evaluate a diagnosis of excess aldosterone, a hormone secreted by the adrenal cortex, in a condition called Conn's syndrome.

Precautions

Patients taking **diuretics**, antihypertensives, **vasodilators**, **oral contraceptives**, and licorice should discontinue use of these substances for two to four weeks before the test. It should be noted that renin is increased in **pregnancy** and in **diets** with reduced salt intake. Also, since renin is affected by body position, as well as by diurnal (daily) variation, blood samples should be drawn in the morning, and the position of the patient (sitting or lying down) should be noted.

Description

When the kidneys release the enzyme renin in response to certain conditions (high blood potassium, low blood sodium, decreased blood volume), it is the first step in what is called the renin-angiotensin-aldosterone cycle. This cycle includes the conversion of angiotensinogen to angiotensin I, which in turn is converted to angiotensin II, in the lung. Angiotensin II is a powerful blood vessel constrictor, and its action stimulates the release of aldosterone from an area of the adrenal glands called the adrenal cortex. Together, angiotensin and aldosterone increase the blood volume, the blood pressure, and the blood sodium to re-establish the body's sodium-potassium and fluid volume balance. Primary aldosteronism, the symptoms of which include hypertension and low blood potassium (**hypokalemia**), is considered "low-renin aldosteronism."

Renin itself is not actually measured in the PRA test, because renin can be measured only with great difficulty even in research laboratories. In the most commonly used renin assay, the test actually determines, by a procedure called radioimmunoassay, the rate of angiotensin I generation per unit time, while the PRC (plasma renin concentration) measures the maximum renin effect.

Both the PRA and the PRC are extremely difficult to perform. Not only is renin itself unstable, but the patient's body position and the time of day affect the results. Also, the sample must be collected properly: drawn into a chilled syringe and collection tube, placed on ice, and sent to the performing laboratory immediately. Even if all these procedures are followed, results can vary significantly.

A determination of the PRA and a measurement of the plasma aldosterone level are used in the differential diagnosis of primary and secondary **hyperaldosteronism**. Patients with primary hyperaldosteronism (caused by an adrenal tumor that overproduces aldosterone) will have an increased aldosterone level with decreased renin activity. Conversely, patients with secondary hyperaldosteronism (caused by certain types of kidney disease) will have increased levels of renin.

Renin stimulation test

The renin stimulation test is performed to help diagnose and distinguish the two forms of hyperaldosteronism. With the patient having been on a low-salt diet and lying

down for the test, a blood sample for PRA is obtained. The PRA is repeated with the patient still on the low-salt diet but now standing upright. In cases of primary hyperaldosteronism, the blood volume is greatly expanded, and a change in position or reduced salt intake does not result in decreased kidney blood flow or decreased blood sodium. As a result, renin levels do not increase. However, in secondary hyperaldosteronism, blood sodium levels decrease with a lowered salt intake, and when the patient is standing upright, the kidney blood flow decreases as well. Consequently, renin levels do increase.

Captopril test

The captopril test is a screening test for hypertension of kidney origin (**renovascular hypertension**). For this test, a baseline PRA test is done first, then the patient receives an oral dose of captopril, which is an angiotensin-converting enzyme (ACE) inhibitor. Blood pressure measurements are taken at this time and again at 60 minutes when another PRA test is done. Patients with kidney-based hypertension demonstrate greater falls in blood pressure and increases in PRA after captopril administration than do those with essential hypertension. Consequently, the captopril test is an excellent screening procedure to determine the need for a more invasive radiographic evaluation such as renal arteriography.

Preparation

This test requires a blood sample. For the PRA, the patient should maintain a normal diet with a restricted amount of sodium (approximately 3 g per day) for three days before the test. It is recommended that the patient be **fasting** (nothing to eat or drink) from midnight the day of the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference values for the PRA test are laboratory-specific and depend upon the kind of diet (sodium restricted or normal), the age of the patient, and the patient's posture at the time of the test. Values are also affected if renin has been stimulated or if the patient has received an ACE inhibitor, like captopril.

Abnormal results

Increased PRA levels are seen in essential hypertension (uncommon), malignant hypertension, and kidney-based (renovascular) hypertension. Renin-producing renal tumors, while rare, can also cause elevated levels, as can **cirrhosis**, low blood volume due to hemorrhage, and diminished adrenal function (**Addison's disease**). Decreased renin levels may indicate increased blood volume due to a high-sodium diet, salt-retaining steroids, primary aldosteronism, licorice ingestion syndrome, or essential hypertension with low renin levels.

KEY TERMS

Aldosteronism—A disorder caused by excessive production of the hormone aldosterone, which is produced by a part of the adrenal glands called the adrenal cortex. Causes include a tumor of the adrenal gland (Conn's syndrome), or a disorder reducing the blood flow through the kidney. This leads to overproduction of renin and angiotensin, and in turn causes excessive aldosterone production. Symptoms include hypertension, impaired kidney function, thirst and muscle weakness.

Conn's syndrome—A disorder caused by excessive aldosterone secretion by a benign tumor of one of the adrenal glands. This results in malfunction of the body's salt and water balance and subsequently causes hypertension. Symptoms include thirst, muscle weakness, and excessive urination.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Plasmapheresis

Definition

Plasmapheresis is a blood purification procedure used to treat several autoimmune diseases. It is also known as therapeutic plasma exchange.

Purpose

In an autoimmune disease, the immune system attacks the body's own tissues. In many autoimmune diseases, the chief weapons of attack are antibodies, proteins that circulate in the bloodstream until they meet and bind with the target tissue. Once bound, they impair the functions of the target, and signal other immune components to respond as well.

Plasmapheresis is used to remove antibodies from the bloodstream, thereby preventing them from attacking their targets. It does not directly affect the immune system's ability to make more antibodies, and therefore may only offer temporary benefit. This procedure is most useful in acute, self-limited disorders such as **Guillain-Barré syndrome**, or when chronic disorders, such as **myasthenia gravis**, become more severe in symptoms. In these instances, a rapid improvement could save the patient's life. Neurologic diseases comprise 90% of the diseases that could profit from plasmapheresis.

Precautions

Patients with clotting disorders may not be suitable candidates for plasmapheresis.

Description

The basic procedure consists of removal of blood, separation of blood cells from plasma, and return of these blood cells to the body's circulation, diluted with fresh plasma or a substitute. Because of concerns over viral infection and allergic reaction, fresh plasma is not routinely used. Instead, the most common substitute is saline solution with sterilized human albumin protein. During the course of a single session, two to three liters of plasma is removed and replaced.

Plasmapheresis requires insertion of a venous catheter, either in a limb or central vein. Central veins allow higher flow rates and are more convenient for repeat procedures, but are more often the site of complications, especially bacterial infection.

When blood is outside the body, it must be treated to prevent it from clotting. While most of the anticlotting agent is removed from the blood during treatment, some is returned to the patient.

Three procedures are available:

- "Discontinuous flow centrifugation." Only one venous catheter line is required. Approximately 300 ml of blood is removed at a time and centrifuged to separate plasma from blood cells.
- "Continuous flow centrifugation." Two venous lines are used. This method requires slightly less blood volume to be out of the body at any one time.
- "Plasma filtration." Two venous lines are used. The pasma is filtered using standard hemodialysis equipment. It requires less than 100 ml of blood to be outside the body at one time.

A single plasmapheresis session may be effective, although it is more common to have several sessions per week over the course of two weeks or more.

Preparation

Good **nutrition** and plenty of rest make the procedure less stressful. The treating physician determines which of the patient's medications should be discontinued before the plasmapheresis session.

Aftercare

The patient may experience **dizziness**, nausea, numbness, tingling, or lightheadedness during or after the procedure. These effects usually pass quickly, allowing the patient to return to normal activities the same day.

Risks

Reinfusion (replacement) with human plasma may cause **anaphylaxis**, a life threatening allergic reaction. All procedures may cause a mild allergic reaction, leading to **fever**, chills, and rash. Bacterial infection is a risk, especially when a central venous catheter is used. Reaction to the citrate anticoagulant used may cause cramps and numbness, though these usually resolve on their own. Patients with impaired kidney function may require drug treatment for the effects of citrate metabolism.

Plasma contains clotting agents, chemicals that allow the blood to coagulate into a solid clot. Plasma exchange removes these. Bleeding complications are rare following plasmapheresis, but may require replacement of clotting factors.

Normal results

Plasmapheresis is an effective temporary treatment for:

- Guillain-Barré syndrome (an acute neurological disorder following a viral infection that produces progressive muscle weakness and **paralysis**)
- Myasthenia gravis (an autoimmune disease that causes muscle weakness)

KEY TERMS

Anaphylaxis—Also called anaphylactic shock, it is a severe allergic reaction to a foreign substance that the patient has had contact with. Penicillin is an example of a substance that causes severe allergic reactions for some people.

Antibody—Chemicals produced by the body to defend it against bacteria, viruses, or other cells foreign to the body (antigens). Each specific antibody reacts against a specific foreign body. Antibodies are also termed immunoglobulins.

Autoimmune—Autoimmune refers to the body's development of intolerance of the antigens on its own cells.

Hemodialysis—A method to take out unwanted parts of the blood. The patient's blood is run through a catheter and tubing into a machine called a dialyzer, which filters out the unwanted blood component.

Plasma—Plasma makes up 50% of human blood. It is a watery fluid that carries red cells, white cells, and platelets throughout the body.

- chronic inflammatory demyelinating polyneuropathy (a chronic neurological disorder caused by destruction of the myelin sheath of peripheral nerves, which produces symptoms similar to Guillain-Barré syndrome)
- thrombotic thrombocytopenic purpura (a rare blood disorder)
- paraproteinemic peripheral neuropathies (a neurological disorder affecting the peripheral nerves)
- blood that is too thick (hyperviscosity)

Other conditions may respond to plasmapheresis as well. Beneficial effects are usually seen within several days. Effects commonly last up to several months, although longer-lasting changes are possible, presumably by inducing shifts in immune response.

Resources

BOOKS

Office Practice of Neurology. Ed. Martin Samuels and Steven Feske. New York: Churchill Livingstone, 1996.

Richard Robinson

Plasmodium infection *see* **Malaria**

Plastic, cosmetic, and reconstructive surgery

Definition

Plastic, cosmetic, and reconstructive surgery refers to a variety of operations performed in order to repair or restore body parts to look normal, or to change a body part to look better. These types of surgery are highly specialized. They are characterized by careful preparation of the patient's skin and tissues, by precise cutting and suturing techniques, and by care taken to minimize scarring. Recent advances in the development of miniaturized instruments, new materials for artificial limbs and body parts, and improved surgical techniques have expanded the range of plastic surgery operations that can be performed.

Purpose

Although these three types of surgery share some common techniques and approaches, they have somewhat different emphases. Plastic surgery is usually performed to treat **birth defects** and to remove skin blemishes such as **warts**, **acne** scars, or **birthmarks**. Cosmetic surgery procedures are performed to make the patient look younger or enhance his or her appearance in other ways. Reconstructive surgery is used to reattach body parts severed in combat or accidents, to perform skin grafts after severe **burns**, or to reconstruct parts of the patient's body that were missing at birth or removed by surgery. Reconstructive surgery is the oldest form of plastic surgery, having developed out of the need to treat wounded soldiers in wartime.

Precautions

Medical

Some patients should not have plastic surgery because of certain medical risks. These groups include:

- patients recovering from a **heart attack**, severe infection (for example, **pneumonia**), or other serious illness
- patients with infectious hepatitis or HIV infection
- **cancer** patients whose cancer might spread (metastasize)
- patients who are extremely overweight. Patients who are more than 30% overweight should not have **liposuction**
- patients with blood clotting disorders

Psychological

Plastic, cosmetic, and reconstructive surgeries have an important psychological dimension because of the

high value placed on outward appearance in Western society. Many people who are born with visible deformities or disfigured by accidents later in life develop emotional problems related to social rejection. Other people work in fields such as acting, modeling, media journalism, and even politics, where their employment depends on how they look. Some people have unrealistic expectations of cosmetic surgery and think that it will solve all their life problems. It is important for anyone considering nonemergency plastic or cosmetic surgery to be realistic about its results. One type of psychiatric disorder, called body dysmorphic disorder, is characterized by an excessive preoccupation with imaginary or minor flaws in appearance. Patients with this disorder frequently seek unnecessary plastic surgery.

The Top 10 Elective Cosmetic Surgeries In The U.S. (1999)

Procedure	Female Patients	Male Patients	Total
Liposuction	201,083	29,782	230,865
Breast augmentation	167,318	0	167,318
Eyelid surgery	120,160	21,859	142,033
Face lift	66,096	6,697	72,793
Tummy tuck	52,888	2,089	54,977
Collagen injections	48,989	4,208	53,197
Chemical peel	47,359	4,215	51,589
Laser skin resurfacing	46,162	4,343	50,505
Rhinoplasty	34,761	11,831	46,596
Forehead lift	36,995	3,962	40,969

Description

Plastic surgery

Plastic surgery includes a number of different procedures that usually involve skin. Operations to remove excess fat from the abdomen ("tummy tucks"), dermabrasion to remove acne scars or tattoos, and reshaping the cartilage in children's ears (otoplasty) are common applications of plastic surgery.

Cosmetic surgery

Most cosmetic surgery is done on the face. It is intended either to correct disfigurement or to enhance the patient's features. The most common cosmetic procedure for children is correction of a cleft lip or palate. In adults, the most common procedures are remodeling of the nose (**rhinoplasty**), removal of baggy skin around the eyelids (**blepharoplasty**), facelifts (rhytidectomy), or changing the size of the breasts (mammoplasty). Although many people still think of cosmetic surgery as only for women, growing numbers of men are choosing to have facelifts and eyelid surgery, as well as hair transplants and "tummy tucks."

Reconstructive surgery

Reconstructive surgery is often performed on burn and accident victims. It may involve the rebuilding of severely fractured bones, as well as **skin grafting**. Reconstructive surgery includes such procedures as the reattachment of an amputated finger or toe, or implanting a prosthesis. Prostheses are artificial structures and materials that are used to replace missing limbs or teeth, or arthritic hip and knee joints.

Preparation

Preparation for nonemergency plastic or reconstructive surgery includes patient education, as well as medical considerations. Some operations, such as nose reshaping or the removal of warts, small birthmarks, and tattoos can be done as outpatient procedures under local anesthesia. Most plastic and reconstructive surgery, however, involves a stay in the hospital and general anesthesia.

Medical preparation

Preparation for plastic surgery includes the surgeon's detailed assessment of the parts of the patient's body that will be involved. Skin grafts require evaluating suitable areas of the patient's skin for the right color and texture to match the skin at the graft site. Facelifts and cosmetic surgery in the eye area require very close attention to the texture of the skin and the placement of surgical cuts (incisions).

Patients scheduled for plastic surgery under general anesthesia will be given a **physical examination**, blood and urine tests, and other tests to make sure that they do not have any previously undetected health problems or blood clotting disorders. The doctor will check the list of prescription medications that the patient may be taking to make sure that none of them will interfere with normal blood clotting or interact with the anesthetic.

Patients are asked to avoid using **aspirin** or medications containing aspirin for a week to two weeks before surgery, because these drugs lengthen the time of blood clotting. Smokers are asked to stop **smoking** two weeks before surgery because smoking interferes with the healing process. For some types of plastic surgery, the patient may be asked to donate several units of his or her own blood before the procedure, in case a **transfusion** is needed during the operation. The patient will be asked to sign a consent form before the operation.

Patient education

The doctor will meet with the patient before the operation is scheduled, in order to explain the procedure

and to be sure that the patient is realistic about the expected results. This consideration is particularly important if the patient is having cosmetic surgery.

Aftercare

Medical

Medical aftercare following plastic surgery under general anesthesia includes bringing the patient to a recovery room, monitoring his or her vital signs, and giving medications to relieve **pain** as necessary. Patients who have had fat removed from the abdomen may be kept in bed for as long as two weeks. Patients who have had mammoplasties, **breast reconstruction**, and some types of facial surgery typically remain in the hospital for a week after the operation. Patients who have had liposuction or eyelid surgery are usually sent home in a day or two.

Patients who have had outpatient procedures are usually given **antibiotics** to prevent infection and are sent home as soon as their vital signs are normal.

Psychological

Some patients may need follow-up psychotherapy or counseling after plastic or reconstructive surgery. These patients typically include children whose schooling and social relationships have been affected by birth defects, as well as patients of any age whose deformities or disfigurements were caused by trauma from accidents, war injuries, or violent crime.

Risks

The risks associated with plastic, cosmetic, and reconstructive surgery include the postoperative complications that can occur with any surgical operation under anesthesia. These complications include wound infection, internal bleeding, pneumonia, and reactions to the anesthesia.

In addition to these general risks, plastic, cosmetic, and reconstructive surgery carry specific risks:

- formation of undesirable scar tissue
- persistent pain, redness, or swelling in the area of the surgery
- infection inside the body related to inserting a prosthesis; these infections can result from contamination at the time of surgery or from bacteria migrating into the area around the prosthesis at a later time
- anemia or fat embolisms from liposuction
- rejection of skin grafts or tissue transplants
- loss of normal feeling or function in the area of the operation (for example, it is not unusual for women who have had mammoplasties to lose sensation in their nipples)
- complications resulting from unforeseen technological problems (the best-known example of this problem was the discovery in the mid-1990s that **breast implants** made with silicone gel could leak into the patient's body)

KEY TERMS

Blepharoplasty—Surgical reshaping of the eyelid.

Dermabrasion—A technique for removing the upper layers of skin with planing wheels powered by compressed air.

Facelift—Plastic surgery performed to remove sagging skin and wrinkles from the patient's face.

Liposuction—A surgical technique for removing fat from under the skin by vacuum suctioning.

Mammoplasty—Surgery performed to change the size of breasts.

Rhinoplasty—Surgery performed to change the shape of the nose.

Normal results

Normal results include the patient's recovery from the surgery with satisfactory results and without complications.

Resources

BOOKS

Carpenito, Lynda Juall. *Nursing Diagnosis: Application to Clinical Practice*. Philadelphia: J. B. Lippincott, 1995.

Everything You Need to Know about Medical Treatments, ed. Matthew Cahill et al. Springhouse, PA: Springhouse Co., 1996.

Fallon Jr., L. Fleming. "Plastic, Cosmetic, and Reconstructive Surgery." In *Magill's Medical Guide: Health and Illness, Supplement*, ed. Nancy A. Piotrowski. Pasadena, CA: Salem Press, Inc., 1996.

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Rebecca J. Frey

Platelet aggregation test

Definition

Platelets are disk-shaped blood cells that are also called thrombocytes. They play a major role in the blood-clotting process. The platelet aggregation test is a measure of platelet function.

Purpose

The platelet aggregation test aids in the evaluation of bleeding disorders by measuring the rate and degree to which platelets form a clump (aggregate) after the addition of a chemical that stimulates clumping (aggregation).

Precautions

There are many medications that can affect the results of the platelet aggregation test. The patient should discontinue as many as possible beforehand. Some of the drugs that can decrease platelet aggregation include **aspirin**, some **antibiotics**, **beta blockers**, dextran (Macrodex), alcohol, heparin (Lipo-Hepin), **nonsteroidal anti-inflammatory drugs** (NSAIDs), tricyclic antidepressants, and warfarin (Coumadin).

Description

There are many factors involved in blood clotting (coagulation). One of the first steps in the process involves small cells in the bloodstream called platelets, which are produced in the bone marrow. Platelets gather at the site of an injury and clump together to form a plug, or aggregate, that helps to limit the loss of blood and promote healing.

Inherited bleeding disorders (e.g., **hemophilia** or von Willebrand's disease) and acquired bleeding problems that occur because of another disorder or a medication can affect the number of platelets and their level of function. When these problems are present, the result is a drop in platelet aggregation and a lengthened **bleeding time**.

The platelet aggregation test uses a machine called an aggregometer to measure the cloudiness (turbidity) of blood plasma. Several different substances called agonists are used in the test. These agonists include adenosine diphosphate, epinephrine, thrombin, collagen, and ristocetin. The addition of an agonist to a plasma sample causes the platelets to clump together, making the fluid more transparent. The aggregometer then measures the increased light transmission through the specimen.

KEY TERMS

Aggregation—The blood cell clumping process that is measured in the platelet aggregation test.

Agonist—A chemical that is added to the blood sample in the platelet aggregation test to stimulate the clumping process.

Hemophilia—An inherited bleeding disorder caused by a deficiency of factor VIII, one of a series of blood proteins essential for blood clotting.

Platelets—Small, round, disk-shaped blood cells that are involved in clot formation. The platelet aggregation test measures the clumping ability of platelets.

Turbidity—The cloudiness or lack of transparency of a solution.

von Willebrand's disease—An inherited lifelong bleeding disorder caused by an abnormal gene, similar to hemophilia. The gene defect results in a decreased blood concentration of a substance called von Willebrand's factor (vWF).

Preparation

The test requires a blood sample. The patient should either avoid food and drink altogether for eight hours before the test, or eat only nonfat foods. High levels of fatty substances in the blood can affect test results.

Because the use of aspirin and/or aspirin compounds can directly affect test results, the patient should avoid these medications for two weeks before the test. If the patient must take aspirin and the test cannot be postponed, the laboratory should be notified and asked to verify the presence of aspirin in the blood plasma. If the results are abnormal, aspirin use must be discontinued and the test repeated in two weeks.

Aftercare

Because the platelet aggregation test is ordered when some type of bleeding problem is suspected, the patient should be cautioned to watch the puncture site for signs of additional bleeding.

Risks

Risks for this test are minimal in normal individuals. Patients with bleeding disorders, however, may have prolonged bleeding from the puncture wound or the forma-

tion of a bruise (hematoma) under the skin where the blood was withdrawn.

Normal results

The normal time for platelet aggregation varies somewhat depending on the laboratory, the temperature, the shape of the vial in which the test is performed, and the patient's response to different agonists. For example, the difference between the response to ristocetin and other products should be noted because ristocetin triggers aggregation through a different mechanism than other agonists.

Abnormal results

Prolonged platelet aggregation time can be found in such congenital disorders as hemophilia and von Willebrand's disease, as well as in some connective tissue disorders. Prolonged aggregation times can also occur in leukemia or myeloma; after recent heart/lung bypass or **kidney dialysis**; and after taking certain drugs.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Platelet count

Definition

A platelet count is a diagnostic test that determines the number of platelets in the patient's blood. Platelets, which are also called thrombocytes, are small disk-shaped blood cells produced in the bone marrow and involved in the process of blood clotting. There are normally between 150,000-450,000 platelets in each microliter of blood. Low platelet counts or abnormally shaped platelets are associated with bleeding disorders. High platelet counts sometimes indicate disorders of the bone marrow.

Purpose

The primary functions of a platelet count are to assist in the diagnosis of bleeding disorders and to monitor patients who are being treated for any disease involving bone marrow failure. Patients who have leukemia, **polycythemia vera**, or **aplastic anemia** are given periodic platelet count tests to monitor their health.

Description

Blood collection and storage

Platelet counts use a freshly-collected blood specimen to which a chemical called EDTA has been added to prevent clotting before the test begins. About 5 mL of blood are drawn from a vein in the patient's inner elbow region. Blood drawn from a vein helps to produce a more accurate count than blood drawn from a fingertip. Collection of the sample takes only a few minutes.

After collection, the mean platelet volume of EDTA-blood will increase over time. This increase is caused by a change in the shape of the platelets after removal from the body. The changing volume is relatively stable for a period of one to three hours after collection. This period is the best time to count the sample when using electronic instruments, because the platelets will be within a standard size range.

Counting methods

Platelets can be observed in a direct blood smear for approximate quantity and shape. A direct smear is made by placing a drop of blood onto a microscope slide and spreading it into a thin layer. After staining to make the various blood cells easier to see and distinguish, a laboratory technician views the smear through a light microscope. Accurate assessment of the number of platelets requires other methods of counting. There are three methods used to count platelets; hemacytometer, voltage-pulse counting, and electro-optical counting.

HEMACYTOMETER COUNTING. The microscopic method uses a phase contrast microscope to view blood on a hemacytometer slide. A sample of the diluted blood mixture is placed in a hemacytometer, which is an instrument with a grid etched into its surface to guide the counting. For a proper count, the platelets should be evenly distributed in the hemacytometer. Counts made from samples with platelet clumping are considered unreliable. Clumping can be caused by several factors, such as clotting before addition of the anticoagulant and allowing the blood to remain in contact with a capillary blood vessel during collection. Errors in platelet counting are more common when blood is collected from capillaries than from veins.

ELECTRONIC COUNTING. Electronic counting of platelets is the most common method. There are two types of electronic counting, voltage-pulse and electro-

optical counting systems. In both systems, the collected blood is diluted and counted by passing the blood through an electronic counter. The instruments are set to count only particles within the proper size range for platelets. The upper and lower levels of the size range are called size exclusion limits. Any cells or material larger or smaller than the size exclusion limits will not be counted. Any object in the proper size range is counted, however, even if it isn't a platelet. For these instruments to work properly, the sample must not contain other material that might mistakenly be counted as platelets. Electronic counting instruments sometimes produce artificially low platelet counts. If a platelet and another blood cell pass through the counter at the same time, the instrument will not count the larger cell because of the size exclusion limits, which will cause the instrument to accidentally miss the platelet. Clumps of platelets will not be counted because clumps exceed the upper size exclusion limit for platelets. In addition, if the patient has a high white blood cell count, electronic counting may yield an unusually low platelet count because white blood cells may filter out some of the platelets before the sample is counted. On the other hand, if the red blood cells in the sample have burst, their fragments will be falsely counted as platelets.

Aftercare

Because platelet counts are sometimes ordered to diagnose or monitor bleeding disorders, patients with these disorders should be cautioned to watch the puncture site for signs of additional bleeding.

Risks

Risks for a platelet count test are minimal in normal individuals. Patients with bleeding disorders, however, may have prolonged bleeding from the puncture wound or the formation of a bruise (hematoma) under the skin where the blood was withdrawn.

Normal results

The normal range for a platelet count is 150,000-450,000 platelets per microliter of blood.

Abnormal results

An abnormally low platelet level (**thrombocytopenia**) is a condition that may result from increased destruction of platelets, decreased production, or increased usage of platelets. In **idiopathic thrombocytopenic purpura** (ITP), platelets are destroyed at abnormally high rates. **Hypersplenism** is characterized by the collection (sequestration) of platelets in the spleen. Disseminated intravascular coagulation (DIC) is a condition in which blood clots occur within blood vessels in a number of tissues. All of these diseases produce reduced platelet counts.

Abnormally high platelet levels (**thrombocytosis**) may indicate either a benign reaction to an infection, surgery, or certain medications; or a disease like polycythemia vera, in which the bone marrow produces too many platelets too quickly.

KEY TERMS

Capillaries—The smallest of the blood vessels that bring oxygenated blood to tissues.

EDTA—A colorless compound used to keep blood samples from clotting before tests are run. Its chemical name is ethylene-diamine-tetra-acetic acid.

Hemocytometer—An instrument used to count platelets or other blood cells.

Phase contrast microscope—A light microscope in which light is focused on the sample at an angle to produce a clearer image.

Thrombocyte—Another name for platelet.

Thrombocytopenia—An abnormally low platelet count.

Thrombocytosis—An abnormally high platelet count. It occurs in polycythemia vera and other disorders in which the bone marrow produces too many platelets.

Resources

BOOKS

Henry, John B. *Clinical Diagnosis and Management by Laboratory Methods.* Philadelphia: W. B. Saunders Co., 1996.

Merck Manual of Medical Information. Ed. Robert Berkow, et al. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

John T. Lohr, PhD

Platelet function disorders

Definition

Platelets are elements within the bloodstream that recognize and cling to damaged areas inside blood ves-

sels. When they do this, the platelets trigger a series of chemical changes that result in the formation of a blood clot. There are certain hereditary disorders that affect platelet function and impair their ability to start the process of blood clot formation. One result is the possibility of excessive bleeding from minor injuries or menstrual flow.

Description

Platelets are formed in the bone marrow—a spongy tissue located inside the long bones of the body—as fragments of a large precursor cell (a megakaryocyte). These fragments circulate in the bloodstream and form the first line of defense against blood escaping from injured blood vessels.

Damaged blood vessels release a chemical signal that increases the stickiness of platelets in the area of the injury. The sticky platelets adhere to the damaged area and gradually form a platelet plug. At the same time, the platelets release a series of chemical signals that prompt other factors in the blood to reinforce the platelet plug. Between the platelet and its reinforcements, a sturdy clot is created that acts as a patch while the damaged area heals.

There are several hereditary disorders characterized by some impairment of the platelet's action. Examples include von Willebrand's disease, Glanzmann's thrombasthenia, and **Wiskott-Aldrich syndrome**. Vulnerable aspects of platelet function include errors in the production of the platelets themselves or errors in the formation, storage, or release of their chemical signals. These defects can prevent platelets from responding to injuries or from prompting the action of other factors involved in clot formation.

Causes and symptoms

Platelet function disorders can be inherited, but they may also occur as a symptom of acquired diseases or as a side effect of certain drugs, including **aspirin**. Common symptoms of platelet function disorders include bleeding from the nose, mouth, vagina, or anus; pinpoint **bruises** and purplish patches on the skin; and abnormally heavy menstrual bleeding.

Diagnosis

In diagnosing platelet function disorders, specific tests are needed to determine whether the problem is caused by low numbers of platelets or impaired platelet function. A blood **platelet count** and **bleeding time** are common screening tests. If these tests confirm that the symptoms are due to impaired platelet function, further tests are done—such as platelet aggregation or an analysis of the platelet proteins—that pinpoint the exact nature of the defect.

KEY TERMS

Anemia—A condition in which inadequate quantities of hemoglobin and red blood cells are produced.

Bone marrow—A spongy tissue located within the body's flat bones—including the hip and breast bones and the skull. Marrow contains stem cells, the precursors to platelets and red and white blood cells.

Hemoglobin—The substance inside red blood cells that enables them to carry oxygen.

Megakaryocyte—A large bone marrow cell with a lobed nucleus that is the precursor cell of blood platelets.

Platelets—Fragments of a large precursor cell (a megakaryocyte) found in the bone marrow. These fragments adhere to areas of blood vessel damage and release chemical signals that direct the formation of a blood clot.

Treatment

Treatment is intended to prevent bleeding and stop it quickly when it occurs. For example, patients are advised to be careful when they brush their teeth to reduce damage to the gums. They are also warned against taking medications that interfere with platelet function. Some patients may require iron and folate supplements to counteract potential anemia. Platelet transfusions may be necessary to prevent life-threatening hemorrhaging in some cases. **Bone marrow transplantation** can cure certain disorders but also carries some serious risks. Hormone therapy is useful in treating heavy menstrual bleeding. Von Willebrand's disease can be treated with desmopressin (DDAVP, Stimate).

Prognosis

The outcome depends on the specific disorder and the severity of its symptoms. Platelet function disorders range from life-threatening conditions to easily treated or little-noticed problems.

Prevention

Inherited platelet function disorders cannot be prevented except by **genetic counseling**; however, some

acquired function disorders may be guarded against by avoiding substances that trigger the disorder.

Resources

BOOKS

Ware, J. Anthony, and Barry S. Coller. "Platelet Morphology, Biochemistry, and Function." In *Williams Hematology*, ed. Ernest Beutler et al. New York: McGraw-Hill, Inc., 1995.

Williams, William J. "Classification and Clinical Manifestations of Disorders of Hemostasis." In *Williams Hematology*, ed. Ernest Beutler et al. New York: McGraw-Hill, Inc., 1995.

PERIODICALS

Liesner, R. J., and S. J. Machin. "Platelet Disorders." *British Medical Journal* 314, no. 7083 (1997): 809.

Julia Barrett

Pleural biopsy

Definition

The pleura is the membrane that lines the lungs and chest cavity. A pleural biopsy is the removal of pleural tissue for examination.

Purpose

Pleural biopsy is done to differentiate between benign and malignant disease, to diagnose viral, fungal, or parasitic diseases, and to identify a condition called collagen vascular disease of the pleura. It is also ordered when a **chest x ray** indicates a pleural-based tumor, reaction, or thickening of the lining.

Precautions

Because pleural biopsy is an invasive procedure, it is not recommended for patients with severe bleeding disorders.

Description

Pleural biopsy is usually ordered when pleural fluid obtained by another procedure called **thoracentesis** (aspiration of pleural fluid) suggests infection, signs of **cancer**, or **tuberculosis**. Pleural biopsies are 85–90% accurate in diagnosing these diseases.

The procedure most often performed for pleural biopsy is called a percutaneous (passage through the skin by needle puncture) needle biopsy. The procedure takes 30–45 minutes, although the biopsy needle itself remains in the pleura for less than one minute. This type of biopsy is usually performed by a physician at bedside, if the patient is hospitalized, or in the doctor's office under local anesthetic.

The actual procedure begins with the patient in a sitting position, shoulders and arms elevated and supported. The skin overlying the biopsy site is anesthetized and a small incision is made to allow insertion of the biopsy needle. This needle is inserted with a cannula (a plastic or metal tube) until fluid is removed. Then the inner needle is removed and a trocar (an instrument for withdrawing fluid from a cavity) is inserted to obtain the actual biopsy specimen. As many as three separate specimens are taken from different sites during the procedure. These specimens are then placed into a fixative solution and sent to the laboratory for tissue (histologic) examination.

Preparation

Preparations for this procedure vary, depending on the type of procedure requested. Pleural biopsy can be performed in several ways: percutaneous needle biopsy (described above), by **thoracoscopy** (insertion of a visual device called a laparoscope into the pleural space for inspection), or by open pleural biopsy, which requires general anesthesia.

Aftercare

Potential complications of this procedure include bleeding or injury to the lung, or a condition called **pneumothorax**, in which air enters the pleural cavity (the space between the two layers of pleura lining the lungs and the chest wall). Because of these possibilities, the patient is to report any **shortness of breath**, and to note any signs of bleeding, decreased blood pressure, or increased pulse rate.

Risks

Risks for this procedure include respiratory distress on the side of the biopsy, as well as bleeding, possible shoulder **pain**, pneumothorax (immediate) or **pneumonia** (delayed).

Normal results

Normal findings indicate no evidence of any pathologic or disease conditions.

Abnormal results

Abnormal findings include tumors called neoplasms (any new or abnormal growth) that can be either benign or malignant. Pleural tumors are divided into two classifica-

tions: primary (mesothelioma), or metastatic (arising from cancer sites elsewhere in the body). These tumors are often associated with an accumulation of fluid between the pleural layers called a **pleural effusion**, which itself may be caused by pneumonia, **heart failure**, cancer, or blood clot in the lungs (**pulmonary embolism**).

Other causes of abnormal findings include viral, fungal, or parasitic infections, and tuberculosis.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Pleural effusion

Definition

Pleural effusion occurs when too much fluid collects in the pleural space (the space between the two layers of the pleura). It is commonly known as "water on the lungs." It is characterized by **shortness of breath**, chest **pain**, gastric discomfort (**dyspepsia**), and **cough**.

Description

There are two thin membranes in the chest, one (the visceral pleura) lining the lungs, and the other (the parietal pleura) covering the inside of the chest wall. Normally, small blood vessels in the pleural linings produce a small amount of fluid that lubricates the opposed pleural membranes so that they can glide smoothly against one another during breathing movements. Any extra fluid is taken up by blood and lymph vessels, maintaining a balance. When either too much fluid forms or something prevents its removal, the result is an excess of pleural fluid—an effusion. The most common causes are disease of the heart or lungs, and inflammation or infection of the pleura.

Pleural effusion itself is not a disease as much as a result of many different diseases. For this reason, there is no "typical" patient in terms of age, sex, or other characteristics. Instead, anyone who develops one of the many conditions that can produce an effusion may be affected.

There are two types of pleural effusion: the transudate and the exudate. This is a very important point because the two types of fluid are very different, and which type is present points to what sort of disease is likely to have produced the effusion. It also can suggest the best approach to treatment.

Transudates

A transudate is a clear fluid, similar to blood serum, that forms not because the pleural surfaces themselves are diseased, but because the forces that normally produce and remove pleural fluid at the same rate are out of balance. When the heart fails, pressure in the small blood vessels that remove pleural fluid is increased and fluid "backs up" in the pleural space, forming an effusion. Or, if too little protein is present in the blood, the vessels are less able to hold the fluid part of blood within them and it leaks out into the pleural space. This can result from disease of the liver or kidneys, or from **malnutrition**.

Exudates

An exudate—which often is a cloudy fluid, containing cells and much protein—results from disease of the pleura itself. The causes are many and varied. Among the most common are infections such as bacterial **pneumonia** and **tuberculosis**; blood clots in the lungs; and connective tissue diseases, such as **rheumatoid arthritis**. **Cancer** and disease in organs such as the pancreas also may give rise to an exudative pleural effusion.

Special types of pleural effusion

Some of the pleural disorders that produce an exudate also cause bleeding into the pleural space. If the effusion contains half or more of the number of red blood cells present in the blood itself, it is called hemothorax. When a pleural effusion has a milky appearance and contains a large amount of fat, it is called chylothorax. Lymph fluid that drains from tissues throughout the body into small lymph vessels finally collects in a large duct (the thoracic duct) running through the chest to empty into a major vein. When this fluid, or chyle, leaks out of the duct into the pleural space, chylothorax is the result. Cancer in the chest is a common cause.

Causes and symptoms

Causes of transudative pleural effusion

Among the most important specific causes of a transudative pleural effusion are:

- Congestive **heart failure**. This causes pleural effusions in about 40% of patients and is often present on both sides of the chest. Heart failure is the most common cause of bilateral (two-sided) effusion. When only one

side is affected it usually is the right (because patients usually lie on their right side).

- Pericarditis. This is an inflammation of the pericardium, the membrane covering the heart.
- Too much fluid in the body tissues, which spills over into the pleural space. This is seen in some forms of kidney disease; when patients have bowel disease and absorb too little of what they eat; and when an excessive amount of fluid is given intravenously.
- Liver disease. About 5% of patients with a chronic scarring disease of the liver called **cirrhosis** develop pleural effusion.

Causes of exudative pleural effusions

A wide range of conditions may be the cause of an exudative pleural effusion:

- Pleural tumors account for up to 40% of one-sided pleural effusions. They may arise in the pleura itself (mesothelioma), or from other sites, notably the lung.
- Tuberculosis in the lungs may produce a long-lasting exudative pleural effusion.
- Pneumonia affects about three million persons each year, and four of every ten patients will develop pleural effusion. If effective treatment is not provided, an extensive effusion can form that is very difficult to treat.
- Patients with any of a wide range of infections by a virus, fungus, or parasite that involve the lungs may have pleural effusion.
- Up to half of all patients who develop blood clots in their lungs (**pulmonary embolism**) will have pleural effusion, and this sometimes is the only sign of **embolism**.
- Connective tissue diseases, including rheumatoid arthritis, lupus, and **Sjögren's syndrome** may be complicated by pleural effusion.
- Patients with disease of the liver or pancreas may have an exudative effusion, and the same is true for any patient who undergoes extensive abdominal surgery. About 30% of patients who undergo heart surgery will develop an effusion.
- Injury to the chest may produce pleural effusion in the form of either hemothorax or chylothorax.

Symptoms

The key symptom of a pleural effusion is shortness of breath. Fluid filling the pleural space makes it hard for the lungs to fully expand, causing the patient to take many breaths so as to get enough oxygen. When the parietal pleura is irritated, the patient may have mild pain that quickly passes or, sometimes, a sharp, stabbing pleuritic type of pain. Some patients will have a dry cough. Occasionally a patient will have no symptoms at all. This is more likely when the effusion results from recent abdominal surgery, cancer, or tuberculosis. Tapping on the chest will show that the usual crisp sounds have become dull, and on listening with a stethoscope the normal breath sounds are muted. If the pleura is inflamed, there may be a scratchy sound called a "pleural friction rub."

Diagnosis

When pleural effusion is suspected, the best way to confirm it is to take chest x rays, both straight-on and from the side. The fluid itself can be seen at the bottom of the lung or lungs, hiding the normal lung structure. If heart failure is present, the x-ray shadow of the heart will be enlarged. An ultrasound scan may disclose a small effusion that caused no abnormal findings during chest examination. A computed tomography scan is very helpful if the lungs themselves are diseased.

In order to learn what has caused the effusion, a needle or catheter is often used to obtain a fluid sample, which is examined for cells and its chemical make-up. This procedure, called a **thoracentesis**, is the way to determine whether an effusion is a transudate or exudate, giving a clue as to the underlying cause. In some cases—for instance when cancer or bacterial infection is present—the specific cause can be determined and the correct treatment planned. Culturing a fluid sample can identify the bacteria that cause tuberculosis or other forms of pleural infection. The next diagnostic step is to take a tissue sample, or **pleural biopsy**, and examine it under a microscope. If the effusion is caused by lung disease, placing a viewing tube (bronchoscope) through the large air passages will allow the examiner to see the abnormal appearance of the lungs.

Treatment

The best way to clear up a pleural effusion is to direct treatment at what is causing it, rather than treating the effusion itself. If heart failure is reversed or a lung infection is cured by **antibiotics**, the effusion will usually resolve. However, if the cause is not known, even after extensive tests, or no effective treatment is at hand, the fluid can be drained away by placing a large-bore needle or catheter into the pleural space, just as in diagnostic thoracentesis. If necessary, this can be repeated as often as is needed to control the amount of fluid in the pleural space. If large effusions continue to recur, a drug or material that irritates the pleural membranes can be injected to deliberately inflame them and cause them to

KEY TERMS

Culture—A test that exposes a sample of body fluid or tissue to special material to see whether bacteria or another type of microorganism is present.

Dyspepsia—A vague feeling of being too full and having heartburn, bloating, and nausea. Usually felt after eating.

Exudate—The type of pleural effusion that results from inflammation or other disease of the pleura itself. It features cloudy fluid containing cells and proteins.

Pleura or pleurae—A delicate membrane that encloses the lungs. The pleura is divided into two areas separated by fluid—the visceral pleura, which covers the lungs, and the parietal pleura, which lines the chest wall and covers the diaphragm.

Pleural cavity—The area of the thorax that contains the lungs.

Pleural space—The potential area between the visceral and parietal layers of the pleurae.

Pneumonia—An acute inflammation of the lungs, usually caused by bacterial infection.

Sclerosis—The process by which an irritating material is placed in the pleural space in order to inflame the pleural membranes and cause them to stick together, eliminating the pleural space and recurrent effusions.

Thoracentesis—Placing a needle, tube, or catheter in the pleural space to remove the fluid of pleural effusion. Used for both diagnosis and treatment.

Transudate—The type of pleural effusion seen with heart failure or other disorders of the circulation. It features clear fluid containing few cells and little protein.

adhere close together—a process called sclerosis. This will prevent further effusion by eliminating the pleural space. In the most severe cases, open surgery with removal of a rib may be necessary to drain all the fluid and close the pleural space.

Prognosis

When the cause of pleural effusion can be determined and effectively treated, the effusion itself will reliably clear up and should not recur. In many other cases, sclerosis will prevent sizable effusions from recurring. Whenever a large effusion causes a patient to be short of breath, thoracentesis will make breathing easier, and it may be repeated if necessary. To a great extent, the outlook for patients with pleural effusion depends on the primary cause of effusion and whether it can be eliminated. Some forms of pleural effusion, such as that seen after abdominal surgery, are only temporary and will clear without specific treatment. If heart failure can be controlled, the patient will remain free of pleural effusion. If, on the other hand, effusion is caused by cancer that cannot be controlled, other effects of the disease probably will become more important.

Prevention

Because pleural effusion is a secondary effect of many different conditions, the key to preventing it is to promptly diagnose the primary disease and provide effective treatment. Timely treatment of infections such as tuberculosis and pneumonia will prevent many effusions. When effusion occurs as a drug side-effect, withdrawing the drug or using a different one may solve the problem. On rare occasions, an effusion occurs because fluid meant for a vein is mistakenly injected into the pleural space. This can be prevented by making sure that proper technique is used.

Resources

BOOKS

Smolley, Lawrence A., and Debra F. Bryse. *Breathe Right Now: A Comprehensive Guide to Understanding and Treating the Most Common Breathing Disorders*. New York: W. W. Norton & Co., 1998.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

OTHER

"Pulmonary Medicine." *Healthweb Page*. 12 Jan. 1998 <http://healthweb.org/browse.cfm?subjectid=81>.

David A. Cramer, MD

Pleural fluid analysis *see* **Thoracentesis**

Pleurisy

Definition

Pleurisy is an inflammation of the membrane that surrounds and protects the lungs (the pleura). Inflammation occurs when an infection or damaging agent irritates the pleural surface. As a consequence, sharp chest pains are the primary symptom of pleurisy.

Description

Pleurisy, also called pleuritis, is a condition that generally stems from an existing respiratory infection, disease, or injury. In people who have otherwise good health, respiratory infections or **pneumonia** are the main causes of pleurisy. This condition used to be more common, but with the advent of **antibiotics** and modern disease therapies, pleurisy has become less prevalent.

The pleura is a double-layered structure made up of an inner membrane, which surrounds the lungs, and an outer membrane, which lines the chest cavity. The pleural membranes are very thin, close together, and have a fluid coating in the narrow space between them. This liquid acts as a lubricant, so that when the lungs inflate and deflate during breathing, the pleural surfaces can easily glide over one another.

Pleurisy occurs when the pleural surfaces rub against one another, due to irritation and inflammation. Infection within the pleural space is the most common irritant, although the abnormal presence of air, blood, or cells can also initiate pleurisy. These disturbances all act to displace the normal pleural fluid, which forces the membranes to rub, rather than glide, against one another. This rubbing irritates nerve endings in the outer membrane and causes **pain**. Pleurisy also causes a chest noise that ranges from a faint squeak to a loud creak. This characteristic sound is called a "friction rub."

Pleurisy cases are classified either as having **pleural effusion** or as being "dry." Pleural effusion is more common and refers to an accumulation of fluid within the pleural space; dry pleurisy is inflammation without fluid build-up. Less pain occurs with pleural effusion because the fluid forces the membrane surfaces apart. However, pleural effusion causes additional complications because it places pressure on the lungs. This leads to respiratory distress and possible lung collapse.

Causes and symptoms

A variety of conditions can give rise to pleurisy. The following list represents the most common sources of pleural inflammation.

- infections, including pneumonia, **tuberculosis**, and other bacterial or viral respiratory infections
- immune disorders, including **systemic lupus erythematosus**, **rheumatoid arthritis**, and **sarcoidosis**
- diseases, including **cancer**, **pancreatitis**, liver **cirrhosis**, and heart or kidney failure
- injury, from a rib fracture, collapsed lung, esophagus rupture, blood clot, or material such as asbestos
- drug reactions, from certain drugs used to treat tuberculosis (isoniazid), cancer (methotrexate, procarbazine), or the immune disorders mentioned above (hydralazine, procainamide, phenytoin, quinidine)

Symptomatic pain

The hallmark symptom of pleurisy is sudden, intense chest pain that is usually located over the area of inflammation. Although the pain can be constant, it is usually most severe when the lungs move during breathing, coughing, sneezing, or even talking. The pain is usually described as shooting or stabbing, but in minor cases it resembles a mild cramp. When pleurisy occurs in certain locations, such as near the diaphragm, the pain may be felt in other areas such as the neck, shoulder, or abdomen (referred pain). Another indication of pleurisy is that holding one's breath or exerting pressure against the chest causes pain relief.

Breathing difficulties

Pleurisy is also characterized by certain respiratory symptoms. In response to the pain, pleurisy patients commonly have a rapid, shallow breathing pattern. Pleural effusion can also cause **shortness of breath**, as excess fluid makes expanding the lungs difficult. If severe breathing difficulties persist, patients may experience a blue colored complexion (**cyanosis**).

Additional symptoms of pleurisy are specific to the illness that triggers the condition. Thus, if infection is the cause, then chills, **fever**, and **fatigue** will be likely pleurisy symptoms.

Diagnosis

The distinctive pain of pleurisy is normally the first clue physicians use for diagnosis. Doctors usually feel the chest to find the most painful area, which is the likely site of inflammation. A stethoscope is also used to listen for abnormal chest sounds as the patient breathes. If the doctor hears the characteristic friction rub, the diagnosis of pleurisy can be confirmed. Sometimes, a friction rub is masked by the presence of pleural effusion and further examination is needed for an accurate diagnosis.

Identifying the actual illness that causes pleurisy is more difficult. To make this diagnosis, doctors must evaluate the patient's history, additional symptoms, and laboratory test results. A **chest x ray** may also be taken to look for signs of accumulated fluid and other abnormalities. Possible causes, such as pneumonia, fractured ribs, esophagus rupture, and lung tumors may be detected on an x ray. Computed tomography scan (CT scan) and ultrasound scans are more powerful diagnostic tools used to visualize the chest cavity. Images from these techniques more clearly pinpoint the location of excess fluid or other suspected problems.

The most helpful information in diagnosing the cause of pleurisy is a fluid analysis. Once the doctor knows the precise location of fluid accumulation, a sample is removed using a procedure called **thoracentesis**. In this technique, a fine needle is inserted into the chest to reach the pleural space and extract fluid. The fluid's appearance and composition is thoroughly examined to help doctors understand how the fluid was produced. Several laboratory tests are performed to analyze the chemical components of the fluid. These tests also determine whether infection-causing bacteria or viruses are present. In addition, cells within the fluid are identified and counted. Cancerous cells can also be detected to learn whether the pleurisy is caused by a malignancy.

In certain instances, such as dry pleurisy, or when a fluid analysis is not informative, a biopsy of the pleura may be needed for microscopic analysis. A sample of pleural tissue can be obtained several ways: with a biopsy needle, by making a small incision in the chest wall, or by using a thoracoscope (a video-assisted instrument for viewing the pleural space and collecting samples).

Treatment

Pain management

The pain of pleurisy is usually treated with analgesic and anti-inflammatory drugs, such as **acetaminophen**, ibuprofen, and indomethacin. People with pleurisy may also receive relief from lying on the painful side. Sometimes, a painful **cough** will be controlled with codeine-based cough syrups. However, as the pain eases, a person with pleurisy should try to breathe deeply and cough to clear any congestion, otherwise pneumonia may occur. Rest is also important to aid in the recovery process.

Treating the source

The treatment used to cure pleurisy is ultimately defined by the underlying cause. Thus, pleurisy from a bacterial infection can be successfully treated with antibiotics, while no treatment is given for viral infections that must run their course. Specific therapies designed for more chronic illnesses can often cause pleurisy to subside. For example, tuberculosis pleurisy is treated with standard anti-tuberculosis drugs. With some illnesses, excess fluid continues to accumulate and causes severe respiratory distress. In these individuals, the fluid may be removed by thoracentesis, or the doctor may insert a chest tube to drain large amounts. If left untreated, a more serious infection may develop within the fluid, called **empyema**.

Alternative treatment

Alternative treatments can be used in conjunction with conventional treatment to help heal pleurisy. **Acupuncture** and botanical medicines are alternative approaches for alleviating pleural pain and breathing problems. An herbal remedy commonly recommended is pleurisy root (*Asclepias tuberosa*), so named because of its use by early American settlers who learned of this medicinal plant from Native Americans. Pleurisy root helps to ease pain, inflammation, and breathing difficulties brought on by pleurisy. This herb is often used in conjunction with mullein (*Verbascum thapsus*) or elecampane (*Inula helenium*), which serve as **expectorants** to clear excess mucus from the lungs. In addition, there are many other respiratory herbs that are used as expectorants or for other actions on the respiratory system. Herbs thought to combat infection, such as **echinacea** (*Echinacea* spp.) are also included in herbal pleurisy remedies. Anitviral herbs, such as *Lomatium dissectum* and *Ligusticum porteri*, can be used if the pleurisy is of viral origin. **Traditional Chinese medicine** uses the herb ephedra (*Ephedra sinica*), which acts to open air passages and alleviate respiratory difficulties in pleurisy patients. Dietary recommendations include eating fresh fruits and vegetables, adequate protein, and good quality fats (omega–3 fatty acids are anti-inflammatory and are found in fish and flax oil). Taking certain nutritional supplements, especially large doeses of vitamin C, may also provide health benefits to people with pleurisy. Contrast **hydrotherapy** applied to the chest and back, along with compresses (cloths soaked in an herbal solution) or poultices (crushed herbs applied directly to the skin) of respiratory herbs, can assist in the healing process. Homeopathic treatment, guided by a trained practitioner, can be effective in resolving pleurisy.

Prognosis

Prompt diagnosis, followed by appropriate treatment, ensures a good recovery for most pleurisy patients. Generally speaking, the prognosis for pleurisy is linked to the seriousness of its cause. Therefore, the outcome of pleurisy caused by a disease such as cancer will vary depending on the type and location of the tumor.

KEY TERMS

Effusion—The accumulation of fluid within a cavity, such as the pleural space.

Empyema—An infection that causes pus to accumulate in the pleural space. The pus may cause a tear in the pleural membrane, which allows the infection to spread to other areas in the body. Intravenous antibiotics are often given to control the infection.

Inflammation—An accumulation of fluid and cells within tissue that is often caused by infection and the immune response that occurs as a result.

Pneumonia—A condition caused by bacterial or viral infection that is characterized by inflammation of the lungs and fluid within the air passages. Pneumonia is often an underlying cause of pleurisy.

Referred pain—The presence of pain in an area other than where it originates. In some pleurisy cases, referred pain occurs in the neck, shoulder, or abdomen.

Prevention

Preventing pleurisy is often a matter of providing early medical attention to conditions that can cause pleural inflammation. Along this line, appropriate antibiotic treatment of bacterial respiratory infections may successfully prevent some cases of pleurisy. Maintaining a healthy lifestyle and avoiding exposure to harmful substances (for example, asbestos) are more general preventative measures.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Fife, WA: Future Medicine Publishing, 1995.

Light, Richard W. "Disorders of the Pleura, Mediastinum, and Diaphragm." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Light, Richard W. *Pleural Diseases.* Baltimore: Williams and Wilkins, 1995.

Stauffer, John L. "Lung: Pleural Diseases." In *Current Medical Diagnosis and Treatment, 1996.* 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Julie A. Gelderloos

Pleuritis *see* **Pleurisy**

Plumbism *see* **Lead poisoning**

PMS *see* **Premenstrual syndrome**

Pneumococcal pneumonia

Definition

Pneumococcal **pneumonia** is a common but serious infection and inflammation of the lungs. It is caused by the bacterium *Streptococcus pneumoniae*.

Description

The gram-positive, spherical bacteria, *Streptococcus pneumoniae*, is the cause of many human diseases, including pneumonia. Although the bacteria can normally be found in the nose and throat of healthy individuals, it can grow and cause infection when the immune system is weakened. Infection usually begins with the upper respiratory tract and then travels into the lungs. Pneumonia occurs when the bacteria find their way deep into the lungs, to the area called the alveoli, or air sacs. This is the functional part of the lungs where oxygen is absorbed into the blood. Once in the alveoli, *Streptococcus pneumoniae* begin to grow and multiply. White blood cells and immune proteins from the blood also accumulate at the site of infection in the alveoli. As the alveoli fill with these substances and fluid, they can no longer function in the exchange of oxygen. This fluid filling of the lungs is how pneumonia is defined.

Those people most at risk of developing pneumococcal pneumonia have a weakened immune system. This includes the elderly, infants, **cancer** patients, **AIDS** patients, post-operative patients, alcoholics, and those with diabetes. Pneumococcal pneumonia is a disease that has a high rate of hospital transmission, putting hospital patients at greater risk. Prior lung infections also makes someone more likely to develop pneumococcal pneumonia. The disease can be most severe in patients who have had their spleen removed. It is the spleen that is responsible for removing the bacteria from the blood. Cases of pneumonia, which is spread by close contact, seem to occur most often between November through April. If

not treated, the disease can spread, causing continually decreasing lung function, heart problems, and arthritis.

Causes and symptoms

Symptoms of bacterial pneumonia include a **cough**, sputum (mucus) production that may be puslike or bloody, shaking and chills, **fever**, and chest **pain**. Symptoms often have an abrupt beginning and occur after an upper respiratory infection such as a cold. Symptoms may differ somewhat in the elderly, with minimal cough, no sputum and no fever, but rather tiredness and confusion leading to **hypothermia** and **shock**.

Diagnosis

The presence of symptoms and a physical exam that reveals abnormal lung sounds usually suggest the presence of pneumonia. Diagnosis is typically made from an x ray of the lungs, which indicates the accumulation of fluid. Additional tests that may be done include a complete **blood count**, a sputum sample for microscopic examination and culture for *Streptococcus pneumoniae*, and possibly blood cultures.

Treatment

Depending on the severity of the disease, **antibiotics** are given either at home or in the hospital. Historically, the treatment for pneumococcal pneumonia has been penicillin. An increasing number of cases of pneumococcal pneumonia have become partially or completely resistant to penicillin, making it less effective in treating this disease. Other effective antibiotics include amoxicillin and erythromycin. If these antibiotics are not effective, vancomycin or cephalosporin may alternatively be used.

Symptoms associated with pneumococcal pneumonia can also be treated. For instance, fever can be treated with **aspirin** or **acetaminophen**. Supplemental oxygen and intravenous fluids may help. Patients are advised to get plenty of rest and take increased amounts of fluids. Coughing should be promoted because it helps to clear the lungs of fluid.

Alternative treatment

Being a serious, sometimes fatal disease, pneumococcal pneumonia is best treated as soon as possible with antibiotics. However, there are alternative treatments that both support this conventional treatment and prevent recurrences. Maintaining a healthy immune system is important. One way to do this is by taking the herb, **echinacea** (*Echinacea* spp.). Getting plenty of rest and reducing **stress** can help the body heal. Some practitioners feel that mucus-producing foods (including dairy products, eggs, gluten-rich grains such as wheat, oats, rye, as well as sugar) can contribute to the lung congestion that accompanies pneumonia. Decreasing these foods and increasing the amount of fresh fruits and vegetables may help to decrease lung congestion. Adequate protein in the diet is also essential for the body to produce antibodies. Contrast and constitutional **hydrotherapy** can be very helpful in treating cases of pneumonia. Other alternative therapies, including **acupuncture**, Chinese herbal medicine, and **homeopathy**, can be very useful during the recovery phase, helping the body to rebuild after the illness and contributing to the prevention of recurrences.

Prognosis

Simple, uncomplicated cases of pneumococcal pneumonia will begin to respond to antibiotics in 48 to 72 hours. Full recovery from pneumonia, however, is greatly dependent on the age and overall health of the individual. Normally, healthy and younger patients can recover in only a few days, while the elderly or otherwise weakened individuals may not recover for several weeks. Complications may develop which give a poorer prognosis. Even when promptly and properly diagnosed, such weakened patients may die of their pneumonia.

Prevention

Vaccination

Recently, a **vaccination** has become available for the prevention of pneumococcal pneumonia. This vaccination is generally recommended for people with a high likelihood of developing pneumococcal infection or for those in whom a serious complication of infection is likely to develop. This would include persons over the age of 65, as well as those with:

- chronic pulmonary disease
- advanced cardiovascular disease
- diabetes mellitus
- alcoholism
- cirrhosis
- chronic kidney disease
- spleen dysfunction, or removal of spleen
- iimmunosuppression (cancer, organ transplant or AIDS)
- sickle cell anemia

Unfortunately, those people for whom the vaccination is most recommended are also those who are least

KEY TERMS

Acetaminophen—A drug used for pain relief as well as to decrease fever. A common trade name for the drug is Tylenol.

Aspirin—A commonly used drug for pain relief and to decrease fever.

Bronchi—Two main branches of the trachea that go into the lungs. This then further divides into the bronchioles and alveoli.

Sputum—A substance that comes up from the throat when coughing or clearing the throat. It is important since it contains materials from the lungs.

likely to respond favorably to a vaccination. Therefore, the overall effectiveness of this vaccine remains questionable.

Antibiotics

The use of oral penicillin to prevent infection may be recommended for some patients at high risk, such as children with **sickle cell disease** and those with a spleen removed. This treatment, however, must be weighed with the increased likelihood of developing penicillin-resistant infections.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide.* Fife, WA: Future Medicine Publishing, 1995.

Musher, Daniel M. "Streptococcus Pneumoniae." In *Principles and Practice of Infectious Diseases*, ed. G. L. Mandell, J. E. Bennett, and R. Dolin. New York: Churchill Livingston, 1995.

PERIODICALS

Obaro, S. K., M. A. Monteil, and D. C. Henderson. "The Pneumococcal Problem." *British Medical Journal* 312 (15 June 1996): 1521-1526.

"Pneumonia Prevention: It's Worth a Shot." *Executive Health's Good Health Report* 34 (Dec. 1997): 1-2.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Pneumocystis pneumonia

Definition

Pneumocystis **pneumonia** is a lung infection that occurs primarily in people with weakened immune systems—especially people who are HIV-positive. The disease agent is an organism whose biological classification is still uncertain. *Pneumocystis carinii* was originally thought to be a one-celled organism (a protozoan), but more recent research suggests that it is a fungus. Although its life cycle is known to have three stages, its method of reproduction is not yet completely understood. The complete name of the disease is *Pneumocystis carinii* pneumonia, often shortened to PCP. PCP is also sometimes called pneumocystosis.

Description

Pneumonia as a general term refers to a severe lung inflammation. In pneumocystis pneumonia, this inflammation is caused by the growth of *Pneumocystis carinii*, a fungus-like organism that is widespread in the environment. PCP is ordinarily a rare disease, affecting only people with weakened immune systems. Many of these people are patients receiving drugs for organ transplants or **cancer** treatment. With the rising incidence of **AIDS**, however, PCP has become primarily associated with AIDS patients. In fact, as many as 75% of AIDS patients have developed PCP. It has also been the leading cause of **death** in AIDS patients.

Transmission

The organism that causes PCP is widely distributed in nature and is transmitted through the air. When the organism is inhaled, it enters the upper respiratory tract and infects the tiny air sacs at the ends of the smaller air tubes (bronchioles) in the lungs. These tiny air sacs are called alveoli. Under a microscope, alveoli look like groups of hollow spheres resembling grape clusters. The exchange of oxygen with the blood takes place in the alveoli. It appears that *P. carinii* lives in the fluid in the lining of the alveoli.

Person-to-person infection does not appear to be very common; however, clusters of PCP outbreaks in hospitals and groups of immunocompromised people indicate that patients with active PCP should not be exposed to others with weakened immune systems. It is thought that many people actually acquire mild *Pneumocystis carinii* infections from time to time, but are protected by their immune systems from developing a full-blown case of the disease.

Causes and symptoms

Causes

P. carinii is an opportunistic organism. This means that it causes disease only under certain conditions, as when a person is immunocompromised. Under these circumstances, *P. carinii* can multiply and cause pneumonia. The mechanisms of the organism's growth within the alveoli are not fully understood. As the pneumocystis organism continues to replicate, it gradually fills the alveoli. As the pneumonia becomes more severe, fluid accumulates and tissue scarring occurs. These changes result in decreased respiratory function and lower levels of oxygen in the blood.

High-risk groups

Some patients are at greater risk of developing PCP. These high-risk groups include:

- premature infants
- patients with **immunodeficiency** diseases, including **severe combined immunodeficiency** disease (SCID) and acquired immunodeficiency syndrome (AIDS)
- patients receiving immunosuppressive drugs, especially cortisone-like drugs (**corticosteroids**)
- patients with protein malnutrition.

AIDS is currently the most common risk factor for PCP in the United States. PCP is, however, also found in countries with widespread hunger and poor hygiene.

Symptoms

The incubation period of PCP is not definitely known, but is thought to be between four and eight weeks. The major symptoms include **shortness of breath**, **fever**, and a nonproductive **cough**. Less common symptoms include production of sputum, blood in the sputum, difficulty breathing, and chest **pain**. Most patients will have symptoms for one to two weeks before seeing a physician. Occasionally, the disease will spread outside of the lung to other organs, including the lymph nodes, spleen, liver, or bone marrow.

Diagnosis

The diagnosis of PCP begins with a thorough **physical examination** and blood tests. Although imaging studies are helpful in identifying abnormal areas in the lungs, the diagnosis of PCP must be confirmed by microscopic identification of the organism in the lung. Samples may be taken from the patient's sputum, or may be obtained via **bronchoscopy** or **lung biopsy**. Because of the severity of the disease, many physicians will proceed to treat patients with symptoms of pneumocystis pneumonia if they belong to a high-risk group, without the formality of an actual diagnosis. The severity of PCP can be measured by x-ray studies and by determining the amount of oxygen and carbon dioxide present in the patient's blood.

Treatment

Treatment for PCP involves the use of **antibiotics**. These include trimethoprim-sulfamethoxazole (TMP-SMX, Bactrim, Septra) and pentamidine isoethionate (Nebupent, Pentam 300). Both of these anti-microbial drugs are equally effective. AIDS patients are typically treated for 21 days, whereas non-AIDS patients are treated for 14 days. TMP-SMX may be highly toxic in AIDS patients, causing severe side effects that include fever, rash, decreased numbers of white blood cells and platelets, and hepatitis. Pentamidine also causes side effects in immunocompromised patients. These side effects include decreased blood pressure, irregular heart beats, the accumulation of nitrogenous waste products in the blood (azotemia), and electrolyte imbalances. Pentamidine can be given in aerosol form to minimize side effects. Alternative drugs can be used for patients experiencing these side effects.

P. carinii appears to be developing resistance to TMP-SMX. In addition, some patients are allergic to the standard antibiotics given for PCP. As a result, other antibiotics for the treatment of PCP are continually under investigation. Some drugs proven to be effective against *P. carinii* include dapsone (DDS) with trimethoprim (Trimpex), clindamycin (Cleocin) with primaquine, as well as atovaquone (Mepron). Paradoxically, corticosteroids have been found to improve the ability of TMP-SMX or pentamidine to treat PCP. As a treatment of last resort, trimetrexate with leucovorin (Wellcovorin) can also be used.

Prognosis

If left untreated, PCP will cause breathing difficulties that will eventually cause death. The prognosis for this disease depends on the amount of damage to the patient's lungs prior to treatment. Prognosis is usually better at a facility that specializes in caring for AIDS patients. Antibiotic treatment of PCP is about 80% effective.

Prevention

Medications

For patients at serious risk for PCP infection, low doses of TMP-SMX, given daily or three times a week,

KEY TERMS

Alveoli—Small, hollow air sacs found in the lungs at the end of the smaller airways (bronchioles). Air exchange occurs in the alveoli.

Azotemia—The presence of excess nitrogenous wastes in the blood.

Biopsy—A procedure in which a piece of tissue is obtained for microscopic study.

Bronchoscopy—A procedure that uses a fiber-optic scope to view the airways in the lung.

Fungus—A single-celled form of plant life that lives on organic material, including human tissues.

Pentamidine isoethionate—An antibiotic used to treat and prevent PCP.

Pneumocystosis—Another name for active PCP infection.

Protozoan—A microorganism belonging to the Protista, which includes the simplest one-celled organisms.

Sputum—A substance obtained from the lungs and bronchial tubes by clearing the throat or coughing. Sputum can be tested for evidence of PCP infection.

Trimethoprim-sulfamethoxazole (TMP-SMX)—An antibiotic used to treat and prevent PCP.

are effective in preventing PCP. The drug is, however, highly toxic. Researchers are currently evaluating the effectiveness and toxicity of aerosol pentamidine and dapsone in preventing PCP.

Lifestyle modifications

Patients who have previously had PCP often experience a recurrence. Healthy lifestyle choices, including exercising, eating well, and giving up **smoking** may keep the disease at bay.

Resources

BOOKS

Dobkin, Jay. *"Pneumocystis carinii* Pneumonia (PCP)." In *The Columbia University College of Physicians and Surgeons Complete Home Medical Guide.* New York: Crown Publishers, Inc., 1995.

Walzer, Peter D. *"Pneumocystis carinii."* In *Principles and Practice of Infectious Diseases*, ed. G. L. Mandell, et al. New York: Churchill Livingston, 1995.

PERIODICALS

Korraa, H., and C. Saadeh. "Options in the Management of Pneumonia Caused by *Pneumocystis carinii* in Patients with Acquired Immune Deficiency Syndrome and Intolerance to Trimethoprim/Sulfamethoxazole." *Southern Medical Journal* 89, no. 3 (Mar. 1996): 272-277.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Pneumonectomy *see* **Lung surgery**

Pneumonia

Definition

Pneumonia is an infection of the lung, and can be caused by nearly any class of organism known to cause human infections. These include bacteria, viruses, fungi, and parasites. In the United States, pneumonia is the sixth most common disease leading to **death**. It is also the most common fatal infection acquired by already hospitalized patients. In developing countries, pneumonia ties with **diarrhea** as the most common cause of death.

Description

Anatomy of the lung

To better understand pneumonia, it is important to understand the basic anatomic features of the respiratory system. The human respiratory system begins at the nose and mouth, where air is breathed in (inspired) and out (expired). The air tube extending from the nose is called the nasopharynx. The tube carrying air breathed in through the mouth is called the oropharynx. The nasopharynx and the oropharynx merge into the larynx. The oropharynx also carries swallowed substances, including food, water, and salivary secretion, which must pass into the esophagus and then the stomach. The larynx is protected by a trap door called the epiglottis. The epiglottis prevents substances that have been swallowed, as well as substances that have been regurgitated (thrown up), from heading down into the larynx and toward the lungs.

A useful method of picturing the respiratory system is to imagine an upside-down tree. The larynx flows into the trachea, which is the tree trunk, and thus the broadest

part of the respiratory tree. The trachea divides into two tree limbs, the right and left bronchi. Each one of these branches off into multiple smaller bronchi, which course through the tissue of the lung. Each bronchus divides into tubes of smaller and smaller diameter, finally ending in the terminal bronchioles. The air sacs of the lung, in which oxygen-carbon dioxide exchange actually takes place, are clustered at the ends of the bronchioles like the leaves of a tree. They are called alveoli.

The tissue of the lung which serves only a supportive role for the bronchi, bronchioles, and alveoli is called the lung parenchyma.

Function of the respiratory system

The main function of the respiratory system is to provide oxygen, the most important energy source for the body's cells. Inspired air (the air you breath in) contains the oxygen, and travels down the respiratory tree to the alveoli. The oxygen moves out of the alveoli and is sent into circulation throughout the body as part of the red blood cells. The oxygen in the inspired air is exchanged within the alveoli for the waste product of human metabolism, carbon dioxide. The air you breathe out contains the gas called carbon dioxide. This gas leaves the alveoli during expiration. To restate this exchange of gases simply, you breathe in oxygen, you breathe out carbon dioxide

Respiratory system defenses

The normal, healthy human lung is sterile. There are no normally resident bacteria or viruses (unlike the upper respiratory system and parts of the gastrointestinal system, where bacteria dwell even in a healthy state). There are multiple safeguards along the path of the respiratory system. These are designed to keep invading organisms from leading to infection.

The first line of defense includes the hair in the nostrils, which serves as a filter for larger particles. The epiglottis is a trap door of sorts, designed to prevent food and other swallowed substances from entering the larynx and then trachea. Sneezing and coughing, both provoked by the presence of irritants within the respiratory system, help to clear such irritants from the respiratory tract.

Mucous, produced through the respiratory system, also serves to trap dust and infectious organisms. Tiny hair like projections (cilia) from cells lining the respiratory tract beat constantly. They move debris trapped by mucus upwards and out of the respiratory tract. This mechanism of protection is referred to as the mucociliary escalator.

Cells lining the respiratory tract produce several types of immune substances which protect against various organisms. Other cells (called macrophages) along the respiratory tract actually ingest and kill invading organisms.

The organisms that cause pneumonia, then, are usually carefully kept from entering the lungs by virtue of these host defenses. However, when an individual encounters a large number of organisms at once, the usual defenses may be overwhelmed, and infection may occur. This can happen either by inhaling contaminated air droplets, or by aspiration of organisms inhabiting the upper airways.

Conditions predisposing to pneumonia

In addition to exposure to sufficient quantities of causative organisms, certain conditions may make an individual more likely to become ill with pneumonia. Certainly, the lack of normal anatomical structure could result in an increased risk of pneumonia. For example, there are certain inherited defects of cilia which result in less effective protection. Cigarette smoke, inhaled directly by a smoker or second-hand by a innocent bystander, interferes significantly with ciliary function, as well as inhibiting macrophage function.

Stroke, seizures, alcohol, and various drugs interfere with the function of the epiglottis. This leads to a leaky seal on the trap door, with possible contamination by swallowed substances and/or regurgitated stomach contents. Alcohol and drugs also interfere with the normal **cough** reflex. This further decreases the chance of clearing unwanted debris from the respiratory tract.

Viruses may interfere with ciliary function, allowing themselves or other microorganism invaders (such as bacteria) access to the lower respiratory tract. One of the most important viruses is HIV (Human **Immunodeficiency** Virus), the causative virus in **AIDS** (acquired immunodeficiency syndrome). In recent years this virus has resulted in a huge increase in the incidence of pneumonia. Because AIDS results in a general decreased effectiveness of many aspects of the host's immune system, a patient with AIDS is susceptible to all kinds of pneumonia. This includes some previously rare parasitic types which would be unable to cause illness in an individual possessing a normal immune system.

The elderly have a less effective mucociliary escalator, as well as changes in their immune system. This causes this age group to be more at risk for the development of pneumonia.

Various chronic conditions predispose a person to infection with pneumonia. These include **asthma**, **cystic fibrosis**, and neuromuscular diseases which may interfere with the seal of the epiglottis. Esophageal disorders may result in stomach contents passing upwards into the

esophagus. This increases the risk of aspiration into the lungs of those stomach contents with their resident bacteria. Diabetes, sickle cell anemia, lymphoma, leukemia, and **emphysema** also predispose a person to pneumonia.

Pneumonia is also one of the most frequent infectious complications of all types of surgery. Many drugs used during and after surgery may increase the risk of aspiration, impair the cough reflex, and cause a patient to underfill their lungs with air. **Pain** after surgery also discourages a patient from breathing deeply enough, and from coughing effectively.

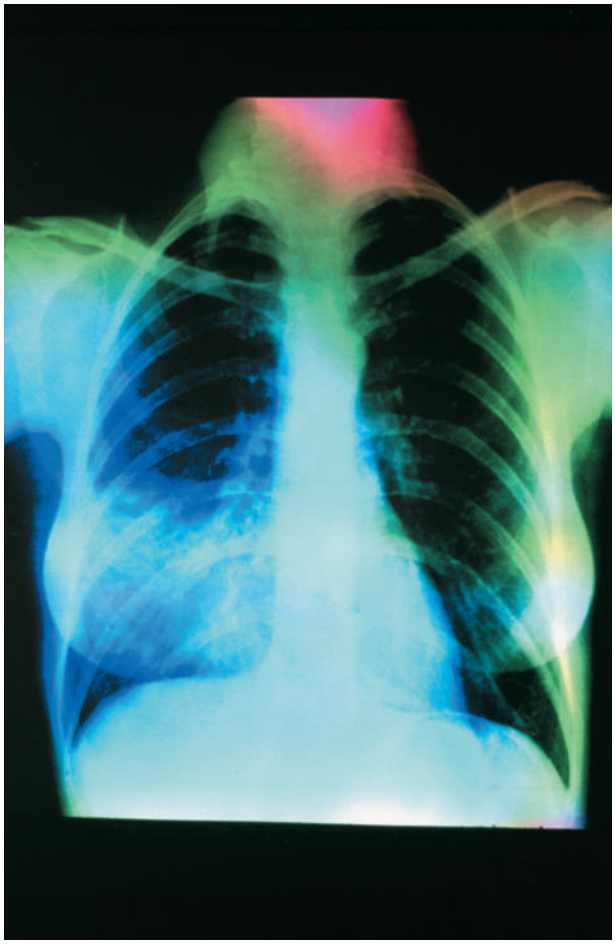
Causes

The list of organisms which can cause pneumonia is very large, and includes nearly every class of infecting organism: viruses, bacteria, bacteria-like organisms, fungi, and parasites (including certain worms). Different organisms are more frequently encountered by different age groups. Further, other characteristics of an individual may place him or her at greater risk for infection by particular types of organisms:

- Viruses cause the majority of pneumonias in young children (especially respiratory syncytial virus, parainfluenza and **influenza** viruses, and adenovirus).
- Adults are more frequently infected with bacteria (such as *Streptococcus pneumoniae, Haemophilus influenzae,* and *Staphylococcus aureus*).
- Pneumonia in older children and young adults is often caused by the bacteria-like *Mycoplasma pneumoniae* (the cause of what is often referred to as "walking" pneumonia).
- *Pneumocystis carinii* is an extremely important cause of pneumonia in patients with immune problems (such as patients being treated for **cancer** with **chemotherapy**, or patients with AIDS. Classically considered a parasite, it appears to be more related to fungi.
- People who have reason to come into contact with bird droppings, such as poultry workers, are at risk for pneumonia caused by the organism *Chlamydia psittaci.*
- A very large, serious outbreak of pneumonia occurred in 1976, when many people attending an American Legion convention were infected by a previously unknown organism. Subsequently named *Legionella pneumophila,* it causes what is now called "Legionnaire's disease." The organism was traced to air conditioning units in the convention's hotel.

Symptoms

Pneumonia is suspected in any patient who has **fever**, cough, chest pain, **shortness of breath**, and increased respirations (number of breaths per minute). Fever with a shaking chill is even more suspicious. Many patients cough up clumps of sputum, commonly known as spit. These secretions are produced in the alveoli during an infection or other inflammatory condition. They may appear streaked with pus or blood. Severe pneumonia results in the signs of oxygen deprivation. This includes blue appearance of the nail beds or lips (**cyanosis**).



A chest x-ray showing lobar pneumonia in the lower lobe of a patient's right lung. The alveoli (air sacs) of the lung become blocked with pus, which forces air out and causes the lung to become solidified. *(Photo Researchers, Inc. Reproduced by permission.)*

The invading organism causes symptoms, in part, by provoking an overly-strong immune response in the lungs. In other words, the immune system, which should help fight off infections, kicks into such high gear, that it damages the lung tissue and makes it more susceptible to infection. The small blood vessels in the lungs (capillaries) become leaky, and protein-rich fluid seeps into the alveoli. This results in less functional area for oxygen-carbon dioxide exchange. The patient becomes relatively

oxygen deprived, while retaining potentially damaging carbon dioxide. The patient breathes faster and faster, in an effort to bring in more oxygen and blow off more carbon dioxide.

Mucus production is increased, and the leaky capillaries may tinge the mucus with blood. Mucus plugs actually further decrease the efficiency of gas exchange in the lung. The alveoli fill further with fluid and debris from the large number of white blood cells being produced to fight the infection.

Consolidation, a feature of bacterial pneumonias, occurs when the alveoli, which are normally hollow air spaces within the lung, instead become solid, due to quantities of fluid and debris.

Viral pneumonias and mycoplasma pneumonias, do not result in consolidation. These types of pneumonia primarily infect the walls of the alveoli and the parenchyma of the lung.

Diagnosis

For the most part, diagnosis is based on the patient's report of symptoms, combined with examination of the chest. Listening with a stethoscope will reveal abnormal sounds, and tapping on the patient's back (which should yield a resonant sound due to air filling the alveoli) may instead yield a dull thump if the alveoli are filled with fluid and debris.

Laboratory diagnosis can be made of some bacterial pneumonias by staining sputum with special chemicals and looking at it under a microscope. Identification of the specific type of bacteria may require culturing the sputum (using the sputum sample to grow greater numbers of the bacteria in a lab dish.).

X-ray examination of the chest may reveal certain abnormal changes associated with pneumonia. Localized shadows obscuring areas of the lung may indicate a bacterial pneumonia, while streaky or patchy appearing changes in the x-ray picture may indicate viral or mycoplasma pneumonia. These changes on x ray, however, are known to lag in time behind the patient's actual symptoms.

Treatment

Prior to the discovery of penicillin **antibiotics**, bacterial pneumonia was almost always fatal. Today, antibiotics, especially given early in the course of the disease, are very effective against bacterial causes of pneumonia. Erythromycin and tetracycline improve recovery time for symptoms of mycoplasma pneumonia. They, do not, however, eradicate the organisms. Amantadine and acyclovir may be helpful against certain viral pneumonias.

Prognosis

Prognosis varies according to the type of organism causing the infection. Recovery following pneumonia with *Mycoplasma pneumoniae* is nearly 100%. *Staphylococcus pneumoniae* has a death rate of 30–40%. Similarly, infections with a number of gram negative bacteria (such as those in the gastrointestinal tract which can cause infection following aspiration) have a death rate of 25–50%. *Streptococcus pneumoniae,* the most common organism causing pneumonia, produces a death rate of about 5%. More complications occur in the very young or very old individuals who have multiple areas of the lung infected simultaneously. Individuals with other chronic illnesses (including **cirrhosis** of the liver, congestive **heart failure**, individuals without a functioning spleen, and individuals who have other diseases that result in a weakened immune system, experience complications. Patients with immune disorders, various types of cancer, transplant patients, and AIDS patients also experience complications.

Prevention

Because many bacterial pneumonias occur in patients who are first infected with the influenza virus (the flu), yearly **vaccination** against influenza can decrease the risk of pneumonia for certain patients. This is particularly true of the elderly and people with chronic diseases (such as asthma, cystic fibrosis, other lung or heart diseases, **sickle cell disease**, diabetes, kidney disease, and forms of cancer).

A specific vaccine against *Streptococcus pneumoniae* is very protective, and should also be administered to patients with chronic illnesses.

Patients who have decreased immune resistance are at higher risk for infection with *Pneumocystis carinii*. They are frequently put on a regular drug regimen of Trimethoprim sulfa and/or inhaled pentamidine to avoid **pneumocystis pneumonia**.

Resources

BOOKS

Johanson, Waldemar G. "Bacterial Meningitis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Lower Respiratory Tract Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley & Sons, 1995.

KEY TERMS

Alveoli—The little air sacs clustered at the ends of the bronchioles, in which oxygen-carbon dioxide exchange takes place.

Aspiration—A situation in which solids or liquids which should be swallowed into the stomach are instead breathed into the respiratory system.

Cilia—Hair-like projections from certain types of cells.

Cyanosis—A bluish tinge to the skin which can occur when the blood oxygen level drops too low.

Parenchyma—A term used to describe the supportive tissue surrounding a particular structure. An example is that tissue which surrounds and supports the actually functional lung tissue.

Sputum—Material produced within the alveoli in response to an infectious or inflammatory process.

PERIODICALS

Brody, Jane E. "Pneumonia Is Still a Killer." *The New York Times* (8 Jan. 1997): B10+.

William, Temple W. "Community-Acquired Pneumonia." *Consultant* (Nov. 1995): 1621+.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

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Pneumonitis *see* **Pneumonia**

Pneumothorax

Definition

Pneumothorax is a collection of air or gas in the chest or pleural space that causes part or all of a lung to collapse.

Description

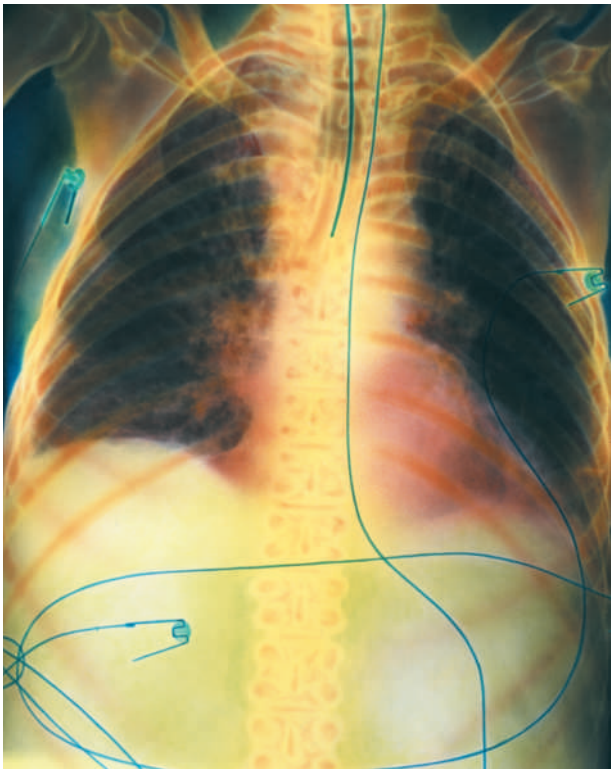
Normally, the pressure in the lungs is greater than the pressure in the pleural space surrounding the lungs. However, if air enters the pleural space, the pressure in the pleura then becomes greater than the pressure in the lungs, causing the lung to collapse partially or completely. Pneumothorax can be either spontaneous or due to trauma.

If a pneumothorax occurs suddenly or for no known reason, it is called a spontaneous pneumothorax. This condition most often strikes tall, thin men between the ages of 20 to 40. In addition, people with lung disorders, such as **emphysema**, **cystic fibrosis**, and **tuberculosis**, are at higher risk for spontaneous pneumothorax. Traumatic pneumothorax is the result of accident or injury due to medical procedures performed to the chest cavity, such as **thoracentesis** or mechanical ventilation. Tension pneumothorax is a serious and potentially life-threatening condition that may be caused by traumatic injury, chronic lung disease, or as a complication of a medical procedure. In this type of pneumothorax, air enters the chest cavity, but cannot escape. This greatly increased pressure in the pleural space causes the lung to collapse completely, compresses the heart, and pushes the heart and associated blood vessels toward the unaffected side.

Causes and symptoms

The symptoms of pneumothrax depend on how much air enters the chest, how much the lung collapses, and the extent of lung disease. Symptoms include the following, according to the cause of the pneumothorax:

- Spontaneous pneumothorax. Simple spontaneous pneumothorax is caused by a rupture of a small air sac or fluid-filled sac in the lung. It may be related to activity in otherwise healthy people or may occur during scuba diving or flying at high altitudes. Complicated spontaneous pneumothorax, also generally caused by rupture of a small sac in the lung, occurs in people with lung diseases. The symptoms of complicated spontaneous pneumothorax tend to be worse than those of simple pneumothorax, due to the underlying lung disease. Spontaneous pneumothorax is characterized by dull, sharp, or stabbing chest **pain** that begins suddenly and becomes worse with deep breathing or coughing. Other symptoms are **shortness of breath**, rapid breathing, abnormal breathing movement (that is, little chest wall movement when breathing), and cough.
- Tension pneumothorax. Following trauma, air may enter the chest cavity. A penetrating chest wound allows outside air to enter the chest, causing the lung to collapse. Certain medical procedures performed in the chest cavity, such as thoracentesis, also may cause a lung to collapse. Tension pneumothorax may be the immediate result of an injury; the delayed complication of a hidden injury, such as a fractured rib, that punctures the lung; or the result of lung damage from **asthma**, chronic **bronchitis**, or emphysema. Symptoms of tension pneumothorax tend to be severe with sudden onset. There is



An x ray of a patient undergoing pneumothorax treatment. ECG electrodes attached to the chest monitor heartbeat while an endotracheal tube is inserted in windpipe. *(Photo Researchers. Reproduced by permission.)*

marked **anxiety**, distended neck veins, weak pulse, decreased breath sounds on the affected side, and a shift of the mediastinum to the opposite side.

Diagnosis

To diagnose pneumothorax, it is necessary for the health care provider to listen to the chest (auscultation) during a **physical examination**. By using a stethoscope, the physician may note that one part of the chest does not transmit the normal sounds of breathing. A **chest x ray** will show the air pocket and the collapsed lung. An electrocardiogram (ECG) will be performed to record the electrical impulses that control the heart's activity. Blood samples may be taken to check for the level of arterial blood gases.

Treatment

A small pneumothorax may resolve on its own, but most require medical treatment. The object of treatment is to remove air from the chest and allow the lung to re-expand. This is done by inserting a needle and syringe (if the pneumothorax is small) or chest tube through the chest wall. This allows the air to escape without allowing any air back in. The lung will then re-expand itself within a few days. Surgery may be needed for repeat occurrences.

KEY TERMS

Electrocardiagram—A test that provides a typical record of normal heart action.

Mediastinum—The space between the right and left lung.

Pleural—Pleural refers to the pleura or membrane that enfolds the lungs.

Thoracentesis—Also called a pleural fluid tap, this procedure involves aspiration of fluid from the pleural space using a long, thin needle inserted between the ribs.

Prognosis

Most people recover fully from spontaneous pneumothorax. Up to half of patients with spontaneous pneumothorax experience recurrence. Recovery from a collapsed lung generally takes one to two weeks. Tension pneumothorax can cause **death** rapidly due to inadequate heart output or insufficient blood oxygen (hypoxemia), and must be treated as a medical emergency.

Prevention

Preventive measures for a non-injury related pneumothorax include stopping **smoking** and seeking medical attention for respiratory problems. If the pneumothorax occurs in both lungs or more than once in the same lung, surgery may be needed to prevent it from occurring again.

Resources

BOOKS

Light, Richard. "Disorders of the Pleura, Mediastinum, and Diaphragm." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American Association for Respiratory Care. 11030 Ables Lane, Dallas, TX 75229. (972) 243-2272. <http://www.aarc.org>.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

OTHER

"Collapsed Lung: Non-Injury-Related." *InteliHealth Page.* 19 June 1998 <http://www.intelihealth.com>.

"Spontaneous Pneumothorax." *HealthAnswers.com*. <http://www.healthanswers.com>.

Lorraine Steefel, RN

Podiatry *see* **Foot care**

Poisoning

Definition

Poisoning occurs when any substance interferes with normal body functions after it is swallowed, inhaled, injected, or absorbed.

Description

Poisonings are a common occurrence. About 10 million cases of poisoning occur in the United States each year. In 80% of the cases, the victim is a child under the age of five. About 50 children die each year from poisonings. Curiosity, inability to read warning labels, a desire to imitate adults, and inadequate supervision lead to childhood poisonings.

The elderly are the second most likely group to be poisoned. Mental confusion, poor eyesight, and the use of multiple drugs are the leading reasons why this group has a high rate of accidental poisoning. A substantial number of poisonings also occur as suicide attempts or drug overdoses.

Poisons are common in the home and workplace, yet there are basically two major types. One group consists of products that were never meant to be ingested or inhaled, such as shampoo, paint thinner, pesticides, houseplant leaves, and carbon monoxide. The other group contains products that can be ingested in small quantities, but which are harmful if taken in large amounts, such as pharmaceuticals, medicinal herbs, or alcohol. Other types of poisons include the bacterial toxins that cause **food poisoning**, such as ***Escherichia coli***; heavy metals, such as the lead found in the paint on older houses; and the venom found in the **bites and stings** of some animals and insects. The staff at a poison control center and emergency room doctors have the most experience diagnosing and treating poisoning cases.

Causes and symptoms

The effects of poisons are as varied as the poisons themselves; however, the exact mechanisms of only a few are understood. Some poisons interfere with the metabolism. Others destroy the liver or kidneys, such as heavy metals and some **pain** relief medications, including **acetaminophen** (Tylenol) and **nonsteroidal anti-inflammatory drugs** (Advil, Ibuprofen). A poison may severely depress the central nervous system, leading to **coma** and eventual respiratory and circulatory failure. Potential poisons in this category include anesthetics (e.g. ether and chloroform), opiates (e.g., morphine and codeine), and **barbiturates**. Some poisons directly affect the respiratory and circulatory system. Carbon monoxide causes **death** by binding with hemoglobin that would normally transport oxygen throughout the body. Certain corrosive vapors trigger the body to flood the lungs with fluids, effectively drowning the person. Cyanide interferes with respiration at the cellular level. Another group of poisons interferes with the electrochemical impulses that travel between neurons in the nervous system. Yet another group, including **cocaine**, ergot, strychnine, and some snake venoms, causes potentially fatal seizures.

Severity of symptoms can range from **headache** and nausea to convulsions and death. The type of poison, the amount and time of exposure, and the age, size, and health of the victim are all factors which determine the severity of symptoms and the chances for recovery.

Plant poisoning

There are more than 700 species of poisonous plants in the United States. Plants are second only to medicines in causing serious poisoning in children under age five. There is no way to tell by looking at a plant if it is poisonous. Some plants, such as the yew shrub, are almost entirely toxic: needles, bark, seeds, and berries. In other plants, only certain parts are poisonous. The bulb of the hyacinth and daffodil are toxic, but the flowers are not; while the flowers of the jasmine plant are the poisonous part. Moreover, some plants are confusing because portions of them are eaten as food while other parts are poisonous. For example, the fleshy stem (tuber) of the potato plant is nutritious; however, its roots, sprouts, and vines are poisonous. The leaves of tomatoes are poisonous, while the fruit is not. Rhubarb stalks are good to eat, but the leaves are poisonous. Apricots, cherries, peaches, and apples all produce healthful fruit, but their seeds contain a form of cyanide that can kill a child if chewed in sufficient quantities. One hundred milligrams (mg) of moist, crushed apricot seeds can produce 217 mg of cyanide.

Common houseplants that contain some poisonous parts include:

- Aloe
- Amaryllis
- Cyclamen

- Dumbcane (also called Diffenbachia)
- Philodendron

Common outdoor plants that contain some poisonous part include:

- Bird of paradise flower
- Buttercup
- Castor bean
- Chinaberry tree
- Daffodil
- English ivy
- Eucalyptus
- Foxglove
- Holly
- Horse chestnut
- Iris
- Jack-in-the-pulpit
- Jimsonweed (also called thornapple)
- Larkspur
- Lily-of-the-valley
- Morning glory
- Nightshade (several varieties)
- Oleander
- Potato
- Rhododendron
- Rhubarb
- Sweet pea
- Tomato
- Wisteria
- Yew

Symptoms of plant poisoning range from irritation of the skin or mucous membranes of the mouth and throat to nausea, vomiting, convulsions, irregular heartbeat, and even death. It is often difficult to tell if a person has eaten a poisonous plant because there are no tell-tale empty containers and no unusual lesions or odors around the mouth.

Household chemicals

Many products used daily in the home are poisonous if swallowed. These products often contain strong acids or strong bases (alkalis). Toxic household cleaning products include:

- ammonia
- bleach
- dishwashing liquids
- drain openers
- floor waxes and furniture polishes
- laundry detergents, spot cleaners, and fabric softeners
- mildew removers
- oven cleaners
- toilet bowl cleaners

Personal care products found in the home can also be poisonous. These include:

- deodorant
- hairspray
- hair straighteners
- nail polish and polish remover
- perfume
- shampoo

Signs that a person has swallowed one of these substances include evidence of an empty container nearby, nausea or vomiting, and **burns** on the lips and skin around the mouth if the substance was a strong acid or alkali. The chemicals in some of these products may leave a distinctive odor on the breath.

Pharmaceuticals

Both over-the-counter and prescription medicines can help the body heal if taken as directed. However, when taken in large quantities, or with other drugs where there may be an adverse interaction, they can act as poisons. Drug overdoses, both accidental and intentional, are the leading cause of poisoning in adults. Medicinal herbs should be treated like pharmaceuticals and taken only in designated quantities under the supervision of a knowledgeable person. Herbs that have healing qualities when taken in small doses can be toxic in larger doses.

Drug overdoses cause a range of symptoms, including excitability, sleepiness, confusion, unconsciousness, rapid heartbeat, convulsions, nausea, and changes in blood pressure. The best initial evidence of a **drug overdose** is the presence of an empty container near the victim.

Other causes of poisonings

People can be poisoned by fumes they inhale. Carbon monoxide is the most common form of inhaled poison. Other toxic substances that can be inhaled include:

- farm and garden insecticides and herbicides
- gasoline fumes
- insect repellent
- paint thinner fumes

Common Household, Industrial, And Agricultural Products Containing Toxic Sustances

Alcohol (rubbing)	Fuel
Antifreeze	Floor/furniture polish
Arsenic	Gasoline
Art and craft supplies	Glues/adhesives
Automotive fluids	Hemlock
Batteries, automotive	Kerosene
Batteries, household	Mercury
Building products	Metal primers
Cleaning products	Metalworking materials
Cosmetics/personal care products	Mothballs
Cyanide	Oven cleaners
Daffodil bulbs	Paint strppers/thinners
Dieffenbachia	Paints, oil-based or alkyds
Disinfectants/air fresheners	Paints, water-based or latex
Drain openers	Pesticides, flea collars, insect repellents
English nightshade	Stains/finishes
Ethanol (found in alcoholic beverages)	Strychnine
Foxglove	Wood preservatives

Diagnosis

Initially, poisoning is suspected if the victim shows changes in behavior and signs or symptoms previously described. Evidence of an empty container or information from the victim are helpful in determining exactly what substance has caused the poisoning. Some acids and alkalis leave burns on the mouth. Petroleum products, such as lighter fluid or kerosene, leave a distinctive odor on the breath. The vomit may be tested to determine the exact composition of the poison. Once hospitalized, blood and urine tests may be done on the patient to determine his metabolic condition.

Treatment

Treatment for poisoning depends on the poison swallowed or inhaled. Contacting the poison control center or hospital emergency room is the first step in getting proper treatment. The poison control center's telephone number is often listed with emergency numbers on the inside cover of the telephone book, or it can be reached by dialing the operator. The poison control center will ask for specific information about the victim and the poison, then give appropriate first aid instructions. If the patient is to be taken to a hospital, a sample of vomit and the poison container should be taken along, if they are available.

Most cases of plant poisoning are treated by inducing vomiting, if the patient is fully conscious. Vomiting can be induced by taking syrup of **ipecac**, an over-the-counter product available at any pharmacy.

For acid, alkali, or petroleum product poisonings, the patient should not vomit. Acids and alkalis can burn the esophagus if they are vomited, and petroleum products can be inhaled into the lungs during vomiting, resulting in **pneumonia**.

Once under medical care, doctors have the option of treating the patient with a specific remedy to counteract the poison (antidote) or with activated charcoal to absorb the substance inside the patient's digestive system. In some instances, pumping the stomach may be required. Medical personnel will also provide supportive care as needed, such as intravenous fluids or mechanical ventilation.

Prognosis

The outcome of poisoning varies from complete recovery to death, and depends on the type and amount of the poison, the health of the victim, and the speed with which medical care is obtained.

Prevention

Most accidental poisonings are preventable. The number of deaths of children from poisoning has declined from about 450 per year in the 1960s to about 50 each year in the 1990s. This decline has occurred mainly because of better packaging of toxic materials and better public education.

Actions to prevent poisonings include:

- removing plants that are poisonous
- keeping medicines and household chemicals locked and in a place inaccessible to children
- keeping medications in child-resistant containers
- never referring to medicine as "candy"
- keeping cleaners and other poisons in their original containers
- disposing of outdated prescription medicines

Resources

OTHER

Arizona Poison and Drug Information Center Page. <http://www.pharmacy.arizona.edu/centers/poisoncenter>.
"Homeowner Chemical Safety." *Centers for Disease Control*. <http://www.cdc.gov/niosh/nasd/docs2/pdfs/as23900.pdf>.
"Poisonous Plant Databases." University of Maryland <http://www.inform.umd.edu>.

Tish Davidson

Polarity therapy

Definition

Polarity therapy is a holistic, energy-based system that includes bodywork, diet, **exercise**, and lifestyle counseling for the purpose of restoring and maintaining proper energy flows throughout the body. The underlying concept of polarity therapy is that all energy within the human body is based in electromagnetic force and that disease results from improperly dissipated energy.

Purpose

Polarity therapy unblocks and recharges the flow of life energy and realigns unbalanced energy as a means of eliminating disease. Patients learn to release tension by addressing the source of the **stress** and by maintaining a healthy demeanor accordingly.

This treatment may be effective to promote health and healing to anyone willing to embrace the appropriate lifestyle. Polarity therapy is reportedly effective for anyone who has been exposed to toxic poisons. Likewise, HIV-positive individuals may find comfort in polarity therapy. Additionally this is an appropriate therapy for relieving general stress, back **pain**, stomach cramps, and other recurring maladies and conditions.

Description

Origins

Austrian-American chiropractor, osteopath, and naturopath Randolph Stone (1888–1981) developed polarity therapy as an integration of Eastern and Western principles and techniques of healing. Stone discovered the ancient principles of the Ayurvedic philosophy in the course of his travels during a sojourn in India. On a life-long quest to learn the fundamentals of human vitality, he also studied **reflexology** and **traditional Chinese medicine**.

Stone became committed to the principles of **Ayurvedic medicine**, which he interpreted in conjunction with his scientific and medical knowledge to define polarity therapy. According to the philosophy of Ayurved, which is based in a set of principles called the tridosha—the energy of the human body is centered in five organs or regions (the brain; the cardiopulmonary [heart and lungs] region, the diaphragm, the smaller intestine, and the larger intestine). One of five airs or energy forms controls each respective region: prana in the brain, vyana in the heart and lungs, udana in the diaphragm, samana in the smaller intestine, and apana in the larger intestine. The five airs control all directional motion in the body, with each air in command of a different type of movement. Stone established further that the prana, centered in the brain, ultimately controlled the combined forces of the body. Any impediment or restriction to the flow of prana in turn affects the health of the entire body. The prana force is nurtured through the flow of food and air into the body as well as through our interactions with other living beings and through the intake of the five sensory organs.

Stone devoted much of his life to defining an elaborately detailed cause and effect relationship between the human anatomy and illness, based on the energy flow of the prana. He further attributed electromagnetic energy as the basis of the energy forces. He used the medical symbol of the Caduceus to define the patterns of the flow and described the energy movement in detail in charts of the human body. Polarity therapy is based in charted energy flows. The primary energy pattern is defined in a spiral motion that radiates from the umbilicus and defines the original energy flow of the fetus in the womb.

After determining the exact source of a patient's energy imbalance, the therapist begins the first of a series of bodywork sessions designed to rechannel and release the patient's misdirected prana. This therapy, akin to massage, is based in energetic pressure and involves circulating motions. In performing the regimen, the therapist pays strict attention to the pressure exerted at each location—even to which finger is used to apply pressure at any given point of the patient's anatomy. This technique, which comprises the central regimen or focal point of polarity therapy is very gentle and is unique to polarity therapy. It typically involves subtle rocking movements and cranial holds to stimulate body energy. Although firm, deep pushing touches are employed in conjunction with the massage technique, the polarity therapist never exerts a particularly forceful contact.

To support the bodywork, the therapist often prescribes a diet for the patient, to encourage cleansing and eliminate waste. The precepts of polarity therapy take into consideration specific interactions between different foods and the human energy fields.

KEY TERMS

Apana—Life sustaining energy centered in the larger intestine; the fifth of the five airs of Ayurvedic philosophy; the life force governing expulsion activity.

Ayurveda—(Sanskrit, *Ayur,* life, and *veda,* knowledge) is translated as "knowledge of life" or "science of longevity." It became established as the traditional Hindu system of medicine.

Caduceus—The ancient and universal symbol of medicine consisting of the winged staff of Mercury and two intertwining serpents.

Primary energy pattern—A spiral motion that radiates from the umbilicus; the energy pattern associated with a child in the womb.

Prana—Life sustaining energy centered in the human brain; the first of the five airs of Ayurvedic philosophy; the life force governing inspiration and the conscious intellect.

QV—Quantum vacuum, a theory coined by physicists, which defines the interactions of energy that combine to form reality.

Reflexology—Belief that reflex areas in the feet correspond to every part of the body, including organs and glands, and that stimulating the correct reflex area can affect the body part.

Samana—Life sustaining energy of the smaller intestine; the fourth of the five airs of Ayurvedic philosophy; the life force governing side-to-side motion.

Tridosha—The combination of three basic principles of energy, or biological humor, that comprise life, according to Ayurvedic philosophy.

Udana—Life sustaining energy of the diaphragm, the third of the five airs of Ayurvedic philosophy, the life force governing upward motion.

Vyana—Life sustaining energy of the heart and lungs; the second of the five airs of Ayurvedic philosophy; the life force governing circular motion.

Likewise, a series of exercises is frequently prescribed. These exercises, called polarity **yoga** include squats, stretches, rhythmic movements, deep breathing, and expression of sounds. They can be both energizing and relaxing. Counseling may be included whenever appropriate as a part of a patient's highly individual therapy regimen to promote balance.

Preparations

Therapists take a comprehensive case history from every patient prior to beginning treatment. This preliminary verbal examination often monopolizes the first therapy session. Depending upon circumstances, a therapist might have a need to assess the patient's physical structural balance through observation and **physical examination**.

Precautions

Polarity therapy is safe for virtually anyone, even the elderly and the most frail patients, because of the intrinsic gentleness of the **massage therapy**.

Side effects

Highly emotional releases of energy (laughter, tears, or a combination of both) are associated with this therapy.

Research and general acceptance

This is a complementary therapy of holistic, spiritually based treatment, which may be used in conjunction with a medical approach. Polarity therapy is practiced worldwide, but the majority of practitioners are based in the United States. Modern physicists employ concepts similar to Stone's basic theories of polarity in defining the quantum vacuum (QV) as a foundation of all reality. Still, by 2000, this holistic regimen had not achieved the widespread acceptance anticipated by Stone before his death in 1981.

When St. Paul Fire and Marine insurers offered a liability insurance package to therapy providers, the company recognized polarity therapy as an alternative medical treatment along with **acupuncture**, **biofeedback**, **homeopathy**, reflexology, and others.

Resources

BOOKS

Stone, Randolph. *Polarity Therapy—The Complete Collected Works*. Reno, CRCS Publications, 1986.

PERIODICALS

Modern Medicine (August 1, 1999): 15.

ORGANIZATIONS

American Polarity Therapy Association. P.O. Box 19858, Boulder Colorado 80308. (303) 545-2080. Fax: (303) 545-2161.

Trans-Hyperboreau Institute of Science. P.O. Box 2344 Sausalito, California 94966. (415) 331-0230. (800) 485-8095. Fax: (415) 331-0231.

OTHER

Young, Phil. "Prana." <http://www.eclipse.co.uk/masterworks/Polarity/PolarityArticles.htm. (16 June 2000).

Gloria Cooksey

Polio

Definition

Poliomyelitis, also called polio or infantile **paralysis**, is a highly infectious viral disease that may attack the central nervous system and is characterized by symptoms that range from a mild nonparalytic infection to total paralysis in a matter of hours.

Description

There are three known types of polioviruses (called 1,2, and 3), each causing a different strain of the disease and all are members of the viral family of enteroviruses (viruses that infect the gastrointestinal tract). Type 1 is the cause of epidemics and many cases of paralysis, which is the most severe manifestation of the infection. The virus is usually a harmless parasite of human beings. Some statistics quote one in 200 infections as leading to paralysis while others state that one in 1,000 cases reach the central nervous system (CNS). When it does reach the CNS, inflammation and destruction of the spinal cord motor cells (anterior horn cells) occurs, which prevents them from sending out impulses to muscles. This causes the muscles to become limp or soft and they cannot contract. This is referred to as flaccid paralysis and is the type found in polio. The extent of the paralysis depends on where the virus strikes and the number of cells that it destroys. Usually, some of the limb muscles are paralyzed; the abdominal muscles or muscles of the back may be paralyzed, affecting posture. The neck muscles may become too weak for the head to be lifted. Paralysis of the face muscles may cause the mouth to twist or the eyelids to droop. Life may be threatened if paralysis of the throat or of the breathing muscles occurs.

Man is the only natural host for polioviruses and it most commonly infects younger children, although older children and adults can be infected. Crowded living conditions and poor hygiene encourage the spread of poliovirus. Risk factors for this paralytic illness include older age, **pregnancy**, abnormalities of the immune system, recent tonsillectomy, and a recent episode of excessively strenuous **exercise** concurrent with the onset of the CNS phase.

Causes and symptoms

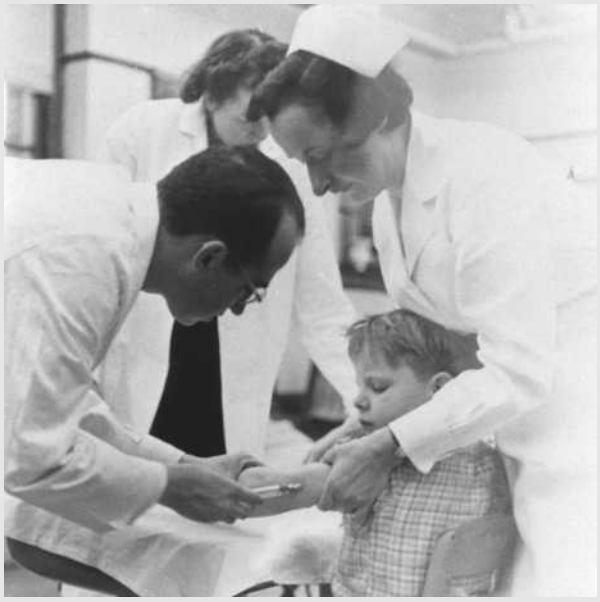
Poliovirus can be spread by direct exposure to an infected individual, and more rarely, by eating foods contaminated with waste products from the intestines (feces) and/or droplets of moisture (saliva) from an infected person. Thus, the major route of transmission is fecal-oral, which occurs primarily with poor sanitary conditions. The virus is believed to enter the body through the mouth with primary multiplication occurring in the lymphoid tissues in the throat, where it can persist for about one week. During this time, it is absorbed into the blood and lymphatics from the gastrointestinal tract where it can reside and multiply, sometimes for as long as 17 weeks. Once absorbed, it is widely distributed throughout the body until it ultimately reaches the CNS (the brain and spinal cord). The infection is passed on to others when poor handwashing allows the virus to remain on the hands after eating or using the bathroom. Transmission remains possible while the virus is being excreted and it can be transmitted for as long as the virus remains in the throat or feces. The incubation period ranges from three to 21 days, but cases are most infectious from seven to 10 days before and after the onset of symptoms.

There are two basic patterns to the virus: the minor illness (abortive type) and the major illness (which may be paralytic or nonparalytic). The minor illness accounts for 80–90% of clinical infections and is found mostly in young children. It is mild and does not involve the CNS. Symptoms include a slight **fever**, **fatigue**, **headache**, **sore throat**, and vomiting, which generally develop three to five days after exposure. Recovery from the minor illness occurs within 24–72 hours. Symptoms of the major illness usually appear without a previous minor illness and generally affect older children and adults.

About 10% of people infected with poliovirus develop severe headache and **pain** and stiffness of the neck and back. This is due to an inflammation of the meninges (tissues which cover the spinal cord and brain). This syndrome is called "aseptic meningitis." The term "aseptic" is used to differentiate this type of **meningitis** from those caused by bacteria. The patient usually recovers completely from this illness within several days.

About 1% of people infected with poliovirus develop the most severe form. Some of these patients may have two to three symptom-free days between the minor illness and the major illness but the symptoms often

DR. JONAS E. SALK (1914–1995)



(Library of Congress.)

Jonas Salk was born in New York, New York, on October 28, 1914. He received his medical degree from New York University in 1939. In 1942, Salk began working for a former teacher, Thomas Francis, Jr., to produce influenza vaccines, a project that continued until 1949. That year, as a research professor, Salk began a three-year project sponsored by the National Foundation for Infantile Paralysis, also known as the March of Dimes. Caused by the poliomyelitis virus, polio was also known as infantile paralysis. Periodic outbreaks of the disease, which attacks the nervous system, caused death or a lifetime of paralysis, especially in children. It was a difficult disease to study because sufficient viruses could not be obtained. Unlike bacteria, which can be grown in cultures, viruses need living tissue on which to grow. Once a method for preparing viruses was discovered and improved, sufficient viruses became available for research.

Salk first set out to confirm that there were three virus types responsible for polio and then began to experiment with ways to kill the virus and yet retain its ability to produce an immune response. By 1952, he had produced a dead virus vaccine that worked against the three virus types. He began testing. First the vaccine was tested on monkeys, then on children who had recovered from the disease, and finally on Salk's own family and children, none of whom had ever had the disease. Following large-scale trials in 1954, the vaccine was finally released for public use in 1955. The Salk vaccine was not the first vaccine against polio, but it was the first to be found safe and effective. By 1961, there was a 96% reduction in polio cases in the United States.

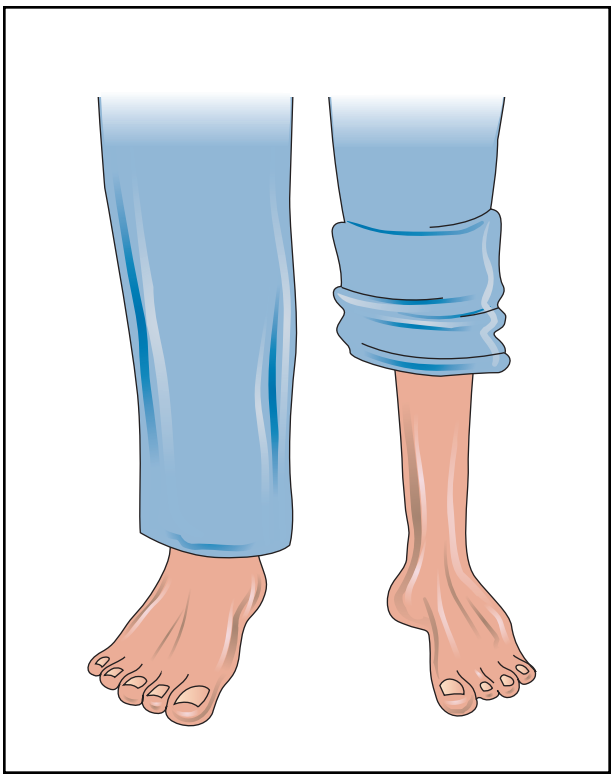
appear without any previous minor illness. Symptoms again include headache and back and neck pain. The major symptoms, however, are due to invasion of the motor nerves, which are responsible for movement of the muscles. This viral invasion causes inflammation, and then destruction of these nerves. The muscles, therefore, no longer receive any messages from the brain or spinal cord. The muscles become weak, floppy, and then totally paralyzed. All muscle tone is lost in the affected limb and the muscle becomes soft (flaccid). Within a few days, the muscle will begin to decrease in size (atrophy). The affected muscles may be on both sides of the body (symmetric paralysis), but are often on unbalanced parts of the body (asymmetric paralysis). Sensation or the ability to feel is not affected in these paralyzed limbs.

When poliovirus invades the brainstem (the stalk of brain which connects the two cerebral hemispheres with the spinal cord; called bulbar polio), a person may begin to have trouble breathing and swallowing. If the brainstem is severely affected, the brain's control of such vital functions as heart rate and blood pressure may be disturbed. This can lead to **death**.

The maximum state of paralysis is usually reached within just a few days. The remaining, unaffected nerves then begin the process of attempting to grow branches which can compensate for the destroyed nerves. Fortunately, the nerve cells are not always completely destroyed. By the end of a month, the nerve impulses start to return to the apparently paralyzed muscle and by the end of six months, recovery is almost complete. If the nerve cells are completely destroyed, however, paralysis is permanent.

Diagnosis

Fever and asymmetric flaccid paralysis without sensory loss in a child or young adult almost always indicate poliomyelitis. Using a long, thin needle inserted into the lower back to withdraw spinal fluid (lumbar puncture) will reveal increased white blood cells and no bacteria (aseptic meningitis). Nonparalytic poliomyelitis cannot be distinguished clinically from aseptic meningitis due to other agents. Virus isolated from a throat swab and/or feces or blood tests demonstrating the rise in a specific antibody is required to confirm the diagnosis.



In its most severe form, polio causes paralysis of the muscles of the legs, arms, and respiratory system. All muscle tone is lost in the affected limb, and the muscle becomes flaccid and begins to atrophy, as shown in the illustration above. *(Illustration by Electronic Illustrators Group.)*

Treatment

There is no specific treatment for polio except symptomatic. Therapy is designed to make the patient more comfortable (pain medications and hot packs to soothe the muscles), and intervention if the muscles responsible for breathing fail (for instance, a ventilator to take over the work of breathing). During active infection, rest on a firm bed is indicated. Physical therapy is the most important part of management of paralytic polio during recovery.

Prognosis

When poliovirus causes only the minor illness or simple aseptic meningitis, the patient can be expected to recover completely. When the patient is diagnosed with the major illness, about 50% will recover completely. About 25% of such patients will have slight disability, and about 25% will have permanent and serious disability. Approximately 1% of all patients with major illness die. The greatest return of muscle function occurs in the first six months, but improvements may continue for two years.

A recently described phenomenon called post-polio syndrome may begin many years after the initial illness. This syndrome is characterized by a very slow, gradual decrease in muscle strength.

Prevention

There are two types of polio immunizations available in the United States. Both of these vaccines take advantage of the fact that infection with polio leads to an immune reaction, which will give the person permanent, lifelong immunity from re-infection with the form of poliovirus for which the person was vaccinated.

The Sabin vaccine (also called the oral polio vaccine or OPV) is given to infants by mouth at the same intervals as the DPT (three doses). It contains the live, but weakened, poliovirus, which make the recipient immune to future infections with poliovirus. Because OPV uses live virus, it has the potential to cause infection in individuals with weak immune defenses (both in the person who receives the vaccine and in close contacts). This is a rare complication, however, occurring in only one in 6.8 million doses administered and one in every 6.4 million doses from having close contact with someone who received the vaccine.

The Salk vaccine (also called the killed polio vaccine or inactivated polio vaccine) consists of a series of three shots that are given just under the skin. This immunization contains no live virus, just the components of the virus that provoke the recipient's immune system to react as if the recipient were actually infected with the poliovirus. The recipient thus becomes immune to infection with the poliovirus in the future.

In the 13 years following the launching of the Global Polio Eradication Initiative, the number of cases has fallen 99% from an estimated 350,000 cases to less than 3,500 cases worldwide in 2000. At the end of 2000, the number of polio-infected countries was approximately 20, down from 125. The goal of the World Health Organization (WHO) is to have polio eliminated from the planet by the year 2005. The virus has still been identified in Africa and parts of Asia, so travelers to those areas may want to check with their physicians concerning booster vaccinations.

Resources

BOOKS

Braunwald MD, E., A. Fauci MD, D. Kasper MD, S. Hauser MD, D. Longo MD, and J. Jameson MD. *Harrison's Principles of Internal Medicine.* New York: McGraw-Hill, 2001.

Cecil, R. and L. Goldman. *Cecil Textbook of Medicine.* Philadelphia: W.B. Saunders, 1999.

KEY TERMS

Aseptic—Sterile; containing no microorganisms, especially no bacteria.

Asymmetric—Not occurring evenly on both sides of the body.

Atrophy—Shrinking; growing smaller in size.

Brainstem—The stalk of the brain which connects the two cerebral hemispheres with the spinal cord.

DPT—Diphtheria, Pertussis and Tetanus injections.

Epidemic—Refers to a situation in which a particular disease rapidly spreads among many people in the same geographical region over a small time period.

Flaccid—Weak, soft, floppy.

Gastrointestinal—Pertaining to the stomach and intestines.

Lymph/lymphatic—One of the three body fluids that is transparent and a slightly yellow liquid that is collected from the capillary walls into the tissues and circulates back to the blood supply.

Paralysis—The inability to voluntarily move.

Symmetric—Occurring on both sides of the body, in a mirror-image fashion.

PERIODICALS

Centers for Disease Control and Prevention. "Poliomyelitis prevention in the United States: Updated recommendations of the Advisory Committee on Immunization Practices (ACIP)." *MMWR* (2000). <http://www.cdc.gov/>.

ORGANIZATION

International Polio Network, 4207 Lindell Blvd., Suite 110, St. Louis, MO 63108-2915. (314) 534-0475. <http://www.post-polio.org>.

March of Dimes Birth Defects Foundation. National Office, 1275 Mamaroneck Avenue, White Plains, NY 10605. <http://www.modimes.org/>.

OTHER

World Health Organization. "Global Polio Eradication Progress 2000." <http://www.polioeradication.org/>.

Linda K. Bennington, CNS

Poliomyelitis *see* **Polio**

Polyangiitis overlap syndrome *see* **Vasculitis**

Polyarteritis nodosa *see* **Vasculitis**

Polycystic kidney disease

Definition

Polycystic kidney disease (PKD) is one of the most common of all life-threatening human genetic disorders. It is an incurable genetic disorder characterized by the formation of fluid-filled cysts in the kidneys of affected individuals. These cysts multiply over time. It was originally believed that the cysts eventually caused kidney failure by crowding out the healthy kidney tissue. It is now thought that the kidney damage seen in PKD is actually the result of the body's immune system. The immune system, in its attempts to rid the kidney of the cysts, instead progressively destroys the formerly healthy kidney tissue.

Description

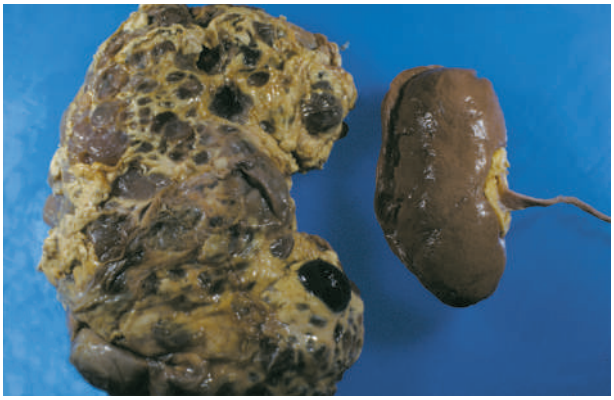
A healthy kidney is about the same size as a human fist. PKD cysts, which can be as small as the head of a pin or as large as a grapefruit, can expand the kidneys until each one is bigger than a football and weighs as much as 38 lb (17 kg).

There are two types of PKD: infantile PKD, which generally shows symptoms prior to birth; and adult onset PKD. Individuals affected with infantile PKD are often stillborn. Among the liveborn individuals affected with infantile PKD, very few of these children survive to the age of two. The adult onset form of PKD is much more common. The time and degree of symptom onset in the adult form of PKD can vary widely, even within a single family with two or more affected individuals. Symptoms of this form of PKD usually start to appear between the ages of 20 and 50. Organ deterioration progresses more slowly in adult onset PKD than it does in the infantile form; but, if left untreated, adult onset PKD also eventually leads to kidney failure.

One of the most common of all life-threatening genetic diseases, PKD affects more than 60,000 Americans. Over 12.5 million people worldwide are affected with PKD. Approximately one in every 400 to 1,000 people is affected with ADPKD. Another one in 10,000 is affected with ARPKD. PKD is observed in equal numbers in both males and females. PKD is also observed with equal frequency among ethnic groups.

Causes and symptoms

Polycystic kidney disease is expressed as both a recessive and a dominant trait. A recessive genetic trait will not cause disease in a child unless it it inheritied from both parents. A dominant genetic trait can



A pair of human kidneys. The left is a polycystic kidney, the right is a normal kidney. *(Photograph by A. Glauberman, Photo Researchers, Inc. Reproduced by permission.)*

be inherited from just one parent. Those people affected with autosomal dominant PKD (ADPKD) have the much more common adult onset form. Those with autosomal recessive PKD (ARPKD) have the infantile form.

There are mutations on at least three genes that cause adult onset PKD. Approximately 85% of these cases are known to arise from mutations in the PKD1 gene that has been mapped to a region on the short arm of chromosome 16 (16p13.3-p13.12). Another 10–15% percent of cases of adult onset PKD are thought to be caused by mutations in the PKD2 gene that has been mapped to a region on the long arm of chromosome 4 (4q21-q23). As of early 2001, it is thought that the remainder of the cases of PKD are caused by mutations in the PKD3 gene, which has not yet been mapped. This unidentified "PKD3 gene" may, in fact, be more than one gene.

Adult onset PKD is transmitted from parents to their offspring as a non-sex linked (autosomal) dominant trait. This means that if either parent carries this genetic mutation, there is a 50% chance that their child will inherit this disease. In the case of two affected parents, there is a 75% probability that their children will be affected with adult onset PKD.

Infantile PKD is caused by a non-sex linked (autosomal) recessive genetic mutation that has been mapped to a region on the short arm of chromosome 6 (6p21). Both parents must be carriers of this mutation for their children to be affected with infantile PKD. In the case of two carrier parents, the probability is 25% that their child will be affected by infantile PKD.

A baby born with infantile PKD has floppy, low-set ears, a pointed nose, a small chin, and folds of skin surrounding the eyes (epicanthal folds). Large, rigid masses can be felt on the back of both thighs (flanks), and the baby usually has trouble breathing.

In the early stages of adult onset PKD, many people show no symptoms. Generally, the first symptoms to develop are: high blood pressure (**hypertension**); general **fatigue**; **pain** in the lower back or the backs of the thighs; headaches; and/or urinary tract infections accompanied by frequent urination.

As PKD becomes more advanced, the kidneys' inability to function properly becomes more pronounced. The cysts on the kidney may begin to rupture and the kidneys tend to be much larger than normal. Individuals affected with PKD have a much higher rate of **kidney stones** than the rest of the population at this, and later stages, of the disease. Approximately 60% of those individuals affected with PKD develop cysts in the liver, while 10% develop cysts in the pancreas.

Because the kidneys are primarily responsible for cleaning the blood, individuals affected with PKD often have problems involving the circulatory system. These include: an underproduction of red blood cells which results in an insufficient supply of oxygen to the tissues and organs (anemia); an enlarged heart (cardiac hypertrophy) probably caused by long term hypertension; and, a leakage of the valve between the left chambers (auricle and ventricle) of the heart (**mitral valve prolapse**). Less common (affecting approximately 5% of PKD patients) are brain aneurysms. An aneurysm is an abnormal and localized bulging of the wall of a blood vessel. If an aneurysm within the brain leaks or bursts, it may cause a **stroke** or even **death**.

Other health problems associated with adult onset PKD include: chronic leg or back pain; frequent infections; and herniations of the groin and abdomen, including herniation of the colon (diverticular disease). A herniation, or **hernia**, is caused when a tissue, designed to hold the shape of an underlying tissue, becomes weakened at a particular spot. The underlying tissue pushes against this weakened area until the area is no longer able to hold back the underlying tissue and the area forms an abnormal bulge through which the underlying tissue projects. Diverticular disease is caused by a weakening of the muscles that hold the shape of the organs of the digestive tract. These muscles weaken allowing these organs, particularly one section of the colon, to form sac-like projections that can trap feces and become infected, or rupture.

In the final stages of PKD, the major symptom is kidney (renal) failure. Renal failure is indicated by an increase of nitrogen (in the form of urea) in the blood (uremia, or uremic **poisoning**). Uremia is a rapidly fatal condition without treatment.

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Cancer—A disease caused by uncontrolled growth of the body's cells.

Computed tomography (CT) scan—An imaging procedure that produces a three-dimensional picture of organs or structures inside the body, such as the brain.

Cyst—An abnormal sac or closed cavity filled with liquid or semisolid matter.

Diuretics—Medications that increase the excretion of urine.

Kidney—Either of two organs in the lumbar region that filter the blood, excreting the end products of the body's metabolism in the form of urine and regulating the concentrations of hydrogen, sodium, potassium, phosphate and other ions in the body.

Magnetic resonance imaging (MRI)—A technique that employs magnetic fields and radio waves to create detailed images of internal body structures and organs, including the brain.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes, which are then used by the computer to create sonograms or pictures of areas inside the body.

Uremic poisoning—Accumulation of waste products in the body.

Diagnosis

Many patients who have PKD do not have any symptoms. Their condition may not be discovered unless tests that detect it are performed for other reasons.

When symptoms of PKD are present, the diagnostic procedure begins with a family medical history and **physical examination** of the patient. If several family members have PKD, there is a strong likelihood that the patient has it too. If the disease is advanced, the doctor will be able to feel the patient's enlarged kidneys. Heart murmur, high blood pressure, and other signs of cardiac impairment can also be detected.

Urinalysis and a blood test called creatine clearance can indicate how effectively the kidneys are functioning. Scanning procedures using intravenous dye reveal kidney enlargement or deformity and scarring caused by cysts. Ultrasound and **computed tomography scans** (CT scans) can reveal kidney enlargement and the cysts that caused it. CT scans can highlight cyst-damaged areas of the kidneys. A sampling of the kidney cells (biopsy) may be performed to verify the diagnosis.

Treatment

There is no way to prevent cysts from forming or becoming enlarged, or to prevent PKD from progressing to kidney failure. Treatment goals include preserving healthy kidney tissue; controlling symptoms; and preventing infection and other complications.

If adult PKD is diagnosed before symptoms become evident, urinalysis and other diagnostic tests are performed at six-week intervals to monitor the patient's health status. If results indicate the presence of infection or another PKD-related health problem, aggressive antibiotic therapy is initiated to prevent inflammation that can accelerate disease progression; iron supplements or infusion of red blood cells are used to treat anemia; and surgery may be needed to drain cysts that bleed, cause pain, have become infected, or interfere with normal kidney function.

Lowering high blood pressure can slow loss of kidney function. Blood-pressure control, which is the cornerstone of PKD treatment, is difficult to achieve. Therapy may include antihypertensive medications, diuretic medications, and/or a low-salt diet. As kidney function declines, some patients need dialysis and/or a kidney transplant.

There is no known way to prevent PKD, but certain lifestyle modifications can help control symptoms. People who have PKD should not drink heavily or smoke. They should not use **aspirin**, non-steroidal anti-inflammatory drugs (NSAIDs), or other prescription or over-the-counter medications that can impair kidney function. Individuals affected with PKD should eat a balanced diet, **exercise** regularly, and maintain a weight appropriate for their height, age, and body type. Regular medical monitoring is also recommended.

Prognosis

There is no known cure for PKD. Those affected with infantile PKD generally die before the age of two.

In adults, untreated disease can be rapidly fatal or continue to progress slowly, even after symptoms of kidney failure appear. About half of all adults with PKD also develop kidney failure. Unless the patient undergoes dialysis or has a kidney transplant, this condition usually leads to death within four years of diagnosis.

Although medical treatment can temporarily alleviate symptoms of PKD, the expanding cysts continue to increase pressure on the kidneys. Kidney failure and uremic poisoning (accumulation of waste products the body is unable to eliminate) generally cause death about 10 years after symptoms first appear.

Medications used to fight **cancer** and reduce elevated cholesterol levels have slowed the advance of PKD in laboratory animals. They may soon be used to treat adults and children who have the disease. Researchers are also evaluating the potential benefits of anti-inflammatory drugs, which may prevent the scarring that destroys kidney function.

Resources

BOOKS

Shaw, Michael, ed. *Everything You Need to Know About Diseases*. Springhouse, PA.: Springhouse Corporation, 1996.

PERIODICALS

Koptides, M. and C. Deltas. "Autosomal dominant polycystic kidney disease: Molecular genetics and molecular pathogenesis." *Human Genetics* (August 2000): 115–26.

Pei, Y., A. Paterson, K. Wang, N. He, et al. "Bilineal disease and trans-heterozygotes in autosmal dominant polycystic kidney disease." *American Journal of Human Genetics* (February 2001): 355–63.

ORGANIZATIONS

Polycystic Kidney Disease Foundation. 4901 Main Street, Kansas City, MO 64112-2634. (800) PKD-CURE. <http://www.pkdcure.org/home.htm>.

OTHER

Brochert, Adam, MD. "Polycystic Kidney Disease." (September 4, 2000). *HealthAnswers*. <http://www.healthanswers.com/library/library_fset.asp>.

Cooper, Joel R. "Treating Polycystic Kidney Disease. What Does the Future Hold?" *Coolware, Inc*. <http://www.coolware.com/health/medical_reporter/kidney1.html>.

Online Mendelian Inheritance in Man (OMIM). <http://www.ncbi.nlm.nih.gov/htbin-post/Omim/dispmim?600595>. (15 February 2001).

Polycystic Kidney Disease Access Center. <http://www.nhpress.com/pkd/>.

Paul A. Johnson

Polycystic ovary syndrome

Definition

Polycystic ovary syndrome (PCOS) is a condition characterized by the accumulation of numerous cysts (fluid-filled sacs) on the ovaries associated with high male hormone levels, chronic anovulation (absent ovulation), and other metabolic disturbances. Classic symptoms include excess facial and body hair, **acne**, **obesity**, irregular menstrual cycles, and **infertility**.

Description

PCOS, also called Stein-Leventhal syndrome, is a group of symptoms caused by underlying hormonal and metabolic disturbances that affect about 6% of premenopausal women. PCOS symptoms appear as early as adolescence in the form of **amenorrhea** (missed periods), obesity, and **hirsutism**, the abnormal growth of body hair.

A disturbance in normal hormonal signals prevents ovulation in women with PCOS. Throughout the cycle, estrogen levels remain steady, luteinizing hormone (LH) levels are high, and follicle stimulating hormone (FSH) and progesterone levels are low. Since eggs are rarely or never released from their follicles, multiple **ovarian cysts** develop over time.

One of the most important characteristics of PCOS is hyperandrogenism, the excessive production of male hormones (androgens), particularly testosterone, by the ovaries. This accounts for the male hair-growth patterns and acne in women with PCOS. Hyperandrogenism has been linked with insulin resistance (the inability of the body to respond to insulin) and hyperinsulinemia (high blood insulin levels), both of which are common in PCOS.

Causes and symptoms

While the exact cause of PCOS is unknown, it runs in families, so the tendency to develop the syndrome may be inherited. The interaction of hyperinsulinemia and hyperandrogenism is believed to play a role in chronic anovulation in susceptible women.

The numbers and types of PCOS symptoms that appear vary among women. These include:

- Hirsutism. Related to hyperandrogenism, this occurs in 70% of women.
- Obesity. Approximately 40–70% of persons with PCOS are overweight.
- Anovulation and menstrual disturbances. Anovulation appears as amenorrhea in 50% of women, and as heavy uterine bleeding in 30% of women. However, 20% of women with PCOS have normal menstruation.

- Male-pattern hair loss. Some women with PCOS develop bald spots.
- Infertility. Achieving **pregnancy** is difficult for many women with PCOS.
- Polycystic ovaries. Most, but not all, women with PCOS have multiple cysts on their ovaries.
- Skin discoloration. Some women with PCOS have dark patches on their skin.
- Abnormal blood chemistry. Women with PCOS have high levels of low-density lipoprotein (LDL or "bad") cholesterol and triglycerides, and low levels of high-density lipoprotein (HDL or "good") cholesterol.
- Hyperinsulinemia. Some women with PCOS have high blood insulin levels, particularly if they are overweight.

Diagnosis

PCOS is diagnosed when a woman visits her doctor for treatment of symptoms such as hirsutism, obesity, menstrual irregularities, or infertility. Women with PCOS are treated by a gynecologist, a doctor who treats diseases of the female reproductive organs, or a reproductive endocrinologist, a specialist who treats diseases of the body's endocrine (hormones and glands) system and infertility.

PCOS can be difficult to diagnose because its symptoms are similar to those of many other diseases or conditions, and because all of its symptoms may not occur. A doctor takes a complete medical history, including questions about menstruation and reproduction, and weight gain. **Physical examination** includes a pelvic examination to determine the size of the ovaries, and visual inspection of the skin for hirsutism, acne, or other changes. Blood tests are performed to measure levels of luteinizing hormone, follicle stimulating hormone, estrogens, androgens, glucose, and insulin. A glucose-tolerance test may be administered. An ultrasound examination of the ovaries is performed to evaluate their size and shape. Most insurance plans cover the costs of diagnosing and treating PCOS and its related problems.

Treatment

PCOS treatment is aimed at correcting anovulation, restoring normal menstrual periods, improving fertility, eliminating hirsutism and acne, and preventing future complications related to high insulin and blood lipid (fat) levels. Treatment consists of weight loss, drugs or surgery, and hair removal, depending upon which symptoms are most bothersome, and whether a woman desires pregnancy.

Weight loss

In overweight women, weight loss (as little as 5%) through diet and **exercise** may correct hyperandrogenism, and restore normal ovulation and fertility. This is often tried first.

Drugs

HORMONAL DRUGS. Women who do not want to become pregnant and require **contraception** (spontaneous ovulation occurs occasionally among women with PCOS) are treated with low-dose oral contraceptive pills (OCPs). OCPs bring on regular menstrual periods and correct heavy uterine bleeding, as well as hirsutism, although improvement may not be seen for up to a year.

If an infertile woman desires to become pregnant, the first drug usually given to help induce ovulation is clomiphene citrate (Clomid), which results in pregnancy in about 70% of women but can cause multiple births. In the 20–25% of women who do not respond to clomiphene, other drugs that stimulate follicle development and induce ovulation, such as human menstrual gonadotropin (Pergonal) and human chorionic gonadotropin (HCG), are given. However, these drugs have a lower pregnancy rate (less than 30%), a higher rate of **multiple pregnancy** (from 5–30%, depending on the dose of the drug), and a higher risk of medical problems. Women with PCOS have a high rate of **miscarriage** (30%), and may be treated with the gonadotropin-releasing hormone agonist leuprolide (Lupron) to reduce this risk.

Since women with PCOS do not have regular endometrial shedding due to high estrogen levels, they are at increased risk for overgrowth of this tissue and **endometrial cancer**. The drug medroxyprogesterone acetate, when taken for the first 10 days of each month, causes regular shedding of the endometrium, and reduces the risk of **cancer**. However, in most cases, oral contraceptive pills are used instead to bring about regular menstruation.

OTHER DRUGS. Another drug that helps to trigger ovulation is the steroid hormone dexamethasone. This drug acts by reducing the production of androgens by the adrenal glands.

The antiandrogen spironolactone (Aldactazide), which is usually given with an oral contraceptive, improves hirsutism and male-pattern baldness by reducing androgen production, but has no effect on fertility. The drug causes abnormal uterine bleeding and is linked with **birth defects** if taken during pregnancy. Another antiandrogen used to treat hirsutism, flutamide (Eulexin), can cause liver abnormalities, **fatigue**, mood swings, and loss of sexual desire. A drug used to reduce insulin levels, metformin (Glucophage), has shown promising results in women with PCOS hirsutism, but its effects on infertility and other PCOS symptoms are unknown. Drug treatment of hirsutism is long-term, and improvement may not be seen for up to a year or longer.

Acne is treated with **antibiotics**, antiandrogens, and other drugs such as retinoic acids (vitamin A compounds).

Surgical treatment

Surgical treatment of PCOS may be performed if drug treatment fails, but it is not common. A wedge resection, the surgical removal of part of the ovary and cysts through a laparoscope (an instrument inserted into the pelvis through a small incision), or an abdominal incision, reduces androgen production and restores ovulation. Although laparoscopic surgery is less likely to cause scar tissue formation than abdominal surgery, both are associated with the potential for scarring that may require additional surgery. Laparoscopic ovarian drilling is another type of laparoscopic surgery used to treat PCOS. The ovarian cysts are penetrated with a laser beam and some of the fluid is drained off. Between 50–65% of women may become pregnant after either type of surgery.

Some cases of severe hirsutism are treated by removal of the uterus (**hysterectomy**) and the ovaries (oopherectomy), followed by estrogen replacement therapy.

Other treatment

Hirsutism may be treated by hair removal techniques such as shaving, depilatories (chemicals that break down the structure of the hair), tweezing, waxing, electrolysis (destruction of the hair root by an electrical current), or the destruction of hair follicles by laser therapy. However, the treatments may have to be repeated.

Alternative treatment

PCOS can be addressed using many types of alternative treatment. The rebalancing of hormones is a primary focus of all these therapies. **Acupuncture** works on the body's energy flow according to the meridian system. Chinese herbs, such as *gui zhi fu ling wan*, can be effective. In **naturopathic medicine**, treatment focuses on helping the liver function more optimally in the horomonal balancing process. Dietary changes, including reducing animal products and fats, while increasing foods that nourish the liver such as carrots, dark green vegetables, lemons, and beets, can be beneficial. Essential fatty acids, including flax oil, evening primrose oil (*Oenothera biennis*), and black currant oil, act as anti-inflammatories and hormonal regulators. Western herbal medicine uses phytoestrogen and phytoprogesteronic herbs, such as blue cohosh (*Caulophyllum thalictroides*) and false unicorn root (*Chamaelirium luteum*), as well as liver herbs, like dandelion (*Taraxacum mongolicum*), to work toward hormonal balance. Supplementation with antioxidants, including zinc, and **vitamins** A, E, and C, is also recommended. Constitutional **homeopathy** can bring about a deep level of healing with the correct remedies.

Prognosis

With proper diagnosis and treatment, most PCOS symptoms can be adequately controlled or eliminated. Infertility can be corrected and pregnancy achieved in most women although, in some, hormonal disturbances and anovulation may recur. Women should be monitored for endometrial cancer. Because of the high rate of hyperinsulinemia seen in PCOS, women with the disorder should have their glucose levels checked regularly to watch for the development of diabetes. Blood pressure and cholesterol screening are also needed because these women also tend to have high levels of LDL cholesterol and triglycerides, which put them at risk for developing heart disease.

Prevention

There is no known way to prevent PCOS, but if diagnosed and treated early, risks for complications such as heart disease and diabetes may be minimized. Weight control through diet and exercise stabilizes hormones and lowers insulin levels.

Resources

BOOKS

Carr, Bruce R and Bradshaw, Karen D. "Disorders of the ovary and remale reproductive tract." In *Harrison's Principles of Internal Medicine, 14th ed.,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998, 2097-2115.

DeGroot, Leslie J and Jameson, J Larry. *Endocribnology, 4th ed*. Philadelphia, W B Saunders, 2001.

Genazzani, AR and Petraglia, F. *Advances in Gynecological Endocrinology* London, Parthenon Press, 2001.

Nader, Shala. *Case Studies in Reproductive Endocrinology.* London, Edward Arnold, 2000.

Speroff, Leon. *Handbook for Clinical Gynecologic Endocrinology and Infertility* Philadelphia, Lippincott Williams & Wilkins, 2001.

Spratt, Daniel and Santoro, Nanette. *Endocrinology and Management of Reproduction and Fertility: Practical Diagnosis and Treatment*. Totowa, NJ, Humana Press, 2001.

PERIODICALS

Bracero N, Zacur HA. *Polycystic ovary syndrome and hyperprolactinemia*. Obstetrics and Gynecology Clinics of North America, 28(1): 77-84, 2001.

Calvo RM, Villuendas G, Sancho J, San Millan JL, Escobar-Morreale HF. *Role of the follistatin gene in women with polycystic ovary syndrome*. Fertility and Sterility, 75(5): 1020-1023, 2001.

Dejager S, Pichard C, Giral P, Bruckert E, Federspield MC, Beucler I, Turpin G. *Smaller LDL particle size in women with polycystic ovary syndrome compared to controls*. Clinical Endocrinology (Oxford), 54(4): 455-462, 2001.

KEY TERMS

Androgens—Male sex hormones produced by the adrenal glands and testes, the male sex glands.

Anovulation—The absence of ovulation.

Antiandrogens—Drugs that inhibit androgen production.

Estrogens—Hormones produced by the ovaries, the female sex glands.

Follicle stimulating hormone—A hormone that stimulates the growth and maturation of mature eggs in the ovary.

Gynecologist—A physician with specialized training in diseases and conditions of the female reproductive system.

Hirsutism—An abnormal growth of hair on the face and other parts of the body caused by an excess of androgens.

Hyperandrogenism—The excessive secretion of androgens.

Hyperinsulinemia—High blood insulin levels.

Insulin resistance—An inability to respond to insulin, a hormone produced by the pancreas that helps the body to use glucose.

Laparoscope—An instrument inserted into the pelvis through a small incision.

Luteinizing hormone—A hormone that stimulates the secretion of sex hormones by the ovary.

Ovarian follicles—Structures found within the ovary that produce eggs.

Heinonen S, Korhonen S, Hippelainen M, Hiltunen M, Mannermaa A, Saarikoski S. *Apolipoprotein E alleles in women with polycystic ovary syndrome*. Fertility and Sterility, 75(5): 878-880, 2001.

Hoeger K. *Obesity and weight loss in polycystic ovary syndrome*. Obstetrics and Gynecology Clinics of North America, 28(1): 85-97, 2001.

Iuorno MJ, Nestler JE. *Insulin-lowering drugs in polycystic ovary syndrome*. Obstetrics and Gynecology Clinics of North America, 28(1): 153-164, 2001.

Kalro BN, Loucks TL, Berga SL. *Neuromodulation in polycystic ovary syndrome*. Obstetrics and Gynecology Clinics of North America, 28(1): 35-62, 2001.

Legro RS. *Diabetes prevalence and risk factors in polycystic ovary syndrome*. Obstetrics and Gynecology Clinics of North America, 28(1): 99-109, 2001.

Lewis V. *Polycystic ovary syndrome. A diagnostic challenge.* Obstetrics and Gynecology Clinics of North America, 28(1): 1-20, 2001.

Moran C, Azziz R. *The role of the adrenal cortex in polycystic ovary syndrome*. Obstetrics and Gynecology Clinics of North America, 28(1): 63-75, 2001.

Padmanabhan V, Christman GM, Randolph JF, Kelch RP, Marshall JC, Beitins IZ. *Dynamics of bioactive follicle-stimulating hormone secretion in women with polycystic ovary syndrome: effects of estradiol and progesterone*. Fertility and Sterility, 75(5): 881-888, 2001.

Phipps WR. *Polycystic ovary syndrome and ovulation induction*. Obstetrics and Gynecology Clinics of North America, 28(1): 165-182, 2001.

Talbott EO, Zborowski JV, Sutton-Tyrrell K, McHugh-Pemu KP, Guzick DS. *Cardiovascular risk in women with polycystic ovary syndrome*. Obstetrics and Gynecology Clinics of North America, 28(1): 111-133, 2001.

Zacur HA. *Polycystic ovary syndrome, hyperandrogenism, and insulin resistance*. Obstetrics and Gynecology Clinics of North America, 28(1): 21-33, 2001.

Zborowski JV, Talbott EO, Cauley JA. *Polycystic ovary syndrome, androgen excess, and the impact on bone*. Obstetrics and Gynecology Clinics of North America, 28(1): 135-151, 2001.

ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672, Phone: (913) 906-6000, Website: <http://www.aafp.org/>., E-mail: <fp@aafp.org>.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098, Phone: (847) 434-4000, FAX: (847) 434-8000, Website: <http://www.aap.org/default.htm>., E-mail: <kidsdoc@aap.org>.

American Medical Association, 515 N. State Street, Chicago, IL 60610, Phone: (312) 464-5000, Website: <http://www.ama-assn.org/>.

Polycystic Ovarian Syndrome Association, PO Box 80517, Portlabd, OR 97280, Phone: (877) 775-7267; Website: <http://www.pcosupport.org/>., E-mail: <info@pcos support.org>.

OTHER

American Academy of Family Physicians: <http://www.aafp.org/afp/20000901/1079.html>.

Jewish Hospital of Cincinnati: <http://uc.edu/~gartsips/polycyst.htm>.

Merck Manual: <http://www.merck.com/pubs/mmanual/section18/chapter235/235d.htm>.

Vanderbilt University School of Medicine: <http://www.mc.vanderbilt.edu/peds/pidl/adolesc/polcysov.htm>.

Women's Health-UK <http://www.womens-health.co.uk/pcos.htm>.

L. Fleming Fallon, Jr., MD, DrPH

Polycythemia *see* **Secondary polycythemia**

Polycythemia rubra vera *see* **Polycythemia vera**

Polycythemia vera

Definition

Polycythemia vera (PV) is a chronic blood disorder marked by an abnormal increase in three types of blood cells produced by bone marrow: red blood cells (RBCs), white blood cells (WBCs), and platelets. PV is called a myeloproliferative disorder, which means that the bone marrow is producing too many cells too quickly. Most of the symptoms of PV are related to the increased volume of the patient's blood and its greater thickness (high viscosity). PV sometimes evolves into a different myeloproliferative disorder or into acute leukemia.

Description

Polycythemia vera is a relatively common progressive disorder that develops over a course of 10–20 years. In the United States, PV affects about one person in every 200,000. PV has several other names, including splenomegalic polycythemia, Vaquez-Osler syndrome, erythremia, and primary polycythemia. Primary polycythemia means that the disorder is not caused or triggered by other illnesses. PV most commonly affects middle-aged adults. It is rarely seen in children or young adults and does not appear to run in families. The male/female ratio is 2:1.

Risk factors for polycythemia vera include:

- caucasian race
- male sex
- age between 40 and 60

Causes and symptoms

The cause of PV remains uncertain. In general, the increased mass of red blood cells in the patient's blood causes both hemorrhage and abnormal formation of blood clots in the circulatory system (thrombosis). The reasons for these changes in clotting patterns are not yet fully understood.

Early symptoms

The symptoms of early PV may be minimal—it is not unusual for the disorder to be discovered during a routine blood test. More often, however, patients have symptoms that include headaches, ringing in the ears, tiring easily, memory problems, difficulty breathing, giddiness or lightheadedness, **hypertension**, visual problems, or tingling or burning sensations in their hands or feet. Another common symptom is **itching** (pruritus). Pruritus related to PV is often worse after the patient takes a warm bath or shower.

Some patients' early symptoms include unusually heavy bleeding from minor cuts, nosebleeds, stomach ulcers, or bone **pain**. In a few cases, the first symptom is the development of blood clots in an unusual part of the circulatory system (e.g., the liver).

Later symptoms and complications

As the disease progresses, patients with PV may have episodes of hemorrhage or thrombosis. Thrombosis is the most frequent cause of **death** from PV. Other complications include a high level of uric acid in the blood and an increased risk of peptic ulcer disease. About 10% of PV patients eventually develop **gout**; another 10% develop peptic ulcers.

Spent phase

The spent phase is a development in late PV that affects about 30% of patients. The bone marrow eventually fails and the patient becomes severely anemic, requiring repeated blood transfusions. The spleen and liver become greatly enlarged—in the later stages of PV, the patient's spleen may fill the entire left side of the abdomen.

Diagnosis

Physical examination

PV is often a diagnosis of exclusion, which means that the doctor will first rule out other possible causes of the patient's symptoms. The doctor can detect some signs of the disorder during a **physical examination**. Patients with PV will have an enlarged spleen (splenomegaly) in 75% of cases. About 50% will have a slightly enlarged liver. The doctor can feel these changes when he or she presses on (palpates) the patient's abdomen while the patient is lying flat. An **eye examination** will usually reveal swollen veins at the back of the eye. Patients with PV often have unusually red complexions; mottled red patches on their legs, feet, or hands; or swelling at the ends of the fingers.

Diagnostic criteria for PV

Accurate diagnosis of PV is critical because its treatment may require the use of drugs with the potential to

cause leukemia. The results of the patient's blood tests are evaluated according to criteria worked out around 1970 by the Polycythemia Vera Study Group. The patient is considered to have PV if all three major criteria are met; or if the first two major criteria and any two minor criteria are met.

Major criteria:

- red blood cell mass greater than 36 mL/kg in males, greater than 32 mL/kg in females
- arterial oxygen level greater than 92%
- splenomegaly

Minor criteria:

- platelet count greater than 400,000/mm^3
- WBC greater than 12,000/mm^3 without **fever** or infection
- leukocyte alkaline phosphatase (LAP) score greater than 100 with increased blood serum levels of vitamin B_{12}

Laboratory testing

BLOOD TESTS. The diagnosis of PV depends on a set of findings from blood tests. The most important single measurement is the patient's red blood cell mass as a proportion of the total blood volume. This measurement is made by tagging RBCs with radioactive chromium (^{51}Cr) in order to determine the patient's RBC volume. While a few patients with PV may have a red cell mass level within the normal range if they have had recent heavy bleeding, a high score may eliminate the need for some other tests. A score higher than 36 mL/kg for males and 32 mL/kg for females on the ^{51}Cr test suggests PV. Measurements of the oxygen level in the patient's arterial blood, of the concentration of vitamin B_{12} in the blood serum, and of leukocyte alkaline phosphatase (LAP) staining can be used to distinguish PV from certain types of leukemia or from other types of polycythemia. LAP staining measures the intensity of enzyme activity in a type of white blood cell called a neutrophil. In PV, the LAP score is higher than normal whereas in leukemia it is below normal.

BONE MARROW TESTS. Bone marrow testing can be used as part of the diagnostic process. A sample of marrow can be cultured to see if red blood cell colonies develop without the addition of a hormone that stimulates RBC production. The growth of a cell colony without added hormone indicates PV. Bone marrow testing is also important in monitoring the progress of the disease, particularly during the spent phase.

GENETIC TESTING. **Genetic testing** can be used to rule out the possibility of chronic myeloid leukemia. Patients with this disease have a characteristic chromosomal abnormality called the Philadelphia chromosome. The Philadelphia chromosome does *not* occur in patients with PV.

Imaging studies

Imaging studies are not necessary to make the diagnosis of PV. In some cases, however, imaging studies can detect enlargement of the spleen that the doctor may not be able to feel during the physical examination.

Treatment

Treatment of PV is tailored to the individual patient according to his or her age, the severity of the symptoms and complications, and the stage of the disease.

Phlebotomy

Phlebotomy is the withdrawal of blood from a vein. It is the first line of treatment for patients with PV. Phlebotomy is used to bring down the ratio of red blood cells to fluid volume (the **hematocrit**) in the patient's blood to a level below 45%. In most cases the doctor will withdraw about 500 mL of blood (about 15 fluid ounces) once or twice a week until the hematocrit is low enough. Phlebotomy is considered the best course of treatment for patients younger than 60 and for women of childbearing age. Its drawback is that patients remain at some risk for either thrombosis or hemorrhage.

Myelosuppression

Myelosuppressive therapies are used to slow down the body's production of blood cells. They are given to patients who are older than 60 and at high risk for thrombosis. These therapies, however, increase the patient's risk of developing leukemia. The substances most frequently used as of 1998 include hydroxyurea (Hydrea), interferon alfa (Intron), or radioactive phosphorus (^{32}P). ^{32}P is used only in elderly patients with life expectancies of less than five years because it causes leukemia in about 10% of patients. Interferon alfa is expensive and causes side effects resembling the symptoms of **influenza** but is an option for some younger PV patients.

Investigational treatment

The Food and Drug Administration (FDA) has approved the use of anagrelide, an orphan drug, for investigational use in the treatment of PV. Anagrelide has moderate side effects and controls the platelet level in over 90% of patients.

Treatment of complications

The itching caused by PV is often difficult to control. Patients with pruritus are given diphenhydramine (Benadryl) or another antihistamine. Patients with high levels of uric acid are usually given allopurinol (Lopurin, Zyloprim) by mouth. Supportive care includes advice

KEY TERMS

Anagrelide—An orphan drug that is approved for treating PV patients on an investigational basis. Anagrelide works by controlling the level of platelets in the blood.

Leukocyte alkaline phosphatase (LAP) test—A blood test that measures the level of enzyme activity in a type of white blood cell called neutrophils.

Myeloproliferative disorder—A disorder in which the bone marrow produces too many cells too rapidly.

Myelosuppressive therapy—Any form of treatment that is aimed at slowing down the rate of blood cell production.

Orphan drug—A drug that is known to be useful in treatment but lacks sufficient funding for further research and development.

Philadelphia chromosome—An abnormal chromosome that is found in patients with a chronic form of leukemia but not in PV patients.

Phlebotomy—Drawing blood from a patient's vein as part of diagnosis or therapy. Phlebotomy is sometimes called venesection. It is an important part of the treatment of PV.

Pruritus—An itching sensation or feeling. In PV the itching is not confined to a specific part of the body and is usually worse after a warm bath or shower.

Spent phase—A late development in PV leading to failure of the bone marrow and severe anemia.

Splenomegaly—Abnormal enlargement of the spleen. Splenomegaly is a major diagnostic criterion of PV.

about diet—splenomegaly often makes patients feel full after eating only a little food. This problem can be minimized by advising patients to eat small meals followed by rest periods.

Because of the clotting problems related to PV, patients should not undergo surgery until their blood counts are close to normal levels. Female patients of childbearing age should be warned about the dangers of **pregnancy** related to their clotting abnormalities.

Prognosis

The prognosis for untreated polycythemia vera is poor; 50% of patients die within 18 months after diagnosis. Death usually results from **heart failure**, leukemia, or hemorrhage. Patients being treated for PV can expect to live between 11 and 15 years on average after diagnosis.

Resources

BOOKS

Fruchtman, Steven M. "Polycythemia Vera." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Hematology and Oncology: Polycythemia Vera (PV)." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Linker, Charles A. "Blood." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Magalini, Sergio I., et al. *Dictionary of Medical Syndromes*. Philadelphia: J. B. Lippincott Co., 1990.

Physicians' Guide to Rare Diseases. Ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Co., Inc., 1995.

"Polycythemia Vera." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Silver, Richard T. "Polycythemia Vera and Other Polycythemia Syndromes." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

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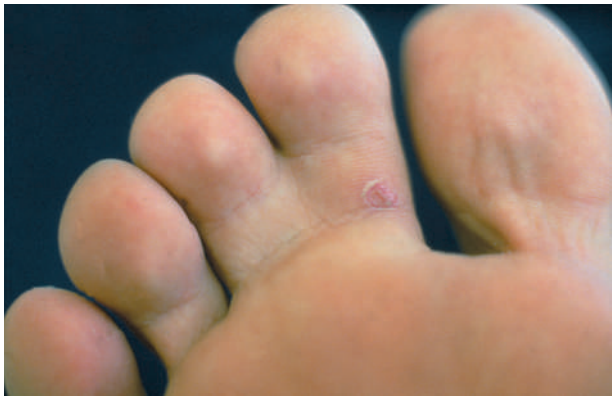
Polydactyly and syndactyly

Definition

Polydactyly and syndactyly are congenital irregularities of the hands and feet. Polydactyly is the occurrence of extra fingers or toes, and syndactyly is the webbing or fusing together of two or more fingers or toes.



Syndactyly is the webbing or fusing together of two or more fingers or toes. *(Photograph by Keith, Custom Medical Stock Photo. Reproduced by permission.)*

Description

Polydactyly can vary from an unnoticeable rudimentary finger or toe to fully developed extra digits.

Syndactyly also exhibits a large degree of variation. Digits can be partially fused or fused along their entire length. The fusion can be simple with the digits connected only by skin, or it can be complicated with shared bones, nerves, vessels, or nails.

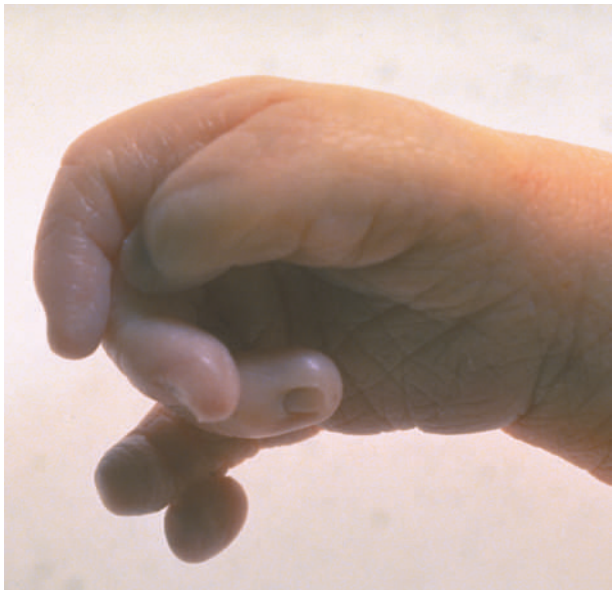
Polydactyly and syndactyly can occur simultaneously when extra digits are fused. This condition is known as polysyndactyly.

Causes and symptoms

Polydactyly and syndactyly are due to errors in the process of fetal development. For example, syndactyly results from the failure of the programmed cell death that normally occurs between digits. Most often these errors are due to genetic defects.

Polydactyly and syndactyly can both occur by themselves as isolated conditions or in conjunction with other symptoms as one aspect of a multi-symptom disease. There are several forms of isolated syndactyly and several forms of isolated polydactyly; each of these, where the genetics is understood, is caused by an autosomal dominant gene. This means that since the gene is autosomal (not sex-linked), males and females are equally likely to inherit the trait. This also means that since the gene is dominant, children who have only one parent with the trait have a 50% chance of inheriting it. However, people in the same family carrying the same gene can have different degrees of polydactyly or syndactyly.

Polydactyly and syndactyly are also possible outcomes of a large number of rare inherited and developmental disorders. One or both of them can be present in over 100 different disorders where they are minor features compared to other characteristics of these diseases.



Polydactyly is the occurrence of extra or partial fingers or toes. *(Custom Medical Stock Photo. Reproduced by permission.)*

For example, polydactyly is a characteristic of Meckel syndrome and Laurence-Moon-Biedl syndrome. Polydactyly may also be present in Patau's syndrome, asphyxiating thoracic dystrophy, hereditary spherocytic **hemolytic anemia**, Moebius syndrome, VACTERL association, and Klippel-Trenaunay syndrome.

Syndactyly is a characteristic of Apert syndrome, Poland syndrome, Jarcho-Levin syndrome, oral-facial-digital syndrome, Pfeiffer syndrome, and Edwards syndrome. Syndactyly may also occur with Gordon syndrome, Fraser syndrome, Greig cephalopolysyndactyly, **phenylketonuria**, Saethre-Chotzen syndrome, Russell-Silver syndrome, and triploidy.

In some isolated cases of polydactyly or syndactyly, it is not possible to determine the cause. Some of these cases might nevertheless be due to genetic defects; sometimes there is too little information to demonstrate a genetic cause. Some cases might be due to external factors like exposure to toxins or womb anomalies.

Diagnosis

Polydactyly and syndactyly can be diagnosed by external observation, x ray, and fetal sonogram.

Treatment

Polydactyly can be corrected by surgical removal of the extra digit or partial digit. Syndactyly can also be

KEY TERMS

Autosomal chromosome—One of the non-X or non-Y chromosomes.

Congenital—A condition present at birth.

Digit—A finger or a toe.

Dominant trait—A genetic trait that will always express itself when present as one of a pair of genes (as opposed to a recessive trait where two copies of the gene are necessary to give the individual the trait).

Gene—A portion of a DNA molecule that either codes for a protein or RNA molecule or has a regulatory function.

Triploidy—The condition where an individual has three entire sets of chromosomes instead of the usual two.

Trisomy—An abnormal condition where three copies of one chromosome are present in the cells of an individual's body instead of two, the normal number.

corrected surgically, usually with the addition of a skin graft from the groin.

Prognosis

The prognosis for isolated polydactyly and syndactyly is excellent. When polydactyly or syndactyly are part of a larger condition, the prognosis depends on the condition. Many of these conditions are quite serious, and early death may be the probable outcome.

Prevention

There is no known prevention for these conditions.

Resources

BOOKS

Emery and Rimoin's Principles and Practice of Medical Genetics. 3rd ed. Ed. David L. Rimoin, et al. New York: Churchill Livingstone, 1998.

Jones, Kenneth Lyons. *Smith's Recognizable Patterns of Human Malformation*. 5th ed. W. B. Saunders Co., 1997.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

National Institute of Child Health and Human Development. Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD 20892-2425. (800) 505-2742. <http://www.nichd.nih.gov/sids/sids.htm>.

OTHER

Mih, Alex D., and Gary Schnitz. "Congenital Deformities of the Hand." *The Indian Hand Center Page*. 1997. 19 June 1998 <http://www.indianahandcenter.com>.

OMIM Home Page, Online Mendelian Inheritance in Man. <http://www.ncbi.nlm.nih.gov/Omim>.

Lorraine Lica, PhD

Polyendocrine deficiency syndromes *see* **Polyglandular deficiency syndromes**

Polyglandular deficiency syndromes

Definition

Polyglandular deficiency syndromes are disorders characterized by the failure of more than one endocrine gland to make hormones in sufficient quantities for the body to function normally.

Description

The endocrine system is a diverse group of glands located all over the body that work together to regulate the body's metabolic activities. It includes:

- the pituitary gland, located deep in the brain, is considered the "master gland" that regulates many of the others
- the thyroid gland is located in the neck and sets the metabolic speed of many processes
- the parathyroid glands, attached to the back of the thyroid, regulate calcium balance
- the adrenal glands are located on top of the kidneys and make four separate kinds of hormones
- the gonads (sex organs) produce sex hormones
- the pancreas is responsible for the production of digestive juices, insulin, and glucagon.

There are over a dozen different syndromes that involve failure of more than one endocrine gland.

Causes and symptoms

The cause of polyglandular deficiency syndromes is usually an autoimmune response—a condition in which

KEY TERMS

Antibody—A weapon in the body's immune defense arsenal that attacks a specific antigen.

Congenital—Present at birth.

Myasthenia gravis—A disease that causes muscle weakness.

Rubella—German measles.

Syndrome—A collection of abnormalities that occur often enough to suggest they have a common cause.

the body generates antibodies to its own tissues. The immune system may attack one or more glands; however, because of their inter dependence, the destruction of one gland can often lead to the impairment of another. Other causes may include infectious disease; insufficient blood flow to the glands due to an obstruction such as a blood clot; or the presence of a tumor.

Doctors usually group polyglandular deficiency syndromes into three types:

- Type I occurs during childhood and is characterized by failure of the adrenals, parathyroids, thyroid, and gonads combined with hepatitis, hair loss, skin pigment changes, and inability of the bowel to absorb adequate **nutrition**. These children also get a persistent skin fungus infection called **candidiasis**.
- Type II occurs during adulthood and is characterized by failure of the adrenals, thyroid (Schmidt's syndrome), and gonads combined with similar nutritional failures and hair and skin changes. These patients also have **myasthenia gravis**. This type of polyglandular deficiency syndrome often produces insulin-dependent **diabetes mellitus** (IDDM).
- Type III disease may produce diabetes or adrenal failure combined with thyroid problems. It may also include baldness (**alopecia**), anemia, and **vitiligo** (condition characterized by white patches on normally pigmented skin).

Not all symptoms of any syndrome appear at once or in the same patient.

Diagnosis

Because these diseases evolve over time, the final diagnosis may not appear for years. A family history is very helpful in knowing what to expect. Any single endocrine abnormality should heighten suspicion that there are others, since they so often occur together, both as underproduction and overproduction of hormones. Most hormone levels can be monitored through blood tests. Many of the antibodies that characterize these conditions can also be found by blood testing.

Treatment

Fortunately there are replacements available for all the missing hormones. Careful balancing of them all can provide a reasonably comfortable quality of life for these patients.

Resources

BOOKS

Sherman, Steven I., and Robert F. Gagel. "Disorders Affecting Multiple Endocrine Systems." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Polyhydramnios and oligohydramnios

Definition

Polyhydramnios is a high level and oligohydramnios is low level of amniotic fluid.

Description

Amniotic fluid is the liquid that surrounds the developing fetus during **pregnancy**. It is contained within the amniotic membrane that forms the amniotic sac (bag of waters). During the first three months after conception (first trimester), amniotic fluid is mainly derived from the blood plasma that diffuses through the thin tissues of the fetus into the surrounding space. After the fetal kidneys form and become functional at about 10-11 weeks, fetal urine becomes the main source of amniotic fluid and remains so for the rest of the pregnancy. In addition, the lungs also produce liquid that becomes part of the amniotic fluid. Other contributions come from fetal oral and nasal secretions and from the fetal surface of the placenta. Amniotic fluid removal is largely due to fetal swallowing and absorption into the fetal blood. Uptake also occurs across the placental surface. The volume of amniotic fluid normally increases throughout pregnancy, reaching a peak at about 32-33 weeks and remaining fairly constant or decreasing slightly thereafter. There is a wide range of

normal fluid volumes with an average of 700-800 ml at 32-33 weeks. Through the processes of swallowing and urination, a fetus can recycle the entire volume in less than 24 hours. Because the normal values for amniotic fluid volume increase during pregnancy, the actual volume that constitutes polyhydramnios is dependent on the gestational age of the fetus. During the last two months of pregnancy, polyhydramnios usually refers to amniotic fluid volumes greater than 1,700-1,900 ml. Severe cases are associated with much greater fluid volume excesses. The range of fluid values diagnostic of oligohydramnios is not as wide as that for polyhydramnios. Less than 300 ml, or lower than the 5% percentile for gestational age, is usually considered the upper threshold.

Causes and symptoms

Polyhydramnios, also referred to as hydramnios, can have any one of a number of causes related either to an underlying maternal or fetal condition. Maternal diabetes, which is associated with a macrosomic (enlarged) fetus, is a common cause. The medication lithium, used to treat depression, can also increase amniotic fluid levels. Twin gestations are prone to polyhydramnios. Infections passed from mother to fetus such as **rubella**, cytomegalovirus, and **toxoplasmosis**, can also result in damage to the fetus and elevated amniotic fluid levels. Fetal abnormalities, including many that are life-threatening or lead to a significant impairment in the quality of life, are found in up to a quarter of all patients. For this reason, the initial finding of excess amniotic fluid should be followed by thorough diagnostic studies to determine the cause and the prognosis.

Because fetal swallowing is a major factor in amniotic fluid removal, fetal abnormalities that prevent fluid uptake should be investigated. These include gastrointestinal obstructions such as **esophageal atresia** and duodenal atresia, as well as neurological conditions that affect swallowing including anencephaly. Certain cardiac abnormalities, kidney disorders, and genetic conditions such as **myotonic dystrophy** and alpha-thalassemia can also cause polyhydramnios. Fetal chromosome abnormalities are frequently associated with elevated amniotic fluid levels. The more severe the polyhydramnios the more likely it is that fetal abnormalities will be present. In addition, there are other, infrequent causes, and in a number of cases, no cause can be found. Polyhydramnios can lead to maternal abdominal discomfort and respiratory difficulties as well as preterm labor. When polyhydramnios is associated with fetal abnormalities, perinatal mortality is significantly increased.

Oligohydramnios is most commonly associated with abnormalities of the fetal kidneys. Since fetal urine is the main source of amniotic fluid in the latter two-thirds of pregnancy, any condition that interferes with fetal urine production can lead to oligohydramnios. Renal agenesis, cystic kidneys, and bladder outlet obstructions are common. Meckel-Gruber syndrome, a lethal autosomal recessive genetic disorder featuring brain and kidney abnormalities and extra digits is one specific cause. Placental insufficiency and fetal growh retardation can also result in oligohydramnios. **Premature rupture of membranes**, especially between 16 and 24 weeks is another cause and, because amniotic fluid is important in lung growth, it can lead to underdevelopment of the lungs (pulmonary hypoplasia). In general, regardless of the cause, oligohydramnios that arises early in a pregnancy, can cause hypoplastic lungs. It can also result in space limitations within the amniotic sac that cause fetal compression and orthopedic abnormalities such as clubbed feet in the newborn. In general, oligohydramnios that begins near the time of delivery is associated with a better outcome than cases than have an onset earlier in pregnancy.

Diagnosis

In current obstetrical practice, polyhydramnios and oligohydramnios are usually detected during a routine prenatal ultrasound. If the ultrasonographer suspects that excess or reduced fluid is present, it is customary to take measurements of pockets of fluid visualized around the fetus, calculate the amniotic fluid index (AFI), and compare it to AFI values found in standard tables. Subsequent ultrasound measurements can then be used to track the increase or decrease in fluid.

It is extremely important that the cause of an abnormal AFI be sought. Because of the high risk of fetal abnormalities, detailed ultrasound exams (targeted exams) should then be performed. The mother should be counseled about the possible complications and offered additional testing as necessary. For example, an **amniocentesis** for prenatal chromosome analysis may be important because of the high risk of fetal chromosome abnormalities. This test is usually indicated if fetal abnormalities are suspected on the basis of the ultrasound exam. An amniocentesis can also be used to check for fetal infections and some rare single gene defects.

Treatment

Effective treatments for polyhydramnios and oligohydramnios are limited. To relieve maternal discomfort, an excess fluid level can be reduced by inserting a needle into the amniotic sac and using a syringe to withdraw excess fluid. This can be done repeatedly, if necessary. In oligohydramnios, the opposite approach of adding fluid either by increasing oral intake in the mother or by directly infusing saline into the amniotic sac has been tried in select cases. If the cause of oligohydramnios is a fetal

KEY TERMS

Alpha-thalassemia—An inherited disorder that interferes with the normal production of hemoglobin.

Anencephaly—Congenital absence of the brain. Occurs during the first month of embryonic development.

Autosomal recessive—A pattern of inheritance in which both copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is one that is located on one of the autosomes or non-sex chromosomes. When both parents have one abnormal copy of the same gene, they have a 25% chance with each pregnancy that their offspring will have the disorder.

Congenital—Present at birth.

Duodenal atresia—Closure or blockage of the duodenum, the upper section of the small intestine.

Esophageal atresia—Blockage or closure of the esophagus, the tube leading from the mouth to the stomach.

Gestational age—The estimated age of a fetus expressed in weeks, calculated from the first day of the last normal menstrual period.

Myotonic dystrophy—A genetic defect resulting in abnormal muscle function.

Placenta—The flat, spongy structure that forms within the uterus during pregnancy and provides nourishment to the developing fetus.

Renal agenesis—Failure of the fetal kidneys to form. Oligohydramnios usually associated with absence of both kidneys.

bladder obstruction, it may be possible to place a small tube in the bladder to shunt the fluid into the amniotic sac.

Alternative treatment

In select cases where polyhydramnios is thought to be due to an increased output of fetal urine, the drug indomethicin has been used with some success, but there is concern about side effects, particularly on the fetus. Another similar drug, sulindac, is currently being investigated. If oligohydramnios is due to premature rupture of the membranes, a protocol to manage complications should be instituted.

Prognosis

The prognosis for both polyhydramnios and oligohydramnios depends on the cause. If excess or reduced amniotic fluid is the result of an underlying fetal abnormality, the nature of that abnormality will determine the prognosis. This is one reason why it is important to perform the necessary follow-up studies. A woman who has been diagnosed with polyhydramnios or oligohydramnios needs to be made fully aware of the types of testing available and carefully counseled about the diagnosis and its impact on the chance for a successful pregnancy outcome and a healthy infant.

Prevention

In order to prevent polyhydramnios or oligohydramnios, it would be necessary to prevent the underlying cause. Good control of maternal diabetes and the prevention of infections transmittable from mother to fetus are two approaches for a subset of cases, but, in general, prevention is not possible.

Resources

BOOKS

Cunningham, F. Gary. *Williams Obstetrics*. New York; McGraw-Hill, 2001

Rodeck, Charles H. and Whittle, Martin J. *Fetal Medicine, Basic Science and Clnical Practice*. New York, Churchill Livingstone, 1999.

PERIODICALS

Moise, Kenneth J. Jr. "Polyhydramnios" *Clinical Obstetric and GYN* 40, no. 2, (June 1997): 266-279.

Kilpactrick, Sarah J. "Therapeutic Interventions for Oligohydramnios: Amnioinfusion and Maternal Hydration" *Clinical Obstetric and GYN* 40, no. 2, (June 1996): 266-279.

Sallie Freeman

Polymyalgia rheumatica

Definition

Polymyalgia rheumatica is a syndrome that causes **pain** and stiffness in the hips and shoulders of people over the age of 50.

KEY TERMS

Anemia—A condition in which the blood lacks enough red blood cells (hemoglobin).

Atrophy—Wasting away of a body part.

Frozen shoulder—A shoulder that becomes scarred and cannot move.

Giant cell arteritis—Also called temporal arteritis. A condition that causes the inflammation of temporal arteries. It can cause blindness when the inflammation affects the ophthalmic artery.

NSAIDs—Nonsteroidal anti-inflammatory drugs like aspirin, ibuprofen, and naproxen.

Syndrome—A collection of abnormalities that occur often enough to suggest they have a common cause.

Description

Allthough the major characteristics of this condition are just pain and stiffness, there are reasons to believe it is more than just old-fashioned rheumatism. Patients are commonly so afflicted that their muscles atrophy from disuse. A similar complaint of such weakness is also seen in serious muscle diseases. Moreover, some patients develop arthritis or a disease called giant cell arteritis or **temporal arteritis**.

Causes and symptoms

This condition may arise as often as once in every 2,000 people. Rarely does it affect people under 50 years old. The average age is 70; women are afflicted twice as often as men. Along with the pain and stiffness of larger muscles, **headache** may add to the discomfort. The scalp is often tender. Pain is usually worse at night. There may be **fever** and weight loss before the full disease appears. Patients complain that stiffness is worse in the morning and returns if they have been inactive for any period of time, a condition called gelling. Sometimes the stiffness is severe enough that it causes frozen shoulder.

Diagnosis

Symptoms are usually present for over a month by the time patients seek medical attention. A mild anemia is often present. One blood test, called an **erythrocyte sedimentation rate,** is very high, much more so than in most other diseases. The most important issue in evaluating polymyalgia rheumatica is to check for giant cell arteritis. Giant cell arteritis can lead to blindness if left untreated.

Treatment

Polymyalgia rheumatica responds dramatically to cortisone-like drugs in modest doses. In fact, one part of confirming the diagnosis is to observe the response to this treatment. It may also respond to nonsteroidal anti-inflammatory drugs (NSAIDs). Temporal arteritis is also treated with cortisone, but in higher doses.

Prognosis

The disease often remits after a while, with no further treatment required.

Resources

BOOKS

Fauci, Anthony S. "The Vasculitis Syndromes." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Griggs, Robert C. "Episodic Muscle Spasms, Cramps, and Weakness." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hellmann, David B. "Arthritis and Musculoskeletal Disorders." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Hunder, Gene C. "Giant Cell Arteritis and Polymyalgia Rheumatica." In *Testbook of Rheumatology*, ed. William N. Kelley, et al. Philadelphia: W. B. Saunders Co., 1997.

Hunder, Gene C. "Polymyalgia Rheumatica and Giant Cell Arteritis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Polymyositis

Definition

Polymyositis is an inflammatory muscle disease causing weakness and **pain**. Dermatomyositis is identical to polymyositis with the addition of a characteristic skin rash.

Description

Polymyositis (PM) is an inflammatory disorder in which muscle tissue becomes inflamed and deteriorates, causing weakness and pain. It is one of several types of

inflammatory muscle disease, or myopathy. Others include dermatomyositis (DM) and inclusion body myositis. All three types are progressive conditions, usually beginning in adulthood. A fourth type, juvenile dermatomyositis, occurs in children. Although PM and DM can occur at any age, 60% of cases appear between the ages of 30 and 60. Females are affected twice as often as males.

Causes and symptoms

Causes

The cause of PM and DM is not known, but it is suspected that a variety of factors may play a role in the development of these diseases. PM and DM may be autoimmune diseases, caused by the immune system's attack on the body's own tissue. The reason for this attack is unknown, although some researchers believe that a combination of immune system susceptibility and an environmental trigger may explain at least some cases. Known environmental agents associated with PM and DM include infectious agents such as *Toxoplasma*, *Borrella* (**Lyme disease** bacterium), and coxsackievirus. Most cases, however, have no obvious triggers (direct causative agents). There may also be a genetic component in the development of PM and DM.

Symptoms

The early symptoms of PM and DM are slowly progressing muscle weakness, usually symmetrical between the two sides of the body. PM and DM affect primarily the muscles of the trunk and those closest to the trunk, while the hands, feet, and face usually are not involved. Weakness may cause difficulty walking, standing, and lifting objects. Rarely, the muscles of breathing may be affected. Weakness of the muscles used for swallowing can cause difficulty with swallowing (dysphagia). Joint pain and/or swelling also may be present. Later in the course of these diseases, muscle wasting or shortening (contracture) may develop in the arms or legs. Heart abnormalities, including electrocardiogram (ECG) changes and **arrhythmias**, develop at some time during the coursed of these diseases in about 30% of patients.

Dermatomyositis is marked by a skin rash. The rash is dusky, reddish, or lilac in color, and is most often seen on the eyelids, cheeks, bridge of the nose, and knuckles, as well as on the back, upper chest, knees, and elbows. The rash often appears before the muscle weakness.

Diagnosis

PM and DM are often difficult diseases to diagnose, because they are rare, because symptoms come on slowly, and because they can be mistaken for other diseases that cause muscle weakness, especially limb girdle **muscular dystrophy**.

Accurate diagnosis involves:

- A neurological exam.
- Blood tests to determine the level of the muscle enzyme creatine kinase, whose presence in the circulation indicates muscle damage.
- Electromyography, an electrical test of muscle function.
- Muscle biopsy, in which a small sample of affected muscle is surgically removed for microscopic analysis. A biopsy revealing muscle cells surrounded by immune system cells is a strong indicator of myositis.

Treatment

PM and DM respond to high doses of **immunosuppressant drugs** in most cases. The most common medication used is the corticosteroid prednisone. Prednisone therapy usually leads to improvement within two or three months, at which point the dose can be tapered to a lower level to avoid the significant side effects associated with high doses of prednisone. Unresponsive patients are often given a replacement or supplementary immunosuppressant, such as azathioprine, cyclosporine, or methotrexate. Intravenous immunoglobulin treatments may help some people who are unresponsive to other immunosuppressants.

Pain can usually be controlled with an over-the-counter analgesic, such as **aspirin**, ibuprofen, or naproxen. A speech-language therapist can help suggest exercises and tips to improve difficulty in swallowing. Avoiding weight gain helps prevent overtaxing weakened muscles.

Alternative treatment

As with all autoimmune conditions, food allergies/intolerances and environmental triggers may be contributing factors. For the food **allergies** and intolerances, an elimination challenge diet can be used under the supervision of a trained practitioner, naturopath, or nutritionist, to identify trigger foods. These foods can then be eliminated from the person's diet. For environmental triggers, it is helpful to identify the source so that it can be avoided or eliminated. A thorough **detoxification** program can help alleviate symptoms and change the course of the disease. Dietary changes from processed foods to whole foods that do not include allergen triggers can have significant results. Nutrient supplements, especially the antioxidants zinc, selenium, and **vitamins** A, C, and E, can be beneficial. Constitutional homeopathic treatment can work at a deep level to rebalance the whole person. **Acupuncture** and Chinese herbs can be effective in symptom alleviation

KEY TERMS

Autoimmune disease—Diseases in which the body's immune system, responsible for fighting off foreign invaders such as bacteria and viruses, begins to attack and damage a part of the body as if it were foreign.

Immunosuppressant—A drug that reduces the body's natural immunity by suppressing the natural functioning of the immune system.

and deep healing. Visualization, **guided imagery**, and hypnosis for **pain management** are also useful.

Prognosis

The progression of PM and DM varies considerably from person to person. Immunosuppressants can improve strength, although not all patients respond, and relapses may occur. PM and DM can lead to increasing weakness and disability, although the lifespan usually is not significantly affected. About half of the patients recover and can discontinue treatment within five years of the onset of their symptoms. About 20% still have active disease requiring ongoing treatment after five years, and about 30% have inactive disease but some remaining muscle weakness.

Prevention

There is no known way to prevent myositis, except to avoid exposure to those environmental agents that may be associated with some cases.

Resources

BOOKS

Thoene, Jess G., ed. *Physicians' Guide to Rare Diseases*. 2nd ed. Montvale, NJ: Dowden Publishing Co., 1995.

PERIODICALS

Masteglia, Frank L., Beverley A. Phillipos, and Paul Zilko. "Treatment of Inflammatory Myopathies." *Muscle & Nerve* 20 (June 1997): 651+.

Plotz, Paul H., et al. "Myositis: Immunologic Contributions to Understanding Cause, Pathogenesis, and Therapy." *Annals of Internal Medicine* 122 (1995): 715-724.

ORGANIZATIONS

Dermatomyositis and Polymyositis Support Group. 146 Newtown Road, Southampton, SO2 9HR, U.K.

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (800) 572-1717. <http://www.mdausa.org>.

Myositis Association of America. 600-D University Boulevard, Harrisonburg, VA 22801. (540) 433-7686. <http://www.myositis.org>.

National Institutes of Health. National Institute of Arthritis and Musculoskeletal and Skin Diseases. 900 Rockville Pike, Bethesda, MD 20892. (301) 496-8188. <http://www.hih.gov.niams>.

Richard Robinson

Polyneuritis *see* **Peripheral neuropathy**

Polysomnography

Definition

The word polysomnography, derived from the Greek roots "poly," meaning many, "somno," meaning sleep, and "graphy" meaning to write, refers to multiple tests performed on patients while they sleep. Polysomnography is an overnight test to evaluate **sleep disorders**. Polysomnography generally includes monitoring of the patient's airflow through the nose and mouth, blood pressure, electrocardiographic activity, blood oxygen level, brain wave pattern, eye movement, and the movement of respiratory muscle and limbs.

Purpose

Polysomnography is used to help diagnose and evaluate a number of sleep disorders. For instance, it can help diagnose **sleep apnea**, a common disorder in middle-aged and elderly obese men, in which the muscles of the soft palate in the back of the throat relax and close off the airway during sleep. This may cause the person to snore loudly and gasp for air at night, and to be excessively sleepy and doze off during the day. Another syndrome often evaluated by polysomnography is **narcolepsy**. In narcolepsy, people have sudden attacks of sleep and/or cataplexy (temporary loss of muscle tone caused by moments of emotion, such as fear, anger, or surprise, which causes people to slump or fall over), sleep **paralysis** or **hallucinations** at the onset of sleep. Polysomnography is often used to evaluate parasomnias (abnormal behaviors or movements during sleep), such as sleep walking, talking in one's sleep, nightmares, and bedwetting. It can also be used to detect or evaluate seizures that occur in the middle of the night, when the patient and his or her family are unlikely to be aware of them.

Precautions

Polysomnography is extremely safe and no special precautions need to be taken.

Description

Polysomnography requires an overnight stay in a sleep laboratory. During this stay, while the patient sleeps, he or she is monitored in a number of ways that can provide very useful information.

One form of monitoring is **electroencephalography** (EEG), in which electrodes are attached to the patient's scalp in order to record his or her brain wave activity. The electroencephalograph records brain wave activity from different parts of the brain and charts them on a graph. The EEG not only helps doctors establish what stage of sleep the patient is in, but may also detect seizures.

Another form of monitoring is continuous electro-oculography (EOG), which records eye movement and is used to determine when the patient is going through a stage of sleep called rapid-eye-movement (REM) sleep. Both EEG and EOG can be helpful in determining sleep latency (the time that transpires between lights out and the onset of sleep), total sleep time, the time spent in each sleep stage, and the number of arousals from sleep.

The air flow through the patient's nose and mouth are measured by heat-sensitive devices called thermistors. This can help detect episodes of apnea (stopped breathing), or hypnopea (inadequate breathing). Another test called pulse oximetry measures the amount of oxygen in the blood, and can be used to assess the degree of oxygen starvation during episodes of hypnopea or apnea.

The electrical activity of the patient's heart is also measured on an electrocardiogram, or ECG. Electrodes are affixed to the patient's chest and they pick up electrical activity from various areas of the heart. They help detect cardiac arrythmias (abnormal heart rhythms), which may occur during periods of sleep apnea. Blood pressure is also measured: sometimes episodes of sleep apnea can dangerously elevate blood pressure.

In some cases, sleep laboratories monitor the movement of limbs during sleep. This can be helpful in detecting such sleep disorders as periodic limb movements.

Preparation

The patient may be asked to discontinue taking any medications used to help him/her sleep. Before the patient goes to sleep, the technician hooks him or her up to all of the monitors being used.

Aftercare

Once the test is over, the monitors are detached from the patient. No special measures need to be taken after polysomnography.

KEY TERMS

Cataplexy—A condition characterized by sudden loss of muscle tone brought on by emotions, often associated with narcolepsy.

Electrocardiography (ECG)—Recording of the electrical activity from various regions of the heart muscle.

Electroencephalography (EEG)—Recording of the electrical activity from various regions of the brain.

Electro-oculography (EOG)—Recording of the electrical activity of the muscles that control eye movement.

Narcolepsy—A sleep disorder characterized by attacks of sleep, cataplexy, sleep paralysis, or hallucinations with the onset of sleep.

Parasomnias—Abnormal behaviors during sleep, such as sleep walking, talking in one's sleep, nightmares, sleep paralysis, or bedwetting.

Sleep apnea—A sleep disorder characterized by lapses in breathing during sleep.

Sleep latency—The time it takes to fall asleep once the lights are out.

Normal results

A normal result in polysomnography shows normal results for all parameters (EEG, ECG, blood pressure, eye movement, air flow, pulse oximetry, etc.) monitored throughout all stages of sleep.

Abnormal results

Polysomnography may yield a number of abnormal results, indicating a number of potential disorders. For instance, abnormal transitions in and out of various stages of sleep, as documented by the EEG and the EOG, may be a sign of narcolepsy. Reduced air flow through the nose and mouth, along with a fall in oxygenation of the blood, may indicate apnea or hypopnea. If apnea is accompanied by abnormalities in ECG or elevations in blood pressure, this can indicate that sleep apnea may be particularly harmful. Frequent movement of limbs may indicate a sleep disorder called periodic limb movement.

Resources

PERIODICALS

"Disorders of Breathing During Sleep: Snoring and Sleep Apnea." *Harvard Men's Health Watch* 1 (May 1997): 1-4.

National Heart, Lung, and Blood Institute Working Group on Sleep Apnea, National Institutes of Health. "Sleep Apnea: Is Your Patient At Risk?" *American Family Physician* 53 (Jan. 1996): 247-53.

"Sleep Apnea: No Sleep for the Weary Without Proper Diagnosis." *Harvard Health Letter* (Nov. 1997): 4-5.

Ten Brock, Eric, and David W. Shucard. "Sleep Apnea." *American Family Physician* 49 (1 Feb. 1994): 385-94.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

Pompe's disease *see* **Glycogen storage diseases**

Porphyrias

Definition

The porphyrias are disorders in which the body produces too much porphyrin and insufficient heme (an iron-containing nonprotein portion of the hemoglobin molecule). Porphyrin is a foundation structure for heme and certain enzymes. Excess porphyrins are excreted as waste in the urine and stool. Overproduction and overexcretion of porphyrins causes low, unhealthy levels of heme and certain important enzymes, creating various physical symptoms.

Description

Biosynthesis of heme is a multistep process that begins with simple molecules and ends with a large, complex heme molecule. Each step of the chemical pathway is directed by its own task-specific protein, called an enzyme. As a heme precursor molecule moves through each step, an enzyme modifies the precursor in some way. If a precursor molecule is not modified, it cannot proceed to the next step, causing a buildup of that specific precursor.

This situation is the main characteristic of the porphyrias. Owing to a defect in one of the enzymes of the heme biosynthesis pathway, protoporphyrins or porphyrins (heme precursors) are prevented from proceeding further along the pathway. These precursors accumulate at the stage of the enzyme defect causing an array of physical symptoms in an affected person. Specific symptoms depend on the point at which heme biosynthesis is blocked and which precursors accumulate. In general, the porphyrias primarily affect the skin and the nervous system. Symptoms can be debilitating or life threatening in some cases. Porphyria is most commonly an inherited condition. It can also, however, be acquired after exposure to poisonous substances.

Heme

Heme is produced in several tissues in the body, but its primary biosynthesis sites are the liver and the bone marrow. Heme synthesis for immature red blood cells, namely the erythroblasts and the reticulocytes, occurs in the bone marrow.

Although production is concentrated in the liver and bone marrow, heme is utilized in various capacities in virtually every tissue in the body. In most cells, heme is a key building block in the construction of factors that oversee metabolism and transport of oxygen and energy. In the liver, heme is a component of several vital enzymes, particularly cytochrome P450. Cytochrome P450 is involved in the metabolism of chemicals, **vitamins**, fatty acids, and hormones; it is very important in transforming toxic substances into easily excretable materials. In immature red blood cells, heme is the featured component of hemoglobin. Hemoglobin is the red pigment that gives red blood cells their characteristic color and their essential ability to transport oxygen.

Heme biosynthesis

The heme molecule is composed of porphyrin and an iron atom. Much of the heme biosynthesis pathway is dedicated to constructing the porphyrin molecule. Porphyrin is a large molecule shaped like a four-leaf clover. An iron atom is placed at its center point in the last step of heme biosynthesis.

The production of heme may be compared to a factory assembly line. At the start of the line, raw materials are fed into the process. At specific points along the line, an addition or adjustment is made to further development. Once additions and adjustments are complete, the final product rolls off the end of the line.

The heme "assembly line" is an eight-step process, requiring eight different and properly functioning enzymes:

- delta-aminolevulinic acid synthase
- delta-aminolevulinic acid dehydratase
- porphobilogen deaminase
- uroporphyrinogen III cosynthase
- uroporphyrinogen decarboxylase
- coproporphyrinogen oxidase
- protoporphyrinogen oxidase
- ferrochelatase

The control of heme biosynthesis is complex. Various chemical signals can trigger increased or decreased production. These signals can affect the enzymes themselves or the production of these enzymes, starting at the genetic level. For example, one point at which heme biosynthesis may be controlled is at the first step. When heme levels are low, greater quantities of delta-aminolevulinic acid (ALA) synthase are produced. As a result, larger quantities of heme precursors are fed into the biosynthesis pathway to step up heme production.

Porphyrias

Under normal circumstances, when heme concentrations are at an appropriate level, precursor production decreases. However, a glitch in the biosynthesis pathway—represented by a defective enzyme—means that heme biosynthesis does not reach completion. Because heme levels remain low, the synthesis pathway continues to churn out precursor molecules in an attempt to correct the heme deficit.

The net effect of this continued production is an abnormal accumulation of precursor molecules and development of some type of porphyria. Each type of porphyria corresponds with a specific enzyme defect and an accumulation of the associated precursor. Although there are eight steps in heme biosynthesis, there are only seven types of porphyrias; a defect in ALA synthase activity does not have a corresponding porphyria.

Enzymes involved in heme biosynthesis display subtle, tissue-specific variations; therefore, heme biosynthesis may be impeded in the liver, but normal in the immature red blood cells, or vice versa. Incidence of porphyria varies widely between types and occasionally by geographic location. Although certain porphyrias are more common than others, their greater frequency is only relative to other types. All porphyrias are considered to be rare disorders.

In the past, the porphyrias were divided into two general categories based on the location of the porphyrin production. Porphyrias affect heme biosynthesis in the liver were referred to as hepatic porphyrias. Porphyrias that affect heme biosynthesis in immature red blood cells were referred to as erythropoietic porphyrias (erythropoiesis is the process through which red blood cells are produced). As of 2001, porphyrias are usually grouped into acute and non-acute types. Acute porphyrias produce severe attacks of **pain** and neurological effects. Non-acute porphyrias present as chronic diseases.

The acute porphyrias, and the heme biosynthesis steps at which enzyme defects occur, are:

- ALA dehydratase deficiency porphyria (step 2). This porphyria type is very rare. The inheritance pattern appears to be autosomal recessive. In autosomal recessively inherited disorders, a person must inherit two defective genes, one from each parent. A parent with only one gene for an autosomal recessive disorder does not display symptoms of the disease.
- Acute intermittent porphyria (step 3). Acute intermittent porphyria (AIP) is also known as Swedish porphyria, pyrroloporphyria, and intermittent acute porphyria. AIP is inherited as an autosomal dominant trait, which means that only one copy of the defective gene needs to be present for the disorder to occur. Simply inheriting this gene, however, does not necessarily mean that a person will develop the disease. Approximately five to 10 per 100,000 persons in the United States carry a gene for AIP, but only 10% of these people ever develop symptoms of the disease.
- Hereditary coproporphyria (step 6). Hereditary coproporphyria (HCP) is inherited in an autosomal dominant manner. As with all porphyrias, it is an uncommon ailment. By 1977, only 111 cases of HCP were recorded; in Denmark, the estimated incidence is two in one million people.
- Variegate porphyria (step 7). Variegate porphyria (VP) is also known as porphyria variegata, protocoproporphyria, South African genetic porphyria, and Royal malady (supposedly King George III of England and Mary, Queen of Scots, suffered from VP). VP is inherited in an autosomal dominant manner and is especially prominent in South Africans of Dutch descent. Among that population, the incidence is approximately three in 1,000 persons. It is estimated that there are 10,000 cases of VP in South Africa. Interestingly, it appears that the affected South Africans are descendants of two Dutch settlers who came to South Africa in 1680. Among other populations, the incidence of VP is estimated to be one to two cases per 100,000 persons.

The non-acute porphyrias, and the steps of heme biosynthesis at which they occur, are:

- Congenital erythropoietic porphyria (step 4). Congenital erythropoietic porphyria (CEP) is also called Gunther's disease, erythropoietic porphyria, congenital porphyria, congenital hematoporphyria, and erythropoietic uroporphyria. CEP is inherited in an autosomal recessive manner. It is a rare disease, estimated to affect fewer than one in one million people. Onset of dramatic symptoms usually occurs in infancy, but may hold off until adulthood.
- Porphyria cutanea tarda (step 5). Porphyria cutanea tarda (PCT) is also called symptomatic porphyria, porphyria cutanea symptomatica, and idiosyncratic porphyria. PCT may be acquired, typically as a result of

disease (especially **hepatitis C**), drug or alcohol use, or exposure to certain poisons. PCT may also be inherited as an autosomal dominant disorder, however most people remain latent—that is, symptoms never develop. PCT is the most common of the porphyrias, but the incidence of PCT is not well defined.

- Hepatoerythopoietic porphyria (step 5). Hepatoerythopoietic porphyria (HEP) affects heme biosynthesis in both the liver and the bone marrow. HEP results from a defect in uroporphyrinogen decarboxylase activity (step 5), and is caused by defects in the same gene as PCT. Disease symptoms, however, strongly resemble congenital erythropoietic porphyria. HEP seems to be inherited in an autosomal recessive manner.
- Erythropoietic protoporphyria (step 8). Also known as protoporphyria and erythrohepatic protoporphyria, erythropoietic protoporphyria (EPP) is more common than CEP; more than 300 cases have been reported. In these cases, onset of symptoms typically occurred in childhood.

Causes and symptoms

General characteristics

The underlying cause of all porphyrias is a defective enzyme important to the heme biosynthesis pathway. Porphyrias are inheritable conditions. In virtually all cases of porphyria an inherited factor causes the enzyme's defect. An environmental trigger—such as diet, drugs, or sun exposure—may be necessary before any symptoms develop. In many cases, symptoms do not develop. These asymptomatic individuals may be completely unaware that they have a gene for porphyria.

All of the hepatic porphyrias—except porphyria cutanea tarda—follow a pattern of acute attacks separated by periods during which no symptoms are present. For this reason, this group is often referred to as the acute porphyrias. The erythropoietic porphyrias and porphyria cutanea tarda do not follow this pattern and are considered to be chronic conditions.

The specific symptoms of each porphyria vary based on which enzyme is affected and whether that enzyme occurs in the liver or in the bone marrow. The severity of symptoms can vary widely, even within the same type of porphyria. If the porphyria becomes symptomatic, the common factor between all types is an abnormal accumulation of protoporphyrins or porphyrin.

ALA dehydratase porphyria (ADP)

ADP is characterized by a deficiency of ALA dehydratase. ADP is caused by mutations in the delta-aminolevulinate dehydratase gene (ALAD) at 9q34. Of the few cases on record, the prominent symptoms are vomiting, pain in the abdomen, arms, and legs, and neuropathy. (Neuropathy refers to nerve damage that can cause pain, numbness, or paralysis.) The nerve damage associated with ADP could cause breathing impairment or lead to weakness or **paralysis** of the arms and legs.

Acute intermittent porphyria (AIP)

AIP is caused by a deficiency of porphobilogen deaminase, which occurs due to mutations in the hydroxymethylbilane synthase gene (HMBS) located at 11q23.3. Symptoms of AIP usually do not occur unless a person with the deficiency encounters a trigger substance. Trigger substances can include hormones (for example **oral contraceptives**, menstruation, **pregnancy**), drugs, and dietary factors. Most people with this deficiency never develop symptoms.

Attacks occur after **puberty** and commonly feature severe abdominal pain, nausea, vomiting, and **constipation**. Muscle weakness and pain in the back, arms, and legs are also typical symptoms. During an attack, the urine is a deep reddish color. The central nervous system may also be involved. Possible psychological symptoms include **hallucinations**, confusion, seizures, and mood changes.

Congenital erythropoietic porphyria (CEP)

CEP is caused by a deficiency of uroporphyrinogen III cosynthase due to mutations in the uroporphyrinogen III cosynthase gene (UROS) located at 10q25.2-q26.3. Symptoms are often apparent in infancy and include reddish urine and possibly an enlarged spleen. The skin is unusually sensitive to light and blisters easily if exposed to sunlight. (Sunlight induces protoporphyrin changes in the plasma and skin. These altered protoporphyrin molecules can cause skin damage.) Increased hair growth is common. Damage from recurrent blistering and associated skin infections can be severe. In some cases facial features and fingers may be lost to recurrent damage and infection. Deposits of protoporphyrins can sometimes lead to red staining of the teeth and bones.

Porphyria cutanea tarda (PCT)

PCT is caused by deficient uroporphyrinogen decarboxylase. PCT is caused by mutations in the uroporphyrinogen decarboxylase gene (UROD) located at 1p34. PCT may occur as an acquired or an inherited condition. The acquired form usually does not appear until adulthood. The inherited form may appear in childhood, but often demonstrates no symptoms. Early symptoms

include blistering on the hands, face, and arms following minor injuries or exposure to sunlight. Lightening or darkening of the skin may occur along with increased hair growth or loss of hair. Liver function is abnormal but the signs are mild.

Hepatoerythopoietic porphyria (HEP)

HEP is linked to a deficiency of uroporphyrinogen decarboxylase in both the liver and the bone marrow. HEP is an autosomal recessive disease caused by mutations in the gene responsible for PCT, the uroporphyrinogen decarboxylase gene (UROD), located at 1p34. The gene is shared, but the mutations, inheritance, and specific symptoms of these two diseases are different. The symptoms of HEP resemble those of CEP.

Hereditary coproporphyria (HCP)

HCP is similar to AIP, but the symptoms are typically milder. HCP is caused by a deficiency of coproporphyrinogen oxidase due to mutations in a gene by the same name at 3q12. The greatest difference between HCP and AIP is that people with HCP may have some skin sensitivity to sunlight. However, extensive damage to the skin is rarely seen.

Variegate porphyria (VP)

VP is caused by a deficiency of protoporphyrinogen oxidase. There is scientific evidence that VP is caused by mutation in the gene for protoporphyrinogen oxidase located at 1q22. Like AIP, symptoms of VP occur only during attacks. Major symptoms of this type of porphyria include neurological problems and sensitivity to light. Areas of the skin that are exposed to sunlight are susceptible to burning, blistering, and scarring.

Erythropoietic protoporphyria (EPP)

Owing to deficient ferrochelatase, the last step in the heme biosynthesis pathway—the insertion of an iron atom into a porphyrin molecule—cannot be completed. This enzyme deficiency is caused by mutations in the ferrochelatase gene (FECH) located at 18q21.3. The major symptoms of this disorder are related to sensitivity to light—including both artificial and natural light sources. Following exposure to light, a person with EPP experiences burning, **itching**, swelling, and reddening of the skin. Blistering and scarring may occur but are neither common nor severe. EPP is associated with increased risks for **gallstones** and liver complications. Symptoms can appear in childhood and tend to be more severe during the summer when exposure to sunlight is more likely.

Diagnosis

Depending on the array of symptoms an individual may exhibit, the possibility of porphyria may not immediately come to a physician's mind. In the absence of a family history of porphyria, non-specific symptoms, such as abdominal pain and vomiting, may be attributed to other disorders. Neurological symptoms, including confusion and hallucinations, can lead to an initial suspicion of psychiatric disease. Diagnosis is more easily accomplished in cases in which non-specific symptoms appear in combination with symptoms more specific to porphyria, like neuropathy, sensitivity to sunlight, or certain other manifestations. Certain symptoms, such as urine the color of port wine, are hallmark signs very specific to porphyria. DNA analysis is not yet of routine diagnostic value.

A common initial test measures protoporphyrins in the urine. However, if skin sensitivity to light is a symptom, a blood plasma test is indicated. If these tests reveal abnormal levels of protoporphyrins, further tests are done to measure heme precursor levels in red blood cells and the stool. The presence and estimated quantity of porphyrin and protoporphyrins in biological samples are easily detected using spectrofluorometric testing. Spectrofluorometric testing uses a spectrofluorometer that directs light of a specific strength at a fluid sample. The porphyrins and protoporphyrins in the sample absorb the light energy and fluoresce, or glow. The spectrofluorometer detects and measures fluorescence, which indicates the amount of porphyrins and protoporphyrins in the sample.

Whether heme precursors occur in the blood, urine, or stool gives some indication of the type of porphyria, but more detailed biochemical testing is required to determine their exact identity. Making this determination yields a strong indicator of which enzyme in the heme biosynthesis pathway is defective; which, in turn, allows a diagnosis of the particular type of porphyria.

Biochemical tests rely on the color, chemical properties, and other unique features of each heme precursor. For example, a screening test for acute intermittent porphyria (AIP) is the Watson-Schwartz test. In this test, a special dye is added to a urine sample. If one of two heme precursors—porphobilinogen or urobilinogen—is present, the sample turns pink or red. Further testing is necessary to determine whether the precursor present is porphobilinogen or urobilinogen—only porphobilinogen is indicative of AIP.

Other biochemical tests rely on the fact that heme precursors become less soluble in water (able to be dissolved in water) as they progress further through the

heme biosynthesis pathway. For example, to determine whether the Watson-Schwartz urine test is positive for porphobilinogen or urobilinogen, chloroform is added to the test tube. Chloroform is a water-insoluble substance. Even after vigorous mixing, the water and chloroform separate into two distinct layers. Urobilinogen is slightly insoluble in water, while porphobilinogen tends to be water-soluble. The porphobilinogen mixes more readily in water than chloroform, so if the water layer is pink (from the dye added to the urine sample), that indicates the presence of porphobilinogen, and a diagnosis of AIP is probable.

As a final test, measuring specific enzymes and their activities may be done for some types of porphyrias; however, such tests are not done as a screening method. Certain enzymes, such as porphobilinogen deaminase (the defective enzyme in AIP), can be easily extracted from red blood cells; other enzymes, however, are less readily collected or tested. Basically, an enzyme test involves adding a certain amount of the enzyme to a test tube that contains the precursor it is supposed to modify. Both the production of modified precursor and the rate at which it appears can be measured using laboratory equipment. If a modified precursor is produced, the test indicates that the enzyme is doing its job. The rate at which the modified precursor is produced can be compared to a standard to measure the efficiency of the enzyme.

Treatment

Treatment for porphyria revolves around avoiding acute attacks, limiting potential effects, and treating symptoms. Treatment options vary depending on the specific type of porphyria diagnosed. **Gene therapy** has been successful for both CEP and EPP. In the future, scientists expect development of gene therapy for the remaining porphyrias. Given the rarity of ALA dehydratase porphyria, definitive treatment guidelines for this rare type have not been developed.

Acute intermittent porphyria, hereditary coproporphyria, and variegate porphyria

Treatment for acute intermittent porphyria, hereditary coproporphyria, and variegate porphyria follows the same basic regime. A person who has been diagnosed with one of these porphyrias can prevent most attacks by avoiding precipitating factors, such as certain drugs that have been identified as triggers for acute porphyria attacks. Individuals must maintain adequate **nutrition**, particularly with respect to carbohydrates. In some cases, an attack can be stopped by increasing carbohydrate consumption or by receiving carbohydrates intravenously.

When attacks occur prompt medical attention is necessary. Pain is usually severe, and narcotic **analgesics** are the best option for relief. Phenothiazines can be used to counter nausea, vomiting, and **anxiety**, and chloral hydrate or diazepam is useful for **sedation** or to induce sleep. Hematin, a drug administered intravenously, may be used to halt an attack. Hematin seems to work by signaling the pathway of heme biosynthesis to slow production of precursors. Women, who tend to develop symptoms more frequently than men owing to hormonal fluctuations, may find ovulation-inhibiting hormone therapy to be helpful.

Gene therapy is a possible future treatment for these porphyrias. An experimental animal model of AIP has been developed and research is in progress.

Congenital erythropoietic porphyria

The key points of congenital erythropoietic porphyria treatment are avoiding exposure to sunlight and prevention of skin trauma or skin infection. Liberal use of **sunscreens** and consumption of beta-carotene supplements can provide some protection from sun-induced damage. Medical treatments such as removing the spleen or administering transfusions of red blood cells can create short-term benefits, but these treatments do not offer a cure. Remission can sometimes be achieved after treatment with oral doses of activated charcoal. Severely affected patients may be offered **bone marrow transplantation** which appears to confer long-term benefit.

Porphyria cutanea tarda

As with other porphyrias, the first line of defense is avoidance of factors, especially alcohol, that could bring about symptoms. Regular blood withdrawal is a proven therapy for pushing symptoms into remission. If an individual is anemic or cannot have blood drawn for other reasons, chloroquine therapy may be used.

Erythropoietic protoporphyria

Avoiding sunlight, using sunscreens, and taking beta-carotene supplements are typical treatment options for erythropoietic protoporphyria. The drug cholestyramine may reduce the skin's sensitivity to sunlight as well as the accumulated heme precursors in the liver. **Liver transplantation** has been used in cases of liver failure, but it has not effected a long-term cure of the porphyria.

KEY TERMS

Autosomal dominant—A pattern of genetic inheritance in which only one abnormal gene is needed to display the trait or disease.

Autosomal recessive—A pattern of genetic inheritance in which two abnormal genes are needed to display the trait or disease.

Biosynthesis—The manufacture of materials in a biological system.

Bone marrow—A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Erythropoiesis—The process through which new red blood cells are created; it begins in the bone marrow.

Erythropoietic—Referring to the creation of new red blood cells.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found at a precise location on a chromosome.

Hematin—A drug administered intravenously to halt an acute porphyria attack. It causes heme biosynthesis to decrease, preventing the further accumulation of heme precursors.

Heme—The iron-containing molecule in hemoglobin that serves as the site for oxygen binding.

Hemoglobin—Protein-iron compound in the blood that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hepatic—Referring to the liver.

Neuropathy—A condition caused by nerve damage. Major symptoms include weakness, numbness, paralysis, or pain in the affected area.

Porphyrin—A large molecule shaped like a four-leaf clover. Combined with an iron atom, it forms a heme molecule.

Protoporphyrin—A precursor molecule to the porphyrin molecule.

Alternative treatment

Acute porphyria attacks can be life-threatening events, so attempts at self-treatment can be dangerous. Alternative treatments can be useful adjuncts to conventional therapy. For example, some people may find relief for the pain associated with acute intermittent porphyria, hereditary coproporphyria, or variegate porphyria through **acupuncture** or hypnosis. Relaxation techniques, such as **yoga** or **meditation**, may also prove helpful in **pain management**.

Prognosis

Even when porphyria is inherited, symptom development depends on a variety of factors. In the majority of cases, a person remains asymptomatic throughout life. About one percent of acute attacks can be fatal. Other symptoms may be associated with temporarily debilitating or permanently disfiguring consequences. Measures to avoid these consequences are not always successful, regardless of how diligently they are pursued. Although pregnancy has been known to trigger porphyria attacks, dangers associated with pregnancy as not as great as was once thought.

Prevention

For the most part, the porphyrias are attributable to inherited genes; such inheritance cannot be prevented. However, symptoms can be limited or prevented by avoiding factors that trigger symptom development.

People with a family history of an acute porphyria should be screened for the disease. Even if symptoms are absent, it is useful to know about the presence of the gene to assess the risks of developing the associated porphyria. This knowledge also reveals whether a person's offspring may be at risk. Prenatal testing for certain porphyrias is possible. Prenatal diagnosis of congenital erythropoietic porphyria has been successfully accomplished. Any prenatal tests, however, would not indicate whether a child would develop porphyria symptoms; only that the potential is there.

Resources

BOOKS

Deats-O'Reilly, Diana. *Porphyria: The Unknown Disease.* Grand Forks, N.D.: Porphyrin Publications Press/Educational Services, 1999.

PERIODICALS

Gordon, Neal. "The Acute Porphyrias." *Brain & Development* 21 (September 1999): 373–77.

Thadani, Helen et al. "Diagnosis and Management of Porphyria." *British Medical Journal* 320 (June 2000): 1647–51.

ORGANIZATIONS

American Porphyria Foundation. PO Box 22712, Houston, TX 77227. (713) 266-9617. <http://www.enterprise.net/apf/>.

OTHER

Gene Clinics. <http://www.geneclinics.org>.

National Institute of Diabetes & Digestive & Kidney Diseases. <http://www.niddk.nih.gov>.

Online Mendelian Inheritance in Man (OMIM). <http://www3.ncbi.nlm.nih.gov/Omim>.

Julia Barrett
Judy Hawkins

Port-wine stain *see* **Birthmarks**

Portacaval shunting *see* **Portal vein bypass**

Portal-systemic encephalopathy *see* **Liver encephalopathy**

Portal vein bypass

Definition

Portal vein bypass surgery diverts blood from the portal vein into another vein. It is performed when pressure in the portal vein is so high that it causes internal bleeding from blood vessels in the esophagus.

Purpose

The portal vein carries blood from the stomach and abdominal organs to the liver. It is a major vein that splits into many branches. High pressure in the portal vein causes swelling and bleeding from blood vessels in the esophagus. This situation occurs when the liver is damaged from **cirrhosis** of the liver, a condition usually caused by prolonged, excessive alcohol consumption.

Massive internal bleeding caused by high pressure in the portal vein occurs in about 40% of patients with cirrhosis. It is initially fatal in at least half of these patients. Patients who survive are likely to experience bleeding recurrence. Portal vein bypass, also called portacaval shunting, is performed on these surviving patients to control bleeding.

Precautions

Most patients who need portal vein bypass surgery not only have liver disease and poor liver function, but also suffer from an enlarged spleen, **jaundice**, and damage to the vascular system brought on by years of **alcoholism**. They are likely to experience serious complications during surgery. Some patients are aggressively uncooperative with medical personnel. Under these conditions, half the patients may not survive the operation.

Description

A choice of portal vein bypasses is available. Portal vein bypass is usually performed as an emergency operation in a hospital under general anesthesia. The surgeon makes an abdominal incision and finds the portal vein. In portacaval shunting, blood from the portal vein is diverted into the inferior vena cava. This is the most common bypass. In splenorenal shunting, the splenic vein (a part of the portal vein), is connected to the renal vein. A mesocaval shunt connects the superior mesenteric vein (another part of the portal vein) to the inferior vena cava.

Portal pressure can also be reduced in a procedure called transvenous intrahepatic portosystemic shunt (TIPS). A catheter is threaded into the portal vein, and an expandable balloon or wire mesh is inserted to divert blood from the portal vein to the hepatic vein. The rate of serious complications in TIPS is only 1–2%. The operation cannot be performed at all hospitals, but is becoming the preferred treatment for reducing portal pressure.

Preparation

Standard preoperative blood and urine tests are performed, and liver function is evaluated. The heart and arterial blood pressure are monitored both during and after the operation.

Aftercare

The patient will be connected to a heart monitor and fed through a nasogastric tube. Vital functions are monitored through blood and urine tests. Patients receive **pain** medication and **antibiotics**. Once released from the hospital, patients are expected to abstain from alcohol and follow a diet and medication schedule designed to reduce the risks of re-bleeding.

Risks

Portal vein bypass surgery is high risk because it is performed on patients who are generally in poor

KEY TERMS

Cirrhosis—A chronic degenerative liver disease common among alcoholics.

Inferior vena cava—A large vein that returns blood from the legs, pelvis, and abdomen to the heart.

Portal vein—Formed by a fusion of small veins that end in a network of capillaries, the portal vein delivers blood to the liver.

health. Only half the patients survive, although the chances of survival are greater with TIPS surgery. Those patients who survive the operation still face the risk of **heart failure**, brain disease due to a decrease in the liver's conversion of waste products (**liver encephalopathy**), hemorrhage, lung complications, infection, **coma**, and **death**.

Normal results

The survival rate is directly related to the amount of liver damage patients have. The less damage, the more likely the patient is to recover. Cooperation with restrictions on alcohol and diet affect long-term survival.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

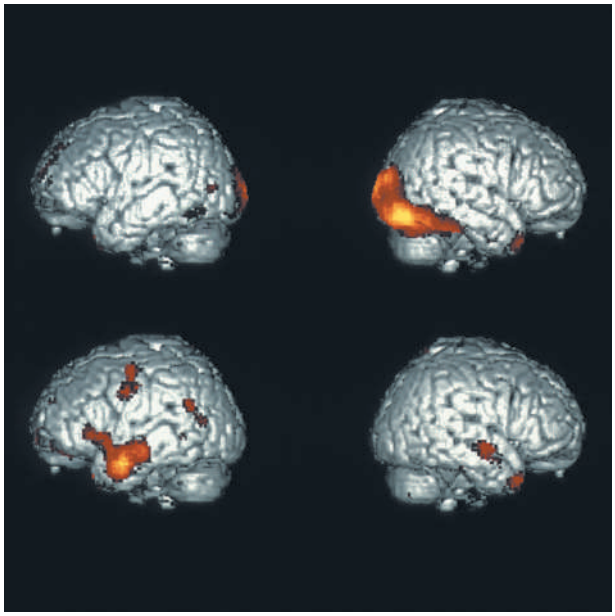
"Stomach and Duodenum." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Tish Davidson

Positron emission tomography (PET)

Definition

Positron emission tomography (PET) is a scanning technique used in conjunction with small amounts of radiolabeled compounds to visualize brain anatomy and function.



A PET scan showing brain activity while patient recognizes faces—left sides at left/right sides at right. Activity is prevalent in temporal lobe (bottom scans). *(Photo Researchers. Reproduced by permission.)*

Purpose

PET was the first scanning method to provide information on brain function as well as anatomy. This information includes data on blood flow, oxygen consumption, glucose metabolism, and concentrations of various molecules in brain tissue.

PET has been used to study brain activity in various neurological diseases and disorders, including **stroke**; epilepsy; **Alzheimer's disease**, **Parkinson's disease**, and Huntington's disease; and in some psychiatric disorders, such as **schizophrenia**, depression, **obsessive-compulsive disorder**, **attention-deficit/hyperactivity disorder**, and **Tourette syndrome**. PET studies have helped to identify the brain mechanisms that operate in drug **addiction**, and to shed light on the mechanisms by which individual drugs work. PET is also proving to be more accurate than other methods in the diagnosis of many types of **cancer**. In the treatment of cancer, PET can be used to determine more quickly than conventional tests whether a given therapy is working. PET scans also give accurate and detailed information on heart disease, particularly in women, in whom breast tissue can interfere with other types of tests.

Description

A very small amount of a radiolabeled compound is inhaled by or injected into the patient. The injected or inhaled compound accumulates in the tissue to be

KEY TERMS

Electron—One of the small particles that make up an atom. An electron has the same mass and amount of charge as a positron, but the electron has a negative charge.

Gamma ray—A high-energy photon, emitted by radioactive substances.

Half-life—The time required for half of the atoms in a radioactive substance to disintegrate.

Photon—A light particle.

Positron—One of the small particles that make up an atom. A positron has the same mass and amount of charge as an electron, but the positron has a positive charge.

studied. As the radioactive atoms in the compound decay, they release smaller particles called positrons, which are positively charged. When a positron collides with an electron (negatively charged), they are both annihilated, and two photons (light particles) are emitted. The photons move in opposite directions and are picked up by the detector ring of the PET scanner. A computer uses this information to generate three-dimensional, cross-sectional images that represent the biological activity where the radiolabeled compound has accumulated.

A related technique is called single photon emission computed tomography (CT) scan (SPECT). SPECT is similar to PET, but the compounds used contain heavier, longer-lived radioactive atoms that emit high-energy photons, called gamma rays, instead of positrons. SPECT is used for many of the same applications as PET, and is less expensive than PET, but the resulting picture is usually less sharp than a PET image and reveals less information about the brain.

Risks

Some of radioactive compounds used for PET or SPECT scanning can persist for a long time in the body. Even though only a small amount is injected each time, the long half-lives of these compounds can limit the number of times a patient can be scanned.

Resources

BOOKS

Kevles, Bettyann Holtzmann. *Medical Imaging in the Twentieth Century.* Rutgers University Press, 1996.

PERIODICALS

"Brain Imaging and Psychiatry: Part 1." *Harvard Mental Health Letter* 13 (Jan. 1997): 1.

"Brain Imaging and Psychiatry: Part 2." *Harvard Mental Health Letter* 13 (Feb. 1997): 1.

Faust, Rita Baron. "Life-Saving Breakthroughs: Innovative Designs and Techniques for Treating Heart Disease." *American Health for Women* 16 (Sept. 1997): 65.

Powledge, Tabatha M. "Unlocking the Secrets of the Brain: Part 2." *BioScience* 47 (17 July 1997): 403.

"Studies Argue for Wider Use of PET for Cancer Patients." *Cancer Weekly Plus* (15 Dec. 1997): 9.

Lisa Christenson, PhD

Post-concussion syndrome

Definition

Post-concussion syndrome (PCS) is a common but controversial disorder that presents with variety of symptoms including—but not limited to—headache, **dizziness**, **fatigue**, and personality changes.

Description

PCS occurs in approximately 23–93% of persons with mild to severe head injuries. It is estimated that a neurologist (a physician who specializes in nerve and brain disorders) sees five patients with PCS per month. There is no accurate correlation between the severity of injury and the development of PCS symptoms, since signs of the disorder can occur in someone who was just dazed by injury. Some studies suggest that PCS symptoms occur at a higher rate in patients who were unconscious after trauma.

Causes and symptoms

PCS is most commonly caused by minor **head injury** called a **concussion**. The majority of patients with minor head injury characteristically develop PCS with distinct symptoms. Patients may report problems with concentration, recent memory, and abstract thinking. Additionally, patients may develop dizziness, irritability, fatigue, and personality changes. Elderly patients are particularly affected by disequilibrium and chronic dizziness even after minor trauma.

Diagnosis

There are no specific or reliable tests to diagnose PCS. A neuropsychologist can perform an in-depth neu-

KEY TERMS

Disequilibrium—Difficulty with equilibrium that can mean a deficiency in balance and/or orientation.

Neuropsychologist—A clinical psychologist who specializes in assessing psychological status caused by a brain disorder.

ropsychologic assessment that can determine presence or absence and extent of impairment. These tests may be performed for medical purposes.

Treatment

Treatment for PCS can be extensive. Medications for **headache** and **pain** may be indicated (**analgesics** and **muscle relaxants**). Antidepressants may be given to improve **insomnia**, irritability, or **anxiety**. Pain control could be achieved with **acupuncture**, nerve blocks, or transcutaneous **electrical nerve stimulation** (TENS, electrical stimulation of muscle groups). It is important for clinicians to educate caretakers and to provide referrals for **family therapy** and cognitive **rehabilitation** for the affected person.

Prognosis

The overall outcome is difficult to assess. Limited interpretation in literature is primarily due to the subjective nature of symptoms. Patient recovery is directed and evaluated by cognitive function changes, subjective symptoms, and return to work. Most cases of PCS can be a financial strain and threaten family stability. There may be compensation and litigation claims, which is often stressful and aggravates symptoms.

Resources

BOOKS

Coper, Paul R., and John G. Golfinos, et al, eds. *Head Injury.* 4th ed. New York: McGraw-Hill, 2000.

Goldman, Lee, et al. *Cecil's Textbook of Medicine.* 21st ed. Philadelphia: W. B. Saunders Company, 2000.

Goetz, Christopher G., et al, eds. *Textbook of Clinical Neurology.* 1st ed. Philadelphia: W. B. Saunders Company, 1999.

Laith Farid Gulli, MD

Post-herpetic neuralgia *see* **Neuralgia**

Postmenopausal bleeding

Definition

Postmenopausal bleeding is bleeding from the reproductive system that occurs six months or more after menstrual periods have stopped due to **menopause**.

Description

Menopause, the end of ovulation and menstrual periods, naturally occurs for most women at age 40–55 years. The process of ending ovulation and menstruation is gradual, spanning one to two years.

Postmenopausal bleeding is bleeding that occurs after menopause has been established for at least six months. It is different from infrequent, irregular periods (**oligomenorrhea**) that occur around the time of menopause.

Many women experience some postmenopausal bleeding. However, postmenopausal bleeding is not normal. Because it can be a symptom of a serious medical condition, any episodes of postmenopausal bleeding should be brought to the attention of a woman's doctor.

Women taking estrogen (called **hormone replacement therapy** or HRT) are more likely to experience postmenopausal bleeding. So are obese women, because fat cells transform male hormones (androgens) secreted by the adrenal gland into estrogen.

Causes and symptoms

Postmenopausal bleeding can originate in different parts of the reproductive system. Bleeding from the vagina may occur because when estrogen secretion stops, the vagina dries out and can diminish (atrophy). This is the most common cause of bleeding from the lower reproductive tract.

Lesions and cracks on the vulva may also bleed. Sometimes bleeding occurs after intercourse. Bleeding can occur with or without an associated infection.

Bleeding from the upper reproductive system can be caused by:

- hormone replacements
- **endometrial cancer**
- endometrial polyps
- cervical **cancer**
- cervical lesions
- uterine tumors
- ovarian cancer

• estrogen-secreting tumors in other parts of the body

The most common cause of postmenopausal bleeding is HRT. The estrogen in the replacement therapy eases the symptoms of menopause (like hot flashes), and decreases the risk of **osteoporosis**. Sometimes this supplemental estrogen stimulates the uterine lining to grow. When the lining is shed, postmenopausal bleeding occurs. Most women on HRT usually take the hormone progesterone with the estrogen, and may have monthly withdrawal bleeding. This is a normal side effect.

About 5–10% of postmenopausal bleeding is due to endometrial cancer or its precursors. Uterine hyperplasia, the abnormal growth of uterine cells, can be a precursor to cancer.

Diagnosis

Diagnosis of postmenopausal bleeding begins with the patient. The doctor will ask for a detailed history of how long postmenopausal bleeding has occurred. A woman can assist the doctor by keeping a record of the time, frequency, length, and quantity of bleeding. She should also tell the doctor about any medications she is taking, especially any estrogens or steroids.

After taking the woman's history, the doctor does a pelvic examination and **PAP test**. The doctor will examine the vulva and vagina for any signs of atrophy, and will feel for any sign of uterine polyps. Depending on the results of this examination, the doctor may want to do more extensive testing.

Invasive diagnostic procedures

Endometrial biopsy allows the doctor to sample small areas of the uterine lining, while cervical biopsy allows the cervix to be sampled. Tissues are then examined for any abnormalities. This is a simple office procedure.

Dilatation and curettage (D & C) is often necessary for definitive diagnosis. This is done under either general or local anesthesia. After examining the tissues collected by an endometrial biopsy or D & C, the doctor may order additional tests to determine if an estrogen-secreting tumor is present on the ovaries or in another part of the body.

Non-invasive diagnostic procedures

With concerns about the rising cost of health care, vaginal probe ultrasound is increasingly being used more than endometrial biopsy to evaluate women with postmenopausal bleeding. Vaginal ultrasound measures the thickness of the endometrium. When the endometrial stripe is less than 0.2 in (5 mm) thick, the chance of cancer is less than 1%. The disadvantage of vaginal ultrasound is that it often does not show polyps and fibroids in the uterus.

A refinement of vaginal probe ultrasound is saline infusion sonography (SIS). A salt water (saline) solution is injected into the uterus with a small tube (catheter) before the vaginal probe is inserted. The presence of liquid in the uterus helps make any structural abnormalities more distinct. These two non-invasive procedures cause less discomfort than endometrial biopsies and D & Cs, but D & C still remains the definitive test for diagnosing uterine cancer.

KEY TERMS

Dilatation and curettage (D & C)—A procedure performed under anesthesia during which the cervix is opened more (or dilated) and tissue lining the uterus is scraped out with a metal, spoon-shaped instrument or a suction tube. The procedure can be used to diagnose a problem or to remove growths (polyps).

Endometrial biopsy—The removal of uterine tissue samples either by suction or scraping; the cervix is not dilated. The procedure has a lower rate of diagnostic accuracy than D & C, but can be done as an office procedure under local anesthesia.

Endometrium—The tissue lining the inside of the uterus.

Fibroid tumors—Non-cancerous (benign) growths in the uterus. These growths occur in 30–40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Osteoporosis—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily. Postmenopausal women are especially vulnerable to this condition because estrogen, a hormone that protects bones against calcium loss, decreases drastically after menopause.

Treatment

It is common for women just beginning HRT to experience some bleeding. Most women who are on HRT also take progesterone with the estrogen and may have monthly withdrawal bleeding. Again, this is a normal side effect that usually does not require treatment.

Postmenopausal bleeding due to bleeding of the vagina or vulva can be treated with local application of estrogen or HRT.

When diagnosis indicates cancer, some form of surgery is required. The uterus, cervix, ovaries, and fallopian tubes may all be removed depending on the type and location of the cancer. If the problem is estrogen- or androgen-producing tumors elsewhere in the body, these must also be surgically removed. Postmenopausal bleeding that is not due to cancer and cannot be controlled by any other treatment usually requires a **hysterectomy**.

Prognosis

Response to treatment for postmenopausal bleeding is highly individual and is not easy to predict. The outcome depends largely on the reason for the bleeding. Many women are successfully treated with hormones. As a last resort, hysterectomy removes the source of the problem by removing the uterus. However, this operation is not without risk and the possibility of complications. The prognosis for women who have various kinds of reproductive cancer varies with the type of cancer and the stage at which the cancer is diagnosed.

Prevention

Postmenopausal bleeding is not a preventable disorder. However, maintaining a healthy weight will decrease the chances of it occurring.

Resources

BOOKS

DeCherney, Alan H., and Martin L. Pernoll. "Complications of Menstruation." In *Current Obstetric & Gynecologic Diagnosis & Treatment*. Norwalk, CT: Appleton & Lange, 1994.

MacKay, H. Trent. "Gynecology." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

OTHER

"Woman's Health News—Menstrual and Bleeding Problems." *Woman's Diagnostic Cyber.* 23 Nov. 1997. <http://www.wdxcyber.com>.

Tish Davidson

Postpartum blues *see* **Postpartum depression**

Postpartum depression

Definition

Postpartum depression is a mood disorder that begins after **childbirth** and usually lasts beyond six weeks.

Description

The onset of postpartum depression tends to be gradual and may persist for many months, or develop into a second bout following a subsequent **pregnancy**. Postpartum depression affects approximately 15% of all childbearing women. Mild to moderate cases are sometimes unrecognized by women themselves. Many women feel ashamed if they are not coping and so may conceal their difficulties. This is a serious problem that disrupts women's lives and can have effects on the baby, other children, her partner, and other relationships. Levels of depression for fathers also increase significantly.

Postpartum depression is often divided into two types: early onset and late onset. An early onset most often seems like the "blues," a mild brief experience during the first days or weeks after birth. During the first week after the birth up to 80% of mothers will experience the "baby blues." This is usually a time of extra sensitivity and symptoms include tearfulness, irritability, **anxiety**, and mood changes, which tend to peak between three to five days after childbirth. The symptoms normally disappear within two weeks without requiring specific treatment apart from understanding, support, skill, and practice. In short, some depression, tiredness, and anxiety may fall within the "normal" range of reactions to giving birth.

Late onset appears several weeks after the birth. This involves a slowly growing feeling of sadness, depression, lack of energy, chronic tiredness, inability to sleep, change in appetite, significant weight loss or gain, and difficulty caring for the baby.

Causes and symptoms

As of 2001, experts cannot say what causes postpartum depression. Most likely, it is caused by many factors that vary from individual to individual. Mothers commonly experience some degree of depression during the first weeks after birth. Pregnancy and birth are accompanied by sudden hormonal changes that affect emotions. Additionally, the 24-hour responsibility for a newborn infant represents a major psychological and lifestyle adjustment for most mothers, even after the first child. These physical and emotional stresses are usually accompanied by inadequate rest until the baby's routine stabilizes, so **fatigue** and depression are not unusual.

Experiences vary considerably but usually include several symptoms.

Feelings:

- persistent low mood
- inadequacy, failure, hopelessness, helplessness
- exhaustion, emptiness, sadness, tearfulness
- guilt, shame, worthlessness
- confusion, anxiety, and panic
- fear for the baby and of the baby
- fear of being alone or going out

Behaviors:

- lack of interest or pleasure in usual activities
- insomnia or excessive sleep, nightmares
- not eating or overeating
- decreased energy and motivation
- withdrawal from social contact
- poor self-care
- inability to cope with routine tasks

Thoughts:

- inability to think clearly and make decisions
- lack of concentration and poor memory
- running away from everything
- fear of being rejected by partner
- worry about harm or **death** to partner or baby
- ideas about suicide

Some symptoms may not indicate a severe problem. However, persistent low mood or loss of interest or pleasure in activities, along with four other symptoms occurring together for a period of at least two weeks, indicate clinical depression, and require adequate treatment.

There are several important risk factors for postpartum depression, including:

- **stress**
- lack of sleep
- poor **nutrition**
- lack of support from one's partner, family or friends
- family history of depression
- labor/delivery complications for mother or baby
- premature or postmature delivery
- problems with the baby's health
- separation of mother and baby
- a difficult baby (temperament, feeding, sleeping, settling problems)
- preexisting neurosis or **psychosis**

Diagnosis

There is no diagnostic test for postpartum depression. However, it is important to understand that it is, nonetheless, a real illness, and like a physical ailment, it has specific symptoms.

Treatment

Several treatment options exist, including medication, psychotherapy, counseling, and group treatment and support strategies, depending on the woman's needs. One effective treatment combines antidepressant medication and psychotherapy. These types of medication are often effective when used for three to four weeks. Any medication use must be carefully considered if the woman are breast-feeding, but with some medications, continuing breast-feeding is safe. Nevertheless, medication alone is never sufficient and should always be accompanied by counseling or other support services.

Alternative treatment

Postpartum depression can be effectively alleviated through counseling and support groups, so that the mother doesn't feel she is alone in her feelings. Constitutional **homeopathy** can be the most effective treatment of the alternative therapies because it acts on the emotional level where postpartum depression is felt. **Acupuncture**, Chinese herbs, and Western herbs can all help the mother suffering from postpartum depression come back to a state of balance. Seeking help from a practitioner allows the new mother to feel supported and cared for and allows for more effective treatment.

A new mother also should remember that this time of stress does not last forever. In addition, there are useful things she can do for herself, including:

- valuing her role as a mother and trusting her own judgment
- making each day as simple as possible
- avoiding extra pressures or unnecessary tasks
- trying to involve her partner more in the care of the baby from the beginning
- discussing with her partner how both can share the household chores and responsibilities
- scheduling frequent outings, such as walks and short visits with friends
- having the baby sleep in a separate room so she sleep more restfully
- sharing her feelings with her partner or a friend who is a good listener

- talking with other mothers to help keep problems in perspective
- trying to sleep or rest when the baby is sleeping
- taking care of her health and well-being
- not losing her sense of humor

Prognosis

With support from friends and family, mild postpartum depression usually disappears quickly. If depression becomes severe, a mother cannot care for herself and the baby, and in rare cases, hospitalization may be necessary. Yet, medication, counseling, and support from others usually cure even severe depression in 3–6 months.

Prevention

Exercise can help enhance a new mother's emotional well-being. New mothers should also try to cultivate good sleeping habits and learn to rest when they feel physically or emotionally tired. It's important for a woman to learn to recognize her own warning signs of fatigue and respond to them by taking a break.

Resources

BOOKS

Dunnewold, Ann, and Diane G. Sanford. *Postpartum Survival Guide*. Oakland, CA: NewHarbinger Publications, 1994.

Kleiman, Karen R., and Valerie D. Raskin. *This Isn't What I Expected: Recognizing and Recovering from Depression and Anxiety after Childbirth*. New York: Bantam Books, 1994.

ORGANIZATIONS

Depression After Delivery (D.A.D.). P.O. Box 1282, Morrisville, PA 19067. (800) 944-4773.

Postpartum Support International. 927 North Kellog Ave., Santa Barbara, CA 93111. (805) 967-7636.

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Postpartum psychosis *see* **Postpartum depression**

Postpolio syndrome

Definition

Postpolio syndrome (PPS) is a condition that strikes survivors of the disease **polio**. PPS occurs about 20–30 years after the original bout with polio, and causes slow but progressive weakening of muscles.

Description

Polio is a disease caused by the poliovirus. It most commonly infects younger children, although it can also infect older children and adults. About 90% of people infected by poliovirus develop only a mild case or no illness at all. However, infected people can continue to spread the virus to others. In its most severe form polio causes **paralysis** of the muscles of the legs, arms, and respiratory system.

About 1% of all people infected with poliovirus develop the actual disease known as polio. In these cases, the virus (which enters the person's body through the mouth) multiplies rapidly within the intestine. The viruses then invade the nearby lymphatic system. Eventually, poliovirus enters the bloodstream, which allows it to gain access to the central nervous system or CNS (the brain and spinal cord). The virus may actually infect a nerve elsewhere in the body, and then spread along that nerve to enter the brain.

The major illness associated with poliovirus often follows a mild illness, which has symptoms of **fever**, nausea, and vomiting. However, after a symptom-free interval of several days, the patient who is on the way to a major illness develops new symptoms such as **headache** and back and neck **pain**. These symptoms are due to invasion of the nervous system. The motor nerves (those nerves responsible for movement of the muscles) become inflamed, injured, and destroyed. The muscles, therefore, no longer receive any messages from the brain or spinal cord. The muscles become weak, floppy, and then totally paralyzed (unable to move). All muscle tone is lost in the affected limb, and the muscle begins to decrease in size (atrophy). The affected muscles are often only on one side (asymmetric paralysis) of the body. Sensation (the person's ability to feel) is not affected in these paralyzed limbs.

The maximum state of paralysis is usually reached within just a few days. The remaining, unaffected nerves then begin the process of attempting to grow branches to compensate (make up for) the destroyed nerves. This process continues for about six months. Whatever function has not been regained in this amount of time will usually be permanently lost.

Causes and symptoms

PPS occurs in about 25% of patients, several decades after their original infection with polio. However, long-term follow-up indicates that two thirds of polio

survivors may experience new weakness. Several theories exist as to the cause of this syndrome.

One such theory has looked at the way function is regained by polio survivors. Three mechanisms seem to be at work:

- injured nerves recuperate and begin functioning again
- muscles which still have working nerve connections grow in size and strength, in order to take over for other paralyzed muscles
- working nerves begin to send small branches out to muscles whose original nerves were destroyed by polio

As a person ages, injured nerves that were able to regain function may fail again, as may muscles that have been over-worked for years in order to compensate for other paralyzed muscles. Even the uninjured nerves that provided new nerve twigs to the muscles may begin to falter after years of relative over-activity. This theory, then, suggests that the body's ability to compensate for destroyed nerves may eventually begin to fail. The compensating nerves and muscles grow older, and because they've been working so much harder over the years, they wear out relatively sooner than would be expected of normal nerves and muscles. Some researchers look at this situation as a form of premature **aging**, brought on by overuse.

Other researchers note that normal aging includes the loss of a fair number of motor nerves. When a patient has already lost motor nerves through polio, normal loss of motor nerves through aging may cause the number of remaining working nerves to drop low enough to cause symptoms of weakness.

Other theories of PPS include the possibility that particles of the original polioviruses remain in the body. These particles may exert a negative effect, decades later, or they may cause the body's immune system to produce substances originally intended to fight the invading virus, but which may accidentally set off a variety of reactions within the body that actually serve to interfere with the normal functioning of the nerves and muscles.

Still other researchers are looking at the possibility that polio patients have important spinal cord changes which, over time, affect the nerves responsible for movement.

The symptoms of PPS include generalized **fatigue**, low energy, progressively increasing muscle weakness, shrinking muscle size (atrophy), involuntary twitching of the muscle fibers (fasciculations), painful muscles and joints, difficulties with breathing and swallowing, and sleep problems.

Survivors of polio may also develop arthritis of the spine, shoulders, or arms, related to the long-term use of crutches or overcompensation for weak leg muscles.

Diagnosis

Diagnosis is primarily through history. When a patient who has recovered from polio some decades previously begins to experience muscle weakness, PPS must be strongly suspected.

Treatment

Just as there are no treatments available to reverse the original damage of polio, there are also no treatments available to reverse the damaging effects of postpolio syndrome. Attempts can be made to relieve some of the symptoms, however.

Pain and inflammation of the muscles and joints can be treated with anti-inflammatory medications, application of hot packs, stretching exercises, and physical therapy. Exercises to maintain/increase flexibility are particularly important. However, an **exercise** regimen must be carefully designed, so as not to strain already fatigued muscles and nerves.

Some patients will require new types of braces to provide support for weakening muscles. Others will need to use wheelchairs or motorized scooters to maintain mobility.

Sleep problems and respiratory difficulties may be related to each other. If breathing is labored during sleep, the blood's oxygen content may drop low enough to interfere with the quality of sleep. This may require oxygen supplementation, or even the use of a machine to aid in breathing.

Prognosis

Prognosis for patients with postpolio syndrome is relatively good. It is a very slow, gradually progressing syndrome. Only about 20% of all patients with PPS will need to rely on new aids for mobility or breathing. It appears that the PPS symptoms reach their most severe about 30–34 years after original diagnosis of polio.

Prevention

There is no way to prevent PPS. However, paying attention to what types of exertion worsen symptoms may slow the progression of the syndrome.

KEY TERMS

Asymmetric—Not occurring equally on both sides of the body.

Atrophy—Shrinking, growing smaller in size.

Flaccid—Weak, soft, floppy.

Paralysis—The inability to voluntarily move.

Resources

BOOKS

Cohen, Jeffrey. "Enteroviruses and Reoviruses." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Price, Richard. "Poliomyelitis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Ray, C. George. "Enteroviruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Bartfeld, Harry, and Dong Ma. "Recognizing Post-Polio Syndrome." *Hospital Practice* 31, no. 5 (15 May 1996): 95+.

Brown, Marybeth. "Post-Polio Syndrome." *The New England Journal of Medicine* 333, no. 8 (24 Aug. 1995): 532+.

Richardson, Sarah. "New Pain, Old Virus." *Discover* 16, no. 1 (Jan. 1995): 72+.

ORGANIZATIONS

International Polio Network, 4207 Lindell Blvd., Suite 110, St. Louis, MO 63108-2915. (314) 534-0475.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

Polio Survivors Association. 12720 Lareina Ave., Downey, CA 90242. (310) 862-4508.

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Postpoliomyelitis muscular atrophy *see* **Postpolio syndrome**

Postpoliomyelitis syndrome *see* **Postpolio syndrome**

Poststreptococcal glomerulonephritis *see* **Acute poststreptococcal glomerulonephritis**

Post-traumatic stress disorder

Definition

Post-traumatic **stress** disorder (PTSD) is a debilitating condition that affects people who have been exposed to a major traumatic event. PTSD is characterized by upsetting memories or thoughts of the ordeal, "blunting" of emotions, increased arousal, and sometimes severe personality changes.

Description

Once called "shell shock" or battle fatigue, PTSD is most well known as a problem of war veterans returning from the battlefield. However, it can affect anyone who has experienced a traumatic event, such as rape, robbery, a natural disaster, or a serious accident. A diagnosis of a serious disease can trigger PTSD in some people. Considered to be one of a group of conditions known as "anxiety disorders," it can affect people of all ages who have experienced severe trauma. Children who have experienced severe trauma, such as war, a natural disaster, sexual or physical **abuse**, or the **death** of a parent, are also prone to PTSD.

Causes and symptoms

PTSD is a response to a profoundly disturbing event. It isn't clear why some people develop PTSD following a trauma and others do not, although experts suspect it may be influenced both by the severity of the event, by the person's personality and genetic make-up, and by whether or not the trauma was expected. As the individual struggles to cope with life after the event, ordinary events or situations reminiscent of the trauma often trigger frightening and vivid memories or "flashbacks." Symptoms usually begin within three months of the trauma, although sometimes PTSD doesn't develop until years after the initial trauma occurred. Once the symptoms begin, they may fade away again within six months. Others suffer with the symptoms for far longer and in some cases, the problem may become chronic. Some untreated Vietnam veterans with PTSD, for example, spent decades living alone in rural areas of the country, struggling to come to grips with the horror of war.

Among the most troubling symptoms of PTSD are flashbacks, which can be triggered by sounds, smells, feelings, or images. During a flashback, the person relives the traumatic event and may completely lose touch with reality, suffering through the trauma for min-

KEY TERMS

Benzodiazepine—A class of drugs that have a hypnotic and sedative action, used mainly as tranquilizers to control symptoms of anxiety.

Cognitive-behavioral therapy—A type of psychotherapy used to treat anxiety disorders (including PTSD) that emphasizes behavioral change, together with alteration of negative thought patterns.

Selective serotonin reuptake inhibitor (SSRI)—A class of antidepressants that work by blocking the reabsorption of serotonin in the brain, raising the levels of serotonin. SSRIs include Prozac, Zoloft, and Paxil.

utes or hours at a time, believing that it is actually happening all over again

A variety of other symptoms may arise following the traumatic event. **Sleep disorders** such as nightmares or **night terrors**, or difficulty falling asleep may occur. Intense distress may be experienced when exposed to events that are associated with the trauma. Avoidance of thoughts surrounding the trauma or inability to remember the event and the accompanying emotions may also arise. Loss of interest in former pleasures (psychic numbing or blunting) or a sense of a shortened future may also be present. Startle reactions (hyper-alertness and strong reactions to unexpected noises), memory and concentration problems, moodiness, and violence may also be symptomatic. Children with PTSD may experience learning disabilities and memory or attention problems. They may become more dependent, anxious, or even self-abusing. Major depression, **anxiety disorders**, substance abuse, adjustment disorder, development of hypochondria disorders, and organic brain disorders may be some of the psychiatric manifestations of exposure to traumatic stress. Recovery may be slowed by injuries, damage to property, loss of employment, or other major problems in the community due to disaster.

Diagnosis

Not every person who experiences a traumatic event will experience PTSD. A mental health professional will diagnose the condition if the symptoms of stress last for more than a month after a traumatic event. While a formal diagnosis of PTSD is made only in the wake of a severe trauma, it is possible to have a mild PTSD-like reaction following less severe stress.

Treatment

Several factors have been shown to be important in the treatment of post-traumatic stress. These include proximity of the treatment to the site of the event, immediate intervention of therapy as soon as possible, and the expectation that the individual will eventually return to more normal functions. The most helpful treatment appears to be a combination of medication along with supportive and cognitive-behavioral therapies.

Medications

Medications used to reduce the symptoms of PTSD include anxiety-reducing medications and antidepressants, especially the **selective serotonin reuptake inhibitors** (SSRIs) such as fluoxetine (Prozac). Sleep problems can be lessened with brief treatment with an anti-anxiety drug, such as a benzodiazepine like alprazolam (Xanax), but long-term usage can lead to disturbing side effects, such as increased anger, drug tolerance, dependency, and abuse.

Therapy

Several types of therapy may be useful and they are often combined in a multi-faceted approach to understand and treat this condition.

- Psychological debriefing may be used as facts are recounted. Impressions, thoughts, and emotions are expressed. These responses are then validated and confirmed to be normal in response to an abnormal situation. The therapist conducting the debriefing may recommend coping skills.
- Psychotherapy can help reduce negative thought patterns and self talk. This can be done on an individual basis or in groups with other PTSD sufferers. **Family therapy** can also be helpful.
- **Cognitive-behavioral therapy** focuses on changing specific actions and thoughts.
- Spiritual healing may also be employed and has been useful in some cases.

Alternative treatment

Several means of alternative treatment may be helpful in combination with conventional therapy for reduction of the symptoms of post-traumatic stress disorder. These include relaxation training, breathing techniques, spiritual treatment, and drama therapy, in which the event is re-enacted.

Prognosis

The severity of the illness depends in part on whether the trauma was unexpected, the severity of the trauma, how chronic the trauma was (such as for victims of sexual abuse), and the person's inherent personality and genetic make-up. With appropriate medication, emotional support, and counseling, most people show significant improvement. However, prolonged exposure to severe trauma, such as experienced by victims of prolonged physical or sexual abuse and survivors of the Holocaust, may cause permanent psychological scars.

Prevention

More studies are needed to determine if PTSD can actually be prevented. Some measures that have been explored include controlling exposure to traumatic events through safety and security measures, psychological preparation for individuals who will be exposed to traumatic events (i.e. policemen, paramedics, soldiers), stress inoculation training (rehearsal of the event with small doses of the stressful situation), and psychological debriefing.

Resources

BOOKS

Allen, Jon. *Coping with Trauma*. Washington, DC: American Psychiatric Press, 1995.

Fullerton, Carol and Robert Ursano, editors. *Posttraumatic Stress Disorder: Acute and Long-term Responses to Trauma and Disaster.* Washington, DC: American Psychiatric Press, 1997.

O'Brien, Stephen. *Traumatic Events and Mental Health*. Cambridge: Cambridge University Press, 1998.

OTHER

National Institute of Mental Health. <http://www.nimh.nih.gov/May 22,2001>.

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Postural drainage *see* **Chest physical therapy**

Postural hypotension *see* **Orthostatic hypotension**

Postviral thrombocytopenia *see* **Idiopathic thrombocytopenic purpura**

Potassium hydroxide test *see* **KOH test**

Potassium imbalance *see* **Hyperkalemia; Hypokalemia**

PPD skin test *see* **Tuberculin skin test**

Prader-Willi syndrome

Definition

Prader-Willi syndrome (PWS) is a genetic condition caused by the absence of chromosomal material from chromosome 15. The genetic basis of PWS is complex. Characteristics of the syndrome include developmental delay, poor muscle tone, short stature, small hands and feet, incomplete sexual development, and unique facial features. Insatiable appetite is a classic feature of PWS. This uncontrollable appetite can lead to health problems and behavior disturbances.

Description

The first patients with features of PWS were described by Dr. Prader, Dr. Willi, and Dr. Lambert in 1956. Since that time, the complex genetic basis of PWS has begun to be understood. Initially, scientists found that individuals with PWS have a portion of genetic material deleted (erased) from chromosome 15. In order to have PWS, the genetic material must be deleted from the chromosome 15 received from one's father. If the deletion is on the chromosome 15 inherited from one's mother a different syndrome develops. This was an important discovery. It demonstrated for the first time that the genes inherited from one's mother can be expressed differently than the genes inherited from one's father.

Over time, scientists realized that some individuals with PWS do not have deleted genetic material from chromosome 15. Further studies found that these patients inherit both copies of chromosome 15 from their mother. This is not typical. Normally, an individual receives one chromosome 15 from their father and one chromosome 15 from their mother. When a person receives both chromosomes from the same parent it is called "uniparental disomy." When a person receives both chromosomes from his or her mother it is called "maternal uniparental disomy."

Scientists are still discovering other causes of PWS. A small number of patients with PWS have a change (mutation) in the genetic material on the chromosome 15 inherited from their father. This mutation prevents certain genes on chromosome 15 from working properly. PWS develops when these genes do not work normally.

Newborns with PWS generally have poor muscle tone (hypotonia) and do not feed well. This can lead to poor weight gain and **failure to thrive**. Genitalia can be smaller than normal. Hands and feet are also typically smaller than normal. Some patients with PWS

have unique facial characteristics. These unique facial features are typically subtle and detectable only by physicians.

As children with PWS age, development is typically slower than normal. Developmental milestones, such as crawling, walking and talking occur later than usual. Developmental delay continues into adulthood for approximately 50% of individuals with PWS. At about one to two years of age, children with PWS develop an uncontrollable, insatiable appetite. Left to their own devices, individuals with PWS will eat until they suffer from life-threatening **obesity**. The desire to eat can lead to significant behavior problems.

The symptoms and features of PWS require life long support and care. If food intake is strictly monitored and various therapies provided, individuals with PWS have a normal life expectancy.

PWS affects approximately 1 in 10,000 to 25,000 live births. It is the most common genetic cause of life-threatening obesity. It affects both males and females. PWS can be seen in all races and ethnic groups.

Causes and symptoms

In order to comprehend the various causes of PWS, the nature of chromosomes and genes must be well understood. Human beings have 46 chromosomes in the cells of their body. Chromosomes contain genes, which regulate the function and development of the body. An individual's chromosomes are inherited from his or her parents. Each parent normally gives a child 23 chromosomes. A child normally receives 23 chromosomes from the egg and 23 chromosomes from the sperm.

The 46 chromosomes in the human body are divided into pairs based on their physical characteristics. Each pair is assigned a number or a letter. When viewed under a microscope, chromosomes within the same pair appear identical because they contain the same genes.

Most chromosomes have a constriction near the center called the centromere. The centromere separates the chromosome into long and short arms. The short arm of a chromosome is called the "p arm," the long arm is called the "q arm."

Chromosomes in the same pair contain the same genes. However, some genes work differently depending on if they were inherited from the egg or the sperm. Sometimes, genes are silenced when inherited from the mother. Other times, genes are silenced when inherited from the father. When genes in a certain region on a chromosome are silenced, they are said to be "imprinted." Imprinting is a normal process that does not typically cause disease. If normal imprinting is disrupted a genetic disease can develop.

Individuals have two complete copies of chromosome 15. One chromosome 15 is inherited from the mother, or "maternal" in origin. The other chromosome 15 is inherited from the father, or "paternal" in origin.

Chromosome 15 contains many different genes. There are several genes found on the q arm of chromosome 15 that are imprinted. A gene called "SNPRN" is an example of one of these genes. It is normally imprinted, or silenced, if inherited from the mother. The imprinting of this group of maternal genes does not typically cause disease. The genes in this region should not be imprinted if paternal in origin. Normal development depends on these paternal genes being present and active. If these genes are deleted, not inherited, or incorrectly imprinted PWS develops.

Seventy percent of the cases of PWS are caused when a piece of material is deleted, or erased, from the paternal chromosome 15. This deletion occurs in a specific region on the q arm of chromosome 15. The piece of chromosomal material that is deleted contains genes that must be present for normal development. These paternal genes must be working normally, because the same genes on the chromosome 15 inherited from the mother are imprinted. When these paternal genes are missing, the brain and other parts of the body do not develop as expected. This is what causes the symptoms associated with PWS.

In 99% of the cases of PWS the deletion is sporadic. This means that it happens randomly and there is not an apparent cause. It does not run in the family. If a child has PWS due to a sporadic deletion in the paternal chromosome 15, the chance the parents could have another child with PWS is less than 1%. In fewer than 1% of the cases of PWS there is a chromosomal rearrangement in the family which causes the deletion. This chromosomal rearrangement is called a "translocation." If a parent has a translocation the risk of having a child with PWS is higher than 1%.

PWS can also develop if a child receives both chromosome 15s from his or her mother. This is seen in approximately 25% of the cases of PWS. Maternal uniparental disomy for chromosome 15 leads to PWS because the genes on chromosome 15 that should have been inherited from the father are missing, and the genes on both the chromosome 15s inherited from the mother are imprinted.

PWS caused by maternal uniparental is sporadic. This means that it occurs randomly and there is not an apparent cause. If a child has PWS due to maternal uniparental disomy the chance the parents could have another child with PWS is less than 1%.

Approximately 3–4% of patients with PWS have a change (mutation) in a gene located on the q arm of chromosome 15. This mutation leads to incorrect imprinting. This mutation causes genes inherited from the father to be imprinted or silenced, which should not normally be imprinted. If a child has PWS due to a mutation that changes imprinting, the chance the parents could have another child with PWS is approximately 5%.

Infants with PWS have weak muscle tone (hypotonia). This hypotonia causes problems with sucking and eating. Infants with PWS may have problems gaining weight. Some infants with PWS are diagnosed with "failure to thrive" due to slow growth and development. During infancy, babies with PWS may also sleep more than normal and have problems controlling their temperature.

Some of the unique physical features associated with PWS can be seen during infancy. Genitalia that is smaller than normal is common. This may be more evident in males with PWS. Hands and feet may also be smaller than average. The unique facial features seen in some patients with PWS may be difficult to detect in infancy. These facial features are very mild and do not cause physical problems.

As early as 6 months, but more commonly between one to two years a compulsive desire to eat develops. This uncontrollable appetite is a classic feature of PWS. Individuals with PWS lack the ability to feel full or satiated. This uncontrollable desire to eat is thought to be related to a difference in the brain, which controls hunger. Over-eating (hyperpahgia), a lack of a desire to **exercise**, and a slow metabolism places individuals with PWS at high risk for severe obesity. Some individuals with PWS may also have a reduced ability to vomit.

Behavior problems are a common feature of PWS. Some behavior problems develop from the desire to eat. Other reported problems include obsessive/compulsive behaviors, depression, and temper tantrums. Individuals with PWS may also pick their own skin (skin picking). This unusual behavior may be due to a reduced **pain** threshold.

Developmental delay, learning disabilities, and **mental retardation** are associated with PWS. Approximately 50% of individuals with PWS have developmental delay. The remaining 50% are described as having mild mental retardation. The mental retardation can occasionally be more severe. Infants and children with PWS are often delayed in development.

Puberty may occur early or late, but it is usually incomplete. In addition to the effects on sexual development and fertility, individuals do not undergo the normal adolescent growth spurt and may be short as adults. Muscles often remain underdeveloped and body fat is increased.

Diagnosis

During infancy the diagnosis of PWS may be suspected if poor muscle tone, feeding problems, small genitalia, or the unique facial features are present. If an infant has these features, testing for PWS should be performed. This testing should also be offered to children and adults who display features commonly seen in PWS (developmental delay, uncontrollable appetite, small genitalia, etc.). There are several different genetic tests that can detect PWS. All of these tests can be performed from a blood sample.

Methylation testing detects 99% of the cases of PWS. Methylation testing can detect the absence of the paternal genes that should be normally active on chromosome 15. Although methylation testing can accurately diagnose PWS, it can not determine if the PWS is caused by a deletion, maternal uniparental disomy, or a mutation that disrupts imprinting. This information is important for **genetic counseling**. Therefore, additional testing should be performed.

Chromosome analysis can determine if the PWS is the result of a deletion in the q arm of chromosome 15. Chromosome analysis, also called "karyotyping," involves staining the chromosomes and examining them under a microscope. In some cases the deletion of material from chromosome 15 can be easily seen. In other cases, further testing must be performed. FISH (fluorescence in-situ hybridization) is a special technique that detects small deletions that cause PWS.

More specialized DNA testing is required to detect maternal uniparental disomy or a mutation that disrupts imprinting. This DNA testing identifies unique DNA patterns in the mother and father. The unique DNA patterns are then compared with the DNA from the child with PWS.

PWS can be detected before birth if the mother undergoes **amniocentesis** testing or **chorionic villus sampling** (CVS). This testing is only recommended if the mother or father is known to have a chromosome rearrangement, or if they already have a child with PWS syndrome.

Treatment

There is currently not a cure for PWS. Treatment during infancy includes therapies to improve muscle tone. Some infants with PWS also require special nipples and feeding techniques to improve weight gain.

Treatment and management during childhood, adolescence, and adulthood is typically focused on weight control. Strict control of food intake is vital to prevent severe obesity. In many cases food must be made inac-

KEY TERMS

Amniocentesis—A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus. Amniotic fluid is then removed from around the fetus and may be used for genetic testing.

Centromere—Major constriction in a chromosome.

Deletion—Removal of a piece of genetic material.

DNA—Deoxyribonucleic acid. Genes are made of sections of DNA.

FISH (**Flourescence in-situ hybridization**)—Technique used to detect small deletions or rearrangements in chromosomes.

Gene—Segment of DNA that controls the development and function of the body. Genes are contained within chromosomes.

Hyperphagia—Over-eating.

Hypotonia—Low muscle tone.

Imprinting—Process that silences a gene or group of genes. The genes are silenced depending on if they are inherited through the egg or the sperm.

Maternal—From one's mother.

Maternal uniparental disomy—Chromosome abnormality in which both chromosomes in a pair are inherited from one's mother.

Methylation testing—DNA testing that detects if a gene is active or imprinted.

Mutation—A change in a gene.

Paternal—From one's father.

Translocation—Chromosome abnormality in which chromosomes are rearranged and placed together.

Uniparental disomy—Chromosome abnormality in which both chromosomes in a pair are inherited from the same parent.

cessible. This may involve unconventional measures such as locking the refrigerator or kitchen cabinets. A lifelong restricted-calorie diet and regular exercise program are also suggested. Unfortunately, diet medications have not been shown to significantly prevent obesity in PWS. However, growth hormone therapy has been shown to improve the poor muscle tone and reduced height typically associated with PWS.

Special education may be helpful in treating developmental delays and behavior problems. Individuals with PWS typically excel in highly structured environments.

Prognosis

Life expectancy is normal and the prognosis good, if weight gain is well controlled.

Resources

BOOKS

Couch, Cheryl. *My Rag Doll*. Couch Publishing, October 2000.

Jones, Kenneth Lyons. "Prader-Willi Syndrome." In *Smith's Recognizable Patterns of Human Malformation*. 5th edition Philadelphia: W.B. Saunders, 1997.

PERIODICALS

Butler, Merlin G., and Travis Thompson. "Prader-Willi Syndrome: Clinical and Genetic Findings" *The Endocrinologist* 10 (2000): 3S–16S.

State, Matthew W., and Elisabeth Dykens. "Genetics of Childhood Disorders: XV. Prader-Willi Syndrome: Genes, Brain and Behavior." *J. Am. Acad. Child. Adolesc. Psychiatry* 39, no. 6 (June 2000): 797–800.

ORGANIZATIONS

Alliance of Genetic Support Groups. 4301 Connecticut Ave. NW, Suite 404, Washington DC 20008. (202) 966-5557. <http://www.geneticalliance.org>.

International Prader-Willi Syndrome Organization. <http://www.ipwsp.org>.

National Organization for Rare Disorders, Inc., P.O. Box 8923, New Fairfield, CT 06812. (800) 999-6673. <http://www.rarediseases.org>.

Prader-Willi Foundation. 223 Main Street, Port Washington, NY 11050. (800)253-7993. <http://www.prader-willi.org>.

Prader-Willi Syndrome Association(USA). 5700 Midnight Pass Rd., Sarasota, FL 34242. (800) 926-4797. <http://www.pwsusa.org>.

OTHER

GeneClinics. <http://www.geneclinics.org/profiles/pws/details.html>.

OMIM. <http://www.ncbi.nlm.nih.gov/htbin-port/Omim/dispmim?176270.

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Praziquantel *see* **Antihelminthic drugs**

Precocious puberty

Definition

Sexual development before the age of eight in girls, and age 10 in boys.

Description

Not every child reaches **puberty** at the same time, but in most cases it's safe to predict that sexual development will begin at about age 11 in girls and 12 or 13 in boys. However, occasionally a child begins to develop sexually much earlier. Between four to eight times more common in girls than boys, precocious puberty occurs in one out of every 5,000 to 10,000 U.S. children.

Precocious puberty often begins before age 8 in girls, triggering the development of breasts and hair under the arms and in the genital region. The onset of ovulation and menstruation also may occur. In boys, the condition triggers the development of a large penis and testicles, with spontaneous erections and the production of sperm. Hair grows on the face, under arms and in the pubic area, and **acne** may become a problem.

While the early onset of puberty may seem fairly benign, in fact it can cause problems when hormones trigger changes in the growth pattern, essentially halting growth before the child has reached normal adult height. Girls may never grow above 5 ft (152 cm) and boys often stop growing by about 5 ft 2 in (157 cm).

The abnormal growth patterns are not the only problem, however. Children with this condition look noticeably different than their peers, and may feel rejected by their friends and socially isolated. Adults may expect these children to act more maturely simply because they look so much older. As a result, many of these children—especially boys—are much more aggressive than others their own age, leading to behavior problems both at home and at school.

Causes and symptoms

Puberty begins when the brain secretes a hormone that triggers the pituitary gland to release gonadotropins, which in turn stimulate the ovaries or testes to produce sex hormones. These sex hormones (especially estrogen in girls and testosterone in boys) are what causes the onset of sexual maturity.

The hormonal changes of precious puberty are normal—it's just that the whole process begins a few years too soon. Especially in girls, there is not usually any underlying problem that causes the process to begin too soon. However, some boys do inherit the condition; the responsible gene may be passed directly from father to son, or inherited indirectly from the maternal grandfather through the mother, who does not begin early puberty herself). This genetic condition in girls can be traced in only about 1% of cases.

In about 15% of cases, there is an underlying cause for the precious puberty, and it is important to search for these causes. The condition may result from a benign tumor in the part of the brain that releases hormones. Less commonly, it may be caused by other types of brain tumors, central nervous system disorders, or adrenal gland problems.

Diagnosis

Physical exams can reveal the development of sexual characteristics in a young child. Bone x rays can reveal bone age, and **pelvic ultrasound** may show an enlarged uterus and rule out ovarian or adrenal tumors. Blood tests can highlight higher-than-normal levels of hormones. MRI or CAT scans should be considered to rule out intracranial tumors.

Treatment

Treatment aims to halt or reverse sexual development so as to stop the accompanying rapid growth that will limit a child's height. There are two possible approaches: either treat the underlying condition (such as an ovarian or intracranial tumor) or change the hormonal balance to stop sexual development. It may not be possible to treat the underlying condition; for this reason, treatment is usually aimed at adjusting hormone levels.

There are several drugs that have been developed to do this:

- histrelin (Supprelin)
- nafarelin (Synarel)
- synthetic gonadotropin-releasing hormone agonist
- deslorelin
- ethylamide
- triptorelin
- leuprolide

Prognosis

Drug treatments can slow growth to 2–3 in (5–7.5 cm) a year, allowing these children to reach normal adult height, although the long-term effects aren't known.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

Franck, Irene, and David Brownstone *The Parent's Desk Reference*. New York: Prentice Hall, 1991.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1997.

ORGANIZATIONS

National Institute of Child Health and Human Development. Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD 20892-2425. (800) 505-2742. <http://www.nichd.nih.gov/sids/sids.htm>.

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Prednis *see* **Corticosteroids**

Preeclampsia and eclampsia

Definition

Preeclampsia and eclampsia are complications of **pregnancy**. In preeclampsia, the woman has dangerously high blood pressure, swelling, and protein in the urine. If allowed to progress, this syndrome will lead to eclampsia.

Description

Blood pressure is a measurement of the pressure of blood on the walls of blood vessels called arteries. The arteries deliver blood from the heart to all of the tissues in the body. Blood pressure is reported as two numbers. For example a normal blood pressure is reported as 110/70 mm Hg (read as 110 over 70 millimeters of mercury; or just 110 over 70). These two numbers represent two measurements, the systolic pressure and the diastolic pressure. The systolic pressure (the first number in the example; 110/70 mm Hg) measures the peak pressure of the blood against the artery walls. This higher pressure occurs as blood is being pumped out of the heart and into the circulatory system. The pumping chambers of the heart (ventricles) squeeze to force the blood out of the heart. The diastolic pressure (the second number in the example 110/70 mm Hg) measures the pressure during the filling of the ventricles. At this point, atria contract to fill the ventricles. Because the ventricles are relatively relaxed, and are not pumping blood into the arteries, the pressure in the arteries is lower as well.

High blood pressure in pregnancy (**hypertension**) is a very serious complication. It puts both the mother and the fetus (developing baby) at risk for a number of problems. Hypertension can exist in several different forms:

- The preeclampsia-eclampsia continuum (also called pregnancy-induced hypertension or PIH). In this type of hypertension, high blood pressure is first noted sometime after week 20 of pregnancy and is accompanied by protein in the urine and swelling.
- Chronic hypertension. This type of hypertension usually exists before pregnancy or may develop before week 20 of pregnancy.
- Chronic hypertension with superimposed preeclampsia. This syndrome occurs when a woman with pre-existing chronic hypertension begins to have protein in the urine after week 20 of pregnancy.
- Late hypertension. This is a form of high blood pressure occurring after week 20 of pregnancy and is unaccompanied by protein in the urine and does not progress the way preeclampsia-eclampsia does.

Preeclampsia is most common among women who have never given birth to a baby (called nulliparas). About 7% of all nulliparas develop preeclampsia. The disease is most common in mothers under the age of 20, or over the age of 35. African-American women have higher rates of preeclampsia than do Caucasian women. Other risk factors include poverty, multiple pregnancies (twins, triplets, etc.), pre-existing chronic hypertension or kidney disease, diabetes, excess amniotic fluid, and a condition of the fetus called nonimmune hydrops. The tendency to develop preeclampsia appears to run in families. The daughters and sisters of women who have had preeclampsia are more likely to develop the condition.

Causes and symptoms

Experts are still trying to understand the exact causes of preeclampsia and eclampsia. It is generally accepted that preeclampsia and eclampsia are problematic because these conditions cause blood vessels to leak. The effects are seen throughout the body.

- General body tissues. When blood vessels leak, they allow fluid to flow out into the tissues of the body. The result is swelling in the hands, feet, legs, arms, and face. While many pregnant women experience swelling in their feet, and sometimes in their hands, swelling of the upper limbs and face is a sign of a more serious problem. As fluid is retained in these tissues, the woman may experience significant weight gain (two or more pounds per week).
- Brain. Leaky vessels can cause damage within the brain, resulting in seizures or **coma**.
- Eyes. The woman may experience problems seeing, and may have blurry vision or may see spots. The retina may become detached.
- Lungs. Fluid may leak into the tissues of the lungs, resulting in **shortness of breath**.

- Liver. Leaky vessels within the liver may cause it to swell. The liver may be involved in a serious complication of preeclampsia, called the HELLP syndrome. In this syndrome, red blood cells are abnormally destroyed, chemicals called liver enzymes are abnormally high, and cells involved in the clotting of blood (platelets) are low.
- Kidneys. The small capillaries within the kidneys can leak. Normally, the filtration system within the kidney is too fine to allow protein (which is relatively large) to leave the bloodstream and enter the urine. In preeclampsia, however, the leaky capillaries allow protein to be dumped into the urine. The development of protein in the urine is very serious, and often results in a low birth weight baby. These babies have a higher risk of complications, including death.
- Blood pressure. In preeclampsia, the volume of circulating blood is lower than normal because fluid is leaking into other parts of the body. The heart tries to make up for this by pumping a larger quantity of blood with each contraction. Blood vessels usually expand in diameter (dilate) in this situation to decrease the work load on the heart. In preeclampsia, however, the blood vessels are abnormally constricted, causing the heart to work even harder to pump against the small diameters of the vessels. This causes an increase in blood pressure.

The most serious consequences of preeclampsia and eclampsia include brain damage in the mother due to brain swelling and oxygen deprivation during seizures. Mothers can also experience blindness, kidney failure, liver rupture, and **placental abruption**. Babies born to preeclamptic mothers are often smaller than normal, which makes them more susceptible to complications during labor, delivery, and in early infancy. Babies of preeclamptic mothers are also at risk of being born prematurely, and can suffer the complications associated with **prematurity**.

Diagnosis

Diagnosing preeclampsia may be accomplished by noting painless swelling of the arms, legs, and/or face, in addition to abnormal weight gain. The patient's blood pressure is taken during every doctor's visit during pregnancy. An increase of 30 mm Hg in the systolic pressure, or 15 mm Hg in the diastolic pressure, or a blood pressure reading greater than 140/90 mm Hg is considered indicative of preeclampsia. A simple laboratory test in the doctor's office can indicate the presence of protein in a urine sample (a dipstick test). A more exact measurement of the amount of protein in the urine can be obtained by collecting urine for 24 hours, and then testing it in a laboratory to determine the actual quantity of protein present. A 24-hour urine specimen containing more than 500 mg of protein is considered indicative of preeclampsia.

Treatment

With mild preeclampsia, treatment may be limited to bed rest, with careful daily monitoring of weight, blood pressure, and urine protein via dipstick. This careful monitoring will be required throughout pregnancy, labor, delivery, and even for 2–4 days after the baby has been born. About 25% of all cases of eclampsia develop in the first few days after the baby's birth. If the diastolic pressure does not rise over 100 mm Hg prior to delivery, and no other symptoms develop, the woman can continue pregnancy until the fetus is mature enough to be delivered safely. Ultrasound tests can be performed to monitor the health and development of the fetus.

If the diastolic blood pressure continues to rise over 100 mm Hg, or if other symptoms like **headache**, vision problems, abdominal **pain**, or blood abnormalities develop, then the patient may require medications to prevent seizures. Magnesium sulfate is commonly given through a needle in a vein (intravenous, or IV). Medications that lower blood pressure (antihypertensive drugs) are reserved for patients with very high diastolic pressures (over 110 mm Hg), because lowering the blood pressure will decrease the amount of blood reaching the fetus. This places the fetus at risk for oxygen deprivation. If preeclampsia appears to be progressing toward true eclampsia, then medications may be given in order to start labor. Babies can usually be delivered vaginally. After the baby is delivered, the woman's blood pressure and other vital signs will usually begin to return to normal quickly.

Prognosis

The prognosis in preeeclampsia and eclampsia depends on how carefully a patient is monitored. Very careful, consistent monitoring allows quick decisions to be made, and improves the woman's prognosis. Still, the most common causes of death in pregnant women are related to high blood pressure.

About 33% of all patients with preeclampsia will have the condition again with later pregnancies. Eclampsia occurs in about 1 out of every 200 women with preeclampsia. If not treated, eclampsia is almost always fatal.

Prevention

More information on how preeclampsia and eclampsia develop is needed before recommendations

KEY TERMS

Capillary—The tiniest blood vessels with the smallest diameter. These vessels receive blood from the arterioles and deliver blood to the venules.

Diastolic—The phase of blood circulation in which the heart's pumping chambers (ventricles) are being filled with blood. During this phase, the ventricles are at their most relaxed, and the pressure against the walls of the arteries is at its lowest.

Placenta—The organ that provides oxygen and nutrition from the mother to the fetus during pregnancy. The placenta is attached to the wall of the uterus and leads to the fetus via the umbilical cord.

Placental abruption—An abnormal separation of the placenta from the uterus before the birth of the baby, with subsequent heavy uterine bleeding. Normally, the baby is born first and then the placenta is delivered within a half hour.

Systolic—The phase of blood circulation in which the heart's pumping chambers (ventricles) are actively pumping blood. The ventricles are squeezing (contracting) forcefully, and the pressure against the walls of the arteries is at its highest.

Urine dipstick test—A test using a small, chemically treated strip that is dipped into a urine sample; when testing for protein, an area on the strip changes color depending on the amount of protein (if any) in the urine.

Uterus—The muscular organ that contains the developing baby during pregnancy.

Ventricles—The two chambers of the heart that are involved in pumping blood. The right ventricle pumps blood into the lungs to receive oxygen. The left ventricle pumps blood into the circulation of the body to deliver oxygen to all of the body's organs and tissues.

can be made on how to prevent these conditions. Research is being done with patients in high risk groups to see if calcium supplementation, **aspirin**, or fish oil supplementation may help prevent preeclampsia. Most importantly, it is clear that careful monitoring during pregnancy is necessary to diagnose preeclampsia early. Although even carefully monitored patients may develop preeclampsia and eclampsia, close monitoring by practitioners will help decrease the complications of these conditions.

Resources

BOOKS

Cunningham, F. Gary, et al. *Williams Obstetrics.* 20th ed. Stamford: Appleton & Lange, 1997.

Mabie, William C., and Baha M. Sibai. "Hypertensive States of Pregnancy." In *Current Obstetric and Gynecologic Diagnosis and Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Caritis, Steve, et al. "Low-Dose Aspirin to Prevent Preeclampsia in Women at High Risk." *The New England Journal of Medicine* 338, no. 11 (12 Mar. 1998): 701+.

Kirchner, Jeffrey T. "Calcium Supplementation and Prevention of Preeclampsia." *American Family Physician* 57, no. 4 (15 Feb. 1998): 791+.

Penny, J. A. "Blood Pressure Measurement in Severe Preeclampsia." *The Lancet* 349, no. 9064 (24 May 1997): 1518.

Pipkin, F. Broughton. "The Hypertensive Disorders of Pregnancy." *British Medical Journal* 311, no. 7005 (2 Sept. 1995): 609+.

Roberts, James M. "Prevention or Early Treatment of Preeclampsia." *The New England Journal of Medicine* 337, no. 2 (10 July 1997): 124+.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

Rosalyn Carson-DeWitt, MD

Pregnancy

Definition

The period from conception to birth. After the egg is fertilized by a sperm and then implanted in the lining of the uterus, it develops into the placenta and embryo, and later into a fetus. Pregnancy usually lasts 40 weeks, beginning from the first day of the woman's last menstrual period, and is divided into three trimesters, each lasting three months.

Description

Pregnancy is a state in which a woman carries a fertilized egg inside her body. Due to technological advances,

pregnancy is increasingly occurring among older women in the United States.

First month

At the end of the first month, the embryo is about a third of an inch long, and its head and trunk—plus the beginnings of arms and legs—have started to develop. The embryo receives nutrients and eliminates waste through the umbilical cord and placenta. By the end of the first month, the liver and digestive system begin to develop, and the heart starts to beat.

Second month

In this month, the heart starts to pump and the nervous system (including the brain and spinal cord) begins to develop. The 1 in (2.5 cm) long fetus has a complete cartilage skeleton, which is replaced by bone cells by month's end. Arms, legs and all of the major organs begin to appear. Facial features begin to form.

Third month

By now, the fetus has grown to 4 in (10 cm) and weighs a little more than an ounce (28 g). Now the major blood vessels and the roof of the mouth are almost completed, as the face starts to take on a more recognizably human appearance. Fingers and toes appear. All the major organs are now beginning to form; the kidneys are now functional and the four chambers of the heart are complete.

Fourth month

The fetus begins to kick and swallow, although most women still can't feel the baby move at this point. Now 4 oz (112 g), the fetus can hear and urinate, and has established sleep-wake cycles. All organs are now fully formed, although they will continue to grow for the next five months. The fetus has skin, eyebrows, and hair.

Fifth month

Now weighing up to a 1 lb (454 g) and measuring 8–12 in (20–30 cm), the fetus experiences rapid growth as its internal organs continue to grow. At this point, the mother may feel her baby move, and she can hear the heartbeat with a stethoscope.

Sixth month

Even though its lungs are not fully developed, a fetus born during this month can survive with intensive care. Weighing 1–1.5 lb (454–681 g), the fetus is red, wrinkly, and covered with fine hair all over its body. The fetus will grow very fast during this month as its organs continue to develop.

Seventh month

There is a better chance that a fetus born during this month will survive. The fetus continues to grow rapidly, and may weigh as much as 3 lb (1.3 kg) by now. Now the fetus can suck its thumb and look around its watery womb with open eyes.

Eighth month

Growth continues but slows down as the baby begins to take up most of the room inside the uterus. Now weighing 4–5 lbs (1.8–2.3 kg) and measuring 16–18 in (40–45 cm) long, the fetus may at this time prepare for delivery next month by moving into the head-down position.

Ninth month

Adding 0.5 lb (227 g) a week as the due date approaches, the fetus drops lower into the mother's abdomen and prepares for the onset of labor, which may begin any time between the 37th and 42nd week of gestation. Most healthy babies will weigh 6–9 lbs (2.7–4 kg) at birth, and will be about 20 in long.

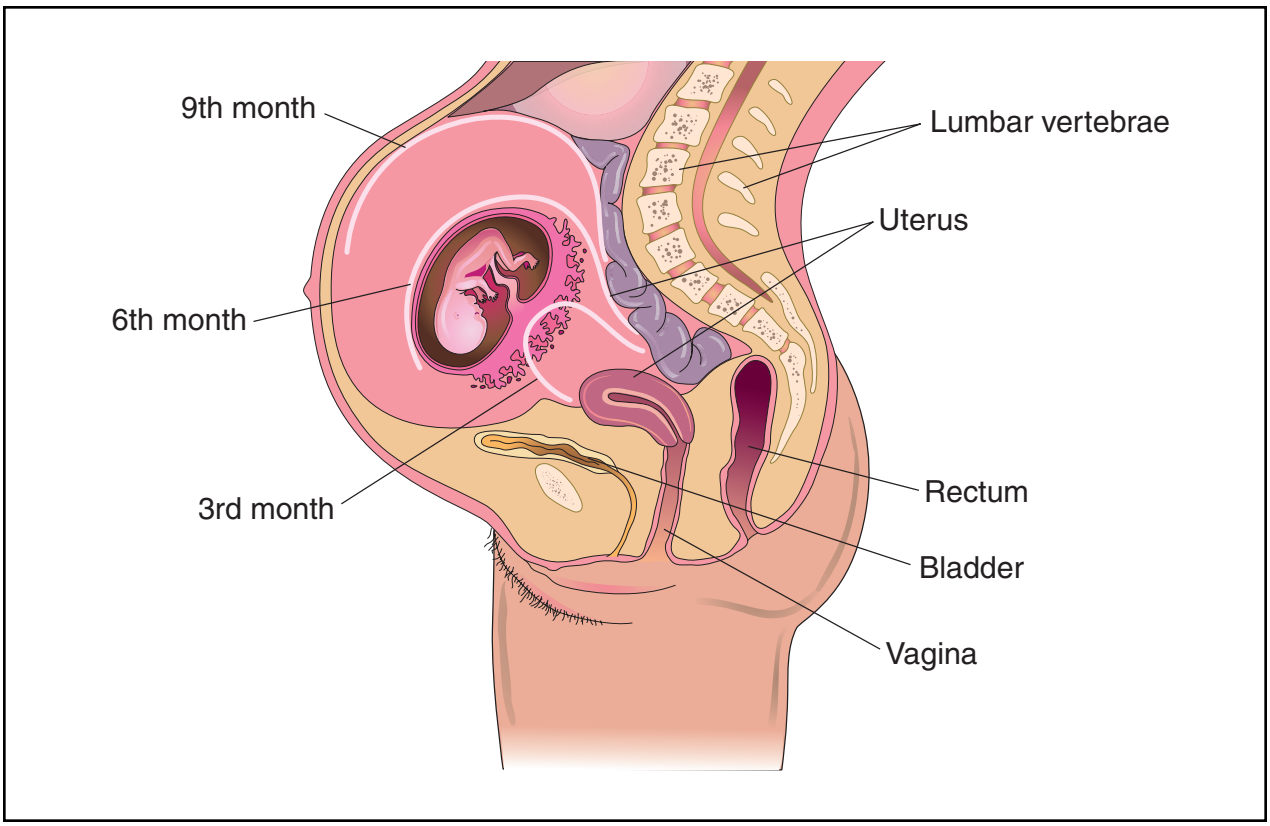
Causes and symptoms

The first sign of pregnancy is usually a missed menstrual period, although some women bleed in the beginning. A woman's breasts swell and may become tender as the mammary glands prepare for eventual breastfeeding. Nipples begin to enlarge and the veins over the surface of the breasts become more noticeable.

Nausea and vomiting are very common symptoms and are usually worse in the morning and during the first trimester of pregnancy. They are usually caused by hormonal changes, in particular, increased levels of progesterone. Women may feel worse when their stomach is empty, so it is a good idea to eat several small meals throughout the day, and to keep things like crackers on hand to eat even before getting out of bed in the morning.

Many women also feel extremely tired during the early weeks. Frequent urination is common, and there may be a creamy white discharge from the vagina. Some women crave certain foods, and an extreme sensitivity to smell may worsen the nausea. Weight begins to increase.

In the second trimester (13–28 weeks) a woman begins to look noticeably pregnant and the enlarged uterus is easy to feel. The nipples get bigger and darker, skin may darken, and some women may feel flushed and warm.



Pregnancy usually lasts 40 weeks in humans, beginning from the first day of the woman's last menstrual period, and is divided into three trimesters. The illustration above depicts the position of the developing fetus during each trimester. *(Illustration by Electronic Illustrators Group.)*

Appetite may increase. By the 22nd week, most women have felt the baby move. During the second trimester, nausea and vomiting often fade away, and the pregnant woman often feels much better and more energetic. Heart rate increases as does the volume of blood in the body.

By the third trimester (29–40 weeks), many women begin to experience a range of common symptoms. Stretch marks may develop on abdomen, breasts and thighs, and a dark line may appear from the navel to pubic hair. A thin fluid may be expressed from the nipples. Many women feel hot, sweat easily and often find it hard to get comfortable. Kicks from an active baby may cause sharp pains, and lower backaches are common. More rest is needed as the woman copes with the added **stress** of extra weight. Braxton Hicks contractions may get stronger.

At about the 36th week in a first pregnancy (later in repeat pregnancies), the baby's head drops down low into the pelvis. This may relieve pressure on the upper abdomen and the lungs, allowing a woman to breathe more easily. However, the new position places more pressure on the bladder.

A healthy gain for most women is between 25 and 35 pounds. Women who are overweight should gain less; and women who are underweight should gain more. On average, pregnant women need an additional 300 calories a day. Generally, women will gain three to five pounds in the first three months, adding one to two pounds a week until the baby is born. An average, healthy full-term baby at birth weighs 7.5 lb (3.4 kg), and the placenta and fluid together weigh another 3.5 lb. The remaining weight that a woman gains during pregnancy is mostly due to water retention and fat stores. Her breasts, for instance, gain about 2 lb. in weight, and she gains another 4 lb due to the increased blood volume of pregnancy.

In addition to the typical, common symptoms of pregnancy, some women experience other problems that may be annoying, but which usually disappear after delivery. **Constipation** may develop as a result of food passing more slowly through the intestine. **Hemorrhoids** and **heartburn** are fairly common during late pregnancy. Gums may become more sensitive and bleed more easily; eyes may dry out, making contact lenses feel painful. **Pica** (a craving to eat substances other than food) may occur. Swollen

ankles and **varicose veins** may be a problem in the second half of pregnancy, and chloasma may appear on the face.

Chloasma, also known as the "mask of pregnancy" or melasma, is caused by hormonal changes that result in blotches of pale brown skin appearing on the forehead, cheeks, and nose. These blotches may merge into one dark mask. It usually fades gradually after pregnancy, but it may become permanent or recur with subsequent pregnancies. Some women also find that the line running from the top to the bottom of their abdomen darkens. This is called the linea nigra.

While the above symptoms are all considered to be normal, there are some symptoms that could be a sign of a more dangerous underlying problem. A pregnant woman with any of the following signs should contact her doctor immediately:

- abdominal pain
- rupture of the amniotic sac or leaking of fluid from the vagina
- bleeding from the vagina
- no fetal movement for 24 hours (after the fifth month)
- continuous headaches
- marked, sudden swelling of eyelids, hands or face during the last three months
- dim or blurry vision during last three months
- persistent vomiting

Diagnosis

Many women first discover they are pregnant after a positive home pregnancy test. Pregnancy urine tests check for the presence of human chorionic gonadotropin (hCG), which is produced by a placenta. The newest home tests can detect pregnancy on the day of the missed menstrual period.

Home pregnancy tests are more than 97% accurate if the result is positive, and about 80% accurate if the result is negative. If the result is negative and there is no menstrual period within another week, the pregnancy test should be repeated. While home pregnancy tests are very accurate, they are less accurate than a pregnancy test conducted at a lab. For this reason, women may want to consider having a second pregnancy test conducted at their doctor's office to be sure of the accuracy of the result.

Blood tests to determine pregnancy are usually used only when a very early diagnosis of pregnancy is needed. This more expensive test, which also looks for hCG, can produce a result within nine to 12 days after conception.

Once pregnancy has been confirmed, there are a range of screening tests that can be done to screen for **birth defects**, which affect about 3% of unborn children. Two tests are recommended for all pregnant women: alpha-fetoprotein (AFP) and the triple marker test.

Other tests are recommended for women at higher risk for having a child with a birth defect. This would include women over age 35, who had another child or a close relative with a birth defect, or who have been exposed to certain drugs or high levels of radiation. Women with any of these risk factors may want to consider **amniocentesis**, **chorionic villus sampling** (CVS) or ultrasound.

Other prenatal tests

There are a range of other prenatal tests that are routinely performed, including:

- **PAP test**
- gestational diabetes screening test at 24–28 weeks
- tests for **sexually transmitted diseases**
- **urinalysis**
- blood tests for anemia or blood type
- screening for immunity to various diseases, such as German measles

Treatment

Prenatal care is vitally important for the health of the unborn baby. A pregnant woman should be sure to eat a balanced, nutritious diet of frequent, small meals. Women should begin taking 400 mcg of **folic acid** several months before becoming pregnant, as folic acid has been shown to reduce the risk of spinal cord defects, such as **spina bifida**.

No medication (not even a nonprescription drug) should be taken except under medical supervision, since it could pass from the mother through the placenta to the developing baby. Some drugs, called teratogens, have been proven harmful to a fetus, but no drug should be considered completely safe (especially during early pregnancy). Drugs taken during the first three months of a pregnancy may interfere with the normal formation of the baby's organs, leading to birth defects. Drugs taken later on in pregnancy may slow the baby's growth rate, or they may damage specific fetal tissue (such as the developing teeth), or cause preterm birth.

To have the best chance of having a healthy baby, a pregnant woman should avoid:

- smoking
- alcohol
- street drugs

KEY TERMS

Alpha-fetoprotein—A substance produced by a fetus's liver that can be found in the amniotic fluid and in the mother's blood. Abnormally high levels of this substance suggests there may be defects in the fetal neural tube, a structure that will include the brain and spinal cord when completely developed. Abnormally low levels suggest the possibility of Down syndrome.

Braxton Hicks contractions—Short, fairly painless uterine contractions during pregnancy that may be mistaken for labor pains. They allow the uterus to grow and help circulate blood through the uterine blood vessels.

Chloasma—A skin discoloration common during pregnancy, also known as the "mask of pregnancy" or melasma, in which blotches of pale brown skin appear on the face. It is usually caused by hormonal changes. The blotches may appear in the forehead, cheeks, and nose, and may merge into one dark mask. It usually fades gradually after pregnancy, but it may become permanent or recur with subsequent pregnancies. Some women may also find that the line running from the top to the bottom of their abdomen darkens. This is called the linea nigra.

Embryo—An unborn child during the first eight weeks of development following conception (fertilization with sperm). For the rest of pregnancy, the embryo is known as a fetus.

Fetus—An unborn child from the end of the eighth week after fertilization until birth.

Human chorionic gonadotropin (hCG)—A hormone produced by the placenta during pregnancy.

Placenta—The organ that develops in the uterus during pregnancy that links the blood supplies of the mother and baby.

Rhythm method—The oldest method of contraception with a very high failure rate, in which partners periodically refrain from having sex during ovulation. Ovulation is predicted on the basis of a woman's previous menstrual cycle.

Spina bifida—A congenital defect in which part of the vertebrae fail to develop completely, leaving a portion of the spinal cord exposed.

- large amounts of **caffeine**
- artificial sweeteners

Nutrition

Women should begin following a healthy diet even before they become pregnant. This means cutting back on high-calorie, high-fat, high-sugar snacks, and increasing the amount of fruits, vegetables and whole grains in her diet. Once she becomes pregnant, she should make sure to get at least six to 11 servings of breads and other whole grains, three to five servings of vegetables, two to four servings of fruits, four to six servings of milk and milk products, three to four servings of meat and protein foods, and six to eight glasses of water. She should limit caffeine to no more than one soft drink or cup of coffee per day.

Prognosis

Pregnancy is a natural condition that usually causes little discomfort provided the woman takes care of herself and gets adequate prenatal care. **Childbirth** education classes for the woman and her partner help prepare the couple for labor and delivery.

Prevention

There are many ways to avoid pregnancy. A woman has a choice of many methods of **contraception** which will prevent pregnancy, including (in order of least to most effective):

- spermicide alone
- natural (rhythm) method
- diaphragm or cap alone
- condom alone
- diaphragm with spermicide
- condom with spermicide
- intrauterine device (IUD)
- contraceptive pill
- sterilization (either a man or woman)
- avoiding intercourse

Resources

BOOKS

Brott, Armin, and Jennifer Ash. *The Expectant Father.* New York: Abbeville Press, 1995.

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.
Cunningham, F. Gary, et al. *Williams Obstetrics,* 20th ed. Stamford, CT: Appleton & Lange, 1997.
Eisenberg, Arlene, Heidi E. Murkoff, and Sandee E. Hathaway. *What to Expect When You're Expecting.* New York: Workman Publishing Co., 1995.
Johnson, Robert V. *Mayo Clinic Complete Book of Pregnancy and Baby's First Year.* New York: William Morrow and Co., Inc., 1994.
Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology,* 6th ed. St. Louis: Mosby, 1997.
Spencer, Paula. *The Parenting Guide to Pregnancy & Childbirth.* New York: Ballantine, 1998.

ORGANIZATION

National Institute of Child Health and Human Development. 9000 Rockville Pike, Bldg. 31, Rm. 2A32, Bethesda, MD 20892. (301) 496-5133.
Healthy Mothers, Healthy Babies National Coalition. 409 12th St., Washington, DC 20024. (202) 638-5577.
Positive Pregnancy and Parenting Fitness. 51 Saltrock Rd., Baltic, CT 06330. (203) 822-8573.

OTHER

Doulas of North America. <http://www.dona.com/>.
Planned Parenthood. <http://www.plannedparenthood.org/>.
Pregnancy Information. <http://www.childbirth.org/>.

Debra L. Gordon

Pregnancy-induced high blood pressure *see* **Preeclampsia and eclampsia**

Pregnancy test *see* **Human chorionic gonadotropin pregnancy test**

Preleukemia *see* **Myelodysplastic syndrome**

Premature atrial contractions *see* **Atrial ectopic beats**

Premature birth *see* **Prematurity**

Premature ejaculation

Definition

Premature ejaculation occurs when male sexual climax (orgasm) occurs before a man wishes it or too quickly during intercourse to satisfy his partner.

Description

Premature ejaculation is the most commonly reported sexual complaint of men and couples. The highest number of complaints is among teenage, young adult, and sexually inexperienced males. Increased risk is associated with sexual inexperience and lack of knowledge of normal male sexual responses.

Causes and symptoms

There are several reasons why a man may ejaculate prematurely. For some men, the cause is due to an innate reflex or psychological predisposition of the nervous system. Sometimes it can be caused by certain drugs, such as non-prescription cold medications. Psychological factors, such as **stress**, fear, or guilt can also play a role. Examples of psychological factors include guilt that the sexual activity is wrong or sinful, fear of getting caught, or stress from problems at work or home.

In general, symptoms are when a male reaches climax in less than two minutes or when it occurs before the male or couple want it to occur.

Diagnosis

There are no tests used to diagnose premature ejaculation. It is usually determined by the male involved based on his belief that he reached orgasm too quickly. General guidelines for premature ejaculation is if it occurs in two minutes or less, or prior to about 15 thrusts during sexual intercourse.

Treatment

In 1966, William H. Masters and Virginia E. Johnson published *Human Sexual Response,* in which they broke the first ground in approaching this topic from a new perspective. Their method was devised by Dr. James Seman and has been modified subsequently by Dr. Helen Singer Kaplan and others.

A competent and orthodox sex therapist will spend much more time focusing on the personal than the sexual relationship between the two people who come for treatment. Without emotional intimacy, sexual relations are superficial and sexual problems such as premature ejaculation are not always overcome.

With that foremost in mind, a careful plan is outlined that requires dedication, patience, and commitment by both partners. It necessarily begins by prohibiting intercourse for an extended period of time—at least a week, often a month. This is very important to the man because "performance anxiety" is the greatest enemy of performance. If he knows he cannot have intercourse he is able to relax and focus on the exercises. The first stage is called "sensate focus" and involves his concentration on the process of sexual arousal and climax. He should learn to recognize each step in the process, most particularly the moment just before the "point of no return." Ide-

ally, this stage of treatment requires the man's partner to be devoted to his sensations. In order to regain equality, he should in turn spend separate time stimulating and pleasing his mate, without intercourse.

At this point the techniques diverge. The original "squeeze technique" requires that the partner become expert at squeezing the head of the penis at intervals to prevent orgasm. The modified procedure, described by Dr. Ruth Westheimer, calls upon the man to instruct the partner when to stop stimulating him to give him a chance to draw back. A series of stages follows, each offering greater stimulation as the couple gains greater control over his arousal. This whole process has been called "outercourse." After a period of weeks, they will have together retrained his response and gained satisfactory control over it. In addition, they will each have learned much about the other's unique sexuality and ways to increase each other's pleasure.

With either technique, the emphasis is on the mutual goal of satisfactory sexual relations for both partners.

However, the 1990s ushered in a new era in the treatment of premature ejaculation when physicians discovered that certain antidepression drugs had a side effect of delaying ejaculation. Clinical studies have shown that a class of antidepressants called selective seratonin reuptake inhibitors (SSRIs) can be very effective in prolonging the time to ejaculation. The individual drugs and the average amount of time they delay ejaculation are fluoxetine (Prozac), one to two minutes with doses of 20-40 milligrams per day (mg/day) and eight minutes with 60 mg/day; paroxetine (Paxil), three to 10 minutes with doses of 20–40 mg/day; and sertraline (Zoloft), two to five minutes with doses of 50–200 mg/day.

Alternative treatment

There are several alternative products, usually found in health food and nutrition stores, designed to be sprayed or rubbed on the penis to delay ejaculation. Although the products promise results, there are no valid clinical studies to support the claims. A device called a testicular restraint, sold through erotic mail-order magazines, sometimes helps men delay ejaculation. The Velcro-like device restrains the testicles from their natural tendency to move during sex. Testicular movement can cause premature ejaculation.

Prognosis

The "squeeze technique" has elicited a 95% success rate, whereby the patient is able to control ejaculation. Treatment with SSRIs is effective in 85–90% of cases. However, the effectiveness begins to decrease after five weeks of daily administration. Although more studies are needed, this suggests the SSRIs are more effective when used on an as-needed basis.

Prevention

The best prevention is obtaining adequate information on normal sexual responses of males before having sex. It is also helpful to have sex in a comfortable, relaxed, private setting, free of guilt, stress, and fear.

Resources

BOOKS

Masters, William H., Virginia E. Johnson, and Robert C. Kolodny. *Heterosexuality*. New York: Harper Collins Publishers, Inc. 1994, pp. 101-135.

PERIODICALS

"Lengthen Your Fuse." *Men's Health* (November 1999): 56.

Holzapfel, Stephen. "The Physician's Role in Dealing With Men's Sexual Health Concerns." *The Canadian Journal of Human Sexuality* (Fall 1998): 273-274.

Rowland, David L. and Burnett, Arthur L. "Pharmacotherapy in the Treatment of Male Sexual Dysfunction." *The Journal of Sex Research* (August 2000): 226+.

ORGANIZATIONS

American Association for Marriage and Family Therapy. 1100 17th St. NW, 10th Floor, Washington, DC 20036. (202) 452-0109. <http://www.aamft.org>.

American Association of Sex Educators, Counselors, and Therapists. P.O. Box 5488, Richmond, VA 23220. <http://www.aasect.org>.

Sexuality Information and Education Council of the U.S. 130 W. 42nd St., Ste. 350, New York, NY 10036. (212) 819-9770. <http://www.siecus.org>.

Ken R. Wells

Premature labor

Definition

Premature labor is the term to describe contractions of the uterus that begin at 20–36 weeks of a **pregnancy**.

Description

The usual length of a human pregnancy is 38–42 weeks after the first day of the last menstrual period. Labor is a natural series of events that indicate that the birth process is starting. Premature labor is defined as contractions that occur after 20 weeks and before 37 weeks during the term of pregnancy. The baby is more likely to survive and be healthy if it remains in the uterus for the full term of the pregnancy. It is estimated that around 10% of births in the United States occur during

the premature period. Premature birth is the greatest cause of newborn illness and **death**. In the United States, **prematurity** has a greater impact on African-Americans.

Causes and symptoms

The causes of premature labor cannot always be determined. Some research suggests that infection of the urinary or reproductive tract may stimulate premature labor and premature births. Multiple pregnancies (twins, triplets, etc.) are more likely to result in to premature labor. **Smoking**, alcohol use, drug abuse, and poor **nutrition** can increase the risk of premature labor and birth. Adolescent mothers are also at higher risk for premature delivery. Women whose mothers took diethylstilbestrol (DES) when they carried them are more likely to deliver prematurely, as are women who have had previous surgery on the cervix.

The symptoms of premature labor can include contractions of the uterus or tightening of the abdomen, which occurs every ten minutes or more frequently. These contractions usually increase in frequency, duration, and intensity, and may or may not be painful. Other symptoms associated with premature labor can include menstrual-like cramps, abdominal cramping with or without **diarrhea**, pressure or **pain** in the pelvic region, low backache, or a change in the color or amount of vaginal discharge. As labor progresses, the cervix or opening of the uterus will open (dilate) and the tissue around it will become thinner (efface). **Premature rupture of membranes** (when the water breaks) may also occur.

An occasional contraction can occur anytime during the pregnancy and does not necessarily indicate that labor is starting. Premature contractions are sometimes confused with Braxton Hicks contractions, which can occur throughout the pregnancy. Braxton Hicks contractions do not cause the cervix to open or efface, and are considered "false labor."

Diagnosis

The health care provider will conduct a **physical examination** and ask about the timing and intensity of the contractions. A vaginal examination is the only way to determine if the cervix has started to dilate or efface. Urine and blood samples may be collected to screen for infection. A vaginal culture (a cotton-tipped swab is used to collect some fluid and cells from the vagina) may be done to look for a vaginal infection. A fetal heart monitor may be placed on the mother's abdomen to record the heartbeat of the fetus and to time the contractions. A fetal ultrasound may be performed to determine the age and weight of the fetus, the condition of the placenta, and to see if there is more than one fetus present. **Amniocentesis** will sometimes be performed. This is a procedure where a needle-like tube is inserted through the mother's abdomen to draw out some of the fluid surrounding the fetus. Analysis of the amniotic fluid can determine if the baby's lungs are mature. A baby with mature lungs is much more likely to survive outside the uterus.

Treatment

The goal of treatment is to stop the premature labor and prevent the fetus from being delivered before it is full term. A first recommendation may be for the woman with premature contractions to lie down with feet elevated and to drink juice or other fluids. If contractions continue or increase, medical attention should be sought. In addition to bed rest, medical care may include intravenous fluids. Sometimes, this extra fluid is enough to stop contractions. In some cases, oral or injectable drugs like terbutaline sulfate, ritodrine, magnesium sulfate, or nifedipine must be given to stop the contractions. These are generally very effective; however, as with any drug therapy, there are risks of side effects. Some women may need to continue on medication for the duration of the pregnancy. **Antibiotics** may be prescribed if a vaginal or urinary tract infection is detected. If the membranes have already ruptured, it may be difficult or impossible to stop premature labor. If infection of the membranes that cover the fetus (chorioamnionitis) develops, the baby must be delivered.

Prognosis

If premature labor is managed successfully, the pregnancy may continue normally for the delivery of a healthy infant. Once symptoms of preterm labor occur during the pregnancy, the mother and fetus need to be monitored regularly since it is likely that premature labor will occur again. If the preterm labor cannot be stopped or controlled, the infant will be delivered prematurely. These infants that are born prematurely have an increased risk of health problems including **birth defects**, lung problems, **mental retardation**, blindness, deafness, and developmental disabilities. If the infant is born too early, its body systems may not be mature enough for it to survive. Evaluating the infant's lung maturity is one of the keys to determining its chance of survival. Fetuses delivered further into pregnancy and those with more mature lungs are more likely to survive.

Prevention

Smoking, poor nutrition, and drug or alcohol abuse can increase the risk of premature labor and early delivery. Smoking and drug or alcohol use should be stopped. A healthy diet and prenatal vitamin supplements (prescribed by the health care provider) are important for the growth of the fetus and the health of the mother. Pregnant women are advised to see a health care provider early in the pregnancy

KEY TERMS

Braxton Hicks contractions—Tightening of the uterus or abdomen that can occur throughout pregnancy. These contractions do not cause changes to the cervix and are sometimes called false labor or practice contractions.

Cervix —The opening at the bottom of the uterus, which dilates or opens in order for the fetus to pass into the vagina or birth canal during the delivery process.

Contraction—A tightening of the uterus during pregnancy. Contractions may or may not be painful and may or may not indicate labor.

and receive regular prenatal examinations throughout the pregnancy. The health care provider should be informed of any medications that the mother is receiving and any health conditions that exist before and during the pregnancy.

Resources

BOOKS

Berkow, Robert, et al., eds. *Merck Manual of Diagnosis and Therapy.* 16th ed. Merck Research Laboratories, 1992.

PERIODICALS

Guinn D. A., et al. "Management Options in Women with Preterm Uterine Contractions: A Randomized Clinical Trial." *American Journal of Obstetrics and Gynecology* 177 (Oct. 1997): 814-818.

Hueston, W. J. "Variations Between Family Physicians and Obstetricians in the Evaluation and Treatment of Preterm Labor." *Journal of Family Practice* 45 (Oct. 1997): 336-340.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

OTHER

"Am I in Labor?" *The Virtual Hospital Page*. University of Iowa. <http://www.vh.org>.

Altha Roberts Edgren

Premature menopause

Definition

The average age at which American women go through **menopause** is 51 years. If menopause (hormonal changes at the end of the female reproductive years) occurs before age 40, it is said to be premature menopause. Possible causes include autoimmune problems and common **cancer** treatments.

Description

About half of all women will go through menopause before age 51 and the rest will go through it after. Most women will finish menopause between the ages of 42 and 58. A small number of women will find that their periods stop prematurely, before age 40.

Causes and symptoms

There are many possible causes of premature menopause. Women who have premature menopause often have **autoimmune disorders** like thyroid disease or **diabetes mellitus**. In these diseases, the body produces antibodies to one or more of its own organs. These antibodies interfere with the normal function of the organ. Just as antibodies might attack the thyroid or the pancreas (causing thyroid disease or diabetes), antibodies may attack the ovaries and stop the production of female hormones.

Cancer treatments like **chemotherapy** or radiation can cause premature menopause. The risk depends on the type and length of treatment and the age of the woman when she first begins radiation or chemotherapy.

If the ovaries are surgically removed (during a **hysterectomy**, for example) menopause will occur within a few days, no matter how old the woman is.

The symptoms of premature menopause are similar to those of menopause at any time. Menstrual periods stop and women may notice hot flashes, vaginal dryness, mood swings, and sleep problems. Sometimes the first symptom of premature menopause is **infertility**. A woman may find that she cannot become pregnant because she is not ovulating (producing eggs) anymore.

When menopause occurs after the ovaries are surgically removed, the symptoms begin within several days after surgery and tend to be more severe. This happens because the drop in the level of estrogen is dramatic, unlike the gradual drop that usually occurs.

Diagnosis

Premature menopause can be confirmed by blood tests to measure the levels of follicle stimulating hormone (FSH) and luteinizing hormone (LH). The levels of these hormones will be higher if menopause has occurred.

Because premature menopause is often associated with other hormonal problems, women who have prema-

KEY TERMS

Autoimmune diseases—Diseases in which the body creates antibodies that attack one of its own organs.

Follicle stimulating hormone (FSH) —A female hormone that regulates ovulation and menstruation.

Hormone replacement therapy (HRT)—Replacement of estrogen and progesterone lost by women who have gone through menopause. Hormone replacement therapy has been shown to lower the risk of osteoporosis and heart disease in elderly women.

Luteinizing hormone (LH) —A female hormone that regulates ovulation and menstruation.

Menopause—The end of a woman's reproductive years. The hormonal changes that accompany menopause include the hot flashes, vaginal dryness, mood swings, sleep problems, and the end of menstrual periods. Commonly known as "the change" or "the change of life."

ture menopause should be screened for diabetes, thyroid disease, and similar diseases.

Treatment

There is no treatment to reverse premature menopause. **Hormone replacement therapy** (HRT) can prevent the common symptoms of menopause and lower the long-term risk of **osteoporosis**. Women who have premature menopause should take HRT. Estrogen relieves the unpleasant symptoms of menopause, including the hot flashes and the vaginal dryness. Estrogen is especially important for women who go through premature menopause. The long-term health risks of menopause (osteoporosis and increased risk of heart disease) are even more likely to occur after premature menopause. However, women who have certain medical conditions (like liver disease, uterine cancer, or **breast cancer**) may not be candidates for estrogen.

If a woman still has her uterus after premature menopause, she will also need to take progesterone along with the estrogen. If her uterus has been removed, estrogen alone will be enough.

Women who wish to become pregnant after premature menopause now have the option of fertility treatments using donor eggs. This is similar to **in vitro fertilization**, but the eggs come from a donor instead of the woman who is trying to become pregnant.

Prevention

Premature menopause cannot be prevented.

Resources

BOOKS

Hall, Janet E. "Amenorrhea." In *Primary Care of Women*, ed. Karen J. Carlson and Stephanie A. Eisenstat. St. Louis: Mosby-Year Book, Inc., 1995.

Martin, Kathryn A. "Menopause and Estrogen Replacement Therapy." In *Primary Care of Women*, ed. Karen J. Carlson and Stephanie A. Eisenstat. St. Louis: Mosby-Year Book, Inc., 1995.

Amy B. Tuteur, MD

Premature rupture of membranes

Definition

Premature rupture of membranes (PROM) is an event that occurs during **pregnancy** when the sac containing the developing baby (fetus) and the amniotic fluid bursts or develops a hole prior to the start of labor.

Description

During pregnancy, the unborn baby (fetus) is surrounded and cushioned by a liquid called amniotic fluid. This fluid, along with the fetus and the placenta, is enclosed within a sac called the amniotic membrane. The amniotic fluid is important for several reasons. It cushions and protects the fetus, allowing the fetus to move freely. The amniotic fluid also allows the umbilical cord to float, preventing it from being compressed and cutting off the fetus's supply of oxygen and nutrients. The amniotic membrane contains the amniotic fluid and protects the fetal environment from the outside world. This barrier protects the fetus from organisms (like bacteria or viruses) that could travel up the vagina and potentially cause infection.

Although the fetus is almost always mature at 36–40 weeks and can be born without complication, a normal pregnancy lasts an average of 40 weeks. At the end of 40 weeks, the pregnancy is referred to as being "term." At term, labor usually begins. During labor, the muscles of the uterus contract repeatedly. This allows the cervix to begin to grow thinner (called effacement) and more open (dilatation). Eventually, the cervix will become completely effaced and dilated. In the most common

sequence of events (about 90% of all deliveries), the amniotic membrane breaks (ruptures) around this time. The baby then leaves the uterus and enters the birth canal. Ultimately, the baby will be delivered out of the mother's vagina. In the 30 minutes after the birth of the baby, the placenta should separate from the wall of the uterus and be delivered out of the vagina.

Sometimes the membranes burst before the start of labor, and this is called premature rupture of membranes (PROM). There are two types of PROM. One occurs at a point in pregnancy before normal labor and delivery should take place. This is called preterm PROM. The other type of PROM occurs at 36–40 weeks of pregnancy.

PROM occurs in about 10% of all pregnancies. Only about 20% of these cases are preterm PROM. Preterm PROM is responsible for about 34% of all premature births.

Causes and symptoms

The causes of PROM have not been clearly identified. Some risk factors include **smoking**, multiple pregnancies (twins, triplets, etc.), and excess amniotic fluid (polyhydramnios). Certain procedures carry an increased risk of PROM, including **amniocentesis** (a diagnostic test involving extraction and examination of amniotic fluid) and cervical cerclage (a procedure in which the uterus is sewn shut to avoid **premature labor**). A condition called **placental abruption** is also associated with PROM, although it is not known which condition occurs first. In some cases of preterm PROM, it is believed that bacterial infection of the amniotic membrane causes it to weaken and then break. However, most cases of PROM and infection occur in the opposite order, with PROM occurring first followed by an infection.

The main symptom of PROM is fluid leaking from the vagina. It may be a sudden, large gush of fluid, or it may be a slow, constant trickle of fluid. The complications that may follow PROM include premature labor and delivery of the fetus, infections of the mother and/or the fetus, and compression of the umbilical cord (leading to oxygen deprivation in the fetus).

Labor almost always follows PROM, although the delay between PROM and the onset of labor varies. When PROM occurs at term, labor almost always begins within 24 hours. Earlier in pregnancy, labor can be delayed up to a week or more after PROM. The chance of infection increases as the time between PROM and labor increases. While this may cause doctors to encourage labor in the patient who has reached term, the risk of complications in a premature infant may cause doctors to try delaying labor and delivery in the case of preterm PROM.

The types of infections that can complicate PROM include amnionitis and endometritis. Amnionitis is an infection of the amniotic membrane. Endometritis is an infection of the innermost lining of the uterus. Amnionitis occurs in 0.5–1% of all pregnancies. In the case of PROM at term, amnionitis complicates about 3–15% of pregnancies. About 15–23% of all cases of preterm PROM will be complicated by amnionitis. The presence of amnionitis puts the fetus at great risk of developing an overwhelming infection (**sepsis**) circulating throughout its bloodstream. Preterm babies are the most susceptible to this life-threatening infection. One type of bacteria responsible for overwhelming infections in newborn babies is called group B streptococci.

Diagnosis

Depending on the amount of amniotic fluid leaking from the vagina, diagnosing PROM may be easy. Some doctors note that amniotic fluid has a very characteristic musty smell. A **pelvic exam** using a sterile medical instrument (speculum) may reveal a trickle of amniotic fluid leaving the cervix, or a pool of amniotic fluid collected behind the cervix. One of two easy tests can be performed to confirm that the liquid is amniotic fluid. A drop of the fluid can be placed on nitrazine paper. Nitrazine paper is made so that it turns from yellowish green to dark blue when it comes in contact with amniotic fluid. Another test involves smearing a little of the fluid on a slide, allowing it to dry, and then viewing it under a microscope. When viewed under the microscope, dried amniotic fluid will be easy to identify because it will look "feathery" like a fern.

Once PROM has been diagnosed, efforts are made to accurately determine the age of the fetus and the maturity of its lungs. Premature babies are at great risk if they have immature lungs. These evaluations can be made using amniocentesis and ultrasound measurements of the fetus' size. Amniocentesis also allows the practitioner to check for infection. Other indications of infection include a **fever** in the mother, increased heart rate of the mother and/or the fetus, high white blood cell count in the mother, foul smelling or pus-filled discharge from the vagina, and a tender uterus.

Treatment

Treatment of PROM depends on the stage of the patient's pregnancy. In PROM occurring at term, the mother and baby will be watched closely for the first 24 hours to see if labor will begin naturally. If no labor begins after 24 hours, most doctors will use medications to start labor. This is called inducing labor. Labor is induced to avoid a prolonged gap between

PROM and delivery because of the increased risk of infection.

Preterm PROM presents more difficult treatment decisions. The younger the fetus, the more likely it may die or suffer serious permanent damage if delivered prematurely. Yet the risk of infection to the mother and/or the fetus increases as the length of time from PROM to delivery increases. Depending on the age of the fetus and signs of infection, the doctor must decide either to try to prevent labor and delivery until the fetus is more mature, or to induce labor and prepare to treat the complications of **prematurity**. However, the baby will need to be delivered to avoid serious risks to both it and the mother if infection is present, regardless of the risks of prematurity.

A variety of medications may be used in PROM:

- Medication to induce labor (oxytocin) may be used, either in the case of PROM occurring at term or in the case of preterm PROM and infection.
- Tocolytics may be given to halt or prevent the start of labor. These may be used in the case of preterm PROM, when there are no signs of infection. Delaying the start of labor may give the fetus time to develop more mature lungs.
- Steroids may be used to help the fetus' lungs mature early. Steroids may be given in preterm PROM if the fetus must be delivered early because of infection or labor that cannot be stopped.
- **Antibiotics** can be given to fight infections. Research is being done to determine whether antibiotics should be given prior to any symptoms of infection to avoid the development of infection.

Prognosis

The prognosis in PROM varies. It depends in large part on the maturity of the fetus and the development of infection.

Prevention

The only controllable factor associated with PROM is smoking. Cigarette smoking should always be discontinued during a pregnancy.

Resources

BOOKS

Garite, Thomas J., and William N. Spellacy. "Premature Rupture of Membranes." In *Danforth's Obstetrics and Gynecology*, ed. James R. Scott, et al. Philadelphia: Lippincott Co., 1994.

KEY TERMS

Amniocentesis—A medical procedure during which a long, thin needle is inserted through the abdominal and uterine walls, and into the amniotic sac. A sample of amniotic fluid is withdrawn through the needle for examination.

Amniotic fluid—The fluid within the amniotic sac; the fluid surrounds, cushions, and protects the fetus.

Amniotic membrane—The thin tissue that creates the walls of the amniotic sac.

Cervical cerclage—A procedure in which the cervix is sewn closed; used in cases when the cervix starts to dilate too early in a pregnancy to allow the birth of a healthy baby.

Placenta—The organ that provides oxygen and nutrition from the mother to the fetus during pregnancy. The placenta is attached to the wall of the uterus, and leads to the fetus via the umbilical cord.

Pernoll, Martin L. "Premature Rupture of Membranes." In *Current Obstetric and Gynecologic Diagnosis and Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Hannah, Mary E., et al. "Induction of Labor Compared with Expectant Management for Prelabor Rupture of the Membrane at Term." *The New England Journal of Medicine*, 334, no. 16 (18 Apr. 1996): 1005+.

Hannah, Mary E., et al. "Maternal Colonization with Group B Streptococcus and Prelabor Rupture of Membranes." *American Journal of Obstetrics and Gynecology* 177 (Oct. 1997): 780+.

Parry, Samuel, and Jerome F. Strauss III. "Premature Rupture of the Fetal Membranes: Mechanisms of Disease." *The New England Journal of Medicine* 338, no. 10 (5 Mar. 1998): 663+.

Walling, Anne D. "Corticosteroids and Antibiotics for Management of PROM." *American Family Physician* 55, no. 5 (Apr. 1997): 1960.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

Rosalyn Carson-DeWitt, MD

Premature ventricular contractions *see* **Ventricular ectopic beats**

Prematurity

Definition

The length of a normal **pregnancy** or gestation is considered to be 40 weeks (280 days) from the date of conception. Infants born before 37 weeks gestation are considered premature and may be at risk for complications.

Description

More than one out of every ten infants born in the United States is born prematurely. Advances in medical technology have made it possible for infants born as young as 23 weeks gestational age (17 weeks premature) to survive. These premature infants, however, are at higher risk for **death** or serious complications, which include heart defects, respiratory problems, blindness, and brain damage.

Causes and symptoms

The birth of a premature baby can be brought on by several different factors, including **premature labor**; **placental abruption**, in which the placenta detaches from the uterus; **placenta previa**, in which the placenta grows too low in the uterus; **premature rupture of membranes**, in which the amniotic sac is torn, causing the amniotic fluid to leak out; **incompetent cervix**, in which the opening to the uterus opens too soon; and maternal toxemia, or blood **poisoning**. While one of these conditions are often the immediate reason for a premature birth, its underlying cause is usually unknown. Prematurity is much more common in **multiple pregnancy** and for mothers who have a history of miscarriages or who have given birth to a premature infant in the past. One of the few, and most important, identifiable causes of prematurity is drug abuse, particularly **cocaine**, by the mother.

Infants born prematurely may experience major complications due to their low birth weight and the immaturity of their body systems. Some of the common problems among premature infants are **jaundice** (yellow discoloration of the skin and whites of the eyes), apnea (a long pause in breathing), and inability to breast or bottle feed. Body temperature, blood pressure, and heart rate may be difficult to regulate in premature infants. The lungs, digestive system, and nervous system (including the brain) are underdeveloped in premature babies, and are particularly vulnerable to complications. Some of the more common risks and complications of prematurity are described below.

Respiratory distress syndrome (RDS) is the most common problem seen in premature infants. Babies born too soon have immature lungs that have not developed surfactant, a protective film that helps air sacs in the lungs to stay open. With RDS, breathing is rapid and the center of the chest and rib cage pull inward with each breath. Extra oxygen can be supplied to the infant through tubes that fit into the nostrils of the nose, or by placing the baby under an oxygen hood. In more serious cases, the baby may have to have a breathing tube inserted and receive air from a respirator or ventilator. A surfactant drug can be given in some cases to coat the lung tissue. Extra oxygen may be need for a few days or weeks, depending on how small and premature the baby was at birth. Bronchopulmonary dysplasia is the development of scar tissue in the lungs, and can occur in severe cases of RDS.

Necrotizing enterocolitis (NEC) is a further complication of prematurity. In this condition, part of the baby's intestines are destroyed as a result of bacterial infection. In cases where only the innermost lining of the bowel dies, the infant's body can regenerate it over time; however, if the full thickness of a portion dies, it must be removed surgically and an opening (ostemy) must be made for the passage of wastes until the infant is healthy enough for the remaining ends to be sewn together. Because NEC is potentially fatal, doctors are quick to respond to its symptoms, which include lethargy, vomiting, a swollen and/or red abdomen, **fever**, and blood in the stool. Measures include taking the infant off mouth feedings and feeding him or her intravenously; administering **antibiotics**; and removing air and fluids from the digestive tract via a nasal tube. Approximately 70% of NEC cases can be successfully treated without surgery.

Intraventricular hemorrhage (IVH) is another serious complication of prematurity. It is a condition in which immature and fragile blood vessels within the brain burst and bleed into the hollow chambers (ventricles) normally reserved for cerebrospinal fluid and into the tissue surrounding them. Physicians grade the severity of IVH according to a scale of I–IV, with I being bleeding confined to a small area around the burst vessels and IV being an extensive collection of blood not only in the ventricles, but in the brain tissue itself. Grades I and II are not uncommon, and the baby's body usually reabsorbs the blood with no ill effects. However, more severe IVH can result in **hydrocephalus**, a potentially fatal condition in which too much fluid collects in the ventricles, exerting increased pressure on the brain and causing the baby's head to expand abnormally. To drain fluid and relieve pressure on the brain, doctors will either perform lumbar punctures, a procedure in which a needle is inserted into the spinal canal to drain fluids; install a reservoir, a tube that drains fluid from a ventricle and into an artificial chamber under or on top of the scalp; or install a **ventricular shunt**, a tube that drains fluid from the ventricles and into the abdomen, where it is reab-

sorbed by the body. Infants who are at high risk for IVH usually have an ultrasound taken of their brain in the first week after birth, followed by others if bleeding is detected. IVH cannot be prevented; however, close monitoring can ensure that procedures to reduce fluid in the brain are implemented quickly to minimize possible damage.

Apnea of prematurity is a condition in which the infant stops breathing for periods lasting up to 20 seconds. It is often associated with a slowing of the heart rate. The baby may become pale, or the skin color may change to a blue or purplish hue. Apnea occurs most commonly when the infant is asleep. Infants with serious apnea may need medications to stimulate breathing or oxygen through a tube inserted in the nose. Some infants may be placed on a ventilator or respirator with a breathing tube inserted into the airway. As the baby gets older, and the lungs and brain tissues mature, the breathing usually becomes more regular.

As the fetus develops, it receives the oxygen it needs from the mother's blood system. Most of the blood in the infant's system bypasses the lungs. Once the baby is born, its own blood must start pumping through the lungs to get oxygen. Normally, this bypass duct closes within the first few hours or days after birth. If it does not close, the baby may have trouble getting enough oxygen on its own. **Patent ductus arteriosus** is a condition in which the duct that channels blood between two main arteries does not close after the baby is born. In some cases, a drug, indomethacin, can be given to close the duct. Surgery may be required if the duct does not close on its own as the baby develops.

Retinopathy of prematurity is a condition in which the blood vessels in the baby's eyes do not develop normally, and can, in some cases, result in blindness. Premature infants are also more susceptible to infections. They are born with fewer antibodies, which are necessary to fight off infections.

Diagnosis

Many of the problems associated with prematurity depend on how early the baby is born and how much it weighs at birth. The most accurate way of determining the gestational age of an infant in utero is calculating from a known date of conception or using ultrasound imaging to observe development. When a baby is born, doctors can use the Dubowitz exam to estimate gestational age. This standardized test scores responses to 33 specific neurological stimuli to estimate the infant's neural development. Once the baby's gestational age and weight are determined, further tests and **electronic fetal monitoring** may need to be used to diagnose problems or to track the baby's condition. A blood pressure monitor may be wrapped around the arm or leg. Several types of monitors can be taped to the skin. A heart monitor or cardiorespiratory monitor may be attached to the baby's chest, abdomen, arms, or legs with adhesive patches to monitor breathing and heart rate. A thermometer probe may be taped on the skin to monitor body temperature. Blood samples may be taken from a vein or artery. X rays or ultrasound imaging may be used to examine the heart, lungs, and other internal organs.

Treatment

Treatment depends on the types of complications that are present. It is not unusual for a premature infant to be placed in a heat-controlled unit (an incubator) to maintain its body temperature. Infants that are having trouble breathing on their own may need oxygen either pumped into the incubator, administered through small tubes placed in their nostrils, or through a respirator or ventilator, which pumps air into a breathing tube inserted into the airway. The infant may require fluids and nutrients to be administered through an intravenous line, in which a small needle is inserted into a vein in the hand, foot, arm, leg, or scalp. If the baby needs drugs or medications, they may also be administered through the intravenous line. Another type of line may be inserted into the baby's umbilical cord. This can be used to draw blood samples or to administer medications or nutrients. If heart rate is irregular, the baby may have heart monitor leads taped to the chest. Many premature infants require time and support with breathing and feeding until they mature enough to breathe and eat unassisted. Depending on the complications, the baby may require drugs or surgery.

Prognosis

Advances in medical care have made it possible for many premature infants to survive and develop normally. However, whether or not a premature infant will survive is still intimately tied to his or her gestational age:

- 21 weeks or less: 0% survival rate
- 22 weeks: 0–10% survival rate
- 23 weeks: 10–35% survival rate
- 24 weeks: 40–70% survival rate
- 25 weeks: 50–80% survival rate
- 26 weeks: 80–90% survival rate
- 27 weeks: greater than 90% survival rate

Physicians cannot predict long-term complications of prematurity and some consequences may not become evident until the child is school-aged. Minor disabilities like learning problems, poor coordination, or short

KEY TERMS

Apnea—A long pause in breathing.

Dubowitz exam—Standardized test that scores responses to 33 specific neurological stimuli to estimate an infant's neural development and, hence, gestational age.

Intraventricular hemorrhage (IVH)—A condition in which blood vessels within the brain burst and bleed into the hollow chambers (ventricles) normally reserved for cerebrospinal fluid and into the tissue surrounding them.

Jaundice —Yellow discoloration of skin and whites of the eyes that results from excess bilirubin in the body's system.

Necrotizing enterocolitis (NEC)—A condition in which part of the intestines are destroyed as a result of bacterial infection.

Respiratory distress syndrome (RDS)—Condition in which a premature infant with immature lungs does not develop surfacant, a protective film that helps air sacs in the lungs to stay open. The most common problem seen in premature infants.

Retinopathy of prematurity—A condition in which the blood vessels in a premature infant's eyes do not develop normally, and can, in some cases, result in blindness.

Surfactant—A protective film that helps air sacs in the lungs to stay open. Premature infants may not have developed this protective layer before birth and are more susceptible to respiratory problems without it. Some surfactant drugs are available. These can be given through a respirator and will coat the lungs when the baby breathes the drug in.

attention span may be the result of premature birth, but can be overcome with early intervention. The risks of serious long term complications depend on many factors including how premature the infant was at birth, weight at birth, and the presence or absence of breathing problems. The development of infection or the presence of a birth defect can also affect long term prognosis. Severe disabilities like brain damage, blindness, and chronic lung problems are possible and may require ongoing care.

Prevention

Some of the risks and complications of premature delivery can be reduced if the mother receives good prenatal care, follows a healthy diet, avoids alcohol consumption, and refrains from cigarette **smoking**. In some cases of premature labor, the mother may be placed on bed rest or given drugs that can stop labor contractions for days or weeks, giving the developing infant more time to develop before delivery. The physician may prescribe a steroid medication to be given to the mother before the delivery to help speed up the baby's lung development. The availability of neonatal intensive care unit, a special hospital unit equipped and trained to deal with premature infants, can also increase the chances of survival.

Resources

PERIODICALS

O'Shea, T. Michael, et al. "Survival and Developmental Disability in Infants with Birth Weights of 501 to 800 grams, Born between 1979 and 1994." *Pediatrics* 100 (Dec. 1997): 982-986.

Trachtenbarg, D. E., and T. C. Miller. "Office Care of the Small, Premature Infant." *Primary Care* 22 (Mar. 1995): 1-21.

OTHER

Brazy, J. E. *For Parents of Preemies*. <http://www2.medsch.wisc.edu/childrenshosp/parents_of_preemies/index.html>.

Levison, Donna. "When Is It Too Early? A Guide to Help Prevent Premature Birth." *Health Net*. <http://www.healthnet.com/preme.htm>.

"Survival of Extremely Premature Babies." *Dr. Plain Talk Health Care Information*. <http://www.drplaintalk.org>.

Altha Roberts Edgren

Premenstrual dysphoric disorder

Definition

Premenstrual dysphoric disorder (PMDD) is a collection of physical and emotional symptoms that occurs 5 to 11 days before a woman's period begins, and goes away once menstruation starts. The most severe form of premenstrual syndrome (PMS) is PMDD.

Description

PMS is estimated to affect 70–90% of women of childbearing age. The more severe form of the disorder,

PMDD, affects 3–5% of women of childbearing age. Up to 40% of women have PMDD symptoms that are so severe they interfere with their daily activities. It is more common in women in their late 20s and early 40s, who have at least one child and a history of depression, anxiety/tension, affective lability, or irritability/anger.

Causes and symptoms

Although the actual cause of PMDD is not known, it is believed to be related to hormonal changes that occur before menstruation. There are more than 150 signs and symptoms attributed to PMDD, and every woman experiences different ones at different times. There seem to be socioeconomic and genetic factors that precipitate PMDD. Twin studies have demonstrated a positive correlation with heritability and PMDD symptoms. Anti-anxiety medications have been shown to help improve symptoms associated with PMDD. The most common symptoms include **headache**, swelling of ankles, feet, and hands, backache, abdominal cramps, heaviness or **pain**, bloating and/or gas, muscle spasms, breast tenderness, weight gain, recurrent cold sores, **acne**, nausea, **constipation** or **diarrhea**, food cravings, **anxiety** or panic, confusion, difficulty concentrating and forgetfulness, poor judgment, and depression.

Diagnosis

PMDD is diagnosed when symptoms occur during the second half of the menstrual cycle (14 days or more after the first day of a woman's period), are absent for about seven days after the period ends, increase in severity as the cycle progresses, go away when the menstrual flow begins or shortly thereafter, and occur for at least three consecutive menstrual cycles. There are no tests to diagnose it. The diagnosis of PMDD emphasizes and requires psychologically important mood symptoms.

Treatment

Recently, the Food and Drug Administration approved the first prescription drug for the treatment of PMDD, Serafem (fluoxetine). Additionally, **nonsteroidal anti-inflammatory drugs**, such as ibuprofen and **aspirin**, may help with bloating and pain; beta-blockers may help with migraines; anti-anxiety medications, such as buspirone or alpraxolam, may help with anxiety; and certain other antidepressants in addition to Serafem may help with depression.

Alternative treatment

Non-pharmaceutical treatments include a variety of lifestyle changes, such as following a healthy diet, **exercise**, **stress** relief therapies, and even such alternative therapies as **aromatherapy**. Certain **vitamins** and supplements may also help, such as vitamin B_6, calcium, magnesium, and vitamin E. Certain herbs may also help with symptom relief, including vitex, black cohosh, valerian, kava kava, and **St. John's wort**.

KEY TERMS

Antidepressant—A medication used to relieve the symptoms of clinical depression.

Beta blockers—Class of drug, including Corgard (nadolol), and Lanoxin (digoxin), that primarily work by blunting the action of adrenaline, the body's natural fight-or-flight chemical.

Nonsteroidal anti-inflammatory drugs—This class of drugs includes aspirin and ibuprofen, and primarily works by interfering with the formation of prostaglandins, enzymes implicated in pain and inflammation.

Prognosis

The prognosis varies for each woman, and is largely dependent on how much work she is willing to do in terms of lifestyle changes. Additionally, planning for PMDD symptoms, joining a support group, and communicating with her spouse and family can help minimize the negative effects of PMDD and its impact on a woman's home and work environments.

Prevention

Some women may find their PMDD disappears periodically. Diet and nutritional supplements can have the greatest impact in preventing PMDD.

Resources

BOOKS

Michelle Harrison, M.D. *Self-Help for Premenstrual Syndrome*. New York: Random House, 1998

Judy E. Marshel, and Anne Egan. *PMDD Relief: Natural Approaches to Treating Symptoms*. Berkley Books, 1998

ORGANIZATIONS

National Association for Premenstrual Syndrome. 7 Swift's Court, High Street, Seal, Kent TN15 0EG UK. +44 (0) 1732 760011 <www.PMDD.org.uk>.

Advancement of Women's Health Research, 1828 L Street, N.W., Suite 625 Washington, D.C. 20036. (202) 223-8224. <www.womens-health.org>.

Premenstrual syndrome

Definition

Premenstrual syndrome (PMS) refers to symptoms that occur between ovulation and the onset of menstruation. The symptoms include both physical symptoms, such as breast tenderness, back **pain**, abdominal cramps, **headache**, and changes in appetite, as well as psychological symptoms of **anxiety**, depression, and unrest. Severe forms of this syndrome are referred to as **premenstrual dysphoric disorder** (PMDD). These symptoms may be related to hormones and emotional disorders.

Description

Approximately 75% of all menstruating women experience some symptoms that occur before or during menstruation. PMS encompasses symptoms severe enough to interfere with daily life. About 3–5% of women experience the more severe PMDD. These symptoms can last 4–10 days and can have a substantial impact on a woman's life.

The reason some women get severe PMS while others have none is not understood. PMS symptoms usually begin at about age 20-30 years. The disease may run in families and is also more prone to occur in women with a history of psychological problems. Overall however, it is difficult to predict who is most at risk for PMS.

Causes and symptoms

Because PMS is restricted to the second half of a woman's menstrual cycle, after ovulation, it is thought that hormones play a role. During a woman's monthly menstrual cycle, which lasts 24–35 days, hormone levels change. The hormone estrogen gradually rises during the first half of a woman's cycle, the preovulatory phase, and falls dramatically at ovulation. After ovulation, the postovulatory phase, progesterone levels gradually increase until menstruation occurs. Both estrogen and progesterone are secreted by the ovaries, which are responsible for producing the eggs. The main role of these hormones is to cause thickening of the lining of the uterus (endometrium). However, estrogen and progesterone also affect other parts of the body, including the brain. In the brain and nervous system, estrogen can affect the levels of neurotransmitters, such as serotonin. Serotonin has long been known to have an effect on emotions, as well as eating behavior. It is thought that when estrogen levels go down during the postovulatory phase of the menstrual cycle, decreases in serotonin levels follow. Whether these changes in estrogen, progesterone, and serotonin are responsible for the emotional aspects of PMS is not known with certainty. However, most researchers agree that the chemical transmission of signals in the brain and nervous system is in some way related to PMS. This is supported by the fact that the times following **childbirth** and **menopause** are also associated with both depression and low estrogen levels.

Symptoms for PMS are varied and many, including both physical and emotional aspects that range from mild to severe. The physical symptoms include: bloating, headaches, food cravings, abdominal cramps, headaches, tension, and breast tenderness. Emotional aspects include mood swings, irritability, and depression.

Diagnosis

The best way to diagnose PMS is to review a detailed diary of a woman's symptoms for several months. PMS is diagnosed by the presence of physical, psychological, and behavioral symptoms that are cyclic and occur in association with the premenstrual period of time. PMDD, which is far less common, was officially recognized as a disease in 1987. Its diagnosis depends on the presence of at least five symptoms related to mood that disappear within a few days of menstruation. These symptoms must interfere with normal functions and activities of the individual. The diagnosis of PMDD has caused controversy in fear that it may be used against women, labeling them as being impaired by their menstrual cycles.

Treatment

There are many treatments for PMS and PMDD depending on the symptoms and their severity. For mild cases, treatment includes **vitamins**, **diuretics**, and pain relievers. Vitamins E and B_6 may decrease breast tenderness and help with **fatigue** and mood swings in some women. Diuretics that remove excess fluid from the body seem to work for some women. For more severe cases and for PMDD, treatments available include **antidepressant drugs**, hormone treatment, or (only in extreme cases) surgery to remove the ovaries. Hormone treatment usually involves **oral contraceptives**. This treatment, as well as removal of the ovaries, is used to prevent ovulation and the changes in hormones that accompany ovulation. Recent studies, however, indicate that hormone treatment has little effect over placebo.

Antidepressants

The most progress in the treatment of PMS and PMDD has been through the use of antidepressant drugs. The most effective of these include sertraline (Zoloft), fluoxetine (Prozac), and paroxetine (Paxil). They are

termed **selective serotonin reuptake inhibitors** (SSRIs) and act by indirectly increasing the brain serotonin levels, thus stabilizing emotions. Some doctors prescribe antidepressant treatment for PMS throughout the cycle, while others direct patients to take the drug only during the latter half of the cycle. Antidepressants should be avoided by women wanting to become pregnant. A recent clinical study found that women who took sertraline had a significant improvement in productivity, social activities, and relationships compared with a placebo group. Side effects of sertraline were found to include nausea, **diarrhea**, and decreased libido.

Alternative treatment

There are alternative treatments that can both affect serotonin and hormone responses, as well as affect some of the physical symptoms of PMS.

Vitamins and minerals

Some women find relief with the use of vitamin and mineral supplements. Magnesium can reduce the fluid retention that causes bloating, while calcium may decrease both irritability and bloating. Magnesium and calcium also help relax smooth muscles and this may reduce cramping. Vitamin E may reduce breast tenderness, nervous tension, fatigue, and **insomnia**. Vitamin B_6 may decrease fluid retention, fatigue, irritability, and mood swings. Vitamin B_5 supports the adrenal glands and may help reduce fatigue.

Phytoestrogens and natural progesterone

The Mexican wild yam (*Dioscorea villosa*) contains a substance that may be converted to progesterone in the body. Because this substance is readily absorbed through the skin, it can be found as an ingredient in many skin creams. (Some products also have natural progesterone added to them.) Some herbalists believe that these products can have a progesterone-like effect on the body and decrease some of the symptoms of PMS.

The most important way to alter hormone levels may be by eating more phytoestrogens. These plant-derived compounds have an effect similar to estrogen in the body. One of the richest sources of phytoestrogens is soy products, such as tofu. Additionally, many supplements can be found that contain black cohosh (*Cimicifugaracemosa*) or dong quai (*Angelica sinensis*), which are herbs high in phytoestrogens. Red clover (*Trifolium pratense*), alfalfa (*Medicago sativa*), licorice (*Glycyrrhiza glabra*), hops (*Humulus lupulus*), and legumes are also high in phytoestrogens. Increasing the consumption of phytoestrogens is also associated with decreased risks of **osteoporosis**, **cancer**, and heart disease.

KEY TERMS

Antidepressant—A drug used to control depression.

Estrogen—A female hormone important in the menstrual cycle.

Neurotransmitter—A chemical messenger used to transmit an impulse from one nerve to the next.

Phytoestrogens—Compounds found in plants that can mimic the effects of estrogen in the body.

Progesterone—A female hormone important in the menstrual cycle.

Serotonin—A neurotransmitter important in regulating mood.

Antidepressant alternatives

Many antidepressants act by increasing serotonin levels. An alternative means of achieving this is to eat more carbohydrates. For instance, two cups of cereal or a cup of pasta have enough carbohydrates to effectively increase serotonin levels. An herb known as **St. John's wort** (*Hypericum perforatum*) has stood up to scientific trials as an effective antidepressant. As with the standard antidepressants, however, it must be taken continuously and does not show an effect until used for 4–6 weeks. There are also herbs, such as skullcap (*Scutellaria lateriflora*) and kava (*Piper methysticum*), that can relieve the anxiety and irritability that often accompany depression. An advantage of these herbs is that they can be taken when symptoms occur rather than continually. Chaste tree (*Vitex agnus-castus*), in addition to helping rebalance estrogen and progesterone in the body, also may relieve the anxiety and depression associated with PMS.

Prognosis

The prognosis for women with both PMS and PMDD is good. Most women who are treated for these disorders do well.

Prevention

Maintaining a good diet, one low in sugars and fats and high in phytoestrogens and complex carbohydrates, may prevent some of the symptoms of PMS. Women should try to **exercise** three times a week, keep in generally good health, and maintain a positive self image. Because PMS is often associated with **stress**, avoidance of stress or developing better means to deal with stress can be important.

Resources

BOOKS

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Fife, WA: Future Medicine Publishing, 1995.

PERIODICALS

Gold, Judith. "Premenstrual Dysphoric Disorder: What's That?" *Journal of the American Medical Association* 278 (24 Sept. 1997): 1024-1026.

Hochwald, Lambeth. "Get with the Program. (PMS and Menstrual Care)." *Natural Health* (Jan./Feb. 1997): 54-56.

Steiner, M. "Premenstrual Syndromes." *Annual Review of Medicine* 48 (1997): 447-455.

Yonkers, Kimberly A., et. al. "Symptomatic Improvement of Premenstrual Dysphoric Disorder with Sertraline Treatment: A Randomized Controlled Trial." *Journal of the American Medical Association* 278 (24 Sept. 1997): 983-989.

Cindy L. A. Jones, PhD

Prepregnancy counseling

Definition

Prepregnancy counseling is advice supplied by an obstetrician, nurse, certified nurse-midwife, or **childbirth** educator about those steps a mother-to-be and father-to-be can take in preparation for **pregnancy**. Basically, it is a checklist for people to see if they are living lives that are most accommodating to having a healthy pregnancy. Prepregnancy counseling gives time for one to make changes before pregnancy.

Purpose

The purpose and goal of prepregnancy counseling is to help patients have full-term, healthy pregnancies and babies. The counseling and education are important because lifestyle habits such as **smoking** or alcohol usage can be hazardous to a developing fetus.

Precautions

Women who have diabetes should take special precautions before pregnancy. This counseling, usually provided by a team of professionals including a registered dietitian, diabetes educators, an obstetrician, and others, helps to prevent early pregnancy loss and congenital malformations in infants of diabetic mothers.

Women who have a history of genetic disease can opt to have **genetic testing**. Prepregnancy counseling can include referrals to those specialists.

Women who are over 40 have higher cesarean section rates. They are also more likely than younger women to have conditions such as high blood pressure, and are more likely to have babies with genetic problem, such as Down syndrome.

Women who are considering pregnancy should avoid exposure to hazards such as chemicals, illicit drugs, alcohol, and smoking. They should reduce their **caffeine** intake and be careful not to let their body temperatures rise to dangerous levels.

Description

Prepregnancy counseling involves communicating important aspects about **nutrition**, medication use, and lifestyle months in advance of getting pregnant. Issues include diet, nutrition, **exercise**, smoking, alcohol, drugs, emotional health, and referral to **genetic counseling** if a patient knows of a history of inherited disease.

Preparation

The mother-to-be should stop using birth control pills to allow for at least two regular menstrual cycles to occur before conception. This requires that she stop taking birth control pills several months before getting pregnant.

Other steps to prepare for pregnancy include:

Being at optimal weight. Women should not go on prepregnancy weight loss **diets** unless they are under the care of a physician because abrupt weight loss can affect the mother's menstrual cycle and reduce fertility.

Eating a balanced diet. This is achieved by taking a prenatal vitamin provided by a health care provider and focusing on nutrients that are important for a developing fetus. These include folate, or **folic acid**, which is important for the development of the baby's brain and spinal cord. Folate can be found in fortified cereals, citrus fruits, and green leafy vegetables. Calcium is important for baby and mother. It helps the baby's bones to develop normally and keeps the mother from suffering a calcium deficiency during pregnancy. Iron keeps the mother from developing anemia during pregnancy. Good sources of iron are green leafy vegetables, red meat, beans, and fortified cereal. Fiber helps mothers avoid **constipation**, a common occurrence during pregnancy. Good sources of fiber include beans, fruits, and vegetables.

Exercising on a regular basis. One should exercise for general overall health.

Undergoing routine physical and dental exams. These include having a physical and breast examination and **Pap test**. Other tests might be recommended according to a woman's health and genetic history. They should

also report any prescription drugs, over-the-counter medications, or natural **vitamins** and herbs they are taking. This is the time for a woman to make sure she is up to date on her immunizations. A dental exam, with x rays, can eliminate the need to have x rays while pregnant.

Getting psychological support. Mental support is also important in the prepregnancy stage. This can help a woman to relax and better prepare mentally and physically for what lies ahead.

Risks

About 10–15% of couples in the United States experience **infertility**. When couples should seek medical evaluation and an infertility work-up depends on their ages. Generally, it takes longer for older couples to conceive. Prepregnancy counseling might include a referral to such a specialist. While infertility is often treatable, treatment can be expensive, emotionally difficult, and time-consuming. About 10 percent of the time, doctors cannot detect a reason for the infertility.

There always is the risk that a pregnancy goes awry or a baby is born with a medical condition, regardless of whether or not a person has had prepregnancy counseling.

Normal results

The counseling can provide guidelines for people so that they can maximize their chances to have emotionally and physically healthy pregnancies and healthy babies.

Abnormal results

Many abnormal results, such as genetic conditions, **miscarriage**, preeclampsia (also known as toxemia), and preterm births, cannot be avoided even with prepregnancy counseling. Still, some abnormal results, such as miscarriages and preterm births, may occur when mothers and fathers lead unhealthy lifestyles despite their counseling.

Resources

ORGANIZATIONS

Take a health inventory before pregnancy. UCDavis Health System. UC Davis Medical Center. 2315 Stockton Blvd. Sacramento. CA 95817. (916) 734-2011. <http://www.ucdmc.ucdavis.edu>.

General pre pregnancy guidelines. <http://parentsplace.com>.

Preconception care of women with diabetes. American Diabetes Association. <http://journal.diabetes.org/FullText/Supplements/DiabetesCare/Supplement100/S65.htm>.

About infertility and pregnancy. Cyberdiet.com. <http://www.cyberdiet.com/modules/ip/reproductive_years/preparation/nutritional_health.html>.

KEY TERMS

Preeclampsia—Also called toxemia, preeclampsia is a condition during pregnancy that results in high blood pressure, swelling that doesn't go away and large amounts of protein in the urine. Without treatment, it can progress to a dangerous condition called eclampsia, in which a woman goes into convulsions.

Trish Booth, M.A., LCCE, FACCE, Childbirth Educator, Educational Process Consultant. 7507 Northfield Lane, Manlius, NY 13104. (315) 682-2922.

Lisette Hilton

Presbyopia

Definition

The term presbyopia means "old eye" and is a vision condition involving the loss of the eye's ability to focus on close objects.

Description

Presbyopia is a condition that occurs as a part of normal **aging** and is not considered to be an eye disease. The process occurs gradually over a number of years. Symptoms are usually noticeable by age 40–45 and continue to develop until the process stabilizes some 10–20 years later. Presbyopia occurs without regard to other eye conditions.

Causes and symptoms

In the eye, the crystalline lens is located just behind the iris and the pupil. Tiny ciliary muscles pull and push the lens, adjusting its curvature, and thereby adjusting the eye's focal power to bring objects into focus. As individuals age, the lens becomes less flexible and elastic, and the muscles become less powerful. Because these changes result in inadequate adjustment of the lens of the eye for various distances, objects that are close will appear blurry. The major cause of presbyopia is loss of elasticity of the lens of the eye. Loss of ciliary muscle power, however, is also believed to contribute to the problem.

Symptoms of presbyopia result in the inability to focus on objects close at hand. As the lens hardens, it is unable to focus the rays of light that come from nearby objects. Individuals typically have difficulty reading small print, such as that in telephone directories and newspaper advertisements, and may need to hold reading materials at arm's length. Symptoms include **headache** and eyestrain when doing close work, blurry vision, and eye **fatigue**. Symptoms may be worse early in the morning or when individuals are fatigued. Dim lighting may also aggravate the problem.

Diagnosis

Presbyopia is officially diagnosed during an **eye examination** conducted by eye specialists, such as optometrists or ophthalmologists. After completing optometric college, doctors of optometry screen patients for eye problems and prescribe glasses and contact lenses. In contrast, ophthalmologists are medical doctors who specialize in eye diseases. They perform eye surgery, treat eye diseases, and also prescribe glasses and contact lenses.

A comprehensive eye examination requires at least 30 minutes. Part of the examination will assess vision while reading by using various strength lenses. If the pupils are dilated with drugs to permit a thorough examination of the retina, an additional hour is required. The cost of eye examinations can range from $40–$250 depending on the complexity and site of the examination and the qualifications and reputation of the examiner. Some insurers cover the cost of routine eye examinations, while others do not. A thorough eye examination is recommended at regular intervals during the adult and aging years to monitor and diagnose eye conditions. However, individuals frequently self-diagnose presbyopia by trying on inexpensive mass-produced reading glasses until they find a pair that permits reading without strain.

Treatment

Presbyopia cannot be cured, but individuals can compensate for it by wearing reading, bifocal, or trifocal eyeglasses. A convex lens is used to make up for the lost automatic focusing power of the eye. Half-glasses can be worn, which leave the top open and uncorrected for distance vision. Bifocals achieve the same goal by allowing correction of other refractive errors (improper focusing of images on the retina of the eye).

In addition to glasses, contact lenses have also been found to be useful in the treatment of presbyopia. The two common types of contact lenses prescribed for this condition are bifocal and monovision contact lenses. Bifocal contact lenses are similar to bifocal glasses. The top portion of the lens serves as the distance lens while the lower serves as the near vision lens. To prevent rotation while in the eye, bifocal contacts use a specially manufactured type of lens. Good candidates for bifocal lenses are those patients who have a good tear film (moist eyes), good binocular vision (ability to focus both eyes together) and visual acuity in each eye, and no disease or abnormalities in the eyelids. The bifocal contact lens wearer must be motivated to invest the time it requires to maintain contact lenses and be involved in occupations that do not impose high visual demands. Further, bifocal contact lenses may limit binocular vision. Bifocal contact lenses are relatively expensive, in part due to the time it takes the patient to be accurately fitted.

An alternative to wearing eyeglasses or bifocal contact lenses is monovision contact lenses. Monovision fitting provides one contact lens that corrects for near vision and a second contact lens for the alternate eye that corrects for distance vision. If distance vision is normal, the individual wears only a single contact lens for near vision. Monovision works by having one eye focus for distant objects while the other eye becomes the reading eye. The brain learns to adapt to this and will automatically use the correct eye depending on the location of material in view. Advantages of monovision are patient acceptability, convenience, and lower cost.

Several problems exist with the use of contact lenses in the treatment of presbyopia. Some individuals experience headache and fatigue during the adjustment period or find the slight decrease in visual acuity unacceptable. Monovision contact lenses usually result in a small reduction in high-contrast visual acuity when compared with bifocal contact lenses.

Prognosis

The changes in vision due to aging usually start in a person's early 40s and continue for several decades. At some point, there is no further development of presbyopia, as the ability to accommodate is virtually gone.

Prevention

There is no known way to prevent presbyopia.

Resources

BOOKS

Ernest, J. Terry. "Changes and Diseases of the Aging Eye." In *Geriatric Medicine*, ed. Christine K. Cassel, et al. New York: Springer, 1997.

Newell, Frank W. "Optical Defects of the Eye." In *Ophthalmology: Principles and Concepts*. 8th ed. St. Louis: Mosby, 1996.

KEY TERMS

Accommodation—The ability of the eye to change its focus from near to distant objects.

Binocular vision—Using both eyes at the same time to see an image.

Ciliary muscles—The small muscles that permit the lens to change its shape in order to focus on near or distant objects.

Lens (or crystalline lens)—The eye structure behind the iris and pupil that helps focus light on the retina.

Visual acuity—Sharpness or clearness of vision.

PERIODICALS

Miller, Martha. "Your Aging Eyes." *Better Homes & Gardens* (July 1996): 46–51.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Lighthouse National Center for Vision and Aging. 111 E. 59th St., New York, NY 10022. (800) 334-5497. <http://www.lighthouse.org>.

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892-3655. (301) 496-5248. <http://www.nei.nih.gov>.

Elaine Souder, PhD

Presenile dementia *see* **Alzheimer's disease**

Pressure sores *see* **Bedsores**

Preterm labor *see* **Premature labor**

Priapism

Definition

Priapism is a rare condition that causes a persistent, and often painful, penile erection.

Description

Priapism is drug induced, injury related, or caused by disease, not sexual desire. As in a normal erection, the penis fills with blood and becomes erect. However, unlike a normal erection that dissipates after sexual activity ends, the persistent erection caused by priapism is maintained because the blood in the penile shaft does not drain. The shaft remains hard, while the tip of the penis is soft. If it is not relieved promptly, priapism can lead to permanent scarring of the penis and inability to have a normal erection.

Causes and symptoms

Priapism is caused by leukemia, **sickle cell disease**, or **spinal cord injury**. It has also been associated as a rare side effect to trazodone (Desyrel), a drug prescribed to treat depression. An overdose of self-injected chemicals to counteract **impotence** has also been responsible for priapism. The chemicals are directly injected into the penis, and at least a quarter of all men who have used this method of treatment for over three months develop priapism.

Diagnosis

A **physical examination** is needed to diagnose priapism. Further testing, including nuclear scanning or Doppler ultrasound, will diagnose the underlying cause of the condition.

Treatment

There are three methods of treatment. The most effective is the injection of medicines into the penis that allow the blood to escape. Cold packs may also be applied to alleviate the condition, but this method becomes ineffective after about eight hours. For the most serious cases and those that do not respond to the first two treatments, a needle can be used to remove the blood. The tissues may need to be flushed with saline or diluted medications by the same needle method. That failing, there are more extensive surgical procedures available. One of them shuts off much of the blood supply to the penis so that it can relax. If the problem is due to a sickle cell crisis, treatment of the crisis with oxygen or **transfusion** may suffice.

Prognosis

If priapism is relieved within the first 12–24 hours, there is usually no residual damage. After that, permanent impotence may result, since the high pressure in the penis compromises blood flow and leads to tissue death (infarction).

Prevention

An antineoplastic drug (hydroxyurea) may prevent future episodes of priapism for patients with sickle cell disease.

KEY TERMS

Antineoplastic—A drug used to inhibit the growth and spread of cancerous cells.

Doppler ultrasound—An imaging technique using ultrasound that can detect moving liquids.

Infarction—Death of tissue due to inadequate blood supply.

Nuclear scanning—Use of injected radioactive elements to analyze blood flow.

Sickle cell anemia—A hereditary abnormality of blood cells in which some are deformed and may plug up small blood vessels.

Resources

BOOKS

Bechtel, Stefan. *The Practical Encyclopedia of Sex and Health*. Emmaus, PA: Rodale Press, 1993.

McConnell, John D., and Jean D. Wilson. "Impotence." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Wertheimer, Neil. *Total Health for Men.* Emmaus, PA: Rodale Press, 1995.

PERIODICALS

Ahmed, I., and N. A. Shaikh. "Treatment of Intermittent Idiopathic Priapism with Oral Terbutaline." *British Journal of Urology* 80 (Aug. 1997): 341.

Bondil P., et al. "Medical Treatment of Venous Priapism Apropos of 46 Cases: Puncture, Pharmacologic Detumescence or Penile Cooling?" *Progres en Urologie* 7 (June 1997): 433-441.

Harmon, W. J., and A. Nehra. "Priapism: Diagnosis and Management." *Mayo Clinic Proceedings* 72 (Apr. 1997): 350-355.

Kulmala, R. V., T. A. Lehtonen, and T. L. Tammela. "Preservation of Potency after Treatment for Priapism." *Scandinavian Journal of Urology and Nephrology* 30 (Aug. 1996): 313-316.

Werthman, P., and J. Rajfer. "MUSE Therapy: Preliminary Clinical Observations." *Urology* 50 (Nov. 1997): 809-811.

J. Ricker Polsdorfer, MD

Prickly heat

Definition

Also known as sweat retention syndrome or miliaria rubra, prickly heat is a common disorder of the sweat glands.

Description

The skin contains two types of glands: one produces oil and the other produces sweat. Sweat glands are coil-shaped and extend deep into the skin. They are capable of plugging up at several different depths, producing four distinct skin **rashes**.

- Miliaria crystallina is the most superficial of the occlusions. At this level, only the thin upper layer of skin is affected. Little blisters of sweat that cannot escape to the surface form. A bad **sunburn** as it just starts to blister can look exactly like this.
- Deeper plugging causes miliaria rubra as the sweat seeps into the living layers of skin, where it irritates and itches.
- Miliaria pustulosais (a complication of miliaria rubra) occurs when the sweat is infected with pyogenic bacteria and turns to pus.
- Deeper still is miliaria profunda. The skin is dry, and goose bumps may or may not appear.

There are two requirements for each of these phases of sweat retention: hot enough weather to induce sweating, and failure of the sweat to reach the surface.

Causes and symptoms

Best evidence as of 2001 suggests that bacteria form the plugs in the sweat glands. These bacteria are probably normal inhabitants of the skin, and why they suddenly interfere with sweat flow is still not known.

Infants are more likely to get miliaria rubra than adults. All the sweat retention rashes are also more likely to occur in hot, humid weather.

Besides **itching**, these conditions prevent sweat from cooling the body, which it is supposed to do by evaporating from the skin surface. Sweating is the most important cooling mechanism available in hot environments. If it does not work effectively, the body can rapidly become too hot, with severe and even lethal consequences. Before entering this phase of heat **stroke**, there will be a period of heat exhaustion symptoms—dizziness, thirst, weakness—when the body is still effectively maintaining its temperature. Then the temperature rises, often rapidly, to 104–5°F (40°C) and beyond. This is an emergency of the first order, necessitating immediate and rapid cooling. The best method is immersion in ice water.

Diagnosis

The rash and dry skin in hot weather are usually sufficient to diagnose these conditions.

KEY TERMS

Ambient—Surrounding.

Pyogenic—Capable of generating pus. *Streptococcus, Staphococcus,* and bowel bacteria are the primary pyogenic organisms.

Syndrome—A collection of abnormalities that occur together often enough to suggest they have a common cause.

Treatment

The rash itself may be treated with topical antipruritics (itch relievers). Preparations containing aloe, menthol, camphor, eucalyptus oil, and similar ingredients are available commercially. Even more effective, particularly for widespread itching in hot weather, are cool baths with corn starch and/or oatmeal (about 0.5 lb [224 g] of each per bathtub-full).

Dermatologists can peel off the upper layers of skin using a special ultraviolet light. This will remove the plugs and restore sweating, but is not necessary in most cases.

Much more important, however, is to realize that the body cannot cool itself adequately without sweating. Careful monitoring for symptoms of heat disease is important. If they appear, some decrease in the ambient temperature must be achieved by moving to the shade, taking a cool bath or shower, or turning up the air conditioner.

Prognosis

The rash disappears in a day with cooler temperatures, but the skin may not recover its ability to sweat for two weeks—the time needed to replace the top layers of skin with new growth from below.

Prevention

Experimental application of topical **antiseptics** like hexachlorophene almost completely prevented these rashes.

Resources

BOOKS

Berger, Timothy G. "Skin and Appendages." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

"Sweat Retention Syndrome." In *Dermatology in General Medicine*, ed. Thomas B. Fitzpatrick, et al. New York: McGraw-Hill, 1993.

J. Ricker Polsdorfer, MD

Primaquine *see* **Antimalarial drugs**

Primary biliary cirrhosis

Definition

Primary biliary **cirrhosis** is the gradual destruction of the biliary system for unknown reasons.

Description

Although the cause of this serious condition is not known, it has many features to suggest that it is an autoimmune disease. Autoimmunity describes the process whereby the body's defense mechanisms are turned against itself. The immune system is supposed to recognize and attack only dangerous foreign invaders like germs, but many times it attacks, for no apparent reason, the cells of the body itself. Autoimmune reactions occur in many different tissues of the body, creating a great variety of diseases.

Primary biliary cirrhosis progressively destroys the system that drains bile from the liver into the intestines. Bile is a collection of waste products excreted by the liver. As the disease progresses it also scars the liver, leading to cirrhosis. In some patients, the disease destroys the liver in as little as five years. In others, it may lie dormant for a decade or more.

Causes and symptoms

Ninety percent of patients with this disease are women between the ages of 35 and 60. The first sign of it may be an abnormal blood test on routine examination. **Itching** is a common early symptom, caused by a buildup of bile in the skin. **Fatigue** is also common in the early stages of the disease. Later symptoms include **jaundice** from the accumulation of bile and specific nutritional deficiencies—bruising from **vitamin K deficiency**, bone **pain** from **vitamin D deficiency**, night blindness from **vitamin A deficiency**, and skin **rashes**, possibly from vitamin E or essential fatty acid deficiency. All these vitamin problems are related to the absence of bile to assist in the absorption of nutrients from the intestines.

Diagnosis

Blood tests strongly suggest the correct diagnosis, but a **liver biopsy** is needed for confirmation. It is also usually necessary to x ray the biliary system to look for other causes of obstruction.

A close-up image indicating biliary cirrhosis of the liver. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Of the many medicines tried to relieve the symptoms and slow the progress of this disease, only one has had consistently positive results. Ursodeoxycholic acid, a chemical that dissolves gall stones, provides substantial symptomatic relief. It is still unclear if it slows liver damage.

Primary biliary cirrhosis is a major reason for **liver transplantation**. Patients do so well that this is becoming the treatment of choice. As experience, technique, and immunosuppression progressively improve, patients with this disease will come to transplant surgery earlier and earlier in their disease course.

Prognosis

So far, this disease has not returned in a transplanted liver.

Resources

BOOKS

Friedman, Lawrence S. "Liver, Biliary Tract and Pancreas." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Friedman, Scott L. "Cirrhosis Of The Liver and Its Major Sequelae." *Cecil Textbook Of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Lindor, Keith D. "Primary Biliary Cirrhosis." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*. 6th ed. Ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

Podolsky, Daniel K., and Kurt J. Isselbacher. "Cirrhosis and Alcoholic Liver Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

KEY TERMS

Biopsy—Surgical removal of tissue for examination.

Cirrhosis—Scarring, usually referring to the liver.

Immunosuppression—Techniques to prevent transplant graft rejection by the body's immune system.

ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. <http://www.liverfoundation.org>.

J. Ricker Polsdorfer, MD

Primary degenerative dementia *see* **Alzheimer's disease**

Primary polycythemia *see* **Polycythemia vera**

Primary pulmonary hypertension *see* **Pulmonary hypertension**

PRK *see* **Photorefractive keratectomy and laser-assisted in-situ keratomileusts**

Pro time *see* **Prothrombin time**

Probenecid *see* **Gout drugs**

Procainamide *see* **Antiarrhythmic drugs**

Prochlorperazine *see* **Antinausea drugs**

Proctitis

Definition

Proctitis is an inflammation of the rectum.

Description

Proctitis affects mainly adolescents and adults. It is most common in men around age 30. Proctitis is caused by several different **sexually transmitted diseases**. Male homosexuals and people who practice anal intercourse are more likely to suffer from proctitis. Patients who have **AIDS** or who are immunocompromised are also more at risk.

Causes and symptoms

Proctitis is caused most often by sexually transmitted diseases, including **gonorrhea**, **syphilis**, herpes simplex (**genital herpes**), **candidiasis**, and chlamydia. It can also be caused by inflammatory bowel diseases, such as **Crohn's disease**, or **ulcerative colitis** (a chronic recurrent ulceration in the colon)—with which it is a very common component. Occasionally it is caused by an amoeba that causes dysentery.

Discharge of blood and mucus and intense **pain** in the area of the rectum and anus are all signs of proctitis. Patients feel the urge to have frequent bowel movements even when there is nothing present to eliminate. They may also have **constipation**, **diarrhea**, **fever**, and open sores around the anus. Other symptoms include cramping, lower back pain, difficulty urinating, and **impotence**.

KEY TERMS

Candidiasis—A common fungal infection caused by yeast that thrives in moist, warm areas of the body.

Chlamydia—A gonorrhea-like bacterial infection.

Proctoscopy—A procedure in which a thin tube containing a camera and a light is inserted into the rectum so that the doctor can visually inspect it.

Rectum—The final section of the large intestine.

Ulcerative colitis—Chronic ulceration of the colon and rectum.

Diagnosis

Proctitis is diagnosed by a patient history and **physical examination**. It is confirmed by a proctoscopy (examination of the rectum with an endoscope inserted through the anus). Proctoscopy usually shows a red, sore, inflamed lining of the rectum. Biopsies, smears, and lab cultures of rectal material are used to determine the exact cause of the inflammation so that the underlying cause can be treated appropriately.

Since the two problems often occur together, in the presence of proctitis, the large bowel should be examined for ulcerative colitis.

Treatment

Once the underlying cause of the inflammation is diagnosed, appropriate treatment begins. **Antibiotics** are given for bacterial infections. There is no cure for genital herpes, but the antiviral drug, acyclovir, is often prescribed to reduce symptoms. Corticosteroid suppositories or ointments such as hydrocortisone are used to lessen discomfort, and the patient is encouraged to take warm baths to ease painful symptoms. Ulcerative proctitis often responds well to corticosteroid **enemas** or foam, or to sulfasalazine and related drugs.

Alternative treatment

Depending on the cause of proctitis, alternative medicine has several types of treatments available. If proctitis is related to gonorrhea, syphilis, or chlamydia, appropriate antibiotic treatment is recommended. Supplementation with *Lactobacillus acidophilus* is also recommended during and following antibiotic therapy to help rebuild normal gut flora that is destroyed by antibiotics. If proctitis is herpes-related, antiviral herbs taken internally, as well as applied topically, can be be helpful. Sitz baths and compresses of herbal infusions (herbs steeped in hot water) and decoctions (herbal extracts prepared by boiling the herb in water) can be very effective. Among the herbs recommended are calendula (*Calendula officinalis*), comfrey (*Symphytum officinale*), and plantain (*Plantago major*). Proctitis related to candidiasis requires dietary alterations, especially elimination of sugar from the diet. Any immunocompromised person needs close medical attention. If proctitis is related to inflammatory bowel diseases, the resolution of the underlying condition should contribute to resolution of the proctitis. **Acupuncture** and homeopathic treatment can be very useful in resolving inflammatory bowel diseases.

Prognosis

Proctitis caused by bacteria is curable with antibiotics. Genital herpes is not curable. Although symptoms can be suppressed, proctitis may reoccur. Patients with AIDS are especially susceptible to candidiasis infections, which may be hard to control. Recovering from proctitis caused by inflammatory bowel diseases is variable and depends on successful management of those diseases. Severe proctitis can result in permanent narrowing of the anus.

Prevention

Proctitis is best prevented by using condoms and practicing safer sex to prevent acquiring sexually transmitted diseases. Avoiding anal intercourse also helps prevent damage to the rectum.

Resources

BOOKS

Margolis, Simon, ed. "Proctitis." In *Johns Hopkins Symptoms and Remedies.* New York: Rebus, 1995.

OTHER

ThriveOnline. "Proctitis." <http://thriveonline.oxygen.com>.

Tish Davidson

Proctosigmoidoscopy *see* **Sigmoidoscopy**

Progesterone assay *see* **Sex hormones tests**

Progressive multifocal leukoencephalopathy

Definition

Progressive multifocal leukoencephalopathy (PML) is a rapidly progressive neuromuscular disease caused by opportunistic infection of brain cells (oligodendrocytes and astrocytes) by the JC virus (JCV).

Description

PML is an opportunistic infection associated with **AIDS** and certain cancers. It occurs in people with inadequate immune response and carries a poor prognosis. The incidence of PML, once quite rare, is rising as the numbers of people living with persistently compromised immune systems rises. An estimated 2–7% of people with HIV disease will develop PML. The infection also occurs among people undergoing long-term **chemotherapy** for **cancer**. PML is not considered a contagious disease. According to the Centers for Disease Control definition of AIDS, PML in the presence of HIV infection is sufficient to form a diagnosis of AIDS.

Causes and symptoms

Although at least 80% of the adults in the United States have been exposed to JC virus (as evidenced by the presence of antibodies to this virus), very few will develop PML. Little is certain about what causes JCV to produce active disease, but the virus persists in the kidneys of otherwise healthy people without making them ill. Recent evidence suggests that after prolonged compromise of the immune system, the virus changes into a form that can reach brain tissue and cause disease. In PML, the JCV infects and kills the cells (oligodendrocytes) that produce myelin, which is needed to form the sheath that surrounds and protects nerves.

About 45% of people with PML experience vision problems, most often a blindness affecting half of the visual field of each eye. Mental impairment affects about 38% of people with PML. Eventually, about 75% experience extreme weakness. Other symptoms include lack of coordination, **paralysis** on one side of the body (hemiparesis), and problems in speaking or using language.

KEY TERMS

Multifocal—Having many focal points. In progressive multifocal leukoencephalopathy, it means that damage caused by the disease occurs at multiple sites.

Opportunistic infection—A illness caused by infecting organisms that would not be able to produce disease in a person with a healthy immune system, but are able to take advantage of an impaired immune response.

Diagnosis

Diagnosis is difficult, but usually relies on a neurologist and radiologist assessing the white matter of the brain on a computed tomography scan or a **magnetic resonance imaging** (MRI). Tests of the cerebrospinal fluid can help distinguish between PML and other diseases, such as **multiple sclerosis** and acute hemorrhagic leukoencephalopathy. The rapid clinical progression in immunocompromised patients is another distinguishing factor.

Treatment

Currently, there is no known cure for PML, although it sometimes responds to treatment in patients with AIDS who are taking anti-HIV drugs (such as AZT, alpha-interferon, and peptide T). Although several agents have shown some potential in the last few years, such as the highly toxic cancer drug cytarabine, none are safe enough or sufficiently effective to be approved for PML.

Prognosis

PML is usually a very aggressive disease. The time between the onset of symptoms and **death** can be as little as one to six months. However, some patients infected with HIV have improved without receiving treatment specifically for PML.

Resources

BOOKS

Harrison's Principles of Internal Medicine, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Royal III, Walter. "Update on Progressive Multifocal Leukoencephalopathy." *The Hopkins HIV Report* 9 (Mar. 1997).

Jill S. Lasker

Progressive supranuclear ophthalmoplegia
see **Progressive supranuclear palsy**

Progressive supranuclear palsy

Definition

Progressive supranuclear palsy (PSP; also known as Steele-Richardson-Olszewski syndrome) is a rare disease that gradually destroys nerve cells in the parts of the brain that control eye movements, breathing, and muscle coordination. The loss of nerve cells causes palsy, or **paralysis**, that slowly gets worse as the disease progresses. The palsy affects ability to move the eyes, relax the muscles, and control balance.

Description

Progressive supranuclear palsy is a disease of middle age. Symptoms usually begin in the 60s, rarely before age 45 or after age 75. Men develop PSP more often than women do. It affects three to four people per million each year.

Causes and symptoms

PSP affects the brainstem, the basal ganglia, and the cerebellum. The brainstem is located at the top of the spinal cord. It controls the most basic functions needed for survival—the involuntary (unwilled) movements such as breathing, blood pressure, and heart rate. The brainstem has three parts: the medulla oblongata, the pons, and the midbrain. The parts affected by PSP are the pons, which controls facial nerves and the muscles that turn the eye outward, and the midbrain, the visual center. The basal ganglia are islands of nerve cells located deep within the brain. They are involved in the initiation of voluntary (willed) movement and control of emotion. Damage to the basal ganglia causes muscle stiffness (spasticity) and **tremors**. The cerebellum is located at the base of the skull. It controls balance and muscle coordination.

Vision is controlled by groups of cells called *nuclei* in the brainstem. In PSP, the nuclei continue to function, but the mechanisms that control the nuclei are destroyed. The term *supranuclear* means that the damage is done above (*supra*) the nuclei. Patients with PSP have difficulty with voluntary (willed) eye movement. At first, the difficulty only occurs in trying to look down. As the disease progresses, ability to move the eyes right and left is also affected. However, reflex or unwilled eye movements remain normal. Thus, when the patient's head is tilted upwards, the eyes move to look down. These reflex movements remain normal until late in the course of the disease. The upper eyelids may be pulled back, the eyebrows raised, and the brow wrinkled, causing a typical wide-eyed stare. Rate of blinking may decrease from the normal 20–30 per minute to three to five per minute. It becomes difficult to walk downstairs, to maintain eye contact during conversation, or to move the eyes up and down to read.

The earliest symptoms of PSP may be frequent falls or stiff, slow movements of the arms and legs. These symptoms may appear as much as five years before the characteristic vision problems. Walking becomes increasingly awkward, and some patients tend to lean and fall backward. Facial muscles may be weak, causing slurred speech and difficulty swallowing. Sleep may be disturbed and thought processes slowed. Although memory remains intact, the slowed speech and thought patterns and the rigid facial expression may be mistaken for senile **dementia** or **Alzheimer's disease**. Emotional responses may become exaggerated and inappropriate, and the patient may experience **anxiety**, depression, and agitation.

The cause of PSP is not known. Most people who develop PSP come from families with no history of the disease, so it does not seem to be inherited, except in certain rare instances. People who have PSP seem to lack the neurotransmitters dopamine and homovanillic acid in the basal ganglia. Neurotransmitters are chemicals that help carry electrical impulses along the nervous system. Transmitting structures in brain cells called neurofibrils become disorganized (neurofibrillary tangles). Neurofibrillary tangles are also found in Alzheimer's disease, but the pattern is somewhat different.

Diagnosis

PSP is sometimes mistaken for **Parkinson's disease**, which is also associated with stiffness, frequent falls, slurred speech, difficulty swallowing, and decreased spontaneous movement. The facial expression in Parkinson's, however, is blank or mask-like, whereas in PSP it is a grimace and wide-eyed stare. PSP does not cause the uncontrolled shaking (tremor) in muscles at rest that is associated with Parkinson's disease. Posture is stooped in Parkinson's disease, but erect in PSP. Speech is of low volume in both diseases, but is more slurred and irregular in rhythm in PSP.

Multiple strokes or abnormal accumulations of fluid within the skull (**hydrocephalus**) can also cause balance problems similar to PSP. **Magnetic resonance imaging** (MRI) scans of the brain may be needed to rule out these conditions. In advanced cases, MRI shows characteristic abnormalities in the brainstem described as "mouse ears."

Treatment

PSP cannot be cured. Drugs are sometimes given to relieve symptoms, but drug treatment is usually disappointing. Dopaminergic medications used in Parkinson's disease, such as levodopa (Sinemet), sometimes decrease stiffness and ease spontaneous movement. Anticholinergic medications, such as trihexyphenidyl (Artane), which restore function to neurotransmitters, or tricyclic drugs, such as amitriptyline (Elavil) may improve speech, walking, and inappropriate emotional responses.

Speech therapy may help manage the swallowing and speech difficulty in PSP. As the disease progresses, the difficulty in swallowing may cause the patient to choke and get small amounts of food in the lungs. This condition can cause aspiration **pneumonia**. The patient may also lose too much weight. In these cases, a feeding tube may be needed. The home environment should be modified to decrease potential injury from falls. Walkers can be weighted in front, to prevent backward falls and handrails can be installed in the bathroom. Because the patient cannot look down, low objects like throw rugs and coffee tables should be removed. Dry eyes from infrequent blinking can be treated with drops or ointments.

Prognosis

The patient's condition gradually deteriorates. After about seven years, balance problems and stiffness make it nearly impossible for the patient to walk. Persons with PSP become more and more immobile and unable to care for themselves. **Death** is not caused by the PSP itself. It is usually caused by pneumonia related to **choking** on secretions or by **starvation** related to swallowing difficulty. It usually occurs within 10 years, but if good general health and **nutrition** are maintained, the patient may survive longer.

Prevention

PSP cannot be prevented.

Resources

BOOKS

Brusa, A., and P. F. Peloso. *An Introduction to Progressive Supranuclear Palsy.* Rome: John Libby, 1993.

Golbe, L. I. *Progressive Supranuclear Palsy—Some Answers: A Guide for Patient and Family.* 3rd ed. Baltimore: Society for Progressive Supranuclear Palsy, 1994.

PERIODICALS

Hauw, J. J., et al. "Preliminary NINDS Neuropathologic Criteria for Steele-Richardson-Olszewski Syndrome (Progressive Supranuclear Palsy)." *Neurology* 44 (1994): 2015-2019.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Society for Progressive Supranuclear Palsy, Inc. Suite #5065 Johns Hopkins Outpatient Center, 601 N. Caroline St., Baltimore, MD 21287. (800) 457-4777. <http://www.psp.org>.

Laurie Barclay, MD

KEY TERMS

Basal ganglia—Brain structure at the base of the cerebral hemispheres, involved in controlling movement.

Brainstem—Brain structure closest to the spinal cord, involved in controlling vital functions, movement, sensation, and nerves supplying the head and neck.

Cerebellum—The part of the brain involved in coordination of movement, walking, and balance.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Parkinson's disease—A slowly progressive disease that destroys nerve cells. Parkinson's is characterized by shaking in resting muscles, a stooping posture, slurred speech, muscular stiffness, and weakness.

Progressive systemic sclerosis *see* **Scleroderma**

Prolactin test

Definition

Prolactin is a hormone secreted by the anterior portion of the pituitary gland (sometimes called the "master

gland"). Its role in the male has not been demonstrated, but in females, prolactin promotes **lactation**, or milk production, after **childbirth**.

Purpose

The prolactin test is used to diagnose pituitary dysfunction that might be caused by a tumor called an adenoma. In some circumstances, the test is also used to evaluate absence of menstrual periods (**amenorrhea**), or spontaneous production of milk (**galactorrhea**) by a woman who is not pregnant or lactating.

Precautions

Stress from trauma, illness, surgery, or even nervousness about a blood test can elevate prolactin levels. Drugs that may increase prolactin include phenothiazines, **oral contraceptives**, opiates, histamine antagonists, **monoamine oxidase inhibitors** (MAO inhibitors), estrogen, and **antihistamines**. Drugs that can decrease values include levodopa and dopamine.

KEY TERMS

Adenoma—A benign tumor

Amenorrhea—The absence or abnormal stoppage of menstrual periods.

Factor—Any of several substances necessary to produce a result or activity in the body. The term is used when the chemical nature of the substance is unknown. In endocrinology, when the chemical nature is known, factors are renamed hormones.

Galactorrhea—Excessive or spontaneous flow of milk.

Pituitary gland—A gland located at the base of the brain, and controlled by the hypothalamus. It controls most endocrine functions and is responsible for things such as kidney function, lactation, and growth and development.

Description

Prolactin is also known as the lactogenic hormone or lactogen. It is essential for the development of the mammary glands for lactation during **pregnancy**, and for stimulating and maintaining lactation after childbirth. Like the human growth hormone, prolactin acts directly on tissues, and its levels rise in response to sleep and to physical or emotional stress. During sleep, prolactin levels can increase to the circulating levels found in pregnant women (as high as ten to twenty times the normal level).

Prolactin secretion is controlled by prolactin-releasing and prolactin-inhibiting chemicals (factors) secreted by an area of the brain called the hypothalamus. Another hormone, thyroid-releasing hormone, or TRH, can also stimulate prolactin.

Tumors of the pituitary, called adenomas, are the most common cause of excessive levels of prolactin. Depending on the type of cell involved, these tumors are also called prolactin-secreting pituitary acidophilic or chromophobic adenomas. Moderately high prolactin levels are found to a lesser extent in women with secondary amenorrhea, galactorrhea, low thyroid, anorexia, and a disorder known as **polycystic ovary syndrome**, a disease whose cause is not well-known.

Because high prolactin levels are more likely due to pituitary adenoma than other causes, the prolactin level is used to diagnose and monitor this type of tumor. Several stimulation and suppression tests, with TRH or levodopa, respectively, have been designed to differentiate pituitary adenoma from other causes of prolactin overproduction.

Preparation

This test requires a blood sample that should be drawn in the morning at least two hours after the patient wakes (samples drawn earlier may show sleep-induced peak levels). The patient need not restrict food or fluids nor limit physical activity, but should relax for approximately 30 minutes before the test.

Risks

Risks posed by this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or lightheadedness after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges vary from laboratory to laboratory but are generally within the following values:

- adult male: 0–20 ng/ml.
- adult female: 0–20 ng/ml.
- pregnant female: 20–400 ng/ml.

Abnormal results

Increased prolactin levels are found in galactorrhea, amenorrhea, prolactin-secreting pituitary tumor, infiltrative diseases of the hypothalamus, and metastatic **cancer** of the pituitary gland. Higher levels than normal are seen in stress which may be produced by **anorexia nervosa**,

surgery, strenuous **exercise**, trauma, and in renal (kidney) failure.

Decreased prolactin levels are seen in Sheehan's syndrome, a condition of severe hemorrhage after obstetric delivery that causes decreased blood supply to the pituitary.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Prolactinoma *see* **Galactorrhea**

Prolapsed disk *see* **Herniated disk**

Prolonged QT syndrome

Definition

Prolonged QT syndrome, also known as long QT syndrome (LQTS), refers to a group of disorders that increase the risk for sudden **death** due to an abnormal heartbeat.

Description

Abnormal heartbeats (cardiac **arrhythmias**) are a primary cause of sudden death, especially in the young population. In the United States, an estimated 1 in 300,000 individuals per year die suddenly due to irregular heart rhythms. One of the better understood causes of these arrhythmias is LQTS.

The QT of LQTS refers to an interval between two points (Q and T) on the common electrocardiogram (ECG, EKG) used to record the electrical activity of the heart. This electrical activity, in turn, is the result of small molecules (ions such as sodium and potassium) passing in and out of channels in the membranes surrounding heart cells. A prolonged QT interval indicates an abnormality in electrical activity that leads to irregularities in heart muscle contraction. One of these irregularities is a specific pattern of very rapid contractions (tachycardia) of the lower chambers of the heart called torsade de pointes, a type of **ventricular tachycardia**. The rapid contractions, which are not effective in pumping blood to the body, result in a decreased flow of oxygen-rich blood to the brain. This can result in a sudden loss of consciousness (syncope) and death.

Causes and symptoms

Both inherited and acquired forms of LQTS have been identified. Most acquired forms are thought to be due to certain drugs including adrenaline (epinephrine), several **antihistamines** and **antibiotics**, specific heart medications, **diuretics**, and others. It has been proposed, but not yet documented, that individuals who experience LQTS after using one of these medications, may actually have a genetic defect that increases their tendency to cardiac arrhythmias. Severe weight loss such as is associated with **anorexia nervosa** can also disrupt ion balances in the heart and result in prolongation of the QT interval.

Three inherited forms of LQTS have been described to date. Jervell and Lange-Neilsen syndrome, named for the physicians who described the condition in 1957, is associated with congenital deafness and is inherited as an autosomal recessive trait. Romano-Ward syndrome, the most common inherited form of LQTS, was first described in the 1960's. It is inherited in an autosomal dominant pattern and is not associated with other physical impairments such as deafness. In 1995, a third type of LQTS was reported in to occur in association with bilateral syndactyly. Little is known about the inheritance of this form, except that reported cases have been sporadic with no associated family history of LQTS.

As of early 2001, six different genes have been associated with the inherited forms of LQTS, and mutations in at least four of these genes had been reported in a number of affected individuals and families. The genes involved in LQTS play important roles in the formation of ion channels in the cell membrane, and, thus, mutations in these genes disrupt normal cardiac rhythms.

LQTS usually presents with symptoms that constitute a life-threatening emergency. Sudden loss of consciousness or cardiac arrest can be brought on by emotional or physical **stress** in young, otherwise healthy individuals, both female and male. Fright, anger, surprise, sudden awakening as a result of loud sounds (alarm clock, telephone), as well as physical activities, especially swimming, have all been reported to precipitate an episode of cardiac arrhythmia in susceptible individuals. Sudden death often occurs. Although the information is preliminary, recent research has also suggested that a small number of SIDS (**sudden infant death syndrome**) cases may be due to mutations in one or more of the genes associated with LQTS.

KEY TERMS

Anorexia nervosa—A loss of appetite for food not explainable by local disease. It is thought to have a psychological basis.

Autosomal dominant—A pattern of inheritance in which only one of the two copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is a gene that is located on one of the autosomes or non-sex chromosomes. A person with an autosomal dominant disorder has a 50% chance of passing it to each of their offspring.

Autosomal recessive—A pattern of inheritance in which both copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is a gene that is located on one of the autosomes or non-sex chromosomes. When both parents have one abnormal copy of the same gene, they have a 25% chance with each pregnancy that their offspring will have the disorder.

Diuretic—An agent that increases the production of urine.

Electrocardiogram—A record of the electrical activity of the heart showing certain waves called P, Q, R, S, and T waves. The Q, R, S, T waves are associated with contraction of the ventricles, the lower two chambers of the heart.

Sympathetic nervous system—A division of the autonomic nervous sytem, the portion of the nervous system that controls involuntary bodily functions such as heart rate.

Syndactyly—A fusion of two or more toes or fingers.

Diagnosis

Problems exist in diagnosing LQTS. Although the method of diagnosis is the electrocardiogram, most young, healthy people do not routinely undergo this test, and, thus, their first, and possibly fatal, episode of LQTS comes without warning. In some cases, a non-fatal episode is mistakenly treated as a seizure, and, therefore, a follow-up assessment does not include an electrocardiogram. In addition, some cases of LQTS cannot be diagnosed by a routine electrocardiogram. That is, the QT interval is not found to be prolonged in routine testing. If LQTS is suspected either because of a previous episode of syncope or because of a family member with LQTS, an **exercise** electrocardiogram should be performed. In all instances where an individual is diagnosed with LQTS, family members should be thoroughly evaluated, and a detailed family history should be taken noting any individuals with episodes of sudden loss of consciousness and any cases of unexplained sudden death. Because many of the genes involved in LQTS have been identified, **genetic testing** can offer a more reliable means of diagnosis of other family members at risk. The first step in determining if this type of testing is appropriate in any particular situation is to consult a genetic counselor or medical geneticist.

Treatment

A conventional treatment is the oral administration of beta-blockers, medications that decrease the input from the sympathetic nervous system to the heart. Although beta-blockers do not correct the abnormalities in the ion channels of the heart cells, they do appear to decrease the occurrence of cardiac arrhythmias. However, these medications are not helpful in all cases, and are actually contraindicated in some individuals. Potassium supplementation is also being explored as a treatment in certain cases. As the genetics of LQTS becomes better understood, it should be possible to tailor treatments that will be effective for each of the various gene mutations.

Alternative treatment

In some patients, severing of the sympathetic nerve to the heart has decreased the occurrence of arrhythmias. **Pacemakers** and defibrillators appear to hold promise as new forms of treatment. As devices of this type are developed that are smaller in size, they may come into more widespread use, either alone or in conjunction with specific medications.

Prognosis

LQTS is a life-long condition. Individuals who are not diagnosed and treated are at an increased risk of syncope and sudden death. Adequate treatment can decrease this risk. There is no cure. Individuals with one of the inherited forms of LQTS are at risk of passing the mutation and the disease to their offspring.

Prevention

The risk of cardiac arrhythmias due to acquired forms of LQTS can be decreased by avoiding the medications and situations that trigger episodes. At present there is no genetic therapy to correct the gene mutations present in the inherited forms of LQTS, but individuals who are known to have an inherited form may also be able to lessen the risk of a life-threatening episode by avoiding such environmental triggers and by taking the appropriate medications.

Resources

BOOKS

Keating, Mark T. and Sanguinetti, Michael C. "Familial Cardiac Arrhythmias." In *The Metabolic & Molecular Bases of Inherited Disease, ed.* C.R. Scriver et al. New York: McGraw-Hill Press, 2001

PERIODICALS

Towbin, Jeffrey A. and Vatta, Matteo. "Molecular Biology and the Prolonged QT Syndromes" *American Journal of Medicine* 110 (April 2001): 385–398.

Vizgirda, Vida M. "The Genetic Basis for Cardiac Dysrhythmias and the Long QT Syndrome *J. Cardiovasc Nursing* 13 no. 4 (1999): 34–45.

ORGANIZATIONS

Sudden Arrhythmia Death Syndromes Foundation. 540 Arapeen Drive, Suite 207, Salt Lake City, Utah 84108. (800) STOP SAD. <http://www.sads.org>. or <http://www.ihc.com/research/longqt.html>.

OTHER

NORD (National Organization for Rare Disorders, Inc.). <http://www.rarediseases.org/cgi-bin/nord>.

American Heart Association. <http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/longqt.html>.

Sallie Freeman, PhD

PROM *see* **Premature rupture of membranes**

Promethaz *see* **Antihistamines**

Prophylaxis

Definition

A prophylaxis is a measure taken to maintain health and prevent the spread of disease. Antibiotic prophylaxis is the focus of this article and refers to the use of **antibiotics** to prevent infections.

Purpose

Antibiotics are well known for their ability to treat infections. But some antibiotics also are prescribed to *prevent* infections. This usually is done only in certain situations or for people with particular medical problems. For example, people with abnormal heart valves have a high risk of developing heart valve infections after even minor surgery. This happens because bacteria from other parts of the body get into the bloodstream during surgery and travel to the heart valves. To prevent these infections, people with heart valve problems often take antibiotics before having any kind of surgery, including dental surgery.

Antibiotics also may be prescribed to prevent infections in people with weakened immune systems, such as people with **AIDS** or people who are having **chemotherapy** treatments for **cancer**. But even healthy people with strong immune systems may occasionally be given preventive antibiotics—if they are having certain kinds of surgery that carry a high risk of infection, or if they are traveling to parts of the world where they are likely to get an infection that causes **diarrhea**, for example.

In all of these situations, a physician should be the one to decide whether antibiotics are necessary. Unless a physician says to do so, it is not a good idea to take antibiotics to prevent ordinary infections.

Because the overuse of antibiotics can lead to resistance, drugs taken to prevent infection should be used only for a short time.

Description

Among the drugs used for antibiotic prophylaxis are amoxicillin (a type of penicillin) and **fluoroquinolones** such as ciprofloxacin (Cipro) and trovafloxacin (Trovan). These drugs are available only with a physician's prescription and come in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of antibiotic prescribed and the reason it is being used. For the correct dosage, check with the physician or dentist who prescribed the medicine or the pharmacist who filled the prescription. Be sure to take the medicine exactly as prescribed. Do not take more or less than directed, and take the medicine only for as long as the physician or dentist says to take it.

Precautions

If the medicine causes nausea, vomiting, or diarrhea, check with the physician or dentist who prescribed it as

KEY TERMS

AIDS—Acquired immunodeficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, opening the door to other infections and some types of cancer.

Antibiotic—A medicine used to treat infections.

Chemotherapy—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs.

Immune system—The body's natural defenses against disease and infection.

soon as possible. Patients who are taking antibiotics before surgery should not wait until the day of the surgery to report problems with the medicine. The physician or dentist needs to know right away if problems occur.

For other specific precautions, see the entry on the type of drug prescribed such as **penicillins** or fluoroquinolones.

Side effects

Antibiotics may cause a number of side effects. For details, see entries on specific types of antibiotics. Anyone who has unusual or disturbing symptoms after taking antibiotics should get in touch with his or her physician.

Interactions

Whether used to treat or to prevent infection, antibiotics may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antibiotics for any reason should inform the physician about all the other medicines he or she is taking and should ask whether any possible interactions may interfere with drugs' effects. For details of drug interactions, see entries on specific types of antibiotics.

Nancy Ross-Flanigan

Proportionate dwarfism *see* **Pituitary dwarfism**

Proptosis *see* **Exophthalmos**

Prostaglandins *see* **Drugs used in labor**

Prostate biopsy

Definition

Prostate biopsy is a surgical procedure that involves removing a small piece of prostate tissue for microscopic examination.

Purpose

This test is usually done to determine whether the patient has **prostate cancer**. Occasionally, it may also be used to diagnose a condition called benign prostatic hyperplasia that causes enlargement of the prostate. In the United States, prostate **cancer** is the most common cancer among men over 50, and is the second leading cause of cancer deaths.

Prostate biopsy is recommended when a digital **rectal examination** (a routine screening test for prostate diseases) reveals a lump or some other abnormality in the prostate. In addition, if blood tests reveal that the levels of certain markers, such as PSA, are above normal, the doctor may order a biopsy.

Description

The prostate gland is one of the three male sex glands and lies just below the urinary bladder, in the area behind the penis and in front of the rectum. It secretes semen, the liquid portion of the ejaculate. The urethra carries the urine from the urinary bladder and the semen from the sex glands to the outside of the body.

Prostate biopsies can be performed in three different ways. They can be performed by inserting a needle through the perineum (the area between the base of the penis and the rectum), by inserting a needle through the wall of the rectum, or by cytoscopy. Before the procedure is performed, the patient may be given a sedative to help him relax. Patients undergoing cytoscopy may be given either general anesthesia or local anesthesia. The doctor will ask the patient to have an enema before carrying out the biopsy. The patient is also given **antibiotics** to prevent any possible infection.

Needle biopsy via the perineum

The patient lies either on one side or on his back with his knees up. The skin of the perineum is thoroughly cleansed with an iodine solution. A local anesthetic is injected at the site where the biopsy is performed. Once

KEY TERMS

Benign prostatic hyperplasia (BPH)— A noncancerous condition of the prostate that causes growth of the prostate tissue, thus enlarging the prostate and obstructing urination.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Computed tomography (CT) scan—A medical procedure in which a series of x rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Digital rectal examination—A routine screening test that is used to detect any lumps in the prostate gland or any hardening or other abnormality of the prostate tissue. The doctor inserts a gloved and lubricated finger (digit) into the patient's rectum, which lies just behind the prostate. Typically, since a majority of tumors develop in the posterior region of the prostate, they can be detected through the rectum.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes where pictures of areas inside the body are created using a magnet linked to a computer.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Ultrasonogram—A procedure in which high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes that are then used by the computer to create sonograms or pictures of areas inside the body.

Urethra—The tube that carries the urine from the urinary bladder and the semen from the sex glands to the outside of the body.

the area is numb, the doctor makes a small (1 in) incision in the perineum. The doctor places one finger in the rectum to guide the placement of the needle. The needle is then inserted into the prostate, a small amount of tissue is collected, and the needle is withdrawn. The needle is then re-inserted into another part of the prostate. Tissue may be taken from several areas. Pressure is then applied at the biopsy site to stop the bleeding. The procedure generally takes 15-30 minutes and is usually done in a physician's office or in a hospital operating room. Though it sounds painful, it typically causes only slight discomfort.

Needle biopsy via the rectum

This procedure is also done in the physician's office or in the hospital operating room, and is usually done without any anesthetic. The patient is asked to lie on his side or on his back with his legs in stirrups. The doctor attaches a curved needle guide to his finger and then inserts the finger into the rectum. After firmly placing the needle guide in the rectum, the biopsy needle is pushed along the guide, through the wall of the rectum and into the prostate. The needle is rotated gently, prostate tissue samples are collected and the needle withdrawn.

Cytoscopy

For this procedure, the patient is given either a general or a local anesthetic. An instrument called a cytoscope (a thin-lighted tube with telescopic lenses) is passed through the urethra. By looking through the cytoscope, the doctor can see if there is any blockage in the urethra and remove it. Tissue samples from the urinary bladder or the prostate can be collected for microscopic examination.

This test is generally performed in an operating room or in a physician's office. An hour before the procedure, the patient is given a sedative to help him relax. An intravenous (IV) line will be placed in a vein in the arm to give medications and fluids if necessary. The patient is asked to lie on a special table with his knees apart and stirrups are used to support his feet and thighs. The genital area is cleansed with an antiseptic solution. If general anesthesia is being used, the patient is given the medication through the IV tube or inhaled gases or both. If a local anesthetic is being used, the anesthetic solution is gently instilled into the urethra.

After the area is numb, a cytoscope is inserted into the urethra and slowly pushed into the prostate. Tiny forceps or scissors are inserted through the cytoscope to collect small pieces of tissue that are used for biopsy. The cytoscope is then withdrawn. The entire procedure may take 30–45 minutes. Sometimes a catheter (tube) is left in the urinary bladder to help the urine drain out, until the swelling in the urethra has subsided.

Alternate procedures

Many different tests can be performed to diagnose prostate diseases and cancer. A routine screening test

called digital rectal examination (DRE) can identify any lumps or abnormality with the prostate. Blood tests that measure the levels of certain protein markers, such as PSA, can indicate the presence of prostate cancer cells. X rays and other imaging techniques (such as **computed tomography scans**, **magnetic resonance imaging**, and ultrasonograms), where detailed pictures of areas inside the body are put together by a computer, can also be used to determine the extent and spread of the disease. However, a prostate biopsy and examination of the cells under a microscope remains the most definitive test for diagnosing and grading prostate cancer.

Preparation

Before scheduling the biopsy, the doctor should be made aware of all the medications that the patient is taking, if the patient is allergic to any medication, and if he has any bleeding problems. The patient may be given an antibiotic shortly before the test to reduce the risk of any infection afterwards. If the biopsy is done through the perineum, there are no special preparations. If it is being done through the rectum, the patient is asked to take an enema and is instructed on how to do it.

If a cytoscopy is being performed, the patient is asked to sign a consent form. The patient is also asked to take antibiotics before and for several days after the test to prevent infection due to insertion of the instruments. If a general anesthetic is going to be used, food and liquids will be restricted for at least eight hours before the test.

Aftercare

Following a needle biopsy, the patient may experience some **pain** and discomfort. He should avoid strenuous activities for the rest of the day. He may also notice some blood in his urine for two to three days after the test and some amount of rectal bleeding. If there is persistent bleeding, pain, or **fever**, and if the patient is unable to urinate for 24 hours, the doctor should be notified immediately.

When a cytoscopy is performed under a local anesthetic, the patient is asked to lie down for 30 minutes after the test and is then allowed to go. If general anesthesia is used, the patient is taken to the recovery room and kept there until he wakes up and is able to walk. He is allowed food and liquids after he wakes up. After general anesthesia, the patient may experience some tiredness and aching of the muscles throughout the body. If local anesthesia was administered, there is a brief burning sensation and a strong urge to urinate when the cytoscope is removed.

After the procedure, it is common to experience frequent urination with a burning sensation for a few days. Drinking a lot of fluids will help reduce the burning sensation and the chances of an infection. There may also be some blood in the urine. However, if blood clots are seen, or if the patient is unable to pass urine eight hours after the cytoscopy, the doctor should be notified. In addition, if the patient develops a high fever, and complains of chills or abdominal pain after the procedure, he should see the doctor right away.

Risks

Prostate biopsy performed with a needle is a low-risk procedure. The possible complications include some bleeding into the urethra, an infection, or an inability to urinate. These complications are treatable and the doctor should be notified of them.

Cytoscopy is generally a very safe procedure. The most common complication is an inability to urinate due to a swelling of the urethra. A catheter (tube) may have to be inserted to help drain out the urine. If there is an infection after the procedure, antibiotics are given to treat it. In very rare instances, the urethra or the urinary bladder may be perforated because of the insertion of the instrument. If this occurs, surgery may be needed to repair the damage.

Normal results

If the prostate tissue samples show no sign of inflammation, and if no cancerous cells are detected, the results are normal.

Abnormal results

Analysis of the prostate tissue under the microscope reveals any abnormalities. In addition, the presence of cancerous cells can be detected. If a tumor is present, the pathologist "grades" the tumor, in order to estimate how aggressive the tumor is. The most commonly used grading system is called the "Gleason system."

Normal prostate tissue has certain characteristic features that the cancerous tissue lacks. In the Gleason system, prostate cancers are graded by how closely they resemble normal prostate tissue. The system assigns a grade ranging from 1 to 5. The grades assigned to two areas of cancer are added up for a combined score that is between 2 and 10. A score between 2 and 4 is called low and implies that the cancer is a slow-growing one. A Gleason score of 8 to 10 is high and indicates that the cancer is aggressive. The higher the Gleason score, the more likely it is that the cancer is fast-growing and may have already grown out of the prostate and spread to other areas (metastasized).

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Sobel, David S., and T. Ferguson. *The People's Book of Medical Tests.* New York: Summit Books, 1985.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

American Urologic Association. 1120 N. Charles St., Baltimore, MD 21201. (410) 223-4310.

National Prostate Cancer Coalition. 1300 19th Street NW, Suite 400, Washington, DC 20036. (202) 842-3600 ext. 214.

The Prostate Cancer InfoLink. <http://www.comed.com/Prostate/index.html>.

Lata Cherath, PhD

Prostate cancer

Definition

Prostate **cancer** is a disease in which cells of the prostate become abnormal and start to grow uncontrollably, forming tumors.

Description

Prostate cancer is a malignancy of one of the major male sex glands. Along with the testicles and the seminal vesicles, the prostate secretes the fluid that makes up semen. The prostate is about the size of a walnut and lies just behind the urinary bladder. A tumor in the prostate interferes with proper control of the bladder and normal sexual functioning. Often the first symptom of prostate cancer is difficulty in urinating. However, because a very common, non-cancerous condition of the prostate, benign prostatic hyperplasia (BPH), also causes the same problem, difficulty in urination is not necessarily due to cancer.

Cancerous cells within the prostate itself are generally not deadly on their own. However, as the tumor grows, some of the cells break off and spread to other parts of the body through the lymph or the blood, a process known as metastasis. The most common sites for prostate cancer to metastasize are the seminal vesicles, the lymph nodes, the lungs, and various bones around the hips and the pelvic region. The effects of these new tumors are what can cause **death**.

Second only to skin cancer, the American Cancer Society estimates that in 2000 at least 180,400 new cases of prostate cancer were diagnosed. Of this number, the disease will cause at least 31,900 deaths. Although prostate cancer is often very slow growing, it can be aggressive, especially in younger men. Given its slow growing nature, many men with the disease die of other causes rather than from the cancer itself.

Prostate cancer affects African-American men twice as often as white men and the mortality rate among African-Americans is also two times higher. African-Americans have the highest rate of prostate cancer of any world population group.

Causes and symptoms

The precise cause of prostate cancer is not known. However, there are several known risk factors for disease including age over 55, African-American heritage, a family history of the disease, occupational exposure to cadmium or rubber, and a high fat diet. Men with high plasma testosterone levels may also have an increased risk for developing prostate cancer.

Frequently, prostate cancer has no symptoms and the disease is diagnosed when the patient goes for a routine screening examination. However, when the tumor is big or the cancer has spread to the nearby tissues, the following symptoms may be seen:

- weak or interrupted flow of the urine
- frequent urination (especially at night)
- difficulty starting urination
- inability to urinate
- **pain** or burning sensation when urinating
- blood in the urine
- persistent pain in lower back, hips, or thighs (bone pain)
- painful ejaculation.

Diagnosis

Prostate cancer is curable when detected early. Yet the early stages of prostate cancer are often asymptomatic, so the disease often goes undetected until the patient has a routine **physical examination**. Diagnosis of prostate cancer can be made using some or all of the following tests.

Digital rectal examination (DRE)

In order to perform this test, the doctor puts a gloved, lubricated finger (digit) into the rectum to feel for any lumps in the prostate. The rectum lies just behind the prostate gland, and a majority of prostate tumors

KEY TERMS

Antiandrogen—A substance that blocks the action of androgens, the hormones responsible for male characteristics. Used to treat prostate cancers that require male hormones for growth.

Benign prostate hyperplasia (BPH)—A non-cancerous swelling of the prostate.

Brachytherapy—A method of treating cancers, such as prostate cancer, involving the implantation near the tumor of radioactive seeds.

Gleason grading system—A method of predicting the tendency of a tumor in the prostate to metastasize based on how similar the tumor is to normal prostate tissue.

Granulocyte/macrophage colony stimulating factor (GM-CSF)—A substance produced by cells of the immune system that stimulates the attack upon foreign cells. Used to treat prostate cancers as a genetically engineered component of a vaccine that stimulates the body to attack prostate tissue.

Histopathology—The study of diseased tissues at a minute (microscopic) level.

Luteinizing hormone releasing hormone (LHRH) agonist—A substance that blocks the action of LHRH, a hormone that stimulates the production of testosterone (a male hormone) in men. Used to treat prostate cancers that require testosterone for growth.

Orchiectomy—Surgical removal of the testes that eliminates the production of testosterone to treat prostate cancer.

Radical prostatectomy—Surgical removal of the entire prostate, a common method of treating prostate cancer.

Prostate-specific antigen—A protein made by the cells of the prostate that is increased by both BPH and prostate cancer.

Transurethral resection of the prostate (TURP)—Surgical removal of a portion of the prostate through the urethra, a method of treating the symptoms of an enlarged prostate, whether from BPH or cancer.

begin in the posterior region of the prostate. If the doctor does detect an abnormality, he or she may order more tests in order to confirm these findings.

Blood tests

Blood tests are used to measure the amounts of certain protein markers, such as prostate-specific antigen (PSA), found circulating in the blood. The cells lining the prostate generally make this protein and a small amount can be detected normally in the bloodstream. In contrast, prostate cancers produce a lot of this protein, significantly raising the circulating levels. A finding of a PSA level higher than normal for the patient's age group therefore suggests that cancer is present.

Transrectal ultrasound

A small probe is placed in the rectum and sound waves are released from the probe. These sound waves bounce off the prostate tissue and an image is created. Since normal prostate tissue and prostate tumors reflect the sound waves differently, the test is an efficient and accurate way to detect tumors. Though the insertion of the probe into the rectum may be slightly uncomfortable, the procedure is generally painless and takes only 20 minutes.

Prostate biopsy

If cancer is suspected from the results of any of the above tests, the doctor will remove a small piece of prostate tissue with a hollow needle. This sample is then checked under the microscope for the presence of cancerous cells. **Prostate biopsy** is the most definitive diagnostic tool for prostate cancer.

Prostate cancer can also be diagnosed based on the examination of the tissue removed during a transurethral resection of the prostate (TURP). This procedure is performed to help alleviate the symptoms of BPH, a benign enlargement of the prostate. Like a biopsy, this is a definitive diagnostic method for prostate cancer.

X rays and imaging techniques

A **chest x ray** may be ordered to determine whether the cancer has spread to the lungs. Imaging techniques (such as **computed tomography scans** (CT) and **magnetic resonance imaging** (MRI)), where a computer is used to generate a detailed picture of the prostate and areas nearby, may be done to get a clearer view of the internal organs. A bone scan may be used to check whether the cancer has spread to the bone.

Treatment

Once cancer is detected during the microscopic examination of the prostate tissue during a biopsy or TURP, doctors will determine two different numerical scores that will help define the patient's treatment and prognosis.

Tumor grading

Initially, the pathologist will grade the tumor based on his or her examination of the biopsy tissue. The pathologist scores the appearance of the biopsy sample using the Gleason system. This system uses a scale of one to five based on the sample's similarity or dissimilarity to normal prostate tissue. If the tissue is very similar to normal tissue, it is still well differentiated and given a low grading number, such as one or two. As the tissue becomes more and more abnormal (less and less differentiated), the grading number increases, up to five. Less differentiated tissue is considered more aggressive and more likely to be the source of metastases.

The Gleason grading system is best predictive of the prognosis of a patient if the pathologist gives two scores to a particular sample—a primary and a secondary pattern. The two numbers are then added together and that is the Gleason score reported to the patient. Thus, the lowest Gleason score available is two (a primary and secondary pattern score of one each). A typical Gleason score is five (which can be a primary score of two and a secondary score of three or visa-versa). The highest score available is 10, with a pure pattern of very undifferentiated tissue, that is, of grade five. The higher the score, the more abnormal behavior of the tissue, the greater the chance for metastases, and the more serious the prognosis after surgical treatment. A study found that the ten-year cancer survival rate without evidence of disease for grade two, three, and four cancers is 94% of patients. The rate is 91% for grade five cancers, 78% for grade six, 46% for grade seven, and 23% for grade eight, nine, and ten cancers.

Cancer staging

The second numeric score determined by the doctor will be the stage of the cancer, which takes into account the grade of the tumor determined by the pathologist. Based on the recommendations of the American Joint Committee on Cancer (AJCC), two kinds of data are used for staging prostate cancer. Clinical data are based on the external symptoms of the cancer, while histopathological data is based on surgical removal of the prostate and examination of its tissues. Clinical data are most useful to make treatment decisions, while pathological data is the best predictor of prognosis. For this reason, the staging of prostate cancer takes into account both clinical and histopathologic information. Specifically, doctors look at tumor size (T), lymph node involvement (N), the presence of visceral (internal organ) involvement (metastasis = M), and the grade of the tumor (G).

The classification of tumor as T1 means the cancer that is confined to the prostate gland and the tumor that is too small to be felt during a DRE. T1 tumors are often found after examination of tissue removed during a TURP. The T1 definition is subdivided into those cancers that show less than 5% cancerous cells in the tissue sample (T1a) or more than 5% cancerous cells in the tissue sample (T1b). T1c means that the biopsy was performed based on an elevated PSA result. The second tumor classification is T2, where the tumor is large enough to be felt during the DRE. T2a indicates that only the left or the right side of the gland is involved, while T2b means both sides of the prostate gland has tumor.

With a T3 tumor the cancer has spread to the connective tissue near the prostate (T3a) or to the seminal vesicles as well (T3b). T4 indicates that cancer has spread within the pelvis to tissue next to the prostate such as the bladder's sphincter, the rectum, or the wall of the pelvis. Prostate cancer tends to spread next into the regional lymph nodes of the pelvis, indicated as N1. Prostate cancer is said to be at the M1 stage when it has metastasized outside the pelvis in distant lymph nodes (M1a), bone (M1b) or organs such as the liver or the brain (M1c). Pain, weight loss, and fatigue often accompany the M1 stage.

The grade of the tumor (G) can assessed during a biopsy, TURP surgery, or after removal of the prostate. There are three grades recognized: G1, G2, and G3, indicating the tumor is well, moderately, or poorly differentiated, respectively. The G, LN, M descriptions are combined with the T definition to determine the stage of the prostate cancer.

Stage I prostate cancer comprises patients that are T1a, N0, M0, G1. Stage II includes a variety of condition combinations including T1a, N0, M0, G2, 3 or 4; T1b, N0, M0, Any G; T1c, N0, M0, Any G; T1, N0, M0, Any G or T2, N0, M0, Any G. The prognosis for cancers at these two stages is very good. For men treated with stage I or stage II disease, over 95% are alive after five years.

Stage III prostate cancer occurs when conditions are T3, N0, M0, any G. Stage IV is T4, N0, M0, any G; any T, N1, M0, any G; or any T, any N, M1, Any G. Although the cancers of Stage III are more advanced, the five year prognosis is still good, with 70% of men diagnosed at these stage still living. The spread of the cancer into the pelvis (T4), lymph (N1), or distant locations (M1) are very significant events, as the five year survival rate drops to 30% for Stage IV.

Treatment options

The doctor and the patient will decide on the treatment mode after considering many factors. For example, the patient's age, the stage of the disease, his general health, and the presence of any co-existing illnesses have to be considered. In addition, the patient's personal preferences and the risks and benefits of each treatment protocol are also taken into account before any decision is made.

SURGERY. For stage I and stage II prostate cancer, surgery is the most common method of treatment because it theoretically offers the chance of completely removing the cancer from the body. Radical **prostatectomy** involves complete removal of the prostate. The surgery can be done using a perineal approach, where the incision is made between the scrotum and the anus, or using a retropubic approach, where the incision is made in the lower abdomen. Perineal approach is also known as nerve-sparing prostatectomy, as it is thought to reduce the effect on the nerves and thus reduce the side effects of impotence and incontinence. However, the retropubic approach allows for the simultaneous removal of the pelvic lymph nodes, which can give important pathological information about the tumor spread.

The drawback to surgical treatment for early prostate cancer is the significant risk of side effects that impact the quality of life of the patient. Even using nerve-sparing techniques, studies run by the National Cancer Institute (NCI) found that 60–80% of men treated with radical prostatectomy reported themselves as impotent (unable to achieve an erection sufficient for sexual intercourse) two years after surgery. This side effect can be sometimes countered by prescribing sildenafil citrate (Viagra). Furthermore, 8% to 10% of patients were incontinent in that time span. Despite the side effects, the majority of men were reported as satisfied with their treatment choice. Additionally, there is some evidence that the skill and the experience of the surgeon are central factors in the ultimate side effects seen.

A second method of surgical treatment of prostate cancer is cryosurgery. Guided by ultrasound, surgeons insert up to eight cryoprobes through the skin and into close proximity with the tumor. Liquid nitrogen (temperature of -320.8°F, or -196°C) is circulated through the probe, freezing the tumor tissue. In prostate surgery, a warming tube is also used to keep the urethra from freezing. Patients currently spend a day or two in the hospital following the surgery, but it could be an outpatient procedure in the near future. Recovery time is about one week. Side effects have been reduced in recent years, although impotence still affects almost all who have had cryosurgery for prostate cancer. Cryosurgery is considered a good alternative for those too old or sick to have traditional surgery or radiation treatments or when these more traditional treatments are unsuccessful. There is a limited amount of information about the long-term efficacy of this treatment for prostate cancer.

RADIATION THERAPY. **Radiation therapy** involves the use of high-energy x rays to kill cancer cells or to shrink tumors. It can be used instead of surgery for stage I and II cancer. The radiation can either be administered from a machine outside the body (external beam radiation), or small radioactive pellets can be implanted in the prostate gland in the area surrounding the tumor, called brachytherapy or interstitial implantation. Pellets containing radioactive iodine (I-125), palladium (Pd 103), or iridium (Ir 192) can be implanted on an outpatient basis, where they remain permanently. The radioactive effect of the seeds last only about a year.

The side effects of radiation can include inflammation of the bladder, rectum, and small intestine. **Impotence** and incontinence are often delayed side effects of the treatment. A study indicated that bowel control problems were more likely after radiation therapy when compared to surgery, but impotent and incontinence were more likely after surgical treatment. Long-term results with radiation therapy are dependent on stage. A review of almost 1000 patients treated with megavoltage irradiation showed 10 year survival rates to be significantly different by T-stage: T1 (79%), T2 (66%), T3 (55%), and T4 (22%). There does not appear to be a large difference in survival between external beam or interstitial treatments.

HORMONE THERAPY. Hormone therapy is commonly used when the cancer is in an advanced stage and has spread to other parts of the body, such as stage III or stage IV. Prostate cells need the male hormone testosterone to grow. Decreasing the levels of this hormone, or inhibiting its activity, will cause the cancer to shrink. Hormone levels can be decreased in several ways. Orchiectomy is a surgical procedure that involves complete removal of the testicles, leading to a decrease in the levels of testosterone. Another method "tricks" the body by administering the female hormone estrogen. When this is given, the body senses the presence of a sex hormone and stops making the male hormone testosterone. However, there are some unpleasant side effects to hormone therapy. Men may have "hot flashes," enlargement and tenderness of the breasts, or impotence and loss of sexual desire, as well as blood clots, heart attacks, and strokes, depending on the dose of estrogen.

WATCHFUL WAITING. Watchful waiting means no immediate treatment is recommended, but doctors keep the patient under careful observation. This is often done using periodic PSA tests. This option is generally used in older patients when the tumor is not very aggressive and the patients have other, more life-threatening, illnesses.

Prostate cancer in older men tends to be slow-growing. Therefore, the risk of the patient dying from prostate cancer, rather than from other causes, is relatively small.

Alternative treatment

A mixture of eight Chinese herbs have been tested in the treatment of prostate cancer that does not respond to hormone therapy. The mixture is called PC-SPES and is believed to stimulate the production of hormones in the body. In a small study, the herbal mixture causes a drop of 52% in PSA levels for 87% of the study participants. The herb mixture does have side effects, including blood clots and nipple tenderness and the potency of the herbs suffers from batch variation.

Prevention

Because the cause of the cancer is not known, there is no definite way to prevent prostate cancer. Given its common occurrence and the low cost of screening, the American Cancer Society (ACS) and the National Comprehensive Cancer Network (NCCN) recommends that all men over age 40 have an annual **rectal examination** and that men have an annual PSA test beginning at age 50. African-American men and men with a family history of prostate cancer, who have a higher than average risk, should begin annual PSA testing even earlier, starting at age 45.

However, mandatory screening for prostate cancer is controversial. Because the cancer is so slow growing, and the side effects of the treatment can have significant impact on patient quality of life, some medical organizations question the wisdom of yearly exams. Some organizations have even noted that the effect of screening is discovering the cancer at an early stage when it may never grow to have any outward effect on the patient during their lifetime. Nevertheless, the NCI reports that the current aggressive screening methods have achieved a reduction in the death rate of prostate cancer of about 2.3% for African-Americans and about 4.6% for Caucasians since the mid-1990s, with a 20% increase in overall survival rate during that period.

A low fat diet may slow the progression of prostate cancer. To reduce the risk or progression of prostate cancer, the American Cancer Society recommends a diet rich in fruits, vegetables and dietary fiber, and low in red meat and saturated fats.

Resources

BOOKS

Carroll, Peter R., et al. "Cancer of the Prostate." In *Cancer Principles and Practice of Oncology,* Devita, Vincent T., et al., eds. Philadelphia: Lippincott Williams & Wilkins, 2001.

Wainrib, Barbara R., and Sandra Haber. *Men, Women, and Prostate Cancer.* Oakland, CA: New Harbinger Productions, Inc., 2000.

PERIODICALS

Nelson, W.G., et al. "Cancer Cells Engineered to Secrete Granulocyte-Macrophage Colony-Stimulating Factor Using Ex Vivo Gene Transfer as Vaccines for the Treatment of Genitourinary Malignanacies." *Cancer Chemotherapy and Pharmacology* 46 (2000): S67–72.

ORGANIZATIONS

National Cancer Institute. Building 31, Room 10A31 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 4-CANCER. <http://cancernet.nci.nih.gov>.

The Association for the Cure of Cancer of the Prostate (CaPCure). 1250 Fourth St., Suite 360, Santa Monica, CA 90401. (800) 757-CURE. <http://www.capcure.org>.

OTHER

"Using Herbs to Fight Prostate Cancer." *HealthScout@CancerOnline* 30 May 2000. 18 July 2001. <http://www.healthscout.com>.

Lata Cherath
Michelle Johnson, MS, JD

Prostate gland removal *see* **Prostatectomy**

Prostate sonogram *see* **Prostate ultrasound**

Prostate-specific antigen test

Definition

Prostate-specific antigen, or PSA, is a protein produced by the prostate gland that may be found in elevated levels in the blood when a person develops certain diseases of the prostate, notably **prostate cancer**. PSA is *specific*, because it is present only in prostate tissue. It is not specific for prostate *cancer*, however, as it may also be elevated in men with benign enlargement of this organ. The PSA test has been called the "male PAP test."

Purpose

The blood test for PSA is used to screen older men to detect prostate **cancer** at an early stage, and also to monitor its response to treatment. After lung cancer, prostate cancer is the most common form of cancer in men in the United States. Any routine physical exam of a man aged 50 and older should include a digital **rectal examination** (DRE), in which the doctor's finger probes the surface of the prostate gland to detect any suspicious area of hardness or a tumor mass. If the examination suggests that a tumor may in fact be present or if the examin-

er is uncertain the logical next step is a PSA test. If the PSA test is positive, a sample of prostate tissue (biopsy) may be taken to confirm that cancer is present. If negative, the test may be repeated immediately to confirm the diagnosis, or repeated the next year. Many physicians today routinely do both a DRE and a PSA test each year on their older male patients, so that, if cancer does develop, it will be found at an early stage will be easier to treat. The combination of a DRE and a PSA test can detect approximately 80% of all prostate cancers.

At present, the PSA test is widely accepted as a way of telling whether a patient with definite cancer is responding to treatment. Because only the prostate produces PSA, its presence in the blood following complete removal of the prostate (radical **prostatectomy**) indicates that some cancer has been left behind.

Precautions

There is no physical reason not to do a PSA test. Although, the level of PSA usually is elevated in men with prostate cancer, it also may be abnormally high (though usually not *as* high) in men with non-cancerous enlargement of the prostate (benign prostatic hyperplasia or BPH). If thousands of men have the PSA test routinely each year, many of them will have unnecessary tests (such as biopsy or an ultrasound study) to confirm cancer. If a "false-positive" result is obtained, where the PSA level seems high but really is not, some men may even be treated for prostate cancer when no cancer is present. Both the American Cancer Society and the American Urological Association urge annual PSA testing to detect early cancers, but the National Cancer Institute does not.

Description

The PSA test is a radioimmunoassay. Any antigen causes the body to produce antibodies in an attempt to neutralize or eliminate the antigen, often a substance that harms body tissues. In the laboratory, a sample of the patient's blood is exposed to the antibody against PSA, so that the amount of antigen (PSA) can be measured. The results generally are available the next day.

Preparation

No special measures are needed when doing a PSA test other than taking the usual precautions to prevent infection at the needle puncture site.

Normal results

Each laboratory has its own normal range for PSA. In fact, they may redefine the normal range whenever starting to use a new batch of test chemicals.

KEY TERMS

Antibody—A substance formed in the body in reaction to some foreign material invading the body, or sometimes to diseased body tissue such as prostate cancer. An antibody also may be prepared in the laboratory and used to measure the amount of antigen in the blood.

Antigen—Either a foreign substance such as a virus or bacterium, or a protein produced by diseased or injured body tissue.

Biopsy—A procedure using a hollow needle to obtain a small sample of tissue, such as from the prostate. Often done to determine whether cancer is present.

BPH—Benign prostatic hyperplasia, a noncancerous disorder that causes the prostate to enlarge.

Abnormal results

Some experts believe that more than 90% of men with prostate cancer will have an elevated PSA level. Others claim that as many as one-third of cancers will be missed. The amount of PSA in the blood drops when cancer is successfully treated, but rises again if the tumor recurs, especially if it spreads to other parts of the body. A new variation of the PSA test shows how much of the material is bound to other protein in the blood and how much is "free." This procedure may be more accurate and could well indicate whether either prostate cancer or BPH is present.

Resources

BOOKS

Fox, Arnold, and Barry Fox. *The Healthy Prostate*. New York: John Wiley & Sons, 1996.

Rous, Stephen N. *The Prostate Book: Sound Advice on Symptoms and Treatment*. 2nd ed. New York: W. W. Norton, 1995.

ORGANIZATIONS

Prostate Health Council, American Foundation for Urologic Disease. 1128 N. Charles St., Baltimore, MD 21201.

OTHER

Prostate Health Council *Important Information About Prostate-Specific Antigen (PSA)*. American Foundation for Urologic Disease, 1128 N. Charles St., Baltimore, MD 21201.

David A. Cramer, MD

Prostate ultrasound

Definition

A prostate ultrasound is a diagnostic test used to detect potential problems with a man's prostate. An ultrasound test uses very high frequency sound waves that are passed through the body. The pattern of reflected sound waves, or "echoes," shows the outline of the prostate. This test can show whether the prostate is enlarged, and whether an abnormal growth that might be **cancer** is present.

Purpose

The prostate is a chestnut-shaped organ surrounding the beginning of the urethra in men. It produces a milky fluid that is part of the seminal fluid discharged during ejaculation. The prostate can become enlarged, particularly in men over age 50. Also, cancer of the prostate can develop, which tends to affect older men.

During a **physical examination**, a doctor may perform a digital **rectal examination**. In this examination, the doctor uses a gloved and lubricated finger inserted in the rectum to feel for any abnormalities. If this examination shows that the prostate is enlarged or a hard lump is present, an ultrasound may be done. Another reason a doctor might perform an ultrasound is if a blood test shows abnormal levels of a substance called prostate-specific antigen (PSA). Abnormal levels of PSA may indicate the presence of cancer.

If there is a suspicious lump, the doctor will want to take a sample of some of the tissue (**prostate biopsy**) to test it to see whether it is in fact cancer. Doing an ultrasound first will show the doctor what part of the prostate should be taken as a sample. Ultrasound can also show whether cancerous tissue is still only within the prostate or whether it has begun to spread to other locations. If **prostate cancer** is present and the doctor decides to treat it with a surgical freezing procedure, ultrasound is used as an aid in the procedure.

An ultrasound can reveal other types of prostate disease as well. For example, it can show if there is inflammation of the prostate (**prostatitis**). Sometimes it is used to learn why a man is unable to father children (**infertility**).

Precautions

A prostate ultrasound study is generally not performed on men who have recently had surgery on their lower bowel. This is because the test requires placing an ultrasound probe about the size of a finger into the rectum.

Description

Prostate ultrasound is generally done using a technique called the transrectal method. This procedure can be done in an outpatient clinic. The cylinder-shaped ultrasound probe is gently placed in the rectum as the patient lies on his left side with the knees bent. The probe is rocked back and forth to obtain images of the entire prostate. The procedure takes about 15–25 minutes to perform. After the test, the patient's doctor can be notified right away, and usually he or she will have a written report within 36 hours.

Preparation

To prepare for a prostate ultrasound, an enema is taken two to four hours before the exam. The patient should not urinate for one hour before the test. If biopsies may be done, the doctor will prescribe an antibiotic that usually is taken in four doses starting the night before the biopsy, the morning of the test, that evening, and the following morning.

Aftercare

There is some discomfort, but less than most patients expect. In fact, worrying ahead of time is usually the hardest part. Generally, the patient is allowed to leave after a radiologist or urologist has reviewed the results. There may be some mucus or a small amount of bleeding from the rectum after the ultrasound. Some patients notice a small amount of blood in the urine for up to two days after the test. Blood may also be present in the semen. As long as the amount of blood is small, there is no cause for concern.

Risks

There are no serious risks from a prostate ultrasound study. Infection is rare and probably is a result of biopsy rather than the sonogram itself. If the ultrasound probe is moved too vigorously, some bleeding may continue for a few days.

Normal results

Modern ultrasound techniques can display both the smooth-surfaced outer shell of the prostate and the core tissues surrounding the urethra. The entire volume of the prostate should be less than 20 milliliters, and its outline should appear as a smooth echo-reflecting (echogenic) rim. Some irregularities within the substance of the gland and calcium deposits are normal findings.

Abnormal results

An **enlarged prostate** with dimmed echoes may indicate either prostatitis or benign enlargement of the

KEY TERMS

Benign prostatic hypertrophy (BPH)—Benign prostatic hypertrophy is an enlargement of the prostate that is not cancerous. However, it may cause problems with urinating or other symptoms.

Prostate-specific antigen (PSA)—A substance that often is produced by cancers of the prostate. It can be detected in a blood test.

Urethra—The tube through which urine passes from the bladder and is excreted to outside the body.

gland, called benign prostatic hypertrophy (BPH). A distinct lump of tissue more likely means cancer. Cancer also often appears as an irregular area within the gland that distorts the normal pattern of echoes. In either case, a biopsy should clarify the diagnosis.

Resources

BOOKS

Rous, Stephen N. *The Prostate Book: Sound Advice on Symptoms and Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Selmans, Sandra. *Prostate: Questions You Have...Answers You Need*. Allentown, PA: People's Medical Society, 1996.

ORGANIZATIONS

Prostate Health Council, American Foundation for Urologic Disease. 1128 N. Charles St., Baltimore, MD 21201. 800-242-AFUD.

David A. Cramer, MD

Prostatectomy

Definition

Prostatectomy is surgical removal of part of the prostate gland (transurethral resection, a procedure performed to relieve urinary symptoms caused by benign enlargement), or all of the prostate (radical prostatectomy, the curative surgery most often used to treat **prostate cancer**).

Purpose

Benign disease

When men reach their mid-40s, the prostate gland begins to enlarge. This condition, benign prostatic hyperplasia (BPH) is present in more than half of men in their 60s and as many as 90% of those over 90. Because the prostate surrounds the urethra, the tube leading urine from the bladder out of the body, the enlarging prostate narrows this passage and makes urination difficult. The bladder does not empty completely each time a man urinates, and, as a result, he must urinate with greater frequency, night and day. In time, the bladder can overfill, and urine escapes from the urethra, resulting in incontinence. An operation called transurethral resection of the prostate (TURP) relieves symptoms of BPH by removing the prostate tissue that is blocking the urethra. No incision is needed. Instead a tube (retroscope) is passed through the penis to the level of the prostate, and tissue is either removed or destroyed, so that urine can freely pass from the body.

Malignant disease

Prostate cancer is the single most common form of non-skin cancer in the United States and the most common **cancer** in men over 50. Half of men over 70 and almost all men over the age of 90 have prostate cancer, and the American Cancer Society estimates that 198,000 new cases will be diagnosed in 2001. This condition does not always require surgery. In fact, many elderly men adopt a policy of "watchful waiting," especially if their cancer is growing slowly. Younger men often elect to have their prostate gland totally removed along with the cancer it contains—an operation called radical prostatectomy. The two main types of this surgery, radical retropubic prostatectomy and radical perineal prostatectomy, are performed only on patients whose cancer is limited to the prostate. If cancer has broken out of the capsule surrounding the prostate gland and spread in the area or to distant sites, removing the prostate will not prevent the remaining cancer from growing and spreading throughout the body.

Precautions

Potential complications of TURP include bleeding, infection, and reactions to general or **local anesthesia**. About one man in five will need to have the operation again within 10 years.

Open (incisional) prostatectomy for cancer should not be done if the cancer has spread beyond the prostate, as serious side effects may occur without the benefit of removing all the cancer. If the bladder is retaining urine, it is necessary to insert a catheter before starting surgery. Patients should be in the best possible general condition before radical prostatectomy. Before surgery, the bladder is inspected using an instrument called a cystoscope to help determine the best surgical technique to use, and to rule out other local problems.

Description

TURP

This procedure does not require an abdominal incision. With the patient under either general or spinal anesthesia, a cutting instrument or heated wire loop is inserted to remove as much prostate tissue as possible and seal blood vessels. The excised tissue is washed into the bladder, then flushed out at the end of the operation. A catheter is left in the bladder for one to five days to drain urine and blood. Advanced laser technology enables surgeons to safely and effectively burn off excess prostate tissue blocking the bladder opening with fewer of the early and late complications associated with other forms of prostate surgery. This procedure can be performed on an outpatient basis, but urinary symptoms do not improve until swelling subsides several weeks after surgery.

Radical prostatectomy

RADICAL RETROPUBIC PROSTATECTOMY. This is a useful approach if the prostate is very large, or cancer is suspected. With the patient under general or spinal anesthesia or an epidural, a horizontal incision is made in the center of the lower abdomen. Some surgeons begin the operation by removing pelvic lymph nodes to determine whether cancer has invaded them, but recent findings suggest there is no need to sample them in patients whose likelihood of lymph node metastases is less than 18%. A doctor who removes the lymph nodes for examination will not continue the operation if they contain cancer cells, because the surgery will not cure the patient. Other surgeons remove the prostate gland before examining the lymph nodes. A tube (catheter) inserted into the penis to drain fluid from the body is left in place for 14–21 days.

Originally, this operation also removed a thin rim of bladder tissue in the area of the urethral sphincter—a muscular structure that keeps urine from escaping from the bladder. In addition, the nerves supplying the penis often were damaged, and many men found themselves impotent (unable to achieve erections) after prostatectomy. A newer surgical method called potency-sparing radical prostatectomy preserves sexual potency in 75% of patients and fewer than 5% become incontinent following this procedure.

RADICAL PERINEAL PROSTATECTOMY. This procedure is just as curative as radical retropubic prostatectomy but is performed less often because it does not allow the surgeon to spare the nerves associated with erection or, because the incision is made above the rectum and below the scrotum, to remove lymph nodes. Radical perineal prostatectomy is sometimes used when the cancer is limited to the prostate and there is no need to spare nerves or when the patient's health might be compromised by the longer procedure. The perineal operation is less invasive than retropubic prostatectomy. Some parts of the prostate can be seen better, and blood loss is limited. The absence of an abdominal incision allows patients to recover more rapidly. Many urologic surgeons have not been trained to perform this procedure. Radical prostatectomy procedures last one to four hours, with radical perineal prostatectomy taking less time than radical retropubic prostatectomy. The patient remains in the hospital three to five days following surgery and can return to work in three to five weeks. Ongoing research indicates that laparoscopic radical prostatectomy may be as effective as open surgery in treatment of early-stage disease.

Cryosurgery

Also called **cryotherapy** or cryoablation, this minimally invasive procedure uses very low temperatures to freeze and destroy cancer cells in and around the prostate gland. A catheter circulates warm fluid through the urethra to protect it from the cold. When used in connection with ultrasound imaging, cryosurgery permits very precise tissue destruction. Traditionally used only in patients whose cancer had not responded to radiation, but now approved by Medicare as a primary treatment for prostate cancer, cryosurgery can safely be performed on older men, on patients who are not in good enough general health to undergo radical prostatectomy, or to treat recurrent disease. Recent studies have shown that total cryosurgery, which destroys the prostate, is at least as effective as radical prostatectomy without the trauma of major surgery.

Preparation

As with any type of major surgery done under **general anesthesia**, the patient should be in optimal condition. Most patients having prostatectomy are in the age range when cardiovascular problems are frequent, making it especially important to be sure that the heart is beating strongly, and that the patient is not retaining too much fluid. Because long-standing prostate disease may cause kidney problems from urine "backing up," it also is necessary to be sure that the kidneys are working properly. If not, a period of catheter drainage may be necessary before doing the surgery.

Aftercare

Following TURP, a catheter is placed in the bladder to drain urine and remains in place for two to three days. A solution is used to irrigate the bladder and urethra until the urine is clear of blood, usually within 48 hours after

surgery. Whether antibiotics should be routinely given remains an open question. Catheter drainage also is used after open prostatectomy. The bladder is irrigated only if blood clots block the flow of urine through the catheter. Patients are given intravenous fluids for the first 24 hours, to ensure good urine flow. Patients resting in bed for long periods are prone to blood clots in their legs (which can pass to the lungs and cause serious breathing problems). This can be prevented by elastic stockings and by periodically exercising the patient's legs. The patient remains in the hospital one to two days following surgery and can return to work in one to two weeks.

Risks

The complications and side effects that may occur during and after prostatectomy include:

- Excessive bleeding, which in rare cases may require blood **transfusion**.
- Incontinence when, during retropubic prostatectomy, the muscular valve (sphincter) that keeps urine in the bladder is damaged. Less common today, when care is taken not to injure the sphincter.
- **Impotence**, occurring when nerves to the penis are injured during the retropubic operation. Today's "nerve-sparing" technique has drastically cut down on this problem.
- Some patients who receive a large volume of irrigating fluid after TURP develop high blood pressure, vomiting, trouble with their vision, and mental confusion. This condition is caused by a low salt level in the blood, and is reversed by giving salt solution.
- A permanent narrowing of the urethra, called a stricture, occasionally develops when the urethra is damaged during TURP.

Normal results

In patients with BPH who have the TURP operation, urination should become much easier and less frequent, and dribbling or incontinence should cease. In patients having radical prostatectomy for cancer, a successful operation will remove the tumor and prevent its spread to other areas of the body (metastasis). If examination of lymph nodes shows that cancer already had spread beyond the prostate at the time of surgery, other measures are available to control the tumor.

Resources

BOOKS

Marks, Sheldon. *Prostate Cancer: A Family Guide to Diagnosis, Treatment and Survival*. Cambridge, MA: Fisher Books, 2000.

KEY TERMS

BPH—Benign prostatic hypertrophy, a very common, noncancerous cause of prostatic enlargement in older men.

Catheter—A tube that is placed through the urethra into the bladder in order to provide free drainage of urine and blood following either TURP or open prostatectomy.

Cryosurgery—In prostatectomy, the use of a very low-temperature probe to freeze and thereby destroy prostatic tissue.

Impotence—The inability to achieve and sustain penile erections.

Incontinence—The inability to retain urine in the bladder until a person is ready to urinate voluntarily.

Prostate gland—The gland surrounding the male urethra just below the base of the bladder. It secretes a fluid that constitutes a major portion of the semen.

Urethra—The tube running from the bladder to the tip of the penis that provides a passage for eliminating urine from the body.

Wainrib, Barbara, et al. *Men, Women, and Prostate Cancer: A Medical and Psychological Guide for Women and the Men they Love*. Oakland, CA: New Harbinger Publications, 2000.

ORGANIZATIONS

Prostate Health Council. American Foundation for Urologic Disease. 1128 N. Charles St., Baltimore, MD 21201-5559. (800) 828-7866. <http://www.afud.org>.

Cancer Research Institute. 681 Fifth Ave., New York, NY 10022. (800) 99CANCER. <http://www.cancerresearch.org>.

National Prostate Cancer Coalition. 1156 15th St., NW, Washington, DC 20005. (202) 463-9455. <www.4npcc.org>.

David A. Cramer

Prostatic acid phosphatase test *see* **Acid phosphatase test**

Prostatitis

Definition

Prostatitis is an inflammation of the prostate gland, a common condition in adult males. Often caused by infec-

tion, prostatitis may develop rapidly (*acute*) or slowly (*chronic*).

Description

Prostatitis may be the symptom-producing disease of the genitourinary tract for which men most often seek medical help. About 40% of visits to a specialist in genitourinary problems (urologist) are for prostatitis. Forms of prostate inflammation include acute and chronic bacterial prostatitis and inflammation not caused by bacterial infection. A painful condition called *prostatodynia*, which may be caused by abnormal nerves or muscles in the region, is also thought to be a form of prostatitis. The chronic bacterial form is sometimes experienced by men whose sex partners have a bacterial infection of the vagina, making this a sexually transmitted disease. Other cases occur when small stones form within the prostate and become infected. Sometimes infection is caused by poor hygiene, surgical procedures, or even swimming in polluted water.

The sexually transmitted disease **gonorrhea** may sometimes cause prostatitis, and **tuberculosis** may spread to the prostate. Parasites and fungi may infect the prostate gland. Some men whose prostatitis is not caused by any microorganism have microscopic collections of cells called *granulomas* in their prostate tissue. Whether viruses also may cause prostatitis is debatable.

Causes and symptoms

However the inflammation may begin, it causes blockages in the tiny glands within the prostate so that secretions build up, and the prostate swells. In acute cases, this swelling can occur very suddenly and cause considerable **pain**. When prostatitis develops gradually, trouble with the flow of urine may be the first symptom. Small stones may form, because the body attempts to neutralize bacteria by coating them with calcium. These stones may become infected themselves and make the condition worse.

Symptoms and signs that are typically experienced by men with prostatitis include:

- Difficulties in urinating. Most urinary problems are caused when the swollen prostate blocks the tube that carries urine from the bladder to the outside of the body (urethra). Patients feel the need to urinate more often than usual, often urgently. Urination is sometimes painful. It is hard to start the flow of urine and difficult to totally empty the bladder. Patients wake up at night to urinate. The stream may be weak or split. Dribbling after attempts to urinate may leave embarrassing wet spots on clothing. In severe prostatitis blood or sand-like particles (small calcium collections) may be passed in the urine.
- Pain. Besides pain when urinating, caused by prostate swelling, stimulation of nerves in the prostate gland may cause pain in the penis, one or both testicles, the lower stomach, the low back, and the area between the scrotum and the anus (perineum). Some patients experience pain during or after ejaculation, whenever they sit down or walk, or during bowel movements.
- Sex and fertility. The pain of prostatitis can make it impossible to enjoy sex. Men with prostatitis may be troubled by early release of sperm (**premature ejaculation**). Occasionally there is blood in the semen. Some of the drugs prescribed to ease the flow of the urine can dampen the desire to have sex. Because the normal prostate secretions make up part of the semen, prostatitis may lower fertility by severely lowering the number of sperm and making them less mobile.
- Psychological problems. A man with prostatitis who feels that nothing can be done and he "just has to live with it" may experience serious depression. Low sexual desire certainly contributes to depression.

A person with *acute prostatitis* may suddenly develop **fever** and chills, along with rapidly developing urinary symptoms and pain in the perineum or low back. This state is a medical emergency that demands immediate medical help.

Diagnosis

Most often the symptoms and physical findings are enough to form a diagnosis of prostatitis. When the examiner inserts a finger in the rectum, the swollen prostate can be felt; it may be extremely tender when probed. Squeezing the gland slightly will produce a few drops of fluid that may be *cultured* to learn whether bacteria are present. The fluid typically contains a large number of white blood cells, especially the cells used to fight off infection (*macrophages*). Note: too much pressure on the prostate can force bacteria into the blood and cause a serious general infection. Many patients with chronic bacterial prostatitis also have recurring urinary tract infections (diagnosed by examining and culturing urine samples). These infections can be an important clue to the diagnosis. If doubt remains, the urologist may insert a special instrument called a *cystoscope* through the penis to directly view the prostate from inside and see whether it looks inflamed.

Treatment

Acute prostatitis is first treated with **antibiotics**. Even though it may be difficult for drugs to actually get

into the inflamed prostate, most patients do quickly get better. If intravenous antibiotics are needed or the bladder is retaining urine, a hospital stay may be necessary. Broad-spectrum antibiotics that work against most bacteria are used first. At the same time tests are done with samples of prostatic fluid to determine which bacterium is causing the infection, so that drugs can be prescribed to fight the specific germ. In chronic cases, the best results are obtained with a combination of the antibiotics trimethoprim and sulfamethoxazole. Oral antibiotics should be given for 1–3 months; longer, if necessary. If a fungus or some other organism is causing infection, special drugs are available. If chronic prostatitis continues despite all medical efforts and is seriously affecting the patient's life, the prostate may be removed surgically.

Nonbacterial prostatitis requires other measures to relieve urinary symptoms. These measures include drugs that fight inflammation (steroids or nonsteroids) and a type of drug called an alpha-blocker that reduces muscle tension. Reduced muscle tension eases urine flow, allowing the bladder to empty. A narrowed urethra may be widened by placing a collapsed balloon at the site of obstruction and expanding it. This procedure is called *balloon dilation*. The effects of such dilation are usually temporary. Some physicians believe that **stress** is an important factor in prostatitis, and therefore prescribe diazepam (Valium) or another tranquilizer. The type of prostatitis known as prostatodynia is usually treated with a combination of muscle relaxing drugs, heat, special exercises, and sometimes a tranquilizer.

There are a number of "tips" for relieving symptoms of prostatitis. They are especially helpful early on, before antibiotics have a chance to cure infection, or for patients with chronic or non-bacterial prostatitis:

- Hot sitz baths. Exposing the perineum to very hot water for 20 minutes or longer often relieves pain.
- Ice. When heat does not help, ice packs, or simply placing a small ice cube in the rectum, may relieve pain for hours.
- Water. A patient who has to urinate very often may want to cut back on his fluid intake but this will cause **dehydration** and increase the risk of bladder infection. Instead, it is best to drink plenty of water.
- Diet. Most doctors recommend cutting out—or cutting down on—caffeine (as in coffee or tea), alcohol, and spicy or acid foods. **Constipation** should be avoided because large, hard bowel movements may press on the swollen prostate and cause great pain. Bran cereals and whole-grain breads are helpful.
- Exercise. It is especially important for patients with chronic prostatitis to keep up their activity level. Simply walking often will help (unless walking happens to make the pain worse).
- Frequent ejaculation. Ejaculating two or three times a week often is recommended, especially when taking antibiotics.

KEY TERMS

Culture—A test in which a sample of body fluid, such as prostatic fluid, is placed on materials specially formulated to grow microorganisms. A culture is used to learn what type of bacterium is causing infection.

Cystoscope—A viewing instrument that is passed up the urethra into the region of the prostate to get a good look at the organ "from the inside."

Ejaculation—The process by which semen (made up in part of prostatic fluid) is ejected by the erect penis.

Granuloma—A cluster of cells that form in tissue that has been inflamed for some time.

Perineum—An area close to the prostate, between the scrotum and anus.

Alternative treatment

A treatment popularized in the Philippines is called "prostate drainage." At regular intervals, a finger is inserted into the rectum, to exert pressure on the prostate at the same time that an antibiotic treatment is given. **Acupuncture** and Chinese herbal medicine also can be effective in treating prostatitis. Nutritional supplements that support the prostate, including zinc, omega-3 fatty acids, several amino acids, and anti-inflammatory nutrients and herbs, can help reduce pain and promote healing. Western herbal medicine recommends **saw palmetto** *(Serenoa repens)* to support the prostate gland. Hot and cold contrast sitz baths can help reduce inflammation.

Prognosis

Most patients with acute bacterial prostatitis are cured if they receive proper antibiotic treatment. Every effort should be made to get a cure at the acute stage because chronic prostatitis can be much more difficult to eliminate. If the acute illness is *not* controlled, complications such as a localized infection (prostatic **abscess**), kidney infection, or infection of the blood (septicemia) may develop. When chronic prostatitis cannot be cured,

it still is possible to keep urinary symptoms under control and keep the patient active by using low doses of antibiotics and other measures. If a man with any form of prostatitis develops serious psychological problems, he should be referred to a psychiatric specialist.

Prevention

Potential sources of infection should be avoided. Good perineal hygiene should be maintained and sex should be avoided when one's partner has an active bacterial vaginal infection. If the kidneys, bladder, or other genitourinary organs are infected, prompt treatment may prevent the development of prostatitis. By far the best way of preventing chronic prostatitis is to treat an initial *acute* episode promptly and effectively.

Resources

BOOKS

Rous, Stephen N. *The Prostate Book: Sound Advice on Symptoms and Treatment*. 2nd ed. New York: W. W. Norton, 1995.

Walsh, Patrick C., and Janet F. Worthington. *The Prostate: A Guide for Men and the Women Who Love Them*. New York: Warner Books, 1997.

ORGANIZATIONS

Prostate Health Council, American Foundation for Urologic Disease. 1128 N. Charles St., Baltimore, MD 21201. (800) 242-AFUD.

The Prostatitis Foundation, Information Distribution Center. 2029 Ireland Grove Park, Bloomington, IL 61704. (309) 664-6222. <http://www.prostate.org>.

David A. Cramer, MD

Prosthetic joint infection *see* **Infectious arthritis**

Protease inhibitors

Definition

A protease inhibitor is a type of drug that cripples the enzyme protease. An enzyme is a substance that triggers chemical reactions in the body. The human **immunodeficiency** virus (HIV) uses protease in the final stages of its reproduction (replication) process.

Purpose

The drug is used to treat selected patients with HIV infection. Blocking protease interferes with HIV reproduction, causing it to make copies of itself that cannot infect new cells. The drug may improve symptoms and suppress the infection but does not cure it.

Precautions

Patients should not discontinue this drug even if symptoms improve without consulting a doctor.

These drugs do not necessarily reduce the risk of transmitting HIV to others through sexual contact, so patients should avoid sexual activities or use condoms.

Description

Protease inhibitors are considered one of the most potent medications for HIV developed so far.

This class of drugs includes indinavir (Crixivan), ritonavir (Norvir), nelfinavir (Viracept), and saquinavir (Invirase or Fortovase). Several weeks or months of drug therapy may be required before the full benefits are apparent.

The drug should be taken at the same time each day. Some types should be taken with a meal to help the body absorb them. Each of the types of protease inhibitor may have to be taken in a different way.

Risks

Common side effects include **diarrhea**, stomach discomfort, nausea, and mouth sores. Less often, patients may experience rash, muscle **pain**, **headache**, or weakness. Rarely, there may be confusion, severe skin reaction, or seizures. Some of these drugs can have interactions with other medication, and indinavir can be associated with **kidney stones**. Diabetes or high blood pressure may become worse when these drugs are taken.

Experts do not know whether the drugs pass into breast milk, so breastfeeding mothers should avoid them or should stop nursing until the treatment is completed.

Resources

BOOKS

Griffith, H. Winter. *Complete Guide to Prescription and Nonprescription Drugs*. 1998 ed. New York: Berkeley Publishing, 1998.

PERIODICALS

Fox, Maggie. "Doctors Grapple With Huge Pool of AIDS Drugs." *Reuters* (4 Feb. 1998).

Rochell, Anne. "Hope and a Reality Check: Although a Cure Is Still a Distant Dream, New AIDS Treatments Invite Optimism." *Atlanta Journal and Constitution* (6 July 1996): D1.

Wilson, Billie Ann. "Understanding Strategies for Treating HIV." *Medical Surgical Nursing* 6 (1 Apr. 1997): 109–111.

KEY TERMS

Human immunodeficiency virus (HIV)—The virus that causes AIDS.

ORGANIZATIONS

National AIDS Treatment Advocacy Project. 580 Broadway, Ste. 403, New York, NY 10012. (888) 266-2827. <http://www.natap.org>.

Carol A. Turkington

Protein-calorie malnutrition *see* **Protein-energy malnutrition**

Protein components test

Definition

Protein components tests measure the amounts and types of protein in the blood. Proteins are constituents of muscle, enzymes, hormones, transport proteins, hemoglobin, and other functional and structural elements of the body. Albumin and globulin make up most of the protein within the body and are measured in the total protein of the blood and other body fluids. Thus, the serum (blood) protein components test measures the total protein, as well as its albumin and globulin components in the blood.

Purpose

The protein components test is used to diagnose diseases that either affect proteins as a whole, or that involve a single type of protein. The test is also used to monitor the course of disease in certain cancers, intestinal and kidney protein-wasting states, immune disorders, liver dysfunction, and impaired **nutrition**.

Precautions

Drugs that may cause increased protein levels include the anabolic steroids, androgens (male hormones), growth hormone, insulin, and progesterone. Drugs that may decrease protein levels include estrogen, drugs poisonous to the liver, and **oral contraceptives**.

Description

Proteins are large molecules (complex organic compounds) that consist of amino acids, sugars, and lipids. There are two main types of proteins: those that are made of fiber and form the structural basis of body tissues, such as hair, skin, muscle, tendons, and cartilage; and globular proteins (generally water soluble), which interact with many hormones, various other proteins in the blood, including hemoglobin and antibodies, and all the enzymes (substances that promote biochemical reactions in the body).

Proteins are needed in the diet to supply the body with amino acids. Ingested proteins are broken down in the digestive system to amino acids, which are then absorbed and rebuilt into new body proteins. One of the most important functions of proteins in the body is to contribute to the osmotic pressure (the movement of water between the bloodstream and tissues). An example of this is seen in diseases that result in damage to the filtering units of the kidneys (**nephrotic syndrome**). A severe loss of protein from the bloodstream into the urine (proteinuria) results, lowering the protein content of the blood and resulting in fluid retention, or **edema**.

Albumin and globulin are two key components of protein. Albumin is made in the liver and constitutes approximately 60% of the total protein. The main function of albumin is to maintain osmotic pressure and to help transport certain blood constituents around the body via the bloodstream. Because albumin is made in the liver, it is one element that is used to monitor liver function.

Globulin is the basis for antibodies, glycoproteins (protein-carbohydrate compounds), lipoproteins (proteins involved in fat transport), and clotting factors. Globulins are divided into three main groups, the alpha-, beta-, and gammaglobulins. Alphaglobulins include enzymes produced by the lungs and liver, and haptoglobin, which binds hemoglobin together. The betaglobulins consist mostly of low-density lipoproteins (LDLs), substances involved in fat transport. All of the **gammaglobulins** are antibodies, proteins produced by the immune system in response to infection, during allergic reaction, and after organ transplants.

Both serum albumin and globulin are measures of nutrition. Malnourished patients, especially after surgery, demonstrate greatly decreased protein levels, while burn patients and those who have protein-losing syndromes show low levels despite normal synthesis. **Pregnancy** in the third trimester is also associated with reduced protein levels.

The relationship of albumin to globulin is determined by ratio, so when certain diseases cause the albumin levels to drop, the globulin level will be increased by the body in an effort to maintain a normal total protein level. For example, when the liver is unable to synthesize sufficient albumin in chronic liver disease, the albumin

level will be low, but the globulin levels will be normal or higher than normal. In such cases, the protein components test is an especially valuable diagnostic aid because it determines the ratio of albumin to globulin, as well as the total protein level. It should be noted, however, that when globulin is provided as a calculation (total protein – albumin = globulin), the result is much less definitive than other methods of determining globulin.

Consequently, when the albumin/globulin ratio (A/G ratio) is less than 1.0, more precise tests should be ordered. These tests include **protein electrophoresis**, a method of separating the different blood proteins into groups. If the protein electrophoresis indicates a rise, or "spike" at the globulin level, an even more specific test for globulins, called **immunoelectrophoresis**, should be ordered to separate out the various globulins according to type. Some diseases characterized by dysproteinemia (derangement of the protein content of the blood), have typical electrophoretic globulin peaks.

Preparation

Unless this is requested by the physician, there is no need that the patient restrict food or fluids before the test.

Risks

Risks posed by this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or lightheadedness after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference values vary from laboratory to laboratory, but can generally be found within the following ranges: Total protein: 6.4–8.3 g/dL; albumin: 3.5–5.0 g/dL; globulin: 2.3–3.4 g/dL.

Abnormal results

Increased total protein levels are seen in **dehydration**, in some cases of chronic liver disease (like autoimmune hepatitis and **cirrhosis**), and in certain tropical diseases (for example, **leprosy**). Very low total protein levels (less than 4.0 g/dl) and low albumin cause the edema (water retention) usually seen in nephrotic syndromes. Decreased protein levels may be seen in pregnancy, chronic **alcoholism**, prolonged **immobilization**, **heart failure**, **starvation**, and malabsorption or **malnutrition**.

Increased albumin levels are found in dehydration. Decreased albumin levels are indicative of liver disease, protein-losing syndromes, malnutrition, inflammatory disease, and familial idiopathic (of unknown cause) dysproteinemia, a genetic disease in which the albumin is significantly reduced and globulins increased.

KEY TERMS

Nephrotic syndromes—A collection of symptoms that result from damage to the filtering units of the kidney (glomeruli) causing severe loss of protein from the blood into the urine.

Increased globulin levels are found in **multiple myeloma** and Waldenström's macroglobulinemia, two cancers characterized by overproduction of gammaglobulin from proliferating plasma cells. Increased globulin levels are also found in chronic inflammatory diseases such as **rheumatoid arthritis**, acute and chronic infection, and cirrhosis. Decreased globulin levels are seen in genetic immune disorders and secondary immune deficiency.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Protein electrophoresis

Definition

Electrophoresis is a technique used to separate different elements (fractions) of a blood sample into individual components. Serum protein electrophoresis (SPEP) is a screening test that measures the major blood proteins by separating them into five distinct fractions: albumin, alpha$_1$, alpha$_2$, beta, and gamma proteins. Protein electrophoresis can also be performed on urine.

Purpose

Protein electrophoresis is used to evaluate, diagnose, and monitor a variety of diseases and conditions. It can be used for these purposes because the levels of different blood proteins rise or fall in response to such disorders as **cancer**, intestinal or kidney protein-wasting syndromes,

disorders of the immune system, liver dysfunction, impaired **nutrition**, and chronic fluid-retaining conditions.

Precautions

Certain other diagnostic tests or prescription medications can affect the results of SPEP tests. The administration of a contrast dye used in some other tests may falsely elevate protein levels. Drugs that can alter results include **aspirin**, bicarbonates, chlorpromazine (Thorazine), **corticosteroids**, isoniazid (INH), and neomycin (Mycifradin).

Description

Proteins are major components of muscle, enzymes, hormones, hemoglobin, and other body tissues. Proteins are composed of elements that can be separated from one another by several different techniques: chemical methods, ultracentrifuge, or electrophoresis. There are two major types of electrophoresis: protein electrophoresis and **immunoelectrophoresis**. Immunoelectrophoresis is used to assess the blood levels of specific types of proteins called immunoglobulins. An immunoelectrophoresis test is usually ordered if a SPEP test has a "spike," or rise, at the immunoglobulin level. Protein electrophoresis is used to determine the total amount of protein in the blood, and to establish the levels of other types of proteins called albumin, $alpha_1$ globulin, $alpha_2$ globulin, and beta-globulin.

Blood proteins

ALBUMIN. Albumin is a protein that is made in the liver. It helps to retain elements like calcium, some hormones, and certain drugs in the circulation by binding to them to prevent their being filtered out by the kidneys. Albumin also acts to regulate the movement of water between the tissues and the bloodstream by attracting water to areas with higher concentrations of salts or proteins.

GLOBULINS. Globulins are another type of protein, larger in size than albumin. They are divided into three main groups: alpha, beta, and gamma.

- Alphaglobulins. These proteins include $alpha_1$ and $alpha_2$ globulins. $Alpha_1$ globulin is predominantly $alpha_1$-antitrypsin, an enzyme produced by the lungs and liver. $Alpha_2$ globulin, which includes serum haptoglobin, is a protein that binds hemoglobin to prevent its excretion by the kidneys. Various other alphaglobulins are produced as a result of inflammation, tissue damage, **autoimmune disorders**, or certain cancers.
- Betaglobulins. These include low-density substances involved in fat transport (lipoproteins), iron transport (transferrin), and blood clotting (plasminogen and complement).
- Gammaglobulins. All of the gammaglobulins are antibodies—proteins produced by the immune system in response to infection, allergic reactions, and organ transplants. If serum protein electrophoresis has demonstrated a significant rise at the gammaglobulin level, immunoelectrophoresis is done to identify the specific globulin that is involved.

Electrophoretic measurement of proteins

All proteins have an electrical charge. The SPEP test is designed to make use of this characteristic. There is some difference in method, but basically the sample is placed in or on a special medium (e.g., a gel), and an electric current is applied to the gel. The protein particles move through the gel according to the strength of their electrical charges, forming bands or zones. An instrument called a densitometer measures these bands, which can be identified and associated with specific diseases. For example, a decrease in albumin with a rise in the $alpha_2$ globulin usually indicates an acute reaction of the type that occurs in infections, **burns**, **stress**, or **heart attack**. On the other hand, a slight decrease in albumin, with a slight increase in **gammaglobulin**, and a normal $alpha_2$ globulin is more indicative of a chronic inflammatory condition, as might be seen in **cirrhosis** of the liver.

Protein electrophoresis is performed on urine samples to classify kidney disorders that cause protein loss. Here also certain band patterns are specific for disease. For example, the identification of a specific protein called the Bence Jones protein (by performing the **Bence Jones protein test**) during the procedure suggests **multiple myeloma**.

Preparation

The serum protein electrophoresis test requires a blood sample. It is not necessary for the patient to restrict food or fluids before the test. The urine protein electrophoresis test requires either an early morning urine sample or a 24-hour urine sample according to the physician's request. The doctor should check to see if the patient is taking any medications that may affect test results.

Risks

Risks posed by the blood test are minimal but may include slight bleeding from the puncture site, **fainting** or lightheadedness after the blood is drawn, or the development of a small bruise at the puncture site.

KEY TERMS

Albumin—A blood protein that is made in the liver and helps to regulate water movement in the body.

Electrophoresis—A technique for separating various blood fractions by running an electric current through a gel containing a blood sample.

Globulins—A group of proteins in blood plasma whose levels can be measured by electrophoresis in order to diagnose or monitor a variety of serious illnesses.

Haptoglobin—A protein in blood plasma that binds hemoglobin.

Immunoglobulins—Any of several types of globulin proteins that function as antibodies.

Normal results

The following values are representative, although there is some variation among laboratories and specific methods. These values are based on the agarose system.

- total protein: 5.9–8.0 g/dL
- albumin: 4.0–5.5 g/dL
- alpha$_1$ globulin: 0.15–0.25 g/dL
- alpha$_2$ globulin: 0.43–0.75 g/dL
- beta-globulin: 0.5–1.0 g/dL
- gamma-globulin: 0.6–1.3 g/dL

Abnormal results

Albumin levels are increased in **dehydration**. They are decreased in **malnutrition**, **pregnancy**, liver disease, inflammatory diseases, and such protein-losing syndromes as **malabsorption syndrome** and certain kidney disorders.

Alpha$_1$ globulins are increased in inflammatory diseases. They are decreased or absent in juvenile pulmonary **emphysema**, which is a genetic disease.

Alpha$_2$ globulins are increased in a kidney disorder called **nephrotic syndrome**. They are decreased in patients with an overactive thyroid gland (**hyperthyroidism**) or severe liver dysfunction.

Betaglobulin levels are increased in conditions of **high cholesterol** levels (**hypercholesterolemia**) and **iron deficiency anemia**. They are decreased in malnutrition.

Gammaglobulin levels are increased in chronic inflammatory disease (for example, **rheumatoid arthritis**, **systemic lupus erythematosus**); cirrhosis; acute and chronic infection; and a cancerous disease characterized by uncontrolled multiplication of plasma cells in the bone marrow (multiple myeloma). Gammaglobulins are decreased in a variety of genetic immune disorders, and in secondary immune deficiency related to steroid use, leukemia, or severe infection.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Protein-energy malnutrition

Definition

Protein-energy **malnutrition** (PEM) is a potentially fatal body-depletion disorder. It is the leading cause of **death** in children in developing countries.

Description

PEM is also referred to as protein-calorie malnutrition. It develops in children and adults whose consumption of protein and energy (measured by calories) is insufficient to satisfy the body's nutritional needs. While pure protein deficiency can occur when a person's diet provides enough energy but lacks the protein minimum, in most cases the deficiency will be dual. PEM may also occur in persons who are unable to absorb vital nutrients or convert them to energy essential for healthy tissue formation and organ function.

Although PEM is not prevalent among the general population of the United States, it is often seen in elderly people who live in nursing homes and in children whose parents are poor. PEM occurs in one of every two surgical patients and in 48% of all other hospital patients.

Types of PEM

Primary PEM results from a diet that lacks sufficient sources of protein and/or energy. Secondary PEM is more common in the United States, where it usually occurs as a complication of **AIDS**, **cancer**, **chronic kid-**

ney failure, inflammatory bowel disease, and other illnesses that impair the body's ability to absorb or use nutrients or to compensate for nutrient losses. PEM can develop gradually in a patient who has a chronic illness or experiences chronic semi-starvation. It may appear suddenly in a patient who has an acute illness.

Kwashiorkor

Kwashiorkor, also called wet protein-energy malnutrition, is a form of PEM characterized primarily by protein deficiency. This condition usually appears at the age of about 12 months when breastfeeding is discontinued, but it can develop at any time during a child's formative years. It causes fluid retention (**edema**); dry, peeling skin; and hair discoloration.

Marasmus

Primarily caused by energy deficiency, marasmus is characterized by stunted growth and wasting of muscle and tissue. Marasmus usually develops between the ages of six months and one year in children who have been weaned from breast milk or who suffer from weakening conditions like chronic **diarrhea**.

Causes and symptoms

Secondary PEM symptoms range from mild to severe, and can alter the form or function of almost every organ in the body. The type and intensity of symptoms depend on the patient's prior nutritional status and on the nature of the underlying disease and the speed at which it is progressing.

Mild, moderate, and severe classifications have not been precisely defined, but patients who lose 10–20% of their body weight without trying are usually said to have moderate PEM. This condition is also characterized by a weakened grip and inability to perform high-energy tasks.

Losing 20% of body weight or more is generally classified as severe PEM. People with this condition can't eat normal-sized meals. They have slow heart rates and low blood pressure and body temperatures. Other symptoms of severe secondary PEM include baggy, wrinkled skin; **constipation**; dry, thin, brittle hair; lethargy; pressure sores and other **skin lesions**.

Kwashiorkor

People who have kwashiorkor often have extremely thin arms and legs, but liver enlargement and **ascites** (abnormal accumulation of fluid) can distend the abdomen and disguise weight loss. Hair may turn red or yellow. Anemia, diarrhea, and fluid and **electrolyte disorders** are common. The body's immune system is often weakened, behavioral development is slow, and **mental retardation** may occur. Children may grow to normal height but are abnormally thin.

Kwashiorkor-like secondary PEM usually develops in patients who have been severely burned, suffered trauma, or had **sepsis** (tissue-destroying infection) or another life-threatening illness. The condition's onset is so sudden that body fat and muscle mass of normal-weight people may not change. Some obese patients even gain weight.

Marasmus

Profound weakness accompanies severe marasmus. Since the body breaks down its own tissue to use as calories, people with this condition lose all their body fat and muscle strength, and acquire a skeletal appearance most noticeable in the hands and in the temporal muscle in front of and above each ear. Children with marasmus are small for their age. Since their immune systems are weakened, they suffer from frequent infections. Other symptoms include loss of appetite, diarrhea, skin that is dry and baggy, sparse hair that is dull brown or reddish yellow, mental retardation, behavioral retardation, low body temperature (**hypothermia**), and slow pulse and breathing rates.

The absence of edema distinguishes marasmus-like secondary PEM, a gradual wasting process that begins with weight loss and progresses to mild, moderate, or severe malnutrition (cachexia). It is usually associated with cancer, chronic obstructive pulmonary disease (COPD), or another chronic disease that is inactive or progressing very slowly.

Some individuals have both kwashiorkor and marasmus at the same time. This most often occurs when a person who has a chronic, inactive condition develops symptoms of an acute illness.

Hospitalized patients

Difficulty chewing, swallowing, and digesting food, **pain**, nausea, and lack of appetite are among the most common reasons that many hospital patients don't consume enough nutrients. Nutrient loss can be accelerated by bleeding, diarrhea, abnormally high sugar levels (glycosuria), kidney disease, malabsorption disorders, and other factors. **Fever**, infection, surgery, and benign or malignant tumors increase the amount of nutrients hospitalized patients need. So do trauma, **burns**, and some medications.

Diagnosis

A thorough **physical examination** and a health history that probes eating habits and weight changes, focuses on body-fat composition and muscle strength, and assesses gastrointestinal symptoms, underlying illness, and nutritional status is often as accurate as blood tests and urinalyses used to detect and document abnormalities.

Some doctors further quantify a patient's nutritional status by:

- comparing height and weight to standardized norms
- calculating body mass index (BMI)
- measuring skinfold thickness or the circumference of the upper arm

Treatment

Treatment is designed to provide adequate **nutrition**, restore normal body composition, and cure the condition that caused the deficiency. Tube feeding or intravenous feeding is used to supply nutrients to patients who can't or won't eat protein-rich foods.

In patients with severe PEM, the first stage of treatment consists of correcting fluid and electrolyte imbalances, treating infection with **antibiotics** that don't affect protein synthesis, and addressing related medical problems. The second phase involves replenishing essential nutrients slowly to prevent taxing the patient's weakened system with more food than it can handle. Physical therapy may be beneficial to patients whose muscles have deteriorated significantly.

Prognosis

Most people can lose up to 10% of their body weight without side effects, but losing more than 40% is almost always fatal. Death usually results from **heart failure**, an electrolyte imbalance, or low body temperature. Patients with certain symptoms, including semiconsciousness, persistent diarrhea, **jaundice**, and low blood sodium levels, have a poorer prognosis than other patients. Recovery from marasmus usually takes longer than recovery from kwashiorkor. The long-term effects of childhood malnutrition are uncertain. Some children recover completely, while others may have a variety of lifelong impairments, including an inability to properly absorb nutrients in the intestines and mental retardation. The outcome appears to be related to the length and severity of the malnutrition, as well as to the age of the child when the malnutrition occurred.

Prevention

Breastfeeding a baby for at least six months is considered the best way to prevent early-childhood malnutrition. Preventing malnutrition in developing countries is a complicated and challenging problem. Providing food directly during famine can help in the short-term, but more long-term solutions are needed, including agricultural development, public health programs (especially programs that monitor growth and development, as well as programs that provide nutritional information and supplements), and improved food distribution systems. Programs that distribute infant formula and discourage breastfeeding should be discontinued, except in areas where many mothers are infected with HIV.

Every patient being admitted to a hospital should be screened for the presence of illnesses and conditions that could lead to PEM. The nutritional status of patients at higher-than-average risk should be more thoroughly assessed and periodically reevaluated during extended hospital stays or nursing home residence.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Harrison's Principles of Internal Medicine, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

American College of Nutrition. 722 Robert E. Lee Drive, Wilmington, NC 20412-0927. (919) 152-1222.

American Institute of Nutrition. 9650 Rockville Pike, Bethesda, MD 20814-3990. (301) 530-7050.

Food and Nutrition Information Center. 10301 Baltimore Boulevard, Room 304, Beltsville, MD 20705-2351. <http://www.nalusda.gov/fnic>.

Maureen Haggerty

Protein-modified diet *see* **Diets**

Prothrombin time

Definition

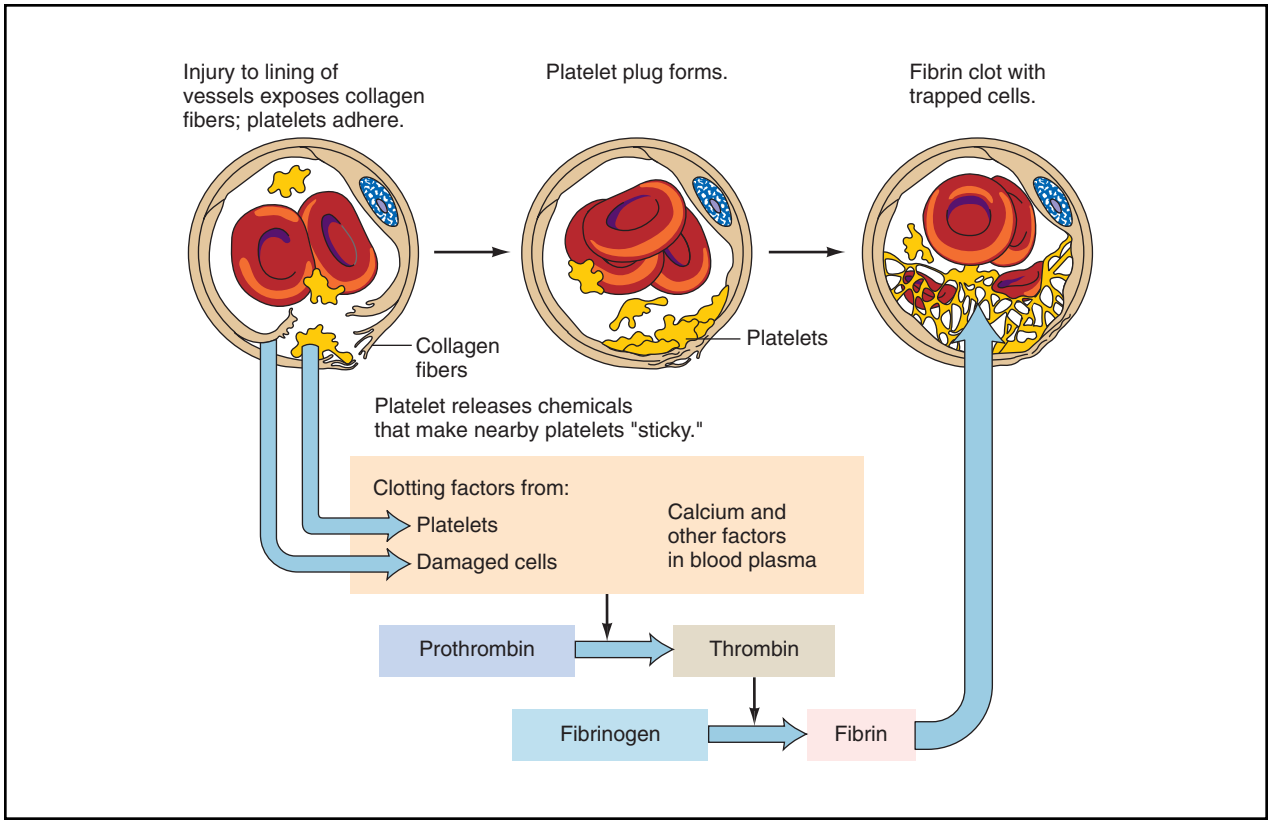
The prothrombin time test belongs to a group of blood tests that assess the clotting ability of blood. The test is also known as the pro time or PT test.

Purpose

The PT test is used to monitor patients taking certain medications as well as to help diagnose clotting disorders.

Diagnosis

Patients who have problems with delayed blood clotting are given a number of tests to determine the cause of the problem. The prothrombin test specifically evaluates the presence of factors VIIa, V, and X, prothrombin, and fibrinogen. Prothrombin is a protein in the liquid part of blood (plasma) that is converted to throm-



The blood clotting process. *(Illustration by Hans & Cassidy.)*

bin as part of the clotting process. Fibrinogen is a type of blood protein called a globulin; it is converted to fibrin during the clotting process. A drop in the concentration of any of these factors will cause the blood to take longer to clot. The PT test is used in combination with the **partial thromboplastin time** (PTT) test to screen for **hemophilia** and other hereditary clotting disorders.

Monitoring

The PT test is also used to monitor the condition of patients who are taking warfarin (Coumadin). Warfarin is a drug that is given to prevent clots in the deep veins of the legs and to treat **pulmonary embolism**. It interferes with blood clotting by lowering the liver's production of certain clotting factors.

Description

A sample of the patient's blood is obtained by venipuncture. The blood is collected in a tube that contains sodium citrate to prevent the clotting process from starting before the test. The blood cells are separated from the liquid part of blood (plasma). The PT test is performed by adding the patient's plasma to a protein in the blood (thromboplastin) that converts prothrombin to thrombin. The mixture is then kept in a warm water bath at 37°C for one to two minutes. Calcium chloride is added to the mixture in order to counteract the sodium citrate and allow clotting to proceed. The test is timed from the addition of the calcium chloride until the plasma clots. This time is called the prothrombin time.

Preparation

The doctor should check to see if the patient is taking any medications that may affect test results. This precaution is particularly important if the patient is taking warfarin, because there are a number of medications that can interact with warfarin to increase or decrease the PT time.

Aftercare

Aftercare consists of routine care of the area around the puncture mark. Pressure is applied for a few seconds and the wound is covered with a bandage.

Risks

The primary risk is mild **dizziness** and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

KEY TERMS

Disseminated intravascular coagulation (DIC)—A condition in which spontaneous bleeding and clot formation occur throughout the circulatory system. DIC can be caused by transfusion reactions and a number of serious illnesses.

Fibrin—The protein formed as the end product of the blood clotting process when fibrinogen interacts with thrombin.

Fibrinogen—A type of blood protein called a globulin that interacts with thrombin to form fibrin.

Plasma—The liquid part of blood, as distinct from blood cells.

Prothrombin—A protein in blood plasma that is converted to thrombin during the clotting process.

Thrombin—An enzyme in blood plasma that helps to convert fibrinogen to fibrin during the last stage of the clotting process.

Thromboplastin—A protein in blood that converts prothrombin to thrombin.

Warfarin—A drug given to control the formation of blood clots. The PT test can be used to monitor patients being treated with warfarin.

Normal results

The normal prothrombin time is 11-15 seconds, although there is some variation depending on the source of the thromboplastin used in the test. (For this reason, laboratories report a normal control value along with patient results.) A prothrombin time within this range indicates that the patient has normal amounts of clotting factors VII and X.

Abnormal results

A prolonged PT time is considered abnormal. The prothrombin time will be prolonged if the concentration of any of the tested factors is 10% or more below normal plasma values. A prolonged prothrombin time indicates a deficiency in any of factors VII, X, V, prothrombin, or fibrinogen. It may mean that the patient has a **vitamin K deficiency**, a liver disease, or disseminated intravascular coagulation (DIC). The prothrombin time of patients receiving warfarin therapy will also be prolonged—usually in the range of one and one half to two times the normal PT time. A PT time that exceeds approximately two and a half times the control value (usually 30 seconds or longer) is grounds for concern, as abnormal bleeding may occur.

Resources

BOOKS

Jandl, J. H. *Blood: Textbook of Hematology.* New York: Little, Brown and Co., 1996.

Merck Manual of Medical Information, ed. Robert Berkow, et al. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

John T. Lohr, PhD

Pruritis *see* **Itching**

PSA test *see* **Prostate-specific antigen test**

PSDD *see* **Premenstrual disphoric disorder**

Pseudoephedrin *see* **Decongestants**

Pseudohermaphroditism *see* **Intersex states**

Pseudomembraneous enterocolitis *see* **Antibiotic-associated colitis**

Pseudomonas aeruginosa infection *see* **Pseudomonas infections**

Pseudomonas infections

Definition

A pseudomonas infection is caused by a bacterium, *Pseudomonas aeruginosa*, and may affect any part of the body. In most cases, however, pseudomonas infections strike only persons who are very ill, usually hospitalized.

Description

P. aeruginosa is a rod-shaped organism that can be found in soil, water, plants, and animals. Because it rarely causes disease in healthy persons, but infects those who are already sick or who have weakened immune systems, it is called an opportunistic pathogen. Opportunistic pathogens are organisms that do not ordinarily cause disease, but multiply freely in persons whose immune systems are weakened by illness or medication. Such persons are said to be immunocompromised. Patients with **AIDS** have an increased risk of developing serious pseudomonas infections. Hospitalized patients are another high-risk group, because *P. aeruginosa* is often found in hospitals. Infections that can be acquired in the hospital are sometimes called nosocomial diseases.

Of the two million nosocomial infections each year, 10% are caused by *P. aeruginosa*. The bacterium is the second most common cause of nosocomial **pneumonia** and the most common cause of intensive care unit (ICU) pneumonia. Pseudomonas infections can be spread within hospitals by health care workers, medical equipment, sinks, disinfectant solutions, and food. These infections are a very serious problem in hospitals for two reasons. First, patients who are critically ill can die from a pseudomonas infection. Second, many *Pseudomonas* bacteria are resistant to certain **antibiotics**, which makes them difficult to treat.

P. aeruginosa is able to infect many different parts of the body. Several factors make it a strong opponent. These factors include:

- the ability to stick to cells
- minimal food requirements
- resistance to many antibiotics
- production of proteins that damage tissue
- a protective outer coat

Infections that can occur in specific body sites include:

- Heart and blood. *P. aeruginosa* is the fourth most common cause of bacterial infections of the blood (**bacteremia**). Bacteremia is common in patients with blood **cancer** and patients who have pseudomonas infections elsewhere in the body. *P. aeruginosa* infects the heart valves of intravenous drug abusers and persons with artificial heart valves.
- Bones and joints. Pseudomonas infections in these parts of the body can result from injury, the spread of infection from other body tissues, or bacteremia. Persons at risk for pseudomonas infections of the bones and joints include diabetics, intravenous drug abusers, and bone surgery patients.
- Central nervous system. *P. aeruginosa* can cause inflammation of the tissues covering the brain and spinal cord (**meningitis**) and brain abscesses. These infections may result from brain injury or surgery, the spread of infection from other parts of the body, or bacteremia.
- Eye and ear. *P. aeruginosa* can cause infections in the external ear canal—so-called "swimmer's ear"— that usually disappear without treatment. The bacterium can cause a more serious ear infection in elderly patients, possibly leading to hearing problems, facial **paralysis**, or even **death**. Pseudomonas infections of the eye usually follow an injury. They can cause ulcers of the cornea that may cause rapid tissue destruction and eventual blindness. The risk factors for pseudomonas eye infections include: wearing soft extended-wear contact lenses; using topical corticosteroid eye medications; being in a **coma**; having extensive **burns**; undergoing treatment in an ICU; and having a tracheostomy or endotracheal tube.
- Urinary tract. Urinary tract infections can be caused by catheterization, medical instruments, and surgery.
- Lung. Risk factors for *P. aeruginosa* pneumonia include: **cystic fibrosis**; chronic lung disease; immunocompromised condition; being on antibiotic therapy or a respirator; and congestive **heart failure**. Patients with cystic fibrosis often develop pseudomonas infections as children and suffer recurrent attacks of pneumonia.
- Skin and soft tissue. Even healthy persons can develop a pseudomonas skin rash following exposure to the bacterium in contaminated hot tubs, water parks, whirlpools, or spas. This skin disorder is called pseudomonas or "hot tub" **folliculitis**, and is often confused with **chickenpox**. Severe skin infection may occur in patients with *P. aeruginosa* bacteremia. The bacterium is the second most common cause of burn wound infections in hospitalized patients.

Causes and symptoms

P. aeruginosa can be sudden and severe, or slow in onset and cause little **pain**. Risk factors for acquiring a pseudomonas infection include: having a serious illness; being hospitalized; undergoing an invasive procedure such as surgery; having a weakened immune system; and being treated with antibiotics that kill many different kinds of bacteria (broad-spectrum antibiotics).

Each of the infections listed above has its own set of symptoms. *Pseudomonas* bacteremia resembles other bacteremias, producing **fever**, tiredness, muscle pains, joint pains, and chills. Bone infections are marked by swelling, redness, and pain at the infected site and possibly fever. *Pseudomonas* meningitis causes fever, **headache**, irritability, and clouded consciousness. Ear infection is associated with pain, ear drainage, facial paralysis, and reduced hearing. Pseudomonas infections of the eye cause ulcers that may spread to cover the entire eye, pain, reduced vision, swelling of the eyelids, and pus accumulation within the eye.

P. aeruginosa pneumonia is marked by chills, fever, productive **cough**, difficult breathing, and blue-tinted skin. Patients with cystic fibrosis with pseudomonas lung infections experience coughing, decreased appetite, weight loss, tiredness, **wheezing**, rapid breathing, fever, blue-tinted skin, and abdominal enlargement. Skin infections can cause a range of symptoms from a mild rash to large bleeding ulcers. Symptoms of pseudomonas folli-

culitis include a red itchy rash, headache, **dizziness**, earache, sore eyes, nose, and throat, breast tenderness, and stomach pain. Pseudomonas wound infections may secrete a blue-green colored fluid and have a fruity smell. Burn wound infections usually occur one to two weeks after the burn and cause discoloration of the burn scab, destruction of the tissue below the scab, early scab loss, bleeding, swelling, and a blue-green drainage.

Diagnosis

Diagnosis and treatment of pseudomonas infections can be performed by specialists in infectious disease. Because *P. aeruginosa* is commonly found in hospitals, many patients carry the bacterium without having a full-blown infection. Consequently, the mere presence of *P. aeruginosa* in patients does not constitute a diagnostic finding. Cultures, however, can be easily done for test purposes. The organism grows readily in laboratory media; results are usually available in two to three days. Depending on the location of the infection, body fluids that can be tested for *P. aeruginosa* include blood, urine, cerebrospinal fluid, sputum, pus, and drainage from an infected ear or eye. X rays and other imaging techniques can be used to assess infections in deep organ tissues.

Treatment

Medications

Because *P. aeruginosa* is commonly resistant to antibiotics, infections are usually treated with two antibiotics at once. Pseudomonas infections may be treated with combinations of ceftazidime (Ceftaz, Fortraz, Tazicef), ciprofloxacin (Cipro), imipenem (Primaxin), gentamicin (Garamycin), tobramycin (Nebcin), ticarcillin-clavulanate (Timentin), or piperacillin-tazobactam (Zosyn). Most antibiotics are administered intravenously or orally for two to six weeks. Treatment of an eye infection requires local application of antibiotic drops.

Surgery

Surgical treatment of pseudomonas infections is sometimes necessary to remove infected and damaged tissue. Surgery may be required for brain abscesses, eye infections, bone and joint infections, ear infections, heart infections, and wound infections. Infected **wounds** and burns may cause permanent damage requiring arm or leg **amputation**.

Prognosis

Most pseudomonas infections can be successfully treated with antibiotics and surgery. In immunocompromised persons, however, *P. aeruginosa* infections have a high mortality rate, particularly following bacteremia or infections of the lower lung. Mortality rates range from 15 to 20% of patients with severe ear infections to 89% of patients with infections of the left side of the heart.

KEY TERMS

Bacteremia—Bacterial infection of the blood.

"Hot tub" folliculitis—A skin infection caused by *P. aeruginosa* that often follows bathing in a hot tub or public swimming pool.

Immunocompromised—Having a weak immune system due to disease or the use of certain medications.

Nosocomial infection—An infection that is acquired in the hospital.

Opportunistic—Causing disease only under certain conditions, as when a person is already sick or has a weak immune system.

Pathogen—Any microorganism that produces disease.

Prevention

Most hospitals have programs for the prevention of nosocomial infections. Patients with cystic fibrosis may be given periodic doses of antibiotics to prevent episodes of pseudomonas pneumonia.

Minor skin infections can be prevented by avoiding hot tubs with cloudy water; avoiding public swimming pools at the end of the day; removing wet swimsuits as soon as possible; bathing after sharing a hot tub or using a public pool; cleaning hot tub filters every six weeks; and using appropriate amounts of chlorine in the water.

Resources

OTHER

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.
Mayo Clinic Online. 5 Mar. 1998. <http://www.mayohealth.org>.

Belinda Rowland, PhD

Pseudomonas pseudomallei infection *see* **Melioidosis**

Pseudost *see* **Strabismus**

Pseudotuberculosis *see* **Sarcoidosis**

Pseudoxanthoma elasticum

Definition

Pseudoxanthoma elascticum (PXE) is an inherited connective tissue disorder in which the elastic fibers present in the skin, eyes, and cardiovascular system gradually become calcified and inelastic.

Description

PXE was first reported in 1881 by Rigal, but the defect in elastic fibers was described in 1986 by Darier, who gave the condition its name. PXE is also known as Grönblad-Strandberg-Touraine syndrome and systemic elastorrhexis.

The course of PXE varies greatly between individuals. Typically it is first noticed during adolescence as yellow-orange bumps on the side of the neck. Similar bumps may appear at other places where the skin bends a lot, like the backs of the knees and the insides of the elbows. The skin in these areas tends to get thick, leathery, inelastic, and acquire extra folds. These skin problems have no serious consequences, and for some people, the disease progresses no further.

Bruch's membrane, a layer of elastic fibers in front of the retina, becomes calcified in some people with PXE. Calcification causes cracks in Bruch's membrane, which can be seen through an ophthalmoscope as red, brown, or gray streaks called angioid streaks. The cracks can eventually (e.g., in 10–20 years) cause bleeding, and the usual resultant scarring leads to central vision deterioration. However, peripheral vision is unaffected.

Arterial walls and heart valves contain elastic fibers that can become calcified. This leads to a greater susceptibility to the conditions that are associated with hardening of the arteries in the normal **aging** population—high blood pressure, **heart attack**, **stroke**, and arterial obstruction—and, similarly, **mitral valve prolapse**. Heart disease and **hypertension** associated with PXE have been reported in children as young as four to 13 years of age. Although often appearing at a younger age, the overall incidence of these conditions is only slightly higher for people with PXE than it is in the general population.

Arterial inelasticity can lead to bleeding from the gastrointestinal tract and, rarely, acute vomiting of blood.

PXE is rare and occurs in about 1 in every 160,000 people in the general population. It is likely, though, that PXE is underdiagnosed, because of the presence of mild symptoms in some affected persons and the lack of awareness of the condition among primary care physicians.

Causes and symptoms

PXE is caused by changes in the genetic material, called mutations, that are inherited in either a dominant or recessive mode. A person with the recessive form of the disease (which is most common) must possess two copies of the PXE gene to be affected, and, therefore, must have received one from each parent. In the dominant form, one copy of the defective gene is sufficient to cause the disease. In some cases, a person with the dominant form inherits the abnormal gene from a parent with PXE. More commonly, the mutation arises as a spontaneous change in the genetic material of the affected person. These cases are called "sporadic" and do not affect parents or siblings, although each child of a person with sporadic PXE has a 50% risk to inherit the condition.

Both males and females develop PXE, although the skin findings seem to be somewhat more common in females.

The actual genetic causes of this condition were not discovered until 2000. The recessive, dominant, and sporadic forms of PXE all appear to be caused by different mutations or deletions in a single gene called ABCC6 (also known as MRP6), located on chromosome 16. Although the responsible gene has been identified, how it causes PXE is still unknown.

Genetic researchers have since identified mutations in a number of persons with PXE, most of whom have been found to have the recessive type. Affected individuals in these families had mutations in both copies of the gene and parents, who are obligate carriers, had a mutation in only one copy. Contrary to the usual lack of symptoms in carriers of recessive genes, some carriers of recessive PXE have been found to have cardiovascular symptoms typical of PXE.

Although the recessive type is the most common, there are also familial and sporadic cases that have been found to be caused by dominant mutations in the ABCC6 gene.

A wide range in the type and severity of symptoms exists between people with PXE. The age of onset also varies, although most people notice initial symptoms during adolescence or early adulthood. Often, the first symptoms to appear are thickened skin with yellow bumps in localized areas such as the folds of the groin, arms, knees, and armpits. These changes can also occur in the mucous membranes, most often in the inner portion of the lower lip. The appearance of the skin in PXE has been likened to a plucked chicken or Moroccan leather.

Angioid streaks in front of the retina are present in most people with PXE and an ophthalmologic examination can be used as an initial screen for the condition. Persons

KEY TERMS

Angioid streaks—Gray, orange, or red wavy branching lines in Bruch's membrane.

Bruch's membrane—A membrane in the eye between the choroid membrane and the retina.

Carrier—A person who possesses a gene for an abnormal trait without showing signs of the disorder. The person may pass the abnormal gene on to offspring.

Claudication—Pain in the lower legs after exercise caused by insufficient blood supply.

Connective tissue—A group of tissues responsible for support throughout the body; includes cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

Deletion—The absence of genetic material that is normally found in a chromosome. Often, the genetic material is missing due to an error in replication of an egg or sperm cell.

Dominant trait—A genetic trait in which one copy of the gene is sufficient to yield an outward display of the trait; dominant genes mask the presence of recessive genes; dominant traits can be inherited from a single parent.

Elastic fiber—Fibrous, stretchable connective tissue made primarily from proteins, elastin, collagen, and fibrillin.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Mitral valve—The heart valve that prevents blood from flowing backwards from the left ventricle into the left atrium. Also known as bicuspid valve.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Recessive trait—An inherited trait or characteristic that is outwardly obvious only when two copies of the gene for that trait are present.

with PXE often complain of sensitivity to light. Because of the progressive breakdown of Bruch's membrane, affected persons are at increased risk for bleeding and scarring of the retina, which can lead to decreased central vision but does not usually cause complete blindness.

Calcium deposits in the artery walls contribute to early-onset **atherosclerosis**, and another condition called claudication, inadequate blood flow that results in **pain** in the legs after exertion. Abnormal bleeding, caused by calcification of the inner layer of the arteries, can occur in the brain, retina, uterus, bladder, and joints but is most common in the gastrointestinal tract.

Diagnosis

The presence of calcium in elastic fibers, as revealed by microscopic examination of biopsied skin, unequivocally establishes the diagnosis of PXE.

Treatment

PXE cannot be cured, but plastic surgery can treat PXE **skin lesions**, and **laser surgery** is used to prevent or slow the progression of vision loss. Excessive blood loss due to bleeding into the gastrointestinal tract or other organ systems may be treated by **transfusion**. Mitral valve prolapse (protrusion of one or both cusps of the mitral heart valve back into the atrium during heart beating) can be corrected by surgery, if necessary.

Measures should be taken to prevent or lessen cardiovascular complications. People with PXE should control their cholesterol and blood pressure, and maintain normal weight. They should **exercise** for cardiovascular health and to prevent or reduce claudication later in life. They should also avoid the use of tobacco, thiazide **antihypertensive drugs**, blood thinners like coumadin, and **nonsteroidal anti-inflammatory drugs** like **aspirin** and ibuprofen. In addition, they should avoid strain, heavy lifting, and contact sports, since these activities could trigger retinal and gastrointestinal bleeding.

People with PXE should have regular eye examinations by an ophthalmologist and report any eye problems immediately. Regular check-ups with a physician are also recommended, including periodic blood pressure readings.

Some people have advocated a calcium-restricted diet, but it is not yet known whether this aids the problems brought about by PXE. It is known, however, that calcium-restriction can lead to bone disorders.

Prognosis

The prognosis is for a normal life span with an increased chance of cardiovascular and circulatory problems, hypertension, gastrointestinal bleeding, and impaired vision. However, now that the gene for PXE has been identified, the groundwork for research to provide effective treatment has been laid. Studying the role of the ABCC6 protein in elastic fibers may lead to drugs that will ameliorate or arrest the problems caused by PXE.

Genetic tests are now available that can provide knowledge needed to both diagnose PXE in symptomatic persons and predict it prior to the onset of symptoms in persons at risk. Prenatal diagnosis of PXE, by testing fetal cells for mutations in the ABCC6 gene, can be done in early **pregnancy** by procedures such as **amniocentesis** or **chorionic villus sampling**. For most people, PXE is compatible with a reasonably normal life, and prenatal diagnosis is not likely to be highly desired.

Genetic testing to predict whether an at-risk child will develop PXE may be helpful for medical management. A child who is found to carry a mutation can be monitored more closely for eye problems and bleeding, and can begin the appropriate lifestyle changes to prevent cardiovascular problems.

Resources

BOOKS

Pope, F. Michael. "Pseudoxanthoma Elasticum, Cutis Laxa, and Other Disorders of Elastic Tissue." In *Emery and Rimoin's Principles and Practice of Medical Genetics*. 3rd ed. Ed. David L. Rimoin, J. Michael Connor, and Reed E. Pyeritz. New York: Churchill Livingstone, 1997.

PERIODICALS

Sherer, D.W., et al. "Pseudoxanthoma Elasticum: An Update." *Dermatology* 199 (1999): 3–7.

Ringpfeil, F., et al. "Pseudoxanthoma Elasticum: Mutations in the MRP6 Gene Encoding a Transmembrane AFP-binding Cassette (ABC) Transporter." *Proceedings of the National Academy of Sciences* 97 (May 2000): 6001–6.

ORGANIZATIONS

National Association for Pseudoxanthoma Elasticum. 3500 East 12th Avenue, Denver, CO 80206. (303) 355-3866. Fax: (303) 355-3859. Pxenape@estreet.com. <http://www.napxe.org>.

PXE International, Inc. 23 Mountain Street, Sharon, MA 02067. (781) 784-3817. Fax: (781) 784-6672. PXEInter@aol.com. <http://www.pxe.org/>.

Barbara J. Pettersen

Psittacosis *see* **Parrot fever**

Psoas abscess *see* **Abscess**

Psoriasis

Definition

Named for the Greek word *pso¯ra* meaning "itch," psoriasis is a chronic, non-contagious disease characterized by inflamed lesions covered with silvery-white scabs of dead skin.

Description

Psoriasis, which affects at least four million Americans, is slightly more common in women than in men. Although the disease can develop at any time, 10–15% of all cases are diagnosed in children under 10, and the average age at the onset of symptoms is 28. Psoriasis is most common in fair-skinned people and extremely rare in dark-skinned individuals.

Normal skin cells mature and replace dead skin every 28–30 days. Psoriasis causes skin cells to mature in less than a week. Because the body can't shed old skin as rapidly as new cells are rising to the surface, raised patches of dead skin develop on the arms, back, chest, elbows, legs, nails, folds between the buttocks, and scalp.

Psoriasis is considered mild if it affects less than 5% of the surface of the body; moderate, if 5–30% of the skin is involved, and severe, if the disease affects more than 30% of the body surface.

Types of psoriasis

Dermatologists distinguish different forms of psoriasis according to what part of the body is affected, how severe symptoms are, how long they last, and the pattern formed by the scales.

PLAQUE PSORIASIS. Plaque psoriasis (psoriasis vulgaris), the most common form of the disease, is characterized by small, red bumps that enlarge, become inflamed, and form scales. The top scales flake off easily and often, but those beneath the surface of the skin clump together. Removing these scales exposes tender skin, which bleeds and causes the plaques (inflamed patches) to grow.

Plaque psoriasis can develop on any part of the body, but most often occurs on the elbows, knees, scalp, and trunk.

SCALP PSORIASIS. At least 50 of every 100 people who have any form of psoriasis have scalp psoriasis. This form of the disease is characterized by scale-capped plaques on the surface of the skull.

NAIL PSORIASIS. The first sign of nail psoriasis is usually pitting of the fingernails or toenails. Size, shape,

and depth of the marks vary, and affected nails may thicken, yellow, or crumble. The skin around an affected nail is sometimes inflamed, and the nail may peel away from the nail bed.

GUTTATE PSORIASIS. Named for the Latin word *gutta,* which means "a drop," guttate psoriasis is characterized by small, red, drop-like dots that enlarge rapidly and may be somewhat scaly. Often found on the arms, legs, and trunk and sometimes in the scalp, guttate psoriasis can clear up without treatment or disappear and resurface in the form of plaque psoriasis.

PUSTULAR PSORIASIS. Pustular psoriasis usually occurs in adults. It is characterized by blister-like lesions filled with non-infectious pus and surrounded by reddened skin. Pustular psoriasis, which can be limited to one part of the body (localized) or can be widespread, may be the first symptom of psoriasis or develop in a patient with chronic plaque psoriasis.

Generalized pustular psoriasis is also known as Von Zumbusch pustular psoriasis. Widespread, acutely painful patches of inflamed skin develop suddenly. Pustules appear within a few hours, then dry and peel within two days.

Generalized pustular psoriasis can make life-threatening demands on the heart and kidneys.

Palomar-plantar pustulosis (PPP) generally appears between the ages of 20 and 60. PPP causes large pustules to form at the base of the thumb or on the sides of the heel. In time, the pustules turn brown and peel. The disease usually becomes much less active for a while after peeling.

Acrodermatitis continua of Hallopeau is a form of PPP characterized by painful, often disabling, lesions on the fingertips or the tips of the toes. The nails may become deformed, and the disease can damage bone in the affected area.

INVERSE PSORIASIS. Inverse psoriasis occurs in the armpits and groin, under the breasts, and in other areas where skin flexes or folds. This disease is characterized by smooth, inflamed lesions and can be debilitating.

ERYTHRODERMIC PSORIASIS. Characterized by severe scaling, **itching**, and **pain** that affects most of the body, erythrodermic psoriasis disrupts the body's chemical balance and can cause severe illness. This particularly inflammatory form of psoriasis can be the first sign of the disease, but often develops in patients with a history of plaque psoriasis.

PSORIATIC ARTHRITIS. About 10% of partients with psoriasis develop a complication called **psoriatic arthritis**. This type of arthritis can be slow to develop and mild, or it can develop rapidly. Symptoms of psoriatic arthritis include:

- joint discomfort, swelling, stiffness, or throbbing
- swelling in the toes and ankles
- pain in the digits, lower back, wrists, knees, and ankles
- eye inflammation or pink eye (conjunctivitis).

Causes and symptoms

The cause of psoriasis is unknown, but research suggests that an immune-system malfunction triggers the disease. Factors that increase the risk of developing psoriasis include:

- family history
- stress
- exposure to cold temperatures
- injury, illness, or infection
- steroids and other medications
- race

Trauma and certain bacteria may trigger psoriatic arthritis in patients with psoriasis.

Diagnosis

A complete medical history and examination of the skin, nails, and scalp are the basis for a diagnosis of psoriasis. In some cases, a microscopic examination of skin cells is also performed.

Blood tests can distinguish psoriatic arthritis from other types of arthritis. **Rheumatoid arthritis**, in particular, is diagnosed by the presence of a particular antibody present in the blood. That antibody is not present in the blood of patients with psoriatic arthritis.

Treatment

Age, general health, lifestyle, and the severity and location of symptoms influence the type of treatment used to reduce inflammation and decrease the rate at which new skin cells are produced. Because the course of this disease varies with each individual, doctors must experiment with or combine different treatments to find the most effective therapy for a particular patient.

Mild-moderate psoriasis

Steroid creams and ointments are commonly used to treat mild or moderate psoriasis, and steroids are sometimes injected into the skin of patients with a limited number of lesions. In mid-1997, the United States Food and Drug Administration (FDA) approved the use of tazarotene (Tazorac) to treat mild-to-moderate plaque psoriasis. This water-based gel has chemical properties similar to vitamin A.

Brief daily doses of natural sunlight can significantly relieve symptoms. **Sunburn** has the opposite effect.

Moisturizers and bath oils can loosen scales, soften skin, and may eliminate the itch. So can adding a cup of oatmeal to a tub of bath water. Salicylic acid (an ingredient in **aspirin**) can be used to remove dead skin or increase the effectiveness of other therapies.

Moderate psoriasis

Administered under medical supervision, ultraviolet light B (UVB) is used to control psoriasis that covers many areas of the body or that has not responded to topical preparations. Doctors combine UVB treatments with topical medications to treat some patients and sometimes prescribe home **phototherapy**, in which the patient administers his or her own UVB treatments.

Photochemotherapy (PUVA) is a medically supervised procedure that combines medication with exposure to ultraviolet light (UVA) to treat localized or widespread psoriasis. An individual with wide-spread psoriasis that has not responded to treatment may enroll in one of the day treatment programs conducted at special facilities throughout the United States. Psoriasis patients who participate in these intensive sessions are exposed to UVB and given other treatments for six to eight hours a day for two to four weeks.

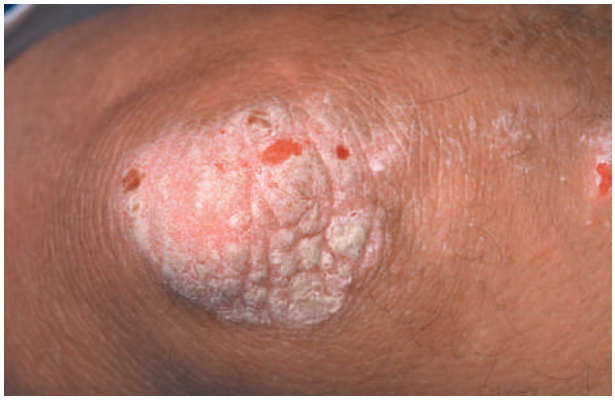
Severe psoriasis

Methotrexate (MTX) can be given as a pill or as an injection to alleviate symptoms of severe psoriasis or psoriatic arthritis. Patients who take MTX must be carefully monitored to prevent liver damage.

Psoriatic arthritis can also be treated with **nonsteroidal anti-inflammatory drugs** (NSAID), like **acetaminophen** (Tylenol) or aspirin. Hot compresses and warm water soaks may also provide some relief for painful joints.

Other medications used to treat severe psoriasis include etrentinate (Tegison) and isotretinoin (Accutane), whose chemical properties are similar to those of vitamin A. Most effective in treating pustular or erythrodermic psoriasis, Tegison also relieves some symptoms of plaque psoriasis. Tegison can enhance the effectiveness of UVB or PUVA treatments and reduce the amount of exposure necessary.

Accutane is a less effective psoriasis treatment than Tegison, but can cause many of the same side effects, including nosebleeds, inflammation of the eyes and lips, bone spurs, hair loss, and **birth defects**. Tegison is stored in the body for an unknown length of time, and should not be taken by a woman who is pregnant or planning to become pregnant. A woman should use reliable birth control while taking Accutane and for at least one month before and after her course of treatment.



Psoriasis, a chronic skin disorder, may appear on any area of the body, including the elbow, as shown above. *(Photo Researchers, Inc. Reproduced by permission.)*

Cyclosporin emulsion (Neoral) is used to treat stubborn cases of severe psoriasis. Cyclosporin is also used to prevent rejection of transplanted organs, and Neoral, approved by the FDA in 1997, should be particularly beneficial to psoriasis patients who are young children or African-Americans, or those who have diabetes.

Other conventional treatments for psoriasis include:

- Capsaicin (*Capsicum frutecens*), an ointment that can stop production of the chemical that causes the skin to become inflamed and halts the runaway production of new skin cells. Capsaicin is available without a prescription, but should be used under a doctor's supervision to prevent **burns** and skin damage.
- Hydrocortisone creams, topical ointments containing a form of vitamin D called calcitriol, and coal-tar shampoos and ointments can relieve symptoms. Hydrocortisone creams have been associated with such side effects as **folliculitis** (inflammation of the hair follicles), while coal-tar preparations have been associated with a heightened risk of skin **cancer**.

Alternative treatment

Non-traditional psoriasis treatments include:

- Soaking in warm water and German chamomile (*Matricaria recutita*) or bathing in warm salt water.
- Drinking as many as three cups a day of hot tea made with one or a combination of the following herbs: burdock (*Arctium lappa*) root, dandelion (*Taraxacum mongolicum*) root, Oregon grape (*Mahonia aquifolium*),

sarsaparilla (*Smilax officinalis*), and balsam pear (*Momardica charantia*).

- Taking two 500-mg capsules of evening primrose oil (*Oenothera biennis*) a day. Pregnant women should not use evening primrose oil, and patients with liver disease or **high cholesterol** should use it only under a doctor's supervision.
- Eating a diet that includes plenty of fish, turkey, celery (for cleansing the kidneys), parsley, lettuce, lemons (for cleansing the liver), limes, fiber, and fruit and vegetable juices.
- Eating a diet that eliminates animal products high in saturated fats, since they promote inflammation.
- Drinking plenty of water (at least eight glasses) each day.
- Taking nutritional supplements including **folic acid**, lecithin, vitamin A (specific for the skin), vitamin E, selenium, and zinc.
- Regularly imagining clear, healthy skin.

Other helpful alternative approaches include identifying and eliminating food allergens from the diet, enhancing the fuction of the liver, augmenting the hydrochloric acid in the stomach, and completing a **detoxification** program. Constitutional homeopathic treatment, if properly prescribed, can also help resolve psoriasis.

Prognosis

Most cases of psoriasis can be controlled, and most people who have psoriasis can live normal lives.

Some people who have psoriasis are so self-conscious and embarrassed about their appearance that they become depressed and withdrawn. The Social Security Administration grants disability benefits to about 400 psoriasis patients each year, and a comparable number die from complications of the disease.

Prevention

A doctor should be notified if:

- psoriasis symptoms appear or reappear after treatment
- pustules erupt on the skin and the patient experiences **fatigue**, muscle aches, and **fever**
- unfamiliar, unexplained symptoms appear

Resources

BOOKS

New Choices in Natural Healing, Ed. Bill Gottlieb, et al. Emmaus, PA: Rodale Press, 1995.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments.* Alexandria, VA: Time Life, Inc., 1996.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

American Skin Association, Inc. 150 E. 58th St., 3rd floor, New York, NY 10155-0002. (212) 688-6547.

National Psoriasis Foundation. 6600 S.W. 92nd Ave., Suite 300, Portland, OR 97223. (800) 723-9166. <http://www.psoriasis.org>.

Maureen Haggerty

KEY TERMS

Arthritis—An inflammation of joints.

Psoriatic arthritis

Definition

Psoriatic arthritis is a form of arthritic joint disease associated with the chronic skin scaling and fingernail changes seen in **psoriasis**.

Description

Physicians recognize a number of different forms of psoriatic arthritis. In some patients, the arthritic symptoms will affect the small joints at the ends of the fingers and toes. In others, symptoms will affect joints on one side of the body but not on the other. In addition, there are patients whose larger joints on both sides of the body simultaneously become affected, as in **rheumatoid arthritis**. Some people with psoriatic arthritis experience arthritis symptoms in the back and spine; in rare cases, called psoriatic arthritis mutilans, the disease destroys the joints and bones, leaving patients with gnarled and club-like hands and feet. In many patients, symptoms of psoriasis precede the arthritis symptoms; a clue to possible joint disease is pitting and other changes in the fingernails.

Most people develop psoriatic arthritis at ages 35–45, but it has been observed earlier in adults and children. Both the skin and joint symptoms will come and go; there is no clear relationship between the severity of the psoriasis symptoms and arthritis **pain** at any given time. It is unclear how common psoriatic arthritis is. Recent surveys

suggest that between 1 in 5 people and 1 in 2 people with psoriasis may also have some arthritis symptoms.

Causes and symptoms

The cause of psoriatic arthritis is unknown. As in psoriasis, genetic factors appear to be involved. People with psoriatic arthritis are more likely than others to have close relatives with the disease, but they are just as likely to have relatives with psoriasis but no joint disease. Researchers believe genes increasing the susceptibility to developing psoriasis may be located on chromosome 6p and chromosome 17, but the specific genetic abnormality has not been identified. Like psoriasis and other forms of arthritis, psoriatic arthritis also appears to be an autoimmune disorder, triggered by an attack of the body's own immune system on itself.

Symptoms of psoriatic arthritis include dry, scaly, silver patches of skin combined with joint pain and destructive changes in the feet, hands, knees, and spine. Tendon pain and nail deformities are other hallmarks of psoriatic arthritis.

Diagnosis

Skin and nail changes characteristic of psoriasis with accompanying arthritic symptoms are the hallmarks of psoriatic arthritis. A blood test for rheumatoid factor, antibodies that suggest the presence of rheumatoid arthritis, is negative in nearly all patients with psoriatic arthritis. X rays may show characteristic damage to the larger joints on either side of the body as well as fusion of the joints at the ends of the fingers and toes.

Treatment

Treatment for psoriatic arthritis is meant to control the **skin lesions** of psoriasis and the joint inflammation of arthritis. **Nonsteroidal anti-inflammatory drugs**, gold salts, and sulfasalazine are standard arthritis treatments, but have no effect on psoriasis. Antimalaria drugs and systemic **corticosteroids** should be avoided because they can cause **dermatitis** or exacerbate psoriasis when they are discontinued.

Several treatments are useful for both the skin lesions and the joint inflammation of psoriatic arthritis. Etretinate, a vitamin A derivative; methotrexate, a potent suppressr of the immune system; and ultraviolet light therapy have all been successfully used to treat psoriatic arthritis.

Alternative treatment

Food allergies/intolerances are believed to play a role in most **autoimmune disorders**, including psoriatic arthritis. Identification and elimination of food allergens from the diet can be helpful. Constitutional **homeopathy** can work deeply and effectively with this condition, if the proper prescription is given. **Acupuncture**, Chinese herbal medicine, and western herbal medicine can all be useful in managing the symptoms of psoriatic arthritis. Nutritional supplements can contribute added support to the healing process. Alternative treatments recommended for psoriasis and rheumatoid arthritis may also be helpful in treating psoriatic arthritis.

KEY TERMS

Psoriasis—A common recurring skin disease that is marked by dry, scaly, and silvery patches of skin that appear in a variety of sizes and locations on the body.

Psoriatic arthritis mutilans—A severe form of psoriatic arthritis that destroys the joints of the fingers and toes and causes the bones to fuse, leaving patients with gnarled and club-like hands and feet.

Rheumatoid arthritis—A systemic disease that primarily affects the joints, causing inflammation, changes in structure, and loss of function.

Rheumatoid factor—A series of antibodies that signal the presence of rheumatoid arthritis. May also be present in Sjögren's syndrome and systemic lupus erythematosus, among others.

Prognosis

The prognosis for most patients with psoriatic arthritis is good. For many the joint and other arthritis symptoms are much milder than those experienced in rheumatoid arthritis. One in five people with psoriatic arthritis, however, face potentially crippling joint disease. In some cases, the course of the arthritis can be far more mutilating than in rheumatoid arthritis.

Prevention

There are no preventive measures for psoriatic arthritis.

Resources

BOOKS

Fitzpatrick, Thomas B., et al. *Color Atlas and Synopsis of Clinical Dermatology.* New York: McGraw-Hill, 1997.

Lynch, Peter J., and W. Mitchell Sams Jr. *Principles and Practice of Dermatology.* 2nd ed. New York: Churchill Livingstone, 1996.

PERIODICALS

FitzGerald, Oliver, and David Kane. "Clinical, Immunopathogenic, and Therapeutic Aspects of Psoriatic Arthritis." *Current Opinion in Rheumatology* 9 (July 1997): 295–301.

Winchester, Robert. "Psoriatic Arthritis." *Dermatologic Clinics* 13 (Oct. 1995): 779–792.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

The American College of Rheumatology. 1800 Century Place, Suite 250, Atlanta, GA 30345. (404) 633-3777. <http://www.rheumatology.org>.

Richard H. Camer

PSP *see* **Progressive supranuclear palsy**

Psychiatric confinement

Definition

Psychiatric confinement is the use of restraints to detain a person in need of care and further evaluation.

Purpose

The purpose of restraint and confinement are crucial since they have a medico legal implication. The primary purpose for such intervention is typically an urgent or emergent condition that could cause danger to the affected person or others, or cause severe disability to the extent whereby the affected person is unable to care for himself or herself.

Precautions

Clinicians utilizing this form of patient and public safety should perform a comprehensive **mental status examination** and document the findings. This approach can potentially provide clear records establishing the specific presenting problems and symptoms that can lead to ambiguities and potential legal action.

Description

Confinement with restraints can be categorized as urgent or emergent. Emergent causes can include patients exhibiting abnormal vital signs (breathing, pulse rate, temperature, blood pressure), threatening or violent behavior, and those who present with signs and symptoms of alcohol or illicit drug intoxication. Urgent use of confinement is indicated in patients showing suicidal thoughts, extreme **anxiety**, homicidal or violent tendencies, or a danger to self or the public at large.

Preparation

Those categorized as emergent should be prepared for further testing that can include blood chemistry and psychological assessment and evaluation. Initially the patient is restrained with four point leather restraints (both arms and both legs) and placed in a quiet room with a sitter. For those with urgent needs, restraint is initiated and initial management is directed to assess for an underlying medical cause and address psychological needs.

Aftercare

Further assessment, testing, and evaluation is necessary for a definitive diagnosis and devising an appropriate treatment plan.

Risks

A deficiency in record-keeping can lead to legal problems. The criteria and specifications for confinement should be clearly indicated. Meticulous clinical examination and documentation is essential for a definitive diagnosis. Persons who are confined due to substance abuse problems may have legal issues. As of 2001 there is proposed legislation concerning the misuse of restraints for psychiatric inpatients, which in the past has been responsible for numerous wrongful deaths. There are currently no federal laws that regulate the use of inpatient restraints nor any requirements for reporting injuries or **death**.

Resources

BOOKS

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. St. Louis: Mosby-Year Books, Inc, 1998.

PERIODICALS

Reeves,R., et al. "Medicolegal Errors in the ED Related to the Involuntary Confinement of Psychiatric Patients." *American Journal of Emergency Medicine* (Nov. 1998).

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Catherine Seeley
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Psychoanalysis

Definition

Psychoanalysis is a form of psychotherapy used by qualified psychotherapists to treat patients who have a range of mild to moderate chronic life problems. It is related to a specific body of theories about the relationships between conscious and unconscious mental

processes, and should not be used as a synonym for psychotherapy in general. Psychoanalysis is done one-on-one with the patient and the analyst; it is not appropriate for group work.

Purpose

Psychoanalysis is the most intensive form of an approach to treatment called psychodynamic therapy. Psychodynamic refers to a view of human personality that results from interactions between conscious and unconscious factors. The purpose of all forms of psychodynamic treatment is to bring unconscious mental material and processes into full consciousness so that the patient can gain more control over his or her life.

Classical psychoanalysis has become the least commonly practiced form of psychodynamic therapy because of its demands on the patient's time, as well as on his or her emotional and financial resources. It is, however, the oldest form of psychodynamic treatment. The theories that underlie psychoanalysis were worked out by Sigmund Freud (1856–1939), a Viennese physician, during the early years of the twentieth century. Freud's discoveries were made in the context of his research into hypnosis. The goal of psychoanalysis is the uncovering and resolution of the patient's internal conflicts. The treatment focuses on the formation of an intense relationship between the therapist and patient, which is analyzed and discussed in order to deepen the patient's insight into his or her problems.

Psychoanalytic psychotherapy is a modified form of psychoanalysis that is much more widely practiced. It is based on the same theoretical principles as psychoanalysis, but is less intense and less concerned with major changes in the patient's character structure. The focus in treatment is usually the patient's current life situation and the way problems relate to early conflicts and feelings, rather than an exploration of the unconscious aspects of the relationship that has been formed with the therapist.

Not all patients benefit from psychoanalytic treatment. Potential patients should meet the following prerequisites:

- The capacity to relate well enough to form an effective working relationship with the analyst. This relationship is called a therapeutic alliance.
- At least average intelligence and a basic understanding of psychological theory.
- The ability to tolerate frustration, sadness, and other painful emotions.
- The capacity to distinguish between reality and fantasy.

People considered best suited to psychoanalytic treatment include those with depression, character disorders, neurotic conflicts, and chronic relationship problems. When the patient's conflicts are long-standing and deeply entrenched in his or her personality, psychoanalysis may be preferable to psychoanalytic psychotherapy, because of its greater depth.

Precautions

Psychoanalysis is not suitable for patients suffering from severe depression or psychotic disorders such as **schizophrenia**. It is also not appropriate for people with addictions or substance dependency, disorders of aggression or impulse control, or acute crises; some of these people may benefit from psychoanalysis after the crisis has been resolved.

Description

In both psychoanalysis and psychoanalytic psychotherapy, the therapist does not tell the patient how to solve problems or offer moral judgments. The focus of treatment is exploration of the patient's mind and habitual thought patterns. Such therapy is termed "non-directed." It is also "insight-oriented," meaning that the goal of treatment is increased understanding of the sources of one's inner conflicts and emotional problems. The basic techniques of psychoanalytical treatment include:

Therapist neutrality

Neutrality means that the analyst does not take sides in the patient's conflicts, express feelings about the patient, or talk about his or her own life. Therapist neutrality is intended to help the patient stay focused on issues rather than be concerned with the therapist's reactions. In psychoanalysis, the patient lies on a couch facing away from the therapist. In psychodynamic psychotherapy, however, the patient and therapist usually sit in comfortable chairs facing each other.

Free association

Free association means that the patient talks about whatever comes into mind without censoring or editing the flow of ideas or memories. Free association allows the patient to return to earlier or more childlike emotional states ("regress"). Regression is sometimes necessary in the formation of the therapeutic alliance. It also helps the analyst to understand the recurrent patterns of conflict in the patient's life.

Therapeutic alliance and transference

Transference is the name that psychoanalysts use for the patient's repetition of childlike ways of relating that were learned in early life. If the therapeutic alliance has been well established, the patient will begin to transfer

thoughts and feelings connected with siblings, parents, or other influential figures to the therapist. Discussing the transference helps the patient gain insight into the ways in which he or she misreads or misperceives other people in present life.

Interpretation

In psychoanalytic treatment, the analyst is silent as much as possible, in order to encourage the patient's free association. However, the analyst offers judiciously timed interpretations, in the form of verbal comments about the material that emerges in the sessions. The therapist uses interpretations in order to uncover the patient's resistance to treatment, to discuss the patient's transference feelings, or to confront the patient with inconsistencies. Interpretations may be either focused on present issues ("dynamic") or intended to draw connections between the patient's past and the present ("genetic"). The patient is also often encouraged to describe dreams and fantasies as sources of material for interpretation.

Working through

"Working through" occupies most of the work in psychoanalytic treatment after the transference has been formed and the patient has begun to acquire insights into his or her problems. Working through is a process in which the new awareness is repeatedly tested and "tried on for size" in other areas of the patient's life. It allows the patient to understand the influence of the past on his or her present situation, to accept it emotionally as well as intellectually, and to use the new understanding to make changes in present life. Working through thus helps the patient to gain some measure of control over inner conflicts and to resolve them or minimize their power.

Although psychoanalytic treatment is primarily verbal, medications are sometimes used to stabilize patients with severe **anxiety**, depression, or other **mood disorders** during the analysis.

The cost of either psychoanalysis or psychoanalytic psychotherapy is prohibitive for most patients without insurance coverage. A full course of psychoanalysis usually requires three to five weekly sessions with a psychoanalyst over a period of three to five years. A course of psychoanalytic psychotherapy involves one to three meetings per week with the therapist for two to five years. Each session or meeting typically costs between $80 and $200, depending on the locale and the experience of the therapist. The increasing reluctance of most HMOs and other managed care organizations to pay for long-term psychotherapy is one reason that these forms of treatment are losing ground to short-term methods of treatment and the use of medications to control the patient's emotions. It is also not clear that long-term psychoanalytically oriented approaches are more beneficial than briefer therapy methods for many patients.

KEY TERMS

Free association—A technique used in psychoanalysis in which the patient allows thoughts and feelings to emerge without trying to organize or censor them.

Interpretation—A verbal comment made by the analyst in response to the patient's free association. It is intended to help the patient gain new insights.

Neurosis—A mental and emotional disorder that affects only part of the personality and is accompanied by a significantly less distorted perception of reality than in psychosis.

Psychodynamic—An approach to psychotherapy based on the interplay of conscious and unconscious factors in the patient's mind. Psychoanalysis is one type of psychodynamic therapy.

Regression—The process in which the patient reverts to earlier or less mature feelings and behaviors.

Therapeutic alliance—The working relationship between a therapist and a patient that is necessary to the success of therapy.

Transference—The process that develops during psychoanalytic work during which the patient redirects feelings about early life figures toward the analyst.

Working through—The repeated testing of insights, which takes up most of the work in psychoanalysis after the therapeutic alliance has been formed.

Preparation

Some patients may need evaluation for possible medical problems before entering psychoanalysis because numerous diseases—including virus infections and certain vitamin deficiencies—have emotional side effects or symptoms. The therapist will also want to know whether the patient is taking any prescription medications that may affect the patient's feelings or ability to concentrate. In addition, it is important to make sure that the patient is not abusing drugs or alcohol.

Risks

The primary risk to the patient is related to the emotional **pain** resulting from new insights and changes in

long-standing behavior patterns. In some patients, psychoanalysis produces so much anxiety that they cannot continue with this treatment method. In other cases, the therapist's lack of skill may prevent the formation of a solid therapeutic alliance.

Normal results

Psychoanalysis and psychoanalytic psychotherapy both have the goal of basic changes in the patient's personality structure and level of functioning, although psychoanalysis typically aims at more extensive and more profound change. In general, this approach to treatment is considered successful if the patient has shown:

- reduction in intensity or number of symptoms
- some resolution of basic emotional conflicts
- increased independence and self-esteem
- improved functioning and adaptation to life

Attempts to compare the effectiveness of psychoanalytical treatment to other modes of therapy are difficult to evaluate. Some aspects of Freudian theory have been questioned since the 1970s on the grounds of their limited applicability to women and to people from non-Western cultures. There is, however, general agreement that psychoanalytic approaches work well for certain types of patients. In particular, these approaches are recommended for patients with neurotic conflicts.

Resources

BOOKS

Glick, Robert Alan, and Henry I. Spitz. "Common Approaches to Psychotherapy." In *The Columbia University College of Physicians and Surgeons Complete Home Guide to Mental Health*, ed. Frederic I. Kass, et al. New York: Henry Holt and Co., 1992.

Meissner, W. W. "The Psychotherapies: Individual, Family, and Group." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

"Theories of Personality." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

Rebecca J. Frey

Psychological tests

Definition

Psychological tests are written, visual, or verbal evaluations administered to assess the cognitive and emotional functioning of children and adults.

Purpose

Psychological tests are used to assess a variety of mental abilities and attributes, including achievement and ability, personality, and neurological functioning.

Achievement and ability tests

For children, academic achievement, ability, and intelligence tests may be used as a tool in school placement, in determining the presence of a learning disability or a developmental delay, in identifying giftedness, or in tracking intellectual development. Intelligence testing may be used with adults to determine vocational ability (e.g., in career counseling) or to assess adult intellectual ability in the classroom.

Personality tests

Personality tests are administered for a wide variety of reasons, from diagnosing psychopathology (e.g., personality disorder, depressive disorder) to screening job candidates. They may be used in an educational or vocational setting to determine personality strengths and weaknesses, or in the legal system to evaluate parolees.

Neuropsychological tests

Patients who have experienced a traumatic brain injury, brain damage, or organic neurological problems (for example, **dementia**) are administered neuropsychological tests to assess their level of functioning and identify areas of mental impairment. They may also be used to evaluate the progress of a patient who has undergone treatment or **rehabilitation** for a neurological injury or illness. In addition, certain neuropsychological measures may be used to screen children for developmental delays and/or learning disabilities.

Precautions

Psychological testing requires a clinically trained examiner. All psychological tests should be administered, scored, and interpreted by a trained professional, preferably a psychologist or psychiatrist with expertise in the appropriate area.

Psychological tests are only one element of a psychological assessment. They should never be used alone as the sole basis for a diagnosis. A detailed history of the test subject and a review of psychological, medical, educational, or other relevant records are required to lay the groundwork for interpreting the results of any psychological measurement.

Cultural and language differences in the test subject may affect test performance and may result in inaccurate

test results. The test administrator should be informed before psychological testing begins if the test taker is not fluent in English and/or belongs to a minority culture. In addition, the subject's motivation and motives may also affect test results.

Description

Psychological tests are formalized measures of mental functioning. Most are objective and quantifiable; however, certain projective tests may involve some level of subjective interpretation. Also known as inventories, measurements, questionnaires, and scales, psychological tests are administered in a variety of settings, including preschools, primary and secondary schools, colleges and universities, hospitals, outpatient healthcare settings, social agencies, prisons, and employment or human resource offices. They come in a variety of formats, including written, verbal, and computer administered.

Achievement and ability tests

Achievement and ability tests are designed to measure the level of an individual's intellectual functioning and cognitive ability. Most achievement and ability tests are standardized, meaning that norms were established during the design phase of the test by administering the test to a large representative sample of the test population. Achievement and ability tests follow a uniform testing protocol, or procedure (i.e., test instructions, test conditions, and scoring procedures) and their scores can be interpreted in relation to established norms. Common achievement and ability tests include the **Wechsler intelligence test** (WISC-III and WAIS) and the **Stanford-Binet intelligence scales**.

Personality tests

Personality tests and inventories evaluate the thoughts, emotions, attitudes, and behavioral traits that comprise personality. The results of these tests determine an individual's personality strengths and weaknesses, and may identify certain disturbances in personality, or psychopathology. Tests such as the **Minnesota multiphasic personality inventory** (**MMPI-2**) and the Millon clinical multiaxial inventory III (MCMI-III), are used to screen individuals for specific psychopathologies or emotional problems.

Another type of personality test is the projective personality assessment. A projective test asks a subject to interpret some ambiguous stimuli, such as a series of inkblots. The subject's responses provide insight into his or her thought processes and personality traits. For example, the Rorschach inkblot test and the **Holtzman ink blot test** (HIT) use a series of inkblots that the test subject is asked to identify. Another projective assessment, the **Thematic apperception test** (TAT), asks the subject to tell a story about a series of pictures. Some consider projective tests to be less reliable than objective personality tests. If the examiner is not well-trained in psychometric evaluation, subjective interpretations may affect the evaluation of these tests.

Neuropsychological tests

Many insurance plans cover all or a portion of diagnostic neuropsychological or psychological testing. As of 1997, Medicare reimbursed for psychological and neuropsychological testing. Billing time typically includes test administration, scoring and interpretation, and reporting.

Preparation

Prior to the administration of any psychological test, the administrator should provide the test subject with information on the nature of the test and its intended use, complete standardized instructions for taking the test (including any time limits and penalties for incorrect responses), and information on the confidentiality of the results. After these disclosures are made, informed consent should be obtained from the test subject before testing begins (except in cases of legally mandated testing, where consent is not required of the subject).

Normal results

All psychological and neuropsychological assessments should be administered, scored, and interpreted by a trained professional. When interpreting test results for test subjects, the test administrator will review with subjects: what the test evaluates, its precision in evaluation, any margins of error involved in scoring, and what the individual scores mean in the context of overall test norms and the background of the test subject.

Resources

BOOKS

The American Psychological Association. *Standards for Educational and Psychological Testing*. Washington, DC: APA Press, 1985.

The Buros Institute of Mental Measurements at the University of Nebraska-Lincoln. *The Twelfth Mental Measurements Yearbook*, ed. Jane C. Conoley and James C. Impara. Lincoln, NE: University of Nebraska Press, 1995.

Keyser, Daniel J., and Richard C. Sweetland, eds. *Test Critiques*. Vols. 1-10. Kansas City: Test Corporation of America, 1984-1992; Austin: Pro-ed, 1993-1994.

Maddox, Taddy. *Tests: A Comprehensive Reference for Assessments in Psychology, Education, and Business*. 4th ed. Austin: Pro-ed, 1997.

Shore, Milton F, et al. *When Your Child Needs Testing*. New York: Crossroad Publishing, 1992.

KEY TERMS

Norms—A fixed or ideal standard; normative or mean score for a particular age group.

Psychopathology—A mental disorder or illness, such as schizophrenia, personality disorder, or major depressive disorder.

Quantifiable—Can be expressed as a number. The results of quantifiable psychological tests can be translated into numerical values, or scores.

Representative sample—A random sample of people that adequately represent the test taking population in age, gender, race, and socioeconomic standing.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

Wodrich, David L. *Children's Psychological Testing: A Guide for Nonpsychologists*. Baltimore: Paul H. Brookes Publishing, 1997.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

The ERIC Clearinghouse on Assessment and Evaluation.1131 Shriver Laboratory (Bldg 075), University of Maryland, College Park, MD 20742. <http://ericae.net>.

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Psychosis

Definition

Psychosis is a symptom or feature of mental illness typically characterized by radical changes in personality, impaired functioning, and a distorted or non-existent sense of objective reality.

Description

Patients suffering from psychosis have impaired reality testing; that is, they are unable to distinguish personal, subjective experience from the reality of the external world. They experience **hallucinations** and/or **delusions** that they believe are real, and may behave and communicate in an inappropriate and incoherent fashion. Psychosis may appear as a symptom of a number of mental disorders, including mood and **personality disorders**. It is also the defining feature of **schizophrenia**, schizophreniform disorder, **schizoaffective disorder**, delusional disorder, and the psychotic disorders (i.e., brief psychotic disorder, shared psychotic disorder, psychotic disorder due to a general medical condition, and substance-induced psychotic disorder).

Causes and symptoms

Psychosis may be caused by the interaction of biological and psychosocial factors depending on the disorder in which it presents; psychosis can also be caused by purely social factors, with no biological component.

Schizophrenia, schizophreniform disorder, and schizoaffective disorder

Psychosis in schizophrenia and perhaps schizophreniform disorder appears to be related to abnormalities in the structure and chemistry of the brain, and appears to have strong genetic links; but its course and severity can be altered by social factors such as **stress** or a lack of support within the family. The cause of schizoaffective disorder is less clear cut, but biological factors are also suspected.

Delusional disorder

The exact cause of delusional disorder has not been conclusively determined, but potential causes include heredity, neurological abnormalities, and changes in brain chemistry. Some studies have indicated that delusions are generated by abnormalities in the limbic system, the portion of the brain on the inner edge of the cerebral cortex that is believed to regulate emotions.

Brief psychotic disorder

Trauma and stress can cause a short-term psychosis (less than a month's duration) known as brief psychotic disorder. Major life-changing events such as the **death** of a family member or a natural disaster have been known to stimulate brief psychotic disorder in patients with no prior history of mental illness.

Psychotic disorder due to a general medical condition

Psychosis may also be triggered by an organic cause, termed a psychotic disorder due to a general medical condition. Organic sources of psychosis include neurological conditions (for example, epilepsy and cerebrovascular disease), metabolic conditions (for example, porphyria), endocrine conditions (for example, hyper- or

hypothyroidism), renal failure, electrolyte imbalance, or **autoimmune disorders**.

Substance-induced psychotic disorder

Psychosis is also a known side effect of the use, abuse, and withdrawal from certain drugs. So-called recreational drugs, such as hallucinogenics, PCP, amphetamines, **cocaine**, **marijuana**, and alcohol, may cause a psychotic reaction during use or withdrawal. Certain prescription medications such as steroids, anticonvulsants, chemotherapeutic agents, and antiparkinsonian medications may also induce psychotic symptoms. Toxic substances such as carbon monoxide have also been reported to cause substance-induced psychotic disorder.

Psychosis is characterized by the following symptoms:

- Delusions. Those delusions that occur in schizophrenia and its related forms are typically bizarre (i.e., they could not occur in real life). Delusions occurring in delusional disorder are more plausible, but still patently untrue. In some cases, delusions may be accompanied by feelings of **paranoia**.
- Hallucinations. Psychotic patients see, hear, smell, taste, or feel things that aren't there. Schizophrenic hallucinations are typically auditory or, less commonly, visual; but psychotic hallucinations can involve any of the five senses.
- Disorganized speech. Psychotic patients, especially those with schizophrenia, often ramble on in incoherent, nonsensical speech patterns.
- Disorganized or catatonic behavior. The catatonic patient reacts inappropriately to his or her environment by either remaining rigid and immobile or by engaging in excessive motor activity. Disorganized behavior is behavior or activity that is inappropriate for the situation, or unpredictable.

Diagnosis

Patients with psychotic symptoms should undergo a thorough **physical examination** and history to rule out possible organic causes. If a psychiatric cause such as schizophrenia is suspected, a mental health professional will typically conduct an interview with the patient and administer one of several clinical inventories, or tests, to evaluate mental status. This assessment takes place in either an outpatient or hospital setting.

Treatment

Psychosis that is symptomatic of schizophrenia or another psychiatric disorder should be treated by a psychologist and/or psychiatrist. An appropriate course of medication and/or psychosocial therapy is employed to treat the underlying primary disorder. If the patient is considered to be at risk for harming himself or others, inpatient treatment is usually recommended.

Antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), sertindole (Serlect), olanzapine (Zyprexa), or risperidone (Risperdal) is usually prescribed to bring psychotic symptoms under control and into remission. Possible side effects of antipsychotics include **dry mouth**, drowsiness, muscle stiffness, and **tardive dyskinesia** (involuntary movements of the body). Agranulocytosis, a potentially serious but reversible health condition in which the white blood cells that fight infection in the body are destroyed, is a possible side effect of clozapine. Patients treated with this drug should undergo weekly blood tests to monitor white blood cell counts for the first six months, then every two weeks.

After an acute psychotic episode has subsided, antipsychotic drug maintenance treatment is typically employed and psychosocial therapy and living and vocational skills training may be attempted.

Prognosis

Prognosis for brief psychotic disorder is quite good; for schizophrenia, less so. Generally, the longer and more severe a psychotic episode, the poorer the prognosis is for the patient. Early diagnosis and treatment are critical to improving outcomes for the patient across all psychotic disorders.

Approximately 10% of America's permanently disabled population is comprised of schizophrenic individuals. The mortality rate of schizophrenic individuals are also high—approximately 10% of schizophrenics commit suicide, and 20% attempt it. However, early diagnosis and long-term follow up care can improve the outlook for these patients considerably. Roughly 60% of patients with schizophrenia will show substantial improvement with appropriate treatment.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

Maxmen, Jerrold S., and Nicholas G. Ward. "Schizophrenia and Related Disorders." In *Essential Psychopathology and Its Treatment*. 2nd ed. New York: W. W. Norton, 1995.

PERIODICALS

American Psychiatric Association. "Practice Guideline for the Treatment of Patients with Schizophrenia." *American Journal of Psychiatry* 154, no. 4, (Apr. 1997).

Volkmar, Fred R. "Diagnosis and Treatment of Psychosis in Adolescence." *Medscape Mental Health* 2, no. 12 (1997).

KEY TERMS

Brief psychotic disorder—An acute, short-term episode of psychosis lasting no longer than one month. This disorder may occur in response to a stressful event.

Delusional disorder—Individuals with delusional disorder suffer from long-term, complex delusions that fall into one of six categories: persecutory, grandiose, jealousy, erotomanic, somatic, or mixed.

Delusions—An unshakable belief in something untrue which cannot be explained by religious or cultural factors. These irrational beliefs defy normal reasoning and remain firm even when overwhelming proof is presented to refute them.

Hallucinations—False or distorted sensory experiences that appear to be real perceptions to the person experiencing them.

Paranoia—An unfounded or exaggerated distrust of others, sometimes reaching delusional proportions.

Porphyria—A disease of the metabolism characterized by skin lesions, urine problems, neurologic disorders, and/or abdominal pain.

Schizoaffective disorder—Schizophrenic symptoms occurring concurrently with a major depressive and/or manic episode.

Schizophrenia—A debilitating mental illness characterized by delusions, hallucinations, disorganized speech and behavior, and inappropriate or flattened affect (a lack of emotions) that seriously hampers the afflicted individual's social and occupational functioning. Approximately 2 million Americans suffer from schizophrenia.

Schizophreniform disorder—A short-term variation of schizophrenia that has a total duration of one to six months.

Shared psychotic disorder—Also known as *folie à deux*, shared psychotic disorder is an uncommon disorder in which the same delusion is shared by two or more individuals.

Tardive dyskinesia— Involuntary movements of the face and/or body which are a side effect of the long-term use of some older antipsychotic (neuroleptic) drugs. Tardive dyskinesia affects 15-20% of patients on long-term neuroleptic treatment.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

OTHER

The Schizophrenia Page. <http://www.schizophrenia.com>.

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Psychosocial disorders

Definition

A psychosocial disorder is a mental illness caused or influenced by life experiences, as well as maladjusted cognitive and behavioral processes.

Description

The term psychosocial refers to the psychological and social factors that influence mental health. Social influences such as peer pressure, parental support, cultural and religious background, socioeconomic status, and interpersonal relationships all help to shape personality and influence psychological makeup. Individuals with psychosocial disorders frequently have difficulty functioning in social situations and may have problems effectively communicating with others.

The American Psychiatric Association distinguishes 16 different subtypes (or categories) of mental illness. Although psychosocial variables arguably have some degree of influence on all subtypes of mental illness, the major categories of mental disorders thought to involve significant psychosocial factors include:

- Substance-related disorders. Disorders related to alcohol and drug use, abuse, dependence, and withdrawal.
- **Schizophrenia** and other psychotic disorders. These include the schizoid disorders (schizophrenia, schizophreniform, and **schizoaffective disorder**), delusional disorder, and psychotic disorders.

- Mood disorders. Affective disorders such as depression (major, dysthymic) and bipolar disorders.
- **Anxiety** disorders. Disorders in which a certain situation or place triggers excessive fear and/or anxiety symptoms (i.e., **dizziness**, racing heart), such as **panic disorder**, **agoraphobia**, social phobia, **obsessive-compulsive disorder**, post-traumatic **stress** disorder, and generalized anxiety disorders.
- **Somatoform disorders**. Somatoform disorders involve clinically significant physical symptoms that cannot be explained by a medical condition (e.g., somatization disorder, conversion disorder, **pain** disorder, **hypochondriasis**, and body dysmorphic disorder).
- Factitious disorders. Disorders in which an individual creates and complains of symptoms of a non-existent illness in order to assume the role of a patient (or sick role).
- Sexual and gender identity disorders. Disorders of sexual desire, arousal, and performance. It should be noted that the categorization of **gender identity disorder** as a mental illness has been a point of some contention among mental health professionals.
- Eating disorders. Anorexia and bulimia nervosa.
- **Adjustment disorders**. Adjustment disorders involve an excessive emotional or behavioral reaction to a stressful event.
- Personality disorders. Maladjustments of personality, including paranoid, schizoid, schizotypal, antisocial, borderline, histrionic, narcissistic, avoidant, dependent, and obsessive-compulsive personality disorder (not to be confused with the anxiety disorder OCD).
- Disorders usually first diagnosed in infancy childhood, or adolescence. Some learning and developmental disorders (i.e., **ADHD**) may be partially psychosocial in nature.

Causes and symptoms

It is important to note that the causes of mental illness are diverse and not completely understood. The majority of psychological disorders are thought to be caused by a complex combination of biological, genetic (hereditary), familial, and social factors or biopsychosocial influences. In addition, the role that each of these play can differ from person to person, so that a disorder such as depression that is caused by genetic factors in one person may be caused by a traumatic life event in another.

The symptoms of psychosocial disorders vary depending on the diagnosis in question. In addition to disorder-specific symptoms, individuals with psychosocial dysfunction usually have difficulty functioning normally in social situations and may have trouble forming and maintaining close interpersonal relationships.

Diagnosis

Patients with symptoms of psychosocial disorders or other mental illness should undergo a thorough **physical examination** and patient history to rule out an organic cause for the illness (such as a neurological disorder). If no organic cause is suspected, a psychologist or other mental healthcare professional will meet with the patient to conduct an interview and take a detailed social and medical history. If the patient is a minor, interviews with a parent or guardian may also be part of the diagnostic process. The physician may also administer one or more **psychological tests** (also called clinical inventories, scales, or assessments).

Treatment

Counseling is typically a front-line treatment for psychosocial disorders. A number of counseling or talk therapy approaches exist, including psychotherapy, cognitive therapy, behavioral therapy, and **group therapy**. Therapy or counseling may be administered by social workers, nurses, licensed counselors and therapists, psychologists, or psychiatrists.

Psychoactive medication may also be prescribed for symptom relief in patients with mental disorders considered psychosocial in nature. For disorders such as major depression or **bipolar disorder**, which may have psychosocial aspects but also have known organic causes, drug therapy is a primary treatment approach. In cases such as personality disorder that are thought to not have biological roots, psychoactive medications are usually considered a secondary, or companion treatment to psychotherapy.

Many individuals are successful in treating psychosocial disorders through regular attendance in self-help groups or 12-step programs such as Alcoholics Anonymous. This approach, which allows individuals to seek advice and counsel from others in similar circumstances, can be extremely effective.

In some cases, treating mental illness requires hospitalization of the patient. This hospitalization, also known as inpatient treatment, is usually employed in situations where a controlled therapeutic environment is critical for the patient's recovery (e.g., **rehabilitation** treatment for **alcoholism** or other drug addictions), or when there is a risk that the patient may harm himself (suicide) or others. It may also be necessary when the patient's physical health has deteriorated to a point where life-sustaining

treatment is necessary, such as with severe **malnutrition** associated with **anorexia nervosa**.

Alternative treatment

Therapeutic approaches such as **art therapy** that encourage self-discovery and empowerment may be useful in treating psychosocial disorders. Art therapy, the use of the creative process to express and understand emotion, encompasses a broad range of humanistic disciplines, including visual arts, dance, drama, music, film, writing, literature, and other artistic genres. This use of the creative process is believed to provide the patient/artist with a means to gain insight to emotions and thoughts they might otherwise have difficulty expressing. After the artwork is created, the patient/artist continues the therapeutic journey by interpreting its meaning under the guidance of a trained therapist.

Prognosis

According to the National Institute of Mental Health, more than 90% of Americans who commit suicide have a diagnosable mental disorder, so swift and appropriate treatment is important. Because of the diversity of types of mental disorders influenced by psychosocial factors, and the complexity of diagnosis and treatment, the prognosis for psychosocial disorders is highly variable. In some cases, they can be effectively managed with therapy and/or medication. In others, mental illness can cause long-term disability.

Prevention

Patient education (i.e., therapy or self-help groups) can encourage patients to take an active part in their treatment program and to recognize symptoms of a relapse of their condition. In addition, educating friends and family members on the nature of the psychosocial disorder can assist them in knowing how and when to provide support to the patient.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Press, Inc., 1994.

PERIODICALS

Epperly, Ted D., and Kevin E. Moore. "Health Issues in Men: Part II. Common Psychosocial Disorders." *American Family Physician*. 62 (July 2000):117-24.

ORGANIZATIONS

American Psychiatric Association (APA). Office of Public Affairs. 1400 K Street NW, Washington, DC 20005. (202) 682-6119. <http://www.psych.org/>.

American Psychological Association (APA). Office of Public Affairs. 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org/>.

National Institute of Mental Health. 6001 Executive Boulevard, Rm. 8184, MSC 9663, Bethesda, MD 20892-9663. (301) 443-4513.

OTHER

Satcher, David. *Mental Health: A Report of the Surgeon General*. Washington, DC: Government Printing Office, 1999. <http://www.surgeongeneral.gov>.

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KEY TERMS

Affective disorder—An emotional disorder involving abnormal highs and/or lows in mood.

Bipolar disorder—An affective mental illness that causes radical emotional changes and mood swings, from manic highs to depressive lows. The majority of bipolar individuals experience alternating episodes of mania and depression.

Bulimia—An eating disorder characterized by binge eating and inappropriate compensatory behavior such as vomiting, misusing laxatives, or excessive exercise.

Cognitive processes—Thought processes (i.e., reasoning, perception, judgment, memory).

Learning disorders—Academic difficulties experienced by children and adults of average to above-average intelligence that involve reading, writing, and/or mathematics, and which significantly interfere with academic achievement or daily living.

Schizophrenia—A debilitating mental illness characterized by delusions, hallucinations, disorganized speech and behavior, and flattened affect (i.e., a lack of emotions) that seriously hampers normal functioning.

Psychosurgery

Definition

Psychosurgery involves severing or otherwise disabling areas of the brain to treat a personality disorder, behavior disorder, or other mental illness. Modern psychosurgical techniques target the pathways between the

limbic system (the portion of the brain on the inner edge of the cerebral cortex) that is believed to regulate emotions, and the frontal cortex, where thought processes are seated.

Purpose

Lobotomy is a psychosurgical procedure involving selective destruction of connective nerve fibers or tissue. It is performed on the frontal lobe of the brain and its purpose is to alleviate mental illness and chronic **pain** symptoms. The bilateral cingulotomy, a modern psychosurgical technique which has replaced the lobotomy, is performed to alleviate mental disorders such as major depression, **bipolar disorder**, or **obsessive-compulsive disorder** (OCD), which have not responded to psychotherapy, behavioral therapy, electroshock, or pharmacologic treatment. Bilateral cingulotomies are also performed to treat chronic pain in **cancer** patients.

Precautions

Psychosurgery should be considered only after all other non-surgical psychiatric therapies have been fully explored. Much is still unknown about the biology of the brain and how psychosurgery affects brain function.

Description

Psychosurgery, and lobotomy in particular, reached the height of use just after World War II. Between 1946 and 1949, the use of the lobotomy grew from 500 to 5,000 annual procedures in the United States. At that time, the procedure was viewed as a possible solution to the overcrowded and understaffed conditions in state-run mental hospitals and asylums. Known as prefrontal or transorbital lobotomy, depending on the surgical technique used and area of the brain targeted, these early operations were performed with surgical knives, electrodes, suction, or ice picks, to cut or sweep out portions of the frontal lobe.

Today's psychosurgical techniques are much more refined. Instead of going in "blind" to remove large sections on the frontal lobe, as in these early operations, neurosurgeons use a computer-based process called stereotactic **magnetic resonance imaging** to guide a small electrode to the limbic system (brain structures involved in autonomic or automatic body functions and some emotion and behavior). There an electrical current **burns** in a small lesion (usually 0.5 in (1.3 cm) in size). In a bilateral cingulotomy, the cingulate gyrus, a small section of brain that connects the limbic region of the brain with the frontal lobes, is targeted. Another surgical technique uses a non-invasive tool known as a gamma knife to focus beams of radiation at the brain. A lesion forms at the spot where the beams converge in the brain.

Preparation

Candidates for cingulotomies or other forms of psychosurgery undergo a rigorous screening process to ensure that all possible non-surgical psychiatric treatment options have been explored. Psychosurgery is only performed with the patient's informed consent.

Aftercare

Ongoing behavioral and medication therapy is often required in OCD patients who undergo cingulotomy. All psychosurgery patients should remain under a psychiatrist's care for follow-up evaluations and treatment.

Risks

As with any type of brain surgery, psychosurgery carries the risk of permanent brain damage, though the advent of non-invasive neurosurgical techniques, such as the gamma knife, has reduced the risk of brain damage significantly.

Normal results

In a 1996 study at Massachusetts General Hospital, over one-third of patients undergoing cingulotomy demonstrated significant improvements after the surgery. And, in contrast to the bizarre behavior and personality changes reported with lobotomy patients in the 1940s and 1950s, modern psychosurgery patients have demonstrated little post-surgical losses of memory or other high level thought processes.

Resources

BOOKS

Rodgers, Joann Ellison. *Psychosurgery: Damaging the Brain to Save the Mind.* New York: HarperCollins, 1992.

Valenstein, Elliot S. *Great and Desperate Cures: The Rise and Decline of Psychosurgery and Other Radical Treatments for Mental Illness.* New York: Basic Books, 1986.

PERIODICALS

Herbert, Wray. "Psychosurgery Redux." *U.S. News and World Report* 123, no. 17 (Nov. 1997): 63-64.

Spangler, W. J., et al. "Magnetic Resonance Image-Guided Stereotactic Cingulotomy for Intractable Psychiatric Disease." *Neurosurgery* 38, no. 6 (June 1996): 1076-8.

Vertosick Jr., Frank. "Lobotomy's Back." *Discover* 18, no. 10 (Oct. 1997): 66-72.

ORGANIZATIONS

Massachusetts General Hospital. Functional and Stereotactic Neurosurgery Cingulotomy Unit. Fruit St., Boston, MA 02114. (617) 726-2000. <http://neurosurgery.mgh.harvard.edu/cingulot.htm>.

KEY TERMS

Gamma knife—A surgical tool that focuses beams of radiation at the head, which converge in the brain to form a lesion.

Lesion—Any discontinuity of tissue. Often a cut or wound.

Limbic system—A portion of the brain on the inner edge of the cerebral cortex that is thought to regulate emotions.

Psychosurgery—Brain surgery performed to alleviate chronic psychological conditions such as obsessive-compulsive disorder (OCD), depression, and bipolar disorder.

Stereotactic technique—A technique used by neurosurgeons to pinpoint locations within the brain. It employs computer imaging to create an external frame of reference.

National Alliance for the Mentally Ill (NAMI). Colonial Place Three, 2107 Wilson Blvd., Ste. 300, Arlington, VA 22201-3042. (800) 950-6264. <http://www.nami.org>.

National OCD Headquarters. P.O. Box 70, Milford, CT 06460. (203) 878-5669.

Paula Anne Ford-Martin

Psyllium preparations *see* **Laxatives**

PT *see* **Prothrombin time**

Pterygium *see* **Pinguecula and pterygium**

Ptomaine poisoning *see* **Food poisoning**

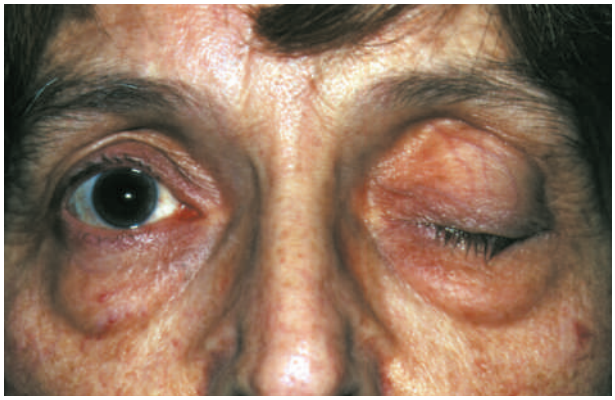
Ptosis

Definition

Ptosis is the term used for a drooping upper eyelid. Ptosis, also called blepharoptosis, can affect one or both eyes.

Description

The eyelids serve to protect and lubricate the outer eye. The upper eyelid is lifted by a muscle called the levator muscle. Inside the back part of the lid is a tarsal plate which adds rigidity to the lid. The levator muscle is attached to the tarsal plate by a flat tendon called the levator aponeurosis. When the muscle cannot lift the eyelid or lifts it only partially, the person is said to have a ptosis.



A close-up view of a drooping upper eyelid (ptosis) on an elderly woman's face. Ptosis is normally due to a weakness of the levator muscle of the upper eyelid or to interference with the nerve supply to the muscle. *(Photograph by Dr. P. Marazzi, Photo Researchers, Inc. Reproduced by permission.)*

There are two types of ptosis, acquired and congenital. Acquired ptosis is more common. Congenital ptosis is present at birth. Both congenital and acquired ptosis can be, but are not necessarily, hereditary.

Causes and symptoms

Ptosis may occur because the levator muscle's attachment to the lid is weakening with age. Acquired ptosis can also be caused by a number of different things, such as disease that impairs the nerves, diabetes, injury, tumors, inflammation, or aneurysms. Congenital ptosis may be caused by a problem with nerve innervation or a weak muscle. Drooping eyelids may also be the result of diseases such as **myotonic dystrophy** or **myasthenia gravis**.

The primary symptom of ptosis is a drooping eyelid. Adults will notice a loss of visual field because the upper portion of the eye is covered. Children who are born with a ptosis usually tilt their head back in an effort to see under the obstruction. Some people raise their eyebrows in order to lift the lid slightly and therefore may appear to be frowning.

Diagnosis

Diagnosis of ptosis is usually made by observing the drooping eyelid. Finding the cause of the condition will require testing for any of the illnesses or injuries known to have this effect. Some possible tests include x rays and blood tests.

Treatment

Ptosis is usually treated surgically. Surgery can generally be done on an outpatient basis under local anesthetic. For minor drooping, a small amount of the eyelid

KEY TERMS

Congenital—A condition existing at birth.

Hereditary—A condition passed from parent to child. In other words, a genetic condition.

tissue can be removed. For more pronounced ptosis the approach is to surgically shorten the levator muscle or connect the lid to the muscles of the eyebrow. Or, the aponeurosis can be reattached to the tarsal plate if it has separated. Correcting the ptosis is usually done only after determining the cause of the condition. For example, myasthenia gravis must be ruled out before performing any surgery. As with any surgery, there are risks, and they should be discussed with the surgeon.

Children with ptosis need not have surgery immediately, however their vision must be checked periodically to prevent lazy eye (**amblyopia**).

"Ptosis crutches" are also available. These can be attached to the frame of eyeglasses to hold up the eyelid. These devices are uncomfortable and usually not well tolerated.

Prognosis

After diagnosing the cause of a drooping eyelid, then correcting the condition, most people have no further problems related to the ptosis. The correction, however, may still not make the eyes symmetrical. Patients should have reasonable expectations and discuss the outcome with their doctor prior to surgery.

Prevention

Ptosis cannot be prevented.

Resources

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

U.S. Department of Health and Human Services, 200 Independence Ave., SW, Washington, DC 20201. (202) 619-0257.

Dorothy Elinor Stonely

PTSD *see* **Post-traumatic stress disorder**

PTT *see* **Partial thromboplastin time**

Puberty

Definition

Puberty is the period of human development during which physical growth and sexual maturation occurs.

Description

Beginning as early as age eight in girls—and two years later, on average, in boys—the hypothalamus (part of the brain) signals hormonal change that stimulates the pituitary. In turn, the pituitary releases its own hormones called gonadotrophins that stimulate the gonads and adrenals. From these glands come a flood of sex hormones—androgens and testosterone in the male, estrogens and progestins in the female—that regulate the growth and function of the sex organs. It is interesting to note that the gonadotrophins are the same for males and females, but the sex hormones they induce are different.

In the United States, the first sign of puberty occurs on average at age 11 in girls, with menstruation and fertility following about two years later. Boys lag behind by about two years. Puberty may not begin until age 16 in boys and continue in a desultory fashion on past age 20. In contrast to puberty, adolescence is more of a social/cultural term referring to the interval between childhood and adulthood.

Diagnosis

Puberty has been divided into five Sexual Maturity Rating (SMR) stages by two doctors, W. Marshall and J. M. Tanner. These ratings are often referred to as Tanner Stages 1–5. Staging is based on pubic hair growth, on male genital development, and female breast development. Staging helps determine whether development is normal for a given age. Both sexes also grow axillary (arm pit) hair and pimples. Males develop muscle mass, a deeper voice, and facial hair. Females redistribute body fat. Along with the maturing of the sex organs, there is a pronounced growth spurt averaging 3–4 in (8–10 cm) and culminating in full adult stature. Puberty can be precocious (early) or delayed. It all depends upon the sex hormones.

Puberty falling outside the age limits considered normal for any given population should prompt a search for the cause. As health and **nutrition** have improved over the past few generations, there has been a gradual decrease in the average age for the normal onset of puberty.

- Excess hormone stimulation is the cause for **precocious puberty**. It can come from the brain in the form of gonadotrophins or from the gonads and adrenals. Overproduction may be caused by functioning tumors or simple overactivity. Brain overproduction can also be the result of brain infections or injury.
- Likewise, delayed puberty is due to insufficient hormone. If the pituitary output is inadequate, so will be the output from the gonads and adrenals. On the other hand, a normal pituitary will overproduce if it senses there are not enough hormones in the circulation.
- There are several congenital disorders (**polyglandular deficiency syndromes**) that include failure of hormone output. These children do not experience normal puberty, but it may be induced by giving them the proper hormones at the proper time.
- Finally, there are in females abnormalities in hormone production that produce male characteristics—so called virilizing syndromes. Should one of these appear during adolescence, it will disturb the normal progress of puberty. Notice that virilizing requires abnormal hormones in the female, while feminizing results from absent hormones in the male. Each embryo starts out life as female. Male hormones transform it if they are present.

Delayed or precocious puberty requires measurement of the several hormones involved to determine which are lacking or which are in excess. There are blood tests for each one. If a tumor is suspected, imaging of the suspect organ needs to be done with x rays, **computed tomography scans** (CT scans), or **magnetic resonance imaging** (MRI).

Treatment

Puberty is a period of great **stress**, both physically and emotionally. The psychological changes and challenges of puberty are made infinitely greater if its timing is off.

In preocious puberty, the offending gland or tumor may require surgical attention, although there are several drugs now that counteract hormone effects. If delayed, puberty can be stimulated with the correct hormones. Treatment should not be delayed because necessary bone growth is also affected.

Prognosis

Properly administered hormones can restore the normal growth pattern.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Matsumoto, Alvin M. "The Testis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Nelson Textbook of Pediatrics. Ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Rebar, Robert W. "The Ovaries." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

KEY TERMS

Adrenals—Glands on top of the kidneys that produce four different types of hormones.

Computed tomography scan (CT)—A method of creating images of internal organs using x rays.

Embryo—The life in the womb during the first two months.

Hormone—A chemical produced in one place that has an effect somewhere else in the body.

Hypothalamus—Part of the brain located deep in the center of the skull and just above the pituitary.

Gonads—Glands that make sex hormones and reproductive cells—testes in the male, ovaries in the female.

Magnetic resonance imaging (MRI)—A method of creating images of internal organs. Magnetic resonance imaging (MRI) uses magnet fields and radiofrequency signals.

Pituitary—The "master gland" of the body, controlling many of the others by releasing stimulating hormones.

Syndrome—A collection of abnormalities that occur often enough to suggest they have a common cause.

Pubic lice *see* **Lice infestation**

Puerperal infection

Definition

The term puerperal infection refers to a bacterial infection following **childbirth**. The infection may also

be referred to as puerperal or postpartum **fever**. The genital tract, particularly the uterus, is the most commonly infected site. In some cases infection can spread to other points in the body. Widespread infection, or **sepsis**, is a rare, but potentially fatal complication.

Description

Puerperal infection affects an estimated 1–8% of new mothers in the United States. Given modern medical treatment and **antibiotics**, it very rarely advances to the point of threatening a woman's life. An estimated 2–4% of new mothers who deliver vaginally suffer some form of puerperal infection, but for cesarean sections, the figure is five-10 times higher.

Deaths related to puerperal infection are very rare in the industrialized world. It is estimated three in 100,000 births result in maternal **death** due to infection. However, the death rate in developing nations may be 100 times higher.

Postpartum fever may arise from several causes, not necessarily infection. If the fever is related to infection, it often results from endometritis, an inflammation of the uterus. Urinary tract, breast, and wound infections are also possible, as well as septic **thrombophlebitis**, a blood clot-associated inflammation of veins. A woman's susceptibility to developing an infection is related to such factors as **cesarean section**, extended labor, **obesity**, anemia, and poor prenatal **nutrition**.

Causes and symptoms

The primary symptom of puerperal infection is a fever at any point between birth and 10 days postpartum. A temperature of 100.4°F (38°C) on any two days during this period, or a fever of 101.6°F (38.6 °C) in the first 24 hours postpartum, is cause for suspicion. An assortment of bacterial species may cause puerperal infection. Many of these bacteria are normally found in the mother's genital tract, but other bacteria may be introduced from the woman's intestine and skin or from a healthcare provider.

The associated symptoms depend on the site and nature of the infection. The most typical site of infection is the genital tract. Endometritis, which affects the uterus, is the most prominent of these infections. Endometritis is much more common if a small part of the placenta has been retained in the uterus. Typically, several species of bacteria are involved and may act synergistically—that is, the bacteria's negative effects are multiplied rather than simply added together. Synergistic action by the bacteria can result in a stubborn infection such as an **abscess**. The major symptoms of a genital tract infection include fever, malaise, abdominal **pain**, uterine tenderness, and abnormal vaginal discharge. If these symptoms do not respond to antibiotic therapy, an abscess or blood clot may be suspected.

Other causes of postpartum fever include urinary tract infections, wound infections, septic thrombophlebitis, and **mastitis**. Mastitis, or breast infection, is indicated by fever, malaise, achy muscles, and reddened skin on the affected breast. It is usually caused by a clogged milk duct that becomes infected. Infections of the urinary tract are indicated by fever, frequent and painful urination, and back pain. An **episiotomy** and a cesarean section carry the risk of a wound infection. Such infections are suggested by a fever and pus-like discharge, inflammation, and swelling at wound sites.

Diagnosis

Fever is not an automatic indicator of puerperal infection. A new mother may have a fever owing to prior illness or an illness unconnected to childbirth. However, any fever within 10 days postpartum is aggressively investigated. Physical symptoms such as pain, malaise, loss of appetite, and others point to infection.

Many doctors initiate antibiotic therapy early in the fever period to stop an infection before it advances. A pelvic examination is done and samples are taken from the genital tract to identify the bacteria involved in the infection. The pelvic examination can reveal the extent of infection and possibly the cause. Blood samples may also be taken for blood counts and to test for the presence of infectious bacteria. A **urinalysis** may also be ordered, especially if the symptoms are indicative of a urinary tract infection.

If the fever and other symptoms resist antibiotic therapy, an ultrasound examination or computed tomography scan (CT scan) is done to locate potential abscesses or blood clots in the pelvic region. **Magnetic resonance imaging** (MRI) may be useful as well, in addition to a heparin challenge test if blood clots are suspected. If a lung infection is suspected, a **chest x ray** may also be ordered.

Treatment

Antibiotic therapy is the backbone of puerperal infection treatment. Initial antibiotic therapy may consist of clindamycin and gentamicin, which fight a broad array of bacteria types. If the fever and other symptoms do not respond to these antibiotics, a third, such as ampicillin, is added. Other antibiotics may be used depending on the identity of the infective bacteria and the possibility of an allergic reaction to certain antibiotics.

Antibiotics taken together are effective against a wide range of bacteria, but may not be capable of clearing up the infection alone, especially if an abscess or blood

KEY TERMS

Abscess—A pus-filled area with definite borders.

Blood clot—A dense mat formed by certain components of the blood stream to prevent blood loss.

Cesarean section—Incision through the abdomen and uterus to facilitate delivery.

Computed tomography scan (CT scan)—Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Episiotomy—Incision of the vulva (external female genitalia) during vaginal delivery to prevent tissue tearing.

Heparin—A blood component that controls the amount of clotting. It can be used as a drug to reduce blood clot formation.

Heparin challenge test—A medical test to evaluate how readily the blood clots.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Postpartum—Referring to the time period following childbirth.

Prophylactic—Measures taken to prevent disease.

Sepsis—The presence of viable bacteria in the blood or body tissues.

Septic—Referring to the presence of infection.

Thrombophlebitis—An inflammation of veins accompanied by the formation of blood clots.

Ultrasound examination—A medical test in which high frequency sound waves are directed at a particular internal area of the body. As the sound waves are reflected by internal structures, a computer uses the data to construct an image of the structures.

Warfarin—A drug that reduces the ability of the blood to clot.

clot is present. Heparin is combined with the antibiotic therapy in order to break apart blood clots. Heparin is used for five-seven days, and may be followed by warfarin for the following month. If the infection is complicated, it may be necessary to surgically drain the infected site. Infected episiotomies can be opened and allowed to drain, but abscesses and blood clots may require surgery.

Prognosis

Antibiotic therapy and other treatment measures are virtually always successful in curing puerperal infections.

Prevention

Careful attention to antiseptic procedures during childbirth is the basic underpinning of preventing infection. With some procedures, such as cesarean section, a doctor may administer prophylactic antibiotics as a preemptive strike against infectious bacteria.

Resources

BOOKS

Charles, Jonathan, and David Charles. "Postpartum Infection." In *Obstetric and Perinatal Infections*, ed. David Charles. St. Louis: Mosby-Year Book, Inc., 1993.

Rivlin, Michel E. "Puerperal Infections." In *Manual of Clinical Problems in Obstetrics and Gynecology.* 4th ed. Ed. Michel E. Rivlin and Rick W. Martin. Boston: Little, Brown and Co., 1994.

PERIODICALS

Hamadeh, Ghassan, Cindy Dedmon, and Paul D. Mozley. "Postpartum Fever." *American Family Physician* 52, no. 2 (Aug. 1995): 531.

Julia Barrett

Pulmonary alveolar proteinosis

Definition

Pulmonary alveolar proteinosis (PAP) is a rare disease of the lungs.

Description

In this disease, also called alveolar proteinosis or phospholipidosis, gas exchange in the lungs is progressively impaired by the accumulation of phospholipids,

KEY TERMS

Alveoli—The small cavities, or air sacs, in the lungs.

Bronchoscopy—A bronchoscopy is the examination of the bronchi, the primary divisions of the trachea that penetrate the lung, through a tube called a bronchoscope.

Clubbing—Clubbing is the rounding of the ends and swelling of fingers found in people with lung disease.

Remission—Lessening of severity, or abatement of symptoms.

Transtracheal biopsy—A transtracheal biopsy is the removal of a small piece of tissue from across the trachea or windpipe for examination under a microscope.

compounds widely found in other living cells of the body. The alveoli are filled with this substance that renders them less effective in protecting the lung. This may explain why infections are often associated with the disease.

Pulmonary alveolar proteinosis most commonly affects people ages 20–50, although it has been reported in children and the elderly. The incidence is five out of every one million people. The disease is more common among males.

Causes and symptoms

The cause of this disease is unknown. In some people, however, it appears to result from infection, immune deficiency, or from exposure to silica, aluminum oxide, and a variety of dusts and fumes.

Symptoms include mild **shortness of breath** associated with a nonproductive or minimally productive **cough**, weight loss, and **fatigue**. Acute symptoms such as **fever** or progressive shortness of breath suggest a complicating infection.

Diagnosis

Physical examination may reveal clubbing of the fingers or a bluish coloration of the skin as a result of decreased oxygen.

A **chest x ray** may show alveolar disease. An arterial blood gas reveals low oxygen levels in the blood. **Bronchoscopy** with transtracheal biopsy shows alveolar proteinosis. Specific diagnosis requires a **lung biopsy**.

Treatment

Treatment consists of periodic whole-lung lavage, a washing out of the phospholipids from the lung with a special tube placed in the trachea. This is performed under general anesthesia.

Prognosis

In some, spontaneous remission occurs, while in others progressive **respiratory failure** develops. Disability from respiratory insufficiency is common, but **death** rarely occurs. Repeated lavage may be necessary. Lung transplant is a last resort option.

Prevention

There is no known prevention for this very rare disorder.

Resources

ORGANIZATIONS

American Association for Respiratory Care. 11030 Ables Lane, Dallas, Texas 75229. (972) 243-2272. <http://www.aarc.org>.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

Lorraine Steefel, RN

Pulmonary angiography *see* **Angiography**

Pulmonary artery catheterization

Definition

Pulmonary artery catheterization is a diagnostic procedure in which a small catheter is inserted through a neck, arm, chest, or thigh vein and maneuvered into the right side of the heart, in order to measure pressures at different spots in the heart.

Purpose

Pulmonary artery catheterization is performed to:

- evaluate **heart failure**
- monitor therapy after a **heart attack**
- check the fluid balance of a patient with serious **burns**, kidney disease, or after heart surgery
- check the effect of medications on the heart

Precautions

Pulmonary artery catheterization is a potentially complicated and invasive procedure. The doctor must decide if the value of the information obtained will outweigh the risk of catheterization.

Description

Pulmonary artery catheterization, sometimes called Swan-Ganz catheterization, is usually performed at the bedside of a patient in the intensive care unit. A catheter is threaded through a vein in the arm, thigh, chest, or neck until it passes through the right side of the heart. This procedure takes about 30 minutes. Local anesthesia is given to reduce discomfort.

Once the catheter is in place, the doctor briefly inflates a tiny balloon at its end. This temporarily blocks the blood flow and allows the doctor to make a pressure measurement in the pulmonary artery system. Pressure measurements are usually recorded for the next 48-72 hours in different parts of the heart. During this time, the patient must stay in bed so the catheter stays in place. Once the pressure measurements are no longer needed, the catheter is removed.

Preparation

Before and during the test, the patient will be connected to an electrocardiograph, which makes a recording of the electrical stimuli that cause the heart to contract. The insertion site is sterilized and prepared. The catheter is often sutured to the skin to prevent dislodgment.

Aftercare

The patient is observed for any sign of infection or complications from the procedure.

Risks

Pulmonary artery catheterization is not without risks. Possible complications from the procedure include:

- infection at the site where the catheter was inserted
- pulmonary artery perforation
- blood clots in the lungs
- irregular heartbeat

Normal results

Normal pressures reflect a normally functioning heart with no fluid accumulation. These normal pressure readings are:

KEY TERMS

Cardiac shunt—A defect in the wall of the heart that allows blood from different chambers to mix.

- right atrium: 1-6 mm of mercury (mm Hg)
- right ventricle during contraction (systolic): 20–30 mm Hg
- right ventricle at the end of relaxation (end diastolic): less than 5 mm Hg
- pulmonary artery during contraction (systolic): 20–30 mm Hg
- pulmonary artery during relaxation (diastolic): about 10 mm Hg
- mean pulmonary artery: less than 20 mm Hg
- pulmonary artery wedge pressure: 6–12 mm Hg
- left atrium: about 10 mm Hg

Abnormal results

Abnormally high right atrium pressure can indicate:

- pulmonary disease
- right side heart failure
- fluid accumulation
- compression of the heart after hemorrhage (**cardiac tamponade**)
- right heart valve abnormalities
- pulmonary **hypertension** (high blood pressure)

Abnormally high right ventricle pressure may indicate:

- pulmonary hypertension (high blood pressure)
- pulmonary valve abnormalities
- right ventricle failure
- defects in the wall between the right and left ventricle
- congestive heart failure
- serious heart inflammation

Abnormally high pulmonary artery pressure may indicate:

- diversion of blood from a left-to-right cardiac shunt
- pulmonary artery hypertension
- chronic obstructive pulmonary disease or **emphysema**
- blood clots in the lungs
- fluid accumulation in the lungs

• left ventricle failure

Abnormally high pulmonary artery wedge pressure may indicate:

• left ventricle failure
• mitral valve abnormalities
• cardiac insufficiency
• compression of the heart after hemorrhage

Resources

BOOKS

"Pulmonary Artery Catheterization." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Tish Davidson

Pulmonary edema

Definition

Pulmonary **edema** is a condition in which fluid accumulates in the lungs, usually because the heart's left ventricle does not pump adequately.

Description

The build-up of fluid in the spaces outside the blood vessels of the lungs is called pulmonary edema. Pulmonary edema is a common complication of heart disorders, and most cases of the condition are associated with **heart failure**. Pulmonary edema can be a chronic condition, or it can develop suddenly and quickly become life threatening. The life-threatening type of pulmonary edema occurs when a large amount of fluid suddenly shifts from the pulmonary blood vessels into the lung, due to lung problems, **heart attack**, trauma, or toxic chemicals. It can also be the first sign of coronary heart disease.

In heart-related pulmonary edema, the heart's main chamber, the left ventricle, is weakened and does not function properly. The ventricle does not completely eject its contents, causing blood to back up and cardiac output to drop. The body responds by increasing blood pressure and fluid volume to compensate for the reduced cardiac output. This, in turn, increases the force against which the ventricle must expel blood. Blood backs up, forming a pool in the pulmonary blood vessels. Fluid leaks into the spaces between the tissues of the lungs and begins to accumulate. This process makes it more difficult for the lungs to expand. It also impedes the exchange of air and gases between the lungs and blood moving through lung blood vessels.

Causes and symptoms

Most cases of pulmonary edema are caused by failure of the heart's main chamber, the left ventricle. It can be brought on by an acute heart attack, severe **ischemia**, volume overload of the heart's left ventricle, and mitral stenosis. Non-heart-related pulmonary edema is caused by lung problems like **pneumonia**, an excess of intravenous fluids, some types of kidney disease, bad **burns**, liver disease, nutritional problems, and **Hodgkin's disease**. Non-heart-related pulmonary edema can also be caused by other conditions where the lungs do not drain properly, and conditions where the respiratory veins are blocked.

Early symptoms of pulmonary edema include:

• shortness of breath upon exertion
• sudden respiratory distress after sleep
• difficulty breathing, except when sitting upright
• Coughing

In cases of severe pulmonary edema, these symptoms will worsen to:

• labored and rapid breathing
• frothy, bloody fluid containing pus coughed from the lungs (sputum)
• a fast pulse and possibly serious disturbances in the heart's rhythm (atrial fibrillation, for example)
• cold, clammy, sweaty, and bluish skin
• a drop in blood pressure resulting in a thready pulse

Diagnosis

A doctor can usually diagnose pulmonary edema based on the patient's symptoms and a physical exam. Patients with pulmonary edema will have a rapid pulse, rapid breathing, abnormal breath and heart sounds, and enlarged neck veins. A **chest x ray** is often used to confirm the diagnosis. Arterial blood gas testing may be done. Sometimes **pulmonary artery catheterization** is performed to confirm that the patient has pulmonary edema and not a disease with similar symptoms (called **adult respiratory distress syndrome** or "noncardiogenic pulmonary edema").

Treatment

Pulmonary edema requires immediate emergency treatment. Treatment includes: placing the patient in a sitting position, oxygen, assisted or mechanical ventilation (in some cases), and drug therapy. The goal of treatment is to reduce the amount of fluid in the lungs, improve gas exchange and heart function, and, where possible, to correct the underlying disease.

To help the patient breathe better, he/she is placed in a sitting position. High concentrations of oxygen are administered. In cases where respiratory distress is severe, a mechanical ventilator and a tube down the throat (tracheal intubation) will be used to improve the delivery of oxygen. Non-invasive pressure support ventilation is a new treatment for pulmonary edema in which the patient breathes against a continuous flow of positive airway pressure, delivered through a face or nasal mask. Non-invasive pressure support ventilation decreases the effort required to breathe, enhances oxygen and carbon dioxide exchange, and increases cardiac output.

Drug therapy could include morphine, nitroglycerin, **diuretics**, angiotensin-converting enzyme (ACE) inhibitors, and **vasodilators**. Vasopressors are used for cardiogenic shock. Morphine is very effective in reducing the patient's **anxiety**, easing breathing, and improving blood flow. Nitroglycerin reduces pulmonary blood flow and decreases the volume of fluid entering the overloaded blood vessels. Diuretics, like furosemide (Lasix), promote the elimination of fluids through urination, helping to reduce pressure and fluids in the blood vessels. ACE inhibitors reduce the pressure against which the left ventricle must expel blood. In patients who have severe **hypertension**, a vasodilator such as nitroprusside sodium (Nipride) may be used. For cardiogenic shock, an adrenergic agent (like dopamine hydrochloride [Intropin], dobutamine hydrochloride [Dobutrex], or epinephrine) or a bipyridine (like amrinone lactate [Inocor] or milrinone lactate [Primacor]) are given.

Prognosis

Most patients with pulmonary edema who seek immediate treatment can be treated quickly and effectively.

Prevention

Cardiogenic pulmonary edema can sometimes be prevented by treating the underlying heart disease. These treatments can including maintaining a healthy diet, taking appropriate medications correctly, and avoiding excess alcohol and salt.

Resources

BOOKS

"Acute Pulmonary Edema." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

DeBakey, Michael E., and Antonio M. Gotto Jr. *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

KEY TERMS

Edema—Swelling caused by accumulation of fluid in body tissues.

Ischemia—A condition in which the heart muscle receives an insufficient supply of blood and slowly starves.

Left ventricle—The large chamber on the lower left side of the heart. The left ventricle sends blood to the lungs and the rest of the body.

Mitral stenosis—Narrowing or constricting of the mitral valve, which separates the left atrium from the left ventricle.

Pulmonary—Referring to the lungs and respiratory system.

PERIODICALS

Gammage, Michael. "Treatment of Acute Pulmonary Oedema: Diuresis or Vasodilation?" *The Lancet* 351, no. 9100 (7 Feb. 1998): 382.

Sacchetti, Alfred D., and Russel H. Harris. "Acute Cardiogenic Pulmonary Edema: What's the Latest in Emergency Treatment?" *Postgraduate Medicine* 103, no. 2 (Feb. 1998): 145-166.

Van Orden Wallace, Carol J. "Emergency! Acute Pulmonary Edema." *RN* (Jan. 1998): 36-40.

Lori De Milto

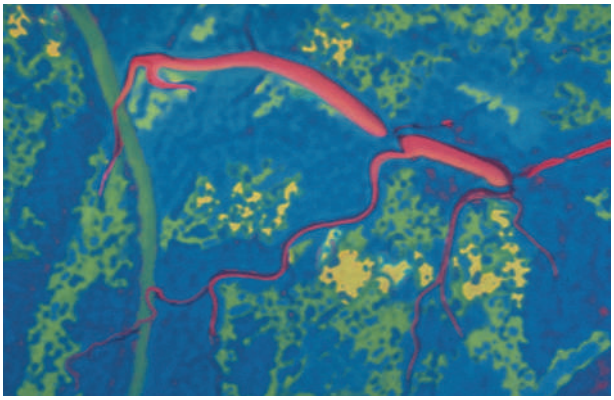
Pulmonary embolism

Definition

Pulmonary **embolism** is an obstruction of a blood vessel in the lungs, usually due to a blood clot, which blocks a coronary artery.

Description

Pulmonary embolism is a fairly common condition that can be fatal. According to the American Heart Association, an estimated 600,000 Americans develop pulmonary embolism annually; 60,000 die from it. As many as 25,000 Americans are hospitalized each year for pulmonary embolism, which is a relatively common complication in hospitalized patients. Even without warning symptoms, pulmonary embolism can cause sudden **death**. Treatment is not always successful.



An angiography of a pulmonary embolism. *(Custom Medical Stock Photo. Reproduced by permission.)*

Pulmonary embolism is difficult to diagnose. Less than 10% of patients who die from pulmonary embolism were diagnosed with the condition. It occurs when emboli block a pulmonary artery, usually due to a blood clot that breaks off from a large vein and travels to the lungs. More than 90% of cases of pulmonary embolism are complications of **deep vein thrombosis**, blood clots from the leg or pelvic veins. Emboli can also be comprised of fat, air, or tumor tissue. When emboli block the main pulmonary artery, pulmonary embolism can quickly become fatal.

Causes and symptoms

Pulmonary embolism is caused by emboli that travel through the blood stream to the lungs and block a pulmonary artery. When this occurs, circulation and oxygenation of blood is compromised. The emboli are usually formed from blood clots but are occasionally comprised of air, fat, or tumor tissue. Risk factors include: prolonged bed rest, surgery, **childbirth**, **heart attack**, **stroke**, congestive **heart failure**, **cancer**, **obesity**, a broken hip or leg, **oral contraceptives**, sickle cell anemia, congenital **coagulation disorders**, chest trauma, certain congenital heart defects, and old age.

Common symptoms of pulmonary embolism include:

- labored breathing, sometimes accompanied by chest **pain**
- a rapid pulse
- a **cough** that produces bloody sputum
- a low **fever**
- fluid build-up in the lungs

Less common symptoms include:

- coughing up a lot of blood
- pain caused by movement
- leg swelling
- bluish skin
- fainting
- swollen neck veins

In some cases there are no symptoms.

Diagnosis

Pulmonary embolism can be diagnosed through the patient's history, a physical exam, and diagnostic tests including **chest x ray**, lung scan, pulmonary **angiography**, **electrocardiography**, arterial blood gas measurements, and leg vein ultrasonography or **venography**.

A chest x ray can be normal or show fluid or other signs and rule out other diseases. The lung scan shows poor flow of blood in areas beyond blocked arteries. The patient inhales a small amount of radiopharmaceutical and pictures of airflow into the lungs are taken with a gamma camera. Then a different radiopharmaceutical is injected into an arm vein and lung blood flow is scanned. A normal result essentially rules out pulmonary embolism. A lung scan can be performed in a hospital or an outpatient facility and takes about 45 minutes.

Pulmonary angiography is the most reliable test for diagnosing pulmonary embolism but it is not used often, because it carries some risk and is expensive, invasive, and not readily available in many hospitals. Pulmonary angiography is a radiographic test which involves injection of a pharmaceutical "contrast agent" to show up the pulmonary arteries. A cinematic camera records the blood flow through the lungs of the patient, who lies on a table. Pulmonary angiography is usually performed in a hospital's radiology department and takes 30 minutes to one hour.

An electrocardiograph shows the heart's electrical activity and helps distinguish pulmonary embolism from a heart attack. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. Impulses of the heart's activity are traced on paper. The test takes about 10 minutes and can be performed in a physician's office or hospital lab.

Arterial blood gas measurements can be helpful, but they are rarely diagnostic for pulmonary embolism. Blood is taken from an artery instead of a vein, usually in the wrist and it is analyzed for oxygen, carbon dioxide and acid levels.

Venography is used to look for the most likely source of pulmonary embolism, deep vein thrombosis. It is very accurate, but it is not used often, because it is painful, expensive, exposes the patient to a fairly high dose of radiation, and can cause complications. Venography identifies the location, extent, and degree of attachment of the

blood clots and enables the condition of the deep leg veins to be assessed. A contrast solution is injected into a foot vein through a catheter. The physician observes the movement of the solution through the vein with a fluoroscope while a series of x rays are taken. Venography takes between 30–45 minutes and can be done in a physician's office, a laboratory, or a hospital. Radionuclide venography, in which a radioactive isotope is injected, is occasionally used, especially if a patient has had reactions to contrast solutions. Most commonly performed are ultrasound and Doppler studies of leg veins.

Treatment

Patients with pulmonary embolism are hospitalized and generally treated with clot-dissolving and clot-preventing drugs. Oxygen therapy is often needed to maintain normal oxygen concentrations. For people who can't take anticoagulants and in some other cases, surgery may be needed to insert a device that filters blood returning to the heart and lungs. The goal of treatment is to maintain the patient's cardiovascular and respiratory functions while the blockage resolves, which takes 10–14 days, and to prevent the formation of other emboli.

Thrombolytic therapy to dissolve blood clots is the aggressive treatment for very severe pulmonary embolism. Streptokinase, urokinase, and recombinant tissue plasminogen activator (TPA) are thrombolytic agents. Heparin is the injectable anticoagulant (clot-preventing) drug of choice for preventing formation of blood clots. Warfarin, an oral anticoagulant, is usually continued when the patient leaves the hospital and doesn't need heparin any longer.

Prognosis

About 10% of patients with pulmonary embolism die suddenly within the first hour of onset of the condition. The outcome for all other patients is generally good; only 3% of patients who are properly diagnosed and treated die. In cases of undiagnosed pulmonary embolism, about 30% of patients die.

Prevention

Pulmonary embolism risk can be reduced in certain patients through judicious use of antithrombotic drugs such as heparin, venous interruption, gradient elastic stockings and/or intermittent pneumatic compression of the legs.

Resources

BOOKS

DeBakey, M. E., and A. M. Gotto. "Invasive Diagnostic Procedures." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

"Disorders of the Pulmonary Circulation." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Texas Heart Institute. "Diseases of the Peripheral Arteries and Veins." In *Texas Heart Institute's Heart Owner's Handbook*. New York: John Wiley & Sons, 1996.

PERIODICALS

ACCP Consensus Committee on Pulmonary Embolism. "Opinions Regarding the Diagnosis of Venous Thromboembolic Disease." *Chest* 113, no. 2 (Feb. 1998): 499-503.

Charland, Scott L., and Dawn E Klinter. "Low-Molecular Weight Heraprins in the Treatment of Pulmonary Embolism." *The Annals of Pharmacotherapy* 32 (Feb. 1998): 258-263.

Tapson, Victor F. "Pulmonary Embolism-New Diagnostic Approaches." *The New England Journal of Medicine* 336, no. 20 (15 May 1997): 1449-1451.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Lori De Milto

KEY TERMS

Deep vein thrombosis—A blood clot in the calf's deep vein. This frequently leads to pulmonary embolism if untreated.

Emboli—Clots or other substances that travel through the blood stream and get stuck in an artery, blocking circulation.

Thrombosis—The development of a blood clot inside a blood vessel.

Pulmonary fibrosis

Definition

Pulmonary fibrosis is scarring in the lungs.

Description

Pulmonary fibrosis develops when the alveoli, tiny air sacs that transfer oxygen to the blood, become damaged and inflamed. The body tries to heal the damage with scars, but these scars collapse the alveoli and make the lungs less elastic. If the cycle of inflammation and scarring continues, the lungs become increasingly unable to deliver oxygen to the blood. Changes in the lungs can also increase the blood pressure in the pulmonary artery.

This condition, called **pulmonary hypertension**, makes the heart work harder and it may fail.

Pulmonary fibrosis can result from many different lung diseases including **sarcoidosis**, drug reactions, autoimmune diseases, environmental **allergies** such as Farmer's lung, and exposure to toxic dusts and gases.

Pulmonary fibrosis that develops without a known cause is called idiopathic pulmonary fibrosis. This disease is equally common in men and women. It is usually diagnosed between the ages of 40 and 60.

Causes and symptoms

The causes and risk factors vary with the underlying disease. They may include genetics, environmental factors, and infections.

The first symptom of pulmonary fibrosis is usually shortness of breath—at first, during **exercise**, but later also while resting. Patients may also have a dry **cough**, a rapid heartbeat, or enlargement of the fingertips and ends of the toes. Some people feel tired or have a **fever**, weight loss, muscle or joint pains. In late stages of the disease, the lack of oxygen in the blood can give the skin and mucus membranes a blue tinge known as **cyanosis**.

Diagnosis

Pulmonary fibrosis is often referred to a lung specialist. Several tests are usually needed to diagnose this disease and determine its cause. They include a **physical examination**, detailed history of the symptoms, chest x rays, lung function tests, and blood tests, including a measurement of the amount of oxygen in the blood. Computed tomography (CT scan) may give a more detailed picture of the lungs. **Bronchoscopy** may be done to examine the air passages and analyze the cells found deep in the lungs.

Lung biopsies are necessary to diagnose some diseases. Lung biopsies can be done through a needle inserted into the chest through the skin, during bronchoscopy, or as a surgical procedure under general anesthesia.

Treatment

The treatment of pulmonary fibrosis depends on the underlying cause. Many diseases are treated by suppressing inflammation with **corticosteroids**. Stronger immune suppressants such as cyclophosphamide (Cytoxan) or azathioprine (Imuran) may also be tried. Some patients need supplemental oxygen. A lung transplant may be an option for incurable diseases. Approximately 60–80% of patients live for at least two years after the transplant.

There is no good treatment for idiopathic pulmonary fibrosis. Only 10–20% of patients with this disease respond to corticosteroids.

Alternative treatment

Anxiety and fear can make breathing difficulties worse. Some patients find that activities such as **yoga**, prayer or **meditation**, **music therapy**, or **biofeedback** help to relax them.

Prognosis

The prognosis depends on the specific disease. Some cases may stop progressing or improve, particularly if the cause can be identified and treated. Others may develop quickly or slowly into end-stage lung disease. The course of idiopathic pulmonary fibrosis is very difficult to predict; however, average survival is approximately five to seven years.

Prevention

There is no known prevention for idiopathic pulmonary fibrosis.

Some ways to prevent other causes of pulmonary fibrosis are:

- avoid exposure to particle dust such as asbestos, coal dust, and silica
- avoid exposure to chemical fumes
- do not smoke

Resources

BOOKS

Kobzik, Lester. "Diffuse Interstitial (Infiltrative, Restrictive) Diseases" In *Robbins Pathologic Basis of Disease*. 6th ed. Ed. Ramzi S. Cotran, Vinay Kumar, and Tucker Collins. Philadelphia: W.B. Saunders, 2000, 727-740.

Toews, Galen B. "Interstitial Lung Disease" In *Cecil Textbook of Medicine*. 21st ed. Ed. Lee Goldman and J. Claude Bennett. Philadelphia: W.B. Saunders, 2000, pp. 409-419.

PERIODICALS

Mason, Robert J., Marvin I. Schwarz, Gary W. Hunninghake, and Robert A. Musson. "Pharmacologic Therapy for Idiopathic Pulmonary Fibrosis: Past, Present, and Future. " *American Journal of Respiratory and Critical Care Medicine* 160 (1999) :1771-1777.

Michaelson, Jeffrey E., Samuel M. Aguayo, and Jesse Roman. "Idiopathic Pulmonary Fibrosis: A Practical Approach for Diagnosis and Management." *Chest* 118, no. 3 (September 2000):788-94.

ORGANIZATIONS

Pulmonary Fibrosis Association. P.O. Box 75004, Seattle, WA 98125-0004. (206) 417-0949. <http://pulmonaryfibrosisassn.com>.

Pulmonary Fibrosis Foundation. 1075 Santa Fe Drive, Denver, Colorado 80204. (720) 932-7850. <http://pulmonaryfibrosis.org>.

KEY TERMS

Alveoli—Tiny air sacs in the lungs where oxygen and carbon dioxide are exchanged with the blood.

Autoimmune disease—A disease that develops when the immune system attacks normal cells or organs.

Bronchoscopy—The examination of the air passages through a flexible or rigid tube inserted into the nostril (or mouth). Sometimes cells are collected by washing the lungs with a small amount of fluid.

Computed tomography (CT)—A special x-ray technique that produces a cross sectional image of the organs inside the body.

Corticosteroids—A class of drugs, related to hormones naturally found in the body, that suppress the immune system. One example is prednisone, sold under many brand names including Deltasone.

End-stage lung disease—The final stages of lung disease, when the lung can no longer keep the blood supplied with oxygen. End-stage lungs in pulmonary fibrosis have large air spaces separated by bands of inflammation and scarring.

Farmer's lung—An allergic reaction to moldy hay, most often seen in farmers, that results in lung disease.

Immune suppressant drug—Any drug that dampens immune responses and decreases inflammation.

Inflammation—The body's reaction to an irritant, characterized by the accumulation of immune cells, redness, and swelling.

Lung function tests—Tests of how much air the lungs can move in and out, and how quickly and efficiently this can be done. Lung function tests are usually done by breathing into a device that measures air flow.

Mucous membranes—The moist coverings that line the mouth, nose, intestines, and other internal organs.

Pulmonary artery—The blood vessel that delivers blood from the heart to the lungs.

Sarcoidosis—A disease of unknown origin that results in clumps of immune cells and inflammation in organs throughout the body.

The American Lung Association. 1740 Broadway, New York. NY 10019. (212) 315-8700. <http://www.lungusa.org>.

OTHER

"Bronchoscopy with Transtracheal Biopsy " *Health Encyclopedia*. 2001. 2 May 2001 <http://www. merck-medco.com/medco/index.jsp>.

Chronic Lung Disease Information Resource. The Cheshire Medical Center. 5 May 2001 <http://www.cheshire-med.com/programs/pulrehab/rehinfof.html>.

"Lung Needle Biopsy " *Health Encyclopedia*. 2001. 2 May 2001 <http://www.merck-medco. com/medco/index.jsp>.

"Open Lung Biopsy " *Health Encyclopedia*. 2001 Adam.com Tests. 2 May 2001 <http://www.merck-medco.com/medco/index.jsp>.

Anna Rovid Spickler, D.V.M., Ph.D.

Pulmonary function test

Definition

Pulmonary function tests are a group of procedures that measure the function of the lungs, revealing problems in the way a patient breathes. The tests can determine the cause of **shortness of breath** and may help confirm lung diseases, such as **asthma**, **bronchitis** or **emphysema**. The tests also are performed before any major **lung surgery** to make sure the person won't be disabled by having a reduced lung capacity.

Purpose

Pulmonary function tests can help a doctor diagnose a range of respiratory diseases which might not otherwise be obvious to the doctor or the patient. The tests are important since many kinds of lung problems can be successfully treated if detected early.

The tests are also used to measure how a lung disease is progressing, and how serious the lung disease has become. Pulmonary function tests also can be used to assess how a patient is responding to different treatments.

One of the most common of the pulmonary function tests is spirometry (from the Greco-Latin term meaning "to measure breathing"). This test, which can be given in a hospital or doctor's office, measures how much and how fast the air is moving in and out of the lungs. Specific measurements taken during the test include the volume of air from start to finish, the fastest flow that is

This young girl is undergoing a pulmonary function test in order to measure the functionality of her lungs. *(Custom Medical Stock Photo. Reproduced by permission.)*

achieved, and the volume of air exhaled in the first second of the test.

A peak flow meter can determine how much a patient's airways have narrowed. A test of blood gases is a measurement of the concentration of oxygen and carbon dioxide in the blood, which shows how efficient the gas exchange is in the lungs.

Another lung function test reveals how efficient the lungs are in absorbing gas from the blood. This is measured by testing the volume of carbon monoxide a person breathes out after a known volume of the gas has been inhaled.

Precautions

Pulmonary function tests shouldn't be given to patients who have had a recent **heart attack**, or who have certain other types of heart disease. It is crucial that the patient cooperate with the health care team if accurate results are to be obtained.

Description

The patient places a clip over the nose and breathes through the mouth into a tube connected to a machine known as a spirometer. First the patient breathes in deeply, and then exhales as quickly and forcefully as possible into the tube. The exhale must last at least six seconds for the machine to work properly. Usually the patient repeats this test three times, and the best of the three results is considered to be the measure of the lung function. The results will help a doctor figure out which type of treatment to pursue.

Preparation

The patient should not eat a heavy meal before the test, nor smoke for four to six hours beforehand. The patient's doctor will issue specific instructions about whether or not to use specific medications, including **bronchodilators** or inhalers, before the test. Sometimes, medication may be administered as part of the test.

Risks

The risk is minimal for most people, although the test carries a slight risk of a collapsed lung in some patients with lung disease.

Normal results

Normal results are based on a person's age, height, and gender. Normal results are expressed as a percentage of the predicted lung capacity. The prediction takes into account the patient's age, height, and sex.

Abnormal results

Abnormal results mean that the person's lung capacity is less than 80% of the predicted value. Such findings usually mean that there is some degree of chest or lung disease.

Resources

BOOKS

Madama, Vincent C., and Vince Madama. *Pulmonary Function Testing and Cardiopulmonary Stress Testing*. Delmar Publishing, 1997.

Ruppel, Gregg L. *Manual of Pulmonary Function Testing*. St. Louis: Mosby, 1997.

Wagner, Jack. *Pulmonary Function Testing: A Practical Approach*. Williams and Wilkins, 1996.

Carol A. Turkington

KEY TERMS

Emphysema—A disease in which the small air sacs in the lungs become damaged, causing shortness of breath. In severe cases it can lead to respiratory or heart failure.

Pulmonary heart disease *see* **Cor pulmonale**

Pulmonary hypertension

Definition

Pulmonary **hypertension** is a rare lung disorder characterized by increased pressure in the pulmonary artery. The pulmonary artery carries oxygen-poor blood from the lower chamber on the right side of the heart (right ventricle) to the lungs where it picks up oxygen.

Description

Pulmonary hypertension is present when the blood pressure in the circulation of the lungs is measured at greater than 25 mm of mercury (Hg) at rest or 30 mm Hg during **exercise**. Pulmonary hypertension can be either primary or secondary:

- Primary pulmonary hypertension. The cause of pulmonary hypertension is unknown. It is rare, affecting two people per one million. The illness most often occurs in young adults, especially women.
- Secondary pulmonary hypertension. Secondary pulmonary hypertension is increased pressure of the blood vessels of the lungs as a result of other medical conditions.

Regardless of whether pulmonary hypertension is primary or secondary, the disorder results in thickening of the pulmonary arteries and narrowing of these blood vessels. In response, the right side of the heart works harder to move the blood through these arteries and it becomes enlarged. Eventually overworking the right side of the heart may lead to right-sided **heart failure**, resulting in **death**.

Causes and symptoms

While the cause of primary pulmonary hypertension is uncertain, researchers think that in most people who develop the disease, the blood vessels are sensitive to certain factors that cause them to narrow. Diet suppressants, **cocaine**, and **pregnancy** are some of the factors that are thought to trigger constriction or narrowing of the pulmonary artery. In about 6–10% of cases, primary pulmonary hypertension is inherited.

Secondary pulmonary hypertension can be associated with breathing disorders such as **emphysema** and **bronchitis**, or diseases such as **scleroderma**, **systemic lupus erythematosus** (SLE) or **congenital heart disease** involving heart valves, and pulmonary thromboembolism.

Symptoms of pulmonary hypertension include **shortness of breath** with minimal exertion, general **fatigue**, **dizziness**, and **fainting**. Swelling of the ankles, bluish lips and skin, and chest **pain** are among other symptoms of the disease.

Diagnosis

Pulmonary hypertension is rarely detected during routine physical examinations and, therefore, often progresses to later stages before being diagnosed. In addition to listening to heart sounds with a stethoscope, physicians also use electrocardiogram, pulmonary function tests, perfusion lung scan, and/or right-heart **cardiac catheterization** to diagnose pulmonary hypertension.

Treatment

The aim of treatment for pulmonary hypertension is to treat the underlying cause, if it is known. For example, thromboendarterectomy is a surgical procedure performed to remove a blood clot on the lung that is causing the pulmonary hypertension. Lung transplants are another surgical treatment.

Some patients are helped by taking medicines that make the work of the heart easier. Anticoagulants, drugs that thin the blood, decrease the tendency of the blood to clot and allow blood to flow more freely. **Diuretics** decrease the amount of fluid in the body and reduce the amount of work the heart has to do. **Calcium channel blockers** relax the smooth muscle in the walls of the heart and blood vessels and improve the ability of the heart to pump blood.

One effective medical treatment that dilates blood vessels and seems to help prevent blood clots from forming is epoprostenol (prostacyclin). Prostacyclin is given intravenously to improve survival, exercise duration, and well-being. It is sometimes used as a bridge to help people who are waiting for a lung transplant. In other cases it is used for long-term treatment.

KEY TERMS

Hypertension—The medical term for abnormally high blood pressure.

Perfusion lung scan—A scan that shows the pattern of blood flow in the lungs.

Pulmonary—Having to do with the lungs.

Pulmonary function test—A test that measures how much air the lungs hold and the air flow in and out of the lungs.

Right-heart cardiac catherization—A medical procedure during which a physician threads a catheter into the right side of the heart to measure the blood pressure in the right side of the heart and the pulmonary artery. The right heart's pumping ability can also be evaluated.

Some people require supplemental oxygen through nasal prongs or a mask if breathing becomes difficult.

Prognosis

Pulmonary hypertension is chronic and incurable with an unpredictable survival rate. Length of survival has been improving, with some patients able to live 15–20 years or longer with the disorder.

Prevention

Since the cause of primary pulmonary hypertension is still unknown, there is no way to prevent or cure this disease. A change in lifestyle may assist patients with daily activities. For example, relaxation exercises help to reduce **stress**. Good health habits such as a healthy diet, not **smoking**, and getting plenty of rest should be maintained.

Resources

BOOKS

Gohlke, Mary, with Max Jennings. *I'll Take Tomorrow.* Clifton Heights, PA: M. Evans & Co., 1985.

Rubin, Lewis J., and Stuart Rich. *Primary Pulmonary Hypertension.* New York: Marcel Dekker, 1996.

ORGANIZATIONS

American Association for Respiratory Care. 11030 Ables Lane, Dallas, TX 75229. (972) 243-2272. <http://www.aarc.org>.

Pulmonary Hypertension Association. P.O. Box 24733, Speedway, IN 46224-0733. (800) 748-7274. <http://www.phassociation.org>.

OTHER

"Primary Pulmonary Hypertensiton. *National Heart, Lung, and Blood Institute.* <http://www.nhlbi.nih.gov/nhlbi/lung/other/gp/pph.txt>.

Lorraine Steefel, RN

Pulmonary incompetence *see* **Pulmonary valve insufficiency**

Pulmonary regurgitation *see* **Pulmonary valve insufficiency**

Pulmonary stenosis *see* **Pulmonary valve stenosis**

Pulmonary valve insufficiency

Definition

Pulmonary valve insufficiency is a disorder involving a defect of the valve located in the pulmonary artery.

Description

This disorder is also known as pulmonary valve regurgitation or pulmonary incompetence. The pulmonary valve is the structure in the pulmonary artery consisting of three flaps, which open and close during each heartbeat. The flaps keep blood from flowing back into the heart from the pulmonary artery—the artery that supplies blood to the lungs. With pulmonary valve insufficiency, the flaps may allow the blood to flow backward, resulting in a distinct murmur. The disorder may be congenital, but also often occurs in patients with severe **pulmonary hypertension**.

Causes and symptoms

There are generally few to no symptoms with pulmonary valve insufficiency. It may be initially noticed as a murmur in a routine exam of the heart and chest with a stethoscope. The most common causes of the disorder are severe pulmonary **hypertension**, or the presence of high pressure in the arteries and veins of the lungs. Pulmonary hypertension is usually caused by chronic lung disease, lung blood clots, and sometimes other diseases, such as **endocarditis**, an inflammation of the lining of the heart and valves. Previous surgery for **congenital heart disease** may also cause pulmonary valve insufficiency.

Diagnosis

The pitch and location of the murmur will help a physician determine if the cause is pulmonary valve insufficiency. An electrocardiogram (EKG) can detect flow changes. **Echocardiography** with color Doppler can usually detect regurgitation of blood in the area. This exam is done with ultrasound imaging. A **chest x ray** may show prominence of the pulmonary artery. In some cases, angiocardiography, or x ray of the arteries and vessels with injection of a dye, may be ordered.

Treatment

On its own, pulmonary valve insufficiency is seldom severe enough to require treatment. **Antibiotics** are usually recommended before dental work to reduce the possibility of bacterial endocarditis. Management of the primary condition, such as medications to manage pulmonary hypertension, may help control pulmonary valve insufficiency.

Alternative treatment

Since there are few or no symptoms and the disorder is a structural defect, alternative treatment may have only limited usefulness. Proper diet, **exercise**, and **stress reduction** may help control hypertension. Coenzyme Q10 and hawthorn (*Crataegus laevigata*) are two important nutrients to nourish the heart. Antioxidant supplements (including **vitamins** A, C, and E, selenium, and zinc) can help keep the tissues of the whole body, including the heart, in optimal condition.

Prognosis

Patients with this disorder may never experience limitations from pulmonary valve insufficiency. The disorder may only show up if complicated by pulmonary hypertension. There is an increased incidence of bacterial endocarditis in patients with pulmonary valve insufficiency. Endocarditis can progress rapidly and be fatal.

Prevention

Pulmonary valve insufficiency resulting from chronic lung diseases can be prevented by behaviors and interventions to prevent those primary diseases. Bacterial endocarditis resulting from pulmonary valve insufficiency can usually be prevented with the use of antibiotic **prophylaxis** in preparation for dental procedures or other procedures which may introduce bacteria into the bloodstream.

KEY TERMS

Congenital—Used to describe a condition or defect present at birth.

Endocarditis—Inflammation of the lining of the heart and valves.

Prophylaxis—Preventive. Antibiotic prophylaxis is the use of antibiotics to prevent a possible infection.

Pulmonary—Refers to the lungs and the breathing system and function.

Pulmonary hypertension—High blood pressure in the veins and arteries of the lungs.

Resources

BOOKS

Giuliani, Emilio R., et al., eds. *Mayo Clinic Practice of Cardiology.* 3rd ed. St. Louis: Mosby, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris, RN

Pulmonary valve stenosis

Definition

Pulmonary valve stenosis is a congenital heart defect in which blood flow from the heart to the pulmonary artery is blocked.

Description

Pulmonary valve stenosis is an obstruction in the pulmonary valve, located between the right ventricle and the pulmonary artery. Normally, the pulmonary valve opens to let blood flow from the right ventricle to the lungs. When the pulmonary valve is malformed, it forces the right ventricle to pump harder to overcome the obstruction. In its most severe form, pulmonary valve stenosis can be life-threatening.

Patients with pulmonary valve stenosis are at increased risk for getting valve infections and must take antiobiotics to help prevent this before certain dental and surgical procedures. Pulmonary valve stenosis is also called pulmonary stenosis.

Causes and symptoms

Pulmonary valve stenosis is caused by a congenital malformation in which the pulmonary valve does not open properly. In most cases, scientists don't know why it occurs. In cases of mild or moderate stenosis, there are often no symptoms. With more severe obstruction, symptoms include a bluish skin tint and signs of **heart failure**.

Diagnosis

Diagnosis of pulmonary valve stenosis begins with the patient's medical history and a physical exam. Tests to confirm the diagnosis include **chest x ray**, echocardiogram, electrocardiogram, and catherization. An electrocardiograph shows the heart's activity. Electrodes covered with conducting jelly are placed on the patient. The electrodes send impulses that are traced on a recorder. **Echocardiography** uses sound waves to create an image of the heart's chambers and valves. The technician applies gel to a wand (transducer) and presses it against the patient's chest. The returning sound waves are converted into an image displayed on a monitor. Catherization is an invasive procedure used to diagnose, and in some cases treat, heart problems. A thin tube, called a catheter, is inserted into a blood vessel and threaded up into the heart, enabling physicians to see and sometimes correct the problems.

Treatment

Patients with mild to moderate pulmonary valve stenosis, and few or no symptoms, do not require treatment. In more severe cases, the blocked valve will be opened surgically, either through **balloon valvuloplasty** or surgical valvulotomy. For initial treatment, balloon valvuloplasty is the procedure of choice. This is a catherization procedure in which a special catheter containing a deflated balloon is inserted in a blood vessel and threaded up into the heart. The catheter is positioned in the narrowed heart valve and the balloon is inflated to stretch the valve open.

In some cases, surgical valvulotomy may be necessary. This is open heart surgery performed with a heart-lung machine. The valve is opened with an incision and in some cases, hypertrophied muscle in the right ventricle is removed. Rarely does the pulmonary valve need to be replaced.

KEY TERMS

Congenital—Present at birth.

Pulmonary—Relating to the opening leading from the right large chamber of the heart into the lung artery.

Stenosis—A narrowing or constriction, in this case of various heart valves. Stenosis reduces or cuts off the flow of blood.

Valve—Tissue between the heart's upper and lower chambers that controls blood flow.

Alternative treatment

Pulmonary valve stenosis can be life threatening and always requires a physician's care. In mild to moderate cases of pulmonary valve stenosis, general lifestyle changes, including dietary modifications, **exercise**, and **stress reduction**, can contribute to maintaining optimal wellness.

Prognosis

Patients with the most severe form of pulmonary valve stenosis may die in infancy. The prognosis for children with more severe stenosis who undergo balloon valvuloplasty or surgical valvulotomy is favorable. Patients with mild to moderate pulmonary stenosis can lead a normal life, but they require regular medical care.

Prevention

Pulmonary valve stenosis cannot be prevented.

Resources

BOOKS

"Congenital Heart Disease." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

DeBakey, Michael E., and Antonio M. Gotto Jr. "Congenital Abnormalities of the Heart." In *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Giuliani, Emilio R., et al., eds. "Pulmonary Stenosis with Intact Ventricular Septum." In *Mayo Clinic Practice of Cardiology.* 3rd ed. St. Louis: Mosby, 1996.

PERIODICALS

O'Laughlin, M. P. "Catherization Treatment of Stenosis and Hypoplasia of Pulmonary Arteries." *Pediatric Cardiology* 19 (1998): 48-56.

Rome, J. J. "Balloon Pulmonary Valvuloplasty." *Pediatric Cardiology* 19 (1998): 18-24.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Congenital Heart Anomalies Support, Education & Resources, Inc. 2112 North Wilkins Road, Swanton, OH 43558. (419) 825-5575. <http://www.csun.edu/~hfmth006/chaser>.

Children's Health Information Network. 1561 Clark Drive, Yardley, PA 19067. (215) 493-3068. <http://www.tchin.org>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Lori De Milto

Punctures *see* **Wounds**

Purple coneflower *see* **Echinacea**

Purpura hemorrhagica *see* **Idiopathic thrombocytopenic purpura**

Pustule *see* **Skin lesions**

Pyelography *see* **Intravenous urography**

Pyelonephritis

Definition

Pyelonephritis is an inflammation of the kidney and upper urinary tract that usually results from noncontagious bacterial infection of the bladder (**cystitis**).

Description

Acute pyelonephritis is most common in adult females but can affect people of either sex and any age. Its onset is usually sudden, with symptoms that are often mistaken as the results of straining the lower back. Pyelonephritis is often complicated by systemic infection. Left untreated or unresolved, it can progress to a chronic condition that lasts for months or years, leading to scarring and possible loss of kidney function.

Causes and symptoms

The most common cause of pyelonephritis is the backward flow (reflux) of infected urine from the bladder to the upper urinary tract. Bacterial infections may also be carried to one or both kidneys through the bloodstream or lymph glands from infection that began in the bladder. Kidney infection sometimes results from urine that becomes stagnant due to obstruction of free urinary flow. A blockage or abnormality of the urinary system, such as those caused by stones, tumors, congenital deformities, or loss of bladder function from nerve disease, increases a person's risk of pyelonephritis. Other risk factors include **diabetes mellitus**, **pregnancy**, chronic bladder infections, a history of analgesic abuse, **paralysis** from **spinal cord injury**, or tumors. Catheters, tubes, or surgical procedures may also trigger a kidney infection.

The bacteria that are most likely to cause pyelonephritis are those that normally occur in the feces. ***Escherichia coli*** causes about 85% of acute bladder and kidney infections in patients with no obstruction or history of surgical procedures. *Klebsiella*, *Enterobacter*, *Proteus*, or *Pseudomonas* are other common causes of infection. Once these organisms enter the urinary tract, they cling to the tissues that line the tract and multiply in them.

Symptoms of acute pyelonephritis typically include **fever** and chills, burning or frequent urination, aching **pain** on one or both sides of the lower back or abdomen, cloudy or bloody urine, and **fatigue**. The patient may also have nausea, vomiting, and **diarrhea**. The flank pain may be extreme. The symptoms of chronic pyelonephritis include weakness, loss of appetite, **hypertension**, anemia, and protein and blood in the urine.

Diagnosis

The diagnosis of pyelonephritis is based on the patient's history, a **physical examination**, and the results of laboratory and imaging tests. During the physical examination, the doctor will touch (palpate) the patient's abdomen carefully in order to rule out **appendicitis** or other causes of severe abdominal pain.

Laboratory tests

In addition to collecting urine samples for **urinalysis** and **urine culture** and sensitivity tests, the doctor will take a sample of the patient's blood for a blood cell count. If the patient has pyelonephritis, the urine tests will show the presence of white blood cells, and bacteria in the urine. Bacterial counts of 100,000 organisms or higher per milliliter of urine point to a urinary tract infection. The presence of antibody-coated bacteria (ACB) in the urine sample distinguishes kidney infection from bladder infection, because bacteria in the kidney trigger an antibody response that coats the bacteria. The blood cell count usually indicates a sharp increase in the number of white blood cells.

Imaging studies

The doctor may order ultrasound imaging of the kidney area if he or she suspects that there is an obstruction blocking the flow of urine. X rays may demonstrate scarring of the kidneys and ureters resulting from long-standing infection.

Treatment

Treatment of acute pyelonephritis may require hospitalization if the patient is severely ill or has complications. Therapy most often involves a two- to three-week course of **antibiotics**, with the first few days of treatment given intravenously. The choice of antibiotic is based on laboratory sensitivity studies. The antibiotics that are used most often include ciprofloxacin (Cipro), ampicillin (Omnipen), or trimethoprim-sulfamethoxazole (Bactrim, Septra). The primary objective of antimicrobial therapy is the permanent eradication of bacteria from the urinary tract. The early symptoms of pyelonephritis usually disappear within 48 to 72 hours of the start of antibacterial treatment. Repeat urine cultures are done in order to evaluate the effectiveness of the medication.

Chronic pyelonephritis may require high doses of antibiotics for as long as six months to clear the infection. Other medications may be given to control fever, nausea, and pain. Patients are encouraged to drink extra fluid to prevent **dehydration** and increase urine output. Surgery is sometimes necessary if the patient has complications caused by **kidney stones** or other obstructions, or to eradicate infection. Urine cultures are repeated as part of the follow-up of patients with chronic pyelonephritis. These repeat tests are necessary to evaluate the possibility that the patient's urinary tract is infected with a second organism as well as to assess the patient's response to the antibiotic. Some persons are highly susceptible to reinfection, and a second antibiotic may be necessary to treat the organism.

Prognosis

The prognosis for most patients with acute pyelonephritis is quite good if the infection is caught early and treated promptly. The patient is considered cured if the urine remains sterile for a year. Untreated or recurrent kidney infection can lead to bacterial invasion of the bloodstream (**bacteremia**), hypertension, chronic pyelonephritis with scarring of the kidneys, and permanent kidney damage.

Prevention

Persons with a history of urinary tract infections should urinate frequently, and drink plenty of fluids at the first sign of infection. Women should void after intercourse which may help flush bacteria from the bladder. Girls should be taught to wipe their genital area from front to back after urinating to avoid getting fecal matter into the opening of the urinary tract.

KEY TERMS

Bacteremia—The presence of bacteria in the bloodstream.

Cystitis—Inflammation of the bladder, usually caused by bacterial infection.

Reflux—The backward flow of a fluid in the body. Pyelonephritis is often associated with the reflux of urine from the bladder to the upper urinary tract.

Resources

BOOKS

Brunner, Lillian, and Doris Suddarth. *The Lippincott Manual of Nursing Practice*. Philadelphia: J. B. Lippincott Co., 1991.

David, Alan K., et al. *Family Medicine: Principles and Practice*. New York: Springer-Verlag, Inc., 1994.

Griffith, H. Winter. *Complete Guide to Pediatric Symptoms, Illness and Medications*. New York: Putnam Berkley Group, Inc., 1989.

Monahan, Frances, and Marianne Neighbors. *Medical-Surgical Nursing: Foundations for Clinical Practice*. Philadelphia: W. B. Saunders Co., 1998.

ORGANIZATIONS

American Foundation for Urologic Disease, 300 West Pratt St., Suite 401, Baltimore, MD 21201.

National Kidney and Urologic Diseases. Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

OTHER

"Kidney Infection." *ThriveOnline*. 26 Feb. 1998 <http:// thriveonline.oxygen.com>.

"Pyelonephritis." *HealthOnline Page*. 26 Feb. 1998 <http://www.healthonline.com>.

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Pyloric stenosis

Definition

Pyloric stenosis refers to a narrowing of the passage between the stomach and the small intestine. The condi-

tion, which affects infants during the first several weeks of life, can be corrected effectively with surgery.

KEY TERMS

Laparoscope—A thin, camera-fitted tube that can be inserted into the abdomen in order to view internal organs.

Stenosis—The narrowing of a passage (such as the pylorus).

Ultrasonography—A non-invasive imaging procedure that uses high-frequency sound waves.

Description

Frequent vomiting may be an indication of pyloric stenosis. The pylorus is the passage between the stomach and the small intestine. During the digestive process food passes through the pylorus, which is located near the bottom of the stomach, on its way to the intestines. In pyloric stenosis, the muscular wall of the passage becomes abnormally thickened. This causes the pylorus to become too narrow, which prevents food from emptying out of the stomach in a normal fashion. The partially digested contents of the stomach are forced upwards into the mouth. As a result, a baby with pyloric stenosis often vomits after feedings.

The condition affects one in 4,000 infants. Most are diagnosed between three and five weeks old, though some babies may show symptoms during the first or second week of life. Infants with a family history of pyloric stenosis are more at risk for the condition, which tends to occur less often in females, blacks, and Asians. Pyloric stenosis is also referred to as hypertrophic pyloric stenosis.

Causes and symptoms

The cause of pyloric stenosis is not known. The main symptom is vomiting after feedings. These episodes of vomiting usually get worse over time, happening more often and becoming more forceful (forceful vomiting is often called "projectile" vomiting). Other symptoms include increased appetite, weight loss, infrequent bowel movements, belching, and **diarrhea**. Due to **dehydration**, the infant may also have fewer wet diapers.

Diagnosis

The clinician will examine the baby and talk with the parents about their infant's symptoms. If a child has the condition, the doctor should be able to feel a hard mass (about 2 cm wide and olive shaped) in the area above the bellybutton. If the doctor cannot detect the mass, ultrasonography will be done to confirm the diagnosis. A blood test may also be performed to see if the infant is dehydrated, in which case intravenous fluids can be used to correct the problem.

Treatment

Pyloric stenosis can be cured with a surgical procedure called a pyloromyotomy. In this operation, the surgeon makes an incision in the baby's abdomen. Then a small cut is made in the thickened muscle of the pylorus and it is spread apart. In this manner, the passage can be widened without removing any tissue. (The procedure may be performed with the aid of a laparoscope.) After surgery, the pylorus will heal itself. The thickening gradually goes away and the passage resumes a normal shape. The whole procedure (including anesthesia) takes about an hour.

Most babies go home one or two days after surgery. Any mild discomfort can be controlled with Tylenol. The infant may still vomit occasionally after surgery, but this is not usually a cause for alarm. However, if vomiting occurs three or more times a day, or for several consecutive days, the baby's pediatrician should be notified.

Alternative treatment

None known.

Prognosis

Surgery is often a complete cure. Most infants do not experience complications or long-term effects.

Prevention

It is not known how to prevent pyloric stenosis.

Resources

BOOKS

Behrman, Richard E, et al. *Nelson Textbook of Pediatrics.* Philadelphia: WB Saunders, 2000.

PERIODICALS

Yoshizawa J, et al. "Ultrasonographic Features of Normalization of the Pylorus after Pyloromyotomy for Hypertrophic pyloric Stenosis." *Journal of Pediatric Surgery* 36 (April 2001): 582-6.

ORGANIZATIONS

The American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000. <http://www.aap.org>.

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000. <http://www.aafp.org>.

Greg Annussek

Pyloroplasty

Definition

Pyloroplasty is an elective surgical procedure in which the lower portion of the stomach, the pylorus, is cut and resutured, to relax the muscle and widen the opening into the intestine. Pyloroplasty is a treatment for high-risk patients for gastric or peptic ulcer disease. A peptic ulcer is a well-defined sore on the stomach where the lining of the stomach or duodenum has been eaten way by stomach acid and digestive juices.

Purpose

The end of the pylorus is surrounded by a strong band of muscle (pyloric sphincter), through which stomach contents are emptied into the duodenum (the first part of the small intestine). Pyloroplasty widens this opening into the duodenum.

A pyloroplasty is performed to treat complications of gastric ulcer disease, or when conservative treatment is unsatisfactory. The longitudinal cut made in the pylorus is closed transversely, permitting the muscle to relax. By establishing an enlarged outlet from the stomach into the intestine, the stomach empties more quickly. A pyloroplasty is often done is conjunction with a **vagotomy**, a procedure in which the nerves that stimulate stomach acid production and gastric motility (movement) are cut. As these nerves are cut, gastric emptying may be delayed, and the pyloroplasty compensates for that effect.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays may be ordered as the doctor deems necessary. Food and fluids will be prohibited after midnight before the procedure. Cleansing **enemas** may be ordered to empty the intestine. If nausea or vomiting are present, a suction tube to empty the stomach may be used.

Aftercare

Post-operative care for the patient who has had a pyloroplasty, as for those who have had any major surgery, involves monitoring of blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience **pain** that is caused by the abdominal incision. The patient is shown how to support the operative site while breathing deeply and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and wound drainage. Fluids are given intravenously for 24–48 hours, until the patient's diet is gradually advanced as bowel activity resumes. The patient is generally allowed to walk approximately eight hours after surgery and the average hospital stay, dependent upon overall recovery status, ranges from six to eight days.

Risks

Potential complications of this abdominal surgery include:

- excessive bleeding
- surgical wound infection
- incisional **hernia**
- recurrence of gastric ulcer
- chronic **diarrhea**
- malnutrition

Normal results

Complete healing is expected without complications. Four to six weeks should be allowed for recovery from the surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, **dizziness**, or **fever**
- increased abdominal pain or swelling, **constipation**, nausea or vomiting, rectal bleeding, or black, tarry stools.

Resources

BOOKS

Monahan, Frances. *Medical-Surgical Nursing*. Philadelphia: W. B. Saunders Co., 1998.

Suddarth, Doris. *The Lippincott Manual of Nursing*. Philadelphia: J. B. Lippincott, 1991.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

KEY TERMS

Gastric (or peptic) ulcer—An ulcer (sore) of the stomach, duodenum or other part of the gastrointestinal system. Though the causes are not fully understood, they include excessive secretion of gastric acid, stress, heredity, and the use of certain drugs, especially acetylsalicylic acid and nonsteroidal antiinflammatory drugs.

Pylorus—The valve which releases food from the stomach into the intestines.

Vagotomy—Cutting of the vagus nerve. If the vagus nerves are cut as they enter the stomach (truncal vagotomy), gastric secretions are decreased, as is intestinal motility (movement) and stomach emptying. In a selective vagotomy, only those branches of the vagus nerve are cut that stimulate the secretory cells.

"Peptic ulcer surgery." *ThriveOnline*. 20 Apr. 1998 <http://thriveonline.oxygen.com>.
"Surgical Treatment of Peptic Ulcer Disease. 12 Apr. 1998 <http://www.avicenna.com>.

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Pylorus repair *see* **Pyloroplasty**
Pyorrhea *see* **Periodontal disease**
Pyrazinamide *see* **Antituberculosis drugs**
Pyridoxine deficiency *see* **Vitamin B_6 deficiency**
Pyrimethamine *see* **Antimalarial drugs**
Pyschogenic disorder *see* **Somatoform disorders**

Pyruvate kinase deficiency

Definition

Pyruvate kinase deficiency (PKD) is part of a group of disorders called hereditary nonspherocytic hemolytic **anemias**. Hereditary nonspherocytic anemias are rare genetic conditions that affect the red blood cells. PKD is caused by a deficiency in the enzyme, pyruvate kinase. Although PKD is the second most common of the hereditary nonspherocytic anemias, it is still rare, with the incidence estimated to be 51 cases per million in the Caucasian population.

Description

In PKD, there is an functional abnormality with the enzyme, pyruvate kinase. Usually, pyruvate kinase acts as a catalyst in the glycolysis pathway, and is considered an essential component in this pathway. Glycolysis is the method by which cells produce their own energy. A problem with any of the key components in glycolysis can alter the amount of energy produced. In the red blood cells, glycolysis is the only method available to produce energy. Without the proper amount of energy, the red blood cells do not function normally. Since pyruvate kinase is one of the key components in glycolysis, when there is a problem with this enzyme in the red blood cells, there is a problem with the production of energy, causing the red blood cells not to function properly.

There are four different forms of the pyruvate kinase enzyme in the human body. These forms, called isozymes, all perform the same function but each isozyme of pyruvate kinase is structurally different and works in different tissues and organs. The four isozymes of pyruvate kinase are labeled M1, M2, L, and R. The isozyme M1 is found in the skeletal muscle and brain, isozyme M2 can be found in most fetal and adult tissues, isozyme L works in the liver, and isozyme R works in the red blood cells. In PKD, only the pyruvate kinase isozyme found in red blood cells, called PKR, is abnormal. Therefore, PKD only affects the red blood cells and does not directly affect the energy production in the other organs and tissues of the body.

In general, PKD not does appear to affect one gender more than another or be more common in certain regions. However, there are studies of an Amish group in Pennsylvania where a severe form of PKD is more common. As previously mentioned, the three mutations found in the PKLR gene have been linked to individuals of specific decents. Caucasians of northern and central European decent are more likely to have the 1529A mutations, individuals of southern European descent usually have the 1456T mutation, and individuals of Asian descent are more likely to have the 1468T mutation.

Causes and symptoms

There are two PK genes and each gene produces two of the four isozymes of pyruvate kinase. The M1 and M2 isozymes are produced by the pyruvate kinase gene called PKM2 and pyruvate kinase isozymes, L and R, are products of the pyruvate kinase gene, PKLR. The PKLR gene is located on chromosome 1, on the q arm (the top

KEY TERMS

Anemia—When the amount of red blood cells is less than normal.

Catalyst—A substance that causes the next step in a pathway or reaction to occur, but is not physically changed by the process.

Compound heterozygotes—Individuals who have one gene in a pair with one mutation and the other gene in the pair has a different mutation.

Enzyme—A protein produced by cells that acts as a catalyst to allow a change or function to occur.

Glycolysis—The pathway in which a cell breaks down glucose into energy.

Hemolytic anemia—Anemia that results from red blood cells being destroyed sooner than normal.

Heterozygote/Heterozygotes—Are individuals who have one gene in a pair that has a mutation while the other gene in the pair is unaffected.

Homozygote/Homozygotes—Are individuals who have both genes in a pair with the same mutation.

Homozygous—When both genes in a pair have the same mutation.

Isozyme/Isoenzyme—Are a group of enzymes that perform the same function, but are different from one another in their structure or how they move.

Mutation—A change in the gene that causes it to alter its function

Nonspherocytic—Literally means not sphere-shaped. Often in inherited hemolytic anemias, the red blood cells are sphere-shaped. In Nonspherocytic Hemolytic Anemias, the red blood cells are not sphere-shaped.

half of the chromosome), in region 21 (written as 1q21). As of 2001, there have been over 125 different mutations described in the PKLR gene that have been detected in individuals with PKD.

PKD is mainly inherited in an autosomal recessive manner. There have been a few families where it appeared that PKD was inherited in either an autosomal dominant manner or where the carriers of PKD exhibited mild problems with their red blood cells. As with all autosomal recessive conditions, affected individuals have a mutation in both pair of genes. Most individuals with PKD are compound heterozygotes, meaning that each PKLR gene in a pair contains a different mutation. There are individuals who have the same mutation on each PKLR gene, but these individuals tend to be children of parents who are related to each other.

There are three mutations in the PKLR gene called, 1529A, 1456T, and 1468T, that are seen more frequently in individuals with PKD than the other mutations. The mutation 1529A is most frequently seen in Caucasians of northern and central European descent and is the most common mutation seen in PKD. The mutation 1456T is more common in individuals of southern European descent and the mutation 1468T is more common in individuals of Asian descent.

In general, the more severe the PKD, the earlier in life symptoms tend to be detected. Individuals with the more severe form of PKD often show symptoms soon after birth, but most individuals with PKD begin to exhibit symptoms during infancy or childhood. In individuals with the more mild form of PKD, the condition is sometimes not diagnosed until late adulthood, after an acute illness, or during a **pregnancy** evaluation.

For most of the mutations seen in the PKLR gene, no correlation between the specific mutation and the severity of the disorder has been observed. However, for two of the mutations, there has been speculation on their effect on the severity of PKD. When the mutation 1456T has been seen in the homozygous state (when both PKLR genes contain the same mutation), those rare individuals experienced very mild symptoms of PKD. Also, there have been individuals who were homozygous for the 1529A mutation. These individuals had a very severe form of PKD. Therefore, it is thought that the 1456T mutation is associated with a milder form of the disease and the 1529A mutation is associated with a more severe form of the disease. It is not known how these mutations affect the severity of PKD when paired with different mutations.

Symptoms of PKD are similar to those symptoms seen in individuals who have long-term **hemolytic anemia**. The more common symptoms include variable degrees of **jaundice** (a yellowish pigment of the skin), slightly to moderately enlarged spleen (splenomegaly), and increased incidence of **gallstones**. Other physical effects of PKD can include smaller head size and the forehead appearing prominent and rounded (called frontal bossing). If a child with PKD has their spleen removed, their growth tends to improve. Even within the

same family, individuals can have different symptoms and severity of PKD.

In individuals with PKD, the red blood cells are taken out of their circulation earlier than normal (shorten life-span). Because of this, individuals with PKD will have hemolytic anemia. Additionally, the anemia or other symptoms of PKD may worsen during a sudden illness or pregnancy.

Diagnosis

A diagnosis of PKD can be made by measuring the amount of pyruvate kinase in red blood cells. Individuals with PKD tend to have 5–25% of the normal amount of pyruvate kinase. Carriers of PKD also can have less pyruvate kinase in their red blood cells, approximately 40–60% of the normal value. However, there is an overlap between the normal range of pyruvate kinase and the ranges seen with carriers of PKD. Therefore, measuring the amount of pyruvate kinase in the red blood cells is not a good method of detecting carriers of PKD. If the mutations causing PKD in a family are known, it may be possible to perform mutation analysis to determine carrier status of an individual and to help diagnose individuals with PKD.

Treatment

In the severest cases, individuals with PKD will require multiple blood transfusions. In some of those cases, the spleen may be removed (**splenectomy**). Red blood cells are normally removed from circulation by the spleen. By removing an individual's spleen (usually a child), the red blood cells are allowed to stay in circulation longer than normal; thereby, reducing the severity of the anemia. After a splenectomy, or once an individual with PKD is older, the number of transfusions tends to decrease.

Prognosis

The prognosis of PKD is extremely variable. Early intervention and treatment of symptoms frequently improves the individual's health. Without treatment, individuals may experience severe complications that may become lethal. Individuals with a mild form of PKD may appear to have no symptoms at all.

Resources

PERIODICALS

Beutler, Ernest, and Terri Gelbart. "Estimating the Prevalence of Pyruvate Kinase Deficiency from the Gene Frequency in the General White Population." *Blood* 95 (June 2000): 3585-3588.

Kugler, W., et. al. "Eight Novel Mutations and Consequences of mRNA and Protein Level in Pyruvate Kinase Deficient Patients with Nonspherocytic Hemolytic Anemia." *Human Mutation* 15 (2000): 261-272.

ORGANIZATIONS

NIH/National Heart, Lung, and Blood Institute. 31 Center Drive MSC 2480, Building 31A Rm 4A16, Bethesda, MD 20892-2480. (301) 592-8573.

OTHER

"Entry 266200: Pyruvate Kinase Deficiency of Erythrocyte." *OMIM—Online Mendelian Inheritance in Man*. 24 Mar. 1999 <http://www.ncbi.nih.gov/htbin-post/Omim/dispmim?266200>.

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Q

Q fever

Definition

Q fever is an illness caused by a type of bacteria, *Coxiella burnetii*, resulting in a **fever** and rash.

Description

C. burnetii lives in many different kinds of animals, including cattle, sheep, goats, ticks, cats, rabbits, birds, and dogs. In sheep and cattle, for example, the bacteria tends to accumulate in large numbers in the female's uterus (the organ where lambs and calves develop) and udder. Other animals have similar patterns of bacterial accumulation within the females. As a result, *C. burnetii* can cause infection through contaminated milk, or when humans come into contact with the fluids or tissues produced when a cow or sheep gives birth. Also, the bacteria can survive in dry dust for months; therefore, if the female's fluids contaminate the ground, humans may become infected when they come in contact with the contaminated dust.

Persons most at risk for Q fever include anybody who works with cattle or sheep, or products produced from them. These include farm workers, slaughterhouse workers, workers in meat-packing plants, veterinarians, and wool workers.

Q fever has been found all over the world, except in some areas of Scandinavia, Antarctica, and New Zealand.

Causes and symptoms

C. burnetii causes infection when a human breathes in tiny droplets, or drinks milk, containing the bacteria. After three to 30 days, symptoms of the illness appear.

The usual symptoms of Q fever include fever, chills, heavy sweating, **headache**, **nausea and vomiting**, **diarrhea**, **fatigue**, and **cough**. Also, a number of other problems may present themselves, including inflammation of the liver (hepatitis); inflammation of the sac containing the heart (**pericarditis**); inflammation of the heart muscle itself (**myocarditis**); inflammation of the coverings of the brain and spinal cord, or of the brain itself (meningoencephalitis); and **pneumonia**.

Chronic Q fever occurs most frequently in patients with other medical problems, including diseased heart valves, weakened immune systems, or kidney disease. Such patients usually have about a year's worth of vague symptoms, including a low fever, enlargement of the spleen and/or liver, and fatigue. Testing almost always reveals that these patients have inflammation of the lining of the heart (**endocarditis**).

Diagnosis

Q fever is diagnosed by demonstrating that the patient's immune system is making increasing numbers of antibodies (special immune cells) against markers (antigens) that are found on *C. burnetii*.

Treatment

Doxycycline and quinolone **antibiotics** are effective for treatment of Q fever. Treatment usually lasts for two weeks. Rifampin and doxycycline together are given for chronic Q fever. Chronic Q fever requires treatment for at least three years.

Prognosis

Death is rare from Q fever. Most people recover completely, although some patients with endocarditis will require surgery to replace their damaged heart valves.

Prevention

Q fever can be prevented by the appropriate handling of potentially infective substances. For example, milk should always be pasteurized, and people who work with animals giving birth should carefully dispose of the tissues and fluids associated with birth. Industries which process animal materials (meat, wool) should take care to prevent the contamination of dust within the plant.

KEY TERMS

Antibodies—Specialized cells of the immune system that can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Antigens—Markers on the outside of bacteria or viruses which can be recognized by antibodies.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Inflammation—The body's response to tissue damage. Includes increased heat, swelling, redness, and pain in the affected part.

Vaccines are available for workers at risk for Q fever.

Resources

BOOKS

Corey, Lawrence. "Rickettsia and Coxiella." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Walker, David, et al. "Rickettsial Diseases." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

"Q Fever Outbreak: Germany, 1996." *Morbidity and Mortality Weekly Report* 46, no. 2 (17 Jan. 1997): 29+.

Valero, Frank. "Pericardial Effusion as the Initial Feature of Q Fever." *American Heart Journal* 130, no. 6 (Dec. 1995): 1308+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Qigong

Definition

Qigong (pronounced "chee-gung," also spelled *chi kung*) is translated from the Chinese to mean "energy cultivation" or "working with the life energy." Qigong is an ancient Chinese system of postures, exercises, breathing techniques, and meditations. Its techniques are designed to improve and enhance the body's *qi*. According to traditional Chinese philosophy, qi is the fundamental life energy responsible for health and vitality.

Purpose

Qigong may be used as a daily routine to increase overall health and well-being, as well as for disease prevention and longevity. It can be used to increase energy and reduce **stress**. In China, qigong is used in conjunction with other medical therapies for many chronic conditions, including **asthma**, **allergies**, **AIDS**, **cancer**, headaches, **hypertension**, depression, mental illness, strokes, heart disease, and **obesity**.

Description

Origins

Qigong originated before recorded history. Scholars estimate qigong to be 5000–7000 old years. Tracing the exact historical development of qigong is difficult, because it was passed down in secrecy among monks and teachers for many generations. Qigong survived through many years before paper was invented, and it also survived the Cultural Revolutions in China of the 1960s and 1970s, which banned many traditional practices.

Qigong has influenced and been influenced by many of the major strands of Chinese philosophy. The Taoist philosophy states that the universe operates within laws of balance and harmony, and that people must live within the rhythms of nature—ideas that pervade qigong. When Buddhism was brought from India to China around the seventh century A.D., **yoga** techniques and concepts of mental and spiritual awareness were introduced to qigong masters. The Confucian school was concerned with how people should live their daily lives, a concern of qigong as well. The martial arts were highly influenced by qigong, and many of them, such as t'ai chi and kung fu, developed directly from it. **Traditional Chinese medicine** also shares many of the central concepts of qigong, such as the patterns of energy flow in the body. **Acupuncture** and **acupressure** use the same points on the body that qigong seeks to stimulate. In China, qigong masters have been renowned physicians and healers. Qigong is often prescribed by Chinese physicians as part of the treatment.

Due to the political isolation of China, many Chinese concepts have been shrouded from the Western world. Acupuncture was "discovered" by American doctors in the 1970s, although it had been in use for thousands of years. With an increased exchange of information, more

Americans have gained access to the once-secret teachings of qigong. In 1988, the First World Conference for Academic Exchange of Medical Qigong was held in Beijing, China, where many studies were presented to attendees from around the world. In 1990, Berkeley, California, hosted the First International Congress of Qigong. In the past decade, more Americans have begun to discover the beneficial effects of qigong, which motivate an estimated 60 million Chinese to practice it every day.

Basic concepts

In Chinese thought, qi, or chi, is the fundamental life energy of the universe. It is invisible but present in air, water, food and sunlight. In the body, qi is the unseen vital force that sustains life. We are all born with inherited amounts of qi, and we also get acquired qi from the food we eat and the air we breathe. In qigong, the breath is believed to account for the largest quantity of acquired qi, because the body uses air more than any other substance. The balance of our physical, mental, and emotional levels also affect qi levels in the body.

Qi travels through the body along channels called meridians. There are 12 main meridians, corresponding to the 12 principal organs as defined by the traditional Chinese system: the lung, large intestines, stomach, spleen, heart, small intestine, urinary bladder, kidney, liver, gallbladder, pericardium, and the "triple warmer," which represents the entire torso region. Each organ has qi associated with it, and each organ interacts with particular emotions on the mental level. Qigong techniques are designed to improve the balance and flow of energy throughout the meridians, and to increase the overall quantity and volume of qi. In qigong philosophy, mind and body are not separated as they often are in Western medicine. In qigong, the mind is present in all parts of the body, and the mind can be used to move qi throughout the body.

Yin and yang are also important concepts in qigong. The universe and the body can be described by these two separate but complementary principles, which are always interacting, opposing, and influencing each other. One goal of qigong is to balance yin and yang within the body. Strong movements or techniques are balanced by soft ones, leftward movements by rightward, internal techniques by external ones, and so on.

Practicing qigong

There are thousands of qigong exercises. The specific ones used may vary depending on the teacher, school, and objective of the practitioner. Qigong is used for physical fitness, as a martial art, and most frequently for health and healing. Internal qigong is performed by those wishing to increase their own energy and health. Some qigong masters are renowned for being able to perform external qigong, by which the energy from one person is passed on to another for healing. This transfer may sound suspect to Western logic, but in the world of qigong there are some amazing accounts of healing and extraordinary capabilities demonstrated by qigong masters. Qigong masters generally have deep knowledge of the concepts of Chinese medicine and healing. In China, there are hospitals that use medical qigong to heal patients, along with herbs, acupuncture, and other techniques. In these hospitals, qigong healers use external qigong and also design specific internal qigong exercises for patients' problems.

There are basic components of internal qigong sessions. All sessions require warm-up and concluding exercises. Qigong consists of postures, movements, breathing techniques, and mental exercises. Postures may involve standing, sitting, or lying down. Movements include stretches, slow motions, quick thrusts, jumping, and bending. Postures and movements are designed to strengthen, stretch, and tone the body to improve the flow of energy. One sequence of postures and movements is known as the "Eight Figures for Every Day." This sequence is designed to quickly and effectively work the entire body, and is commonly performed daily by millions in China.

Breathing techniques include deep abdominal breathing, chest breathing, relaxed breathing, and holding breaths. One breathing technique is called the "Six Healing Sounds." This technique uses particular breathing sounds for each of six major organs. These sounds are believed to stimulate and heal the organs.

Meditations and mind exercises are used to enhance the mind and move qi throughout the body. These exercises are often visualizations that focus on different body parts, words, ideas, objects, or energy flowing along the meridians. One mental exercise is called the "Inner Smile," during which the practitioner visualizes joyful, healing energy being sent sequentially to each organ in the body. Another mental exercise is called the "Microscopic Orbit Meditation," in which the practitioner intently meditates on increasing and connecting the flow of qi throughout major channels.

Discipline is an important dimension of qigong. Exercises are meant to be performed every morning and evening. Sessions can take from 15 minutes to hours. Beginners are recommended to practice between 15–30 minutes twice a day. Beginners may take classes once or twice per week, with practice outside of class. Classes generally cost between $10–$20 per session.

Preparations

Qigong should be practiced in a clean, pleasant environment, preferably outdoors in fresh air. Loose and comfortable clothing is recommended. Jewelry should be

KEY TERMS

Martial arts—Group of diverse activities originating from the ancient fighting techniques of the Orient.

Meridians—Channels or conduits through which Qi travels in the body.

Qi—Basic life energy, according to traditional Chinese medicine.

Yin/Yang—Universal characteristics used to describe aspects of the natural world.

removed. Practitioners can prepare for success at qigong by practicing at regular hours each day to promote discipline. Qigong teachers also recommend that students prepare by adopting lifestyles that promote balance, moderation, proper rest, and healthy **diets**, all of which are facets of qigong practice.

Precautions

Beginners should learn from an experienced teacher, as performing qigong exercises in the wrong manner may cause harm. Practitioners should not perform qigong on either full or completely empty stomachs. Qigong should not be performed during extreme weather, which may have negative effects on the body's energy systems. Menstruating and pregnant women should perform only certain exercises.

Side effects

Side effects may occur during or after qigong exercises for beginners, or for those performing exercises incorrectly. Side effects may include **dizziness**, **dry mouth**, **fatigue**, headaches, **insomnia**, rapid heartbeat, **shortness of breath**, heaviness or numbness in areas of the body, emotional instability, **anxiety**, or decreased concentration. Side effects generally clear up with rest and instruction from a knowledgeable teacher.

Research and general acceptance

Western medicine generally does not endorse any of the traditional Chinese healing systems that utilize the concept of energy flow in the body, largely because this energy has yet to be isolated and measured scientifically. New research is being conducted using sophisticated equipment that may verify the existence of energy channels as defined by the Chinese system. Despite the lack of scientific validation, the results of energy techniques including qigong and acupuncture have gained widespread interest and respect. Furthermore, qigong masters have demonstrated to Western observers astounding control over many physical functions, and some have even shown the ability to increase electrical voltage measured on their skin's surface. Most of the research and documentation of qigong's effectiveness for medical conditions has been conducted in China, and is slowly becoming more available to English readers.

Training and certification

In China, qigong has been subject to much government regulation, from banning to increased requirements for teachers. In the United States at this time, qigong has not been regulated. Different schools may provide teacher training, but there are no generally accepted training standards. Qigong teachings may vary, depending on the founder of the school, who is often an acknowledged Chinese master. The organizations listed below can provide further information to consumers.

Resources

BOOKS

Lui, Dr. Hong, and Paul Perry. *Mastering Miracles: The Healing Art of Qi Gong as Taught by a Master.* New York: Warner Books, 1997.

MacRichie, Mames. *Chi Kung: Cultivating Personal Energy.* Boston: Element, 1993.

Reid, Daniel. *A Complete Guide to Chi Gung*. Boston: Shambhala, 1998.

Tzu, Lao. *The Tao Te Ching: A New English Version*, translated by Stephen Mitchell. New York: HarperCollins: 1988.

PERIODICALS

Qi: The Journal of Traditional Eastern Health and Fitness. PO Box 221343. Chantilly, VA 22022. (202) 378 3859.

Qigong Magazine. PO Box 31578. San Francisco, CA 94131. (800) 824-2433.

ORGANIZATIONS

Chinese National Chi Kung Institute. PO Box 31578. San Francisco, CA 94131. (800) 824-2433.

International Chi Kung/Qi Gong Directory. 2730 29th Street. Boulder, CO 80301. (303) 442-3131.

Qigong Human Life Research Foundation. PO Box 5327. Cleveland, OH 44101. (216) 475-4712.

Douglas Dupler

Quadriplegia *see* **Paralysis**

Quarantine *see* **Isolation**

Quinidine *see* **Antiarrhythmic drugs**

Quinine *see* **Antimalarial drugs**

R

Rabbit fever *see* **Tularemia**

Rabies

Definition

Rabies is an acute viral disease of the central nervous system that affects humans and other mammals. It is almost exclusively transmitted through saliva from the bite of an infected animal. Another name for the disease is *hydrophobia*, which literally means "fear of water," a symptom shared by half of all people infected with rabies. Other symptoms include **fever**, depression, confusion, painful muscle spasms, sensitivity to touch, loud noise, and light, extreme thirst, painful swallowing, excessive salivation, and loss of muscle tone. If rabies is not prevented by immunization, it is essentially always fatal.

Description

Worldwide, approximately 15,000 cases of human rabies continue to occur annually. Remarkably, although more than one million persons in the United States are bitten each year by animals, on average, only one or two persons die from the disease each year. Nevertheless, with the continued encroachment of humans on animal habitats, both for housing and recreational purposes, rabies remains a public health concern.

Both domestic and wild animals may transmit rabies. With the widespread **vaccination** of domesticated animals in the United States, dogs in particular, the number of cases of rabies has significantly declined. In 1955 domesticated animals, especially dogs, constituted 47% of the reported rabies cases. By 1994, fewer than 2% of positive tests occurred in dogs. In fact, in the 1990s, cats outnumbered dogs as transmitters of the disease. As of 1997, most cases of rabies are in wild animals, particularly bats, raccoons, skunks, foxes, wolves, and coyotes.

Anyone who has been bitten by an animal, regardless of age or sex, can contract rabies. However, people whose occupations involve routine exposure to a domestic animal that has not been immunized or to wildlife are at a greater risk for getting the disease. As a result, cave explorers, farm and ranch workers, animal trainers and caretakers, forest rangers, animal exterminators, some laboratory workers, and veterinarians are at a higher risk.

Causes and symptoms

Rabies is caused by a rod- or bullet-shaped virus in the family Rhabdoviridae. The virus is usually transmitted via an animal bite, however, cases have also been reported in which the virus penetrated the body through infected saliva, moist tissues such as the eyes or lips, a scratch on the skin, or the transplantation of infected tissues. Inhalation of the virus in the air, as might occur in a highly populated bat cave, is also thought to occur.

From the bite or other area of penetration, the virus multiplies as it spreads along nerves that travel away from the spinal cord and brain (efferent nerves) and into the salivary glands. The rabies virus may lie dormant in the body for several weeks or months, but rarely much longer, before symptoms appear. Initially, the area around the bite may burn and be painful. Early symptoms may also include a **sore throat**, low-grade fever, **headache**, loss of appetite, **nausea and vomiting**, and **diarrhea**. Painful spasms develop in the muscles that control breathing and swallowing. The individual may begin to drool thick saliva and may have dilated or irregular pupils, increased tears and perspiration, and low blood pressure.

Later, as the disease progresses, the patient becomes agitated and combative and may exhibit increased mental confusion. The affected person usually becomes sensitive to touch, loud noises, and bright lights. The victim also becomes extremely thirsty, but is unable to drink because swallowing is painful. Some patients begin to dread water because of the painful spasms that occur. Other severe

symptoms during the later stage of the disease include excessive salivation, **dehydration**, and loss of muscle tone. **Death** usually occurs three to 20 days after symptoms have developed. Unfortunately, recovery is very rare.

Diagnosis

After the onset of symptoms, blood tests and **cerebrospinal fluid (CSF) analysis** tests will be conducted. CSF will be collected during a procedure called a lumbar puncture in which a needle is used to withdraw a sample of CSF from the area around the spinal cord. The CSF tests do not confirm diagnosis but are useful in ruling out other potential causes for the patient's altered mental state.

The two most common diagnostic tests are the fluorescent antibody test and **isolation** of the rabies virus from an individual's saliva or **throat culture**. The fluorescent antibody test involves taking a small sample of skin (biopsy) from the back of the neck of the patient. If specific proteins, called antibodies, that are produced only in response to the rabies virus are present, they will bind with the fluorescent dye and become visible. Another diagnostic procedure involves taking a corneal impression in which a swab or slide is pressed lightly against the cornea of the eye to determine whether viral material is present.

Treatment

Because of the extremely serious nature of a rabies infection, the need for rabies immunizations will be carefully considered for anyone who has been bitten by an animal, based on a personal history and results of diagnostic tests.

If necessary, treatment includes the following:

- The wound is washed thoroughly with medicinal soap and water. Deep puncture **wounds** should be flushed with a catheter and soapy water. Unless absolutely necessary, a wound should not be sutured.
- Tetanus toxoid and **antibiotics** will usually be administered.
- Rabies vaccination may or not be given, based on the available information. If the individual was bitten by a domestic animal and the animal was captured, the animal will be placed under observation in quarantine for ten days. If the animal does not develop rabies within four to seven days, then no immunizations are required. If the animal is suspected of being rabid, it is killed, and the brain is examined for evidence of rabies infection. In cases involving bites from domestic animals where the animal is not available for examination, the decision for vaccination is made based on the prevalence of rabies within the region where the bite occurred. If the bite was from a wild animal and the animal was captured, it is generally killed because the incubation period of rabies is unknown in most wild animals.
- If necessary, the patient is vaccinated immediately, generally through the administration of human rabies immune globulin (HRIG) for passive immunization, followed by human diploid cell vaccine (HDCV) or rabies vaccine adsorbed (RVA) for active immunization. Passive immunization is designed to provide the individual with antibodies from an already immunized individual, while active immunization involves stimulating the individual's own immune system to produce antibodies against the rabies virus. Both rabies vaccines are equally effective and carry a lower risk of side effects than some earlier treatments. Unfortunately, however, in underdeveloped countries, these newer vaccines are usually not available. Antibodies are administered to the patient in a process called passive immunization. To do this, the HRIG vaccine is administered once, at the beginning of treatment. Half of the dose is given around the bite area, and the rest is given in the muscle. Inactivated viral material (antigenic) is then given to stimulate the patient's own immune system to produce antibodies against rabies. For active immunization, either the HDCV or RVA vaccine is given in a series of five injections. Immunizations are typically given on days one, three, seven, 14, and 28.

In those rare instances in which rabies has progressed beyond the point where immunization would be effective, the patient will be given medication to prevent seizures, relieve some of the **anxiety**, and relieve painful muscle spasms. **Pain** relievers will also be given. In the later stages, aggressive supportive care will be provided to maintain breathing and heart function. Survival is rare but can occur.

Prognosis

If preventative treatment is sought promptly, rabies need not be fatal. Immunization is almost always effective if started within two days of the bite. Chance of effectiveness declines, however, the longer vaccination is put off. It is, however, important to start immunizations, even if it has been weeks or months following a suspected rabid animal bite, because the vaccine can be effective even in these cases. If immunizations do not prove effective or are not received, rabies is nearly always fatal with a few days of the onset of symptoms.

Prevention

The following precautions should be observed in environments where humans and animals may likely come into contact.

KEY TERMS

Active immunization—Treatment that provides immunity by challenging an individual's own immune system to produce antibody against a particular organism, in this case the rabies virus.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Biopsy—The removal of a small sample of tissue for diagnostic purposes.

Efferent nerves—Nerves that convey impulses away from the central nervous system to the periphery.

Fluorescent antibody test (FA test)—A test in which a fluorescent dye is linked to an antibody for diagnostic purposes.

Lumbar puncture—A procedure that involves withdrawing a small sample of cerebrospinal fluid from the back around the spinal cord.

Passive immunization—Treatment that provides immunity through the transfer of antibodies obtained from an immune individual.

Rhabdovirus—A type of virus named for its rod- or bullet-like shape.

- Domesticated animals, including household pets, should be vaccinated against rabies. Semi-annual booster shots are required to maintain immunity.
- Wild animals should not be touched or petted, no matter how friendly an animal may appear. It is also important not to touch an animal that appears ill or passive, or whose behavior seems odd, such as failing to show the normal fear of humans. These are all possible signs of rabies. Many animals, such as raccoons and skunks, are nocturnal and their activity during the day should be regarded as suspicious.
- Do not interfere with fights between animals.
- Because rabies is transmitted through saliva, a person should wear rubber gloves when handling a pet that has had an encounter with a wild animal.
- Windows and doors should be screened. Some victims of rabies have been attacked by infected animals, particularly bats, that entered through unprotected openings.
- State or county health departments should be consulted for information about the prevalence of rabies in an area. Some areas, such as New York City, have been rabies-free, only to have the disease reintroduced at a later time.
- Preventative vaccination against rabies should be considered if you are in an occupation that involves frequent contact with wild animals or non-immunized domestic animals.
- Bites from mice, rats, or squirrels rarely require rabies prevention because these rodents are typically killed by any encounter with a larger, rabid animal, and would, therefore, not be carriers.
- If traveling, ask about the prevalence of the disease in the area because rabies is more prevalent in other countries.

Resources

BOOKS

Cockrum, E. Lendell. *Rabies, Lyme Disease, Hanta Virus, and Other Animal-Borne Human Diseases in the United States and Canada*. Tucson: Fisher Books, 1997.

Corey, Lawrence. "Rabies Virus and Other Rhabdoviruses." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Janet Byron Anderson

Radial keratotomy

Definition

Radial keratotomy (RK) is a type of eye surgery used to correct **myopia** (nearsightedness). It works by changing the shape of the cornea—the transparent part of the eye that covers the iris and the pupil.

Purpose

About 25–30% of all people in the world are nearsighted and need eyeglasses or contact lenses for distance vision to be clear. For a number of reasons, some people don't like wearing corrective lenses. Some feel unattractive in eyeglasses. Others worry about not being able to see without their glasses in an emergency, such as a house fire or a burglary. Both glasses and contact lenses can be scratched, broken, or lost. In addition, contact lenses require special care and can irritate the eyes.

Radial keratotomy was introduced in North America in 1978. Since then doctors have improved the technique, and its results have become more predictable. Radial keratotomy is one of several surgical techniques to correct

nearsightedness, reducing or eliminating the need for corrective lenses. It is most successful in patients with a low to moderate amount of nearsightedness—people whose eyes require up to -5.00 diopters of correction. A diopter (D) is a unit of measure of focusing power. Minus lenses correct nearsightedness.

Precautions

Not every nearsighted person is a good candidate for radial keratotomy. This type of surgery cannot help people whose nearsightedness is caused by keratoconus, a rare condition in which the cornea is cone shaped. The procedure usually is not done on patients under 18, because their eyes are still growing and changing shape. It is important that visual status is stable. Women who are pregnant, have just given birth, or are breast-feeding should not have the surgery because hormonal changes may cause temporary changes in the cornea. In addition, anyone with **glaucoma** or with any disease that interferes with healing (e.g., **rheumatoid arthritis**, lupus erythematosus, or uncontrolled diabetes) should not have RK.

Radial keratotomy weakens the cornea, making it vulnerable to injuries even long after the surgery. Getting hit in the head after having RK can cause the cornea to tear and can lead to blindness. For this reason, the procedure is not recommended for people who engage in sports that could result in a blow to the head (i.e., karate or racquetball).

It is important to keep in mind that RK is a permanent procedure and that success cannot be guaranteed. An experienced eye surgeon can estimate how likely it is that the surgery will help a particular patient, but that is just an estimate. There is no way to know for sure whether the surgery will improve eyesight enough to eliminate the need for corrective lenses. Vision usually improves after RK, but it is not always perfect. Anyone who decides to have RK should be prepared to accept less-than-perfect vision after surgery, which may necessitate the continued use of glasses or contact lenses. This surgery does not eliminate the need for reading glasses. Actually, someone who didn't need reading glasses before surgery because their myopia allowed near vision to be clear may find themselves needing reading glasses. Patients must ask about this prior to surgery.

Anyone considering RK should also be aware that certain professions, including branches of the military, are not open to people who have had the procedure.

A reputable ophthalmologist will discuss the risks of the procedure and should tell anyone considering it that perfect vision can't be guaranteed. Patients should be wary of any doctor who tries too hard to "sell" them on RK.

Description

In a person with clear vision, light passes through the cornea and the lens of the eye and focuses on a membrane lining the back of the eye called the retina. In a person with myopia, the eyeball is usually too long, so light focuses in front of the retina. Radial keratotomy reduces myopia by flattening the cornea. This reduces the focusing power of the cornea allowing light to focus further back onto the retina (or at least closer to it), forming a clearer image.

A surgeon performing RK uses a very small diamond-blade knife to makes four to eight radial incisions around the edge of the cornea. These slits are made in a pattern that resembles the spokes of wheel. As the cornea heals, its center flattens out.

Radial keratotomy is usually performed in an ophthalmologist's office. Before the surgery begins, the patient may be given medicine to help him or her relax. A local anesthetic—usually in the form of eye drops—is used to numb the eye, but the patient remains conscious during the procedure. The surgeon looks through a surgical microscope while making the slits. The treatment usually takes no more than 30 minutes.

Some ophthalmologists will perform RK on both eyes at once but others prefer to do one eye at a time. It once was thought that surgeons could use the results of the first eye to predict how the well the procedure would work on the second eye. However, a study published in 1997 found that this was not the case. The authors of the study cautioned that there might be other reasons not to operate on both eyes at once, such as increased risk of infection and other complications.

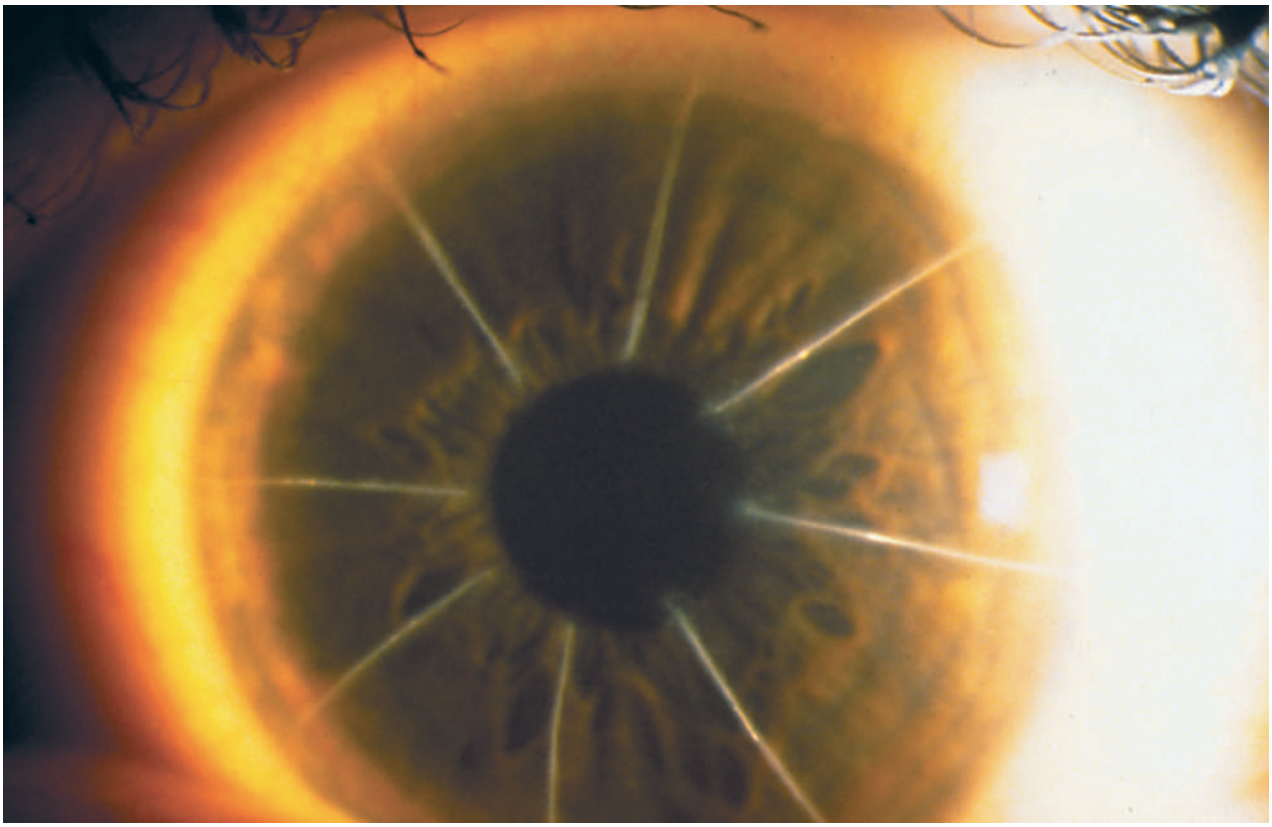
The cost for RK depends on the surgeon, but usually ranges from $1,000–$1,500 per eye. Medical insurance usually does not cover RK, because it is considered an elective procedure—one that people choose to have done.

Preparation

Before beginning the procedure, the surgeon marks an area in the center of the cornea called the optical zone. This is the part of the cornea that one sees through (it's the area over the pupil). No cuts are made in this region. The surgeon also measures the cornea's thickness, to decide how deep the slits should be.

Aftercare

After the surgery is over, the anesthetic wears off. Some patients feel slight **pain** and are given eye drops and medications to relieve their discomfort. For several days after the surgery, the eye that was treated may feel



Radial keratotomy scars on the cornea of an eye. *(Photograph by Bob Masini, Phototake NYC. Reproduced by permission.)*

scratchy and look red. This is normal. The eye may also water, burn slightly, and be sensitive to light.

As with any type of surgery, it is important to guard against infection. Patients are given eye drops to protect against infection and may be told to use them for several weeks after the surgery. Because RK weakens the cornea it is important to protect the head and eyes.

The cornea heals slowly, and full recovery can take several months (another reason not to have the surgery done on both eyes at the same time). While the cornea is healing, patients may experience these problems:

- Variations in vision. Eyesight may be better in the morning than in the evening or vice versa.
- Temporary pain.
- Increased glare.
- Starburst or halo effects. Rays or rings of light around lights at night.
- Hyperopic shift. As the cornea flattens, vision may become more farsighted (hyperopic). For this reason, the surgeon may initially undercorrect the patient. This gradual shift may occur over several years.

If RK does not completely correct a person's nearsightedness, glasses or contact lenses may be needed. In general, people who were able to wear contact lenses before the procedure can still wear them afterward. Even patients whose nearsightedness was corrected may still need glasses for reading. This is especially true for middle-aged and older patients. The lens of the eye stiffens with age, making reading glasses necessary (**presbyopia**). Radial keratotomy does not correct this problem.

The surgeon who performs the RK procedure will tell the patient how often to return for follow-up visits. Often, two to four visits are needed, including one the day after surgery. It is also important to know what side effects should be reported immediately to the surgeon (e.g., pain or nausea).

Risks

Complications from RK are rare, but they can occur. These include:

- cataract, (a clouding of the lens of the eye, resulting in partial or total loss of vision)
- serious infection
- lasting pain

- rips along an incision, especially after being hit in the head or eye
- loss of vision
- chance of overcorrection (hyperopic shift)

The chances of complications are reduced when the surgery is done by an ophthalmologist with a lot of experience in RK. Younger patients also tend to heal faster.

Normal results

The desired result of radial keratotomy is a reduction in myopia. A major study by the National Eye Institute, reported in 1994, tracked the success of RK in 374 patients who had had the procedure done 10 years earlier. The study found that:

- 85% had at least 20/40 vision (the acuity considered good enough to drive without glasses)
- 70% did not need glasses or contact lenses for distance vision
- 53% had 20/20 vision without glasses
- 30% still needed glasses or contact lenses to see clearly
- 1–3% had worse vision than before they had RK
- 40% had a hyperopic shift

As with all surgeries, RK has risks. These risks include having worse vision than before the surgery; halos; glare; and although rare, blindness. Some aftereffects, such as halos or glare may last for years. Other refractive surgeries, such as photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK) use lasers to change the shape of the cornea and they may produce fewer side effects. It is important to speak with an experienced eye surgeon who has done many refractive surgeries to fully understand the options and risks involved before making a decision.

Resources

PERIODICALS

Brink, Susan. "Sculptors of Better Vision." *U.S. News & World Report* 118 (22 May 1995): 66+.

Harding, Anne. "A Closer Look at Eye Surgery." *Harvard Health Letter* 21 (June 1996): 4+.

Segal, Marian. "Eye Surgery Helps Some See Better." *FDA Consumer* 29 (July/Aug. 1995): 15+.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

KEY TERMS

Cornea—The transparent part of the eye that covers the iris and the pupil.

Diopter (D)—Unit describing the amount of focusing power of a lens.

Iris—The colored part of the eye.

Laser-assisted in situ keratomileusis (LASIK)—A type of refractive eye surgery using a laser and another instrument to change the shape of the cornea.

Local anesthetic—Used to numb an area where surgery or another procedure is to be done, without causing the patient to lose consciousness.

Myopia—Nearsightedness. People with myopia cannot see distant objects clearly.

Ophthalmologist—A physician who specializes in treating eyes.

Photorefractive keratectomy (PRK)—A type of refractive eye surgery using a laser to change the shape of the cornea.

Pupil—The part of the eye that looks like a black circle in the center of the iris. It is actually an opening through which light passes.

Retina—A membrane lining the back of the eye onto which light is focused to form images.

American Society of Cataract & Refractive Surgery. 4000 Legato Road, Suite 850, Fairfax, VA 22033. (703) 591-2220. <http://www.ascrs.org>.

Nancy Ross-Flanigan

Radiation injuries

Definition

Radiation injuries is damage caused by ionizing radiation emitted by the sun, x-ray machines, and radioactive elements.

Description

Radio and television signals, radar, heat, infrared, ultraviolet, sunlight, starlight, cosmic rays, gamma rays, and x rays all belong to the electromagnetic spectrum

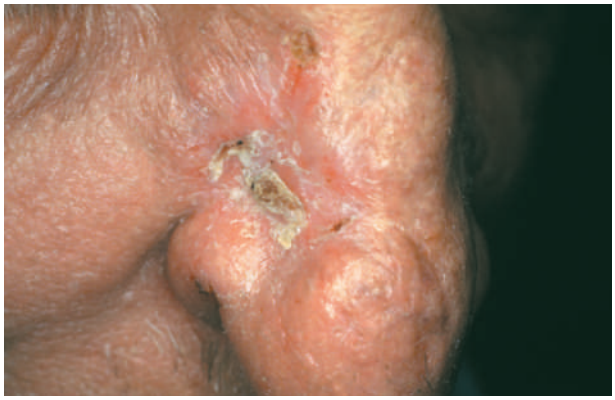
and differ only in their relative energy, frequency, and wavelength. These waves all travel at the speed of light, and unlike sound they can all travel through empty space. The frequencies above visible light have enough energy to penetrate and cause damage to living tissue, damage that can be as minor as a **sunburn** caused by ultraviolet light or as extreme as the incineration of Hiroshima, Japan, during World War II. Lower frequencies do not penetrate, but can cause eye and skin damage, primarily due to the heat they transmit.

Atomic particles can also have enough energy to do damage. They come from radioactive isotopes as they decay to stable elements. Electrons are called beta particles when they radiate. Alpha particles are the nuclei of helium atoms—two protons and two neutrons—without the surrounding electrons. Alpha particles are too large to penetrate a piece of paper unless they are greatly accelerated in electric and magnetic fields. Other subatomic particles are much less common outside of nuclear reactors and particle accelerators.

The energy of electromagnetic radiation is a direct function of its frequency. The high-energy, high-frequency waves, which can penetrate solids to various depths, cause damage by separating molecules into electrically charged pieces, a process known as ionization. Atomic particles, cosmic rays, gamma rays, x rays, and some ultraviolet are called ionizing radiation. The pieces they generate are called free radicals. They act like acid, but they last only fractions of a second before they revert to harmless forms. Adjusting the energy of therapeutic radiation can select a depth at which it will do the most damage. Ionizing radiation also does damage to chromosomes by breaking strands of DNA. DNA is so good at repairing itself that both strands of the double helix must be broken to produce genetic damage.

Because radiation is energy, it can be measured. There are a number of units used to quantify radiation energy. Some refer to effects on air, others to effects on living tissue. The roentgen, named after Wilhelm Conrad Roentgen, who discovered x rays in 1895, measures ionizing energy in air. A rad expresses the energy transferred to tissue. The rem measures tissue response. A roentgen generates about a rad of effect and produces about a rem of response. The gray and the sievert are international units equivalent to 100 rads and rems, respectively. A curie, named after French physicists who experimented with radiation, is a measure of actual radioactivity given off by a radioactive element, not a measure of its effect. The average annual human exposure to natural background radiation is roughly 3 milliSieverts (mSv).

It is reasonable to presume that any amount of ionizing radiation will produce some damage. However, there is radiation everywhere, from the sun (cosmic rays) and from traces of radioactive elements in the air (radon) and the ground (uranium, radium, carbon-14, potassium-40 and many others). Earth's atmosphere protects us from most of the sun's radiation. Living at 5,000 feet altitude in Denver, Colorado, doubles exposure to radiation, and flight in a commercial airliner increases it 150-fold by lifting us above 80% of that atmosphere. Because no amount of radiation is perfectly safe and because radiation is ever present, arbitrary limits have been established to provide some measure of safety for those exposed to unusual amounts. Less than 1% of them reach the current annual permissible maximum of 50 mSv.



This person's nose is inflamed and scaly due to radiation exposure. *(Custom Medical Stock Photo. Reproduced by permission.)*

One of the most remarkable bits of information to come out of studies of Japanese people exposed to atomic bomb irradiation in 1945 is the absence of genetic damage to survivors. Forty years of studying 76,000 children has detected no increase in abnormal pregnancies or chromosomes. This evidence suggests that it takes about 1 Sv of gonad radiation to double human mutations caused by background radiation, and that background radiation causes less than 1% of these mutations. Other organisms are much more susceptible than humans to mutations from radiation.

Ionizing radiation has many uses in medicine, both in diagnosis and in treatment. X rays and CT scanners use it to form images of the body's insides. Nuclear medicine uses radioactive isotopes to diagnose and to treat medical conditions. In the body, radioactive elements localize to specific tissues and give off tiny amounts of radiation. Detecting that radiation provides information on both anatomy and function. Radioactive chemicals are also used to treat certain conditions, most commonly an overactive thyroid. Because the thyroid is the only gland in the body to utilize iodine, all iodine in the body is con-

centrated there. A radioactive isotope of iodine (I-131) will gradually destroy overactive thyroid tissue, curing the disease. The dosage must be carefully measured and even then sometimes does too good a job. Since it is easier to replace inadequate thyroid than to deal with too much, this treatment is very acceptable.

Early workers with x rays frequently died from its long term effects, notably leukemia. Wrist watches used to glow in the dark due to radium that was painted on the dial and watch hands. This work was done by workers who moistened their brushes with their tongues. Many of them developed **cancer** of the tongue. After lessons like these, most sources of man-made radioactivity have been eliminated from the environment. Watches no longer glow in the dark from radium. Shoe salesmen no longer use fluoroscopes to check shoes for a proper fit. Today, doses used for medical examinations are ordinarily too small to be of concern. Methods of magnification, lead shielding, and a greater awareness of the risks have all but eliminated the danger from diagnostic radiation. It adds on average only 0.6 Sv a year, or 20% of the background radiation. Nevertheless, people who work around x rays monitor their exposure, because there is no such thing as a completely safe dose.

It is therapeutic, accidental, and deliberate radiation that does the obvious damage. There has not been much in the way of deliberate radiation damage since Nagasaki, but accidental radiation exposure happens periodically. Between 1945 and 1987, there were 285 nuclear reactor accidents, injuring over 1,550 people and killing 64. The most striking example, and the only one to endanger the public, was the meltdown of the graphite core nuclear reactor at Chernobyl in 1986, which spread a cloud of radioactive particles across the entire continent of Europe. Information about radiation effects is still being gathered from that disaster. There have also been a few accidents with medical and industrial radioactivity.

Nevertheless, it is believed that radiation is responsible for less than 1% of all human disease and for about 3% of all cancers. This figure does not include lung cancer from environmental radon, because that information is unknown. The figure could be significant, but it is greatly confounded by the similar effects of tobacco.

Because cancers are usually faster growing than their host tissues, they can be selectively killed by carefully measured radiation. This is most true of the lymphomas. Other cancers are less radiosensitive. Whenever radiation is used to treat cancer, care must be taken to measure the dose carefully and aim it as accurately as possibly. Even so, many cancers differ so little from the surrounding tissue in their sensitivity that undesirable damage is unavoidable. Skin will become thin making the blood vessels very visible. Bowels will become irritated and cause vomiting and **diarrhea**. Other organs may scar and decrease their function. Bone marrow is always at risk of damage. Fortunately, the bone marrow is so widely spread throughout the body that localized treatment damages only a part of it. A typical therapeutic dose of radiation to a localized area is about 2 Gy (grays) per day, repeated at intervals to a total dose that varies with the type of cancer being treated.

Newer techniques of directing radiation are providing greater safety for equivalent tumor doses of radiation. One method uses several different beams of radiation so that only the point of their convergence receives the full dose. A gamma knife is a new surgical tool that focuses radiation with extreme accuracy in three dimensions, sparing closely surrounding tissue from the radiation effects. It focuses 201 Cobalt-60 or linear accelerator sources without need for a surgical incision.

Causes and symptoms

Radiation can damage every tissue in the body. The particular manifestation will depend upon the amount of radiation, the time over which it is absorbed, and the susceptibility of the tissue. The fastest growing tissues are the most vulnerable, because radiation as much as triples its effects during the growth phase. Bone marrow cells that make blood are the fastest growing cells in the body. A fetus in the womb is equally sensitive. The germinal cells in the testes and ovaries are only slightly less sensitive. Both can be rendered useless with very small doses of radiation. More resistant are the lining cells of the body—skin and intestines. Most resistant are the brain cells, because they grow the slowest.

The relative sensitivity of various tissues gives a good idea of the wide range that presents itself. The numbers represent the minimum damaging doses; a gray and a sievert represent roughly the same amount of radiation:

- fetus—2 grays (Gy)
- bone marrow—2 Gy
- ovary—2–3 Gy
- testes—5–15 Gy
- lens of the eye—5 Gy
- child cartilage—10 Gy
- adult cartilage—60 Gy
- child bone—20 Gy
- adult bone—60 Gy
- kidney—23 Gy
- child muscle—20-30 Gy
- adult muscle—100+ Gy
- intestines—45–55 Gy

• brain—50 Gy

Notice that the least of these doses is a thousand times greater than the background exposure and nearly 50 times greater than the maximum permissible annual dosage.

The length of exposure makes a big difference in what happens. Over time the accumulating damage, if not enough to kill cells outright, distorts their growth and causes scarring and/or cancers. In addition to leukemias, cancers of the thyroid, brain, bone, breast, skin, stomach, and lung all arise after radiation. Damage depends, too, on the ability of the tissue to repair itself. Some tissues and some types of damage produce much greater consequences than others.

Immediately after sudden irradiation, the fate of the patient depends mostly on the total dose absorbed. This information comes mostly from survivors of the atomic bomb blasts over Japan in 1945.

- Massive doses incinerate immediately and are not distinguishable from the heat of the source.
- A sudden whole body dose over 50 Sv produces such profound neurological, heart, and circulatory damage that patients die within the first two days.
- Doses in the 10–20 Sv range affect the intestines, stripping their lining and leading to **death** within three months from vomiting, diarrhea, **starvation**, and infection.
- Victims receiving 6–10 Sv all at once usually escape an intestinal death, facing instead bone marrow failure and death within two months from loss of blood coagulation factors and the protection against infection provided by white blood cells.
- Between 2–6 Sv gives a fighting chance for survival if victims are supported with blood transfusions and **antibiotics**.
- One or two Sv produces a brief, non-lethal sickness with vomiting, loss of appetite, and generalized discomfort.

Treatment

It is clearly important to have some idea of the dose received as early as possible, so that attention can be directed to those victims in the 2–10 Sv range that might survive with treatment. Blood transfusions, protection from infection in damaged organs, and possibly the use of newer stimulants to blood formation can save many victims in this category.

Local radiation exposures usually damage the skin and require careful wound care, removal of dead tissue, and **skin grafting** if the area is large. Again **infection control** is imperative.

KEY TERMS

DNA—Deoxyribonucleic acid. The chemical of chromosomes and hence the vehicle of heredity.

Gonad—Testes in males, ovaries in women—the organs that produce germ cells for future generations.

Isotope—An unstable form of an element that gives off radiation to become stable. Elements are characterized by the number of electrons around each atom. One electron's negative charge balances the positive charge of each proton in the nucleus. To keep all those positive charges in the nucleus from repelling each other (like the same poles of magnets), neutrons are added. Only certain numbers of neutrons work. Other numbers cannot hold the nucleus together, so it splits apart, giving off ionizing radiation. Sometimes one of the split products is not stable either, so another split takes place. The process is called radioactivity.

Leukemia—Cancer of the white blood cells found in bone marrow.

Lymphoma—Cancer of lymphatic tissue, including Hodgkin's disease.

Alternative treatment

There is considerable interest these days in benevolent chemicals called "free radical scavengers." How well they work is yet to be determined, but population studies strongly suggest that certain **diets** are better than others, and that those diets are full of free radical scavengers, otherwise known as antioxidants. The recommended ingredients are beta-carotene, **vitamins** E and C, and selenium, all available as commercial preparations. Beta-carotene is yellow-orange and is present in yellow and orange fruits and vegetables. Vitamin C can be found naturally in citrus fruits. **Traditional Chinese medicine** (TCM) and **acupuncture**, botanical medicine, and **homeopathy** all have contributions to make to recovery from the damage of radiation injuries. The level of recovery will depend on the exposure. Consulting practitioners trained in these modalities will result in the greatest benefit.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Upton, Arthur C. "Radiation Injury." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.
Weil, Andrew. *Natural Health, Natural Medicine*. Boston: Houghton Mifflin, 1995.

J. Ricker Polsdorfer, MD

Radiation sickness *see* **Radiation injuries**

Radiation therapy

Definition

Radiation therapy, sometimes called radiotherapy, x-ray therapy radiation treatment, cobalt therapy, electron beam therapy, or irradiation uses high energy, penetrating waves or particles such as x rays, gamma rays, proton rays, or neutron rays to destroy cancer cells or keep them from reproducing.

Purpose

The purpose of radiation therapy is to kill or damage cancer cells. Radiation therapy is a common form of cancer therapy. It is used in more than half of all cancer cases. Radiation therapy can be used:

- alone to kill cancer
- before surgery to shrink a tumor and make it easier to remove
- during surgery to kill cancer cells that may remain in surrounding tissue after the surgery (called intraoperative radiation)
- after surgery to kill cancer cells remaining in the body
- to shrink an inoperable tumor in order to and reduce pain and improve quality of life
- in combination with chemotherapy

For some kinds of cancers such as early-stage Hodgkin's disease, non-Hodgkin's lymphoma, and certain types of prostate, or brain cancer, radiation therapy alone may cure the disease. In other cases, radiation therapy used in conjunction with surgery, chemotherapy, or both, increases survival rates over any of these therapies used alone.

Precautions

Radiation therapy does not make the person having the treatments radioactive. In almost all cases, the benefits of this therapy outweigh the risks. However radiation therapy can have has serious consequences, so anyone contemplating it should be sure understand why the treatment team believes it is the best possible treatment option for their cancer. Radiation therapy is often not appropriate for pregnant women, because the radiation can damage the cells of the developing baby. Women who think they might be pregnant should discuss this with their doctor.

Description

Radiation therapy is a local treatment. It is painless. The radiation acts only on the part of the body that is exposed to the radiation. This is very different from chemotherapy in which drugs circulate throughout the whole body. There are two main types of radiation therapy. In external radiation therapy a beam of radiation is directed from outside the body at the cancer. In internal radiation therapy, called brachytherapy or implant therapy, where a source of radioactivity is surgically placed inside the body near the cancer.

How radiation therapy works

The protein that carries the code controlling most activities in the cell is called deoxyribonucleic acid or DNA. When a cell divides, its DNA must also double and divide. High-energy radiation kills cells by damaging their DNA, thus blocking their ability to grow and increase in number.

One of the characteristics of cancer cells is that they grow and divide faster than normal cells. This makes them particularly vulnerable to radiation. Radiation also damages normal cells, but because normal cells are growing more slowly, they are better able to repair radiation damage than are cancer cells. In order to give normal cells time to heal and reduce side effects, radiation treatments are often given in small doses over a six or seven week period.

External radiation therapy

External radiation therapy is the most common kind of radiation therapy. It is usually done during outpatient visits to a hospital clinic and is usually covered by insurance.

Once a doctor, called a radiation oncologist, determines the proper dose of radiation for a particular cancer, the dose is divided into smaller doses called fractions. One fraction is usually given each day, five days a week for six to seven weeks. However, each radiation plan is individualized depending on the type and location of the cancer and what other treatments are also being used. The actual administration of the therapy usually takes

about half an hour daily, although radiation is administered for only from one to five minutes at each session. It is important to attend every scheduled treatment to get the most benefit from radiation therapy.

Recently, trials have begun to determine if there are ways to deliver radiation fractions so that they kill more cancer cells or have fewer side effects. Some trials use smaller doses given more often. Up-to-date information on voluntary participation in clinical trials and where they are being held is available by entering the search term "radiation therapy" at the following web sites:

- National Cancer Institute. <http://cancertrials.nci.nih.gov> or (800) 4-CANCER.
- National Institutes of Health Clinical Trials. <http://clinicaltrials.gov>.
- Center Watch: A Clinical Trials Listing. <http://www.centerwatch.com>.

The type of machines used to administer external radiation therapy and the material that provides the radiation vary depending on the type and location of the cancer. Generally, the patient puts on a hospital gown and lies down or sits in a special chair. Parts of the body not receiving radiation are covered with special shields that block the rays. A technician then directs a beam of radiation to a pre-determined spot on the body where the cancer is located. The patient must stay still during the administration of the radiation so that no other parts of the body are affected. As an extra precaution in some treatments, special molds are made to make sure the body is in the same position for each treatment. However, the treatment itself is painless, like having a bone x-rayed.

Internal radiation therapy

Internal radiation therapy is called brachytherapy, implant therapy, interstitial radiation, or intracavitary radiation. With internal radiation therapy, a bit of radioactive material is sealed in an implant (sometimes called a seed or capsule). The implant is then placed very close to the cancer. The advantage of internal radiation therapy is that it concentrates the radiation near the cancer and lessens the chance of damage to normal cells. Many different types of radioactive materials can be used in the implant, including cesium, iridium, iodine, phosphorus, and palladium.

How the implant is put near the cancer depends on the size and location of the cancer. Internal radiation therapy is used for some cancers of the head, neck, thyroid, breast, female reproductive system, and prostate. Most people will have the radioactive capsule implanted by a surgeon while under either general or local anesthesia at a hospital or surgical clinic.

Patients receiving internal radiation therapy do become temporarily radioactive. They must remain in the hospital during the time that the implant stays in place. The length of time is determined by the type of cancer and the dose of radioactivity to be delivered. During the time the implant is in place, the patient will have to stay in bed and remain reasonably still.

While the implant is in place, the patient's contact with other people will be limited. Healthcare workers will make their visits as brief as possible to avoid exposure to radiation, and visitors, especially children and pregnant women, will be limited.

The implant usually can be removed in a simple procedure without an anesthetic. As soon as the implant is out of the body, the patient is no longer radioactive, and restrictions on being with other people are lifted. Generally people can return to a level of activity that feels comfortable to them as soon as the implant is removed. Occasionally the site of the implant is sore for some time afterwards. This discomfort may limit specific activities.

In some cases, an implant is left permanently inside the body. People who have permanent implants need to stay in the hospital and away from other people for the first few days. Gradually the radioactivity of the implant decreases, and it is safe to be around other people.

Radioimmunotherapy

Radioimmunotherapy is a promising way to treat cancer that has spread (metastasized) to multiple locations throughout the body. Antibodies are immune system proteins that specifically recognize and bind to only one type of cell. They can be designed to bind only with a certain type of cancer cell. To carry out radioimmunotherapy, antibodies with the ability to bind specifically to a patient's cancer cells are attached to radioactive material and injected into the patient's bloodstream. When these man-made antibodies find a cancer cell, they bind to it. Then the radiation kills the cancer cell. This process is still experimental, but because it can be used to selectively attack only cancer cells, it holds promise for eliminating cancers that have spread beyond the primary tumor.

Radiation used to treat cancer

PHOTON RADIATION. Early radiation therapy used x rays like those used to take pictures of bones,or gamma rays. X rays and gamma rays are high energy rays composed of massless particles of energy (like light) called photons. The distinction between the two is that gamma rays originate from the decay of radioacive substances (like radium and cobalt-60), while x rays are generated by devices that excite electrons (such as cathode ray tubes and linear accelerators). These high energy rays act on

cells by disrupting the electrons of atoms within the molecules inside cells, disrupting cell functions, and most importantly stop their ability to divide and make new cells.

PARTICLE RADIATION. Particle radiation is radiation delivered by particles that have mass. Proton therapy has been used since the early 1990s. Proton rays consist of protons, a type of positively charged atomic particle, rather than photons, which have neither mass nor charge. Like x rays and gamma rays, proton rays disrupt cellular activity. The advantage of using proton rays is that they can be shaped to conform to the irregular shape of the tumor more precisely than x rays and gamma rays. They allow delivery of higher radiation doses to tumors without increasing damage to the surrounding tissue.

Neutron therapy is another type of particle radiation. Neutron rays are very high-energy rays. They are composed of neutrons, which are particles with mass but no charge. The type of damage they cause to cells is much less likely to be repaired than that caused by x rays, gamma rays, or proton rays.

Neutron therapy can treat larger tumors than conventional radiation therapy. Conventional radiation therapy depends on the presence of oxygen to work. The center of large tumors lack sufficient oxygen to be susceptible to damage from conventional radiation. Neutron radiation works in the absence of oxygen, making it especially effective for the treatment of inoperable salivary gland tumors, bone cancers, and some kinds of advanced cancers of the pancreas, bladder, lung, prostate, and uterus.

Preparation

Before radiation therapy, the size and location of the patient's tumor are determined very precisely using magnetic resonance imaging (MRI) and/or computed tomography scans (CT scans). The correct radiation dose, the number of sessions, the interval between sessions, and the method of application are calculated by a radiation oncologist based on the tumor type, its size, and the sensitivity of the nearby tissues.

The patient's skin is be marked with a semi-permanent ink to help the radiation technologist achieve correct positioning for each treatment. Molds may be built to hold tissues in exactly the right place each time.

Aftercare

Many patients experience skin burn, fatigue, nausea, and vomiting after radiation therapy regardless of the where radiation is applied. After treatment, the skin around the site of the treatment may also become sore. Affected skin should be kept clean and can be treated like sunburn, with skin lotion or vitamin A and D ointment. Patients should avoid perfume and scented skin products and protect affected areas from the sun.

Nausea and vomiting are most likely to occur when the radiation dose is high or if the abdomen or another part of the digestive tract is irradiated. Sometimes nausea and vomiting occur after radiation to other regions, but in these cases the symptoms usually disappear within a few hours after treatment. Nausea and vomiting can be treated with antacids, Compazine, Tigan, or Zofran.

Fatigue frequently starts after the second week of therapy and may continue until about two weeks after the therapy is finished. Patients may need to limit their activities, take naps, and get extra sleep at night.

Patients should see their oncologist (cancer doctor) at least once within the first few weeks after their final radiation treatment. They should also see an oncologist every six to twelve months for the rest of their lives so they can be checked to see if the tumor has reappeared or spread.

Risks

Radiation therapy can cause anemia, nausea, vomiting, diarrhea, hair loss, skin burn, sterility, and rarely death. However, the benefits of radiation therapy almost always exceed the risks. Patients should discuss the risks with their doctor and get a second opinion about their treatment plan.

Normal results

The outcome of radiation treatment varies depending on the type, location, and stage of the cancer. For some cancers such as Hodgkin's disease, about 75% of the patients are cured. Prostate cancer also responds well to radiation therapy. Radiation to painful bony metastases is usually a dramatically effective form of pain control. Other cancers may be less sensitive to the benefits of radiation.

Resources

BOOKS

Cukier, Daniel, and Virginia McCullough. *Coping with Radiation Therapy: A Ray of Hope*. Chicago: Contemporary Books, 1996.

McCay, Judith, and Nancee Hirano. *The Chemotherapy & Radiation Therapy Survival Guide*. 2nd ed. Oakland: New Harbinger Publications, 1998.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd. NE, Atlanta GA 30329-4251. (800) ACS-2345. <http://www.cancer.org>.

National Association for Proton Therapy. 7910 Woodmont Ave., Suite 1303, Bethesda, MD 20814. (301) 913-9360. <http://www.proton-therapy.org/Default.htm.>.

KEY TERMS

Anemia—Insufficient red blood cells in the body.

Antibody—Protein molecule that recognizes and binds specifically to a foreign substance in the body in order to eliminate it.

Chemotherapy—Injecting drugs into the body where they circulate and kill cancer cells.

Computed tomography (CT or CAT) scan—Using x rays taken from many angles and computer modeling, CT scans help locate and size tumors and provide information on whether they can be surgically removed.

Fractionation—A procedure for dividing a dose of radiation into smaller treatment doses.

Gamma rays—Short wavelength, high energy electromagnetic radiation emitted by radioactive substances.

Hodgkin's disease—Cancer of the lymphatic system, characterized by lymph node enlargement and the presence of a large polyploid cells called Reed-Sternberg cells.

Magnetic resonance imaging (MRI)—MRI uses magnets and radio waves to create detailed cross-sectional pictures of the interior of the body.

OTHER

Radiation Therapy and You. A Guide to Self-Help During Treatment. National Cancer Institute CancerNet Information Service. <http://cancernet.nci.nih.gov>.

Lorraine Lica

Radiation treatments *see* **Radiation therapy**

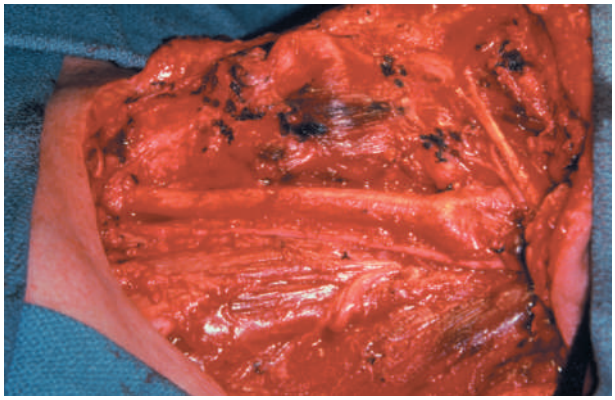
Radical neck dissection

Definition

Radical neck dissection is an operation used to remove cancerous tissue in the head and neck.

Purpose

The purpose of radical neck dissection is to remove lymph nodes and other structures in the head and neck that are likely or proven to be malignant. Variations on neck dissections exist depending on the extent of the **cancer**. A radical neck dissection removes the most tissue. It is done when the cancer has spread widely in the neck. A modified neck dissection removes less tissue, and a selective neck dissection even less.



A specimen taken from radical neck surgery. *(Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

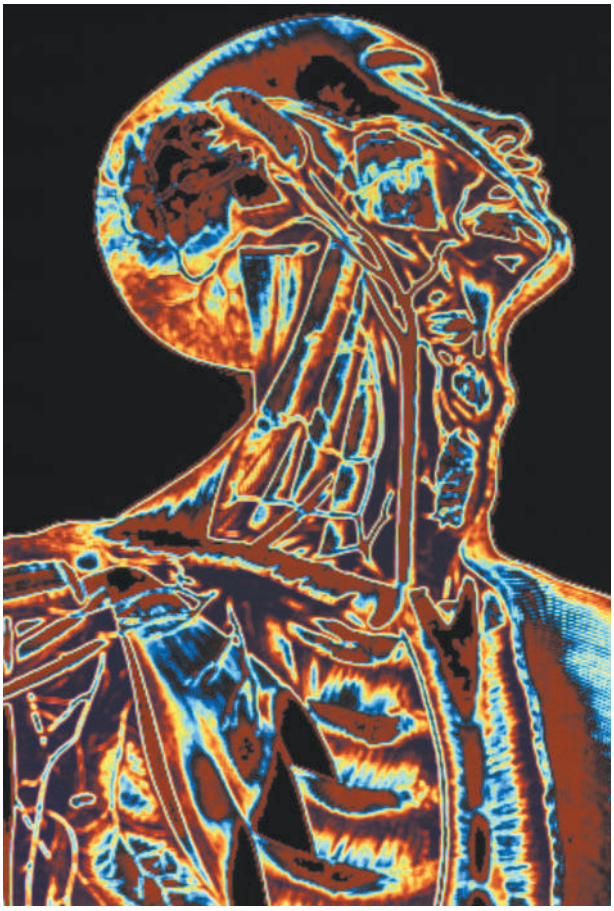
This operation should not be done if cancer has metastasized (spread) beyond the head and neck, or if the cancer has invaded the bones of the cervical vertebrae (the first seven vertebrae of the spinal column) or the skull. In these cases, the surgery will not effectively contain the cancer.

Description

Cancers of the head and neck (sometimes inaccurately called throat cancer) often spread to nearby tissues and into the lymph nodes. Removing these structures is one way of controlling the cancer.

Of the 600 lymph nodes in the body, about 200 are in the neck. Only a small number of these are removed during a neck dissection. In addition, other structures such as muscles, veins, and nerves may be removed during a radical neck dissection. These include the sternocleidomastoid muscle (one of the muscles that functions to flex the head), internal jugular (neck) vein, submandibular gland (one of the salivary glands), and the spinal accessory nerve (a nerve that helps control speech, swallowing and certain movements of the head and neck). The goal is always to remove all the cancer but to save as many components surrounding the nodes as possible.

Radical neck dissections are done in a hospital under general anesthesia by a head and neck surgeon. An incision is made in the neck, and the skin is pulled back to reveal the muscles and lymph nodes. The surgeon is guid-



A digitized illustration of the human head and chest showing nasal passages, sinuses, trachea, vascular nerves, as well as ribs and parts of the lungs. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Barium swallow—Barium is used to coat the throat in order to take x-ray pictures of the tissues lining the throat.

Computed tomography (CT or CAT) scan—Using x rays taken from many angles and computer modeling, CT scans help size and locate tumors and provide information on whether they can be surgically removed.

Lymphatic system—Primary defense against infection in the body. The tissues, organs, and channels (similar to veins) that produce, store, and transport lymph and white blood cells to fight infection.

Lymph nodes—Small, bean-shaped collections of tissue found in lymph vessels. They produce cells and proteins that fight infection and filter lymph. Nodes are sometimes called lymph glands.

Malignant—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

Metastasize—Spread of cells from the original site of the cancer to other parts of the body where secondary tumors are formed.

Magnetic resonance imaging (MRI)—MRI uses magnets and radio waves to create detailed cross-sectional pictures of the interior of the body.

ed in what to remove by tests done prior to surgery and by examination of the size and texture of the lymph nodes.

Preparation

Radical neck dissection is a major operation. Extensive tests are done before the operation to try to determine where and how far the cancer has spread. These may include lymph node biopsies, CT (computed tomography) scans, MRI scans, and barium swallows. In addition, standard preoperative blood and **liver function tests** are performed, and the patient will meet with an anesthesiologist before the operation. The patient should tell the anesthesiologist about all drug **allergies** and all medication (prescription, non-prescription, or herbal) that he or she is taking.

Aftercare

A person who has had a radical neck dissection will stay in the hospital several days after the operation, and sometimes longer if surgery to remove the primary tumor was done at the same time. Drains are inserted under the skin to remove the fluid that accumulates in the neck area. Once the drains are removed and the incision appears to be healing well, patients are usually discharged from the hospital, but will require follow-up doctor visits. Depending on how many structures are removed, a person who has had a radical neck dissection may require physical therapy to regain use of the arm and shoulder.

Risks

The greatest risk in a radical neck dissection is damage to the nerves, muscles, and veins in the neck. Nerve damage can result in numbness (either temporary or permanent) to different regions on the neck and loss of function (temporary or permanent) to parts of the neck, throat, and shoulder. The more extensive the neck dissection, the more function the patient is likely to lose. As a result, it is common following radical neck dissection for a person to have stooped shoulders, limited ability to lift

the arm, and limited head and neck rotation and flexion due to the removal of nerves and muscles. Other risks are the same as for all major surgery: potential bleeding, infection, and allergic reaction to anesthesia.

Normal results

Normal lymph nodes are small and show no cancerous cells under the microscope.

Abnormal results

Abnormal lymph nodes may be enlarged and show malignant cells when examined under the microscope.

Resources

ORGANIZATIONS

American Cancer Society. National Headquarters, 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS-2345. <http://www.cancer.org>.

Cancer Information Service. National Cancer Institute, Building 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800) 4-CANCER. <http://www.nci.nih.gov/cancerinfo/index.html>.

OTHER

The Voice Center at Eastern Virginia Medical School. (February 17, 2001). <http://www.voice-center.com>. (June 7, 2001).

John Thomas Lohr
Tish Davidson, A.M.

Radioactive implants

Definition

Radioactive implants are devices that are placed directly within cancerous tissue or tumors, in order to deliver **radiation therapy** intended to kill cancerous cells.

Purpose

With the use of radioactive implants, the tumor is subjected to radioactive activity over a longer period of time, as compared to external beam therapy.

Precautions

The patient is required to remain in his bed or room during the treatment. During the period of greatest radioactivity (24–72 hours), health care providers will limit the amount of time spent with the patient to that required for essential care.

Description

Interstitial radiation therapy places the sources of radiation directly into the tumor and surrounding structures. Most commonly used in tumors of the head, neck, prostate, and breast, it may also be used in combination with external radiation therapy. The implant may be permanent or removable. A permanent implant of radioactive seeds, such as gold or iodine, is placed directly into the organ. Over several weeks or months, the seeds slowly deliver radiation to the tumor. More commonly used is the removable implant that requires an operation under general anesthesia to place narrow, hollow stainless steel needles through the tumor. Teflon tubes are inserted through the needles, and the needles are then removed. After the patient returns to his room, radioactive seeds are inserted into the tubes in a procedure called afterloading. Once the desired dosage is reached, the tubes and seeds are removed.

Intracavity radiation is often used for gynecologic cancers. Under general or spinal anesthesia, hollow applicators are placed directly inside the affected organ. Correct positioning is confirmed by x rays, and once the patient has returned to her room, a small plastic tube containing the radioactive isotope is inserted into the hollow applicator. The treatment is delivered over 48–72 hours, after which time the applicator and radioactive sources are removed. Very high doses of radiation can be delivered to the tumor, while the rapid removal of the radioactive dose limits damage to the surrounding structures.

Abnormal results

Normal cells are subjected to the effects of radiation; any tissue near the radiation site may be damaged or destroyed. Some side effects are acute and temporary, while others develop over time and may be permanent. Skin reactions, such as redness, **itching**, flaking, or stripping of the top layer, are usually temporary; long-term effects can include scarring, and changes in texture. Radiation recall is a delayed skin side effect in which the area that had been exposed to radiation becomes irritated or blistered after the patient receives certain **chemotherapy**.

Following treatment for tumors of the head and neck region, the lining of the mouth and throat can become inflamed or irritated, resulting in a condition known as mucositis or **stomatitis**. Injury to the salivary glands can decrease saliva production, resulting in a condition known as xerostomia, or **dry mouth**. There also may be alteration in the patient's taste buds, resulting in decrease or loss of taste sensation (hypogeusia or ageusia), or the presence of unpleasant taste, sometimes described as metallic (dysgeusia). Patients may experience **nausea**

KEY TERMS

Ageusia—The loss of taste perception.

Alopecia—The loss of hair, or baldness.

Dysgeusia—Unpleasant alteration of taste sensation, often with a metallic taste.

Hypogeusia—Diminshed taste perception.

and vomiting as a result of the effect of radiation on the brain. Hair loss (**alopecia**) may result from radiation's effect on hair follicles.

Radiation's effect on the rapidly growing cells of the gastrointestinal tract may result in **diarrhea** or abdominal cramping. Pelvic radiation can affect the bowel, bladder, or sexual function. Radiation can also affect production of blood cell components in the bone marrow.

Resources

BOOKS

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Monahan, Frances. *Medical-Surgical Nursing.* Philadelphia: W. B. Saunders Co., 1998.

Suddarth, Doris. *The Lippincott Manual of Nursing Practice.* Philadelphia: J. B. Lippincott, 1991.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Kathleen D. Wright, RN

Radioactive iodine uptake test *see* **Thyroid nuclear medicine scan**

Radioallergosorbent test (RAST) *see* **Allergy tests**

Radiotherapy *see* **Radiation therapy**

Ramipril *see* **Angiotensin-converting enzyme inhibitors**

Radiotherapy *see* **Radiation therapy**

Range-of-motion exercises *see* **Exercise**

Ranitidine *see* **Antiulcer drugs**

Rape and sexual assault

Definition

The various definitions of rape range from the broad (coercing an individual to engage in any sexual act) to the specific (forcing a woman to submit to sexual intercourse). The United States Code includes the crime of rape under the more comprehensive term "sexual abuse." Two types of sexual assault are defined in the code: sexual abuse and aggravated sexual abuse. Sexual abuse includes acts in which an individual is forced to engage in sexual activity by use of threats or other fear tactics, or instances in which an individual is physically unable to decline. Aggravated sexual abuse occurs when an individual is forced to submit to sexual acts by use of physical force; threats of **death**, injury, or kidnapping; or substances that render that individual unconscious or impaired.

Description

Many misconceptions exist about rape and sexual assault. It is often assumed that rape victims are all women who have been attacked by a total stranger and forced into having sexual intercourse. In reality, sexual assault can take many forms—it may be violent or nonviolent; the victim may be male or female, child or adult; the offender may be a stranger, relative, friend, authority figure, or spouse.

The number of sexual assaults reported depends on how those abuses are defined. The United States Code uses two terms to distinguish between different sexual activities:

- Sexual act: contact between penis and vagina or penis and anus that involves penetration; contact between the mouth and genitals or anus; penetration of the vagina or anus with an object; or direct touching (not through clothing) of the genitals of an individual under the age of 16.
- Sexual contact: intentional touching of the genitals, breasts, buttocks, anus, inner thigh, or groin with no sexual penetration.

National statistics

There were 89,167 forcible rapes reported to U.S. law enforcement agencies in 1999. Sixty-four out of every 100,000 women were reported to be victims of rape that year, down 5% from 1998 and 11% from 1995. The actual number of rapes and sexual assaults, however, is in reality much larger. The National Violence Against Women Survey, jointly sponsored by the Centers for Disease Control and Prevention (CDC) and the National

Institute of Justice (NIJ) and conducted in the mid-1900s, found that one in six women (18%) and one in 33 men (3%) has experienced an attempted or completed rape. The survey estimated that approximately 17,722,672 women and 2,782,440 men in the United States have been raped or have had rape attempted as a child or adult, and that 302,091 women and 92,748 men were raped in the 12 months prior to the study.

There are numerous reasons why the majority of sexual assaults are never reported. Often the victim fears retaliation from the offender. He or she may be afraid of family, friends, the community, or the media learning about the offense. There may be a concern about being judged or blamed by others. The victim may think that no one will believe the assault occurred.

THE VICTIMS. The 2000 "Victim, Incident, and Offender Characteristics," published by the National Center for Juvenile Justice (NCJJ), analyzed sexual assault data collected by law enforcement agencies over a five-year span. The following characteristics were found to be significant among victims of sexual assault:

- Age: Over two-thirds of reported victims of sexual assault were juveniles under the age of 18. Twelve to 18 year olds represented the largest group of victims at 33%; 20% were between the ages of six and 11; children less than five years old and adults between 18 and 24 years of age each constituted 14% of victims; 12% were between the ages of 25 and 34; and 7% were over the age of 34. Persons over the age of 54 represented 1% of all victims. One out of every seven victims surveyed in the study were under the age of six.
- Gender: Females were more than six times more likely to be a victim of sexual assault then males; more than 86% of victims were females. The great majority (99%) of the victims of forcible rapes were women, while men constituted the majority (54%) of the victims of forcible sodomy (oral or anal intercourse). Females are most likely to be the victim of sexual assault at age 14, while males are at most risk at age four.
- Location: The residence of the victim was the most commonly noted location of sexual assault (70%). Other common locations included schools, hotels/motels, fields, woods, parking lots, roadways, and commercial/office buildings.
- Weapons: A personal weapon (hands, feet, or fists) was used in 77% of cases. No weapon was noted in 14% of assaults; other weapons (knifes, clubs, etc.) were used in 6% of cases. Firearms were involved in only 2% of assaults.

THE OFFENDERS. Similar statistics were gathered by the NCJJ regarding the perpetrators of rape and sexual assault. These characteristics included:

- Age: Over 23% of offenders were under the age of 18; juveniles were more likely to be perpetrators of forcible sodomy and fondling. The remaining 77% of offenders were adults and were responsible for 67% of juvenile victims. For younger juvenile victims (under the age of 12), juvenile offenders were responsible for approximately 40% of assaults.
- Gender: The great majority of all reported offenders were male (96%). The number of female offenders rose for victims under the age of six (12%), in contrast to 6% for victims aged six through 12, 3% for victims aged 12 through 17, and 1% for adult victims.
- Relationship with offender: Approximately 59% of offenders were acquaintances of their victims, compared to family members (27%) or strangers (14%). Family members were more likely to be perpetrators against juveniles (34%) than against adults (12%). In contrast, strangers accounted for 27% of adult victims and 7% of juveniles.
- Past offenses: In 19% of juvenile cases, the victim was not the only individual to be assaulted by the offender, compared to only 4% of adult cases.

Consequences

Victims of sexual assault may sustain a range of injuries. The National Women's Study, funded by the National Institute of Drug Abuse, found that more than 70% of rape victims report no physical injuries as a result of their assault; only 4% sustain serious injuries that require hospitalization. At least 49% of victims, however, state that they feared severe injuries or death during their assault. Fatalities occur in approximately 0.1% of rape cases.

Sexually transmitted diseases (STDs) are a source of concern for many victims of sexual assault. The most commonly transmitted diseases are **gonorrhea** (caused by *Neisseria gonorrhoeae)*, chlamydia (caused by *Chlamydia trachomatis)*, **trichomoniasis** (caused by *Trichomonas vaginalis)*, and **genital warts** (caused by human papillomavirus). **Syphilis** (caused by *Treponema pallidum)* and human **immunodeficiency** virus (HIV) are also noted among some sexual assault victims. The transmission rate of STDs is estimated to be between 3.6% and 30% of rapes.

According to the National Women's Study, approximately 5% of adult female rape victims become pregnant as a result of their assault, leading to 32,100 pregnancies a year among women 18 years of age or older. Approxi-

mately 50% of pregnant rape victims had an abortion, 6% put the child up for adoption, and 33% kept the child (the remaining pregnancies resulted in **miscarriage**).

MENTAL HEALTH PROBLEMS. Also known as rape trauma syndrome, **post-traumatic stress disorder** (PTSD) is a mental health disorder that describes a range of symptoms often experienced by someone who has undergone a severely traumatic event. Approximately 31% of rape victims develop PTSD as a result of their assault; victims are more than six times more likely to develop PTSD than women who have not been victimized.

The symptoms of PTSD include:

- recurrent memories or flashbacks of the incident
- nightmares
- insomnia
- mood swings
- difficulty concentrating
- panic attacks
- emotional numbness
- depression
- **anxiety**

Individuals who have been sexually assaulted have also been noted to have increased risk for developing other mental health problems. Over those who have not been victimized, rape victims are:

- three times more likely to have a major depressive episode
- four times more likely to have contemplated suicide
- thirteen times more likely to develop alcohol dependency problems
- twenty-six times more likely to develop drug abuse problems

Treatment

Once a victim of sexual assault reports the crime to local authorities, calls a rape crisis hotline, or arrives at the emergency room to be treated for injuries, a multidisciplinary team is often formed to address his or her physical, psychological, and judicial needs. This team usually includes law enforcement officers, physicians, nurses, mental health professionals, victim advocates, and/or prosecutors.

The victim of sexual assault may continue to feel fear and anxiety for some time after the incident, and in some instances this may significantly impact his or her personal or professional life. Follow-up counseling should therefore be provided for the victim, particularly if symptoms of PTSD become evident.

What To Do If You Are Raped

Don't bathe.
Don't blame yourself.
Retain all evidence.
Get examined.
Consider the "morning-after" pill.

Forensic medical examination

The forensic medical examination is an invaluable tool for collecting evidence against a perpetrator. Since the great majority of victims know their assailant, the purpose of the medical examination is often not to establish identity but to establish nonconsensual sexual contact. The Sexual Assault Nurse Examiner program is an effective model that is used in many United States hospitals and clinics to collect and document evidence, evaluate and treat for STDs and **pregnancy**, and refer victims to follow-up medical care and counseling. The "Sexual Assault Nurse Examiner Development and Operation Guide," prepared by the Sexual Assault Resource Service, describes the ideal protocol for collecting evidence from a sexual assault victim. This includes:

- performing the medical examination within 72 hours of the assault
- taking a history of the assault
- documenting the general health of the victim, including menstrual cycle, potential **allergies**, and pregnancy status
- assessment for trauma and taking photographic evidence of injuries
- taking fingernail clippings or scrapings
- taking samples for sperm or seminal fluid
- combing head/pubic hair for foreign hairs, fibers, and other substances
- collection of bloody, torn, or stained clothing
- taking samples for blood typing and DNA screening

Prevention

STD Prevention

While the concern of sexual assault victims of contracting an STD is often high, the actual risk of transmission is relatively low; the CDC estimates that the risk of contracting gonorrhea from an offender is between 6% and 12%, chlamydia between 4% and 17%, syphilis between 0.5% and 3%, and HIV less than 1%. Nonetheless, post-exposure **prophylaxis** (preventative treatment)

Common Misconceptions Of Males Perpetrating Date Rape

Since I took her out and paid for the date, she should have sex with me.
When she says no, she really means yes.
If she's aroused, she wants to have sex.
She wouldn't go parking with me if she didn't want to have sex.
If she didn't want to have sex, why did she let me go as far as she did?
If she gets me erect, then it's her responsibility to do something about it.
She's slept with other people, so she should sleep with me.
We've had sex before, and she didn't say no then.

against certain STDs is often provided for the victim. Treatment with zidovudine, for example, is recommended for individuals who are at a high risk of exposure to HIV. The CDC recommends the following prophylactic regimen be provided for victims of sexual assaults in which vaginal, oral, or anal penetration took place:

- a single dose of ceftriaxone, an antibiotic effective against *Neisseria gonorrhoeae*
- a single dose of metronidazole, an antibiotic effective against *Trichomonas vaginalis*
- a single dose of azithromycin or doxycycline, **antibiotics** effective against *Chlamydia trachomatis*
- inoculation with the post-exposure **hepatitis B** vaccine

In some instances, cultures may be taken during the medical examination and at time points afterward to test for gonorrhea or chlamydia. It is important that the victim receive information regarding the symptoms of STDs and be counseled to return for further examination if any of these symptoms occur.

Pregnancy prevention

Female victims at risk for becoming pregnant after an assault should be counseled on the availability of emergency **contraception**. According to the Food and Drug Administration (FDA), emergency contraception is not effective if there is no pregnancy but works to prevent pregnancy from occurring by delaying or preventing ovulation, by affecting the transport of sperm, and/or by thinning the inner layer of the uterus (endometrium) so that implantation is prevented. It is therefore not a form of abortion.

A number of options are available for women if they choose to use emergency contraceptives to prevent pregnancy following a sexual assault. The Yupze regimen uses two oral contraceptive pills that contain both of the hormones estrogen and progestin. The risk of pregnancy is reduced by 75% after use of the Yupze regimen, reducing the average number of pregnancies after unprotected sex from eight in 100 to two in 100. Progestin-only **oral contraceptives** are also available and reduce the risk of pregnancy by 89% to 95%.

KEY TERMS

Aggravated sexual abuse—When an individual is forced to submit to sexual acts by use of physical force; threats of death, injury, or kidnapping; or substances that render that individual unconscious or impaired.

Forcible sodomy—Forced oral or anal intercourse.

Post-traumatic stress disorder (PTSD)—Also known as rape trauma syndrome; a mental health disorder that describes a range of symptoms often experienced by someone who has undergone a severely traumatic event.

Sexual abuse—When an individual is forced to engage in sexual activity by use of threats or other fear tactics, or instances in which an individual is physically unable to decline.

Sexual assault nurse examiner (SANE)—A registered nurse who is trained to collect and document evidence from a sexual assault victim, evaluate and treat for STDs and pregnancy, and refer victims to follow-up medical care and counseling.

Yupze regimen—A form of emergency contraception in which two oral contraceptive pills that contain both of the hormones estrogen and progestin are taken to prevent pregnancy.

Resources

PERIODICALS

Hampton, HL. "Care of the Woman Who Has Been Raped." *New England Journal of Medicine*. 332 (26 January 1995): 234-237.

Reynolds, Matthew W., Jeffery Peipert, and Beverly Collins. "Epidemiologic Issues of Sexually Transmitted Diseases in Sexual Assault Victims." *Obstetrical and Gynecological Survey* 55 (January 2000): 51-57.

ORGANIZATIONS

Rape, Abuse, and Incest National Network. 635-B Pennsylvania Ave. SE, Washington, DC 20003. (800) 656-HOPE.

U.S. Department of Justice, Office for Victims of Crime. 810 7th Street NW, Washington, DC 20531.

OTHER

Kilpatrick, Dean G., Anna Whalley, and Christine Edmunds. "Sexual Assault." In *2000 National Victim Assistance Academy Textbook*, edited by Anne Seymour, Morna Mur-

ray, Jane Sigmon, Christine Edmunds, Mario Gaboury, and Grace Coleman. October 2000.
Ledray, Linda E. "Sexual Assault Nurse Examiner Development and Operation Guide." *Sexual Assault Resource Service*. August 1999.
"National Crime Victim's Rights Week: Resource Guide." *U.S. Department of Justice, Office for Victims of Crime*. April 2001.
"Rape Fact Sheet: Prevalence and Incidence." *Centers for Disease Control and Prevention*. 10 February 2000.
Snyder, Howard N. "Sexual Assault of Young Children as Reported to Law Enforcement: Victim, Incident, and Offender Characteristics." *National Center for Juvenile Justice*. July 2000.
Tjaden, Patricia and Nancy Thoennes. "Prevalence, Incidence, and Consequences of Violence Against Women: Findings from the National Violence Against Women Survey." *National Institute of Justice/Centers for Disease Control and Prevention Research in Brief*. November 1998.

Stéphanie Islane Dionne

Rashes

Definition

The popular term for a group of spots or red, inflamed skin that is usually a symptom of an underlying condition or disorder. Often temporary, a rash is only rarely a sign of a serious problem.

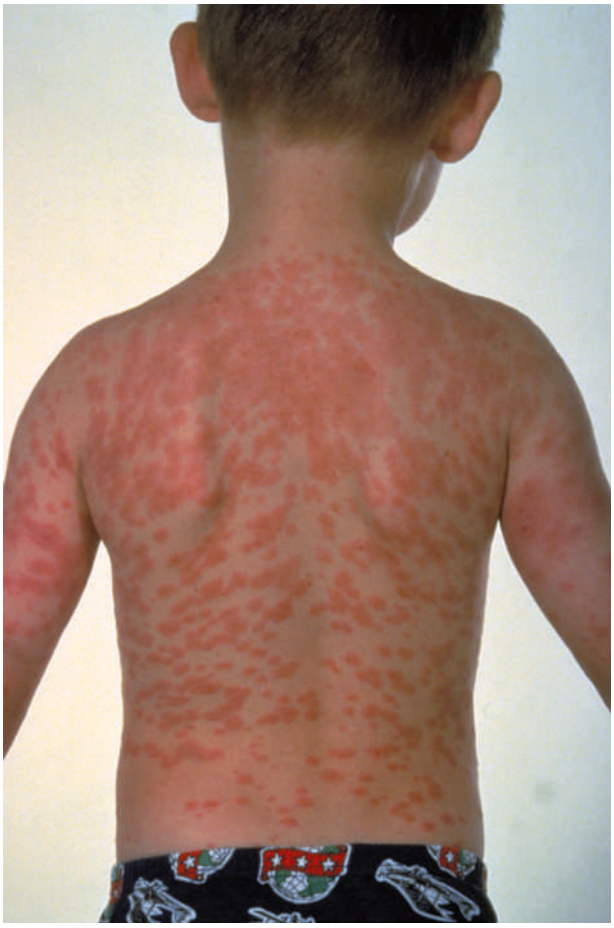
Description

A rash may occur on only one area of the skin, or it could cover almost all of the body. Also, a rash may or may not be itchy. Depending on how it looks, a rash may be described as:

- blistering (raised oval or round collections of fluid within or beneath the outer layer of skin)
- macular (flat spots)
- nodular (small, firm, knotty rounded mass)
- papular (small solid slightly raised areas)
- pustular (pus-containing skin blister)

Causes and symptoms

There are many theories as to the development of skin rashes, but experts are not completely clear what causes some of them. Generally a skin rash is an intermittent symptom, fading and reappearing. Rashes may accompany a range of disorders and conditions, such as:



An unidentified rash on young boy's back. *(Custom Medical Stock Photo. Reproduced by permission.)*

- Infectious illness. A rash is symptom of many different kinds of childhood infectious illnesses, including **chickenpox** and **scarlet fever**. It may be triggered by other infections, such as **Rocky Mountain spotted fever** or **ringworm**.
- Allergic reactions. One of the most common symptoms of an allergic reaction is an itchy rash. **Contact dermatitis** is a rash that appears after the skin is exposed to an allergen, such as metal, rubber, some cosmetics or lotions, or some types of plants (e.g. poison ivy). Drug reactions are another common allergic cause of rash; in this case, a rash is only one of a variety of possible symptoms, including **fever**, seizures, **nausea and vomiting**, **diarrhea**, heartbeat irregularities, and breathing problems. This rash usually appears soon after the first dose of the course of medicine is taken.
- **Autoimmune disorders**. Conditions in which the immune system turns on the body itself, such as **systemic lupus erythematosus** or purpura, often have a characteristic rash.

- Nutritional disorders. For example, **scurvy**, a disease caused by a lack of Vitamin C, has a rash as one of its symptoms.
- **Cancer**. A few types of cancer, such as chronic lymphocytic leukemia, can be the underlying cause of a rash.

Rashes in infancy

Rashes are extremely common in infancy, and are usually not serious at all and can be treated at home.

Diaper rash is caused by prolonged skin contact with bacteria and the baby's waste products in a damp diaper. This rash has red, spotty sores and there may be an ammonia smell. In most cases the rash will respond within three days to drying efforts. A diaper rash that does not improve in this time may be a yeast infection requiring prescription medication. A doctor should be consulted if the rash is solid, bright red, causes fever, or the skin develops blisters, **boils**, or pus.

Infants also can get a rash on cheeks and chin caused by contact with food and stomach contents. This rash will come and go, but usually responds to a good cleaning after meals. About a third of all infants develop "acne" usually after the third week of life in response to their mothers' hormones before birth. This rash will disappear between weeks and a few months. Heat rash is a mass of tiny pink bumps on the back of the neck and upper back caused by blocked sweat glands. The rash usually appears during hot, humid weather, although a baby with a fever can also develop the rash.

A baby should see a doctor immediately if the rash:

- appears suddenly and looks purple or blood-colored
- looks like a burn
- appears while the infant seems to be sick

Diagnosis

A physician can make a diagnosis based on the medical history and the appearance of the rash, where it appears, and any other accompanying symptoms.

Treatment

Treatment of rashes focuses on resolving the underlying disorder and providing relief of the **itching** that often accompanies them. Soothing lotions or oral **antihistamines** can provide some relief, and topical **antibiotics** may be administered if the patient, particularly a child, has caused a secondary infection by scratching. The rash triggered by **allergies** should disappear as soon as the allergen is removed; drug rashes will fade when the patient stops taking the drug causing the allergy. For the treatment of diaper rash, the infant's skin should be exposed to the air as much as possible; ointments are not needed unless the skin is dry and cracked. Experts also recommend switching to cloth diapers and cleaning affected skin with plain water.

KEY TERMS

Purpura—A group of disorders characterized by purple or red brown areas of discoloration visible through the skin.

Scurvy—A nutritional disorder that causes skin bruising and hemorrhages.

Prognosis

Most rashes that have an acute cause, such as an infection or an allergic reaction, will disappear as soon as the infection or irritant is removed from the body's system. Rashes that are caused by chronic conditions, such as autoimmune disorders, may remain indefinitely or fade and return periodically.

Prevention

Some rashes can be prevented, depending on the triggering factor. A person known to be allergic to certain drugs or substances should avoid those things in order to prevent a rash. Diaper rash can be prevented by using cloth diapers and keeping the diaper area very clean, breast feeding, and changing diapers often.

Resources

BOOKS

Orkin, Milton, et al. *Dermatology.* Norwalk, CT: Appleton & Lange, 1991.

PERIODICALS

Pellman, Harry. "A Rash Pot Pourri." *Pediatrics for Parents* 16 (1 Nov. 1995): 4-5.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

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Rat-bite fever

Definition

Rat-bite **fever** refers to an infection which develops after having been bitten or scratched by an infected animal.

Description

Rat-bite fever occurs most often among laboratory workers who handle lab rats in their jobs, and among people who live in poor conditions, with rodent infestation. Children are particularly likely to be bitten by rodents infesting their home, and are therefore most likely to contract rat-bite fever. Other animals that can carry the types of bacteria responsible for this illness include mice, squirrels, weasels, dogs, and cats. One of the causative bacteria can cause the same illness if it is ingested, for example in unpasteurized milk.

Causes and symptoms

There are two variations of rat-bite fever, caused by two different organisms. In the United States, the bacteria *Streptobacillus moniliformis* is the most common cause (causing streptobacillary rat-bite fever). In other countries, especially Africa, *Spirillum minus* causes a different form of the infection (called spirillary rat-bite fever).

Streptobacillary rat-bite fever occurs up to 22 days after the initial bite or scratch. The patient becomes ill with fever, chills, **nausea and vomiting**, **headache**, and **pain** in the back and joints. A rash made up of tiny pink bumps develops, covering the palms of the hands and the soles of the feet. Without treatment, the patient is at risk of developing serious infections of the lining of the heart (**endocarditis**), the sac containing the heart (**pericarditis**), the coverings of the brain and spinal cord (**meningitis**), or lungs (**pneumonia**). Any tissue or organ throughout the body may develop a pocket of infection and pus, called an **abscess**.

Spirillary rat-bite fever occurs some time after the initial injury has already healed, up to about 28 days after the bite or scratch. Although the wound had appeared completely healed, it suddenly grows red and swollen again. The patient develops a fever. Lymph nodes in the area become swollen and tender, and the patient suffers from fever, chills, and headache. The skin in the area of the original wound sloughs off. Although rash is less common than with streptobacillary rat-bite fever, there may be a lightly rosy, itchy rash all over the body. Joint and muscle pain rarely occur. If left untreated, the fever usually subsides, only to return again in repeated two- to four-day cycles. This can go on for up to a year, although, even without treatment, the illness usually resolves within four to eight weeks.

Diagnosis

In streptobacillary rat-bite fever, found in the United States, diagnosis can be made by taking a sample of blood or fluid from a painful joint. In a laboratory, the sample can be cultured, to allow the growth of organisms. Examination under a microscope will then allow identification of the bacteria *Streptobacillus moniliformis*.

In spirillary rat-bite fever, diagnosis can be made by examining blood or a sample of tissue from the wound for evidence of *Spirillum minus*.

KEY TERMS

Abscess—A pocket of infection; a collection of pus.

Endocarditis—An inflammation of the lining of the heart.

Meningitis—An inflammation of the tissues covering the brain and spinal cord.

Pasteurization—A process during which milk is heated up and maintained at a particular temperature long enough to kill bacteria.

Pericarditis—An inflammation of the sac containing the heart.

Treatment

Shots of procaine penicillin G or penicillin V by mouth are effective against both streptobacillary and spirillary rat-bite fever. When a patient is allergic to the **penicillins**, erythromycin may be given by mouth for streptobacillary infection, or tetracycline by mouth for spirillary infection.

Prognosis

With treatment, prognosis is excellent for both types of rat-bite fever. Without treatment, the spirillary form usually resolves on its own, although it may take up to a year to do so.

The streptobacillary form, found in the United States, however, can progress to cause extremely serious, potentially fatal complications. In fact, before **antibiotics** were available to treat the infection, streptobacillary rat-bite fever frequently resulted in **death**.

Prevention

Prevention involves avoiding contact with those animals capable of passing on the causative organisms. This can be an unfortunately difficult task for people whose economic situations do not allow them to move out of rat-infested buildings. Because streptobacillary rat-bite fever can occur after drinking contaminated milk or

water, only pasteurized milk, and water from safe sources, should be ingested.

Resources

BOOKS

Madoff, Lawrence C. "Infections from Bites, Scratches, and Burns." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Sherris Medical Microbiology: An Introduction to Infectious Diseases. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

"Rat-Bite Fever: New Mexico, 1996." *Journal of the American Medical Association* 279, no. 10 (11 Mar. 1998): 740+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Rational-emotive therapy *see* **Cognitive-behavioral therapy**

Raynaud's disease

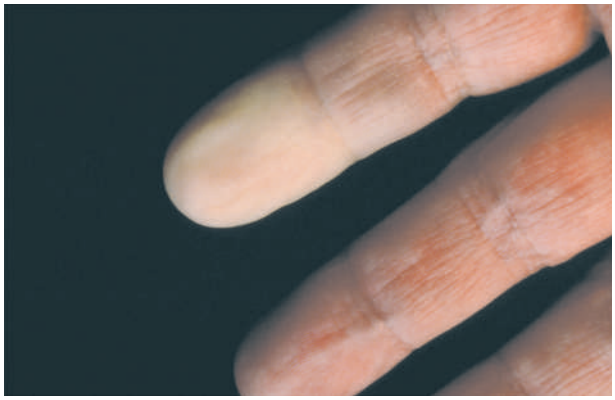
Definition

Raynaud's disease refers to a disorder in which the fingers or toes (digits) suddenly experience decreased blood circulation. It is characterized by repeated episodes of color changes of the skin of digits on cold exposure or emotional **stress**.

Description

Raynaud's disease can be classified as one of two types: primary (or idiopathic) and secondary (also called Raynaud's phenomenon). Primary Raynaud's disease has no predisposing factor, is more mild, and causes fewer complications. About half of all cases of Raynaud's disease are of this type. Women are five times more likely than men to develop primary Raynaud's disease. The average age of diagnosis is between 20 and 40 years. Approximately three out of ten people with primary Raynaud's disease eventually progress to secondary Raynaud's disease after diagnosis. About 15% of individuals improve.

Secondary Raynaud's disease is the same as primary Raynaud's disease, but occurs in individuals with a predisposing factor, usually a form of collagen vascular disease. What is typically identified as primary Raynaud's is later identified as secondary once a predisposing disease is diagnosed. This occurs in approximately 30% of patients. As a result, the secondary type is often more complicated and severe, and is more likely to worsen.



A close-up view of a patient's fingers afflicted with Raynaud's disease. While this disorder may initially only affect the tips of the fingers and toes, eventually blood circulation of the entire finger or toe is affected. *(Custom Medical Stock Photo. Reproduced by permission.)*

Several related conditions that predispose persons to secondary Raynaud's disease include **scleroderma**, **systemetic lupus erythematosus**, **rheumatoid arthritis** and **polymyositis**. **Pulmonary hypertension** and some nervous system disorders such as herniated discs and tumors within the spinal column, strokes, and **polio** can progress to Raynaud's disease. Finally, injuries due to mechanical trauma caused by vibration (such as that associated with chain saws and jackhammers), repetitive motion (**carpal tunnel syndrome**), electrical shock, and exposure to extreme cold can led to the development of Raynaud's disease. Some drugs used to control high blood pressure or migraine headaches have been known to cause Raynaud's disease.

The prevalence of Reynaud's Phenomena in the general population varies from 4–15%. Females are seven times more likely to develop Raynaud's diseases than are men. The problem has not been correlated with coffee consumption, dietary habits, occupational history (excepting exposure to vibration) and exposure to most drugs. An association between Raynaud's disease and migraine headaches and has been reported. Secondary Raynaud's disease is common among individuals with systemic lupus erythematosus in tropical countries.

Causes and symptoms

There is significant familial aggregation of primary Raynaud's disease. However, as of 2001, no causative gene has been identified.

Risk factors for Raynaud's disease differ between males and females. Age and **smoking** seem to be associated with Raynaud's disease only in men, while the associations of marital status and alcohol use with Raynaud's disease are usually only observed in women. These findings suggest that different mechanisms influence the expression of Raynaud's disease in men and women.

Both primary and secondary Raynaud's disease signs and symptoms are thought to be due to arterioles over-reacting to stimuli. Cold normally causes the tiny muscles in the walls of arteries to contract, thus reducing the amount of blood that can flow through them. In people with Raynaud's disease, the extent of constriction is extreme, thus severely restricting blood flow. Attacks or their effects may be brought on or worsened by **anxiety** or emotional distress.

There are three distinct phases to an episode of Raynaud's disease. When first exposed to cold, small arteries respond with intense contractions (vasoconstriction). The affected fingers or toes (in rare instances, the tip of the nose or tongue) become pale and white because they are deprived of blood and, thus, oxygen. In response, capillaries and veins expand (dilate). Because these vessels are carrying deoxygenated blood, the affected area then becomes blue in color. The area often feels cold and tingly or numb. After the area begins to warm up, the arteries dilate. Blood flow is significantly increased. This changes the color of the area to a bright red. During this phase, persons often describe the affected area as feeling warm and throbbing painfully.

Raynaud's disease may initially affect only the tips of fingers or toes. As the disease progresses, it may eventually involve all of one or two digits. Ultimately, all the fingers or toes may be affected. About one person in ten, will experience a complication called sclerodactyly. In sclerodactyly, the skin over the involved digits becomes tight, white, thick, smooth and shiny. In approximately 1% of cases of Raynaud's disease, deep sores (ulcers) may develop in the skin. In rare cases of frequent, repetitive bouts of severe **ischemia** (decreased supply of oxygenated blood to tissues or organs), tissue loss, or **gangrene** may result and **amputation** may be required.

Diagnosis

Primary Raynaud's disease is diagnosed following the Allen Brown criteria. There are four components. The certainty of the diagnosis and severity of the disease increase as more criteria are met. The first is that at least two of the three color changes must occur during attacks provoked by cold and or stress. The second is that episodes must periodically occur for at least two years. The third is that attacks must occur in both the hands and the feet in the absence of vascular occlusive disease. The last is that there is no other identifiable cause for the Raynaud's episodes.

A cold stimulation test may also be performed to help to confirm a diagnosis of Raynaud's disease. The temperature of affected fingers or toes is taken. The hand or foot is then placed completely into a container of ice water for 20 seconds. After removal from the water, the temperature of the affected digits is immediately recorded. The temperature is retaken every five minutes until it returns to the pre-immersion level. Most individuals recover normal temperature within 15 minutes. People with Raynaud's disease may require 20 minutes or more to reach their pre-immersion temperature.

Laboratory testing is performed frequently. However, these results are often inconclusive for several reasons. Provocative testing such as the ice emergence just described, is difficult to interpret because there is considerable overlap between normal and abnormal results. The **antinuclear antibody test** of blood is usually negative in Raynaud's disease. Capillary beds under finger nails usually appear normal. Erythrocyte sedimentation rates are often abnormal in people with connective tissue diseases. Unfortunately, this finding is not consistent in people with Raynaud's disease.

Treatment

There is no known way to prevent the development of Raynaud's disease. Further, there is no known cure for this condition. Therefore, avoidance of the trigger is the best supportive management available. Most cases of primary Raynaud's disease can be controlled with proper medical care and avoidance.

Many people are able to find relief by simply adjusting their lifestyles. Affected individuals need to stay warm, and keep their hands and feet well covered in cold weather. Layered clothing, scarves, heavy coats, heavy socks, and mittens under gloves are suggested because gloves alone allow heat to escape. It is also recommended that patients cover or close the space between their sleeves and mittens. Indoors, they should wear socks and comfortable shoes. Smokers should quit as nicotine will worsen the problem. Avoid the use of vibrating tools as well.

People with severe cases of Raynaud's disease may need to be treated with medications to help keep the arterioles relaxed and dilated. Medications such as calcium-channel blockers, reserpine or nitroglycerin may be prescribed to relax artery walls and improve blood flow.

Alternative treatment

Because episodes of Raynaud's disease have also been associated with stress and emotional upset, the con-

dition may be improved by learning to manage stress. Regular **exercise** is known to decrease stress and lower anxiety. Hypnosis, relaxation techniques, and visualization are also useful methods to help control emotions.

Biofeedback training is a technique during which a patient is given continuous information on the temperature of his or her digits, and then taught to voluntarily control this temperature. Some alternative practitioners believe that certain dietary supplements and herbs may be helpful in decreasing the vessel spasm of Raynaud's disease. Suggested supplements include vitamin E (found in fruits, vegetables, seeds, and nuts), magnesium (found in seeds, nuts, fish, beans, and dark green vegetables), and fish oils. The circulatory herbs cayenne, ginger and prickly ash may help enhance circulation to affected areas.

Prognosis

The prognosis for most people with Raynaud's disease is very good. In general, primary Raynaud's disease has the best prognosis, with a relatively small chance (1%) of serious complications. Approximately half of all affected individuals do well by taking simple precautions, and never require medication. The prognosis for people with secondary Raynaud's disease (or phenomenon) is less predictable. This prognosis depends greatly on the severity of other associated conditions such as scleroderma, lupus, or Sjögren syndrome.

Prevention

There is no way to prevent the development of Raynaud's disease. Once an individual realizes that he or she suffers from this disorder, however, steps can be taken to reduce the frequency and severity of episodes.

KEY TERMS

Arteriole—The smallest type of artery.

Artery—A blood vessel that carries blood away from the heart to peripheral tissues.

Gangrene—Death of a tissue, usually caused by insufficient blood supply and followed by bacterial infection of the tissue.

Idiopathic—Of unknown origin.

Polymyositis—An inflammation of many muscles.

Pulmonary hypertension—A severe form of high blood pressure caused by diseased arteries in the lung.

Rheumatoid arthritis—Chronic, autoimmune disease marked by inflammation of the membranes surrounding joints.

Scleroderma—A relatively rare autoimmune disease affecting blood vessels and connective tissue that makes skin appear thickened.

Systemoc lupus erythematosus—A chronic inflammatory disease that affects many tissues and parts of the body including the skin.

Resources

BOOKS

Coffman, Jay D. D. *Raynaud's Phenomenon.* New York, Oxford University Press, 1989.

Creager, Mark A., and Victor J. Dzau. "The Vasculitis Syndromes." In *Harrison's Principles of Internal Medicine. 14th* ed. Ed. Anthony Fauci. New York: McGraw Hill, 1998, 1910-1922.

Rosenwasser, Lanny J. "The Vasaculitic Syndromes." In *Cecil Textbook of Medicine.* 21st ed. Ed. Lee Goldman, et al. Philadelphia: Saunders, 2000, 1524-1527.

PERIODICALS

Brand, F. N., M. G. Larson, W. B. Kannel, and J. M. McGuirk. "The Occurrence of Raynaud's Phenomenon in a General Population: the Framingham Study." *Vascular Medicine* 2, no. 4 (November 1997): 296-301.

Fraenkel, L., et al. "Different Factors Influencing the Expression of Raynaud's Phenomenon in Men and Women." *Arthritis and Rheumatology* 42, no. 2 (February 1999): 306-310.

Voulgari, P. V., et al. "Prevalence of Raynaud's Phenomenon in a Healthy Greek Population." *Annals of Rheumatic Disease* 59, no. 3 (March 2000): 206-210.

ORGANIZATIONS

American Heart Association. 7272 Greenville Ave., Dallas, TX 75231-4596. (214) 373-6300 or (800) 242-8721. <inquire@heart.org.> <http://www.americanheart.org>.

Irish Raynaud's and Scleroderma Society. PO Box 2958 Foxrock, Dublin 18, Ireland. (01) 235 0900. <irss@indigo.ie>.

National Heart, Lung, and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 592-8573. <nhlbiinfo@rover.nhlbi.nih.gov.> <http://www.nhlbi.nih.gov>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

Raynaud's & Scleroderma Association (UK). 112 Crewe Road, Alsager, Cheshire, ST7 2JA. UK (44) (0) 1270 872776. <webmaster@raynauds.demon.co.uk>. <http://www.raynauds.demon.co.uk>.

OTHER

Arthritis Foundation. <http//www.arthritis-foundation.com/>.

British Sjögren's Syndrome Association. <http://ourworld.copmpuserve.com/homepages/BSSAssociation>.
Raynaud's & Scleroderma Association. <http://www.Raunaud's.demon.co,uk/>.
Rodriguez, J., and S. Wasson. "Raynaud's Disease." *Wayne State University School of Medicine*. <http://www.med.wayne.edu/raynauds/>.

L. Fleming Fallon, Jr., MD, PhD, DrPH

RDS *see* **Respiratory distress syndrome**

Reactive airway disease *see* **Asthma**

Reactive polycythemia *see* **Secondary polycythemia**

Reading disorder *see* **Learning disorders**

Recompression treatment

Definition

Recompression treatment is the use of elevated pressure to treat conditions within the body after it has been subjected to a rapid decrease in pressure. It also includes hyperbaric oxygen therapy.

Purpose

Recompression treatment is used to overcome the adverse effects of **gas embolism** and **decompression sickness** (sometimes called the bends) in underwater divers who breathe compressed air. It is also approved for treatment of severe **smoke inhalation**, **carbon monoxide poisoning**, gas **gangrene**, radiation tissue damage, thermal **burns**, extreme blood loss, crush injuries, and **wounds** that won't heal.

Precautions

Hyperbaric oxygen therapy delivers greater amounts of oxygen more quickly to the body than breathing room air (which is only 21% oxygen) at regular pressure. Unmonitored, increased oxygen can produce toxic effects. Treatments must follow safe time-dose limits and may only be administered by a doctor.

Description

Recompression treatment is performed in a hyperbaric chamber, a sealed compartment in which the patient breathes normal air or "enhanced" air with up to 100% oxygen while exposed to controlled pressures up to three times normal atmospheric pressure. The patient may receive the oxygen through a face mask, a hood or tent around the head, or an endotracheal tube down the windpipe if the patient is already on a ventilator. When used to treat decompression sickness or gas **embolism**, the increased pressure reduces the size of gas bubbles in the patient's body. The increased oxygen concentration speeds the diffusion of the nitrogen within the bubbles out of the patient's body. As gas bubbles deflate, the trauma of gas embolism and decompression sickness begins to resolve. Treatment for diving emergencies typically involves one session, lasting four to six hours, at three atmospheres of pressure.

When used to treat other conditions, the increased pressure allows oxygen and other gases to dissolve more rapidly into the blood and thus be carried to oxygen-starved tissues to enhance healing. Elevated oxygen levels can also purge toxins such as carbon monoxide from the body. In addition, when body tissues are super-saturated with oxygen, the destruction of some bacteria is enhanced and the spread of certain toxins is halted. This makes hyperbaric oxygen therapy useful in treating gas gangrene and infections that cause tissue necrosis (**death**). Hyperbaric oxygen therapy also promotes the growth of new blood vessels.

Preparation

Oxygen is often administered to a patient as first aid while he or she is being transported to a hyperbaric chamber. The treatment begins with chamber compression; as the pressure of the chamber atmosphere increases, the temperature also rises and the patient's ears may fill as they would during an airplane landing. Swallowing and yawning are ways to relieve the inner ear pressure. Once the desired pressure is achieved, the patient is given pure oxygen to breathe. Because treatment is lengthy, patients are encouraged to sleep or listen to music. In larger chambers, patients may also read or watch videos.

Aftercare

Depending on the reason for treatment and the treatment outcome, the patient may be taken to a hospital for further care, or examined and released.

Risks

There is minimal risk when recompression treatment is administered by a competent physician. However, some common side effects are sinus **pain**, temporary changes in vision, and **fatigue**.

Normal results

With prompt and appropriate recompression treatment, most patients show marked improvement in their

KEY TERMS

Atmosphere—A measurement of pressure. One atmosphere equals the pressure of air at sea level (14.7 pounds per square inch [psi]).

Compressed air—Air that is held under pressure in a tank to be breathed underwater by divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

Decompression—A decrease in pressure from the surrounding water that occurs with decreasing diving depth.

Decompression sickness—A condition found in divers in which gas bubbles of nitrogen form in tissues and blood vessels as a result of decreasing surrounding pressure, such as in ascent from a dive. It may be a painful condition, especially as nitrogen bubbles invade the joints; persons stricken may walk stooped over in pain, in a bent stance that led to it being called "the bends."

Gas embolism—The presence of gas bubbles in the bloodstream that obstruct circulation. Also called air embolism.

Hyperbaric chamber—A sealed compartment in which patients are exposed to controlled pressures up to three times normal atmospheric pressure. Hyperbaric treatment may be used to regulate blood gases, reduce gas bubbles, and provide higher levels of oxygen more quickly.

Recompression—Restoring the elevated pressure of the diving environment to treat decompression sickness and gas embolism by decreasing bubble size.

blood oxygen levels and tissue circulation, as well as other signs of healing. Divers treated for gas embolism or decompression sickness may recover with no lasting effects.

Abnormal results

When recompression treatment is not begun promptly or not conducted at adequate time-dose levels, patients with decompression sickness may develop bone necrosis. This significant destruction of bone, most commonly found in the hip and shoulder, produces chronic pain and severe disability. Another result of delayed or inadequate treatment may be permanent neurological damage. When decompression sickness involves the spinal cord, partial **paralysis** may occur.

Resources

BOOKS

Martin, Lawrence. *Scuba Diving Explained: Questions and Answers of Physiology and Medical Aspects of Scuba Diving*. Flagstaff, AZ: Best Publishing, 1997.

ORGANIZATIONS

American College of Hyperbaric Medicine. P.O. Box 25914-130, Houston, Texas 77265. (713) 528-0657. <http://www.hyperbaricmedicine.org>.

Divers Alert Network. The Peter B. Bennett Center, 6 West Colony Place, Durham, NC 27705. (800) 446-2671. <http://www.diversalertnetwork.org>.

Undersea and Hyperbaric Medical Society. 10531 Metropolitan Ave., Kensington, MD 20895. (301) 942-2980. <http://www.uhms.org>.

Bethany Thivierge

Reconstructive surgery *see* **Plastic, cosmetic, and reconstructive surgery**

Rectal cancer

Definition

The rectum is the portion of the large bowel that lies in the pelvis, terminating at the anus. Cancer of the rectum is the disease characterized by the development of malignant cells in the lining or epithelium of the rectum. Malignant cells have changed such that they lose normal control mechanisms governing growth. These cells may invade surrounding local tissue or they may spread throughout the body and invade other organ systems.

Description

The rectum is the continuation of the colon (part of the large bowel) after it leaves the abdomen and descends into the pelvis. Anatomically, it is divided into equal thirds; the upper, mid, and lower rectum.

The pelvis and other organs in the pelvis form boundaries to the rectum. Behind, or more accurately, posterior to the rectum is the sacrum (the lowest portion of the spine, closest to the pelvis). Laterally, on the sides, the rectum is bounded by soft tissue and bone. In front, the rectum is bounded by different organs in the male and female. In the male, the bladder and prostate are present. In the female, the vagina, uterus, and ovaries are present.

The upper rectum receives its blood supply from branches of the inferior mesenteric artery from the abdomen. The lower rectum has blood vessels entering

from the sides of the pelvis. Lymph, a protein-rich fluid that bathes the cells of the body, is transported in small channels known as lymphatics. These channels run with the blood supply of the rectum. Lymph nodes are small filters through which the lymph flows on its way back to the blood stream. Cancer spreads elsewhere in the body by invading the lymph and vascular systems.

When a cell or cells lining the rectum become malignant, they first grow locally and may invade partially or totally through the wall of the rectum. The tumor here may invade surrounding tissue or the organs that bound it, a process known as local invasion. In this process, the tumor penetrates and may invade the lymphatics or the capillaries locally and gain access to the circulation in this way. As the malignant cells work their way to other areas of the body, they again become locally invasive in the new area to which they have spread. These tumor deposits, originating in the primary tumor in the rectum, are then known as metastasis. If metastases are found in the regional lymph nodes, they are known as regional metastases. If they are distant from the primary tumor, they are known as distant metastases. The patient with distant metastases may have widespread disease, also referred to as systemic disease. Thus the cancer originating in the rectum begins locally and, given time, may become systemic.

By the time the primary tumor is originally detected, it is usually larger than 0.39 in (about 1 cm) in size and has over a million cells. This amount of growth itself is estimated to take about three to seven years. Each time the cells double in number, the size of the tumor quadruples. Thus like most cancers, the part that is identified clinically is later in the progression than would be desired and screening becomes a very important endeavor to aid in earlier detection of this disease.

Passage of red blood with the stool, (noticeable bleeding with defecation), is much more common in rectal cancer than that originating in the colon because the tumor is much closer to the anus. Other symptoms (constipation and/ or diarrhea) are caused by obstruction and, less often, by local invasion of the tumor into pelvic organs or the sacrum. When the tumor has spread to distant sites, these metastases may cause dysfunction of the organ they have spread to. Distant metastasis usually occurs in the liver, less often to the lung(s), and rarely to the brain.

There are about 36,500 cases of rectal cancer diagnosed per year in the United States. Together, colon and rectal cancers account for 10% of cancers in men and 11% of cancers in women. It is the second most common site-specific cancer affecting both men and women. (Lung cancer is the first affecting both men and women, breast is the leader in women and prostate the leader in men.) About 8,500 people died from rectal cancer in the United States in 2000. In recent years the incidence of this disease is decreasing very slightly, as has the mortality rate. It is difficult to tell if the decrease in mortality reflects earlier diagnosis, less death related to the actual treatment of the disease, or a combination of both factors.

Cancer of the rectum is felt to arise sporadically in about 80% of those who develop the disease. 20% of cases are felt to have genetic predisposition that ranges from familial syndromes affecting 50% of the offspring of a mutation carrier, to a risk of 6% when there is just a family history of rectal cancer occurring in a first-degree relative. Development of rectal cancer at an early age suggests a genetically transmitted form of the disease as opposed to the sporadic form.

Causes and symptoms

Causes of rectal cancer are probably environmental in the sporadic cases (80%), and genetic in the heredity-predisposed (20%) cases. Since malignant cells have a changed genetic makeup, this means that in 80% of cases, the environment spontaneously induces change. In those born with a genetic predisposition, they are either destined to get the cancer, or it will take less environmental exposure to induce the cancer. Exposure to agents in the environment that may induce mutation is the process of carcinogenesis and is caused by agents known as carcinogens. Specific carcinogens have been difficult to identify; dietary factors, however, seem to be involved.

Rectal cancer is more common in industrialized nations, and dietary factors are thought to be related to this observation. Diets high in fat, red meat, total calories, and alcohol seem to predispose. Diets high in fiber are associated with a decreased risk. The mechanism for protection by high-fiber diets may be related to less exposure of the rectal epithelium to carcinogens from the environment as the transit time through the bowel is faster with a high-fiber diet than with a low-fiber diet.

Age plays a definite role in the predisposition to rectal cancer. Rectal cancer is rare before age 40. This incidence increases substantially after age 50 and doubles with each succeeding decade.

There is also a slight increase risk for rectal cancer in the individual who smokes.

Patients who suffer from an inflammatory disease of the colon known as ulcerative colitis are also at increased risk.

In regards to genetic predisposition, on chromosome 5, there is a gene called the APC gene associated with familial adenomatous polyposis (FAP) syndrome. There

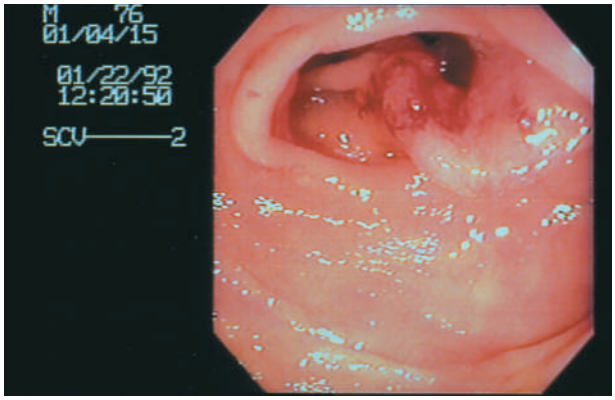
are multiple different mutations that occur at this site, yet they all cause a defect in tumor suppression that results in early and frequent development of colon cancer. This genetic aberration is transmitted to 50% of offspring and each of those affected will develop colon or rectal cancer, usually at an early age. Another syndrome, hereditary non-polyposis colon cancer (HNPCC), is related to mutations in any of four genes responsible for DNA mismatch repair. In patients with colon or rectal cancer, the p53 gene is mutated 70% of the time. When the p53 gene is mutated and ineffective, cells with damaged DNA escape repair or destruction, allowing the damaged cell to perpetuate itself. Continued replication of the damaged DNA may lead to tumor development. Though these syndromes (FAP and HNPCC) have a very high incidence of colon or rectal cancer, family history without the syndromes is also a substantial risk factor. When considering first-degree relatives, history of one with colon or rectal cancer raises the baseline risk of 2% to 6%, the presence of a second raises the risk to 17%.

The development of polyps of the colon or rectum commonly precedes the development of rectal cancer. Polyps are growths of the rectal lining. They can be unrelated to cancer, pre-cancerous, or malignant. Polyps, when identified, are removed for diagnosis. If the polyp, or polyps, are benign, the patient should undergo careful surveillance for the development of more polyps or the development of colon or rectal cancer.

Symptoms of rectal cancer most often result from the local presence of the tumor and its capacity to invade surrounding pelvic structure:

- bright red blood present with stool
- abdominal distention, bloating, inability to have a bowel movement
- narrowing of the stool, so-called ribbon stools
- pelvic pain
- unexplained weight loss
- persistent chronic fatigue
- rarely, urinary infection or passage of air in urine in males (late symptom)
- rarely, passage of feces through vagina in females(late symptom)

Most of the symptoms are understood on the basis of obstruction or the invasion of surrounding pelvic anatomic structures. If the tumor is large and obstructing the rectum, the patient will not be evacuating stool normally and will get bloated and have abdominal discomfort. The tumor itself may bleed and, since it is near the anus, the patient may see bright red blood on the surface of the stool. Blood alone (without stool) may also be passed. Thus, hemorrhoids are often incorrectly blamed for bleeding, delaying the diagnosis. If anemia develops, which is rare, the patient will experience chronic fatigue. If the tumor invades the bladder in the male or the vagina in the female, stool will get where it doesn't belong and cause infection or discharge. (This condition is also rare.) Patients with widespread disease lose weight secondary to the chronic illness.



An endoscopic view of a rectal tumor. *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

Screening evaluation of the colon and rectum are accomplished together. Screening involves physical exam, simple laboratory tests, and the visualization of the lining of the rectum and colon. The ways to visualize the epithelium are with x rays, (indirect visualization), and endoscopy, (direct visualization).

The physical examination involves the performance of a digital rectal exam (DRE). At the time of this exam, the physician checks the stool on the examining glove with a chemical to see if any occult (invisible), blood is present. At home, after having a bowel movement, the patient is asked to swipe a sample of stool obtained with a small stick on a card. After three such specimens are on the card, the card is then easily chemically tested for occult blood also. These exams are accomplished as an easy part of a routine yearly physical exam.

Proteins are sometimes produced by cancers and these may be elevated in the patients blood. When this occurs the protein produced is known as a tumor marker. There is a tumor marker for cancer of the colon and rectum; it is known as carcinoembryonic antigen, (CEA). Unfortunately, this may be made by other adenocarcinomas as well, or it may not be produced by a particular colon or rectal cancer. Therefore, screening by chemical analysis for CEA has not been helpful. CEA has been

helpful in patients treated for colon or rectal cancer if their tumor makes the protein. It is used in a follow-up role, not a screening role.

Direct visualization of the lining of the rectum is accomplished using a scope or endoscope. The physician introduces the instrument into the rectum and is able to see the epithelium of the rectum directly. A simple rigid tubular scope may be used to see the rectal epithelium; however, screening of the colon is done at the same time. The lower colon may be visualized using a fiberoptic flexible scope in a procedure known as flexible sigmoidoscopy. When the entire colon is visualized, the procedure is known as total colonoscopy. Each type of endoscopy requires pre-procedure preparation (evacuation) of the rectum and colon.

The American Cancer Society has recommended the following screening protocol for those over 50 years:

- yearly digital rectal exam with occult blood in stool testing
- flexible sigmoidoscopy at age 50
- flexible sigmoidoscopy repeated every five years

If there are predisposing factors such as positive family history, history of polyps, or a familial syndrome, screening evaluations should start sooner.

Evaluation of patients with symptoms

When patients visit their physician because they are experiencing symptoms that could possibly be related to colon or rectal cancer, the entire colon and rectum must be visualized. Even if a rectal lesion is identified, the entire colon must be screened to rule out a syndromous polyp or cancer of the colon. The combination of a flexible sigmoidoscopy and double contrast barium enema may be performed, but the much preferred evaluation of the entire colon and rectum is that of complete colonoscopy. Colonoscopy allows direct visualization, photography, as well as the opportunity to obtain a biopsy, (a sample of tissue), of any abnormality visualized. If, for technical reasons the entire colon is not visualized endoscopically, a double contrast barium enema should complement the colonoscopy. A patient who is identified to have a problem in one area of the colon or rectum is at greater risk to have a similar problem in area of the colon or rectum. Therefore the entire colon and rectum need to be visualized during the evaluation.

The diagnosis of rectal cancer is actually made by the performance of a biopsy of any abnormal lesion in the rectum. Many rectal cancers are within reach of the examiner's finger. Identifying how close to the anus the cancer has developed is very important in planning the treatment. Another characteristic ascertained by exam is whether the tumor is mobile or fixed to surrounding structure. Again, this will have implications related to primary treatment. As a general rule, it is easier to identify and adequately obtain tissue for evaluation in the rectum as opposed to the colon. This is because the lesion is closer to the anus.

If the patient presents with advanced disease, areas where the tumor has spread, such as the liver, may be amenable to biopsy. Such biopsies are usually obtained using a special needle under local anesthesia.

Once a diagnosis of rectal cancer has been established by biopsy, in addition to the physical exam, an endorectal ultrasound will be performed to assess the extent of the disease. For rectal cancer, endorectal ultrasound is the most preferred method for staging both depth of tumor penetration and local lymph node metastatic status. Endorectal ultrasound:

- differentiates areas of invasion within large rectal adenomas that seem benign
- determines the depth of tumor penetration into the rectal wall
- determines the extent of regional lymph node invasion
- can be combined with other tests (chest x rays and computed tomography scans, or CT scans) to determine the extent of cancer spread to distant organs, such as the lungs or liver

The resulting rectal cancer staging allows physicians to determine the need for—and order of—radiation, surgery, and chemotherapy.

Treatment

Once the diagnosis has been confirmed by biopsy and the endorectal ultrasound has been performed, the clinical stage of the cancer is assigned. The staging characteristics are utilized by the treating physicians to plan the specific treatment protocol for the patient. In addition, the stage of the cancer at the time of presentation gives a statistical likelihood of the treatment outcome, the prognosis.

Clinical staging

Rectal cancer first invades locally and then progresses to spread to regional lymph nodes or to other organs as noted in the description above. Using the characteristics of the primary tumor, its depth of penetration through the rectum, local invasion into pelvic structure, and the presence or absence of regional or distant metastases, stage is derived. A CT scan of the pelvis is very helpful here because the presence of invasion into the sacrum or pelvic sidewalls may mean that surgical therapy is not initially possible. On this basis, clinical staging is used to

begin treatment. The pathologic stage is defined when the results of analyzing the surgical specimen are available for assigning stage, (typically stage I and II).

Rectal cancer is assigned stages I through IV, based on the following general criteria:

- Stage I: the tumor is confined to the epithelium or has not penetrated through the first layer of muscle in the rectal wall.
- Stage II: the tumor has penetrated through to the outer wall of the rectum or has gone through it, possibly invading other local tissue or organs.
- Stage III: Any depth or size of tumor associated with regional lymph node involvement.
- Stage IV: any of previous criteria associated with distant metastasis.

Surgery

The first, or primary, treatment modality utilized in the treatment of rectal cancer is surgery. Stage I, II, and even suspected stage III disease are treated by surgical removal of the involved section of the rectum along with the complete vascular and lymphatic supply. Most Stage II and Stage III rectal cancers (based on endorectal ultrasound, CT scan, and chest x ray) are treated with radiation and possibly chemotherapy prior to surgery.

A factor that needs to be considered when considering primary treatment for rectal cancer is the surgeon's ability to reconnect the ends of the rectum. The pelvis is a confining space that makes the performance of the hook-up more difficult to do safely when the tumor is in the lower rectum. The upper rectum does not usually present a substantial problem to the surgeon restoring bowel continuity after the cancer has been removed. Mid-rectal tumors, (especially in males where the pelvis is usually smaller than a woman's), may present technical difficulties in hooking the proximal bowel to the remaining rectum. Technical advances in stapling instrumentation have largely overcome these difficulties. If the anastomosis, (hook-up), leaks postoperatively, infection will ensue and in the past was a major cause of complications in resection of rectal cancers. Today, utilizing the stapling instrumentation, a hook-up at the time of original surgery is much safer. If the surgeon feels that the hook-up is compromised or may leak, a colostomy may be performed. A colostomy is performed by bringing the colon through the abdominal wall and sewing it to the skin. In these cases the stool is thus diverted away from the hook-up, allowing it to heal and preventing the infectious complications associated with leak. Later, when the hook-up has completely healed, the colostomy can be taken down and bowel continuity thus restored.

Stapling devices have allowed the surgeon to get closer to the anus and still allow the technical performance of a hook-up but there are limits. It is generally felt that there should be at least three centimeters of normal rectum below the tumor or the risk of recurrence locally will be excessive. In addition, if there is no residual native rectum, the patient will not have normal sensation or control and will have problems with uncontrollable soilage, (incontinence). For these reasons, patients presenting with low rectal tumors may undergo total removal of the rectum and anus. This procedure is known as an abdominal-perineal resection. A colostomy is performed in the lower left abdomen and it is permanent.

Radiation

As mentioned, for many late stage II or stage III tumors, radiation therapy can shrink the tumor prior to surgery. The other roles for radiation therapy are as an aid to surgical therapy in locally advanced disease that has been removed, and in the treatment of certain distant metastases. Especially when utilized in combination with chemotherapy, radiation used postoperatively has been shown to reduce the risk of local recurrence in the pelvis by 46% and death rates by 29%. Such combined therapy is recommended in patients with locally advanced primary tumors that have been removed surgically. In the treatment of distant metastases, radiation has been helpful at reducing local effects from them, particularly in the brain.

Chemotherapy

Adjuvant chemotherapy, (treating the patient who has no evidence of residual disease but who is at high risk for recurrence), is considered in patients whose tumors deeply penetrate or locally invade (late stage II and stage III). If the tumor was not locally advanced, this form of chemotherapeutic adjuvant therapy may be recommended without radiation. This therapy is identical to that of colon cancer and leads to similar results. Standard therapy is treatment with 5-fluorouracil, (5-FU) combined with leucovorin for a period of six to 12 months. 5-FU is an antimetabolite and leucovorin improves the response rate. Another agent, levamisole, (which seems to stimulate the immune system), may be substituted for leucovorin. These protocols reduce rate of recurrence by about 15% and reduce mortality by about 10%. The regimens do have some toxicity but usually are tolerated fairly well.

Similar chemotherapy is administered for stage IV disease or if a patient progresses and develops metastasis. Results show response rates of about 20%. A response is a temporary regression of the cancer in response to the chemotherapy. Unfortunately, these patients eventually succumb to the disease. Clinical trials have now shown

KEY TERMS

Adenocarcinoma—Type of cancer beginning in glandular epithelium.

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

Anastomosis—Surgical re-connection of the ends of the bowel after removal of a portion of the bowel.

Anemia—The condition caused by too few circulating red blood cells, often manifest in part by fatigue.

Carcinogens—Substances in the environment that cause cancer, presumably by inducing mutations, with prolonged exposure.

Defecation—The act of having a bowel movement.

Epithelium—Cells composing the lining of an organ.

Lymphatics—Channels that are conduits for lymph.

Lymph nodes—Cellular filters through which lymphatics flow.

Malignant—Cells that have been altered such that they have lost normal control mechanisms and are capable of local invasion and spread to other areas of the body.

Metastasis—Site of invasive tumor growth that originated from a malignancy elsewhere in the body.

Mutation—A change in the genetic make up of a cell that may occur spontaneously or be environmentally induced.

Occult blood—Presence of blood that cannot be appreciated visually.

Polyps—Localized growths of the epithelium that can be benign, pre-cancerous, or harbor malignancy.

Resect—To remove surgically.

Sacrum—Posterior bony wall of the pelvis.

Systemic—Referring to throughout the body.

that the results can be improved with the addition of another agent to this regimen. Irinotecan does not seem to increase toxicity but it improved response rates to 39%, added two-three months to disease free survival, and prolonged overall survival by a little over two months.

Alternative treatment

Alternative therapies have not been studied in a scientific way so it is very difficult to make any recommendation. Large doses of vitamins, fiber, and green tea are among therapies tried. Before initiating any alternative therapies, the patient is wise to consult his/her physician to be sure that these therapies do not complicate or interfere with the recommended therapy.

Prognosis

Prognosis is the long-term outlook or survival after therapy. Overall, about 50% of patients treated for colon and rectal cancer survive the disease. As expected, the survival rates are dependent upon the stage of the cancer at the time of diagnosis, making early detection a very worthwhile endeavor.

About 15% of patients present with stage I disease, or are diagnosed with Stage I disease when they initially visit a doctor, and 85-90% survive. Stage II represents 20-30% of cases and 65-75% survive. 30-40% comprise the stage III presentation of which 55% survive. The remaining 20-25% present with stage IV disease and are very rarely cured.

Prevention

There is not an absolute way of preventing colon or rectal cancer. Still there is a lot that an individual can do to lessen risk or to identifiy the precursors of colon and rectal cancer so that it does not manifest itself. The patient with a familial history can enter screening and surveillance programs earlier than the general population. High-fiber diets and vitamins, avoiding obesity, and staying active lessen the risk. Avoiding cigarettes and alcohol may be helpful. By controlling these environmental factors, an individual can lessen risk and to this degree prevent the disease.

By undergoing appropriate screening when uncontrollable genetic risk factors have been identified, an individual may be rewarded by the identification of benign polyps that can be treated as opposed to having these growths degenerate into a malignancy.

Resources

BOOKS

Abelhoff, Martin, MD, James O. Armitage MD, Allen S. Lichter MD, and John E. Niederhuber MD. *Clinical Oncology Library.* Philadelphia: Churchill Livingstone, 1999.

Jorde, Lynn B., PhD, John C. Carey MD, Michael J. Bamshad MD, and Raymond L. White, PhD. *Medical Genetics,* Second Edition. St. Louis: Mosby, 1999.
Kirkwood, John M., MD, Michael T. Lotze MD, Joyce M. Yasko PhD. *Current Cancer Therapeutics,* Third Edition. Philadelphia: Churchill Livingstone, 1998

PERIODICALS

Greenlee, Robert T., PhD, MPH, Mary Beth Hill-Harmon, MSPH, Taylor Murray, and Michael Thun, MD, MS. "Cancer Statistics 2001." *CA: A Cancer Journal for Clinicians* 51, no. 1 (Jan/Feb 2001).
Saltz, Leonard, et al. "Irinotecan plus Fluorouracil and Leucovorin for Metastatic Colorectal Cancer." *The New England Journal of Medicine* 343, no. 13 (September 28, 2000).

ORGANIZATIONS

American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.
Cancer Information Service of the NCI. (1-800-4-CANCER). <http://wwwicic.nci.nih.gov>.

OTHER

National Cancer Institute Clinical Trials. <http://www.cancertrials.nci. nih.gov>.
Colon Cancer Alliance. <http://www.ccalliance.org>.

Richard A. McCartney, MD

Rectal examination

Definition

Rectal examination or digital rectal examination (DRE) is performed by means of inserting a gloved, lubricated finger into the rectum and palpating (feeling) for lumps.

Purpose

DRE is used as a screening tool to locate **rectal cancer** and **prostate cancer**. It is also used as a diagnostic test to find non-cancerous abnormalities within the rectum like **hemorrhoids**, anal fissures, or congenital deformities that can cause chronic **constipation**.

Precautions

There are no precautions when performing DRE, aside from routine sanitary procedures.

Description

DRE is performed in most instances as an annual routine procedure in colorectal **cancer** screening. Digital palpitation of the rectum can often find abnormal growths which may require further testing or commonplace hemorrhoids. It is a critical initial clinical test and is important in the assessment of the size and location of tumors.

This procedure is often not performed routinely on patients over 70, even though this population is at high risk for colorectal cancer. It also is not done as often in elderly women as in elderly men.

DRE has also been used as a screening tool for prostate cancer. It seems to be very effective for larger masses found in the prostate and correlated well with higher prostate-specific antigens.

Of less predictive value was DRE in routine rectovaginal examinations of women under the age of 50. These instances of DRE did not locate colorectal cancer or any other abnormality.

More gastroenterologists are recommending that pediatricians and family physicians perform DRE on pediatric patients exhibiting chronic constipation before those patients are referred to intestinal specialists. The pediatrician or family physician could identify fecal compaction and treat it themselves, and then only refer patients who have a specific abnormality to gastroenterologists.

Preparation

The physician must conduct DRE using a gloved hand. Some sort of lubricant should be used so that penetration of the rectum is easier and does not create the damage that the procedure is seeking.

Aftercare

There is no aftercare after a DRE is performed.

Risks

There are no risks to DRE and it is virtually painless.

Normal results

The physician finds a normal rectal canal with no abnormalities.

Abnormal results

Growths, tears, anal fissures, or congenital structural defects can be found inside the rectum with DRE.

Resources

BOOKS

Weber, Janet, ed. *Nurses' Handbook of Health Assessment* Philadelphia: Lippincott, 1993.

KEY TERMS

DRE—Digital rectal examination.

Gastroenterologist—A physician who specializes in diseases of the digestive system.

Rectum—The last eight to ten inches of the colon, of which the anus is a part and the opening through which wastes are removed from the body.

PERIODICALS

Borum, Marie L. "Does Age Influence Screening for Colorectal Cancer?" *Age and Aging* 27 (July 1998) no. 4. 508-511.

Kirchner, Jeffrey T. "Digital Rectal Examination in Children with Constipation." *American Family Physician* no. 5 (October 1, 1999) 60: 1530.

Schroder, Fritz H. "Evaluation of the Digital Rectal Examination as a Screening Test for Prostate Cancer." *JAMA, The Journal of the American Medical Association* no. 7 (February 7, 1999) 281: 594.

OTHER

"Practice Parameters for the Treatment of Rectal Carcinoma " *American Society of Colon and Rectal Surgeons* May 7, 2001. <http://www.asco.org/ prof/me/html/abstracts/gasc/m_969.htm>.

Janie F. Franz

Rectal polyps

Definition

Rectal polyps are tissue growths that arise from the wall of the rectum and protrude into it. They may be either benign or malignant (cancerous).

Description

The rectum is the last segment of the large intestine, ending in the anus, the opening to the exterior of the body. Rectal polyps are quite common. They occur in 7–50% of all people, and in two thirds of people over age 60.

Rectal polyps can be either benign or malignant, large or small. There are several different types of polyps. The type is determined by taking a sample of the polyp and examining it microscopically. Most polyps are benign. They are of concern, however, because 90% of colon and rectal cancers arise from polyps that are initially benign. For this reason, rectal polyps are usually removed when they are discovered.

Causes and symptoms

The cause of most rectal polyps is unknown, however a diet high in animal fat and red meat, and low in fiber, is thought to encourage polyp formation. Some types of polyps are hereditary. In an inherited disease called **familial polyposis**, hundreds of small, malignant and pre-malignant polyps are produced before the age of 40. Also, inflammatory bowel disease may cause growth of polyps and pseudo-polyps. Juvenile polyps (polyps in children) are usually benign and often outgrow their blood supply and disappear at **puberty**.

Most rectal polyps produce no symptoms and are discovered on routine digital or endoscopic examination of the rectum. Rectal bleeding is the most common complaint when symptoms do occur. Abdominal cramps, **pain**, or obstruction of the intestine occur with some large polyps. Certain types of polyps cause mucous-filled or watery **diarrhea**.

Diagnosis

Rectal polyps are commonly found by **sigmoidoscopy** (visual inspection with an instrument consisting of a tube and a light) or **colonoscopy**. If polyps are found in the rectum, a complete examination of the large intestine is done, as multiple polyps are common. Polyps do not show up on regular x rays, but they do appear on **barium enema** x rays.

Treatment

Normally polyps are removed when they are found. Polypectomy is the name for the surgery that removes these growths. Polypectomy is performed at a hospital, outpatient surgical facility or in a doctor's office, depending on the number and type of polyps to be removed, and the age and health of the patient. The procedure can be done by a surgeon, gastroenterologist, or family practitioner.

Before the operation, a colonoscopy (examination of the intestine with an endoscope) is performed, and standard pre-operative blood and urine studies are done. The patient is also given medicated **enemas** to cleanse the bowel.

The patient is given a sedative and a narcotic pain killer. A colonoscope is inserted into the rectum. The polyps are located and removed with a wire snare, ultrasound, or laser beam. After they are removed, the polyps are examined to determine if they are malignant or benign. When polyps are malignant, it may be necessary to remove a portion of the rectum or colon to completely remove cancerous tissue.

KEY TERMS

Colon—The part of the large intestine that extends from the cecum to the rectum. The sigmoid colon is the area of the intestine just above the rectum; linking the descending colon with the rectum. It is shaped like the letter S.

Rectum—The final part of the large intestine, ending in the anus.

Sigmoidoscopy—A procedure where a thin tube containing a camera and a light is inserted into the lower section of the large intestine so that the doctor can visually inspect the lower (sigmoid) colon and rectum. Colonoscopy examines the entire large intestine using the same techniques.

Alternative treatment

In addition to a diet low in animal fat and high in fiber, nutritionists recommend anitoxidant supplements (including **vitamins** A, C, and E, selenium, and zinc) to reduce rectal polyps.

Prognosis

For most people, the removal of polyps is an uncomplicated procedure. Benign polyps that are left in place can give rise to **rectal cancer**. People who have had rectal polyps once are more likely to have them again and should have regular screening examinations.

Prevention

Eating a diet low in red meat and animal fat, and high in fiber, is thought to help prevent rectal polyps.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Polypectomy." In *The Complete Guide to Symptoms, Illness and Surgery.* 3rd ed. Ed. H. Winter Griffith, et al. New York: Berkeley Publishing, 1995.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

Tish Davidson

Rectal prolapse

Definition

Rectal prolapse is protrusion of rectal tissue through the anus to the exterior of the body. The rectum is the final section of the large intestine.

Description

Rectal prolapse can be either partial or complete. In partial prolapse, only the mucosa layer (mucous membrane) of the rectum extends outside the body. The projection is generally 0.75–1.5 in (2–4 cm) long. In complete prolapse, called procidentia, the full thickness of the rectum protrudes for up to 4.5 in (12 cm).

Rectal prolapse is most common in people over age 60, and occurs much more frequently in women than in men. It is also more common in psychiatric patients. Prolapse can occur in normal infants, where it is usually transient. In children it is often an early sign of **cystic fibrosis** or is due to neurological or anatomical abnormalities.

Although rectal prolapse in adults may initially reduce spontaneously after bowel movements, it eventually becomes permanent. Adults who have had prior rectal or vaginal surgery, who have chronic **constipation**, regularly depend on **laxatives**, have **multiple sclerosis** or other neurologic diseases, **stroke**, or **paralysis** are more likely to experience rectal prolapse.

Causes and symptoms

Rectal prolapse in adults is caused by a weakening of the sphincter muscle or ligaments that hold the rectum in place. Weakening can occur because of **aging**, disease, or in rare cases, surgical trauma. Prolapse is brought on by straining to have bowel movements, chronic laxative use, or severe **diarrhea**.

Symptoms of rectal prolapse include discharge of mucus or blood, **pain** during bowel movements, and inability to control bowel movements (**fecal incontinence**). Patients may also feel the mass of tissue protruding from the anus. With large prolapses, the patient may lose the normal urge to have a bowel movement.

Diagnosis

Prolapse is initially diagnosed by taking a patient history and giving a **rectal examination** while the patient is in a squatting position. It is confirmed by **sigmoidoscopy** (inspection of the colon with a viewing instrument called a endoscope) **Barium enema** x rays and other tests are done to rule out neurologic (nerve) disorders or disease as the primary cause of prolapse.

KEY TERMS

Rectum—The part of the large intestine that ends at the anal canal.

Treatment

In infants, conservative treatment, consisting of strapping the buttocks together between bowel movements and eliminating any causes of bowel straining, usually produces a spontaneous resolution of prolapse. For partial prolapse in adults, excess tissue is surgically tied off with special bands causing the tissue to wither in a few days.

Complete prolapse requires surgery. Different surgical techniques are used, but all involve anchoring the rectum to other parts of the body, and using plastic mesh to reinforce and support the rectum. In patients too old, or ill, to tolerate surgery, a wire or plastic loop can be inserted to hold the sphincter closed and prevent prolapse. Treatment should be undertaken as soon as prolapse is diagnosed, since the longer the condition exists, the more difficult it is to reverse.

Alternative treatment

Alternative therapies can act as support for conventional threatment, especially if surgery is required. **Acupuncture**, **homeopathy**, and botanical medicine can all be used to assist in resolution of the prolapse or in recovery from surgery.

Prognosis

Successful resolution of rectal prolapse involves prompt treatment and the elimination of any underlying causes of prolapse. Infants and children usually recover completely without complications. Recovery in adults depends on age, general health, and the extent of the prolapse.

Prevention

Reducing constipation by eating a diet high in fiber, drinking plenty of fluids, and avoiding straining during bowel movements help prevent the onset of prolapse. Exercises that strengthen the anal sphincter may also be helpful.

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 17th eds. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1997.

OTHER

"Rectal Prolapse." *ThriveOnline*. <http://thriveonline.oxygen.com>.

Tish Davidson

Recurrent fever *see* **Relapsing fever**

Recurrent miscarriage

Definition

Recurrent **miscarriage** is defined as three or more miscarriages of a fetus before 20 weeks of gestation (i.e., before the fetus can live outside the womb).

Description

Also referred to as spontaneous abortion, miscarriage occurs in 15–20% of all conceptions. The majority of miscarriages occur during the first trimester. The number of previous miscarriages does not affect subsequent full-term pregnancies.

Causes and symptoms

Recurrent miscarriage can be caused by several factors, including fetal, placental, or maternal abnormalities.

- In over half of all miscarriages, the fetus is abnormal. The abnormality can either be genetic or developmental. The fetus is very sensitive to ionizing radiation. Tobacco and even moderate alcohol consumption are known to cause fetal damage that may lead to miscarriage. There is some evidence that over four cups of coffee a day, because of the **caffeine**, adversely affect **pregnancy**, as well.
- Placental abnormalities, including abnormal implantation in the placental wall and premature separation of the placenta, can cause miscarriage.
- Maternal abnormalities include insufficient hormones (usually progesterone) to support the pregnancy, an **incompetent cervix** (mouth of the womb does not stay closed), or a deformed uterus (womb). A deformed uterus can be caused by diethylstilbestrol (DES) given to the mother's mother during her pregnancy. Some immunologic abnormalities may cause the mother to reject the fetus as if it were an infection or a transplant. Maternal blood clotting abnormalities may cut-off blood supply to the fetus, causing miscarriage.

KEY TERMS

Fetus—A developing embryo in the womb after the first eight weeks of gestation.

Ionizing radiation—Radiation produced by x rays and radioactivity.

Ovulation—Release of an egg for fertilization from the ovary that happens about fourteen days before each menstrual period.

- Maternal **diabetes mellitus** causes miscarriage if the diabetes is poorly controlled. Maternal infections may occasionally lead to miscarriage. There is some evidence that conceptions that take place between old eggs (several days after ovulation) or old sperm (that start out several days before ovulation) may be more likely to miscarry.

Symptoms of miscarriage include pink or brown colored discharge for several weeks, which develops into painful cramping and increased vaginal bleeding; dilation of the cervix; and expulsion of the fetus.

Diagnosis

A pelvic examination can detect a deformed uterus, and frequent examinations during pregnancy can detect an incompetent cervix. Blood tests can detect the presence of immunologic or blood-clotting problems in the mother. **Genetic testing** can also determine if chromosomal abnormalities may be causing the miscarriages.

Treatment

If a uterus is deformed, it may be surgically repaired. If a cervix is incompetent, it can be surgically fortified, until the fetus matures, by a procedure known as circlage (tying the cervix closed). Supplemental progesterone may also help sustain a pregnancy. Experimental treatment of maternal immunologic abnormalities with white cell immunization (injecting the mother with white cells from the father) has been successful in some cases of recurrent miscarriage. Clotting abnormalities can be treated with anticoagulant drugs, such as heparin and **aspirin**, to keep blood flowing to the fetus.

Prognosis

If there is no underlying disease or abnormality present, the rate of successful pregnancy after several miscarriages approaches normal. Seventy to eighty-five percent of women with three or more miscarriages will go on to complete a healthy pregnancy.

Resources

BOOKS

Cunningham, F. Gary, et al., ed. *Williams Obstetrics*. Stamford: Appleton & Lange, 1997.

J. Ricker Polsdorfer, MD

Red blood cell components transfusion *see* **Transfusion**

Red blood cell indices

Definition

Red blood cell indices are measurements that describe the size and oxygen-carrying protein (hemoglobin) content of red blood cells. The indices are used to help in the differential diagnosis of anemia. They are also called red cell absolute values or erythrocyte indices.

Purpose

Anemia includes a variety of conditions with the same outcome: a person's blood cannot carry as much oxygen as it should. A healthy person has an adequate number of correctly sized red blood cells that contain enough hemoglobin to carry sufficient oxygen to all the body's tissues. An anemic person has red blood cells that are either too small or too few in number. As a result, the heart and lungs must work harder to make up for the lack of oxygen delivered to the tissues by the blood.

Anemia is caused by many different diseases or disorders. The first step in finding the cause is to determine what type of anemia the person has. Red blood cell indices help to classify the **anemias**.

Precautions

Certain prescription medications may affect the test results. These drugs include zidovudine (Retrovir), phenytoin (Dilantin), and azathioprine (Imuran).

Description

Overview

Anemia has several general causes: blood loss; a drop in production of red blood cells; or a rise in the number of red blood cells destroyed. Blood loss can result from severe hemorrhage or a chronic slow bleed, such as the result of an accident or an ulcer. Lack of iron, vitamin B_{12}, or **folic acid** in the diet, as well as certain

KEY TERMS

Anemia—A variety of conditions in which a person's blood can't carry as much oxygen as it should due to a decreased number or size of red blood cells.

Hypochromic—A descriptive term applied to a red blood cell with a decreased concentration of hemoglobin.

Macrocytic—A descriptive term applied to a larger than normal red blood cell.

Mean corpuscular hemoglobin (MCH)—A measurement of the average weight of hemoglobin in a red blood cell.

Mean corpuscular hemoglobin concentration (MCHC)—The measurement of the average concentration of hemoglobin in a red blood cell.

Mean corpuscular volume (MCV)—A measure of the average volume of a red blood cell.

Microcytic—A descriptive term applied to a smaller than normal red blood cell.

Normochromic—A descriptive term applied to a red blood cell with a normal concentration of hemoglobin.

Normocytic—A descriptive term applied to a red blood cell of normal size.

Red blood cell indices—Measurements that describe the size and hemoglobin content of red blood cells.

Red cell distribution width (RDW)—A measure of the variation in size of red blood cells.

chronic diseases, lower the number of red blood cells produced by the bone marrow. Inherited disorders affecting hemoglobin, severe reactions to blood transfusions, prescription medications, or poisons can cause red blood cells to burst (hemolyze) well before the end of their usual 120-day lifespan.

Anemia of any type affects the results of one or more of the common blood tests. These tests are the **hematocrit**, hemoglobin, and red blood cell count. The hematocrit is a measure of red blood cell mass, or how much space in the blood is occupied by red blood cells. The **hemoglobin test** is a measure of how much hemoglobin protein is in the blood. The red blood cell count (RBC) measures the number of red blood cells present in the blood. Red blood cell indices are additional measurements of red blood cells based on the relationship of these three test results.

The relationships between the hematocrit, the hemoglobin level, and the RBC are converted to red blood cell indices through mathematical formulas. These formulas were worked out and first applied to the classification of anemias by Maxwell Wintrobe in 1934.

The indices include these measurements: mean corpuscular volume (MCV); mean corpuscular hemoglobin (MCH); mean corpuscular hemoglobin concentration (MCHC); and red cell distribution width (RDW). They are usually calculated by an automated instrument as part of a complete **blood count** (CBC). Indices are covered by insurance when medically necessary. Results are available the same day that the blood is drawn or the following day.

Mean corpuscular volume (MCV)

MCV is the index most often used. It measures the average volume of a red blood cell by dividing the hematocrit by the RBC. The MCV categorizes red blood cells by size. Cells of normal size are called normocytic, smaller cells are microcytic, and larger cells are macrocytic. These size categories are used to classify anemias. Normocytic anemias have normal-sized cells and a normal MCV; microcytic anemias have small cells and a decreased MCV; and macrocytic anemias have large cells and an increased MCV. Under a microscope, stained red blood cells with a high MCV appear larger than cells with a normal or low MCV.

Mean corpuscular hemoglobin concentration (MCHC)

The MCHC measures the average concentration of hemoglobin in a red blood cell. This index is calculated by dividing the hemoglobin by the hematocrit. The MCHC categorizes red blood cells according to their concentration of hemoglobin. Cells with a normal concentration of hemoglobin are called normochromic; cells with a lower than normal concentration are called hypochromic. Because there is a physical limit to the amount of hemoglobin that can fit in a cell, there is no hyperchromic category.

Just as MCV relates to the size of the cells, MCHC relates to the color of the cells. Hemoglobin contains iron, which gives blood its characteristic red color. When examined under a microscope, normal red blood cells

that contain a normal amount of hemoglobin stain pinkish red with a paler area in the center. These normochromic cells have a normal MCHC. Cells with too little hemoglobin are lighter in color with a larger pale area in the center. These hypochromic cells have a low MCHC. Anemias are categorized as hypochromic or normochromic according to the MCHC index.

Mean corpuscular hemoglobin (MCH)

The average weight of hemoglobin in a red blood cell is measured by the MCH. The formula for this index is the sum of the hemoglobin multiplied by 10 and divided by the RBC. MCH values usually rise or fall as the MCV is increased or decreased.

Red cell distribution width (RDW)

The RDW measures the variation in size of the red blood cells. Usually red blood cells are a standard size. Certain disorders, however, cause a significant variation in cell size.

Obtaining the blood sample

The RBC indices test requires 0.17–0.24 oz (5-7 ml) of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Preparation

The doctor should check to see if the patient is taking any medications that may affect test results. The patient does not need to fast before the test.

Aftercare

Aftercare consists of routine care of the area around the puncture mark. Pressure is applied for a few seconds and the wound is covered with a bandage.

Risks

The primary risk is mild **dizziness** and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

Normal results

Normal results for red blood cell indices are as follows:

- MCV 82–98 fl (femtoliters)
- MCHC 31–37 g/dl
- MCH 26–34 pg (picograms)
- RDW 11.5–14.5%

Abnormal results

The category into which a person's anemia is placed based on the indices provides a significant clue as to the cause of the anemia, but further testing is needed to confirm a specific diagnosis.

The most common causes of macrocytic anemia (high MCV) are vitamin B_{12} and folic acid deficiencies. Lack of iron in the diet, **thalassemia** (a type of hereditary anemia), and chronic illness are the most common causes of microcytic anemia (low MCV). Normocytic anemia (normal MCV) can be caused by kidney and liver disease, bone marrow disorders, or excessive bleeding or hemolysis of the red blood cells.

Lack of iron in the diet and thalassemia are the most common causes of hypochromic anemia (low MCHC). Normocytic anemias are usually also normochromic and share the same causes (normal MCHC).

The RDW is increased in anemias caused by deficiencies of iron, vitamin B_{12}, or folic acid. Abnormal hemoglobins, such as in sickle cell anemia, can change the shape of red blood cells as well as cause them to hemolyze. The abnormal shape and the cell fragments resulting from hemolysis increase the RDW. Conditions that cause more immature cells to be released into the bloodstream, such as severe blood loss, will increase the RDW. The larger size of immature cells creates a distinct size variation.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy James Pagana, eds. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Nancy J. Nordenson

Red blood cell test *see* **Hemoglobin test**

Reduced-sized liver transplantation *see* **Liver transplantation**

Reflex sympathetic dystrophy

Definition

Reflex sympathetic dystrophy is the feeling of **pain** associated with evidence of minor nerve injury.

Description

Historically, reflex sympathetic dystrophy (RSD) was noticed during the civil war in patients who suffered

pain following gunshot **wounds** that affected the median nerve (a major nerve in the arm). In 1867 the condition was called causalgia form the Greek term meaning "burning pain." Causalgia refers to pain associated with major nerve injury. The exact causes of RSD are still unclear. Patients usually develop a triad of phases. In the first phase, pain and sympathetic activity is increased. Patients will typically present with swelling (**edema**), stiffness, pain, increased vascularity (increasing warmth), hyperhydrosis, and x-ray changes demonstrating loss of **minerals** in bone (demineralization). The second phase develops three to nine months later, It is characterized by increased stiffness and changes in the extremity that include a decrease in warmth and atrophy of the skin and muscles. The late phase commencing several months to years later presents with a pale, cold, painful, and atrophic extremity. Patients at this stage will also have **osteoporosis**.

It has been thought that each phase relates to a specific nerve defect that involves nerve tracts from the periphery spinal cord to the brain. Both sexes are affected, but the number of new cases is higher in women, adolescents, and young adults. RDS has been associated with other terms such as Sudeck's atrophy, post-traumatic osteoporosis, causalgia, shoulder-hand syndrome, and reflex neuromuscular dystrophy.

Causes and symptoms

The exact causes of RSD at present is not clearly understood. There are several theories such as sympathetic overflow (over activity), abnormal circuitry in nerve impulses through the sympathetic system, and as a post-operative complication for both elective and traumatic surgical procedures. Patients typically develop pain, swelling, temperature, color changes, and skin and muscle wasting.

Diagnosis

The diagnosis is simple and confirmed by a local anesthetic block along sympathetic nerve paths in the hand or foot, depending on whether an arm or leg is affected. A test called the **erythrocyte sedimentation rate** (ESR) can be performed to rule out diseases with similar presentation and arising from other causes.

Treatment

The preferred method to treat RSD includes sympathetic block and physical therapy. Pain is improved as motion of the affected limb improves. Patients may also require tranquilizers and mild **analgesics**. Patients who received repeated blocks should consider surgical symathectomy (removal of the nerves causing pain).

KEY TERMS

Atrophy—Abnormal changes in a cell that lead to loss of cell structure and function.

Osteoporosis—Reduction in the quantity of bone.

Prognosis

The prognosis for treatment during phase one is favorable. As the disease progresses undetected into phase two or three the prognosis for recovery is poor.

Prevention

There is no known prevention since the cause is not clearly understood.

Resources

BOOKS

Canale, S., Terry, et al. *Campbell's Operative Orthopaedics*. 9th ed. Mosby, Inc., 1998.

Goetz, Christopher G., et al, eds. *Textbook of Clinical Neurology.* 1st ed. W. B. Saunders Company, 1999.

Rockwood, Charles A., and David P. Green, et al. *Fractures in Adults*. 4th ed. Lippincott-Raven Publishers, 1996.

Ruddy, Shaun, et al, eds. *Kelly's Textbook of Rheumatology.* 6th ed. W. B. Saunders Company, 2001.

OTHER

Reflex Sympathetic Dystrophy Syndrome Association of America. <http://www.rsds.org/fact.html>.

Laith Farid Gulli, M.D.
Robert Ramirez, B.S.

Reflex tests

Definition

Reflex tests are simple physical tests of nervous system function.

Purpose

A reflex is a simple nerve circuit. A stimulus, such as a light tap with a rubber hammer, causes sensory neurons (nerve cells) to send signals to the spinal cord. Here, the signals are conveyed both to the brain and to nerves that control muscles affected by the stimulus. Without

any brain intervention, these muscles may respond to an appropriate stimulus by contracting.

Reflex tests measure the presence and strength of a number of reflexes. In so doing, they help to assess the integrity of the nerve circuits involved. Reflex tests are performed as part of a neurological exam, either a "mini-exam" done to quickly confirm integrity of the spinal cord, or a more complete exam performed to diagnose the presence and location of **spinal cord injury** or neuromuscular disease.

Deep tendon reflexes are responses to muscle stretch. The familiar "knee-jerk" reflex is an example; this reflex tests the integrity of the spinal cord in the lower back region. The usual set of deep tendon reflexes tested, involving increasingly higher regions of the spinal cord, are:

- ankle
- knee
- abdomen
- forearm
- biceps
- triceps

Another type of reflex test is called the Babinski test, which involves gently stroking the sole of the foot to assess proper development of the spine and cerebral cortex.

Precautions

Reflex tests are entirely safe, and no special precautions are needed.

Description

The examiner positions the patient in a comfortable position, usually seated on the examination table with legs hanging free. The examiner uses a rubber mallet to strike different points on the patient's body, and observes the response. The examiner may position, or hold, one of the limbs during testing, and may require exposure of the ankles, knees, abdomen, and arms. Reflexes can be difficult to elicit if the patient is paying too much attention to the stimulus. To compensate for this, the patient may be asked to perform some muscle contraction, such as clenching teeth or grasping and pulling the two hands apart. When performing the Babinski reflex test, the doctor will gently **stroke** the outer soles of the patient's feet with the mallet while checking to see whether or not the big toe extends out as a result.

Normal results

The strength of the response depends partly on the strength of the stimulus. For this reason, the examiner will attempt to elicit the response with the smallest stimulus possible. Learning the range of normal responses requires some clinical training. Responses should be the same for both sides of the body. A normal response to the Babinski reflex test depends upon the age of the person being examined. In children under the age of one and a half years, the big toe will extend out with or without the other toes. This is due to the fact that the fibers in the spinal cord and cerebral cortex have not been completely covered in myelin, the protein and lipid sheath that aids in processing neural signals. In adults and children over the age of one and a half years, the myelin sheath should be completely formed, and, as a result, all the toes will curl under (planter flexion reflex).

Abnormal results

Weak or absent response may indicate damage to the nerves outside the spinal cord (**peripheral neuropathy**), damage to the motor neurons just before or just after they leave the spinal cord (motor neuron disease), or muscle disease. Excessive response may indicate spinal cord damage above the level controlling the hyperactive response. Different responses on the two sides of the body may indicate early onset of progressive disease, or localized nerve damage, as from trauma. An adult or older child who responds to the Babinski with an extended big toe may have a lesion in the spinal cord or cerebral cortex.

Resources

BOOKS

Marsden, C. David, et al., eds. *Neurology in Clinical Practice.* 2nd ed. Oxford, UK: Butterworth-Heinemann, 1996.

Spillane, J. A. *Bickerstaff's Neurological Examination in Clinical Practice*. 6th ed. Oxford, UK: Blackwell Science, 1996.

OTHER

Rathe, Richard. "The Neurological Exam." *A Healthy Me Page.* 2 July 1997 <http://www.ahealthyme.com>.

Richard Robinson

Reflexology

Definition

Reflexology is a therapeutic method of relieving **pain** by stimulating predefined pressure points on the feet and hands. This controlled pressure alleviates the source of the discomfort. In the absence of any particular malady or abnormality, reflexology may be as effective for pro-

moting good health and for preventing illness as it may be for relieving symptoms of **stress**, injury, and illness.

Reflexologists work from maps of predefined pressure points that are located on the hands and feet. These pressure points are reputed to connect directly through the nervous system and affect the bodily organs and glands. The reflexologist manipulates the pressure points according to specific techniques of reflexology therapy. By means of this touching therapy, any part of the body that is the source of pain, illness, or potential debility can be strengthened through the application of pressure at the respective foot or hand location.

Purpose

Reflexology promotes healing by stimulating the nerves in the body and encouraging the flow of blood. In the process, reflexology not only quells the sensation of pain, but relieves the source of the pain as well.

Anecdotally, reflexologists claim success in the treatment of a variety of conditions and injuries. One condition is **fibromyalgia**. People with this disease are encouraged to undergo reflexology therapy to alleviate any of a number of chronic bowel syndromes associated with the condition. Frequent brief sessions of reflexology therapy are also recommended as an alternative to drug therapy for controlling the muscle pain associated with fibromyalgia and for relieving difficult breathing caused by tightness in the muscles of the patient's neck and throat.

Reflexology applied properly can alleviate allergy symptoms, as well as stress, back pain, and chronic **fatigue**. The techniques of reflexology can be performed conveniently on the hand in situations where a session on the feet is not practical, although the effectiveness of limited hand therapy is less pronounced than with the foot pressure therapy.

Description

Origins

Reflexology is a healing art of ancient origin. Although its origins are not well documented, there are reliefs on the walls of a Sixth Dynasty Egyptian tomb (c. 2450 B.C.) that depict two seated men receiving massage on their hands and feet. From Egypt, the practice may have entered the Western world during the conquests of the Roman Empire. The concepts of reflexology have also been traced to pre-dynastic China (possibly as early as 3000 B.C.) and to ancient Indian medicine. The Inca civilization may have subscribed to the theories of reflexology and passed on the practice of this treatment to the Native Americans in the territories that eventually entered the United States.

In recent times, Sir Henry Head first investigated the concepts underlying reflexology in England in the 1890s. Therapists in Germany and Russia were researching similar notions at approximately the same time, although with a different focus. Less than two decades later, a physician named William H. Fitzgerald presented a similar concept that he called zone analgesia or zone therapy. Fitzgerald's zone analgesia was a method of relieving pain through the application of pressure to specific locations throughout the entire body. Fitzgerald divided the body into 10 vertical zones, five on each side, that extended from the head to the fingertips and toes, and from front toback. Every aspect of the human body appears in one of these 10 zones, and each zone has a reflex area on the hands and feet. Fitzgerald and his colleague, Dr. Edwin Bowers, demonstrated that by applying pressure on one area of the body, they could anesthetize or reduce pain in a corresponding part. In 1917, Fitzgerald and Bowers published *Relieving Pain at Home*, an explanation of zone therapy.

Later, in the 1930s, a physical therapist, Eunice D. Ingham, explored the direction of the therapy and made the startling discovery that pressure points on the human foot were situated in a mirror image of the corresponding organs of the body with which the respective pressure points were associated. Ingham documented her findings, which formed the basis of reflexology, in *Stories the Feet Can Tell*, published in 1938. Although Ingham's work in reflexology was inaccurately described as zone therapy by some, there are differences between the two therapies of pressure analgesia. Among the more marked differences, reflexology defines a precise correlation between pressure points and afflicted areas of the body. Furthermore, Ingham divided each foot and hand into 12 respective pressure zones, in contrast to the 10 vertical divisions that encompass the entire body in Fitzgerald's zone therapy.

In 1968 two siblings, Dwight Byers and Eusebia Messenger, established the National Institute of Reflexology. By the early 1970s the institute had grown and was renamed the International Institute of Reflexology.

In a typical reflexology treatment, the therapist and patient have a preliminary discussion prior to therapy, to enable the therapist to focus more accurately on the patient's specific complaints and to determine the appropriate pressure points for treatment.

A reflexology session involves pressure treatment that is most commonly administered in foot therapy sessions of approximately 40–45 minutes in duration. The foot therapy may be followed by a brief 15-minute hand

therapy session. No artificial devices or special equipment are associated with this therapy. The human hand is the primary tool used in reflexology. The therapist applies controlled pressure with the thumb and forefinger, generally working toward the heel of the foot or the outer palm of the hand. Most reflexologists apply pressure with their thumbs bent; however, some also use simple implements, such as the eraser end of a pencil. Reflexology therapy is not massage, and it is not a substitute for medical treatment.

Reflexology is a complex system that identifies and addresses the mass of 7,000 nerve endings that are contained in the foot. Additional reflexology addresses the nerves that are located in the hand. This is a completely natural therapy that affords relief without the use of drugs. The Reflexology Association of America (RAA) formally discourages the use of oils or other preparations in performing this hands-on therapy.

Preparations

In order to realize maximum benefit from a reflexology session, the therapist as well as the patient should be situated so as to afford optimal comfort for both. Patients in general receive treatment in a reclining position, with the therapist positioned as necessary—to work on the bare feet, or alternately on the bare hands.

A reflexology patient removes both shoes and socks in order to receive treatment. No other preparation is involved. No prescription drugs, creams, oils, or lotions are used on the skin.

Precautions

Reflexology is extremely safe. It may even be self-administered in a limited form whenever desired. The qualified reflexologist offers a clear and open disclaimer that reflexology does not constitute medical treatment in any form, nor is reflexology given as a substitute for medical advice or treatment. The ultimate purpose of the therapy is to promote wellness; fundamentally it is a form of preventive therapy.

People with serious and long-term medical problems are urged to seek the advice of a physician. Diabetes patients in particular are urged to approach this therapy cautiously. Likewise pregnant women are cautioned emphatically to avoid reflexology during the early phases of **pregnancy** altogether, as accidentally induced labor and subsequent premature delivery can result from reflexology treatment.

A consultation with a reflexologist is recommended in order to determine the safety and appropriateness of reflexology therapy for a specific health problem or condition.

EUNICE INGHAM (1889–1974)

Eunice D. Ingham was born on February 24, 1889. A physical therapist by occupation, she was a colleague of Dr. Shelby Riley, who along with Dr. W. H. Fitzgerald actively developed zone therapy, a similar but distinct therapy from reflexology. Unlike reflexology, zone therapy does not connect the zones with the body as a whole. In the 1930s, Ingham discovered an unmistakable pattern of reflexes on the human foot; she subsequently devoted the rest of her life to publicizing the message of reflexology until shortly before her death on December 10, 1974.

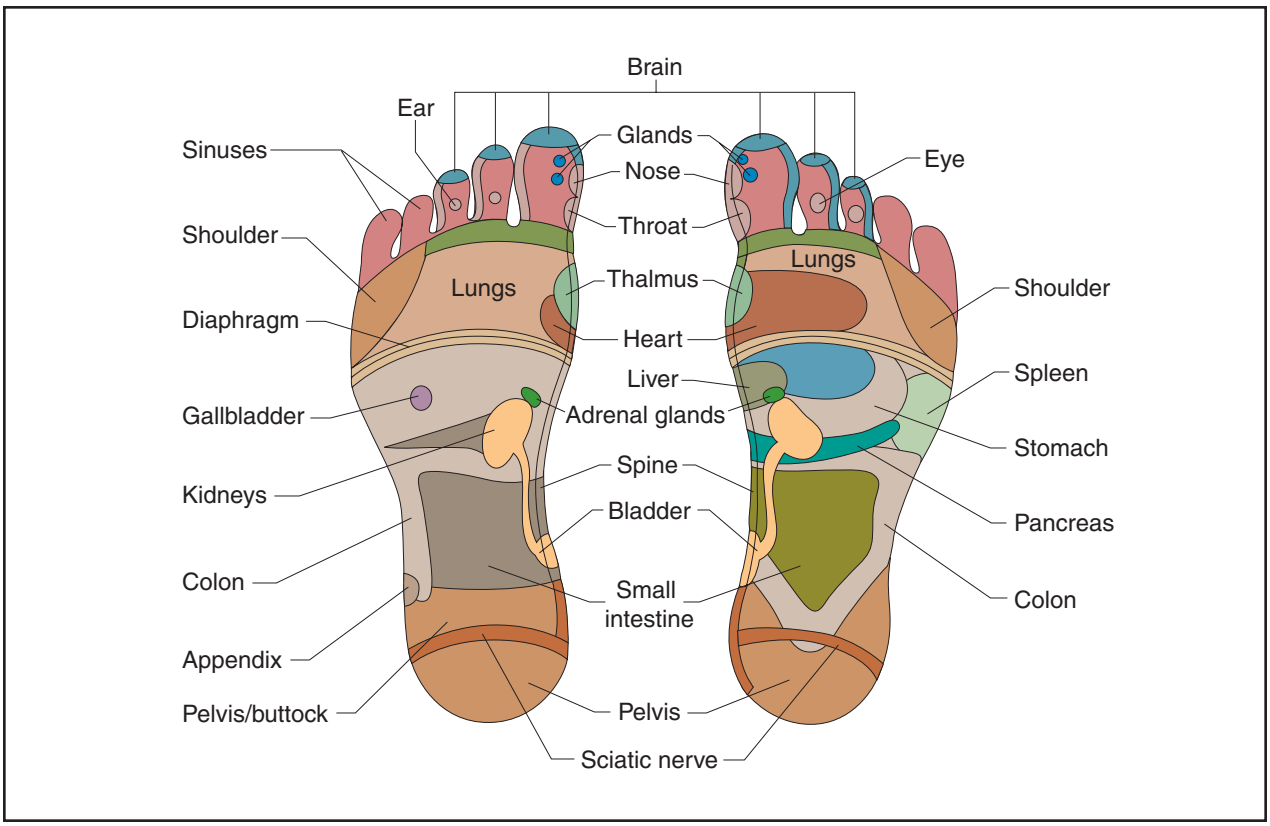
Ingham traveled and lectured widely about reflexology, initially to audiences of extremely desperate or aging patients who had lost hope in finding relief. Because of their sometimes astonishing improvement, reflexology became better known and respected among the medical community and gained credibility for its therapeutic value. Ingham described her theories of reflexology in her 1938 book, entitled *Stories the Feet Can Tell*, which included a map of the reflex points on the feet and the organs that they parallel. The book was translated into seven languages, although it was erroneously published as *Zone Therapy* in some countries, an error which led to misunderstanding about the true nature of reflexology and inaccurately linked it to zone therapy.

Side effects

Because reflexology is intended to normalize the body functions, the therapy does not cause a condition to worsen. Most patients find that pain diminishes over the course of the therapy. It has been noted, however, that some patients experience greater discomfort in the second session than in the first session, because a significant easing of pain and tension is generally associated with the initial therapy session. As a result, when pressure is reapplied to the tender points of the foot during the second session, the sensitivity has been heightened. This increase in sensitivity may cause minor additional discomfort for the patient.

Research and general acceptance

Although only one controlled trial of reflexology therapy, done in 1993, has been documented in medical journals, this therapy is practiced worldwide at different levels of medical care. In Russia, for example, only licensed physicians may legally perform reflexology treatment. In contrast, the practice is a commonplace homestyle remedy in the Netherlands. The Internet "Home of Reflexology" lists at least 66 professional



Reflexology employs the principle that the reflex points on the feet, when hand pressure is applied, will reflexively stimulate energy to a related muscle or organ in the body and promote healing. *(Illustration by Electronic Illustrators Group.)*

organizations worldwide, including New Zealand and Malaysia. Associations include the following:

- Academy of Reflexology Austria
- Association of Finnish Reflexologists
- Chinese Society of Reflexologists
- Hellenic Association of Reflexologists
- Indian Society for Promotion of Reflexology
- International Council of Reflexologists (HQ: San Diego, USA)
- Israeli Reflexology Association
- New Zealand Reflexology Association
- Polish Instytut of Reflexology (Polish Language)
- Reflexology Association of America
- Reflexology Association of Australia
- Rwo-Shr Health Institute International (Malaysia)
- The South African Reflexology Society

Regulatory status

Ongoing legislative debate ensued during the 1990s regarding the legal status of the reflexology trade. The reflexology community, along with legislators and other bodywork practitioners, engaged in reassessment of the reflexology business and its relationship to **massage therapy** and massage parlors. Organizations and individuals brought judicial appeals of certain court cases that threatened the legitimate licensing of reflexologists as practitioners of alternative medicine. Such professional reflexology interests as the RAA documented in detail the disparities between reflexology and massage, citing the purpose of reflexology, which is to stimulate internal body functions (glands and organs) as opposed to the topical muscular and joint relief associated with massage. In a status update in 1998 the Association reported that 19 states had laws requiring the licensing of massage/reflexology therapists. Licensing laws established educational requirements and required candidates to pass written, oral, and/or practical examinations.

Also at issue was a trend among municipalities to license massage parlors (and reflexologists) under the business codes affecting the adult entertainment business. B. and K. Kunz reported that judicial decisions in two states—Tennessee and New Mexico—had excluded the practice of reflexology practice from the laws pertaining

to massage parlors. Those courts held that reflexology is a business separate and distinct from massage parlors, and deserving of its own respective licensing standards. In Sacramento, California, reflexologists petitioned successfully to become licensed as practitioners of somatic therapy rather than as providers of adult entertainment. Likewise, in the Canadian province of Ontario, a nonprofit organization to register reflexology practitioners was established in order to define a distinct classification for therapists separate from erotic body rubbers, which was the original classification given to reflexologists. Other states where court proceedings or legislative attempts to legitimize reflexology have stalled include Pennsylvania, Florida, New Jersey, and New York

Training and certification

Training programs

Reflexology is taught by means of a series of seminars, classes, and training films. Certification is earned after a six month program that includes 200 hours of training. The certification training breaks down as follows: 28 hours of preliminary seminar training; 14 hours of advanced seminar training; 58 hours of self-directed study; and 100 hours of practical experience, including administering reflexology to a minimum of 15 people.

Specific aspects of the training include instruction in the assessment of the pressure points on the feet and hands through a study of human anatomy. Students also learn to give reflexology sessions to patients along with specific techniques for working with the hands.

Certification and advanced certification

As part if its function, the independently organized American Reflexology Certification Board (ARCB) certifies the competency of reflexology practitioners on an individual basis. The ARCB does not evaluate schools and teachers. Prerequisites for individual certification include completion of educational requirements and passing a standard qualifying examiniation. Successful candidates receive the title of Board Certified Reflexologist.

Minimum qualifications to take the certification examination include attendance at an advanced seminar within two years prior to taking the examination. In addition, the applicant must have attended preliminary seminars for two full days—in addition to the required day of advanced seminar training—and the applicant is required to have a minimum of six months of practical experience in administering the therapy. Applicants are examined by means of both written tests and practical demonstrations.

Continuing education certification is available. Advanced training focuses on mastering the ability to perform hand reflexology. The therapist also receives instruction in new and advanced techniques of basic reflexology. Some reflexology training classes may be applied toward degree programs in other disciplines, depending on the specific course of study and the certification of the respective training institutions involved.

The RAA provides published standards of practice for reflexologists.

KEY TERMS

Pressure points—Specific locations on the feet and hands that correspond to nerve endings that connect to the organs and glands of the human body via the spinal cord.

Zone therapy—Also called zone analgesia, a method of relieving pain by applying pressure to specific points on the body. It was developed in the early twentieth century by Dr. William Fitzgerald.

Resources

BOOKS

Byers, Dwight. *Better Health with Foot Reflexology: The Original Ingham Method.* 1983.

Dougans, Inge. *The Complete Illustrated Guide to Reflexology.* New York: Barnes & Noble, 1996.

Stein, Diane. "Foot and Hand Reflexology." In *All Women Are Healers: A Comprehensive Guide to Natural Healing.* Freedom, CA: The Crossing Press, 1990.

ORGANIZATIONS

International Institute of Reflexology. P.O. Box 12642. St. Petersburg, FL 33733-2642. (727) 343-4811. Fax: (727) 381-2807. <fteflex@concentric.net>.

Reflexology Association of America. 4012 Rainbow St. KPMB#585. Las Vegas, NV 89103-2059.

Gloria Cooksey

Refsum's syndrome *see* **Lipidoses**

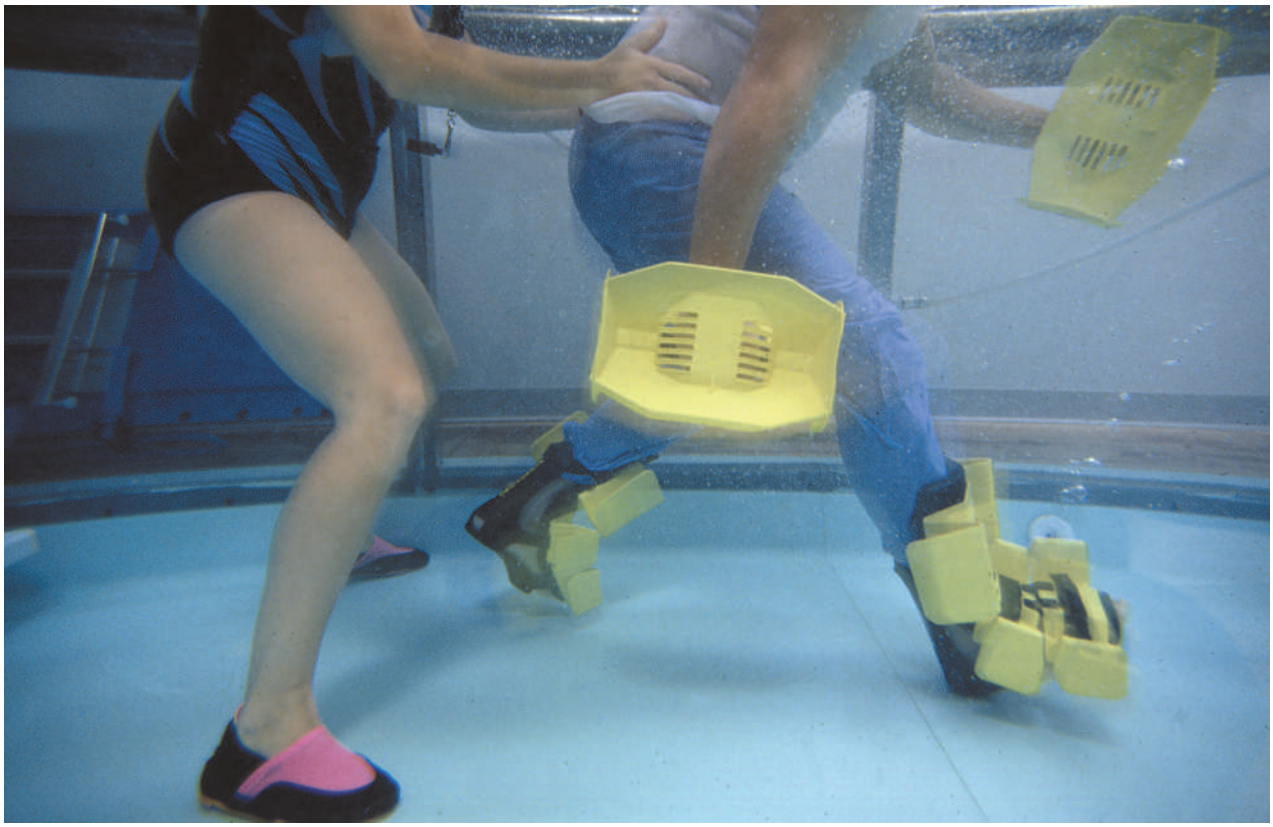
Regional anesthetic *see* **Anesthesia, local**

Regional enteritis *see* **Crohn's disease**

Rehabilitation

Definition

Rehabilitation is a treatment or treatments designed to facilitate the process of recovery from injury, illness, or disease to as normal a condition as possible.



A patient (holding paddles) is undergoing a hydrotherapy treatment. *(Photograph by Will & Deni McIntyre, Photo Researchers, Inc. Reproduced by permission.)*

Purpose

The purpose of rehabilitation is to restore some or all of the patient's physical, sensory, and mental capabilities that were lost due to injury, illness, or disease. Rehabilitation includes assisting the patient to compensate for deficits that cannot be reversed medically. It is prescribed after many types of injury, illness, or disease, including amputations, arthritis, **cancer**, cardiac disease, neurological problems, orthopedic injuries, spinal cord injuries, **stroke**, and traumatic brain injuries.The Institute of Medicine has estimated that as many as 14% of all Americans may be disabled at any given time.

Precautions

Rehabilitation should be carried out only by qualified therapists. Exercises and other physical interventions must take into account the patient's deficit. An example of a deficit is the loss of a limb.

Description

A proper and adequate rehabilitation program can reverse many disabling conditions or can help patients cope with deficits that cannot be reversed by medical care. Rehabilitation addresses the patient's physical, psychological, and environmental needs. It is achieved by restoring the patient's physical functions and/or modifying the patient's physical and social environment. The main types of rehabilitation are physical, occupational, and speech therapy.

Each rehabilitation program is tailored to the individual patient's needs and can include one or more types of therapy. The patient's physician usually coordinates the efforts of the rehabilitation team, which can include physical, occupational, speech, or other therapists; nurses; engineers; physiatrists (physical medicine); psychologists; orthotists (makes devices such as braces to straighten out curved or poorly shaped bones); prosthetists (a therapist who makes artificial limbs or protheses); and vocational counselors. Family members are often actively involved in the patient's rehabilitation program.

Physical therapy

Physical therapy helps the patient restore the use of muscles, bones, and the nervous system through the use of heat, cold, massage, whirlpool baths, ultrasound,

exercise, and other techniques. It seeks to relieve **pain**, improve strength and mobility, and train the patient to perform important everyday tasks. Physical therapy may be prescribed to rehabilitate a patient after amputations, arthritis, **burns**, cancer, cardiac disease, cervical and lumbar dysfunction, neurological problems, orthopedic injuries, pulmonary disease, spinal cord injuries, stroke, traumatic brain injuries, and other injuries/illnesses. The duration of the physical therapy program varies depending on the injury/illness being treated and the patient's response to therapy.

Exercise is the most widely used and best known type of physical therapy. Depending on the patient's condition, exercises may be performed by the patient alone or with the therapist's help, or with the therapist moving the patient's limbs. Exercise equipment for physical therapy could include an exercise table or mat, a stationary bicycle, walking aids, a wheelchair, practice stairs, parallel bars, and pulleys and weights.

Heat treatment, applied with hot-water compresses, infrared lamps, short-wave radiation, high frequency electrical current, ultrasound, paraffin wax, or warm baths, is used to stimulate the patient's circulation, relax muscles, and relieve pain. Cold treatment is applied with ice packs or cold-water soaking. Soaking in a whirlpool can ease muscle spasm pain and help strengthen movements. Massage aids circulation, helps the patient relax, relieves pain and muscle spasms, and reduces swelling. Very low strength electrical currents applied through the skin stimulate muscles and make them contract, helping paralyzed or weakened muscles respond again.

Occupational therapy

Occupational therapy helps the patient regain the ability to do normal everyday tasks. This may be achieved by restoring old skills or teaching the patient new skills to adjust to disabilities through adaptive equipment, orthotics, and modification of the patient's home environment. Occupational therapy may be prescribed to rehabilitate a patient after **amputation**, arthritis, cancer, cardiac disease, head injuries, neurological injuries, orthopedic injuries, pulmonary disease, spinal cord disease, stroke, and other injuries/illnesses. The duration of the occupational therapy program varies depending on the injury/illness being treated and the patient's response to therapy.

Occupational therapy includes learning how to use devices to assist in walking (artificial limbs, canes, crutches, walkers), getting around without walking (wheelchairs or motorized scooters), or moving from one spot to another (boards, lifts, and bars). The therapist will visit the patient's home and analyze what the patient can and cannot do. Suggestions on modifications to the home, such as rearranging furniture or adding a wheelchair ramp, will be made. Health aids to bathing and grooming could also be recommended.

Speech therapy

Speech therapy helps the patient correct **speech disorders** or restore speech. Speech therapy may be prescribed to rehabilitate a patient after a brain injury, cancer, neuromuscular diseases, stroke, and other injuries/illnesses. The duration of the speech therapy program varies depending on the injury/illness being treated and the patient's response to therapy.

Performed by a speech pathologist, speech therapy involves regular meetings with the therapist in an individual or group setting and home exercises. To strengthen muscles, the patient might be asked to say words, smile, close his mouth, or stick out his tongue. Picture cards may be used to help the patient remember everyday objects and increase his vocabulary. The patient might use picture boards of everyday activities or objects to communicate with others. Workbooks might be used to help the patient recall the names of objects and practice reading, writing, and listening. Computer programs are available to help sharpen speech, reading, recall, and listening skills.

Other types of therapists

Inhalation therapists, audiologists, and registered dietitians are other types of therapists. Inhalation therapists help the patient learn to use respirators and other breathing aids to restore or support breathing. Audiologists help diagnose the patient's **hearing loss** and recommend solutions. Dietitians provide dietary advice to help the patient recover from or avoid specific problems or diseases.

Rehabiltation centers

Rehabilitation services are provided in a variety of settings including clinical and office practices, hospitals, skilled-care nursing homes, sports medicine clinics, and some health maintenance organizations. Some therapists make home visits. Advice on choosing the appropriate type of therapy and therapist is provided by the patient's medical team.

Resources

BOOKS

Hertling, Darlene, and Randolph Kessler. *Management of Common Musculoskeletal Disorders: Physical Therapy Principles and Methods*. 3rd ed. Philadelphia: Lippincott, 1996.

Institute of Medicine. *Enabling America: Assessing the Role of Rehabilitation Science and Engineering*. Washington, DC: National Academy Press, 1997.

KEY TERMS

Orthotist—A health care professional who is skilled in making and fitting orthopedic appliances.

Physiatrist—A physician who specializes in physical medicine.

Prosthetist—A health care professional who is skilled in making and fitting artificial parts (prosthetics) for the human body.

Myers, Rose Sgarlat. *Saunders Manual of Physical Therapy.* Philadelphia: W. B. Saunders Co., 1995.

Oxford Medical Publications. *Oxford Textbook of Sports Medicine.* Oxford, UK: Oxford University Press, 1994.

Pedretti, Lorraine Williams, ed. *Occupational Therapy: Practice Skills for Physical Disfunction.* 4th ed. St. Louis: Mosby, 1996.

PERIODICALS

Bloom, Marc. "Know Thy Injury." *Women's Sports & Fitness* (May 1997): 81.

Enderby, Pam. "Speech and Language Therapy: Does It Work?" *Student British Medical Journal* 4, no. 43 (Aug. 1996): 282.

"Speech After Stroke: Rehabilitation Enhances Recovery and Lifestyle." *Mayo Clinic Health Letter* (Aug. 1996).

ORGANIZATIONS

National Rehabilitation Association. 633 S. Washington St., Alexandria, VA 22314. (703) 836-0850.

National Rehabilitation Information Center. 8455 Colesville Road, Suite 935, Silver Spring, MD 20910. (800) 34-NARIC.

Rehabilitation International. 25 East 21st St., New York, NY 10010. (212) 420-1500.

OTHER

"Speech-Language Pathology," "Physical Therapy," and "Occupational Therapy." *A Healthy Me Page.* 27 Feb.1998. 15 Apr. 1998 <http://www.ahealthyme.com/topic/topic100587394>.

Lori De Milto

Rehydration *see* **Intravenous rehydration**

Reiki

Definition

Reiki is a form of therapy that uses simple hands-on, no-touch, and visualization techniques, with the goal of improving the flow of life energy in a person. Reiki (pronounced *ray-key*) means "universal life energy" in Japanese, and Reiki practitioners are trained to detect and alleviate problems of energy flow on the physical, emotional, and spiritual level. Reiki touch therapy is used in much the same way to achieve similar effects that traditional **massage therapy** is used—to relieve **stress** and **pain**, and to improve the symptoms of various health conditions.

Purpose

Reiki claims to provide many of the same benefits as traditional massage therapy, such as reducing stress, stimulating the immune system, increasing energy, and relieving the pain and symptoms of health conditions. Practitioners have reported success in helping patients with acute and chronic illnesses, from **asthma** and arthritis to trauma and recovery from surgery. Reiki is a gentle and safe technique, and has been used successfully in some hospitals. It has been found to be very calming and reassuring for those suffering from severe or fatal conditions. Reiki can been used by doctors, nurses, psychologists and other health professionals to bring touch and deeper caring into their healing practices.

Description

Origins

Reiki was developed in the mid-1800s by Dr. Mikao Usui, a Japanese scholar of religion. According to the story that has been passed down among reiki teachers, Usui was a Christian who was intrigued by the idea that Christ could heal sick people by touching them with his hands. Searching for clues that would explain the secrets of healing with hands, Usui made a long pilgrimage around the world, visiting many ancient religious sects and studying ancient books. Some reiki teachers claim that Usui found clues leading back nearly 10,000 years to healing arts that originated in ancient Tibet. During his intense studies, Usui claimed he had a spiritual experience, which enabled him to heal with his own hands by becoming aware of and tapping into the universal life force. After that, he dedicated his life to helping the sick and poor. His reputation grew as he healed sick people for many years in Kyoto, Japan. Before his **death**, Usui passed on his healing insights using universal life energy to Dr. Chujiru Hayashi, a close acquaintance. Hayashi, in turn, passed on the healing techniques in 1938 to Hawayo Takata, a Japanese woman from Hawaii, whom he had cured of life-threatening illness using reiki methods. Takata became a firm believer and proponent of reiki, and during the 1970s formed an initiation program for training reiki masters to preserve Usui's teachings. Before she died, she prepared her granddaughter, Phyllis Lei Furumoto, to continue the

lineage. Takata had personally trained 21 practitioners before she died at the age of 80 in 1980. Along with other reiki masters authorized by Takata, Furumoto formed the reiki Alliance. A faction led by Barbara Ray, formed the American Reiki Association, which was known as Radiance Technique Association International. Today, there are over 1,000 reiki masters practicing around the world, whose methods can all be traced back directly to Dr. Usui.

The basic philosophy of reiki

The basic idea of reiki is that the body has an energy field that is central to its health and proper functioning, and this energy travels in certain pathways that can become blocked or weakened. This idea of energy flow in the body is also a central concept in **Ayurvedic medicine** and **traditional Chinese medicine**, including **acupuncture**.

Reiki practitioners believe that everyone has the potential to access the universal life energy, but that over time most people's systems become blocked and the energy becomes weakened in them. A reiki practitioner is trained to be able to detect these blockages, and practitioners will use their hands, thoughts, and own energy fields to improve the energy flow in a patient. Reiki is one of the more esoteric alternative medical practices, because no one is sure exactly how it works on the physiological level. Practitioners claim that it works on very subtle energy levels, or possibly works on the *chakra* system. The chakras are the system of seven energy centers along the middle of the body believed to be connected with the nervous and endocrine systems, as defined by **yoga** and Ayurvedic medicine. Reiki masters claim that healing energy can even be sent to a person from far away, noting that reiki works on the same principles that enables praying to work for some patients, although a practitioner needs advanced training to be able to send energy from afar.

According to the original principles of Usui, patients must also have a proper attitude for reiki to work most effectively. Patients must take responsibility for their own health, and must want to be healed. Furthermore, when energy is received from a reiki healer, patients must be willing to give back energy to others, and to compensate the healer in some way, as well. Finally, Usui claimed that a healing attitude was free from worry and fear, was filled with gratitude for life and for others, and placed emphasis on each person finding honest and meaningful work in their lives—all this, in order to complete the picture of overall health.

A reiki session

Reiki sessions can take various forms, but most commonly resemble typical bodywork appointments, where the receiver lies clothed on his or her back on a flat surface or massage table. A session generally lasts from an hour to an hour and a half. Reiki is a simple procedure, consisting of calm and concentrated touching, with the practitioner focusing on healing and giving energy to specific areas on the receiver's body. Practitioners place their hands over positions on the body where the organs and endocrine glands reside, and the areas that correspond to the chakra centers. Practitioners also use mental visualization to send healing energy to areas of the receiver's body that need it. In special cases or with injuries, a no-touch technique is used, where the practitioner's hands are sometimes held just above the body without touching it. Advanced practitioners rely on intuition and experience to determine which areas of a body need the most energy healing.

The practitioner's hands are held flat against the receiver's body, with the fingertips touching. There can be over 20 positions on both sides of the body where the hands are placed. The positions begin at the crown of the head and move towards the feet. The receiver usually turns over once during the session. The practitioner's hands are held in each position for a usually five minutes,

MIKAO USUI (1865–1926)

Mikao Usui, born in the Gifu Prefecture (Japan), was an ethereal child who sought to unravel the mysteries of the universe. As an adult he developed an interest in the metaphysical healing talent of Buddha. Usui became determined to regenerate the healing secrets of Buddha in order to improve the lot of humanity. He traveled to many temples and spoke with holy people, but all said that the secret of Buddha's powers were lost to the world due to lack of use.

Eventually the abbot of a Zen monastery encouraged Usui to study the ancient writings containing the secrets on healing. Usui learned two new languages, Chinese and Sanskrit, in order to understand the writings better, and from his reading he obtained the formula for healing. The Sutras in particular provided the enlightenment that he sought.

Usui next set out to obtain the power to heal. It is widely believed that he developed that ability after spending 21 days in retreat and in fasting on the holy Mountain of Kori-yama, where he had a vision of light and received the knowledge of the symbols of reiki and their use in healing. He officially formulated Usui Reiki therapy in 1922 and touted as many as one million followers during his lifetime.

Prior to the transition (death) of Usui, he imparted the secrets of healing to 16 teachers in order that the secrets would not be lost again.

to allow the transfer of energy and the healing process to take place. In each position, the hands are kept stationary, unlike typical massage where the hands move, and both the giver and receiver attempt to maintain an attitude of awareness, openness, and caring.

Reiki practitioners recommend that those receiving reiki for the first time go through a series of three to four initial treatments over the course of about a week, to allow for cleansing and the initial readjustment of energy. Reiki sessions can cost from $30–100 per session. Insurance coverage is rare, and consumers should consult their individual policies as to whether or not such therapies are included.

Self-treatment with reiki

Although reiki practitioners believe that formal training is necessary to learn the proper methods of energy channeling and healing, individuals can still use some of the basic positions of reiki to relieve stress and to stimulate healing on themselves or another. The positions can be performed anywhere and for however long they are needed. Positions generally move from the top of the body down, but positions can be used wherever there is pain or stress. Mental attitude is important during reiki; the mind should be cleared of all stressful thoughts and concentrated on compassion, love, and peace as forms of energy that are surrounding, entering, and healing the body.

The following positions are illustrated in *Reiki: Energy Medicine:*

- Position one: Hands are placed on the top of the head, with the wrists near the ears and the fingertips touching on the crown of the head. Eyes should be closed. Hold for five minutes or more, until the mind feels clear and calm.
- Position two: Cup the hands slightly and place the palms over the closed eyes, with the fingers resting on the forehead.
- Position three: Place the hands on the sides of the head, with the thumbs behind the ear and the palms over the lower jaws, with the fingers covering the temples.
- Position four: Place one hand on the back of the neck, at the base of the skull, and put the other hand on the head just above it, parallel to it.
- Position five: Wrap the hands around the front of the throat, and rest them there gently with the heels of the hands touching in front.
- Position six: Place each hand on top of a shoulder, close to the side of neck, on top of the trapezius muscle.
- Position seven: Form a T-shape with the hands over the chest, with the left hand covering the heart and the right hand above it, covering the upper part of the chest.
- Position eight: The hands are placed flat against the front of the body with fingertips touching. Hold for five minutes or so, and repeat four or five times, moving down a hand-width each time until the pelvic region is reached, which is covered with a v-shape of the hands. Then, for the final position, repeat this technique on the back, beginning as close to the shoulders as the hands can reach, and ending by forming a T-shape with the hands at the base of the spine.

Side effects

Reiki generally has no side effects, as it is a very low impact and gentle procedure. Some receivers report tingling or sensations of heat or cold during treatment. Others have reported sadness or **anxiety** during treatment, which practitioners claim are buried or repressed emotions being released by the new energy flow.

Research and general acceptance

Reiki has been used in major clinics and hospitals as part of alternative healing practice, and doctors, dentists, nurses and other health professionals have been trained to use its gentle touch techniques as part of their practice. To date, the little scientific research that has been conducted with reiki implies that its techniques bring about the *relaxation response*, in which stress levels decrease, and immune response increases. Reiki practitioners claim that the most important measurement of their technique is whether the individual feels better after treatment. They also claim that science cannot measure the subtle energy changes that they are attempting to make.

Training and certification

Reiki practitioners undergo a series of *attunements*, which are sessions with reiki masters that teach the basic methods of energy healing. Several organizations provide resources for reiki training. Reiki practitioners believe these attunements are necessary for correct technique. The masters teach each person how to activate the universal life energy in themselves before they can pass it on to others. These initiations often are held during weekend workshops. Trainees can achieve up to four levels of attunements, until they reach the level of master themselves. The certification process is not a formal one; masters approve students when they feel satisfied with their progress.

Resources

BOOKS

Baginski, B. J. and, S. Sharamon. *Reiki: Universal Life Energy.* Mendocino, CA: LifeRhythm, 1988.

Barnett, Libby, and Maggie Chambers. *Reiki: Energy Medicine.* Rochester, VT: Healing Arts Press, 1996.

KEY TERMS

Attunement—Life energy teaching given by Reiki master to a student.

Chakra—One of seven major energy centers in the body, as defined by Hindu and yoga philosophy.

Relaxation response—Body's response to relaxation techniques, during which metabolism and stress levels decrease and immune response increases.

Brown, Fran. *Living Reiki: Takata's Teachings.* Mendocino, CA: LifeRhythm, 1992.

ORGANIZATIONS

The International Association of Reiki Professionals. P.O. Box 481, Winchester, MA 01890. <http://www.iarp. org>.

OTHER

American Reiki Masters Association (ARMA). PO Box 130, Lake City, FL 32056-0130. (904) 755-9638.

Center for Reiki Training. 29209 Northwestern Highway, #592, Southfield, MI 48034. (800) 332-8112.

Global Reiki Healing Network. <http://www.reiki.org>.

The Reiki Alliance. P.O. Box 41, Cataldo, ID 83810–1041, (208) 682-3535.

Douglas Dupler

Reiter's syndrome

Definition

Reiter's syndrome (RS), which is also known as arthritis urethritica, venereal arthritis, reactive arthritis, and polyarteritis enterica, is a form of arthritis that affects the eyes, urethra, and skin, as well as the joints. It was first described by Hans Reiter, a German physician, during World War I.

Description

Reiter's syndrome is marked by a cluster of symptoms in different organ systems of the body that may or may not appear simultaneously. The disease may be acute or chronic, with spontaneous remissions or recurrences.

RS primarily affects sexually active males between ages 20–40, particularly males who are HIV positive. Most women and children who develop RS acquire the disease in its intestinal form.

Causes and symptoms

The cause of Reiter's syndrome was unknown as of early 1998, but scientists think the disease results from a combination of genetic vulnerability and various disease agents. Over 80% of Caucasian patients and 50–60% of African Americans test positive for HLA-B27, which suggests that the disease has a genetic component. In sexually active males, most cases of RS follow infection with *Chlamydia trachomatis* or *Ureaplasma urealyticum*. Other patients develop the symptoms following gastrointestinal infection with *Shigella*, *Salmonella*, *Yersinia*, or *Campylobacter* bacteria.

The initial symptoms of RS are inflammation either of the urethra or the intestines, followed by acute arthritis four to 28 days later. The arthritis usually affects the fingers, toes, and weight-bearing joints in the legs. Other symptoms include:

- inflammation of the urethra, with painful urination and a discharge from the penis
- mouth ulcers
- inflammation of the eye
- keratoderma blennorrhagica. These are patches of scaly skin on the palms, soles, trunk, or scalp of RS patients

Diagnosis

Patient history

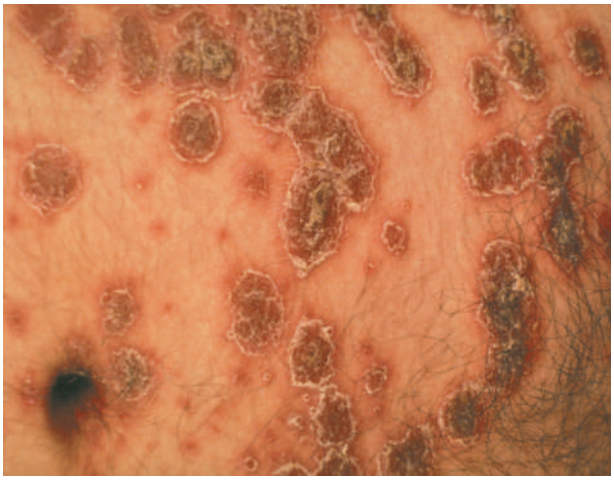
Diagnosis of Reiter's syndrome can be complicated by the fact that different symptoms often occur several weeks apart. The patient does not usually draw a connection between the arthritis and previous sexual activity. The doctor is likely to consider Reiter's syndrome when the patient's arthritis occurs together with or shortly following inflammation of the eye and the genitourinary tract lasting a month or longer.

Laboratory tests

There is no specific test for diagnosing RS, but the physician may have the urethral discharge cultured to rule out **gonorrhea**. Blood tests of RS patients are typically positive for the HLA-B27 genetic marker, with an elevated white blood cell (WBC) count and an increased sedimentation rate of red blood cells. The patient may also be mildly anemic.

Diagnostic imaging

X rays do not usually reveal any abnormalities unless the patient has had recurrent episodes of the disease. Joints that have been repeatedly inflamed may



Keratoderma, a skin condition characterized by horny patches, is one symptom of Reiter's syndrome. *(Photograph by Milton Reisch, M.D., Corbis Images. Reproduced by permission.)*

show eroded areas, signs of **osteoporosis**, or bony spurs when x rayed.

Treatment

There is no specific treatment for RS. Joint inflammation is usually treated with **nonsteroidal anti-inflammatory drugs** (NSAIDs.) Skin eruptions and eye inflammation can be treated with **corticosteroids**. Gold treatments may be given for eroded bone.

Patients with chronic arthritis are also given physical therapy and advised to **exercise** regularly.

Prognosis

The prognosis varies. Most patients recover in three to four months, but about 50% have recurrences for several years. Some patients develop complications that include inflammation of the heart muscle, stiffening inflammation of the vertebrae, **glaucoma**, eventual blindness, deformities of the feet, or accumulation of fluid in the lungs.

Prevention

In males, Reiter's syndrome can be prevented by sexual abstinence or the use of condoms.

Resources

BOOKS

Hellman, David B. "Arthritis & Musculoskeletal Disorders." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Lawson, William, and Anthony J. Reino. "Neoplastic and Non-neoplastic Lesions of the Oral Mucosa." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Magalini, Sergio I., et al. *Dictionary of Medical Syndromes.* Philadelphia: J. B. Lippincott Co., 1990.

"Musculoskeletal and Connective Tissue Disorders: Reiter's Syndrome (RS)." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Reiter Syndrome." In *Physicians' Guide to Rare Diseases*, ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Co. Inc., 1995.

"Reiter's Syndrome." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Theodosakis, Jason, et al. *The Arthritis Cure.* New York: St. Martin's Paperbacks, 1997.

Rebecca J. Frey

KEY TERMS

Acute—Having a sudden onset and lasting a short time.

Chronic—Of long duration.

Keratoderma blennorrhagica—The medical name for the patches of scaly skin that occur on the arms, legs, and trunk of RS patients.

Reactive arthritis—Another name for Reiter's syndrome.

Relapsing fever

Definition

Relapsing **fever** refers to two similar illnesses, both of which cause high fevers. The fevers resolve, only to recur again within about a week.

Description

Relapsing fever is caused by spiral-shaped bacteria of the genus *Borrelia*. This bacterium lives in rodents and in insects, specifically ticks and body lice. The form of relapsing fever acquired from ticks is slightly different from that acquired from body lice.

In tick-borne relapsing fever (TBRF), rodents (rats, mice, chipmunks, and squirrels) which carry *Borrelia* are

fed upon by ticks. The ticks then acquire the bacteria, and are able to pass it on to humans. TBRF is most common in sub-Saharan Africa, parts of the Mediterranean, areas in the Middle East, India, China, and the south of Russia. Also, *Borrelia* causing TBRF exist in the western regions of the United States, particularly in mountainous areas. The disease is said to be endemic to these areas, meaning that the causative agents occur naturally and consistently within these locations.

In louse-borne relapsing fever (LBRF), lice acquire *Borrelia* from humans who are already infected. These lice can then go on to infect other humans. LBRF is said to be epidemic, as opposed to endemic, meaning that it can occur suddenly in large numbers in specific communities of people. LBRF occurs in places where poverty and overcrowding predispose to human infestation with lice. LBRF has flared during wars, when conditions are crowded and good hygiene is next to impossible. At this time, LBRF is found in areas of east and central Africa, China, and in the Andes Mountains of Peru.

Causes and symptoms

In TBRF, humans contract *Borrelia* when they are fed upon by ticks. Ticks often feed on humans at night, so many people who have been bitten are unaware that they have been. The bacteria is passed on to humans through the infected body fluids of the tick.

In LBRF, a louse must be crushed or smashed in order for *Borrelia* to be released. The bacteria then enter the human body through areas where the person may have scratched him or herself.

Both types of relapsing fever occur some days after having acquired the bacteria. About a week after becoming infected, symptoms begin. The patient spikes a very high fever, with chills, sweating, terrible **headache**, nausea, vomiting, severe **pain** in the muscles and joints, and extreme weakness. The patient may become dizzy and confused. The eyes may be bloodshot and very sensitive to light. A **cough** may develop. The heart rate is greatly increased, and the liver and spleen may be swollen. Because the substances responsible for blood clotting may be disturbed during the illness, tiny purple marks may appear on the skin, which are evidence of minor bleeding occurring under the skin. The patient may suffer from a **nosebleed**, or may cough up bloody sputum. All of these symptoms last for about three days in TBRF, and about five days in LBRF.

With or without treatment, a crisis may occur as the bacteria are cleared from the blood. This crisis, called a Jarisch-Herxheimer reaction, results in a new spike in fever, chills, and an initial rise in blood pressure. The blood pressure then falls drastically, which may deprive tissues and organs of appropriate blood flow (shock). This reaction usually lasts for about a day.

Recurrent episodes of fever with less severe symptoms occur after about a week. In untreated infections, fevers recur about three times in TBRF, and only once or twice in LBRF.

Diagnosis

Diagnosis of relapsing fever is relatively easy, because the causative bacteria can be found by examining a sample of blood under the microscope. The characteristically spiral-shaped bacteria are easily identifiable. The blood is best drawn during the period of high fever, because the bacteria are present in the blood in great numbers at that time.

Treatment

Either tetracycline or erythromycin is effective against both forms of relapsing fever. The medications are given for about a week for cases of TBRF; LBRF requires only a single dose. Children and pregnant women should receive either erythromycin or penicillin. Because of the risk of the Jarish-Herxheimer reaction, patients must be very carefully monitored during the initial administration of antibiotic medications. Solutions containing salts must be given through a needle in the vein (intravenously) to keep the blood pressure from dropping too drastically. Patients with extreme reactions may need medications to improve blood circulation until the reaction resolves.

Prognosis

In epidemics of LBRF, **death** rates among untreated victims have run as high as 30%. With treatment, and careful monitoring for the development of the Jarish-Herxheimer reaction, prognosis is good for both LBRF and TBRF.

Prevention

Prevention of TBRF requires rodent control, especially in and near homes. Careful use of insecticides on skin and clothing is important for people who may be enjoying outdoor recreation in areas known to harbor the disease-carrying ticks.

Prevention of LBRF is possible, but probably more difficult. Good hygiene and decent living conditions would prevent the spread of LBRF, but these may be difficult for those people most at risk for the disease.

KEY TERMS

Endemic—Refers to a particular organism which consistently exists in a particular location under normal conditions.

Epidemic—Refers to a condition suddenly acquired by a large number of people within a specific community, and which spreads rapidly throughout that community.

Shock—A state in which the blood pressure is so low that organs and tissues are not receiving an appropriate flow of blood.

Resources

BOOKS

Dennis, David T., and Grant L. Campbell. "Relapsing Fever." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Spirochetes." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Anda, Pedro, et al. "A New Borrelia Species Isolated from Patients with Relapsing Fever in Spain." *The Lancet* 348, no. 9021 (20 July 1996): 162+.

Cooper, Randy I., and Thomas Neuhauser. "Borreliosis." *The New England Journal of Medicine*. 338, no. 4 (22 Jan. 1998): 231.

Newton, James A., and Patricia V. Pepper. "Relapsing Fever." *The New England Journal of Medicine* 335, no. 16 (17 Oct. 1996): 1197.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Relapsing polychondritis

Definition

Relapsing polychondritis is a disease characterized by autoimmune-like episodic or progressive inflammation of cartilage and other connective tissue, such as the nose, ears, throat, joints, kidneys, and heart.

Description

Cartilage is a tough, flexible tissue that turns into bone in many places in the body. Bones all start out as cartilage in the fetus. Consequently, children have more cartilage than adults. Cartilage persists in adults in the linings of joints, the ears, the nose, the airway and the ribs near the breast bone. All these sites are attacked by relapsing polychondritis, which usually occurs equally in middle-aged males and females. It is frequently diagnosed along with **rheumatoid arthritis**, **systemic lupus erythematosus**, and other connective tissue diseases.

Causes and symptoms

The most common first symptom of relapsing polychondritis is **pain** and swelling of the external ear. Usually, both ears turn red or purple and are tender to the touch. The swelling can extend into the ear canal and beyond, causing ear infections, **hearing loss**, balance disturbances with vertigo and vomiting, and eventually a droopy ear. The nose is often afflicted as well and can deteriorate into a flattened nose bridge called saddle nose. Inflammation of the eye occurs less frequently, but can lead to blindness.

As relapsing polychondritis advances, it causes more dangerous symptoms such as deterioration of the cartilage that holds the windpipe open. Progressive disease can destroy the integrity of the airway and compromise breathing. Destruction of the rib cartilage can collapse the chest, again hindering breathing. Joints everywhere are involved in episodes of arthritis, with pain and swelling. Other tissues besides cartilage are also involved, leading to a variety of problems with the skin and other tissues. Occasionally, the aorta or heart valves are damaged.

The disease may occur in episodes with complete remission between, or it may smolder along for years, causing progressive destruction.

Diagnosis

A characteristic array of symptoms and physical findings will yield a diagnosis of relapsing polychondritis. Laboratory tests are sometime helpful. Biopsies of the affected cartilage may confirm the diagnosis. Further diagnostic tests are done to confirm other associated conditions such as rheumatoid arthritis. It is important to evaluate the airway, although only 10% of patients will die from airway complications.

Treatment

Mild inflammations can be treated with **aspirin** or **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as ibuprofen. **Corticosteroids** (most often prednisone) are usually prescribed for more advanced conditions and do

KEY TERMS

Aorta—The biggest artery in the body, receiving blood directly from the heart.

Connective tissue—Several types of tissue that hold the body's parts together—tendons, ligaments, fascia, and cartilage.

Inflammation—The body's immune reaction to presumed foreign substances like germs. Inflammation is characterized by increased blood supply and activation of defense mechanisms. It produces redness, swelling, heat, and pain.

improve the disease. They may have to be continued over long periods of time, in which case their usage must be closely watched to avoid complications. Immune suppression with cyclophosphamide, azathioprine, cyclosporine, or dapsone is reserved for more aggressive cases. A collapsed chest or airway may require surgical support, and a heart valve or aorta may need repair or replacing.

Prognosis

There is no known cure for relapsing polychondritis. It can only be combated with each onset of inflammation and deterioration of cartilaginous tissue. As the disease progresses over a period of years, the mortality rate increases. At five years duration, relapsing polychondritis has a 30% mortality rate.

Resources

BOOKS

Gilliland, Bruce C. "Relapsing Polychondritis and Other Arthritides." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Nelson Textbook of Pediatrics. Ed. Waldo E. Nelson. Philadelphia: W. B. Saunders Co., 1996.

Schumacher, H. Ralph. "Relapsing Polychondritis." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Renal artery occlusion

Definition

Renal artery occlusion is a blockage of the major arteries that supply blood to the kidneys caused by thrombosis or **embolism**.

Description

Renal artery occlusion occurs when the flow of blood from the arteries leading to the kidneys becomes blocked by a blood clot or cholesterol emboli. The lack of oxygenation can lead to necrosis (tissue **death**) and ultimately, **chronic kidney failure**.

Causes and symptoms

Renal arterial occlusion occurs when a thrombus or embolism (blood clot or cholesterol plaque) breaks free and blocks the arteries leading to one or both kidneys.

Symptoms of an acute renal arterial occlusion may include:

- **hypertension**
- fever
- sudden **pain** in the lower back or flank
- nausea and vomiting
- protein and/or blood in the urine

An individual with renal arterial occlusion may have no overt symptoms, particularly if only one kidney is affected or if the blockage is only partial. Health problems from secondary complications such as chronic kidney failure may be the first indication that something is wrong.

Diagnosis

The high blood pressure that is sometimes associated with a renal artery blockage may be the first sign that it is present, particularly if the hypertension is not responding to standard treatment. Urine and blood tests may or may not be useful in diagnosing this condition. Blood tests may show an elevated plasma creatinine level. If kidney tissue infarction (cell death caused by a lack of blood supply) has occurred, lactic dehydrogenase (LDH) may also be present in the urine and blood.

An arteriogram, an x-ray study of the arteries that uses a radiopaque substance, or dye, to make the arteries visible under x ray, may also be performed. This test is used with caution in patients with impaired kidney function, as the contrast medium can cause further kidney damage. In patients with whom this is not an issue, a spiral computed tomography (CT) scan with contrast medium may also be used.

Treatment

Occlusions may be treated with anticoagulant (blood thinning) or thrombolytic (clot destroying) drugs. If the blockage is significant, surgical intervention or **angioplasty** may be required.

KEY TERMS

Angioplasty—A non-surgical procedure which uses a balloon-tipped catheter to open a blocked artery.

Artherosclerotic plaque—A deposit of fatty and calcium substances that accumulate in the lining of the artery wall, restricting blood flow.

Atrophy—Cell or tissue wasting or death.

Chronic kidney failure—End-stage renal disease (ESRD); chronic kidney failure is diagnosed as ESRD when kidney function falls to 5–10% of capacity.

Embolism—Blood vessel obstruction by a blood clot or other substance (i.e., air).

Thrombus—Formation of a blood clot within the vascular system. A thrombus becomes an embolism if it breaks away and blocks a blood vessel.

Alternative treatment

Renal arterial occlusion is a serious and potentially life-threatening condition, and should always be treated by a healthcare professional familiar with the disorder.

Prognosis

The outcome of renal arterial occlusion depends on the speed with which it is treated. Once the blood supply is minimized or cut off to the kidney, tissue death soon results, ultimately leading to chronic kidney failure (end-stage renal disease).

Prevention

Artherosclerosis may encourage the formation of cholesterol emboli, a potential cause of renal artery occlusion. Strategies for avoiding vascular disease include eating right, maintaining a desirable weight, quitting **smoking**, managing **stress**, and exercising regularly.

Resources

PERIODICALS

Bloch, M. J., and T. Pickering. "Renal Vascular Disease: Medical Management, Angioplasty, and Stenting." *Seminars in Nephrology.* 20, no. 5 (September 2000): 474-88.

ORGANIZATIONS

American Kidney Fund (AKF). Suite 1010, 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http:// www.arbon.com/kidney/>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Natcher Building, 6AS-13K, 45 Center Drive, Bethesda, MD 20892-6600. <http://www.niddk.nih.gov>.

National Kidney Foundation (NKF). 30 East 33rd Street, New York, NY 10016. (800) 622-9020. <http://www.kidney.org>.

Paula Ford-Martin

Renal artery stenosis

Definition

Renal artery stenosis is a blockage or narrowing of the major arteries that supply blood to the kidneys.

Description

Renal artery stenosis occurs when the flow of blood from the arteries leading to the kidneys is constricted by tissue or artherosclerotic plaque. This narrowing of the arteries diminishes the blood supply to the kidneys, which can cause them to atrophy and may ultimately lead to kidney failure. It may also cause **renovascular hypertension**, or high blood pressure related to renal artery blockage.

Causes and symptoms

The two main causes of renal artery stenosis are artherosclerosis and fibromuscular disease. Fibromuscular diseases such as fibromuscular dysplasia cause growth of fibrous tissues on the arterial wall. Stenosis may also occur when scar tissue forms in the renal artery after trauma to the kidney.

Renal arterial stenosis has no overt symptoms. Eventually, untreated renal arterial stenosis causes secondary complications such as **chronic kidney failure**, which may be characterized by frequent urination, anemia, **edema**, headaches, **hypertension**, lower back **pain**, and other signs and symptoms.

Diagnosis

The high blood pressure that is sometimes associated with renal artery stenosis may be the first sign that it is present, particularly if the hypertension is not responding to standard treatment. Presence of a *bruit*, a swooshing sound from the artery that indicates an obstruction, may be heard through a stethoscope.

An arteriogram, an x-ray study of the arteries that uses a radiopaque substance, or dye, to make the arteries visible under x ray, may also be performed. This test is used with caution in patients with impaired kidney function, as the contrast medium may cause further kidney damage.

KEY TERMS

Artherosclerotic plaque—A deposit of fatty and calcium substances that accumulate in the lining of the artery wall, restricting blood flow.

Atrophy—Cell or tissue wasting or death.

Chronic kidney failure—End-stage renal disease (ESRD); chronic kidney failure is diagnosed as ESRD when kidney function falls to 5–10% of capacity.

Edema—Swelling which occurs when body tissues retain fluid.

Stent—An expandable "scaffold-like" device, usually constructed of a stainless steel material, that is inserted into an artery to expand the inside passage and improve blood flow.

Treatment

Treatment for renal artery stenosis is either surgical, pharmaceutical, or with **angioplasty** or stenting. Angioplasty involves guiding a balloon catheter down into the renal artery and inflating the balloon to clear the blockage. A stent may be inserted into the artery to widen the opening. Some patients may be candidates for surgical revascularization, which involves restoring blood flow with an arterial bypass. Drugs known as angiotension-converting enzyme (ACE) inhibitors may be prescribed for some patients. The chosen treatment approach depends on the cause of the stenosis and factors such as the patient's kidney function and blood pressure control.

Alternative treatment

Renal artery stenosis is a serious and potentially life-threatening condition, and should always be treated by a healthcare professional familiar with the disorder.

Prognosis

Untreated renal artery stenosis can cause hypertension (high blood pressure) and may ultimately lead to chronic kidney failure (end-stage renal disease).

Prevention

Maintaining a heart healthy lifestyle can help to prevent cases of renal arterial stenosis attributable to artherosclerosis. Strategies for avoiding vascular disease include eating right, maintaining a desirable weight, quitting **smoking**, managing **stress**, and exercising regularly.

Resources

PERIODICALS

Bloch, M. J. and, T. Pickering. "Renal Vascular Disease: Medical Management, Angioplasty, and Stenting." *Seminars in Nephrology* 20, no.5 (September 2000): 474-88.

Fenves, A. Z., and C. V. Ram. "Fibromuscular Dysplasia of the Renal Arteries." *Current Hypertension Reports* 1, no. 6 (December 1999):546-9.

ORGANIZATIONS

American Kidney Fund (AKF). Suite 1010, 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http:// www.arbon.com/kidney/>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Natcher Building, 6AS-13K, 45 Center Drive, Bethesda, MD 20892-6600. <http://www.niddk.nih.gov>.

National Kidney Foundation (NKF). 30 East 33rd Street, New York, NY 10016. (800) 622-9020. <http://www.kidney.org>.

Paula Ford-Martin

Renal calculi *see* **Kidney stones**

Renal cell carcinoma *see* **Kidney Cancer**

Renal failure *see* **Acute kidney failure; Chronic kidney failure**

Renal nuclear medicine scan *see* **Kidney nuclear medicine scan**

Renal tubular acidosis

Definition

Renal tubular acidosis (RTA) is a condition characterized by too much acid in the body due to a defect in kidney function.

Description

Chemical balance is critical to the body's functioning. Therefore, the body controls its chemicals very strictly. The acid-base balance must be between a pH of 7.35 and 7.45 or trouble will start. Every other chemical in the body is affected by the acid-base balance. The most important chemicals in this system are sodium, chloride, potassium, calcium, ammonium, carbon dioxide, oxygen, and phosphates.

The lungs rapidly adjust acid-base balance by the speed of breathing, because carbon dioxide dissolved in water is an acid—carbonic acid. Faster breathing eliminates more carbon dioxide, decreases the carbonic acid

in the blood and increases the pH. Holding your breath does the opposite. Blood acidity from carbon dioxide controls the rate of breathing, not oxygen.

The kidneys also regulate acid-base balance somewhat more slowly than the lungs. They handle all the chemicals, often trading one for another that is more or less acidic. The trading takes place between the blood and the urine, so that extra chemicals end up passing out of the body. If the kidneys do not effectively eliminate acid, it builds up in the blood, leading to a condition called **metabolic acidosis**. These conditions are called renal tubular acidosis.

Causes and symptoms

There are three types of renal tubular acidosis. They include:

- Distal renal tubular acidosis (type 1) may be a hereditary condition or may be triggered by an autoimmune disease, lithium therapy, **kidney transplantation**, or chronic obstruction.
- Proximal renal tubular acidosis (type 2) is caused by hereditary diseases, such as **Fanconi's syndrome**, fructose intolerance, and Lowe's syndrome. It can also develop with **vitamin D deficiency**, kidney transplantation, **heavy metal poisoning**, and treatment with certain drugs.
- Type 4 renal tubular acidosis is not hereditary, but is associated with **diabetes mellitus**, sickle cell anemia, an autoimmune disease, or an obstructed urinary tract.

Symptoms vary with the underlying mechanism of the defect and the readjustment of chemicals required to compensate for the defect.

- Distal RTA results in high blood acidity and low blood potassium levels. Symptoms include mild **dehydration**; muscle weakness or **paralysis** (due to potassium deficiency); **kidney stones** (due to excess calcium in the urine); and bone fragility and pain.
- Proximal RTA also results in high blood acidity and low blood potassium levels. Symptoms include mild dehydration.
- Type 4 RTA is characterized by high blood acidity and high blood potassium levels; it rarely causes symptoms unless potassium levels rise so high as to cause heart **arrhythmias** or muscle paralysis.

Diagnosis

RTA is suspected when a person has certain symptoms indicative of the disease or when routine tests show high blood acid levels and low blood potassium levels. From there, more testing of blood and urine chemicals will help determine the type of RTA present.

KEY TERMS

Autoimmune disease—Type of diseases characterized by antibodies that attack the body's own tissues.

Fanconi's syndrome—A disorder of the kidneys characterized by glucose in the urine.

Lowe's syndrome—A rare inherited disorder that is distinguished by congenital cataracts, glaucoma, and severe mental retardation.

Rickets—A deficiency disease that affects the bone development of growing bodies, usually causing soft bones.

Treatment

The foundation of treatment for RTA types 1 and 2 is replacement of alkali (base) by drinking a bicarbonate solution daily. Potassium may also have to be replaced, and other chemicals added to maintain balance. In type 4 RTA acidity will normalize if potassium is reduced. This is done by changing the diet and by using diuretic medicines that promote potassium excretion in the urine.

Prognosis

Careful balancing of body chemicals will usually produce good results. If there is an underlying disease responsible for the kidney malfunction, it may be the determining factor in the prognosis.

Prevention

Relatives of patients with the possibly hereditary forms of renal tubular acidosis should be tested.

Resources

BOOKS

Chesney, Russell W. "Specific Renal Tubular Disorders." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

J. Ricker Polsdorfer, MD

Renal ultrasound *see* **Abdominal ultrasound**

Renal vein thrombosis

Definition

Renal vein thrombosis develops when a blood clot forms in the renal vein, which carries blood from the kidneys back to the heart. The disorder is not common.

Description

Renal vein thrombosis occurs in both infants and adults. Onset of the disorder can be rapid (acute) or gradual. The number of people who suffer from renal vein thrombosis is difficult to determine, as many people do not show symptoms, and the disorder is diagnosed only by specific tests. Ninety percent of childhood cases occur in children under one year old, and 75% occur in infants under one month of age. In adult women, oral contraceptive use increases the risk of renal vein thrombosis.

Causes and symptoms

In children, renal vein thrombosis almost always occurs rapidly after an episode of severe **dehydration**. Severe dehydration decreases blood volume and causes the blood to clot more readily.

In adults, renal vein thrombosis can be caused by injury to the abdomen or back, as a result of malignant kidney tumors growing into the renal vein, or as a result of kidney diseases that cause degenerative changes in the cells of the renal tubules (**nephrotic syndrome**).

Acute onset of renal vein thrombosis at any age causes **pain** in the lower back and side, **fever**, bloody urine, decreased urine output, and sometimes kidney failure. In adults, when the onset of the disorder is gradual, there is a slow decrease in kidney function, and protein appears in the urine. Many adults with renal vein thrombosis show few symptoms.

Diagnosis

Renal **venography**, where a contrast material (dye) is injected into the renal vein before x rays are taken, is one of the best ways to detect renal vein thrombosis. Other useful tests to detect a clot include **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), and ultrasound.

Treatment

One of the major goals of treatment is to prevent the blood clot in the renal vein from detaching and moving into the lungs, where it can cause serious complications as a **pulmonary embolism**. The enzyme streptokinase may be given to help dissolve the renal clot. Anticoagulant medications are usually prescribed to prevent clots from recurring. Rarely, when there is a complete blockage of the renal vein in infants, the kidney must be surgically removed.

Prognosis

Most cases of renal vein thrombosis resolve without any permanent damage. **Death** from renal vein thrombosis is rare, and is often caused by the blood clot detaching and lodging in the heart or lungs.

Prevention

There is no specific prevention for renal vein thrombosis. Preventing dehydration reduces the risk that it will occur.

Resources

BOOKS

"Vascular Diseases of Acute Onset: Renal Vein Thrombosis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

ORGANIZATIONS

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

OTHER

"Renal Vein Thrombosis." *HealthAnswers.com*. <http://www.healthanswers.com/database/ami/converted/ooo513.html>.

Tish Davidson

Rendu-Osler-Weber disease *see* **Hereditary hemorrhagic telangiectasia**

Renin assay *see* **Plasma renin activity**

Renovascular hypertension

Definition

Renovascular **hypertension** is a secondary form of high blood pressure caused by a narrowing of the renal artery.

Description

Primary hypertension, or high blood pressure, affects millions of Americans. It accounts for over 90% of all cases of hypertension and develops without apparent causes. It is helpful for the clinician to know if a secondary dis-

ease is present and may be contributing to the high pressure. If clinical tests indicate this is so, the term used for the rise in blood pressure is secondary hypertension.

Renal hypertension is the most common form of secondary hypertension and affects no more than one percent of all adults with primary hypertension. There are two forms of renovascular hypertension.

In atherosclerotic renovascular hypertension disease, plaque is deposited in the renal artery. The deposits narrow the artery, disrupting blood flow. Atherosclerotic renovascular hypertension is most often seen in men over age 45 and accounts for two-thirds of the cases of renovascular hypertension. In most patients, it affects the renal arteries to both kidneys.

Renovascular hypertension caused by fibromuscular dysplasia occurs mainly in women under age 45. It is also the cause of hypertension in 10% of children with the disorder. In fibromuscular dysplasia, cells from the artery wall overgrow and cause a narrowing of the artery channel.

The risk of having hypertension is related to age, lifestyle, environment, and genetics. **Smoking**, **stress**, **obesity**, a diet high in salt, exposure to heavy metals, and an inherited predisposition toward hypertension all increase the chances that a person will develop both primary and renovascular hypertension.

Causes and symptoms

Narrowing of the renal artery reduces the flow of blood to the kidney. In response, the kidney produces the protein renin. Renin is released into the blood stream. Through a series of steps, renin is converted into an enzyme that causes sodium (salt) retention and constriction of the arterioles. In addition to atherosclerotic and fibromuscular dysplasia, narrowing of the renal artery can be caused by compression from an injury or tumor, or by blood clots.

Renovascular hypertension is suspected when hypertension develops suddenly in patients under 30 or over 55 years of age or abruptly worsens in any patient. Symptoms are often absent or subtle.

Diagnosis

No single test for renovascular hypertension is definitive. About half of patients with renovascular hypertension have a specific cardiovascular sound that is heard when a doctor listens to the upper abdomen with a stethoscope. Other diagnostic tests give occasional false positive and false negative results. Most tests are expensive, and some involve serious risks.

Imaging studies are used to diagnose renovascular hypertension. In **intravenous urography**, a dye is injected into the kidney, pictures are made, and the kidneys compared. In renal arteriography, contrast material is inserted into the renal artery and cinematic x rays (showing motion within the kidney) are taken. Studies of kidney function are performed. Tests are done to measure renin production. The results of these tests taken together are used to diagnose renovascular hypertension.

Treatment

Renovascular hypertension may not respond well to anti-hypertensive drugs. Percutaneous transluminal **angioplasty** (PTA), where a balloon catheter is used to dilate the renal artery and remove the blockage, is effective in improving the condition of about 90% of patients with fibromuscular dysplasia. One year later, 60% remain cured. It is less successful in patients with **atherosclerosis**, where renovascular hypertension recurs in half the patients. Where kidney damage occurs, surgery to repair or bypass the renal artery blockage is often effective. In some cases, the damaged kidney must be removed.

Alternative treatment

Alternative treatment stresses eliminating the root causes of hypertension. With renovascular hypertension, as with primary hypertension, the root causes generally cannot be totally reversed by any method. Lifestyle changes are recommended. These include stopping smoking, eating a diet low in animal fats and salt, avoiding exposure to heavy metals, stress control through **meditation**, and anger management. Herbal medicine practitioners recommend garlic (*Allium sativum*) to help lower blood pressure. Constitutional **homeopathy** and **acupuncture** also can be helpful in lowering blood pressure.

Prognosis

PTA is effective in many younger patients with fibromuscular dysplasia. Older patients are less responsive to this treatment. Surgery is also more risky and less successful in older patients.

Prevention

Renovascular hypertension is possibly preventable through lifestyles that prevent atherosclerosis and primary hypertension. It is unknown how to prevent fibromuscular hyperplasia

Resources

BOOKS

Braunwald, Eugene, ed. "Renovascular Hypertension." In *Heart Disease: A Textbook of Cardiovascular Medicine.* Philadelphia: W. B. Saunders Co., 1997.

"Renovascular Hypertension." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

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KEY TERMS

pH—A measurement of acid or alkali (base) of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkali with a normal range of 7.36–7.44.

Respiratory acidosis

Definition

Respiratory acidosis is a condition in which a build-up of carbon dioxide in the blood produces a shift in the body's pH balance and causes the body's system to become more acidic. This condition is brought about by a problem either involving the lungs and respiratory system or signals from the brain that control breathing.

Description

Respiratory acidosis is an acid imbalance in the body caused by a problem related to breathing. In the lungs, oxygen from inhaled air is exchanged for carbon dioxide from the blood. This process takes place between the alveoli (tiny air pockets in the lungs) and the blood vessels that connect to them. When this exchange of oxygen for carbon dioxide is impaired, the excess carbon dioxide forms an acid in the blood. The condition can be acute with a sudden onset, or it can develop gradually as lung function deteriorates.

Causes and symptoms

Respiratory acidosis can be caused by diseases or conditions that affect the lungs themselves, such as **emphysema**, chronic **bronchitis**, **asthma**, or severe **pneumonia**. Blockage of the airway due to swelling, a foreign object, or vomit can induce respiratory acidosis. Drugs like anesthetics, sedatives, and narcotics can interfere with breathing by depressing the respiratory center in the brain. Head injuries or brain tumors can also interfere with signals sent by the brain to the lungs. Such neuromuscular diseases as **Guillain-Barré syndrome** or **myasthenia gravis** can impair the muscles around the lungs making it more difficult to breathe. Conditions that cause chronic **metabolic alkalosis** can also trigger respiratory acidosis.

The most notable symptom will be slowed or difficult breathing. **Headache**, drowsiness, restlessness, tremor, and confusion may also occur. A rapid heart rate, changes in blood pressure, and swelling of blood vessels in the eyes may be noted upon examination. This condition can trigger the body to respond with symptoms of metabolic alkalosis, which may include **cyanosis**, a bluish or purplish discoloration of the skin due to inadequate oxygen intake. Severe cases of respiratory acidosis can lead to **coma** and **death**.

Diagnosis

Respiratory acidosis may be suspected based on symptoms. A blood sample to test for pH and arterial blood gases can be used to confirm the diagnosis. In this type of acidosis, the pH will be below 7.35. The pressure of carbon dioxide in the blood will be high, usually over 45 mmHg.

Treatment

Treatment focuses on correcting the underlying condition that caused the acidosis. In patients with chronic lung diseases, this may include use of a bronchodilator or steroid drugs. Supplemental oxygen supplied through a mask or small tubes inserted into the nostrils may be used in some conditions, however, an oversupply of oxygen in patients with lung disease can make the acidosis worse. **Antibiotics** may be used to treat infections. If the acidosis is related to an overdose of narcotics, or a **drug overdose** is suspected, the patient may be given a dose of naloxone, a drug that will block the respiratory-depressing effects of narcotics. Use of mechanical ventilation like a respirator may be necessary. If the respiratory acidosis has triggered the body to compensate by developing metabolic alkalosis, symptoms of that condition may need to be treated as well.

Prognosis

If the underlying condition that caused the respiratory acidosis is treated and corrected, there may be no long term effects. Respiratory acidosis may occur chronically along with the development of lung disease or **respiratory**

failure. In these severe conditions, the patient may require the assistance of a respirator or ventilator. In extreme cases, the patient may experience coma and death.

Prevention

Patients with chronic lung diseases and those who receive sedatives and narcotics need to be monitored closely for development of respiratory acidosis.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. "Acid-Base Disturbances." In *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

"Fluid & Electrolyte Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Fluid, Electrolyte, and Acid-Base Disorders." In *Family Medicine Principles and Practices*. 5th ed. New York: Springer-Verlag, 1998.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Altha Roberts Edgren

Respiratory alkalosis

Definition

Respiratory alkalosis is a condition where the amount of carbon dioxide found in the blood drops to a level below normal range. This condition produces a shift in the body's pH balance and causes the body's system to become more alkaline. This condition is brought on by rapid, deep breathing called *hyperventilation*.

Description

Respiratory alkalosis is an alkali imbalance in the body caused by a lower-than-normal level of carbon dioxide in the blood. In the lungs, oxygen from inhaled air is exchanged for carbon dioxide from the blood. This process takes place between the alveoli (tiny air pockets in the lungs) and the blood vessels that connect to them. When a person hyperventilates, this exchange of oxygen for carbon dioxide is speeded up, and the person exhales too much carbon dioxide. This lowered level of carbon dioxide causes the pH of the blood to increase, leading to alkalosis.

Causes and symptoms

The primary cause of respiratory alkalosis is hyperventilation. This rapid, deep breathing can be caused by conditions related to the lungs like **pneumonia**, lung disease, or **asthma**. More commonly, hyperventilation is associated with **anxiety**, **fever**, **drug overdose**, **carbon monoxide poisoning**, or serious infections. Tumors or swelling in the brain or nervous system can also cause this type of respiration. Other stresses to the body, including **pregnancy**, liver failure, high elevations, or **metabolic acidosis** can also trigger hyperventilation leading to respiratory alkalosis.

Hyperventilation, the primary cause of respiratory alkalosis, is also the primary symptom. This symptom is accompanied by **dizziness**, light headedness, agitation, and tingling or numbing around the mouth and in the fingers and hands. Muscle twitching, spasms, and weakness may be noted. Seizures, irregular heart beats, and tetany (muscle spasms so severe that the muscle locks in a rigid position) can result from severe respiratory alkalosis.

KEY TERMS

Hyperventilation—Rapid, deep breathing, possibly exceeding 40 breaths/minute. The most common cause is anxiety, although fever, aspirin overdose, serious infections, stroke, or other diseases of the brain or nervous system.

pH—A measurement of acid or alkali (base) of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkali with a normal range of 7.36-7.44.

Diagnosis

Respiratory alkalosis may be suspected based on symptoms. A blood sample to test for pH and arterial blood gases can be used to confirm the diagnosis. In this type of alkalosis, the pH will be elevated above 7.44. The pressure of carbon dioxide in the blood will be low, usually under 35 mmHg.

Treatment

Treatment focuses on correcting the underlying condition that caused the alkalosis. Hyperventilation due to anxiety may be relieved by having the patient breath into a paper bag. By rebreathing the air that was exhaled, the patient will inhale a higher amount of carbon dioxide than he or she would normally. **Antibiotics** may be used

to treat pneumonia or other infections. Other medications may be required to treat fever, seizures, or irregular heart beats. If the alkalosis is related to a drug overdose, the patient may require treatment for **poisoning**. Use of mechanical ventilation like a respirator may be necessary. If the respiratory alkalosis has triggered the body to compensate by developing metabolic acidosis, symptoms of that condition may need to be treated, as well.

Prognosis

If the underlying condition that caused the respiratory alkalosis is treated and corrected, there may be no long-term effects. In severe cases of respiratory alkalosis, the patient may experience seizures or heart beat irregularities that may be serious and life threatening.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. "Acid-Base Disturbances." In *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

"Fluid & Electrolyte Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Fluid, Electrolyte, and Acid-Base Disorders." In *Family Medicine Principles and Practices*. 5th ed. New York: Springer-Verlag, 1998.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

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Respiratory distress syndrome

Definition

Respiratory distress syndrome (RDS) of the newborn, also known as infant RDS, is an acute lung disease present at birth, which usually affects premature babies. Layers of tissue called hyaline membranes keep the oxygen that is breathed in from passing into the blood. The lungs are said to be "airless." Without treatment, the infant will die within a few days after birth, but if oxygen can be provided, and the infant receives modern treatment in a neonatal intensive care unit, complete recovery with no after-effects can be expected.

Description

If a newborn infant is to breathe properly, the small air sacs (alveoli) at the ends of the breathing tubes must remain open so that oxygen in the air can get into the tiny blood vessels that surround the alveoli. Normally, in the last months of **pregnancy**, cells in the alveoli produce a substance called surfactant, which keep the surface tension inside the alveoli low so that the sacs can expand at the moment of birth, and the infant can breathe normally. Surfactant is produced starting at about 34 weeks of pregnancy and, by the time the fetal lungs mature at 37 weeks, a normal amount is present.

If an infant is born prematurely, enough surfactant might not have formed in the alveoli causing the lungs to collapse and making it very difficult for the baby to get enough air (and the oxygen it contains). Sometimes a layer of fibrous tissue called a hyaline membrane forms in the air sacs, making it even harder for oxygen to get through to the blood vessels. RDS in newborn infants used to be called hyaline membrane disease.

Causes and symptoms

RDS nearly always occurs in premature infants, and the more premature the birth, the greater is the chance that RDS will develop. RDS also is seen in some infants whose mothers are diabetic. Paradoxically, RDS is less likely in the presence of certain states or conditions which themselves are harmful: abnormally slow growth of the fetus; high blood pressure, a condition called toxemia in the mother; and early rupture of the birth membranes.

Labored breathing (the "respiratory distress" of RDS) may begin as soon as the infant is born, or within a few hours. Breathing becomes very rapid, the nostrils flare, and the infant grunts with each breath. The ribs, which are very flexible in young infants, move inwards each time a breath is taken. Before long the muscles that move the ribs and diaphragm, so that air is drawn into the lungs, become fatigued. When the oxygen level in the blood drops severely the infant's skin turns bluish in color. Tiny, very premature infants may not even have signs of trouble breathing. Their lungs may be so stiff that they cannot even start breathing when born.

There are two major complications of RDS. One is called **pneumothorax**, which means "air in the chest." When the infant itself or a breathing machine applies pressure on the lungs in an attempt to expand them, a lung may rupture, causing air to leak into the chest cavity. This air causes the lung to collapse further, making breathing even harder and interfering with blood flow in the lung arteries. The blood pressure can drop suddenly, cutting the blood supply to the brain. The other complication is called intraventricular hemorrhage; this is bleeding into the cavities (ventricles) of the brain, which may be fatal.

Diagnosis

When a premature infant has obvious trouble breathing when born or within a few hours of birth, RDS is an

KEY TERMS

Alveoli—The small air sacs located at the ends of the breathing tubes of the lung, where oxygen normally passes from inhaled air to blood vessels.

Amniotic fluid—The fluid bathing the fetus, which may be sampled using a needle to determine whether the fetus is making enough surfactant.

Endotracheal tube—A metal or plastic tube inserted in the windpipe which may be attached to a ventilator. It also may be used to deliver medications such as surfactant.

Hyaline membranes—A fibrous layer that settles in the alveoli in RDS, and prevents oxygen from escaping from inhaled air to the bloodstream.

Pneumothorax—Air in the chest, often a result of the lung rupturing when oxygen is delivered under too high a pressure.

Steroid—A natural body substance that often is given to women before delivering a very premature infant to stimulate the fetal lungs to produce surfactant, hopefully preventing RDS (or making it less severe).

Surfactant—A material normally produced in the fetal lungs in the last months of pregnancy, which helps the air sacs to open up at the time of birth so that the newborn infant can breathe freely.

Toxemia—A disease of pregnancy in which the mother's blood pressure is elevated; associated with both maternal and fetal complications, and sometimes with fetal death.

Ventilator—A machine that can breathe for an infant having RDS until its lungs are producing enough surfactant and are able to function normally.

obvious possibility. If premature birth is expected, or there is some condition that calls for delivery as soon as possible, the amount of surfactant in the amniotic fluid will indicate how well the lungs have matured. If little surfactant is found in an amniotic fluid sample taken by placing a needle in the uterus (**amniocentesis**), there is a definite risk of RDS. Often this test is done at regular intervals so that the infant can be delivered as soon as the lungs are mature. If the membranes have ruptured, surfactant can easily be measured in a sample of vaginal fluid.

The other major diagnostic test is a **chest x ray**. Collapsed lung tissue has a typical appearance, and the more lung tissue is collapsed, the more severe the RDS. An x ray also can demonstrate pneumothorax (air or gas in the area around the lung), if this complication has occurred. The level of oxygen in the blood can be measured by taking a blood sample from an artery, or, more easily, using a device called an oximeter, which is clipped to an earlobe. Pneumothorax may have occurred if the infant suddenly becomes worse while on ventilation; x rays can help make the diagnosis.

Treatment

If only a mild degree of RDS is present at birth, placing the infant in an oxygen hood may be enough. It is important to guard against too much oxygen, as this may damage the retina and cause loss of vision. Using an oximeter to keep track of the blood oxygen level, repeated artery punctures or heel sticks can be avoided. In more severe cases a drug very like natural surfactant (Exosurf Neonatal or Survanta), can be dripped into the lungs through a fine tube (endotracheal tube) placed in the infant's windpipe (trachea). Typically the infant will be able to breathe more easily within a few days at the most, and complications such as lung rupture are less likely to occur. The drug is continued until the infant starts producing its own surfactant. There is a risk of bleeding into the lungs from surfactant treatment; about 10% of the smallest infants are affected.

Infants with severe RDS may require treatment with a ventilator, a machine that takes over the work of the lungs and delivers air under pressure. In tiny infants who do not breathe when born, ventilation through a tracheal tube is an emergency procedure. Assisted ventilation must be closely supervised, as too much pressure can cause further lung damage. A gentler way of assisting breathing, continuous positive airway pressure or CPAP, delivers an oxygen mixture through nasal prongs or a tube placed through the nose rather than an endotracheal tube. CPAP may be tried before resorting to a ventilator, or after an infant placed on a ventilator begins to improve. Drugs that stimulate breathing may speed the recovery process.

Pneumothorax is an emergency that must be treated right away. Air may be removed from the chest using a needle and syringe. A tube then is inserted into the lung cavity, and suction applied.

Prognosis

If an infant born with RDS is not promptly treated, lack of an adequate oxygen supply will damage the

body's organs and eventually cause them to stop functioning altogether. **Death** is the result. The central nervous system in particular—made up of the brain and spinal cord—is very dependent on a steady oxygen supply and is one of the first organ systems to feel the effects of RDS. On the other hand, if the infant's breathing is supported until the lungs mature and make their own surfactant, complete recovery within three to five days is the rule.

If an air leak causes pneumothorax, immediate removal of air from the chest will allow the lungs to re-expand. Bleeding into the brain is a very serious condition that worsens the outlook for an infant with RDS.

Prevention

The best way of preventing RDS is to delay delivery until the fetal lungs have matured and are producing enough surfactant—generally at about 37 weeks of pregnancy. If delivery cannot be delayed, the mother may be given a steroid hormone, similar to a natural substance produced in the body, which crosses the barrier of the placenta and helps the fetal lungs to produce surfactant. The steroid should be given at least 24 hours before the expected time of delivery. If the infant does develop RDS, the risk of bleeding into the brain will be much less if the mother has been given a dose of steroid.

If a very premature infant is born without symptoms of RDS, it may be wise to deliver surfactant to its lungs. This may prevent RDS, or make it less severe if it does develop. An alternative is to wait until the first symptoms of RDS appear and then immediately give surfactant. Pneumothorax may be prevented by frequently checking the blood oxygen content, and limiting oxygen treatment under pressure to the minimum needed.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Diagnosis and Therapy.* 16th ed. Rahway, NJ: Merck Research Laboratories, 1992.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

National Respiratory Distress Syndrome Foundation. P.O. Box 723, Montgomeryville, PA 18936.

David A. Cramer, MD

Respiratory failure

Definition

Respiratory failure is nearly any condition that affects breathing function or the lungs themselves and can result in failure of the lungs to function properly. The main tasks of the lungs and chest are to get oxygen from the air that is inhaled into the bloodstream, and, at the same to time, to eliminate carbon dioxide ($C0_2$) from the blood through air that is breathed out. In respiratory failure, the level of oxygen in the blood becomes dangerously low, and/or the level of $C0_2$ becomes dangerously high. There are two ways in which this can happen. Either the process by which oxygen and $C0_2$ are exchanged between the blood and the air spaces of the lungs (a process called "gas exchange") breaks down, or the movement of air in and out of the lungs (ventilation) does not take place properly.

Description

Respiratory failure often is divided into two main types. One of them, called hypoxemic respiratory failure, occurs when something interferes with normal gas exchange. Too little oxygen gets into the blood (hypoxemia), and all organs and tissues in the body suffer as a result. One common type of hypoxemic failure, occurring in both adults and prematurely born infants, is **respiratory distress syndrome**, a condition in which fluid or tissue changes prevent oxygen from passing out of the air sacs of the lungs into the circulating blood. Hypoxemia also may result from spending time at high altitudes (where there is less oxygen in the air); various forms of lung disease that separate oxygen from blood in the lungs; severe anemia ("low blood"); and blood vessel disorders that shunt blood away from the lungs, thus precluding the lungs from picking up oxygen.

The other main type of respiratory failure is ventilatory failure, occurring when, for any reason, breathing is not strong enough to rid the body of $C0_2$. Then CO_2 builds up in the blood (hypercapnia). Ventilatory failure can result when the respiratory center in the brainstem fails to drive breathing; when muscle disease keeps the chest wall from expanding when breathing in; or when a patient has **chronic obstructive lung disease** that makes it very difficult to exhale air with its $C0_2$. Many of the specific diseases and conditions that cause respiratory failure cause both too little oxygen in the blood (hypoxemia) and abnormal ventilation.

Causes and symptoms

Several different abnormalities of breathing function can cause respiratory failure. The major categories, with specific examples of each, are:

- Obstruction of the airways. Examples are chronic **bronchitis** with heavy secretions; **emphysema**; **cystic fibrosis**; **asthma** (a condition in which it is very hard to get air in and out through narrowed breathing tubes).

- Weak breathing. This can be caused by drugs or alcohol, which depress the respiratory center; extreme **obesity**; or **sleep apnea**, where patients stop breathing for long periods while sleeping.
- Muscle weakness. This can be caused by a muscle disease called myasthenia; **muscular dystrophy**; **polio**; a **stroke** that paralyzes the respiratory muscles; injury of the spinal cord; or Lou Gehrig's disease.
- Lung diseases, including severe **pneumonia**. **Pulmonary edema**, or fluid in the lungs, can be the source of respiratory failure. Also, it can often be a result of heart disease; respiratory distress syndrome; **pulmonary fibrosis** and other scarring diseases of the lung; radiation exposure; burn injury when smoke is inhaled; and widespread lung **cancer**.
- An abnormal chest wall (a condition that can be caused by **scoliosis** or severe injury of the chest wall).

A majority of patients with respiratory failure are short of breath. Both low oxygen and high carbon dioxide can impair mental functions. Patients may become confused and disoriented and find it impossible to carry out their normal activities or do their work. Marked $C0_2$ excess can cause headaches and, in time, a semi-conscious state, or even **coma**. Low blood oxygen causes the skin to take on a bluish tinge. It also can cause an abnormal heart rhythm (arrhythmia). **Physical examination** may show a patient who is breathing rapidly, is restless, and has a rapid pulse. Lung disease may cause abnormal sounds heard when listening to the chest with a stethoscope: **wheezing** in asthma, "crackles" in obstructive lung disease. A patient with ventilatory failure is prone to gasp for breath, and may use the neck muscles to help expand the chest.

Diagnosis

The symptoms and signs of respiratory failure are not specific. Rather, they depend on what is causing the failure and on the patient's condition before it developed. Good general health and some degree of "reserve" lung function will help see a patient through an episode of respiratory failure. The key diagnostic determination is to measure the amount of oxygen, carbon dioxide, and acid in the blood at regular intervals. A sudden low oxygen level in the lung tissue may cause the arteries of the lungs to narrow. This, in turn, causes the resistance in these vessels to increase, which can be measured using a special catheter. A high blood level of $C0_2$ may cause increased pressure in the fluid surrounding the brain and spinal cord; this, too, can be measured.

Treatment

Nearly all patients are given oxygen as the first treatment. Then the underlying cause of respiratory failure must be treated. For example, **antibiotics** are used to fight a lung infection, or, for an asthmatic patient, a drug to open up the airways is commonly prescribed.

A patient whose breathing remains very poor will require a ventilator to aid breathing. A plastic tube is placed through the nose or mouth into the windpipe and is attached to a machine that forces air into the lungs. This can be a lifesaving treatment and should be continued until the patient's own lungs can take over the work of breathing. It is very important to use no more pressure than is necessary to provide sufficient oxygen; otherwise ventilation may cause further lung damage. Drugs are given to keep the patient calm, and the amount of fluid in the body is carefully adjusted so that the heart and lungs can function as normally as possible. Steroids, which combat inflammation, may sometimes be helpful but they can cause complications, including weakening the breathing muscles.

The respiratory therapist has a number of methods available to help patients overcome respiratory failure. They include:

- Suctioning the lungs through a small plastic tube passed through the nose, in order to remove secretions from the airways that the patient cannot **cough** up.
- Postural drainage, in which the patient is propped up at an angle or tilted to help secretions drain out of the lungs. The therapist may clap the patient on the chest or back to loosen the secretions, or a vibrator may be used for the same purpose.
- Breathing exercises often are prescribed after the patient recovers. They make the patient feel better and help to strengthen the muscles that aid breathing. One useful method is for the patient to suck on a tube attached to a clear plastic hosing containing a ball so as to keep the ball lifted. Regular deep breathing exercises are simpler and often just as helpful. Another technique is to have the patient breathe out against pursed lips to increase pressure in the airways and keep them from collapsing.

Prognosis

The outlook for patients with respiratory failure depends chiefly on its cause. If the underlying disease can be effectively treated, with the patient's breathing supported in the meantime, the outlook is usually good.

Care is needed not to expose the patient to polluting substances in the atmosphere while recovering from respiratory failure; this could tip the balance against recovery. When respiratory failure develops slowly, pressure may build up in the lung's blood vessels, a condition called **pulmonary hypertension**. This condition may damage the vessels, worsen hypoxemia, and cause the heart to fail. If it is not possible to provide enough oxy-

KEY TERMS

Chronic obstructive lung disease—A common form of lung disease in which breathing, and therefore gas exchange, is labored and increasingly difficult.

Gas exchange—The process by which oxygen is extracted from inhaled air into the bloodstream, and, at the same time, carbon dioxide is eliminated from the blood and exhaled.

Hypoxemia—An abnormally low amount of oxygen in the blood, the major consequence of respiratory failure, when the lungs no longer are able to perform their chief function of gas exchange.

Pulmonary fibrosis—An end result of many forms of lung disease (especially chronic inflammatory conditions). Normal lung tissue is converted to scarred, "fibrotic" tissue that cannot carry out gas exchange.

gen to the body, complications involving either the brain or the heart may prove fatal.

If the kidneys fail or the diseased lungs become infected, the prognosis is worse. In some cases, the primary disease causing the lungs to fail is irreversible. The patient, family, and physician together then must decide whether to prolong life by ventilator support. Occasionally, **lung transplantation** is a possibility, but it is a highly complex procedure and is not widely available

Prevention

Because respiratory failure is not a disease itself, but the end result of many lung disorders, the best prevention is to treat any lung disease promptly and effectively. It is also important to make sure that any patient who has had lung disease is promptly treated for any respiratory infection (even of the upper respiratory tract). Patients with lung problems should also avoid exposure to pollutants, as much as is possible. Once respiratory failure is present, it is best for a patient to receive treatment in an intensive care unit, where specialized personnel and all the needed equipment are available. Close supervision of treatment, especially mechanical ventilation, will help minimize complications that would compound the problem.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information: Home Edition.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Smolley, Lawrence A., and Debra F. Bryse. *Breathe Right Now: A Comprehensive Guide to Understanding and Treating the Most Common Breathing Disorders.* New York: W. W. Norton & Co., 1998.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Respiratory Distress Syndrome Foundation. P.O. Box 723, Montgomeryville, PA 18936.

OTHER

"Pulmonary Medicine." *HealthWeb.com.* 12 Jan. 1998 <http://healthweb.org>.

David A. Cramer, MD

Respiratory syncytial virus infection

Definition

Respiratory syncytial virus (RSV) is a virus that can cause severe lower respiratory infections in children under the age of two, and milder upper respiratory infections in older children and adults. RSV infection is also called bronchiolitis, because it is marked in young children by inflammation of the bronchioles. Bronchioles are the narrow airways that lead from the bronchi to the tiny air sacs (alveoli) in the lungs. The result is **wheezing**, difficulty breathing, and sometimes fatal **respiratory failure**.

Description

RSV infection is caused by a group of viruses found worldwide. There are two different subtypes of the virus with numerous different strains. Taken together, these viruses account for a significant number of deaths in infants.

RSV infection is primarily a disease of winter or early spring, with waves of illness sweeping through a community. The rate of RSV infection is estimated to be 11.4 cases in every 100 children during their first year of life. In the United States, RSV infection occurs most frequently in infants between the ages of two months and six months.

RSV infection shows distinctly different symptoms, depending on the age of the infected person. In children under two, the virus causes a serious lower respiratory infection in the lungs. In older children and healthy adults, it causes a mild upper respiratory infection often mistaken for the **common cold**.

Although anyone can get this disease, infants suffer the most serious symptoms and complications. Breast feeding seems to provide partial protection from the virus. Conditions in infants that increase their risk of infection include:

- premature birth
- lower socio-economic environment
- congenital heart disease
- chronic lung diseases, such as cystic fibrosis
- immune system deficiencies, including HIV infection
- immunosuppressive therapy given to organ transplant patients

Many older children and adults get RSV infection, but the symptoms are so similar to the common cold that the true cause is undiagnosed. People of any age with weakened immune systems, either from such diseases as **AIDS** or leukemia, or as the result of **chemotherapy** or corticosteroid medications, are more at risk for serious RSV infections. So are people with chronic lung disease.

Causes and symptoms

Respiratory syncytial virus is spread through close contact with an infected person. It has been shown that if a person with RSV infection sneezes, the virus can be carried to others within a radius of six f (1.8 m). This group of viruses is hardy. They can live on the hands for up to half an hour and on toys or other inanimate objects for several hours.

Scientists have yet to understand why RSV viruses attack the lower respiratory system in infants and the upper respiratory system in adults. In infants, RSV begins with such cold symptoms as a low **fever**, runny nose, and **sore throat**. Soon, other symptoms appear that suggest an infection which involves the lower airways. Some of these symptoms resemble those of **asthma**. RSV infection is suggested by:

- wheezing and high-pitched, whistling breathing
- rapid breathing (more than 40 breaths per minute)
- shortness of breath
- labored breathing out (exhalations)
- bluish tinge to the skin (cyanosis)
- croupy, seal-like, barking **cough**
- high fever

Breathing problems occur in RSV infections because the bronchioles swell, making it difficult for air to get in and out of the lungs. If the child is having trouble breathing, immediate medical care is needed. Breathing problems are most common in infants under one year of age; they can develop rapidly.

Diagnosis

Physical examination and imaging studies

RSV infection is usually diagnosed during a **physical examination** by the pediatrician or primary care doctor. The doctor listens with a stethoscope for wheezing and other abnormal lung sounds in the patient's chest. The doctor will also take into consideration whether there is a known outbreak of RSV infection in the area. Chest x rays give some indication of whether the lungs are hyperinflated from an effort to move air in and out. X rays may also show the presence of a secondary bacterial infection, such as **pneumonia**.

Laboratory tests

A blood test can also detect RSV infection. This test measures the level of antibodies the body has formed against the virus. The blood test is less reliable in infants than in older children because antibodies in the infant's blood may have come from the mother during **pregnancy**. If infants are hospitalized, other tests such as an arterial **blood gas analysis** are done to determine if the child is receiving enough oxygen.

Treatment

Home care

Home treatment for RSV infection is primarily supportive. It involves taking steps to ease the child's breathing. **Dehydration** can be a problem, so children should be encouraged to drink plenty of fluids. **Antibiotics** have no effect on viral illnesses. In time, the body will make antibodies to fight the infection and return itself to health.

Home care for keeping a child with RSV comfortable and breathing more easily includes:

- Use a cool mist room humidifier to ease congestion and sore throat.
- Raise the baby's head by putting books under the head end of the crib.
- Give **acetaminophen** (Tylenol, Pandol, Tempra) for fever. **Aspirin** should not be given to children because of its association with **Reye's syndrome**, a serious disease.
- For babies too young to blow their noses, suction away any mucus with an infant nasal aspirator.

Hospital treatment

In the United States, RSV infections are responsible for 90,000 hospitalizations and 4,500 deaths each year. Children who are hospitalized receive oxygen and humidity through a mist tent or vaporizer. They also are given intravenous fluids to prevent dehydration. Mechan-

ical ventilation may be necessary. Blood gases are monitored to assure that the child is receiving enough oxygen.

Medications

Bronchiodilators, such as albuterol (Proventil, Ventilin), may be used to keep the airways open. Ribavirin (Virazole) is used for desperately ill children to stop the growth of the virus. Ribavirin is both expensive and has toxic side effects, so its use is restricted to the most severe cases.

Alternative treatment

Alternative medicine has little to say specifically about bronchiolitis, especially in very young children. Practitioners emphasize that people get viral illnesses because their immune systems are weak. Prevention focuses on strengthening the immune system by eating a healthy diet low in sugars and high in fresh fruits and vegetables, reducing **stress**, and getting regular, moderate **exercise**. Like traditional practitioners, alternative practitioners recommend breastfeeding infants so that the child may benefit from the positive state of health of the mother. Inhaling a steaming mixture of lemon oil, thyme oil, eucalyptus, and tea tree oil (**aromatherapy**) may make breathing easier.

Prognosis

RSV infection usually runs its course in seven to14 days. The cough may linger weeks longer. There are no medications that can speed the body's production of antibodies against the virus. Opportunistic bacterial infections that take advantage of a weakened respiratory system may cause ear, sinus, and throat infections or pneumonia.

Hospitalization and **death** are much more likely to occur in children whose immune systems are weakened or who have underlying diseases of the lungs and heart. People do not gain permanent immunity to respiratory syncytial virus and can be infected many times. Children who suffer repeated infections seem to be more likely to develop asthma in later life.

Prevention

As of 1998 there are no vaccines against RSV. Respiratory syncytial virus infection is so common that prevention is impossible. However, steps can be taken to reduce a child's contact with the disease. People with RSV symptoms should stay at least six feet away from young children. Frequent handwashing, especially after contact with respiratory secretions, and the correct disposal of used tissues help keep the disease from spreading. Parents should try to keep their children under 18 month old away from crowded environments—for example, shopping malls during holiday seasons—where they are likely to come in contact with older people who have only mild symptoms of the disease. Child care centers should regularly disinfect surfaces that children touch.

KEY TERMS

Alveoli—Small air sacs or cavities in the lung that give the tissue a honeycomb appearance and expand its surface area for the exchange of oxygen and carbon dioxide.

Antibody—A protein produced by specialized white blood cells in response to the presence of a foreign protein such as a virus. Antibodies help the body fight infection.

Reye's syndrome—A rare disorder in children that follows a viral infection and is associated with a reaction to aspirin. Its symptoms include vomiting, damaged liver function, and swelling of the brain.

Resources

BOOKS

Burton Goldberg Group. "Respiratory Conditions." In *Alternative Medicine: The Definitive Guide*, ed. James Strohecker. Puyallup, WA: Future Medicine Publishing, 1994.

PERIODICALS

Hemming, Val, et al. "Bracing for the Cold and Flu Season." *Patient Care* 31 (Sept. 1997): 47-54.

Jeng, Mei-Jy, and Richard J. Lemen. "Respiratory Syncytial Virus Bronchiolitis." *American Family Physician* (Mar. 1997): 1139-1149.

Tish Davidson

Restless legs syndrome

Definition

Restless legs syndrome (RLS) is characterized by unpleasant sensations in the limbs, usually the legs, that occur at rest or before sleep and are relieved by activity such as walking. These sensations are felt deep within the legs and are described as creeping, crawling, aching, or fidgety.

Description

Restless legs syndrome, also known as Ekbom syndrome, Wittmaack-Ekbom syndrome, *anxietas tibiarum*, or *anxietas tibialis*, affects up to 10–15% of the population. Some studies show that RLS is more common among elderly people. Almost half of patients over age 60 who complain of **insomnia** are diagnosed with RLS. In some cases, the patient has another medical condition with which RLS is associated. In idiopathic RLS, no cause can be found. In familial cases, RLS may be inherited from a close relative, most likely a parent.

Causes and symptoms

Most people experience mild symptoms. They may lie down to rest at the end of the day and, just before sleep, will experience discomfort in their legs that prompts them to stand up, massage the leg, or walk briefly. Eighty-five percent of RLS patients either have difficulty falling asleep or wake several times during the night, and almost half experience daytime **fatigue** or sleepiness. It is common for the symptoms to be intermittent. They may disappear for several months and then return for no apparent reason. Two-thirds of patients report that their symptoms become worse with time. Some older patients claim to have had symptoms since they were in their early 20s, but were not diagnosed until their 50s. Suspected under-diagnosis of RLS may be attributed to the difficulty experienced by patients in describing their symptoms.

More than 80% of patients with RLS experience periodic limb movements in sleep (PLMS). These random movements of arms or legs may result in further sleep disturbance and daytime fatigue. Most patients have restless feelings in both legs, but only one leg may be affected. Arms may be affected in nearly half of patients.

There is no known cause for the disorder, but recent research has focused on several key areas. These include:

- Central nervous system (CNS) abnormalities. Several types of drugs have been found to reduce the symptoms of RLS. Based on an understanding of how these drugs work, theories have been developed to explain the cause of the disorder. Levodopa and other drugs that correct problems with signal transmission within the central nervous system (CNS) can reduce the symptoms of RLS. It is therefore suspected that the source of RLS is a problem related to signal transmission systems in the CNS.
- Iron deficiency. The body stores iron in the form of ferritin. There is a relationship between low levels of iron (as ferritin) stored in the body and the occurrence of RLS. Studies have shown that older people with RLS often have low levels of ferritin. Supplements of iron sulfate have been shown to significantly reduce RLS symptoms for these patients.

Diagnosis

A careful history enables the physician to distinguish RLS from similar types of disorders that cause night time discomfort in the limbs, such as muscle cramps, burning feet syndrome, and damage to nerves that detect sensations or cause movement (polyneuropathy).

The most important tool the doctor has in diagnosis is the history obtained from the patient. There are several common medical conditions that are known to either cause or to be closely associated with RLS. The doctor may link the patient's symptoms to one of these conditions, which include anemia, diabetes, disease of the spinal nerve roots (lumbosacral radiculopathy), **Parkinson's disease**, late-stage **pregnancy**, kidney failure (uremia), and complications of stomach surgery. In order to identify or eliminate such a primary cause, blood tests may be performed to determine the presence of serum iron, ferritin, folate, vitamin B_{12}, creatinine, and thyroid-stimulating hormones. The physician may also ask if symptoms are present in any close family members, since it is common for RLS to run in families and this type is sometimes more difficult to treat.

In some cases, sleep studies such as **polysomnography** are undertaken to identify the presence of PLMS that are reported to affect 70–80% of people who suffer from RLS. The patient is often unaware of these movements, since they may not cause him to wake. However, the presence of PLMS with RLS can leave the person more tired, because it interferes with deep sleep. A patient who also displays evidence of some neurologic disease may undergo **electromyography** (EMG). During EMG, a very small, thin needle is inserted into the muscle and electrical activity of the muscle is recorded. A doctor or technician usually performs this test at a hospital outpatient department.

Treatment

The first step in treatment is to treat existing conditions that are known to be associated with RLS and that will be identified by blood tests. If the patient is anemic, iron (iron sulfate) or vitamin supplements (folate or vitamin B_{12}) will be prescribed. If kidney disease is identified as a cause, treatment of the kidney problem will take priority.

Prescription drugs

In some people whose symptoms cannot be linked to a treatable associated condition, drug therapy may be

necessary to provide relief and restore a normal sleep pattern. Prescription drugs that are normally used for RLS include:

- **Benzodiazepines** and low-potency opioids. These drugs are prescribed for use only on an "as needed" basis, for patients with mild RLS. Benzodiazepines appear to reduce nighttime awakenings due to PLMS. The benzodiazepine most commonly used to treat RLS is clonazepam (Klonopin, Rivotril). The main disadvantage of this drug type is that it causes daytime drowsiness. It also causes unsteadiness that may lead to accidents, especially for an elderly patient. Opioids are narcotic **pain** relievers. Those commonly used for mild RLS are low potency opioids, such as codeine (Tylenol #3) and propoxyphene (Darvocet). Studies have shown that these can be successfully used in the treatment of RLS on a long-term basis without risk of **addiction**. However, narcotics can cause **constipation** and difficulty urinating.
- Levodopa (L-dopa) and carbidopa (Sinemet). Levodopa is the drug most commonly used to treat moderate or severe RLS. It acts by supplying a chemical called dopamine to the brain. It is often taken in conjunction with carbidopa to prevent or decrease side effects. Although it is effective against RLS, levodopa may also causes a worsening of symptoms during the afternoon or early evening in 50–80% of patients. This phenomenon is known as "restless legs augmentation," and if it occurs, the physician will probably discontinue Levodopa for a brief period while an alternate drug is used. Levodopa can often be reintroduced after a short break.
- Pergolide (Permax). Pergolide acts on the same part of the brain as Levodopa. It is less likely than Levodopa to cause daytime worsening of symptoms (occurs in about 25% of patients). However, it is not recommended as the first choice in drug therapy since it causes a high rate of minor side effects. Pergolide is often used only if Levodopa has been discontinued.
- High potency opioids. If the symptoms of RLS are difficult to treat with the above medication, higher dose opioids will be used. These include **methadone** (Dolophine), oxycodone, and clonidine (Catapres, Combipres, Dixarit). A significant disadvantage of these drugs is risk of addiction.
- Anticonvulsants. Some cases of RLS may be improved by **anticonvulsant drugs**, such as carbamazepine (Tegretol).
- Combination therapy. Some patients respond well to combinations of drugs such as a benzodiazepine and Levodopa.

Many drugs have been investigated for treatment of RLS, but it seems as though the perfect therapy has not yet been found. However, careful monitoring of side effects and good communication between patient and doctor can result in a flexible program of therapy that minimizes side effects and maximizes effectiveness.

Alternative treatment

It is likely that the best alternative therapy will combine both conventional and alternative approaches. Levodopa may be combined with a therapy that relieves pain, relaxes muscles, or focuses in general on the nervous system and the brain. Any such combined therapy that allows a reduction in dosage of levodopa is advantageous, since this will reduce the likelihood of unacceptable levels of drug side effects. Of course, the physician who prescribes the medication should monitor any combined therapy. Alternative methods may include:

- **Acupuncture**. Patients who also suffer from **rheumatoid arthritis** may especially benefit from acupuncture to relieve RLS symptoms. Acupuncture is believed to be effective in arthritis treatment and may also stimulate those parts of the brain that are involved in RLS.
- Homeopathy. Homeopaths believe that disorders of the nervous system are especially important because the brain controls so many other bodily functions. The remedy is tailored to the individual patient and is based on individual symptoms as well as the general symptoms of RLS.
- **Reflexology**. Reflexologists claim that the brain, head, and spine all respond to indirect massage of specific parts of the feet.
- Nutritional supplements. Supplementation of the diet with vitamin E, calcium, magnesium, and **folic acid** may be helpful for people with RLS.

Some alternative methods may treat the associated condition that is suspected to cause restless legs. These include:

- Anemia or low ferritin levels. Chinese medicine will emphasize stimulation of the spleen as a means of improving blood circulation and vitamin absorption. Other treatments may include acupuncture and herbal therapies, such as ginseng (*Panax ginseng*) for anemia-related fatigue.
- Late-stage pregnancy. There are few conventional therapies available to pregnant women, since most of the drugs prescribed are not recommended for use during pregnancy. Pregnant women may benefit from alternative techniques that focus on body work, including **yoga**, reflexology, and acupuncture.

KEY TERMS

Anemia—A condition that affects the size and number of red blood cells. It often results from lack of iron or certain B vitamins and may be treated with iron or vitamin supplements.

Insomnia—Trouble sleeping. People who suffer from RLS often lose sleep either because they spend time walking to relieve discomfort or because they have PLMS, which causes them to wake often during the night.

Periodic limb movements in sleep (PLMS)—Random movements of the arms or legs that occur at regular intervals of time during sleep.

Prognosis

RLS usually does not indicate the onset of other neurological disease. It may remain static, although two-thirds of patients get worse with time. The symptoms usually progress gradually. Treatment with Levodopa is effective in moderate to severe cases that may include significant PLMS. However, this drug produces significant side effects, and continued successful treatment may depend on carefully monitored use of combination drug therapy. The prognosis is usually best if RLS symptoms are recent and can be traced to another treatable condition that is associated with RLS. Some associated conditions are not treatable. In these cases, such as for rheumatoid arthritis, alternative therapies such as acupuncture may be helpful.

Prevention

Diet is key in preventing RLS. A preventive diet will include an adequate intake of iron and the B **vitamins**, especially B_{12} and folic acid. Strict vegetarians should take vitamin supplements to obtain sufficient vitamin B_{12}. Ferrous gluconate may be easier on the digestive system than ferrous sulfate, if iron supplements are prescribed. Some medications may cause symptoms of RLS. Patients should check with their doctor about these possible side effects, especially if symptoms first occur after starting a new medication. **Caffeine**, alcohol, and nicotine use should be minimized or eliminated. Even a hot bath before bed has been shown to prevent symptoms for some sufferers.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

Long, James W., and James J. Rybacki. *The Essential Guide to Prescription Drugs*. New York: HarperPerennial, 1995.

Mills, Simon, and Stephen J. Finando. *Alternatives in Healing*. New York: New American Library, 1989.

"Peripheral Neuropathies." In *Mayo Clinic Family Health Book*, ed. David E. Larson. New York: William Morrow and Co., 1996.

PERIODICALS

Montplaisir, Jaques, et al. "Clinical, Polysomnographic, and Genetic Characteristics of Restless Legs Syndrome: A Study of 133 Patients Diagnosed with New Standard Criteria." *Movement Disorders* 12 (1997): 61-65.

O'Keeffe, Shaun T. "Restless Legs Syndrome: A Review." *Archives of Internal Medicine* 56 (12 Feb. 1996): 243-246.

Silber, Michael H. "Concise Review for Primary-Care Physicians. Restless Legs Syndrome." *Mayo Clinical Proceedings* 72 (Mar. 1997): 261-264.

ORGANIZATIONS

Restless Legs Syndrome Foundation. 1904 Banbury Road, Raleigh, NC 27608-4428. (919) 781-4428. <http://www.rls.org>.

Ann M. Haren

Restrictive cardiomyopathy

Definition

Cardiomyopathy is an ongoing disease process that damages the muscle wall of the lower chambers of the heart. Restrictive cardiomyopathy is a form of cardiomyopathy in which the walls of the heart become rigid.

Description

Restrictive cardiomyopathy is the least common type of cardiomyopathy in the United States. The stiffened heart walls cannot stretch properly to allow enough blood to fill the ventricles between heartbeats. As the stiffening worsens, **heart failure** occurs. The blood backs up into the blood vessels, causing fluid buildup in tissues (congestion and **edema**).

Causes and symptoms

Restrictive cardiomyopathy can be caused by a number of diseases. Often, the cause is unknown. The rigidity of the heart walls may be caused by fibrosis, the replacement of muscle cells with tough, fibrous tissue. In some disorders, proteins and other substances are deposited in the heart wall. **Amyloidosis** is the accumulation of a protein material, called amyloid, in the tissue of the heart

wall and other organs. In **hemochromatosis**, there is too much iron in the body and some of the excess iron can build up in the heart. **Sarcoidosis** causes the formation of many small lesions, called granulomas, in the heart wall and other tissues of the body. These granulomas contain inflammatory white blood cells and other cells that decrease the flexibility of the heart.

People with restrictive cardiomyopathy usually feel tired and weak, and have **shortness of breath**, especially during **exercise**. If blood is backing up in the circulation they may also experience edema (large amounts of fluid in tissues) of the legs and feet.

Diagnosis

The diagnosis is usually based on a **physical examination**, **echocardiography**, and other tests as needed. The physician listens to the heart with a stethoscope to detect abnormal heart rhythms and heart sounds.

Echocardiography uses sound waves to make images of the heart. These images provide information about the structures of the heart and its heart valves. Echocardiography can also be used to find out how much blood the heart is pumping. It determines the amount of blood in the ventricle, called the ventricular volume, and the amount of blood the ventricle pumps each time it beats, called the ejection fraction. A healthy heart pumps at least one half the amount of blood in the left ventricle with each heartbeat.

Computed tomography scan (CT scan) and **magnetic resonance imaging** (MRI) are imaging tests that can also provide information about the structure of the heart. However, these tests are rarely needed for diagnosis.

Cardiac catheterization may be needed to confirm a diagnosis or cause. In cardiac catheterization, a small tube called a catheter is inserted into an artery and passed into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart. A small tissue sample (biopsy) of the heart muscle can be removed through the catheter for microscopic examination. Fibrous tissue or deposits in the heart muscle can be identified in this biopsy.

Treatment

There is no effective treatment for restrictive cardiomyopathy. Treatment of a causative disease may reduce or stop the damage to the heart, but existing damage cannot be reversed. Medications may be used to lessen the workload on the heart and to control the heart rhythm. Drugs normally used to treat other types of cardiomyopathy and heart failure may cause problems for patients with restrictive cardiomyopathy. For example, medicines that reduce the heart's workload may lower blood pressure too much.

A heart transplant may be necessary for patients who develop severe heart failure.

KEY TERMS

Amyloidosis—Build up of amyloid, a protein substance, in tissues of the body, including the heart.

Cardiac catheterization—A diagnostic test for evaluating heart disease; a catheter is inserted into an artery and passed into the heart.

Edema—Swelling caused by fluid buildup in tissues.

Fibrosis—Replacement of normal tissue with tough, fibrous tissue.

Hemochromatosis—A disease in which there is too much iron in the body; iron deposits can build up in the heart muscle and other tissues.

Sarcoidosis—A chronic disease causing the formation of many small lesions called granulomas in the heart wall and other tissues of the body.

Prognosis

The prognosis for patients with restrictive cardiomyopathy is poor. If the disease process causing the problem can be treated, the damage to the heart muscle may be stopped. Also, medicines may relieve symptoms. However, for most patients, restrictive cardiomyopathy eventually causes heart failure. A heart transplant may be necessary when heart failure becomes too severe to treat with medicines.

Prevention

Obtaining early treatment for diseases that might cause restrictive cardiomyopathy might prevent or slow the development of heart wall stiffness. Anyone experiencing symptoms of shortness of breath, tiredness, and weakness should see a physician.

Resources

BOOKS

Bellenir, Karen, and Peter D. Dresser, eds. *Cardiovascular Diseases and Disorders Sourcebook*. Detroit: Omnigraphics, 1995.

Texas Heart Institute. *Heart Owner's Handbook*. New York: John Wiley and Sons, 1996.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Toni Rizzo

Reticulocyte count

Definition

A reticulocyte count is a blood test performed to assess the body's production of immature red blood cells (reticulocytes). A reticulocyte count is usually performed when patients are evaluated for anemia and response to its treatment. It is sometimes called a retic count.

Purpose

Diagnosis

A reticulocyte count provides information about the rate at which the bone marrow is producing red cells. A normal count means that the production is adequate; a decreased count means it is not. This information helps determine whether a lack of red cells in an anemic person is caused by a bone marrow problem, by excessive bleeding, or by red cell destruction.

Monitoring

The test is also used to monitor the response of bone marrow response to treatment for anemia. The reticulocyte count rises within days if the treatment is successful. It is also used following bone marrow transplant to evaluate the new marrow's cell production.

Description

Reticulocytes were first described as transitional forms of red blood cells by Wilhelm H. Erb in 1865. A red cell begins in the bone marrow as a large bluish cell filled with ribonucleic acid (RNA). As the cell matures, it shrinks. Its color gradually changes from blue to pink as its load of oxygen-carrying protein (hemoglobin) increases and the RNA decreases. The center of the cell (nucleus) becomes clumped. It is expelled three days before the cell leaves the bone marrow. The cell is now a reticulocyte. On its fourth and final day of maturation, the reticulocyte enters the bloodstream. One day later, it is a mature red blood cell.

The first step in a retic count is drawing the patient's blood sample. About 17 oz (5 ml) of blood is withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

After the sample is collected, the blood is mixed with a dye (methylene blue) in a test tube. The RNA remaining in the reticulocytes picks up a deep blue stain. Drops of the mixture are smeared on slides and examined under a microscope. Reticulocytes appear as cells containing dark blue granules or a blue network. The laboratory technologist counts 1,000 red cells, keeping track of the number of reticulocytes. The number of reticulocytes is reported as a percentage of the total red cells. When the red cell count is low, the percentage of reticulocytes is inaccurately high, suggesting that more reticulocytes are present than there are in reality. The percentage is mathematically corrected for greater accuracy. This figure is called the corrected reticulocyte count or reticulocyte index.

Reticulocyte counts can also be done on automated instruments, such as flow cytometers, using fluorescent stains. These instruments are able to detect small changes in the reticulocyte count because they count a larger number of cells (10,000–50,000).

Preparation

The doctor should make a note of any prescription medications that the patient is taking. Some drugs lower the red blood cell count.

Aftercare

Aftercare consists of routine care of the area around the puncture mark. Pressure is applied for a few seconds and the wound is covered with a bandage.

Risks

The primary risk is mild **dizziness** and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

Normal results

Adults have reticulocyte counts of 0.5–2.5%. Women and children usually have higher reticulocyte counts than men.

Abnormal results

A low reticulocyte count indicates that the bone marrow is not producing a normal number of red blood

KEY TERMS

Anemia—A condition marked by a decrease in the number or size of red blood cells

Methylene blue—A dye that is used to stain the blood cells for the reticulocyte count.

Reticulocyte—An immature red blood cell.

cells. Low production may be caused by a lack of vitamin B_{12}, **folic acid**, or iron in the diet; or by an illness affecting the bone marrow (for example, **cancer**). Further tests are needed to diagnose the specific cause.

The reticulocyte count rises when the bone marrow makes more red cells in response to blood loss or treatment of anemia.

Resources

PERIODICALS

Rowan, R. M., et al. "The Reticulocyte Count: Progress Towards the Resurrection of a Useful Clinical Test." *Clinical and Laboratory Haematology* 18, no. 1 (1996): 3-8.

Nancy J. Nordenson

Retinal artery occlusion

Definition

Retinal artery occlusion refers to the closure of the central retinal artery and usually results in complete loss of vision in one eye. Occlusion of its branches causes loss of vision in only a portion of the field of vision.

Description

Retinal artery occlusion (RAO) occurs when the central retinal artery, the main source of blood supply to the retina, or one of its branches becomes blocked.

Causes and symptoms

The main causes of RAO are the following:

- embolism (the sudden obstruction of a blood vessel by a blood clot)
- atherosclerotic disease that results in the progressive narrowing of the arteries over time
- endarteritis (the chronic inflammation of the inner layer of arteries)
- angiospasm (a spasmodic contraction of a blood vessel with increase in blood pressure)

The most common symptom of RAO is an acute, painless loss of vision in one eye. The degree of loss depends on the location of the occlusion. If the occlusion occurs in the central artery of the retina, damage usually results in complete loss of vision in the affected eye. If occlusion occurs in a branch artery, vision loss will be partial and may even go unnoticed if only a section of the peripheral vision is affected.

People affected by RAO typically have high blood pressure, heart disease, or diabetes as an underlying condition. Other conditions that may increase the risk of RAO include **high cholesterol** and **glaucoma**. Incidence is slightly more common in men and in people age 60 or older.

Diagnosis

RAO is diagnosed by examination of the retina with an ophtalmoscope.

Treatment

Central retinal artery occlusion (CRAO) is an emergency. If treatment begins within an hour, the patient has the highest possibility of regaining vision in the affected eye, although complete restoration is unlikely.

A common treatment is inhalation of carbon dioxide so as to dilate the retinal vessels and move the occlusion from the central retinal artery to a branch artery. This movement reduces the area of the retina affected and may restore a certain amount of vision. Eyeball massage may also be performed, also in an effort to remove the occlusion. The physician may also consider puncturing the eyeball.

Drug therapy includes the use of carbonic anhydrase inhibitors to reduce the internal eye pressure and enhance movement of the occlusion. Both of the treatments would be used within the first 24 hours of noticeable vision loss.

Alternative treatment

Hyperbaric oxygen therapy may be beneficial if started within 90 minutes of the onset of symptoms. Some studies indicate a 40% improvement of visual acuity using this method.

Prognosis

The prognosis for central retinal visual acuity is poor with only about one-third of patients recovering useful vision. The longest delay in getting treatment that

KEY TERMS

Angiospasm—Spasmodic contraction of a blood vessel with increase in blood pressure.

Arterioles—Small blood vessels that carry arterial (oxygenated) blood.

Atherosclerotic disease—The progressive narrowing and hardening of the arteries over time.

Central retinal artery—A branch of the ophthalmic artery that supplies blood to the retina and branches to form the arterioles of the retina.

Embolism—The sudden obstruction of a blood vessel by a blood clot.

Endarteritis—Chronic inflammation of the inner layer of arteries.

Hyperbaric oxygenation—Administration of oxygen in a compression chamber at an ambient pressure greater than 1 atmosphere, in order to increase the amount of oxygen in organs and tissues.

Occlusion—Momentary complete closure of some area or channel of the body.

Ophthalmic artery—The artery supplying the eye and adjacent structures with blood.

Ophthalmoscope—An instrument used for viewing the inside of the eye that consists of a concave mirror with a hole in the middle through which the physician examines the eye, and a light source that is reflected into the eye by the mirror.

Retina—Light sensitive layer of the eye, that consists of four major layers: the outer neural layer, containing nerve cells and blood vessels, the photoreceptor layer, a single layer that contains the light sensing rods and cones, the pigmented retinal epithelium (PRE) and the choroid, consisting of connective tissue and capillaries.

has been associated with significant visual recovery was approximately 72 hours.

Branch retinal artery occlusions (BRAO) have a recovery rate of 80% where vision is restored to 20/40 or better.

Prevention

Individuals affected by underlying conditions such as high blood pressure, heart disease, diabetes, glaucoma, and elevated cholesterol should treat their conditions appropriately to minimize the possibility of a retinal artery occlusion.

Resources

ORGANIZATIONS

American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. Fax: (415) 561-8533. <http://www.eyenet.org/>.

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) DIABETES. <http://www.diabetes.org/>.

American Heart Association National Center. 7272 Greenville Avenue, Dallas, Texas 75231. (800) AHA-USA1. <http://www.americanheart.org/>.

CliniWeb International. <http://www.ohsu.edu/cliniweb/C11/C11.768.html>.

Gary Gilles

Retinal detachment

Definition

Retinal detachment is movement of the transparent sensory part of the retina away from the outer pigmented layer of the retina. In other words, the moving away of the retina from the outer wall of the eyeball.

Description

There are three layers of the eyeball. The outer, tough, white sclera. Lining the sclera is the choroid, a thin membrane that supplies nutrients to part of the retina. The innermost layer is the retina.

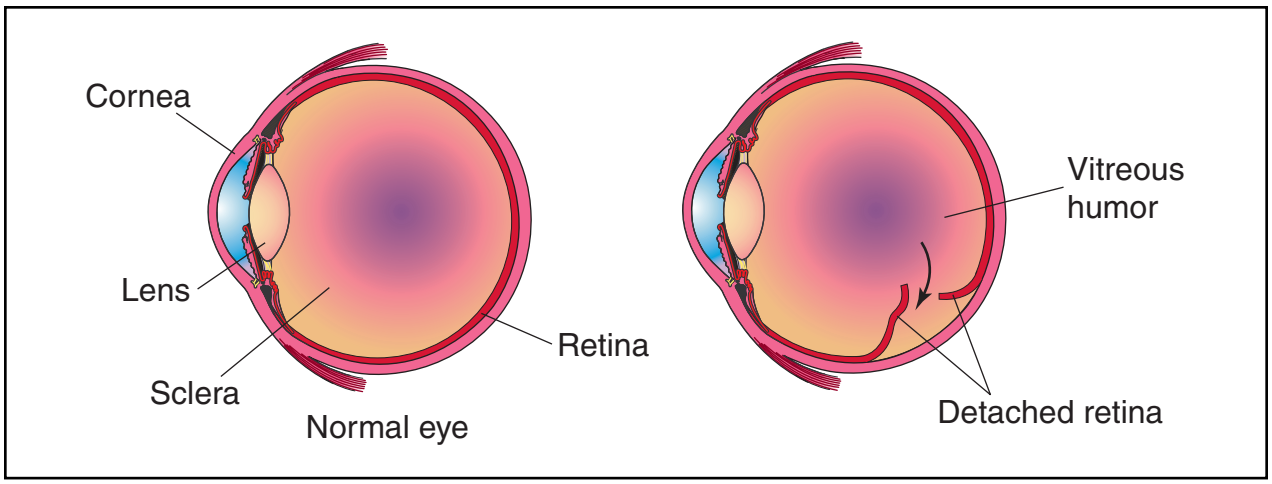
The retina is the light-sensitive membrane that receives images and transmits them to the brain. It is made up of several layers. One layer contains the photoreceptors. The photoreceptors, the rods and cones, send the visual message to the brain. Between the photoreceptor layer (also called the sensory layer) and the choroid is the pigmented epithelium.

The vitreous is a clear gel-like substance that fills up most of the inner space of the eyeball. It lies behind the lens and is in contact with the retina.

A retinal detachment occurs between the two outermost layers of the retina—the photoreceptor layer and the outermost pigmented epithelium. Because the choroid supplies the photoreceptors with nutrients, a detachment can basically starve the photoreceptors. If a detachment is not repaired within 24–72 hours, permanent damage may occur.

Causes and symptoms

Several conditions may cause retinal detachment:



Retinal detachment refers to the movement of the retina away from the inner wall of the eyeball, resulting in a sudden defect in vision. Persons suffering from diabetes have a high incidence of developing retinal disease. *(Illustration by Electronic Illustrators Group.)*

- Scarring or shrinkage of the vitreous can pull the retina inward.
- Small tears in the retina allow liquid to seep behind the retina and push it forward.
- Injury to the eye can simply knock the retina loose.
- Bleeding behind the retina, most often due to diabetic retinopathy or injury, can push it forward.
- Retinal detachment may be spontaneous. This occurs more often in the elderly or in very nearsighted (myopic) eyes.
- Cataract surgery causes retinal detachment 2% of the time.
- Tumors can cause the retina to detach.

Retinal detachment will cause a sudden defect in vision. It may look as if a curtain or shadow has just descended before the eye. If most of the retina is detached, there may be only a small hole of vision remaining. If just a part of the retina is involved, there will be a blind spot that may not even be noticed. It is often associated with *floaters*—little dark spots that float across the eye and can be mistaken for flies in the room. There may also be *flashes* of light. Anyone experiencing a sudden onset of flashes and/or floaters should contact their eye doctor immediately, as this may signal a detachment.

Diagnosis

If the eye is clear—that is, if there is no clouding of the liquids inside the eye—the detachment can be seen by looking into the eye with a hand-held instrument called an ophthalmoscope. To evaluate the blood vessels in the retina, a fluorescent dye (fluorescein) may be injected into a vein and photographed with ultraviolet light as it passes through the retina. Further studies may include computed tomography scan (CT scan), **magnetic resonance imaging** (MRI), or ultrasound study. Other lenses may be used to examine the back of the eyes. One example is binocular indirect ophthalmoscopy. The doctor dilates the patient's eyes with eyedrops and then examines the back of the eyes with a hand-held lens.

Treatment

Reattaching the retina to the inner surface of the eye requires making a scar that will hold it in place and then bringing the retina close to the scarred area. The scar can be made from the outside, through the sclera, using either a laser or a freezing cold probe (cryopexy). Bringing the retina close to the scar can be done in two ways. A tiny belt tightened around the eyeball will bring the sclera in until it reaches the retina. This procedure is called scleral buckling and may be done under general anesthesia. Using this procedure permits the repair of retinal detachments without entering the eyeball. Sometimes, the eye must be entered to pump in air or gas, forcing the retina outward against the sclera and its scar. This is called pneumatic retinopexy and can generally be done under local anesthesia.

If all else fails, and especially if there is disease in the vitreous, the vitreous may have to be removed in a procedure called **vitrectomy**. This can be done through tiny holes in the eye, through which equally tiny instruments are placed to suck out the vitreous and replace it with saline, a salt solution. The procedure must maintain pressure inside the eye so that the eye does not collapse.

KEY TERMS

Cauterize—To damage with heat or cold so that tissues shrink. It is an effective way to stop bleeding.

Diabetic retinopathy—Disease that damages the blood vessels in the back of the eye caused by diabetes.

Saline—A salt solution equivalent to that in the body—0.9% salt in water.

Prognosis

Retinal reattachment has an 80–90% success rate.

Prevention

In diseases such as diabetes, with a high incidence of retinal disease, routine eye examinations can detect early changes. Early treatment can prevent both progressing to detachment and blindness from other events like hemorrhage. The most common problem is weakness of blood vessels that causes them to break down and bleed. When enough vessels have been damaged, new vessels grow to replace them. These new vessels may grow into the vitreous, producing blind spots and scarring. The scarring can in turn pull the retina loose. Other diseases can cause the tiny holes and tears in the retina through which fluid can leak. Preventive treatment uses a laser to cauterize the blood vessels, so that they do not bleed and the holes, so they do not leak.

Good control of diabetes can help prevent diabetic eye disease. Blood pressure control can prevent **hypertension** from damaging the retinal blood vessels. Eye protection can prevent direct injury to the eyes. Regular eye exams can also detect changes that the patient may not be aware of. This is important for patients with high **myopia** who may be more prone to detachment.

Resources

BOOKS

Hardy, Robert A. "Retina and Intraocular Tumors." In *General Ophthalmology.* 13th ed. Ed. Daniel Vaughan. Stamford: Appleton & Lange, 1993.

Sardegna, Jill Otis, and T. Paul. *The Encyclopedia of Blindness and Vision Impairment*. New York: Facts on File, Inc., 1990.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

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Retinal vein occlusion

Definition

Retinal vein occlusion refers to the closure of the central retinal vein that drains the retina or to that of one of its branches.

Description

Retinal vein occlusion (RVO) occurs when the central retinal vein, the blood vessel that drains the retina, or one of its branches becomes blocked. RVO may be categorized by the anatomy of the occluded vein and the degree of **ischemia** produced. The two major RVO types are central retinal vein occlusion (CRVO) and branch retinal vein occlusion (BRVO). CRVO has been diagnosed in patients as young as nine months to patients of 90 years. The age of affected individuals is usually low to mid 60s. Approximately 90% of patients are over 50 at the time of diagnosis, with 57% of them being male and 43% being female. BRVO accounts for some 30% of all vein occlusions.

Causes and symptoms

CRVO is a painless loss of vision that can be caused by a swollen optic disk, the small area in the retina where the optic nerve enters the eye, by dilated retinal veins, and by retinal hemorrhages. CRVO is also called venous stasis retinopathy, or hemorrhagic retinopathy.

In BRVO, the superotemporal branch vein is the most often affected vessel. Retinal hemorrhages follows, often occurring at the crossing of two vessels near the optic disk. Initially the hemorrhage may be extensive and underlie the fovea.

The exact cause of RVO is not yet identified, but the following mechanisms been proposed:

- external compression between the central connective strand and the cribriform plate
- venous disease
- blood clot formation

Conditions associated with RVO risk include:

- hypertension
- hyperlipidemia
- diabetes mellitus

KEY TERMS

Anticoagulants—Drugs that act by lowering the capacity of the blood to coagulate, thus facilitating removal of blood clots.

Central retinal vein—Central blood vessel and its branches that drains the retina.

Cribriform plate—The horizontal bone plate perforated with several holes for the passage of olfactory nerve filaments from the nasal cavity.

Fovea—A small area of the retina responsible for acute vision.

Glaucoma—A group of eye diseases characterized by an increase in eyeball pressure.

Hyperlipidemia—A general term for elevated concentrations of any or all of the lipids in the plasma.

Iris—The contractile diaphragm located in the fluid in front of the lens of the eye that is perforated by the eye pupil.

Ischemia—A state of low oxygen in a tissue usually due to

Neovascularization—Abnormal or excessive formation of blood vessels as in some retinal disorders.

Occlusion—Momentary complete closure of some area or channel of the body.

Optic disk—The small area in the retina where the optic nerve enters the eye that is not sensitive to light. Also called the blind spot.

Retina—Light sensitive layer of the eye, that consists of four major layers: the outer neural layer, containing nerve cells and blood vessels, the photoreceptor layer, a single layer that contains the light sensing rods and cones, the pigmented retinal epithelium (PRE) and the choroid, consisting of connective tissue and capillaries.

- hyperviscosity
- hypercoagulability
- **glaucoma**
- trauma

Diagnosis

A complete physical evaluation is recommended for CRVO and BRVO, including complete blood tests, and glucose tolerance test (for non-diabetics). In the case of a **head injury** when bleeding around the optic nerve is a possibility, an MRI may be performed.

Treatment

Following a patient with RVO is vital. Patients should be seen at least monthly for the first three months to monitor for signs of other complications, such as the abnormal formation of blood vessels (neovascularization) in the iris of the eye or glaucoma.

The treatment for retinal vein occlusion varies for each case and should be given based on the doctor's best recommendation. Although treatments for occlusion itself are limited, surgical treatment of the occlusion provides an option.

Treatments may include anticoagulants with heparin, bishydroxycoumarin, and streptokinase. When the blood is highly viscous, dilution of the blood may be useful. Ideally, an alternate pathway is needed to allow venous drainage. Recent reports published in 1999 suggest that use of a laser to create a retinal choroidal hole may be useful to treat CRVO. Laser therapy depends on the type of occlusion. The management of laser therapy should be controlled by an ophthalmologist.

Alternative treatment

There are no documented alternative treatment methods.

Prognosis

The outlook for people with RVO is fairly good whether it is treated early or not. With no treatment at all, approximately 60% of all patients recover 20/40 vision or better within a year.

Prevention

Retinal vein occlusion is difficult to prevent because the exact cause is still uncertain. Ethnic factors may play a role since in the UK the disease is rare in Asians and West Indians.

Resources

BOOKS

Newell, Frank W. *Ophthalmology Principles and Concepts, 8th Ed*. Boston: Mosby-Year Brook Inc., 1996.

Spaide, Richard F., MD. *Diseases of the Retina and Vitreous.* New York: W.B. Saunders Co., 1999.

Michael Sherwin Walston
Ronald Watson, PhD

Retinitis pigmentosa

Definition

Retinitis pigmentosa (RP) refers to a group of inherited disorders that slowly leads to blindness due to abnormalities of the photoreceptors (primarily the rods) in the retina.

Description

The retina lines the interior surface of the back of the eye. The retina is made up of several layers. One layer contains two types of photoreceptor cells referred to as the rods and cones. The cones are responsible for sharp, central vision and color vision and are primarily located in a small area of the retina called the fovea. The area surrounding the fovea contains the rods, which are necessary for peripheral vision and night vision (scotopic vision). The number of rods increases in the periphery. The rod and cone photoreceptors convert light into electrical impulses and send the message to the brain via the optic nerve. Another layer of the retina, called the retinal pigmented epithelium (RPE), may also be affected.

In RP, the photoreceptors (primarily the rods) begin to deteriorate and lose their ability to function. Because the rods are primarily affected, it becomes harder to see in dim light, thus causing a loss of night vision. As the condition worsens, peripheral vision disappears, which results in tunnel vision. The ability to see color is eventually lost. In the late stages of the disease, there is only a small area of central vision remaining. Ultimately, this too is lost.

There are many forms of retinitis pigmentosa. Sometimes the disorder is classified by the age of onset or the inheritance pattern. RP can also accompany other conditions. This entry discusses "non-syndromic" RP, the type that is not associated with other organ or tissue dysfunction.

The prevalence of RP is approximately one out of every 4,000 people in the United States and Europe. For other parts of the world, there are no published data. Nor is there any known ethnic difference in the occurrence of RP.

Causes and symptoms

Retinitis pigmentosa is an inherited disease that has many different modes of inheritance. RP, with any inheritance pattern, may be either familial (multiple family members affected) or isolated (only one affected person). In the non-sex-linked, or autosomal, form, it can either be a dominant or recessive trait. In the sex-linked form, called x-linked recessive, it is a recessive trait. This x-linked form is more severe than the autosomal forms. Two rare forms of RP are the digenic and mitochondrial forms.

Isolated RP cases represent 10–40% of all cases. Some of these cases may be the result of new gene mutations (changes in the genes). Other isolated cases are those in which the person has a relative with a mutation in the gene, but the relative is not affected by the condition.

Autosomal dominant RP (AdRP) occurs in about 15–25% of affected individuals. At least 12 different genes have been identified as causing AdRP. People with AdRP will usually have an affected parent. The risk for affected siblings or children is 50%.

Autosomal recessive RP (ArRP) occurs in about 5–20% of affected individuals. More than 16 genes have been identified that cause this type of RP. In ArRP, each parent of the affected person is a carrier of an abnormal gene that causes RP. Neither of these carrier parents is affected. There is a two-thirds chance that an unaffected sibling is a carrier of RP. All of the children of an affected person would be a carrier of the ArRP gene.

Five to 15% of individuals with RP have x-linked recessive RP (XLRP). Six different genes have been identified as the cause of this type of RP. Usually in this type of inheritance, males are affected carriers, while females are unaffected carriers or have a milder form of the disease. The mother may be a carrier of the mutation on the X-chromosome. It is also possible that a new mutation can occur for the first time in an affected person. For families with one affected male, there is a mathematical formula called the Baysean analysis that can be applied to the family history. It takes into account the number of unaffected males to determine whether a female is likely to be a carrier or not. If a mother is a carrier, her children have a 50% chance of inheriting the RP gene. For affected males, all of their daughters will be carriers but none of their sons will be affected.

The digenic form of RP occurs when the affected person has inherited one copy of an altered ROM1 gene from one parent and one copy of an altered peripherin/RDS gene from the other parent. The parents are asymptomatic. Mitochondrial inheritance occurs when the gene mutation is in a mitochondrial gene. People with this type of RP have progressive **hearing loss** and mild myopathy. Both of these types of RP are very rare.

The first symptoms, a loss of night vision followed by a loss of peripheral vision, usually begin in early adolescence or young adulthood. Occasionally, the loss of

the ability to see color occurs before the loss of peripheral vision. Another possible symptom is seeing twinkling lights or small flashes of lights.

Diagnosis

When a person complains of a loss of night vision, a doctor will examine the interior of the eye with an ophthalmoscope to determine if there are changes in the retina. For people with advanced RP, the condition is characterized by the presence of clumps of black pigment in the inner retina (intraretinal). However, the appearance of the retina is not enough for an RP diagnosis since there are other disorders that may give the retina a similar appearance. There are also other reasons someone may have night blindness. Consequently, certain electrodiagnostic tests must be performed. An electroretinogram (ERG) determines the functional status of the photoreceptors by exposing the retina to light. The ERG uses a contact lens in the eye, and the output is measured on a special instrument called an oscilloscope. The functional assessments of visual fields, visual acuity, or color vision may also be performed.

The diagnosis of RP can be established when the following criteria are met:

- rod dysfunction measured by dark adaptation test or ERG,
- progressive loss in photoreceptor function,
- loss of peripheral (side) vision,
- both eyes affected (bilaterality).

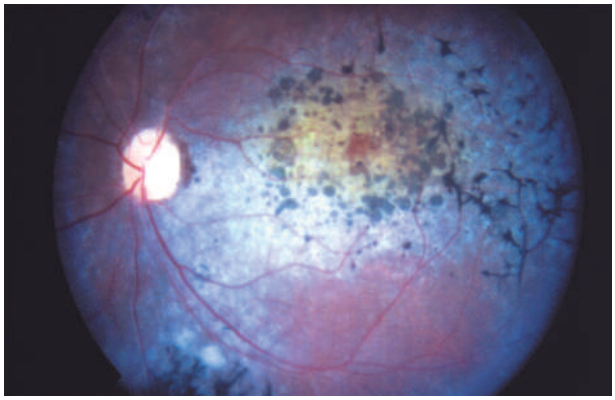
Molecular **genetic testing** is available on a research basis. Prenatal diagnosis for this condition has not yet been achieved.

Treatment

There are no medications or surgery to treat RP. Some doctors believe **vitamins** A and E will slightly slow the progression of the disease in some people. However, large doses of certain vitamins may be toxic and affected individuals should speak to their doctors before taking supplements.

If a person with RP must be exposed to bright sunlight, some doctors recommend wearing dark sunglasses to reduce the effect on the retina. Affected people should talk to their eye doctors about the correct lenses to wear outdoors.

Because there is no cure for RP, the affected person should be monitored for visual function and counseled about low-vision aids (for example, field-expansion devices). **Genetic counseling** is also appropriate. A three-generation family history with attention to other relatives with possible RP can help to clarify the inheritance pattern. For some people however, the inheritance pattern cannot be discerned.



A fundus camera image showing the degeneration of the retina due to retinitis pigmentosa. The pattern of dark spots across the retina corresponds to the extent of loss of vision. *(Custom Medical Stock Photo. Reproduced by permission.)*

Prognosis

There is no known cure for RP, which will eventually lead to blindness. The more severe forms will lead to blindness sooner than milder forms.

Resources

BOOKS

Newell, Frank W. *Ophthalmology: Principles and Concepts*, 7th ed. St. Louis, MO: Mosby Year Book, 1992.

ORGANIZATIONS

American Academy of Ophthalmology. PO Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. <http://www.eyenet.org>.

American Association of the Deaf-Blind. 814 Thayer Ave., Suite 302, Silver Spring, MD 20910. (301) 588-6545.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Foundation Fighting Blindness. Executive Plaza 1, Suite 800, 11350 McCormick Rd., Hunt Valley, MD 21031. (888) 394-3937. <http://www.blindness.org>.

National Retinitis Pigmentosa Foundation. 11350 McCormick Rd., Executive Plaza 1, Suite 800, Hung Valley, MD 21031-1014. (800) 683-5555. <http://www.blindness.org>.

Prevent Blindness America. 500 East Remington Rd., Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

OTHER

Genetic Alliance. <http://www.geneticalliance.org>.

KEY TERMS

Ophthalmoscope—An instrument, with special lighting, designed to view structures in the back of the eye.

"OMIM—Online Mendelian Inheritance in Man". *National Center for Biotechnology Information*. <http://www.ncbi.nlm.nih.gov/Omim/searchomim.html>.
National Federation of the Blind. <http://www.nfb.org>.
Retinitis Pigmentosa International. <http://www.rpinternational.org>.

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Retinoblastoma

Definition

Retinoblastoma is a malignant tumor of the retina that occurs predominantly in young children.

Description

The eye has three layers, the sclera, the choroid, and the retina. The sclera is the outer protective white coating of the eye. The choroid is the middle layer and contains blood vessels that nourish the eye. The front portion of the choroid is colored and is called the iris. The opening in the iris is called the pupil. The pupil is responsible for allowing light into the eye and usually appears black. When the pupil is exposed to bright light it contracts (closes), and when it is exposed to low light conditions it dilates (opens) so that the appropriate amount of light enters the eye. Light that enters through the pupil hits the lens of the eye. The lens then focuses the light onto the retina, the innermost of the three layers. The job of the retina is to transform the light into information that can be transmitted to the optic nerve, which will transmit this information to the brain. It is through this process that people are able to see the world around them.

Occasionally a tumor, called a retinoblastoma, will develop in the retina of the eye. Usually this tumor forms in young children but it can occasionally occur in adults. Most people with retinoblastoma develop only one tumor (unifocal) in only one eye (unilateral). Some, however, develop multiple tumors (multifocal) in one or both eyes. When retinoblastoma occurs independently in both eyes, it is then called bilateral retinoblastoma.

Occasionally, children with retinoblastoma develop trilateral retinoblastoma. Trilateral retinoblastoma results from the development of an independent **brain tumor** that often forms in a part of the brain called the pineal gland. In order for retinoblastoma to be classified as trilateral retinoblastoma, the tumor must have developed independently and not as the result of the spread of the retinal **cancer**. The prognosis for trilateral retinoblastoma is quite poor.

The retinal tumor which characterizes retinoblastoma is malignant, meaning that it can metastasize (spread) to other parts of the eye and eventually other parts of the body. In most cases, however, retinoblastoma is diagnosed before it spreads past the eye to other parts of the body (intraocular) and the prognosis is quite good. The prognosis is poorer if the cancer has spread beyond the eye (extraocular).

Retinoblastoma can be inherited or can arise spontaneously. Approximately 40% of people with retinoblastoma have an inherited form of the condition and approximately 60% have a sporadic (not inherited) form. Individuals with multiple independent tumors, bilateral retinoblastoma, or trilateral retinoblastoma are more likely to be affected with the inherited form of retinoblastoma.

Approximately one in 15,000 to one in 30,000 infants are born with retinoblastoma, making it the most common childhood **eye cancer**. It is, however, a relatively rare childhood cancer and accounts for approximately 3% of childhood cancers. Retinoblastoma is found mainly in children under the age of five but can occasionally be seen in older children and adults. Retinoblastoma is found in individuals of all ethnic backgrounds and is found equally frequently in males and females.

Causes and symptoms

Causes

Retinoblastoma is caused by changes in or absence of a gene called RB1. RB1 is located on chromosome 13. Cells of the body, with the exception of the egg and sperm cells, contain 23 pairs of chromosomes. All of the cells of the body excluding the egg and the sperm cells are called the somatic cells. The somatic cells contain two of each chromosome 13 and therefore two copies of the RB1 gene. Each egg and sperm cell only contains one copy of chromosome and therefore only one copy of the RB1 gene.

RB1 produces a tumor suppressor protein that normally helps to regulate the cell cycle of cells such as those of the retina. A normal cell of the retina goes through a growth cycle during which it produces new cells. Genes such as tumor suppressor genes tightly regulate this growth cycle.

Cells that lose control of their cell cycle and replicate out of control are called cancer cells. These undergo many cell divisions, often at a quicker rate than normal cells, and do not have a limited lifespan. A group of adjacent cancer cells can form a mass called a tumor. Malignant (cancerous) tumors can spread to other parts of the body. A malignant tumor of the retina (retinoblastoma) can result when just one retinal cell looses control of it cell cycle and replicates out of control.

Normally the tumor suppressor protein produced by RB1 prevents a retinal cell from becoming cancerous. Each RB1 gene produces tumor suppressor protein. Only one functioning RB1 gene in a retinal cell is necessary to prevent the cell from becoming cancerous. If both RB1 genes in a retinal cell become non-functional, then a retinal cell can become cancerous and retinoblastoma can result. An RB1 gene is non-functional when it is changed or missing (deleted) and no longer produces normal tumor suppressor protein.

Approximately 40% of people with retinoblastoma have inherited a non-functional or deleted RB1 gene from either their mother or father. Therefore, they have a changed/deleted RB1 gene in every somatic cell. A person with an inherited missing or non-functional RB1 gene will develop a retinal tumor if the remaining RB1 gene becomes changed or deleted in a retinal cell. The remaining RB1 gene can become non-functional when exposed to environmental triggers such as chemicals and radiation. In most cases, however, the triggers are unknown. Approximately 90% of people who inherit a changed or missing RB1 gene will develop retinoblastoma.

People with an inherited form of retinoblastoma are more likely to have a tumor in both eyes (bilateral) and are more likely to have more than one independent tumor (multifocal) in one or both eyes. The average age of onset for the inherited form of retinoblastoma is one year, which is earlier than the sporadic form of retinoblastoma. Although most people with the inherited form of retinoblastoma develop bilateral tumors, approximately 15% of people with a tumor in only one eye (unilateral) are affected with an inherited form of retinoblastoma.

A person with an inherited missing or non-functional RB1 gene has a 50% chance of passing on this abnormal gene to his or her offspring. The chance that their children will inherit the changed/deleted gene and actually develop retinoblastoma is approximately 45%.

Some people with retinoblastoma have inherited a non-functioning or missing RB1 gene from either their mother or father even though their parents have never developed retinoblastoma. It is possible that one parent has a changed or missing RB1 gene in every somatic cell but has not developed retinoblastoma because their remaining RB1 gene has remained functional. It is also possible that the parent had developed a retinal tumor that was destroyed by the body. In other cases, one parent has two normal RB1 genes in every somatic cell, but some of their egg or sperm cells contain a changed or missing RB1 gene. This is called gonadal mosaicism.

Retinoblastoma can also result when both RB1 genes become spontaneously changed or deleted in a retinal cell but the RB1 genes are normal in all the other cells of the body. Approximately 60% of people with retinoblastoma have this type of disease, called sporadic retinoblastoma. A person with sporadic retinoblastoma does not have a higher chance of having children with the disease. Their relatives do not have a higher risk of developing retinoblastoma themselves or having children who develop retinoblastoma. Sporadic retinoblastoma is usually unifocal and has an average age of onset of approximately two years.

Symptoms

The most common symptom of retinoblastoma is leukocoria. Leukocoria results when the pupil reflects a white color rather than the normal black or red color that is seen on a flash photograph. It is often most obvious in flash photographs; since the pupil is exposed to a lot of light and the duration of the exposure is so short, the pupil does not have time to constrict. Children with retinoblastoma can also have problems seeing and this can cause them to appear cross-eyed (**strabismus**). People with retinoblastoma may also experience red, painful, and irritated eyes, inflamed tissue around the eye, enlarged pupils, and possibly different-colored eyes.

Diagnosis

Children who have symptoms of retinoblastoma are usually first evaluated by their pediatrician. The pediatrician will often perform a red reflex test to diagnose or confirm leukocoria. Prior to this test the doctor inserts medicated eye drops into the child's eyes so that the pupils will remain dilated and not contract when exposed to bright light. The doctor then examines the eyes with an ophthalmoscope, which shines a bright light into the eyes and allows the doctor to check for leukocoria. Leukocoria can also be diagnosed by taking a flash Polaroid photograph of a patient who has been in a dark room for three to five minutes.

If the pediatrician suspects retinoblastoma on the basis of these evaluations, he or she will most likely refer the patient to an ophthalmologist (eye doctor) who has experience with retinoblastoma. The ophthalmologist will examine the eye using an indirect ophthalmoscope. The opthalmoscope shines a bright light into the eye, which helps the doctor to visualize the retina. This evalu-

ation is usually done under general anesthetic, although some very young or older patients may not require it. Prior to the examination, medicated drops are put into the eyes to dilate the pupils, and anesthetic drops may also be used. A metal clip is used to keep the eyes open during the evaluation. During the examination, a cotton swab or a metal instrument with a flattened tip is used to press on the outer lens of the eye so that a better view of the front areas of the retina can be obtained. Sketches or photographs of the tumor as seen through the ophthalmoscope are taken during the procedure.

An ultrasound evaluation is used to confirm the presence of the tumor and to evaluate its size. Computed tomography (CT scan) is used to determine whether the tumor has spread outside of the eye and to the brain. Sometimes **magnetic resonance imaging** (MRI) is also used to look at the eyes, eye sockets, and the brain to see if the cancer has spread.

In most cases the cancer has not spread beyond the eye, and other evaluations are unnecessary. If the cancer appears to have spread beyond the eye, then other assessments such as a blood test, spinal tap (lumbar puncture), and/or bone marrow biopsy may be recommended. During a spinal tap, a needle is inserted between the vertebrae of the spinal column and a small sample of the fluid surrounding the spinal cord is obtained. In a bone marrow biopsy, a small amount of tissue (bone marrow) is taken from inside the hip or breast bone for examination.

Genetic testing

Establishing whether someone is affected with an inherited or non-inherited form of retinoblastoma can help to ascertain whether other family members such as siblings, cousins, and offspring are at increased risk for developing retinoblastoma. It can also sometimes help guide treatment choices, since patients with an inherited form of retinoblastoma may be at increased risk for developing recurrent tumors or other types of cancers, particularly when treated with radiation. It is helpful for the families of a child diagnosed with retinoblastoma to meet with a genetic specialist such as a genetic counselor and/or geneticist. These specialists can help to ascertain the chances that the retinoblastoma is inherited and facilitate **genetic testing** if desired.

If a patient with unilateral or bilateral retinoblastoma has a relative or relatives with retinoblastoma, it can be assumed that they have an inherited form of retinoblastoma. However, it cannot be assumed that a patient without a family history of the disease has a sporadic form.

Even when there is no family history, most cases of bilateral and trilateral retinoblastoma are inherited, as are most cases of unilateral, multifocal retinoblastoma. However, only 15% of unilateral, unifocal retinoblastoma cases are inherited.

The only way to establish whether someone has an inherited form of retinoblastoma is to see if the retinoblastoma gene is changed or deleted in the blood cells obtained from a blood sample. Approximately 5–8% of individuals with retinoblastoma possess a chromosomal abnormality involving the RB1 gene that can be detected by looking at their chromosomes under the microscope. The chromosomes can be seen by obtaining a blood sample. If this type of chromosomal abnormality is detected in a child, then analysis of the parents' chromosomes should be performed. If one of the parents possesses a chromosomal abnormality, then they are at higher risk for having other offspring with retinoblastoma. Chromosome testing would be recommended for the blood relatives of the parent with the abnormality.

Usually, however, a chromosomal abnormality is not detected in a child with retinoblastoma. In this case, specialized DNA tests that look for small RB1 gene changes need to be performed on the blood cells. DNA testing can be difficult, time consuming, and expensive, since there are many possible RB1 gene changes that can cause the gene to become nonfunctional.

If a sample of tumor is available, then it is recommended that DNA testing be performed on the tumor cells prior to DNA testing of the blood cells. This testing can usually identify the gene changes/deletions in the RB1 genes that caused the tumor to develop. In some cases, RB1 gene changes/deletions are not found in the tumor cells (as of 2001, approximately 20% of RB1 gene changes or deletions are not detectable). In these cases, DNA testing of the blood cells will not be able to ascertain whether someone is affected with an inherited or non-inherited form of retinoblastoma.

If the changes in both RB1 genes are detected in the tumor cell, then these same changes can be looked for in the blood cells. If an RB1 gene is deleted or changed in all of the blood cells tested, the patient can be assumed to have been born with a changed/deleted RB1 gene in all of their cells. This person has a 50% chance of passing the RB1 gene change/deletion on to his or her children. Most of the time, this change/deletion has been inherited from a parent. Occasionally the gene change/deletion occurred spontaneously in the original cell that was formed when the egg and sperm came together at conception (de novo).

If an RB1 gene change/deletion is found in all of the blood cells tested, both parents should undergo blood testing to check for the same RB1 gene change/deletion. If the RB1 gene change/deletion is identified in one of the parents, it can be assumed that the retinoblastoma was inherited and that siblings have a 50% chance of inherit-

ing the altered gene. More distant blood relatives of the parent with the identified RB1 gene change/deletion may also be at risk for developing retinoblastoma. Siblings and other relatives could undergo DNA testing to see if they have inherited the RB1 gene change/deletion.

If the RB1 gene change/deletion is not identified in either parent, then the results can be more difficult to interpret. In this case, there is a 90–94% chance that the retinoblastoma was not inherited.

In some cases, a person with retinoblastoma will have an RB1 gene change/deletion detected in some of their blood cells and not others. It can be assumed that this person did not inherit the retinoblastoma from either parent. Siblings and other relatives would therefore not be at increased risk for developing retinoblastoma. Offspring would be at increased risk since some of the egg or sperm cells could have the changed/deleted RB1 gene. The risks to offspring would probably be less than 50%.

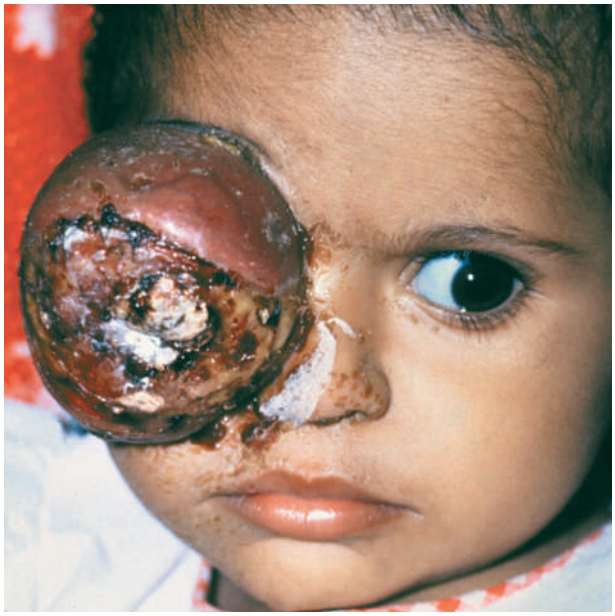
In families where there are multiple family members affected with retinoblastoma, blood samples from multiple family members are often analyzed and compared through DNA testing. Ninety-five percent of the time, this type of analysis is able to detect patterns in the DNA that are associated with a changed RB1 gene in that particular family. When a pattern is detected, at-risk relatives can be tested to establish whether they have inherited an RB1 gene change/deletion.

PRENATAL TESTING. If chromosome or DNA testing identifies an RB1 gene/deletion in someone's blood cells, then prenatal testing can be performed on this person's offspring. An **amniocentesis** or **chorionic villus sampling** can be used to obtain fetal cells which can be analyzed for the RB1 gene change/deletion or chromosomal abnormality.

Treatment

A number of different classification (staging) systems are used to establish the severity of retinoblastoma and aid in choosing an appropriate treatment plan. The most widely used staging system is the Reese-Ellsworth system. This system is used to classify intraocular tumors and predict which tumors are favorable enough that sight can be maintained. The Reese-Ellsworth classification system is divided into:

- Group I (very favorable for maintenance of sight): small solitary or multiple tumors, less than 6.4 mm in size (1 inch = 25.4 mm), located at or below the equator of the eye
- Group II (favorable for maintenance of sight): solitary or multiple tumors, 6.4mm–16 mm in size, located at or behind the equator of the eye



This child's right eye is completely covered with a tumor associated with retinoblastoma. *(Custom Medical Stock Photo. Reproduced by permission.)*

- Group III (possible for maintenance of sight): any tumor located in front of the equator of the eye, or a solitary tumor larger than 16 mm in size and located behind the equator of the eye
- Group IV (unfavorable for maintenance of sight): multiple tumors, some larger than 16 mm in size, or any tumor extending in front of the outer rim of the retina (ora serrata)
- Group V (very unfavorable for maintenance of sight): large tumors involving more than half of the retina, or vitreous seeding, in which small pieces of tumor are broken off and floating around the inside of the eye

When choosing a treatment plan, the first important criteria to ascertain is whether the cancer is localized within the eye (intralocular) or has spread to other parts of the body (extralocular). An intraocular retinoblastoma may only involve the retina or could involve other parts of the eye. An extraocular retinoblastoma could involve only the tissues around the eye or could result from the spread of cancer to the brain or other parts of the body.

It is also important to establish whether the cancer is unilateral (one eye) or bilateral (both eyes), multifocal or unifocal. In order for the tumors to be considered multifocal, they must have arisen independently and not as the result of the spread of cancer cells. It is also important to check for trilateral retinoblastoma.

Treatments

The treatment chosen depends on the size and number of tumors, whether the cancer is unilateral or bilateral, and whether the cancer has spread to other parts of the body. The goal of treatment is to cure the cancer and prevent as much loss of vision as possible.

TREATMENT OF INTRAOCULAR TUMORS. Surgical removal of the affected eye (enucleation) is used when the tumor(s) are so large and extensive that preservation of sight is not possible. This surgery is performed under general anesthetic and usually takes less than an hour. Most children who have undergone this surgery can leave the hospital on the same day. A temporary ball is placed in the eye socket after the surgery. Approximately three weeks after the operation, a plastic artificial eye (prosthesis) that looks like the normal eye is inserted into the eye socket.

Radiation therapy is often used for treatment of large tumors when preservation of sight is possible. External beam radiation therapy involves focusing a beam of radiation on the eye. If the tumor has not spread extensively, the radiation beam can be focused on the cancerous retinal cells. If the cancer is extensive, radiation treatment of the entire eye may be necessary. External beam radiation is performed on an outpatient basis and usually occurs over a period of three to four weeks. Some children may need sedatives prior to the treatment. This type of therapy can result in a temporary loss of a patch of hair on the back of the head and a small area of "sun-burned" skin. Long-term side effects of radiation treatment can include **cataracts**, vision problems, bleeding from the retina, and decreased growth of the bones on the side of the head. People with an inherited form of retinoblastoma have an increased risk of developing other cancers as a result of this therapy. Some consideration should therefore be given to alternative treatment therapies for those with an inherited form of retinoblastoma.

Photocoagulation therapy is often used in conjunction with radiation therapy but may be used alone to treat small tumors that are located on the back of the eye. Photocoagulation involves using a laser to destroy the cancer cells. This type of treatment is done under local or general anesthesia and is usually not associated with post-procedural **pain**.

Thermotherapy is also often used in conjunction with radiation therapy or drug therapy (**chemotherapy**). Thermotherapy involves the use of heat to help shrink tumor cells. The heat is either used on the whole eye or localized to the tumor area. It is done under local or general anesthesia and is usually not painful.

Cryotherapy is a treatment often used in conjunction with radiation therapy but can also be used alone on small tumors located on the front part of the retina. Cryotherapy involves the use of intense cold to destroy cancer cells and can result in harmless, temporary swelling of the external eye and eyelids that can last for up to five days. Eye drops or ointment are sometimes provided to reduce the swelling.

Brachytherapy involves the application of radioactive material to the outer surface of the eye at the base of the tumor. It is generally used for tumors of medium size. A patient undergoing this type of procedure is usually hospitalized for three to seven days. During that time, he or she undergoes one surgery to attach the radioactive material and one surgery to remove it. Eye drops are often administered for three to four weeks following the operation to prevent inflammation and infection. The long-term side effects of this treatment can include cataracts and damage to the retina, which can lead to impaired vision.

Intravenous treatment with one or more drugs (chemotherapy) is often used for treatment of both large and small tumors. Chemotherapy is sometimes used to shrink tumors prior to other treatments such as radiation therapy or brachytherapy. Occasionally, it is also used alone to treat very small tumors.

TREATMENT OF INTRAOCULAR AND UNILATERAL RETINOBLASTOMA. Often, by the time that unilateral retinoblastoma is diagnosed, the tumor is so large that useful vision cannot be preserved. In these cases removal of the eye (enucleation) is the treatment of choice. Other therapies are unnecessary if enucleation is used to treat intraocular unilateral retinoblastoma. If the tumor is small enough, other therapies such as external beam radiation therapy, photocoagulation, cryotherapy, thermotherapy, chemotherapy, and brachytherapy may be considered.

TREATMENT OF INTRAOCULAR AND BILATERAL RETINOBLASTOMA. If vision can be preserved in both eyes, radiation therapy of both eyes may be recommended. Smaller, more localized tumors can sometimes be treated by local therapies such as cryotherapy, photocoagulation therapy, thermotherapy or brachytherapy. Some centers may use chemotherapy in place of radiation therapy when the tumors are too large to be treated by local therapies or are found over the optic nerve of the eye. Many centers are moving away from radiation treatment and toward chemotherapy because it is less likely to induce future tumors. Enucleation is performed on the more severely affected eye if sight cannot be preserved in both.

EXTRAOCULAR RETINOBLASTOMA. There is no proven effective therapy for the treatment of extraocular retinoblastomas. Commonly, radiation treatment of the eyes and chemotherapy is provided.

KEY TERMS

Amniocentesis—Prenatal testing performed at 16 to 20 weeks of pregnancy that involves inserting a needle through the abdomen of a pregnant mother and obtaining a small sample of fluid from the amniotic sack, which contains the fetus. Often is used to obtain a sample of the fetus' cells for biochemical or DNA testing.

Benign tumor—An abnormal proliferation of cells that does not spread to other parts of the body.

Bilateral—Affecting both eyes.

Brachytherapy—Cancer treatment that involves the application of radioactive material to the site of the tumor.

Cryotherapy—Cancer treatment in which the tumor is destroyed by exposure to intense cold.

Chromosome—A microscopic structure found within each cell of the body, made of a complex of proteins and DNA.

Chorionic villus sampling (CVS)—Prenatal testing performed at 10 to 12 weeks of pregnancy, which involves inserting a catheter through the vagina of a pregnant mother or inserting a needle through the abdomen of the mother and obtaining a sample of placenta. Often is used to obtain a sample of the fetus' cells for biochemical or DNA testing.

DNA (deoxyribonucleic acid)—The hereditary material that makes up genes; influences the development and functioning of the body.

DNA testing—Testing for a change or changes in a gene or genes.

Enucleation—Surgical removal of the eye.

Equator—Imaginary line encircling the eyeball and dividing the eye into a front and back half.

Extraocular retinoblastoma—Cancer that has spread from the eye to other parts of the body.

Gene—A building block of inheritance, made up of a compound called DNA (deoxyribonucleic acid) and containing the instructions for the production of a particular protein. Each gene is found in a specific location on a chromosome.

Intraocular retinoblastoma—Cancer that is limited to the eye and has not spread to other parts of the body.

Malignant tumor—An abnormal proliferation of cells that can spread to other sites.

Multifocal—More than one tumor present.

Ophthalmologist—Physician specializing in the diseases of the eye.

Optic nerve—The part of the eye which contains nerve fibers that transmit signals from the eye to the brain.

Oncologist—A physician specializing in the diagnosis and treatment of cancer

Photocoagulation—Cancer treatment in which the tumor is destroyed by an intense beam of laser light.

Prenatal testing—Testing for a disease such as a genetic condition in an unborn baby.

Protein—A substance produced by a gene that is involved in creating the traits of the human body, such as hair and eye color, or is involved in controlling the basic functions of the human body, such as control of the cell cycle.

Retina—The light-sensitive layer of the eye that receives images and sends them to the brain.

Somatic cells—All the cells of the body with the exception of the egg and sperm cells.

Tumor—A growth of tissue resulting from the uncontrolled proliferation of cells.

Tumor-suppressor gene—Gene involved in controlling normal cell growth and preventing cancer.

Unifocal—Only one tumor present in one eye.

Unilateral—Affecting only one eye.

Vitreous—The transparent gel that fills the back part of the eye.

Vitreous seeding—When small pieces of tumor have broken off and are floating around the vitreous.

Alternative treatment

There are no alternative or complementary therapies specific to the treatment of retinoblastoma. Since most people diagnosed with retinoblastoma are small children, most drug-based alternative therapies designed to treat general cancer would not be recommended. Many specialists would, however, stress the importance of establishing a well-balanced diet, including certain fruits, vegetables, and vitamin supplements, to ensure that the body is strengthened in its fight against cancer. Some advocate

the use of visualization strategies, in which patients would visualize the immune cells of their body attacking and destroying the cancer cells.

Prognosis

Individuals with intraocular retinoblastoma who do not have trilateral retinoblastoma usually have a good survival rate with a 90% chance of disease-free survival for five years. Those with extraocular retinoblastoma have less than a 10% chance of disease-free survival for the same amount of time. Trilateral retinoblastoma generally has a very poor prognosis. Patients with trilateral retinoblastoma who receive treatment have an average survival rate of approximately eight months, while those who remain untreated have an average survival rate of approximately one month. Patients with trilateral retinoblastoma who are asymptomatic at the time of diagnosis may have a better prognosis then those who experience symptoms.

Patients with an inherited form of unilateral retinoblastoma have a 70% chance of developing retinoblastoma in the other eye. Retinoblastoma reoccurs in the other eye in approximately 5% of people with a non-inherited form of retinoblastoma, so it is advisable for even these patients to be closely monitored. People with an inherited form of retinoblastoma who have not undergone radiation treatment have approximately a 26% chance of developing cancer in another part of the body within 50 years of the initial diagnosis. Those with an inherited form who have undergone radiation treatment have a 58% chance of developing a secondary cancer by 50 years after the initial diagnosis. Most of the secondary cancers are skin cancers, bone tumors (osteosarcomas), and soft-tissue **sarcomas**. Soft-tissue sarcomas are malignant tumors of the muscle, nerves, joints, blood vessels, deep skin tissues, or fat.

Prevention

Although retinoblastoma cannot be prevented, appropriate screening and surveillance should be applied to all at-risk individuals to ensure that the tumor(s) are diagnosed at an early stage. The earlier the diagnosis, the more likely that an eye can be salvaged and vision maintained.

Screening of people diagnosed with retinoblastoma

Children who have been diagnosed with retinoblastoma should receive periodic dilated retinal examinations until the age of five. Young children will need to undergo these evaluations under anesthetic. After five years of age, periodic eye examinations are recommended. It may be advisable for patients with bilateral retinoblastoma or an inherited form of retinoblastoma to undergo periodic screening for the brain tumors found in trilateral retinoblastoma. There are no specific screening protocols designed to detect non-ocular tumors. All lumps and complaints of bone pain, however, should be thoroughly evaluated.

Screening of relatives

When a child is diagnosed with retinoblastoma, it is recommended that parents and siblings receive a dilated retinal examination by an ophthalmologist who is experienced in the diagnosis and treatment of the disease. It is also recommended that siblings continue to undergo periodic retinal examinations under anesthetic until they are three years of age. From three to seven years of age, periodic eye examinations are recommended. The retinal examinations can be avoided if DNA testing indicates that the patient has a non-inherited form of retinoblastoma or if the sibling has not inherited the RB1 gene change/deletion. Any relatives who are found through DNA testing to have inherited an RB1 gene change/deletion should undergo the same surveillance procedures as siblings.

The children of someone diagnosed with retinoblastoma should also undergo periodic retinal examinations under anesthetic. Retinal surveillance should be performed unless DNA testing proves that their child does not possess the RB1 gene change/deletion. If desired, prenatal detection of tumors using ultrasound may also be performed. During the ultrasound procedure, a handheld instrument is placed on the maternal abdomen or inserted vaginally. The ultrasound produces sound waves that are reflected back from the body structures of the fetus, producing a picture that can be seen on a video screen. If a tumor is detected through this evaluation, the affected baby may be delivered a couple of weeks earlier. This can allow for earlier intervention and treatment.

Resources

BOOKS

Brunner, Sharon H. *Perfect Vision: A Mother's Experience with Childhood Cancer.* Fuquay-Varina, NC: Research Triangle Publishing, 1998.

Chernus-Mansfield, Nancy, and Marilyn Horn. *My Fake Eye: The Story of My Prosthesis*. The Institute for Families of Blind Children. 1991. <http://www. retinoblastoma. net/institute/books.htm>.

Newsham, Irene, Theodora Hadjistilianou, and Webster Cavenee. "Retinoblastoma." In *The Genetic Basis of Human Cancer,* ed. Bert Vogelstein and Kenneth Kinzler. New York: McGraw-Hill, 1998.

PERIODICALS

Quesnel, Susan, and David Malkin. "Genetic Predisposition to Cancer and Familial Cancer Syndrome." *Pediatric Oncology* 44 (August 1997): 791-95.

Shields, Carol, and Jerry Shields. "Recent Developments in the Management of Retinoblastoma." *Journal of Pediatric Ophthalmology and Strabismus* 36 (1999): 8-18.

Sippel, Kimberly, et al. "Frequency of Somatic and Germ-line Mosaicism in Retinoblastoma: Implications for Genetic Counseling." *American Journal of Human Genetics* 62 (1998): 610-19.

ORGANIZATIONS

Institute for Families with Blind Children. PO Box 54700, Mail Stop 111, Los Angeles, CA 90054-0700. (213) 669-4649.

National Retinoblastoma Parents Group. PO Box 317, Watertown, MA 02471 (800) 562-6265. Fax: (617) 972-7444. <napvi@perkins.pvt.k12.ma.us>.

Retinoblastoma International. 4650 Sunset Blvd., Mail Stop #88, Los Angeles, CA 90027. (323) 669-2299. <info@retinoblastoma.net>. <http://www.retinoblastoma.net/rbi/index_rbi.htm>.

The Retinoblastoma Society. Saint Bartholomew's Hospital, London, UK EC1A 7BE. (020) 7600 3309. (020) 7600 8579. <http://ds.dial.pipex.com/rbinfo>.

OTHER

Abramson, David, and Camille Servodidio. "A Parent's Guide to Understanding Retinoblastoma.".<http://www.retinoblastoma.com/guide/guide.html>. (June 20, 2001)

Kid's Eye Cancer. <http://www.kidseyecancer.org>. (June 20, 2001).

Lohmann, Dietmar, N. Bornfeld, B. Horsthemke, and E. Passarge. "Retinoblastoma." *Gene Clinics.* (July 17, 2000). <http://www.geneclinics.org/profiles/retinoblastoma>. (June 20, 2001).

McCusick, Victor. "Retinoblastoma; RB1." *Online Mendelian Inheritance in Man.* (February 14, 2001) <http://www.ncbi.nlm.nih.gov/Omim>. (June 20, 2001).

"Retinoblastoma" *CancerNet.* <http://cancernet.nci.nih.gov/Cancer_Types/Retinoblastoma.shtml>.

Solutions by Sequence. <http://www.solutionsbysequence.com>. (June 20, 2001).

Lisa Andres, M.S., C.G.C.

Retinol deficiency *see* **Vitamin A deficiency**

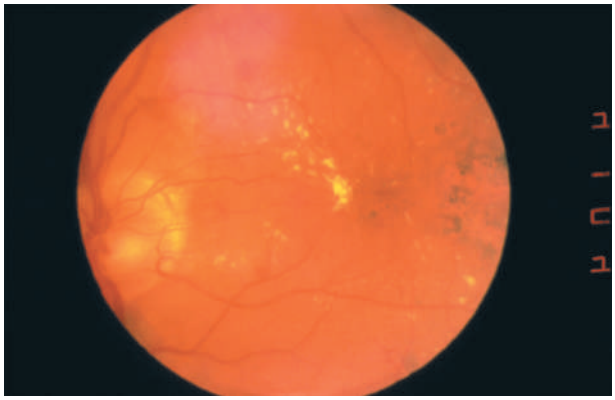
Retinopathies

Definition

Retinopathy is a noninflammatory disease of the retina. There are many causes and types of retinopathy.

Description

The retina is the thin membrane that lines the back of the eye and contains light-sensitive cells (photoreceptors). Light enters the eye and is focused onto the retina. The photoreceptors send a message to the brain via the optic nerve. The brain then "interprets" the electrical message sent to it, resulting in vision. The macula is a specific area of the retina responsible for central vision. The fovea is about 1.5 mm in size and located in the macula. The fovea is responsible for sharp vision. When looking at something, the fovea should be directed at the object.



A slit lamp view of a human eye with diabetic retinopathy. *(Custom Medical Stock Photo. Reproduced by permission.)*

Retinopathy, or damage to the retina, has various causes. A hardening or thickening of the retinal arteries is called arteriosclerotic retinopathy. High blood pressure in the arteries of the body can damage the retinal arteries and is called hypertensive retinopathy. The spreading of a **syphilis** infection to the retinal blood vessels cases syphilitic retinopathy, and diabetes damages the retinal vessels resulting in a condition called diabetic retinopathy. Sickle cell anemia also affects the blood vessels in the eyes. Exposure to the sun (or looking at the sun during an eclipse) can cause damage (solar retinopathy), as well as certain drugs (for example, chloroquine, thioridazine, and large doses of tamoxifen). The arteries and veins can become blocked, thus resulting in a retinal artery or vein occlusion. These are just some of the causes of the various retinopathies.

Retinopathies are divided into two broad categories, *simple* or *nonproliferative* retinopathies and *proliferative* retinopathies. The simple retinopathies include the defects identified by bulging of the vessel walls, by bleeding into the eye, by small clumps of dead retinal cells called cotton wool exudates, and by closed vessels. This form of retinopathy is considered mild. The proliferative, or severe, forms of retinopathies include the defects identified by newly grown blood vessels, by scar tissue formed within the eye, by closed-off blood vessels that are badly damaged, and by the retina breaking away from its mesh of blood vessels that nourish it (**retinal detachment**).

While each disease has its own specific effect on the retina, a general scenario for many of the retinopathies is

as follows (note: not all retinopathies necessarily affect the blood vessels). Blood flow to the retina is disrupted, either by blockage or breakdown of the various vessels. This can lead to bleeding (hemorrhage) and fluids, cells, and proteins leaking into the area (exudates). There can be a lack of oxygen to surrounding tissues (hypoxia) or decreased blood flow (**ischemia**). Chemicals produced by the body then can cause new blood vessels to grow (neovascularization), however, these new vessels generally leak and cause more problems. Neovascularization can even grow on the colored part of the eye (iris). The retina can swell and vision will be affected.

Diabetic retinopathy is the leading cause of blindness in people ages 20 to 74. Diabetic retinopathy will occur in 90% of persons with type 1 diabetes (insulin-dependent, or insulin requiring) and 65% of persons with type II diabetes (non-insulin-dependent, or not requiring insulin) by about 10 years after the beginning of diabetes. In the United States, new cases of blindness are most often caused by diabetic retinopathy. Among these new cases of blindness, 12% are people between the ages of 20 to 44 years, and 19% are people between the ages of 45 to 64 years.

Causes and symptoms

There are many causes of retinopathy. Some of the more common ones are listed below.

Diabetic retinopathy

Diabetes is a complex disorder characterized by an inability of the body to properly regulate the levels of sugar and insulin (a hormone made by the pancreas) in the blood. As diabetes progresses, the blood vessels that feed the retina become damaged in different ways. The damaged vessels can have bulges in their walls (aneurysms), they can leak blood into the surrounding jelly-like material (vitreous) that fills the inside of the eyeball, they can become completely closed, or new vessels can begin to grow where there would not normally be blood vessels. However, although these new blood vessels are growing in the eye, they cannot nourish the retina and they bleed easily, releasing blood into the inner region of the eyeball, which can cause dark spots and cloudy vision.

Diabetic retinopathy begins prior to any outward signs of disease being noticed. Once symptoms are noticed, they include poorer than normal vision, fluctuating or distorted vision, cloudy vision, dark spots, episodes of temporary blindness, or permanent blindness.

Hypertensive retinopathy

High blood pressure can affect the vessels in the eyes. Some blood vessels can narrow. The blood vessels can thicken and harden (arteriosclerosis). There will be flame-shaped hemorrhages and macular swelling (**edema**). This edema may cause distorted or decreased vision.

Sickle cell retinopathy

Sickle cell anemia occurs mostly in blacks and is a hereditary disease that affects the red blood cells. The sickle-shaped blood cell reduces blood flow. People will not have visual symptoms early on in the disease—symptoms are more systemic. However, patients need to be followed closely in case neovascularization occurs.

Retinal vein and artery occlusion

Retinal vein occlusion generally occurs in the elderly. There is usually a history of other systemic disease, such as diabetes or high blood pressure. The central retinal vein (CRV), or the retinal veins branching off of the CRV, can become compressed, thus stopping the drainage of blood from the retina. This may occur if the central retinal artery hardens.

Symptoms of retinal vein occlusion include a sudden, painless loss of vision or field of vision in one eye. There may be a sudden onset of floating spots (floaters) or flashing lights. Vision may be unchanged or decrease dramatically.

Retinal artery occlusion is generally the result of an **embolism** that dislodges from somewhere else in the body and travels to the eye. Transient loss of vision may precede an occlusion. Symptoms of a central retinal artery or branch occlusion include a sudden, painless loss of vision or decrease in visual field. Ten percent of the cases of a retinal artery occlusion occur because of giant cell arteritis (a chronic vascular disease).

Solar retinopathy

Looking directly at the sun or watching an eclipse can cause damage. There may be a loss of the central visual field or decreased vision. The symptoms can occur hours to days after the incident.

Drug-related retinopathies

Certain medications can affect different areas of the retina. Doses of 20–40 mg a day of tamoxifen usually does not cause a problem, but much higher doses may cause irreversible damage.

Patients taking chloroquine for lupus, **rheumatoid arthritis**, or other disorders may notice a decrease in vision. If so, discontinuing medication will stop, but not reverse, any damage. However, patients should never discontinue medication without the advise of their physician.

Patients taking thioridazine may notice a decrease in vision or color vision.

These drug-related retinopathies generally only affect patients taking large doses. However, patients need to be aware if any medication they are taking will affect the eyes. Patients need to inform their doctors of any visual effects.

Diagnosis

The damaged retinal blood vessels and other retinal changes are visible to an eye doctor when an examination of the retina (fundus exam) is done. This can be done using a hand-held instrument called an ophthalmoscope or another instrument called a binocular indirect ophthalmoscope. This allows the doctor to see the back of the eye. Certain retinopathies have classic signs (for example, vascular "sea fans" in sickle cell, dot and blot hemorrhages in diabetes, flame-shaped hemorrhages in high blood pressure). Patients may then be referred for other tests to confirm the underlying cause of the retinopathy. These tests include blood tests and measurement of blood pressure.

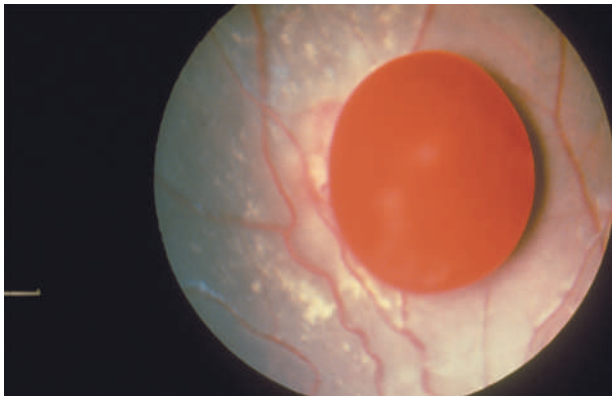
Fluorescein **angiography**, where a dye is injected into the patient and the back of the eyes are viewed and photographed, helps to locate leaky vessels. Sometimes patients may become nauseated from the dye.

Treatment

Retinal specialists are ophthalmologists who specialize in retinal disorders. Retinopathy is a disorder of the retina that can result from different underlying systemic causes, so general physicians should be consulted as well. For drug-related retinopathies, the treatment is generally discontinuation of the drug (only under the care of a physician).

Surgery with lasers can help to prevent blindness or lessen any losses in vision. The high-energy light from a laser is aimed at the weakened blood vessels in the eye, destroying them. Scars will remain where the laser treatment was performed. For that reason, laser treatment cannot be performed everywhere. For example, laser photocoagulation at the fovea would destroy the area for sharp vision. Panretinal photocoagulation may be performed. This is a larger area of treatment in the periphery of the retina; hopefully it will decrease neovascularization. Prompt treatment of proliferative retinopathy may reduce the risk of severe vision loss by 50%.

Patients with retinal artery occlusion should be referred to a cardiologist. Patients with retinal vein occlusion need to be referred to a physician, as they may have an underlying systemic disorder, such as high blood pressure.



A close-up view of a human eye following retinal hemorrhage. *(Custom Medical Stock Photo. Reproduced by permission.)*

Prognosis

Nonproliferative retinopathy has a better prognosis than proliferative retinopathy. Prognosis depends upon the extent of the retinopathy, the cause, and promptness of treatment.

Prevention

Complete eye examinations done regularly can help to detect early signs of retinopathy. Patients on certain medications should have more frequent eye exams. They also should have a baseline eye exam when starting the drug. Persons with diabetes must take extra care to be sure to have thorough, periodic eye exams, especially if early signs of **visual impairment** are noticed. Anyone experiencing a sudden loss of vision, decrease in vision or visual field, flashes of light, or floating spots should contact their eye doctor right away.

Proper medical treatment for any of the systemic diseases known to cause retinal damage will help prevent retinopathy. For diabetics, maintaining proper blood sugar and blood pressure levels is important as well; however, some form of retinopathy will usually occur in diabetics, given enough time. A proper diet, particularly for those persons with diabetes, and stopping **smoking** will also help delay retinopathy.

Frequent, thorough eye exams and control of systemic disorders are the best prevention.

Resources

BOOKS

Foster, Daniel, W. "Diabetes Mellitus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Horton, Jonathan, C. "Disorders of the Eye." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

KEY TERMS

Exudate—Cells, protein, fluid, or other material that passes through blood vessel walls to accumulate in the surrounding tissue.

Neovascularization—New blood vessel formation—usually leaky vessels.

Nonproliferative retinopathy—Retinopathy without the growth of new blood vessels.

Proliferative retinopathy—Retinopathy with the growth of new blood vessels (neovascularization).

PERIODICALS

Zoorob, Roger J., and Michael D. Hagen. "Guidelines on the Care of Diabetic Neuropathy, Retinopathy, and Foot Disease." *American Family Physician* 56 (15 Nov. 1997): 202.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

The Foundation Fighting Blindness. Executive Plaza I, Suite 800, 11350 McCormick Road, Hunt Valley, MD 21031-1014. (888) 394-3937. <http://www.blindness.org>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

Faye A. Fishman

Retrocaval ureter *see* **Congenital ureter anomalies**

Retrograde cystography

Definition

A retrograde cystogram provides x-ray visualization of the bladder with injection of sterile dye.

Purpose

A retrograde cystogram is performed to evaluate the structure of the bladder and identify bladder disorders, such as tumors, or recurrent urinary tract infections. The presence of urine reflux (backward flow) into the ureters may also be visualized with this x-ray study.

Precautions

The doctor should be made aware of any previous history of reactions to shellfish, iodine, or any iodine-containing foods or dyes. Allergic reactions during previous dye studies is not necessarily a contraindication, as dye is not infused into the bloodstream for this study. Other conditions to be considered by the physician prior to proceeding with the test include active urinary tract infection, **pregnancy**, recent bladder surgery, or presence of obstruction that interferes with passage of a urinary catheter.

Description

After administration of anesthesia, the doctor will insert a thin, tubelike instrument called a catheter through the patient's urethra and into the bladder. The contrast medium is then injected through the catheter into the bladder. X-ray pictures are taken at various stages of filling, from various angles, to visualize the bladder. Additional films are taken after drainage of the dye. The procedure takes approximately one to one and one-half hours and the patient may be asked to wait while films are developed.

Alternately, instead of a contrast dye and x-ray pictures, the test can be done with a radioactive tracer and a different camera. This is known as a "radionuclide" retrograde cystogram.

Preparation

The patient will be required to sign a consent form after the risks and benefits of the procedure have been explained. **Laxatives** or **enemas** may be necessary before the procedure, as the bowel must be relatively empty of stool and gas to provide visualization of the urinary tract. Immediately before the procedure, the patient should remove all clothing and jewelry, and put on a surgical gown.

Aftercare

Sometimes, pulse, blood pressure, breathing status, and temperature are checked at regular intervals after the procedure, until they are stable. The patient may have some burning on urination for a few hours after the test, due to the irritation of the urethra from the catheter. The discomfort can be reduced by liberal fluid intake, in order to dilute the urine. The appearance and amount of urine output

KEY TERMS

Bladder—A balloon-like organ located in the lower abdomen that stores urine.

Catheter—A thin tube used to inject or withdraw fluids from the body.

Stones—Also known as calculi, stones result from an excessive build-up of mineral crystals in the kidney. Symptoms of stones include intense pain in the lower back or abdomen, urinary tract infection, fever, burning sensation on urination, and/or blood in the urine.

Ureter—Tube that carries urine from the kidney to the bladder.

Urethra—Tube that empties urine from the bladder to outside the body.

should be noted, and the doctor should be notified if blood appears in the urine after three urinations. Also, patients should report any signs of urinary infection, including chills, **fever**, rapid pulse, and rapid breathing rate.

Normal results

A normal result would reveal no anatomical or functional abnormalities.

Abnormal results

Abnormal results may indicate:

- stones
- blood clots
- tumors
- reflex (urine passing backward from the bladder into the ureters)

Resources

BOOKS

Golomb, Gail. *The Kidney Stones Handbook: A Patient's Guide to Hope, Cure, and Prevention.* Winter Park, FL: Four G Press, 1994.

Lerner, Judith, and Zafar Khan. *Mosby's Manual of Urologic Nursing.* St. Louis: The C. V. Mosby Co., 1982.

Malarkey, Louise M., and Mary Ellen McMorrow. *Nurse's Manual of Laboratory Tests and Diagnostic Procedures.* Philadelphia: W. B. Saunders Co., 1996.

ORGANIZATIONS

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

Kathleen D. Wright, RN

Retrograde ureteropyelography

Definition

A retrograde ureteropyelogram provides x-ray visualization of the bladder, ureters, and the kidney (renal) pelvis by injection of sterile dye into the renal collecting system.

Purpose

A retrograde ureteropyelogram is performed to determine the exact location of a ureteral obstruction when it cannot be visualized on an intravenous pyelogram (a dye is injected and an x ray taken of the kidneys and the tubes that carry urine to the bladder). This may occur due to poor renal function and inadequate excretion of the contrast medium (dye).

Precautions

The doctor should be made aware of any previous history of reactions to shellfish, iodine, or any iodine-containing foods or dyes. Allergic reactions during previous dye studies is not necessarily a contraindication, as dye is not infused into the bloodstream for this study. Other conditions to be considered by the physician prior to proceeding with the test include **pregnancy** and active urinary tract infection.

Description

After administration of anesthesia, the doctor will insert a thin, tubelike instrument (catheter) through the patient's urethra and into the bladder. A catheter is then placed into the affected ureter to instill the contrast medium. X-ray pictures are taken to visualize the ureter. If complete obstruction is found, a ureteral catheter may be left in place and secured to an indwelling urethral catheter to facilitate drainage of urine. The procedure takes approximately one hour.

Preparation

Laxatives or **enemas** may be necessary before the procedure, as the bowel must be relatively empty to pro-

vide visualization of the urinary tract. When general anesthesia is used for insertion of the ureteral catheter, there should be no eating and drinking after midnight prior to the procedure.

Aftercare

Even if no catheters are left in place after the procedure, the patient may have some burning on urination for a few hours after the procedure due to the irritation of the urethra. The discomfort can be reduced by liberal fluid intake, in order to dilute the urine. The appearance and amount of urine output should be noted for 24 hours after the procedure. If a stone was found, all urine should be strained to allow chemical analysis of any stones passed spontaneously. This will allow the doctor to provide advise on measures to prevent recurrent stone formation. **Antibiotics** are usually given after the procedure to prevent urinary tract infection.

Normal results

A normal result would reveal no anatomical or functional abnormalities.

Abnormal results

Abnormal results may indicate:

- congenital abnormalities
- fistulas or false passages
- renal stones
- strictures
- tumors

Resources

BOOKS

Barker, L. Randol, et al. *Principles of Ambulatory Medicine*. Baltimore: Williams & Wilkins, 1991.

Golomb, Gail. *The Kidney Stones Handbook: A Patient's Guide to Hope, Cure, and Prevention*. Winter Park, FL: Four G Press, 1994.

Lerner, Judith, and Zafar Khan. *Mosby's Manual of Urologic Nursing*. St. Louis: The C. V. Mosby Co., 1982.

Malarkey, Louise M., and Mary Ellen McMorrow. *Nurse's Manual of Laboratory Tests and Diagnostic Procedures*. Philadelphia: W. B. Saunders Co., 1996.

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Kathleen D. Wright, RN

Retrograde urethrography

Definition

Retrograde urethrography involves the use of x-ray pictures to provide visualization of structural problems or injuries to the urethra.

Purpose

Retrograde urethrography is used, in combination with a doctor's observation and other tests, to establish a diagnosis for individuals, almost exclusively men, who may have structural problems of the urethra.

Precautions

The doctor should be made aware of any previous history of reactions to shellfish, iodine, or any iodine-containing foods or dyes. An earlier allergic reaction during a dye study is not necessarily something that makes the test inadvisable (a contraindication) as no dye is injected into the bloodstream for this study. Other conditions that should be considered by the physician before the test is done include **pregnancy**, recent urethral surgery, or severe inflammation of the urethra, bladder, or prostate.

Description

The urethra is first visually examined by the doctor, and the opening is cleansed with an antiseptic solution. A flexible rubber or plastic catheter is then inserted into the urethra, and dye is injected into the catheter. A clamp is applied to hold the dye in place while x-ray pictures are taken of the urethral structure. The clamp and catheter are then removed. The procedure takes approximately 15 minutes. However, the patient may be asked to wait while films are developed, which also permits the patient to be observed for any immediate side effects from the dye. The test may be performed in a hospital, doctor's office, outpatient center, or freestanding surgical facility. The time involved for reporting of test results to the doctor may vary from a few minutes to a few days.

Preparation

The patient will be asked to sign a consent form after the risks and benefits of the procedure have been

KEY TERMS

Bladder—The balloonlike organ in the lower abdomen that holds urine.

Catheter—Tube used to inject into or withdraw fluids from the bladder.

Renal—Relating to the kidneys, from the Latin word for kidneys, *renes*.

Urethra—Tube that carries the urine from the bladder out of the body.

Visualization—The process of making an internal organ visible. A radiopaque subtance is introduced into the body, then an x-ray picture of the desired organ is taken.

explained. No diet or activity changes are necessary in preparation for the procedure. The patient will be asked to remove all clothing and put on a surgical gown before the test begins.

Normal results

The presence of no anatomical or functional abnormalities is considered a normal result.

Abnormal results

Abnormal findings may indicate:

- congenital abormalities
- fistulas or false passages
- lacerations
- strictures
- valves, known as "posterior urethral valves"
- tumors

Resources

BOOKS

Barker, L. Randol, John R. Burton, and Philip D. Zieve, eds. *Principles of Ambulatory Medicine*. Baltimore: Williams & Wilkins, 1991.

Lerner, Judith, and Zafar Khan. *Mosby's Manual of Urologic Nursing*. St. Louis: The C. V. Mosby Co., 1982.

ORGANIZATIONS

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National Kidney Foundation. 30 East 33rd St., New York, NY 10016. (800) 622-9010. <http://www.kidney.org>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

OTHER

"Retrograde Urethrography." *ThriveOnline*. 28 Mar. 1998 <http://thriveonline.oxygen.com>.

Kathleen D. Wright, RN

Retrograde urography *see* **Retrograde urethrography**

Retropharyngeal abscess *see* **Abscess**

Reye's syndrome

Definition

Reye's syndrome is a disorder principally affecting the liver and brain, marked by rapid development of life-threatening neurological symptoms.

Description

Reye's syndrome is an emergency illness chiefly affecting children and teenagers. It almost always follows a viral illness such as a cold, the flu, or chicken pox. Reye's syndrome may affect all the organs of the body, but most seriously affects the brain and liver. Rapid development of severe neurological symptoms, including lethargy, confusion, seizures, and **coma**, make Reye's syndrome a life-threatening emergency.

Reye's syndrome is a rare illness, even rarer now than when first described in the early 1970s. The incidence of the disorder peaked in 1980, with 555 cases reported. The number of cases declined rapidly thereafter due to decreased use of **aspirin** compounds for childhood **fever**, an important risk factor for Reye's syndrome development. Because of its rarity, it is often misdiagnosed as **encephalitis**, **meningitis**, diabetes, or **poisoning**, and the true incidence may be higher than the number of reported cases indicates.

Causes and symptoms

Reye's syndrome causes fatty accumulation in the organs of the body, especially the liver. In the brain, it causes fluid accumulation (**edema**), which leads to a rise in intracranial pressure. This pressure squeezes blood vessels, preventing blood from entering the brain. Untreated, this pressure increase leads to brain damage and **death**.

KEY TERMS

Acetylsalicylic acid—Aspirin; an analgesic, antipyretic, and antirheumatic drug prescribed to reduce fever and for relief of pain and inflammation.

Edema—The abnormal accumulation of fluid in interstitial spaces of tissue.

Mitochondria—Small rodlike, threadlike, or granular organelle witin the cytoplasm that function in metabolism and respiration.

Although the cause remains unknown, Reye's syndrome appears to be linked to an abnormality in the energy-converting structures (mitochondria) within the body's cells.

Reye's syndrome usually occurs after a viral, fever-causing illness, most often an upper respiratory tract infection. Its cause is unknown. It is most often associated with use of aspirin during the fever, and for this reason aspirin and aspirin-containing products are not recommended for people under the age of 19 during fever. Reye's syndrome may occur without aspirin use, and in adults, although very rarely.

After the beginning of recovery from the viral illness, the affected person suddenly becomes worse, with the development of persistent vomiting. This may be followed rapidly by quietness, lethargy, agitation or combativeness, seizures, and coma. In infants, **diarrhea** may be more common than vomiting. Fever is usually absent at this point.

Diagnosis

Reye's syndrome may be suspected in a child who begins vomiting three to six days after a viral illness, followed by an alteration in consciousness. Diagnosis involves blood tests to determine the levels of certain liver enzymes, which are highly elevated in Reye's syndrome. Other blood changes may occur as well, including an increase in the level of ammonia and amino acids, a drop in blood sugar, and an increase in clotting time. A **liver biopsy** may also be done after clotting abnormalities are corrected with vitamin K or blood products. A lumbar puncture (spinal tap) may be needed to rule out other possible causes, including meningitis or encephalitis.

Treatment

Reye's syndrome is a life-threatening emergency that requires intensive management. The likelihood of recovery is greatest if it is recognized early and treated promptly. Children with Reye's syndrome should be managed in an intensive-care unit.

Treatment in the early stages includes intravenous sugar to return levels to normal and plasma **transfusion** to restore normal clotting time. Intracranial pressure is monitored, and if elevated, is treated with intravenous mannitol and hyperventilation to constrict the blood vessels in the brain. If the pressure remains high, **barbiturates** may be used.

Prognosis

The mortality rate for Reye's syndrome is between 30–50%. The likelihood of recovery is increased to 90% by early diagnosis and treatment. Almost all children who survive Reye's syndrome recover fully, although recovery may be slow. In some patients, permanent neurologic damage may remain, requiring physical or educational special services and equipment.

Prevention

Because Reye's syndrome is so highly correlated with use of aspirin for fever in young people, avoidance of aspirin use by children is strongly recommended. Aspirin is in many over-the-counter and prescription drugs, including drugs for **headache**, fever, menstrual cramps, muscle **pain**, nausea, upset stomach, and arthritis. It may be used in drugs taken orally or by suppository.

Any of the following ingredients indicates that aspirin is present:

- aspirin
- acetylsalicylate
- acetylsalicylic acid
- salicylic acid
- salicylate

Teenagers who take their own medications without parental consultation should be warned not to take aspirin-containing drugs.

Resources

BOOKS

Hurst, J. Willis. *Medicine for the Practicing Physician.* Stamford: Appleton & Lange, 1988.

Schiff, E., and L. Schiff, eds. *Diseases of the Liver.* 7th ed. Philadelphia: J. B. Lippincott, 1993.

ORGANIZATIONS

National Reye's Syndrome Foundation. P.O. Box 829, Bryan, OH 43506-0829. (800) 233-7393. <http://www.bright.net/~reyessyn>.

Richard Robinson

Rh disease *see* **Erythroblastosis fetalis**

Rh incompatibility *see* **Erythroblastosis fetalis**

Rh typing *see* **Blood typing and crossmatching**

Rheumatic fever

Definition

Rheumatic **fever** (RF) is an illness which arises as a complication of untreated or inadequately treated **strep throat** infection. Rheumatic fever can seriously damage the valves of the heart.

Description

Throat infection with a member of the Group A streptococcus (strep) bacteria is a common problem among school-aged children. It is easily treated with a ten-day course of **antibiotics** by mouth. However, when such a throat infection occurs without symptoms, or when a course of medication is not taken for the full ten days, there is a 3% chance of that person developing rheumatic fever. Other types of strep infections (such as of the skin) do not put the patient at risk for RF.

Children between the ages of five and fifteen are most susceptible to strep throat, and therefore most susceptible to rheumatic fever. Other risk factors include poverty, overcrowding (as in military camps), and lack of access to good medical care. Just as strep throat occurs most frequently in fall, winter, and early spring, so does rheumatic fever.

Causes and symptoms

Two different theories exist as to how a bacterial throat infection can develop into the disease called rheumatic fever. One theory, less supported by research evidence, suggests that the bacteria produce some kind of poisonous chemical (toxin). This toxin is sent into circulation throughout the bloodstream, thus affecting other systems of the body.

Research seems to point to a different theory, however. This theory suggests that the disease is caused by the body's immune system acting inappropriately. The body produces immune cells (called antibodies), which are specifically designed to recognize and destroy invading agents; in this case, streptococcal bacteria. The antibodies are able to recognize the bacteria because the bacteria contain special markers called antigens. Due to a resemblance between Group A streptococcus bacteria's antigens and antigens present on the body's own cells, the antibodies mistakenly attack the body itself.

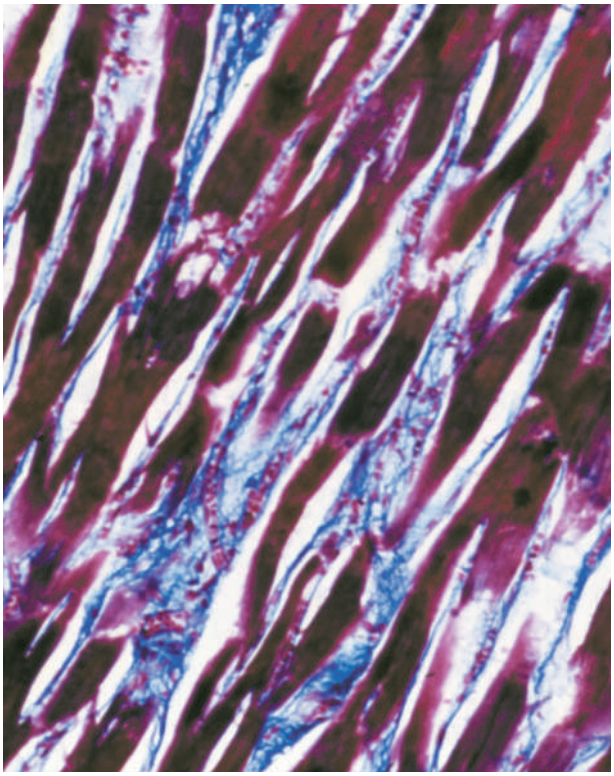
It is interesting to note that members of certain families seem to have a greater tendency to develop rheumatic fever than do others. This could be related to the above theory, in that these families may have cell antigens which more closely resemble streptococcal antigens than do members of other families.

In addition to fever, in about 75% of all cases of RF one of the first symptoms is arthritis. The joints (especially those of the ankles, knees, elbows, and wrists) become red, hot, swollen, shiny, and extraordinarily painful. Unlike many other forms of arthritis, the arthritis may not occur symmetrically (affecting a particular joint on both the right and left sides, simultaneously). The arthritis of RF rarely strikes the fingers, toes, or spine. The joints become so tender that even the touch of bedsheets or clothing is terribly painful.

A peculiar type of involuntary movement, coupled with emotional instability, occurs in about 10% of all RF patients (the figure used to be about 50%). The patient begins experiencing a change in coordination, often first noted by changes in handwriting. The arms or legs may flail or jerk uncontrollably. The patient seems to develop a low threshold for anger and sadness. This feature of RF is called **Sydenham's chorea** or St. Vitus' Dance.

A number of skin changes are common to RF. A rash called erythema marginatum develops (especially in those patients who will develop heart problems from their illness), composed of pink splotches, which may eventually spread into each other. It does not itch. Bumps the size of peas may occur under the skin. These are called subcutaneous nodules; they are hard to the touch, but not painful. These nodules most commonly occur over the knee and elbow joint, as well as over the spine.

The most serious problem occurring in RF is called pancarditis ("pan" means total; "carditis" refers to inflammation of the heart). Pancarditis is an inflammation that affects all aspects of the heart, including the lining of the heart (endocardium), the sac containing the heart (pericardium), and the heart muscle itself (myocardium). About 40-80% of all RF patients develop pancarditis. This RF complication has the most serious, long-term effects. The valves within the heart (structures which allow the blood to flow only in the correct direction, and only at the correct time in the heart's pumping cycle) are frequently damaged during the course of pancarditis. This may result in blood which either leaks back in the wrong direction, or has a difficult time passing a



A magnified image of cardiac muscle damaged by chronic myocarditis caused by rheumatic fever. *(Science Photo Library. Custom Medical Stock Photo. Reproduced by permission.)*

stiff, poorly moving valve. Either way, damage to a valve can result in the heart having to work very hard in order to move the blood properly. The heart may not be able to "work around" the damaged valve, which may result in a consistently inadequate amount of blood entering the circulation.

Diagnosis

Diagnosis of RF is done by carefully examining the patient. A list of diagnostic criteria has been created. These "Jones Criteria" are divided into major and minor criteria. A patient can be diagnosed with RF if he or she has either two major criteria (conditions), or one major and two minor criteria. In either case, it must also be proved that the individual has had a previous infection with streptococcus.

The major criteria include:

- carditis
- arthritis
- chorea
- subcutaneous nodules
- erythema marginatum

The minor criteria include:

- fever.
- joint **pain** (without actual arthritis).
- evidence of electrical changes in the heart (determined by measuring electrical characteristics of the heart's functioning during a test called an electrocardiogram, or EKG).
- evidence (through a blood test) of the presence in the blood of certain proteins, which are produced early in an inflammatory/infectious disease.

Tests are also performed to provide evidence of recent infection with group A streptococcal bacteria. A swab of the throat can be taken, and smeared on a substance in a petri dish, to see if bacteria will multiply and grow over 24-72 hours. These bacteria can then be specially processed, and examined under a microscope, to identify streptococcal bacteria. Other tests can be performed to see if the patient is producing specific antibodies; that are only made in response to a recent strep infection.

Treatment

A 10-day course of penicillin by mouth, or a single injection of penicillin G, is the first line of treatment for RF. Patients will need to remain on some regular dose of penicillin to prevent recurrence of RF. This can mean a small daily dose of penicillin by mouth, or an injection every three weeks. Some practitioners keep patients on this regimen for five years, or until they reach 18 years of age (whichever comes first). Other practitioners prefer to continue treating those patients who will be regularly exposed to streptococcal bacteria (teachers, medical workers), as well as those patients with known RF heart disease.

Arthritis quickly improves when the patient is given a preparation containing **aspirin**, or some other anti-inflammatory agent (ibuprofen). Mild carditis will also improve with such anti-inflammatory agents, although more severe cases of carditis will require steroid medications. A number of medications are available to treat the involuntary movements of chorea, including diazepam for mild cases, and haloperidol for more severe cases.

Prognosis

The long-term prognosis of an RF patient depends primarily on whether he or she develops carditis. This is the only manifestation of RF which can have permanent effects. Those patients with no or mild carditis have an excellent prognosis. Those with more severe carditis have a risk of **heart failure**, as well as a risk of future heart problems, which may lead to the need for valve replacement surgery.

KEY TERMS

Antibodies—Specialized cells of the immune system which can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Antigen—A special, identifying marker on the outside of cells.

Arthritis—Inflammation of the joints.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system therefore attacks and causes damage to these tissues.

Chorea—Involuntary movements in which the arms or legs may jerk or flail uncontrollably.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body, which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Inflammation—The body's response to tissue damage. Includes hotness, swelling, redness, and pain in the affected part.

Pancarditis—Inflammation of the lining of the heart, the sac around the heart, and the muscle of the heart.

Prevention

Prevention of the development of RF involves proper diagnosis of initial strep throat infections, and adequate treatment within 10 days with an appropriate antibiotic. Prevention of RF recurrence requires continued antibiotic treatment, perhaps for life. Prevention of complications of already-existing RF heart disease requires that the patient always take a special course of antibiotics when he or she undergoes any kind of procedure (even dental cleanings) that might allow bacteria to gain access to the bloodstream.

Resources

BOOKS

Kaplan, Edward L. "Rheumatic Fever." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

"Streptococci." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Todd, James. "Rheumatic Fever." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Albert, Daniel A., et al. "The Treatment of Rheumatic Carditis: A Review and Meta-Analysis." *Medicine* 74, no. 1 (Jan. 1995): 1+.

Capizzi, Stephen A., et al. "Rheumatic Fever Revisited: Keep This Diagnosis on Your List of Suspects." *Postgraduate Medicine* 102, no. 6 (Dec. 1997): 65+.

Eichbaum, Q. G., et al. "Rheumatic Fever: Autoantibodies Against a Variety of Cardiac, Nuclear, and Streptococcal Antigens." *Annals of the Rheumatic Diseases* 54, no. 9 (Sept. 1995): 740+.

Stollerman, Gene H. "Rheumatic Carditis." *Lancet* 346, no. 8972 (12 Aug. 1995): 390+.

Stollerman, Gene H. "Rheumatic Fever." *Lancet* 349, no. 9056 (29 Mar. 1997): 935+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Rheumatoid arthritis

Definition

Rheumatoid arthritis (RA) is a chronic autoimmune disease that causes inflammation and deformity of the joints. Other problems throughout the body (systemic problems) may also develop, including inflammation of blood vessels (**vasculitis**), the development of bumps (called rheumatoid nodules) in various parts of the body, lung disease, blood disorders, and weakening of the bones (**osteoporosis**).

Description

The skeletal system of the body is made up of different types of strong, fibrous tissue called connective tissue. Bone, cartilage, ligaments, and tendons are all forms of connective tissue that have different compositions and different characteristics.

The joints are structures that hold two or more bones together. Some joints (synovial joints) allow for movement between the bones being joined (articulating bones). The simplest synovial joint involves two bones,

separated by a slight gap called the joint cavity. The ends of each articular bone are covered by a layer of cartilage. Both articular bones and the joint cavity are surrounded by a tough tissue called the articular capsule. The articular capsule has two components, the fibrous membrane on the outside and the synovial membrane (or synovium) on the inside. The fibrous membrane may include tough bands of tissue called ligaments, which are responsible for providing support to the joints. The synovial membrane has special cells and many tiny blood vessels (capillaries). This membrane produces a supply of synovial fluid that fills the joint cavity, lubricates it, and helps the articular bones move smoothly about the joint.

In rheumatoid arthritis (RA), the synovial membrane becomes severely inflamed. Usually thin and delicate, the synovium becomes thick and stiff, with numerous infoldings on its surface. The membrane is invaded by white blood cells, which produce a variety of destructive chemicals. The cartilage along the articular surfaces of the bones may be attacked and destroyed, and the bone, articular capsule, and ligaments may begin to wear away (erode). These processes severely interfere with movement in the joint.

RA exists all over the world and affects men and women of all races. In the United States alone, about two million people suffer from the disease. Women are three times more likely than men to have RA. About 80% of people with RA are diagnosed between the ages of 35-50. RA appears to run in families, although certain factors in the environment may also influence the development of the disease.

Causes and symptoms

The underlying event that promotes RA in a person is unknown. Given the known genetic factors involved in RA, some researchers have suggested that an outside event occurs that triggers the disease cycle in a person with a particular genetic makeup.

Many researchers are examining the possibility that exposure to an organism (like a bacteria or virus) may be the first event in the development of RA. The body's normal response to such an organism is to produce cells that can attack and kill the organism, protecting the body from the foreign invader. In an autoimmune disease like RA, this immune cycle spins out of control. The body produces misdirected immune cells, which accidentally identify parts of the person's body as foreign. These immune cells then produce a variety of chemicals that injure and destroy parts of the body.

RA can begin very gradually, or it can strike quickly. The first symptoms are **pain**, swelling, and stiffness in the joints. The most commonly involved joints include hands, feet, wrists, elbows, and ankles, although other joints may also be involved. The joints are affected in a symmetrical fashion. This means that if the right wrist is involved, the left wrist is also involved. Patients frequently experience painful joint stiffness when they first get up in the morning, lasting for perhaps an hour. Over time, the joints become deformed. The joints may be difficult to straighten, and affected fingers and toes may be permanently bent (flexed). The hands and feet may curve outward in an abnormal way.

Many patients also notice increased **fatigue**, loss of appetite, weight loss, and sometimes **fever**. Rheumatoid nodules are bumps that appear under the skin around the joints and on the top of the arms and legs. These nodules can also occur in the tissue covering the outside of the lungs and lining the chest cavity (pleura), and in the tissue covering the brain and spinal cord (meninges). Lung involvement may cause **shortness of breath** and is seen more in men. Vasculitis (inflammation of the blood vessels) may interfere with blood circulation. This can result in irritated pits (ulcers) in the skin, tissue **death** (**gangrene**), and interference with nerve functioning that causes **numbness and tingling**.

Juvenile RA is a chronic inflammatory disease that affects the joints of children less than 16 years old. It is estimated to affect as many as 250,000 children in the United States alone. Most children with juvenile RA have arthritis when the illness starts, which affects multiple joints in 50% of these children, and only one joint in 30%. In all, 20% of the children affected by juvenile RA have the acute systemic form of the disease, which is characterized by fever, joint inflammation, rash, liver disease, and gastrointestinal disease.

Two periods of childhood are associated with an increased incidence of onset of juvenile RA. The first is from one to three years of age, and the second, from eight to 12 years. When more than four joints are affected, the disease is described as being polyarticular. If less than four joints are affected, the disease is known as pauciarticular juvenile RA, and this particular manifestation falls into two categories. The first occurs in girls aged one to four years old, and the onset of joint involvement is in the knees, ankles, or elbows. The second form occurs in boys aged eight years and older, and involves the larger joints, such as those of the hips and legs.

Diagnosis

There are no tests available that can absolutely diagnose RA. Instead, a number of tests exist that can suggest the diagnosis of RA. Blood tests include a special test of red blood cells (called **erythrocyte sedimentation rate**), which is positive in nearly 100% of patients with RA. However, this test is also positive in a variety of

other diseases. Tests for anemia are usually positive in patients with RA, but can also be positive in many other unrelated diseases. Rheumatoid factor is another diagnostic test that measures the presence and amounts of rheumatoid factor in the blood. Rheumatoid factor is an autoantibody found in about 80% of patients with RA. It is often not very specific however, because it is found in about 5% of all healthy people and in 10-20% of healthy people over the age of 65. In addition, rheumatoid factor is also positive in a large number of other autoimmune diseases and other infectious diseases, including **systemic lupus erythematosus**, bacterial **endocarditis**, **malaria**, and **syphilis**. In addition, young people who have a process called juvenile rheumatoid arthritis often have no rheumatoid factor present in their blood.

Finally, the clinician may examine the synovial fluid, by inserting a thin needle into a synovial joint. In RA, this fluid has certain characteristics that indicate active inflammation. The fluid is cloudy, with increased protein and decreased or normal glucose. It also contains a higher than normal number of white blood cells. While these findings suggest inflammatory arthritis, they are not specific to RA.

Treatment

There is no cure available for RA. However, treatment is available to combat the inflammation in order to prevent destruction of the joints, and to prevent other complications of the disease. Efforts are also made to maintain flexibility and mobility of the joints.

The "first line" agents for the treatment of RA include nonsteroidal anti- inflammatory agents (NSAIDs) and **aspirin**, which are used to decrease inflammation and to treat pain. The NSAIDs include naproxen (Naprosyn), ibuprofen (Advil, Medipren, Motrin), and etodolac (Lodine). While these medications can be helpful, they do not interrupt the progress of the disease. Low-dose steroid medications can be helpful at both managing symptoms and slowing the progress of RA. Disease-modifying **antirheumatic drugs**, including gold compounds, D-penicillamine, certain antimalarial-like drugs, and sulfasalazine (Azulfadine) are also often the first agents clinicians use to treat RA, but in patients with the aggressive destructive type of RA, more slow-acting medications are needed. Methotrexate, azathioprine, and cyclophosphamide are all drugs that suppress the immune system and can decrease inflammation. All of the drugs listed have significant toxic side effects, which require health-care professionals to carefully compare the risks associated with these medications versus the benefits.

Recently, several categories of drugs have been explored and developed for the treatment of RA. The first is a category of agents known as biological response modifiers. These work to reduce joint inflammation by blocking a substance called tumor necrosis factor (TNF). TNF is a protein that triggers inflammation during the body's normal immune responses. When TNF production is not regulated, the excess TNF can cause inflammation. Three agents in this class have become "second line" drugs for the treatment of RA. These are etanercept (Enbrel), leflunamide (Arava), and infliximab (Remicade), and they are recommended for patients in whom other medications have not been effective. Etanercept is approved by the FDA but is not recommended for patients with active infection. It is given twice weekly via subcutaneous injections by either the patient or a health care professional. Because this agent is so new, long-term side effects have not been fully studied. Infliximab is given intravenously once every eight weeks, and is approved for combined use with methotrexate to combat RA.

The cyclo-oxygenase-2 (COX-2) inhibitors are another category of drugs used to treat RA. Like the traditional NSAIDs, the COX-2 inhibitors work to block COX-2, which is an enzyme that stimulates inflammatory responses in the body. Unlike the NSAIDs, the COX-2 inhibitors do not carry a high risk of gastrointestinal ulcers and bleeding, because they do not inhibit COX-1, which is the enzyme that protects the stomach lining. These new agents include celecoxib (Celebrex) and rofecoxib (Vioxx). Celecoxib has been approved by the FDA for the treatment of RA and **osteoarthritis**, and is taken once or twice daily by mouth. Rofecoxib is approved for RA and osteoarthritis, and for acute pain caused by primary **dysmenorrhea** and surgery.

Total bed rest is sometimes prescribed during the very active, painful phases of RA. Splints may be used to support and rest painful joints. Later, after inflammation has somewhat subsided, physical therapists may provide a careful **exercise** regimen in an attempt to maintain the maximum degree of flexibility and mobility. **Joint replacement** surgery, particularly for the knee and the hip joints, is sometimes recommended when these joints have been severely damaged.

Alternative treatment

A variety of alternative therapies has been recommended for patients with RA. **Meditation**, hypnosis, **guided imagery**, and relaxation techniques have been used effectively to control pain. **Acupressure** and **acupuncture** have also been used for pain. Bodywork can be soothing, decreasing **stress** and tension, and is thought to improve/restore chemical balance within the body.

A multitude of nutritional supplements can be useful for RA. Fish oils, the enzymes bromelain and pancreatin,

and the antioxidants (**vitamins** A, C, and E, selenium, and zinc) are the primary supplements to consider.

Many herbs also are useful in the treatment of RA. Anti-inflammatory herbs may be very helpful, including tumeric (*Curcuma longa*), ginger (*Zingiber officinale*), feverfew (*Chrysanthemum parthenium*), devil's claw (*Harpagophytum procumbens*), Chinese thoroughwax (*Bupleuri falcatum*), and licorice (*Glycyrrhiza glabra*). Lobelia (*Lobelia inflata*) and cramp bark (*Vibernum opulus*) can be applied topically to the affected joints.

Homeopathic practitioners recommended *Rhus toxicondendron* and *Bryonia* (*Bryonia alba*) for acute prescriptions, but constitutional treatment, generally used for chronic problems like RA, is more often recommended. **Yoga** has been used for RA patients to promote relaxation, relieve stress, and improve flexibility. Nutritionists suggest that a vegetarian diet low in animal products and sugar may help to decrease both inflammation and pain from RA. Beneficial foods for patients with RA include cold water fish (mackerel, herring, salmon, and sardines) and flavonoid-rich berries (cherries, blueberries, hawthorn berries, blackberries, etc.).

RA, considered an autoimmune disorder, is often connected with food allergies/intolerances. An elimination/challenge diet can help to decrease symptoms of RA as well as identify the foods that should be eliminated to prevent flare-ups and recurrences. **Hydrotherapy** can help to greatly reduce pain and inflammation. Moist heat is more effective than dry heat, and cold packs are useful during acute flare-ups.

Prognosis

About 15% of all RA patients will have symptoms for a short period of time and will ultimately get better, leaving them with no long-term problems. A number of factors are considered to suggest the likelihood of a worse prognosis. These include:

- race and gender (female and Caucasian).
- more than 20 joints involved.
- extremely high erythrocyte sedimentation rate.
- extremely high levels of rheumatoid factor.
- consistent, lasting inflammation.
- evidence of erosion of bone, joint, or cartilage on x rays.
- poverty.
- older age at diagnosis.
- rheumatoid nodules.
- other coexisting diseases.
- certain genetic characteristics, diagnosable through testing.

Patients with RA have a shorter life span, averaging a decrease of three to seven years of life. Patients sometimes die when very severe disease, infection, and gastrointestinal bleeding occur. Complications due to the side effects of some of the more potent drugs used to treat RA are also factors in these deaths.

KEY TERMS

Articular bones—Two or more bones connected to each other via a joint.

Joint—Structures holding two or more bones together.

Pauciarticular juvenile RA—Rheumatoid arthritis found in children that affects less than four joints.

Polyarticular juvenile RA—Rheumatoid arthritis found in children that affects more than four joints.

Synovial joint—A type of joint that allows articular bones to move.

Synovial membrane—The membrane that lines the inside of the articular capsule of a joint and produces a lubricating fluid called synovial fluid.

Prevention

There is no known way to prevent the development of RA. The most that can be hoped for is to prevent or slow its progress.

Resources

BOOKS

Arthritis Foundation. *The Good Living with Rheumatoid Arthritis*. New York: Longstreet Press Inc., 2000.

Lipsky, Peter E. "Rheumatoid Arthritis." In *Harrison's Principles of Internal Medicine.* 14th ed. Ed. by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

PERIODICALS

Case, J. P. "Old and New Drugs Used in Rheumatoid Arthritis: A Historical Perspective. Part 2: The Newer Drugs and Drug Strategies." *American Journal of Therapeutics* (May–June 2001): 163-79.

Goekoop, Y. P, et al. "Combination Therapy in Rheumatoid Arthritis." *Current Opinions in Rheumatology* (May 2001): 177-83.

Koivuniemi, R. and M. Leirisalo-Repo. "Juvenile Chronic Arthritis in Adult Life: A Study of Long-term Outcome in

Patients with Juvenile Chronic Arthritis or Adult Rheumatoid Arthritis." *Clinical Rheumatology* (1999): 220-6.

ORGANIZATION

American College of Rheumatology. 60 Executive Park South, Suite 150, Atlanta, GA 30329. (404) 633-1870. <http://www.rheumatology.org>.

Arthritis Foundation. 1330 West Peachtree St., Atlanta, GA 30309. (404) 872-7100. <http://www.arthritis.org>.

Liz Meszaros

Rheumatoid spondylit *see* **Ankylosing spondylitis**

Rhinitis

Definition

Rhinitis is inflammation of the mucous lining of the nose.

Description

Rhinitis is a nonspecific term that covers infections, **allergies**, and other disorders whose common feature is the location of their symptoms. In rhinitis, the mucous membranes become infected or irritated, producing a discharge, congestion, and swelling of the tissues. The most widespread form of infectious rhinitis, is the **common cold**.

The common cold is the most frequent viral infection in the general population, causing more absenteeism from school or work than any other illness. Colds are self-limited, lasting about 3-10 days, although they are sometimes followed by a bacterial infection. Children are more susceptible than adults; teenage boys more susceptible than teenage girls; and adult women more susceptible than adult men. In the United States, colds are most frequent during the late fall and winter.

Causes and symptoms

Colds can be caused by as many as 200 different viruses. The viruses are transmitted by sneezing and coughing, by contact with soiled tissues or handkerchiefs, or by close contact with an infected person. Colds are easily spread in schools, offices, or any place where people live or work in groups. The incubation period ranges between 24 and 72 hours.

The onset of a cold is usually sudden. The virus causes the lining of the nose to become inflamed and produce large quantities of thin, watery mucus. Children sometimes run a **fever** with a cold. The inflammation spreads from the nasal passages to the throat and upper airway, producing a dry **cough**, **headache**, and watery eyes. Some people develop muscle or joint aches and feel generally tired or weak. After several days, the nose becomes less inflamed and the watery discharge is replaced by a thick, sticky mucus. This change in the appearance of the nasal discharge helps to distinguish rhinitis caused by a viral infection from rhinitis caused by an allergy.

Diagnosis

There is no specific test for viral rhinitis. The diagnosis is based on the symptoms. In children, the doctor will examine the child's throat and glands to rule out **measles** and other childhood illnesses that have similar early symptoms. Adults whose symptoms last longer than a week may require further testing to rule out a secondary bacterial infection, or an allergy. Bacterial infections can usually be identified from a laboratory culture of the patient's nasal discharge. Allergies can be evaluated by blood tests, skin testing for specific substances, or nasal smears.

Treatment

There is no cure for the common cold; treatment is given for symptom relief. Medications include **aspirin** or **nonsteroidal anti-inflammatory drugs** (NSAIDs) for headache and muscle **pain**, and **decongestants** to relieve stuffiness or runny nose. Patients should be warned against overusing decongestants, because they can cause a rebound effect. **Antibiotics** are not given for colds because they do not kill viruses.

Supportive care includes bed rest and drinking plenty of fluid.

Treatments under investigation include the use of ultraviolet light and injections of interferon.

Alternative treatment

Homeopaths might prescribe any of ten different remedies, depending on the appearance of the nasal discharge, the patient's emotional state, and the stage of infection. Naturopaths would recommend vitamin A and zinc supplements, together with botanical preparations made from **echinacea** (*Echinacea* spp.), goldenseal (*Hydrastis canadensis*), licorice (*Glycyrrhiza glabra*), or astragalus (*Astragalus membraneceus*) root.

Prognosis

Most colds resolve completely in about a week. Complications are unusual but may include **sinusitis**

KEY TERMS

Interferon—A protein produced by cells infected by a virus that stimulates the body's resistance to the virus.

(inflammation of the nasal sinuses), bacterial infections, or infections of the middle ear.

Prevention

There is no vaccine effective against colds, and infection does not confer immunity. Prevention depends on:

- washing hands often, especially before touching the face
- minimizing contact with people already infected
- not sharing hand towels, eating utensils, or water glasses

Resources

BOOKS

Berman, Stephen, and Ken Chan. "Ear, Nose, & Throat." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

"Common Cold." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Jackler, Robert K, and Michael J. Kaplan. "Ear, Nose, & Throat." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

King, Hueston C., and Richard L. Mabry. "Rhinitis." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Otolaryngology: Rhinitis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Rebecca J. Frey

Rhinoplasty

Definition

The term rhinoplasty means "nose molding" or "nose forming." It refers to a procedure in plastic surgery in which the structure of the nose is changed. The change can be made by adding or removing bone or cartilage, grafting tissue from another part of the body, or implanting synthetic material to alter the shape of the nose.

Purpose

Rhinoplasty is most often performed for cosmetic reasons. A nose that is too large, crooked, misshapen, malformed at birth, or deformed by an injury can be given a more pleasing appearance. If breathing is impaired due to the form of the nose or to an injury, it can often be improved with rhinoplasty.

Precautions

The best candidates for rhinoplasty are those with relatively minor deformities. Nasal anatomy and proportions are quite varied and the final look of any rhinoplasty operation is the result of the patient's anatomy, as well as of the surgeon's skill.

The quality of the skin plays a major role in the outcome of rhinoplasty. Patients with extremely thick skin may not see a definite change in the underlying bone structure after surgery. On the other hand, thin skin provides almost no cushion to hide the most minor of bone irregularities or imperfections.

A cosmetic change of the nose will change a person's appearance, but it will not change self-image. A person who expects a different lifestyle after rhinoplasty is likely to be disappointed.

Rhinoplasty should not be performed until the pubertal growth spurt is complete, between ages 14-15 for girls and older for boys.

The cost of rhinoplasty depends on the difficulty of the work required and on the specialist chosen. Prices run from about $3,000 to over $6,000. If the problem was caused by an injury, insurance will usually cover the cost. A rhinoplasty done only to change a person's appearance is not usually covered by insurance.

Description

The external nose is composed of a series of interrelated parts which include the skin, the bony pyramid, cartilage, and the tip of the nose, which is both cartilage and skin. The strip of skin separating the nostrils is called the columella.

Surgical approaches to nasal reconstruction are varied. Internal rhinoplasty involves making all incisions inside the nasal cavity. The external or "open" technique involves a skin incision across the base of the nasal columella. An external incision allows the surgeon to expose the bone and cartilage more fully and is most often used for complicated procedures. During surgery, the surgeon will separate the skin from the bone and cartilage support. The framework of the nose is then reshaped in the desired form. Shape can be altered by

removing bone, cartilage, or skin. The remaining skin is then replaced over the new framework. If the procedure requires adding to the structure of the nose, the donated bone, cartilage, or skin can come from the patient or from a synthetic source.

When the operation is over, the surgeon will apply a splint to help the bones maintain their new shape. The nose may also be packed, or stuffed with a dressing, to help stabilize the septum.

When a local anesthetic is used, light **sedation** is usually given first, after which the operative area is numbed. It will remain insensitive to **pain** for the length of the surgery. A general anesthetic is used for lengthy or complex procedures or if the doctor and patient agree that it is the best option.

Simple rhinoplasty is usually performed in an outpatient surgery center or in the surgeon's office. Most procedures take only an hour or two, and patients go home right away. Complex procedures may be done in the hospital and require a short stay.

Preparation

During the initial consultation, the patient and surgeon will determine what changes can be made in the shape of the nose. Most doctors take photographs at the same time. The surgeon will also explain the techniques and anesthesia options available to the patient.

The patient and surgeon should also discuss guidelines for eating, drinking, **smoking**, taking or avoiding certain medications, and washing of the face.

Aftercare

Patients usually feel fine immediately after surgery, however, most surgery centers do not allow patients to drive themselves home after an operation.

The first day after surgery there will be some swelling of the face. Patients should stay in bed with their heads elevated for at least a day. The nose may hurt and a **headache** is not uncommon. The surgeon will prescribe medication to relieve these conditions. Swelling and bruising around the eyes will increase for a few days, but will begin to diminish after about the third day. Slight bleeding and stuffiness are normal, and vary according to the extensiveness of the surgery performed. Most people are up in two days, and back to school or work in a week. No strenuous activities are allowed for two to three weeks.

Patients are given a list of postoperative instructions, which include requirements for hygiene, **exercise**, eating, and follow-up visits to the doctor. Patients should not blow their noses for the first week to avoid disruption of healing. It is extremely important to keep the surgical dressing dry. Dressings, splints, and stitches are removed in one to two weeks. Patients should avoid **sunburn**.

KEY TERMS

Cartilage—Firm supporting tissue that does not contain blood vessels.

Columella—The strip of skin running from the tip of the nose to the upper lip, which separates the nostrils.

Septum—The dividing wall in the nose.

Risks

Any type of surgery carries a degree of risk. There is always the possibility of unexpected events, such as an infection or a reaction to the anesthesia.

When the nose is reshaped or repaired from inside, the scars are not visible, but if the surgeon needs to make the incision on the outside of the nose, there will be some slight scarring. In addition, tiny blood vessels may burst, leaving small red spots on the skin. These spots are barely visible, but may be permanent.

About 10% of patients require a second procedure.

Resources

BOOKS

Paparella, Michael M., et.al *Otolaryngology, Volume IV: Plastic and Reconstructive Surgery and Interrelated Disciplines.* 3rd ed. Philadelphia: W. B. Saunders Co., 1991.

Schuller, David E., and Alexander J. Schleuning II. *DeWeese and Saunders' Otolaryngology: Head and Neck Surgery.* St. Louis: Mosby-Year Book, Inc., 1994.

PERIODICALS

Maksud, D. P., and R. C. Anderson. "Psychological Dimensions of Aesthetic Surgery; Essentials for Nurses." *Plastic Surgical Nursing* 15 (Fall 1995): 137-44, 176-8.

ORGANIZATIONS

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

Dorothy Elinor Stonely

Rhinovirus infection *see* **Common cold**

Rhytidoplasty *see* **Face lift**

Riboflavin deficiency

Definition

Riboflavin deficiency occurs when the chronic failure to eat sufficient amounts of foods that contain riboflavin produces lesions of the skin, lesions of smooth surfaces in the digestive tract, or nervous disorders.

Description

Riboflavin, also called vitamin B_2, is a water-soluble vitamin. The recommended daily allowance (RDA) for riboflavin is 1.7 mg/day for an adult man and 1.3 mg/day for an adult woman. The best sources of this vitamin are meat, dairy products, and dark green vegetables, especially broccoli. Grains and legumes (beans and peas) also contribute riboflavin to the diet. Riboflavin is required for the processing of dietary fats, carbohydrates, and proteins to convert these nutrients to energy. Riboflavin is also used for the continual process of renewal and regeneration of all cells and tissues in the body.

Riboflavin is sensitive to light. For this reason, commercially available milk is sometimes supplied in cartons, rather than in clear bottles. Riboflavin is not rapidly destroyed by cooking. Milk contains about 1.7 mg riboflavin/kg. Cheese contains about 4.3 mg/kg, while beef has 2.4 mg/kg and broccoli has about 2.0 mg/kg. Apples, a food that is low in all nutrients, except water, contains only 0.1 mg riboflavin per kg.

Causes and symptoms

A deficiency only in riboflavin has never occurred in the natural environment. In contrast, diseases where people are deficient in one vitamin, such as thiamin, vitamin C, and vitamin D, for example, have been clearly documented. Poorer populations in the United States may be deficient in riboflavin, but when this happens, they are also deficient in a number of other nutrients as well. When riboflavin deficiency is actually detected, it is often associated with low consumption of milk, chronic **alcoholism**, or chronic **diarrhea**.

The symptoms of riboflavin deficiency include:

- swelling and fissuring of the lips (cheilosis)
- ulceration and cracking of the angles of the mouth (angular stomatitisis)
- oily, scaly skin **rashes** on the scrotum, vulva, or area between the nose and lips
- inflammation of the tongue
- red, itchy eyes that are sensitive to light.

KEY TERMS

Recommended daily allowance—The recommended daily allowances (RDAs) are quantities of nutrients of the diet that are required to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient needed to maintain health in a population of people. The actual amounts of each nutrient required to maintain health in any specific individual differs from person to person.

Water-soluble vitamin—Water-soluble vitamins can be dissolved in water or juice. Fat-soluble vitamins can be dissolved in oil or in melted fat.

The nervous symptoms of riboflavin deficiency include:

- numbness of the hands
- decreased sensitivity to touch, temperature, and vibration

Diagnosis

Riboflavin status is diagnosed using a test conducted on red blood cells that measures the activity of an enzyme called glutathione reductase. An extract of the red blood cells is placed in two test tubes. One test tube contains no added riboflavin, while the second test tube contains a derivative of riboflavin, called flavin adenine dinucleotide. The added riboflavin derivative results in little or no stimulation of enzyme activity in patients with normal riboflavin levels. A stimulation of 20% or less is considered normal. A stimulation of over 20% means that the patient is deficient in riboflavin.

Treatment

Riboflavin deficiency can be treated with supplemental riboflavin (0.5 mg/kg body weight per day) until the symptoms disappear.

Prognosis

The prognosis for correcting riboflavin deficiency is excellent.

Prevention

Riboflavin deficiency can be prevented by including milk, cheese, yogurt, meat, and/or certain vegetables in

the daily diet. Of the vegetables, broccoli, asparagus, and spinach are highest in riboflavin. These vegetables have a riboflavin content that is similar to that of milk, yogurt, or meat.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.
Combs, Gerald. *The Vitamins.* San Diego: Academic Press, 1992.
Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

Tom Brody, PhD

Rickets *see* **Vitamin D deficiency**

Rickettsia rickettsii infection *see* **Rocky Mountain spotted fever**

Rickettsialpox

Definition

Rickettsialpox is a relatively mild disease caused by a member of the bacterial family called Rickettsia. Rickettsialpox causes rash, **fever**, chills, heavy sweating, **headache**, eye **pain** (especially when exposed to light), weakness, and achy muscles.

Description

Like other members of the family of Rickettsia, the bacteria causing rickettsialpox live in mice. Tiny mites feed on these infected mice, thus acquiring the organism. When these mites feed on humans, the bacteria can be transmitted.

Rickettsialpox occurs mostly within cities. In the United States, the disease has cropped up in such places as New York City, Boston, Philadelphia, Pittsburgh, and Cleveland. It has also been identified in Russia, Korea, and Africa.

Causes and symptoms

The specific bacteria responsible for rickettsialpox is called *Rickettsia akari*. A person contracts this bacteria through the bite of an infected mite. After a person has been bitten by an infected mite, there is a delay of about 10 days to three weeks prior to the onset of symptoms.

The first symptom is a bump which appears at the site of the original bite. The bump (papule) develops a tiny, fluid-filled head (vesicle). The vesicle sloughs away, leaving a crusty black scab in its place (eschar). In about a week, the patient develops a fever, chills, heavy sweating, headache, eye pain (especially when exposed to light), weakness, and achy muscles. The fever rises and falls over the course of about a weak. A bumpy rash spreads across the body. Each individual papule follows the same progression: papule, then vesicle, then eschar. The rash does not affect the palms of the hands or the soles of the feet.

Diagnosis

Most practitioners are able to diagnose rickettsialpox simply on the basis of its rising and falling fever, and its characteristic rash. Occasionally, blood will be drawn and tests performed to demonstrate the presence of antibodies (immune cells directed against specific bacterial agents) which would confirm a diagnosis of rickettsialpox.

Treatment

Because rickettsialpox is such a mild illness, some practitioners choose to simply treat the symptoms (giving **acetaminophen** for fever and achiness, pushing fluids to avoid **dehydration**). Others will give their patients a course of the antibiotic tetracycline, which will shorten the course of the illness to about one to two days.

Prognosis

Prognosis for full recovery from rickettsialpox is excellent. No deaths have ever been reported from this illness, and even the skin rash heals without scarring.

Prevention

As with all mite- or tick-borne illnesses, prevention includes avoidance of areas known to harbor the insects, and/or careful application of insect repellents. Furthermore, because mice pass the bacteria on to the mites, it is important to keep mice from nesting in or around residences.

Resources

BOOKS

Corey, Lawrence. "Rickettsia and Coxiella." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

KEY TERMS

Eschar—A crusty, blackish scab.

Papule—A bump on the skin.

Vesicle—A fluid-filled head on a papule.

Walker, David, et al. "Rickettsial Diseases." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Rifampin *see* **Antituberculosis drugs**

Ringing ears *see* **Tinnitus**

Ringworm

Definition

Ringworm is a common fungal infection of the skin. The name is a misnomer since the disease is not caused by a worm.

Description

More common in males than in females, ringworm is characterized by patches of rough, reddened skin. Raised eruptions usually form the circular pattern that gives the condition its name. Ringworm may also be referred to as dermatophyte infection.

As lesions grow, the centers start to heal. The inflamed borders expand and spread the infection.

Types of ringworm

Ringworm is a term that is commonly used to encompass several types of fungal infection. Sometimes, however, only body ringworm is classified as true ringworm.

Body ringworm (tinea corporis) can affect any part of the body except the scalp, feet, and facial area where a man's beard grows. The well-defined, flaky sores can be dry and scaly or moist and crusty.

Scalp ringworm (tinea capitis) is most common in children. It causes scaly, swollen blisters or a rash that looks like black dots. Sometimes inflamed and filled with pus, scalp ringworm lesions can cause crusting, flaking, and round bald patches. Most common in black children, scalp ringworm can cause scarring and permanent hair loss.

Ringworm of the groin (tinea cruris or jock itch) produces raised red sores with well-marked edges. It can spread to the buttocks, inner thighs, and external genitals.

Ringworm of the nails (tinea unguium) generally starts at the tip of one or more toenails, which gradually thicken and discolor. The nail may deteriorate or pull away from the nail bed. Fingernail infection is far less common.

Causes and symptoms

Ringworm can be transmitted by infected people or pets or by towels, hairbrushes, or other objects contaminated by them. Symptoms include inflammation, scaling, and sometimes, **itching**.

Diabetes mellitus increases susceptibility to ringworm. So do dampness, humidity, and dirty, crowded living areas. Braiding hair tightly and using hair gel also raise the risk.

Diagnosis

Diagnosis is based on microscopic examination of scrapings taken from lesions. A dermatologist may also study the scalp of a patient with suspected tinea capitis under ultraviolet light.

Treatment

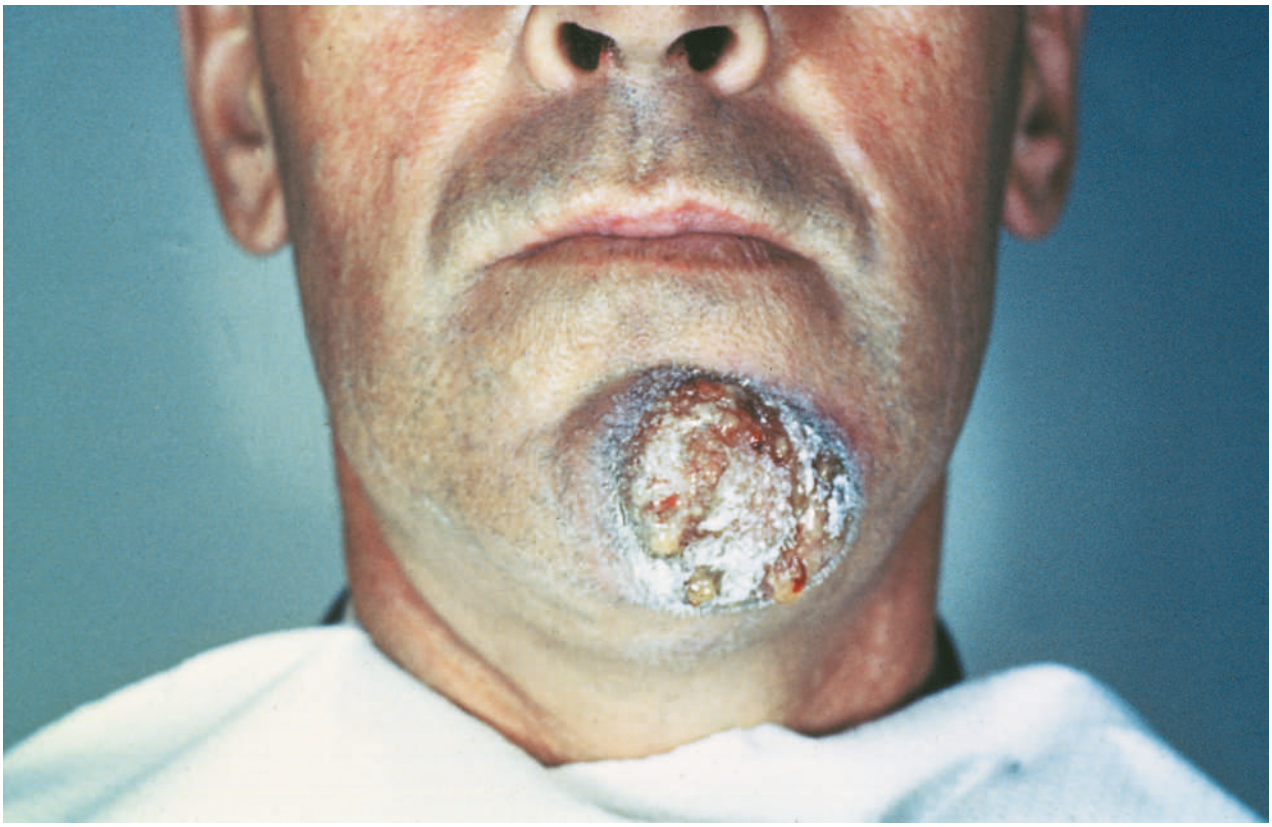
Some infections disappear without treatment. Others respond to such topical antifungal medications as naftifine (Caldesene Medicated Powder) or tinactin (Desenex) or to griseofulvin (Fulvicin), which is taken by mouth. Medications should be continued for two weeks after lesions disappear.

A person with body ringworm should wear loose clothing and check daily for raw, open sores. Wet dressings applied to moist sores two or three times a day can lessen inflammation and loosen scales. The doctor may suggest placing special pads between folds of infected skin, and anything the patient has touched or worn should be sterilized in boiling water.

Infected nails should be cut short and straight and carefully cleared of dead cells with an emery board.

Patients with jock itch should:

- wear cotton underwear and change it more than once a day



Ringworm on a man's chin. These infections are most common on the feet, scalp, or in toenails, but they can infect any part of the skin. *(Custom Medical Stock Photo. Reproduced by permission.)*

- keep the infected area dry
- apply antifungal ointment over a thin film of antifungal powder

Shampoo containing selenium sulfide can help prevent spread of scalp ringworm, but prescription shampoo or oral medication is usually needed to cure the infection.

Alternative treatment

The fungal infection ringworm can be treated with homeopathic remedies. Among the homeopathic remedies recommended are:

- *sepia* for brown, scaly patches.
- *tellurium* for prominent, well-defined, reddish sores.
- *graphites* for thick scales or heavy discharge.
- *sulphur* for excessive itching.

Topical applications of antifungal herbs and essential oils also can help resolve ringworm. Tea tree oil (*Melaleuca* spp.), thuja (*Thuja occidentalis*), and lavender (*Lavandula officinalis*) are the most common. Two drops of essential oil in 1/4 oz of carrier oil is the dose recommended for topical application. Essential oils should not be applied to the skin undiluted. Botanical medicine can be taken internally to enhance the body's immune response. A person must be susceptible to exhibit this overgrowth of fungus on the skin. **Echinacea** *(Echinacea* spp.) and astragalus (*Astragalus membranaceus*) are the two most common immune-enhancing herbs. A well-balanced diet, including protein, complex carbohydrates, fresh fruits and vegetables, and good quality fats, is also important in maintaining optimal immune function.

Prognosis

Ringworm can usually be cured, but recurrence is common. Chronic infection develops in one patient in five.

It can take six to 12 months for new hair to cover bald patches, and three to 12 months to cure infected fingernails. Toenail infections do not always respond to treatment.

Prevention

Likelihood of infection can be lessened by avoiding contact with infected people or pets or contaminated objects and staying away from hot, damp places.

Resources

BOOKS

Cummings, Stephen, and Dana Ullman. *Everybody's Guide to Homeopathic Medicine*. Los Angeles: Jeremy P. Tarcher, 1984.

Shaw, Michael, ed. *Everything You Need to Know About Diseases*. Springhouse, PA: Springhouse Corporation, 1996.

OTHER

"Athlete's Foot, Jock Itch and Ringworm." *The Cleveland Clinic*. 7 Apr. 1998 <http://www.clevelandclinic.org/health>.

"Ringworm." *ThriveOnline*. 5 Apr. 1998 <http://thriveonline.oxygen.com>.

"Ringworm." *YourHealth.com Page*. 7 Apr. 1998 <http://www.yourhealth.com>.

Maureen Haggerty

Rinne test *see* **Hearing tests with a tuning fork**

Ritonavir *see* **Protease inhibitors**

River blindness *see* **Filariasis**

RMSF *see* **Rocky Mountain spotted fever**

Rocky Mountain spotted fever

Definition

Rocky Mountain spotted **fever** (RMSF) is a tick-borne illness caused by a bacteria, resulting in a high fever and a characteristic rash.

Description

The bacteria causing RMSF is passed to humans through the bite of an infected tick. The illness begins within about two weeks of such a bite. RMSF is the most widespread tick-borne illness in the United States, occurring in every state except Alaska and Hawaii. The states in the mid-Atlantic region, the Carolinas, and the Virginias have a great deal of tick activity during the spring and summer months, and the largest number of RMSF cases come from those states. About 5% of all ticks carry the causative bacteria. Children under the age of 15 years have the majority of RMSF infections.

Causes and symptoms

The bacterial culprit in RMSF is called *Rickettsia rickettsii*. It causes no illness in the tick carrying it, and can be passed on to the tick's offspring. When a tick attaches to a human, the bacteria is passed. The tick must be attached to the human for about six hours for this passage to occur. Although prompt tick removal will cut down on the chance of contracting RMSF, removal requires great care. If the tick's head and body are squashed during the course of removal, the bacteria can be inadvertently rubbed into the tiny bite wound.

Symptoms of RMSF begin within two weeks of the bite of the infected tick. Symptoms usually begin suddenly, with high fever, chills, **headache**, severe weakness, and muscle **pain**. Pain in the large muscle of the calf is very common, and may be particularly severe. The patient may be somewhat confused and delirious. Without treatment, these symptoms may last two weeks or more.

The rash of RMSF is quite characteristic. It usually begins on the fourth day of the illness, and occurs in at least 90% of all patients with RMSF. It starts around the wrists and ankles, as flat pink marks (called macules). The rash spreads up the arms and legs, toward the chest, abdomen, and back. Unlike **rashes** which accompany various viral infections, the rash of RMSF does spread to the palms of the hands and the soles of the feet. Over a couple of days, the macules turn a reddish-purple color. They are now called petechiae, which are tiny areas of bleeding under the skin (pinpoint hemorrhages). This signifies a new phase of the illness. Over the next several days, the individual petechiae may spread into each other, resulting in larger patches of hemorrhage.

The most severe effects of RMSF occur due to damage to the blood vessels, which become leaky. This accounts for the production of petechiae. As blood and fluid leak out of the injured blood vessels, other tissues and organs may swell and become damaged, and:

- breathing difficulties may arise as the lungs are affected
- heart rhythms may become abnormal
- kidney failure occurs in very ill patients
- liver function drops
- the patient may experience nausea, vomiting, abdominal pain, and diarrhea
- The brain may swell (**encephalitis**) in about 25% of all RMSF patients (brain injury can result in seizures, changes in consciousness, actual **coma**, loss of coordination, imbalance on walking, muscle spasms, loss of bladder control, and various degrees of paralysis).
- the clotting system becomes impaired, and blood may be evident in the stools or vomit

Diagnosis

Diagnosis of RMSF is almost always made on the basis of the characteristic symptoms, coupled with either a known tick bite (noted by about 60-70% of patients) or exposure to an area known to harbor ticks. Complex tests exist to nail down a diagnosis of RMSF, but these are performed in only a few laboratories. Because the results of these tests take so long to obtain, they are seldom used. This is because delaying treatment is the main cause of **death** in patients with RMSF.

Treatment

It is essential to begin treatment absolutely as soon as RMSF is seriously suspected. Delaying treatment can result in death.

Antibiotics are used to treat RMSF. The first choice is a form of tetracycline; the second choice (used in young children and pregnant women) is chloramphenicol. If the patient is well enough, treatment by oral intake of medicine is perfectly effective. Sicker patients will need to be given the medication through a needle in the vein (intravenously). Penicillin and sulfa drugs are not suitable for treatment of RMSF, and their use may increase the death rate by delaying the use of truly effective medications.

Very ill patients will need to be hospitalized in an intensive care unit. Depending on the types of complications a particular patient experiences, a variety of treatments may be necessary, including intravenous fluids, blood transfusions, anti-seizure medications, **kidney dialysis**, and mechanical ventilation (a breathing machine).

Alternative treatment

Although alternative treatments should never be used in place of conventional treatment with antibiotics, they can be useful adjuncts to antibiotic therapy. The use of *Lactobacillus acidophilus* and *L. bifidus* supplementaion during and after antibiotic treatment can help rebalance the intestinal flora. **Acupuncture**, **homeopathy**, and botanical medicine can all be beneficial supportive therapies during recovery from this disease.

Prognosis

Prior to the regular use of antibiotics to treat RMSF, the death rate was about 25%. Although the death rate from RMSF has improved greatly with an understanding of the importance of early use of antibiotics, there is still a 5% death rate. This rate is believed to be due to delays in the administration of appropriate medications.

Certain risk factors suggest a worse outcome in RMSF. Death rates are higher in males and increase as people age. It is considered a bad prognostic sign to develop symptoms of RMSF within only two to five days of a tick bite.

KEY TERMS

Encephalitis—Inflammation of the tissues of the brain.

Macule—A flat, discolored area on the skin.

Petechia—A small, round, reddish purple spot on the skin, representing a tiny area of bleeding under the skin.

Prevention

The mainstay of prevention involves avoiding areas known to harbor ticks. However, because many people enjoy recreational activities in just such areas, the following steps can be taken:

- Wear light colored clothing (so that attached ticks are more easily noticed).
- Wear long sleeved shirts and long pants; tuck the pants legs into socks.
- Spray clothing with appropriate tick repellents.
- Examine. Anybody who has been outside for any amount of time in an area known to have a population of ticks should examine his or her body carefully for ticks. Parents should examine their children at the end of the day.
- Remove any ticks using tweezers, so that infection doesn't occur due to handling the tick. Grasp the tick's head with the tweezers, and pull gently but firmly so that the head and body are entirely removed.
- Keep areas around homes clear of brush, which may serve to harbor ticks.

Resources

BOOKS

Corey, Lawrence. "Rickettsia and Coxiella." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

Walker, David, et al. "Rickettsial Diseases." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Kalish, Robert. "How to Recognize and Treat Tick-Borne Infections." *Patient Care* 31 (15 May 1997): 184+.

Lyon, G. Marshall, and Anita M. Kelsey. "Rocky Mountain Spotted Fever." *Consultant* 36 (Aug. 1996): 1729+.
"Other Tick-Bite Ailments." *American Health* 14 (June 1995): 78+.
"Rocky Mountain Spotted Fever: A Disease For All Seasons—and All Parts of the Country." *Consultant* 35 (Sept. 1995): 1318.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Rogaine *see* **Minoxidil**

Rolfing

Definition

Rolfing, also called Rolf therapy or structural integration, is a holistic system of bodywork that uses deep manipulation of the body's soft tissue to realign and balance the body's myofascial structure. Rolfing improves posture, relieves chronic **pain**, and reduces **stress**.

Purpose

Rolfing helps to improve posture and bring the body's natural structure into proper balance and alignment. This can bring relief from general aches and pains, improve breathing, increase energy, improve self-confidence, and relieve physical and mental stress. Rolfing has also been used to treat such specific physical problems as chronic back, neck, shoulder, and joint pain, and repetitive stress injuries, including **carpal tunnel syndrome**. Many amateur and professional athletes, including Olympic skaters and skiers, use Rolfing to keep in top condition, to prevent injuries, and to more quickly recover from injuries.

Description

Origins

Ida Pauline Rolf (1896–1979) was a biochemist from New York who developed structural integration over the course of many years after an accident as a young woman. She was kicked by a horse's hoof on a trip out West and developed symptoms resembling those of acute **pneumonia**. She made her way to a hospital in Montana, where she was treated by a physician who called in an osteopath to assist in her treatment. After the osteopath treated her, she was able to breathe normally. After her return to New York, her mother took her to a blind osteopath for further treatment. He taught her about the body's structure and function, after which Rolf became dissatisfied with conventional medical treatment. Following completion of a doctorate in biochemistry from Columbia University in 1920, Rolf studied atomic physics, mathematics, and homeopathic medicine in Europe. After 1928, when her father died and left her an inheritance that allowed her to pursue her own studies, she explored various forms of alternative treatment, including **osteopathy**, **chiropractic** medicine, tantric **yoga**, the **Alexander technique** of tension reduction through body movement, and Alfred Korzybski's philosophy of altered states of consciousness.

By 1940, Rolf had synthesized what she had learned from these various disciplines into her own technique of body movement that she called structural integration, which later became known as Rolfing. During the Second World War, Rolf continued to study with an osteopath in California named Amy Cochran. In the mid-1960s, Gestalt therapist Fritz Perls invited Rolf to Esalen, where she began to develop a following among people involved in the human potential movement. In 1977, she published *Rolfing: The Integration of Human Structures*, the definitive book on structural integration bodywork. She continued to refine the therapy until her **death** in 1979. Rolf's work is carried on through her Guild for Structural Integration, now known as the Rolf Institute of Structural Integration, which she founded in 1971 in Boulder, Colo.

Rolfing is more than just a massage of the body's surface. It is a system that reshapes the body's myofascial structure by applying pressure and energy, thereby freeing the body from the effects of physical and emotional traumas. Although Rolfing is used extensively to treat **sports injuries** and back pain, it is not designed as a therapy for any particular condition. Rather, it is a systematic approach to overall wellness. It works by counteracting the effects of gravity, which over time pulls the body out of alignment. This pull causes the body's connective tissue to become harder and stiffer, and the muscles to atrophy. Signs of this stiffening and contraction include slouching or an overly erect posture.

Rolfing identifies the vertical line as the ideal that the body should approximate. The mission statement of the Guild for Structural Integration describes Rolfing as "a method and a philosophy of personal growth and integrity... The vertical line is our fundamental concept. The physical and psychological embodiment of the vertical line is a way of Being in the physical world [that] forms a basis for personal growth and integrity."

The basic ten

Basic Rolfing treatment consists of 10 sessions, each lasting 60–90 minutes and costing about $100 each. The sessions are spaced a week or longer apart. After a period of integration, specialized or advanced treatment sessions are available. A "tuneup" session is recommended every six months. In each session, the Rolfer uses his or her fingers, hands, knuckles, and elbows to rework the connective tissue over the entire body. The tissues are worked until they become pliable, allowing the muscles to lengthen and return to their normal alignment. The deep tissue manipulation improves posture and agility, and increases the body's range of movement. Rolfers also believe that the blocked energy accumulated in the tissue from emotional tension is released through Rolfing treatment, causing the patient to feel more energetic and have a more positive frame of mind.

Clients are asked to wait for a period of six to 12 months before scheduling advanced work, known as the PostTen/Advanced Series. This period allows the body to integrate the work done in the "Basic Ten."

Rolfing movement integration

Rolfing movement integration, or RMI, is intended to help clients develop better awareness of their vertical alignment and customary movement patterns. They learn to release tension and discover better ways to use body movement effectively.

Rolfing rhythms

Rolfing rhythms are a series of exercises intended to remind participants of the basic principles of Rolfing: ease, length, balance, and harmony with gravity. In addition, Rolfing rhythms improve the client's flexibility as well as muscle tone and coordination.

Preparations

No pre-procedure preparations are needed to begin Rolfing treatment. The treatment is usually done on a massage table with the patient wearing only undergarments. Prior to the first session, however, the client is asked to complete a health questionnaire, and photographs are taken to assist with evaluation of his or her progress.

Precautions

Since Rolfing involves vigorous deep tissue manipulation, it is often described as uncomfortable and sometimes painful, especially during the first several sessions. In the past decade, however, Rolfers have developed newer techniques that cause less discomfort to participants. Since Rolfing is a bodywork treatment that requires the use of hands, it may be a problem for people who do not like or are afraid of being touched. It is not recommended as a treatment for any disease or a chronic inflammatory condition such as arthritis, and can worsen such a condition. Anyone with a serious medical condition, including heart disease, diabetes, or respiratory problems, should consult with a medical practitioner before undergoing Rolfing.

Side effects

There are no reported serious side effects associated with Rolfing when delivered by a certified practitioner to adults and juveniles.

Research and general acceptance

There is a growing amount of mainstream scientific research documenting the effectiveness of Rolf therapy. A

IDA P. ROLF, PH.D. (1896–1979)

Born in New York City and raised in the Bronx, Ida P. Rolf attended school in the New York area, graduating from Barnard College in 1916. In 1920, she graduated from the Columbia University College of Physicians and Surgeons with a doctorate in biological chemistry. For the next 12 years, she worked in the departments of chemotherapy and organic chemistry at the Rockefeller Institute. During an extended leave of absence, she studied atomic physics and mathematics at the Swiss Technical University in Zurich and homeopathic medicine in Geneva. During the 1930s, she studied osteopathy, chiropractic medicine, tantric yoga, the Alexander Technique of tension reduction through body movement, and the philosophy of altered states of consciousness of Alfred H.S. Korzybski.

Her interest in body structure, movement, and manipulation began after being kicked by a horse shortly after graduating from Barnard. The accident left her with acute pneumonia. Dissatisfied with conventional medical treatment, she began her quest for more natural and effective ways of treating the body.

By 1940, Dr. Rolf had developed a technique of body movement she called structural integration, also known today as Rolfing. The therapy reshapes the body's muscular structure by applying pressure and energy, freeing the body from physical and emotional traumas. In 1977, she authored *Rolfing: The Integration of Human Structures*. She continued to teach and refine her therapy until her death in 1979. Dr. Rolf's desire to teach her work to others led to her establishing the Guild for Structural Engineering, now known as the Rolf Institute of Structural Integration, 205 Canyon Blvd., Boulder, CO 80302.

KEY TERMS

Atrophy—A progressive wasting and loss of function of any part of the body.

Carpal tunnel syndrome—A condition caused by compression of the median nerve in the carpal tunnel of the hand, characterized by pain.

Fascia—The sheet of connective tissue that covers the body under the skin and envelops every muscle, bone, nerve, gland, organ, and blood vessel. Fascia helps the body to retain its basic shape.

Osteopathy—A system of medical practice that believes that the human body can make its own remedies to heal infection. It originally used manipulative techniques but also added surgical, hygienic, and medicinal methods when needed.

Parasympathetic nervous system—A part of the autonomic nervous system that is concerned with conserving and restoring energy. It is the part of the nervous system that predominates in a state of relaxation.

Structural integration—The term used to describe the method and philosophy of life associated with Rolfing. Its fundamental concept is the vertical line.

1988 study published in the *Journal of the American Physical Therapy Association* indicated that Rolfing stimulates the parasympathetic nervous system, which can help speed the recovery of damaged tissue. Other studies done in the 1980s concerned the effectiveness of Rolfing in treating figure skaters and children with **cerebral palsy**. In 1992 a presentation was made to the National Center of Medical **Rehabilitation** Research regarding Rolfing in the treatment of degenerative joint disease. A 1997 article in *The Journal of Orthopedic and Sports Physical Therapy* reported that Rolfing can provide effective and sustained pain relief from lower back problems.

Resources

BOOKS

Anson, Brian. *Rolfing: Stories of Personal Empowerment.* Berkeley, CA: North Atlantic Books, 1998.

Claire, Thomas. *Bodywork: What Type of Massage to Get and How to Make the Most of It.* New York: William Morrow and Co., 1995.

Levine, Andrew S., and Valerie J. Levine. *The Bodywork and Massage Sourcebook.* Lincolnwood, IL: Lowell House. 1999.

Rolf, Ida P. *Rolfing: The Integration of Human Structures.* New York: Harper and Row, 1977.

Rolf, Ida P. *Rolfing: Reestablishing the Natural Alignment and Structural Integration of the Human Body for Vitality and Well-Being.* Rochester, VT: Healing Arts Press, 1989.

ORGANIZATIONS

Rolf Institute of Structural Integration. 209 Canyon Blvd. P.O. Box 1868. Boulder, CO 80306-1868. (303) 449-5903. (800) 530-8875. <http://www.rolf.org>.

Ken R. Wells

Root canal treatment

Definition

Root canal treatment, also known as endodontic treatment, is a dental procedure in which the diseased or damaged pulp (core) of a tooth is removed and the inside areas (the pulp chamber and root canals) are filled and sealed.

Purpose

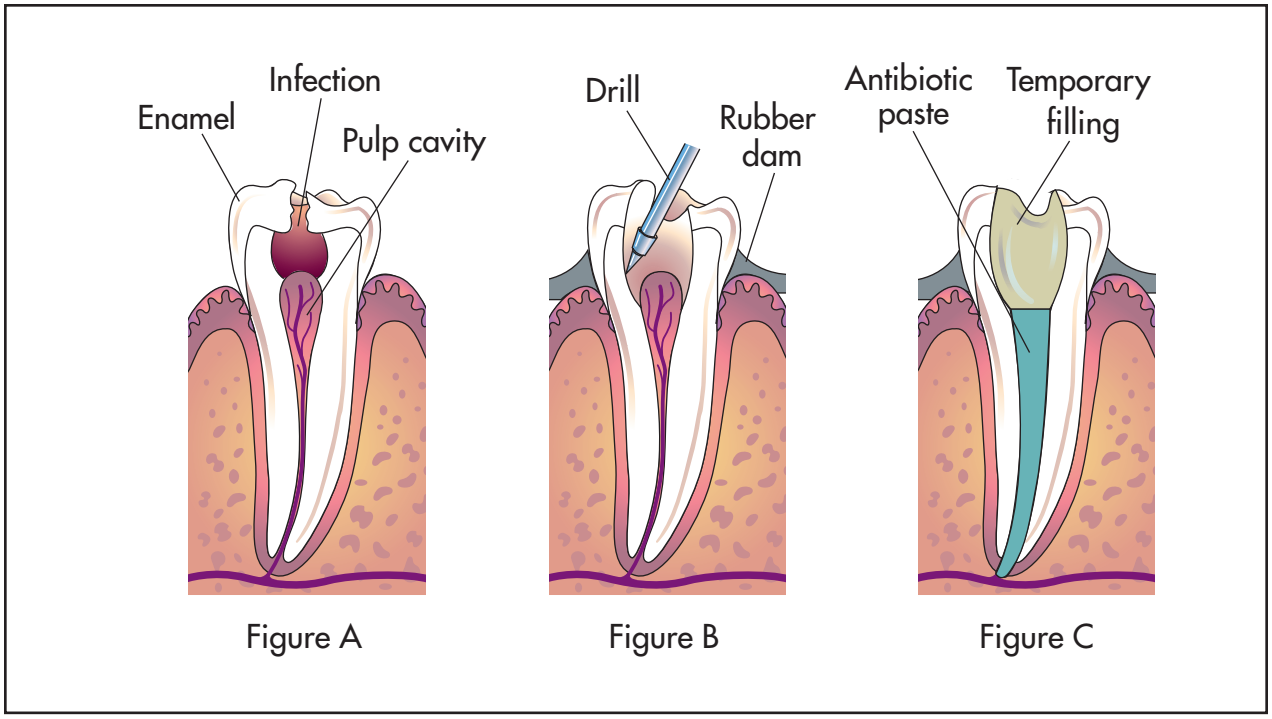
Inflamed or infected pulp (pulpitis) most often causes a **toothache**. To relieve the **pain** and prevent further complications, the tooth may be extracted (surgically removed) or saved by root canal treatment. Root canal treatment has become a common dental procedure; more than 14 million are performed every year, with a 95% success rate, according to the American Association of Endodontists.

Precautions

Once root canal treatment is performed, the patient must have a crown placed over the tooth to protect it. The cost of the treatment and the crown may be expensive. However, replacing an extracted tooth with a fixed bridge, a removable partial denture, or an implant to maintain the space and restore the chewing function is typically even more expensive.

Description

Root canal treatment may be performed by a general dentist or by an endodontist, a dentist who specializes in endodontic (literally "inside of the tooth") procedures. Inside the tooth, the pulp's soft tissue contains the blood supply, by which the tooth gets its nutrients, and the nerve, by which the tooth senses hot and cold. This tissue is vulnerable to damage from deep dental decay, accidental injury, tooth fracture, or trauma from repeated dental procedures (such as multiple fillings over time). If a tooth becomes diseased or injured, bacteria build up inside the pulp, spreading infection from the natural crown of the tooth to the root tips in the jawbone. Pus



Root canal treatment is a dental procedure in which the diseased pulp of a tooth is removed and the inside areas are filled and sealed. In figure A, the infection can be seen above the pulp cavity. The dentist drills into the enamel and the pulp cavity is extracted (figure B). Finally, the dentist fills the pulp cavity with antibiotic paste and a temporary filling (figure C). *(Illustration by Electronic Illustrators Group.)*

accumulates at the ends of the roots, forming a painful **abscess** which can damage the bone supporting the teeth. Such an infection may produce pain that is severe, constant, or throbbing, as well as prolonged sensitivity to heat or cold, swelling and tenderness in the surrounding gums, facial swelling, and discoloration of the tooth. However, in some cases, the pulp may die so gradually that there is little noticeable pain.

Root canal treatment is performed under local anesthesia. A thin sheet of rubber, called a rubber dam, is placed in the mouth to isolate the tooth. The dentist removes any **tooth decay** and makes an opening through the natural crown of the tooth into the pulp chamber. Creating this access also relieves the pressure inside the tooth and can dramatically ease pain.

The dentist determines the length of the root canals, usually with a series of x rays. Small wire-like files are then used to clean the entire canal space of diseased pulp tissue and bacteria. The debris is flushed out with large amounts of water (irrigation). The canals are also slightly enlarged and shaped to receive an inert (non-reactive) filling material called gutta percha. However, the tooth is not filled and permanently sealed until it is completely free of active infection. The dentist may place a temporary seal, or leave the tooth open to drain, and prescribe an antibiotic to counter any spread of infection from the tooth. This is why root canal treatment may require several visits to the dentist.

Once the canals are completely clean, they are filled with gutta percha and a sealer cement to prevent bacteria from entering the tooth in the future. A metal post may be placed in the pulp chamber for added structural support and better retention of the crown restoration. The tooth is protected by a temporary filling or crown until a permanent restoration may be made. This restoration is usually a gold or porcelain crown, although it may be a gold inlay, or an amalgam or composite filling (paste fillings that harden).

Preparation

There is no typical preparation for root canal treatment. Once the tooth is opened to drain, the dentist may prescribe an antibiotic, then the patient should take the full prescribed course. With the infection under control, local anesthetic is more effective, so that the root canal procedure may be performed without discomfort.

Aftercare

The tooth may be sore for several days after filling. Pain relievers, such as ibuprofen (Advil, Motrin) may be

KEY TERMS

Abscess—A hole in the tooth or gum tissue filled with pus as the result of infection. Its swelling exerts pressure on the surrounding tissues, causing pain.

Apicoectomy—Also called root resectioning. The root tip of a tooth is accessed in the bone and a small amount is shaved away. The diseased tissue is removed and a filling is placed to reseal the canal.

Crown—The natural crown of a tooth is that part of the tooth covered by enamel. Also, a restorative crown is a protective shell that fits over a tooth.

Endodontic—Pertaining to the inside structures of the tooth, including the dental pulp and tooth root, and the periapical tissue surrounding the root.

Endodontist—A dentist who specializes in the diagnosis and treatment of disorders affecting the inside structures of the tooth.

Extraction—The surgical removal of a tooth from its socket in the bone.

Gutta percha—An inert latex-like substance used for filling root canals.

Pulp—The soft innermost layer of a tooth, containing blood vessels and nerves.

Pulp chamber—The area within the natural crown of the tooth occupied by dental pulp.

Pulpitis—Inflammation of the pulp of a tooth involving the blood vessels and nerves.

Root canal—The space within a tooth that runs from the pulp chamber to the tip of the root.

Root canal treatment—The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

taken to ease the soreness. The tissues around the tooth may also be irritated. Rinsing the mouth with hot salt water several times a day will help. Chewing on that side of the mouth should be avoided for the first few days following treatment. A follow-up appointment should be scheduled with the dentist for six months after treatment to make sure the tooth and surrounding structures are healthy.

Risks

There is a possibility that the root canal treatment will not be successful the first time. If infection and inflammation recur and an x ray indicates retreatment is feasible, the old filling material is removed and the canals are thoroughly cleaned out. The dentist will try to identify and correct problems with the first root canal treatment before filling and sealing the tooth a second time.

In cases where an x ray indicates that retreatment cannot correct the problem, endodontic surgery may be performed. In a procedure called an apicoectomy, or root resectioning, the root end of the tooth is accessed in the bone, and a small amount is shaved away. The area is cleaned of diseased tissue and a filling is placed to reseal the canal.

In some cases, despite root canal treatment and endodontic surgery, the tooth dies anyway and must be extracted.

Normal results

With successful root canal treatment, the tooth will no longer cause pain. However, because it does not contain an internal nerve, it no longer has sensitivity to hot, cold, or sweets. These are signs of dental decay, so the patient must receive regular dental check-ups with periodic x rays to avoid further disease in the tooth. The restored tooth could last a lifetime; however, with routine wear, the filling or crown may eventually need to be replaced.

Resources

ORGANIZATIONS

American Association of Endodontists. 211 East Chicago Ave., Ste. 1100, Chicago, IL 60611-2691. (800) 872-3636. <http://www.aae.org>.

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

OTHER

"Root Canal Treatment." *Annapolis Endodontics.* <http://users.erols.com/canals/index.html>.

"Root Canal Treatment." *Value Added Benefits.* <http://www.vab.com>.

" Endodontic (Root Canal) Therapy." *Tooth Talk and Your Health with Dr. Frank Gober.* <http://www.toothtalk.com>.

Thivierge, Bethany. "What is the Value (and Cost) of a Root Canal?" *A Healthy Me Page.* <http://www.ahealthyme.com/topic/rootcanal>.

Bethany Thivierge

Rosacea

Definition

Rosacea is a skin disease typically appearing in people during their 30s and 40s. It is marked by redness

(erythema) of the face, flushing of the skin, and the presence of hard pimples (papules) or pus-filled pimples (pustules), and small visible spider-like veins called telangiectasias. In later stages of the disease, the face may swell and the nose may take on a bulb-like appearance called rhinophyma.

Description

Rosacea produces redness and flushing of the skin, as well as pustules and papules. Areas of the face, including the nose, cheeks, forehead, and chin, are the primary sites, but some people experience symptoms on their necks, backs, scalp, arms, and legs.

The similarity in appearance of rosacea to **acne** led people in the past to erroneously call the disease acne rosacea or adult acne. Like acne, the skin can have pimples and papules. Unlike acne, however, people with rosacea do not have blackheads.

In early stages of rosacea, people typically experience repeated episodes of flushing. Later, areas of the face are persistently red, telangiectasia appear on the nose and cheeks, as well as inflamed papules and pustules. Over time, the skin may take on a roughened, orange peel texture. Very late in the disorder, a small group of patients with rosacea will develop rhinophyma, which can give the nose a bulb-like look.

Up to one half of patients with rosacea may experience symptoms related to their eyes. Ocular rosacea, as it is called, frequently precedes the other manifestations on the skin. Most of these eye symptoms do not threaten sight, however. Telangiectasia may appear around the borders of the eyelid, the eyelids may be chronically inflamed, and small lumps called chalazions may develop. The cornea of the eye, the transparent covering over the lens, can also be affected, and in some cases vision will be affected.

Causes and symptoms

There is no known specific cause of rosacea. A history of redness and flushing precedes the disease in most patients. The consensus among many experts is that multiple factors may lead to an overreaction of the facial blood vessels, which triggers flushing. Over time, persistent episodes of redness and flushing leave the face continually inflamed. Pimples and blood-vessel changes follow.

Certain genetic factors may also come into play, although these have not been fully described. The disease is more common in women and light-skinned, fair-haired people. It may be more common in people of Celtic background, although this is an area of disagreement among experts.

Certain **antibiotics** are useful in the treatment of rosacea, leading some researchers to suspect a bacterium or other infectious agent may be the cause. One of the newest suspects is a bacterium called *Helicobacter pylori*, which has been implicated in causing many cases of stomach ulcers but the evidence here is mixed.

Other investigators have observed that a particular parasite, the mite *Demodex folliculorum*, can be found in areas of the skin affected by rosacea. The mite can also be detected, however, in the skin of people who do not have the disease. It is likely that the mite does not cause rosacea, but merely aggravates it.

Diagnosis

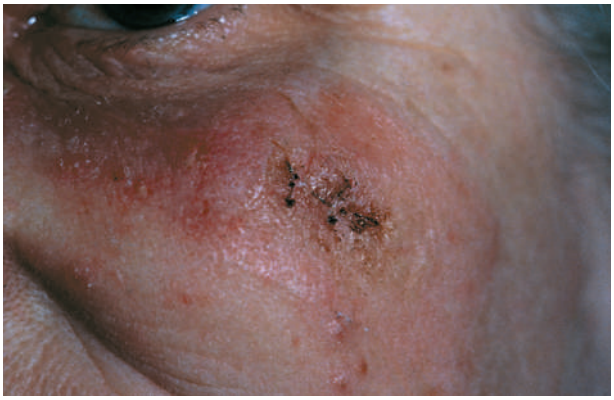
Diagnosis of rosacea is made by the presence of clinical symptoms. There is no specific test for the disease. Episodes of persistent flushing, redness (erythema) of the nose, cheeks, chin, and forehead, accompanied by pustules and papules are hallmarks of the disease. A dermatologist will attempt to rule out a number of other diseases that have similar symptoms. Acne vulgaris is perhaps the disorder most commonly mistaken for rosacea, but redness and spider-like veins are not observed in patients with acne. Blackheads and cysts, however, are seen in acne patients, but not in those with rosacea.

Other diseases that produce some of the same symptoms as rosacea include perioral **dermatitis** and **systemic lupus erythematosus**.

Treatment

The mainstay of treatment for rosacea is oral antibiotics. These appear to work by reducing inflammation in the small blood vessels and structure of the skin, not by destroying bacteria that are present. Among the more widely used oral antibiotics is tetracycline. In many patients, antibiotics are effective against the papules and pustules that can appear on the face, but they appear less effective against the background redness, and they have no effect on telangiectasia. Patients frequently take a relatively high dose of antibiotics until their symptoms are controlled, and then they slowly reduce their daily dose to a level that just keeps their symptoms in check. Other oral antibiotics used include erythromycin and minocycline.

Some patients are concerned about long-term use of oral antibiotics. For them, a topical agent applied directly to the face may be tried in addition to an oral antibiotic, or in its place. Topical antibiotics are also useful for controlling the papules and pustules of rosacea, but do not control the redness, flushing, and telangiectasias. The newest of these topical agents is metronidazole gel, which can be applied twice daily. Like the oral antibi-



Rosacea on a woman's cheek. *(Custom Medical Stock Photo. Reproduced by permission.)*

otics, topical preparations appear to work by reducing inflammation, not by killing bacteria.

Vitamin A derivatives, called retinoids, also appear useful in the treatment of rosacea. An oral retinoid, called isotretinoin, which is used in severe cases of acne also reduces the pustules and papules in severe cases of rosacea that do not respond to antibiotics. Isotretinoin must be taken with care, however, particularly in women of childbearing age. They must agree to a reliable form of **contraception**, because the drug is known to cause **birth defects**.

Topical vitamin A derivatives that are used in the treatment of acne also may have a role in the treatment of rosacea. Accumulating evidence suggests that topical isotretinoin and topical azelaic acid can reduce the redness and pimples. Some patients who use these medications experience skin irritation that tends to resolve with time.

For later stages of the disorder, a surgical procedure may be needed to improve the appearance of the skin. To remove the telangiectasias, a dermatologist may use an electrocautery device to apply a current to the blood vessel in order to destroy it. Special lasers, called tunable dye lasers, can also be adjusted to selectively destroy these tiny blood vessels.

A variety of surgical techniques can be used to improve the shape and appearance of a bulbous nose in the later stages of the disease. Surgeons may use a scalpel or laser to remove excess tissue from the nose and restore a more natural appearance.

Alternative treatment

Alternative treatments have not been extensively studied in rosacea. Some reports advocate gentle circular massage for several minutes daily to the nose, cheeks, and forehead. Scientifically controlled studies are lacking, however.

Many people are able to avoid outbreaks by reducing things that trigger flushing. Alcoholic beverages, hot beverages, and spicy foods are among the more common factors in the diet that can provoke flushing. Reducing or eliminating these items in the diet can help limit rosacea outbreaks in many people. Exposure to heat, cold, and sunlight are also known triggers of flushing. The specific things that provoke flushing vary considerably from person to person, however. It usually takes some trial and error to figure these out.

A deficiency in hydrochloric acid (HCl) in the stomach may be a cause of rosacea, and supplementation with HCl capsules may bring relief in some cases.

Prognosis

The prognosis for controlling symptoms of rosacea and improving the appearance of the face is good. Many people require life-long treatment and achieve good results. There is no known cure for the disorder.

Prevention

Rosacea cannot be prevented, but once correctly diagnosed, outbreaks can be treated and repeated episodes can be limited.

Use mild soaps

Avoiding anything that irritates the skin is a good preventive measure for people with rosacea. Mild soaps and cleansers are recommended. Astringents and alcohol should be avoided.

Learn what triggers flushing

Reducing factors in the diet and environment that cause flushing of the face is another good preventive strategy. Alcoholic and hot beverages, and spicy foods are among the more common triggers.

Use sunscreen

Limiting exposure of the face to excesses of heat and cold can also help. A sunscreen with a skin protection factor (SPF) of 15 or greater used daily can limit the damage to the skin and small blood vessels caused by the sun, and reduce outbreaks.

Resources

BOOKS

Bleicher, Paul A. "Rosacea." In *Manual of Clinical Problems in Dermatology*, ed. Susan M. Olbricht, et al. Boston: Little, Brown and Co.,1992.

KEY TERMS

Blackhead—A plug of fatty cells capped with a blackened mass.

Erythema—A diffuse red and inflamed area of the skin.

Papule—A small hard elevation of the skin.

Pustule—A small pus-filled elevation of the skin.

Retinoid—A synthetic vitamin A derivative used in the treatment of a variety of skin disorders.

Rhinophyma—Long-term swelling and overgrowth in skin tissue of the nose that leaves it with a knobby bulb-like look.

Telangiectasia—Small blood veins visible at the surface of the skin of the nose and cheeks.

Helm, Klaus F., and James G. Marks, Jr. *Atlas of Differential Diagnosis in Dermatology.* New York: Churchill Livingstone, 1998.

Macsai, Marian S., et al. "Acne Rosacea." In *Eye and Skin Disease*, ed. Mark J. Mannis, et al. Philadelphia: Lippincott-Raven, 1996.

PERIODICALS

Jansen, Thomas, and Gerd Plewig. "Rosacea: Classification and Treatment." *Journal of the Royal Society of Medicine* 90 (Mar. 1997): 144-150.

Thiboutot, Diane M. "Acne Rosacea." *American Family Physician* 50 (Dec. 1994): 1691-1697.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

National Rosacea Society. 800 S. Northwest Highway, Suite 200, Barrington, IL 60010. (888) 662-5874. <http://www.rosacea.org>.

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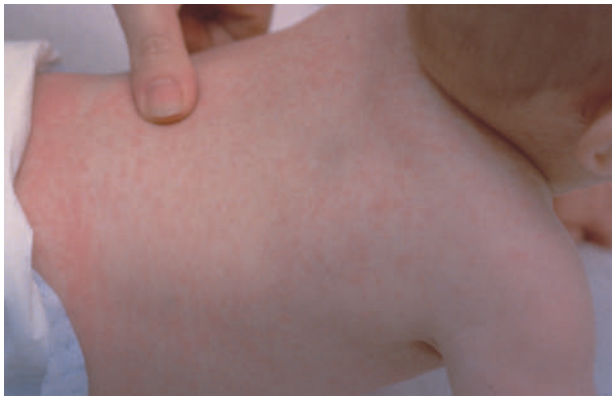
Rosary bead esophagus *see* **Diffuse esophageal spasm**

Roseola

Definition

Roseola is a common disease of babies or young children, in which several days of very high **fever** are followed by a rash.



Roseola rash on infant's back and shoulders. *(Custom Medical Stock Photo. Reproduced by permission.)*

Description

Roseola is an extraordinarily common infection, caused by a virus. About 90% of all children have been exposed to the virus, with about 33% actually demonstrating the syndrome of fever followed by rash.

The most common age for a child to contract roseola is between six and twelve months. Roseola infection strikes boys and girls equally. The infection may occur at any time of year, although late spring and early summer seem to be peak times for it.

Causes and symptoms

About 85% of the time, roseola is caused by a virus called Human Herpesvirus 6, or HHV-6. Although the virus is related to those herpesviruses known to cause sores on the lips or genitalia, HHV-6 causes a very different type of infection. HHV-6 is believed to be passed between people via infected saliva. A few other viruses (called enteroviruses) can produce a similar fever-then-rash illness, which is usually also called roseola.

Researchers believe that it takes about 5-15 days to develop illness after having been infected by HHV-6. Roseola strikes suddenly, when a previously-well child spikes an impressively high fever. The temperature may reach 106°F. As is always the case with sudden fever spikes, the extreme change in temperature may cause certain children to have seizures. About 5-35% of all children with roseola will have these "febrile seizures."

The most notable thing about this early phase of roseola is the absence of symptoms, other than the high fever. Although some children have a slightly reddened throat, or a slightly runny nose, most children have no symptoms whatsoever, other than the sudden development of high fever. This fever lasts for between three and five days.

KEY TERMS

Jaundice—The development of a yellowish tone to the skin and the whites of the eyes, caused by poor liver function.

Mononuclosis—An infection which causes swelling of lymph nodes, spleen, and liver, usually accompanied by extremely sore throat, fever, headache, and intense long-lasting fatigue.

Somewhere around the fifth day, a rash begins on the body. The rash is usually composed of flat pink patches or spots, although there may be some raised patches as well. The rash usually starts on the chest, back, and abdomen, and then spreads out to the arms and neck. It may or may not reach the legs and face. The rash lasts for about three days, then fades.

Very rarely, roseola will cause more serious disease. Patients so afflicted will experience significant swelling of the lymph nodes, the liver, and the spleen. The liver may become sufficiently inflamed to interfere with its functioning, resulting in a yellowish color to the whites of the eyes and the skin (**jaundice**). This syndrome (called a mononucleosis-like syndrome, after the disease called mononucleosis that causes many of the same symptoms) has occurred in both infants and adults.

Diagnosis

The diagnosis of roseola is often made by carefully examining the feverish child to make sure that other illnesses are not causing the temperature spike. Once it is clear that no **pneumonia**, ear infection, **strep throat**, or other common childhood illness is present, the practitioner usually feels comfortable waiting to see if the characteristic rash of roseola begins.

Treatment

There are no treatments available to stop the course of roseola. **Acetaminophen** or ibuprofen is usually given to try to lower the fever. Children who are susceptible to seizures may be given a sedative medication when the fever first spikes, in an attempt to prevent such a seizure.

Prognosis

Children recover quickly and completely from roseola. The only complications are those associated with seizures, or the rare mononucleosis-like syndrome.

Prevention

Other than the usual good hygiene practices always recommended to decrease the spread of viral illness, no methods are available to specifically prevent roseola.

Resources

BOOKS

Kohl, Steve. "Human Herpesvirus 6." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

Rosalyn Carson-DeWitt, MD

Roseola infantum *see* **Roseola**

Rotator cuff injury

Definition

A rotator cuff injury is a tear or inflammation of the rotator cuff tendons in the shoulder.

Description

Rotator cuff injury is known by several names, including pitcher's shoulder, swimmer's shoulder, and tennis shoulder. As these names imply, the injury occurs most frequently in athletes practicing sports that require the arm to be moved over the head repeatedly, such as pitching, swimming, tennis, and weight lifting. Rotator cuff tendonitis is an inflammation of the shoulder tendons while a rotator cuff tear is a ripping of one or more of the tendons.

The tendons of four muscles make up the rotator cuff. The muscles are the supraspinatus, infraspinatus, teres minor, and subscapularis. The tendons attach the muscles to four shoulder bones: the shoulder blade (scapula), the upper arm bone (humerus), and the collarbone (clavicles.) The rotator cuff tendons can also degenerate due to age, usually starting around age 40. Rotator cuff injury may also be caused by falling on the outstretched arm or joint of the elbow. Either of these may produce enough force to drive the humerus into the shoulder socket.

Causes and symptoms

Some areas of the rotator cuff tendons have poor blood supply. Thus, the tissue is very slow to heal and

maintain itself during normal use. Tearing and inflammation in athletes is usually due to hard and repetitive use, especially in baseball pitchers. In non-athletes over age 40, the injuries usually occur as a result of lifting heavy objects. The two primary symptoms are **pain** and weakness in the shoulder or arm, especially with arm movement or at night. A partial tear may cause pain but still allow normal arm movement. A complete tear usually leaves the injured person unable to raise the arm away from the side.

Diagnosis

Diagnosis is usually made after a **physical examination**, often by a sports medicine physician. X rays are also sometimes used in diagnosis as well as an arthrogram. However, the arthrogram is an invasive procedure and may be painful afterwards. For this reason, **magnetic resonance imaging** (MRI) is preferred to determine tendon tears as it also show greater detail than the arthrogram.

Treatment

The primary treatment is resting the shoulder and, for minor tears and inflammation, applying ice packs. Anti-inflammatory medications may also be prescribed. As soon as pain decreases, physical therapy is usually started to help regain normal motion. If pain persists after several weeks, the physician may inject cortisone into the affected area.

Serious tears to the rotator cuff tendons usually require surgery to repair. An instrument called an arthroscope is used to view the shoulder joint and confirm the presence of a tear. The arthroscope can also be used to remove any bone spurs that may be present in the shoulder area. Current arthroscopic procedures usually involve a 2-in (5.1cm) incision in the outer shoulder. Through this incision the torn rotator edge may be reattached to the humerus with stitches.

Alternative treatment

There are no effective alternative medicine treatments for rotator cuff injuries.

Prognosis

The prognosis for recovery from minor rotator cuff injuries is excellent. For serious injuries, the prognosis is usually good, some six weeks of physical therapy being required following surgery. Full recovery may take several more months. In some cases, the injury is so severe that it requires tendon grafts and muscle transfers. In rare cases, a severe injury is not repairable, usually because the tendon has been torn for too long a time.

KEY TERMS

Arthrogram—A test done by injecting dye into the shoulder joint and then taking x rays. Areas where the dye leaks out indicate a tear in the tendons.

Arthroscope—An instrument for the visual examination of the interior of a joint.

Arthroscopy—Examination of a joint with an arthroscope or joint surgery using an arthroscope.

Cortisone—A hormone produced naturally by the adrenal glands or made synthetically.

Magnetic resonance imaging (MRI) scan—A special radiological test that uses magnetic waves to create pictures of an area, including bones, muscles, and tendons.

Spur—Any projection from a bone.

Prevention

The best prevention is to avoid repetitive overhead arm movements and to develop shoulder strength.

Resources

PERIODICALS

Fongemie, Allen E., et al. "Management of Shoulder Impingement Syndrome and Rotator Cuff Tears." *American Family Physician* (15 Feb. 1998): 667-678.

Hersch, Jonathan C. "Arthroscopically Assisted Mini-Open Rotator Cuff Repairs." *The American Journal of Sports Medicine* (May 2000): 301.

Huie, Gordon, and Peter D. McCann. "The Shoulder Exam and Diagnosing Rotator Cuff Injuries." *Physician Assistant* (Apr. 1999): 53.

Murrell, George A. C., and Judie R. Walton. "Diagnosis of Rotator Cuff Tears." *The Lancet* (10 Mar. 2001): 769.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 N. River Road, Rosemont, IL 60018. (847) 823-7186. <http://www.aaos.org.>.

American Orthopaedic Society for Sports Medicine. 6300 N. River Road, Ste. 200, Rosemont, IL 60018. (847) 292-4900. <http://www.sportsmed.org.>.

OTHER

Collins, David. "Rotator Cuff Repair: A Guide for Patients." Health Information Network, 1997.

Iannotti, Joseph P. "The Rotator Cuff: Current Concepts and Complex Problems." Rosemont, IL: American Academy of Orthopaedic Surgeons, 1998.

WebMD. <http://www.my.webmd.com>.

Ken R., Wells

Rotavirus infections

Definition

Rotavirus is the major cause of **diarrhea** and vomiting in young children worldwide. The infection is highly contagious and may lead to severe **dehydration** (loss of body fluids) and even death. In the United States, more than 50,000 children are hospitalized and up to 125 die each year as a result of rotavirus infection.

Description

Gastroenteritis, or inflammation of the stomach and the intestine, is the second most common illness in the United States, after the **common cold**. More than one-third of such cases are caused by viruses. Many different viruses can cause gastroenteritis, but the most common ones are the rotavirus and the Norwalk virus.

The name rotavirus comes from the Latin word "rota" for wheel and is given because the viruses have a distinct wheel-like shape. Rotavirus infection is also known as infantile diarrhea, or winter diarrhea, because it mainly targets infants and young children. The outbreaks are usually in the cooler months of winter.

The virus is classified into different groups (Group A through group G), depending on the type of protein marker (antigen) that is present on its surface. The diarrheal infection of children is caused by the Group A rotaviruses. Group B rotaviruses have caused major epidemics of adult diarrhea in China. Group C rotavirus has been associated with rare cases of diarrheal outbreaks in Japan and England. Groups D through G have not been detected in humans.

Causes and symptoms

The main symptoms of the rotavirus infection are **fever**, stomach cramps, vomiting, and diarrhea (this could lead to severe dehydration). The symptoms last anywhere from four to six days. If a child has dry lips and tongue, dry skin, sunken eyes, and wets fewer than six diapers a day, it is a sign of dehydration and a physician needs to be notified. Because of the excellence of healthcare in this country, rotavirus is rarely fatal to American children. However, it causes deaths of up to a million children in the third world countries, every year.

The virus is usually spread by the "fecal-oral route." In other words, a child can catch a rotavirus infection if she puts her finger in her mouth after touching toys or things that have been contaminated by the stool of another infected child. This usually happens when children do not wash their hands after using the toilet, or before eating food.

The viruses can also spread by way of contaminated food and drinking water. Infected food handlers who prepare salads, sandwiches, and other foods that require no cooking can spread the disease. Generally, symptoms appear within 4–48 hours after exposure to the contaminated food or water.

Children between the ages of six months and two years, especially in a daycare setting, are the most susceptible to this infection. Breastfed babies may be less likely to become infected, because breast milk contains antibodies (proteins produced by the white blood cells of the immune system) that fight the illness. Nearly every child by the age of four has been infected by this virus, and has rotavirus antibodies in their body. The disease also targets the elderly and people who have weak immune systems.

Children who have been infected once can be infected again. However, second infections are less severe than the first infections. By the time a child has had two infections, the chances of subsequent severe infection is remote.

Diagnosis

The rotavirus infection is diagnosed by identifying the virus in the patient's stool. This is done using electron microscopy. Immunological tests such as ELISA (Enzyme-linked immunosorbent assay) are also widely used for diagnosis, and several commercial kits are available.

Treatment

"Oral rehydration therapy," or drinking enough fluids to replace those lost through bowel movements and vomiting, is the primary aim of the treatment. Electrolyte and fluid replacement solutions are available over the counter in food and drug stores. Dehydration is one of the greatest dangers for infants and young children. If the diarrhea becomes severe, it may be necessary to hospitalize the patient so that fluids can be administered intravenously.

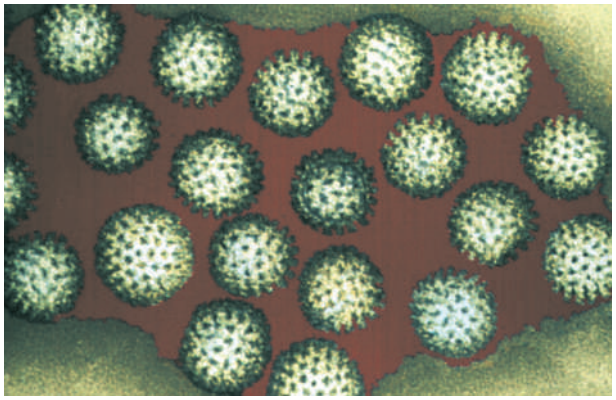
Anti-diarrheal medication should not be given to children unless directed to do so by the physician. Antibiotic therapy is not useful in viral illness. Specific drugs for the virus are not available.

Prognosis

Most of the infections resolve spontaneously. Dehydration due to severe diarrhea is one of the major complications.

Prevention

The best way to prevent the disease is by proper food handling and thorough hand washing, after using the toilet and whenever hands are soiled. In child care centers and hospital settings, the staff should be educated



Rotaviruses are probably the most common viruses to infect humans and animals. These viruses are associated with gastroenteritis and diarrhea in humans and other animals. *(Photograph by Dr. Linda Stannard, Photo Researchers, Inc. Reproduced by permission.)*

about personal and environmental hygiene. All dirty diapers should be regarded as infectious and disposed of in a sanitary manner.

Vaccines that prevent rotavirus in young children have been tested in nationwide trials. Researchers report that the vaccines appear to prevent the infection in 80% of the tested children. The vaccine is intended to be given orally (by mouth) at two, four, and six months of age. The only side effect of the vaccine is a low-grade fever in a small percentage of the children, three to four days after the **vaccination**. Within the next few years, a rotavirus vaccine may become part of every child's immunization schedule.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Merck Manual of Diagnosis and Therapy. Ed. Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1992.

Zinsser, Hans. *Zinsser Microbiology.* 19th ed. Ed. Wolfgang K. Joklik, et al. Stamford: Appleton Lange, 1988.

Lata Cherath, PhD

Roundworm infections

Definition

Roundworm infections are diseases of the digestive tract and other organ systems caused by nematodes. Nematodes are parasitic worms with long, cylindrical bodies.

Description

Roundworm infections are widespread throughout the world, with some regional differences. Ascariasis and trichuriasis are more common in warm, moist climates where people use human or animal feces for fertilizer. Anisakiasis is most common in countries where raw or pickled fish or squid is a popular food item.

Causes and symptoms

The causes and symptoms of roundworm infection vary according to the species. Humans acquire most types of roundworm infection from contaminated food or by touching the mouth with unwashed hands.

Anisakiasis

Anisakiasis is caused by anisakid roundworms. Humans are not the primary host for these parasites. Anisakid roundworms infest whales, seals, and dolphins; crabs then ingest roundworm eggs from the feces of these animals. In the crabs, the eggs hatch into larvae that can infect fish. The larvae enter the muscles of marine animals further up the food chain, including squid, mackerel, herring, cod, salmon, tuna, and halibut. Humans become accidental hosts when they eat raw or undercooked fish containing anisakid larvae. The larvae attach themselves to the tissues lining the stomach and intestine, and eventually die inside the inflamed tissue.

In humans, anisakiasis can produce a severe syndrome that affects the stomach and intestines, or a mild chronic disease that may last for weeks or years. In acute anisakiasis, symptoms begin within one to seven hours after the patient eats infected seafood. Patients are often violently sick, with nausea, vomiting, **diarrhea**, and severe abdominal **pain** that may resemble **appendicitis**. In chronic anisakiasis, the patient has milder forms of stomach or intestinal irritation that resemble stomach ulcers or **irritable bowel syndrome**. In some cases, the acute form of the disease is followed by chronic infestation.

Ascariasis

Ascariasis, which is caused by *Ascaris lumbricoides*, is one of the most widespread parasitic infections in humans, affecting over 1.3 billion people worldwide. Ascarid roundworms cause a larger burden on the human host than any other parasite; adult worms can grow as long as 12 or 14 inches, and release 200,000 eggs per day. The eggs infect people who eat unwashed vegetables from contaminated soil or touch their mouths with unwashed hands. Once inside the digestive tract, the eggs release larvae that penetrate the intestinal wall and migrate to the lungs through the liver and the blood-

stream. After about 10 days in the lungs, the larvae migrate further into the patient's upper lung passages and airway, where they are swallowed. When they return to the intestine, they mature into adults and reproduce. The time period from the beginning of the infection to egg production is 60–75 days.

The first symptoms of infection may occur when the larvae reach the lungs. The patient may develop chest pain, coughing, difficulty breathing, and inflammation of the lungs. In some cases, the patient's sputum is streaked with blood. This phase of the disease is sometimes called Loeffler's syndrome. It is marked by an accumulation of parasites in the lung tissue and by eosinophilia (an abnormal increase in the number of a specific type of white blood cell). The intestinal phase of ascariasis is marked by stomach pain, cramping, nausea, and intestinal blockage in severe cases.

Toxocariasis

Toxocariasis is sometimes called visceral larva migrans (VLM) because the larval form of the organism hatches inside the intestines and migrates throughout the body to other organs (viscera). The disease is caused by *Toxocara canis* and *T. cati*, which live within the intestines of dogs and cats. Most human patients are children between the ages of two and four years, who become infected after playing in sandboxes or soil contaminated by pet feces, although adults are also susceptible. The eggs can survive in soil for as long as seven years.

The organism's eggs hatch inside the human intestine and release larvae that are carried in the bloodstream to all parts of the body, including the eyes, liver, lungs, heart, and brain. The patient usually has a **fever**, with coughing or **wheezing** and a swollen liver. Some patients develop skin **rashes** and inflammation of the lungs. The larvae may survive inside the body for months, producing allergic reactions and small granulomas, which are tissue swellings or growths produced in response to inflammation. Infection of the eye can produce ocular larva migrans (OLM), which is the first symptom of toxocariasis in some patients.

Trichuriasis

Trichuriasis, caused by *Trichuris trichiura*, is sometimes called whipworm because the organism has a long, slender, whiplike front end. The adult worm is slightly less than an inch long. Trichuriasis is most common in warm, humid climates, including the southeastern United States. The number of people with trichuriasis may be as high as 800 million worldwide.

Whipworm larvae hatch from swallowed eggs in the small intestine and move on to the upper part of the large intestine, where they attach themselves to the lining. The adult worms produce eggs that are passed in the feces and mature in the soil. Patients with mild infections may have few or no symptoms. In cases of heavy infestation, the patient may have abdominal cramps and other symptoms resembling amebic dysentery. In children, severe trichuriasis may cause anemia and developmental retardation.

Diagnosis

Since the first symptoms of roundworm infection are common to a number of illnesses, a doctor is most likely to consider the possibility of a parasitic disease on the basis of the patient's history—especially in children. The definite diagnosis is based on the results of stool or tissue tests. In trichuriasis, adult worms may also be visible in the lining of the patient's rectum. In ascariasis, adult worms may appear in the patient's feces or vomit; they can also be detected by x ray and ultrasound. In toxocariasis, larvae are sometimes found in tissue samples taken from a granuloma. If a patient with toxocariasis develops OLM, it is important to obtain a granuloma sample in order to distinguish between OLM and **retinoblastoma** (a type of eye tumor).

Anisakiasis is one of two roundworm infections that cannot be diagnosed from stool specimens. Instead, the diagnosis is made by x rays of the patient's stomach and small intestine. The larvae may appear as small threads when double contrast x rays are used. In acute cases, the doctor may use an endoscope (an instrument for examining the interior of a body cavity) to look for or remove larvae.

Blood tests cannot be used to differentiate among different types of roundworm infections, but the presence of eosinophilia can help to confirm the diagnosis.

Patients with trichuriasis or ascariasis should be examined for signs of infection by other roundworm species; many patients are infected by several parasites at the same time.

Treatment

Trichuriasis, ascariasis, and toxocariasis are treated with anthelminthic medications. These are drugs that destroy roundworms either by paralyzing them or by blocking them from feeding. Anthelminthic drugs include pyrantel pamoate, piperazine, albendazole, and mebendazole. Mebendazole cannot be given to pregnant women because it may harm the fetus. Treatment with anthelminthic drugs does not prevent reinfection.

There is no drug treatment for anisakiasis; however, symptoms usually resolve in one to two weeks when the larvae die. In some cases, the larvae are removed with an endoscope or by surgery.

Patients with an intestinal obstruction caused by ascariasis may be given **nasogastric suction**, followed by anthelminthic drugs, in order to avoid surgery. If suction fails, the worms must be removed surgically to prevent intestinal rupture or blockage.

Prognosis

The prognosis for recovery from roundworm infections is good for most patients. The severity of infection, however, varies considerably from person to person. Children are more likely to have heavy infestations and are also more likely to suffer from malabsorption and **malnutrition** than adults.

Ascariasis is the only roundworm infection with a significant mortality rate. *A. lumbricoides* grows large enough to perforate the bile or pancreatic ducts; in addition, a mass of worms in the digestive tract can cause rupture or blockage of the intestines. It is estimated that 20,000 children die every year from intestinal ascariasis.

Prevention

There are no effective vaccines against any of the soil-transmitted roundworms, nor does infection confer immunity. Prevention of infection or reinfection requires adequate hygiene and sanitation measures, including regular and careful handwashing before eating or touching the mouth with the hands.

With respect to specific infections, anisakiasis can be prevented by avoiding raw or improperly prepared fish or squid. Trichuriasis, ascariasis, and toxocariasis can be prevented by keeping children from playing in soil contaminated by human or animal feces; by teaching children to wash their hands before eating; and by having pets dewormed regularly by a veterinarian.

Resources

BOOKS

Goldsmith, Robert S. "Infectious Diseases: Protozoal & Helminthic." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Gumprecht, Jeffrey P., and Murray Wittner. "Other Intestinal Parasites." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Infectious Disease: Parasitic Infections." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Kennedy, Malcolm W. "Ascariasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

"Mebendazole." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

KEY TERMS

Eosinophilia—An abnormal increase in the number of a specific type of white blood cell. Eosinophilia is a characteristic of all types of roundworm infections.

Granuloma—A tissue swelling produced in response to inflammation. Granulomas are important in diagnosing toxocariasis.

Loeffler's syndrome—The respiratory phase of ascariasis, marked by inflammation of the lungs and eosinophilia.

Nematode—A parasitic roundworm with a long, cylindrical body.

Ocular larva migrans (OLM)—A syndrome associated with toxocariasis, in which the eye is invaded by migrating larvae.

Visceral larva migrans (VLM)—Another name for toxocariasis. The name is derived from the life cycle of the organism.

Whipworm—Another name for trichuriasis. The name comes from the organism's long whiplike front end.

Phillips, Elizabeth, and Jay S. Keystone. "Intestinal Parasites." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Piperazine." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

"Pyrantel pamoate." In *Nurses Drug Guide 1995*, ed. Billie Ann Wilson, et al. Norwalk, CT: Appleton & Lange, 1995.

"Toxocariasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Wakelin, Derek. "Trichuriasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Weinberg, Adriana, and Myron J. Levin. "Infections: Parasitic & Mycotic." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey

Routine urinalysis *see* **Urinalysis**

RSV *see* **Respiratory syncytial virus infection**

RTA *see* **Renal tubular acidosis**

RU-486 *see* **Mifepristone**

Rubella

Definition

Rubella is a highly contagious viral disease, spread through contact with discharges from the nose and throat of an infected person. Although rubella causes only mild symptoms of low **fever**, swollen glands, joint **pain**, and a fine red rash in most children and adults, it can have severe complications for women in their first trimester of **pregnancy**. These complications include severe **birth defects** or **death** of the fetus.

Description

Rubella is also called German **measles** or three-day measles. This disease was once a common childhood illness, but its occurrence has been drastically reduced since vaccine against rubella became available in 1969. In the 20 years following the introduction of the vaccine, reported rubella cases dropped 99.6%. Only 229 cases of rubella were reported in the United States in 1996.

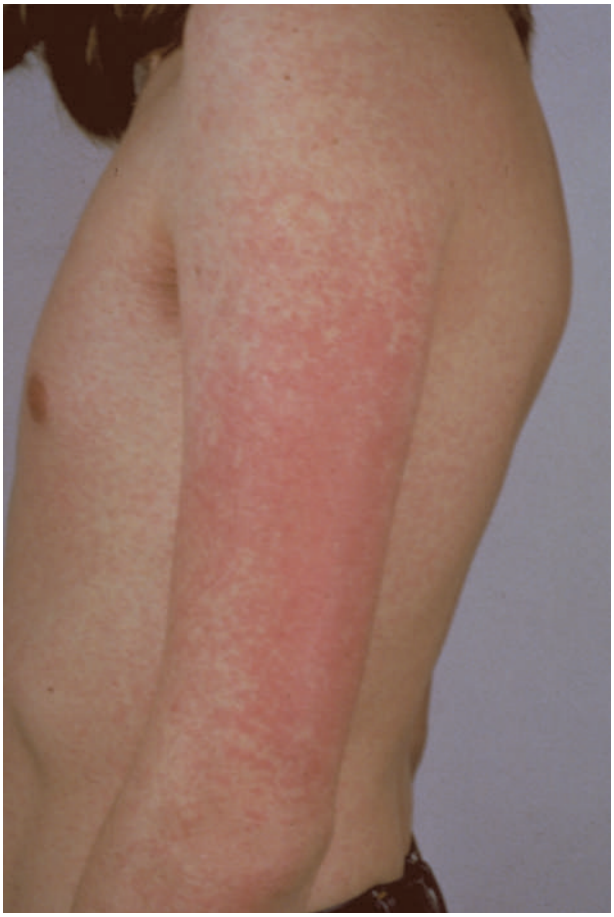
Rubella is spread through contact with fluid droplets expelled from the nose or throat of an infected person. A person infected with the rubella virus is contagious for about seven days before any symptoms appear and continues to be able to spread the disease for about four days after the appearance of symptoms. Rubella has an incubation period of 12–23 days.

Although rubella is generally considered a childhood illness, people of any age who have not been vaccinated or previously caught the disease can become infected. Having rubella once or being immunized against rubella normally gives lifetime immunity. This is why **vaccination** is so effective in reducing the number of rubella cases.

Women of childbearing age who do not have immunity against rubella should be the most concerned about getting the disease. Rubella infection during the first three months of pregnancy can cause a woman to miscarry or cause her baby to be born with birth defects. Although it has been practically eradicated in the United States, rubella is still common in less developed countries because of poor immunization penetration, creating a risk to susceptible travelers. Some countries have chosen to target rubella vaccination to females only and outbreaks in foreign-born males have occurred on cruise ships and at U.S. summer camps.

Causes and symptoms

Rubella is caused by the rubella virus (*Rubivirus*). Symptoms are generally mild, and complications are rare in anyone who is not pregnant.



A red rash is one characteristic of rubella, or German measles, as seen on this man's arm. *(Custom Medical Stock Photo. Reproduced by permission.)*

The first visible sign of rubella is a fine red rash that begins on the face and rapidly moves downward to cover the whole body within 24 hours. The rash lasts about three days, which is why rubella is sometimes called the three-day measles. A low fever and swollen glands, especially in the head (around the ears) and neck, often accompany the rash. Joint pain and sometimes joint swelling can occur, more often in women. It is quite common to get rubella and not show any symptoms (subclinical infection).

Symptoms disappear within three to four days, except for joint pain, which may linger for a week or two. Most people recover fully with no complications. However, severe complications may arise in the unborn children of women who get rubella during the first three months of their pregnancy. These babies may be miscarried or stillborn. A high percentage are born with birth defects. Birth defects are reported to occur in 50% of women who contract the disease during the first month of pregnancy, 20% of those who contract it in the second month, and 10% of those who contract it in the third month.

The most common birth defects resulting from congenital rubella infection are eye defects such as **cataracts**, **glaucoma**, and blindness; deafness; congenital heart defects; and **mental retardation**. Taken together, these conditions are called congenital rubella syndrome (CRS). The risk of birth defects drops after the first trimester, and by the 20th week, there are rarely any complications.

Diagnosis

The rash caused by the rubella virus and the accompanying symptoms are so similar to other viral infections that it is impossible for a physician to make a confirmed diagnosis on visual examination alone. The only sure way to confirm a case of rubella is by isolating the virus with a blood test or in a laboratory culture.

A blood test is done to check for rubella antibodies. When the body is infected with the rubella virus, it produces both immunoglobulin G (IgG) and immunoglobulin M (IgM) antibodies to fight the infection. Once IgG exists, it persists for a lifetime, but the special IgM antibody usually wanes over six months. A blood test can be used either to confirm a recent infection (IgG and IgM) or determine whether a person has immunity to rubella (IgG only). The lack of antibodies indicates that a person is susceptible to rubella.

All pregnant women should be tested for rubella early in pregnancy, whether or not they have a history of vaccination. If the woman lacks immunity, she is counseled to avoid anyone with the disease and to be vaccinated after giving birth.

Treatment

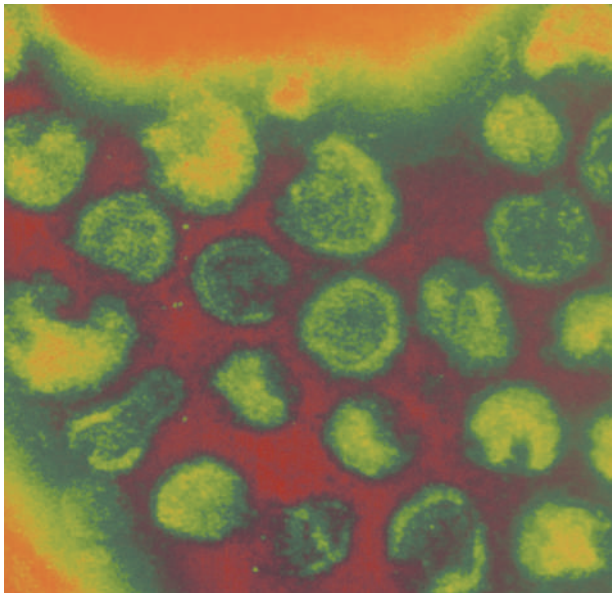
There is no drug treatment for rubella. Bed rest, fluids, and **acetaminophen** for pain and temperatures over 102°F (38.9°C) are usually all that is necessary.

Babies born with suspected CRS are isolated and cared for only by people who are sure they are immune to rubella. Congenital heart defects are treated with surgery.

Alternative treatment

Rather than vaccinating a healthy child against rubella, many alternative practitioners recommend allowing the child to contract the disease naturally at the age of five or six years, since the immunity conferred by contracting the disease naturally lasts a lifetime. It is, however, difficult for a child to contract rubella naturally when everyone around him or her has been vaccinated.

Ayurvedic practitioners recommend making the patient comfortable and giving the patient ginger or clove tea to hasten the progress of the disease. **Traditional Chinese medicine** uses a similar approach. Believing that inducing the skin rash associated with rubella hastens the progress of the disease, traditional Chinese practitioners prescribe herbs such as peppermint (*Mentha piperita*) and *chai-hu* (*Bupleurum chinense*). Cicada is often prescribed as well. Western herbal remedies may be used to alleviate rubella symptoms. Distilled witch hazel (*Hamamelis virginiana*) helps calm the **itching** associated with the skin rash and an eyewash made from a filtered diffusion of eyebright (*Euphrasia officinalis*) can relieve eye discomfort. Antiviral western herbal or Chinese remedies can be used to assist the immune system in establishing equilibrium during the healing process. Depending on the patient's symptoms, among the remedies a homeopath may prescribe are *Belladonna,Pulsatilla,* or *Phytolacca*.



A digitized image of rubella virus particles. *(Custom Medical Stock Photo. Reproduced by permission.)*

Prognosis

Complications from rubella infection are rare in children, pregnant women past the 20th week of pregnancy, and other adults. For women in the first trimester of pregnancy, there is a high likelihood of the child being born with one or more birth defect. Unborn children exposed to rubella early in pregnancy are also more likely to be miscarried, stillborn, or have a low birthweight. Although the symptoms of rubella pass quickly for the mother, the consequences to the unborn child can last a lifetime.

Prevention

Vaccination is the best way to prevent rubella and is normally required by law for children entering school.

KEY TERMS

Incubation period—The time it takes for a person to become sick after being exposed to a disease.

Trimester—The first third or 13 weeks of pregnancy.

Rubella vaccine is usually given in conjunction with measles and **mumps** vaccines in a shot referred to as MMR (mumps, measles, and rubella). Children receive one dose of MMR vaccine at 12-15 months and another dose at four to six years.

Pregnant women should not be vaccinated, and women who are not pregnant should avoid conceiving for at least three months following vaccination. To date, however, accidental rubella vaccinations during pregnancy have not clearly been associated with the same risk as the natural infection itself. Women may be vaccinated while they are breastfeeding. People whose immune systems are compromised, either by the use of drugs such as steroids or by disease, should discuss possible complications with their doctor before being vaccinated.

Resources

BOOKS

Cooper, Louis Z. "Rubella." In *Rudolph's Pediatric*, ed. Abraham M. Rudolph, et al. Stamford: Appleton & Lange, 1996.

Gershon, Anne. "Rubella (German Measles)." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

"Case Definitions for Infectious Conditions under Public Health Surveillance." *Morbidity and Mortality Weekly Report* 46 (1997): 30.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (914) 428-7100. <http://www.modimes.org>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Tish Davidson

Rubella test

Definition

The **rubella** test is a routine blood test performed as part of prenatal care of pregnant women. It is sometimes also used to screen women of childbearing age before the first **pregnancy**.

Purpose

The test is given to evaluate whether a woman is immune to rubella (German **measles**) as a result of childhood exposure or immunization, or whether she may be presently infected with the disease. The question of a current infection is particularly urgent for pregnant women. Although the disease itself is not serious in adults, it can cause **miscarriage**, **stillbirth**, or damage to the fetus during the first trimester (three months) of pregnancy. The rubella test is regarded as a more reliable indication of the patient's immune status than her history, because reinfection with rubella is possible even after immunization. The results of the test may influence decisions to terminate a pregnancy.

Description

The rubella test belongs to a category of blood tests called hemagglutination inhibition (HI) tests. Hemagglutination refers to the clumping or clustering of red blood cells caused by a disease antibody, virus, or certain other substances. Inhibition refers to interference with the clumping process. The presence of rubella antibodies inhibits the cell clumping caused by the rubella virus. Thus, the addition of the virus to a sample of the patient's blood allows a doctor to determine the presence and concentration of rubella antibodies and the patient's immunity to the disease.

When a person is infected with the rubella virus, the body produces both immunoglobulin G (IgG) and immunoglobulin M (IgM) antibodies to fight the infection. Once IgG exists, it persists for a lifetime, but the special IgM antibody usually wanes over six months. The rubella test can either confirm that a recent infection has occurred (both IgG and IgM are present) or that a patient has immunity to rubella (IgG only is present).

When the test is performed to confirm the diagnosis of rubella in a woman already pregnant, two blood samples are drawn. One is drawn during the acute phase of the illness about three days after the rash breaks out, and the second is drawn during the convalescent phase about three weeks later. The specimens are then tested simultaneously by a single laboratory. Alternatively, a pregnant woman with a rash suspected to be rubella can be tested for IgM antibody. If the test shows that IgM antibody is present, then a recent rubella infection has occurred.

Normal results

If the patient has been successfully immunized against rubella or has had the disease, the HI antibody

KEY TERMS

Antibody—A protein molecule produced by the immune system that is specific to a virus, such as the rubella virus. The antibody combines with the virus and disables it.

Hemagglutination—The clumping or clustering of red blood cells caused by certain viruses, antibodies, or other substances.

Inhibition—Restraint of or interference with a biological process, such as the clumping of blood cells.

Titer—The concentration of a substance in a given sample of blood or other tissue fluid.

titer (concentration) will be greater than 1:10-1:20. The red blood cells will fail to clump when the rubella virus is added to the blood serum.

In the case of paired testing for pregnant women, a fourfold rise in antibody titer between the first and second blood samples indicates the suspicious rash was caused by rubella. The alternative test for IgM antibody confirms recent rubella infection if IgM is found in the patient's blood.

Abnormal results

If the patient has little or no immunity to rubella, her HI antibody titer will be 1:8 or less. Women without immunity should receive immunization against rubella provided that they avoid pregnancy for a period of three months following immunization. Women with disease of the immune system or who are taking corticosteroid medications should receive immune serum globulin rather than rubella vaccine to prevent infection.

Resources

BOOKS

Levin, Myron J. "Infections: Viral and Rickettsial." In *Current Pediatric Diagnosis and Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Stanberry, Lawrence R., and Shirley A. Floyd-Reising. "Rubella and Congenital Rubella." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Rebecca J. Frey

Rubeola *see* **Measles**

Ruptured disk *see* **Herniated disk**

RVT *see* **Renal vein thrombosis**

S

Sacroiliac disease

Definition

Sacroiliac disease is high-impact trauma to the sacroiliac joint that can cause death or bone and nerve damage.

Description

The sacroiliac joint is a strong, weight bearing synovial joint between the ilium and sacrum bones of the pelvis. The bones are held in place and allowed limited movements by a system of sacroiliac ligaments. Relaxation of this and other joints and ligaments is important during **pregnancy** and is accomplished by a special hormone called relaxin. Usually the sacroiliac is damaged by high-impact injuries. These injuries may be life threatening and mortality is approximately 20% if neighboring structures are also damaged. Injuries to this area often includes neurological deficits. Dislocation and nerve damage are frequently missed in the diagnosis.

Causes and symptoms

The primary cause of dislocations, **fractures**, and accompanying damage is usually a traumatic accident. Patients receiving such injuries require emergency medical attention. There may be severe blood loss due to breakage of large bones and resuscitative measures may be required for stabilization.

Diagnosis

The diagnosis can be difficult since nerve damage can mimic other conditions with similar symptoms (i.e., **low back pain** in persons with **sciatica**). Additionally imaging studies and **physical examination** maneuvers will miss the diagnosis. The definitive method for diagnosing sacroiliac pathology would be injection of local anesthetic in the correct area of the affected sacroiliac joint. This procedure is usually performed using advance guidance systems (CT or fluoroscopic assisted guidance). If the **pain** is relieved by anesthetic injection, then the diagnosis is confirmed. There are three typical patterns of pain: pain directly over the joint, pain in the groin extending down the affected leg that can mimic the signs associated with a herniated lumbar disc, and pain widely dispersed in the affected leg.

KEY TERMS

Herniated disk—A protrusion in a disk located in the spinal column.

Ligament—Fibrous tissue which connect bones.

Synovial joint—A joint that allows for bone movement.

Treatment

Treatment initially can include emergency interventions, but usually is conservative. Treatment includes physical therapy, manipulation, and medications for pain control. In some cases a sacroiliac belt can help with symptoms. In sacroiliac joint disease that has already progressed and is chronic and severe, corrective joint fusion may be indicated.

Prognosis

Outcome is variable and takes into account the extent of injuries, early diagnosis, and responsiveness to conservative treatment.

Prevention

There is no known prevention since the disease is secondary to an accident.

Resources

BOOKS

Canale, S., Terry, et al. *Campbell's Operative Orthopaedics.* 9th ed. Mosby, Inc., 1998.

Goetz, Christopher G., et al, eds. *Textbook of Clinical Neurology.* 1st ed. W. B. Saunders Company, 1999.

Ruddy, Shaun, et al, eds. *Kelly's Textbook of Rheumatology.* 6th ed. W. B. Saunders Company, 2001.

Rockwood, Charles A., and Green, David P. et al. *Fractures in Adults.* 4th ed. Lippincott-Raven Publishers, 1996.

OTHER

American Academy of Orthopaedic Surgeons. <http://www.aaos.org>.

Laith Farid Gulli, M.D.

SAD *see* **Seasonal affective disorder**

KEY TERMS

Hypertrophy—Overgrowth of tissue not due to a tumor.

Parotid Gland—The salivary gland below and in front of each ear.

Radiopharmaceutical—A radioactive pharmaceutical or chemical (usually radioactive iodine or cobalt) used for diagnostic or therapeutic purposes.

Sjogren's Syndrome—A disease, often associated with rheumatoid arthritis, that causes dry mouth, lesions on the skin, and enlargement of the parotid glands. It is often seen in menopausal women.

Warthin's Tumor—A benign tumor of the parotid gland.

Salivary gland scan

Definition

A salivary gland scan is a nuclear medicine test that examines the uptake and secretion in the salivary glands of a radioactively labeled marker substance. The pattern of uptake and secretion shows if these glands are functioning normally.

Purpose

A salivary gland scan is done to help diagnose the cause of **dry mouth**. It is a test that is done when Sjogren's syndrome, salivary duct obstruction, asymmetric hypertrophy, or growths such as Warthin's tumors are suspected.

Precautions

Salivary gland scans are a safe, effective way to diagnose problems associated with dry mouth. The level of radioactivity in the marker substance is low and poses no threat. The only people who should not undergo this test are pregnant women.

Other recent nuclear medicine tests may affect the results of this scan. It may be necessary to wait until earlier radiopharmaceuticals have been cleared from the body before undergoing this scan.

Description

Salivary gland scan, also called parotid gland scan, is a non-invasive test. The patient is positioned under a gamma scintillation camera that detects radiation. The patient then is injected with a low level radioactive marker, usually technetium-99m.

Immediately after the injection, imaging begins. For accurate results, the patient must stay still during imaging. After several images, the patient is given lemon drop candies to suck on, which stimulate the salivary glands. Another set of images is made for comparison purposes. The entire process takes about ten minutes for the injection and 30-45 minutes for the scan.

Preparation

No special preparations are needed for this test. It is not necessary to fast or to restrict medications before testing. Any blood that needs to be drawn for other tests should be taken before the radiopharmaceutical is injected.

Aftercare

Patients can return to normal activities immediately.

Risks

A salivary gland scan is a safe test. The only risk is to the fetus of a pregnant woman. Women who are pregnant should discuss the risks and benefits of this procedure with their doctor.

Normal results

Normally functioning salivary glands take up the radiopharmaceutical then secrete it when stimulated by the lemon drops.

Abnormal results

Abnormally functioning salivary glands fail to exhibit a normal uptake and secretion pattern. This test does not differentiate between benign and malignant lesions.

Resources

OTHER

"Salivary Gland Scan." *HealthGate Page*. <http://www3.healthgate.com>.

Tish Davidson

Salivary gland tumors

Definition

A salivary gland tumor is an uncontrolled growth of cells that originates in one of the many saliva-producing glands in the mouth.

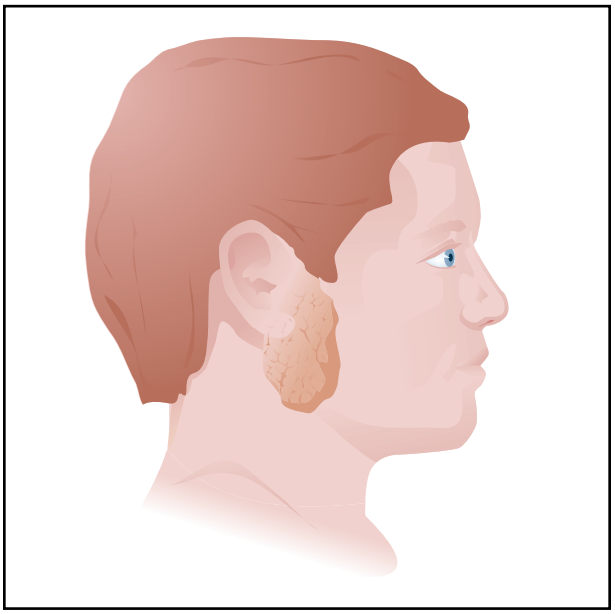
Description

The tongue, cheeks, and palate (the hard and soft areas at the roof of the mouth) contain many glands that produce saliva. In saliva there are enzymes, or catalysts, that begin the breakdown (digestion) of food while it is still in the mouth. The glands are called salivary glands because of their function.

There are three big pairs of salivary glands in addition to many smaller ones. The parotid glands, submandibular glands and sublingual glands are the large, paired salivary glands. The parotids are located inside the cheeks, one below each ear. The submandibular glands are located on the floor of the mouth, with one on the inner side of each part of the lower jaw, or mandible. The sublingual glands are also in the floor of the mouth, but they are under the tongue.

The parotids are the salivary glands most often affected by tumors. Yet most of the tumors that grow in the parotid glands are benign, or not cancerous. Approximately 8 out of 10 salivary tumors diagnosed are in a parotid gland. One in 10 diagnosed is in a submandibular gland. The remaining 10% are diagnosed in other salivary glands.

In general, glands more likely to show tumor growth are also glands least likely to show malignant tumor growth. Thus, although tumors of the sublingual glands are rare, almost all of them are malignant. In contrast, about one in four tumors of the parotid glands is malignant.



A salivary gland with a tumor. *(Illustration by Argosy Inc.)*

Cancers of the salivary glands begin to grow in epithelial cells, or the flat cells that cover body surfaces. Thus, they are called carcinomas, cancers that by definition begin in epithelial cells.

Demographics

About 7% of all cancers diagnosed in the head and neck region are diagnosed in a salivary gland. Men and women are at equal risk.

Causes and symptoms

When survivors of the 1945 atomic bombings of Nagasaki and Hiroshima began to develop salivary gland tumors at a high rate, radiation was suspected as a cause. Ionizing radiation is a factor that contributes to tumor development. So is **radiation therapy**. Adults who received radiation therapy for enlarged adenoids or tonsils when they were children, are at greater risk for salivary gland tumors.

There seems to be some link between **breast cancer** and salivary gland tumors. Women with breast **cancer** are more likely to be diagnosed with salivary gland tumors. Also linked to salivary gland tumors is alcohol use, exposure to sunlight (ultraviolet radiation) and hair dye use. There is evidence that people infected with herpes viruses may be at greater risk for salivary gland tumors. Individuals infected with human **immunodeficiency** virus (HIV) have more salivary gland disease in general, and may be at greater risk for salivary gland tumors.

Symptoms are often absent until the tumor is large or has metastasized (spread to other sites). In regular dental exams, however, the dentist looks for masses on the palate or under the tongue or in the cheeks, and such check-ups are a good way to detect tumors early.

- a lump or mass in the mouth
- swelling in the face
- pain in the jaw or the side of the face
- difficulty swallowing
- difficulty breathing
- difficulty speaking

Diagnosis

A tissue sample will be taken for study via a biopsy. Usually an incision is necessary to take the tissue sample. Sometimes it is possible to take a tissue sample with a needle.

Magnetic resonance imaging (MRI) and computed tomography (CT) scans are also used to evaluate the tumor. They help determine whether the cancer has spread to sites adjacent to the salivary gland where it is found. MRI offers a good way to examine the tonsils and the back of the tongue, which are soft tissues. CT is tapped as a way of studying the jaw, which is bone.

Treatment

To assess the stage of growth of a salivary gland tumor, many features are examined, including how big it is and the type of abnormal cell growth. Analysis of the types of abnormal cell growth in tissue is so specific that many salivary gland tumors are given unique names.

In stage I cancer the tumor is less than one inch in size and it has not spread. Stage II salivary gland cancers are larger than one inch and smaller than two and one-half inches, but they have not spread. Stage III cancers are smaller than one inch, but they have spread to a lymph node. Stage IV cancers have spread to adjacent sites in the head, which may include the base of the skull and nearby nerves, or they are larger than two and one-half inches and have invaded a lymph node.

Surgical removal (excision) of the tumor is the most common treatment. **Chemotherapy** and radiation therapy may be part of the treatment, particularly if the cancer has metastasized, or spread to other sites. Because there are many nerves and blood vessels near the three major pairs of salivary glands, particularly the parotids, the surgery can be quite complicated. A complex surgery is especially true if the tumor has spread.

KEY TERMS

Adenoids—Common name for the pharyngeal tonsils, which are lymph masses in the wall of the air passageway (pharynx) just behind the nose.

Biopsy—Tissue sample is taken from the body for examination.

Computed tomography (CT)—X rays are aimed at slices of the body (by rotating equipment) and results are assembled with a computer to give a three-dimensional picture of a structure.

Lymph—Tissue that is part of the lymphatic system, the system that collects and returns fluid to the blood vessels and produces substances that fight infection.

Magnetic resonance imaging (MRI)—Magnetic fields and radio frequency waves are used to take pictures of the inside of the body.

Tonsils—Common name for the palatine tonsils, which are lymph masses in the back of the mouth, on either side of the tongue.

Alternative treatment

Any technique, such as **yoga**, **meditation** or **biofeedback**, that helps a patient cope with **anxiety** over the condition and discomfort from treatment is useful and should be explored as an option.

Prognosis

Tumors in small salivary glands that are localized can usually be removed without much difficulty. The outlook for survival once the tumor is removed is very good if it has not metastasized.

For parotid cancers, the five-year survival rate is more than 85% whether or not a lymph node is involved at diagnosis. Ten-year survival rate is just under 50%.

Most early stage salivary gland tumors are removed, and they do not return. Those that do return, or recur, are the most troublesome and reduce the chance an individual will remain cancer-free.

Prevention

Minimizing intake of beverages containing alcohol may be important. Avoiding unnecessary exposure of the head to radiation and to sunlight may also be considered preventative. Anything that reduces the risk of contract-

ing a sexually transmitted disease, such as the use of condoms, also may lower the risk of salivary gland cancer.

Resources

BOOKS

Atkinson, Lucy Jo and Nancymarie Fortunato. Chapter 36, Head and Neck Surgery. *Berry & Kohn's Operating Room Technique*. St. Louis: Mosby, 1996.

ORGANIZATIONS

SPOHNC, Support for People with Oral and Head and Neck Cancer. P.O. Box 53, Locust Valley, NY 11560-0053. 800-377-0928. <http://www.spohnc.org>.

OTHER

"Oral Cavity and Pharyngeal Cancer." Online text. American Cancer Society. Revised 05/22/2000. <http://www3.cancer.org/cancerinfo/load_cont.asp?st=tr&ct=60&language=English>.

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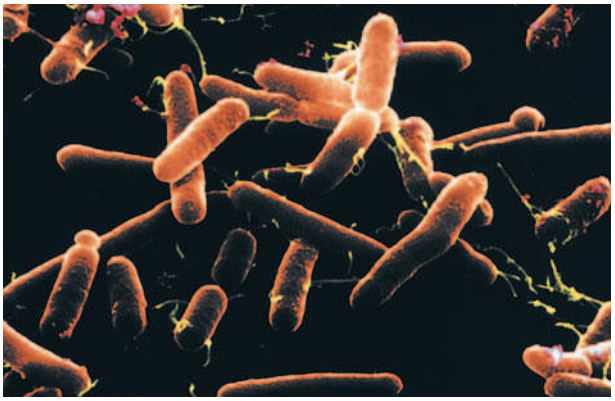

Salmonella enteritidis. **Exposure to this bacterium usually occurs by contact with contaminated food.** *(Photograph by Oliver Meckes, Photo Researchers, Inc. Reproduced by permission.)*

Salmonella food poisoning

Definition

Salmonella **food poisoning** is a bacterial food **poisoning** caused by the *Salmonella* bacterium. It results in the swelling of the lining of the stomach and intestines (**gastroenteritis**). While domestic and wild animals, including poultry, pigs, cattle, and pets such as turtles, iguanas, chicks, dogs, and cats can transmit this illness, most people become infected by ingesting foods contaminated with significant amounts of *Salmonella*.

Description

Salmonella food poisoning occurs worldwide, however it is most frequently reported in North America and Europe. Only a small proportion of infected people are tested and diagnosed, and as few as 1% of cases are actually reported. While the infection reate may seem relatively low, even an attack rate of less than 0.5% in such a large number of exposures results in many infected individuals. The poisoning typically occurs in small, localized outbreaks in the general population or in large outbreaks in hospitals, restaurants, or institutions for children or the elderly. In the United States, *Salmonella* is responsible for about 15% of all cases of food poisoning.

Improperly handled or undercooked poultry and eggs are the foods which most frequently cause Salmonella food poisoning. Chickens are a major carrier of *Salmonella* bacteria, which accounts for its prominence in poultry products. However, identifying foods which may be contaminated with *Salmonella* is particularly difficult because infected chickens typically show no signs or symptoms. Since infected chickens have no identifying characteristics, these chickens go on to lay eggs or to be used as meat.

At one time, it was thought that *Salmonella* bacteria were only found in eggs which had cracked, thus allowing the bacteria to enter. Ultimately, it was learned that, because the egg shell has tiny pores, even uncracked eggs which sat for a time on a surface (nest) contaminated with *Salmonella* could themselves become contaminated. It is known also that the bacteria can be passed from the infected female chicken directly into the substance of the egg before the shell has formed around it.

Anyone may contract Salmonella food poisoning, but the disease is most serious in infants, the elderly, and individuals with weakened immune systems. In these individuals, the infection may spread from the intestines to the blood stream, and then to other body sites, causing **death** unless the person is treated promptly with **antibiotics**. In addition, people who have had part or all of their stomach or their spleens removed, or who have sickle cell anemia, **cirrhosis** of the liver, leukemia, lymphoma, **malaria**, louse-borne **relapsing fever**, or Acquired **Immunodeficiency** Syndrome (**AIDS**) are particularly susceptible to Salmonella food poisoning.

Causes and symptoms

Salmonella food poisoning can occur when someone drinks unpasteurized milk or eats undercooked chicken or eggs, or salad dressings or desserts which contain raw eggs. Even if *Salmonella*-containing foods such as chicken are thoroughly cooked, any food can become contami-

nated during preparation if conditions and equipment for food preparation are unsanitary.

Other foods can then be accidentally contaminated if they come into contact with infected surfaces. In addition, children have become ill after playing with turtles or iguanas, and then eating without washing their hands. Because the bacteria are shed in the feces for weeks after infection with *Salmonella*, poor hygiene can allow such a carrier to spread the infection to others.

Symptoms appear about one-two days after infection, and include **fever** (in 50% of patients), **nausea and vomiting**, **diarrhea**, and abdominal cramps and **pain**. The diarrhea is usually very liquid, and rarely contains mucus or blood. Diarrhea usually lasts for about four days. The illness usually ends in about five-seven days.

Serious complications are rare, occurring most often in individuals with other medical illnesses. Complications occur when the *Salmonella* bacteria make their way into the bloodstream (**bacteremia**). Once in the bloodstream, the bacteria can enter any organ system throughout the body, causing disease. Other infections which can be caused by *Salmonella* include:

- bone infections (**osteomyelitis**)
- joint infections (arthritis)
- infection of the sac containing the heart (**pericarditis**)
- infection of the tissues which cover the brain and spinal cord (**meningitis**)
- infection of the liver (hepatitis)
- lung infections (**pneumonia**)
- infection of aneurysms (aneurysms are abnormal outpouchings which occur in weak areas of the walls of blood vessels)
- infections in the center of already-existing tumors or cysts

Diagnosis

Under appropriate laboratory conditions, *Salmonella* can be grown and then viewed under a microscope for identification. Early in the infection, the blood is far more likely to positively show a presence of the *Salmonella* bacterium when a sample is grown on a nutrient substance (culture) for identification purposes. Eventually, however, positive cultures can be obtained from the stool and in some cases from a **urine culture**.

Treatment

Even though Salmonella food poisoning is a bacterial infection, most practitioners do not treat simple cases with antibiotics. Studies have shown that using antibiotics does not usually reduce the length of time that the patient is ill. Paradoxically, it appears that antibiotics do, however, cause the patient to shed bacteria in their feces for a *longer* period of time. In order to decrease the length of time that a particular individual is a carrier who can spread the disease, antibiotics are generally not given.

In situations where an individual has a more severe type of infection with *Salmonella* bacteria, a number of antibiotics may be used. Chloramphenicol was the first antibiotic successfully used to treat Salmonella food poisoning. It is still a drug of choice in developing countries because it is so inexpensive, although some resistance has developed to it. Ampicillin and trimethoprim-sulfonamide have been used successfully in the treatment of infections caused by chloramphenicol-resistant strains. Newer types of anibiotics, such as cephalosporin or quinolone, are also effective. These drugs can be given by mouth or through a needle in the vein (intravenously) for very ill patients. With effective antibiotic therapy, patients feel better in 24–48 hours, the temperature returns to normal in three to five days, and the patient is generally recovered by 10–14 days.

Alternative treatment

A number of alternative treatments have been recommended for food poisoning. One very effective treatment that is stongly recommended is supplementation with *Lactobacillus acidophilus*, *L. bulgaricus*, and/or *Bifidobacterium* to restore essential bacteria in the digestive tract. These preparations are available as powders, tablets, or capsules from health food stores; yogurt with live *L. acidophilus* cultures can also be eaten. **Fasting** or a liquid-only diet is often used for food poisoning. Homeopathic treatment can work very effectively in the treatment of Salmonella food poisoning. The appropriate remedy for the individual and his/her symptoms must be used to get the desired results. Some examples of remedies commonly used are *Chamomilla*, *Nux vomica*, *Ipecac*, and *Colchicum*. Juice therapy, including carrot, beet, and garlic juices, is sometimes recommended, although it can cause discomfort for some people. Charcoal tablets can help absorb toxins and remove them from the digestive tract through bowel elimination. A variety of herbs with antibiotic action, including citrus seed extract, goldenseal (*Hydrastis canadensis*), and Oregon grape (*Mahonia aquifolium*), may also be effective in helping to resolve cases of food poisoning.

Prognosis

The prognosis for uncomplicated cases of Salmonella food poisoning is excellent. Most people recover completely within a week's time. In cases where other med-

KEY TERMS

Carrier—Someone who has an organism (bacteria, virus, fungi) in his or her body, without signs of illness. The individual may therefore pass the organism on to others.

Gastroenteritis—Inflammation of the stomach and intestines. Usually causes nausea, vomiting, diarrhea, abdominal pain and cramps.

ical problems complicate the illness, prognosis depends on the severity of the other medical conditions, as well as the specific organ system infected with *Salmonella*.

Prevention

Prevention of Salmonella food poisoning involves the proper handling and cooking of foods likely to carry the bacteria. This means that recipes utilizing uncooked eggs (Caesar salad dressing, meringue toppings, mousses) need to be modified to eliminate the raw eggs. Not only should chicken be cooked thoroughly, until no pink juices flow, but all surfaces and utensils used on raw chicken must be carefully cleaned to prevent *Salmonella* from contaminating other foods. Careful handwashing is a must before, during, and after all food preparation involving eggs and poultry. Handwashing is also important after handling and playing with pets such as turtles, iguanas, chicks, dogs and cats.

Resources

BOOKS

"Enterobacteriaceae." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Keusch, Gerald T. "Salmonellosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Salmonella paratyphi infection *see* **Paratyphoid fever**

Salmonella typhi infection *see* **Typhoid fever**

Salpingectomy

Definition

Salpingectomy is the removal of one or both of a woman's fallopian tubes, the tubes through which an egg travels from the ovary to the uterus.

Purpose

A salpingectomy may be performed for several different reasons. Removal of one tube (unilateral salpingectomy) is usually performed if the tube has become infected (a condition known as salpingitis).

Salpingectomy is also used to treat an **ectopic pregnancy**, a condition in which a fertilized egg has implanted in the tube instead of inside the uterus. In most cases, the tube is removed only after drug treatments designed to save the structure have failed. (Women with one remaining fallopian tube are still able to get pregnant and carry a **pregnancy** to term.) The other alternative to salpingectomy is surgery to remove the fetus from the fallopian tube, followed by surgery to repair the tube.

A bilateral salpingectomy (removal of both the tubes) is usually done if the ovaries and uterus are also going to be removed. If the fallopian tubes and the ovaries are both removed at the same time, this is called a **salpingo-oophorectomy**. A salpingo-oophorectomy is necessary when treating ovarian and **endometrial cancer** because the fallopian tubes and ovaries are the most common sites to which **cancer** may spread.

Description

Regional or general anesthesia may be used. Often a laparoscope (a hollow tube with a light on one end) is used in this type of operation, which means that the incision can be much smaller and the recovery time much shorter.

In this procedure, the surgeon makes a small incision just beneath the navel. The surgeon inserts a short hollow tube into the abdomen and, if necessary, pumps in carbon dioxide gas in order to move intestines out of the way and better view the organs. After a wider double tube is inserted on one side for the laparoscope, another small incision is made on the other side through which other instruments can be inserted. After the operation is completed, the tubes and instruments are withdrawn. The tiny incisions are sutured and there is very little scarring.

KEY TERMS

Ectopic pregnancy—The development of a fetus at a site other than the inside of the uterus; most commonly, the egg implants itself in the fallopian tube.

Laparoscope—A surgical instrument with a light attached that is inserted through the abdominal wall to allow the surgeon to see the organs in the abdomen.

In the case of a pelvic infection, the surgeon makes a horizontal (bikini) incision 4-6 in (10-15 cm) long in the abdomen right above the pubic hairline. This allows the doctor to remove the scar tissue. (Alternatively, a surgeon may use a vertical incision from the pubic bone toward the navel, although this is less common.)

Preparation

The patient is given an injection an hour before surgery to encourage drowsiness.

Aftercare

Aftercare varies depending on whether the tube was removed by **laparoscopy** or through an abdominal incision. Even when major surgery is performed, most women are out of bed and walking around within three days. Within a month or two, a woman can slowly return to normal activities such as driving, exercising, and working.

Risks

All surgery, especially under general anesthesia, carries certain risks, such as the risk of scarring, hemorrhaging, infection, and reactions to the anesthesia. Pelvic surgery can also cause internal scarring which can lead to discomfort years afterward.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 1996.

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

ORGANIZATIONS

National Women's Health Resource Center. 120 Albany St., Suite 820, New Brunswick, NJ 08901. (877) 986-9472. <http://www.healthywomen.org>.

Carol A. Turkington

Salpingitis *see* **Pelvic inflammatory disease**

Salpingo-oophorectomy

Definition

The surgical removal of a fallopian tube and an ovary.

Purpose

This surgery is performed to treat ovarian or other gynecological cancers, or infections as a result of **pelvic inflammatory disease**. Occasionally, removal of one or both ovaries may be done to treat **endometriosis**. If only one tube and ovary are removed, the woman may still be able to conceive and carry a **pregnancy** to term.

Description

If the procedure is performed through a laparoscope, the surgeon can avoid a large abdominal incision and can shorten recovery. With this technique, the surgeon makes a small cut through the abdominal wall just below the navel. When the laparoscope is used, the patient can be given either regional or general anesthesia; if there are no complications, the patient can leave the hospital in a day or two.

If a laparoscope is not used, the surgery involves an incision 4–6 in (10–15 cm) long into the abdomen either extending vertically up from the pubic bone toward the navel, or horizontally (the "bikini incision") across the pubic hairline. The scar from a bikini incision is less noticeable, but some surgeons prefer the vertical incision because it provides greater visibility while operating.

Preparation

A spinal block or general anesthesia may be given before surgery.

Aftercare

If performed through an abdominal incision, salpingo-oophorectomy is major surgery that requires three to six weeks for full recovery. However, if performed laparascopically, the recovery time can be much shorter. There may be some discomfort around the incision for the first few days after surgery, but most women are walking around by the third day. Within a month or so, patients can gradually resume normal activities such as driving, exercising, and working.

Immediately following the operation, the patient should avoid sharply flexing the thighs or the knees. Persistent back **pain** or bloody or scanty urine indicates that a ureter may have been injured during surgery.

If both ovaries are removed in a premenopausal woman as part of the operation, the sudden loss of estrogen will trigger an abrupt **premature menopause** that may involve severe symptoms of hot flashes, vaginal dryness, painful intercourse, and loss of sex drive. (This is also called "surgical menopause.") In addition to these symptoms, women who lose both ovaries also lose the protection these hormones provide against heart disease and **osteoporosis** many years earlier than if they had experienced natural **menopause**. Women who have had their ovaries removed are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact.

For these reasons, some form of estrogen replacement therapy (ERT) may be prescribed to relieve the symptoms of surgical menopause and to help prevent heart and bone disease.

In addition, to help offset the higher risks of heart and bone disease after loss of the ovaries, women should get plenty of **exercise**, maintain a low-fat diet, and ensure intake of calcium is adequate.

Reaction to the removal of fallopian tubes and ovaries depends on a wide variety of factors, including the woman's age, the condition that required the surgery, her reproductive history, how much social support she has, and any previous history of depression. Women who have had many gynecological surgeries or chronic pelvic pain seem to have a higher tendency to develop psychological problems after the surgery.

Risks

Major surgery always involves some risk, including infection, reactions to the anesthesia, hemorrhage, and scars at the incision site. Almost all pelvic surgery causes some internal scars, which, in some cases, can cause discomfort years after surgery.

Resources

BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. *The Harvard Guide to Women's Health.* Cambridge, MA: Harvard University Press, 1996.

Landau, Carol. *The Complete Book of Menopause: Every Woman's Guide to Good Health.* New York: G. P. Putnam's Sons, 1994.

Notelovitz, Morris, and Diana Tonnessen. *Estrogen: Yes or No?* New York: St. Martin's Press, 1993.

KEY TERMS

Androgens—Hormones (specifically testosterone) responsible for male sex characteristics.

Endometriosis—A painful disease in which cells from the lining of the uterus (endometrium) aren't shed during menstruation, but instead attach themselves to other organs in the pelvic cavity. The condition is hard to diagnose and often causes severe pain as well as infertility.

Fallopian tubes—Tubes that extend from either end of the uterus that convey the egg from the ovary to the uterus during each monthly cycle.

Ureter—The tube that carries urine from the bladder to the kidneys.

Ryan, Kenneth J., Ross S. Berkowitz, and Robert L. Barbieri. *Kistner's Gynecology.* 6th ed. St. Louis: Mosby, 1995.

ORGANIZATIONS

Midlife Women's Network. 5129 Logan Ave. S., Minneapolis, MN 55419.(800) 886-4354.

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San Joaquin fever *see* **Coccidioidomycosis**

Sanfilippo's syndrome *see* **Mucopolysaccharidoses**

Saquinavir *see* **Protease inhibitors**

Sarcoidosis

Definition

Sarcoidosis is a disease which can affect many organs within the body. It causes the development of granulomas. Granulomas are masses resembling little tumors. They are made up of clumps of cells from the immune system.

Description

Sarcoidosis is a very puzzling disorder. In addition to having no clear-cut understanding of the cause of sarcoidosis, researchers are also puzzled by its distribution in the world population. In the United States, for example, 10-17 times as many African-Americans are affected as white Americans. In Europe, whites are primarily affected.

Prevalence is a way of measuring the number of people affected per 100,000 people in a given population. The prevalence figures for sarcoidosis are very unusual. In the United States, prevalence figures range from five (5/100,000 in the United States) for whites to 40 for blacks. In Europe, prevalence ranges from three in Poland, to 10 in France, to 64 in Sweden, to 200 for Irish women living in London. Furthermore, a person from a group with very low prevalence who leaves his or her native land for a second location with a higher prevalence will then have the same risk as anyone living in that second location.

Sarcoidosis affects both men and women, although women are more likely to have the disorder. The average age for diagnosis is around 20-40 years.

Causes and symptoms

The cause of sarcoidosis is not known. Because the granulomas are primarily made up of cells from the immune system (macrophages and lymphocytes), an immune connection is strongly suspected. One of the theories which has been put forth suggests that exposure to some toxic or infectious material starts up an immune response. For some reason, the body is unable to stop the response, and it spreads from the original organ to other organs.

Because sarcoidosis has been noted to occur in family groups, a genetic cause has also been suggested. Research shows that identical twins are more likely to both have sarcoidosis than are nonidentical twins or other siblings.

Some cases of sarcoidosis occur without the patient even noting any symptoms. These cases are often discovered by chance during routine chest x rays. Most cases of sarcoidosis, however, begin with very nonspecific symptoms, such as decreased energy, weakness, and a dry **cough**. Occasionally, the cough is accompanied by some mild **pain** in the breastbone (sternum). Some patients note that they are having unusual **shortness of breath** while exercising. Some patients develop **fever**, decreased appetite, and weight loss.

Virtually every system of the body has the potential to suffer the effects of sarcoidosis:

- tender reddish bumps (nodules) or patches often appear on the skin
- the eyes may become red and teary, and the vision blurry
- the joints may become swollen and painful (arthritis)
- lymph nodes in the neck, armpits, and groin become enlarged and tender, lymph nodes within the chest, around the lungs, also become enlarged
- fluid may accumulate around the lungs (**pleural effusion**), making breathing increasingly difficult
- nasal stuffiness is common, as well as a hoarse sound to the voice
- cysts in the bone may cause pain in the hands and feet, or in other bony areas
- the bone marrow may decrease the production of all blood cells; decreased number of red blood cells causes anemia, fewer white blood cells increases the chance of infections, fewer platelets can increase the chance of bleeding
- the body's ability to process calcium often becomes abnormal, so that excess calcium passes through the kidneys and into the urine; this may cause **kidney stones** to form
- the liver may become enlarged
- the heart may suffer a variety of complications, including abnormal or missed beats (**arrhythmias**), inflammation of the covering of the heart (**pericarditis**), and an increasing tendency toward weak, ineffective pumping of the blood (heart failure)
- the nervous system may display the effects of sarcoidosis by **hearing loss**, chronic inflammation of the coverings of the brain and spinal cord (**meningitis**), abnormalities of the nerve that is involved in vision (optic nerve dysfunction), seizures, and the development of psychiatric disorders

Any, all, or even none of the above symptoms may be present in sarcoidosis.

Diagnosis

Diagnosis depends on information from a number of sources, including the patient's symptoms, the **physical examination**, x-ray pictures of the chest, and a number of other laboratory examinations of blood or other tissue. None of these categories of information are sufficient to make the diagnosis of sarcoidosis. There is no one test or sign or symptom which clearly points to sarcoidosis, excluding all other types of diseases. This is because nearly all of the symptoms and laboratory results in sarcoidosis also occur in other diseases. Diagnosis, then, requires careful consideration of many facts.

The physical examination in sarcoidosis may reveal the characteristic **skin lesions**. Wheezes may be heard throughout the lungs. The liver may be enlarged. Examination of the eyes using a special light called a slit-lamp may reveal changes indicative of sarcoidosis.

The **chest x ray** will show some pattern of abnormalities, which may include enlargement of the lymph nodes

which drain the lung, scarring and abnormalities to the tissue of the lungs, and fluid accumulation around the lungs.

Lung function tests measure such things as the amount of air an individual can breathe in and breathe out, the speed at which the air flows in and out, and the amount of air left in the lung after blowing out as much as possible in one second. A variety of lung function tests may show abnormal results in sarcoidosis.

Other types of tests may be abnormal in sarcoidosis. The abnormal test results may also indicate other diseases. They include an elevation of a substance called angiotensin-converting enzyme in the blood, and an increased amount of calcium present in 24 hours worth of urine.

Bronchoscopy is a very helpful diagnostic test. This involves passing a tiny tube (bronchoscope) through the nose or mouth, down the trachea, and into the airways (bronchial tubes). The bronchial tubes can be inspected through the bronchoscope. The bronchoscope is also designed in such a way as to allow biopsies to be obtained. Bronchoalveolar lavage involves washing the surfaces with a sterile saltwater (saline) solution. The saline is then retrieved and examined in a laboratory. Cells and debris from within the bronchial tubes and the tiny sacs of the lung (the alveoli) will be obtained in this way, and can be studied for the presence of an abnormally large number of white blood cells. A tiny piece of the lung tissue can also be obtained through the bronchosocope. This can be studied under a microscope to look for the characteristic granulomas and inflammation of sarcoidosis.

A gallium 67 scan involves the injection of a radioactive material called gallium 67. In sarcoidosis, areas of the body which are inflamed will retain the gallium 67. These areas will then show up on the scan.

Treatment

Many cases of sarcoidosis resolve without treatment. If treatment is needed, the most effective one for sarcoidosis is the administration of steroid medications. These medications work to decrease inflammation throughout the body. The long-term use of steroid medications has serious potential side-effects. Patients are only treated with steroids when the problems caused by sarcoidosis are particularly serious. Many cases of sarcoidosis resolve without treatment.

Prognosis

The prognosis for sarcoidosis is quite good. About 60-70% of the time, sarcoidosis cures itself within a year or two. In about 20-30% of patients, permanent damage occurs to the lungs. About 15-20% of all patients go on to develop a chronic, relapsing form of sarcoidosis.

KEY TERMS

Granuloma—Masses made up of a variety of immune cells, as well as fibroblasts (cells which make up connective tissue).

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Death can be blamed on sarcoidosis in about 10% of all sarcoidosis cases.

Prevention

Until researchers are able to pinpoint the cause of sarcoidosis, there will be no available recommendations for how to prevent it.

Resources

BOOKS

Crystal, Ronald G. "Sarcoidosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Gottlieb, Jonathan E., et al. "Outcome in Sarcoidosis: the Relationship of Relapse to Corticosteroid Therapy." *Chest* 111, no. 3 (Mar. 1997): 623+.

Newman, Lee S., et al. "Sarcoidosis." *The New England Journal of Medicine* 336, no. 17 (24 Apr. 1997): 1224+.

Zitkus, Bruce S. "Sarcoidosis: Varied Symptoms Often Impede Diagnosis of this Multisystem Disorder." *American Journal of Nursing* 97, no. 10 (Oct. 1997): 40+.

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Sarcomas

Definition

A sarcoma is a bone tumor that contains **cancer** (malignant) cells. A benign bone tumor is an abnormal growth of noncancerous cells.

Description

A primary bone tumor originates in or near a bone. Most primary bone tumors are benign, and the cells that

compose them do not spread (metastasize) to nearby tissue or to other parts of the body.

Malignant primary bone tumors account for fewer than 1% of all cancers diagnosed in the United States. They can infiltrate nearby tissues, enter the bloodstream, and metastasize to bones, tissues, and organs far from the original malignancy. Malignant primary bone tumors are characterized as either:

- bone cancers which originate in the hard material of the bone.
- soft-tissue sarcomas which begin in blood vessels, nerves, or tissues containing muscles, fat, or fiber.

Types of bone tumors

Osteogenic sarcoma, or osteosarcoma, is the most common form of bone cancer, accounts for 6% of all instances of the disease, and for about 5% of all cancers that occur in children. Nine hundred new cases of osteosarcoma are diagnosed in the United States every year. The disease usually affects teenagers, and is almost twice as common in boys as in girls.

Osteosarcomas, which grow very rapidly, can develop in any bone but most often occur along the edge or on the end of one of the fast-growing long bones that support the arms and legs. About 80% of all osteosarcomas develop in the parts of the upper and lower leg nearest the knee (the distal femur or in the proximal tibia). The next likely location for an osteosarcoma is the bone of the upper arm closest to the shoulder (the proximal humerus).

Ewing's sarcoma is the second most common form of childhood bone cancer. Accounting for fewer than 5% of bone tumors in children, Ewing's sarcoma usually begins in the soft tissue (the marrow) inside bones of the leg, hips, ribs, and arms. It rapidly infiltrates the lungs, and may metastasize to bones in other parts of the body.

More than 80% of patients who have Ewing's sarcoma are white, and the disease most frequently affects children between ages 5-9, and young adults between ages 20-30. About 27% of all cases of Ewing's sarcoma occur in children under age 10, and 64% occur in adolescents between ages 10-20.

Chondrosarcomas are cancerous bone tumors that most often appear in middle age. Usually originating in strong connective tissue (cartilage) in ribs or leg or hip bones, chondrosarcomas grow slowly. They rarely spread to the lungs. It takes years for a chondrosarcoma to metastasize to other parts of the body, and some of these tumors never spread.

Parosteal osteogenic sarcomas, fibrosarcomas, and chordomas are rare. Parosteal osteosarcomas generally involve both the bone and the membrane that covers it. Fibrosarcomas originate in the ends of the bones in the arm or leg, and then spread to soft tissue. Chordomas develop on the skull or spinal cord.

Osteochondromas, which usually develop between age 10-20, are the most common noncancerous primary bone tumors. Giant cell tumors generally develop in a section of the thigh bone near the knee. Giant cell tumors are originally benign but sometimes become malignant.

Causes and symptoms

The cause of bone cancer is unknown, but the tendency to develop it may be inherited. Children who have bone tumors are often tall for their age, and the disease seems to be associated with growth spurts that occur during childhood and adolescence. Injuries can make the presence of tumors more apparent but do not cause them.

A bone that has been broken or exposed to high doses of radiation used to treat other cancers is more likely than other bones to develop osteosarcoma. A history of noncancerous bone disease also increases bone-cancer risk.

The amount of radiation in diagnostic x rays poses little or no danger of bone-cancer development, but children who have a family history of the most common childhood cancer of the eye (**retinoblastoma**), or who have inherited rare cancer syndromes have a greater-than-average risk of developing bone cancer. Exposure to chemicals found in some paints and dyes can slightly raise the risk.

Both benign and malignant bone tumors can distort and weaken bone and cause **pain**, but benign tumors are generally painless and asymptomatic.

It is sometimes possible to feel a lump or mass, but pain in the affected area is the most common early symptom of bone cancer. Pain is not constant in the initial stages of the disease, but it is aggravated by activity and may be worse at night. If the tumor is located on a leg bone, the patient may limp. Swelling and weakness of the limb may not be noticed until weeks after the pain began.

Other symptoms of bone cancer include:

- a bone that breaks for no apparent reason
- difficulty moving the affected part of the body
- fatigue
- fever
- a lump on the trunk, an arm or leg, or another bone
- persistent, unexplained back pain
- weight loss

Diagnosis

Physical examination and routine x rays may yield enough evidence to diagnose benign bone tumors, but removal of tumor tissue for microscopic analysis (biopsy) is the only sure way to rule out malignancy.

A needle biopsy involves using a fine, thin needle to remove small bits of tumor, or a thick needle to extract tissue samples from the innermost part (the core) of the growth. An excisional biopsy is the surgical removal of a small, accessible tumor. An incisional biopsy is performed on tumors too large or inaccessible to be completely removed. The surgeon performing an incisional biopsy cuts into the patient's skin and removes a portion of the exposed tumor. Performed under local or general anesthetic, biopsy reveals whether a tumor is benign or malignant and identifies the type of cancer cells the malignant tumor contains.

Bone cancer is usually diagnosed about three months after symptoms first appear, and 20% of malignant tumors have metastasized to the lungs or other parts of the body by that time.

Imaging techniques

The following procedures are used, in conjunction with biopsy, to diagnose bone cancer:

- Bone x rays. These x rays usually provide a clear image of osteosarcomas.
- Computerized axial tomography (CAT scan) is a specialized x ray that uses a rotating beam to obtain detailed information about an abnormality and its physical relationship to other parts of the body. A CAT scan can differentiate between osteosarcomas and other types of bone tumors, illustrate how tumor cells have infiltrated other tissues, and help surgeons decide which portion of a growth would be best to biopsy. Because more than four of every five malignant bone tumors metastasize to the lungs, a CAT scan of the chest is performed to see if these organs have been affected. Chest and abdominal CAT scans are used to determine whether Ewing's sarcoma has spread to the lungs, liver, or lymph nodes.
- Magnetic resonance imaging (MRI) is a specialized scan that relies on radio waves and powerful magnets to reflect energy patterns created by tissue abnormalities and specific diseases. An MRI provides more detailed information than does a CAT scan about tumors and marrow cavities of the bone, and can sometimes detect clusters of cancerous cells that have separated from the original tumor. This valuable information helps surgeons select the most appropriate approach for treatment.

A specimen of a femur bone indicating the cancerous growth around the knee. Osteosarcoma is the most common primary cancer of the bone. *(Photo Researchers, Inc. Reproduced by permission.)*

- Radionuclide bone scans. These scans involve injecting a small amount of radioactive material into a vein. Primary tumors or cells that have metastasized absorb the radioactive material and show up as dark spots on the scan.

Cytogenic and molecular genetic studies, which assess the structure and composition of chromosomes and genes, may also be used to diagnose osteosarcoma. These tests can sometimes indicate what form of treatment is most appropriate.

Laboratory studies

A complete **blood count** (CBC) reveals abnormalities in the blood, and may indicate whether bone marrow has been affected. A blood test that measures levels of the enzyme lactate dehydrogenase (LDH) can predict the likelihood of a specific patient's survival.

Immunohistochemistry involves adding special antibodies and chemicals, or stains, to tumor samples. This technique is effective in identifying cells that are found in Ewing's sarcoma but are not present in other malignant tumors.

Reverse transcription polymerase chain reaction (RTPCR) relies on chemical analysis of the substance in the body that transmits genetic information (RNA) to:

- evaluate the effectiveness of cancer therapies
- identify mutations consistent with the presence of Ewing's sarcoma
- reveal cancer that recurs after treatment has been completed

Staging

Once bone cancer has been diagnosed, the tumor is staged. This process indicates how far the tumor has spread

from its original location. The stage of a tumor suggests which form of treatment is most appropriate, and predicts how the condition will probably respond to therapy.

An osteosarcoma may be localized or metastatic. A localized osteosarcoma has not spread beyond the bone where it arose or beyond nearby muscles, tendons, and other tissues. A metastatic osteosarcoma has spread to the lungs, to bones not directly connected to the bone in which the tumor originated, or to other tissues or organs.

Treatment

Since the 1960s, when **amputation** was the only treatment for bone cancer, new **chemotherapy** drugs and innovative surgical techniques have improved survival with intact limbs. Because osteosarcoma is so rare, patients should consider undergoing treatment at a major cancer center staffed by specialists familiar with the disease.

A treatment plan for bone cancer, developed after the tumor has been diagnosed and staged, may include:

- Amputation. Amputation may be the only therapeutic option for large tumors involving nerves or blood vessels that have not responded to chemotherapy. MRI scans indicate how much of the diseased limb must be removed, and surgery is planned to create a cuff, formed of muscles and skin, around the amputated bone. Following surgery, an artificial (prosthetic) leg is fitted over the cuff. A patient who actively participates in the **rehabilitation** process may be walking independently as soon as three months after the amputation.
- Chemotherapy. Chemotherapy is usually administered in addition to surgery, to kill cancer cells that have separated from the original tumor and spread to other parts of the body. Although chemotherapy can increase the likelihood of later development of another form of cancer, the American Cancer Society maintains that the need for chemotherapeutic bone-cancer treatment is much greater than the potential risk.
- Surgery. Surgery, coordinated with diagnostic biopsy, enhances the probability that limb-salvage surgery can be used to remove the cancer while preserving nearby blood vessels and bones. A metal rod or bone graft is used to replace the area of bone removed, and subsequent surgery may be needed to repair or replace rods that have loosened or broken. Patients who have undergone limb-salvage surgery need intensive rehabilitation. It may take as long as a year for a patient to regain full use of a leg following limb-salvage surgery, and patients who have this operation may eventually have to undergo amputation.
- **Radiation therapy**. Radiation therapy is used often to treat Ewing's sarcoma.
- Rotationoplasty. Rotationoplasty, sometimes performed after a leg amputation, involves attaching the lower leg and foot to the thigh bone, so that the ankle replaces the knee. A prosthetic is later added to make the leg as long as it should be. Prosthetic devices are not used to lengthen limbs that remain functional after amputation to remove osteosarcomas located on the upper arm. When an osteosarcoma develops in the jaw bone, the entire lower jaw is removed. Bones from other parts of the body are later grafted on remaining bone to create a new jaw.

Follow-up treatments

After a patient completes the final course of chemotherapy, CAT scans, bone scans, x rays, and other diagnostic tests may be repeated to determine if any traces of tumor remain. If none are found, treatment is discontinued, but patients are advised to see their oncologist and orthopedic surgeon every two or three months for the next year. X rays of the chest and affected bone are taken every four months. An annual echocardiogram is recommended to evaluate any adverse effect chemotherapy may have had on the heart, and CT scans are performed every six months.

Patients who have received treatment for Ewing's sarcoma are examined often - at gradually lengthening intervals - after completing therapy. Accurate growth measurements are taken during each visit and blood is drawn to be tested for side effects of treatment. X rays, CT scans, bone scans, and other imaging studies are generally performed every three months during the first year. If no evidence of tumor growth or recurrence is indicated, these tests are performed less frequently in the following years.

Some benign bone tumors shrink or disappear without treatment. However, regular examinations are recommended to determine whether these tumors have changed in any way.

Alternative treatment

Alternative treatments should never be substituted for conventional bone-cancer treatments or used without the approval of a physician. However, some alternative treatments can be used as adjunctive and supportive therapies during and following conventional treatments.

Dietary adjustments can be very helpful for patients with cancer. Whole foods, including grains, beans, fresh fruits and vegetables, and high quality fats, should be emphasized in the diet, while processed foods should be avoided. Increased consumption of fish, especially cold water fish like salmon, mackerel, halibut, and tuna, pro-

vides a good source of omega-3 fatty acids. Nutritional supplements can build strength and help maintain it during and following chemotherapy, radiation, or surgery. These supplements should be individually prescribed by an alternative practitioner who has experience working with cancer patients.

Many cancer patients claim that **acupuncture** alleviates pain, nausea, and vomiting. It can also be effective in helping to maintain energy and relative wellness during surgery, chemotherapy, and radiation. Massage, **reflexology**, and relaxation techniques are said to relieve pain, tension, **anxiety**, and depression. **Exercise** can be an effective means of reducing mental and emotional **stress**, while increasing physical strength. **Guided imagery**, **biofeedback**, hypnosis, body work, and progressive relaxation can also enhance quality of life.

Claims of effectiveness in fighting cancer have been made for a variety of herbal medicines. These botanical remedies work on an individual basis and should only be used when prescribed by a practitioner familiar with cancer treatment.

Treating cancer is a complex and individual task. It should be undertaken by a team of support practitioners with varying specialities who can work together for healing the person with cancer.

Prognosis

Benign brain tumors rarely recur, but sarcomas can reappear after treatment was believed to have eliminated every cell.

Likelihood of long-term survival depends on:

- the type and location of the tumor
- how much the tumor has metastasized, and what organs, bones, or tissues have been affected

More than 85% of patients survive for more than five years after complete surgical removal of low-grade osteosarcomas (tumors that arise in mature tissue and contain a small number of cancerous cells). About 25-30% of patients diagnosed with high-grade osteosarcomas (tumors that develop in immature tissue and contain a large number of cancer cells) will die of the disease.

Two-thirds of all children diagnosed with Ewing's sarcoma will live for more than five years after the disease is detected. The outlook is most favorable for children under age 10, and least favorable in patients whose cancer is not diagnosed until after it has metastasized: fewer than three of every 10 of these patients remain alive five years later. More than 80% of patients whose Ewing's sarcoma is confined to a small area and surgically removed live, for at least five years. Postsurgical radiation and chemotherapy add years to their lives. More than 70% of patients live five years or more with a small Ewing's sarcoma that cannot be removed, but only three out of five patients with large, unremovable tumors survive that long.

Prevention

There is no known way to prevent bone cancer.

Resources

BOOKS

Cancer Sourcebook. Ed. Frank E. Bair. Detroit: Omnigraphics, Inc., 1990.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

CancerCare, Inc. 1180 Avenue of the Americas, New York, NY 10036. (800) 813-4673. <http://www.cancercare.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

OTHER

"Bone Tumors." *Glasgow Area Drug Information Centre*. 11 Apr. 1998 <http://www.digri.demon.co.uk/index.htm>.

"Ewing's Family of Tumors Cancer Information." *American Cancer Society Page*. 6 Apr. 1998 <http://www.cancer.org>.

Maureen Haggerty

Saw palmetto

Definition

Saw palmetto is an extract derived from the deep purple berries of the saw palmetto fan palm (*Serenoa repens*), a plant indigenous to the coastal regions of the southern United States and southern California. There is an estimated one million acres of wild saw palmetto palms in Florida, where the bulk of commercial saw palmetto is grown.

Purpose

Saw palmetto is used by natural health practitioners to treat a variety of ailments in men and women, such as testicular inflammation, urinary tract inflammation, coughs, and respiratory congestion. It is also used to strengthen the thyroid gland, balance the metabo-

lism, stimulate appetite, and aid digestion. Most of the evidence supporting these uses is anecdotal and has not been proven by controlled clinical trials. However, there is much scientific documentation outlining the effectiveness of the herb in treating irritable bladder and urinary problems in men with benign prostate hyperplasia (BPH), an enlargement of the prostate gland. BPH results in a swelling of the prostate gland that obstructs the urethra. This causes painful urination, reduced urine flow, difficulty starting or stopping the flow, dribbling after urination, and more frequent nighttime urination. Saw palmetto does not reduce prostate enlargement. Instead, it is thought to work in a variety of ways. First, it inhibits the conversion of testosterone into dihydrotestosterone (DHT). BPH is thought to be caused by an increase in testosterone to DHT. Secondly, saw palmetto is believed to interfere with the production of estrogen and progesterone, hormones associated with DHT production.

In addition to causing **pain** and embarrassment, BPH can lead to serious kidney problems if undiagnosed and left untreated. It is a common problem in men over the age of 40. Estimates are that 50-60% of all men will develop BPH in their lifetimes. It is estimated that there are six million men between the ages of 50–79 who have BPH serious enough to require some type of therapy. Yet only half of them seek treatment from physicians. Health practitioners in both the allopathic and natural medicine communities recommend annual prostate exams for men over the age of 50, and an annual blood test that measures prostate specific antigen, a marker for **prostate cancer**.

Recently, a number of clinical trials have confirmed the effectiveness of saw palmetto in treating BPH. Many of these trials have shown saw palmetto works better than the most commonly used prescription drug, Proscar. Saw palmetto is effective in nearly 90% of patients after six weeks of use, while Proscar is effective in less than 50% of patients. In addition, Proscar may take up to six months to achieve its full effect. Since Proscar blocks the production of testosterone, it can cause **impotence** and breast enlargement. Also, saw palmetto is significantly less expensive than Proscar. A one month supply of saw palmetto costs $12–25, while a one month supply of Proscar costs $65–75. Other prescription drugs used to treat BPH are Cardura (doxazosin), Hytrin (terazosin), and Flomax (tamsulosin hydrochloride). Originally prescribed to treat **hypertension**, Cardura and Hytrin can drop blood pressure, causing lightheadedness and **fainting**. Presently, saw palmetto is being evaluated by the U.S. Food and Drug Administration (FDA) for treatment of BPH. If approved, it would become the first herbal product to be licensed by the agency as a treatment for a specific condition. Saw palmetto is also used as a treatment for prostate complaints and irritable bladder.

Since the 1960s, extensive clinical studies of saw palmetto have been done in Europe. A 1998 review of 24 European trials involved nearly 3,000 men, some taking saw palmetto, others taking Proscar, and a third group taking a placebo. The men taking saw palmetto had a 28% improvement in urinary tract symptoms, a 24% improvement in peak urine flow, and 43% improvement in overall urine flow. The results were nearly comparable to the group taking Proscar and superior to the men taking a placebo.

Uses in women

There is very little documentation or scientific research into saw palmetto use in women. However, several studies in the 1990s show that the BPH drug Proscar can be effective in stopping unwanted facial and body hair growth, and in treating thinning hair in women. It works by blocking the action of an enzyme called 5-alpha reductase. Anecdotal reports suggest that saw palmetto may be as effective as Proscar in treating unwanted hair growth and thinning hair, and in preventing some types of **acne**. It has also been used to treat urinary tract inflammation and help relieve the symptoms of menstruation. There are claims it can be used to enlarge breasts, but these claims have not been scientifically tested.

History

Saw palmetto berries have been used in American folk medicine for several hundred years as an aphrodisiac and for treating prostate problems. Native Americans in the southeast United States have used saw palmetto since the 1700s to treat male urinary problems. In the 1800s, medical botanist John Lloyd noted that animals that ate saw palmetto appeared healthier and fatter than other livestock. Early American settlers noticed the same effects and used the juice from saw palmetto berries to gain weight, to improve general disposition, as a sedative, and to promote reproductive health.

In the United States, the medicinal uses of saw palmetto were first documented in 1879 by Dr. J.B. Read, a physician in Savannah, Georgia, who published a paper on the medicinal benefits of the herb in the April 1879 issue of *American Journal of Pharmacy*. He found the herb useful in treating a wide range of conditions. "By its peculiar soothing power on the mucous membrane it induces sleep, relieves the most troublesome coughs, promotes expectoration, improves digestion, and increases fat, flesh and strength. Its sedative and

Saw palmetto leaves. *(Photo Researchers, Inc. Reproduced by permission.)*

diuretic properties are remarkable," Read wrote. "Considering the great and diversified power of the saw palmetto as a therapeutic agent, it seems strange that it should have so long escaped the notice of the medical profession."

A pungent tea made from saw palmetto berries was commonly used in the early 1900s to treat prostate enlargement and urinary tract infections. It was also used in men to increase sperm production and sex drive, although these uses are discounted today. One of the first published medical recommendations that saw palmetto was effective in treating prostate problems appeared in the 1926 edition of *United States Dispensatory*. In the late 1920s, the use of medicinal plants, including saw palmetto, began to decline in the United States, while at the same time, it was on the rise in Europe.

Preparations

People taking saw palmetto should use only standardized extracts that contain 85–95% fatty acids and sterols. Dosages vary depending on the type of saw palmetto used. A typical dose is 320 mg per day of standardized extract or 0.04–0.07 (1–2 g) per day of ground, dried, whole berries. It may take up to four weeks of use before beneficial effects are seen. In late 1999, the web-based independent consumer organization ConsumerLab.com tested 27 leading brands of saw palmetto for fatty acid and sterol content. Ten of the brands contained less than the minimum recommended level of 85% fatty acids and sterols.

Precautions

There are no special precautions associated with taking saw palmetto, even in high doses. However, BPH can become a serious problem if left untreated. Men who are experiencing symptoms should be examined by a physician, since the symptoms of BPH are similar to those of prostate **cancer**. Men over the age of 50 should have a yearly prostate exam. Saw palmetto should only be used under a doctor's supervision by people with prostate cancer, **breast cancer**, or any sex hormone related diseases. Although the effects of saw palmetto on a fetus is unknown, pregnant women are advised not to take saw palmetto. Saw palmetto can alter hormonal activity that could have an adverse effect on the fetus. Women taking birth control pills or estrogen replacement products should consult a physician before taking saw palmetto. Persons taking testosterone or other anabolic steroids

should not take saw palmetto without first consulting their doctor.

In rare cases, allergic reactions to saw palmetto have been reported. Symptoms include difficulty breathing, constricting of the throat, **hives**, and swelling of the lips, tongue, or face. Persons experiencing any of these symptoms should stop taking saw palmetto and seek immediate medical attention.

Side effects

The only reported minor side effects are rare and include cramps, nausea, **diarrhea**, and **headache**.

Interactions

Saw palmetto may interfere with hormone-related drugs such as testosterone and estrogen replacements, including Premarin, Cenestin, Vivelle, Fempatch, and Climara. It may also interact with birth control pills, such as Triphasil, Ovral, Lo-Ovral, Nordette, Alesse, Demulen, and Ortho-Novum. Anyone on these types of medications should consult with their doctor before taking saw palmetto. There are no known restrictions on food, beverages, or physical activity while taking saw palmetto.

Several herbs and **minerals** have been used in conjunction with saw palmetto in treating BPH. A 1996 European study showed positive results in treating patients with a daily dose of 320 mg of saw palmetto extract and 240 mg of nettle root extract. Many alternative health practitioners also recommend saw palmetto be used in combination with the herb pygeum africanung, pumpkin seeds, zinc, flaxseed oil, certain amino acids, antioxidants, and **diets** high in protein and soy products. Some factors that can impair the effectiveness of saw palmetto include beer, cigarette smoke, and some chemical pesticides used on fruit and vegetables. Some physicians recommend using saw palmetto in addition to a prescription medicine, such as Proscar, Hytrin, or Cardura.

Resources

BOOKS

Fleming, Thomas, ed. *PDR for Herbal Medicine.* Medical Economics Co., 1998.

Foster, Steven W. *101 Medicinal Herbs.* Interweave Press, 1998.

Foster, Steven W. *Guide to Herbal Dosages.* Interweave Press, 2000.

Sahelian, Ray. *Saw Palmetto, Nature's Prostate Healer.* Kensington Publishing Corp., 1998.

Winston, David. *Saw Palmetto for Men & Women: Herbal Healing for the Prostate, Urinary Tract, Immune System, and More.* Storey Books, 1999.

KEY TERMS

Anabolic steroids—A group of mostly synthetic hormones sometimes taken by athletes to temporarily increase muscle size.

Aphrodesiac—Any substance that excites sexual desire.

Estrogen—A hormone that stimulates development of female secondary sex characteristics.

Placebo—An inert or innocuous substance used in controlled experiments testing the efficacy of another substance.

Progesterone—A steroid hormone that is a biological precursor to corticoid (another steroid hormone) and androgen (a male sex hormone).

Testosterone—A male hormone produced in the testes or made synthetically that is responsible for male secondary sex characteristics.

Urethra—The canal that carries urine from the bladder.

PERIODICALS

D'Epiro, Nancy Walsh. "Saw Palmetto and the Prostate." *Patient Care* (April 15, 1999): 29.

Overmyer, Mac. "Saw Palmetto Shown to Shrink Prostatic Epithelium." *Urology Times* (June 1999): 1, 42.

Starbuck, J. Jamison. "It's a Guy Thing." *Better Nutrition* (Oct. 1999): 46.

Wilt, Timothy J., et al. "Saw Palmetto for Benign Prostatic Hyperplasia." *Nutritional Research Newsletter* (March 1999): 1.

Ken R. Wells

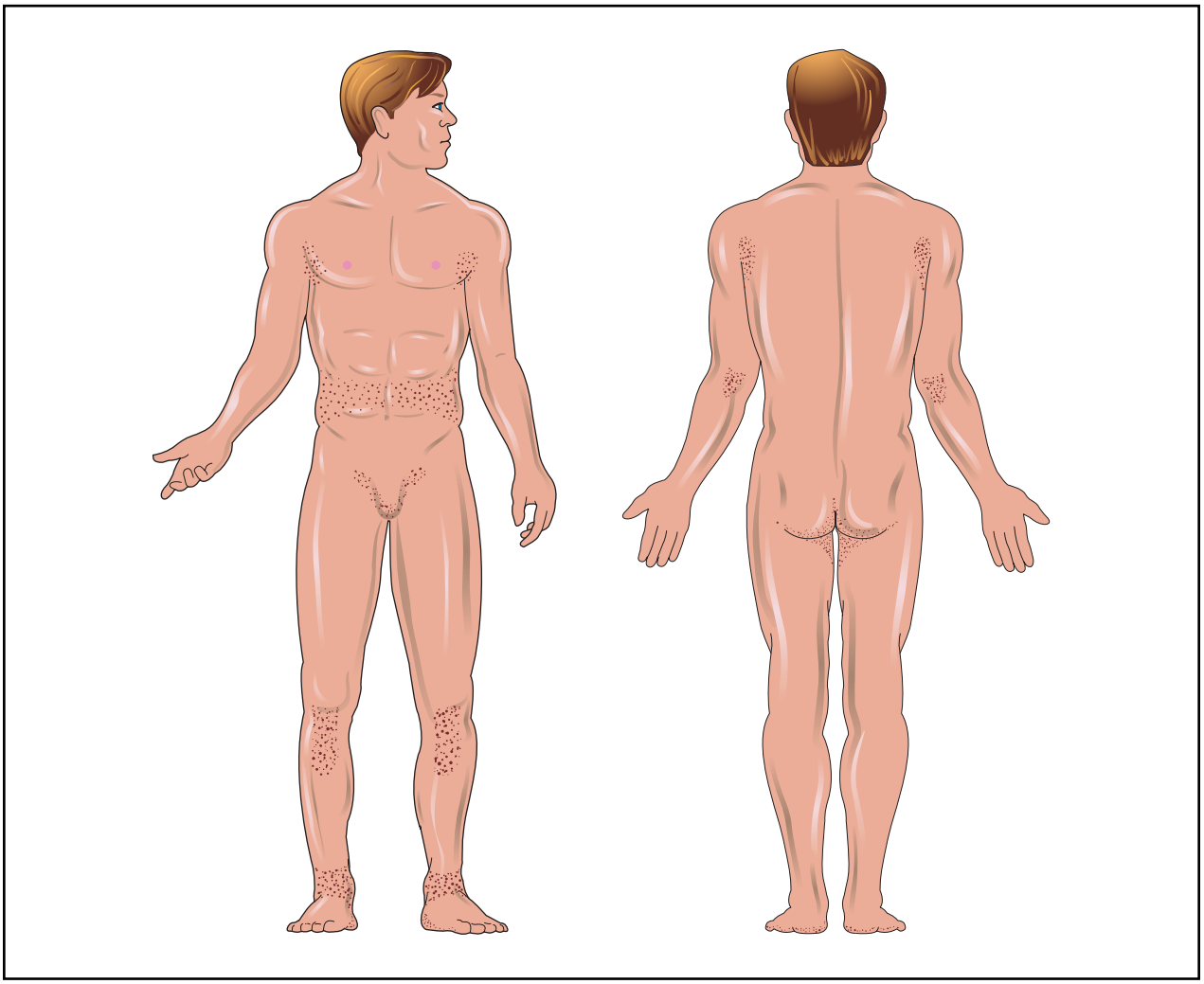
Scabies

Definition

Scabies is a relatively contagious infection caused by a tiny mite.

Description

Scabies is caused by a tiny, 0.3 mm long insect called a mite. When a human comes in contact with the female mite, the mite burrows under the skin, laying eggs along the line of its burrow. These eggs hatch, and the resulting offspring rise to the surface of the skin, mate,



Scabies is a contagious skin infection common among people who live in overcrowded, less than ideal hygienic environments. It is caused by the infestation of female scab mites that, upon contact, burrow under the victim's skin and lay eggs along the lines of passage. Once the eggs hatch, the new mites rise to the skin's surface, mate, and repeat the infestation. Scabies can occur anywhere on the body, including the armpit, groin, buttocks, genital area, and ankles, as shown in the illustration above. *(Illustration by Electronic Illustrators Group.)*

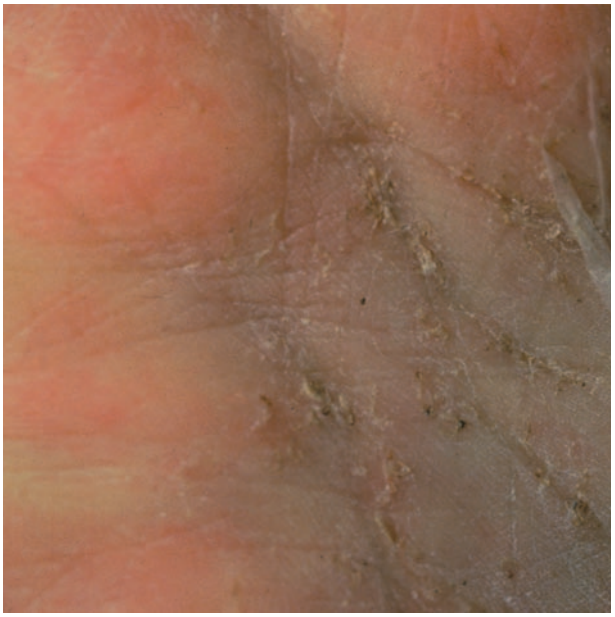
and repeat the cycle either within the skin of the original host, or within the skin of its next victim.

The intense **itching** almost always caused by scabies is due to a reaction within the skin to the feces of the mite. The first time someone is infected with scabies, he or she may not notice any itching for a number of weeks (four to six weeks). With subsequent infections, the itchiness will begin within hours of picking up the first mite.

Causes and symptoms

Scabies is most common among people who live in overcrowded conditions, and whose ability to practice good hygiene is limited. Scabies can be passed between people by close skin contact. Although the mites can only live away from human skin for about three days, sharing clothing or bedclothes can pass scabies among family members or close contacts.

The itching from scabies is worse after a hot shower and at night. Burrows are seen as winding, slightly raised gray lines along the skin. The female mite may be seen at one end of the burrow, as a tiny pearl-like bump underneath the skin. Because of the intense itching, burrows may be obscured by scratch marks left by the patient. The most common locations for burrows include the sides of the fingers, between the fingers, the top of the wrists, around the elbows and armpits, around the nipples of the breasts in women, in the genitalia of men, around the waist (beltline), and on the lower part of the



Scab mites have penetrated under the skin of this person's hand. *(Custom Medical Stock Photo. Reproduced by permission.)*

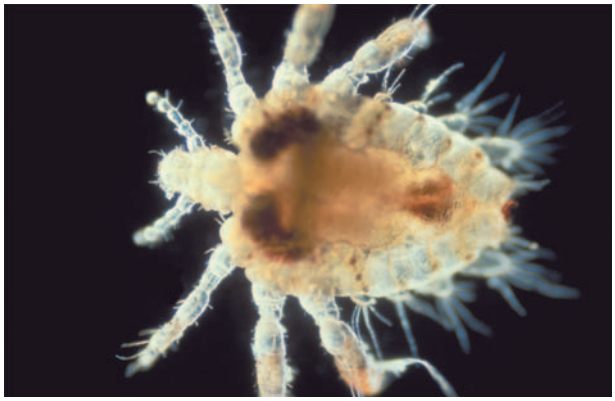
buttocks. Babies may have burrows on the soles of their feet, palms of their hands, and faces.

Scratching seems to serve some purpose in scabies, as the mites are apparently often inadvertently removed. Most infestations with scabies are caused by no more than 15 mites altogether.

Infestation with huge numbers of mites (on the order of thousands to millions) occurs when an individual does not scratch, or when an individual has a weakened immune system. These patients include those who live in institutions; are mentally retarded, or physically infirm; have other diseases which affect the amount of sensation they have in their skin (**leprosy** or syringomyelia); have leukemia or diabetes; are taking medications which lower their immune response (**cancer chemotherapy**, drugs given after organ transplantation); or have other diseases which lower their immune response (such as acquired **immunodeficiency** syndrome or **AIDS**). This form of scabies, with its major infestation, is referred to as crusted scabies or Norwegian scabies. Infected patients have thickened, crusty areas all over their bodies, including over the scalp. Their skin is scaly. Their fingernails may be thickened and horny.

Diagnosis

Diagnosis can be made simply by observing the characteristic burrows of the mites causing scabies. A sterilized needle can be used to explore the pearly bump at the end of a burrow, remove its contents, and place it on a slide to be examined. The mite itself may then be identified under a microscope.



An enhanced image of a scab mite. *(Custom Medical Stock Photo. Reproduced by permission.)*

Occasionally, a type of mite carried on dogs may infect humans. These mites cannot survive for very long on humans, and so the infection is very light.

Treatment

Several types of lotions (1% lindane or 5% permethrin) can be applied to the body, and left on for 12-24 hours. This is usually sufficient, although it may be reapplied after a week if mites remain. Preparations containing lindane should not be used to treat pregnant women and infants. Itching can be lessened by the use of calamine lotion and antihistamine medications.

Prognosis

The prognosis for complete recovery from scabies infestation is excellent. In patients with weak immune systems, the biggest danger is that the areas of skin involved with scabies will become secondarily infected with bacteria.

Prevention

Good hygiene is essential in the prevention of scabies. When a member of a household is diagnosed with scabies, all that person's recently-worn clothing and bedding should be washed in very hot water.

Resources

BOOKS

Darmstadt, Gary L., and Al Lane. "Arthropod Bites and Infestations." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Maguire, James H. "Ectoparasite Infestations and Arthropod Bites and Stings." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Apgar, Barbara. "Comparison of Lindane and Permethrin for Scabies." *American Family Physician* 54, no. 7 (15 Nov. 1996): 2293+.

Forsman, Karen E. "Pediculosis and Scabies: What to Look For In Patients Who Are Crawling With Clues." *Postgraduate Medicine* 98, no. 6 (Dec. 1995): 89+.

Moore, Adrienne V. "Stopping the Spread of Scabies." *American Journal of Nursing* 97, no. 10 (15 Nov. 1996): 2293+.

Pariser, Robert J. "Scabies: The Myth and the Reality." *Consultant* 36, no. 3 (Mar. 1996): 527+.

Rosalyn Carson-DeWitt, MD

Scarlatina *see* **Scarlet fever**

Scarlet fever

Definition

Scarlet **fever** is an infection that is caused by a bacteria called streptococcus. The disease is characterized by a **sore throat**, fever, and a sandpaper-like rash on reddened skin. It is primarily a childhood disease. If scarlet fever is untreated, serious complications such as **rheumatic fever** (a heart disease) or kidney inflammation (**glomerulonephritis**) can develop.

Description

Scarlet fever, also known as scarlatina, gets its name from the fact that the patient's skin, especially on the cheeks, is flushed. A sore throat and raised rash over much of the body are accompanied by fever and sluggishness (lethargy). The fever usually subsides within a few days and recovery is complete by two weeks. After the fever is gone, the skin on the face and body flakes; the skin on the palms of the hands and soles of the feet peels more dramatically.

This disease primarily affects children ages two to ten. It is highly contagious and is spread by sneezing, coughing, or direct contact. The incubation period is three to five days, with symptoms usually beginning on the second day of the disease, and lasting from four to ten days.

GLADYS DICK (1881–1963)

Before 1922, not much was known about the then-endemic disease of scarlet fever, which primarily affected children in Europe and North America, killing about 25% of the children who contracted it. Additionally, scarlet fever had many complications, some of which were severe and could be crippling. Gladys Dick, with her husband, George Dick, successfully isolated the bacteria which caused scarlet fever, developed a test for human vulnerability to the disease, and devised preventive methods. The couple patented their findings, specifically the way their scarlet fever toxin and antitoxin were prepared, although this decision was controversial at the time.

In 1923, the Dicks published papers in which they proved that scarlet fever was caused by hemolytic streptococcus. Within a few years, the Dicks also published papers on how to prevent, test, diagnose, and treat scarlet fever. Their ground-breaking work ensured that the disease was finally understood and brought under control.

Dick and her husband announced the development of what came to be known as the Dick test in 1924. This skin test showed whether the patient was susceptible or immune to scarlet fever. The test involved injecting a toxin-containing substance in the arm and determining if the skin around the area became inflamed. If it did, the patient was vulnerable to scarlet fever. This test was also useful in predicting if pregnant women would develop puerperal infection during childbirth.

Early in the 20th century, severe scarlet fever epidemics were common. Today, the disease is rare. Although this decline is due in part to the availability of **antibiotics**, that is not the entire reason since the decline began before the widespread use of antibiotics. One theory is that the strain of bacteria that causes scarlet fever has become weaker with time.

Causes and symptoms

Scarlet fever is caused by Group A streptococcal bacteria (*S. pyogenes*). Group A streptococci can be highly toxic microbes that can cause **strep throat**, wound or skin infections, **pneumonia**, and serious kidney infections, as well as scarlet fever. The Group A streptococci are ß-hemolytic bacteria, which means that the bacteria have the ability to lyse or break red blood cells. The strain of streptococcus that causes scarlet fever is slightly different from the strain that causes most strep throats. The scarlet fever strain of bacteria produces a

toxin, called an erythrogenic toxin. This toxin is what causes the skin to flush.

The main symptoms and signs of scarlet fever are fever, lethargy, sore throat, and a bumpy rash that blanches under pressure. The rash appears first on the upper chest and spreads to the neck, abdomen, legs, arms, and in folds of skin such as under the arm or groin. In scarlet fever, the skin around the mouth tends to be pale, while the cheeks are flushed. The patient usually has a "strawberry tongue," in which inflamed bumps on the tongue rise above a bright red coating. Finally, dark red lines (called Pastia's lines) may appear in the creases of skin folds.

Diagnosis

Cases of scarlet fever are usually diagnosed and treated by pediatricians or family medicine practitioners. The chief diagnostic signs of scarlet fever are the characteristic rash, which spares the palms and soles of the feet, and the presence of a strawberry tongue in children. Strawberry tongue is rarely seen in adults.

The doctor will take note of the signs and symptoms to eliminate the possibility of other diseases. Scarlet fever can be distinguished from **measles**, a viral infection that is also associated with a fever and rash, by the quality of the rash, the presence of a sore throat in scarlet fever, and the absence of the severe eye inflammation and severe runny nose that usually accompany measles.

The doctor will also distinguish between a strep throat, a viral infection of the throat, and scarlet fever. With a strep infection, the throat is sore and appears beefy and red. White spots appear on the tonsils. Lymph nodes under the jawline may swell and become tender. However, none of these symptoms are specific for strep throat and may also occur with a viral infection. Other signs are more characteristic of bacterial infections. For example, inflammation of the lymph nodes in the neck is typical in strep infections, but not viral infections. On the other hand, **cough**, **laryngitis**, and stuffy nose tend to be associated with viral infections rather than strep infections. The main feature that distinguishes scarlet fever from a mere strep throat is the presence of the sandpaper-red rash.

Laboratory tests are needed to make a definitive diagnosis of a strep infection and to distinguish a strep throat from a viral sore throat. One test that can be performed is a blood cell count. Bacterial infections are associated with an elevated white blood cell count. In viral infections, the white blood cell count is generally below normal.

A **throat culture** can distinguish between a strep infection and a viral infection. A throat swab from the infected person is brushed over a nutrient gel (a sheep blood agar plate) and incubated overnight to detect the presence of hemolytic bacteria. In a positive culture, a clear zone will appear in the gel surrounding the bacterium, indicating that a strep infection is present.

KEY TERMS

Clindamycin—An antibiotic that can be used instead of penicillin.

Erythrogenic toxin—A toxin or agent produced by the scarlet fever-causing bacteria that causes the skin to turn red.

Erythromycin—An antibiotic that can be used instead of penicillin.

Glomerulonephritis—A serious inflammation of the kidneys that can be caused by streptococcal bacteria; a potential complication of untreated scarlet fever.

Hemolytic bacteria—Bacteria that are able to burst red blood cells.

Lethargy—The state of being sluggish.

Pastia's lines—Red lines in the folds of the skin, especially in the armpit and groin, that are characteristic of scarlet fever.

Penicillin—An antibiotic that is used to treat bacterial infections.

Procaine penicillin—An injectable form of penicillin that contains an anesthetic to reduce the pain of the injection.

Rheumatic fever—A heart disease that is a complication of a strep infection.

Sheep blood agar plate—A petri dish filled with a nutrient gel containing red blood cells that is used to detect the presence of streptococcal bacteria in a throat culture. Streptococcal bacteria will lyse or break the red blood cells, leaving a clear spot around the bacterial colony.

Strawberry tongue—A sign of scarlet fever in which the tongue appears to have a red coating with large raised bumps.

Treatment

Although scarlet fever will often clear up spontaneously within a few days, antibiotic treatment with either oral or injectable penicillin is usually recommended to reduce the severity of symptoms, prevent complications, and prevent spread to others. Antibiotic treatment will

shorten the course of the illness in small children but may not do so in adolescents or adults. Nevertheless, treatment with antibiotics is important to prevent complications.

Since penicillin injections are painful, oral penicillin may be preferable. If the patient is unable to tolerate penicillin, alternative antibiotics such as erythromycin or clindamycin may be used. However, the entire course of antibiotics, usually 10 days, will need to be followed for the therapy to be effective. Because symptoms subside quickly, there is a temptation to stop therapy prematurely. It is important to take all of the pills in order to kill the bacteria. Not completing the course of therapy increases the risk of developing rheumatic fever and kidney inflammation.

If the patient is considered too unreliable to take all of the pills or is unable to take oral medication, daily injections of procaine penicillin can be given in the hip or thigh muscle. Procaine is an anesthetic that makes the injections less painful.

Bed rest is not necessary, nor is **isolation** of the patient. **Aspirin** or Tylenol (**acetaminophen**) may be given for fever or relief of **pain**.

Prognosis

If treated promptly with antibiotics, full recovery is expected. Once a patient has had scarlet fever, they develop immunity and cannot develop it again.

Prevention

Avoiding exposure to children who have the disease will help prevent the spread of scarlet fever.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

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Schatzki's ring *see* **Lower esophageal ring**

Schistosomiasis

Definition

Schistosomiasis, also known as bilharziasis or snail **fever**, is a primarily tropical parasitic disease caused by the larvae of one or more of five types of flatworms or blood flukes known as schistosomes. The name bilharziasis comes from Theodor Bilharz, a German pathologist, who identified the worms in 1851.

Description

Infections associated with worms present some of the most universal health problems in the world. In fact, only **malaria** accounts for more diseases than schistosomiasis. The World Health Organization (WHO) estimates that 200 million people are infected and 120 million display symptoms. Another 600 million people are at risk of infection. Schistosomes are prevalent in rural and outlying city areas of 74 countries in Africa, Asia, and Latin America. In Central China and Egypt, the disease poses a major health risk.

There are five species of schistosomes that are prevalent in different areas of the world and produce somewhat different symptoms:

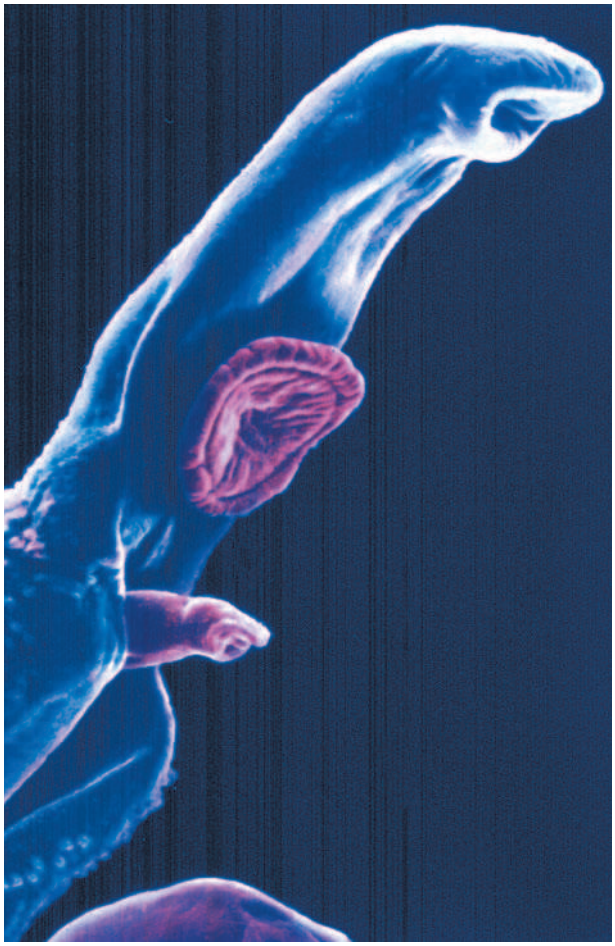
- *Schistosoma mansoni* is widespread in Africa, the Eastern-Mediterranean, the Caribbean, and South America and can only infect humans and rodents.
- *S. mekongi* is prevalent only in the Mekong river basin in Asia.
- *S. japonicum* is limited to China and the Philippines and can infect other mammals, in addition to humans, such as pigs, dogs, and water buffalos. As a result, it can be harder to control disease caused by this species.
- *S. intercalatum* is found in central Africa.
- *S. haematobium* occurs predominantly in Africa and the Eastern Mediterranean.

Intestinal schistosomiasis, caused by *Schistosoma japonicum, S. mekongi, mansoni*, and *S. intercalatum*, can lead to serious complications of the liver and spleen. Urinary schistosomiasis is caused by *S. haematobium.*

It is difficult to know how many individuals die of schistomiasis each year because **death** certificates and patient records seldom identify schistosomiasis as the primary cause of death. Mortality estimates vary related to the type of schistosome infection but is generally low, for example, 2.4 of 100,000 die each year from infection with *S. mansoni*.

Causes and symptoms

All five species are contracted in the same way, through direct contact with fresh water infested with the free-living form of the parasite known as cercariae. The building of dams, irrigation systems, and reservoirs, and the movements of refugee groups introduce and spread schistosomiasis.



A scanning electron microscopy (SEM) of the head region of the male and female adult flukes of *Schistosoma sp.* These worms cause schistosomiasis (bilharziasis) in humans. Flukes live in human blood vessels and their eggs contaminate freshwater. *(Photo Researchers, Inc. Reproduced by permission.)*

Eggs are excreted in human urine and feces and, in areas with poor sanitation, contaminate freshwater sources. The eggs break open to release a form of the parasite called miracidium. Freshwater snails become infested with the miracidium, which multiply inside the snail and mature into multiple cercariae that the snail ejects into the water. The cercariae, which survive outside a host for 48 hours, quickly penetrate unbroken skin, the lining of the mouth, or the gastrointestinal tract. Once inside the human body, the worms penetrate the wall of the nearest vein and travel to the liver where they grow and sexually mature. Mature male and female worms pair and migrate either to the intestines or the bladder where egg production occurs. One female worm may lay an average of 200 to 2,000 eggs per day for up to twenty years. Most eggs leave the blood stream and body through the intestines. Some of the eggs are not excreted, however, and can lodge in the tissues. It is the presence of these eggs, rather than the worms themselves, that causes the disease.

Early symptoms of infection

Many individuals do not experience symptoms. If present, it usually takes four to six weeks for symptoms to appear. The first symptom of the disease may be a general ill feeling. Within twelve hours of infection, an individual may complain of a tingling sensation or light rash, commonly referred to as "swimmer's itch," due to irritation at the point of entrance. The rash that may develop can mimic **scabies** and other types of **rashes**. Other symptoms can occur two to ten weeks later and can include fever, aching, **cough**, **diarrhea**, or gland enlargement. These symptoms can also be related to avian schistosomiasis which does not cause any further symptoms in humans.

Katayama fever

Another primary condition, called Katayama fever, may also develop from infection with these worms, and it can be very difficult to recognize. Symptoms include fever, lethargy, the eruption of pale temporary bumps associated with severe **itching** (urticarial) rash, liver and spleen enlargement, and bronchospasm.

Intestinal schistosomiasis

In intestinal schistosomiasis, eggs become lodged in the intestinal wall and cause an immune system reaction called a granulomatous reaction. This immune response can lead to obstruction of the colon and blood loss. The infected individual may have what appears to be a potbelly. Eggs can also become lodged in the liver, leading to high blood pressure through the liver, enlarged spleen, the build-up of fluid in the abdomen (**ascites**), and potentially life-threatening dilations or swollen areas in the esophagus or gastrointestinal tract that can tear and bleed profusely (esophageal varices). Rarely, the central nervous system may be affected. Individuals with chronic active schistosomiasis may not complain of typical symptoms.

Urinary tract schistosomiasis

Urinary tract schistosomiasis is characterized by blood in the urine, **pain** or difficulty urinating, and frequent urination and are associated with *S. haematobium*. The loss of blood can lead to **iron deficiency anemia**. A large percentage of persons, especially children, who are moderately to heavily infected experience urinary tract damage that can lead to blocking of the urinary tract and **bladder cancer**.

Diagnosis

Proper diagnosis and treatment may require a tropical disease specialist because the disease can be confused with malaria or typhoid in the early stages. The healthcare provider should do a thorough history of travel in endemic areas. The rash, if present, can mimic scabies or other rashes, and the gastrointestinal symptoms may be confused with those caused by bacterial illnesses or other intestinal parasites. These other conditions will need to be excluded before an accurate diagnosis can be made. As a result, clinical evidence of exposure to infected water along with physical findings, a negative test for malaria, and an increased number of one type of immune cell, called an eosinophil, are necessary to diagnose acute schistosomiasis.

Eggs may be detected in the feces or urine. Repeated stool tests may be required to concentrate and identify the eggs. Blood tests may be used to detect a particular antigen or particle associated with the schistosome that induces an immune response. Persons infected with schistosomiasis may not test positive for six months, and as a result, tests may need to be repeated to obtain an accurate diagnosis. Blood can be detected visually in the urine or with chemical strips that react to small amounts of blood.

Sophisticated imaging techniques, such as ultrasound, computed tomography scan (CT scan), and **magnetic resonance imaging** (MRI), can detect damage to the blood vessels in the liver and visualize polyps and ulcers of the urinary tract, for example, that occur in the more advanced stages. *S. haematobium* is difficult to diagnose with ultrasound in pregnant women.

Treatment

The use of medications against schistosomiasis, such as praziquantel (Biltricide), oxamniquine, and metrifonate, have been shown to be safe and effective. Praziquantel is effective against all forms of schistososmiasis and has few side effects. This drug is given in either two or three doses over the course of a single day. Oxamniquine is typically used in Africa and South America to treat intestinal schistosomiasis. Metrifonate has been found to be safe and effective in the treatment of urinary schistosomiasis. Patients are typically checked for the presence of living eggs at three and six months after treatment. If the number of eggs excreted has not significantly decreased, the patient may require another course of medication.

Prognosis

If treated early, prognosis is very good and complete recovery is expected. The illness is treatable, but people can die from the effects of untreated schistomiasis. The severity of the disease depends on the number of worms, or worm load, in addition to how long the person has been infected. With treatment, the number of worms can be substantially reduced, and the secondary conditions can be treated. The goal of the World Health Organization is to reduce the severity of the disease rather than to completely stop transmission of the disease. There is, however, little natural immunity to reinfection. Treated individuals do not usually require retreatment for two to five years in areas of low transmission. The World Health Organization has made research to develop a vaccine against the disease one of its priorities.

KEY TERMS

Ascites—The condition that occurs when the liver and kidneys are not functioning properly and a clear, straw-colored fluid is excreted by the membrane that lines the abdominal cavity (peritoneum).

Cescariae—The free-living form of the schistosome worm that has a tail, swims, and has suckers on its head for penetration into a host.

Miracidium—The form of the schistosome worm that infects freshwater snails.

Prevention

Prevention of the disease involves several targets and requires long term community commitment. Infected patients require diagnosis, treatment, and education about how to avoid reinfecting themselves and others. Adequate healthcare facilities need to be available, water systems must be treated to kill the worms and control snail populations, and sanitation must be improved to prevent the spread of the disease.

To avoid schistosomiasis in endemic areas:

- contact the CDC for current health information on travel destinations.
- upon arrival, ask an informed local authority about the infestation of schistosomiasis before being exposed to freshwater in countries that are likely to have the disease.
- do not swim, stand, wade, or take baths in untreated water.
- treat all water used for drinking or bathing. Water can be treated by letting it stand for three days, heating it for five minutes to around 122°F (around 50°C), or filtering or treating water chemically, with chlorine or iodine, as with drinking water.

• should accidental exposure occur, infection can be prevented by hastily drying off or applying rubbing alcohol to the exposed area.

Resources

PERIODICALS

Day, John H., et al. "Schistosomiasis in Travellers Returning from Sub Saharan Africa." *British Medical Journal* 3 (Aug. 1996): 268-69.

Doherty, J. F., A. H. Moody, and S. G. Wright. "Katayama Fever: An Acute Manifestation of Schistosomiasis." *British Medical Journal* 26 (Oct. 1996): 1071-1072.

Savioli, L., K. E. Mott, and Yu Sen Hai. "Intestinal Worms." *World Health*, (July/Aug. 1996): 28.

Waine, Gary J., and Donald P. McManus. "Schistosomiasis Vaccine Development: The Current Picture." *BioEssays* (May 1997): 435-443.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

OTHER

"Schistosomiasis (Bilharzia)." *Travel Health Information Page.* 5 Mar. 1997. 1 Jan. 1998 <http://www.travelhealth.com/schisto.htm>.

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Schizencephaly *see* **Congenital brain defects**

Schizoaffective disorder

Definition

Schizoaffective disorder is a mental illness that shares the psychotic symptoms of **schizophrenia** and the mood disturbances of depression or **bipolar disorder**.

Description

The term schizoaffective disorder was first used in the 1930s to describe patients with acute psychotic symptoms such as **hallucinations** and **delusions** along with disturbed mood. These patients tended to function well before becoming psychotic; their psychotic symptoms lasted relatively briefly; and they tended to do well afterward. Over the years, however, the term schizoaffective disorder has been applied to a variety of patient groups. The current definition contained in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders IV* (*DSM-IV*) recognizes patients with schizoaffective disorder as those whose mood symptoms are sufficiently severe to warrant a diagnosis of depression or other full-blown mood disorder and whose mood symptoms overlap at some period with psychotic symptoms that satisfy the diagnosis of schizophrenia (e.g. hallucinations, delusions, or thought process disorder).

Causes and symptoms

The cause of schizoaffective disorder remains unknown and subject to continuing speculation. Some investigators believe schizoaffective disorder is associated with schizophrenia and may be caused by a similar biological predisposition. Others disagree, stressing the disorder's similarities to **mood disorders** such as depression and bipolar disorder (manic depression). They believe its more favorable course and less intense psychotic episodes are evidence that schizoaffective disorder and mood disorders share a similar cause.

Many researchers, however, believe schizoaffective disorder may owe its existence to both disorders. These researchers believe that some people have a biologic predisposition to symptoms of schizophrenia that varies along a continuum of severity. On one end of the continuum are people who are predisposed to psychotic symptoms but never display them. On the other end of the continuum are people who are destined to develop outright schizophrenia. In the middle are those who may at some time show symptoms of schizophrenia, but require some other major trauma to set the progression of the disease into motion. It may be an early brain injury—either through a complicated delivery, prenatal exposure to the flu virus or illicit drugs; or it may be emotional, nutritional or other deprivation in early childhood. In this view, major life stresses, or a mood disorder like depression or bipolar disorder, may be sufficient to trigger the psychotic symptoms. In fact, patients with schizoaffective disorder frequently experience depressed mood or **mania** within days of the appearance of psychotic symptoms. Some clinicians believe that "schizomanic" patients are fundamentally different from "schizodepressed" types; the former are similar to bipolar patients, while the latter are a very heterogeneous group.

Symptoms of schizoaffective disorder vary considerably from patient to patient. Delusions, hallucinations, and evidence of disturbances in thinking—as observed in full-blown schizophrenia—may be seen. Similarly, mood fluctuations such as those observed in major depression or bipolar disorder may also be seen. These symptoms tend to appear in distinct episodes that impair the indi-

vidual's ability to function well in daily life. But between episodes, some patients with schizoaffective disorder remain chronically impaired while some may do quite well in day-to-day living.

Diagnosis

There are no accepted tissue or brain imaging tests or techniques to diagnose schizophrenia, mood disorders, or schizoaffective disorder. Instead, physicians look for the hallmark signs and symptoms of schizoaffective disorder described above, and they attempt to rule out other illnesses or conditions that may produce similar symptoms. These include:

- Mania. True manic patients can experience episodes of hallucinations and delusions similar to those seen in schizoaffective disorder; but these do not persist for long periods after the mania recedes, as they do in schizoaffective disorder.
- Psychotic depression. Patients with psychotic depression experience hallucinations and delusions similar to those seen in schizoaffective disorder; but these symptoms do not persist after the depressive symptoms recede, as they do in schizoaffective disorder.
- Schizophrenia. Depressed mood, mania, or other symptoms may be present in patients with schizophrenia, but patients with schizoaffective disorder will meet all the criteria set out for a full-blown mood disorder.
- Medical and neurological disorders that mimic psychotic/affective disorders.

Treatment

Antipsychotic medications used to treat schizophrenia and the **antidepressant drugs** and mood stabilizers used in depression and bipolar disorder are the primary treatments for schizoaffective disorder.

Unfortunately these treatments have not been well studied in controlled investigations. Studies suggest that traditional antipsychotics such as haloperidol are effective in treating psychotic symptoms. Newer generation antipsychotics, such as clozaril and risperidone, have not been as well studied, but also appear effective. For patients with symptoms of bipolar disorder, lithium is often the mood stabilizer of choice; and it is often augmented with an anticonvulsant such as valproate. For those with depressive symptoms, the evidence supporting the use of antidepressant medications in addition to antipsychotic medications is more mixed. **Electroconvulsive therapy** (electric shock) is frequently tried in patients who otherwise do not respond to antidepressant or mood stabilizing drugs.

KEY TERMS

Bipolar disorder—Also referred to as manic depression, it is a mood disorder marked by alternating episodes of extremely low mood (depression) and exuberant highs (mania).

Mood disorder—A collection of disorders that includes major depression and bipolar disorder. They are all characterized by major disruptions in patients' moods and emotions.

Schizophrenia—A major mental illness marked by psychotic symptoms, including hallucinations, delusions, and severe disruptions in thinking.

While the mainstay of treatment for schizoaffective disorder is antipsychotic medications and mood stabilizers, certain forms of psychotherapy for both patients and family members can be useful. Therapy designed to provide structure and help augment patients' ability to solve problems may aid in improving patients' ability to function in the day-to-day world, reducing **stress** and the risk of recurrence. Vocational and other rehabilitative training can help patients to work on skills they need to develop. Whereas hospitalization may be necessary for acute psychotic episodes, half-way houses and day hospitals can provide needed treatment while serving as a bridge for patients to reenter the community.

Alternative treatment

While alternative therapies should never be considered a replacement for medication, these treatments can help support people with schizoaffectve disorder and other mental illnesses. Dietary modifications that eliminate processed foods and emphasize whole foods, along with nutritional supplementation, may be helpful. **Acupuncture**, **homeopathy**, and botanical medicine can support many aspects of the person's life and may help decrease the side effects of any medications prescribed.

Prognosis

In general, patients with schizoaffective disorder have a more favorable prognosis than do those with schizophrenia, but a less favorable course than those with a pure mood disorder. Medication and other interventions can help quell psychotic symptoms and stabilize mood in many patients, but there is great variability in outcome from patient to patient.

Prevention

There is no known way to prevent schizoaffective disorder. Treatment with antipsychotic and mood stabilizing drugs may prevent recurrences. Some researchers believe prompt treatment can prevent the development of full-blown schizophrenia, but this remains the subject of some disagreement.

Resources

BOOKS

Gabbard, Glen O. *Treatment of Psychiatric Disorders*. Washington, DC: American Psychiatric Press, 1995.

Kaplan, Harold I., and Benjamin J. Sadock. *Comprehensive Textbook of Psychiatry/VI*. Baltimore: Williams & Wilkins, 1995.

PERIODICALS

Keck Jr., Paul E., et al. "New Developments in the Pharmacologic Treatment of Schizoaffective Disorder." *Journal of Clinical Psychiatry* 57 (1996): 41-48.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington, DC 20005. (888) 357-7924. <http://www.psych.org>.

National Alliance for Research on Schizophrenia and Depression. 60 Cutter Mill Road, Suite 200, Great Neck, NY 11021. (516) 829-0091. <http://www.mhsource.com>.

Richard H. Camer

Schizophrenia

Definition

Schizophrenia is a psychotic disorder (or a group of disorders) marked by severely impaired thinking, emotions, and behaviors. Schizophrenic patients are typically unable to filter sensory stimuli and may have enhanced perceptions of sounds, colors, and other features of their environment. Most schizophrenics, if untreated, gradually withdraw from interactions with other people, and lose their ability to take care of personal needs and grooming.

Description

The course of schizophrenia in adults can be divided into three phases or stages. In the acute phase, the patient has an overt loss of contact with reality (psychotic episode) that requires intervention and treatment. In the second or stabilization phase, the initial psychotic symptoms have been brought under control but the patient is at risk for relapse if treatment is interrupted. In the third or maintenance phase, the patient is relatively stable and can be kept indefinitely on antipsychotic medications. Even in the maintenance phase, however, relapses are not unusual and patients do not always return to full functioning.

The term schizophrenia comes from two Greek words that mean "split mind." It was observed around 1908, by a Swiss doctor named Eugen Bleuler, to describe the splitting apart of mental functions that he regarded as the central characteristic of schizophrenia.

Recently, some psychotherapists have begun to use a classification of schizophrenia based on two main types. People with Type I, or positive schizophrenia, have a rapid (acute) onset of symptoms and tend to respond well to drugs. They also tend to suffer more from the "positive" symptoms, such as **delusions** and **hallucinations**. People with Type II, or negative schizophrenia, are usually described as poorly adjusted before their schizophrenia slowly overtakes them. They have predominantly "negative" symptoms, such as withdrawal from others and a slowing of mental and physical reactions (psychomotor retardation).

There are five subtypes of schizophrenia:

Paranoid

The key feature of this subtype of schizophrenia is the combination of false beliefs (delusions) and hearing voices (auditory hallucinations), with more nearly normal emotions and cognitive functioning (cognitive functions include reasoning, judgment, and memory). The delusions of paranoid schizophrenics usually involve thoughts of being persecuted or harmed by others or exaggerated opinions of their own importance, but may also reflect feelings of jealousy or excessive religiosity. The delusions are typically organized into a coherent framework. Paranoid schizophrenics function at a higher level than other subtypes, but are at risk for suicidal or violent behavior under the influence of their delusions.

Disorganized

Disorganized schizophrenia (formerly called hebephrenic schizophrenia) is marked by disorganized speech, thinking, and behavior on the patient's part, coupled with flat or inappropriate emotional responses to a situation (affect). The patient may act silly or withdraw socially to an extreme extent. Most patients in this category have weak personality structures prior to their initial acute psychotic episode.

Catatonic

Catatonic schizophrenia is characterized by disturbances of movement that may include rigidity, stupor,

agitation, bizarre posturing, and repetitive imitations of the movements or speech of other people. These patients are at risk for **malnutrition**, exhaustion, or self-injury. This subtype is presently uncommon in Europe and the United States. **Catatonia** as a symptom is most commonly associated with **mood disorders**.

Undifferentiated

Patients in this category have the characteristic positive and negative symptoms of schizophrenia but do not meet the specific criteria for the paranoid, disorganized, or catatonic subtypes.

Residual

This category is used for patients who have had at least one acute schizophrenic episode but do not presently have strong positive psychotic symptoms, such as delusions and hallucinations. They may have negative symptoms, such as withdrawal from others, or mild forms of positive symptoms, which indicate that the disorder has not completely resolved.

The risk of schizophrenia among first-degree biological relatives is ten times greater than that observed in the general population. Furthermore the presence of the same disorder is higher in monozygotic twins (identical twins) than in dizygotic twins (nonidentical twins). The research concerning adoption studies and identical twins also supports the notion that environmental factors are important, because not all relatives who have the disorder express it. There are several chromosomes and loci (specific areas on chromosomes which contain mutated genes), which have been identified. Research is actively ongoing to elucidate the causes, types and variations of these mutations.

A number of studies indicate that about 1% of the world's population is affected by schizophrenia, without regard to race, social class, level of education, or cultural influences (outcome may vary from culture to culture, depending on the familial support of the patient). Most patients are diagnosed in their late teens or early twenties, but the symptoms of schizophrenia can emerge at any age in the life cycle. The male/female ratio in adults is about 1.2:1. Male patients typically have their first acute episode in their early twenties, while female patients are usually closer to age 30 when they are recognized with active symptoms.

Schizophrenia is rarely diagnosed in preadolescent children, although patients as young as five or six have been reported. Childhood schizophrenia is at the upper end of the spectrum of severity and shows a greater gender disparity. It affects one or two children in every 10,000; the male/female ratio is 2:1.

Causes and symptoms

Theories of causality

One of the reasons for the ongoing difficulty in classifying schizophrenic disorders is incomplete understanding of their causes. As of 1998, it is thought that these disorders are the end result of a combination of genetic, neurobiological, and environmental causes. A leading neurobiological hypothesis looks at the connection between the disease and excessive levels of dopamine, a chemical that transmits signals in the brain (neurotransmitter). The genetic factor in schizophrenia has been underscored by recent findings that first-degree biological relatives of schizophrenics are ten times as likely to develop the disorder as are members of the general population.

Prior to recent findings of abnormalities in the brain structure of schizophrenic patients, several generations of psychotherapists advanced a number of psychoanalytic and sociological theories about the origins of schizophrenia. These theories ranged from hypotheses about the patient's problems with **anxiety** or aggression to theories about **stress** reactions or interactions with disturbed parents. Psychosocial factors are now thought to influence the expression or severity of schizophrenia, rather than cause it directly.

Another hypothesis suggests that schizophrenia may be caused by a virus that attacks the hippocampus, a part of the brain that processes sense perceptions. Damage to the hippocampus would account for schizophrenic patients' vulnerability to sensory overload. As of mid-1998, researchers were preparing to test antiviral medications on schizophrenics.

Symptoms of schizophrenia

Patients with a possible diagnosis of schizophrenia are evaluated on the basis of a set or constellation of symptoms; there is no single symptom that is unique to schizophrenia. In 1959, the German psychiatrist Kurt Schneider proposed a list of so-called first-rank symptoms, which he regarded as diagnostic of the disorder.

These symptoms include:

- delusions
- somatic
- hallucinations
- hearing voices commenting on the patient's behavior
- thought insertion or thought withdrawal

Somatic hallucinations refer to sensations or perceptions concerning body organs that have no known medical cause or reason, such as the notion that one's brain is radioactive. Thought insertion and/or withdrawal refer to

delusions that an outside force (for example, the FBI, the CIA, Martians, etc.) has the power to put thoughts into one's mind or remove them.

POSITIVE SYMPTOMS. The positive symptoms of schizophrenia are those that represent an excessive or distorted version of normal functions. Positive symptoms include Schneider's first-rank symptoms as well as disorganized thought processes (reflected mainly in speech) and disorganized or catatonic behavior. Disorganized thought processes are marked by such characteristics as looseness of associations, in which the patient rambles from topic to topic in a disconnected way; tangentially, which means that the patient gives unrelated answers to questions; and "word salad," in which the patient's speech is so incoherent that it makes no grammatical or linguistic sense. Disorganized behavior means that the patient has difficulty with any type of purposeful or goal-oriented behavior, including personal self-care or preparing meals. Other forms of disorganized behavior may include dressing in odd or inappropriate ways, sexual self-stimulation in public, or agitated shouting or cursing.

NEGATIVE SYMPTOMS. **S**chizophrenia includes three so-called negative symptoms. They are called negative because they represent the lack or absence of behaviors. The negative symptoms that are considered diagnostic of schizophrenia are a lack of emotional response (affective flattening), poverty of speech, and absence of volition or will. In general, the negative symptoms are more difficult for doctors to evaluate than the positive symptoms.

Diagnosis

A doctor must make a diagnosis of schizophrenia on the basis of a standardized list of outwardly observable symptoms, not on the basis of internal psychological processes. There are no specific laboratory tests that can be used to diagnose schizophrenia. Researchers have, however, discovered that patients with schizophrenia have certain abnormalities in the structure and functioning of the brain compared to normal test subjects. These discoveries have been made with the help of imaging techniques such as **computed tomography scans** (CT scans).

When a psychiatrist assesses a patient for schizophrenia, he or she will begin by excluding physical conditions that can cause abnormal thinking and some other behaviors associated with schizophrenia. These conditions include organic brain disorders (including traumatic injuries of the brain) temporal lobe epilepsy, Wilson's disease, Huntington's chorea, and **encephalitis**. The doctor will also need to rule out substance abuse disorders, especially amphetamine use.

After ruling out organic disorders, the clinician will consider other psychiatric conditions that may include psychotic symptoms or symptoms resembling **psychosis**. These disorders include mood disorders with psychotic features; delusional disorder; dissociative disorder not otherwise specified (DDNOS) or **multiple personality disorder**; schizotypal, schizoid, or paranoid **personality disorders**; and atypical reactive disorders. In the past, many individuals were incorrectly diagnosed as schizophrenic. Some patients who were diagnosed prior to the changes in categorization should have their diagnoses, and treatment, reevaluated. In children, the doctor must distinguish between psychotic symptoms and a vivid fantasy life, and also identify learning problems or disorders. After other conditions have been ruled out, the patient must meet a set of criteria specified:

- *t*he patient must have two (or more) of the following symptoms during a one-month period: delusions; hallucinations; disorganized speech; disorganized or catatonic behavior; negative symptoms
- decline in social, interpersonal, or occupational functioning, including self-care
- *t*he disturbed behavior must last for at least six months
- *m*ood disorders, substance abuse disorders, medical conditions, and developmental disorders have been ruled out

Treatment

The treatment of schizophrenia depends in part on the patient's stage or phase. Patients in the acute phase are hospitalized in most cases, to prevent harm to the patient or others and to begin treatment with antipsychotic medications. A patient having a first psychotic episode should be given a CT or MRI (**magnetic resonance imaging**) scan to rule out structural brain disease.

Antipsychotic medications

The primary form of treatment of schizophrenia is antipsychotic medication. **Antipsychotic drugs** help to control almost all the positive symptoms of the disorder. They have minimal effects on disorganized behavior and negative symptoms. Between 60-70% of schizophrenics will respond to antipsychotics. In the acute phase of the illness, patients are usually given medications by mouth or by intramuscular injection. After the patient has been stabilized, the antipsychotic drug may be given in a long-acting form called a depot dose. Depot medications last for two to four weeks; they have the advantage of protecting the patient against the consequences of forgetting or skipping daily doses. In addition, some patients who do not respond to oral neuroleptics have better results

KEY TERMS

Affective flattening—A loss or lack of emotional expressiveness. It is sometimes called blunted or restricted affect.

Akathisia—Agitated or restless movement, usually affecting the legs and accompanied by a sense of discomfort. It is a common side effect of neuroleptic medications.

Catatonic behavior—Behavior characterized by muscular tightness or rigidity and lack of response to the environment. In some patients rigidity alternates with excited or hyperactive behavior.

Delusion—A fixed, false belief that is resistant to reason or factual disproof.

Depot dosage—A form of medication that can be stored in the patient's body tissues for several days or weeks, thus minimizing the risk of the patient forgetting daily doses. Haloperidol and fluphenazine can be given in depot form.

Dopamine receptor antagonists (DAs)—The older class of antipsychotic medications, also called neuroleptics. These primarily block the site on nerve cells that normally receive the brain chemical dopamine.

Dystonia—Painful involuntary muscle cramps or spasms.

Extrapyramidal symptoms (EPS)—A group of side effects associated with antipsychotic medications. EPS include parkinsonism, akathisia, dystonia, and tardive dyskinesia.

First-rank symptoms—A set of symptoms designated by Kurt Schneider in 1959 as the most important diagnostic indicators of schizophrenia. These symptoms include delusions, hallucinations, thought insertion or removal, and thought broadcasting. First-rank symptoms are sometimes referred to as Schneiderian symptoms.

Hallucination—A sensory experience of something that does not exist outside the mind. A person can experience a hallucination in any of the five senses. Auditory hallucinations are a common symptom of schizophrenia.

Huntington's chorea—A hereditary disease that typically appears in midlife, marked by gradual loss of brain function and voluntary movement. Some of its symptoms resemble those of schizophrenia.

Negative symptoms—Symptoms of schizophrenia characterized by the absence or elimination of certain behaviors. DSM-IV specifies three negative symptoms: affective flattening, poverty of speech, and loss of will or initiative.

Neuroleptic—Another name for the older type of antipsychotic medications given to schizophrenic patients.

Parkinsonism—A set of symptoms originally associated with Parkinson disease that can occur as side effects of neuroleptic medications. The symptoms include trembling of the fingers or hands, a shuffling gait, and tight or rigid muscles.

Positive symptoms—Symptoms of schizophrenia that are characterized by the production or presence of behaviors that are grossly abnormal or excessive, including hallucinations and thought-process disorder. DSM-IV subdivides positive symptoms into psychotic and disorganized.

Poverty of speech—A negative symptom of schizophrenia, characterized by brief and empty replies to questions. It should not be confused with shyness or reluctance to talk.

Psychotic disorder—A mental disorder characterized by delusions, hallucinations, or other symptoms of lack of contact with reality. The schizophrenias are psychotic disorders.

Serotonin dopamine antagonist (SDA)—The newer second-generation antipsychotic drugs, also called atypical antipsychotics. SDAs include clozapine (Clozaril), risperidone (Risperdal), and olanzapine (Zyprexa).

Wilson disease—A rare hereditary disease marked by high levels of copper deposits in the brain and liver. It can cause psychiatric symptoms resembling schizophrenia.

Word salad—Speech that is so disorganized that it makes no linguistic or grammatical sense.

with depot form. Patients whose long-term treatment includes depot medications are introduced to the depot form gradually during their stabilization period. Most people with schizophrenia are kept indefinitely on antipsychotic medications during the maintenance phase of their disorder to minimize the possibility of relapse.

As of 1998, the most frequently used antipsychotics fall into two classes: the older dopamine receptor antagonists, or DAs, and the newer serotonin dopamine antagonists, or SDAs. (Antagonists block the action of some other substance; for example, dopamine antagonists counteract the action of dopamine.) The exact mechanisms of action of these medications are not known, but it is thought that they lower the patient's sensitivity to sensory stimuli and so indirectly improve the patient's ability to interact with others.

DOPAMINE RECEPTOR ANTAGONIST. The dopamine antagonists include the older antipsychotic (also called neuroleptic) drugs, such as haloperidol (Haldol), chlorpromazine (Thorazine), and fluphenazine (Prolixin). These drugs have two major drawbacks: it is often difficult to find the best dosage level for the individual patient, and a dosage level high enough to control psychotic symptoms frequently produces extrapyramidal side effects, or EPS. EPSs include parkinsonism, in which the patient cannot walk normally and usually develops a tremor; dystonia, or painful muscle spasms of the head, tongue, or neck; and akathisia, or restlessness. A type of long-term EPS is called **tardive dyskinesia**, which features slow, rhythmic, automatic movements. Schizophrenics with **AIDS** are especially vulnerable to developing EPS.

SERATONIN DOPANINE ANTAGONISTS. The serotonin dopamine antagonists, also called atypical antipsychotics, are newer medications that include clozapine (Clozaril), risperidone (Risperdal), and olanzapine (Zyprexa). The SDAs have a better effect on the negative symptoms of schizophrenia than do the older drugs and are less likely to produce EPS than the older compounds. The newer drugs are significantly more expensive in the short term, although the SDAs may reduce long-term costs by reducing the need for hospitalization. They are also presently unavailable in injectable forms. The SDAs are commonly used to treat patients who respond poorly to the DAs. However, many psychotherapists now regard the use of these atypical antipsychotics as the treatment of first choice.

Psychotherapy

Most schizophrenics can benefit from psychotherapy once their acute symptoms have been brought under control by antipsychotic medication. Psychoanalytic approaches are not recommended. Behavior therapy, however, is often helpful in assisting patients to acquire skills for daily living and social interaction. It can be combined with occupational therapy to prepare the patient for eventual employment.

Family therapy

Family therapy is often recommended for the families of schizophrenic patients, to relieve the feelings of guilt that they often have as well as to help them understand the patient's disorder. The family's attitude and behaviors toward the patient are key factors in minimizing relapses (for example, by reducing stress in the patient's life), and family therapy can often strengthen the family's ability to cope with the stresses caused by the schizophrenic's illness. Family therapy focused on communication skills and problem-solving strategies is particularly helpful. In addition to formal treatment, many families benefit from support groups and similar mutual help organizations for relatives of schizophrenics.

Prognosis

One important prognostic sign is the patient's age at onset of psychotic symptoms. Patients with early onset of schizophrenia are more often male, have a lower level of functioning prior to onset, a higher rate of brain abnormalities, more noticeable negative symptoms, and worse outcomes. Patients with later onset are more likely to be female, with fewer brain abnormalities and thought impairment, and more hopeful prognoses.

The average course and outcome for schizophrenics are less favorable than those for most other mental disorders, although as many as 30% of patients diagnosed with schizophrenia recover completely and the majority experience some improvement. Two factors that influence outcomes are stressful life events and a hostile or emotionally intense family environment. Schizophrenics with a high number of stressful changes in their lives, or who have frequent contacts with critical or emotionally over-involved family members, are more likely to relapse. Overall, the most important component of long-term care of schizophrenic patients is complying with their regimen of antipsychotic medications.

Resources

BOOKS

Campbell, Robert Jean. *Psychiatric Dictionary.* New York and Oxford, UK: Oxford University Press, 1989.

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics & Psychiatric Disorders." In *Current Pediatric Diagnosis & Treatment,* edited by William W. Hay Jr., et al. Stamford, CT: Appleton & Lange, 1997.

Day, Max, and Elvin V. Semrad. "Schizophrenia: Comprehensive Psychotherapy." In *The Encyclopedia of Psychiatry, Psychology, and Psychoanalysis*, edited by Benjamin B. Wolman. New York: Henry Holt and Company, 1996.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis & Treatment 1998*, edited by Lawrence M. Tierney Jr., et al. Stamford, CT: Appleton & Lange, 1997.
Marder, Stephen R. "Schizophrenia." In *Conn's Current Therapy*, edited by Robert E. Rakel. Philadelphia: W. B. Saunders Company, 1998.
"Psychiatric Disorders: Schizophrenic Disorders." In *The Merck Manual of Diagnosis and Therapy.* Vol. I, edited by Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1992.
"Schizophrenia and Other Psychotic Disorders." In *Diagnostic and Statistical Manual of Mental Disorders,* 4th ed. Washington, DC: The American Psychiatric Association, 1994.
Schultz, Clarence G. "Schizophrenia: Psychoanalytic Views." In *The Encyclopedia of Psychiatry, Psychology, and Psychoanalysis*, edited by Benjamin B. Wolman. New York: Henry Holt and Company, 1996.
Tsuang, Ming T., et al. "Schizophrenic Disorders." In *The New Harvard Guide to Psychiatry*, edited by Armand M. Nicholi, Jr. Cambridge, MA, and London, UK: The Belknap Press of Harvard University Press, 1988.
Wilson, Billie Ann, et al. *Nurses Drug Guide 1995*. Norwalk, CT: Appleton & Lange, 1995.

PERIODICALS

Winerip, Michael. "Schizophrenia's Most Zealous Foe." *The New York Times Magazine* (February 22, 1998): 26-29.

ORGANIZATIONS

National Alliance for the Mentally Ill. Colonial Place Three, 2107 Wilson Blvd., Suite 300 Arlington, VA 22201. (703) 524-7600 HelpLine: (800) 950-NAMI. <http://www.nami.org/>.
Schizophrenics Anonymous. 15920 W. Twelve Mile, Southfield, MI 48076. (248) 477-1983.

OTHER

"An Introduction to Schizophrenia." *The Schizophrenia Homepage*. <http://www.schizophrenia.com/family/schizintro.html>.
"Schizophrenia." *Internet Mental Health*. <http://www.mentalhealth.com/dis/p20-ps01.html>.
Schizophrenia On-line News Articles. <http://www2.addr.com/~y/mn/>.

Laith Farid Gulli, MD

Schwannoma *see* **Brain tumor**
Sciatic nerve pain *see* **Sciatica**

Sciatica

Definition

Sciatica refers to **pain** or discomfort associated with the sciatic nerve. This nerve runs from the lower part of the spinal cord, down the back of the leg, to the foot. Injury to or pressure on the sciatic nerve can cause the characteristic pain of sciatica: a sharp or burning pain that radiates from the lower back or hip, possibly following the path of the sciatic nerve to the foot.

Description

The sciatic nerve is the largest and longest nerve in the body. About the thickness of a person's thumb, it spans from the lower back to the foot. The nerve originates in the lower part of the spinal cord, the so-called lumbar region. As it branches off from the spinal cord, it passes between the bony vertebrae (the component bones of the spine) and runs through the pelvic girdle, or hip bones. The nerve passes through the hip joint and continues down the back of the leg to the foot.

Sciatica is a fairly common disorder and approximately 40% of the population experiences it at some point in their lives. However, only about 1% have coexisting sensory or motor deficits. Sciatic pain has several root causes and treatment may hinge upon the underlying problem.

Of the identifiable causes of sciatic pain, lumbosacral radiculopathy and back strain are the most frequently suspected. The term lumbosacral refers to the lower part of the spine, and radiculopathy describes a problem with the spinal nerve roots that pass between the vertebrae and give rise to the sciatic nerve. This area between the vertebrae is cushioned with a disk of shock-absorbing tissue. If this disk shifts or is damaged through injury or disease, the spinal nerve root may be compressed by the shifted tissue or the vertebrae.

This compression of the nerve roots sends a pain signal to the brain. Although the actual injury is to the nerve roots, the pain may be perceived as coming from anywhere along the sciatic nerve.

The sciatic nerve can be compressed in other ways. Back strain may cause muscle spasms in the lower back, placing pressure on the sciatic nerve. In rare cases, infection, **cancer**, bone inflammation, or other diseases may be causing the pressure. More likely, but often overlooked, is the piriformis syndrome. As the sciatic nerve passes through the hip joint, it shares the space with several muscles. One of these muscles, the piriformis muscle, is closely associated with the sciatic nerve. In some people, the nerve actually runs through the muscle. If this muscle is injured or has a spasm, it places pressure on the sciatic nerve, in effect, compressing it.

In many sciatica cases, the specific cause is never identified. About half of affected individuals recover from an episode within a month. Some cases can linger a few weeks

longer and may require aggressive treatment. In some cases, the pain may return or potentially become chronic.

Causes and symptoms

Individuals with sciatica may experience some lower back pain, but the most common symptom is pain that radiates through one buttock and down the back of that leg. The most identified cause of the pain is compression or pressure on the sciatic nerve. The extent of the pain varies between individuals. Some people describe pain that centers in the area of the hip, and others perceive discomfort all the way to the foot. The quality of the pain also varies; it may be described as tingling, burning, prickly, aching, or stabbing.

Onset of sciatica can be sudden, but it can also develop gradually. The pain may be intermittent or continuous, and certain activities, such as bending, coughing, sneezing, or sitting, may make the pain worse.

Chronic pain may arise from more than just compression on the nerve. According to some pain researchers, physical damage to a nerve is only half of the equation. A developing theory proposes that some nerve injuries result in a release of neurotransmitters and immune system chemicals that enhance and sustain a pain message. Even after the injury has healed, or the damage has been repaired, the pain continues. Control of this abnormal type of pain is difficult.

Diagnosis

Before treating sciatic pain, as much information as possible is collected. The individual is asked to recount the location and nature of the pain, how long it has continued, and any accidents or unusual activities prior to its onset. This information provides clues that may point to back strain or injury to a specific location. Back pain from disk disease, piriformis syndrome, and back strain must be differentiated from more serious conditions such as cancer or infection. Lumbar stenosis, an overgrowth of the covering layers of the vertebrae that narrows the spinal canal, must also be considered. The possibility that a difference in leg lengths is causing the pain should be evaluated; the problem can be easily be treated with a foot orthotic or built-up shoe.

Often, a straight-leg-raising test is done, in which the person lies face upward and the health care provider raises the affected leg to various heights. This test pinpoints the location of the pain and may reveal whether it is caused by a disk problem. Other tests, such as having the individual rotate the hip joint, assess the hip muscles. Any pain caused by these movements may provide information about involvement of the piriformis muscle, and piriformis weakness is tested with additional leg-strength maneuvers.

Further tests may be done depending on the results of the **physical examination** and initial pain treatment. Such tests might include **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT scans). Other tests examine the conduction of electricity through nerve tissues, and include studies of the electrical activity generated as muscles contract (**electromyography**), nerve conduction velocity, and evoked potential testing. A more invasive test involves injecting a contrast substance into the space between the vertebrae and making x-ray images of the spinal cord (**myelography**), but this procedure is usually done only if surgery is being considered. All of these tests can reveal problems with the vertebrae, the disk, or the nerve itself.

Treatment

Initial treatment for sciatica focuses on pain relief. For acute or very painful flare-ups, bed rest is advised for up to a week in conjunction with medication for the pain. Pain medication includes **acetaminophen**, **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as **aspirin**, or **muscle relaxants**. If the pain is unremitting, opioids may be prescribed for short-term use or a local anesthetic will be injected directly into the lower back. Massage and heat application may be suggested as adjuncts.

If the pain is chronic, different pain relief medications are used to avoid long-term dosing of NSAIDs, muscle relaxants, and opioids. **Antidepressant drugs**, which have been shown to be effective in treating pain, may be prescribed alongside short-term use of muscle relaxants or NSAIDs. Local anesthetic injections or epidural steroids are used in selected cases.

As the pain allows, physical therapy is introduced into the treatment regime. Stretching exercises that focus on the lower back, buttock, and hamstring muscles are suggested. The exercises also include finding comfortable, pain-reducing positions. Corsets and braces may be useful in some cases, but evidence for their general effectiveness is lacking. However, they may be helpful to prevent exacerbations related to certain activities.

With less pain and the success of early therapy, the individual is encouraged to follow a long-term program to maintain a healthy back and prevent re-injury. A physical therapist may suggest exercises and regular activity, such as water **exercise** or walking. Patients are instructed in proper body mechanics to minimize symptoms during light lifting or other activities.

If the pain is chronic and conservative treatment fails, surgery to repair a **herniated disk** or cut out part or all of

the piriformis muscle may be suggested, particularly if there is neurologic evidence of nerve or nerve-root damage.

Alternative treatment

Massage is a recommended form of therapy, especially if the sciatic pain arises from muscle spasm. Symptoms may also be relieved by icing the painful area as soon as the pain occurs. Ice should be left on the area for 30-60 minutes several times a day. After 2-3 days, a hot water bottle or heating pad can replace the ice. **Chiropractic** or **osteopathy** may offer possible solutions for relieving pressure on the sciatic nerve and the accompanying pain. **Acupuncture** and **biofeedback** may also be useful as pain control methods. Body work, such as the **Alexander technique**, can assist an individual in improving posture and preventing further episodes of sciatic pain.

Prognosis

Most cases of sciatica are treatable with pain medication and physical therapy. After 4-6 weeks of treatment, an individual should be able to resume normal activities.

Prevention

Some sources of sciatica are not preventable, such as disk degeneration, back strain due to **pregnancy**, or accidental falls. Other sources of back strain, such as poor posture, overexertion, being overweight, or wearing high heels, can be corrected or avoided. Cigarette **smoking** may also predispose people to pain, and should be discontinued.

General suggestions for avoiding sciatica, or preventing a repeat episode, include sleeping on a firm mattress, using chairs with firm back support, and sitting with both feet flat on the floor. Habitually crossing the legs while sitting can place excess pressure on the sciatic nerve. Sitting a lot can also place pressure on the sciatic nerves, so it's a good idea to take short breaks and move around during the work day, long trips, or any other situation that requires sitting for an extended length of time. If lifting is required, the back should be kept straight and the legs should provide the lift. Regular exercise, such as swimming and walking, can strengthen back muscles and improve posture. Exercise can also help maintain a healthy weight and lessen the likelihood of back strain.

KEY TERMS

Disk—Dense tissue between the vertebrae that acts as a shock absorber and prevents damage to nerves and blood vessels along the spine.

Electromyography—A medical test in which a nerve's ability to conduct an impulse is measured.

Lumbosacral—Referring to the lower part of the backbone or spine.

Myelography—A medical test in which a special dye is injected into a nerve to make it visible on an x ray.

Piriformis—A muscle in the pelvic girdle that is closely associated with the sciatic nerve.

Radiculopathy—A condition in which the spinal nerve root of a nerve has been injured or damaged.

Spasm—Involuntary contraction of a muscle.

Vertebrae—The component bones of the spine.

Resources

BOOKS

Maigne, Robert. "Sciatica." In *Diagnosis and Treatment of Pain of Vertebral Origin: A Manual Medicine Approach.* Baltimore: Williams & Wilkins, 1996.

Rydevik, Björn, Mitsuo Hasue, and Peter Wehling. "Etiology of Sciatic Pain and Mechanisms of Nerve Root Compression." In *The Lumbar Spine.* 2nd ed. Vol. 1. Ed. Sam W. Wiesel, et al. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Douglas, Sara. "Sciatic Pain and Piriformis Syndrome." *The Nurse Practitioner* 22 (May 1997): 166.

Parziale, John R., Thomas H. Hudgins, and Loren M. Fishman. "The Piriformis Syndrome." *The American Journal of Orthopedics* (Dec. 1996): 819.

Wheeler, Anthony H. "Diagnosis and Management of Low Back Pain and Sciatica." *American Family Physician* (Oct. 1995): 1333.

Julia Barrett

SCID *see* **Severe combined immunodeficiency**

Scleral buckling *see* **Retinal detachment**

Scleroderma

Definition

Scleroderma is a progressive disease that affects the skin and connective tissue (including cartilage, bone, fat, and the tissue that supports the nerves and blood vessels

throughout the body). There are two major forms of the disorder. The type known as localized scleroderma mainly affects the skin. Systemic scleroderma, which is also called systemic sclerosis, affects the smaller blood vessels and internal organs of the body.

Description

Scleroderma is an autoimmune disorder, which means that the body's immune system turns against itself. In scleroderma, there is an overproduction of abnormal collagen (a type of protein fiber present in connective tissue). This collagen accumulates throughout the body, causing hardening (sclerosis), scarring (fibrosis), and other damage. The damage may affect the appearance of the skin, or it may involve only the internal organs. The symptoms and severity of scleroderma vary from person to person.

Scleroderma occurs in all races of people all over the world, but it affects about four females for every male. Among children, localized scleroderma is more common, and systemic sclerosis is comparatively rare. Most patients with systemic sclerosis are diagnosed between ages 30 and 50. In the United States, about 300,000 people have scleroderma. Young African-American women and Native Americans of the Choctaw tribe have especially high rates of the disease.

Causes and symptoms

The cause of scleroderma is still a puzzle. Although the accumulation of collagen appears to be a hallmark of the disease, researchers do not know why it occurs. Some theories suggest that damage to blood vessels may cause the tissues of the body to receive an inadequate amount of oxygen—a condition called **ischemia**. Some researchers believe that the resulting damage causes the immune system to overreact, producing an autoimmune disorder. According to this theory of scleroderma, the immune system gears up to fight an invader, but no invader is actually present. Cells in the immune system called antibodies react to the body's own tissues as if they were foreign. The antibodies turn against the already damaged blood vessels and the vessels' supporting tissues. These immune cells are designed to deliver potent chemicals in order to kill foreign invaders. Some of these cells dump these chemicals on the body's own tissues instead, causing inflammation, swelling, damage, and scarring.

Most cases of scleroderma have no recognizable triggering event. Some cases, however, have been traced to exposure to toxic (poisonous) substances. For example, coal miners and gold miners, who are exposed to high levels of silica dust, have above-average rates of scleroderma. Other chemicals associated with the disease include polyvinyl chloride, benzine, toluene, and epoxy resins. In 1981, 20,000 people in Spain were stricken with a syndrome similar to scleroderma when their cooking oil was accidentally contaminated. Certain medications, especially a drug used in **cancer** treatment called bleomycin (Blenoxane), may lead to scleroderma. Some claims of a scleroderma-like illness have been made by women with silicone **breast implants**, but a link has not been proven in numerous studies.

Symptoms of systemic scleroderma

A condition called Raynaud's phenomenon is the first symptom in about 95% of all patients with systemic scleroderma. In Raynaud's phenomenon, the blood vessels of the fingers and/or toes (the digits) react to cold in an abnormal way. The vessels clamp down, preventing blood flow to the tip of the digit. Eventually, the flow is cut off to the entire finger or toe. Over time, oxygen deprivation may result in open ulcers on the skin surface. These ulcers can lead to tissue **death** (**gangrene**) and loss of the digit. When Raynaud's phenomenon is the first sign of scleroderma, the next symptoms usually appear within two years.

SKIN AND EXTREMITIES. Involvement of the skin leads to swelling underneath the skin of the hands, feet, legs, arms, and face. Swelling is followed by thickening and tightening of the skin, which becomes taut and shiny. Severe tightening may lead to abnormalities. For example, tightening of the skin on the hands may cause the fingers to become permanently curled (flexed). Structures within the skin are damaged (including those producing hair, oil, and sweat), and the skin becomes dry and scaly. Ulcers may form, with the danger of infection. Calcium deposits often appear under the skin.

In systemic scleroderma, the mouth and nose may become smaller as the skin on the face tightens. The small mouth may interfere with eating and dental hygiene. Blood vessels under the skin may become enlarged and show through the skin, appearing as purplish marks or red spots. This chronic dilation of the small blood vessels is called telangiectasis.

Muscle weakness, joint **pain** and stiffness, and **carpal tunnel syndrome** are common in scleroderma. Carpal tunnel syndrome involves scarring in the wrist, which puts pressure on the median nerve running through that area. Pressure on the nerve causes numbness, tingling, and weakness in some of the fingers.

DIGESTIVE TRACT. The tube leading from the mouth to the stomach (the esophagus) becomes stiff and scarred. Patients may have trouble swallowing food. The acid contents of the stomach may start to flow backward

into the esophagus (esophageal reflux), causing a very uncomfortable condition known as **heartburn**. The esophagus may also become inflamed.

The intestine becomes sluggish in processing food, causing bloating and pain. Foods are not digested properly, resulting in **diarrhea**, weight loss, and anemia. Telangiectasis in the stomach or intestine may cause rupture and bleeding.

RESPIRATORY AND CIRCULATORY SYSTEMS. The lungs are affected in about 66% of all people with systemic scleroderma. Complications include **shortness of breath**, coughing, difficulty breathing due to tightening of the tissue around the chest, inflammation of the air sacs in the lungs (alveolitis), increased risk of **pneumonia**, and an increased risk of cancer. For these reasons, lung disease is the most likely cause of death associated with scleroderma.

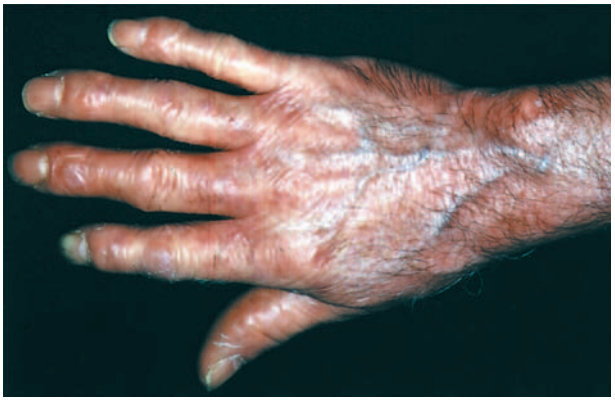
The lining around the heart (pericardium) may become inflamed. The heart may have greater difficulty pumping blood effectively (**heart failure**). Irregular heart rhythms and enlargement of the heart also occur in scleroderma.

Kidney disease is another common complication. Damage to blood vessels in the kidneys often causes a major rise in the person's blood pressure. The blood pressure may be so high that there is swelling of the brain, causing severe headaches, damage to the retinas of the eyes, seizures, and failure of the heart to pump blood into the body's circulatory system. The kidneys may also stop filtering blood and go into failure. Treatments for high blood pressure have greatly improved these kidney complications. Before these treatments were available, kidney problems were the most common cause of death for people with scleroderma.

Other problems associated with scleroderma include painful dryness of the eyes and mouth, enlargement and destruction of the liver, and a low-functioning thyroid gland.

Diagnosis

Diagnosis of scleroderma is complicated by the fact that some of its symptoms can accompany other connective-tissue diseases. The most important symptom is thickened or hardened skin on the fingers, hands, forearms, or face. This is found in 98% of people with scleroderma. It can be detected in the course of a **physical examination**. The person's medical history may also contain important clues, such as exposure to toxic substances on the job. There are a number of nonspecific laboratory tests on blood samples that may indicate the presence of an inflammatory disorder (but not specifically scleroderma). The antinuclear antibody (ANA) test is positive in more than 95% of people with scleroderma.



Scleroderma is a serious, progressive disease caused by the overproduction and accumulation of collagen throughout the body, resulting in hardening (sclerosis) and scarring (fibrosis) of the skin and connective tissue. *(Photo Researchers, Inc. Reproduced by permission.)*

Other tests can be performed to evaluate the extent of the disease. These include a test of the electrical system of the heart (an electrocardiogram), lung-function tests, and x-ray studies of the gastrointestinal tract. Various blood tests can be given to study kidney function.

Treatment

At this time there is no cure for scleroderma. A drug called D-penicillamine has been used to interfere with the abnormal collagen. It is believed to help decrease the degree of skin thickening and tightening, and to slow the progress of the disease in other organs. Taking vitamin D and using ultraviolet light may be helpful in treating localized scleroderma. **Corticosteroids** have been used to treat joint pain, muscle cramps, and other symptoms of inflammation. Other drugs have been studied that reduce the activity of the immune system (immunosuppressants). Because these medications can have serious side effects, they are used in only the most severe cases of scleroderma.

The various complications of scleroderma are treated individually. Raynaud's phenomenon requires that people try to keep their hands and feet warm constantly. Nifedipine is a medication that is sometimes given to help control Raynaud's. Thick ointments and creams are used to treat dry skin. **Exercise** and massage may help joint involvement; they may also help people retain more movement despite skin tightening. Skin ulcers need prompt attention and may require **antibiotics**. People with esophageal reflux will be advised to eat small amounts more often, rather than several large meals a day. They should also avoid spicy foods and items con-

KEY TERMS

Autoimmune disorder—A disorder in which the body's immune cells mistake the body's own tissues as foreign invaders; the immune cells then work to destroy tissues in the body.

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Connective tissue—A group of tissues responsible for support throughout the body; includes cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

Fibrosis—The abnormal development of fibrous tissue; scarring.

Limited scleroderma—A subtype of systemic scleroderma with limited skin involvement. It is somestimes called the CREST form of scleroderma, after the initials of its five major symptoms.

Localized scleroderma—Thickening of the skin from overproduction of collagen.

Morphea—The most common form of localized scleroderma.

Raynaud phenomenon/Raynaud disease—A condition in which blood flow to the body's tissues is reduced by a malfunction of the nerves that regulate the constriction of blood vessels. When attacks of Raynaud's occur in the absence of other medical conditions, it is called Raynaud disease. When attacks occur as part of a disease (as in scleroderma), it is called Raynaud phenomenon.

Sclerosis—Hardening.

Systemic sclerosis—A rare disorder that causes thickening and scarring of multiple organ systems.

Telangiectasis—Very small arteriovenous malformations, or connections between the arteries and veins. The result is small red spots on the skin known as "spider veins".

taining **caffeine**. Some patients with esophageal reflux have been successfully treated with surgery. Acid-reducing medications may be given for heartburn. People must be monitored for the development of high blood pressure. If found, they should be promptly treated with appropriate medications, usually ACE inhibitors or other **vasodilators**. When fluid accumulates due to heart failure, **diuretics** can be given to get rid of the excess fluid.

Prognosis

The prognosis for people with scleroderma varies. Some have a very limited form of the disease called morphea, which affects only the skin. These individuals have a very good prognosis. Other people have a subtype of systemic scleroderma called limited scleroderma. For them, the prognosis is relatively good. Limited scleroderma is characterized by limited involvement of the patient's skin and a cluster of five symptoms called the CREST syndrome. CREST stands for:

- C=Calcinosis
- R=Raynaud's disease (phenomenon)
- E=Esophageal dysmotility (stiffness and malfunctioning of the esophagus)
- S=Sclerodactyly (thick, hard, rigid skin over the fingers)
- T=Telangiectasis

In general, people with very widespread skin involvement have the worst prognosis. This level of disease is usually accompanied by involvement of other organs and the most severe complications. Although women are more commonly stricken with scleroderma, men more often die of the disease. The most common causes of death include heart, kidney, and lung diseases. About 65% of all patients survive 10 years or more following a diagnosis of scleroderma.

There are no known ways to prevent scleroderma. People can try to decrease occupational exposure to high-risk substances.

Resources

BOOKS

Aaseng, Nathan. *Autoimmune Diseases.* New York: F. Watts, 1995.

Gilliland, Bruce C. "Systemic Sclerosis (Scleroderma)." In *Harrison's Principles of Internal Medicine,* ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

"Systemic Sclerosis." *The Merck Manual of Diagnosis and Therapy,* ed. Mark H. Beers and Robert Berkow. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

PERIODICALS

De Keyser, F., et al. "Occurrence of Scleroderma in Monozygotic Twins." *Journal of Rheumatology* 27 (Sept. 2000): 2267-2269.

Englert, H., et al. "Familial Risk Estimation in Systemic Sclerosis." *Australia and New Zealand Journal of Medicine* 29 (Feb. 1999): 36-41.

Legerton, C. W. III, et al. "Systemic Sclerosis: Clinical Management of Its Major Complications." *Rheumatic Disease Clinics of North America* no. 17 no. 221 (1998).

Saito, S., et al. "Genetic and Immunologic Features Associated with Scleroderma-like Syndrome of TSK Mice. *Current Rheumatology Reports* 1 (Oct. 1999): 34-37.

ORGANIZATIONS

American College of Rheumatology. 60 Executive Park South, Suite 150, Atlanta, GA 30329. (404) 633-3777. <http://www.rheumatology.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

Scleroderma Foundation. 12 Kent Way, Suite 101, Byfield, MA 01922. (978) 463-5843 or (800) 722-HOPE. Fax: (978) 463-5809. <http://www.scleroderma.org.>.

Rebecca J. Frey, PhD

Sclerotherapy for esophageal varices

Definition

Sclerotherapy for esophageal varices (also called endoscopic sclerotherapy) is a treatment for esophageal bleeding that involves the use of an endoscope and the injection of a sclerosing solution into veins.

Purpose

In most hospitals, sclerotherapy for esophageal varices is the treatment of choice to stop esophageal bleeding during acute episodes, and to prevent further incidences of bleeding. Emergency sclerotherapy is often followed by preventive treatments to eradicate distended esophageal veins.

Precautions

Sclerotherapy for esophageal varices cannot be performed on an uncooperative patient, since movement during the procedure could cause the vein to tear or the esophagus to perforate and bleed. It should not be performed on a patient with a perforated gastrointestinal tract.

Description

Esophageal varices are enlarged or swollen veins on the lining of the esophagus which are prone to bleeding. They are life-threatening, and can be fatal in up to 50% of patients. They usually appear in patients with severe liver disease. Sclerotherapy for esophageal varices involves injecting a strong and irritating solution (a sclerosant) into the veins and/or the area beside the distended vein. The sclerosant injected into the vein causes blood clots to form and stops the bleeding. The sclerosant injected into the area beside the distended vein stops the bleeding by thickening and swelling the vein to compress the blood vessel. Most physicians inject the sclerosant directly into the vein, although injections into the vein and the surrounding area are both effective. Once bleeding has been stopped, the treatment can be used to significantly reduce or destroy the varices.

Sclerotherapy for esophageal varices is performed by a physician in a hospital, with the patient awake but sedated. Hyoscine butylbromide (Buscopan) may be administered to freeze the esophagus, making injection of the sclerosant easier. During the procedure, an endoscope is passed through the patient's mouth to the esophagus to view the inside. The branches of the blood vessels at or just above where the stomach and esophagus come together, the usual site of variceal bleeding, are located. After the bleeding vein is identified, a long, flexible sclerotherapy needle is passed through the endoscope. When the tip of the needle's sheath is in place, the needle is advanced, and the sclerosant is injected into the vein or the surrounding area. The most commonly used sclerosants are ethanolamine and sodium tetradecyl sulfate. The needle is withdrawn. The procedure is repeated as many times as necessary to eradicate all distended veins.

Sclerotherapy for esophageal varices controls acute bleeding in about 90% of patients, but it may have to be repeated within the first 48 hours to achieve this success rate. During the initial hospitalization, sclerotherapy is usually performed two or three times. Preventive treatments are scheduled every few weeks or so, depending on the patient's risk level and healing rate. Several studies have shown that the risk of recurrent bleeding is much lower in patients treated with sclerotherapy: 30-50%, as opposed to 70-80% for patients not treated with sclerotherapy.

Preparation

Before sclerotherapy for esophageal varices, the patient's vital signs and other pertinent data are recorded, an intravenous line is inserted to administer fluid or blood, and a sedative is prescribed.

Aftercare

After sclerotherapy for esophageal varices, the patient will be observed for signs of blood loss, lung complications, **fever**, a perforated esophagus, or other

KEY TERMS

Endoscope—An instrument used to examine the inside of a canal or hollow organ. Endoscopic surgery is less invasive than traditional surgery.

Esophagus—The part of the digestive canal located between the pharynx (part of the digestive tube) and the stomach.

Sclerosant—An irritating solution that stops bleeding by hardening the blood or vein it is injected into.

Varices—Swollen or enlarged veins, in this case on the lining of the esophagus.

complications. Vital signs are monitored, and the intravenous line maintained. **Pain** medication is usually prescribed. After leaving the hospital, the patient follows a diet prescribed by the physician, and, if appropriate, can take mild pain relievers.

Risks

Sclerotherapy for esophageal varices has a 20-40% incidence of complications, and a 1–2% mortality rate. Complications can arise from the sclerosant or the endoscopic procedure. Minor complications, which are uncomfortable but do not require active treatment or prolonged hospitalization, include transient chest pain, difficulty swallowing, and fever, which usually go away after a few days. Some people have allergic reactions to the solution. Infection occurs in up to 50% of cases. In 2-10% of patients, the esophagus tightens, but this can usually be treated with dilatation. More serious complications may occur in 10-15% of patients treated with sclerotherapy. These include perforation or bleeding of the esophagus and lung problems, such as aspiration **pneumonia**. Long-term sclerotherapy can damage the esophagus, and increase the patient's risk of developing **cancer**.

Patients with advanced liver disease complicated by bleeding are very poor risks for this procedure. The surgery, premedications, and anesthesia may be sufficient to tip the patient into protein intoxication and hepatic **coma**. The blood in the bowels acts like a high protein meal; therefore, protein intoxication may be induced.

Resources

BOOKS

Green, Frederick L., and Jeffrey L. Ponsky, eds. "Endoscopic Management of Esophageal Varices." In *Endoscopic Surgery.* Philadelphia: W. B. Saunders Co., 1994.

Shearman, David J. C., et al., eds. "Endoscopy" and "Gastrointestinal Bleeding." In *Diseases of the Gastrointestinal Tract and Liver.* New York: Churchill Livingstone, 1997.

Yamada, Tadataka, et al., eds. "Endoscopic Control of Upper Gastrointestinal Variceal Bleeding." In *Textbook of Gastroenterology.* Philadelphia: J. B. Lippincott Co., 1995.

PERIODICALS

Cello, J. P. "Endoscopic Management of Esophageal Variceal Hemorrhage: Injection, Banding, Glue, Octreotide, or a Combination?" *Seminars in Gastrointestinal Diseases* 8 (Oct. 1997): 179-187.

Fass, Ronnie, et al. "Esophageal Motility Abnormalities in Cirrhotic Patients Before and After Endoscopic Variceal Treatment." *The American Journal of Gastroenterology* 92 (1997): 941-945.

Lori De Milto

Scoliosis

Definition

Scoliosis is a side-to-side curvature of the spine.

Description

When viewed from the rear, the spine usually appears perfectly straight. Scoliosis is a lateral (side-to-side) curve in the spine, usually combined with a rotation of the vertebrae. (The lateral curvature of scoliosis should not be confused with the normal set of front-to-back spinal curves visible from the side.) While a small degree of lateral curvature does not cause any medical problems, larger curves can cause postural imbalance and lead to muscle **fatigue** and **pain**. More severe scoliosis can interfere with breathing and lead to arthritis of the spine (spondylosis).

Approximately 10% of all adolescents have some degree of scoliosis, though fewer than 1% have curves which require medical attention beyond monitoring. Scoliosis is found in both boys and girls, but a girl's spinal curve is much more likely to progress than a boy's. Girls require scoliosis treatment about five times as often. The reason for these differences is not known.

Causes and symptoms

Four out of five cases of scoliosis are *idiopathic*, meaning the cause is unknown. While idiopathic scoliosis tends to run in families, no responsible genes had been identified as of 1997. Children with idiopathic scoliosis appear to be otherwise entirely healthy, and have

not had any bone or joint disease early in life. Scoliosis is not caused by poor posture, diet, or carrying a heavy bookbag exclusively on one shoulder.

Idiopathic scoliosis is further classified according to age of onset:

- Infantile. Curvature appears before age three. This type is quite rare in the United States, but is more common in Europe.
- Juvenile. Curvature appears between ages 3 and 10. This type may be equivalent to the adolescent type, except for the age of onset.
- Adolescent. Curvature appears between ages of 10 and 13, near the beginning of **puberty**. This is the most common type of idiopathic scoliosis.
- Adult. Curvature begins after physical maturation is completed.

Causes are known for three other types of scoliosis:

- Congenital scoliosis is due to congenital abnormal formation of the bones of the spine, and is often associated with other organ defects.
- Neuromuscular scoliosis is due to loss of control of the nerves or muscles which support the spine. The most common causes of this type of scoliosis are **cerebral palsy** and **muscular dystrophy**.
- Degenerative scoliosis may be caused by degeneration of the discs which separate the vertebrae or arthritis in the joints that link them.

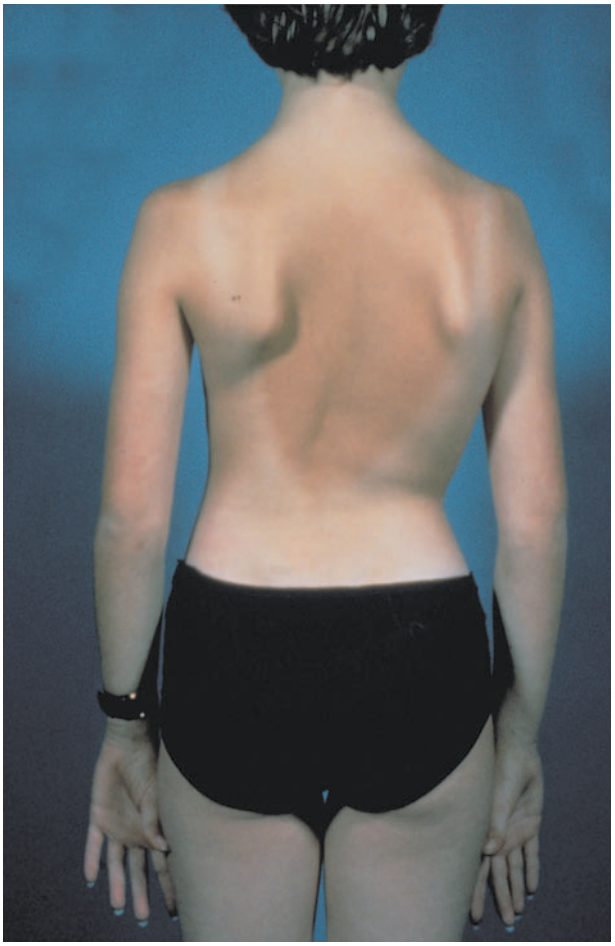
Scoliosis causes a noticeable asymmetry in the torso when viewed from the front or back. The first sign of scoliosis is often seen when a child is wearing a bathing suit or underwear. A child may appear to be standing with one shoulder higher than the other, or to have a tilt in the waistline. One shoulder blade may appear more prominent than the other due to rotation. In girls, one breast may appear higher than the other, or larger if rotation pushes that side forward.

Curve progression is greatest near the adolescent growth spurt. Scoliosis that begins early on is more likely to progress significantly than scoliosis that begins later in puberty.

More than 30 states have screening programs in schools for adolescent scoliosis, usually conducted by trained school nurses or gym teachers.

Diagnosis

Diagnosis for scoliosis is done by an orthopedist. A complete medical history is taken, including questions about family history of scoliosis. The **physical examination** includes determination of pubertal development in adolescents, a neurological exam (which may reveal a neuromuscular cause), and measurements of trunk asymmetry. Examination of the trunk is done while the patient is standing, bending over, and lying down, and involves both visual inspection and use of a simple mechanical device called a scoliometer.



This woman suffers from scoliosis, or curvature of the spine. *(Custom Medical Stock Photo. Reproduced by permission.)*

If a curve is detected, one or more x rays will usually be taken to define the curve or curves more precisely. An x ray is used to document spinal maturity, any pelvic tilt or hip asymmetry, and the location, extent, and degree of curvature. The curve is defined in terms of where it begins and ends, in which direction it bends, and by an angle measure known as the Cobb angle. The Cobb angle is found by projecting lines parallel to the vertebrae tops at the extremes of the curve; projecting perpendiculars from these lines; and measuring the angle of intersection. To properly track the progress of scoliosis, it is important to project from the same points of the spine each time.

Occasionally, **magnetic resonance imaging** (MRI) is used, primarily to look more closely at the condition of the spinal cord and nerve roots extending from it if neurological problems are suspected.

Treatment

Treatment decisions for scoliosis are based on the degree of curvature, the likelihood of significant progression, and the presence of pain, if any.

Curves less than 20 degrees are not usually treated, except by regular follow-up for children who are still growing. Watchful waiting is usually all that is required in adolescents with curves of 20–30 degrees, or adults with curves up to 40 degrees or slightly more, as long as there is no pain.

For children or adolescents whose curves progress to 30 degrees, and who have a year or more of growth left, bracing may be required. Bracing cannot correct curvature, but may be effective in halting or slowing progression. Bracing is rarely used in adults, except where pain is significant and surgery is not an option, as in some elderly patients.

Two general styles of braces are used for daytime wear. The Milwaukee brace consists of metal uprights attached to pads at the hips, rib cage, and neck. The underarm brace uses rigid plastic to encircle the lower rib cage, abdomen, and hips. Both these brace types hold the spine in a vertical position. Because it can be worn out of sight beneath clothing, the underarm brace is better tolerated and often leads to better compliance. A third style, the Charleston bending brace, is used at night to bend the spine in the opposite direction. Braces are often prescribed to be worn for 22–23 hours per day, though some clinicians allow or encourage removal of the brace for **exercise**.

Bracing may be appropriate for scoliosis due to some types of neuromuscular disease, including spinal muscular atrophy, before growth is finished. Duchenne muscular dystrophy is not treated by bracing, since surgery is likely to be required, and since later surgery is complicated by loss of respiratory capacity.

Surgery for idiopathic scoliosis is usually recommended if:

- the curve has progressed despite bracing
- the curve is greater than 40-50 degrees before growth has stopped in an adolescent
- the curve is greater than 50 degrees and continues to increase in an adult
- there is significant pain

Orthopedic surgery for neuromuscular scoliosis is often done earlier. The goals of surgery are to correct the deformity as much as possible, to prevent further deformity, and to eliminate pain as much as possible. Surgery can usually correct 40–50% of the curve, and sometimes as much as 80%. Surgery cannot always completely remove pain.

The surgical procedure for scoliosis is called *spinal fusion*, because the goal is to straighten the spine as much as possible, and then to fuse the vertebrae together to prevent further curvature. To achieve fusion, the involved vertebra are first exposed, and then scraped to promote regrowth. Bone chips are usually used to splint together the vertebrae to increase the likelihood of fusion. To maintain the proper spinal posture before fusion occurs, metal rods are inserted alongside the spine, and are attached to the vertebrae by hooks, screws, or wires. Fusion of the spine makes it rigid and resistant to further curvature. The metal rods are no longer needed once fusion is complete, but are rarely removed unless their presence leads to complications.

Spinal fusion leaves the involved portion of the spine permanently stiff and inflexible. While this leads to some loss of normal motion, most functional activities are not strongly affected, unless the very lowest portion of the spine (the lumbar region) is fused. Normal mobility, exercise, and even contact sports are usually all possible after spinal fusion. Full recovery takes approximately six months.

Alternative treatment

Numerous alternative therapies have been touted to provide relief and help for individuals with scoliosis, but none have been proven beneficial in clinical trials. These include massage, physical therapy, and electrical stimulation. In addition, alternatives such as physical therapy, **rolfing**, or chiropractice manipulation may provide improved flexibility, stronger muscles, and pain relief, but cannot prevent or correct the curvature of the spine or its natural progression.

Although important for general health and strength, exercise has not been shown to prevent or slow the development of scoliosis. It may help relieve pain from scoliosis by helping to maintain range of motion. Aquatic exercise, in particular, can increase flexibility and improve posture, balance, coordination, and range of motion. Because it decreases joint compression, it can lessen the pain caused by scoliosis or surgery.

Good **nutrition** is also important for general health, but no specific dietary regimen has been shown to control scoliosis development. In particular, dietary calcium levels do not influence scoliosis progression.

Chiropractic treatment may relieve pain, but it cannot halt scoliosis development, and should not be a substitute for conventional treatment of progressing scoliosis. **Acupuncture** and **acupressure** may also help reduce pain and discomfort, but they cannot halt scoliosis development either.

Prognosis

The prognosis for a person with scoliosis depends on many factors, including the age at which scoliosis begins and the treatment received. More importantly, mostly unknown individual factors affect the likelihood of progression and the severity of the curve. Most cases of mild adolescent idiopathic scoliosis need no treatment and do not progress. Untreated severe scoliosis often leads to spondylosis, and may impair breathing. Degenerative arthritis of the spine, **sciatica**, and severe physical deformities can also result if severe scoliosis is left untreated. Finally, scoliosis can also poorly affect the individual's self-esteem and cause serious emotional problems.

Prevention

There is no known way to prevent the development of scoliosis. Progression of scoliosis may be prevented through bracing or surgery.

Exercise and physical fitness are of paramount importance for all individuals affected with scoliosis. They not only work to maintain flexibility and health, but decrease the likelihood of **osteoporosis**, which in these individuals, can be extremely debilitating.

Resources

BOOKS

Lonstein, John, et al., eds. *Moe's Textbook of Scoliosis and Other Spinal Deformities.* 3rd ed. Philadelphia: W.B. Saunders, 1995.

Lyons, Brooke, et al. *Scoliosis: Ascending the Curve.* New York: M. Evans & Co., 1999.

Neuwirth, Michael, and Kevin Osborn. *The Scoliosis Handbook.* New York: Henry Holt & Co., 1996.

PERIODICALS

Bridwell, KH, et al., eds. "Parents' and Patients' Preferences and Concerns in Idiopathic Adolescent Scoliosis: A Cross-Sectional Preoperative Analysis." *Spine* 18, no. 25 (September 2000): 2392-9.

ORGANIZATIONS

American Physical Therapy Assocation. Scoliosis, P.O. Box 37257, Washington, DC 20013.

Center for Spinal Disorders, PC. 8515 Pearl Street, Suite 350, Thornton, CO 80229. (303) 287-2800. Fax: (303) 287-7357. <http://www.cntrforspinaldisorders.com>.

KEY TERMS

Cobb angle—A measure of the curvature of scoliosis, determined by measurements made on x rays.

Rolfing—A system of soft tissue manipulation and movement education to realign and reorient the body.

Scoliometer—A tool for measuring trunk asymmetry; it includes a bubble level and angle measure.

Spondylosis—Arthritis of the spine.

National Scoliosis Foundation. 72 Mount Auburn St., Watertown, MA 02172. (617) 926-0397.

The Scoliosis Association. PO Box 811705, Boca Raton, FL 33481-0669. (407) 368-8518.

Scoliosis Research Society. 6300 N. River Rd., Suite 727, Rosemont, IL 60018-4226. (708) 698-1627.

OTHER

"Chiropractic Treatment of Scoliosis." *Scoliosis World* <http://www.scoliosis-world.com>.

Liz Meszaros

Scrotal nuclear medicine scan

Definition

Scrotal nuclear medicine scan is a study of the blood circulation in the scrotum using radioactive contrast agent to highlight obstruction.

Purpose

This test is used almost exclusively to differentiate infection in the testis (testicle) from twisting and infarction. Infection is called **epididymitis** because it mostly involves a collection of tubules on top of the testicle called the epididymis. Twisting of the testis shuts off its blood supply and is called **testicular torsion**. Both conditions cause a very painful, swollen testis on one side. Both occur most often in young men, although infection usually occurs at a slightly greater age. The infection increases the blood supply, and the torsion cuts off the blood supply. This is an ideal situation for a blood flow study.

The distinction is critically important, because testicular torsion must be untwisted immediately or the testis will die. On the other hand, epididymitis responds to **antibiotics**, and surgery might further injure it.

KEY TERMS

Radioisotope—An unstable form of an element that gives off radiation to become stable.

Scrotum—The bag of skin below the penis that contains the testes.

Description

A radioisotope, technetium-99, combined in a chemical (pertechnate) is injected intravenously while the patient is under a special machine that detects radiation. This radiation detector, called a gamma camera, scans the scrotum at one minute intervals for about five minutes, then less often for another 10 or 15 minutes. It then creates pictures (either x ray or polaroid) that reveal where the isotope went in the scrotum. Since both sides are scanned, even greater accuracy is obtained by comparison.

Preparation

This procedure is usually done as an emergency to determine the need for immediate surgery.

Risks

The amount of radiation is so slight that even the sensitive testicular tissue is at minimum risk.

Normal results

Blood flow appears unobstructed.

Abnormal results

Three possible possible images appear. They are:

- increased blood flow indicating infection
- no blood flow indicating testicular torsion
- blood flow illuminated in a "donut" shaped pattern that indicates torsion that has resolved itself within the last few days

Resources

BOOKS

Rajfer, Jacob. "Congenital Anomalies of the Testes and Scrotum." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Rozauski, Thomas, et al. "Surgery of the Scrotum and Testis in Children." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

J. Ricker Polsdorfer, MD

Scrotal sonogram *see* **Scrotal ultrasound**

Scrotal ultrasound

Definition

Scrotal ultrasound is an imaging technique used for the diagnosis of suspected abnormalities of the scrotum. It uses harmless, high-frequency sound waves to form an image. The sound waves are reflected by scrotal tissue to form a picture of internal structures. It is not invasive and involves no radiation.

Purpose

Ultrasound of the scrotum is the primary imaging method used to evaluate disorders of the testicles and surrounding tissues. It is used when a patient has acute **pain** in the scrotum. Some of the problems for which the use of scrotal ultrasound is valuable include an absent or undescended testicle, an inflammation problem, **testicular torsion**, a fluid collection, abnormal blood vessels, or a mass (lump or tumor).

A sudden onset of pain in the scrotum is considered a serious problem, as delay in diagnosis and treatment can lead to loss of function. **Epididymitis** is the most common cause of this type of pain. Epididymitis is an inflammation of the epididymis, a tubular structure that transports sperm from the testes. It is most often caused by bacterial infection, but may occur after injury, or arise from an unknown cause. Epididymitis is treatable with **antibiotics**, which usually resolves pain quickly. Left untreated, this condition can lead to **abscess** formation or loss of blood supply to the testicle.

Testicular torsion is the twisting of the spermatic cord that contains the blood vessels which supply the testicles. It is caused by abnormally loose attachments of tissues that are formed during fetal development. Torsion can be complete, incomplete, or intermittent. Spontaneous detorsion, or untwisting, can occur, making diagnosis difficult. Testicular torsion arises most commonly during adolescence, and is acutely painful. Scrotal ultrasound is used to distinguish this condition from inflammatory problems, such as epididymitis. Testicular torsion is a surgical emergency; it should be operated on as soon as possible to avoid permanent damage to the testes.

A scrotal sac with an absent testicle may be the result of a congenital anomaly (an abnormality present at birth), where a testicle fails to develop. More often, it is due to an undescended testicle. In the fetus, the testicles normally develop just outside the abdomen and descend into the

KEY TERMS

Hydrocele—A collection of fluid between two layers of tissue surrounding the testicle; the most common cause of painless scrotal swelling.

Varicocele—An abnormal enlargement of the veins which drain the testicles.

scrotum during the seventh month. Approximately 3% of full term baby boys have undescended testicles. It is important to distinguish between an undescended testicle and an absent testicle, as an undescended testicle has a very high probability of developing **cancer**.

Ultrasound can be used to locate and evaluate masses in the scrotum. Most masses within the testicle are malignant or cancerous, and most outside the testicle are benign. Primary cancer of the testicles is the most common malignancy in men between the ages of 15-35. Fluid collections and abnormalities of the blood vessels in the scrotum may appear to the physician as masses and need evaluation by ultrasound. A hydrocele, the most common cause of painless scrotal swelling, is a collection of fluid between two layers of tissue surrounding the testicle. An abnormal enlargement of the veins which drain the testicles is called a varicocele. It can cause discomfort and swelling, which can be examined by touch (palpated). Varicocele is a common cause of male **infertility**.

Precautions

Clear scrotal ultrasound images are difficult to obtain if a patient is unable to remain still.

Description

The patient lies on his back on an examining table. The technologist will usually take a history of the problem, then gently palpate the scrotum. A rolled towel is placed between the patient's legs to support the scrotum. The penis is lifted up onto the abdomen and covered. A gel that enhances sound transmission is put directly on the scrotum. The technologist then gently places a transducer (an electronic imaging device) against the skin. It is moved over the area creating images from reflected sound waves, which appear on a monitor screen. There is no discomfort from the study itself. However, if the scrotum is very tender, even the slight pressure involved may be painful.

Normal results

A normal study would reveal testicles of normal size and shape, with no masses.

Abnormal results

An abnormal result of an ultrasound of the scrotum may reveal an absent or undescended testicle, an inflammation problem, testicular torsion, a fluid collection, abnormal blood vessels, or a mass.

Resources

BOOKS

Leonhardt, Wayne C. "Scrotum." In *Abdomen and Superficial Structures*. 2nd ed. Ed. Diane M. Kawamura. Philadelphia: Lippincott, 1997.

PERIODICALS

Bree, Robert L., and Dai T. Hoang. "Scrotal Ultrasound." *Radiologic Clinics of North America* 34 (Nov. 1996): 1183-1205.

Ellen S. Weber, MSN

Scrub typhus

Definition

Scrub **typhus** is an infectious disease that is transmitted to humans from field mice and rats through the bite of mites that live on the animals. The main symptoms of the disease are **fever**, a wound at the site of the bite, a spotted rash on the trunk, and swelling of the lymph glands.

Description

Scrub typhus is caused by *Rickettsia tsutsugamushi*, a tiny parasite about the size of bacteria that belongs to the family Rickettsiaceae. Under the microscope, rickettsiae are either rod-like (bacilli) or spherical (cocci) in shape. Because they are intracellular parasites, they can live only within the cells of other animals.

R. tsutsugamushi lives primarily in mites that belong to the species *Leptotrombidium (Trombicula) akamushi* and *Leptotrombidium deliense*. In Japan, some cases of scrub typhus have been reportedly transmitted by mites of the species *Leptotrombidium scutellare* and *Leptotrombidium pallidum*. The mites have four-stage life cycles: egg, larva, nymph, and adult. The larva is the only stage that can transmit the disease to humans and other vertebrates.

The tiny chiggers (mite larvae) attach themselves to the skin. During the process of obtaining a meal, they may either acquire the infection from the host or transmit the rickettsiae to other mammals or humans. In regions where scrub typhus is a constant threat, a natural cycle of *R. tsutsugamushi* transmission occurs between mite larvae and

small mammals (e.g., field mice and rats). Humans enter a cycle of rickettsial infection only accidentally.

Scrub typhus is also known as *tsutsugamushi disease*. The name tsutsugamushi is derived from two Japanese words: tsutsuga, meaning something small and dangerous, and mushi, meaning creature. The infection is called scrub typhus because it generally occurs after exposure to areas with secondary (scrub) vegetation. It has recently been found, however, that the disease can also be prevalent in such areas as sandy beaches, mountain deserts, and equatorial rain forests. Therefore, it has been suggested that the names mite-borne typhus, or chigger-borne typhus, are more appropriate. Since the disease is limited to eastern and southeastern Asia, India, northern Australia and the adjacent islands, it is also commonly referred to as tropical typhus.

The seasonal occurrence of scrub typhus varies with the climate in different countries. It occurs more frequently during the rainy season. Certain areas such as forest clearings, riverbanks, and grassy regions provide optimal conditions for the infected mites to thrive. These small geographic regions are high-risk areas for humans and have been called scrub-typhus islands.

Causes and symptoms

The incubation period of scrub typhus is about 10 to 12 days after the initial bite. The illness begins rather suddenly with shaking chills, fever, severe **headache**, infection of the mucous membrane lining the eyes (the conjunctiva), and swelling of the lymph nodes (lymphadenopathy). A wound (lesion) is often seen at the site of the chigger bite. Bite **wounds** are common in whites but rare in Asians.

The initial lesion, which is about 0.4 in (1 cm) in diameter and flat, eventually becomes elevated and filled with fluid. After it ruptures, it becomes covered with a black scab (eschar). The patient's fever rises during the first week, generally reaching 40–40.5°C (104–105°F). About the fifth day of fever, a red spotted rash develops on the trunk, often extending to the arms and legs. It may either fade away in a few days or may become spotted and elevated (maculopapular) and brightly colored. **Cough** is present during the first week of the fever. An infection of the lung (pneumonitis) may develop during the second week.

In severe cases, the patient's pulse rate increases and blood pressure drops. The patient may become delirious and lose consciousness. Muscular twitching may develop. Enlargement of the spleen is observed. Inflammation of the heart muscle (interstitial **myocarditis**) is more common in scrub typhus than in other rickettsial diseases. In untreated patients, high fever may last for more than two weeks. With specific therapy, however, the fever breaks within 36 hours. The patient's recovery is prompt and uneventful.

Diagnosis

Patient history and physical examination

Differentiating scrub typhus from other forms of typhus as well as from fever, typhoid and meningococcal infections is often difficult during the first several days before the initial rash appears. The geographical location of scrub typhus, the initial sore caused by the chigger bite, and the occurrence of specific proteins capable of destroying the organism (antibodies) in the blood, provide helpful clues and are useful in establishing the diagnosis.

Laboratory tests

Diagnostic procedures involving the actual **isolation** of rickettsiae from the blood or other body tissues are usually expensive, time-consuming, and hazardous to laboratory workers. As a result, several types of tests known as serological (immunological) tests are used widely to confirm the clinical diagnosis in the laboratory.

Specific antibodies develop in the body in response to an infection. The development of antibodies during the recovery period indicates that an immune response is present. The formation of antibodies is the basic principle of a serological test. Three different tests are available to diagnose rickettsial infections. The most widely used is the Weil-Felix test. This test is based on the fact that some of the antibodies that are formed in the body during a rickettsial infection can react with certain strains (OX-2 and OX-19) of *Proteus* bacteria and cause them to clump (agglutinate). The clumping is easily seen under the microscope. The Weil-Felix test is easy and inexpensive to perform, with the result that it is widely used. The Weil-Felix test, however, is not very specific. In addition, the clumping is not detectable until the second week of the illness, which limits the test's usefulness in early diagnosis.

A second test known as a complement fixation (CF) test is based on the principle that if antibodies are formed in the body in response to the illness, then the antigen and the antibody will form complexes. These antigen-antibody complexes have the ability to inactivate, or fix, a protein that is found in blood serum (serum complement). The serum complement fixation can be measured using standardized biochemical tests and confirms the presence of antibodies. A third test known as the fluorescent antibody test uses fluorescent tags that are attached to antibodies for easy detection. This test has been developed using three strains of *Rickettsia tsutsugamushi* and has proven to be the most specific for diagnosis.

KEY TERMS

Agglutinin—An antibody that causes particulate antigens such as bacteria or other cells to clump together.

Endemic area—A geographical region where a particular disease is prevalent.

Eschar—A hard crust or scab. In scrub typhus, an eschar forms over the initial sore from the chigger bite.

Intracellular parasite—An organism which can only feed and live within the cell of a different animal.

Maculopapular rash—A rash characterized by raised, spotted lesions.

Prophylactic dosage—Giving medications to prevent or protect against diseases.

Rickettsia—A rod-shaped infectious microorganism that can reproduce only inside a living cell. Scrub typhus is a rickettsial disease.

Serological tests—Tests of immune function that are performed using the clear yellow liquid part of blood.

Treatment

Scrub typhus is treated with **antibiotics**. Chloramphenicol (Chloromycetin, Fenicol) and tetracycline (Achromycin, Tetracyn) are the drugs of choice. They bring about prompt disappearance of the fever and dramatic clinical improvement. If the antibiotic treatment is discontinued too quickly, especially in patients treated within the first few days of the fever, relapses may occur. In patients treated in the second week of illness, the antibiotics may be stopped one to two days after the fever disappears.

Antibiotics are given intravenously to patients too sick to take them by mouth. Patients who are severely ill and whose treatment was delayed may be given **corticosteroids** in combination with antibiotics for three days.

Prognosis

Before the use of antibiotics, the mortality rate for scrub typhus varied from 1–60%, depending on the geographic area and the rickettsial strain. Recovery also took a long time. With modern treatment methods, however, deaths are rare and the recovery period is short.

Prevention

General precautions

As of 1998, there are no effective vaccines for scrub typhus. In endemic areas, precautions include wearing protective clothing. Insect repellents containing dibutyl phthalate, benzyl benzoate, diethyl toluamide, and other substances can be applied to the skin and clothing to prevent chigger bites. Clearing of vegetation and chemical treatment of the soil may help to break up the cycle of transmission from chiggers to humans to other chiggers.

Prophylactic antibiotic dosage

It has been shown that a single oral dose of chloramphenicol or tetracycline given every 5 days for a total of 35 days, with 5-day nontreatment intervals, actually produces active immunity to scrub typhus. This procedure is recommended under special circumstances in certain areas where the disease is endemic.

Resources

BOOKS

Merck Manual of Diagnosis and Therapy, ed. Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1992.

"Rickettsial Infections." In *Merck Manual of Medical Information: Home Edition*, ed. Robert Berkow, et al. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Zinsser, Hans. *Zinsser Microbiology.* 19th ed. Ed. Wolfgang K. Joklik, et al. Stamford: Appleton Lange, 1988.

Lata Cherath, PhD

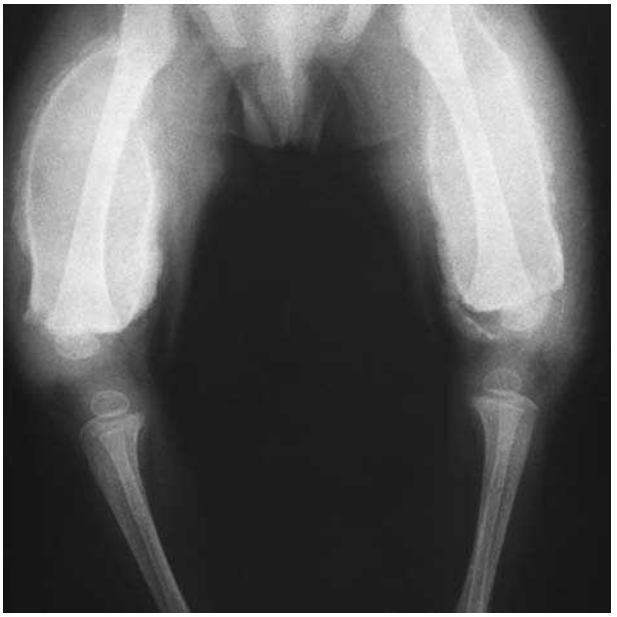
Scurvy

Definition

Scurvy is a condition caused by a lack of vitamin C (ascorbic acid) in the diet. Signs of scurvy include tiredness, muscle weakness, joint and muscle aches, a rash on the legs, and bleeding gums. In the past, scurvy was common among sailors and other people deprived of fresh fruits and vegetables for long periods of time.

Description

Scurvy is very rare in countries where fresh fruits and vegetables are readily available and where processed foods have vitamin C added. Vitamin C is an important antioxidant vitamin involved in the development of con-



An x-ray image of an infant suffering from scurvy. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission.)*

nective tissues, lipid and vitamin metabolism, biosynthesis of neurotransmitters, immune function, and wound healing. It is found in fruits, especially citrus fruits like oranges, lemons, and grapefruit, and in green leafy vegetables like broccoli and spinach. In adults, it may take several months of vitamin C deficiency before symptoms of scurvy develop.

Currently, the recommended daily allowance (RDA) for vitamin C is 50–60 mg/day for adults; 35 mg/day for infants; 40–45 mg/day for children 1–14; 70 mg/day during **pregnancy**; and 90–95 mg/day during **lactation**. The body's need for vitamin C increases when a person is under **stress**, **smoking**, or taking certain medications.

Causes and symptoms

A lack of vitamin C in the diet is the primary cause of scurvy. This can occur in people on very restricted **diets**, who are under extreme physiological stress (for example, during an infection or after an injury), and in chronic alcoholics. Infants can develop scurvy if they are weaned from breast milk and switched to cow's milk without an additional supplement of vitamin C. Babies of mothers who took extremely high doses of vitamin C during pregnancy can develop infantile scurvy. In children, the deficiency can cause painful swelling of the legs along with **fever**, **diarrhea**, and vomiting. In adults, early signs of scurvy include feeling weak, tired, and achy. The appearance of tiny red blood-blisters to larger purplish blotches on the skin of the legs is a common symptom. Wound healing may be delayed and scars that had healed may start to breakdown. The gums swell and bleed easily, eventually leading to loosened teeth. Muscle and joint **pain** may also occur.

KEY TERMS

Ascorbic acid—Another term for vitamin C, a nutrient found in fresh fruits and vegetables. Good sources of vitamin C in the diet are citrus fruits like oranges, lemons, limes, and grapefruits, berries, tomatoes, green peppers, cabbage, broccoli, and spinach.

Recommended daily allowance (RDA)—The daily amount of a vitamin the average person needs to maintain good health.

Diagnosis

Scurvy is often diagnosed based on the symptoms present. A dietary history showing little or no fresh fruits or vegetables are eaten may help to diagnose vitamin C deficiency. A blood test can also be used to check the level of ascorbic acid in the body.

Treatment

Adult treatment is usually 300–1,000 mg of ascorbic acid per day. Infants should be treated with 50 mg of ascorbic acid up to four times per day.

Prognosis

Treatment with vitamin C is usually successful, if the deficiency is recognized early enough. Left untreated, the condition can cause **death**.

Prevention

Eating foods rich in vitamin C every day prevents scurvy. A supplement containing the RDA of vitamin C will also prevent a deficiency. Infants who are being weaned from breast milk to cow's milk need a supplement containing vitamin C.

Resources

BOOKS

"Ascorbic Acid (Vitamin C) Deficiency." In *Internal Medicine*, ed. Jay H. Stein. St. Louis: Mosby, 1998.

"Vitamin C (Ascorbic Acid)." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.
"Vitamin C Deficiency (Scurvy)." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.
"Vitamin C Deficiency (Scurvy)." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.
"Vitamins and Their Functions." In *Cecil Textbook of Medicine*. 20th ed. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

"Major Study Recommends Tripling RDA for Vitamin C." *Environmental Nutrition* 19 (June 1996): 3.

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Seafood poisoning *see* **Fish and shellfish poisoning**

Seasonal affective disorder

Definition

Seasonal affective disorder (SAD) is a form of depression most often associated with the lack of daylight in extreme northern and southern latitudes from the late fall to the early spring.

Description

Although researchers are not certain what causes seasonal affective disorder, they suspect that it has something to do with the hormone melatonin. Melatonin is thought to play an active role in regulating the "internal body clock," which dictates when humans feel like going to bed at night and getting up in the morning. Although seasonal affective disorder is most common when light is low, it may occur in the spring, and it is then often called reverse SAD.

Causes and symptoms

The body produces more melatonin at night than during the day, and scientists believe it helps people feel sleepy at nighttime. There is also more melatonin in the body during winter, when the days are shorter. Some researchers believe that excessive melatonin release during winter in people with SAD may account for their feelings of drowsiness or depression. One variation on this idea is that, during winter, people's internal clocks may become out of sync with the light-dark cycle, leading to a long-term disruption in melatonin release.

Seasonal affective disorder, while not an official category of mental illness listed by the American Psychiatric Association, is estimated to affect 10 million Americans, most of whom are women. Another 25 million Americans may have a mild form of SAD, sometimes called the "winter blues" or "winter blahs." The risk of SAD increases the further from the equator a person lives.

The symptoms of SAD are similar to those of other forms of depression. People with SAD may feel sad, irritable, or tired, and may find themselves sleeping too much. They may also lose interest in normal or pleasurable activities (including sex), become withdrawn, crave carbohydrates, and gain weight.

Diagnosis

Doctors usually diagnose seasonal affective disorder based on the patient's description of symptoms, including the time of year they occur.

Treatment

The first-line treatment for seasonal affective disorder is light therapy, exposing the patient to bright artificial light to compensate for the gloominess of winter. Light therapy uses a device called a light box, which contains a set of fluorescent or incandescent lights in front of a reflector. Typically, the patient sits for 30 minutes next to a 10,000-lux box (which is about 50 times as bright as ordinary indoor light). Light therapy appears to be safe for most people. However, it may be harmful for those with eye diseases. The most common side effects are vision problems such as eye strain, headaches, irritability, and **insomnia**. In addition, hypomania (elevated or expansive mood, characterized by hyperactivity and inflated self esteem) may occasionally occur.

Recently, researchers have begun testing whether people who do not completely respond to light therapy can benefit from tiny doses of the hormone melatonin to reset the body's internal clock. Early results look promising, but the potential benefits must be confirmed in larger studies before this type of treatment becomes widely accepted.

Like other types of **mood disorders**, seasonal affective disorder may also respond to medication and psychotherapy. The four different classes of drugs used for mood disorders are:

- heterocyclic antidepressants (HCAs), such as amitriptyline (Elavil)
- selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine (Prozac), paroxetine (Paxil), and sertraline (Zoloft)

KEY TERMS

Cognitive behavioral therapy—Psychotherapy aimed at helping people change their attitudes, perceptions, and patterns of thinking.

Melatonin—A naturally occurring hormone involved in regulating the body's "internal clock."

Serotonin—A chemical messenger in the brain thought to play a role in regulating mood.

- monoamine oxidase inhibitors (MAO inhibitors), such as phenelzine sulfate (Nardil) and tranylcypromine sulfate (Parnate)
- lithium salts, such as lithium carbonate (Eskalith), often used in people with bipolar mood disorders, are often useful with SAD patients; many SAD patients also suffer from **bipolar disorder** (excessive mood swings; formerly known as manic depression)

A number of psychotherapy approaches are useful as well. Interpersonal psychotherapy helps patients recognize how their mood disorder and their interpersonal relationships interact. **Cognitive-behavioral therapy** explores how the patient's view of the world may be affecting mood and outlook.

Prognosis

Most patients with seasonal affective disorder respond to light therapy and/or **antidepressant drugs**.

Resources

BOOKS

Peters, Celeste A. *Don't Be SAD: Your Guide to Conquering Seasonal Affective Disorder.* Calgary, Alberta: Good Health Books, 1994.

PERIODICALS

Anderson, Janis L., and Gabrielle I. Warner. "Seasonal Depression." *Harvard Health Letter* (Feb. 1996): 7-8.

"Winter Depression: Seeing the Light." *The University of California Berkeley Wellness Letter* (Nov. 1996): 4.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street NW, Washington DC 20005. (888) 357-7924. <http://www.psych.org>.

National Depressive and Manic Depressive Association. 730 N. Franklin St., Ste. 501, Chicago, IL 60610. (800) 826-3632. <http://www.ndmda.org>.

National Institute of Mental Health. Mental Health Public Inquiries, 5600 Fishers Lane, Room 15C-05, Rockville, MD 20857. (888) 826-9438. <http://www.nimh.nih.gov>.

Robert Scott Dinsmoor

Seasonal depression *see* **Seasonal affective disorder**

Seatworm infection *see* **Enterobiasis**

Seborrheic dermatitis

Definition

Seborrheic **dermatitis** is a common inflammatory disease of the skin characterized by scaly lesions usually on the scalp, hairline, and face.

Description

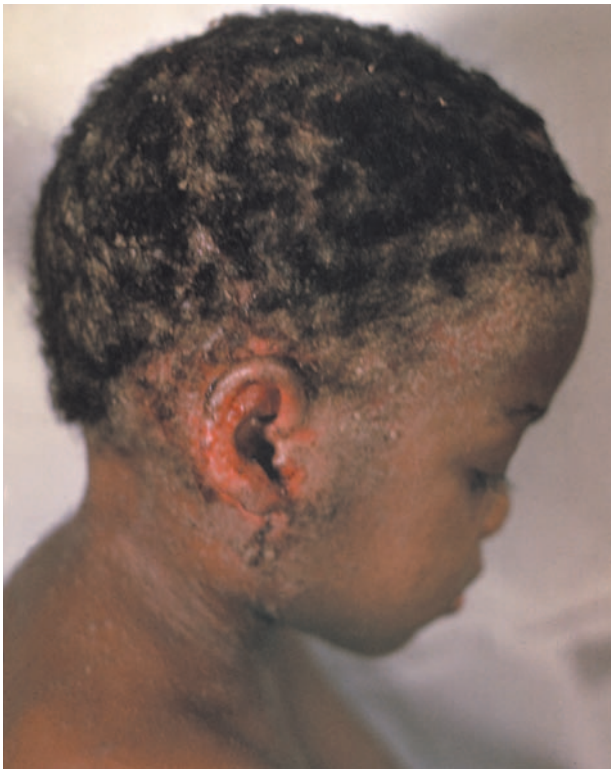
Seborrheic dermatitis appears as red, inflamed skin covered by greasy or dry scales that may be white, yellowish, or gray. It can effect the scalp, eyebrows, forehead, face, folds around the nose and ears, the chest, armpits (axilla), and groin. Dandruff and cradle cap are mild forms of seborrheic dermatitis, and appear as fine white scales without inflammation.

Causes and symptoms

The cause of seborrheic dermatitis is unclear, though it is has been linked to genetic or environmental factors. *Pityrosporum ovale*, a species of yeast normally found in hair follicles, has been proposed as one possible causative factor. A high fat diet and alcohol ingestion are thought to play some role. Other possible risk factors include:

- stress and **fatigue**
- weather extremes (e. g. hot, humid weather or cold, dry weather)
- oily skin
- infrequent shampoos
- obesity
- Parkinson's disease
- AIDS
- use of drying lotions that contain alcohol
- other skin disorders (for example **acne**, **rosacea**, or psoriasis)

Mild forms of the disorder may be asymptomatic. Symptoms also disappear and reappear, and vary in intensity over time. When scaling is present, it may be accompanied by **itching** that can lead to secondary infection.



This young boy is afflicted with seborrheic dermatitis. *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

The diagnosis of seborrheic dermatitis is based on assessment of symptoms, accompanied by consideration of medical history.

Treatment

Treatment consists of vigorous shampoos with preparations that assist with softening and removing the scaly accumulations. For mild cases, a non-prescription shampoo with selenium sulfide or zinc pyrithione may be used. For more severe problems, the doctor may prescribe shampoos containing coal tar or scalp creams containing cortisone. The antiseborrheic shampoo should be left on the scalp for approximately five minutes before rinsing out. Hydrocortisone cream may also be ordered for application to the affected areas on the face and body. Application of the hydrocortisone should be discontinued when the condition clears and restarted with recurrence.

Prognosis

This chronic condition may be characterized by long periods of inactivity. Symptoms in the acute phase can be controlled with appropriate treatment.

KEY TERMS

Acne—A chronic inflammation of the sebaceous glands that manifests as blackheads, whiteheads, and/or pustules on the face or trunk.

Psoriasis—A skin disorder of chronic, itchy scaling most commonly at sites of repeated minor trauma (e.g. elbows, knees, and skin folds). It affects up to 2% of the population in Western countries—males and females equally.

Rosacea—A chronic inflammation of the face, with associated scattered round nodules and increased reactivity of the facial capillaries to heat. It is most common in females, aged 30-50 years.

Prevention

The condition cannot be prevented. The severity and frequency of flare-ups may be minimized with frequent shampoos, thorough drying of skin folds after bathing, and wearing of loose, ventilating clothing. Foods that appear to worsen the condition should be avoided.

Resources

BOOKS

Fitzpatrick, Thomas, et al. *Color Atlas and Synopsis of Clinical Dermatology.* New York: McGraw-Hill, Inc., 1992.

Monahan, Frances, and Marianne Neighbors. *Medical Surgical Nursing: Foundations for Clinical Practice*. Philadelphia: W. B. Saunders, 1998.

Uphold, Constance, and Mary Graham. *Clinical Guidelines in Family Practice*. Gainsville, FL: Barmarrae Books, 1994.

OTHER

"Seborrheic Dermatitis." *ThriveOnline*. 4 Apr. 1998. <http://thriveonline.oxygen.com>.

Kathleen D. Wright, RN

Secobarbital *see* **Barbiturates**

Secondary erythrocytosis *see* **Secondary polycythemia**

Secondary polycythemia

Definition

Secondary polycythemia is an acquired form of a rare disorder characterized by an abnormal increase in the number of mature red cells in the blood.

Secondary polycythemia is also called secondary erythrocytosis.

Description

Polycythemia means too many red blood cells. The resulting excess of red cells thickens the blood and impedes its passage through small blood vessels.

Secondary polycythemia usually affects people between the ages of 40 and 60.

Types of secondary polycythemia

Known as spurious polycythemia, **stress** polycythemia, or Gaisbock's syndrome, relative polycythemia is characterized by normal numbers of red blood cells but decreased levels of plasma (the fluid part of the blood). Overweight, middle-aged white men who smoke, have high blood pressure, and are on diuretic medicines to remove excess water from their bodies may develop Gaisbock's syndrome.

In smoker's polycythemia, the number of red blood cells is elevated. Plasma levels are abnormally low.

Causes and symptoms

Smoking, which impairs red blood cells' ability to deliver oxygen to body tissues, can cause secondary polycythemia. So can the following conditions:

- carbon monoxide **poisoning**
- chronic heart or lung disease
- hormonal (endocrine) disorders
- exposure to high altitudes
- kidney cysts
- tumors of the brain, liver, or uterus

Causes of spurious polycythemia include:

- burns
- diarrhea
- hemoconcentration (higher-than-normal concentration of cells and solids in the blood, usually due to becoming dehydrated or taking **diuretics**)
- stress

Weakness, headaches, and **fatigue** are usually the first symptoms of secondary polycythemia. Patients may feel lightheaded or experience **shortness of breath**.

Visual disturbances associated with this disorder include distorted vision, blind spots, and flashes of light. The gums and small cuts are likely to bleed, and the hands and feet may burn. Extensive **itching** often occurs after taking a bath or shower.

Pain in the chest or leg muscles is common. The face often becomes ruddy, then turns blue after **exercise** or other exertion. Confusion and ringing in the ears (**tinnitus**) may also occur.

Diagnosis

A very important part of diagnosing secondary polycythemia is differentiating it from primary polycythemia (also called polycythemia rubra vera or Vaquez' disease). Unlike secondary polycythemia, primary polycythemia cannot be traced to an underlying condition such as smoking, high altitude, or chronic lung disease.

Doctors diagnose polycythemia by measuring oxygen levels in blood drawn from an artery. A patient whose oxygen level is abnormally low probably has secondary polycythemia. Erythropoietin may also be measured. Levels of this hormone, which stimulates the bone marrow to produce red blood cells, may be normal or elevated in a patient with secondary polycythemia. Red blood cell mass is also frequently measured in diagnosing the disorder.

Imaging studies are sometimes performed to determine whether the spleen and liver are enlarged and to detect erythropoietin-producing kidney lesions. Other diagnostic procedures include chest x rays and an electrocardiogram (EKG).

Treatment

Secondary polycythemia is treated primarily by treating the underlying condition causing the disorder. For example, patients with Gaisbock's syndrome are often taken off diuretics and encouraged to lose weight. Lung disorders, such as chronic obstructive pulmonary disease (COPD), may cause secondary polycythemia; treating the lung disorder generally improves the polycythemia.

Some medications may also be taken to treat symptoms caused by polycythemia. For example, **antihistamines** can alleviate itching, and **aspirin** can soothe burning sensations and bone pain.

Until the underlying condition is controlled, doctors use bloodletting (**phlebotomy**) to reduce the number of red blood cells in the patient's body. In most instances, a pint of blood is drained from the patient as needed and tolerated, until the **hematocrit** (the proportion of red cells in the blood) reaches an acceptable level. **Chemotherapy** is not used to treat secondary polycythemia; however, it may be used to treat the primary form.

Prognosis

Curing or removing the underlying cause of this disorder generally eliminates the symptoms.

Resources

BOOKS

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck & Co., Inc., 1977.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Conn's Current Therapy, 1996. Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

OTHER

"Secondary Erythrocytosis." *The Meck Page*. 3 June 1998 <http://www.merck.com>.

Maureen Haggerty

SED rate *see* **Erythrocyte sedimentation rate**

Sedation

Definition

Sedation is the act of calming by administration of a sedative. A sedative is a medication that commonly induces the nervous system to calm.

Purpose

The process of sedation has two primary intentions. First, sedation is recommended to allow patients the ability to tolerate unpleasant diagnostic or surgical procedures and to relieve **anxiety** and discomfort. Second, sedation for uncooperative patients may expedite and simplify special procedures that require little or no movement. Additionally, sedation is often desirable to diminish fear associated with operative procedures. Sedation is typically used for common diagnostic tests that require prolonged **immobilization** such as **magnetic resonance imaging** (MRI) and computed axial tomography (CAT) scanning. Some cases that require sedation may also necessitate the use of **analgesics** to decrease **pain** associated with a procedure or test.

Precautions

Benzodiazepines (common sedative medication) have a cumulative effect. This means that if the patient has not had time to metabolize the previous dose and ingests more, then the sedative effect may increase. Because of these additive effects these medications taken with other sedatives or alcohol (also a sedative hypnotic drug) may increase chances for accidental **death**. In general, most of the medications that induce sedation may alter breathing and cardiac stability. In patients with preexisting lung and/or heart disease, these medications should be monitored closely or not prescribed.

Description

The future of anesthetic care involves the simultaneous administration of several drugs including IV medications and inhaled anesthetics. An extensive survey of death in 100,000 cases published in 1988 revealed that death within seven days was 2.9 times greater when one or two anesthetic drugs were used than when using three or more medications. As of 2000 this study is accepted as standard practice and multiple IV anesthetics is the preferable recommendation for optimal patient care.

The procedure for sedation is usually explained to the patient by an attending clinician. An IV access line is set in place for fluid replacement and injection of medications. A history is usually taken to assess risk and choice of medication. The patient typically signs consent forms and the possible side effects are explained. The day before the test, the patient may be required to maintain specified dietary restriction.

For outpatient surgery there are two types of sedation, conscious and unconscious sedation. Patients receiving conscious sedation are capable of rational responses, and they are able to maintain their airway for ventilation. The hallmark of conscious sedation is that it does not alter respiratory, cardiac, or reflex functions (nerve reflexes from the brain) to the level that requires external support for these vital functions. Patients receiving conscious sedation are cooperative, have stable vital signs (pulse, respiratory rate, and temperature), shorter recovery room convalescence, and lower risk of developing drug-induced complications. Unconscious sedation is a controlled state of anesthesia, characterized by partial or complete loss of protective nerve reflexes, including the ability to independently breathe and respond to commands. The patient is unable to cooperate, has labile (fluctuating) vital signs, prolonged recovery room convalescence, and higher risk of anesthetic complications.

Preparation

Usually procedures for conscious sedation do not require preoperative or pre-testing orders. Clinical situations for unconscious sedation typically involve eating and drinking protocols starting the day before the procedure.

The age and physical status of the patient is useful in determining sensitivity. A detailed past history, especially prior experiences with sedatives and other anesthetics is an important part of preparatory assessment. It is impor-

KEY TERMS

Baseline—A return to an original state.

Benzodiazepam—One of the most commonly used sedative-hypnotic medications.

tant to determine if there was any untoward side effects associated with a previous medication. Patient positioning is important to prevent blood pressure changes or nerve damage associated with abnormal position.

Patients are also monitored for pulse rate, respiration, blood pressure, and temperature. Additionally, the heart is monitored using **electrocardiography** (ECG). Ventilation is assessed using a pulse oximeter. This machine is clipped with a special probe on one finger and can measure the levels of oxygen and carbon dioxide, which are reliable indicators of respiratory status.

Aftercare

The major goal for recovery room monitoring is assessment of residual drug effects. Recovery room monitoring primarily focuses on heart stability, respiratory adequacy and return to previous brain functioning.

Risks

The original forms of diazepam (Valium, a very common sedative) caused irritation of veins and phlebitis. Newer forms of diazepam (Dizac) are chemically improved to lower the possibility of vein irritation. Age and physical health are important risk factors. Preexisting medical conditions such as high blood pressure and heart and lung disease may increase the chance of developing undesirable side effects.

Normal results

Normal or uncomplicated results for sedation include alleviation of anxiety and discomfort. Coupled with analgesic, patients are usually pain-free. The normal progression post procedure or post operatively would be to return to baseline brain functioning, unassisted breathing, and normal heart rate and rhythm.

Abnormal results

Patients may have excessive **nausea and vomiting** associated with narcotic analgesia (if this is indicated). Excessive drowsiness can occur secondary to benzodiazepine-induced sedation. The patient can also develop hypoventilation (a decrease in ventilation), airway obstruction, high or low blood pressure, abnormal heart rhythms, nausea, vomiting, and shivering.

Resources

BOOKS

Fleisher, Gary R., et al. *Textbook of Pediatric Emergency Medicine*. 4th ed. Lippincott Wlliams & Wilkins, 2000.

Miller, Ronald D., et al, eds. *Anesthesia*. 5th ed. Churchill Livingstone, Inc., 2000.

ORGANIZATION

American Society of Anesthesiologists. 520 N. Northwest Highway, Park Ridge, IL 60068-2573.

Laith Farid Gulli, M.D.
Bilal Nasser,M.Sc.

Sedative-hypnotic drugs *see* **Anti-insomnia drugs**

Sedative-hypnotics *see* **Benzodiazepines**

Sedimentation rate *see* **Erythrocyte sedimentation rate**

Seizure disorder

Definition

A seizure is a sudden disruption of the brain's normal electrical activity accompanied by altered consciousness and/or other neurological and behavioral manifestations. Epilepsy is a condition characterized by recurrent seizures that may include repetitive muscle jerking called convulsions.

Description

There are more than 20 different seizure disorders. One in ten Americans will have a seizure at some time, and at least 200,000 have at least one seizure a month.

Epilepsy affects 1–2% of the population of the United States. Although epilepsy is as common in adults over 60 as in children under 10, 25% of all cases develop before the age of five. One in every two cases develops before the age of 25. About 125,000 new cases of epilepsy are diagnosed each year, and a significant number of children and adults that have not been diagnosed or treated have epilepsy.

Most seizures are benign, but a seizure that lasts a long time can lead to status epilepticus, a life-threatening condition characterized by continuous seizures, sus-

tained loss of consciousness, and respiratory distress. Non-convulsive epilepsy can impair physical coordination, vision, and other senses. Undiagnosed seizures can lead to conditions that are more serious and more difficult to manage.

Types of seizures

Generalized epileptic seizures occur when electrical abnormalities exist throughout the brain. A partial seizure does not involve the entire brain. A partial seizure begins in an area called an epileptic focus, but may spread to other parts of the brain and cause a generalized seizure. Some people who have epilepsy have more than one type of seizure.

Motor attacks cause parts of the body to jerk repeatedly. A motor attack usually lasts less than an hour and may last only a few minutes. Sensory seizures begin with numbness or tingling in one area. The sensation may move along one side of the body or the back before subsiding.

Visual seizures, which affect the area of the brain that controls sight, cause people to see things that are not there. Auditory seizures affect the part of the brain that controls hearing and cause the patient to imagine voices, music, and other sounds. Other types of seizures can cause confusion, upset stomach, or emotional distress.

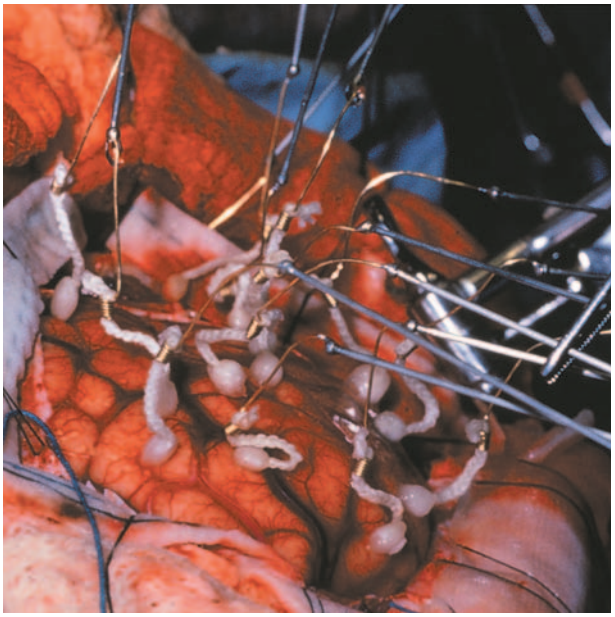
GENERALIZED SEIZURES. A generalized tonic-clonic (grand-mal) seizure begins with a loud cry before the person having the seizure loses consciousness and falls to the ground. The muscles become rigid for about 30 seconds during the tonic phase of the seizure and alternately contract and relax during the clonic phase, which lasts 30–60 seconds. The skin sometimes acquires a bluish tint and the person may bite his tongue, lose bowel or bladder control, or have trouble breathing.

A grand mal seizure lasts between two and five minutes, and the person may be confused or have trouble talking when he regains consciousness (post-ictal state). He may complain of head or muscle aches, or weakness in his arms or legs before falling into a deep sleep.

PRIMARY GENERALIZED SEIZURES. A primary generalized seizure occurs when electrical discharges begin in both halves (hemispheres) of the brain at the same time. Primary generalized seizures are more likely to be major motor attacks than to be absence seizures.

ABSENCE SEIZURES. Absence (petit mal) seizures generally begin at about the age of four and stop by the time the child becomes an adolescent.

Absence seizures usually begin with a brief loss of consciousness and last between one and 10 seconds. A person having a petit mal seizure becomes very quiet and may blink, stare blankly, roll his eyes, or move his lips. A petit mal seizure lasts 15-20 seconds. When it ends, the person who had the seizure resumes whatever he was doing before the seizure began. He will not remember the seizure and may not realize that anything unusual has happened. Untreated, petit mal seizures can recur as many as 100 times a day and may progress to grand mal seizures.



This patient's brain is exposed during surgery in order for surgeons to remove the mass responsible for his epilepsy. *(Custom Medical Stock Photo. Reproduced by permission.)*

MYOCLONIC SEIZURES. Myoclonic seizures are characterized by brief, involuntary spasms of the tongue or muscles of the face, arms, or legs. Myoclonic seizures are most apt to occur when waking after a night's sleep.

A jacksonian seizure is a partial seizure characterized by tingling, stiffening, or jerking of an arm or leg. Loss of consciousness is rare. The seizure may progress in characteristic fashion along the limb.

Limp posture and a brief period of unconsciousness are features of akinetic seizures, which occur in young children. Akinetic seizures, which cause the child to fall, are also called drop attacks.

PARTIAL SEIZURES. Simple partial seizures do not spread from the focal area where they arise. Symptoms are determined by what part of the brain is affected. The patient usually remains conscious during the seizure and can later describe it in detail.

COMPLEX PARTIAL SEIZURES. A distinctive smell, taste, or other unusual sensation (aura) may signal the start of a complex partial seizure.

Complex partial seizures start as simple partial seizures, but move beyond the focal area and cause loss of consciousness. Complex partial seizures can become major motor seizures. Although a person having a complex partial seizure may not seem to be unconscious, he does not know what is happening and may behave inappropriately. He will not remember the seizure, but may seem confused or intoxicated for a few minutes after it ends.

Causes and symptoms

The origin of 50-70% of all cases of epilepsy is unknown. Epilepsy is sometimes the result of trauma at the time of birth. Such causes include insufficient oxygen to the brain; **head injury**; heavy bleeding or incompatibility between a woman's blood and the blood of her newborn baby; and infection immediately before, after, or at the time of birth.

Other causes of epilepsy include:

- head trauma resulting from a car accident, gunshot wound, or other injury
- alcoholism
- brain **abscess** or inflammation of membranes covering the brain or spinal cord
- phenylketonuria (PKU, a disease that is present at birth, is often characterized by seizures, and can result in **mental retardation**) and other inherited disorders
- infectious diseases like **measles**, **mumps**, and diphtheria.
- degenerative disease
- lead **poisoning**, mercury poisoning, **carbon monoxide poisoning**, or ingestion of some other poisonous substance
- genetic factors

Status epilepticus, a condition in which a person suffers from continuous seizures and may have trouble breathing, can be caused by:

- suddenly discontinuing anti-seizure medication
- hypoxic or metabolic encephalopathy (brain disease resulting from lack of oxygen or malfunctioning of other physical or chemical processes)
- acute head injury
- blood infection caused by inflammation of the brain or the membranes that cover it

Diagnosis

Personal and family medical history, description of seizure activity, and physical and neurological examinations help primary care physicians, neurologists, and epileptologists diagnose this disorder. Doctors rule out conditions that cause symptoms that resemble epilepsy, including small strokes (transient ischemic attacks, or TIAs), **fainting** (syncope), pseudoseizures, and sleep attacks (**narcolepsy**).

Neuropsychological testing uncovers learning or memory problems. Neuro-imaging provides views of brain areas involved in seizure activity.

The electroencephalogram (EEG) is the main test used to diagnose epilepsy. EEGs use electrodes placed on or within the skull to record the brain's electrical activity and pinpoint the exact location of abnormal discharges.

The patient may be asked to remain motionless during a short-term EEG or to go about his normal activities during extended monitoring. Some patients are deprived of sleep or exposed to seizure triggers, such as rapid, deep breathing (hyperventilation) or flashing lights (photic stimulation). In some cases, people may be hospitalized for EEG monitorings that can last as long as two weeks. Video EEGs also document what the patient was doing when the seizure occurred and how the seizure changed his behavior.

Other techniques used to diagnose epilepsy include:

- Magnetic resonance imaging (MRI), which provides clear, detailed images of the brain. Functional MRI (fMRI), performed while the patient does various tasks, can measure shifts in electrical intensity and blood flow and indicate which brain region each activity affects.
- Positron emission tomography (**PET**) and single photon emission tomography (SPECT) monitor blood flow and chemical activity in the brain area being tested. PET and SPECT are very effective in locating the brain region where metabolic changes take place between seizures.

Treatment

The goal of epilepsy treatment is to eliminate seizures or make the symptoms less frequent and less severe. Long-term anticonvulsant drug therapy is the most common form of epilepsy treatment.

Medication

A combination of drugs may be needed to control some symptoms, but most patients who have epilepsy take one of the following medications:

- Dilantin (phenytoin)
- Tegretol (carbamazepine)
- Barbita (phenobarbital)
- Mysoline (primidone)

- Depakene (valproic acid, sodium valproate)
- Klonopin (clonazepam)
- Zarontin (ethosuximide)

Dilantin, Tegretol, Barbita, and Mysoline are used to manage or control generalized tonic-clonic and complex partial seizures. Depakene, Klonopin, and Zarontin are prescribed for patients who have absence seizures.

Neurontonin (gabapentin) and Lamictal (lamotrigine) are medications recently approved in the United States to treat adults who have partial seizures or partial and grand mal seizures.

Even a patient whose seizures are well controlled should have regular blood tests to measure levels of anti-seizure medication in his system and to check to see if the medication is causing any changes in his blood or liver. A doctor should be notified if any signs of drug toxicity appear, including uncontrolled eye movements; sluggishness, **dizziness**, or hyperactivity; inability to see clearly or speak distinctly; nausea or vomiting; or sleep problems.

Status epilepticus requires emergency treatment, usually with Valium (Ativan), Dilantin, or Barbita. An intravenous dextrose (sugar) solution is given to patients whose condition is due to low blood sugar, and a vitamin B_1 preparation is administered intravenously when status epilepticus results from chronic alcohol withdrawal. Because dextrose and thiamine are essentially harmless and because delay in treatment can be disastrous, these medications are given routinely, as it is usually difficult to obtain an adequate history from a patient suffering from status epilepticus.

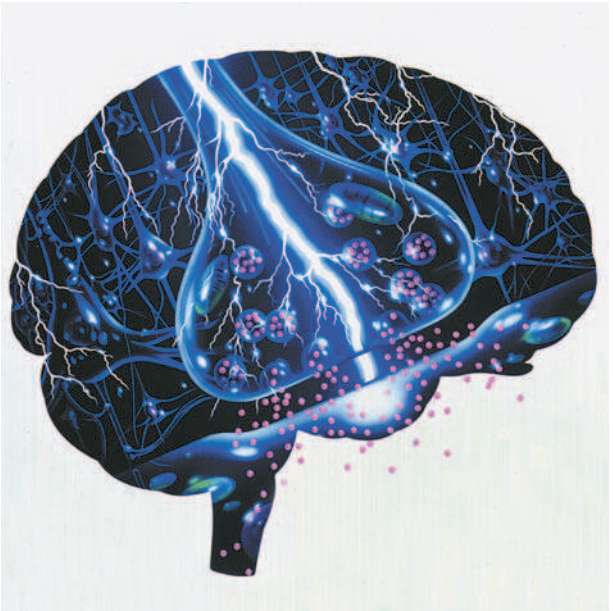
Intractable seizures are seizures that cannot be controlled with medication or without **sedation** or other unacceptable side effects. Surgery may be used to eliminate or control intractable seizures.

Surgery

Surgery can be used to treat patients whose intractable seizures stem from small focal lesions that can be removed without endangering the patient, changing the patient's personality, dulling the patient's senses, or reducing the patient's ability to function.

Each year, as many as 5,000 new patients may become suitable candidates for surgery, which is most often performed at a comprehensive epilepsy center. Potential surgical candidates include patients with:

- partial seizures and secondarily generalized seizures (attacks that begin in one area and spread to both sides of the brain)
- seizures and childhood **paralysis** on one side of the body (hemiplegia)



This abstract artwork is based on a patient's description of what an epileptic seizure feels like. Epileptic seizures are caused by chaotic electrical activity in the brain. They can be triggered by a variety of factors, such as illness or stress, although the underlying causes are not completely understood. *(Illustration by John Bavosi, Photo Researchers, Inc. Reproduced by permission.)*

- complex partial seizures originating in the temporal lobe (the part of the brain associated with speech, hearing, and smell) or other focal seizures. (However, the risk of surgery involving the speech centers is that the patient will lose speech function.)
- generalized myoclonic seizures or generalized seizures featuring temporary paralysis (akinetic) or loss of muscle tone (atonal)

A **physical examination** is conducted to verify that a patient's seizures are caused by epilepsy, and surgery is not used to treat patients with severe psychiatric disturbances or medical problems that raise risk factors to unacceptable levels.

Surgery is never indicated unless:

- the best available anti-seizure medications have failed to control the patient's symptoms satisfactorily,
- the origin of the patient's seizures has been precisely located,
- there is good reason to believe that surgery will significantly improve the patient's health and quality of life.

Every patient considering epilepsy surgery is carefully evaluated by one or more neurologists, neurosurgeons, neuropsychologists, and/or social workers. A psychiatrist, chaplain, or other spiritual advisor may help the

patient and his family cope with the stresses that occur during and after the selection process.

TYPES OF SURGERY. Surgical techniques used to treat intractable epilepsy include:

- Lesionectomy. Removing the lesion (diseased brain tissue) and some surrounding brain tissue is very effective in controlling seizures. Lesionectomy is generally more successful than surgery performed on patients whose seizures are not caused by clearly defined lesions, but removing only part of the lesion lessens the effectiveness of the procedure.
- Temporal resections. Removing part of the temporal lobe and the part of the brain associated with feelings, memory, and emotions (the hippocampus) provides good or excellent seizure control in 75-80% of properly selected patients with appropriate types of temporal lobe epilepsy. Some patients experience post-operative speech and memory problems.
- Extra-temporal resection. This procedure involves removing some or all of the frontal lobe, the part of the brain directly behind the forehead. The frontal lobe helps regulate movement, planning, judgment, and personality, and special care must be taken to prevent post-operative problems with movement and speech. Extra-temporal resection is most successful in patients whose seizures are not widespread.
- Hemispherectomy. This method of removing brain tissue is restricted to patients with severe epilepsy and abnormal discharges that often extend from one side of the brain to the other. Hemispherectomies are most often performed on infants or young children who have had an extensive brain disease or disorder since birth or from a very young age.
- Corpus callosotomy. This procedure, an alternative to hemispherectomy in patients with congenital hemiplegia, removes some or all of the white matter that separates the two halves of the brain. Corpus callosotomy is performed almost exclusively on children who are frequently injured during falls caused by seizures. If removing two-thirds of the corpus callosum doesn't produce lasting improvement in the patient's condition, the remaining one-third will be removed during another operation.
- Multiple subpial transection. This procedure is used to control the spread of seizures that originate in or affect the "eloquent" cortex, the area of the brain responsible for complex thought and reasoning.

Other forms of treatment

KETOGENIC DIET. A special high-fat, low-protein, low-carbohydrate diet is sometimes used to treat patients whose severe seizures have not responded to other treatment. Calculated according to age, height, and weight, the ketogenic diet induces mild **starvation** and **dehydration**. This forces the body to create an excessive supply of ketones, natural chemicals with seizure-suppressing properties.

The goal of this controversial approach is to maintain or improve seizure control while reducing medication. The ketogenic diet works best with children between the ages of one and 10. It is introduced over a period of several days, and most children are hospitalized during the early stages of treatment.

If a child following this diet remains seizure-free for at least six months, increased amounts of carbohydrates and protein are gradually added. If the child shows no improvement after three months, the diet is gradually discontinued.

Introduced in the 1920s, the ketogenic diet has had limited, short-term success in controlling seizure activity. Its use exposes patients to such potentially harmful side effects as:

- staphylococcal infections
- stunted or delayed growth
- low blood sugar (**hypoglycemia**)
- excess fat in the blood (hyperlipidemia)
- disease resulting from calcium deposits in the urinary tract (urolithiasis)
- disease of the optic nerve (optic neuropathy)

VAGUS NERVE STIMULATION. The United States Food and Drug Administration (FDA) has approved the use of vagus nerve stimulation (VNS) in patients over the age of 16 who have intractable partial seizures. This non-surgical procedure uses a pacemaker-like device implanted under the skin in the upper left chest, to provide intermittent stimulation to the vagus nerve. Stretching from the side of the neck into the brain, the vagus nerve affects swallowing, speech, breathing, and many other functions, and VNS may prevent or shorten some seizures.

First aid for seizures

A person having a seizure should not be restrained, but sharp or dangerous objects should be moved out of reach. Anyone having a complex partial seizure can be warned away from danger by someone calling his/her name in a clear, calm voice.

A person having a grand mal seizure should be helped to lie down. Tight clothing should be loosened. A soft, flat object like a towel or the palm of a hand

should be placed under the person's head. Forcing a hard object into the mouth of someone having a grand mal seizure could cause injuries or breathing problems. If the person's mouth is open, placing a folded cloth or other soft object between his teeth will protect his tongue. Turning his head to the side will help him breathe. After a grand mal seizure has ended, the person who had the seizure should be told what has happened and reminded of where he is.

Alternative treatment

Stress increases seizure activity in 30% of people who have epilepsy. Relaxation techniques can provide some sense of control over the disorder, but they should never be used instead of anti-seizure medication or used without the approval of the patient's doctor. **Yoga**, **meditation**, and favorite pastimes help some people relax and manage stress more successfully. **Biofeedback** can teach adults and older adolescents how to recognize an aura and what to do to stop its spread. Children under 14 are not usually able to understand and apply principles of biofeedback. **Acupuncture** treatments (acupuncture needles inserted for a few minutes or left in place for as long as half an hour) make some people feel pleasantly relaxed. **Acupressure** can have the same effect on children or on adults who dislike needles.

Aromatherapy involves mixing aromatic plant oils into water or other oils and massaging them into the skin or using a special burner to waft their fragrance throughout the room. Aromatherapy oils affect the body and the brain, and undiluted oils should never be applied directly to the skin. Ylang ylang, chamomile, or lavender can create a soothing mood. People who have epilepsy should not use rosemary, hyssop, sage or sweet fennel, which seem to make the brain more alert.

Dietary changes that emphasize whole foods and eliminate processed foods may be helpful. Homeopathic therapy also can work for people with seizures, especially constitutional homeopathic treatment that acts at the deepest levels to address the needs of the individual person.

Prognosis

People who have epilepsy have a higher-than-average rate of suicide; sudden, unexplained **death**; and drowning and other accidental fatalities.

Benign focal epilepsy of childhood and some absence seizures may disappear in time, but remission is unlikely if seizures occur several times a day, several times in a 48-hour period, or more frequently than in the past.

Seizures that occur repeatedly over time and always involve the same symptoms are called stereotypic seizures. The probability that stereotypic seizures will abate is poor.

About 85% of all seizure disorders can be partially or completely controlled if the patient takes anti-seizure medication according to directions; avoids seizure-inducing sights, sounds, and other triggers; gets enough sleep; and eats regular, balanced meals.

Anyone who has epilepsy should wear a bracelet or necklace identifying his seizure disorder and listing the medication he takes.

Prevention

Eating properly, getting enough sleep, and controlling stress and fevers can help prevent seizures. A person who has epilepsy should be careful not to hyperventilate. A person who experiences an aura should find a safe place to lie down and stay there until the seizure passes. Anticonvulsant medications should not be stopped suddenly and, if other medications are prescribed or discontinued, the doctor treating the seizures should be notified. In some conditions, such as severe head injury, brain surgery, or **subarachnoid hemorrhage**, anticonvulsant medications may be given to the patient to prevent seizures.

Resources

BOOKS

Shaw, Michael, ed. *Everything You Need to Know About Diseases.* Springhouse, PA: Springhouse Corporation, 1996.

PERIODICALS

Batchelor, Lori, et al. "An Interdisciplinary Approach to Implementing the Ketogenic Diet for the Treatment of Seizures." *Pediatric Nursing* (Sept./Oct. 1997): 465-471.

Dichter, M. A., and M. J. Brodie. "Drug Therapy: New Antiepileptic Drugs." *The New England Journal of Medicine* (15 June 1996): 1583-1588.

Lannox, Susan L. "Epilepsy Surgery for Partial Seizures." *Pediatric Nursing* (Sept./Oct. 1997): 453-458.

McDonald, Melori E. "Use of the Ketogenic Diet in Treating Children with Seizures." *Pediatric Nursing* (Sept./Oct. 1997): 461-463.

ORGANIZATIONS

American Epilepsy Society. 342 North Main Street, West Hartford, CT 06117-2507. (860) 586-7505. <http://www.aesnet.org>.

Epilepsy Concern International Service Group. 1282 Wynnewood Drive, West Palm Beach, FL 33417. (407) 683-0044.

Epilepsy Foundation of America. 4351 Garden City Drive, Landover, MD 20785. (800) 332-1000. <http://www.efa.org>.

Epilepsy Information Service. (800) 642-0500.

KEY TERMS

Acupressure—Needleless acupuncture.

Acupuncture—An ancient Chinese method of relieving pain or treating illness by piercing specific areas of the body with fine needles.

Biofeedback—A learning technique that helps individuals influence automatic body functions.

Epileptologist—A physician who specializes in the treatment of epilepsy.

OTHER

Bourgeois, Blaise F. D. "Epilepsy Surgery in Children." Department of Neurology. Washington University. 3 Mar. 1998 <http://www.neuro.wustl.edu>.

Cosgrove, G. Rees, and Andrew J. Cole. "Surgical Treatment of Epilepsy." Neurosurgical Sevice Page. 12 Mar. 1998. Harvard Medical School. <http://neurosurgery.mgh.harvard.edu/ep-sxtre.htm>.

"Epilepsy." *National Institute of Neurological Disorders and Stroke Page*. 28 Feb. 1998 <http://www.ninds.nih.gov>.

"Epilepsy and Dental Health." *The Epilepsy Foundation of Victoria, Australia*. 3 Mar. 1998 <http://www.epinet.org.au/welcome.asp>.

"Epilepsy Facts and Figures." *Epilepsy Foundation Page*. 28 Feb. 1998 <http://www.efa.org>.

"Ketogenic Diet." *Packard Children's Hospital Page*. Stanford University Medical Center. 28 May 1998 <http://www.stanford.edu/group/ketodiet>.

"The USC Vagus Nerve Stimulator Program." *Keck School of Medicine Page*. University of Southern California. 3 Mar <1998.http://www.usc.edu/schools/medicine>.

Maureen Haggerty

Selective abortion *see* **Abortion, selective**

Selective mutism *see* **Mutism**

Selective serotonin reuptake inhibitors

Definition

Selective serotonin reuptake inhibitors are medicines that relieve symptoms of depression.

Purpose

Selective serotonin reuptake inhibitors are used to treat serious, continuing depression that interferes with a person's ability to function. Like other **antidepressant drugs**, they help reduce the extreme sadness, hopelessness, and lack of interest in life that are typical in people with depression. Selective serotonin reuptake inhibitors also are used to treat **panic disorder**, obsessive compulsive disorder (OCD), and have shown promise for treating a variety of other conditions, such as **premenstrual syndrome**, eating disorders, **obesity**, **self-mutilation**, and **migraine headache**.

Description

Selective serotonin reuptake inhibitors, also known as SSRIs or serotonin boosters, are thought to work by correcting chemical imbalances in the brain. Normally, chemicals called neurotransmitters carry signals from one nerve cell to another. These chemicals are constantly being released and taken back up at the ends of nerve cells. Selective serotonin reuptake inhibitors act on one particular neurotransmitter, serotonin, reducing its reentry into nerve cells and thus allowing serotonin to build up. Although scientists are not exactly sure how it works, serotonin is involved in the control of moods, as well as other functions such as sleep, body temperature, and appetite for sweets and other carbohydrates. Somehow, drugs that prevent the uptake of serotonin improve the moods of people with serious depression, OCD, and some types of **anxiety disorders**.

Selective serotonin reuptake inhibitors are available only with a doctor's prescription and are sold in tablet, capsule, and liquid forms. Commonly used selective serotonin reuptake inhibitors are fluoxetine (Prozac), paroxetine (Paxil), sertraline (Zoloft), and fluvoxamine (Luvox).

Recommended dosage

The recommended dosage depends on the type of SSRI and the type and severity of depression for which it is being taken. Dosages may be different for different people. It is important for people taking SSRIs to take the drug exactly as prescribed. Taking larger or more frequent doses or taking the drug for longer than directed, for example, can cause unwanted effects.

SSRIs are about as effective as other antidepressants. About 60-80% of people taking the drugs as directed will find that their conditions improve. However, it may take four weeks or more for the effects of this medicine to be felt. Therefore, when people begin SSRI therapy, it is important to continue taking the medication, even if an improvement in mood doesn't begin immediately.

People who take SSRIs should ask their doctors about how to stop taking the medication. Usually, doc-

tors advise patients to taper down gradually to reduce the chance of withdrawal symptoms.

SSRIs may be taken with food to prevent stomach upset.

Precautions

There have been reports that some patients taking SSRIs have an increase in thoughts about suicide. It is not clear whether the medicine causes this effect because suicidal thoughts are very often a part of depression itself. While some patients may experience worsening of such thoughts early in the treatment of their depression, there is no credible evidence that SSRIs alone cause people to become suicidal or violent.

Serious and possibly life-threatening reactions may occur when SSRIs are used in combination with **monoamine oxidase inhibitors** (MAO inhibitors), such as Nardil and Parnate, which also are used to treat depression. These reactions also are possible when a person stops taking an SSRI and immediately begins taking an MAOI. SSRIs and MAO inhibitors should never be taken at the same time. When switching from an SSRI to an MAOI or vice versa, it may be necessary to allow two to five weeks or more between stopping one and starting the other. The physician prescribing the medications should tell the patient exactly how much time to allow before beginning the other medication.

People with a history of manic disorders should use any antidepressant, including an SSRI, with caution.

It is important to see a doctor regularly while taking SSRIs. The doctor will check to make sure the medicine is working as it should and will watch for unwanted side effects. The doctor may also need to adjust the dosage during this period.

Some people feel drowsy, dizzy, or lightheaded when using SSRIs. The drugs may also cause blurred vision in some people. Since SSRIs can sometimes cause drowsiness, driving or operating heavy machinery should be undertaken cautiously, particularly when the person first begins taking the medication.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down, a condition known as **orthostatic hypotension**. People may try to lessen the problem by getting up gradually and holding onto something for support if possible. If the problem is severe or doesn't improve, the patient should discuss it with his or her doctor.

Because SSRIs work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. Anyone taking SSRIs should check with his or her doctor before taking any of the drugs mentioned above.

SSRIs may occasionally cause **dry mouth**, although this side effect is much more common with an older class of antidepressants known as tricyclics. To temporarily relieve the discomfort, doctors sometimes suggest chewing sugarless gum, sucking on sugarless candy or ice chips, or using saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than two weeks, check with a doctor or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

Changes in sexual functioning are among the more common side effects with SSRIs. Depending on the particular SSRI prescribed, 8-15% of patients may report these side effects. The most common problem for men is delayed ejaculation. Women may be unable to have orgasms. A doctor should be contacted if any changes in sexual functioning occur.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take SSRIs. Before taking these drugs, a patient should let the doctor know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to SSRIs in the past should let his or her doctor know before taking the drugs again. The doctor should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. In studies of laboratory animals, some SSRIs have caused **miscarriage** and other problems in pregnant females and their offspring. However, at least two studies in humans (by Pastuszak in 1993 and Kuhlin in 1998) have shown SSRIs to be safe during **pregnancy**. Still, women who are pregnant or who may become pregnant should check with their doctors before using SSRIs.

BREASTFEEDING. SSRIs pass into breast milk and some may occasionally cause unwanted side effects in nursing babies whose mothers take the drugs. These effects include vomiting, watery stools, crying, and sleep problems. Women who are breastfeeding should talk to their doctors about the use of SSRIs. They may need to switch to a different medicine while breastfeeding. If SSRIs must be taken, it may be necessary to stop breastfeeding while being treated with these drugs. However,

several studies in people (for example, Yoshida in 1998) have indicated that SSRIs in breast milk have no effect on infant development.

DIABETES. SSRIs may affect blood sugar levels. People with diabetes who notice changes in their blood or urine tests while taking this medicine should check with their doctors.

OTHER MEDICAL CONDITIONS. Before using SSRIs, people with any of these medical problems should make sure their doctors are aware of their conditions: diabetes, kidney disease, liver disease, seizure disorders, current or past drug abuse or dependence, or diseases or conditions that affect the metabolism or blood circulation.

Side effects

The most common side effects are **anxiety** and nervousness (reported by 5–13% of people taking various SSRIs), tremor (5–14%), trouble sleeping (2–8%), tiredness or weakness (4–15%), nausea (11–26%), **diarrhea** (11–26%), **constipation** (1–8%), loss of appetite (3–18%), weight loss (1–13%), dry mouth (10–22%), **headache** (1–5%), sweating (5–9%), trouble urinating (1–2%), and decreased sexual ability (8–15%). Many of these problems diminish or disappear as the body adjusts to the drug and do not require medical treatment unless they interfere with normal activities. Persistent problems, such as **sexual dysfunction**, should be discussed with the doctor.

More serious side effects are possible, but extremely rare. People taking SSRIs who notice unusual joint or muscle pain; breathing problems; chills or **fever**; excessive excitement, fast talking, or actions that are out of control; or mood swings should contact their doctors. People who develop skin **rashes** or **hives** after taking an SSRI should stop taking the medication and contact their doctors as soon as possible. Other rare side effects may occur. Anyone who has unusual symptoms after taking an SSRI should get in touch with his or her doctor.

Side effects may continue for some time after treatment with this medicine ends. How long the effects continue depends on how long the drug was taken and how much of it was used. In most cases, doctors recommend that patients taper off SSRIs rather than abruptly discontinuing them, which usually prevents any withdrawal symptoms. People who experience agitation, confusion, or restlessness; **dizziness** or lightheadedness; vision problems; tremor; sleep problems; unusual tiredness or weakness; **nausea and vomiting** or diarrhea; headache; excessive sweating; runny nose; or muscle pain for more than a few days after stopping or tapering an SSRI should consult their doctors.

KEY TERMS

Anesthetic—Medicine that causes a loss of feeling, especially of pain. Some anesthetics also cause a loss of consciousness.

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Central nervous system—The brain and spinal cord.

Depression—A mental condition in which people feel extremely sad and lose interest in life. People with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Metabolism—All the physical and chemical changes that occur in cells to allow growth and maintain body functions. These include processes that break down substances to yield energy and processes that build up other substances necessary for life.

Obsessive-compulsive disorder—An anxiety disorder in which people cannot prevent themselves from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing their hands or checking to make sure they turned off the lights.

Premenstrual syndrome—(PMS) A set of symptoms that occur in some women 2-14 days before they begin menstruating each month. Symptoms include headache, fatigue, irritability, depression, abdominal bloating, and breast tenderness.

Drug interactions

SSRIs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes SSRIs should let the doctor know about all other medicines he or she is taking. Among the drugs that may interact with SSRIs are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and **asthma**; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; **barbiturates**; and anesthetics.

- blood thinners
- monoamine oxidase inhibitors (MAOIs) such as Nardil or Parnate, used to treat conditions including depression and **Parkinson's disease**
- the antiseizure drug phenytoin (Dilantin)
- the food supplement (and sleep aid) tryptophan, which has been withdrawn from the United States market, but may be found in some herbal preparations
- digitalis and other heart medicines

The list above does not include every drug that may interact with SSRIs. Patients should be sure to check with a doctor or pharmacist before combining SSRIs with any other prescription or nonprescription (over-the-counter) medicine.

Resources

BOOKS

Maxmen, Jerrold S., and Nicholas G. Ward. *Psychotropic Drugs Fast Facts.* 2nd ed. New York: W. W. Norton & Co., 1995.

Pies, Ronald W. *Handbook of Essential Psychopharmacology.* Washington, DC: American Psychiatric Press, Inc.

PERIODICALS

Barondes, Samuel H. "Thinking about Prozac." *Science* 263 (25 Feb.1994): 1102.

Kramer, Peter D. "The Transformation of Personality." *Psychology Today* 26 (July/Aug. 1993): 42.

Mauro, James, and Peter Breggin. "And Prozac for all..." *Psychology Today* 27 (July/Aug. 1994): 44.

Vallone, Doris C. "SSRIs: When comforting words aren't enough." *Nursing* 27 (Dec. 1997): 50.

Nancy Ross-Flanigan

Self-mutilation

Definition

Self-mutilation is a general term for a variety of forms of intentional self-harm without the wish to die. Cutting one's skin with razors or knives is the most common pattern of self-mutilation. Others include biting, hitting, or bruising oneself; picking or pulling at skin or hair; burning oneself with lighted cigarettes, or amputating parts of the body.

Description

Self-mutilation has become a major public health concern as its incidence appears to have risen since the early 1990s. One source estimates that 0.75% of the general American population practices self-mutilation. The incidence of self-mutilation is highest among teenage females, patients diagnosed with borderline personality disorder, and patients diagnosed with one of the **dissociative disorders**. Over half of self-mutilators were sexually abused as children, and many also suffer from eating disorders.

Self-mutilation should not be confused with current fads for tattoos and body piercing. In some cases, however, it may be difficult to distinguish between an interest in these fads and the first indications of a disorder.

The relationship of self-mutilation to suicide is still debated even though statistics show that nearly 50% of individuals who injure themselves also attempt suicide at some point in their lives. Many researchers think that suicide attempts reflect feelings of rejection or hopelessness, while self-mutilation results from feelings of shame or a need to relieve tension.

Causes and symptoms

Several different theories have been proposed to explain self-mutilation:

- self-mutilation is an outlet for strong negative emotions, especially anger or shame, that the person is afraid to express in words or discuss with others.
- self-mutilation represents anger at someone else directed against the self.
- self-mutilation relieves unbearable tension or **anxiety**. Many self-mutilators do report feeling relief after an episode of self-cutting or other injury.
- self-mutilation is a technique for triggering the body's biochemical responses to **pain**. **Stress** and trauma release endorphins, which are the body's natural pain-killing substances.
- self-mutilation is a way of stopping a dissociative episode. Dissociation is a process in which the mind splits off, or dissociates, certain memories and thoughts that are too painful to keep in conscious awareness. Some people report that they feel "numb" or "dead" when they dissociate, and self-injury allows them to feel "alive."
- self-mutilation is a symbolic acting-out of the larger culture's mistreatment of women. This theory is sometimes offered to explain why the great majority (about 75%) of self-mutilators are girls and women.

The symptoms of self-mutilation typically include wearing long-sleeved or baggy clothing, even in hot weather; and an unusual need for privacy. Self-mutilators are often hesitant to change their clothes or undress around others. In most cases the person has also shown signs of depression.

Diagnosis

Self-mutilation is usually diagnosed by a psychiatrist or psychotherapist. A family practitioner or nurse who notices scars, **bruises**, or other physical evidence of self-injury may refer the person to a specialist for evaluation.

Treatment

Persons who mutilate themselves should seek treatment from a therapist with some specialized training and experience with this behavior. Most self-mutilators are treated as outpatients, although there are some inpatient programs, such as S.A.F.E., for adolescent females. A number of different treatment approaches are used with self-mutilators, including psychodynamic psychotherapy, **group therapy**, journaling, and behavioral therapy.

Although there are no medications specifically for self-mutilation, antidepressants are often given, particularly if the patient meets the diagnostic criteria for a depressive disorder.

Alternative treatment

Mindfulness training, which is a form of **meditation**, has been used to teach self-mutilators to observe and identify their feelings in order to have some control over them.

Prognosis

The prognosis depends on the presence and severity of other emotional disorders, and a history of sexual **abuse** and/or suicide attempts. In general, teenagers without a history of abuse or other disorders have a good prognosis. Patients diagnosed with borderline personality disorder and/or a history of attempted suicide are considered to have the worst prognosis.

Prevention

Some society-wide factors that influence self-mutilation, such as the high rate of sexual abuse of children and media stereotypes of women, are difficult to change. In general, however, young people who have learned to express themselves in words or through art and other creative activities are less likely to deal with painful feelings by injuring their bodies.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. Washington, DC: American Psychiatric Association, 1994.

Eisendrath, Stuart J., MD, and Jonathan E. Lichtmacher, MD. "Psychiatric Disorders." In *Current Medical Diagnosis & Treatment 2001*. 40th edition, ed. L. M. Tierney, Jr., MD, et al. New York: Lange Medical Books/McGraw-Hill, 2001.

Pipher, Mary, PhD. *Reviving Ophelia: Saving the Selves of Adolescent Girls*. New York: Ballantine Books, 1994.

ORGANIZATIONS

American Psychiatric Association. 1400 K Street, NW. Washington, DC 20005. (202) 682-6220. <http://www.psych.org>.

Focus Adolescent Services. (877) 362-8727. <http//www.focusas.com>.

National Institute of Mental Health. 5600 Fishers Lane, Rockville, MD 20857. (301) 443-4513. Fax: (301) 443-4513. <http://www.nimh.nih.gov>.

Rebecca J. Frey, PhD

KEY TERMS

Borderline personality disorder (BPD)—A pattern of behavior characterized by impulsive acts, intense but chaotic relationships with others, identity problems, and emotional instability.

Dissociation—The splitting off of certain mental processes from conscious awareness.

Dissociative disorders—A group of mental disorders in which dissociation is a prominent symptom. Patients with dissociative disorders have a high rate of self-mutilation.

Endorphins—Pain-killing substances produced in the human body and released by stress or trauma. Some researchers think that people who mutilate themselves are trying to trigger the release of endorphins.

Semen analysis

Definition

Semen analysis evaluates a man's sperm and semen. It is done to discover cause for **infertility** and to confirm success of **vasectomy**.

Purpose

Semen analysis is an initial step in investigating why a couple has been unable to conceive a child. Abnormali-

ties of sperm and semen can cause male infertility. Semen is the thick yellow-white male ejaculate containing sperm. Sperm are the male sex cells that fertilize the female egg (ovum). They contain the genetic information that the male will pass on to a child.

Vasectomy is an operation done to sterilize a man by stopping the release of sperm into semen. Success of vasectomy is confirmed by the absence of sperm in semen.

KEY TERMS

Infertility—The inability of a man and woman to conceive a child after 12 months of unprotected sexual intercourse.

Morphology—The size and shape of sperm.

Motility—The movement of sperm within the semen.

Description

The semen analysis test is usually done manually, though computerized test systems are available. Many laboratories base their procedures on standards published by the World Health Organization (WHO).

The volume of semen in the entire ejaculate is measured. The appearance, color, thickness, and pH is noted. A pH test looks at the range from a very acid solution to a very alkaline solution. Semen, like many other body fluids, has a standard pH range that would be considered optimal for fertilization of the egg to take place. The thick semen is then allowed to liquify; this usually takes 20-60 minutes.

Drops of semen are placed on a microscope slide and examined under the microscope. Motility, or movement, of 100 sperm are observed and graded in categories, such as rapid progressive or immotile.

The structure of sperm (sperm morphology) is assessed by carefully examining sperm for abnormalities in the size and shape in the head, tail, and neck regions. WHO standards define normal as a specimen with less than 30% abnormal forms. An alternative classification system (Kruger's) measures the dimensions of sperm parts. Normal specimens are allowed 14% or less abnormalities.

Sperm are counted by placing semen in a special counting chamber. The sperm within the chamber are counted under a microscope. White blood cells are recorded; these may indicate a reproductive tract infection. Laboratories may test for other biochemicals such as fructose, zinc, and citric acid. These are believed to contribute to sperm health and fertility.

Results of semen analysis for infertility must be confirmed by a second analysis seven days to three months after the first. Sperm counts may vary from day to day.

Semen analysis to confirm success of vasectomy is concerned only with discovering if sperm are still present. Semen is collected six weeks after surgery. If sperm are seen, another specimen is collected two to four weeks later. The test is repeated until two consecutive specimens are free of sperm.

Preparation

A man should collect an entire ejaculate, by masturbation, into a container provided by his physician. To examine the best quality sperm, the specimen must be collected after two to three days of sexual abstinence, but not more than five to seven days. The specimen must not come into contact with any spermicidal agents used by a female partner for birth control purposes. The man should not have alcohol before the test.

A semen specimen to investigate infertility must be brought to the testing laboratory within one hour of obtaining it. Timing is not as critical for the postvasectomy test but the semen must be kept at body temperature. The most satisfactory sample is one obtained in the lab rather than at home.

Normal results

WHO standards have established these normal values:

- volume less than or equal to 2.0 mL
- sperm count greater than or equal to 20 million per mL
- motility (movement of the sperm) value is greater than or equal to 50% with forward progression, or greater than or equal to 25% with rapid progression within 60 minutes of ejaculation
- morphology greater than or equal to 30% with normal forms
- white blood cell count less than 1 million per mL

If infertility continues, despite normal semen analysis and female studies, further tests are done to evaluate sperm function.

Abnormal results

Abnormalities of semen volume and liquidity, and sperm number and morphology decrease fertility. These abnormalities may be inherited or caused by a hormone

imbalance, medications, or a recent infection. Further tests may be done to determine the cause of abnormalities.

Resources

PERIODICALS

Kamada, M., et al. "Semen Analysis and Antisperm Antibody." *Archives of Andrology* (Mar./Apr.,1998): 117-128.

Trantham, Patricia. "The Infertile Couple." *American Family Physician* (Sept. 1996): 1001-1009.

Yablonsky, Terri. "Male Fertility Testing." *Laboratory Medicine* (June 1996): 379-382.

Nancy J. Nordenson

Senile tremor *see* **Tremors**

Seniors' health

Definition

Seniors' health refers to the physical and mental conditions of senior citizens, those who are in their 60s and older.

Purpose

For a senior, the **aging** process and a person's lifestyle will affect health. People who maintain a healthy weight, **exercise** regularly, eat nutritionally, and don't smoke reduce the risk for many health conditions. This wellness allows people to live longer and to remain independent for more years. **Smoking**, **obesity** (excess weight), and lack of exercise shorten life and increase the risk for many health conditions.

Diet and exercise

Proper diet and regular exercise form the foundation of senior health. A nutritional diet and physical activity can help prevent diseases such as heart disease, **cancer**, **stroke**, and diabetes. A healthy diet can also help to manage diabetes, high blood pressure, and heart disease.

As people age, there is more of a need to exercise on a regular basis. According to the American Heart Association, the inactive person loses from 3–5% of muscle fiber each decade after age 30. That loss would total 30% of lost muscle fiber at age 60. Exercise helps to boost muscle strength. It could help to improve balance and coordination, and therefore help to prevent falls.

Organizations including the heart association advise that regular physical activity helps to prevent bone loss (**osteoporosis**) and the risk of conditions such as heart disease, Type II diabetes, **colon cancer**, **stress**, and depression. In addition, exercise can help a extend the lives of people with conditions such as diabetes, high blood pressure, and **high cholesterol**.

Osteoporosis

Osteoporosis is a condition in which bones become less dense (solid). Bones become brittle, thinner, and break easily. Although osteoporosis is associated with aging, it is only the risk of osteoporosis that increases as a person ages. It is linked to approximately 70% of bone **fractures** in people age 46 and older. According to the National Institutes of Health (NIH), one out of two women over age 50 will experience an osteoporosis-related fracture. So will one out of eight men over 50.

Osteoporosis is associated primarily with the changes that occur to women during **menopause**. During menopause, there is a decrease in the level of estrogen, the hormone that helps maintain bone mass. Other causes of osteoporosis include lack of exercise and a diet deficient in vitamin D.

Osteoporosis is a preventable condition.

Osteoarthritis

Osteoarthritis is a joint disease in which cartilage wears out and bones rub against each other. This condition can occur gradually over time as activities performed throughout the years cause wear on joints. In addition, bones thin as a person ages.

Excess weight and injuries can aggravate this condition. About 16 million Americans experience some form of osteoarthritis. It generally affects the neck, fingers, lower back, knees, and toes. Symptoms include **pain**, stiffness, swelling, and creaking. The pain may disrupt sleep, and joint stiffness may make it difficult for a person to dress.

Falls

More than two million Americans each year fall and experience serious injuries, according to the American Academy of Otolaryngology-Head and Neck Surgery. For seniors, fall-related injuries can reduce mobility and hinder independence.

As people age, their reflexes slow down so it may be more difficult to prevent a fall. Deteriorating vision and hearing can affect balance, which can cause an accidental fall. Furthermore, conditions such as arthritis, **dizziness**, and sleeping disorders can increase the likelihood of a fall. In addition, a person may fall at the start of a condition such as a stroke or **heart attack**.

Falls can result in broken bones or fractures because bones are weakened by osteoporosis. In addition, healing takes longer. Head injuries could affect sight and hearing. Injuries sustained during falls could reduce an active person's mobility and independence.

Vision

Eyesight changes as people age. Generally, people are in their 40s when they experience **presbyopia**, a form of farsightedness. This is a progressive condition involving a decrease in the ability the eye to focus on what is close by (near vision). By age 65, little near focusing ability remains.

Glaucoma is a condition caused by pressure from the build-up of a large amount of fluid in the eye. This progressive condition is often seen in people in their 50s. It starts with the gradual loss of peripheral vision. If not treated, it can lead to some vision loss.

People in their 60s may experience the first signs of age-related **macular degeneration** (AMD). It is a progressive condition affecting the retina. The macula in the retina distinguishes detail. Degeneration in the macula could cause scarring and a gradual reduction in vision. The person experiences a circle of blindness, an area of sightlessness that grows as the condition progress.

More than half of people age 65 or older will be diagnosed with **cataracts**. Cataract refers to the loss of the transparency in the lens of the eye. As the loss progresses, the person is unable to see less detail. This condition generally affects both eyes.

Hearing

Presbycusis, age-related **hearing loss**, is a progressive condition. It usually starts with a difficulty in hearing high-frequency sound such as people talking. A senior has less trouble with low-frequency tones. Background noise will make it even more difficult to hear. Presbycusis affects approximately 25% of people between the ages of 65 and 75 and half of those over 75. Many people diagnosed with this condition say they have lost hearing in both ears. They also report feelings of dizziness and that they experience a ringing in their ears.

Sleep disorders

Sleep patterns change when a person ages. Many people in their 60s and 70s experience less time in the stages of deep sleep known as delta sleep. Despite this change, many healthy older people don't experience **sleep disorders**. Overall health plays a role in whether a senior experiences trouble sleeping.

Obesity is linked to **snoring** and **sleep apnea**. Snoring can turn into apnea. A person with apnea stops breathing for up to one minute until the brain restarts the breathing process. This action could be repeated several hundred times each night.

Furthermore, a senior's sleep can be disrupted by conditions such as arthritis, osteoporosis, and **Alzheimer's disease**. **Insomnia**, or the inability to stay asleep, is a symptom of conditions including depression, **anxiety**, chronic pain, and restless leg syndrome (RLS).

RLS involves movement of legs when a person is at rest. The person moves legs in response to a tingling sensation in the upper leg, calf, or foot. In other cases, legs move involuntarily. Sensations that trigger movement can re-occur within seconds.

A person with RLS is likely to have PLMD (periodic limb movement disorder). A sleeping person with this condition will kick legs or move arms repeatedly. These involuntary movements can last from 20 seconds to an hour. Approximately 45% of the elderly have a mild form of PLMD, according to the National Sleep Foundation.

The cause of these disorders is not known. They are thought to be caused by a chemical reaction in the brain. In addition, the conditions may be hereditary.

Mental health

While age has little effect on the mind, social and emotional factors affect an older person's health. After a lifetime of a work, retirement brings several challenges. A person who has been identified for years by a profession may experience a sense of lost identity.

A senior may find that the thinking process has changed. Learning something new may take longer. However, older people have excellent recall of new information.

Memory loss may be a concern, particularly since this is a symptom of Alzheimer's disease.

Dementia

Alzheimer's disease is a form of **dementia**, a condition in which mental abilities decline. Symptoms of dementia include memory loss that goes beyond forgetting a word or where an item was placed. The person with dementia may never recognize family members or remember how to perform functions such as preparing a meal. Sometimes there is change in personality, with the person becoming aggressive or paranoid.

Alzheimer's disease is the most prevalent form of dementia. Although the cause of this condition is not known, the risk of Alzheimer's condition increases as a

person ages. In 2000, the condition affected one in 15 people above the age of 65. That ratio rose to one in three people age 85 and older.

Alzheimer's is a progressive condition. In most cases, after five to eight years, a patient with this condition is unable to perform basic functions. As of May of 2001, there was no cure for Alzheimer's. However, by March of that year, the U.S. Food and Drug Administration in March had approved four medications that could help stop the degenerative process.

Precautions

A health condition may result in a doctor recommending against some forms of exercises. However, even if a person can't jog, other forms of exercise include those designed for people in wheelchairs and those who are bedridden.

Treatments for menopause and osteoporosis include Raloxifene, a medication that may cause blood clots.

Description

The cost of treatment varies. Cost of medical treatment will be determined by the type of procedure and whether a person has medical insurance. Another factor is the fee assessed by the health plan.

Nutrition

Nutrition plays an important role in senior health. Not only does a well-balanced diet keep a person from becoming obese, that same diet is a safeguard against health conditions that seniors face. Proper diet can help prevent a condition like diabetes or keep it from worsening.

The senior diet should consist of foods that are low in fat, particularly saturated fat and cholesterol. A person should choose foods that provide nutrients such as iron and calcium. Other healthy menu choices include:

- fish, skinless poultry, and lean meat
- proteins such as dry beans (red beans, navy beans, and soybeans), lentils, chickpeas, and peanuts
- low-fat dairy products
- vegetables, especially those that are dark green and leafy
- citrus fruits or juices, melons, and berries
- whole grains like wheat, rice, oats, corn, and barley
- whole grain breads and cereals

Exercise

Physical activity should be rhythmic, repetitive, and should challenge the circulatory system. It should also be enjoyable so that a senior gets in the habit of exercising regularly for 30 minutes each day. It may be necessary to check with a doctor to determine the type of exercise that can be done.

Walking is recommended for weight loss, stress release, and many other conditions. Brisk walking is said to produce the same benefits as jogging. Other forms of exercise can include gardening, bicycling, hiking, swimming, dancing, skating or ice-skating. If weather prohibits outdoor activities, a person can work out indoors with an exercise video.

Exercise also offers a chance to socialize. In some cities, groups of seniors meet for regular walks at shopping malls. Senior centers offer exercise classes ranging from line dancing to belly dancing.

Costs for exercise range from the price of walking shoes to the fees for joining a gym.

Osteoporosis

Prevention is the best method of treating osteoporosis. Methods of preventing osteoporosis include regular weight-bearing exercise such as walking, jogging, weight lifting, **yoga**, and stair climbing.

People should not smoke since smoking makes the body produce less estrogen. Care should be taken to avoid falling.

Diet should include from 1,000–1,300 mg. of calcium each day. Sources of calcium include:

- leafy, dark-green vegetables such as spinach, kale, mustard greens, and turnip greens
- low-fat dairy products such as milk, yogurt, and cheeses such as cheddar, Swiss, mozzarella, and parmesan; also helpful are foods made with milk such as pudding and soup
- canned fish such as salmon, sardine, and anchovies
- tortillas made from lime-processed corn
- tofu processed with calcium-sulfate
- calcium tablets

MEDICAL TREATMENT. An x ray will indicate bone loss when much of the density has decreased. A more effective way of detecting osteoporosis is the DEXA-scan (dual-energy x-ray absorbtiometry). This whole-body scan will indicate whether a person is at risk for fractures. It could be useful for people at risk for osteoporosis as well as women near the age of menopause or older. People should ask their doctors about whether this test is needed.

During menopause, a woman loses estrogen. A pill or skin patch containing estrogen and progesterone eases symptoms of menopause and is used to treat osteoporosis. This treatment is known as **hormone replacement therapy** (HRT). In addition to restoring estrogen, HRT could reduce the risk of colon cancer and Alzheimer's disease. However, more research is needed in these areas.

Osteoarthritis

Treatments for osteoarthritis range from preventative measures such as walking to **joint replacement** surgery. Treatment costs vary from no cost for soaking a joint in cold water, the price of over-the-counter remedies, to fees for surgery.

Preventive and maintenance remedies include low-impact exercise such as swimming and walking, along with maintaining proper posture. Nutritional aids include foods rich in vitamin C such as citrus fruits and broccoli. Also recommended is daily consumption of 400 international units of Vitamin E. A person should cut back on fats, sugar, salt, cholesterol, and alcohol.

HOME REMEDIES AND PHYSICAL THERAPY. The Arthritis Foundation recommends several remedies for easing pain. To treat inflammation, a person should use a cold treatment for 20 minutes. Methods include soaking the affected area in cold water or applying an ice pack. To soothe aches and stimulate circulation, a person applies heat to the affected area for 20 minutes. This should be done three times during the day.

Over-the-counter (OTC) remedies such as **aspirin** and ibuprofen and salves containing capsaicin can be helpful. Furthermore, a doctor may recommend anti-inflammatory medications.

SURGICAL TREATMENT. If osteoarthritis is suspected, a doctor's diagnosis will include an assessment of whether joint pain is part of a patient's medical history. The doctor may take an x ray to determine the presence of cartilage loss and how much degeneration occurred.

Acupuncture may be helpful in treating mild osteoarthritis. Generally, a person should have one to two treatments a week for several weeks. Afterward, one treatment is recommended. An assessment of results should be made after 10 treatments.

In cases of severe osteoarthritis, joint replacement surgery or joint **immobilization** may be required. Joints are replaced with metal, plastic, or ceramic material.

Fall prevention

Fall prevention starts with regular exercise such as walking. This improves balance and muscles. The walk route should be on level ground. Other methods for preventing falls include:

- when rising from a chair or bed, a senior should move slowly to avoid dizziness
- shoes with low-heels and rubber soles are recommended
- medications should be monitored because of side effects that increase the probability of a fall
- vision and hearing should be checked periodically
- fall-proofing the home, including the installation of lighting, especially stairways, clearing up clutter and electrical cords that can cause falls, and the installation handrails and strips in bathtubs and rails on stairs.

MEDICAL TREATMENT FOR FALLS. After a fall, a senior may need First Aid treatment for cuts or fractures. The doctor may evaluate whether medications cause balance problems. If indicated, the doctor may examine the patient's central nervous system function, balance, and muscle/joint function. A hearing or vision test may be ordered.

Corrective measures could include adjusting prescriptions, vision surgery or having the patient use a cane or walker.

Vision

A person diagnosed with presbyopia may need bifocals or reading glasses to read print that appears too small. These lenses may need to be changed as vision changes over the years. Eventually, a person relies on glasses to focus on items that are near. Other seniors who never needed corrective lenses may need to wear eyeglasses. Publishers aware of this condition produce books with large print.

A senior should schedule periodic vision exams because early treatment helps prevent or lessen a risk of cataracts or glaucoma. Diet also plays a role in vision care. Dark green vegetables like broccoli are said to help prevent cataracts from progressing. Physical exercise is thought to reduce the pressure associated with glaucoma.

Glaucoma can be treated with eyedrops. Surgery can remove cataracts. The affected lens is removed and replaced with a permanent synthetic lens called an intraocular lens. There was no successful treatment for age-related macular degeneration as of 2001.

Hearing

An audiologist can administer tests to determine the amount of hearing loss. Although there is no cure for

presbycusis, **hearing aids** can help a senior affected by age-related hearing loss. If this treatment is not effective, the person might need to learn to read lips.

Sleep disorders

Losing weight can help with conditions such as snoring and sleep apnea. A doctor may advise the senior to quit smoking, reduce alcohol consumption, or to sleep on his or her side. In some cases, a doctor may refer the senior to a sleep disorder clinic. The senior may be prescribed a continuous positive airway pressure device. Known as a CPAP, the device is placed over the nose. It sends air into the nose.

PLMD and restless leg syndrome may be treated with the prescription drug Dopar. These disorders could be signs of kidney or circulation conditions. Treatment of those conditions should end these sleeping disorders.

Insomnia treatments include exercising and treating depression, stress, and other causes for sleeplessness.

Mental health

After retirement, a senior must find activities and interests to provide a sense of fulfillment. Otherwise, feelings of loneliness and **isolation** can lead to depression and susceptibility to poor health.

Activities that stimulate a person physically and intellectually contribute to good health. A senior can start an exercise program, take up hobbies, take classes, or volunteer. Senior centers offer numerous activities. Lunch programs provide nutritional meals and companionship. This is important because a senior living alone may not feel motivated to prepare healthy meals.

Dementia

Diagnosis of Alzheimer's disease starts with a thorough medical examination. The doctor should administer memory tests. Blood tests may be required, as well as a CT scan or MRI scan of the brain. If Alzheimer's is diagnosed, the doctor may prescribe medication to slow down progression of this form of dementia.

As of 2001, the FDA had approved four prescription medications for treatment of Alzheimer's. Tacrine, donepezil, riviastigmine, and galantamine are cholinesterase inhibitors that enhance memory. Modest improvement was reported in clinical trials on donepezil, riviastigmine, and galantamine. Tacrine's possible side effects include liver damage, so it is seldom prescribed.

Preparation

Before beginning a weight loss or exercise program, seniors should check with their doctors. The doctor will determine whether a patient is at a healthy weight, or needs to gain or lose weight. The medical professional should be informed about a health condition or a family history of a condition like heart disease. The doctor may order a physical exam or recommend a specific exercise program.

Exercise preparation

A senior should select a form of exercise enjoyable enough to become a regular routine. Suitable clothing or equipment such as walking shoes or a bicycle helmet should be purchased. If a person is active for more than a half-hour, the American Heart Association recommends drinking water every 15 minutes.

In addition to packing a water bottle, a person should pick an exercise buddy. Exercising with a friend or a group makes the activity more enjoyable. In addition, a person is more apt to stick with a routine if a buddy is involved.

Before exercising, the person should warm-up with slow stretching exercises. This could take longer for a senior because muscular elasticity slows down as a person ages. The exercise session should end with a cool-down that includes slow stretches.

Aftercare

Some recovery time may be needed after surgery. However, a healthy person will heal more quickly. A senior needs to maintain a schedule of regular exercise in order to remain mobile. Otherwise, a minor illness could make them dependent on others for daily care, according to the American Heart Association.

If mobility becomes limited due to a condition like osteoarthritis, equipment like a walker and devices that make it easier to open bottles and grip cutlery can be helpful.

Risks

Exercising too long or too strenuously can be physically harmful. The over-exertion could cause the person to lose interest in exercise and put off establishing a regular routine. A person should start out slowly and build up to more intense or longer sessions. This is particularly important for a sedentary person.

Osteoporosis

The longterm effects of hormone replacement therapy are not known. While one study concluded that HRT decreased the risk for **breast cancer**, another maintained the therapy increased the risk, and several other studies proved inconclusive.

Leading causes of death in persons 65 and older

Cause of death	Number of deaths	Death rate (per 100,000 population)	Percentage of all deaths in those Age 65 years old
All causes	1,542,493	4,963.2	100.0
Heart disease	594,858	1,914.0	38.6
Malignant neoplasms, including neoplasms of lymphatic and hematopoietic tissues	345,387	1,111.3	22.4
Cerebrovascular diseases	125,409	403.5	8.1
Chronic obstructive pulmonary disease and associated conditions	72,755	234.1	4.7
Pneumonia and influenza	70,485	226.8	4.6
Diabetes mellitus	35,523	114.3	2.3
Accidents and adverse effects	7,210	84.3	1.7
Motor vehicle accidents	26,213	23.2	0.5
All other accidents and adverse effects	19,003	61.1	1.2
Nephritis, nephrotic syndrome, and nephrosis	17,306	55.7	1.1
Atherosclerosis	17,158	55.2	1.1
Septicemia	15,351	49.4	1.0
All other causes, residual	222,048	2,045.9	14.4

Normal results

Seniors who stay active and eat nutritionally will be at less risk for conditions such as diabetes. A senior should also seek mental stimulation and social interaction. These provide enjoyment, boost self-esteem, and help reduce feelings of isolation and depression. Although eyesight and hearing will weaken, glasses and hearing aids help seniors keep the senses of sight and hearing.

When surgery is required for osteoarthritis, hip replacement surgery is extremely successful. In about 98% of surgeries, flexibility returns and pain is eased. Knee replacement surgery is also effective.

If a person maintains a healthy lifestyle, the ability to avoid falls and recover from them is increased.

After a fall, seniors needs to build up physical strength and the confidence needed so they don't fear falling again. Care should be taken so that seniors don't feel isolated by their injuries. Isolation could lead to decreased mobility and loss of independence.

There was no cure for Alzheimer's disease as of 2001. However, that year several medications proved moderately effective in stopping memory loss. Since Alzheimer's is progressive, a person diagnosed with this condition should make arrangements for the future. Finances should be taken care of and plans should be made for future care. Family should be brought into this discussion of the condition and those issues.

After diagnosis, a person should stay active for as long as possible. Not only does this help a person enjoy this stage of life, activities can help to fight depression. Alzheimer support groups can also be helpful. In addition, modifications to environment can be effective. Some people are bothered by dim lighting; others are disturbed by loud noises.

Resources

BOOKS

Clafin, Edward, ed. *Age Protectors*. Emmaus, PA: Rodale Publishing, Inc.,1998.

Gillick, Muriel R. *Lifelines: Living Longer, Growing Frail, Taking Heart*. New York: W.W. Norton and Co., 2001.

Honn Qualls, Sara and Norman Abeles, ed. *Psychology and the Aging Revolution: How We Adapt to Longer Life*. Washington, DC: American Psychological Association, 2000.

Powell, Douglas H. *The Nine Myths of Aging: Maximizing the Quality of Later Life*. Thorndike, ME: Thorndike Press, 1998.

Wei, Jeanne Y. and Sue Levkoff. *Aging Well: The Complete Guide to Physical and Emotional Health*. New York: Wiley, 2000.

ORGANIZATION

Alzheimer's Association. 919 N. Michigan Ave., Suite 1100, Chicago, IL 60611-1676. (800) 272-3900. <http://www.alz.org>.

American Academy of Otolaryngology-Head and Neck Surgery. One Prince St., Alexandria, VA 22314-3357. (703) 836-4444. <http://www.ent.org>.

American Dietetic Association. 216 W. Jackson Blvd., Chicago, IL 60606-6995. (312) 899-0040. <http://www.eatright.org>.

American Heart Association. 7272 Greenville Ave., Dallas, TX 75231. (800) AHA-USA1. <http://www.americanheart.org>.

National Institute on Aging. P.O. Box 8057, Gaithersburg, MD 20898-8057. (800) 222-2225. <http://www.nih.gov>.

National Osteoporosis Foundation. 1232 22nd St., NW, Washington, DC 20037. (800) 624-BONE. <http://www.osteo.org>.

National Sleep Foundation. 1522 K St., NW, Suite 500 Washington, DC 20005. Fax: (202) 347-3472. <http://www.sleepfoundation.org>.

Liz Swain

Sensory hearing loss *see* **Hearing loss**

Sensory integration disorder

Definition

Sensory integration disorder or dysfunction (SID) is a neurological disorder that results from the brain's inability to integrate certain information received from the body's five basic sensory systems. These sensory systems are responsible for detecting sights, sounds, smell, tastes, temperatures, **pain**, and the position and movements of the body. The brain then forms a combined picture of this information in order for the body to make sense of its surroundings and react to them appropriately. The ongoing relationship between behavior and brain functioning is called sensory integration (SI), a theory that was first pioneered by A. Jean Ayres, Ph.D., OTR in the 1960s.

Description

Sensory experiences include touch, movement, body awareness, sight, sound, smell, taste, and the pull of gravity. Distinguishing between these is the process of sensory integration (SI). While the process of SI occurs automatically and without effort for most, for some the process is inefficient. Extensive effort and attention are required in these individuals for SI to occur, without a guarantee of it being accomplished. When this happens, goals are not easily completed, resulting in sensory integration disorder (SID).

The normal process of SI begins before birth and continues throughout life, with the majority of SI development occurring before the early teenage years. The ability for SI to become more refined and effective coincides with the **aging** process as it determines how well motor and speech skills and emotional stability develop. The beginnings of the SI theory by Ayres instigated ongoing research that looks at the crucial foundation it provides for complex learning and behavior throughout life.

Causes and symptoms

The presence of a sensory integration disorder is typically detected in young children. While most children develop SI during the course of ordinary childhood activities, which helps establish such things as the ability for motor planning and adapting to incoming sensations, others SI ability does not develop as efficiently. When their process is disordered, a variety of problems in learning, development, or behavior become obvious.

Those who have sensory integration dysfunction may be unable to respond to certain sensory information by planning and organizing what needs to be done in an appropriate and automatic manner. This may cause a primitive survival technique called "fright, flight, and fight," or withdrawal response, which originates from the "primitive" brain. This response often appears extreme and inappropriate for the particular situation.

The neurological disorganization resulting in SID occurs in three different ways: the brain does not receive messages due to a disconnection in the neuron cells; sensory messages are received inconsistently; or sensory messages are received consistently, but do not connect properly with other sensory messages. When the brain poorly processes sensory messages, inefficient motor, language, or emotional output is the result.

According to Sensory Integration International (SII), a non-profit corporation concerned with the impact of sensory integrative problems on people's lives, the following are some signs of sensory integration disorder (SID):

- oversensitivity to touch, movement, sights, or sounds
- underreactivity to touch, movement, sights, or sounds
- tendency to be easily distracted
- social and/or emotional problems
- activity level that is unusually high or unusually low
- physical clumsiness or apparent carelessness
- impulsive, lacking in self-control
- difficulty in making transitions from one situation to another
- inability to unwind or calm self
- poor self concept
- delays in speech, language, or motor skills
- delays in academic achievement

While research indicates that sensory integrative problems are found in up to 70% of children who are considered learning disabled by schools, the problems of sensory integration are not confined to children with learning disabilities. SID transfers through all age groups, as well as intellectual levels and socioeconomic groups. Factors that contribute to SID include: premature birth; **autism** and other developmental disorders; learning disabilities; delinquency and substance abuse due to learning disabilities; stress-related disorders; and brain injury. Two of the biggest contributing conditions are autism and attention-deficit hyperactivity disorder (**ADHD**).

Diagnosis

In order to determine the presence of SID, an evaluation may be conducted by a qualified occupational or

physical therapist. An evaluation normally consists of both standardized testing and structured observations of responses to sensory stimulation, posture, balance, coordination, and eye movements. These test results and assessment data, along with information from other professionals and parents, are carefully analyzed by the therapist who then makes recommendations about appropriate treatment.

Treatment

Occupational therapists play a key role in the conventional treatment of SID. By providing sensory integration therapy, occupational therapists are able to supply the vital sensory input and experiences that children with SID need to grow and learn. Also referred to as a "sensory diet," this type of therapy involves a planned and scheduled activity program implemented by an occupational therapist, with each "diet" being designed and developed to meet the needs of the child's nervous system. A sensory diet stimulates the "near" senses (tactile, vestibular, and proprioceptive) with a combination of alerting, organizing, and calming techniques.

Motor skills training methods that normally consist of adaptive physical education, movement education, and gymnastics are often used by occupational and physical therapists. While these are important skills to work on, the sensory integrative approach is vital to treating SID.

The sensory integrative approach is guided by one important aspect—the child's motivation in selection of the activities. By allowing them to be actively involved, and explore activities that provide sensory experiences most beneficial to them, children become more mature and efficient at organizing sensory information.

Alternative treatment

Sensory integration disorder (SID) is treatable with occupational therapy, but some alternative methods are emerging to complement the conventional methods used for SID.

Therapeutic body brushing is often used on children (not infants) who overreact to tactile stimulation. A specific non-scratching surgical brush is used to make firm, brisk movements over most of the body, especially the arms, legs, hands, back and soles of the feet. A technique of deep joint compression follows the brushing. Usually begun by an occupational therapist, the technique is taught to parents who need to complete the process for three to five minutes, six to eight times a day. The time needed for brushing is reduced as the child begins to respond more normally to touch. In order for this therapy to be effective, the correct brush and technique must be used.

KEY TERMS

Axon—A process of a neuron that conducts impulses away from the cell body. Axons are usually long and straight.

Cortical—Regarding the cortex, or the outer layer of the brain, as distinguished from the inner portion.

Neurotransmission—When a neurotransmitter, or chemical agent released by a particular brain cell, travels across the synapse to act on the target cell to either inhibit or excite it.

Proprioceptive—Pertaining to proprioception, or the awareness of posture, movement, and changes in equilibrium and the knowledge of position, weight, and resistance of objects as they relate to the body.

Tactile—The perception of touch.

Vestibular—Pertaining to the vestibule; regarding the vestibular nerve of the ear which is linked to the ability to hear sounds.

A report in 1998 indicates the use of cerebral electrical stimulation (CES) as being helpful to children with conditions such as moderate to severe autistic spectrum disorders, learning disabilities, and sensory integration dysfunction. CES is a modification of Transcutaneous **Electrical Nerve Stimulation** (TENS) technology that has been used to treat adults with various pain problems, including arthritis and **carpal tunnel syndrome**. TENS therapy uses a low voltage signal applied to the body through the skin with the goal of replacing painful impressions with a massage-like sensation. A much lower signal is used for CES than that used for traditional TENS, and the electrodes are placed on the scalp or ears. Occupational therapists who have studied the use of CES suggest that CES for children with SID can result in improved brain activity. The device is worn by children at home for 10 minutes at a time, twice per day.

Music therapy helps promote active listening. Hypnosis and **biofeedback** are sometimes used, along with psychotherapy, to help those with SID, particularly older patients.

Prognosis

By providing treatment at an early age, sensory integration disorder may be managed successfully. The ultimate goal is for the individual to be better able to interact with his or her environment in a more successful and adaptive way.

Resources

PERIODICALS

"Body Brushing Therapy for Tactile Defensiveness." *Latitudes* (April 30, 1997).
"Brain Stimulation for Autism?" *Latitudes* (October 31, 1998).
Morgan, Nancy. "Strategies for Colic." *Birth Gazette* (September 30, 1996).
"Sensory Integration Therapy." *Latitudes* (December 31, 1994).

ORGANIZATIONS

Sensory Integration International/The Ayres Clinic, 1514 Cabrillo Avenue, Torrance, CA 90501-2817.

OTHER

Sensory Integration International. <http://www.sensoryint.com>.
Sensory Integration Dysfunction. <http://home.ptd.net/blnelson/SIDEWEBPAGE2.htm>.
Sensory Integration Network. <http://www.sinetwork.org>.
Southpaw Enterprises, Inc. <http://www.southpaw enterprises.com>.

Beth Kapes

Sepsis

Definition

Sepsis refers to a bacterial infection in the bloodstream or body tissues. This is a very broad term covering the presence of many types of microscopic disease-causing organisms.

Description

Sepsis is also called **bacteremia**. Closely related terms include septicemia and septic syndrome. In the general population, the incidence of sepsis is two people in 10,000.

Causes and symptoms

Sepsis can originate anywhere bacteria can gain entry to the body; common sites include the genitourinary tract, the liver and its bile ducts, the gastrointestinal tract, and the lungs. Broken or ulcerated skin can also provide access to bacteria commonly present in the environment. Invasive medical procedures, including dental work, can introduce bacteria or permit it to accumulate. Entry points and equipment left in place for any length of time present a particular risk. **Heart valve replacement**, catheters, **ostomy** sites, intravenous (IV) or arterial lines, surgical **wounds**, or surgical drains are examples. IV drug users are at high risk as well.

People with inefficient immune systems or blood disorders are at particular risk for sepsis and have a higher **death** rate (up to 60%); in people who have no underlying chronic disease, the death rate is far lower (about 5%). The growing problem of antibiotic resistance has increased the incidence of sepsis, partly because ordinary preventive measures (such as prophylactic **antibiotics**) are less effective.

The most common symptom of sepsis is **fever**, often accompanied by chills or shaking, or other flu-like symptoms. A history of any recent invasive procedure or dental work should raise the suspicion of sepsis and medical help should be sought.

Diagnosis

The presence of sepsis is indicated by blood tests showing particularly high or low white blood cell counts. The causative agent is determined by **blood culture**.

Treatment

Identifying the specific causative agent ultimately determines how sepsis is treated. However, time is of the essence, so a broad-spectrum antibiotic or multiple antibiotics will be administered until blood cultures reveal the culprit and treatment can be made specific to the organism. Intravenous antibiotic therapy is usually necessary and is administered in the hospital.

Sepsis syndrome *see* **Septic shock**
Septal deviation *see* **Deviated septum**
Septic arthritis *see* **Infectious arthritis**

Jill S. Lasker

Septic shock

Definition

Septic **shock** is a potentially lethal drop in blood pressure due to the presence of bacteria in the blood.

Description

Septic shock is a possible consequence of **bacteremia**, or bacteria in the bloodstream. Bacterial toxins, and the immune system response to them, cause a dramatic drop in blood pressure, preventing the delivery of blood to the organs. Septic shock can lead to multiple

organ failure including **respiratory failure**, and may cause rapid **death**. **Toxic shock syndrome** is one type of septic shock.

Causes and symptoms

During an infection, certain types of bacteria can produce and release complex molecules, called endotoxins, that may provoke a dramatic response by the body's immune system. Released in the bloodstream, endotoxins are particularly dangerous, because they become widely dispersed and affect the blood vessels themselves. Arteries and the smaller arterioles open wider, increasing the total volume of the circulatory system. At the same time, the walls of the blood vessels become leaky, allowing fluid to seep out into the tissues, lowering the amount of fluid left in circulation. This combination of increased system volume and decreased fluid causes a dramatic decrease in blood pressure and reduces the blood flow to the organs. Other changes brought on by immune response may cause coagulation of the blood in the extremities, which can further decrease circulation through the organs.

Septic shock is seen most often in patients with suppressed immune systems, and is usually due to bacteria acquired during treatment at the hospital. The immune system is suppressed by drugs used to treat **cancer**, **autoimmune disorders**, organ transplants, and diseases of immune deficiency such as **AIDS**. **Malnutrition**, chronic drug abuse, and long-term illness increase the likelihood of succumbing to bacterial infection. Bacteremia is more likely with preexisting infections such as urinary or gastrointestinal tract infections, or skin ulcers. Bacteria may be introduced to the blood stream by surgical procedures, catheters, or intravenous equipment.

Toxic shock syndrome most often occurs in menstruating women using highly absorbent tampons. Left in place longer than other types, these tampons provide the breeding ground for *Staphylococcus* bacteria, which may then enter the bloodstream through small tears in the vaginal lining. The incidence of toxic shock syndrome has declined markedly since this type of tampon was withdrawn from the market.

Symptoms

Septic shock is usually preceded by bacteremia, which is marked by **fever**, malaise, chills, and nausea. The first sign of shock is often confusion and decreased consciousness. In this beginning stage, the extremities are usually warm. Later, they become cool, pale, and bluish. Fever may give way to lower-than-normal temperatures later on in **sepsis**.

Other symptoms include:

- rapid heartbeat
- shallow, rapid breathing
- decreased urination.
- reddish patches in the skin

Septic shock may progress to cause "adult respiratory distress syndrome," in which fluid collects in the lungs, and breathing becomes very shallow and labored. This condition may lead to ventilatory collapse, in which the patient can no longer breathe adequately without assistance.

Diagnosis

Diagnosis of septic shock is made by measuring blood pressure, heart rate, and respiration rate, as well as by a consideration of possible sources of infection. Blood pressure may be monitored with a catheter device inserted into the pulmonary artery supplying the lungs (Swan-Ganz catheter). Blood cultures are done to determine the type of bacteria responsible. The levels of oxygen, carbon dioxide, and acidity in the blood are also monitored to assess changes in respiratory function.

Treatment

Septic shock is treated initially with a combination of **antibiotics** and fluid replacement. The antibiotic is chosen based on the bacteria present, although two or more types of antibiotics may be used initially until the organism is identified. Intravenous fluids, either blood or protein solutions, replace the fluid lost by leakage. Coagulation and hemorrhage may be treated with transfusions of plasma or platelets. Dopamine may be given to increase blood pressure further if necessary.

Respiratory distress is treated with mechanical ventilation and supplemental oxygen, either using a nosepiece or a tube into the trachea through the throat.

Identification and treatment of the primary infection site is important to prevent ongoing proliferation of bacteria.

Prognosis

Septic shock is most likely to develop in the hospital, since it follows infections which are likely to be the objects of treatment. Because of this, careful monitoring and early, aggressive therapy can minimize the likelihood of progression. Nonetheless, death occurs in at least 25% of all cases.

The likelihood of recovery from septic shock depends on may factors, including the degree of immunosuppression of the patient, underlying disease, promptness of treatment, and type of bacteria responsible. Mor-

KEY TERMS

Bacteremia—Invasion of the bloodstream by bacteria.

tality is highest in the very young and the elderly, those with persistent or recurrent infection, and those with compromised immune systems.

Prevention

The risk of developing septic shock can be minimized through treatment of underlying bacterial infections, and prompt attention to signs of bacteremia. In the hospital, scrupulous aseptic technique on the part of medical professionals lowers the risk of introducing bacteria into the bloodstream.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

OTHER

The Merck Page. 13 Apr. 1998 <http://www.merck.com>.

Richard Robinson

Septoplasty

Definition

Septoplasty is a surgical procedure to correct the shape of septum of the nose. The nasal septum is the separation between the two nostrils. In adults, the septum is composed partly of cartilage and partly of bone.

Purpose

Septoplasty is performed to correct a crooked (deviated) or dislocated septum, often as part of plastic surgery of the nose (**rhinoplasty**). The nasal septum has three functions: to support the nose, regulate air flow, and support the mucous membranes (mucosa) of the nose. Septoplasty is done to correct the shape of the nose caused by a deformed septum or correct deregulated air flow caused by a **deviated septum**. Septoplasty is often needed when the patient is having an operation to reduce the size of the nose (reductive rhinoplasty), because this operation usually reduces the amount of breathing space in the nose.

Precautions

Septoplasty is ordinarily not performed within six months of a traumatic injury to the nose.

Description

Septoplasties are performed in the hospital with a combination of local and intravenous anesthesia. After the patient is anesthetized, the surgeon makes a cut (incision) in the mucous tissue that covers the part of the septum that is made of cartilage. The tissue is lifted, exposing the cartilage and bony part of the septum. Usually, one side of the mucous tissue is left intact to provide support during healing. Cartilage is cut away as needed.

As the surgeon cuts away the cartilage, deformities tend to straighten themselves out, reducing the amount of cartilage that must be cut. Once the cartilage is cut, bony deformities can be corrected. For most patients, this is the extent of the surgery required to improve breathing through the nose and correct deformities. Some patients have bony obstructions at the base of the nasal chamber and require further surgery. These obstructions include bony spurs and ridges that contribute to drying, ulceration, or bleeding of the mucous tissue that covers the inside of the nasal passages. In these cases, the extent of the surgery depends on the nature of the deformities that need correcting.

During surgery, the patient's own cartilage that has been removed can be reused to provide support for the nose if needed. External septum supports are not usually needed. Splints may be needed occasionally to support cartilage when extensive cutting has been done. External splints can be used to support the cartilage for the first few days of healing. Tefla gauze is inserted in the nostril to support the flaps and cartilage and to absorb any bleeding or mucus.

Preparation

Before performing a septoplasty, the surgeon will evaluate the difference in airflow between the two nostrils. In children, this assessment can be done very simply by asking the child to breathe out slowly on a small mirror held in front of the nose.

As with any other operation under general anesthesia, patients are evaluated for any physical conditions that might complicate surgery and for any medications that might affect blood clotting time.

Aftercare

Patients with septoplasties are usually sent home from the hospital later the same day or the morning after the surgery. All dressings inside the nose are removed before the patient leaves. Aftercare includes a list of

KEY TERMS

Cartilage—A tough, elastic connective tissue found in the joints, outer ear, nose, larynx, and other parts of the body.

Rhinoplasty—Plastic surgery of the nose.

Septum (plural, septa)—The dividing partition in the nose that separates the two nostrils. It is composed of bone and cartilage.

Splint—A thin piece of rigid material that is sometimes used during nasal surgery to hold certain structures in place until healing is underway.

detailed instructions for the patient that focus on preventing trauma to the nose.

Risks

The risks from a septoplasty are similar to those from other operations on the face: postoperative **pain** with some bleeding, swelling, bruising, or discoloration. A few patients may have allergic reactions to the anesthetics. The operation in itself, however, is relatively low-risk in that it does not involve major blood vessels or vital organs. Infection is unlikely if proper surgical technique is observed.

Normal results

Normal results include improved breathing and airflow through the nostrils, and an acceptable outward shape of the nose.

Resources

BOOKS

Ballenger, John J., and James B. Snow Jr. *Otorhinolaryngology: Head and Neck Surgery.* Baltimore: Williams and Wilkins, 1996.

Mastery of Plastic and Reconstructive Surgery. Vol. 3. Ed. Mimis Cohen. Boston: Little, Brown and Co., 1994.

Pediatric Plastic Surgery, ed. Michael L. Bentz. Stamford: Appleton & Lange, 1998.

John T. Lohr, PhD

Septum perforation *see* **Perforated septum**

Serenoa repens see **Saw palmetto**

Serotonin boosters *see* **Selective serotonin reuptake inhibitors**

Serum albumin test *see* **Protein components test**

Serum globulin test *see* **Protein components test**

Serum hepatitis *see* **Hepatitis B**

Serum protein electrophoresis *see* **Protein electrophoresis**

Serum sickness

Definition

Serum sickness is a type of delayed allergic response, appearing four to 10 days after exposure to some **antibiotics** or antiserum, the portion of serum that contains antibodies, such as gamma globulin, which may be given to provide immunization against some diseases.

Description

Serum sickness is very similar to an allergic reaction. The patient's immune system recognizes the proteins in the drug or antiserum as foreign proteins, and produces its own antibodies to protect against the foreign proteins. The newly formed antibodies bind with the foreign protein to form immune complexes. These immune complexes may enter the walls of blood vessels where they set off an inflammatory reaction.

While other types of allergic reactions may produce a rapid response, the serum sickness reaction is delayed because it takes time for the body to produce antibodies to the new protein.

Causes and symptoms

The usual symptoms are severe skin reactions, often on the palms of the hands and soles of the feet. **Fever**, sometimes as high as 104°F, is always present and usually appears before the skin rash.

Joint **pain** may be reported in up to 50% of cases. This is usually seen in the larger joints, but occasionally the finger and toe joints may also be involved.

Swelling of lymph nodes, particularly around the site of the injection, is seen in 10–20% of cases. There may also be swelling of the head and neck.

Urine analysis may show traces of blood and protein in the urine.

Other symptoms may involve the heart and central nervous system. These may include changes in vision, and difficulty in movement. Breathing difficulty may occur.

Traditionally, antitoxins were the most common cause of serum sickness, but those reports date from a time when most antitoxins were made from horse serum. As many as 16% of the people who received antirabies serum derived from horses developed serum sickness. The risk of a reaction to antitoxins has dropped dramatically since manufacturers have started using human serum instead of horse serum to make their products.

Although antitoxins are the most common cause of serum sickness, a number of drugs have been reported to cause a serum sickness reaction. The following list is not complete, but indicates some of the drugs that have been associated with this type of reaction:

- allopurinol (Zyloprim)
- barbiturates
- captopril (Capoten)
- cephalosporin antibiotics
- griseofulvin (Fulvicin, Grifulvin)
- penicillins
- pehnytoin (Dilantin)
- procainamide (Procan SR, Procanbid, Pronestyl-SR)
- quinidine (Quinaglute, Quinidex, Quinora)
- streptokinase (Streptase, Kabikinase)
- sulfonamide antibacterial drugs

Of cases of serum sickness reported to the United States Food and Drug Administration, the drugs most commonly associated with the reaction have been the cephalosporin antibiotics, including cefaclor (Ceclor) and cefalexin (Keflex) and the sulfonamide combination trimethoprim-sulfamethoxazole (Bactrim, Septra.) This does not mean that these are high-risk drugs, since these drugs are very widely used, so that there are many people exposed to them.

In addition to these substances, allergenic extracts used for testing and immunization, hormones, and vaccines have been known to cause serum sickness.

Diagnosis

Diagnosis is made by observing the symptoms and reviewing the patient's medical and medication history. Although the symptoms of serum sickness may be similar to other conditions, patients who present with symptoms of serum sickness and who have a recent history of exposure to a drug or other product which may cause this type of reaction should be suspected of having serum sickness.

Treatment

The first step in treatment of serum sickness is always to discontinue the drug or other substance which is suspected of causing the reaction. After that, all treatment is symptomatic. **Antihistamines**, pain relievers, and **corticosteroids** may be given to relieve the symptoms. The choice of treatment depends on the severity of the reaction.

Prognosis

Most serum sickness reactions are mild, and disappear on their own after one or two weeks as long as the cause is removed. Sometimes, symptoms of pain and discomfort may continue for several weeks, even after all the observable reactions such as skin rash and protein in the urine have disappeared. In very rare cases, however, there can be severe reactions and permanent damage. In very rare but extreme cases, serum sickness can lead to **shock**, permanent kidney damage, and even **death**.

Prevention

The most effective method of prevention is simple avoidance of antitoxins that may cause serum sickness. If patients have had a reaction in the past, particularly if the reaction was to a commonly used drug, they should be made aware of it, and be advised to alert physicians and hospitals in the future. Patients who have had particularly severe reactions may be advised to wear identification bracelets, or use other means to alert health care providers.

When it is necessary to administer an antitoxin, skin tests may be used to identify people who are at risk of a reaction. If the situation does not allow enough time for skin testing, the antitoxin should be given along with an intravenous antihistamine. Other drugs, such as epinephrine, which may be needed for an emergency, should be available.

Resources

BOOKS

1999 Year Book: Allergy and Clinical Immunology. Saint Louis: Mosby, Inc., 1999.

Allergen Immunotherapy, 2nd ed. New York: Marcel Dekker, Inc., 1998.

PERIODICALS

"Children at Risk from Medication Mistakes." *Houston Chronicle,* May 18, 2001.

"Drug allergies." *Pediatrics for Parents* 18 (2000): 1.

Fielding, Jonathan. "Our Health; Drug Reactions Differ From Side Effects." *The Los Angeles Times,* February 7, 2000.

KEY TERMS

Allergy—Altered body reaction, usually hypersensitivity, as a response to exposure to a specific substance.

Antibody—Any of a large number of proteins that are produced after stimulation by an antigen and act specifically against the antigen in an immune response.

Antihistamine—A drug that inhibits the actions of histamine. Histamine causes dilatation of capillaries, contraction of smooth muscle, and stimulation of gastric acid secretion.

Antitoxin—An antibody that is capable of neutralizing the specific toxin (a specific cause of disease) that stimulated its production in the body and is produced in animals for medical purposes by injection of a toxin or toxoid with the resulting serum being used to counteract the toxin in other individuals

Serum—The clear yellowish fluid that remains from blood plasma after fibrinogen, prothrombin, and other clotting factors have been removed by clot formation—called also blood serum

Sulfonamide—A sulfa drug, one of a large group of drugs used to treat bacterial infections.

"VA hospitals Test Smart Cards for Patient Information." *Computerworld* (May 14, 2001).

ORGANIZATIONS

Action Against Allergy (AAA). PO Box 278, Twickenham Middlesex, Greater London TW1 4QQ, England.

American Allergy Association (AAA). 3104 E Camelback, Ste. 459 Phoenix, AZ 85016.

Sam Uretsky

Serum therapy *see* **Gammaglobulin**

Severe combined immunodeficiency

Definition

Severe combined **immunodeficiency** (SCID) is the most serious human immunodeficiency disorder(s). It is a group of congenital disorders in which both the humoral part of the patient's immune system and the cells involved in immune responses fail to work properly. Children with SCID are vulnerable to recurrent severe infections, retarded growth, and early **death**.

Description

SCID is thought to affect between one in every 100,000 persons, and one in every 500,000 infants. Several different immune system disorders are currently grouped under SCID:

- Swiss-type agammaglobulinemia. This was the first type of SCID discovered, in Switzerland in the 1950s.
- Adenosine deaminase deficiency (ADA). About 50% of SCID cases are of this type. ADA deficiency leads to low levels of B and T cells in the child's immune system.
- Autosomal recessive. About 40% of SCID cases are inherited from the parents in an autosomal recessive pattern.
- Bare lymphocyte syndrome. In this form of SCID, the white blood cells (lymphocytes) in the baby's blood are missing certain proteins. Without these proteins, the lymphocytes cannot activate the T cells in the immune system.
- SCID with leukopenia. Children with this form of SCID are lacking a type of white blood cell called a granulocyte.

In order to understand why SCID is considered the most severe immunodeficiency disorder, it is helpful to have an outline of the parts of the human immune system. It has three parts: cellular, humoral, and nonspecific. The cellular and humoral parts of the system are both needed to fight infections—they recognize disease agents and attack them. The cellular system is composed of many classes of T-lymphocytes (white blood cells that detect foreign invaders called antigens). The humoral system is made up of B cells, which are the only cells in the body that make antibodies. In SCID, neither the cellular nor the humoral part of the immune system is working properly.

Causes and symptoms

SCID is an inherited disorder. There are two ways in which a developing fetus' immune system can fail to develop normally. In the first type of genetic problem, both B and T cells are defective. In the second type, only the T cells are abnormal, but their defect affects the functioning of the B cells.

For the first few months of life, a child with SCID is protected by antibodies in the mother's blood. As early as three months of age, however, the SCID child begins to suffer from mouth infections (thrush), chronic **diarrhea**,

KEY TERMS

Adenosine deaminase (ADA)—An enzyme that is lacking in a specific type of SCID. Children with an ADA deficiency have low levels of both B and T cells.

Antigens—A substance that usually causes the formation of an antibody. A foreign invaders in the body.

Autosomal recessive inheritance—A pattern of inheritance of a recessive gene where, among other things, both parents may not show symptoms.

B cell—A type of lymphocyte or white blood cell that is derived from precursor cells in the bone marrow.

Congenital—Present at the time of birth. Most forms of SCID are hereditary as well as congenital.

Gene therapy—An experimental treatment for SCID that consists of implanting a gene for ADA into an activated virus and merging it with some of the patient's own T cells. The corrected T cells are infused back into the patient every few months.

Humoral—Pertaining to or derived from a body fluid. The humoral part of the immune system includes antibodies and immunoglobulins in blood serum.

Lymphocyte—A type of white blood cell that is important in the formation of antibodies.

Orphan drug—A drug that is known to be useful in treatment but lacks sufficient funding for further research and development.

PEG-ADA—An orphan drug that is useful in treating SCID related to ADA deficiency.

T cells—Lymphocytes that originate in the thymus gland. T cells regulate the immune system's response to infections. The thymus gland is small or underdeveloped in children with SCID.

Thrush—A disease of the mouth caused by a yeast, *Candida albicans*.

otitis media and pulmonary infections, including **pneumocystis pneumonia**. The child loses weight, becomes very weak, and eventually dies from an opportunistic infection.

Diagnosis

SCID is diagnosed by the typing of T and B cells in the child's blood. B cells can be detected by immunofluorescence tests for surface markers (unique proteins)on the cells. T cells can be identified in tissue sections (samples) using enzyme-labeled antibodies.

Treatment

Patients with SCID can be treated with **antibiotics** and immune serum to protect them from infections, but these treatments cannot cure the disorder. Bone marrow transplants are currently regarded as one of the few effective standard treatments for SCID.

Investigational treatments

In 1990, the Food and Drug Administration (FDA) approved PEG- ADA, an orphan drug (not available in US but available elsewhere), for the treatment of SCID. PEG-ADA, which is also called pegademase bovine, works by replacing the ADA deficiency in children with this form of SCID. Children who receive weekly injections of PEG-ADA appear to have normal immune functions restored. Another treatment that is still in the experimental stage is **gene therapy**. In gene therapy, the children receive periodic infusions of their own T cells corrected with a gene for ADA that has been implanted in an activated virus.

Prognosis

Currently, there is no cure for SCID. Most untreated patients die before age two.

Prevention

Genetic counseling is recommended for parents of a child with SCID.

Resources

BOOKS

Abbas, Abul K., et al. *Cellular and Molecular Immunology.* Philadelphia: W. B. Saunders Co., 1997.

"Immunology: Immunodeficiency Diseases." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Physicians' Guide to Rare Diseases. Ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Co., Inc., 1995.

Roitt, Ivan M. *Roitt's Essential Immunology.* Oxford, UK: Blackwell Science Ltd., 1997.

ORGANIZATIONS

Immune Deficiency Foundation. 25 W. Chesapeake Ave., Suite 206, Towson, MD 21204. (800) 296-4433. <http://www.primaryimmune.org>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Rebecca J. Frey

Sex change surgery

Definition

Also known as sex reassignment surgery, sex change surgery is a procedure that changes genital organs from one gender to another.

Purpose

There are two reasons to alter the genital organs from one sex to another.

- Newborns with intersex deformities must early on be assigned one sex or the other. These deformities represent intermediate stages between the primordial female genitals and the change into male caused by male hormone stimulation.
- Both men and women occasionally believe they are physically a different sex than they are mentally and emotionally. This dissonance is so profound they are willing to be surgically altered.

In both cases, technical considerations favor successful conversion to a female rather than a male. Newborns with ambiguous organs will almost always be assigned to the female sex, unless the penis is at least an inch long. Whatever their chromosomes, they are much more likely to be socially well adjusted as females, even if they cannot have children.

Precautions

Sexual identity is probably the most profound characteristic humans have. Assigning it must take place immediately after birth, both for the child's and the parents' comfort. Changing sexual identity may be the most significant change one can experience. It therefore should be done with every care and caution. By the time most adults come to surgery, they have lived for many years with dissonant identity. The average in one study was 29 years. Nevertheless, even then they may not be fully aware of the implications of becoming the other sex.

Description

Converting male to female anatomy requires removal of the penis, reshaping genital tissue to appear more female, and constructing a vagina. A vagina can be successfully formed from a skin graft or an isolated loop of intestine. Following the surgery, female hormones (estrogen) will reshape the body's contours and grow satisfactory breasts.

Female to male surgery has achieved lesser success, due to the difficulty of building a functioning penis from the much smaller clitoral tissue available in the female genitals. Penis construction is not attempted less than a year after the preliminary surgery to remove the female organs. One study in Singapore found that a third of the patients would not undergo the surgery again. Nevertheless, they were all pleased with the change of sex. Besides the genital organs, the breasts need to be surgically altered for a more male appearance. This can be done quite successfully.

Orgasm, or at least "a reasonable degree of erogenous sensitivity," can be experienced by patients after surgery.

Preparation

In-depth psychological counseling should precede and follow these procedures.

Aftercare

Social support, particularly from the family, is important for readjustment as a member of the opposite sex. If patients were socially or emotionally unstable before the operation, over 30, or had an unsuitable body build for the new sex, they tend to do poorly. In no case studied did the procedure diminish their ability to work.

Risks

All surgery runs the risk of infection, bleeding, and a need to return for repairs. This surgery is irreversible, so the patient must have no doubts about the results.

The most common complication of the male to female surgery is narrowing of the new vagina.

Resources

BOOKS

Hensle, Terry W., and William A. Kennedy. "Surgical Management of Intersexuality." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Jordan, Gerald H. "Surgery of the Penis and Urethra." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

KEY TERMS

Chromosomes—The carriers of genes, which determine sex and characteristics.

PERIODICALS

Eldh, J., A. Berg, and M. Gustafsson. "Long-term Follow Up After Sex Reassignment Surgery." *Scandinavian Journal of Plastic & Reconstructive Surgery & Hand Surgery* 31 (Mar. 1997): 39-45.

Hage, J. J., and P. J. van Kesteren. "Chest-wall Contouring in Female-to-male Transsexuals: Basic Considerations and Review of the Literature." *Plastic & Reconstructive Surgery* 96 (Aug. 1995): 386-391.

Hage, J. J., and R. B. Karim. "Sensate Pedicled Neoclitoroplasty for Male Transsexuals: Amsterdam Experience in the First 60 Patients." *Annals of Plastic Surgery* 36 (June 1996): 621-624.

Huang, T. T. "Twenty Years of Experience in Managing Gender Dysphoric Patients: I. Surgical Management of Male Transsexuals." *Plastic & Reconstructive Surgery* 96 (Sept. 1995): 921-930, 931-934.

Karim, R. B., J. J. Hage, and J. W. Mulder. "Neovaginoplasty in Male Transsexuals: Review of Surgical Techniques and Recommendations Regarding Eligibility." *Annals of Plastic Surgery* 37 (Dec. 1996): 669-675.

Siemssen, P. A., and S. H. Matzen. "Neovaginal Construction in Vaginal Aplasia and Sex-Reassignment Surgery." *Scandinavian Journal of Plastic & Reconstructive Surgery & Hand Surgery* 31 (Mar. 1997): 47-50.

Tsoi, W. F., et al. "Follow-up Study of Female Transsexuals." *Annals of the Academy of Medicine* (24 Sept. 1995): 664-667.

J. Ricker Polsdorfer, MD

Sex hormones tests

Definition

Sex hormones tests measure levels of the sex hormones, including estrogen, progesterone, and testosterone.

Purpose

The sex hormone tests are ordered to determine if secretion of these hormones is normal. Estrogen fraction test is done to evaluate sexual maturity, menstrual problems, and fertility problems in females. This test may also be used to test for tumors that excrete estrogen. In pregnant women it aids in determining fetal-placental health. Estrogen fraction is also used to evaluate males who have enlargement of one or both breasts (**gynecomastia**), or who have feminization syndromes, where they display female sex characteristics.

Progesterone assay test is ordered to evaluate women who are having difficulty becoming pregnant or maintaining a **pregnancy**, and to monitor high-risk pregnancies.

Testosterone levels are ordered to evaluate:

- ambiguous sex characteristics
- **precocious puberty**
- virilizing syndromes in the female
- infertility in the male
- rare tumors of the ovary and testicle

Description

The sex hormones control the development of primary and secondary sexual characteristics. They regulate the sex-related functions of the body, such as the menstrual cycle or the production of eggs or sperm. There are three main types of sex hormones:

- the female sex hormones (called the estrogen hormones)
- the progesterone hormones (which help the body prepare for and maintain pregnancy)
- the male sex hormones, or the androgen hormones

Female sex hormones are responsible for normal menstruation and the development of secondary female characteristics. Testosterone is a hormone that induces **puberty** in the male and maintains male secondary sex characteristics. In females, the adrenal glands and the ovaries secrete small amounts of testosterone.

Estrogen

Estrogen is tested to evaluate menstrual status, sexual maturity, and gynecomastia (or feminization syndromes). It is a tumor marker for patients with certain ovarian tumors. E1, a type of estrogen, is the most active estrogen in the nonpregnant female.

E3 (estriol) is the major estrogen in the pregnant female. It is produced in the placenta. Excretion of estriol increases around the eighth week of gestation and continues to rise until shortly before delivery. Serial urine and blood studies of this hormone are used to assess placental function and fetal normality in high-risk pregnancies. Falling values during pregnancy suggest fetoplacental deterioration and require prompt reassessment of the pregnancy, including the possibility of early delivery.

Progesterone

Progesterone is essential for the healthy functioning of the female reproductive system. Produced in the ovaries during the second half of the menstrual cycle, and by the placenta during pregnancy, small amounts of progesterone are also produced in the adrenal glands and testes.

After ovulation, an increase of progesterone causes the uterine lining to thicken in preparation for the implantation of a fertilized egg. If this event does not take place, progesterone and estrogen levels fall, resulting in shedding of the uterine lining.

Progesterone is essential during pregnancy, not only ensuring normal functioning of the placenta, but passing into the developing baby's circulation, where it is converted in the adrenal glands to corticosteroid hormones.

Testosterone

Testosterone is the most important of the male sex hormones. It is responsible for stimulating bone and muscle growth, and sexual development. It is produced by the testes and in very small amounts by the ovaries. Most testosterone tests measure total testosterone.

Testosterone stimulates sperm production (spermatogenesis), and influences the development of male secondary sex characteristics. Overproduction of testosterone caused by testicular, adrenal, or **pituitary tumors** in the young male may result in precocious puberty.

Overproduction of testosterone in females, caused by ovarian and adrenal tumors, can result in masculinization, the symptoms of which include cessation of the menstrual cycle (**amenorrhea**) and excessive growth of body hair (**hirsutism**).

When reduced levels of testosterone in the male indicate underactivity of the testes (**hypogonadism**), testosterone stimulation tests may be ordered.

Preparation

The progesterone and testosterone tests require a blood sample; it is not necessary for the patient to restrict food or fluids before the test. Testosterone specimens should be drawn in the morning, as testosterone levels are highest in the early morning hours. The estrogen fraction test can be performed on blood and/or urine. It is not necessary for the patient to restrict food or fluids for either test. If a 24-hour urine test has been requested, the patient should call the laboratory for instructions.

Risks

Risks for these blood tests are minimal, but may include slight bleeding from the puncture site, **fainting** or feeling lightheaded after having blood drawn, or blood accumulating under the puncture site (hematoma).

Normal results

Estrogen levels vary in women, ranging from 24–149 picograms per ml of blood. In men, the normal range is between 12–34 picograms per ml of blood.

Progesterone levels vary from less than 150 nanograms per deciliter (ng/dL) of blood to 2,000 nanograms in menstruating women. During pregnancy, progesterone levels range from 1,500–20,000 ng/dL of blood.

Testosterone values vary from laboratory to laboratory, but can generally be found within the following levels:

- Men. 300–1,200 ng/dL
- Women. 30–95 ng/dL
- Prepubertal children. Less than 100 ng/dL (boys), less than 40 ng/dL (girls).

Abnormal results

Increased levels of estrogen are seen in feminization syndromes:

- when a male begins to develop female secondary sex characteristics
- during precocious puberty
- when children develop secondary sexual characteristics at an abnormally early age
- because of ovarian, testicular, or adrenal tumor
- during normal pregnancy, **cirrhosis**, and increased thyroid levels (hyperthyroidism)

Decreased levels of estrogen are found in the following conditions:

- a failing pregnancy
- during **menopause**
- anorexia nervosa
- primary and secondary hypogonadism
- turner's syndrome, seen in females with one missing X chromosome

Increased levels of progesterone are seen:

- during ovulation and pregnancy
- with certain types of ovarian cysts
- a tumor of the ovary known as a choriocarcinoma

Decreased levels of progesterone are seen:

- in toxemia of pregnancy
- with a threatened abortion
- during placental failure

- after fetal **death**
- with amenorrhea
- due to ovarian dysfunction

Increased levels (male) of testosterone are found in:

- sexual precocity
- the viral infection of encephalitis
- tumors involving the adrenal glands
- testicular tumor
- excessive thyroid production (hyperthyroidism)
- testosterone resistance syndromes

Decreased levels (male) of testosterone are seen in:

- klinefelter syndrome
- a chromosomal deficiency
- primary and secondary hypogonadism
- down syndrome
- surgical removal of the testicles
- cirrhosis

Increased levels (females) of testosterone are found in ovarian and adrenal tumors and in the presence of excessive hair growth of unknown cause (hirsutism).

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Sex reassignment surgery *see* **Sex change surgery**

Sex therapy

Definition

Sex therapy is the treatment of **sexual dysfunction**.

Purpose

Sex therapy utilizes various techniques in order to relieve sexual dysfunction commonly caused by **premature ejaculation** or sexual **anxiety** and to improve the sexual health of the patient.

Precautions

Sexual dysfunction conjures up feelings of guilt, anger, insecurity, frustration, and rejection. Therapy is slow and requires open communication and understanding between sexual partners. Therapy may inadvertently address interpersonal communication problems.

Description

Sex therapy is conducted by a trained therapist, doctor, or psychologist. The initial sessions should cover a complete history not only of the sexual problem but of the entire relationship and each individual's background and personality. The sexual relationship should be discussed in the context of the entire relationship. In fact, sexual counseling may de-emphasize sex until other aspects of the relationship are better understood and communicated.

There are several techniques that combat sexual dysfunction and are used in sex therapy. They include:

- Semans' technique, which is used to help combat premature ejaculation with a "start-stop" approach to penis stimulation. By stimulating the man up to the point of ejaculation and then stopping, the man will become more aware of his response. More awareness leads to greater control, and open stimulation of both partners leads to greater communication and less anxiety. The start-stop technique is conducted four times until the man is allowed to ejaculate.
- Sensate focus therapy, the practice of nongenital and genital touching between partners in order to decrease sexual anxiety and build communication. First, partners explore each other's bodies without touching the genitals or breasts. Once the couple is comfortable with nongenital touching, they can expand to genital stimulation. Intercourse is prohibited in order to allow the partners to expand their intimacy and communication.
- Squeeze technique, which is used to treat premature ejaculation. When the man feels the urge to ejaculate, his partner squeezes his penis just below the head. This stops ejaculation and gives the man more control over his response.

Aftercare

Habits change slowly. All the techniques must be practiced faithfully for long periods of time to relearn behaviors. Communication is imperative.

Resources

BOOKS

Masters, William H., Virginia E. Johnson, Virginia, and Robert C. Kolodny. *Heterosexuality.* New York: Harper Collins Publishers, Inc. 1994.

Westheimer, Ruth. *Dr. Ruth's Guide for Married Lovers*. New York: Warner Books, 1986.

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Sexual abuse *see* **Rape and sexual assault**

Sexual arousal disorders *see* **Sexual dysfunction**

Sexual desire disorders *see* **Sexual dysfunction**

Sexual dysfunction

Definition

Sexual dysfunction is broadly defined as the inability to fully enjoy sexual intercourse. Specifically, sexual dysfunctions are disorders that interfere with a full sexual response cycle. These disorders make it difficult for a person to enjoy or to have sexual intercourse. While sexual dysfunction rarely threatens physical health, it can take a heavy psychological toll, bringing on depression, **anxiety**, and debilitating feelings of inadequacy.

Description

Sexual dysfunction takes different forms in men and women. A dysfunction can be life-long and always present, acquired, situational, or generalized, occurring despite the situation. A man may have a sexual problem if he:

- ejaculates before he or his partner desires
- does not ejaculate, or experiences delayed ejaculation
- is unable to have an erection sufficient for pleasurable intercourse
- feels **pain** during intercourse
- lacks or loses sexual desire

A woman may have a sexual problem if she:

- lacks or loses sexual desire
- has difficulty achieving orgasm
- feels anxiety during intercourse
- feels pain during intercourse
- feels vaginal or other muscles contract involuntarily before or during sex
- has inadequate lubrication

The most common sexual dysfunctions in men include:

- Erectile dysfunction: an impairment of the erectile reflex. The man is unable to have or maintain an erection that is firm enough for coitus or intercourse.
- **Premature ejaculation**: rapid ejaculation with minimal sexual stimulation before, on, or shortly after penetration and before the person wishes it.
- Ejaculatory incompetence: the inability to ejaculate within the vagina despite a firm erection and relatively high levels of sexual arousal.
- Retarded ejaculation: a condition in which the bladder neck does not close off properly during orgasm so that the semen spurts backward into the bladder.

Until recently, it was presumed that women were less sexual than men. In the past two decades, traditional views of female sexuality were all but demolished, and women's sexual needs became accepted as legitimate in their own right.

Female sexual dysfunctions include:

- Sexual arousal disorder: the inhibition of the general arousal aspect of sexual response. A woman with this disorder does not lubricate, her vagina does not swell, and the muscle that surrounds the outer third of the vagina does not tighten—a series of changes that normally prepare the body for orgasm ("the orgasmic platform"). Also, in this disorder, the woman typically does not feel erotic sensations.
- Orgasmic disorder: the impairment of the orgasmic component of the female sexual response. The woman may be sexually aroused but never reach orgasm. Orgasmic capacity is less than would be reasonable for her age, sexual experience, and the adequacy of sexual stimulation she receives.
- Vaginismus: a condition in which the muscles around the outer third of the vagina have involuntary spasms in response to attempts at vaginal penetration.
- Painful intercourse: a condition that can occur at any age. Pain can appear at the start of intercourse, midway through coital activities, at the time of orgasm, or after intercourse is completed. The pain can be felt as burning, sharp searing, or cramping; it can be external, within the vagina, or deep in the pelvic region or abdomen.

Causes and symptoms

Many factors, of both physical and psychological natures, can affect sexual response and performance. Injuries, ailments, and drugs are among the physical influences; in addition, there is increasing evidence that chemicals and other environmental pollutants depress sexual function. As for psychological factors, sexual dysfunction may have roots in traumatic events such as rape or incest, guilt feelings, a poor self-image, depression, chronic **fatigue**, certain religious beliefs, or marital problems. Dysfunction is often associated with anxiety. If a man operates under the misconception that all sexual activity must lead to intercourse and to orgasm by his partner, and if the expectation is not met, he may consider the act a failure.

Men

With premature ejaculation, physical causes are rare, although the problem is sometimes linked to a neurological disorder, prostate infection, or **urethritis**. Possible psychological causes include anxiety (mainly performance anxiety), guilt feelings about sex, and ambivalence toward women. However, research has failed to show a direct link between premature ejaculation and anxiety. Rather, premature ejaculation seems more related to sexual inexperience in learning to modulate arousal.

When men experience painful intercourse, the cause is usually physical; an infection of the prostate, urethra, or testes, or an allergic reaction to spermicide or condoms. Painful erections may be caused by **Peyronie's disease**, fibrous plaques on the upper side of the penis that often produce a bend during erection. **Cancer** of the penis or testes and arthritis of the lower back can also cause pain.

Retrograde ejaculation occurs in men who have had prostate or urethral surgery, take medication that keeps the bladder open, or suffer from diabetes, a disease that can injure the nerves that normally close the bladder during ejaculation.

Erectile dysfunction is more likely than other dysfunctions to have a physical cause. Drugs, diabetes (the most common physical cause), **Parkinson's disease**, **multiple sclerosis**, and spinal cord lesions can all be causes of erectile dysfunction. When physical causes are ruled out, anxiety is the most likely psychological cause of erectile dysfunction.

Women

Dysfunctions of arousal and orgasm in women also may be physical or psychological in origin. Among the most common causes are day-to-day discord with one's partner and inadequate stimulation by the partner. Finally, sexual desire can wane as one ages, although this varies greatly from person to person.

Pain during intercourse can occur for any number of reasons, and location is sometimes a clue to the cause. Pain in the vaginal area may be due to infection, such as urethritis; also, vaginal tissues may become thinner and more sensitive during breast-feeding and after **menopause**. Deeper pain may have a pelvic source, such as **endometriosis**, pelvic adhesions, or uterine abnormalities. Pain can also have a psychological cause, such as fear of injury, guilt feelings about sex, fear of **pregnancy** or injury to the fetus during pregnancy, or recollection of a previous painful experience.

Vaginismus may be provoked by these psychological causes as well, or it may begin as a response to pain, and continue after the pain is gone. Both partners should understand that the vaginal contraction is an involuntary response, outside the woman's control.

Similarly, insufficient lubrication is involuntary, and may be part of a complex cycle. Low sexual response may lead to inadequate lubrication, which may lead to discomfort, and so on.

Diagnosis

In deciding when a sexual dysfunction is present, it is necessary to remember that while some people may be interested in sex at almost any time, others have low or seemingly nonexistent levels of sexual interest. Only when it is a source of personal or relationship distress, instead of voluntary choice, is it classified as a sexual dysfunction.

The first step in diagnosing a sexual dysfunction is usually discussing the problem with a doctor, who will need to ask further questions in an attempt to differentiate among the types of sexual dysfunction. The physician may also perform a physical exam of the genitals, and may order further medical tests, including measurement of hormone levels in the blood. Men may be referred to a specialist in diseases of the urinary and genital organs (urologist), and primary care physicians may refer women to a gynecologist.

Treatment

Treatments break down into two main kinds: behavioral psychotherapy and physical. **Sex therapy**, which is ideally provided by a member of the American Association of Sexual Educators, Counselors, and Therapists (AASECT), universally emphasizes correcting sexual misinformation, the importance of improved partner communication and honesty, anxiety reduction, sensual experience and pleasure, and interpersonal tolerance and acceptance. Sex therapists believe that many sexual disorders are rooted in learned patterns and values. These are termed psychogenic. An underlying assumption of sex therapy is that relatively short-term outpatient therapy can alleviate learned patterns, restrict symptoms, and allow a greater satisfaction with sexual experiences.

In some cases, a specific technique may be used during intercourse to correct a dysfunction. One of the most common is the "squeeze technique" to prevent premature ejaculation. When a man feels that an orgasm is imminent, he withdraws from his partner. Then, the man or his partner gently squeezes the head of the penis to halt the orgasm. After 20–30 seconds, the couple may resume intercourse. The couple may do this several times before the man proceeds to ejaculation.

In cases where significant sexual dysfunction is linked to a broader emotional problem, such as depression or substance abuse, intensive psychotherapy and/or pharmaceutical intervention may be appropriate.

In many cases, doctors may prescribe medications to treat an underlying physical cause or sexual dysfunction. Possible medical treatments include:

- clomipramine and fluoxetine for premature ejaculation
- papaverine and prostaglandin for erectile difficulties
- hormone replacement therapy for female dysfunctions
- viagra, a pill approved in 1998 as a treatment for impotence.

Alternative treatment

A variety of alternative therapies can be useful in the treatment of sexual dysfunction. Counseling or psychotherapy is highly recommended to address any emotional or mental components of the disorder. Botanical medicine, either western, Chinese, or ayurvedic, as well as nutritional supplementation, can help resolve biochemical causes of sexual dysfunction. **Acupuncture** and homeopathic treatment can be helpful by focusing on the energetic aspects of the disorder.

Some problems with sexual function are normal. For example, women starting a new or first relationship may feel sore or bruised after intercourse and find that an over-the-counter lubricant makes sex more pleasurable. Simple techniques, such as soaking in a warm bath, may relax a person before intercourse and improve the experience. **Yoga** and **meditation** provide needed mental and physical relaxation for several conditions, such as vaginismus. Relaxation therapy eases and relieves anxiety about dysfunction. Massage is extremely effective at reducing **stress**, especially if performed by the partner.

Prognosis

There is no single cure for sexual dysfunctions, but almost all can be controlled. Most people who have a sexual dysfunction fare well once they get into a treatment program. For example, a high percentage of men with premature ejaculation can be successfully treated in two to three months. Furthermore, the gains made in sex therapy tend to be long-lasting rather than short-lived.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Masters, William H., Virginia E. Johnson, and Robert C. Kolodny. *Human Sexuality*. New York: HarperCollins Publishers, 1992.

PERIODICALS

Cranston-Cuebas, M. A., and D. H. Barlow. "Cognitive and Affective Contributions to Sexual Functioning." *Annual Review of Sex Research* (1990): 119-162.

KEY TERMS

Ejaculatory incompetence—The inability to ejaculate within the vagina.

Erectile dysfunction—Difficulty achieving or maintaining an erect penis.

Orgasmic disorder—The impairment of the ability to reach sexual climax.

Painful intercourse (dyspareunia)—Generally thought of as a female dysfunction but also affects males. Pain can occur anywhere.

Premature ejaculation—Rapid ejaculation before the person wishes it, usually in less than one to two minutes after beginning intercourse.

Retrograde ejaculation—A condition in which the semen spurts backward into the bladder.

Sexual arousal disorder—The inhibition of the general arousal aspect of sexual response.

Vaginismus—Muscles around the outer third of the vagina have involuntary spasms in response to attempts at vaginal penetration, not allowing for penetration.

Pollack, M. H., S. Reiter, and P. Hammerness. "Genitourinary and Sexual Adverse Effects of Psychotropic Medication." *International Journal of Psychiatry in Medicine* 22 (1992): 305-327.

ORGANIZATIONS

American Academy of Clinical Sexologists. 1929 18th St. NW, Suite 1166, Washington, DC 20009. (202) 462-2122.

American Association for Marriage and Family Therapy. 1133 15th St., NW Suite 300, Washington, DC 20005-2710. (202) 452-0109. <http://www.aamft.org>.

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David James Doermann

Sexual perversions

Definition

Sexual perversions are conditions in which sexual excitement or orgasm is associated with acts or imagery that are considered unusual within the culture. To avoid problems associated with the stigmatization of labels, the

neutral term "paraphilia," derived from Greek roots meaning "alongside of" and "love," is used to describe what used to be called sexual perversions. A paraphilia is a condition in which a person's sexual arousal and gratification depend on a fantasy theme of an unusual situation or object that becomes the principal focus of sexual behavior.

Description

Paraphilias can revolve around a particular sexual object or a particular act. They are defined by *DSM-IV* as "sexual impulse disorders characterized by intensely arousing, recurrent sexual fantasies, urges and behaviors considered deviant with respect to cultural norms and that produce clinically significant distress or impairment in social, occupational or other important areas of psychosocial functioning." The nature of a paraphilia is generally specific and unchanging, and most of the paraphilias are far more common in men than in women.

Paraphilias differ from what some people might consider "normal" sexual activity in that these behaviors cause significant distress or impairment in areas of life functioning. They do not refer to the normal use of sexual fantasy, activity or objects to heighten sexual excitement where there is no distress or impairment. The most common signs of sexual activity that can be classified as paraphilia include: the inability to resist an impulse for the sexual act, the requirement of participation by nonconsenting or under-aged individuals, legal consequences, resulting **sexual dysfunction**, and interference with normal social relationships.

Paraphilias include fantasies, behaviors, and/or urges which:

- involve nonhuman sexual objects, such as shoes or undergarments
- require the suffering or humiliation of oneself or partner
- involve children or other non-consenting partners

The most common paraphilias are:

- exhibitionism, or exposure of the genitals
- fetishism, or the use of nonliving objects
- frotteurism, or touching and rubbing against a nonconsenting person
- pedophilia, or the focus on prepubescent children
- sexual masochism, or the receiving of humiliation or suffering
- sexual sadism, or the inflicting of humiliation or suffering
- transvestic fetishism, or cross-dressing
- voyeurism, or watching others engage in undressing or sexual activity

A paraphiliac often has more than one paraphilia. Paraphilias often result in a variety of associated problems, such as guilt, depression, shame, **isolation**, and impairment in the capacity for normal social and sexual relationships. A paraphilia can, and often does, become highly idiosyncratic and ritualized.

Causes and symptoms

There is very little certainty about what causes a paraphilia. Psychoanalysts generally theorize that these conditions represent a regression to or a fixation at an earlier level of psychosexual development resulting in a repetitive pattern of sexual behavior that is not mature in its application and expression. In other words, an individual repeats or reverts to a sexual habit arising early in life. Another psychoanalytic theory holds that these conditions are all expressions of hostility in which sexual fantasies or unusual sexual acts become a means of obtaining revenge for a childhood trauma. The persistent, repetitive nature of the paraphilia is caused by an inability to erase the underlying trauma completely. Indeed, a history of childhood sexual **abuse** is sometimes seen in individuals with paraphilias.

However, behaviorists suggest, instead, that the paraphilia begins via a process of conditioning. Nonsexual objects can become sexually arousing if they are frequently and repeatedly associated with a pleasurable sexual activity. The development of a paraphilia is not usually a matter of conditioning alone; there must usually be some predisposing factor, such as difficulty forming person-to-person sexual relationships or poor self-esteem.

The following are situations or causes that might lead someone in a paraphiliac direction:

- parents who humiliate and punish a small boy for strutting around with an erect penis
- a young boy who is sexually abused
- an individual who is dressed in a woman's clothes as a form of parental punishment
- fear of sexual performance or intimacy
- inadequate counseling
- excessive alcohol intake
- physiological problems
- sociocultural factors
- psychosexual trauma

Diagnosis

Whatever the cause, paraphiliacs apparently rarely seek treatment unless they are induced into it by an arrest

or discovery by a family member. This makes diagnosis before a confrontation very difficult.

Paraphiliacs may select an occupation, or develop a hobby or volunteer work, that puts them in contact with the desired erotic stimuli, for example, selling women's shoes or lingerie in fetishism, or working with children in pedophilia. Other coexistent problems may be alcohol or drug abuse, intimacy problems, and personality disturbances, especially emotional immaturity. Additionally, there may be sexual dysfunctions. Erectile dysfunction and an inability to ejaculate may be common in attempts at sexual activity without the paraphiliac theme.

Paraphilias may be mild, moderate, or severe. An individual with mild paraphilia is markedly distressed by the recurrent paraphiliac urges but has never acted on them. The moderate has occasionally acted on the paraphilic urge. A severe paraphiliac has repeatedly acted on the urge.

Treatment

The literature describing treatment is fragmentary and incomplete. Traditional **psychoanalysis** has not been particularly effective with paraphilia and generally requires several years of treatment. Therapy with hypnosis has also had poor results. Current interests focus primarily on several behavioral techniques that include the following:

- Aversion imagery involves the pairing of a sexually arousing paraphilic stimulus with an unpleasant image, such as being arrested or having one's name appear in the newspaper.
- Desensitization procedures neutralize the anxiety-provoking aspects of nonparaphilic sexual situations and behavior by a process of gradual exposure. For example, a man afraid of having sexual contact with women his own age might be led through a series of relaxation procedures aimed at reducing his **anxiety**.
- Social skills training is used with either of the other approaches and is aimed at improving a person's ability to form interpersonal relationships.
- Orgasmic reconditioning may instruct a person to masturbate using his paraphilia fantasy and to switch to a more appropriate fantasy just at the moment of orgasm.

In addition to these therapies, drugs are sometimes prescribed to treat paraphilic behaviors. Drugs that drastically lower testosterone temporarily (antiandrogens) have been used for the control of repetitive deviant sexual behaviors and have been prescribed for paraphilia-related disorders as well. Cyproterone acetate inhibits testosterone directly at androgen receptor sites. In its oral form, the usual prescribed dosage range is 50–200 mg per day.

KEY TERMS

Exhibitionism—Obtaining sexual arousal by exposing genitals to an unsuspecting stranger.

Fetishism—Obtaining sexual arousal using or thinking about an inanimate object or part of the body.

Frotteurism—Obtaining sexual arousal and gratification by rubbing one's genitals against others in public places.

Masochism—Sexual arousal by having pain and/or humiliation inflicted upon oneself.

Pedophilia—Sex or sexual activity with children who have not reached puberty.

Sadism—Sexual arousal through inflicting pain on another person.

Transvestitism—Sexual arousal from dressing in the clothes of the opposite sex.

Voyeurism—Sexual arousal by observing nude individuals without their knowledge.

Serotonergics (drugs that boost levels of the brain chemical serotonin) are prescribed for anxious and depressive symptoms. Of the serotonergic agents reported, fluoxetine has received the most attention, although lithium, clomipramine, buspirone, and sertraline are reported as effective in case reports and open clinical trials with outpatients. Other alternative augmentation strategies that may be effective include adding a low dose of a secondary amine tricyclic antidepressant to the primary serotonergics, but these reports are only anecdotal.

Prognosis

Despite more than a decade of experience with psychotherapeutic treatment programs, most workers in the field are not convinced that they have a high degree of success. Furthermore, because some cases involve severe abuse, many in the general public would prefer to "lock up" the sex offender than to have him out in the community in a treatment program or on parole after the treatment program has been completed.

Paraphilia and paraphilia-related disorders are more prevalent than most clinicians suspect. Since these disorders are cloaked in shame and guilt, the presence of these conditions may not be adequately revealed until a therapeutic alliance is firmly established. Once a diagnosis is established, appropriate education about possible behavioral therapies and appropriate use of psychopharmacological agents can improve the prognosis for these conditions.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, 1994.

Masters, William H., Virgina E. Johnson, and Robert C. Kolodny. *Human Sexuality.* Harper Collins Publishers, Inc., 1992.

PERIODICALS

Abel, Gene G., et al. "Multiple Paraphiliac Diagnoses Among Sex Offenders." *Bulletin of the American Academy of Psychiatry and Law* (Spring 1988).

ORGANIZATIONS

American Academy of Clinical Sexologists. 1929 18th St., N.W., Suite 1166, Washington, DC 20009. (202) 462-2122.

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Sexually transmitted diseases

Definition

Sexually transmitted disease (STD) is a term used to describe more than 20 different infections that are transmitted through exchange of semen, blood, and other body fluids; or by direct contact with the affected body areas of people with STDs. Sexually transmitted diseases are also called venereal diseases.

Description

The Centers for Disease Control and Prevention (CDC) has reported that 85% of the most prevalent infectious diseases in the United States are sexually transmitted. The rate of STDs in this country is 50 to 100 times higher than that of any other industrialized nation. One in four sexually active Americans will be affected by an STD at some time in his or her life.

About 12 million new STD infections occur in the United States each year. One in four occurs in someone between the ages of 16 and 19. Almost 65% of all STD infections affect people under the age of 25.

Types of STDs

STDs can have very painful long-term consequences as well as immediate health problems. They can cause:

- birth defects
- blindness
- bone deformities
- brain damage
- cancer
- heart disease
- infertility and other abnormalities of the reproductive system
- mental retardation
- **death**

Some of the most common and potentially serious STDs in the United States include:

- Chlamydia. This STD is caused by the bacterium *Chlamydia trachomatis*, a microscopic organism that lives as a parasite inside human cells. Although over 526,000 cases of chlamydia were reported in the United States in 1997, the CDC estimates that nearly three million cases occur annually because 75% of women and 50% of men show no symptoms of the disease after infection. Approximately 40% of women will develop **pelvic inflammatory disease** (PID) as a result of chlamydia infection, a leading cause of infertility.
- Human papillomavirus (HPV). HPV causes **genital warts** and is the single most important risk factor for **cervical cancer** in women. Over 100 types of HPV exist, but only about 30 of them can cause genital **warts** and are spread through sexual contact. In some instances, warts are passed from mother to child during **childbirth**, leading to a potentially life-threatening condition for newborns in which warts develop in the throat (laryngeal papillomatosis).
- **Genital herpes**. Herpes is an incurable viral infection thought to be one of the most common STDs in this country. It is caused by one of two types of herpes simplex viruses: HSV-1 (commonly causing oral herpes) or HSV-2 (usually causing genital herpes). The CDC estimates that 45 million Americans (one out of every five individuals 12 years of age or older) are infected with HSV-2; this number has increased 30% since the 1970s. HSV-2 infection is more common in women (one out of every four women) than men (one out of every five men) and in African Americans (45.9%) than Caucasians (17.6%).
- **Gonorrhea**. The bacterium *Neisseria gonorrhoeae* is the causative agent of gonorrhea and can be spread by vaginal, oral, or anal contact. The CDC reports that approximately 650,000 individuals are infected with gonorrhea each year in the United States, with 132.2 infections per 100,000 individuals occurring in 1999.

Approximately 75% of American gonorrhea infections occur in persons aged 15 to 29 years old. In 1999, 75% of reported gonorrhea cases occurred among African Americans.

- **Syphilis**. Syphilis is a potentially life-threatening infection that increases the likelihood of acquiring or transmitting HIV. In 1998, the CDC reported approximately 38,000 cases of syphilis in the United States; this included 800 cases of congenital syphilis. Congenital syphilis causes irreversible health problems or death in as many as 40% of all live babies born to women with untreated syphilis.
- Human **immunodeficiency** virus (HIV) infection. In 2000, the CDC reported that 120,223 people in the United States are HIV-positive and 426,350 are living with **AIDS**. In addition, approximately 1,000-2,000 children are born each year with HIV infection. It is also estimated that 33 million adults and 1.3 million children worldwide were living with HIV/AIDS as of 1999 with 5.4 million being newly infected that year. As of 2001, there is no cure for this STD.

Social groups and STDs

STDs affect certain population groups more severely than others. Women, young people, and members of minority groups are particularly affected. Women in any age bracket are more likely than men to develop medical complications related to STDs. With respect to racial and ethnic categories, the incidence of syphilis is 60 times higher among African Americans than among Caucasians, and four times higher in Hispanics than in Anglos. According to the CDC, in 1999 African Americans accounted for 77% of the total number of gonorrhea cases and nearly 46% of all genital herpes cases.

Causes and symptoms

The symptoms of STDs vary somewhat according to the disease agent (virus or bacterium), the sex of the patient, and the body systems affected. The symptoms of some STDs are easy to identify; others produce infections that may either go unnoticed for some time or are easy to confuse with other diseases. Syphilis in particular can be confused with disorders ranging from **infectious mononucleosis** to allergic reactions to prescription medications. In addition, the incubation period of STDs varies. Some produce symptoms close enough to the time of sexual contact—often less than 48 hours later—for the patient to recognize the connection between the behavior and the symptoms. Others have a longer incubation period, so that the patient may not recognize the early symptoms as those of a sexually transmitted infection.

STD cultures on agar plates. *(Photograph by T. McCarthy, Custom Medical Stock Photo. Reproduced by permission.)*

Some symptoms of STDs affect the genitals and reproductive organs:

- A woman who has an STD may bleed when she is not menstruating or has abnormal vaginal discharge. Vaginal burning, **itching**, and odor are common, and she may experience **pain** in her pelvic area while having sex.
- A discharge from the tip of the penis may be a sign that a man has an STD. Males may also have painful or burning sensations when they urinate.
- There may be swelling of the lymph nodes near the groin area.
- Both men and women may develop skin **rashes**, sores, bumps, or blisters near the mouth or genitals. Homosexual men frequently develop these symptoms in the area around the anus.

Other symptoms of STDs are systemic, which means that they affect the body as a whole. These symptoms may include:

- fever, chills, and similar flu-like symptoms
- skin rashes over large parts of the body
- arthritis-like pains or aching in the joints
- throat swelling and redness that lasts for three weeks or longer

Diagnosis

A sexually active person who has symptoms of an STD or who has had an STD or symptoms of infection should be examined without delay by one of the following health care professionals:

- a specialist in **women's health** (gynecologist)
- a specialist in disorders of the urinary tract and the male sexual organs (urologist)

Drugs Used To Treat STDS

Brand Name (Generic Name)	Possible Common Side Effects Include:
Achromycin V (tetracyline hydrochloride)	Blurred vision, headache, dizziness, rash, hives, appetite loss, nausea and vomiting
Amoxil (amoxicillin)	Behaviorial changes, diarrhea, hives, nausea and vomiting
Ceftin (cerfuroxime axetil)	Nausea and vomiting, diarrhea, irritated skin
Doryx (doxycycline hyclate)	Itching (genital and/or rectal), nausea and vomiting, appetite loss, diarrhea, swelling
E.E.S., E-Mycin, ERYC, Ery-Tab, Erythrocin, Ilosone (erthromycin)	Diarrhea, nausea and vomiting, appetite loss, abdominal pain
Flagyl (metronidazole)	Numbness, tingling sensation in extremities, seizures
Floxin (ofloxacin)	Genital itching, nausea and vomiting, headache, diarrhea, dizziness
Minocin (minocycline hydrochloride)	Blurred vision, anemia, hives, rash, throat irritation
Noroxin (norfloxacin)	Headache, nausea, dizziness
Omnipen (ampicillin)	Itching, rash, hives, peeling skin, nausea and vomiting
Penetrex (enoxacin)	Nausea and vomiting
Zithromax (azithromycin)	Nausea and vomiting, diarrhea, abdominal pain
Zovirax (acyclovir)	Fluid retention, headache, rash, tingling sensation

- a family physician
- a nurse practitioner
- a specialist in skin disorders (dermatologist)

The diagnostic process begins with a thorough **physical examination** and a detailed medical history that documents the patient's sexual history and assesses the risk of infection.

The doctor or other healthcare professional will:

- describe the testing process. (This includes all blood tests and other tests that may be relevant to the specific infection.)
- explain the meaning of the test results
- provide the patient with information regarding high-risk behaviors and any necessary treatments or procedures

The doctor may suggest that a patient diagnosed with one STD be tested for others, as it is possible to have more than one STD at a time. One infection may hide the symptoms of another or create a climate that fosters its growth. At present, it is particularly important that persons who are HIV-positive be tested for syphilis as well.

Notification

The law in most parts of the United States requires public health officials to trace and contact the partners of persons with STDs. Minors, however, can get treatment without their parents' permission. Public health departments in most states can provide information about STD clinic locations; Planned Parenthood facilities provide testing and counseling. These agencies can also help with or assume the responsibility of notifying sexual partners who must be tested and may require treatment.

Treatment

Although self-care can relieve some of the pain of genital herpes or genital warts that has recurred after being diagnosed and treated by a physician, other STD symptoms require immediate medical attention.

Antibiotics are prescribed to treat gonorrhea, chlamydia, syphilis, and other STDs caused by bacteria. Although prompt diagnosis and early treatment almost always cures these STDs, new infections can develop if exposure continues or is renewed.Viral infections can be treated symptomatically with antiviral medications.

Prognosis

The prognosis for recovery from STDs varies among the different diseases. The prognosis for recovery from gonorrhea, syphilis, and other STDs caused by bacteria is generally good, provided that the disease is diagnosed early and treated promptly. Untreated syphilis in particular can lead to long-term complications and disability. Viral STDs (genital herpes, genital warts, HIV) cannot be cured but must be treated on a long-term basis to relieve symptoms and prevent life-threatening complications.

Prevention

Vaccines

Vaccines for the prevention of **hepatitis A** and **hepatitis B** are currently recommended for gay and bisexual men, users of illegal drugs, health care workers, and others at risk of contracting these diseases. Vaccines to prevent other STDs are being tested and may be available within several years.

Lifestyle choices

The risk of becoming infected with an STD can be reduced or eliminated by changing certain personal

KEY TERMS

Chlamydia—A microorganism that resembles certain types of bacteria and causes several sexually transmitted diseases in humans.

Condom—A thin sheath worn over the penis during sexual intercourse to prevent pregnancy or the transmission of STDs. There are also female condoms.

Diaphragm—A dome-shaped device used to cover the back of a woman's vagina during intercourse in order to prevent pregnancy.

Pelvic inflammatory disease (PID)—An inflammation of the tubes leading from a woman's ovaries to the uterus (the Fallopian tubes), caused by a bacterial infection. PID is a leading cause of fertility problems in women.

Venereal disease—Another term for sexually transmitted disease.

behaviors. Abstaining from sexual relations or maintaining a mutually monogamous relationship with a partner are legitimate options. It is also wise to avoid sexual contact with partners who are known to be infected with an STD, whose health status is unknown, who abuse drugs, or who are involved in prostitution.

Use of condoms and other contraceptives

Men or women who have sex with a partner of known (or unsure) infection should make sure a new **condom** is used every time they have genital, oral, or anal contact. Used correctly and consistently, male condoms provide good protection against HIV and other STDs such as gonorrhea, chlamydia, and syphilis. Female condoms (lubricated sheaths inserted into the vagina) have also been shown to be effective in preventing HIV and other STDs. Condoms provide a measure of protection against genital herpes, genital warts, and hepatitis B.

Spermicides and diaphragms can decrease the risk of transmission of some STDs. They do not protect women from contracting HIV. Birth-control pills, patches, or injections do not prevent STDs. Neither do surgical sterilization or **hysterectomy**.

Hygienic measures

Urinating and washing the genital area with soap and water immediately after having sex may eliminate some germs before they cause infection. Douching, however, can spread infection deeper into the womb. It may also increase a woman's risk of developing pelvic inflammatory disease (PID).

Resources

ORGANIZATIONS

Planned Parenthood Federation of America. (800) 230-7526. <http://www.planned parenthood.org>.

National STD Hotline. (800)227-8922.

OTHER

Basic Facts about STDs. <http://www.mcare.org/healthtips/homecare/basicfac.htm>. (23 May 1998).

Can STDs be Prevented? <http://housecall.orbisnews.com/sponsors/aafp/topics/infections_d/ stds/page5.html>. (23 May 1998).

1998 Guidelines for Treatment of Sexually Transmitted Disease. <http://www.cdc.gov/nchstp/dstd/STD98T03.htm>. (23 May 1998).

Sexually Transmitted Diseases. <http://www.cdc.gov/nchstp/dstd/dstdp.html>. (24 March 2001).

Sexually Transmitted Diseases. <http://www.tod.dm/global/std.html>. (23 May 1998).

The Challenge of STD Prevention in the United States. <http://www.cdc.gov/nch.stp/dstd/STD_Prevention_in_the_United_States.htm>. (23 May 1998).

Maureen Haggerty

SGOT *see* **Aspartate aminotransferase test**

Shaken baby syndrome

Definition

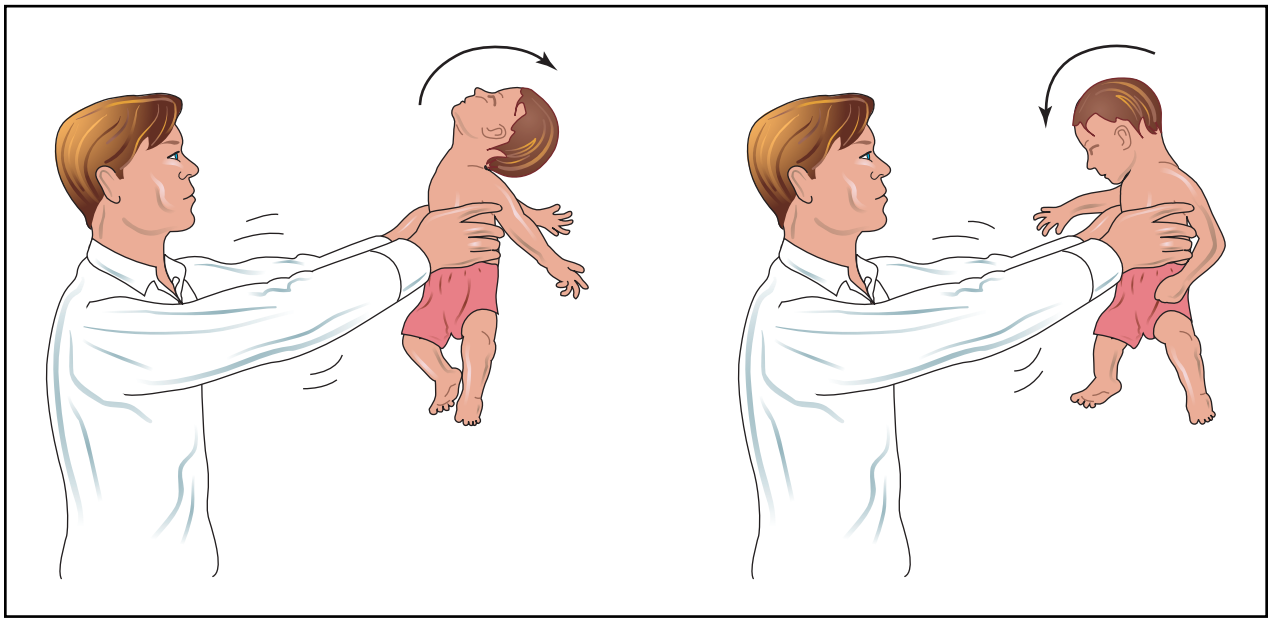
Shaken baby syndrome (SBS) is a collective term for the internal head injuries a baby or young child sustains from being violently shaken.

Description

Shaken baby syndrome was first described in medical literature in 1972. Physicians earlier labeled these injuries as accidental, but as more about **child abuse** became known, more cases of this syndrome were properly diagnosed.

Every year, nearly 50,000 children in the United States are forcefully shaken by their caretakers. More than 60% of these children are boys. The victims are on average six to eight months old, but may be as old as five years or as young as a few days.

Men are more likely than women to shake a child; typically, these men are in their early 20s and are the



Shaken baby syndrome is a collective term for the internal head injuries a baby or young child sustains from being violently shaken. Because of the fragile state of an infant's brain tissue and blood vessels, when a baby is vigorously shaken by the chest, as shown in the illustration above, the whiplash motion repeatedly jars the baby's brain with extreme force, causing serious internal damage and bleeding. Nearly 2,000 American children die annually from this condition. *(Illustration by Electronic Illustrators Group.)*

baby's father or the mother's boyfriend. Women who inflict SBS are more likely to be babysitters or child care providers than the baby's mother. The shaking may occur as a response of frustration to the baby's inconsolable crying or as an action of routine **abuse**.

Causes and symptoms

Infants and small children are especially vulnerable to SBS because their neck muscles are still too weak to adequately support their disproportionately large heads, and their young brain tissue and blood vessels are extremely fragile. When an infant is vigorously shaken by the arms, legs, shoulders, or chest, the **whiplash** motion repeatedly jars the baby's brain with tremendous force, causing internal damage and bleeding. While there may be no obvious external signs of injury following shaking, the child may suffer internally from brain bleeding and bruising (called subdural hemorrhage and hematoma); brain swelling and damage (called cerebral **edema**); **mental retardation**; blindness, **hearing loss**, **paralysis**, speech impairment, and learning disabilities; and **death**. Nearly 2,000 children die every year as a result of being shaken.

Physicians may have difficulty initially diagnosing SBS because there are usually few witnesses to give a reliable account of the events leading to the trauma, few if any external injuries, and, upon close examination, the physical findings may not agree with the account given. A shaken baby may present one or more signs, including vomiting; difficulty breathing, sucking, swallowing, or making sounds; seizures; and altered consciousness.

Diagnosis

To diagnose SBS, physicians look for at least one of three classic conditions: bleeding at the back of one or both eyes (retinal hemorrhage), **subdural hematoma**, and cerebral edema. The diagnosis is confirmed by the results of either a computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI).

Treatment

Appropriate treatment is determined by the type and severity of the trauma. Physicians may medically manage both internal and external injuries. Behavioral and educational impairments as a result of the injuries require the attention of additional specialists. Children with SBS may need physical therapy, speech therapy, vision therapy, and special education services.

Alternative treatment

There is no alternative to prompt medical treatment. An unresponsive child should never be put to bed, but must be taken to a hospital for immediate care.

KEY TERMS

Cerebral edema—Fluid collecting in the brain, causing tissue to swell.

Hematoma—A localized accumulation of blood in tissues as a result of hemorrhaging.

Hemorrhage—A condition of bleeding, usually severe.

Retinal hemorrhage—Bleeding of the retina, a key structure in vision located at the back of the eye.

Subdural hematoma—A localized accumulation of blood, sometimes mixed with spinal fluid, in the space of the brain beneath the membrane covering called the dura mater.

Prognosis

Sadly, children who receive violent shaking have a poor prognosis for complete recovery. Those who do not die may experience permanent blindness, mental retardation, seizure disorders, or loss of motor control.

Prevention

Shaken baby syndrome is preventable with public education. Adults must be actively taught that shaking a child is never acceptable and can cause severe injury or death.

When the frustration from an incessantly crying baby becomes too much, caregivers should have a strategy for coping that does not harm the baby. The first step is to place the baby in a crib or playpen and leave the room in order to calm down. Counting to 10 and taking deep breaths may help. A friend or relative may be called to come over and assist. A calm adult may then resume trying to comfort the baby. A warm bottle, a dry diaper, soft music, a bath, or a ride in a swing, stroller, or car may be offered to soothe a crying child. Crying may also indicate **pain** or illness, such as from abdominal cramps or an earache. If the crying persists, the child should be seen by a physician.

Resources

PERIODICALS

American Academy of Pediatrics. Committee on Child Abuse and Neglect. "Shaken Baby Syndrome: Inflicted Cerebral Trauma." *Pediatrics* 92, no. 6 (1993): 872-875.

ORGANIZATIONS

American Humane Association, Children's Division. 63 Inverness Drive East, Englewood, CO 80112-5117. (800) 227-4645. <www.americanhumane.org>.

Child Abuse Prevention Center of Utah. 2955 Harrison Boulevard, #102, Ogden, UT 84403. (888) 273-0071.

National Center on Shaken Baby Syndrome. 2955 Harrison Blvd., #102, Ogden, UT 84403. (801) 627-3399. <http://www.dontshake.com>.

Bethany Thivierge

Shiatsu

Definition

Shiatsu is a manipulative therapy developed in Japan and incorporating techniques of *anma* (Japanese traditional massage), **acupressure**, stretching, and Western massage. Shiatsu involves applying pressure to special points or areas on the body in order to maintain physical and mental well being, treat disease, or alleviate discomfort. This therapy is considered holistic because it attempts to treat the whole person instead of a specific medical complaint. All types of acupressure generally focus on the same pressure points and so-called energy pathways, but may differ in terms of massage technique. Shiatsu, which can be translated as finger pressure, has been described as needle-free **acupuncture**.

Purpose

Shiatsu has a strong reputation for reducing **stress** and relieving **nausea and vomiting**. Shiatsu is also believed to improve circulation and boost the immune system. Some people use it to treat **diarrhea**, **indigestion**, **constipation**, and other disorders of the gastrointestinal tract; menstrual and menopausal problems; chronic **pain**; migraine; arthritis; **toothache**; **anxiety**; and depression. Shiatsu can be used to relieve muscular pain or tension, especially neck and back pain. It also appears to have sedative effects and may alleviate **insomnia**. In a broader sense, shiatsu is believed to enhance physical vitality and emotional well being.

Description

Origins

Shiatsu is an offshoot of anma that developed during the period after the Meiji Restoration in 1868. Traditional massage (anma) used during the age of shoguns was being criticized, and practitioners of *koho anma* (ancient way) displeased with it introduced new practices and new names for their therapies.

During the twentieth century, shiatsu distinguished itself from anma through the merging of Western knowl-

edge of anatomy, koho anma, *ampuku* (abdominal massage), acupressure, *Do-In* (breathing practices), and Buddhism. Based on the work of Tamai Tempaku, shiatsu established itself in Japan and worldwide. The Shiatsu Therapists Association was founded in 1925 and clinics and schools followed. Students of Tempaku began teaching their own brand of shiatsu, creating branch disciplines. By 1955, the Japanese Ministry of Health and Welfare acknowledged shiatsu as a beneficial treatment, and licensing was established for practitioners.

Shiatsu and other forms of Japanese acupressure are based on the concept of *ki*, the Japanese term for the all-pervading energy that flows through everything in the universe. (This notion is borrowed from the Chinese, who refer to the omnipresent energy as qi or chi.) Ki tends to flow through the body along special energy pathways called meridians, each of which is associated with a vital organ. In Asian systems of traditional medicine, diseases are often believed to occur due to disruptions in the flow this energy through the body. These disruptions may stem from emotional factors, climate, or a host of other causes including stress, the presence of impurities in the body, and physical trauma.

The aim of shiatsu is to restore the proper flow of bodily energy by massaging the surface of the skin along the meridian lines. Pressure may also be applied to any of the 600 or so acupoints. Acupoints, which are supposedly located just under the skin along the meridians, are tiny energy structures that affect the flow of ki through the body. When ki either stagnates and becomes deflected or accumulates in excess along one of these channels, stimulation to the acupoints, which are sensitive to pressure, can unblock and regulate the ki flow through toning or sedating treatment.

Western medicine hasn't proven the existence of meridians and acupoints. However, in one study, two French medical doctors conducted an experiment at Necher Hospital in Paris to test validity of the theory that energy is being transported along acupuncture meridians. They injected and traced isotpes with gamma-camera imaging. The meridians may actually correspond to nerve transmission lines. In this view, shiatsu and other forms of healing massage may trigger the emission of naturally occurring chemicals called neurotransmitters. Release of these chemical messengers may be responsible for some of the therapeutic effects associated with shiatsu, such as pain relief.

Preparations

People usually receive shiatsu therapy while lying on a floor mat or massage table or sitting up. The massage is performed through the clothing—preferably a thin garment made from natural fibers—and disrobing is not required. Pressure is often applied using the thumbs, though various other parts of the body may be employed, including fingertips, palms, knuckles, elbows, and knees—some therapists even use their feet. Shiatsu typically consists of sustained pressure (lasting up to 10 seconds at a time), squeezing, and stretching exercises. It may also involve gentle holding as well as rocking motions. A treatment session lasts anywhere from 30 to 90 minutes.

Before shiatsu treatment begins, the therapist usually performs a general health assessment. This involves taking a family medical history and discussing the physical and emotional health of the person seeking therapy. Typically, the practitioner also conducts a diagnostic examination by palpating the abdomen or back for any energy imbalances present in other parts of the body.

Precautions

While shiatsu is generally considered safe, there are a few precautions to consider. Because it may increase blood flow, this type of therapy is not recommended in people with bleeding problems, heart disease, or **cancer**. **Massage therapy** should always be used with caution in those with **osteoporosis**, fresh **wounds** or scar tissue, bone **fractures**, or inflammation.

Applying pressure to areas of the head is not recommended in people with epilepsy or high blood pressure, according to some practitioners of shiatsu.

Shiatsu is not considered effective in the treatment of **fever**, **burns**, and infectious diseases.

Shiatsu should not be performed right after a meal.

Side effects

When performed properly, shiatsu is not associated with any significant side effects. Some people may experience mild discomfort, which usually disappears during the course of the treatment session.

Research and general acceptance

Like many forms of massage, shiatsu is widely believed to have a relaxing effect on the body. There is also a significant amount of research suggesting that acupressure techniques can relieve nausea and vomiting associated with a variety of causes, including **pregnancy** and anesthetics and other drugs. In one study, acupressure was shown to significantly reduce the effects of nausea in 12 of 16 women suffering from morning sickness. Five days of this therapy also appeared to reduce anxiety and improve mood. Another investigation, published in

1999, studied the effects of acupressure on nausea resulting from the use of anesthetics. Pressure applied to an acupoint on the inside of the wrist appeared to alleviate nausea in patients who received anesthetics during the course of laparoscopic surgery.

Shiatsu may also produce sedative and analgesic effects. The sedative powers of acupressure were investigated in a study published in 1999, which involved over 80 elderly people who suffered from sleeping difficulties. Compared to the people in the control groups, the 28 participants who received acupressure were able to sleep better. They slept for longer periods of time and were less likely to wake up during the night. The researchers concluded that acupressure may improve the quality of sleep in older adults. The use of acupressure in postoperative pain was investigated in a study published in 1996. In this study, which involved 40 knee surgery patients, one group received acupressure (15 acupoints were stimulated) while the control group received sham acupressure. Within an hour of treatment, members of the acupressure group reported less pain than those in the control group. The pain-relieving effects associated with acupressure lasted for 24 hours.

Shiatsu may benefit **stroke** victims. The results of at least one study (which did not include a control group) suggest that shiatsu may be useful during stroke **rehabilitation** when combined with other treatments.

KEY TERMS

Acupressure—An ancient form of Asian healing massage that involves applying pressure to special points or areas on the body in order to maintain good health, cure disease, and restore vitality.

Analgesic—Pain reliever.

Osteoporosis—A disease of the bones due to deficiency of bone matrix, occurring most frequently in postmenopausal women.

Palpate—Feel.

Resources

BOOKS

Cook, Allan R. *Alternative Medicine Sourcebook*. Detroit: Omnigraphics, 1999.

PERIODICALS

Chen, M.L., L.C. Lin, S.C. Wu, et al. "The Effectiveness of Acupressure in Improving the Quality of Sleep of Institutionalized Residents." *Journal of Gerontology, Series A, Biological Sciences and Medican Sciences* (1999): M389-94.

Felhendler, D. and B. Lisander. "Pressure on Acupoints Decreases Postoperative Pain." *Clinical Journal of Pain* (1996): 326-329.

Harmon, D., J. Gardiner, R. Harrison, et al. "Acupressure and the Prevention of Nausea and Vomiting after Laparoscopy." *British Journal of Anaesthesia* (1999): 387-390.

Hogg, P.K. "The effects of Acupressure on the Psychological and Physiological Rehabilitation of the Stroke Patient." *Dissertation Abstracts International* (1986): 841.

Hyde, E. "Acupressure Therapy for Morning Sickness. A Controlled Clinical Trial." *Journal of Nurse-Midwifery* (1989): 171-178.

ORGANIZATIONS

Acupressure Institute. 1533 Shattuck Avenue, Berkeley, CA 94709.

American Massage Therapy Association. 820 Davis Street, Suite 100, Evanston, IL.

American Oriental Bodywork Therapy Association. 50 Maple Place, Manhassett, NY 11030.

International School of Shiatsu. 10 South Clinton Street, Doylestown, PA 18901.

National Certification Board for Therapeutic Massage and Bodywork. 8201 Greensboro Drive, Suite 300, McLean, VA 22102.

OTHER

International School of Shiatsu. <http://www.shiatsubo.com>.

MEDLINE. <http://igm.nlm.nih.gov>.

Greg Annussek

Shigellosis

Definition

Shigellosis is an infection of the intestinal tract by a group of bacteria called *Shigella*. The bacteria is named in honor of Shiga, a Japanese researcher, who discovered the organism in 1897. The major symptoms are **diarrhea**, abdominal cramps, **fever**, and severe fluid loss (**dehydration**). Four different groups of *Shigella* can affect humans; of these, *S. dysenteriae* generally produces the most severe attacks, and *S. sonnei* the mildest.

Description

Shigellosis is a well-known cause of **traveler's diarrhea** and illness throughout the world. *Shigella* are extremely infectious bacteria, and ingestion of just 10 organisms is enough to cause severe diarrhea and dehydration. *Shigella* accounts for 10–20% of all cases of diarrhea worldwide, and in any given year infects over

140 million persons and kills 600,000, mostly children and the elderly. The most serious form of the disease is called dysentery, which is characterized by severe watery (and often blood- and mucous-streaked) diarrhea, abdominal cramping, rectal **pain**, and fever. *Shigella* is only one of several organisms that can cause dysentery, but the term bacillary dysentery is usually another name for shigellosis.

Most deaths are in less-developed or developing countries, but even in the United States, shigellosis can be a dangerous and potentially deadly disease. Poor hygiene, overcrowding, and improper storage of food are leading causes of infection. The following statistics show the marked difference in the frequency of cases between developed and less-developed countries; in the United States, about 30,000 individuals are hit by the disease each year or about 10 cases/100,000 population. On the other hand, infection in some areas of South America is 1,000 times more frequent. Shigellosis is most common in children below age five, and occurs less often in adults over 20.

Causes and Symptoms

Shigella share several of the characteristics of a group of bacteria that inhabit the intestinal tract. *E. coli,* another cause of food-borne illness, can be mistaken for *Shigella* both by physicians and the laboratory. Careful testing is needed to assure proper diagnosis and treatment.

Shigella are very resistant to the acid produced by the stomach, and this allows them to easily pass through the gastrointestinal tract and infect the colon (large intestine). The result is a colitis that produces multiple ulcers, which can bleed. *Shigella* also produce a number of toxins (Shiga toxin and others) that increase the amount of fluid secretion by the intestinal tract. This fluid secretion is a major cause of the diarrhea symptoms.

Shigella infection spreads through food or water contaminated by human waste. Sources of transmission are:

- contaminated milk, ice cream, vegetables and other foods which often cause epidemics
- household contacts (40% of adults and 20% of children will develop infection from such a source)
- poor hygiene and overcrowded living conditions
- day care centers
- sexual practices which lead to oral-anal contact, directly or indirectly

Symptoms can be limited to only mild diarrhea or go on to full-blown dysentery. Dehydration results from the large fluid losses due to diarrhea, vomiting and fever. Inability to eat or drink worsens the situation.

In developed countries, most infections are of the less severe type, and are often due to *S. sonnei*. The period between infection and symptoms (incubation period) varies from one to seven days. Shigellosis can last from a few days to several weeks, with an average of seven days.

Complications

Areas outside the intestine can be involved, including:

- nervous system (irritation of the meninges or **meningitis**, **encephalitis**, and seizures)
- kidneys (producing hemolytic uremic syndrome or HUS which leads to kidney failure)
- joints (leading to an unusual form of arthritis called **Reiter's syndrome**)
- skin (rash)

One of the most serious complications of this disease is HUS, which involves the kidney. The main findings are kidney failure and damage to red blood cells. As many as 15% of patients die from this complication, and half the survivors develop **chronic kidney failure**, requiring dialysis.

Another life-threatening condition is toxic megacolon. Severe inflammation causes the colon to dilate or stretch, and the thin colon wall may eventually tear. Certain medications (particularly those that diminish intestinal contractions) may increase this risk, but this interaction is unclear. Clues to this diagnosis include sudden decrease in diarrhea, swelling of the abdomen, and worsening abdominal pain.

Diagnosis

Shigellosis is one of the many causes of acute diarrhea. Culture (growing the bacteria in the laboratory) of freshly obtained diarrhea fluid is the only way to be certain of the diagnosis. But even this is not always positive, especially if the patient is already on **antibiotics**. *Shigella* are identified by a combination of their appearance under the microscope and various chemical tests. These studies take several days, so quicker means to recognize the bacteria and its toxins are being developed.

Treatment

The first aim of treatment is to keep up **nutrition** and avoid dehydration. Ideally, a physician should be consulted before starting any treatment. Antibiotics may not be necessary, except for the more severe infections. Many cases resolve before the diagnosis is established by culture. Medications that control diarrhea by slowing intestinal contractions can cause problems and should be

avoided by patients with bloody diarrhea or fever, especially if antibiotics have not been started.

Rehydration

The World Health Organization (WHO) has developed guidelines for a standard solution taken by mouth, and prepared from ingredients readily available at home. This Oral Rehydration Solution (ORS) includes salt, baking powder, sugar, orange juice, and water. Commercial preparations, such as Pedialyte, are also available. In many patients with mild symptoms, this is the only treatment needed. Severe dehydration usually requires intravenous fluid replacement.

Antibiotics

In the early and mid-1990s, researchers began to realize that not all cases of bacterial dysentery needed antibiotic treatment. Many patients improve without such therapy, and therefore these drugs are indicated only for treatment of moderate or severe disease, as found in the tropics. Choice of antibiotic is based on the type of bacteria found in the geographical area and on laboratory results. Recommendations as of 1997 include ampicillin, sulfa derivatives such as Trimethoprim-Sulfamethoxazole (TMP-SMX) sold as Bactrim, or **fluoroquinolones** (such as Ciprofloxacin which is not FDA approved for use in children).

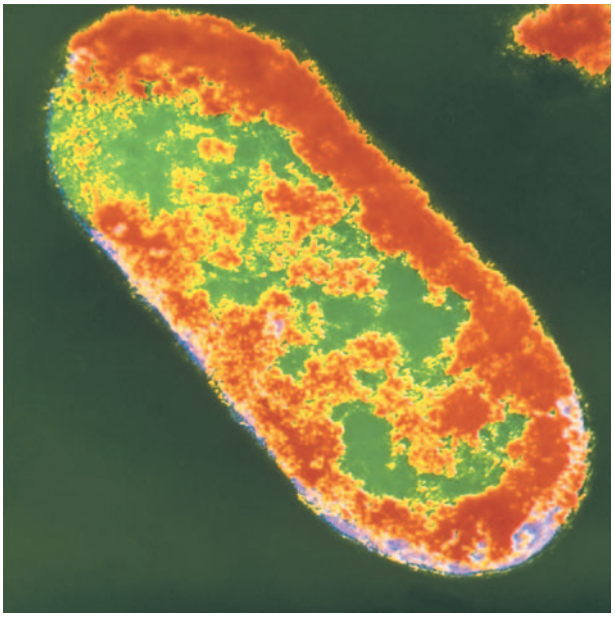
Prognosis

Many patients with mild infections need no specific treatment and recover completely. In those with severe infections, antibiotics will decrease the length of symptoms and the number of days bacteria appear in the feces. In rare cases, an individual may fail to clear the bacteria from the intestinal tract; the result is a persistent carrier state. This may be more frequent in **AIDS** (Acquired Immune Deficiency Syndrome) patients. Antibiotics are about 90% effective in eliminating these chronic infections.

In patients who have suffered particularly severe attacks, some degree of cramping and diarrhea can last for several weeks. This is usually due to damage to the intestinal tract, which requires some time to heal. Since antibiotics can also produce a form of colitis, this must be considered as a possible cause of persistent or recurrent symptoms.

Prevention

Shigellosis is an extremely contagious disease; good hand washing techniques and proper precautions in food handling will help in avoiding spread of infection. Children in day care centers need to be reminded about hand washing during an outbreak to minimize spread. *Shigellosis* in schools or day care settings almost always disappears when holiday breaks occur, which sever the chain of transmission.



A transmission electron microscopy (TEM) scan of *Shigella*, a genus of aerobic bacteria that causes dysentery in humans and animals. *(Custom Medical Stock Photo. Reproduced by permission.)*

Traveler's diarrhea (TD)

Shigella accounts for about 10% of diarrhea illness in travelers to Mexico, South America, and the tropics. Most cases of TD are more of a nuisance than a life-threatening disease. However, bloody diarrhea is an indication that *Shigella* may be responsible.

In some cases though, aside from ruining a well deserved vacation, these infections can interrupt business conference schedules and, in the worst instances, lead to a life-threatening illness. Therefore, researchers have tried to find a safe, yet effective, way of preventing TD. Of course the best prevention is to follow closely the rules outlined by the WHO and other groups regarding eating fresh fruits, vegetables, and other foods.

One safe and effective method of preventing TD is the use of large doses of Pepto Bismol. Tablets are now available which are easier for travel; usage must start a few days before departure. Patients should be aware that Bismuth will turn bowel movements black.

Antibiotics have also proven to be highly effective in preventing TD. They can also produce significant side effects, and therefore a physician should be consulted

KEY TERMS

Dysentery—A disease marked by frequent watery bowel movements, often with blood and mucus, and characterized by pain, urgency to have a bowel movement, fever, and dehydration.

Traveler's diarrhea—An illness due to infection from a bacteria or parasite that occurs in persons traveling to areas where there is a high frequency of the illness. The disease is usually spread by contaminated food or water.

Oral Rehydration Solution(ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Antibiotic—A medication that is designed to kill or weaken bacteria.

Anti-motility medications—Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing codeine or narcotics which decrease the ability of the intestine to contract. These may worsen the condition of a patient with dysentery or colitis.

Food-borne illness—A disease that is transmitted by eating or handling contaminated food.

Fluoroquinolones—A relatively new group of antibiotics that have had good success in treating infections with many gram-negative bacteria, such as *Shigella*. One drawback is that they should not be used in children under 17 years of age, because of possible effect on bone or cartilage growth.

Dialysis—A form of treatment for patients with kidneys that do not function properly. The treatment removes toxic wastes from the body that are normally removed by the kidneys.

Colitis—Inflammation of the colon or large bowel which has several causes. The lining of the colon becomes swollen, and ulcers often develop. The ability of the colon to absorb fluids is also affected, and diarrhea often results.

Carrier state—The continued presence of an organism (bacteria, virus, or parasite) in the body that does not cause symptoms, but is able to be transmitted and infect other persons.

Stool—Passage of fecal material; a bowel movement.

Meninges—Outer covering of the spinal cord and brain. Infection is called meningitis, which can lead to damage to the brain or spinal cord and lead to death.

before use. Like Pepto Bismol, antibiotics need to be started before beginning travel.

Resources

BOOKS

Biddle, Wayne. *A Field Guide to Germs.* New York: Henry Holt and Co., Inc., 1995.

Butterton, Joan R., and Stephen B. Calderwood. "Acute Infectious Diarrheal Diseases and Bacterial Food Poisoning." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hamer, Davidson H., and Sherwood L. Gorbach. "Infectious Diarrhea and Bacterial Food Poisoning." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Karlen, Arno. *Man and Microbes: Disease and Plagues in History and Modern Times.* New York: G. P. Putnam's Sons, 1995.

Keusch, Gerald T. "Shigellosis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Thielman, Nathan M., and Richard L. Guerrant. "Food-Borne Illness." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Khan, Wasif A. "Treatment of Shigellosis: V. Comparison of Azithromycin and Ciprofloxacin." *Annals of Internal Medicine* 26 (1 May 1997): 697-703.

"Traveler's Diarrhea: Don't Let It Ruin Your Trip." *Mayo Clinic Health Letter* (Jan. 1997).

"When Microbes are on the Menu." *Harvard Health Letter* (Dec. 1994): 4-5.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 208792-2560. (301) 496-3583. <http://www.niddk.nih.gov>.

World Health Organization, Division of Emerging and Other Communicable Diseases Surveillance and Control. Avenue Appia 20, 1211 Geneva 27, Switzerland. (+00 41 22) 791 21 11. <http://www.who.int>.

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Shingles

Definition

Shingles, also called herpes zoster, gets its name from both the Latin and French words for belt or girdle and refers to girdle-like skin eruptions that may occur on the trunk of the body. The virus that causes **chickenpox**, the varicella zoster virus (VSV), can become dormant in nerve cells after an episode of chickenpox and later reemerge as shingles. Initially, red patches of rash develop into blisters. Because the virus travels along the nerve to the skin, it can damage the nerve and cause it to become inflamed. This condition can be very painful. If the **pain** persists long after the rash disappears, it is known as post-herpetic **neuralgia**.

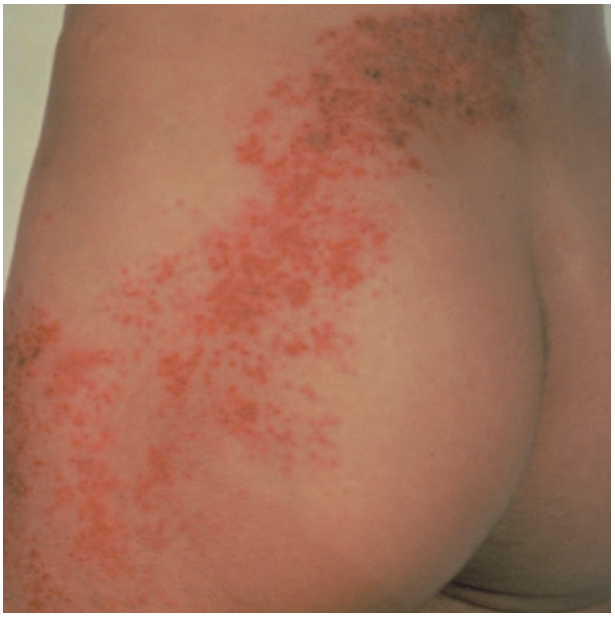
Description

Any individual who has had chickenpox can develop shingles. Approximately 300,000 cases of shingles occur every year in the United States. Overall, approximately 20% of those who had chickenpox as children develop shingles at some time in their lives. People of all ages, even children, can be affected, but the incidence increases with age. Newborn infants, bone marrow and other transplant recipients, as well as indivduals with immune systems weakened by disease or drugs are also at increased risk. However, most individuals who develop shingles do not have any underlying malignancy or other immunosuppressive condition.

Causes and symptoms

Shingles erupts along the course of the affected nerve, producing lesions anywhere on the body and may cause severe nerve pain. The most common areas to be affected are the face and trunk, which correspond to the areas where the chickenpox rash is most concentrated. The disease is caused by a reactivation of the chickenpox virus that has lain dormant in certain nerves following an episode of chickenpox. Exactly how or why this reactivation occurs is not clear, however, it is believed that the reactivation is triggered when the immune system becomes weakened, either as a result of **stress**, **fatigue**, certain medications, **chemotherapy**, or diseases, such as **cancer** or HIV. Further, it can be an early sign in persons with HIV that the immune system has deteriorated.

Early signs of shingles are often vague and can easily be mistaken for other illnesses. The condition may begin with **fever** and malaise (a vague feeling of weakness or discomfort). Within two to four days, severe pain, **itching**, and numbness/tingling (paresthesia) or extreme sensitivity to touch (hyperesthesia) can develop, usually on the trunk and occasionally on the arms and legs. Pain may be continuous or intermittent, usually lasting from one to four weeks. It may occur at the time of the eruption, but can precede the eruption by days, occasionally making the diagnosis difficult. Signs and symptoms may include the following:



Shingles, or herpes zoster, on patient's buttocks and thigh. *(Custom Medical Stock Photo. Reproduced by permission.)*

- itching, tingling, or severe burning pain
- red patches that develop into blisters
- grouped, dense, deep, small blisters that ooze and crust
- swollen lymph nodes

Diagnosis

Diagnosis is usually not possible until the **skin lesions** develop. Once they develop, however, the pattern and location of the blisters and the type of cell damage displayed are very characteristic of the disease, allowing an accurate diagnosis primarily based upon the **physical examination**.

Although tests are rarely necessary, they may include the following:

- viral culture of skin lesion
- microscopic examination using a **Tzanck preparation**, this involves staining a smear obtained from a blister, cells infected with the herpes virus will appear very large and contain many dark cell centers or nuclei

- complete **blood count** (CBC) may show an elevated white blood cell count (WBC), a nonspecific sign of infection
- rise in antibody to the virus

Treatment

Shingles almost always resolves spontaneously and may not require any treatment except for the relief of symptoms. In most people, the condition clears on its own in one or two weeks and seldom recurs.

Cool, wet compresses may help reduce pain. If there are blisters or crusting, applying compresses made with diluted vinegar will make the patient more comfortable. Mix one-quarter cup of white vinegar in two quarts of lukewarm water. Use the compress twice each day for 10 minutes. Stop using the compresses when the blisters have dried up.

Soothing baths and lotions such as colloidal oatmeal baths, starch baths or lotions, and calamine lotion may help to relieve itching and discomfort. Keep the skin clean, and do not re-use contaminated items. While the lesions continue to ooze, the person should be isolated to prevent infecting other susceptible individuals.

Later, when the crusts and scabs are separating, the skin may become dry, tight, and cracked. If that happens, rub on a small amount of plain petroleum jelly three or four times a day.

The **antiviral drugs** acyclovir, valacyclovir, and famciclovir can be used to treat shingles. These drugs may shorten the course of the illness. Their use results in more rapid healing of the blisters when drug therapy is started within 72 hours of the onset of the rash. In fact, the earlier the drugs are administered, the better, because early cases can sometimes be stopped. If taken later, these drugs are less effective but may still lessen the pain. Antiviral drug treatment does not seem to reduce the incidence of post-herpetic neuralgia, but recent studies suggest famciclovir may cut the duration of post-herpetic neuralgia in half. Side effects of typical oral doses of these antiviral drugs are minor with **headache** and nausea reported by 8–20 % of patients. Severely immunocompromised individuals, such as those with **AIDS**, may require intravenous administration of antiviral drugs.

Corticosteroids, such as prednisone, may be used to reduce inflammation but do interfere with the functioning of the immune system. Corticosteroids, in combination with antiviral therapy, also are used to treat severe infections, such as those affecting the eyes, and to reduce severe pain.

Once the blisters are healed, some people continue to experience pain for months or even years (post-herpetic neuralgia). This pain can be excruciating. Consequently, the doctor may prescribe tranquilizers, sedatives, or antidepressants to be taken at night. As noted above, attempts to treat post-herpetic neuralgia with the antiviral drug famciclovir have shown some promising results. When all else fails, severe pain may require a permanent nerve block.

Alternative treatment

There are non-medical methods of prevention and treatment that may speed recovery. For example, getting lots of rest, eating a healthy diet, exercising regularly, and minimizing stress are always helpful in preventing disease. Supplementation with vitamin B_{12} during the first one to two days and continued supplementation with vitamin B complex, high levels of vitamin C with bioflavenoids, and calcium, are recommended to boost the immune system. Herbal antivirals such as **echinacea** can be effective in fighting infection and boosting the immune system.

Although no single alternative approach, technique, or remedy has yet been proven to reduce the pain, there are a few options which may be helpful. For example, topical applications of lemon balm (*Melissa officinalis*) or licorice (*Glycyrrhiza glabra*) and peppermint (*Mentha piperita*) may reduce pain and blistering. Homeopathic remedies include *Rhus toxicodendron* for blisters, *Mezereum* and *Arsenicum album* for pain, and *Ranunculus* for itching. Practitioners of Eastern medicine recommend self-hypnosis, **acupressure**, and **acupuncture** to alleviate pain.

Prognosis

Shingles usually clears up in two to three weeks and rarely recurs. Involvement of the nerves that cause movement may cause a temporary or permanent nerve **paralysis** and/or **tremors**. The elderly or debilitated patient may have a prolonged and difficult course. For them, the eruption is typically more extensive and inflammatory, occasionally resulting in blisters that bleed, areas where the skin actually dies, secondary bacterial infection, or extensive and permanent scarring.

Similarly, an immunocompromised patient usually has a more severe course that is frequently prolonged for weeks to months. They develop shingles frequently and the infection can spread to the skin, lungs, liver, gastrointestinal tract, brain, or other vital organs. Cases of chronic shingles have been reported in patients infected with AIDS, especially when they have a decreased number of one particular kind of immune cell, called CD4 lymphocytes. Depletion of CD4 lymphocytes is associated with more severe, chronic, and recurrent varicella-zoster virus

infections. These lesions are typical at the onset but may turn into ulcers that do not heal.

Potentially serious complications can result from herpes zoster. Many individuals continue to experience persistent pain long after the blisters heal. This pain, called post-herpatic neuralgia, can be severe and debilitating. Post-herpetic neuralgia can persist for months or years after the lesions have disappeared. The incidence of post-herpetic neuralgia increases with age, and episodes in older individuals tend to be of longer duration. Most patients under 30 years of age experience no persistent pain. By age 40, the risk of prolonged pain lasting longer than one month increases to 33%. By age 70, the risk increases to 74%. The pain can adversely affect quality of life, but it does usually diminish over time.

Other complications include a secondary bacterial infection, and rarely, potentially fatal inflammation of the brain (**encephalitis**) and the spread of an infection throughout the body. These rare, but extremely serious, complications are more likely to occur in those individuals who have weakened immune systems (immunocompromised).

Prevention

Strengthening the immune system by making lifestyle changes is thought to help prevent the development of shingles. A lifestyle designed to strengthen the immune system and maintain good overall health includes eating a well-balanced diet rich in essential **vitamins** and **minerals**, getting enough sleep, exercising regularly, and reducing stress.

Resources

BOOKS

Lockie, Andrew. *The Family Guide to Homeopathy: Symptoms and Natural Solutions*. Prentice Hall Press, 1989.

Thomsen, Thomas Carl. *Shingles*. Cross River Press, 1990.

PERIODICALS

Balfour, Henry H. "Varicella Zoster Virus Infections in Immunocompromised Hosts." *American Journal of Medicine* 85 (29 Aug. 1988): 68–72.

Perren, Timothy J., et al. "Prevention of Herpes Zoster in Patients by Long-Term Oral Acyclovir After Allogeneic Bone Marrow Transplantation." *American Journal of Medicine* 85 (29 Aug. 1988): 99–101.

Wood, Martin J., et al. "Efficacy of Oral Acyclovir Treatment of Acute Herpes Zoster." *American Journal of Medicine* 85 (29 Aug. 1988): 79–83.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

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KEY TERMS

Acyclovir—An antiviral drug that is available under the trade name Zovirax, in oral, intravenous, and topical forms. The drug blocks the replication of the varicella zoster virus.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Corticosteroid—A steroid that has similar properties to the steroid hormone produced by the adrenal cortex. It is used to alter immune responses to shingles.

Famciclovir—An oral antiviral drug that is available under the trade name Famvir. The drug blocks the replication of the varicella zoster virus.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Post-herpetic neuralgia—The term used to describe the pain after the rash associated with herpes zoster is gone.

Tzanck preparation—Procedure in which skin cells from a blister are stained and examined under the microscope. Visualization of large skin cells with many cell centers or nuclei indicates a positive diagnosis of herpes zoster when combined with results from a physical examination.

Valacyclovir—An oral antiviral drug that is available under the trade name Valtrex. The drug blocks the replication of the varicella zoster virus.

Shock

Definition

Shock is a medical emergency in which the organs and tissues of the body are not receiving an adequate flow of blood. This deprives the organs and tissues of oxygen (carried in the blood) and allows the buildup of waste products. Shock can result in serious damage or even **death**.

Description

There are three stages of shock: Stage I (also called compensated, or nonprogressive), Stage II (also called decompensated or progressive), and Stage III (also called irreversible).

In Stage I of shock, when low blood flow (perfusion) is first detected, a number of systems are activated in order to maintain/restore perfusion. The result is that the heart beats faster, the blood vessels throughout the body become slightly smaller in diameter, and the kidney works to retain fluid in the circulatory system. All this serves to maximize blood flow to the most important organs and systems in the body. The patient in this stage of shock has very few symptoms, and treatment can completely halt any progression.

In Stage II of shock, these methods of compensation begin to fail. The systems of the body are unable to improve perfusion any longer, and the patient's symptoms reflect that fact. Oxygen deprivation in the brain causes the patient to become confused and disoriented, while oxygen deprivation in the heart may cause chest **pain**. With quick and appropriate treatment, this stage of shock can be reversed.

In Stage III of shock, the length of time that poor perfusion has existed begins to take a permanent toll on the body's organs and tissues. The heart's functioning continues to spiral downward, and the kidneys usually shut down completely. Cells in organs and tissues throughout the body are injured and dying. The endpoint of Stage III shock is the patient's death.

Causes and symptoms

Shock is caused by three major categories of problems: cardiogenic (meaning problems associated with the heart's functioning); hypovolemic (meaning that the total volume of blood available to circulate is low); and **septic shock** (caused by overwhelming infection, usually by bacteria).

Cardiogenic shock can be caused by any disease, or event, which prevents the heart muscle from pumping strongly and consistently enough to circulate the blood normally. **Heart attack**, conditions which cause inflammation of the heart muscle (**myocarditis**), disturbances of the electrical rhythm of the heart, any kind of mass or fluid accumulation and/or blood clot which interferes with flow out of the heart can all significantly affect the heart's ability to adequately pump a normal quantity of blood.

Hypovolemic shock occurs when the total volume of blood in the body falls well below normal. This can occur when there is excess fluid loss, as in **dehydration** due to severe vomiting or **diarrhea**, diseases which cause excess urination (**diabetes insipidus**, **diabetes mellitus**, and kidney failure), extensive **burns**, blockage in the intestine, inflammation of the pancreas (**pancreatitis**), or severe bleeding of any kind.

Septic shock can occur when an untreated or inadequately treated infection (usually bacterial) is allowed to progress. Bacteria often produce poisonous chemicals (toxins) which can cause injury throughout the body. When large quantities of these bacteria, and their toxins, begin circulating in the bloodstream, every organ and tissue in the body is at risk of their damaging effects. The most damaging consequences of these bacteria and toxins include poor functioning of the heart muscle; widening of the diameter of the blood vessels; a drop in blood pressure; activation of the blood clotting system, causing blood clots, followed by a risk of uncontrollable bleeding; damage to the lungs, causing acute **respiratory distress syndrome**; liver failure; kidney failure; and **coma**.

Initial symptoms of shock include cold, clammy hands and feet; pale or blue-tinged skin tone; weak, fast pulse rate; fast rate of breathing; low blood pressure. A variety of other symptoms may be present, but they are dependent on the underlying cause of shock.

KEY TERMS

Cardiogenic—Originating with the heart.

Deprivation—A condition of having too little of something.

Hypovolemic—Having a low volume.

Perfusion—Blood flow through an organ or tissue.

Sepsis—An overwhelming infection throughout the body, usually caused by bacteria in the bloodstream.

Diagnosis

Diagnosis of shock is based on the patient's symptoms, as well as criteria including a significant drop in blood pressure, extremely low urine output, and blood tests that reveal overly acidic blood with a low circulating concentration of carbon dioxide. Other tests are performed, as appropriate, to try to determine the underlying condition responsible for the patient's state of shock.

Treatment

The most important goals in the treatment of shock include: quickly diagnosing the patient's state of shock; quickly intervening to halt the underlying condition (stopping bleeding, re-starting the heart, giving **antibiotics** to combat an infection, etc.); treating the effects of shock (low oxygen, increased acid in the blood, activation of the blood clotting system); and supporting vital functions (blood pressure, urine flow, heart function).

Treatment includes keeping the patient warm, with legs raised and head down to improve blood flow to the brain, putting a needle in a vein in order to give fluids or blood transfusions, as necessary; giving the patient extra oxygen to breathe and medications to improve the heart's functioning; and treating the underlying condition which led to shock.

Prognosis

The prognosis of an individual patient in shock depends on the stage of shock when treatment was begun, the underlying condition causing shock, and the general medical state of the patient.

Prevention

The most preventable type of shock is caused by dehydration during illnesses with severe vomiting or diarrhea. Shock can be avoided by recognizing that a patient who is unable to drink in order to replace lost fluids needs to be given fluids intravenously (through a needle in a vein). Other types of shock are only preventable insofar as one can prevent their underlying conditions, or can monitor and manage those conditions well enough so that they never progress to the point of shock.

Resources

BOOKS

Cotran, Ramzi S., et al. *Robbins Pathologic Basis of Disease*. Philadelphia: W. B. Saunders Co., 1994.

Hollenberg, Steven M., and Joseph E. Parrillo. "Shock." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Kerasote, Ted. "After Shock: Recognizing and Treating Shock." *Sports Afield* 217 (May 1997): 60+.

Saunders Co., Carol Silverman. "In Case of Shock." *Current Health 2,* 23 (Nov. 1996): 22+.

Rosalyn Carson-DeWitt, MD

Shock | *see* **Adult respiratory distress syndrome**

Shock therapy *see* **Electroconvulsive therapy**

Shortness of breath

Definition

Shortness of breath, or dyspnea, is a feeling of difficult or labored breathing that is out of proportion to the patient's level of physical activity. It is a symptom of a variety of different diseases or disorders and may be either acute or chronic.

Description

The experience of dyspnea depends on its severity and underlying causes. The feeling itself results from a combination of impulses relayed to the brain from nerve endings in the lungs, rib cage, chest muscles, or diaphragm, combined with the patient's perception and interpretation of the sensation. In some cases, the patient's sensation of breathlessness is intensified by **anxiety** about its cause. Patients describe dyspnea variously as unpleasant shortness of breath, a feeling of increased effort or tiredness in moving the chest muscles, a panicky feeling of being smothered, or a sense of tightness or cramping in the chest wall.

Causes and symptoms

ACUTE DYSPNEA. Acute dyspnea with sudden onset is a frequent cause of emergency room visits. Most cases of acute dyspnea involve pulmonary (lung and breathing) disorders, cardiovascular disease, or chest trauma.

PULMONARY DISORDERS. Pulmonary disorders that can cause dyspnea include airway obstruction by a foreign object, swelling due to infection, or anaphylactic **shock**; acute **pneumonia**; hemorrhage from the lungs; or severe bronchospasms associated with **asthma**.

CARDIOVASCULAR DISEASE. Acute dyspnea can be caused by disturbances of the heart rhythm, failure of the left ventricle, mitral valve (a heart valve) dysfunction, or an embolus (a clump of tissue, fat, or gas) that is blocking the pulmonary circulation. Most pulmonary emboli (blood clots) originate in the deep veins of the lower legs and eventually migrate to the pulmonary artery.

TRAUMA. Chest injuries, both closed injuries and penetrating **wounds**, can cause **pneumothorax** (the presence of air inside the chest cavity), **bruises**, or fractured ribs. **Pain** from these injuries results in dyspnea. The impact of the driver's chest against the steering wheel in auto accidents is a frequent cause of closed chest injuries.

OTHER CAUSES. Anxiety attacks sometimes cause acute dyspnea; they may or may not be associated with chest pain. Anxiety attacks are often accompanied by hyperventilation, which is a breathing pattern characterized by abnormally rapid and deep breaths. Hyperventilation raises the oxygen level in the blood, causing chest pain and **dizziness**.

Chronic dyspnea

PULMONARY DISORDERS. Chronic dyspnea can be caused by asthma, chronic obstructive pulmonary disease (COPD), **bronchitis**, **emphysema**, inflammation of the lungs, **pulmonary hypertension**, tumors, or disorders of the vocal cords.

HEART DISEASE. Disorders of the left side of the heart or inadequate supply of blood to the heart muscle can cause dyspnea. In some cases a tumor in the heart or inflammation of the membrane surrounding the heart may cause dyspnea.

NEUROMUSCULAR DISORDERS. Neuromuscular disorders cause dyspnea from progressive deterioration of the patient's chest muscles. They include **muscular dystrophy**, **myasthenia gravis**, and **amyotrophic lateral sclerosis**.

OTHER CAUSES. Patients who are severely anemic may develop dyspnea if they **exercise** vigorously. **Hyperthyroidism** or **hypothyroidism** may cause shortness of breath, and so may gastroesophageal reflux disease (GERD). Both chronic **anxiety disorders** and a low level of physical fitness can also cause episodes of dyspnea. Deformities of the chest or **obesity** can cause dyspnea by limiting the movement of the chest wall and the ability of the lungs to fill completely.

Diagnosis

Patient history

The patient's history provides the doctor with such necessary information as a history of gastroesophageal reflux disease (GERD), asthma, or other allergic conditions; the presence of chest pain as well as difficulty breathing; recent accidents or recent surgery; information about **smoking** habits; the patient's baseline level of physical activity and exercise habits; and a psychiatric history of panic attacks or anxiety disorders.

ASSESSMENT OF BODY POSITION. How a person's body position affects his/her dyspnea symptoms sometimes gives hints as to the underlying cause of the disorder. Dyspnea that is worse when the patient is sitting up is called platypnea and indicates the possibility of liver disease. Dyspnea that is worse when the patient is lying down is called orthopnea, and is associated with heart disease or **paralysis** of the diaphragm. Paroxysmal nocturnal dyspnea (PND) refers to dyspnea that occurs during sleep and forces the patient to awake gasping for breath. It is usually relieved if the patient sits up or stands. PND may point to dysfunction of the left ventricle of the heart, **hypertension**, or narrowing of the mitral valve.

Physical examination

The doctor will examine the patient's chest in order to determine the rate and depth of breathing, the effort required, the condition of the patient's breathing muscles, and any evidence of chest deformities or trauma. He or she will listen for **wheezing**, **stridor**, or signs of fluid in the lungs. If the patient has a **fever**, the doctor will look for other signs of pneumonia. The doctor will check the patient's heart functions, including blood pressure, pulse rate, and the presence of **heart murmurs** or other abnormal heart sounds. If the doctor suspects a blood clot in one of the large veins leading to the heart, he or she will examine the patient's legs for signs of swelling.

Diagnostic tests

BASIC DIAGNOSTIC TESTS. Patients who are seen in emergency rooms are given a **chest x ray** and electrocardiogram (ECG) to assist the doctor in evaluating abnormalities of the chest wall, also to determine the position of the diaphragm, possible rib **fractures** or pneumothorax, irregular heartbeat, or the adequacy of the supply of blood to the heart muscle. Also, the patient may be given a breathing test on an instrument called a spirometer to screen for airway disorders.

The doctor may order blood tests and arterial blood gas tests to rule out anemia, hyperventilation from an anxiety attack, or thyroid dysfunction. A **sputum culture** can be used to test for pneumonia.

SPECIALIZED TESTS. Specialized tests may be ordered for patients with normal results from basic diagnostic tests for dyspnea. High-resolution CT scans can be used for suspected airway obstruction or mild emphysema. Tissue biopsy performed with a bronchoscope can be used for patients with suspected lung disease.

If the doctor suspects a **pulmonary embolism**, he or she may order ventilation-perfusion scanning to inspect lung function, an angiogram of blood vessels, or ultrasound studies of the leg veins. **Echocardiography** can be used to test for pulmonary hypertension and heart disease.

Pulmonary function studies or **electromyography** (EMG) are used to assess neuromuscular diseases. Exercise testing is used to assess dyspnea related to COPD, anxiety attacks, poor physical fitness, and the severity of lung or heart disease. The level of acidity in the patient's esophagus may be monitored to rule out GERD.

Treatment

Treatment of dyspnea depends on its underlying cause.

Acute dyspnea

Patients with acute dyspnea are given oxygen in the emergency room, with the following treatments for specific conditions:

- Asthma. Treatment with Alupent, epinephrine, or aminophylline.
- Anaphylactic shock. Treatment with Benadryl, steroids, or aminophylline, with hydrocortisone if necessary.
- Congestive **heart failure**. Treatment with oxygen, **diuretics**, and placing patient in upright position.
- Pneumonia. Treatment with **antibiotics** and removal of lung secretions.
- Anxiety attacks. Immediate treatment includes antidepressant medications. If the patient is hyperventilating, he or she may be asked to breathe into a paper bag to normalize breathing rhythm and the oxygen level of the blood.
- Pneumothorax. Surgical placement of a chest tube.

Chronic dyspnea

The treatment of chronic dyspnea depends on the underlying disorder. Asthma can often be managed with a combination of medications to reduce airway spasms and removal of allergens from the patient's environment. COPD requires both medication, lifestyle changes, and long-term physical **rehabilitation**. Anxiety disorders are usually treated with a combination of medication and psychotherapy. GERD can usually be managed with **antacids**, other medications, and dietary changes. There are no permanent cures for myasthenia gravis or muscular dystrophy.

Tumors and certain types of chest deformities can be treated surgically.

Alternative treatment

The appropriate alternative therapy for shortness of breath depends on the underlying cause of the condition. When dyspnea is acute and severe, oxygen therapy is used either in the doctor's office or in the emergency room. For shortness of breath with an underlying physical cause like asthma, anaphylactic shock, or pneumonia, the physical condition should be treated. Botanical and homeopathic remedies can be used for acute dyspnea, if the proper remedies and formulas are prescribed. If the dyspnea has a psychological basis (especially if it is caused by anxiety), **acupuncture**, botanical medicine, and **homeopathy** can help the patient heal at a deep level.

KEY TERMS

Anaphylactic shock—A severe systemic reaction to an allergen that occurs in hypersensitive individuals. It can cause spasms of the larynx that block the patient's airway and cause dyspnea.

Dyspnea—A sensation of difficult or labored breathing.

Electromyography—A technique for recording electric currents in an active muscle in order to measure its level of function.

Orthopnea—Difficulty in breathing that occurs while the patient is lying down.

Paroxysmal nocturnal dyspnea (PND)—A form of dyspnea characterized by the patient's waking from sleep unable to breathe.

Platypnea—Dyspnea that occurs when the patient is sitting up.

Pneumothorax—The presence of air or gas inside the chest cavity.

Spirometer—An instrument that is used to test lung capacity. It is used to screen patients with dyspnea.

Stridor—A harsh or crowing breath sound caused by partial blockage of the patient's upper airway.

Wheezing—A whistling or musical sound caused by tightening of the air passages inside the patient's chest. Wheezing is most commonly associated with asthma.

Prognosis

The prognosis for recovery depends on the underlying cause of the dyspnea, its severity, and the type of treatment required.

Prevention

Dyspnea caused by asthma can be minimized or prevented by removing dust and other triggers from the patient's environment. Long-term prevention of chronic dyspnea includes such lifestyle choices as regular aerobic exercise and avoidance of smoking.

Resources

BOOKS

Gillespie, D. J., and E. J. Olson. "Dyspnea." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"On-Call Problems: Dyspnea." In *Surgery On Call*, ed. Leonard G. Gomella and Alan T. Lefor. Stamford: Appleton & Lange, 1996.

"Pulmonary Disorders: Dyspnea." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Stauffer, John L. "Lung." In *Current Medical Diagnosis and Treatment, 1996*. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

Rebecca J. Frey

Shy-Drager syndrome

Definition

Shy-Drager syndrome (SDS) is a rare condition that causes progressive damage to the autonomic nervous system. The autonomic nervous system controls vital involuntary body functions such as heart rate, breathing, and intestinal, urinary, and sexual functions. The autonomic nervous system also controls skin and body temperature, and how the body responds to **stress**. Shy-Drager syndrome leads to **dizziness** or **fainting** when standing up, **urinary incontinence**, **impotence**, and muscle **tremors**.

Description

SDS was named for neurologists Milton Shy, M.D., from the National Institutes of Health, and Glenn Drager, M.D., from the Baylor College of Medicine, who first described the condition in 1960. It typically affects those between ages 50-70. It affects more men than women. In severe cases, the person cannot even stand up. Symptoms can be mild as well. Sometimes, people with mild cases are misdiagnosed as having **anxiety** or **hypertension**.

Many nonprescription drugs, such as cold medicines and diet capsules, can trigger extremely high blood pressure spikes in patients with SDS, even in very low doses. Therefore, these patients are at risk for strokes and excessive bleeding (hemorrhage) if they take even the recommended dosage of these drugs.

Causes and symptoms

The cause of SDS is unknown. Symptoms develop because of degeneration of certain groups of nerve cells in the spinal cord.

Patients with SDS usually have problems with the function of the autonomic nervous system. Progressive degeneration may occur in other areas of the nervous system as well. The hallmark of the syndrome is dizziness and fainting when arising or after standing still for a long time (postural **hypotension**). This is caused by low blood pressure and inadequate blood flow to the brain. When this problem becomes severe (for example, a blood pressure below 70/40 mmHg), it can lead to a momentary loss of consciousness. When the person faints, the blood pressure returns to normal and the person wakes up.

Many patients also notice impotence, urinary incontinence, **dry mouth** and skin, and trouble regulating body temperature because of abnormal sweating. Since the autonomic nervous system also controls the narrowing and widening of the iris, some patients with SDS have vision problems, such as trouble focusing.

In later stages, problems in the autonomic nervous system lead to breathing difficulties such as **sleep apnea**, loud breathing, and **snoring**. In advanced stages of the disease, patients can die from irregular heartbeat.

Other symptoms of SDS do not involve the autonomic nervous system. These include parkinsonism (muscle tremor, rigidity, and slow movements), double vision, problems controlling emotions, and wasting of muscles in the hands and feet. Eventually, patients may have problems chewing, swallowing, speaking, and breathing. There may be a loss of color pigment in the iris.

Diagnosis

While no blood test can reveal the disorder, a careful assessment of symptoms should alert a neurologist to suspect SDS. A combination of parkinsonism and certain autonomic problems (especially impotence, incontinence, and postural hypotension) are clear indications of the syndrome.

Tests of the autonomic nervous system may help diagnose the condition. In normal patients, blood levels of norepinephrine rise when they stand up. This doesn't happen in people with SDS. Norepinephrine is a hormone that helps maintain blood pressure by triggering certain blood vessels to constrict when blood pressure falls below normal. Another test for the condition is the **Valsalva maneuver**. In this test, the patient holds his or her breath and strains down as if having a bowel movement while the doctor monitors blood pressure and heart rate for 10 seconds. Patients with SDS will not have the normal increase in blood pressure and heart rate.

A variety of other tests can identify a broad range of autonomic problems in patients with SDS. Brain scans, however, don't usually reveal any problems.

Treatment

Medication can relieve many of the symptoms, especially the parkinsonism and low blood pressure. Howev-

er, typical antiparkinsonism drugs such as carbidopa-levodopa (Sinemet) should be used with caution, since they often worsen the postural low blood pressure and may cause fainting.

Because postural hypotension is the most troublesome of the symptoms in the early years, treatments center on relieving this problem. Patients are encouraged to eat a liberal salt diet and drink plenty of fluids. They are advised to wear waist-high elastic hosiery and to sleep with the head elevated at least 5 in (13 cm). Other drug treatment includes fludrocortisone, indomethacin, **nonsteroidal anti-inflammatory drugs**, **beta blockers**, central stimulants, and other medications.

Occasionally, a pacemaker, **gastrostomy**, or tracheostomy may be needed. A pacemaker is a device that delivers electrical impulses to the heart to keep it beating regularly. A gastrostomy creates an opening in the stomach to connect a feeding tube from outside the body. In a tracheostomy an opening is made in the windpipe and a tube is inserted to maintain breathing.

Prognosis

While the course of the disease varies, and some patients live for up to 20 years after the symptoms first appear, most patients become severely disabled within seven or eight years. It is unusual for someone to survive more than 15 years after diagnosis.

Symptoms (especially tremor) often get worse if the patient smokes, because of the nicotine.

Many patients develop swallowing problems which may lead to recurrent episodes of **pneumonia**, a frequent cause of **death**. Others experience Cheyne-Stokes (periodic breathing). One of the most common causes of death is pulmonary embolus. This is caused by a blood clot in the main artery in the lung.

Prevention

Since scientists don't know the cause of Shy-Drager syndrome, there is no way to prevent the condition.

Resources

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Association for Neuro-Metabolic Disorders. 5223 Brookfield Lane, Sylvania, OH 43560-1809. (419) 885-1497.

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

KEY TERMS

Autonomic nervous system—The part of the nervous system that controls the involuntary (apparently automatic) activities of organs, blood vessels, glands, and many other body tissues.

Degenerative—Degenerative disorders involve progressive impairment of both the structure and function of part of the body.

Gastrostomy—An artificial opening into the stomach through the abdomen to enable a patient to be fed via a feeding tube. The procedure is given to patients with SDS who are unable to chew or swallow.

Norepinephrine—A hormone that helps maintain blood pressure by triggering certain blood vessels to constrict when blood pressure falls below normal.

Sleep apnea—A sleep disorder characterized by periods of breathing cessation lasting for 10 seconds or more.

Tracheostomy—An opening through the neck into the trachea through which a tube may be inserted to maintain an effective airway and help a patient breathe.

Shy-Drager Syndrome Support Group. 2004 Howard Lane, Austin, TX 78728. (800) 288-5582. <http://www.shy-drager.com>.

Carol A. Turkington

Sick sinus syndrome

Definition

Sick sinus syndrome is a disorder of the sinus node of the heart, which regulates heartbeat. With sick sinus syndrome, the sinus node fails to signal properly, resulting in changes in the heart rate.

Description

The sinus node in the heart functions as the heart's pacemaker, or beat regulator. In sick sinus syndrome, patients normally will experience bradycardia, or slowed heart rate. Also, it is not uncommon to see fluctuations between slow and rapid heart rate (tachycardia). This

makes the diagnosis and treatment of sick sinus syndrome more complicated than most other cardiac **arrhythmias** (irregular heart beats). A sick sinus node may be responsible for starting beats too slowly, pausing too long between initiation of heartbeats, or not producing heartbeats at all.

Causes and symptoms

Sick sinus syndrome may be brought on by the use of certain drugs, but is most common in elderly patients. Cardiac **amyloidosis**, a condition in which amyloid, a kind of protein, builds up in heart tissue, may affect the sinus node. Other conditions, such as **sarcoidosis** (round bumps in the tissue surrounding the heart and other organs), **Chagas' disease** (resulting from the bite of a bloodsucking insect) or certain cardiac **myopathies** can cause fiber-like tissue to grow around the normal sinus node, causing the node to malfunction.

A patient may not show any symptoms of sick sinus syndrome. In general, however, the common symptoms are those associated with slow heart rate, such as lightheadedness, or **dizziness**, **fatigue** and **fainting**. Patients may also experience confusion, heart **palpitations**, **angina** or **heart failure**.

Diagnosis

A slow pulse, especially one that is irregular, may be the first indication of sick sinus syndrome. **Electrocardiography** (ECGs) is a commonly used method of detecting sick sinus syndrome. ECG monitoring for 24 hours is most useful, since with this syndrome, heart rate may alternate between slow and fast, and the determination of this fact can help differentiate sick sinus syndrome from other arrhythmias.

Treatment

If drugs are causing the problem, their withdrawal may effectively eliminate the disorder. However, the treatment of sick sinus syndrome is normally delayed until a patient shows symptoms. Once treatment is indicated, most patients will receive a pacemaker. This is a permanent treatment involving implantation of a small device under the skin below the collarbone. Small electrodes run from the device to the heart; they deliver and regulate the electrical signals that cause the heart to beat. Patients with sick sinus syndrome should generally receive dual chamber pacing systems to prevent atrial fibrillation (involuntary contraction of the muscles of the atria). Some drugs are used to treat sick sinus syndrome, but digitalis should be used with caution. Often the use of drugs to regulate the heartbeat should be implemented only after the pacemaker has been placed, since these drugs may further worsen the slow heart rate.

KEY TERMS

Arrhythmia—Irregular heart beat.

Atria—Plural for atrium. The atria are the upper chambers of the heart.

Bradycardia—A heart rate slower than normal.

Electrocardiograph (ECG)—A test of a patient's heartbeat that involves placing leads, or detectors, on the patient's chest to record electrical impulses in the heart. This test will produce a strip, or picture record of the heart's electrical functioning.

Myopathy—Weakness of muscle.

Pacemaker—A device implanted under the skin, below the collarbone, to regulate heartbeat. Leads from the device to the heart stimulate the electrical functions of the heart. Pacemakers are often used to control bradycardia and are usually smaller than a silver dollar.

Alternative treatment

The reduction or elimination of certain foods and substances, such as alcohol or **caffeine**, may be advised to control heart rate. **Stress reduction** may also assist with changes in rate. Homeopathic treatment can work on a deep healing level, while **acupuncture** and botanical medicine can offer supportive treatment for symptoms.

Prognosis

Patients with sick sinus syndrome face relatively normal lives if the disorder is controlled by a pacemaker. However, in some patients, the pacemaker does not adequately control the fluctuations in heart rate. Left untreated, or in severe cases, the heart could stop beating.

Prevention

Elimination of a drug therapy which aggravates sick sinus syndrome is the first line of treatment for some patients. Other causes of the syndrome are not preventable. However, proper treatment of those underlying conditions which affect the tissues of the heart may intervene to prevent sick sinus syndrome from becoming a significant problem.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris, RN

Sickle cell disease

Definition

Sickle cell disease describes a group of inherited blood disorders characterized by chronic anemia, painful events, and various complications due to associated tissue and organ damage.

Description

The most common and well-known type of sickle cell disease is sickle cell anemia, also called SS disease. All types of sickle cell disease are caused by a genetic change in hemoglobin, the oxygen-carrying protein inside the red blood cells. The red blood cells of affected individuals contain a predominance of a structural variant of the usual adult hemoglobin. This variant hemoglobin, called sickle hemoglobin, has a tendency to polymerize into rod-like structures that alter the shape of the usually flexible red blood cells. The cells take on a shape that resembles the curved blade of the sickle, an agricultural tool. Sickle cells have a shorter life span than normally-shaped red blood cells. This results in chronic anemia characterized by low levels of hemoglobin and decreased numbers of red blood cells. Sickle cells are also less flexible and more sticky than normal red blood cells, and can become trapped in small blood vessels preventing blood flow. This compromises the delivery of oxygen, which can result in **pain** and damage to associated tissues and organs. Sickle cell disease presents with marked variability, even within families.

Carriers of the sickle cell gene are said to have sickle cell trait. Unlike sickle cell disease, sickle cell trait does not cause health problems. In fact, sickle cell trait is protective against **malaria**, a disease caused by blood-borne parasites transmitted through mosquito bites. According to a widely accepted theory, the genetic mutation associated with the sickle cell trait occurred thousands of years ago. Coincidentally, this mutation increased the likelihood that carriers would survive malaria infection. Survivors then passed the mutation on to their offspring, and the trait became established throughout areas where malaria was common. As populations migrated, so did the sickle cell trait. Today, approximately one in 12 African Americans has sickle cell trait.

Worldwide, it has been estimated that one in every 250,000 babies is born annually with sickle cell disease. Sickle cell disease primarily affects people of African, Mediterranean, Middle Eastern, and Asian Indian ancestry. In the United States, sickle cell disease is most often seen in African Americans, in whom the disease occurs in one out of every 400 births. The disease has been described in individuals from several different ethnic backgrounds and is also seen with increased frequency in Latino Americans—particularly those of Caribbean, Central American, and South American ancestry. Approximately one in every 1000-1400 Latino births are affected.

Causes and symptoms

Humans normally make several types of the oxygen-carrying protein hemoglobin. An individual's stage in development determines whether he or she makes primarily embryonic, fetal, or adult hemoglobins. All types of hemoglobin are made of three components: heme, alpha (or alpha-like) globin, and beta (or beta-like) globin. Sickle hemoglobin is the result of a genetic change in the beta globin component of normal adult hemoglobin. The beta globin gene is located on chromosome 11. The sickle cell form of the beta globin gene results from the substitution of a single DNA nucleotide, or genetic building-block. The change from adenine to thymine at codon (position) 6 of the beta globin gene leads to insertion of the amino acid valine–instead of glutamic acid–at this same position in the beta globin protein. As a result of this change, sickle hemoglobin has unique properties in comparison to the usual type of adult hemoglobin.

Most individuals have two normal copies of the beta globin gene, which make normal beta globin that is incorporated into adult hemoglobin. Individuals who have sickle cell trait (called sickle cell carriers) have one normal beta globin gene and one sickle cell gene. These individuals make both the usual adult hemoglobin and sickle hemoglobin in roughly equal proportions, so they do not experience any health problems as a result of having the trait. Although traces of blood in

the urine and difficulty in concentrating the urine can occur, neither represents a significant health problem as a result of sickle cell trait. Of the millions of people with sickle cell trait worldwide, a small handful of individuals have experienced acute symptoms. In these very rare cases, individuals were subject to very severe physical strain.

When both members of a couple are carriers of sickle cell trait, there is a 25% chance in each **pregnancy** for the baby to inherit two sickle cell genes and have sickle cell anemia, or SS disease. Correspondingly, there is a 50% chance the baby will have sickle cell trait and a 25% chance that the baby will have the usual type of hemoglobin. Other types of sickle cell disease include SC disease, SD disease, and S/beta **thalassemia**. These conditions are caused by the co-inheritance of the sickle cell gene and another altered beta globin gene. For example, one parent may have sickle cell trait and the other parent may have hemoglobin C trait (another hemoglobin trait that does not cause health problems). For this couple, there would be a 25% chance of SC disease in each pregnancy.

Normal adult hemoglobin transports oxygen from the lungs to tissues throughout the body. Sickle hemoglobin can also transport oxygen. However, once the oxygen is released, sickle hemoglobin tends to polymerize (line-up) into rigid rods that alter the shape of the red blood cell. Sickling of the red blood cell can be triggered by low oxygen, such as occurs in organs with slow blood flow. It can also be triggered by cold temperatures and **dehydration**.

Sickle cells have a decreased life span in comparison to normal red blood cells. Normal red blood cells survive for approximately 120 days in the bloodstream; sickle cells last only 10–12 days. As a result, the bloodstream is chronically short of red blood cells and hemoglobin, and the affected individual develops anemia.

Sickle cells can create other complications. Due to their shape, they do not fit well through small blood vessels. As an aggravating factor, the outside surfaces of sickle cells may have altered chemical properties that increase the cells' 'stickiness'. These sticky sickle cells are more likely to adhere to the inside surfaces of small blood vessels, as well as to other blood cells. As a result of the sickle cells' shape and stickiness, blockages form in small blood vessels. Such blockages prevent oxygenated blood from reaching areas where it is needed, causing pain as well as organ and tissue damage.

The severity of symptoms cannot be predicted based solely on the genetic inheritance. Some individuals with sickle cell disease develop health- or life-threatening problems in infancy, but others may have only mild symptoms throughout their lives. Individuals may experience varying degrees of health at different stages in the life cycle. For the most part, this clinical variability is unpredictable, and the reasons for the observed variability can not usually be determined. However, certain types of sickle cell disease (i.e. SC disease) tend to result in fewer and less severe symptoms on average than other types of sickle cell disease (i.e. SS disease). Some additional modifying factors are known. For example, elevated levels of fetal hemoglobin in a child or adult can decrease the quantity and severity of some symptoms and complications. Fetal hemoglobin is a normally occurring hemoglobin that usually decreases from over 90% of the total hemoglobin to under 1% during the first year of life. This change is genetically determined, although some individuals may experience elevated levels of fetal hemoglobin due to variation in the genes that control fetal hemoglobin production. Such individuals often experience a reduction in their symptoms and complications due to the ability of fetal hemoglobin to prevent the polymerization of sickle hemoglobin, which leads to sickling of the red blood cell.

There are several symptoms that warrant immediate medical attention, including the following:

- signs of infection (**fever** greater than 101°F or 38.3°C, coughs frequently or breathing trouble, unusual crankiness, feeding difficulties)
- signs of severe anemia (pale skin or lips, yellowing of the skin or eyes, very tired, very weak)
- signs indicating possible dehydration (vomiting, **diarrhea**, fewer wet diapers)
- other signs (pain or swelling in the abdomen, swollen hands or feet, screams when touched)

These can be signs of various complications that occur in sickle cell disease.

Infections and effects on the spleen

Children with sickle cell disease who are under age three are particularly prone to life-threatening bacterial infections. *Streptococcus pneumoniae* is the most common offending bacteria, and invasive infection from this organism leads to **death** in 15% of cases. The spleen, an organ that helps to fight bacterial infections, is particularly vulnerable to the effects of sickling. Sickle cells can impede blood flow through the spleen, causing organ damage, which usually results in loss of spleen function by late childhood. The spleen can also become enlarged due to blockages and/or increased activity of the spleen. Rapid enlargement of the spleen may be a sign of another complication called *splenic sequestration*, which occurs mostly in young children and can be life-threatening.

Widespread sickling in the spleen prevents adequate blood flow from the organ, removing increasing volumes of blood from the circulation and leading to accompanying signs of severe anemia.

Painful events

Painful events, also known as *vaso-occlusive events*, are a hallmark symptom of sickle cell disease. The frequency and duration of the pain can vary tremendously from person to person and over an individual's lifecycle. Painful events are the most common cause of hospitalizations in sickle cell disease. However, only a small portion of individuals with sickle cell disease experience frequent and severe painful events. Most painful events can be managed at home. Pain results when small blood vessel blockages prevent oxygen from reaching tissues. Pain can affect any area of the body, although the extremities, chest, abdomen, and bones are frequently affected sites. There is some evidence that cold temperatures or infection can trigger a painful event, but most events occur for unknown reasons. The hand-foot syndrome, or *dactylitis*, is a particular type of painful event. Most common in toddlers, dactylitis results in pain and swelling in the hands and feet, sometimes accompanied by a fever.

Anemia

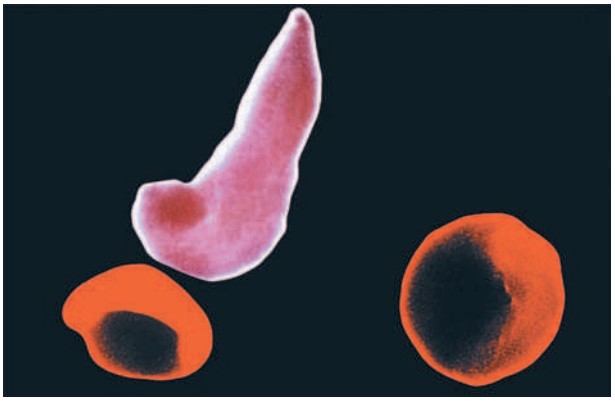
Sickle cells have a high turnover rate leading to a deficit of red blood cells in the bloodstream. Common symptoms of anemia include **fatigue**, paleness, and a **shortness of breath**. A particularly severe form of anemia—aplastic anemia—occurs following infection with parvovirus. Parvovirus causes extensive destruction of the bone marrow, bringing production of new red blood cells to a halt. Bone marrow production resumes after seven to 10 days; however, given the short lives of sickle cells, even a brief shut-down in red blood cell production can cause a rapid decline in hemoglobin concentrations.

Delayed growth

The energy demands of the bone marrow for red blood cell production compete with the demands of a growing body. Children with sickle cell anemia may have delayed growth and reach **puberty** at a later age than normal. By early adulthood, they catch up on growth and attain normal height; however, weight typically remains below average.

Stroke

Children with sickle cell disease have a significantly elevated risk of having a **stroke**, which can be one of the most concerning complications of sickle cell disease. Approximately 11% of individuals with sickle cell disease will have a recognizable stroke by the age of 20. **Magnetic resonance imaging** studies have found that 17% of children with sickle cell anemia have evidence of a previous stroke or clinically 'silent' stroke-like events called *transient ischemic events*. Stroke in sickle cell disease is usually caused by a blockage of a blood vessel, but about one fourth of the time may be caused by a hemorrhage (or rupture) of a blood vessel.



A scanning electron microscopy (SEM) scan of red blood cells taken from a person with sickle cell anemia. The blood cells at the bottom are normal; the diseased, sickle-shaped cells appear at the top. *(Photograph by Dr. Gopal Murti, Photo Researchers, Inc. Reproduced by permission.)*

Strokes result in compromised delivery of oxygen to an area of the brain. The consequences of stroke can range from life-threatening, to severe physical or cognitive impairments, to apparent or subtle learning disabilities, to undetectable effects. Common stroke symptoms include weakness or numbness that affects one side of the body, sudden behavioral changes, loss of vision, confusion, loss of speech or the ability to understand spoken words, **dizziness**, **headache**, seizures, vomiting, or even **coma**.

Approximately two-thirds of the children who have a stroke will have at least one more. Transfusions have been shown to decrease the incidence of a second stroke. A recent study showed that children at highest risk to experience a first stroke were 10 times more likely to stroke if untreated when compared to high-risk children treated with chronic blood **transfusion** therapy. High-risk children were identified using transcranial doppler ultrasound technology to detect individuals with increased blood flow speeds due to constricted intracranial blood vessels.

Acute Chest Syndrome

Acute chest syndrome (ACS) is a leading cause of death for individuals with sickle cell disease, and recurrent attacks can lead to permanent lung damage. There-

fore rapid diagnosis and treatment is of great importance. ACS can occur at any age and is similar but distinct from **pneumonia**. Affected persons may experience fever, **cough**, chest pain, and shortness of breath. ACS seems to have multiple causes including infection, sickling in the small blood vessels of the lungs, fat embolisms to the lungs, or a combination of factors.

Priapism

Males with sickle cell anemia may experience **priapism**, a condition characterized by a persistent and painful erection of the penis. Due to blood vessel blockage by sickle cells, blood is trapped in the tissue of the penis. Priapism may be short in duration or it may be prolonged. Priapism can be triggered by low oxygen (hypoxemia), alcohol consumption, or sexual intercourse. Since priapism can be extremely painful and result in damage to this tissue causing **impotence**, rapid treatment is essential.

Kidney disease

The environment in the kidney is particularly prone to damage from sickle cells. Signs of kidney damage can include blood in the urine, incontinence, and enlarged kidneys. Adults with sickle cell disease often experience insufficient functioning of the kidneys, which can progress to kidney failure in a small percentage of adults with sickle cell disease.

Jaundice and gallstones

Jaundice is indicated by a yellow tone in the skin and eyes, and alone it is not a health concern. Jaundice may occur if bilirubin levels increase, which can occur with high levels of red blood cell destruction. Bilirubin is the final product of hemoglobin degradation, and is typically removed from the bloodstream by the liver. Therefore, jaundice can also be a sign of a poorly functioning liver, which may also be evidenced by an enlarged liver. Increased bilirubin also leads to increased chance for **gallstones** in children with sickle cell disease. Treatment, which may include removal of the gall bladder, may be selected if the gallstones start causing symptoms.

Retinopathy

The blood vessels that supply oxygen to the retina—the tissue at the back of the eye—may be blocked by sickle cells, leading to a condition called retinopathy. This is one of the only complications that is actually more common in SC disease as compared to SS disease. Retinopathy can be identified through regular ophthalmology evaluations and effectively treated in order to avoid damage to vision.

Joint problems

Avascular necrosis of the hip and shoulder joints, in which bone damage occurs due to compromised blood flow due to sickling, can occur later in childhood. This complication can affect an individual's physical abilities and result in substantial pain.

Diagnosis

Inheritance of sickle cell disease or trait cannot be prevented, but it may be predicted. Screening is recommended for individuals in high-risk populations. In the United States, African Americans and Latino Americans have the highest risk of having the disease or trait. Sickle cell is also common among individuals of Mediterranean, Middle Eastern, and Eastern Indian descent.

A complete **blood count** (CBC) will describe several aspects of an individual's blood cells. A person with sickle cell disease will have a lower than normal hemoglobin level, together with other characteristic red blood cell abnormalities. A *hemoglobin electrophoresis* is a test that can help identify the types and quantities of hemoglobin made by an individual. This test uses an electric field applied across a slab of gel-like material. Hemoglobins migrate through this gel at various rates and to specific locations, depending on their size, shape, and electrical charge. Although sickle hemoglobin (Hb S) and regular adult hemoglobin (called Hb A) differ by only one amino acid, they can be clearly separated using **hemoglobin electrophoresis**. *Isoelectric focusing* and *high-performance liquid chromatography (HPLC)* use similar principles to separate hemoglobins and can be used instead of or in various combinations with hemoglobin electrophoresis to determine the types of hemoglobin present.

Another test called the 'sickledex' can help confirm the presence of sickle hemoglobin, although this test cannot provide accurate or reliable diagnosis when used alone. When Hb S is present, but there is an absence or only a trace of Hb A, sickle cell anemia is a likely diagnosis. Additional beta globin *DNA testing*, which looks directly at the beta globin gene, can be performed to help confirm the diagnosis and establish the exact genetic type of sickle cell disease. CBC and hemoglobin electrophoresis are also typically used to diagnose sickle cell trait and various other types of beta globin traits.

Diagnosis of sickle cell disease can occur under various circumstances. If an individual has symptoms that are suggestive of this diagnosis, the above-described screening tests can be performed followed by DNA testing, if indicated. Screening at birth using HPLC or a related technique offers the opportunity for early intervention. More than 40 states include sickle cell screening

KEY TERMS

Amino acid—Organic compounds that form the building blocks of protein. There are 20 types of amino acids (eight are "essential amino acids" which the body cannot make and must therefore be obtained from food).

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Bilirubin—A yellow pigment that is the end result of hemoglobin breakdown. This pigment is metabolized in the liver and excreted from the body through the bile. Bloodstream levels are normally low; however, extensive red cell destruction leads to excessive bilirubin formation and jaundice.

Bone marrow—A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

Bone marrow transplantation—A medical procedure used to treat some diseases that arise from defective blood cell formation in the bone marrow. Healthy bone marrow is extracted from a donor to replace the marrow in an ailing individual. Proteins on the surface of bone marrow cells must be identical or very closely matched between a donor and the recipient.

Globin—One of the component protein molecules found in hemoglobin. Normal adult hemoglobin has a pair each of alpha-globin and beta-globin molecules.

Heme—The iron-containing molecule in hemoglobin that serves as the site for oxygen binding.

Hemoglobin—Protein-iron compound in the blood that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hemoglobin A—Normal adult hemoglobin that contains a heme molecule, two alpha-globin molecules, and two beta-globin molecules.

Hemoglobin electrophoresis—A laboratory test that separates molecules based on their size, shape, or electrical charge.

Hemoglobin S—Hemoglobin produced in association with the sickle cell trait; the beta-globin molecules of hemoglobin S are defective.

Hydroxyurea—A drug that has been shown to induce production of fetal hemoglobin. Fetal hemoglobin has a pair of gamma-globin molecules in place of the typical beta-globins of adult hemoglobin. Higher-than-normal levels of fetal hemoglobin can prevent sickling from occurring.

Impotence—The inability to have a penile erection, which can be due to tissue damage resulting from sickling within the penis (priapism).

Iron overload—A side effect of frequent blood transfusions in which the body accumulates abnormally high levels of iron. Iron deposits can form in organs, particularly the heart, and cause life-threatening damage.

Jaundice—Yellowing of the skin or eyes due to excess of bilirubin in the blood.

Magnetic resonance imaging (MRI)—A technique that employs magnetic fields and radio waves to create detailed images of internal body structures and organs, including the brain.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Narcotics—Strong, prescription medication that can be effective in treating pain, but have the potential to be habit-forming if their use is not supervised correctly.

Nucleic acid—A type of chemical used as a component for building DNA. The nucleic acids found in DNA are adenine, thymine, guanine, and cytosine.

Ophthalmology—The medical specialty of vision and the eye.

Placenta—The organ responsible for oxygen and nutrition exchange between a pregnant mother and her developing baby.

Red blood cell—Hemoglobin-containing blood cells that transport oxygen from the lungs to tissues. In the tissues, the red blood cells exchange their oxygen for carbon dioxide, which is brought back to the lungs to be exhaled.

Screening—Process through which carriers of a trait may be identified within a population.

Sickle cell—A red blood cell that has assumed an elongated shape due to the presence of hemoglobin S.

as part of the usual battery of blood tests done for newborns. This allows for early identification and treatment. Hemoglobin trait screening is recommended for any individual of a high-risk ethnic background who may be considering having children. When both members of a couple are found to have sickle cell trait, or other related hemoglobin traits, they can receive **genetic counseling** regarding the risk of sickle cell disease in their future children and various testing options.

Sickle cell disease can be identified before birth through the use of prenatal diagnosis. *Chorionic villus sampling (CVS)* can be offered as early as 10 weeks of pregnancy and involves removing a sample of the placenta made by the baby and testing the cells. CVS carries a risk of causing a **miscarriage** that is between one-half to one percent.

Amniocentesis is generally offered between 15 and 22 weeks of pregnancy, but can sometimes be offered earlier. Two to three tablespoons of the fluid surrounding the baby is removed. This fluid contains fetal cells that can be tested. This test carries a risk of causing a miscarriage, which is not greater than 1%. Pregnant woman and couples may choose prenatal testing in order to prepare for the birth of a baby that may have sickle cell disease. Alternately, knowing the diagnosis during pregnancy allows for the option of pregnancy termination.

Preimplantation genetic diagnosis (PGD) is a relatively new technique that involves in-vitro fertilization followed by **genetic testing** of one cell from each developing embryo. Only the embryos unaffected by sickle cell disease are transferred back into the uterus. PGD is currently available on a research basis only, and is relatively expensive.

Treatment

There are several practices intended to prevent some of the symptoms and complications of sickle cell disease. These include preventative **antibiotics**, good hydration, immunizations, and access to comprehensive care. Maintaining good health through adequate **nutrition**, avoiding stresses and infection, and getting proper rest is also important. Following these guidelines is intended to improve the health of individuals with sickle cell disease.

Penicillin

Infants are typically started on a course of penicillin that extends from infancy to age six. Use of this antibiotic is meant to ward off potentially fatal infections. Infections at any age are treated aggressively with antibiotics. Vaccines for common infections, such as *pneumococcal pneumonia*, are also recommended.

Pain management

Pain is one of the primary symptoms of sickle cell anemia, and controlling it is an important concern. The methods necessary for pain control are based on individual factors. Some people can gain adequate pain control through over-the-counter oral painkillers (**analgesics**). Other individuals, or painful events, may require stronger methods which can include administration of narcotics. Alternative therapies may be useful in avoiding or controlling pain, including relaxation, hydration, avoiding extremes of temperature, and the application of local warmth.

Blood transfusions

Blood transfusions are not usually given on a regular basis but are used to treat individuals with frequent and severe painful events, severe anemia, and other emergencies. In some cases blood transfusions are given as a preventative measure, for example to treat spleen enlargement or prevent a second stroke (or a first stroke in an individual shown to be at high risk).

Regular blood transfusions have the potential to decrease formation of hemoglobin S, and reduce associated symptoms. However, there are limitations and risks associated with regular blood transfusions, including the risk of blood-borne infection and sensitization to proteins in the transfused blood that can make future transfusions very difficult. Most importantly, chronic blood transfusions can lead to iron overload. The body tends to store excess iron, such as that received through transfusions, in various organs. Over time, this iron storage can cause damage to various tissues and organs, such as the heart and endocrine organs.

Some of this damage can be prevented by the administration of a medication called *desferoxamine* that helps the body to eliminate excess iron through the urine. Alternately, some individuals receive a new, non-standard treatment called *erythrocytapheresis*. This involves the automated removal of sickle cells and is used in conjunction with a reduced number of regular transfusions. This treatment helps to reduce iron overload.

Hydroxyurea

Emphasis is being placed on developing drugs that treat sickle cell anemia directly. The most promising of these drugs in the late 1990s is hydroxyurea, a drug that was originally designed for anticancer treatment. Hydroxyurea has been shown to reduce the frequency of painful crises and acute chest syndrome in adults, and to lessen the need for blood transfusions. Hydroxyurea, and other related medications, seem to work by inducing a higher production of fetal hemoglobin. The major side effects of

the drug include decreased production of platelets, red blood cells, and certain white blood cells. The effects of long-term hydroxyurea treatment are unknown.

Bone marrow transplantation

Bone marrow transplantation has been shown to cure sickle cell anemia in some cases. This treatment is reserved primarily for severely affected children with a healthy donor whose marrow proteins match those of the recipient, namely a brother or sister who has inherited the same tissue type. Indications for a bone marrow transplant are stroke, recurrent acute chest syndrome, and chronic unrelieved pain.

Bone marrow transplantations tend to be the most successful in children; adults have a higher rate of transplant rejection and other complications. There is approximately a 10% fatality rate associated with bone marrow transplants done for sickle cell disease. Survivors face potential long-term complications, such as chronic graft-versus-host disease (an immune-mediated attack by the donor marrow against the recipient's tissues), **infertility**, and development of some forms of **cancer**. A relatively recent advance in transplantation involves the use of donor stem cells obtained from *cord blood*, the blood from the placenta that is otherwise discarded following the birth of a new baby. Cord blood cells, as opposed to fully mature bone marrow cells, appear to be less likely to result in graft-versus-host disease in the recipient. This increases the safety and efficacy of the transplant procedure.

Surgery

Certain surgical interventions are utilized in the treatment of specific sickle cell-related complications. Removal of a dysfunctioning gallbladder or spleen can often lead to improvements in health. Investigations are currently underway to establish the efficacy of hip coring surgery, in which a portion of affected bone is removed to treat avascular necrosis of the hip. The hope is that this may provide an effective treatment to alleviate some pain and restore function in the affected hip.

Psychosocial support

As in any lifelong, chronic disease, comprehensive care is important. Assistance with the emotional, social, family-planning, economic, vocational, and other consequences of sickle cell disease can enable affected individuals to better access and benefit from their medical care.

Prognosis

Sickle cell disease is characteristically variable between and within affected individuals. Predicting the course of the disorder based solely on genes is not possible. Several factors aside from genetic inheritance determine the prognosis for affected individuals, including the frequency, severity, and nature of specific complications in any given individual. The availability and access of comprehensive medical care also plays an important role in preventing and treating serious, acute complications, which cause the majority of sickle cell-related deaths. For those individuals who do not experience such acute events, life-expectancy is probably substantially greater than the average for all people with sickle cell disease. The impact of recent medical advances supports the hypothesis that current life-expectancies may be significantly greater than those estimated in the early 1990s. At that time, individuals with SS disease lived to the early- to mid-40s, and those with SC disease lived into the upper 50s *on average*. With early detection and comprehensive medical care, most people with sickle cell disease are in fairly good health most of the time. Most individuals can be expected to live well into adulthood, enjoying an improved quality of life including the ability to choose a variety of education, career, and family-planning options for themselves.

Resources

BOOKS

Beutler, Ernest. "The Sickle Cell Diseases and Related Disorders." In *Williams Hematology,* edited by Ernest Beutler, et al. 5th ed. New York: McGraw-Hill, 1995.

Bloom, Miriam. *Understanding Sickle Cell Disease.* Jackson, MS: University Press of Mississippi, 1995.

Embury, Stephen H., et al., eds. *Sickle Cell Disease: Basic Principles and Clinical Practice.* New York: Raven Press, 1994.

Reid, C.D., S. Charache, and B. Lubin, eds. *Management and Therapy of Sickle Cell Disease.* 3rd ed. National Institutes of Health Publication No. 96-2117, 1995.

PERIODICALS

Adams, R. J., et al. "Prevention of a First Stroke by Transfusions in Children with Sickle Cell Anemia and Abnormal Results on Transcranial Doppler Ultrasonography." *New England Journal of Medicine,* 339 (1998): 5-11.

Davies, Sally C. "Management of Patients with Sickle Cell Disease." *British Medical Journal* 315 (September 13, 1997): 656.

Golden, C., L. Styles, and E. Vichinsky. "Acute Chest syndrome and Sickle Cell Disease." *Current Opinion in Hematology* 5 (1998): 89-92.

Hoppe, C., L. Styles, and E. Vichinsky. "The Natural History of Sickle Cell Disease." *Current Opinion in Pediatrics* 10 (1998): 49-52.

Kinney, T.R., et al. "Safety of Hydroxyurea in Children with Sickle Cell Anemia: Results of the HUG-KIDS Study, A Phase I/II Trial." *Blood* 94 (1999): 1550-1554.

Platt, O., et al. "Mortality in Sickle Cell Disease: Life Expectancy and Risk Factors for Early Death." *New England Journal of Medicine* 330 (1994): 1639-1644.

Reed, W., and E.P. Vichinsky. "New Considerations in the Treatment of Sickle Cell Disease." *Annual Review of Medicine* 49 (1998): 461.

Schnog, J.B., et al. "New Concepts in Assessing Sickle Cell Disease Severity." *American Journal of Hematology* 58 (1998): 61-66.

Serjeant, Graham R. "Sickle-Cell Disease." *The Lancet* 350 (September 6, 1997): 725.

Singer, S.T., et al. "Erythrocytapheresis for Chronically Transfused Children with Sickle Cell Disease: An Effective Method for Maintaining a Low Hemoglobin S Level and Reducing Iron Overload." *Journal of Clinical Apheresis* 14 (1999): 122-125.

Xu, K., et. al. "First Unaffected Pregnancy Using Preimplantation Genetic Diagnosis for Sickle Cell Anemia." *Journal of the American Medical Association* 281 (1999): 1701-1706.

ORGANIZATIONS

Sickle Cell Disease Association of America, Inc. 200 Corporate Point Suite 495, Culver City, CA 90230-8727. (800) 421-8453. <Scdaa@sicklecelldisease.org>. <http://sicklecelldisease.org/>.

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Sideroblastic anemia

Definition

Sideroblastic anemia is a term used to describe a group of rare blood disorders characterized by the bone marrow's inability to manufacture normal red blood cells.

Description

Named for the Greek words for iron and germ, sideroblastic anemia is one of the principal types of iron-utilization anemia. Abnormal, iron-saturated red cells are present in the blood of people who have this disease. Although the iron circulates normally from the plasma to the bone marrow, where new red blood cells are created, it is not properly incorporated into new red blood cells.

Sideroblastic anemia can be inherited, but the disease is usually acquired as a result of illness or exposure to toxic substances.

Sideroblastic anemia is a disease of adults.

Causes and symptoms

The cause of sideroblastic anemia cannot always be identified. Drug toxicity, alcohol abuse, and **lead poisoning** are common causes of this condition.

Sideroblastic anemia is also associated with:

- leukemia
- lymphoma (**cancer** of the lymph glands)
- myeloma (cancer of the bone marrow)
- rheumatoid arthritis, and other inflammatory diseases

Symptoms of sideroblastic anemia are the same as symptoms of the disease that causes the condition, as well as anemia.

Complications

Possible complications of sideroblastic anemia include:

- congestive **heart failure**
- diabetes mellitus
- enlargement of the liver and spleen
- formation of liver nodules and scar tissue
- irregular heartbeat
- recurring inflammation of the sac that surrounds the heart
- secondary **hypopituitarism** (dwarfism)
- skin darkening
- underactivity of the thyroid gland

Diagnosis

Blood tests are used to examine the appearance and other characteristics of red cells and to measure the amount of iron in the blood. Bone marrow biopsy is also used.

Treatment

Acquired sideroblastic anemia may be cured when the condition that causes it is treated or removed.

If the cause of a patient's anemia cannot be determined, blood transfusions may be necessary. Medications are prescribed to stimulate excretion or excess iron that accumulates as a result of these transfusions.

In rare instances, treatment with oral pyridoxine (a B-complex vitamin) benefits patients whose sideroblastic anemia was present at birth. This treatment improves the condition of some patients but does not cure the anemia.

Prognosis

Sideroblastic anemia of unknown origin may lead to leukemia. It may take as long as 10 years for this disease progression to take place.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

Leukemia Society of America, Inc. 600 Third Ave., New York, NY 10016. (212) 573-8484. <http://www.leukemia.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

OTHER

"Iron-utilization Anemias." *The Merck Page*. 3 June 1998 <http://www.merck.com>.

Haggerty, Maureen. "Sideroblastic Anemia." *A Healthy Me Page*. 31 May 1998 <http://www.ahealthyme.com/topic/sideroblastic>.

Maureen Haggerty

SIDS *see* **Sudden infant death syndrome**

Sigmoidoscopy

Definition

Sigmoidoscopy is a procedure by which a doctor inserts either a short and rigid or slightly longer and flexible fiber-optic tube into the rectum to examine the lower portion of the large intestine (or bowel).

Purpose

Sigmoidoscopy is used most often in screening for colorectal **cancer** or to determine the cause of rectal bleeding. It is also used for the diagnosis of inflammatory bowel disease and other benign diseases of the lower intestine.

Cancer of the rectum and colon is the second most common cancer in the United States, and claims the lives of approximately 60,000 people annually. As a result, cancer authorities now recommend that people over 50 be screened for colorectal cancer every three to five years. Screening at an earlier age should be done on patients who have a family history of colon or **rectal cancer**, or small growths in the colon (polyps).

Individuals with inflammatory bowel disease (Crohn's colitis or **ulcerative colitis**) are at increased risk for colorectal cancer and should begin their screenings at a younger age, and be screened more frequently. Many doctors screen such patients more often than every three to five years. Those with ulcerative colitis should be screened beginning 10 years after the onset of disease; those with Crohn's colitis beginning 15 years after the onset of disease.

Some doctors prefer to do this screening with a colonoscope, which allows them to see the entire colon (certain patients, such as those with Crohn's colitis or ulcerative colitis, must be screened with a colonoscope). However, compared with sigmoidoscopy, **colonoscopy** is a longer process, causes more discomfort, and is more costly.

Studies have indicated that about one quarter of all precancerous or small cancerous growths in the colorectal region can be seen with a rigid sigmoidoscope. The longer, flexible version, which is the primary type of sigmoidoscope used in the screening process, can detect more than half of all growths in this region. This examination is usually performed in combination with a **fecal occult blood test**, in an effort to increase detection of polyps and cancers that lie beyond the scope's reach.

Precautions

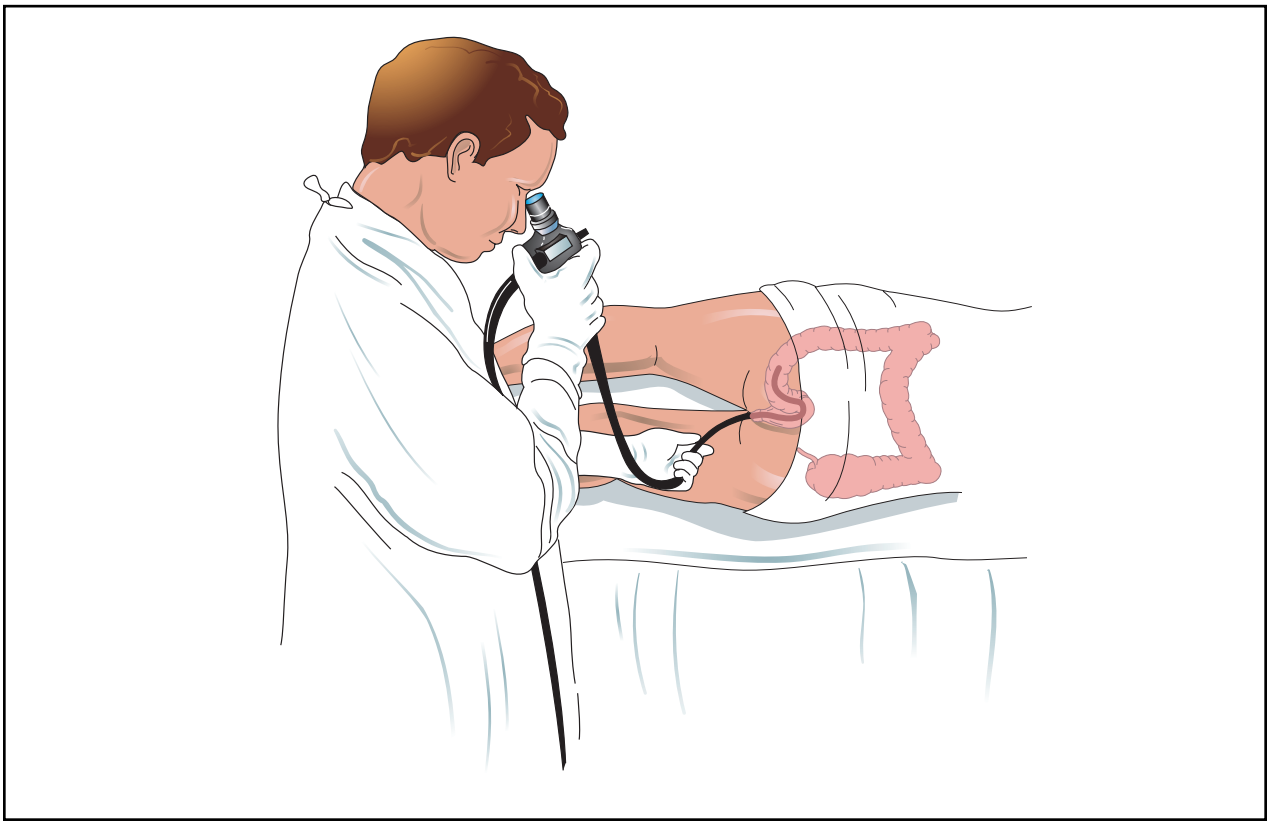
Sigmoidoscopy can usually be conducted in a doctor's office or a health clinic. However, some individuals should have the procedure done in a hospital day surgery facility. These include patients with rectal bleeding, and patients whose blood does not clot well (possibly as a result of blood-thinning medications).

Description

Most sigmoidoscopy is done with a flexible fiber-optic tube. The tube contains a light source and a camera lens. The doctor moves the sigmoidoscope up beyond the rectum (the first 1 ft/30 cm of the colon), examining the interior walls of the rectum. If a 2 ft/60 cm scope is used, the next portion of the colon can also be examined for any irregularities.

The procedure takes 20 to 30 minutes, during which time the patient will remain awake. Light **sedation** may be given to some patients. There is some discomfort (usually bloating and cramping) because air is injected into the bowel to widen the passage for the sigmoidoscope. **Pain** is rare except in individuals with active inflammatory bowel disease.

In a colorectal cancer screening, the doctor is looking for polyps or tumors. Studies have shown that over time, many polyps develop into cancerous lesions and tumors. Using instruments threaded through the fiber-optic tube,



Sigmoidoscopy is a procedure most often used in screening for colorectal cancer and as a test in diagnosis of possible inflammatory bowel disease. As illustrated above, the physician can view the rectum and colon through a sigmoidoscope, a 12 inch (30 cm) or 24 inch (60 cm) flexible fiber-optic tube which contains a light source and a lens. *(Illustration by Electronic Illustrators Group.)*

cancerous or precancerous polyps can either be removed or biopsied during the sigmoidoscopy. People who have cancerous polyps removed can be referred for full colonoscopy, or more frequent sigmoidoscopy, as necessary.

The doctor may also look for signs of ulcerative colitis, which include a loss of blood flow to the lining of the bowel, a thickening of the lining, and sometimes a discharge of blood and pus mixed with stool. The doctor can also look for **Crohn's disease**, which often appears as shallow or deep ulcerations, or erosions and fissures in the lining of the colon. In many cases, these signs appear in the first few centimeters of the colon above the rectum, and it is not necessary to do a full colonoscopic exam.

Private insurance plans often cover the cost of sigmoidoscopy for screening in healthy individuals over 50, or for diagnostic purposes. Medicare covers the cost for diagnostic exams, and may cover the costs for screening exams.

Preparation

The purpose of preparation for sigmoidoscopy is to clean the lower bowel of stool so that the doctor can see the lining. Many patients are required to consume only clear liquids on the day before the test, and to take two **enemas** on the morning of the procedure. The bowel is cleaner, however, if patients also take an oral laxative preparation of 1.5 oz phospho-soda the evening before the sigmoidoscopy.

Certain medications should be avoided for a week before having a sigmoidoscopy. These include:

- aspirin, or products containing aspirin
- ibuprofin products (Nuprin, Advil, or Motrin)
- iron or **vitamins** containing iron

Although most prescription medication can be taken as usual, patients should check with their doctor in advance.

Aftercare

Patients may feel mild cramping after the procedure that will improve after passing gas. Patients can resume their normal activities almost immediately.

KEY TERMS

Biopsy—A procedure where a piece of tissue is removed from a patient for diagnostic testing.

Colorectal cancer—Cancer of the large intestine, or colon, including the rectum (the last 16 in of the large intestine before the anus).

Inflammatory bowel disease—Ulcerative colitis or Crohn's colitis; chronic conditions characterized by periods of diarrhea, bloating, abdominal cramps, and pain, sometimes accompanied by weight loss and malnutrition because of the inability to absorb nutrients.

Polyp—A small growth that can be precancerous when it appears in the colon.

Risks

There is a slight risk of bleeding from the procedure. This risk is heightened in individuals whose blood does not clot well, either due to disease or medication, and in those with active inflammatory bowel disease. The most serious complication of sigmoidoscopy is bowel perforation (tear). This complication is very rare, however, occurring only about once in every 7,500 procedures.

Normal results

A normal exam shows a smooth bowel wall with no evidence of inflammation, polyps or tumors.

Abnormal results

For a cancer screening sigmoidoscopy, an abnormal result involves one or more noncancerous or precancerous polyps or tumors. Patients showing polyps have an increased risk of developing colorectal cancer in the future.

Small polyps can be completely removed. Larger polyps or tumors usually require the doctor to remove a portion of the growth for diagnostic testing. Depending on the test results, the patient is then scheduled to have the growth removed surgically, either as an urgent matter if it is cancerous, or as an elective surgery within a few months if it is noncancerous.

In a diagnostic sigmoidoscopy, an abnormal result shows signs of active inflammatory bowel disease, either a thickening of the intestinal lining consistent with ulcerative colitis, or ulcerations or fissures consistent with Crohn's disease.

Resources

BOOKS

Cahill, Matthew, et al, ed. *Everything You Need To Know About Medical Tests*. Springhouse, PA: Springhouse Corporation, 1996.

Feldman, Mark, et al, ed. *Sleisenger and Fordtran's Gastrointestinal and Liver Disease,* 6th ed. Philadelphia: W.B Saunders Company, 1998.

PERIODICALS

Johnson, Brett Andrew. "Flexible Sigmoidoscopy: Screening for Colorectal Cancer." *American Family Physician* 59, no. 6 (March 15, 1999): 1537–46.

Manoucheri, Manoucher, et al. "Bowel Preparations for Flexible Sigmoidoscopy: Which Method Yields the Best Results?" *The Journal of Family Practice* 48, no. 4 (April, 1999): 272–4.

OTHER

"Diagnostic Tests." *The National Digestive Diseases Information Clearinghouse (National Institutes of Health).* 5 July 2001 <http://www.niddk.nih.gov/health/digest/pubs/diagtest/index.htm>.

Jon H. Zonderman

Sildenafil citrate

Definition

Sildenafil citrate (Viagra) is a medication used to treat *erectile dysfunction* (ED), or **impotence**, in men.

Purpose

Viagra treats erectile dysfunction, the inability to achieve and/or maintain an erection of the penis that is adequate for sexual intercourse. Ten to fifteen million men in the United States suffer from ED, and by age 65, up to 25% of men have experienced impotence problems. Erectile dysfunction can be caused by a number of physical and psychological conditions, including diabetes, depression, **prostate cancer**, **spinal cord injury**, **multiple sclerosis**, artherosclerosis, and heart disease. Injuries to the penis that cause nerve, tissue, or vascular damage can trigger impotence. It is also a common side effect of some prescription medications, including **antihistamines**, antidepressants, antihypertensives, antipsychotics, **beta blockers**, **diuretics**, tranquilizers, appetite suppressants, cimetidine (Tagamet), and finasteride (Propecia).

Although not approved for use in women, clinical studies have shown that sildenafil citrate may be effective in relieving female **sexual dysfunction** for some women. In one study, both female and male study partici-

pants who suffered from sexual dysfunction related to their use of psychotropic medications such as **benzodiazepines** reported an increase in arousal and overall sexual satisfaction when they began taking Viagra. Several studies have also indicated the drug may be effective in improving libido and arousal in women taking selective serotonin uptake inhibitors (SSRIs).

Another investigational study conducted by researchers at Johns Hopkins University School of Medicine in Baltimore, and published in the August 2000 issue of the *Journal of Clinical Investigation* found that Viagra may have additional clinical promise for people with diabetes beyond treating ED. In animal studies, Viagra was effective in relaxing the pyloric muscle of stomach, improving digestion and relieving the symptoms of gastroparesis. Up to 75% of people with diabetes suffer from gastroparesis, which causes bloating, nausea, loss of appetite, and vomiting. Further human studies are needed to evaluate Viagra's effectiveness in treating this common diabetic complication.

Because of its capacity to enhance nitric oxide production, sildenafil has been investigated as a possible treatment for other disorders that are caused by impaired nitric oxide production. One such disorder is esophageal motility dysfunction (**achalasia**), in which the smooth muscles of the esophagus and the cardiac sphincter remain constricted, causing difficulty in swallowing, regurgitation of food, and chest **pain** when eating. A study published in 2000 in the journal *Gastroenterology* found that sildenafil temporarily improved the condition in some patients by relaxing the lower esophageal muscles.

Precautions

Viagra is not labeled or approved for use by women or children, or by men without erectile dysfunction. The medication may also be contraindicated (not recommended for use) in patients with certain medical conditions.

Because sexual activity can **stress** the heart, men who have heart problems should check with their physician to see if sexual activity is recommended. Viagra may trigger temporary **hypotension** (low blood pressure) and is known to increase cardiovascular nerve activity, so it is prescribed with caution in men with a history of **heart attack**, artherosclerosis, **angina**, arrhythmia, and chronic low blood pressure problems. However, a study published in the March 15, 2001, *British Medical Journal* found no evidence that the drug causes a higher incidence of heart attack. Further long-term studies are needed to determine the full implications of sildenafil citrate on heart disease.

Anyone experiencing cardiovascular symptoms such as **dizziness**, chest or arm pain, and nausea when participating in sexual activity after taking Viagra should stop the encounter. They should also not take Viagra again until they have discussed the episode with their healthcare provider.

It is recommended that men with kidney or liver impairments, and men over age 65, start at the lowest possible dosage of Viagra (25 mg). Clinical studies have shown that the drug builds up in the plasma of these patients to a concentration that is three to eight times higher than normal. Caution is also recommended in prescribing the drug to individuals with *retinitis pigmentosa*, a rare genetic eye disorder. Viagra should not be taken more than once per day by anyone.

Viagra has not been studied for use on patients with stomach ulcers and bleeding disorders, and its safety in these individuals is unknown. Men who have either of these conditions should let their physician know before taking Viagra. It should also be used with caution in men with misshapen or deformed penises, such as those with **Peyronie's disease**, cavernosal fibrosis, or with angulation of the penis.

Men who take medications containing nitrates (e.g., nitroglycerin, isosorbide mononitrate, isosorbide dinitrate) should never take Viagra, as the interaction between the two drugs may cause a dramatic drop in blood pressure, and possibly trigger a heart attack or **stroke**. This includes illegal recreational drugs such as amyl nitrates (also known as poppers).

Viagra may also interact with other prescription and over-the-counter (OTC) medications, either magnifying or diluting the intended therapeutic effects of one or both drugs. Some drugs that have a known interaction with Viagra include the protease inhibitor ritonavir and the antibiotic erythromycin. For this reason, it is critical that men who are prescribed Viagra let their healthcare providers know all the medications they are taking.

Other medications and therapies for erectile dysfunction, including vacuum or pump devices, drug injections (Caverject), and urethral suppositories (MUSE), should never be used in conjunction with Viagra.

Description

Sildenafil citrate was originally developed in 1991 as a treatment for angina, or chest pain. The drug, marketed under the name Viagra, received FDA market clearance as a treatment for impotence in March 1998, and since that time it has been prescribed for over 10 million men worldwide. It is the first, and as of early 2001, only oral medication approved for ED treatment.

Viagra is a vasodilator, a drug that has the effect of dilating the blood vessels. It works by improving blood

KEY TERMS

Angina—Angina pectoris, or chest pain, caused by an insufficient supply of oxygen and decreased blood flow to the heart muscle. Angina is frequently the first sign of coronary artery disease.

Angulation of the penis—Abnormal bend or angle to the structure of the penis.

Antidepressants—Medications prescribed to relieve major depression. Classes of antidepressants include selective serotonin reuptake inhibitors (fluoxetine/Prozac, sertraline/Zoloft), tricyclics (amitriptyline/Elavil), MAOIs (phenelzine/Nardil), and heterocyclics (bupropion/Wellbutrin, trazodone/Desyrel).

Antihistamines—A drug used to treat allergic conditions that counteracts histamines—a substance in the body that causes itching, vascular changes, and mucus secretion when released by cells.

Antihypertensives—Medications used to treat high blood pressure.

Antipsychotics—A class of drugs used to control psychotic symptoms in patients with psychotic disorders such as schizophrenia and delusional disorder. Antipsychotics include risperidone (Risperdal), haloperidol (Haldol), and chlorpromazine (Thorazine).

Arrhythmia—Irregular heartbeat caused by erratic electrical signals or nerve impulses to the cardiac muscles.

Artherosclerosis—The cause of coronary artery disease, in which the walls of the coronary arteries thicken due to the accumulation of plaque in the blood vessels.

Beta blockers—Drugs that lower blood pressure and reduce stress to the heart by blocking the actions of beta receptors that control the speed and strength of heart muscle contractions and blood vessel dilation.

Cavernosal fibrosis—The formation of abnormal, fibrous tissue in the erectile tissue of the penis.

Diuretics—Any substance that increases urine output.

Erectile dysfunction—Impotence; the inability of a man to achieve and/or maintain an erection of sufficient quality for sexual intercourse.

Gastroparesis—Nerve damage of the stomach that delays or stops stomach emptying, resulting in nausea, vomiting, bloating, discomfort, and weight loss.

Peyronie's disease—A disease which causes a hardening of the corpora cavernosa, the erectile tissue of the penis. The penis may become misshapen and/or curved as a result.

Placebo—An inactive substance with no pharmacological action that is administered to some patients in clinical trials to determine the relative effectiveness of another drug administered to a second group of patients.

Priapism—A painful, abnormally prolonged erection (i.e., four or more hours).

Protease inhibitor—A drug that inhibits the action of enzymes.

Retinitis pigmentosa—An inherited degenerative eye disease that impairs night vision and drastically narrows the field of vision.

Selective serotonin uptake inhibitors (SSRIs)—A drug that regulates depression by blocking the reabsorption of serotonin in the brain consequently raising serotonin levels. SSRIs include fluoxetine (Prozac), sertraline (Zoloft), and paroxetine (Paxil).

Serotonin—One of three major neurotransmitters found in the brain that is linked to emotions.

circulation to the penis, and by enhancing the effects of *nitric oxide*, the agent that relaxes the smooth muscle of the penis and regulates blood vessels during sexual stimulation, allowing the penis to become engorged and achieve an erection.

The average recommended dose of Viagra is 50 mg. For men that do not respond adequately to this amount, the dosage may be increased up to 100 mg or decreased to 25 mg. The medication is taken approximately one hour before sexual activity is planned, and may remain effective for up to four hours.

Viagra does not increase sexual desire. Sexual stimulation and arousal are required for the medication to be effective. Despite its widespread use as a recreational drug, it is not an aphrodisiac and there is no clinical evi-

dence that it improves sexual performance in men who are not suffering from ED.

Many insurance plans provide coverage or reimbursement for sildenafil citrate, provided it is prescribed to treat erectile dysfunction. A 1999 report issued by a health insurance consulting group indicated that almost half of the men taking Viagra at least once weekly receive insurance reimbursement for the drug. The pills cost approximately $10 each, and insurers may limit coverage to a specific number of pills each month.

Preparation

Viagra requires time to be absorbed by the body and become effective. The average recommended time frame for taking the drug is one hour before initiating sexual activity, although depending on an individual's response to the drug, this time can vary from four hours to 30 minutes.

Men should always consult with their physician before beginning treatment with sildenafil citrate. The medication is not for everyone, and a healthcare professional needs to evaluate medical history and perform a thorough medical examination before prescribing the drug. In addition, erectile dysfunction may be a symptom of an undiagnosed condition (i.e., diabetes) for which treatment is critical, and may actually reverse the impotence problem.

Risks

The most commonly reported side effects of Viagra are **headache**, flushing of the face, upset stomach, and nasal congestion.

Other less common side effects include, but are not limited to:

- vision problems, including sensitivity to light, blurred vision, and a color tinge to vision
- urinary tract infection
- diarrhea
- dizziness
- rash

Side effects may be reduced or eliminated through adjustments to dosage. Men who experience these symptoms should consult their physician.

Priapism, a painful and prolonged erection that lasts for two to six hours, is a rare, but potentially serious, side effect of Viagra. Because prolonged erection can permanently damage the tissues of the penis, anyone who experiences an erection lasting over four hours should call a healthcare professional immediately.

Men who are taking Viagra and inadvertently or intentionally take a medication containing nitrates may suffer from life-threatening hypotension—a severe drop in blood pressure.

The cardiovascular risks of sildenafil citrate are still under investigation. The drug is known to cause dips in blood pressure and to boost cardiovascular nerve activity. Some cardiovascular-related deaths have been reported in men who use Viagra, but it is unclear whether the fatalities were due to the drug itself or to the underlying heart disease. Further complicating the picture is the fact that the stress of sexual activity may have triggered the fatal cardiac event with or without the use of Viagra. The *BMJ* study, and a report published in the April 18, 2001 issue of the *The Journal of the American Medical Association* (JAMA) suggest that the drug does not increase the risk of heart attack. However, JAMA also notes that further studies are necessary to confirm this finding.

Although it is a prescription drug, as of early 2001 there was still a thriving illicit market for Viagra via the internet. Aside from the health risks recreational use of the drug poses to individuals with heart conditions and other contraindicated disorders, any adverse effects caused by Viagra cannot be tracked by regulatory authorities if it has been illegally obtained.

Normal results

When used as directed, Viagra allows men with erectile dysfunction to achieve and maintain a penile erection when aroused during sexual activity. Double-blind, randomized clinical trials of sildenafil citrate have shown that the drug has an 63–82% efficacy rate in improving erectile activity among men with ED, depending on the dose administered (between 25 and 100 mg), compared to a 24% improvement in men receiving a placebo.

Resources

BOOKS

Medical Economics Company. *The Physicians Desk Reference (PDR)*. 55th edition. Montvale, NJ: Medical Economics Company, 2001.

Stolar, Mark. *Viagra & You*. New York: Berkley Books, 1999.

PERIODICALS

Boyce, E. G. and E. M. Umland. "Sildenafil Citrate: A Therapeutic Update. *Clinical Therapeutics* 1 (January 2001): 2-23.

Mitka, Mike. "Studies of Viagra Offer Some Reassurance to Men With Concerns About Cardiac Effects." *The Journal of the American Medical Association* 285, no.15 (April 18, 2001): 1950.

Shakir, S. A., et al. "Cardiovascular Events in Users of Sildenafil: Results from First Phase of Prescription Event Monitoring in England." *British Medical Journal* 322, no.7287 (March 17, 2001): 651-2.

"Viagra Increases Nerve Activity Associated with Cardiovascular Function." *Drug Week* (January 26, 2001): 11.

ORGANIZATIONS

American Heart Association. National Center. 7272 Greenville Avenue, Dallas, TX 75231-4596. (800) AHA-USA1. <http://www.americanheart.org>.

U.S. Food and Drug Administration (FDA), Center for Drug Evaluation and Research. Viagra Information. <http://www.fda.gov/cder/consumerinfo/viagra/default.htm>.

OTHER

Pfizer, Inc. Viagra Information Site. <http://www.viagra.com/>.

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Silent thyroiditis *see* **Thyroiditis**

Silicosis

Definition

Silicosis is a progressive disease that belongs to a group of lung disorders called pneumoconioses. Silicosis is marked by the formation of lumps (nodules) and fibrous scar tissue in the lungs. It is the oldest known occupational lung disease, and is caused by exposure to inhaled particles of silica, mostly from quartz in rocks, sand, and similar substances.

Description

It is estimated that there are two million workers in the United States employed in occupations at risk for the development of silicosis. These include miners, foundry workers, stonecutters, potters and ceramics workers, sandblasters, tunnel workers, and rock drillers. Silicosis is mostly found in adults over 40. It has four forms:

- Chronic. Chronic silicosis may take 15 or more years of exposure to develop. There is only mild impairment of lung functioning. Chronic silicosis may progress to more advanced forms.
- Complicated. Patients with complicated silicosis have noticeable **shortness of breath**, weight loss, and extensive formation of fibrous tissue (fibrosis) in the lungs. These patients are at risk for developing **tuberculosis** (TB).
- Accelerated. This form of silicosis appears after 5-10 years of intense exposure. The symptoms are similar to those of complicated silicosis. Patients in this group often develop **rheumatoid arthritis** and other **autoimmune disorders**.
- Acute. Acute silicosis develops within six months to two years of intense exposure to silica. The patient loses a great deal of weight and is constantly short of breath. These patients are at severe risk of TB.

Causes and symptoms

The precise mechanism that triggers the development of silicosis is still unclear. What is known is that particles of silica dust get trapped in the tiny sacs (alveoli) in the lungs where air exchange takes place. White blood cells called macrophages in the alveoli ingest the silica and die. The resulting inflammation attracts other macrophages to the region. The nodule forms when the immune system forms fibrous tissue to seal off the reactive area. The disease process may stop at this point, or speed up and destroy large areas of the lung. The fibrosis may continue even after the worker is no longer exposed to silica.

Early symptoms of silicosis include shortness of breath after exercising and a harsh, dry **cough**. Patients may have more trouble breathing and cough up blood as the disease progresses. Congestive **heart failure** can give their nails a bluish tint. Patients with advanced silicosis may have trouble sleeping and experience chest **pain**, hoarseness, and loss of appetite. Silicosis patients are at high risk for TB, and should be checked for the disease during the doctor's examination.

Diagnosis

Diagnosis of silicosis is based on:

- a detailed occupational history.
- chest x rays will usually show small round opaque areas in chronic silicosis; the round areas are larger in complicated and accelerated silicosis
- bronchoscopy
- lung function tests

It should be noted that the severity of the patient's symptoms does not always correlate with x-ray findings or lung function test results.

Treatment

Symptom management

There is no cure for silicosis. Therapy is intended to relieve symptoms, treat complications, and prevent respiratory infections. It includes careful monitoring for signs of TB. Respiratory symptoms may be treated with **bronchodilators**, increased fluid intake, steam inhalation, and physical therapy. Patients with severe breathing difficulties may be given oxygen therapy or placed on a mechanical ventilator. Acute silicosis may progress to complete

respiratory failure. Heart-lung transplants are the only hope for some patients.

Patients with silicosis should call their doctor for any of the following symptoms:

- tiredness or mental confusion
- continued weight loss
- coughing up blood
- fever, chest pain, breathlessness, or new unexplained symptoms

Lifestyle changes

Patients with silicosis should be advised to quit **smoking**, prevent infections by avoiding crowds and persons with colds or similar infections, and receive vaccinations against **influenza** and **pneumonia**. They should be encouraged to increase their **exercise** capacity by keeping up regular activity, and to learn to pace themselves with their daily routine.

Prognosis

Silicosis is currently incurable. The prognosis for patients with chronic silicosis is generally good. Acute silicosis, however, may progress rapidly to respiratory failure and **death**.

Prevention

Silicosis is a preventable disease. Preventive occupational safety measures include:

- controls to minimize workplace exposure to silica dust
- substitution of substances—especially in sandblasting—that are less hazardous than silica
- clear identification of dangerous areas in the workplace
- informing workers about the dangers of overexposure to silica dust, training them in safety techniques, and giving them appropriate protective clothing and equipment

Coworkers of anyone diagnosed with silicosis should be examined for symptoms of the disease. The state health department and the Occupational Safety and Health Administration (OSHA) or the Mine Safety and Health Administration (MSHA) must be notified whenever a diagnosis of silicosis is confirmed.

Resources

BOOKS

"Occupational Lung Diseases: Silicosis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Parker, John E. "Silicosis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Silicosis." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

OTHER

"Preventing Silicosis." *Centers for Disease Control*. 25 May 1998 <http://www.cdc.gov/niosh/silfact1.html>.

"Prevention of Silicosis Deaths." *Centers for Disease Control*. 25 May 1998 <http://www.cdc.gov/niosh/nasd/docs2/us 71700.html>.

"Silicosis." *ThriveOnline*. 25 May 1998 <http://thriveonline.oxygen.com>.

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KEY TERMS

Fibrosis—The development of excess fibrous connective tissue in an organ. Fibrosis of the lungs is a symptom of silicosis.

Pneumoconiosis (plural, pneumoconioses)—Any chronic lung disease caused by inhaling particles of silica or similar substances that lead to loss of lung function.

Silica—A substance (silicon dioxide) occurring in quartz sand, flint, and agate. It is used in making glass, scouring and grinding powders, pottery, etc.

Silo-filler's disease *see* **Lung diseases due to gas or chemical exposure**

Simethicone *see* **Antigas agents**

Singer's nodules *see* **Vocal cord nodules and polyps**

Sinus endoscopy

Definition

An endoscope is a narrow flexible tube which contains an optical device like a telescope or magnifying

lens with a bright light. In sinus endoscopy, the endoscope is inserted into the nose, and the interior of the nasal passages, sinuses, and throat is examined.

Purpose

Sinus endoscopy is used to help diagnose structural defects, infection or damage to the sinuses, or structures in the nose and throat. It may be used to view polyps and growths in the sinuses and to investigate causes of recurrent inflammation of the sinuses (**sinusitis**). During surgical procedures, an endoscope may be used to view the area to correct sinus-drainage problems or to remove polyps from the nose and throat.

Precautions

Insertion of the endoscope may cause a gag reflex and some discomfort, however, no special precautions are required to prepare for nasal endoscopy.

Description

This procedure can be done in a physician's office. The endoscope is inserted into a nostril and is threaded through the sinus passages to the throat. To make viewing of these areas easier, and to record the areas being examined, a camera, monitor, or other such viewing device is connected to the endoscope

Preparation

For the procedure, the patient is usually awake and seated upright in a chair. A local anesthetic spray or liquid may be applied to the throat to make insertion of the endoscope less uncomfortable.

Aftercare

After the endoscope is removed, the patient can return to most normal activities. If an anesthetic was used, the patient may have to wait until the numbness wears off to be able to eat or drink.

Risks

The insertion and removal of the endoscope may stimulate a gag reflex, and can cause some discomfort. The procedure may also irritate the tissues of the nose and throat, causing a **nosebleed** or coughing.

Normal results

Under normal conditions, no polyps, or growths are found in the sinuses. There should also be no evidence of infection, swelling, injury, or any structural defect that would prevent normal draining of the sinuses.

Abnormal results

Polyps, growths, infections, or structural defects of the nasal passages are considered abnormal.

Resources

BOOKS

"Nasal Endoscopy." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Ear Foundation. 1817 Patterson St., Nashville, TN 37203. (800) 545-4327. <http://www.earfoundation.org>.

OTHER

"Endoscopic Plastic Surgery." *Southern California Plastic Surgery Group' Page*. <http://www.face-doctor.com>.

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Sinus x ray *see* **Skull x rays**

Sinusitis

Definition

Sinusitis refers to an inflammation of the sinuses, airspaces within the bones of the face. Sinusitis is most often due to an infection within these spaces.

Description

The sinuses are paired air pockets located within the bones of the face. They are:

- the frontal sinuses; located above the eyes, in the center region of each eyebrow
- the maxillary sinuses; located within the cheekbones, just to either side of the nose
- the ethmoid sinuses; located between the eyes, just behind the bridge of the nose
- the sphenoid sinuses; located just behind the ethmoid sinuses, and behind the eyes

The sinuses are connected with the nose. They are lined with the same kind of skin found elsewhere within the respiratory tract. This skin has tiny little hairs project-

ing from it, called cilia. The cilia beat constantly, to help move the mucus produced in the sinuses into the respiratory tract. The beating cilia sweeping the mucus along the respiratory tract helps to clear the respiratory tract of any debris, or any organisms which may be present. When the lining of the sinuses is at all swollen, the swelling interferes with the normal flow of mucus. Trapped mucus can then fill the sinuses, causing an uncomfortable sensation of pressure and providing an excellent environment for the growth of infection-causing bacteria.

Causes and symptoms

Sinusitis is almost always due to an infection, although swelling from **allergies** can mimic the symptoms of pressure, **pain**, and congestion; and allergies can set the stage for a bacterial infection. Bacteria are the most common cause of sinus infection. *Streptococcus pneumoniae* causes about 33% of all cases, while *Haemophilus influenzae* causes about 25% of all cases. Sinusitis in children may be caused by *Moraxella catarrhalis* (20%). In people with weakened immune systems (including patients with diabetes; acquired **immunodeficiency** syndrome or **AIDS**; and patients who are taking medications which lower their immune resistance, such as **cancer** and transplant patients), sinusitis may be caused by fungi such as *Aspergillus*, *Candida*, or Mucorales.

Acute sinusitis usually follows some type of upper respiratory tract infection or cold. Instead of ending, the cold seems to linger on, with constant or even worsening congestion. Drainage from the nose often changes from a clear color to a thicker, yellowish-green. There may be **fever**. **Headache** and pain over the affected sinuses may occur, as well as a feeling of pressure which may worsen when the patient bends over. There may be pain in the jaw or teeth. Some children, in particular, get upset stomachs from the infected drainage going down the back of their throats, and being swallowed into their stomachs. Some patients develop a **cough**.

Chronic sinusitis occurs when the problem has existed for at least three months. There is rarely a fever with chronic sinusitis. Sinus pain and pressure is frequent, as is nasal congestion. Because of the nature of the swelling in the sinuses, they may not be able to drain out the nose. Drainage, therefore, drips constantly down the back of the throat, resulting in a continuously **sore throat** and **bad breath**.

Diagnosis

Diagnosis is sometimes tricky, because the symptoms so often resemble those of an uncomplicated cold. However, sinusitis should be strongly suspected when a cold lingers beyond about a week's time.

Medical practitioners have differing levels of trust of certain basic examinations commonly conducted in the office. For example, tapping over the sinuses may cause pain in patients with sinusitis, but it may not. A procedure called "sinus transillumination" may, or may not, also be helpful. Using a flashlight pressed up against the skin of the cheek, the practitioner will look in the patient's open mouth. When the sinuses are full of air (under normal conditions), the light will project through the sinus, and will be visible on the roof of the mouth as a lit-up, reddened area. When the sinuses are full of mucus, the light will be stopped. While this simple test can be helpful, it is certainly not a perfect way to diagnose or rule out the diagnosis of sinusitis.

X-ray pictures and CT scans of the sinuses are helpful for both acute and chronic sinusitis. People with chronic sinusitis should also be checked for allergies; and they may need a procedure with a scope to see if any kind of anatomic obstruction is causing their illness. For example, the septum (the cartilage which separates the two nasal cavities from each other) may be slightly displaced, called a **deviated septum**. This can result in chronic obstruction, setting the person up for the development of an infection.

Treatment

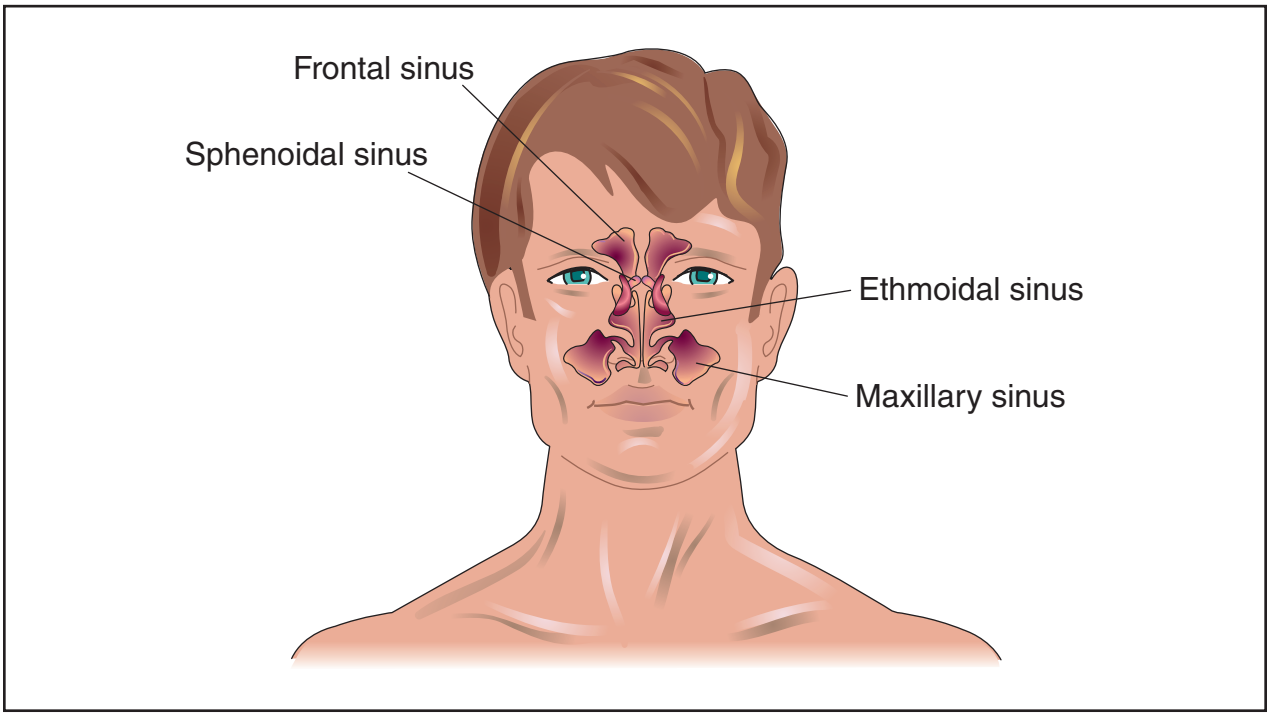
Antibiotic medications are used to treat acute sinusitis. Suitable **antibiotics** include sulfa drugs, amoxicillin, and a variety of **cephalosporins**. These medications are usually given for about two weeks, but may be given for even longer periods of time. **Decongestants**, or the short-term use of decongestant nose sprays, can be useful. **Acetaminophen** and ibuprofen can decrease the pain and headache associated with sinusitis. Also, running a humidifier can prevent mucus within the nasal passages from drying out uncomfortably, and can help soothe any accompanying sore throat or cough.

Chronic sinusitis is often treated initially with antibiotics. Steroid nasal sprays may be used to decrease swelling in the nasal passages. If an anatomic reason is found for chronic sinusitis, it may need to be corrected with surgery. If a surgical procedure is necessary, samples are usually taken at the same time to allow identification of any organisms present which may be causing infection.

Fungal sinusitis will require surgery to clean out the sinuses. Then, a relatively long course of a very strong antifungal medication called amphotericin B is given through a needle in the vein (intravenously).

Alternative treatment

Chronic sinusitis is often associated with food allergies. An elimination/challenge diet is recommended to



Sinusitis is the inflammation of the sinuses caused by a bacterial infection. Sometimes diagnosis may be problematic because the symptoms often mimic those of the common cold. Sinusitis is usually treated with antibiotics. *(Illustration by Electronic Illustrators Group.)*

identify and eliminate allergenic foods. Irrigating the sinuses with a salt water solution is often recommended for sinusitis and allergies, in order to clear the nasal passages of mucus. Another solution for nasal lavage (washing) utilizes powdered goldenseal (*Hydrastis canadensis*). Other herbal treatments, taken internally, include a mixture made of eyebright (*Euphrasia officinalis*), goldenseal, yarrow (*Achillea millefolium*), horseradish, and ephedra (*Ephedra sinica*), or, when infection is present, a mixture made of **echinacea** (*Echinacea* spp.), wild indigo, and poke root (*Phytolacca decandra-Americana*).

Homeopathic practitioners find a number of remedies useful for treating sinusitis. Among those they recommend are: *Arsenicum album*, *Kalium bichromium*, *Nux vomica*, *Mercurius iodatus*, and *Silica*.

Acupuncture has been used to treat sinusitis, as have a variety of dietary supplements, including **vitamins** A, C, and E, and the mineral zinc. Contrast **hydrotherapy** (hot and cold compresses, alternating 3 minutes hot, 30 seconds cold, repeated 3 times always ending with cold) applied directly over the sinuses can relieve pressure and enhance healing. A direct inhalation of essential oils (2 drops of oil to 2 cups of water) using thyme, rosemary, and lavender can help open the sinuses and kill bacteria that cause infection.

Prognosis

Prognosis for sinus infections is usually excellent, although some individuals may find that they are particularly prone to contracting such infections after a cold. Fungal sinusitis, however, has a relatively high **death** rate.

Prevention

Prevention involves the usual standards of good hygiene to cut down on the number of colds an individual catches. Avoiding exposure to cigarette smoke, identifying and treating allergies, and avoiding deep dives in swimming pools may help prevent sinus infections. During the winter, it is a good idea to use a humidifier. Dry nasal passages may crack, allowing bacteria to enter. When allergies are diagnosed, a number of nasal sprays are available to try to prevent inflammation within the nasal passageways, thus allowing the normal flow of mucus.

Resources

BOOKS

Durand, Marlene, et al. "Infections of the Upper Respiratory Tract." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Ray, C. George. "Eye, Ear, and Sinus Infections." In *Sherris Medical Microbiology: An Introduction to Infectious Dis-*

KEY TERMS

Cilia—Tiny, hair-like projections from a cell. Within the respiratory tract, the cilia act to move mucus along, in an effort to continually flush out and clean the respiratory tract.

Sinus—An air-filled cavity.

eases. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley & Sons, 1995.

PERIODICALS

Kaliner, Michael A. "The Signs of Sinusitis." *Discover* 19 (Mar. 1998): S16+.

O'Brien, Katherine L., et al. "Acute Sinusitis: Principles of Judicious Use of Antimicrobial Agents." *Pediatrics* 101 (Jan. 1998): 174+.

William, J. W., et al. "Clinical Evaluation for Sinusitis: Making the Diagnosis by History and Physical Examination." *Annals of Internal Medicine* 117 (1992): 705+.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Rosalyn Carson-DeWitt, MD

Situs inversus

Definition

Situs inversus is a condition in which the organs of the chest and abdomen are arranged in a perfect mirror image reversal of the normal positioning.

Description

Normal human development results in an asymmetrical arrangement of the organs within the chest and abdomen. Typically, the heart lies on the left side of the body (*levocardia*), the liver and spleen lie on the right, and the lung on the left has two lobes while the lung on the right has three lobes. This normal arrangement is known as *situs solitus*.

However, in about 1 in 8,500 people, the organs of the chest and abdomen are arranged in the exact opposite position: the heart is on the right (*dextrocardia*), as is the two-lobed lung, and the liver, spleen, and three-lobed lung are on the left. Yet because this arrangement, called *situs inversus*, is a perfect mirror image, the relationship between the organs is not changed, so functional problems rarely occur.

Causes and symptoms

Early in the normal development of an embryo, the tube-like structure that becomes the heart forms a loop toward the left, identifying the left/right axis along which the other organs should be positioned. Although the mechanism that causes the heart loop to go left is not fully understood, at least one gene has been identified to have a role in this process. However, it is thought that many factors may be involved in causing situs inversus. Rarely, situs inversus can run in families, but most often it is an isolated and accidental event occurring in an individual for the first time in the family.

Most people with situs inversus have no medical symptoms or complications resulting from the condition. Although only 3-5% of people with situs inversus have any type of functional heart defect, this is higher than the rate of heart defects in the general population, which is less than 1%.

It is estimated that about 25% of people with situs inversus have an underlying condition called primary ciliary dyskinesia (PCD). PCD, also known as Kartagener's syndrome, is characterized as situs inversus, chronic sinus infections, increased mucous secretions from the lungs, and increased susceptibility to respiratory infections. PCD is caused by a defect in the cilia that impairs their normal movements.

Diagnosis

Situs inversus should detected by a thorough **physical examination**. It is often picked up when a physician, using a stethoscope, hears otherwise normal heart sounds on the right side of the body instead of the left. To confirm the a suspected diagnosis of situs inversus, imaging studies such as MRI, CT, or ultrasound may be ordered, and a referral may be made to a cardiologist or internist for completeness. Imaging studies will also rule out the possibility of random arrangement of the organs, or heterotaxy, which has a much higher risk for serious medical complications.

Treatment

There is no treatment for situs inversus. In the unlikely case that a heart defect is present, it should be treated accordingly by a cardiologist.

KEY TERMS

Cilia—Tiny hairlike projections on certain cells within the body; cilia produce lashing or whipping movements to direct or cause motion of substances or fluids within the body.

Gene—A single unit of genetic information, providing the body with instruction for a specific biological task.

MRI—An imaging study that uses magnetic forces to produce an image of the body's internal structures.

CT—A special technique that uses a computer to create a cross-sectional image of the body from a series of x rays.

Ultrasound—An imaging study that uses high-frequency sound waves to form a visual image of the body's internal structures.

Individuals who have situs inversus should be sure to inform all physicians involved in their medical care. In addition to preventing unnecessary confusion, this will reduce the risk of missing a crucial diagnosis that presents with location-specific symptoms (such as **appendicitis**).

Alternative treatment

Not applicable.

Prognosis

The prognosis for an individual with situs inversus is good, and in the absence of a heart defect or other underlying diagnosis, life expectancy is normal.

Prevention

There is no known method of preventing situs inversus.

Resources

PERIODICALS

Ainsworth, Claire. "Left Right and Wrong." *New Scientist* 66, no. 2243 (17 June 2000): 40-45.

Janchar, T., Milzman, D., and Clement, M. "Situs Inversus: Emergency Evaluations of Atypical Presentations." *American Journal of Emergency Medicine* 18, no. 3 (May 2000): 349-50.

Splitt, Miranda P., Burn, John, and Goodship, Judith. "Defects in the Determination of Left-right Asymmetry." *Journal of Medical Genetics* 33, no. 6 (June 1996): 498-503.

Travis, John. "Twirl Those Organs into Place." *Science News* 156, no. 8 (21 August 1999): 124-125.

Winer-Muram, Helen T., and Tonkin, Ina L.D. "The Spectrum of Heterotaxic Syndromes." *Radiologic Clinics of North America* 27, no. 6 (November 1989): 1147-1170.

ORGANIZATIONS

American Heart Association. National Center. 7272 Greenville Avenue, Dallas, TX 75231-4596. (214) 373-6300. (800) 242-8721. e-mail: inquire@heart.org. <http://www.americanheart.org>.

NIH/National Heart, Lung and Blood Institute Information Center. P.O. Box 30105. Bethesda, MD 20824-0105. (301) 592-8573. <http://www.nhlbi.nih.gov>.

Stefanie B. N. Dugan, M.S.

Sitz bath

Definition

A sitz bath (also called a hip bath) is a type of bath in which only the hips and buttocks are soaked in water or saline solution. Its name comes from the German verb "sitzen," meaning "to sit."

Purpose

A sitz bath is used for patients who have had surgery in the area of the rectum, or to ease the **pain** of **hemorrhoids**, uterine cramps, prostate infections, painful ovaries, and/or testicles. It is also used to ease discomfort from infections of the bladder, prostate, or vagina. Inflammatory bowel diseases are also treated with sitz baths.

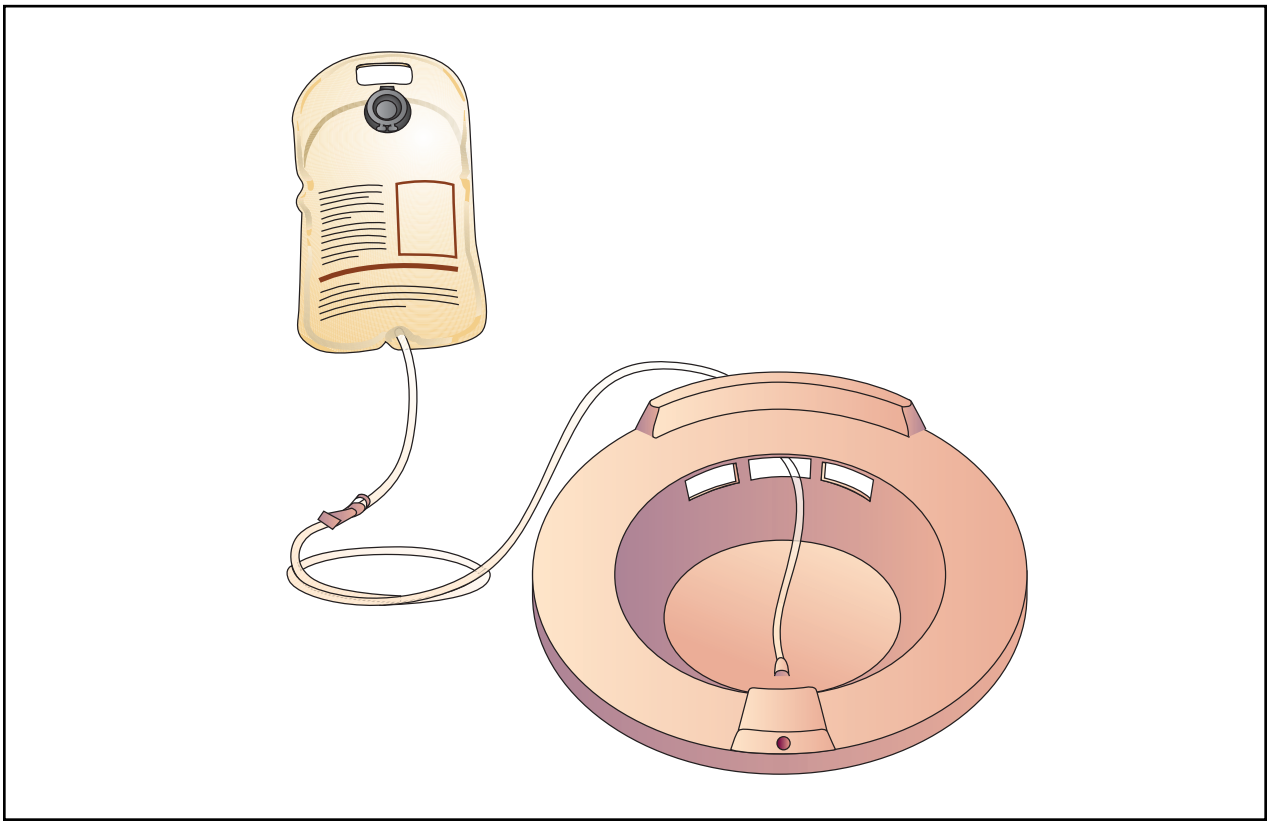
Precautions

Some patients may become dizzy when standing up after sitting in hot water; it is best to have someone else present when doing a contrast sitz bath.

Description

The sitz bath is a European tradition in which only the pelvis and abdominal area are placed in water, with the upper body, arms, legs, and feet out of the water. The water can be warm or cool and one or two tubs may be used.

Warm sitz baths are one of the easiest and most effective ways to ease the pain of hemorrhoids. A warm bath is also effective in lessening the discomfort associated with **genital herpes**, uterine cramps, and other painful conditions in the pelvic area.



Equipment used for sitz baths. A sitz bath, in which only the hips and buttocks are soaked in water or saline solution, is used for patients who have had surgery in the rectal area or to ease discomfort from bladder, prostate, or vaginal infections. *(Illustration by Electronic Illustrators Group.)*

For prostate pain, patients should take two hot sitz baths a day, for about 15 minutes each.

To ease discomfort from a vaginal yeast infection, women should take a warm saline sitz bath. To prepare, fill the tub to hip height with warm water and add 1/2 c of salt (enough to make the water taste salty) and 1/2 c vinegar. Sit in the bath for 20 minutes (or until the water gets cool). The vinegar will help bring the vaginal pH back to 4.5 (pH is a measurement of how acid or alkaline a fluid is).

A brief, cool sitz bath helps ease inflammation, **constipation**, and vaginal discharge. It can be used to tone the muscles in cases of bladder or bowel incontinence.

Other conditions respond to a "contrast bath" of both hot and cold. For this a patient should have a tub of hot water (about 110°F/43°C) and one tub of ice water. The patient should sit in the hot water for 3–4 minutes and in the cold for 30–60 seconds in the cold. This is repeated 3–5 times, always ending with the cold water.

If two tubs are not handy, the patient may sit in a hot bath (up to the navel). Then the patient stands up in the water and pulls a cold towel between the legs and over the pelvis in front and back. The cold towel is held in place for up to 60 seconds. Then the patient should sit back into the hot bath, and repeat the process 3–5 times, ending with the cold towel.

KEY TERMS

pH—A standard laboratory test that measures how acidic or alkaline a solution is.

Saline solution—Another word for salt water.

Preparation

The bath should be filled with 3–4 in (8–10cm) of water. For most conditions, nothing else should be added (no bubble bath or oil).

Aftercare

The area should be carefully patted dry and, if necessary, clean dressings should be applied.

Risks

Sitz baths pose almost no risk. On rare occasions, patients can feel dizzy or experience rapid heart beat because of blood vessel dilation.

Normal results

Swelling goes down; discomfort is eased; healing is promoted.

Carol A. Turkington

Sjögren's syndrome

Definition

Sjögren's syndrome is a disorder where the mouth and eyes become extremely dry. Sjögren's syndrome is often associated with other **autoimmune disorders**.

Description

Like other autoimmune disorders, Sjögren's syndrome occurs when the body's immune system mistakenly begins treating parts of the body as foreign invaders. While the immune cells should attack and kill invaders like bacteria, viruses, and fungi, these cells should not attack the body itself. In autoimmune disorders, however, cells called antibodies see tissues of the body as foreign, and help to start a chain of events that results in damage and destruction of those tissues.

There are three types of Sjögren's syndrome. Primary Sjögren's syndrome occurs by itself, with no other associated disorders. Secondary Sjögren's syndrome occurs along with other autoimmune disorders, like **systemic lupus erythematosus**, **rheumatoid arthritis**, **scleroderma**, **vasculitis**, or **polymyositis**. When the disorder is limited to involvement of the eyes, with no other organ or tissue involvement evident, it is called sicca complex.

Women are about nine times more likely to suffer from Sjögren's syndrome than are men. It affects all age groups, although most patients are diagnosed when they are between 40 and 55 years old. Sjögren's syndrome is commonly associated with other autoimmune disorders. In fact, 30% of patients with certain autoimmune disorders will also have Sjögren's syndrome.

Causes and symptoms

The cause of Sjögren's syndrome has not been clearly defined, but several causes are suspected. The syndrome sometimes runs in families. Other potential causes include hormonal factors (since there are more women than men with the disease) and viral factors. The viral theory suggests that the immune system is activated in response to a viral invader, but then fails to turn itself off. Some other immune malfunction then causes the overly active immune system to begin attacking the body's own tissues.

The main problem in Sjögren's syndrome is dryness. The salivary glands are often attacked and slowly destroyed, leaving the mouth extremely dry and sticky. Swallowing and talking become difficult. Normally, the saliva washes the teeth clean. Saliva cannot perform this function in Sjögren's syndrome, so the teeth develop many cavities and decay quickly. The parotid glands produce the majority of the mouth's saliva. They are located lying over the jaw bones behind the area of the cheeks and in front of the ears, and may become significantly enlarged in Sjögren's syndrome.

The eyes also become extremely dry as the tear glands (called glands of lacrimation) are slowly destroyed. Eye symptoms include **itching**, burning, redness, increased sensitivity to light, and thick secretions gathering at the eye corners closest to the nose. The cornea may have small irritated pits in its surface (ulcerations).

Destruction of glands in other areas of the body may cause a variety of symptoms. In the nose, dryness may result in nosebleeds. In the rest of the respiratory tract, the rates of ear infection, hoarseness, **bronchitis**, and **pneumonia** may increase. Vaginal dryness can be quite uncomfortable. Rarely, the pancreas may slow production of enzymes important for digestion. The kidney may malfunction. About 33% of all patients with Sjögren's syndrome have other symptoms unrelated to gland destruction. These symptoms include **fatigue**, decreased energy, fevers, muscle aches and pains, and joint **pain**.

Patients who also have other autoimmune diseases will suffer from the symptoms specific to those conditions.

Diagnosis

Diagnosis of Sjögren's syndrome is based on the patient having at least three consecutive months of bothersome eye and/or mouth dryness. A variety of tests can then be done to determine the quantity of tears produced, the quantity of saliva produced, and the presence or absence of antibodies that could be involved in the destruction of glands.

Treatment

There is no cure for Sjögren's syndrome. Instead, treatment usually attempts to reduce the discomfort and complications associated with dryness of the eyes and

KEY TERMS

Autoimmune disorder—A disorder in which the body's immune cells mistake the body's own tissues as foreign invaders; the immune cells then work to destroy tissues in the body.

Cornea—A transparent structure of the eye over the iris and pupil; light must pass through the cornea to make vision possible.

Immune system—The complex network of organs and blood cells that protect the body from foreign invaders, like bacteria, viruses, and fungi.

mouth (and other areas). Artificial tears are available, and may need to be used up to every 30 minutes. By using these types of products, the patient is more comfortable and avoids the complications associated with eyes that are overly dry. **Dry mouth** is treated by sipping fluids slowly but constantly throughout the day. Sugarless chewing gum can also be helpful. An artificial saliva is available for use as a mouthwash. Careful dental hygiene is important in order to avoid **tooth decay**, and it is wise for patients to decrease sugar intake. Vaginal dryness can be treated with certain gel preparations. Steroid medications may be required when other symptoms of autoimmune disorders complicate Sjögren's syndrome. However, these medications should be avoided when possible because they may make the cornea thin and even more susceptible to injury.

Prognosis

The prognosis for patients with primary Sjögren's syndrome is particularly good. Although the condition is quite annoying, serious complications rarely occur. The prognosis for patients with secondary Sjögren's syndrome varies since it depends on the prognosis for the accompanying autoimmune disorder.

Prevention

Since the cause of Sjögren's syndrome is unknown, there are no known ways to prevent this syndrome.

Resources

BOOKS

Aaseng, Nathan. *Autoimmune Diseases*. New York: F. Watts, 1995.

Moutsopoulos, Haralampos M. "Sjögren's Syndrome." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Talal, N., et al. *Sjögren's syndrome: Clinical and Immunological Aspects*. Berlin: Springer, 1987.

PERIODICALS

Moutsopoulos, H. M., and P. G. Vlachoyiannopoulos. "What Would I Do If I Had Sjögren's syndrome?" *Rheumatology Review* 2 (1993): 17+.

Moutsopoulos, H. M., and P. Youinou. "New Developments in Sjögren's syndrome." *Current Opinion in Rheumatology* 3 (1991): 815+.

Rosalyn Carson-DeWitt, MD

Skeletal traction *see* **Traction; Immobilization**

Skin abrasion *see* **Skin resurfacing**

Skin allergy test *see* **Allergy tests**

Skin biopsy

Definition

A skin biopsy is a procedure in which a small piece of living skin is removed from the body for examination, usually under a microscope, to establish a precise diagnosis. Skin biopsies are usually brief, straightforward procedures performed by a skin specialist (dermatologist) or family physician.

Purpose

The word *biopsy* is taken from Greek words that mean "to view life." The term describes what a specialist in identifying diseases (pathologist) does with tissue obtained from a skin biopsy. The pathologist *visually* examines the tissue under a microscope.

A skin biopsy is used to make a diagnosis of many skin disorders. Information from the biopsy also helps the doctor choose the best treatment for the patient.

Doctors perform skin biopsies to:

- make a diagnosis
- confirm a diagnosis made from the patient's medical history and a **physical examination**
- check whether a treatment prescribed for a previously diagnosed condition is working
- check the edges of tissue removed with a tumor to make certain it contains all the diseased tissue

Skin biopsies also can serve a therapeutic purpose. Many skin abnormalities (lesions) can be removed completely during the biopsy procedure.

Precautions

A patient taking **aspirin** or another blood thinner (anticoagulant) may be asked to stop taking them a week or more before the skin biopsy. This adjustment in medication will prevent excessive bleeding during the procedure and allow for normal blood clotting.

Some patients are allergic to lidocaine, the numbing agent most frequently used during a skin biopsy. The doctor can usually substitute another anesthetic agent.

Description

The first part of the skin biopsy test is obtaining a sample of tissue that best represents the lesion being evaluated. Many biopsy techniques are available. The choice of technique and precise location from which to take the biopsy material are determined by factors such as the type and shape of the lesion. Biopsies can be classified as excisional or incisional. In excisional biopsy, the lesion is completely removed; in incisional biopsy, a portion of the lesion is removed.

The most common biopsy techniques are:

- Shave biopsy. A scalpel or razor blade is used to shave off a thin layer of the lesion parallel to the skin.
- Punch biopsy. A small cylindrical punch is screwed into the lesion through the full thickness of the skin and a plug of tissue is removed. A stitch or two may be needed to close the wound.
- Scalpel biopsy. A scalpel is used to make a standard surgical incision or excision to remove tissue. This technique is most often used for large or deep lesions. The wound is closed with stitches.
- Scissors biopsy. Scissors are used to snip off surface (superficial) skin growths and lesions that grow from a stem or column of tissue. Such growths are sometimes seen on the eyelids or neck.

After the biopsy tissue is removed, bleeding may be controlled by applying pressure or by burning with electricity or chemicals. **Antibiotics** often are applied to the wound to prevent infection. Stitches may be placed in the wound, or the wound may be bandaged and allowed to heal on its own.

The second part of the skin biopsy test is handling and examining the tissue sample. Drying and structural damage to the tissue sample must be prevented, so it should be placed immediately in an appropriate preservative, such as formaldehyde.

The pathologist can use a variety of laboratory techniques to process the biopsy tissue. Tissue stains and several different kinds of microscopes are used. Because there are many skin disorders (broadly called dermatosis and **dermatitis**), the pathologist has extensive training in their accurate identification. Cases of melanoma, the most malignant kind of skin **cancer**, have almost tripled in the past 30 years. Because melanoma grows very rapidly in the skin, quick and accurate diagnosis is important.

KEY TERMS

Benign—Noncancerous.

Dermatitis—A skin disorder that causes inflammation, that is, redness, swelling, heat, and pain.

Dermatologist—A doctor who specializes in skin care and treatment.

Dermatosis—A noninflammatory skin disorder.

Lesion—An area of abnormal or injured skin.

Malignant—Cancerous.

Pathologist—A person who specializes in studying diseases. In particular, this person examines the structural and functional changes in the tissues and organs of the body that are caused by disease or that cause disease themselves.

Preparation

The area of the biopsy is cleansed thoroughly with alcohol or a disinfectant containing iodine. Sterile cloths (drapes) may be positioned, and a local anesthetic, usually lidocaine, is injected into the skin near the lesion. Sometimes the anesthetic contains epinephrine, a drug that helps reduce bleeding during the biopsy. Sterile gloves and surgical instruments are always used to reduce the risk of infection.

Aftercare

If stitches have been placed, they should be kept clean and dry until removed. Stitches are usually removed five to 10 days after the biopsy. Sometimes the patient is instructed to put protective ointment on the stitches before showering. **Wounds** that have not been stitched should be cleaned with soap and water daily until they heal. Adhesive strips should be left in place for two to three weeks. **Pain** medications usually are not necessary.

Risks

Infection and bleeding occur rarely after skin biopsy. If the skin biopsy may leave a scar, the patient usually is asked to give informed consent before the test.

Normal results

The biopsy reveals normal skin layers.

Abnormal results

The biopsy reveals a noncancerous (benign) or cancerous (malignant) lesion. Benign lesions may require treatment.

Resources

BOOKS

Goldsmith, Lowell A., et al. *Adult and Pediatric Dermatology: A Color Guide to Diagnosis and Treatment*. Philadelphia: S. A. Davis Co., 1997.

Graham-Brown, Robin, and Tony Burns. *Lecture Notes on Dermatology.* 7th ed. Cambridge, MA: Blackwell Science Inc., 1996.

Robinson, June K., et al. *Atlas of Cutaneous Surgery.* Philadelphia: W. B. Saunders Co., 1996.

Wheeland, Ronald. *Cutaneous Surgery.* Philadelphia: W. B. Saunders Co., 1994.

PERIODICALS

Achar, Suraj. "Principles of Skin Biopsies for the Family Physician." *American Family Physician* 8 (1996): 2411.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

Collette L. Placek

Skin cancer *see* **Melanoma**

Skin cancer, non-melanoma

Definition

Non-melanoma skin **cancer** is a malignant growth of the external surface or epithelial layer of the skin.

Description

Skin cancer is the growth of abnormal cells capable of invading and destroying other associated skin cells. Skin cancer is often subdivided into either melanoma or non-melanoma. Melanoma is a dark-pigmented, usually malignant tumor arising from a skin cell capable of making the pigment melanin (a melanocyte). Non-melanoma skin cancer most often originates from the external skin surface as a squamous cell carcinoma or a basal cell carcinoma.

The cells of a cancerous growth originate from a single cell that reproduces uncontrollably, resulting in the formation of a tumor. Exposure to sunlight is documented as the main cause of almost 800,000 cases of non-melanoma skin cancer diagnosed each year in the United States. The incidence increases for those living where direct sunshine is plentiful, such as near the equator.

Basal cell carcinoma affects the skin's basal layer and has the potential to grow progressively larger in size, although it rarely spreads to distant areas (metastasizes). Basal cell carcinoma accounts for 80% of skin cancers (excluding melanoma), whereas squamous cell cancer makes up about 20%. Squamous cell carcinoma is a malignant growth of the external surface of the skin. Squamous cell cancers metastasize at a rate of 2-6%, with up to 10% of lesions affecting the ear and lip.

Causes and symptoms

Cumulative sun exposure is considered a significant risk factor for non-melanoma skin cancer. There is evidence suggesting that early, intense exposure causing blistering **sunburn** in childhood may also play an important role in the cause of non-melanoma skin cancer. Basal cell carcinoma most frequently affects the skin of face, with next most common sites being the ears, the backs of the hands, the shoulders, and the arms. It is prevalent in both sexes and most commonly occurs in people over 40.

Basal cell carcinoma usually appears as a small skin lesion that persists for at least three weeks. This form of non-melanoma looks flat and waxy, with the edges of the lesion translucent and rounded. The edges also contain small, fresh blood vessels. An ulcer found in the center gives the lesion a dimpled appearance. Basal cell carcinoma lesions vary from 0.16–0.2 (4–6 mm) in size, but can slowly grow larger if untreated.

Squamous cell carcinoma also involves skin exposed to the sun, such as the face, ears, hands or arms. This form of non-melanoma is also most common among people over 40. Squamous cell carcinoma presents itself as a small, scaling, raised bump on the skin with a crusting ulcer in the center, but without **pain** and **itching**.

Basal cell and squamous cell carcinomas can grow more easily when people have a suppressed immune system because they are taking immunosuppressive drugs or are exposed to radiation. Some people must take immunosuppressive drugs to prevent the rejection of a transplanted organ or because they have a disease in which the immune system attacks the body's own tissues (autoimmune illnesses); others may need **radiation therapy** to treat another form of cancer. Because of this, everyone taking these immunosuppressive drugs or

receiving radiation treatments should undergo complete skin examination at regular intervals. If proper treatment is delayed and the tumor continues to grow, the tumor cells can spread (metastasize) to muscle, bone, nerves, and possibly the brain.

Diagnosis

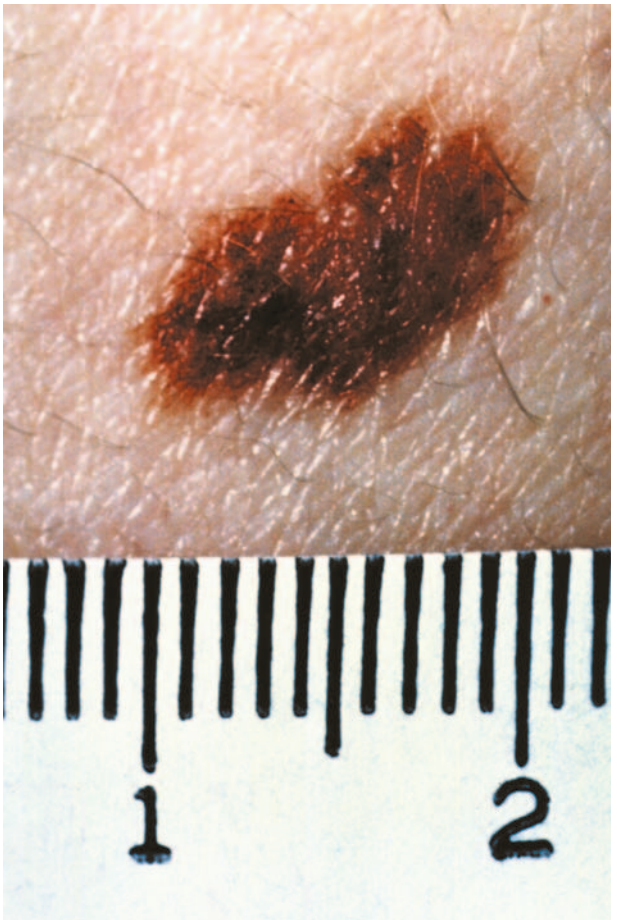
To diagnose skin cancer, doctors must carefully examine the lesion and ask the patient about how long it has been there, whether it itches or bleeds, and other questions about the patient's medical history. If skin cancer cannot be ruled out, a sample of the tissue is removed and examined under a microscope (a biopsy). A definitive diagnosis of squamous or basal cell cancer can only be made with microscopic examination of the tumor cells. Once skin cancer has been diagnosed, the stage of the disease's development is determined. The information from the biopsy and staging allows the physician and patient to plan for treatment and possible surgical intervention.

Treatment

A variety of treatment options are available for those diagnosed with non-melanoma skin cancer. Some carcinomas can be removed by cryosurgery, the process of freezing with liquid nitrogen. Uncomplicated and previously untreated basal cell carcinoma of the trunk and arms is often treated with curettage and electrodesiccation, which is the scraping of the lesion and the destruction of any remaining malignant cells with an electrical current. Removal of a lesion layer-by-layer down to normal margins (Moh's surgery) is an effective treatment for both basal and squamous cell carcinoma. Radiation therapy is best reserved for older, debilitated patients or when the tumor is considered inoperable. Laser therapy is sometimes useful in specific cases; however, this form of treatment is not widely used to treat skin cancer.

Alternative treatment

Alternative medicine aims to prevent, rather than treat, skin cancer. **Vitamins** have been shown to prevent sunburn and, possibly, skin cancer. Some dermatologists have suggested that taking vitamins E and C may help prevent sunburn. In one particular study, men and women took these vitamins for eight days prior to being exposed to ultraviolet light. The researchers found that those who consumed vitamins required about 20% more ultraviolet light to induce sunburn than did people who didn't take vitamins. This is the first study that indicates the oral use of vitamins E and C increases resistance to sunburn. These antioxidants are thought to reduce the risk of skin cancer, and are expected to provide protection from the sun even in lower doses. Other anitoxidant nutrients, including beta carotene, selenium, zinc, and the bioflavonoid quercetin, antioxidant herbs as bilberry (*Vaccinium myrtillus*), hawthorn (*Crataegus laevigata*), tumeric (*Curcuma longa*), and ginkgo (*Ginkgo biloba*) may also help prevent skin cancer.



A close up image of a precancerous mole that could develop into a melanoma. Melanomas arise from pigment-producing cells, while non-melanoma skin cancer arises from squamous cells or basal cells. *(Custom Medical Stock Photo. Reproduced by permission.)*

Prognosis

Both squamous and basal cell carcinoma are curable with appropriate treatment. Early detection remains critical for a positive prognosis.

Prevention

Avoiding exposure to the sun reduces the incidence of non-melanoma skin cancer. Sunscreen with a sun-protective factor of 15 or higher is helpful in prevention, along with a hat and clothing to shield the skin from sun

KEY TERMS

Autoimmune—Pertaining to an immune response by the body against one of its own tissues or types of cells.

Curettage—The removal of tissue or growths by scraping with a curette.

Dermatologist—A physician specializing in the branch of medicine concerned with skin.

Electrodesiccation—To make dry, dull, or lifeless with the use of electrical current.

Lesion—A patch of skin that has been infected or diseased.

damage. People should examine their skin monthly for unusual lesions, especially if previous skin cancers have been experienced.

Resources

BOOKS

Chandrasoma, Parakrama, and Clive R. Taylor. *Concise Pathology.* East Norwalk, CT: Appleton & Lange, 1991.

Copstead, Lee-Ellen C. "Alterations in the Integument." In *Perspectives on Pathophysiology.* Philadelphia: W. B. Saunders Co., 1994.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

Jeffrey P. Larson, RPT

Skin culture

Definition

A skin culture is a test that is done to identify the microorganism (bacteria, fungus, or virus) causing a skin infection and to determine the antibiotic or other treatment that will effectively treat the infection.

Purpose

Microorganisms can infect healthy skin, but more often they infect skin already damaged by an injury or abrasion. Skin infections are contagious and, if left untreated, can lead to serious complications. A culture enables a physician to diagnose and treat a skin infection.

Description

Several groups of microorganisms cause skin infections: bacteria, fungi (molds and yeast), and viruses. Based on the appearance of the infection, the physician determines what group of microorganisms is likely causing the infection, then he or she collects a specimen for one or more types of cultures. A sample of material—such as skin cells, pus, or fluid—is taken from the infection site, placed in a sterile container, and sent to the laboratory. In the laboratory, each type of culture is handled differently.

Bacterial infections are the most common. Bacteria cause lesions, ulcers, **cellulitis**, and **boils**. Pyoderma are pus-containing skin infections, such as **impetigo**, caused by *Staphylococcus* or group A *Streptococcus* bacteria. To culture bacteria, a portion of material from the infection site is spread over the surface of a culture plate and placed in an incubator at body temperature for one to two days. Bacteria in the skin sample multiply and appear on the plates as visible colonies. They are identified by noting the appearance of their colonies, and by performing biochemical tests and a Gram's stain.

The Gram's stain is done by smearing part of a colony onto a microscope slide. After it dries, the slide is colored with purple and red stains, then examined under a microscope. The color of stain picked up and retained by the bacteria (purple or red), their shape (such as round or rectangle), and their size provide valuable clues as to their identity.

A sensitivity test, also called antibiotic susceptibility test, is also done. The bacteria are tested against different **antibiotics** to determine which will effectively treat the infection by killing the bacteria.

Fungal cultures are done less frequently. A group of fungi called dermatophytes cause a skin infection called **ringworm**. Yeast causes an infection called thrush. These infections are usually diagnosed using a method other than culture, such as the **KOH test**. A culture is done only when specific identification of the mold or yeast is necessary. The specimen is spread on a culture plate designed to grow fungi, then incubated. Several different biochemical tests and stains are used to identify molds and yeasts.

Viruses, such as herpes, can also cause skin infections. Specimens for viral cultures are mixed with commercially-prepared animal cells in a test tube. Characteristic changes to the cells caused by the growing virus help identify the virus.

Results for bacterial cultures are usually available in one to three days. Cultures for fungi and viruses may take longer—up to three weeks. Cultures are covered by insurance.

KEY TERMS

Pyoderma—A pus-containing skin infection, such as impetigo, caused by *Staphylococcus* or group A *Streptococcus* bacteria.

Sensitivity test—A test that determines which antibiotics will treat an infection by killing the bacteria.

Preparation

After cleaning the infected area with sterile saline and alcohol, the physician collects skin cells, pus, or fluid using a needle or swab. If necessary, the physician will open a lesion to collect the specimen. To collect a specimen for a fungal culture, the physician uses a scalpel to scrape skin cells into a sterile container.

Normal results

Many types of microorganisms are normally found on a person's skin. Presence of these microorganisms is noted on a skin culture report as "normal flora."

Abnormal results

A microorganism is considered to be a cause of the infection if it is either the only or predominant microorganism that grew, if it grew in large numbers, or if it is known to produce infection.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Fitzpatrick, Thomas B., et al., ed. *Dermatology in General Medicine*. New York: McGraw-Hill, Inc., 1993.

PERIODICALS

Carroll, John A. "Common Bacterial Pyodermas." *Postgraduate Medicine* (Sept. 1996): 311-322.

Nancy J. Nordenson

Skin grafting

Definition

Skin grafting is a surgical procedure by which skin or skin substitute is placed over a burn or non-healing wound to permanently replace damaged or missing skin or provide a temporary wound covering.

Purpose

Wounds such as third-degree **burns** must be covered as quickly as possible to prevent infection or loss of fluid. Wounds that are left to heal on their own can contract, often resulting in serious scarring; if the wound is large enough, the scar can actually prevent movement of limbs. Non-healing wounds, such as diabetic ulcers, venous ulcers, or pressure sores, can be treated with skin grafts to prevent infection and further progression of the wounded area.

Precautions

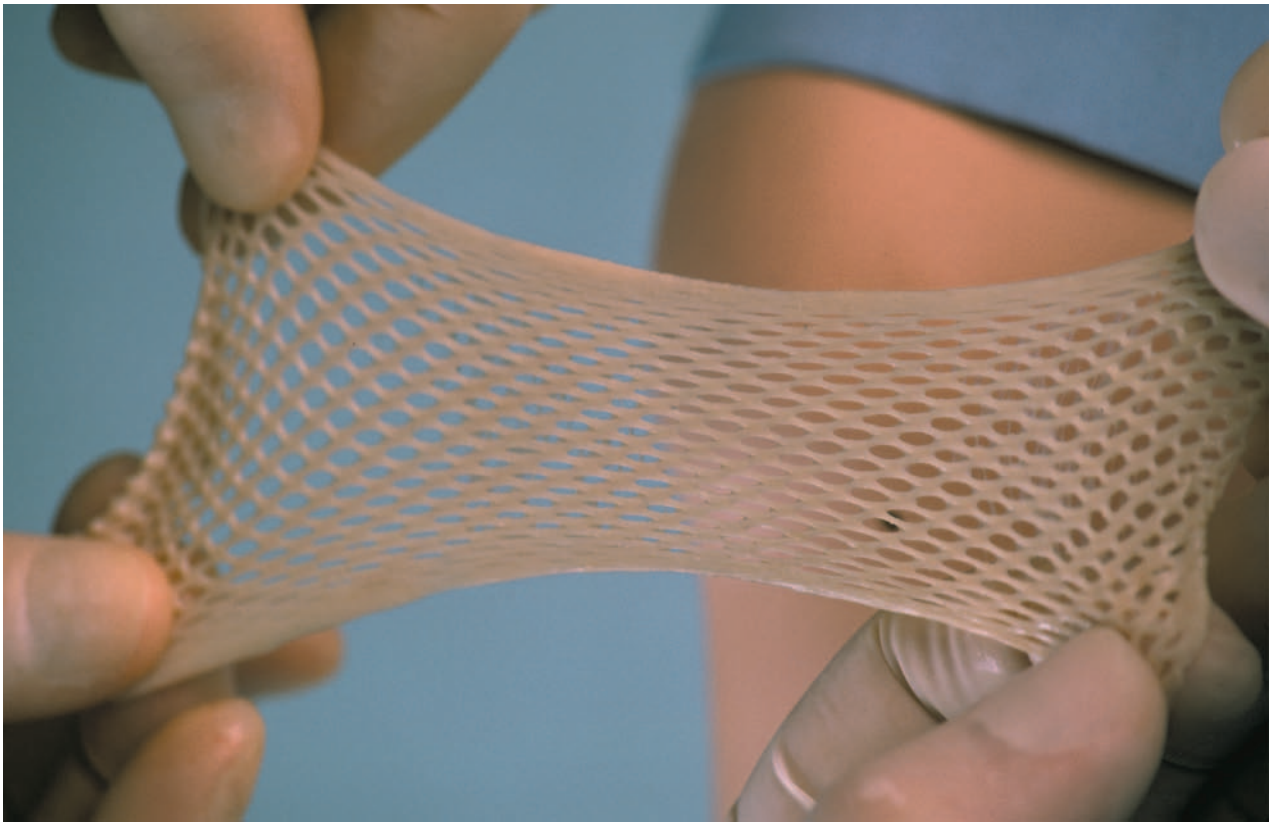
Skin grafting is generally not used for first- or second-degree burns, which generally heal with little or no scarring. Also, the tissue for grafting and the recipient site must be as sterile as possible to prevent later infection that could result in failure of the graft.

Description

The skin is the largest organ of the human body. It consists of two main layers: the epidermis is the outer layer, sitting on and nourished by the thicker dermis. These two layers are approximately 0.04-0.08 in (1-2 mm) thick. The epidermis consists of an outer layer of dead cells, which provides a tough, protective coating, and several layers of rapidly dividing cells called keratinocytes. The dermis contains the blood vessels, nerves, sweat glands, hair follicles, and oil glands. The dermis consists mainly of connective tissue, primarily the protein collagen, which gives the skin its flexibility and provides structural support. Fibroblasts, which make collagen, are the main cell type in the dermis.

Skin protects the body from fluid loss, aids in temperature regulation, and helps prevent disease-causing bacteria or viruses from entering the body. Skin that is damaged extensively by burns or non-healing wounds can compromise the health and well-being of the patient. More than 50,000 people are hospitalized for burn treatment each year in the United States, and 5,500 die. Approximately 4 million people suffer from non-healing wounds, including 1.5 million with venous ulcers and 800,000 with diabetic ulcers, which result in 55,000 amputations per year in the United States.

Skin for grafting can be obtained from another area of the patient's body, called an autograft, if there is enough undamaged skin available, and if the patient is healthy enough to undergo the additional surgery



This skin graft is ready for application. *(Photograph by Ted Horowitz, The Stock Market. Reproduced by permission.)*

required. Alternatively, skin can be obtained from another person (donor skin from cadavers is frozen, stored, and available for use), called an allograft, or from an animal (usually a pig), called a xenograft. Allografts and xenografts provide only temporary covering—they are rejected by the patient's immune system within seven to 10 days and must be replaced with an autograft.

A split-thickness skin graft takes mainly the epidermis and a little of the dermis, and usually heals within several days. The wound must not be too deep if a split-thickness graft is going to be successful, since the blood vessels that will nourish the grafted tissue must come from the dermis of the wound itself.

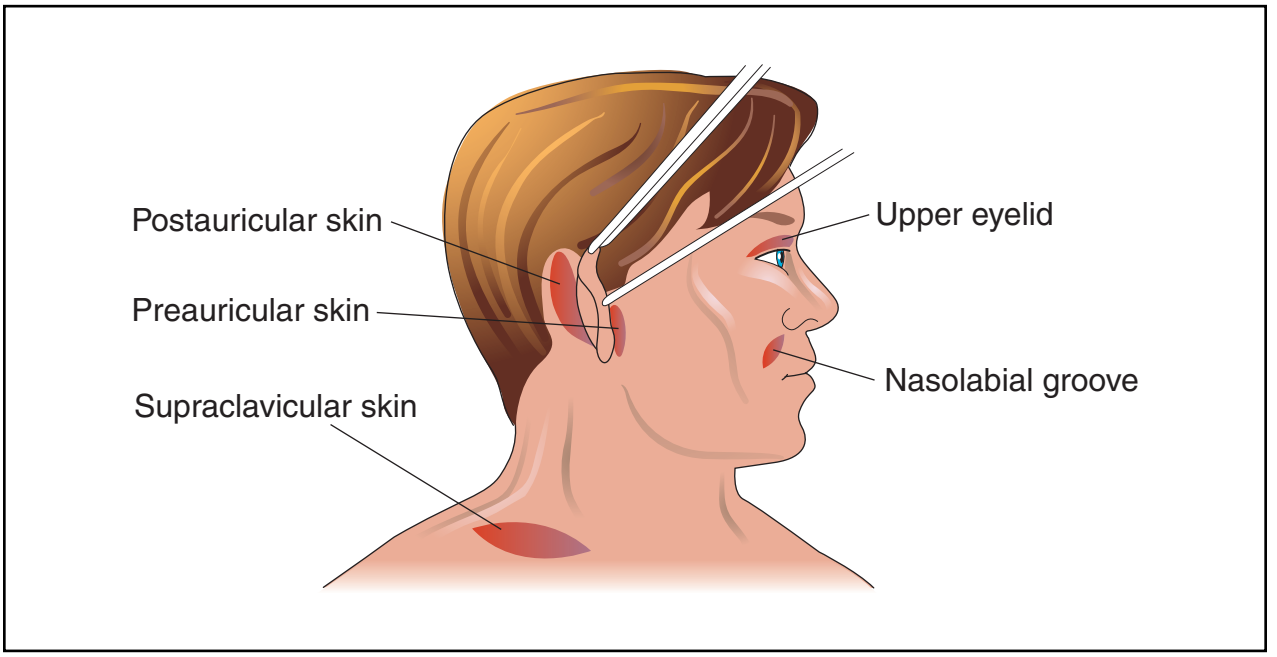
A full-thickness graft involves both layers of the skin. Full-thickness autografts provide better contour, more natural color, and less contraction at the grafted site. The main disadvantage of full-thickness skin grafts is that the wound at the donor site is larger and requires more careful management; often a split-thickness graft must be used to cover the donor site.

A composite skin graft is sometime used, consisting of combinations of skin and fat, skin and cartilage, or dermis and fat. Composite grafts are used where three-dimensional reconstruction is necessary. For example, a wedge of ear containing skin and cartilage can be used to repair the nose.

Several artificial skin products are available for burns or non-healing wounds. Unlike allographs and xenographs, these products are not rejected by the patient's body and actually encourage the generation of new tissue. Artificial skin usually consists of a synthetic epidermis and a collagen-based dermis. This artificial dermis, the fibers of which are arranged in a lattice, acts as a template for the formation of new tissue. Fibroblasts, blood vessels, nerve fibers, and lymph vessels from surrounding healthy tissue cross into the collagen lattice, which eventually degrades as these cells and structures build a new dermis. The synthetic epidermis, which acts as a temporary barrier during this process, is eventually replaced with a split-thickness autograft or with an epidermis cultured in the laboratory from the patient's own epithelial cells. The cost for the synthetic products in about $1,000 for a 40-in (100-cm) square piece of artificial skin, in addition to the costs of the surgery. This procedure is covered by insurance.

Aftercare

Once a skin graft has been put in place, even after it has healed, it must be maintained carefully. Patients who



Skin grafting is a surgical procedure by which skin or a skin substitute is placed over a burn or non-healing wound to replace the damaged skin or provide a temporary wound covering. Skin for grafting can be obtained from another area of the patient's body, such as the face and neck, as shown in the illustration above. *(Illustration by Electronic Illustrators Group.)*

have grafts on their legs should remain in bed for seven to 10 days, with their legs elevated. For several months, the patient should support the graft with an Ace bandage or Jobst stocking. Grafts in other areas of the body should be similarly supported after healing to decrease the amount of contracture.

Grafted skin does not contain sweat or oil glands, and should be lubricated daily for two to three months with a bland oil (e.g., mineral oil) to prevent drying and cracking.

Risks

The risks of skin grafting include those inherent in any surgical procedure that involves anesthesia. These include reactions to the medications, problems breathing, bleeding, and infection. In addition, the risks of an allograft procedure include transmission of infectious disease.

Normal results

A skin graft should provide significant improvement in the quality of the wound site, and may prevent the serious complications associated with burns or non-healing wounds.

Abnormal results

Failure of a graft can result from poor blood flow, swelling, or infection.

Resources

BOOKS

Stueber, Kristin, and Nelson H. Goldberg. "Wound Coverage: Grafts and Flaps." In *Cutaneous Wounds*, ed. F. Joseph Dagher. Mount Kisco, NY: Future Publishing, 1985.

PERIODICALS

McCarthy, Michael. "Bio-Engineered Tissues Move Towards the Clinic." *Lancet* 348 (16 Aug. 1996): 466

Myers, S. R., M. R. Machesney, R. M. Warwick, and P. D. Cussons. "Skin Storage." *British Medical Journal* 313 (24 Aug. 1996): 439.

Strange, Carolyn J. "Brave New Skin." *Technology Review* 100 (July 1997): 18-19.

Strange, Carolyn J. "Second Skins." *FDA Consumer* 31 (Jan./Feb. 1997): 13-17.

Ward, C. Gillon. "Burns." *Journal of the American College of Surgeons* 186 (Feb. 1998): 123-126.

ORGANIZATIONS

American Burn Association. 625 N. Michigan Ave., Suite 1530, Chicago, IL 60611. (800) 548-2876. <http://www.ameriburn.org>.

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. <http://www.diabetes.org>.

Lisa Christenson, PhD

KEY TERMS

Allograft—Tissue that is taken from one person's body and grafted to another person.

Autograft—Tissue that is taken from one part of a person's body and transplanted to a different part of the same person.

Collagen—A protein that provides structural support; the main component of connective tissue.

Dermis—The underlayer of skin, containing blood vessels, nerves, hair follicles, and oil and sweat glands.

Epidermis—The outer layer of skin, consisting of a layer of dead cells that perform a protective function and a second layer of dividing cells.

Fibroblasts—A type of cell found in connective tissue; produces collagen.

Keratinocytes—Cells found in the epidermis. The keratinocytes at the outer surface of the epidermis are dead and form a tough protective layer. The cells underneath divide to replenish the supply.

Xenograft—Tissue that is transplanted from one species to another (e.g., pigs to humans).

Skin lesion removal

Definition

Skin lesion removal employs a variety of techniques, from relatively simple biopsies to more complex surgical excisions, to remove lesions that range from benign growths to **malignant melanoma**.

Purpose

Sometimes the purpose of skin lesion removal is to excise an unsightly mole or other cosmetically unattractive skin growth. Other times, physicians will remove a skin lesion to make certain it is not cancerous, and, if it proves cancerous, to prevent its spread to other parts of the body.

Precautions

Most skin lesion removal procedures require few precautions. The area to be treated is cleaned before the procedure with alcohol or another antibacterial preparation, but generally it is not necessary to use a sterile operating room. Most procedures are performed on an outpatient basis, using a local anesthetic. Some of the more complex procedures may require specialized equipment available only in an outpatient surgery center. Most of the procedures are not highly invasive and, frequently, can be well-tolerated by young and old patients, as well as those with other medical conditions.

Description

A variety of techniques are used to remove **skin lesions**. The particular technique selected will depend on such factors as the seriousness of the lesion, its location, and the patient's ability to tolerate the procedure. Some of the simpler techniques, such as a biopsy or cryosurgery, can be performed by a primary care physician. Some of the more complex techniques, such as excision with a scalpel, electrosurgery, or **laser surgery**, are typically performed by a dermatologic surgeon, plastic surgeon, or other surgical specialist. Often, the technique selected will depend on how familiar the physician is with the procedure and how comfortable he or she is with performing it.

Biopsy

In this procedure, the physician commonly injects a local anesthetic at the site of the skin lesion, then removes a sample of the lesion, so that a definite diagnosis can be made. The sample is sent to a pathology laboratory, where it is examined under a microscope. Certain characteristic skin cells, and their arrangement in the skin, offer clues to the type of skin lesion, and whether it is cancerous or otherwise poses danger. Depending on the results of the microscopic examination, additional surgery may be scheduled.

A variety of methods are used to obtain a **skin biopsy**. The physician may use a scalpel to cut a piece or remove all of the lesion for examination. Lesions that are confined to the surface may be sampled with a shave biopsy, where the physician holds a scalpel blade parallel to the surface of the skin and slides the blade across the base of the lesion, removing a sample. Some physicians use a single-edge razor blade for this, instead of a scalpel. A physician may also perform a punch biopsy, in which a small circular punch removes a plug of skin.

Excision

When excising a lesion, the physician attempts to remove it completely by using a scalpel to cut the shape of an ellipse around the lesion. Leaving an elliptical wound, rather than a circular wound, makes it easier to insert stitches. If a lesion is suspected to be cancerous, the physician will not cut directly around the lesion, but

will attempt to also remove a healthy margin of tissue surrounding it. This is to ensure that no cancerous cells remain, which would allow the tumor to reappear. To prevent recurrence of basal and squamous cell skin cancers, experts recommend a margin of 0.08–0.16 in (2–4 mm) for malignant melanoma, the margin may be 1.2 in (3 cm) or more.

Destruction

Not all lesions need to be excised. A physician may simply seek to destroy the lesion using a number of destructive techniques. These techniques do not leave sufficient material to be examined by a pathologist, however, and are best used in cases where a visual diagnosis is certain.

- Cryosurgery. This technique employs an extremely cold liquid or instrument to freeze and destroy abnormal skin cells that require removal. Liquid nitrogen is the most commonly used cryogen. It is typically sprayed on the lesion in several freeze-thaw cycles to ensure adequate destruction of the lesion.
- Curettage. In this procedure, an instrument with a circular cutting loop at the end is drawn across the lesion, starting at the middle and moving outward. With successive strokes, the physician scrapes portions of the lesion away. Sometimes a physician will use the curet to reduce the size of the lesion before turning to another technique to finish removing it.
- Electrosurgery. This utilizes an alternating current to selectively destroy skin tissue. Depending on the type of current and device used, physicians may use electrosurgical equipment to dry up surface lesions (electrodessication), to burn off the lesion (electrocoagulation), or to cut the lesion (electrosection). One advantage of electrosurgery is that it minimizes bleeding.

Mohs' micrographic surgery

The real extent of some lesions may not be readily apparent to the eye, making it difficult for the surgeon to decide where to make incisions. If some **cancer** cells are left behind, for example, the cancer may reappear or spread. In a technique called Mohs' micrographic surgery, surgeons begin by removing a lesion and examining its margins under a microscope for evidence of cancer. If cancerous cells are found, the surgeon then removes another ring of tissue and examines the margins again. The process is repeated until the margins appear clear of cancerous cells. The technique is considered ideal for aggressive tumors in areas such as the nose or upper lip, where an excision with wide margins may be difficult to repair, and may leave a cosmetically poor appearance.

Lasers

Laser surgery is now applied to a variety of skin lesions, ranging from spider veins to more extensive blood vessel lesions called hemangiomas. Until recently, CO_2 lasers were among the more common laser devices used by physicians, primarily to destroy skin lesions. Other lasers, such as the Nd:YAG and flashlamp-pumped pulse dye laser have been developed to achieve more selective results when used to treat vascular lesions, such as hemangiomas, or pigmented lesions, such as café-au-lait spots.

Preparation

No extensive preparation is required for skin lesion removal. Most procedures can be performed on an outpatient basis with a local anesthetic. The lesion and surrounding area is cleaned with an antibacterial compound before the procedure. A sterile operating room is not required.

Aftercare

The amount of aftercare will vary, depending on the skin lesion removal technique. For biopsy, curettage, cryosurgery, and electrosurgery procedures, the patient is told to keep the wound clean and dry. Healing will take at least several weeks, and may take longer, depending on the size of the wound and other factors. Healing times will also vary with excisions and with Mohs' micrographic surgery, particularly if a skin graft or skin flap is needed to repair the resulting wound. Laser surgery may produce changes in skin coloration that often resolve in time. **Pain** is usually minimal following most outpatient procedures, so pain medicines are not routinely prescribed. Some areas of the body, such as the scalp and fingers, can be more painful than others, however, and a pain medicine may be required.

Risks

All surgical procedures present risk of infection. Keeping the wound clean and dry can minimize the risk. **Antibiotics** are not routinely given to prevent infection in skin surgery, but some doctors believe they have a role. Other potential complications include:

- bleeding below the skin, which may create a hematoma and sometimes requires the wound to be reopened and drained,
- temporary or permanent nerve damage resulting from excision in an area with extensive and shallow nerve branches,
- wounds that may reopen after they have been stitched closed, increasing the risk of infection and scarring.

KEY TERMS

Curet—A surgical instrument with a circular cutting loop at one end. The curet is pulled over the skin lesion in repeated strokes to remove one portion of the lesion at a time.

Mohs' micrographic surgery—A surgical technique in which successive rings of skin tissue are removed and examined under a microscope to ensure that no cancer is left.

Shave biopsy—A method of removing a sample of skin lesion so it can be examined by a pathologist. A scalpel or razor blade is held parallel to the skin's surface and is used to slice the lesion at its base.

Normal results

Depending on the complexity of the skin lesion removal procedure, patients can frequently resume their normal routine the day of surgery. Healing frequently will take place within weeks. Some excisions will require later reconstructive procedures to improve the appearance left by the original procedure.

Abnormal results

In addition to the complications outlined above, it is always possible that the skin lesion will reappear, requiring further surgery.

Resources

BOOKS

Fewkes, Jessica L. *Illustrated Atlas of Cutaneous Surgery.* New York: Gower Medical Publishing, 1992.

Roenigk, Randall K., and Henry H. Roenigk. *Roenigk & Roenigk's Dermatologic Surgery: Principles and Practice*. New York: Marcel Dekker, 1996.

PERIODICALS

Alster, Tina S., and Amy B. Lewis. "Dermatologic Laser Surgery: A Review." *Dermatologic Surgery* 22 (Sept. 1996): 797-805.

Lener, Elizabeth V., et al. "Topical Anesthetic Agents in Dermatologic Surgery: A Review." *Dermatologic Surgery* 23 (Aug. 1997): 673-683.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asds-net.org>.

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

Richard H. Camer

Skin lesions

Definition

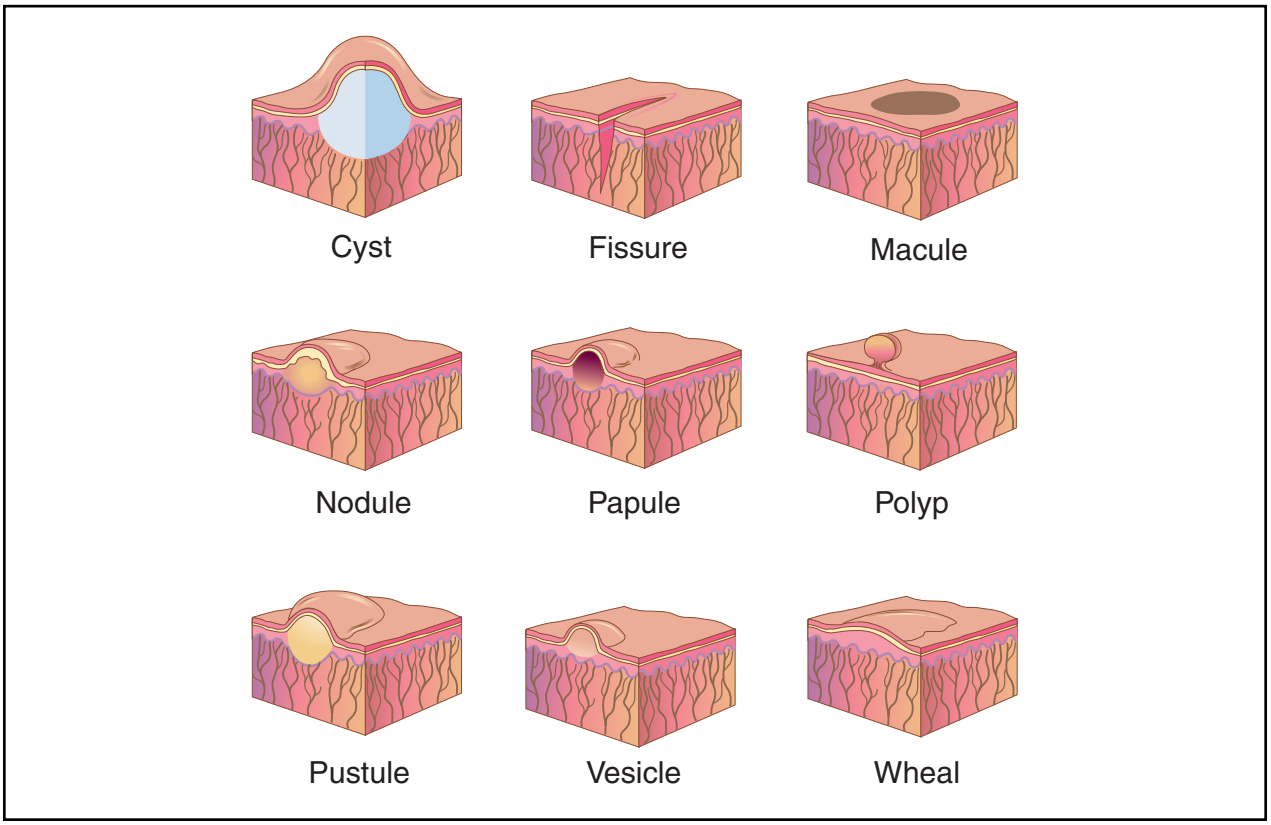
A skin lesion is a superficial growth or patch of the skin that does not resemble the area surrounding it.

Description

Skin lesions can be grouped into two categories: primary and secondary. Primary skin lesions are variations in color or texture that may be present at birth, such as **moles** or **birthmarks**, or that may be acquired during a person's lifetime, such as those associated with infectious diseases (e.g., **warts**, **acne**, or **psoriasis**), allergic reactions (e.g., **hives** or **contact dermatitis**), or environmental agents (e.g., **sunburn**, pressure, or temperature extremes). Secondary skin lesions are those changes in the skin that result from primary skin lesions, either as a natural progression or as a result of a person manipulating (e.g., scratching or picking at) a primary lesion.

The major types of primary lesions are:

- Macule. A small, circular, flat spot less than 0.4 in (1 cm) in diameter. The color of a macule is not the same as that of nearby skin. Macules come in a variety of shapes and are usually brown, white, or red. Examples of macules include freckles and flat moles. A macule more than 0.4 in (1 cm) in diameter is called a patch.
- Vesicle. A raised lesion less than 0.2 in (5 mm) across and filled with a clear fluid. Vesicles that are more than 0.2 in (5 mm) across are called bullae or blisters. These lesions may may be the result of sunburns, insect bites, chemical irritation, or certain viral infections, such as herpes.
- Pustule. A raised lesion filled with pus. A pustule is usually the result of an infection, such as acne, impetigeo, or **boils**.
- Papule. A solid, raised lesion less than 0.4 in (1 cm) across. A patch of closely grouped papules more than 0.4 in (1 cm) across is called a plaque. Papules and plaques can be rough in texture and red, pink, or brown in color. Papules are associated with such conditions as warts, **syphilis**, psoriasis, seborrheic and actinic keratoses, **lichen planus**, and skin **cancer**.



A skin lesion is an abnormal growth or an area of skin that does not resemble the skin surrounding it. The illustrations above feature some of the different types of skin lesions. *(Illustration by Electronic Illustrators Group.)*

- Nodule. A solid lesion that has distinct edges and that is usually more deeply rooted than a papule. Doctors often describe a nodule as "palpable," meaning that, when examined by touch, it can be felt as a hard mass distinct from the tissue surrounding it. A nodule more than 0.8 in (2 cm) in diameter is called a tumor. Nodules are associated with, among other conditions, keratinous cysts, lipomas, fibromas, and some types of lymphomas.
- Wheal. A skin elevation caused by swelling that can be itchy and usually disappears soon after erupting. Wheals are generally associated with an allergic reaction, such as to a drug or an insect bite.
- Telangiectasia. Small, dilated blood vessels that appear close to the surface of the skin. Telangiectasia is often a symptom of such diseases as **rosacea** or **scleroderma**.

The major types of secondary skin lesions are:

- Ulcer. Lesion that involves loss of the upper portion of the skin (epidermis) and part of the lower portion (dermis). Ulcers can result from acute conditions such as bacterial infection or trauma, or from more chronic conditions, such as scleroderma or disorders involving peripheral veins and arteries. An ulcer that appears as a deep crack that extends to the dermis is called a fissure.
- Scale. A dry, horny build-up of dead skin cells that often flakes off the surface of the skin. Diseases that promote scale include fungal infections, psoriasis, and **seborrheic dermatitis**.
- Crust. A dried collection of blood, serum, or pus. Also called a scab, a crust is often part of the normal healing process of many infectious lesions.
- Erosion. Lesion that involves loss of the epidermis.
- Excoriation. A hollow, crusted area caused by scratching or picking at a primary lesion.
- Scar. Discolored, fibrous tissue that permanently replaces normal skin after destruction of the dermis. A very thick and raised scar is called a keloid.
- Lichenification. Rough, thick epidermis with exaggerated skin lines. This is often a characteristic of scratch **dermatitis** and **atopic dermatitis**.
- Atrophy. An area of skin that has become very thin and wrinkled. Normally seen in older individuals and people who are using very strong topical corticosteroid medication.

Causes and symptoms

Skin lesions can be caused by a wide variety of conditions and diseases. A tendency toward developing moles, freckles, or birthmarks may be inherited. Infection of the skin itself by bacteria, viruses, fungi, or parasites is the most common cause of skin lesions. Acne, **athlete's foot** (tinea pedis), warts, and **scabies** are examples of skin infections that cause lesions. Allergic reactions and sensitivity to outside environmental factors can also lead to the formation of skin lesions. Underlying conditions can also precipitate the appearance of skin lesions. For example, the decreased sensitivity and poor circulation that accompanies **diabetes mellitus** can contribute to the formation of extensive ulcers on extremities such as the feet. Infections of body's entire system can cause the sudden onset of skin lesions. For example, skin lesions are a hallmark symptom of such diseases as chicken pox, herpes, and small pox. Cancers affecting the skin, including basal cell carcinoma, squamous cell carcinoma, **malignant melanoma**, and **Kaposi's sarcoma**, are recognized by their lesions.

Diagnosis

Diagnosis of the underlying cause of skin lesions is usually based on patient history, characteristics of the lesion, and where and how it appears on the patient's body (e.g., pustules confined to the face, neck, and upper back can indicate acne, while scales appearing on the scalp and face may indicate seborrheic dermatitis). To determine the cause of an infection, doctors may also take scrapings or swab samples from lesions for examination under a microscope or for use in bacterial, fungal, or viral cultures. In cases where a fungal infection is suspected, a doctor may examine a patient's skin under ultraviolet light using a filter device called a Woods light—under these conditions, certain species will taken on specific fluorescent colors. Dermatologists may also use contrast lighting and subdued lighting to detect variations in the skin. When involvement of the immune system is suspected, doctors may order a immunofluorescence test, which detects antibodies to specific antigens using a fluorescent chemical. In cases of contact dermatitis, a condition in which a allergic reaction to something irritates the skin, doctors may use patch tests, in which samples of specific antigens are introduced into the skin via a scratch or a needle prick, to determine what substances are provoking the reaction.

The vast majority of skin lesions are noncancerous. However, doctors will determine whether or not a particular lesion or lesions are cancerous based on observation and the results of an excisional or punch biopsy, in which a tissue sample is excised for microscopic analysis. Since early detection is a key to successful treatment, individuals should examine their skin on a monthly basis for changes to existing moles, the presence of new moles, or a change in a certain area of skin. When examining moles, factors to look for include:

- Asymmetry. A normal mole is round, whereas a suspicious mole is uneven.
- Border. A normal mole has a clear-cut border with the surrounding skin, whereas the edges of a suspect mole may be irregular.
- Color. Normal moles are uniformly tan or brown, but cancerous moles may appear as mixtures of red, white, blue, brown, purple, or black.
- Diameter. Normal moles are usually less than 0.2 in (5 mm) in diameter, a skin lesion greater than this may be suspected as cancerous.

Treatment

Treatment of skin lesions depends upon the underlying cause, what type of lesions they are, and the patient's overall health. If the cause of the lesions is an allergic reaction, removing the allergen from the patient's environment is the most effective treatment. Topical preparations can also be used to clean and protect irritated skin as well as to remove dead skin cells and scales. These may come in a variety of forms, including ointments, creams, lotions, and solutions. Topical **antibiotics**, fungicides, pediculicides (agents that kill lice), and scabicides (agents that kill the scabies parasite) can be applied to treat appropriate skin infections. Oral medications may be taken to address systemic infections or conditions. Deeply infected lesions may require minor surgery to lance and drain pus. Topical agents to sooth irritated skin and reduce inflammation may also be applied. **Corticosteroids** are particularly effective in reducing inflammation and **itching** (puritis). Oatmeal baths, baking soda mixtures, and calamine lotion are also recommended for the relief of these symptoms. A type of corticosteroid may be used to reduce the appearance of keloid scars. Absorbent powders may also be used to reduce moisture and prevent the spread of infection. In cases of ulcers that are slow to heal, pressure dressings may be used. At times, surgical removal of a lesion may be recommended—this is the usual course of therapy for skin cancer. Surgical removal usually involves a simple excision under local anesthetic, but it may also be accomplished through freezing (**cryotherapy**) or **laser surgery**.

Prognosis

Skin lesions such as moles, freckles, and birthmarks are a normal part of skin and will not disappear unless deliberately removed by a surgical procedure. Lesions due to an allergic reaction often subside soon after the

KEY TERMS

Corticosteroid—A type of steroid medication that helps relieve itching (puritis) and reduce inflammation.

Fibroma—A usually benign tumor consisting of fiborous tissue.

Lesion—A possibly abnormal change or difference in a tissue or structure, such as the skin.

Lipoma—A usually benign tumor of fatty tissue.

Patch test—Test in which different antigens (substances that cause an allergic reaction) are introduced into a patient's skin via a needle prick or scratch and then observed for evidence of an allergic reaction to one or more of them. Also known as a scratch test.

Woods light—Device that allows only ultraviolet light to pass through it.

offending agent is removed. Healing of lesions due to infections or disorders depends upon the type of infection or disorder and the overall health of the individual. Prognosis for skin cancer primarily depends upon whether or not the lesion is localized and whether or not it has spread to other areas of the body, such as the lymph nodes. In cases where the lesion is localized and has not spread to other parts of the body, the cure rate is 95–100%.

Prevention

Not all skin lesions are preventable; moles and freckles, for example, are benign growths that are common and unavoidable. However others can be avoided or minimized by taking certain precautions. Skin lesions caused by an allergic reaction can be avoided by determining what the offending agent is and removing it from the home or workplace, or, if this is impossible, developing strategies for safely handling it, such as with gloves and protective clothing. Keeping the skin, nails, and scalp clean and moisturized can help reduce or prevent the incidence of infectious skin diseases, as can not sharing personal care items such as combs and make-up with others. Skin lesions associated with **sexually transmitted diseases** can be prevented by the use of condoms. Scratching or picking at existing lesions should be avoided since this usually serves only to spread infection and may result in scarring. Individuals who have systemic conditions, such as diabetes mellitus or poor circulation, that could lead to serious skin lesions should inspect their bodies regularly for changes in their skin's condition. Regular visual inspection of the skin is also a key to preventing or minimizing the occurrence of skin cancer, as is the regular use of sun screens with an SPF of 15 or more.

Resources

BOOKS

Leibrandt, Thomas, ed. *Nurse's Reference Library: Diseases.* Springhouse, PA: Springhouse Corporation, 1985.

Rosen, Theodore, Marilyn B. Lanning, and Marcia J. Hill. *The Nurse's Atlas of Dermatology.* Boston: Little Brown & Co., 1983.

Turkington, Carol. *Skin Deep: An A-Z of Skin Disorders, Treatments and Health.* New York: Facts on File, Inc. 1996.

OTHER

"Keloids." *The Skin Site.* 7 Apr. 1998 <http://www.skinsite.com/info_keloids.htm>.

"Seborrheic Keratoses." *American Academy of Dermatology.* 7 Apr. 1998 <http://www.aad.org>.

"Skin Lesions." *Dalhousie Medical School Page.* 78 Apr. 1998 <http://www.medicine.dal.ca>.

"Skin Lesions, Benign." *ThriveOnline.* 6 Apr. 1998 <http://thriveonline.oxygen.com>.

Bridget Travers

Skin pigmentation disorders

Definition

Skin pigmentation disorders are conditions that cause the skin to appear lighter or darker than normal, or blotchy and discolored.

Description

People of all races have skin pigmentation disorders. Some disorders, like **albinism** (which affects one out of every 17,000 people) are rare. Others, such as age spots, are very common.

Skin pigmentation disorders occur because the body produces either too much or too little melanin, a pigment that creates hair, skin, and eye color. Melanin protects the body by absorbing ultraviolet light.

In hypopigmentation means the body does not produces enough melanin. Albinism, for example, is an inherited condition that causes a lack of pigment. So people with albinism typically have light skin, white or pale yellow hair, and light blue or gray eyes. Another condition called vitilgo, creates smooth, depigmented white spots on the skin. Vitilgo affects nearly 2% of the population, but it strikes people between 10 and 30 years old more often, and is more evident in people with darker skin.

In **hyperpigmentation**, the body produces too much melanin, causing skin to become darker than usual. **Lichen simplex chronicus** is a skin disorder with severe **itching** that causes thick, dark patches of skin to develop. Lamellar **ichthyosis** (fish scale disease) is an inherited disease that also is characterized by darkened, scaly, dry patches of skin.

Hyperpigmentation also occurs in melasma, a dark mask-like discoloration that covers the cheeks and bridge of the nose. Melasma can occur during the end of **pregnancy**. People with the autoimmune disease (when immune cells, which attack invaders, become abnormally programed to kill self cells inside the body) systemic lupus also may develop a similar butterfly-shaped mask on their faces. In addition, many people have **moles**, freckles, age spots, and **birthmarks**, ranging from red or brown to bluish-black, covering various parts of their bodies.

Causes and symptoms

Scientists are still studying the reasons why skin pigmentation disorders occur. In some cases there are tangible causes, such as sun exposure, drug reactions or genetic inheritance. In other cases, it is not as clear.

Albinism is an inherited recessive trait. Albinism has many different forms, but most people who have this condition have pale skin, hair, and eyes. Melanin also creates eye color, and serves as a filter that prevents too much light from entering the eye. Since they lack melanin in their eyes, many people with albinism also have **visual impairment**. With little skin pigmentation, they also **sunburn** easily and are more prone to skin **cancer**.

The hypopigmentation spots associated with vitilgo sometimes form where a person has been cut or injured. Research has shown that the light patches associated with vitilgo do not contain melanocytes, the type of skin cells that create melanin. Some scientists believe vitilgo may be caused by an autoimmune disorder. It also has been linked to other conditions such as **hyperthyroidism** (too much thyroid hormone) and **Addison's Disease**, which affects the adrenal gland.

Hyperpigmentation can be caused by many factors, from too much sunbathing to drug reactions or poor **nutrition**. **Wounds** and scars also can develop darker patches of skin. A psychological syndrome gives people with lichen simplex chronicus to develop a compulsive need to scratch, which causes dark, leathery skin to form. This can lead to permanent scarring and infection if untreated. Scientists believe lamellar ichthyosis is caused by genetics.

The mask caused by melasma may be related to pregnancy hormones, and usually disappears after a woman gives birth. Birthmarks, moles, and aging spots usually are harmless. Some moles, however, can change in size, color, texture, or start bleeding, which could indicate possible skin cancer.

Diagnosis

Diagnostic tests vary for different types of skin pigmentation disorders. Physicians usually can diagnose albinism by looking carefully at a person's hair, skin, and eyes. They may order blood tests and eye exams as well. A visual exam also is enough to diagnose vitilgo.

For most hyperpigmentation disorders, doctors can make a diagnosis by looking at a person's appearance. To detect conditions like lichen simplex chronicus or lamellar ichthyosis, or skin cancer they may also do a biopsy, to remove some of the affected skin for further study under a microscope. Some physicians also use a wood's lamp, or black light test, to diagnose skin conditions. Affected areas would absorb the ultraviolet light and stand out with flourescent colors in the darkened room.

Treatment

For albinism, health care providers advise people to cover up, use sunscreen and avoid excess sunlight to prevent skin cancer. People with albinism also must wear protective sunglasses and, in some cases, prescription corrective lenses. Surgery may be necessary to correct visual impairments.

To treat vitilgo, physicians may prescribe a combination of photo-sensitive medications like trimethylpsoralen and ultraviolet light therapy to darken the spots. If the person has depigmented patches covering more than 50% of the body, doctors also may be able to use skin bleaching agents like monobenzone to give the skin a lighter, more uniform appearance. Other options include cosmetic concealers and **skin grafting**.

Skin-lightening creams are available for hyperpigmentation disorders. Doctors also advise staying out of the sun. Counseling with a dietitian may help in cases caused by poor nutrition. For lichen simplex chronicus, doctors could prescribe **antihistamines** and topical steroid creams to stop the itching. If a mole or birthmark appears suspicious, physicians often will surgically remove it to prevent skin cancer.

Prognosis

Most skin pigmentation disorders do not affect a person's health, only the outward appearance.

Prevention

In most cases, doctors will recommend using sunscreen and avoiding too much sun exposure.

KEY TERMS

Melanin—A pigment that creates hair, skin and eye color. Melanin also protects the body by absorbing ultraviolet light.

Melanocytes—The type of skin cells that create melanin.

Albinism—An inherited condition that causes a lack of pigment. People with albinism typically have light skin, white or pale yellow hair and light blue or gray eyes

Hypopigmentation—A skin condition that occurs when the body has too little melanin, or pigment.

Hyperpigmentation—A skin condition that occurs when the body has too much melanin, or pigment.

Lichen simplex chronicus—A skin disorder with severe itching that causes thick, dark patches of skin to develop.

Vitilgo—A skin disorder that creates smooth, depigmented white spots on the skin.

Lamellar ichthyosis—Also called fish scale disease, this inherited condition is characterized by darkened, scaly, dry patches of skin.

Melasma—A dark mask-like discoloration that covers the cheeks and bridge of the nose. Also called "the mask of pregnancy."

Resources

BOOKS

Levine, Norman. *Pigmentation and Pigmentary Disorders.* CRC Press, 1993.

PERIODICALS

Wilson, Tracy. "The Paler Side of Beauty." *Heart and Soul* 6, no. 1 (February, 1999): 30-33.

ORGANIZATIONS

American Academy of Dermatology. 1350 I St. NW, Washington, DC, 20005-4355. (202) 842-3555. <http://www.aad.org>.

National Organization for Albinism and Hypopigmentation (NOAH), 1530 Locust St., #29, Philadelphia, PA, 19102-4415. (800) 473-2310. <http://www.albinism.org>.

OTHER

MelanomaNet. <http://www.skincarephysicians.com/melanomanet/index.html>.

National Weather Service. "Ultraviolet Light Index." <http://www.nws.noaa.gov/pa/secnews/uv/index.html>.

Melissa Knopper

Skin resurfacing

Definition

Skin resurfacing employs a variety of techniques to change the surface texture and appearance of the skin. Common skin resurfacing techniques include chemical peels, dermabrasion, and laser resurfacing.

Purpose

Skin resurfacing procedures may be performed for cosmetic reasons, such as diminishing the appearance of wrinkles around the mouth or eyes. They may also be used as a medical treatment, such as removing large numbers of certain precancerous lesions called actinic keratoses. Physicians sometimes combine techniques, using dermabrasion or laser resurfacing on some areas of the face, while performing a chemical peel on other areas.

Precautions

As the popularity of skin resurfacing techniques has increased, many unqualified or inexperienced providers have entered the field. Patients should choose their provider with the same degree of care they take for any other medical procedure. Complications of skin resurfacing techniques can be serious, including severe infection and scarring.

Patient's with active herpesvirus infections are not good candidates for resurfacing procedures. Persons who tend to scar easily may also experience poor results. Patients who have recently used the oral **acne** medication isotretinoin (Accutane) may be at higher risk of scarring following skin resurfacing.

Description

Chemical peel

Chemical peels employ a variety of caustic chemicals to selectively destroy several layers of skin. The peeling solutions are "painted on," area-by-area, to ensure that the entire face is treated. After the skin heals, discoloration, wrinkles, and other surface irregularities are often eliminated.

Chemical peels are divided into three types: superficial, medium-depth, and deep. The type of peel depends on the strength of the chemical used, and on how deeply it penetrates. Superficial peels are used for fine wrinkles, sun damage, acne, and **rosacea**. The medium-depth peel is used for more obvious wrinkles and sun damage, as well as for precancerous lesions like actinic keratoses. Deep peels are used for the most severe wrinkling and sun damage.

Dermabrasion

Dermabrasion uses an abrasive tool to selectively remove layers of skin. Some physicians use a hand-held motorized tool with a small wire brush or diamond-impregnated grinding wheel at the end. Other physicians prefer to abrade the skin by hand with an abrasive pad or other instrument. Acne scarring is one of the prime uses for dermabrasion. It also can be used to treat wrinkling, remove surgical scars, and obliterate tattoos.

Laser resurfacing

Laser resurfacing is the most recently developed technique for skin resurfacing. Specially designed, pulsed CO_2 lasers can vaporize skin layer-by-layer, causing minimal damage to other skin tissue. Special scanning devices move the laser light across the skin in predetermined patterns, ensuring proper exposure. Wrinkling around the eyes, mouth, and cheeks are the primary uses for laser resurfacing. Smile lines or those associated with other facial muscles tend to reappear after laser resurfacing. Laser resurfacing appears to achieve its best results as a spot treatment; patients expecting complete elimination of their wrinkles will not be satisfied.

Preparation

Chemical peel

Preparation for the chemical peel begins several weeks before the actual procedure. To promote turnover of skin cells, patients use a mild glycolic acid lotion or cream in the morning, and the acne cream tretinoin in the evening. They also use hydroquinone cream, a bleaching product that helps prevent later discoloration. To prevent reappearance of a herpes simplex virus infection, antiviral medicine is started a few days before the procedure and continues until the skin has healed.

Patients arrive for the procedure wearing no makeup. The physician "degreases" the patient's face using alcohol or another cleanser. Some degree of **pain** accompanies all types of peels. For a superficial peel, use of a hand held fan to cool the face during the procedure is often sufficient. For medium-depth peels, the patient may take a sedative or **aspirin**. During the procedure, cold compresses and a hand-held fan can also reduce pain. Deep peels can be extremely painful. Some physicians prefer general anesthesia, but local anesthetics combined with intravenous sedatives are frequently sufficient to control pain.

Dermabrasion

Dermabrasion does not require much preparation. It is usually performed under local anesthesia, although some physicians use intravenous **sedation** or general anesthesia. The physician begins by marking the areas to be treated and then chilling them with ice packs. In order to stiffen the skin, a spray refrigerant is applied to the area, which also helps control pain. Some physicians prefer to inject the area with a solution of saline and local anesthetic, which also leaves the skin's surface more solid. Since dermabrasion can cause quite a bit of bleeding, physicians and their assistants will wear gloves, gowns, and masks to protect themselves from possible blood-transmitted infection.

Laser resurfacing

Antiviral medications should be started several days before the procedure. Laser resurfacing is performed under local anesthesia. An oral sedative may also be taken. The patient's eyes must be shielded, and the area surrounding the face should be shielded with wet drapes or crumpled foil to catch stray beams of laser light. The physician will mark the areas to be treated before beginning the procedure.

Aftercare

Chemical peel

Within a day or so following a superficial peel, the skin will turn faint pink or brown. Over the next few days, dead skin will peel away. Patients will be instructed to wash their skin frequently with a mild cleanser and cool water, then apply an ointment to the skin to keep it moist. After a medium-depth peel, the skin turns deep red or brown, and crusts may form. Care is similar to that following a superficial peel. Redness may persist for a week or more. Deep-peeled skin will turn brown and crusty. There may also be swelling and some oozing of fluid. Frequent washing and ointments are favored over dressings. The skin typically heals in about two weeks, but redness may persist.

Dermabrasion

Following the procedure, an ointment may be applied, and the wound will be covered with a dressing and mask. Patients with a history of herpesvirus infections will begin taking an antiviral medication to prevent a recurrence. After 24 hours, the dressing is removed, and ointment is reapplied to keep the wound moist. Patients are encouraged to wash their face with plain water and reapply ointment every few hours. This relieves **itching** and pain and helps remove oozing fluid and other matter. Patients may require a pain medication. A steroid medication may be taken during the first few days to reduce swelling. The skin will take a week or more to heal, but may remain very red.

Laser resurfacing

The skin should be kept moist following laser resurfacing. This promotes more rapid healing and reduces the risk of infection. Some physicians favor application of ointments only to the skin; others prefer the use of dressings. In either case, care of the skin is similar to that given following a chemical peel. The face is washed with plain water to remove ooze, and an ointment is reapplied. Healing will take approximately two weeks. Pain medications and a steroid to reduce swelling may also be taken.

Risks

All resurfacing procedures can lead to infection and scarring. It is also possible that skin coloration will be altered, or that redness of the skin will be prolonged for many months. Some of the peeling agents used in deep chemical peels can affect the function of the heart.

Normal results

Depending on the resurfacing techniques selected, it is possible to improve the appearance of skin damaged by sun, age, or disease in many people. Skin resurfacing techniques address only the surface of the skin; procedures such as face-lift surgery or **blepharoplasty** may be needed to repair other age-related skin changes. All resurfacing procedures are accompanied by some pain, redness, and skin color changes. These may persist for several months following the procedure, but they usually resolve over time.

Abnormal results

As noted above, resurfacing procedures can reactivate herpesvirus infections or lead to new, sometimes serious infections. All resurfacing techniques intentionally create skin **wounds**, creating the possibility for scarring. Abnormal results such as these can be minimized with use of antiviral medications prior to the procedure and good wound care afterward. Selection of an experienced, reputable provider also is key.

Resources

BOOKS

Fewkes, Jessica L. *Illustrated Atlas of Cutaneous Surgery.* New York: Gower Medical Publishing, 1992.

Weinstein, Cynthia. "Carbon Dioxide Laser Resurfacing." In *Cosmetic Surgery of the Skin: Principles and Techniques*, ed. William P. Coleman. St. Louis: Mosby, 1997.

PERIODICALS

Fulton Jr., James E. "Dermabrasion, Chemabrasion, and Laserabrasion: Historical Perspectives, Modern Dermabrasion Techniques, and Future Trends." *Dermatologic Surgery* 22 (July 1996): 619-628.

Matarasso, Seth L., et al. "Cutaneous Resurfacing." *Dermatologic Clinics* 15 (Oct. 1997): 569-582.

ORGANIZATIONS

American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asds-net.org>.

American Society for Laser Medicine and Surgery. 2404 Stewart Square, Wausau, WI 54401. (715) 845-9283. <http://www.aslms.org>.

American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.

Richard H. Camer

KEY TERMS

Actinic keratosis—A crusty, scaly skin lesion, caused by exposure to the sun, which can transform into skin cancer.

Herpesviruses—A family of viruses responsible for cold sores, chicken pox, and genital herpes.

Isotretinoin—A powerful vitamin A derivative used in the treatment of acne. It can promote scarring after skin resurfacing procedures.

Skin traction *see* **Traction; Immobilization**

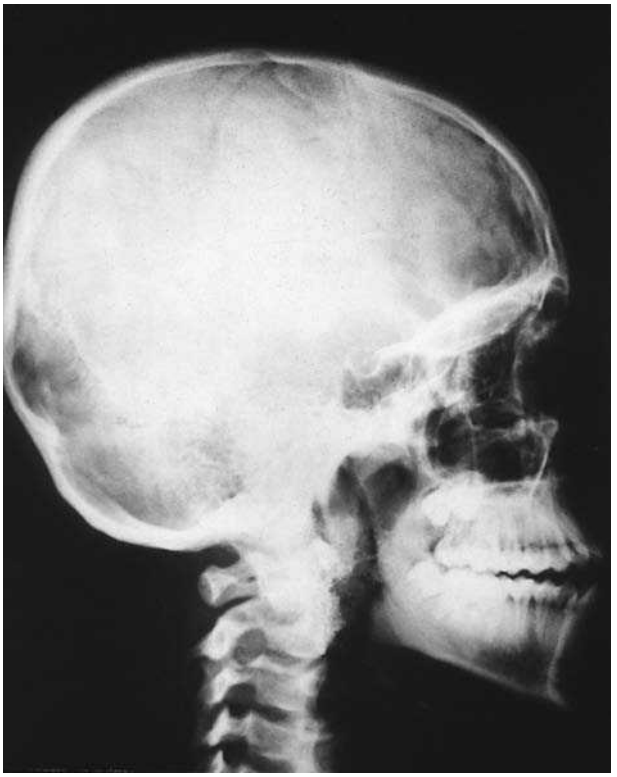
Skull x rays

Definition

Skull x rays are performed to examine the nose, sinuses, and facial bones. These studies may also be referred to as sinus x rays. X-ray studies produce films, also known as radiographs, by aiming x rays at soft bones and tissues of the body. X-ray beams are similar to light waves, except their shorter wavelength allows them to penetrate dense substances, producing images and shadows on film.

Purpose

Doctors may order skull x rays to aid in the diagnosis of a variety of diseases or injuries.



A skull x ray. *(Photo Researchers. Reproduced by permission.)*

Sinusitis

Sinus x rays may be ordered to confirm a diagnosis of **sinusitis**, or sinus infection.

Fractures

A skull x ray may detect bone **fractures** resulting from injury or disease. The skull x ray should clearly show the skull cap, jaw bones, and facial bones.

Tumors

Skull radiographs may indicate tumors in facial bones, tissues, or the sinuses. Tumors may be benign (not cancerous) or malignant (cancerous).

Other

Birth defects (referred to as congenital anomalies) may be detected on a skull x ray by changes in bone structure. Abnormal tissues or glands resulting from various conditions or diseases may also be shown on a skull radiograph.

Precautions

As with any x-ray procedure, women who may be pregnant are advised against having a skull x ray if it is not absolutely necessary. However, a lead apron may be worn across the abdomen during the procedure to protect the fetus. Children are also more sensitive to x-ray exposure. Children of both sexes should wear a protective covering (a lead apron) in the genital/reproductive area. In general, skull x-ray exposure is minimal and x-ray equipment and procedures are monitored to ensure radiation safety.

Description

Skull or sinus x rays may be performed in a doctor's office that has x-ray equipment and a technologist available. The exam may also be performed in an outpatient radiology facility or a hospital radiology department.

In many instances, particularly for sinus views, the patient will sit upright in a chair, perhaps with the head held stable by a foam vise. A film cassette is located behind the patient. The x-ray tube is in front of the patient and may be moved to allow for different positions and views. A patient may also be asked to move his or her head at various angles and positions.

In some cases, technologists will ask the patient to lie on a table and will place the head and neck at various angles. In routine skull x rays, as many as five different views may be taken to allow a clear picture of various bones and tissues. The length of the test will vary depending on the number of views taken, but in general, it should last about 10 minutes. The technologist will usually ask a patient to wait while the films are being developed to ensure that they are clear before going to the radiologist.

Preparation

There is no preparation for the patient prior to arriving at the radiology facility. Patients will be asked to remove jewelry, dentures, or other metal objects that may produce artifacts on the film. The referring doctor or x-ray technologist can answer any questions regarding the procedure. Any woman who is, or may be, pregnant should tell the technologist.

Aftercare

There is no aftercare required following skull or sinus x-ray procedures.

Risks

There are no common side effects from skull or sinus x ray. The patient may feel some discomfort in the positioning of the head and neck, but will have no complications. Any x-ray procedure carries minimal radiation risk, and children and pregnant women should be protected from radiation exposure to the abdominal or genital areas.

KEY TERMS

Radiograph—The actual picture or film produced by an x-ray study.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

Normal results

Normal results should indicate sinuses, bones, tissues, and other observed areas are of normal size, shape, and thickness for the patient's age and medical history. Results, whether normal or abnormal, will be provided to the referring doctor in a written report.

Abnormal results

Abnormal results may include:

Sinusitis

Air in sinuses will show up on a radiograph as black, but fluid will be cloudy or white (opaque). This helps the radiologist to identify trapped fluids in the sinuses. In chronic sinusitis, the radiologist may also note thickening or hardening of the bony wall of an infected sinus.

Fractures

Radiologists may recognize even tiny facial bone fractures as a line of defect.

Tumors

Tumors may be visible if the bony sinus wall is distorted or destroyed. Abnormal findings may result in follow-up imaging studies.

Other

Skull x rays may also detect disorders that show up as changes in bone structure, such as Paget's disease of the bone or acromegaly (a disorder associated with excess growth hormones from the pituitary gland). Areas of calcification, or gathering of calcium deposits, may indicate a condition such as an infection of bone or bone marrow (**osteomyelitis**).

Resources

BOOKS

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

ORGANIZATIONS

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

The National Head Injury Foundation, Inc. (888) 222-5287. <http://www.nhif.org/home.html>.

Radiological Society of North America. 820 Jorie Boulevard, Oak Brook, IL 60523-2251. (630) 571-2670. <http://www.rsna.org>.

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SLE *see* **Systemic lupus erythematosus**

Sleep apnea

Definition

Sleep apnea is a condition in which breathing stops for more than 10 seconds during sleep. Sleep apnea is a major, though often unrecognized, cause of daytime sleepiness.

Description

A sleeping person normally breathes continuously and uninterruptedly throughout the night. A person with sleep apnea, however, has frequent episodes (up to 400–500 per night) in which he or she stops breathing. This interruption of breathing is called "apnea." Breathing usually stops for about 30 seconds; then the person usually startles awake with a loud snort and begins to breathe again, gradually falling back to sleep.

There are two forms of sleep apnea. In obstructive sleep apnea (OSA), breathing stops because tissue in the throat closes off the airway. In central sleep apnea, (CSA), the brain centers responsible for breathing fail to send messages to the breathing muscles. OSA is much more common than CSA. It is thought that about 1–10% of adults are affected by OSA; only about one tenth of that number have CSA. OSA can affect people of any age and of either sex, but it is most common in middle-aged, somewhat overweight men, especially those who use alcohol.

Causes and symptoms

Obstructive sleep apnea

Obstructive sleep apnea occurs when part of the airway is closed off (usually at the back of the throat) while a person is trying to inhale during sleep. People whose airways are slightly narrower than average are more like-

ly to be affected by OSA. **Obesity**, especially obesity in the neck, can increase the risk of developing OSA, because the fat tissue tends to narrow the airway. In some people, the airway is blocked by enlarged tonsils, an enlarged tongue, jaw deformities, or growths in the neck that compress the airway. Blocked nasal passages may also play a part in some people.

When a person begins to inhale, the expansion of the lungs lowers the air pressure inside the airway. If the muscles that keep the airway open are not working hard enough, the airway narrows and may collapse, shutting off the supply of air to the lungs. OSA occurs during sleep because the neck muscles that keep the airway open are not as active then. Congestion in the nose can make collapse more likely, since the extra effort needed to inhale will lower the pressure in the airway even more. Drinking alcohol or taking tranquilizers in the evening worsens this situation, because these cause the neck muscles to relax. (These drugs also lower the "respiratory drive" in the nervous system, reducing breathing rate and strength.)

People with OSA almost always snore heavily, because the same narrowing of the airway that causes **snoring** can also cause OSA. Snoring may actually help cause OSA as well, because the vibration of the throat tissues can cause them to swell. However, most people who snore do not go on to develop OSA.

Central sleep apnea

In central sleep apnea, the airway remains open, but the nerve signals controlling the respiratory muscles are not regulated properly. This can cause wide fluctuations in the level of carbon dioxide (CO_2) in the blood. Normal activity in the body produces CO_2, which is brought by the blood to the lungs for exhalation. When the blood level of CO_2 rises, brain centers respond by increasing the rate of respiration, clearing the CO_2. As blood levels fall again, respiration slows down. Normally, this interaction of CO_2 and breathing rate maintains the CO_2 level within very narrow limits. CSA can occur when the regulation system becomes insensitive to CO_2 levels, allowing wide fluctuations in both CO_2 levels and breathing rates. High CO_2 levels cause very rapid breathing (hyperventilation), which then lowers CO_2 so much that breathing becomes very slow or even stops. CSA occurs during sleep because when a person is awake, breathing is usually stimulated by other signals, including conscious awareness of breathing rate.

A combination of the two forms is also possible, and is called "mixed sleep apnea." Mixed sleep apnea episodes usually begin with a reduced central respiratory drive, followed by obstruction.

OSA and CSA cause similar symptoms. The most common symptoms are:

- daytime sleepiness
- morning headaches
- a feeling that sleep is not restful
- disorientation upon waking

Sleepiness is caused not only by the frequent interruption of sleep, but by the inability to enter long periods of deep sleep, during which the body performs numerous restorative functions. OSA is one of the leading causes of daytime sleepiness, and is a major risk factor for motor vehicle accidents. Headaches and disorientation are caused by low oxygen levels during sleep, from the lack of regular breathing.

Other symptoms of sleep apnea may include **sexual dysfunction**, loss of concentration, memory loss, intellectual impairment, and behavioral changes including **anxiety** and depression.

Sleep apnea can also cause serious changes in the cardiovascular system. Daytime **hypertension** (high blood pressure) is common. An increase in the number of red blood cells (polycythemia) is possible, as is an enlarged left ventricle of the heart (**cor pulmonale**), and left ventricular failure. In some people, sleep apnea causes life-threatening changes in the rhythm of the heart, including heartbeat slowing (bradycardia), racing (tachycardia), and other types of "arrhythmias." Sudden **death** may occur from such **arrhythmias**. Patients with the **Pickwickian syndrome** (named after a Charles Dickens character) are obese and sleepy, with right **heart failure**, **pulmonary hypertension**, and chronic daytime low blood oxygen (hypoxemia) and increased blood CO_2 (hypercapnia).

Diagnosis

Excessive daytime sleepiness is the complaint that usually brings a person to see the doctor. A careful medical history will include questions about alcohol or tranquilizer use, snoring (often reported by the person's partner), and morning headaches or disorientation. A physical exam will include examination of the throat to look for narrowing or obstruction. Blood pressure is also measured. Measuring heart rate or blood levels of oxygen and CO_2 during the daytime will not usually be done, since these are abnormal only at night in most patients.

Confirmation of the diagnosis usually requires making measurements while the person sleeps. These tests are called a **polysomnography** study, and are conducted during an overnight stay in a specialized sleep laboratory. Important parts of the polysomnography study include measurements of:

- Heart rate

- airflow at the mouth and nose
- respiratory effort
- sleep stage (light sleep, deep sleep, dream sleep, etc.)
- oxygen level in the blood, using a noninvasive probe (ear oximetry)

Simplified studies done overnight at home are also possible, and may be appropriate for people whose profile strongly suggests the presence of obstructive sleep apnea; that is, middle-aged, somewhat overweight men, who snore and have high blood pressure. The home-based study usually includes ear oximetry and cardiac measurements. If these measurements support the diagnosis of OSA, initial treatment is usually suggested without polysomnography. Home-based measurements are not used to rule out OSA, however, and if the measurements do not support the OSA diagnosis, polysomnography may be needed to define the problem further.

Both types of studies are usually covered by insurance with the appropriate referral from a physician. Without insurance, lab-based polysomnography cost approximately $1,500 in 1997, while overnight home monitoring cost between $500 and $1,000.

Treatment

Behavioral changes

Treatment of obstructive sleep apnea begins with reducing the use of alcohol or tranquilizers in the evening, if these have been contributing to the problem. Weight loss is also effective, but if the weight returns, as it often does, so does the apnea. Changing sleeping position may be effective; snoring and sleep apnea are both most common when a person sleeps on his back. Turning to sleep on the side may be enough to clear up the symptoms. Raising the head of the bed may also help. Opening of the nasal passages can provide some relief. There are a variety of nasal devices such as clips, tapes, or holders which may help, though discomfort may limit their use. Nasal **decongestants** may be useful, but should not be taken for sleep apnea without the consent of the treating physician.

Oxygen and drug therapy

Supplemental nighttime oxygen can be useful for some people with either central and obstructive sleep apnea. Tricyclic **antidepressant drugs** such as protriptyline (Vivactil) may help by increasing the muscle tone of the upper airway muscles, but their side effects may severely limit their usefulness.

Mechanical ventilation

For moderate to severe sleep apnea, the most successful treatment is nighttime use of a ventilator, called a CPAP machine. CPAP (continuous positive airway pressure) blows air into the airway continuously, preventing its collapse. CPAP requires the use of a nasal mask. The appropriate pressure setting for the CPAP machine is determined by polysomnography in the sleep lab. Its effects are dramatic; daytime sleepiness usually disappears within one to two days after treatment begins. CPAP is used to treat both obstructive and central sleep apnea.

CPAP is tolerated well by about two-thirds of patients who try it. Bilevel positive airway pressure (BiPAP), is an alternative form of ventilation. With BiPAP, the ventilator reduces the air pressure when the person exhales. This is more comfortable for some.

Surgery

Surgery can be used to correct the obstruction in the airways. The most common surgery is called UPPP, for uvulopalatopharngyoplasty. This surgery removes tissue from the rear of the mouth and top of the throat. The tissues removed include parts of the uvula (the flap of tissue that hangs down at the back of the mouth), the soft palate, and the pharynx. Tonsils and adenoids are usually removed in this operation. This operation significantly improves sleep apnea in slightly more than half of all cases.

Reconstructive surgery is possible for those whose OSA is due to constriction of the airway by lower jaw deformities.

When other forms of treatment are not successful, obstructive sleep apnea may be treated by a tracheostomy. In this procedure, an opening is made into the trachea (windpipe) below the obstruction, and a tube inserted to maintain an air passage. A tracheostomy requires a great deal of care to prevent infection of the tracheostomy site. In addition, since air is no longer being filtered and moistened by the nasal passages before entering the lungs, the lower airways can become dry and susceptible to infection as well. Tracheostomy is usually reserved for those whose apnea has led to life-threatening heart arrhythmias, and who have not been treated successfully with other treatments.

Prognosis

The combination of behavioral changes, ventilation assistance, drug therapy, and surgery allow most people with sleep apnea to be treated successfully, although it may take some time to determine the most effective and

KEY TERMS

Continuous positive airway pressure (CPAP)—A ventilation system that blows a gentle stream of air into the nose to keep the airway open.

Polysomnography—A group of tests administered to analyze heart, blood, and breathing patterns during sleep.

Uvulopalatopharyngoplasty (UPPP)—An operation to remove excess tissue at the back of the throat to prevent it from closing off the airway during sleep.

least intrusive treatment. Polysomnography testing is usually required after beginning a treatment to determine how effective it has been.

Prevention

For people who snore frequently, weight control, avoidance of evening alcohol or tranquilizers, and adjustment of sleeping position may help reduce the risk of developing obstructive sleep apnea.

Resources

BOOKS

Becker, Barbara. *Relief From Sleep Disorders.* Dell, 1993.

Chokroverty, Sudhansu. *Sleep Disorders Medicine.* Boston: Butterworth-Heinemann, 1994.

Fairbanks, D., and S. Fujita. *Snoring and Obstructive Sleep Apnea.* New York: Raven Press, 1994.

Pasqulay, Ralph, and Sally Warren Soest. *Snoring and Sleep Apnea.* 2nd ed. New York: Demos Vermande, 1996.

ORGANIZATIONS

The American Sleep Apnea Association. 1424 K St. NW, Ste. 302, Washington, DC 20005. (202) 293-3650. <http://www.sleepapnea.org>.

National Sleep Foundation. 1522 K St., NW, Suite 500, Washington, DC 20005. (202) 785-2300. <http://www.sleepfoundation.org>.

OTHER

WAKE-UP CALL: The Wellness Letter for Snoring and Apnea. Available from the American Sleep Apnea Association.

Canadian Coordinating Office for Health Technology Assessment Page. <http://www.ccohta.ca>.

"Sleep Apnea: There Is An Alternative." *American Sleep Apnea Association.* Video.

"What Is Sleep Apnea?" *American Sleep Apnea Association.* Video.

Richard Robinson

Sleep disorders

Definition

Sleep disorders are a group of syndromes characterized by disturbance in the patient's amount of sleep, quality or timing of sleep, or in behaviors or physiological conditions associated with sleep. There are about 70 different sleep disorders. To qualify for the diagnosis of sleep disorder, the condition must be a persistent problem, cause the patient significant emotional distress, and interfere with his or her social or occupational functioning.

Although sleep is a basic behavior in animals as well as humans, researchers still do not completely understand all of its functions in maintaining health. In the past 30 years, however, laboratory studies on human volunteers have yielded new information about the different types of sleep. Researchers have learned about the cyclical patterns of different types of sleep and their relationships to breathing, heart rate, brain waves, and other physical functions. These measurements are obtained by a technique called **polysomnography**.

There are five stages of human sleep. Four stages have non-rapid eye movement (NREM) sleep, with unique brain wave patterns and physical changes occurring. Dreaming occurs in the fifth stage, during rapid eye movement (REM) sleep.

- Stage 1 NREM sleep. This stage occurs while a person is falling asleep. It represents about 5% of a normal adult's sleep time.
- Stage 2 NREM sleep. In this stage, (the beginning of "true" sleep), the person's electroencephalogram (EEG) will show distinctive wave forms called sleep spindles and K complexes. About 50% of sleep time is stage 2 REM sleep.
- Stages 3 and 4 NREM sleep. Also called delta or slow wave sleep, these are the deepest levels of human sleep and represent 10–20% of sleep time. They usually occur during the first 30–50% of the sleeping period.
- REM sleep. REM sleep accounts for 20–25% of total sleep time. It usually begins about 90 minutes after the person falls asleep, an important measure called REM latency. It alternates with NREM sleep about every hour and a half throughout the night. REM periods increase in length over the course of the night.

Sleep cycles vary with a person's age. Children and adolescents have longer periods of stage 3 and stage 4 NREM sleep than do middle aged or elderly adults. Because of this difference, the doctor will need to take a

patient's age into account when evaluating a sleep disorder. Total REM sleep also declines with age.

The average length of nighttime sleep varies among people. Most people sleep between seven and nine hours a night. This population average appears to be constant throughout the world. In temperate climates, however, people often notice that sleep time varies with the seasons. It is not unusual for people in North America and Europe to sleep about 40 minutes longer per night during the winter.

Description

Sleep disorders are classified based on what causes them. Primary sleep disorders are distinguished from those that are not caused by other mental disorders, prescription medications, substance abuse, or medical conditions. The two major categories of primary sleep disorders are the dyssomnias and the parasomnias.

Dyssomnias

Dyssomnias are primary sleep disorders in which the patient suffers from changes in the amount, restfulness, and timing of sleep. The most important dyssomnia is primary **insomnia**, which is defined as difficulty in falling asleep or remaining asleep that lasts for at least one month. It is estimated that 35% of adults in the United States experience insomnia during any given year, but the number of these adults who are experiencing true primary insomnia is unknown. Primary insomnia can be caused by a traumatic event related to sleep or bedtime, and it is often associated with increased physical or psychological arousal at night. People who experience primary insomnia are often anxious about not being able to sleep. The person may then associate all sleep-related things (their bed, bedtime, etc.) with frustration, making the problem worse. The person then becomes more stressed about not sleeping. Primary insomnia usually begins when the person is a young adult or in middle age.

Hypersomnia is a condition marked by excessive sleepiness during normal waking hours. The patient has either lengthy episodes of daytime sleep or episodes of daytime sleep on a daily basis even though he or she is sleeping normally at night. In some cases, patients with primary hypersomnia have difficulty waking in the morning and may appear confused or angry. This condition is sometimes called sleep drunkenness and is more common in males. The number of people with primary hypersomnia is unknown, although 5-10% of patients in sleep disorder clinics have the disorder. Primary hypersomnia usually affects young adults between the ages of 15 and 30.

Nocturnal myoclonus and **restless legs syndrome** (RLS) can cause either insomnia or hypersomnia in adults. Patients with nocturnal myoclonus wake up because of cramps or twitches in the calves. These patients feel sleepy the next day. Nocturnal myoclonus is sometimes called periodic limb movement disorder (PLMD). RLS patients have a crawly or aching feeling in their calves that can be relieved by moving or rubbing the legs. RLS often prevents the patient from falling asleep until the early hours of the morning, when the condition is less intense.

Kleine-Levin syndrome is a recurrent form of hypersomnia that affects a person three or four times a year. Doctors do not know the cause of this syndrome. It is marked by two to three days of sleeping 18–20 hours per day, hypersexual behavior, compulsive eating, and irritability. Men are three times more likely than women to have the syndrome. Currently there is no cure for this disorder.

Narcolepsy is a dyssomnia characterized by recurrent "sleep attacks" that the patient cannot fight. The sleep attacks are about 10–20 minutes long. The patient feels refreshed by the sleep, but typically feels sleepy again several hours later. Narcolepsy has three major symptoms in addition to sleep attacks: cataplexy, **hallucinations**, and sleep **paralysis**. Cataplexy is the sudden loss of muscle tone and stability ("drop attacks"). Hallucinations may occur just before falling asleep (hypnagogic) or right after waking up (hypnopompic) and are associated with an episode of REM sleep. Sleep paralysis occurs during the transition from being asleep to waking up. About 40% of patients with narcolepsy have or have had another mental disorder. Although narcolepsy is often regarded as an adult disorder, it has been reported in children as young as three years old. Almost 18% of patients with narcolepsy are 10 years old or younger. It is estimated that 0.02–0.16% of the general population suffer from narcolepsy. Men and women are equally affected.

Breathing-related sleep disorders are syndromes in which the patient's sleep is interrupted by problems with his or her breathing. There are three types of breathing-related sleep disorders:

- Obstructive **sleep apnea** syndrome. This is the most common form of breathing-related sleep disorder, marked by episodes of blockage in the upper airway during sleep. It is found primarily in obese people. Patients with this disorder typically alternate between periods of **snoring** or gasping (when their airway is partly open) and periods of silence (when their airway is blocked). Very loud snoring is a clue to this disorder.
- Central sleep apnea syndrome. This disorder is primarily found in elderly patients with heart or neurological conditions that affect their ability to breathe properly. It

is not associated with airway blockage and may be related to brain disease.

- Central alveolar hypoventilation syndrome. This disorder is found most often in extremely obese people. The patient's airway is not blocked, but his or her blood oxygen level is too low.
- Mixed-type sleep apnea syndrome. This disorder combines symptoms of both obstructive and central sleep apnea.

Circadian rhythm sleep disorders are dyssomnias resulting from a discrepancy between the person's daily sleep/wake patterns and demands of social activities, shift work, or travel. The term circadian comes from a Latin word meaning daily. There are three circadian rhythm sleep disorders. Delayed sleep phase type is characterized by going to bed and arising later than most people. **Jet lag** type is caused by travel to a new time zone. Shift work type is caused by the schedule of a person's job. People who are ordinarily early risers appear to be more vulnerable to jet lag and shift work-related circadian rhythm disorders than people who are "night owls." There are some patients who do not fit the pattern of these three disorders and appear to be the opposite of the delayed sleep phase type. These patients have an advanced sleep phase pattern and cannot stay awake in the evening, but wake up on their own in the early morning.

PARASOMNIAS. Parasomnias are primary sleep disorders in which the patient's behavior is affected by specific sleep stages or transitions between sleeping and waking. They are sometimes described as disorders of physiological arousal during sleep.

Nightmare disorder is a parasomnia in which the patient is repeatedly awakened from sleep by frightening dreams and is fully alert on awakening. The actual rate of occurrence of nightmare disorder is unknown. Approximately 10–50% of children between three and five years old have nightmares. They occur during REM sleep, usually in the second half of the night. The child is usually able to remember the content of the nightmare and may be afraid to go back to sleep. More females than males have this disorder, but it is not known whether the sex difference reflects a difference in occurrence or a difference in reporting. Nightmare disorder is most likely to occur in children or adults under severe or traumatic **stress**.

Sleep terror disorder is a parasomnia in which the patient awakens screaming or crying. The patient also has physical signs of arousal, like sweating, shaking, etc. It is sometimes referred to as pavor nocturnus. Unlike nightmares, sleep terrors typically occur in stage 3 or stage 4 NREM sleep during the first third of the night. The patient may be confused or disoriented for several minutes and cannot recall the content of the dream. He or she may fall asleep again and not remember the episode the next morning. Sleep terror disorder is most common in children four to 12 years old and is outgrown in adolescence. It affects about 3% of children. Fewer than 1% of adults have the disorder. In adults, it usually begins between the ages of 20 and 30. In children, more males than females have the disorder. In adults, men and women are equally affected.

Sleepwalking disorder, which is sometimes called somnambulism, occurs when the patient is capable of complex movements during sleep, including walking. Like sleep terror disorder, sleepwalking occurs during stage 3 and stage 4 NREM sleep during the first part of the night. If the patient is awakened during a sleepwalking episode, he or she may be disoriented and have no memory of the behavior. In addition to walking around, patients with sleepwalking disorder have been reported to eat, use the bathroom, unlock doors, or talk to others. It is estimated that 10–30% of children have at least one episode of sleepwalking. However, only 1-5% meet the criteria for sleepwalking disorder. The disorder is most common in children eight to 12 years old. It is unusual for sleepwalking to occur for the first time in adults.

Unlike sleepwalking, REM sleep behavior disorder occurs later in the night and the patient can remember what they were dreaming. The physical activities of the patient are often violent.

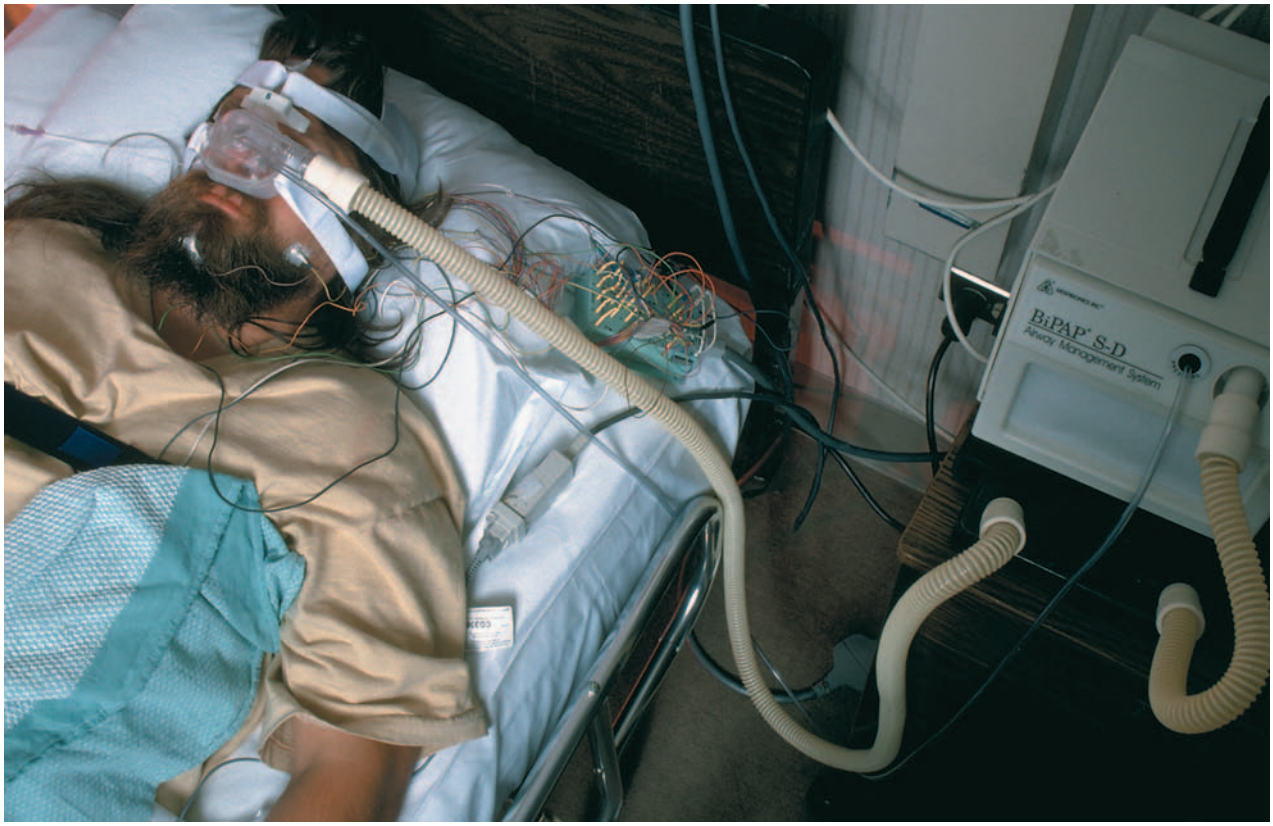
Sleep disorders related to other conditions

In addition to the primary sleep disorders, there are three categories of sleep disorders that are caused by or related to substance use or other physical or mental disorders.

SLEEP DISORDERS RELATED TO MENTAL DISORDERS. Many mental disorders, especially depression or one of the **anxiety disorders**, can cause sleep disturbances. Psychiatric disorders are the most common cause of chronic insomnia.

SLEEP DISORDERS DUE TO MEDICAL CONDITIONS. Some patients with chronic neurological conditions like **Parkinson's disease** or Huntington's disease may develop sleep disorders. Sleep disorders have also been associated with viral **encephalitis**, brain disease, and hypo- or **hyperthyroidism**.

SUBSTANCE-INDUCED SLEEP DISORDERS. The use of drugs, alcohol, and **caffeine** frequently produces disturbances in sleep patterns. Alcohol abuse is associated with insomnia. The person may initially feel sleepy after drinking, but wakes up or sleeps fitfully during the second half of the night. Alcohol can also increase the sever-



A patient suffering from acute sleep apnea is hooked up to monitors in preparation for a night's sleep at a Stanford University sleep lab. *(Photograph by Russell D. Curtis, Photo Researchers, Inc. Reproduced by permission.)*

ity of breathing-related sleep disorders. With amphetamines or **cocaine**, the patient typically suffers from insomnia during drug use and hypersomnia during drug withdrawal. Opioids usually make short-term users sleepy. However, long-term users develop tolerance and may suffer from insomnia.

In addition to alcohol and drugs that are abused, a variety of prescription medications can affect sleep patterns. These medications include **antihistamines**, **corticosteroids**, **asthma** medicines, and drugs that affect the central nervous system.

Sleep disorders in children and adolescents

Pediatricians estimate that 20–30% of children have difficulties with sleep that are serious enough to disturb their families. Although sleepwalking and night terror disorder occur more frequently in children than in adults, children can also suffer from narcolepsy and sleep apnea syndrome.

Causes and symptoms

The causes of sleep disorders have already been discussed with respect to the classification of these disorders.

The most important symptoms of sleep disorders are insomnia and sleepiness during waking hours. Insomnia is by far the more common of the two symptoms. It covers a number of different patterns of sleep disturbance. These patterns include inability to fall asleep at bedtime, repeated awakening during the night, and/or inability to go back to sleep once awakened.

Diagnosis

Diagnosis of sleep disorders usually requires a psychological history as well as a medical history. With the exception of sleep apnea syndromes, physical examinations are not usually revealing. The patient's sex and age are useful starting points in assessing the problem. The doctor may also talk to other family members in order to obtain information about the patient's symptoms. The family's observations are particularly important to evaluate sleepwalking, kicking in bed, snoring loudly, or other behaviors that the patient cannot remember.

Sleep logs

Many doctors ask patients to keep a sleep diary or sleep log for a minimum of one to two weeks in order to

KEY TERMS

Apnea—The temporary absence of breathing. Sleep apnea consists of repeated episodes of temporary suspension of breathing during sleep.

Cataplexy—Sudden loss of muscle tone (often causing a person to fall), usually triggered by intense emotion. It is regarded as a diagnostic sign of narcolepsy.

Circadian rhythm—Any body rhythm that recurs in 24-hour cycles. The sleep-wake cycle is an example of a circadian rhythm.

Dyssomnia—A primary sleep disorder in which the patient suffers from changes in the quantity, quality, or timing of sleep.

Electroencephalogram (EEG)—The record obtained by a device that measures electrical impulses in the brain.

Hypersomnia—An abnormal increase of 25% or more in time spent sleeping. Patients usually have excessive daytime sleepiness.

Hypnotic—A medication that makes a person sleep.

Hypopnea—Shallow or excessively slow breathing usually caused by partial closure of the upper airway during sleep, leading to disruption of sleep.

Insomnia—Difficulty in falling asleep or remaining asleep.

Jet lag—A temporary disruption of the body's sleep-wake rhythm following high-speed air travel across several time zones. Jet lag is most severe in people who have crossed eight or more time zones in 24 hours.

Kleine-Levin syndrome—A disorder that occurs primarily in young males, three or four times a year. The syndrome is marked by episodes of hypersomnia, hypersexual behavior, and excessive eating.

Narcolepsy—A life-long sleep disorder marked by four symptoms: sudden brief sleep attacks, cataplexy, temporary paralysis, and hallucinations. The hallucinations are associated with falling asleep or the transition from sleeping to waking.

Nocturnal myoclonus—A disorder in which the patient is awakened repeatedly during the night by cramps or twitches in the calf muscles. Nocturnal myoclonus is sometimes called periodic limb movement disorder (PLMD).

Non-rapid eye movement (NREM) sleep—A type of sleep that differs from rapid eye movement (REM) sleep. The four stages of NREM sleep account for 75–80% of total sleeping time.

Parasomnia—A primary sleep disorder in which the person's physiology or behaviors are affected by sleep, the sleep stage, or the transition from sleeping to waking.

Pavor nocturnus—Another term for sleep terror disorder.

Polysomnography—Laboratory measurement of a patient's basic physiological processes during sleep. Polysomnography usually measures eye movement, brain waves, and muscular tension.

Primary sleep disorder—A sleep disorder that cannot be attributed to a medical condition, another mental disorder, or prescription medications or other substances.

Rapid eye movement (REM) sleep—A phase of sleep during which the person's eyes move rapidly beneath the lids. It accounts for 20–25% of sleep time. Dreaming occurs during REM sleep.

REM latency—After a person falls asleep, the amount of time it takes for the first onset of REM sleep.

Restless legs syndrome (RLS)—A disorder in which the patient experiences crawling, aching, or other disagreeable sensations in the calves that can be relieved by movement. RLS is a frequent cause of difficulty falling asleep at night.

Sedative—A medication given to calm agitated patients; sometimes used as a synonym for hypnotic.

Sleep latency—The amount of time that it takes to fall asleep. Sleep latency is measured in minutes and is important in diagnosing depression.

Somnambulism—Another term for sleepwalking.

evaluate the severity and characteristics of the sleep disturbance. The patient records medications taken as well as the length of time spent in bed, the quality of the sleep, and similar information. Some sleep logs are designed to indicate circadian sleep patterns as well as simple duration or restfulness of sleep.

Psychological testing

The doctor may use **psychological tests** or inventories to evaluate insomnia because it is frequently associated with mood or affective disorders. The **Minnesota Multiphasic Personality Inventory** (MMPI), the Mil-

lon Clinical Multiaxial Inventory (MCMI), the Beck Depression Inventory, and the Zung Depression Scale are the tests most commonly used in evaluating this symptom.

SELF-REPORT TESTS. The Epworth Sleepiness Scale, a self-rating form recently developed in Australia, consists of eight questions used to assess daytime sleepiness. Scores range from 0–24, with scores higher than 16 indicating severe daytime sleepiness.

Laboratory studies

If the doctor is considering breathing-related sleep disorders, myoclonus, or narcolepsy as possible diagnoses, he or she may ask the patient to be tested in a sleep laboratory or at home with portable instruments.

POLYSOMNOGRAPHY. Polysomnography can be used to help diagnose sleep disorders as well as conduct research into sleep. In some cases the patient is tested in a special sleep laboratory. The advantage of this testing is the availability and expertise of trained technologists, but it is expensive. As of 2001, however, portable equipment is available for home recording of certain specific physiological functions.

MULTIPLE SLEEP LATENCY TEST (MSLT). The multiple sleep latency test (MSLT) is frequently used to measure the severity of the patient's daytime sleepiness. The test measures sleep latency (the speed with which the patient falls asleep) during a series of planned naps during the day. The test also measures the amount of REM sleep that occurs. Two or more episodes of REM sleep under these conditions indicates narcolepsy. This test can also be used to help diagnose primary hypersomnia.

REPEATED TEST OF SUSTAINED WAKEFULNESS (RTSW). The repeated test of sustained wakefulness (RTSW) is a test that measures sleep latency by challenging the patient's ability to stay awake. In the RTSW, the patient is placed in a quiet room with dim lighting and is asked to stay awake. As with the MSLT, the testing pattern is repeated at intervals during the day.

Treatment

Treatment for a sleep disorder depends on what is causing the disorder. For example, if major depression is the cause of insomnia, then treatment of the depression with antidepressants should resolve the insomnia.

Medications

Sedative or hypnotic medications are generally recommended only for insomnia related to a temporary stress (like surgery or grief) because of the potential for **addiction** or overdose. Trazodone, a sedating antidepressant, is often used for chronic insomnia that does not respond to other treatments. Sleep medications may also cause problems for elderly patients because of possible interactions with their other prescription medications. Among the safer hypnotic agents are lorazepam, temazepam, and zolpidem. Chloral hydrate is often preferred for short-term treatment in elderly patients because of its mildness. Short-term treatment is recommended because this drug may be habit forming.

Narcolepsy is treated with stimulants such as dextroamphetamine sulfate or methylphenidate. Nocturnal myoclonus has been successfully treated with clonazepam.

Children with sleep terror disorder or sleepwalking are usually treated with **benzodiazepines** because this type of medication suppresses stage 3 and stage 4 NREM sleep.

Psychotherapy

Psychotherapy is recommended for patients with sleep disorders associated with other mental disorders. In many cases the patient's scores on the Beck or Zung inventories will suggest the appropriate direction of treatment.

Sleep education

"Sleep hygiene" or sleep education for sleep disorders often includes instructing the patient in methods to enhance sleep. Patients are advised to:

- wait until he or she is sleepy before going to bed
- avoid using the bedroom for work, reading, or watching television
- get up at the same time every morning no matter how much or how little he or she slept
- avoid **smoking** and avoid drinking liquids with caffeine
- get some physical **exercise** early in the day every day
- limit fluid intake after dinner; in particular, avoid alcohol because it frequently causes interrupted sleep
- learn to meditate or practice relaxation techniques
- avoid tossing and turning in bed; instead, he or she should get up and listen to relaxing music or read

Lifestyle changes

Patients with sleep apnea or hypopnea are encouraged to stop smoking, avoid alcohol or drugs of abuse, and lose weight in order to improve the stability of the upper airway.

In some cases, patients with sleep disorders related to jet lag or shift work may need to change employment

or travel patterns. Patients may need to avoid rapid changes in shifts at work.

Children with nightmare disorder may benefit from limits on television or movies. Violent scenes or frightening science fiction stories appear to influence the frequency and intensity of children's nightmares.

Surgery

Although making a surgical opening into the windpipe (a tracheostomy) for sleep apnea or hypopnea in adults is a treatment of last resort, it is occasionally performed if the patient's disorder is life threatening and cannot be treated by other methods. In children and adolescents, surgical removal of the tonsils and adenoids is a fairly common and successful treatment for sleep apnea. Most sleep apnea patients are treated with continuous positive airway pressure (CPAP). Sometimes an oral prosthesis is used for mild sleep apnea.

Alternative treatment

Some alternative approaches may be effective in treating insomnia caused by **anxiety** or emotional stress. **Meditation** practice, breathing exercises, and **yoga** can break the vicious cycle of sleeplessness, worry about inability to sleep, and further sleeplessness for some people. Yoga can help some people to relax muscular tension in a direct fashion. The breathing exercises and meditation can keep some patients from obsessing about sleep.

Homeopathic practitioners recommend that people with chronic insomnia see a professional homeopath. They do, however, prescribe specific remedies for at-home treatment of temporary insomnia: *Nux vomica* for alcohol or substance-related insomnia, *Ignatia* for insomnia caused by grief, *Arsenicum* for insomnia caused by fear or anxiety, and *Passiflora* for insomnia related to mental stress.

Melatonin has also been used as an alternative treatment for sleep disorders. Melatonin is produced in the body by the pineal gland at the base of the brain. This substance is thought to be related to the body's circadian rhythms.

Practitioners of Chinese medicine usually treat insomnia as a symptom of excess yang energy. Cinnabar is recommended for chronic nightmares. Either magnetic magnetite or "dragon bones" is recommended for insomnia associated with **hysteria** or fear. If the insomnia appears to be associated with excess yang energy arising from the liver, the practitioner will give the patient oyster shells. **Acupuncture** treatments can help bring about balance and facilitate sleep.

Dietary changes like eliminating stimulant foods (coffee, cola, chocolate) and late-night meals or snacks can be effective in treating some sleep disorders. Nutritional supplementation with magnesium, as well as botanical medicines that calm the nervous system, can also be helpful. Among the botanical remedies that may be effective for sleep disorders are valerian (*Valeriana officinalis*), passionflower (*Passiflora incarnata*), and skullcap (*Scutellaria lateriflora*).

Prognosis

The prognosis depends on the specific disorder. Children usually outgrow sleep disorders. Patients with Kleine-Levin syndrome usually get better around age 40. Narcolepsy is a life-long disorder. The prognosis for sleep disorders related to other conditions depends on successful treatment of the substance abuse, medical condition, or other mental disorder. The prognosis for primary sleep disorders is affected by many things, including the patient's age, sex, occupation, personality characteristics, family circumstances, neighborhood environment, and similar factors.

Resources

BOOKS

Becker, Philip M. "Sleep Disorders." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Borysenko, Joan. *Minding the Body, Mending the Mind.* Reading, MA: Addison-Wesley Publishing Co., 1987.

Eisendrath, Stuart J. "Psychiatric Disorders: Sleep Disorders." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Goldson, Edward. "Behavioral Disorders and Developmental Variations: Sleep Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Hartmann, Ernest. "Sleep." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

Kabat-Zinn, Jon. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness.* New York: Bantam Doubleday Dell Publishing Group, 1990.

Moe, Paul G., and Alan R. Seay. "Neurologic & Muscular Disorders: Sleep Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

"Neurologic Disorders: Sleep Disorders." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Sanders, Mark H. "Sleep Apnea and Hypopnea." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Sleep Disorders." In *Diagnostic and Statistical Manual of Mental Disorders.* 4th ed. Washington, DC: American Psychiatric Association, 1994.

Rebecca J. Frey

Sleep study *see* **Polysomnography**
Sleeping drugs *see* **Anti-insomnia drugs**

Sleeping sickness

Definition

Sleeping sickness (also called trypanosomiasis) is an infection caused by *Trypanosoma* protozoa; it is passed to humans through the bite of the tsetse fly. If left untreated, the infection progresses to **death** within months or years.

Description

Protozoa are single-celled organisms considered to be the simplest life form in the animal kingdom. The protozoa responsible for sleeping sickness are a variety that bear numerous flagella (hair-like projections from the cell that help the cell to move). These protozoa exist only on the continent of Africa. The type of protozoa causing sleeping sickness in humans is referred to as the *Trypanasoma brucei* complex, which can be divided further into Rhodesian (Central and East African) and Gambian (Central and West African) subspecies.

The Rhodesian variety live within antelopes in savanna and woodland areas, and they cause no problems with the antelope's health. The protozoa are then acquired by tsetse flies when they bite and suck the blood of an infected antelope or cow.

Within the tsetse fly, the protozoa cycle through several different life forms; ultimately they migrate to the salivary glands of the tsetse fly. Once the protozoa are harbored in the salivary glands, they are ready to be deposited into the bloodstream of the fly's next source of a blood meal.

Humans most likely to become infected by Rhodesian trypanosomes are people such as game wardens and visitors to game parks in East Africa, who may be bitten by a tsetse fly that has fed on game (antelope) carrying the protozoa. The Rhodesian variety of sleeping sickness causes a much more severe illness, with even greater likelihood of eventual death than the Gambian form.

The Gambian variety of *Trypanosoma* thrives in tropical rain forests throughout Central and West Africa; it does not infect game or cattle, and is primarily a threat to people dwelling in such areas, rarely infecting visitors.

Causes and symptoms

The first sign of infection with the trypanosome may be a sore appearing at the site of the tsetse fly bite about two to tree days after having been bitten. Redness, **pain**, and swelling occur, but are often ignored by the patient.

Stage I illness

Two to three weeks later, Stage I disease develops as a result of the protozoa being carried through the blood and lymph circulation of the host. This systemic (meaning that symptoms affect the whole body) phase of the illness is characterized by a **fever** that rises quite high, then falls to normal, then respikes (rises rapidly). A rash with intense **itching** may be present, and **headache** and mental confusion may occur. The Gambian form, in particular, includes extreme swelling of lymph tissue, with enlargement of both the spleen and liver, and greatly swollen lymph nodes. "Winterbottom's sign" is classic of Gambian sleeping sickness, and consists of a visibly swollen area of lymph nodes located behind the ear and just above the base of the neck. During this stage, the heart may be affected by a severe inflammatory reaction, particularly when the infection is caused by the Rhodesian variety of trypanosomiasis.

Many of the symptoms of sleeping sickness are actually the result of attempts by the patient's immune system to get rid of the invading organism. The heightened activity of the cells of the immune system result in damage to the patient's own organs, anemia, and leaky blood vessels. These leaks in the blood vessels end up helping to further spread the protozoa throughout the afflicted person's body.

One reason for the intense reaction of the immune system to the presence of the trypanosomes is also the reason why the trypanosomes survive so well despite the efforts of the immune system to eradicate them. The protozoa causing sleeping sickness are able to rapidly change specific markers (unique proteins) on their outer coats. These kinds of markers usually serve to stimulate the host's immune system to produce immune cells that will specifically target the marker, allowing quick destruction of those cells bearing the markers. Trypanosomes, however, are able to express new markers at such a high rate of change that the host's immune system is constantly trying to catch up.

Stage II illness

Stage II sleeping sickness involves the nervous system. Gambian sleeping sickness, in particular, has a clearly delineated phase in which the predominant symptoms involve the brain. The patient's speech becomes slurred, mental processes slow, and the patient sits and stares for long periods of time, or sleeps. Other symptoms resemble **Parkinson's disease**, including imbalance when walking, slow and shuffling gait, trembling of

KEY TERMS

Immune system—That network of tissues and cells throughout the body that is responsible for ridding the body of any invaders, such as viruses, bacteria, protozoa, etc.

Protozoa—Single-celled organisms considered to be the simplest life form in the animal kingdom.

the limbs, involuntary movements, muscle tightness, and increasing mental confusion. Untreated, these symptoms eventually lead to **coma** and then to death.

Diagnosis

Diagnosis of sleeping sickness can be made by microscopic examination of fluid from the original sore at the site of the tsetse fly bite. Trypanosomes will be present in the fluid for a short period of time following the bite. If the sore has already resolved, fluid can be obtained from swollen lymph nodes for examination. Other methods of trypanosome diagnosis involve culturing blood, lymph node fluid, bone marrow, or spinal fluid. These cultures are then injected into rats, which develop blood-borne protozoa infection that can be detected in blood smears within one to two weeks. However, this last method is effective only for the Rhodesian variety of sleeping sickness.

Treatment

Without treatment, sleeping sickness will lead to death. Unfortunately, however, those medications effective against the *Trypanosoma brucei* complex protozoa all have significant potential side effects for the patient. Suramin, eflornithine, pentamidine, and several drugs that contain arsenic (a chemical, which in higher doses is highly poisonous to humans), are all effective anti-trypanosomal agents. Each of these drugs, however, requires careful monitoring to ensure that the drugs themselves do not cause serious complications such as fatal hypersensitivity (allergic) reaction, kidney or liver damage, or inflammation of the brain.

Prevention

Prevention of sleeping sickness requires avoiding contact with the tsetse fly. Insect repellents and clothing that covers the limbs to the wrists and ankles are advisable. Public health measures have included drug treatment of humans who are infected with one of the *Trypanosoma brucei* complex. There are currently no immunizations available to prevent the acquisition of sleeping sickness.

Resources

BOOKS

Plorde, James J. "African Trypanosoma." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Ekwanzala, Mosiana. "In the Heart of Darkness: Sleeping Sickness in Zaire." *The Lancet* 348, no. 9039 (23 Nov. 1996): 1427+.

Farley, Dixie. "Tropical Diseases: Travelers Take Note." *Consumer's Research Magazine* 80, no. 5 (May 1997): 27+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Sleepwalking *see* **Sleep disorders**

Slipped disk *see* **Herniated disk**

Slit lamp examination *see* **Eye examination**

Small-for-gestational-age infant *see* **Intrauterine growth retardation**

Small bowel follow-through (SBFT) *see* **Upper GI exam**

Small cell lung cancer *see* **Lung cancer, small cell**

Small intestine biopsy

Definition

A biopsy is a diagnostic procedure in which tissue or cells are removed from a part of the body and specially prepared for examination under a microscope. When the tissue involved is part of the small intestine, the procedure is called a small-intestine (or small-bowel) biopsy.

Purpose

The small-bowel biopsy is used to diagnose and confirm disease of the intestinal mucosa (the lining of the small intestine).

Precautions

Due to the slight risk of bleeding during or after this procedure, **aspirin**, aspirin-containing medications, **nonsteroidal anti-inflammatory drugs**, and anticoagulants and antiplatelet drugs should be withheld for at least five days before the test.

Description

The small intestine is approximately 21 ft (6.4 m) long. It has three sections: the duodenum (a short, curved segment fixed to the back wall of the abdomen), the jejunum, and the ileum (two larger, coiled, and mobile segments). Some digestion occurs in the stomach, but the small intestine is mainly responsible for digestion and absorption of foods.

Malabsorption syndromes occur when certain conditions result in impaired absorption of nutrients, **vitamins**, or **minerals** from the diet by the lining of the small intestine. For example, injury to the intestinal lining can interfere with absorption, as can infections, some drugs, blockage of the lymphatic vessels, poor blood supply to the intestine, or diseases like sprue.

Malabsorption is suspected when a patient not only loses weight, but has **diarrhea** and nutritional deficiencies despite eating well (weight loss alone can have other causes). Laboratory tests like fecal fat, a measurement of fat in stool samples collected over 72 hours, are the most reliable tests for diagnosing fat malabsorption, but abnormalities of the small intestine itself are diagnosed by small-intestine biopsy.

Several different methods are used to detect abnormalities of the small intestine. A tissue specimen can be obtained by using an endoscope (a flexible viewing tube), or by using a thin tube with a small cutting instrument at the end. This latter procedure is ordered when specimens larger than those provided by endoscopic biopsy are needed, because it allows removal of tissue from areas beyond the reach of an endoscope.

Several similar types of capsules are used for tissue collection. In each, a mercury-weighted bag is attached to one end of the capsule, while a thin polyethylene tube about 5 ft (1.5 m) long is attached to the other end. Once the bag, capsule, and tube are in place in the small bowel, suction on the tube draws the tissue into the capsule and closes it, cutting off the piece of tissue within. This is an invasive procedure, but it causes little **pain** and complications are rare.

Small-intestine biopsy procedure

After application of a topical anesthetic to the back of the patient's throat, the capsule and the tube are introduced, and the patient is asked to swallow as the tube is advanced. The patient is then placed on the right side and the instrument tip is advanced another 20 in (51 cm) or so. The tube's position is checked by fluoroscopy or by instilling air through the tube and listening with a stethoscope for air to enter the stomach.

The tube is advanced 2–4 in (5.1–10 cm) at a time to pass the capsule through the stomach outlet (pylorus). When fluoroscopy confirms that the capsule has passed the pylorus, small samples of small intestine tissue are obtained by the instrument's cutting edge, after which the instrument and tube are withdrawn. The entire procedure may be completed in minutes.

Preparation

This procedure requires tissue specimens from the small intestine through means of a tube inserted into the stomach through the mouth. The patient is to withhold food and fluids for at least eight hours before the test.

Aftercare

The patient should not have anything to eat or drink until the topical anesthetic wears off (usually about one to two hours). If intravenous sedatives were administered during the procedure, the patient should not drive for the remainder of the day. Complications from this procedure are uncommon, but can occur. The patient is to note any abdominal pain or bleeding and report either immediately to the doctor.

Risks

Complications from this procedure are rare, but can include bleeding (hemorrhage), bacterial infection with **fever** and pain, and bowel puncture (perforation). The patient should immediately report any abdominal pain or bleeding to the physician in charge. Biopsy is contraindicated in uncooperative patients, those taking aspirin or anticoagulants, and in those with uncontrolled bleeding disorders.

Normal results

Normal results are no abnormalities seen on gross examination of the specimen(s) or under the microscope after tissue preparation.

Abnormal results

Small-intestine tissue exhibiting abnormalities may indicate Whipple's disease, a malabsorption disease; lymphoma, a group of cancers; and parasitic infections

KEY TERMS

Sprue—A disorder of impaired absorption of nutrients from the diet by the small intestine (malabsorption), resulting in malnutrition. Two forms of sprue exist: tropical sprue, which occurs mainly in tropical regions; and celiac sprue, which occurs more widely and is due to sensitivity to the wheat protein gluten.

Whipple's disease—A disorder of impaired absorption of nutrients by the small intestine. Symptoms include diarrhea, abdominal pain, progressive weight loss, joint pain, swollen lymph nodes, abnormal skin pigmentation, anemia, and fever. The precise cause is unknown, but it is probably due to an unidentified bacterial infection.

like **giardiasis** and coccidiosis. When biopsy indicates celiac sprue (a malabsorption disorder), infectious **gastroenteritis** (inflammation of the gastrointestinal tract), folate and B_{12} deficiency, or **malnutrition**, confirmation studies are needed for conclusive diagnosis.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Smallpox

Definition

Smallpox is an infection caused by the virus called variola, a member of the poxvirus family. Throughout all of history, smallpox has been a greatly feared disease, responsible for huge epidemics worldwide, and the cause of great suffering and massive numbers of deaths. In 1980, the World Health Organization (WHO) announced that an extensive program of **vaccination** against the disease had resulted in the complete eradication of the virus, with the exception of samples of stored virus in two laboratories.

Description

Smallpox was strictly an infection of human beings. Animals and insects could neither be infected by smallpox, nor carry the virus in any form. Most infections were caused by contact with a person who had already developed the characteristic **skin lesions** (pox) of the disease, although a person who had a less severe infection (not symptomatic or diagnosable in the usual way) could unwittingly spreading the virus.

Causes and symptoms

Smallpox was a relatively contagious disease, which accounts for its ability to cause massive epidemics. The variola virus was acquired from direct contact with individuals sick with the disease, from contaminated air droplets, and even from objects used by another smallpox victim (books, blankets, utensils, etc.). The respiratory tract was the usual entry point for the variola virus into a human being.

After the virus entered the body, there was a 12–14 day incubation period during which the virus multiplied, although no symptoms were recognizable. After the incubation period, symptoms appeared abruptly and included **fever** and chills, muscle aches, and a flat, reddish purple rash on the chest, abdomen, and back. These symptoms lasted about three days, after which the rash faded and the fever dropped. A day or two later, fever would return, along with a bumpy rash starting on the feet, hands, and face. The rash would progress, ultimately reaching the chest, abdomen, and back. The individual bumps (papules) would fill with clear fluid, and eventually become pus-filled over the course of 10–12 days. These pox would eventually scab over, each leaving a permanently scarred pock or pit when the scab dropped off.

Death from smallpox usually followed complications such as bacterial infection of the open skin lesions, **pneumonia**, or bone infections. A very severe and quickly fatal form of smallpox was called "sledgehammer smallpox," and resulted in massive, uncontrollable bleeding (hemorrhage) from the skin lesions, as well as from the mouth, nose, and other areas of the body.

Fear of smallpox came from both the epidemic nature of the disease, as well as from the fact that no therapies were ever discovered to either treat the symptoms of smallpox, or shorten the course of the disease.

Diagnosis

In modern times, prior to the eradication of the variola virus, a diagnosis of smallpox could be made using an electron microscope to identify virus in fluid from the papules, urine, or in the patient's blood prior to the appearance of the papular rash.

Treatment

Treatment for smallpox was only supportive, meaning that the only treatment available was aimed at keeping a patient as comfortable as possible. No treatments were ever found that would halt the progression of the disease.

Prognosis

Death from smallpox ranged up to about 35%, with the more severe, hemorrhagic form nearly 100% fatal. Patients who survived smallpox infection nearly always had multiple areas of scarring where each pock had been.

Prevention

From about the tenth century in China, India, and the Americas, it was noted that individuals who had had even a mild case of smallpox could not be infected again. Fascinating accounts appear in writings from all over the world of ways in which people tried to vaccinate themselves against smallpox. Material from people ill with smallpox (fluid or pus from the papules, scabs over the pox) was scratched into the skin of people who had never had the illness, in an attempt to produce a mild reaction and its accompanying protective effect. These efforts often resulted in full-fledged smallpox, and probably served only to help effectively spread the infection throughout a community. In fact, such crude smallpox vaccinations were against the law in Colonial America.

In 1798, Edward Jenner published a paper in which he discussed his important observation that milkmaids who contracted a mild infection of the hands (called cowpox, and caused by a relative of the variola virus) appeared to be immune to smallpox. Jenner created an immunization against smallpox that used the pus found in the lesions of cowpox infection. Jenner's paper led to much work in the area of vaccinations, and ultimately resulted in the creation of a very effective vaccination against smallpox which utilized the vaccinia virus, another close relative of variola.

In 1967, WHO began its attempt to eradicate the smallpox virus worldwide. The methods used in the program were simple:

- Careful surveillance for all smallpox infections worldwide, to allow for quick diagnosis and immediate quarantine of patients.
- Immediate vaccination of all contacts diagnosed with infection, in order to interrupt the virus' usual pattern of infection.

The WHO's program was extremely successful, and the virus was declared to have been eradicated worldwide in May of 1980. Today, two laboratories (in Atlanta, Georgia, and in Moscow, Russia) retain samples of the smallpox virus. These samples, as well as stockpiles of the smallpox vaccine, are stored because some level of concern exists that another poxvirus could undergo genetic changes (mutate) and cause human infection. Other areas of concern include the possibility of smallpox virus being utilized in biological warfare, or the remote chance that smallpox virus could somehow escape from the laboratories where it is stored. For these reasons, surveillance continues of various animal groups that continue to be infected with viruses related to the variola virus, and large quantities of vaccine are stored in different countries around the world, so that response to any future threat by the smallpox virus could be prompt.

Smallpox pustules on the arm of an Asian Indian man. *(Photograph by C. James Webb, Phototake NYC. Reproduced by permission.)*

Resources

BOOKS

Lyons, Albert S., and R. Joseph Petrucelli II. *Medicine: An Illustrated History.* New York: Harry N. Abrams, 1987.

KEY TERMS

Epidemic—A situation in which a particular infection is experienced by a very large percentage of the people in a given community within a given time frame.

Eradicate—To completely do away with something, eliminate it, end its existence.

Hemorrhage—Bleeding that is massive, uncontrollable, and often life-threatening.

Lesion—The tissue disruption or the loss of function caused by a particular disease process.

Papules—Firm bumps on the skin.

Pock—A pus-filled bump on the skin.

Vaccine—A preparation using a non-infectious element or relative of a particular virus or bacteria, and administered with the intention of halting the progress of an infection, or completing preventing it.

Ray, C. George. "Poxviruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases.* New York: John Wiley & Sons, 1995.

Wang, Fred. "Smallpox, Vaccinia, and Other Poxviruses." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Siebert, Charles. "Smallpox is Dead; Long Live Smallpox." *New York Times Magazine*, 21 Aug. 1994, 30+.

Wagner, Betsy. "Smallpox is Now a Hostage in the Lab." *The Washington Post*, 4 Jan. 1997, WH8+.

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Smelling disorders

Definition

Smelling disorders are disturbances of the olfactory sense, which is known as the sense of smell. These nasal dysfunctions range from the total loss of smell (**anosmia**) to dysosmia, a distorted sense of smell.

Description

An awareness of how the olfactory system works is helpful for understanding how smelling disorders affect the sense of smell. People detect odors because sensory receptors located in the nose carry smell sensations to the brain. The receptors, which are nerve cell endings, are found in the mucous membrane in the roof of the nose. This section of the nose called the olfactory area is located just below the brain's frontal lobes.

In the olfactory area are millions of tiny olfactory cells. Each cell contains about 12 cilia, tiny hairs that extend into a mucus layer. The mucus moistens the cilia. Mucus also catches odor molecules, while receptors in the cilia stimulate the molecules and send nerve impulses to the brain.

Olfactory nerve fibers carry the impulse to two olfactory bulbs located in the brain. Information is processed in the bulbs and then sent to the cerebral cortex. Once the transmission is inside the smell center of the brain, a person experiences the sense of smell.

A person with a normal sense of smell (normosmia) is able to distinguish 10,000 odors. The sense of smell stimulates salivary glands. As a result, smelling disorders often affect the sense of taste. The olfactory sense allows people to experience pleasurable odors like the scent of roses. And smell is thought to contribute to sexual attraction.

A smelling disorder that affects the sense of smell is generally not life-threatening. However, it can be dangerous. Without a sense of smell, a person might eat spoiled food. Lack of a sense of smell could pose a health risk if a person has little appetite and fails to eat enough. Furthermore, without a sense of smell, a person might not detect a gas leak or the smell of something burning. Loss of smell and the resulting loss of taste may lead to depression.

Types of smelling disorders

Smelling disorders differ in the way that the sense of smell is affected and how long a person has the disorder. For example, anosmia, the loss of the sense of smell, is often a temporary symptom of a cold or flu. However, a **head injury** could cause permanent anosmia. In addition, a head injury could produce dysosmia, the distorted sense of smell that could cause a person to hallucinate a foul odor.

Smelling disorders are categorized as:

- Anosmia, the loss of the sense of smell. It is the most common smelling disorder. This condition can be temporary or permanent.
- Dysosmia is a distorted sense of smell. A person senses non-existent unpleasant odors. It can be caused by medical and mental conditions.
- Hyperosmia is an increased sensitivity to smell. It can be a characteristic of someone with a neurotic or histrionic personality.

- Hyposmia is the diminished sense of smell. This is usually a temporary condition that a person may experience after a case of acute **influenza**. Sometimes this condition is referred to as partial anosmia.
- Presbyosmia refers to the lessening or loss of the olfactory sense that occurs when a person ages.

Smelling disorder demographics

Anosmia occurs in about 10% of head trauma injuries, and head trauma is a leading cause of anosmia in young adults. In older adults, the disorder is generally caused by viral infection. **Aging** may also bring a loss of the sense of smell. In rare cases, anosmia is inherited. It is a symptom of male **hypogonadism** (Kallmann's syndrome).

Olfactory **hallucinations** known as dysosmia are generally associated with psychological conditions. In some cases, people may believe they are the source of foul odors.

Causes and symptoms

Anosmia is the most common type of smelling disorder. Loss of the olfactory sense is generally caused by nasal congestion or obstruction. Temporary partial anosmia often occurs when a person has a cold, the flu, or some types of **rhinitis**, especially hay fever (**allergic rhinitis**). During these conditions, nasal mucus membranes become inflamed. Other causes for anosmia are:

- **Nasal polyps** and other disorders that prevent air from getting to the area in the nose where the smell receptors are found. Hay fever or an allergy may cause one or more polyps to show up.
- Viral upper respiratory infection.
- Atrophic rhinitis. This condition causes mucus membrane to waste away. The person may experience some level of permanent anosmia. One symptom of this condition is that a person expels a foul-smelling discharge.
- Hypertrophic rhinitis. Mucous membrane thickens, covering the olfactory nerve endings. If not treated, hypertrophic rhinitis can lead to permanent anosmia. This discharge could overpower other odors.
- Cigarettes. **Smoking** aggravates the nose's membrane and intensifies nasal polyp symptoms.
- A crooked nose or a deviated septum.
- When the olfactory bulbs, tracts, or central connections are destroyed. This can occur in situations such as head trauma, infections or nasal or sinus surgery.
- Head injury. If both olfactory nerves are torn during a head injury, permanent anosmia results.
- Medications such as **antihistamines** and **decongestants**, especially prolonged use of decongestants.
- Drugs like amphetamines, estrogen, naphazoline, phenothiazines, and resperine.
- The aging process may cause the sense to lessen. In most cases, there is no other obvious cause for the disorder.
- A tumor behind the nose or in the membranes surrounding the brain.
- Lead poisoning.
- Exposure to insecticides or other chemicals.
- Radiation therapy.
- Nervous disorders.
- Idiopathic loss, which means there is no diagnosable cause for the condition.

Anosmia symptoms

Most people with anosmia can distinguish salty, sweet, bitter, and sour tastes since the tongue senses these tastes. However, people with anosmia cannot sense other tastes. Since taste is largely based on the olfactory sense, people complain of losing the sense of taste (ageusia).

Dysosmia

Infected nasal sinuses and damage to the olfactory bulbs can cause dysosmia, the distorted sense of smell. Head trauma can cause this disorder. Poor **oral hygiene** can lead to dysosmia. In these cases, a person may also find that disagreeable odors are accompanied by the sensing of unpleasant tastes. In addition, brain-stem disease can cause smelling disorders. An epileptic seizure can include olfactory hallucinations.

Mental conditions such as depression and **schizophrenia** may be accompanied by dysosmia. In addition, when people who are person severely dependent on alcohol quit drinking, they may experience dysosmia.

Diagnosis

If a smelling disorder is a symptom of a mental condition such as schizophrenia, diagnosis should be part of treatment for that condition.

When the condition is caused by a medical condition such as **allergies** or a viral infection, a person may notice that the olfactory sense is impaired during that condition. If the smelling disorder continues after the person is well, an appointment should be made with a primarily health care provider.

Diagnosis of smelling disorders begins with a health assessment to determine the cause of the olfactory

impairment. The patient's primary care doctor will ask if the patient has a cold, allergies, **sinusitis**, or an upper respiratory infection.

Treatment of a head injury or follow-up medical appointment should address smelling disorders. In all cases, discussion of the symptoms covers issues such as when the smelling disorder started, if this has been an ongoing problem, and whether the disorder is becoming more intense. The assessment will include questions about whether the patient can taste food and if the disorder affects all odors or specific smells. The patient will also be asked about medications taken.

Physical examinations

The **physical examination** will include a thorough inspection of the nose, nasopharynx, and the examination of the upper respiratory tract. The examination could include sinus transillumination, placement of a light on the face to help determine if sinuses are full. **Skull x rays** may be required to determine the presence of tumors in the nose or brain.

The patient may be referred to a neurologist—an ear, nose, and throat specialist—or to a center that specializes in treatment of smelling disorders.

Other diagnostic tests could be required. These include:

- A CT scan (**computed tomograpy scans**) of the head. Also known as a CAT scan, this process provides a more detailed image than the x ray.
- Olfactory nerve testing.
- Nasal cytology, which involves the study of mucus under a microscope.
- Testing to determine the scope of smelling disorder. A basic smell test involves the patient trying to identify each one of a group of different odors. A variation of this is a scratch-and-sniff test. The patient may be asked to differentiate among concentrations of one odor. The alcohol sniff test that involves use of a material soaked in isopropyl alcohol. Patients close their eyes and the doctor moves around. Patients tell the doctor when they smell the alcohol.
- The patient may also take a taste test.

Medical costs

The costs for diagnosis and treatment vary because of the different types of smelling disorders, the range of causes for olfactory dysfunction, and the different types of treatment.

There are also differences in what health plans require in terms of patient co-pay. A health plan could cover treatments ranging from the initial appointment with a primary care provider to the surgery to remove brain tumors.

In addition, some health plans cover costs of treatment at specialized facilities like the Center for Smell and Taste Disorders at the University of Colorado Health Sciences Center in Denver. A series of tests including a taste-and-smell test cost $250 in May of 2001.

Treatment

Treating a condition that causes a smelling disorder can sometimes restore the olfactory sense. Treatments for smelling disorders are as varied as the olfactory dysfunctions. Treatment for smelling disorders ranges from lifestyle changes to surgery. Treatment of mental conditions could affect the smelling disorder. In some cases, the disorder can't be treated, and the person must adjust to the loss of the sense of smell. Anosmia associated with aging is not treatable.

Basic treatments for anosmia

The sense of smell should return after a condition like a cold or the flu ends. Decongestants such as Sudafed help reduce congestion related to colds, allergies, and sinus conditions. Manufacturer's dosage recommendations should be followed. If anosmia is related to excessive use of nasal decongestants, a person should discontinue use of those medications.

Saline sprays can be used to clean the interior of the nose.

If smoking causes anosmia, a person should quit smoking.

The sense of smell may return after treatment of allergic or bacterial rhinitis and sinusitis. An over-the-counter antihistamine such as Actifed may provide relief.

If allergies cause anosmia, adjustments should be made to avoid allergens. If dust causes allergies, care should be taken to clean areas such as the bedroom.

Antibiotics may be prescribed for infections.

Other medications prescribed for smelling disorders include steroids such as Prednisone. It should only be used for a short time since longterm use could lessen resistance to infection.

Surgical treatment

Removal of nasal polyps and benign tumors may cause the sense of smell to return. Polyp removal is an uncomplicated surgery. Generally, only a local anesthetic is needed.

Septoplasty straightens the nasal passage. It is generally an outpatient surgery, with local or general anesthesia required. **Rhinoplasty** straightens the structure of the nose. This surgery could be combined with septoplasty.

Endoscopic sinus surgery opens sinus drainage channels. This outpatient surgery is an option after a person sees no improvement after trying treatments such as medications.

Surgical treatment may not be effective in conditions that result in the destruction of the olfactory nerve or its central passages. However, regeneration of those tissues may cause the sense to return.

Enhancing taste

Without a sense of smell, most people can still taste salt and flavors that are sweet, sour, and bitter. People with anosmia could distinguish other tastes by adding spices such as pepper to food. These spices stimulate facial nerves that also sense flavors.

Alternative treatment

Alternative treatments for smelling disorder center around the theory that zinc supplements help improve the sense of smell. The supplement is said to be effective when the olfactory sense is impaired by conditions such as a head injury or an upper respiratory infection. A person should take 50 mg of zinc picolinate each day after eating. This procedure might be effective in the case of head injury. However, it may be several months before results are seen. **Acupuncture** may also produce results.

If polyps cause a smelling disorder, a change in diet could be helpful. A person should avoid dairy products, take supplements such as garlic, and follow other recommendations from a health care practitioner. A daily dosage of 5,000–10,000 mg of vitamin C could cut back on the amount of polyps. **Vitamins** should not be taken all at once. A multi-vitamin and mineral complex could also help.

Prognosis

In cases where smelling disorders are treatable, the outcome is positive because the olfactory sense is restored. In those cases where the sense of smell is lost, the person must make adjustments to adapt to life without that sense. Those adjustments include using spices like pepper to stimulate tastebuds.

Since a person with anosmia can no longer smell food to determine whether it is safe to eat, care should be taken. The person who lives with other people can ask them if food smells fresh. People who live alone should discard food if there is a chance that it has spoiled. Other home safety measures include installing smoke alarms and gas detectors. Cooking on an electric stove is preferable to a gas stove.

Furthermore, people with smelling disorders can find support groups. These are often associated with smell and taste clinics. In addition, there are on-line bulletin board where people can share experiences. One site contains descriptions of how things smell. Those words provide a connection to a missing sense in the same way that sign language allows the hearing-impaired to understand the spoken word.

KEY TERMS

Histrionic—A behavior characterized by an excitable nature and the constant desire for stimulation.

Nasopharynx—The passage that connects the nasal cavity to the top of the throat.

Neurotic—Behavior characterized by neurosis, mental functional orders with symptoms such as anxiety, depression, compulsions, and phobias.

Polyp—A benign growth in areas such as the nasal passage.

Rhinitis—The inflammation of the mucous membrane in the nose.

Septum—A sheet of cartilage and bone that separates the nostrils.

Sinusitis—Inflammation of the paranasal sinuses because of allergic reactions or viral, bacterial, or functional infections.

Prevention

Not all causes of smelling disorders can be prevented. However, people with a disorder should not smoke and should ask those around them not to smoke. Those with smelling disorders related to allergies should be taken to avoid allergens. Since head trauma injuries can lead to smelling disorders, people should wear protective helmets when bicycling or participating in sports like football.

Resources

BOOKS

Watson, Lyall. *Jacob's Organ and the Remarkable Sense of Smell.* New York: W.W. Norton & Company, 2000.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery. One Prince St., Alexandria, VA 23314-3357. (703) 836-4444. <http://www.ent.org>.

Center for Taste and Smell Disorders. University of Colorado Health Sciences Center, 4200 E, Ninth Ave., Denver, CO 80262. (303) 315-5660. <http://www.hsc.colorado.edu>.

San Diego Nasal Dysfunction Clinic. University of California San Diego Perlman Ambulatory Care Center. 9350 Campus Point Drive, La Jolla, CA 92037. (858) 657-8590. <http://www-surgery.ucsd.edu/ent>.

U.S. Department of Health and Human Services. 200 Independence Avenue, SW, Washington, DC 20201.(877) 696-6775. <http://www.hhs.gov>.

Liz Swain

Smoke inhalation

Definition

Smoke inhalation is breathing in the harmful gases, vapors, and particulate matter contained in smoke.

Description

Smoke inhalation typically occurs in victims or firefighters caught in structural fires. However, cigarette **smoking** also causes similar damage on a smaller scale over a longer period of time. People who are trapped in fires may suffer from smoke inhalation independent of receiving skin **burns**; however, the incidence of smoke inhalation increases with the percentage of total body surface area burned. Smoke inhalation contributes to the total number of fire-related deaths each year for several reasons: the damage is serious; its diagnosis is not always easy and there are no sensitive diagnostic tests; and patients may not show symptoms until 24–48 hours after the event. Children under age 11 and adults over age 70 are most vulnerable to the effects of smoke inhalation.

Causes and symptoms

The harmful materials given off by combustion injure the airways and lungs in three ways: heat damage, tissue irritation, and oxygen **starvation** of tissues (asphyxiation). Signs of heat damage are singed nasal hairs, burns around and inside the nose and mouth, and internal swelling of the throat. Tissue irritation of the throat and lungs may appear as noisy breathing, coughing, hoarseness, black or gray spittle, and fluid in the lungs. Asphyxiation is apparent from **shortness of breath** and blue-gray or cherry-red skin color. In some cases, the patient may not be conscious or breathing.

Diagnosis

In addition to looking for the signs of heat damage, tissue irritation, and asphyxiation, the physician will assess the patient's breathing by the respiratory rate (number of breaths per minute) and motion of the chest as the lungs inflate and deflate. The patient's circulation is also evaluated by the pulse rate (number of heartbeats per minute) and blood pressure. Blood tests will indicate the levels of oxygen and byproducts of poisonous gases. Chest x rays are too insensitive to show damage to delicate respiratory tissues, but can show fluid in the lungs (**pulmonary edema**).

The physician may perform a **bronchoscopy**, a visual examination in which the airways and lungs are seen through a fiber optic tube inserted down the patient's windpipe (trachea). Other pulmonary function tests may be performed to measure how efficiently the lungs are working.

Treatment

Treatment will vary with the severity of the damage caused by smoke inhalation. The primary focus of treatment is to maintain an open airway and provide an adequate level of oxygen. If the airway is open and stable, the patient may be given high-flow humidified 100% oxygen by mask. If swelling of the airway tissues is closing off the airway, the patient may require the insertion of an endotracheal tube to artificially maintain an open airway.

Oxygen is often the only medication necessary. However, patients who have a **cough** with **wheezing** (bronchospasm), indicating that the bronchial airways are narrowed or blocked, may be given a bronchodilator to relax the muscles and increase ventilation. There are also antidotes for specific poisonous gases in the blood; dosage is dependent upon the level indicated by blood tests. **Antibiotics** are not given until sputum and blood cultures confirm the presence of a bacterial infection.

In institutions where it is available, hyperbaric oxygen therapy may be used to treat smoke inhalation resulting in severe carbon monoxide or cyanide **poisoning**. This treatment requires a special chamber in which the patient receives pure oxygen at three times the normal atmospheric pressure, thus receiving more oxygen faster to overcome loss of consciousness, altered mental state, cardiovascular dysfunction, pulmonary **edema**, and severe neurological damage.

KEY TERMS

Asphyxiation—Oxygen starvation of tissues. Chemicals such as carbon monoxide prevent the blood from carrying sufficient oxygen to the brain and other organs. As a result, the person may lose consciousness, stop breathing, and die without artificial respiration (assisted breathing) and other means of elevating the blood oxygen level.

Hyperbaric oxygen therapy—Pure oxygen is administered to the patient in a special chamber at three times the normal atmospheric pressure. The patient gets more oxygen faster to overcome severe asphyxiation.

Pulmonary—Pertaining to the lungs.

Pulmonary edema—The filling of the lungs with fluid as the body's response to injury or infection.

Alternative treatment

Botanical medicine can help to maintain open airways and heal damaged mucous membranes. It can also help support the entire respiratory system. **Acupuncture** and homeopathic treatment can provide support to the whole person who has suffered a traumatic injury such as smoke inhalation.

Prognosis

Although the outcome depends of the severity of the smoke inhalation and the severity of any accompanying burns or other injuries, with prompt medical treatment, the prognosis for recovery is good. However, some patients may experience chronic pulmonary problems following smoke inhalation, and those with **asthma** or other chronic respiratory conditions prior to smoke inhalation may find their original conditions have been aggravated by the inhalation injury.

Prevention

Smoke inhalation is best avoided by preventing structural fires. This includes inspection of wiring, safe use and storage of flammable liquids, and maintenance of clean, well-ventilated chimneys, wood stoves, and space heaters. Properly placed and working smoke detectors in combination with rapid evacuation plans will minimize a person's exposure to smoke in the event of a fire. When escaping a burning building, a person should move close to the floor where there is more cool, clear air to breathe because hot air rises, carrying gases and particulate matter upward. Finally, firefighters should wear proper protective gear.

Resources

BOOKS

Speizer, Frank E. "Environmental Lung Diseases." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Clark Jr., W. R. "Smoke Inhalation: Diagnosis and Treatment." *World Journal of Surgery* 16 (1992): 24.

OTHER

Johnson, Norma Jean. "Smoke Inhalation." *eMedicine World Medical Library.* <http://www.emedicine.com>.

Bethany Thivierge

Smoking

Definition

Smoking is the inhalation of the smoke of burning tobacco encased in cigarettes, pipes, and cigars. Casual smoking is the act of smoking only occasionally, usually in a social situation or to relieve **stress**. A smoking habit is a physical **addiction** to tobacco products. Many health experts now regard habitual smoking as a psychological addiction, too, and one with serious health consequences.

Description

The U.S. Food and Drug Administration has asserted that cigarettes and smokeless tobacco should be considered nicotine delivery devices. Nicotine, the active ingredient in tobacco, is inhaled into the lungs, where most of it stays. The rest passes into the bloodstream, reaching the brain in about 10 seconds and dispersing throughout the body in about 20 seconds.

Depending on the circumstances and the amount consumed, nicotine can act as either a stimulant or tranquilizer. This can explain why some people report that smoking gives them energy and stimulates their mental activity, while others note that smoking relieves **anxiety** and relaxes them. The initial "kick" results in part from the drug's stimulation of the adrenal glands and resulting release of epinephrine into the blood. Epinephrine causes several physiological changes—it temporarily narrows the arteries, raises the blood pressure, raises the levels of fat in the blood, and increases the heart rate and flow of blood from the heart. Some researchers think epinephrine contributes to smokers' increased risk of high blood pressure.

Nicotine, by itself, increases the risk of heart disease. However, when a person smokes, he or she is ingesting a lot more than nicotine. Smoke from a cigarette, pipe, or cigar is made up of many additional toxic chemicals, including tar and carbon monoxide. Tar is a sticky substance that forms into deposits in the lungs, causing lung **cancer** and respiratory distress. Carbon monoxide limits the amount of oxygen that the red blood cells can convey throughout your body. Also, it may damage the inner walls of the arteries, which allows fat to build up in them.

Besides tar, nicotine, and carbon monoxide, tobacco smoke contains 4,000 different chemicals. More than 200 of these chemicals are known be toxic. Nonsmokers who are exposed to tobacco smoke also take in these toxic chemicals. They inhale the smoke exhaled by the smoker as well as the more toxic *sidestream smoke*—the smoke from the end of the burning cigarette, cigar, or pipe.

Here's why sidestream smoke is more toxic than exhaled smoke: When a person smokes, the smoke he or she inhales and then breathes out leaves harmful deposits inside the body. But because lungs partially cleanse the smoke, exhaled smoke contains fewer poisonous chemicals. That's why exposure to tobacco smoke is dangerous even for a nonsmoker.

Causes and symptoms

No one starts smoking to become addicted to nicotine. It isn't known how much nicotine may be consumed before the body becomes addicted. However, once smoking becomes a habit, the smoker faces a lifetime of health risks associated with one of the strongest addictions known to man.

Smoking risks

Smoking is recognized as the leading preventable cause of **death**, causing or contributing to the deaths of approximately 430,700 Americans each year. Anyone with a smoking habit has an increased chance of lung, cervical, and other types of cancer; respiratory diseases such as **emphysema**, **asthma**, and chronic **bronchitis**; and cardiovascular disease, such as **heart attack**, high blood pressure, **stroke**, and **atherosclerosis** (narrowing and hardening of the arteries). The risk of stroke is especially high in women who take birth control pills.

Smoking can damage fertility, making it harder to conceive, and it can interfere with the growth of the fetus during **pregnancy**. It accounts for an estimated 14% of premature births and 10% of infant deaths. There is some evidence that smoking may cause **impotence** in some men.

Because smoking affects so many of the body's systems, smokers often have vitamin deficiencies and suffer oxidative damage caused by free radicals. Free radicals are molecules that steal electrons from other molecules, turning the other molecules into free radicals and destabilizing the molecules in the body's cells.

Smoking is recognized as one of several factors that might be related to a higher risk of hip **fractures** in older adults.

Studies reveal that the more a person smokes, the more likely he is to sustain illnesses such as cancer, chronic bronchitis, and emphysema. But even smokers who indulge in the habit only occasionally are more prone to these diseases.

Some brands of cigarettes are advertised as "low tar," but no cigarette is truly safe. If a smoker switches to a low-tar cigarette, he is likely to inhale longer and more deeply to get the chemicals his body craves. A smoker has to quit the habit entirely in order to improve his health and decrease the chance of disease.

Though some people believe chewing tobacco is safer, it also carries health risks. People who chew tobacco have an increased risk of heart disease and mouth and throat cancer. Pipe and cigar smokers have increased health risks as well, even though these smokers generally do not inhale as deeply as cigarette smokers do. These groups haven't been studied as extensively as cigarette smokers, but there is evidence that they may be at a slightly lower risk of cardiovascular problems but a higher risk of cancer and various types of circulatory conditions.

Recent research reveals that passive smokers, or those who unavoidably breathe in second-hand tobacco smoke, have an increased chance of many health problems such as lung cancer and asthma, and in children, **sudden infant death syndrome**.

Smokers' symptoms

Smokers are likely to exhibit a variety of symptoms that reveal the damage caused by smoking. A nagging morning **cough** may be one sign of a tobacco habit. Other symptoms include **shortness of breath**, **wheezing**, and frequent occurrences of respiratory illness, such as bronchitis. Smoking also increases **fatigue** and decreases the smoker's sense of smell and taste. Smokers are more likely to develop poor circulation, with cold hands and feet and premature wrinkles.

Sometimes the illnesses that result from smoking come on silently with little warning. For instance, **coronary artery disease** may exhibit few or no symptoms. At other times, there will be warning signs, such as bloody discharge from a woman's vagina, a sign of cancer of the cervix. Another warning sign is a hacking cough, worse

Symptoms That Occur After Quitting Smoking

Symptom	Cause	Duration	Relief
Craving for cigarette	nicotine craving	first week can linger for months	distract yourself with other activity
Irritability, impatience	nicotine craving	2 to 4 weeks	Exercise, relaxation techniques, avoid caffeine
Insomnia	nicotine craving temporarily reduces deep sleep	2 to 4 weeks	Avoid caffeine after 6 PM relaxation techniques; exercise
Fatigue	lack of nicotine stimulation	2 to 4 weeks	Nap
Lack of concentration	lack of nicotine stimulation	A few weeks	Reduce workload; avoid stress
Hunger	cigarettes craving confused hunger pangs	Up to several weeks	Drink water or low calorie drinks; eat low-calorie snacks
Coughing, dry throat, nasal drip	Body ridding itself of mucus in lungs and airways	Several weeks	Drink plenty of fluids; use cough drops
Constipation, gas	Intestinal movement decreases with lack of nicotine	1 to 2 weeks	Drink plenty of fluids; add fiber to diet; exercise

than the usual smoker's cough, that brings up phlegm or blood—a sign of lung cancer.

Withdrawal symptoms

A smoker who tries to quit may expect one or more of these withdrawal symptoms: nausea, **constipation** or **diarrhea**, drowsiness, loss of concentration, **insomnia**, **headache**, nausea, and irritability.

Diagnosis

It's not easy to quit smoking. That's why it may be wise for a smoker to turn to his physician for help. For the greatest success in quitting and to help with the withdrawal symptoms, the smoker should talk over a treatment plan with his doctor or alternative practitioner. He should have a general **physical examination** to gauge his general health and uncover any deficiencies. He should also have a thorough evaluation for some of the serious diseases that smoking can cause.

Treatment

Research shows that most smokers who want to quit benefit from the support of other people. It helps to quit with a friend or to join a group such as those organized by the American Cancer Society. These groups provide support and teach behavior modification methods that can help the smoker quit. The smoker's physician can often refer him to such groups.

Other alternatives to help with the withdrawal symptoms of kicking the habit include nicotine replacement therapy in the form of gum, patches, nasal sprays, and oral inhalers. These are available by prescription or over the counter. A physician can provide advice on how to use them. They slowly release a small amount of nicotine into the bloodstream, satisfying the smoker's physical craving. Over time, the amount of gum the smoker chews is decreased and the amount of time between applying the patches is increased. This helps wean the smoker from nicotine slowly, eventually beating his addiction to the drug. But there's one important caution: If the smoker lights up while taking a nicotine replacement, a nicotine overdose may cause serious health problems.

The prescription drug Zyban (buproprion hydrochloride) has shown some success in helping smokers quit. This drug contains no nicotine, and was originally developed as an antidepressant. It isn't known exactly how buproprion works to suppress the desire for nicotine.

Expected results

Research on smoking shows that 80% of all smokers desire to quit. But smoking is so addictive that fewer than 20% of the people who try ever successfully kick the habit. Still, many people attempt to quit smoking over and over again, despite the difficulties—the cravings and withdrawal symptoms, such as irritability and restlessness.

For those who do quit, it's well worth the effort. The good news is that once a smoker quits the health effects are immediate and dramatic. After the first day, oxygen and carbon monoxide levels in the blood return to normal. At two days, nerve endings begin to grow back and the senses of taste and smell revive. Within two weeks to three months, circulation and breathing improve. After one year of not smoking, the risk of heart disease is reduced by 50%. After 15 years of abstinence, the risks of health problems from smoking virtually vanish. A smoker who quits for good often feels a lot better too, with less fatigue and fewer respiratory illnesses.

Alternative treatment

There are a wide range of alternative treatments that can help a smoker quit the habit, including **hypnothera-**

KEY TERMS

Antioxidant—Any substance that reduces the damage caused by oxidation, such as the harm caused by free radicals.

Chronic bronchitis—A smoking-related respiratory illness in which the membranes that line the bronchi, or the lung's air passages, narrow over time. Symptoms include a morning cough that brings up phlegm, breathlessness, and wheezing.

Emphysema—An incurable, smoking-related disease, in which the air sacs at the end of the lung's bronchi become weak and inefficient. People with emphysema often first notice shortness of breath, repeated wheezing and coughing that brings up phlegm.

Epinephrine—A nervous system hormone stimulated by the nicotine in tobacco. It increases heart rate and may raise smokers' blood pressure.

Flavonoid—A food chemical that helps to limit oxidative damage to the body's cells, and protects against heart disease and cancer.

Free radical—An unstable molecule that causes oxidative damage by stealing electrons from surrounding molecules, thereby disrupting activity in the body's cells.

Nicotine—The addictive ingredient of tobacco, it acts on the nervous system and is both stimulating and calming.

Nicotine replacement therapy—A method of weaning a smoker away from both nicotine and the oral fixation that accompanies a smoking habit by giving the smoker smaller and smaller doses of nicotine in the form of a patch or gum.

Sidestream smoke—The smoke that is emitted from the burning end of a cigarette or cigar, or that comes from the end of a pipe. Along with exhaled smoke, it is a constituent of second-hand smoke.

py, herbs, **acupuncture**, and **meditation**. For example, a controlled trial demonstrated that self-massage can help smokers crave less intensely, smoke fewer cigarettes, and in some cases completely give them up.

Hypnotherapy

Hypnotherapy helps the smoker achieve a trance-like state, during which the deepest levels of the mind are accessed. A session with a hypnotherapist may begin with a discussion of whether the smoker really wants to and truly has the motivation to stop smoking. The therapist will explain how hypnosis can reduce the stress-related symptoms that sometimes come with kicking the habit.

Often the therapist will discuss the dangers of smoking with the patient and begin to "reframe" the patient's thinking about smoking. Many smokers are convinced they can't quit, and the therapist can help persuade them that they can change this behavior. These suggestions are then repeated while the smoker is under hypnosis. The therapist may also suggest while the smoker is under hypnosis that his feelings of worry, anxiety, and irritability will decrease.

In a review of 17 studies of the effectiveness of hypnotherapy, the percentage of people treated by hypnosis who still were not smoking after six months ranged from 4%–8%. In programs that included several hours of treatment, intense interpersonal interaction, individualized suggestions, and follow-up treatment, success rates were above 50%.

Aromatherapy

One study demonstrated that inhaling the vapor from black pepper extract can reduce symptoms associated with smoking withdrawal. Other essential oils can be used for relieving the anxiety a smoker often experiences while quitting.

Herbs

A variety of herbs can help smokers reduce their cravings for nicotine, calm their irritability, and even reverse the oxidative cellular damage done by smoking. Lobelia, sometimes called Indian tobacco, has historically been used as a substitute for tobacco. It contains a substance called lobeline, which decreases the craving for nicotine by bolstering the nervous system and calming the smoker. In high doses, lobelia can cause vomiting, but the average dose—about 10 drops per day—should pose no problems.

Herbs that can help relax a smoker during withdrawal include wild oats and kava kava.

To reduce the oral fixation supplied by a nicotine habit, a smoker can chew on licorice root—the plant, not the candy. Licorice is good for the liver, which is a major player in the body's **detoxification** process. Licorice also

acts as a tonic for the adrenal system, which helps reduce stress. And there's an added benefit: If a smoker tries to light up after chewing on licorice root, the cigarette tastes like burned cardboard.

Other botanicals that can help repair free-radical damage to the lungs and cardiovascular system are those high in flavonoids, such as hawthorn, gingko biloba, and bilberry, as well as antioxidants such as vitamin A, vitamin C, zinc, and selenium.

Acupuncture

This ancient Chinese method of healing is used commonly to help beat addictions, including smoking. The acupuncturist will use hair-thin needles to stimulate the body's *qi*, or healthy energy. Acupuncture is a sophisticated treatment system based on revitalizing qi, which supposedly flows through the body in defined pathways called meridians. During an addiction like smoking, qi isn't flowing smoothly or gets stuck, the theory goes.

Points in the ear and feet are stimulated to help the smoker overcome his addiction. Often the acupuncturist will recommend keeping the needles in for five to seven days to calm the smoker and keep him balanced.

Vitamins

Smoking seriously depletes vitamin C in the body and leaves it more susceptible to infections. Vitamin C can prevent or reduce free-radical damage by acting as an antioxidant in the lungs. Smokers need additional C, in higher dosage than nonsmokers. Fish in the diet supplies Omega-3 fatty acids, which are associated with a reduced risk of chronic obstructive pulmonary disease (emphysema or chronic bronchitis) in smokers. Omega-3 fats also provide cardiovascular benefits as well as an anti-depressive effect. Vitamin therapy doesn't reduce craving but it can help beat some of the damage created by smoking. Vitamin B_{12} and **folic acid** may help protect against smoking-induced cancer.

Prevention

How do you give up your cigarettes for good and never go back to them again?

Here are a few tips from the experts:

- Tell your friends and neighbors that you're quitting. Doing so helps make quitting a matter of pride.
- Chew sugarless gum or eat sugar-free hard candy to redirect the oral fixation that comes with smoking. This will prevent weight gain, too.
- Eat as much as you want, but only low-calorie foods and drinks. Drink plenty of water. This may help with the feelings of tension and restlessness that quitting can bring. After eight weeks, you'll lose your craving for tobacco, so it's safe then to return to your usual eating habits.
- Stay away from situations that prompt you to smoke. Dine in the nonsmoking section of restaurants.
- Spend the money you save not smoking on an occasional treat for yourself.

Resources

BOOKS

"Acupuncture." In *The American Medical Association Encyclopedia of Medicine,* ed. Charles B. Clayman. New York: Random House, 1989.

Molony, David, and Ming Ming Pan. *The American Association of Oriental Medicine's Complete Guide to Herbal Medicine*. New York: Berkley Books, 1998.

Tyler, Varro E. *The Honest Herbal: A Sensible Guide to the Use of Herbs and Related Remedies*. New York: Haworth Press, 1993.

PERIODICALS

Holroyd, J. "Hypnosis Treatment for Smoking: An Evaluative Review." *International Journal of Clinical and Experimental Hypnosis* 28, no. 4 (October 1980): 341–57.

Yochum, L., L. H. Kushi, and A. R. Folsom. "Dietary Flavonoid Intake and Risk of Cardiovascular Disease in Postmenopausal Women." *American Journal of Epidemiology* 149, no. 10 (May 1999): 943–9.

ORGANIZATIONS

American Association of Oriental Medicine. 433 Front St., Catasququa, PA 18032. (888) 500-7999. <http://www.aaom.org>.

American Cancer Society. (800) 227-2345. <http://www.cancer.org>.

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872 or (212) 315-8700. <http://www.lungusa.org>.

Herb Research Foundation. 1007 Pearl St., Suite 200, Boulder CO 80302. (303) 449-2265. <http://www.herbs.org>.

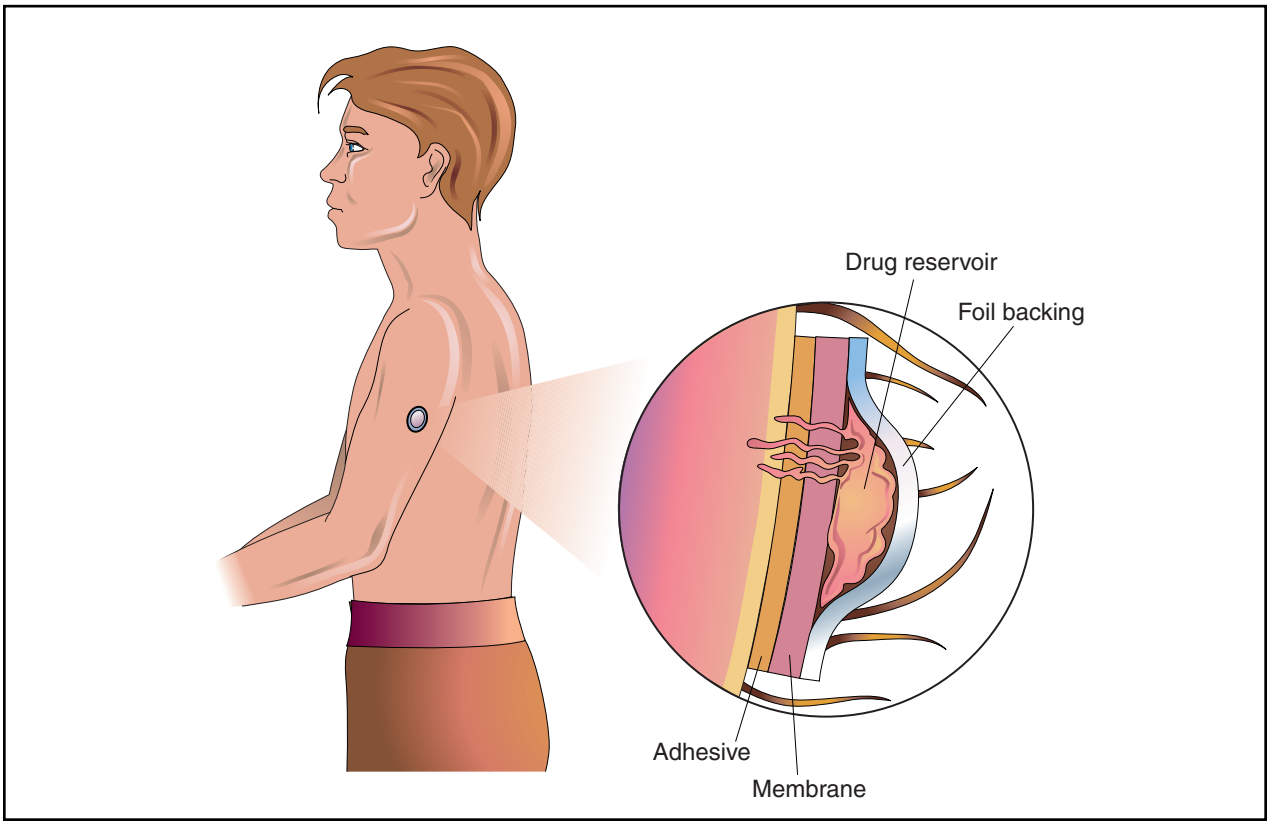
Smoking, Tobacco, and Health Information Line; Centers for Disease Control and Prevention. Mailstop K-50, 4770 Buford Highway NE, Atlanta, GA 30341-3724. (800) 232-1311. <http://www.cdc.gov/tobacco>.

Barbara Boughton

Smoking-cessation drugs

Definition

Smoking cessation drugs are medicines that help people stop smoking cigarettes or using other forms of tobacco.



The nicotine patch is a type of transepidermal patch designed to deliver nicotine, the addictive substance contained in cigarettes, directly through the skin and into the blood stream. The patch contains a drug reservoir sandwiched between a non-permeable back layer and a permeable adhesive layer that attaches to the skin. The drug leeches slowly out of the reservoir, releasing small amounts of the drug at a constant rate for up to 24 hours. *(Illustration by Electronic Illustrators Group.)*

Purpose

People who smoke cigarettes or use other forms of tobacco often have a difficult time when they try to stop. The difficulty is partly psychological; they get in the habit of using tobacco at certain times of day or while they are doing certain things, such as having a cup of coffee or reading the newspaper. But the habit is also hard to break for physical reasons. Tobacco contains nicotine, a drug that is as addictive as **cocaine** or heroin. Of those who have ever tried even a single cigarette, about a third will become nicotine-dependent. A person who is addicted to nicotine has withdrawal symptoms, such as irritability, **anxiety**, difficulty concentrating, and craving for tobacco when he or she stops using tobacco.

Some people can stop smoking through willpower alone, but most do better if they have support from friends, family, a physician or pharmacist, or a formal stop-smoking program. Heavy tobacco users may find that smoking cessation products also help by easing their withdrawal symptoms. Most smoking cessation products contain nicotine, but the nicotine is delivered in small, steady doses spread out over many hours. In contrast, when a person inhales a cigarette, nicotine enters the lungs and then travels to the brain within seconds, delivering the "rush" that smokers come to crave. Another difference is that smoking cessation products do not contain the tar, carbon monoxide, and other toxins that make cigarettes so harmful to people's health. According to one Canadian study, tobacco smoke contains over 40 different chemicals known to cause **cancer**.

The importance of smoking cessation is reflected in legal penalties against the tobacco industry for its long-standing denial of the harm caused by tobacco products. Recent legal findings against the tobacco industry have led to legislation in three states concerning lawsuits against the industry. In Florida, state agencies can sue on behalf of Medicaid recipients for repayment of benefits. Maryland allows the use of statistical analysis in lawsuits against tobacco companies. In Vermont, the state can bring direct lawsuits against tobacco manufacturers to recover Medicaid benefits for tobacco-related illnesses paid after April 1998. Nineteen states (Alabama, Alaska, Connecticut, Florida, Hawaii, Louisiana, Maryland,

Massachusetts, Minnesota, Mississippi, Montana, New Hampshire, New York, Rhode Island, Texas, Vermont, Virginia, Washington, and Wisconsin) have set aside as of 2001 a portion of their money from tobacco settlements to smoking prevention programs.

Description

Nicotine replacement products

Smoking cessation drugs that contain nicotine are also called nicotine substitution products or nicotine replacement therapy. There are four forms approved by the Food and Drug Administration (FDA) as of 2001—chewing gum, skin patch, nasal spray, and inhaler. The nasal spray and inhaler are available only with a prescription, but the gum and some brands of the patch can be bought over the counter (without a prescription). People who buy the nonprescription products should check with a physician before starting to use them. The patches are sold under the brand names Nicotrol, Nicoderm CQ, and Habitrol (prescription only). The gum is sold under the brand name Nicorette. The nasal spray and inhaler are marketed as Nicotrol NS and Nicotrol respectively. The costs of these products are about $30 for a box of 48 pieces of the gum and about $30 per week for the patches.

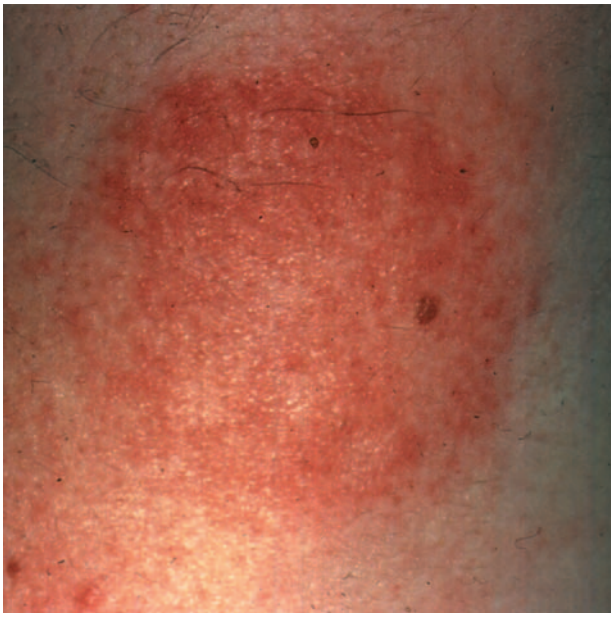
Other medications

Another type of smoking cessation drug, bupropion (Zyban), also reduces craving and withdrawal symptoms, although it is not a nicotine replacement product. Bupropion is an antidepressant medication that is thought to help people stop smoking by mimicking some of the effects of tobacco on brain tissue. Bupropion can be used together with nicotine replacement products; several studies indicate that the combination helps more smokers quit than either method by itself.

Buspirone (BuSpar) is a tranquilizer that appears to be effective in helping smokers deal with feelings of anxiety resulting from tobacco withdrawal.

Alternative approaches

Other approaches that have been used to help smokers quit include hypnosis and **acupuncture**. The evidence for the usefulness of hypnosis is largely anecdotal; it appears to be most helpful when used in combination with nicotine replacement products or bupropion. Although acupuncture has been used in Western countries since the 1970s to help people quit smoking, it does not appear to be particularly effective in this regard. A British study that was published in 1999 found that smokers who received acupuncture did not have a higher quit rate than those who received only sham acupuncture.



The wheals on the arm of this patient was caused by an allergic reaction to nicotine patches used to help subdue the urge to smoke. *(Custom Medical Stock Photo. Reproduced by permission.)*

Recommended dosage

The recommended dosage of nicotine replacement products depends on the method of administration. Each form of this medicine comes with detailed instructions for its use. Following directions exactly is very important. For example, nicotine gum should not be chewed like regular chewing gum. It must be chewed very slowly until it has a slight taste or causes a slight tingling sensation in the mouth; then "parked" between the cheek and gum until the taste and tingling goes away; then chewed and parked in the same way for about 30 minutes. Nicotine patches and other products also must be used correctly to be effective. Some patches are meant to be worn only during the day and removed at night; others are worn 24 hours a day.

Smokers who are heavily dependent on nicotine may want to ask their doctors about using a combination of nicotine replacement products. Studies done between 1995 and 2000 indicate that combining the transdermal patch with either the gum or the nasal spray helps more smokers quit than any of the three products by themselves. It is thought that the higher success rate is due to the different rates of speed at which these products deliver nicotine to the body. The nasal spray delivers nicotine very rapidly, and can be used to relieve intense cravings at times of the day when the smoker is accustomed to having a cigarette, while the patch delivers a smaller dosage of nicotine to the body at a steadier rate.

Precautions

Seeing a physician regularly while using smoking cessation drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects.

Nicotine by itself is a poisonous substance. Do not smoke during treatment with smoking cessation drugs that contain nicotine, as the combination could lead to nicotine overdose. For the same reason, do not use more than one type of smoking cessation product at a time, and never use more than the recommended amount of medicine. Signs of nicotine overdose include:

- nausea
- vomiting
- severe **pain** in the stomach or abdomen
- severe diarrhea
- severe dizziness
- fainting
- convulsions (seizures)
- low blood pressure
- fast, weak, or irregular heartbeat
- hearing or vision problems
- severe breathing problems
- severe watering of the mouth or drooling
- cold sweat
- severe headache
- confusion
- severe weakness

Keep these drugs, including thrown-away patches and gum—out of the reach of children and pets. Even a small amount of nicotine can seriously harm a child or animal.

Nicotine in any form should not be used during **pregnancy**, as it may harm the fetus or cause **miscarriage**. Women who may become pregnant should use effective birth control while taking smoking cessation drugs. Women who become pregnant while taking this medicine should stop taking it immediately and check with their physicians.

Nicotine passes into breast milk and may cause problems for nursing babies. Women who are breastfeeding and want to use smoking cessation drugs may need to stop breastfeeding during treatment.

Anyone who has had unusual reactions to nicotine in the past should let his or her physician know before using a smoking cessation drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances. People who have had a rash or irritation from adhesive bandages should check with a physician before using a nicotine patch.

Smoking cessation patches, gum, and other products may make certain medical problems worse. Before using a smoking cessation drug, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart or blood vessel disease
- high blood pressure
- diabetes
- overactive thyroid
- skin rash or irritation
- stomach ulcer
- pheochromocytoma (pcc) (a tumor of the adrenal medulla)
- dental problems or mouth sores
- sore throat
- jaw pain or temporomandibular joint disorder (TMJ)

There are also precautions to take with bupropion and buspirone. Bupropion should not be taken by patients with a history of seizures, high blood pressure, anorexia, or **bulimia nervosa**. People taking buspirone should be careful about driving or operating heavy machinery until they can tell whether the drug makes them drowsy as a side effect. Although buspirone does not interact with alcohol as intensely as most tranquilizers do, patients should still use alcohol cautiously if they are taking buspirone.

Side effects

Each type of smoking cessation product may cause minor side effects that usually go away as the body adjusts to the drug. These usually do not need medical attention unless they continue or they interfere with normal activities. For example, nicotine gum may cause belching, jaw aches, or sore mouth or throat. Nicotine patches may cause redness, **itching**, or burning where the patch is applied. The nasal spray may irritate the nose and sinuses, while the inhaler may cause throat irritation or coughing.

If nicotine gum injures the mouth, teeth, or dental work, check with a physician as soon as possible. Other side effects are possible. Anyone who has unusual symptoms while using smoking cessation drugs should get in touch with his or her physician.

The side effects of bupropion include **dry mouth** and difficulty sleeping. The possible side effects of buspirone include headaches and drowsiness.

Interactions

People taking certain drugs may need to change their doses when they stop smoking. Anyone who uses a smoking cessation drug should let the physician know all other medicines he or she is taking and should ask whether the doses need to be changed. Examples of drugs that may be affected when a person stops smoking are:

- insulin
- airway opening drugs (**bronchodilators**) such as aminophylline (Somophyllin), oxtriphylline (Choledyl) or theophylline (Somophyllin-T)
- opioid (narcotic) pain relievers such as propoxyphene (Darvon)
- the beta blocker propranolol (Inderal)

Other drugs may also interact with smoking cessation drugs. Be sure to check with a physician or pharmacist before combining smoking cessation drugs with any other prescription or nonprescription (over-the-counter) medicine.

Bupropion should not be used by patients who are also taking monoamine oxidase inhibitor (MAOI) medications. These include such drugs as furazolidone, isocarboxazid, and phenelzine. Bupropion may also interact with phenytoin, carbamazepine, and levodopa. Buspirone also interacts with MAOIs, as well as with trazadone and haloperidol.

Resources

BOOKS

American Cancer Society. *Quitting Smoking*. New York: American Cancer Society, 2000. <http://www.cancer.org/tobacco/quitting>.

"Smoking Cessation." *The Merck Manual of Diagnosis and Therapy*, ed. Mark H. Beers, MD, and Robert Berkow, MD. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

United States Public Health Service. *You Can Quit Smoking*. Consumer Guide, June 2000. Government Publications Clearinghouse, P.O. Box 8547, Silver Spring, MD 20907. <http:www.surgeongeneral.gov/ tobacco/consquits.htm>.

PERIODICALS

Okuyemi, K. S., et al. "Pharmacotherapy of Smoking Cessation." *Archives of Family Medicine* 9 (March 2000): 270-281.

ORGANIZATIONS

American Association for Respiratory Care. 11030 Ables Lane, Dallas, TX 75229. <http://www.aarc.org>.

American Cancer Society (ACS). 1599 Clifton Road, NE, Atlanta, GA 30329. (404) 320-3333 or (800) ACS-2345. Fax: (404) 329-7530. <http://www.cancer.org>.

American Lung Association. 1740 Broadway, 14th Floor, New York, NY 10019. (212) 315-8700 or (800) 586-4872.

Office on Smoking and Health. Centers for Disease Control and Prevention. Mailstop K-50, 4770 Buford Highway NE, Atlanta, GA 30341-3724. (800) 232-1311. <http://www.cdc.gov/tobacco/>.

OTHER

de Guia, Nicole. *Rethinking Stop-Smoking Medications: Myths and Facts*. Position paper prepared for the Ontario Medical Association (OMA). OMA Health Policy Department, Ontario, Canada, June 1999.

Questions and Answers About Finding Smoking Cessation Services. Fact Sheet, National Cancer Institute. <http://www.nci.nih.gov>.

Smoking Cessation Guidelines. Agency for Health Care Policy and Research Publications Clearinghouse. PO Box 8547, Silver Spring, MD 20907.

Rebecca J. Frey, PhD

KEY TERMS

Acupuncture—A Chinese medical practice that treats illness or addictions by the insertion of very thin steel needles at specified points along the body's energy channels.

Bupropion—An antidepressant medication given to smokers for nicotine withdrawal symptoms. It is sold under the trade name Zyban.

Buspirone—An antianxiety medication that is also given for withdrawal symptoms. It is sold under the trade name BuSpar.

Nicotine—A colorless, oily chemical found in tobacco that makes people physically dependent on smoking. It is poisonous in large doses.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug on which he or she has become dependent.

Snoring

Definition

Snoring is a sound generated during sleep when the roof of the mouth vibrates.

Description

Snoring is one symptom of a group of disorders known as sleep disordered breathing. It occurs when the soft palate, uvula, tongue, tonsils, and/or muscles in the back of the throat rub against each other and generate a vibrating sound during sleep. Twenty percent of all adults are chronic snorers, and 45% of normal adults snore occasionally. As people grow older, their chance of snoring increases. Approximately half of all individuals over 60 snore regularly.

In some cases, snoring is a symptom of a more serious disorder called obstructed **sleep apnea** (OSA). OSA occurs when part of the airway is closed off (usually at the back of the throat) while a person is trying to inhale during sleep, and breathing stops for more than 10 seconds before resuming again. These breathless episodes can occur as many as several hundred times a night.

People with OSA almost always snore heavily, because the same narrowing of the airway that causes snoring can also cause OSA. Snoring may actually attribute to OSA as well, because the vibration of the throat tissues which occurs in snoring can cause the tissue to swell.

Causes and symptoms

There are several major causes of snoring, including:

- Excessively relaxed throat muscles. Alcohol, drugs, and sedatives can cause the throat muscles to become lax, and/or the tongue to pull back into the airway.
- Large uvula. The piece of tissue that hangs from the back of the throat is called the uvula. Individuals with a large or longer than average uvula can suffer from snoring when the uvula vibrates in the airway.
- Large tonsils and/or adenoids. The tonsils (tissue at the back of either side of the throat) can also vibrate if they are larger than normal, as can the adenoids.
- Excessive weight. Overweight people are more likely to snore. This is frequently caused by the extra throat and neck tissue they are carrying around.
- Nasal congestion. Colds and **allergies** can plug the nose, creating a vacuum in the throat that results in snoring as airflow increases.
- Cysts and tumors. Cysts and/or tumors of the throat can trigger snoring.
- Structural problems of the nose. A **deviated septum** or other nasal problems can also cause snoring.

Diagnosis

A patient interview, and possibly an interview with the patient's spouse or anyone else in the household who has witnessed the snoring, is usually enough for a diagnosis of snoring. A medical history which includes questions about alcohol or tranquilizer use; past ear, nose, and throat problems; and the pattern and degree of snoring will be completed, and a physical exam will be performed to determine the cause of the problem. This will typically include examination of the throat to look for narrowing, obstruction, or malformations. If the snoring is suspected to be a symptom of a more serious disorder such as obstructive sleep apnea, the patient will require further testing. This testing is called a **polysomnography** study, and is conducted during an overnight stay in a specialized sleep laboratory. The polysomnography study include measurements of heart rate, airflow at the mouth and nose, respiratory effort, sleep stage (light sleep, deep sleep, dream sleep, etc.), and oxygen level in the blood.

Treatment

Several surgical procedures are available for treating chronic snoring. These include:

- Uvulopalathopharyngoplasty (UPPP), a surgical procedure which involves removing excess throat tissues (e.g., tonsils, parts of the soft palate) to expand the airway.
- Laser-assisted uvulopalatoplasty (LAUP) uses a surgical laser to remove part of the uvula and palate.
- Palatal stiffening is a minimally-invasive surgical technique where a laser or a cauterizer is used to produce scar tissue in the soft palate in order to stop the vibrations that produce snoring.
- Radiofrequency ablation is another technique which uses scarring to shrink the uvula and/or soft palate. A needle electrode is used to shrink and scar the mouth and throat tissues.

Alternative treatment

There are a number of remedies for snoring, but few are proven clinically effective. Popular treatments include:

- Mechanical devices. Many splints, braces, and other devices are available which reposition the nose, jaw, and/or mouth in order to clear the airways. Other devices are designed to wake an individual when snoring occurs.
- Nasal strips. Nasal strips that attach like an adhesive bandage to the bridge of the nose are available at most drugstores, and can help stop snoring in some individuals by opening the nasal passages.
- Continuous positive airway pressure (CPAP). Some chronic snorers find relief by sleeping with a nasal mask which provides air pressure to the throat.

KEY TERMS

Cauterize—To seal tissue or blood vessels using a heat or electrical source.

Deviated septum—A hole or perforation in the septum, the wall that divides the two nasal cavities.

Soft palate—The structure at the roof of the mouth that separates the mouth and the pharynx.

- **Decongestants**. Snoring caused by nasal congestion may be successfully treated with decongestants. Some effective herbal remedies that clear the nasal passages include golden rod (*Solidago virgauria*) and golden seal (*Hydrastis canadensis*). Steam inhalation of essential oils of eucalyptus blue gum (*Eucalyptus globulus*) or peppermint (*Mentha x piperata*) can also relieve congestion.
- Weight loss. Snoring thought to be caused by excessive weight may be curtailed by a sensible weight loss and **exercise** program.
- Sleep position. Snoring usually worsens when an individual sleeps on his or her back, so side sleeping may alleviate the problem. Those who have difficulty staying in a side sleeping position may find sleeping with pillows behind them helps them maintain the position longer.
- Bed adjustments. For some people, raising the head of the bed solves their snoring problem. A slight incline can prevent the tongue from retracting into the back of the throat. Bricks, wooden blocks, or specially designed wedges can be used to elevate the head of the bed approximately 4–l6 in (10–41 cm).

Prevention

Adults with a history of snoring may be able to prevent snoring episodes with the following measures:

- avoid alcohol and sedatives before bedtime.
- remove allergens from the bedroom.
- use a decongestant before bed.
- sleep on the side, not the back.

Resources

BOOKS

Pascualy, Ralph A., and Sally Warren Soest. *Snoring and Sleep Apnea: Personal and Family Guide to Diagnosis and Treatment*. New York: Demos Medical Publishing, 1996.

ORGANIZATIONS

American Sleep Apnea Association. *Wake-Up Call: The Wellness Letter for Snoring and Apnea*. 1424 K Street NW, Suite 302, Washington, DC 20005. (202) 293-3650. <http://www.sleepapnea.org>.

National Sleep Foundation. 1522 K Street, NW, Suite 500, Washington, DC 20005. <http://www.sleepfoundation.org>.

Paula Ford-Martin

Sodium imbalance *see* **Hypernatremia; Hyponatremia**

Somatization disorder *see* **Somatoform disorders**

Somatoform disorders

Definition

The somatoform disorders are a group of mental disturbances placed in a common category on the basis of their external symptoms. These disorders are characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of substance abuse, or by another mental disorder. In order to meet the criteria for a somatoform disorder, the physical symptoms must be serious enough to interfere with the patient's employment or relationships, and must be symptoms that are not under the patient's voluntary control.

It is helpful to understand that the present classification of these disorders reflects recent historical changes in the practice of medicine and psychiatry. When psychiatry first became a separate branch of medicine at the end of the nineteenth century, the term *hysteria* was commonly used to describe mental disorders characterized by altered states of consciousness (for example, sleepwalking or trance states) or physical symptoms (for example, a "paralyzed" arm or leg with no neurologic cause) that could not be fully explained by a medical disease. The term *dissociation* was used for the psychological mechanism that allows the mind to split off uncomfortable feelings, memories, or ideas so that they are lost to conscious recall. Sigmund Freud and other pioneering psychoanalysts thought that the hysterical patient's symptoms resulted from dissociated thoughts or memories reemerging through bodily functions or trance states. Prior to the categorization in 1980, all mental disorders that were considered to be forms of **hysteria** were grouped togeth-

er on the basis of this theory about their cause. Since 1980, however, the somatoform disorders and the so-called **dissociative disorders** have been placed in separate categories on the basis of their chief symptoms. In general, the somatoform disorders are characterized by disturbances in the patient's physical sensations or ability to move the limbs or walk, while the dissociative disorders are marked by disturbances in the patient's sense of identity or memory.

Description

As a group, the somatoform disorders are difficult to recognize and treat because patients often have long histories of medical or surgical treatment with several different doctors. In addition, the physical symptoms are not under the patient's conscious control, so that he or she is not intentionally trying to confuse the doctor or complicate the process of diagnosis. Somatoform disorders are, however, a significant problem for the health care system because patients with these disturbances overuse medical services and resources.

Somatization disorder (Briquet's syndrome)

Somatization disorder was formerly called Briquet's syndrome, after the French physician who first recognized it. The distinguishing characteristic of this disorder is a group or pattern of symptoms in several different organ systems of the patient's body that cannot be accounted for by medical illness. The criteria for this disorder require four symptoms of **pain**, two symptoms in the digestive tract, one symptom involving the sexual organs, and one symptom related to the nervous system. Somatization disorder usually begins before the age of 30. It is estimated that 0.2% of the United States population will develop this disorder in the course of their lives. Another researcher estimates that 1% of all women in the United States have symptoms of this disorder. The female-to-male ratio is estimated to range between 5:1 and 20:1.

Somatization disorder is considered to be a chronic disturbance that tends to persist throughout the patient's life. It is also likely to run in families. Some psychiatrists think that the high female-to-male ratio in this disorder reflects the cultural pressures on women in North American society and the social "permission" given to women to be physically weak or sickly.

Conversion disorder

Conversion disorder is a condition in which the patient's senses or ability to walk or move are impaired without a recognized medical or neurological disease or cause and in which psychological factors (such as **stress** or trauma) are judged to be temporarily related to onset or exacerbation. The disorder gets its name from the notion that the patient is converting a psychological conflict or problem into an inability to move specific parts of the body or to use the senses normally. An example of a conversion reaction would be a patient who loses his or her voice in a situation in which he or she is afraid to speak. The symptom simultaneously contains the **anxiety** and serves to get the patient out of the threatening situation. The resolution of the emotion that underlies the physical symptom is called the patient's *primary gain*, and the change in the patient's social, occupational, or family situation that results from the symptom is called a *secondary gain*. Doctors sometimes use these terms when they discuss the aftereffects of conversion disorder or of other somatoform disorders on the patient's emotional adjustment and lifestyle.

The specific physical symptoms of conversion disorder may include a loss of balance or **paralysis** of an arm or leg; the inability to swallow or speak; the loss of touch or pain sensation; going blind or deaf; seeing double; or having **hallucinations**, seizures, or convulsions.

Unlike somatization disorder, conversion disorder may begin at any age, and it does not appear to run in families. It is estimated that as many as 34% of the population experiences conversion symptoms over a lifetime, but that the disorder is more likely to occur among less educated or sophisticated people. Conversion disorder is not usually a chronic disturbance; 90% of patients recover within a month, and most do not have recurrences. The female-to-male ratio is between 2:1 and 5:1. Male patients are likely to develop conversion disorders in occupational settings or military service.

Pain disorder

Pain disorder is marked by the presence of severe pain as the focus of the patient's concern. This category of somatoform disorder covers a range of patients with a variety of ailments, including chronic headaches, back problems, arthritis, muscle aches and cramps, or pelvic pain. In some cases the patient's pain appears to be largely due to psychological factors, but in other cases the pain is derived from a medical condition as well as the patient's psychology.

Pain disorder is relatively common in the general population, partly because of the frequency of work-related injuries in the United States. This disorder appears to be more common in older adults, and the sex ratio is nearly equal, with a female-to-male ratio of 2:1.

Hypochondriasis

Hypochondriasis is a somatoform disorder marked by excessive fear of or preoccupation with having a seri-

ous illness that persists in spite of medical testing and reassurance. It was formerly called hypochondriacal neurosis.

Although hypochondriasis is usually considered a disorder of young adults, it is now increasingly recognized in children and adolescents. It may also develop in elderly people without previous histories of health-related fears. The disorder accounts for about 5% of psychiatric patients, and is equally common in men and women. Hypochondriasis may persist over a number of years but usually occurs as a series of episodes rather than continuous treatment-seeking. The flare-ups of the disorder are often correlated with stressful events in the patient's life.

Body dysmorphic disorder

Body dysmorphic disorder is a new category of somatoform disorders. It is defined as a preoccupation with an imagined or exaggerated defect in appearance. Most cases involve features on the patient's face or head, but other body parts—especially those associated with sexual attractiveness, such as the breasts or genitals—may also be the focus of concern.

Body dysmorphic disorder is regarded as a chronic condition that usually begins in the patient's late teens and fluctuates over the course of time. It was initially considered to be a relatively unusual disorder, but may be more common than was formerly thought. It appears to affect men and women with equal frequency. Patients with body dysmorphic disorder frequently have histories of seeking or obtaining plastic surgery or other procedures to repair or treat the supposed defect. Some may even meet the criteria for a delusional disorder of the somatic type.

Somatoform disorders in children and adolescents

The most common somatoform disorders in children and adolescents are conversion disorders, although body dysmorphic disorders are being reported more frequently. Conversion reactions in this age group usually reflect stress in the family or problems with school rather than long-term psychiatric disturbances. Some psychiatrists speculate that adolescents with conversion disorders frequently have overprotective or overinvolved parents with a subconscious need to see their child as sick; in many cases the son or daughter's symptoms become the center of family attention. The rise in body dysmorphic disorders in adolescents is thought to reflect the increased influence of media preoccupation with physical perfection.

Causes and symptoms

Because the somatoform disorders are categorized on the basis of symptom patterns, their causes as presently understood include several different factors.

Family stress

Family stress is believed to be one of the most common causes of somatoform disorders in children and adolescents. Conversion disorders in this age group may also be connected with physical or sexual abuse within the family of origin.

Parental modeling

Somatization disorder and hypochondriasis may result in part from the patient's unconscious reflection or imitation of parental behaviors. This "copycat" behavior is particularly likely if the patient's parent derived considerable secondary gain from his or her symptoms.

Cultural influences

Cultural influences appear to affect the gender ratios and body locations of somatoform disorders, as well as their frequency in a specific population. Some cultures (for example, Greek and Puerto Rican) report higher rates of somatization disorder among men than is the case for the United States. In addition, researchers found lower levels of somatization disorder among people with higher levels of education. People in Asia and Africa are more likely to report certain types of physical sensations (for example, burning hands or feet, or the feeling of ants crawling under the skin) than are Westerners.

Biological factors

Genetic or biological factors may also play a role. For example, people who suffer from somatization disorder may also differ in how they perceive and process pain.

Diagnosis

Accurate diagnosis of somatoform disorders is important to prevent unnecessary surgery, laboratory tests, or other treatments or procedures. Because somatoform disorders are associated with physical symptoms, patients are often diagnosed by primary care physicians as well as by psychiatrists. In many cases the diagnosis is made in a general medical clinic. Children and adolescents with somatoform disorders are most likely to be diagnosed by pediatricians. Diagnosis of somatoform disorders requires a thorough physical workup to exclude medical and neurological conditions, or to assess their severity in patients with pain disorder. A detailed examination is especially necessary when conversion disorder is a possible diagnosis, because some neurological conditions—including **multiple sclerosis** and myasthenia gravis—have on occasion been misdiagnosed as conversion disorder. Some patients who receive a diagnosis of somatoform disorder ultimately go on to develop neurologic disorders.

KEY TERMS

Briquet's syndrome—Another name for somatization disorder.

Conversion disorder—A somatoform disorder characterized by the transformation of a psychological feeling or impulse into a physical symptom. Conversion disorder was previously called hysterical neurosis, conversion type.

Dissociation—A psychological mechanism in which the mind splits off certain aspects of a traumatic event from conscious awareness. Dissociation can affect the patient's memory, sense of reality, and sense of identity.

Hysteria—The earliest term for a psychoneurotic disturbance marked by emotional outbursts and/or disturbances of movement and sense perception. Some forms of hysteria are now classified as somatoform disorders and others are grouped with the dissociative disorders.

Hysterical neurosis—An older term for conversion disorder or dissociative disorder.

Primary gain—The immediate relief from guilt, anxiety, or other unpleasant feelings that a patient derives from a symptom.

Repression—A unconscious psychological mechanism in which painful or unacceptable ideas, memories, or feelings are removed from conscious awareness or recall.

Secondary gain—The social, occupational, or interpersonal advantages that a patient derives from symptoms. A patient's being relieved of his or her share of household chores by other family members would be an example of secondary gain.

Somatoform disorder—A category of psychiatric disorder characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of substance abuse, or by another mental disorder.

In addition to ruling out medical causes for the patient's symptoms, a doctor who is evaluating a patient for a somatization disorder will consider the possibility of other psychiatric diagnoses or of overlapping psychiatric disorders. Somatoform disorders often coexist with **personality disorders** because of the chicken-and-egg relationship between physical illness and certain types of character structure or personality traits. At one time, the influence of Freud's theory of hysteria led doctors to assume that the patient's hidden emotional needs "cause" the illness. But in many instances, the patient's personality may have changed over time due to the stresses of adjusting to a chronic disease. This gradual transformation is particularly likely in patients with pain disorder. Patients with somatization disorder often develop panic attacks or **agoraphobia** together with their physical symptoms. In addition to anxiety or personality disorders, the doctor will usually consider major depression as a possible diagnosis when evaluating a patient with symptoms of a somatoform disorder. Pain disorders may be associated with depression, and body dismorphic disorder may be associated with obsessive-compulsive disease.

Treatment

Relationship with primary care practitioner

Because patients with somatoform disorders often have lengthy medical histories, a long-term relationship with a trusted primary care practitioner (PCP) is a safeguard against unnecessary treatments as well as a comfort to the patient. Many PCPs prefer to schedule brief appointments on a regular basis with the patient and keep referrals to specialists to a minimum. This practice also allows them to monitor the patient for any new physical symptoms or diseases. However, some PCPs work with a psychiatric consultant.

Medications

Patients with somatoform disorders are sometimes given **antianxiety drugs** or **antidepressant drugs** if they have been diagnosed with a coexisting mood or anxiety disorder. In general, however, it is considered better practice to avoid prescribing medications for these patients since they are likely to become psychologically dependent on them. However, body dysmorphic disorder as been successfully treated with **selective serotonin reuptake inhibitors** (SSRI) antidepressants.

Psychotherapy

Patients with somatoform disorders are not considered good candidates for **psychoanalysis** and other forms of insight-oriented psychotherapy. They can benefit, however, from supportive approaches to treatment that are aimed at symptom reduction and stabilization of the patient's personality. Some patients with pain disor-

der benefit from **group therapy** or support groups, particularly if their social network has been limited by their pain symptoms. **Cognitive-behavioral therapy** is also used sometimes to treat pain disorder.

Family therapy is usually recommended for children or adolescents with somatoform disorders, particularly if the parents seem to be using the child as a focus to divert attention from other difficulties. Working with families of chronic pain patients also helps avoid reinforcing dependency within the family setting.

Hypnosis is a technique that is sometimes used as part of a general psychotherapeutic approach to conversion disorder because it may allow patients to recover memories or thoughts connected with the onset of the physical symptoms.

Alternative treatment

Patients with somatization disorder or pain disorder may be helped by a variety of alternative therapies including **acupuncture**, **hydrotherapy**, therapeutic massage, **meditation**, botanical medicine, and homeopathic treatment. Relief of symptoms, including pain, can occur on the physical level, as well as on the mental, emotional, and spiritual levels.

Prognosis

The prognosis for somatoform disorders depends, as a rule, on the patient's age and whether the disorder is chronic or episodic. In general, somatization disorder and body dysmorphic disorder rarely resolve completely. Hypochondriasis and pain disorder may resolve if there are significant improvements in the patient's overall health and life circumstances, and people with both disorders may go through periods when symptoms become less severe (remissions) or become worse (exacerbations). Conversion disorder tends to be rapidly resolved, but may recur in about 25% of all cases.

Prevention

Generalizations regarding prevention of somatoform disorders are difficult because these syndromes affect different age groups, vary in their symptom patterns and persistence, and result from different problems of adjustment to the surrounding culture. In theory, allowing expression of emotional pain in children, rather than regarding it as "weak," might reduce the secondary gain of physical symptoms that draw the care or attention of parents.

Resources

BOOKS

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics and Psychiatric Disorders." In *Current Pediatric Diagnosis and Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Kaplan, David W., and Kathleen A. Mammel. "Adolescence." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Kolb, Lawrence C., and H. Keith Brodie. *Modern Clinical Psychiatry.* Philadelphia: W. B. Saunders Co., 1982.

Nemiah, John C. "Psychoneurotic Disorders." In *The New Harvard Guide to Psychiatry*, ed. Armand M. Nicholi Jr. Cambridge, MA: The Belknap Press of Harvard University Press, 1988.

"Psychiatric Disorders: The Neuroses." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Somatoform Disorders." In *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: The American Psychiatric Association, 1994.

Stone, Timothy E., and Romaine Hain. "Somatoform Disorders." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

Rebecca J. Frey

Somatotrophic hormone test *see* **Growth hormone tests**

Sore throat

Definition

Sore throat, also called pharyngitis, is a painful inflammation of the mucous membranes lining the pharynx. It is a symptom of many conditions, but most often is associated with colds or **influenza**. Sore throat may be caused by either viral or bacterial infections or environmental conditions. Most sore throats heal without complications, but they should not be ignored because some develop into serious illnesses.

Description

Almost everyone gets a sore throat at one time or another, although children in child care or grade school have them more often than adolescents and adults. Sore throats are most common during the winter months when upper respiratory infections (colds) are more frequent.

Sore throats can be either acute or chronic. Acute sore throats are the more common. They appear suddenly and last from three to about seven days. A chronic sore throat lasts much longer and is a symptom of an

unresolved underlying condition or disease, such as a sinus infection.

Causes and symptoms

Sore throats have many different causes, and may or may not be accompanied by cold symptoms, **fever**, or swollen lymph glands. Proper treatment depends on understanding the cause of the sore throat.

Viral sore throat

Viruses cause 90–95% of all sore throats. Cold and flu viruses are the main culprits. These viruses cause an inflammation in the throat and occasionally the tonsils (**tonsillitis**). Cold symptoms almost always accompany a viral sore throat. These can include a runny nose, **cough**, congestion, hoarseness, **conjunctivitis**, and fever. The level of throat **pain** varies from uncomfortable to excruciating, when it is painful for the patient to eat, breathe, swallow, or speak.

Another group of viruses that cause sore throat are the adenoviruses. These may also cause infections of the lungs and ears. In addition to a sore throat, symptoms that accompany an adenovirus infection include cough, runny nose, white bumps on the tonsils and throat, mild **diarrhea**, vomiting, and a rash. The sore throat lasts about one week.

A third type of virus that can cause severe sore throat is the coxsackie virus. It can cause a disease called herpangina. Although anyone can get herpangina, it is most common in children up to age ten and is more prevalent in the summer or early autumn. Herpangina is sometimes called summer sore throat.

Three to six days after being exposed to the virus, an infected person develops a sudden sore throat that is accompanied by a substantial fever usually between 102–104°F (38.9–40°C). Tiny grayish-white blisters form on the throat and in the mouth. These fester and become small ulcers. Throat pain is often severe, interfering with swallowing. Children may become dehydrated if they are reluctant to eat or drink because of the pain. In addition, people with herpangina may vomit, have abdominal pain, and generally feel ill and miserable.

One other common cause of a viral sore throat is mononucleosis. Mononucleosis occurs when the Epstein-Barr virus infects one specific type of lymphocyte. The infection spreads to the lymphatic system, respiratory system, liver, spleen, and throat. Symptoms appear 30–50 days after exposure.

Mononucleosis, sometimes called the kissing disease, is extremely common. It is estimated that by the age of 35–40, 80–95% of Americans will have had mononucleosis. Often, symptoms are mild, especially in young children, and are diagnosed as a cold. Since symptoms are more severe in adolescents and adults, more cases are diagnosed as monomucleosis in this age group. One of the main symptoms of mononucleosis is a severe sore throat.

Although a runny nose and cough are much more likely to accompany a sore throat caused by a virus than one caused by a bacteria, there is no absolute way to tell what is causing the sore throat without a laboratory test. Viral sore throats are contagious and are passed directly from person to person by coughing and sneezing.

Bacterial sore throat

From 5–10% of sore throats are caused by bacteria. The most common bacterial sore throat results from an infection by group A *Streptococcus*. This type of infection is commonly called **strep throat**. Anyone can get strep throat, but it is most common in school age children.

Pharyngeal **gonorrhea**, a sexually transmitted bacterial disease, causes a severe sore throat. Gonorrhea in the throat is transmitted by having oral sex with an infected person.

Noninfectious sore throat

Not all sore throats are caused by infection. Postnasal drip can irritate the throat and make it sore. It can be caused by hay fever and other **allergies** that irritate the sinuses. Environmental and other conditions, such as heavy **smoking** or breathing secondhand smoke, heavy alcohol consumption, breathing polluted air or chemical fumes, or swallowing substances that burn or scratch the throat can also cause pharyngitis. Dry air, like that in airplanes or from forced hot air furnaces, can make the throat sore. People who breathe through their mouths at night because of nasal congestion often get sore throats that improve as the day progresses. Sore throat caused by environmental conditions is not contagious.

Diagnosis

It is easy for people to tell if they have a sore throat, but difficult to know what has caused it without laboratory tests. Most sore throats are minor and heal without any complications. A small number of bacterial sore throats do develop into serious diseases. Because of this, it is advisable to see a doctor if a sore throat lasts more than a few days or is accompanied by fever, nausea, or abdominal pain.

Diagnosis of a sore throat by a doctor begins with a **physical examination** of the throat and chest. The doctor will also look for signs of other illness, such as a sinus

infection or **bronchitis**. Since both bacterial and viral sore throat are contagious and pass easily from person to person, the doctor will seek information about whether the patient has been around other people with flu, sore throat, colds, or strep throat. If it appears that the patient may have strep throat, the doctor will do laboratory tests.

If mononucleosis is suspected, the doctor may do a mono spot test to look for antibodies indicating the presence of the Epstein-Barr virus. The test in inexpensive, takes only a few minutes, and can be done in a physician's office. An inexpensive blood test can also determine the presence of antibodies to the mononucleosis virus.

Treatment

Effective treatment varies depending on the cause of the sore throat. As frustrating as it may be to the patient, viral sore throat is best left to run its course without drug treatment. **Antibiotics** have no effect on a viral sore throat. They do not shorten the length of the illness, nor do they lessen the symptoms.

Sore throat caused by a streptococci or another bacteria must be treated with antibiotics. Penicillin is the preferred medication. Oral penicillin must be taken for 10 days. Patients need to take the entire amount of antibiotic prescribed, even after symptoms of the sore throat improve. Stopping the antibiotic early can lead to a return of the sore throat. Occasionally a single injection of long-acting penicillin G is given instead of 10 days of oral treatment. These medications generally cost under $15.

Because mononucleosis is caused by a virus, there is no specific drug treatment available. Rest, a healthy diet, plenty of fluids, limiting heavy **exercise** and competitive sports, and treatment of aches with **acetaminophen** (Datril, Tylenol, Panadol) or ibuprofen (Advil, Nuprin, Motrin, Medipren) will help the illness pass. Nearly 90% of mononucleosis infections are mild. The infected person does not normally get the disease again.

In the case of chronic sore throat, it is necessary to treat the underlying disease to heal the sore throat. If a sore throat caused by environmental factors, the aggravating stimulus should be eliminated from the sufferer's environment.

Home care for sore throat

Regardless of the cause of a sore throat, there are some home care steps that people can take to ease their discomfort. These include:

- taking acetaminophen or ibuprofen for pain; **aspirin** should not be given to children because of its association with increased risk for **Reye's Syndrome**, a serious disease

This young woman is having her sore throat examined by a medical practitioner using a fiber-optic tongue depressor. *(Custom Medical Stock Photo. Reproduced by permission.)*

- gargling with warm double strength tea or warm salt water made by adding 1 tsp of salt to 8 oz (237 ml) of water.
- drinking plenty of fluids, but avoiding acid juices like orange juice, which can irritate the throat (sucking on popsicles is a good way to get fluids into children.)
- eating soft, nutritious foods like noodle soup and avoiding spicy foods
- refraining from smoking
- resting until the fever is gone, then resuming strenuous activities gradually
- a room humidifier may make sore throat sufferers more comfortable
- antiseptic lozenges and sprays may aggravate the sore throat rather than improve it

Alternative treatment

Alternative treatment focuses on easing the symptoms of sore throat using herbs and botanical medicines.

- Aromatherapists recommend inhaling the fragrances of essential oils of lavender (Lavandula officinalis), thyme (*Thymus vulgaris*), eucalyptus (*Eycalyptus globulus*), sage (*Salvia officinalis*), and sandalwood.
- Ayurvedic practitioners suggest gargling with a mixture of water, salt, and tumeric (*Curcuma longa*) powder or

KEY TERMS

Antigen—A foreign protein to which the body reacts by making antibodies

Conjunctivitis—An inflammation of the membrane surrounding the eye; also known as pinkeye.

Lymphocyte—A type of white blood cell. Lymphocytes play an important role in fighting disease.

Pharynx—The pharynx is the part of the throat that lies between the mouth and the larynx or voice box.

Toxin—A poison. In the case of scarlet fever, the toxin is secreted as a byproduct of the growth of the streptococcus bacteria and causes a rash.

astringents such as alum, sumac, sage, and bayberry (*Myrica* spp.).

- Herbalists recommend taking osha root (*Ligusticum porteri*) internally for infection or drinking ginger (*Zingiber officinale*) or slippery elm (*Ulmus fulva*) tea for pain.
- Homeopaths may treat sore throats with superdilute solutions *Lachesis*, *Belladonna*, *Phytolacca*), yellow jasmine (*Gelsemium*), or mercury.
- Nutritional recommendations include zinc lozenges every two hours along with vitamin C with bioflavonoids, vitamin A, and beta-carotene supplements.

Prognosis

Sore throat caused by a viral infection generally clears up on its own within one week with no complications. The exception is mononucleosis. Ninety percent of cases of mononucleosis clear up without medical intervention or complications, so long as **dehydration** does not occur. In young children the symptoms may last only a week, but in adolescents the symptoms last longer. Adults over age 30 have the most severe and long lasting symptoms. Adults may take up to six months to recover. In all age groups **fatigue** and weakness may continue for up to six weeks after other symptoms disappear.

In rare cases of mononucleosis, breathing may be obstructed because of swollen tonsils, adenoids, and lymph glands. If this happens, the patient should immediately seek emergency medical care.

Patients with bacterial sore throat begin feeling better about 24 hours after starting antibiotics. Untreated strep throat has the potential to cause **scarlet fever**, kidney damage, or **rheumatic fever**. Scarlet fever causes a rash, and can cause high fever and convulsions. Rheumatic fever causes inflammation of the heart and damage to the heart valves. Taking antibiotics within the first week of a strep infection will prevent these complications. People with strep throat remain contagious until after they have been taking antibiotics for 24 hours.

Prevention

There is no way to prevent a sore throat; however, the risk of getting one or passing one on to another person can be minimized by:

- washing hands well and frequently
- avoiding close contact with someone who has a sore throat
- not sharing food and eating utensils with anyone
- not smoking
- staying out of polluted air

Resources

BOOKS

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Tish Davidson

Sotalol *see* **Antiarrhythmic drugs**

Sound therapy *see* **Music therapy**

South American blastomycosis

Definition

South American **blastomycosis** is a potentially fatal, chronic fungus infection that occurs more often in men. The infection may affect different parts of the body, including the lungs or the skin, and may cause ulcers of the mouth, voicebox, and nose.

Description

South American blastomycosis occurs primarily in Brazil, although cases crop up in Mexico, Central America, or other parts of South America. It affects men between ages 20 and 50 about 10 times more often than women.

The disease is far more serious than its North American variant (North American blastomycosis), which is endemic to the eastern United States, southern Canada, and the midwest.

South American blastomycosis is known medically as paracoccidioidal granuloma, or paracoccidioidomycosis. The infection has a very long incubation period (at least five years).

Causes and symptoms

South American blastomycosis is caused by the yeast-like fungus *Paracoccidioides brasiliensis* that is acquired by breathing in the spores of the fungus, which is commonly found in old wood and soil. It may appear very similar to **tuberculosis**; in fact, both diseases may infect a patient at the same time.

Symptoms include ulcers in the mouth, larynx and nose, in addition to large, draining lymph nodes, **cough**, chest **pain**, swollen lymph glands, weight loss, and lesions on the skin, genitals, and intestines. There may also be lesions in the liver, spleen, intestines, and adrenal glands.

Diagnosis

A physician can diagnose the condition by microscopic examination of a smear prepared from a lesion or sputum (spit). Biopsy specimens may also reveal the infection. While blood tests are helpful, they can't determine the difference between past and active infection.

Treatment

The primary goal of treatment is to control the infection. The best treatment has been amphotericin B. Sulfonamide drugs have been used and can stop the progress of the infection, but they don't kill the fungus.

Scientists are studying new treatments for the fungal infection, including ketoconazole, fluconazole, and itraconazole, which appear to be equally effective as amphotericin B, according to research.

Prognosis

The disease is chronic and often fatal. Because blastomycosis may be recurrent, patients should continue follow-up care for several years.

Prevention

There is no way to prevent the disease.

KEY TERMS

Amphotericin B—A drug used to treat fungal infections.

Sulfonamide drugs—A group of antibacterial drugs used to treat infections of the lungs and skin, among other things.

Resources

PERIODICALS

Cadavid, D., et al. "Factors Associated with Paracoccidioides Brasiliensis Infection Among Permanent Residents of Three Endemic Areas in Colombia." *Epidemiological Infections* 111, no. 1 (Aug. 1993): 121-133.

Diaz, M., et al. "A Pan-American 5-year Study of Fluconazole Therapy for Deep Mycoses in the Immunocompetent Host." *Clinical Infectious Diseases* 14 (Mar. 1992): S68-76.

ORGANIZATIONS

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

National Institute of Allergy and Infectious Disease. Building 31, Room 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892-2520. (301) 496-5717. <http://www.niaid.nih.gov/default.htm>.

Carol A. Turkington

Space medicine *see* **Aviation medicine**

Spanish flu *see* **Influenza**

Spastic colitis *see* **Irritable bowel syndrome**

Spastic colon *see* **Irritable bowel syndrome**

Speech disorders

Definition

According to the American Speech-Language-Hearing Association (ASHA), a language disorder is an impairment in comprehension use of the spoken, written, or other symbol system.

Description

Speech disorders affect the language and mechanics, the content of speech, or the function of language in

communication. Because speech disorders affect a person's ability to communicate effectively, every aspect of the person's life can be affected, for example, the person's ability to make friends, and to communicate at school or at work.

Amyotrophic lateral sclerosis (ALS)

Amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's disease, is a neurological disease that attacks the nerve cells in the brain that control voluntary muscles. ALS causes motor neurons to die so that the brain and spinal cord are unable to send messages to the muscles telling them to move. Because the muscles are not functioning, they begin to atrophy. Muscles in the face and jaw can be affected, and thereby affecting a person's speech.

Aphasia

Aphasia results from damage to the language centers of the brain, which affects a person's ability to communicate through speaking, listening, and writing.

Persons with aphasia have trouble with expressive language, what is said, or receptive language, what is understood. Not only are speech and understanding speech affected, but also reading and writing is affected. The severity of aphasia varies from person to person, but in the most severe cases, a person may not be able to understand speech at all. Persons with mild aphasia may only become confused when speech becomes lengthy and complicated.

Developmental apraxia of speech

Developmental apraxia is a disorder that affects the nervous system and affects a person's ability to sequence and say sounds, syllables, and words. The brain does not send the correct messages to the mouth and jaw so that the person can say what he or she wants to say.

Children who are suffering from this disorder don't babble as an infant and first words are delayed. Older children may have more difficulty with longer phrases, and may appear to be searching for words to express a thought. Listeners will likely have a difficult time understanding the child.

Laryngeal cancer

Laryngeal cancer is characterized by a malignant growth in the larynx, or the voice box, which sometimes requires removal of the larynx or part of it.

Cancer anywhere in the throat affects speech, swallowing, and chewing. Depending on the size of the growth, a person may have trouble moving the mouth and lips. Therefore, speech sounds and eating will be affected and a person will have trouble communicating.

Orofacial myofunctional disorders

Orofacial myofunctional disorder (OMD) causes the tongue to move forward in an exaggerated manner while a person is speaking or swallowing. The tongue also may protrude when resting in the mouth.

Because heredity contributes to the size and shape of a person's mouth, there may be genetic reasons for the disorder. **Allergies** also affect the mouth and face muscles, which make it difficult to breathe because of nasal congestion. Because a person may sleep with the tongue protruding, lip muscles weaken. Enlarged tonsils also can block airways, creating the same breathing problems. Additionally, thumb-sucking, nail-biting, and teeth-clenching and grinding also can contribute to the disorder.

Stuttering

Stuttering is a disorder of speech fluency that frequently interrupts the flow of speech.

Because children typically stumble and confuse their words as speech develops, stuttering is not immediately evident. It is usually when children become older and continue to stumble that stuttering becomes evident.

Causes and symptoms

Amyotrophic lateral sclerosis (ALS)

Initial symptoms include weakness in any part of the body, and appendages begin to tire easily. Occasionally the disease affects only one appendage rather than both at the same time. Persons with ALS may have trouble maintaining balance and may stumble or have difficulty with tasks that require manual dexterity, such as buttoning a shirt or tying a shoe.

Eventually, the diaphragm and chest wall become so weak that a person cannot breathe on his or her own and needs the help of a ventilator. Because of the lack of muscle strength, a person with ALS will experience difficulty speaking loudly and clearly until the person is unable to speak at all using the vocal cords. The person will have difficulty pronouncing words and have difficulty completing lengthy sentences.

Along with the difficulty in speaking also comes difficulty in chewing and swallowing. Food can be broken down and pureed to make it easier to chew and swallow. However, a person eventually will have difficulty chewing and swallowing foods that are broken down or pureed. When ability to eat is affected, proper **nutrition** and body weight also are affected, and medical professionals may decide that it is best to put in a feeding tube.

Aphasia

Stroke is the most common cause of aphasia, although other injuries, such as a **brain tumor** or gunshot wound, also can cause aphasia.

Developmental apraxia of speech

Developmental apraxia is a disorder that affects the nervous system and affects a person's ability to sequence and say sounds, syllables, and words. The brain does not send the correct messages to the mouth and jaw so that the person can say what he or she wants to say.

Children who are suffering from this disorder don't babble as an infant and first words are delayed. Older children may have more difficulty with longer phrases, and may appear to be searching for words to express a thought. Listeners will likely have a difficult time understanding the child.

There is no known cause for developmental apraxia of speech. Symptoms include weakness of the jaw, tongue, and lips, and delayed speech development. Persons with the disorder also may have trouble identifying an object in the mouth using the sense of touch, which is known as oral-sensory perception.

Laryngeal cancer

Any kind of **smoking** of cigarettes, cigars, or tobacco and alcohol abuse contribute to oral cancer, including smokeless tobacco. Persons with laryngeal cancer or another type of oral cancer may have a red or white patch or lump in the mouth. Symptoms also include difficulty chewing, swallowing, or chewing.

Stuttering

There is no known cause for stuttering, although poor muscle coordination and the rate of language development are believed to contribute to it.

Stuttering is characterized by repetition of sounds, syllables, portions of a word, words, and complete phrases; stretching the sounds and syllables; hesitation between words; words spoken in spurts; tense muscles in the jaw and mouth; and a feeling of loss of control.

Diagnosis

Amyotrophic lateral sclerosis (ALS)

About 20,000 people in the United States have ALS at any given time with 5,000 new cases diagnosed every year. ALS is in the same family of disorders as **multiple sclerosis**, **Parkinson's disease**, and **muscular dystrophy**. Persons of all races and ethic groups are afflicted by the disease, although men are more likely to have it than women.

Aphasia

About 700,000 persons in the United States have strokes every year, and one million are estimated to have aphasia.

Developmental apraxia of speech

A child suspected to have apraxia should first have his or her hearing tested to determine if the child has any deafness. Muscle development in the face and jaw should be evaluated and speech exercises tested. Articulation of words should be tested as well as the person's expressive and receptive language skills.

Laryngeal cancer

It is likely that a dentist or physician will first detect signs of possible cancer. Oral cancer makes up about 2–5% of all cancers, and about 30,000 cases are diagnosed each year. Twice as many men than women are diagnosed with cancer typically between the ages of 50 and 70.

Orofacial myofunctional disorders

The diagnosis of orofacial myofunctional disorder affects speech sounds because of weak tongue tip muscles, although a person's speech may not be affected at all.

Stuttering

Stuttering is a problem that most likely will manifest itself during childhood rather than adulthood.

Treatment

Amyotrophic lateral sclerosis (ALS)

In addition to treatments such as a feeding tube, a person with ALS would likely enlist the help of a speech therapist to help him or her determine ways in which he or she can maintain vocal control. A person also may enlist the help of an occupational therapist, a medical professional trained to help persons who have trouble with activities of daily living such as dressing, bathing, and eating.

Aphasia

A speech-language pathologist can perform drills and exercises with a person that include practice in naming objects and following directions to try to improve skills. The person learns the best way to express himself

of herself. **Group therapy** also is an option, which focuses on structured discussions.

Developmental apraxia of speech

Treatment should focus on the coordination of motor movements necessary during speech production, which includes controlling breathing. A speech-language pathologist teaches exercises to a person with apraxia that will strengthen the jaws, lips, and tongue to improve coordination during speech. The therapist uses tactile, auditory, and visual feedback to direct the brain to move the muscles used during speech.

Laryngeal cancer

Depending on when the cancer is first detected, and depending on the size of the cancer, the entire larynx may not need to be removed. Radiation, **chemotherapy**, or partial removal can be done in lieu of complete removal. In these cases, the voice may be preserved although the quality likely will be affected.

Orofacial myofunctional disorders

In cases where speech is affected, a speech pathologist should be consulted to help control breathing problems and work on speech articulation. The lip, palate, tongue, and facial muscles should be evaluated so that errors in speech can be detected. Therapy includes increasing awareness of the mouth and facial muscles, as well as the posture of the mouth and tongue. Muscle **exercise** can be done to increase strength and control.

Stuttering

A treatment plan by a speech therapist includes improving fluency and ease with which a person speaks. Strategies include reducing the rate of speech and using slower speech movements; articulating lightly; and starting air flow for speech before any other muscle movement.

Alternative treatment

Developmental apraxia of speech

Some persons with apraxia may decide to use alternative communication systems, such as a computer that transcribes and "speaks" what a person is directing it to say. These augmentative systems should only be used when a person is so severely impaired that effective speech or communication isn't possible.

Laryngeal cancer

In cases of a full **laryngectomy**, a hole is made in the neck and, rather than using the mouth and nose to talk and breath, the person must use the hole.

Once the larynx is removed, the person needs to develop a new speech system without a voice. A speech pathologist should follow one of three plans: esophageal speech, artificial larynx, or tracheoesophageal puncture (TEP).

- Esophageal speech. Without a larynx, a person is no longer able to exhale air from the lungs through the mouth to speak. Using esophageal speech, the person inhales and traps the air in the throat, causing the esophagus to vibrate and create sound.
- Artificial larynx. A mechanical instrument can be used that produces sound for some speech. These devices can be held against the neck or used by inserting a tube in the mouth.
- Tracheoesophageal puncture. This is a popular method in restoring speech production. During surgery, a hole is made between the trachea and esophagus and a valve is inserted into the hole. The person breathes air into the lungs and then covers the hole in the throat. During exhalation, the esophagus vibrates and creates speech.

Stuttering

A person suffering from stuttering may employ distraction strategies to help him or her stop stuttering. Typically, a person stuttering becomes frustrated and embarrassed; subsequently, encouraging the person to think of something or do something else may break the stuttering cycle.

Prognosis

Amyotrophic lateral sclerosis (ALS)

ALS patients often die of **respiratory failure** within three to five years of being diagnosed, although some persons have been known to survive as many as 10 years or longer.

Aphasia

Persons with aphasia can improve and eventually function in more typical public settings, and possibly return to school or work.

Developmental apraxia of speech

With proper treatment, apraxia can be brought under control and the person will be able to function normally as an adult.

Laryngeal cancer

Full removal of the larynx removes the risk of a cancer relapse, although other parts of the throat and mouth can be affected.

KEY TERMS

Neurons—Nerve cells in the brain, brain stem, and spinal cord that connect the nervous system and the muscles.

Orofacial myofunctional disorders

A person can learn to control this disorder with proper treatment and maintain normal speech and breathing patterns.

Stuttering

With proper speech therapy, stuttering can be controlled or eliminated.

Prevention

Laryngeal cancer

Persons should not engage in smoking or drug abuse to decrease the risk of oral cancer.

Orofacial myofunctional disorders

In cases where the cause is evident, such as allergies or enlarged tonsils, a person should first remedy that problem; perhaps have the tonsils removed and treat allergies with medication.

Resources

BOOKS

Johnson, Alex F., and Barbara H. Jacobson, eds. *Medical Speech-Language Pathology: A Practitioner's Guide*. New York: Thieme Medical Publishers, Inc., 1998.

Paul, Rhea. *Language Disorders from Infancy through Adolescence*. 2nd ed. St. Louis: Mosby, Inc., 2001.

Van Riper, Charles and Robert L. Erickson. *Speech Correction, An Introduction to Speech Pathology and Audiology*. 9th ed. Needham Heights: Allyn & Bacon, 1996.

ORGANIZATIONS

American Speech-Language-Hearing Association. 1801 Rockville Pike, Rockville, MD 20852. (800) 638-8255. <http://www.asha.org>.

Meghan Gourley

Speech disturbance *see* **Aphasia**

Speech therapy *see* **Rehabilitation**

Sperm count *see* **Semen analysis**

Spina bifida

Definition

Spina bifida is a serious birth abnormality in which the spinal cord is malformed and lacks its usual protective skeletal and soft tissue coverings.

Description

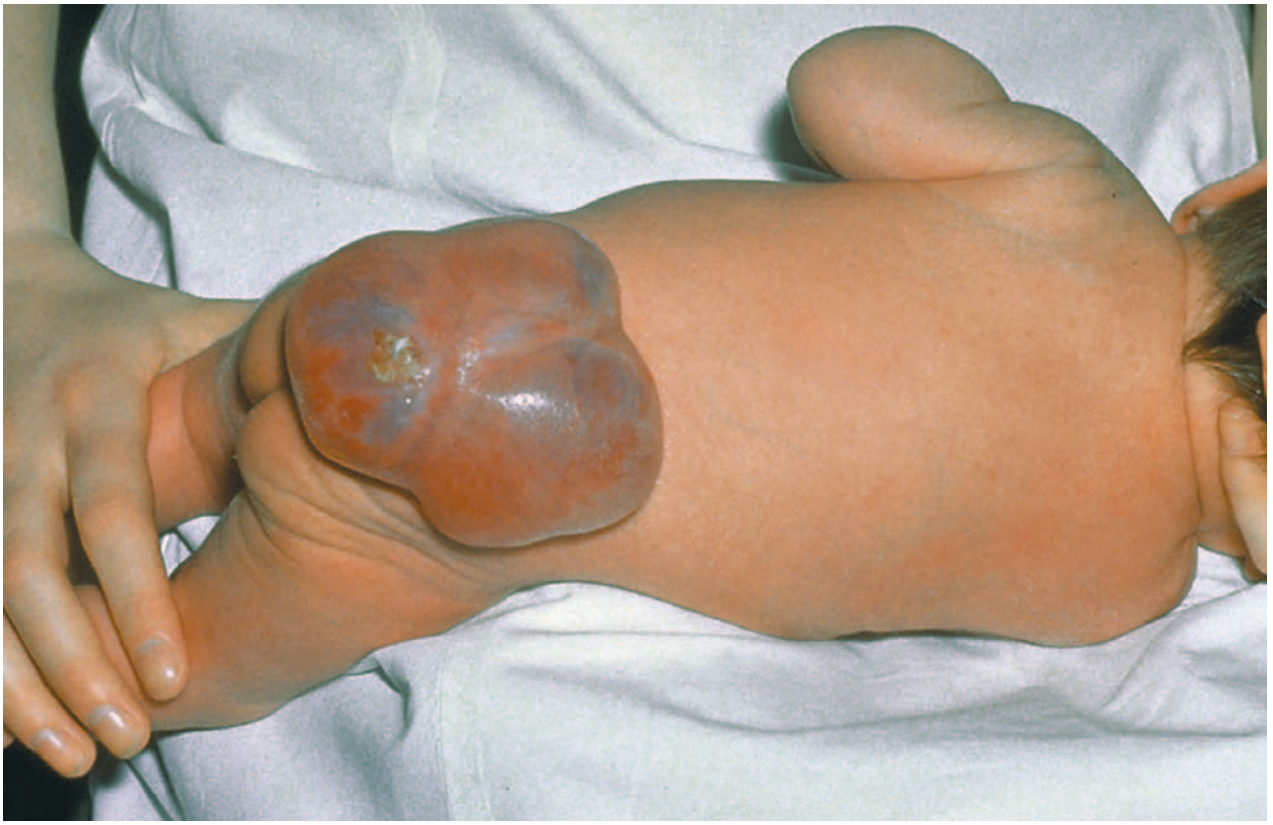
Spina bifida may appear in the body midline anywhere from the neck to the buttocks. In its most severe form, termed spinal rachischisis, the entire spinal canal is open, exposing the spinal cord and nerves. More commonly, the abnormality appears as a localized mass on the back that is covered by skin or by the meninges, the three-layered membrane that envelopes the spina cord. Spina bifida is usually readily apparent at birth because of the malformation of the back and **paralysis** below the level of the abnormality.

Various forms of spina bifida are known as meningomyelocele, myelomeningocele, spina bifida aperta, open spina bifida, myelodysplasia, spinal dysraphism, spinal rachischisis, myelocele, and meningocele. The term meningocele is used when the spine malformation contains only the protective covering (meninges) of the spinal cord. The other terms indicate involvement of the spinal cord and nerves in the malformation. A related term, spina bifida occulta, indicates that one or more of the bony bodies in the spine are incompletely hardened, but that there is no abnormality of the spinal cord itself.

Spina bifida occurs worldwide, but there has been a steady downward trend in occurrence rates over the past 50 to 70 years, particularly in regions of high prevalence. The highest prevalence rates, about one in 200 pregnancies, have been reported from certain northern provinces in China. Intermediate prevalence rates, about one in 1,000 pregnancies, have been found in Central and South America. The lowest prevalence rates, less than one in 2,000 pregnancies, have been found in the European countries. The highest regional prevalence in the United States of about one in 500 pregnancies has occurred in the Southeast.

Causes and symptoms

Spina bifida may occur as an isolated abnormality or in the company of other malformations. As an isolated abnormality, spina bifida is caused by the combination of genetic factors and environmental influences that bring about malformation of the spine and spinal column. The specific genes and environmental influ-



An infant with spina bifida. *(Photograph by Biophoto Associates, Photo Researchers, Inc. Reproduced by permission.)*

ences that contribute to the many-factored causes of spina bifida are not completely known. An insufficiency of **folic acid** is known to be one influential nutritional factor. Changes (mutations) in genes involving the metabolism of folic acid are believed to be significant genetic risk factors. The recurrence risk after the birth of an infant with isolated spina bifida is 3–5%. Recurrence may be for spina bifida or another type of spinal abnormality.

Spina bifida may arise because of chromosome abnormalities, single gene mutations, or specific environmental insults such as maternal **diabetes mellitus** or prenatal exposure to certain **anticonvulsant drugs**. The recurrence risk varies with each of these specific causes.

In most cases, spina bifida is obvious at birth because of malformation of the spine. The spine may be completely open, exposing the spinal cord and nerves. More commonly, the spine abnormality appears as a mass on the back covered by membrane (meninges) or skin. Spina bifida may occur anywhere from the base of the skull to the buttocks. About 75% of abnormalities occur in the lower back (lumbar) region. In rare instances, the spinal cord malformation may occur internally, sometimes with a connection to the gastrointestinal tract.

In spina bifida, many complications arise, dependent in part on the level and severity of the spine malformation. As a rule, the nerves below the level of the abnormality develop in a faulty manner and fail to function, resulting in paralysis and loss of sensation below the level of the spine malformation. Since most abnormalities occur in the lumbar region, the lower limbs are paralyzed and lack sensation. Furthermore, the bowel and bladder have inadequate nerve connections, causing an inability to control bowel and bladder function. Most infants also develop hydrocephaly, an accumulation of excess fluid in the four cavities of the brain. At least one of every seven cases develop findings of Chiari II malformation, a condition in which the lower part of the brain is crowded and may be forced into the upper part of the spinal cavity.

There are a number of mild variant forms of spina bifida, including multiple vertebral abnormalities, skin dimples, tufts of hair, and localized areas of skin deficiency over the spine. Two variants, lipomeningocele and lipomyelomeningocele, typically occur in the lower back area (lumbar or sacral) of the spine. In these conditions, a tumor of fatty tissue becomes isolated among the nerves

below the spinal cord, which may result in tethering of the spinal cord and complications similar to those with open spina bifida.

Diagnosis

Few disorders are to be confused with open spina bifida. The diagnosis is usually obvious based on the external findings at birth. Paralysis below the level of the abnormality and fluid on the brain (hydrocephaly) may contribute to the diagnosis. Other spine abnormalities such as congenital **scoliosis** and **kyphosis**, or soft tissue tumors overlying the spine, are not likely to have these accompanying findings. In cases in which there are no external findings, the diagnosis is more difficult and may not become evident until neurological abnormalities or hydrocephaly develop weeks, months, or years following birth.

Prenatal diagnosis may be made in most cases with ultrasound examination after 12–14 weeks of **pregnancy**. Many cases are also detected by the testing of the mother's blood for the level of alpha-fetoprotein at about 16 weeks of pregnancy. If the spine malformation is not skin covered, alpha-fetoprotein from the fetus' circulation may leak into the surrounding amniotic fluid, a small portion of which is absorbed into the mother's blood.

Treatment

Aggressive surgical and medical management have improved the survival and function of infants with spina bifida. Initial surgery may be carried out during the first days of life, providing protection against injury and infection. Subsequent surgery is often necessary to protect against excessive curvature of the spine, and in the presence of hydrocephaly, to place a mechanical shunt to decrease the pressure and amount of cerebrospinal fluid in the cavities of the brain. Because of weakness or paralysis below the level of the spine abnormality, most children will require physical therapy, bracing, and other orthopedic assistance to enable them to walk. A variety of approaches including periodic bladder catheterization, surgical diversion of urine, and **antibiotics** are used to protect urinary function.

Although most individuals with spina bifida have normal intellectual function, learning disabilities or **mental retardation** occur in a minority. This may result, in part, from hydrocephaly and/or infections of the nervous system. Children so affected may benefit from early educational intervention, physical therapy, and occupational therapy. Counseling to improve self-image and lessen barriers to socialization becomes important in late childhood and adolescence.

Open fetal surgery has been performed for spina bifida during the last half of pregnancy. After direct closure of the spine malformation, the fetus is returned to the womb. By preventing chronic intrauterine exposure to mechanical and chemical trauma, prenatal surgery improves neurological function and leads to fewer complications after birth. Fetal surgery is considered experimental, and results have been mixed.

Prevention of isolated spina bifida and other spinal abnormalities has become possible during recent decades. The major prevention is through the use of a B vitamin, folic acid, for several months prior to and following conception. The Centers for Disease Control and Prevention recommend the intake of 400 micrograms of synthetic folic acid every day for all women of childbearing years.

Prognosis

More than 80% of infants born with spina bifida survive with surgical and medical management. Although complications from paralysis, hydrocephaly, Chiari II malformation, and urinary tract deterioration threaten the well-being of the survivors, the outlook for normal intellectual function is good.

KEY TERMS

Chiari II anomaly—A structural abnormality of the lower portion of the brain (cerebellum and brain stem) associated with spina bifida. The lower structures of the brain are crowded and may be forced into the foramen magnum, the opening through which the brain and spinal cord are connected.

Fetus—The term used to describe a developing human infant from approximately the third month of pregnancy until delivery. The term embryo is used prior to the third month.

Hydrocephalus—The excess accumulation of cerebrospinal fluid around the brain, often causing enlargement of the head.

Resources

PERIODICALS

Sells, C. J., and J. G. Hall, eds. "Neural Tube Defects" *Mental Retardation and Developmental Disabilities Research Reviews* 4, No. 4. New York: Wiley-Liss, 1998.

ORGANIZATIONS

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (888) 663-4637. <resourcecenter@modimes.org>. <http://www.modimes.org>.

National Birth Defects Prevention Network. Atlanta, GA (770) 488-3550. <http://www.nbdpn.org>.
Shriners Hospitals for Children. International Shrine Headquarters, 2900 Rocky Point Dr., Tampa, FL 33607-1460. (813) 281-0300. <http://www.shrinershq.org>.
Spina Bifida Association of America. 4590 MacArthur Blvd. NW, Suite 250, Washington, DC 20007-4226. (800) 621-3141 or (202) 944-3285. Fax: (202) 944-3295.

Roger E. Stevenson

Spina bifida occulta *see* **Spina bifida**

Spinal cord injury

Definition

Spinal cord injury is damage to the spinal cord that causes loss of sensation and motor control.

Description

Approximately 10,000 new spinal cord injuries (SCIs) occur each year in the United States. About 250,000 people are currently affected. Spinal cord injuries can happen to anyone at any time of life. The typical patient, however, is a man between the ages of 19 and 26, injured in a motor vehicle accident (about 50% of all SCIs), a fall (20%), an act of violence (15%), or a sporting accident (14%). Alcohol or other drug abuse plays an important role in a large percentage of all spinal cord injuries. Six percent of people who receive injuries to the lower spine die within a year, and 40% of people who receive the more frequent higher injuries die within a year.

Short-term costs for hospitalization, equipment, and home modifications are approximately $140,000 for an SCI patient capable of independent living. Lifetime costs may exceed one million dollars. Costs may be three to four times higher for the SCI patient who needs long-term institutional care. Overall costs to the American economy in direct payments and lost productivity are more than $10 billion per year.

Causes and symptoms

Causes

The spinal cord is about as big around as the index finger. It descends from the brain down the back through hollow channels of the backbone. The spinal cord is made of nerve cells (neurons). The nerve cells carry sensory data from the areas outside the spinal cord (periphery) to the brain, and they carry motor commands from brain to periphery. Peripheral neurons are bundled together to make up the 31 pairs of peripheral nerve roots. The peripheral nerve roots enter and exit the spinal cord by passing through the spaces between the stacked vertebrae. Each pair of nerves is named for the vertebra from which it exits. These are known as:

- C1-8. These nerves enter from the eight cervical or neck vertebrae.
- T1-12. These nerves enter from the thoracic or chest vertebrae.
- L1-5. These nerves enter from the lumbar vertebrae of the lower back.
- S1-5. These nerves enter through the sacral or pelvic vertebrae.
- Coccygeal. These nerves enter through the **coccyx** or tailbone.

Peripheral nerves carry motor commands to the muscles and internal organs, and they carry sensations from these areas and from the body's surface. (Sensory data from the head, including sight, sound, smell, and taste, do not pass through the spinal cord and are not affected by most SCIs.) Damage to the spinal cord interrupts these signals. The interruption damages motor functions that allow the muscles to move, sensory functions such as feeling heat and cold, and autonomic functions such as urination, sexual function, sweating, and blood pressure.

Spinal cord injuries most often occur where the spine is most flexible, in the regions of C5-C7 of the neck, and T10-L2 at the base of the rib cage. Several physically distinct types of damage are recognized. Sudden and violent jolts to nearby tissues can jar the cord. This jarring causes a temporary spinal concussion. Concussion symptoms usually disappear completely within several hours. A spinal contusion or bruise is bleeding within the spinal column. The pressure from the excess fluid may kill spinal cord neurons. Spinal compression is caused by some object, such as a tumor, pressing on the cord. Lacerations or tears cause direct damage to cord neurons. Lacerations can be caused by bone fragments or missiles such as bullets. Spinal transection describes the complete severing of the cord. Most spinal cord injuries involve two or more of these types of damage.

Symptoms

PARALYSIS AND LOSS OF SENSATION. The extent to which movement and sensation are damaged depends on the level of the spinal cord injury. Nerves leaving the

spinal cord at different levels control sensation and movement in different parts of the body. The distribution is roughly as follows:

- C1-C4: head and neck.
- C3-C5: diaphragm (chest and breathing).
- C5-T1: shoulders, arms and hands.
- T2-T12: chest and abdomen (excluding internal organs).
- L1-L4: abdomen (excluding internal organs), buttocks, genitals, and upper legs.
- L4-S1: legs.
- S2-S4: genitals and muscles of the perineum.

Damage below T1, which lies at the base of the rib cage, causes **paralysis** and loss of sensation in the legs and trunk below the injury. Injury at this level usually does no damage to the arms and hands. Paralysis of the legs is called paraplegia. Damage above T1 involves the arms as well as the legs. Paralysis of all four limbs is called quadriplegia or tetraplegia. Cervical or neck injuries not only cause quadriplegia but also may cause difficulty in breathing. Damage in the lower part of the neck may leave enough diaphragm control to allow unassisted breathing. Patients with damage at C3 or above, just below the base of the skull, require mechanical assistance to breathe.

Symptoms also depend on the extent of spinal cord injury. A completely severed cord causes paralysis and loss of sensation below the wound. If the cord is only partially severed, some function will remain below the injury. Damage limited to the front portion of the cord causes paralysis and loss of sensations of **pain** and temperature. Other sensation may be preserved. Damage to the center of the cord may spare the legs but paralyze the arms. Damage to the right or left half causes loss of position sense, paralysis on the side of the injury, and loss of pain and temperature sensation on the opposite side.

DEEP VENOUS THROMBOSIS. Blood does not flow normally to a paralyzed limb that is inactive for long periods. The blood pools in the deep veins and forms clots, a condition known as **deep vein thrombosis**. A clot or thrombus can break free and lodge in smaller arteries in the brain, causing a **stroke**, or in the lungs, causing **pulmonary embolism**.

PRESSURE ULCERS. Inability to move also leads to pressure ulcers or bed sores. Pressure ulcers form where skin remains in contact with a bed or chair for a long time. The most common sites of pressure ulcers are the buttocks, hips, and heels.

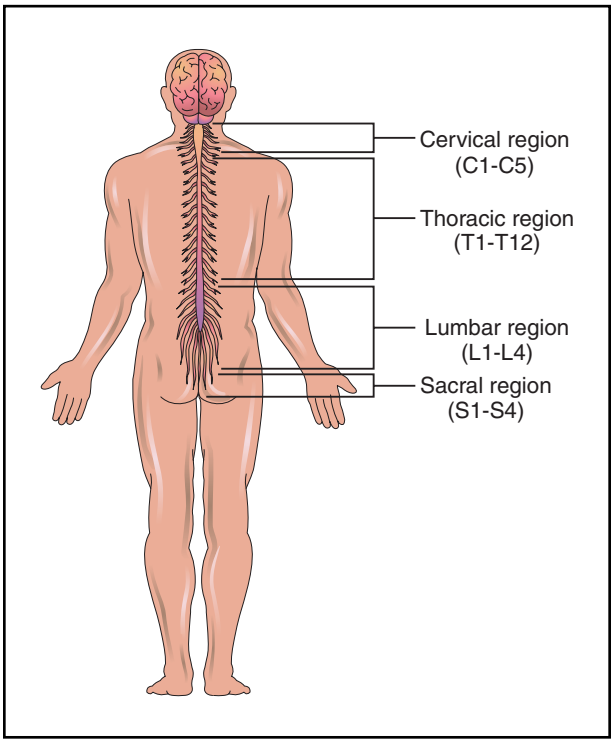
SPASTICITY AND CONTRACTURE. A paralyzed limb is incapable of active movement, but the muscle still has tone, a constant low level of contraction. Normal muscle tone requires communication between the muscle and the brain. Spinal cord injury prevents the brain from telling the muscle to relax. The result is prolonged muscle contraction or spasticity. Because the muscles that extend and those that bend a joint are not usually equal in strength, the involved joint is bent, often severely. This constant pressure causes deformity. As the muscle remains in the shortened position over several weeks or months, the tendons remodel and cause permanent muscle shortening or contracture. When muscles have permanently shortened, the inner surfaces of joints, such as armpits or palms, cannot be cleaned and the skin breaks down in that area.

HETEROTOPIC OSSIFICATION. Heterotopic ossification is an abnormal deposit of bone in muscles and tendons that may occur after injury. It is most common in the hips and knees. Initially heterotopic ossification causes localized swelling, warmth, redness, and stiffness of the muscle. It usually begins one to four months after the injury and is rare after one year.

AUTONOMIC DYSREFLEXIA. Body organs that regulate themselves, such as the heart, gastrointestinal tract, and glands, are controlled by groups of nerves called autonomic nerves. Autonomic nerves emerge from three different places: above the spinal column, in the lower back from vertebrae T1-L4, and from the lowest regions of the sacrum at the base of the spine. In general, these three groups of autonomic nerves operate in balance. Spinal cord injury can disrupt this balance, a condition called autonomic dysreflexia or autonomic hyperreflexia. Patients with injuries at T6 or above are at greatest risk.

In autonomic dysreflexia, irritation of the skin, bowel, or bladder causes a highly exaggerated response from autonomic nerves. This response is caused by the uncontrolled release of norepinephrine, a hormone similar to adrenaline. Uncontrolled release of norepinephrine causes a rapid rise in blood pressure and a slowing of the heart rate. These symptoms are accompanied by throbbing **headache**, nausea, **anxiety**, sweating, and goose bumps below the level of the injury. The elevated blood pressure can rapidly cause loss of consciousness, seizures, cerebral hemorrhage, and **death**. Autonomic dysreflexia is most often caused by an over-full bladder or bladder infection, impaction or hard impassable fecal mass in the bowel, or skin irritation from tight clothing, **sunburn**, or other irritant. Inability to sense these irritants before the autonomic reaction begins is a major cause of dysreflexia.

LOSS OF BLADDER AND BOWEL CONTROL. Bladder and bowel control require both motor nerves and the



The extent of sensory and motor loss resulting from a spinal cord injury depends on the level of the injury because nerves at different levels control sensation and movement in different parts of the body. The distribution is as follows: C1-C4: head and neck; C3-C5: diaphragm; C5-T1: shoulders, arms, and hands; T2-T12: chest and abdomen (excluding internal organs); L1-L4: abdomen (excluding internal organs), buttocks, genitals, upper legs; L4-S3: legs; S2-S4: genitals, muscles of the perineum. *(Illustration by Electronic Illustrators Group.)*

autonomic nervous system. Both of these systems may be damaged by SCI. When the autonomic nervous system triggers an urge to urinate or defecate, continence is maintained by contracting the anal or urethral sphincters. A sphincter is a ring of muscle that contracts to close off a passage or opening in the body. When the neural connections to these muscles are severed, conscious control is lost. In addition, loss of feeling may prevent sensations of fullness from reaching the brain. To compensate, the patient may help empty the bowel or bladder by using physical maneuvers that stimulate autonomic contractions before they would otherwise begin. However, the patient may not be able to relax the sphincters. If the sphincters cannot be relaxed, the patient will retain urine or feces.

Retention of urine may cause muscular changes in the bladder and urethral sphincter that make the problem worse. Urinary tract infection is common. Retention of feces can cause impaction. Symptoms of impaction include loss of appetite and nausea. Untreated impaction may cause perforation of the large intestine and rapid overwhelming infection.

SEXUAL DYSFUNCTION. Men who have sustained SCI may be unable to achieve an erection or ejaculate. Sperm formation may be abnormal too, reducing fertility. Fertility and the ability to achieve orgasm are less impaired for women. Women may still be able to become pregnant and deliver vaginally with proper medical care.

Diagnosis

The location and extent of spinal cord injury is determined with **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI) scans, and x rays. X rays may be enhanced with an injected contrast dye.

Treatment

A person who may have a spinal cord injury should not be moved. Treatment of SCI begins with **immobilization**. This strategy prevents partial injuries of the cord from severing it completely. Use of splints to completely immobilize suspected SCI at the scene of the injury has helped reduce the severity of spinal cord injuries in the last two decades. Intravenous methylprednisone, a steroidal anti-inflammatory drug, is given during the first 24 hours to reduce inflammation and tissue destruction.

Rehabilitation after spinal cord injury seeks to prevent complications, promote recovery, and make the most of remaining function. Rehabilitation is a complex and long-term process. It requires a team of professionals, including a neurologist, physiatrist or rehabilitation specialist, physical therapist, and occupational therapist. Other specialists who may be needed include a respiratory therapist, vocational rehabilitation counselor, social worker, speech-language pathologist, nutritionist, special education teacher, recreation therapist, and clinical psychologist. Support groups provide a critical source of information, advice, and support for SCI patients.

Paralysis and loss of sensation

Some limited mobility and sensation may be recovered, but the extent and speed of this recovery cannot be predicted. Experimental electrical stimulation has been shown to allow some control of muscle contraction in paraplegia. This experimental technique offers the possibility of unaided walking. Further development of current control systems will be needed before useful movement is possible outside the laboratory.

KEY TERMS

Autonomic nervous system—The part of the nervous system that controls involuntary functions such as sweating and blood pressure.

Botulinum toxin—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*.

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Motor—Of or pertaining to motion, the body apparatus involved in movement, or the brain functions that direct purposeful activity.

Motor nerve—Motor or efferent nerve cells carry impulses from the brain to muscle or organ tissue.

Peripheral nervous system—The part of the nervous system that is outside the brain and spinal cord. Sensory, motor, and autonomic nerves are included.

Postural drainage—The use of positioning to drain secretions from the bronchial tubes and lungs into the trachea or windpipe.

Range of motion (ROM)—The range of motion of a joint from full extension to full flexion (bending) measured in degrees like a circle.

Sensory nerves—Sensory or afferent nerves carry impulses of sensation from the periphery or outward parts of the body to the brain. Sensations include feelings, impressions, and awareness of the state of the body.

Voluntary—An action or thought undertaken or controlled by a person's free will or choice.

The physical therapist focuses on mobility, to maintain range of motion of affected limbs and reduce contracture and deformity. Physical therapy helps compensate for lost skills by using those muscles that are still functional. It also helps to increase any residual strength and control in affected muscles. A physical therapist suggests adaptive equipment such as braces, canes, or wheelchairs.

An occupational therapist works to restore ability to perform the activities of daily living, such as eating and grooming, with tools and new techniques. The occupational therapist also designs modifications of the home and workplace to match the individual impairment.

A pulmonologist or respiratory therapist promotes airway hygiene through instruction in assisted coughing techniques and postural drainage. The respiratory professional also prescribes and provides instruction in the use of ventilators, facial or nasal masks, and tracheostomy equipment where necessary.

Pressure ulcers

Pressure ulcers are prevented by turning in bed at least every two hours. The patient should be turned more frequently when redness begins to develop in sensitive areas. Special mattresses and chair cushions can distribute weight more evenly to reduce pressure. Electrical stimulation is sometimes used to promote muscle movement to prevent pressure ulcers.

Spasticity and contracture

Range of motion (ROM) exercises help to prevent contracture. Chemicals can be used to prevent **contractures** from becoming fixed when ROM **exercise** is inadequate. Phenol or alcohol can be injected onto the nerve or botulinum toxin directly into the muscle. Botulinum toxin is associated with fewer complications, but it is more expensive than phenol and alcohol. Contractures can be released by cutting the shortened tendon or transferring it surgically to a different site on the bone where its pull will not cause as much deformity. Such tendon transfers may also be used to increase strength in partially functional extremities.

Heterotopic ossification

Etidronate disodium (Didronel), a drug that regulates the body's use of calcium, is used to prevent heterotopic ossification. Treatment begins three weeks after the injury and continues for 12 weeks. Surgical removal of ossified tissue is possible.

Autonomic dysreflexia

Autonomic dysreflexia is prevented by bowel and bladder care and attention to potential irritants. It is treated by prompt removal of the irritant. Drugs to lower blood pressure are used when necessary. People with SCI should educate friends and family members about the

symptoms and treatment of dysreflexia, because immediate attention is necessary.

Loss of bladder and bowel control

Normal bowel function is promoted through adequate fluid intake and a diet rich in fiber. Evacuation is stimulated by deliberately increasing the abdominal pressure, either voluntarily or by using an abdominal binder.

Bladder care involves continual or intermittent catheterization. The full bladder may be detected by feeling its bulge against the abdominal wall. Urinary tract infection is a significant complication of catheterization and requires frequent monitoring.

Sexual dysfunction

Counseling can help in adjusting to changes in sexual function after spinal cord injury. Erection may be enhanced through the same means used to treat erectile dysfunction in the general population.

Prognosis

The prognosis of SCI depends on the location and extent of injury. Injuries of the neck above C4 with significant involvement of the diaphragm hold the gravest prognosis. Respiratory infection is one of the leading causes of death in long-term SCI. Overall, 85% of SCI patients who survive the first 24 hours are alive 10 years after their injuries. Recovery of function is impossible to predict. Partial recovery is more likely after an incomplete wound than after the spinal cord has been completely severed.

Prevention

Risk of spinal cord injury can be reduced through prevention of the accidents that lead to it. Chances of injury from automobile accidents, the major cause of SCIs, can be significantly reduced by driving at safe speeds, avoiding alcohol while driving, and using seat belts.

Resources

BOOKS

Bradley, Walter G., et al., eds. *Neurology in Clinical Practice.* 2nd ed. Boston: Butterworth-Heinemann, 1996.

Martini, F. *Fundamentals of Anatomy and Physiology.* Englewood Cliffs, NJ: Prentice Hall, 1989.

Yarkony, Gary M., ed. *Spinal Cord Injury: Medical Management and Rehabilitation.* Gaithersburg, MD: Aspen Publishers, Inc., 1994.

ORGANIZATIONS

The National Spinal Cord Injury Association. 8300 Colesville Road, Silver Spring, Maryland 20910. (301) 588-6959. <http://www.erols.com/nscia>.

Richard Robinson

Spinal cord tumors

Definition

A spinal cord tumor is a benign or cancerous growth in the spinal cord, between the membranes covering the spinal cord, or in the spinal canal. A tumor in this location can compress the spinal cord or its nerve roots; therefore, even a noncancerous growth can be disabling unless properly treated.

Description

The spinal cord contains bundles of nerves that carry messages betweent the brain and the body. Because the spinal cord is rigidly encased in bone, any tumor that grows on or near it can compress the nerves, and interfere in this communication. About 10,000 Americans develop spinal cord tumors each year, and about 40% of these are cancerous. Similar to brain tumors, spinal cord growths are rare.

Newly formed tumors that begin within the spinal cord are unusual, especially among children and the elderly. More typically, tumors originate elsewhere in the body and move through the bloodstream (metastasize) to the spinal cord.

Causes and symptoms

Scientists don't know what causes these tumors, although the noncancerous growths may be hereditary or present since birth.

When the tumor presses on the spinal cord, it causes symptoms including;

- back **pain**
- severe or burning pain in other parts of the body
- numbness or cold
- progressive loss of muscle strength or sensation in the legs
- loss of bladder or bowel control

A tumor in the top of the spinal column can cause pain radiating from the arms or neck; a tumor in the lower spine may cause leg or back pain. If there are several tumors in different areas of the spinal cord at the same time, it may cause symptoms in a variety of spots on the body.

Diagnosis

Suspected spinal cord compression, by tumor, is a medical emergency. Prompt intervention may prevent **paralysis**.

KEY TERMS

Computed tomography scans (CT scan)—The CT scan combines an x ray with a computer to create a detailed picture of the spinal cord. It may help to determine the type of tumor, locate swelling or bleeding, and check results of treatment.

Magnetic resonance imaging—MRI is an imaging technique that uses a magnetic field to scan the body's tissues and structures. It gives a better picture of tumors located near bone than does a CT scan, without the risk of radiation, and can provide a three-dimensional image of the tumor.

Myelogram—A myelogram is an x ray exam of the spinal cord, nerves and other tissues within the spinal cord that are highlighted by injected contrast dye.

If a neurological exam and review of symptoms suggest a spinal cord tumor, the doctor may order some of these additional tests:

- MRI or CT scan
- myelography
- blood and spinal fluid studies
- x rays of the spine
- biopsy
- radionuclide bone scan.

Treatment

If the tumor is malignant and has metastasized, treatment depends on the type of the primary **cancer**. Surgery is usually the first step in treating benign and malignant tumors outside the spinal cord. Tumors inside the spinal cord may not be able to be completely removed with surgery. If they can not be, radiation and **chemotherapy** treatments may be effective. Treatment also may include pain relievers and cortisone drugs to lessen swelling around the tumor, and ease pressure on the spinal cord.

Prognosis

Early diagnosis and treatment can produce a higher success rate. Long-term survival also depends on the tumor's type, location, and size. Surgery to remove the bone around the cord can ease pressure on the spinal nerves and nerve pathways, which will usually ease pain and other symptoms; however, it may make walking more difficult. Physical therapy and **rehabilitation** may help.

Prevention

Since spinal cord tumors usually are the result of a cancer that has first appeared elsewhere in the body, early detection of cancer in other organs may prevent spinal cord tumors. Lifestyle changes, as stopping **smoking**, to lower the risk of the development of other types of cancer, may also help.

Resources

BOOKS

Greenberg, David A., et al. *Clinical Neurology.* 2nd ed. Norwalk, CT: Appleton & Lange, 1993.

ORGANIZATIONS

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

Carol A. Turkington

Spinal fluid analysis *see* **Cerebrospinal fluid (CSF) analysis**

Spinal fusion *see* **Disk removal**

Spinal instrumentation

Definition

Spinal instrumentation is a method of straightening and stabilizing the spine after spinal fusion, by surgically attaching hooks, rods, and wire to the spine in a way that redistributes the stresses on the bones and keeps them in proper alignment.

Purpose

Spinal instrumentation is used to treat instability and deformity of the spine. Instability occurs when the spine no longer maintains its normal shape during movement. Such instability results in nerve damage, spinal deformities, and disabling **pain**. Spinal deformities may be caused by:

- birth defects
- fractures
- marfan syndrome
- neurofibromatosis
- neuromuscular diseases
- severe injuries
- tumors

Curvature of the spine (**scoliosis**) is usually treated with spinal fusion and spinal instrumentation. Scoliosis is a disorder of unknown origin. It causes bending and twisting of the spine that eventually results in distortion of the chest and back. About 85% of cases occur in girls between the ages of 12 and 15, who are experiencing adolescent growth spurt.

Spinal instrumentation serves three purposes. It provides a stable, rigid column that encourages bones to fuse after spinal-fusion surgery. Second, it redirects the stresses over a wider area. Third, it restores the spine to its proper alignment.

Different types of spinal instrumentation are used to treat different spinal problems. Several common types of spinal instrumentation are explained below. Although the details of the insertion of rods, wires, and hooks varies, the purpose of all spinal instrumentation is the same—to correct and stabilize the backbone.

Harrington rod

The Harrington Rod is one of the oldest and most proven forms of spinal instrumentation. It is used to straighten and stabilize the spine when curvature is greater than 60 degrees. It is an appropriate treatment for scoliosis.

Advantages of the Harrington rod are its relative simplicity of installation, the low rate of complications, and a proven record of reducing curvature of the spine. The main disadvantage is that the patient must remain in a body cast for about six months, then wear a brace for another three to six months while the bone fusion solidifies.

Luque rod

Luque rods are custom contoured metal rods that are fixed to each segment (vertebra) in the affected part of the spine. The main advantage is that the patient may not need to wear a cast or brace after the procedure. The main disadvantage is that the risk of injury to the nerves and spinal cord is higher than with a some other forms of instrumentation. This is because wires must be threaded through each vertebra near the spinal column, increasing the risk of such damage. Luque rods are sometimes used to treat scoliosis.

Drummond instrumentation

Drummond instrumentation, also called Harri-Drummond instrumentation, uses a Harrington rod on the concave side of the spine and a Luque rod on the convex side. The advantage is that each vertebra segment is fixed, with the risk of nerve injury decreased over Luque rod instrumentation. The disadvantage is that, like Harrington rod instrumentation, the patient must wear a cast and a brace after surgery.

Cotrel-Dubousset instrumentation

Cotrel-Dubousset instrumentation uses hooks and rods in a cross-linked pattern to realign the spine and redistribute the biomechanical stress. The main advantage of Cotrel-Dubousset instrumentation is that, because of the extensive cross-linking, the patient may have to wear a cast or brace after surgery. The disadvantage is the complexity of the operation and the number of hooks and cross-links that may fail.

Zeilke instrumentation

Zeilke instrumentation is similar to Cotrel-Dubousset instrumentation, but is used to treat double curvature of the spine. It requires wearing a brace for many months after surgery.

Other forms of instrumentation

The Kaneda device is used to treat fractured thoracic or lumbar vertebrae when it is suspected that bone fragments are present in the spinal canal. Variations on the basic forms of spinal instrumentation, such as Wisconsin instrumentation, are being refined as technology improves. A physician chooses the proper type of instrumentation based on the type of disorder, the age and health of the patient, and on the physician's experience.

Precautions

Since the hooks and rods of spinal instrumentation are anchored in the bones of the back, spinal instrumentation should not be performed on people with serious **osteoporosis**. To overcome this limitation, techniques are being explored that help anchor instrumentation in fragile bones.

Description

Spinal instrumentation is performed by a neuro and/or orthopedic surgical team with special experience in spinal operations. The surgery is done in a hospital under general anesthesia. It is done at the same time as spinal fusion.

The surgeon strips the muscles away from the area to be fused. The surface of the bone is peeled away. A piece of bone is removed from the hip and placed along side the area to be fused. The stripping of the bone helps the bone graft to fuse.

After the fusion site is prepared, the rods, hooks, and wires are inserted. There is some variation in how this is done based on the spinal instrumentation chosen. In general, Harrington rods are the simplest instrumentation to install, and Cotrel-Dubousset instrumentation is the most complex and risky. Once the rods are in place, the incision is closed.

Preparation

Spinal fusion with spinal instrumentation is major surgery. The patient will undergo many tests to determine that nature and exact location of the back problem. These tests are likely to include x rays, **magnetic resonance imaging** (MRI), **computed tomography scans** (CT scans), and myleograms. In addition, the patient will undergo a battery of blood and urine tests, and possibly an electrocardiogram to provide the surgeon and anesthesiologist with information that will allow the operation to be performed safely. In Harrington rod instrumentation, the patient may be placed in **traction** or an upper body cast to stretch contracted muscles before surgery.

Aftercare

After surgery, the patient will be confined to bed. A catheter is inserted so that the patient can urinate without getting up. Vital signs are monitored, and the patient's position is changed frequently so that **bedsores** do not develop.

Recovery from spinal instrumentation can be a long, arduous process. Movement is severely limited for a period of time. In certain types of instrumentation, the patient is put in a cast to allow the realigned bones to stay in position until healing takes place. This can be as long as six to eight months. Many patients will need to wear a brace after the cast is removed.

During the recovery period, the patient is taught respiratory exercises to help maintain respiratory function during the time of limited mobility. Physical therapists assist the patient in learning self-care and in performing strengthening and range of motion exercises. Length of hospital stay depends on the age and health of the patient, as well as the specific problem that was corrected. The patient can expect to remain under a physician's care for many months.

Risks

Spinal instrumentation carries a significant risk of nerve damage and **paralysis**. The skill of the surgeon can affect the outcome of the operation, so patients should look for a hospital and surgical team that has a lot of experience doing spinal procedures.

After surgery there is a risk of infection or an inflammatory reaction due to the presence of the foreign material in the body. Serious infection of the membranes covering the spinal cord and brain can occur. In the long-term, the instrumentation may move or break, causing nerve damage and requiring a second surgery. Some bone grafts do not heal well, lengthening the time the patient must spend in a cast or brace, or necessitating additional surgery. Casting and wearing a brace may take an emotional toll, especially on young people. Patients who have had spinal instrumentation must avoid contact sports, and, for the rest of their lives, eliminate situations that will abnormally put stress on their spines.

Normal results

Many young people with scoliosis heal with significantly improved alignment of the spine. Results of spinal instrumentation done for other conditions vary widely.

KEY TERMS

Lumbar vertebrae—The vertebrae of the lower back below the level of the ribs.

Marfan syndrome—A rare hereditary defect that affects the connective tissue.

Neurofibromatosis—A rare hereditary disease that involves the growth of lesions that may affect the spinal cord.

Osteoporosis—A bone disorder, usually seen in the elderly, in which the boned become increasingly less dense and more brittle.

Spinal fusion—An operation in which the bones of the lower spine are permanently joined together using a bone graft obtained usually from the hip.

Thoracic vertebrae—The vertebrae in the chest region to which the ribs attach.

Resources

BOOKS

"Cotrel-Dubousset Spinal Instrumentation." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

"Harrington Rod." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

ORGANIZATIONS

National Scoliosis Foundation. 5 Cabot Place, Stoughton, MA 020724. (800) 673-6922. <http://www.scoliosis.org>.

OTHER

Orthogate. <http://owl.orthogate.org/>.

Tish Davidson

Spinal meningitis *see* **Meningitis**

Spinal stenosis

Definition

Spinal stenosis is any narrowing of the spinal canal that causes compression of the spinal nerve cord. Spinal stenosis causes **pain** and may cause loss of some body functions.

Description

Spinal stenosis is a progressive narrowing of the opening in the spinal canal. The spine is a long series of bones called vertebrae. Between each pair of vertebra is a fibrous intervertebral disk. Collectively, the vertebrae and disks are called the backbone. Each vertebra has a hole through it. These holes line up to form the spinal canal. A large bundle of nerves called the spinal cord runs through the spinal canal. This bundle of 31 nerves carries messages between the brain and the various parts of the body. At each vertebra, some smaller nerves branch out from these nerve roots to serve the muscles and tissue in the immediate area. When the spinal canal narrows, nerve roots in the spinal cord are squeezed. Pressure on the nerve roots causes chronic pain and loss of control over some functions because communication with the brain is interrupted. The lower back and legs are most affected by spinal stenosis. The nerve roots that supply the legs are near the bottom of the spinal cord. The pain gets worse after standing for a long time and after some forms of **exercise**. The posture required by these physical activities increases the **stress** on the nerve roots. Spinal stenosis usually affects people over 50 years of age. Women have the condition more frequently than men do.

Cervical spinal stenosis is a narrowing of the vertebrae of the neck (cervical vertebrae). The disease and its effects are similar to stenosis in the lower spine. A narrower opening in the cervical vertebrae can also put pressure on arteries entering the spinal column, cutting off the blood supply to the remainder of the spinal cord.

Causes and symptoms

Spinal stenosis causes pain in the buttocks, thigh, and calf and increasing weakness in the legs. The patient may also have difficulty controlling bladder and bowel functions. The pain of spinal stenosis seems more severe when the patient walks downhill. Spinal stenosis can be congenital, acquired, or a combination. Congenital spinal stenosis is a birth defect. Acquired spinal stenosis develops after birth. It is usually a consequence of tissue destruction (degeneration) caused by an infectious disease or a disease in which the immune system attacks the body's own cells (autoimmune disease). The two most common causes of spinal stenosis are birth defect and progressive degeneration of the tissue of the joints (**osteoarthritis**). Other causes include improper alignment of the vertebrae as in spondylolisthesis, destruction of bone tissue as in Paget's disease, or an overgrowth of bone tissue as in diffuse idiopathic skeletal hyperostosis. The spinal canal is usually more than 0.5 in (12 mm) in diameter. A smaller diameter indicates stenosis. The diameter of the cervical spine ranges is 0.6–1 in (5–12 mm). Any opening under 0.5 in (13 mm) in diameter is considered evidence of stenosis. Acquired spinal stenosis usually begins with degeneration of the intervertebral disks or the surfaces of the vertebrae or both. In trying to heal this degeneration, the body builds up the spinal column. In the process, the spinal canal can become narrower.

Diagnosis

The physician must determine that the symptoms are caused by spinal stenosis. Conditions that can cause similar symptoms include a slipped (herniated) intervertebral disk, spinal tumors, and disorders of the blood flow (circulatory disorders). Spinal stenosis causes back and leg pain. The leg pain is usually worse when the patient is standing or walking. Some forms of spinal stenosis are less painful when the patient is riding an exercise bike because the forward tilt of the body changes the pressure in the spinal column. Doppler scanning can trace the flow of blood to determine whether the pain is caused by circulatory problems. X-ray images, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) scans can reveal any narrowing of the spinal canal. **Electromyography**, nerve conduction velocity, or **evoked potential studies** can locate problems in the muscles indicating areas of spinal cord compression.

Treatment

Mild cases of spinal stenosis may be treated with rest, **nonsteroidal anti-inflammatory drugs** (such as **aspirin**), and **muscle relaxants**. Spinal stenosis can be a progressive disease, however, and the source of pressure may have to be surgically removed (surgical decompres-

KEY TERMS

Computed tomography (CT) scans—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Congenital—Present before birth. The term is used to describe disorders that developed in the fetal stage.

Doppler scanning—A procedure in which ultrasound images are used to watch a moving structure such as the flow of blood or the beating of the heart.

Electromyography—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to find disorders of the nerves that serve the muscles.

Evoked potential—A test of nerve response that uses electrodes placed on the scalp to measure brain reaction to a stimulus such as a touch.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Nerve conduction velocity test—A test that measures the time it takes a nerve impulse to travel a specific distance over the nerve after electronic stimulation.

Stenosis—The narrowing or constriction of a channel or opening.

sion) if the patient is losing control over bladder and bowel functions. The surgical procedure removes bone and other tissues that have entered the spinal canal or put pressure on the spinal cord. Two vertebrae may be fused, to eliminate improper alignment, such as that caused by spondylolisthesis. For surgery, patients lie on their sides or in a modified kneeling position. This position reduces bleeding and places the spine in proper alignment. Alignment is especially important if vertebrae are to be fused. Surgical decompression can eliminate leg pain and restore control of the legs, bladder, and bowels, but usually does not eliminate lower back pain. Physical therapy and massage can help reduce the symptoms of spinal stenosis. An exercise program should be developed to increase flexibility and mobility. A brace or corset may be worn to improve posture. Activities that place stress on the lower back muscles should be avoided.

Prognosis

Surgical decompression does not stop the degenerative processes that cause spinal stenosis, and the condition can develop again. Nevertheless, most patients achieve good results with surgical decompression. The patient will probably continue to have lower back pain after the surgical procedure.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Dee, Roger, et al. *Principles of Orthopaedic Practice.* New York: McGraw-Hill Health Professional Books, 1997.

Larsen, D. E., ed. *Mayo Clinic Family Health Book:* New York. William Morrow and Co., Inc., 1996.

John T. Lohr, PhD

Spinal tap *see* **Cerebrospinal fluid (CSF) analysis**

Spirometry *see* **Pulmonary function test**

Spleen, enlarged *see* **Hypersplenism**

Spleen removal *see* **Splenectomy**

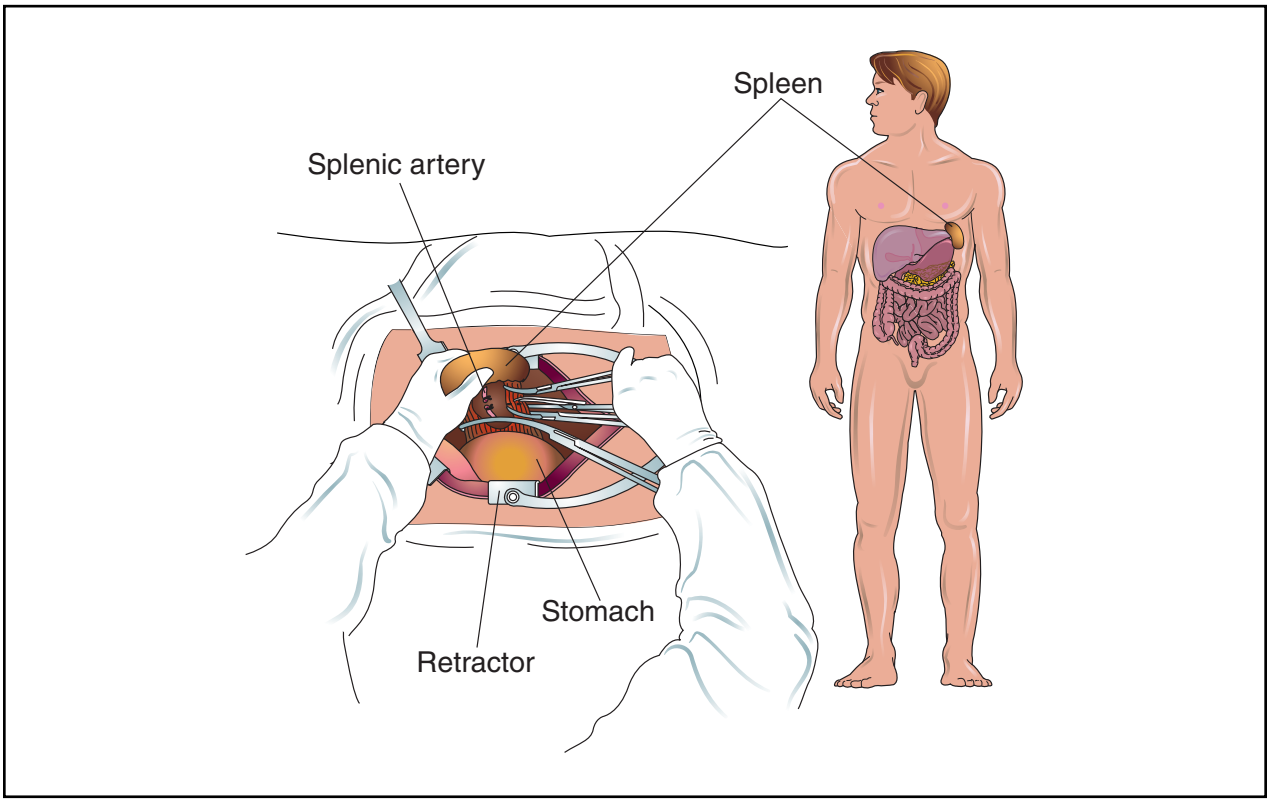
Splenectomy

Definition

Splenectomy is the surgical removal of the spleen, which is an organ that is part of the lymphatic system. The spleen is a dark-purple, bean-shaped organ located in the upper left side of the abdomen, just behind the bottom of the rib cage. In adults, the spleen is about 4.8 × 2.8 × 1.6 in (12 × 7 × 4 cm) in size, and weighs about 4–5 oz (113–142 g). Its functions include a role in the immune system; filtering foreign substances from the blood; removing worn-out blood cells from the blood; regulating blood flow to the liver; and sometimes storing blood cells. The storage of blood cells is called sequestration. In healthy adults, about 30% of blood platelets are sequestered in the spleen.

Purpose

Splenectomies are performed for a variety of different reasons and with different degrees of urgency. Most splenectomies are done after the patient has been diagnosed with **hypersplenism**. Hypersplenism is not a specific disease but a group of symptoms, or syndrome, that can



Splenectomy is the surgical removal of the spleen. This procedure is performed as a last result in most diseases involving the spleen. In some cases, however, splenectomy does not address the underlying causes of splenomegaly or other conditions affecting the spleen. *(Illustration by Electronic Illustrators Group.)*

be produced by a number of different disorders. It is characterized by enlargement of the spleen (splenomegaly), defects in the blood cells, and an abnormally high turnover of blood cells. It is almost always associated with splenomegaly caused by specific disorders such as **cirrhosis** of the liver or certain cancers. The decision to perform a splenectomy depends on the severity and prognosis of the disease that is causing the hypersplenism.

Splenectomy always necessary

There are two diseases for which splenectomy is the only treatment—primary cancers of the spleen and a blood disorder called hereditary spherocytosis (HS). In HS, the absence of a specific protein in the red blood cell membrane leads to the formation of relatively fragile cells that are easily damaged when they pass through the spleen. The cell destruction does not occur elsewhere in the body and ends when the spleen is removed. HS can appear at any age, even in newborns, although doctors prefer to put off removing the spleen until the child is five or six years old.

Splenectomy usually necessary

There are some disorders in which splenectomy is usually recommended. They include:

- Immune (idiopathic) thrombocytopenic purpura (ITP). ITP is a disease involving platelet destruction. Splenectomy is the definitive treatment for this disease and is effective in about 70% of chronic ITP cases.
- Trauma. The spleen can be ruptured by blunt as well as penetrating injuries to the chest or abdomen. Car accidents are the most common cause of blunt traumatic injury to the spleen.
- Abscesses in the spleen. These are relatively uncommon but have a high mortality rate.
- Rupture of the splenic artery. Rupture sometimes occurs as a complication of pregnancy.
- Hereditary elliptocytosis. This is a relatively rare disorder. It is similar to HS in that it is characterized by red blood cells with defective membranes that are destroyed by the spleen.

Splenectomy sometimes necessary

In other disorders, the spleen may or may not be removed.

- Hodgkin's disease, a serious form of **cancer** that causes lymph nodes to enlarge. Splenectomy is often per-

formed in order to find out how far the disease has progressed.

- Thrombotic thrombocytopenic purpura (TTP). TTP is a rare disorder marked by **fever**, kidney failure, and an abnormal decrease in the number of platelets. Splenectomy is one part of treatment for TTP.
- Autoimmune hemolytic disorders. These disorders may appear in patients of any age but are most common in patients over 50. The red blood cells are destroyed by antibodies produced by the patient's own body (autoantibodies).
- **Myelofibrosis**. Myelofibrosis is a disorder in which bone marrow is replaced by fibrous tissue. It produces severe and painful splenomegaly. Splenectomy does not cure myelofibrosis but may be performed to relieve **pain** caused by the swollen spleen.
- **Thalassemia**. Thalassemia is a hereditary form of anemia that is most common in people of Mediterranean origin. Splenectomy is sometimes performed if the patient's spleen has become painfully enlarged.

Precautions

Patients should be carefully assessed regarding the need for a splenectomy. Because of the spleen's role in protecting people against infection, it should not be removed unless necessary. The operation is relatively safe for young and middle-aged adults. Older adults, especially those with cardiac or pulmonary disease, are more vulnerable to post-surgical infections. Thromboembolism following splenectomy is another complication for this patient group, which has about 10% mortality following the surgery. Splenectomies are performed in children only when the benefits outweigh the risks.

The most important part of the assessment is the measurement of splenomegaly. The normal spleen cannot be felt when the doctor examines the patient's abdomen. A spleen that is large enough to be felt indicates splenomegaly. In some cases the doctor will hear a dull sound when he or she thumps (percusses) the patient's abdomen near the ribs on the left side. Imaging studies that can be used to demonstrate splenomegaly include ultrasound tests, technetium-99m sulfur colloid imaging, and CT scans. The rate of platelet or red blood cell destruction by the spleen can be measured by tagging blood cells with radioactive chromium or platelets with radioactive indium.

Description

Complete splenectomy

REMOVAL OF ENLARGED SPLEEN. Splenectomy is performed under general anesthesia. The most common technique is used to remove greatly enlarged spleens. After the surgeon makes a cut (incision) in the abdomen, the artery to the spleen is tied to prevent blood loss and reduce the spleen's size. It also helps prevent further sequestration of blood cells. The surgeon detaches the ligaments holding the spleen in place and removes it. In many cases, tissue samples will be sent to a laboratory for analysis.

REMOVAL OF RUPTURED SPLEEN. When the spleen has been ruptured by trauma, the surgeon approaches the organ from its underside and fastens the splenic artery.

Partial splenectomy

In some cases the surgeon removes only part of the spleen. This procedure is considered by some to be a useful compromise that reduces pain from an enlarged spleen while leaving the patient less vulnerable to infection. Long-term follow-up of the results of partial splenectomies has not yet been done.

Laparoscopic splenectomy

Laparoscopic splenectomy, or removal of the spleen through several small incisions, has been more frequently used in recent years. Laparoscopic surgery involves the use of surgical instruments, with the assistance of a tiny camera and video monitor. Laparoscopic procedures reduce the length of hospital stay, the level of post-operative pain, and the risk of infection. They also leave smaller scars. Laparoscopic splenectomy is not, however, the best option for many patients.

Splenic embolization

Splenic embolization is an alternative to splenectomy that is used in some patients who are poor surgical risks. Embolization involves plugging or blocking the splenic artery to shrink the size of the spleen. The substances that are injected during this procedure include polyvinyl alcohol foam, polystyrene, and silicone. Embolization is a technique that needs further study and refinement.

Preparation

Preoperative preparation for nonemergency splenectomy includes:

- Correction of abnormalities of blood clotting and the number of red blood cells.
- Treatment of any infections.
- Control of immune reactions. Patients are usually given protective vaccinations about a month before surgery. The most common vaccines used are Pneumovax or Pnu-Imune 23 (against pneumococcal infections) and Menomune-A/C/Y/W-135 (against meningococcal infections).

KEY TERMS

Embolization—An alternative to splenectomy that involves injecting silicone or similar substances into the splenic artery to shrink the size of the spleen.

Hereditary spherocytosis (HS)—A blood disorder in which the red blood cells are relatively fragile and are damaged or destroyed when they pass through the spleen. Splenectomy is the only treatment for HS.

Hypersplenism—A syndrome marked by enlargement of the spleen, defects in one or more types of blood cells, and a high turnover of blood cells.

Immune or idiopathic thrombocytopenic purpura (ITP)—A blood disease that results in destruction of platelets, which are blood cells involved in clotting.

Laparoscope—An instrument used to view the abdominal cavity through a small incision and perform surgery on a small area, such as the spleen.

Pneumovax—A vaccine that is given to splenectomy patients to protect them against bacterial infections. Other vaccines include Pnu-Imune and Menomune.

Sepsis—A generalized infection of the body, most often caused by bacteria.

Sequestration—A process in which the spleen withdraws some normal blood cells from circulation and holds them in case the body needs extra blood in an emergency. In hypersplenism, the spleen sequesters too many blood cells.

Splenomegaly—Abnormal enlargement of the spleen.

Thromboembolism—A clot in the blood that forms and blocks a blood vessel. It can lead to infarction, or death of the surrounding tissue due to lack of blood supply.

Aftercare

Immediately following surgery, patients should follow instructions and take all medications intended to prevent infection. Blood transfusions may be indicated for some patients to replace defective blood cells. The most important part of aftercare, however, is long-term caution regarding vulnerability to infection. Patients should see their doctor at once if they have a fever or any other sign of infection, and avoid travel to areas where exposure to **malaria** or similar diseases is likely. Children with splenectomies may be kept on antibiotic therapy until they are 16 years old. All patients can be given a booster dose of pneumococcal vaccine five to 10 years after splenectomy.

Risks

The chief risk following splenectomy is overwhelming bacterial infection, or postsplenectomy **sepsis**. This vulnerability results from the body's decreased ability to clear bacteria from the blood, and lowered levels of a protein in blood plasma that helps to fight viruses (immunoglobulin M). The risk of dying from infection after splenectomy is highest in children, especially in the first two years after surgery. The risk of postsplenectomy sepsis can be reduced by vaccinations before the operation. Some doctors also recommend a two-year course of penicillin following splenectomy or long-term treatment with ampicillin.

Other risks following splenectomy include inflammation of the pancreas and collapse of the lungs. In some cases, splenectomy does not address the underlying causes of splenomegaly or other conditions. Excessive bleeding after the operation is an additional possible complication, particularly for ITP patients. Infection immediately following surgery may also occur.

Normal results

Results depend on the reason for the operation. In blood disorders, the splenectomy will remove the cause of the blood cell destruction. Normal results for patients with an enlarged spleen are relief of pain and of the complications of splenomegaly. It is not always possible, however, to predict which patients will respond well or to what degree.

Resources

BOOKS

Hohn, David C. "Spleen." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Packman, Charles H. "Autoimmune Hemolytic Anemia." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Tanaka, Kouichi R. "Nonimmune Hemolytic Anemia." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Tsoukas, Christos M., et al. "Effect of Splenectomy on Slowing Human Immunodeficiency Virus Disease Progression." *Archives of Surgery* 133 (Jan. 1998): 25-31.

ORGANIZATIONS

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Leukaemia Research Fund. 43 Great Ormond Street, London, WC1N 3JJ. (020) 7405-0101. <http://dspace.dial.pipex.com/lrf-//>.

OTHER

"Laparoscopic Splenectomy." *Foxhall Surgical Page*. <http://www.foxhall.com/lap_sple.htm>.

Non-emergency Surgery Hotline. (800) 638-6833.

Teresa Norris, RN

Splenic trauma

Definition

Splenic trauma is physical injury to the spleen, the lymphatic organ located in the upper left side of the abdomen.

Description

The spleen is an organ that produces white blood cells, filters the blood, stores blood cells and destroys those that are **aging**. It is located near the stomach on the left side of the abdomen. A direct blow to the abdomen may bruise, tear or shatter the spleen. Trauma to the spleen can cause varying degrees of damage, the major problem associated with internal bleeding. Mild splenic subcapsular hematomas are injuries in which bleeding is limited to small areas on and immediately around the spleen. Splenic contusions refer to bruising and bleeding on and around larger areas of the spleen. Lacerations (tears) are the most common splenic trauma injuries. Tears tend to occur on the areas between the three main blood vessels of the spleen. Because of the abundant blood supply, splenic trauma may cause serious internal bleeding. Most injuries to the spleen in children heal spontaneously. Severe trauma can cause the spleen or its blood vessels to rupture or fragment.

Splenic trauma is more common in children than in adults. In general, children are prone to abdominal injuries due to accidents and falls and because their abdominal organs are less protected by bone, muscle and fat. Abdominal injuries including splenic trauma are the most common cause of preventable deaths in children.

Causes and symptoms

The most common cause of injury to the spleen is blunt abdominal trauma. Blunt trauma is often caused by a direct blow to the belly, car and motorcycle accidents, falls, sports mishaps, and fights. The spleen is the most commonly injured organ from blunt abdominal trauma. Penetrating injuries such as those from stabbing, gunshot **wounds**, and accidental impaling also account for cases of splenic trauma, although far less frequently than blunt trauma.

In adults, ruptured spleens may have been preceded by conditions causing splenic enlargement, such as infections, **cancer**, immune system disorders, diseases of the spleen, or circulatory problems.

Damage to the spleen may cause localized or general abdominal **pain**, tenderness, and swelling. Fractured ribs may be present. Splenic trauma may cause mild or severe internal bleeding, leading to **shock** and for which symptoms include rapid heartbeat, **shortness of breath**, thirst, pale or clammy skin, weak pulse, low blood pressure, **dizziness**, **fainting**, sweating. Vomiting blood, blood in the stools or urine, deterioration of vital signs, and loss of consciousness are other symptoms.

Diagnosis

The goal of diagnosis of all abdominal traumas is to detect and treat life-threatening injuries as quickly as possible. The physician will determine the extent of organ damage and whether surgery will be necessary while providing appropriate emergency care. Initial diagnosis consists of detailing all circumstances of the injury from the patient and bystanders as well as the close **physical examination** of the patient and measurement of vital signs. Blood tests, **urinalysis**, stool samples and x rays of the chest and abdomen are usually performed. Plain x–rays may show abdominal air pockets that indicate internal ruptures, but are rarely helpful because they do not show splenic and intra-abdominal damage.

Several other diagnostic tests may be used for the non-invasive and accurate assessment of splenic damage: **computed tomography scans** (CT), **magnetic resonance imaging** (MRI), radionuclide scanning, and ultrasonography. Ultrasonography has now become a standard bedside technique in many hospitals to check for bleeding in the abdomen. Imaging tests allow doctors to determine the necessity and type of surgery required. The CT scan has been shown to be the most available and accurate test for abdominal trauma. MRI tests are accurate but costly and less available in some hospitals, while radionuclide scanning requires more time and patient stability. Peritoneal lavage is another diagnostic technique in which the abdominal cavity is entered and flushed to check for bleeding. When patients exhibit shock, infection, or prolonged internal bleeding, exploratory **laparoscopy** is used for emergency diagnosis.

Treatment

Not long ago nearly all cases of splenic trauma were treated by laparoscopy, opening the abdomen, and by **splenectomy**, the surgical removal of the spleen. This approach resulted from the difficulty in assessing the severity of the injury, the potential dangers of shock and **death**, and the beliefs that the spleen healed poorly and that it was not an important organ. Nowadays, improved techniques of diagnosis and monitoring, as well as understanding that removal of the spleen creates future risk of a lowered capacity to fight infection has modified treatment approaches. Research over the past two decades has shown that the spleen has high healing potential, and confirmed that children are more susceptible to infection after splenectomy (post splenectomy **sepsis**, PSS). PSS has a mortality rate of over 50% and standard procedure now avoids splenectomy as much as possible. Adult splenic trauma is treated by splenectomy more often than children's; for unknown reasons, the adult spleen more frequently spontaneously ruptures after injury. Adults are also less susceptible to PSS.

Nonoperative Treatment

In nonoperative therapy, splenic trauma patients are monitored closely, often in intensive care units for several days. Fluid and blood levels are observed and maintained by intravenous fluid and possible blood transfusions. Follow-up scans may be used to observe the healing process.

Operative Treatment

Splenic trauma patients require surgery when nonoperative treatment fails, when major or prolonged internal bleeding exists and for gunshot and many stab wounds. Whenever possible, surgeons try to preserve at least part of the spleen and try to repair its blood vessels.

Prognosis

The ample blood supply to the spleen can promote rapid healing. Studies have shown that intra-abdominal bleeding associated with splenic trauma stops without surgical intervention in up to two out of three cases in children. When trauma patients stabilize during nonoperative therapy, chances are high that surgery will be avoided and that spleen injuries will heal themselves. Splenic trauma patients undergoing diagnostic tests such as CT and MRI scans have improved chances of avoiding splenectomy and retaining whole or partial spleens.

Resources

BOOKS

Hohn, David C., "Spleen" In *Current Surgical Diagnosis and Treatment*. Ed. Lawrence W. Way, Stamford, CT: Appleton & Lange, 1994.

Schwartz, George, MD. *Principles and Practice of Emergency Medicine*. Philadelphia: Lea & Febiger, 1992.

ORGANIZATIONS

American Trauma Society. 8903 Presidential Pkwy Suite 512, Upper Marlboro, MD 20227. (800) 556-7890. <http://www.amtrauma.org>.

OTHER

American Association for the Surgery of Trauma home page. <http://www.aast.org>.

Douglas Dupler

KEY TERMS

Computed tomography (CT) scan—Computer-aided x-ray exam that allows cross-sectional views of organs and tissues.

Laparoscope—An optical or fiberoptic instrument that is inserted by incision in the abdominal wall and is used to view the interior of the peritoneal cavity.

Laparoscopy—Procedure using a laparoscope to view organs, obtain tissue samples and perform surgery.

Magnetic resonance imaging (MRI)—Imaging technique using magnets and radio waves to provide internal pictures of the body.

Radionuclide scanning—Diagnostic test in which a radioactive dye is injected into the bloodstream and photographed to display internal vessels, organs and tissues.

Ultrasonography—Imaging test using sound waves to view internal organs and tissues.

Split personality *see* **Multiple personality disorder**

Spontaneous abortion *see* **Miscarriage**

Sporothrix schenckii infection *see* **Sporotrichosis**

Sporotrichosis

Definition

Sporotrichosis is a chronic infection caused by the microscopic fungus *Sporothrix schenckii*. The disease

causes ulcers on the skin that are painless but do not heal, as well as nodules or knots in the lymph channels near the surface of the body. Infrequently, sporotrichosis affects the lungs, joints, or central nervous system and can cause serious illness.

Description

The fungus that causes sporotrichosis is found in spagnum moss, soil, and rotting vegetation. Anyone can get sporotrichosis, but it is most common among nursery workers, farm laborers, and gardeners handling spagnum moss, roses, or barberry bushes. Cases have also been reported in workers whose jobs took them under houses into crawl spaces contaminated with the fungus. Children who played on baled hay have also gotten the disease. Sporotrichosis is sometimes called spagnum moss disease or alcoholic rose gardener's disease.

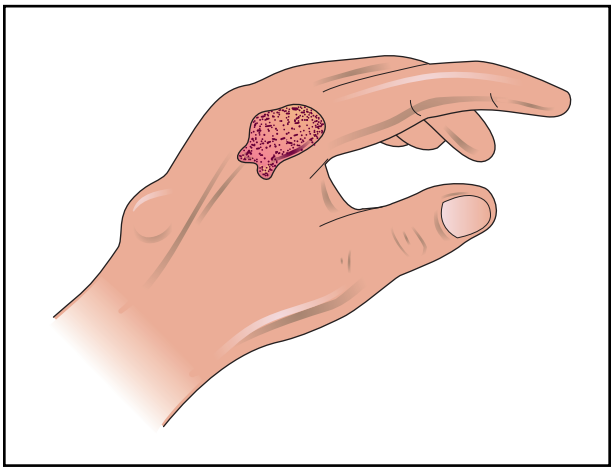
Causes and symptoms

The fungus causing sporotrichosis enters the body through scratches or cuts in the skin. Therefore, people who handle plants with sharp thorns or needles, like roses, barberry, or pines, are more likely to get sporotrichosis. Sporotrichosis is not passed directly from person to person, so it is not possible to catch sporotrichosis from another person who has it.

The first signs of sporotrichosis are painless pink, red, or purple bumps usually on the finger, hand, or arm where the fungus entered the body. These bumps may appear anywhere from one to 12 weeks after infection, but usually appear within three weeks. Unlike many other fungal infections sporotrichosis does not cause **fever** or any feelings of general ill health.

The reddish bumps eventually expand and fester, creating skin ulcers that do not heal. In addition, the infection often moves to nearby lymph nodes. Although most cases of sporotrichosis are limited to the skin and lymph channels, occasionally the joints, lungs, and central nervous system become infected. In rare cases, **death** may result.

People who have weakened immune systems, either from a disease such as acquired immune deficiency Syndrome (**AIDS**) or leukemia, or as the result of medications they take (**corticosteroids**, **chemotherapy** drugs), are more likely to get sporotrichosis and are more at risk for the disease to spread to the internal organs. Alcoholics and people with **diabetes mellitus** or a pre-existing lung disease are also more likely to become infected. Although sporotrichosis is painless, it is important for people with symptoms to see a doctor and receive treatment.



Sporotrichosis is a chronic infection caused by the microscopic fungus *Sporothrix schenckii*. It produces ulcers on the skin that are painless but do not heal, and nodules or knots in the lymph channels near the surface of the body. *(Illustration by Electronic Illustrators Group.)*

Diagnosis

The preferred way to diagnose sporotrichosis is for a doctor to obtain a sample of fluid from a freshly opened sore and send it to a laboratory to be cultured. The procedure is fast and painless. It is possible to confirm the presence of advanced sporotrichosis through a blood test or a biopsy. Doctors may also take a blood sample to perform tests that rule out other fungal infections or diseases such as **tuberculosis** or bacterial **osteomyelitis**.

Dermatologists and doctors who work with AIDS patients are more likely to have experience in diagnosing sporotrichosis. In at least one state, New York, the laboratory test to confirm this disease is provided free through the state health department. In other cases, diagnosis should be covered by health insurance at the same level as other diagnostic laboratory tests.

Treatment

When sporotrichosis is limited to the skin and lymph system, it is usually treated with a saturated solution of potassium iodine that the patient dilutes with water or juice and drinks several times a day. The iodine solution can only be prescribed by a physician. This treatment must be continued for many weeks. Skin ulcers should be treated like any open wound and covered with a clean bandage to prevent a secondary bacterial infection. The drug itraconazol (Sporanox), taken orally, is also available to treat sporotrichosis.

In serious cases of sporotrichosis, when the internal organs are infected, the preferred treatment is the drug

KEY TERMS

Acidophilus—The bacteria *Lactobacillus acidophilus,* usually found in yogurt.

Bacterial osteomyelitis—An infection of the bone or bone marrow that is caused by a bacterium.

Bifidobacteria—A group of bacteria normally present in the intestine. Commercial supplements are available.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Lymph channels—The vessels that transport lymph throughout the body. Lymph is a clear fluid that contains cells important in forming antibodies that fight infection.

amphotericin B. Amphotericin B is a strong anti-fungal drug with potentially severe toxic side effects. It is given intravenously, so hospitalization is required for treatment. The patient may also receive other drugs to minimize the side effects of the amphotericin B.

Alternative treatment

Alternative treatment for fungal infections focuses on maintaining general good health and eating a diet low in dairy products, sugars, including honey and fruit juice, and foods, such as beer, that contain yeast. This is complemented by a diet high in raw food. Supplements of and **vitamins** C, E, and A, B complex, and pantothenic acid may also be added to the diet, as may *Lactobacillus acidophilus*, bifidobacteria, and garlic capsules.

Fungicidal herbs such as myrrh (*Commiphora molmol*), tea tree oil (*Melaleuca* spp.), citrus seed extract, pau d'arco tea, and garlic (*Allium sativum*) may also be applied directly to the infected skin.

Prognosis

Most cases of sporotrichosis are confined to the skin and lymph system. With treatment, skin sores begin healing in one to two months, but complete recovery often takes six months or more. People who have AIDS are also more likely to have the fungus spread throughout the body, causing a life-threatening infection. In people whose bones and joints are infected or who have pulmonary lesions, surgery may be necessary.

Prevention

Since an opening in the skin is necessary for the sporotrichosis fungus to enter the body, the best way to prevent the disease is to avoid accidental scrapes and cuts on the hands and arms by wearing gloves and long sleeves while gardening. Washing hands and arms well after working with roses, barberry, spagnum moss, and other potential sources of the fungus may also provide some protection.

Resources

BOOKS

Griffith, H. Winter. *Complete Guide to Symptoms, Illness & Surgery.* Putnam Berkley Group. 1995.

PERIODICALS

Dillon, Gary P., et. al. "Handyperson's Hazard: Crawl Space Sporotrichosis." *The Journal of the American Medical Association* 274 (6 Dec. 1995): 1673+.

Tish Davidson

Sports injuries

Definition

Sports injuries result from acute trauma or repetitive **stress** associated with athletic activities. Sports injuries can affect bones or soft tissue (ligaments, muscles, tendons).

Description

Adults are less likely to suffer sports injuries than do children, whose vulnerability is heightened by:

- immature reflexes
- inability to recognize and evaluate risks
- underdeveloped coordination

Each year, about 3.2 million children between the ages of five and 14 are injured while participating in athletic activities, and account for 40% of all sports injuries. As many as 20% of children who play sports get hurt, and about 25% of their injuries are classified as serious. More than 775,000 boys and girls under age 14 are treated in hospital emergency rooms for sports-related injuries.

Injury rates are highest for athletes who participate in contact sports, but the most serious injuries are associated with individual activities. Between one-half and two-thirds of childhood sports injuries occur during practice, or in the course of unorganized athletic activity.

Chauncy Billups, a guard for the Denver Nuggets, grimaces after spraining his ankle during a game. *(AP/Wide World Photos. Reproduced by permission.)*

Types of sports injuries

About 95% of sports injuries are minor soft tissue traumas.

The most common sports injury is a bruise (contusion). It is caused when blood collects at the site of an injury and discolors the skin.

Sprains account for one-third of all sports injuries. A sprain is a partial or complete tear of a ligament, a strong band of tissue that connects bones to one another and stabilizes joints.

A strain is a partial or complete tear of:

- muscle (tissue composed of cells that enable the body to move)
- tendon (strong connective tissue that links muscles to bones)

Inflammation of a tendon (**tendinitis**) and inflammation of one of the fluid-filled sacs that allow tendons to move easily over bones (**bursitis**) usually result from minor stresses that repeatedly aggravate the same part of the body. These conditions often occur at the same time.

SKELETAL INJURIES. **Fractures** account for 5–6% of all sports injuries. The bones of the arms and legs are most apt to be broken. Sports activities rarely involve fractures of the spine or skull. The bones of the legs and feet are most susceptible to stress fractures, which occur when muscle strains or contractions make bones bend. Stress fractures are especially common in ballet dancers, long-distance runners, and in people whose bones are thin.

Shin splints are characterized by soreness and slight swelling of the front, inside, and back of the lower leg, and by sharp **pain** that develops while exercising and gradually intensifies. Shin splints are caused by overuse or by stress fractures that result from the repeated foot pounding associated with activities like aerobics, long-distance running, basketball, and volleyball.

A compartment syndrome is a potentially debilitating condition in which the muscles of the lower leg grow too large to be contained within membranes that enclose them. This condition is characterized by **numbness and tingling**. Untreated compartment syndrome can result in long-term loss of function.

BRAIN INJURIES. Brain injury is the primary cause of fatal sports-related injuries. **Concussion** can result from even minor blows to the head. A concussion can cause loss of consciousness and may affect:

- balance
- comprehension
- coordination
- hearing
- memory
- vision

Causes and symptoms

Common causes of sports injuries include:

- athletic equipment that malfunctions or is used incorrectly
- falls
- forceful high-speed collisions between players
- wear and tear on areas of the body that are continually subjected to stress

Symptoms include:

- instability or obvious dislocation of a joint
- pain
- swelling
- weakness

Diagnosis

Symptoms that persist, intensify, or reduce the athlete's ability to play without pain should be evaluated by an orthopedic surgeon. Prompt diagnosis can often prevent minor injuries from becoming major problems, or causing long-term or lasting damage.

An orthopedic surgeon should examine anyone:

- who is prevented from playing by severe pain associated with acute injury,
- whose ability to play has declined due to chronic or long-term consequences of an injury,
- whose injury has caused visible deformities in an arm or leg.

The physician will perform a **physical examination**, ask how the injury occurred, and what symptoms the patient has experienced. X rays and other imaging studies of bones and soft tissues may be ordered.

Anyone who has suffered a blow to the head should be examined immediately, and at five-minute intervals until normal comprehension has returned. The initial examination measures the athlete's:

- awareness
- concentration
- short-term memory

Subsequent evaluations of concussion assess:

- dizziness
- headache
- nausea
- visual disturbances

Treatment

Treatment for minor soft tissue injuries generally consists of:

- compressing the injured area with an elastic bandage
- elevation
- ice
- rest

Anti-inflammatories, taken by mouth or injected into the swelling, may be used to treat bursitis. Anti-inflammatory medications and exercises to correct muscle imbalances are usually used to treat tendinitis. If the athlete keeps stressing inflamed tendons, they may rupture, and casting or surgery is sometimes necessary to correct this condition.

Orthopedic surgery may be required to repair serious **sprains and strains**.

Controlling inflammation as well as restoring normal use and mobility are the goals of treatment for overuse injuries.

Athletes who have been injured are usually advised to limit their activities until their injuries are healed. The physician may suggest special exercises or behavior modifications for athletes who have had several injuries. Athletes who have been severely injured may be advised to stop playing altogether.

Prevention

Every child who plans to participate in organized athletic activity should have a pre-season sports physical.

This special examination is performed by a pediatrician or family physician who:

- carefully evaluates the site of any previous injury
- may recommend special stretching and strengthening exercises to help growing athletes create and preserve proper muscle and joint interaction
- pays special attention to the cardiovascular and skeletal systems

Telling the physician which sport the athlete plays will help that physician to determine which parts of the body will be subjected to the most stress. The physician will then be able to suggest to the athlete steps to take to minimize the chance of getting hurt.

Other injury-reducing game plans include:

- being in shape
- knowing and obeying the rules that regulate the activity
- not playing when tired, ill, or in pain
- not using steroids, which can improve athletic performance but cause life-threatening problems
- taking good care of athletic equipment and using it properly
- wearing appropriate protective equipment

Resources

BOOKS

Taylor, Robert B., ed. *Family Medicine Principles and Practice*. New York: Springer-Verlag, 1994.

ORGANIZATIONS

American Academy of Orthopedic Surgeons. 6300 North River Road, Rosemont, IL 60018-4262. (800) 346-2267. <http://www.aaos.org>.

The Institute for Preventative Sports Medicine. P.O. Box 7032, Ann Arbor, MI 48107 (313) 434-3390. <http://www.ipsm.org>.

OTHER

Varlotta, Gerard. "Health Guide 96: Kids Need Physical Exam to Help Ensure Good Health." *The Daily Herald* 6 Nov. 1996. 22 May 1998 <http://www.texasonline.net/livenews/health/med18.htm>.

"Orthopaedics: Soft-Tissue Injuries." *Jeffline Page*. Thomas Jefferson University. 17 May 1998 <http://jeffline.tju.edu/index-new.html>.

"Shin Splints." *Loyola University Health System*. 13 May 1998 <http://www.luhs.org>.

Maureen Haggerty

Sports vision *see* **Vision training**

Spouse abuse *see* **Abuse**

Sprains and strains

Definition

Sprain refers to damage or tearing of ligaments or a joint capsule. Strain refers to damage or tearing of a muscle.

Description

When excessive force is applied to a joint, the ligaments that hold the bones together may be torn or damaged. This results in a sprain, and its seriousness depends on how badly the ligaments are torn. Any joint can be sprained, but the most frequently injured joints are the ankle, knee, and finger.

Strains are tears in the muscle. Sometimes called pulled muscles, they usually occur because of overexertion or improper lifting techniques. Sprains and strains are common. Anyone can have them.

Children under age eight are less likely to have sprains than are older people. Childrens' ligaments are tighter, and their bones are more apt to break before a ligament tears. People who are active in sports suffer more strains and sprains than less active people. Repeated sprains in the same joint make the joint less stable and more prone to future sprains.

Causes and symptoms

There are three grades of sprains. Grade I sprains are mild injuries where there is no tearing of the ligament, and no joint function is lost, although there may be tenderness and slight swelling.

Grade II sprains are caused by a partial tear in the ligament. These sprains are characterized by obvious swelling, extensive bruising, **pain**, difficulty bearing weight, and reduced function of the joint.

Grade III, or third degree, sprains are caused by complete tearing of the ligament where there is severe pain, loss of joint function, widespread swelling and bruising, and the inability to bear weight. These symptoms are similar to those of bone **fractures**.

Strains can range from mild muscle stiffness to great soreness. Strains result from overuse of muscles, improper use of the muscles, or as the result of injury in another part of the body when the body compensates for pain by altering the way it moves.

Diagnosis

Grade I sprains and mild strains are usually self-diagnosed. Grade II and III sprains are often seen by a

physician, who x rays the area to differentiate between a sprain and a fracture.

Treatment

Grade I sprains and mild strains can be treated at home. Basic first aid for sprains consists of RICE: Rest, Ice for 48 hours, Compression (wrapping in an elastic bandage), and Elevation of the sprain above the level of the heart. Over-the-counter pain medication such as **acetaminophen** (Tylenol) or ibuprofen (Motrin) can be taken for pain.

In addition to RICE, people with grade II and grade III sprains in the ankle or knee usually need to use crutches until the sprains have healed enough to bear weight. Sometimes, physical therapy or home exercises are needed to restore the strength and flexibility of the joint.

Grade III sprains are usually immobilized in a cast for several weeks to see if the sprain heals. Pain medication is prescribed. Surgery may be necessary to relieve pain and restore function. Athletic people under age 40 are the most likely candidates for surgery, especially with grade III knee sprains. For complete healing, physical therapy usually will follow surgery.

Alternative treatment

Alternative practitioners endorse RICE and conventional treatments. In addition, nutritional therapists recommend vitamin C and bioflavonoids to supplement a diet high in whole grains, fresh fruits, and vegetables. Anti-inflammatories, such as bromelain (a proteolytic enzyme from pineapples) and tumeric (*Curcuma longa*), may also be helpful. The homeopathic remedy arnica (*Arnica montana*) may be used initially for a few days, followed by ruta (*Ruta graveolens*) for joint-related injuries or *Rhus toxicodendron* for muscle-related injuries. If surgery is needed, alternative practitioners can recommend pre- and post-surgical therapies that will enhance healing.

Prognosis

Moderate sprains heal within two to four weeks, but it can take months to recover from severe ligament tears. Until recently, tearing the ligaments of the knee meant the end to an athlete's career. Improved surgical and rehabilitative techniques now offer the possibility of complete recovery. However, once a joint has been sprained, it will never be as strong as it was before.

Prevention

Sprains and strains can be prevented by warming-up before exercising, using proper lifting techniques, wearing properly fitting shoes, and taping or bracing the joint.

KEY TERMS

Ligament—Tough, fibrous connective tissue that holds bones together at joints.

Resources

BOOKS

Burton Goldberg Group. "Sprains." In *Alternative Medicine: The Definitive Guide*, ed. James Strohecker. Puyallup, WA: Future Medicine Publishing, 1994.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

PERIODICALS

Wexler, Randall K. "The Injured Ankle." *American Family Physician* 57 (1 Feb. 1998): 474.

Tish Davidson

Sputum culture

Definition

Sputum is material coughed up from the lungs and expectorated (spit out) through the mouth. A sputum culture is done to find and identify the microorganism causing an infection of the lower respiratory tract such as **pneumonia** (an infection of the lung). If a microorganism is found, more testing is done to determine which **antibiotics** will be effective in treating the infection.

Purpose

A person with a **fever** and a continuing **cough** that produces pus-like material and/or blood may have an infection of the lower respiratory tract. Infections of the lungs and bronchial tubes are caused by several types of microorganisms, including bacteria, fungi (molds and yeast), and viruses. A **chest x ray** provides visual evidence of an infection; a culture can grow the microorganism causing the infection. The microorganism is grown in the laboratory so it can be identified, and tested for its response to medications, such as antifungals and antibiotics.

Description

Based on the clinical condition of the patient, the physician determines what group of microorganism is

likely to be causing the infection, and then orders one or more specific types of cultures: bacterial, viral, or fungal (for yeast and molds). For all culture types, the sputum must be collected into a sterile container. The sputum specimen must be collected carefully, so that bacteria that normally live in the mouth and saliva don't contaminate the sputum and complicate the process of identifying the cause of the infectious agent. Once in the laboratory, each culture type is handled differently.

Bacterial culture

A portion of the sputum is smeared on a microscope slide for a Gram stain. Another portion is spread over the surface of several different types of culture plates, and placed in an incubator at body temperature for one to two days.

A Gram stain is done by staining the slide with purple and red stains, then examining it under a microscope. Gram staining checks that the specimen does not contain saliva or material from the mouth. If many epithelial (skin) cells and few white blood cells are seen, the specimen is not pure sputum and is not adequate for culture. Depending on laboratory policy, the specimen may be rejected and a new specimen requested. If many white blood cells and bacteria of one type are seen, this is an early confirmation of infection. The color of stain picked up by the bacteria (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to their identity and helps the physician predict what antibiotics might work best before the entire test is completed. Bacteria that stain purple are called gram-positive; those that stain red are called gram-negative.

During incubation, bacteria present in the sputum sample multiply and will appear on the plates as visible colonies. The bacteria are identified by the appearance of their colonies, by the results of biochemical tests, and through a Gram stain of part of a colony.

A sensitivity test, also called antibiotic susceptibility test, is also done. The bacteria are tested against different antibiotics to determine which will treat the infection by killing the bacteria.

The initial result of the Gram stain is available the same day, or in less than an hour if requested by the physician. An early report, known as a preliminary report, is usually available after one day. This report will tell if any bacteria have been found yet, and if so, their Gram stain appearance—for example, a gram-negative rod, or a gram-positive cocci. The final report, usually available in one to three days, includes complete identification and an estimate of the quantity of the bacteria and a list of the antibiotics to which they are sensitive.

Fungal culture

To look for mold or yeast, a fungal culture is done. The sputum sample is spread on special culture plates that will encourage the growth of mold and yeast. Different biochemical tests and stains are used to identify molds and yeast. Cultures for fungi may take several weeks.

Viral culture

Viruses are a common cause of pneumonia. For a viral culture, sputum is mixed with commercially-prepared animal cells in a test tube. Characteristic changes to the cells caused by the growing virus help identify the virus. The time to complete a viral culture varies with the type of virus. It may take from several days to several weeks.

Special procedures

Tuberculosis is caused by a slow-growing bacteria called *Mycobacterium tuberculosis*. Because it does not easily grow using routine culture methods, special procedures are used to grow and identify this bacteria. When a sputum sample for tuberculosis first comes into the laboratory, a small portion of the sputum is smeared on a microscope slide and stained with a special stain, called an acid-fast stain. The stained sputum is examined under a microscope for tuberculosis organisms, which pick-up the stain, making them visible. This smear is a rapid screen for the organism, and allows the physician to receive a preliminary report within 24 hours.

To culture for tuberculosis, portions of the sputum are spread on and placed into special culture plates and tubes of broth that promote the growth of the organism. Growth in broth is faster than growth on culture plates. Instruments are available that can detect growth in broth, speeding the process even further. Growth and identification may take two to four weeks.

Other microorganisms that cause various types of lower respiratory tract infections also require special culture procedures to grow and identify. *Mycoplasma pneumonia* causes a mild to moderate form of pneumonia, commonly called walking pneumonia; *Bordetella pertussis* causes **whooping cough**; *Legionella pneumophila*, Legionnaire's disease; *Chlamydia pneumoniae*, an atypical pneumonia; and *Chlamydia psittaci*, **parrot fever**.

*Pneumocystis carnii*causes pneumonia in people with weakened immune systems, such as people with **AIDS**. This organism does not grow in culture. Special stains are done on sputum when pneumonia caused by this organism is suspected. The diagnosis is based on the results of these stains, the patient's symptoms, and medical history.

Sputum culture is also called sputum culture and sensitivity.

Preparation

The specimen for culture should be collected before antibiotics are begun. Antibiotics in the person's system may prevent microorganisms present in the sputum from growing in culture.

The best time to collect a sputum sample is early in the morning, before having anything to eat or drink. The patient should first rinse his or her mouth with water to decrease mouth bacteria and dilute saliva. Through a deep cough, the patient must cough up sputum from within the chest. Taking deep breaths and lowering the head helps bring up the sputum. Sputum must not be held in the mouth but immediately spat into a sterile container. For tuberculosis, the physician may want the patient to collect sputum samples on three consecutive mornings.

If coughing up sputum is difficult, a health care worker can have the patient breathe in sterile saline produced by a nebulizer. This nebulized saline coats the respiratory tract, loosening the sputum, and making it easier to cough up. Sputum may also be collected by a physician during a **bronchoscopy** procedure.

If tuberculosis is suspected, collection of sputum should be carried out in an **isolation** room, with all attending healthcare workers wearing masks.

Normal results

Sputum from a healthy person would have no growth on culture. A mixture of microorganisms, however, normally found in a person's mouth and saliva often contaminate the culture. If these microorganisms grow in the culture, they may be reported as normal flora contamination.

Abnormal results

The presence of bacteria and white blood cells on the Gram stain and the isolation of a microorganism from culture, other than normal flora contamination, is evidence of a lower respiratory tract infection.

Microorganisms commonly isolated from sputum include: *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Staphylococcus aureus*, *Legionella pneumophila*, *Mycoplasma pneumonia*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Bordetella pertussis*, and ***Escherichia coli***.

KEY TERMS

Acid-fast stain—A special stain done to microscopically identify the bacteria that cause tuberculosis.

Culture—A laboratory test done to grow and identify microorganisms causing infection.

Gram stain—Microscopic examination of a portion of a bacterial colony or sample from an infection site after it has been stained by special stains. Certain bacteria pick-up and retain the purple stain; these bacteria are called gram-positive. Other bacteria loose the purple stain and retain the red stain; these bacteria are called gram-negative. The color of the bacteria, in addition to their size and shape, provide clues as to the identity of the bacteria.

Normal flora—The mixture of bacteria normally found at specific body sites.

Pneumonia—An infection of the lungs.

Sputum—Material coughed up from the lower respiratory tract and expectorated through the mouth.

Sensitivity test—A test that determines which antibiotics will kill the bacteria that has been isolated from a culture.

Resources

BOOKS

Isada, Carlos M., et al. *Infectious Diseases Handbook.* Hudson, OH: Lexi-Comp., 1995.

Koneman, Elmer W., et al. *Color Atlas and Textbook of Diagnostic Microbiology.* 4th ed. Philadelphia: J. B. Lippincott Co., 1992.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

Shulman, Stanford T., et al., eds. *The Biologic and Clinical Basis of Infectious Diseases.* 5th ed. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Buono, Nancy J., et al. "The Fight Against TB: A New Laboratory Arsenal Fights Back." *Medical Laboratory Observer* (Aug. 1996): 38-40, 42, 44, 46, 48, 50, 52.

Skerritt, Shawn J. "Diagnostic Testing to Establish a Microbial Cause is Helpful in the Management of Community-Acquired Pneumonia." *Seminars in Respiratory Infections* (Dec. 1997): 308-321.

Nancy J. Nordenson

Squam *see* **Skin cancer, non-melanoma**

Squint *see* **Strabismus**

SSPE *see* **Subacute sclerosing panencephalitis**

SSRIs *see* **Selective serotonin reuptake inhibitors**

SSSS *see* **Staphylococcal scalded skin syndrome**

St. Anthony's fire *see* **Erysipelas**

St. John's wort

Definition

Hypericum perforatum is the most medicinally important species of the Hypericum genus, commonly known as St. John's wort. There are as many as 400 species in the genus, which is part of the Guttiferae family. Native to Europe, St. John's wort is found throughout the world. It thrives in sunny fields, open woods, and gravelly roadsides. Early colonists brought this valuable medicinal to North America, and the plant has become naturalized in the eastern United States and California, as well as in Australia, New Zealand, eastern Asia, and South America.

The entire plant, particularly the round, black seed, exudes a slight, turpentine-like odor. The woody, branched root spreads from the base with runners that produce numerous stalks. The simple, dark green leaves are veined and grow in opposite, oblong-obvate pairs on round, branching stalks that reach 3 ft (91.4 cm) high. Tiny holes, visible when the leaf is held to the light, are actually transparent oil glands containing the chemical photo sensitizer known as hypericin. These characteristic holes inspired the species name, *perforatum*, Latin for perforated. The bright yellow, star-shaped flowers, often clustered in a trio, have five petals. Each blossom has many showy stamens. Black dots along the margins of the blossom contain more of the red-pigmented chemical hypericin. The herb is also useful as a dye. The flowers bloom in branching, flat-topped clusters atop the stalks in mid-summer, around the time of the summer solstice. St. John's wort, sometimes called devil's flight or grace of God, was believed to have magical properties to ward off evil spirits. It's generic name hypericum is derived from a Greek word meaning "over an apparition." The herb was traditionally gathered on mid-summer's eve, June 23. This date was later christianized as the eve of the feast day of St. John the Baptist. This folk custom gave the plant its popular name. The Anglo-Saxon word wort means medicinal herb.

Purpose

St. John's wort has been known for its numerous medicinal properties as far back as Roman times. It was a valued remedy on the Roman battlefields where it was used to promote healing from trauma and inflammation.

St. John's wort flowers. *(Photo Researchers, Inc. Reproduced by permission.)*

The herb is vulnerary and can speed the healing of **wounds**, **bruises**, ulcers, and **burns**. It is popularly used as a nervine for its calming effect, easing tension and **anxiety**, relieving mild depression, and soothing emotions during **menopause**. The bittersweet herb is licensed in Germany for use in cases of mild depression, anxiety, and sleeplessness. It is useful in circumstances of nerve injury and trauma, and has been used to speed healing after brain surgery. Its antispasmodic properties can ease uterine cramping and menstrual difficulties. St. John's wort acts medicinally as an astringent, and may also be used as an expectorant. The hypericin in St. John's wort possesses anti-viral properties that may be active in combating certain cancers, including many brain cancers. An infusion of the plant, taken as a tea, has been helpful in treating night-time incontinence in children. The oil, taken internally, has been used to treat **colic**, intestinal worms, and abdominal **pain**. The medicinal parts of St. John's wort are the fresh leaves and flowers. This valuable remedy has been extensively tested in West Ger-

KEY TERMS

Antispasmodic—Relieves mild cramping or muscle spasm.

Expectorant—Promotes the discharge of mucus from respiratory system.

Nervine—Soothes and calms the nervous system.

Vulnerary—Heals wounds, bruises, sprains, and ulcers.

many, and is dispensed throughout Germany as a popular medicine called, *Johnniskraut*. Commercially prepared extracts are commonly standardized to 0.3% hypericin.

Clinical studies

A 1988 study at New York University found the antiviral properties in hypericin, a chemical component of Hypericum, to be useful in combating the virus that causes **AIDS**. Additional studies are under way through the Federal Drug Administration (FDA) to determine the effectiveness of the herb as a treatment for AIDS. Hypericin extract has also been reported to inhibit a form of leukemia that sometimes occurs after **radiation therapy**. Numerous clinical studies have found hypericum preparations to have an antidepressive effect when used in standardized extracts for treatment of mild depression. Clinical trials continue with this important herbal antidepressant, particularly in view of its relative lack of undesirable side effects in humans.

Preparations

An oil extract can be purchased commercially or prepared by combining fresh flowers and leaves of St. John's wort in a glass jar and sunflower or olive oil. Seal the container with an airtight lid and leave on a sunny windowsill for four to six weeks, shaking daily. The oil will absorb the red pigment. Strain through muslin or cheesecloth, and store in a dark container. The medicinal oil will maintain its potency for two years or more. The oil of St. John's wort has been known in folk culture as "Oil of Jesus." This oil makes a good rub for painful joints, **varicose veins**, muscle strain, arthritis, and rheumatism. Used in a compress it can help to heal wounds and inflammation, and relieve the pain of deep bruising.

An infusion is made by pouring one pint of boiling water over 1 oz (28 g) of dried herb, or 2 oz (57 g) of fresh, minced flower and leaf. Steep in a glass or enamel pot for five to 10 minutes. Strain and cover. Drink the tea warm. A general dose is one cupful, up to three times daily.

Capsule: Dry the leaves and flowers and grind with mortar and pestle into a fine powder. Place in gelatin capsules. The potency of the herb varies with the soil, climate and harvesting conditions of the plant. A standardized extract of 0.3% hypericin extract, commercially prepared from a reputable source, is more likely to yield reliable results. Standard dosage is up to three 300 mg capsules of 0.3% standardized extract daily.

A tincture is prepared by combining one part fresh herb to three parts alcohol (50% alcohol/water solution) in glass container. Set aside in dark place, shaking the mixture daily for two weeks. Strain through muslin or cheesecloth, and store in dark bottle. The tincture should maintain potency for two years. Standard dosage, unless otherwise prescribed, is 0.24–1 tsp added to 8 oz (237 ml) of water, up to three times daily.

A salve is made by warming 2 oz (59 ml) of prepared oil extract in double boiler. Once warmed, 1 oz (28 g) of grated beeswax is added and mixed until melted. Pour into a glass jar and cool. The salve can be stored for up to one year. The remedy keeps best if refrigerated after preparation. The salve is useful in treating burns, wounds, and soothing painful muscles. It is also a good skin softener. St. John's wort salve may be prepared in combination with calendula extract (*Calendula officinalis*) for application on bruises.

Precautions

Consult a physician prior to use. Pregnant or lactating women should not use the herb. Individuals taking prescribed psychotropic medications classified as **selective serotonin reuptake inhibitors**, or SSRI, such as Prozac, should not simultaneously use St. John's wort. Many herbalists also discourage use of St. John's wort by individuals taking any other anti-depressant medication.

Cattlemen dislike the shrub because there have been some reports of toxicity to livestock that over-graze in fields abundant with the wild herb. Toxic effects in livestock include reports of **edema** of the ears, eyelids, and the face due to photosensitization after ingestion of the herb. Exposure to sunlight activates the hypercin in the plant. Adverse effects have been reported in horses, sheep, and swine and include staggering, and blistering and peeling of the skin. Toxicity is greater in smaller mammals, such as rabbits.

Side effects

When used either internally or externally, the herb may cause photo-dermatitis in humans with fair or sen-

sitive skin when exposed to sun light or other ultraviolet light source. There have been some reports of changes in **lactation** in some nursing women taking the hypericum extract. Changes in the nutritional quality and flavor of the milk, and reduction or cessation of lactation have also been reported. It can also cause headaches, stiff neck, **nausea and vomiting**, and high blood pressure.

Interactions

St. John's wort can interact with amphetamines, **asthma** inhalants, **decongestants**, diet pills, narcotics, and amino acid tryptophan and tyrosine, as well as certain foods. Reactions range from nausea to increased high blood pressure. Consult a practitioner prior to using St. John's wort.

Resources

BOOKS

Blumenthal, Mark. *The Complete German Commission E Monographs, Therapeutic Guide to Herbal Medicines.* American Botanical Council, Boston: Integrative Medicine Communications, 1998.

Bown, Deni. *The Herb Society of America, Encyclopedia of Herbs & Their Uses.* New York: D. K. Publishing, Inc., 1995.

Foster, Steven and James A. Duke. *A Field Guide to Medicinal Plants.* New York: Peterson Field Guides, Houghton Mifflin Company, 1990.

Hoffmann, David. *The New Holistic Herbal.* Massachusetts: Element Books, 1992.

McIntyre, Anne. *The Medicinal Garden.* New York: Henry Holt and Company Inc., 1997.

McVicar, Jekka. *Herbs For The Home.* New York: Penguin Books, 1995.

"Prevention's 200 Herbal Remedies." Excerpted from *The Complete Book of Natural & Medicinal Cures.* Pennsylvania: Rodale Press Inc., 1994.

PERIODICALS

Hoffmann, David. *Herbal Alternatives to Prozac, Medicines from the Earth, Protocols for Botanical Healing* Official Proceedings, Gaia Herbal Research Institute, Harvard, MA. 1996

ORGANIZATIONS

American Botanical Council. PO Box 201660, Austin, TX 78720-1660.

OTHER

Herb Research Foundation. <http://www.herbs.org>.

Clare Hanrahan

St. Vitus' dance *see* **Sydenham's chorea**

Stanford-Binet intelligence scales

Definition

The Stanford-Binet intelligence scale is a standardized test that assesses intelligence and cognitive abilities in children and adults aged two to 23.

Purpose

The Stanford-Binet intelligence scale is used as a tool in school placement, in determining the presence of a learning disability or a developmental delay, and in tracking intellectual development. In addition, it is sometimes included in neuropsychological testing to assess the brain function of individuals with neurological impairments.

Precautions

Although the Stanford-Binet was developed for children as young as two, examiners should be cautious in using the test to screen very young children for developmental delays or disabilities. The test cannot be used to diagnose **mental retardation** in children aged three and under, and the scoring design may not detect developmental problems in preschool-age children.

Intelligence testing requires a clinically trained examiner. The Stanford-Binet intelligence scale should be administered and interpreted by a trained professional, preferably a psychologist.

Description

The Stanford-Binet intelligence scale is a direct descendent of the Binet-Simon scale, the first intelligence scale created in 1905 by psychologist Alfred Binet and Dr. Theophilus Simon. This revised edition, released in 1986, was designed with a larger, more diverse, representative sample to minimize the gender and racial inequities that had been criticized in earlier versions of the test.

The Stanford-Binet scale tests intelligence across four areas: verbal reasoning, quantitative reasoning, abstract/visual reasoning, and short-term memory. The areas are covered by 15 subtests, including vocabulary, comprehension, verbal absurdities, pattern analysis, matrices, paper folding and cutting, copying, quantitative, number series, equation building, memory for sentences, memory for digits, memory for objects, and bead memory.

All test subjects take an initial vocabulary test, which along with the subject's age, determines the number and level of subtests to be administered. Total testing time is 45–90 minutes, depending on the subject's age and the number of subtests given. Raw scores are based

KEY TERMS

Norms—Normative or mean score for a particular age group.

Representative sample—A random sample of people that adequately represents the test-taking population in age, gender, race, and socioeconomic standing.

Standard deviation—A measure of the distribution of scores around the average (mean). In a normal distribution, two standard deviations above and below the mean includes about 95% of all samples.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results. The Stanford-Binet test was standardized on a national representative sample of 5,000 subjects.

on the number of items answered, and are converted into a standard age score corresponding to age group, similar to an IQ measure.

The 1997 Medicare reimbursement rate for psychological and neuropsychological testing, including intelligence testing, is $58.35 an hour. Billing time typically includes test administration, scoring and interpretation, and reporting. Many insurance plans cover all or a portion of diagnostic psychological testing.

Normal results

The Stanford-Binet is a standardized test, meaning that norms were established during the design phase of the test by administering the test to a large, representative sample of the test population. The test has a mean, or average, standard score of 100 and a standard deviation of 16 (subtests have a mean of 50 and a standard deviation of 8). The standard deviation indicates how far above or below the norm the subject's score is. For example, an eight-year-old is assessed with the Stanford-Binet scale and achieves a standard age score of 116. The mean score of 100 is the average level at which all eight-year-olds in the representative sample performed. This child's score would be one standard deviation above that norm.

While standard age scores provide a reference point for evaluation, they represent an average of a variety of skill areas. A trained psychologist will evaluate and interpret an individual's performance on the scale's subtests to discover strengths and weaknesses and offer recommendations based upon these findings.

Resources

BOOKS

Maddox, Taddy. *Tests: A Comprehensive Reference For Assessments in Psychology, Education, and Business*. 4th ed. Austin: Pro-ed, 1997.

Shore, Milton F., Patrick J. Brice, and Barbara G. Love. *When Your Child Needs Testing*. New York: Crossroad Publishing, 1992.

Wodrich, David L. *Children's Psychological Testing: A Guide for Nonpsychologists*. Baltimore: Paul H. Brookes Publishing, 1997.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <http://www.apa.org>.

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Stapedectomy

Definition

Stapedectomy is a surgical procedure in which the innermost bone (stapes) of the three bones (the stapes, the incus, and the malleus) of the middle ear is removed, and replaced with a small plastic tube of stainless-steel wire (a prosthesis) to improve the movement of sound to the inner ear.

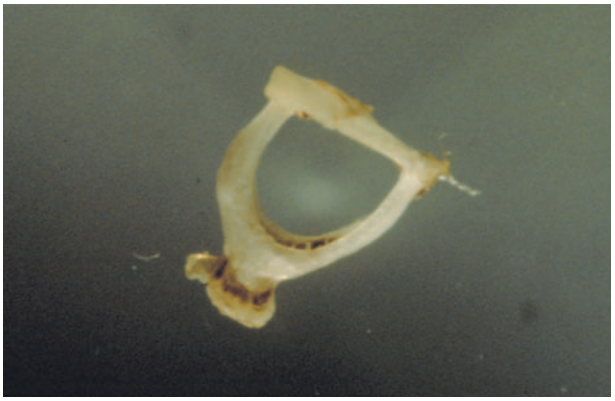
Purpose

A stapedectomy is used to treat progressive **hearing loss** caused by **otosclerosis**, a condition in which spongy bone hardens around the base of the stapes. This condition fixes the stapes to the opening of the inner ear, so that the stapes no longer vibrates properly; therefore, the transmission of sound to the inner ear is disrupted. Untreated otosclerosis eventually results in total deafness, usually in both ears.

Description

With the patient under local or general anesthesia, the surgeon opens the ear canal and folds the eardrum forward. Using an operating microscope, the surgeon is able to see the structures in detail, and evaluates the bones of hearing (ossicles) to confirm the diagnosis of otosclerosis.

Next, the surgeon separates the stapes from the incus; freed from the stapes, the incus and malleus bones can now move when pressed. A laser (or other tiny



A human stapes bone (located in middle ear) extracted during a stapedectomy. *(Custom Medical Stock Photo. Reproduced by permission.)*

instrument) vaporizes the tendon and arch of the stapes bone, which is then removed from the middle ear.

The surgeon then opens the window that joins the middle ear to the inner ear and acts as the platform for the stapes bone. The surgeon directs the laser's beam at the window to make a tiny opening, and gently clips the prosthesis to the incus bone. A piece of tissue is taken from a small incision behind the ear lobe and used to help seal the hole in the window and around the prosthesis. The eardrum is then gently replaced and repaired, and held there by absorbable packing ointment or a gelatin sponge. The procedure usually takes about an hour and a half.

Good candidates for the surgery are those who have a fixed stapes from otosclerosis, and a conductive hearing loss at least 20 dB. Patients with a severe hearing loss might still benefit from a stapedectomy, if only to improve their hearing to the point where a hearing aid can be of help. The procedure can improve hearing in more than 90% of cases.

Preparation

Prior to admission to the hospital, the patient will be given a hearing test to measure the degree of deafness, and a full ear, nose, and throat exam.

Most surgeons prefer to use general anesthesia; in this case, an injection will be given to the patient before surgery.

Aftercare

The patient is usually discharged the morning after surgery. **Antibiotics** are given up to five days after surgery to prevent infection; packing and sutures are removed about a week after surgery.

KEY TERMS

Cochlea—The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies, in addition to the organ of Corti (the receptor for hearing).

Conductive hearing loss—A type of medically treatable hearing loss in which the inner ear is usually normal, but there are specific problems in the middle or outer ears that prevent sound from getting to the inner ear in a normal way.

Incus—The middle of the three bones of the middle ear. It is also known as the "anvil."

Malleus—One of the three bones of the middle ear. It is also known as the "hammer."

Ossicles—The three small bones of the middle ear: the malleus (hammer), the incus (anvil) and the stapes (stirrup). These bones help carry sound from the eardrum to the inner ear.

Vertigo—A feeling of dizziness together with a sensation of movement and a feeling of rotating in space.

It is important that the patient not put pressure on the ear for a few days after surgery. Blowing one's nose, lifting heavy objects, swimming underwater, descending rapidly in high-rise elevators, or taking an airplane flight should be avoided.

Right after surgery, the ear is usually quite sensitive, so the patient should avoid loud noises until the ear retrains itself to hear sounds properly.

It is extremely important that the patient avoid getting the ear wet until it has completely healed. Water in the ear could cause an infection; most seriously, water could enter the middle ear and cause an infection within the inner ear, which could then lead to a complete hearing loss. When taking a shower, and washing the hair, the patient should plug the ear with a cotton ball or lamb's wool ball, soaked in Vaseline. The surgeon should give specific instructions about when and how this can be done.

Usually, the patient may return to work and normal activities about a week after leaving the hospital, although if the patient's job involves heavy lifting, three weeks of home rest is recommend. Three days after surgery, the patient may fly in pressurized aircraft.

Risks

The most serious risk is an increased hearing loss, which occurs in about one percent of patients. Because of this risk, a stapedectomy is usually performed on only one ear at a time.

Less common complications include:

- temporary change in taste (due to nerve damage) or lack of taste
- perforated eardrum
- vertigo that may persist and require surgery
- damage to the chain of three small bones attached to the eardrum
- temporary facial nerve **paralysis**
- ringing in the ears

Severe **dizziness** or vertigo may be a signal that there has been an incomplete seal between the fluids of the middle and inner ear. If this is the case, the patient needs immediate bed rest, an exam by the ear surgeon, and (rarely) an operation to reopen the eardrum to check the prosthesis.

Normal results

Most patients are slightly dizzy for the first day or two after surgery, and may have a slight **headache**. Hearing improves once the swelling subsides, the slight bleeding behind the ear drum dries up, and the packing is absorbed or removed, usually within two weeks. Hearing continues to get better over the next three months.

About 90% of patients will have a completely successful surgery, with markedly improved hearing. In 8% of cases, hearing improves, but not quite as patients usually expect. About half the patients who had ringing in the ears (**tinnitus**) before surgery will have significant relief within six weeks after the procedure.

Resources

BOOKS

The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations. Ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

ORGANIZATIONS

American Academy of Otolaryngology-Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314-3357. (703) 836-4444. <http://www.entnet.org>.

Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684-3391.

Carol A. Turkington

Staphylococcal infections

Definition

Staphylococcal (staph) infections are communicable conditions caused by certain bacteria and generally characterized by the formation of abscesses. They are the leading cause of primary infections originating in hospitals (nosocomial infections) in the United States.

Description

Classified since the early twentieth century as among the deadliest of all disease-causing organisms, staph exists on the skin or inside the nostrils of 20–30% of healthy people. It is sometimes found in breast tissue, the mouth, and the genital, urinary, and upper respiratory tracts.

Although staph bacteria are usually harmless, when injury or a break in the skin enables the organisms to invade the body and overcome the body's natural defenses, consequences can range from minor discomfort to **death**. Infection is most apt to occur in:

- newborns
- women who are breastfeeding
- individuals whose immune systems have been undermined by radiation treatments, **chemotherapy**, or medication
- intravenous drug users
- those with surgical incisions, skin disorders, and serious illness like **cancer**, diabetes, and lung disease

Types of infections

Staph infections produce pus-filled pockets (abscesses) located just beneath the surface of the skin or deep within the body. Risk of infection is greatest among the very young and the very old.

A localized staph infection is confined to a ring of dead and dying white blood cells and bacteria. The skin above it feels warm to the touch. Most of these abscesses eventually burst, and pus that leaks onto the skin can cause new infections.

A small fraction of localized staph infections enter the bloodstream and spread through the body. In children, these systemic (affecting the whole body) or disseminated infections frequently affect the ends of the long bones of the arms or legs, causing a bone infection called **osteomyelitis**. When adults develop invasive staph infections, bacteria are most apt to cause abscesses of the brain, heart, kidneys, liver, lungs, or spleen.

Staphylococcus aureus

Named for the golden color of the bacteria grown under laboratory conditions, *S. aureus* is a hardy organism that can survive in extreme temperatures or other inhospitable circumstances. About 70–90% of the population carry this strain of staph in the nostrils at some time. Although present on the skin of only 5–20% of healthy people, as many as 40% carry it elsewhere, such as in the throat, vagina, or rectum, for varying periods of time, from hours to years, without developing symptoms or becoming ill.

S. aureus flourishes in hospitals, where it infects healthcare personnel and patients who have had surgery; who have acute **dermatitis**, insulin-dependent diabetes, or dialysis-dependent kidney disease; or who receive frequent allergy-desensitization injections. Staph bacteria can also contaminate bedclothes, catheters, and other objects.

S. aureus causes a variety of infections. **Boils** and inflammation of the skin surrounding a hair shaft (**folliculitis**) are the most common. Toxic shock (TSS) and scalded skin syndrome (SSSS) are among the most serious.

TOXIC SHOCK. **Toxic shock syndrome** is a life-threatening infection characterized by severe **headache**, **sore throat**, **fever** as high as 105°F, and a sunburn-like rash that spreads from the face to the rest of the body. Symptoms appear suddenly; they also include **dehydration** and watery **diarrhea**.

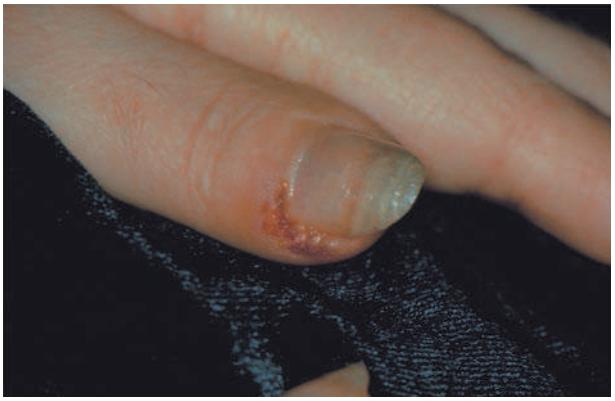
Inadequate blood flow to peripheral parts of the body (shock) and loss of consciousness occur within the first 48 hours. Between the third and seventh day of illness, skin peels from the palms of the hands, soles of the feet, and other parts of the body. Kidney, liver, and muscle damage often occur.

SCALDED SKIN SYNDROME. Rare in adults and most common in newborns and other children under the age of five, scalded skin syndrome originates with a localized skin infection. A mild fever and/or an increase in the number of infection-fighting white blood cells may occur.

A bright red rash spreads from the face to other parts of the body and eventually forms scales. Large, soft blisters develop at the site of infection and elsewhere. When they burst, they expose inflamed skin that looks as if it had been burned.

MISCELLANEOUS INFECTIONS. *S. aureus* can also cause:

- arthritis
- bacteria in the bloodstream (**bacteremia**)
- pockets of infection and pus under the skin (carbuncles)
- tissue inflammation that spreads below the skin, causing **pain** and swelling (cellulitis)



A close-up of a woman's finger and nail cuticle infected with *Staphyloccus aureus.* *(Custom Medical Stock Photo. Reproduced by permission.)*

- inflammation of the valves and walls of the heart (**endocarditis**)
- inflammation of tissue that enclosed and protects the spinal cord and brain (**meningitis**)
- inflammation of bone and bone marrow (osteomyelitis)
- pneumonia

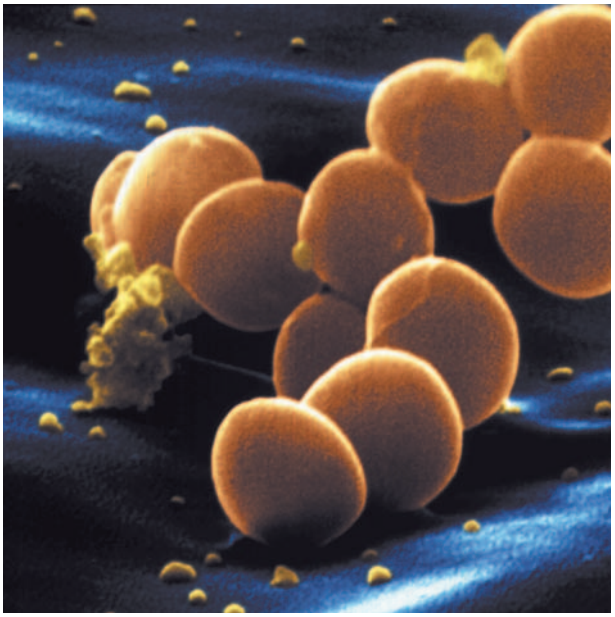
Other strains of staph

S. EPIDERMIDIS. Capable of clinging to tubing (as in that used for intravenous feeding, etc.), prosthetic devices, and other non-living surfaces, *S. epidermidis* is the organism that most often contaminates devices that provide direct access to the bloodstream.

The primary cause of bacteremia in hospital patients, this strain of staph is most likely to infect cancer patients, whose immune systems have been compromised, and high-risk newborns receiving intravenous supplements.

S. epidermidis also accounts for two of every five cases of prosthetic valve endocarditis. Prosthetic valve endocarditis is endocarditis as a complication of the implantation of an artificial valve in the heart. Although contamination usually occurs during surgery, symptoms of infection may not become evident until a year after the operation. More than half of the patients who develop prosthetic valve endocarditis die.

STAPHYLOCOCCUS SAPROPHYTICUS. Existing within and around the tube-like structure that carries urine from the bladder (urethra) of about 5% of healthy males and females, *S. saprophyticus* is the second most common cause of unobstructed urinary tract infections (UTIs) in sexually active young women. This strain of staph is responsible for 10–20% of infections affecting healthy outpatients.



A micrographic image of *Staphylococcus aureus.* *(Photograph by Oliver Meckes, Photo Researchers, Inc. Reproduced by permission.)*

Causes and symptoms

Staph bacteria can spread through the air, but infection is almost always the result of direct contact with open sores or body fluids contaminated by these organisms.

Staph bacteria often enter the body through inflamed hair follicles or oil glands. Or they penetrate skin damaged by **burns**, cuts and scrapes, infection, insect bites, or **wounds**.

Multiplying beneath the skin, bacteria infect and destroy tissue in the area where they entered the body. Staph infection of the blood (staphylococcal bacteremia) develops when bacteria from a local infection infiltrate the lymph glands and bloodstream. These infections, which can usually be traced to contaminated catheters or intravenous devices, usually cause persistent high fever. They may cause shock. They also can cause death within a short time.

Warning signs

Common symptoms of staph infection include:

- pain or swelling around a cut, or an area of skin that has been scraped
- boils or other skin abscesses
- blistering, peeling, or scaling of the skin; this is most common in infants and young children
- enlarged lymph nodes in the neck, armpits, or groin.

A family physician should be notified whenever:

- Lymph nodes in the neck, armpits, or groin become swollen or tender.
- An area of skin that has been cut or scraped becomes painful or swollen, feels hot, or produces pus. These symptoms may mean the infection has spread to the bloodstream.
- A boil or carbuncle appears on any part of the face or spine. Staph infections affecting these areas can spread to the brain or spinal cord.
- A boil becomes very sore. Usually a sign that infection has spread, this condition may be accompanied by fever, chills, and red streaks radiating from the site of the original infection.
- Boils that develop repeatedly. This type of recurrent infection could be a symptom of diabetes.

Diagnosis

Blood tests that show unusually high concentrations of white blood cells can suggest staph infection, but diagnosis is based on laboratory analysis of material removed from pus-filled sores, and on analysis of normally uninfected body fluids, such as, blood and urine. Also, x rays can enable doctors to locate internal abscesses and estimate the severity of infection. Needle biopsy (removing tissue with a needle, then examining it under a microscope) may be used to assess bone involvement.

Treatment

Superficial staph infections can generally be cured by keeping the area clean, using soaps that leave a germ-killing film on the skin, and applying warm, moist compresses to the affected area for 20–30 minutes three or four times a day.

Severe or recurrent infections may require a seven to 10 day course of treatment with penicillin or other oral **antibiotics**. The location of the infection and the identity of the causal bacteria determines which of several effective medications should be prescribed.

In case of a more serious infection, antibiotics may be administered intravenously for as long as six weeks. Intravenous antibiotics are also used to treat staph infections around the eyes or on other parts of the face.

Surgery may be required to drain or remove abscesses that form on internal organs, or on shunts or other devices implanted inside the body.

Alternative treatment

Alternative therapies for staph infection are meant to strengthen the immune system and prevent recurrences.

Among the therapies believed to be helpful for the person with a staph infection are **yoga** (to stimulate the immune system and promote relaxation), **acupuncture** (to draw heat away from the infection), and herbal remedies. Herbs that may help the body overcome, or withstand, staph infection include:

- Garlic (*Allium sativum*). This herb is believed to have anitbacterial properties. Herbalists recommend consuming three garlic cloves or three garlic oil capsules a day, starting when symptoms of infection first appear.
- Cleavers (*Galium aparine*). This anti-inflammatory herb is believed to support the lymphatic system. It may be taken internally to help heal staph abscesses and reduce swelling of the lymph nodes. A cleavers compress can also be applied directly to a skin infection.
- Goldenseal (*Hydrastis canadensis*). Another herb believed to fight infection and reduce imflammation, goldenseal may be taken internally when symptoms of infection first appear. Skin infections can be treated by making a paste of water and powdered goldenseal root and applying it directly to the affected area. The preparation should be covered with a clean bandage and left in place overnight.
- Echinacea (*Echinacea* spp.). Taken internally, this herb is believed to have antibiotic properties and is also thought to strengthen the immune system.
- Thyme (*Thymus vulgaris*), lavender (*Lavandula officinalis*), or bergamot (*Citrus bergamot*) oils. These oils are believed to have antibacterial properties and may help to prevent the scarring that may result from skin infections. A few drops of these oils are added to water and then a compress soaked in the water is applied to the affected area.
- Tea tree oil (*Melaleuca* spp.). Another infection-fighting herb, this oil can be applied directly to a boil or other skin infection.

Prognosis

Most healthy people who develop staph infections recover fully within a short time. Others develop repeated infections. Some become seriously ill, requiring long-term therapy or emergency care. A small percentage die.

Prevention

Healthcare providers and patients should always wash their hands thoroughly with warm water and soap after treating a staph infection or touching an open wound or the pus it produces. Pus that oozes onto the skin from the site of an infection should be removed immediately. This affected area should then be cleansed with antiseptic or with antibacterial soap.

KEY TERMS

Abscess—A cavity containing pus surrounded by inflamed tissue.

Endocarditis—Inflammation of the lining of the heart, and/or the heart valves, caused by infection.

Nosocomial infections—Infections that were not present before the patient came to a hospital, but were acquired by a patient while in the hospital.

To prevent infection from spreading from one part of the body to another, it is important to shower rather than bathe during the healing process. Because staph infection is easily transmitted from one member of a household to others, towels, washcloths, and bed linens used by someone with a staph infection should not be used by anyone else. They should be changed daily until symptoms disappear, and laundered separately in hot water with bleach.

Children should frequently be reminded not to share:

- brushes, combs, or hair accessories
- caps
- clothing
- sleeping bags
- sports equipment
- other personal items

A diet rich in green, yellow, and orange vegetables can bolster natural immunity. A doctor or nutritionist may recommend **vitamins** or mineral supplements to compensate for specific dietary deficiencies. Drinking eight to 10 glasses of water a day can help flush disease-causing organisms from the body.

Because some strains of staph bacteria are known to contaminate artificial limbs, prosthetic devices implanted within the body, and tubes used to administer medication or drain fluids from the body, catheters and other devices should be removed on a regular basis, if possible, and examined for microscopic signs of staph. Symptoms may not become evident until many months after contamination has occurred, so this practice should be followed even with patients who show no sign of infection.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Civetta, Joseph M., et al., eds. *Critical Care.* Philadelphia: Lippincott-Raven Publishers, 1997.
Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.
The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments.* Alexandria, VA: Time Life, Inc., 1996.

Maureen Haggerty

Staphylococcal scalded skin syndrome

Definition

Staphylococcal scalded skin syndrome (SSSS) is a disease, caused by a type of bacteria, in which large sheets of skin may peel away.

Description

SSSS primarily strikes children under the age of five, particularly infants. Clusters of SSSS cases (epidemics) can occur in newborn nurseries, when staff in those nurseries accidentally pass the causative bacteria between patients. It can also strike other age groups who have weakened immune systems. Such immunocompromised patients include those with kidney disease, people undergoing **cancerchemotherapy**, organ transplant patients, and individuals with acquired immunodeficiency syndrome (**AIDS**).

Causes and symptoms

SSSS is caused by a type of bacteria called *Staphylococcus aureus*. This bacteria produces a chemical called an epidermolytic toxin ("epiderm," deriving from the Greek words *epi,* meaning on, and *derma,* meaning skin, refers to the top layer of skin; "-lytic," deriving from the Greek word *lysis,* which literally denotes the act of undoing, means breaking or destroying; a toxin is a poison). While the bacteria itself is not spread throughout the body, it affects all of the skin by sending this toxin through the bloodstream.

SSSS begins with a small area of infection. In newborn babies, this may appear as a crusted area around the umbilicus, or in the diaper area. In children between the ages of one and six, a small, red, crusty bump appears near the nose or ear. The child may have no energy, and may have a **fever**. The skin becomes sensitive and uncomfortable even before the rash is fully visible. The rash starts out as bright red patches around the original area of crusting. Blisters may appear, and the skin may look wrinkled. When the blisters pop, they leave pitted areas. Even gently touching these red patches of skin may cause them to peel away in jagged sheets. The skin below is shiny, moist, and bright pink. Within a day or two, the top layer of skin all over the body is peeling off in large sheets.

The dangers of this illness include the chance that a different kind of bacteria will invade through the open areas in the skin and cause a serious systemic infection (**sepsis**). A lot of body fluid is lost as the skin peels away, and the layer underneath dries. **Dehydration** is a danger at this point.

Diagnosis

Although good patient care includes taking specimens of blister fluid and smears from the nose or throat, no bacteria are usually demonstrated. SSSS is usually diagnosed on the basis of the typical progression of symptoms in a child of this age, prone to this disorder. A sample of skin (**skin biopsy**) should be taken, prepared, and examined under a microscope. If the patient's disease is truly SSSS, the biopsy will show a characteristic appearance. There will be no accumulation of those cells usually present in the case of a bacterial infection. Instead, there will be evidence of disruption of only the top layer of skin (epidermis).

Treatment

Treatment involves careful attention to avoid the development of dehydration. A variety of lotions and creams are available to apply to areas where the epidermis has peeled away. This both soothes the sensitive areas, and protects against drying and further moisture loss.

Prognosis

Most patients heal from SSSS within about 10–14 days. Healing occurs without scarring in the majority of patients. **Death** may occur if severe dehydration or sepsis complicate the illness. About 3% of children die of these complications; about 50% of immunocompromised adults die of these complications.

Prevention

As always, good hygiene can prevent the passage of the causative bacteria between people. In the event of an outbreak in a newborn nursery, members of the staff should have nasal smears taken to identify an adult who may be unknowingly carrying the bacteria and passing it on to the babies.

KEY TERMS

Epidermis—The top layer of skin.

Epidermolytic—Damaging to the top layer of skin.

Sepsis—An overwhelming infection affecting all the systems of the body.

Resources

BOOKS

Deresiewicz, Robert L., and Jeffrey Parsonnet. In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Nelson Textbook of Pediatrics. Ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

"Staphylococci." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

Rosalyn Carson-DeWitt, MD

Staphylococccal food poisoning *see* **Food poisoning**

Starvation

Definition

Starvation is the result of a serious, or total, lack of nutrients needed for the maintenance of life.

Description

Adequate **nutrition** has two components—necessary nutrients and energy in the form of calories. It is possible to ingest enough energy without a well-balanced selection of individual nutrients and produce diseases that are noticeably different from those resulting from an overall insufficiency of nutrients and energy. Although all foods are a source of energy for the organism, it is possible to consume a seemingly adequate amount of food without getting the required minimum of energy (calories). For example, marasmus is the result of a diet that is deficient mainly in energy. Children who get enough calories, but not enough protein have kwashiorkor. This is typical in cultures with a limited variety of foods that eat mostly a single staple carbohydrate like maize or rice. These conditions overlap and are associated with multiple vitamin and mineral deficits, most of which have specific names and set of problems associated with them.

- Marasmus produces a very skinny child with stunted growth.
- Children with kwashiorkor have body fat, an enlarged liver, and edema—swelling from excess water in the tissues. They also have growth retardation.
- Niacin deficiency produces **pellagra** characterized by **diarrhea**, skin **rashes**, brain dysfunction, tongue, mouth and vaginal irritation, and trouble swallowing.
- Thiamine (Vitamin B_1) deficiency causes **beriberi**, which can appear as **heart failure** and **edema**, a brain and nerve disease, or both.
- Riboflavin deficiency causes a sore mouth and throat, a skin rash, and anemia.
- Lack of vitamin C (ascorbic acid)—scurvy—causes hair damage, bleeding under the skin, in muscles and joints, gum disease, poor wound healing, and in severe cases convulsions, **fever**, loss of blood pressure, and **death**.
- Vitamin B_{12} is needed to keep the nervous system working right, and it and pyridoxine (vitamin B_6) are both necessary for blood formation.
- Vitamin A deficiency causes at first loss of night vision and eventually blindness from destruction of the cornea, a disease called keratomalacia.
- Vitamin K is necessary for blood clotting.
- Vitamin D regulates calcium balance. Without it, children get rickets and adults get osteomalacia.

Causes and symptoms

Starvation is caused by a number of factors. They include:

- anorexia nervosa
- fasting
- coma
- stroke
- famine
- severe gastrointestinal disease

Since the body will combat **malnutrition** by breaking down its own fat and eventually its own tissue, a whole host of symptoms can appear. The body's structure, as well as its functions, are affected.

Characteristic symptoms of starvation include:

- shrinkage of vital organs, such as the heart, lungs, and ovaries or testes, and their functions.
- chronic diarrhea
- anemia

- reduction in muscle mass and weakness because of it
- low body temperature
- decreased ability to digest food because of lack of digestive acid production
- irritability
- immune deficiency
- swelling from fluid under the skin
- decreased sex drive

In children, chronic malnutrition is marked by growth retardation. Anemia is the first sign to appear in an adult. Swelling of the legs is next, due to a drop in the protein content of the blood. Loss of resistance to infection follows next, along with poor wound healing. There is also progressive weakness and difficulty swallowing, which may lead to inhaling food. At the same time, the signs of specific nutrient deficiencies may appear.

Treatment

If the degree of malnutrition is severe, the intestines may not tolerate a fully balanced diet. They may, in fact, not be able to absorb adequate nutrition at all. Carefully prepared elemental **diets** or intravenous feeding must begin the treatment. The treatment back to health is long and first begins with liquids. Gradually, solid foods are introduced and a daily diet of 5,000 calories or more is instituted.

Prognosis

People can recover from severe degrees of starvation to a normal stature and function. Children may suffer from permanent **mental retardation** or growth defects if their deprivation was long and extreme.

Resources

BOOKS

Baron, Robert B. "Protein and Energy Malnutrition." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Denke, Margo, and Jean D. Wilson. "Protein and Energy Malnutrition." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Wilson, Jean D. "Vitamin Deficiency and Excess." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Stasis dermatitis *see* **Dermatitis**

Static encephalopathy *see* **Cerebral palsy**

STDs *see* **Sexually transmitted diseases**

KEY TERMS

Anemia—Not enough red blood cells in the blood.

Anorexia nervosa—Eating disorder marked by malnutrition and weight loss commonly occurring in young women.

Cornea—The clear part of the front of the eye, through which vision occurs.

Kwashiorkor—Severe malnutritution in children caused by mainly by a protein-poor diet, characterized by growth retardation.

Marasmus—Severe malnutritution in children caused by a diet lacking mainly in calories. Can also be caused by disease and parasitic infection.

Steatosis *see* **Fatty liver**

Steele-Richardson-Olszewski syndrome *see* **Progressive supranuclear palsy**

Stein-Leventhal syndrome *see* **Polycystic ovary syndrome**

Steinert's disease *see* **Myotonic dystrophy**

Stem cell therapy *see* **Bone marrow transplantation**

Sterilization *see* **Tubal ligation; Vasectomy**

Stillbirth

Definition

A stillbirth is defined as the **death** of a fetus at any time after the 20th week of **pregnancy**. Stillbirth is also referred to as intrauterine fetal death (IUFD).

Description

It is important to distinguish between a stillbirth and other words that describe the unintentional end of a pregnancy. A pregnancy that ends before the twentieth week is called a **miscarriage** rather than a stillbirth, even though the death of the fetus is a common cause of miscarriage. After the twentieth week, the unintended end of a pregnancy is called a stillbirth if the infant is dead at birth and premature delivery if it is born alive.

Factors that increase a mother's risk of stillbirth include: age over 35, **malnutrition**, inadequate prenatal care, **smoking**, and alcohol or drug abuse.

Causes and symptoms

Causes

A number of different disorders can cause stillbirth. They include:

- Pre-eclampsia and eclampsia. These are disorders of late pregnancy characterized by high blood pressure, fluid retention, and protein in the urine.
- Diabetes in the mother.
- Hemorrhage.
- Abnormalities in the fetus caused by infectious diseases, including **syphilis**, **toxoplasmosis**, German **measles** (**rubella**), and **influenza**.
- Severe **birth defects**, including **spina bifida**. Birth defects are responsible for about 20% of stillbirths.
- Postmaturity. Postmaturity is a condition in which the pregnancy has lasted 41 weeks or longer.
- Unknown causes. These account for about one third of stillbirths.

Symptoms

In most cases the only symptom of stillbirth is that the mother notices that the baby has stopped moving. In some cases, the first sign of fetal death is **premature labor**. Premature labor is marked by a rush of fluid from the vagina, caused by the tearing of the membrane around the baby; and by abdominal cramps or contractions.

Diagnosis

When the mother notices that fetal movement has stopped, the doctor can use several techniques to evaluate whether the baby has died. The doctor can listen for the fetal heartbeat with a stethoscope, use Doppler ultrasound to detect the heartbeat, or give the mother an electronic fetal nonstress test. In this test, the mother lies on her back with electronic monitors attached to her abdomen. The monitors record the baby's heart rate, movements, and contractions of the uterus.

Treatment

Medical

In most cases of intrauterine death, the mother will go into labor within two weeks of the baby's death. If the mother does not go into labor, the doctor will bring on (induce) labor in order to prevent the risk of hemorrhage. Labor is usually induced by giving the mother a drug (oxytocin) that cause the uterus to contract.

Follow-up therapy

Emotional support from family and friends, self-help groups, and counseling by a mental health professional can help bereaved parents cope with their loss.

Prognosis

With the exception of women with diabetes, women who have a stillbirth have as good a chance of carrying a future pregnancy to term as women who are pregnant for the first time.

Prevention

The risk of stillbirth can be lowered to some extent by good prenatal care and the mother's avoidance of exposure to infectious diseases, smoking, alcohol abuse, or drug consumption. Tests before delivery (**antepartum testing**), such as ultrasound, the alpha-fetoprotein blood test, and the electronic fetal nonstress test, can be used to evaluate the health of the fetus before there is a stillbirth.

Resources

BOOKS

Cunningham, F. Gary, et al. *Williams Obstetrics*. Stamford: Appleton & Lange, 1997.

Johnson, Robert V. *Mayo Clinic Complete Book of Pregnancy and Baby's First Year.* New York: William Morrow and Co., Inc.

ORGANIZATIONS

Compassionate Friends. P.O. Box 3696, Oak Brook, IL 60522. (877) 969-0010. <http:www/compassionatefriends.org>.

Hannah's Prayer. P.O. Box 5016, Auburn CA 95604. (775) 852-9202. <http://www.hannah.org>.

GriefNet. P.O. Box 3272, Ann Arbor, MI 48106. <http://riven dell.org>.

M.E.N.D. (Mommies Enduring Neonatal Death). P.O. Box 1007, Coppell, TX 75067. (972) 459-2396; (888) 695-6363. <http://www.mend.org/home_index.asp>.

Pregnancy and Infant Loss Support (SHARE). St. Joseph Health Center, 300 First Capitol Dr., St. Charles, MO 63301. (800) 821-6819. <http://www.nationalshareoffice.com/index.html>.

Carol A. Turkington

Stings *see* **Bites and stings**

Stomach acid determination *see* **Gastric acid determination**

KEY TERMS

Alpha-fetoprotein analysis—A blood test that can be done after the sixteenth week of pregnancy to evaluate the possibility of spina bifida and other birth defects in the fetus.

Electronic fetal nonstress test—A test in which electronic monitors attached to the mother's abdomen to detect contractions of the uterus as well as the baby's heartbeat and movements.

Miscarriage—The spontaneous end of a pregnancy before the twentieth week. The death of the fetus is a common cause of miscarriage.

Oxytocin—A drug that is given to induce labor in some cases of stillbirth.

Pre-eclampsia and eclampsia—Disorders of late pregnancy associated with high blood pressure, fluid retention, and protein in the urine. They can cause stillbirth.

Premature delivery—The birth of a live baby when a pregnancy ends spontaneously after the twentieth week.

Stomach cancer

Definition

Stomach **cancer** (also known as gastric cancer) is a disease in which the cells forming the inner lining of the stomach become abnormal and start to divide uncontrollably, forming a mass called a tumor.

Description

The stomach is a J-shaped organ that lies in the left and central portion of the abdomen. The stomach produces many digestive juices and acids that mix with food and aid in the process of digestion. There are five regions of the stomach that doctors refer to when determining the origin of stomach cancer. These are:

- the cardia, area surrounding the cardiac sphincter which controls movement of food from the esophagus into the stomach
- the fundus, upper expanded area adjacent to the cardiac region
- the antrum, lower region of the stomach where it begins to narrow
- the prepyloric, region just before or nearest the pylorus
- and the pylorus, the terminal region where the stomach joins the small intestine

Cancer can develop in any of the five sections of the stomach. Symptoms and outcomes of the disease will vary depending on the location of the cancer.

Based on previous data from the National Cancer Institute and the United States Census, the American Cancer Society estimates that 21,700 Americans will be diagnosed with stomach cancer during 2001 and approximately 13,000 deaths will result from the disease. In most areas, men are affected by stomach cancer nearly twice as often as women. Most cases of stomach cancer are diagnosed between the ages of 50 and 70, but in families with a hereditary risk of stomach cancer, younger cases are more frequently seen.

Stomach cancer is one of the leading causes of cancer deaths in several areas of the world, most notably Japan and other Asian countries. In Japan it appears almost ten times as frequently as in the United States. The number of new stomach cancer cases is decreasing in some areas, however, especially in developed countries. In the United States, incidence rates have dropped from 30 individuals per 100,000 in the 1930s, to only 8 in 100,000 individuals developing stomach cancer by the 1980s. The use of refrigerated foods and increased consumption of fresh fruits and vegetables, instead of preserved foods with high salt content, may be a reason for the decline.

Causes and symptoms

While the exact cause for stomach cancer has not been identified, several potential factors have lead to increased numbers of individuals developing the disease and therefore, significant risk has been associated. Diet, work environment, exposure to the bacterium *Helicobacter pylori*, and a history of stomach disorders such as ulcers or polyps are some of these believed causes.

Studies have shown that eating foods with high quantities of salt and nitrites increases the risk of stomach cancer. The diet in a specific region can have a great impact on its residents. Making changes to the types of foods consumed has been shown to decrease likelihood of disease, even for individuals from countries with higher risk. For example, Japanese people who move to the United States or Europe and change the types of foods they eat have a far lower chance of developing the disease than do Japanese people who remain in Japan and do not change their dietary habits. Eating recommended amounts of fruit and vegetables may lower a person's chances of developing this cancer.

A high risk for developing stomach cancers has been linked to certain industries as well. The best proven association is between stomach cancer and persons who work in coal mining and those who work processing timber, nickel, and rubber. An unusually large number of these workers have been diagnosed with this form of cancer.

Several studies have identified a bacterium (*Helicobacter pylori*) that causes stomach ulcers (inflammation in the inner lining of the stomach). Chronic (long-term) infection of the stomach with these bacteria may lead to a particular type of cancer (lymphomas or mucosa-associated lymphoid tissue [MALT]) in the stomach.

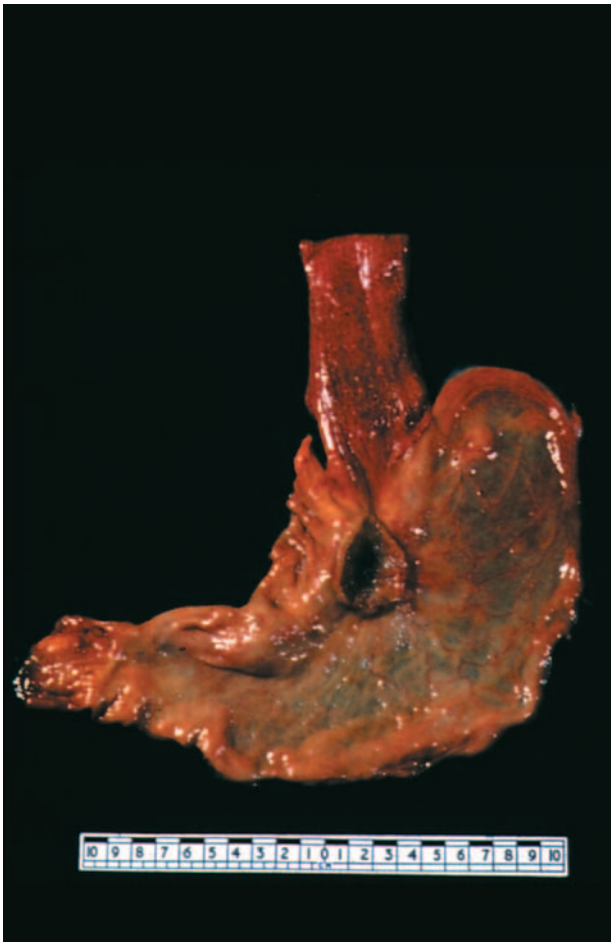
Another risk factor is the development of polyps, benign growths in the lining of the stomach. Although polyps are not cancerous, some may have the potential to turn cancerous. People in blood group A are also at elevated risk for this cancer for unknown reasons. Other speculative causes of stomach cancer include previous stomach surgery for ulcers or other conditions, or a form of anemia known as **pernicious anemia**.

Stomach cancer is a slow-growing cancer. It may be years before the tumor grows very large and produces distinct symptoms. In the early stages of the disease, the patient may only have mild discomfort, **indigestion**, **heartburn**, a bloated feeling after eating, and mild nausea. In the advanced stages, a patient will have loss of appetite and resultant weight loss, stomach pains, vomiting, difficulty in swallowing, and blood in the stool. Stomach cancer often spreads (metastasizes) to adjoining organs such as the esophagus, adjacent lymph nodes, liver, or colon.

Diagnosis

Unfortunately, many patients diagnosed with stomach cancer experience **pain** for two or three years before informing a doctor of their symptoms. When a doctor suspects stomach cancer from the symptoms described by the patient, a complete medical history will be taken to check for any risk factors. A thorough **physical examination** will be conducted to assess all the symptoms. Laboratory tests may be ordered to check for blood in the stool (**fecal occult blood test**) and anemia (low red blood cell count), which often accompany gastric cancer.

In some countries, such as Japan, it is appropriate for patients to be given routine screening examinations for stomach cancer, as the risk of developing cancer in that society is very high. Such screening might be useful for all high-risk populations. Due to the low prevalence of stomach cancer in the United States, routine screening is usually not recommended unless a family history of the disease exists.



An excised section of a human stomach showing a cancerous tumor (center, triangular shape). *(Custom Medical Stock Photo. Reproduced by permission.)*

Whether as a screening test or because a doctor suspects a patient may have symptoms of stomach cancer, endoscopy or barium x rays are used in diagnosing stomach cancer. For a barium x ray of the upper gastrointestinal tract, the patient is given a chalky, white solution of barium sulfate to drink. This solution coats the esophagus, the stomach, and the small intestine. Air may be pumped into the stomach after the barium solution in order to get a clearer picture. Multiple x rays are then taken. The barium coating helps to identify any abnormalities in the lining of the stomach.

In another more frequently used test, known as upper gastrointestinal endoscopy, a thin, flexible, lighted tube (endoscope) is passed down the patient's throat and into the stomach. The doctor can view the lining of the esophagus and the stomach through the tube. Sometimes, a small ultrasound probe is attached at the end of the endoscope. This probe sends high frequency sound waves that bounce off the stomach wall. A computer creates an

image of the stomach wall by translating the pattern of echoes generated by the reflected sound waves. This procedure is known as an endoscopic ultrasound or EUS.

Endoscopy has several advantages, in that the physician is able to see any abnormalities directly. In addition, if any suspicious-looking patches are seen, biopsy forceps can be passed painlessly through the tube to collect some tissue for microscopic examination. This is known as a biopsy. EUS is beneficial because it can provide valuable information on depth of tumor invasion.

After stomach cancer has been diagnosed and before treatment starts, another type of x-ray scan is taken. Computed tomography (CT) is an imaging procedure that produces a three-dimensional picture of organs or structures inside the body. CT scans are used to obtain additional information in regard to how large the tumor is and what parts of the stomach it borders; whether the cancer has spread to the lymph nodes; and whether it has spread to distant parts of the body (metastasized), such as the liver, lung, or bone. A CT scan of the chest, abdomen, and pelvis is taken. If the tumor has gone through the wall of the stomach and extends to the liver, pancreas, or spleen, the CT will often show this. Although a CT scan is an effective way of evaluating whether cancer has spread to some of the lymph nodes, it is less effective than EUS in evaluating whether the nodes closest to the stomach are free of cancer. However, CT scans, like barium x rays, have the advantage of being less invasive than upper endoscopy.

Laparoscopy is another procedure used to stage some patients with stomach cancer. This involves a medical device similar to an endoscope. A laparoscopy is a minimally invasive surgery technique with one or a few small incisions, which can be performed on an outpatient basis, followed by rapid recovery. Patients who may receive **radiation therapy** or **chemotherapy** before surgery may undergo a laparoscopic procedure to determine the precise stage of cancer. The patient with bone pain or with certain laboratory results should be given a bone scan.

Benign gastric neoplasms are tumors of the stomach that cause no major harm. One of the most common is called a submucosal leiomyoma. If a leiomyoma starts to bleed, surgery should be performed to remove it. However, many leiomyomas require no treatment. Diagnosis of stomach cancers should be conducted carefully so that if the tumor does not require treatment the patient is not subjected to a surgical operation.

Treatment

More than 95% of stomach cancers are caused by adenocarcinomas, malignant cancers that originate in glandular tissues. The remaining 5% of stomach cancers include lymphomas and other types of cancers. It is important that gastric lymphomas be accurately diagnosed because these cancers have a much better prognosis than stomach adenocarcinomas. Approximately half of the people with gastric lymphomas survive five years after diagnosis. Treatment for gastric lymphoma involves surgery combined with chemotherapy and radiation therapy.

Staging of stomach cancer is based on how deep the growth has penetrated the stomach lining; to what extent (if any) it has invaded surrounding lymph nodes; and to what extent (if any) it has spread to distant parts of the body (metastasized). The more confined the cancer, the better the chance for a cure.

One important factor in the staging of adenocarcinoma of the stomach is whether or not the tumor has invaded the surrounding tissue and, if it has, how deep it has penetrated. If invasion is limited, prognosis is favorable. Disease tissue that is more localized improves the outcome of surgical procedures performed to remove the diseased area of the stomach. This is called a resection of the stomach.

Several distinct ways of classifying stomach cancer according to cell type have been proposed. The Lauren classification is encountered most frequently. According to this classification system, gastric adenocarcinomas are either called intestinal or diffuse. Intestinal cancers are much like a type of intestinal cancer called intestinal carcinoma. Intestinal tumors are more frequently found in males and in older patients. The prognosis for these tumors is better than that for diffuse tumors. Diffuse tumors are more likely to infiltrate, that is, to move into another organ of the body.

Because symptoms of stomach cancer are so mild, treatment often does not commence until the disease is well advanced. The three standard modes of treatment for stomach cancer include surgery, radiation therapy, and chemotherapy. While deciding on the patient's treatment plan, the doctor takes into account many factors. The location of the cancer and its stage are important considerations. In addition, the patient's age, general health status, and personal preferences are also taken into account.

Surgery

In the early stages of stomach cancer, surgery may be used to remove the cancer. Surgical removal of adenocarcinoma is the only treatment capable of eliminating the disease. Laparoscopy is often used before surgery to investigate whether or not the tumor can be removed surgically. If the cancer is widespread and cannot be removed with surgery, an attempt will be made to remove blockage and control symptoms such as pain or bleeding. Depending on the location of the cancer, a portion of the

stomach may be removed, a procedure called a partial **gastrectomy**. In a surgical procedure known as total gastrectomy, the entire stomach may be removed. However, doctors prefer to leave at least part of the stomach if possible. Patients who have been given a partial gastrectomy achieve a better quality of life than those having a total gastrectomy and typically lead normal lives. Even when the entire stomach is removed, the patients quickly adjust to a different eating schedule. This involves eating small quantities of food more frequently. High-protein foods are generally recommended.

Partial or total gastrectomy is often accompanied by other surgical procedures. Lymph nodes are frequently removed and nearby organs, or parts of these organs, may be removed if cancer has spread to them. Such organs may include the pancreas, colon, or spleen.

Preliminary studies suggest that patients who have tumors that cannot be removed by surgery at the start of therapy may become candidates for surgery later. Combinations of chemotherapy and radiation therapy are sometimes able to reduce disease for which surgery is not initially appropriate. Preliminary studies are being performed to determine if some of these patients can become candidates for surgical procedures after such therapies are applied.

Chemotherapy

Whether or not patients undergoing surgery for stomach cancer should receive chemotherapy is a controversial issue. Chemotherapy involves administering anti-cancer drugs either intravenously (through a vein in the arm) or orally (in the form of pills). This can either be used as the primary mode of treatment or after surgery to destroy any cancerous cells that may have migrated to distant sites. Most cancers of the gastrointestinal tract do not respond well to chemotherapy, however, adenocarcinoma of the stomach and advanced stages of cancer are exceptions.

Chemotherapy medicines such as doxorubicin, mitomycin C, and 5-fluorouracil, used alone, provide benefit to at least one in five patients. Combinations of agents may provide even more benefit, although it is not certain that this includes longer survival. For example, some doctors use what is called the FAM regimen, which combines 5-fluorouacil, doxorubicin, and mitomycin. Some doctors prefer using 5-fluorouracil alone to FAM since side effects are more moderate. Another combination some doctors are using involve high doses of the medications methotrexate, 5- fluorouracil, and doxorubicin. Other combinations that have shown benefit include the ELF regimen, a combination of leucovorin, 5- fluorouracil, and etoposide. The EAP regimen, a combination of etoposide, doxorubicin, and cisplatin is also used.

Although chemotherapy using a single medicine is sometimes used, the best response rates are often achieved with combinations of medicines. Therefore, in addition to studies exploring the effectiveness of new medicines there are other studies attempting to evaluate how to best combine existing forms of chemotherapy to bring the greatest degree of help to patients.

Radiation therapy

Radiation therapy is often used after surgery to destroy the cancer cells that may not have been completely removed during surgery. To treat stomach cancer, external beam radiation therapy is generally used. In this procedure, high-energy rays from a machine that is outside of the body are concentrated on the area of the tumor. In the advanced stages of gastric cancer, radiation therapy is used to ease symptoms such as pain and bleeding. However, studies of radiation treatment for stomach cancer have shown that the way it has been used it has been ineffective for many patients.

Researchers are actively assessing the role of chemotherapy and radiation therapy used before a surgical procedure is conducted. They are searching for ways to use both chemotherapy and radiation therapy so that they increase the length of survival of patients more effectively than current methods are able to do.

Prognosis

Overall, approximately 20% of patients with stomach cancer live at least five years following diagnosis. Patients diagnosed with stomach cancer in its early stages have a far better prognosis than those for whom it is in the later stages. In the early stages, the tumor is small, lymph nodes are unaffected, and the cancer has not migrated to the lungs or the liver. Unfortunately, only about 20% of patients with stomach cancer are diagnosed before the cancer had spread to the lymph nodes or formed a distant metastasis.

It is important to remember that statistics on prognosis may be misleading. Newer therapies are being developed rapidly and five-year survival has not yet been measured with these. Also, the largest group of people diagnosed with stomach cancer are between 60 and 70 years of age, suggesting that some of these patients die not from cancer but from other age-related diseases. As a result, some patients with stomach cancer may be expected to have longer survival than did patients just ten years ago.

KEY TERMS

Adenocarcinoma—Malignant cancers that originate in the tissues of glands or that form glandular structures.

Anemia—A condition in which iron levels in the blood are low.

Barium x ray (upper GI)—An x-ray test of the upper part of the gastrointestinal (GI) tract (including the esophagus, stomach, and a small portion of the small intestine) after the patient is given a white, chalky barium sulfate solution to drink. This substance coats the upper GI and the x rays reveal any abnormality in the lining of the stomach and the upper GI.

Biopsy—Removal of a tissue sample for examination under the microscope to check for cancer cells.

Chemotherapy—Treatment of cancer with synthetic drugs that destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Endoscopic ultrasound (EUS)—A medical procedure in which sound waves are sent to the stomach wall by an ultrasound probe attached to the end of an endoscope. The pattern of echoes generated by the reflected sound waves are translated into an image of the stomach wall by a computer.

External radiation therapy—Radiation therapy that focuses high-energy rays from a machine on the area of the tumor.

Infiltrate—A tumor that moves into another organ of the body.

Polyp—An abnormal growth that develops on the inside of a hollow organ such as the colon, stomach, or nose.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Total gastrectomy—Surgical removal (excision) of the entire stomach.

Upper endoscopy—A medical procedure in which a thin, lighted, flexible tube (endoscope) is inserted down the patient's throat. Through this tube the doctor can view the lining of the esophagus, stomach, and the upper part of the small intestine.

Prevention

Avoiding many of the risk factors associated with stomach cancer may prevent its development. Excessive amounts of salted, smoked, and pickled foods should be avoided, as should foods high in nitrates. A diet that includes recommended amounts of fruits and vegetables is believed to lower the risk of several cancers, including stomach cancer. The American Cancer Society recommends eating at least five servings of fruits and vegetables daily and choosing six servings of food from other plant sources, such as grains, pasta, beans, cereals, and whole grain bread.

Abstaining from tobacco and excessive amounts of alcohol will reduce the risk for many cancers. In countries where stomach cancer is common, such as Japan, early detection is important for successful treatment.

Resources

BOOKS

Braunwald, Eugene, et al. *Harrison's Principles of Internal Medicine*. 15th ed. New York: McGraw-Hill, 2001.

Herfindal Eric T., and Dick R. Gourley. *Textbook of Therapeutics: Drug and Disease Management*. 7th ed. Philadelphia: Lippincott Williams & Wilkins, 2000.

Humes, H. David, ed. *Kelley's Textbook of Internal Medicine*. Philadelphia: Lippincott Williams & Wilkins, 2000.

Pazdur, Richard, et al. *Cancer Management: A Multidisciplinary Approach: Medical, Surgical, & Radiation Oncology*. 4th ed. Melville, NY: PRR, 2000.

Souhami, Robert, and Jeffrey Tobias. *Cancer and Its Management*. 3rd ed. London: Blackwell Science, 1998.

Steen, Grant, and Joseph Mirro. *Childhood Cancer: A Handbook from St. Jude Children's Research Hospital*. Cambridge, MA: Perseus Publishing, 2000.

ORGANIZATIONS

National Coalition for Cancer Survivorship. 1010 Wayne Ave., 7th Floor, Silver Spring, MD 20910-5600. (301) 650-9127 or (877) NCCS-YES. <http://www.cansearch.org>.

What You Need to Know About Stomach Cancer. and *PDQ Treatment—Patients: Gastric Cancer.* The National Cancer Institute. (800) 4-CANCER. <http://www.nci.nih.gov>.

Stomach Cancer: Detection and Symptoms, Stomach Cancer: Prevention and Risk Factors, Stomach Cancer: Treatment, and *Stomach Cancer: What Is It?* American Cancer Society. (800) ACS-2345. <http://www.cancer.org>.

Lata Cherath
Bob Kirsch

Stomach flu *see* **Gastroenteritis**

Stomach flushing

Definition

Stomach flushing is the repeated introduction of fluids into the stomach through a nasogastric tube, and their subsequent withdrawal by **nasogastric suction**.

KEY TERMS

Electrolytes—Salts and minerals that ionize in body fluids. Common human electrolytes are sodium chloride, potassium, calcium, and sodium bicarbonate. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost any major biochemical reaction in the body.

Saline—A salt water solution that mimics the concentration of electrolytes in the blood.

Purpose

Stomach flushing is performed to aid in controlling gastrointestinal bleeding or to cleanse the stomach of poisons.

Controlling stomach bleeding

Bleeding from the esophagus due to ruptured veins or bleeding from the stomach due to ulcers is a medical emergency. In an attempt to stop the bleeding, the stomach is flushed with large quantities of body-temperature saline solution or ice water. This procedure is called stomach flushing or gastric lavage.

Stomach flushing to control bleeding is not uniformly accepted, and some experts believe it is of little benefit and exposes the patient to unnecessary risks. It is usually done in conjunction with the administration of drugs to constrict the blood vessels.

Stomach flushing to remove poisons

At one time, stomach flushing was common practice to remove certain poisons. Recent thinking by the American Academy of Clinical Toxicology is that stomach flushing should not be used routinely with poisoned patients. It is useful only if the patient has swallowed a life-threatening quantity of poison, and when the flushing can be done within 60 minutes of having swallowed the poison.

Precautions

In **poisoning** cases, stomach flushing should not be used if the poison is a strong corrosive acid (hydrochloric acid, sulfuric acid), alkali (lye, ammonia), or a volatile hydrocarbon such as gasoline. Stomach flushing should also not be done on patients who are having convulsions. Patients who are losing or have lost consciousness must have their airways intubated before a nasogastric tube is inserted.

Description

Stomach flushing is performed in a hospital emergency room or intensive care unit by an emergency room physician or gastroenterologist. A nasogastric tube is inserted, and small amounts of saline or ice water are introduced into the stomach and withdrawn. The procedure is repeated until the withdrawn fluid is clear.

Preparation

Little preparation is necessary for this procedure other than educating the patient as to what will happen. The patient should remove dental appliances before the nasogastric tube is inserted.

Aftercare

After stomach flushing, the patient's vital signs will be monitored. Checks will be made for fluid and electrolyte imbalances. If necessary, additional treatment to prevent gastrointestinal bleeding or poisoning will be done.

Risks

In poisoning cases, stomach flushing delays the administration of activated charcoal, which may be more beneficial to treating the patient than flushing the stomach. In addition, stomach flushing may stimulate bleeding from the esophagus or stomach. The patient may inhale some of the stomach contents, causing aspiration, **pneumonia**, or infection in the lungs. Fluid and electrolyte imbalances are more likely to occur in older, sicker patients. Mechanical damage to the throat is more likely in patients who are uncooperative.

Normal results

Stomach flushing is usually tolerated by patients and is a temporary treatment, performed in conjunction with other therapies.

Resources

BOOKS

"Stomach Flushing." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

PERIODICALS

"Gastric Lavage (The AACT/EAPCCT Position Statements on Gastrointestinal Decontamination)." *Journal of Toxicology: Clinical Toxicology* 35, no. 7 (Dec. 1997): 771.

Tish Davidson

Stomach removal *see* **Gastrectomy**

Stomach resection *see* **Gastrectomy**

Stomatitis

Definition

Inflammation of the mucous lining of any of the structures in the mouth, which may involve the cheeks, gums, tongue, lips, and roof or floor of the mouth. The word "stomatitis" literally means inflammation of the mouth. The inflammation can be caused by conditions in the mouth itself, such as poor **oral hygiene**, poorly fitted dentures, or from mouth **burns** from hot food or drinks, or by conditions that affect the entire body, such as medications, allergic reactions, or infections.

Description

Stomatitis is an inflammation of the lining of any of the soft-tissue structures of the mouth. Stomatitis is usually a painful condition, associated with redness, swelling, and occasional bleeding from the affected area. **Bad breath** (halitosis) may also accompany the condition. Stomatitis affects all age groups, from the infant to the elderly.

Causes and symptoms

A number of factors can cause stomatitis. Poorly fitted oral appliances, cheek biting, or jagged teeth can persistently irritate the oral structures. Chronic mouth breathing due to plugged nasal airways can cause dryness of the mouth tissues, which in turn leads to irritation. Drinking beverages that are too hot can burn the mouth, leading to irritation and **pain**. Diseases, such as herpetic infections (the **common cold** sore), **gonorrhea**, **measles**, leukemia, **AIDS**, and lack of vitamin C can present with oral signs. Aphthous stomatitis, also known as "canker sores," is a specific type of stomatitis that presents with shallow, painful ulcers that are usually located on the lips, cheeks, gums, or roof or floor of the mouth. These ulcers can range from pinpoint size to up to 1 in (2.5 cm) or more in diameter. Though the causes of **canker sores** is unknown, nutritional deficiencies, especially of vitamin B_{12}, folate, or iron is suspected. Generalized stomatitis can result from excessive use of alcohol, spices, hot food, or tobacco products. Sensitivity to mouthwashes, toothpastes, and lipstick can irritate the lining of the mouth. Exposure to heavy metals, such as mercury, lead, or bismuth can cause stomatitis. Thrush, a fungal infection, is a type of stomatitis.

Diagnosis

Diagnosis of stomatitis can be difficult. A patient's history may disclose a dietary deficiency, a systemic disease, or contact with materials causing an allergic reaction. A **physical examination** is done to evaluate the oral lesions and other skin problems. Blood tests may be done to determine if any infection is present. Scrapings of the lining of the mouth may be sent to the laboratory for microscopic evaluation, or cultures of the mouth may be done to determine if an infectious agent may be the cause of the problem.

Treatment

The treatment of stomatitis is based on the problem causing it. Local cleansing and good oral hygiene is fundamental. Sharp-edged foods such as peanuts, tacos, and potato chips should be avoided. A soft-bristled toothbrush should be used, and the teeth and gums should be brushed carefully; the patient should avoid banging the toothbrush into the gums. Local factors, such as ill-fitting dental appliances or sharp teeth, can be corrected by a dentist. An infectious cause can usually be treated with medication. Systemic problems, such as AIDS, leukemia, and anemia are treated by the appropriate medical specialist. Minor mouth burns from hot beverages or hot foods will usually resolve on their own in a week or so. Chronic problems with aphthous stomatitis are treated by first correcting any vitamin B_{12}, iron, or folate deficiencies. If those therapies are unsuccessful, medication can be prescribed which can be applied to each aphthous ulcer with a cotton-tipped applicator. This therapy is successful with a limited number of patients.

Alternate treatment

Alternate treatment of stomatitis mainly involves prevention of the problem. Patients with dental appliances such as dentures should visit their dentist on a regular basis. Patients with systemic diseases or chronic medical problems need to ask their health care provider what types of oral problems they can expect from their particular disease. These patients must also contact their medical clinic at the first sign of problems. Common

KEY TERMS

Aphthous stomatitis—A specific type of stomatitis presenting with shallow, painful ulcers. Also known as *canker sores*.

Stomatitis—Inflammation of the lining of the mouth, gums, or tongue.

Thrush—A form of stomatitis caused by *Candida* fungi and characterized by cream-colored or bluish patches on the tongue, mouth, or pharynx.

sense needs to be exercised when consuming hot foods or drinks. Use of tobacco products should be discouraged. Alcohol should be used in moderation. Mouthwashes and toothpastes known to the patient to cause problems should be avoided.

Botanical medicine can assist in resolving stomatitis. One herb, calendula (*Calendula officinalis*), in tincture form (an alcohol-based herbal extract) and diluted for a mouth rinse, can be quite effective in treating aphthous stomatitis and other manifestations of stomatitis.

Prognosis

The prognosis for the resolution of stomatitis is based on the cause of the problem. Many local factors can be modified, treated, or avoided. Infectious causes of stomatitis can usually be managed with medication, or, if the problem is being caused by a certain drug, by changing the offending agent.

Prevention

Stomatitis caused by local irritants can be prevented by good oral hygiene, regular dental checkups, and good dietary habits. Problems with stomatitis caused by systemic disease can be minimized by good oral hygiene and closely following the medical therapy prescribed by the patients' health care provider.

Resources

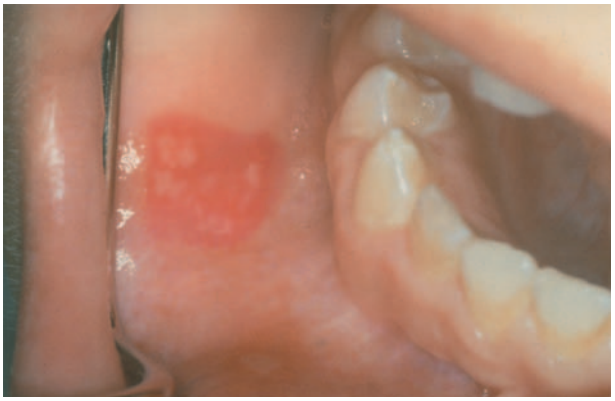
BOOKS

Conn's Current Therapy, 1996. Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

The Merck Manual. Ed. Robert Berkow. Rahway, NJ: Merck Sharp & Dohme Research Laboratories, 1987.

ORGANIZATIONS

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.



This patient is afflicted with stomatitis, a common inflammatory disease of the mouth. *(Photograph by Edward H. Gill, Custom Medical Stock Photo. Reproduced by permission.)*

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Joseph Knight, PA

Stone removal *see* **Gallstone removal**

Stool culture

Definition

Stool culture is a test to identify bacteria in patients with a suspected infection of the digestive tract. A sample of the patient's feces is placed in a special medium where bacteria is then grown. The bacteria that grow in the culture are identified using a microscope and biochemical tests.

Purpose

Stool culture is performed to identify bacteria or other organisms in persons with symptoms of gastrointestinal infection, most commonly **diarrhea**. Identification of the organism is necessary to determine how to treat the patient's infection.

Precautions

Stool culture is only performed if an infection of the digestive tract is suspected. The test has no harmful effects.

Description

Stool culture may also be called fecal culture. To obtain a specimen for culture, the patient is asked to

collect a stool sample into a special sterile container. In some cases, the container may contain a transport solution. Specimens may need to be collected on three consecutive days. It is important to return the specimen to the doctor's office or the laboratory in the time specified by the physician or nurse. Laboratories do not accept stool specimens contaminated with water, urine, or other materials.

The culture test involves placing a sample of the stool on a special substance, called a medium, that provides nutrients for certain organisms to grow and reproduce. The medium is usually a thick gel-like substance. The culture is done in a test tube—or on a flat round culture plate—which is incubated at the proper temperature for growth of the bacteria. After a colony of bacteria grows in the medium, the type of bacteria is identified by observing the colony's growth, its physical characteristics, and its microscopic features. The bacteria may be dyed with special stains that make it easier to identify features specific to particular bacteria.

The length of time needed to perform a stool culture depends on the laboratory where it is done and the culture methods used. Stool culture usually takes 72 hours or longer to complete. Some organisms may take several weeks to grow in a culture.

An antibiotic sensitivity test may be done after a bacteria is identified. This test shows which **antibiotics** will be most effective for treating the infection.

Although most intestinal infections are caused by bacteria, in some cases a fungal or viral culture may be necessary. The most common bacterial infections of the digestive tract are caused by *Shigella*, *Salmonella*, *Campylobacter*, and *Yersinia*. Patients taking certain antibiotics may be susceptible to infection with *Clostridium difficile*. In some cases, as with *Clostridium difficile*, the stool culture is used to detect the toxin (poison or harmful chemical) produced by the bacteria.

Patients with **AIDS**, or other immune system diseases, may also have gastrointestinal infections caused by fungal organisms such as *Candida*, or viral organisms including cytomegalovirus.

Several intestinal parasites may cause gastrointestinal infection and diarrhea. Parasites are not cultured, but are identified microscopically in a test called "Stool Ova and Parasites."

Insurance coverage for stool culture may vary among different insurance plans. This common test usually is covered if ordered by a physician approved by the patient's insurance plan, and if it is done at an approved laboratory.

KEY TERMS

Bismuth—A substance used in medicines to treat diarrhea, nausea, and indigestion.

Enteric—Pertaining to the intestine.

Enterotoxigenic—Refers to an organism that produces toxins in the gastrointestinal tract that cause such things as vomiting, diarrhea, and other symptoms of food poisoning.

Feces—Material excreted by the intestines.

Flora—Refers to normal bacteria found in a healthy person.

Gastrointestinal—Referring to the digestive tract; the stomach and intestines.

Psyllium hydrophilic mucilloid—A plant material contained in some laxatives.

Sterile—Free of microorganisms.

Toxin—A poison; usually refers to protein poisons produced by bacteria, animals, and some plants.

Preparation

The physician, or other healthcare provider, will ask the patient for a complete medical history and perform a **physical examination** to determine possible causes of the gastrointestinal problem. Information about the patient's diet, any medications taken, and recent travel may provide clues to the identity of possible infectious organisms.

Stool culture normally doesn't require any special preparation. Patients do not need to change their diet before collecting the specimen. Intake of some substances can contaminate the stool specimen and should not be taken the day before collection. These substances include castor oil, bismuth, and laxative preparations containing psyllium hydrophilic mucilloid.

Normal results

Bacteria that are normally found in the intestines include *Pseudomonas* and ***Escherichia coli***. These enteric bacteria (bacteria of the gastrointestinal system) are considered normal flora and usually do not cause infection in the digestive tract.

Abnormal results

Bacteria that do not normally inhabit the digestive tract, and that are known to cause gastrointestinal infec-

tion include *Shigella*, *Salmonella*, *Campylobacter*, and *Yersinia*. *Clostridium difficile* produces a toxin that can cause severe diarrhea. Other bacteria that produce toxins are *Staphylococcus aureus*, *Bacillus cereus*, and enterotoxigenic (producing disease in the digestive system) *Escherichia coli*. Although *Escherichia coli* is a normal bacteria found in the intestines, the enterotoxigenic type of this bacteria can be acquired from eating contaminated meat, juice, or fruits. It produces a toxin that causes severe inflammation and bleeding of the colon.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Toni Rizzo

Stool fat test

Definition

Stool fats, also known as fecal fats, or fecal lipids, are fats that are excreted in the feces. When secretions from the pancreas and liver are adequate, emulsified dietary fats are almost completely absorbed in the small intestine. When a malabsorption disorder or other cause disrupts this process, excretion of fat in the stool increases.

Purpose

This test evaluates digestion of fats by determining excessive excretion of lipids in patients exhibiting signs of malabsorption, such as weight loss, abdominal distention, and scaly skin.

Precautions

Drugs that may increase fecal fat levels include **enemas** and **laxatives**, especially mineral oil. Drugs that may decrease fecal fat include Metamucil and barium. Other substances that can affect test results include alcohol, potassium chloride, calcium carbonate, neomycin, kanamycin, and other broad-spectrum **antibiotics**.

Description

Excessive excretion of fecal fat is called steatorrhea, a condition that is suspected when the patient has large, "greasy," and foul-smelling stools. Both digestive and absorptive disorders can cause steatorrhea. Digestive disorders affect the production and release of the enzyme lipase from the pancreas, or bile from the liver, which are substances that aid digestion of fats; absorptive disorders disturb the absorptive and enzyme functions of the intestine. Any condition that causes malabsorption or maldigestion is also associated with increased fecal fat. As an example, children with **cystic fibrosis** have mucous plugs that block the pancreatic ducts. The absence or significant decrease of the pancreatic enzymes, amylase, lipase, trypsin, and chymotrypsin, limits fat protein and carbohydrate digestion, resulting in steatorrhea due to fat malabsorption.

Both qualitative and quantitative tests are used to identify excessive fecal fat. The qualitative test involves staining a specimen of stool with a special dye, then examining it microscopically for evidence of malabsorption, such as undigested muscle fiber and various fats. The quantitative test involves drying and weighing a 72-hour stool specimen, then using an extraction technique to separate the fats, which are subsequently evaporated and weighed. This measurement of the total output of fecal fat per 24 hours in a three-day specimen is the most reliable test for steatorrhea.

Preparation

This test requires a 72-hour stool collection. The patient should abstain from alcohol during this time and maintain a high-fat diet (100 g/day) for three days before the test, and during the collection period. The patient should call the laboratory for instructions on how to collect the specimen.

Normal results

Reference values vary from laboratory to laboratory, but are generally found within the range of 5–7 g/24 hr.

It should be noted that children, especially infants, cannot ingest the 100 g/day of fat that is suggested for the test. Therefore, a fat retention coefficient is determined by measuring the difference between ingested fat and fecal fat, and expressing that difference as a percentage. The figure, called the fat retention coefficient, is 95% or greater in healthy children and adults. A low value is indicative of steatorrhea.

Abnormal results

Increased fecal fat levels are found in cystic fibrosis, malabsorption secondary to other conditions like Whipple's disease or **Crohn's disease**, maldigestion sec-

ondary to pancreatic or bile duct obstruction, and "short-gut" syndrome secondary to surgical resection, bypass, or congenital anomaly.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Stool O & P test

Definition

The stool O & P test is the stool ova and parasites test. In this test, a stool sample is examined for the presence of intestinal parasites and their eggs, which are called ova.

Purpose

The ova and parasites test is performed to look for and identify intestinal parasites and their eggs in persons with symptoms of gastrointestinal infection. Patients may have no symptoms, or experience **diarrhea**, blood in the stools, and other gastrointestinal distress. Identification of a particular parasite indicates the cause of the patient's disease and determines the medication needed to treat it.

Precautions

Stool O & P is performed if an infection of the digestive tract is suspected. The test has no harmful effects.

Description

Examination of the stool for ova and parasites is done to diagnose parasitic infection of the intestines. The test may be done in the doctor's office or a laboratory. The patient collects a stool sample in one or more sterile containers containing special chemical fixatives. The feces should be collected directly into the container. It must not be contaminated with urine, water, or other materials. Three specimens are often needed—collected every other day, or every third day. However, as many as six specimens may be needed to diagnose the amoeba *Entamoeba histolytica*. The specimen does not need to be refrigerated. It should be delivered to the doctor's office or laboratory within 12 hours.

In the laboratory, the stool sample is observed for signs of parasites and their eggs. Some parasites are large enough to be seen without a microscope. For others, microscope slides are prepared with fresh unstained stool, and with stool dyed with special stains. These preparations are observed with a microscope for the presence of parasites or their eggs.

An unstained stool examination for ova and parasites normally only takes a few minutes. If specimen staining and other preparation is done, the test may take longer. When the specimen is sent to a laboratory, the results may take 8 to 24 hours to be reported.

The most common intestinal parasites in North America that cause infections are:

- roundworms: *Ascaris lumbricoides*
- hookworms: *Necator americanus*
- pinworms: *Enterobius follicularis*
- tapeworms: *Diphyllobothrium latum*, *Taenia saginata*, and *Taenia solium*
- protozoa: *Entamoeba histolytica* (an amoeba), and *Giardia lamblia* (a flagellate)

Numerous other parasites are found in other parts of the world. These may be contracted by travelers to other countries. Patients with acquired immune deficiency syndrome (**AIDS**) or other immune system disorders are commonly infected with the parasites in the *Microsporidia* family, *Cryptosporidium*, and *Isospora belli*.

Insurance coverage for stool ova and parasites may vary among different insurance plans. This test usually is covered if ordered by a physician approved by the patient's insurance plan, and if it is done at an approved laboratory.

Preparation

The physician, or other healthcare provider, will ask the patient for a complete medical history, and perform a **physical examination** to determine possible causes of the gastrointestinal symptoms. Information about the patient's diet, any medications taken, and recent travel may provide clues to the identity of possible infectious parasites.

Collecting a stool sample for ova and parasite detection normally doesn't require any special preparation. Patients do not need to change their diet before collecting the specimen. Patients should avoid taking any medications or treatments containing mineral oil, castor oil, or bismuth, magnesium or other antidiarrheal medicines, or **antibiotics** for seven to 10 days before collecting the specimen.

KEY TERMS

Amoeba—A type of protozoa (one-celled animal) that can move or change its shape by extending projections of its cytoplasm.

Bismuth—A substance used in medicines to treat diarrhea, nausea, and indigestion.

Cryptosporidium—A type of parasitic protozoa.

Feces—Material excreted by the intestines.

Flagellate—A microorganism that uses flagella (hair-like projections) to move.

Gastrointestinal—Referring to the digestive tract; the stomach and intestines.

Isospora belli—A type of parasitic protozoa.

Microsporida—A type of parasitic protozoa.

Ova—Eggs.

Parasite—An organism that lives on or inside another living organism (host), causing damage to the host.

Pathogenic—Disease-causing.

Protozoa—One-celled eukaryotic organisms belonging to the kingdom Protista.

Sterile—Free of microorganisms.

Normal results

Normally, parasites and eggs should not be found in stools. Some parasites are not pathogenic, which means they do not cause disease. If these are found, no treatment is necessary.

Abnormal results

The presence of any pathogenic parasite indicates an intestinal parasitic infection. Depending on the parasite identified, other tests may need to be performed to determine if the parasite has invaded other parts of the body. Some parasites travel from the intestines to other parts of the body and may already have caused damage to other tissues by the time a diagnosis is made. For example, the roundworm, *Ascaris* penetrates the intestinal wall and can cause inflammation in the abdomen. It can also migrate to the lungs and cause **pneumonia**. This kind of injury can occur weeks before the roundworm eggs show up in the stool.

Other types of damage caused by intestinal parasites include anemia due to hemorrhage caused by hookworms, and anemia caused by depletion of vitamin B_{12} through the action of tapeworms.

When a parasite is identified, the patient can be treated with the appropriate medications to eliminate the parasite.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Toni Rizzo

Stool occult blood test *see* **Fecal occult blood test**

Stool ova and parasites test *see* **Stool O & P test**

Strabismus

Definition

Strabismus is a condition in which the eyes do not point in the same direction. It can also be referred to as a tropia or squint.

Description

Strabismus occurs in 2–5% of all children. About half are born with the condition, which causes one or both eyes to turn:

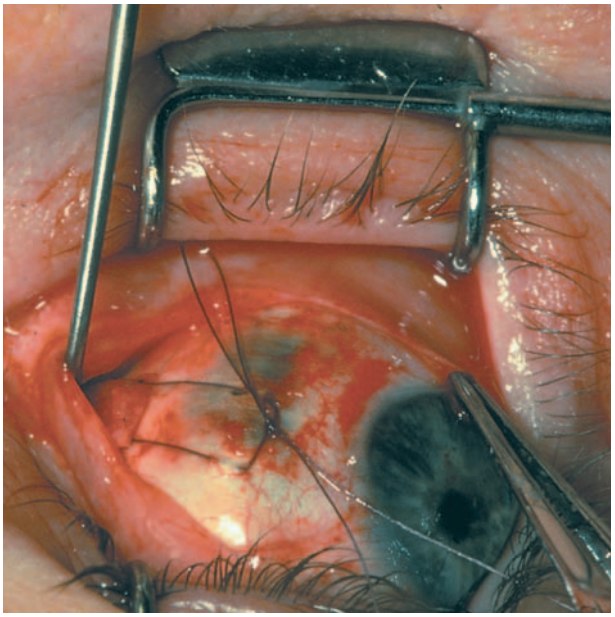
- inward (esotropia or "crossed eyes")
- outward (exotropia or "wall eyes")
- upward (hypertropia)
- downward (hypotropia)

Strabismus is equally common in boys and girls. It sometimes runs in families.

Types of strabismus

Esotropia is the most common type of strabismus in infants. Accommodative esotropia develops in children under age two who cross their eyes when focusing on objects nearby. This usually occurs in children who are moderately to highly farsighted (hyperopic).

Another common form of strabismus, exotropia, may only be noticeable when a child looks at far-away objects, daydreams, or is tired or sick.



A close-up of ophthalmic surgery being performed to correct strabismus. *(Photograph by Michael English, M.D. Custom Medical Stock Photo. Reproduced by permission.)*

Sometimes the eye turn is always in the same eye; however sometimes the turn alternates from one eye to the other.

Most children with strabismus have comitant strabismus. No matter where they look, the degree of deviation does not change. In incomitant strabismus, the amount of misalignment depends upon which direction the eyes are pointed.

False strabismus (pseudostrabismus)

A child may appear to have a turned eye, however this appearance may actually be due to:

- extra skin that covers the inner corner of the eye
- a broad, flat nose
- eyes set unusually close together or far apart

This condition, false strabismus, usually disappears as the child's face grows. An eye doctor needs to determine whether the eyeturn is true or pseudostrabismus.

With normal vision, both eyes send the brain the same message. This binocular fixation (both eyes looking directly at the same object) is necessary to see three-dimensionally and to aid in depth perception. When an eye is misaligned, the brain receives two different images. Young children learn to ignore distorted messages from a misaligned eye, but adults with strabismus often develop double vision (diplopia).

A baby's eyes should be straight and parallel by three or four months of age. A child who develops strabismus after the age of eight or nine years is said to have adult-onset strabismus.

Causes and symptoms

Strabismus can be caused by a defect in muscles or the part of the brain that controls eye movement. It is especially common in children who have:

- brain tumors
- cerebral palsy
- down syndrome
- hydrocephalus
- other disorders that affect the brain

Diseases that cause partial or total blindness can cause strabismus. So can extreme farsightedness, **cataracts**, eye injury, or having much better vision in one eye than the other.

In adults, strabismus is usually caused by:

- diabetes
- head trauma
- stroke
- brain tumor
- other diseases affecting nerves that control eye muscles

The most obvious symptom of strabismus is an eye that isn't always straight. The deviation can vary from day to day or during the day. People who have strabismus often squint in bright sunlight or tilt their heads to focus their eyes.

Diagnosis

Every baby's eyes should be examined by the age of six months. A baby whose eyes have not straightened by the age of four months should be examined to rule out serious disease.

A pediatrician, family doctor, ophthalmologist, or optometrist licensed to use diagnostic drugs uses drops that dilate the pupils and temporarily paralyze eye-focusing muscles to evaluate visual status and ocular health. Early diagnosis is important. Some eye turns may be a result of a tumor. Untreated strabismus can damage vision in the unused eye and possibly result in lazy eye (**amblyopia**).

Treatment

Preserving or restoring vision and improving appearance may involve one or more of the following:

- glasses to aid in focusing and straighten the eye(s)
- patching to force infants and young children to use and straighten the weaker eye
- eye drops or ointments as a substitute for patching or glasses, or to make glasses more effective
- surgery to tighten, relax, or reposition eye muscles
- medication injected into an overactive eye muscle to allow the opposite muscle to straighten the eye
- vision training (also called eye exercises)

Prognosis

Early consistent treatment usually improves vision and appearance. The most satisfactory results are achieved if the condition is corrected before the age of seven years old.

Resources

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Academy of Pediatric Ophthalmology and Strabismus (AAPOS). <http://med-aapos.bu.edu>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

OTHER

"Strabismus." *The American Academy of Opthamology Page*. 7 May 1998 <http://www.aao.org>.

"Strabismus (Crossed Eyes)." *The Eye Station Page*. 8 May 1998 <http://www.theeyestation.com>.

Maureen Haggerty

Strawberry marks *see* **Birthmarks**

Strengthening exercises *see* **Exercise**

Strep culture *see* **Throat culture**

Strep test *see* **Streptococcal antibody tests**

Strep throat

Definition

Streptococcal **sore throat**, or strep throat as it is more commonly called, is an infection of the mucous membranes lining the pharynx. Sometimes the tonsils are also infected (**tonsillitis**). The disease is caused by group A *Streptococcus* bacteria. Untreated strep throat may develop into **rheumatic fever** or other serious conditions.

Description

Strep throat accounts for between 5–10% of all sore throats. Although anyone can get strep throat, it is most common in school-age children. People who smoke, who are fatigued, run down, or who live in damp, crowded conditions are also more likely to become infected. Children under age two and adults who are not around children are less likely to get the disease.

Strep throat occurs most frequently from November to April. The disease passes directly from person to person by coughing, sneezing, and close contact. Very occasionally the disease is passed through food, when a food handler infected with strep throat accidentally contaminates food by coughing or sneezing. Statistically, if someone in the household is infected, one out of every four other household members may get strep throat within two to seven days.

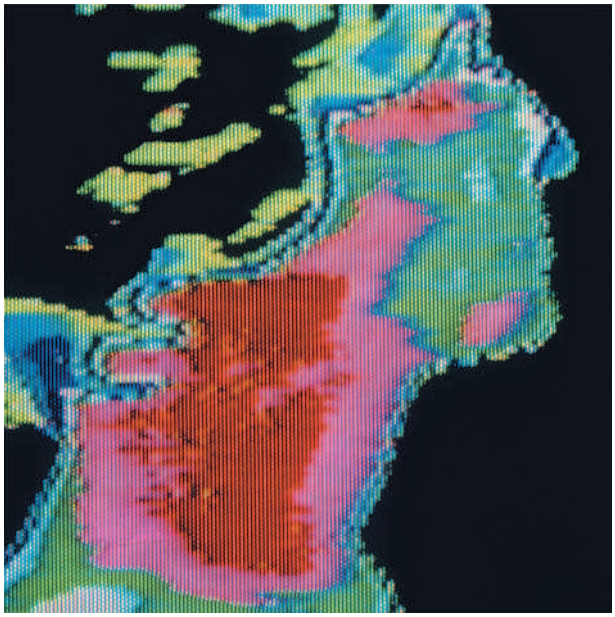
Causes and symptoms

A person with strep throat suddenly develops a painful sore throat one to five days after being exposed to the streptococcus bacteria. The **pain** is indistinguishable from sore throats caused by other diseases.

The infected person usually feels tired and has a **fever**, sometimes accompanied by chills, **headache**, muscle aches, swollen lymph glands, and nausea. Young children may complain of abdominal pain. The tonsils look swollen and are bright red, with white or yellow patches of pus on them. Sometimes the roof of the mouth is red or has small red spots. Often a person with strep throat has **bad breath**.

Despite these common symptoms, strep throat can be deceptive. It is possible to have the disease and not show any of these symptoms. Many young children complain only of a headache and stomachache, without the characteristic sore throat.

Occasionally, within a few days of developing the sore throat, an individual may develop a fine, rough, sunburn-like rash over the face and upper body, and have a fever of 101–104°F (38.3–40°C). The tongue becomes bright red, with a flecked, strawberry-like appearance. When a rash develops, this form of strep throat is called **scarlet fever**. The rash is a reaction to toxins released by the streptococcus bacteria. Scarlet fever is no more dangerous than strep throat, and is treated the same way. The rash disappears in about five days. One to three weeks later, patches of skin may peel off, as might occur with a **sunburn**, especially on the fingers and toes.



A thermographic image showing a streptococcal sore throat, or strep throat. *(Photograph by Howard Sochurek, The Stock Market. Reproduced by permission.)*

Untreated strep throat can cause rheumatic fever. This is a serious illness, although it occurs rarely. The most recent outbreak appeared in the United States in the mid-1980s. Rheumatic fever occurs most often in children between the ages of five and 15, and may have a genetic component, since it seems to run in families. Although the strep throat that causes rheumatic fever is contagious, rheumatic fever itself is not.

Rheumatic fever begins one to six weeks after an untreated streptococcal infection. The joints, especially the wrists, elbows, knees, and ankles become red, sore, and swollen. The infected person develops a high fever, and possibly a rapid heartbeat when lying down, paleness, **shortness of breath**, and fluid retention. A red rash over the trunk may come and go for weeks or months. An acute attack of rheumatic fever lasts about three months.

Rheumatic fever can cause permanent damage to the heart and heart valves. It can be prevented by promptly treating **streptococcal infections** with **antibiotics**. It does not occur if all the streptococcus bacteria are killed within the first 10–12 days after infection.

In the 1990s, outbreaks of a virulent strain of group A *Streptococcus* were reported to cause a toxic-shock-like illness and a severe invasive infection called necrotizing fasciitis, which destroys skin and muscle tissue. Although these diseases are caused by group A *Streptococci*, they rarely begin with strep throat. Usually the streptococcus bacteria enters the body through a skin wound. These complications are rare. However, since the **death** rate in necrotizing fasciitis is 30–50%, it is wise to seek prompt treatment for any streptococcal infection.

Diagnosis

Diagnosis of a strep throat by a doctor begins with a **physical examination** of the throat and chest. The doctor will also look for signs of other illness, such as a sinus infection or **bronchitis**, and seek information about whether the patient has been around other people with strep throat. If it appears that the patient may have strep throat, the doctor will do laboratory tests.

There are two types of tests to determine if a person has strep throat. A rapid strep test can only determine the presence of streptococcal bacteria, but will not tell if the sore throat is caused by another kind of bacteria. The results are available in about 20 minutes. The advantage of this test is the speed with which a diagnosis can be made.

The rapid strep test has a false negative rate of about 20%. In other words, in about 20% of cases where no strep is detected by the rapid strep test, the patient actually does have strep throat. Because of this, when a rapid strep test is negative, the doctor often does a **throat culture**.

For a rapid strep test or a throat culture, a nurse will use a sterile swab to reach down into the throat and obtain a sample of material from the sore area. The procedure takes only a few seconds, but may cause gagging.

For a throat culture a sample of swabbed material is cultured, or grown, in the laboratory on a medium that allows technicians to determine what kind of bacteria are present. Results take 24–48 hours. The test is very accurate and will show the presence of other kinds of bacteria besides *Streptococci*. It is important not to take any leftover antibiotics before visiting the doctor and having a throat culture. Even small amounts of antibiotics can suppress the bacteria and mask its presence in the throat culture.

In the event that rheumatic fever is suspected, the doctor does a blood test. This test, called an antistreptolysin-O test, will tell the doctor whether the person has recently been infected with strep bacteria. This helps the doctor distinguish between rheumatic fever and **rheumatoid arthritis**.

Treatment

Strep throat is treated with antibiotics. Penicillin is the preferred medication. Oral penicillin must be taken for 10 days. Patients need to take the entire amount of antibiotic prescribed and not discontinue taking the medication when they feel better. Stopping the antibiotic early can lead to a return of the strep infection. Occasion-

ally, a single injection of long-acting penicillin (Bicillin) is given instead of 10 days of oral treatment.

About 10% of the time, penicillin is not effective against the strep bacteria. When this happens a doctor may prescribe other antibiotics such as amoxicillin (Amoxil, Pentamox, Sumox, Trimox), clindamycin (Cleocin), or a cephalosporin (Keflex, Durocef, Ceclor). Erythromycin (Eryzole, Pediazole, Ilosone), another inexpensive antibiotic, is given to people who are allergic to penicillin. Scarlet fever is treated with the same antibiotics as strep throat.

Without treatment, the symptoms of strep throat begin subsiding in four or five days. However, because of the possibility of getting rheumatic fever, it is important to treat strep throat promptly with antibiotics. If rheumatic fever does occur, it is also treated with antibiotics. Anti-inflammatory drugs, such as steroids, are used to treat joint swelling. **Diuretics** are used to reduce water retention. Once the rheumatic fever becomes inactive, children may continue on low doses of antibiotics to prevent a reoccurrence. Necrotizing fasciitis is treated with intravenous antibiotics.

Home care for strep throat

There are home care steps that people can take to ease the discomfort of their strep symptoms.

- Take **acetaminophen** or ibuprofen for pain. **Aspirin** should not be given to children because of its association with an increase in **Reye's Syndrome**, a serious disease.
- Gargle with warm double-strength tea or warm salt water, made by adding one teaspoon of salt to eight ounces of water, to relieve sore throat pain.
- Drink plenty of fluids, but avoid acidic juices like orange juice because they irritate the throat.
- Eat soft, nutritious foods like noodle soup. Avoid spicy foods.
- Avoid smoke and smoking.
- Rest until the fever is gone, then resume strenuous activities gradually.
- Use a room humidifier, as it may make sore throat sufferers more comfortable.
- Be aware that antiseptic lozenges and sprays may aggravate the sore throat rather than improve it.

Alternative treatment

Alternative treatment focuses on easing the symptoms of strep throat through herbs and botanical medicines. Some practitioners suggest using these treatments in addition to antibiotics, since they primarily address the comfort of the patient and not the underlying infection. Many practitioners recommend *Lactobacillus acidophilus* to offset the suppressive effects of antibiotics on the beneficial bacteria of the intestines.

Some suggested treatments include:

- Inhaling fragrances of the essential oils of lavender (*Lavandula officinalis*), thyme (*Thymus vulgaris*), eucalyptus (*Eucalyptus globulus*), sage (*Salvia officinalis*), and sandalwood (Aromatherapy).
- Gargling with a mixture of water, salt, and tumeric (*Curcuma longa*) powder or astringents, such as alum, sumac, sage, and bayberry (Ayurvedic medicine).
- Taking osha root (*Ligusticum porteri*) internally for infection or drinking tea made of sage, **echinacea** (*Echinacea* spp.) and cleavers (*Gallium aparine*). Osha root has an unpleasant taste many children will not accept (Botanical medicine).

Prognosis

Patients with strep throat begin feeling better about 24 hours after starting antibiotics. Symptoms rarely last longer than five days.

People remain contagious until after they have been taking antibiotics for 24 hours. Children should not return to school or childcare until they are no longer contagious. Food handlers should not work for the first 24 hours after antibiotic treatment, because strep infections are occasionally passed through contaminated food. People who are not treated with antibiotics can continue to spread strep bacteria for several months.

About 10% of strep throat cases do not respond to penicillin. People who have even a mild sore throat after a 10-day treatment with antibiotic should return to their doctor. An explanation for this may be that the person is just a carrier of strep, and that something else is causing the sore throat.

Taking antibiotics within the first week of a strep infection will prevent rheumatic fever and other complications. If rheumatic fever does occur, the outcomes vary considerably. Some cases may be cured. In others there may be permanent damage to the heart and heart valves. In rare cases, rheumatic fever can be fatal.

Necrotizing fasciitis has a death rate of 30–50%. Patients who survive often suffer a great deal of tissue and muscle loss. Fortunately, this complication of a streptococcus infection is very rare.

Prevention

There is no way to prevent getting a strep throat. However, the risk of getting one or passing one on to another person can be minimized by:

KEY TERMS

Lactobacillus acidophilus—A bacteria found in yogurt that changes the balance of the bacteria in the intestine in a beneficial way.

- washing hands well and frequently, especially after nose blowing or sneezing and before food handling
- disposing of used tissues properly
- avoiding close contact with someone who has a strep throat
- not sharing food and eating utensils with anyone
- not smoking

Resources

BOOKS

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

OTHER

"Group A Streptococcal Infections." *National Institute of Allergy and Infectious Diseases Page*. 22 Feb. 1998 <http://www.niaid.nih.govfactsheets/strep.htm.>.

Tish Davidson

Streptobacillary rat-bite fever *see* **Rat-bite fever**

Streptococcal antibody tests

Definition

Streptococcal infections are caused by a microorganism called *Streptococcus*. Three streptococcal antibody tests are available: the antistreptolysin O titer (ASO), the antideoxyribonuclease-B titer (anti-Dnase-B, or ADB), and the streptozyme test.

Purpose

The antistreptolysin O titer, or ASO, is ordered primarily to determine whether a previous group A *Streptococcus* infection has caused a poststreptococcal disease, such as **scarlet fever**, **rheumatic fever**, or a kidney disease called **glomerulonephritis**.

The anti-DNase-B (ADB) test is performed to determine a previous infection of a specific type of *Streptococcus*, group A beta-hemolytic *Streptococcus*. Identification of infections of this type are particularly important in suspected cases of acute rheumatic **fever** (ARF) or acute glomerulonephritis.

Streptozyme is a screening test used to detect antibodies to several streptococcal antigens. An antigen is a substance that can trigger an immune response, resulting in production of an antibody as part of the body's defense against infection and disease.

Precautions

For the ASO test, increased levels of fats, called beta lipoproteins, in the blood can neutralize streptolysin O and cause a false-positive ASO titer. **Antibiotics**, which reduce the number of streptococci and thereby suppress ASO production, may decrease ASO levels. Steroids, which suppress the immune system, consequently may also suppress ASO production. Also Group A streptococcal infections of the skin may not produce an ASO response. Antibiotics also may decrease anti-DNase-B (ADB) levels.

Description

Streptococcal infections are caused by bacteria known as *Streptococcus*. There are several disease-causing strains of streptococci (groups A, B, C, D, and G), which are identified by their behavior, chemistry, and appearance. Each group causes specific types of infections and symptoms. These antibody tests are useful for group A streptococci. Group A streptococci are the most virulent species for humans and are the cause of **strep throat**, **tonsillitis**, wound and skin infections, blood infections (septicemia), scarlet fever, **pneumonia**, rheumatic fever, **Sydenham's chorea** (formerly called St. Vitus' dance), and glomerulonephritis.

Although symptoms may suggest a streptococcal infection, the diagnosis must be confirmed by tests. The best procedure, and one that is used for an acute infection, is to take a sample from the infected area for culture, a means of growing bacteria artificially in the laboratory. However, cultures are useless about two to three weeks after initial infection, so the ASO, anti-DNase-B, and streptozyme tests are used to determine if a streptococcal infection is present.

Antistreptolysin O titer (ASO)

The ASO titer is used to demonstrate the body's reaction to an infection caused by group A beta-hemolytic streptococci. Group A streptococci produce the

KEY TERMS

Antibody—A protein manufactured by a type of white blood cells called lymphocytes, in response to the presence of an antigen, or foreign protein, in the body. Because bacteria, viruses, and other organisms commonly contain many antigens, antibodies are formed against these foreign proteins to neutralize or destroy the invaders.

Antigen—A substance that can trigger a defensive response in the body, resulting in production of an antibody as part of the body's defense against infection and disease. Many antigens are foreign proteins not found naturally in the body, and include bacteria, viruses, toxins, and tissues from another person used in organ transplantation.

Glomerulonephritis—An inflammation of the glomeruli, the filtering units of the kidney. Damage to these structures hampers removal of waste products, salt, and water from the bloodstream, which may cause serious complications. This disorder can be mild and cause no symptoms, or so severe enough to cause kidney failure.

Rheumatic fever—A disease that causes inflammation in various body tissues. Rare in most developed countries, but reported to be on the increase again in parts of the United States. Joint inflammation occurs, but more serious is the frequency with which the disease permanently damages the heart. The nervous system may also be affected, causing Sydenham's chorea.

Sydenham's chorea—A childhood disorder of the central nervous system. Once called St. Vitus' dance, the condition is characterized by involuntary, jerky movements that usually follow an attack of rheumatic fever. Rare in the United States today, but a common disorder in developing countries. Usually resolves in two to three months with no long-term adverse effects.

enzyme streptolysin O, which can destroy (lyse) red blood cells. Because streptolysin O is antigenic (contains a protein foreign to the body), the body reacts by producing antistreptolysin O (ASO), which is a neutralizing antibody. ASO appears in the blood serum one week to one month after the onset of a strep infection. A high titer (high levels of ASO) is not specific for any type of poststreptococcal disease, but it does indicate if a streptococcal infection is or has been present.

Serial (several given in a row) ASO testing is often performed to determine the difference between an acute or convalescent blood sample. The diagnosis of a previous strep infection is confirmed when serial titers of ASO rise over a period of weeks, then fall slowly. ASO titers peak during the third week after the onset of acute symptoms of a streptococcal disease; at six months after onset, approximately 30% of patients exhibit abnormal titers.

Antideoxyribonuclease-B titer (anti-DNase B, or ADB)

Anti-DNase-B, or ADB, also detects antigens produced by group A strep, and is elevated in most patients with rheumatic fever and poststreptococcal glomerulonephritis. This test is often done concurrently with the ASO titer, and subsequent testing is usually performed to detect differences in the acute and convalescent blood samples. When ASO and ADB are performed concurrently, 95% of previous strep infections are detected. If both are repeatedly negative, the likelihood is that the patient's symptoms are not caused by a poststreptococcal disease.

When evaluating patients with acute rheumatic fever, the American Heart Association recommends the ASO titer rather than ADB. Even though the ADB is more sensitive than ASO, its results are too variable. It also should be noted that, while ASO is the recommended test, when ASO and ADB are done together, the combination is better than either ASO or ADB alone.

Streptozyme

The streptozyme test is often used as a screening test for antibodies to the streptococcal antigens NADase, DNase, streptokinase, streptolysin O, and hyaluronidase. This test is most useful in evaluating suspected poststreptococcal disease following *Streptococcus pyogenes* infection, such as rheumatic fever.

Streptozyme has certain advantages over ASO and ADB. It can detect several antibodies in a single assay, it is technically quick and easy, and it is unaffected by factors that can produce false-positives in the ASO test. The disadvantages are that, while it detects different antibodies, it does not determine which one has been detected, and it is not as sensitive in children as in adults. In fact, borderline antibody elevations, which could be signifi-

cant in children, may not be detected at all. As with the ASO and ADB, a serially rising titer is more significant than a single determination.

Preparation

These tests are performed on blood specimens drawn from the patient's vein. The patient does not need to fast before these tests.

Risks

The risks associated with these tests are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after the blood is drawn, or blood accumulating under the puncture site (hematoma).

Normal results

Antistreptolysin O titer:

- adult: 160 Todd units/ml
- child: six months to two years: 50 Todd units/ml ;two to 4 years: 160 Todd units/ml; five to 12 years: 170–330 Todd units/ml
- Newborn: similar to the mother's value

Antideoxyribonuclease-B titer:

- Adult: 85 units
- Child (preschool): 60 units
- Child (school age): 170 units

Streptozyme: less than 100 streptozyme units.

Abnormal results

Antistreptolysin O titer: Increased levels are seen after the second week of an untreated infection in acute streptococcal infection, and are also increased with acute rheumatic fever, acute glomerulonephritis (66% of patients will not have high ASO titers), and scarlet fever.

Antideoxyribonuclease-B titer: Increased titers are seen in cases of acute rheumatic fever and poststreptococcal glomerulonephritis.

Streptozyme: As this is a screening test for antibodies to streptococcal antigens, increased levels require more definitive tests to confirm diagnosis.

Resources

BOOKS

Cahill, Mathew. *Handbook of Diagnostic Tests*. Springhouse, PA: Springhouse Corporation, 1995.

Jacobs, David S., et al. *Laboratory Test Handbook*. 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Janis O. Flores

Streptococcal gangrene *see* **Gangrene**

Streptococcal infections

Definition

Streptococcal (strep) infections are communicable diseases that develop when bacteria normally found on the skin or in the intestines, mouth, nose, reproductive tract, or urinary tract invade other parts of the body and contaminate blood or tissue.

Some strep infections don't produce symptoms. Some are fatal.

Description

Most people have some form of strep bacteria in their body at some time. A person who hosts bacteria without showing signs of infection is considered a carrier.

Types of infection

Primary strep infections invade healthy tissue, and most often affect the throat. Secondary strep infections invade tissue already weakened by injury or illness. They frequently affect the bones, ears, eyes, joints, or intestines.

Both primary and secondary strep infections can travel from affected tissues to lymph glands, enter the bloodstream, and spread throughout the body.

Numerous strains of strep bacteria have been identified. Types A, B, C, D, and G are most likely to make people sick.

Group A

Group A strep (GAS) is the form of strep bacteria most apt to be associated with serious illness.

Between 10,000 and 15,000 GAS infections occur in the United States every year. Most are mild inflammations of the throat or skin, where the bacteria are normally found; however, GAS infections can be deadly.

Two of the most severe invasive GAS infections are necrotizing fasciitis or flesh-eating bacteria (destruction of muscle tissue and fat) and **toxic shock syndrome** (a rapidly progressive disorder that causes **shock** and damages internal organs).

GROUP B. Group B strep (GBS) most often affects pregnant women, infants, the elderly, and chronically ill adults.

Since first emerging in the 1970s, GBS has been the primary cause of life-threatening illness and **death** in newborns. GBS exists in the reproductive tract of 20-25% of all pregnant women. Although no more than 2% of these women develop invasive infection, 40-73% transmit bacteria to their babies during delivery.

About 12,000 of the 3.5 million babies born in the United States each year develop GBS disease in infancy. About 75% of them develop early-onset infection. Sometimes evident within a few hours of birth and always apparent within the first week of life, this condition causes inflammation of the membranes covering the brain and spinal cord (**meningitis**), **pneumonia**, blood infection (**sepsis**), and other problems.

Late-onset GBS develops between the ages of seven days and three months. It often causes meningitis. About half of all cases of this rare condition can be traced to mothers who are GBS carriers. The cause of the others is unknown.

GBS has also been linked to a history of **breast cancer**.

GROUP C. Group C strep (GCS) is a common source of infection in animals. It rarely causes human illness.

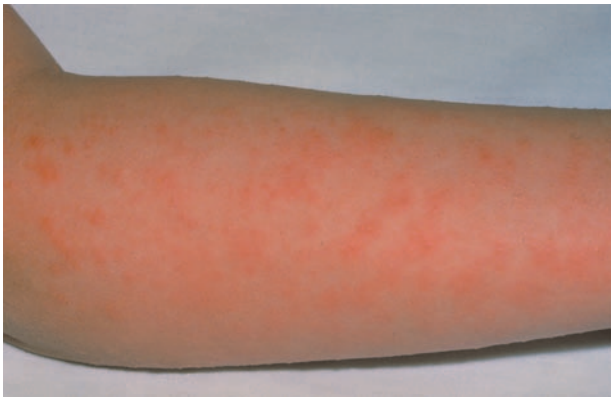
GROUP D. Group D strep (GDS) is a common cause of wound infections in hospital patients. GDS is also associated with:

- abnormal growth of tissue in the gastrointestinal tract
- urinary tract infection (UTI)
- womb infections in women who have just given birth

GROUP G. Normally present on the skin, in the mouth and throat, and in the intestines and genital tract, Group G strep (GGS) is most likely to lead to infection in alcoholics and in people who have **cancer**, **diabetes mellitus**, **rheumatoid arthritis**, and other conditions that suppress immune-system activity.

GGS can cause a variety of infections, including:

- bacteria in the bloodstream (bacteremia)
- inflammation of the connective tissue structure surrounding a joint (bursitis)
- endocarditis (a condition that affects the lining of the heart chambers and the heart valves)
- meningitis
- inflammation of bone and bone marrow (osteomyelitis)
- inflammation of the lining of the abdomen (peritonitis)



The scarlet fever rash on this person's arm was caused by a streptococcal infection. *(Custom Medical Stock Photo. Reproduced by permission.)*

Causes and symptoms

Streptococcal infection occurs when bacteria contaminate cuts or open sores or otherwise penetrate the body's natural defenses.

GAS

GAS is transmitted by direct contact with saliva, nasal discharge, or open **wounds** of someone who has the infection. Chronic illness, kidney disease treated by dialysis, and steroid use increase vulnerability to infection.

About one of five people with GAS infection develops a sore, inflamed throat, and pus on the tonsils. The majority of those infected by GAS either have no symptoms or develop enlarged lymph nodes, **fever**, **headache**, nausea, vomiting, weakness, and a rapid heartbeat.

Flesh-eating bacteria is characterized by fever, extreme **pain**, and swelling and redness at a site where skin is broken.

Symptoms of toxic shock include abdominal pain, confusion, **dizziness**, and widespread red skin rash.

GBS

A pregnant woman who has GBS infection can develop infections of the bladder, blood, and urinary tract, and deliver a baby who is infected or stillborn. The risk of transmitting GBS infection during birth is highest in a woman whose labor begins before the 37th week of **pregnancy** or lasts more than 18 hours or who:

- becomes a GBS carrier during the final stages of pregnancy
- has a GBS urinary-tract infection
- has already given birth to a baby infected with GBS

• develops a fever during labor

More than 13% of babies who develop GBS infection during birth or within the first few months of life develop neurologic disorders. An equal number of them die.

Among men, and in women who are not pregnant, the most common consequences of GBS infection are pneumonia and infections of blood, skin, and soft tissue.

Miscellaneous symptoms

Other symptoms associated with strep infection include:

• anemia

• elevated white blood cell counts

• inflammation of the epiglottis (epiglottitis)

• heart murmur

• high blood pressure

• infection of the heart muscle

• kidney inflammation (**nephritis**)

• swelling of the face and ankles

Diagnosis

Strep bacteria can be obtained by swabbing the back of the throat or the rectum with a piece of sterile cotton. Microscopic examination of the smear can identify which type of bacteria has been collected.

Treatment

Penicillin and other **antibiotics** are used to treat strep infections.

It takes less than 24 hours for antibiotics to eliminate an infected person's ability to transmit GAS.

Guidelines developed by the American Academy of Obstetrics and Gynecology (AAOG), the American Academy of Pediatrics (AAP), and the Centers for Disease Control and Prevention (CDC) recommend administering intravenous antibiotics to a woman at high risk of passing GBS infection on to her child, and offering the medication to any pregnant woman who wants it.

Initiating antibiotic therapy at least four hours before birth allows medication to become concentrated enough to protect the baby during passage through the birth canal.

Babies infected with GBS during or shortly after birth may die. Those who survive often require lengthy hospital stays and develop vision or **hearing loss** and other permanent disabilities.

Alternative treatment

Conventional medicine is very successful in treating strep infections. However, several alternative therapies, including **homeopathy** and botanical medicine, may help relieve symptoms or support the person with a strep infection. For example, several herbs, including garlic (*Allium sativum*), **echinacea** (*Echinacea* spp.), and goldenseal (*Hydrastis canadensis*), are believed to strengthen the immune system, thus helping the body fight a current infection, as well as helping prevent future infections.

Prognosis

GAS is responsible for more than 2,000 deaths a year. About 20% of people infected with flesh-eating bacteria die. So do three of every five who develop toxic shock syndrome.

Early-onset GBS kills 15% of the infants it affects. Late-onset disease claims the lives of 10% of babies who develop it.

GBS infections are fatal in about 20% of the men and non-pregnant women who develop them.

About 10–15% of non-GAS strep infections are fatal. Antibiotic therapy, begun when symptoms first appear, may increase a patient's chance of survival.

Prevention

Washing the hands frequently, especially before eating and after using the bathroom, and keeping wounds clean can help prevent strep infection. Exposure to infected people should be avoided, and a family physician should be notified by anyone who develops an extremely **sore throat** or pain, redness, swelling, or drainage at the site of a wound or break in the skin.

Until vaccines to prevent strep infection become available, 12 monthly doses of oral or injected antibiotics may prevent some types of recurrent infection.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

OTHER

"Group A Streptococcus." *Centers for Disease Control*. 6 June 1998 <http://www.cdc.gov/ncidod/diseases/bacter/strep_a.htm>.

"Group B Streptococcus." *Centers for Disease Control*. 6 June 1998 <http://www.cdc.gov/ncidod/diseases/bacter/strep_b.htm>.

"Infectious Diseases." *The Merck Page.* 17 June 1998 <http://www.merck.com>.

Maureen Haggerty

Streptococcal sore throat *see* **Strep throat**

Streptococcal toxic shock syndrome *see* **Toxic shock syndrome**

Streptomycin *see* **Aminoglycosides**

Streptozyme test *see* **Streptococcal antibody tests**

Stress

Definition

Stress is defined as an organism's total response to environmental demands or pressures. When stress was first studied in the 1950s, the term was used to denote both the causes and the experienced effects of these pressures. More recently, however, the word stressor has been used for the stimulus that provokes a stress response. One recurrent disagreement among researchers concerns the definition of stress in humans. Is it primarily an external response that can be measured by changes in glandular secretions, skin reactions, and other physical functions, or is it an internal interpretation of, or reaction to, a stressor; or is it both?

Description

Stress in humans results from interactions between persons and their environment that are perceived as straining or exceeding their adaptive capacities and threatening their well- being. The element of perception indicates that human stress responses reflect differences in personality, as well as differences in physical strength or general health.

Risk factors for stress-related illnesses are a mix of personal, interpersonal, and social variables. These factors include lack or loss of control over one's physical environment, and lack or loss of social support networks. People who are dependent on others (e.g., children or the elderly) or who are socially disadvantaged (because of race, gender, educational level, or similar factors) are at greater risk of developing stress-related illnesses. Other risk factors include feelings of helplessness, hopelessness, extreme fear or anger, and cynicism or distrust of others.

Causes and symptoms

The causes of stress can include any event or occurrence that a person considers a threat to his or her coping strategies or resources. Researchers generally agree that a certain degree of stress is a normal part of a living organism's response to the inevitable changes in its physical or social environment, and that positive, as well as negative, events can generate stress as well as negative occurrences. Stress-related disease, however, results from excessive and prolonged demands on an organism's coping resources.

The symptoms of stress can be either physical and psychological. Stress-related physical illnesses, such as **irritable bowel syndrome**, heart attacks, and chronic headaches, result from long-term overstimulation of a part of the nervous system that regulates the heart rate, blood pressure, and digestive system. Stress-related emotional illness results from inadequate or inappropriate responses to major changes in one's life situation, such as marriage, completing one's education, becoming a parent, losing a job, or retirement. Psychiatrists sometimes use the term adjustment disorder to describe this type of illness. In the workplace, stress-related illness often takes the form of burnout—a loss of interest in or ability to perform one's job due to long-term high stress levels.

Diagnosis

When the doctor suspects that a patient's illness is connected to stress, he or she will take a careful history that includes stressors in the patient's life (family or employment problems, other illnesses, etc.). Many physicians will evaluate the patient's personality as well, in order to assess his or her coping resources and emotional response patterns. There are a number of personality inventories and **psychological tests** that doctors can use to help diagnose the amount of stress that the patient experiences and the coping strategies that he or she uses to deal with them. Stress-related illness can be diagnosed by primary care doctors, as well as by those who specialize in psychiatry. The doctor will need to distinguish between **adjustment disorders** and **anxiety** or **mood disorders**, and between psychiatric disorders and physical illnesses (e.g., thyroid activity) that have psychological side effects.

Treatment

Recent advances in the understanding of the many complex connections between the human mind and body have produced a variety of mainstream approaches to stress-related illness. Present treatment regimens may include one or more of the following:

Top Ten Stressful Life Events

Death of spouse
Divorce
Marital separation
Jail term or death of close family member
Personal injury or illness
Marriage
Loss of job due to termination
Marital reconciliation or retirement
Pregnancy
Change in financial state

- Medications. These may include drugs to control blood pressure or other physical symptoms of stress, as well as drugs that affect the patient's mood (tranquilizers or antidepressants).
- Stress management programs. These may be either individual or group treatments, and usually involve analysis of the stressors in the patient's life. They often focus on job or workplace related stress.
- Behavioral approaches. These strategies include relaxation techniques, breathing exercises, and physical **exercise** programs including walking.
- Massage. Therapeutic massage relieves stress by relaxing the large groups of muscles in the back, neck, arms, and legs.
- Cognitive therapy. These approaches teach patients to reframe or mentally reinterpret the stressors in their lives in order to modify the body's physical reactions.
- Meditation and associated spiritual or religious practices. Recent studies have found positive correlations between these practices and stress hardiness.

Alternative treatments

Treatment of stress is one area in which the boundaries between traditional and alternative therapies have changed in recent years, in part because some forms of physical exercise (**yoga**, **tai chi**, aikido) that were once associated with the counterculture have become widely accepted as useful parts of mainstream **stress reduction** programs. Other alternative therapies for stress, which are occasionally recommended by mainstream medicine, include **aromatherapy**, dance therapy, nutrition-based treatments (including dietary guidelines and nutritional supplements), **acupuncture**, **homeopathy**, and herbal medicine.

Prognosis

The prognosis for recovery from a stress-related illness is related to a wide variety of factors in a person's life, many of which are genetically determined (race, sex, illnesses that run in families) or beyond the individual's control (economic trends, cultural stereotypes and prejudices). It is possible, however, for humans to learn new responses to stress and, thus, change their experiences of it. A person's ability to remain healthy in stressful situations is sometimes referred to as stress hardiness. Stress-hardy people have a cluster of personality traits that strengthen their ability to cope. These traits include believing in the importance of what they are doing; believing that they have some power to influence their situation; and viewing life's changes as positive opportunities rather than as threats.

KEY TERMS

Adjustment disorder—A psychiatric disorder marked by inappropriate or inadequate responses to a change in life circumstances. Depression following retirement from work is an example of adjustment disorder.

Burnout—An emotional condition, marked by tiredness, loss of interest, or frustration, that interferes with job performance,. Burnout is usually regarded as the result of prolonged stress.

Stress hardiness—A personality characteristic that enables persons to stay healthy in stressful circumstances. It includes belief in one's ability to influence the situation; being committed to or fully engaged in one's activities; and having a positive view of change.

Stress management—A category of popularized programs and techniques intended to help people deal more effectively with stress.

Stressor—A stimulus, or event, that provokes a stress response in an organism. Stressors can be categorized as acute or chronic, and as external or internal to the organism.

Prevention

Complete prevention of stress is neither possible nor desirable, because stress is an important stimulus of human growth and creativity, as well as an inevitable part of life. In addition, specific strategies for stress prevention vary widely from person to person, depending on the nature and number of the stressors in an individual's life, and the amount of control he or she has over these factors. In general, however, a combination of attitudinal and behavioral changes works well for most patients. The best

form of prevention appears to be parental modeling of healthy attitudes and behaviors within the family.

Resources

BOOKS

Clark, R. Barkley. "Psychosocial Aspects of Pediatrics and Psychiatric Disorders." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Eisendrath, Stuart J. "Psychiatric Disorders." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Inglis, Brian, and Ruth West. *The Alternative Health Guide*. New York: Alfred A. Knopf, 1983.

Kabat-Zinn, Jon. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness*. New York: Bantam Doubleday Dell Publishing Group, 1990.

Lowe, Carl, James W. Nechas, and the Editors of Prevention Magazine. *Whole Body Healing: Natural Healing with Movement, Exercise, Massage and Other Drug-Free Methods*. Emmaus, PA: Rodale Press, 1983.

"Psychiatric Disorders: Mood Disorders." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

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Stress reduction

Definition

Stress is the body's normal response to anything that disturbs its natural physical, emotional, or mental balance. Stress reduction refers to various strategies that counteract this response and produce a sense of relaxation and tranquility

Purpose

Although stress is a natural phenomenon of living, stress that is not controlled and that continues for a long period of time can seriously compromise health. For this reason, stress must be understood, managed and appropriately reduced. Several very different strategies and therapies are available that help with relaxation and stress management.

Precautions

Stress reduction can only present a problem if an individual attributes an actual, serious condition or disease to being simply a stress-related response and avoids consulting a physician.

Description

Everyone encounters stress every day. Although most people think of it as something negative that happens to them, in fact stress itself is really neither good nor bad but is neutral or nonspecific. Stress may be internal (from within ourselves) or external (such as noise from the environment) and does not always result from something unpleasant. A certain amount of stress in our lives is actually essential to being sufficiently stimulated to meet the challenges of everyday life, but when stress is constant and acute, it can have dangerous consequences. Since stress is both natural and unavoidable, it is necessary to understand it and to learn how to deal with it, particularly how to reduce it.

The specific and immediate cause of stress is called the stressor. A stressor can be something dramatic or terrible, such as a violent experience or the **death** of a loved one, or it can be a positive and rewarding event, like marriage or a promotion. The stressor can be internal, such as feelings of guilt or anger felt in a relationship, or it can be external, such as a natural disaster or the ordinary rigors and frustrations of commuting. It can also have a physical source, like simple **exercise** or hard work, or it can be strictly mental, like worry. Our bodies react the same way physiologically no matter what the source and reasons for stress might be.

From a physical standpoint, the body reacts to stress in a standard and predictable manner. When stress occurs, the brain immediately receives nerve impulses. These impulses initiate an automatic sequence carried out by the body's sympathetic nervous system: it begins with stimulation of the brain's hypothalamus, which sends nerve impulses to both the adrenal and the pituitary glands. Also called the "fight or flight" response, this automatic physiological process is known to have evolved in humans and animals to enable them to cope with sudden life-threatening emergencies. When faced with a major stressor, the body's biochemistry instantly hurtles into a ready mode that marshals all the possible resources necessary to either escape or do battle. Thus, the adrenal glands located on top of the kidneys provide an instant surge of adrenaline, the body's rocket fuel, quickening the heart rate and blood flow and providing every cell with extra oxygen. They also release cortisol or hydrocortisone, causing an increase in both amino acids (the building blocks of proteins) and blood sugar. These will be needed if tissue repair must take place. Finally, the pituitary gland at the base of the brain releases a variety of hormones, endorphins among them, that act as natural painkillers and permit the body to do things it ordinarily cannot do. Thus, at just about the same time a stressor is recognized by the body, the heart and breath-

ing rate spikes, the pupils dilate to let in more light, perspiration increases and digestion slows, and the body is aroused, energized, and temporarily feels no **pain**. This sequence of events allows individuals to do whatever is required to save themselves, whether it is to flee from a predator or engage in combat and fend off an attack.

While these automatic physiological responses served early man well and were essential to survival of the species, today's men and women rarely must literally fight for their lives or dodge and elude a predator. Yet their bodies' automatic response to stress has remained unchanged in a radically changed, modern world. Whether caveman or corporate executive, when the fight-or-flight response kicks in, a three-stage process begins. Stage one is the alarm stage in which the body releases hormones and prepares for extreme physical action. Resistance is stage two in which the body attempts to resist yet adapt to the stress and to repair any damage done. The final stage, exhaustion, occurs if the stress remains constant. It is especially dangerous since stage one's physical response may begin all over again. The persistence of stress and stage three's exhaustion is the point at which disease can occur. The body may then experience severe debilitating conditions like migraine, heart irregularities, and mental illness. The body's functions may even shut down altogether.

Although different individuals may have different levels of tolerance to stress, chronic stress will eventually wear down even the strongest of people. Prolonged stress can cause biochemical imbalances that weaken the immune system and invite serious illness. Overall, stress that persists is known to interfere with digestion and, more seriously, alter brain chemistry, create hormonal imbalances, increase heart rate, raise blood pressure, and negatively affect both metabolic and immune function. It is also important to recognize that although stress itself is not a disease, it can worsen any number of already serious physical conditions. Many physicians feel that chronic stress can so overtax an individual's physical resources and ways of coping that **cancer**, **stroke**, and heart disease can occur. While long-term stress can seriously affect one's quality of life and lead to major, sometimes fatal, diseases, prolonged stress also results in the everyday miseries of **headache** and allergy, digestive disorders and **fatigue**, irritable bladder and **impotence**, **insomnia**, **anxiety**, depression, and simple aches and pains. Researchers exploring the connection between stress and susceptibility to colds exposed stressed individuals (who had experienced a death in the family, become divorced, or had recently moved) to cold viruses and then tested for antibodies a month later. Results indicated that severely stressed individuals were four times more likely to become infected.

It follows that if stress can cause or contribute to illness, then reducing stress should have the opposite effect and perhaps even encourage healing. Probably the most important step toward reducing the stress in everyone's life is to understand the nature of stress and to learn how to condition ourselves to be able to gain some control over it. Being able to recognize that we are stressed is probably the first step toward understanding. Of the many signs and symptoms that alert us, some are obvious and require only common sense to recognize. Short-term noticeable effects of stress include sweaty palms and other types of perspiration, dilated pupils, and difficulty in swallowing ("a lump in the throat"). Tightness in the chest is another stress signal as are stomach problems and some skin conditions. Stress that is the result of prolonged anxiety (a sense of apprehension) often results in feelings of panic or actual trembling, fatigue, insomnia, and **shortness of breath**, heart **palpitations** and **dizziness**, and sometimes simple irritability. Although none of these symptoms is pleasant, they are relatively minor compared to the silent but much more serious internal effects that can lead to immune-related disorders and even cancer and heart disease.

Fortunately, stress and the negative effects it creates can be reduced by a wide variety of therapeutic approaches. When successfully applied, many of these therapies or strategies can both reduce stress and reverse its damage. Before selecting a particular therapy, it is important to be able distinguish bad or unhealthy stress from the type that is not bad. Researchers have found that the most important variable among types of stress is an individual's sense of control in a given situation. The least harmful stress scenario is one in which an individual has a sufficient degree of control or some idea of predictability. Put simply, predictable pain is less stressful because individuals know when to relax (gaining relief from pain as well as protecting themselves from its damaging effects). But when individuals have no warning of pain, they are in a state of constant stress. An example from daily life might be the difference between the stress experienced by top executives who are in control of their fate and their middle-level managers who are not. The former can pick and choose when to enter or engage a stressful situation or problem, but the latter have no control nor any ability to predict when such a situation will arise and are constantly on alert or in a state of anxiety.

For those with little control over situations that make them anxious, there are basically two ways to deal with their stress. One is to remove or at least reduce the stressor, and the other is to increase their resistance to it. Although there are many strategies to achieve each of these, all of them can be reduced to some variation of a single, simple concept - relaxation. While there is no one

single technique or therapy for everyone to use to manage and reduce stress, there is certainly some combination of lifestyle change, diet, exercise, and relaxation that will allow all types of individuals to better manage the stress in their lives. Although relaxation is at the core of most stress reduction methods, it is not something that everyone can fully achieve without assistance and guidance. Interestingly, our modern life experiences often do not provide us with the coping skills needed to deal with stressful stimuli, and increasingly, people find that simple relaxing is something that they must learn how to do.

Fortunately, there are a number of relaxation therapies that enable the willing individual to achieve deep, beneficial relaxation. In fact, there are almost too many from which to choose. A 1997 book on stress remedies cowritten by the editors of *Prevention* magazine and published by Rodale Press is organized alphabetically and lists fifty-nine separate stress-reducing techniques and subjects, from Acceptance to **Yoga**. These and many other methods of reducing stress can be grouped into the following general categories: mind-body therapies, body work and movement therapies, and herbal-based **diets** and natural regimens. Many of the specific techniques in these categories can be part of a self-help or self-care approach, although some require the help of an experienced practitioner.

Therapies that focus on the mind/body connection are based on the fact that thinking and emotions can have physical effects on the body. These techniques encourage the individual to take control and learning how to cope with stressors rather than trying to eliminate them. Such therapies range from individual counseling and **meditation** or involvement with a support group to the mystery of **guided imagery** and the technology of **biofeedback**. They all have the common goal of evoking the physiological relaxation response, in which a person can achieve such beneficial internal results as lowering blood pressure and decreasing gastric acid secretion.

Body work and movement therapies include techniques ranging from dance therapy and the gentleness of massage to **reflexology** and the rigors of **rolfing**. Body work is based partly on the therapeutic power of human touch and can also include manipulation, realignment, and posture correction. Movement therapies are a particular form of physical exercise, although they attempt to do much more than simply get a person into shape. Most usually emphasize the mind/body connection and strive to put people in better touch with both their bodies and their feelings. Body work and movement therapies can be as vigorous as deep tissue manipulation or as simple and minimal as the Alexander technique's light posture corrections.

Herbal remedies for stress are usually part of a larger system of natural, **holistic medicine**. Whether Chinese traditional medicine, its counterpart from India, or the **homeopathy** of the West, all these systems of natural medicine have a holistic focus and emphasize the need for inner balance. All demonstrate how the individual's physical, emotional, mental, and spiritual states are connected and use natural substances as part of the treatment for reducing stress. Such therapies range from the occasional purging (cleansing) of **Ayurvedic medicine** to the sleep-inducing properties of chamomile tea. They also can include the use of cayenne to relieve pain, fragrant essential oils from flowers to evoke a pleasing response and relieve tension, or aloe vera to soothe burned skin.

A list of some of the more common therapies and techniques available for reducing stress includes:

- Acupuncture. Insertion of needles at certain spots under the skin for the purpose of attaining balance by either releasing blocked energy or draining off excess energy.
- Alexander technique. Improving the alignment of head, neck, and back claims to achieve efficient posture and movement.
- Aromatherapy. Massage with essential oils from flowers claims to affect mood and produce a sense of well-being.
- Art therapy. Creating something allows free expression and results in feelings of achievement and mood change.
- Autogenic training therapy. A form of deep meditation or self-hypnosis.
- Autosuggestion therapy. A form of verbal therapy involving repetition of a positive idea.
- Ayurvedic medicine. A complete system of daily living based on awareness of one's particular constitution.
- Behavioral therapy. A variety of psychotherapies that are based on changing ourselves by retraining.
- Bach Flower Therapy. Herbal remedies that are prepared from flowers acting energetically to soothe the mind and body.
- Bioenergetics. A practice that encourages sudden release of tensions by crying or kicking.
- Biofeedback. Monitoring rates of body functions and using data to influence and gain control over autonomic functions.
- Breathing for relaxation. Stylized breathing technique to control and lower body functions.
- Counseling. Working with a therapist trained in talking-based therapy.
- Dance **movement therapy**. Freedom of expression through movement.

KEY TERMS

Adrenal gland—A pair of glands that rest on the top of each kidney that produce steroids, such as sex hormones and those concerned with metabolic functions.

Amino acid—Organic acids that are the main components of proteins and are synthesized by living cells.

Antibody—A type of protein produced in the blood in response to a foreign substance that destroys the intruding substance; it is responsible for immunity.

Chronic—Long-term or frequently recurring.

Debilitating—Weakening, or reducing the strength of.

Dilate—To enlarge, open wide, or distend.

Endorphins—A group of proteins with powerful pain-killing properties that originate naturally in the brain.

Holistic—That which pertains to the entire person, involving the body, mind, and spirit.

Hydrocortisone—A steroid hormone produced by the adrenal glands that provides resistance to stress.

Hypothalamus—A part of the brain that controls some of the body's automatic regulatory functions.

Immune function—The state in which the body recognizes foreign materials and is able to neutralize them before they can do any harm.

Impotence—The inability of the male to engage in sexual intercourse because of insufficient erection.

Insomnia—Inability to sleep under normal conditions.

Metabolic function—Those processes necessary for the maintenance of a living organism.

Neuromuscular—Relating to nerve and muscle or their interaction.

Physiological—Dealing with the functions and processes of the body.

Pituitary gland—A gland at the base of the brain responsible for growth, maturation, and reproduction.

Sympathetic nervous system—That part of the autonomic nervous system that affects contraction of muscles and blood vessels. Stimulation of this system by a stressor triggers the production of hormones that prepare the body for fight or flight

Therapeutic—Curative or healing.

- Feldenkrais method. Slow, light movements alter habits and reeducate neuromuscular system.
- Flotation therapy. Floating in a soundproof tank with no external stimulation.
- Guided imagery. Creating a mental picture of what is desired. Also called Creative imagery or Visualization.
- Herbal medicine. Uses substances derived from plants as treatment instead of synthetic drugs.
- Homeopathy. Uses minute doses of plant, animal, and mineral substances to stimulate the body's natural healing.
- Hydrotherapy. Use of water internally and externally for healing purposes.
- Hypnotherapy. Hypnosis in order to identify and release patterns that keep an individual from a personal balance point.
- Kinesiology. Uses muscle testing to correct imbalances in the body's "energy system." Also called Touch for Health.
- Massage. Use of touch and manipulation to soothe. Can also employ vigorous deep tissue manipulation.
- Meditation. Deep, relaxed, receptive, and focused concentration on a single object, sound, or word.
- Music therapy. Playing or listening to music to create an emotional reaction.
- Naturopathy. A complete health care system that uses a variety of natural healing therapies.
- Psychotherapy. A talking-based therapy with a mental health professional to get at the root of a conflict, modify behavior and disruptive negative thought patterns.
- Reflexology. Manipulation of zones of the feet that relate to the major organs, glands, and areas of the body.
- Rolfing. Vigorous manipulation of the body's connective tissue to restore "balance."
- Shiatsu. Traditional Japanese finger pressure massage therapy.
- Sound therapy. Uses sound waves to slow the body's autonomic system.
- Tai Chi Chuan. System of slow, continuous exercises based on rhythm and equilibrium.

• Yoga. System of exercises that combines certain positions with deep breathing and meditation.

These and many other techniques, systems, and therapies are available to the person searching for some way to reduce and manage the stress of everyday life. Some methods are very simple and can be easily learned, while others are high-tech and often involve a practitioner. A search for common elements among most of these stress-reducing systems reveals several obvious strategies that nearly everyone can employ on their own. However, it is important to know and recognize the signals of stress. Further, it is easier to resist the negative effects of stress by eating properly and getting sufficient sleep and exercise.

Nearly all stress-reducing systems are geared to evoking some degree of beneficial mind/body relaxation, and most include some version of the following:

• mental time out
• deep breathing
• meditation and singular focus
• gentle, repetitive exercise

The best stress reduction system is the one that works for the individual. Whether stress can be relieved by laughter, mellow music, repetition of a single word, self-massage, vigorous activity, or simply by doing everyday chores in a mindful state of heightened awareness, it is important that stress be recognized and managed every day. Studies have shown that regular relaxation eventually makes the body less responsive to its stress hormones and acts as a sort of natural tranquilizer. People can build their own immune defense against the stress response.

Risks

All relaxation-based therapies to reduce stress are virtually free of serious risk.

Normal results

Learning how to manage stress has the short-term benefits of giving people some sense of control in their lives, providing them with positive coping strategies, and making them more relaxed and healthier. The long-term benefits can be a stronger immune system, proper hormonal balance, and reduced susceptibility to serious, life-threatening diseases like heart disease and cancer.

Resources

BOOKS

Alternative Healthcare. Ed. Nikki Bradford. San Diego: Thunder Bay Press, 1997.

The Burton Goldberg Group. *Alternative Medicine: The Definitive Guide*. Puyallup, WA: Future Medicine Publishing, Inc., 1993.

Chichester, Brian, and Perry Garfinkel. *Stress Blasters*. Emmaus, PA: Rodale Press Inc., 1997.

Sherman, Carl. *Stress Remedies*. Emmaus, PA: Rodale Press, Inc., 1997.

The Stress Factor. New York: Reader's Digest Association, Inc., 1995.

PERIODICALS

Golin, Mark, Sharon Stocker, and Toby Hanlon. "Natural Tranquilizers: Stress Relief That Works Round the Clock." *Prevention Magazine*, Dec. 1995, 65-74.

Jaret, Peter. "Going for the Bliss: You Don't Have to Sweat to Reduce Stress." *Health*, Nov./Dec. 1995, 83-88.

Perlmutter, Cathy. "Take A Moment to Muse." *Prevention Magazine*, June 1991, 38-41, 121.

Rattenbury, Jeanne. "What? Me Relax?" *Vegetarian Times*, Mar. 1996, 74-80.

Sharp, Katie. "Get Ready.Get Set.RELAX!" *Current Health 2* (Dec. 1996): 21-23.

ORGANIZATIONS

The American Institute of Stress. 124 Park Avenue. Yonkers, NY 10703. (914) 963-1200. <http://www.stress.org>.

Center for Mindfulness. University of Massachusetts Medical Center, 55 Lake Avenue North, Worcester, MA 01655. (508) 856-2656. <http://www.umassmed.edu/cfm>.

Leonard C. Bruno, PhD

Stress test

Definition

Used to evaluate heart function, a **stress** test requires that a patient exercises on a treadmill or **exercise** bicycle while his or her heart rate, breathing, blood pressure, electrocardiogram (ECG), and feeling of well being are monitored.

Purpose

When the body is active, it requires more oxygen than when it is at rest, and, therefore, the heart has to pump more blood. Because of the increased stress on the heart, exercise can reveal coronary problems that are not apparent when the body is at rest. This is why the stress test, though not perfect, remains the best initial, noninvasive, practical coronary test.

The stress test helps doctors determine how well the heart handles the increased demands imposed by physical activity. It is particularly useful for evaluating possible **coronary artery disease**, detecting inadequate supply of oxygen-rich blood to the tissues of the heart muscle (**ischemia**), and determining safe levels of exercise in people with existing heart disease.

Precautions

The exercise stress test carries a very slight risk (1 in 100,000) of causing a **heart attack**. For this reason, the exercise stress test should be attended by a health care professional with a defibrillator and other emergency equipment on standby.

The patient must be aware of the symptoms of a heart attack and stop the test if he or she develops any of the following symptoms:

- an unsteady gait
- confusion
- skin is grayish or cold and clammy
- **dizziness** or **fainting**
- a drop in blood pressure
- chest **pain** (**angina**)
- irregular heart beat (cardiac arrhythmias)

Description

The technician affixes electrodes to specific areas of the patient's chest, using special adhesive patches with a special gel that conducts electrical impulses. Typically, electrodes are placed under each collarbone and each bottom rib, and six electrodes are placed across the chest in a rough outline of the heart. Then the technician attaches wires from the electrodes to an ECG, which records the electrical activity picked up by the electrodes.

The technician runs resting ECG tests while the patient is lying down, then standing up, and then breathing heavily for half a minute. These tests can later be compared with the ECG tests performed while the patient is exercising. The patient's blood pressure is taken and the blood pressure cuff is left in place, so that blood pressure can be measured periodically throughout the test.

The patient begins riding a stationary bicycle or walking on a treadmill. Gradually the intensity of the exercise is increased. For example, if the patient is walking on a treadmill, the speed of the treadmill increases and the treadmill is tilted upward to simulate an incline. If the patient is on an exercise bicycle, the resistance or "drag" is gradually increased. The patient continues exercising at increasing intensity until he or she reaches his or her target heart rate (generally set at a minimum of 85% of the maximal predicted heart rate based on the patient's age) or experiences severe **fatigue**, dizziness, or chest pain. During this time, the patient's heart rate, ECG pattern, and blood pressure are continually monitored.

In some cases, other tests, such as **echocardiography** or thallium scanning, are also used in conjunction with the exercise stress test. For instance, recent studies suggest that women have a high rate of false negatives (results showing no problem when one exists) and false positives (results showing a problem when one does not exist) with the stress test. They may benefit from another test, such as exercise echocardiography. People who are unable to exercise may be injected with drugs that mimic the effects of exercise on the heart and given a thallium scan, which can detect the same abnormalities that an exercise test can.

Preparation

Patients are usually instructed not to eat or smoke for several hours before the test. They should also tell the doctor about any medications they are taking. They should wear comfortable sneakers and exercise clothing.

Aftercare

After the test, the patient should rest until blood pressure and heart rate return to normal. If all goes well, and there are no signs of distress, the patient may return to his or her normal daily activities.

Risks

There is a very slight risk of a heart attack from the exercise, as well as cardiac arrhythmia (irregular heart beats), angina, or cardiac arrest (about one in 100,000).

Normal results

A normal result of an exercise stress test shows normal electrocardiogram tracings and heart rate, blood pressure within the normal range, and no angina, unusual dizziness, or **shortness of breath**.

Abnormal results

A number of abnormalities may show up on an exercise stress test. An abnormal electrocardiogram (ECG) may indicate deprivation of oxygen-rich blood to the heart muscle (ST wave segment depression, for example), heart rhythm disturbances, or structural abnormalities of the heart, such as overgrowth of muscle (hypertrophy). If the blood pressure rises too high or the patient experiences distressing symptoms during the test, the heart may be unable to handle the increased workload. Stress test abnormalities usually require further evaluation and therapy.

Resources

BOOKS

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

"Cardiac Stress Testing: New Variations on an Old Theme." *Harvard Men's Health Watch* 1 (Mar. 1997): 10-4.

KEY TERMS

Angina—Chest pain from a poor blood supply to the heart muscle due to narrowing of the coronary arteries.

Cardiac arrhythmia—An irregular heart rate or rhythm.

Coronary arteries—Two arteries that branch off from the aorta and supply blood to the heart.

Defibrillator—A device that delivers an electric shock to the heart muscle through the chest wall in order to restore a normal heart rate.

False negative—Test results showing no problem when one exists.

False positive—Test results showing a problem when one does not exist.

Hypertrophy—The overgrowth of muscle.

Ischemia—Dimished supply of oxygen-rich blood to an organ or area of the body.

Castleman, Michael. "Is It Time for a Stress Test?" *The Walking Magazine*, Aug. 1995, 20-23.
"Exercise Stress Test." *Mayo Clinic Health Letter* 17 (Nov. 1994): 6-7.
"Going Somewhere Fast: Heart Test May Spare Extra Procedures." *Prevention Magazine*, 1 Aug. 1996, 49-50.
Merrill, Jim. "Don't Sweat a Stress Test." *Diabetes Forecast* (Oct. 1996): 32-36.
Patlak, Margie. "Women and Heart Disease." *FDA Consumer* (Nov. 1994): 32-36.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.
National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

Stridor

Definition

Stridor is a term used to describe noisy breathing in general, and to refer specifically to a high-pitched crowing sound associated with **croup**, respiratory infection, and airway obstruction.

Description

Stridor occurs when erratic air currents attempt to force their way through breathing passages narrowed by:

- illness
- infection
- the presence of **foreign objects**
- throat abnormalities

Stridor can usually be heard from a distance but is sometimes audible only during deep breathing. Someone who has stridor may crow and wheeze when:

- inhaling
- exhaling
- inhaling and exhaling

Most common in young children, whose naturally small airways are easily obstructed, stridor can be a symptom of a life-threatening respiratory emergency.

Causes and symptoms

During childhood, stridor is usually caused by infection of the cartilage flap (epiglottis) that covers the opening of the windpipe to prevent **choking** during swallowing. It can also be caused by a toy or other tiny object the child has tried to swallow.

Laryngomalacia is a common cause of a rapid, low-pitched form of stridor that may be heard when a baby inhales. This harmless condition does not require medical attention. It usually disappears by the time the child is 18 months old.

The most common causes of stridor in adults are:

- abscess or swelling of the upper airway
- paralysis or malfunction of the vocal cords
- tumor

Other common causes of stridor include:

- enlargement of the thyroid gland (**goiter**)
- swelling of the voice box (largyngeal **edema**)
- narrowing of the windpipe (tracheal stenosis)

When stridor is caused by a condition that slowly narrows the airway, crowing and **wheezing** may not develop until the obstruction has become severe.

Diagnosis

When stridor is present in a newborn, pediatricians and neonatologists look for evidence of:

- heart defects inherent at birth (congenital)
- neurological disorders
- General toxicity

If examinations do not reveal the reasons for the baby's noisy breathing, the air passages are assumed to be the cause of the problem.

Listening to an older child or adult breathe usually enables pediatricians, family physicians, and pulmonary specialists to estimate where an airway obstruction is located. The extent of the obstruction can be calculated by assessing the patient's:

- complexion
- chest movements
- breathing rate
- level of consciousness

X rays and direct examination of the voice box (larynx) and breathing passages indicate the exact location of the obstruction or inflammation. Flow-volume loops and pulse oximetry are diagnostic tools used to measure how much air flows through the breathing passages, and how much oxygen those passages contain.

Pulmonary function tests may also be performed.

Treatment

The cause of this condition determines the way it is treated.

Life-threatening emergencies may require:

- The insertion of a breathing tube through the mouth and nose (tracheal intubation)
- The insertion of a breathing tube directly into the windpipe (tracheostomy).

Resources

BOOKS

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck & Co., Inc., 1997.

Clayman, Charles B., ed. *The American Medical Association Encyclopedia of Medicine*. New York: Random House, 1989.

Dershewitz, Robert A., ed. *Ambulatory Pediatric Care*. Philadelphia: J. B. Lippincott Co., 1993.

Pierson, David J., ed. *Foundations of Respiratory Care*. New York: Churchill Livingstone, 1992.

Maureen Haggerty

Stroke

Definition

A stroke is the sudden **death** of brain cells in a localized area due to inadequate blood flow.

Description

A stroke occurs when blood flow is interrupted to part of the brain. Without blood to supply oxygen and nutrients and to remove waste products, brain cells quickly begin to die. Depending on the region of the brain affected, a stroke may cause **paralysis**, speech impairment, loss of memory and reasoning ability, **coma**, or death. A stroke is also sometimes called a brain attack or a cerebrovascular accident (CVA).

Some important stroke statistics:

- more than half a million people in the United States experience a new or recurrent stroke each year
- stroke is the third leading cause of death in the United States and the leading cause of disability
- stroke kills about 150,000 Americans each year, or almost one out of three stroke victims
- three million Americans are currently permanently disabled from stroke
- in the United States, stroke costs about $30 billion per year in direct costs and loss of productivity
- two-thirds of strokes occur in people over age 65
- strokes affect men more often than women, although women are more likely to die from a stroke
- strokes affect blacks more often than whites, and are more likely to be fatal among blacks

Stroke is a medical emergency requiring immediate treatment. Prompt treatment improves the chances of survival and increases the degree of recovery that may be expected. A person who may have suffered a stroke should be seen in a hospital emergency room without delay. Treatment to break up a blood clot, the major cause of stroke, must begin within three hours of the stroke to be effective. Improved medical treatment of all types of stroke has resulted in a dramatic decline in death rates in recent decades. In 1950, nine in ten died from stroke, compared to slightly less than one in three today.

Causes and symptoms

Causes

There are four main types of stroke. Cerebral thrombosis and cerebral **embolism** are caused by blood clots that block an artery supplying the brain, either in the brain itself or in the neck. These account for 70–80% of all strokes. **Subarachnoid hemorrhage** and intracerebral hemorrhage occur when a blood vessel bursts around or in the brain.

Cerebral thrombosis occurs when a blood clot, or thrombus, forms within the brain itself, blocking the flow

of blood through the affected vessel. Clots most often form due to "hardening" (**atherosclerosis**) of brain arteries. Cerebral thrombosis occurs most often at night or early in the morning. Cerebral thrombosis is often preceded by a **transient ischemic attack**, or TIA, sometimes called a "mini-stroke." In a TIA, blood flow is temporarily interrupted, causing short-lived stroke-like symptoms. Recognizing the occurrence of a TIA, and seeking immediate treatment, is an important step in stroke prevention.

Cerebral embolism occurs when a blood clot from elsewhere in the circulatory system breaks free. If it becomes lodged in an artery supplying the brain, either in the brain or in the neck, it can cause a stroke. The most common cause of cerebral embolism is atrial fibrillation, a disorder of the heart beat. In atrial fibrillation, the upper chambers (atria) of the heart beat weakly and rapidly, instead of slowly and steadily. Blood within the atria is not completely emptied. This stagnant blood may form clots within the atria, which can then break off and enter the circulation. Atrial fibrillation is a factor in about 15% of all strokes. The risk of a stroke from atrial fibrillation can be dramatically reduced with daily use of anticoagulant medication.

Hemorrhage, or bleeding, occurs when a blood vessel breaks, either from trauma or excess internal pressure. The vessels most likely to break are those with preexisting defects such as an aneurysm. An aneurysm is a "pouching out" of a blood vessel caused by a weak arterial wall. Brain aneurysms are surprisingly common. According to **autopsy** studies, about 6% of all Americans have them. Aneurysms rarely cause symptoms until they burst. Aneurysms are most likely to burst when blood pressure is highest, and controlling blood pressure is an important preventive strategy.

Intracerebral hemorrhage affects vessels within the brain itself, while subarachnoid hemorrhage affects arteries at the brain's surface, just below the protective arachnoid membrane. Intracerebral hemorrhages represent about 10% of all strokes, while subarachnoid hemorrhages account for about 7%.

In addition to depriving affected tissues of blood supply, the accumulation of fluid within the inflexible skull creates excess pressure on brain tissue, which can quickly become fatal. Nonetheless, recovery may be more complete for a person who survives hemorrhage than for one who survives a clot, because the blood deprivation effects are usually not as severe.

Death of brain cells triggers a chain reaction in which toxic chemicals created by cell death affect other nearby cells. This is one reason why prompt treatment can have such a dramatic effect on final recovery.

Risk factors

Risk factors for stroke involve age, sex, heredity, predisposing diseases or other medical conditions, and lifestyle choices:

- Age and sex. The risk of stroke increases with increasing age, doubling for each decade after age 55. Men are more likely to have a stroke than women.
- Heredity. Blacks, Asians, and Hispanics all have higher rates of stroke than do whites, related partly to higher blood pressure. People with a family history of stroke are at greater risk.
- Diseases. Stroke risk is increased for people with diabetes, heart disease (especially atrial fibrillation), high blood pressure, prior stroke, or TIA. Risk of stroke increases tenfold for someone with one or more TIAs.
- Other medical conditions. Stroke risk increases with **obesity**, high blood cholesterol level, or high red blood cell count.
- Lifestyle choices. Stroke risk increases with cigarette **smoking** (especially if combined with the use of **oral contraceptives**), low level of physical activity, alcohol consumption above two drinks per day, or use of **cocaine** or intravenous drugs.

Symptoms

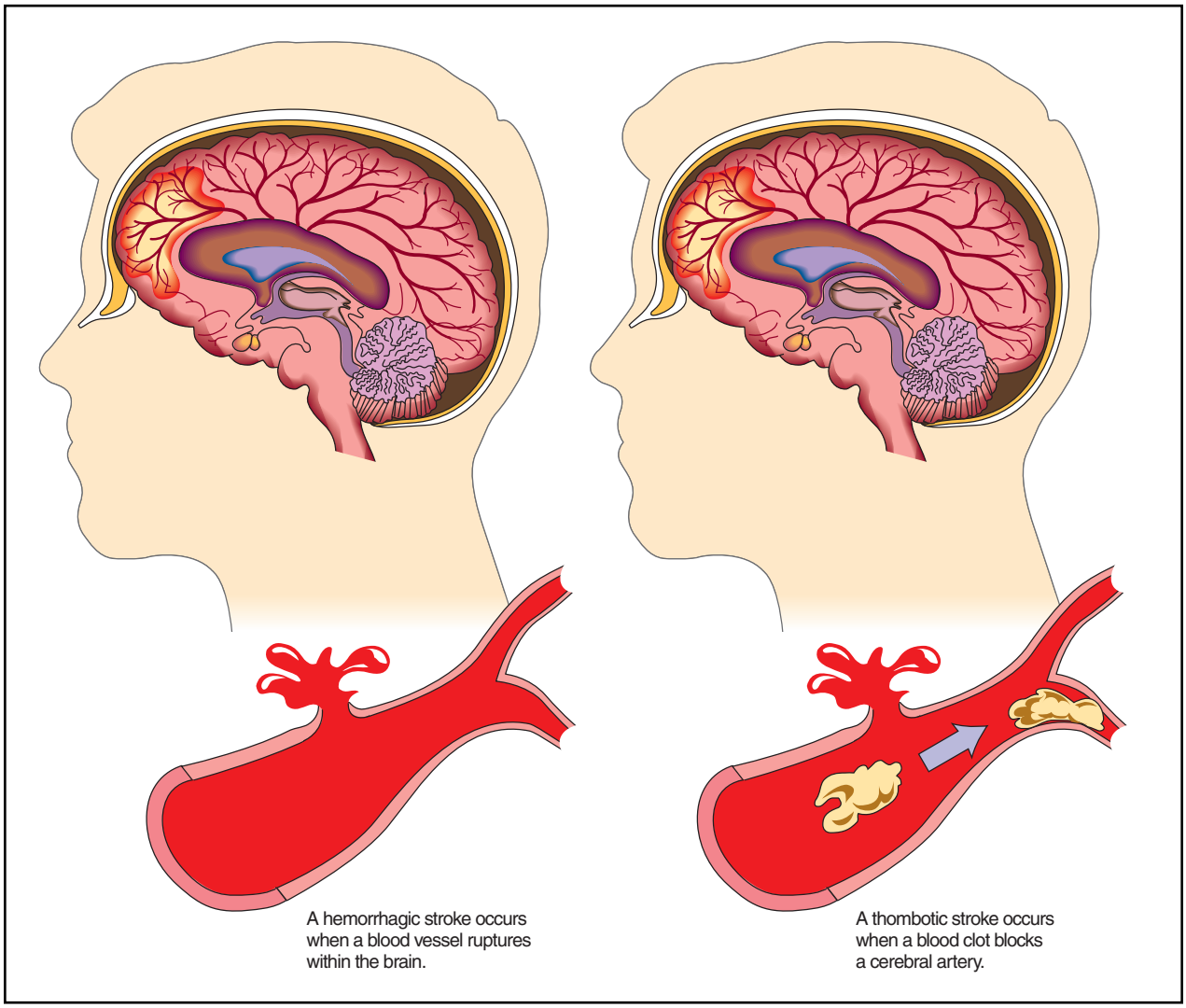
Symptoms of an embolic stroke usually come on quite suddenly and are at their most intense right from the start, while symptoms of a thrombotic stroke come on more gradually. Symptoms may include:

- blurring or decreased vision in one or both eyes
- severe **headache**, often described as "the worst headache of my life"
- weakness, numbness, or paralysis of the face, arm, or leg, usually confined to one side of the body
- dizziness, loss of balance or coordination, especially when combined with other symptoms

Diagnosis

The diagnosis of stroke is begun with a careful medical history, especially concerning the onset and distribution of symptoms, presence of risk factors, and the exclusion of other possible causes. A brief neurological exam is performed to identify the degree and location of any deficits, such as weakness, incoordination, or visual losses.

Once stroke is suspected, a computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scan is performed to distinguish a stroke caused by blood clot from one caused by hemorrhage, a critical distinc-



A hemorrhagic stroke (left) compared to a thrombotic stroke (right). *(Illustration by Hans & Cassady, Inc.)*

tion that guides therapy. Blood and urine tests are done routinely to look for possible abnormalities.

Other investigations that may be performed to guide treatment include an electrocardiogram, **angiography**, ultrasound, and electroencephalogram.

Treatment

Emergency treatment

Emergency treatment of stroke from a blood clot is aimed at dissolving the clot. This "thrombolytic therapy" is currently performed most often with tissue plasminogen activator, or t-PA. t-PA must be administered within three hours of the stroke event. Therefore, patients who awaken with stroke symptoms are ineligible for t-PA therapy, as the time of onset cannot be accurately determined. t-PA therapy has been shown to improve recovery and decrease long-term disability in selected patients. t-PA therapy carries a 6.4% risk of inducing a cerebral hemorrhage, and is not appropriate for patients with bleeding disorders, very high blood pressure, known aneurysms, any evidence of intracranial hemorrhage, or incidence of stroke, head trauma, or intracranial surgery within the past three months. Patients with clot-related (thrombotic or embolic) stroke who are ineligible for t-PA treatment may be treated with heparin or other blood thinners, or with **aspirin** or other anti-clotting agents in some cases.

Emergency treatment of hemorrhagic stroke is aimed at controlling intracranial pressure. Intravenous urea or mannitol plus hyperventilation is the most common treatment. **Corticosteroids** may also be used. Patients with reversible bleeding disorders, such as those

due to anticoagulant treatment, should have these bleeding disorders reversed, if possible.

Surgery for hemorrhage due to aneurysm may be performed if the aneurysm is close enough to the cranial surface to allow access. Ruptured vessels are closed off to prevent rebleeding. For aneurysms that are difficult to reach surgically, endovascular treatment may be used. In this procedure, a catheter is guided from a larger artery up into the brain to reach the aneurysm. Small coils of wire are discharged into the aneurysm, which plug it up and block off blood flow from the main artery.

Rehabilitation

Rehabilitation refers to a comprehensive program designed to regain function as much as possible and compensate for permanent losses. Approximately 10% of stroke survivors are without any significant disability and able to function independently. Another 10% are so severely affected that they must remain institutionalized for severe disability. The remaining 80% can return home with appropriate therapy, training, support, and care services.

Rehabilitation is coordinated by a team of medical professionals and may include the services of a neurologist, a physician who specializes in rehabilitation medicine (physiatrist), a physical therapist, an occupational therapist, a speech-language pathologist, a nutritionist, a mental health professional, and a social worker. Rehabilitation services may be provided in an acute care hospital, rehabilitation hospital, long-term care facility, outpatient clinic, or at home.

The rehabilitation program is based on the patient's individual deficits and strengths. Strokes on the left side of the brain primarily affect the right half of the body, and vice versa. In addition, in left brain dominant people, who constitute a significant majority of the population, left brain strokes usually lead to speech and language deficits, while right brain strokes may affect spatial perception. Patients with right brain strokes may also deny their illness, neglect the affected side of their body, and behave impulsively.

Rehabilitation may be complicated by cognitive losses, including diminished ability to understand and follow directions. Poor results are more likely in patients with significant or prolonged cognitive changes, sensory losses, language deficits, or incontinence.

PREVENTING COMPLICATIONS. Rehabilitation begins with prevention of stroke recurrence and other medical complications. The risk of stroke recurrence may be reduced with many of the same measures used to prevent stroke, including quitting smoking and controlling blood pressure.

One of the most common medical complications following stroke is deep venous thrombosis, in which a clot forms within a limb immobilized by paralysis. Clots that break free often become lodged in an artery feeding the lungs. This type of **pulmonary embolism** is a common cause of death in the weeks following a stroke. Resuming activity within a day or two after the stroke is an important preventive measure, along with use of elastic stockings on the lower limbs. Drugs that prevent clotting may be given, including intravenous heparin and oral warfarin.

Weakness and loss of coordination of the swallowing muscles may impair swallowing (dysphagia), and allow food to enter the lower airway. This may lead to aspiration **pneumonia**, another common cause of death shortly after a stroke. Dysphagia may be treated with retraining exercises and temporary use of pureed foods.

Depression occurs in 30–60% of stroke patients. Antidepressants and psychotherapy may be used in combination.

Other medical complications include urinary tract infections, pressure ulcers, falls, and seizures.

TYPES OF REHABILITATIVE THERAPY. Brain tissue that dies in a stroke cannot regenerate. In some cases, the functions of that tissue may be performed by other brain regions after a training period. In other cases, compensatory actions may be developed to replace lost abilities.

Physical therapy is used to maintain and restore range of motion and strength in affected limbs, and to maximize mobility in walking, wheelchair use, and transferring (from wheelchair to toilet or from standing to sitting, for instance). The physical therapist advises on mobility aids such as wheelchairs, braces, and canes. In the recovery period, a stroke patient may develop muscle spasticity and **contractures**, or abnormal contractions. Contractures may be treated with a combination of stretching and splinting.

Occupational therapy improves self-care skills such as feeding, bathing, and dressing, and helps develop effective compensatory strategies and devices for activities of daily living. A speech-language pathologist focuses on communication and swallowing skills. When dysphagia is a problem, a nutritionist can advise alternative meals that provide adequate **nutrition**.

Mental health professionals may be involved in the treatment of depression or loss of thinking (cognitive) skills. A social worker may help coordinate services and ease the transition out of the hospital back into the home. Both social workers and mental health professionals may help counsel the patient and family during the difficult rehabilitation period. Caring for a person affected with stroke requires learning a new set of skills and adapting

to new demands and limitations. Home caregivers may develop **stress**, **anxiety**, and depression. Caring for the caregiver is an important part of the overall stroke treatment program.

Support groups can provide an important source of information, advice, and comfort for stroke patients and for caregivers. Joining a support group can be one of the most important steps in the rehabilitation process.

Prognosis

Stroke is fatal for about 27% of white males, 52% of black males, 23% of white females, and 40% of black females. Stroke survivors may be left with significant deficits. Emergency treatment and comprehensive rehabilitation can significantly improve both survival and recovery.

Prevention

Damage from stroke may be significantly reduced through emergency treatment. Knowing the symptoms of stroke is as important as knowing those of a **heart attack**. Patients with stroke symptoms should seek emergency treatment without delay, which may mean dialing 911 rather than their family physician.

The risk of stroke can be reduced through lifestyle changes:

- stop smoking
- control blood pressure
- get regular exercise
- keep body weight down
- avoid excessive alcohol consumption
- get regular checkups and follow the doctor's advice regarding diet and medicines

Treatment of atrial fibrillation may significantly reduce the risk of stroke. Preventive anticoagulant therapy may benefit those with untreated atrial fibrillation. Warfarin (Coumadin) has proven to be more effective than aspirin for those with higher risk.

Screening for aneurysms may be an effective preventive measure in those with a family history of aneurysms or autosomal **polycystic kidney disease**, which tends to be associated with aneurysms.

Resources

BOOKS

Caplan, L. R., M. L. Dyken, and J. D. Easton. *American Heart Association Family Guide to Stroke Treatment, Recovery, and Prevention*. New York: Times Books, 1996.

Warlow, C. P., et al. *Stroke: A Practical Guide to Management*. Boston: Blackwell Science, 1996.

Weiner F., M. H. M. Lee, and H. Bell. *Recovering at Home After a Stroke: A Practical Guide for You and Your Family.* Los Angeles: The Body Press/Perigee Books, 1994.

PERIODICALS

Selman, W. R., R. Tarr, and D. M. D. Landis. "Brain Attack: Emergency Treatment of Ischemic Stroke." *American Family Physician* 55 (June 1997): 2655-2662.

Wolf, P. A., and D. E. Singer. "Preventing Stroke in Atrial Fibrillation." *American Family Physician* (Dec. 1997).

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Stroke Association. 9707 E. Easter Lane, Englewood, Co 80112. (800) 787-6537. <http://www.stroke.org>.

Richard Robinson

KEY TERMS

Aneurysm—A pouchlike bulging of a blood vessel. Aneurysms can rupture, leading to stroke.

Atrial fibrillation—A disorder of the heart beat associated with a higher risk of stroke. In this disorder, the upper chambers (atria) of the heart do not completely empty when the heart beats, which can allow blood clots to form.

Cerebral embolism—A blockage of blood flow through a vessel in the brain by a blood clot that formed elsewhere in the body and traveled to the brain.

Cerebral thrombosis—A blockage of blood flow through a vessel in the brain by a blood clot that formed in the brain itself.

Intracerebral hemorrhage—A cause of some strokes in which vessels within the brain begin bleeding.

Subarachnoid hemorrhage—A cause of some strokes in which arteries on the surface of the brain begin bleeding.

Tissue plasminogen activator (tPA)—A substance that is sometimes given to patients within three hours of a stroke to dissolve blood clots within the brain.

Strongyloidiasis *see* **Threadworm infection**

Structural integration *see* **Rolfing**

Stupor *see* **Coma**

Stuttering

Definition

Stuttering is a speech problem characterized by repetitions, pauses, or drawn out syllables, words, and phrases. Stutterers are different than people experiencing normal fluency problems because a stutterer's disfluency is more severe and consistent than that of people who do not stutter.

Description

Normal language development in a child can include a period of disfluency. Children might repeat syllables or words once or twice. Sometimes, children experiencing normal disfluencies hesitate during speech or use fillers, including "um," with frequency. These developmental problems usually happen between one and five years of age. Often, parents are concerned about the disfluency they hear in their children. In fact, about 25% of all children experience speech disfluencies during development concern their parents because of their severity.

A child with mild stuttering, however, will repeat sounds more than twice. Parents and teachers often notice the child's facial muscles become tense and he or she might struggle to speak. The child's voice pitch might rise with repetitions, and some children experience occasional periods when airflow or voice stops for seconds at a time. Children with more severe stuttering stutter through more than 10% of their speech. This child exhibits considerable tension and tries to avoid stuttering by using different words. In these children, complete blocks of speech are more common than repetitions or prolongations, during which children lengthen syllables or words.

Stuttering usually begins in childhood when the child is developing language skills, and it rarely develops in adulthood with only 1% of the population affected by the disorder. Stuttering does not affect intelligence. Teens often experience more noticeable problems with stuttering as they enter the dating scene and increase their social interactions. Stuttering can severely affect one's life. Often, adults who are concerned about stuttering choose their careers based on the disability.

The degree of stuttering is often inconsistent. Stutterers can be fluent in some situations. Many find that they stop stuttering when singing or doing other activities involving speech. Some have good and bad days when it comes to stuttering. On good days, a stutterer might be able to talk fluently using words that usually cause him to repeat, pause or prolongate sounds, syllables, parts of words, entire words or phrases.

Causes and symptoms

There is no known cause of stuttering. Some believe that it has a physical cause and that it might be related to a breakdown in the neurological system. Stuttering starts early in life and often is inherited. Brain scan research has revealed that there might be abnormalities in the brains of stutterers, while they are stuttering. Myths about why stuttering occurs abound. Some cultures believe that stuttering is caused by emotional problems, tickling an infant too much or because a mother ate improperly during breastfeeding. None have been proven to be true. It is believed that some drugs might induce stuttering-like conditions. These include antidepressants, **antihistamines**, tranquilizers and **selective serotonin reuptake inhibitors**.

Diagnosis

Speech and language therapists diagnose stuttering by asking stutterers to read out loud, pronounce specific words, and talk. Some also order hearing tests. The tests will determine whether or not a person needs speech therapy.

Treatment

Researchers don't understand what causes stuttering. However, progress has been made into what contributes to the development of the disability and, therefore, in some cases it can be prevented in childhood with the help of therapy early on. Therapy can help people of all ages suffering from the speech disability. While not an overnight cure, therapy can offer positive results and more fluent speech patterns. The goals of therapy are to reduce stuttering frequency, decrease the tension and struggle of stuttering, become educated about stuttering, and learn to use effective communications skills, such as making eye contact, to further enhance speech. The therapy focuses on helping stutterers to discover easier and different ways of producing sounds and expressing thoughts. The success of therapy depends largely on the stutterer's willingness to work at getting better.

The duration of stuttering therapy needed varies among stutterers. Sometimes, it helps stutterers if they have therapy intermittently throughout their lives.

Parents, teachers and others can do things to help ease stuttering. These include: talking slowly, but normally, clearly, and in a relaxed manner to a stutterer; answering questions after a pause to encourage a relaxed transaction; trying not to make stuttering worse by getting annoyed by a person's stuttering; giving stutterers reassurance about their stuttering; and encouraging the stutterer to talk about his or her stuttering.

KEY TERMS

Antipsychotics—A class of drugs used to treat psychotic or neurotic behavior.

Disfluency—An interruption in speech flow.

Neuroleptics—Antipsychotic drugs that affect psychomotor activity.

Electronic fluency aids help some stutterers when used as an adjunct to therapy. Medications, such as antipsychotics and neuroleptics, have been used to treat stuttering with limited success.

Alternative treatment

Some use relaxation techniques to help their stuttering.

Prognosis

More than three million Americans stutter and four times more males are affected than females. Winston Churchill, Marilyn Monroe, Carly Simon, James Earl Jones and King George VI are among the many people who stuttered but went on to live successful professional lives. Decades of research have yielded no answers to the causes of stuttering; still much has been learned about what contributes to stuttering's development and how to prevent it in children. People who stutter can get better through therapy.

Prevention

New and exciting developments are occurring in researchers' understanding of the genetics of stuttering. Researchers are finding the locations of genes that predispose people to stuttering. While genetic factors will not explain all stuttering, genetics will help to uncover the disability's causes. Speech therapy, especially that performed at a young age, can stop the progression of stuttering.

Resources

ORGANIZATIONS

The National Stuttering Foundation of America. (800) 992-9392. <http://www.stutteringhelp.org>.

National Stuttering Project. John Ahlbach, Executive Director. 5100 East La Palma Ave., Suite 208 Anaheim Hills, CA 92807. (800) 364-1677. <http://www.mankato.msus.edu/dept/comdis/kuster/Infostuttering/ExecDirNSP.html>.

OTHER

"Stuttering." The Nemours Foundation, KidsHealth.org. <http://kidshealth.org>.

The Stuttering Home Page. Minnesota State University, Mankato. <http://www.mandato.msus.edu/deprt/comdis/kuster/stutter.html>.

"What is Stuttering?" Robert W. Quesal, PhD, Professor and Program Director. Communications Sciences and Disorders. Western Illinois University. <http://www.wiu.edu>.

Lisette Hilton

Stye *see* **Eyelid disorders**

Subacute sclerosing panencephalitis

Definition

Subacute sclerosing panencephalitis is a rare, progressive brain disorder caused by an abnormal immune response to the **measles** virus.

Description

This fatal condition is a complication of measles, and affects children and young adults before the age of 20. It usually occurs in boys more often than in girls, but is extremely rare, appearing in only one out of a million cases of measles.

Causes and symptoms

Experts believe this condition is a form of measles **encephalitis** (swelling of the brain), caused by an improper response by the immune system to the measles virus.

The condition begins with behavioral changes, memory loss, irritability, and problems with school work. As the neurological damage increases, the child experiences seizures, involuntary movements, and further neurological deterioration. Eventually, the child starts suffering from progressive **dementia**. The optic nerve begins to shrink and weaken (atrophy) and subsequently the child becomes blind.

Diagnosis

Blood tests and spinal fluid reveal high levels of antibodies to measles virus, and there is a characteristically abnormal electroencephalogram (EEG), or brain wave test. Typically, there is a history of measles infection two to ten years before symptoms begin.

Treatment

There is no standard treatment, and a number of **antiviral drugs** have been tested with little success.

KEY TERMS

Measles encephalitis—A serious complication of measles occurring in about one out of every 1,000 cases, causing headache, drowsiness, and vomiting seven to ten days after the rash appears. Seizures and coma can follow, which may lead to retardation and death.

Treatment of symptoms, including the use of **anticonvulsant drugs**, can be helpful.

Prognosis

While there may be periodic remissions during the course of this disease, it is usually fatal (often from **pneumonia**) within one to three years after onset.

Resources

BOOKS

Adams, R. D., and M. Victor, eds. *Principles of Neurology.* 5th ed. New York: McGraw-Hill, 1993.

Thoene, Jess G., and Nancy P. Coker, eds. *Physician's Guide to Rare Diseases.* 2nd ed. Montvale, NJ: Dowden Publishing Co., 1997.

PERIODICALS

Frank, J., et al. "SSPE: But We Thought Measles was Gone!" *Journal of Pediatric Nursing* 6, no.2 (Apr. 1991): 87-92.

ORGANIZATIONS

National Institute of Allergy and Infectious Disease. Building 31, Room 7A-50, 31 Center Drive MSC 2520, Bethesda, MD 20892-2520. (301) 496-5717. <http://www.niaid.nih.gov/default.htm>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Carol A. Turkington

Subacute spongiform encephalopathy *see* **Creutzfeldt-Jakob disease**

Subacute thyroiditis *see* **Thyroiditis**

Subarachnoid hemorrhage

Definition

A subarachnoid hemorrhage is an abnormal and very dangerous condition in which blood collects beneath the arachnoid mater, a membrane that covers the brain. This area, called the subarachnoid space, normally contains cerebrospinal fluid. The accumulation of blood in the subarachnoid space can lead to **stroke**, seizures, and other complications. Additionally, subarachnoid hemorrhages may cause permanent brain damage and a number of harmful biochemical events in the brain. A subarachnoid hemorrhage and the related problems are frequently fatal.

Description

Subarachnoid hemorrhages are classified into two general categories: traumatic and spontaneous. Traumatic refers to brain injury that might be sustained in an accident or a fall. Spontaneous subarachnoid hemorrhages occur with little or no warning and are frequently caused by ruptured aneurysms or blood vessel abnormalities in the brain.

Traumatic brain injury is a critical problem in the United States. According to annual figures compiled by the Brain Injury Association, approximately 373,000 people are hospitalized, more than 56,000 people die, and 99,000 survive with permanent disabilities due to traumatic brain injuries. The leading causes of injury are bicycle, motorcycle, and automobile accidents, with a significant minority due to accidental falls, and sports and recreation mishaps.

Exact statistics are not available on traumatic subarachnoid hemorrhages, but several large clinical studies have found an incidence of 23–39% in relation to severe **head injury**. Furthermore, subarachnoid hemorrhages have been described in the medical literature as the most common brain injury found during **autopsy** investigations of head trauma.

Spontaneous subarachnoid hemorrhages are often due to an aneurysm (a bulge or sac-like projection from a blood vessel) which bursts. **Arteriovenous malformations** (AVMs), which are abnormal interfaces between arteries and veins, may also rupture and release blood into the subarachnoid space. Both aneurysms and AVMs are associated with weak spots in the walls of blood vessels and account for approximately 60% of all spontaneous subarachnoid hemorrhages. The rest may be attributed to other causes, such as **cancer** or infection, or are of unknown origin.

In industrialized countries, it is estimated that there are 6.5–26.4 cases of spontaneous subarachnoid hemorrhage per 100,000 people annually. Certain factors raise the risk of suffering a hemorrhage. Aneurysms are acquired over a person's lifetime and are rarely a factor in subarachnoid hemorrhage before age 20. Conversely, AVMs are present at birth. In some cases, there may be a genetic predisposition for aneurysms or AVMs. Other fac-

tors that have been implicated, but not definitively linked to spontaneous subarachnoid hemorrhages, include **atherosclerosis**, cigarette use, extreme alcohol consumption, and the use of illegal drugs, such as **cocaine**. The exact role of high blood pressure is somewhat unclear, but since it does seem linked to the formation of aneurysms, it may be considered an indirect risk factor.

The immediate danger due to subarachnoid hemorrhage, whether traumatic or spontaneous, is **ischemia**. Ischemia refers to tissue damage caused by restricted or blocked blood flow. The areas of the brain that do not receive adequate blood and oxygen can suffer irreparable injury, leading to permanent brain damage or **death**. An individual who survives the initial hemorrhage is susceptible to a number of complications in the following hours, days, and weeks.

The most common complications are intracranial **hypertension**, vasospasm, and **hydrocephalus**. Intracranial hypertension, or high pressure within the brain, can lead to further bleeding from damaged blood vessels; a complication associated with a 70% fatality rate. Vasospasm, or blood vessel constriction, is a principal cause of secondary ischemia. The blood vessels in the brain constrict in reaction to chemicals released by blood breaking down within the subarachnoid space. As the blood vessels become narrower, blood flow in the brain becomes increasingly restricted. Approximately one third of spontaneous subarachnoid hemorrhages and 30-60% of traumatic bleeds are followed by vasospasm. Hydrocephalus, an accumulation of fluid in the chambers of the brain (ventricles) due to restricted circulation of cerebrospinal fluid, follows approximately 15% of subarachnoid hemorrhages. Because cerebrospinal fluid cannot drain properly, pressure accumulates on the brain, possibly prompting further ischemic complications.

Causes and symptoms

Whether through trauma or disease, subarachnoid hemorrhages are caused by blood being released by a damaged blood vessel and accumulating in the subarachnoid space. Symptoms associated with traumatic subarachnoid hemorrhage may or may not resemble those associated with spontaneous hemorrhage, as trauma can involve multiple injuries with overlapping symptoms.

Typically, a spontaneous subarachnoid hemorrhage is indicated by a sudden, severe **headache**. Nausea, vomiting, and **dizziness** frequently accompany the **pain**. Loss of consciousness occurs in about half the cases of spontaneous hemorrhage. A **coma**, usually brief, may occur. A stiff neck, **fever**, and aversion to light may appear following the hemorrhage. Neurologic symptoms may include partial **paralysis**, loss of vision, seizures, and speech difficulties.

Spontaneous subarachnoid hemorrhages may be preceded by warning signs prior to the initial bleed. Sentinel, or warning, headaches may be present in the days or weeks before an aneurysm or AVM ruptures. These headaches can be accompanied by dizziness, nausea, and vomiting, and possibly neurologic symptoms. Approximately 50% of AVMs are discovered before they bleed significantly; however, most aneurysms are not diagnosed before they rupture.

Diagnosis

To make a diagnosis, a health-care provider takes a detailed history of the symptoms and does a **physical examination**. The symptoms may mimic other disorders and diagnosis can be complicated, especially if the individual is unconscious. The sudden, severe headache can fuel suspicion of a subarachnoid hemorrhage or similar event, and a computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scan is considered essential to a quick diagnosis. The MRI is less sensitive than the CT in detecting acute subarachnoid bleeding, but more sensitive in diagnosing AVM or aneurysm.

A CT scan reveals blood that has escaped into the subarachnoid space. For the best results, the scan should be done within 12 hours of the hemorrhage. If this is not possible, lumbar puncture and examination of the cerebrospinal fluid is advised. Lumbar puncture is also done in cases in which the CT scan doesn't reveal a hemorrhage, but there is a high suspicion that one has occurred. In subarachnoid hemorrhage, cerebrospinal fluid shows red blood cells and/or xanthochromia, a yellowish tinge caused by blood breakdown products. Xanthochromia first appears six to 12 hours after subarachnoid hemorrhage, making it advisable to delay lumbar puncture until at least 12 hours after the onset of symptoms for a more definite diagnosis.

Once a hemorrhage, AVM, or aneurysm has been diagnosed, further tests are done to pinpoint the damage. The CT scan may be useful in giving the general location, but cerebral **angiography** maps out the exact details. This procedure involves injecting a special dye into the blood stream. This dye makes blood vessels visible in x rays of the area.

Treatment

The initial course of treatment focuses on stabilizing the hemorrhage victim. Depending on the individual's condition, this may involve intubation and mechanical ventilation, supplemental oxygen, intravenous fluids, and close monitoring of vital signs. If the person suffers seizures, an anticonvulsant, such as phenytoin (Dilantin), is administered. Nimodipine, a calcium channel blocker,

KEY TERMS

Aneurysm—A weak point in a blood vessel where the pressure of the blood causes the vessel wall to bulge outwards. An aneurysm may also appear as a sac-like projection from the blood vessel wall.

Arachnoid mater—One of three membranes that encase the brain and spinal cord. The arachnoid mater is the middle membrane.

Arteriovenous malformation—An abnormal tangle of arteries and veins in which the arteries feed directly into the veins without a normal intervening capillary bed.

Atherosclerosis—An abnormal condition in which lipids, or fats, form deposits on the inside walls of blood vessels.

Cerebral angiography—A medical test in which an x-ray visible dye is injected into blood vessels to allow them to be imaged on an x ray.

Cerebrospinal fluid—The clear, normally colorless fluid found within the subarachnoid space.

Computerized tomography (CT) scan—Cross-sectional x rays of the body compiled to create a three-dimensional image of the body's internal structures.

Hemorrhage—The escape of blood from blood vessels.

Hydrocephalus—Englargement of the chambers in the brain (ventricles) caused by an accumulation of cerebrospinal fluid.

Intracranial hypertension—Abnormally high pressure within the brain.

Ischemia—A condition in which blood flow is cut off or restricted from a particular area. The tissue becomes starved of oxygen and nutrients, resulting in tissue death.

Ischemic—Referring to ischemia.

Lumbar puncture—A diagnostic procedure in which a needle is inserted into the lower spine to withdraw a small amount of cerebrospinal fluid. This fluid is examined to assess trauma to the brain.

Subarachnoid—Referring to the space underneath the arachnoid mater.

Vasospasm—The constriction or narrowing of blood vessels. In cases of hemorrhage, the constriction is prompted by chemical signals from the escaped blood as it breaks down.

may be given to prevent vasospasm and its complications. Sedatives and medications for pain, nausea, and vomiting are administered as needed.

Once the individual is stabilized, cerebral angiography is done to locate the damaged blood vessel. This information and the individual's condition are considered before attempting surgical treatment. Surgery is necessary to remove the damaged area of the blood vessel and prevent a second hemorrhage. The specific neurosurgical procedures depend on the location and type of blood vessel damage. Typically, clip ligation is the preferred means of treating an aneurysm, and surgical excision, radiosurgery, or endovascular embolization are used to manage an AVM.

Prognosis

Individuals who are conscious and demonstrate few neurologic symptoms when they reach medical help have the best prognosis. However, the overall prospects for subarachnoid hemorrhage patients are generally not good. Of the individuals who suffer an aneurysmal hemorrhage, approximately 15% do not live long enough to get medical treatment. Another 20-40% will not survive the complications caused by the hemorrhage, and approximately 12% of the survivors will experience permanent neurologic disability. Neurologic disabilities may include partial paralysis, weakened or numbed areas of the body, cognitive or speech difficulties, and vision problems. Individuals whose subarachnoid hemorrhages occur as a result of AVMs have a slightly better prognosis, although the risk of death is approximately 10–15% for each hemorrhage.

Subarachnoid hemorrhage associated with traumatic brain injury has a poor prognosis. In clinical studies, 46–78% of head injury cases involving subarachnoid hemorrhage resulted in severe disability, vegetative survival, or death. Furthermore, it is possible that traumatic subarachnoid hemorrhages are accompanied by additional injuries, which would further diminish survival and recovery rates.

Prevention

Traumatic brain injury is the leading cause of subarachnoid hemorrhages, so it follows that efforts to prevent head injury would prevent these hemorrhages. Since accidents cannot always be prevented, measures to mini-

mize potential damage are always advisable. Use of activity-appropriate protective gear, such as bicycle helmets, motorcycle helmets, and sports head gear, is strongly encouraged and promoted by medical associations, consumer organizations, advocacy groups, and health-care professionals. These same groups also advise using seat belts in automobiles.

Spontaneous subarachnoid hemorrhages are more difficult to prevent. Since there may be a genetic component to aneurysms and AVMs, close relatives to individuals with these conditions may consider being screened to assess their own status. Quitting **smoking** and keeping blood pressure within normal limits may also reduce the risk of suffering a spontaneous subarachnoid hemorrhage.

Resources

PERIODICALS

Bell, Teresa E., and Gail L. Kongable. "Innovations in Aneurysmal Subarachnoid Hemorrhage: Intracisternal t-PA for the Prevention of Vasospasm." *Journal of Neuroscience Nursing* 28, no. 2 (Apr. 1996): 107.

Kakarieka, Algirdas. "Review on Traumatic Subarachnoid Hemorrhage." *Neurological Research* 19 (June 1997): 230.

Sawin, Paul D. "Diagnosis of Spontaneous Subarachnoid Hemorrhage." *American Family Physician* 55, no. 1 (Jan. 1997): 145.

ORGANIZATIONS

Brain Injury Association of America. 105 North Alfred St., Alexandria, VA 22314. (800) 444-6443. <http://www.biausa.org>.

National Stroke Association. 9707 E. Easter Lane, Englewood, CO 80112. (800) 787-6537. <http://www.stroke.org>.

Julia Barrett

Subdural empyema *see* **Central nervous system infections**

Subdural hematoma

Definition

A subdural hematoma is a collection of blood in the space between the outer layer (dura) and middle layers of the covering of the brain (the meninges). It is most often caused by torn, bleeding veins on the inside of the dura as a result of a blow to the head.

Description

Subdural hematomas most often affect people who are prone to falling. Only a slight hit on the head or even a fall to the ground without hitting the head may be enough to tear veins in the brain, often without fracturing the skull. There may be no external evidence of the bruising on the brain's surface.

Subdural hematoma present on autopsied body. *(Custom Medical Stock Photo. Reproduced by permission.)*

Small subdural hematomas may not be very serious, and the blood can be slowly absorbed over several weeks. Larger hematomas, however, can gradually enlarge over several weeks, even though the bleeding has stopped. This enlargement can compress the brain itself, possibly leading to **death** if the blood is not drained.

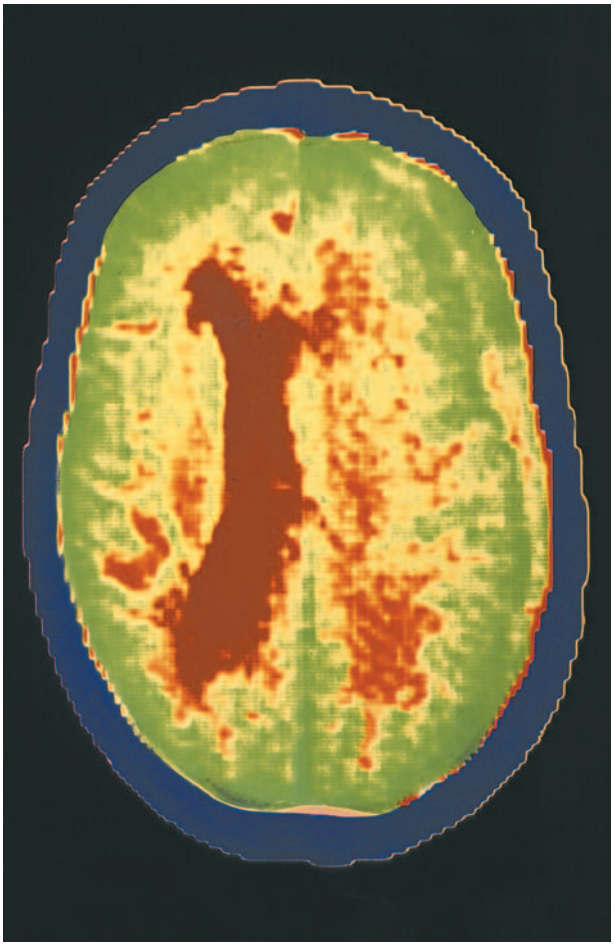
The time between the injury and the appearance of symptoms can vary from less than 48 hours to several weeks, or more. Symptoms appearing in less than 48 hours are due to an acute subdural hematoma. This type of bleeding is often fatal, and results from tearing of the venous sinus. If more than two weeks have passed before symptoms appear, the condition is called a chronic subdural hematoma, resulting from tearing of the smaller vein. The young and the old are most likely to experience a chronic condition. This chronic form is less risky, as pressure of the veins against the skull lessens the bleeding. Prompt medical care can reduce the probability of permanent brain damage.

Causes and symptoms

A subdural hematoma is caused by an injury to the head that tears blood vessels. In childhood, hematomas are a common complication of falls. A subdural hematoma also may be an indication of **child abuse**, as evidenced by **shaken baby syndrome**.

Symptoms tend to fluctuate, and include:

- **headache**
- episodes of confusion and drowsiness
- one-sided weakness or **paralysis**
- lethargy



CT scan indicating subdural hematoma highlighted as a red mass on the center left of the brain. *(Photo Researchers. Reproduced by permission.)*

- enlarged or asymmetric pupils
- convulsions or loss of consciousness after **head injury**
- coma

A doctor should be contacted immediately if symptoms appear. Because these symptoms mimic the signs of a **stroke**, the patient should tell the doctor about any head injury within the previous few months.

In an infant, symptoms may include increased pressure within the skull, growing head size, bulging fontanelle (one of two soft spots on a infant's skull), vomiting, irritability, lethargy, and seizures. In cases of child **abuse**, there may be **fractures** of the skull or other bones.

Diagnosis

A chronic subdural hematoma can be difficult to diagnose, but a slow loss of consciousness after a head injury is assumed to be a hematoma unless proven otherwise. The hematoma can be confirmed with **magnetic resonance imaging** (MRI), which is the preferred type of scan; a hematoma can be hard to detect on a computed tomography scan (CT scan), depending on how long after the hemorrhage the CT is done.

KEY TERMS

Corticosteroids—A group of drugs similar to natural corticosteroid hormones produced by the adrenal glands. The drugs have a wide variety of applications, including use for inflammatory disorders and swelling.

Diuretics—A group of drugs that helps remove excess water from the body by increasing the amount lost by urination.

Fontanelle—One of the two soft areas on a baby's scalp; a membrane-covered gap between the bones of the skull.

Treatment

Small hematomas that do not cause symptoms may not need to be treated. Otherwise, the hematoma should be surgically removed. Liquid blood can be drained from burr holes drilled into the skull. The surgeon may have to open a section of skull to remove a large hematoma or to tie off the bleeding vein.

Corticosteroids and **diuretics** can control brain swelling. After surgery, **anticonvulsant drugs** (such as phenytoin) may help control or prevent seizures, which can begin as late as two years after the head injury.

Prognosis

If treatment is provided soon enough, recovery is usually complete. Headache, **amnesia**, attention problems, **anxiety**, and giddiness may continue for some time after surgery. Most symptoms in adults usually disappear within six months, with further improvement over several years. Children tend to recover much faster.

Prevention

Because a subdural hematoma usually follows a head injury, preventing head injury can prevent a hematoma.

Resources

BOOKS

Brumback, Roger A. *Neurology and Clinical Neuroscience.* New York: Springer-Verlag, 1993.

Lambert, David, Martyn Bramwell, and Gail Lawther, eds. *The Brain: A User's Manual*. New York: Springer-Verlag, 1993.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Brain Injury Association of America. 105 North Alfred St., Alexandria, VA 22314. (800) 444-6443. <http://www.biausa.org>.

Head Injury Hotline. P.O. Box 84151, Seattle WA 98124. (206) 621- 8558. <http://www.headinjury.com>.

Head Trauma Support Project, Inc. 2500 Marconi Ave., Ste. 203, Sacramento, CA 95821. (916) 482-5770.

Carol A. Turkington

Subdural hemorrhage *see* **Subdural hematoma**

Subluxations *see* **Dislocations and subluxations**

Substance abuse and dependence

Definition

Substance abuse and dependence refer to any continued pathological use of a medication, non-medically indicated drug (called drugs of abuse), or toxin. Although there are on-going debates on the exact distinctions between substance abuse and substance dependence, the current practice standard—distinguishes between the two by defining substance dependence in terms of physiological and behavioral symptoms of substance use, and substance abuse in terms of the social consequences of substance use.

Substance abuse is any pattern of substance use that results in repeated adverse social consequences related to drug-taking—for example, failure to meet work, family, or school obligations, interpersonal conflicts, or legal problems. Substance dependence, commonly known as **addiction**, is characterized by physiological and behavioral symptoms related to substance use. These symptoms include the need for increasing amounts of the substance to maintain desired effects, withdrawal if drug-taking ceases, and an inordinate amount of time spent in activities related to substance use.

Substance abuse is more likely to be diagnosed among those who have just begun drug-taking and is often an early symptom of substance dependence. However, substance dependence can appear without substance abuse, and substance abuse can persist for extended periods of time without a transition to substance dependence.

Description

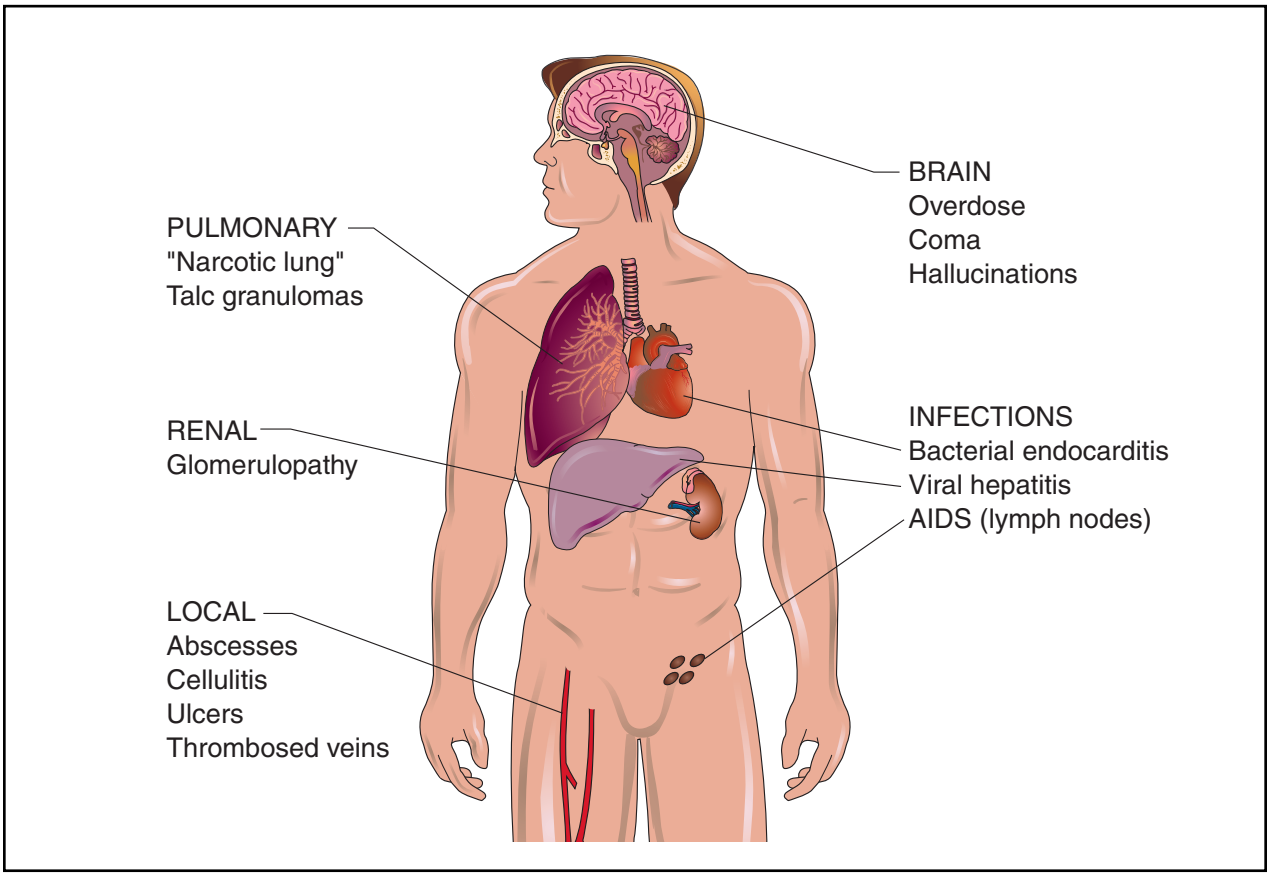
Substance abuse and dependence are disorders that affect all population groups although specific patterns of abuse and dependence vary with age, gender, culture, and socioeconomic status. According to data from the National Longitudinal Alcohol Epidemiologic Survey, 13.3% of the nationally representative survey group exhibited symptoms of alcohol dependence during their lifetime, and 4.4% exhibited symptoms of alcohol dependence during the past 12 months. According to the 1997 National Household Survey on Drug Abuse, 6.4% of those surveyed had used an illicit drug in the past month.

Although substance dependence can begin at any age, persons aged 18 to 24 have relatively high substance use rates, and that dependence often arises sometime during the ages of 20 to 49. Gender proportions vary according to the class of drugs, but substance use disorders are in general more frequently seen in men.

In addition to being an individual health disorder, substance abuse and dependence may be viewed as a public health problem with far-ranging health, economic, and adverse social implications. Substance-related disorders are associated with teen **pregnancy** and the transmission of **sexually transmitted diseases** (STDs), as well as failure in school, unemployment, domestic violence, homelessness, and crimes such as **rape and sexual assault**, aggravated assault, robbery, burglary, and larceny. According to the National Institute on Alcohol Abuse and Alcoholism (NIAAA), the estimated cost of alcohol-related disorders alone (including health care expenditures, lost productivity, and premature **death**) was $166.5 billion in 1995.

The term substance, when discussed in the context of substance abuse and dependence, refers to medications, drugs of abuse, and toxins. These substances have an intoxicating effect, desired by the user, which can have either stimulating (speeding up) or depressive/sedating (slowing down) effects on the body. Substance dependence and/or abuse can involve any of the following 10 classes of substances:

- alcohol
- amphetamines (including "crystal meth," some medications used in the treatment of attention deficit disorder [ADD], and amphetamine-like substances found in appetite suppressants)
- cannibis (including marijuana and hashish)



Substance abuse often causes a variety of medical abnormalities and conditions throughout the body, as shown in the illustration above. *(Illustration by Electronic Illustrators Group.)*

- **cocaine** (including "crack")
- hallucinogens (including **LSD**, mescaline, and MDMA ["ecstasy"])
- inhalants (including compounds found in gasoline, glue, and paint thinners)
- nicotine (substance dependence only)
- opioids (including morphine, heroin, codeine, **methadone**, oxycodone [Oxycontin (TM)])
- phencyclidine (including PCP, angel dust, ketamine)
- sedative, hypnotic, and anxiolytic (antianxiety) substances (including **benzodiazepines** such as valium, **barbiturates**, prescription sleeping medications, and most prescription anti-anxiety medications)

Caffeine has been identified as a substance in this context, but as yet there is insufficient evidence to establish whether caffeine-related symptoms constitute substance abuse and dependence.

Substances of abuse may thus be illicit drugs, readily available substances such as alcohol or glue, over-the-counter drugs, or prescription medications. In many cases, a prescription medication that becomes a substance of abuse may have been a legal, medically indicated prescription for the user, but the pattern of use diverges from the use prescribed by the physician.

Causes and symptoms

Causes

The causes of substance dependence are not well-established, but three factors are believed to contribute to substance-related disorders: genetic factors, psychopathology, and social learning. In genetic epidemiological studies of alcoholism, the probability of identical twins both exhibiting alcohol dependence was significantly greater than with fraternal twins, thus suggesting a genetic component in alcoholism. It is unclear, however, whether the genetic factor is related to alcoholism directly, or whether it is linked to other psychiatric disorders that are known to be associated with substance abuse. For example, there is evidence that alcoholic males from families with **depressive disorders** tend to have more

severe courses of substance dependence than alcoholic men from families without such family histories.

These and other empirical findings that relate psychological pathologies to substance dependence are also consistent with a model of substance dependence where substance use is a way to relieve the symptoms of a psychological disorder. In this model, the psychopathology is the cause of ongoing substance use because individuals use the substance to alleviate their subjective experience of the pathology. Unless the underlying pathology is treated, attempts to permanently stop substance dependence are ineffective. Psychopathologies that are associated with substance dependence include antisocial personality disorder, **bipolar disorder**, depression, **anxiety** disorder, and **schizophrenia**.

A third factor related to substance dependence is social environment. In this model, drug-taking is essentially a socially learned behavior. Local social norms determine the likelihood that a person is exposed to the substance and whether continued use is reinforced. For example, individuals may, by observing family or peer role models, learn that substance use is a normal way to relieve daily stresses. External penalties, such as legal or social sanctions, may reduce the likelihood of substance use.

At the level of neurobiology, it is believed that substances of abuse operate through similar pathways in the brain (one well-known pathway is the "mesolimbic dopamine system" or "mesolimbic reward pathway"). The chemical changes induced by the stimulation of these pathways by initial use of the substance lead to the desire to continue substance use, possibly leading to substance dependence.

Symptoms

The DSM-IV-TR identifies seven criteria (symptoms), at least three of which must be met during a given 12-month period, for the diagnosis of substance dependence:

- Tolerance, as defined either by the need for increasing amounts of the substance to obtain the desired effect or by experiencing less effect with extended use of the same amount of the substance.
- Withdrawal, as exhibited either by experiencing unpleasant mental, physiological, and emotional changes when drug-taking ceases or by using the substance as a way to relieve or prevent withdrawal symptoms.
- Substance is taken for a longer duration or in greater quantities than was originally intended.
- Persistent desire or repeated unsuccessful efforts to stop or attenuate substance use.
- A relatively large amount of time spent in securing and using the substance, or in recovering from the effects of the substance.
- Important work and social activities reduced because of substance use.
- Continued substance use despite negative physical and psychological effects of use.

Although not explicitly listed in the DSM-IV-TR criteria, "craving," or the overwhelming desire to use the substance regardless of countervailing forces, is a universally-reported symptom of substance dependence.

Symptoms of substance abuse, as specified by DSM-IV-TR, include one or more of the following occurring during a given 12-month period:

- Substance use resulting in a recurrent failure to fulfill work, school, or home obligations (e.g. work absences, substance-related school suspensions, neglect of children).
- Substance use in physically hazardous situations such as driving or operating machinery.
- Substance use resulting in legal problems such as drug-related arrests.
- Continued substance use despite negative social and relationship consequences of use.

In addition to the general symptoms, there are other physical signs and symptoms of substance abuse that are related to specific drug classes:

- Signs and symptoms of alcohol intoxication are well-known; these include such physical signs as slurred speech, lack of coordination, unsteady gait, memory impairment, and stupor, as well as behavior changes manifesting themselves shortly after alcohol ingestion, including inappropriate aggressive behavior, mood volatility, and impaired functioning.
- Amphetamine users may exhibit rapid heartbeat, elevated or depressed blood pressure, dilated (enlarged) pupils, weight loss, as well as excessively high energy, inability to sleep, confusion, and occasional paranoid psychotic behavior.
- Cannibis users may exhibit red eyes with dilated pupils, increased appetite, **dry mouth**, and rapid pulse; they may also be sluggish and slow to react.
- Cocaine users may exhibit rapid heart rate, elevated or depressed blood pressure, dilated pupils, weight loss, in addition to wide variations in their energy-level, severe mood disturbances, **psychosis**, and **paranoia**.
- Users of hallucinogens may exhibit anxiety or depression, paranoia, and unusual behavior in response to **hallucinations** (imagined sights, voices, sounds, or smells that appear real). Signs include dilated pupils, rapid heart rate, **tremors**, lack of coordination, and sweating. Flashbacks, or the re-experiencing of a hallucination

long after stopping substance use, are also a symptom of hallucinogen use.

- Users of inhalants experience **dizziness**, spastic eye movements, lack of coordination, slurred speech, and slowed reflexes. Associated behaviors may include belligerence, predisposition to violence, apathy, and impaired judgment.
- Opioid drug users exhibit slurred speech, drowsiness, impaired memory, and constricted (small) pupils. They may appear slowed in their physical movements.
- Phencyclidine users exhibit spastic eye movements, rapid heartbeat, decreased sensitivity to **pain**, and lack of muscular coordination. They may show belligerence, predisposition to violence, impulsiveness, and agitation.
- Users of sedative, hypnotic, or anxiolytic drugs show slurred speech, unsteady gait, inattentiveness, and impaired memory. They may display inappropriate behavior, mood volatility, and impaired functioning.

Other signs are related to the form in which the substance is used. For example, heroin, certain other opioid drugs, and certain forms of cocaine may be injected. A person using an injectable substance may have "track marks" (outwardly visible signs of the site of an injection, with possible redness and swelling of the vein in which the substance was injected). Furthermore, poor judgment brought on by substance use can result in the injections being made under dangerously unhygienic conditions. These unsanitary conditions and the use of shared needles are risk factors for major infections of the heart, as well as infection with HIV (the virus that causes **AIDS**), certain forms of hepatitis (a liver infection), and **tuberculosis**.

Cocaine is often taken as a powdery substance which is "snorted" through the nose. This can result in frequent nosebleeds, sores in the nose, and even erosion (an eating away) of the nasal septum (the structure that separates the two nostrils).

Overdosing on a substance is a frequent complication of substance abuse. **Drug overdose** can be purposeful (with suicide as a goal), or due to carelessness, the unpredictable strength of substances purchased from street dealers, mixing of more than one type of substance, or as a result of the increasing doses that a person must take to experience intoxicating effects. Substance overdose can be a life-threatening emergency, with the specific symptoms depending on the type of substance used. Substances with depressive effects may dangerously slow the breathing and heart rate, drop the body temperature, and result in a general unresponsiveness. Substances with stimulatory effects may dangerously increase the heart rate and blood pressure, produce abnormal heart rhythms, increase body temperature, induce seizures, and cause erratic behavior.

Diagnosis

Tools used in the diagnosis of substance dependence include screening questionnaires and patient histories, **physical examination**, and laboratory tests. A simple and popular screening tool is the CAGE questionnaire. CAGE refers to the first letters of each word that forms the basis of each of the four questions of the screening exam:

- have you ever tried to Cut down on your substance use?
- have you ever been Annoyed by people trying to talk to you about your substance use?
- do you ever feel Guilty about your substance use?
- do you ever need an Eye opener (use of the substance first thing in the morning) in order to start your day?

A "yes" answer to two or more of these questions is an indication that the individual should be referred for more thorough work-up for substance dependency or abuse.

In addition to CAGE, other screening questionnaires are available. Some are designed for particular population groups such as pregnant women, and others are designed to more thoroughly assess the severity of substance dependence. These questionnaires, known by their acronyms, include AUDIT, HSS, HSQ, PRIME-MD, ACE, TWEAK, s-MAST, and SADD. There is some variability among questionnaires in terms of how accurately and comprehensively they can identify individuals as substance dependent.

Patient history, as taken through the direct interview, is important for identifying physical symptoms and psychiatric factors related to substance use. Family history of alcohol or other substance dependency is also useful for diagnosis.

A physical examination may reveal signs of substance abuse. These signs are specific to the substances used, as well as needle marks, tracks, or nasal erosion.

With the individual's permission, substance use can be detected through laboratory testing of his or her blood, urine, or hair. Laboratory testing, however, may be limited by the sensitivity and specificity of the testing method, and by the time elapsed since the person last used the drug.

One of the most difficult aspects of diagnosis involves overcoming the patient's denial. Denial is a psychological state during which a person is unable to acknowledge the (usually negative) circumstances of a

situation. In this case, denial leads a person to underestimate the degree of substance use and of the problems associated with substance use.

Treatment

According to the American Psychiatric Association, there are three goals for the treatment of persons with substance use disorders: (1) the patient abstains from or reduces the use and effects of the substance; (2) the patient reduces the frequency and severity of relapses; and (3) the patient develops the psychological and emotional skills necessary to restore and maintain personal, occupational, and social functioning.

In general, before treatment can begin, many treatment centers require that the patient undergo **detoxification**. Detoxification is the process of weaning the patient from his or her regular substance use. Detoxification can be accomplished "cold turkey," by complete and immediate cessation of all substance use, or by slowly decreasing (tapering) the dose which a person is taking, to minimize the side effects of withdrawal. Some substances must be tapered because "cold turkey" methods of detoxification are potentially life threatening. In some cases, medications may be used to combat the unpleasant and threatening physical and psychological symptoms of withdrawal. For example, methadone is used to help patients adjust to the tapering of heroin use.

Treatment itself consists of three parts: (1) assessment; (2) formulation of a treatment plan; (3) psychiatric management. The first step in treatment is a comprehensive medical and psychiatric evaluation of the patient. This evaluation includes:

- a history of the patient's past and current substance use, and its cognitive, psychological, physiological, and behavioral effects
- a medical and psychiatric history and examination
- a history of psychiatric treatments and outcomes
- a family and social history
- screening of blood, breath, or urine for substances
- other laboratory tests to determine the presence of other conditions commonly found with substance use disorders

After the assessment is made, a treatment plan is formulated. Treatment plans vary according to the needs of the specific patient and can change for the same patient as he or she undergoes different phases of the disorder. Plans typically involve the following elements: (1) a strategy for the psychiatric management of the patient; (2) a strategy for reducing effects or use of substances, or for abstinence; (3) efforts to ensure compliance with the treatment program and to prevent relapse; (4) treatments for other conditions associated with substance use. Initial therapy and treatment setting (hospital, residential treatment, partial hospitalization, outpatient) decisions are made as part of the treatment plan, but because substance use disorders are considered a chronic condition requiring long-term care, these plans can and do change through the course of treatment.

Frequency Of Substance Abuse By Gender And Age

Men		
	Ages 18 to 29	17 to 24 percent
	Ages 30 to 44	11 to 14 percent
	Ages 45 to 64	6 to 8 percent
	Over age 65	1 to 3 percent
Women		
	Ages 18 to 29	4 to 10 percent
	Ages 30 to 44	2 to 4 percent
	Ages 45 to 64	1 to 2 percent
	Over age 65	less than 1 percent

The third step, psychiatric management of the patient, is the implementation of the treatment plan. Psychiatric management of the patient includes establishing a trusting relationship between clinician and patient; monitoring the patient's progress; managing the patient's relapses and withdrawal; diagnosing and treating associated psychiatric disorders; and helping the patient adhere to the treatment plan through therapy and the development of skills and social interactions that reinforce a drug-free lifestyle.

As part of the treatment process, patients typically undergo psychosocial therapy and, in some cases, pharmacologic treatment. Psychosocial therapeutic modalities include **cognitive-behavioral therapy**, behavioral therapy, individual psychodynamic or interpersonal therapy, **group therapy**, **family therapy**, and self-help groups. Pharmacologic treatment may include medications that ease withdrawal symptoms, reduce craving, interact negatively with substances of abuse to discourage drug-taking, or treat associated psychiatric disorders.

Alternative treatment

The efficacy of alternative treatments for substance use disorders remains for the most part ambiguous. One treatment that has been recently shown to have variable success is the use of **acupuncture** in treating substance dependence. In 2000, a randomized controlled trial of the effect of acupuncture on cocaine addiction reported that acupuncture significantly reduced the cocaine use of study participants. A 1999 meta-analysis (summary analysis of studies), however, reported that acupuncture had no statistically significant effect on **smoking** cessation.

There has been movement towards examining some of the (anecdotally) promising treatments in more rigorous clinical trials. In particular, there has been some interest in *Pueraria lobata*, or kudzu, an herb that has reputedly been used in Chinese medicine to treat alcoholism. Preclinical trials of an herbal formula with kudzu have shown that increased consumption of the herbal formula is associated with decreased consumption of alcohol. Toxicity studies show few ill effects of the formula, and human trials are currently being undertaken to more fully evaluate the efficacy of this treatment.

The effectiveness of electroacupuncture (the practice of acupuncture accompanied by the application of low levels of electrical current at acupuncture points) in alleviating opiate withdrawal symptoms is also being examined. Preclinical trials suggest that electroacupuncture treatment given prior to the administration of naxolone (a medication that counteracts the effects of opiates but precipitates withdrawal symptoms) seems to to alleviate the withdrawal effects of naxolone.

Prognosis

Recovery from substance use is notoriously difficult, even with exceptional treatment resources. Although relapse rates are difficult to accurately obtain, the NIAAA cites evidence that 90% of alcohol dependent users experience at least one relapse within the 4 years after treatment. Relapse rates for heroin and nicotine users are believed to be similar. Certain pharmacological treatments, however, have been shown to reduce relapse rates.

Relapses are most likely to occur within the first 12 months of having discontinued substance use. Triggers for relapses can include any number of life stresses (problems on the job or in the marriage, loss of a relationship, death of a loved one, financial stresses), in addition to seemingly mundane exposure to a place or an acquaintance associated with previous substance use.

The development of adaptive life skills and on-going drug-free social support are believed to be two important factors in avoiding relapse. The effect of the support group Alcoholics Anonymous has been intensively studied, and a 1996 meta-analysis noted that long-term sobriety appears to be positively related to Alcoholics Anonymous attendance and involvement. Support for family members in addition to support for the individual in recovery is also important. Because substance dependence has a serious impact on family functioning, and because family members may inadvertently maintain behaviors that initially led to the substance dependence, on-going therapy and support for family members should not be neglected.

KEY TERMS

Addiction—The state of being both physically and psychologically dependent on a substance.

Dependence—A state in which a person requires a steady concentration of a particular substance to avoid experiencing withdrawal symptoms.

Detoxification—A process whereby an addict is withdrawn from a substance.

Intoxication—The desired mental, physical, or emotional state produced by a substance.

Street drug—A substance purchased from a drug dealer; may be a legal substance, sold illicitly (without a prescription, and not for medical use), or it may be a substance which is illegal to possess.

Tolerance—A phenomenon whereby a drug user becomes physically accustomed to a particular dose of a substance, and requires increasing dosages in order to obtain the same effects.

Withdrawal—Those side effects experienced by a person who has become physically dependent on a substance, upon decreasing the substance's dosage or discontinuing its use.

Prevention

Prevention is best aimed at teenagers and young adults aged 18–24 who are at very high risk for substance experimentation. Prevention programs should include an education component that outlines the risks and consequences of substance use and a training component that gives advice on how to resist peer pressure to use drugs.

Furthermore, prevention programs should work to identify and target children who are at relatively higher risk for substance abuse. This group includes victims of physical or sexual abuse, children of parents who have a history of substance abuse, and children with poor school performance and/or attention deficit disorder. These children may require more intensive intervention.

Resources

BOOKS

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed., text revision. Washington, DC: American Psychiatric Association, 2000.

American Psychiatric Association. *DMS-IV Sourcebook*. Vol. 1. Washington, DC: American Psychiatric Association, 1994.

PERIODICALS

Rivara, F., et al. "Alcohol and Illicit Drug Abuse and the Risk of Violent Death in the Home." *Journal of the American Medical Association* 278 (20 August 1997): 569+.

Schneider, Robert K., James L. Levenson, and Sidney H. Schnoll. "Update in Addiction Medicine." *Annals of Internal Medicine* 134 (March 6, 2001): 387-395.

ORGANIZATION

Alcoholics Anonymous. Grand Central Station, P.O. Box 459, New York, NY 10163. (212) 870-3400. <http://www.alcoholics-anonymous.org>.

Al-Anon Family Group Headquarters, Inc. 1600 Corporate Landing Parkway, Virginia Beach, VA 23454. (757) 563-1600. <http://www.al-anon.alateen.org>.

National Clearinghouse for Alcohol and Drug Information. 11426-28 Rockville Pike, Suite 200, Rockville, MD 20852. (800) 729-6686. <http://www.health.org>.

National Institute on Alcohol Abuse and Alcoholism (NIAAA). 6000 Executive Boulevard, Willco Building, Bethesda, MD 20892-7003. (301) 443-3860. <http://www.niaaa.nih.gov>.

OTHER

American Psychiatric Association. "Practice Guidelines for the Treatment of Patients with Substance Use Disorders." Washington, DC: American Psychiatric Association, 1995.

Genevieve Pham-Kanter

Substance dependence *see* **Substance abuse and dependence**

Sucralfate *see* **Antiulcer drugs**

Sucrose intolerance *see* **Carbohydrate intolerance**

Sudden cardiac death

Definition

Sudden cardiac **death** (SCD) is an unexpected death due to heart problems, which occurs within one hour from the start of any cardiac-related symptoms. SCD is sometimes called cardiac arrest.

Description

When the heart suddenly stops beating effectively and breathing ceases, a person is said to have experienced sudden cardiac death.

SCD is not the same as actual death. In actual death, the brain also dies. The important difference is that sudden cardiac death is potentially reversible. If it is reversed quickly enough, the brain will not die.

Sudden cardiac death is also not the same as a **heart attack**. A heart attack (myocardial infarction) is the result of a blockage in an artery which feeds the heart, so the heart becomes starved for oxygen. The part that has been starved is damaged beyond repair, but the heart can still beat effectively.

Causes and symptoms

Sudden cardiac death is usually caused by **ventricular fibrillation** (the lower chamber of the heart quivers instead of pumping in an organized rhythm). Ventricular fibrillation almost never returns to normal by itself, so the condition requires immediate intervention. **Ventricular tachycardia** can also lead to sudden cardiac death. The risk for SCD is higher for anyone with heart disease.

When the heart stops beating effectively and the brain is being deprived of oxygenated blood, a medical emergency exists.

Diagnosis

Diagnosis of sudden cardiac death is made when there is a sudden loss of consciousness, breathing stops, and there is no effective heart beat.

Treatment

When sudden cardiac death occurs, the first priority is to establish the flow of oxygenated blood to the brain. The next priority is to restore normal rhythm to the heart. Forcing air into the mouth will get oxygen into the lungs. Compressing the chest simulates a pumping heart and will get some blood flow to the lungs, brain, and coronary arteries. This method is called **cardiopulmonary resuscitation** (**CPR**). When trained help arrives, they will attempt to establish a normal heart beat by using a device called a defibrillator.

If sudden cardiac death occurs outside the hospital setting, cardiopulmonary resuscitation (CPR) must begin within four to six minutes and advanced **life support** measures must begin within eight minutes, to avoid brain death. CPR requires no special medical skills and training is available for the ordinary person nationwide.

Prognosis

Sudden cardiac death is reversible in most people if treatment is begun quickly. However, of the people who are resuscitated, 40% will have another SCD within two years if they do not receive appropriate treatment for the underlying cause of the episode.

KEY TERMS

Defibrillator—A device which delivers a controlled electric shock to the heart to return it to normal beating rhythm.

Ventricular fibrillation—The lower chamber of the heart quivers instead of pumping in an organized way.

Ventricular tachycardia—A rapid heartbeat, usually over 100 beats per minute.

Prevention

In order to prevent sudden cardiac death, underlying heart conditions must be addressed. Medications and implantable cardioverter-defibrillators may be used.

Resources

BOOKS

McGood, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

PERIODICALS

Society for the Advancement of Education. "Sudden Cardiac Death (SCD)." *USA Today*, Feb. 1997, 11.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Sudden infant death syndrome

Definition

Sudden infant **death** syndrome (SIDS) is the unexplained death without warning of an apparently healthy infant, usually during sleep.

Description

Also known as crib death, SIDS has baffled physicians and parents for years. In the 1990s, advances have been made in preventing the occurrence of SIDS, which killed more than 4,800 babies in 1992 and 3,279 infants in 1995. Education programs aimed at encouraging parents and caregivers to place babies on their backs and sides when putting them to bed have helped contribute to a lower mortality rate from SIDS.

In the United States, SIDS strikes one or two infants in every thousand, making it the leading cause of death in newborns. It accounts for about 10% of deaths occurring during the first year of life. SIDS most commonly affects babies between the ages of two months and six months; it almost never strikes infants younger than two weeks of age or older than eight months. Most SIDS deaths occur between midnight and 8 A.M.

Causes and symptoms

Risk factors for SIDS

The exact causes of SIDS are still unknown, although studies have shown that many of the infants had recently been under a doctor's care for a cold or other illness of the upper respiratory tract. Most SIDS deaths occur during the winter and early spring, which are the peak times for respiratory infections. The most common risk factors for SIDS include:

- sleeping on the stomach (in the prone position)
- mother who smokes during **pregnancy**; smokers are as much as three times more likely than nonsmokers to have a SIDS baby
- the presence of passive smoke in the household
- male sex. The male/female ratio in SIDS deaths is 3:2
- belonging to an economically deprived or minority family
- mother under 20 years of age at pregnancy
- mother who abuses drugs
- mother with little or no prenatal care
- prematurity or low weight at birth
- family history of SIDS

Most of these risk factors are associated with significantly higher rates of SIDS; however, none of them are exact enough to be useful in predicting which specific children may die from SIDS.

Theories about SIDS

MEDICAL DISORDERS. Currently it is not known whether the immediate cause of death from SIDS is a heart problem or a sudden interruption of breathing. The most consistent **autopsy** findings are pinpoint hemorrhages inside the baby's chest and mild inflammation or congestion of the nose, throat, and airway. Some doctors have thought that the children stop breathing because their upper airway gets blocked. Others have suggested that the chil-

Ten Leading Causes Of Infant Death (U.S.)

Congenital anomalies
Pre-term/Low birthweight
Sudden Infant Death Syndrome (SIDS) Respiratory Distress Syndrome
Problems related to complications of pregnancy Complications of placenta, cord, and membrane Accidents
Perinatal infections
Pneumonia/Influenza
Intrauterine hypoxia and birth asphyxia

dren have an abnormally high blood level of the chemicals that transmit nerve impulses to the brain, or that there is too much fetal hemoglobin in the blood. A third theory concerns the possibility that SIDS infants have an underlying abnormality in the central nervous system. This suggestion is based on the assumption that normal infants sense when their air supply is inadequate and wake up. Babies with an abnormal nervous system, however, do not have the same alarm mechanism in their brains. Other theories about the cause of death in SIDS include immune system disorders that cause changes in the baby's heart rate and breathing patterns during sleep, or a metabolic disorder that causes a buildup of fatty acids in the baby's system.

PHYSICAL SURROUNDINGS. A recent theory proposes that SIDS is connected to the child's rebreathing of stale air trapped in soft bedding. In addition to the infant's sleeping in the prone position, pillows, sheepskins, and other soft items may contribute to trapping air around the baby's mouth and nose, which causes the baby to breathe in too much carbon dioxide and not enough oxygen. Wrapping a baby too warmly has also been proposed as a factor.

Diagnosis

The diagnosis of SIDS is primarily a diagnosis of exclusion. This means that it is given only after other possible causes of the baby's death have been ruled out. Known risk factors aid in the diagnosis. Unlike the pattern in other diseases, however, the diagnosis of SIDS can only be given post-mortem. It is recommended that all infants who die in their sleep receive an autopsy to determine the cause. Autopsies indicate a definite explanation in about 20% of cases of sudden infant death. In addition, an autopsy can often put to rest any doubts the parents may have. Investigation of the location of the death is also useful in determining the child's sleeping position, bedding, room temperature, and similar factors.

Treatment

There is no treatment for SIDS, only identification of risk factors and preventive measures. The baby's parents may benefit from referral to counseling and support groups for parents of SIDS victims.

Prevention

SIDS appears to be at least partly preventable, which has been shown by a decrease in the case rate. The following are recommended as preventive measures:

- Sleep position. The United States Department of Health and Human Services initiated a "Back-to-Sleep" campaign in 1994 to educate the public about sleep position. Prior to that time, an estimated 70% of infants slept on their stomachs, since parents had been taught that a "back down" position contributed to **choking** during sleep. There are some conditions for which doctors will recommend the prone position, but for normal infants, side or back (supine) positions are better. When placing an infant on his or her side, the parent should pull the child's lower arm forward so that he or she is less likely to roll over onto the stomach. When babies are awake and being observed, they should be placed on their stomachs frequently to aid in the development of the muscles and skills involved in lifting the head. Once a baby can roll over to his or her stomach, he or she has developed to the point where the risk of SIDS is minimal.
- Good prenatal care. Proper prenatal care can help prevent the abnormalities that put children at higher risk for SIDS. Mothers who do not receive prenatal care are also more likely to have premature and low birthweight babies. Expectant mothers should also be warned about the risks of **smoking**, alcohol intake, and drug use during pregnancy.
- Proper bedding. Studies have shown that soft bedding, such as beanbags, waterbeds and soft mattresses, contributes to SIDS. Babies should sleep on firm mattresses with no soft or fluffy materials underneath or around them—including quilts, pillows, thick comforters or lambskin. Soft stuffed toys should not be placed in the crib while babies sleep.
- Room temperature. Although babies should be kept warm, they do not need to be any warmer than is comfortable for the caregiver. An overheated baby is more

likely to sleep deeply, perhaps making it more difficult to wake when short of breath. Room temperature and wrapping should keep the baby warm and comfortable but not overheated.

- Diet. Some studies indicate that breastfed babies are at lower risk for SIDS. It is thought that the mother's milk may provide additional immunity to the infections that can trigger sudden death in infants.
- Bedsharing with parents. Opinions differ on whether or not bedsharing of infant and mother increases or decreases the risk of SIDS. Bedsharing may encourage breastfeeding or alter sleep patterns, which could lower the risk of SIDS. On the other hand, some studies suggest that bedsharing increases the risk of SIDS. In any case, mothers who choose to bring their babies to bed should observe the following cautions: Soft sleep surfaces, as well as quilts, blankets, comforters or pillows should not be placed under the baby. Parents who sleep with their infants should not smoke around the baby, or use alcohol or other drugs which might make them difficult to arouse. Parents should also be aware that adult beds are not built with the same safety features as infant cribs.
- Secondhand smoke. It is as important to keep the baby's environment smoke-free during infancy as it was when the mother was pregnant with the baby.
- Electronic monitoring. Electronic monitors are available for use in the home. These devices sound an alarm for the parents if the child stops breathing. There is no evidence, however, that these monitors prevent SIDS. In 1986, experts consulted by the National Institutes of Health (NIH) recommended monitors only for infants at risk. These infants include those who have had one or more episodes of breath stopping; premature infants with breathing difficulties; and babies with two or more older siblings that died of SIDS. Parents who use monitors should know how to use them properly and what to for the baby if the alarm goes off.
- Immunizations. There is no evidence that immunizations increase the risk of SIDS. In fact, babies who receive immunizations on schedule are less likely to die of SIDS.

Resources

PERIODICALS

Kemp, James S., et al. "Softness and Potential to Cause Rebreathing: Differences in Bedding Used by Infants at High and Low Risk for Sudden Infant Death Syndrome." *Journal of Pediatrics* 132 (Feb. 98): 234-238.

ORGANIZATIONS

Association of SIDS and Infant Mortality Programs. MN SID Center, Children's Hospitals and Clinics, 2525 Chicago Ave. So., Minneapolis, MN 55404. (612) 813-6285. <http://www.asip1.org>.

National Institute of Child Health and Human Development. Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD 20892-2425. (800) 505-2742. <http://www.nichd.nih.gov/sids/sids.htm>.

National SIDS Resource Center. 2070 Chain Bridge Road, Suite 450, Vienna, VA 22181. (703) 821-8955. <http://www.circsol.com/SIDS/>.

Sudden Infant Death Syndrome Alliance. 1314 Bedford Avenue, Suite 210, Baltimore, MD 21208. (800) 221-7437. <http://www.sidsalliance.org>.

Teresa Norris, RN

KEY TERMS

Congenital—Existing or present at the time of birth.

Crib death—Another name for SIDS.

Prone—Lying on the stomach with the face downward.

Supine—Lying on the back with the face upward.

Sugar diabetes *see* **Diabetes mellitus**

Sugar intolerance *see* **Carbohydrate intolerance**

Sulfacetamide *see* **Antibiotics, ophthalmic**

Sulfamethoxazole and trimethoprim *see* **Sulfonamides**

Sulfinpyrazone *see* **Gout drugs**

Sulfisoxazole *see* **Sulfonamides**

Sulfonamides

Definition

Sulfonamides are medicines that prevent the growth of bacteria in the body.

Purpose

Sulfonamides are used to treat many kinds of infections caused by bacteria and certain other microorganisms. Physicians may prescribe these drugs to treat uri-

nary tract infections, ear infections, frequent or long-lasting **bronchitis**, bacterial **meningitis**, certain eye infections, *Pneumocystis carinii* **pneumonia**, **traveler's diarrhea**, and a number of other kinds of infections. These drugs will *not* work for colds, flu, and other infections caused by viruses.

Description

Sulfonamides, also called sulfa medicines, are available only with a physician's prescription. They are sold in tablet and liquid forms. Some commonly used sulfonamides are sulfisoxazole (Gantrisin) and the combination drug sulfamethoxazole and trimethoprim (Bactrim, Cotrim).

Recommended dosage

The recommended dosage depends on the type of sulfonamide, the strength of the medicine, and the medical problem for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take sulfonamides exactly as directed. To make sure the infection clears up completely, take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon.

Sulfonamides work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. For best results, take the medicine with a full glass of water and drink several more glasses of water every day. This will help prevent some of the medicine's side effects.

Precautions

Symptoms should begin to improve within a few days of beginning to take this medicine. If they do not, or if they get worse, check with the physician who prescribed the medicine.

Although such side effects are rare, some people have had severe and life-threatening reactions to sulfonamides. These include sudden, severe liver damage, serious blood problems, breakdown of the outer layer of the skin, and a condition called Stevens-Johnson syndrome, in which people get blisters around the mouth, eyes, or anus. Call a physician immediately if any of these signs of a dangerous reaction occur:

- skin rash or reddish or purplish spots on the skin
- other skin problems, such as blistering or peeling
- fever
- sore throat
- cough
- shortness of breath
- joint **pain**
- pale skin
- yellow skin or eyes

This medicine may cause **dizziness**. Anyone who takes sulfonamides should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Sulfonamides may cause blood problems that can interfere with healing and lead to additional infections. Avoid injuries while taking this medicine. Be especially careful not to injure the mouth when brushing or flossing the teeth or using a toothpick. Do not have dental work done until the blood is back to normal.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this medicine, avoid being in direct sunlight, especially between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use tanning beds, tanning booths, or sunlamps.

Babies under 2 months should not be given sulfonamides unless their physician has ordered the medicine.

Older people may be especially sensitive to the effects of sulfonamides, increasing the chance of unwanted side effects, such as severe skin problems and blood problems. Patients who are taking water pills (**diuretics**) at the same time as sulfonamides may also be more likely to have these problems.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take sulfonamides. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to sulfonamides, water pills (diuretics), diabetes medicines, or **glaucoma** medicine in the past should let his or her physician know before taking sulfonamides. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. In studies of laboratory animals, some sulfonamides cause **birth defects**. The drugs' effects on

human fetuses have not been studied. However, pregnant women are advised not to use this medicine around the time of labor and delivery, because it can cause side effects in the baby. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using sulfonamides during **pregnancy**.

BREASTFEEDING. Sulfonamides pass into breast milk and may cause liver problems, anemia, and other problems in nursing babies whose mothers take the medicine. Because of those problems, women should not breastfeed when they are under treatment with this drug. Women who are breastfeeding and who need to take this medicine should check with their physicians to find out how long they need to stop breastfeeding.

OTHER MEDICAL CONDITIONS. Before using sulfonamides, people with any of these medical problems should make sure their physicians are aware of their conditions:

- anemia or other blood problems
- kidney disease
- liver disease
- asthma or severe allergies
- alcohol abuse
- poor **nutrition**
- abnormal intestinal absorption
- porphyria
- folic acid deficiency
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD)

USE OF CERTAIN MEDICINES. Taking sulfonamides with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

KEY TERMS

Anemia—A lack of hemoglobin—the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Bronchitis—Inflammation of the air passages of the lungs.

Fetus—A developing baby inside the womb.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Meningitis—Inflammation of tissues that surround the brain and spinal cord.

***Pneumocystis carinii* pneumonia**—A lung infection that affects people with weakened immune systems, such as people with AIDS or people taking medicines that weaken the immune system.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things.

Urinary tract—The passage through which urine flows from the kidneys out of the body.

Side effects

The most common side effects are mild **diarrhea**, nausea, vomiting, dizziness, **headache**, loss of appetite, and tiredness. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with a physician immediately:

- itching or skin rash
- reddish or purplish spots on the skin
- other skin problems, such as redness, blistering, peeling
- severe, watery or bloody diarrhea
- muscle or joint aches
- fever
- sore throat
- cough
- shortness of breath
- unusual tiredness or weakness
- unusual bleeding or bruising
- pale skin
- yellow eyes or skin
- swallowing problems

Other rare side effects may occur. Anyone who has unusual symptoms while taking sulfonamides should get in touch with his or her physician.

Interactions

Sulfonamides may interact with a large number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes sulfonamides should let the physician know all other medicines he or she is taking. Among the drugs that may interact with sulfonamides are:

- acetaminophen (Tylenol)
- medicine for overactive thyroid
- male hormones (androgens)
- female hormones (estrogens)
- other medicines used to treat infections
- birth control pills
- medicines for diabetes such as glyburide (Micronase)
- anticoagulants such as warfarin (Coumadin)
- disulfiram (Antabuse), used to treat alcohol abuse
- amantadine (Symmetrel), used to treat flu and also **Parkinson's disease**
- water pills (diuretics) such as hydrochlorothiazide (HCTZ, HydroDIURIL)
- the anticancer drug methotrexate (Rheumatrex)
- antiseizure medicines such as valproice acid (Depakote, Depakene)

The list above does not include every drug that may interact with sulfonamides. Be sure to check with a physician or pharmacist before combining sulfonamides with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Sumatriptan *see* **Antimigraine drugs**

Sunburn

Definition

Inflammation of the skin caused by overexposure to the sun.

Description

Sunburn is caused by exposure to the ultraviolet (UV) rays of the sun. There are two types of ultraviolet rays, UVA and UVB. UVA rays penetrate the skin more deeply and can cause melanoma in susceptible people. UVB rays, which don't penetrate as deeply, cause sunburn and wrinkling. Most UVB rays are absorbed by **sunscreens**, but only about half the UVA rays are absorbed.

Skin **cancer** from sun overexposure is a serious health problem in the United States, affecting almost a million Americans each year. One out of 87 will develop **malignant melanoma**, the most serious type of skin cancer, and 7,300 of them will die each year.

Fair-skinned people are most susceptible to sunburn, because their skin produces only small amounts of the protective pigment called melanin. People trying to get a tan too quickly in strong sunlight are also more vulnerable to sunburn. While they have a lower risk, even the darkest-skinned people can get skin cancer.

Repeated sun overexposure and burning can prematurely age the skin, causing yellowish, wrinkled skin. Overexposure can increase the risk of skin cancer, especially a serious burn in childhood.

Causes and symptoms

The ultraviolet rays in sunlight destroy cells in the outer layer of the skin, damaging tiny blood vessels underneath. When the skin is burned, the blood vessels dilate and leak fluid. Cells stop making protein. Their DNA is damaged by the ultraviolet rays. Repeated DNA damage can lead to cancer.

When the sun **burns** the skin, it triggers immune defenses which identify the burned skin as foreign. At the same time, the sun transforms a substance on the skin which interferes with this immune response. While this substance keeps the immune system from attacking a person's own skin, it also means that any malignant cells in the skin will be able to grow freely.

Sunburn causes skin to turn red and blister. Several days later, the dead skin cells peel off. In severe cases, the burn may occur with sunstroke (vomiting, **fever** and collapse).

Diagnosis

Visual inspection and a history of exposure to the sun.

Treatment

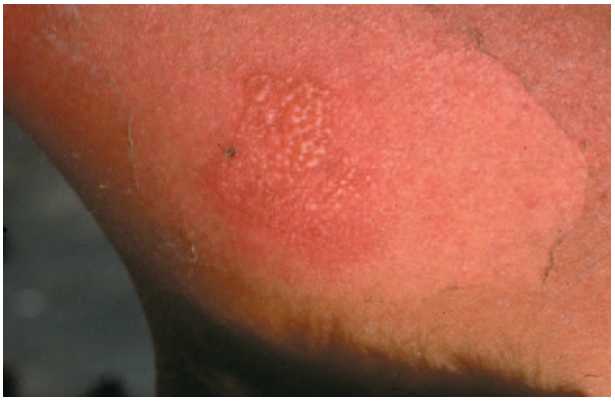
Aspirin can ease **pain** and inflammation. Tender skin should be protected against the sun until it has healed. In addition, apply:

- calamine lotion
- sunburn cream or spray
- cool tap water compress
- colloidal oatmeal (Aveeno) baths
- dusting powder to reduce chafing

People who are severely sunburned should see a doctor, who may prescribe corticosteroid cream to speed healing.

Alternative treatment

Over-the-counter preparations containing aloe (*Aloe barbadensis*) are an effective treatment for sunburn, eas-



This person has a second-degree sunburn on the back of the neck. *(Custom Medical Stock Photo. Reproduced by permission.)*

ing pain and inflammation while also relieving dryness of the skin. A variety of topical herbal remedies applied as lotions, poltices, or compresses may also help relieve the effects of sunburn. Calendula (*Calendula officinalis*) is one of the most frequently recommended to reduce inflammation.

Prognosis

Moderately burned skin should heal within a week. While the skin will heal after a sunburn, the risk of skin cancer increases with exposure and subsequent burns. Even one bad burn in childhood carries an increased risk of skin cancer.

Prevention

Everyone from age six months on should use a water-resistant sunscreen with a sun protective factor (SPF) of at least 15. Apply at least an ounce 15–30 minutes before going outside. It should be reapplied every two hours (more often after swimming). Babies should be kept completely out of the sun for the first six months of life, because their skin is thinner than older children. Sunscreens have not been approved for infants.

In addition, people should:

- limit sun exposure to 15 minutes the first day, even if the weather is hazy, slowly increasing exposure daily
- reapply sunscreen every two hours (more often if sweating or swimming)
- reapply waterproof sunscreen after swimming more than 80 minutes, after toweling off, or after perspiring heavily
- avoid the sun between 10 A.M. and 3 P.M
- use waterproof sunscreen on legs and feet, since the sun can burn even through water
- wear an opaque shirt in water, because reflected rays are intensified

If using a sunscreen under SPF 15, simply applying more of the same SPF won't prolong allowed time in the sun. Instead, patients should use a higher SPF in order to lengthen exposure safely. A billed cap protects 70% of the face; a wide-brimmed hat is better. People at very high risk for skin cancer can wear clothing that blocks almost all UV rays, but most people can simply wear white cotton summer-weight clothing with a tight weave.

KEY TERMS

Malignant melanoma—The most deadly of the three types of skin cancer.

Sunscreen—Products which block the damaging rays of the sun. Good sunscreens contain either para-aminobenzoic acid (PABA) or benzophenone, or both. Sunscreen protection factors range from 2–45.

Resources

BOOKS

Orkin, Milton, Howard Maibach, and Mark Dahl. *Dermatology.* Norwalk, CT: Appleton & Lange, 1992.

PERIODICALS

Brink, Susan, and Corinna Wu. "Sun Struck." *U.S. News and World Report* (24 June 1996): 62-7.

Davis, Robert, and Tim Friend. "Defining Risks of Melanoma and Ramifications of Sunscreen." *USA Today*, 18 Feb. 1998, 09B.

Pion, Ira A. "Educating Children and Parents About Sun Protection." *Dermatology Nursing* 8 (1 Feb. 1996): 29-37.

Tyler, Varro. "Aloe: Nature's Skin Soother." *Prevention Magazine*, 1 Apr. 1998, 94-96.

Carol A. Turkington

Sunscreens

Definition

Sunscreens are products applied to the skin to protect against the harmful effects of the sun's ultraviolet (UV) rays.

Purpose

Everyone needs a little sunshine. About 15 minutes of exposure a day helps the body make Vitamin D, which is important for healthy bones and teeth. But longer exposure may cause many problems, from wrinkles to skin **cancer**. One particularly deadly form of skin cancer, **malignant melanoma**, has been on the rise in recent decades, as tanning has become more popular. Over the same period, scientists have warned that the thin layer of ozone that protects life on Earth from the sun's ultraviolet (UV) radiation is being depleted. This allows more UV radiation to get through, adding to the risk of overexposure.

Sunscreens help protect against the sun's damaging effects. But just how much protection they provide is a matter of debate. The sun gives off two kinds of ultraviolet radiation, called UV-A and UV-B. For many years, experts thought that only UV-B was harmful. However, recent research suggests that UV-A may be just as dangerous as UV-B, although its effects may take longer to show up. In particular, UV-A may have a role in causing melanoma. Most sunscreen products contain ingredients that provide adequate protection only against UV-B rays. Even those labeled as "broad spectrum" sunscreens may offer only partial protection against UV-A radiation. Those containing the ingredient avobenzone give the most protection against UV-A rays.

Some medical experts are concerned that sunscreens give people a false sense of security, allowing them to stay in the sun longer than they should. Although sunscreens protect the skin from burning, they may not protect against other kinds of damage. A number of studies suggest that people who use sunscreens may actually increase their risk of melanoma because they spend too much time in the sun. This does not mean that people should stop using sunscreens. It means that they should not rely on sunscreens *alone* for protection. According to the American Academy of Dermatology, sunscreens should be one part of sun protection, along with wide-brimmed hats and tightly-woven clothing that covers the arms and legs.

Description

Many brands of sunscreens are available, containing a variety of ingredients. The active ingredients work by absorbing, reflecting, or scattering some or all of the sun's rays. Most sunscreen products contain combinations of ingredients.

The U.S. Food and Drug Administration requires sunscreen products to carry a sun protection factor (SPF) rating on their labels. This number tells how well the sunscreen protects against burning. The higher the number, the longer a person can stay in the sun without burning.

Sunscreen products are sold as lotions, creams, gels, oils, sprays, sticks, and lip balms, and can be bought without a physician's prescription.

Recommended dosage

Be sure to read the instructions that come with the sunscreen. Some need to be applied as long as 1-2 hours before sun exposure. Others should be applied 30 minutes before exposure, and frequently during exposure.

Apply sunscreen liberally to all exposed parts of the skin, including the hands, feet, nose, ears, neck, scalp (if the hair is thin or very short), and eyelids. Take care not to get sunscreen in the eyes, as it can cause irritation. Use a lip balm containing sunscreen to protect the lips. Reapply sunscreen liberally every 1-2 hours—more frequently when perspiring heavily. Sunscreen should also be reapplied after going in the water.

Precautions

Sunscreen alone will not provide full protection from the sun. When possible, wear a hat, long pants, a long-sleeved shirt, and sunglasses. Try to stay out of the sun between 10 A.M. and 2 P.M. (11 A.M. to 3 P.M. Daylight Saving Time), when the sun's rays are strongest. The sun can damage the skin even on cloudy days, so get in the habit of using a sunscreen every day. Be especially careful at high elevations or in areas with surfaces that reflect the sun's rays, such as sand, water, concrete, or snow.

Sunlamps, tanning beds, and tanning booths were once thought to be safer than the sun, because they give off mainly UV-A rays. However, UV-A rays are now known to cause serious skin damage and may increase the risk of melanoma. Health experts advise people not to use these tanning devices.

People with fair skin, blond, red or light brown hair, and light colored eyes are at greatest risk for developing skin cancer. So are people with many large skin **moles**. These people should avoid exposure to the sun as much as possible. However, even dark skinned people, including African Americans and Hispanic Americans may suffer skin damage from the sun and should be careful about exposure.

Sunscreens should not be used on children under 6 months because of the risk of side effects. Instead, children this young should be kept out of the sun. Children over 6 months should be protected with clothing and sunscreens of at least SPF 15, preferably lotions. Sunscreens containing alcohol should not be used on children because they may irritate the skin.

Older people who stay out of the sun and use sunscreens may not produce enough vitamin D in their bod-

ies. They may need to increase the vitamin D in their **diets** by including foods such as fortified milk and salmon. A health care professional can help decide if this is necessary.

Anyone who has had unusual reactions to any sunscreen ingredients in the past should check with a physician or pharmacist before using a sunscreen. The physician or pharmacist should also be told about any **allergies** to foods, dyes, preservatives, or other substances, especially the following:

- artificial sweeteners
- anesthetics such as benzocaine, procaine, or tetracaine
- diabetes medicine taken by mouth
- hair dyes
- sulfa medicines
- water pills
- cinnamon flavoring

People with skin conditions or diseases should check with their physicians before using a sunscreen. This is especially true of people with conditions that get worse with exposure to light.

Side effects

The most common side effects are drying or tightening of the skin. This problem does not need medical attention unless it does not improve.

Other side effects are rare, but possible. If any of the following symptoms occur, check with a physician as soon as possible:

- acne
- burning, **itching**, or stinging of the skin
- redness or swelling of the skin
- rash, with or without blisters that ooze and become crusted
- pain in hairy parts of body
- pus in hair follicles

Interactions

Anyone who is using a prescription or nonprescription (over-the-counter) drug that is applied to the skin should check with a physician before using a sunscreen.

Resources

PERIODICALS

Center for Medical Consumers Inc. "Sunscreens and Sunglasses: A Consumer's Guide." *HealthFacts* 15 (June 1990): 1.

Kurtzweil, Paula. "Seven Steps to Safer Sunning." *FDA Consumer* 30 (June 1996): 6.

KEY TERMS

Hair follicle—A tiny pit in the skin from which hair grows.

Melanoma—A rapidly spreading and deadly form of cancer that usually occurs on the skin.

Ozone—A gas found in the atmosphere. A layer of ozone about 15 mi (24 km) above Earth's surface helps protect living things from the damaging effects of the sun's ultraviolet rays.

Pus—Thick, whitish or yellowish fluid that forms in infected tissue.

Ultraviolet rays—Invisible light rays with a wavelength shorter than that of visible light but longer than that of x rays.

Underwood, Anne. "A Warning on Sunscreen." *Newsweek* (2 Mar. 1998): 61.

University of California. "Sunscreen May Not Protect You." *Berkeley Wellness Letter* 10 (June 1994): 5.

Nancy Ross-Flanigan

Sunstroke *see* **Heat disorders**

Superficial phlebitis *see* **Thrombophlebitis**

Superior vena cava syndrome

Definition

The superior vena cava is the major vein in the chest that carries blood from the upper part of the body into the heart. A restriction of the blood flow (occlusion) through this vein can cause superior vena cava syndrome (SVCS).

Description

Superior vena cava syndrome is a partial occlusion of the superior vena cava. This leads to a lower than normal blood flow through this major vein. SVCS is also called superior mediastinal syndrome and/or superior vena cava obstruction.

Causes and symptoms

More than 95% of all cases of SVCS are associated with cancers involving the upper chest. The cancers most

commonly associated with SVCS are advanced lung cancers, which account for nearly 80% of all cases of SVCS, and lymphoma. Cancers that have spread (metastasized) to the chest, such as metastatic **breast cancer** to the chest and metastatic **testicular cancer** to the chest have also been shown to cause SVCS.

Other causes of SVCS include: the formation of a blood clot in the superior vena cava, enlargement of the thyroid gland, **tuberculosis**, and **sarcoidosis**.

The symptoms of SVCS include:

- change in voice
- confusion
- cough
- enlargement of the veins in the upper body, particularly those in the arms
- headache
- light-headedness
- shortness of breath
- swelling of the arms
- swelling of the face
- trouble swallowing

Diagnosis

SVCS should be considered in any **cancer** patient with swelling of the face and arms. This diagnosis can be confirmed by x ray, computerized tomography (CT) scan, or medical resonance imaging (MRI) of the chest that reveals a partial occlusion of the superior vena cava.

Treatment

Treatment of SVCS depends on the underlying cancer that is causing it. This treatment may include radiation, **chemotherapy**, or a combination of both. In some cases, surgical procedures may be performed to open (dilate) the vessel. These procedures are generally performed by a trained radiologist or vascular surgeon.

Alternative treatment

Since treatment of SVCS is aimed at treating the underlying disorder that is causing SVCS, alternative treatments must also focus on treating these underlying causes. Alternative treatments for cancer include **acupuncture**, **aromatherapy**, herbal remedies, **hydrotherapy**, hypnosis, and massage, among many others.

Prognosis

The prognosis depends on the underlying cause of SVCS. In cases of SVCS caused by lung cancers, the prognosis is generally rather poor since SVCS does not generally occur until the later stages of these diseases.

KEY TERMS

Metastasis—The spread of a cancer from one part of the body (where the cancer originated) to another part of the body.

Sarcoidosis—A disease of unknown origin in which there is chronic (recurrent) swelling in the lymph nodes and other tissues.

Superior vena cava—The major vein that carries blood from the upper body to the heart.

Thymoma—A tumor that originates in the thymus, a small gland just in front of the heart that produces hormones necessary for the development of certain components of the immune system.

Prevention

SVCS may be prevented by early medical intervention to halt and/or reverse the cancer which, in a later stage, would have lead to SVCS.

Resources

PERIODICALS

Haapoja, I.S. and C. Blendowski. "Superior Vena Cava Syndrome." *Seminars in Oncology Nursing* 15 (August 1999): 183-9.

Hemann, Rhonda. "Superior Vena Cava Syndrome." *Clinical Excellence for Nurse Practitioners* 5 (March 2001): 85-7.

Yellin, A. et al. "Superior Vena Cava Syndrome: The Myth - the Facts." *American Review of Respiratory Disease* 141 (May 1990): 1114-1118.

ORGANIZATIONS

Alliance for Lung Cancer Advocacy, Support and Education. P.O. Box 849 Vancouver, WA 98666. (800) 298-2436 or (360) 696-2436. <http://www.alcase.org/>.

OTHER

Beeson, Michael S. *eMedicine - Superior Vena Cava Syndrome.* <http://www.emedicine.com/emerg/topic561.htm>. (12 May 2001).

Paul A. Johnson

Supportive cancer therapy *see* **Cancer therapy, supportive**

Surgical debridement *see* **Debridement**

Swan-Ganz catheterization *see* **Pulmonary artery catheterization**

Sweating, excessive *see* **Hyperhidrosis**

Swimmer's ear *see* **Otitis externa**

Swimming pool conjunctivitis *see* **Inclusion conjunctivitis**

Swollen glands *see* **Lymphadenitis**

Sydenham's chorea

Definition

Also called St. Vitus' dance, Sydenham's chorea is a disorder effecting children and characterized by jerky, uncontrollable movements, either of the face or of the arms and legs.

Description

Sydenham's chorea is a disorder that occurs in children and is associated with **rheumatic fever**. Rheumatic **fever** is an acute infectious disease caused by certain types of streptococci bacteria. It usually starts with **strep throat** or **tonsillitis**. These types of streptococci are able to cause disease throughout the body. The most serious damage caused by rheumatic fever is to the valves in the heart. At one time, rheumatic fever was the most common cause of damaged heart valves, and it still is in most developing countries around the world. Rheumatic fever and rheumatic heart disease are still present in the industrialized countries, but the incidence has dropped substantially.

Rheumatic fever may appear in several different forms. Sydenham's chorea is one of five "major criteria" for the diagnosis of rheumatic fever. There are also four "minor criteria" and two types of laboratory tests associated with the disease. The "Jones criteria" define the diagnosis. They require laboratory evidence of a streptococcal infection plus two or more of the criteria. The laboratory evidence may be identification of streptococci from a **sore throat** or antibodies to streptococcus in the blood. The most common criteria are arthritis and heart disease, occurring in half to three-quarters of the patients. Sydenham's chorea, characteristic nodules under the skin, and a specific type of skin rash occur only 10% of the time.

Causes and symptoms

The cause is only certain types of streptococci, called "Lancefield Group A beta-hemolytic." These particular germs seem to be able to create an immune response that attacks the body's own tissues along with the germs. Those tissues are joints, heart valves, skin, and brain.

Many patients suffer from strep throat, just before developing this new set of symptoms. They may also have joint pains without swelling, a condition known as arthralgia. Sydenham's chorea will appear as uncontrollable twitching or jerking of any part of the body that is worse when trying to repress it but disappears with sleep.

Diagnosis

Because rheumatic fever is such a damaging disease, a complete evaluation should be done whenever it is suspected. This includes cultures for streptococci, blood tests, and usually an electrocardiogram (heartbeat mapping to detect abnormalities).

Treatment

Suspected streptococcus infections must be treated. All the other manifestations of rheumatic fever, including Sydenham's chorea and excluding heart valve damage, remit with the acute disease and do not require treatment. Sydenham's chorea generally lasts for several months.

Prognosis

Syndenham's chorea clears up without complications when the rheumatic fever is treated. The heart valve damage associated with rheumatic fever may lead to heart trouble and require a surgical valve repair or replacement.

Prevention

All strep throats should be treated with a full 10 days of **antibiotics** (penicillin or erythromycin). Treatment may best be delayed a day or two to allow the body to build up its own antibodies. In addition, for those who have had an episode of rheumatic fever or have damaged heart valves from any other cause, prophylactic antibiotics should be continued to prevent recurrence.

It is possible to eradicate dangerous streptococcus from a community by culturing everyone's throat and treating everyone who tests positive. This is worth doing wherever a case of rheumatic fever appears, but it is expensive and requires many resources.

Resources

BOOKS

Bisno, Alan L. "Rheumatic Fever." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

KEY TERMS

Arthralgia—Joint pain.

Electrocardiogram—Mapping the electrical activity of the heart.

Rheumatic fever—Chiefly childhood disease marked by fever, inflammation, joint pain, and Syndenham's chorea. It is often recurrent and can lead to heart valve damage.

Tonsillitis—Inflammation of the tonsils, which are in the back of the throat.

Kaplan, Edward L. "Rheumatic Fever." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Todd, James. "Streptococcal Infections." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

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Sympathectomy

Definition

Sympathectomy is a surgical procedure that destroys nerves in the sympathetic nervous system. The procedure is done to increase blood flow and decrease long-term **pain** in certain diseases that cause narrowed blood vessels. It can also be used to decrease excessive sweating. This surgical procedure cuts or destroys the sympathetic ganglia, collections of nerve cell bodies in clusters along the thoracic or lumbar spinal cord.

Purpose

The autonomic nervous system that controls unwilled (involuntary) body functions, such as breathing, sweating, and blood pressure, are divided into the sympathetic and the parasympathetic nervous systems. The sympathetic nervous system speeds the heart rate, narrows (constricts) blood vessels, and raises blood pressure. Blood pressure is controlled by means of nerve cells that run through sheaths around the arteries. The sympathetic nervous system can be described as the "fight or flight" system because it allows us to respond to danger by fighting off an attacker or by running away. When danger threatens, the sympathetic nervous system increases heart and respiratory rate, increases blood flow to muscles, and decreases blood flow to other areas, such as skin, digestive tract, and limb veins. The net effect is an increase in blood pressure.

Sympathectomy is performed to relieve intermittent constricting of blood vessels (**ischemia**) when the fingers, toes, ears, or nose are exposed to cold (Raynaud's phenomenon). In Raynaud's phenomenon, the affected extremities turn white, then blue, and red as the blood supply is cut off. The color changes are accompanied by numbness, tingling, burning, and pain. Normal color and feeling are restored when heat is applied. The condition sometimes occurs without direct cause but it is more often caused by an underlying medical condition, such as **rheumatoid arthritis**. Sympathectomy is usually less effective when Raynaud's is caused by an underlying medical condition. Narrowed blood vessels in the legs that cause painful cramping (claudication) are also treated with sympathectomy.

Sympathectomy may be helpful in treating **reflex sympathetic dystrophy** (RSD), a condition that sometimes develops after injury. In RSD, the affected limb is painful (causalgia) and swollen. The color, temperature, and texture of the skin change. These symptoms are related to prolonged and excessive activity of the sympathetic nervous system.

Because sweating is controlled by the sympathetic nervous system, sympathectomy is also effective in treating excessive sweating (**hyperhidrosis**) of the palms, armpits, or face.

Precautions

To determine whether sympathectomy is needed, a reversible block of the affected nerve cell (**ganglion**) should be done. A reversible ganglion block interrupts nerve impulses by means of steroid and anesthetic injected into it. If the block has a positive effect on pain and blood flow in the affected area, the sympathectomy will probably be helpful. The surgical procedure should be performed only if conservative treatment has not worked. Conservative treatment includes avoiding exposure to **stress** and cold, physical therapy, and medications.

Sympathectomy is most likely to be effective in relieving the pain of reflex sympathetic dystrophy if it is done soon after the injury occurs. However, increased benefit from early surgery should be balanced against time needed to promote spontaneous recovery and response to conservative treatment.

Description

Sympathectomy was traditionally done as an inpatient surgical procedure under general anesthesia. An incision was made on the mid-back, exposing the ganglia to be cut. Recent techniques are less invasive and may be

done under local anesthesia and as outpatient surgery. If only one arm or leg is affected, it may be treated with a percutaneous radiofrequency technique. In this technique, the surgeon locates the ganglia by a combination of x ray and electrical stimulation. The ganglia are destroyed by applying radio waves through electrodes on the skin.

Sympathectomy for hyperhidrosis can be done by making a small incision under the armpit and introducing air into the chest cavity. The surgeon inserts a fiber optic tube (endoscope) that projects an image of the operation on a video screen. The ganglia can then be cut with fine scissors attached to the endoscope. Laser beams can also be used to destroy the ganglia.

Preparation

As with any surgery, patients should discuss expected results and possible risks with their surgeons. They should tell their surgeons all medications they are taking and all their medical problems, and they should be in good general health. To improve general health, the patient may be asked to lose weight, give up **smoking** or alcohol, and get the proper sleep, diet, and **exercise**. Immediately before the surgery, patients will not be permitted to eat or drink, and the surgical site will be cleaned and scrubbed.

Aftercare

The surgeon will inform the patient about specific aftercare needed for the technique used. **Doppler ultrasonography**, a test using sound waves to measure blood flow, can help to determine whether sympathectomy has had a positive result.

Risks

Side effects of sympathectomy may include decreased blood pressure while standing, which may cause **fainting** spells. After sympathectomy in men, semen is sometimes ejaculated into the bladder, which may impair fertility. After a sympathectomy done by inserting an endoscope in the chest cavity, patients may experience chest pain with deep breathing. This problem usually disappears within two weeks. They may also experience **pneumothorax** (air in the chest cavity).

In 30% of cases, surgery for hyperhidrosis may cause increased sweating on the chest. In 2% of cases, this surgery causes increased sweating in other areas, including increased facial sweating while eating. Other complications occur less frequently. These complications include Horner's syndrome, a condition of the nervous system that causes the pupil of the eye to close, the eyelid to droop, and sweating to decrease on one side of the face. Other rare complications are nasal blockage and pain of the nerves supplying the skin between the ribs.

KEY TERMS

Causalgia—A severe burning sensation sometimes accompanied by redness and inflammation of the skin. Causalgia is caused by injury to a nerve outside the spinal cord.

Claudication—Cramping or pain in a leg caused by poor blood circulation. This condition is frequently caused by hardening of the arteries (atherosclerosis). Intermittent claudication occurs only at certain times, usually after exercise, and is relieved by rest.

Fiberoptics—In medicine, fiberoptics uses glass or plastic fibers to transmit light through a specially designed tube. The tube is inserted into organs or body cavities where it transmits a magnified image of the internal body structures.

Hyperhidrosis—Excessive sweating. Hyperhidrosis can be caused by heat, overactive thyroid glands, strong emotion, menopause, or infection.

Parasympathetic nervous system—The division of the autonomic (involuntary or unwilled) nervous system that slows heart rate, increases digestive and gland activity, and relaxes the sphincter muscles that close off body organs.

Percutaneous—Performed through the skin, from the Latin *per*, meaning through and *cutis*, meaning skin.

Pneumothorax—A collection of air or gas in the chest cavity that causes a lung to collapse. Pneumothorax may be caused by an open chest wound that admits air.

Normal results

Some studies report that sympathectomy relieves causalgia in as many as 75% of cases. The studies also show that it relieves hyperhidrosis in more than 90% of cases. The less invasive procedures cause very little scarring. Most patients stay in the hospital for less than one day and return to work within the week.

Resources

PERIODICALS

Lai, Y. T., et al. "Complications in Patients with Palmar Hyperhidrosis Treated with Transthoracic Endoscopic Sympathectomy." *Neurosurgery* 41 (1997): 110-113.

Lee, K.H, and P. Y. Hwang. "Video Endoscopic Sympathectomy for Palmar Hyperhidrosis." *Journal of Neurosurgery* 84 (1996): 484-486.

Schwartzman, R. J., et al. "Long-Term Outcome Following Sympathectomy for Complex Regional Pain Syndrome Type 1 (RSD)." *Journal of the Neurological Sciences* 150 (1997): 149-152.

Wilkinson, H. A. "Percutaneous Radiofrequency Upper Thoracic Sympathectomy." *Neurosurgery* 38 (1996): 715-725.

OTHER

The American Institute for Hyperhidrosis Page. <http:/www.handsweat.com>.

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Syncope *see* **Fainting**

Syndactyly *see* **Polydactyly and syndactyly**

Synergistic gangrene *see* **Flesh-eating disease**

Synovial fluid analysis *see* **Joint fluid analysis**

Synovial membrane biopsy *see* **Joint biopsy**

Syphilis

Definition

Syphilis is an infectious systemic disease that may be either congenital or acquired through sexual contact or contaminated needles.

Description

Syphilis has both acute and chronic forms that produce a wide variety of symptoms affecting most of the body's organ systems. The range of symptoms makes it easy to confuse syphilis with less serious diseases and ignore its early signs. Acquired syphilis has four stages (primary, secondary, latent, and tertiary) and can be spread by sexual contact during the first three of these four stages.

Syphilis, which is also called lues (from a Latin word meaning **plague**), has been a major public health problem since the sixteenth century. The disease was treated with mercury or other ineffective remedies until World War I, when effective treatments based on arsenic or bismuth were introduced. These were succeeded by **antibiotics** after World War II. At that time, the number of cases in the general population decreased, partly because of aggressive public health measures. This temporary decrease, combined with the greater amount of attention given to **AIDS** in recent years, leads some people to think that syphilis is no longer a serious problem. In actual fact, the number of cases of syphilis in the United States has risen since 1980. This increase affects both sexes, all races, all parts of the nation, and all age groups, including adults over 60. The number of women of childbearing age with syphilis is the highest that has been recorded since the 1940s. About 25,000 cases of infectious syphilis in adults are reported annually in the United States. It is estimated, however, that 400,000 people in the United States need treatment for syphilis every year, and that the annual worldwide total is 50 million persons.

The increased incidence of syphilis in recent years is associated with drug abuse as well as changes in sexual behavior. The connections between drug abuse and syphilis include needle sharing and exchanging sex for drugs. In addition, people using drugs are more likely to engage in risky sexual practices. With respect to changing patterns of conduct, a sharp increase in the number of people having sex with multiple partners makes it more difficult for public health doctors to trace the contacts of infected persons. High-risk groups for syphilis include:

- sexually active teenagers
- people infected with another sexually transmitted disease (STD), including AIDS
- sexually abused children
- women of childbearing age
- prostitutes of either sex and their customers
- prisoners
- persons who abuse drugs or alcohol

The chances of contracting syphilis from an infected person in the early stages of the disease during unprotected sex are between 30–50%.

Causes and symptoms

Syphilis is caused by a spirochete, *Treponema pallidum*. A spirochete is a thin spiral- or coil-shaped bacterium that enters the body through the mucous membranes or breaks in the skin. In 90% of cases, the spirochete is transmitted by sexual contact. Transmission by blood **transfusion** is possible but rare; not only because blood products are screened for the disease, but also because the spirochetes die within 24 hours in stored blood. Other methods of transmission are highly unlikely because *T. pallidum* is easily killed by heat and drying.

Primary syphilis

Primary syphilis is the stage of the organism's entry into the body. The first signs of infection are not always

noticed. After an incubation period ranging between 10 and 90 days, the patient develops a chancre, which is a small blister-like sore about 0.5 in (13 mm) in size. Most chancres are on the genitals, but may also develop in or on the mouth or on the breasts. Rectal chancres are common in male homosexuals. Chancres in women are sometimes overlooked if they develop in the vagina or on the cervix. The chancres are not painful and disappear in three to six weeks even without treatment. They resemble the ulcers of **lymphogranuloma venereum**, herpes simplex virus, or skin tumors.

About 70% of patients with primary syphilis also develop swollen lymph nodes near the chancre. The nodes may have a firm or rubbery feel when the doctor touches them but are not usually painful.

Secondary syphilis

Syphilis enters its secondary stage between six to eight weeks and six months after the infection begins. Chancres may still be present but are usually healing. Secondary syphilis is a systemic infection marked by the eruption of skin **rashes** and ulcers in the mucous membranes. The skin rash may mimic a number of other skin disorders such as drug reactions, **rubella**, **ringworm**, mononucleosis, and **pityriasis rosea**. Characteristics that point to syphilis include:

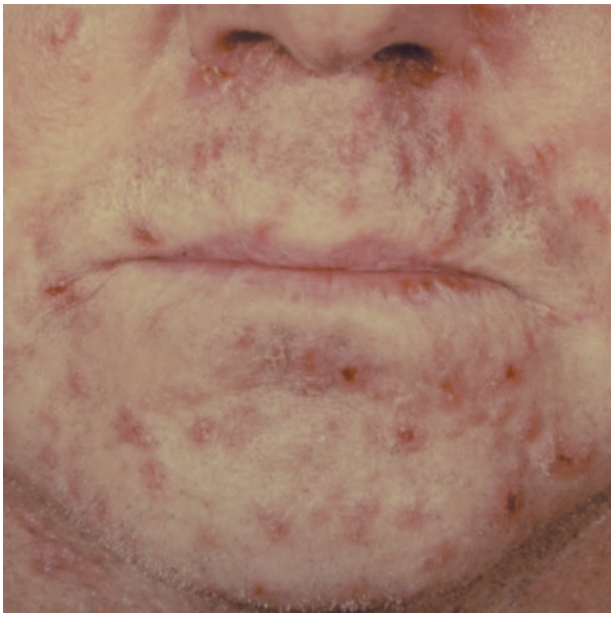
- a coppery color
- absence of **pain** or **itching**
- occurrence on the palms of hands and soles of feet

The skin eruption may resolve in a few weeks or last as long as a year. The patient may also develop condylomata lata, which are weepy pinkish or grey areas of flattened skin in the moist areas of the body. The skin rashes, mouth and genital ulcers, and condylomata lata are all highly infectious.

About 50% of patients with secondary syphilis develop swollen lymph nodes in the armpits, groin, and neck areas; about 10% develop inflammations of the eyes, kidney, liver, spleen, bones, joints, or the meninges (membranes covering the brain and spinal cord). They may also have a flulike general illness with a low **fever**, chills, loss of appetite, headaches, runny nose, **sore throat**, and aching joints.

Latent syphilis

Latent syphilis is a phase of the disease characterized by relative absence of external symptoms. The term latent does not mean that the disease is not progressing or that the patient cannot infect others. For example, pregnant women can transmit syphilis to their unborn children during the latency period.



This patient has secondary syphilis, evidenced by the appearance of lesions on the skin. *(Custom Medical Stock Photo. Reproduced by permission.)*

The latent phase is sometimes divided into early latency (less than two years after infection) and late latency. During early latency, patients are at risk for spontaneous relapses marked by recurrence of the ulcers and skin rashes of secondary syphilis. In late latency, these recurrences are much less likely. Late latency may either resolve spontaneously or continue for the rest of the patient's life.

Tertiary syphilis

Untreated syphilis progresses to a third or tertiary stage in about 35–40% of patients. Patients with tertiary syphilis cannot infect others with the disease. It is thought that the symptoms of this stage are a delayed hypersensitivity reaction to the spirochetes. Some patients develop so-called benign late syphilis, which begins between three and 10 years after infection and is characterized by the development of gummas. Gummas are rubbery tumor-like growths that are most likely to involve the skin or long bones but may also develop in the eyes, mucous membranes, throat, liver, or stomach lining. Gummas are increasingly uncommon since the introduction of antibiotics for treating syphilis. Benign late syphilis is usually rapid in onset and responds well to treatment.

CARDIOVASCULAR SYPHILIS. Cardiovascular syphilis occurs in 10–15% of patients who have progressed to tertiary syphilis. It develops between 10 and 25 years after infection and often occurs together with neurosyphilis. Cardiovascular syphilis usually begins as an inflammation

of the arteries leading from the heart and causes heart attacks, scarring of the aortic valves, congestive **heart failure**, or the formation of an **aortic aneurysm**.

NEUROSYPHILIS. About 8% of patients with untreated syphilis will develop symptoms in the central nervous system that include both physical and psychiatric symptoms. Neurosyphilis can appear at any time, from 5-35 years after the onset of primary syphilis. It affects men more frequently than women and Caucasians more frequently than African Americans.

Neurosyphilis is classified into four types:

- Asymptomatic. In this form of neurosyphilis, the patient's spinal fluid gives abnormal test results but there are no symptoms affecting the central nervous system.
- Meningovascular. This type of neurosyphilis is marked by changes in the blood vessels of the brain or inflammation of the meninges (the tissue layers covering the brain and spinal cord). The patient develops headaches, irritability, and visual problems. If the spinal cord is involved, the patient may experience weakness of the shoulder and upper arm muscles.
- Tabes dorsalis. Tabes dorsalis is a progressive degeneration of the spinal cord and nerve roots. Patients lose their sense of perception of one's body position and orientation in space (proprioception), resulting in difficulties walking and loss of muscle reflexes. They may also have shooting pains in the legs and periodic episodes of pain in the abdomen, throat, bladder, or rectum. Tabes dorsalis is sometimes called locomotor ataxia.
- General paresis. General paresis refers to the effects of neurosyphilis on the cortex of the brain. The patient has a slow but progressive loss of memory, ability to concentrate, and interest in self-care. Personality changes may include irresponsible behavior, depression, **delusions** of grandeur, or complete **psychosis**. General paresis is sometimes called **dementia** paralytica, and is most common in patients over 40.

Special populations

CONGENITAL SYPHILIS. Congenital syphilis has increased at a rate of 400–500% over the past decade, on the basis of criteria introduced by the Centers for Disease Control (CDC) in 1990. In 1994, over 2,200 cases of congenital syphilis were reported in the United States. The prognosis for early congenital syphilis is poor: about 54% of infected fetuses die before or shortly after birth. Those who survive may look normal at birth but show signs of infection between three and eight weeks later.

Infants with early congenital syphilis have systemic symptoms that resemble those of adults with secondary syphilis. There is a 40-60% chance that the child's central nervous system will be infected. These infants may have symptoms ranging from **jaundice**, enlargement of the spleen and liver, and anemia to skin rashes, condylomata lata, inflammation of the lungs, "snuffles" (a persistent runny nose), and swollen lymph nodes.

CHILDREN. Children who develop symptoms after the age of two years are said to have late congenital syphilis. The characteristic symptoms include facial deformities (saddle nose), Hutchinson's teeth (abnormal upper incisors), saber shins, dislocated joints, deafness, **mental retardation**, **paralysis**, and seizure disorders.

PREGNANT WOMEN. Syphilis can be transmitted from the mother to the fetus through the placenta at any time during **pregnancy**, or through the child's contact with syphilitic ulcers during the birth process. The chances of infection are related to the stage of the mother's disease. Almost all infants of mothers with untreated primary or secondary syphilis will be infected, whereas the infection rate drops to 40% if the mother is in the early latent stage and 6–14% if she has late latent syphilis.

Pregnancy does not affect the progression of syphilis in the mother; however, pregnant women should not be treated with **tetracyclines**.

HIV PATIENTS. Syphilis has been closely associated with HIV infection since the late 1980s. Syphilis sometimes mimics the symptoms of AIDS. Conversely, AIDS appears to increase the severity of syphilis in patients suffering from both diseases, and to speed up the development or appearance of neurosyphilis. Patients with HIV are also more likely to develop lues maligna, a skin disease that sometimes occurs in secondary syphilis. Lues maligna is characterized by areas of ulcerated and dying tissue. In addition, HIV patients have a higher rate of treatment failure with penicillin than patients without HIV.

Diagnosis

Patient history and physical diagnosis

The diagnosis of syphilis is often delayed because of the variety of early symptoms, the varying length of the incubation period, and the possibility of not noticing the initial chancre. Patients do not always connect their symptoms with recent sexual contact. They may go to a dermatologist when they develop the skin rash of secondary syphilis rather than to their primary care doctor. Women may be diagnosed in the course of a gynecological checkup. Because of the long-term risks of untreated syphilis, certain groups of people are now routinely screened for the disease:

- pregnant women

- sexual contacts or partners of patients diagnosed with syphilis
- children born to mothers with syphilis
- patients with HIV infection
- persons applying for marriage licenses

When the doctor takes the patient's history, he or she will ask about recent sexual contacts in order to determine whether the patient falls into a high-risk group. Other symptoms, such as skin rashes or swollen lymph nodes, will be noted with respect to the dates of the patient's sexual contacts. Definite diagnosis, however, depends on the results of laboratory blood tests.

Blood tests

There are several types of blood tests for syphilis presently used in the United States. Some are used in follow-up monitoring of patients as well as diagnosis.

NONTREPONEMAL ANTIGEN TESTS. Nontreponemal antigen tests are used as screeners. They measure the presence of reagin, which is an antibody formed in reaction to syphilis. In the venereal disease research laboratory (VDRL) test, a sample of the patient's blood is mixed with cardiolipin and cholesterol. If the mixture forms clumps or masses of matter, the test is considered reactive or positive. The serum sample can be diluted several times to determine the concentration of reagin in the patient's blood.

The rapid plasma reagin (RPR) test works on the same principle as the VDRL. It is available as a kit. The patient's serum is mixed with cardiolipin on a plastic-coated card that can be examined with the naked eye.

Nontreponemal antigen tests require a doctor's interpretation and sometimes further testing. They can yield both false-negative and false-positive results. False-positive results can be caused by other infectious diseases, including mononucleosis, **malaria**, **leprosy**, **rheumatoid arthritis**, and lupus. HIV patients have a particularly high rate (4%, compared to 0.8% of HIV-negative patients) of false-positive results on reagin tests. False-negatives can occur when patients are tested too soon after exposure to syphilis; it takes about 14-21 days after infection for the blood to become reactive.

TREPONEMAL ANTIBODY TESTS. Treponemal antibody tests are used to rule out false-positive results on reagin tests. They measure the presence of antibodies that are specific for *T. pallidum*. The most commonly used tests are the microhemagglutination-*T. pallidum* (MHA-TP) and the fluorescent treponemal antibody absorption (FTA-ABS) tests. In the FTA-ABS, the patient's blood serum is mixed with a preparation that prevents interference from antibodies to other treponemal infections. The test serum is added to a slide containing *T. pallidum*. In a positive reaction, syphilitic antibodies in the blood coat the spirochetes on the slide. The slide is then stained with fluorescein, which causes the coated spirochetes to fluoresce when the slide is viewed under ultraviolet (UV) light. In the MHA-TP test, red blood cells from sheep are coated with *T. pallidum* antigen. The cells will clump if the patient's blood contains antibodies for syphilis.

Treponemal antibody tests are more expensive and more difficult to perform than nontreponemal tests. They are therefore used to confirm the diagnosis of syphilis rather than to screen large groups of people. These tests are, however, very specific and very sensitive; false-positive results are relatively unusual.

INVESTIGATIONAL BLOOD TESTS. Currently ELISA, Western blot, and PCR testing are being studied as additional diagnostic tests, particularly for congenital syphilis and neurosyphilis.

Other laboratory tests

MICROSCOPE STUDIES. The diagnosis of syphilis can also be confirmed by identifying spirochetes in samples of tissue or lymphatic fluid. Fresh samples can be made into slides and studied under darkfield illumination. A newer method involves preparing slides from dried fluid smears and staining them with fluorescein for viewing under UV light. This method is replacing darkfield examination because the slides can be mailed to professional laboratories.

SPINAL FLUID TESTS. Testing of cerebrospinal fluid (CSF) is an important part of patient monitoring as well as a diagnostic test. The VDRL and FTA-ABS tests can be performed on CSF as well as on blood. An abnormally high white cell count and elevated protein levels in the CSF, together with positive VDRL results, suggest a possible diagnosis of neurosyphilis. CSF testing is not used for routine screening. It is used most frequently for infants with congenital syphilis, HIV-positive patients, and patients of any age who are not responding to penicillin treatment.

Treatment

Medications

Syphilis is treated with antibiotics given either intramuscularly (benzathine penicillin G or ceftriaxone) or orally (doxycycline, minocycline, tetracycline, or azithromycin). Neurosyphilis is treated with a combination of aqueous crystalline penicillin G, benzathine penicillin G, or doxycycline. It is important to keep the levels

of penicillin in the patient's tissues at sufficiently high levels over a period of days or weeks because the spirochetes have a relatively long reproduction time. Penicillin is more effective in treating the early stages of syphilis than the later stages.

Doctors do not usually prescribe separate medications for the skin rashes or ulcers of secondary syphilis. The patient is advised to keep them clean and dry, and to avoid exposing others to fluid or discharges from condylomata lata.

Pregnant women should be treated as early in pregnancy as possible. Infected fetuses can be cured if the mother is treated during the second and third trimesters of pregnancy. Infants with proven or suspected congenital syphilis are treated with either aqueous crystalline penicillin G or aqueous procaine penicillin G. Children who acquire syphilis after birth are treated with benzathine penicillin G.

Jarisch-Herxheimer reaction

The Jarisch-Herxheimer reaction, first described in 1895, is a reaction to penicillin treatment that may occur during the late primary, secondary, or early latent stages. The patient develops chills, fever, **headache**, and muscle pains within two to six hours after the penicillin is injected. The chancre or rash gets temporarily worse. The Jarisch-Herxheimer reaction, which lasts about a day, is thought to be an allergic reaction to toxins released when the penicillin kills massive numbers of spirochetes.

Alternative treatment

Antibiotics are essential for the treatment of syphilis. Recovery from the disease can be assisted by dietary changes, sleep, **exercise**, and **stress reduction**.

Homeopathy

Homeopathic practitioners are forbidden by law in the United States to claim that homeopathic treatment can cure syphilis. Given the high rate of syphilis in HIV-positive patients, however, some alternative practitioners who are treating AIDS patients with homeopathic remedies maintain that they are beneficial for syphilis as well. The remedies suggested most frequently are *Medorrhinum*, *Syphilinum*, *Mercurius vivus*, and *Aurum*. The historical link between **homeopathy** and syphilis is Hahnemann's theory of miasms. He thought that the syphilitic miasm was the second oldest cause of constitutional weakness in humans.

Prognosis

The prognosis is good for the early stages of syphilis if the patient is treated promptly and given sufficiently large doses of antibiotics. Treatment failures can occur and patients can be reinfected. There are no definite criteria for cure for patients with primary and secondary syphilis, although patients who are symptom-free and have had negative blood tests for two years after treatment are usually considered cured. Patients should be followed up with blood tests at one, three, six, and 12 months after treatment, or until the results are negative. CSF should be examined after one year. Patients with recurrences during the latency period should be tested for reinfection.

The prognosis for patients with untreated syphilis is spontaneous remission for about 30%; lifelong latency for another 30%; and potentially fatal tertiary forms of the disease in 40%.

Prevention

Immunity

Patients with syphilis do not acquire lasting immunity against the disease. Currently no effective vaccine for syphilis has been developed. Prevention depends on a combination of personal and public health measures.

Lifestyle choices

The only reliable methods for preventing transmission of syphilis are sexual abstinence or monogamous relationships between uninfected partners. Condoms offer some protection but protect only the covered parts of the body.

Public health measures

CONTACT TRACING. The law requires reporting of syphilis cases to public health agencies. Sexual contacts of patients diagnosed with syphilis are traced and tested for the disease. This includes all contacts for the past three months in cases of primary syphilis and for the past year in cases of secondary disease. Neither the patients nor their contacts should have sex with anyone until they have been tested and treated.

All patients who test positive for syphilis should be tested for HIV infection at the time of diagnosis.

PRENATAL TESTING OF PREGNANT WOMEN. Pregnant women should be tested for syphilis at the time of their first visit for prenatal care, and again shortly before delivery. Proper treatment of secondary syphilis in the mother reduces the risk of congenital syphilis in the infant from 90% to less than 2%.

EDUCATION AND INFORMATION. Patients diagnosed with syphilis should be given information about the disease and counseling regarding sexual behavior and

KEY TERMS

Chancre—The initial skin ulcer of primary syphilis, consisting of an open sore with a firm or hard base.

Condylomata lata—Highly infectious patches of weepy pink or gray skin that appear in the moist areas of the body during secondary syphilis.

Darkfield—A technique of microscope examination in which light is directed at an oblique angle through the slide so that organisms look bright against a dark background.

General paresis—A form of neurosyphilis in which the patient's personality, as well as his or her control of movement, is affected. The patient may develop convulsions or partial paralysis.

Gumma—A symptom that is sometimes seen in tertiary syphilis, characterized by a rubbery swelling or tumor that heals slowly and leaves a scar.

Jarisch-Herxheimer reaction—A temporary reaction to penicillin treatment for syphilis that includes fever, chills, and worsening of the skin rash or chancre.

Lues maligna—A skin disorder of secondary syphilis in which areas of ulcerated and dying tissue are formed. It occurs most frequently in HIV-positive patients.

Spirochete—A type of bacterium with a long, slender, coiled shape. Syphilis is caused by a spirochete.

Tabes dorsalis—A progressive deterioration of the spinal cord and spinal nerves associated with tertiary syphilis.

the importance of completing antibiotic treatment. It is also important to inform the general public about the transmission and early symptoms of syphilis, and provide adequate health facilities for testing and treatment.

Resources

BOOKS

Fiumara, Nicholas J. "Syphilis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Infectious Diseases: Syphilis." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

Jacobs, Richard A. "Infectious Diseases: Spirochetal." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Ramin, Susan M., et al. "Sexually Transmitted Diseases and Pelvic Infections." In *Current Obstetric & Gynecologic Diagnosis & Treatment*, ed. Alan H. DeCherney and Martin L. Pernoll. Norwalk, CT: Appleton & Lange, 1994.

"Sexually Transmitted Diseases: Syphilis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Sigel, Eric J. "Sexually Transmitted Diseases." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

"Syphilis." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Wicher, Konrad, and Victoria Wicher. "Treponema, Infection and Immunity." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London: Academic Press, 1992.

Wolf, Judith E. "Syphilis." In *Current Diagnosis.* Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

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Systemic antifungal drugs *see* **Antifungal drugs, systemic**

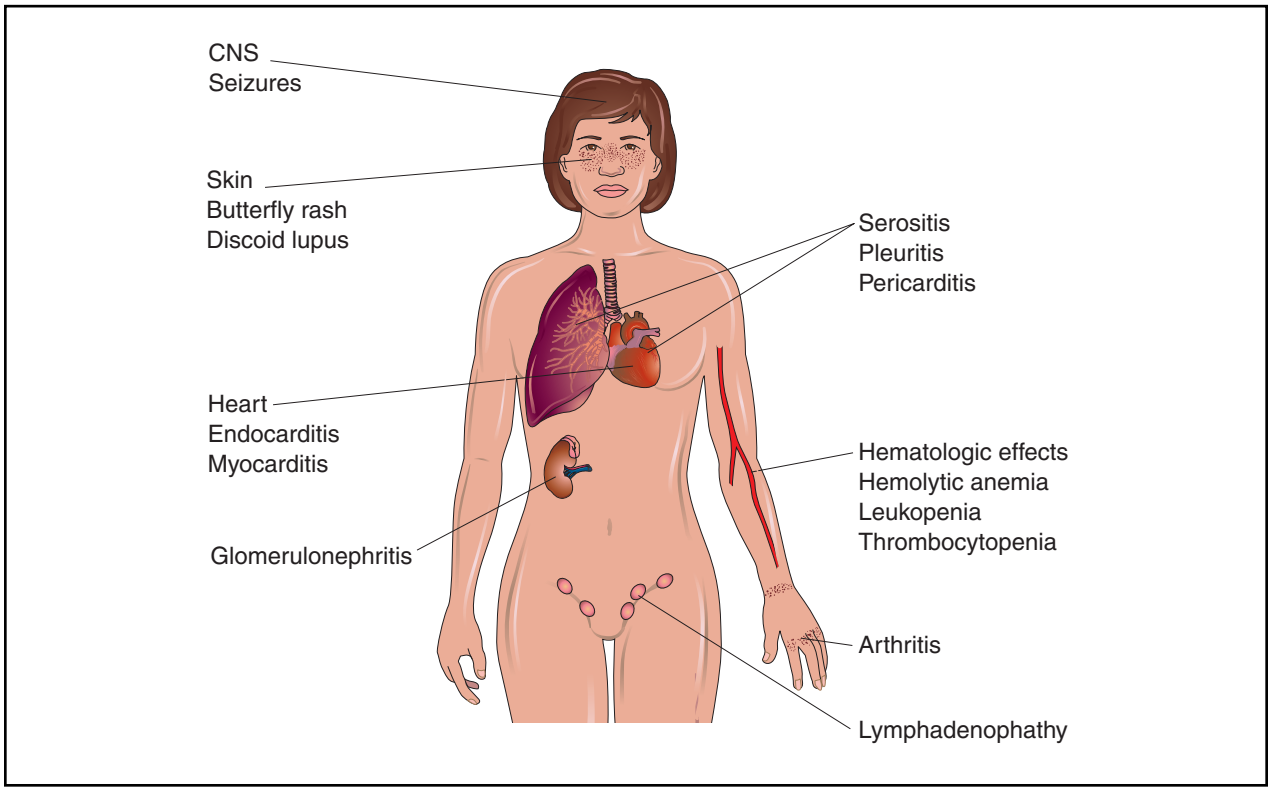
Systemic lupus erythematosus

Definition

Systemic lupus erythematosus (also called lupus or SLE) is a disease where a person's immune system attacks and injures the body's own organs and tissues. Almost every system of the body can be affected by SLE.

Description

The body's immune system is a network of cells and tissues responsible for clearing the body of invading foreign organisms, like bacteria, viruses, and fungi. Antibodies are special immune cells that recognize these foreign invaders, and begin a chain of events to destroy them. In an autoimmune disorder like SLE, a person's antibodies begin to recognize the body's own tissues as foreign. Cells and chemicals of the immune system damage the tissues of the body. The reaction that occurs in tissue is called inflammation. Inflammation includes swelling, redness, increased blood flow, and tissue destruction.



Systemic lupus erythematosus (SLE) is an autoimmune disease in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. Nearly every system of the body can be affected by SLE, as depicted in the illustration above. *(Illustration by Electronic Illustrators Group.)*

In SLE, some of the common antibodies that normally fight diseases are thought to be out of control. These include antinuclear antibodies and anti-DNA antibodies. Antinuclear antibodies are directed against the cell's central structure that contains genetic material (the nucleus). Anti-DNA antibodies are directed against the cell's genetic material. DNA is the chemical substance that makes up the chromosomes and genes.

SLE can occur in both males and females of all ages, but 90% of patients are women. The majority of these women are in their childbearing years. African Americans are more likely than Caucasians to develop SLE.

Occasionally, medications can cause a syndrome of symptoms very similar to SLE. This is called drug-induced lupus. Medications that may cause this syndrome include hydralazine (used for high blood pressure) and procainamide (used for abnormal heartbeats). Drug-induced lupus almost always disappears after the patient stops taking the medications that caused it.

Causes and symptoms

The cause of SLE is unknown. Because the vast majority of patients are women, some research is being done to determine what (if any) link the disease has to female hormones. SLE may have a genetic basis, although more than one gene is believed to be involved in the development of the disease. Because patients with the disease may suddenly have worse symptoms (called a flare) after exposure to things like sunlight, alfalfa sprouts, and certain medications, researchers suspect that some environmental factors may also be at work.

The severity of a patient's SLE varies over time. Patients may have periods with mild or no symptoms, followed by a flare. During a flare, symptoms increase in severity and new organ systems may become affected.

Many SLE patients have fevers, **fatigue**, muscle **pain**, weakness, decreased appetite, and weight loss. The spleen and lymph nodes are often swollen and enlarged. The development of other symptoms in SLE varies, depending on the organs affected.

- Joints. Joint pain and problems, including arthritis, are very common. About 90% of all SLE patients have these types of problems.
- Skin. A number of skin **rashes** may occur, including a red butterfly-shaped rash that spreads across the face. The "wings" of the butterfly appear across the cheek-

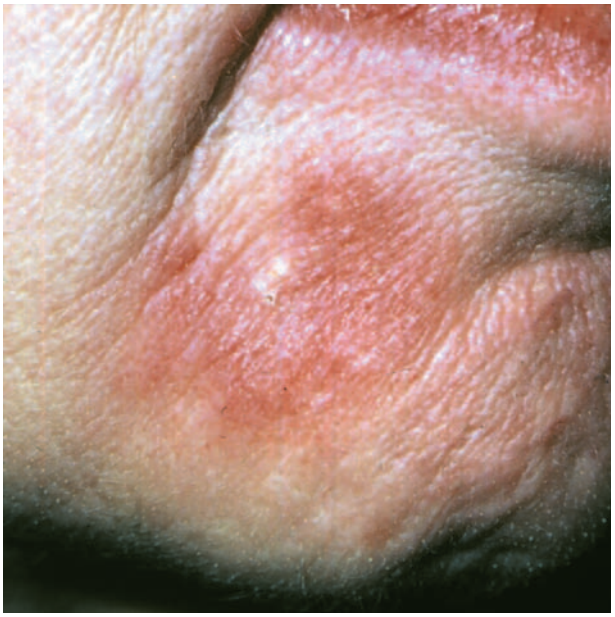
bones, and the "body" appears across the bridge of the nose. A discoid, or coin-shaped, rash causes red, scaly bumps on the cheeks, nose, scalp, ears, chest, back, and the tops of the arms and legs. The roof of the mouth may develop sore, irritated pits (ulcers). Hair loss is common. SLE patients tend to be very easily sunburned (photosensitive).

- Lungs. Inflammation of the tissues that cover the lungs and line the chest cavity causes pleuritis, with fluid accumulating in the lungs. The patient frequently experiences coughing and shortness of breath.
- Heart and circulatory system. Inflammation of the tissue surrounding the heart causes **pericarditis**; inflammation of the heart itself causes **myocarditis**. These heart problems may result in abnormal beats (**arrhythmias**), difficulty pumping the blood strongly enough (**heart failure**), or even sudden **death**. Blood clots often form in the blood vessels and may lead to complications.
- Nervous system. Headaches, seizures, changes in personality, and confused thinking (**psychosis**) may occur.
- Kidneys. The kidneys may suffer significant destruction, with serious life-threatening effects. They may become unable to adequately filter the blood, leading to kidney failure.
- Gastrointestinal system. Patients may experience nausea, vomiting, **diarrhea**, and abdominal pain. The lining of the abdomen may become inflamed (peritonitis).
- Eyes. The eyes may become red, sore, and dry. Inflammation of one of the nerves responsible for vision may cause vision problems, and blindness can result from inflammation of the blood vessels (**vasculitis**) that serve the retina.

Diagnosis

Diagnosis of SLE can be somewhat difficult. There are no definitive tests for diagnosing SLE. Many of the symptoms and laboratory test results of SLE patients are similar to those of patients with different diseases, including **rheumatoid arthritis**, **multiple sclerosis**, and various nervous system and blood disorders.

Laboratory tests that are helpful in diagnosing SLE include several tests for a variety of antibodies commonly elevated in SLE patients (including antinuclear antibodies, anti-DNA antibodies, etc.). SLE patients tend to have low numbers of red blood cells (anemia) and low numbers of certain types of white blood cells. The **erythrocyte sedimentation rate** (ESR), a measure of inflammation in the body, tends to be quite elevated. Samples of tissue (biopsies) from affected skin and kidneys show characteristics of the disease.



A close-up view of a woman's face with a lesion caused by systemic lupus erythematosus (SLE). One characteristic of this autoimmune disease is a butterfly rash present across the cheeks and nose. *(Photograph by Dr. P. Marazzi, Custom Medical Stock Photo. Reproduced by permission.)*

A test called the lupus erythematosus cell preparation (or LE prep) test is also performed. This test involves obtaining a sample of the patient's blood. Cells from the blood are damaged in the laboratory in order to harvest their nuclei. These damaged cells are then put together with the patient's blood serum, the liquid part of blood separated from the blood cells. Antinuclear antibodies within the patient's serum will clump together with the damaged nuclear material. A material called Wright's stain will cause these clumps to turn blue. These stained clumps are then reacted with some of the patient's white blood cells, which will essentially eat the clumps. LE cells are the white blood cells that contain the blue clumps. This test will be positive in about 70-80% of all patients with SLE.

The American Rheumatism Association developed a list of symptoms used to diagnose SLE. Research supports the idea that people who have at least four of the eleven criteria (not necessarily simultaneously) are extremely likely to have SLE. The criteria are:

- butterfly rash
- discoid rash
- photosensitivity
- mouth ulcers
- arthritis
- inflammation of the lining of the lungs or the lining around the heart

- kidney damage, as noted by the presence of protein or other abnormal substances called casts in the urine
- seizures or psychosis
- the presence of certain types of anemia and low counts of particular white blood cells
- the presence of certain immune cells, anti-DNA antibodies, or a falsely positive test for **syphilis**
- the presence of antinuclear antibodies

Treatment

Treatment depends on the organ systems affected by SLE and the severity of the disease. Some patients have a mild form of SLE. Their mild symptoms of inflammation can be treated with **nonsteroidal anti-inflammatory drugs** like ibuprofen (Motrin, Advil) and **aspirin**. Severe skin rashes and joint problems may respond to a group of medications usually used to treat **malaria**. More severely ill patients with potentially life-threatening complications (including kidney disease, pericarditis, or nervous system complications) will require treatment with more potent drugs, including steroid medications. Because steroids have serious side effects, they are reserved for more severe cases of SLE. Drugs that decrease the activity of the immune system (called **immunosuppressant drugs**) may also be used for severely ill SLE patients. These include azathioprine and cyclophosphamide.

Other treatments for SLE try to help specific symptoms. Clotting disorders will require blood thinners. Psychotic disorders will require specific medications. Kidney failure may require the blood to be cleaned outside the body through a machine (dialysis) or even a **kidney transplantation**.

Alternative treatment

A number of alternative treatments have been suggested to help reduce the symptoms of SLE. These include **acupuncture** and massage for relieving the pain of sore joints and muscles. **Stress** management is key for people with SLE and such techniques as **meditation**, hynotherapy, and **yoga** may be helpful in promoting relaxation. Dietary suggestions include eating a whole foods diet with reduced amounts of red meat and dairy products in order to decrease pain and inflammation. Food **allergies** are believed either to contribute to SLE or to arise as a consequence of the digestive difficulties. Wheat, dairy products, and soy are the major offenders. An elimination/challenge diet can help identify the offending foods so that they can be avoided. Another dietary measure that may be beneficial is eating more fish that contain omega-3 fatty acids, like mackerel, sardines, and salmon. Because alfalfa sprouts have been associated with the onset of flares in SLE, they should be avoided. Supplements that have been suggested to improve the health of SLE patients include **vitamins** B, C, and E, as well as selenium, zinc, magnesium, and a complete trace mineral supplement. Vitamin A is believed to help improve discoid skin rashes. Botanical medicine can help the entire body through immune modulation and **detoxification**, as well as assisting individual organs and systems. **Homeopathy** and flower essences can work deeply on the emotional level to help people with this difficult disease.

Prognosis

The prognosis for patients with SLE varies, depending on the organ systems most affected and the severity of inflammation. Some patients have long periods of time with mild or no symptoms. About 90-95% of patients are still living after 2 years with the disease. About 82-90% of patients are still living after 5 years with the disease. After 10 years, 71-80% of patients are still alive, and 63-75% are still alive after 20 years. The most likely causes of death during the first 10 years include infections and kidney failure. During years 11-20 of the disease, the most likely cause of death involves the development of abnormal blood clots.

Because SLE frequently affects women of childbearing age, **pregnancy** is an important issue. For pregnant SLE patients, about 30% of the pregnancies end in **miscarriage**. About 25% of all babies born to mothers with SLE are premature. Most babies born to mothers with SLE are normal. However, a rare condition called neonatal lupus causes a baby of a mother with SLE to develop a skin rash, liver or blood problems, and a serious heart condition.

Prevention

There are no known ways to avoid developing SLE. However, it is possible for a patient who has been diagnosed with SLE to prevent flares of the disease. Recommendations for improving general health to avoid flares include decreasing sun exposure, getting sufficient sleep, eating a healthy diet, decreasing stress, and exercising regularly. It is important for a patient to try to identify the early signs of a flare (like **fever**, increased fatigue, rash, **headache**). Some people believe that noticing and responding to these warning signs will allow a patient with SLE to prevent a flare, or at least to decrease its severity.

Resources

BOOKS

Aaseng, Nathan. *Autoimmune Diseases*. New York: F. Watts, 1995.

KEY TERMS

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system then attacks and causes damage to these tissues.

Chromosomes—Spaghetti-like structures located within the nucleus (or central portion) of each cell. Chromosomes contain genes, structures that direct the growth and functioning of all the cells and systems in the body. Chromosomes are responsible for passing on hereditary traits from parents to child.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body that work together to prevent foreign organisms (bacteria, viruses, fungi, etc.) from invading the body.

Psychosis—Extremely disordered thinking with a poor sense of reality; may include hallucinations (seeing, hearing, or smelling things that are not really there).

Hahn, Bevra Hannahs. "Systemic Lupus Erythematosus." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Long, James W. *The Essential Guide to Chronic Illness*. New York: HarperPerennial, 1997.

Ravel, Richard. "Systemic Lupus Erythematosus (SLE)." In *Clinical Laboratory Medicine: Clinical Application of Laboratory Data*. St. Loius: Mosby, 1995.

Wallace, Daniel J. *The Lupus Book*. New York: Oxford University Press, 1995.

PERIODICALS

Mann, Judy. "The Harsh Realities of Lupus." *The Washington Post*, 8 Oct. 1997, C12.

Umansky, Diane. "Living with Lupus." *American Health for Women* 16 (June 1997): 92+.

ORGANIZATIONS

American College of Rheumatology. 1800 Century Place, Suite 250, Atlanta, GA 30345. (404) 633-3777. <http://www.rheumatology.org>.

Lupus Foundation of America. 1300 Piccard Dr., Suite 200, Rockville, MD 20850. (800) 558-0121. <http://www.lupus.org>.

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CONTENTS

PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Medicine 2* is a medical reference product designed to inform and educate readers about a wide variety of disorders, conditions, treatments, and diagnostic tests. The Gale Group believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioner. While the Gale Group has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, the Gale Group makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of medical opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their health care provider.

INTRODUCTION

The *Gale Encyclopedia of Medicine 2 (GEM2)* is a one-stop source for medical information on nearly 1,700 common medical disorders, conditions, tests, and treatments, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart attack. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 2* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

SCOPE

Almost 1,700 full-length articles are included in the *Gale Encyclopedia of Medicine 2*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses, eg. acetaminophen (Tylenol). Throughout the *Gale Encyclopedia of Medicine 2*, many prominent individuals are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Description	Purpose
Causes and symptoms	Precautions
Diagnosis	Description
Treatment	Preparation
Alternative treatment	Aftercare
Prognosis	Risks
Prevention	Normal/Abnormal results
Resources	Resources
Key terms	Key terms

In recent years there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 2* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies.

INCLUSION CRITERIA

A preliminary list of diseases, disorders, tests and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM2* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale Group editor.

ABOUT THE CONTRIBUTORS

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM2* medical advisors reviewed the completed essays to insure that they are appropriate, up-to-date, and medically accurate.

HOW TO USE THIS BOOK

The *Gale Encyclopedia of Medicine 2* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.

- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms are also cross-referenced.
- A list of **key terms** are provided where appropriate to define unfamiliar terms or concepts.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix contains an extensive list of organizations arranged in alphabetical order.
- **Resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

GRAPHICS

The *Gale Encyclopedia of Medicine 2* is enhanced with over 675 color images, including photos, charts, tables, and customized line drawings.

ADVISORY BOARD

A number of experts in the library and medical communities provided invaluable assistance in the formulation of this encyclopedia. Our advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. The editor would like to express her appreciation to them.

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Taeniasis *see* **Tapeworm diseases**

Tagged red blood cell scan *see* **GI bleeding studies**

T'ai chi

Definition

T'ai chi is a Chinese **exercise** system that uses slow, smooth body movements to achieve a state of relaxation of both body and mind.

Purpose

As a system of physical exercise used to improve and maintain health, t'ai chi can be helpful in achieving a state of physical and mental relaxation while also strengthening the cardiovascular system.

Precautions

As a very slow and gentle form of moving, t'ai chi has virtually no side effects. However, if a person has any doubts about the condition of his or her joints, vertebrae, or heart, a physician should be consulted.

Description

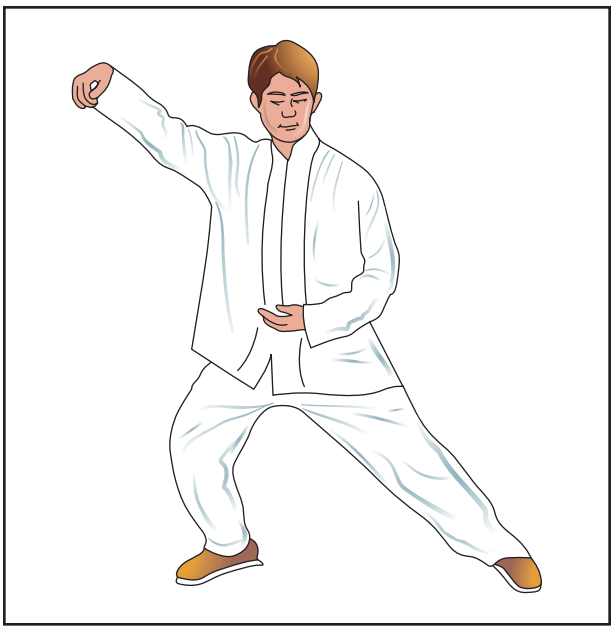
Developed originally in China as a self-defense strategy, or martial art, t'ai chi—the "supreme ultimate fist"—is practiced in modern times primarily as a gentle exercise technique. Described as "meditation in motion," t'ai chi consists of a standing person performing a series of postures or bodily movements in a slow and graceful manner, with each movement flowing without pause to the next. According to Chinese legend, the technique was created by a Taoist monk who was inspired as he watched a crane and a snake do battle. Impressed by the snake's ability to subtly and swiftly avoid the bird's thrusts, he devised a series of self-defense techniques that do not involve meeting the opponent's force with force, but rather stress evading the blow; causing the opponent's own momentum to work against him.

T'ai chi is an ancient form of exercise, about 2,000 years old, that at one point had over 100 separate movements or postures. In current practice, there are two popular versions, of 18 and 37 movements respectively. The fact that in China 10 million people practice some type of t'ai chi daily suggests that it is one of the most popular forms of exercise in the world. In the United States, t'ai chi is learned in classes in which students (or "players," as they are called in China) wear loose, comfortable clothing and either go barefoot or wear only socks or soft shoes on the feet. In China, t'ai chi is almost always practiced outdoors at dawn, and ideally near trees. Unlike other martial arts, t'ai chi is not competitive. Classes usually begin with a few minutes of standing **meditation** to calm the mind and gather energy. Following warm-up exercises, students are taught the basics of a particular form or posture. Learning forms is not easy, and it takes some time to master what looks like a simple position. Properly done postures are done in a relaxed, artful, and linked way, with the circular and rhythmic movements of one position flowing seamlessly into the next.

While strict attention to body position is critical, proper breathing is considered to be equally important. Just as movements are slow and continuous and without strain, breathing should be effortless yet deep. Finally, both mental and physical balance is considered essential to t'ai chi. The experienced practitioner of t'ai chi maintains perfect body balance throughout the exercise series. Altogether, the five essential qualities of t'ai chi are:

- Slowness. To develop awareness.
- Lightness. To make movements flow.
- Balance. To prevent body strain.
- Calmness. To maintain continuity.
- Clarity. To focus the mind.

T'ai chi has both physical and mental benefits. If done regularly, it improves muscle tone, flexibility, balance, and



T'ai chi is a Chinese exercise system that uses slow, smooth body movements to achieve a state of relaxation. The posture above is part of the single whip sequence of t'ai chi motions. *(Illustration by Electronic Illustrators Group.)*

coordination. Many older people find that it boosts their energy, stamina, and agility, sharpens their reflexes, and gives an overall sense of well-being. The calming and meditative aspects of t'ai chi allow many to experience its ability to relieve **stress**. Some claim t'ai chi to be a healing therapy, and it is often used to support other treatments for chronic conditions; arthritis and digestive disorders are just two examples. Like **yoga**, t'ai chi has several different styles to suit the individual. Also, it can eventually be done daily by oneself, and ultimately becomes a very personal endeavor. Most Westerners find it best to practice t'ai chi in the same place and at the same time of day, and those who enjoy it most are those who are not seeking major, dramatic breakthroughs, but rather who can take pleasure in small gains that accumulate over a long period of time.

Risks

T'ai chi is a safe exercise system for people of all ages and fitness levels. Done properly, without any over-stretching, t'ai chi should not leave a person feeling tired or sore.

Normal results

Besides its overall fitness benefits and **stress reduction** aspects, regular t'ai chi sessions are said to be especially helpful for seniors, as they lower their blood pressure. T'ai chi claims to benefit arthritis sufferers, those recovering from an injury or rehabilitating their hearts, and also improves balance, and therefore, reduces the risk of falling, especially important for the elderly. T'ai chi can result in a significant improvement in the quality of life for anyone. But, because of the low stress level of the exercises it is a particularly attractive form of exercise to seniors.

KEY TERMS

Arthritis—Inflammation of the joints.

Cardiovascular—Relating to the heart and blood vessels.

Continuity—Uninterrupted and successive.

Meditation—An exercise of contemplation that induces a temporary feeling of relaxation.

Stamina—Staying power, endurance.

Yoga—A system of exercise aimed at promoting the control of the body and the mind.

Resources

BOOKS

Crompton, Paul. *T'ai Chi*. New York: Macmillan, 1996.

Guiness, Alma E. *Family Guide to Natural Medicine*. Pleasantville, NY: The Reader's Digest Association, Inc., 1993.

Parry, Robert. *T'ai Chi*. Chicago: NTC Publishing Group, 1997.

PERIODICALS

Brody, Jane. "T'ai Chi Offers Gentle, Stylized Exercises." *The New York Times*, 16 July 1997, C1.

Krucoff, Carol. "Western Science Studies Healing Effects of Ancient Eastern Practice." *The Washington Post*, 14 Apr. 1998, 28, 30.

ORGANIZATIONS

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Tailbone injuries *see* **Coccyx injuries**

Talipes *see* **Clubfoot**

Tamoxifen *see* **Anticancer drugs**

Tamponade *see* **Cardiac tamponade**

Tapeworm diseases

Definition

Tapeworms are a group of parasitic worms that live in the intestinal tracts of some animals. Several different

species of tapeworms can infect humans. Tapeworm disease or cestodiasis occurs most commonly after eating raw or undercooked meat or fish that contains the immature form of the tapeworm.

Description

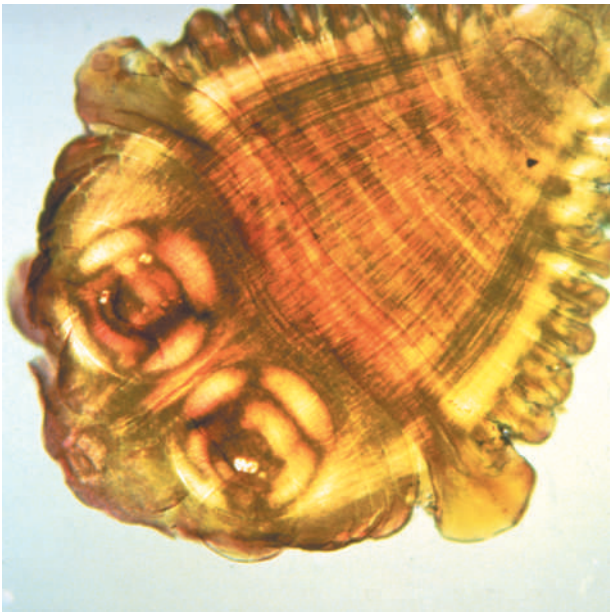
Tapeworm infections pose a serious public health problem in many less developed countries due to poor sanitation conditions. The disease is most common where livestock, such as cattle and pigs, are raised in areas where human feces are not disposed of in a sanitary manner. Another common source of human tapeworms are certain species of freshwater fish. Tapeworm infections tend to occur more frequently in areas of the world where the people regularly eat raw or undercooked beef, pork, or fish. Persons of all ages and both sexes are susceptible to tapeworm infection, but children are generally not exposed until they are old enough to begin eating meat or fish.

Tapeworm is less common in industrialized regions of the world, but travel to areas in which tapeworm infections are more common and immigration of people from these areas serve as new sources of the parasite. Infected persons are often unaware of the presence of adult tapeworms in their intestinal tract, as they may have no obvious symptoms of infection. Some tapeworms can live in an infected person for over 10 years if diagnosis is not made and treatment is not administered.

In addition to the typical infection caused by eating undercooked meat or fish, people may also be directly infected by ingesting tapeworm eggs shed by the adult worm. This type of tapeworm infection can lead to a condition referred to as cysticercosis, in which the larvae continue to develop within tissues other than the intestinal tract. One of the most serious forms of this disease occurs when the tapeworm larvae infect the central nervous system, a disease referred to as neurocysticercosis. In contrast to a typical tapeworm infection, which may not be associated with symptoms, neurocysticercosis is a serious condition that may cause seizures and is potentially life-threatening.

Causes and symptoms

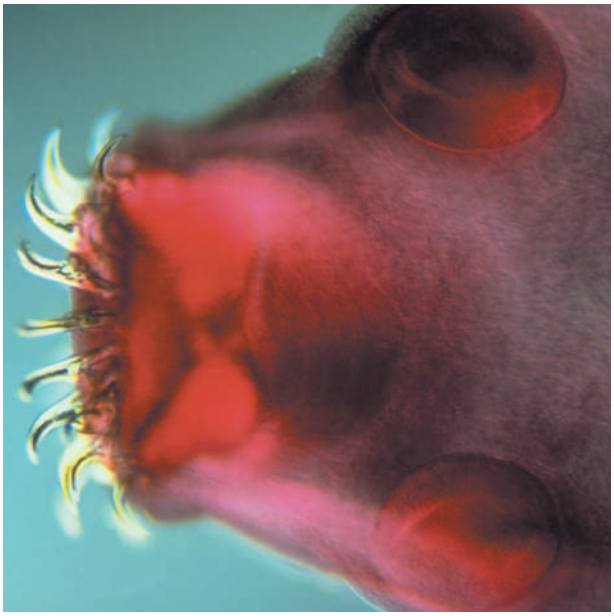
Several species of tapeworm can infect people. The two most common species are the pork tapeworm (*Taenia solium*) and the beef tapeworm (*Taenia saginata*). Improperly treated human sewage may be used to fertilize pastures or crops. Pigs or cattle become infected by grazing in contaminated pastures or drinking water contaminated with tapeworm eggs from human feces. The pea-sized larvae of these tapeworms are deposited in certain tissues of the body of infected pigs and cattle, including the muscles. The infection is then transmitted to people when raw or undercooked meat containing tapeworm larvae is consumed. The immature tapeworm develops into the adult form in the human intestine and may remain there for many years if not identified and treated.



The head of an adult beef tapeworm. *(Custom Medical Stock Photo. Reproduced by permission.)*

The *Taenia* tapeworms attach to the intestinal walls but cause only mild inflammation at the site of attachment. As a result, most tapeworm carriers show no symptoms (asymptomatic) and usually become aware of the infection only after noticing tapeworm segments in their feces. Segments of the beef tapeworm may spontaneously pass through the anus causing a noticeable sensation. Mild gastrointestinal symptoms, such as nausea or abdominal **pain**, can occur in infected individuals. In rare cases where the tapeworm segments migrate into the appendix, pancreas, or bile duct, there may be a sudden onset of severe abdominal discomfort.

Cysticercosis is a potentially serious complication of *Taenia solium* infection in which the larvae develop outside the intestinal tract. This type of infection is less common and occurs following accidental consumption of tapeworm eggs released from the adult worm. These eggs initially are localized in the anal area, but they may also contaminate the fingers or other parts of the body. Infection can occur in the person harboring the adult tapeworm or in other people with whom that individual comes in contact. The tapeworm larvae may develop in various tissues throughout the body. The most serious clinical problems occur when the larvae develop in the central nervous system (neurocysticercosis), potentially



The head of an adult pork tapeworm. *(Custom Medical Stock Photo. Reproduced by permission.)*

causing seizures and other neurological problems. An important aspect of this type of infection is that poor hygiene on the part of the individuals harboring an adult tapeworm can lead to an infection in an individual who may never consume meat. This is a particular problem if infected individuals are employed as food handlers.

Another important tapeworm that may infect people is the fish tapeworm (*Diphyllobothrium latum*). This is a frequent human intestinal parasite in many areas where raw freshwater fish is consumed. Human infection with the fish tapeworm is referred to as diphyllobothriasis. Feces from infected hosts or raw sewage contaminates a fresh water source. Tapeworm larvae are initially ingested by freshwater crustaceans and then are eaten by fish. Human infection occurs when a person consumes raw fish contaminated with the tapeworm larvae. Adult tapeworms then develop in the human intestinal tract.

Most infections with the fish tapeworm are not associated with symptoms. The tapeworm causes little damage to the lining of the intestine. Infected individuals may report **diarrhea**, **fatigue**, weakness, or sensations of hunger more commonly than uninfected individuals. One problem unique to this tapeworm is that it may compete with the host for absorption of vitamin B_{12} from the small intestine, causing the person to become deficient in this vitamin and leading to a condition called **pernicious anemia**.

Two smaller species of tapeworms may also infect people. The dwarf tapeworm (*Hymenolepis nana*) is a common infection throughout the world that can be passed from one person to another. Transmission is usually the result of inadvertent ingestion of tapeworm eggs from feces eliminated by infected individuals. As a result, infection with this tapeworm is encountered most frequently in children, the developmentally disabled, and psychiatric patient populations. Abdominal pain that is not localized to any particular area is the most common complaint. Patients may experience loose bowel movements or diarrhea with mucus, but bloody diarrhea is rare.

Another small tapeworm capable of infecting people is the rodent tapeworm (*Hymenolepis diminuta*). Rats, mice, and other rodents are the usual hosts for the adult tapeworm (definitive host), but humans can become infected following accidental consumption of insects containing tapeworm larvae. Meal worms or grain beetles that infest cereal, flour, or dried fruit are the most likely source of infection. Most human infections are not associated with symptoms, although some individuals report headaches, anorexia, nausea, and diarrhea.

Diagnosis

Identification of tapeworm segments or eggs in a stool sample is necessary for diagnosis of an adult tapeworm infection. In many cases, a tentative diagnosis may be made on the basis of a patient's description of short chains of tapeworm segments in their stool. Further evaluation is recommended to determine the actual species involved since infection with *Taenia solium* is potentially more serious due to the added risk of cysticercosis. Whenever possible, tapeworm segments should be carefully collected in water or salt solutions, using strict precautions to avoid contamination. Stool examination should be performed in a laboratory having experience in the diagnosis of intestinal parasites. It is recommended that at least three stool samples be collected on alternate days to increase the likelihood of being able to make an accurate diagnosis.

Although the general appearance of tapeworm segments from the two *Taenia* species is quite similar, trained laboratory personnel can detect distinct differences between the beef and pork tapeworms when samples are examined under a microscope. Tapeworm segments and eggs from the fish tapeworm and the dwarf tapeworm have characteristic appearances that allow accurate differentiation from the *Taenia* species of worms. Other diagnostic procedures may be necessary when cysticercosis is suspected. Blood samples from an infected individual are collected to look for the presence of antibodies against the tapeworm larvae. In cases in which infection of the central nervous system is present, advanced imaging tests, such as **computed tomography scans** and **magnetic resonance imaging** (MRI), may be necessary to determine the exact location of the tapeworm larvae within the body.

KEY TERMS

Cestodiasis—Parasitic infection caused by the presence of adult tapeworms of the class Cestoda within the intestinal tract. Infection is caused by accidental consumption of tapeworm larvae.

Cysticercosis—Parasitic infection caused by the presence of immature tapeworm larvae (cysticerci) that have developed outside the intestinal tract. Infection is caused by accidental consumption of tapeworm eggs.

Diphyllobothriasis—Parasitic infection caused by the presence of tapeworms from the *Diphyllobothrium* genus, such as the fish tapeworm (*Diphyllobothrium latum*).

Hymenolepiasis—Parasitic infection caused by the presence of tapeworms from the *Hymenolepis* genus, such as the dwarf tapeworm (*Hymenolepis nana*) or the rodent tapeworm (*Hymenolepis diminuta*).

Neurocysticercosis—Parasitic infection caused by the presence of immature tapeworm larvae within the central nervous system.

Pernicious anemia—Type of anemia caused by a deficiency in vitamin B_{12}.

Taeniasis—Parasitic infection caused by the presence of tapeworms from the *Taenia* genus, such as the pork tapeworm (*Taenia solium*) or the beef tapeworm (*Taenia saginata*).

Treatment

Effective treatment of tapeworm infections involves administering compounds that are toxic to the adult worm. Many of the early treatments were also somewhat toxic to the patient, so treatment was often quite an ordeal. Newer medications are much more easily tolerated and are highly effective in eliminating the parasite from the body.

One treatment that has been in use since the early 1960s is niclosamide (Niclocide). This drug is poorly absorbed from the digestive tract and rapidly kills tapeworms upon exposure. It has been shown to be effective against *Taenia* species and the fish tapeworm, but treatment of the dwarf tapeworm (*Hymenolepis nana*) may require a more prolonged treatment schedule. Side effects reported with niclosamide are infrequent and typically mild. When present, side effects may include nausea, abdominal discomfort, vomiting, diarrhea, lightheadedness, and skin rash. This medication should be taken in the morning on an empty stomach. The tablets are chewed thoroughly and swallowed with water. For young children, the tablets may be pulverized and mixed with water. Patients are allowed to eat two hours after treatment. Recommended dosage is 2 grams for adults and about half this for children.

Another oral medication that has been shown to be 95% effective in the treatment of tapeworm infections associated with both *Taenia* and *Diphyllobothrium latum* species is praziquantel (Biltricide). Side effects reported for praziquantel are mild and appear to be short-lived. They include nausea, abdominal pain, **itching**, sore joints, and muscle pain.

It is recommended that follow-up stool samples be examined at one month and three months after treatment has been completed. Treatment can be considered successful if no eggs are present in several stool samples. It should be noted that the tapeworm medications do not kill the tapeworm eggs when they kill the adult worm, so the potential for infection with eggs still exists as the dead worm segments are passed. Proper personal hygiene in individuals receiving treatment will greatly reduce this potential.

Cases of neurocysticercosis, where larvae have developed in the central nervous system, may also be treated with praziquantel or albendazole. If the patient is treated promptly, damage to the central nervous system will be minimized.

Prognosis

When confined to the intestinal tract, tapeworms cause minimal damage to their human host. Once the diagnosis of an intestinal tapeworm infection has been made, prognosis following treatment with niclosamide or praziquantel is good. The worms can be eliminated from the intestines with oral treatment, and there are usually no residual side effects. Serious problems from tapeworm infections occur when tapeworm eggs are consumed and the larvae localize in tissues outside the digestive tract (cysticercosis). Prompt diagnosis and treatment of this condition is necessary to prevent permanent damage to the central nervous system and other internal organs. Untreated cases of cysticercosis have the rare potential to be life-threatening.

Prevention

The best way to prevent infection with tapeworms is to eliminate the exposure of livestock to the tapeworm eggs by properly disposing of human feces. The next best strategy is to thoroughly cook or freeze all meat and fish before it is eaten to prevent consumption

of live tapeworm larvae in infected samples. Larval cysts in pork and beef are killed by moderate temperatures of 150°F (65°C) or if frozen for at least 12 hours. Proper cooking of freshwater fish could also eliminate the possibility of human infection with the fish tapeworm. Freezing fresh fish for 24 hours will also kill the larval form.

Resources

PERIODICALS

Despommier, Dickson D. "Tapeworm Infection: The Long and the Short of It." *New England Journal of Medicine* 327 (3 Sept. 1992): 727-728.

Pearson, Richard D., and Erik L. Hewlett. "Niclosamide Therapy for Tapeworm Infections." *Annals of Internal Medicine* 102 (Apr. 1985): 550-551.

Schantz, Peter M. "Tapeworms (Cestodiasis)." *Gastroenterology Clinics of North America* 25 (Sept. 1996): 637-653.

Schantz, Peter M., et al. "Neurocysticercosis in an Orthodox Jewish Community in New York City." *New England Journal of Medicine* 327 (3 Sept. 1992): 692-695.

Tanowitz, Herbert B., Louis M. Weiss and Murray Wittner. "Diagnosis and Treatment of Intestinal Helminths: Common Intestinal Cestodes." *The Gastroenterologist* 1 (Dec. 1993): 265-273.

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Tardive dyskinesia

Definition

Tardive dyskinesia is a mostly irreversible neurological disorder of involuntary movements caused by long-term use of antipsychotic or neuroleptic drugs.

Description

Antipsychotic or neuroleptic drugs are powerful tranquilizers generally prescribed for serious psychiatric disorders, as well as neurological and gastrointestinal disorders. Some common antipsychotics are: chlorpromazine HCl (Thorazine), thioridazine HCl (Mellaril), haloperidol (Haldol), perphenazine (Trilafon), thiothixene (Navane), trifluoperazine HCl (Stelazine), and fluphenazine HCl (Permitil, Prolixin).

When these drugs are used long term, tardive dyskinesia (TD) can result. About 20 percent of people taking **antipsychotic drugs** for more then one year become affected by TD. The prevalence of TD tends to be highest among elderly patients and among women.

Causes and symptoms

TD usually appears after years of antipsychotic drug use, and seems to be related to the total lifetime dose of medication. The symptoms include the following:

- tongue protrusion
- grimacing
- rapid eye blinking
- lip smacking, pursing, or puckering
- rapid movement of the arms or legs
- other involuntary movements of the head, face, neck and tongue muscles

Diagnosis

The diagnosis of TD is suspected upon observation of involuntary movements of the head, neck, face, and tongue in individuals who have a history of antipsychotic drug prescription.

Treatment

There is no standard treatment for TD. The primary approach is to discontinue or minimize the use of antipsychotic drugs while attempting to treat some of the symptoms. The treatment must be individualized to the patient, because discontinuation of the antipsychotic drug(s) may not be advisable, depending on the patient's condition. In some cases, substituting another drug for the antipsychotic drug may be beneficial.

Prognosis

Once TD appears in full-blown form, it can be permanent. With careful management, some symptoms may improve and even disappear with time. In less severe cases, some patients may recover from TD within three months of discontinuing the use of antipsychotic medication. Studies report that at least half of patients experience remission of major symptoms within 12 to 18 months following discontinuation of antipsychotic drugs. In some patients, however, decreasing the dose of the antipsychotic drug actually increases the symptoms of TD, while increasing the dose sometimes offers a temporary remission of the symptoms.

Prevention

TD can be prevented by early recognition and discontinuation of the antipsychotic medication if this is clinically possible. The use of antipsychotic drugs should in any case be kept to a minimum in all patients. Patients should be followed carefully to determine when

KEY TERMS

Antipsychotics—Drugs used to treat psychotic conditions such as schizophrenia or psychosis. These medications are powerful tranquilizers that all have sedating and calming effects, but their major effect is to reduce psychotic thinking and behavior.

Neuroleptics—Any of a class of drugs used to treat psychotic conditions.

Psychosis—A condition where a person's ability to recognize reality and cope with everyday life is severely affected.

the dose of the drug can be tapered off as the psychiatric condition improves. In all cases, the benefits of taking the antipsychotic medication should outweigh the risk of developing TD.

A study has shown that elderly institutionalized patients with **dementia** that were treated with risperidone had a low incidence of TD. Although further study is needed, this study shows that non-conventional neuroleptic drugs should be considered to avoid the risk of tardive dyskinesia, particularly in elderly patients.

Resources

BOOKS

Tasman, Allan. *Psychiatry.* Philadelphia: W.B. Saunders Company, 1997.

Tierney, Lawrence, et al. *Current Medical Diagnosis and Treatment.* Los Altos: Lange Medical Publications, 2001.

PERIODICALS

"Risperidone May Lower Incidence of TD." *Brown University geroPsych Report* (August 2000):2.

ORGANIZATIONS

National Institute for Mental Health. 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD 20892-9663. <http://www.nimh.nih.gov>.

Tardive Dyskinesia/Tardive Dystonia National Association. P.O. Box 45732, Seattle, WA 98145-0732. (206) 522-3166.

Tarsorrhaphy

Definition

Tarsorrhaphy is a rare procedure where the eyelids are partially sewn together to narrow the opening.

Purpose

The eye needs a lid to protect it. It also needs tears and periodic blinking to cleanse it and keep it moist. There are many conditions that impair these functions and threaten the eye, specifically the cornea, with drying. Until they can be corrected, sewing the eyelids partially together helps protect the eye.

A partial list of the conditions that can require tarsorrhaphy includes:

- Paralysis or weakness of the eyelids so that they cannot close or blink adequately. **Bell's palsy** is a nerve condition that weakens the muscles of the face, including the eyelids. It is usually temporary. **Myasthenia gravis** also weakens facial muscles, but it is usually treatable. A **stroke** can also weaken eyelids so they do not close.
- Exophthalmos (the eyes sticking out of their sockets) occurs with Graves' disease of the thyroid and with tumors behind the eyes. If the eyes stick out too far, the lids cannot close over them.
- Enophthalmos is a condition in which the eye falls back into the socket so that the eyelid function is inadequate.
- Several eye and corneal diseases cause swelling of the cornea and require temporary added protection until the condition resolves.
- Sjögren's syndrome reduces tear flow to the point where it can endanger the cornea.
- Dendritic ulcers of the cornea caused by viruses may need to be covered with the eyelid while they heal.

Precautions

The use of eye drops and contact lenses to moisten and protect the eyes must be considered first before tarsorrhaphy is performed.

Description

Stitches are carefully placed at the corners of the eyelid opening (called the palpebral fissure) to narrow it. This allows the eye better lubrication and less exposure to the air. Eyeball motion can then help bathe the cornea in tears when it rolls up under the lid. The outpatient procedure is done under local anesthetic.

Preparation

Tarsorrhaphy is a minor procedure done under local anesthesia. Special preparation is not necessary.

Aftercare

Eye drops or ointment may still be needed to preserve the cornea or treat accompanying disease.

KEY TERMS

Cornea—The clear part of the front of the eye through which vision occurs.

Enophthalmos—A condition in which the eye falls back into the socket and inhibits proper eyelid function.

Exophthalmos—A condition in which the eyes stick out of their sockets and inhibit proper eyelid function.

Palpebral fissure—Eyelid opening.

Sjögren's syndrome—A connective tissue disease that hinders the production of tears and other body fluids.

Risks

Tarsorrhaphy carries few risks. If complications occur, they are usually minor eyelid swelling and superficial infection.

Resources

BOOKS

Sardegna, Jill Otis, and T. Paul. *The Encyclopedia of Blindness and Vision Impairment*. New York: Facts on File Inc., 1990.

J. Ricker Polsdorfer, MD

Tattoos *see* **Piercing and tattoos**

Tay-Sachs disease

Definition

Tay-Sachs disease is a genetic disorder caused by a missing enzyme that results in the accumulation of a fatty substance in the nervous system. This results in disability and **death**.

Description

Gangliosides are fatty substances necessary for the proper development of the brain and nerve cells (nervous system). Under normal conditions, gangliosides are continuously broken down, so that an appropriate balance is maintained. In Tay-Sachs disease, the enzyme necessary for removing excess gangliosides is missing. This allows gangliosides to accumulate throughout the brain, and is responsible for the disability associated with the disease.

Tay-Sachs disease is particularly common among Jewish people of Eastern European and Russian (Ashkenazi) origin. About one out of every 3,600 babies born to Ashkenazi Jewish couples will have the disease. Tay-Sachs is also more common among certain French-Canadian and Cajun French families.

Causes and symptoms

Tay-Sachs is caused by a defective gene. Genes are located on chromosomes, and serve to direct specific development/processes within the body. The genetic defect in Tay-Sachs disease results in the lack of an enzyme called hexosaminidase A. Without this enzyme, gangliosides cannot be degraded. They build up within the brain, interfering with nerve functioning. Because Tay-Sachs is a recessive disorder, only people who receive two defective genes (one from the mother and one from the father) will actually have the disease. People who have only one defective gene and one normal gene are called carriers. They carry the defective gene and thus the possibility of passing the gene and/or the disease onto their offspring.

When a carrier and a non-carrier have children, none of their children will actually have Tay-Sachs. It is likely that 50% of their children will be carriers themselves. When two carriers have children, their children have a 25% chance of having normal genes, a 50% chance of being carriers of the defective gene, and a 25% chance of having two defective genes. The two defective genes cause the disease itself.

Classic Tay-Sachs disease strikes infants around the age of six months. Up until this age, the baby will appear to be developing normally. When Tay-Sachs begins to show itself, the baby will stop interacting with other people and develop a staring gaze. Normal levels of noise will startle the baby to an abnormal degree. By about one year of age, the baby will have very weak, floppy muscles, and may be completely blind. The head will be quite large. Patients also present with loss of peripheral (side) vision, inability to breath and swallow, and **paralysis** as the disorder progresses. Seizures become a problem between ages one and two, and the baby usually dies by about age four.

A few variations from this classical progression of Tay-Sachs disease are possible:

- Juvenile hexosaminidase A deficiency. Symptoms appear between ages two and five; the disease progresses more slowly, with death by about 15 years.
- Chronic hexosaminidase A deficiency. Symptoms may begin around age five, or may not occur until age

KEY TERMS

Ganglioside—A fatty (lipid) substance found within the brain and nerve cells.

20–30. The disease is milder. Speech becomes slurred. The individual may have difficulty walking due to weakness, muscle cramps, and decreased coordination of movements. Some individuals develop mental illness. Many have changes in intellect, hearing, or vision.

Diagnosis

Examination of the eyes of a child with Tay-Sachs disease will reveal a characteristic cherry-red spot at the back of the eye (in an area called the retina). Tests to determine the presence and quantity of hexosaminidase A can be performed on the blood, specially treated skin cells, or white blood cells. A carrier will have about half of the normal level of hexosaminidase A present, while a patient with the disease will have none.

Treatment

There is no treatment for Tay-Sachs disease.

Prognosis

Sadly, the prognosis for a child with classic Tay-Sachs disease is certain death. Because the chronic form of Tay-Sachs has been discovered recently, prognosis for this type of the disease is not completely known.

Prevention

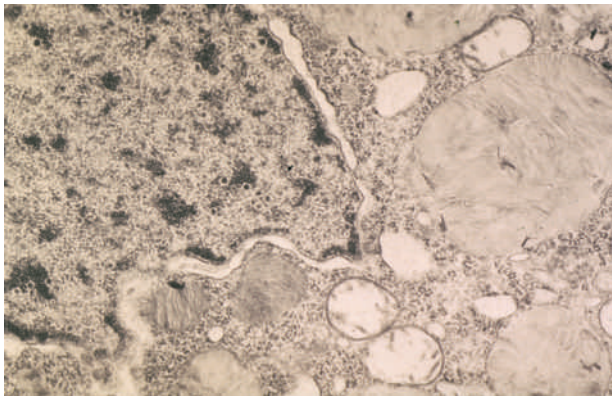
Prevention involves identifying carriers of the disease and providing them with appropriate information concerning the chance of their offspring having Tay-Sachs disease. When the levels of hexosaminidase A are half the normal level, a person is a carrier of the defective gene. Blood tests of carriers reveals reduction of hexosaminidase A.

When a woman is already pregnant, tests can be performed on either the cells of the baby (aminocentesis) or the placenta (chorionic villus sampling) to determine whether the baby will have Tay-Sachs disease.

Resources

BOOKS

Nelson Textbook of Pediatrics, edited by Richard Behrman. Philadelphia: W.B. Saunders, 1996.



Section of brain tissue from patient with Tay-Sachs disease. *(Custom Medical Stock Photo. Reproduced by permission.)*

PERIODICALS

Motulsky, Arno G. "Screening for Genetic Disease." *New England Journal of Medicine,* 336, no. 18 (May 1, 1997): 1314+.

Rosebush, Patricia I. "Late-Onset Tay-Sachs Disease Presenting as Catatonic Schizophrenia: Diagnostic and Treatment Issues." *Journal of the American Medical Association* 274, no. 22 (December 13, 1995): 1744.

ORGANIZATIONS

Late Onset Tay-Sachs Foundation. 1303 Paper Mill Road, Erdenheim, PA 19038. (800) 672-2022.

March of Dimes Birth Defects Foundation. National Office. 1275 Mamaroneck Avenue, White Plains, NY 10605. (888) 663-4637. <resourcecenter@modimes.org>. <http://www.modimes.org>.

National Tay-Sachs and Allied Diseases Association, Inc. 2001 Beacon Street, Suite 204, Brighton, MA 02146. (800) 906-8723. Fax: 617-277-0134. <NTSAD-Boston@worldnet.att.net>. <http://www.ntsad.org>.

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TB *see* **Tuberculosis**

T-cell count *see* **Lymphocyte typing**

TCM *see* **Traditional Chinese medicine**

TE fistula *see* **Tracheoesophageal fistula**

Technetium heart scan

Definition

The technetium heart scan is a noninvasive nuclear scan that uses a radioactive isotope called technetium to evaluate blood flow after a **heart attack**.

Purpose

The technetium heart scan is used to evaluate the heart after a heart attack. It can confirm that a patient had a heart attack when the symptoms and **pain** usually associated with a heart attack were not present; identify the size and location of the heart attack; and provide information useful in determining the patient's post-heart attack prognosis. The scan is most useful when the electrocardiogram and cardiac enzyme studies do not provide definitive results—after heart surgery, for example, or when chest pain occurred more than 48 hours before the patient was examined. It is also used to evaluate the heart before and after heart surgery.

Precautions

Pregnant women and those who are breastfeeding should not be exposed to technetium.

Description

The technetium heart scan is a nuclear heart scan, which means that it involves the use of a radioactive isotope that targets the heart, and a radionuclide detector that traces the absorption of the radioactive isotope. The isotope is injected into a vein and absorbed by healthy tissue at a known rate during a certain time period. The radionuclide detector, in this case a gamma scintillation camera, picks up the gamma rays emitted by the isotope.

The technetium heart scan uses technetium Tc-99m stannous pyrophosphate (usually called technetium), a mildly radioactive isotope that binds to calcium. After a heart attack, tiny calcium deposits appear on diseased heart valves and damaged heart tissue. These deposits appear within 12 hours of the heart attack. They are generally seen two to three days after the heart attack and are usually gone within one to two weeks. In some patients, they can be seen for several months.

After the technetium is injected into a blood vessel in the arm, it accumulates in heart tissue that has been damaged, leaving "hot spots" that can be detected by the scintillation camera. The technetium heart scan provides better image quality than commonly used radioactive agents such as thallium, because it has a shorter half-life and can thus be given in larger doses.

During the test, the patient lies motionless on the test table. Electrocardiogram electrodes are placed on the patient's body for continuous monitoring during the test. The test table is rotated so that different views of the heart can be scanned. The camera, which looks like an x-ray machine and is suspended above the table, moves back and forth over the patient. It displays a series of images of technetium's movement through the heart and records them on a computer for later analysis.

The test is usually performed at least 12 hours after a suspected heart attack, but it can also be done during triage of a patient who goes to a hospital emergency room with chest pain but does not appear to have had a heart attack. Recent clinical studies demonstrate that technetium heart scans are very accurate in detecting heart attacks while the patient is experiencing chest pain. They are far more accurate than electrocardiogram findings.

The technetium heart scan is usually performed in a hospital's nuclear medicine department but it can be done at the patient's bedside during a heart attack if the equipment is available. The scan is done two to three hours after the technetium is injected. Scans are usually done with the patient in several positions, with each scan taking 10 minutes. The entire test takes about 30 minutes to an hour. The scan is usually repeated over several weeks to determine if any further damage has been done to the heart. The test is also called technetium 99m pyrophosphate scintigraphy, hot-spot myocardial imaging, infarct avid imaging, or myocardial infarction scan.

The technetium heart scan is not dangerous. The technetium is completely gone from the body within a few days of the test. The scan itself exposes the patient to about the same amount of radiation as a **chest x ray**. The patient can resume normal activities immediately after the test.

Preparation

Two to three hours before the scan, technetium is injected into a vein in the patient's forearm.

Normal results

If the technetium heart scan is normal, no technetium will show up in the heart.

Abnormal results

In an abnormal technetium heart scan, hot spots reveal damage to the heart. The larger the hot spots, the poorer the patient's prognosis.

Resources

BOOKS

DeBakey, Michael E., and Antonio M. Gotto Jr. "Noninvasive Diagnostic Procedures." In *The New Living Heart.* Holbrook, MA: Adams Media Corporation, 1997.

Iskandrian, A. S., and Mario S. Verani. "Instrumentation and Technical Considerations in Planar and SPECT Imaging." In *Nuclear Cardiac Imaging: Principles and Applications.* 2nd ed. Philadelphia: F. A. Davis, 1996.

KEY TERMS

Electrocardiogram—A test in which electronic sensors called electrodes are placed on the body to record the heart's electrical activities.

Noninvasive—A procedure that does not penetrate the body.

Radioactive isotope—One of two or more atoms with the same number of protons but a different number of neutrons with a nuclear composition. In nuclear scanning, radioactive isotopes are used as a diagnostic agent.

Technetium—A radioactive isotope frequently used in radionuclide scanning of the heart and other organs. It is produced during nuclear fission reactions.

Sandler, M. P., et.al. "Radiopharmaceuticals." In *Diagnostic Nuclear Medicine*. 3rd ed. Vol. 1. Baltimore: Williams & Wilkins, 1996.

PERIODICALS

Kim, Samuel C., et. al. "Role of Nuclear Cardiology in the Evaluation of Acute Coronary Syndromes." *Annals of Emergency Medicine* 30, no. 2 (Aug. 1997): 210-218.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

Lori De Milto

TEE *see* **Transesophageal echocardiography**

Template bleeding time *see* **Bleeding time**

Temporal arteritis

Definition

The term temporal arteritis literally means "inflammation of the temporal arteries."As implied by the name, these blood vessels run along the temples after they branch off from the carotid artery in the neck. They provide the blood supply to portions of the scalp, jaw muscles, and salivary glands. Inflammation of these arteries, probably resulting from an abnormal immune reaction, disrupts this blood supply, resulting in a variety of symptoms. They can range from relatively minor—jaw **pain** or headache—through major— including temporary or permanent blindness.

Temporal arteritis is also called giant cell arteritis or cranial arteritis. It is a rheumatic disease that affects large and medium-sized arteries throughout the body and can occur in a variety of patients. Although the temporal arteries are most commonly affected, other arteries throughout the body may be affected. The disease seems to target arteries containing elastic tissue. Veins are rarely affected. Temporal arteritis is a type of **vasculitis**.

Description

Temporal arteritis almost always occurs in people over 50, and it becomes more common as people age. About 20 out of 100,000 people over the age of 50 suffer from temporal arteritis. Women are affected twice as often as men. Some authorities say that temporal arteritis is more common in Caucasians (especially Scandinavians) than in people of other races. Close relatives of patients with temporal arteritis may be more likely than others to get the disease.

Patients with temporal arteritis are diagnosed and overlap with a broader disorder called giant cell arteritis. This can affect parts of the body in addition to the scalp, eyes, and jaw. Sometimes the disease can cause restricted circulation to both arms or both legs, producing pain in the affected limbs. With other blood vessels involved, patients with advanced forms of the disease may experience strokes or transient ischemic attacks (TIA). These result in brief episodes of pain caused by decreased blood flow. Even heart attacks are occasionally caused by giant cell arteritis.

Causes and symptoms

This disease is one of a group of diseases in which the linings of large- or medium-sized blood vessels become inflamed. The elastic layer of these vessels is attacked by "giant" cells and chemicals produced by the immune system. This reaction reduces blood flow through the blood vessels, and the limited blood supply causes the symptoms.

The disease usually begins with "flu-like" symptoms, including a mild **fever** (100–101°F), general body discomfort, and a persistent, dull **headache**. The scalp may be tender to the touch over the affected blood vessels. Jaw muscles sometimes become painful when the patient chews.

As the disease progresses, more severe symptoms occur. These include blurred vision or temporary blindness that typically lasts ten minutes or less. Eventually, permanent loss of vision can occur. Transient ischemic

attacks, strokes, and heart attacks may occur when the disease is far advanced.

Diagnosis

Doctors from a number of specialties develop experience in diagnosing and treating temporal arteritis. These include internists, who treat a broad range of diseases; rheumatologists, who focus on rheumatic diseases; geriatricians, who treat older people; ophthalmologists, who treat eye and vision disorders; neurologists, who treat headaches and problems of the optic nerve; and vascular surgeons, who treat blood vessel problems.

The doctor will generally take a medical history first. The patient can help the doctor tremendously by reviewing all symptoms—both major and minor—from the last two or three months. If possible, the patient should ask family or close friends for help in recalling his/her ailments from recent months. Then the doctor will conduct a complete **physical examination**. Often, he or she will detect a tender, swollen artery on the scalp.

The doctor will order blood tests as well. A standard and inexpensive test called the **erythrocyte sedimentation rate** (ESR or "sed" rate) is particularly helpful. Results from this test, which measures inflammation in the body, will almost always be higher than normal. Tests of the red blood cells may show mild anemia. Sometimes blood tests for liver function will also be abnormal.

The definitive diagnostic test is a temporal artery biopsy. A doctor will make one or more tiny incisions under local anesthesia to remove samples of the suspect artery. Under the microscope, a pathologist usually can identify the typical damage caused by temporal arteritis.

Treatment

The mainstay of treatment is a course of **corticosteroids** (steroid hormones that have an anti-inflammatory effect), usually prednisone. The initial prescription involves a fairly high dose of steroids (40–60 mg/day) which is gradually tapered down to a maintenance dose. Because of the high incidence of blindness in untreated cases, steroid therapy should be started immediately rather than waiting for biopsy results. Patients typically take this maintenance dose for periods of one to three years. Sometimes **nonsteroidal anti-inflammatory drugs** (NSAIDs) are prescribed for muscle aches or headaches, especially while steroid doses are being reduced.

Prognosis

The outlook for most patients with temporal arteritis is good, especially if the disorder is diagnosed early. Symptoms often diminish within a month once patients begin to take steroids. Although physicians do not talk about a "cure" for temporal arteritis, symptoms typically do not return after a full course of steroid treatment. Unfortunately, if the diagnosis is made late in the disease, lost vision may not return.

KEY TERMS

Anemia—Lower than normal level of red blood cells, or of the oxygen-carrying chemical hemoglobin.

Biopsy—Removal and examination of a sample tissue from the body for diagnostic purposes.

Corticosteroids—A group of hormones, produced naturally by the adrenal gland and other organs. They are used to treat a wide variety of disorders, including many rheumatic disorders.

Erythrocyte sedimentation rate—The speed at which red blood cells sink in a tube of freshly drawn blood, which is a rough measure of clotting disorders or inflammation.

Prednisone—A corticosteroid often used to treat inflammation.

Rheumatic disease—A type of disease involving inflammation of muscles, joints, and other tissues.

Transient ischemic attack—A brief experience of stroke-like symptoms (for instance, numbness, paralysis, problems in speaking or understanding speech) that go away within hours, with no permanent damage. Also known as TIA.

Vasculitis—An inflammation of the blood vessels.

Prevention

There is no medically proven approach to prevention. The best way to prevent severe, permanent damage is to obtain expert medical advice if the patient or the family physician suspects this problem.

Resources

BOOKS

Diamond, Seymour, and David Dalessio. *The Practicing Physician's Guide to Headache*. 5th ed. Baltimore: Williams & Wilkins, 1992.

PERIODICALS

Hayreh, S. S., et al. "Giant Cell Arteritis: Validity of Reliability of Various Diagnostic Criteria." *American Journal of Ophthalmology* 123, no. 3 (1997): 285-296.

Perkins, A. T., and W. Ondo."When to Worry About Headache." *Postgraduate Medicine* 98, no. 2 (1995): 197-205.

ORGANIZATIONS

National Headache Foundation. 428 W. St. James Place, Chicago, IL 60614. (800) 843-2256. <http://www.headaches.org>.

Richard H. Lampert

Temporomandibular joint disorders

Definition

Temporomandibular joint disorder (TMJ) is the name given to a group of symptoms that cause **pain** in the head, face, and jaw. The symptoms include headaches, soreness in the chewing muscles, and clicking or stiffness of the joints. They often have psychological as well as physical causes.

Description

TMJ disorder, which is also sometimes called TMJ syndrome, results from pressure on the facial nerves due to muscle tension or abnormalities of the bones in the area of the hinge joint between the lower jaw and the temporal bone. This hinge joint is called the temporomandibular joint. There are two temporomandibular joints, one on each side of the skull just in front of the ear. The name of the joint comes from the two bones that make it up. The temporal bone is the name of the section of the skull bones where the jaw bone (the mandible) is connected. The jaw bone is held in place by a combination of ligaments, tendons, and muscles. The temporomandibular joint also contains a piece of cartilage called a disc, which keeps the temporal bone and the jaw bone from rubbing against each other. The jaw pivots at the joint area in front of the ear. The pivoting motion of the jaw is complicated because it can move downward and from side to side as well as forward. Anything that causes a change in shape or functioning of the temporomandibular joint will cause pain and other symptoms.

Causes and symptoms

Causes

TMJ syndrome has several possible physical causes:

- Muscle tension. Muscle tightness in the temporomandibular joint usually results from overuse of muscles. This overuse in turn is often associated with psychological **stress** and clenching or grinding of the teeth (**bruxism**).
- Injury. A direct blow to the jaw or the side of the head can result in bone fracture, soft tissue bruising, or a dislocation of the temporomandibular joint itself.
- Arthritis. Both **osteoarthritis** and **rheumatoid arthritis** can cause TMJ.
- Internal derangement. Internal derangement is a condition in which the cartilage disk lies in front of its proper position. In most cases of internal derangement, the disc moves in and out of its correct location, making a clicking or popping noise as it moves. In a few cases, the disc is permanently out of position, and the patient's range of motion in the jaw is limited.
- Hypermobility. Hypermobility is a condition in which the ligaments that hold the jaw in place are too loose and the jaw tends to slip out of its socket.
- Birth abnormalities. These are the least frequent cause of TMJ but do occur in a minority of patients. In some cases, the top of the jawbone is too small; in others, the top of the jawbone outgrows the lower part.

Symptoms

The symptoms of TMJ depend in part on its cause. The most common symptoms are facial pain in front of the ears; headaches; sore jaw muscles; a clicking sound when chewing; a grating sensation when opening and closing the mouth; and temporary locking of the jaw. Some patients also report a sensation of buzzing or ringing in the ears. Usually, the temporomandibular joint itself is not painful. Most cases of TMJ are seen in women between 20-50 years of age.

Diagnosis

Dental examination and patient history

TMJ disorders are most frequently diagnosed by dentists. The dentist can often diagnose TMJ based on **physical examination** of the patient's face and jaw. The examination might include pressing on (palpating) the jaw muscles for soreness or asking the patient to open and close the jaw in order to check for misalignment of the teeth in the upper and lower jaw. This condition is called **malocclusion**. The dentist might also gently move the patient's jaw in order to check for loose ligaments.

Imaging studies

Imaging studies are not usually necessary to diagnose TMJ. In most cases, x rays and MRI scans of the temporomandibular joint will be normal. Consequently, these two tests are not commonly used to diagnose TMJ. If the dentist suspects that the patient has internal derangement of the disc, he or she can use a technique called **arthrography** to make the diagnosis. In an arthrogram, a special dye is injected into the joint, which is then x-rayed. Arthrography can be used to evaluate the movement of the jaw and the disc as well as size and shape, and to evaluate the effectiveness of treatment for TMJ.

KEY TERMS

Arthrography—An imaging technique that is sometimes used to evaluate TMJ associated with internal derangement.

Bruxism—Habitual clenching and grinding of the teeth, especially during sleep.

Electromyographic biofeedback—A method for relieving jaw tightness by monitoring the patient's attempts to relax the muscle while the patient watches a gauge. The patient gradually learns to control the degree of muscle relaxation.

Internal derangement—A condition in which the cartilage disc in the temporomandibular joint lies in front of its proper position.

Malocclusion—The misalignment of opposing teeth in the upper and lower jaws.

Mandible—The medical name for the lower jaw.

Osteoarthritis—A type of arthritis marked by chronic degeneration of the cartilage of the joints, leading to pain and sometimes loss of function.

Rheumatoid arthritis—A chronic autoimmune disorder marked by inflammation and deformity of the affected joints.

Temporal bones—The compound bones that form the left and right sides of the skull.

Transcutaneous electrical nerve stimulation—A method for relieving the muscle pain of TMJ by stimulating nerve endings that do not transmit pain. It is thought that this stimulation blocks impulses from nerve endings that do transmit pain.

Treatment

In many cases, the cause of pain in the TMJ area is temporary and disappears without treatment. About 80% of patients with TMJ will improve in six months without medications or physical treatments.

Medications

Patients with TMJ can be given **muscle relaxants** if their symptoms are related to muscle tension. Some patients may be given **aspirin** or **nonsteroidal anti-inflammatory drugs** (NSAIDs) for minor discomfort. If the TMJ is related to rheumatoid arthritis, it may be treated with **corticosteroids**, methotrexate (MTX, Rheumatrex) or gold sodium (Myochrysine).

Physical therapy and mechanical devices

Patients who have difficulty with bruxism are usually treated with splints. A plastic splint called a nightguard is given to the patient to place over the teeth before going to bed. Splints can also be used to treat some cases of internal derangement by holding the jaw forward and keeping the disc in place until the ligaments tighten. The splint is adjusted over a period of two to four months.

TMJ can also be treated with ultrasound, electromyographic **biofeedback**, stretching exercises, transcutaneous **electrical nerve stimulation**, stress management techniques, or friction massage.

Surgery

Surgery is ordinarily used only to treat TMJ caused by birth deformities or certain forms of internal derangement caused by misshapen discs.

Prognosis

The prognosis for recovery from TMJ is excellent for almost all patients. Most patients do not need any form of long-term treatment. Surgical procedures to treat TMJ are quite successful. In the case of patients with TMJ caused by arthritis or infectious diseases, the progression of the arthritis or the success of eliminating infectious agents determines whether TMJ can be eliminated.

Resources

BOOKS

"Disorders of the Temporomandibular Joint." In *Merck Manual of Medical Information: Home Edition*, ed. Robert Berkow, et al. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Murphy Jr., William A., and Phoebe A. Kaplan, "Temporomandibular Joint." In *Diagnosis of Bone and Joint Disorders*, ed. Donald Resnick. Philadelphia: W. B. Saunders Co., 1995.

John T. Lohr, PhD

TEN *see* **Toxic epidermal necrolysis**

Tendinitis

Definition

Tendinitis is the inflammation of a tendon, a tough rope-like tissue that connects muscle to bone.

Description

Tendinitis usually occurs in individuals in middle or old age because it is often the result of overuse over a

long period of time. Tendinitis does occur in younger patients as a result of acute overuse.

Tendons that commonly become inflamed include:

- tendons of the hand
- tendons of the upper arm that effect the shoulder
- achilles tendon and the tendon that runs across the top of the foot

Causes and symptoms

Sudden stretching or repeated overuse injures the connection between the tendon and its bone or muscle. The injury is largely mechanical, but when it appears, the body tries to heal it by initiating inflammation. Inflammation increases the blood supply, bringing nutrients to the damaged tissues along with immunogenic agents to combat infection. The result is swelling, tenderness, **pain**, heat, and redness if the inflammation is close to the skin.

Diagnosis

Some tendon injuries are superficial and easy to identify. These include "tennis elbow" (extensor tendinitis) over the outside of the elbow, and Achilles' tendinitis just above the heel of the foot. There are several tendons in the shoulder that can be overused or stretched, and usually a shoulder will have more than one injury at a time. Tendinitis in the biceps, the infraspinatus, or the supraspinatus tendon may accompany a tear of the shoulder ligaments or an impingement of one bone on another. Careful pressure testing and movement of the parts is all that is necessary to identify the tendinitis.

Treatment

Rest, ice, compression, and elevation (RICE) will treat the acute condition. The best way to apply ice is in a bag with water. The water applies the cold directly to the skin. Chemical ice packs can get too cold and cause frostbite. Compression using an elastic wrap minimizes swelling and bleeding in an acute sprain. Splinting may help rest the limb. Pain and anti-inflammatory medications (**aspirin**, naproxen, ibuprofen) will help. Sometimes the inflammation lingers and requires additional treatment. Injections of cortisone-like medicine often relieve chronic tendinitis, but should be reserved for resistant cases since cortisone can occasionally cause problems of its own.

If tendinitis is persistent and unresponsive to nonsurgical treatment, a surgery to remove the afflicted portion of tendon can be performed. Surgery is also conducted to remove calcium buildup that comes with persistent tendinitis.

KEY TERMS

Biceps—The muscle in the front of the upper arm.

Infraspinatus—A muscle at the middle of the shoulder blade.

Supraspinatus—A muscle at the top of the shoulder blade.

Alternative treatment

An osteopathic soft-tissue treatment on the tendon may relieve pain and increase mobility. Increasing intake of antioxidant-rich foods and lowering intake of animal fats may help reduce the inflammation. **Acupuncture** has also been used to combat tendinitis. Hydrotherapies, such as whirlpool baths, help relax the surrounding muscles.

Prognosis

Generally, tendinitis will heal if the provoking activity is stopped.

Prevention

If given enough time, tendons will strengthen to meet the demands placed on them. They grow slowly because of their poor blood supply, so adequate time is required for good conditioning.

Resources

BOOKS

Boulware, Dennis W. "The Painful Shoulder." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

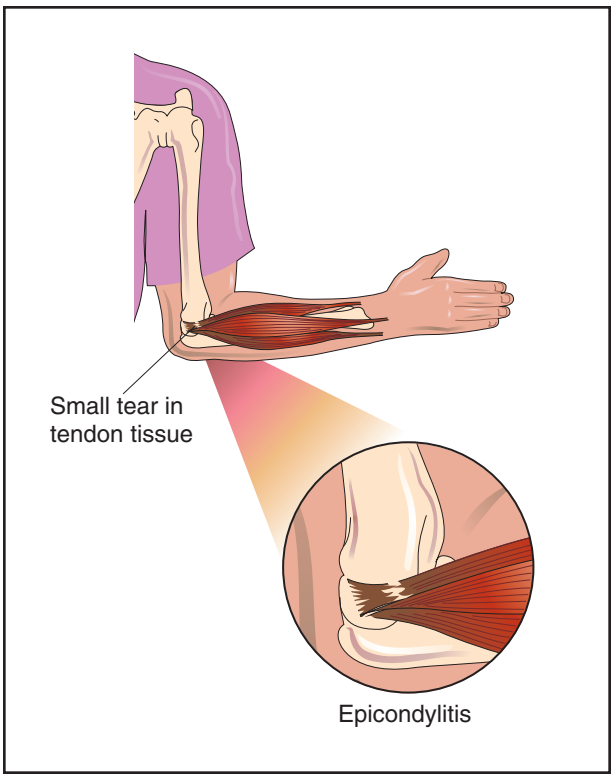
Gilliland, Bruce C. "Relapsing Polychondritis and Other Arthritides." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

J. Ricker Polsdorfer, MD

Tennis elbow

Definition

Tennis elbow is an inflammation of several structures of the elbow. These include muscles, tendons, bursa, periosteum, and epicondyle (bony projections on the outside and inside of the elbow, where muscles of the forearm attach to the bone of the upper arm).



The classic tennis elbow is caused by repeated forceful contractions of wrist muscles located on the outer forearm. The stress created at a common muscle origin causes microscopic tears leading to inflammation. Persons who are most at risk of developing tennis elbow are those whose occupations requires strenuous or repetitive forearm movement. *(Illustration by Electronic Illustrators Group.)*

Description

The classic tennis elbow is caused by repeated forceful contractions of wrist muscles located on the outer forearm. The **stress**, created at a common muscle origin, causes microscopic tears leading to inflammation. This is a relatively small surface area located at the outer portion of the elbow (the lateral epicondyle). Medial tennis elbow, or medial epicondylitis, is caused by forceful, repetitive contractions from muscles located on the inside of the forearm. All of the forearm muscles are involved in tennis serves, when combined motions of the elbow and wrist are employed. This overuse injury is common between ages 20 and 40.

People at risk for tennis elbow are those in occupations that require strenuous or repetitive forearm movement. Such jobs include mechanics or carpentry. Sport activities that require individuals to twist the hand, wrist, and forearm, such as tennis, throwing a ball, bowling, golfing, and skiing, can cause tennis elbow. Individuals in poor physical condition, who are exposed to repetitive wrist and forearm movements for long periods of time may be prone to tennis elbow. This condition is also called epicondylitis, lateral epicondylitis, medial epicondylitis, or golfer's elbow, where **pain** is present at the inside epicondyle.

Causes and symptoms

Tennis elbow pain originates from a partial tear of the tendon and the attached covering of the bone. It is caused by chronic stress on tissues attaching forearm muscles to the elbow area. Individuals experiencing tennis elbow may complain of pain and tenderness over either of the two epicondyles. This pain increases with gripping or rotation of the wrist and forearm. If the condition becomes long-standing and chronic, a decrease in grip strength can develop.

Diagnosis

Diagnosis of tennis elbow includes the individual observation and recall of symptoms, a thorough medical history, and **physical examination** by a physician. Diagnostic testing is usually not necessary unless there may be evidence of nerve involvement from underlying causes. X rays are usually always negative because the condition primarily affects soft tissue, in contrast to a bony disorder.

Treatment

Conservative

Heat or ice is helpful in relieving tennis elbow pain. Once acute symptoms have subsided, **heat treatments** are used to increase blood circulation and promote healing. The physician may recommend physical therapy to apply diathermy or ultrasound to the inflamed site. These are two common modalities used to increase the temperature of the tissues in order to address both pain and inflammation. Occasionally, a tennis elbow splint may be useful to help decrease stress on the elbow throughout daily activities. Exercises become very important to improve flexibility to all forearm muscles, and will aid in decreasing muscle and tendon tightness that has been creating excessive pull at the common attachment of the epicondyle. The physician may also prescribe **nonsteroidal anti-inflammatory drugs** (NSAIDS) to reduce inflammation and pain. Injections of cortisone or anesthetics are often used if physical therapy is ineffective. Cortisone reduces inflammation, and anesthetics temporarily relieve pain. Physicians are cautious regarding excessive number of injections as they have recently been found to weaken the tendon's integrity.

KEY TERMS

Epicondyle—A projection on the surface of a bone; often an area for muscle and tendon attachment.

Epicondylitis—A painful and sometimes disabling inflammation of the muscle and surrounding tissues of the elbow caused by repeated stress and strain on the forearm near the lateral epicondyle of the humerus (arm bone).

Periosteum—A fibrous vascular membrane that covers bones.

Surgery

If conservative methods of treatment fail, surgical release of the tendon at the epicondyle may be a necessary form of treatment. However, surgical intervention is relatively rare.

Alternative treatment

Massage therapy has been found to be beneficial if symptoms are mild. Massage techniques are based primarily on increasing circulation to promote efficient reduction of inflammation. Manipulation, **acupuncture**, and **acupressure** have been used as well. Contrast **hydrotherapy** (alternating hot and cold water or compresses, three minutes hot, 30 seconds cold, repeated three times, always ending with cold) applied to the elbow can help bring nutrient-rich blood to the joint and carry away waste products. Botanical medicine and **homeopathy** may also be effective therapies for tennis elbow. For example, cayenne (*Capsicum frutescens*) ointment or prickly ash (*Zanthoxylum americanum*) oil applied topically may help to increase blood flow to the affected area and speed healing.

Prognosis

Tennis elbow is usually curable; however, if symptoms become chronic, it is not uncommon for treatment to continue for three to six months.

Prevention

Until symptoms of pain and inflammation subside, activities requiring repetitive wrist and forearm motion should be avoided. Once pain decreases to the point that return to activity can begin, the playing of sports, such as tennis, for long periods should not occur until excellent condition returns. Many times, choosing a different size or type of tennis racquet may help. Frequent rest periods are important despite what the wrist and forearm activity may be. Compliance with a stretching and strengthening program is very important in helping prevent recurring symptoms and exacerbation.

Resources

BOOKS

Hertling, Darlene, and Randolph M. Kessler. *Management of Common Musculoskeletal Disorders: Physical Therapy Principles and Methods*. 2nd ed. Philadelphia: J. B. Lippincott Co., 1990.

Norkin, Cynthia C., and Pamela K. Levangie. *Joint Structure and Function: A Comprehensive Analysis*. Philadelphia: F. A. Davis Co., 1992.

ORGANIZATIONS

American College of Sports Medicine. P.O. Box 1440, Indianapolis, IN 46206-1440. (317) 637-9200. <http://www.acsm.org>.

Jeffrey P. Larson, RPT

TENS *see* **Electrical nerve stimulation**

Tensilon test

Definition

Tensilon is the trade name for edrophonium chloride. The Tensilon test is an injection of edrophonium chloride used to diagnosis **myasthenia gravis** (MG).

Purpose

Tensilon blocks the action of an enzyme, acetylcholinesterase, an important part of the system regulating neuromuscular transmission. To stimulate a muscle, a nerve cell (neuron) releases the chemical acetylcholine. To prevent prolonged muscle response to a single nerve signal, acetylcholine is broken down by acetylcholinesterase after the muscle is stimulated.

In myasthenia gravis, there are too few receptors for acetylcholine on the muscle. The acetylcholine is broken down before it can fully stimulate this reduced number of receptors, and, as a result, the muscle is weak. By blocking the action of acetylcholinesterase, Tensilon prolongs the muscle stimulation, and temporarily improves strength. Increased strength following an injection of Tensilon strongly suggests a dignosis of MG. The Tensilon test is most effective when easily observed weakness is present, and is less useful for vague or fluctuating complaints.

KEY TERMS

Acetylcholine—a molecule released by neurons at the neuromuscular junction that causes muscle contraction.

Precautions

The Tensilon test may cause heart rhythm abnormalities, especially in those patients with preexisting conditions.

Description

The Tensilon test involves the intravenous injection of a small amount of Tensilon. The needle is left in place. If no adverse reaction is observed within 30 seconds, an additional volume is injected. Results are apparent within one minute.

Preparation

Before the test, the patient must stop taking all drugs that can inhibit acetylcholinesterase. The referring physician can advise on specific drugs the patient is taking.

Aftercare

The effects of Tensilon subside quickly, and are completely gone after 30-60 minutes. No aftercare is needed.

Risks

Atrial fibrillation and bradycardia are possible in sensitive individuals. The administering physician must have appropriate resuscitative equipment available.

Normal results

In a patient without MG, the Tensilon test will not produce an obvious increase in a previously weak muscle. Some subjective feelings of increased strength are possible but not significant.

Abnormal results

An obvious increase in strength in weakened muscles strongly suggests the diagnosis of myasthenia gravis. The effect comes on very rapidly, and fades within minutes.

Resources

ORGANIZATIONS

Myasthenia Gravis Foundation of America. 222 S. Riverside Plaza, Suite 1540, Chicago, IL 60606. (800) 541-5454. <http://www.med.unc.edu>.

Muscular Dystrophy Association. 3300 East Sunrise Drive, Tucson, AZ 85718. (800) 572-1717. <http://www.mdausa.org>.

Richard Robinson

Tension headache

Definition

This most common type of **headache** is caused by severe muscle contractions triggered by **stress** or exertion. It affects as many as 90% of adult Americans.

Description

While most American adults get a tension headache from time to time, women and people with more education are slightly more likely to suffer with them. People who are so anxious that they grind their teeth or hunch their shoulders may find that the physical strain in their body can be experienced as **pain** and tension in the muscles of the neck and scalp, producing almost constant pain.

Causes and symptoms

Tension headaches are caused by tightening in the muscles of the face, neck and scalp because of stress or poor posture. They can last for days or weeks and can cause pain of varying intensity. The tightening muscles cause more expansion and constriction of blood vessels, which can make head pain worse. Eyestrain caused by dealing with a large amount of paperwork or reading can cause a tension headache as well.

Many people report tension headache pain as a kind of steady ache (as opposed to a throb) that forms a tight band around the forehead, affecting both sides of the head. Tension headaches usually occur in the front of the head, although they also may appear at the top or the back of the skull.

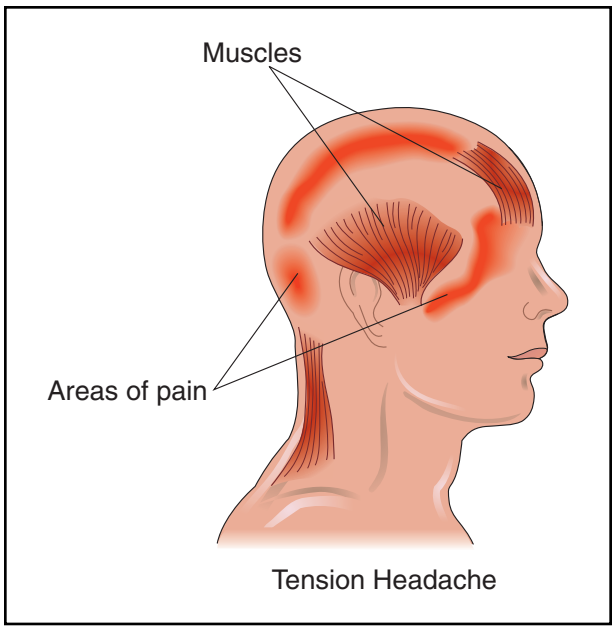
Tension headaches often begin in late afternoon and can last for several hours; they can occur every day and last throughout most of the day. When this happens, the headache is called a chronic tension headache. Unlike migraines, tension headaches don't cause **nausea and vomiting**, sensitivity to light, or any kind of aura before the headache begins.

Diagnosis

Diagnosis of tension headaches is made from a medical history, discussion of symptoms, and elimination of other types of headaches or underlying disorders.

Very few headaches are the sign of a serious underlying medical problem. However, sufferers should call a physician at once if they:

- have more than three headaches a week
- take painkillers almost every day
- need more than the recommended dose of painkiller
- have a stiff neck and/or **fever** in addition to headache
- are dizzy, unsteady, or have slurred speech, weakness, or numbness
- have confusion or drowsiness with the headache
- have headaches that began with a head injury
- have headaches triggered by bending, coughing or exertion
- have headaches that keep getting worse
- have severe vomiting with the headache
- had the first headache after age 50
- awaken with headache that gets better as the day goes on



Tension headache is the most common type of headache, caused by severe muscle contractions triggered by stress or exertion. Tension headaches usually occur in the front of the head, although they may also appear at the top or the back of the skull, as shown in the illustration above. *(Illustration by Electronic Illustrators Group.)*

Treatment

There are many different treatments for tension headaches, which respond well to both medication and massage. If these headaches become chronic, however, they are best treated by identifying the source of tension and stress and reducing or eliminating it.

Medication

Tension headaches usually respond very well to such over-the-counter medicines as **aspirin**, ibuprofen, or **acetaminophen**. However, some of these drugs (especially those that contain **caffeine**) may trigger rebound headaches if discontinued after they are taken for more than a few days.

More severe tension headaches may require combination medications, including a mild sedative such as butalbital; these should be used sparingly, though. Chronic tension headaches may respond to low-dose amitriptyline taken at night.

Massage

Massaging the tense muscle groups may help ease pain. Instead of directly massaging the temple, patients will get more relief from rubbing the neck and shoulders, because tension headaches can arise from tension in this area. In fact, relaxing the muscles of the neck can cut the intensity and duration of tension headaches at least in half.

To relax these muscles, the neck should be rotated from side to side as the shoulders shrug. Some people find that imagining a sense of warmth or heaviness in the neck muscles can help. Taking three very deep breaths at the first hint of tension can help prevent a headache.

Other therapy

If tension headaches are a symptom of either depression or **anxiety**, the underlying problem should be treated with counseling, medication, or a combination of both.

Alternative treatment

Eliminating the source of the tension as much as possible will help prevent tension headaches. **Acupuncture** may be helpful in treating some chronic tension headaches. Homeopathic remedies and botanical medicine can also help relieve tension headaches. Valerian (*Valeriana officinalis*), skullcap (*Scutellaria lateriflora*), and passionflower (*Passiflora incarnata*) are three herbal remedies that may be helpful. A tension headache can also be relieved by soaking the feet in hot water while an ice cold towel is wrapped around the neck.

Prognosis

Cutting down on stress and relying less on caffeine-containing medications can reduce the number of tension headaches for most people.

Prevention

Tension headaches can often be prevented by managing everyday stress and making some important lifestyle changes. Those who are prone to tension headaches should:

- take frequent "stress breaks"
- get regular exercise—even a brisk 15-minute walk can help prevent tension headaches
- get enough sleep
- release angry feelings

Resources

BOOKS

Rapoport, Alan M., and Fred Sheftell. *Headache Relief for Women*. Boston: Little, Brown and Co.,1996.

Robbins, Lawrence, and Susan S. Lang. *Headache Help*. New York: Houghton Mifflin, 1995.

Solomon, Seymour, and Steven Fraccaro. *The Headache Book*. New York: Consumer Reports Books, 1991.

PERIODICALS

Byfield, Ted. "Sock It to Headache Pain." *Body Bulletin* (1 Feb. 1996): 3.

Kleiman, Carol. "For Women, Success at Work Can Be a Tension Headache." *St. Louis Post-Dispatch*, 2 Apr. 1998, C8.

Munson, Marty, Therese Walsh, and Yun Lee. "On the Mark: Aim Low to Relieve Tension Headache." *Prevention Magazine*, 1 Jan. 1996, 24-25.

Rogers, June. "Your Aching Head." *Chatelaine* 69 (1 Aug. 1996): 47-50.

ORGANIZATIONS

American Council for Headache Education (ACHE). 19 Mantua Road, Mt. Royal, NJ 08061. (800) 255-2243. <http://www.achenet.org>.

National Headache Foundation. 428 W. St. James Place, Chicago, IL 60614. (800) 843-2256. <http://www.headaches.org>.

Carol A. Turkington

Terazosin *see* **Alpha$_1$-adrenergic blockers**

Testicular cancer

Definition

Testicular **cancer** is a disease in which cancer cells are discovered in one or both testicles. The testicles, also known as testes or gonads, are located in a pouch beneath the penis called the scrotum.

Description

The testicles make up one portion of the male reproductive system. Normally, they are each somewhat smaller than a golf ball in size and are contained within the scrotum. The testicles are a man's primary source of male hormones, particularly testosterone. They also produce sperm.

There are several types of cells contained in the testicles, and any of these may develop into one or more types of cancer. Over 90% of all testicular cancers begin in cells called germ cells. There are two main types of germ cell tumors in men: seminomas and nonseminomas. Seminomas make up about 40% of all testicular germ cell tumors. Nonseminomas make up a group of cancers, which include **choriocarcinoma**, yolk sac tumors, embryonal carcinoma, and teratoma.

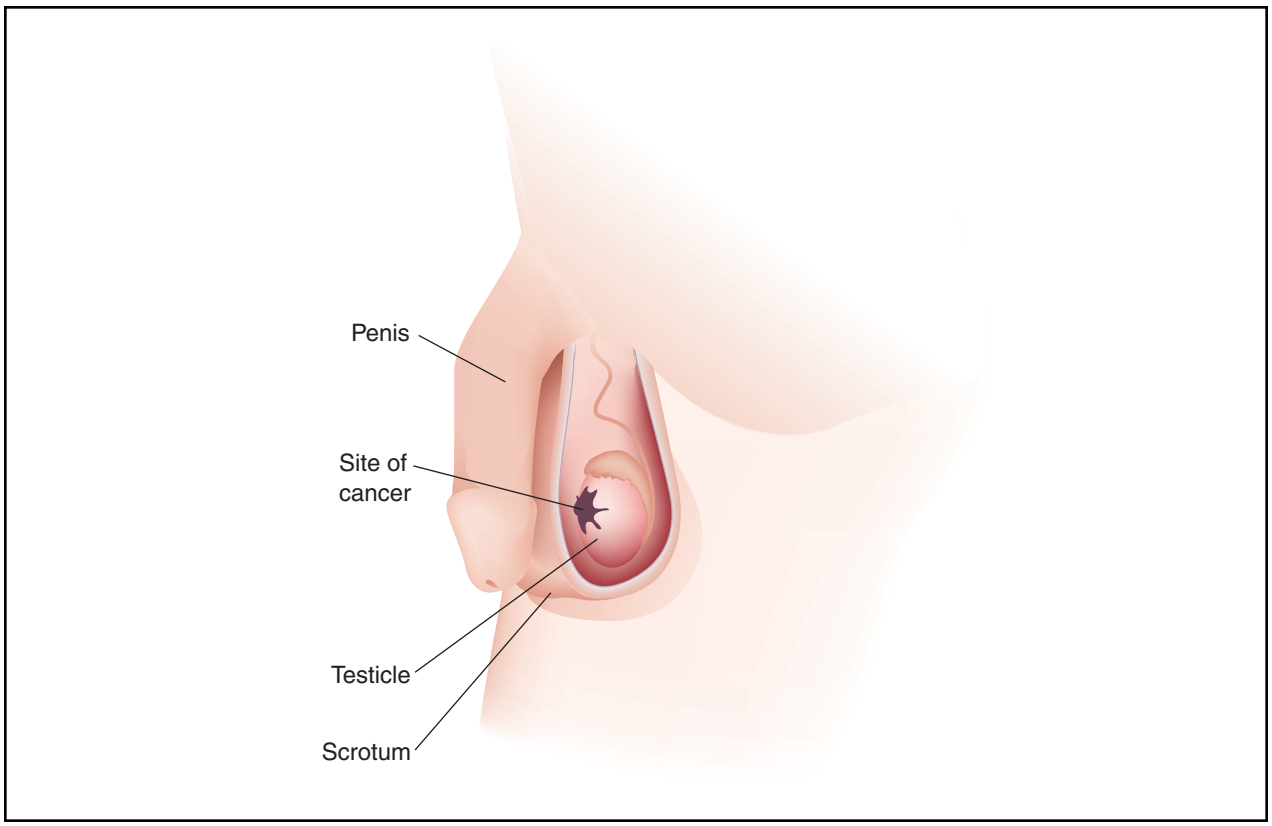
Although testicular cancer accounts for less then 2% of all cancers in men, it is the most commonly seen cancer in young men aged 15 to 35. It is also one of the most curable.

The American Cancer Society estimates that approximately 7,200 new cases of testicular cancer will be diagnosed in 2001. In addition, about 400 men will die of the disease during that year. Though the incidence of testicular cancer is rising, having doubled in the last 30 years, it is still rare. Scandinavian countries have the highest rate in the world. Germany and New Zealand also have high rates. The lowest incidences of testicular cancer are in Asia and Africa.

Causes and symptoms

The exact causes of testicular cancer are unknown. However, there is research showing that some men are more likely to acquire it than others. The risk for testicular cancer is much higher for boys born with one or both of their testicles located in the lower abdomen rather than in the scrotum. This condition is called cryptorchidism or undescended testicles. The lifetime risk of getting testicular cancer is four times higher for boys with cryptorchidism than the risk in the general population. This risk factor remains even if surgery is done to place the testicle back into the scrotum.

There are other risk factors as well. Men who have had abnormal development of their testicles are at increased risk, as are men with Klinefelter's syndrome (a disorder of the sex chromosomes). A family history of testicular cancer increases the possibility of getting the disease. Men infected with the human **immunodeficien-**



A cancerous growth on the testicle. *(Illustration by Argosy Inc.)*

cy virus (HIV), especially those with **AIDS**, have a higher incidence, as do infertile men. Certain testicular tumors appear more frequently among men who work in certain occupations, like miners, oil workers, and utility workers. There is no conclusive evidence that injuries to the testicles or environmental exposure to various chemicals cause the disease.

Testicular cancer usually shows no early symptoms. It is suspected when a mass or lump is felt in the testes, although a testicular mass does not always indicate cancer and is usually painless.

Symptoms:

- a lump in either testicle (usually pea-sized, but may be as large as a marble or an egg)
- any enlargement or significant shrinking of a testicle
- a sensation of heaviness in the scrotum
- a dull ache in the groin or lower abdomen
- any sudden collection of fluid in the scrotum
- tenderness or enlargement of the breasts
- pain or discomfort in a testicle or in the scrotum

Diagnosis

When a man exhibits symptoms that suggest a possibility of testicular cancer, several diagnostic steps will occur before a definitive diagnosis is made.

History and physical

The physician takes a personal and family medical history and a complete **physical examination** is performed. The doctor will examine the scrotum as well as the abdomen and other areas to check for additional masses.

Ultrasound

If a mass is found, the physician will likely have an ultrasound performed. Through the use of sound waves, ultrasounds can help visualize internal organs and may be useful in telling the difference between fluid-filled cysts and solid masses. If the tumor is solid, it is most likely cancerous.

Blood tests

Certain blood tests can be helpful in diagnosing some testicular tumors. **Tumor markers** are substances

often found in higher-than-normal amounts in cancer patients. Some testicular cancers secrete high levels of certain proteins such as alpha-fetoprotein (AFP), human chorionic gonadotropin (HCG), and enzymes like lactate dehydrogenase (LDH). These markers may help find a tumor that is too small to be felt during a physical examination. In addition, these tests are also helpful in determining how much cancer is actually present, and in evaluating the response to treatment to make sure the tumor has not returned.

Surgery

If a suspicious growth is found, a surgeon will need to remove the tumor and send it to the laboratory for testing. A pathologist examines the testicular tissue microscopically to determine whether cancer cells are present. If cancer cells are found, the pathologist sends back a report describing the type and extent of the cancer. In almost all cases, the surgeon removes the entire affected testicle through an incision in the groin, though not through the scrotum. This procedure is called radical inguinal orchiectomy.

Once testicular cancer is determined, further tests are necessary to find out if the cancer has metastasized (spread) to other parts of the body, and to ascertain the stage or extent of the disease. This information helps the doctor plan appropriate treatment. These tests may include computed tomography (CT scan), **lymphangiography** (x rays of the lymph system), bone scans, and chest x rays.

Treatment

Staging

One method the cancer treatment team uses to describe the scope of a patient's cancer is the use of a staging system. Testicular cancer is classified using the TNM system. However, in order to simplify and summarize this information, the TNM description can be grouped according to stages.

Stages of testicular cancer:

- Stage I. This stage refers to a cancer found only in the testicle, with no spread to the lymph nodes or to distant organs.
- Stage II. This indicates that the cancer has spread to the lymph nodes in the abdomen, but not to lymph nodes in other parts of the body.
- Stage III. In this stage, the cancer has spread beyond the lymph nodes in the abdomen, and/or the cancer is in parts of the body far away from the testicles, such as the lungs or the liver.
- Recurrent. Recurrent disease indicates that the cancer has come back after it has already been treated. Testicular cancer can come back in the same testicle (if it was not surgically removed) or in some other body part.

Treatment

The treatment decisions for testicular cancer are dependent on the stage and cell type of the disease, as well as the patient's age and overall health. The four kinds of treatment most commonly used are surgery, **radiation therapy**, **chemotherapy**, and bone marrow or stem cell transplantation.

Surgery is normally the first line of treatment for testicular cancer and involves the removal of the affected testicle. This procedure is known as a radical inguinal orchiectomy. Depending on the type and stage of the cancer, some lymph nodes may also be removed at the same time, or possibly in a second operation. This procedure is called a retroperitoneal lymph node dissection, and can be a major operation. Some patients will experience temporary complications after surgery, including infections and bowel obstruction. If both of the testicles are taken out, a man will have no ability to produce sperm cells and will become infertile (unable to father a child). Surgery removing the lymph nodes may cause some damage to nearby nerves, which may interfere with the ability to ejaculate. Men undergoing surgery for testicular cancer may wish to discuss nerve-sparing surgery with their doctor, as well as sperm banking.

Radiation therapy for testicular cancer is delivered from a machine and is known as external beam radiation. One potential problem with this type of radiation is that it can also destroy nearby healthy tissue as well as cancer cells. Other potential side effects include nausea, **diarrhea** and **fatigue**. A special device can be used to protect the unaffected testicle to preserve fertility.

Chemotherapy refers to the use of drugs in treating cancer. Since the drugs enter the bloodstream and circulate throughout the body, chemotherapy is considered a systemic treatment. The drugs primarily used in the treatment of testicular cancer are cisplatin, vinblastine, bleomycin, cyclophosphamide, etoposide, and ifosfamide. These drugs are given in various combinations, since the use of two or more drugs is considered more effective than using only one drug.

Since chemotherapy agents can affect normal as well as cancerous cells, several side effects are possible. These side effects include:

- **nausea and vomiting**
- changes in appetite
- hair loss (temporary)

- mouth sores
- increased risk of infections
- bleeding or bruising
- fatigue
- diarrhea or constipation

Several drugs are available to assist in treating these side effects, most of which will disappear after the treatment is completed. However, some of the chemotherapy agents used during treatment of testicular cancer may cause long-term side effects. These include **hearing loss**, nerve damage, and possible kidney or lung damage. Another potentially serious long-term complication is an increased risk of leukemia. This is a rare side effect, however, as it occurs in less than 1% of testicular cancer patients who receive chemotherapy. Chemotherapy may also interfere with sperm production. This may be permanent for some, but many will regain their fertility within a few years.

Studies are ongoing to determine whether high doses of chemotherapy combined with stem-cell transplantation will prove effective in treating some patients with advanced testicular cancer. In this treatment, blood-forming cells called stem cells are taken from the patient (either from the bone marrow or filtered out of the patient's blood). These cells are kept frozen while high-dose chemotherapy is administered. After receiving the chemotherapy, the patient is given the stem cells through an infusion. This treatment enables the use of extra large doses of chemotherapy that might increase the cure rate for some testicular cancers.

Preferred treatment plans by stage of disease

Stage I: Stage I seminomas are normally treated with a radical inguinal orchiectomy followed by radiation treatment aimed at the lymph nodes. More than 95% of Stage I seminomas are cured through this method. Another approach is to perform surgery only. Patients are then followed closely for several years with blood tests and imaging studies. If the cancer spreads later on, radiation or chemotherapy can still be used. Stage I non-seminomas are also highly curable with surgery, followed by one of three options. These options include the performance of a retroperitoneal lymph node dissection, two cycles of chemotherapy, or careful observation for several years.

Stage II: Stage II seminomas and non-seminomas are cured in 90% to 95% of the cases. For the purposes of treatment, stage II testicular cancers are classified as either bulky or nonbulky. Nonbulky seminomas (no lymph nodes can be felt in the abdomen) are treated with an orchiectomy followed by radiation to the lymph nodes. Men with bulky seminomas have surgery, which may be followed by either radiation or a course of chemotherapy. Nonbulky Stage II non-seminomas are treated with surgery and lymph node removal, with possible chemotherapy. Men with bulky disease have surgery followed by chemotherapy.

Stage III: Stage III seminomas and non-seminomas are treated with surgery followed by chemotherapy. This produces a cure in about 70% of the cases. Those who are not cured may be eligible to participate in clinical trials of other chemotherapy agents.

Recurrent: Treatment of recurrent testicular cancer is dependent upon the initial stage and the treatment given. This might include further surgery and chemotherapy. Many men whose disease comes back after chemotherapy are treated with high-dose chemotherapy followed by bone marrow or stem cell transplantation.

Alternative treatment

There are currently no scientifically proven alternative treatments known for testicular cancer. Nothing has been shown to be as successful as conventional treatment. However, some patients may find certain alternative or complementary treatments supportive while undergoing surgery, chemotherapy or radiation. For example, **meditation** and relaxation exercises may prove effective in reducing nausea and vomiting. Some dietary modifications and nutritional supplements may be helpful in assisting with recovery after surgery. The testicular cancer patient considering alternative treatments should talk it over with members of the cancer care team. They may be able to offer additional information.

Prevention

The main risk factors associated with testicular cancer—cryptorchidism, family history of the disease, and being Caucasian—are unavoidable since they are present at birth. In addition, many men diagnosed with the disease have no known risk factors. Because of these reasons, it is not possible to prevent most incidences of testicular cancer.

Resources

BOOKS

Nichols, Craig R., et al. "Neoplasms of the Testis." In *Cancer Medicine,* 5th ed. Hamilton, Ontario: American Cancer Society, 2000.

PERIODICALS

"Curable Cancer: Testicular Malignancies are Easy to Find and Treat. But You Have to be Willing to Probe a Bit." *Time* 154 (September 6, 1999): 85.

"Early Diagnosis is Key to Treatment." *USA Today Magazine* 129 (October 2000): 10.

KEY TERMS

Cryptorchidism—Occurs when a boy is born with one or both testicles in the lower abdomen rather than the scrotum. Known also as undescended testicles, it is the primary risk factor for testicular cancer.

Metastatic testicular cancer—Testicular cancer that has spread to other parts of the body.

Radical inguinal orchiectomy—Surgical procedure performed to remove one or both testicles. It is done via a groin incision.

Testicles—Also called testes or gonads, they are part of the male reproductive system, and are located beneath the penis in the scrotum.

Kirchner, Jeffrey T. "Family History as a Risk Factor For Testicular Cancer." *American Family Physician* 57 (March 15, 1998): 1419.

"Testicular Cancer—What to Look For." *American Family Physician* (May 1, 1998): 1.

ORGANIZATIONS

American Cancer Society. (800) ACS-2345.

National Cancer Institute. Cancer Information Service. (800) 4-CANCER.

OTHER

American Cancer Society Cancer Resource Center. (June 19, 2001). <http://www3.cancer.org/cancerinfo>.

Beeson, Dr. Debra. "Commentary: Testicular Cancer Commonly Seen in Younger Men." *Cancer News* (April 12, 2000). (June 19, 2001) <http://www.ontumor.com/cancernews_sm/testicular041200.htm>.

National Cancer Institute CancerNet. (June 19, 2001). <http://www.Cancernet.nci.nih.gov.>.

The Testicular Cancer Resource Center. (June 19, 2001). <http://www.acor.org/TCRC>.

Deanna Swartout-Corbeil, R.N.

Testicular scan *see* **Scrotal nuclear medicine scan**

Testicular self-examination

Definition

A testicular self-examination (TSE) is the procedure by which a man checks the appearance and consistency of his testes.

Purpose

Most testicular cancers are first noticed by the man himself. Men should do a TSE every month to find out if the testes contain any suspicious lumps or other irregularities, which could be signs of **cancer** or infection.

Precautions

None.

Description

A TSE should take place during a warm shower or bath, when the skin is warm, wet, and soapy. The man needs to step out of the tub so that he is in front of a mirror. The heat from the tub or shower will relax the scrotum (sac containing the testes) and the skin will be softer and thinner, making it easier to feel a lump. It is important that the exam be done very gently.

The man should stand facing his mirror and look for swelling on the scrotum. Using both hands, the scrotum should be gently lifted so that the area underneath can be checked.

The next step is the examination by hand. The index and middle fingers should be placed under each testicle, with the thumbs on top. The testes should be examined one at a time. The man should roll each testicle between his fingers and thumbs. He should feel for lumps of any size (even as small as a pea) particularly on the front or side of each testicle. He should also look for soreness or irregularities. Next, the epididymis and vas deferens, located on the top and back of the testes, should be felt. This area feels like a cord, and should not be tender.

Normal results

It is normal for one testicle to be larger than the other is, and for them to hang at different levels; but the size should stay the same from one month to the next. The testes should be free from lumps, **pain**, irregularities and swelling.

Abnormal results

A TSE is considered abnormal if any swelling, tenderness, lumps, or irregularities are found. Hard, unmoving lumps are abnormal, even if they are painless. A lump could be a sign of an infection or a cancerous tumor. A change in testicle size from one month to the next is also abnormal. A feeling of heaviness in the scrotum is another abnormal sign. If any abnormality is found, a man is encouraged to check with his doctor as soon as possible because **testicular cancer** is highly curable if found early.

KEY TERMS

Epididymis—A tube in the back of the testes that transports sperm.

Scrotum—The pouch containing the testes.

Testes—Egg-shaped male gonads located in the scrotum. Testes is the plural form of testis, which is a testicle.

Vas deferens—A tube that is a continuation of the epididymis. This tube transports sperm from the testis to the prostatic urethra.

Resources

BOOKS

Hainsworth, John D., and F. Anthony Greco. "Testis." In *Cancer Treatment,* 5th ed. edited by Charles M. Haskell. Philadelphia: W.B. Saunders, 2001.

Seidel, Henry M. et al. *Mosby's Guide to Physical Examination, 4th ed.* St. Louis: Mosby, Inc., 1999.

PERIODICALS

Schaffner, Robert J. "Knowledge of Testicular Self-exam." *Nurse Practitioner* 20 (August 1995): 10-11.

OTHER

"Questions and Answers About Testicular Cancer." Feb. 2000 *National Cancer Institute*. <http://cis.nci.nih.gov/fact/6_34.htm>.

Rhonda Cloos,, R.N.

Testicular sonogram *see* **Scrotal ultrasound**

Testicular surgery

Definition

Testicular surgery is any surgical operation on the testicles.

Purpose

Testicular surgery is used primarily to correct developmental defects, treat infection, and treat **cancer** of the testes.

Precautions

Testicular surgery, a group of surgical operations performed on the testicles, is considered major surgery. In all cases, except when the testes are being removed, care must be taken not to damage any of the nerves and blood vessels supplying the testes and associated organs.

Description

Testicular surgery is commonly performed for the following reasons: to reposition **undescended testes** (orchiopexy); to correct **testicular torsion**; to treat **testicular cancer**, which may involve removal of the testicles (castration) or the testes (orchiectomy); and to correct **intersex states**.

Undescended testes

Undescended testes are testes that have not dropped into the scrotum. During the fetal stage of development, the testes are not in the scrotum, but in the body. As male children age, the testes descend from the body to the scrotum for proper maturation and function. Undescended testes must be treated with surgery. There are two types of undescended testes, ectopic and cryptorchid. Ectopic testes are outside the normal route of descent. Cryptorchid testes are in the proper route of descent, but descent has been stopped before the testes reached the scrotum. The treatment for undescended testes is a surgical operation called orchiopexy, in which an incision allows the surgeon to reach the testes and pull them down into the scrotum. This operation is best done between the ages of one and two; otherwise, the testes are unlikely to mature normally. If the patient has one normal testis and one poorly developed testis, the undeveloped testis is usually removed.

Testicular torsion

Testicular torsion is a developmental defect in the tissues of the scrotum that allows the testes to rotate within the scrotum. This results in the blood vessels around other tubes in the scrotum to become wrapped around each other, resulting in blood supply to the testes bring cut off. Torsion disease is seen in young boys. **Pain**, nausea, and scrotal swelling are the main symptoms. When torsion is suspected, immediate surgery is recommended. An incision is made in the scrotum, and the blood vessels and other tissues are untangled. During surgery, the testes are examined to determine their condition. If they have received enough blood to remain viable, the testes are surgically attached to scrotal tissue to prevent twisting from recurring. If the testes do not regain a healthy pink color after the blood vessels have been untangled, then it is best to remove the testes. The lack of a pink color indicates that the testes have been without blood for too long a time period, and are dead tissue. Unless removed, they will turn necrotic and cause further harm to the body. Usually, testicular torsion

occurs in only one testis. However, because the other testicle has similar anatomy, it too is subject to torsion. During surgery, the other testicle is attached to scrotal tissue to prevent torsion from occurring.

Cancer

Carcinoma of the testes is cancer in the testicles. For males between ages 20–35, carcinoma of the testes is the second most common cancer. It accounts for 1–2% of all cancers in all males. There are many kinds of cancer that can affect the testes. A mass of tissue that is suspected to be cancer should be removed surgically. It is recommended that a biopsy not be performed, but that the physician proceed directly to surgery. Biopsies have not proven to be better at diagnosing cancer of the testicles than exploratory surgery. If the presence of cancer is confirmed during exploratory surgery, surgical excision of the cancer can be performed immediately.

The approach to the cancer during the operation depends on the location of the tissue mass. The two main approaches are through the scrotum and through the groin (inguinal region). The amount of tissue removed is variable and depends on the amount of cancerous tissue and the location. However, if a solid lesion is confirmed within a testis, a radical orchiectomy should be performed. A radical orchiectomy is a complete removal of one or both testes and associated lymphatic tissue. Other tumors allow partial removal of a testis. After surgery, the tumor is examined to determine the type of tumor for use as a guide in followup therapy.

Castration is the surgical removal of the testicles. Castration is performed as a cancer therapy, to reduce the amount of testosterone being produced, and as part of treatment for **prostate cancer**. In castration, an incision is made through one or both sides of the scrotum, depending on whether one or both testicles are being removed.

Intersex states

Intersex states are a group of developmental diseases in which the patient has parts of both male and female genitalia. In testicular feminization syndrome, the patient appears to be a female and will have female genitalia but has internal testes. The internal testes are undescended. Genetic studies show that the person was to be a male. This form of intersex is also called male pseudohermaphroditism. There are a number of different causes of this condition. These patients produce the male hormone testosterone. Treatment consists of surgical removal of the internal testes, and the administration of the hormone estrogen, which produces female characteristics. Failure to remove the testes is associated with a higher rate of cancer in these patients.

KEY TERMS

Biopsy—Removing tissue to test it for disease.

Lesion—An injury in the body tissue, such as a wound, sore, rash, or boil.

Orchiectomy—Surgical removal of one or both testes.

Orchiopexy—Surgical fixation of one or both testes.

Testes—The pair of male reproductive glands enclosed in the scrotum that produce the male sex hormone testosterone and the spermatozoa. The singular form is testis.

Testicles—The testes along with their enclosing structures.

Preparation

About one hour before receiving general anesthesia, the patient will get a shot that dries up internal fluids and makes him sleepy. Presurgical counseling is often recommended for patients whose reproductive abilities will be compromised by their surgeries.

Aftercare

A patient who has had a testicle removed should visit his physician once a month for the first year and every other month for the second year, with periodic followups thereafter.

Risks

Testicular surgery, like any major surgery, can have postoperative complications. These complications include internal bleeding and wound infection, as well as adverse reactions to anesthesia.

Normal results

Undescended testes are pulled down into their correct position and mature normally. In testicular torsion, the affected testis either regains its healthy pink color and is attached to the surrounding tissue with sutures, or it is removed along with any dead tissue surrounding it. (So long as only one testis is removed, sexual function and fertility will not be affected.) Successful surgery for cancer results in the removal of malignant tissue.

Resources

BOOKS

Bentz, M. L. *Pediatric Plastic Surgery.* Stamford: Appleton & Lange, 1998.
Hurst, J. Willis. *Medicine for the Practicing Physician.* Stamford: Appleton & Lange, 1988.
Sabiston, D. C., and H. K. Lyerly. *Essentials of Surgery.* Philadelphia: W. B. Saunders Co., 1994.

Testicular torsion

Definition

Testicular torsion is the twisting of a testis (testicle) on its connection.

Description

The testes are suspended in the scrotum by a single bundle of tissues that also carries the blood supply to and from the testes. If the testicle rotates, the bundle kinks, and the blood supply is shut off. The resulting situation is an emergency because the testis will die within hours if the blood supply is not restored.

Causes and symptoms

Some testes hang in such a way that they twist more easily than others. Nearly all torsions happen to adolescent males—between the ages of 12 and 18—because their testes enlarge by a factor of five to six during **puberty**. A larger testis is more likely to twist. Torsion can also occur in a newborn.

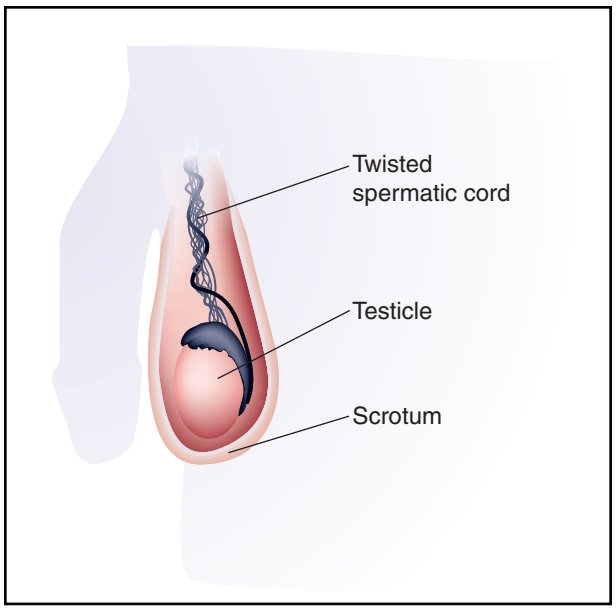
Symptoms of testicular torsion are sudden severe **pain** in the scrotum, swelling, **nausea and vomiting**.

Diagnosis

A nuclear scan of the scrotum may be performed. In this procedure, a tiny amount of radioactive fluid is injected into the blood and detected as it flows through the scrotum and testicles. Torsion is indicated if the radioactive fluid does not flow through the sore testis. Ultrasound scan accompanied by a contrast agent can also be used to diagnose testicular torsion.

Treatment

Surgery must be performed within 24 hours to ensure the health of the affected testis. During the procedure, the surgeon untwists the cord and secures the testis in place so that it cannot rotate again. The other testicle should also be secured to deter future testicular torsion. This procedure is called orchiopexy.



A rare condition, testicular torsion occurs when the spermatic cord is twisted and cuts off the blood supply to the testicle. *(Illustration by Argosy Inc.)*

KEY TERMS

Orchiopexy—The surgical securing of the testis to prevent torsion.

Scrotum—The bag of skin below the penis that contains the testes.

Prognosis

If the torsion is relieved within 24 hours, the testis will recover normal blood flow and function.

Prevention

Torsion of the unaffected testis is prevented by securing it during the surgery to correct the twisted testis.

Resources

BOOKS

Rajfer, Jacob. "Congenital Anomalies of the Testes and Scrotum." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Rozauski, Thomas, et al. "Surgery of the Scrotum and Testis in Children." In *Campbell's Urology.* ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.
Walsh, Patrick C., et al., ed. *Campbell's Urology.* Philadelphia: W. B. Saunders Co., 1998.

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Testicular ultrasound *see* **Scrotal ultrasound**

Testicular x ray *see* **Scrotal nuclear medicine scan**

Testosterone test *see* **Sex hormones tests**

Tetanus

Definition

Tetanus is a rare but often fatal disease that affects the central nervous system by causing painful muscular contractions. It begins when tetanus bacteria enter the body, usually through a wound or cut exposed to contaminated soil. Tetanus is easily preventable through **vaccination**.

Description

Tetanus is rare in the United States, with nearly all cases occurring in adults who were not vaccinated as children. About 100 cases are reported each year; 63% of these occur in people over the age of 50. The number of tetanus cases in the United States has steadily decreased since the 1940s (500 to 600 cases per year); the number of reported cases has remained at approximately 50 to 100 cases per year since the mid-1970s. In 1999, however, the lowest number of annual cases to date was reported (33, or 0.02 per 100,000).

Tetanus causes convulsive muscle spasms and rigidity that can lead to respiratory **paralysis** and **death**. It is sometimes called "lockjaw" because one of the most common symptoms is a stiff jaw, unable to be opened. Sometimes, tetanus affects only the part of the body where the infection began, but in almost all of reported cases, it spreads to the entire body. The incubation period from the time of the injury until the first symptoms appear ranges from two to 50 days. Symptoms usually occur within five to 10 days. When symptoms occur early, the chance of death is increased. Tetanus is not contagious.

Causes and symptoms

Tetanus is caused by a bacteria called *Clostridium tetani,* whose spores (the dormant form) are found in soil, street dust, and animal (or even human) feces. Tetanus spores germinate in the body, producing a highly poisonous neurotoxin in the blood, spreading to the nervous system. The infection is usually transmitted through deep puncture **wounds** or cuts or scratches that are not cleaned well. Between 1997 and 1999, approximately 64% of tetanus cases in the United States were associated with such wounds as punctures, lacerations, or abrasions. Many people associate tetanus with rusty nails and other dirty objects, but any wound can be a source. Less common ways of getting tetanus are animal scratches and bites, surgical wounds, dental work, and therapeutic abortion. About 18% of cases reported between 1997 and 1999 were a result of intravenous drug use. Cases have also been reported in people with no known wound or medical condition.

The first symptom of tetanus is often a stiff or "locked" jaw that prevents the patient from opening his/her mouth or swallowing. This is also called trismus and results in a facial expression called a sardonic smile (or risus sardonicus). Stiffness of the neck and other muscles throughout the body and uncontrollable spasms often follow. Sometimes these convulsions are severe enough to cause broken bones. The bacterial toxin (*tetanospasmin*) affects the nerve endings, causing a continuous stimulation of muscles. Other symptoms include irritability, restlessness, loss of appetite, and drooling. People with tetanus that is localized experience **pain** and tingling only at the wound site and spasms in nearby muscles.

In the underdeveloped world, neonatal tetanus accounts for about one-half of tetanus deaths and is related to infection of the umbilical stump in a baby born of an unimmunized mother. The Centers for Disease Control and Prevention (CDC) estimate that over 270,000 deaths occur annually worldwide as a result of neonatal tetanus. In contrast, only two cases of neonatal tetanus in the United States were reported to the CDC between 1989 and 1999. Mothers who have been adequately immunized against tetanus protect their newborns by passing the antibody through the placenta.

Diagnosis

Tetanus is diagnosed by the clinical symptoms and a medical history that shows no tetanus immunization. Early diagnosis and treatment is crucial to recovery from tetanus.

Treatment

Tetanus is a life-threatening disease that requires immediate hospitalization, usually in an intensive care unit (ICU). Treatment can take several weeks and includes **antibiotics** to kill the bacteria and shots of anti-

toxin to neutralize the toxin. It also includes muscle-relaxing drugs to control muscle spasms or **barbiturates** for **sedation**. In severe cases, patients are placed on an artificial respirator. Recovery can take six weeks or more. After recovery, since the levels of circulating toxin are too low to stimulate natural antibody production, the patient must still be immunized against this disease to prevent reinfection.

Prognosis

Up to 30% of tetanus victims in the United States die. Early diagnosis and treatment improves the prognosis. Neonatal tetanus has a mortality rate of more than 90%.

Prevention

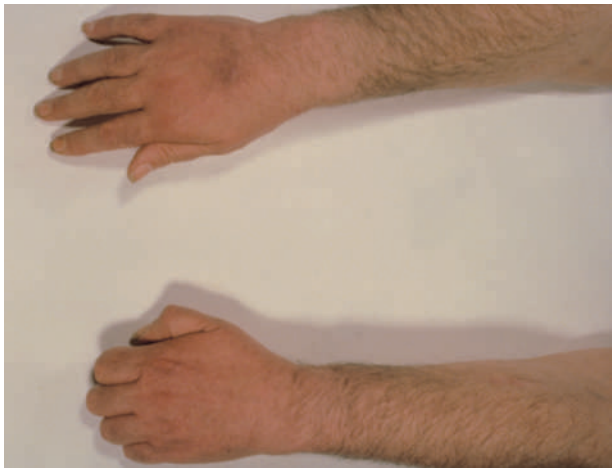
Pre-exposure vaccination

Tetanus is easily preventable through vaccination. All children should have a series of five doses of DTaP, a combined vaccine that offers protection against **diphtheria**, tetanus, and pertussis, before the age of seven, according to the Centers for Disease Control and Prevention's national immunization guidelines, the Advisory Committee on Immunization Practices, the Committee on Infectious Diseases of the American Academy of Pediatrics, and the American Academy of Family Physicians. Children will not be admitted to school without proof of this and other immunizations.

The DTaP (diptheria, tetanus, accellular pertussis) vaccine should be given at ages two months, four months, six months, 15 to 18 months, and four to six years. DTaP is the preferred vaccine for children up to the age of seven in the United States; it has fewer side effects than DTP and can be used to complete a vaccination schedule begun with DTP. DTaP was first approved by the Food and Drug Administration (FDA) in September 1996. In December 1996, it was approved for use in infants. Between the ages of 11 and 13, children should have a booster for diphtheria and tetanus, called Td.

Adults should have a Td booster every 10 years. Statistics from the Centers for Disease Control and Prevention (CDC) show that fewer than half of Americans 60 years of age and older have antibodies against tetanus. The CDC suggests adults may be revaccinated at mid-decade birthdays (for example, 45, 55). Adults who have never been vaccinated against tetanus should get a series of three injections of Td over six to 12 months and then follow the 10-year booster shot schedule.

Side effects of the tetanus vaccine are minor: soreness, redness, or swelling at the site of the injection that appear anytime from a few hours to two days after the vaccination and go away in a day or two. Rare but serious side effects that require immediate treatment by a doctor are serious allergic reactions or deep, aching pain and muscle wasting in the upper arms. These symptoms could start from two days to four weeks after the shot and could continue for months.



One characteristic of tetanus bacillus is the recurrent contracture of a muscle. Here, the patient's left hand is affected. *(Custom Medical Stock Photo. Reproduced by permission.)*

In early 2001, a shortage of the tetanus vaccine became evident after the pharmaceutical company Wyeth-Ayerst Laboratories decided to stop production of the tetanus vaccine, leaving Aventis-Pasteur as the sole manufacturer of the vaccine. As a result, hospitals were provided with only a minimal amount of the drug on a weekly basis—enough to vaccinate patients with potentially infected wounds and other priority cases. Despite stepped-up production efforts on the part of the manufacturer, however, a spokesperson for Aventis-Pasteur predicted that the shortage would last until the end of 2001, as the vaccine takes 11 months to produce.

Post-exposure care

Keeping wounds and scratches clean is important in preventing infection. Since this organism grows only in the absence of oxygen, wounds must be adequately cleaned of dead tissue and foreign substances. Run cool water over the wound and wash it with a mild soap. Dry it with a clean cloth or sterile gauze. To help prevent infection, apply an antibiotic cream or ointment and cover the wound with a bandage. The longer a wound takes to heal, the greater the chance of infection. If the wound doesn't heal, or if it is red, warm, drains, or swells, consult a doctor.

Following a wound, to produce rapid levels of circulating antibody, a doctor may administer a specific antitoxin (human tetanus immune globulin, TIG) if the individual

KEY TERMS

Clostridium—A genus of deadly bacteria that are responsible for tetanus and other serious diseases, including botulism and gangrene from war wounds. Clostridia thrive without oxygen.

DTaP—Diphtheria and tetanus toxoids and acellular pertussis combination vaccine.

DTP— Diphtheria, tetanus, and whole-cell pertussis vaccine.

Td—Tetanus and diphtheria vaccine.

Toxin—A poisonous substance that flows through the body.

Wound—Any injury that breaks the skin, including cuts, scratches, and puncture wounds.

does not have an adequate history of immunization. The antitoxin is given at the same sitting as a dose of vaccine but at separate sites. Some individuals will report a history of significant allergy to "tetanus shots." In most cases, this occurred in the remote past and was probably due to the previous use of antitoxin derived from horse serum.

Resources

PERIODICALS

"Have You Had Your Shots Yet?" *Tufts University Health & Nutrition Newsletter* (August 1997): 4.

Landers, Susan J. "Tetanus vaccine shortage leads to rationing." *American Medical News*. <http://www.ama-assn.org/sci-pubs/amnews/pick_01/hlsb0319.htm>. (19 March 2001).

Zamalu, Evelyn. "Adults Need Tetanus Shots, Too." *FDA Consumer* (July/August 1996): 14-18.

OTHER

"Childhood Infections: Tetanus." The Nemours Foundation of the duPont Hospital for Children and the Nemours Children's Clinic. <http://www.KidsHealth.org>. (10 December 1997).

"Shots for Safety." National Institute on Aging Age Page. <http://www.nih.gov/nia/health/pubpub/shots.htm>. (7 December 1997).

"Taking Care of Cuts, Scrapes, and Minor Wounds: What Mom May Not Have Told You." Mayo Health Oasis. <http://www.mayo.ivi.com>. (9 December 1997).

"Tetanus." Centers for Disease Control and Prevention. <http://www.cdc.gov/nip/publications/pink/tetanus.pdf>.

"Tetanus & Diphtheria (Td) Vaccine." Centers for Disease Control and Prevention. <http://www.healthtouch.com/level1/leaflets/cdc181.htm>. (10 December 1997).

Lori De Milto

Tetracyclines

Definition

Tetracyclines are medicines that kill certain infection-causing microorganisms.

Purpose

Tetracyclines are called "broad-spectrum" **antibiotics**, because they can be used to treat a wide variety of infections. Physicians may prescribe these drugs to treat eye infections, **pneumonia**, **gonorrhea**, **Rocky Mountain spotted fever**, urinary tract infections, and other infections caused by bacteria. The medicine is also used to treat **acne**. The tetracyclines will *not* work for colds, flu, and other infections caused by viruses.

Description

Tetracyclines are available only with a physician's prescription. They are sold in capsule, tablet, liquid, and injectable forms. Some commonly used medicines in this group are tetracycline (Achromycin V, Sumycin) and doxycycline (Doryx, Vibramycin).

Recommended dosage

The recommended dosage depends on the type of tetracycline, its strength, and the type and severity of infection for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

To make sure the infection clears up completely, take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve.

Tetracyclines work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses.

This medicine works best when taken on an empty stomach, with a full glass of water. The water will help prevent irritation of the stomach and esophagus (the tube-like structure that runs from the throat to the stomach). If the medicine still causes stomach upset, it may be necessary to take it with food. However, tetracyclines should *never* be taken with milk or milk products, as these may prevent the medicine from working properly. Do not drink or eat milk or dairy products within one to two hours of taking tetracyclines (except doxycycline and minocycline).

Precautions

Taking outdated tetracyclines can cause serious side effects. Do not take this medicine if:

- its color, appearance, or taste have changed
- it has been stored in a warm or damp area
- the expiration date on its label has passed flush any such medicine down the toilet, if there is any question about whether the medicine is still good, check with a physician or pharmacist

Do not take **antacids**, calcium supplements, salicylates such as Magan or Trilisate, magnesium-containing **laxatives**, or sodium bicarbonate (baking soda) within one to two hours of taking tetracyclines.

Do not take any medicines that contain iron (including multivitamin and mineral supplements) within two to three hours of taking tetracyclines.

Some people feel dizzy when taking these drugs. The medicine may also cause blurred vision. Because of these possible effects, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Birth control pills may not work properly while tetracyclines are being taken. To prevent **pregnancy**, use alternative methods of birth control while taking tetracyclines.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this medicine, avoid being in direct sunlight, especially between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use tanning beds, tanning booths, or sunlamps. The sensitivity to sunlight and sunlamps may continue for two weeks to several months after stopping the medicine, so continue to be careful about sun exposure.

Tetracyclines may permanently discolor the teeth of people who took the medicine in childhood. The drugs may also slow down the growth of children's bones. Do not give tetracyclines to infants or children under 8 years of age unless directed to do so by the child's physician.

Special conditions

People with certain medical conditions or who are taking certain other medicines may have problems if they take tetracyclines. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to tetracyclines in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Pregnant women should not take tetracyclines during the last half of pregnancy. These drugs can prevent the baby's bones and teeth from developing properly and can cause the baby's adult teeth to be permanently discolored. The medicine can also cause liver problems in pregnant women.

BREASTFEEDING. Women who are breastfeeding should not take tetracyclines. The drugs pass into breast milk and can affect the nursing baby's teeth and bones. They may also make the baby more sensitive to sunlight and may increase its risk of fungal infections.

OTHER MEDICAL CONDITIONS. Before using tetracyclines, people with any of these medical problems should make sure their physicians are aware of their conditions:

- diabetes
- liver disease
- kidney disease

USE OF CERTAIN MEDICINES. Taking tetracyclines with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are stomach cramps or a burning sensation in the stomach, mild **diarrhea**, nausea, or vomiting. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as sore mouth or tongue and **itching** of the rectal or genital areas also may occur and do not need medical attention unless they do not go away or they are bothersome.

Other rare side effects may occur. Anyone who has unusual symptoms during or after treatment with tetracyclines should get in touch with his or her physician.

Interactions

Tetracyclines may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes tetracyclines should let the physician know all other medicines he or she is taking. Among the drugs that may interact with tetracyclines are:

- antacids

KEY TERMS

Gonorrhea—A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

Microorganism—An organism that is too small to be seen with the naked eye.

Rocky Mountain spotted fever—An infectious disease that is caused by a microorganism and spread by ticks. High fever, muscle pain, and spots on the skin are among the symptoms.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

- calcium supplements
- medicines that contain iron (including multivitamin and mineral supplements)
- laxatives that contain magnesium
- cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid)
- salicylates such as Magan and Trilisate
- penicillins
- birth control pills

Nancy Ross-Flanigan

Tetralogy of Fallot

Definition

Tetralogy of Fallot is a common syndrome of congenital heart defects.

Description

The heart is two pumps in one. The ventricle on the left side pumps blood full of oxygen through the body; the ventricle on the right side pumps the same blood through the pulmonary artery to the lungs to take up oxygen. The left ventricle operates at pressures about four times as high as the right ventricle. Blood is supposed to flow through one side, then the other.

Tetralogy of Fallot is a condition that is characterized by several congenital heart defects occurring at once. They include:

KEY TERMS

Aorta—Main arterial trunk that moves blood from the heart to the arteries, which transport the blood throughout the body.

Cyanosis—Blue-colored skin due to oxygen-deficient blood.

Endocarditis—Inflammation of the lining of the heart.

Infarct—Death of tissue due to shutting off the blood supply.

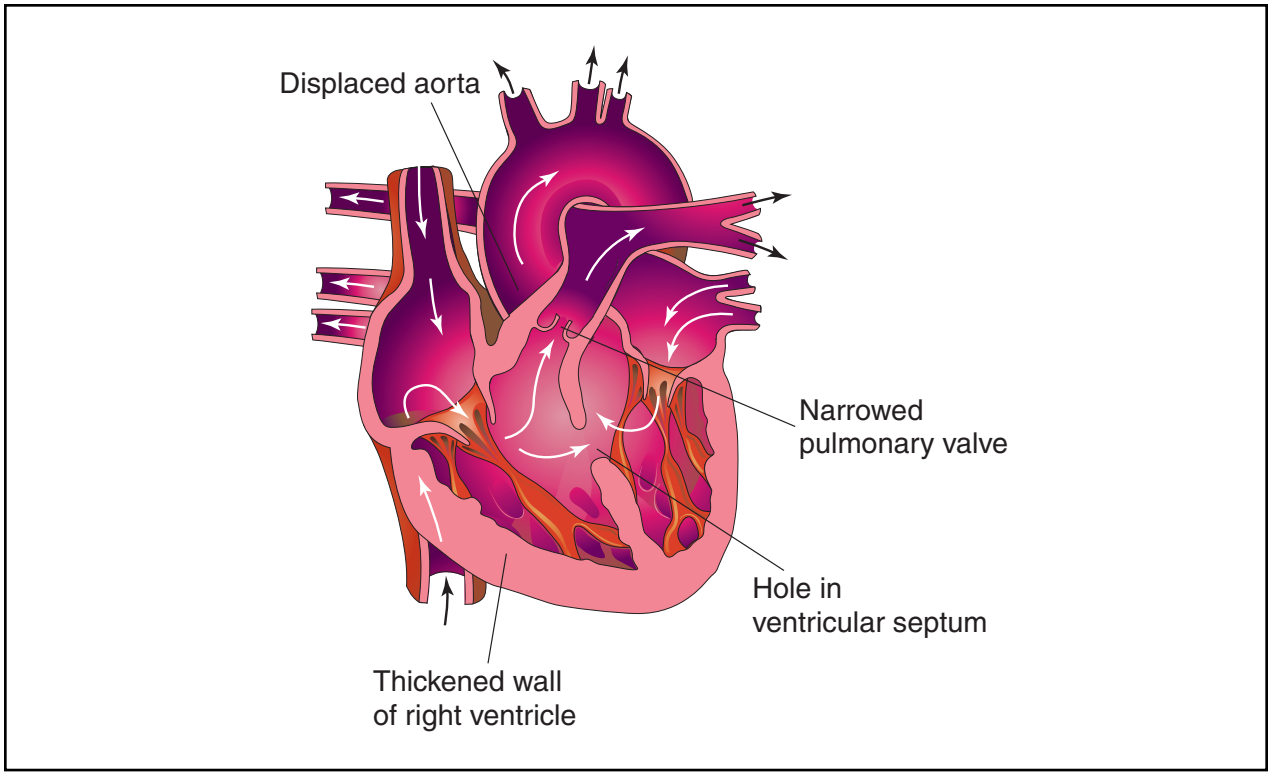
Septicemia—Blood poisoning.

Systemic circulation—Through the body, as opposed to "pulmonary"—through the lungs.

Ventricles—The muscular chambers of the heart that do the pumping.

- **ventricular septal defect** (Abnormal passageway between the right and left ventricles)
- displaced aorta
- narrowed pulmonary valve
- thickened right ventricle wall

Each defect acts in combination with the others to create a malfunction of the heart. The problem starts very early in the uterus with a narrowed pulmonary valve and a hole between the ventricles. This is not particularly a problem for a fetus because hardly any blood flows through the lungs until birth. It is only after birth that the defects pose a problem. The blood that is supposed to start flowing through the lungs cannot easily get there because of the narrowed valve; however, the hole between the ventricles remains open. Because of the opening between ventricles, much of the blood that comes back to the heart needing oxygen is sent out without being properly oxygenated. In addition, the right heart has to pump at the same pressure as the left side. Several changes follow. First, the baby turns blue (cyanotic) because of the deoxygenated blood that bypasses the lungs. Deoxygenated blood is darker and appears blue through the skin. Second, the right side of the heart (ventricle) hypertrophies (gets more muscular) from the extra **exercise** demanded of it. Next, the low oxygen causes the blood to get thicker and clot more easily. Clots in the veins can now pass through the hole in the heart and directly enter the aorta, where they can do much more damage than in the lungs—such as causing infarcts in the brain. In addition, these anomalies make the lining of the heart more suscep-



Tetralogy of Fallot is a common syndrome of congenital heart defects. This condition, present *in utero,* is caused by the narrowing of the pulmonary artery and a hole between the ventricles. When the baby is born and begins to breathe on its own, the baby turns cyanotic, or blue, due to the deoxygenated blood that bypasses the lungs because of the narrowed pathway and because the hole between the ventricles has remained open. *(Illustration by Electronic Illustrators Group.)*

tible to infection—endocarditis— which can damage valves and lead to blood **poisoning** (septicemia).

Causes and symptoms

Tetralogy of Fallot is a congenital defect with unknown causes.

Babies with tetralogy of Fallot are blue at birth (**cyanosis**). Sometimes the blue color appears only when they cry. They also have detectable **heart murmurs**. Infants with mild forms can have surgery postponed until they are older. Infants with more severe symptoms often have attacks of worsened cyanosis. During attacks, they turn very blue, have **shortness of breath**, and can faint. This usually occurs during heightened activity, such as crying.

Diagnosis

A complete evaluation of the circulation is required, including testing the blood for its oxygen content, ultrasound and x rays of the heart accompanied by a contrast agent to determine the amount of blood flowing in the wrong direction. A search for other **birth defects** is also necessary, because they tend to happen together.

Treatment

Correction of the defects are done through surgery. Surgery must be carefully timed with attention to the progression of the disease process, the size of the infant, and the size of the various defects. There are temporary surgical procedures that can prolong the time before corrective surgery while the baby grows larger and stronger.

During surgery, the pulmonary valve is widened, the ventricular septal defect is closed, and any interim corrections removed.

Prognosis

Surgical correction has a high rate of success, returning the child to near-normal health.

Resources

BOOKS

Friedman, William F., and John S. Child. "Congenital Heart Disease in the Adult." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Nelson Textbook of Pediatrics. Ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

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Thalassemia

Definition

Thalassemia describes a group of inherited disorders characterized by reduced or absent amounts of hemoglobin, the oxygen-carrying protein inside the red blood cells. There are two basic groups of thalassemia disorders: alpha thalassemia and beta thalassemia. These conditions cause varying degrees of anemia, which can range from insignificant to life threatening.

Description

All types of thalassemias are considered *quantitative* diseases of hemoglobin, because the quantity of hemoglobin produced is reduced or absent. Usual adult hemoglobin is made up of three components: alpha globin, beta globin, and heme. Thalassemias are classified according to the globin that is affected, hence the names *alpha* and *beta* thalassemia. Although both classes of thalassemia affect the same protein, the alpha and beta thalassemias are distinct diseases that affect the body in different ways.

Beta thalassemia

Beta thalassemia may be the best-known type of thalassemia and is also called Cooley's anemia. It is caused by a change in the gene for the beta globin component of hemoglobin. Beta thalassemia causes variable anemia that can range from moderate to severe, depending in part on the exact genetic change underlying the disease. Beta thalassemia can be classified based on clinical symptoms. *Beta thalassemia major* usually causes severe anemia that can occur within months after birth. If left untreated, severe anemia can result in insufficient growth and development, as well as other characteristic physical complications that can lead to a dramatically decreased life-expectancy. Fortunately, in developed countries beta thalassemia is usually identified by screening in the newborn period, before symptoms have developed. Children who are identified early can be started on ongoing blood **transfusion** therapy as needed. Although transfusion therapy prevents many of the complications of severe anemia, the body is unable to eliminate the excess iron contained in the transfused blood. Over time, this excess iron deposits in tissues and organs, resulting in damage and organ failure. Another medication must be administered to help the body eliminate the excess iron and prevent iron-overload complications. *Beta thalassemia intermedia* describes the disease in individuals who have moderate anemia that only requires blood transfusions intermittently, if at all.

Alpha thalassemia

Alpha thalassemia is the result of changes in the genes for the alpha globin component of hemoglobin. There are two main types of alpha thalassemia disease: hemoglobin H disease and alpha thalassemia major. The two diseases are quite different from beta thalassemia as well as from one another. Individuals with hemoglobin H disease can experience events of hemolytic anemia—anemia caused by the rapid breakdown of the red blood cells. These events are thought to be triggered by various environmental causes, such as infection and/or exposure to certain chemicals. Hemoglobin H disease is in most cases milder than beta thalassemia. It does not generally require transfusion therapy. *Alpha thalassemia major* is a very serious disease that results in severe anemia that begins even before birth. Most affected babies do not survive to be born or die shortly after birth.

The thalassemias are among the most common genetic diseases worldwide. Both alpha and beta thalassemia have been described in individuals of almost every ancestry, but the conditions are more common among certain ethnic groups. Unaffected carriers of all types of thalassemia traits do not experience health problems. In fact, the thalassemia trait is protective against **malaria**, a disease caused by blood-borne parasites transmitted through mosquito bites. According to a widely accepted theory, most genetic changes—mutations—that cause thalassemia occurred multiple generations ago. Coincidentally, these mutations increased the likelihood that carriers would survive malaria infection. Survivors passed the mutation onto their offspring, and the trait became established throughout areas where malaria is common. As populations migrated, so did the thalassemia traits.

Beta thalassemia trait is seen most commonly in people with the following ancestry: Mediterranean (including North African, and particularly Italian and Greek), Middle Eastern, Indian, African, Chinese, and Southeast Asian (including Vietnamese, Laotian, Thai, Singaporean, Filipino, Cambodian, Malaysian, Burmese, and Indonesian). Alpha-thalassemia trait is seen with increased frequency in the same ethnic groups. However, there are different types of alpha thalassemia traits within these populations. The frequency of hemoglobin H disease and alpha thalassemia major depends on the type of

alpha thalassemia trait. The populations in which alpha thalassemia diseases are most common include Southeast Asians and Chinese (particularly Southern Chinese).

It is difficult to obtain accurate prevalence figures for various types of thalassemia within different populations. This difficulty arises due to testing limitations in determining exact genetic diagnoses, as well as the fact that many studies have focused on small, biased hospital populations.

Two studies reflect prevalence figures that can be helpful counseling families and determining who to screen for beta thalassemia. Between the years of 1990 and 1996, the State of California screened over 3.1 million infants born in this multiethnic state for beta thalassemia. Approximately one in 114,000 infants had beta thalassemia major, with prevalence rates being highest among Asian Indians (about one in 4,000), Southeast Asians (about one in 10,000), and Middle Easterners (about one in 7,000). Another type of beta thalassemia disease, E/beta thalassemia, was represented in approximately one in 110,000 births, all of which occurred in families of Southeast Asian ancestry. Among Southeast Asians, the prevalence of E/beta thalassemia was approximately one in 2,600 births. This is in keeping with the observation that hemoglobin E trait carrier rates are relatively high within the Southeast Asian population: 16% in a study of 768 immigrants to California, and up to 25% in some specific Southeast Asian populations such as Cambodians. While these California studies address some of the limitations of earlier population studies, the pattern observed in California is expected to be different in other areas of the United States and the world. For example, Italians are underrepresented in this population when compared to the population of the East Coast of the United States.

Determining prevalence figures for alpha thalassemia is even more difficult due to increased limitations in diagnostic testing. All types of alpha thalassemia disease are most common among people of Southeast Asian and Chinese descent, for reasons that become clearer with an understanding of the underlying genetics of alpha thalassemia. One study of 500 pregnant women in Northern Thailand estimated a frequency of one in 500 pregnancies affected by alpha thalassemia major, for example. Prevalence of alpha thalassemia disease is significantly lower in the United States owing primarily to immigration patterns; although at least one state, California, has observed growing hemoglobin H disease incidence rates that are high enough to justify universal newborn screening for the condition.

Causes

Genetics

Humans normally make several types of the oxygen-carrying protein hemoglobin. An individual's stage in development determines whether he or she makes primarily embryonic, fetal, or adult hemoglobins. All types of hemoglobin are made of three components: heme, alpha (or alpha-like) globin, and beta (or beta-like) globin. All types of thalassemia are caused by changes in either the alpha- or beta-globin gene. These changes cause little or no globin to be produced. The thalassemias are, therefore, considered *quantitative* hemoglobin diseases. All types of thalassemias are recessively inherited, meaning that a genetic change must be inherited from both the mother and the father. The severity of the disease is influenced by the exact thalassemia mutations inherited, as well as other genetic and environmental factors. There are rare exceptions, notably with beta thalassemia, where globin gene mutations exhibit a dominant pattern of inheritance in which only one gene needs to be altered in order to see disease expression.

BETA-THALASSEMIA. Most individuals have two normal copies of the beta globin gene, which is located on chromosome 11 and makes the beta globin component of normal adult hemoglobin, hemoglobin A. There are approximately 100 genetic mutations that have been described that cause beta thalassemia, designated as either beta0 or beta+ mutations. No beta globin is produced with a beta0 mutation, and only a small fraction of the normal amount of beta globin is produced with a beta+ mutation.

When an individual has one normal beta globin gene and one with a beta thalassemia mutation, he or she is said to carry the beta thalassemia trait. Beta thalassemia trait, like other hemoglobin traits, is protective against malaria infection. Trait status is generally thought not to cause health problems, although some women with beta thalassemia trait may have an increased tendency toward anemia during **pregnancy**.

When two members of a couple carry the beta thalassemia trait, there is a 25% chance that each of their children will inherit beta thalassemia disease by inheriting two beta thalassemia mutations, one from each parent. The clinical severity of the beta thalassemia disease—whether an individual has beta thalassemia intermedia or beta thalassemia major—will depend largely on whether the mutations inherited are beta0 thalassemia or beta+ thalassemia mutations. Two beta0 mutations generally lead to beta thalassemia major, and two beta+ thalassemia mutations generally lead to beta thalassemia intermedia. Inheritance of one beta0 and one beta+ thalassemia mutation tends to be less predictable.

Although relatively uncommon, there are other thalassemia-like mutations that can affect the beta globin gene. Hemoglobin E is the result of a substitution of a single nucleotide. This change results in a structurally

altered hemoglobin that is produced in decreased amounts. Therefore, hemoglobin E is unique in that it is both a quantitative (i.e. thalassemia-like) and qualitative trait. When co-inherited with a beta thalassemia trait, it causes a disease that is almost indistinguishable from beta thalassemia disease. Large deletions around and including the beta globin gene can lead to delta/beta thalassemia or hereditary persistence of fetal hemoglobin (HPFH). Interestingly, delta/beta thalassemia trait behaves very similar to beta thalassemia trait in its clinical manisfestations. However, HPFH trait does not tend to cause hemoglobin disease when co-inherited with a second thalassemia or other beta globin mutation.

ALPHA-THALASSEMIA. Most individuals have four normal copies of the alpha globin gene, two copies on each chromosome 16. These genes make the alpha globin component of normal adult hemoglobin, which is called hemoglobin A. Alpha globin is also a component of fetal hemoglobin and the other major adult hemoglobin called hemoglobin A2. Mutations of the alpha globin genes are usually deletions of the gene, resulting in absent production of alpha globin. Since there are four genes (instead of the usual two) to consider when looking at alpha globin gene inheritance, there are several alpha globin types that are possible.

Absence of one alpha globin gene leads to a condition known as silent alpha thalassemia trait. This condition causes no health problems and can be detected only by special **genetic testing**. Alpha thalassemia trait occurs when two alpha globin genes are missing. This can occur in two ways. The genes may be deleted from the same chromosome, causing the 'cis' type of alpha thalassemia trait. Alternately, they may be deleted from different chromosomes, causing the 'trans' type of alpha thalassemia trait. In both instances, there are no associated health problems, although the trait status may be detected by more routine blood screening.

Hemoglobin H disease results from the deletion of three alpha globin genes, such that there is only one functioning gene. Typically, this can occur when one parent carries the silent alpha thalassemia trait, and the other parent carries the 'cis' type of the alpha thalassemia trait. In this situation, there is a 25% chance for hemoglobin H disease in each of such a couple's children.

Hemoglobin H disease-like symptoms can also be a part of a unique condition called *alpha thalassemia mental retardation syndrome*. Alpha thalassemia **mental retardation** syndrome can be caused by a deletion of a significant amount of chromosome 16, affecting the alpha globin genes. This is usually not inherited, but rather occurs sporadically in the affected individual. Affected individuals have mild hemoglobin H disease, mild-to-moderate mental retardation, and characteristic facial features. This syndrome can also occur as a sex-linked form in which a mutation is inherited in a particular gene on the X-chromosome. This gene influences alpha globin production, as well as various other developmental processes. Individuals affected with this form of the syndrome tend to have more severe mental retardation, delayed development, nearly absent speech, characteristic facial features, and genital-urinary abnormalities. The remaining discussion will focus only on aspects of hemoglobin H disease.

Alpha thalassemia major results from the deletion of all four alpha globin genes, such that there are no functioning alpha globin genes. This can occur when both parents carry the 'cis' type of the alpha thalassemia trait. In this situation, there is a 25% chance for alpha thalassemia major in each of such a couple's children.

Symptoms

Beta thalassemia

Beta thalassemia major is characterized by severe anemia that can begin months after birth. In the United States and other developed countries beta thalassemia is identified and treated early and effectively. Therefore, the following discussion of symptoms applies primarily to affected individuals in the past and unfortunately in some underdeveloped countries now. If untreated, beta thalassemia major can lead to severe lethargy, paleness, and growth and developmental delay. The body attempts to compensate by producing more blood, which is made inside the bones in the marrow. However, this is ineffective without the needed genetic instructions to make enough functioning hemoglobin. Instead, obvious bone expansion and changes occur that cause characteristic facial and other changes in appearance, as well as increased risk of **fractures**. Severe anemia taxes other organs in the body—such as the heart, spleen, and liver—which must work harder than usual. This can lead to **heart failure**, as well as enlargement and other problems of the liver and spleen. When untreated, beta thalassemia major generally results in childhood **death,** usually due to heart failure. Fortunately, in developed countries diagnosis is usually made early, often before symptoms have begun. This allows for treatment with blood transfusion therapy, which can prevent most of the complications of the severe anemia caused by beta thalassemia major. Individuals with beta thalassemia intermedia have a more moderate anemia that may only require treatment with transfusion intermittently, such as when infections occur and stress the body. As a person with beta thalassemia intermedia gets older, however, the need for blood transfusions may increase to the point that

KEY TERMS

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Bilirubin—A yellow pigment that is the end result of hemoglobin breakdown. This pigment is metabolized in the liver and excreted from the body through the bile. Bloodstream levels are normally low; however, extensive red cell destruction leads to excessive bilirubin formation and jaundice.

Bone marrow—A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

Bone marrow transplantation—A medical procedure used to treat some diseases that arise from defective blood cell formation in the bone marrow. Healthy bone marrow is extracted from a donor to replace the marrow in an ailing individual. Proteins on the surface of bone marrow cells must be identical or very closely matched between a donor and the recipient.

Desferoxamine—The primary drug used in iron chelation therapy. It aids in counteracting the life-threatening buildup of iron in the body associated with long-term blood transfusions.

Globin—One of the component protein molecules found in hemoglobin. Normal adult hemoglobin has a pair each of alpha-globin and beta-globin molecules.

Heme—The iron-containing molecule in hemoglobin that serves as the site for oxygen binding.

Hemoglobin—Protein-iron compound in the blood that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hemoglobin A—Normal adult hemoglobin that contains a heme molecule, two alpha-globin molecules, and two beta-globin molecules.

Hemoglobin electrophoresis—A laboratory test that separates molecules based on their size, shape, or electrical charge.

Hepatomegaly—An abnormally large liver.

HLA type—Refers to the unique set of proteins called human leukocyte antigens. These proteins are present on each individual's cell and allow the immune system to recognize 'self' from 'foreign'. HLA type is particularly important in organ and tissue transplantation.

Hydroxyurea—A drug that has been shown to induce production of fetal hemoglobin. Fetal hemoglobin has a pair of gamma-globin molecules in place of the typical beta-globins of adult hemoglobin. Higher-than-normal levels of fetal hemoglobin can ameliorate some of the symptoms of thalassemia.

Iron overload—A side effect of frequent blood transfusions in which the body accumulates abnormally high levels of iron. Iron deposits can form in organs, particularly the heart, and cause life-threatening damage.

Jaundice—Yellowing of the skin or eyes due to excess of bilirubin in the blood.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Placenta—The organ responsible for oxygen and nutrition exchange between a pregnant mother and her developing baby.

Red blood cell—Hemoglobin-containing blood cells that transport oxygen from the lungs to tissues. In the tissues, the red blood cells exchange their oxygen for carbon dioxide, which is brought back to the lungs to be exhaled.

Screening—Process through which carriers of a trait may be identified within a population.

Splenomegaly—Enlargement of the spleen.

they are required on a regular basis. When this occurs their disease becomes more similar to beta thalassemia major. Other genetic and environmental factors can influence the course of the disease as well. For example, co-inheritance of one or two alpha thalassemia mutations can tend to ameliorate some of the symptoms of beta thalassemia disease, which result in part from an imbalance in the amount of alpha- and beta-globin present in the red blood cells.

Hemoglobin H disease

Absence of three alpha globin genes causes an imbalance of alpha and beta globin proteins in the red blood cells. The excess beta globin proteins tend to come together to form hemoglobin H, which is unable to release oxygen to the tissues. In addition, hemoglobin H tends to precipitate out in the cells, causing damage to the red blood cell membrane. When affected individuals are exposed to certain drugs and chemicals known to make the membrane more fragile, the cells are thought to become vulnerable to breakdown in large numbers, a complication called **hemolytic anemia**. **Fever** and infection are also considered to be triggers of hemolytic anemia in hemoglobin H disease. This can result in **fatigue**, paleness, and a yellow discoloration of the skin and whites of eyes called **jaundice**. Usually, the anemia is mild enough not to require treatment. Severe anemia events may require blood transfusion, however, and are usually accompanied by such other symptoms as dark feces or urine and abdominal or back **pain**. These events are uncommon in hemoglobin H disease, although they occur more frequently in a more serious type of hemoglobin H disease called hemoglobin H/Constant Spring disease. Individuals effected with this type of hemoglobin H disease are also more likely to have enlargement of and other problems with the spleen.

Alpha thalassemia major

Because alpha globin is a necessary component of all major hemoglobins and some minor hemoglobins, absence of all functioning alpha globin genes leads to serious medical consequences that begin even before birth. Affected fetuses develop severe anemia as early as the first trimester of pregnancy. The placenta, heart, liver, spleen, and adrenal glands may all become enlarged. Fluid can begin collecting throughout the body as early as the start of the second trimester, causing damage to developing tissues and organs. Growth retardation is also common. Affected fetuses usually miscarry or die shortly after birth. In addition, women carrying affected fetuses are at increased risk of developing complications of pregnancy and delivery. Up to 80% of such women develop toxemia, a disturbance of metabolism that can potentially lead to convulsions and **coma**. Other maternal complications include premature delivery and increased rates of delivery by **cesarean section**, as well as hemorrhage after delivery.

Diagnosis

Thalassemia may be suspected if an individual shows signs that are suggestive of the disease. In all cases, however, laboratory diagnosis is essential to confirm the exact diagnosis and to allow for the provision of accurate **genetic counseling** about recurrence risks and testing options for parents and affected individuals. Screening is likewise recommended to determine trait status for individuals of high-risk ethnic groups.

The following tests are used to screen for thalassemia disease and/or trait:

- complete blood count
- **hemoglobin electrophoresis** with quantitative hemoglobin A2 and hemoglobin F
- free erythrocyte-protoporphyrin (or ferritin or other studies of serum iron levels)

A *complete blood count* will identify low levels of hemoglobin, small red blood cells, and other red blood cell abnormalities that are characteristic of a thalassemia diagnosis. Since thalassemia trait can sometimes be difficult to distinguish from iron deficiency, tests to evaluate iron levels are important. A *hemoglobin electrophoresis* is a test that can help identify the types and quantities of hemoglobin made by an individual. This test uses an electric field applied across a slab of gel-like material. Hemoglobins migrate through this gel at various rates and to specific locations, depending on their size, shape, and electrical charge. *Isoelectric focusing* and *high-performance liquid chromatography (HPLC)* use similar principles to separate hemoglobins and can be used instead of or in various combinations with hemoglobin electrophoresis to determine the types and quantities of hemoglobin present. Hemoglobin electrophoresis results are usually within the normal range for all types of alpha thalassemia. However, hemoglobin A2 levels and sometimes hemoglobin F levels are elevated when beta thalassemia disease or trait is present. Hemoglobin electrophoresis can also detect structurally abnormal hemoglobins that may be co-inherited with a thalassemia trait to cause thalassemia disease (i.e., hemoglobin E) or other types of hemoglobin disease (i.e., sickle hemoglobin). Sometimes DNA testing is needed in addition to the above screening tests. This can be performed to help confirm the diagnosis and establish the exact genetic type of thalassemia.

Diagnosis of thalassemia can occur under various circumstances and at various ages. Several states offer thalassemia screening as part of the usual battery of blood

tests done for newborns. This allows for early identification and treatment. Thalassemia can be identified before birth through the use of prenatal diagnosis. **Chorionic villus sampling** (CVS) can be offered as early as 10 weeks of pregnancy and involves removing a sample of the placenta made by the baby and testing the cells. CVS carries a risk of causing a **miscarriage** that is between 0.5%–1%. **Amniocentesis** is generally offered between 15 and 22 weeks of pregnancy, but can sometimes be offered earlier. Two to three tablespoons of the fluid surrounding the baby is removed. This fluid contains fetal cells that can be tested. The risk of miscarriage associated with amniocentesis ranges from 0.33–0.5%. Pregnant woman and couples may choose prenatal testing in order to prepare for the birth of a baby that may have thalassemia. Alternately, knowing the diagnosis during pregnancy allows for the option of pregnancy termination. Preimplantation genetic diagnosis (PGD) is a relatively new technique that involves in-vitro fertilization followed by genetic testing of one cell from each developing embryo. Only the embryos unaffected by **sickle cell disease** are transferred back into the uterus. PGD is currently available on a research basis only and is relatively expensive.

Treatment

Beta Thalassemia

Individuals with beta thalassemia major receive regular blood transfusions, usually on a monthly basis. This helps prevent severe anemia and allow for more normal growth and development. Transfusion therapy does have limitations, however. Individuals can develop reactions to certain proteins in the blood—called a transfusion reaction. This can make locating appropriately matched donor blood more difficult. Although blood supplies in the United States are very safe, particularly relative to the past and to other areas of the world, there remains an increased risk of exposure to such blood-borne infections as hepatitis. Additionally, the body is not able to get rid of the excess iron that accompanies each transfusion. An additional medication called desferoxamine is administered, usually five nights per week over a period of several hours, using an automatic pump that can be used during sleep or taken anywhere the person goes. This medication is able to bind to the excess iron, which can then be eliminated through urine. If desferoxamine is not used regularly or is unavailable, iron overload can develop and cause tissue damage and organ damage and failure. The heart, liver, and endocrine organs are particularly vulnerable. Desferoxamine itself may rarely produce allergic or toxic side effects, including hearing damage. Signs of desferoxamine toxicity are screened for and generally develop in individuals who overuse the medication when body iron levels are sufficiently low. Overall, however, transfusion and desferoxamine therapy have increased the life expectancy of individuals with the most severe types of beta thalassemia major to the 4th or 5th decade. This can be expected to improve with time and increased developments in treatment, as well as for those with more mild forms of the disease.

New treatments offer additional options for some individuals with beta thalassemia major. There are various medications that target the production of red blood cells (i.e. erythropoeitin) or fetal hemoglobin (i.e. hydroxyurea and butyrate). Their effectiveness in ameliorating the severity of beta thalassemia is currently being investigated. Another promising new treatment is **bone marrow transplantation**, in which the bone marrow of an affected individual is replaced with the bone marrow of an unaffected donor. If successful, this treatment can provide a cure. However, there is an approximately 10-15% chance the procedure could be unsuccessful (i.e. the thalassemia returns); result in complications (i.e. graft-versus-host disease); or result in death. The risk for specific individuals depends on current health status, age, and other factors. Because of the risks involved and the fact that beta thalassemia is a treatable condition, transplant physicians require a brother or sister donor who has an identically matched tissue type, called HLA type. HLA type refers to the unique set of proteins present on each individual's cells, which allows the immune system to recognize "self" from "foreign." HLA type is genetically determined, so there is a 25% chance for two siblings to be a match. Transplant physicians and researchers are also investigating ways to improve the safety and effectiveness of bone marrow transplantation. Using newborn sibling umbilical cord blood—the blood from the placenta that is otherwise discarded after birth but contains cells that can go on to make bone marrow—seems to provide a safer and perhaps more effective source of donor cells. Donors and recipients may not have to be perfect HLA matches for a successful transplant using cord blood cells. Trials are also underway to determine the effectiveness of "partial transplants," in which a safer transplant procedure is used to replace only a percentage of the affected individual's bone marrow. Other possible treatments on the horizon may include **gene therapy** techniques aimed at increasing the amount of normal hemoglobin the body is able to make.

Hemoglobin H disease

Hemoglobin H disease is a relatively mild form of thalassemia that may go unrecognized. It is not generally considered a condition that will reduce one's life expectancy. Education is an important part of managing the health of an individual with hemoglobin H disease. It is important to be able to recognize the signs of severe

anemia that require medical attention. It is also important to be aware of the medications, chemicals, and other exposures to avoid due to the theoretical risk they pose of causing a severe anemia event. When severe anemia occurs, it is treated with blood transfusion therapy. For individuals with hemoglobin H disease, this is rarely required. For those with the hemoglobin H/Constant Spring form of the disease, the need for transfusions may be intermittent or ongoing, perhaps on a monthly basis and requiring desferoxamine treatment. Individuals with this more severe form of the disease may also have an increased chance of requiring removal of an enlarged and/or overactive spleen.

Alpha thalassemia major

Because alpha thalassemia major is most often a condition that is fatal in the prenatal or newborn period, treatment has previously been focused on identifying affected pregnancies in order to provide appropriate management to reduce potential maternal complications. Pregnancy termination provides one form of management. Increased prenatal surveillance and early treatment of maternal complications is an approach that is appropriate for mothers who wish to continue their pregnancy with the knowledge that the baby will most likely not survive. In recent years, there have been a handful of infants with this condition who have survived long-term. Most of these infants received experimental treatment including transfusions before birth, early delivery, and even bone marrow transplantation before birth, although the latter procedure has not yet been successful. For those infants that survive to delivery, there seems to be an increased risk of developmental problems and physical effects, particularly heart and genital malformations. Otherwise, their medical outlook is similar to a child with beta thalassemia major, with the important exception that ongoing, lifelong blood transfusions begin right at birth.

Prognosis

As discussed above, the prognosis for individuals with the most serious types of thalassemia has improved drastically in the last several years following recent medical advances in transfusion, chemo-, and transplantation therapy. Advances continue and promise to improve the life expectancy and quality of life further for affected individuals.

Resources

BOOKS

Cohen, A., et. al. *Cooley's Anemia: Progress in Biology and Medicine*. National Heart, Lung, and Blood Institute, 1995.

Stamatoyannopoulos, G., et. al., eds. *The Molecular Basis of Blood Diseases*. 2nd ed. Philadelphia: W.B. Saunders, 1994, pp. 176-177.

Weatherall, D.J. "The Thalassemias." In *Williams Hematology,* edited by Ernest Beutler, et al. 5th ed. New York: McGraw-Hill, 1995.

Weatherall, D.J., et al."The Hemoglobinopathies." In *The Metabolic and Molecular Bases of Inherited Disease,* edited by Charles R. Scriver, et al. 7th ed. New York: McGraw-Hill, 1995.

PERIODICALS

Collins, A.F., et. al. "Oral Sodium Phenlybutyrate Therapy in Homozygous Beta Thalassemia: A Clinical Trial." *Blood* 85, no.1 (1995): 43-49.

Dumars, K.W., et. al. "Practical Guide to the Diagnosis of Thalassemia." *American Journal of Medical Genetics* 62 (1996): 29-37.

Fucharoen, S., et. al. "Hydroxyurea Increases Hemoglobin F Levels and Improves the Effectiveness of Erythropoiesis in Beta-thalassemia/Hemoglobin E Disease." *Blood* 87, no. 3 (1996): 887-892.

Giardini, Claudio. "Treatment of ß-thalassemia." *Current Opinion in Hematology* 4 (1997): 79.

Glader, B.E., and K.A. Look. "Hematologic Disorders in Children from Southeast Asia." *Pediatric Hematology* 43, no.3 (1996): 665-681.

Lorey, F., et al. "Distribution of Hemoglobinopathy Variants by Ethnicity in a Multiethnic State." *Genetic Epidemiology* 13(1996): 501-512.

Olivieri, N.F., and G.M. Brittenham. "Iron-Chelating Therapy and the Treatment of Thalassemia." *Blood* 89, no. 3 (1997): 739-761.

Styles, L.A., et al. "Hemoglobin H-Constant Spring Disease: An Underrecognized, Severe Form of Alpha Thalassemia." *International Journal of Pediatric Hematology/Oncology* 4(1997): 69-74.

Weatherall, D.J. "The Thalassemias." *British Medical Journal* 314 (June 7, 1997): 1675.

Wilkie, A.O.M., et al. "Clinical Features and Molecular Analysis of the Alpha Thalassemia/Mental Retardation Syndromes: Cases Due to Deletions Involving Chromosome Band 16p13.3." *American Journal of Human Genetics* 46 (1990): 1112-1126.

Wilkie, A.O.M., et al. "Clinical Features and Molecular Analysis of the Alpha Thalassemia/Mental Retardation Syndromes: Cases Without Detectable Abnormality of the Alpha Globin Complex." *American Journal of Human Genetics* 46 (1990): 1127-1140.

Zeng, Y., et al. "Hydroxyurea Therapy in Beta-thalassemia Intermedia; Improvement in Haematological Parameters Due to Enhanced Beta-globin Synthesis." *British Journal of Haematology* 90 (1995): 557-563.

ORGANIZATIONS

Children's Blood Foundation. 333 East 38th St., Room 830, New York, NY 10016-2745. (212) 297-4336. <cfg@nyh.med.cornell.edu>.

Cooley's Anemia Foundation, Inc. 129-09 26th Ave. #203, Flushing, NY 11354. (800) 522-7222 or (718) 321-2873. <http://www.thalassemia.org>.
March of Dimes Birth Defects Foundation. 1275 Mamaroneck Ave., White Plains, NY 10605. (888) 663-4637. <resourcecenter@modimes.org>. <http://www.modimes.org>.
National Heart, Lung, and Blood Institute. PO Box 30105, Bethesda, MD 20824-0105. (301) 592-8573. <nhlbiinfo@rover.nhlbi.nih.gov. <http://www.nhlbi.nih.gov>.
National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

OTHER

"Alpha-thalassemia Mental Retardation Syndrome, Nondeletion Type." *Online Mendelian Inheritance of Man*. <http://www.ncbi.nlm.nih.gov/entrez/dispomim.cgi?id=301040>. (1998).
Children's Hospital Oakland, Northern California Comprehensive Thalassemia Center website. <http://www.thalassemia.com>.
Cooley's Anemia Foundation, Inc. website. <http://www.thalassemia.org/gohome.html>.
Joint Center for Sickle Cell and Thalassemic Disorders website. <http://cancer.mgh.harvard.edu/medOnc/sickle.htm>.

OTHER

Bojanowski J. "Alpha Thalassemia Major: The Possibility of Long-Term Survival." Pamphlet from the Northern California Comprehensive Thalassemia Center. (1999).

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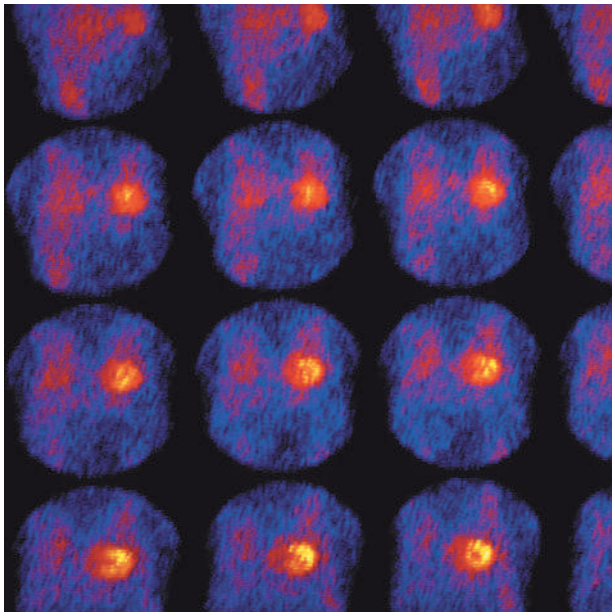
Thallium heart scan

Definition

A thallium heart scan is a test using a special camera and a small amount of radioactive substance injected into the bloodstream to make an image of the blood flow to the heart.

Purpose

A thallium heart scan is used to evaluate the blood supply to the heart muscle. It can identify areas of the heart that may have a poor blood supply as a result of damage from a previous **heart attack** or blocked coronary arteries. While **exercise** testing has long been a standard examination in the diagnosis of **coronary artery disease**, in some cases, the thallium scan may be more sensitive and more specific in the information it provides. In other words, the test may be better able to detect a problem and to differentiate one condition from another. A thallium heart scan may more accurately detect ischemic heart disease. This type of scan is most likely to be helpful in cases in which the exercise test is inconclusive, the patient cannot exercise adequately, or a quantitative evaluation of blood flow is required. In addition to evaluating coronary artery disease, thallium scanning can help to evaluate blood flow following treatment of clogged arteries with **coronary artery bypass graft surgery** or **angioplasty**.



A thallium scan showing many images of a human heart with cold spots. *(Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

Radioisotopes such as thallium 201 should not be administered during **pregnancy** because they may be harmful to the fetus.

Description

The thallium scan is performed in conjunction with an exercise **stress test**. At the end of the **stress** test (once the patient has reached the highest level of exercise he or she can comfortably achieve), a small amount of the harmless radioisotope thallium 201 is injected into the patient's bloodstream through an intravenous (IV) line. The patient then lies down under a special camera called a gamma scintillation camera, which makes photographs from the gamma rays emitted by the thallium.

The thallium attaches itself to the red blood cells and is carried throughout the body in the bloodstream. It enters the heart muscle by way of the coronary arteries and collects in the cells of the heart muscle that come into contact with the blood. Since the thallium can reach only those areas of the heart with an adequate blood supply, no thallium will show up in poorly perfused areas of the heart (perfusion defects). These areas show up as "cold spots" on the thallium scan. The patient may then be given a second injection of thallium. Several hours later, the gamma scintillation camera takes more pictures in order to get an image of the heart when the patient is at rest.

Cold spots that appear at rest as well as during exercise often indicate areas where the heart tissue has been damaged (for example, as a result of a prior heart attack). Sometimes perfusion is adequate during rest but cold spots appear during exercise, when the heart has to work harder and has a greater demand for blood. This can indicate some blockage in the coronary arteries, producing a condition called **ischemia**. In ischemia, the heart temporarily does not get enough blood flow. People with perfusion defects, especially perfusion defects that appear only during exercise, have the greatest risk of such future cardiac events as heart attacks.

In recent years, there have been improvements in heart scanning. Many centers now use a single photon emission computed tomographic (SPECT) camera, which provides a clearer image. Some centers also use a type of radioactive chemical called sestamibi. Sestamibi is used along with a radioactive compound called technetium. While thallium may still be better for some uses, such as providing a better image of the heart muscle itself, sestamibi may produce clearer images in overweight patients and is more useful in assessing how well the heart pumps blood.

If the patient is unable to exercise because of another medical condition, such as arthritis, he or she may be given a drug to mimic the effects of exercise on the heart. Some of these drugs include dipyridamole (Persantine), which dilates the coronary arteries; and dobutamine, which increases blood flow through the heart muscle.

Preparation

Patients should not drink alcoholic or caffeinated beverages, smoke tobacco, or ingest other nicotine products for 24 hours before the test. These substances can affect test results. Patients should also not eat anything for at least three hours before the test. They may also be instructed to stop taking certain medications during the test that may interfere with test results.

KEY TERMS

Angioplasty—The reconstruction of damaged blood vessels.

Coronary bypass surgery—Surgery in which a section of blood vessel is used to bypass a blocked coronary artery and restore an adequate blood supply to the heart muscle.

Perfusion—The passage of fluid (such as blood) through a specific organ or area of the body (such as the heart).

Radioisotope—A radioactive form of a chemical element, which is used in medicine for therapeutic or diagnostic purposes.

Aftercare

In some cases, another set of scans may be needed, and the patient may be given special instructions regarding eating and test preparation. Otherwise, the patient is free to return to his or her normal daily activities.

Risks

Radioisotopes such as thallium 201 should not be administered during pregnancy because they may be harmful to the fetus.

Normal results

A normal thallium scan shows healthy blood flow through the coronary arteries and normal perfusion of the heart muscle, without cold spots, both at rest and during exercise.

Abnormal results

Cold spots on the scan, where no thallium shows up, indicate areas of the heart that are not getting an adequate supply of blood. Cold spots appearing both at rest and during exercise may indicate areas where the heart tissue has been damaged. However, "reversible" cold spots appearing only during exercise usually indicate some blockage of the coronary arteries.

Resources

BOOKS

"Myocardial Perfusion Scan." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

PERIODICALS

Christian, T. F., et al. "Exercise Tomographic Thallium-201 Imaging in Patients with Severe Coronary Artery Disease and Normal Electrocardiograms." *Annals of Internal Medicine* 121 (1 Dec. 1994): 825-832.

Rivitz, S. Mitchell, and Salvatore A. DeLuca. "Perfusion Imaging in Ischemic Heart Disease." *American Family Physician* 48 (1 Nov. 1993): 1071- 1078.

Simon, Harvey B., ed. "Cardiac Stress Testing: New Variations on an Old Theme." *Harvard Men's Health Watch* 1, no. 8 (Mar. 1997): 1-4.

Wiley Jr., John P. "Phenomena, Comment and Notes." *Smithsonian* (Oct. 1995): 28-31.

Zabel, M. K., and R. M. Califf. "The Value of Exercise Thallium Imaging." *Annals of Internal Medicine* 121 (1994): 891-893.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

KEY TERMS

Apperception—The process of understanding through linkage with previous experience.

Human potential movement—A movement in psychotherapy that began in the 1960s and emphasized maximizing the potential of each participant through such techniques as group therapy and sensitivity training.

Projective test—A type of psychological test that assesses a person's thinking patterns, observational ability, feelings, and attitudes on the basis of responses to ambiguous test materials. It is not intended to diagnose psychiatric disorders.

Thematic apperception test

Definition

The thematic apperception test (TAT) is a projective personality test that was designed at Harvard in the 1930s by Christiana D. Morgan and Henry A. Murray. Along with the MMPI and the Rorschach, the TAT is one of the most widely used **psychological tests**. A projective test is one in which a person's patterns of thought, attitudes, observational capacity, and emotional responses are evaluated on the basis of responses to ambiguous test materials. The TAT consists of 31 pictures that depict a variety of social and interpersonal situations.The subject is asked to tell a story about each picture to the examiner. Of the 31 pictures, 10 are gender-specific while 21 others can be used with adults of either sex and with children. As of 2001, the TAT is distributed by Harcourt Brace Educational Measurement.

Purpose

The original purpose of the TAT was to reveal the underlying dynamics of the subject's personality, such as internal conflicts, dominant drives and interests, motives, etc. The specific motives that the TAT assesses include the need for achievement, need for power, the need for intimacy, and problem-solving abilities. After World War II, however, the TAT was used by psychoanalysts and clinicians from other schools of thought to evaluate emotionally disturbed patients. Another shift took place in the 1970s, when the influence of the human potential movement led many psychologists to emphasize the usefulness of the TAT in assessment services—that is, using the test to help clients understand themselves better and stimulate their personal growth.

The TAT is widely used to research certain topics in psychology, such as dreams and fantasies, mate selection, the factors that motivate people's choice of occupations, and similar subjects. It is sometimes used in psychiatric evaluations to assess disordered thinking and in forensic examinations to evaluate crime suspects, even though it is not a diagnostic test. As mentioned earlier, the TAT can be used to help people understand their own personality in greater depth and build on that knowledge in making important life decisions. Lastly, it is sometimes used as a screener in psychological evaluations of candidates for high-stress occupations (law enforcement, the military, religious ministry, etc.).

Precautions

The TAT has been criticized for its lack of a standardized method of administration as well as the lack of standard norms for interpretation. Studies of the interactions between examiners and test subjects have found that the race, sex, and social class of both participants influence both the stories that are told and the way the stories are interpreted by the examiner. Attempts have been made to design sets of TAT cards for African American and for elderly test subjects, but the results have not been encouraging. In addition, the 31 standard pictures have been criticized for being too gloomy or depressing,

and therefore limiting the range of personality characteristics that the test can assess.

Description

There is no standardized procedure or set of cards for administering the TAT, except that it is a one-on-one test. It cannot be administered to groups. In one common method of administration, the examiner shows the subject only 10 of the 31 cards at each of two sessions. The sessions are not timed, but average about an hour in length.

Preparation

There is no specific preparation necessary before taking the TAT, although most examiners prefer to schedule sessions (if there is more than one) over two days.

Risks

The chief risks involved in taking the TAT are a bad "fit" between the examiner and the test subject, and misuse of the results.

Normal results

Since the TAT is used primarily for personality assessment rather than diagnosis of mental disorders, it does not yield a "score" in the usual sense.

Resources

BOOKS

Arbisi, Paul A. "The Senior Apperception Technique." In *The Thirteenth Mental Measurements Yearbook*, ed. J. C. Impara and B. S. Plake (Lincoln, NE: The Buros Institute of Mental Measurements, The University of Nebraska-Lincoln, 1998).

Dana, Richard H. "Thematic Apperception Test." In *International Encyclopedia of Psychiatry, Psychology, Psychoanalysis, & Neurology*, vol. 11, ed. Benjamin B. Wolman. New York: Aesculapius Publishers, Inc., 1977.

Geiser, Lon, and Morris I. Stein. *Evocative Images: The Thematic Apperception Test and the Art of Projection*. Washington, DC: American Psychological Association, 1999.

Sweetland, R. C., PhD, and D. J. Keyser, PhD, eds. *Tests: A Comprehensive Reference for Assessments in Psychology, Education, and Business,* 2nd edition. Kansas City, KS: Test Corporation of America, 1986.

ORGANIZATION

American Psychological Association. 750 First Street, NE, Washington, DC 20002. (800) 374-2721. <http://www.apa.org>.

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Therapeutic abortion *see* **Abortion, therapeutic**

Therapeutic baths

Definition

Bathing the skin in a variety of preparations in order to remove crusts, scales, and old medications or to relieve inflammation and itching is called a therapeutic bath.

Purpose

Baths or soaks (balneotherapy) are an easy way to treat a variety of skin disorders involving large areas of the skin. They relieve general aches and pains and can ease dry or oily, inflamed or itchy skin. Hot baths are relaxing and stimulating; cool baths can reduce inflammation.

Therapeutic baths are useful for itchy skin, hives, sunburn, chafing, poison ivy and oak, eczema, skin irritation, and dry skin.

Precautions

The temperature of the water should be comfortable. The bath should not last longer than 20–30 minutes because of the tendency of these soaks to soften and wear away the skin.

A bath mat should be used, since medications may cause the floor of the tub to be slippery.

Eczema and other skin diseases can be treated with an ointment that contains a derivative of coal tar. Parts of the coal tar are volatile, so the bathroom should be well ventilated.

Description

The tub should be filled half-full with water at a comfortable temperature. The water should not be allowed to cool too much. If an emollient action is needed, the patient should apply a lubricating agent to the skin after the bath, since this increases hydration.

Different types of therapeutic baths are used for different conditions:

Types Of Therapeutic Baths

Bath Solution	Uses/benefits
Aveeno/Oatmeal	Soothes irritated skin; lubricates and softens dry skin
Corn starch	Soothes irritated skin
Potassium permanganate	Treats infected skin areas; cleans and disinfects
Saline	Cools and cleanses skin; decreases skin irritation
Sodium bicarbonate	Cools skin; relieves skin irritation

KEY TERMS

Eczema—An inflammation of the skin that usually itches and sometimes forms scales or blisters.

- colloidal oatmeal (oatmeal that has been ground into a fine powder, e.g. Aveeno) coats, soothes, stops itch and doesn't dry out the skin
- potassium permanganate—a dark purple salt—makes a good disinfectant
- bath oils are used to ease itchy skin and eczema as an emollient
- cornstarch is a soothing, drying bath for itchy skin
- sodium bicarbonate can be cooling for hot, dry skin conditions
- saline (salt) water baths are used to treat lesions scattered over the body

Preparation

Keep the room warm to minimize temperature fluctuations.

Aftercare

After the bath, the skin should be blotted (not rubbed) carefully with a towel. The patient should wear loose, light clothing after the bath.

Resources

BOOKS

Boyle, Wade, and Andre Saine. *Lectures in Naturopathic Hydrotherapy.* East Palestine, OH: Buckeye Naturopathic Press, 1988.

Carol A. Turkington

Therapeutic drug monitoring *see* **Drug therapy monitoring**

Therapeutic massage *see* **Massage**

Therapeutic touch

Definition

Therapeutic touch, or TT, is a noninvasive method of healing that was derived from an ancient laying-on of hands technique. In TT, the practitioner alters the patient's energy field through an energy transfer that moves from the hands of the practitioner to the patient.

Origins

Therapeutic touch was developed in 1972 by Dora Kunz, a psychic healer, and Dolores Krieger, PH.D., R.N, a nurse and professor of nursing at New York University. The year before, in 1971, when Krieger was working as a registered nurse in a hospital, she became very frustrated when one of her patients, a 30-year-old female, lay dying from a gallbladder condition. In desperation, she tried what she was learning from Kunz. Within one treatment, the patient's condition began to shift and she lived, surprising the other hospital staff. Krieger and Kunz met during the study of Oskar Estebany, a world-renowned healer. They had invited Estebany to form a study for three years, observing his work with patients. In this study, Estebany practiced laying-on of hands healing on various patients. Using her psychic and intuitive abilities, Kunz would observe and assist in the healing, while Krieger recorded the activities of the healing session and created profiles of the patients.

As the study progressed, Kunz began teaching Krieger how to heal, based on her perceptions of Estebany's healing techniques. During her research of ancient healing methods, Krieger concluded that the energy transfer between the healer and the healee that takes place in a TT session is *prana*, an Eastern Indian concept representing energy, vitality, and vigor. Krieger then combined her research with Kunz's techniques to create TT.

TT was initially developed for persons in the health professions, but is currently taught worldwide to anyone who is interested in learning the technique. As of 1998, an estimated 100,000 people around the world have been trained in TT; 43,000 of those persons are health care professionals, many of whom use TT in conjunction with traditional medicine, as well as osteopathic, **chiropractic**, naturopathic, and homeopathic therapies. TT is taught in over 100 colleges, universities, and medical schools.

Benefits

The major effects of TT are relaxation, **pain** reduction, accelerated healing, and alleviation of psychosomatic symptoms. Studies have shown that TT has a beneficial effect on the blood as it has the ability to raise hemoglobin values. It also affects brain waves to induce a relaxed state. TT can induce the relaxation response often within five minutes.

Krieger has said that it is not individual illnesses that validate the effectiveness of TT, but rather, it is ques-

tioned which systems are most sensitive to TT. She and others have found that the most sensitive is the autonomic nervous system (ANS), which, for example, controls urination. The ANS is followed by dysfunctions of lymphatic and circulatory systems, and then finally musculoskeletal systems. In addition, the female endocrine system is more sensitive to TT than the corresponding male system. Thus, TT helps with **dysmenorrhea**, **amenorrhea**, problems with **contraception**, and the course of **pregnancy**.

TT is reported to have a positive effect on the immune system and thus accelerates the healing of **wounds**. Nurses use therapeutic touch in operating rooms to relax patients before surgery and in recovery rooms on postoperative patients to help speed the healing process. TT is used in the treatment of terminally ill patients, such as those with **cancer** and autoimmune deficiency syndrome (**AIDS**), to relieve **anxiety** and **stress**, create peace of mind, and reduce pain.

Many nurses use TT in the nursery. The conditions of many premature babies who received TT reportedly improved rapidly. TT has been used to calm colicky infants, assist women in **childbirth**, and increase milk let-down in breast-feeding mothers.

Other claims of TT include relief of acute pain, nausea, **diarrhea**, tension and migraine headaches, **fever**, and joint and tissue swelling. TT has been used to treat thyroid imbalances, ulcers, psychosomatic illnesses, **premenstrual syndrome**, **Alzheimer's disease**, **stroke** and **coma**, **multiple sclerosis**, **measles**, infections, **asthma**, and bone and muscle injuries.

Therapeutic touch is performed in many different locations, including healing centers, delivery rooms, hospitals, hospice settings, accident scenes, homes, and schools.

Description

Therapeutic touch treats the whole person: relaxes the mind, heals the body, and soothes the spirit. The principle behind it is that it does not stop at the skin. The human body extends an energy field, or aura, several inches to several feet from the body. When illness occurs, it creates a disturbance or blockage in the vital energy field. The TT practitioner uses her/his hands to sense the blockage or disturbance. In a series of gentle strokes, the healer removes the disturbance and rebalances the energy to restore health.

The TT session generally lasts about 20–30 minutes. Although the name is therapeutic touch, there is generally no touching of the physical body, only the energetic body or field. It is usually performed on fully clothed patients who are either lying down on a flat surface or sitting up in a chair.

Each session consists of five steps. Before the session begins, the practitioner enters a state of quiet **meditation** in which he/she becomes centered and grounded in order to establish intent for the healing session and to garner the compassion necessary to heal.

The second step involves the assessment of the person's vital energy field. During this step, the practitioner places the palms of his/her hands 2–3 in (5–8 cm) from the patient's body and sweeps them over the energy field in slow, gentle strokes beginning at the head and moving toward the feet. The practitioner might feel heat, coolness, heaviness, pressure, or a prickly or tingling sensation. These cues, as they are called, each signal a blockage or disturbance in the field.

To remove these blockages and restore balance to the body, the practitioner then performs a series of downward sweeping movements to clear away any energy congestion and smooth the energy field. This is known as the unruffling process and is generally performed from head to feet. To prevent any energy from clinging to him/her, the practitioner shakes his/her hands after each stroke.

During the next phase, the practitioner acts as a conduit to transfer energy to the patient. The energy used is not solely the energy of the practitioner. The practitioner relies on a universal source of energy so as not to deplete his/her own supply. In short, the healer acts as an energy support system until the patient's immune system is able to take over.

The practitioner then smoothes the field to balance the energy and create a symmetrical flow. When the session is over, it is recommended that the patient relax for 10–15 minutes in order for the energies to stabilize.

Side effects

The side effects reported occur when an excess of energy enters the body for an extended period of time creating restlessness, irritability, and hostility, or increasing anxiety and pain. **Burns** are sensitive to therapeutic touch, and it is recommended that TT be performed on burned tissue for short periods, generally two to three minutes at a time.

Research and general acceptance

Therapeutic touch is not generally accepted by Western medical professionals. Basic and anecdotal research has been performed on TT since its development in 1972, although little quantitative research has been carried out. It is based on a theory derived from formal research. It began as the basis of Dolores Krieger's postdoctoral research.

DOLORES KRIEGER (1935–)

Dolores Krieger, a prominent professor of nursing at the New York University Division of Nursing, conceived of therapeutic touch as a healing technique in the early 1970s and introduced the therapy in 1972. Therapeutic touch rarely consists of physical contact with the patient. The practitioner focuses positive energy through the hands, which are held or waved two to three inches away from the patient, and directs it towards the patient's energy field. Krieger developed the technique along with a colleague, Dora Van Gelder Kunz, who is believed to be clairvoyant. They initially taught the system to graduate students at the nursing school, and it evolved from that basis. Since the introduction of therapeutic touch, Krieger traveled the world in teaching the technique before she retired as professor emerita at the university. An estimated 70,000 nurses were trained by Krieger and Kunz.

In 1981 Dr. Krieger published *Foundations for Holistic Health Nursing Practices*. She later published a manual, *The Therapeutic Touch: How to Use Your Hands to Help or to Heal*, in 1992.

Krieger became embroiled in controversy over the potential benefits of therapeutic touch technique between 1996-98, when nine-year-old schoolgirl Emily Rosa challenged the validity of the therapy with a simple experiment. She gathered 21 practitioners and through a covered box held her hand over one of the practitioner's own to test whether they could sense her energy field. Only 44% of the time were the practitioners able to determine which of their hands that Rosa's was hovering over. Although Rosa contacted Krieger in 1997, Krieger refused to meet with her, refused to participate in Rosa's experiment, and disputed the relevancy of an elementary school student's observations. Krieger holds both an R.N. and a Ph.D. degree and dismissed the validity of the experiment due to the student's and practitioners' lack of experience.

Krieger continues to promote her technique; her latest book, *Living the Therapeutic Touch*, was published by in 1999.

Dolores Krieger has performed extensive research on TT, including with pregnant women, and has noted that the following changes occur in a patient after short, consistent treatment: relaxation within the first five minutes of a session, a reduction of pain, and the acceleration of the healing process.

One study was created to determine the effect TT would have on wounds that resulted from a biopsy of the upper arm. Forty-four patients placed their injured arms through a hole in a door. Twenty-two of them received TT on their arms. The other half received no treatment. The wounds treated with TT healed more quickly than the wounds that received no treatment.

In 1998, a study was performed on 27 patients with **osteoarthritis** in at least one knee. For six weeks, the patients were treated with therapeutic touch, mock therapeutic touch, or standard care. According to *The Journal of Family Practice*, the journal who published the study, the results showed that the group who had received TT had "significantly decreased pain and improved function as compared with both the placebo and control groups."

Therapeutic touch can be combined with a number of different therapies, including **acupressure**, massage, mental imagery, physical therapy, and **yoga**. When combined with massage and physiotherapy, TT may reduce tension headaches, back pain, stress-related problems, circulatory problems, and **constipation**. **Shiatsu** and TT may help **sinusitis**, digestive disorders, muscle cramps, menstrual difficulties, and **insomnia**. Yoga and TT may be beneficial in the treatment of **bronchitis**, asthma, blood pressure, **fatigue**, and anxiety.

TT is practiced in over 70 countries worldwide: by Egyptians and Israelis during fighting in the Gaza Strip; in South Africa to reduce racial strife; and in Poland, Thailand, and the former Soviet Union.

Training and certification

Therapeutic touch is taught at over 100 universities and nursing and medical schools around the United States and Canada. Although it was developed primarily for nurses, anyone can learn TT.

State laws vary regarding the practice of TT. In general, laypersons are allowed to practice TT within their families. Therapeutic touch is considered an extension of health care skills, so most health care professionals are covered under the state medical practice act.

Many hospitals have established policies allowing nurses and staff to perform TT on patients at no extra charge. The American Nurse's Association often holds workshops on TT at national conventions. Therapeutic touch classes are often held for the general public through community education, healing clinics, and holistic schools.

Resources

BOOKS

Krieger, Dolores, Ph.D., R.N. *Accepting Your Power to Heal. The Personal Practice of Therapeutic Touch*. Bear & Company, 1993.

Krieger, Dolores, Ph.D., R.N. *The Therapeutic Touch. How to Use Your Hands to Help or to Heal*. New York: Prentice Hall Press, 1979.

Macrae, Janet, Ph.D., R.N. *Therapeutic Touch: A Practical Guide*. New York: Knopf, 1998.

PERIODICALS

Rosa, Linda, Emily Rosa, Larry Sarner, and Stephen Barrett. "A Close Look At Therapeutic Touch." *JAMA, The Journal of the American Medical Association* (April 1, 1998): 1005–11.

OTHER

The Nurse Healers Professional Associates International (NHPAI), the Official Organization of Therapeutic Touch. 3760 S. Highland Dr. Salt Lake City, UT 84106. (801) 273–3399. nhpai@therapeutic-touch.org. <http://www.therapeutic-touch.org.

Jennifer Wurges

Thiabendazole *see* **Antihelminthic drugs**

Thiamine deficiency *see* **Beriberi**

Thoracentesis

Definition

Also known as pleural fluid analysis, thoracentesis is a procedure that removes fluid or air from the chest through a needle or tube.

Purpose

The lungs are lined on the outside with two thin layers of tissue called pleura. The space between these two layers is called the pleural space. Normally, there is only a small amount of lubricating fluid in this space. Liquid and/or air accumulates in this space between the lungs and the ribs from many conditions. The liquid is called a **pleural effusion**; the air is called a **pneumothorax**. Most pleural effusions are complications emanating from metastatic malignancy (movement of **cancer** cells from one part of the body to another). Most malignant pleural effusions are detected and controlled by thoracentesis. Thoracentesis is also performed as a diagnostic measure. In these cases, only small amounts of material need to be withdrawn.

Symptoms of a pleural effusion include breathing difficulty, chest **pain**, **fever**, weight loss, **cough**, and **edema**. Removal of air is often an emergency procedure to prevent suffocation from pressure on the lungs. Negative air pressure within the chest cavity allows normal respiration. The accumulation of air or fluid within the pleural space can eliminate these normal conditions and disrupt breathing and the movement of air within the chest cavity. Fluid removal is performed to reduce the pressure in the pleural space and to analyze the liquid. In addition, thoracentesis was traditionally used to remove blood from the chest cavity. This is rare now that the placement of a thoracostomy tube has proven to be a more effective and safer method.

Thoracentesis often provides immediate abatement of symptoms. However, fluid often begins to reaccumulate. A majority of patients will ultimately require additional therapy beyond a simple thoracentesis.

There are two types of liquid in the pleural space, one having more protein in it than the other. More watery liquids are called transudates; thicker fluids are called exudates. On the basis of this difference, the cause of the effusion can more easily be determined.

Transudates

Thin, watery fluid oozes into the chest either because back pressure from circulation squeezes it out or because the blood has lost some of its osmotic pressure.

- Heart failure creates back pressure in the veins as blood must wait to be pumped through the heart.
- A **pulmonary embolism** is a blood clot in the lung. It will create back pressure in the blood flow and also damage a part of the lung so that it leaks fluid.
- Cirrhosis is a sick, scarred liver that both fails to make enough protein for the blood and also restricts the flow of blood through it.
- Nephrosis is a collection of kidney disorders that change the osmotic pressure of blood and allow liquid to seep into body cavities.
- Myxedema is a disease caused by too little thyroid hormone.

Exudates

Thicker, more viscous fluid is usually due to greater damage to tissues, allowing blood proteins as well as water to seep out.

- Pneumonia, caused by viruses and by bacteria, damages lung tissue and can open the way for exudates to enter the pleural space.
- Tuberculosis can infect the pleura as well as the lungs and cause them to leak liquid.

- Cancers of many types settle in the lungs or the pleura and leak liquids from their surface.
- Depending upon its size and the amount of damage it has done, a pulmonary **embolism** can also produce an exudate.
- Several drugs can damage the lung linings as an unexpected side effect. None of these drugs is commonly used.
- An esophagus perforated by cancer, trauma, or other conditions can spill liquids and even food into the chest. The irritation creates an exudate in the pleural space.
- Pancreatic disease can cause massive fluid in the abdomen, which can then find its way into the chest.
- Pericarditis is an inflammation of the sac that contains the heart. It can ooze fluid from both sides—into the heart's space and into the chest.
- Radiation to treat cancer or from accidents with radioactive materials can damage the pleura and lead to exudates.
- A wide variety of autoimmune diseases attacks the pleura. Among these are **rheumatoid arthritis** and **systemic lupus erythematosus** (SLE).
- Many other rare conditions can also lead to exudates.

Blood

Blood in the chest (hemothorax) is infrequently seen outside of two conditions:

- major trauma can sever blood vessels in the chest, causing them to bleed into the pleural space
- cancers can ooze blood as well as fluid. They do not usually bleed massively

Chyle

Occasionally, the liquid that comes out of the chest is neither transparent nor bloody, but milky. This is due to a tear of the large lymphatic channel—the thoracic duct carrying lymph fluid from the intestines to the heart. It is milky because it is transporting fats absorbed in the process of digestion. The major causes of chylothorax are:

- injury from major trauma, such as an automobile accident
- cancers eroding into the thoracic duct

Air

Air in the pleural space is called pneumothorax. Air can enter the pleural space either directly through a hole between the ribs or from a hole in the lungs. Holes in the lungs are sometimes spontaneous, sometimes traumatic, and sometimes the result of disease opening a communication to the air in the lung.

Precautions

Care must be taken not to puncture the lung when inserting the needle. Thoracentesis should never be performed by inserting the needle through an area with an infection. An alternative site needs to be found in these cases. Patients who are on anticoagulant drugs should be carefully considered for the procedure.

Description

The usual place to tap the chest is below the armpit (axilla). Under sterile conditions and local anesthesia, a needle, a through-the-needle-catheter, or an over-the-needle catheter may be used to perform the procedure. Overall, the catheter techniques may be safer. Fluid or air is withdrawn. Fluid is sent to the laboratory for analysis. If the air or fluid continue to accumulate, a tube is left in place and attached to a one-way system so that it can drain without sucking air into the chest.

Preparation

The location of the fluid is pinpointed through x ray or ultrasound. Ultrasound is a more accurate method when the effusion is small. A sedative may be administered in some cases but is generally not recommended. Oxygen should be given to the patient.

Aftercare

As long as the tube is in the chest, the patient must lie still. After it is removed, x rays will determine if the effusion or air is reaccumulating—though some researchers and clinicians believe chest x rays do not need to be performed after routine thoracentesis.

Risks

Reaccumulation of fluid or air is a possible complications, as are hypovolemic **shock** (shock caused by a lack of circulating blood) and infection. Patients are at increased risk for poor outcomes if they have a recent history of anticoagulant use, have very small effusions, have significant amounts of fluid, have poor health leading into this condition, have positive airway pressure, and have adhesions in the pleural space. A pneumothorax can sometimes be caused by the thoracentesis procedure. The use of ultrasound to guide the procedure can reduce the risk of pneumothorax.

Thoracentesis can also result in hemothorax, or bleeding within the thorax. In addition, such internal structures, as the diaphragm, spleen, or liver, can be damaged by needle insertion. Repeat thoracenteses can increase the risk of developing hypoproteinemia (a decrease in the amount of protein in the blood).

KEY TERMS

Axilla—Armpit.

Catheter—A tube that is moved through the body for removing or injecting fluids into body cavities.

Hypovolemic shock—Shock caused by a lack of circulating blood.

Osmotic pressure—The pressure in a liquid exerted by chemicals dissolved in it. It forces a balancing of water in proportion to the amount of dissolved chemicals in two compartments separated by a semi-permeable membrane.

Pleura—Two thin layers lining the lungs on the outside.

Resources

BOOKS

Celli, R. Bartolome. "Diseases of the Diaphragm, Chest Wall, Pleura and Mediastinum." In *Cecil Textbook of Medicine,* edited by J. Claude Bennett. Philadelphia: W. B. Saunders, 2000.

Clinical Oncology edited by Martin D. Abeloff, et al. New York: Churchill Livingstone, 2000.

Miller, Don R. "Pleural Effusion and Empyema Thoracis." In *Conn's Current Therapy,* edited by Robert E. Rakel, et al. Philadelphia: W.B. Saunders, 1998.

Ross, David S. "Thoracentesis." In *Clinical Procedures in Medicine,* edited by James R. Roberts, et al. Philadelphia: W.B. Saunders, 1998.

PERIODICALS

Colt, Henri G. "Factors Contributing to Pneumothorax After Thoracentesis." *Chest* 117 (February 2000).

Petersen, W.G. "Limited Utility of Chest Radiograph After Thoracentesis." *Chest* 117 (April 2000): 1038-1042.

Mark A. Mitchell

Thoracic aortic aneurysm *see* **Aortic aneurysm**

Thoracic empyema *see* **Empyema**

Thoracic outlet syndrome

Definition

Thoracic outlet syndromes are a group of disorders that cause **pain** and abnormal nerve sensations in the neck, shoulder, arm, and/or hand.

Description

The thoracic outlet is an area at the top of the rib cage, between the neck and the chest. Several anatomical structures pass through this area, including the esophagus, trachea, and nerves and blood vessels that lead to the arm and neck region. The area contains the first rib; collar bone (clavicle); the arteries beneath the collar bone (subclavian artery), which supply blood to the arms, a network of nerves leading to the arms (brachial plexus); and the top of the lungs.

Pain and other symptoms occur when the nerves or blood vessels in this area are compressed. The likelihood of blood vessels or nerves in the thoracic outlet being compressed increases with increased size of body tissues in this area or with decreased size of the thoracic outlet. The pain of thoracic outlet syndrome is sometimes confused with the pain of **angina** that indicates heart problems. The two conditions can be distinguished from each other because the pain of thoracic outlet syndrome does not appear or increase when walking, while the pain of angina does. Also, the pain of thoracic outlet syndrome usually increases if the affected arm is raised, which does not happen in cases of angina.

There are three types of thoracic outlet syndromes:

- True neurogenic thoracic outlet syndrome is caused by a compression of the nerves in the brachial plexus. Abnormal muscle or other tissue causes the problem.
- Arterial thoracic outlet syndrome is caused by compression of the major artery leading to the arm, usually by a rib.
- Disputed thoracic outlet syndrome describes patients who have chronic pain in the shoulders and arms and have no other disease or syndrome, but the underlying cause cannot be accurately determined.

Thoracic outlet syndrome is most common in women who are 35–55 years of age.

Causes and symptoms

Compression of blood vessels or nerves in the thoracic outlet causes pain and/or abnormal nerve sensations. Compression usually occurs at the location where the blood vessels and nerves pass out of the thoracic outlet into the arm.

There are several factors that contribute to a person developing thoracic outlet syndrome. Poor posture is a major cause and is easy to treat. A person's physical makeup also can cause thoracic outlet syndrome. For example, abnormalities of certain anatomical structures can put pressure on blood vessels or nerves. Typical abnormalities that can cause problems are malformed

ribs and too narrow an opening between the collar bone and the first rib.

The main symptom is pain in the affected area. The patient can also develop weakness in the arm and hands, tingling nerve sensations, and a condition called Raynaud's syndrome. In Raynaud's syndrome, exposure to cold causes small arteries in the fingers to contract, cutting off blood flow. This causes the fingers to turn pale. In very severe cases of blood vessel compression, **gangrene** can result. Gangrene is the **death** of tissue caused by the blood supply being completely cut off.

In the case of arterial thoracic outlet syndrome, the artery beneath the collar bone leading to the arm is compressed, causing the artery to increase in size. Blood clots (thrombi) may form in the blood vessel. When blood vessels are compressed, the hands, arms, and shoulders do not receive proper blood supply. They can swell and turn blue from a lack of blood.

In the case of true neurogenic thoracic outlet syndrome, the nerves most affected are those of the network of nerves supplying the chest, shoulder, arm, forearm, and hand (brachial plexus). When a nerve is affected in thoracic outlet syndrome it produces a tingling sensation (paresthesia). It can also cause weakness in the hand and reduced sensation in the palm and fingers.

Diagnosis

There are no specific diagnostic tests for thoracic outlet syndromes. The diagnosis is made by ruling out other diseases and by observing the patient. Two nonspecific tests that can suggest the presence of thoracic outlet syndrome are the Adsons test and the Allen test. In the Adson test, the patient takes a deep breath and tilts his or her head back and turns it to one side. The physician tests to see if the strength of the patient's pulse is reduced in the wrist on the arm on the opposite side of the head turn. In the Allen test, the arm in which the patient is experiencing symptoms is raised and rotated while the head is turned to the opposite side. The physician tests to see if the pulse strength at the wrist is reduced. If the strength of the pulse is reduced in either of these two tests it indicates compression of the subclavian artery.

Occasionally, examination with a stethoscope may reveal abnormal sounds in affected blood vessels. X rays can reveal constrictions in blood vessels if a special dye is injected into the blood stream to make the blood vessels visible (**angiography**).

Certain tests are available to help with the diagnosis of nerve compression. These include the nerve conduction velocity test and somatosensory evoked potential test. In the nerve conduction velocity test, electrodes are placed at various locations on the skin along a nerve that is being tested. A mild electrical impulse is delivered through an electrode at one end of the nerve and the electrical activity is recorded by the other electrodes. The time it takes for the electrical impulse to travel down the nerve from the stimulating electrodes to the recording electrodes is used to calculate the nerve conduction velocity. This can be used to determine if any nerve damage exists.

In a somatosensory evoked potential test, electrodes are placed on the skin at the scalp, neck, shoulder, and wrist. A mild electrical impulse is delivered at the wrist, and a recording is made of the response by the brain and spinal cord. This test also can determine the presence of nerve damage.

Treatment

The main treatment for thoracic outlet syndrome is physical therapy. Exercises aimed at improving the posture of the affected person are also useful. In some cases, surgery can be performed to remove the cervical rib if this is causing the problem and physical therapy has failed to work. However, surgery is generally not used to treat thoracic outlet syndrome.

Prognosis

Treatment of true neurogenic and arterial thoracic outlet syndromes is usually successful. Treatment of disputed thoracic outlet syndrome is often unsuccessful. This may relate to the uncertainty of the underlying cause of the pain.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Braunwald, E. *Heart Disease*. Philadelphia: W. B. Saunders Co., 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

John T. Lohr, PhD

Thoracic surgery

Definition

Thoracic surgery is the repair of organs located in the thorax, or chest. The thoracic cavity lies between the

KEY TERMS

Angina—A severe constricting pain in the chest, usually caused by a lack of oxygen to the heart.

Neurogenic—Caused by nerves; originating in the nerves.

Subclavian—Located beneath the collarbone (clavicle).

neck and the diaphragm, and contains the heart and lungs (cardiopulmonary system), the esophagus, trachea, pleura, mediastinum, chest wall, and diaphragm.

Purpose

Thoracic surgery repairs diseased or injured organs and tissues in the thoracic cavity. General thoracic surgery deals specifically with disorders of the lungs and esophagus. Cardiothoracic surgery also encompasses disorders of the heart and pericardium. Blunt chest trauma, reflux esophagitis, **esophageal cancer**, **lung transplantation**, lung **cancer**, and **emphysema** are just a few of the many clinical indications for thoracic surgery.

Precautions

Patients who have blood-clotting problems (coagulopathies), and who have had previous standard thoracic surgery may not be good candidates for video-assisted thoracic surgery (VATS). Because VATS requires the collapse of one lung, potential patients should have adequate respiratory function to maintain oxygenation during the procedure.

Description

Thoracic surgery is usually performed by a surgeon who specializes in either general thoracic surgery or cardiothoracic surgery. The patient is placed under general anesthesia and endotracheally intubated for the procedure. The procedure followed varies according to the purpose of the surgery. An incision that opens the chest (thoracotomy) is frequently performed to give the surgeon access to the thoracic cavity. Commonly, the incision is made beginning on the back under the shoulder blade and extends in a curved arc under the arm to the front of the chest. The muscles are cut, and the ribs are spread with a retractor. The surgeon may also choose to open the chest through an incision down the breastbone, or sternum (sternotomy). Once the repair, replacement, or removal of the organ being operated on is complete, a chest tube is inserted between the ribs to drain the wound and re-expand the lung.

Video-assisted thoracic surgery (VATS) is a minimally invasive surgical technique that uses a thoracic endoscope (thoracoscope) to allow the surgeon to view the chest cavity. A lung is collapsed and 3-4 small incisions, or access ports, are made to facilitate insertion of the thoracoscope and the surgical instruments. During the procedure, the surgeon views the inside of the pleural space on a video monitor. The thoracoscope may be extracted and inserted through a different incision site as needed. When the surgical procedure is complete, the surgeon expands the lung and inserts a chest tube in one of the incision sites. The remaining incisions are sealed with adhesive.

The thoracic surgeon may also use a mediastinoscope or a bronchoscope to explore the thoracic cavity. **Mediastinoscopy** allows visualization of the mediastinum, the cavity located between the lungs. The bronchoscope enables the surgeon to view the larynx, trachea, and bronchi. These instruments may be used in a separate diagnostic procedure prior to thoracic surgery, or during the surgery itself.

Preparation

Except in the case of emergency procedures, candidates for general thoracic surgery should undergo a complete medical history and thorough **physical examination** prior to surgery. Particular attention is given to the respiratory system. The patient's **smoking** history will be questioned. If the patient is an active smoker, encouragement is always given for the patient to quit smoking prior to the surgery to facilitate recovery and reduce chances of complications.

Diagnostic tests used to evaluate the patient preoperatively may include, but are not limited to, X-rays, MRI, CT scans, **blood gas analysis**, pulmonary function tests, **electrocardiography**, endoscopy, pulmonary **angiography**, and **sputum culture**.

Candidates for thoracic surgery should be fully educated by their physician or surgeon on what their surgery will involve, the possible risks and complications, and requirements for postoperative care.

Patients are instructed not to eat 10 to 12 hours prior to a thoracic surgery procedure. A sedative may be provided to relax the patient prior to surgery. An intravenous line (IV) is inserted into the patient's arm or neck to administer fluids and/or medication.

Aftercare

After surgery, the patient is taken to the recovery room, where vital signs are monitored; depending on

KEY TERMS

Blood gas analysis—A blood test that measures the level of oxygen, carbon dioxide, and pH in arterial blood. A blood gas analysis can help a physician assess how well the lungs are functioning.

Electrocardiography—A cardiac test that measures the electrical activity of the heart.

Embolism—A blood clot, air bubble, or clot of foreign material that blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction, or death of the tissue that the artery feeds, occurs. Without immediate and appropriate treatment, an embolism can be fatal.

Emphysema—A lung disease characterized by shortness of breath and a chronic cough. Emphysema is caused by the progressive stretching and rupture of alveoli, the air sacs in the lung that oxygenate the blood.

Endoscopy—The examination of organs and body cavities using a long, tubular optical instrument called an endoscope.

Intubation—Insertion of an endotracheal tube down the throat to facilitate airflow to the lung(s) during thoracic surgery.

Pericardium—The sac around the heart.

Pleural space—The space between the pleural membranes that surround the lungs and the chest cavity.

Pulmonary angiography—An x-ray study of the lungs, performed by insertion of a catheter into a vein, through the heart, and into the pulmonary artery. Pulmonary angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a pulmonary embolism.

Sputum culture—A laboratory analysis of the fluid produced from the lungs during coughing. A sputum culture can confirm the presence of pathogens in the respiratory system, and help to diagnose certain respiratory infections, including bronchitis, tuberculosis, and pneumonia.

the procedure performed, the breathing tube may be removed. The patient typically experiences moderate to severe **pain** following surgery. **Analgesics** or other pain medication are administered to keep the patient comfortable. Chest tubes are monitored closely for signs of fluid or air accumulation in the lungs that can lead to lung collapse. A urinary catheter will remain in the patient for 24 to 48 hours to drain urine from the bladder.

The hospital stay for thoracic surgery depends on the specific procedure performed. Patients who undergo a thoracotomy may be hospitalized a week or longer, while patients undergoing VATS typically have a shorter hospital stay of 2-3 days. During the recovery period, respiratory therapists and nurses work with the patient on deep breathing and coughing exercises to improve lung function.

Risks

Respiratory failure, hemorrhage, nerve injury, **heart attack**, **stroke**, **embolism**, and infection are all possible complications of general thoracic surgery. The chest tubes used for drainage after thoracic surgery may cause a build-up of fluid or the accumulation of air in the pleural space. Both of these conditions can lead to total lung collapse. Other specific complications may occur, depending on the procedure performed.

Normal results

Normal results of thoracic surgery are dependent on the type of procedure performed and the clinical purpose of the surgery.

Resources

ORGANIZATIONS

American Thoracic Society. 1740 Broadway, New York, NY 10019. (212) 315-8700. <http://www.thoracic.org>.

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Thoracoscopy

Definition

Thoracoscopy is the insertion of an endoscope, a narrow-diameter tube with a viewing mirror or camera attachment, through a very small incision (cut) in the chest wall.

Purpose

Thoracoscopy makes it possible for a physician to examine the lungs or other structures in the chest cavity, without making a large incision. It is an alternative to thoracotomy (opening the chest cavity with a large incision). Many surgical procedures, especially taking tissue samples (biopsies), can also be accomplished with thoracoscopy. The procedure is done to:

- assess lung **cancer**
- take a biopsy for study
- determine the cause of fluid in the chest cavity
- introduce medications or other treatments directly into the lungs
- treat accumulated fluid, pus (**empyema**), or blood in the space around the lungs

For many patients, thoracoscopy replaces thoracotomy. It avoids many of the complications of open chest surgery and reduces **pain**, hospital stay, and recovery time.

Precautions

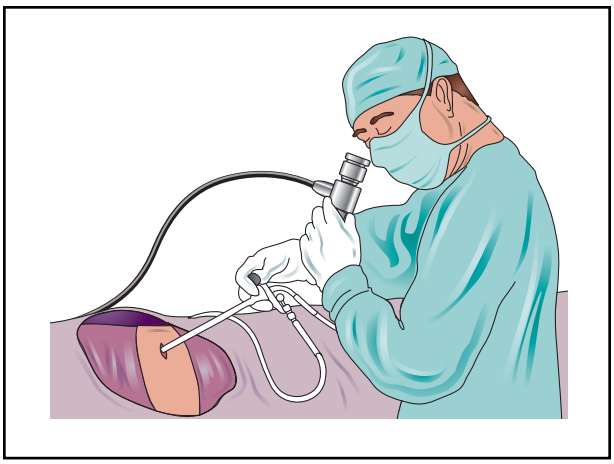
Because one lung is partially deflated during thoracoscopy, the procedure cannot be done on patients whose lung function is so poor that they do not receive enough oxygen with only one lung. Patients who have had previous surgery that involved the chest cavity, or who have bloodclotting problems, are not good candidates for this procedure.

Thoracoscopy gives physicians a good but limited view of the organs, such as lungs, in the chest cavity. Endoscope technology is being refined every day, as is what physicians can accomplish by inserting scopes and instruments through several small incisions instead of making one large cut.

Description

Thoracoscopy is most commonly performed in a hospital, and general anesthesia is used. Some of the procedures are moving toward outpatient services and local anesthesia. More specific names are sometimes applied to the procedure, depending on what the target site of the effort is. For example, if a physician intends to examine the lungs, the procedure is often called pleuroscopy. The procedure takes two to four hours.

The surgeon makes two or three small incisions in the chest wall, often between the ribs. By making the incisions between the ribs, the surgeon minimizes damage to muscle and nerves and the ribs themselves. A tube is inserted in the trachea and connected to a ventilator, which is a mechanical device that assists the patient with inhaling and exhaling.



Thoracoscopy is a procedure in which a physician can view the chest cavity and the lungs by inserting an endoscope through the chest wall. Thoracoscopy is less invasive than surgical lung biopsy. *(Illustration by Electronic Illustrators Group.)*

The most common reason for a thoracoscopy is to examine a lung that has a tumor or a metastatic growth of cancer. The lung to be examined is deflated to create a space between the chest wall and the lung. The patient breathes with the other lung with the assistance of the ventilator.

A specialized endoscope, or narrow-diameter tube, with a video camera or mirrored attachment, is inserted through the chest wall. Instruments for taking necessary tissue samples are inserted through other small incisions. After tissue samples are taken, the lung is reinflated. All incisions except one are closed. The remaining open incision is used to insert a drainage tube. The tissue samples are sent to a laboratory for evaluation.

Preparation

Prior to thoracoscopy, the patient will have several routine tests, such as blood, urine and **chest x ray**. Older patients must have an electrocardiogram (a trace record of the heart activity) because the anesthesia and the lung deflation put a big load on the heart muscle. The patient should not eat or drink from midnight the night before the thoracoscopy. The anesthesia used can cause vomiting, and, because anesthesia also causes the loss of the gag reflex, a person who vomits is in danger of moving food into the lungs, which can cause serious complications and **death**.

Aftercare

After the procedure, a chest tube will remain in one of the incisions for several days to drain fluid and release residual air from the chest cavity. Hospital stays range from two to five days. Medications for pain are given as

KEY TERMS

Endoscope—Instrument designed to allow direct visual inspection of body cavities, a sort of microscope in a long access tube.

Thoracotomy—Open chest surgery.

Trachea—Tube of cartilage that carries air into and out of the lungs.

needed. After returning home, patients should do only light lifting for several weeks.

Risks

The main risks of thoracoscopy are those associated with the administration of general anesthesia. Sometimes excessive bleeding, or hemorrhage, occurs, necessitating a thoracotomy to stop it. Another risk comes when the drainage tube is removed, and the patient is vulnerable to lung collapse (**pneumothorax**).

Resources

BOOKS

Atkinson, Lucy Jo, and Nancymarie Fortunato. *Berry & Kohn's Operating Room Technique.* St. Louis: Mosby, 1996.

Manncke, Klaus, and R. David Rosin. *Minimal Access Thoracic Surgery.* London: Chapman & Hall, 1998.

"Thoracoscopy." In *Everything You Need to Know About Medical Treatments* Springhouse, PA: Springhouse Corp., 1996.

PERIODICALS

Dardes, N., E.P. Graziani, I. Fleishman, and M. Papale. "Medical Thoracoscopy in Management of Pleural Effusions." *Chest* 118, no. 4 (October 2000): 129s.

Shawgo, T., T.M. Boley, and S. Hazelrigg. "The Utility of Thoracoscopic Lung Biopsy for Diagnosis and Treatment." *Chest* 118, no. 4 (October 2000): 114s.

Tish Davidson, A.M.

Thoracotomy *see* **Lung surgery; Thoracic surgery**

Threadworm *see* **Enterobiasis**

Threadworm infection

Definition

Threadworm infection is an intestinal disease, which occasionally spreads to the skin, caused by a type of parasitic roundworm (helminth). In untreated patients, the disease has a high rate of reinfection caused by worms already present in the body. This type of disease recurrence is called autoinfection. Because of autoinfection, threadworms can remain inside humans for as long as 45 years after the initial infestation.

Description

Threadworm infection, which is also called strongyloidiasis, occurs in most countries of the world but is natural to (endemic in) tropical and subtropical climates. Strongyloidiasis is less common than other parasitic infections but may affect as much as 25% of the population in some developing countries. In the United States, threadworm infection is most likely to be found among immigrants; returning travelers or military personnel; people who live in parts of Appalachia and the southeastern states; and persons in homes for the retarded and similar institutions.

Human beings are universally susceptible to threadworm infection, although adults and older children are at greater risk of infection than younger children. The disease does not confer immunity. In addition to humans, threadworms can infect dogs, cats, horses, pigs, rats, and monkeys.

Causes and symptoms

Threadworm infection is caused by *Strongyloides stercoralis*, a roundworm that lives in soil and can survive there for several generations. Mature threadworms may grow as long as 1–2 in (2.5–5 cm). The larvae have two stages in their life cycle: a rod-shaped (rhabdoid) first stage, which is not infective; and a threadlike (filariform) stage, in which the larvae can penetrate intact human skin and internal tissues.

The infection is most commonly transmitted when a person comes into contact—usually by walking barefoot—with soil containing *S. stercoralis* larvae in their filariform stage. The threadlike larvae penetrate the skin, enter the lymphatic system, and are carried by the blood to the lungs. Once in the lungs, the larvae burst out of the capillaries into the patient's main respiratory system. They migrate upwards—usually without symptoms—to the patient's throat, where they are swallowed and carried down into the digestive tract. The filariform larvae settle in the small intestine. They mature into adults that deposit eggs that hatch—usually in the intestines— into noninfectious rhabdoid larvae. The rhabdoid larvae then migrate into the patient's large intestine and are excreted in the feces. The time from initial penetration of the skin to excretion is 17–28 days. The rhabdoid larvae metamorphose into the infective filariform stage in the soil.

Threadworms are unique among human parasites in having both free-living and parasitic forms. In the free-living life cycle, some rhabdoid larvae develop into adult worms that live in contaminated soil and produce eggs that hatch into new rhabdoid larvae. The adult worms may live as long as five years.

The signs and symptoms of threadworm infection vary according to the stage of the disease as the larvae migrate throughout the body. Patients who suffer from autoinfection may have chronic or intermittent symptoms for years after they are first infected.

Skin

The filariform larvae usually enter the body through the skin of the feet. There may be swelling, **itching**, and **hives** at the point of entry that may be confused with insect bites. Patients with chronic threadworm infection may also develop an itchy rash on their buttocks, thighs, or abdomen.

Digestive tract

Although some patients may notice only mild **diarrhea** and cramps, others may have **fever**, nausea, vomiting, general weakness, and blood or mucus in their stools. The **pain** may mimic a stomach ulcer.

Throat and lungs

When the larvae migrate to the lungs and air passages, the patient may have symptoms ranging from a simple dry **cough** to fever, difficulty breathing, and coughing up blood or pus.

Hyperinfection syndrome

Hyperinfection syndrome is a potentially fatal set of complications resulting from the spread of filariform larvae to the lungs and other organ systems. It can include inflammation of the heart tissue, stomach ulcers, perforation of the intestines, blood **poisoning**, **meningitis**, **shock**, and eventual **death**. Hyperinfection syndrome is most likely to occur in patients with immune disorders or **malnutrition**, or in those taking anti-inflammatory corticosteroid (anti-inflammatory) medications. It has been reported in only a few **AIDS** patients.

Autoinfection

Threadworm autoinfection in humans follows two patterns. In internal autoinfection, some rhabdoid larvae in the lower bowel develop into filariform larvae that enter the bloodstream from the intestines and migrate to the lungs. In external autoinfection, the skin around the patient's anus is infected by larvae in the feces.

Diagnosis

The doctor is likely to consider a diagnosis of threadworm infection when a patient has the symptoms described earlier and a history of travel or military service in areas where the disease is endemic. A definite diagnosis is made by finding rhabdoid or filariform larvae in the patient's body fluids. The larvae may be found in fresh stool specimens or in mucus coughed up when the infection has reached the lungs. Because the larvae cannot be detected in the stools of 25% of infected patients, the string test is often performed to confirm the diagnosis. In this test, the patient swallows a weighted string which is withdrawn after four hours. The digestive juices absorbed by the string are then examined for the presence of threadworm larvae.

Doctors can also use blood tests and diagnostic imaging to support the diagnosis. Between 85% and 95% of patients with threadworm infections will have a measurable level of antibodies in their blood, even though these antibodies do not prevent the disease from spreading. In addition, patients with severe infections often have unusually high levels of white cells in their blood. X rays of the intestines or the chest often help in locating specific areas of inflamed or ulcerated tissue.

Treatment

Threadworm infections are treated with medications. The drugs most often given are ivermectin, thiabendazole (Mintezol), and albendazole. Ivermectin is generally preferred because it has fewer side effects than thiabendazole. These drugs, which are taken by mouth over a period of two to seven days, work by preventing the development of eggs and new larvae. Patients with severe infections should be given protein replacement, blood transfusions, and fluids to replace losses from nausea, vomiting, and diarrhea.

Patients who are taking **corticosteroids** should be carefully evaluated if they have symptoms of threadworm infection, because these medications encourage the development of hyperinfection syndrome.

Prognosis

The prognosis for complete recovery is good for most patients, except those with hyperinfection syndrome or severe protein loss.

Prevention

There is no effective immunization against threadworm infection. Prevention of the disease requires careful attention to personal and institutional hygiene in

KEY TERMS

Antibody—A protein molecule produced by the immune system that is specific to a disease agent, such as threadworm larvae. The severity of a patient's infection can be measured from the level of antibody in the blood.

Autoinfection—An infection caused by a disease agent that is already present in the body.

Corticosteroid—A class of drugs based on hormones formed in the adrenal gland, used to reduce inflammation. They increase the likelihood of hyperinfection syndrome in patients with threadworm infection.

Endemic—Natural to or characteristic of a particular place, population, or climate. Threadworm infections are endemic in the tropics.

Filariform—Threadlike in appearance, like the infectious stage of the threadworm larva.

Helminth—A type of parasitic worm. Threadworms belong to a subcategory of helminths called nematodes, or roundworms.

Hyperinfection syndrome—A condition of massive infection in which threadworm larvae multiply rapidly and spread throughout the body. It is usually associated with damage to the immune system, the use of steroid medications, or malnutrition.

Rhabdoid—Rod- or wand-shaped, like the first stage of the threadworm larva.

String test—A test performed to diagnose threadworm infection. The patient is asked to swallow a weighted string that absorbs stomach juices, which can be analyzed for the presence of threadworm larvae.

endemic areas, including handwashing after defecating and before handling food. Other precautions include wearing shoes when visiting countries with high rates of threadworm infection, and monitoring close contacts of patients for signs of infection.

Resources

BOOKS

Genta, Robert M. "Strongyloidiasis." In *Encyclopedia of Immunology.* Vol. 3. Ed. Ivan M. Roitt and Peter J. Delves. London, UK: Academic Press, 1992.

Goldsmith, Robert S. "Infectious Diseases: Protozoal & Helminthic." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Infectious Disease: Parasitic Infections." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

McCarthy, James S., and Thomas B. Nutman. "Parasitic Diseases of the Skin." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Phillips, Elizabeth, and Jay S. Keystone. "Intestinal Parasites." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Weinberg, Adriana, and Myron J. Levin. "Infections: Parasitic & Mycotic." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Rebecca J. Frey, PhD

Throat culture

Definition

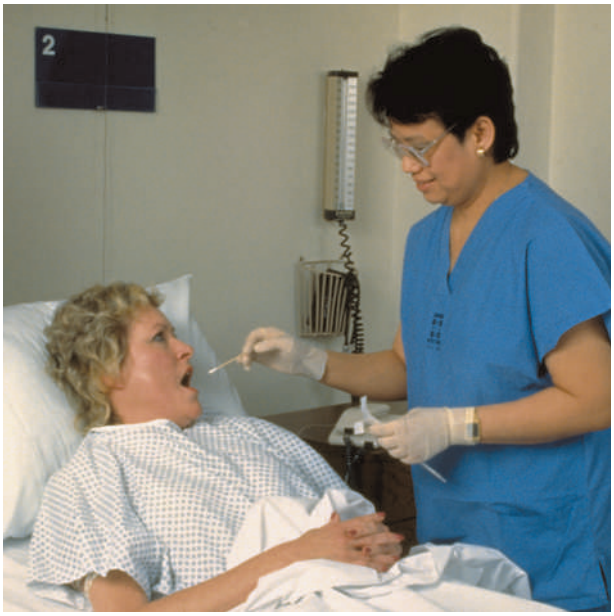
A throat culture is a technique for identifying disease bacteria in material taken from the throat. Most throat cultures are done to rule out infections caused by beta-hemolytic streptococci, which cause **strep throat**. Hemolytic means that these streptococci destroy red blood cells.

Purpose

The primary purpose of a throat culture is identification of the specific organisms that cause strep throat. These organisms are Group A streptococci, specifically *Streptococcus pyogenes*. Since most sore throats are caused by viral infections rather than by *S. pyogenes*, a correct diagnosis is important to prevent unnecessary use of **antibiotics** and to begin treatment of strep infections as soon as possible. Group A **streptococcal infections** are potentially life-threatening, often involving other parts of the body in addition to the throat. Besides causing **sore throat** (pharyngitis), streptococci can also cause **scarlet fever**, **rheumatic fever**, kidney disease, or abscesses around the tonsils.

Throat cultures can also be used to identify other disease organisms that are present in the patient's throat; and to identify people who are carriers of the organisms that cause **meningitis** and **whooping cough**.

Besides their use in diagnosis, throat cultures are sometimes used to test antibiotics for their effectiveness in treating different infections.



This nurse is taking a throat culture from a patient for laboratory analysis. *(Photograph by David Weinstein & Associates, Custom Medical Stock Photo. Reproduced by permission.)*

Precautions

Throat cultures should be taken before the patient is given any antibiotic medications. In addition, the patient's immunization history should be checked to evaluate the possibility that diseases other than strep are causing the sore throat. The care provider should wash the hands carefully after taking the specimen to prevent the spread of any infectious organisms.

Description

A throat culture test should be done on anyone who has symptoms of a strep throat. These symptoms include a sore throat that may be accompanied by a **fever**, body aches, and loss of appetite. Age is a consideration, in that strep throat is more common in children than in adults. The tonsils and the back of the throat often appear red, swollen, and streaked with pus. These symptoms usually appear one to three days after being exposed to group A strep. Because strep is highly contagious, family members and close contacts of patients diagnosed with strep throat should also have throat cultures performed if they show signs of the disease.

The specimen for throat culture is obtained by wiping the patient's throat with a cotton swab. The patient is asked to tilt the head back and open the mouth wide. With the tongue depressed and the patient saying "ah," the care provider wipes the back of the throat and the tonsils with a sterile swab. The swab is applied to any area that appears either very red or discharging pus. The swab is removed gently without touching the teeth, gums, or tongue. It is then placed in a sterile tube for immediate delivery to a laboratory. Obtaining the specimen takes less than 30 seconds. Laboratory results are usually available in two to three days. The swabbing procedure may cause gagging but is not painful. The doctor makes a note for the laboratory to indicate if any disease organisms other than strep are suspected, because some require special growth conditions in the laboratory.

S. pyogenes is cultured on a growth medium called blood agar. Agar is a gel that is made from the cell walls of red algae. Blood agar is made from agar gel and sheep's blood. When the throat swab reaches the laboratory, it is wiped across a blood agar plate. The plate is allowed to incubate for 24–48 hours to allow the growth of bacteria. If the organism is a Group A hemolytic streptococcus, the area immediately around the bacterial colony will be cleared of red blood cells. Hemolytic streptococci dissolve (lyse) red blood cells, leaving a clear zone surrounding the colony.

Alternative procedures

So-called instant strep tests are now available to help diagnose strep throat. They can be used in the doctor's office and take about 10–30 minutes to perform. Instant tests detect an antigen associated with the streptococcus. These tests are relatively new and not available at all clinics. Their reliability has improved since they were first introduced. If an instant throat test is negative, however, a standard throat culture can be performed to verify the results.

Preparation

The patient does not need to avoid food or fluids before the test. Recent gargling or treatment with antibiotics, however, will affect the culture results. The laboratory should be notified if the patient has been recently taking antibiotic medications.

Aftercare

No specific aftercare is needed.

Risks

There is a minor risk for the health professional of exposure to the patient's illness.

Normal results

Normal results would include finding organisms that grow in healthy throat tissues. These organisms include

KEY TERMS

Agar—A gel made from red algae that is used to culture certain disease agents in the laboratory.

Antibiotic—A drug given to stop the growth of bacteria. Antibiotics are ineffective against viruses.

Antigen—A substance that interacts with an antibody and causes an immune reaction.

Carrier—A person harboring an infectious disease who may be immune to it but who can give it to others.

Diphtheria—A serious disease caused by a bacterium, *Corynebacterium diphtheriae*.

Hemolytic—Able to dissolve red blood cells. The bacteria that cause strep throat are hemolytic organisms.

Streptococcus—A category (genus) of sphere-shaped bacteria that occur in pairs or chains.

Thrush—A disease occurring in the mouth or throat that is caused by a yeast, *Candida albicans*.

Whooping cough—An infectious disease of the respiratory tract caused by a bacterium, *Bordetella pertussis*.

non-hemolytic and alpha-hemolytic streptococci, some *Neisseria* species, staphylococci, **diphtheria** and hemophilus organisms, pneumococci, yeasts, and Gram-negative rods.

Abnormal results

In addition to *S. pyogenes*, other disease agents may be identified in the throat culture. Infectious agents that can be identified include *Candida albicans*, which can cause thrush; *Corynebacterium diphtheriae*, which can cause diphtheria; and *Bordetella pertussis*, which can cause whooping **cough**. In addition, the appearance of a normal organism in very high numbers may also be regarded as an abnormal result.

Resources

BOOKS

"Throat Culture." In *Illustrated Guide to Diagnostic Tests*, ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

PERIODICALS

Perkins, A. "An Approach to Diagnosing the Acute Sore Throat." *American Family Physician* 55 (Jan. 1997): 131-137.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Cindy L. A. Jones, PhD

Thromboangiitis obliterans *see* **Buerger's disease**

Thrombocyte count *see* **Platelet count**

Thrombocytopenia

Definition

Thrombocytopenia is an abnormal drop in the number of blood cells involved in forming blood clots. These cells are called platelets.

Description

Thrombocytopenia is a blood disease characterized by an abnormally low number of platelets in the bloodstream. The normal amount of platelets is usually between 150,000 and 450,000 cells per microliter of blood. A microliter is an amount equal to one one-millionth of a liter (a liter is almost equal to a quart). Platelet numbers are counted by having a blood sample collected and placing a measured amount of blood in a machine called a cell counter. When the platelet number drops below 150,000 cells per microliter of blood, this person is said to be thrombocytopenic.

Causes and symptoms

Abnormal reductions in the number of platelets are caused when abnormalities occur in any of the following three processes: decreased platelet production by the bone marrow; increased trapping of platelets by the spleen; or a more rapid than normal destruction of platelets. Persons with this condition easily bruise and can have episodes of excess bleeding (a hemorrhage).

Platelets come from megakaryocytes, which are produced in the material located within the center cavity of the bones (bone marrow). When abnormalities develop in the marrow, the marrow cells can lose their ability to produce platelets in correct amounts. The result is a lower than normal level of platelets in the blood. Drugs used in **cancer chemotherapy** can cause the marrow to mal-

function in this way, as can the presence of tumor cells in the marrow itself.

Normally, the spleen holds about one-third of the body's platelets as part of this organ's function to recycle **aging** or damaged red blood cells (the cells that carry oxygen in the blood). When liver disease or cancer of the spleen is present, the spleen can enlarge, resulting in a greater number of platelets staying in the organ. This condition results in abnormally low numbers of platelets in the blood.

Platelets can break down in unusually high amounts in persons with abnormalities in their blood vessel walls; with blood clots; or with man-made replacement heart valves. Devices placed inside blood vessels to keep them from closing (stents) due to weakened walls or fat build-up can also cause platelets to break down. In addition, infections and other changes in the immune system can speed up the removal of platelets from the circulation.

Diagnosis

Thrombocytopenia is diagnosed by having a blood sample taken and counting the platelets present in the sample. However, accurately determining the medical reason for this conditions is complex.

Once a low **platelet count** is verified, a careful evaluation of the function of the bone marrow and spleen are necessary. Improper functioning of either or both of these organs can cause thrombocytopenia. In addition, the causes for the abnormal spleen or marrow function must be investigated since different cancers, blood disorders, or liver disease can be the true cause for the drop in platelets found in the blood.

Treatment

If low platelet counts are caused by an enlarged spleen, removal of the spleen can help raise the platelet level, since the spleen is no longer there to capture the platelets. However, proper treatment for what causes the enlarged spleen is necessary as well.

Low platelet counts can indicate more serious conditions. If a dysfunctional immune system is found to be the cause for this condition, drugs like steroids or gamma globulin can be used to help maintain platelet levels in certain cases.

If low platelet levels are due to an abnormally low level of platelet production, transfusions of platelets can be given as well.

Prognosis

Thrombocytopenia can result in fatal bleeding, but it also can indicate various other, more serious, cancers and disorders that affect the blood cells. This condition requires thorough medical evaluation.

KEY TERMS

Gamma globulin—One of a group of proteins found in the blood that is involved in helping the body fight infections.

Stent—A man-made surgical device, usually tube-shaped, that is placed into a blood vessel to keep it from closing.

Transfusion—The transfer of blood from one person to another. Transfusions can be direct, in which blood is transferred from the donor to the recipient; or indirect, in which the blood is taken from the donor, stored in a container, and then given to the recipient.

Prevention

There is no known way to prevent thrombocytopenia.

Resources

BOOKS

Handin, Robert I. "Disorders of the Platelet and Vessel Wall." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Sadovsky, Richard. "Management of Heparin-Induced Thrombocytopenia." *American Family Physician* 55 (1 May 1997): 2310.

Winkelstein, Alan, and Joseph E. Kiss. "Immunohematologic Disorders." *Journal of the American Medical Association* 278 (10 Dec. 1997): 1982.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dominic De Bellis, PhD

Thrombocytosis

Definition

Thrombocytosis is a blood disorder in which the body produces a surplus of platelets (thrombocytes).

Description

Thrombocytosis is an abnormally increased number of platelets in the blood. Platelets are blood cells that stick together, helping blood to clot. Thrombocytosis is a condition that may have many causes.

Throbocytosis is classified as one of two types. Secondary thrombocytosis can be traced to another cause, such as inflammation, severe bleeding, iron deficiency, or some cancers. Primary thrombocytosis (or essential thrombocythemia) is a single disease entity, with unique clinical characteristics.

Causes and symptoms

The cause of essential thrombocytosis is unknown.

Secondary thrombocytosis may develop as a result of:

- acute hemorrhage or infection
- anemia
- arthritis and other chronic inflammations
- cancer
- exercise
- iron deficiency
- medication
- osteoporosis
- removal of the spleen (**splenectomy**)
- polycythemia vera (a disorder affecting other red blood cells, as well as platelets)
- stress
- surgery

Symptoms

Two of every three patients who have thrombocytosis do not have any symptoms of the disease at the time of diagnosis. Younger patients may remain symptom-free for years.

Enlargement of the spleen is detected in 60% of patients with thrombocytosis. The liver may also be enlarged. As many as half of all patients experience bleeding from the skin, gums, or nose; and 20–50% have some blockage of veins or arteries.

Other symptoms of thrombocytosis include:

- bloody stools
- bruising
- dizziness
- headache
- hemorrhage
- prolonged bleeding after having surgery or after having a tooth pulled
- redness or tingling of the hands and feet
- weakness. In rare instances, the lymph nodes become enlarged

The highest platelet counts usually produce the most severe symptoms. Younger patients (especially women) may not have symptoms, even though their platelet counts are very high.

Complications

Complications of thrombocytosis include **stroke**, **heart attack**, and formation of blood clots in the arms and legs.

A doctor should be notified whenever bleeding is unexplained or prolonged or the patient develops:

- chest or leg **pain**
- confusion
- numbness
- weakness

Diagnosis

The patient's symptoms suggest the presence of thrombocytosis. Blood tests confirm the diagnosis.

Bone marrow aspiration (removal of a tissue sample for microscopic examination) may also be performed.

Treatment

The key to treating secondary thrombocytosis is treating the underlying condition.

Any patient who has thrombocytosis should be encouraged not to smoke.

In young people who have no symptoms, this condition can remain stable for many years. These patients should be monitored by a physician, but may not require treatment.

Treatment for patients who do have symptoms focuses on controlling bleeding, preventing the formation of blood clots, and lowering platelet levels. Treatment for secondary thrombocytosis involves treating the condition or disease responsible for excess platelet production.

In 1997, the United States Food and Drug Administration (FDA) approved the use of anagrelide HCl (Agrylin) to reduce elevated platelet counts and decrease the risk of clot formation. Some patients have benefited from the use of hydroxyurea, an anti-cancer drug.

Low doses of **aspirin** may prevent clotting, but can cause serious hemorrhages.

If drug therapy does not bring platelet counts down to an acceptable level as rapidly as necessary, plateletpheresis may be performed. Usually combined with drug therapy and used primarily in medical emergencies, this procedure consists of:

- withdrawing blood from the patient's body
- removing platelets from the blood
- returning the platelet-depleted blood to the patient

Prognosis

Many patients with thrombocytosis remain free of complications for long periods. However, some patients may die as a result of blood clots or uncontrolled bleeding.

Prevention

There is no known way to prevent thrombocytosis.

Resources

BOOKS

Berkow, Robert, ed. *The Merck Manual of Medical Information: Home Edition*. Whitehouse Station, NJ: Merck & Co., Inc., 1997.

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

OTHER

"FDA Approves Marketing of Agrylin for Thrombocythemia." 31 May 1998 <http://www.plsgroup.com.dg/2114a.htm>.

"Primary Thrombocythemia." *The Meck Page*. 3 June 1998 <http://www.merck.com>.

"Primary Thrombocythemia." *HealthAnswers.com* 31 May 1998 <http://www.healthanswers.com>.

Maureen Haggerty

Thromboembolism *see* **Embolism**

Thrombolytic therapy

Definition

Thrombolytic therapy is the use of drugs that dissolve blood clots.

Purpose

When a blood clot forms in a blood vessel, it may cut off or severely reduce blood flow to parts of the body that are served by that blood vessel. This can cause serious damage to those parts of the body. If the clot forms in an artery that supplies blood to the heart, for example, it can cause a **heart attack**. A clot that cuts off blood to the brain can cause a **stroke**. Thrombolytic therapy is used to dissolve blood clots that could cause serious, and possibly life-threatening, damage if they are not removed. Research suggests that when used to treat stroke, thrombolytic therapy can prevent or reverse **paralysis** and other problems that otherwise might result.

Thrombolytic therapy also is used to dissolve blood clots that form in tubes put into people's bodies for medical treatments, such as dialysis or **chemotherapy**.

Description

Thrombolytic therapy uses drugs called thrombolytic agents, such as alteplase (Activase), anistreplase (Eminase), streptokinase (Streptase, Kabikinase), urokinase (Abbokinase), and tissue plasminogen activator (TPA) to dissolve clots. These drugs are given as injections, only under a physician's supervision.

Recommended dosage

The physician supervising thrombolytic therapy decides on the proper dose for each patient. He or she will take into account the type of drug, the purpose for which it is being used, and in some cases, the patient's weight.

Precautions

For thrombolytic therapy to be effective in treating stroke or heart attack, prompt medical attention is very important. The drugs must be given within a few hours of the beginning of a stroke or heart attack. However, this treatment is not right for every patient who has a heart attack or a stroke. Only a qualified medical professional can decide whether a thrombolytic agent should be used. To increase the chance of survival and reduce the risk of serious, permanent damage, anyone who has signs of a heart attack or stroke should get immediate medical help.

Thrombolytic therapy may cause bleeding. Usually this is not serious, but severe bleeding does occur in some people. This is especially likely in older people. To lower the risk of serious bleeding, people who are given this drug should move around as little as possible and should not try to get up on their own unless told to do so by a health care professional. Following all the instructions of the health care providers in charge is very important.

Thrombolytic therapy may be more likely to cause serious bleeding in people who have certain medical conditions or have recently had certain medical procedures. Before being given a thrombolytic agent, anyone with

any of these problems or conditions should tell the physician in charge about it:

- blood disease or current or past bleeding problems in any part of the body
- heart or blood vessel disease
- stroke (recent or in the past)
- high blood pressure
- brain tumor or other brain disease
- stomach ulcer or colitis
- severe liver disease
- active **tuberculosis**
- recent falls, injuries, or blows to the body or head
- recent injections into a blood vessel
- recent surgery, including dental surgery
- tubes recently placed in the body for any reason
- recent delivery of a baby

In addition, anyone who has had a recent streptococcal (strep) infection should tell the physician in charge. Some thrombolytic agents may not work properly in people who have just had a strep infection, so the physician may want to use a different drug.

People who take certain medicines may be at greater risk for severe bleeding when they are given a thrombolytic agent.

Women who are pregnant should tell the physician in charge before being given a thrombolytic agent. There is a slight chance that a woman who is given thrombolytic therapy during the first spell months of **pregnancy** will have a **miscarriage**. However, streptokinase and urokinase have both been used without problems in pregnant women.

After being treated with thrombolytic therapy, women who are breastfeeding should check with their physicians before starting to breastfeed again.

Side effects

Anyone who has **fever** or who notices bleeding or oozing from their gums, from cuts, or from the site where the thrombolytic agent was injected should immediately tell their health care provider.

People who are given thrombolytic therapy should also be alert to the signs of bleeding inside the body and should check with a physician immediately if any of the following symptoms occur:

- blood in the urine
- blood or black, tarry stools
- constipation
- coughing up blood
- vomiting blood or material that looks like coffee grounds
- nosebleeds
- unexpected or unusually heavy vaginal bleeding
- dizziness
- sudden, severe, or constant headaches
- **pain** or swelling in the abdomen or stomach
- back pain or backache
- severe or constant muscle pain or stiffness
- stiff, swollen, or painful joints

Other side effects of thrombolytic agents are possible. Anyone who has unusual symptoms during or after thrombolytic therapy should tell a health care professional.

Interactions

People who take certain medicines may be at greater risk for severe bleeding when they receive a thrombolytic agent. Anyone who is given a thrombolytic agent should tell the physician in charge about all other prescription or nonprescription (over-the-counter) medicines he or she is

KEY TERMS

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Blood clot—A hard mass that forms when blood gels.

Chemotherapy—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs.

Dialysis—A process used in people whose kidneys are not working well. By way of a filtering machine, dialysis separates waste and other useless materials from the blood—a job the kidneys usually do.

Paralysis—Loss of the ability to move one or more parts of the body.

Stroke—A serious medical event in which blood flow to the brain is stopped. This may be because of a blood clot in an artery or because an artery has burst. Strokes may cause paralysis and changes in speech, memory, and behavior.

taking. Among the medicines that may increase the chance of bleeding are:

- aspirin and other medicines for pain and inflammation
- blood thinners (anticoagulants)
- antiseizure medicines, such as Depakote (divalproex) and Depakene (valproic acid)
- cephalosporins, such as cefamandole (Mandol), cefoperazone (Cefobid), and Cefotetan (Cefotan)

Also, anyone who has been treated with anistreplase or streptokinase within the past year should tell the physician in charge. These drugs may not work properly if they are given again, so the physician may want to use a different thrombolytic agent.

Nancy Ross-Flanigan

Thrombophlebitis

Definition

Thrombophlebitis is the inflammation of a vein with blood clot formation inside the vein at the site of inflammation. Thrombophlebitis is also known as phlebitis, phlebothrombosis, and venous thrombosis.

Description

There are two parts to thrombophlebitis, inflammation of a vein and blood clot formation. If the inflammation component is minor, the disease is usually called venous or phlebothrombosis. Thrombophlebitis can occur in both deep veins and superficial veins, but most often occurs in the superficial veins of the extremities (legs and arms). Most cases occur in the legs. When thrombophlebitis occurs in a superficial vein, one that is near the surface of the skin and is visible to the eye, the disease is called superficial thrombophlebitis. Any form of injury to a blood vessel can result in thrombophlebitis. In the case of superficial thrombophlebitis, the blood clot usually attaches firmly to the wall of the affected blood vein. Since superficial blood veins do not have muscles that massage the veins, blood clots in superficial veins tend to remain where they form and seldom break loose. When thrombophlebitis occurs in a deep vein, a vein that runs deep within muscle tissue, it is called deep venous thrombosis. Deep venous thrombosis presents the threat of producing blood clots that will break loose to form emboli. These can lodge in other tissues where they can block the blood supply, typically in the lungs. This results in tissue damage and can sometimes be serious or fatal; for example, **pulmonary embolism**.

Causes and symptoms

The main symptoms are tenderness and **pain** in the area of the affected vein. Redness and/or swelling may also be seen. In the case of deep venous thrombosis, there is more swelling than is caused by superficial thrombophlebitis, and the patient may experience muscle stiffness in the affected area. There are many causes of thrombophlebitis. The main causes can be grouped into three categories; injury to blood veins, increased blood clotting, and blood stasis. When blood veins are damaged, collagen in the blood vein wall is exposed. Platelets respond to collagen by initiating the clotting process. Damage to a vein can occur as a consequence of indwelling catheters, trauma, infection, **Buerger's disease**, or the injection of irritating substances. Increased tendency of the blood to clot can be caused by malignant tumors, genetic disorders, and **oral contraceptives**. Stasis, in which the blood clots due to decreased blood flow in an area, can happen following surgery, as a consequence of **varicose veins**, as a complication of postpartum states, and following prolonged bed rest. In the case of prolonged bed rest, blood clots form because of inactivity, which allows blood to move sluggishly and stagnate (collect) in blood veins. This can lead to blood clots. These clots (also called emboli) are sometimes released when the patient stands up and resumes activity. This can present a problem if the emboli lodge in vital organs. In the case of postpartum patients, a **fever** developing four to 10 days after delivery may indicate thrombophlebitis.

Diagnosis

In superficial thrombophlebitis, the location of the clot can sometimes be seen by the unaided eye. Blood clots are hard and can usually be detected by a physician using palpation (massage). Deep venous thrombosis requires specialized diagnostic instruments to detect the blood clot. Among the instruments a physician may use are ultrasound and x ray, coupled with dye injection (venogram).

Treatment

Superficial thrombophlebitis usually resolves without treatment. If treatment of superficial thrombophlebitis is given, it is usually limited to the application of heat or anti-inflammatory drugs, like **aspirin** or ibuprofen, which also help to relieve the pain. It can take from several days to several weeks for the clot to resolve and the symptoms to completely disappear. Rarely, anticoagulant drugs may be administered. Deep venous thrombosis is a serious condition and is treated with anticoagulant drugs and by keeping the affected limb elevated. The primary objective in treating deep venous throm-

bosis is prevention of a pulmonary **embolism**. The patient usually is hospitalized during initial treatment. The prescribed anticoagulant drugs limit the ability of blood clots to grow and new clots to form. Sometimes, a drug that dissolves blood clots is administered. These drugs must be used with caution because, as the clot dissolves, it may release from the site where it formed and become an embolus. Surgery may be used if the affected vein is likely to present a long term threat of producing blood clots that will release emboli. When superficial thrombophlebitis occurs in the groin, where the superficial veins join the deep veins, the threat of emboli is present. In this case, blood clots formed in the superficial veins can extend into the much larger deep vein where they break off and are released into the blood stream. The affected veins are either removed or tied off to prevent the release of the blood clots. Tying off superficial blood veins is an outpatient procedure that can be performed with local anesthesia. The patient is capable of immediately resuming normal activities.

Prognosis

Superficial thrombophlebitis seldom progresses to a serious medical complication, although non-lethal embolisms may be produced. Deep venous thrombosis may lead to embolism, especially pulmonary embolism. This is a serious consequence of deep venous thrombosis, and is sometimes fatal.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Larsen, D. E., ed. *Mayo Clinic Family Health Book*. New York: William Morrow and Co., Inc., 1996.

John T. Lohr, PhD

Thrush *see* **Candidiasis**

Thymol *see* **Antiseptics**

Thymoma

Definition

Thymomas are the most common tumor of the thymus.

KEY TERMS

Emboli, embolus—Emboli is the plural form of embolus. Embolus is any mass of air, blood clot, or foreign body that travels through the blood stream and is capable of lodging in smaller blood vessels where they obstruct the blood flow to that vessel.

Embolism—The obstruction of a blood vessel by a blot clot.

Phlebitis—Inflammation of a vein.

Thrombus—A blood clot that forms within a blood vessel or the heart.

Description

The thymus is located in the upper chest just below the neck. It is a small organ that produces certain types of white blood cells before birth and during childhood. These white blood cells are called lymphocytes and are an important part of the body‘s immune system. Once released from the thymus, lymphocytes travel to lymph nodes where they help to fight infections. The thymus gland becomes smaller in adulthood and is gradually taken over by fat tissue.

Although rare, thymomas are the most common type of thymic **cancer**. They arise from thymic epithelial cells, which make up the covering of the thymus. Thymomas frequently contain lymphocytes, which are noncancerous. Thymomas are classified as either noninvasive (previously called “benign”) or invasive (previously called “malignant”). Noninvasive thymomas are those in which the tumor is encapsulated and easy to remove. Invasive thymomas have spread to nearby structures (such as the lungs) and are difficult to remove. Approximately 30% to 40% of thymomas are of the invasive type.

Thymoma affects men and women equally. It is usually diagnosed between the ages of 40 and 60 years. Thymomas are uncommon in children.

Causes and symptoms

The cause of thymoma is unknown. Cancer is caused when the normal mechanisms that control cell growth become disturbed, causing the cells to continually grow without stopping. This is caused by damage to the DNA in the cell.

Approximately 40% of the patients diagnosed with thymoma have no symptoms. The symptoms in the

remaining 60% of patients are caused by pressure from the enlarged thymus on the windpipe (trachea) or blood vessels, or by paraneoplastic syndromes. Paraneoplastic syndromes are collections of symptoms in cancer patients that cannot be explained by the tumor. Seventy-one percent of thymomas are associated with paraneoplastic syndromes. The most common syndromes related to thymoma are pure red cell aplasia (having abnormally low levels of red blood cells), **myasthenia gravis** (a muscular disorder), and hypogammaglobulinemia (having abnormally low levels of antibodies). These conditions are autoimmune diseases—those in which the body mounts an attack against certain normal cells of the body.

Symptoms of thymoma may include:

- **shortness of breath**
- swelling of the face
- coughing
- chest pain
- muscle weakness (especially in the eyes, neck, and chest, causing problems with vision, swallowing, and breathing)
- weakness
- dizziness
- shortness of breath
- **fatigue**

Diagnosis

The physician will conduct a complete physical exam. He or she may be able to feel a fullness in the lower neck region. Routine blood tests may be performed. Imaging studies are necessary because the symptoms of thymoma can be caused by many other diseases. Thymomas can be identified by **chest x ray**, **magnetic resonance imaging**, and computed tomography.

A biopsy may be performed, in which a small sample of the tumor is removed and examined under the microscope. However, because of the risk of "seeding" cancerous cells, biopsies are not routinely performed. There are a few different methods to biopsy a thymoma. For a **mediastinoscopy**, a wand-like lighted camera (endoscope) and special instruments are passed through a small cut in the lower neck. The surgeon can see the tumor on a monitor and can cut off small samples for microscopic analysis. Mediastinoscopy is performed under general anesthesia. Alternatively, a needle biopsy will be taken in which a long needle is passed through the skin and into the tumor. Fine needle biopsy uses a thin needle and larger-core needle biopsy uses a wider needle. Needle biopsies may be performed in conjunction with CT imaging.

Patients who are having difficulty breathing may have a **bronchoscopy** performed to examine the wind pipe. An endoscope, in this case a bronchoscope, is inserted through the mouth and into the windpipe. The physician will look for tumors and may perform biopsies.

Treatment

Clinical staging

There is more than one type of staging system for thymoma; but the Masaoka system, a surgical staging system developed in 1981, is used most often. Thymoma is categorized into four stages (I, II, III, and IV), which may be further subdivided (A and B) based on the spread of cancerous tissue. The Masaoka staging system is as follows:

- Stage I. The thymoma lies completely within the thymus.
- Stage II. The thymoma has spread out of the thymus and invaded the outer layer of the lung (pleura) or nearby fatty tissue.
- Stage III. The thymoma has spread to other neighboring tissues of the upper chest, including the outer layer of the heart (pericardium), the lungs, or the heart's main blood vessels.
- Stage IVA. The thymoma has spread throughout the pericardium and/or the pleura.
- Stage IVB. The thymoma has spread to organs in other parts of the body.

In 1999, the World Health Organization (WHO) adopted a new classification system for thymic tumors. This system is a histologic classification, which means that it is based on the microscopic features of the cells that make up the tumor. The WHO classification system ranks thymomas into types A, AB, B1, B2, B3, and C, by increasing severity.

The treatment for thymoma depends on the stage of cancer and the patients overall health. Because thymomas are so rare, there are no defined treatment plans. Treatment options include surgery, **radiation therapy**, and/or **chemotherapy**. Surgical removal of the tumor is the preferred treatment. Surgery is often the only treatment required for stage I tumors. Treatment of thymoma often relieves the symptoms caused by paraneoplastic syndromes.

A treatment that is intended to aid the primary treatment is called adjuvant therapy. For instance, chemother-

apy may be used along with surgery to treat thymoma. Stages II, III, and IV thymomas are often treated with surgery and some form of adjuvant therapy.

Surgery

Thymoma may be treated by surgically removing (resecting) the tumor and some of the nearby healthy tissue. Removal of the entire thymus gland is called a thymectomy. Surgery on the thymus is usually performed through the chest wall by splitting open the breast bone (sternum), a procedure called a median sternotomy. When complete removal of the tumor is impossible, the surgeon will remove as much of the tumor as possible (debulking surgery, subtotal resection). In these cases, If the tumor has spread, surgery may include removal of such other tissues as the pleura, pericardium, blood vessels of the heart, lung, and nerves.

Radiation therapy

Radiation therapy uses high-energy radiation from x rays and gamma rays to kill the cancer cells. Radiation given from a machine that is outside the body is called external radiation therapy. Radiation therapy is often used as adjuvant therapy following surgery to reduce the chance of cancer recurrence. Radiation may be used to kill cancer cells in cases in which the tumor was only partially removed. It may be used before surgery to shrink a large tumor. Radiation therapy is not very effective when used alone, although it may be used alone when the patient is too sick to withstand surgery.

The skin in the treated area may become red and dry and may take as long as a year to return to normal. Radiation to the chest may damage the lung, causing shortness of breath and other breathing problems. Also, the tube that goes between the mouth and stomach (esophagus) may be irritated by radiation, causing swallowing difficulties. Fatigue, upset stomach, **diarrhea**, and nausea are also common complaints of patients having radiation therapy. Most side effects go away about two to three weeks after radiation therapy has ended.

Chemotherapy

Chemotherapy uses **anticancer drugs** to kill the cancer cells. The drugs are given by mouth (orally) or intravenously. They enter the bloodstream and can travel to all parts of the body. Chemotherapy may be given before surgery to shrink a tumor, which is called neoadjuvant therapy. Thymoma cells are very sensitive to anticancer drugs, especially cisplatin, doxorubicin, and ifosfamide. Generally, a combination of drugs is given because it is more effective than a single drug in treating cancer. **Corticosteroids** are also used to treat thymoma.

The side effects of chemotherapy are significant; and include stomach upset, vomiting, appetite loss, hair loss (**alopecia**), mouth sores, and fatigue. Women may experience vaginal sores, menstrual cycle changes, and **premature menopause**. There is also an increased chance of infections.

Alternative treatment

Although alternative and complementary therapies are used by many cancer patients, very few controlled studies on the effectiveness of such therapies exist. Mind-body techniques such as prayer, **biofeedback**, visualization, **meditation**, and **yoga**, have not shown any effect in reducing cancer; but they can reduce **stress** and lessen some of the side effects of cancer treatments. Gerson, macrobiotic, orthomolecular, and Cancell therapies are ineffective treatments for cancer.

Clinical studies of hydrazine sulfate found that it had no effect on cancer and even worsened the health and well-being of the study subjects. One clinical study of the drug amygdalin (Laetrile) found that it had no effect on cancer. Laetrile can be toxic and has caused deaths. Shark cartilage has been studied as a cancer treatment and is presently being studied by the FDA in clinical studies. Although the results are mixed, clinical studies suggest that melatonin may increase the survival time and quality of life for cancer patients.

Selenium, in safe doses, may delay the progression of cancer. Laboratory and animal studies suggest that curcumin, the active ingredient of turmeric, has anticancer activity. Maitake mushrooms may boost the immune system, according to laboratory and animal studies. The results of laboratory studies suggest that mistletoe has anticancer properties; however, clinical studies have not been conducted in the United States yet.

Prognosis

The five-year survival rates for thymomas are 96% for stage I, 86% for stage II, 69% for stage III, and 50% for stage IV. Thorough (radical) surgery is associated with a longer survival rate. Almost 15% of thymoma patients develop a second cancer.

Thymomas rarely spread (metastasize) outside of the chest cavity. Metastasis is usually limited to the pleura. Invasive thymomas are prone to recurrence, even 10 to 15 years following surgery. The recurrence rates are drastically reduced and the five-year survival rates are drastically increased in patients who receive adjuvant radiation therapy.

KEY TERMS

Adjuvant therapy—A treatment that is intended to aid the primary treatment. Adjuvant treatments for thymic cancer are radiation therapy and chemotherapy.

Invasive—A descriptive term for thymoma that has spread beyond the outer wall of the thymus.

Lymphocyte—A type of white blood cell that is found in the thymus.

Neoadjuvant therapy—Radiation therapy or chemotherapy used to shrink a tumor before surgical removal of the tumor.

Paraneoplastic syndrome—A set of symptoms that is associated with cancer but is not directly caused by the cancer.

Pleura—The outer covering of the lungs.

Prevention

Because there are no known risk factors for the development of thymoma, there are no preventive measures. However, there may be an association between thymic cancer and exposure of the chest to radiation.

Resources

BOOKS

American Cancer Society's Guide to Complementary and Alternative Cancer Methods, ed. Bruss, Katherine, Salter, Christina, and Esmeralda Galan. Atlanta: American Cancer Society, 2000.

Cameron, Robert, Loehrer, Patrick, and Charles Thomas. "Neoplasms of the Mediastinum." In *Cancer: Principles & Practice of Oncology*, ed. DeVita, Vincent, Hellman, Samuel, and Steven Rosenberg. Philadelphia: Lippincott Williams & Wilkins, 2001, pp.1019- 36.

PERIODICALS

Giaccone, Giuseppe. "Treatment of Thymoma and Thymic Carcinoma." *Annals of Oncology* 11, Sup. 3 (2000): 245-6.

Muller-Hermelink, H. and A. Marx. "Thymoma." *Current Opinion in Oncology* 12 (September 2000): 426-33.

Thomas, Charles, Wright, Cameron, and Patrick Loehrer. "Thymoma: State of the Art." *Journal of Clinical Oncology* 17 (July 1999): 2280-89.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS-2345. <http://www.cancer.org>.

Cancer Research Institute, National Headquarters. 681 Fifth Ave., New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

National Institutes of Health. National Cancer Institute. 9000 Rockville Pike, Bethesda, MD 20982. Cancer Information Service: (800) 4-CANCER. <http://cancernet.nci.nih.gov>.

Belinda Rowland, Ph.D.

Thymus tumor *see* **Thymoma**

Thyroid biopsy

Definition

The thyroid biopsy is a procedure in which a sample of thyroid tissue is withdrawn for laboratory examination. The sample can be withdrawn through a needle or a surgical incision may be made to obtain a piece of thyroid tissue.

Purpose

The test is generally performed when a lump or a nodule is detected in the thyroid. The test may also be ordered if the thyroid gland is enlarged and the cause is not apparent. The biopsy is usually a test for **thyroid cancer**.

Precautions

A patient with a bleeding disorder should not have a biopsy unless the bleeding problem can be corrected by a **transfusion** of the cells that cause blood to clot (platelets).

Description

The thyroid is a butterfly-shaped gland located at the base of the neck. It produces thyroxine, a hormone that plays a very crucial role in regulating the metabolism of the body and controlling several vital functions, such as the heart beat, blood pressure, and body temperature. The thyroid also regulates childhood growth and development.

A thyroid biopsy is usually ordered when a painless lump or a nodule is detected, either by the patient or by a doctor during a routine **physical examination**. A biopsy is the only test that can accurately determine whether the lump is non-cancerous (benign) or cancerous (malignant). The biopsy can be performed in several ways.

The "fine needle aspiration" (FNA) can be done in the doctor's office. An anesthetic is not usually given.

The patient will be asked to lie on his or her back. A pillow will be placed under the shoulders and the neck will be extended. The biopsy site will be cleansed with a sterile antiseptic solution. A thin needle will be inserted into the thyroid, and a sample of thyroid cells and some fluid will be collected. The needle will be quickly withdrawn. Pressure will be applied at the biopsy site to stop the bleeding and a bandage may be used to cover the area. The test takes three to five minutes.

For "large needle biopsy," a mild sedative may be given an hour before the procedure, to relax the patient. The patient will be asked to lie on his or her back, with the head tipped back and the neck extended. The biopsy site will be thoroughly cleansed and the physician will inject a local anesthetic. A small incision (about 1 inch) will be made in the skin. The biopsy needle will be inserted through the incision into the thyroid. A sample of tissue will be removed and the needle withdrawn. Pressure is applied at the biopsy site to stem the bleeding and a bandage applied. This test takes five to ten minutes.

The "open incisional biopsy" is done in an operating room by a surgeon. The patient will be given a general anesthetic. A sedative will be given an hour before the procedure to relax the patient. An intravenous line will be placed in the arm for infusion of fluids or drugs. An endotracheal tube will be inserted through the mouth into the lungs for administering anesthetic gases. After the patient is anesthetized, a small incision is made in the neck. Either the whole thyroid or a part of it is removed. If only a portion is being removed, the surgeon may send a small piece of remaining tissue to the laboratory for immediate testing while the patient is still on the operating table. If the pathologist's report comes back stating that **cancer** is present in the remaining tissue, the entire thyroid is removed. The incision is closed with stitches. The whole procedure may take about an hour.

Preparation

The doctor should be informed of any **allergies** to medications and every medication the patient is taking. If the patient is pregnant, the doctor should be told.

The patient will be asked to sign the necessary consent forms. If a needle biopsy is done, no special preparation is needed. If a large needle biopsy is being done, the doctor may order some tests to determine the clotting ability of the blood. If an open incisional biopsy is being done, a general anesthetic is required and the patient will be asked to refrain from eating or drinking anything 8-12 hours before the test.

Aftercare

The needle used in fine needle aspiration is so thin, the whole procedure feels like a quick injection. There is no **pain** or tenderness at the site after the test. In large needle biopsy, a stinging needle prick may be felt when the local anesthetic is injected. The site may be sore for a few hours and tender for a day or two after the test.

In the open incisional biopsy, the patient will feel nothing during the procedure, because of the effects of the anesthetic and the sedative. However, the anesthetic may cause the patient to feel drowsy for several hours after the procedure. The anesthetic may also cause the patient to experience some **fatigue**, and general aches and pains for a day or two after the procedure. The endotracheal tube may make the throat feel mildly sore. If there is swelling at the biopsy site or if the patient develops a **fever**, the doctor should be notified immediately.

Risks

No risks are associated with fine needle aspiration. Large needle biopsy may cause bleeding into the thyroid gland. There is a small risk that the anesthetic used in open surgical biopsy may cause a life-threatening reaction.

Normal results

The normal appearance and architecture of the thyroid cells indicate that no cancer cells are present in the thyroid tissue.

Abnormal results

Any abnormalities of the thyroid tissue cells may indicate cancer, benign tumors, or some other thyroid disease. If cancer is suspected, the pathologist may do some more testing to identify the extent of the cancer so that it can be treated appropriately.

Resources

BOOKS

The Patient's Guide to Medical Tests. Ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

Sobel, David S., and Tom Ferguson. *The People's Book of Medical Tests*. New York: Summit Books, 1985.

ORGANIZATIONS

American Thyroid Association, Inc. Montefiore Medical Center, 111 East 210th St., Bronx, NY 10467. <http://thyroid.org>.

Thyroid Foundation of America, Inc. Ruth Sleeper Hall, RSL 350, 40 Parkman St., Boston, MA 02114-2698. (800) 832-8321.

Lata Cherath, PhD

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Endotracheal tube—A hollow tube that is inserted into the windpipe (trachea), leading to the lungs.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Thyroid cancer

Definition

Thyroid **cancer** is a disease in which the cells of the thyroid gland become abnormal, grow uncontrollably, and form a mass of cells called a tumor.

Description

Thyroid cancer is grouped into four types based on how its cells appear under a microscope. The types are papillary, follicular, medullary and anaplastic thyroid cancers. They grow at different rates and can spread to other parts of the body if left untreated.

The thyroid is a hormone-producing butterfly-shaped gland located in the neck at the base of the throat. It has two lobes, the left and the right. The thyroid uses iodine, a mineral found in some foods, to make several of its hormones. **Thyroid hormones** regulate essential body processes such as heart rate, blood pressure, body temperature, metabolism; and affect the nervous system, muscles and other organs. These hormones also play an important role in regulating childhood growth and development.

Diseases of the thyroid gland affect millions of Americans. The most common diseases of the thyroid are either **hyperthyroidism** (Graves' disease) or **hypothyroidism**, an overactive or an underactive gland, respectively. Sometimes lumps or masses may develop in the thyroid, and although most (ninety-five percent) of these lumps or nodules are noncancerous (benign), all thyroid lumps should be taken seriously. The American Cancer Society estimates that the approximately 17,200 new cases of thyroid cancer that occur in the United States account for 1% of all cancers.

Women are three times more likely to develop thyroid cancer than men. Although the disease affects teenagers and young adults, most people that develop thyroid cancer are over 50 years of age.

Causes and symptoms

The exact cause of thyroid cancer is not known; but it is more common in whites than in African Americans. Radiation was used in the 1950s and 1960s to treat **acne** and to reduce swelling in infections of the tonsils, adenoids and lymph nodes. It has been proven that this exposure is a risk factor for thyroid cancer. In some areas of the world, **diets** are low in iodine. Papillary and follicular cancers occur more frequently in these areas. Iodine deficiency is not a large problem in the United States because iodine is added to table salt and other foods. Approximately 7% of thyroid cancers are caused by the alteration (mutation) of a gene called the RET gene, which can be inherited.

Symptoms are rare so the lump is not usually painful. The symptoms of thyroid nodules are:

- a lump or nodule that can be felt in the neck is the most frequent sign of thyroid cancer
- the lymph nodes may be swollen and the voice may become hoarse because the tumor presses on the nerves leading to the voice box
- some patients experience a tight or full feeling in the neck and have difficulty breathing or swallowing

Diagnosis

Physicians use several tests to confirm the suspicion of thyroid cancer, to identify the size and location of the lump and to determine whether the lump is noncancerous (benign) or cancerous (malignant). Blood tests such as the thyroid stimulating hormone (TSH) test check thyroid function. These are drawn by a technician with a needle and take a few minutes. It takes several days to be interpreted by a pathologist. Calcitonin is produced by the C cells (parafollicular cells) of the thyroid gland when the parafollicular cells of the thyroid become cancerous. Blood calcitonin levels are used to confirm the diagnosis of medullary thyroid cancer if it is suspected.

Computed tomography scan (CT scan) or an ultrasonography (ultrasound scan) are imaging tests used to produce a picture of the thyroid and usually last less than one hour. A radiologist usually interprets the results within 24 hours. In ultrasonography, high-frequency sound waves are bounced off the thyroid. The pattern of echoes that is produced by these waves is converted into a computerized image on a television screen. This test can determine whether the lumps found in the thyroid are benign fluid-filled cysts or solid malignant tumors.

A radioactive scan may take several hours and can be used to identify any abnormal areas in the thyroid

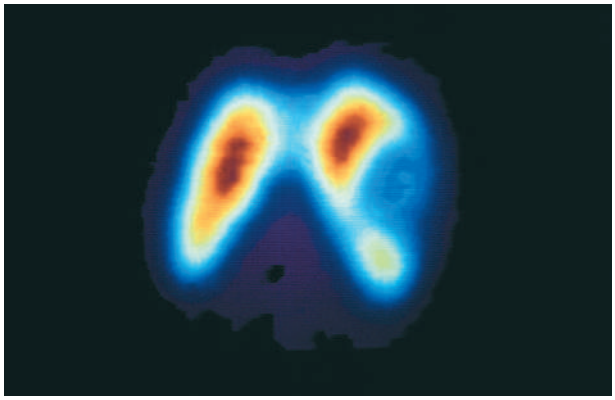
by giving the patient a very small amount of radioactive iodine, which can either be swallowed or injected into the thyroid. Since the thyroid is the only gland in the body that absorbs iodine, the radioactive iodine accumulates there. An x-ray image can then be taken or an instrument called a "scanner" can be used to identify areas in the thyroid that do not absorb iodine normally. These abnormal spots are called "cold spots" and further tests are performed to check whether the cold spots are benign or malignant tumors. If a significant amount of radioactive iodine is concentrated in the nodule, then it is termed "hot" and is usually benign. Again a radiologist interprets the results within a day.

The most accurate diagnostic tool for thyroid cancer is a biopsy. In this process a sample of thyroid tissue is withdrawn and examined under a microscope by a pathologist. This usually takes a day or so. The tissue samples can be obtained either by drawing out a sample of tissue through a needle (needle biopsy) or by surgical removal of the nodule (surgical biopsy). A needle biopsy takes a few minutes and can be done by any trained physician, usually a radiologist. The surgical biopsy is done by a surgeon under general anesthesia with the help of an anesthesiologist and will take a few hours. If thyroid cancer is diagnosed, further tests may be done to learn about the stage of the disease and help doctors plan appropriate treatment.

Treatment

The aggressiveness of each type of thyroid cancer is different. Cancer staging considers the size of the tumor, whether it has grown into surrounding lymph nodes and whether it has spread to distant parts of the body (metastasized). Age and general health status are also taken into account. In patients less than 45 years old there are only two stages. I papillary or follicular type thyroid cancer, stage I refers to patients without evidence of cancer that has spread to the body. Stage II refers to patients with spread of cancer outside the thyroid gland. In patients over 45, patients with tumors smaller than one cm are classified as stage I, those with tumors not broken through the capsule (covering) of the thyroid belong to stage II, those with tumors outside the capsule or lymph node involvement are called stage III and those with spread outside the thyroid area are stage IV. In medullary-type thyroid cancer, stage I and IV are the same. Stage II consists of patients with tumors greater than one cm and stage III comprises patients with lymph node involvement.

The papillary type (60–80% of all thyroid cancers) is a slow-growing cancer that develops in the hormone-producing cells (that contain iodine) and can be treated successfully. The follicular type (30–50% of thyroid cancers) also develops in the hormone-producing cells, has a good cure rate but may be difficult to control if the cancer invades blood vessels or grows into nearby structures in the neck. The medullary type (5–7% of all thyroid cancers) develops in the parafollicular cells (also known as the C cells) that produce calcitonin, a hormone that does not contain iodine. Medullary thyroid cancers are more difficult to control because they often spread to other parts of the body. The fourth type of thyroid cancer, anaplastic (2% of all thyroid cancers), is the fastest growing and is usually fatal because the cancer cells rapidly spread to the different parts of the body.



A gamma scan of the human thyroid gland revealing cancer. *(Custom Medical Stock Photo. Reproduced by permission.)*

More than 90% of patients who are treated for papillary or follicular cancer will live for 15 years or longer after the diagnosis of thyroid cancer. Eighty percent of patients with medullary thyroid cancer will live for at least 10 years after surgery. Only 3–17% of patients with anaplastic cancer survive for five years.

Like most cancers, cancer of the thyroid is best treated when it is found early by a primary physician. Treatment depends on the type of cancer and its stage. Four types of treatment are used: surgical removal, **radiation therapy**, hormone therapy and **chemotherapy**. Surgical removal is the usual treatment if the cancer has not spread to distant parts of the body.

The surgeon may remove the side or lobe of the thyroid where the cancer is found (lobectomy) or all of it (total **thyroidectomy**). If the adjoining lymph nodes are affected, they may also be removed during surgery. When the thyroid gland is removed and levels of thyroid hormones decrease, the pituitary gland starts to produce TSH that stimulates the thyroid cells to grow.

A radiation-oncologist uses radiation therapy with high-energy x-rays to kill cancer cells and shrink tumors. The radiation may come from a machine outside the body (external beam radiation), or the patient may be asked to swallow a drink containing radioactive iodine. Because the thyroid cells take up iodine, the radioactive iodine collects in any thyroid tissue remaining in the body and kills the cancer cells. A hematologist-oncologist uses chemotherapy either as a pill or an injection through a vein in the arm.

Alternative treatment

Hormone therapy uses hormones after surgery to stop this growth and the formation of new cancerous thyroid cells. To prevent cancerous growth, the natural hormones that are produced by the thyroid are taken in the form of pills. Thus, their levels remain normal and inhibit the pituitary gland from making TSH. If the cancer has spread to other parts of the body and surgery is not possible, hormone treatment is aimed at killing or slowing the growth of cancer cells throughout the body.

A powerful phytochemical, lycopene, gives tomatoes their red color and appears to act as an antioxidant in the body, repairing damaged cells and scavenging free radicals, the molecules responsible for most types of degenerative diseases and **aging**. Antioxidants such as lycopene help inhibit DNA oxidation, which can lead to certain forms of cancer. Lycopene is a normal constituent of human blood and tissues, where it is found in greater concentrations than beta-carotene or any other carotenoid. Tomatoes, including cooked or processed tomatoes, tomato juices, soups, sauces, paste and ketchup, contain more lycopene than any other food. Guava, rose hip, watermelon and grapefruit also contain lycopene.

Other antioxidants are: vitamin E (Dosage: 400 IU daily), vitamin C (Dosage: 1,000 to 4,000 mg daily), beta carotene (Dosage: 15 mg (25,000 IU) daily), lutein (Dosage: 6 to 20 mg daily), pycnogenol (Dosage: 25 to 50 mg daily), green tea (Dosage: 300 to 400 mg of green tea polyphenols daily), grape-seed extract (Dosage: 100 mg daily), alpha lipoic acid (Dosage: 50 to 200 mg daily), N-acetylcysteine (Dosage: 600 mg daily) and selenium (Dosage: 200 to 400 mcg daily). Pregnant women should consult a physician before taking any medication.

Prevention

Because most people with thyroid cancer have no known risk factor, it is not possible to completely prevent this disease. However, inherited cases of medullary thyroid cancer can be prevented if radiation to the neck is avoided. If a family member has had this disease, the rest of the family can be tested and treated early. The National Cancer Institute recommends that a doctor examine anyone who has received radiation to the head and neck during childhood at intervals of one or two years. The neck and the thyroid should be carefully examined for any lumps or enlargement of the nearby lymph nodes. Ultrasound may also be used to screen for the disease in people at risk for thyroid cancer.

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Calcitonin—A hormone produced by the parafollicular cells (C cells) of the thyroid. The main function of the hormone is to regulate calcium levels in body serum.

Chemotherapy—Treatment of cancer with synthetic drugs that destroy the tumor either by inhibiting the growth of the cancerous cells or by killing them.

Hormone therapy—Treatment of cancer by inhibiting the production of such hormones as testosterone and estrogen.

Hyperthyroidism—A condition in which the thyroid is overactive due to overstimulation of the thyroid cells.

Hypothyroidism—A condition in which the thyroid gland is underactive.

Lobectomy—A surgical procedure that removes one lobe of the thyroid.

Radiation therapy—Treatment with high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Total thyroidectomy—A surgical procedure that removes the entire thyroid gland.

Resources

BOOKS

Current Surgical Therapy. 6th ed. Ed. John L. Cameron. Harcourt Brace, 1998.

Harrison's Principles of Internal Medicine. 13th ed. Ed. Eugene Braunwald, et al. McGraw-Hill, 1995.

Schwartz Principles of Surgery. 6th ed. Ed. Seymour Schwartz, et al. McGraw-Hill, 1998.

ORGANIZATIONS

National Cancer Institute—Cancernet. <http://www.ilil.nci.gov/index.html>.

Kulbir Rangi, DO

Thyroid drugs *see* **Thyroid hormones**

Thyroid function tests

Definition

Thyroid function tests are blood tests used to evaluate how effectively the thyroid gland is working. These tests include the thyroid-stimulating hormone test (TSH), the thyroxine test (T_4), the triiodothyronine test (T_3), the thyroxine-binding globulin test (TBG), the triiodothyronine resin uptake test (T_3RU), and the long-acting thyroid stimulator test (LATS).

Purpose

Thyroid function tests are used to:

- help diagnose an underactive thyroid (**hypothyroidism**) and an overactive thyroid (**hyperthyroidism**)
- evaluate thyroid gland activity
- monitor response to thyroid therapy

Precautions

Thyroid treatment must be stopped one month before blood is drawn for a thyroxine (T_4) test.

Steroids, propranolol (Inderal), cholestyramine (Questran), and other medications that may influence thyroid activity are usually stopped before a triiodothyronine (T_3) test.

Estrogens, anabolic steroids, phenytoin, and thyroid medications may be discontinued prior to a thyroxine-binding globulin (TBG) test. The laboratory analyzing the blood sample must be told if the patient cannot stop taking any of these medications. Some patients will be told to take these medications as usual so that the doctor can determine how they affect thyroxine-binding globulin.

Patients are asked not to take estrogens, androgens, phenytoin (Dilantin), salicylates, and thyroid medications before having a triiodothyronine resin uptake (T_3RU) test.

Prior to taking a long-acting thyroid stimulant (LATS) test, the patient will probably be told to stop taking all drugs that could affect test results.

Description

Most doctors consider the sensitive thyroid-stimulating hormone (TSH) test to be the most accurate measure of thyroid activity. By measuring the level of TSH, doctors can determine even small problems in thyroid activity. Because this test is sensitive, abnormalities in thyroid function can be determined before a patient complains of symptoms.

TSH "tells" the thyroid gland to secrete the hormones thyroxine (T_4) and triiodothyronine (T_3). Before TSH tests were used, standard blood tests measured levels of T_4 and T_3 to determine if the thyroid gland was working properly. The triiodothyrine (T_3) test measures the amount of this hormone in the blood. T_3 is normally present in very small amounts, but has a significant impact on metabolism. It is the active component of thyroid hormone.

The thyroxine-binding globulin (TBG) test measures blood levels of this substance, which is manufactured in the liver. TBG binds to T_3 and T_4, prevents the kidneys from flushing the hormones from the blood, and releases them when and where they are needed to regulate body functions.

The triiodothyronine resin uptake (T_3RU) test measures blood T_4 levels. Laboratory analysis of this test takes several days, and it is used less often than tests whose results are available more quickly.

The long-acting thyroid stimulator (LATS) test shows whether blood contains long-acting thyroid stimulator. Not normally present in blood, LATS causes the thyroid to produce and secrete abnormally high amounts of hormones.

It takes only minutes for a nurse or medical technician to collect the blood needed for these blood tests. A needle is inserted into a vein, usually in the forearm, and a small amount of blood is collected and sent to a laboratory for testing. The patient will usually feel minor discomfort from the "stick" of the needle.

Preparation

There is no need to make any changes in diet or activities. The patient may be asked to stop taking certain medications until after the test is performed.

Aftercare

Warm compresses can be used to relieve swelling or discomfort at the site of the puncture. With a doctor's approval, the patient may start taking medications stopped before the test.

Normal results

Not all laboratories measure or record thyroid hormone levels the same way. Each laboratory will provide a range of values that are considered normal for each test. Some acceptable ranges are listed below.

TSH

Normal TSH levels for adults are 0.5–5.0 mU/L.

T_4

Normal T_4 levels are:

- 10.1–2.0 ug/dl at birth
- 7.5–16.5 ug/dl at one to four months
- 5.5–14.5 ug/dl at four to 12 months
- 5.6–12.6 ug/dl at one to six years
- 4.9–11.7 ug/dl at six to 10 years
- 4–11 ug/dl at 10 years and older.

Levels of free T_4 (thyroxine not attached to TBG) are higher in teenagers than in adults.

Normal T_4 levels do not necessarily indicate normal thyroid function. T_4 levels can register within normal ranges in a patient who:

- is pregnant
- has recently had contrast x rays
- has nephrosis or **cirrhosis**

T_3

Normal T_3 levels are:

- 90–170 ng/dl at birth
- 115–190 ng/dl at six to 12 years
- 110–230 ng/dl in adulthood.

TBG

Normal TBG levels are:

- 1.5–3.4 mg/dl or 15–34 mg/L in adults
- 2.9–5.4 mg/dl or 29–54 mg/L in children.

T_3RU

Between 25% and 35% of T_3 should bind to or be absorbed by the resin added to the blood sample. The test indirectly measures the amount of thyroid binding globulin (TBG) and thyroid-binding prealbumin (TBPA) in the blood.

LATS

Long-acting thyroid stimulator is found in the blood of only 5% of healthy people.

Abnormal results

T_4

Elevated T_4 levels can be caused by:

- acute thyroiditis
- birth control pills
- clofibrate (Altromed-S)
- contrast x rays using iodine
- estrogen therapy
- heparin
- heroin
- hyperthyroidism
- **pregnancy**
- thyrotoxicosis
- toxic thyroid adenoma

Cirrhosis and severe non-thyroid disease can raise T_4 levels slightly.

Reduced T_4 levels can be caused by:

- anabolic steroids
- androgens
- antithyroid drugs
- cretinism
- hypothyroidism
- kidney failure
- lithium (Lithane, Lithonate)
- myxedema
- phenytoin
- propranolol

T_3

Although T_3 levels usually rise and fall when T_4 levels do, T_3 toxicosis causes T_3 levels to rise while T_4 levels remain normal. T_3 toxicosis is a complication of:

- Graves' disease
- toxic adenoma
- toxic nodular **goiter**

T_3 levels normally rise when a woman is pregnant or using birth-control pills. Elevated T_3 levels can also occur in patients who use estrogen or **methadone** or who have:

- certain genetic disorders that do not involve thyroid malfunction

KEY TERMS

Acidosis—A condition in which blood and tissues are unusually acidic.

Acromegaly—A disorder in which growth hormone (a chemical released from the pituitary gland in the brain) causes increased growth in bone and soft tissue. Patients have enlarged hands, feet, noses, and ears, as well as a variety of other disturbances throughout the body.

Acute intermittent porphyria—An inherited disease affecting the liver and bone marrow. The liver overproduces a specific acid and the disease is characterized by attacks of high blood pressure, abdominal colic, psychosis, and nervous system disorders.

Anabolic steroids—Protein-building compounds used to treat certain anemias and cancers, strengthen bones, and stimulate weight gain and growth. Anabolic steroids are sometimes used to illegally enhance athletic performance.

Cholestyramine (Questran)—A drug used to bind with bile acids and prevent their reabsorption and to stimulate fat absorption.

Cirrhosis—Progressive disease of the liver, associated with failure in liver cell functioning and blood flow in the liver. Tissue and cells are damaged, the liver becomes fibrous, and jaundice can result.

Clofibrate (Altromed-S)—Medication used to lower levels of blood cholesterol and triglycerides.

Cretinism—Severe hypothyroidism that is present at birth and characterized by severe mental retardation.

Graves' disease—The most common form of hyperthyroidism, characterized by bulging eyes, rapid heart rate, and other symptoms.

Heparin—An organic acid that occurs naturally in the body and prevents blood clots. Heparin is also made synthetically and can be given as a treatment when required.

Hepatitis—Inflammation of the liver.

Hyperthyroidism—Overactive thyroid gland; symptoms include irritability/nervousness, muscle weakness, tremors, irregular menstrual periods, weight loss, sleep problems, thyroid enlargement, heat sensitivity, and vision/eye problems. The most common type of this disorder is called Graves' disease.

Hypoproteinemia—Abnormally low levels of protein in the blood.

Hypothyroidism—Underactive thyroid gland; symptoms include fatigue, difficulty swallowing, mood swings, hoarse voice, sensitivity to cold, forgetfulness, and dry/coarse skin and hair.

Lithium (Lithane, Lithromate)—Medication prescribed to treat manic (excited) phases of bipolar disorder.

Myxedema—Hypothyroidism, characterized by thick, puffy features, an enlarged tongue, and lack of emotion.

Nephrosis—Any degenerative disease of the kidney (not to be confused with nephritis, an inflammation of the kidney due to bacteria).

Nodular goiter—An enlargement of the thyroid (goiter) caused when groups of cells collect to form nodules.

Phenytoin (Dilantin)—Anti-convulsive medication used to treat seizure disorders.

Propranolol (Inderal)—Medication commonly prescribed to treat high blood pressure; is a beta-adrenergic blocker and can also be used to treat irregular heartbeat, heart attack, migraine, and tremors.

Reserpine (Serpasil)—A drug prescribed for high blood pressure.

Salicylates—Aspirin and certain other nonsteroidal anti-inflammatory drugs (NSAIDs).

Thiazides—A group of drugs used to increase urine output.

Thyroid gland—A butterfly-shaped gland in front and to the sides of the upper part of the windpipe; influences body processes like growth, development, reproduction, and metabolism.

Thyroiditis—Inflammation of the thyroid gland.

Thyrotoxicosis—A condition resulting from high levels of thyroid hormones in the blood.

Toxic thyroid adenoma—Self-contained concentrations of thyroid tissue that may produce excessive amounts of thyroid hormone.

- hyperthyroidism
- thyroiditis
- T_3 thyrotoxicosis
- toxic adenoma.

Low T_3 levels may be a symptom of:

- acute or chronic illness
- hypothyroidism
- kidney or liver disease
- starvation.

Decreased T_3 levels can also be caused by using:

- anabolic steroids
- androgens
- phenytoin
- propranolol
- reserpine (Serpasil)
- salicylates in high doses

TBG

TBG levels, normally high during pregnancy, are also high in newborns. Elevated TBG levels can also be symptoms of:

- acute hepatitis
- acute intermittent porphyria
- hypothyroidism
- inherited thyroid hormone abnormality

TBG levels can also become high by using:

- anabolic steroids
- birth control pills
- anti-thyroid agents
- clofibrate
- estrogen therapy
- phenytoin
- salicylates in high doses
- thiazides
- thyroid medications
- warfarin (Coumadin)

TBG levels can be raised or lowered by inherited liver disease whose cause is unknown.

Low TBG levels can be a symptom of:

- acromegaly
- acute hepatitis or other acute illness
- hyperthyroidism
- kidney disease
- malnutrition
- marked hypoproteinemia
- uncompensated acidosis

T_3RU

A high degree of resin uptake and high thyroxine levels indicate hyperthyroidism. A low degree of resin uptake, coupled with low thyroxine levels, is a symptom of hypothyroidism.

Thyroxine and triiodothyronine resin uptake that are not both high or low may be a symptom of a thyroxine-binding abnormality.

LATS

Long-acting thyroid stimulator, not usually found in blood, is present in the blood of 80% of patients with Graves' disease. It is a symptom of this disease whether or not symptoms of hyperthyroidism are detected.

Resources

BOOKS

A Manual of Laboratory and Diagnostic Tests. 5th ed. Ed. Francis Fishback. Philadelphia: Lippincott, 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Everything You Need to Know About Medical Tests. Ed. Michael Shaw, et al. Springhouse, PA: Springhouse Corporation, 1996.

ORGANIZATIONS

The American Thyroid Association, Inc. Montefiore Medical Center, 111 E. 210th St., Bronx, NY 10467. <http://www.thyroid.org>.

The Thyroid Foundation of America, Inc. Ruth Sleeper Hall, RSL350, 40 Parkman St., Boston, MA 02114-2698. (800) 832-8321. <http://www.tfaeweb.org/pub/tfa >.

Maureen Haggerty

Thyroid gland removal *see* **Thyroidectomy**

Thyroid hormones

Definition

Thyroid hormones are artificially made hormones that make up for a lack of natural hormones produced by the thyroid gland.

Purpose

The thyroid gland, a butterfly-shaped structure in the lower part of the neck, normally produces a hormone

called thyroxine. This hormone controls the rate of metabolism—all the physical and chemical processes that occur in cells to allow growth and maintain body functions. When the thyroid gland does not produce enough thyroxine, body processes slow down. People with underactive thyroid glands feel unusually tired and may gain weight even though they eat less. They may also have trouble staying warm and may have other symptoms, such as dry skin, dry hair, and a puffy face. By making up for the lack of natural thyroxine and bringing the rate of metabolism back to normal, artificially made thyroid hormone improves these symptoms.

Thyroid hormones also may be used to treat **goiter** (enlarged thyroid gland) and certain types of **thyroid cancer**.

Description

Thyroid hormones, also called thyroid drugs, are available only with a physician's prescription. They are sold in tablet form. A commonly used thyroid hormone is levothyroxine (Synthroid, Levoxyl, Levothroid).

Recommended dosage

For adults and teenagers, the usual starting dose of levothyroxine tablets is 0.0125 mg (12.5 micrograms) to 0.05 mg (50 micrograms) per day. The physician who prescribes the medicine may gradually increase the dose over time.

For children, the dose depends on body weight and must be determined by a physician.

Taking thyroid hormones exactly as directed is very important. The physician who prescribes the medicine will figure out exactly how much of the medicine a patient needs. Taking too much or too little can make the thyroid gland overactive or underactive.

This medicine should be taken at the same time every day.

Precautions

People who take thyroid hormones because their thyroid glands do not produce enough natural hormone may need to take the medicine for the rest of their lives. Seeing a physician regularly while taking this medicine is important. The physician will make sure that the medicine is working and that the dosage is correct.

In patients with certain kinds of heart disease, this medicine may cause chest pains and **shortness of breath** during **exercise**. People who have this problem should be careful not to exert themselves too much.

Anyone who is taking thyroid hormones should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

This medicine is safe to take during **pregnancy**, but the dosage may need to be changed. Women who are pregnant should check with their physicians to make sure they are taking the proper dosage.

Anyone who has had unusual reactions to thyroid hormones in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Before using thyroid hormones, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart disease
- high blood pressure
- hardening of the arteries
- diabetes
- history of overactive thyroid
- underactive adrenal gland
- underactive pituitary gland

Side effects

This medicine usually does not cause side effects if the dosage is right. Certain symptoms may be signs that the dose needs to be changed. Check with a physician if any of these symptoms occur:

- headache
- **fever**
- diarrhea
- vomiting
- changes in appetite
- weight loss
- changes in menstrual period
- tremors of the hands
- leg cramps
- increased sensitivity to heat
- sweating
- irritability
- nervousness
- sleep problems

KEY TERMS

Adrenal glands—A pair of glands located next to the kidneys. The adrenal glands produce hormones that control many body functions.

Hormone—A chemical that is produced in one part of the body and then travels through the bloodstream to another part of the body where it has its effect.

Pituitary gland—A pea-sized gland at the base of the brain that produces many hormones that affect growth and body functions.

Other side effects are possible. Anyone who has unusual symptoms while taking thyroid hormones should get in touch with his or her physician.

Interactions

Thyroid hormones may interact with other medicines. This may increase or decrease the effects of the thyroid medicine and may interfere with treatment. Anyone who takes thyroid hormones should not take any other prescription or nonprescription (over-the-counter) medicines without the approval of his or her physician. Among the drugs that may interact with thyroid hormones are:

- Medicine for colds, hay fever, and other allergies
- Medicine for **asthma** and other breathing problems
- Medicine for diabetes
- Blood thinners
- Amphetamines
- Diet pills (appetite suppressants)
- Cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid)

Nancy Ross-Flanigan

Thyroid nuclear medicine scan

Definition

A thyroid nuclear medicine scan is a diagnostic procedure to evaluate the thyroid gland, which is located in the front of the neck and controls the body's metabolism. A radioactive substance that concentrates in the thyroid is taken orally or injected into a vein (intravenously), or both. A special camera is used to take an image of the distribution of the radioactive substance in and around the thyroid gland. This is interpreted to evaluate thyroid function and to diagnose abnormalities.

Purpose

A thyroid scan may be ordered by a physician when the gland becomes abnormally large, especially if the enlargement is greater on one side, or when hard lumps (nodules) are felt. The scan can be helpful in determining whether the enlargement is caused by a diffuse increase in the total amount of thyroid tissue or by a nodule or nodules.

When other laboratory studies show an overactive thyroid (**hyperthyroidism**) or an underactive thyroid (**hypothyroidism**), a radioactive iodine uptake scan is often used to confirm the diagnosis. It is frequently done along with a thyroid scan.

Precautions

Women who are pregnant should not have this test.

Description

This test is performed in a radiology facility, either in an outpatient x ray center or a hospital department. Most often, the patient is given the radioactive substance in the form of a tasteless liquid or capsule. It may be injected into a vein (intravenously) in some instances. Images will be taken at a specified amount of time after this, depending on the radioisotope used. Most often, scanning is done 24 hours later, if the radioisotope is given orally. If it is given intravenously, the scan is performed approximately 20 minutes later.

For a thyroid scan, the patient is positioned lying down on his or her back, with the head tilted back. The radionuclide scanner, also called a gamma camera, is positioned above the thyroid area as it scans. This takes 30-60 minutes.

The uptake study may be done with the patient sitting upright in a chair or lying down. The procedure is otherwise the same as described for the thyroid scan. It takes approximately 15 minutes. There is no discomfort involved with either study.

A thyroid scan may also be referred to as a thyroid scintiscan. The name of the radioactive substance used may be incorporated and the study called a technetium thyroid scan or an iodine thyroid scan. The radioactive iodine uptake scan may be called by its initials, an RAIU test, or an iodine uptake test.

Preparation

Certain medications can interfere with iodine uptake. These include certain **cough** medicines, some **oral contraceptives**, and thyroid medications. The patient is usually instructed to stop taking these medicines for a period of time before the test. This period may range from several days up to three to four weeks, depending on the amount of time the medicine takes to clear from the body.

Other nuclear medicine scans and x ray studies using contrast material performed within the past 60 days may affect this test. Therefore, patients should tell their doctors if they have had either of these types of studies before the thyroid scan is begun, to avoid inaccurate results.

Some institutions prefer that the patient have nothing to eat or drink after midnight on the day before the radioactive liquid or capsule is to be taken. A normal diet can usually be resumed two hours after the radioisotope is taken. Dentures, jewelry, and other metallic objects must be removed before the scanning is performed. No other physical preparation is needed.

The patient should understand that there is no danger of radiation exposure to themselves or others. Only very small amounts of radioisotope are used. The total amount of radiation absorbed is often less than the dose received from ordinary x rays. The scanner or camera does not emit any radiation, but detects and records it from the patient.

Aftercare

No **isolation** or special precautions are needed after a thyroid scan. The patient should check with his or her physician about restarting any medications that were stopped before the scan.

Risks

There are no risks with this procedure.

Normal results

A normal scan will show a thyroid of normal size, shape, and position. The amount of radionuclide uptake by the thyroid will be normal according to established laboratory figures. There will be no areas where radionuclide uptake is increased or decreased.

Abnormal results

An area of increased radionuclide uptake may be called a hot nodule or "hot spot." This means that a benign growth is overactive. Despite the name, hot nodules are unlikely to be caused by **cancer**.

KEY TERMS

Radioisotope—A radioactive or radiation-emitting form of an element.

Radionuclide—A substance that emits radiation as it disintegrates.

An area of decreased radionuclide uptake may be called a cold nodule or "cold spot." This indicates that this area of the thyroid gland is underactive. A variety of conditions, including cysts, nonfunctioning benign growths, localized inflammation, or cancer may produce a cold spot.

A thyroid nuclear medicine scan is rarely sufficient to establish a clear diagnosis. Frequently, the information revealed will need to be combined with data from other studies to determine the problem.

Resources

BOOKS

Goldsmith, Stanley J. "Endocrine System." In *Nuclear Medicine*, ed. Donald R. Bernier, et al. St. Louis: Mosby, 1997.

PERIODICALS

Rifat, Sami T., and Mack T. Ruffin. "Management of Thyroid Nodules." *American Family Physician* 50 (15 Sept. 1994): 785-791.

Ellen S. Weber, MSN

Thyroid sonogram *see* **Thyroid ultrasound**

Thyroid ultrasound

Definition

Thyroid ultrasound is an imaging technique used for diagnosing suspected thyroid disease. It uses harmless, high-frequency sound waves to form an image. The sound waves are reflected by thyroid tissue to form a picture of internal structures. It is not invasive and involves no radiation.

Purpose

The thyroid gland is an organ located in front of the neck. It plays an important role in controlling the body's metabolism. Most thyroid ultrasounds are performed to evaluate a small lump (nodule) in the thyroid found during a **physical examination** or found by a radionuclide

study (thyroid scan). The ultrasound can establish if the nodule is a cyst, which is an abnormal lump that contains fluid, or a solid mass. Cysts are almost always noncancerous (benign), although in some cases the fluid may be taken out for additional testing.

If there are several masses or nodules, this indicates the presence of enlargement of the thyroid gland (**goiter**). If there is only one mass, it may be cancerous and needs further evaluation. Specialized thyroid ultrasounds, such as color Doppler flow studies, can add valuable information. By showing an image of the blood circulation in the gland, this study can assess some ambiguous masses in greater detail, to further refine diagnosis. In some cases, a needle will be inserted to remove some tissue from the mass for evaluation in a laboratory (needle biopsy). Ultrasound is used during this procedure to help the physician guide the needle to the mass that needs to be evaluated.

Thyroid ultrasound can measure the size of the thyroid with great precision. Ultrasound studies may be done periodically to assess the response of the thyroid gland to medical therapy. An enlarged gland or a benign nodule should decrease in size when appropriate thyroid medication is taken.

Patients who have received therapeutic radiation to the head or neck may be monitored at regular intervals using thyroid ultrasound. The radiation puts these patients at higher risk for developing **thyroid cancer** or other abnormalities. In the early stages, these conditions may not cause symptoms or be apparent during a physical examination. They can, however, be detected by ultrasound.

Certain invasive medical procedures may be performed under ultrasound guidance. This is because ultrasound allows the physician to observe a needle as it enters body tissue below the skin. This is useful to direct the removal of fluid from a cyst (aspiration) or needle biopsy. Medications to treat recurrent cysts may be administered directly to the area using ultrasound guidance.

Precautions

Thyroid ultrasound is safe for people of all ages. It is the preferred procedure to evaluate suspected disease in pregnant women because no radiation is involved.

Description

The study may be done in an outpatient facility or in a hospital department. The patient lies on his or her back. A pillow or rolled towel is placed under the shoulders and upper back, allowing the head to tilt back (hyperextend). A gel that enhances sound transmission is spread over the thyroid area. The technologist then gently places a transducer, an instrument about the size of an electric shaver, against the skin. It is moved over the thyroid area. The images from reflected sound waves appear on a monitor screen. There is no discomfort involved with this study. The examination takes 15–30 minutes.

Preparation

Some facilities recommend limiting food and drink for one hour before the study to prevent discomfort. No other preparation is needed.

Aftercare

No special restrictions or procedures are needed after a thyroid ultrasound.

Risks

There are no risks with this procedure.

Normal results

A normal study would reveal a thyroid gland of normal size, shape, position, and uniform texture.

Abnormal results

A thyroid ultrasound may reveal cysts, solid masses that may or may not be cancerous, or an enlarged thyroid gland (goiter). In many cases, the ultrasound can establish a diagnosis. Sometimes the information revealed will need to be combined with data from other studies to determine the problem.

Resources

PERIODICALS

Rifat, Sami F., and Mack T. Ruffin. "Management of Thyroid Nodules." *American Family Physician* 50 (15 Sept. 1994): 785-791.

Ellen S. Weber, MSN

Thyroid storm *see* **Hyperthyroidism**

Thyroid x ray *see* **Thyroid nuclear medicine scan**

Thyroidectomy

Definition

Thyroidectomy is a surgical procedure in which all or part of the thyroid gland is removed. The thyroid gland is located in the forward part of the neck (anterior) just under the skin and in front of the Adam's apple.

Purpose

All or part of the thyroid gland may be removed to correct a variety of abnormalities of the gland. If the patient has a **goiter** (an enlargement of the thyroid gland, causing a swelling in the front of the neck), it may cause difficulties with swallowing or breathing. **Hyperthyroidism** (over-functioning of the thyroid gland) produces hypermetabolism (abnormally increased use of oxygen, nutrients, and other materials). If medication cannot adequately treat this condition, or if the patient is a child or pregnant, the thyroid gland must be removed. Both cancerous tumors and noncancerous tumors (frequently called nodules) can occur and they must be removed, in addition to some or all of the thyroid gland.

Precautions

There are definite risks associated with the procedure. Therefore, the thyroid gland should be removed only if there is a pressing reason or medical condition that requires it.

Description

Thyroidectomy is an operative procedure done most commonly by a general surgeon, or occasionally by an otolaryngologist, in the operating room of a hospital. The operation begins when an anesthesiologist puts the patient to sleep. The anesthesiologist injects drugs into the patient's veins and then places an airway tube in the windpipe to ventilate (provide air for) the patient. The surgeon makes an incision in the front of the neck where a tight-fitting necklace would rest. He locates and takes care not to injure the parathyroid glands and the recurrent laryngeal nerves, while freeing the thyroid gland from these surrounding structures. The blood supply to the portion of the thyroid gland that is to be removed is clamped off. Then all or part of the gland is removed. If **cancer** is present, all, or almost all, of the gland is removed. If other diseases or a nodule is present, the surgeon may remove only part of the gland. The total amount of thyroid gland removed depends upon the thyroid disease being treated. A drain (a soft plastic tube that drains fluid out of the area) may be placed before the incision is closed. The incision is closed either with sutures (stitches) or metal clips. A dressing is placed over the incision and the drain, if one is used.

Patients generally stay in the hospital one to four days after completion of the operation.

Preparation

Before a thyroidectomy is performed, a variety of tests and studies are usually required to determine the nature of the thyroid disease. Laboratory analysis of blood determines the levels of active thyroid hormone circulating in the body. Sonograms and **computed tomography scans** (CT scans) help to determine the size of the thyroid gland and location of abnormalities. A **thyroid nuclear medicine scan** assesses the function of the gland. A needle biopsy of an abnormality or aspiration (removal by suction) of fluid from the thyroid gland may also be done to help determine the diagnosis.

If the diagnosis is hyperthyroidism, the patient may be asked to take antithyroid medication or iodides before the operation; or continued treatment with antithyroid drugs may be the treatment of choice. Otherwise, no other special procedure must be followed prior to the operation.

Aftercare

The incision requires little to no care after the dressing is removed. The area may be bathed gently with a mild soap. The sutures or the metal clips are removed three to seven days after the operation.

Risks

As with all operations, patients who are obese, smoke, or have poor **nutrition** are at greater risk for developing complications related to the general anesthetic itself.

Hoarseness or voice loss may develop if the recurrent laryngeal nerve was injured or destroyed during the operation. This is more apt to occur in patients who have large goiters or cancerous tumors.

Hypoparathyroidism (under-functioning of the parathyroid glands) can occur if the parathyroid glands are injured or removed at the time of the thyroidectomy.

Hypothyroidism (under-functioning of the thyroid gland) can occur if all or nearly all of the thyroid gland is removed. This may be intentional when the diagnosis is cancer. If the patient's thyroid levels remain high, he may be required to take thyroid replacement for the rest of his life.

The neck and the area surrounding the thyroid gland have a rich supply of blood vessels. Bleeding in the area of the operation may occur and be difficult to control or stop. Rarely is a blood **transfusion** required, although a hematoma (collection of blood) may develop. If this occurs, it may be life-threatening. As the hematoma enlarges, it may obstruct the airway and cause the patient to stop breathing. If a hematoma does develop in the neck, it may require drainage to clear the airway.

Wound infections can occur. If they do, the incision is drained, and there are usually no serious consequences.

KEY TERMS

Endocrinologist—A physician who specializes in treating patients who have diseases of the thyroid, parathyroid, adrenal glands, and/or the pancreas.

Hyperthyroidism—Abnormal over-functioning of the thyroid glands. Patients are hypermetabolic, lose weight, are nervous, have muscular weakness and fatigue, sweat more, and have increased urination and bowel movements. This is also called thyrotoxicosis.

Hypothyroidism—Abnormal under-functioning of the thyroid gland. Patients are hypometabolic, gain weight, and are sluggish.

Recurrent laryngeal nerve—A nerve that lies very near the parathyroid glands and serves the larynx or voice box.

Normal results

Most patients are discharged from the hospital one to four days after the procedure. Most resume their normal activities two weeks after the operation. Patients who have cancer may require subsequent treatment by an oncologist or a endocrinologist.

Resources

BOOKS

Kaplan, Edwin. "Thyroid and Parathyroid." In *Principles of Surgery*, ed. Seymour I. Schwartz, et al. New York: McGraw-Hill, 1994.

"Thyroidectomy." In *The American Medical Association Encyclopedia of Medicine*, ed. Charles B. Claymon. New York: Random House, 1989.

OTHER

"Thyroid Gland Removal." *ThriveOnline*. <http://thriveonline.oxygen.com>.

Mary Jeanne Krob, MD, FACS

Thyroiditis

Definition

Thyroiditis is inflammation of the thyroid gland, a butterfly-shaped organ next to the windpipe.

Description

The thyroid is the largest gland in the neck. It produces, secretes, and stores thyroxine (T_4), a hormone that influences the metabolism of just about every body process.

When the thyroid gland is functioning properly, hormone release is carefully regulated. When bacteria or viruses invade and inflame the gland, T_4 surges into the bloodstream and raises hormone levels that then discourage the gland from creating more T_4. Eventually the hormone stores are exhausted, the thyroid loses its ability to manufacture T_4, and an underactive thyroid (**hypothyroidism**) results.

The major cause of hypothyroidism, thyroiditis affects about 12 million people in the United States. This condition is more common in women than in men and usually develops between ages 30–50.

Hashimoto's disease

The most common type of thyroiditis is Hashimoto's disease, a painless disorder also known as:

- autoimmune thyroiditis
- chronic lymphocytic thyroiditis
- lymphadenoid **goiter**
- struma lymphomatosa

Hashimoto's disease can develop at any age, but is most common in middle-aged women. This immune system disorder runs in families, and affects about 5% of adults in the United States.

Hashimoto's disease slowly destroys thyroid tissue and robs the gland of its ability to change iodine into T_4. The condition progresses so gradually that many people who have it do not realize anything is wrong until the enlarged gland forms a goiter, a swelling seen and felt in the front of the neck. This may not happen until weeks or even years after an individual develops Hashimoto's.

Subacute thyroiditis

Much less common than Hashimoto's disease, subacute thyroiditis is a painful inflammation that develops suddenly in a patient who has had a viral infection, such as **mumps** or an upper respiratory illness. **Pain** radiates throughout the neck and patients feel ill and feverish. It may take as long as several months for normal thyroid function to resume.

Subacute thyroiditis is also called:

- DeQuervain's thyroiditis
- giant cell thyroiditis

- granulomatous thyroiditis
- subacute granulomatous thyroiditis

Silent thyroiditis

The least common of the three major types, silent thyroiditis is characterized by rigidity and slight enlargement of the thyroid gland. Postpartum thyroiditis, a form of silent thyroiditis, develops in 5–9% of all women who have recently given birth. Postpartum thyroiditis develops within a year of the baby's birth and disappears within six months.

Acute thyroiditis

Caused by acute infection, this rare disease is a medical emergency. A patient who has acute thyroiditis has a high **fever** and feels very ill. The neck is red, hot, and very tender.

Causes and symptoms

Hashimoto's disease

Hashimoto's disease develops when the immune system attacks the thyroid gland. It may be related to such hormone-related (endocrine system) disorders as:

- Addison's disease. This condition, caused by malfunction of the adrenal gland, is characterized by weakness, loss of weight and appetite, and increased sensitivity to cold.
- Diabetes mellitus. This metabolic disorder is caused by a lack of insulin production or by the body's inability to process insulin.
- Graves' disease. This disease is the most common form of **hyperthyroidism**.
- Vitiligo. This is a noncancerous skin disease characterized by unpigmented patches of skin.

Being female and having a family history of Hashimoto's thyroiditis increases the likelihood of developing the disease. Its symptoms include:

- constipation
- fatigue
- goiter or enlarged neck
- inability to tolerate cold temperatures
- weight gain, some patients' faces swell and their joints stiffen.

Subacute thyroiditis

Characterized by painful gland enlargement that is sometimes mistaken for a **sore throat** that may last for months, subacute thyroiditis often follows:

- influenza
- mumps
- upper respiratory infections
- viruses that produce cold symptoms and inflammation of the membrane that protects the brain (**meningitis**), inflammation of the sac that surrounds the heart (**pericarditis**), inflammation of the heart muscle (**myocarditis**), and other diseases

People who have subacute thyroiditis feel feverish, weak, and tired. The thyroid is sore to the touch. They may be nervous, sweat, and have trouble tolerating heat or swallowing. Symptoms of subacute thyroiditis also include:

- rapid heartbeat
- tremors
- weight loss

Silent thyroiditis

The cause of silent thyroiditis is uncertain, but the condition is believed to be an immune-system disorder triggered by **childbirth**. Although silent thyroiditis is painless, the condition's other symptoms are similar to those of subacute thyroiditis. The thyroid gland enlarges only slightly, and the eyes do not bulge.

Diagnosis

Family physicians and endocrinologists usually base a diagnosis of thyroiditis on:

- blood levels of **thyroid hormones**, thyroid-stimulating hormone, and anti-thyroid antibodies
- personal and family medical history
- the appearance of a patient's thyroid gland

Thyroid antibodies present in 95% of patients with Hashimoto's thyroiditis make it possible to diagnose this disease without surgery or biopsy. A blood test that measures sedimentation rate, an indication of the extent of inflammation, is a useful tool for diagnosing subacute thyroiditis.

Treatment

Medical therapy for thyroiditis includes:

- **antibiotics** to fight infection
- high doses of **aspirin** to relieve inflammation
- hormones to suppress or replace thyroid function
- pain medications

Cortisone drugs are sometimes prescribed to reduce persistent inflammation. In rare instances, surgery can be

used to drain infection or relieve pressure near the thyroid gland.

Hashimoto's disease

The goal of treatment for Hashimoto's disease is to prevent the thyroid gland from getting larger. Regular monitoring may be the only treatment indicated for patients whose gland is only slightly enlarged, and who show no signs of hormone deficiency. Levothyroxine (Synthroid) may be prescribed to correct hormone deficiency in a patient who has a large goiter.

Subacute thyroiditis

The goal of treatment for subacute thyroiditis is to relieve pain, reduce inflammation, and regulate hyperthyroidism. Bed rest and **beta blockers** (propranolol, nadolol) may be necessary until thyroid activity is controlled, and the patient may have to take:

- anti-inflammatory medication for several weeks
- high doses of aspirin
- other **analgesics**

If subacute thyroiditis continues for a long time, cortisone and thyroid hormone medication may be prescribed to relieve inflammation and allow the gland to rest. Glucocorticoids (prednisone) are prescribed for symptoms that do not respond to other treatment. The original problem often becomes more pronounced after these medications are discontinued.

Silent thyroiditis

Most patients who have silent thyroiditis don't need any treatment, but:

- bed rest and beta blockers are occasionally needed to regulate rapid heart beat
- inderal (propanolol) may be prescribed for brief periods of hyperthyroidism
- steroids may be prescribed for severe episodes of acute inflammation

Acute thyroiditis

Acute thyroiditis requires emergency treatment with antibiotics and surgery.

Prognosis

Thyroiditis usually responds to treatment, and some patients recover normal thyroid function without treatment. Because permanent loss of thyroid function is a possibility and life-long thyroid replacement therapy may be necessary, regular medical monitoring should continue even after the patient has apparently recovered.

Hashimoto's disease

Some cases of Hashimoto's disease remain stable for years. Others slowly progress to hypothyroidism, which is treated with thyroid **hormone replacement therapy**.

Subacute thyroiditis

Most patients with subacute thyroiditis recover fully after no more than a few months. This condition occasionally recurs, but severe or long-term complications are rare.

Silent thyroiditis

Four of every five patients with silent thyroiditis recover completely within three months. The thyroid status of these patients should be evaluated within 12 months. Because silent thyroiditis recurs in 10% of patients within three years and may progress to hypothyroidism, medical monitoring should continue for three years after recovery appears complete.

Prevention

Flu shots or immunizations for **measles**, mumps, and **rubella** may help prevent conditions associated with subacute thyroiditis. There is no known way to prevent other forms of thyroiditis.

Resources

ORGANIZATIONS

The Thyroid Foundation of America. 350 Ruth Sleeper Hall, Parkman St., Boston, MA 02114. (800) 232-8321. <http://www.clark.net/pub/tfa>.

The Thyroid Society for Education and Research. 7515 South Main St., Suite 545, Houston, TX 77030. (800) 849-7643. <http:the-thyroid-society.org/thyroid.html>.

OTHER

"Chronic Thyroiditis (Hashimoto's disease)." *Health Answers.com* 30 Apr. 1998 <http://www.healthanswers.com>.

"How do Doctors Test for Thyroiditis?" *The Thyroid Society Page*. 20 Apr. 1998 <http://the-thyroid-society.org>.

"Silent Thyroiditis." *The Merck Page*. 22 Apr. 1998 <http://www.merck.com>.

"Subacute Thyroiditis." *The Merck Page*. 22 Apr. 1998 <http://www.merck.com>.

"Subacute Thyroiditis." *HealthAnswers.com* 30 Apr. 1998 <http://healthanswers.com>.

"Thyroiditis." *ThriveOnline*. 21 Apr. 1998 <http://thriveonline.oxygen.com>.

KEY TERMS

Addison's disease—A disease that results from a deficiency in adrenocortical hormones.

Diabetes mellitus—A disorder of the pancreas. This chronic disorder of carbohydrate metabolism results in hyperglycemia and glycosuria.

Goiter—An abnormal enlargement of the thryroid gland.

Graves' disease—Also called hyperthyroidism, this disease results from overactivity of the thyroid gland.

Subacute—An abnormal condition present in a person who appears to be clinically well.

Vitiligo—A benign skin disease that results in irregular patches of skin that are totally lacking in color.

"What are the Main Types of Thyroiditis?" *The Thyroid Society Page*. 20 Apr. 1998 <http://the-thyroid-society.org>.
"What is Thyroiditis?" *The Thyroid Society Page*. 20 Apr. 1998 <http://the-thyroid-society.org>.
"Your Thyroid." *Endocrine Web Page*. 22 Apr. 1998 <http://www.endocrineweb.com>.

Maureen Haggerty

Thyrotoxicosis *see* **Hyperthyroidism**

Thyroxine-binding globulin test *see* **Thyroid function tests**

Thyroxine test *see* **Thyroid function tests**

TIA *see* **Transient ischemic attack**

Tic douloureux *see* **Trigeminal neuralgia**

Tick fever *see* **Relapsing fever**

Tilt table test

Definition

The tilt table test is a test in which a patient is positioned in a supine position and brought to a predetermined angle or angles from the horizontal position. Such positioning helps to determine the cause of any decrease in oxygen to the brain. Different types of drugs may also used in the testing process.

Purpose

The purpose of the tilt table test is to help determine appropriate therapy for individuals with **fainting** (syncope) and presyncope of unexplained origin.

Precautions

Precautions are few with the tilt table test. However, when any drug is used with this test, the appropriate precautions for that particular drug should be observed. For example, when isoproterenol or similiar drugs are used during the tilt table test, the taking of non-prescription drugs for **asthma**, **cough**, cold, or allergy; appetite suppressants; sleeping pills; or drugs containing **caffeine** should be made known to the physician prior to the test. Likewise, the physician should be informed of any **allergies** to any sympathomimetic drugs, including several of the diet pills on the market. The physician should be told of any serious heart-rhythm disorders.

Description

Syncope is described as a pathological brief loss of consciousness caused by a temporary deficiency of oxygen in the brain. Previous studies have shown the effectiveness of tilt table testing in establishing the diagnosis of neurocardiogenic syncope, and in dictating therapy in patients with syncope of unknown origin. Despite its usefulness, small numbers of patients and brief followup reports have limited the majority of studies. Sensitivity-enhancing techniques, such as the administration of isoproterenol, are applied in specific cases to children and young adults to compensate for the otherwise low sensitivity (20-30%) observed in that population.

Preparation

In order for a patient to make informed decisions about any diagnostic test or procedure, there are important questions that need to be asked prior to the procedure. The information gained will be helpful for that patient in determining benefits, risks, and cost of the procedure, and alternatives. The patient should understand the purpose of the tilt table test, and the diagnosis that the physician is trying to confirm or rule out. If the tilt table test is positive, the patient should ask questions about the frequency of false-positive results for that particular tilt table procedure, and should inquire about the next step in treatment.

Aftercare

After the procedure, the patient is asked to transfer from the supine position to a sitting position, and is observed for a short period of time. During this time and

KEY TERMS

Sympathomimetic—Denoting a drug that mimics the effects of stimulation of organs and structures by the sympathetic nervous system. The sympathetic nervous system pertains to the part of the nervous system originating in the thoracic and lumbar regions of the spinal cord. In general, it inhibits or opposes the physiological effects of another aspect of the nervous system, as in tending to reduce digestive secretions, speed up the heart, and contract the blood vessels.

Syncope—A loss of consciousness over a short period of time, caused by a temporary lack of oxygen in the brain.

Vertigo—The sensation of dizziness.

after several minutes in the sitting position, any symptoms of **dizziness** and vertigo are noted. When ready, the individual transfers from the sitting position to standing. After additional observation and taking of vital signs, the individual is allowed to go home.

Risks

Risks of the tilt table test are low, but do include significant changes in blood pressure while in the supine position, and any adverse reactions to any drugs administered during the tilt table test.

Normal results

Normal results of the tilt table test should help the physician in assessing what may or may not be the cause of the syncope.

Abnormal results

Abnormal results include any pathologic reactions to the position changes or sensitivity enhancing techniques, such as the administration of isoproterenol or other related drugs.

Resources

PERIODICALS

Tonnessen, G. E., et. al. "The Value of Tilt Table Testing with Isoproterenol in Determining Therapy in Adults with Syncope and Presyncope of Unexplained Origin." *Archives of Internal Medicine* 154, no. 14 (25 July 1994): 1613-7.

ORGANIZATIONS

American Medical Association. 515 N. State St., Chicago, IL 60612. (312) 464-5000. <http://www.ama-assn.org>.

Jeffrey P. Larson, RPT

Tinea pedis *see* **Athlete's foot**

Tinea cruris *see* **Ringworm**

Tingling *see* **Numbness and tingling**

Tinnitus

Definition

Tinnitus is hearing ringing, buzzing, or other sounds without an external cause. Patients may experience tinnitus in one or both ears or in the head.

Description

Tinnitus affects as many as 40 million adults in the United States. It is defined as either objective or subjective. In objective tinnitus, the doctor can hear the sounds, as well as the patient. Objective tinnitus is typically caused by tumors, turbulent blood flow through malformed vessels, or by rhythmic muscular spasms. Most cases of tinnitus are subjective, which means that only the patient can hear the sounds.

Causes and symptoms

Subjective tinnitus is frequently associated with **hearing loss**. About 90% of patients have sensorineural hearing loss; 5% suffer from conductive hearing loss; 5% have normal hearing. The causes of subjective tinnitus include:

- impacted ear wax
- ear infections
- hardening of the structures of the inner ear
- hearing loss related to age or excessive noise
- ototoxic medications, including **aspirin**, quinine, some **diuretics**, heavy metals, alcohol, and certain antibiotics
- meniere's syndrome
- head trauma
- systemic diseases, including **syphilis**, **hypertension**, anemia, or **hypothyroidism**
- tumors of the ear

Diagnosis

Diagnosis of tinnitus includes a **physical examination** of the patient's head and neck. The doctor will use an otoscope to examine the ears for wax, infection, or structural changes. He or she will also use a stethoscope to listen to the blood vessels in the neck. Additional tests may include the following:

Tuning fork tests

The Rinne and Weber tests are commonly used to evaluate the type and severity of hearing loss. In the Weber test, the doctor holds a tuning fork against the patient's forehead or front teeth. If the hearing loss is sensorineural, the sound radiates to the ear with better hearing; if the hearing loss is conductive, the sound will be louder in the damaged ear. In the Rinne test, the tuning fork is placed alternately on the mastoid bone (behind the ear) and in front of the ear. In conductive hearing loss, bone conduction (BC) is greater than air conduction (AC). In sensorineural hearing loss, AC is greater than BC.

Diagnostic imaging

Magnetic resonance **angiography** or **venography** (MRA and MRV) can be used to evaluate malformations of the blood vessels. **Computed tomography scans** (CT scans) or **magnetic resonance imaging** scans (MRIs) can be used to locate tumors or abnormalities of the brain stem.

Blood tests

The doctor may order a complete **blood count** (CBC) with specific antibody tests to rule out syphilis or immune system disorders.

Treatment

Some cases of tinnitus can be treated by removal of the underlying cause. These include surgical treatment of impacted ear wax, tumors, head injuries, or malformed blood vessels; discontinuance of ototoxic medications; and antibiotic treatment of infections.

Subjective tinnitus, especially that associated with age-related hearing loss, can be treated with **hearing aids**, noise generators or other masking devices, **biofeedback**, antidepressant medications, or lifestyle modifications (elimination of **smoking**, coffee, and aspirin).

Alternative treatment

A variety of alternative therapies may be helpful in the treatment of tinnitus. Dietary adjustments, including the elimination of coffee and other stimulants, may be useful, since stimulants can make tinnitus worse. In addition, reducing the amount of fat and cholesterol in the diet can help improve blood circulation to the ears. Nutritional supplementation with vitamin C, vitamin E, B **vitamins**, calcium, magnesium, potassium, and essential fatty acids is also recommended. Gingko (*Gingko biloba*) is often suggested, since it is believed to enhance circulation to the brain. **Acupuncture** treatments may help decrease the level of tinnitus sounds the patient hears, and constitutional homeopathic treatment may also be effective.

KEY TERMS

Conductive hearing loss—Hearing loss caused by loss of function in the external or middle ear.

Ménière's syndrome—A disease of the inner ear, marked by recurrent episodes of loss of balance (vertigo) and roaring in the ears lasting several hours. Its cause is unknown.

Ototoxic—Damaging to the nerves controlling the senses of hearing and balance.

Sensorineural hearing loss—Hearing loss caused by damage to the nerves or parts of the inner ear governing the sense of hearing.

Prognosis

The prognosis depends on the cause of the tinnitus and the patient's emotional response. Most patients with subjective tinnitus do not find it seriously disturbing, but about 5% have strong negative feelings. These patients are frequently helped by instruction in relaxation techniques.

Resources

BOOKS

House, John W. "Tinnitus." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

Jackler, Robert K., and Michael J. Kaplan. "Ear, Nose, & Throat." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Otolaryngology: Tinnitus." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Rowe, Lee D. "Otolaryngology—Head & Neck Surgery." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Rebecca J. Frey, PhD

Tissue compatibility *see* **Tissue typing**

Tissue plasminogen activator *see* **Thrombolytic therapy**

Tissue typing

Definition

Tissue typing is a group of procedures that determines the type of histocompatibility antigens on a person's cells or tissues. This procedure is typically used prior to transplantation of tissues or organs.

KEY TERMS

Antibody—A molecule produced by the body that is part of the immune response to attack antigens.

Antigen—A molecule that causes the body to produce an immunological response to attack the antigen.

Cornea—The transparent outer layer of the eye. It covers the iris and lens.

Lymphocyte—A class of white blood cells that are responsible for creating the immune response to antigens.

Purpose

Tissue typing is done prior to transplantation to ensure as close a match as possible between the donor and the recipient. If the histocompatibility antigens do not match well, there is a much greater chance that the recipient will reject the donated tissue.

Histocompatibility antigens are molecules on the surface of all cells in the body. The specific types of histocompatibility antigens present on a person's cells determine their identity and distinguish each person. They are a "fingerprint."

Each person has a unique set of histocompatibility antigens. If the antigens on tissue or organs from a donor do not match that of the recipient, a rejection response can occur. The recipient's immune system will detect the difference between the two sets of antigen and start a rejection response to kill the donated tissue. Except in the case of identical twins, no two people are identical in terms of their histocompatibility antigen types. However, the closer two tissues come to matching, the more likely the recipient will accept the donated tissue or organ.

Human Lymphocyte Antigens (HLA) is the name given to the most commonly used histocompatibility antigens. The antigens can be grouped into two classes: class I antigens are found on almost all cells, and class II antigens are normally found only on B lymphocytes, macrophages, monocytes, dendritic cells, and endothelial cells.

Description

Generally, typing is performed on blood cells because they are an easy sample to obtain. Blood is withdrawn from a vein in the forearm, and the cells are separated. There are a number of different techniques used to identify the antigens on the cells. Typically, specific antibodies react with the cells. Each antibody preparation is specific for one histocompatibility antigen. If the antigen is present, the antibody will bind to it. Laboratory instruments are used to detect antibody binding to the cells. Class II antigens are determined by the mixed lymphocyte reaction (MLR) or by a polymerase chain reaction (PCR). In the mixed lymphocyte reaction, lymphocyte replication occurs if there is a mismatch, and is detected by a specific assay. The PCR test is a new DNA-based test that can detect the presence or absence of antigens by determining whether cells have the genes for the antigens.

One type of transplant does not require tissue typing. In the case of corneal transplants, tissue typing is not needed because corneas do not have their own blood supply. This greatly reduces the chance that immune cells will come in contact with the cornea and recognize it as foreign. For this reason, corneas can be transplanted from any person, and there is little chance of rejection.

Normal results

Because each person has their own histocompatibility antigen "fingerprint," there is no true normal result. Each fingerprint is unique.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Beutler, E., et al., eds. *William's Hematology.* 5th ed. New York: McGraw-Hill, Inc. 1995.

Henry, J. B. *Clinical Diagnosis and Management by Laboratory Methods.* New York: W. B. Saunders Co., 1996.

John T. Lohr, PhD

TMJ *see* **Temporomandibular joint disorders**

Tobramycin *see* **Aminoglycosides; Antibiotics, ophthalmic**

Tocopherol deficiency *see* **Vitamin E deficiency**

Toenail removal *see* **Nail removal**

Tonsil removal *see* **Tonsillectomy and adenoidectomy**

KEY TERMS

Abscess—A localized area of tissue destruction and pus formation.

Adenoids—Masses of lymphoid tissue that are found in the upper throat.

Sleep apnea—A condition marked by loud snoring during sleep and periodic episodes of suspended breathing.

Tonsils—Oval masses of lymphoid tissue on each side of the throat.

Tonsillectomy and adenoidectomy

Definition

Tonsillectomy and adenoidectomy (T & A) are surgical procedures to remove the tonsils from the back of the mouth or adenoids from the back of the nasal cavity—both are are part of the lymphatic system, which is responsible for fighting infection. These operations are often performed together and are usually done on children. T & As are the most common childhood operations.

Purpose

Tonsillectomy

Tonsils are removed (with or without the adenoids) when the child has any of the following conditions:

- obstruction of the upper airway.
- sleep apnea. This is a condition in which the child snores loudly and stops breathing temporarily at intervals during sleep.
- inability to swallow properly because of enlarged tonsils.
- "hot potato" voice (breathy voice) and other speech abnormalities due to enlarged tonsils
- recurrent or persistent abscesses or throat infections

Doctors do not agree completely on the number of sore throats that make a tonsillectomy necessary. Most would agree that four cases of **strep throat** in any one year; six or more episodes of **tonsillitis** in one year; or five or more episodes of tonsillitis per year for two years indicate that the tonsils should be removed.

Adenoidectomy

Adenoids are removed (with or without the tonsils) when the child has any of the following conditions:

- alteration of facial growth because of enlarged adenoids
- upper airway obstruction
- development of an irregular bite (dental malocclusion)
- difficult speech or swallowing

Precautions

T & As are not performed as frequently today as they were in the past. One reason for a more conservative approach is that there is always some risk involved when a patient is put under general anesthesia.

In some cases, a T & A may need to be modified or postponed:

- children with cleft palates should not have the adenoids removed
- bleeding disorders; these must be brought under control before surgery
- acute tonsillitis; surgery should be postponed—usually for three to four weeks—until the infection is gone

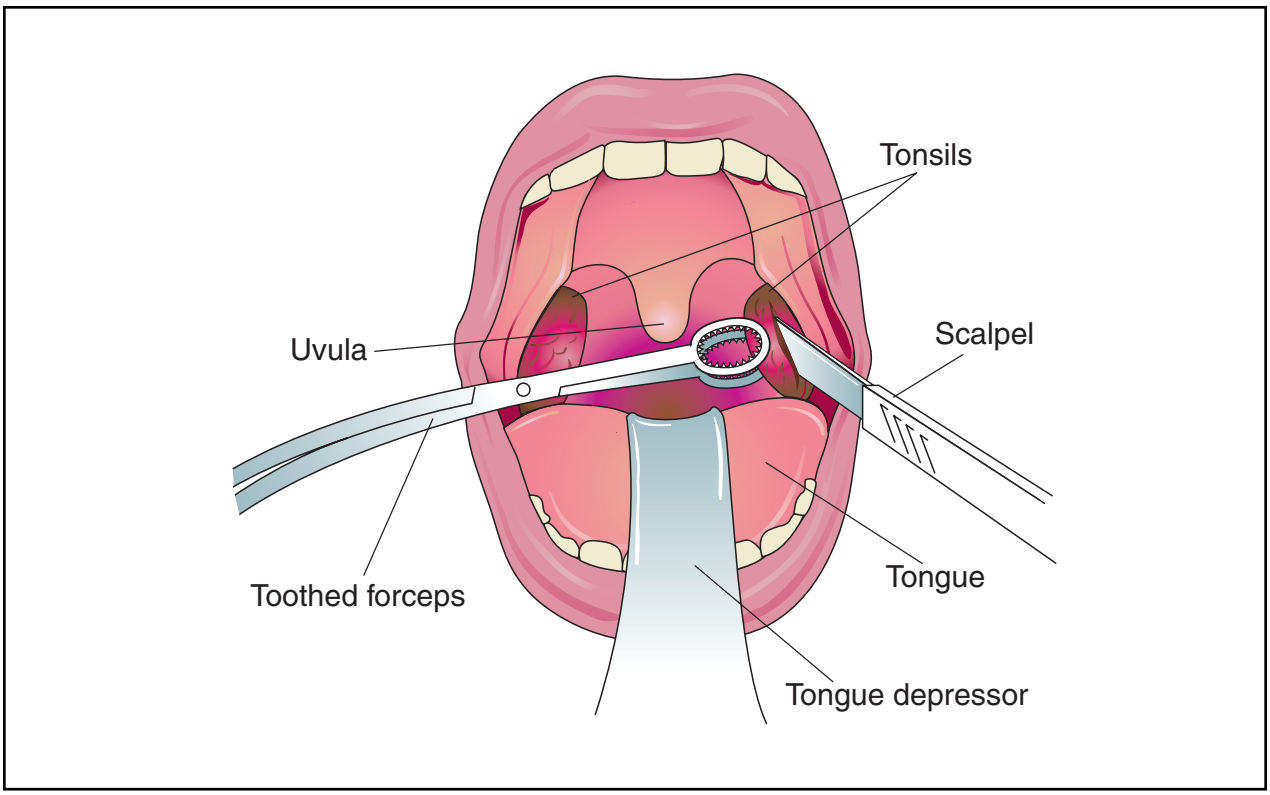
Description

Tonsillectomies are hospital procedures. In adults, they may be performed under local anesthesia. Children are usually placed under general anesthesia. The doctor depresses the tongue in order to see the throat and removes the tonsils with a scooplike instrument. The adenoids are usually removed through the nose.

Aftercare

Patients are turned on the side after the operation to prevent the possibility of blood being drawn into the lungs. The patient's vital signs are checked. After the patient is fully awake, he or she can drink water and other nonirritating liquids.

Adult patients are usually warned to expect some bleeding after the operation and a very **sore throat**.



Tonsillectomy and adenoidectomy are surgical procedures performed to remove the tonsils or adenoids. The tonsils are removed in cases where they are a source of recurrent infection or have developed an abscess. Both operations are typically performed on children. The illustration above shows a tonsillectomy in progress. *(Illustration by Electronic Illustrators Group.)*

Antibiotics are given to prevent infection. Medications to relieve **pain** may also be given. For at least the first 24 hours, the patient is fed soft or pureed foods and fluids. If the adenoids alone were removed, the patient may be allowed solid food the day after surgery.

Patients are usually sent home the next day, with instructions to call the doctor if there is bleeding, an earache, or a **fever** that lasts longer than three days. They are told to expect a white scab to form in the throat between five and 10 days after surgery.

Risks

About one in every fifteen thousand tonsillectomies ends in **death**, either from the anesthesia or from bleeding to death five to seven days after the operation. There is also a chance that children with previously normal speech will develop a nasal-sounding voice. In addition, children younger than five years may be badly emotionally upset by the hospital experience.

Normal results

Normal results include the correction of the condition for which the surgery was performed.

Resources

BOOKS

Berman, Stephen, and Ken Chan. "Ear, Nose, & Throat." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

Markel, Howard, and Frank A. Oski. *The Practical Pediatrician: The A to Z Guide to Your Child's Health, Behavior, and Safety.* New York: W. H. Freeman and Co., 1995.

"Tonsillitis." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Rebecca J. Frey, PhD

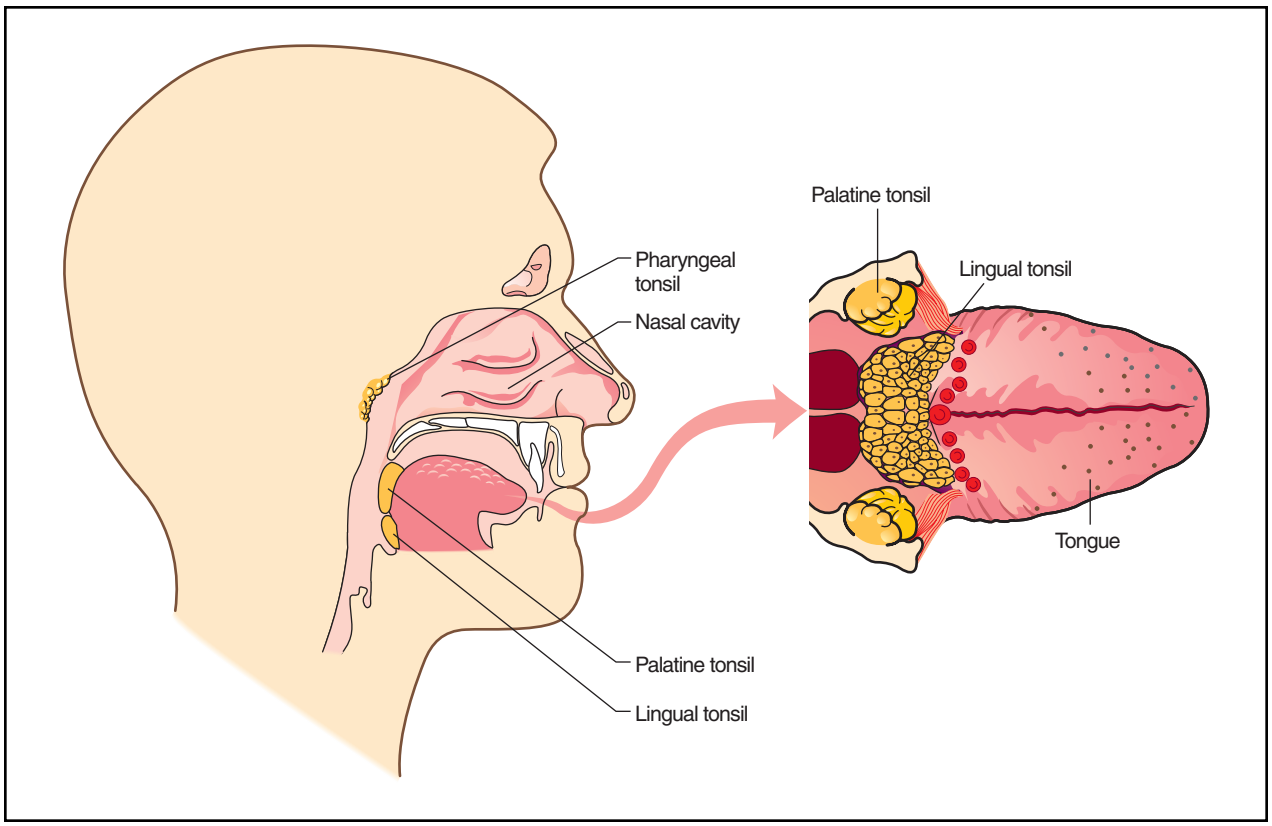
Tonsillitis

Definition

Tonsillitis is an infection and swelling of the tonsils, which are oval-shaped masses of lymph gland tissue located on both sides of the back of the throat.

Description

The tonsils normally help to prevent infections. They act like filters to trap bacteria and viruses entering



The palatine, lingual, and pharyngeal tonsils. *(Illustration by Hans & Cassady, Inc.)*

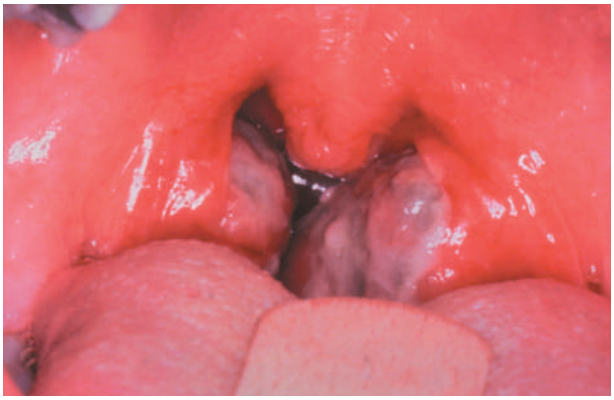
the body through the mouth and sinuses. The tonsils also stimulate the immune system to produce antibodies to help fight off infections. Anyone of any age can have tonsillitis; however, it is most common in children between the ages of five and 10 years.

Causes and symptoms

Tonsillitis is caused by viruses or bacteria that cause the tonsils to swell and become inflamed. A mild or severe **sore throat** is one of the first symptoms of tonsillitis. Symptoms can also include **fever**, chills, tiredness, muscle aches, earache, **pain** or discomfort when swallowing, and swollen glands in the neck. Very young children may be fussy and stop eating. When a doctor or nurse looks into the mouth with a flashlight, the tonsils may appear swollen and red. Sometimes, the tonsils will have white or yellow spots or flecks or a thin coating. Symptoms usually last four to six days.

Diagnosis

The diagnosis of tonsillitis is made from the visible symptoms and a **physical examination** of the patient. The doctor will examine the eyes, ears, nose, and throat, looking at the tonsils for signs of swelling, redness, or a discharge. A careful examination of the throat is necessary to rule out **diphtheria** and other conditions that may cause a sore throat. Since most sore throats in children are caused by viruses rather than bacteria, the doctor may take a **throat culture** in order to test for the presence of streptococcal bacteria. A throat culture is performed by wiping a cotton swab across the tonsils and back of the throat, and sending the swab to a laboratory for culturing. *Streptococcus pyogenes*, the bacterium that causes **strep throat**, is the most common disease agent responsible for tonsillitis. Depending on what type of test is used for strep, the doctor may be able to determine within a few minutes if *S. pyogenes* is present. The quick tests for strep are not as reliable as a laboratory culture, which can take 24–48 hours. If the results of a quick test are positive, however, the doctor can prescribe **antibiotics** right away. If the quick test results are negative, the doctor can do a throat culture to verify the results and wait for the laboratory report before prescribing antibiotics. A blood test may also be done to rule out a more serious infection or condition, and to check the white blood cell count to see if the body is responding to the infection. In some cases, the doctor may order blood tests for mononucleosis, since about a third of patients with mononucleosis develop **streptococcal infections** of the tonsils.



An examination of this patient's mouth reveals acute tonsillitis. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Treatment of tonsillitis usually involves keeping the patient comfortable while the illness runs its course. This supportive care includes bed rest, drinking extra fluids, gargling with warm salt water, and taking pain relievers—usually NSAIDs—to reduce fever. Frozen juice bars and cold fruit drinks can bring some temporary relief of sore throat pain; drinking warm tea or broth can be soothing. If the throat culture shows that *S. pyogenes* is present, penicillin or other antibiotics will be prescribed. An injection of benzathine or procaine penicillin may be most effective in treating the infection, but it is also painful. If an oral antibiotic is prescribed, it must be taken for the full course of treatment, usually 10-14 days. If the patient has several episodes of severe tonsillitis, the doctor may recommend a tonsillectomy, which is the surgical removal of the tonsils.

Alternative treatment

Strengthening the immune system is important whether tonsillitis is caused by bacteria or viruses. Naturopaths often recommend dietary supplements of vitamin C, bioflavonoids, and beta-carotenes—found naturally in fruits and vegetables—to ease inflammation and fight infection. A variety of herbal remedies also may be helpful in treating tonsillitis. Calendula (*Calendula officinalis*) and cleavers (*Galium aparine*) target the lymphatic system, while **echinacea** (*Echinacea* spp.) and astragalus (*Astragalus membranaceus*) stimulate the immune system. Goldenseal (*Hydrastis canadensis*), myrrh (*Commiphora molmol*), and bitter orange act as antibacterials. *Lomatium dissectum* and *Ligusticum porteri* have an antiviral action. Some of the homeopathic medicines that may be used to treat symptoms of tonsillitis include *Belladonna*, *Phytolacca*, *Mercurius*, *Lycopodium*, *Lachesis*, *Hepar sulphuris*, *Arsenicum*, or *Rhus toxicodendron*. As with any condition, the treatment and dosage should be appropriate for the particular symptoms and age of the patient.

Prognosis

Tonsillitis usually resolves within a few days with rest and supportive care. Treating the symptoms of sore throat and fever will make the patient more comfortable. If fever persists for more than 48 hours, however, or is higher than 102°F, the patient should be seen by a doctor. If antibiotics are prescribed to treat an infection, they should be taken as directed for the complete course of treatment, even if the patient starts to feel better in a few days. Prolonged symptoms may indicate that the patient has other upper respiratory infections, most commonly in the ears or sinuses. An **abscess** behind the tonsil (a peritonsillar abscess) may also occur. In rare cases, a persistent sore throat may point to more serious conditions, such as **rheumatic fever** or **pneumonia**.

Prevention

The bacteria and viruses that cause tonsillitis are easily spread from person to person. It is not unusual for an entire family or several students in the same classroom to come down with similar symptoms, especially if *S. pyogenes* is the cause. The risk of transmission can be lowered by avoiding exposure to anyone who already has tonsillitis or a sore throat. Drinking glasses and eating utensils should not be shared and should be washed in hot, soapy water before reuse. Old toothbrushes should be replaced to prevent reinfection. People who are caring for someone with tonsillitis should wash their hands frequently, to prevent spreading the infection to others.

Resources

BOOKS

"Ear, Nose, and Throat Disorders: Tonsillitis." In *Diseases*, ed. Margaret Eckman and Nancy Priff. Springhouse, PA: Springhouse Corporation, 1997.

"Pharyngitis & Tonsillitis." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Tonsillitis." In *The Consumer's Medical Desk Reference*, ed. Charles B. Inlander and the staff of the People's Medical Society. New York: A Stonesong Press Book, 1995.

Shaw, Michael, ed. *Everything You Need to Know About Diseases*. Springhouse, PA: Springhouse Corporation, 1996.

"Tonsillitis." In *The Merck Manual of Diagnosis and Therapy*. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Tonsillitis." In *Professional Guide to Diseases*. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

KEY TERMS

Streptococcus pyogenes—A common bacterium that causes strep throat and can also cause tonsillitis.

Tonsillectomy—A surgical procedure to remove the tonsils if the patient has recurrent sore throats or throat infections, or if the tonsils have become so swollen that the patient has trouble breathing or swallowing.

Tonsils—Oval-shaped masses of glandular tissue located on both sides at the back of the throat. Tonsils act like filters to trap bacteria and viruses.

PERIODICALS

Sataloff, Robert Thayer. "Treating Common Disorders of the Voice." *Hospital Medicine* 33 (1997): 47-60.

OTHER

"Tonsillitis." *Kids Health Page*. <http://KidsHealth.org/parent/common/tonsillitis.html>.

Altha Roberts Edgren

Tooth decay

Definition

Tooth decay, which is also called dental cavities or dental caries, is the destruction of the outer surface (enamel) of a tooth. Decay results from the action of bacteria that live in plaque, which is a sticky, whitish film formed by a protein in saliva (mucin) and sugary substances in the mouth. The plaque bacteria sticking to tooth enamel use the sugar and starch from food particles in the mouth to produce acid.

Description

Tooth decay is a common health problem, second in prevalence only to the **common cold**. It has been estimated that 90% of people in the United States have at least one cavity and that 75% of people had their first cavity by the age of five. Although anyone can have a problem with tooth decay, children and senior citizens are the two groups at highest risk. Other high-risk groups include people who eat a lot of starchy and sugary foods; people living in areas without a fluoridated water supply; and people who already have numerous dental restorations (fillings and crowns).

Baby bottle tooth decay

Baby bottle tooth decay is a dental problem that frequently develops in infants that are put to bed with a bottle containing a sweet liquid. Baby bottle tooth decay is also called nursing-bottle caries and bottle-mouth syndrome. Bottles containing such liquids as milk, formula, fruit juices, sweetened drink mixes, and sugar water continuously bathe an infant's mouth with sugar during naps or at night. The bacteria in the mouth use this sugar to produce acid that destroys the child's teeth. The upper front teeth are typically the ones most severely damaged; the lower front teeth receive some protection from the tongue. Pacifiers dipped in sugar, honey, corn syrup, or other sweetened liquid also contribute to bottle-mouth syndrome. The first signs of damage are chalky white spots or lines across the teeth. As decay progresses, the damage to the child's teeth becomes obvious.

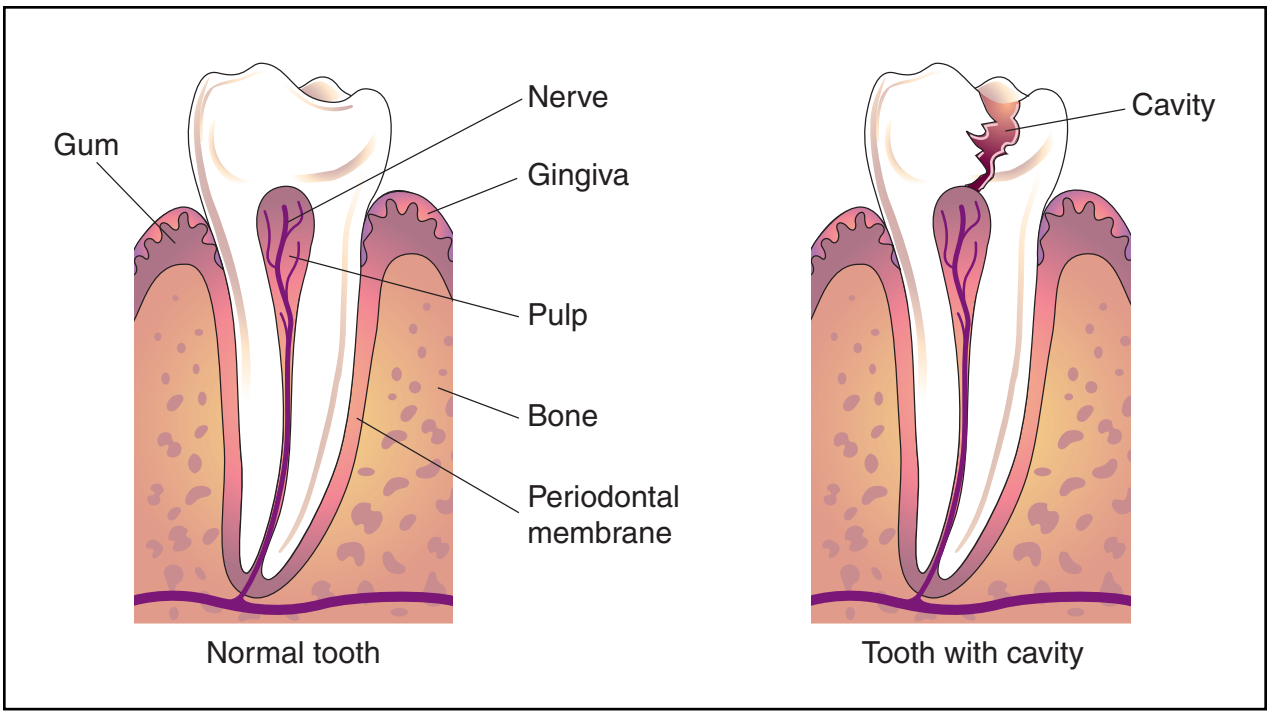
Causes and symptoms

Tooth decay requires the simultaneous presence of three factors: plaque bacteria, sugar, and a vulnerable tooth surface. Although several microorganisms found in the mouth can cause tooth decay, the primary disease agent appears to be *Streptococcus mutans*. The sugars used by the bacteria are simple sugars such as glucose, sucrose, and lactose. They are converted primarily into lactic acid. When this acid builds up on an unprotected tooth surface, it dissolves the **minerals** in the enamel, creating holes and weak spots (cavities). As the decay spreads inward into the middle layer (the dentin), the tooth becomes more sensitive to temperature and touch. When the decay reaches the center of the tooth (the pulp), the resulting inflammation (pulpitis) produces a **toothache**.

Diagnosis

Tooth decay develops at varying rates. It may be found during a routine six-month dental checkup before the patient is even aware of a problem. In other cases, the patient may experience common early symptoms, such as sensitivity to hot and cold liquids or localized discomfort after eating very sweet foods. The dentist or dental hygienist may suspect tooth decay if a dark spot or a pit is seen during a visual examination. Front teeth may be inspected for decay by shining a light from behind the tooth. This method is called transillumination. Areas of decay, especially between the teeth, will appear as noticeable shadows when teeth are transilluminated. X rays may be taken to confirm the presence and extent of the decay. The dentist then makes the final clinical diagnosis by probing the enamel with a sharp instrument.

Tooth decay in pits and fissures may be differentiated from dark shadows in the crevices of the chewing sur-



Tooth decay is the destruction of the outer surface, or enamel, of a tooth. It is caused by acid buildup from plaque bacteria, which dissolves the minerals in the enamel and creates cavities. *(Illustration by Electronic Illustrators Group.)*

faces by a dye that selectively stains parts of the tooth that have lost mineral content. A dentist can also use this dye to tell whether all tooth decay has been removed from a cavity before placing a filling.

Diagnosis in children

Damage caused by baby bottle tooth decay is often not diagnosed until the child has a severe problem, because parents seldom bring infants and toddlers in for dental check-ups. Dentists want to initially examine primary teeth between 12 and 24 months. Children still drinking from a bottle anytime after their first birthday are likely to have tooth decay.

Treatment

To treat most cases of tooth decay in adults, the dentist removes all decayed tooth structure, shapes the sides of the cavity, and fills the cavity with an appropriate material, such as silver amalgam or composite resin. The filling is put in to restore and protect the tooth. If decay has attacked the pulp, the dentist or a specialist called an endodontist may perform **root canal treatment** and cover the tooth with a crown.

In cases of baby bottle tooth decay, the dentist must assess the extent of the damage before deciding on the treatment method. If the problem is caught early, the teeth involved can be treated with fluoride, followed by changes in the infant's feeding habits and better **oral hygiene**. Primary teeth with obvious decay in the enamel that has not yet progressed to the pulp need to be protected with stainless steel crowns. Fillings are not usually an option in small children because of the small size of their teeth and the concern of recurrent decay. When the decay has advanced to the pulp, pulling the tooth is often the treatment of choice. Unfortunately, loss of primary teeth at this age may hinder the young child's ability to eat and speak. It may also have bad effects on the alignment and spacing of the permanent teeth when they come in.

Prognosis

With timely diagnosis and treatment, the progression of tooth decay can be stopped without extended **pain**. If the pulp of the tooth is infected, the infection may be treated with **antibiotics** prior to root canal treatment or extraction. The longer decay goes untreated, however, the more destructive it becomes and the longer and more intensive the necessary treatment will be. In addition, a patient with two or more areas of tooth decay is at increased risk of developing additional cavities in the future.

Prevention

It is easier and less expensive to prevent tooth decay than to treat it. The four major prevention strategies include: proper oral hygiene; fluoride; sealants; and attention to diet.

Oral hygiene

GENERAL CARE OF THE MOUTH. The best way to prevent tooth decay is to brush the teeth at least twice a day, preferably after every meal and snack, and floss daily. Cavities develop most easily in spaces that are hard to clean. These areas include surface grooves, spaces between teeth, and the area below the gum line. Effective brushing cleans each outer tooth surface, inner tooth surface, and the horizontal chewing surfaces of the back teeth, as well as the tongue. Flossing once a day also helps prevent gum disease by removing food particles and plaque at and below the gum line, as well as between teeth. Patients should visit their dentist every six months for oral examination and professional cleaning.

MOUTH CARE IN OLDER ADULTS. Older adults who have lost teeth or had them removed still need to maintain a clean mouth. Bridges and dentures must be kept clean to prevent gum disease. Dentures should be relined and adjusted by a dentist whenever necessary to maintain proper fit. These adjustments help to keep the gums from becoming red, swollen, and tender.

MOUTH CARE IN CHILDREN. Parents can easily prevent baby bottle tooth decay by not allowing a child to fall asleep with a bottle containing sweetened liquids. Bottles should be filled only with plain, unsweetened water. The child should be introduced to drinking from a cup around six months of age and weaned from bottles by twelve months. If an infant seems to need oral comfort between feedings, a pacifier specially designed for the mouth may be used. Pacifiers, however, should never be dipped in honey, corn syrup, or other sweet liquids. After the eruption of the first tooth, parents should begin routinely wiping the infant's teeth and gums with a moist piece of gauze or a soft cloth, especially right before bedtime. Parents may begin brushing a child's teeth with a small, soft toothbrush at about two years of age, when most of the primary teeth have come in. They should apply only a very small amount (the size of a pea) of toothpaste containing fluoride. Too much fluoride may cause spotting (fluorosis) of the tooth enamel. As the child grows, he or she will learn to handle the toothbrush, but parents should control the application of toothpaste and do the followup brushing until the child is about seven years old.

Fluoride application

Fluoride is a natural substance that slows the destruction of enamel and helps to repair minor tooth decay damage by remineralizing tooth structure. Toothpaste, mouthwash, fluoridated public drinking water, and vitamin supplements are all possible sources of fluoride. Children living in areas without fluoridated water should receive 0.5 mg/day of fluoride (0.25 mg/day if using a toothpaste containing fluoride) from three to five years of age, and 1 mg/day from six to 12 years.

While fluoride is important for protecting children's developing teeth, it is also of benefit to older adults with receding gums. It helps to protect their newly exposed tooth surfaces from decay. Older adults can be treated by a dentist with a fluoride solution that is painted onto selected portions of the teeth or poured into a fitted tray and held against all the teeth.

Sealants

Because fluoride is most beneficial on the smooth surfaces of teeth, sealants were developed to protect the irregular surfaces of teeth. A sealant is a thin plastic coating that is painted over the grooves of chewing surfaces to prevent food and plaque from being trapped there. Sealant treatment is painless because no part of the tooth is removed, although the tooth surface is etched with acid so that the plastic will adhere to the rough surface. Sealants are usually clear or tooth-colored, making them less noticeable than silver fillings. They cost less than fillings and can last up to 10 years, although they should be checked for wear at every dental visit. Children should get sealants on their first permanent "6-year" molars, which come in between the ages of five and seven, and on the second permanent "12-year" molars, which come in between the ages of 11 and 14. Sealants should be applied to the teeth shortly after they erupt, before decay can set in. Although sealants have been used in the United States for about 25 years, one survey by the National Institute of Dental Research reported that fewer than 8% of American children have them.

Diet

The risk of tooth decay can be lowered by choosing foods wisely and eating less often. Foods high in sugar and starch, especially when eaten between meals, increase the risk of cavities. The bacteria in the mouth use sugar and starch to produce the acid that destroys the enamel. The damage increases with more frequent eating and longer periods of eating. For better dental health, people should eat a variety of foods, limit the number of snacks, avoid sticky and overly sweetened foods, and brush often after eating.

Drinking water is also beneficial for rinsing food particles from the mouth. Children can be taught to "swish and swallow" if they are unable to brush after lunch at school. Similarly, saliva stimulated during eating

KEY TERMS

Amalgam—A mixture (alloy) of silver and several other metals, used by dentists to make fillings for cavities.

Caries—The medical term for tooth decay.

Cavity—A hole or weak spot in the tooth surface caused by decay.

Dentin—The middle layer of a tooth, which makes up most of the tooth's mass.

Enamel—The hard, outermost surface of a tooth.

Fluoride—A chemical compound containing fluorine that is used to treat water or applied directly to teeth to prevent decay.

Mucin—A protein in saliva that combines with sugars in the mouth to form plaque.

Plaque—A thin, sticky, colorless film that forms on teeth. Plaque is composed of mucin, sugars from food, and bacteria that live in the plaque.

Pulp—The soft, innermost layer of a tooth containing blood vessels and nerves.

Sealant—A thin plastic substance that is painted over teeth as an anti-cavity measure to seal out food particles and acids produced by bacteria.

Transillumination—A technique of checking for tooth decay by shining a light behind the patient's teeth. Decayed areas show up as spots or shadows.

makes it more difficult for food and bacteria to stick to tooth surfaces. Saliva also appears to have a buffering effect on the acid produced by the plaque bacteria and to act as a remineralizing agent. Older patients should be made aware that some prescription medications may decrease salivary flow. Less saliva tends to increase the activity of plaque bacteria and encourage further tooth decay. Chewing sugarless gum increases salivation and thus helps to lower the risk of tooth decay.

Resources

BOOKS

"Dental Caries and Its Complications—Tooth Decay." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

ORGANIZATIONS

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

American Dental Hygienists' Association. 444 North Michigan Ave., Chicago, IL 60611. (800)847-6718.

National Institute of Dental Research. 31 Center Drive, MSC 2190, Building 31, Room 5B49, Bethesda, MD 20892-2190.

OTHER

Healthtouch Online Page. <http://www.healthtouch.com>.

Bethany Thivierge

Tooth extraction

Definition

Tooth extraction is the removal of a tooth from its socket in the bone.

Purpose

Extraction is performed for positional, structural, or economic reasons. Teeth are often removed because they are impacted. Teeth become impacted when they are prevented from growing into their normal position in the mouth by gum tissue, bone, or other teeth. Impaction is a common reason for the extraction of wisdom teeth. Extraction is the only known method that will prevent further problems. Teeth may also be extracted to make more room in the mouth prior to straightening the remaining teeth (orthodontic treatment), or because they are so badly positioned that straightening is impossible. Extraction may be used to remove teeth that are so badly decayed or broken that they cannot be restored. In addition, patients sometimes choose extraction as a less expensive alternative to filling or placing a crown on a severely decayed tooth.

Precautions

In some situations, tooth extractions may need to be postponed temporarily. These situations include:

- Infection that has progressed from the tooth into the bone. Infections may make anesthesia difficult. They can be treated with **antibiotics** before the tooth is extracted.
- The patient's use of drugs that thin the blood (anticoagulants). These medications include warfarin (Coumadin) and **aspirin**. The patient should stop using these medications for three days prior to extraction.
- Patients who have had any of the following procedures in the previous six months: **heart valve replacement**, open heart surgery, prosthetic **joint replacement**, or placement of a medical shunt. These patients may be given antibiotics to reduce the risk of bacterial infection.

KEY TERMS

Dry socket—A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket. Dry socket leaves the underlying bone exposed to air and food.

Extraction site—The empty tooth socket following removal of the tooth.

Impacted tooth—A tooth that is growing against another tooth, bone, or soft tissue.

Luxate—To loosen or dislocate the tooth from the socket.

Nitrous oxide—A colorless, sweet-smelling gas used by dentists for mild anesthesia. It is sometimes called laughing gas because it makes some patients feel giddy or silly.

Oral surgeon—A dentist who specializes in surgical procedures of the mouth, including extractions.

Orthodontic treatment—The process of straightening teeth to correct their appearance and function.

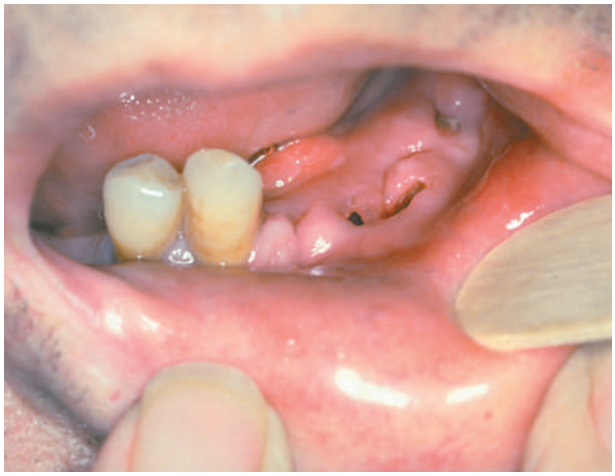
Description

Tooth extraction can be performed with local anesthesia if the tooth is exposed and appears to be easily removable in one piece. An instrument called an elevator is used to loosen (luxate) the tooth, widen the space in the bone, and break the tiny elastic fibers that attach the tooth to the bone. Once the tooth is dislocated from the bone, it can be lifted and removed with forceps.

If the extraction is likely to be difficult, the dentist may refer the patient to an oral surgeon. Oral surgeons are specialists who are trained to give nitrous oxide, an intravenous sedative, or a general anesthetic to relieve **pain**. Extracting an **impacted tooth** or a tooth with curved roots typically requires cutting through gum tissue to expose the tooth. It may also require removing portions of bone to free the tooth. Some teeth must be cut and removed in sections. The extraction site may or may not require one or more stitches to close the cut (incision).

Preparation

Before an extraction, the dentist will take the patient's medical history, noting **allergies** and prescription medications. A dental history is also taken, with particular attention to previous extractions and reactions to anesthetics. The dentist may then prescribe antibiotics or



A close-up view inside a person's mouth following the extraction of the lower right molar. *(Custom Medical Stock Photo. Reproduced by permission.)*

recommend stopping certain medications prior to the extraction. The tooth is x-rayed to determine its full shape and position, especially if it is impacted.

If the patient is going to have deep anesthesia, he or she should wear loose clothing with sleeves that are easily rolled up to allow for an intravenous line. The patient should not eat or drink anything for at least six hours before the procedure. Arrangements should be made for a friend or relative to drive the patient home after the surgery.

Aftercare

An important aspect of aftercare is encouraging a clot to form at the extraction site. The patient should put pressure on the area by biting gently on a roll or wad of gauze for several hours after surgery. Once the clot is formed, it should not be disturbed. The patient should not rinse, spit, drink with a straw, or smoke for at least 24 hours after the extraction and preferably longer. Vigorous **exercise** should not be done for the first three to five days.

For the first two days after the procedure, the patient should drink liquids without using a straw, and eat soft foods. Any chewing must be done on the side away from the extraction site. Hard or sticky foods should be avoided. The mouth may be gently cleaned with a toothbrush, but the extraction area should not be scrubbed.

Wrapped ice packs can be applied to reduce facial swelling. Swelling is a normal part of the healing process. It is most noticeable in the first 48–72 hours. As the swelling subsides, the patient may experience muscle stiffness. Moist heat and gentle exercise will restore jaw movement. The dentist may prescribe medications to relieve the postoperative pain.

Risks

Potential complications of tooth extraction include postoperative infection, temporary numbness from nerve irritation, jaw fracture, and jaw joint pain. An additional complication is called dry socket. When a blood clot does not properly form in the empty tooth socket, the bone beneath the socket is painfully exposed to air and food, and the extraction site heals more slowly.

Normal results

After an extraction, the wound usually closes in about two weeks. It takes three to six months for the bone and soft tissue to be restructured. Complications such as infection or dry socket may prolong the healing time.

Resources

ORGANIZATIONS

American Association of Oral and Maxillofacial Surgeons. 9700 West Bryn Mawr Ave., Rosemont, IL 60018-5701. (847) 678-6200. <http://www.aaoms.org>.

Bethany Thivierge

Tooth grinding *see* **Bruxism**

Tooth replacements and restorations

Definition

A tooth restoration is any artificial substance or structure that replaces missing teeth or part of a tooth in order to protect the mouth's ability to eat, chew, and speak. Restorations include fillings, inlays, crowns, bridges, partial and complete dentures, and dental implants.

Purpose

Restorations have somewhat different purposes depending on their extensiveness. Fillings, inlays, and crowns are intended to repair damage to individual teeth. They replace tooth structure lost by decay or injury, protect the part of the tooth that remains, and restore the tooth's shape and function. Bridges, dentures, and implants are intended to protect the shape and function of the mouth as a whole.

Precautions

Some patients are allergic to the medications used for local anesthesia in dental restorations. In addition, many people in the general population are afraid of dental work. Most dentists in present-day practice can help patients with this specific fear.

Description

Fillings

Fillings are restorations that are done to repair damage caused by **tooth decay** (dental caries). Tooth decay occurs when microorganisms in the mouth convert sugar from food to acid, which attacks the tooth. The acid forms cavities that start in the hard outer surface of the tooth (the enamel) and may extend inward to the pulp, which contains the tooth's nerves and blood vessels. Left untreated, tooth decay may lead to inflammation and infection that may cause **toothache** and perhaps more serious complications.

To stop the decay process, the dentist removes the decayed portion of the tooth using a high-speed drill or an air abrasion system, shapes the cavity walls, and replaces the tooth structure with a filling of silver amalgam, composite resin, or gold. The filling is placed in the cavity as a liquid or soft solid. It sets within a few minutes and continues to harden over the next several hours. Silver amalgam is commonly used to fill cavities on the biting surfaces of the back teeth, because it is strong enough to withstand the tremendous pressures exerted by grinding and chewing. Composite resin is typically used to fill cavities in front teeth and any other teeth that are visible when the patient smiles, because its color can be matched to the tooth surface. Gold as a filling material is far less common, but is being increasingly used. Although it is more expensive and less easily applied, it does not trigger the sensitivity reactions that some patients have to silver amalgam.

Inlays

An inlay resembles a filling in that it fills the space remaining after the decayed portion of a tooth has been removed. The difference is that an inlay is shaped outside the patient's mouth and then cemented into place. After the decay is removed and the cavity walls are shaped, the dentist makes a wax pattern of the space. A mold is cast from the wax pattern. An inlay, usually of gold, is made from this mold and sealed into the tooth with dental cement.

Crowns

The crown of a tooth is the portion that is covered by enamel. A restorative crown replaces this outer part to protect the tooth. This protection becomes necessary when a tooth cracks or has its entire structure weakened by decay. As with a filling or inlay, the dentist first removes the decayed portion of the tooth. The tooth is

then prepared for a crown. It may be tapered on the outside edges to a peg, reinforced with a cast metal core, or rebuilt with both a cast metal core and a post. A wax impression of the prepared tooth and the teeth next to it is made. The new crown is made to fit this mold. The crown may be made of gold or stainless steel alone, metal with a veneer of tooth-colored porcelain or resin, or of porcelain or resin alone. The finished crown is then placed over the prepared tooth, adjusted, and cemented into place.

Bridges

Bridges are a type of restoration that is done when one or more permanent teeth are lost or pulled. The resulting gap must be filled in to prevent the remaining teeth from shifting. If the other teeth shift, they will affect the patient's bite (occlusion), which sometimes produces **pain** in the jaw joint. As the teeth move and become crooked, they also become more difficult to keep clean. The risk of tooth decay and gum disease increases, increasing the likelihood that additional teeth will be lost. A bridge is inserted to prevent this risk. Bridges are nonremovable appliances of one or more artificial teeth (pontics) anchored by crowns on the adjacent teeth (abutment teeth). The abutment teeth carry the pressure when the patient chews food.

Partial dentures

A partial denture is similar to a bridge in that it fills a gap left by missing teeth with artificial teeth on a metal frame. A partial denture is removable, however. It attaches to a crown on the abutment tooth with a metal clasp or precision attachment. A partial denture is primarily used at the end of a row of natural teeth, where there is only one abutment tooth. The pressure exerted by chewing is shared by this abutment and the soft tissues of the gum ridge beneath the appliance.

Complete dentures

Complete dentures may be worn when all of the top or bottom teeth have been lost. A complete denture consists of artificial teeth mounted in a plastic base molded to fit the remaining oral anatomy. It may or may not be held in place with a denture adhesive.

Implants

Dental implants are a means of securing crowns, bridges, and dentures in the mouth. A hard plastic or metal fixture is implanted through the soft tissue into the bone. Over time, the bone grows around this fixture, firmly anchoring it. The exposed end of this fixture is covered with a crown and may serve as a stable abutment for a bridge or denture.

Preparation

Before a restoration is placed in the mouth, the dentist removes all traces of decay and shapes the remaining tooth structure for the restoration. Fillings are the only restoration created within the tooth itself—the others are made up in a laboratory using a model of the tooth structure. Thus, a filling may be placed in a single dental visit, while the other restorations usually take several appointments. Temporary crowns and dentures are put in place after the tooth is shaped until the permanent restoration is delivered by the laboratory.

Aftercare

Fillings

Fillings need time to harden for several hours after being placed, so the patient should chew food on the opposite side of the mouth for the first day.

Dentures

A partial or complete denture may take several weeks of getting used to. Inserting and removing the denture will take practice. Speaking clearly may be difficult at first—the patient may find it helpful to read out loud for practice. Eating may also feel awkward. The patient should begin by eating small pieces of soft foods. Very hard or sticky foods should be avoided.

Patients with dentures must work on good **oral hygiene**. Specialty brushes and floss threaders may be used to remove plaque and food from around crowns and bridges. Dentures should be removed and brushed daily with a specially designed brush and a denture cleaner or other mild soap.

The patient should see the dentist for an adjustment if there is any discomfort or irritation resulting from a restoration. Otherwise, the patient should see the dentist at least twice a year for an oral examination.

Risks

Restoration procedures typically require local anesthesia. Some people may have allergic reactions to the medication. A very small number of people are allergic to one or more of the metals used in a dental restoration. In most cases, the dentist can use another material.

Normal results

A well-made restoration should feel comfortable and last a relatively long time with proper care. Artificial dental restorations only approximate the original tooth, however. A complete denture will never feel as comfortable or work

KEY TERMS

Abutment tooth—A crowned tooth that stabilizes a bridge or partial denture.

Bridge—An appliance of one or more artificial teeth anchored by crowns on the adjacent teeth.

Complete denture—A full set of upper or lower teeth, mounted in a plastic base. Dentures are also called false teeth.

Crown—A protective shell that fits over the tooth.

Dental caries—A disease of the teeth in which microorganisms convert sugar in the mouth to acid that erodes the tooth.

Enamel—The hard outermost surface of a tooth.

Filling—Dental material that occupies the space remaining within a tooth after the decayed portion has been removed.

Implant—A fixture with one end implanted into the bone and the other end covered with a crown, often to serve as a stable abutment for a bridge or denture.

Inlay—A filling that is made outside of the tooth and the cemented into place.

Occlusion—The way upper and lower teeth fit together during biting and chewing.

Partial denture—A removable bridge that usually clasps onto only one abutment.

Pontic—An artificial tooth.

Pulp—The soft innermost layer of a tooth that contains its blood vessels and nerves.

as well as natural teeth. It is better, therefore, to prevent the need for restorative dental work than to replace teeth. Restorations are expensive, may require many appointments, and still need careful cleaning and attention.

Resources

BOOKS

"Dentistry in Medicine—Dental Restorations and Appliances." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

ORGANIZATIONS

Academy of General Dentistry. Suite 1200, 211 East Chicago Ave., Chicago, IL 60611. (312) 440-4300. <http://www.agd.org>.

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

Bethany Thivierge

Toothache

Definition

A toothache is any **pain** or soreness within or around a tooth, indicating inflammation and possible infection.

Description

A toothache may feel like a sharp pain or a dull ache. The tooth may be sensitive to pressure, heat, cold, or sweets. In cases of severe pain, identifying the problem tooth is often difficult. Any patient with a toothache should see a dentist at once for diagnosis and treatment. Most toothaches get worse if not treated.

Causes and symptoms

Toothaches may result from any of a number of causes:

- **tooth decay** (dental caries)
- inflammation of the tooth pulp (pulpitis)
- abscesses
- gum disease, including periodontitis
- loose or broken filling
- cracked or **impacted tooth**
- exposed tooth root
- food wedged between teeth or trapped below the gum line
- tooth nerve irritated by clenching or grinding of teeth (bruxism)
- pressure from congested sinuses
- traumatic injury

Diagnosis

Diagnosis includes identifying the location of the toothache, as well as the cause. The dentist begins by asking the patient specific questions about the toothache, including the types of foods that make the pain worse, whether the tooth is sensitive to temperature or biting, and whether the pain is worse at night. The dentist then exam-

ines the patient's mouth for signs of swelling, redness, and obvious tooth damage. The presence of pus indicates an **abscess** or gum disease. The dentist may flush the sore area with warm water to dislodge any food particles and to test for sensitivity to heat. The dentist may then dry the area with gauze to determine sensitivity to touch and pressure. The dentist may probe tooth crevices and the edges of fillings with a sharp instrument, looking for areas of tooth decay. Finally, the dentist may take x rays, looking for evidence of decay between teeth, a cracked or impacted tooth, or a disorder of the underlying bone.

Treatment

Emergency self-care

Toothaches should always be professionally treated by a dentist. Some methods of self-treatment, however, may help manage the pain until professional care is available:

- rinsing with warm salt water
- using dental floss to remove any food particles
- taking **aspirin** or **acetaminophen** (Tylenol) to relieve pain; the drug should be swallowed—*never* placed directly on the aching tooth or gum
- applying a *cold* compress against the outside of the cheek; do not use heat, because it will tend to spread infection
- using clove oil (*Syzygium aromaticum*) to numb the gums; the oil may be rubbed directly on the sore area or used to soak a small piece of cotton and applied to the sore tooth

Professional care

Treatment will depend on the underlying cause of the toothache. If the pain is due to tooth decay, the dentist will remove the decayed area and restore the tooth with a filling of silver amalgam or composite resin. Loose or broken fillings are removed, new decay cleaned out, and a new filling is placed. If the pulp of the tooth is damaged, root canal therapy is needed. The dentist or a specialist called an endodontist removes the decayed pulp, fills the space left behind with a soothing paste, and covers the tooth with a crown to protect and seal it. If the damage cannot be treated by these methods, or if the tooth is impacted, the tooth must be extracted.

Alternative treatment

Toothaches caused by infection or tooth decay must be treated by a dentist. Several alternative therapies may be helpful for pain relief until dental treatment is available. Clove oil (*Syzygium aromaticum*) may be rubbed on sensitive gums to numb them or added to a small cotton pellet that is then placed into or over a hole in the tooth. The herb corydalis (*Corydalis yanhusuo*) may also help relieve toothache pain. Pain also may be reduced using **acupressure**, **acupuncture**, or **reiki**. Acupuncture should be done only by a licensed practitioner.

KEY TERMS

Abscess—A hole in the tooth or gum tissue filled with pus as the result of infection.

Bruxism—Habitual clenching and grinding of the teeth as a result of stress. The behavior usually occurs during sleep.

Cavity—A hole or weak spot in the tooth surface caused by decay.

Dental caries—A disease of the teeth in which microorganisms convert sugar in the mouth to acid, which then erodes the tooth.

Enamel—The hard outermost surface of a tooth.

Endodontist—A dentist who specializes in diagnosing and treating diseases of the pulp and other inner parts of the tooth.

Impacted tooth—A tooth that is growing against another tooth, bone, or soft tissue.

Periodontitis—A gum disease that destroys the structures supporting the teeth, including bone.

Pulp—The soft innermost part of a tooth, containing blood vessels and nerves.

Pulpitis—Inflammation of the pulp of a tooth that involves the blood vessels and nerves.

Prognosis

Prompt dental treatment provides a positive outcome for toothache. In the absence of active infection, fillings, root canal treatments, or extractions may be performed with minimal discomfort to the patient. When a toothache is left untreated, a severe infection may develop and spread to the sinuses or jawbone, and eventually cause blood **poisoning**.

Prevention

Maintaining proper **oral hygiene** is the key to preventing toothaches. The best way to prevent tooth decay is to brush at least twice a day, preferably after every

meal and snack. Flossing once a day also helps prevent gum disease by removing food particles and bacteria at and below the gum line, as well as between teeth. People should visit their dentist at least every six months for oral examinations and professional cleaning.

Resources

ORGANIZATIONS

Academy of General Dentistry. Suite 1200, 211 East Chicago Ave., Chicago, IL 60611. (312) 440-4300. <http://www.agd.org>.

American Dental Association. 211 E. Chicago Ave., Chicago, IL 60611. (312) 440-2500. <http://www.ada.org>.

OTHER

Medical Source. Medical Alliances, Inc. 2121 Eisenhower Ave., Suite 603, Alexandria, VA 22314. (800) 463-6482 <http://www.medsource.com>.

Bethany Thivierge

Topical antibiotics *see* **Antibiotics, topical**

Topical antifungal drugs *see* **Antifungal drugs, topical**

TORCH test

Definition

The TORCH test, which is sometimes called the TORCH panel, belongs to a category of blood tests called infectious-disease antibody titer tests. This type of blood test measures the presence of antibodies (protein molecules produced by the human immune system in response to a specific disease agent) and their level of concentration in the blood. The name of the test comes from the initial letters of the five disease categories. The TORCH test measures the levels of an infant's antibodies against five groups of chronic infections: *t*oxoplasmosis, *o*ther infections, *r*ubella, *c*ytomegalovirus (CMV), and *h*erpes simplex virus (HSV). The "other infections" usually include **syphilis**, **hepatitis B**, coxsackie virus, Epstein-Barr virus, varicella-zoster virus, and human parvovirus.

Since the TORCH test is a screening or first-level test, the pediatrician may order tests of other body fluids or tissues to confirm the diagnosis of a specific infection. In the case of **toxoplasmosis**, **rubella**, and syphilis, cerebrospinal fluid may be obtained from the infant through a spinal tap in order to confirm the diagnosis. In the case of CMV, the diagnosis is confirmed by culturing the virus in a sample of the infant's urine. In HSV infections, tissue culture is the best method to confirm the diagnosis.

Purpose

The five categories of organisms whose antibodies are measured by the TORCH test are grouped together because they can cause a cluster of symptomatic **birth defects** in newborns. This group of defects is sometimes called the TORCH syndrome. A newborn baby with these symptoms will be given a TORCH test to see if any of the five types of infection are involved.

The symptoms of the TORCH syndrome include:

- Small size in proportion to length of the mother's **pregnancy** at time of delivery. Infants who are smaller than would be expected (below the tenth percentile) are referred to as small-for-gestational-age, or SGA.
- Enlarged liver and spleen
- Low level of platelets in the blood
- Skin rash. The type of skin rash associated with the TORCH syndrome is usually reddish-purple or brown and is caused by the leakage of blood from broken capillaries into the baby's skin.
- Involvement of the central nervous system. These defects can include **encephalitis**, calcium deposits in the brain tissue, and seizures.
- Jaundice. The yellowish discoloration of the skin and whites of the eyes due to liver disease.

In addition to these symptoms, each of the TORCH infections has its own characteristic symptom cluster in newborns:

Toxoplasmosis

Toxoplasmosis is caused by *Toxoplasma gondii*, a parasite that the mother can acquire from handling infected cats, drinking unpasteurized milk, or eating contaminated meat. The infection is carried to the infant through the mother's placenta, and can cause infections of the eyes or central nervous system. The organism can invade brain or muscle tissue and form tissue cysts. The later in pregnancy that the mother is infected, the higher the probability that the fetus will be infected. On the other hand, toxoplasmosis early in pregnancy is more likely to cause a **miscarriage** or serious birth defects. The incidence of toxoplasmosis in newborns is one in 1,000 live births.

Other (syphilis)

Syphilis is caused by a spirochete (spiral- or coil-shaped bacterium), *Treponema pallidum*. It is transmitted in the adult population by sexual intercourse. About 2-5% of children born to mothers diagnosed with syphilis will have the disease at birth. Syphilis was added to the

TORCH panel because of a rapid increase in reported cases since 1990. It is also a potentially life-threatening infection for the fetus. Syphilis can cause early delivery, miscarriage, or **stillbirth**. The mortality rate in infants infected with syphilis is about 54%.

Rubella

Rubella is a virus that has a seasonal pattern, with epidemics most likely in the spring. Between 0.1-2% of newborns will be infected with rubella. The rate of fetal infection varies according to the timing of the mother's infection during pregnancy. Birth defects, however, are most likely (85%) in infants infected during the first eight weeks of pregnancy. Infants born with rubella may already show signs of heart disease, retarded growth, **hearing loss**, blood disorders, vision problems, or **pneumonia**. They may also develop problems later in childhood, including **autism**, hearing loss, brain syndromes, immune system disorders, or thyroid disease.

Cytomegalovirus (CMV)

Cytomegalovirus belongs to the herpesvirus group of infections. It can be transmitted through body secretions, as well as by sexual contact; some newborns acquire CMV through the mother's breast milk. In adults, it produces symptoms resembling those of mononucleosis. About 1–2.2% of newborns in the United States are infected with CMV. Of this group, 10% will have measurable symptoms. The mortality rate for these symptomatic newborns is 20–30%. Surviving infants with CMV may suffer from hearing problems (15%) or **mental retardation** (30%). Newborns that acquire CMV during the birth process or shortly after birth may develop pneumonia, hepatitis, or various blood disorders.

Herpes simplex virus (HSV)

Herpesvirus infections are among the most common viral infections in humans. They are spread by oral, as well as genital, contact. It is estimated that between 1 in 1,000 and 1 in 5,000 infants are born with HSV infections. About 80% of these infections are acquired during the birth process itself; the virus enters the infant through its eyes, skin, mouth, and upper respiratory tract. Of infants born with HSV infection, about 20% will have localized infections of the eyes, mouth, or skin. About 50% of infected infants will develop disease spread throughout the body (disseminated) within nine to 11 days after birth. Disseminated herpes infections attack the liver and adrenal glands, as well as other body organs. Without treatment, the mortality rate is 80%. Even with antiviral medication, the mortality rate is still 15–20%, with 40–55% of the survivors having long-term damage to the central nervous system. It is critical for the doctor to diagnose HSV infection in the newborn as soon as possible, for effective treatment.

Description

The TORCH panel requires a sample of the infant's blood. Samples from infants are usually obtained by the heelstick procedure when only a small quantity of blood is needed. The baby's foot is wrapped in a warm cloth for five minutes, to make the blood flow more easily. The foot is then wiped with an alcohol swab and a lancet is used to stick the baby's heel on one side. It is important to avoid the center of the heel, in order to prevent an inflammation of the bone.

Preparation

No special preparation, other than sterile technique, is required.

Risks

The only complications associated with the TORCH test are those resulting from the heelstick technique itself. These risks include scarring, infection of the bone, **cellulitis** (inflammation of cellular tissue), small lumpy calcium deposits, and inaccurate test results.

Normal results

The normal result would be normal levels of immunoglobulin M (IgM) antibody in the infant's blood. IgM is one of five types of protein molecules found in blood that function as antibodies. IgM is a specific class of antibodies that seeks out virus particles. In contrast to adults, IgM is the most common type of immunoglobulin in newborn children. It is, therefore, the most useful indicator of the presence of a TORCH infection.

Abnormal results

The general abnormal, or positive, finding would be high levels of IgM antibody. The test can be refined further for antibodies specific to given disease agents. The TORCH screen, however, can produce both false-positive and false-negative findings. Doctors can measure IgM levels in the infant's cerebrospinal fluid, as well as in the blood, if they want to confirm the TORCH results.

Resources

BOOKS

Cruse, Julius M., and Robert E. Lewis. *Illustrated Dictionary of Immunology.* New York: CRC Press, 1995.

"Infectious Diseases: TORCH Infections." In *Neonatology: Management, Procedures, On-Call Problems, Diseases*

KEY TERMS

Antibody—A protein molecule produced by the immune system that is specific to a disease agent, such as CMV and the other organisms sought by the TORCH test. The antibody combines with the organism and disables it.

Perinatal—Referring to the period of time surrounding an infant's birth, from the last two months of pregnancy to the first 28 days of life. The TORCH panel tests for perinatal infections.

Small-for-gestational-age (SGA)—A term used to describe newborns who are below the 10th percentile in height or weight for their estimated gestational age. The gestational age is based upon the date of the mother's last menstrual period. SGA is one of the symptoms of TORCH syndrome.

Titer—The concentration of a substance in a given sample of blood or other tissue fluid.

and Drugs, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

Levin, Myron J. "Infections: Viral & Rickettsial." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

"Pediatrics and Genetics: Disturbances in Newborns and Infants." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Procedures: Heelstick (Capillary Blood Sampling)." In *Neonatology: Management, Procedures, On-Call Problems, Diseases and Drugs*, ed. Tricia Lacy Gomella, et al. Norwalk, CT: Appleton & Lange, 1994.

Rebecca J. Frey, PhD

Torticollis

Definition

Torticollis (cervical dystonia or spasmodic torticollis) is a type of movement disorder in which the muscles controlling the neck cause sustained twisting or frequent jerking.

Description

In torticollis, certain muscles controlling the neck undergo repetitive or sustained contraction, causing the neck to jerk or twist to the side. Cervical dystonia causes forward twisting, and is called antecollis. Backward twisting is known as retrocollis. The abnormal posture caused by torticollis is often debilitating, and is usually painful.

Torticollis most commonly begins between age 30–60, with females affected twice as often as males. According to the National Spasmodic Torticollis Association, torticollis affects 83,000 people in the United States. Dystonia tends to become more severe during the first months or years after onset, and may spread to other regions, especially the jaw, arm, or leg. Torticollis should not be confused with such other causes of abnormal neck posture as orthopedic or congenital problems.

Causes and symptoms

The nerve signals responsible for torticollis are thought to originate in the basal ganglia, a group of brain structures involved in movement control. The exact defect is unknown. Some cases of dystonia are due to the inheritance of a defective gene, whose function was unknown as of mid-1998. Other cases are correlated with neck or head trauma, such as from an automobile accident. Use of certain **antipsychotic drugs**, or neuroleptics, can induce dystonia.

There are three types of torticollis:

- tonic, in which the abnormal posture is sustained
- clonic, marked by jerky head movements.
- mixed, a combination of tonic and clonic movements

Symptoms usually begin gradually, and may be intermittent at first, worsening in times of **stress**. Symptoms usually progress over two to five years, and then remain steady. Symptoms may be relieved somewhat when lying down. Many people with torticollis can temporarily correct their head position by sensory tricks, as touching the chin or cheek on the side opposite the turning. The reason for the effectiveness of this "geste antagoniste," as it is called, is unknown.

Pain in the neck, back, or shoulder affects more than two-thirds of all people with torticollis. Pain may spread to the arm or hand.

Diagnosis

Diagnosis of torticollis is aided by an electrical study (**electromyography**) that can detect overactive muscles. Imaging studies, including x rays, may be done to rule out other causes of abnormal posture. A detailed medical history is needed to determine possible causes, including trauma.

Treatment

A variety of oral drugs are available to relax muscles, including baclofen. For a subgroup of patients, L-dopa provides effective relief. Denervation of the involved neck muscles may be performed with injection of alcohol or phenol on to the nerve.

Injection of botulinum toxin (BTX) is considered by many to be the treatment of choice. By preventing release of chemical messages from the nerve endings that stimulate the involved muscles, BTX partially paralyzes the muscles, therefore allowing more normal posture and range of motion. BTX treatment lasts several months, and may be repeated.

Physical therapy can help relieve secondary consequences of torticollis. Regular muscle stretching prevents contracture, or permanent muscle shortening. Pain and spasm may be temporarily lessened with application of heat or ice. Stress management techniques may help prevent worsening. An occupational therapist can suggest home or work modifications to reduce **fatigue** and improve function. Braces constructed to replace the patient's own sensory tricks may help reduce abnormal posture.

Alternative treatment

Biofeedback may be effective for some patients. Regular **massage therapy** can reduce additional pain in compensating areas of the body. Two energy-based therapies, **acupuncture** and homeopathic medicine, can work to rebalance the whole person, helping to correct the torticollis. Antispasmodic herbs may help to relax the muscles. In addition, herbs that can help balance the stimulus from the nervous system are often recommended.

Prognosis

Spontaneous remission is seen in up to 20% of patients, most often those patients with older onset and milder symptoms. Dystonia may spread to affect other regions of the body.

Prevention

There is no way known to prevent torticollis.

Resources

BOOKS

Watts, R. L., and W. C. Koller, eds. *Movement Disorders*. New York: McGraw-Hill, 1997.

ORGANIZATIONS

National Spasmodic Torticollis Association. P.O. Box 5849, Orange, CA 92863-5849. (800) 487-8385. <http://www.bluheronweb.com>.

Worldwide Education and Awareness for Movement Disorders. One Gustave L. Levy Place, Box 1052, New York, NY 10029. (800) 437-6683. <http://www.wemove.org>.

Richard Robinson

Total protein test *see* **Protein components test**

Tourette syndrome

Definition

Tourette syndrome (TS) is an inherited disorder of the nervous system, characterized by a variable expression of unwanted movements and noises (tics).

Description

The first references in the literature to what might today be classified as Tourette syndrome largely describe individuals who were wrongly believed to be possessed by the devil. In 1885 Gilles de la Tourette, a French neurologist, provided the first formal description of this syndrome, which he described as an inherited neurological condition characterized by motor and vocal tics.

Although vocal and motor tics are the hallmark of Tourette syndrome, such other symptoms as the expression of socially inappropriate comments or behaviors, obsessive compulsive disorder, attention deficit disorder, self-injuring behavior, depression, and **anxiety** also appear to be associated with Tourette syndrome. Most research suggests that Tourette syndrome is an autosomal dominant disorder, although a gene responsible for Tourette syndrome has not yet been discovered.

Tourette syndrome is found in all populations and all ethnic groups, but is three to four times more common in males than females and is more common in children than adults. The exact frequency of Tourette syndrome is unknown, but estimates range from 0.05% to 3%.

Causes and symptoms

The cause of Tourette syndrome is unknown, although some studies suggest that the tics in Tourette syndrome are caused by an increased amount of a neurotransmitter called dopamine. A neurotransmitter is a chemical found in the brain that helps to transmit information from one brain cell to another. Other studies suggest that the defect in Tourette syndrome involves another neurotransmitter called serotonin; or involves other chemicals required for normal functioning of the brain.

Most studies suggest that Tourette syndrome is an autosomal dominant disorder with decreased penetrance, although this hypothesis has not been proven and may not be true in all families. An autosomal dominant disorder results from a change in one copy of a pair of genes. Individuals with an autosomal dominant disorder have a 50% chance of passing on the changed gene to their children. Decreased penetrance means that not all people who inherit the changed gene will develop symptoms. There is some evidence that females who inherit the Tourette syndrome gene have a 70% chance of exhibiting symptoms and males have a 99% chance of having symptoms. It has been suggested that other genetic and environmental factors may play a role in the development of symptoms in people who inherit the changed gene but none have been discovered. Some researchers believe that Tourette syndrome has different causes in different individuals or is caused by changes in more than one gene, although these theories are less substantiated. Further research is needed to establish the cause of Tourette syndrome.

Motor and vocal tics

The principal symptoms of Tourette syndrome include simple and complex motor and vocal tics. Simple motor tics are characterized by brief muscle contractions of one or more limited muscle groups. An eye twitch is an example of a simple motor tic. Complex motor tics tend to appear more complicated and purposeful than simple tics, and involve coordinated contractions of several muscle groups. Some examples of complex motor tics include the act of hitting oneself and jumping. Copropraxia, the involuntary display of unacceptable/obscene gestures; and echopraxia, the imitation of the movement of another individual, are other examples of complex motor tics.

Vocal tics are actually manifestations of motor tics that involve the muscles required for vocalization. Simple vocal tics include **stuttering**, stammering, abnormal emphasis of part of a word or phrase, and inarticulate noises such as throat clearing, grunts, and high-pitched sounds. Complex vocal tics typically involve the involuntary expression of words. Perhaps the most striking example of this is coprolalia, the involuntary expression of obscene words or phrases, which occurs in fewer than one-third of people with Tourette syndrome. The involuntary echoing of the last word, phrase, sentence or sound vocalized by oneself (phalilalia) or of another person or sound in the environment (echolalia) are also classified as complex tics.

The type, frequency, and severity of tics exhibited varies tremendously between individuals with Tourette syndrome. Tourette syndrome has a variable age of onset and tics can start anytime between infancy and age 18. Initial symptoms usually occur before the early teens; the mean age of onset for both males and females is approximately seven years of age. Most individuals with symptoms initially experience simple muscle tics involving the eyes and the head. These symptoms can progress to tics involving the upper torso, neck, arms, hands, and occasionally the legs and feet. Complex motor tics are usually the latest-onset muscle tics. Vocal tics usually have a later onset then motor tics. In some rare cases, people with Tourette syndrome suddenly present with multiple, severe, or bizarre symptoms.

Not only is there extreme variability in clinical symptoms between individuals with Tourette syndrome, but individuals commonly experience a variability in type, frequency, and severity of symptoms over the course of their lifetime. Adolescents with Tourette syndrome often experience unpredictable and variable symptoms, which may be related to fluctuating hormone levels and decreased compliance in taking medications. Adults often experience a decrease in symptoms or a complete end to symptoms.

A number of factors appear to affect the severity and frequency of tics. **Stress** appears to increase the frequency and severity of tics, while concentration on another part of the body that is not involved in a tic can result in the temporary alleviation of symptoms. Relaxation, following attempts to suppress the occurrence of tics, may result in an increased frequency of tics. An increased frequency and severity of tics can also result from exposure to such drugs as steroids, **cocaine**, amphetamines, and **caffeine**. Hormonal changes such as those that occur prior to the menstrual cycle can also increase the severity of symptoms.

Other associated symptoms

People with Tourette syndrome are more likely to exhibit non-obscene, socially inappropriate behaviors such as expressing insulting or socially unacceptable comments or socially unacceptable actions. It is not known whether these symptoms stem from a more general dysfunction of impulse control that might be part of Tourette syndrome.

Tourette syndrome appears to also be associated with attention deficit disorder (ADD). ADD is a disorder characterized by a short attention span and impulsivity, and in some cases hyperactivity. Researchers have found that 21–90% of individuals with Tourette syndrome also exhibit symptoms of ADD, whereas 2–15% of the general population exhibit symptoms of ADD.

People with Tourette syndrome are also at higher risk for having symptoms of **obsessive-compulsive disorder** (OCD). OCD is a disorder characterized by persis-

tent, intrusive, and senseless thoughts (obsessions) or compulsions to perform repetitive behaviors that interfere with normal functioning. A person with OCD, for example, may be obsessed with germs and may counteract this obsession with continual hand washing. Symptoms of OCD are present in 1.9–3% of the general population, whereas 28–50% of people with Tourette syndrome have symptoms of OCD.

Self-injurious behavior (SIB) is also seen more frequently in those with Tourette syndrome. Approximately 34–53% of individuals with Tourette syndrome exhibit some form of self-injuring behavior. The SIB is often related to OCD but can also occur in those with Tourette syndrome who do not have OCD.

Symptoms of anxiety and depression are also found more commonly in people with Tourette syndrome. It is not clear, however, whether these symptoms are symptoms of Tourette syndrome or occur as a result of having to deal with the symptoms of moderate to severe Tourette syndrome.

People with Tourette syndrome may also be at increased risk for having learning disabilities and **personality disorders;** and may be more predisposed to such behaviors as aggression, antisocial behaviors, severe temper outbursts, and inappropriate sexual behavior. Further controlled studies need to be performed, however, to ascertain whether these behaviors are symptoms of Tourette syndrome.

Diagnosis

Tourette syndrome cannot be diagnosed through a blood test. The diagnosis is made through observation and interview of the patient and discussions with other family members. The diagnosis, of Tourette syndrome is complicated by a variety of factors. The extreme range of symptoms of this disorder makes it difficult to differentiate Tourette syndrome from other disorders with similar symptoms. Diagnosis is further complicated by the fact that some tics appear to be within the range of normal behavior. For example an individual who only exhibits such tics as throat clearing and sniffing may be misdiagnosed with a medical problem such as **allergies**. In addition, such bizarre and complex tics as coprolalia may be mistaken for psychotic or "bad" behavior. Diagnosis is also confounded by individuals who attempt to control tics in public and in front of health care professionals, and deny the existence of symptoms. Although there is disagreement over what criteria should be used to diagnose Tourette syndrome, one aid in the diagnosis is the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV). The DSM-IV outlines suggested diagnostic criteria for a variety of conditions, including Tourette syndrome.

DSM-IV criteria:

- presence of both motor and vocal tics at some time during the course of the illness
- the occurrence of multiple tics nearly every day through a period of more than one year, without a remission of tics for a period of greater than three consecutive months
- the symptoms cause distress or impairment in functioning
- age of onset of prior to 18 years of age
- the symptoms are not due to medications or drugs and are not related to another medical condition

Some physicians critique the DSM-IV criteria, arguing that they do not include the full range of behaviors and symptoms seen in Tourette syndrome. Others criticize the criteria since they limit the diagnosis to those who experience a significant impairment, which may not be true for individuals with milder symptoms. For this reason many physicians use their clinical judgment as well as the DSM-IV criteria as a guide to diagnosing Tourette syndrome.

Treatment

There is no cure for Tourette syndrome. Treatment involves the control of symptoms through educational and psychological interventions and/or medications. The treatment and management of Tourette syndrome varies from patient to patient and should focus on the alleviation of the symptoms that are most bothersome to the patient or that cause the most interference with daily functioning.

Psychological and educational interventions

Psychological treatments such as counseling are not generally useful for the treatment of tics but can be beneficial in the treatment of such associated symptoms as obsessive-compulsive behavior and attention deficit disorder. Counseling may also help individuals to cope better with the symptoms of this disorder and to have more positive social interactions. Psychological interventions may also help people cope better with stressors that can normally be triggers for tics and negative behaviors. Relaxation therapies may, however, increase the occurrence of tics. The education of family members, teachers, and peers about Tourette syndrome can be helpful and may help to foster acceptance and prevent social **isolation**.

Medications

Many people with mild symptoms of Tourette syndrome never require medications. Those with severe

symptoms may require medications for all or part of their lifetime. The most effective treatment of tics associated with Tourette syndrome involves the use of drugs such as haloperidol, pimozide, sulpiride, and tiapride, which decrease the amount of dopamine in the body. Unfortunately, the incidence of side effects, even at low dosages, is quite high. The short-term side effects can include **sedation**, dysphoria, weight gain, movement abnormalities, depression, and poor school performance. Long-term side effects can include **phobias**, memory difficulties, and personality changes. These drugs are therefore better candidates for short-term rather than long-term therapy.

Tourette syndrome can also be treated with such other drugs as clonidine, clonazepam, and risperidone, but the efficacy of these treatments is unknown. In many cases, treatment of such associated conditions as ADD and OCD is often more of a concern than the tics themselves. Clonidine used in conjunction with such stimulants as Ritalin may be useful for treating people with Tourette syndrome who also have symptoms of ADD. Stimulants should be used with caution in individuals with Tourette syndrome since they can sometimes increase the frequency and severity of tics. OCD symptoms in those with Tourette syndrome are often treated with such drugs as Prozac, Luvox, Paxil, and Zoloft.

In many cases the treatment of Tourette syndrome with medications can be discontinued after adolescence. Trials should be performed through the gradual tapering off of medications and should always be done under a doctor's supervision.

Prognosis

The prognosis for Tourette syndrome in individuals without associated psychological conditions is often quite good, and only approximately 10% of Tourette syndrome individuals experience severe tic symptoms. Approximately 30% of people with Tourette syndrome will experience a decrease in the frequency and severity of tics, and another 30–40% will experience a complete end of symptoms by late adolescence. The other 30–40% will continue to exhibit moderate to severe symptoms in adulthood. There does not appear to be a definite correlation between the type, frequency, and severity of symptoms and the eventual prognosis. Patients with severe tics may experience social difficulties and may isolate themselves from others in fear of shocking and embarrassing them. People with Tourette syndrome who have such other symptoms as obsessive compulsive disorder, attention deficit disorder, and self-injurious behavior usually have a poorer prognosis.

KEY TERMS

Attention deficit disorder (ADD)—Disorder characterized by a short attention span, impulsivity, and in some cases hyperactivity.

Autosomal dominant—A pattern of genetic inheritance in which only one abnormal gene is needed to display the trait or disease.

Coprolalia—The involuntary expression of obscene words or phrases.

Copropraxia—The involuntary display of unacceptable/obscene gestures.

Decreased penetrance—Individuals who inherit a changed disease gene but do not develop symptoms.

Dysphoria—Feelings of anxiety, restlessness, and dissatisfaction.

Echolalia—Involuntary echoing of the last word, phrase, or sentence spoken by someone else or sound in the environment.

Echopraxia—The imitation of the movement of another individual.

Neurotransmitter—Chemical in the brain that transmits information from one nerve cell to another.

Obsessive compulsive disorder (OCD)—Disorder characterized by persistent, intrusive, and senseless thoughts (obsessions) or compulsions to perform repetitive behaviors that interfere with normal functioning.

Phalilalia—Involuntary echoing of the last word, phrase, sentence, or sound vocalized by oneself.

Tic—Brief and intermittent involuntary movement or sound.

Resources

BOOKS

Haerle, Tracy, ed., and Jim Eisenreich. *Children with Tourette Syndrome: A Parent's Guide*. Bethesda, MD: Woodbine House, 1992.

Leckman, James, and Donald Cohen. *Tourette's Syndrome: Tics, Obsessions, Compulsions: Development, Psychopathology and Clinical Care*. New York: John Wiley & Sons, 1999.

PERIODICALS

Alsobrook, J.P. II, and D.L. Pauls. "The Genetics of Tourette Syndrome." *Neurologic Clinics* 15 (May 1997): 381–393.

Chappell, P.B., L.D. Scahill, and J.F. Leckman. "Future Therapies of Tourette Syndrome." *Neurologic Clinics* 15 (May 1997): 429–450.
Eidelberg, D., et al. "The Metabolic Anatomy of Tourette's Syndrome." *Neurology* 48 (April 1997): 927–934.
Freeman, R.D. "Attention Deficit Hyperactivity Disorder in the Presence of Tourette Syndrome." *Neurologic Clinics* 15 (May 1997): 411–420.
Lichter, D.G., and L.A. Jackson. "Predictors of Clonidine Response in Tourette Syndrome: Implications and Inferences." *Journal of Child Neurology* 11 (March 1997): 93–97.
Robertson, Mary. "Tourette Syndrome, Associated Conditions and the Complexities of Treatment." *Brain* 123 (2000): 425–462.

ORGANIZATIONS

National Institute of Neurological Disorders and Stroke. 31 Center Drive, MSC 2540, Bldg. 31, Room 8806, Bethesda, MD 20814. (301) 496-5751 or (800) 352-9424. <http://www.ninds.nih.gov>.
National Tourette Syndrome Association, Inc. 42-40 Bell Blvd., Bayside, NY 11361-2820. (718) 224-2999. Fax: (718) 279-9596. tourette@ix.netcom.com.
Tourette Syndrome Foundation of Canada. 194 Jarvis Street, #206, Toronto, ONT M5B 2B7. Canada (800) 361-3120. tsfc.org@sympatico.ca. <http://www.tourette.ca>.

OTHER

"About Tourette Syndrome." Tourette Help. <http://www.tourettehelp.com/pages/patient/about.html>.
"Tourette's Disorder." Internet Mental Health. <http://www.mentalhealth.com/fr20.html>.

Lisa Maria Andres, MS, CGC

Toxic encephalopathy *see* **Delirium**

Toxic epidermal necrolysis

Definition

Toxic epidermal necrolysis is a rare condition that causes large portions of the epidermis, the skin's outermost layer, to detach from the layers of skin below. A reaction to a medication is the primary cause.

Description

Toxic epidermal necrolysis (TEN) begins with **fever**, **cough**, and other nonspecific symptoms, and is soon followed by purplish, bloody-looking lesions on the skin and mucous membranes. These early lesions, typically found on the head, neck, and upper chest, soon merge and blister. Sheets of epidermis then begin to detach from the skin layers below. In time, the entire surface of the skin may be involved, with detachment of 100% of the epidermis.

Causes and symptoms

The main cause of TEN is a severe drug reaction. Some investigators believe there may be additional infectious causes. A severe reaction in transplant patients, called **graft-vs.-host disease**, can also produce TEN. One study reported more than 100 different drugs as causes of TEN. The drugs most commonly implicated, however, include antibacterial **sulfonamides** such as sulfadiazine, **antibiotics** such as aminopenicillins and **cephalosporins**, and anticonvulsants like phenytoin. TEN is extremely rare. Researchers estimate that there are 0.2 cases per million users of aminopenicillins and 4.5 cases per million users of sulfonamides.

Exactly what leads to detachment of the epidermis remains unclear. People with TEN seem to have difficulty metabolizing the offending drug. Some researchers suggest that certain substances that should be cleared from the body instead get deposited on the outer shell of the epidermis, causing an immune response that leads the body to "reject" the skin.

Diagnosis

Diagnosis is made primarily on the appearance and spread of the **skin lesions**, and on a history that includes introduction of a new medication within the previous one to three weeks. A biopsy of the early lesions will confirm the diagnosis. Physicians will consider other potential diseases that cause similar symptoms before reaching a diagnosis of TEN. One is **erythema multiforme**, a recurrent skin disorder that produces lesions similar in appearance to TEN. However, this disorder is not caused by a drug reaction and does not lead to sheet-like shedding of the skin. Another disease, Stevens-Johnson syndrome, is a drug-induced skin disease that some experts believe is really a milder form of TEN. **Staphylococcal scalded skin syndrome** (SSSS) also looks like TEN, but it is caused by a staphylococcal infection. Unlike TEN, which occurs rarely in children, SSSS primarily affects infants, young children, and adults with weakened immune systems.

Treatment

There is no specific treatment for TEN. Patients are typically treated in an intensive care unit or in a burn unit and receive treatment similar to that given to patients with major **burns**. With the loss of skin, severe **dehydration** is a major risk, so health care workers will attempt to replace fluids intravenously. Nutritional supplementa-

KEY TERMS

Epidermis—The outermost layer of the skin.

Erythema multiforme—A recurrent skin disorder that produces lesions similar in appearance to TEN, but is not caused by a drug reaction and does not lead to sheet-like shedding of the skin.

Staphylococcal scalded skin syndrome—A disease caused by *Staphylococcus aureus,* in which large sheets of skin may peel away from the body. It most often affects infants, young children, and people with weakened immune systems.

Stevens-Johnson syndrome—A drug-induced skin disease that some experts believe is really a milder form of TEN.

tion from a tube routed through the nose to the stomach may also be contemplated to promote the healing of the skin. Infection is a major risk, so some physicians "paint" the open lesions with topical **antiseptics**. Others use skin grafts taken from cadavers or cultured skin substitutes to cover large open areas until healing can occur. Some investigators believe systemic **corticosteroids** are useful in the treatment of TEN. But since these medications have also been implicated as a cause in some cases of TEN and are known to suppress the immune system, their use should be considered carefully.

Prognosis

About 25–30% of patients with TEN die. Elderly patients, those with extensive skin lesions, and those with **AIDS** have the worst prognosis. Widespread systemic infection (**sepsis**) is the primary cause of **death**. Survivors, however, will be completely healed in three to four weeks.

Prevention

There is no prevention for TEN. No reliable test can indicate that a specific drug may cause TEN in a specific patient. Some researchers believe skin tests of potentially offending drugs may prove useful in the future.

Resources

BOOKS

Fitzpatrick, Thomas B., et al. *Color Atlas and Synopsis of Clinical Dermatology.* New York: McGraw-Hill, 1997.

Helm, Klaus F., and James G. Marks Jr. *Atlas of Differential Diagnosis in Dermatology.* New York: Churchill Livingstone, 1996.

PERIODICALS

Revuz, Jean E., and Jean Claude Roujeau. "Advances in Toxic Epidermal Necrolysis." *Seminars in Cutaneous Medicine and Surgery* 15 (Dec. 1996): 258-266.

Weightman, Warren. "Toxic Epidermal Necrolysis." *Australasian Journal of Dermatology* 37 (Nov. 1996): 167-177.

ORGANIZATIONS

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Toxic shock syndrome

Definition

Toxic shock syndrome (TSS) is an uncommon, but potentially serious, illness that occurs when poisonous substances (toxins) produced by certain bacteria enter the bloodstream. The toxins cause a type of blood **poisoning** caused by staphylococcal, or less commonly streptococcal, infections in the lungs, throat, skin or bone, or from injuries. Women using super-absorbent tampons during menstruation were found to be most likely to get toxic shock syndrome.

Description

TSS first came to the attention of the public in the 1970s. Shortly after the introduction of a super-absorbent tampon, young women across the United States experienced an epidemic of serious but unexplained symptoms. Thousands went to emergency rooms with high **fever**, vomiting, peeling skin, low blood pressure, **diarrhea**, and a rash resembling **sunburn**. The only thing they had in common was that they all were menstruating at the time they felt sick, and all were using tampons—especially super absorbent products.

At its height, the epidemic affected 15,000 people in the United States each year between 1980 and 1984; 15% of the women died. Since the offending products were taken off the market, the numbers of TSS cases have declined sharply. As of 1998, only about 5,000 cases are diagnosed annually in the United States, 5% of which are fatal. The decline is most likely due to the tampon manufacturers' discontinuing the use of some synthetic materials, and the removal from the market of the brand of tampon associated with most cases of TSS. Today, most of these products are made with rayon and cotton.

In spite of TSS' association with menstruating women, the disease can affect anyone of either sex or any age or race. The infection may occur in children, men, and non-menstruating women who are weakened from surgery, injury, or disease, and who cannot fight off a staphylococcal infection. New mothers are also at higher risk for TSS.

Most cases reported in the recent past, however, still involve menstruating women under age 30. TSS still occurs in about 17 out of every 100,000 menstruating girls and women each year; more than half of these cases are related to tampons. Between five and 10% of patients with TSS die.

Streptococcal toxic shock syndrome (STSS)

A new type of toxic shock syndrome is caused by a different bacteria, called Group A streptococcus. This form of TSS is called streptococcal toxic shock syndrome, or STSS. Officially recognized in 1987, STSS is related to the strain of streptococcus nicknamed the "flesh-eating bacterium." STSS affects only one or two out of every 100,000 Americans. It almost never follows a simple "strep throat" infection.

Causes and symptoms

Transmission

TSS is caused by a strain of *Staphylococcus aureus* found in the nose, mouth, and occasionally the vagina. The bacteria produce a characteristic toxin. In large enough quantities, the toxin can enter the bloodstream, causing a potentially fatal infection.

While experts know the name of the bacterium, more than 10 years after the 1980s epidemic scientists still do not fully understand the link between TSS and tampons. Most medical researchers today suspect that the absorbent tampons introduce oxygen into the vagina, which is normally an oxygen-free area of the body. Oxygen triggers bacterial growth, and the more absorbent the tampon, the more bacteria it can harbor. Some experts believe that the reason TSS is linked to tampons in particular is that bacteria can contaminate and multiply in a tampon. If left in place for a long time—as a woman could do with a super-absorbent product—the bacteria have a better chance of multiplying and producing a large amount of toxin. It is also possible that the tampons or the chemicals they contain may irritate the vaginal lining, enabling the toxin to enter the bloodstream.

These types of bacteria are normally present either on hands or in the vagina, and it takes an amount of bacteria only the size of a grain of sand to start an infection. Of the 15% of women who carry *Staphylococcus aureus*, only about 5% have the strain that produces the TSS toxin.

Symptoms

TSS. TSS begins suddenly, with a high fever of 102°F (38.9°C) or above, vomiting and watery diarrhea, **headache**, and sunburn-like rash; together with a **sore throat** and body aches. Blood pressure may plummet a day or two after the first symptoms appear. When the blood pressure drops, a woman may become disoriented or go into shock. Her kidneys may fail. After these developments, the skin on her hands and feet may peel.

STSS. STSS can occur after a streptococcal infection in the body, usually from an infected wound or even **chickenpox**. Within 48 hours, the patient's blood pressure drops. There is also fever, **dizziness**, breathing problems, and a weak, rapid pulse. The area around the wound may swell, the liver and kidneys can fail, and bleeding problems may occur.

Diagnosis

Any woman who is wearing a tampon and begins to experience the symptoms of toxic shock syndrome should remove the tampon right away and seek medical care.

The doctor will probably examine the vagina for signs of inflammation and rule out common **sexually transmitted diseases** with similar symptoms. A variety of blood tests, tests of vaginal secretions, and a **physical examination** are needed to identify this condition.

Treatment

TSS

In a menstruating woman, the vagina is first cleansed with an antiseptic solution to eliminate some of the bacteria that produce the toxin. TSS is treated with **antibiotics**, together with other drugs and fluids to lower fever and control blood pressure.

STSS

Antibiotics are used to treat STSS. Surgery may be needed to remove dead skin and muscle.

Prognosis

TSS lasts as long as three weeks, and has a tendency to recur. About a third of the women who are treated for TSS have it again within six months. In addition, TSS can affect the liver, kidneys, lungs, and other organs, depending on the severity of the infection. Untreated toxic shock syndrome can be fatal.

KEY TERMS

Shock—A condition in which the amount of blood circulating in the body is inadequate to meet the body's needs. Shock can be caused by certain diseases, serious injury, or blood loss.

Staphylococcus—A genus of bacteria that is commonly found on human skin and mucous membranes.

Streptococcus—A genus of sphere-shaped bacteria that can cause a wide variety of infections.

Toxin—A poisonous protein that is produced by some bacteria. A toxin is less complex than a poison.

Prevention

TSS

Women who wear tampons should change them often and use different brands and types of pads and tampons. If a woman really prefers tampons, experts recommend using the lowest possible absorbency product made of cotton and rayon, and wearing it only during the day. In the past, it was difficult to compare absorbency rates for different products. Today, the Food and Drug Administration (FDA) requires standardized absorbency measurements on all tampon boxes. Above all, women should wash their hands before inserting a tampon, and change the tampon every four to six hours.

Anyone who has had TSS even once should not use tampons again.

STSS

Doctors still are not sure how people can avoid STSS, but they advise patients to clean and bandage open **wounds** immediately. Anyone with a red, swollen, or tender wound, or a sudden fever should seek medical care.

Resources

BOOKS

Garrett, Laurie. *The Coming Plague.* New York: Penguin Books, 1994.

Turkington, Carol A. *Infectious Disease A to Z.* New York: Facts on File, 1998.

PERIODICALS

"CDC defines group A streptococcal toxic shock syndrome." *American Family Physician* 47, no. 7 (15 May 1993): 1643-1644.

"Toxic Shock Syndrome—United States." *Morbidity and Mortality Weekly Report* 46, no. 22 (6 June 1997): 492-495.

OTHER

Kids Health Page. <http://KidsHealth.org>.

Carol A. Turkington

Toxocariasis *see* **Roundworm infections**

Toxoplasma gondii infection *see* **Toxoplasmosis**

Toxoplasmosis

Definition

Toxoplasmosis is an infectious disease caused by the one-celled protozoan parasite *Toxoplasma gondii*. Although most individuals do not experience any symptoms, the disease can be very serious, and even fatal, in individuals with weakened immune systems.

Description

Toxoplasmosis is caused by a one-celled protozoan parasite known as *Toxoplasma gondii*. Cats, the primary carriers of the organism, become infected by eating rodents and birds infected with the organism. Once ingested, the organism reproduces in the intestines of cats, producing millions of eggs known as oocysts, which are excreted in cat feces daily for approximately two weeks. In the United States, it is estimated that approximately 30% of cats have been infected by *T. gondii*. Oocysts are not capable of producing infection until approximately 24 hours after being excreted, but they remain infective in water or moist soil for approximately one year. When cattle, sheep, or other livestock forage through areas with contaminated cat feces, these animals become carriers of the disease. Fruits and vegetables can also become contaminated when irrigated with untreated water that has been contaminated with cat feces. In humans and other animals, the organisms produce thick-walled, dormant structures called cysts in the muscle and other tissues of the body.

Most humans contract toxoplasmosis by eating cyst-contaminated raw or undercooked meat, vegetables, or milk products. Humans can also become infected when they come into contact with the *T. gondii* eggs while cleaning a cat's litterbox, gardening, or playing in a sandbox, for instance. Once infected, an individual is immune to reinfection. The incubation period or period between

infection and the start of the disease ranges from several days to months.

Anyone can be infected by *T. gondii*, but usually only those individuals with weakened immune systems (immunocompromised) develop symptoms of the disease. For them, toxoplasmosis can be severe, debilitating, and fatal. Immunocompromised individuals at risk include those with **AIDS**, **cancer**, or other chronic illnesses.

There is no person-to-person transmission, except from an infected mother to her child in the womb. Approximately six out of 1,000 women contract toxoplasmosis during **pregnancy**. Nearly half of these maternal infections are passed on to the fetus. Known as congenital toxoplasmosis, this form of the disease is acquired at birth by approximately 3,300 infants in the United States every year. The risk of fetal infection is estimated to be between one in 1,000 to one in 10,000. In children born with toxoplasmosis, symptoms may be severe and quickly fatal, or may not appear until several months or even years after birth.

Causes and symptoms

Healthy individuals do not usually display symptoms. When symptoms do occur, they are usually mild, resembling **infectious mononucleosis**, and include the following:

- enlarged lymph nodes
- muscle pains
- fever that comes and goes
- general sick feeling

The distinction is made between acquired toxoplasmosis, in which an individual becomes infected, and neonatal congenital toxoplasmosis, in which a fetus is born with the infection because the mother became infected during pregnancy. If a fetus becomes infected early in pregnancy, the disease can cause the fetus to spontaneously abort, be stillborn. If full-term, the infant may die in infancy or suffer from central nervous system lesions. If the mother becomes infected in the last three months of pregnancy, however, the prognosis is good and the baby may not even display any symptoms.

In adults, if the infection continues for an extended period of time, chronic toxoplasmosis can cause an inflammation of the eyes called retinochoroiditis, which can lead to blindness, severe yellowing of the skin and whites of the eyes (**jaundice**), easy bruising, and convulsions.

Adults with weakened immune systems have a high risk of developing cerebral toxoplasmosis, including inflammation of the brain (**encephalitis**), one-sided weakness or numbness, mood and personality changes, vision disturbances, muscle spasms, and severe headaches. If untreated, cerebral toxoplasmosis can lead to **coma** and **death**. This form of encephalitis is the second most common AIDS-related nervous system infection that takes advantage of a person's weakened immune system (opportunistic infection).

Diagnosis

A diagnosis of toxoplasmosis is made based on clinical signs and supporting laboratory results, including visualization of the protozoa in body tissue or **isolation** in animals and blood tests. Laboratory tests for toxoplasmosis are designed to detect increased amounts of a protein or antibody produced in response to infection with the toxoplasmosis organism. Antibody levels can be elevated for years, however, without active disease.

Treatment

Most individuals who contract toxoplasmosis do not require treatment because their immune systems are able to control the disease. Symptoms are not usually present. Mild symptoms may be relieved by taking over-the-counter medications, such as **acetaminophen** (Tylenol) and ibuprofen (Motrin, Advil). **Sore throat** lozenges and rest may also ease the symptoms.

Although the treatment of women infected with toxoplasmosis during pregnancy is controversial, most physicians feel that treatment is justified. Transmission of toxoplasmosis from the mother to the fetus may be prevented if the mother takes the antibiotic spiramycin. Later in a pregnancy, if the fetus has contracted the disease, treatment with the antibiotic pyrimethamine (Daraprim, Fansidar) or **sulfonamides** may be effective. Babies born with toxoplasmosis who show symptoms of the disease may be treated with pyrimethamine, the sulfa drug sulfadiazine (Microsulfon), and folinic acid (an active form of **folic acid**).

AIDS patients who have not been infected may be given a drug called TMP/SMX (Bactrim or Septra) to prevent toxoplasmosis infection. To treat cases of toxoplasmosis in immunocompromised AIDS patients, a combination of pyrimethamine and a sulfa-based drug, either sulfadiazine or clindamycin (Cleocin), have been used together and can be effective in treating this disease. Other antibiotic combinations and dosing schedules are still being investigated. Physicians have reported success in alleviating symptoms by using trimethoprim-sulfamethoxazole (Proloprim or Trimpex) or dapsone (DDS) plus pyrimethamine. These drugs can produce side effects, such as allergic reaction, **itching**, **rashes**, and nausea; and patients must be monitored closely.

Prognosis

The prognosis is poor when congenital toxoplasmosis is acquired during the first three months of pregnancy. Afflicted children die in infancy or suffer damage to their central nervous systems that can result in physical and **mental retardation**. Infection later in pregnancy usually results in only mild symptoms, if any. The prognosis for acquired toxoplasmosis in adults with strong immune systems is excellent. The disease often disappears by itself after several weeks. However, the prognosis for immunodeficient patients is not as positive. These patients often relapse when treatment is stopped. The disease can be fatal to all immunocompromised patients, especially AIDS patients, and particularly if not treated. As a result, immunocompromised patients are typically placed on anti-toxoplasmosis drugs for the rest of their lives.

Prevention

There are no drugs that can eliminate *T. gondii* cysts in animal or human tissues. Humans can reduce their risks of developing toxoplasmosis by practicing the following:

- freezing (to 10.4°F/–12°C) and cooking foods to an internal temperature of 152°F/67°C will kill the cysts
- practicing sanitary kitchen techniques, such as washing utensils and cutting boards that come into contact with raw meat
- keeping pregnant women and children away from household cats and cat litter
- disposing of cat feces daily, because the oocysts do not become infective until after 24 hours
- helping cats to remain free of infection by feeding them dry, canned, or boiled food and by discouraging hunting and scavenging
- washing hands after outdoor activities involving soil contact and wearing gloves when gardening

Resources

BOOKS

Conn's Current Therapy, 1996. Ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Shulman, Stanford T., et al. *The Biologic and Clinical Basis of Infectious Diseases.* 5th ed. Philadelphia: W. B. Saunders Co., 1997.

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

PERIODICALS

Alger, L. S. "Toxoplasmosis and Parvovirus B19." *Infectious Disease Clinics of North America* 11 (Mar. 1997): 55-75.

KEY TERMS

Cyst—The thick-walled dormant form of many organisms.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Oocyst—The egg form of the toxoplasmosis organism.

Protozoan—A single-celled, usually microscopic, organism.

Campagna, A. C. "Pulmonary Toxoplasmosis." *Seminars in Respiratory Infections* 12 (June 1997): 98-105.

Rose, I. "Morphology and Diagnostics of Human Toxoplasmosis." *General & Diagnostic Pathology* 142 (June 1997): 257-70.

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Toxoplasmosis, Other, Rubella, Cytomegalovirus, Herpes simplex test *see* **TORCH test**

T-PA *see* **Thrombolytic therapy**

Trabeculectomy

Definition

Trabeculectomy is a surgical procedure that removes part of the trabeculum in the eye to relieve pressure caused by **glaucoma**.

Purpose

Glaucoma is a disease that injures the optic nerve, causing progressive loss of vision. Presently, glaucoma is a major cause of blindness in the United States If caught early, glaucoma-related blindness is easily prevented, However, since it does not produce symptoms until late in its cycle, periodic tests for the disease are necessary.

Glaucoma is usually associated with an increase in the pressure inside the eye. This increase occurs in front of the iris in a fluid called the aqueous humor. Aqueous humor is supposed to exit through tiny channels between the iris and the cornea, in an area called the trabeculum.

KEY TERMS

Cornea—Transparent film that covers the iris and pupil.

Iris—Colored part of the eye, which is suspended in aqueous humor and perforated by the pupil.

Sclera—White, outer coating of the eyeball.

Trabeculoplasty—Laser surgery that creates perforations in the trabeculum, to drain built up aqueous humor and relieve pressure.

Trabeculum—Tissue that is a drainage point for aqueous humor in the eye.

When the trabeculum is blocked, pressure from the build up of aqueous humor either increases rapidly with considerable **pain** and redness, or, as in most cases, the pressure builds slowly with no symptoms until much of the vision is lost. Trabeculectomy is the last treatment employed for either type of glaucoma. It is used only after medications and laser trabeculoplasty (less invasive procedure that uses a laser to open the blocked trabeculum) have failed to alleviate the pressure.

Description

A trabeculectomy involves removing a tiny piece of the eyeball right at the place where the cornea connects to the sclera (the white part), and creating a flap to allow fluid to escape the anterior chamber without deflating the eye. Along with that tiny piece of cornea and sclera comes a piece of the iris. The whole area is called the trabeculum. Fluid can then flow out onto the surface of the eye and be absorbed by the conjunctiva, the transparent membrane that lines the sclera and the eyelids. Sometimes, an additional piece is taken out of the iris so that anterior chamber fluid can also flow backward into the vitreous part of the eye. This procedure is called an iridectomy.

Preparation

The procedure and its benefits and possible complications are fully explained. Antiglaucoma drugs are prescribed before surgery. Added pressure on the eye caused from coughing or sneezing should be avoided.

Aftercare

Eye drops, and perhaps patching, will be needed until the eye is healed. The pressure inside the eye will still be monitored. Immediately following the procedure, the patient may experience blurred vision.

Risks

Infection and bleeding are risks of any surgery. Scarring can cause the drainage to stop. A third of patients with trabeculectomies will develop **cataracts**.

Resources

BOOKS

General Ophthalmology. 13th ed. Ed. Daniel Vaughan. Stamford: Appleton & Lange, 1993.

Sardegna, Jill, and T. Paul Otis. *The Encyclopedia of Blindness and Vision Impairment.* New York: Facts on File, Inc., 1990.

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Tracheoesophageal fistula

Definition

Tracheoesophageal fistula (TEF) is commonly a birth defect, with the trachea connected to the esophagus. In most cases, the esophagus is discontinuous, causing immediate feeding difficulties. TEFs may develop in adult life, secondary to the invasion of **cancer** in the area. In addition, TEFs may be deliberately constructed with surgery to aid talking in a patient who has the larynx removed (a **laryngectomy**).

Description

The trachea, or windpipe, carries air to the lungs. The esophagus carries food to the stomach. Sometimes during development, these two tubes do not separate completely, but remain connected by a short passage. When this happens, air enters the gastrointestinal system, causing the bowels to distend, and mucus is breathed into the lungs causing aspiration **pneumonia** and breathing problems.

Most tracheoesophageal fistulas are diagnosed when a child is born. There are three types. In 85–90% of tracheoesophageal fistulas, the top part of the esophagus ends in a blind sac, and the lower part inserts into the trachea. In the second type, the upper part of the esophagus is connected directly to the trachea, while the lower part ends in a pouch. In a rare type of fistula called an H type, both the esophagus and trachea are complete, but they are connected. This is the most difficult type of tracheoesophageal fistula to diagnose, because both eating and breathing are possible.

Causes and symptoms

Tracheoesophageal fistulas arise as a developmental abnormality. At birth, the infant has difficulty swallowing. Eating produces severe coughing spells that interfere with breathing. Aspiration pneumonia can develop from fluid breathed into the lungs.

Small H type fistulas may go undiagnosed until later in life. Symptoms of an H type fistula include frequent pulmonary infections and bouts of abdominal bloating.

Diagnosis

Diagnosis that the esophagus is interrupted is confirmed by the inability to insert a **nasogastric suction** tube into the stomach. The exact type and location of the fistula can be determined using a radiopaque catheter, which allows pictures to be taken of the esophagus. X rays may show air in the bowels. Endoscopy often fails to located the fistula if it is small.

Treatment

Babies with all but H type fistulas are unlikely to survive without surgical separation and repair of the trachea and the esophagus. Surgery cannot always be performed immediately because of **prematurity**, the presence of other **birth defects**, or complications from aspiration pneumonia. It is usually done at a hospital that has special facilities for treating seriously ill newborns.

While awaiting surgery, the infant's condition is stabilized. Preoperative care concentrates on avoiding aspiration pneumonia and includes:

- elevating the head to avoid reflux and aspiration of the stomach contents
- using a suction catheter to continuously removed mucus and saliva that could be inhaled
- when necessary, placement of a **gastrostomy** tube
- withholding feeding by mouth

When surgery is performed, the esophagus is reconnected to make it continuous and separate from the trachea. If the two ends of the esophagus are too far apart to be reattached, a piece of tissue from the large intestine is used to join the parts.

Prognosis

Infants who have tracheoesophageal fistula often have other birth defects that affect their recovery. Even when the esophagus is successfully separated and reattached, many infants have difficulty swallowing, because the contractility of the esophagus is impaired. Infants may also have problems with gastroesophageal reflux, in which the acidic contents of the stomach back up into the bottom of the esophagus and cause ulcers and scarring.

KEY TERMS

Endoscopy—A procedure in which an instrument containing a camera and a light source is inserted into the gastrointestinal tract so that the physician can visually inspect the gastrointestinal system.

Gastrostomy tube—Stomach tube for feeding.

Laryngectomy—Surgical removal of the larynx to treat cancer.

Prevention

Tracheoesophageal fistulas are not preventable birth defects.

Resources

BOOKS

"Gastrointestinal Defects." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Tish Davidson

Tracheostomy *see* **Tracheotomy**

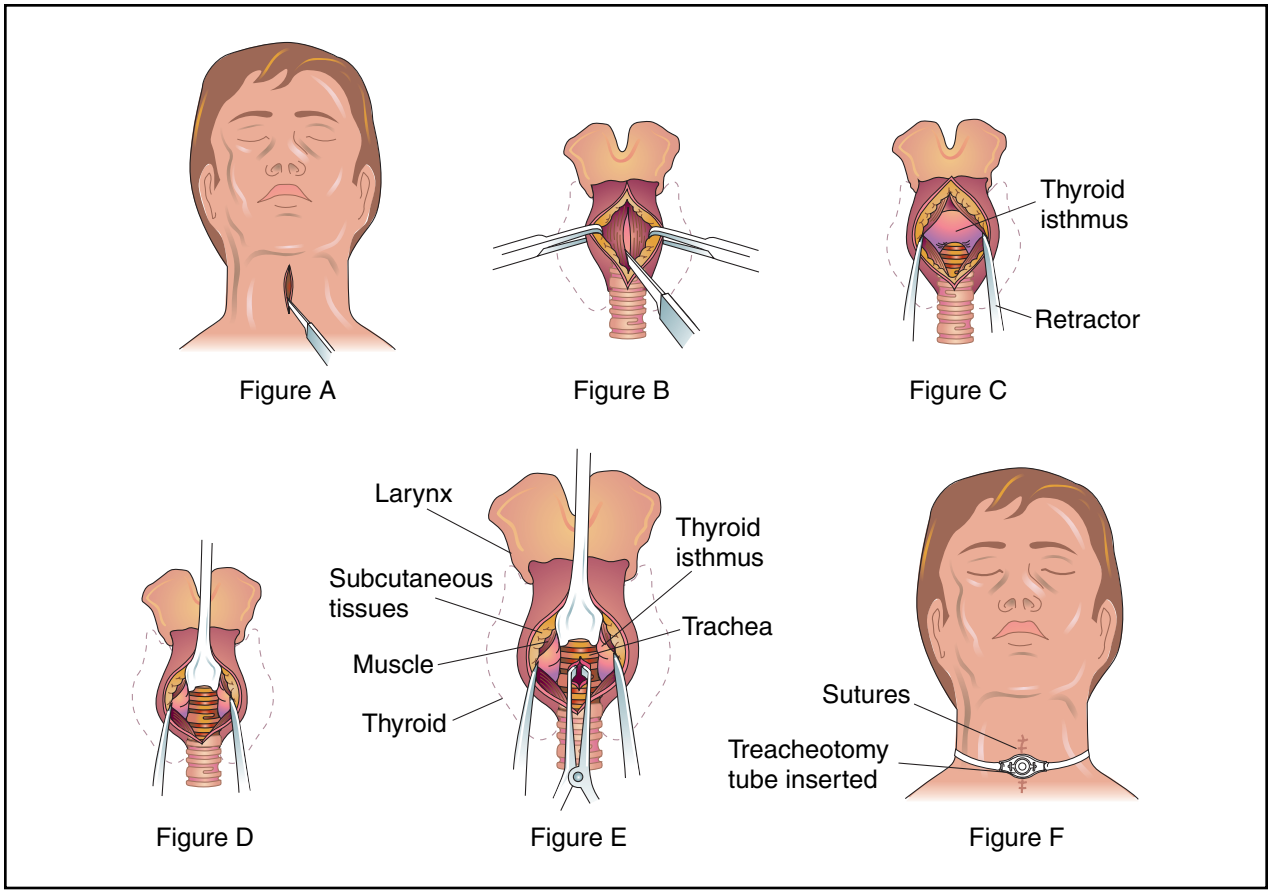
Tracheotomy

Definition

A tracheotomy is a surgical procedure in which a cut or opening is made in the windpipe (trachea). The surgeon inserts a tube into the opening to bypass an obstruction, allow air to get to the lungs, or remove secretions. The term tracheostomy is sometimes used interchangeably with tracheotomy. Strictly speaking, however, tracheostomy usually refers to the opening itself while a tracheotomy is the actual operation.

Purpose

A tracheotomy is performed if enough air is not getting to the lungs, if the person cannot breathe without help, or is having problems with mucus and other secretions get-



Tracheotomy is a surgical procedure in which an opening is made in the windpipe or trachea. As shown in the illustration above, the physician or surgeon will follow these steps in performing this procedure: Figure A: A vertical incision is made through the skin. Figure B: Another incision is made through the subcutaneous tissues and muscles of the neck. Figure C: The neck muscles are separated using retractors. Figure D: The thyroid isthmus is either cut or retracted. Figure E: The surgeon identifies the rings of cartilage that make up the trachea and cuts into the walls. Figure F: A metal or plastic tube is inserted into the opening and sutures are used to hold the tube in place. *(Illustration by Electronic Illustrators Group.)*

ting into the windpipe because of difficulty swallowing. There are many reasons why air cannot get to the lungs. The patient's windpipe may be blocked by a swelling; by a severe injury to the neck, nose or mouth; by a large foreign object; by **paralysis** of the throat muscles; or by a tumor. The patient may be in a **coma**, or need a ventilator to pump air into the lungs for a long period of time.

Precautions

Doctors perform emergency tracheotomies as last-resort procedures. They are done only if the patient's windpipe is obstructed and the situation is life-threatening.

Description

Emergency tracheotomy

There are two different procedures that are called tracheotomies. The first is done only in emergency situations and can be performed quite rapidly. The emergency room physician or surgeon makes a cut in a thin part of the voice box (larynx) called the cricothyroid membrane. A tube is inserted and connected to an oxygen bag. This emergency procedure is sometimes called a cricothyroidotomy.

Nonemergency tracheotomy

The second type of tracheotomy takes more time and is usually done in an operating room. The surgeon first makes a cut (incision) in the skin of the neck that lies over the trachea. This incision is in the lower part of the neck between the Adam's apple and top of the breastbone. The neck muscles are separated and the thyroid gland, which overlies the trachea, is usually cut down the middle. The surgeon identifies the rings of cartilage that make up the trachea and cuts into the tough walls. A metal or plastic tube, called a tracheotomy tube, is inserted through the opening. This tube acts like a windpipe and allows the

person to breathe. Oxygen or a mechanical ventilator may be hooked up to the tube to bring oxygen to the lungs. A dressing is placed around the opening. Tape or stitches (sutures) are used to hold the tube in place.

After a nonemergency tracheotomy, the patient usually stays in the hospital for three to five days, unless there is a complicating condition. It takes about two weeks to recover fully from the surgery.

Preparation

Emergency tracheotomy

In the emergency tracheotomy, there is no time to explain the procedure or the need for it to the patient. The patient is placed on his or her back with face upward (supine), with a rolled-up towel between the shoulders. This positioning of the patient makes it easier for the doctor to feel and see the structures in the throat. A local anesthetic is injected across the cricothyroid membrane.

Nonemergency tracheotomy

In a nonemergency tracheotomy, there is time for the doctor to discuss the surgery with the patient, to explain what will happen and why it is needed. The patient is then put under general anesthesia. The neck area and chest are then disinfected as preparation for the operation, and surgical drapes are placed over the area, setting up a sterile field.

Aftercare

Postoperative care

A **chest x ray** is often taken, especially in children, to check whether the tube has become displaced or if complications have occurred. The doctor may prescribe **antibiotics** to reduce the risk of infection. If the patient can breathe on their own, the room is humidified; otherwise, if the tracheotomy tube is to remain in place, the air entering the tube from a ventilator is humidified. During the hospital stay, the patient and his or her family members will learn how to care for the tracheotomy tube, including suctioning and clearing it. Secretions are removed by passing a smaller tube (catheter) into the tracheotomy tube.

It takes most patients several days to adjust to breathing through the tracheotomy tube. At first, it will be hard even to make sounds. If the tube allows some air to escape and pass over the vocal cords, then the patient may be able to speak by holding a finger over the tube. A patient on a ventilator will not be able to talk at all.

The tube will be removed if the tracheotomy is temporary. Then the wound will heal quickly and only a small scar may remain. If the tracheotomy is permanent, the hole stays open and, if it is no longer needed, it will be surgically closed.

Home care

After the patient is discharged, he or she will need help at home to manage the tracheotomy tube. Warm compresses can be used to relieve **pain** at the incision site. The patient is advised to keep the area dry. It is recommended that the patient wear a loose scarf over the opening when going outside. He or she should also avoid contact with water, food particles, and powdery substances that could enter the opening and cause serious breathing problems. The doctor may prescribe pain medication and antibiotics to minimize the risk of infections. If the tube is to be kept in place permanently, the patient can be referred to a speech therapist in order to learn to speak with the tube in place. The tracheotomy tube may be replaced four to 10 days after surgery.

Patients are encouraged to go about most of their normal activities once they leave the hospital. Vigorous activity is restricted for about six weeks. If the tracheotomy is permanent, further surgery may be needed to widen the opening, which narrows with time.

Risks

Immediate risks

There are several short-term risks associated with tracheotomies. Severe bleeding is one possible complication. The voice box or esophagus may be damaged during surgery. Air may become trapped in the surrounding tissues or the lung may collapse. The tracheotomy tube can be blocked by blood clots, mucus, or the pressure of the airway walls. Blockages can be prevented by suctioning, humidifying the air, and selecting the appropriate tracheotomy tube. Serious infections are rare.

Long-term risks

Over time, other complications may develop following a tracheotomy. The windpipe itself may become damaged for a number of reasons, including pressure from the tube; bacteria that cause infections and form scar tissue; or friction from a tube that moves too much. Sometimes the opening does not close on its own after the tube is removed. This risk is higher in tracheotomies with tubes remaining in place for 16 weeks or longer. In these cases, the wound is surgically closed.

High-risk groups

The risks associated with tracheotomies are higher in the following groups of patients:

KEY TERMS

Cartilage—A tough, fibrous connective tissue that forms various parts of the body, including the trachea and larynx.

Cricothyroidotomy—An emergency tracheotomy that consists of a cut through the cricothyroid membrane to open the patient's airway as fast as possible.

Larynx—A structure made of cartilage and muscle that connects the back of the throat with the trachea. The larynx contains the vocal cords.

Trachea—The tube that leads from the larynx or voice box to two major air passages that bring oxygen to each lung. The trachea is sometimes called the windpipe.

Ventilator—A machine that helps patients to breathe. It is sometimes called a respirator.

- children, especially newborns and infants
- smokers
- alcoholics
- obese adults
- persons over 60
- persons with chronic diseases or respiratory infections
- persons taking **muscle relaxants**, sleeping medications, tranquilizers, or cortisone

The overall risk of **death** from a tracheotomy is less than 5%.

Normal results

Normal results include uncomplicated healing of the incision and successful maintenance of long-term tube placement.

Resources

BOOKS

Fagan, Johannes J., et al. *Tracheotomy.* Alexandria, VA: American Academy of Otolaryngology-Head and Neck Surgery Foundation, Inc., 1997.

"Neck Surgery." In *The Surgery Book: An Illustrated Guide to 73 of the Most Common Operations*, ed. Robert M. Younson, et al. New York: St. Martin's Press, 1993.

Schantz, Nancy V. "Emergency Cricothyroidotomy and Tracheostomy." In *Procedures for the Primary Care Physician*, ed. John Pfenninger and Grant Fowler. New York: Mosby, 1994.

OTHER

"Answers to Common Otolaryngology Health Care Questions." *Department of Otolaryngology–Head and Neck Surgery Page*. University of Washington School of Medicine. <http://weber.u.washington.edu/~otoweb/trach.html>.

Sicard, Michael W. "Complications of Tracheotomy." *The Bobby R. Alford Department of Otorhinolaryngology and Communicative Sciences*. <http:www.bcm.tmc.edu/oto/grand/12194.html>.

Jeanine Barone, Physiologist

Trachoma

Definition

Trachoma, which is also called granular **conjunctivitis** or Egyptian ophthalmia, is a contagious, chronic inflammation of the mucous membranes of the eyes, caused by *Chlamydia trachomatis*. It is characterized by swelling of the eyelids, sensitivity to light, and eventual scarring of the conjunctivae and corneas of the eyes.

Description

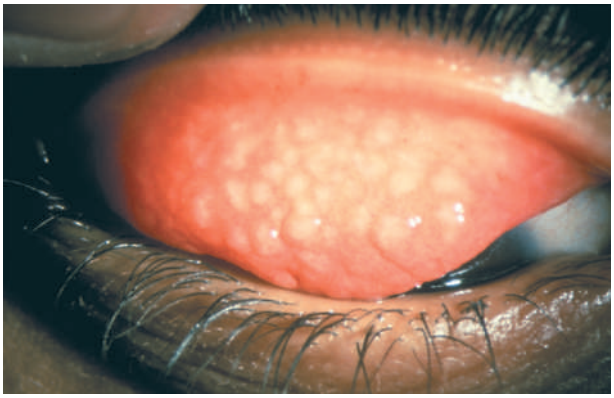
Trachoma is a major cause of blindness in the world. It is found in the Far East, as well as countries with desert climates. In the United States, it is most common among certain Native Americans and in parts of Appalachia. The infection is highly contagious in its early stages. Blindness results from recurrent untreated infections.

The conjunctiva is the clear mucous membrane that lines the inside of the eyelid and covers the white part (sclera) of the eye. Conjunctivitis is an inflammation of the conjunctiva.

Causes and symptoms

Trachoma is caused by *C. trachomatis*, a parasitic organism closely related to bacteria. It is transmitted by insects, by hand-to-eye contact, or by the sharing of infected handkerchiefs or towels. The incubation period is about a week.

The early symptoms of trachoma include the development of follicles (small sacs) on the conjunctivae of the upper eyelids, **pain**, swollen eyelids, a discharge, tearing, and sensitivity to light. If the infection is not treated, the follicles develop into large yellow or gray pimples, and small blood vessels develop inside the cornea. In most cases, both eyes are infected.



A close-up of a human eye with trachoma. Trachoma is caused by *Chlamydia trachomatis* and commonly results in blindness if left untreated. *(Custom Medical Stock Photo. Reproduced by permission.)*

Repeated infections eventually lead to contraction and turning-in of the eyelids, scarring of the corneas and conjunctivae, eventual blockage of the tear ducts, and blindness.

Diagnosis

Diagnosis is based on a combination of the patient's history (especially living or traveling in areas with high rates of trachoma) and examination of the eyes. The doctor will look for the presence of follicles or scarring. He or she will take a small sample of cells from the patient's conjunctivae and examine them, following a procedure called Giemsa staining, to confirm the diagnosis.

Treatment

Treatment of early-stage trachoma consists of four to six weeks of antibiotic treatment with tetracycline, erythromycin, or **sulfonamides**. **Antibiotics** should be given without waiting for laboratory test results. Treatment may combine oral medication with antibiotic ointment applied directly to the eyes. A single-dose treatment with azithromycin is an alternative method. **Tetracyclines** should not be given to pregnant women or children below the age of seven years.

Patients with complications from untreated or repeated infections are treated surgically. Surgery can be used for **corneal transplantation** or to correct eyelid deformities.

Prognosis

The prognosis for full recovery is excellent if the patient is treated promptly. If the infection has progressed to the stage of follicle development, prevention of blindness depends on the severity of the follicles, the presence of additional bacterial infections, and the development of scarring.

KEY TERMS

Conjunctivitis—Inflammation of the conjunctivae, which are the mucous membranes covering the white part of the eyeball (sclera) and lining the inside of the eyelids.

Cornea—The transparent front part of the eye that allows light to enter.

Ophthalmia—Inflammation of the eye. Usually severe and affecting the conjunctiva. Trachoma is sometimes called Egyptian ophthalmia.

Prevention

There are vaccines available that offer temporary protection against trachoma, but there is no permanent immunization. Prevention depends upon good hygiene and public health measures:

- seek treatment immediately if a child shows signs of eye infection, and minimize his or her contact with other children
- teach children to wash hands carefully before touching their eyes
- protect children from flies or gnats that settle around the eyes
- if someone has trachoma (or any eye infection), do not share towels, pillowcases, etc.; wash items well
- if medications are prescribed, follow the doctor's instructions carefully

Resources

BOOKS

O'Brien, Terrence P. "Conjunctivitis." In *Conn's Current Therapy, 1996*, ed. Robert E. Rakel. Philadelphia: W. B. Saunders Co., 1996.

"Ophthalmologic Disorders: Trachoma." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Riordan-Eva, Paul, et al. "Eye." In *Current Medical Diagnosis and Treatment, 1998.* 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

"Trachoma." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Rebecca J. Frey, PhD

Traction

Definition

Traction is the use of a pulling force to treat muscle and skeleton disorders.

Purpose

Traction is usually applied to the arms and legs, the neck, the backbone, or the pelvis. It is used to treat **fractures**, dislocations, and long-duration muscle spasms, and to prevent or correct deformities. Traction can either be short-term, as at an accident scene, or long-term, when it is used in a hospital setting.

Traction serves several purposes:

- it aligns the ends of a fracture by pulling the limb into a straight position
- it ends muscle spasm
- it relieves pain
- it takes the pressure off the bone ends by relaxing the muscle

There are two main types of traction: skin traction and skeletal traction. Within these types, many specialized forms of traction have been developed to address problems in particular parts of the body. The application of traction is an exacting technique that requires training and experience, since incorrectly applied traction can cause harm.

Positioning the extremity so that the angle of pull brings the ends of the fracture together is essential. Elaborate methods of weights, counterweights, and pulleys have been developed to provide the appropriate force while keeping the bones aligned and preventing muscle spasm. The patient's age, weight, and medical condition are all taken into account when deciding on the type and degree of traction.

Precautions

People who are suffering from skin disorders or who are allergic to tape should not undergo skin traction, because the application of traction will aggravate their condition. Likewise, circulatory disorders or **varicose veins** can be aggravated by skin traction. People with an inflammation of the bone (**osteomyelitis**) should not undergo skeletal traction.

Description

Skin traction

Skin traction uses five- to seven-pound weights attached to the skin to indirectly apply the necessary pulling force on the bone. If traction is temporary, or if only a light or discontinuous force is needed, then skin traction is the preferred treatment. Because the procedure is not invasive, it is usually performed in a hospital bed.

Weights are attached either through adhesive or non-adhesive tape, or with straps, boots, or cuffs. Care must be taken to keep the straps or tape loose enough to prevent swelling and allow good circulation to the part of the limb beyond the spot where the traction is applied. The amount of weight that can be applied through skin traction is limited because excessive weight will irritate the skin and cause it to slough off.

Specialized forms of skin traction have been developed to address specific problems. Dunlop's traction is used on children with certain fractures of the upper arm, when the arm must be kept in a flexed position to prevent problems with the circulation and nerves around the elbow. Pelvic traction is applied to the lower spine, with a belt around the waist. Buck's skin traction is used to treat knee injuries other than fractures. The purpose of this traction is to stabilize the knee and reduce muscle spasm.

Skeletal traction

Skeletal traction is performed when more pulling force is needed than can be withstood by skin traction; or when the part of the body needing traction is positioned so that skin traction is impossible. Skeletal traction uses weights of 25-40 pounds.

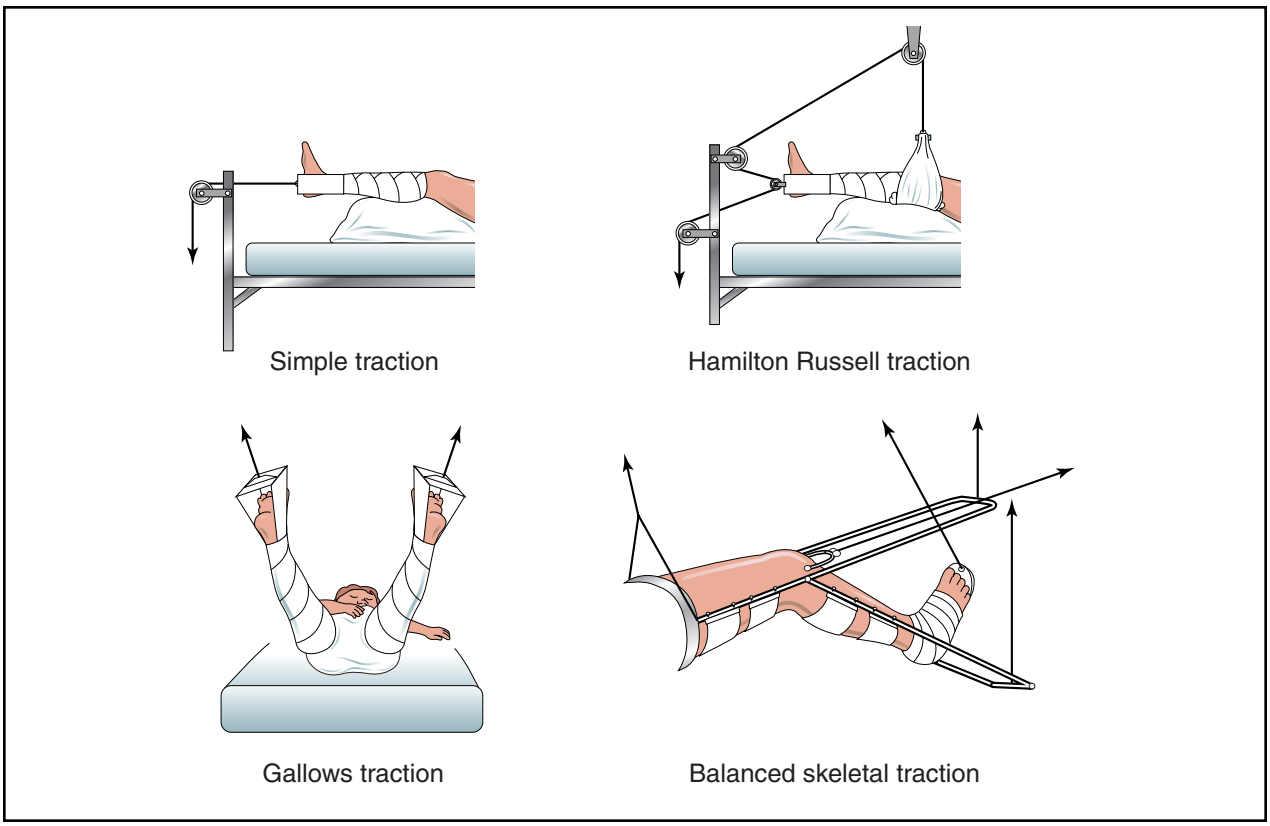
Skeletal traction requires the placement of tongs, pins, or screws into the bone so that the weight is applied directly to the bone. This is an invasive procedure that is done in an operating room under general, regional, or local anesthesia.

Correct placement of the pins is essential to the success of the traction. The pin can be kept in place several months, and must be kept clean to prevent infection. Once the hardware is in place, pulleys and weights are attached to wires to provide the proper pull and alignment on the affected part.

Specialized forms of skeletal traction include cervical traction used for fractures of the neck vertebrae; overhead arm traction used for certain types of upper arm fractures; and tibia pin traction used for some fractures of the femur, hip, or pelvis.

Preparation

X rays are done prior to the application of both forms of traction, and may be repeated during treatment to assure that the affected parts are staying in alignment



Traction refers to the usage of a pulling force and special devices, such as a cast or splint, to treat muscle and skeletal disorders. It is used to treat fractures, dislocations, and long-duration muscle spasms, and to prevent or correct deformities. The illustration above features several commonly used forms of traction. *(Illustration by Electronic Illustrators Group.)*

and healing properly. Since the insertion of the anchoring devices in skeletal traction is a surgical procedure, standard preoperative blood and urine testing are done, and the patient may meet with an anesthesiologist to discuss any health conditions that might affect the administration of anesthesia.

Aftercare

Aftercare for skin traction involves making sure the limb stays aligned, and caring for the skin so that it does not become sore and irritated. The patient should also be alert to any swelling or tingling in the limb that would suggest that the limb has been wrapped too tightly.

Aftercare for skeletal traction is more complex. The patient is likely to be immobile for an extended period. Deep breathing exercises are taught so that respiratory function is maintained during this time of little activity. Patients are also encouraged to do range-of motion exercises with the unaffected parts of the body. The patient is taught how to use a trapeze (an overhead support bar) to shift on and off a bedpan, since it is not possible to get up to use the toilet. In serious injuries, traction may be continued for several months until healing is complete.

Risks

The main risks associated with skin traction are that the traction will be applied incorrectly and cause harm, or that the skin will become irritated. There are more risks associated with skeletal traction. Bone inflammation may occur in response to the introduction of foreign material into the body. Infection can occur at the pin sites. If caught early, infection can be treated with **antibiotics**, but if severe, it may require removal of the pin.

Both types of traction have complications associated with long periods of immobility. These include the development of bed sores, reduced respiratory function, urinary problems, and circulatory problems. Occasionally, fractures fail to heal. Being confined to traction for a long period can take a an emotional toll on the patient, also.

Normal results

When correctly applied, traction generally produces very good, if slow, results.

Resources

BOOKS

Rodrigo, Juan J. "Traction." In *Orthopaedic Surgery: Basic Science and Clinical Science*. Boston: Little, Brown and Co., 1986.

"Traction." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

Tish Davidson

Traditional Chinese medicine

Definition

Traditional Chinese medicine (TCM) is an ancient and still very vital holistic system of health and healing, based on the notion of harmony and balance, and employing the ideas of moderation and prevention.

Purpose

TCM is a complete system of health-care with its own unique theories of anatomy, health, and treatment. It emphasizes diet and prevention and using **acupuncture**, herbal medicine, massage, and **exercise**; and focuses on stimulating the body's natural curative powers.

Precautions

In situations of severe trauma, TCM should not be substituted for contemporary modern trauma practice; it is most useful as an adjunct to the healing regimen. TCM is not the first line of treatment for bacterial infection or **cancer**, but may usefully complement contemporary medical treatment for those conditions.

Description

In theory and practice, traditional Chinese medicine is completely different from Western medicine, both in terms of considering how the human body works and how illness occurs and should be treated. As a part of a continuing system that has been in use for thousands of years, it is still employed to treat over one-quarter of the world's population. Since the earliest Chinese physicians were also philosophers, their ways of viewing the world and human beings' role in it affected their medicine. In TCM, both philosophically and medically, moderation in all things is advocated, as is living in harmony with nature and striving for balance in all things. Prevention is also a key goal of Chinese medicine, and much emphasis is placed on educating the patient to live responsibly. The

Chinese medicine practitioner preparing herbal medicines. *(Photograph by Eric Nelson. Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Chinese physician also is more of an advisor than an authority; he or she believes in treating every patient differently, based on the notion that one does not treat the disease or condition but rather the individual patient. Thus two people with the same complaint may be treated entirely differently, if their constitutions and life situations are dissimilar. Disease is also considered to be evidence of the failure of preventive health care and a falling out of balance or harmony.

There is some confusion in the West about the fundamental philosophical principles upon which traditional Chinese medicine is based — such as the concept of yin and yang, the notion of five elements (wood, fire, earth, metal and water), and the concept of *chi* — yet each can be explained in a way that is understandable to Westerners.

Yin and yang describe the interdependent relationship of opposing but complementary forces believed to be necessary for a healthy life. Basically, the goal is to maintain a balance of yin and yang in all things.

The five elements, or five-phase theory, is also grounded in the notion of harmony and balance. The concept of *chi*, which means something like "life force" or "energy," is perhaps most different from Western ideas. TCM asserts that *chi* is an invisible energy force that flows freely in a healthy person, but is weakened or blocked when a person is ill. Specifically, the illness is a result of the blockage, rather than the blockage being the result of the illness.

Besides these philosophical concepts that differ considerably from infection-based principles of medicine and health, the methods employed by traditional Chinese

medicine are also quite different. If allopathic Western practitioners could be described as interventionist and dependent on synthetic pharmaceuticals, TCM methods are mostly natural and noninvasive. For example, where Western physicians might employ surgery and **chemotherapy** or radiation for a cancer patient, a TCM physician might use acupuncture and dietary changes. TCM believes in "curing the root" of a disease and not merely in treating its symptoms.

Another major difference is how the patient is regarded. In Western medicine, patients with similar complaints or diseases, usually will receive virtually the same treatment. In TCM however, the physician treats the patient and not the condition, believing that identical diseases can have entirely different causes. In terms of the principles upon which it is based and the methods used, traditional Chinese medicine, therefore, is considered by many in the West to be a radically different system of healthcare.

To some in the Western world, this very strangeness is the reason why it might be attractive. To others, tired of what they perceive as their physician's perfunctory, analytical, and sometimes cold manner, TCM offers a more humane, patient-oriented approach that encourages a high degree of practitioner-patient interaction and is not overly dependent on technology.

For example, during a consultation with a TCM practitioner, the patient will receive a considerable amount of time and attention. During the important first visit, the practitioner will conduct four types of examinations, all extremely observational and all quite different from what patients usually experience.

First, the practitioner will ask many questions, going beyond the typical patient history to inquire about such particulars as eating and bowel habits or sleep patterns. Next, the physician looks at the patient, observing his or her complexion and eyes, while also examining the tongue very closely, believing that it is a barometer of the body's health and that different areas of the tongue can reflect the functioning of different body organs. After observing, they listen to the patient's voice or **cough** and then smell his or her breath, body odor, urine, and even bowel movements. Finally, the practitioner touches the patient, palpating his or her abdomen and feeling the wrist to take up to six different pulses. It is through these different pulses that the well-trained practitioner can diagnose any problem with the flow of the all-important *chi*. Altogether, this essentially observational examination will lead the physician to diagnose or decide the patient's problem. This diagnosis is very different from one in contemporary Western medicine. No blood or urine samples are tested in a laboratory. The key to this technique lies in the experience and skill of the practitioner.

After making a diagnosis, the physician will suggest a course of treatment from one or all of the available TCM methods. These fall into four main categories: herbal medicine, acupuncture, dietary therapy, and massage and exercise. A typical TCM prescription consists of a complex variety of many different herbal and mineral ingredients. Chinese herbal remedies are intended to assist the body's own systems so that eventually the patient can stop taking them and never becomes dependent on them. Herbal formulas are usually given as teas, which differ according to the patient.

Other common techniques used in a TCM prescription are as follows:

- Acupuncture is based on the notion that the body's vital energy force, *chi*, travels through known channels or "meridians." The acupuncturist inserts tiny, thin sterile needles at particular, selected points on the body to unblock or correct the flow of energy. These needles are hardly felt as they are inserted and are left in place for 15–20 minutes. Some patients report immediate improvement, others feel exhilarated, while some feel like sleeping. In some cases, patients say their condition worsens before it improves. No contemporary scientific explanation exists as to how or why acupuncture works.
- Moxibustion is a variation sometimes employed. Moxibustion is the slow burning on or over the body of special herbal "cones." These are placed on specific acupoints and provide penetrating, relaxing heat.
- Massage is often recommended, and a deep finger pressure technique known as **acupressure** is often used to promote the proper flow of *chi*.
- Diet is considered essential to good health, and what might be called "kitchen medicine" is just another aspect of herbalism. One example is a delicious *dong quai* black bean soup that is traditionally eaten by women in China after **childbirth** and each menstrual cycle.
- Therapeutic exercises are sometimes prescribed as well. In both the exact and flowing movements of **t'ai chi**, and the breathing techniques of Qi Dong exercise is considered essential to relieving **stress** and promoting the smooth flow of *chi*.

As a system of total healthcare, TCM is prepared to deal with any physical or mental problem, condition, or disease. However, unlike Western medicine at its best, TCM is not able to render the kind of emergency crisis intervention that saves lives during physical traumas. Nonetheless, it works best at achieving its goal of practicing preventive medicine. It has proven effective in treating many types of aches and pains and in helping

KEY TERMS

Allopathic—Pertaining to conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

Anatomy—The science of the body structure of an organism and its parts.

Holistic—That which pertains to the entire person, including the mind, body, and spirit.

Palpate—To examine the body by touching or pressing with the fingers or the palm of the hand.

Pharmaceutical—Pertaining to drugs.

Therapeutic—Curative or healing.

Trauma—Injury or damage to the body.

people with depression and **fatigue**, as well as circulation and digestive problems. Overall, its emphasis on good diet and exercise, as well as on individual responsibility and moderation in all things, suggest that it is grounded in fundamentally sound principles.

Risks

In the hands of a qualified practitioner, TCM is very safe. However, there is a small chance of not only getting an infection from acupuncture, but also that an existing infection could be spread to other parts of the body by increased blood flow and circulation.

Normal results

Traditional Chinese medicine seeks to harmonize and rebalance the entire human system rather than to treat just symptoms. Since proper internal balance is considered to be the key to human health, TCM strives to cure disease by restoring that balance and therefore allowing the body to repair itself. Its continuing medical goal is to detect and correct abnormalities before they cause permanent physical damage.

Resources

BOOKS

Eckert, Achim. *Chinese Medicine for Beginners*. Rocklin, CA: Prima Publishing, 1996.

Reid, Daniel. *The Shambhala Guide to Traditional Chinese Medicine*. Boston: Shambhala Publications, Inc., 1996.

Williams, Tom. *Chinese Medicine*. Rockport, MA: Element Books Ltd., 1995.

Ziyin, Shen, and Chen Zelin. *The Basis of Traditional Chinese Medicine*. Boston: Shambhala Publications, Inc., 1994.

PERIODICALS

Huston, Peter. "China, Chi, and Chicanery." *Skeptical Inquirer* (Sept./Oct. 1995): 38-42, 58.

Light, Louise. "Kitchen Medicine for Women." *Vegetarian Times*, July 1997, 102-106.

Salmons, Catherine A. "Zen and the Art of Healing." *Boston Magazine*, Apr. 1997, 62-65, 95.

ORGANIZATIONS

American Academy of Medical Acupuncture. 2520 Milvia St., Berkeley, CA 94704. (415) 841-3220.

American Association of Acupuncture & Oriental Medicine. 4101 Lake Boone Trail, Suite 201, Raleigh, NC 27607. (919) 787-5181.

Leonard C. Bruno, PhD

Trager psychophysical integration

Definition

Trager psychophysical integration therapy, also known as the Tragerwork system of physical integration, is a combination of hands-on tissue mobilization, relaxation, and movement reeducation called Mentastics. The underlying principle of psychophysical integration is that clients learn to be lighter, easier, and freer by experiencing lightness, ease, and freedom of movement in their bodies.

The Trager method is a psychologically grounded physical approach to muscle relaxation, which is induced when a practitioner and patient achieve a state of mind called hook-up. Hook-up is described as a connection to a state of grace or a powerful and nourishing life force. It is the opposite of strain or effort.

Purpose

Psychophysical integration therapy has been helpful in relieving muscle discomfort in patients afflicted with **polio**, **muscular dystrophy**, **Parkinson's disease**, **multiple sclerosis**, post-stroke trauma, and psychiatric disturbances. The therapy is useful in alleviating such chronic conditions as back and leg **pain**. Athletes may benefit from this system to increase resilience to injuries and to improve their mental attitudes. In addition, the Trager Institute maintains that Tragerwork helps clients achieve greater mental clarity through the release of "deep-seated physical and mental patterns."

MILTON TRAGER (1909–1997)

Milton Trager was a medical doctor and a somatic educator, specializing in body learning. He was a contemporary of F. Matthias Alexander, Moshe Feldenkrais, and Ida Rolf.

As a young man in the 1920s, he occupied himself with gymnastics and boxing. Through his intensely physical pursuits, he arrived at his self-taught body learning theories. The techniques that he nurtured emphasized body control over strength, prowess, and endurance. For example, in striving to leap as high as possible, Trager focused his concentration on landing as softly as possible. He obtained a degree in physical medicine before serving in the military during World War II.

Upon his return, Trager funded his medical school education with his GI benefits. He established a private practice and spent the ensuing 50 years refining his body learning techniques and assisting afflicted individuals in the process. When Trager's father was stricken with sciatic pain, Trager learned to relieve the spasms by hand. In time he learned to alleviate the symptoms of polio victims and others who suffered from muscle spasms.

Trager established the Trager Institute in the 1970s to propagate the techniques that he had developed. By the year 2000, an estimated 2,000 students and practitioners had embraced the Trager Approach.

Trager lived with his wife, Emily, in Southern California at the time of his death in January 1997.

Description

Origins

Psychophysical integration therapy began with Dr. Milton Trager (1909–1997), who earned a medical degree in midlife after working out his approach to healing chronic pain. Trager was born with a spinal deformity and overcame it through practicing a variety of athletic exercises. At the time that he discovered his approach to bodywork, he was training to become a boxer. His therapy came to public attention when Esalen Institute in California, the famous center of the human potential movement, invited him to give a demonstration of his technique during the mid-1970s. Trager abandoned his private medical practice in 1977 to devote full energy to the development and further understanding of psychophysical integration. The Trager Institute, which continues his work, was founded in 1980.

The Trager method consists of two parts, a passive aspect referred to as tablework and an active aspect called Mentastics, which is a self-care **exercise** program. Although the benefits of the Trager approach are said to be cumulative, practitioners and clients appear to be free to set their own schedules for a series of sessions. There is no minimum number of sessions that clients must agree to take.

Tablework

The tablework is performed on a comfortable padded table. Sessions last about 60–90 minutes. The practitioner moves the client in ways that he or she naturally moves, in such a way that he or she experiences how it feels to move effortlessly and freely on one's own. The movements resemble general mobilization techniques, and incorporate some manual, cervical, and lumbar **traction**. The goal of tablework is to allow the client "slowly to give up muscular and mental control and sink into a very deep state of relaxation not unlike that experienced in hypnosis."

Mentastics

Mentastics are free-flowing dance-like movements intended to increase the client's self-awareness, as well as providing tools to help the client move through and control chronic pain. The client is encouraged to "let go," which means that they are asked to begin a movement, then release their muscle tension and allow the weight of the body part involved to complete the motion. By experiencing movement as something pleasurable and positive rather than painful or negative, clients begin to loosen up, learn new movements more easily, and even begin inventing their own. In the early stages of treatment, clients are advised to do Mentastic movements at home for 10–15-minute sessions, three times per day.

Preparations

Prior to a session of tablework, the client dresses for comfort, "with a minimum of swimwear or briefs," according to the Trager Institute. The client is also covered with a drape. No oils or lotions are used.

The practitioner prepares for the session by clearing his or her mind of everything but the client, until he or she achieves a state of hook-up. This attitude of "relaxed meditative awareness" on the part of the practitioner is one of the unique features of Tragerwork. It is described as allowing the therapist "to connect deeply with the recipient in an unforced way and enables the practitioner to perceive the slightest responses from the [client's] body."

Precautions

Because of the unusual sensitivity and heightened awareness that is associated with the practitioner's touch, pain should never result from tablework sessions. It is important for clients to alert the practitioner to any pain

KEY TERMS

Hook-up—A state of effortless connection with a life-enhancing force. Trager practitioners enter a state of hook-up before working with clients in order to focus on their needs. Trager himself described hook-up as a meditative process of "becoming one with the energy force that surrounds all living things."

Mentastics—The active phase of Trager therapy. Mentastics are a form of movement reeducation in which clients learn to reexperience movement as pleasurable and positive.

Tablework—The passive phase of Trager therapy, in which the practitioner uses gentle and noninvasive movements to allow the client to relax deeply and experience physical movement as free and effortless.

associated with either the tablework or the Mentastics program.

Although the movements used in Trager tablework are gentle and noninvasive, clients who have had recent injuries or surgery should wait to heal before undertaking a course of Tragerwork.

Side effects

The Trager method should not produce physical side effects when employed by a qualified practitioner. It is possible that some clients may have emotional reactions associated with the release of physical patterns acquired as a response to trauma, but such reactions are unusual.

Research and general acceptance

Tragerwork, like other forms of bodywork, has gained increasing acceptance as a form of treatment since the 1980s. In 2000 there were 1,200 certified psychophysical integration practitioners in 15 countries worldwide. The therapy has been reported as a commonly employed treatment for mainstream athletes. In addition, the National Institutes of Health lists psychophysical therapy as a mind-body form of complementary alternative medicine.

Resources

BOOKS

Juhan, Deanne. *Job's Body.* Station Hill Press, 1987.

Trager, Milton, M.D. *Trager Mentastics: Movements as a Way to Agelessness.* Station Hill Press, 1987.

ORGANIZATIONS

Florida Institute of Psychophysical Integration: Quantum Balance. 5837 Mariner Drive. Tampa, FL 33609-3411. (813) 186-2273. Fax: (813) 287-2870. Dr.Joy@JohnsonMail.com>.

Trager Institute. 21 Locust Avenue. Mill Valley, CA 94941-2806. (415) 388-2688. Fax: (415) 399-2710. admin@trager.com. <http://www.trager.com>.

Gloria Cooksey

Tranquilizers *see* **Antianxiety drugs**

Transcranial Doppler ultrasonography

Definition

Transcranial **Doppler ultrasonography** is a noninvasive method of analyzing blood flow in the brain.

Purpose

The blood that flows through the brain distributes nutrients to the brain and removes wastes. This flow maintains the high rate of metabolism necessary for the brain to function. Restrictions in blood flow may occur from vessel narrowing (stenosis), clot formation (thrombosis), blockage (**embolism**), or blood vessel rupture (hemorrhage). Lack of sufficient blood flow (**ischemia**) threatens brain tissue and may cause a **stroke**.

The flow of blood through the arteries in the brain can be analyzed using transcranial Doppler ultrasonography (TCD). TCD is a form of ultrasound, in which high frequency sound waves bounce off or pass through body tissues. While most other types of ultrasonography create images of the tissue being studied, the results of TCD are audible sounds that the examiner listens to and records.

Doppler ultrasonography uses what is called the Doppler effect to measure the rate and direction of blood flow in the vessels. Just as a siren's pitch sounds higher when its source is moving toward you and lower as it moves away, so too will ultrasound waves change pitch, or frequency, as they bounce off the red blood cells moving in the blood. It is these pitch changes that produce the audible sounds during the exam.

Changes in frequency can be used to measure both the direction and the speed of blood flow. Faster blood flow causes a greater change in frequency. Combined with other tests, this information can be used to locate restrictions in the blood vessels in the brain, and to track

changes in blood flow over time. In this way, TCD gives valuable information about the site of a stroke and the patient's progress after a stroke. TCD is also used to evaluate the contraction of blood vessels that can occur if a blood vessel ruptures.

Precautions

Ultrasonography procedures are safe, noninvasive, and painless. No special precautions are necessary.

Description

TCD is done with either one or two probes placed against the skin. The examiner spreads a clear gel on the areas of the head where the probe will be placed. Usually, the probes are placed on the temple, on the base of the skull at the back of the neck, and over the closed eyelid. In these places, there is the least amount of thick protective bone and the sound waves can penetrate the best. The examiner adjusts the probe position and orientation to direct the sound waves toward the blood vessels of interest. Finding the best approach may take some time. A compression test may be performed during the exam. In this test, the main artery in the neck (carotid artery) is briefly compressed, and changes in blood flow patterns are observed. A full TCD exam may last 30–45 minutes, and often longer in patients with disease.

Preparation

No special preparation is needed. The patient should remove contact lenses, and may wish to avoid the use of eye makeup, since the gel is likely to smear it.

Aftercare

The gel is washed off with soap and water. No other after care is needed.

Risks

TCD is noninvasive and has no risks. A compression test is occasionally, though very rarely, hazardous for a patient with narrowed arteries (**atherosclerosis**), since the increased pressure may dislodge a piece of the substance that causes the narrowing (plaque).

Normal results

TCD produces an audible sound that varies with the heartbeat. It also varies depending on the direction and rate of flow through the vessel being examined. Each of the vessels in the brain has a characteristic direction of flow, which can be detected by TCD. Flow rates are somewhat variable from person to person.

Abnormal results

Lack of flow indicates a vessel has been completely blocked (although absence of a signal may also be due to absorption of sound waves by bone). If blood flows in the wrong direction or alternates between normal and reverse flow, it may mean there is a blockage elsewhere. This happens because blood is rerouted due to abnormalities in pressure caused by the blockage.

If the speed of flow is increased, it may mean that blood is flowing through a restricted area that is just "upstream" from the probe. Intuitively, one might think that a restricted blood vessel would cause the speed of blood flow to slow down. However, the opposite is true. This is because the same amount of blood going through a narrower opening must go faster. Increased speed is also seen if a vessel is carrying rerouted blood.

Resources

BOOKS

Office Practice of Neurology. Ed. Martin Samuels and Steven Feske. New York: Churchill Livingstone, 1996.

von Reutern, G. M., and H. J. von Budingen. *Ultrasound Diagnosis of Cerebrovascular Disease.* New York: Georg Thieme Verlag, 1993.

Richard Robinson

Transesophageal echocardiography

Definition

Transesophageal **echocardiography** is a diagnostic test using an ultrasound device that is passed into the esophagus of the patient to create a clear image of the heart muscle and other parts of the heart. A tube with a device called a transducer is passed down into the patient's throat and into the esophagus (the food tube that connects the mouth to the stomach). The transducer directs ultrasound waves into the heart, and the reflected sound waves picked up by the transducer are translated into an image of the heart.

Purpose

Since the esophagus is right next to the heart, transesophageal echocardiography provides a very clear pic-

ture of the heart. It can provide information on the size of the heart, its pumping strength, and the location and extent of any damage to its tissues. It can detect abnormal tissue growth around the heart valves. It is also good at detecting abnormalities in the pattern of blood flow, such as the backward flow of blood through partly closed heart valves, known as regurgitation or insufficiency. It is especially useful in cases in which conventional echocardiography (a test where the transducer is kept on the patient's chest) cannot offer a good image, such as when the patient is obese or has a thick chest wall. It is useful for monitoring heart function during cardiac surgery and detecting blood clots in the left atrium of the heart.

Precautions

Patients should avoid consuming alcohol for a day or so before the procedure, since alcohol may amplify the effects of the sedative used with the procedure.

Description

Echocardiography creates an image of the heart using ultra-high-frequency sound waves—sound waves that are much too high in frequency to be heard by the human ear. The technique is very similar to ultrasound scanning commonly used to visualize the fetus during **pregnancy**.

A transesophageal echocardiography examination generally lasts 30–60 minutes. The patient is given a mild sedative and the back of the throat is sprayed with a local anesthetic, in order to suppress the gag reflex. Next, a special viewing tube called an endoscope, containing a tiny transducer, is passed through the mouth and into the esophagus. It is carefully moved until it is positioned directly next to the heart. Essentially a modified microphone, the transducer directs ultrasound waves into the heart, some of which get reflected (or "echoed") back to the transducer. Different tissues and blood all reflect ultrasound waves differently. These sound waves can be translated into a meaningful image of the heart, which is displayed on a monitor or recorded on paper or tape. The transducer may be moved several times during the test to help doctors get a better view of the heart.

Preparation

The patient may be given a mild sedative before the procedure, and an anesthetic is sprayed into the back of the throat in order to suppress the gag reflex.

Aftercare

After the test, it is important to refrain from eating or drinking until the gag reflex has returned—otherwise, the patient may accidentally inhale some of the food or beverage. If a sedative has been given, patients should not drive or operate heavy machinery for at least 10-12 hours. They should avoid consuming alcohol for a day or so, since alcohol may amplify the effect of the sedative.

Risks

Transesophageal echocardiography may cause gagging and discomfort when the transducer is passed down into the throat. Patients may also experience **sore throat** for a few days after the test. In rare cases, the procedure may cause bleeding or perforation of the esophagus or an inflammatory condition known as infective **endocarditis**. The patient may have an adverse reaction to the sedative or local anesthetic.

Normal results

A normal transesophageal echocardiogram shows a normal heart structure and the normal flow of blood through the heart chambers and heart valves.

Abnormal results

A transesophageal echocardiogram may show a number of abnormalities in the structure and function of the heart, such as thickening of the wall of the heart muscle (especially the left ventricle). Other abnormalities can include blood leaking backward through the heart valves (regurgitation), or blood clots in the left atrium of the heart.

Resources

BOOKS

Faculty Members of the Yale University School of Medicine. *The Patient's Book of Medical Tests*. Boston: Houghton Mifflin Co., 1997.

PERIODICALS

Rose, Verna L. "American College of Cardiology and American Heart Association Address the Use of Echocardiography." *American Family Physician* 56 (7 Oct. 1997): 1489-90.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Robert Scott Dinsmoor

Transferrin test *see* **Iron tests**

KEY TERMS

Endoscope—An instrument used to see and examine the inside of a body cavity or organ.

Gag reflex—A normal reflex consisting of elevation of the palate, retraction of the tongue, and contraction of the throat muscles.

Regurgitation—Backward flow of blood through a partly closed valve.

Transducer—A device that converts electrical signals into ultrasound waves and ultrasound waves back into electrical impulses.

Ultrasound—Sound waves at a frequency of 20,000 kHz, often used for diagnostic imaging.

Transfusion

Definition

The process of transferring whole blood or blood components from one person (donor) to another (recipient).

Purpose

Transfusions are given to restore lost blood, to improve clotting time, and to improve the ability of the blood to deliver oxygen to the body's tissues.

Precautions

For donors, the process of giving blood is very safe. Only sterile equipment is used and there is no chance of catching an infection from the equipment. There is a slight chance of infection at the puncture site if the skin is not properly washed before the collection needle is inserted. Some donors feel light-headed upon standing for the first time after donating. Occasionally, a donor will faint. Donors are advised to drink lots of liquids to replace the fluid lost with the donated blood. It is important to maintain the fluid volume of the blood so that the blood pressure will remain stable. Strenuous **exercise** should be avoided for the rest of the day. Most patients have very slight symptoms or no symptoms at all after donating blood.

For recipients, a number of precautions must be taken. The blood given by transfusion must be matched with the recipient's blood type. Incompatible blood types can cause a serious adverse reaction (transfusion reaction). Blood is introduced slowly by gravity flow directly into the veins (intravenous infusion) so that medical personnel can observe the patient for signs of adverse reactions. People who have received many transfusions can develop an immune response to some factors in foreign blood cells (see below). This immune reaction must be checked before giving new blood. Infectious diseases can also be transmitted through donated blood.

Description

Either whole blood or blood components can be used for transfusion. Whole blood is used exactly as it was received from the donor. Blood components are parts of whole blood, such as red blood cells (RBCs), plasma, platelets, clotting factors, immunoglobulins, and white blood cells. Whole blood is used only when needed or when components are not available. Most of the time whole blood is not used because the patient's medical condition can be treated with a blood component. Too much whole blood can raise a recipient's blood pressure. High blood pressure can have medical side effects and should be avoided. Use of blood components is a more efficient way to use the blood supply, because blood that has been processed (fractionated) into components can be used to treat more than one person.

Whole blood is generally used when a person has lost a lot of blood. Such blood loss can be caused by injury or surgical procedures. Whole blood is given to help restore the blood volume, which is essential for maintaining blood pressure. Whole blood is also given to ensure that the body's tissues are receiving enough oxygen. Whole blood is occasionally given when a required blood component is unavailable in isolated form.

Red blood cells are the blood component most frequently used for transfusion. RBCs are the only cells in the body that transport oxygen. A transfusion of RBCs increases the amount of oxygen that can be carried to the tissues of the body. RBCs that have been separated from the liquid plasma (packed RBCs) are given to people who have anemia or who have lost a lot of blood. Platelets are another component frequently given by transfusion. Platelets are a key factor in blood clotting. The clear fluid that carries blood cells (plasma) also contains blood-clotting factors. The platelets and plasma clotting factors are extracted from donated blood and concentrated for use. These factors are used to treat people with such clotting disorders, as **hemophilia**. Immunoglobulins, also called gamma globulin or immune serum, are collected from plasma for use in temporarily boosting the immune capability of a patient. White blood cells (WBCs) are another infection-fighting component of the blood. White blood cells are given by transfusion only rarely.

Blood donation

Each year in the United States, about 14,000,000 pints of blood are donated. Blood collection is strictly regulated by the Food and Drug Administration (FDA). The FDA has rules for the collection, processing, storage, and transportation of blood and blood products. In addition, the American Red Cross, the American Association of Blood Banks, and most states have specific rules for the collection and processing of blood. The main purpose of regulation is to ensure the quality of blood and to prevent the transmission of infectious diseases through donated blood. Before blood and blood products are used, they are extensively tested for such infectious agents as hepatitis and **AIDS**.

DONORS. Blood donors are questioned about their general health, their lifestyle, and any medical conditions that might disqualify them as donors. These conditions include hepatitis, AIDS, **cancer**, heart disease, **asthma**, **malaria**, bleeding disorders, and high blood pressure. Screening prevents blood donation by people who could transmit diseases or by people whose medical condition would place them at risk if they donated blood. Some geographical areas or communities have a high rate of hepatitis or AIDS. Blood collection in most of these areas has been discontinued.

The blood pressure, temperature, and pulse of donors are taken to ensure that they are physically able to donate blood. One pint (450 ml) of blood is usually donated, although it is possible to donate smaller volumes. The average man has 10-12 pints and the average woman 8-9 pints of blood. Within hours after donating, most people have replaced the fluid lost with the donated blood, bringing their blood volume back to normal. Replacing donated blood cells and platelets can take several weeks. People with low blood pressure or anemia and pregnant women should not donate blood or should limit the amount of blood they donate. Generally, people are allowed to donate blood only once every two months. This delay ensures the health of the donor and discourages people from selling their blood. The practice of paying donors for blood has essentially stopped. Donors who sell blood tend to have a high risk for the transmission of infectious agents.

BLOOD COLLECTION. Blood is collected from the donor by inserting a large needle into a vein in the arm. Usually, one of the larger veins near the inside of the elbow is used. A tourniquet is placed on the upper arm to increase the pressure in the arm veins and make them swell and become more accessible. Once a suitable vein is identified, the area where the needle will be inserted is sterilized by washing with soap solution or an iodine-containing antiseptic. Sometimes both are used. The donor lies on a bed or cot during the procedure, which takes about ten minutes. Generally, an 18-gauge needle is used. This needle can easily fit into the veins and yet is large enough that the blood flows easily. Blood will sometimes clot in a smaller needle and stop flowing. Blood is collected in sterile plastic bags that hold one pint (450 ml). The bags contain an anticoagulant to prevent clotting and preservatives to keep the blood cells alive. Properly handled and refrigerated, whole blood can last for 42 days.

AUTOLOGOUS TRANSFUSION. Autologous transfusion is a procedure in which patients donate blood for their own use. Patients who are to undergo surgical procedures for which a blood transfusion might be required may elect to donate a store of blood for the purpose ahead of time. The blood is stored at the hospital for the exclusive use of the patient. This procedure assures that the blood type is an exact match. It also assures that no infection will be transmitted through the blood transfusion.

DIRECTED DONATION. Directed donors are family or friends of the patient who needs a transfusion. Some people think that family and friends provide a safer source of blood than the general blood supply. Studies do not show that directed donor blood is any safer. Blood that is not used for the identified patient becomes part of the general blood supply.

APHERESIS. Apheresis is a special procedure in which only the necessary components of a donor's blood are collected. The remaining components are returned to the donor. A special blood-processing instrument is used in apheresis. It separates the blood into components, saves the desired component, and pumps all the other components back into the donor. Because donors give only part of their blood, they can donate more frequently. For example, people can give almost ten times as many platelets by apheresis as they could give by donating whole blood.

BLOOD PROCESSING. A sample of the donator's blood is collected at the time of donation and tested for infectious diseases. Blood is not used until the results from these tests confirm that it is safe.

BLOOD TYPING. The donated blood is typed. There are major and minor blood types, also called blood groups. The major types are classified by the ABO system. This system groups blood by two substances, called antigen A and antigen B, in the red blood cells. The four ABO blood types are A, B, AB, and O. Type A blood has the A antigen, type B has the B antigen, type AB has both, and type O has neither. These four types of blood are further sorted by the Rh

factor. The Rh, or rhesus factor, is also an antigen in the red blood cells. A person who has the Rh factor is Rh positive; a person who does not have the factor is Rh negative. If a person has red blood cells with both the B and the Rh antigens, that person is said to have a B positive (B+) blood type. Blood types determine what blood a patient can receive. Generally, patients are limited to receiving only blood of the exact same ABO and Rh type as their own. For example, a person with B+ blood can only receive blood or blood cells from another person with B+ blood. An exception is blood type O. O is called the universal donor, because people of all blood types can accept it.

Blood can be typed by several other minor antigens, such as Kell, Duffy, and Lewis. These minor antigens can become important when a patient has received many transfusions. These patients tend to build up an immune response to the minor blood groups that do not match their own. Upon receiving a transfusion with a mismatched minor blood group, they may have an adverse reaction. A third group of antigens to which a patient can react are residues from the donor's plasma that have attached to the RBCs. To eliminate this problem, the RBCs are rinsed to remove plasma residues. These rinsed cells are called washed RBCs.

Blood components used in transfusion

Most blood collected from donors is broken down (fractionated) into components that are used to treat specific problems or diseases. Treating patients with blood components is the most efficient way to use the blood supply.

RED BLOOD CELLS. Red blood cells (RBCs) carry oxygen throughout the body. They obtain oxygen as they pass through the lungs and give up oxygen to the other tissues of the body as they are pumped through arteries and veins. When patients do not have enough RBCs to properly oxygenate their bodies, they can be given a transfusion with RBCs obtained from donors. RBCs are recovered from whole blood after donation. They are then typed, removed from the watery blood plasma to minimize the volume (packed), and stored. They are given to people who have anemia (including **thalassemia**), whose bone marrow does not make enough RBCs, or who have other conditions that decrease the number of RBCs in the blood. Occasionally, red blood cells from rare blood types are frozen. Once frozen, RBCs can survive for as long as ten years. Packed RBCs are given in the same manner as whole blood.

PLASMA. Plasma is the liquid portion of blood. It contains many useful proteins, especially clotting factors and immunoglobulins. After they are processed, plasma or plasma factors (fractions) are usually frozen. Some plasma fractions are freeze-dried. These fractions include clotting factors I through XIII. Some people have an inherited disorder in which the body produces too little of the plasma clotting factors VIII (hemophilia A) or IX (hemophilia B). Transfusions of these clotting factors help people with hemophilia stop bleeding. Frozen plasma must be thawed before it is used and freeze-dried plasma must be mixed with liquid (reconstituted). In both cases, these blood fractions are usually small in volume and can be injected by syringe and needle.

PLATELETS. Platelets are small bodies in the blood that are essential for clotting. People who do not have enough platelets have bleeding problems. People who have lymphoma, leukemia, or **thrombocytopenia**, and people who are receiving cancer therapy do not make enough platelets. Platelets have a very short shelf life; they must be used within five days of blood donation. Platelets are packed into bags. A platelet transfusion is given in the same manner as whole blood.

IMMUNOGLOBULINS. Immunoglobulins are the infection-fighting fraction of blood plasma. They are also known as gamma globulin, antibodies, and immune serum. This blood fraction is given to people who have difficulty fighting infections, especially people whose immune systems are depressed by diseases, such as AIDS. Immunoglobulins are also used to prevent **tetanus** after cuts, to treat animal bites when **rabies** infection is suspected, or to treat severe childhood diseases. Generally, the volume used is small, and the immunoglobulins can be injected.

WHITE BLOOD CELLS. White blood cells (WBCs) are another infection-fighting component of the blood. On rare occasions, white blood cells are given by transfusion to treat life-threatening infections. Such transfusions are given when the WBC count is very low or when WBCs are not functioning normally. Most of the time, however, **antibiotics** are used in these cases.

Preparation

A person receiving a transfusion is treated in much the same way as a blood donor. The site where the needle will be inserted is carefully washed with a soap-based solution, followed by an iodine-containing antiseptic. The skin is then dried and the transfusion needle inserted into the recipient's vein. During the early stages of a transfusion, the recipient is monitored closely to detect any adverse reactions. If no signs of adverse reaction are evident, the patient is monitored occasionally for the duration of the transfusion period. Upon completion of

the transfusion, a compress bandage is place over the needle-insertion site to prevent bleeding.

Aftercare

Recipients of blood transfusion are monitored during and after the transfusion for signs of adverse reaction.

Risks

Adverse reaction to mismatched blood (transfusion reaction) and transmission of infectious disease are the two major risks of blood transfusion. Transfusion reaction occurs when antibodies in the recipient's blood react to foreign blood cells introduced by the transfusion. The antibodies bind to the foreign cells and destroy them (hemolytic reaction). Transfusion reaction may also cause a hypersensitivity of the immune system that, in turn, may cause tissue damage within the patient's body. The patient may also have an allergic reaction to mismatched blood. The first symptoms of transfusion reaction are a feeling of general discomfort and **anxiety**. Breathing difficulties, flushing, a sense of pressure in the chest, and back **pain** may develop. Evidence of a hemolytic reaction can be seen in the urine, which will be colored from the waste of destroyed red blood cells. Severe hemolytic reactions are occasionally fatal. Reactions to mismatches of minor factors are milder. These symptoms include itchiness, **dizziness**, **fever**, **headache**, rash, and swelling. Sometimes the patient will experience breathing difficulties and muscle spasms. Most adverse reactions from mismatched blood are not life-threatening. The infectious diseases most often acquired from blood transfusion in the United States are hepatitis and AIDS.

Patients who are given too much blood can develop high blood pressure, a concern for people who have heart disease. Very rarely, an air **embolism** is created when air is introduced into a patient's veins through the tubing used for intravenous infusion. The danger of embolism is greatest when infusion is begun or ended. Care must be taken to ensure that all air is bled out of the tubing before infusion begins, and that infusion is stopped before air can enter the patients, blood system.

Resources

BOOKS

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Beutler, Ernest, ed, et al. *Williams Hematology.* 5th ed. New York: McGraw-Hill, Inc., 1995.

Larsen, D. E., ed. *Mayo Clinic Family Health Book.* New York: William Morrow and Co., Inc., 1996.

John T. Lohr, PhD

KEY TERMS

ABO blood groups—A system in which human blood is classified by whether the red blood cells contain A or B antigens. Type A blood has the A antigen; type B has the B antigen, AB has both, and 0 has neither.

Antibody—A simple protein produced by the body to destroy bacteria, viruses, or other foreign bodies. Production of each antibody is triggered by a specific antigen.

Antigen—A substance that stimulates the immune system to manufacture antibodies (immunoglobulins). The function of antibodies is to fight off intruder cells, such as bacteria or viruses, in the body. Antigens stimulate the blood to fight other blood cells that have the wrong antigens. If a person with blood type A is given a transfusion with blood type B, the A antigens will fight the foreign blood cells as though they were an infection.

Immunoglobulin—An antibody.

Infusion—Introduction of a substance directly into a vein or tissue by gravity flow.

Injection—Forcing a fluid into the body by means of a needle and syringe.

Rh (rhesus) factor—An antigen present in the red blood cells of 85% of humans. A person with Rh factor is Rh positive (Rh+); a person without it is Rh negative (Rh-). The Rh factor was first identified in the blood of a rhesus monkey.

Transhepatic biliary catheterization

Definition

Transhepatic biliary catheterization is a surgical procedure during which a catheter is inserted into the bile duct to relieve an obstruction.

Purpose

Bile is a fluid made in the liver and stored in the gall bladder. The function of bile is to break down fats during digestion. When fatty foods move into the intestine, bile is released from the gall bladder, travels through the bile duct, and enters the first part of the small intestine (duodenum).

If the bile duct is blocked, the skin becomes yellowish (jaundiced), the abdomen is painful, and a **fever** develops. The bile duct can be blocked by **gallstones**, surgical injury, infection in the duct, or by tissue growth due to **cancer**. Transhepatic biliary catheterization is performed to relieve bile duct blockage. The most common reason for this procedure is to relieve obstruction from the overgrowth of cancer cells. Obstruction due to gallstones is usually cleared by other means.

Precautions

Transhepatic biliary catheterization is done when cancer has progressed to the point where all the malignant cells cannot be removed by surgery. Patients who need transhepatic biliary catheterization often suffer from additional complications of their cancer. Because of the likelihood of bleeding from the liver, this procedure should not be done on patients who have blood clotting abnormalities.

Description

Transhepatic biliary catheterization is performed by inserting a needle through the skin, into the abdomen, through the liver, and into the bile duct. A wire attached to the needle then guides the catheter into place. The procedure can take several hours. The patient is given medication for **pain**.

The catheter can either reestablish bile flow into the duodenum or reroute the bile so it drains into a bag outside the body. The choice depends on the extent and position of the obstruction.

Preparation

The standard preoperative blood tests are performed. The patient should not eat or drink the day of the procedure.

Aftercare

The patient must stay in bed after the procedure for at least six hours, to reduce the risk of bleeding. A nurse checks vital signs and looks for indications of complication such as pain, cramping, or leakage around the catheter. The catheter is flushed periodically to keep it open. Patient and caregiver education on how to keep the catheter clean and irrigated is an important part of aftercare.

Risks

The most common complication of transhepatic biliary catheterization is bleeding as a result of puncturing the liver. Infection may also result from this procedure. Sometimes the catheter itself becomes blocked and is ineffective.

Normal results

Transhepatic biliary catheterization is a treatment, not a cure. Successful treatment relieves the blocked bile duct, but does not change the underlying conditions that caused the blockage.

Resources

BOOKS

"Insertion of a Catheter to Relieve Bile Duct Obstruction." In *Everything You Need to Know About Medical Treatments*. Springhouse, PA: Springhouse Corp., 1996.

ORGANIZATIONS

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

OTHER

"Extrahepatic Bile Duct Cancer." *National Cancer Institute Page*. <http://www.nci.nih.gov>.

Tish Davidson

Transient ischemic attack

Definition

A transient ischemic attack, or TIA, is often described as a mini-stroke. Unlike a **stroke**, however, the symptoms can disappear within a few minutes. TIAs and strokes are both caused by a disruption of the blood flow to the brain. In TIAs and most strokes, this disruption is caused by a blood clot blocking one of the blood vessels leading to the brain. The blockage produces symptoms such as sudden weakness or numbness on one side of the body, sudden dimming or loss of vision, and difficulty speaking or understanding speech. If the symptoms are caused by a TIA, they last less than 24 hours and do not cause brain damage. Stroke-associated symptoms, on the other hand, do not go away and may cause brain damage or **death**. TIAs can serve as an early warning sign of stroke and require immediate medical attention.

Description

Strokes are the third leading cause of death in the United States and the leading cause of disability. Approximately 500,000-600,000 people have strokes each year, and more than 160,000 die as a result. About 85% of these strokes are classified as ischemic. In ischemic stroke, a blood vessel leading to the brain

becomes blocked and an area of the brain is deprived of oxygenated blood. (The other 15% of strokes are caused by bleeding from a blood vessel that has ruptured.) Without the blood supply, the cells in that area of the brain die. Since brain cells cannot grow back, the functions that are controlled by that brain area may be permanently lost.

Approximately 10% of strokes are preceded by one or more TIAs. The estimated annual number of TIAs is about 50,000; an exact count is difficult because TIAs are not always reported. They may be under-reported because they typically last less than an hour, perhaps only for a few minutes. Because they are so brief, TIAs may not seem important. However, an estimated one-third of all TIAs are followed by a stroke within five years. They are considered a medical emergency and prompt medical attention is very important.

Risk factors for strokes and TIAs are very similar. The risk of a TIA or stroke is higher among men, African Americans, people over age 65, and people with heart disease or diabetes. Smokers, people with high blood pressure, and people who are overweight also have a greater risk for TIAs and strokes.

Causes and symptoms

A TIA is caused by a temporary blockage of one of the arteries that leads into the brain. Small blood clots, called microemboli, are the immediate cause of the blockage. The blockage forms because of damage or disease within the circulatory system. Blood clots can form in blood vessels because of artery damage, heart disease, and other cardiovascular problems. For example, **atherosclerosis** is strongly associated with TIAs. Atherosclerosis is the build-up of fatty deposits or plaque at certain areas in the circulatory system. Clotting cells in blood, called platelets, tend to stick to atherosclerotic plaques or other damaged sites within blood vessels. Occasionally, a clot may grow large enough to block a blood vessel, or a piece of a clot may break off and circulate to other areas of the body. If a clot does not dissolve quickly enough, it can lodge in a blood vessel and block it. In TIAs, the microemboli dissolve within a short time.

Blood flows into the brain through two main pathways: the carotid arteries and the vertebrobasilar arteries. The carotid arteries are located on the front of the neck; the vertebrobasilar arteries are at the base of the skull at the back of the head. The symptoms produced by a TIA are determined by the arteries affected.

If a vertebrobasilar artery is blocked, common symptoms include double vision and **dizziness**, **nausea and vomiting**, difficulty speaking, and problems understanding and using spoken words. There may also be a numbness around the mouth and a tingling sensation in the limbs. Blockage of a carotid artery produces complete loss of vision, dimmed or foggy vision, and **paralysis** or weakness on one side of the body. These symptoms may also be accompanied by language problems and speech difficulty.

With either type of blockage, the microemboli dissolve within hours and full function returns.

Diagnosis

The goal of diagnosis is to identify the precise cause of the TIA and to recommend treatment. Initial information that an individual can supply includes a medical history, what drugs are currently being taken and why, and a full description of the symptoms. Blood tests are ordered to screen blood counts—that is, the numbers of specific blood cell types—and to measure sugar and lipid (fats, including cholesterol) levels. Based on this information and a **physical examination** that includes blood pressure, pulse, and respiration measurements, one or more of the following imaging tests are ordered.

A computed tomography scan (CT scan) or a **magnetic resonance imaging** (MRI) scan is usually the first imaging test. CT or MRI can rule out other problems, such as a tumor or **subdural hematoma**, which can mimic the symptoms of a TIA. A CT scan can also uncover aneurysms and arteriovenous malformation, both of which are blood vessel abnormalities that can cause bleeding in the brain.

Another imaging test that is very useful is carotid ultrasonography, a noninvasive procedure that allows examination of the interior of the carotid artery. This examination can detect carotid stenosis, a condition in which the artery is abnormally narrow because of atherosclerosis. Ultrasonography is very reliable in identifying stenosis, but it does not give enough information to accurately assess the degree of stenosis. Because the treatment used depends on the degree of stenosis, treatment decisions cannot be based on ultrasonography. Another type of ultrasonography, called **transcranial doppler ultrasonography**, is used to detect stenosis of the blood vessels within the brain and in the vertebrobasilar arteries.

If stenosis is identified, a further test called cerebral arteriography may be done. This test is not done if the individual is in poor health, because it may be too risky. Arteriography involves injecting a special dye into the blood vessels which makes them visible on x rays. This procedure is also used to find suspected

KEY TERMS

Angioplasty—A medical procedure in which a catheter, or thin tube, is threaded through blood vessels. The catheter is used to place a balloon or stent (a small metal rod) at an area of stenosis and expand it mechanically.

Arteriography—A medical test in which an x-ray visible dye is injected into blood vessels. This dye allows the blood vessels to be imaged with x rays.

Atherosclerosis—A build-up of fatty tissue called plaque inside arteries that can impede or block blood flow.

Carotid artery—One of the major blood vessels leading to the brain; it runs up the front of the neck.

Echocardiography—A type of ultrasonography that is used to create an image of the heart and its functioning.

Endarterectomy—A surgical procedure in which diseased tissue and atherosclerotic plaque are removed from the inside of an artery.

Ischemia—A condition in which blood flow is cut off or restricted from a particular area. The surrounding tissue, starved of oxygen and nutrients, dies.

Microemboli—Small blot clots in the bloodstream.

Platelets—Tiny cells in the blood that help form blood clots.

Stenosis—The narrowing of an opening or passageway in the body. In arteries, stenosis is caused by a build-up of atherosclerotic plaque, disease, or other disorder.

Stroke—A condition in which blood flow to the brain has been blocked, thereby causing brain cells to die from lack of oxygen and nutrients; also called a "brain attack."

Ultrasonography—A medical test in which sound waves are directed against internal structures in the body. As sound waves bounce off the internal structure, they create an image on a video screen.

Vertebrobasilar arteries—Major blood vessels that lead to the brain. They are located at the base of the skull at the back of the head.

problems with blood vessels in the brain. Because it is an invasive procedure, complications may arise. Typically, these complications are minor and temporary. In a very small percentage of people with cardiovascular disease, the procedure may cause serious complications, such as stroke.

Although TIAs affect the brain, the ultimate cause of the problem may be found in the heart. Heart disease or damage to the heart's blood vessels is assessed by **echocardiography**. Echocardiography is a type of ultrasonography and is a noninvasive procedure.

Treatment

Treatment is aimed at preventing further TIAs and especially at preventing a stroke. The particular therapy depends on the root cause of the TIA and is not begun until this cause is identified. If at all possible, drug therapy is the preferred method of treating TIAs. Surgical intervention may be required if an individual's situation is not likely to respond to medication or if medication has failed.

Aspirin is often chosen for drug therapy. It is sometimes called a blood thinner because it blocks the function of platelets, the sticky cells that trigger blood clotting. Since aspirin can cause gastrointestinal side effects, other drugs may be prescribed. These drugs include dipyridamole or ticlopidine hydrochloride (Ticlid). Dipyridamole, which works by relaxing the smooth muscles of the arteries, is not as effective as aspirin. Ticlopidine hydrochloride is an anti-platelet drug that is slightly more effective than aspirin, especially in women. However, it may cause **diarrhea** or lowered blood cell counts. Blood tests must, therefore, be done frequently when patients are taking ticlopidine.

If carotid arteriography reveals at least a 70% blockage of the carotid artery, surgical treatment is usually recommended. The particular surgical method is called carotid **endarterectomy**. In endarterectomy, the artery is opened and the material clogging it is removed. Another procedure, called **angioplasty**, has been suggested for treating carotid stenosis, but it is not widely used. This procedure is performed by threading a thin tube through the blood vessel to the site that is clogged. A balloon or a stent (a slender rod) is then passed through the tube to mechanically widen the narrowed area. This procedure is successfully used in other blood vessels in the body, but there is some worry that

using it close to the brain may be too dangerous. Surgical treatment of blockage of the vertebrobasilar arteries is not usually recommended.

Treatment of TIAs also focuses on underlying problems. High blood pressure, heart disease, and high levels of blood lipids all require medical intervention. Condition-specific medications are often prescribed and lifestyle changes are strongly encouraged. These changes include giving up **smoking** or excess alcohol consumption, engaging in physical **exercise**, and eating sensibly.

Prognosis

One-third of TIAs are followed by stroke in next five years; in the other two-thirds, the TIAs may either continue or disappear on their own. However, because of the risk of stroke-related disability and death, all TIAs should be treated as emergency medical situations.

Medical treatment significantly decreases the risk of stroke for people who experience one or more TIAs. Anti-platelet therapy with aspirin or ticlopidine may reduce risk as much as 31%. Carotid endarterectomy also substantially reduces stroke risk. The procedure itself carries some risk, but the complication rate is less than 5%. The risk of complication can be lowered by choosing to have the procedure done in a facility experienced with it and by a surgeon with a low complication rate.

Prevention

Treatment for TIAs is complemented by lifestyle changes. These practices may also prevent TIAs and strokes from ever occurring. Doctors and other healthcare providers universally recommend that individuals stop smoking and consume alcohol in moderation. Regular health checkups can detect high blood pressure, heart disease, and other underlying problems. Adhering to treatment for these problems can help minimize TIA and stroke risks. Finally, maintaining a healthy weight and engaging in regular exercise as able are strongly recommended.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1998. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

PERIODICALS

Edmeads, John G. "Transient Ischemic Attacks: Rethinking Concepts in Management." *Postgraduate Medicine* 96, no. 5 (Oct. 1994): 42.

Hinkle, Janice L. "New Developments in Managing Transient Ischemic Attack and Acute Stroke." *AACN Clinical Issues* 8, no. 2 (May 1997): 205.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Stroke Association. 9707 E. Easter Lane, Englewood, Co. 80112. (800) 787-6537. <http://www.stroke.org>.

Julia Barrett

Transplant reaction screening test *see* **Cytomegalovirus antibody screening test**

Transplantation *see* **Corneal transplantation; Hair transplantation; Heart transplantation; Kidney transplantation; Lung transplantation; Pancreas transplantation**

Transposition of the great arteries

Definition

Transposition of the great arteries is a birth defect causing a fatal condition in which there is a reversal, or switch, in the truncal connections of the two main (great) blood vessels to the heart, the aorta and pulmonary artery.

Description

There are two great arteries, the pulmonary artery and the aorta. Normally, the pulmonary artery carries blood from the right ventricle to the lungs. The aorta carries blood from the left ventricle to the vessels of the rest of the body.

Normally, blood returning to the heart is depleted in oxygen. It goes first to the right atrium of the heart and then to the right ventricle where it is pumped to the lungs. While in the lungs, the blood picks up more oxygen. After the lungs, the blood flows to the left atrium, then the left ventricle, which pumps the blood out through the aorta to the rest of the body, thereby supplying the body with oxygenated blood.

Transposition of the great arteries results in oxygen-depleted blood going to the body. The reason is that the connection of the two great arteries is reversed. In this case, the aorta is connected to the right ventricle. Blood returning to the heart goes to the right atrium and ventricle, which is normal. Then, when the right ventricle pumps the blood out, it goes into the aorta for distri-

bution throughout the body. At the same time, blood in the lungs goes to the left atrium, the left ventricle, but then back to the lungs. This happens because the pulmonary artery is connected to the left ventricle. The result is that highly-oxygenated blood keeps recycling through the lungs, while oxygen-depleted blood recycles through the body without going through the lungs to reoxygenate.

This condition develops during the fetal stage and must be treated promptly after birth if the newborn is to survive. The newborn can survive for a few days because the foramen ovale, a small hole in the septum that separates the two atria, is open, allowing some oxygenated blood to escape and mix into the blood that is being pumped throughout the body. However, the foramen ovale normally closes within a few days after birth.

Causes and symptoms

Transposition of the great arteries is a birth defect that occurs during fetal development. There is no identifiable disease or cause. The main symptom is a "blue" baby appearance, caused by a general lack of oxygen in the body's tissues.

Diagnosis

Diagnosis is made immediately after birth, when it is observed that the newborn is lacking oxygen. This is noted by the bluish color of the newborn, indicating **cyanosis**, a lack of oxygen. A definite diagnosis is made by x ray, **electrocardiography** (ECG), and **echocardiography**.

Treatment

The only treatment for this condition is prompt heart surgery shortly after birth. In surgery, the two great arteries are reconnected to their proper destination. This restores the normal blood flow pattern. The coronary arteries are also reconnected, so that they can supply blood to the heart itself. A catheter may be used to maintain or enlarge the opening between the two atria until surgery can be performed.

Prognosis

Left untreated, this disease is fatal within the first weeks of life.

Prevention

Because there is no identifiable cause, there is no way to prevent this condition.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Larsen, D. E., ed. *Mayo Clinic Family Health Book.* New York: William Morrow and Co., Inc., 1996.

John T. Lohr, PhD

Transsexualism *see* **Gender identity disorder**

Transurethral bladder resection

Definition

Transurethral bladder resection is a surgical procedure, performed under **sedation** or anesthesia, with a lighted tube inserted through the urethra (the small tube-like structure that allows urine to empty from the bladder), into the bladder. It plays both a diagnostic and therapeutic role in the treatment of bladder cancers.

Purpose

Tranurethral resection is the initial form of treatment for bladder cancers. The procedure is performed to remove and examine bladder tissue and/or tumor. It may also serve to remove lesions and be the only treatment necessary for noninvasive tumors.

Description

For this procedure, a lighted tube (resectoscope) is inserted through the urethra, into the bladder. A clear solution is infused to maintain visibility, and the tumor or tissue to be examined is cut away using an electric current. Tumor and muscle fibers are biopsied (a sample is cut out and examined, usually under a microscope) in order to evaluate the depth of tissue involvement, while avoiding perforation of the bladder wall. Every attempt is made to remove all visible tumor tissue, along with a small border of healthy tissue. The resected tissue is examined under the microscope for diagnostic purposes. An indwelling catheter may be inserted to ensure adequate drainage of the bladder postoperatively. At this

time, interstitial **radiation therapy** may be initiated if necessary.

Preparation

Preoperative x rays with dye studies are helpful as a guide in determining the character and extent of tumor involved. As with any surgical procedure, the patient is asked to sign a consent form after the procedure is thoroughly explained.

Aftercare

As with any surgical procedure, blood pressure and pulse will be monitored. Urine is expected to be blood-tinged in the early postoperative period. Continuous bladder irrigation (rinsing) may be used for approximately 24 hours after surgery. Most operative sites should be completely healed in three months. The patient is followed closely for possible recurrence with visual examination, using a special viewing device (cystoscope) at regular intervals as the physician deems necessary.

Abnormal results

Complications of the procedure may include bleeding, which may require bladder irrigation postoperatively, during which time the patient's activity is limited to bedrest. Perforation of the bladder is another risk, in which case the urinary catheter is left in place for four to five days postoperatively. The patient is started on antibiotic therapy preventively. If the bladder is lacerated, accompanied by spillage of urine into the abdomen, an abdominal incision may be required.

Resources

BOOKS

Dollinger, Malin, et al. *Everyone's Guide to Cancer Therapy: How Cancer is Diagnosed, Treated, and Managed Day to Day.* 3rd ed. Kansas City: Andres & McMeel, 1998.

Hanno, Philip, and Alan Wein. *Clinical Manual of Urology.* Philadelphia: McGraw-Hill, Inc., 1994.

Lerner, Judith. *Mosby's Manual Of Urologic Nursing.* St. Louis: The C. V. Mosby Co., 1982.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

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Transverse myelitis

Definition

Transverse myelitis (TM) is an uncommon neurological syndrome caused by inflammation (a protective response which includes swelling, **pain**, heat, and redness) of the spinal cord, characterized by weakness, back pain, and bowel and bladder problems. It affects one to five persons per million.

Description

TM affects the entire thickness of the spinal cord, producing both sensory and movement problems. It is believed to be linked to the immune system, which may be prompted to attack the body's own spinal cord. Striking rapidly without warning, its effects can be devastating.

Causes and symptoms

Transverse myelitis has many different causes, often triggered by a variety of viral and bacterial infections (especially those associated with a rash such as **measles** or **chickenpox**). Once the infection subsides, the inflammation in the cord begins. About a third of patients experience a flu-like illness with **fever** about the time they develop symptoms of TM. Sometimes, there appears to be a direct invasion of, and injury to, the spinal cord by an infectious agent (such as herpes zoster or the **AIDS** virus).

TM can also accompany a variety of diseases that break down tissue that surrounds and insulates the nerves (demyelinating diseases), such as **multiple sclerosis** (MS).

Some toxic substances, such as carbon monoxide, lead, or arsenic, can cause a type of myelitis characterized by inflammation followed by hemorrhage or bleeding that destroys the entire circumference of the spinal cord. Other types of myelitis can be caused by poliovirus; herpes zoster; **rabies**, **smallpox** or **poliovaccination**; or parasitic and fungal infections.

Many experts believe that TM can occur without any apparent cause, probably as the result of an autoimmune process. This means that a person's immune system attacks the spinal cord, causing inflammation and tissue damage.

Regardless of the cause of the myelitis, onset of symptoms is sudden and rapid. Problems with movement and sensation appear within one or two days after inflammation begins. Symptoms include soft (flaccid)

paralysis of the legs, with pain in the lower legs or back, followed by loss of feeling and sphincter (muscles which close an opening, as in the anus) control. The earliest symptom may be a girdle-like sensation around the trunk.

The extent of damage occuring will depend on how much of the spinal cord is affected, but TM rarely involves the arms. Severe spinal cord damage also can lead to **shock**.

Diagnosis

A doctor will suspect transverse myelitis in any patient with a rapid onset of paralysis. Medical history, **physical examination**, brain and spinal cord scans, myelogram, spinal tap, and blood tests are used to rule out other neurological causes of symptoms, such as a tumor. If none of these tests suggest a cause for the symptoms, the patient is presumed to have transverse myelitis.

Treatment

There is no effective treatment for transverse myelitis, but any underlying infection must be treated. After this, the focus of care shifts from diagnosis and treatment to learning how to live with the effects of the syndrome. Patients are helped to cope psychologically with new limitations, and are given physical **rehabilitation**.

Physical adaptations include learning to cope with bowel and bladder control, sexuality, inability to control muscles (spasticity), mobility, pain, and activities of daily living (such as dressing).

As nerve impulses from the spinal cord are often scrambled and misinterpreted by the brain as pain, painkillers are given to ease discomfort. Antidepressants or anticonvulsants may also help.

Prognosis

The prognosis depends on how much of the cord was damaged. Some people recover completely, while others have lasting problems and need help in learning how to cope with activities of daily living. People who develop spastic reflexes early in the course of the condition are more likely to recover than those who do not. If spinal cord tissue **death** (necrosis) occurs, the chance of a complete recovery is poor. Most recovery occurs within the first three months. A certain percentage of patients with TM will go on to develop multiple sclerosis.

KEY TERMS

Demyelinating disorders—A group of diseases characterized by the breakdown of myelin, the fatty sheath surrounding and insulating nerve fibers. This breakdown interferes with nerve function, and can result in paralysis. Multiple sclerosis is a demyelinating disorder.

Myelogram—An x-ray examination of the brain and spinal cord with the aid of a contrast dye, to look for tumors or spinal cord injury.

Resources

BOOKS

Stone, L. A. "Transverse Myelitis." In *Neuroimmunology for the Clinician*, ed. L. A. Rolak and Y. Harati. New York: Butterworth-Heinemann, 1997.

PERIODICALS

Scott, T.F., et.al. "Transverse Myelitis: Comparison with Spinal Cord Presentations of Multiple Sclerosis." *Neurology* 50, no. 2 (Feb. 1998): 429-433.

ORGANIZATIONS

Transverse Myelitis Association. 1787 Sutter Parkway, Powell, OH 43065-8806. (614) 766-1806. <http://www.myelitis.org>.

Carol A. Turkington

Tranylcypromine *see* **Monoamine oxidase inhibitors**

Traumatic amputations

Definition

Traumatic **amputation** is the accidental severing of some or all of a body part. A complete amputation totally detaches a limb or appendage from the rest of the body. In a partial amputation, some soft tissue remains attached to the site.

Description

Trauma is the second leading cause of amputation in the United States. About 30,000 traumatic amputations occur in this country every year. Four of every five traumatic amputation victims are male, and most of them are between the ages of 15–30.

Traumatic amputation most often affects limbs and appendages like the arms, ears, feet, fingers, hands, legs, and nose.

Causes and symptoms

Farm and factory workers have greater-than-average risks of suffering injuries that result in traumatic amputation. Automobile and motorcycle accidents and the use of lawnmowers, saws, and power tools are also common causes of traumatic amputation.

Blood loss may be massive or minimal, depending on the nature of the injury and the site of the amputation. Patients who lose little blood and have less severe injuries sometimes feel more **pain** than patients who bleed heavily and whose injuries are life-threatening.

Diagnosis

When the patient and the amputated part(s) reach the hospital, an Emergency Department physician will assess the probability that the severed tissue can be successfully reattached.

The Mangled Extremity Severity Score (MESS) assigns numerical values to such factors as body temperature, circulation, numbness, **paralysis**, tissue health, and the patient's age and general health. This is one of the diagnostic tools used to determine how successful reattachment surgery is apt to be. The total score is doubled if blood supply to the amputated part has been absent or diminished for more than six hours.

A general, emergency, or orthopedic surgeon makes the final determination about whether surgery should be performed. The surgeon also considers the patient's wishes and lifestyle. Additional concerns are how and to what extent the amputation will affect the patient's quality of life and ability to perform everyday activities.

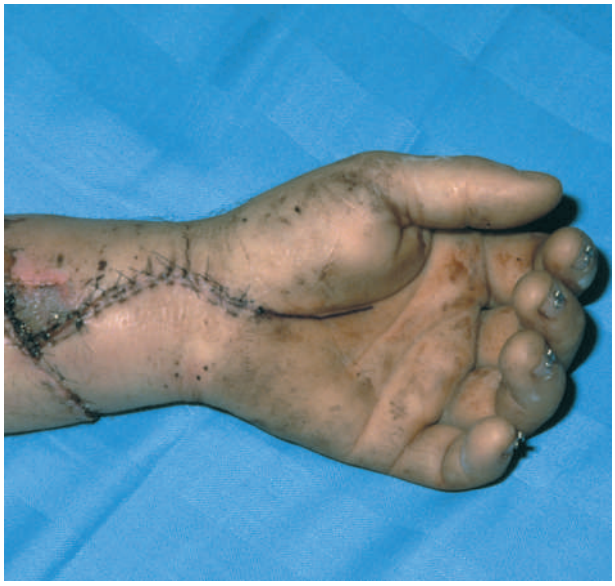
Treatment

First aid or emergency care given immediately after the amputation has a critical impact on both the physicians' ability to salvage and reattach the severed part(s) and the patient's ability to regain feeling and function.

Muscle tissue dies quickly, but a well-preserved part can be successfully reattached as much as 24 hours after the amputation occurs. Tissue that has not been preserved will not survive for more than six hours.

Initial response

The most important steps to take when a traumatic amputation occurs are:



This man's hand was surgically reattached following a traumatic amputation. *(Photograph by Michael English, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

- Contact the nearest emergency services provider, clearly describe what has happened, and follow any instructions given.
- Make sure the victim can breathe; administer **CPR** if necessary.
- Control bleeding, using direct pressure but minimizing or avoiding contact with blood and other body fluids.
- Patients should not be moved if back, head, leg, or neck injuries are suspected or if motion causes pain. If none are found by the EMT, lie the victim flat, with the feet raised 12 inches above the surface.
- Cover the victim with a coat or blanket to prevent shock.

The injured site should be cleansed with a sterile solution and wrapped in a clean towel or other thick material that will protect the wound from further injury. Tissue that is still attached to the body should not be forced back into place. If it cannot be gently replaced, it should be held in its normal position and supported until additional care is available.

Saving the patient's life is always more important than recovering the amputated part(s). Transporting the patient to a hospital or emergency center should never be delayed until missing pieces are located.

Preserving tissue

No amputated body part is too small to be salvaged. Debris or other contaminating material should be removed, but the tissue should not be allowed to get wet.

KEY TERMS

Phantom pain—Pain, tingling, itching, or numbness in the place where the amputated part used to be.

An amputated body part should be wrapped in bandages, towels, or other clean, protective material and sealed in a plastic bag. Placing the sealed bag in a cooler or in a container that is inside a second container filled with cold water or ice will help prevent tissue deterioration.

Prognosis

Possible complications of traumatic amputation include:

- excessive bleeding
- infection
- muscle shortening
- pulmonary embolism

Improved medical and surgical care and **rehabilitation** have improved the long-term outlook for these patients.

Phantom pain

About 80% of all amputees over the age of four experience tingling, **itching**, numbness, or pain in the place where the amputated part used to be. Phantom sensations may begin immediately after the amputation, or they may develop months or years later. They often occur after an injury to the site of the amputation.

These intermittent feelings may:

- occur frequently or only once in a while
- be mild or intense
- last for a few minutes or several hours
- help patients adjust more readily to an artificial limb (prosthesis)

Prevention

The best way to prevent traumatic amputation is to observe common-sense precautions like using seat belts and obeying speed limits and other traffic regulations. It is important to take special precautions when using potentially dangerous equipment and make sure machinery is turned off and disconnected before attempting to service or repair it. Appropriate protective clothing should be worn at all times.

Resources

BOOKS

Sheehy, Susan Budassi. *Manual of Emergency Care*. St. Louis: The C. V. Mosby Co., 1990.

ORGANIZATIONS

American Amputation Foundation, Inc. P.O. Box 250218, Hillcrest Station, Little Rock, AR 72225. (501) 666-2523.

The Amputee Coalition of America. P.O. Box 2528, Knoxville, TN 37901-2528. (888) 267-5669. <http://www.amputee-coalition.org>.

OTHER

"Amputation." *ThriveOnline*. 23 May 1998 <http://thriveonline.oxygen.com>.

"Amputation, Traumatic." *HealthAnswers.com* 24 May 1998 <http://www.healthanswers.com/database/ami/converted/000006.htm>.

Maureen Haggerty

Traveler's diarrhea

Definition

The occurrence of multiple loose bowel movements in someone traveling to an area outside of their usual surroundings (usually from temperate industrialized regions to tropical areas), is known as traveler's **diarrhea** (TD). The cause is almost always due to a bacterial or viral infection, acquired through ingesting contaminated food or water.

Description

It is estimated that anywhere from 20–50% of the 12–20 million travelers going from temperate industrialized countries to the tropics will develop TD. Fortunately, most of these episodes are of short duration; nevertheless, about 40% of those affected will need to rearrange their schedule, and 20% will be ill enough to remain in bed for some days.

The chance of winding up with TD is directly related to the area one is traveling to; only about 8% of individuals visiting an industrialized country are affected, whereas at least half of those traveling to non-industrialized regions become ill. It is also clearly related to the number of potentially contaminated foods or beverages consumed. Attention to recommended guidelines regarding food safety and sanitation can greatly decrease the risk of infection.

Causes and symptoms

Bacterial infections are the most common cause of the illness. Viruses and occasional parasites can also be

the cause. As for the bacteria involved, toxin producing types of *E. coli* (called enterotoxigenic) account for approximately 40–60% of cases, with *Campylobacter* and *Shigella* each reported in at least 10% of cases. In some studies, *Campylobacter* has accounted for almost half of the attacks, especially during cooler seasons of the year. The cause can vary depending on several factors, including the season and country visited. More than one organism can be found in 15–30% of cases, and none is identified in up to 40% of cases worldwide.

Rotaviruses and a parvovirus called Norwalk agent are also responsible for TD. *Giardia* is probably the most common parasite identified, though amoebas (*Entamoeba histolytica*), *Cryptosporidium*, and *Cyclospora* are being found with increasing frequency.

Younger age groups, particularly students, are at greatest risk, probably because of where and what they eat. Individuals over 55 years of age, persons staying with relatives, or business travelers are at lower risk. Foods with the highest chance of transmitting disease are uncooked vegetables, unpeeled fruits, meat, and seafood. Tap water and even ice can be dangerous unless one is sure of the source.

Symptoms usually start within a few days after arrival, but can be delayed for as long as two weeks. Illness lasts an average of three to five days, but is sometimes longer. Cramping abdominal **pain**, lack of appetite, and diarrhea are the main complaints. In approximately 10% of patients, diarrhea turns bloody and **fever** develops in about half of those. The presence of bloody bowel movements and fever usually indicates a more severe form of illness and makes *Shigella* a more likely cause. Medications that decrease the motility or contractions of the intestine, such as loperamide (Imodium) or diphenoxylate (Lomotil), should not be used when fever or bleeding occur.

Complications

Diarrhea varies from a few loose stools per day to 10 or more. **Dehydration** and changes in the normal blood pH (acid-base balance) are the main dangers associated with TD. Signs of dehydration can be hard to notice, but increasing thirst, **dry mouth**, weakness or lightheadedness (particularly if worsening while standing), or a darkening/decrease in urination are suggestive. Severe dehydration and changes in the body's chemistry can lead to kidney failure and become life-threatening.

Another potential complication is "toxic megacolon," in which the colon gradually stretches and its wall thins to the point where it can tear. The presence of a hole in the intestine leads to **peritonitis** and is fatal unless quickly recognized and treated.

Other complications related to TD can involve the nervous system, skin, blood, or kidneys.

Diagnosis

The occurrence of diarrhea in an individual while traveling is very suggestive of TD. Although there are other possible causes, these are less likely. In most instances, the specific organism responsible for the symptoms does not need to be identified, and the majority of patients need only rest and treatment to avoid potential complications.

When patients develop fever or bloody diarrhea, the illness is more serious and a specific diagnosis is needed. In those cases, or when symptoms last longer than expected, stool samples are obtained to identify the organism.

For this purpose, laboratories can either try to grow (culture) the organism, or identify it with high-powered microscopes (electron microscopy) or with the use of special tests or stains. These can show parasites such as *Giardia, Amoeba, Cryptosporidium* and others in freshly obtained stool specimens. New techniques that involve identification of DNA (the characteristic material that controls reproduction and is unique for all individuals) of the various organisms, can also be used in special circumstances.

Treatment

The best treatment of TD is prevention; however, once disease occurs, therapy is aimed at preventing or reducing dehydration, and using **antibiotics** when needed. Fortunately, severe dehydration is unusual in patients with TD, but any fluid losses should be treated early with either fruit juices and "clear fluids" such as tea or broth, or with the recommended Oral Rehydration Solutions (ORS) suggested by the World Health Organization (WHO). Persons traveling to known areas of infection should consult with their physician prior to departure and obtain appropriate instructions. For example, it may be advised to take along pre-prepared packets of ORS designed for easy mixing or commercial preparations such as Pedialyte, Ceralyte, Ricelyte, etc.

When nothing else is available, the following WHO recipe can be made up from household items and taken in small frequent sips;

- table salt: 3/4 teaspoon
- baking powder: 1 teaspoon
- orange juice: 1 cup
- water: 1 quart or liter

A debate has occurred in the medical community over the amount of salt (sodium) in the WHO preparations; some physicians feel that the content is too much for use by well-nourished persons in developed countries. Therefore these preparations should not be used for extended periods of time without consulting a physician.

KEY TERMS

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Pepto-Bismol (bismuth subsalicylate preparation) is effective in both preventing and treating TD. For treatment once symptoms begin, the drug must be taken more frequently than when used for prevention. Bismuth subsalicylate preparation (1 oz of liquid or two 262.5 mg tablets every 30 minutes for eight doses) has been shown to decrease the number of bowel movements and shorten the length of illness. However, there is some concern about the large doses of bismuth in patients with kidney disease; therefore patients should check with physicians before starting this or any other therapy. Patients should be aware that bismuth can turn bowel movements black in color.

Medications designed to decrease intestinal motility and contractions such as loperamide (Imodium), diphenoxylate (Lomotil), or others are safest when used by those without fever or bloody bowel movements. The presence of either of these symptoms indicates a more severe form of colitis.

Antibiotics are usually not needed, because most cases of TD rapidly improve with minimal treatment. For patients in whom symptoms are especially severe (4 or more stools per day or the onset of bloody diarrhea or fever), antibiotics are indicated. Individuals with less severe attacks can be treated with either antimotility medications or bismuth subsalicylate.

Choice of an antibiotic should ideally be tailored to the most likely organism and then adjusted according to results of stool cultures. Trimethoprim-sulfamethoxazole (Bactrim) or ciprofloxacin (Cipro) are the antibiotics most often prescribed, but others are also used. The type and duration of treatment continues to be revised, and it is therefore extremely important that patients check with a physician prior to beginning treatment. In many instances, an antibiotic can be combined with an antimotility agent to provide the quickest relief.

Prognosis

Up to 1% of patients with TD will become sick enough to require hospitalization, and 3% will continue to experience diarrhea for at least one month. The majority of patients rapidly recover with minimal therapy. Some will suffer symptoms for even longer. The small number who continue to suffer symptoms will need careful evaluation to rule out the many causes of chronic diarrhea (such as lactase deficiency, **irritable bowel syndrome**, parasites, etc.). It is unusual for diarrhea caused by bacteria to last over two weeks; therefore, more prolonged diarrhea indicates a non-bacterial cause.

Prevention

The best means of prevention is avoiding foods, beverages, and food handling practices that lead to infection with the organisms that cause TD.

One effective means to prevent TD is liquid Pepto-Bismol; this bismuth-containing compound has been shown to be very effective in reducing the incidence of TD. Tablets are now available, which are easier to carry. Two tablets four times a day is recommended, but use should not go beyond three weeks.

Antibiotics can also prevent TD, but their use is controversial, unless it is absolutely necessary to avoid infection (such as someone on an important business trip). There is the tendency for bacteria in to become resistant to these medications if used excessively; and these drugs do have side effects which can be worse than the effects of TD. The benefits and risks of antibiotic treatment should be carefully weighed.

Resources

BOOKS

Butterton, Joan R., and Stephen Calderwood. "Acute Infectious Diarrheal Diseases and Bacterial Food Poisoning." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hamer, Davidson H., and Sherwood L. Gorbach. "Traveler's Diarrhea." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

Keystone, J. S, and P. E. Kozarsky. "Health Risks to Travelers." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Dupont, Herbert L., et al. "Guidelines on Acute Infectious Diarrhea in Adults." *American Journal of Gastroenterology* 92, no. 11 (1962, 1997).

"Traveler's Diarrhea: Don't Let It Ruin Your Trip." *Mayo Clinic Health Letter* (Jan. 1997).

"When Microbes are on the Menu." *Harvard Health Letter* (Dec. 1994): 4-5.

OTHER

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

Centers for Disease Control. <http://www.cdc.gov/nccdphp/ddt/ddthome.htm>.

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Tremors

Definition

Tremor is an unintentional (involuntary), rhythmical alternating movement that may affect the muscles of any part of the body. Tremor is caused by the rapid alternating contraction and relaxation of muscles and is a common symptom of diseases of the nervous system (neurologic disease).

Description

Occasional tremor is felt by almost everyone, usually as a result of fear or excitement. However, uncontrollable tremor or shaking is a common symptom of disorders that destroy nerve tissue, such as **Parkinson's disease** or **multiple sclerosis**. Tremor may also occur after **stroke** or **head injury**. Other tremors appear without any underlying illness.

Causes and symptoms

Tremor may be a symptom of an underlying disease, and it may be caused by drugs. It may also exist as the only symptom (essential tremor).

Underlying disease

Some types of tremor are signs of an underlying condition. About a million and a half Americans have Parkinson's disease, a disease that destroys nerve cells. Severe shaking is the most apparent symptom of Parkinson's disease. This coarse tremor features four to five muscle movements per second. The shaking is evident at rest but declines or disappears during movement.

Other disorders that cause tremor are multiple sclerosis, Wilson's disease, mercury **poisoning**, thyrotoxicosis, and **liver encephalopathy**.

A tremor that gets worse during body movement is called an "intention tremor." This type of tremor is a sign that something is amiss in the cerebellum, a region of the brain concerned chiefly with movement, balance and coordination.

Essential tremor

Many people have what is called "essential tremor," in which the tremor is the only symptom. This type of shaking affects between three and four million Americans.

The cause of essential tremor is not known, although it is an inherited problem in more than half of all cases. The genetic condition has an autosomal dominant inheritance pattern, which means that any child of an affected parent will have a 50% chance of developing the condition.

Essential tremor most often appears when the hands are being used, whereas a person with Parkinson's disease will most often have a tremor while walking or while the hands are resting. People with essential tremor will usually have shaking head and hands, but the tremor may involve other parts of the body. The shaking often begins in the dominant hand and may spread to the other hand, interfering with eating and writing. Some people also develop a quavering voice.

Essential tremor affects men and women equally. The shaking often appears at about age 45, although the disorder may actually begin in adolescence or early adulthood. Essential tremor that begins very late in life is sometimes called "senile tremor."

Drugs and tremor

Several different classes of drugs can cause tremor as a side effect. These drugs include amphetamines, antidepressant drugs, antipsychotic drugs, caffeine, and lithium. Tremor also may be a sign of withdrawal from alcohol or street drugs.

Diagnosis

Close attention to where and how the tremor appears can help provide a correct diagnosis of the cause of the shaking. The source of the tremor can be diagnosed when the underlying condition is found. Diagnostic techniques that make images of the brain, such as computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI), may help form a diagnosis of multiple sclerosis or other tremor caused by disorders of the central nervous system. Blood tests can rule out such metabolic causes as thyroid disease. A family history can help determine whether the tremor is inherited.

Treatment

Neither tremor nor most of its underlying causes can be cured. Most people with essential tremor respond to drug treatment, which may include propranolol, primidone, or a benzodiazepine. People with Parkinson's disease may respond to levodopa or other **antiparkinson drugs**.

Research has shown that about 70% of patients treated with botulinum toxin A (Botox) have some improvement in tremor of the head, hand, and voice. Botulinum is derived from the bacterium *Clostridium botulinum*. This

KEY TERMS

Computed tomography (CT) scan—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Essential tremor—An uncontrollable (involuntary) shaking of the hands, head, and face. Also called familial tremor because it is sometimes inherited, it can begin in the teens or in middle age. The exact cause is not known.

Fetal tissue transplantation—A method of treating Parkinson's and other neurological diseases by grafting brain cells from human fetuses onto the affected area of the human brain. Human adults cannot grow new brain cells but developing fetuses can. Grafting fetal tissue stimulates the growth of new brain cells in affected adult brains.

Intention tremor—A rhythmic purposeless shaking of the muscles that begins with purposeful (voluntary) movement. This tremor does not affect muscles that are resting.

Liver encephalopathy—A condition in which the brain is affected by a buildup of toxic substances that would normally be removed by the liver. The condition occurs when the liver is too severely damaged to cleanse the blood effectively.

Multiple sclerosis—A degenerative nervous system disorder in which the protective covering of the nerves in the brain are damaged, leading to tremor and paralysis.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Pallidotomy—A surgical procedure that destroys a small part of a tiny structure within the brain called the globus pallidus internus. This structure is part of the basal ganglia, a part of the brain involved in the control of willed (voluntary) movement of the muscles.

Parkinson's disease—A slowly progressive disease that destroys nerve cells. Parkinson's is characterized by shaking in resting muscles, a stooping posture, slurred speech, muscular stiffness, and weakness.

Thalamotomy—A surgical procedure that destroys part of a large oval area of gray matter within the brain that acts as a relay center for nerve impulses. The thalamus is an essential part of the nerve pathway that controls intentional movement. By destroying tissue at a particular spot on the thalamus, the surgeon can interrupt the nerve signals that cause tremor.

Thalamus—A large oval area of gray matter within the brain that relays nerve impulses from the basal ganglia to the cerebellum, both parts of the brain that control and regulate muscle movement.

Thyrotoxicosis—An excess of thyroid hormones in the blood, causing a variety of symptoms that include rapid heart beat, sweating, anxiety, and tremor.

Tremor control therapy—A method for controlling tremor by self-administered shocks to the part of the brain that controls intentional movement (thalamus). An electrode attached to an insulated lead wire is implanted in the brain; the battery power source is implanted under the skin of the chest, and an extension wire is tunneled under the skin to connect the battery to the lead. The patient turns on the power source to deliver the electrical impulse and interrupt the tremor.

Wilson's disease—An inborn defect of copper metabolism in which free copper may be deposited in a variety of areas of the body. Deposits in the brain can cause tremor and other symptoms of Parkinson's disease.

bacterium causes **botulism**, a form of **food poisoning**. It is poisonous because it weakens muscles. A very weak solution of the toxin is used in cases of tremor and **paralysis** to force the muscles to relax. However, some patients experience unpleasant side effects with this drug and cannot tolerate effective doses. For other patients, the drug becomes less effective over time. About half of patients don't get any relief of tremor from medications.

Tremor control therapy

Tremor control therapy is a type of treatment using mild electrical pulses to stimulate the brain. These pulses block the brain signals that trigger tremor. In this technique, the surgeon implants an electrode into a large oval area of gray matter within the brain that acts as a relay center for nerve impulses and is involved in generating

movement (thalamus). The electrode is attached to an insulated wire that runs through the brain and exits the skull where it is attached to an extension wire. The extension is connected to a generator similar to a heart pacemaker. The generator is implanted under the skin in the chest, and the extension is tunneled under the skin from the skull to the generator. The patient can control his or her tremor by turning the generator on with a hand-held magnet to deliver an electronic pulse to the brain.

Some patients experience complete relief with this technique, but for others it is of no benefit at all. About 5% of patients experience complications from the surgical procedure, including bleeding in the brain. The procedure causes some discomfort because patients must be awake while the implant is placed. Batteries must be replaced by surgical procedure every three to five years.

Other surgical treatments

A patient with extremely disabling tremor may find relief with a surgical technique called thalamotomy, in which the surgeon destroys part of the thalamus. However, the procedure is complicated by numbness, balance problems, or speech problems in a significant number of cases.

Pallidotomy is another type of surgical procedure sometimes used to decrease tremors from Parkinson's disease. In this technique, the surgeon destroys part of a small structure within the brain called the globus pallidus internus. The globus is part of the basal ganglia, another part of the brain that helps control movement. This surgical technique also carries the risk of disabling permanent side effects.

Fetal tissue transplantation (also called a nigral implant) is a controversial experimental method to treat Parkinson's disease symptoms. This method implants fetal brain tissue into the patient's brain to replace malfunctioning nerves. Unresolved issues include how to harvest the fetal tissue and the moral implications behind using such tissue; the danger of tissue rejection; and how much tissue may be required. Although initial studies using this technique looked promising, there has been difficulty in consistently reproducing positive results.

Small amounts of alcohol may temporarily (sometimes dramatically) ease the shaking. Some experts recommend a small amount of alcohol (especially before dinner). The possible benefits, of course, must be weighed against the risks of alcohol abuse.

Prognosis

Essential tremor and the tremor caused by neurologic disease (including Parkinson's disease) slowly get worse and can interfere with a person's daily life. While the condition is not life-threatening, it can severely disrupt a person's everyday experiences.

Prevention

Essential tremor and tremor caused by a disease of the central nervous system cannot be prevented. Avoiding use of stimulant drugs such as **caffeine** and amphetamines can prevent tremor that occurs as a side effect of drug use.

Resources

BOOKS

Greenberg, David A., et al. *Clinical Neurology.* 2nd ed. Norwalk, CT: Appleton & Lange, 1993.

Weiner, William J., and Christopher Goetz. "Essential Tremor." *In Neurology for the Non-Neurologist.* Philadelphia: J. B. Lippincott, 1994.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

American Parkinson Disease Association. 60 Bay Street, Suite 401, Staten Island, NY 10301. (800) 223-2732. <http://www.apdaparkinson.org>.

International Tremor Foundation. 7046 West 105th St., Overland Park, KS 66212. (913) 341-3880.

National Parkinson Foundation. 1501 N.W. 9th Ave., Miami, FL 33136-1494. (800) 327-4545. <http://www.parkinson.org>.

Carol A. Turkington

Trench fever

Definition

Trench **fever** is a bacterial infection that causes repeated cycles of high fever.

Description

The term trench fever refers to the crowded conditions in which troops fought in during World War I and World War II. Because the causative bacteria are passed among humans through contact with body lice, overcrowding, and conditions which interfere with good hygiene (including regular washing of clothing) soldiers were predispose to this disease. Currently, homeless people in the United States are sometimes diagnosed with this illness. The bacteria are sometimes passed through the bite of an infected tick. This can cause the illness in

people who participate in outdoor activity and encounter ticks in that particular area.

Causes and symptoms

Two different bacteria can cause trench fever: *Bartonella quintana* and *Bartonella henselae*.*B. quintana* is carried by body lice; *B. henselae* is carried by ticks.

Infection with *B. quintana* occurs when an infected louse defecates while feeding on a human. When the person scratches, the feces (which are full of bacteria) are rubbed into the tiny wound. Infection with *B. henselae* occurs when an infected tick bites a human, passing the bacteria along through the tiny bite wound.

Symptoms of trench fever begin about 2 weeks to a month after exposure to the bacteria. Sudden fever, loss of energy, **dizziness**, **headache**, weight loss, skin rash, severe muscle and bone **pain** can occur. Pain is particularly severe in the shins, leading to the nickname "shin bone fever." The fever can reach 105°F (40.5°C) and stays high for five to six days at a time. The temperature then drops, and stays down for several days, usually recurring in five- to six-day cycles. An individual may experience as many as eight cycles of fever with the illness.

Diagnosis

Diagnosis is usually made on the basis of the patient's symptoms, and on knowledge of the conditions in which the patient lives. A blood sample can be drawn and bacteria in the sample are allowed to grow. Identification is made by looking at the number of bacteria that may be present on a glass slide seen under the lens of a microscope. However, this technique can take up to four weeks, because this type of bacterium grows very slowly. By this time, the practitioner has often decided to treat the patient anyway.

Treatment

Erythromycin and azithromycin are both used to treat trench fever. Four weeks of treatment are usually necessary. Inadequate treatment often results in a relapse. In fact, relapses have been reported to occur as long as 10 years after the first episode.

Prognosis

Prognosis for patients with trench fever is excellent. Recovery may take a couple of months. Without treatment, there is always a risk of recurrence, even years after the original illness.

Prevention

Prevention involves good hygiene and decent living conditions. When this is impossible, insecticide dusting powders are available to apply to clothing. Avoidance of areas known to harbor ticks or the use of insect repellents is necessary to avoid the type of infection passed by ticks.

Resources

BOOKS

Corey, Lawrence. "Rickettsia and Coxiella." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Tompkins, Lucy S. "Bartonella Infections, Including Cat-Scratch Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

PERIODICALS

Bovsun, Mara. "World War I's Trench Fever Germ Making Comeback Among Poor, Homeless." *Biotechnology Newswatch* (5 Jan. 1998): 6.

Relman, David A. "Has Trench Fever Returned?" *The New England Journal of Medicine* 332, no. 7 (16 Feb. 1995): 463+.

Tompkins, Lucy S. "Bartonella Species Infections, Including Cat-Scratch Disease, Trench Fever, and Bacillary Angiomatosis: What Molecular Techniques Have Revealed." *The Western Journal of Medicine* 164, no. 1 (Jan. 1996): 39+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Treponema carateum infection *see* **Pinta**

Treponema pallidum infection *see* **Syphilis**

Tretinoin *see* **Antiacne drugs**

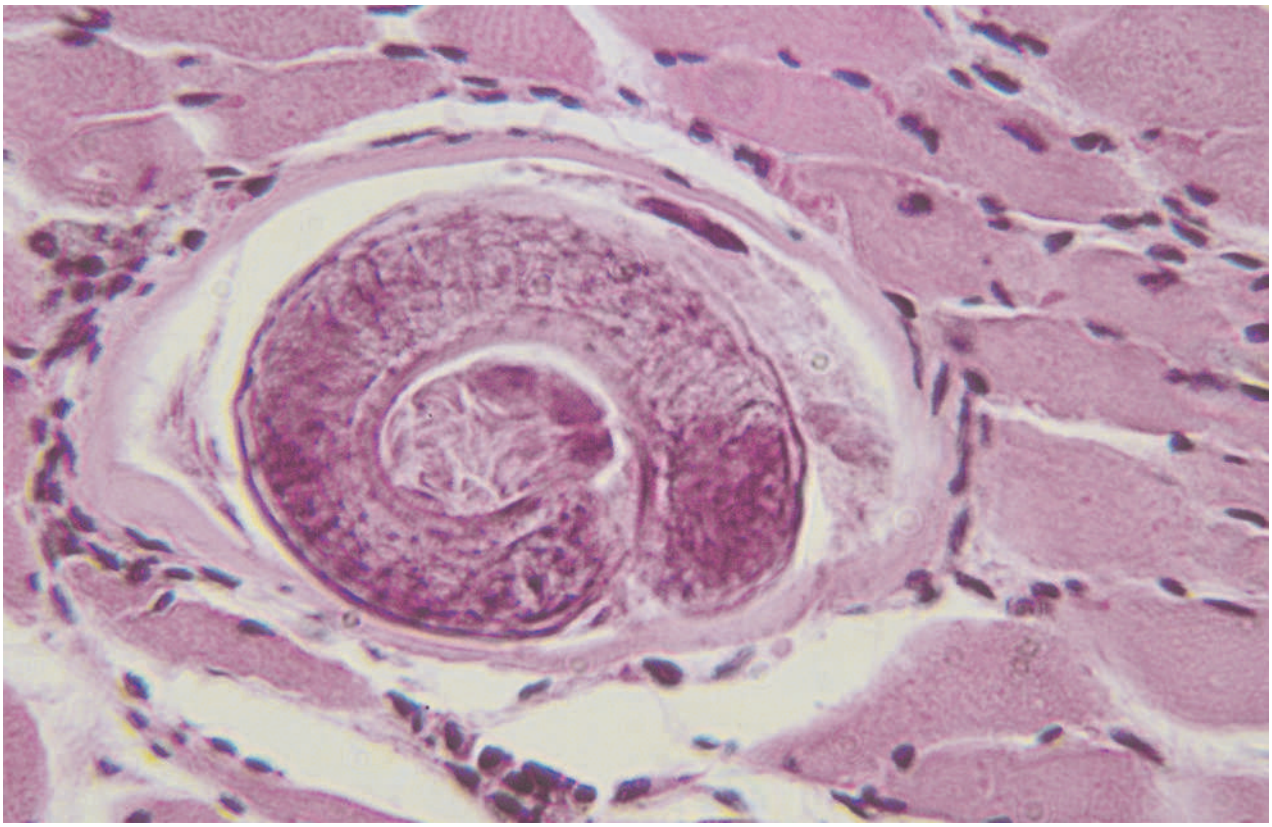
Trichinella spiralis infection *see* **Trichinosis**

Trichiniasis *see* **Trichinosis**

Trichinosis

Definition

Trichinosis is a disease caused by a roundworm (nematode) called *Trichinella spiralis*. An individual worm of this species is called a trichina, from the Greek word meaning "hairlike." Trichinae can be readily avoided by proper handling and cooking of certain meats, particularly pork products.



A *Trichinella spiralis* cyst in striated muscle tissue. *T. spiralis* cysts can survive up to ten years in this form. *(JLM Visuals. Reproduced by permission.)*

Description

The life cycle of *T. spiralis* includes several different stages. The adult trichina lives in the intestinal lining of such meat-eating animals as swine, bears, walrus, and rodents. After mating, the male worm dies while the female goes on to produce the offspring.

Roundworms have a stage of development called the embryonic stage, which in many species occurs after birth. In trichinae, however, this embryonic stage occurs within the uterus of the female, so that the offspring that are ultimately discharged into the host's intestinal lining are in the larval second stage of life. These larvae— bout 1500 from each female worm—travel through the circulatory system to the heart, then through the blood vessels leading to striated muscle (the muscle of the skeletal system and the heart). Most larvae that cannot find suitable locations in striated muscle will die.

Those larvae that reach striated muscle will grow to a length of about one millimeter, coil themselves, and enclose themselves within a protective wall called a cyst. This process is referred to as encysting. The worms in the cysts can live for up to ten years in this form.

A pig that has been infected with *T. spiralis*, then, has thousands of cysts lying dormant within its muscles— the very muscles that humans look forward to consuming in the form of pork chops, ham, barbecued ribs, etc. When humans sit down to a delicious meal of undercooked, trichina-infected pig dinner, they are ingesting *T. spiralis* cysts. The cyst walls are broken down by the usual process of food digestion in the stomach, allowing the larvae to escape into the new host's intestines. There the larvae mature to become adult worms, capable of producing a new crop of larvae. When these new larvae hatch, they begin their migration throughout the human host's bloodstream to his or her muscles, where they live for a short while before encysting.

Causes and symptoms

Human hosts who eat meat infested with trichinae may experience symptoms in varying degrees. If the meat ingested has only a few cysts, then the human host's load of parasites (worm burden) is said to be relatively small, and symptoms will be moderate. In fact, many trichinosis infections are subclinical, which means that the symptoms are so mild that the infection remains undiagnosed.

In a host with a greater worm burden, the initial symptoms will be caused by the presence of the adult worms in the intestine. These symptoms usually include **fever**, **diarrhea**, abdominal **pain**, and perhaps vomiting. The symptoms begin about one to two days after eating the contaminated meat, and may last for a week or so.

When the larvae begin their migration through the blood vessels, the host will begin to experience symptoms that affect the whole body (systemic symptoms), such as fever; swelling of the face and the area around the eyes; rash; bleeding into the nail beds, retina, and whites of the eyes; and **cough**. In very severe cases of trichinosis, inflammation of the heart muscle (**myocarditis**), lungs (pneumonitis), or brain (**encephalitis**) may occur. These symptoms can lead to the few deaths caused by trichinosis.

The larvae begin to burrow into the host's muscles and form cysts within two to three weeks of the initial infection. This encysting produces signs of muscle inflammation (myositis) including swelling of the affected muscle groups, pain, and weakness. The most frequently affected muscles are the muscles outside the eye (extraocular muscles) that control eye movements; the muscles of the jaw, neck, and upper arm (biceps muscle); the muscles of the lower back (lumbar region); and the diaphragm, which is the muscle that separates the abdominal and chest cavities and aids in breathing.

The symptoms of trichinosis are at their most severe at about three weeks after infection, and decrease very slowly in their severity. Recovery is extremely gradual, and symptoms may last for as long as three months. **Fatigue** and muscle pain (myalgia) may take several more months to subside.

Diagnosis

An initial diagnosis of trichinosis relies heavily on the presence of its classic symptoms—swelling around the eyes, muscle inflammation, fever, and high levels of a certain type of white blood cell (eosinophils)—coupled with the patient's history. If the patient reports having eaten undercooked meat from an animal known to be a potential carrier of trichinosis, the doctor may order a muscle biopsy to confirm the diagnosis. By the third or fourth week of infection, muscle biopsies usually indicate the presence of larvae. Stool tests rarely reveal adult worms, although larvae can sometimes be found in blood or duodenal washings after the second week of infection. The blood test that is the most specific for trichinosis is the bentonite flocculation (BF) test.

T. spiralis can infect a number of different animal species used for food. The most common food culprit in the United States has been pork sausage, while outbreaks in Europe have caused by wild boar and horse meat. Outbreaks of trichinosis in Asia and Africa have been traced to dog meat, and outbreaks in Northern Canada have resulted from consumption of walrus and bear meat.

Treatment

Supportive care

Treatment of trichinosis is primarily aimed at decreasing the severity of the symptoms. Symptomatic relief includes bed rest and medications to relieve fever and muscle pain. The medications most commonly given are **aspirin** and **nonsteroidal anti-inflammatory drugs** (NSAIDs). Steroids such as prednisone (Deltasone, Meticorten) are reserved for the most severe cases of muscle inflammation, or for complicated cases that include myocarditis.

Anthelminthic medications

In addition to medications for pain relief, trichinosis can be treated with drugs that are called anti-worm medications or anthelminthics. Two related anti-worm medications, mebendazole (Vermox) and thiabendazole (Mintezol), have been reported to be effective against intestinal larvae, but not against larvae encysted in the muscles. In particular, thiabendazole has worked best when given to patients who knew within 24 hours that they had eaten infested meat. Thiabendazole has, however, anti-inflammatory properties that can relieve some of the pain during the muscle stage of trichinosis.

Prognosis

The prognosis for recovery from trichinosis is generally good. Most people with the disease are unaware that they have even been infected. It is estimated that between 150,000 and 300,00 people in the United States become infected yearly, so that at any given time, 1.5 million people have *T. spiralis* infections. Most of these people have such light cases that trichinosis is never identified. Worm burden is measured in larvae per gram of muscle tissue; people with 10 or fewer larvae per gram of muscle tissue usually have no significant symptoms. When the number climbs to 100 larvae per gram of muscle tissue, the symptoms become noticeable. People with over 1000 larvae per gram of muscle tissue are usually extremely ill, and often die. The mortality rate of trichinosis is about 1%.

Prevention

Prevention of trichinosis is relatively simple. Swine should be fed only grain or cooked garbage because

KEY TERMS

Anthelminthic—A type of medication that is given to destroy or eliminate parasitic worms.

Cyst—In the life cycle of the round worm, a protective, walled-off capsule in which the larvae lie dormant.

Embryonic—In the life cycle of the round worm, a very early life stage occurring within the uterus of the female round worm.

Host—The animal within which a parasite lives, and from which the parasite receives its nutrition.

Inflammation—A reaction within the body to an invader (virus, bacteria, fungus, worm, etc.) or to tissue injury. The classic signs of inflammation include redness, heat, pain, and loss of function.

Larva—In the life cycle of the round worm, the second stage of life, sometimes considered the "adolescent" stage.

Nematode—A type of roundworm with a long, unsegmented body, usually parasitic on animals or plants.

Striated muscle—Also known as striped muscle; it includes muscles of the skeletal system and of the heart.

Trichina—An individual example of *Trichinella spiralis*.

uncooked garbage may contain contaminated pork scraps. Meat from animals prone to trichinosis infection should be cooked or smoked thoroughly until it is no longer pink. Freezing meat at an adequately low temperature (5°F/–15°C for three weeks) can kill most encysted larvae, except for species which infect such arctic mammals as walrus or bear.

Resources

BOOKS

Plorde, James J. "Trichinella." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Stack, Peter S. "Trichinosis: Still a Public Health Threat." *Postgraduate Medicine* 97, no. 6 (June 1995): 137+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Trichomonas vaginalis infection *see* **Trichomoniasis**

Trichomoniasis

Definition

Trichomoniasis refers to an infection of the genital and urinary tract.

Description

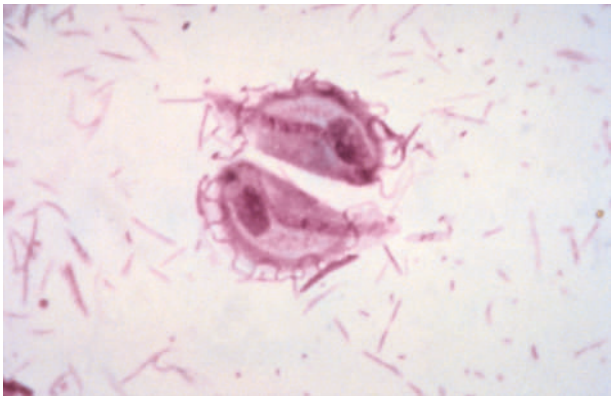
Trichomoniasis is caused by a protozoan (the smallest, single-celled members of the animal kingdom). *Trichomonas vaginalis* is passed almost 100% of the time through sexual contact. Trichomoniasis is primarily an infection of women's vaginal and urinary tracts. A woman is most susceptible to infection just after having completed her menstrual period. Men may carry the organism unknowingly, since infection in men may cause mild or no symptoms.

Causes and symptoms

Because trichomoniasis is a sexually transmitted disease, it occurs more often in individuals who have multiple sexual partners. The protozoan is passed to an individual by contact within the body fluids of an infected sexual partner. It often occurs simultaneously with other **sexually transmitted diseases**, especially **gonorrhea**.

In women, the symptoms of trichomoniasis include an unpleasant vaginal odor, and a heavy, frothy, yellow discharge from the vagina. The genital area (vulva) is often very itchy, and there is frequently **pain** with urination or with sexual intercourse. The labia (lips) of the vagina, the vagina itself, and the cervix (the narrowed, lowest segment of the uterus which extends into the upper part of the vagina) will be bright red and irritated.

In men, there are usually no symptoms at all. Occasionally, a man will notice a small amount of yellowish discharge from his penis, usually first thing in the morning. There may be some mild discomfort while urinating.



A close up image of *Trichomonas vaginalis*, the parasite that causes vaginitis in humans. *(Custom Medical Stock Photo. Reproduced by permission.)*

Diagnosis

Diagnosis is easily made by taking a sample of the discharge from the women's vagina, or from the opening of the man's penis. The sample is put on a slide, and viewed under a microscope. The protozoa, which are able to move about, are easily viewed.

Treatment

The usual treatment is a single large dose of metronidazole, or split doses over the course of a week. Sexual partners of an infected individual must all be treated, to prevent the infection being passed back and forth.

Alternative treatment

Cure of trichomoniasis may be difficult to achieve with alternative treatments. Some practitioners suggest eliminating sweets and carbohydrates from the diet and supplementing with antioxidants, including **vitamins** A, C, and E, and zinc. Naturopaths may recommend treatment with two douches (a wash used inside the vagina), alternating one in the morning and one at bedtime. One douche contains the herbs calendula (*Calendula officinalis*), goldenseal (*Hydrastis canadensis*), and **echinacea** (*Echinacea* spp.); the other douche contains plain yogurt. The herbal douche helps to kill the protozoa, while the yogurt reestablishes healthy flora in the vagina. Acidifying the vagina by douching with boric acid or vinegar may also be useful.

Prognosis

Prognosis is excellent with appropriate treatment of the patient and all sexual partners. Without treatment, the infection can smolder on for a very long time, and can be passed to all sexual partners.

Prevention

All sexually transmitted diseases can be prevented by using adequate protection during sexual intercourse. Effective forms of protection include male and female condoms.

Resources

BOOKS

Nash, Theodore E., and Peter F. Weller. "Protozoal Intestinal Infections and Trichomoniasis." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Plorde, James J. "Introduction to Pathogenic Parasites: Pathogenesis and Chemotherapy of Parasitic Diseases." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Policar, Michael S. "Genital Tract Infections: How Best to Treat Trichomoniasis, Bacterial Vaginosis, and *Candida* Infection." *Consultant* 36 (Aug. 1996): 1769+.

Walling, Anne D. "Lowest Metronidazole Dose for Trichomonas Vaginitis." *American Family Physician* 56 (1 Sept. 1997): 948+.

Rosalyn Carson-DeWitt, MD

Trichotillomania *see* **Alopecia**

Trichuriasis *see* **Roundworm infections**

Tricuspid incompetence *see* **Tricuspid valve insufficiency**

Tricuspid regurgitation *see* **Tricuspid valve insufficiency**

Tricuspid stenosis *see* **Tricuspid valve stenosis**

Tricuspid valve insufficiency

Definition

Tricuspid valve insufficiency occurs when a tricuspid valve does not close tightly enough to prevent leakage. This condition is also called tricuspid valve regurgitation and tricuspid incompetence.

Description

The tricuspid valve is located between the right atrium and the right ventricle of the heart. When the right ventricle contracts, it is supposed to pump blood forward into the lungs. If the tricuspid valve does not close tight-

KEY TERMS

Atrial fibrillation—A rapid, uncoordinated quivering of the upper chamber of the heart.

Atrium—The upper chamber of the heart.

Pulmonary valve—The valve at the opening from the right ventricle to the artery that leads to the lungs.

ly, some of that blood leaks back into the right atrium. When the atrium receives its usual quantity of blood from veins leading to the heart, plus the leaking blood, the pressure inside the atrium increases. This higher pressure creates resistance to the flow of blood in the veins that enter the atrium from the body. In addition, this increase in pressure causes the right atrium to enlarge over time. Congestion from fluid buildup occurs, particularly in the liver and legs.

Causes and symptoms

If a person has serious lung disease or a narrowing of the pulmonary valve, the right ventricle must pump harder to force the blood through the pulmonary valve. In order to pump harder, the right ventricle enlarges and the valve opening stretches, causing the valve to leak.

Tricuspid valve insufficiency usually produces such vague symptoms as general weakness and **fatigue**. As the conditions worsens, a person experiences **pain** in the upper right part of the abdomen, caused by a congested and enlarged liver. The legs may also swell (**edema**).

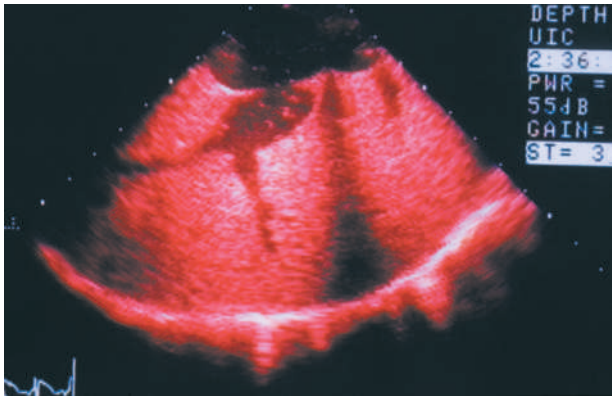
An enlarged right atrium can cause atrial fibrillation (the atria flutters, rather than pumping in a regular rhythm) and severe tricuspid regurgitation of blood, which can eventually lead to congestive **heart failure**.

Diagnosis

A leaky valve can be heard with a stethoscope; the sound is called a heart murmur. Additional support for diagnosing tricuspid valve insufficiency comes from a medical history, physical exam, and **chest x ray**. Further testing with **echocardiography**, to show an image of the leakage and its severity, is the most helpful diagnostic test for this condition.

Treatment

Tricuspid valve insufficiency itself usually does not require treatment, since a tiny leakage occurs in most normal people. In certain cases, however, if there is underlying pulmonary valve disease or lung disease, those conditions should be treated.



This echocardiogram of the heart shows tricuspid valve insufficiency. *(Custom Medical Stock Photo. Reproduced by permission.)*

If irregular heart rhythms or heart failure are present, they are usually treated independently of the valve insufficiency.

Since a person with known tricuspid valve insufficiency is at risk for infections of the heart, **antibiotics** should be taken before and after oral or dental surgery, or urologic procedures.

Prognosis

Tricuspid valve insufficiency is not usually considered to be serious. If it is the result of other cardiopulmonary disease, the extent of those conditions effect the prognosis.

Prevention

In general, tricuspid valve insufficiency cannot be prevented.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Tricuspid valve stenosis

Definition

Tricuspid valve stenosis is a narrowing or stiffening of the opening in the valve. This stenosis causes increased resistance to blood flow through the valve.

Description

The tricuspid valve is located between the right atrium and the right ventricle of the heart. It is the largest of the four valves in the heart. When the tricuspid valve is narrowed or stiffened, it decreases the amount of blood that can flow through it. This decrease raises the pressure in the right atrium and causes the atrium to enlarge. It also causes the right ventricle to shrink, and lowers the cardiac output.

Causes and symptoms

Tricuspid valve stenosis is most often the result of **rheumatic fever**. On rare occasions, it is caused by a tumor or disease of the connective tissue. The rarest cause is a birth defect.

A person with tricuspid valve stenosis may experience generalized weakness and **fatigue**. Many people have **palpitations** and can feel fluttering in their neck. Over time, there may be **pain** in the upper right abdomen, due to increased congestion and enlargement of the liver.

Diagnosis

The noise produced by blood trying to flow through a stenotic valve can be heard with a stethoscope, and is referred to as a murmur. An x ray of the chest will show the right atrium to be enlarged. Further support for this diagnosis is found on an echocardiogram of the heart, which will show an image of the stenotic valve and measure its severity.

Treatment

Tricuspid valve stenosis itself usually doesn't require treatment. However, if there is damage to other valves in the heart as well, then surgical repair or replacement must be considered.

Since a person with known tricuspid valve stenosis is at risk for infections of the heart, **antibiotics** should be taken before and after oral or dental surgery, or urologic procedures.

KEY TERMS

Rheumatic fever—An inflammatory illness that can follow strep throat, and could cause heart damage.

Prognosis

Mild tricuspid valve stenosis is not usually considered cause for surgery. The decision to repair or replace the tricuspid valve is often based on the health of the aortic and mitral valves, rather than on the severity of stenosis in the tricuspid valve.

Prevention

Rheumatic **fever**, the usual cause of tricuspid valve stenosis, has almost disappeared in North America and western Europe. Therefore, the number of people who acquired this condition in childhood will decline over time.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Tricyclic antidepressants *see* **Antidepressants, tricyclic**

Trigeminal neuralgia

Definition

Trigeminal **neuralgia** is a disorder of the trigeminal nerve (the fifth cranial nerve) that causes episodes of sharp, stabbing **pain** in the cheek, lips, gums, or chin on one side of the face.

Description

The trigeminal nerve, which is divided into three branches, is responsible for chewing, for producing sali-

va and tears, and for sending facial sensations to the brain. When this nerve breaks down for some reason, it can trigger brief but agonizing sizzles of pain on one side of the face.

This condition is unusual in those under age 50 and more often occurs after 70. Women are three times more likely to have the condition than are men. When trigeminal neuralgia does occur in younger people, it is often associated with **multiple sclerosis**.

The pain, while brief, is so severe that the sufferer often can't do anything else while the attack lasts. People with this pain often wince or twitch, which is where trigeminal neuralgia gets its French nickname *tic douloureux*, meaning "painful twitch."

Causes and symptoms

The origin of trigeminal neuralgia is not certain, but scientists believe it may be caused by degeneration, pressure, or irritation of the trigeminal nerve. Some doctors believe the pain may be triggered by pressure from a nearby abnormally-formed artery lying too close to the nerve.

Any part of the three branches of the trigeminal nerve may be affected. Neuralgia of the first branch leads to pain around the eyes and over the forehead; the second branch causes pain in the upper lip, nose and cheek; the third branch causes pain on the side of the tongue and lower lip.

The first episodes are usually fairly mild and brief, and it may be minutes, hours, or weeks before the next attack. However, attacks tend to occur in clumps that may last for weeks at a time. As the sufferer ages, the episodes become more frequent and painful, until the person begins to live in constant fear of the next one.

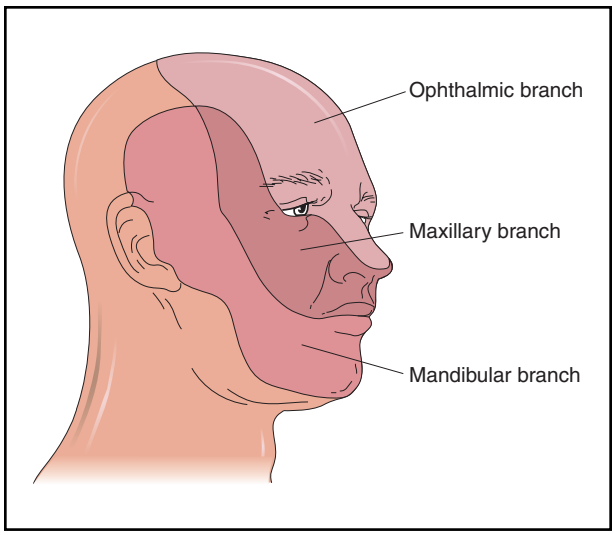
The momentary bursts of pain usually begin from the same spot on the face each time. The pain can be triggered by touching the area, washing, shaving, eating, drinking, or even talking. Even a cool breeze across the face can set off an attack. Pain is more severe at the ends of the affected nerve, especially over the lip, chin, nostrils, or teeth.

Diagnosis

Diagnosis is usually made by eliminating other problems that could cause similar pain in teeth, jaw, head, or sinuses. Because patients with the condition tend to avoid trigger points, avoiding chewing, shaving, touching or washing their faces can be a clue to diagnosis of trigeminal neuralgia.

Treatment

It is not easy to treat trigeminal neuralgia. Pain can be suppressed by a range of medicines, including the anti-



Trigeminal neuralgia is a disorder of the trigeminal nerve (which is divided into three branches, as illustrated above) that causes episodes of sharp, stabbing pain in the cheek, lips, gums, or chin on one side of the face. The origin of this disorder is not certain, but scientists believe it may be caused by degeneration, pressure, or irritation of the trigeminal nerve. *(Illustration by Electronic Illustrators Group.)*

epilepsy medicines carbamazepine (Tegretol) or phenytoin (Dilantin). These drugs slow down the nerve signals at certain nerve terminals, which eases the pain. However, these drugs cause a wide range of side effects, including nausea, **dizziness**, drowsiness, liver problems, and skin **allergies**. Some people develop resistance to the drugs or they can't tolerate the high dosage needed to control the discomfort. If the medicines are stopped, the pain usually returns.

If drug treatment fails, surgical treatment to block pain signals from the nerve may be effective. Radio-frequency waves, gamma rays, or glycerol injections can deaden the nerve (and hence the pain). An operation that frees the nerve from whatever is compressing it (blood vessel or tumor) can permanently relieve pain, but this major neurosurgical procedure carries its own risks and complications. Alternatively, a new procedure seeks to place a cushioning sponge between the nerve and a pulsating artery wrapping around it to soothe the irritated nerve.

Prognosis

Although the pain is momentarily incapacitating, it's not life-threatening. As the person ages, the attacks can be expected to occur more and more frequently.

Prevention

While the condition itself can't be prevented, there are a number of things patients can do to avoid triggering attacks:

KEY TERMS

Multiple sclerosis—A progressive disease of the central nervous system in which the coverings of nerves in the brain and spinal cord are destroyed.

- wash with cotton pads and warm water over the face
- rinse the mouth with water after eating, if toothbrushing triggers pain
- eat and drink food and beverages at room temperature
- chew on the unaffected side
- eat soft foods, if eating is becoming a problem

Resources

BOOKS

Greenberg, David A., et al. *Clinical Neurology.* 2nd ed. Norwalk, CT: Appleton & Lange, 1993.

ORGANIZATIONS

Chronic Pain Outreach. 822 Wycliff Ct., Manassas, VA 22110. (703) 368-7357.

National Chronic Pain Outreach Association, Inc. 4922 Hampden Lane, Bethesda, MD 20814. (301) 652-4948.

National Institute of Neurological Disorders and Stroke. P.O. Box 5801, Bethesda, MD 20824. (800) 352-9424. <http://www.ninds.nih.gov/index.htm>.

Trigeminal Neuralgia Association. P.O. Box 785, Barnegat Light, NJ 08006. (609) 361-1014.

Carol A. Turkington

Trigger finger

Definition

Trigger finger is the popular name of stenosing tenosynovitis, a painful condition in which a finger or thumb locks when it is bent (flexed) or straightened (extended).

Description

Tendons are tough, fibrous cords that connect muscles to bones. Tendons must slide easily through their protective coverings (tendon sheaths). The finger and thumb bones have tendons that are responsible for bending and straightening the fingers. Problems start when a tendon sheath narrows (stenosis) and the outer covering of the tendon becomes inflamed (tenosynovitis). The tendon swells because of the constriction, sometimes forming a nodule, and is no longer able to move smoothly through its sheath. As a result, a finger may lock in an upward position as the person tries to straighten it. The condition usually happens in the ring and middle fingers and is more common in women, typically over age 30. In infants and small children, the condition generally occurs in the thumb.

Causes and symptoms

Trigger finger is often an overuse injury because of repetitive or frequent movement of the fingers. Trigger finger may happen because a person performs the same manipulation over and over on a job, from squeezing and gripping during a weekend of heavy pruning and gardening, or from such hobbies as playing a musical instrument or crocheting. Trigger finger may also result from trauma or accident. The symptoms of trigger finger are **pain** in the fingers and "popping" sensations. Sometimes the finger may lock down into the palm or lock out straight. Symptoms are usually worse in the morning and improve during the day.

Diagnosis

The diagnosis of trigger finger and thumb is obvious on **physical examination**. Often there is a click that can be felt as the nodule passes through the sheath. Most cases are uncomplicated although X rays are often taken to rule out other injuries or disease such as arthritis.

Treatment

Initial treatment for mild or infrequent symptoms of trigger finger include rest, avoiding or modifying those activities that caused the inflammation, and the use of a nonsteroidal anti-inflammatory drug (NSAID) such as ibuprofen. This may relieve the swelling and inflammation that resulted in the constriction of the sheath and the restriction of the tendon. Injection of a steroid medication (cortisone) into the tendon sheath is the next option to treat trigger finger. Depending on the severity, there may be one more injection a week later. Two-thirds of patients improve after one injection. Some physicians will splint the finger in extension after the injection.

In severe cases that do not respond to injections and the finger or thumb remains in a locked position, surgery may be required to relieve the symptoms. A local anesthetic is used for the surgical procedure performed on an outpatient basis. An incision is made by a surgeon in the palm of the hand at the base of the affected finger or thumb to relieve the constriction of the tendon. Recovery

KEY TERMS

Microcirculation—The passage of blood in the smallest blood vessels of the body, such as the capillaries in the hand and fingers.

Myofascial—The fibrous tissue that encloses and separates layers of muscles.

Nodule—A swelling or knob that may form on a tendon and make it difficult to slide smoothly through its sheath.

Stenosis—Narrowing of a passageway or opening in the body. In trigger finger it is the tendon sheath that narrows.

Synovial tendon sheath—Where the tendons cross joints, they are sheathed in thin membranes known as synovium, which provide lubrication to decrease friction.

Tendon sheath—A membrane covering a tendon.

Tenosynovitis—Inflammation of a tendon and its enveloping sheath, usually resulting from overuse injury.

may take up to four weeks. Sometimes physical therapy of the hand is required after surgery to regain good use.

Alternative treatment

Treatment should begin when a person starts having difficulty moving the fingers. If started early, noninvasive measures have a good chance for success. Alternative treatments include **acupuncture** to facilitate healing and microcirculation, pulsed ultrasound, and myofascial release work for the affected area.

Prognosis

At least half of cases can be cured non-surgically. The key to successful treatment is early intervention. A mistake people make is trying to work through the pain. Diabetics have a higher incidence of the condition and are sometimes left with a disability.

Prevention

Taking frequent breaks from a repetitive activity will do much to prevent the condition. Depending on the intensity, that may mean a 10 minute break every hour from the repetitive activity. The break should be spent stretching the hands and arms and generally moving around.

Resources

PERIODICALS

"Ask the Mayo Physician." *HealthOasis Mayo Clinic* (May 4, 2000).

Phillips, D. F. "New Paradigms Sought to Explain Occupational and Environmental Disease." *JAMA* (January 6, 1999).

Stroud, R. "Minimally Invasive Surgical Techniques of the Hand and Upper Extremities." *Orthopedic Technology Review* (September 2000):18.

ORGANIZATIONS

American Society for Surgery of the Hand. 6300 N. River Rd., Suite 600, Rosemont, IL 60018. <http://www.hand-surg.org>.

OTHER

Jameson DC, CCSP, Timothy J. "Explanation,Treatment, and Prevention of Trigger Finger."GuitarBase Articles. <http://www.gbase.com/articles/med/med4.html>.

Ruthan Brodsky

Triglycerides test

Definition

Triglycerides test is a blood test to determine the amount of triglycerides, a form of fat, in the blood.

Purpose

The triglycerides test is one of the screening tests for excess lipids (fats) in the blood. It is usually part of an evaluation of risk factors for heart disease.

Description

Triglycerides are a form of fat that comes from foods. They can also be made and stored in the body and are used as an energy source. High levels of triglycerides in the blood can mean that there is too much fat in the diet. Hypertriglyceridemia (high levels of triglycerides) is associated with coronary heart disease, especially since elevated triglycerides levels are often associated with unhealthy low levels of hyper-density lipoproteins (the "good" cholesterol), which are necessary for good health.

Preparation

For triglycerides testing, blood is drawn from a vein in the arm. A vein at the inside of the elbow or on the back of the hand is usually selected. The area where the needle will be inserted is cleaned with antiseptic. A small needle is inserted through the skin and into the vein,

allowing a small amount of blood to flow into a collection tube or syringe. Once the blood is collected, the needle is removed from the puncture site.

Before the blood test, the patient may be required to refrain from eating food for eight to 12 hours. Patients should not drink alcohol for 24 hours before the test. Some drugs may affect the test and the patient may be asked to cease taking certain medications before the test. **Oral contraceptives**, estrogen, and cholestyramine (a drug used to treat **high cholesterol**) can increase triglyceride levels. Ascorbic acid (vitamin C), asparaginase (an enzyme), and various drugs used to treat high blood lipids, can decrease blood triglyceride levels. These substances should not be taken prior to this test.

Aftercare

After the blood sample has been taken and the needle withdrawn from the puncture site, a cotton ball or gauze pad may be placed over the site and direct pressure applied to reduce bleeding. A piece of surgical tape or gauze adhesive bandage strip may be secured over the site to prevent further bleeding.

Risks

There is a very small risk that the puncture site may bleed excessively, a bruise or infection may develop at the site, or it may take several punctures to locate a vein. Some patients may feel faint or lightheaded when blood is drawn.

Normal results

The normal range of triglycerides in the blood depends on the age and gender of the patient. Women naturally have higher levels of triglycerides than men. **Pregnancy** can also increase triglyceride levels. As people age and gain weight, triglyceride levels generally increase. For adults, a normal level is considered to be less than 200 mg/dl (milligrams per deciliter). Levels from 200–400 mg/dL are considered borderline high.

Abnormal results

Triglyceride levels ranging from 400–1000 mg/dL are considered high and levels greater than 1000 mg/dL are considered very high. High levels of triglycerides may indicate liver disease (**cirrhosis**), an underactive thyroid problem, uncontrolled diabetes, an infection of the pancreas (**pancreatitis**), kidney disease, or a diet too low in protein and too high in carbohydrates.

Extremely low triglycerides levels (less than 10 mg/dL) can also indicate a problem. Low levels may indicate **malnutrition** (not enough nutrients in the diet), malabsorption (inadequate absorption of nutrients in the intestinal tract), a diet too low in fat, or an overactive thyroid problem.

Resources

BOOKS

"Cholesterol and Its Health Hazards." In *The Consumer's Medical Desk Reference*, ed. Charles B. Inlander, et al. New York, NY: Stonesong Press, 1995.

"Primary & Secondary Prevention of Ischemic Heart Disease" and "High Blood Triglycerides." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford, CT: Appleton & Lange, 1997.

OTHER

"Triglyceride levels." *HealthAnswers.com* <http://www.healthanswers.co>.

"Triglycerides." *ThriveOnline.* <http://thriveonline.oxygen.com>.

Altha Roberts Edgren

Triiodothyronine test *see* **Thyroid function tests**

Triplets *see* **Multiple pregnancy**

Trisomy 13 *see* **Patau's syndrome**

Trisomy 18 *see* **Edwards' syndrome**

Trisomy G syndrome *see* **Down syndrome**

Trobofloxacin *see* **Fluoroquinolones**

Tropical spastic paraparesis

Definition

Tropical spastic paraparesis (TSP) is an incurable viral infection of the spinal cord that causes weakness in the legs. It is caused by the human T-cell lymphotropic virus-1 (HTLV-1) retrovirus.

Description

As the name implies, tropical spastic paraparesis usually occurs in tropical locales. Although isolated cases have been diagnosed in the southeastern United States and other places in the United States, TSP is most frequently found in:

- the Caribbean
- Japan
- the Seychelles Islands

- regions of South America
- western Africa

TSP usually affects adults between the ages of 30 and 40, and is far more common in women than in men.

The disease may remain undetected for years after infection is contracted. When the immune system's response to the virus causes nerve damage, the legs gradually lose strength and flexibility.

Causes and symptoms

TSP is caused by the HTLV-1 virus, which also causes leukemia. The virus can be spread through the placenta, and also through blood transfusions, breast-feeding, contaminated needles, and sexual contact.

Symptoms may begin years after infection. In response to the infection, the body's immune response may injure nerve tissue, causing symptoms that include bladder abnormalities, leg **pain**, loss of feeling in the feet, tingling sensations, and unpleasant sensations when the skin is touched.

As many as 20% of patients with TSP may also experience:

- deafness
- double vision
- the tendency to incorrectly estimate the amount of motion necessary to accomplish a specific task (dysmetria)
- exaggerated reflexes
- facial paralysis
- tremor

Diagnosis

Infectious disease specialists use blood tests and **magnetic resonance imaging** (MRI) of the spinal cord to diagnose this condition.

Treatment

While the disease is incurable, significant improvement has been reported in the condition of TSP patients treated with **corticosteroids**. These drugs are believed to alleviate symptoms by suppressing the immune system's response to the virus that causes them.

Plasmapheresis, a dialysis-like procedure in which symptom-producing antibodies are removed from the blood, also provides temporary relief.

Prognosis

As noted, TSP cannot be cured.

KEY TERMS

Retrovirus—A family of RNA viruses containing a reverse transcriptase enzyme which allows the viruses' genetic information to become part of the genetic information of the host cell upon replication.

Virus—A microorganism, smaller than bacteria, which can only replicate within the a cell of a living plant or animal. The virus provides the genetic code and the host cell provides the energy and raw materials for replication.

Prevention

The United States Food and Drug Administration (FDA) has approved screening procedures developed to detect HTLV-1 in donated blood and blood products designated for **transfusion**. These procedures, which can also be used to diagnose patients with TSP, are designed to prevent the spread of the disease.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

OTHER

"Current Trends Licensure of Screening Tests for Antibody to Human T-Lymphotropic Virus Type I." *Centers for Disease Control*. 27 May 1998 <http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/00001311.htm>.

Maureen Haggerty

Tropical sprue *see* **Malabsorption syndrome**

Troponins test

Definition

Troponins are specific proteins found in heart muscle. Troponin testing is done to diagnose heart attacks (myocardial infarctions).

Purpose

When heart muscle is damaged, as in a myocardial infarction (MI), troponins leak out of cells and into the

bloodstream. Increased troponin levels indicate myocardial infarction or injury in a person with chest **pain** or pressure. Some MIs are silent, manifesting few if any symptoms.

If infarction is ruled out in a person with continuing or recurring chest pain (unstable **angina**), an increased troponin level indicates the person has heart muscle **ischemia** (a decreased supply of oxygenated blood to the body), and is at an increased risk for a future serious heart event.

KEY TERMS

Angina—A temporary chest pain caused by the heart not receiving enough oxygen.

Cardiac marker—A substance in the blood whose levels rises following a myocardial infarction.

Myocardial infarction—Commonly known as a heart attack, a myocardial infarction is an episode in which some of the heart's blood supply is severely cut off or restricted, causing the heart muscle to suffer and die from lack of oxygen.

Description

Although troponins also exist in other muscles, those in the heart are unique, and are measured separately in laboratory tests. Troponins in the heart are called cardiac troponins. There are two main types of cardiac troponins; T and I. T is also referred to as cTnT, while I is also referred to as cTnI.

Both troponin T and I are cardiac markers used to diagnose myocardial infarctions. Cardiac markers are substances whose blood levels increase after a myocardial infarction. Others include CK (creatine kinase), myoglobin, and CK-MB (one of three CK isoenzymes).

Like all cardiac markers, troponins have a unique diagnostic window (the timeline during which the marker rises, peaks, and returns to normal). Troponin levels rise within four to six hours after the beginning of chest pain or heart damage, and stay elevated for at least one week. This long elevation allows detection of a myocardial infarction that occurred days earlier, but prevents detection of a second infarction if it occurred only days after the first.

Troponins I and T are considered superior cardiac markers for several reasons. The most significant is that cardiac troponins are the only markers specific for heart muscle. Other markers also increase following damage to other muscles. Troponin levels help predict the extent of heart muscle damage; higher levels are associated with increased damage, lower levels with less damage. Levels in a healthy person are negligible, so an increase is easily detected.

The main difference between troponins I and T is that cardiac troponin I tests measure only cardiac troponin; tests for cardiac troponin T may cross-react with troponin found in other muscles and give positive or increased results in the absence of heart damage.

Two types of tests for troponins T and I are available: a traditional quantitative test that provides an actual measurement of troponin, and a newer qualitative test that simply reports the result as positive or negative. The quantitative test takes 45–90 minutes, and helps distinguish between myocardial infarction and unstable angina. The qualitative test takes 15 minutes and is used in emergency rooms in which rapid patient care decisions can be made based on the presence or absence of troponins.

Preparation

Troponins tests require 5 mL of blood. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

People without heart damage have troponin levels less than 0.5 ng/mL.

Abnormal results

Levels greater than 2.0 ng/mL indicate a person has had a significant myocardial injury, such as an infarction, and is at an increased risk for future serious heart events. Levels between 0.5 and 2.0 ng/mL indicate a diagnosis of unstable angina, other heart disorders, or **chronic kidney failure**.

Resources

BOOKS

Wu, Alan, ed. *Cardiac Markers*. Washington, DC: American Association of Clinical Chemistry (AACC) Press, 1998.

PERIODICALS

Brown, Chris S., and Barry D. Bertolet. "Cardiac Troponin. See Ya Later, CK!" *Chest* (Jan. 1997): 2-4.

Hamm, Christian W., et al. "Emergency Room Triage of Patients With Acute Chest Pain by Means of Rapid Testing for Cardiac Troponin T or Troponin I." *The New England Journal of Medicine* (4 Dec. 1997): 67-78.

Wong, Shan S. "Strategic Utilization of Cardiac Markers for the Diagnosis of Acute Myocardial Infarction." *Annals of Clinical and Laboratory Science* (July 1996): 301-312.

Nancy J. Nordenson

Trypanosoma cruzi infection *see* **Chagas' disease**

TSS *see* **Toxic shock syndrome**

Tsutsugamushi fever *see* **Scrub typhus**

Tubal ligation

Definition

Tubal ligation is a permanent voluntary form of birth control (**contraception**) in which a woman's Fallopian tubes are surgically cut or blocked off to prevent **pregnancy**.

Purpose

Tubal ligation is performed in women who definitely want to prevent future pregnancies. It is frequently chosen by women who do not want more children, but who are still sexually active and potentially fertile, and want to be free of the limitations of other types of birth control. Women who should not become pregnant for health concerns or other reasons may also choose this birth control method. Tubal ligation is one of the leading methods of contraception, having been chosen by over 10 million women in the United States—about 15% of women of reproductive age. The typical tubal ligation patient is over age 30, is married, and has had two to three children.

Precautions

Tubal ligation should be postponed if the woman is unsure about her decision. While it is sometimes reversible, the procedure should be considered permanent and irreversible. Up to 10% of sterilized women regret having had the surgery, and about 1% seek treatment in attempts to restore fertility.

Description

Tubal ligation, or getting one's "tubes tied," refers to female sterilization, the surgery that ends a woman's ability to conceive. The operation is performed on the patient's Fallopian tubes. These tubes, which are about 10 cm long and 0.5 cm in diameter, are found on the upper outer sides of the uterus, and open into the uterus through small channels. It is within the Fallopian tube that fertilization, the joining of the egg and the sperm, takes place. During tubal ligation, the tubes are cut or blocked in order to close off the sperm's access to the egg.

Normally, tubal ligation takes about 20–30 minutes, and is performed under general anesthesia, spinal anesthesia, or local anesthesia with **sedation**. The surgery can be performed on either hospitalized patients within 24 hours after **childbirth** or on outpatients. The woman can usually leave the hospital the same day.

The most common surgical approaches to tubal ligation include **laparoscopy** and mini-laparotomy. In a laparoscopic tubal ligation, a long, thin telescope-like surgical instrument called a laparoscope is inserted into the pelvis through a small cut about 1 cm long near the navel. Carbon dioxide gas is pumped in to help move the abdominal wall to give the surgeon easier access to the tubes. Often the surgical instruments are inserted through a second incision near the pubic hair line. An instrument may be placed through the vagina to hold the uterus in place.

In a mini-laparotomy, a 3–4 cm incision is made just above the pubic bone or under the navel. A larger incision, or laparotomy, is rarely used today. Tubal ligation can also be performed at the time of a **cesarean section**.

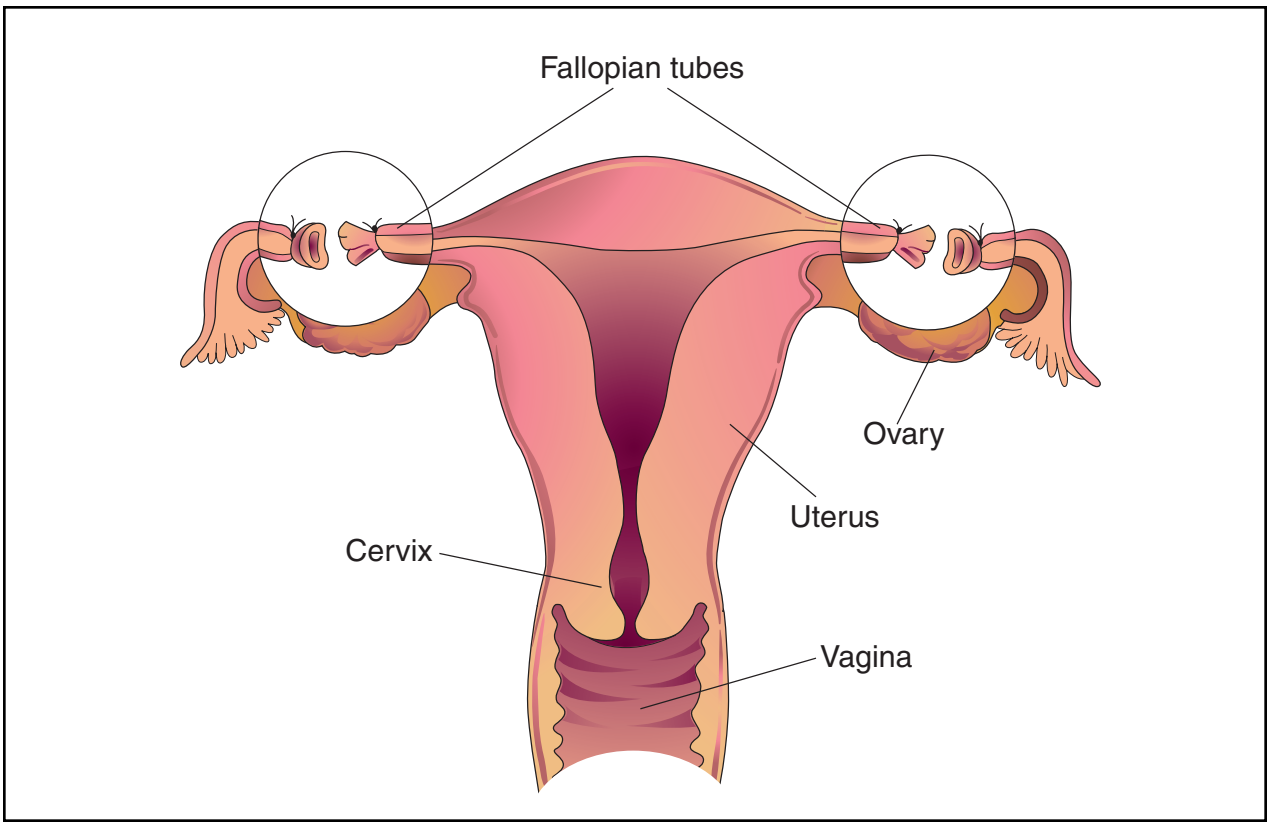
Tubal ligation costs about $2,000 when performed by a private physician, but is less expensive when performed at a family planning clinic. Most insurance plans cover treatment costs.

Tubal ligation is performed in several ways:

- Electrocoagulation. A heated needle connected to an electrical device is used to cauterize or burn the tubes. Electrocoagulation is the most common method of tubal ligation.
- Falope ring. In this technique, an applicator is inserted through an incision above the bladder and a plastic ring is placed around a loop of the tube.
- Hulka clip. The surgeon places a plastic clip across a tube held in place by a steel spring.
- Silicone rubber bands. A band placed over a tube forms a mechanical block to sperm.

Preparation

Preparation for tubal ligation includes patient education and counseling. Before surgery, it is important that the woman understand the permanent nature of tubal ligation, and the risks of anesthesia and surgery. Her med-



Tubal ligation is a permanent form of contraception in which a woman's Fallopian tubes are surgically cut, cauterized, tied, or blocked to prevent pregnancy. This procedure blocks the pathway sperm takes to fertilize an egg. *(Illustration by Electronic Illustrators Group.)*

ical history is reviewed, and a **physical examination** and laboratory testing are performed. The patient is not allowed to eat or drink for several hours before surgery.

Aftercare

After surgery, the patient is monitored for several hours before she is allowed to go home. She is instructed on care of the surgical wound, and what signs to watch for, such as **fever**, nausea, vomiting, faintness, or **pain**. These signs could indicate that complications have occurred.

Risks

While major complications are uncommon after tubal ligation, there are risks with any surgical procedure. Possible side effects include infection and bleeding. Rarely, **death** may occur as a complication of general anesthesia if a major blood vessel is cut. The death rate following tubal ligation is about four per 100,000 sterilizations.

After laparoscopy, the patient may experience pain in the shoulder area from the carbon dioxide used during surgery, but the technique is associated with less pain than mini-laparotomy, as well as a faster recovery period. Mini-laparotomy results in a higher incidence of pain, bleeding, bladder injury, and infection compared with laparoscopy. Patients normally feel better after three or four days of rest, and are able to resume sexual activity at that time.

Following tubal ligation, there is a low risk (less than 1%) of **ectopic pregnancy**. Ectopic pregnancy is a condition in which the fertilized egg implants in a place other than the uterus, usually in one of the Fallopian tubes. Ectopic pregnancies are more likely to happen in younger women, and in women whose tubes were ligated by electrocoagulation.

Normal results

After having her tubes ligated, a woman does not need to use any form of birth control to avoid pregnancy. Tubal ligation is almost 100% effective for the prevention of conception. The possibility for treatment failure is very low—fewer than one in 200 women (0.4%) will become pregnant during the first year after sterilization. Failure can happen if the cut ends of the tubes grow back together; if the tube was not completely cut or blocked off; if a

KEY TERMS

Contraception—The prevention of the union of the male's sperm with the female's egg.

Ectopic pregnancy—The implantation of a fertilized egg in a Fallopian tube instead of the uterus.

Electrocoagulation—The coagulation or destruction of tissue through the application of a high-frequency electrical current.

Female sterilization—The process of permanently ending a woman's ability to conceive by tying off or cutting apart the Fallopian tubes.

Laparoscopy—Abdominal surgery performed through a laparoscope, which is a thin telescopic instrument inserted through an incision near the navel.

plastic clip or rubber band is loose or comes off; or if the woman was already pregnant at the time of surgery.

Resources

BOOKS

MacKay, H. Trent. "Gynecology." In *Current Medical Diagnosis and Treatment, 1996*, ed. Stephen J. McPhee, et al. Stamford: Appleton & Lange, 1995.

Moore, J. George. "Contraception and Sterilization." In *Essentials of Obstetrics and Gynecology*, ed. Neville F. Hacker, et al. Philadelphia: W. B. Saunders Co., 1992.

Pasquale, Samuel A., and Jennifer Cadoff. *The Birth Control Book: A Complete Guide to Your Contraceptive Options*. New York: Ballantine Books, 1996.

PERIODICALS

Andolsek, Kathryn M. "Risk of Ectopic Pregnancy Following Tubal Ligation." *American Family Physician* 1 (Oct. 1997): 1460.

Apgar, Barbara. "Probability of Pregnancy After Tubal Sterilization." *American Family Physician* 15 (Sept. 1996): 1368-1370.

Haspel-Siegel, Alyssa S. "Fallopian Tube Anastomosis Procedures to Restore Fertility." *AORN Journal* (Jan. 1997): 75-82.

Hastings, John. "Could I Get Pregnant Even Though I've Had My Tubes Tied?" *Health*, July/Aug. 1996, 30.

Peterson, Herbert B., et al. "The Risk of Ectopic Pregnancy After Tubal Sterilization." *New England Journal of Medicine* 13 (Mar. 1997): 762-767.

Segen, Joseph. "Elective Surgery, Selective Coverage." *Business and Health*, 19 Aug. 1997, 48.

Walling, Anne D. "Tubal Ligation and Long-Term Probability of Hysterectomy." *American Family Physician* 1 (Oct. 1997): 1442-1443.

ORGANIZATIONS

American College of Obstetricians and Gynecologists. 409 12th Street, S.W., P.O. Box 96920

Planned Parenthood Federation of America, Inc. 810 Seventh Ave., New York, NY,10019. (800) 669-0156. <http://www.plannedparenthood.org>.

Mercedes McLaughlin

Tube compression of the esophagus and stomach

Definition

Tube compression of the esophagus and stomach is an emergency procedure used to stop bleeding from the upper digestive tract.

Purpose

Vomiting blood is both frightening and life-threatening. Among its causes are:

- bleeding from the nose and throat
- peptic ulcers
- stomach **cancer**
- esophageal cancer
- a tear in the esophagus caused by violent vomiting (**Mallory-Weiss syndrome**)
- breaking of blood vessels in the esophagus

The most profuse bleeding comes from veins in the lower esophagus, just above the stomach, that have dilated to enormous dimensions as the result of liver disease. When the liver shrinks due to **cirrhosis** (scarring from chronic disease), its blood vessels shrink, forcing blood from the intestines to find alternate routes back to the heart. The blood usually flows through tiny veins in the esophagus located just beneath the passageway where food passes downward and vomitus passes upward. Major causes for this rearrangement are alcoholic liver disease, chronic hepatitis, and cholangiitis. Called esophageal varices, the affected veins can be easily damaged and bleed voraciously.

Description

One emergency method of stopping bleeding from esophageal varices is to tamponade it with a balloon. The Sengstaken-Blakemore tube is a complex rubber device with two balloons and three channels—one channel for each balloon and one that goes all the way through. The

KEY TERMS

Cholangiitis—Inflammation of the system of tubes that drains bile from the liver into the intestines.

Chronic hepatitis—Long lasting inflammation of the liver due to viruses or other causes.

Peptic ulcers—Wounds in the stomach and duodenum caused by stomach acid and the bacterium *Helicobacter pylori*.

Tamponade—To occlude by pressure.

Minnesota tube has four channels, an extra one that opens above the first balloon. The bottom balloon is round; the upper balloon is long and narrow. The tube is passed through the nose or mouth into the stomach, where the bottom balloon is inflated. Then the tube is pulled back until the bottom balloon comes up against the narrow valve at the top of the stomach, when it can go no further. At this point, the upper balloon is inflated, putting pressure on a length of esophagus where the bleeding veins are located. The tube is then fixed so it cannot be dislodged. The third channel in the tube is used to aspirate (suck out) stomach contents to see if the bleeding has stopped. The fourth channel aspirates from the esophagus.

These tubes are a temporary measure. They stabilize the patient until bleeding has stopped, blood transfusions are received, and permanent repair is imminent.

Since the lower balloon effectively separates the esophagus from the stomach, it is possible to determine more accurately where the bleeding is located when it is in place.

This method of treating upper intestinal bleeding is being replaced by procedures that use a gastroscope, a flexible device that permits viewing and operating without surgery.

Preparation

The procedure is explained to the patient and family. A sedative may be given to prepare the patient for the procedure.

Aftercare

With the tube in place, the patient cannot eat and may have some difficulty breathing. The patient will be hospitalized until the tube can be removed.

Risks

Major complications frequently occur, and **death** results about 3% of the time. Problems include damage to the esophagus and stomach and interference with the airway. Should the tube remain in place too long, there is danger of the pressure eroding the esophagus or the nose.

Resources

BOOKS

Henneman, Philip L. "Gastrointestinal bleeding." In *Emergency Medicine*, ed. Peter Rosen, et al. St. Louis: Mosby, 1998.

J. Ricker Polsdorfer, MD

Tube feedings

Definition

Nutrients, either a special liquid formula or pureed food, are delivered to a patient through a tube directly into the gastrointestinal tract, usually into the stomach or small intestine.

Purpose

Tube feeding provides **nutrition** to patients who are unable or unwilling to eat food. Conditions where tube feeding is considered include **protein-energy malnutrition**, liver or kidney failure, **coma**, or in patients who cannot chew or swallow (dysphagia) due to **stroke**, **brain tumor**, or **head injury**. Patients who are receiving **radiation therapy** or **chemotherapy** treatments for **cancer** may also be candidates for tube feedings.

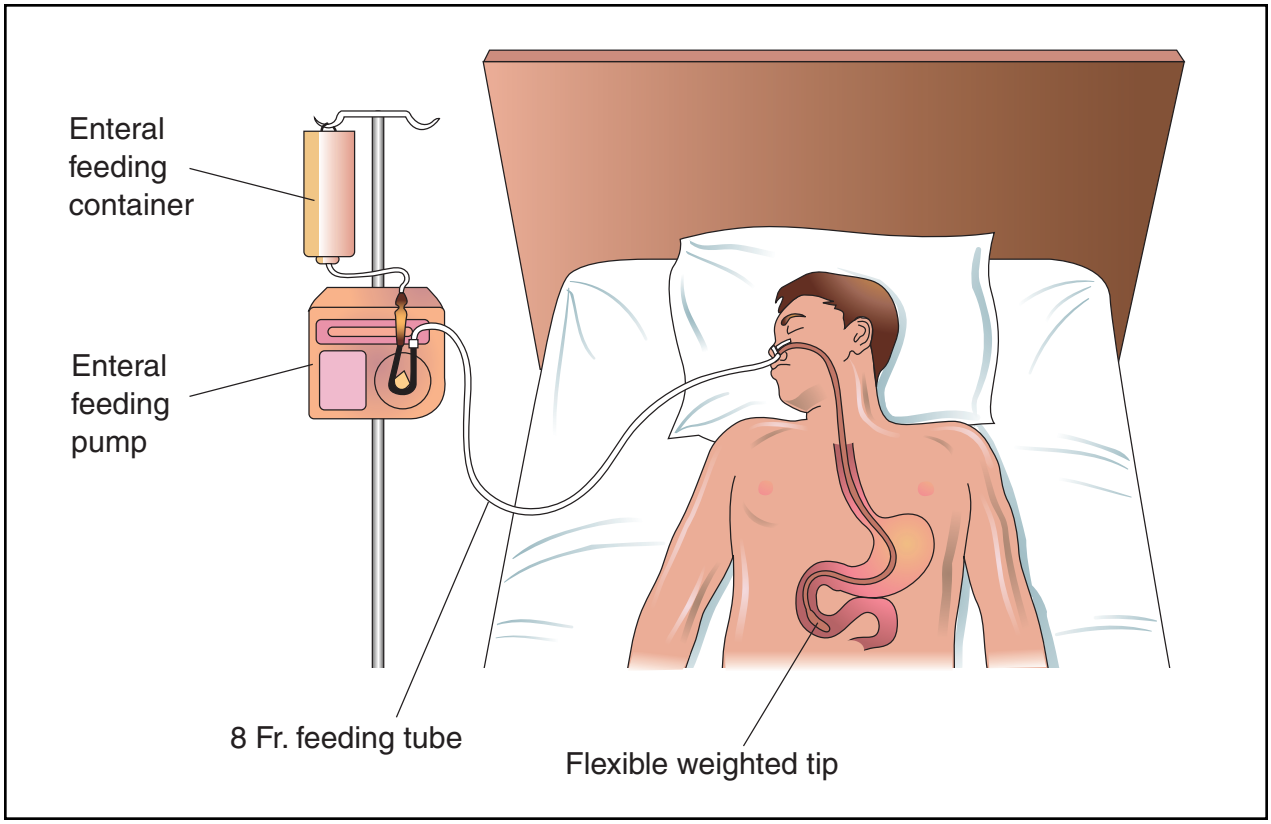
Precautions

Certain medications may interact with some formulas to inactivate the nutrients or change the way that the drug is absorbed.

Description

A flexible, narrow tube is inserted into some portion of the digestive tract and liquid formulas or liquefied foods are placed into the tube to meet the patient's nutritional needs. The feeding may be pumped into the tube or allowed to drip into the tube continuously or at scheduled feeding times.

A feeding tube can be inserted by a surgical or nonsurgical procedure in several positions along the gastrointestinal tract. The tube may be inserted into the nose



A feeding tube can be inserted by a surgical or nonsurgical procedure in several positions along the gastrointestinal tract to provide nutrition to patients who are unable or unwilling to eat food. The feeding may be pumped into the tube or allowed to drip into the tube continuously, or at scheduled feeding times. The illustration above features a nasojejunal tube which is inserted through the nose and ends in either the duodenum or jejunum. *(Illustration by Electronic Illustrators Group.)*

and passed down the throat and through the esophagus. A nasogastric tube is inserted through the nose with the end of the tube reaching into the stomach. A nasoduodenal or nasojejunal tube is inserted through the nose and ends in either the duodenum or jejunum, both of which are portions of the small intestine. This type of tube placement is usually used for short-term feeding. Surgical placement of a feeding tube may be done if there will be a long-term need for feeding that bypasses the upper digestive tract. An esophagostomy creates an opening in the esophagus, a **gastrostomy** creates an opening into the stomach, and a jejunostomy creates an opening into the jejunum. The feeding tube is then inserted through the surgically created opening.

Tube feedings can be a mixture of regular foods that are blended with liquid to make a consistency that will pass through the tube. Nutritionally balanced liquid products are often more convenient to use and ensure a balance of proteins, fats, and carbohydrates along with **vitamins** and **minerals**. Specialized formulas are also available to meet almost any nutritional need. For example, patients with severe **burns**, protein-energy **malnutrition**, or slow wound healing may require formulas that are higher in protein. Patients with renal failure may require low-protein formulas with lower concentrations of minerals and vitamins.

Preparation

The reasons that tube feeding is necessary are discussed with the patient, as is the length of time that the feeding tube is expected to be in place. The specific procedure is also explained to the patient.

Aftercare

Patients with **ostomy** feeding tubes may have the tube positioned level with the surrounding skin. A cap or button can be placed over the opening so that it can be more comfortably concealed under clothing. The opening and surrounding tissue need to be cleaned and inspected regularly to prevent infection. For patients with a tube inserted through the nose, daily nasal hygiene is important and the mouth and lips should be kept moist. Good mouth care is necessary for any patient with a feeding tube.

KEY TERMS

Duodenum—The upper portion of the small intestine. It is approximately 10 in (25 cm) long and extends from the stomach to the jejunum.

Jejunum—The middle portion of the small intestine. It is approximately 8 ft (2.5 m) long and extends from the jejunum to the ileum.

Risks

Formula from the tube can backup in the esophagus and be breathed into the trachea and lungs, causing aspiration **pneumonia**. The placement of the tube should be checked frequently and the head of the bed elevated during and after feeding to prevent the solution from moving back up the digestive tract. Feeding tubes can also become clogged and should be flushed regularly with water. If the feeding formula is too concentrated or given too fast, the patient may experience nausea, vomiting, cramping, and bloating. The feeding may need to be diluted with liquid or the rate at which it is given decreased. **Diarrhea** or **constipation** can occur if the feeding is not the right composition or does not provide enough liquid. The tube itself can irritate the nasal passage, esophagus, or surrounding tissues.

Normal results

A patient may be able to return to a normal diet of solid foods after short-term supplementation with formula through a feeding tube. In cases where long-term nutritional therapy is required, all of the patient's nutritional needs will have to be provided by the formula. The balance of fluids, calories, proteins, fats, vitamins, and minerals may need to be adjusted periodically.

Abnormal results

If formula feedings are not tolerated by the patient or are inadequate to meet his or her nutritional needs, the patient may need to receive **nutrition through an intravenous line** (parenteral nutrition). This type of therapy involves delivery of sterile nutrient solutions directly into the bloodstream through a needle inserted into a vein.

Resources

BOOKS

"Enteral Nutrition." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Howard, Lyn. "Enteral and Parenteral Nutrition Therapy." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Lagua, R. T., and V. S. Claudio. *Nutrition and Diet Therapy Reference Dictionary.* 4th ed. New York: Chapman & Hall, 1996.

Altha Roberts Edgren

Tuberculin skin test

Definition

Tuberculosis (TB) is an airborne infectious disease caused by the bacteria *Mycobacterium tuberculosis*. Besides culturing in the laboratory, the two most common types of tests to screen for exposure to this disease are the Mantoux PPD tuberculin skin test, which is generally considered the most reliable, and the older TB tine test, which is now rarely used. These tests are designed to help identify individuals who may have been infected by the tuberculosis bacteria. A diagnosis of active, infectious tuberculosis is never made solely based on the results of a TB skin test, but requires further testing, including a **sputum culture** and a chest x-ray.

Purpose

Because TB is spread through the air, especially in poorly ventilated areas, it is more commonly found among people living in crowded conditions, such as jails, nursing homes, and homeless shelters. Often, a TB skin test will be given as part of a **physical examination** when a person is hiring a new employee, particularly for those individuals seeking employment in the health-care or food service professions.

People can be exposed to or infected with TB without showing any symptoms or necessarily developing the disease. Individuals with normally functioning immune systems generally prevent the spread of the bacteria by "walling off" or encysting the bacteria within the body. To be at risk for infection a person must have or had close contact with someone who has active tuberculosis (such as a friend or family member). Persons who are more at risk for developing the TB infection overtly include those with a weakened immune system (immunocompromised), either from a chronic disease, such as HIV infection; or as a result of a tissue or organ transplant or other medical treatment designed to suppress the immune system. Symptoms of tuberculosis include a persistent **cough**, **fever**, weight loss, night sweats, **fatigue**, and loss of appetite.

Precautions

Although the test is generally considered safe, it is important to inform the person conducting the test if the patient may be pregnant, have had a positive TB test in the past, or have had tuberculosis in the past. People who have had a positive TB test in the past will probably always have a positive test and should not be tested again.

There are several situations when the TB test results might not be accurate. These include situations involving people who:

- have had vaccinations (such as those for **measles**, **polio**, **rubella** or **mumps**) within the last four weeks
- are taking steroids
- have severe malnutrition

Description

TB skin tests are usually given at a clinic, hospital, or doctor's office. Sometimes the tests are given at schools or workplaces and may be a pre-employment requirement. Many cities provide free TB skin tests and followup care. The Mantoux PPD tuberculin skin test involves injecting a very small amount of a substance called PPD tuberculin just under the top layer of the skin (intracutaneously). Tuberculin is a mixture of antigens obtained from the culture of *M. tuberculosis*. Antigens are foreign particles or proteins that stimulate the immune system to produce antibodies. Two different tuberculin preparations are available, Old Tuberculin (OT) and Purified Protein Derivative (PPD). The latter is the preferred testing substance. The test is usually given on the inside of the forearm about halfway between the wrist and the elbow, where a small bubble will form as the tuberculin is injected. The skin test takes just a minute to administer.

After 48–72 hours, the test site will be examined by a trained person for evidence of swelling. People who have been exposed to tuberculosis will develop an immune response, causing a slight swelling at the injection site. If there is a lump or swelling, the health care provider will use a ruler to measure the size of the reaction.

The other method of TB skin test is called the multiple puncture test or tine test because the small test instrument has several small tines that lightly prick the skin. The small points of the instrument are either coated with dried tuberculin or are used to puncture through a film of liquid tuberculin. The test is read by measuring the size of the largest papule. Because it is not possible to precisely control the amount of tuberculin used in the tine test, a positive test should be verified using the Mantoux test. For this reason, the tine test is not as widely used as the Mantoux test and is considered to be less reliable.

Preparation

There is no special preparation needed before a TB skin test. A brief personal history will be taken to determine whether the person has had tuberculosis or a TB test before, has been in close contact with anyone with TB, or has any significant risk factors. Directly before the test, the skin on the arm at the injection site is usually cleaned with an alcohol swab and allowed to air dry.

Aftercare

After having a TB skin test, it is extremely important to make sure that the patient keeps the appointment to have the test reaction read. The patient is instructed to keep the test site clean, uncovered, and to not scratch or rub the area. Should severe swelling, **itching**, or **pain** occur, or if the patient has trouble breathing, the clinic or health care provider should be contacted immediately.

Risks

The risk of an adverse reaction is very low. Occasionally, an individual who has been exposed to the TB bacteria will develop a large reaction in which the arm swells and is uncomfortable. This reaction should disappear in two weeks. A sore might develop where the injection was given, or a fever could occur, but these are extremely rare reactions.

It is possible that a person who has TB may receive a negative test result (called a "false negative") or a person who does not have TB may receive a positive test result (called a "false positive"). If there is some doubt, the test may be repeated or the person may be given a diagnostic test using a **chest x ray** and/or sputum sample culture test to determine whether the disease is present and/or active in the lungs.

Normal results

In people who have not been exposed to TB, there will be little or no swelling at the test site after 48–72 hours. This is a negative test. Negative tests can be interpreted to mean that the person has not been infected with the tuberculosis bacteria or that the person has been infected recently and not enough time has elapsed for the body to react to the skin test. Persons become sensitive between two and ten weeks after the initial infection. As a result, if the person has been in contact with someone with tuberculosis, the test should be repeated in three months. Also, because it may take longer than 72 hours

for an elderly individual to develop a reaction, it may be useful to repeat the TB skin test after one week to adequately screen these individuals. Immunocompromised persons may be unable to react sufficiently to the Mantoux test, and either a chest x ray or sputum sample may be required.

Abnormal results

A reaction of 5 mm of induration (swelling) is considered positive for the following groups:

- household contacts of persons with active tuberculosis
- AIDS patients
- persons with old healed tuberculosis on chest x ray
- organ transplant recipients
- persons receiving immunosuppressive medications

A reaction of 10 mm of induration is considered positive in individuals with one or more of the following risk factors which are either reasons to have a higher exposure to TB and/or a condition that increases the risk for progression to active TB:

- foreign-born immigrants from Asia, Africa, or Latin America
- injection drug users
- residents and employees of such high-risk congregate settings as hospitals and jails
- medically underserved low-income populations
- TB lab personnel
- children younger than four years of age or infants, children or adolescents exposed to adults in high risk categories
- residents of long-term care facilities
- individuals with certain medical conditions that increase the risk of developing tuberculosis; these medical conditions include being 10% or more below ideal body weight, **silicosis**, chronic renal failure, **diabetes mellitus**, high dose corticosteroid or other immunosuppressive therapy, some blood disorders like leukemia and lymphomas, and other cancer

Finally, a reaction of 15 mm of induration or greater is considered positive in those with no risk factors and are therefore at the lowest risk of developing TB.

A TB skin conversion is defined as an increase of 10 mm or greater of induration within a two year period, regardless of age.

A positive reaction to tuberculin may be the result of a previous natural infection with *M. tuberculosis*, infection with a variety of non-tuberculosis mycobacteria (cross-reaction), or tuberculosis **vaccination** with a live, but weakened (attenuated) mycobacterial strain. TB vaccination is not done in the US. Cross-reactions are positive reactions that occur as a result of a person's exposure to other non-tuberculosis bacteria. These tend to be smaller than those caused by *M. tuberculosis*. There is no reliable way of distinguishing whether a positive TB skin test is due to a previous vaccination against tuberculosis. Generally, however, positive results are not due to vaccination exposure because reactions in vaccinated people tend to be less than 10 mm, and an individual's sensitivity to tuberculin steadily declines after vaccination. If the skin test is interpreted as positive, a chest x ray will be performed to determine whether the person has active tuberculosis or whether the body has sufficiently handled the infection.

Resources

BOOKS

Faculty Members at the Yale University School of Medicine. "Tuberculin Skin Testing." In *The Patient's Guide to Medical Tests,* edited by Barry L. Zaret. New York, NY: Houghton Mifflin Company, 1997.

The Merck Manual of Diagnosis and Therapy. Edited by Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

"Tuberculosis." In *Diseases,* edited by Bryan Bunch. Danbury, CT: Scientific Publishing, Inc., 1997.

PERIODICALS

Advisory Council for the Elimination of Tuberculosis. "Screening for Tuberculosis and Tuberculosis Infection in High Risk Populations." *Morbidity & Mortality Weekly Report* 44 (September 8, 1995):19-34.

Pouchot, J., et al. "Reliability of Tuberculin Skin Test Measurement." *Annals of Internal Medicine* 126 (February 1, 1997): 210-214.

Rose, D. N., et al. "Interpretation of the Tuberculin Skin Test." *Journal of General Internal Medicine* 10 (November 1995): 635-642.

Steele, Russell W. "Tuberculosis in Children: A Growing Concern." *Infectious Medicine* 12, no. 9, (1995): 442, 453.

Centers for Disease Control, "Targeted Tuberculin Testing and Treatment of Latent Tuberculosis Infection." *Morbidity and Mortality Weekly Reporty* 49 (RR-6)(2000): 3-4

ORGANIZATION

American Lung Association. 800-LUNG-USA.

National Tuberculosis Center. University of Medicine and Dentistry of New Jersey. Executive Office, Suite GB1, 65 Bergen Street, Newark, NJ 07107-3268. (800) 4TB-DOCS. <http://www.umdnj.edu/~ntbcweb/ntbchome. htm>.

OTHER

American Family Physician. "Positive Skin Tests for Tuberculosis." <http://www.aafp.org/healthinfo>.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—Any foreign particle or protein that causes an immune response.

Attenuated—A live but weakened microorganism that can no longer produce disease.

Cross-reaction—Positive reactions that occur as a result of a person's exposure to other non-tuberculosis bacteria.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Intracutaneous—Into the skin, in this case directly under the top layer of skin.

Mantoux or PPD test—Other names for a tuberculin skin test. PPD stands for purified protein derivative.

Tuberculin—A mixture of antigens obtained from the cultured bacteria that cause tuberculosis, *Mycobacterium tuberculosis*.

"Diagnostic Standards and Classification of Tuberculosis." <http://aepo-xdv-www.epo.cdc.gov/wonder/prevguid/p0000425/body006.htm>.

U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention. "Questions and Answers About TB." <http://www.cdc.gov/nchstp/tb/faq.htm>.

Suzanne M. Lutwick, MPH

Tuberculosis

Definition

Tuberculosis (TB) is a potentially fatal contagious disease that can affect almost any part of the body but is mainly an infection of the lungs. It is caused by a bacterial microorganism, the tubercle bacillus or *Mycobacterium tuberculosis*. Although TB can be treated, cured, and can be prevented if persons at risk take certain drugs, scientists have never come close to wiping it out. Few diseases have caused so much distressing illness for centuries and claimed so many lives.

Description

Overview

Tuberculosis was popularly known as consumption for a long time. Scientists know it as an infection caused by *M. tuberculosis*. In 1882, the microbiologist Robert Koch discovered the tubercle bacillus, at a time when one of every seven deaths in Europe was caused by TB. Because **antibiotics** were unknown, the only means of controlling the spread of infection was to isolate patients in private sanitoria or hospitals limited to patients with TB—a practice that continues to this day in many countries. The net effect of this pattern of treatment was to separate the study of tuberculosis from mainstream medicine. Entire organizations were set up to study not only the disease as it affected individual patients, but its impact on the society as a whole. At the turn of the twentieth century more than 80% of the population in the United States were infected before age 20, and tuberculosis was the single most common cause of **death**. By 1938 there were more than 700 TB hospitals in this country.

Tuberculosis spread much more widely in Europe when the industrial revolution began in the late nineteenth century. The disease became widespread somewhat later in the United States, because the movement of the population to large cities made overcrowded housing so common. When streptomycin, the first antibiotic effective against *M. tuberculosis*, was discovered in the early 1940s, the infection began to come under control. Although other more effective anti-tuberculosis drugs were developed in the following decades, the number of cases of TB in the United States began to rise again in the mid-1980s. This upsurge was in part again a result of overcrowding and unsanitary conditions in the poor areas of large cities, prisons, and homeless shelters. Infected visitors and immigrants to the United States also contributed to the resurgence of TB. An additional factor is the **AIDS** epidemic. AIDS patients are much more likely to develop tuberculosis because of their weakened immune systems. There still are an estimated 8 to 10 million new cases of TB each year worldwide, causing roughly 3 million deaths.

High-risk populations

THE ELDERLY. Tuberculosis is more common in elderly persons. More than one-fourth of the nearly 23,000 cases of TB reported in the United States in 1995 developed in people above age 65. Many elderly patients developed the infection some years ago when the disease was more widespread. There are additional reasons for the vulnerability of older people: those living in nursing homes and similar facilities are in close contact with others who may be infected. The **aging** process itself may

weaken the body's immune system, which is then less able to ward off the tubercle bacillus. Finally, bacteria that have lain dormant for some time in elderly persons may be reactivated and cause illness.

RACIAL AND ETHNIC GROUPS. TB also is more common in blacks, who are more likely to live under conditions that promote infection. As the end of the century approaches, two-thirds of all cases of TB in the United States affect African Americans, Hispanics, Asians, and persons from the Pacific Islands. Another one-fourth of cases affect persons born outside the United States. As of 1992, the risk of TB was still increasing in all these groups.

LIFESTYLE FACTORS. The high risk of TB in AIDS patients extends to those infected by human **immunodeficiency** virus (HIV) who have not yet developed clinical signs of AIDS. Alcoholics and intravenous drug abusers are also at increased risk of contracting tuberculosis. Until the economic and social factors that influence the spread of tubercular infection are remedied, there is no real possibility of completely eliminating the disease.

Causes and symptoms

Transmission

Tuberculosis spreads by droplet infection. This type of transmission means that when a TB patient exhales, coughs, or sneezes, tiny droplets of fluid containing tubercle bacilli are released into the air. This mist, or aerosol as it is often called, can be taken into the nasal passages and lungs of a susceptible person nearby. Tuberculosis is not, however, highly contagious compared to some other infectious diseases. Only about one in three close contacts of a TB patient, and fewer than 15% of more remote contacts, are likely to become infected. As a rule, close, frequent, or prolonged contact is needed to spread the disease. Of course, if a severely infected patient emits huge numbers of bacilli, the chance of transmitting infection is much greater. Unlike many other infections, TB is not passed on by contact with a patient's clothing, bed linens, or dishes and cooking utensils. The most important exception is **pregnancy**. The fetus of an infected mother may contract TB by inhaling or swallowing the bacilli in the amniotic fluid.

Progression

Once inhaled, tubercle bacilli may reach the small breathing sacs in the lungs (the alveoli), where they are taken up by cells called macrophages. The bacilli multiply within these cells and then spread through the lymph vessels to nearby lymph nodes. Sometimes the bacilli move through blood vessels to distant organs. At this point they may either remain alive but inactive (quiescent), or they may cause active disease. Actual tissue damage is not caused directly by the tubercle bacillus, but by the reaction of the person's tissues to its presence. In a matter of weeks the host develops an immune response to the bacillus. Cells attack the bacilli, permit the initial damage to heal, and prevent future disease permanently.

Infection does not always mean disease; in fact, it usually does not. At least nine of ten patients who harbor *M. tuberculosis* do not develop symptoms or physical evidence of active disease, and their x-rays remain negative. They are not contagious; however, they do form a pool of infected patients who may get sick at a later date and then pass on TB to others. It is thought that more than 90% of cases of active tuberculosis come from this pool. In the United States this group numbers 10 to 15 million persons. Whether or not a particular infected person will become ill is impossible to predict with certainty. An estimated 5% of infected persons get sick within 12–24 months of being infected. Another 5% heal initially but, after years or decades, develop active tuberculosis either in the lungs or elsewhere in the body. This form of the disease is called reactivation TB, or post-primary disease. On rare occasions a previously infected person gets sick again after a later exposure to the tubercle bacillus.

Pulmonary tuberculosis

Pulmonary tuberculosis is TB that affects the lungs. Its initial symptoms are easily confused with those of other diseases. An infected person may at first feel vaguely unwell or develop a **cough** blamed on **smoking** or a cold. A small amount of greenish or yellow sputum may be coughed up when the person gets up in the morning. In time, more sputum is produced that is streaked with blood. Persons with pulmonary TB do not run a high **fever**, but they often have a low-grade one. They may wake up in the night drenched with cold sweat when the fever breaks. The patient often loses interest in food and may lose weight. Chest **pain** is sometimes present. If the infection allows air to escape from the lungs into the chest cavity (**pneumothorax**) or if fluid collects in the pleural space (**pleural effusion**), the patient may have difficulty breathing. If a young adult develops a pleural effusion, the chance of tubercular infection being the cause is very high. The TB bacilli may travel from the lungs to lymph nodes in the sides and back of the neck. Infection in these areas can break through the skin and discharge pus. Before the development of effective antibiotics, many patients became chronically ill with increasingly severe lung symptoms. They lost a great deal of weight and developed a wasted appearance. This outcome is uncommon today—at least where modern treatment methods are available.

Extrapulmonary tuberculosis

Although the lungs are the major site of damage caused by tuberculosis, many other organs and tissues in the body may be affected. The usual progression is for the disease to spread from the lungs to locations outside the lungs (extrapulmonary sites). In some cases, however, the first sign of disease appears outside the lungs. The many tissues or organs that tuberculosis may affect include:

- Bones. TB is particularly likely to attack the spine and the ends of the long bones. Children are especially prone to spinal tuberculosis. If not treated, the spinal segments (vertebrae) may collapse and cause **paralysis** in one or both legs.
- Kidneys. Along with the bones, the kidneys are probably the commonest site of extrapulmonary TB. There may, however, be few symptoms even though part of a kidney is destroyed. TB may spread to the bladder. In men, it may spread to the prostate gland and nearby structures.
- Female reproductive organs. The ovaries in women may be infected; TB can spread from them to the peritoneum, which is the membrane lining the abdominal cavity.
- Abdominal cavity. Tuberculous **peritonitis** may cause pain ranging from the vague discomfort of stomach cramps to intense pain that may mimic the symptoms of appendicitis.
- Joints. Tubercular infection of joints causes a form of arthritis that most often affects the hips and knees. The wrist, hand, and elbow joints also may become painful and inflamed.
- Meninges. The meninges are tissues that cover the brain and the spinal cord. Infection of the meninges by the TB bacillus causes tuberculous **meningitis**, a condition that is most common in young children but is especially dangerous in the elderly. Patients develop headaches, become drowsy, and eventually comatose. Permanent brain damage is the rule unless prompt treatment is given. Some patients with tuberculous meningitis develop a tumor-like brain mass called a tuberculoma that can cause stroke-like symptoms.
- Skin, intestines, adrenal glands, and blood vessels. All these parts of the body can be infected by *M. tuberculosis*. Infection of the wall of the body's main artery (the aorta), can cause it to rupture with catastrophic results. Tuberculous **pericarditis** occurs when the membrane surrounding the heart (the pericardium) is infected and fills up with fluid that interferes with the heart's ability to pump blood.
- Miliary tuberculosis. Miliary TB is a life-threatening condition that occurs when large numbers of tubercle bacilli spread throughout the body. Huge numbers of tiny tubercular lesions develop that cause marked weakness and weight loss, severe anemia, and gradual wasting of the body.

Diseases similar to tuberculosis

There are many forms of mycobacteria other than *M. tuberculosis*, the tubercle bacillus. Some cause infections that may closely resemble tuberculosis, but they usually do so only when an infected person's immune system is defective. People who are HIV-positive are a prime example. The most common mycobacteria that infect AIDS patients are a group known as *Mycobacterium avium* complex (MAC). People infected by MAC are not contagious, but they may develop a serious lung infection that is highly resistant to antibiotics. MAC infections typically start with the patient coughing up mucus. The infection progresses slowly, but eventually blood is brought up and the patient has trouble breathing. In AIDS patients, MAC disease can spread throughout the body, with anemia, **diarrhea**, and stomach pain as common features. Often these patients die unless their immune system can be strengthened. Other mycobacteria grow in swimming pools and may cause skin infection. Some of them infect **wounds** and artificial body parts such as a breast implant or mechanical heart valve.

Diagnosis

The diagnosis of TB is made on the basis of laboratory test results. The standard test for tuberculosis—which is the so-called tuberculin skin test—detects the presence of infection, not of active TB. Tuberculin is an extract prepared from cultures of *M. tuberculosis*. It contains substances belonging to the bacillus (antigens) to which an infected person has been sensitized. When tuberculin is injected into the skin of an infected person, the area around the injection becomes hard, swollen, and red within one to three days. Today skin tests utilize a substance called purified protein derivative (PPD) that has a standard chemical composition and is therefore is a good measure of the presence of tubercular infection. The PPD test is also called the Mantoux test. The Mantoux PPD skin test is not, however, 100% accurate; it can produce false positive as well as false negative results. What these terms mean is that some people who have a skin reaction are not infected (false positive) and that some who do not react are in fact infected (false negative). The PPD test is, however, useful as a screener. Anyone who has suspicious findings on a **chest x ray**, or any condition that makes TB more likely should have a PPD test. In addition, those in close contact with a TB patient and persons who come from a country where TB is common also should be test-

FLORENCE B. SEIBERT (1897–1991)

(Library of Congress.)

Florence Barbara Seibert was born on October 6, 1897, in Easton, Pennsylvania, the second of three children. She was the daughter of George Peter Seibert, a rug manufacturer and merchant, and Barbara (Memmert) Seibert. At the age of three she contracted polio. Despite her resultant handicaps, she completed high school, with the help of her highly supportive parents, and entered Goucher College in Baltimore, where she studied chemistry and zoology. She graduated in 1918, then worked under the direction of one of her chemistry teachers, Jessie E. Minor, at the Chemistry Laboratory of the Hammersley Paper Mill in Garfield, New Jersey. She and her professor, having responded to the call for women to fill positions vacated by men fighting in World War I, coauthored scientific papers on the chemistry of cellulose and wood pulps.

A biochemist who received her Ph.D. from Yale University in 1923, Florence B. Seibert is best known for her research in the biochemistry of tuberculosis. She developed the protein substance used for the tuberculosis skin test. The substance was adopted as the standard in 1941 by the United States and a year later by the World Health Organization. In addition, in the early 1920s, Seibert discovered that the sudden fevers that sometimes occurred during intravenous injections were caused by bacteria in the distilled water that was used to make the protein solutions. She invented a distillation apparatus that prevented contamination. This research had great practical significance later when intravenous blood transfusions became widely used in surgery. Seibert authored or coauthored more than a hundred scientific papers. Her later research involved the study of bacteria associated with certain cancers. Her many honors include five honorary degrees, induction into the National Women's Hall of Fame in Seneca Falls, New York (1990), the Garvan Gold Medal of the American Chemical Society (1942), and the John Elliot Memorial Award of the American Association of Blood Banks (1962).

ed, as should all healthcare personnel and those living in crowded conditions or institutions.

Because the symptoms of TB cover a wide range of severity and affected body parts, diagnosis on the basis of external symptoms is not always possible. Often, the first indication of TB is an abnormal chest x-ray or other test result rather than physical discomfort. On a chest x ray, evidence of the disease appears as numerous white, irregular areas against a dark background, or as enlarged lymph nodes. The upper parts of the lungs are most often affected. A PPD test is always done to show whether the patient has been infected by the tubercle bacillus. To verify the test results, the physician obtains a sample of sputum or a tissue sample (biopsy) for culture. Three to five sputum samples should be taken early in the morning. If necessary, sputum for culture can be produced by spraying salt solution into the windpipe. Culturing *M. tuberculosis* is useful for diagnosis because the bacillus has certain distinctive characteristics. Unlike many other types of bacteria, mycobacteria can retain certain dyes even when exposed to acid. This so-called acid-fast property is characteristic of the tubercle bacillus.

Body fluids other than sputum can be used for culture. If TB has invaded the brain or spinal cord, culturing a sample of spinal fluid will make the diagnosis. If TB of the kidneys is suspected because of pus or blood in the urine, culture of the urine may reveal tubercular infection. Infection of the ovaries in women can be detected by placing a tube having a light on its end (a laparoscope) into the area. Samples also may be taken from the liver or bone marrow to detect the tubercle bacillus.

Treatment

Supportive care

In the past, treatment of TB was primarily supportive. Patients were kept in **isolation**, encouraged to rest, and fed well. If these measures failed the lung was col-

KEY TERMS

Bacillus Calmette-Guérin (BCG)—A vaccine made from a damaged bacillus akin to the tubercle bacillus, which may help prevent serious pulmonary TB and its complications.

Mantoux test—Another name for the PPD test.

Miliary tuberculosis—The form of TB in which the bacillus spreads through all body tissues and organs, producing many thousands of tiny tubercular lesions. Miliary TB is often fatal unless promptly treated.

Mycobacteria—A group of bacteria that includes *Mycobacterium tuberculosis*, the bacterium that causes tuberculosis, and other forms that cause related illnesses.

Pneumothorax—Air inside the chest cavity, which may cause the lung to collapse. Pneumothorax is both a complication of pulmonary tuberculosis and a means of treatment designed to allow an infected lung to rest and heal.

Pulmonary—Refers to the lungs.

Purified protein derivative (PPD)—An extract of tubercle bacilli that is injected into the skin to find out whether a person presently has or has ever had tuberculosis.

Resistance—A property of some bacteria that have been exposed to a particular antibiotic and have "learned" how to survive in its presence.

Sputum—Secretions produced in the infected lung and coughed up. A sign of illness, sputum is routinely used as a specimen for culturing the tubercle bacillus in the laboratory.

Tuberculoma—A tumor-like mass in the brain that sometimes develops as a complication of tuberculous meningitis.

lapsed surgically so that it could "rest" and heal. Today surgical procedures still are used when necessary, but contemporary medicine relies on drug therapy as the mainstay of home care. Given an effective combination of drugs, patients with TB can be treated at home as well as in a sanitorium. Treatment at home does not pose the risk of infecting other household members.

Drug therapy

Most patients with TB can recover if given appropriate medication for a sufficient length of time. Three principles govern modern drug treatment of TB:

- Lowering the number of bacilli as quickly as possible. This measure minimizes the risk of transmitting the disease. When sputum cultures become negative, this has been achieved. Conversely, if the sputum remains positive after five to six months, treatment has failed.
- Preventing the development of drug resistance. For this reason, at least two different drugs and sometimes three are always given at first. If drug resistance is suspected, at least two different drugs should be tried.
- Long-term treatment to prevent relapse.

Five drugs are most commonly used today to treat tuberculosis: isoniazid (INH, Laniazid, Nydrazid); rifampin (Rifadin, Rimactane); pyrazinamide (Tebrazid); streptomycin; and ethambutol (Myambutol). The first three drugs may be given in the same capsule to minimize the number of pills in the dosage. As of 1998, many patients are given INH and rifampin together for six months, with pyrazinamide added for the first two months. Hospitalization is rarely necessary because many patients are no longer infectious after about two weeks of combination treatment. Follow-up involves monitoring of side effects and monthly sputum tests. Of the five medications, INH is the most frequently used drug for both treatment and prevention.

Surgery

Surgical treatment of TB may be used if medications are ineffective. There are three surgical treatments for pulmonary TB: pneumothorax, in which air is introduced into the chest to collapse the lung; thoracoplasty, in which one or more ribs are removed; and removal of a diseased lung, in whole or in part. It is possible for patients to survive with one healthy lung. Spinal TB may result in a severe deformity that can be corrected surgically.

Prognosis

The prognosis for recovery from TB is good for most patients, if the disease is diagnosed early and given prompt treatment with appropriate medications on a long-term regimen. Modern surgical methods have a good outcome in most cases in which they are needed. Miliary tuberculosis is still fatal in many cases but is rarely seen today in developed countries. Even in cases

in which the bacillus proves resistant to all of the commonly used medications for TB, other seldom-used drugs may be tried because the tubercle bacilli have not yet developed resistance to them.

Prevention

General measures

General measures such as avoidance of overcrowded and unsanitary conditions are also necessary aspects of prevention. Hospital emergency rooms and similar locations can be treated with ultraviolet light, which has an antibacterial effect.

Vaccination

Vaccination is one major preventive measure against TB. A vaccine called BCG (Bacillus Calmette-Guérin, named after its French developers) is made from a weakened mycobacterium that infects cattle. Vaccination with BCG does not prevent infection by *M. tuberculosis* but it does strengthen the immune system of first-time TB patients. As a result, serious complications are less likely to develop. BCG is used more widely in developing countries than in the United States. The effectiveness of vaccination is still being studied; it is not clear whether the vaccine's effectiveness depends on the population in which it is used or on variations in its formulation.

Prophylactic use of isoniazid

INH can be given for the prevention as well as the treatment of TB. INH is effective when given daily over a period of 6 to 12 months to people in high-risk categories. INH appears to be most beneficial to persons under the age of 25. Because INH carries the risk of side-effects (liver inflammation, nerve damage, changes in mood and behavior), it is important to give it only to persons at special risk.

High-risk groups for whom isoniazid prevention may be justified include:

- close contacts of TB patients, including health care workers
- newly infected patients whose skin test has turned positive in the past two years
- anyone who is HIV-positive with a positive PPD skin test; isoniazid may be given even if the PPD results are negative if there is a risk of exposure to active tuberculosis
- intravenous drug users, even if they are negative for HIV
- persons with positive PPD results and evidence of old disease on the chest x-ray who have never been treated for TB
- patients who have an illness or are taking a drug that can suppress the immune system
- persons with positive PPD results who have had intestinal surgery; have diabetes or **chronic kidney failure**; have any type of **cancer**; or are more than 10% below their ideal body weight
- people from countries with high rates of TB who have positive PPD results
- people from low-income groups with positive skin test results
- persons with a positive PPD reaction who belong to high-risk ethnic groups (African Americans, Hispanics, Native Americans, Asians, and Pacific Islanders)

Resources

BOOKS

Merck Manual of Medical Information: Home Edition. Ed. Robert Berkow, et al. Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Smolley, Lawrence A., and Debra F. Bryse. *Breathe Right Now: A Comprehensive Guide to Understanding and Treating the Most Common Breathing Disorders*. New York, NY: W. W. Norton & Co., 1998.

ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586-4872. <http://www.lungusa.org>.

OTHER

New York State Department of Health. "Communicable Disease Fact Sheet."

"Pulmonary Medicine." *Healthweb Page*. 12 Jan. 1998 <http://healthweb.org/browse.cfm?subjectid=81>.

David A. Cramer, MD

Tubo-ovarian abscesses *see* **Pelvic inflammatory disease**

Tularemia

Definition

Tularemia is an illness caused by a bacterium. It results in **fever**, rash, and greatly enlarged lymph nodes.

Description

Tularemia infects a variety of wild animals, including rabbits, deer, squirrels, muskrat, and beaver. Humans can acquire the bacterium directly from contact with the blood or body fluids of these animals, from the bite of a

tick or fly which has previously fed on the blood of an infected animal, or from contaminated food or water.

Tularemia occurs most often in the summer months. It is most likely to infect people who come into contact with infected animals, including hunters, furriers, butchers, laboratory workers, game wardens, and veterinarians. In the United States, the vast majority of cases of tularemia occur in the southeastern and Rocky Mountain states.

Causes and symptoms

Five types of illness may occur, depending on where/how the bacteria enter the body:

- Ulceroglandular/glandular tularemia. seventy-five to 85% of all cases are of this type. This type is contracted through the bite of an infected tick that has defecated bacteria-laden feces in the area of the bite wound. A tender red bump appears in the area of the original wound. Over a few weeks, the bump develops a punched-out center (ulcer). Nearby lymph nodes grow hugely swollen and very tender. The lymph nodes may drain a thick, pus-like material. Other symptoms include fever, chills, and weakness. In adults, the lymph nodes in the groin are most commonly affected; in children, the lymph nodes in the neck.
- Oculoglandular tularemia. This type accounts for only about 1% of all cases of tularemia. It occurs when a person's contaminated hand rubs his or her eye. The lining of the eyelids and the surface of the white of the eye (conjunctiva) becomes red and severely painful, with multiple small yellow bumps and pitted sores (ulcers). Lymph nodes around the ears, under the jaw, or in the neck may swell and become painful.
- Oropharyngeal and gastrointestinal tularemia. This type occurs when contaminated meat is undercooked and then eaten, or when water from a contaminated source is drunk. Poor hygiene after skinning and cleaning an animal obtained through hunting can also lead to the bacteria entering through the mouth. Sores in the mouth and throat, as well as abdominal **pain**, **nausea and vomiting**, ulcers in the intestine, intestinal bleeding, and **diarrhea** may all occur.
- Pulmonary tularemia. This rare type of tularemia occurs when a person inhales a spray of infected fluid, or when the bacteria reach the lungs through the blood circulation. A severe **pneumonia** follows.
- Typhoidal tularemia. This type of tularemia is particularly hard to diagnose, because it occurs without the usual skin manifestations or swelling of lymph glands. Symptoms include continuously high fever, terrible **headache**, and confusion. The illness may result in a severely low blood pressure, with signs of poor blood flow to the major organs (shock).

KEY TERMS

Conjunctiva—The lining of the eyelids and the surface of the white part of the eye.

Shock—A state in which drastically low blood pressure prevents adequate blood flow to the tissues and organs throughout the body.

Diagnosis

Samples from the **skin lesions** can be prepared with special stains, to allow identification of the causative bacteria under the microscope. Other tests are available to demonstrate the presence of antibodies (special immune cells that the body produces in response to the presence of specific foreign invaders) which would be increasing over time in an infection with tularemia.

Treatment

Streptomycin (given as a shot in a muscle) and gentamicin (given as either a shot in a muscle or through a needle in the vein) are both used to treat tularemia. Other types of **antibiotics** have been tested, but have often resulted in relatively high rates of relapse (20%).

Prognosis

With treatment, **death** rates from tularemia are under 1%. Without treatment, however, the death rate may reach 30%. The pneumonia and typhoidal types have the worst prognosis without treatment.

Prevention

Prevention involves avoiding areas known to harbor ticks and flies, or the appropriate use of insect repellents. Hunters should wear gloves when skinning animals or preparing meat. Others (butchers, game wardens, veterinarians) who work with animals or carcasses should always wear gloves. A vaccine exists, but is usually only given to people at very high risk due to their profession or hobby (veterinarians, laboratory workers, butchers, hunters, game wardens).

Resources

BOOKS

Jacobs, Richard F. "Tularemia." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Some Bacteria Causing Zoonotic Diseases." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.*

3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

PERIODICALS

Fredericks, David N., and Jack S. Remington. "Tularemia Presenting as Community-Acquired Pneumonia." *Archives of Internal Medicine* 56, no. 18 (14 Oct. 1996): 2137+.

Schofield, Hal. "Infectious Disease: Leporidae's Revenge." *Patient Care* 30, no. 14 (15 Sept. 1996): 171+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Tumor markers

Definition

Tumor markers are substances, such as proteins, biochemicals, or enzymes, produced by tumor cells or by the body in response to tumor cells. As tumor cells multiply, **cancer** spreads, and tissue is damaged, these substances increase and leak into the bloodstream. Tumor marker levels in blood help physicians evaluate people for certain types of cancer.

Purpose

Tumor marker levels provide evidence about the likelihood of undiagnosed cancer or the status of treated cancer without the expense and discomfort of ultrasound, x-ray, or biopsy procedures. Tumor marker levels are used to screen for and diagnose cancer, predict a person's prognosis, monitor treatment, and watch for cancer recurrence.

Description

Tumor markers associated with common cancers include: AFP, Beta-HCG, CA 15-3, CA 19-9, CA 27.29, CA 125, CEA, and PSA. Some tumor markers are associated with many types of cancer; others, with as few as one. Some tumor markers are always elevated in specific cancers; others are less predictable.

A tumor marker test's ability to screen for and diagnose a specific type of cancer depends on its sensitivity and specificity. A test that is 100% sensitive has no false negatives. It is positive or increased in every person who has that type of cancer. A test that is 100% specific has no false positives. It is negative or decreased in every person who does not have that type of cancer.

Most tumor markers are neither sensitive nor specific enough to screen for or diagnose cancer without the support of other clinical findings. Increased levels are not found in all people with a specific type of cancer, yet may be found in some people without that type of cancer. In addition, tumor marker levels often do not increase until the person experiences symptoms.

Once cancer is diagnosed, tumor marker levels help determine the amount of cancer present. Higher levels usually indicate more advanced cancer and a worse prognosis. The person and his or her physician use this information to choose between more or less aggressive treatments.

Monitoring cancer treatment is the most common use of tumor markers. As cancer is reduced, levels decrease. Stable or increasing levels indicate the cancer is not responding to treatment.

The choice of tumor marker to use for monitoring is important. Only a marker elevated before treatment can be used to monitor a person during or after treatment. Timing of the tests is also important. Each tumor marker has a unique lifespan in the blood. To monitor a treatment's success, enough time must have passed for the initial marker to be cleared from the blood. Tests done too soon may be falsely elevated because the marker produced by the untreated cancer is still present.

Watching for cancer recurrence is another common reason for tumor marker testing. Periodic testing can detect a recurrence often months earlier than could an ultrasound, x-ray, or **physical examination**.

Tumor marker tests usually are done by combining a sample of blood with a substance containing antibodies to the tumor markers. These antibodies bind to the markers. Another substance is added, often a radioactive substance, to measure the amount of bound marker and antibodies. From this measurement, the amount of tumor marker is calculated.

Conclusions based on tumor marker tests are seldom based on one test result but on a series of test results, called serial measurements. A series of increasing or decreasing values is more significant than a single value.

Tumor marker testing is currently the object of much research. Their use is directed by approval from the Food and Drug Administration (FDA) and guidelines established by organizations such as the American Society of Clinical Oncology and the American Cancer Society.

Tumor marker test results are available within several days. Insurance coverage for markers still in the research stage for particular uses may vary with the company and individual policy.

Alpha-fetoprotein (AFP)

AFP is a protein normally made by only fetal tissue. When certain types of cells become cancerous, they revert

to a fetal form and begin making AFP. Increased levels are associated most strongly with liver, testicular, and **ovarian cancer**. Seventy-percent of people with **liver cancer** have increased AFP levels. Levels indicate the extent of cancer. Serial measurements monitor treatment response.

Pregnant women and people with such noncancerous liver conditions as **cirrhosis** and hepatitis have moderately increased levels.

Beta-subunit human chorionic gonadotropin (Beta-HCG)

The beta-subunit of the hormone HCG is a marker for **testicular cancer** and cancers that begin in placental cells called trophoblasts. Women with **choriocarcinoma** (a cancer originating in the placenta following **pregnancy**) or molar pregnancy (a tumor inside the uterus) have increased levels of Beta-HCG, as do 70% of men with testicular cancer. Serial measurements monitor the progress and treatment of these cancers.

Cancer antigen 15-3 (CA 15-3)

CA 15-3 is produced by cells in the breast. Increased levels are associated with **breast cancer**. Rarely increased in women with early breast cancer, it is used to detect recurrence of cancer in women following treatment or **mastectomy**.

Cancer antigen 19-9 (CA 19-9)

CA 19-9 helps diagnose pancreatic cancer when combined with other test results and clinical findings. After diagnosis, levels help predict the success of surgery and to monitor the course of the cancer.

Not all people with pancreatic cancer have increased CA 19-9 levels. This marker is associated with a specific blood type. People with pancreatic cancer who are negative for this blood type will not have CA 19-9 in their blood. It is also increased in liver and gastrointestinal cancer and in such noncancerous diseases, as **pancreatitis** and **jaundice**.

Breast carcinoma-associated antigen (CA 27.29)

CA 27.29 is a marker for breast cancer. Eighty percent of women with breast cancer have an increased CA 27.29. Serial measurements monitor treatment response and identify recurrence.

Levels may also be increased in noncancerous breast disease and cancers of other tissues. It is not used to screen for breast cancer because women with small or localized breast tumors often have normal CA 27.29 levels.

Cancer antigen 125 (CA 125)

CA 125 is a protein made by ovarian cells and is a marker for ovarian cancer. Eighty percent of women with ovarian cancer have increased CA 125 levels. Although the test is not sensitive and specific enough to be used for screening, it contributes to a diagnosis when combined with an ultrasound and pelvic examination. After diagnosis and treatment, serial measurements help detect remaining or recurrent cancer. A negative or normal result, however, does not guarantee the absence of cancer.

Women may have increased CA 125 levels during menstruation and pregnancy. Increased levels are also found in **pelvic inflammatory disease**, **endometriosis**, pancreatitis, liver disease, and non-ovarian cancers.

Carcinoembryonic antigen (CEA)

CEA is a protein made by fetal tissues, especially liver, intestinal, and pancreatic tissue. It disappears by birth but often reappears when cells from these tissues become cancerous.

CEA is most often associated with colorectal cancer, although it is not present in all people with this cancer. Pre-surgery CEA levels help stage the cancer and plan the surgery. After surgery, serial measurements indicate the surgery's success and watch for early signs of recurrence. When CEA is found in other body fluids, such as spinal fluid, it indicates cancer has spread.

CEA levels may be increased in many types of cancer: gastrointestinal, colorectal, liver, lung, pancreatic, liver, prostate, thyroid, and breast. People with such noncancerous conditions as cirrhosis or peptic ulcer, and such inflammatory intestinal conditions as colitis or diverticulitis, also may have increased levels.

Prostate specific antigen (PSA)

PSA is used to screen for **prostate cancer**. A protein produced by the prostate gland, increased PSA levels are associated with prostate cancer. Men over the age of 50 years are advised to be screened annually for prostate cancer with a digital rectal exam and a PSA test. Men at high risk for prostate cancer, such as African-Americans or those with a family history, should begin screening at age 40. Once a diagnosis of prostate cancer is made, PSA levels help determine the stage of the cancer, monitor the response to treatment, and watch for recurrence.

PSA is also increased in benign prostatic hyperplasia (BPH), an **enlarged prostate** condition common in older men. Several calculations of the PSA have been developed to help tell the difference between BPH and prostate cancer: PSA density, PSA velocity, and ratio of free to total.

The PSA density calculates the concentration of PSA in the prostate gland. The volume of prostate gland is determined by a procedure called transrectal ultrasound (TRUS). A person with an enlarged prostate, as seen in BPH, has a lower PSA density than a person with prostate

KEY TERMS

AFP (Alpha-fetoprotein)—A tumor marker associated with liver, testicular, and ovarian cancer.

Beta-HCG (Beta-human chorionic gonadotropin)—A tumor marker associated with testicular cancer and tumors, such as choriocarcinoma and molar pregnancies, that begin in placental cells called trophoblasts.

CA 15-3 (Cancer antigen 15-3)—A tumor marker associated with breast cancer.

CA 19-9 (Cancer antigen 19-9)—A tumor marker associated with pancreatic cancer.

CA 27.29 (Breast carcinoma-associated antigen)—A tumor marker associated with breast cancer.

CA 125 (Cancer antigen 125)—A tumor marker associated with ovarian cancer.

CEA (Carcinoembryonic antigen)—A tumor marker associated with many cancers, especially liver, intestinal, and pancreatic.

PSA (Prostate specific antigen)—A tumor marker associated with prostate cancer.

Sensitivity—A test's ability to detect all cases of a disease.

Serial measurements—A series of measurements looking for an increase or decrease over time.

Specificity—A test's ability to detect only the disease in question.

Tumor markers—Substances, such as proteins, biochemicals, or enzymes, produced by tumor cells or by the body in response to tumor cells. Their levels in the blood help physicians evaluate people for certain kinds of cancer.

cancer. PSA velocity or rate calculates the change in PSA levels over time. A rapid increase in PSA is more likely due to cancer than BPH. The ratio of free PSA to total PSA also helps distinguish BPH from cancer. PSA exists either in a free state or bound to another substance. The percentage of free PSA is greater in BPH than cancer.

PSA levels may increase after ejaculation. Men are recommended to abstain from sexual intercourse or masturbation for 48 hours before the test. PSA levels may also increase after prostate manipulation following the digital rectal exam.

Preparation

Tumor marker tests require 5–10 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

AFP:

- 99% of nonpregnant people have less than 15 ng/mL
- 95% have less than 6 ng/mL

Beta-HCG:

- Males less than 2.5 IU/L
- Female less than 5.0 IU/L
- Postmenopausal female less than 9.0 IU/L

CA 15-3:

- females have less than 40 U/mL

CA 19-9:

- less than 40 U/mL

CA 27.29:

- less than or equal to 5 ng/mL

PSA:

- less than 4 ng/mL (PSA levels increase with age)

Abnormal results

The meaning of an increased tumor marker level depends on the specific marker, the person's medical history, and why the test was done. Knowledge of the person's history, and additional tests and physical examinations are needed to correctly interpret tumor marker test results.

Resources

BOOKS

American Association of Clinical Chemistry. *Tumor Markers: Reclassification, Reimbursement & Recent Advances.* Washington, DC: American Association of Clinical Chemistry (AACC) Press, 1997.

Wu, James T. "Diagnosis and Management of Cancer Using Serologic Tumor Markers." In *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

Wu, James T., and Robert M. Makamura. *Human Circulating Tumor Markers: Current Concepts and Clinical Applications*. Chicago: American Society of Clinical Pathologists Press (ASCP) Press, 1997.

PERIODICALS

Aziz, Douglas C. "Clinical Use of Tumor Markers Based on Outcome Analysis. CE-Update—Tumor Markers I." *Laboratory Medicine* (Nov. 1996): 760-764.

Aziz, Douglas C. "Clinical Use of Tumor Markers Based on Outcome Analysis. CE-Update—Tumor Markers II." *Laboratory Medicine* (Dec. 1996): 817-821.

Coley, Christopher M., et al. "Early Detection of Prostate Cancer. Part I: Prior Probability and Effectiveness of Tests." *Annals of Internal Medicine* (Mar. 1997): 394-406.

Pamies, Rubens J., and Deborah R. Crawford. "Tumor Markers. An Update." *Medical Clinics of North America* (Jan. 1996): 185-199.

Vashi, Apoorva R., and Joseph E. Oesterling. "Percent Free Prostate-Specific Antigen: Entering a New Era in the Detection of Prostate Cancer." *Mayo Clinic Proceedings* (Apr. 1997): 337-344.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.

American Society of Clinical Oncology. 225 Reinekers Lane, Suite 650, Alexandria, VA 22314. (703) 299-0150. <http://www.asco.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892-2580. (800) 422-6237. <http://www.nci.nih.gov>.

OTHER

"Screening for Ovarian Cancer." *National Cancer Institute Page*. 11 June 1998 <http://www.nci.nih.gov>.

"Screening for Prostate Cancer." *National Cancer Institute Page*. 11 June 1998 <http://www.nci.nih.gov>.

Nancy J. Nordenson

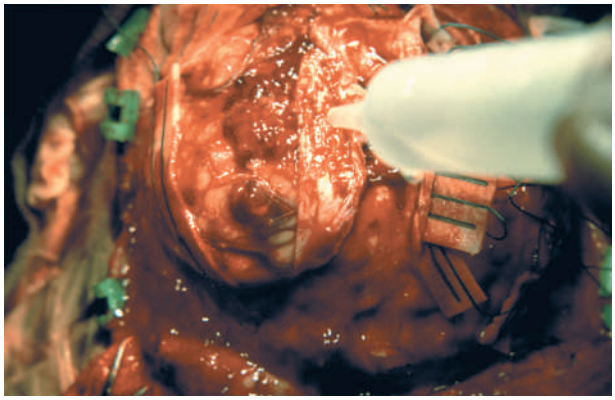
Tumor removal

Definition

Tumor removal is a surgical procedure to remove an abnormal growth.

Purpose

A tumor can be either benign, like a wart, or malignant, in which case it is a **cancer**. Benign tumors are well circumscribed and are generally easy to remove completely. In contrast, cancers pose some of the most difficult problems in all of surgery.



A tumor inside the brain is being removed. *(Photograph by Jennifer Watson-Holton, Custom Medical Stock Photo. Reproduced by permission.)*

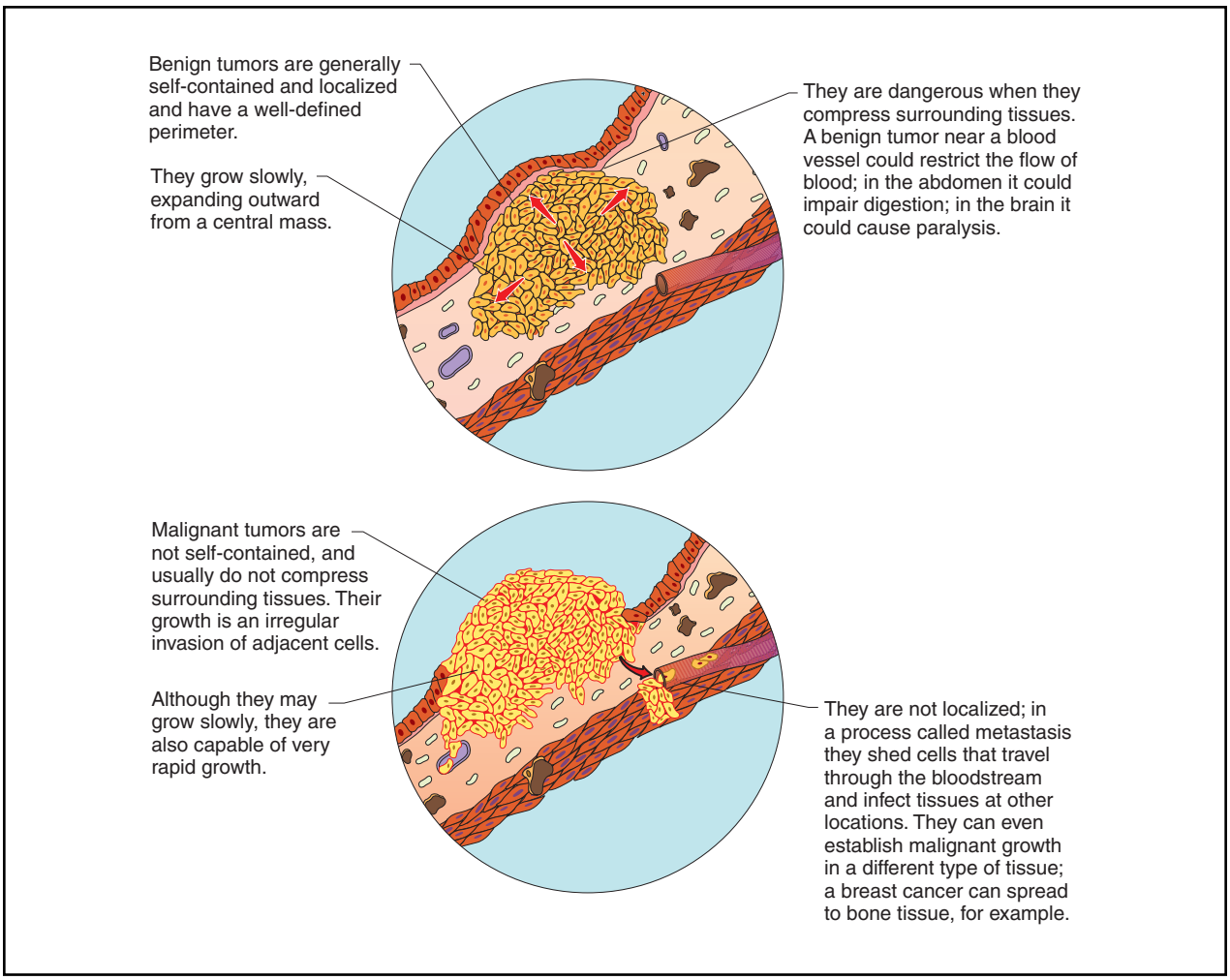
Currently 40% of all cancers are treated with surgery alone. In 55%, surgery is combined with other treatments—usually **radiation therapy** or **chemotherapy**.

The doctor needs to decide if surgery should be done at all. Because cancers spread (metastasize) to normal tissues, sometimes at the other end of the body, the ability of surgery to cure must be addressed at the outset. As long as the cancer is localized, the initial presumption is that cure should be attempted by removing it as soon as possible.

Non-curative surgery may make other treatments more effective. "Debulking" a cancer—making it smaller—is thought to assist radiation and chemotherapy to get to the remaining pieces of the cancer and be more effective.

Another important function surgery performs in cancer treatment is accurately assessing the nature and extent of the cancer. Most cancers cannot be adequately identified without a piece being placed under a microscope. This piece is obtained by surgery. Surgery is also the only way to determine exactly how far the tumor has spread. There are a few standard methods of comparing one cancer to another for the purposes of comparing treatments and estimating outcomes. These methods are called "staging." The most universal method is the TNM system.

- "T" stands for "tumor" and reflects the size of the tumor.
- "N" represents the spread of the cancer to lymph nodes, largely determined by those nodes removed at surgery that contain cancer cells. Since cancers spread mostly through the lymph system, this is a useful measure of their ability to disperse.
- "M" refers to the metastases, how far they are from the original cancer and how often they have multiplied.



A comparison of benign (top of illustration) and malignant tumor characteristics. *(Illustration by Hans & Cassady, Inc.)*

Other methods of staging include Duke's method and similar systems, which add to the above criteria the degree of invasion of the cancer into the surrounding tissues.

Staging is particularly important with such lymphomas as **Hodgkin's disease**. These cancers may appear in many places in the lymphatic system. Because they are very radiosensitive, radiation treatment is often curative if all the cancer is irradiated. Therefore, it must all be located. Surgery is a common, usually essential, method of performing this staging. If the disease is too widespread, the staging procedure will dictate chemotherapy instead of radiation.

Precautions

Curative cancer surgery demands special considerations. There is a danger of spreading or seeding the cancer during the process of removing it. Presuming the cancer cells can grow almost anywhere in the body they end up, the surgeon must not "spill" cells into the operating field or "knock them loose" into the blood stream. Special techniques called "block resection" and "no touch" are used. Block resection means taking the entire specimen out as a single piece. "No touch" means that only the normal tissue removed with specimen is handled; the cancer itself is never touched. This prevents "squeezing" cancer cells out into the circulation. Further, in this technique pains are taken to clamp off the blood supply first, preventing cells from leaving by that route later in the surgery.

Description

Diagnostic biopsies

There are four types of biopsy techniques:

- Aspiration biopsy. A needle is inserted into the tumor and a sample is withdrawn.
- Needle biopsy. A special cutting needle is inserted into the core of the tumor and a core sample is cut out.

- Incisional biopsy. A portion of a large tumor is removed, usually before complete tumor removal.
- Excisional biopsy. A whole lesion is removed along with surrounding normal tissue.

Complete tumor removal

Once surgical removal has been decided, an oncologic surgeon will remove the tumor whole, taking with it a large section of the surrounding normal tissue. The healthy tissue is removed to minimize the risk of possible seeding.

Cytoreduction

When surgical removal of a tumor is unacceptable as a sole treatment, a portion of the tumor is removed to "debulk" the mass. Debulking aids radiation and chemotherapy treatments.

Aftercare

Retesting and periodical examinations are necessary to ensure that a tumor has not reformed after total removal.

Risks

The possibility of mestastasis and seeding are risks that have to be considered in consultation with an oncologist.

Resources

BOOKS

Longo, Dan D. "Approach to the Patient with Cancer." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Morton, Donald M. "Oncology." In *Principles of Surgery*, ed. Seymour I. Schwartz. New York: McGraw Hill Inc., 1989.

J. Ricker Polsdorfer, MD

Turner syndrome

Definition

Turner syndrome is a chromosomal disorder affecting females wherein one of the two X-chromosomes is defective or completely absent.

Description

Chromosomes are structures in the nucleus of every cell in the human body. Chromosomes contain the genetic information necessary to direct the growth and normal functioning of all cells and systems of the body. A normal individual has a total of 46 chromosomes in each cell, two of which are responsible for determining gender. Normally, females have two X-chromosomes and males have one X and one Y-chromosome.

In Turner syndrome, an error occurring very early in development results in an abnormal number and arrangement of chromosomes. Most commonly, an individual with Turner syndrome will be born with 45 chromosomes in each cell rather than 46. The missing chromosome is an X-chromosome. The affected person is always female.

The prevalence of Turner syndrome is widely reported as being approximately one per 2,000 live female births although researchers have reported prevalence rates that range from one in 3,125 to one in 5,000 live female births.

About 1% to 2% of all female conceptions have a missing X-chromosome. Of these, the majority (99%) spontaneously abort, usually during the first trimester of **pregnancy**. With ultrasound being used more frequently, researchers have realized that some pregnancies with a missing X-chromosome that progress into the second trimester are associated with nuchal cysts, severe **lymphedema**, or hydrops fetalis. These pregnancies are associated with a high frequency of fetal **death**.

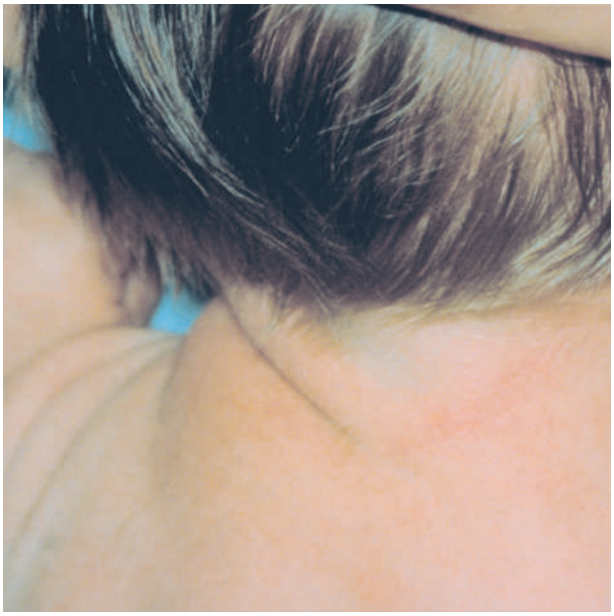
Causes and symptoms

Turner's syndrome is a disorder associated with characteristic defects in the X-chromosome. The most common presentation is a female with a single X-chromosome and an absent X-chromosome. A Greek study from 1999 reported that the intact X-chromosome was as likely to come from the mother as from the father. This means that there is no parental pattern of responsibility for the missing or defective X-chromosome.

Another less common genetic pattern for Turner Syndrome (35%) is a mosaic. A Danish study reported that mosaicism has an effect on malformations that are associated with Turner syndrome. Research reported in 1997 noted that the karyotype can have a significant effect on the growth of children with Turner syndrome.

The exact location of the genes on the X-chromosome involved in Turner syndrome has not been determined as of 2001. At present, evidence exists that there is a locus for stature on the distal portion of the short arm; there are loci for normal ovarian function on both the short and long arms; and there are loci contributing to fetal viability on the long arm of X.

Turner syndrome is characterized by retarded growth that leads to a small stature and frequent **infertility**. Individuals with Turner syndrome report an increased



A low hairline at the back of the neck is one of several characteristics of Turner syndrome. *(Custom Medical Stock Photo. Reproduced by permission.)*

incidence of **fractures** in childhood and osteoporotic fractures in adulthood. The incidence of **diabetes mellitus** (both insulin dependent and non-insulin dependent varieties) has been reported to be increased in Turner syndrome. Ischemic heart disease, **stroke** and **hypertension** are also more common.

Growth in children with Turner syndrome is characterized by a slight **intrauterine growth retardation**, relatively normal growth rates for the first several years of life, a progressive deceleration of growth later in childhood, and the lack of a pubertal growth spurt. Growth patterns of Chinese girls with Turner syndrome parallel those of Caucasians, although their ultimate height is still less than normal.

Contrary to earlier reports, most individuals with Turner syndrome are not mentally retarded. They may have some learning disabilities, particularly with regard to spatial perception, visual-motor coordination, and mathematics. As a result, the nonverbal IQ in Turner syndrome tends to be lower than the verbal IQ.

Cardiovascular malformations are well-recognized congenital anomalies in Turner syndrome. Dilation and dissection of the aorta are reported in approximately half of women with Turner syndrome. Because of the potential consequences of aortic dilation, some experts recommend screening all individuals with Turner syndrome. However, the specific timing for this screening remains controversial in 2001.

Juvenile arthritis, an autoimmune condition, has been recently (1998) associated with Turner syndrome. The prevalence seems to be at least six times greater than would be expected if the two conditions were only randomly associated. Women with Turner syndrome have an elevated prevalence rate of dental caries and such other periodontal conditions as gum disease and plaque.

Normal pubertal development and spontaneous menstrual periods do not occur in the majority of children with Turner' syndrome. It is estimated that 3–8% of girls with a single X-chromosome and 12–21% of females with sex chromosome mosaicism may have normal pubertal development and spontaneous menstrual periods. A few pregnancies have been reported in women with Turner syndrome.

Diagnosis

Turner syndrome is diagnosed on the basis of genetic analysis of chromosomes. This can be done prior to birth. However, the predictive value of **amniocentesis** in diagnosing Turner syndrome varies from 21–67%. There is no significant relation between the mother's age and risk of Turner's syndrome.

Treatment

Because it is so dangerous, experts suggest screening for **aortic dissection**, although the specific timing for this screening is controversial. Plastic surgery to correct webbing of the neck should be considered at an early age (before entering school) for girls with Turner syndrome.

Most individuals with Turner syndrome require female hormone therapy to promote development of secondary sexual characteristics and menstruation. The time of beginning therapy varies with individuals. Experts recommend that therapy begin when a woman expresses concern about her onset of **puberty**.

All women receiving long-term, exogenous female hormone therapy require periodic gynecological examinations, because those with Turner syndrome have an increased risk of developing neoplasms such as gonadoblastoma and dysgerminoma, which arise from their rudimentary streak gonads.

Prognosis

Most women with Turner syndrome can live relatively normal lives. The prognosis for a person with Turner syndrome is dependent on other conditions that may be present. Care must be taken to regularly monitor them for the health problems that are associated with Turner syndrome. For example, heart or kidney defects,

hearing loss, or the development of inflammatory bowel disease may significantly impact the quality of life. Without these types of conditions, however, their life expectancy is normal. Support will be necessary to help an adolescent girl cope with body image issues and to help some women accept the fact that they will never be able to have children.

Resources

BOOKS

Hall, Judith G. "Chromosomal Clinical Abnormalities." In *Nelson Textbook of Pediatrics,* edited by Richard E Behrman, et al. 16th ed. Philadelphia: W.B. Saunders, 2000, pp. 325-334.

Jones, K.L. "XO Syndrome." In *Smith's Recognizable Patterns of Human Malformation,* edited by Kenneth L. Jones and Judy Fletcher. 5th ed. Philadelphia: W.B. Saunders, 1997, pp 81-87.

Plumridge, D. *Good Things Come in Small Packages: The Whys and Hows of Turner Syndrome*. Portland, OR: University of Oregon Health Sciences Center, 1987.

Reiser, P.A., and L.E. Underwood. *Turner Syndrome: A Guide for Families*. Wayzata, MN: Turner Syndrome Society; 1992.

PERIODICALS

Gravholt, C.H., et al. "Morbidity in Turner Syndrome." *Journal of Clinical Epidemiology* 51, no. 2 (February 1998): 147-158.

Gravholt, C.H., et al. "Prenatal and Postnatal Prevalence of Turner's Syndrome: A Registry Study." *British Medical Journal* 312, no. 7022 (January 6, 1996): 16-21.

Zinn, A.R., D.C. Page, and E.M. Fisher. "Turner Syndrome: The Case of the Missing Sex Chromosome." *Trends in Genetics* 9 (1993): 90-93.

ORGANIZATIONS

American Academy of Pediatrics. 141 Northwest Point Blvd., Elk Grove Village, IL 60007-1098. (847) 434-4000. Fax: (847) 434-8000. <http://www.aap.org/visit/contact.htm>.

Endocrine Society. 4350 East West Highway, Suite 500, Bethesda, MD 20814-4410. (301) 941-0200. Fax: (301) 941-0259. endostaff@endo-society.org.

Human Growth Foundation. 997 Glen Cove Ave., Glen Head, NY 11545. (800) 451-6434. Fax: (516) 671-4055. <http://www. hgf1@hgfound.org>.

MAGIC Foundation for Children's Growth. 1327 N. Harlem Ave., Oak Park, IL 60302. (708) 383-0808 or (800) 362-4423. Fax: (708) 383-0899. <mary@magicfoundation.org>. <http://www.magicfoundation.org/ghd.html>.

Turner Syndrome Society of Canada. 7777 Keele St, Floor 2, Concord, ONT L4K 1Y7. Canada (800) 465-6744 or (416) 660-7766. Fax: (416) 660-7450.

Turner Syndrome Society of England. 2 Mayfield Ave., London, W41PW. UK 44 (0)181-994 7625. Fax: 44 (0)181-995 9075. <http://www.exnet.com/staff/sys4/ts.html> or <http://www.tss.org.uk>.

KEY TERMS

Chromosome—A microscopic thread-like structure found within each cell of the body that consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Mosaic—A term referring to a genetic situation in which an individual's cells do not have the exact same composition of chromosomes. In Down syndrome, this may mean that some of the individual's cells have a normal 46 chromosomes, while other cells have an abnormal 47 chromosomes.

Ovary—The female reproductive organ that produces the reproductive cell (ovum) and female hormones.

Zygote—The cell formed by the uniting of egg and sperm.

Turner Syndrome Society of the United States. 14450 T. C. Jester, Suite 260, Houston, TX 77014. (800) 365-9944 or (832) 249-9988. Fax: (832) 249-9987. <tesch@turner-syndrome-us.org>. <http://www.turner-syndrome-us.or>.

OTHER

American Academy of Pediatrics. <http://www.aap.org/visit/contact.htm>.

On-ramp Access. <http://www.onr.com/ts-texas/turner.html>.

Turner Syndrome Support Society(UK). <http://www.tss.org.uk/>.

University of Kansas Medical Center. <http://www.kumc.edu/gec/support/turner.html>.

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Twins *see* **Multiple pregnancy**

2,3-diphosphoglycerate test

Definition

2,3-diphosphoglycerate (2,3-DPG) is a substance made in the red blood cells. It controls the movement of oxygen from red blood cells to body tissues. 2,3-DPG testing is done to help investigate both a deficiency in red blood cells (anemia) and an unexplained increase of red blood cells, called erythrocytosis.

Purpose

Hemoglobin, the protein in the blood that carries oxygen, uses 2,3-DPG to control how much oxygen is released once the blood gets out into the tissues. The more 2,3-DPG in the cell, the more oxygen is delivered to body tissues. Conversely, the less 2,3-DPG in the cell, the less oxygen is delivered.

Increasing the amount of 2,3-DPG is the body's primary way of responding to a lack of oxygen. Anemia, obstructive lung disease, **cystic fibrosis**, and **congenital heart disease** are all accompanied by increases in 2,3-DPG. When more oxygen is required because of increased metabolism, such as in **hyperthyroidism**, more 2,3-DPG is produced.

Decreased 2,3-DPG results from an inherited lack of the red blood cell enzymes 2,3-DPG mutase and 2,3-DPG phosphatase. These enzymes are needed to make 2,3-DPG. Without 2,3-DPG to control the movement of oxygen to its tissues, the body responds by making more red blood cells, a condition called erythrocytosis. The outside membrane of the cell is weakened, causing it to have an irregular shape and burst, or hemolyze, easily. This condition is called nonspherocytic **hemolytic anemia**.

2,3-DPG levels are important in large blood transfusions, because stored blood quickly loses 2,3-DPG and its ability to deliver oxygen. After **transfusion**, the red cells rebuild the 2,3-DPG, but it takes about 24 hours to regain a normal level of 2,3-DPG and hemoglobin function.

Description

In the laboratory, a person's serum is mixed with a substance that will react with 2,3-DPG. The end product of this reaction is measured; and from that measurement, the amount of 2,3-DPG in the person's serum is determined. Results are usually available the next day.

Preparation

This test requires drawing 5-10 mL of blood. The patient should not **exercise** before having the blood drawn. Exercise increases the body's need for oxygen and could cause a temporary increase in levels of 2,3-DPG.

Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Normal results will vary based on the laboratory and testing methods used.

KEY TERMS

Anemia—A reduction in the number of erythrocytes or red blood cells. Erythrocytes are necessary to form hemoglobin for transporting oxygen.

Erythrocytosis—Increased production of red blood cells.

Hemoglobin—A protein within the red blood cell that carries oxygen.

Nonspherocytic hemolytic anemia—Anemia caused by variably shaped red blood cells that burst, or hemolyze, easily.

Abnormal results

Decreased levels of 2,3-DPG are found in cases of erythrocytosis and nonspherocytic hemolytic anemia caused by 2,3-DPG mutase and 2,3-DPG phosphatase deficiencies. Lower levels are also commonly found after large blood transfusions.

Increased levels of 2,3-DPG are found in conditions in which the body needs more oxygen, such as anemia, obstructive lung disease, cystic fibrosis, congenital heart disease, and hyperthyroidism. High altitudes and participating in exercise sessions before the test can also give false high values.

Resources

BOOKS

Clinical Diagnosis and Management by Laboratory Methods. 19th ed. Ed. John B. Henry. Philadelphia: W. B. Saunders Co., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Widmann's Clinical Interpretation of Laboratory Tests. 10th ed. Ed. Ronald A. Sacher, et al. Philadelphia: F. A. Davis Co., 1991.

PERIODICALS

Hsia, Connie C. W. "Respiratory Function of Hemoglobin." *New England Journal of Medicine* 338 (Jan. 1998): 239-247.

Nancy J. Nordenson

2,3-DPG *see* **2,3-diphosphoglycerate test**

Tylenol *see* **Acetaminophen**

Tympanic membrane perforation *see* **Perforated eardrum**

Tympanometry *see* **Audiometry**

Typhoid fever

Definition

Typhoid **fever** is a severe infection caused by a bacterium, *Salmonella typhi*. *S. typhi* is in the same family of bacteria as the type spread by chicken and eggs, commonly known as "salmonella poisoning," or **food poisoning**. *S. typhi* bacteria do not have vomiting and **diarrhea** as the most prominent symptoms of their presence in humans. Instead, persistently high fever is the hallmark of *S. typhi* infection.

Description

S. typhi bacteria are passed into the stool and urine of infected patients. They may continue to be present in the stool of asymptomatic carriers, who are persons who have recovered from the symptoms of the disease but continue to carry the bacteria. This carrier state occurs in about 3% of all individuals recovered from typhoid fever.

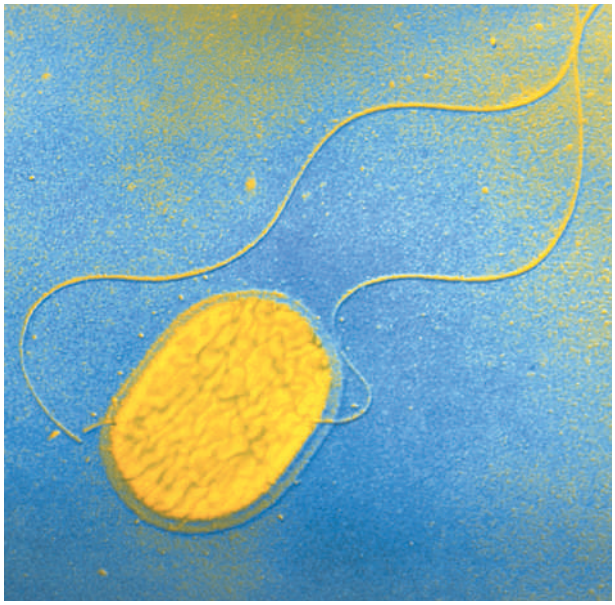
Typhoid fever is passed from person to person through poor hygiene, such as incomplete or no hand washing after using the toilet. Persons who are carriers of the disease and who handle food can be the source of epidemic spread of typhoid. One such individual gave her name to the expression "Typhoid Mary," a name given to someone whom others avoid.

Typhoid fever is a particularly difficult problem in parts of the world with poor sanitation practices. In the United States, most patients who contract typhoid fever have recently returned from travel to another country where typhoid is much more common, including Mexico, Peru, Chile, India, and Pakistan.

Causes and symptoms

S. typhi must be ingested to cause disease. Transmission often occurs when a person in the carrier state does not wash hands thoroughly (or not at all) after defecation and serves food to others. This pathway is sometimes called the fecal-oral route of disease transmission. In countries where open sewage is accessible to flies, the insects land on the sewage, pick up the bacteria, and then contaminate food to be eaten by humans.

After being swallowed, the *S. typhi* bacteria head down the digestive tract, where they are taken in by cells called mononuclear phagocytes. These phagocytes are cells of the immune system, whose job it is to engulf and kill invading bacteria and viruses. In the case of *S. typhi*, however, the bacteria are able to survive ingestion by the phagocytes, and multiply within these cells. This period of time, during which the bacteria are multiplying within the phagocytes, is the 10- to 14-day incubation period of typhoid fever. When huge numbers of bacteria fill an individual phagocyte, they spill out of the cell and into the bloodstream, where their presence begins to cause symptoms.



Transmission electron microscopy (TEM) scan of *Salmonella typhi,* the bacteria which causes typhoid fever in humans. *(Custom Medical Stock Photo. Reproduced by permission.)*

The presence of increasingly large numbers of bacteria in the bloodstream (**bacteremia**) is responsible for an increasingly high fever, which lasts throughout the four to eight weeks of the disease in untreated individuals. Other symptoms of typhoid fever include **constipation** (at first), extreme **fatigue**, **headache**, joint **pain**, and a rash across the abdomen known as rose spots.

The bacteria move from the bloodstream into certain tissues of the body, including the gallbladder and lymph tissue of the intestine (called Peyer's patches). The tissue's response to this invasion causes symptoms ranging from inflammation of the gallbladder (**cholecystitis**) to intestinal bleeding to actual perforation of the intestine. Perforation of the intestine refers to an actual hole occurring in the wall of the intestine, with leakage of intestinal contents into the abdominal cavity. This leakage causes severe irritation and inflammation of the lining of the abdominal cavity, which is called **peritonitis**. Peritonitis is a frequent cause of **death** from typhoid fever.

Other complications of typhoid fever include liver and spleen enlargement, sometimes so great that the spleen ruptures or bursts; anemia, or low red blood cell count due to blood loss from the intestinal bleeding; joint infections, which are especially common in

patients with sickle cell anemia and immune system disorders; **pneumonia** caused by a bacterial infection—usually *Streptococcus pneumoniae*— which is able to take hold due to the patient's weakened state; heart infections; and **meningitis** and infections of the brain, which cause mental confusion and even **coma**. It may take a patient several months to recover fully from untreated typhoid fever.

Diagnosis

In some cases, the doctor may suspect the diagnosis if the patient has already developed the characteristic rose spots, or if he or she has a history of recent travel in areas with poor sanitation. The diagnosis, however, is confirmed by a **blood culture**. Samples of a patient's stool, urine, and bone marrow can also be used to grow *S. typhi* in a laboratory for identification under a microscope. Cultures are the most accurate method of diagnosis. Blood cultures usually become positive in the first week of illness in 80% of patients who have not taken **antibiotics**.

Treatment

Antibiotics are the treatment of choice for typhoid fever. Chloramphenicol (Chloromycetin) is the most effective medication for *S. typhi* . The patient's symptoms begin to improve slightly after only 24-48 hours of receiving the medication. Another drug, ceftriaxone (Rocephin), has been used as well, and is also extremely effective. It lowers fever fairly quickly.

Carriers of *S. typhi* must be treated even when they do not show any symptoms of the infection, because carriers are responsible for the majority of new cases of typhoid fever. Eliminating the carrier state is actually a fairly difficult task. It requires treatment with one or even two different medications over a period of four to six weeks. In the case of a carrier with **gallstones**, surgery may need to be performed to remove the gallbladder. This measure is necessary because typhoid bacteria are often housed in the gallbladder, where they may survive in spite of antibiotic treatment.

Prognosis

The prognosis for recovery is good for most patients. In the era before effective antibiotics were discovered, about 12% of all typhoid fever patients died of the infection. Now, however, fewer than 1% of patients who receive prompt antibiotic treatment will die. The mortality rate is highest in the very young and very old, and in patients suffering from **malnutrition**. The most ominous signs are changes in a patient's state of consciousness, including stupor or coma.

KEY TERMS

Asymptomatic—A state in which a person experiences no symptoms of a disease.

Bacteremia—Bacteria in the blood.

Carrier—A person who has a particular disease agent present within his/her body, and can pass this agent on to others, but who displays no symptoms of infection.

Epidemic—A large number of cases of the same disease or infection all occurring within a short time period in a specific location.

Mononuclear phagocyte—A type of cell of the human immune system that ingests bacteria, viruses, and other foreign matter, thus removing potentially harmful substances from the bloodstream. These substances are usually then digested within the phagocyte.

Rose spots—A pinkish rash across the trunk or abdomen that is a classic sign of typhoid fever.

Prevention

Hygienic sewage disposal systems in a community as well as proper personal hygiene are the most important factors in preventing typhoid fever. Immunizations are available for travelers who expect to visit countries where *S. typhi* is a known public health problem. Some of these immunizations provide only short-term protection (for a few months), while others may be effective for several years. Efforts are being made to develop immunizations that provide a longer period of protection with fewer side effects from the vaccine itself.

Resources

BOOKS

"Salmonellosis." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Zenilman, J. M. "Typhoid Fever." *Journal of the American Medical Association* (10 Sept. 1997): 847+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

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Typhus

Definition

Several different illnesses called "typhus" exist, all of them caused by one of the bacteria in the family Rickettsiae. Each illness occurs when the bacteria is passed to a human through contact with an infected insect.

Description

The four main types of typhus are:

- epidemic typhus
- Brill-Zinsser disease
- endemic or murine typhus
- **scrub typhus**

These diseases are all somewhat similar, although they vary in terms of severity. The specific type of *Rickettsia* that causes the disease also varies, as does the specific insect that can pass the bacteria along.

Epidemic typhus is caused by *Rickettsia prowazekii*, which is carried by body lice. When the lice feed on a human, they may simultaneously defecate. When the person scratches the bite, the feces (which carry the bacteria) are scratched into the wound. Body lice are common in areas in which people live in overcrowded, dirty conditions, with few opportunities to wash themselves or their clothing. Because of this fact, this form of typhus occurs simultaneously in large numbers of individuals living within the same community; that is, in epidemics. This type of typhus occurs when cold weather, poverty, war, and other disasters result in close living conditions that encourage the maintenance of a population of lice living among humans. Epidemic typhus is now found in the mountainous regions of Africa, South America, and Asia.

Brill-Zinsser disease is a reactivation of an earlier infection with epidemic typhus. It affects people years after they have completely recovered from epidemic typhus. When something causes a weakening of their immune system (like **aging**, surgery, illness), the bacteria can gain hold again, causing illness. This illness tends to be extremely mild.

Endemic typhus is carried by fleas. When a flea lands on a human, it may defecate as it feeds. When the person scratches the itchy spot where the flea was feeding, the bacteria-laden feces are scratched into the skin, thus causing infection. The causative bacteria is called *Rickettsia typhi*. Endemic typhus occurs most commonly in warm, coastal regions. In the United States, southern Texas and southern California have the largest number of cases.

Scrub typhus is caused by *Rickettsia tsutsugamushi*. This bacteria is carried by mites or chiggers. As the mites feed on humans, they deposit the bacteria. Scrub typhus occurs commonly in the southwest Pacific, southeast Asia, and Japan. It is a very common cause of illness in people living in or visiting these areas. It occurs more commonly during the wet season.

Causes and symptoms

The four types of typhus cause similar types of illnesses, though varying in severity.

Epidemic typhus causes **fever**, **headache**, weakness, and muscle aches. It also causes a rash composed of both spots and bumps. The rash starts on the back, chest, and abdomen, then spreads to the arms and legs. The worst types of complications involve swelling in the heart muscle or brain (**encephalitis**). Without treatment, this type of typhus can be fatal.

Brill-Zinsser disease is quite mild, resulting in about a week-long fever, and a light rash similar to that of the original illness.

Endemic typhus causes about 12 days of high fever, with chills and headache. A light rash may occur.

Scrub typhus causes a wide variety of effects. The main symptoms include fever, headache, muscle aches and pains, **cough**, abdominal **pain**, **nausea and vomiting**, and **diarrhea**. Some patients experience only these symptoms. Some patients develop a rash, which can be flat or bumpy. The individual spots eventually develop crusty black scabs. Other patients go on to develop a more serious disease, in which encephalitis, **pneumonia**, and swelling of the liver and spleen (hepatosplenomegaly) occur.

Diagnosis

A number of tests exist that can determine the reactions of a patient's antibodies (immune cells in the blood) to the presence of certain viral and bacterial markers. When the antibodies react in a particular way, it suggests the presence of a rickettsial infection. Many tests require a fair amount of time for processing, so practitioners will frequently begin treatment without completing tests, simply on the basis of a patient's symptoms.

Treatment

The **antibiotics** tetracycline or chloramphenicol are used for treatment of each of the forms of typhus.

Prognosis

The prognosis depends on what types of complications an individual patient experiences. While children usually recover well from epidemic typhus, older adults

KEY TERMS

Antibody—Specialized cells of the immune system, which can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Endemic—Occurring naturally and consistently in a particular area.

Epidemic—A large cluster of cases all occurring at about the same time within a specific community or region.

may have as much as a 60% **death** rate without treatment. Brill-Zinsser, on the other hand, carries no threat of death. People usually recover uneventfully from endemic typhus, although the elderly, those with other medical problems, or people mistakenly treated with sulfa drugs may have a 1% death rate from the illness. Scrub typhus responds well to appropriate treatment, but untreated patients have a death rate of about 7%.

Prevention

Prevention for each of these forms of typhus includes avoidance of the insects that carry the causative bacteria. Other preventive measures include good hygiene and the use of insect repellents.

Resources

BOOKS

Walker, David, et al. "Rickettsial Diseases." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Tzanck preparation

Definition

Tzanck preparation is a rapid test done to diagnose infections caused by herpesviruses. Cells are examined under a microscope for signs of infection.

Purpose

Herpesviruses are responsible for several superficial infections. Varicella zoster virus causes **chickenpox** and **shingles**, herpes simplex type 1 causes the **common cold** sore or **fever** blister, and herpes simplex type 2 causes the sexually transmitted disease **genital herpes**. They are all characterized by blisters and ulcers.

Physicians usually can diagnose herpes infections simply by looking at the type of blisters and ulcers, and their distribution on the person's body. Sometimes laboratory evidence of herpes is needed to confirm the diagnosis. For example, herpes can be devastating to a newborn baby or a person with a weakened immune system. Treatment can begin once herpes is confirmed in a laboring mother's genital ulcers or in the skin blisters of an immunocompromised person. A lab tries to grow (culture) the virus that may be present in the blister. This lab test takes several days to complete, but the Tzanck preparation takes minutes.

Description

The Tzanck preparation is done by smearing cells taken from a fresh blister or ulcer onto a microscope slide. The cells are stained with a special stain, such as Wright's stain, and then examined under a microscope for characteristic changes caused by a herpesvirus. Herpes causes giant cells with multiple nuclei. The shape of each nucleus appears molded to fit together with those adjacent. The background of the cell looks like ground glass and contains small dark spots called inclusion bodies.

Tzanck preparation is also called a Tzanck smear, herpes stain for inclusion bodies, or inclusion bodies stain. Results are available the same or following day, often within minutes.

Preparation

A fresh blister is opened with a scalpel or sterile needle. The physician scrapes the base of the blister with the scalpel, gathers as much cellular material as possible, and gently spreads it on a microscope slide.

Normal results

A normal smear shows no evidence of a herpes infection. This test may also have false negatives. Studies have shown that the Tzanck preparation shows signs of infection in only 50–79% of people with a herpes infection. A negative Tzanck preparation may have to be confirmed by a herpes culture.

Abnormal results

A smear that shows evidence of herpes infection does not distinguish between the various infections

caused by herpes virus. The physician uses the person's symptoms and other clinical findings to distinguish between these infections. In certain cases, the physician will follow a positive Tzanck smear with a culture for confirmation.

Resources

BOOKS

Henry, John B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. 19th ed. Philadelphia: W. B. Saunders Co., 1996.

Isada, Carlos M., et al. *Infectious Diseases Handbook*. Hudson: Lexi-Comp Inc., 1995.

Nancy J. Nordenson

Tzanck smear *see* **Tzanck preparation**

U

Ulcer surgery

Definition

Ulcer surgery is a procedure used to cure peptic ulcer disease when medications have failed.

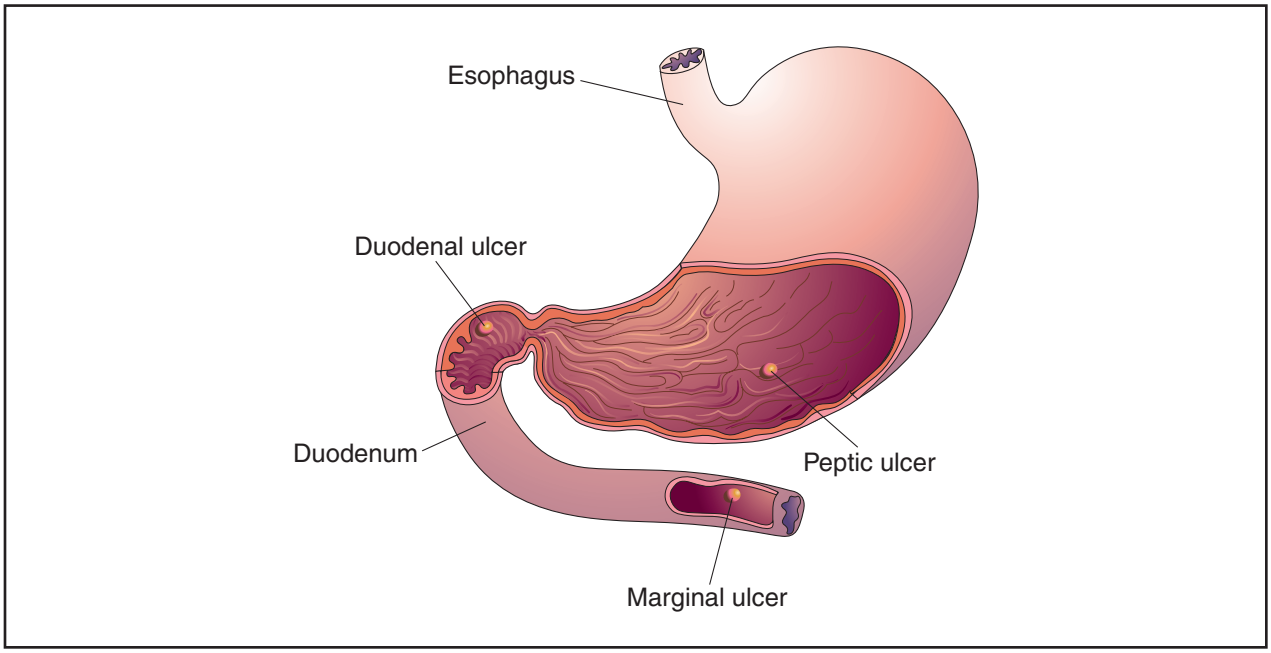
Purpose

Ulcer surgery is used to relieve a present peptic ulcer disease and to prevent recurrence of it.

Surgery is usually required if the ulcer is in one of the following states:

- perforated and overflowed into the abdomen
- scarred or swelled so much that the bowel is obstructed
- acute bleeding
- defied all other types of treatment

The need for ulcer surgery has diminished greatly over the past 20–30 years due to the discovery of two new classes of drugs and the presence of the causal germ *Helicobacter pylori* in the stomach. The drugs are the H2 blockers such as cimetidine and ranitidine and the proton pump inhibitors such as omeprazole. These effectively arrest acid production. *H. pylori* can be eliminated from most patients with a combination of **antibiotics** and bismuth.



Common sites of ulcers in the human stomach. The need for ulcer surgery has diminished over the past 20-30 years due to the discovery that *Helicobacter pylori*, an infectious bacterium, plays a major role in causing ulcers. *H. pylori* can be eliminated from most patients with a combination of antibiotics and bismuth. *(Illustration by Electronic Illustrators Group.)*

Precautions

There is a tumor of the pancreas that produces a hormone called gastrin. Gastrin causes ulcers by stimulating acid production. If this disease—Zollinger-Ellison syndrome—does not respond to medical treatment, either the tumor or the entire stomach must be removed.

Description

The two primary goals of ulcer surgery, elimination of the current problem and prevention of future problems bring with them a third problem—to perpetuate the normal function of the bowel. The vagus nerves relax the pylorus, allowing the stomach to empty. Cutting the vagus nerves, while reducing the stomach's acid production, also prevents stomach emptying. Therefore, the procedures described must guarantee stomach emptying along with their other goals.

Total gastrectomy

Removing the entire stomach is done only for resistant Zollinger-Ellison syndrome or extensive cancers.

Antrectomy

The lower half of the stomach makes most of the acid and gets all the peptic ulcers above the duodenum. Removing it leaves little place for ulcers to form and little acid to produce them.

Vagotomy

Cutting the vagus nerves can be done in three ways:

- The main nerves can be cut completely as they enter the abdomen from the chest.
- The branches that go to the stomach can be cut as they leave the main nerves.
- The tiny branches that stimulate acid production can be cut on the surface of the stomach.

Pyloroplasty

Opening up the valve at the outlet of the stomach guarantees that the stomach can empty, even without vagus nerve stimulation. **Pyloroplasty** is ordinarily done by cutting across the muscle that surrounds the outlet. It can also be done by passing a balloon down from the mouth and inflating it forcefully to stretch out the pylorus (opening from the stomach to the intestine).

Close perforation

For some patients all that can be done is to close the hole in the bowel and wait for the patient to recover before initiating corrective surgery.

Billroth I and II

After removing a piece of the stomach, the remainder must be reattached to the rest of the bowel. Simply joining the upper stomach back to the duodenum is called a Billroth I or gastroduodenostomy. It is sometimes better to attach the stomach with another piece of bowel (the jejunum), creating a "y" with the bile drainage and the duodenum forming the second branch of the "y." This part of the procedure is called a gastrojejunostomy. A gastroenterostomy is a more general term for connecting the stomach with any piece of bowel.

A selective **vagotomy** can be done alone. A complete vagotomy requires either a pyloroplasty or antrectomy. An antrectomy must be reconnected with either a Billroth I or a Billroth II.

Some of these procedures are now being done through a laparoscope.

Risks

All of these procedures carry risks, generally in proportion to their benefits. The more extensive surgeries such as vagotomy and antrectomy with Billroth II reconnection have the highest success rate and the highest complication rate.

Complications include:

- Diarrhea after a meal
- Dumping syndrome occurring after a meal and characterized by sweating, abdominal **pain**, vomiting, lightheadedness, and diarrhea
- Hypoglycemia after a meal
- Alkaline reflux **gastritis** marked by abdominal pain, vomiting of bile, diminished appetite, and iron-deficiency anemia
- Recurrence of an ulcer
- Malabsorption of necessary nutrients, especially iron, in patients who have had all or part of their stomachs removed.

Resources

BOOKS

Debas, Haile T., and Susan L. Orloff. "Surgical Therapy." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Friedman, Lawrence S., and Walter L. Peterson. "Peptic Ulcer and Related Disorders." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Moody, Frank G., et al. "Stomach." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1998.

KEY TERMS

Gastrin—A type of hormone that produces gastric juice.

Hypoglycemia—An abnormal decrease in blood sugar level.

Jejunum—Section of the small intestine.

Laparoscope—A pencil-thin telescope that allows surgery to be done through half-inch incisions.

Pylorus—The opening from the stomach to the intestine.

Vagus nerve—Cranial nerves that supply the internal organs (viscera).

Zollinger-Ellison syndrome—A syndrome marked by peptic ulcers and gastrinomas in the pancreas.

"Stomach and Duodenum." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

J. Ricker Polsdorfer, MD

Ulcerative colitis

Definition

Ulcerative colitis is a form of inflammatory bowel disease (IBD). It causes swelling, ulcerations, and loss of function of the large intestine.

Description

The primary problem in IBD is inflammation, as the name suggests. Inflammation is a process that often occurs in order to fight off foreign invaders in the body, including viruses, bacteria, and fungi. In response to such organisms, the body's immune system begins to produce a variety of cells and chemicals intended to stop the invasion. These immune cells and chemicals, however, also have direct effects on the body's tissues, resulting in heat, redness, swelling, and loss of function. No one knows what starts the cycle of inflammation in IBD, but the result is a swollen, boggy intestine.

In ulcerative colitis, the inflammation affects the lining of the rectum and large intestine. It is thought that the inflammation begins in the last segment of large intestine, which empties into the rectum (sigmoid colon). This inflammation may spread through the entire large intestine, but only rarely affects the very last section of the small intestine (ileum). The rest of the small intestine remains normal.

Ulcerative colitis differs from **Crohn's disease**, which is a form of IBD that affects both the small and large intestines. The inflammation of ulcerative colitis occurs only in the lining of the intestine (unlike Crohn's disease which affects all of the layers of the intestinal wall). As the inflammation continues, the tissue of the intestine begins to slough off, leaving pits (ulcerations) which often become infected.

Like Crohn's disease, ulcerative colitis occurs in all age groups, with the most common age of diagnosis being 15–35 years of age. Men and women are affected equally. Whites are more frequently affected than other racial groups, and people of Jewish origin have 3–6 times greater likelihood of suffering from any IBD. IBD is familial; an IBD patient has a 20% chance of having other relatives who are fellow sufferers.

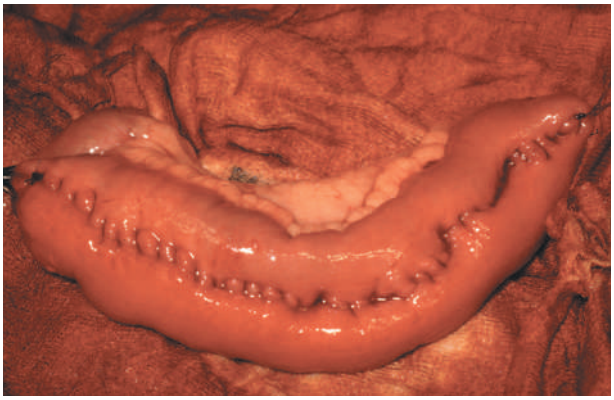
Causes and symptoms

No specific cause of ulcerative colitis has been identified. Although no organism (virus, bacteria, or fungi) has been found to set off the cycle of inflammation that occurs in ulcerative colitis, some researchers continue to suspect that some such organism is responsible for initiating the cycle. Other researchers are concentrating on identifying some change in the cells of the colon that would make the body's immune system accidentally begin treating those cells as foreign invaders. Other evidence for such a disorder of the immune system includes the high number of other immune disorders that tend to accompany ulcerative colitis.

The first symptoms of ulcerative colitis are abdominal cramping and **pain**, a sensation of urgent need to have a bowel movement (defecate), and blood and pus in the stools. Some patients experience **diarrhea**, **fever**, and weight loss. If the diarrhea continues, signs of severe fluid loss (**dehydration**) begin to appear, including low blood pressure, fast heart rate, and **dizziness**.

Severe complications of ulcerative colitis include perforation of the intestine (in which the wall of the intestine develops a hole), toxic dilation of the colon (in which the colon become quite large in diameter), and the development of **colon cancer**.

Intestinal perforation occurs when long-standing inflammation and ulceration of the intestine weakens the wall to such a degree that a hole occurs. This is a life-threatening complication, because the contents of the intestine (which under normal conditions contains a large



A specimen of a colon indicating ulcerative colitis. *(Photo Researchers, Inc. Reproduced by permission.)*

number of bacteria) spill into the abdomen. The presence of bacteria in the abdomen can result in a massive infection called **peritonitis**.

Toxic dilation of the colon is thought to occur because the intestinal inflammation interferes with the normal function of the muscles of the intestine. This allows the intestine to become lax, and its diameter begins to increase. The enlarged diameter thins the walls further, increasing the risk of perforation and peritonitis. When the diameter of the intestine is quite large, and infection is present, the condition is referred to as "toxic megacolon."

Patients with ulcerative colitis have a significant risk of developing colon **cancer**. This risk seems to begin around 10 years after diagnosis of ulcerative colitis. The risk becomes statistically greater every year:

- At 10 years, the risk of cancer is about 0.5–1%.
- At 15 years, the risk of cancer is about 12%.
- At 20 years, the risk of cancer is about 23%.
- At 24 years, the risk of cancer is about 42%.

The overall risk of developing cancer seems to be greatest for those patients with the largest extent of intestine involved in ulcerative colitis.

Patients with ulcerative colitis also have a high chance of experiencing other disorders, including inflammation of the joints (arthritis), inflammation of the vertebrae (spondylitis), ulcers in the mouth and on the skin, the development of painful, red bumps on the skin, inflammation of several areas of the eye, and various disorders of the liver and gallbladder.

Diagnosis

Diagnosis is first suspected based on the symptoms that a patient is experiencing. Examination of the stool will usually reveal the presence of blood and pus (white blood cells). Blood tests may show an increase in the number of white blood cells, which is an indication of inflammation occurring somewhere in the body. The blood test may also reveal anemia, particularly when a great deal of blood has been lost in the stool.

The most important method of diagnosis is endoscopy, during which a doctor passes a flexible tube with a tiny, fiberoptic camera device through the rectum and into the colon. The doctor can then examine the lining of the intestine for signs of inflammation and ulceration that might indicate ulcerative colitis. A tiny sample (biopsy) of the intestine will be removed through the endoscope, which will be examined under a microscope for evidence of ulcerative colitis. Because of the increased risk of cancer in patients with ulcerative colitis, endoscopic exam will need to be repeated frequently. Biopsies should be taken regularly, to closely monitor the intestine for the development of cancer or precancerous changes.

X-ray examination is helpful to determine the amount of intestine affected by the disease. However, x-ray examinations requiring the use of barium should be delayed until treatment has begun. Barium is a chalky solution that the patient drinks or is administered through the rectum and into the intestine (enema). The presence of barium in the intestine allows more detail to be seen on x-ray pictures. However, because of the risk of intestinal perforation in ulcerative colitis, most doctors begin treatment before stressing the wall of the intestine with the barium solution.

Treatment

Treatment for ulcerative colitis addresses the underlying inflammation, as well as the problems occurring due to continued diarrhea and blood loss.

Inflammation is treated with a drug called sulfasalazine, Sulfasalazine is made up of two parts. One part is related to the sulfa **antibiotics**; the other part is a form of the anti-inflammatory chemical salicylic acid (related to **aspirin**). Sulfasalazine is not well-absorbed from the intestine, so it stays mostly within the intestine, where it is broken down into its components. It is believed to be primarily the salicylic acid component that is active in treating ulcerative colitis, by fighting inflammation. For patients who do not respond to sulfasalazine, steroid medications (such as prednisone) are the next choice.

Depending on the degree of blood loss, a patient with ulcerative colitis may require blood transfusions and fluid replacement through a needle in the vein (intravenous or IV). Medications that can slow diarrhea must be used with great care, because they may actually cause the development of toxic megacolon.

A patient with toxic megacolon requires close monitoring and care in the hospital. He or she will usually be given steroid medications through an IV, and may be put on antibiotics. If these measures do not improve the situation, the patient will have to undergo surgery to remove the colon. This is done because the risk of **death** after perforation of toxic megacolon is greater than 50%.

Similarly, a patient with proven cancer of the colon, or even a patient who shows certain signs thought to indicate a precancerous condition, will need his or her colon removed. Removal of the colon is called a colectomy. When a colectomy is performed, a piece of the small intestine (ileum) is pulled through an opening in the abdomen. This bit of intestine is fashioned surgically to allow a special bag to be placed over it, in order to catch the body's waste (feces) which no longer can be passed through the large intestine and out of the anus. This opening, which will remain for the duration of the patient's life, is called an ileostomy.

Prognosis

Remission refers to a disease becoming inactive for a period of time. The rate of remission of ulcerative colitis (after a first attack) is nearly 90%. Those individuals whose colitis is confined primarily to the left side of the large intestine have the best prognosis. Those individuals with extensive colitis, involving most or all of the large intestine, have a much poorer prognosis. Recent studies show that about 10% of these patients will have died by 10 years after diagnosis. About 20–25% of all ulcerative colitis patients will require colectomy. Unlike the case for patients with Crohn's disease, however, such radical surgery results in a cure of the disease.

Resources

BOOKS

Glickman, Robert. "Inflammatory Bowel Disease: Ulcerative Colitis and Crohn's Disease." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Long, James W. *The Essential Guide to Chronic Illness*. New York: Harperperennial, 1997.

Saibil, Fred. *Crohn's Disease and Ulcerative Colitis*. Buffalo, NY: Firefly Books, 1997.

PERIODICALS

Martin, Frances L. "Ulcerative Colitis." *American Journal of Nursing* 97 (Aug. 1997): 38+.

Peppercorn, Mark A., and Susannah K. Gordon. "Making Sense of a Mystery Ailment: Inflammatory Bowel Disease." *Harvard Health Letter* 22 (Dec. 1996): 4+.

"Ulcerative Colitis: Manageable, With a Brighter Outlook." *Mayo Clinic Health Letter* 13 (Dec. 1995): 1+.

KEY TERMS

Endoscopy—A type of medical examination in which an instrument called an endoscope is passed into an area of the body (the bladder or intestine, for example). The endoscope usually has a fiberoptic camera, which allows a greatly magnified image to be projected onto a video screen, to be viewed by the operator. Many endoscopes also allow the operator to retrieve a small sample (biopsy) of the area being examined, in order to more closely view the tissue under a microscope.

Immune system—The system of the body that is responsible for producing various cells and chemicals that fight off infection by viruses, bacteria, fungi, and other foreign invaders. In autoimmune disease, these cells and chemicals are turned against the body itself.

Inflammation—The result of the body's attempts to fight off and wall off an area that is infected. Inflammation results in the classic signs of redness, heat, swelling, and loss of function.

ORGANIZATIONS

Crohn's and Colitis Foundation of America, Inc. 386 Park Avenue South, 17th Floor, New York, NY 10016-8804. (800)932-2423.

Rosalyn Carson-DeWitt, MD

Ulcers (digestive)

Definition

In general, an ulcer is any eroded area of skin or a mucous membrane, marked by tissue disintegration. In common usage, however, ulcer is usually used to refer to disorders in the upper digestive tract. The terms ulcer, gastric ulcer, and peptic ulcer are often used loosely and interchangeably. Peptic ulcers can develop in the lower part of the esophagus, the stomach, the first part of the small intestine (the duodenum), and the second part of the small intestine (the jejunum).

Description

It is estimated that 2% of the adult population in the United States has active peptic ulcers, and that about

10% will develop ulcers at some point in their lives. There are about 500,000 new cases of peptic ulcer in the United States every year, with as many as 4 million recurrences. The male/female ratio for ulcers of the digestive tract is 3:1.

The most common forms of peptic ulcer are duodenal and gastric. About 80% of all ulcers in the digestive tract are duodenal ulcers. This type of ulcer may strike people in any age group but is most common in males between the ages of 20 and 45. The incidence of duodenal ulcers has dropped over the past 30 years. Gastric ulcers account for about 16% of peptic ulcers. They are most common in males between the ages of 55 and 70. The single most common cause of gastric ulcers is the use of **nonsteroidal anti-inflammatory drugs**, or NSAIDs. The widespread use of NSAIDs is thought to explain why the incidence of gastric ulcers in the United States is rising.

Causes and symptoms

Causes of peptic ulcers

There are three major causes of peptic ulcers: infection, certain types of medication, and disorders that cause oversecretion of stomach juices.

***HELICOBACTER PYLORI* INFECTION.** *Helicobacter pylori* is a rod-shaped gram-negative bacterium that lives in the mucous tissues that line the digestive tract. Infection with *H. pylori* is the most common cause of duodenal ulcers. About 95% of patients with duodenal ulcers are infected with *H. pylori*, as opposed to only 70% of patients with gastric ulcers.

USE OF NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS). Nonsteroidal anti-inflammatory drugs, or NSAIDs, are painkillers that many people use for headaches, sore muscles, arthritis, menstrual cramps, and similar complaints. Many NSAIDs are available without prescriptions. Common NSAIDs include **aspirin**, ibuprofen (Advil, Motrin), flurbiprofen (Ansaid, Ocufen), ketoprofen (Orudis), and indomethacin (Indacin). Chronic NSAID users have 40 times the risk of developing a gastric ulcer as nonusers. Users are also three times more likely than nonusers to develop bleeding or fatal complications of ulcers. Aspirin is the NSAID that is most likely to cause ulcers.

MISCELLANEOUS SYNDROMES AND DISORDERS. Fewer than 5% of peptic ulcers are due to these disorders. They include Zollinger-Ellison syndrome, a disorder in which small tumors, called gastrinomas, secrete a hormone (gastrin) that stimulates the production of digestive juices. Because of this excess secretion, these disorders are sometimes called hypersecretory syndromes.

OTHER RISK FACTORS. **Smoking** is an important risk factor that increases a patient's chance of developing an ulcer, decreases the body's response to therapy, and increases the chances of dying from ulcer complications. Blood type appears to be a predisposing factor for ulcer location; people with type A blood are more likely to have gastric ulcers, while those with type O are more likely to develop duodenal ulcers. The role of emotional **stress** in ulcer development is currently debated. Present research indicates that an individual's attitudes toward stress, rather than the amount of stress by itself, is a better predictor of vulnerability to peptic ulcers. Preferences for high-fat or spicy foods do not appear to be significant risk factors.

Symptoms

GASTRIC ULCERS. The symptoms of gastric ulcers include feelings of **indigestion** and **heartburn**, weight loss, and repeated episodes of gastrointestinal bleeding. Ulcer **pain** is often described as gnawing, dull, aching, or resembling hunger pangs. The patient may be nauseated and suffer loss of appetite. About 30% of patients with gastric ulcers are awakened by pain at night. Many patients have periods of chronic ulcer pain alternating with symptom-free periods that last for several weeks or months. This characteristic is called periodicity.

DUODENAL ULCERS. The symptoms of duodenal ulcers include heartburn, stomach pain relieved by eating or **antacids**, weight gain, and a burning sensation at the back of the throat. The patient is most likely to feel discomfort two to four hours after meals, or after having citrus juice, coffee, or aspirin. About 50% of patients with duodenal ulcers awake during the night with pain, usually between midnight and 3 A.M. A regular pattern of ulcer pain associated with certain periods of day or night or a time interval after meals is called rhythmicity.

Not all digestive ulcers produce symptoms; as many as 20% of ulcer patients have so-called painless or silent ulcers. Silent ulcers occur most frequently in the elderly and in chronic NSAID users.

Complications

Between 10–20% of peptic ulcer patients develop complications at some time during the course of their illness. All of these are potentially serious conditions. Complications are not always preceded by diagnosis of or treatment for ulcers; as many as 60% of patients with complications have not had prior symptoms.

HEMORRHAGE. Bleeding is the most common complication of ulcers. It may result in anemia, vomiting blood (hematemesis), or the passage of bright red blood through the rectum (melena). About half of all cases of bleeding

from the upper digestive tract are caused by ulcers. The mortality rate from ulcer hemorrhage is 6–10%.

PERFORATION. About 5% of ulcer patients develop perforations, which are holes in the duodenal or gastric wall through which the stomach contents can leak out into the abdominal cavity. The incidence of perforation is rising because of the increased use of NSAIDs, particularly among the elderly. The signs of an ulcer perforation are severe pain, **fever**, and tenderness when the doctor touches the abdomen. Most cases of perforation require emergency surgery. The mortality rate is about 5%.

PENETRATION. Ulcer penetration is a complication in which the ulcer erodes through the intestinal wall without digestive fluid leaking into the abdomen. Instead, the ulcer penetrates into an adjoining organ, such as the pancreas or liver. The signs of penetration are more severe pain *without* rhythmicity or periodicity, and the spread of the pain to the lower back.

OBSTRUCTION. Obstruction of the stomach outlet occurs in about 2% of ulcer patients. It is caused by swelling or scar tissue formation that narrows the opening between the stomach and the duodenum (the pylorus). Over 90% of patients with obstruction have recurrent vomiting of partly digested or undigested food; 20% are seriously dehydrated. These patients also usually feel full after eating only a little food, and may lose weight.

Diagnosis

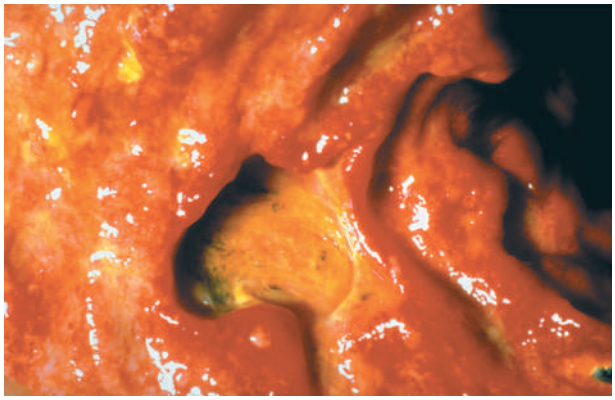
Physical examination and patient history

The diagnosis of peptic ulcers is rarely made on the basis of a **physical examination** alone. The only significant finding may be mild soreness in the area over the stomach when the doctor presses (palpates) it. The doctor is more likely to suspect an ulcer if the patient has one or more of the following risk factors:

- male sex
- age over 45
- recent weight loss, bleeding, recurrent vomiting, **jaundice**, back pain, or anemia
- history of using aspirin or other NSAIDs
- history of heavy smoking
- family history of ulcers or stomach cancer

Endoscopy and imaging studies

An endoscopy is considered the best procedure for diagnosing digestive ulcers and for taking samples of stomach tissue for biopsies. An endoscope is a slender tube-shaped instrument that allows the doctor to view the tissues lining the stomach and duodenum. Duodenal ulcers are rarely malignant. If the ulcer is in the stomach, however, the doctor will take a tissue sample because 3–5% of gastric ulcers are malignant. Radiological studies are sometimes used instead of endoscopy because they are less expensive, more comfortable for the patient, and are 85% accurate in detecting malignancies.



A clinical photograph of a large duodenal ulcer after surgical removal. The ulcer is the prominent triangular crater at center. *(Photo Researchers, Inc. Reproduced by permission.)*

Laboratory tests

BLOOD TESTS. Blood tests usually give normal results in ulcer patients without complications. They are useful, however, in evaluating anemia from a bleeding ulcer or a high white cell count from perforation or penetration. Serum gastrin levels can be used to screen for Zollinger-Ellison syndrome.

TESTS FOR *HELICOBACTER PYLORI*. It is important to test for *H. pylori* because almost all ulcer patients who are not taking NSAIDs are infected. Noninvasive tests include blood tests for immune response and a breath test. In the breath test, the patient is given an oral dose of radiolabeled urea. If *H. pylori* is present, it will react with the urea and the patient will exhale radiolabeled carbon dioxide. Invasive tests for *H. pylori* include tissue biopsies and cultures performed from fluid obtained by endoscopy.

Treatment

Medications

Most drugs that are currently given to treat ulcers work either by lowering the rate of stomach acid secretion or by protecting the mucous tissues that line the digestive tract.

ANTISECRETORY DRUGS. Medications that lower the rate of stomach acid secretions fall into two major cate-

A barium x-ray image of a gastric ulcer. *(Photograph by Bates, M.D., Custom Medical Stock Photo. Reproduced by permission.)*

gories: proton pump inhibitors, which bind an enzyme that secretes stomach acid, and H_2 receptor antagonists, which work by reducing intracellular acid secretion. The proton pump inhibitors include omeprazole (Prilosec) and lansoprazole (Prevacid). The H_2 receptor antagonists include ranitidine (Zantac), cimetidine (Tagamet), famotidine (Pepcid), and nizatidine (Axid). Both types of drugs have few serious side effects and appear to be safe for long-term use.

PROTECTIVE DRUGS. The drugs that are currently used to protect the stomach tissues are sucralfate (Carafate), which forms a pastelike substance that clings to the mucous tissues and prevents further damage from stomach acid; and bismuth preparations. A third type of protective drug includes misoprostol (Cytotec), which is often given to patients with ulcers caused by NSAIDs.

Surgery

Surgical treatment of ulcers is generally used only for complications and suspected malignancies. The most common surgical procedures that are used are vagotomies, in which the connections of the vagus nerve to the stomach are cut in order to reduce acid secretion; and antrectomies, which involve the removal of a part of the stomach (the antrum).

Eradication of Helicobacter pylori

Most doctors presently recommend treatment to eliminate *H. pylori* in order to prevent ulcer recurrences. Without such treatment, ulcers recur at the rate of 80% per year. The usual regimen used to eliminate the bacterium is a combination of tetracycline, bismuth subsalicylate (Pepto-Bismol), and metronidazole (Metizol).

Alternative treatment

Alternative treatments can relieve symptoms and promote healing of ulcers. A primary goal of these treatments is to rebalance the stomach's hydrochloric acid output and to enhance the mucosal lining of the stomach.

Food **allergies** have been pointed to as a major cause of peptic (stomach) ulcers. An elimination/challenge diet can help identify the allergenic food(s) and continued elimination of these foods can assist in healing the ulcer. People with ulcers should not take aspirin. They should also stop smoking, since smoking irritates the mucosal lining of the stomach. Antacids should be avoided by anyone with an ulcer, because they can cause a rebound effect of increasing gastric acid secretion, as well as deplete vital nutrients necessary for healing. **Stress reduction** is also important for ulcer sufferers.

Botanical medicine offers a variety of remedies that may be helpful in ulcer treatment. Deglycyrrhizinated licorice or DGL, in a chewable or powder form, can help heal the mucous membranes and increase mucous so that it mixes with saliva to protect the membranes. Raw cabbage juice, high in glutanic acid, is very effective in healing an ulcer (take 1 quart per day in divided doses). Soothing herbs, such as plantain (*Plantago major*), marsh mallow (*Althaea officinalis*), and slippery elm (*Ulmus fulva*); astringent herbs, such as geranium (*Pelargonium odoratissimum*); and the anitmicrobial herb goldenseal (*Hydrastis canadensis*) can all be effective. Nutritionists advise taking antioxidant nutrients, including **vitamins** A, C, and E, zinc, and selenium.

Prognosis

The prognosis for recovery from ulcers is good for most patients. Very few ulcers fail to respond to the medications that are currently used to treat them. Recurrences can be cut to 5% by eradication of *H. pylori*. Most patients who develop complications recover without problems even when emergency surgery is necessary.

Prevention

Strategies for the prevention of ulcers or their recurrence include the following:

- eradication of *H. pylori* in patients already diagnosed with ulcers
- giving misoprostol to patients who must take NSAIDs
- avoiding unnecessary use of aspirin and NSAIDs
- giving up smoking
- cutting down on alcohol, tea, coffee, and sodas containing caffeine

KEY TERMS

Duodenum—The first of the three segments of the small intestine. The duodenum connects the stomach and the jejunum. Most peptic ulcers are in the duodenum.

Helicobacter pylori—A gram-negative rod-shaped bacterium that lives in the tissues of the stomach and causes inflammation of the stomach lining.

Zollinger-Ellison syndrome—A disorder characterized by the presence of tumors (gastrinomas) that secrete a hormone (gastrin), which stimulates the production of digestive juices.

Resources

BOOKS

McQuaid, Kenneth R. "Alimentary Tract." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Miller, David K. "Chronic Abdominal Pain." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Peptic Ulcers." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

Viggiano, Thomas R. "Peptic Ulcer Disease." In *Current Diagnosis*. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

"Stomach and Duodenum." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

ORGANIZATIONS

American College of Gastroenterology. 4900-B South Thirty-First St., Arlington, VA 22206-1656. (703) 820-7400. <http://www.acg.cgi.gi.org/acghome/html>.

Digestive Health Initiative. 7910 Woodmont Ave., #914, Bethesda, MD 20814. (800) 668-5237. <http://www.gastro.org./dhi.html>.

Rebecca J. Frey

Ultrasonic lithotripsy *see* **Lithotripsy**

Ultraviolet light treatment

Definition

Ultraviolet light treatment uses a particular band of the nonvisible light spectrum to treat **psoriasis** and a variety of other skin diseases. It can be used alone or in combination with other medications applied directly to the skin or taken internally.

Purpose

Ultraviolet (UV) light treatment is used primarily in cases of severe psoriasis that have not responded to other medications or in cases affecting large portions of the body. Patients will typically receive a series of 3–5 weekly treatments for a month or more to bring their psoriasis symptoms into check. They may also receive periodic maintenance treatments to prevent recurrence of their psoriasis. Other skin conditions treated with UV light treatments are **vitiligo**, a condition in which people lose pigmentation in large patches of their skin, and **atopic dermatitis**, an allergy-related skin condition that produces itchy, reddish, and scaly patches of skin.

Precautions

Exposure to UV radiation is known to prematurely age the skin over time and increase the risk of skin **cancer**. These potential effects should be weighed against the potential benefits of the treatment. A history will be taken regarding sun exposure and burning, medications, such as **diuretics**, that may increase UV sensitivity exposure, and any history of skin cancers. Sometimes, UV light treatments are given in combination with photosensitizing agents, which maximize UV's effects on the skin. Patients who receive these agents, called psoralens, must take care to avoid exposure to sunlight, which also contains UV radiation. Exposure to UV radiation can also cause **cataracts** and other eye damage, so the patient's eyes must be adequately shielded during the treatments.

Description

UV light treatment can employ one of two bands of the ultraviolet spectrum: ultraviolet A (UVA), and ultraviolet B (UVB). Patients receive full body treatments in special light boxes; smaller areas of the skin are sometimes treated with hand-held devices.

UVB treatment

Psoriasis is the most common skin disease treated with UVB light treatment. Its mechanism of action remains unclear, but investigators speculate it may kill abnormal skin cells or alter immune system reactions in the skin. Most patients require 18–30 treatments before substantial improvement or complete clearing is seen. The intensity of the UV applied will vary depending on the patient's skin type. Fair-skinned patients will start with a relatively weaker dose; dark-skinned patients, a

stronger dose. Physicians will first expose a small area of skin to UVB to determine the minimum erythema dose (MED), the minimum amount of UVB that produces redness 24 hours after exposure. Patients will be exposed for short times early in the treatment cycle, but these times will gradually increase over time.

The Goeckerman regimen, a treatment that combines UVB light with coal tar applied to the skin, is among the oldest and most frequently used treatments for patients with moderate to severe psoriasis. The coal tar is a photosensitizing agent, and, when it interacts with UVB, it appears to limit the abnormal turnover of skin cells characteristic of psoriasis. Although treatments with UVB and coal tar are highly effective, many patients dislike the smell. Some investigators believe use of petroleum jelly or other emollients are just as effective as the coaltar preparations.

In addition to their UVB treatments, many patients will receive systemic agents such as methotrexate, a drug used in severe case of psoriasis, and certain vitamin A derivatives called retinoids.

PUVA treatment

Psoralens are photosensitizing agents found in plants. They have been known since ancient Egypt but have only been available in a chemically synthesized form since the 1970s. Psoralens are taken systemically or can be applied directly to the skin. The psoralens allow a relatively lower dose of UVA to be used. When they are combined with exposure to UVA in PUVA, they are highly effective at clearing psoriasis. Like UVB light treatments, the reason remains unclear, though investigators speculate there may be similar effects on cell turnover and the skin's immune response.

Choosing the proper dose for PUVA is similar to the procedure followed with UVB. The physician can choose a dose based on the patient's skin type. Often, however, a small area of the patient's skin will be exposed to UVA after ingestion of psoralen. The dose of UVA that produces uniform redness 72 hours later, called the minimum phototoxic dose (MPD), becomes the starting dose for treatment.

Some patients experience nausea and **itching** after ingesting the psoralen compound. For these patients "bath PUVA" may be a good option.

Preparation

No major preparation is required for UV light treatments. Areas of the skin that are especially sensitive to the effects of UV light, such as the groin, backside, or face, are shielded during the treatments. Areas not affected by psoriasis are also covered. Special goggles are worn to protect the eyes. Some physicians apply an emollient, such as petroleum jelly, to the skin or other topical agents, such as coal tar, to enhance the results. In PUVA treatments, the psoralen is usually taken one hour before the treatment.

Aftercare

No major aftercare is required following UV light treatments. Patients, however, must take great care to limit or eliminate other exposures to UV radiation, such as from sunlight or tanning beds, because of the increased risk of premature **aging** of the skin and the development of skin cancers. Patients should monitor their skin closely for any signs of precancerous or cancerous skin growths in the future.

Risks

People who receive UV light treatments are at higher risk of premature aging of the skin, and of developing skin cancer. These risks should be balanced against the benefits of treatment. Patients must also take care to limit or eliminate their exposure to other sources of UV radiation, especially if they are taking a psoralen compound in addition to receiving the UV treatments.

Normal results

Psoriasis will normally show significant improvement to complete healing with three to five UVB treatments a week for about four to five weeks. PUVA treatments may require a bit longer to take effect, but because the overall dosage of UV is lower, they are thought by some investigators to be a safer alternative to UVB treatments.

Abnormal results

Modern light boxes carefully control the dosage of UV radiation and the exposure time. Overdose or overexposure is possible, however, and can lead to severe **burns**. It is important to choose a treatment provider who is experienced in the technique. It is also important to tell the physician about all medications being taken by the patient. Some medications, either alone or in combination with a psoralen, can provoke an extreme reaction to UV radiation.

Resources

BOOKS

Dover, Jeffrey S. "Phototherapy." In *Manual of Clinical Problems in Dermatology*, ed. Susan M. Olbricht, et al. Boston: Little, Brown and Co.,1992.

Lynch, Peter J., and W. Mitchell Sams Jr. *Principles and Practice of Dermatology.* 2nd ed. New York: Churchill Livingstone, 1996.

KEY TERMS

Goeckerman regimen—UVB light therapy combined with topical coal-tar preparations.

Minimum erythema dose—The minimum amount of UVB that produces redness 24 hours after exposure. It is the starting dose for UVB light treatments.

Minimum phototoxic dose— The dose of UVA that produces uniform redness 72 hours after ingesting a psoralen compound. It becomes the starting dose for PUVA treatment.

Psoralen—A family of photosensitizing chemicals that can be found in lemons, celery, and other plants. Chemically synthesized versions are used to augment the effects of UVA light treatments.

PUVA treatments—Treatments with the photosensitizers called psoralens and UVA.

Ultraviolet light—A portion of the light spectrum not visible to the eye. Two bands of the UV spectrum, UVA and UVB, are used to treat psoriasis and other skin diseases.

PERIODICALS

Lowe, Nicholas J. "Photo(chemo)therapy: General Principles." *Clinics in Dermatology* 15 (Sept./Oct. 1997): 745-752.

Nee, Tham Siew. "Phototherapy." *Clinics in Dermatology* 15 (Sept./Oct. 1997): 753-767.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

National Psoriasis Foundation. 6600 SW 92nd Ave., Suite 300, Portland OR 97223-7195. (503) 244-7404. <http://www.psoriasis.org>.

Richard H. Camer

Uncinariasis *see* **Hookworm disease**

Undescended testes

Definition

Also known as cryptorchidism, undescended testes is a congenital condition characterized by testicles that do not extend to the scrotum.

Description

In the fetus, the testes are in the abdomen. As development progresses they migrate downward through the groin and into the scrotum. This event takes place late in fetal development, during the eighth month of gestation. Thirty percent of premature boys have testes that have not yet made the full descent. Only 3–4% of full-term baby boys have undescended testes, and half of those complete the journey by the age of three months. Eighty percent of all undescended testes cases naturally correct themselves during the first year of life. Undescended testes that are not corrected can lead to sterility and an increased risk of **testicular cancer**.

Causes and symptoms

The cause of undescended testes is presently unknown, however its symptoms are quite apparent. One or all of the testicles can be undescended, therefore the testicles appear to be either missing or lopsided.

Diagnosis

The newborn examination always checks for testes in the scrotum. It they are not found, a search will be conducted, but not necessarily right away. In most cases, the testes will drop into place later. If the testes are present at all, they can be anywhere within a couple inches of the appropriate spot. In 5% of cases, one testis is completely absent. In 10%, the condition occurs on both sides. Presence of undescended testes is indicated by measuring the amount of gonadotropin hormone in the blood.

Treatment

Once it is determined that the testes will not naturally descend, surgery becomes necessary. The procedure is called an orchiopexy and is relatively simple once the testes are located. The surgery is usually performed when the boy is between one to two years old.

Prognosis

Undescended testes must be treated to eliminate the increased risk of testicular **cancer** and the possibility of sterility. Undescended testes are twice as likely to develop cancer. Ten percent of all testicular cancers are in undescended testes.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

KEY TERMS

Cryptorchidism—Undescended testes.

Embryonic—Early stages of life in the womb.

Fetal—Refers to the fetus, also known in the first two months after conception as an embryo.

Orchiopexy—Surgical procedure that places the testicles in the scrotum.

Nelson Textbook of Pediatrics. Ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

Rajfer, Jacob. "Congenital Anomalies of the Testes and Scrotum." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

Rozauski, Thomas, et al. "Surgery of the Scrotum and Testis in Children." In *Campbell's Urology*, ed. Patrick C. Walsh, et al. Philadelphia: W. B. Saunders Co., 1998.

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Undulant fever *see* **Brucellosis**

Unipolar depression *see* **Depressive disorders**

Upper GI exam

Definition

An upper GI examination is a fluoroscopic examination (a type of x-ray imaging) of the upper gastrointestinal tract, including the esophagus, stomach, and upper small intestine (duodenum).

Purpose

An upper GI series is frequently requested when a patient experiences unexplained symptoms of abdominal **pain**, difficulty in swallowing (dysphagia), regurgitation, **diarrhea**, or weight loss. It is used to help diagnose disorders and diseases of, or related to, the upper gastrointestinal tract, including cases of hiatal **hernia**, diverticuli, ulcers, tumors, obstruction, enteritis, gastroesophageal reflux disease, **Crohn's disease**, and pulmonary aspiration.

Precautions

Because of the risks of radiation exposure to the fetus, pregnant women are advised to avoid this procedure. Patients with an obstruction or perforation in their bowel should not ingest barium (a radioactive substance used to show contrast in the images) for an upper GI, but may still be able to undergo the procedure if a water-soluble contrast medium is substituted for the barium.

Glucagon, a medication sometimes given prior to an upper GI procedure, may cause nausea and **dizziness**.

Description

An upper GI series takes place in a hospital or clinic setting and is performed by an x-ray technician and a radiologist. A radiologist typically is in attendance to oversee the procedure, and view and interpret the fluoroscopic pictures. Before the test begins, the patient is sometimes administered an injection of glucagon, a medication which slows stomach and bowel activity, to allow the radiologist to get a clearer picture of the gastrointestinal tract. In order to further improve the clarity of the upper GI pictures, the patient may be given a cup of baking soda crystals to swallow, which distend the stomach by producing gas.

Once these preparatory steps are complete, the patient stands against an upright x-ray table, and a fluoroscopic screen is placed in front of him. The patient will be asked to drink from a cup of flavored barium sulfate, a thick and chalky-tasting liquid that allows the radiologist to see the digestive tract, while the radiologist views the esophagus, stomach, and duodenum on the fluoroscopic screen. The patient will be asked to change positions frequently in order to coat the entire surface of the gastrointestinal tract with barium. The technician or radiologist may press on the patient's abdomen in order to spread the barium. The x-ray table will also be moved several times throughout the procedure. The radiologist will ask the patient to hold his breath periodically while exposures are being taken. The entire procedure takes approximately 30 minutes.

In some cases, in addition to the standard upper GI series, a doctor may request a detailed intestine, or small bowel, radiography and fluoroscopy series; it is also called a small bowel follow-through (SBFT). Once the preliminary upper GI series is complete, the patient will be escorted to a waiting area while the barium travels down through the rest of the small intestinal path. Every 15–30 minutes, the patient will return to the x-ray suite for additional x rays, or films. Once the barium has completed its trip down the small bowel tract, the test is completed. This procedure can take anywhere from one to four hours.

Esophageal radiography, also called a barium esophagram or a barium swallow, is a study of the esophagus only, and is usually performed as part of the upper

GI series. It is commonly used to diagnose the cause of difficulty in swallowing (dysphagia) and for detecting hiatal hernia. A barium sulfate liquid, and sometimes pieces of food covered in barium, are given to the patient to drink and eat while a radiologist examines the swallowing mechanism on a fluoroscopic screen. The test takes approximately 30 minutes.

Preparation

Patients must not eat, drink, or smoke for eight hours prior to undergoing an upper GI examination. Longer dietary restrictions may be required, depending on the type and diagnostic purpose of the test. Patients undergoing a small bowel follow-through exam may be asked to take **laxatives** the day prior to the test. Upper GI patients are typically required to wear a hospital gown, or similar attire, and to remove all jewelry, so the camera has an unobstructed view of the abdomen.

Aftercare

No special aftercare treatment or regimen is required for an upper GI series. The patient may eat and drink as soon as the test is completed. The barium sulfate may make the patient's stool white for several days, and patients are encouraged to drink plenty of fluids in order to eliminate it from their system.

Risks

Because the upper GI series is an x-ray procedure, it does involve minor exposure to ionizing radiation. Unless the patient is pregnant, or multiple radiological or fluoroscopic studies are required, the small dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known, on rare occasions, to cause skin **death** (necrosis) in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses administered to these patients.

Normal results

A normal upper GI series will show a healthy, functioning, and unobstructed digestive tract.

Abnormal results

Obstructions or inflammation, including ulcers of the esophagus, stomach, or small intestine; or irregularities in the swallowing mechanism are just a few of the possible abnormalities that may show up on an upper GI series.

Resources

BOOKS

Ross, Linda, ed. *Gastrointestinal Diseases and Disorders Sourcebook*. Vol. 16. Detroit: Omnigraphics, Inc., 1996.

PERIODICALS

Newman, J. "Radiographic and Endoscopic Evaluation of the Upper GI Tract." *Radiology Technology* 69,no. 3 (Jan./Feb. 1998): 213-26.

Urea clearance by the kidneys *see* **Kidney function tests**

Ureteral stenting

Definition

Ureteral stents are thin catheters threaded into segments of the ureter that carry urine, produced by the kidney, either down into the bladder internally, or to an external collection system. Insertion is most often done through the skin (percutaneously); however, in the presence of kidney or ureteral stones, stenting is ideally done during **cystoscopy**.

Purpose

Ureteral stenting may be placed on a long-term basis (months to years) in order to bypass ureteral obstruction. Short-term stenting (weeks to months) may be used as an adjunct to open surgical procedures of the urinary tract to provide a mold around which healing can occur, or to divert the urinary flow away from areas of leakage. Following balloon dilation or incision of ureteral strictures, placement of stents maintains the functionality of the ureters. Stents may also be used in the presence of **kidney stones** to manipulate or prevent stone migration prior to treatment, or to make the ureters more easily identifiable during difficult surgical procedures. Ureteral stents may be used in those with active kidney infection or with markedly diseased, intolerant bladders (e.g., damage from **radiation therapy**, bladder invasion by adjacent neoplasm).

Preparation

The procedure should be thoroughly explained by a medical professional before it takes place. The patient will be asked to put on a hospital gown. If the procedure is performed with the aid of a cytoscope, the patient will assume a position that is typically used in a gynecological exam.

KEY TERMS

Cystoscopy—Examination or treatment of the interior of the urinary bladder by looking through a special instrument with reflected light.

Stricture—An abnormal narrowing of a tube or passageway.

Ureter—The tube-like passageway in the body that carries urine from the kidney to the bladder.

Aftercare

Stents must be periodically replaced to prevent **fractures** within the catheter wall, or buildup of encrustation. Stent replacement is recommended approximately every six months or more often in patients who form stones.

Normal results

Normally, a ureteral stent assures the patient of a free flow of urine. Postoperatively, urine flow will be monitored to ensure the stent has not been dislodged or obstructed.

Abnormal results

Serious complications of the procedure occur in approximately four percent of cases, with minor complications in another 10%. These may include:

- Bleeding. Usually minor and easily treated, occasionally requiring **transfusion**.
- Catheter migration or dislodgement. May require readjustment with the fluoroscope in the Radiology Department.
- Coiling of the stent within the ureter. May cause lower abdominal **pain** or flank pain on urination, urinary frequency, or blood in the urine.
- Introduction or worsening of infection.
- Penetration of adjacent organs (e.g., bowel, gallbladder, or lungs).

Resources

BOOKS

Hanno, Philip, and Alan Wein. *Clinical Manual of Urology.* Philadelphia: McGraw Hill, Inc., 1994.

Lerner, Judith. *Mosby's Manual Of Urologic Nursing.* St. Louis: C. V. Mosby Co., 1982.

Schrier, Robert, and Carl Gottschalk. *Diseases of the Kidney.* Philadelphia: Little, Brown and Co., 1997.

Kathleen D. Wright, RN

Ureterostomy *see* **Urinary diversion surgery**

Urethra defects *see* **Hypospadias and epispadias**

Urethritis

Definition

Urethritis is an inflammation of the urethra that is usually caused by an infection.

Description

The urethra is the canal that moves urine from the bladder to the outside of the body. When this canal becomes infected, inflammation occurs due to the accumulation of white blood cells in the area. When this occurs, it is called urethritis. Besides the urethra, the urinary tract consists of the bladder, ureters, and kidneys. Inflammation can move up the urethra, causing **cystitis** in the bladder, or **nephritis** in the kidneys. Collectively, these inflammations are called urinary tract infections or UTIs.

Urinary tract infections are much more common in women than in men, probably due to anatomy. Infections are especially more common in older women, due to bladder problems.

Causes and symptoms

Uncomplicated urethritis usually results from infection by the bacteria ***Escherichia coli***, commonly found in the bowel. Complicated urethritis can occur when other problems exist, such as **kidney stones**, malformations of the urinary tract, **spinal cord injury**, or a compromised immune system. People with diabetes tend to have more urinary tract infections, as well as hospitalized patients. Urinary tract infections can also be sexually transmitted. Some people seem to be susceptible to urinary tract infections, having them recurrently.

Frequently, a urinary tract infection has no symptoms. Common symptoms though, include **pain** and a burning sensation when urinating, frequent urination, or passing blood in the urine. Signs that the infection may be worsening include **fever** and chills, nausea, vomiting, and lower back pain.

Diagnosis

The diagnosis for a urinary tract infection is made by assessing the symptoms, feeling (palpating) the abdomen

for tenderness, and a **urinalysis**. A urinalysis, or urine sample, is examined for both the presence of bacteria and white blood cells. After this, a **urine culture** to determine what bacteria is causing the infection may be done.

Treatment

Typical treatment for urinary tract infections is a course of **antibiotics**. In women who have recurrent urethritis, the diagnosis and treatment is often resolved over the phone. Additional drugs are sometimes given to relieve discomfort.

Alternative treatment

For those individuals who seem to be more susceptible to urinary tract infections, drinking lots of fluids at the first sign of an infection can ward it off by diluting the bacteria present and flushing the system. Adding a teaspoon of baking soda to a glass of water and drinking it can change the pH of the urine, causing it to burn less. Also, cranberry juice contains a compound that can prevent bacteria from sticking to and thus growing in the urinary tract. Antimicrobial herbs, such as uva ursi (*Arctostaphylos uva-ursi*) and pipsissewa (*Chimaphila umbellata*), may be helpful. Other herbs, such as marsh mallow (*Althaea officinalis*), slippery elm (*Ulmus fulva*), comfrey (*Symphytum officinale*), plantain (*Plantago major*), and cornsilk, can soothe the urinary tract. *Lactobacillus acidophilus* and *L. bifidus* supplementation reintroduces normal flora into the urinary tract. **Acupuncture** and **homeopathy** can also be effective therapies for urethritis.

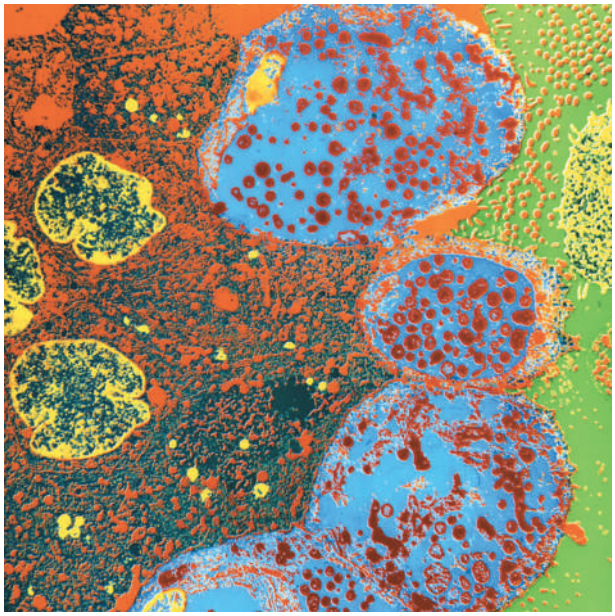
Prognosis

Given the appropriate antibiotic, urinary tract infections usually go away quickly. If not treated soon enough, however, urethritis can move up the urinary tract, infecting the bladder and possibly the kidneys, resulting in kidney damage. If the infection moves into the blood, additional complications can arise. Those who have previously had a urinary tract infection are more susceptible to additional urinary tract infections. Because of this, patients need to be aware of the symptoms so that a physician can be notified if the infection becomes recurrent.

Prevention

There are some steps that can be taken to keep the urinary tract healthy and prevent infection.

- drink plenty of fluids;
- do not hold urine once the urge to urinate has occurred;
- after a bowel movement, wipe from front to rear to keep bowel bacteria at a distance;



A false color transmission electron micrograph (TEM) scan of non-specific urethritis. *(Photograph by Dr. R. Dourmashkin, Custom Medical Stock Photo. Reproduced by permission.)*

- wear cotton underwear
- rinse soap off well in the shower
- urinate after sexual intercourse
- for post-menopausal women, estrogen replacement therapy can help prevent urinary tract infection

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

The Merck Manual of Diagnosis and Therapy. 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

PERIODICALS

"Drink Away Urinary Tract Infections." *Prevention Magazine*, Jan. 1998, 135.

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Uric acid tests

Definition

Uric acid tests are tests that are done to measure the levels of uric acid in blood serum or in urine.

Purpose

The uric acid tests are used to evaluate the blood levels of uric acid for **gout** and to assess uric acid levels in the urine for kidney stone formation. The urine test is used most often to monitor patients already diagnosed with **kidney stones**, but it can also be used to detect disorders that affect the body's production of uric acid and to help measure the level of kidney functioning.

Uric acid is a waste product that results from the breakdown of purine, a nucleic acid. (Nucleic acids are the building blocks of DNA.) Uric acid is made in the liver and excreted by the kidneys. If the liver produces too much uric acid or the kidneys excrete too little, the patient will have too much uric acid in the blood. This condition is called hyperuricemia. Supersaturated uric acid in the urine (uricosuria) can crystallize to form kidney stones that may block the tubes that lead from the kidneys to the bladder (the ureters).

Precautions

Blood test

Patients scheduled for a blood test for uric acid should be checked for the following medications: loop **diuretics** (Diamox, Bumex, Edecrin, or Lasix); ethambutol (Myambutol); vincristine (Oncovin); pyrazinamide (Tebrazid); thiazide diuretics (Naturetin, Hydrex, Diuril, Esidrix, HydroDiuril, Aquatensen, Renese, Diurese); **aspirin** (low doses); **acetaminophen** (Tylenol); ascorbic acid (vitamin C preparations); levodopa (Larodopa); or phenacetin. These drugs can affect test results.

Certain foods that are high in purine may increase the patient's levels of uric acid. These include kidneys, liver, sweetbreads, sardines, anchovies, and meat extracts.

Urine test

Patients should be checked for the following medications before the urine test: diuretics, aspirin, pyrazinamide (Tebrazid), phenylbutazone, probenecid (Benemid), and allopurinol (Lopurin). If the patient needs to continue taking these medications, the laboratory should be notified.

The laboratory should also be notified if the patient has had recent x-ray tests requiring contrast dyes. These chemicals increase uric acid levels in urine and decrease them in blood.

Description

The uric acid blood test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes. The urine test requires the patient to collect all urine voided over a 24-hour period, with the exception of the very first specimen. The patient keeps the specimen container on ice or in the refrigerator during the collection period.

Preparation

The uric acid test requires either a blood or urine sample. For the blood sample, the patient should be **fasting** (nothing to eat or drink) for at least eight hours before the test. The urine test for uric acid requires a 24-hour urine collection. The urine test does *not* require the patient to fast or cut down on fluids. Some laboratories encourage patients to drink plenty of fluids during the collection period.

Risks

Risks for the blood test are minimal, but may include slight bleeding from the puncture site, a small bruise or swelling in the area, or **fainting** or feeling lightheaded.

Normal results

Blood test

Reference values for blood uric acid vary from laboratory to laboratory but are generally found within the following range: Male: 2.1–8.5 mg/dL; female: 2.0–6.6 mg/dL. Values may be slightly higher in the elderly.

Urine test

Reference values for 24-hour urinary uric acid vary from laboratory to laboratory but are generally found within the following range: 250–750 mg/24 hours.

Abnormal results

The critical value for the blood test is a level of uric acid higher than 12 milligrams per deciliter (about 3.4 ounces).

Increased *production* of uric acid may result from eating foods that are high in purine. Increased uric acid levels due to overproduction may also be caused by gout, by a genetic disorder of purine metabolism, or by metastatic **cancer**, destruction of red blood cells, leukemia, or cancer **chemotherapy**.

Decreased *excretion* of uric acid is seen in chronic kidney disease, low thyroid, toxemia of **pregnancy**, and **alcoholism**. Patients with gout excrete less than half the uric acid in their blood as other persons. Only 10-15% of the total cases of hyperuricemia, however, are caused by gout.

KEY TERMS

Fanconi's syndrome—A rare disorder caused by vitamin D deficiency or exposure to heavy metals.

Gout—A metabolic disorder characterized by sudden recurring attacks of arthritis caused by deposits of crystals that build up in the joints due to abnormally high uric acid blood levels. In gout, uric acid may be overproduced, underexcreted, or both.

Hyperuricemia—Excessively high levels of uric acid in the blood, often producing gout.

Purine—A white crystalline substance that is one of the building blocks of DNA. Uric acid is produced when purine is broken down in the body.

Uric acid—A compound resulting from the body's breakdown of purine. It is normally present in human urine only in small amounts.

Uricosuria—Increased levels of uric acid in the urine.

Wilson's disease—A rare hereditary disease marked by the buildup of copper in the liver and brain, causing loss of kidney function.

Abnormally low uric acid levels may indicate that the patient is taking allopurinol or probenecid for treatment of gout; may be pregnant; or suffers from Wilson's disease or **Fanconi's syndrome**.

Resources

BOOKS

Jacobs, David S., et al. *Laboratory Test Handbook.* 4th ed. New York: Lexi-Comp Inc., 1996.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

Cahill, Mathew. *Handbook of Diagnostic Tests.* Springhouse, PA: Springhouse Corporation, 1995.

Janis O. Flores

Urinalysis

Definition

Urinalysis is a diagnostic physical, chemical, and microscopic examination of a urine sample (specimen). Specimens can be obtained by normal emptying of the bladder (voiding) or by a hospital procedure called catheterization.

Purpose

Urinalyses are performed for several reasons:

- general evaluation of health
- diagnosis of metabolic or systemic diseases that affect kidney function
- diagnosis of endocrine disorders. Twenty-four-hour urine studies are often ordered for these tests
- diagnosis of diseases or disorders of the kidneys or urinary tract
- monitoring of patients with diabetes
- testing for **pregnancy**
- screening for drug abuse

Precautions

Voided specimens

Urinalysis should not be performed while a woman is menstruating or having a vaginal discharge. A woman who must have a urinalysis while she has a vaginal discharge or is having her period should insert a fresh tampon before beginning the test. She should also hold a piece of clean material over the entrance to her vagina to avoid contaminating the specimen.

Patients do not have to fast or change their food intake before a urine test. They should, however, avoid intense athletic training or heavy physical work before the test because it may result in small amounts of blood in the urine.

The following drugs can affect urinalysis results. The patient may be asked to stop taking them until after the test:

- Nitrofurantoin (Macrodantin, Furadantin). Nitrofurantoin is prescribed for infections of the urinary tract and other bacterial infections.
- Phenazopyridine (Pyridium). This medication is used to relieve burning and **pain** caused by urinary-tract infections.
- Rifampin (Rifadin). This medication is prescribed to treat **tuberculosis**, prevent the spread of **meningitis**, and treat other infections.

Bladder catheterization

Bladder catheterization is sometimes used to collect urine samples from hospitalized patients. It should not, however, be used to collect specimens from males with

acute inflammation of the prostate or from a patient of either sex with a fractured pelvis.

Description

Collecting a urine sample from emptying the bladder takes about two or three minutes. The sample can be collected at home as well as in a doctor's office. Urine specimens are usually collected early in the morning before breakfast. Urine collected eight hours after eating and at least six hours after the most recent urination is more likely to indicate abnormalities. Some people may be asked to void into a clean container before getting out of bed in the morning.

Specimen containers

The doctor or hospital will supply a sterile container for a specimen being collected for a colony count. A colony count is a test that detects bacteria in urine that has been cultured for 24–48 hours. It is used instead of a routine urinalysis when a patient's symptoms suggest a urinary tract infection. Nonsterile containers can be used for routine specimens that will not be tested immediately after being collected. An ordinary open-necked jar may be used after it and its lid have been soaked in very hot water for 15–20 minutes and then air-dried.

Laboratory procedures

STORAGE. Urine specimens should not remain unrefrigerated for longer than two hours. A urine specimen that cannot be delivered to a laboratory within two hours should be stored in a refrigerator. The reason for this precaution is that urine samples undergo chemical changes at room temperature. Blood cells begin to dissolve and the urine loses its acidity.

VISUAL EXAMINATION. A doctor, nurse, or laboratory technician will look at the specimen to see if the urine is red, cloudy, or looks unusual in any way. He or she will also note any unusual odor.

TESTING TECHNIQUES. Urine samples are tested with a variety of different instruments and techniques. Some tests use dipsticks, which are thin strips of plastic that change color in the presence of specific substances. Dipsticks can be used to measure the acidity of the urine (its pH) or the presence of blood, protein, sugar, or substances produced during the breakdown of fatty acids (ketones). A urinometer is used to compare the density of the urine specimen with the density of plain water. This measurement is called specific gravity.

The urine specimen is also examined under a microscope to determine whether it contains blood cells, crystals, or small pieces of fibrous material (casts).

Preparation

Voided specimens

Most urine specimens from adults or older children are collected by the patient's voiding into a suitable container. Soaps and disinfectants may contaminate urine specimens and should not be used. The doctor or laboratory may supply a special antiseptic solution that won't irritate the skin. The method for collection varies somewhat according to age and sex.

WOMEN AND GIRLS. Before collecting a urine sample, a woman or girl should use a clean cotton ball moistened with lukewarm water to cleanse the external genital area. Gently separating the folded skin (labia) on either side of her vagina, she should move the cotton ball from the front of the area to the back. After repeating this process several times, using a fresh piece of cotton each time, she should dry the area with a clean towel.

To prevent menstrual blood, vaginal discharge, or germs from the external genitalia from contaminating the specimen, a woman or girl should release some urine before she begins to collect her sample. A urine specimen obtained this way is called a midstream clean catch.

MEN AND BOYS. A man or boy should use a piece of clean cotton, moistened with antiseptic, to cleanse the head of his penis and the passage through which urine leaves his body (the urethral meatus). He should draw back his foreskin if he has not been circumcised. He should move the cotton in a circular motion away from the urinary opening, using a fresh piece of cotton each time. After repeating this process several times, he should use a fresh piece of cotton to remove the antiseptic. After the area has been thoroughly cleansed, he should begin urinating and collect a small sample in a container without interrupting the stream of urine.

INFANTS. A parent, nurse, or doctor should cleanse the child's genitals and as much of the surrounding area as will fit into the sterile urine-collection bag provided by the hospital. When the area has been thoroughly cleansed, the bag should be attached to the child's genital area and left in place until the child has urinated. It is important to remember not to touch the inside of the bag and to remove it as soon as a specimen has been obtained.

Bladder catheterization

Bladder catheterization is a hospital procedure used to collect uncontaminated urine when the patient cannot void. A catheter is a thin flexible tube that the doctor inserts through the urethra into the bladder to

allow urine to flow out. To minimize the risk of infecting the patient's bladder with bacteria, many doctors use a so-called Robinson catheter, which is a plain rubber or latex tube that is removed as soon as the specimen is collected.

Suprapubic bladder aspiration is a technique that is sometimes used to collect urine from infants younger than six months. The doctor withdraws urine from the bladder into a syringe through a needle inserted through the skin over the bladder. This technique is used only when the child cannot void because of an abnormal urethra or if he or she has a urinary tract infection that has not responded to treatment.

Aftercare

The patient may return to normal activities after collecting the sample and may start taking medications that were discontinued before the test.

Risks

There are no risks associated with voided specimens. The risk of bladder infection from catheterization with a Robinson catheter is about 3%.

Normal results

Contents and appearance

Normal urine is a clear straw-colored liquid. It has a slight odor. It contains some crystals, a small number of cells from the tissues that line the bladder, and transparent (hyaline) casts. Normal urine does *not* contain sugars, yeast cells, protein, ketones, bacteria, or parasitic organisms.

The time of day a urine sample is collected can make a difference in the appearance of the specimen. Some foods and medicines, including red beets, asparagus, and penicillin, can affect the color or smell of urine. Although most color variations are harmless, they sometimes indicate the presence of serious disease. A doctor, nurse, or laboratory technician should be notified if the urine is red or cloudy or looks unusual in any way.

Acidity

The pH of normal urine is 4.5–8.0. Its specific gravity is 1.0005–1.035.

Abnormal results

Cloudiness

Urine may be cloudy (turbid) because it contains red or white blood cells, bacteria, fat, mucus, digestive fluid (chyle), or pus from a bladder or kidney infection.

Odor

Foul-smelling urine is a common symptom of urinary-tract infection. A fruity odor is associated with **diabetes mellitus**, **starvation** and **dehydration**, or ketone formation. Other distinctive odors are present in the urine of patients with maple syrup urine disease or **phenylketonuria** (PKU).

Specific gravity

The specific gravity of urine can be affected by a range of diseases and disorders. Low specific gravity (below 1.005) is associated with **diabetes insipidus**, nephrogenic diabetes insipidus, acute tubular necrosis, and inflammation of the upper urinary tract (**pyelonephritis**). In fixed specific gravity, the specific gravity of the urine remains at 1.010 no matter how much fluid the person drinks. This condition occurs in patients who have chronic inflammation of the small blood vessels in the kidneys (**glomerulonephritis**) and serious kidney damage. High specific gravity (above 1.035) occurs in patients who are in **shock** or who suffer from **nephrotic syndrome**, dehydration, acute glomerulonephritis, congestive **heart failure**, or liver failure.

pH

A pH factor greater than 7 (more alkaline) may result from **Fanconi's syndrome**, urinary tract infections, or metabolic or **respiratory alkalosis**. A pH factor below 7 (more acid) may be due to **fever**, PKU, the secretion of homogentisic acid in the urine (alkaptonuria), and acidosis.

Blood and tissue cells

Red blood cells in the urine can be due to vigorous **exercise** or exposure to toxic chemicals. Bloody urine can also be a sign of bleeding in the genitourinary tract as a result of systemic bleeding disorders, various kidney diseases, bacterial infections, parasitic infections including **malaria**, obstructions in the urinary tract, **scurvy**, subacute bacterial **endocarditis**, traumatic injuries, and tumors.

A high number of white blood cells in the urine is usually a symptom of urinary tract infection. A large number of cells from tissue lining (epithelial cells) can indicate damage to the small tubes that carry material into and out of the kidneys.

Casts

Casts are small fibrous objects that are formed when protein and other materials settle in the kidney tubules and collecting ducts. Casts are dislodged by normal urine flow. A large number of them in a urine specimen is a sign of kidney disease.

KEY TERMS

Acidosis—A condition of the blood in which bicarbonate levels are below normal.

Alkalosis—A condition of the blood and other body fluids in which bicarbonate levels are higher than normal.

Casts—Small fibrous objects formed from materials that collect in the kidney tubules and are washed out by normal urine flow.

Catheter—A thin flexible tube inserted through the urethra into the bladder to allow urine to flow out.

Clean catch specimen—A urine specimen that is collected from the middle of the urine stream after the first part of the flow has been voided.

Colony count—A measurement of the growth of bacteria in a urine sample that has been cultured for 24 to 48 hours.

Fanconi's syndrome—A rare disorder caused by vitamin D deficiency or exposure to heavy metals.

Ketones—Substances produced during the breakdown of fatty acids. They are produced in excessive amounts in diabetes and certain other abnormal conditions.

Nephrotic syndrome—A condition characterized by water retention, little or no protein in urine, and high blood cholesterol.

pH—A chemical symbol used to describe the acidity or alkalinity of a fluid, ranging from 0 (more acid) to 14 (more alkaline).

Urethra—The duct that carries urine from the bladder to the outside of the body.

Urinalysis (plural, urinalyses)—The diagnostic testing of a urine sample.

Voiding—Another word for emptying the bladder or urinating.

Crystals

There are several different chemicals in body fluids that can form crystals that appear in urine. Some of these appear in normal urine, such as calcium oxalate or uric acid crystals. A large number of calcium oxalate crystals, however, may be a sign of abnormally high levels of calcium in the blood (**hypercalcemia**). Other crystals, including tyrosine, leucine, and cholesterol, are abnormal. The presence of cystine crystals is a symptom of excessive urinary secretion of cystine (**cystinuria**). Cystine is an acid found in many proteins and normally reabsorbed by the kidney tubules.

Protein

Protein in the urine can be a symptom of **kidney stones**, inflammation of the kidneys, degenerative kidney disease, or multiple tumors.

Sugars

A high level of glucose and other sugars in the urine (glycosuria) is often a symptom of diabetes mellitus. Glycosuria can also be caused by advanced kidney disease, **Cushing's syndrome**, impaired tubular reabsorption, shock, a rare tumor of the adrenal gland (**pheochromocytoma**), or **cancer** of the pancreas.

Milk in the urine is normal if a woman is pregnant, has just given birth, or is breastfeeding. On the other hand, rare hereditary metabolic disorders are indicated when urine contains fruit sugar (fructose), milk sugar (galactose), or a simple sugar called pentose.

Ketones

The presence of abnormally high numbers of ketones in the urine (ketonuria) usually results from uncontrolled diabetes mellitus. Ketonuria can also be caused by prolonged **diarrhea** or vomiting that results in starvation.

Bilirubin

Bilirubin is an orange-yellow pigment found in bile, a fluid secreted by the liver. When it is found in urine, bilirubin may be a symptom of liver disease caused by the formation of fibrous tissue, medications that damage the liver, or obstructive **jaundice**.

Urobilinogen

Bacteria in the small intestine can convert bilirubin to urobilinogen, which is excreted in the feces, in bile, or in urine. An accumulation of urobilinogen in the urine may be a sign of severe infection, liver damage, or diseases that destroy red blood cells. Low levels of urobilinogen in the urine may be a result of antimicrobial therapy, inflammatory diseases, kidney disease, severe diarrhea, or blocked bile ducts.

Other findings

The presence of bacteria, parasites, or yeast cells in the urine may be a symptom of urinary tract infection or contamination of the external genitalia. Other factors that may affect urinalysis results include failure to collect a specimen during the day's first voiding; frequent urination; large dietary intake of vitamin C; and urine with a pH value lower than 6.

Resources

BOOKS

"Laboratory Diagnosis: Urine Studies." In *Clinician's Pocket Reference*, ed. Leonard G. Gomella. Norwalk, CT: Appleton & Lange, 1993.

ORGANIZATIONS

American Association of Kidney Patients. 100 S. Ashley Dr., #280, Tampa, FL 33602. (800) 749-2257. <http://www.aakp.org>.

American Kidney Fund. 6110 Executive Boulevard, Rockville, MD 20852. (800) 638-8299. <http://216.248.130.102/Default.htm>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

Maureen Haggerty

Urinary anti-infectives

Definition

Urinary anti-infectives are medicines used to treat or prevent infections of the urinary tract—the passage through which urine flows from the kidneys out of the body.

Purpose

Normally, no bacteria or other disease-causing organisms live in the bladder. Likewise, the urethra—the tube-like structure that carries urine from the bladder out of the body—usually has either no bacteria or not enough to cause problems. But the bladder, urethra, and other parts of the urinary tract may become infected when disease-causing organisms invade from other body regions or from outside the body. Urinary anti-infectives are used to treat such infections or to prevent them in people who get them often.

Description

Commonly used urinary anti-infectives include methenamine (Urex, Hiprex, Mandelamine), nalidixic acid (NegGram) and nitrofurantoin (Macrobid, Furatoin, and other brands). These medicines are available only with a physician's prescription and come in capsule, tablet, granule, and liquid forms.

Recommended dosage

Methenamine

For adults and children 12 years and over, the usual dosage is 1 gram, taken either twice a day or four times a day, depending on the form in which the drug comes. For children aged 6–12 years, the dosage ranges from 500 mg taken 2–4 times a day to 1 gram taken twice a day, again depending on the form of the drug. For children under 6 years, a physician must determine the dose.

This medicine will not work properly unless the urine is acidic, with a pH reading of 5.5 or below. The physician who prescribes the medicine will explain how to test the urine's acidity. The physician also may suggest diet changes that will make the urine more acidic, such as eating more protein, drinking cranberry juice, eating plums and prunes, but avoiding most other fruits, and cutting down on milk and other dairy products. **Antacids** also should be avoided.

Nalidixic acid

The recommended dosage for adults and children 12 years and older is 1 gram every 6 hours. If the medicine is taken for more than one or two weeks, the dosage may be decreased to 500 mg every 6 hours. A physician must determine the correct dosage for children 3 months to 12 years old. Children under 3 months should not take this medicine because it causes bone problems in young animals and could have the same effect in young children.

Nitrofurantoin

CAPSULES, TABLETS, OR LIQUID. The usual dose for adults and teenagers is 50–100 mg every six hours.

EXTENDED-RELEASE CAPSULES. For adults and children 12 years and older, the usual dosage is 100 mg every 12 hours for seven days.

For all forms of nitrofurantoin, a physician must determine the correct dose for children one month and older, based on the child's body weight. Children under one month should not take this medicine.

Precautions

Methenamine

People with certain medical conditions may have problems if they take this medicine. For example, people

with severe liver disease may have worsened symptoms of their disease. And people who are dehydrated or who have severe kidney disease may be more likely to have side effects that affect the kidneys.

Nalidixic acid

Some people feel drowsy, dizzy, or less alert than usual when using this drug. The medicine may also cause blurred vision or other vision changes. Because of these possible problems, anyone who takes nalidixic acid should not drive, operate machinery, or do anything else that might be dangerous until they have found out how the drugs affect them.

Nalidixic acid may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this medicine, avoid being in direct sunlight, especially between 10 a.m. and 3 p.m.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use tanning beds, tanning booths, or sunlamps.

Diabetic patients should be aware that this medicine may cause false results on some urine sugar tests. Check with a physician before making any changes in diet or diabetes medicine based on the results of a urine test.

In laboratory studies, nalidixic acid interferes with bone development in young animals. The drug's effects have not been studied in pregnant women, but because of its effects in animals, it is not recommended for use during **pregnancy**.

This medicine generally does not cause problems in nursing babies whose mothers take it. However, nursing babies with glucose-6-phosphate dehydrogenase (G6PD) deficiency (an inherited disorder that affects mainly black males) may have blood problems if their mothers take nalidixic acid.

People with certain medical conditions may be more likely to have particular side effects if they take this medicine. For example, people with a history of seizures or severe hardening of the arteries in the brain may be more likely to have side effects that affect the nervous system. People with glucose-6-phosphate dehydrogenase (G6PD) deficiency are more likely to have side effects that affect the blood. Also, people with liver disease or severe kidney disease have an increased chance of having any of the drug's possible side effects.

Nitrofurantoin

Pregnant women should not take this medicine within two weeks of their delivery date and should not use it during labor and delivery, as this could cause problems in the baby.

Women who are breastfeeding should check with their physicians before using this medicine. It passes into breast milk and could cause problems in nursing babies whose mothers take it. This is especially true of babies with glucose-6-phosphate dehydrogenase (G6PD) deficiency. The medicine also should not be given directly to babies up to one month of age, as they are particularly sensitive to its effects.

Older people may be more likely to have side effects when taking nitrofurantoin, because they are more sensitive to the drug's effects.

Taking nitrofurantoin may cause problems for people with certain medical conditions. Side effects may be greater, for example, in people with lung disease or nerve damage. In people with kidney disease, the medicine may not work as well as it should, but may cause more side effects. Those with glucose-6-phosphate dehydrogenase (G6PD) deficiency who take nitrofurantoin may develop anemia.

Diabetic patients should be aware that this medicine may cause false results on some urine sugar tests. They should check with a physician before making any changes in diet or diabetes medicine based on the results of a urine test.

General precautions for all urinary anti-infectives

Symptoms should improve within a few days of starting to take a urinary anti-infective. If they do not, or if they become worse, check with a physician right away. Patients who need to take this medicine for long periods should see their physicians regularly, so that the physician can check their progress.

Anyone who has had unusual reactions to urinary anti-infectives in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances. Patients taking nalidixic acid should tell their physicians if they have ever had reactions to related medicines such as cinoxacin (Cinobac), ciprofloxacin (Cipro), enoxacin (Penetrex), norfloxacin (Noroxin) or ofloxacin (Floxin), all of which are also used to treat or prevent infections. Anyone taking nitrofurantoin should let the physician know if he or she has had an unusual reaction to medicines such as furazolidone (Furoxone) or nitrofurazone (Furacin).

Side effects

Methenamine

Nausea and vomiting are not common but may occur. These side effects do not need medical attention unless

they are severe. One side effect that should be brought to a physician's attention immediately is a skin rash.

Nalidixic acid

Some side effects are fairly minor and are likely to go away as the body adjusts to the drug. These include **dizziness**, drowsiness, **headache**, nausea or vomiting, stomach **pain** and **diarrhea**. Unless these problems continue or are bothersome, they do not need medical attention.

Other side effects, however, should have prompt medical attention. Anyone who has changes in vision, such as blurred vision, double vision, decreased vision, changes in color vision, halos around lights, or notices an excessive brightness of lights should check with a physician immediately.

Nitrofurantoin

This medicine may make the urine turn reddish-yellow to brown. This is nothing to worry about. Other possible side effects that do not need medical attention unless they are severe include pain in the stomach or abdomen, stomach upset, diarrhea, loss of appetite, and nausea or vomiting.

Anyone who has chest pain, breathing problems, **fever**, chills, or a **cough** while taking nitrofurantoin should check with a physician immediately.

General advice on side effects for all urinary anti-infectives

Other side effects are possible when taking any urinary anti-infective. Anyone who has unusual symptoms while taking this type of medicine should get in touch with his or her physician.

Interactions

Methenamine

Certain medicines may make methenamine less effective. These include thiazide **diuretics** (water pills) and medicines that make the urine less acid, such as antacids, bicarbonate of soda, and the drugs acetazolamide (Diamox), dichlorphenamide (Daranide), and methazolamide (Neptazane), which are used to treat **glaucoma**, epilepsy, **altitude sickness**, and other conditions.

Nalidixic acid

People who are taking blood thinners (anticoagulants) may be more likely to have bleeding problems if they take this medicine.

KEY TERMS

Altitude sickness—A set of symptoms that people who normally live at low altitudes may have when they travel to high altitudes. The symptoms include nosebleed, nausea, and shortness of breath.

Anemia—A lack of hemoglobin—the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Glucose-6-phosphate dehydrogenase (G6PD) deficiency—An inherited disorder in which the body lacks an enzyme that normally protects red blood cells from toxic chemicals. When people with this condition take certain drugs, their red blood cells break down, causing anemia. This may also happen when they have a fever or an infection. The condition usually occurs in males. About 10% of black males have it, as do a small percentage of people from the Mediterranean region.

Granule—A small grain or pellet. Medicines that come in granule form usually are mixed with liquids or sprinkled on food before they are taken.

Organism—An individual of some type of life form, such as a plant or an animal.

pH—A measure of how acidic or alkaline something is. The pH scale ranges from 0 to 14. Values below 7 are acidic; values above 7 are alkaline.

Seizure—A sudden attack, spasm, or convulsion.

Nitrofurantoin

Nitrofurantoin may interact with many other medicines. For example, taking nitrofurantoin with certain drugs that include methyldopa (Aldomet), **sulfonamides** (sulfa drugs), vitamin K, and diabetes medicines taken by mouth may increase the chance of side effects that affect the blood. General side effects are more likely in people who take nitrofurantoin with the **gout drugs** probenecid (Benemid) or sulfinpyrazone (Anturane). And the risk of side effects that involve the nervous system is higher in people who take nitrofurantoin with various drugs including lithium (Lithane), disulfiram (Antabuse), other anti-infectives, and the **cancer** drugs

cisplatin (Platinol) and vincristine (Oncovin). Patients who have had a DPT (**diphtheria**, **tetanus**, and pertussis) vaccine within the last 30 days or who have one after taking nitrofurantoin are also more likely to have side effects that affect the nervous system. Because of the many possible interactions, anyone taking nitrofurantoin should be sure to check with a physician before combining it with any other medicine.

General advice about interactions

Not every drug that may interact with a urinary anti-infective is listed here. Be sure to check with a physician or pharmacist before combining a urinary anti-infective with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Tucker, M. Susan. "Recurrent UTI: Who Should Treat Herself?" *Patient Care* 26 (15 July 1992): 259.

Nancy Ross-Flanigan

Urinary antiseptics *see* **Urinary anti-infectives**

Urinary catheterization

Definition

Urinary catheterization is the insertion of a catheter into a patient's bladder. The catheter is used as a conduit to drain urine from the bladder into an attached bag or container.

Purpose

Urinary catheterization is employed in hospital and nursing home settings to maintain urine output in patients who are undergoing surgery, or who are confined to the bed and physically unable to use a bedpan. Critically ill patients who require strict monitoring of urinary output are also frequently catheterized.

Intermittent insertion of a urinary catheter is a treatment option for patients with certain types of **urinary incontinence**. Patients who are unable to completely empty the bladder during urination (urinary retention), or patients who have a bladder obstruction, may also require intermittent urinary catheterization. Disabled individuals with neurological disorders that cause **paralysis** or a loss of sensation in the perineal area may also use regular intermittent catheter insertion to void their bladders.

Precautions

Because urinary catheterization carries a risk of causing urinary tract infection (UTI), precautions should be used to keep the catheter clean and free of bacteria. Patients requiring intermittent catheterization should be well trained in the technique by a qualified health care professional.

Description

Intermittent catheterization is performed a minimum of four times a day by the patient or a care giver. The genital area near the urethral opening is wiped with an antiseptic agent, such as iodine. A lubricant may be used to facilitate the entry of the catheter into the urethra, and a topical local anesthetic may be applied to numb the urethral opening during the procedure. One end of the catheter is placed in a container, and the other end is inserted into and guided up the urethra until urine flow begins. When urine flow stops, the catheter may be moved or rotated, or the patient may change positions to ensure that all urine has emptied from the bladder. The catheter is then withdrawn, cleaned, and sterilized for the next use. Recommended cleaning practices vary, from the use of soap and water to submersion in boiling water or a disinfectant solution. Some patients prefer to use a new catheter with each insertion.

Nonintermittent catheterization, which is initiated in a hospital or nursing home setting, uses the same basic technique for insertion of the urinary tract catheter. The catheter is inserted by a nurse or other health care professional, and remains in the patient until bladder function can be maintained independently. When the catheter is removed, patients will experience a pulling sensation and may feel some minor discomfort. If the catheter is required for an extended period of time, a long-term, indwelling catheter, such as a Foley catheter, is used. To prevent infection, it should be regularly exchanged for a new catheter every three to six weeks.

Use of indwelling catheters should be restricted to patients whose incontinence is caused by urinary tract obstruction that can not be treated, and for which alternative therapy is not feasible.

Preparation

If a patient wishes to perform intermittent catheterization himself, training in the technique by a qualified health care professional is required. Basic instruction in the anatomy, antiseptic techniques, catheter insertion, and proper catheter care should be provided. Patients learning chronic intermittent urinary catheterization may also benefit from an ultrasound examination to verify that they are completely emptying their bladder during the procedure.

KEY TERMS

Bladder obstruction—A blockage of the bladder caused by the presence of calculi (e.g., mineral deposits) or an anatomic abnormality.

Catheter—A long, thin, flexible tube.

Foley catheter—A two-channel catheter with a balloon on the bladder end of one channel. Once inflated, the balloon keeps the catheter securely in the bladder. The other channel of the catheter facilitates the flow of urine out of the bladder.

Local anesthetic—Medication applied topically to the skin or administered through an injection that deadens a specific part of the body and inhibits the sensation of pain.

Perineal area—The genital area between the vulva and anus in a woman, and between the scrotum and anus in a man.

Ultrasound examination—A diagnostic test that uses sound waves to generate a picture of an organ or organ system.

Urinary incontinence—The inability to control one's urine flow.

Aftercare

Patients using intermittent catheterization as a treatment for incontinence will experience a period of adjustment as they try to establish a catheterization schedule that is adequate for their normal level of fluid intake.

Antibiotics may be prescribed as a preventative measure in long-term urinary catheterization patients who are at risk for urinary tract infection.

A patient with an indwelling catheter must be reassessed periodically to determine whether alternative treatment may be more effective in treating the problem.

Risks

Trauma to the urethra and/or bladder may result from incorrect insertion of the catheter. Repeated irritation to the urethra during catheter insertion may cause scarring and/or stricture, or narrowing, of the urethra. The catheter may introduce bacteria into the urethra and bladder, resulting in urinary tract infection. UTI can cause **fever** and inflammation of the bladder and urethra. Patients who practice intermittent catheterization can reduce their risks for UTI by using antiseptic techniques for insertion and catheter care.

Normal results

When used correctly, catheterization facilitates complete voiding of the bladder.

Resources

PERIODICALS

Hunt, Gillian M., Pippa Oakeshott, and Robert Whitaker. "Intermittent Catheterization: Simple, Safe, and Effective but Underused." *British Medical Journal* 312, no. 7023 (Jan. 1996): 103-7.

U.S. Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research. "Urinary Incontinence in Adults: Acute and Chronic Management." *Clinical Practice Guideline* no. 2 (1996).

Paula Anne Ford-Martin

Urinary diversion surgery

Definition

A urinary diversion involves removal of the urinary bladder and adjacent tissues and organs, and re-routing of the urinary stream. This may involve creation of an artificial opening in the abdomen called an **ostomy**.

Purpose

A urinary diversion is created as a means to treat **cancer** of the bladder, when conservative measures have been unsuccessful, or when there is recurrence of the disease invading the muscle wall. Congenital deformities or traumatic injury may also necessitate formation of a urinary diversion.

Description

Under general anesthesia, an incision is made in the abdomen. The ureters (tubes that carry urine away from the kidneys) are cut and tied. The bladder and surrounding tissues are cut free and removed. The ureters are then attached to a portion of the intestine. The most common types of urinary diversion are:

- Ileal conduit. Ureters are attached to a portion of the small intestine, the ileum, one end of which is brought through the abdominal wall as a conduit for the urine, creating a stoma.
- Ureterosigmoidostomy. The ureters are attached to a portion of the large intestine, the sigmoid, which allows the urine to flow through the large intestine and out through the rectum.

• Cutaneous ureterostomy. Bringing the detached ureters through the abdominal wall and attaching it to an opening in the skin.

Following creation of an artificial opening to drain the urine, ureteral stents (tubes that go through the stoma and up into the ureters) are often inserted and left in place to allow urine to drain freely from the kidneys, without risk of blockage from swelling due to surgery. The muscles are replaced and sewn together. A transparent pouch is applied to the abdomen to collect urine, and attached to a bedside drainage bag. The incision is closed with sutures or clips ("staples"), which are usually removed about 1 week after surgery.

An alternative to a conventional urinary diversion is the continent urinary diversion. In this surgical procedure, a "false bladder" is constructed within the abdomen, using several lengths of small or large intestine. The ureters are sewn to this new reservoir for urine and nipple valves are created at two sites; the abdominal wall for continence; and where the ureters are implanted, to prevent reflux of urine back to the kidneys. The patient is then taught to catheterize the reservoir to drain urine at regular intervals during the day. Although a continent diversion is not suitable for every patient who requires urinary diversion, it is an option to be considered.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiogram (EKG), may be ordered as the doctor deems necessary. If creation of an ostomy is planned, the patient should visit an enterostomal therapist, who will mark an appropriate place on the abdomen for a stoma and offer preoperative education on ostomy management.

Eating or drinking is prohibited after midnight the night before the surgery. Oral anti-infectives, such as neomycin, erythromycin, or kanamycin sulfate, may be ordered to decrease bacteria in the intestine and help prevent postoperative infection. A nasogastric tube is inserted the day of surgery, or during surgery, to remove gastric secretions and prevent **nausea and vomiting**.

Aftercare

Postoperative care for the patient with a urinary diversion, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia, and the patient is reluctant to breathe deeply and experience **pain** that is caused by the abdominal incision. The patient is shown how to support the operative site during deep breathing and coughing, and is given pain medication as necessary. Fluid intake and output are measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction, until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids. The patient is usually able to move about in 8–24 hours after surgery, and is discharged from the hospital in 5–10 days.

If an ostomy has been placed, the patient and close family members will be educated on how to care for it. Determination of appropriate pouching supplies and a schedule of how often to change the pouch should be established. Regular assessment and meticulous care of the skin surrounding the stoma is important to maintain an adequate surface on which to apply the pouch. The pouch should be connected to a bedside drainage bag at night to prevent large volumes of urine from collecting in the pouch. Otherwise, the weight of the pouch could cause disruption of the pouch seal and leakage of urine onto the surrounding skin. Often, an enterostomal therapist will visit the patient at home after discharge to help the new ostomy patient make the transition back to normal daily activities.

Risks

Potential complications of urinary diversion surgery include:

• excessive bleeding

• surgical wound infection

• thrombophlebitis (inflammation and blood clot to veins in the legs)

• pneumonia

• pulmonary **embolism** (blood clot or air bubble in the lungs' blood supply)

Normal results

Complete healing is expected without complications. The amount of time required for recovery from the surgery may vary depending of the patient's overall health status prior to surgery. The patient with a urinary diversion, without other medical complications, should be able to resume all daily activities once recovered from the surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

KEY TERMS

Ischemia— A compromise in blood supply to body tissues that causes tissue damage or death.

Ostomy—A surgically-created opening in the abdomen for elimination of waste products (urine or stool).

- Increased pain, swelling, redness, drainage, or bleeding in the surgical area
- Headache, muscle aches, **dizziness**, or **fever**
- Increased abdominal pain or swelling, **constipation**, nausea, or vomiting.

Stomal complications to be monitored include:

- Stomal tissue **death** (necrosis). This occurs because of inadequate blood supply, this is usually visible 12 to 24 hours after surgery. It may require additional surgery.
- Stoma flush or below the abdomen surface (retraction). Caused by insufficient stomal length, this may be managed by use of special pouching supplies. Elective revision of the stoma is also an option.
- Narrowing at the opening of the stoma (stenosis). Often associated with infection around the stoma or scarring, mild stenosis can be removed under local anesthesia. Severe stenosis may require surgery for stomal revision.
- Parastomal **hernia**. The bowel causes a bulge in the abdominal wall next to the stoma. This is usually due to placement of the stoma where the abdominal wall is weak, or an overly large opening in the abdominal wall. Use of an ostomy support belt and special pouching supplies may be adequate. If severe, the defect in the abdominal wall should be repaired and the stoma moved to another location.

Resources

BOOKS

Doughty, Dorothy. *Urinary and Fecal Incontinence.* St. Louis: Mosby-Year Book, Inc., 1991.

Hampton, Beverly, and Ruth Bryant. *Ostomies and Continent Diversions.* St. Louis: Mosby-Year Book, Inc., 1992.

Monahan, Frances. *Medical-Surgical Nursing.* Philadelphia: W. B. Saunders Co., 1998.

Suddarth, Doris. *The Lippincott Manual of Nursing.* Philadelphia: J. B. Lippincott, 1991.

ORGANIZATIONS

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. <http://www.uoa.org>.

Wound Ostomy and Continence Nurses Society. 1550 South Coast Highway, Suite #201

OTHER

"Bladder Removal." ThriveOnline. 20 Apr. 1998 <http://thriveonline.oxygen.com>.

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Urinary incontinence

Definition

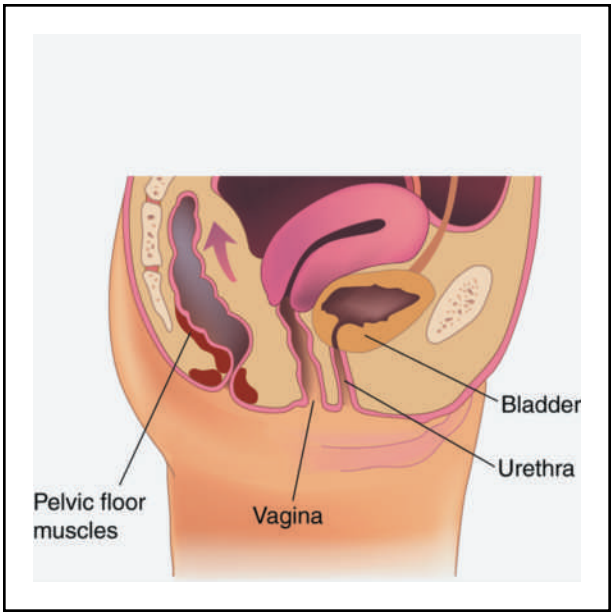
Urinary incontinence is unintentional loss of urine that is sufficient enough in frequency and amount to cause physical and/or emotional distress in the person experiencing it.

Description

Approximately 13 million Americans suffer from urinary incontinence. Women are affected by the disorder more frequently than are men; one in 10 women under age 65 suffer from urinary incontinence. Older Americans, too, are more prone to the condition. Twenty percent of Americans over age 65 are incontinent.

There are five major categories of urinary incontinence: overflow, **stress**, urge, functional, and reflex.

- Overflow incontinence. Overflow incontinence is caused by bladder dysfunction. Individuals with this type of incontinence have an obstruction to the bladder or urethra, or a bladder that doesn't contract properly. As a result, their bladders do not empty completely, and they have problems with frequent urine leakage.
- Stress incontinence. Stress incontinence occurs when an individual involuntarily loses urine after pressure is placed on the abdomen (i.e., during **exercise**, sexual activity, sneezing, coughing, laughing, or hugging).
- Urge incontinence. Urge incontinence occurs when an individual feels a sudden need to urinate, and cannot control the urge to do so. As a consequence, urine is involuntarily lost before the individual can get to the toilet.
- Functional incontinence. Individuals who have control over their own urination and have a fully functioning urinary tract, but cannot make it to the bathroom in time due to a physical or cognitive disability, are functionally incontinent. These individuals may suffer from arthritis, **Parkinson's disease**, **multiple sclerosis**, or **Alzheimer's disease**.
- Reflex incontinence. Individuals with reflex incontinence lose control of their bladder without warning. They typically suffer from neurological impairment.



Strengthening the pelvic floor muscles by performing Kegel exercises helps to alleviate stress incontinence in women. Contract the pelvic floor muscles as if stopping an imaginery flow of urine. Hold for 10 seconds and repeat. *(Illustration by Electronic Illustrators Group.)*

In some cases, an individual may develop short-term or *acute incontinence*. Acute incontinence may occur as a symptom or by-product of illness, as a side effect of medication, or as a result of dietary intake. The condition is typically easily resolved once the cause is determined and addressed.

Causes and symptoms

Urinary incontinence can be caused by a wide variety of physical conditions, including:

- **Childbirth**. Childbirth can weaken the pelvic muscles and cause the bladder to lose some support from surrounding muscles, resulting in stress incontinence.
- Dysfunction of the bladder and/or the urinary sphincter. In a continent individual, as the bladder contracts, the outlet that releases urine into the urethra (bladder sphincter) opens and urine exits the body. In individuals with overflow incontinence, bladder contractions and dilation of the sphincter do not occur at the same time.
- **Enlarged prostate**. In men, an enlarged prostate gland can obstruct the bladder, causing overflow incontinence.
- Hysterectomy or other gynecological surgery. Any surgery involving the urogenital tract runs the risk of damaging or weakening the pelvic muscles and causing incontinence.
- Menopause. The absence of estrogen in the postmenopausal woman can cause the bladder to drop, or prolapse.
- Neurological conditions. The nervous system sends signals to the bladder telling it when to start and stop emptying. When the nervous system is impaired, incontinence may result. Neurological conditions such as multiple sclerosis, **stroke**, spinal cord injuries, or a **brain tumor** may cause the bladder to contract involuntarily, expelling urine without warning, or to cease contractions completely, causing urinary retention.
- Obesity. Individuals who are overweight have undue pressure placed on their bladder and surrounding muscles.
- Obstruction. A blockage at the bladder outlet may permit only small amounts of urine to pass, resulting in urine retention and subsequent overflow incontinence. Tumors, calculi, and scar tissue can all block the flow of urine. A urethral stricture, or narrow urethra caused by scarring or inflammation, may also result in urine retention.

Acute incontinence is a temporary condition caused by a number of factors, including:

- Bladder irritants. Substances in the urine that irritate the bladder may cause the bladder muscle to malfunction. The presence of a urinary tract infection and the ingestion of excess **caffeine** can act as irritants. Highly concentrated urine resulting from low fluid intake may also irritate the bladder.
- **Constipation**. Constipation can cause incontinence in some individuals. Stool that isn't passed presses against the bladder and urethra, triggering urine leakage.
- Illness or disease. Diabetes can greatly increase urine volume, making some individuals prone to incontinence. Other illnesses may temporarily impair the ability to recognize and control the urge to urinate, or to reach the toilet in time to do so.
- Medications and alcohol. Medications that sedate, such as tranquilizers and sleeping pills, can interfere with the proper functioning of the urethral nerves and bladder. Both sedatives and alcohol can also impair an individual's ability to recognize the need to urinate, and act on that need in a timely manner. Other medications such as **diuretics**, **muscle relaxants**, and blood pressure medication can also affect bladder function.
- Surgery. Men who undergo prostate surgery can suffer from temporary stress incontinence as a result of damage to the urethral outlet.

Diagnosis

Urinary incontinence may be diagnosed by a general practitioner, urologist, or gynecologist. If the patient is

over age 65, a geriatrician may diagnose and treat the condition. A thorough medical history and **physical examination** is typically performed, along with specific diagnostic testing to determine the cause of the incontinence. Diagnostic testing may include x rays, ultrasound, urine tests, and a physical examination of the pelvis. It may also include a series of exams that measure bladder pressure and capacity and the urinary flow (urodynamic testing). The patient may also be asked to keep a diary to record urine output, frequency, and any episodes of incontinence over a period of several days or a week.

Treatment

There are numerous invasive and noninvasive treatment options for urinary incontinence:

- **Bladder training**. Used to treat urge incontinence, bladder training involves placing a patient on a toileting schedule. The time interval between urination is then gradually increased until an acceptable time period between bathroom breaks is consistently achieved.
- Biofeedback. The use of sensors to monitor temperature and muscle contractions in the vagina to help incontinent patients learn to control their pelvic muscles.
- Collagen injections. Collagen injected in the tissue surrounding the urethra can provide urethral support for women suffering from stress incontinence.
- Inflatable urethral insert. Sold under the tradename Reliance, this disposable incontinence balloon for women is inserted into the urethra and inflated to prevent urine leakage.
- Intermittent **urinary catheterization**. The periodic insertion of a catheter into a patient's bladder to drain urine from the bladder into an attached bag or container.
- Medication. Estrogen **hormone replacement therapy** can help improve pelvic muscle tone in postmenopausal women. Anticholinergics (i.e., propantheline, or Pro-Banthine) and antispasmodics (i.e., oxybutynin, or Ditropan) are sometimes prescribed to relax the bladder muscles. Other over-the-counter medications such as pseudoephedrine (i.e., Actifed, Benadryl, Dimetapp) and phenylpropanolamine (i.e., Dexatrim, Acutrim) may be prescribed to tighten the urethral sphincter.
- Pelvic toning exercises. Exercises to tone the pelvic muscle can help alleviate stress incontinence in both men and women. These exercises involve tightening the muscles of the pelvic floor, and are also known as Kegel or PC muscle exercises.
- Perineal stimulation. Perineal stimulation is used to treat stress incontinence. The treatment uses a probe to deliver a painless electrical current to the perineal area muscles. The current tones the muscle by contracting it.
- Permanent catheterization. A permanent, or indwelling, catheter may be prescribed for chronic incontinence that doesn't respond to other treatments. A Foley catheter is usually used for urinary catheterization. One end is inserted through the urethra and into the bladder, and the external end is attached to a plastic reservoir bag that the patient may wear on the leg. A second alternative is a permanent catheter, called a suprapubic tube, surgically inserted into the bladder. The tube exits the body through the abdomen near the pubic bone, where it is attached to a drainage bag. As infection may result, this treatment should be reevaluated periodically, and the possibility of alternative treatment addressed.
- Surgery. Bladder neck suspension surgery is used to correct female urinary stress incontinence. Surgical techniques such as the Marshall-Marchetti-Krantz and Burch procedures use sutures to raise and support the bladder neck and urethra. A sling procedure, which uses a strip of biocompatible material or the patient's own muscle or tissue as a supportive sling under the urethra and bladder neck, may also be used to treat stress incontinence. Bladder enlargement surgery may be recommended to treat incontinent men and women with unusually small bladders.
- Urinary sphincter implant. An artificial urinary sphincter may be used to treat incontinence in men and women with urinary sphincter impairment.
- Vaginal inserts. Devices constructed of silicone or other pliable materials that can be inserted into a woman's vagina to support the urethra.

Prognosis

Left untreated, incontinence can cause physical and emotional upheaval. Individuals with long-term incontinence suffer from urinary tract infections, and skin **rashes** and sores. Incontinence can also affect their self-esteem and cause depression and social withdrawal. They frequently stop participating in physical activities they once enjoyed because of the risk of embarrassing "accidents." However, with the wide variety of treatment options for incontinence available today, the prognosis for incontinent patients is promising. If incontinence cannot be stopped, it can be improved in the majority of cases.

Prevention

Women who are pregnant or who have gone through childbirth can reduce their risk for stress incontinence by strengthening their perineal area muscles with Kegel exercises. Men who have undergone prostate surgery

KEY TERMS

Bladder neck—The place where the urethra and bladder join.

Bladder sphincter—The outlet that releases urine into the urethra.

Calculi—Mineral deposits that can form a blockage in the urinary system.

Perineal area—The genital area between the vulva and anus in a woman, and between the scrotum and anus in a man.

may also benefit from pelvic muscle exercises. Men and women should consult with their doctor before initiating any type of exercise program.

Resources

BOOKS

Blaivas, Jerry. *Conquering Bladder and Prostate Problems: The Authoritative Guide for Men and Women.* New York: Plenum, 1998.

King, Barbara, and Judy Harke. *Coping with Bowel and Bladder Problems.* San Diego: Singular Publishing Group, 1994.

PERIODICALS

Sandroff, Ronni. "Urgent Matters: Incontinence is Treatable, if Only Women Would Talk about It." *American Health for Women* 16, no.8 (Oct 1997): 28-30.

Strange, Carolyn J. "Incontinence Can Be Controlled." *FDA Consumer* 31, no. 5 (July/Aug. 1997): 28-31.

ORGANIZATIONS

American Foundation for Urologic Disease. 1128 North Charles St., Baltimore, MD 21201. (800) 242-2383. <http://www.afud.org>.

National Association for Continence. P.O. Box 8310, Spartanburg, SC 29305-8310. (800) 252-3337. <http://www.nafc.org>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

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Urinary tract infections *see* **Cystitis; Nongonococcal urethritis; Urethritis**

Urine concentration test *see* **Kidney function tests**

Urine culture

Definition

A urine culture is a diagnostic laboratory test performed to detect the presence of bacteria in the urine (bacteriuria).

Purpose

Culture of the urine is a method of diagnosis for urinary tract infection that determines the number of microorganisms present in a given quantity of urine.

Precautions

If delivery of the urine specimen to the laboratory within one hour of collection is not possible, it should be refrigerated. The health care provider should be informed of any **antibiotics** currently or recently taken.

Description

There are several different methods for collection of a urine sample. The most common is the midstream clean-catch technique. Hands should be washed before beginning. For females, the external genitalia (sex organs) are washed two or three times with a cleansing agent and rinsed with water. In males, the external head of the penis is similarly cleansed and rinsed. The patient is then instructed to begin to urinate, and the urine is collected midstream into a sterile container. In infants, a urinary collection bag (plastic bag with an adhesive seal on one end) is attached over the labia in girls or a boy's penis to collect the specimen.

Another method is the catheterized urine specimen in which a lubricated catheter (thin rubber tube) is inserted through the urethra (tube-like structure in which urine is expelled from the bladder) into the bladder. This avoids contamination from the urethra or external genitalia. If the patient already has a urinary catheter in place, a urine specimen may be collected by clamping the tubing below the collection port and using a sterile needle and syringe to obtain the urine sample; urine cannot be taken from the drainage bag, as it is not fresh and has had an opportunity to grow bacteria at room temperature. On rare occasions, the health care provider may collect a urine sample by inserting a needle directly into the bladder (suprapubic tap) and draining the urine; this method is used only when a sample is needed quickly.

Negative culture results showing no bacterial growth are available after 24 hours. Positive results require 24–72 hours to complete identification of the number and type of bacteria found.

KEY TERMS

Bacteriuria—The presence of bacteria in the urine.

Preparation

Drinking a glass of water 15–20 minutes before the test is helpful if there is no urge to urinate. There are no other special preparations or aftercare required for the test.

Risks

There are no risks associated with the culture test itself. If insertion of a urinary catheter (thin rubber tube) is required to obtain the urine, there is a slight risk of introducing infection from the catheter.

Normal results

No growth of bacteria is considered the normal result, and this indicates absence of infection.

Abnormal results

Abnormal results, or a positive test, where bacteria are found in the specimen, may indicate a urinary tract infection. Contamination of the specimen from hair, external genitalia, or the rectum may cause a false-positive result. Identification of the number and type of bacteria, with consideration of the method used in obtaining the specimen, is significant in diagnosis.

Escherichia coli causes approximately 80% of infections in patients without catheters, abnormalities of the urinary tract, or calculi (stones). Other bacteria that account for a smaller portion of uncomplicated infections include *Proteus klebsiella* and *Enterobacter*.

Resources

BOOKS

David, Alan K., et al. *Family Medicine: Principles and Practice*. New York: Springer Verlag, Inc., 1994.

Malarkey, Louise, and Mary Ellen McMorrow. *Nurse's Manual of Laboratory Tests and Diagnostic Procedures*. Philadelphia: W. B. Saunders Co., 1996.

ORGANIZATIONS

American Foundation for Urologic Disease. 300 West Pratt St., Suite 401, Baltimore, MD 21201.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

OTHER

"Urine culture." HealthAnswers.com 27 Feb. 1998. <http://www.healthanswers.com>.

Urine Culture." ThriveOnline. 25 Feb. 1998 <http://thriveonline.oxygen.com>.

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Urine flow test

Definition

A urine flow test evaluates the speed of urination, or amount voided per second, and the total time of urination.

Purpose

A urine flow test is utilized to determine bladder function abnormalities, including a narrowed or obstructed urethra (the outflow passage from the bladder) and a weakened bladder muscle (detrusor).

Description

During a urine flow test, the patient urinates into a uroflowmeter, a funnel-shaped device that reads, measures, and computes the rate and amount of urine flow. The test takes approximately 10 minutes.

Preparation

The patient is prohibited from urinating at least two hours before the procedure.

Normal results

Average urine flow rates vary depending on age and gender.

Abnormal results

A urine flow test can indicate problems in bladder function, such as an obstruction, that will need further tests to diagnose.

Resources

BOOKS

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests*. St. Louis: Mosby, Inc., 1998.

Walsh, Patrick C., et al., ed. *Campbell's Urology*. Philadelphia: W. B. Saunders Co., 1998.

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KEY TERMS

Detrusor muscle—Bladder muscle.

Urethra—Passageway that carries urine from the bladder.

Urography *see* **Intravenous urography**

Urticaria *see* **Hives**

Uterine cancer *see* **Endometrial cancer**

Uterine fibroids

Definition

Uterine fibroids (also called leiomyomas or myomas) are benign growths of the muscle inside the uterus. They are not cancerous, nor are they related to **cancer**. Fibroids can cause a wide variety of symptoms, including heavy menstrual bleeding and pressure on the pelvis.

Description

Uterine fibroids are extremely common. About 25% of women in their reproductive years have noticeable fibroids. There are probably many more women who have tiny fibroids that are undetected.

Fibroids develop between the ages of 30–50. They are never seen in women less than 20 years old. After **menopause**, if a woman does not take estrogen, fibroids shrink. It appears that African-American women are much more likely to develop uterine fibroids.

Fibroids are divided into different types, depending on the location. Submucous fibroids are found in the uterine cavity; intramural fibroids grow on the wall of the uterus; and subserous fibroids are located on the outside of the uterus. Many fibroids are so large that they fit into more than one category. The symptoms caused by fibroids are often related to their location.

Causes and symptoms

No one knows exactly what causes fibroids. However, the growth of fibroids appears to depend on the hormone estrogen. Fibroids often grow larger when estrogen levels are high, as in **pregnancy**. Medications that lower the estrogen level can cause the fibroids to shrink.

The signs and symptoms of fibroids include:

- Heavy uterine bleeding. This is the most common symptom, occurring in 30% of women who have fibroids. The excess bleeding usually happens during the menstrual period. Flow may be heavier, and periods may last longer. Women who have submucous or intramural fibroids are most likely to have heavy uterine bleeding.
- Pelvic pressure and **pain**. Large fibroids that press on nearby structures such as the bladder and bowel can cause pressure and pain. Larger fibroids tend to cause worse symptoms.
- **Infertility**. This is a rare symptom of fibroids. It probably accounts for less than 3% of infertility cases. Fibroids can cause infertility by compressing the uterine cavity. Submucous fibroids can fill the uterine cavity and interfere with implantation of the fertilized egg.
- Miscarriage. This is also an unusual symptom of fibroids, probably accounting for only a tiny fraction of the miscarriages that occur.
- Pregnancy complications. Fibroids can greatly increase in size during pregnancy, because of increased levels of estrogen. They can cause pain, and even lead to **premature labor**.

Diagnosis

A health care provider can usually feel fibroids during a routine pelvic examination. Ultrasound can be used to confirm the diagnosis, but this is not necessary.

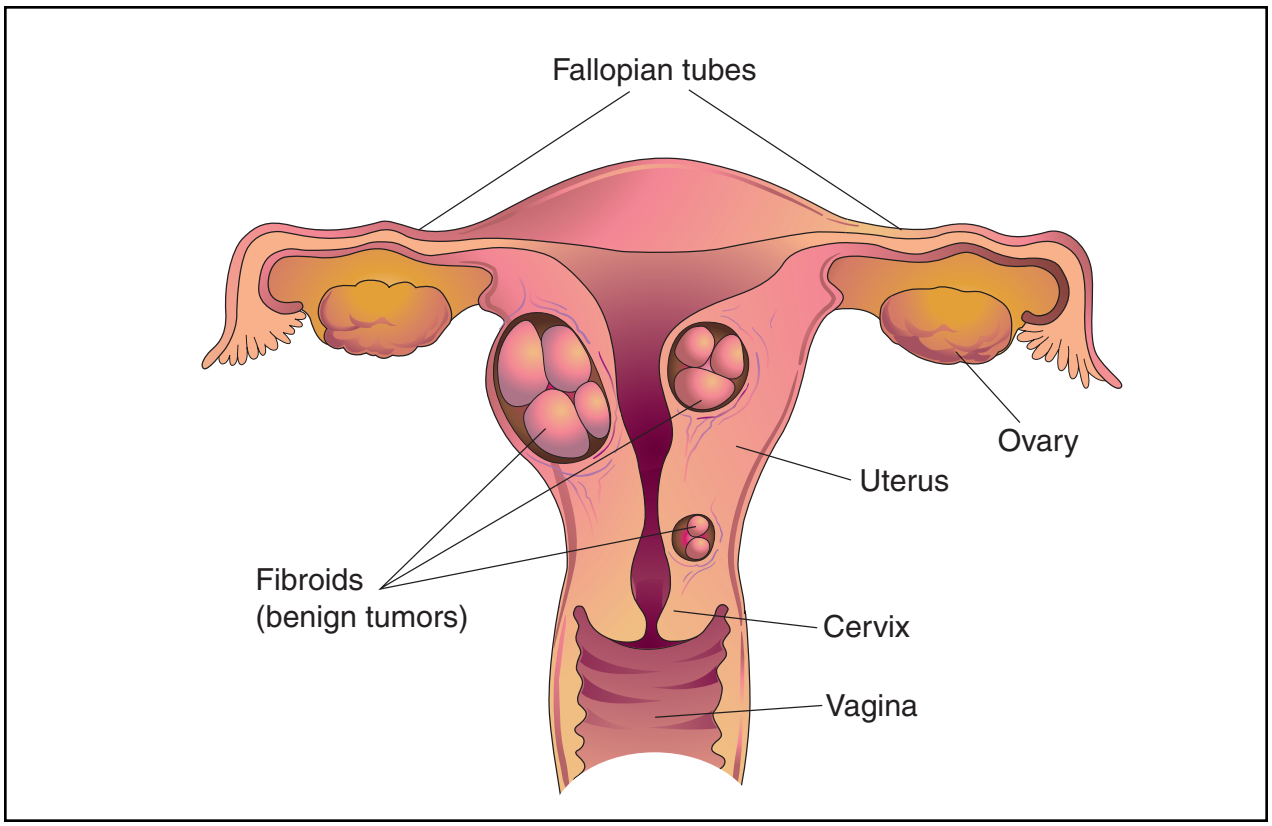
Treatment

Not all fibroids cause symptoms. Even fibroids that do cause symptoms may not require treatment. In the majority of cases, the symptoms are inconvenient and unpleasant, but do not result in health problems.

Occasionally, fibroids lead to such heavy menstrual bleeding that the woman becomes severely anemic. In these cases, treatment of the fibroids may be necessary. Very large fibroids are much harder to treat. Therefore, many doctors recommend treatment for moderately-sized fibroids, in the hopes of preventing them from growing into large fibroids that cause worse symptoms.

The following are possible treatment plans:

- Observation. This is the most common plan. Most women already have symptoms at the time their fibroids are discovered, but feel that they can tolerate their symptoms. Therefore, no active treatment is given, but the woman and her physician stay alert for signs that the condition might be getting worse.



Uterine fibroids are benign growths of uterine muscle and are very common. They are divided into three types, depending on the location. Submucous fibroids are found in the uterine cavity; intramural fibroids grow on the wall of the uterus; and subserous fibroids are located outside of the uterus. *(Illustration by Electronic Illustrators Group.)*

- **Hysterectomy**. This involves surgical removal of the uterus, and it is the only real cure for fibroids. In fact, 25% of hysterectomies are performed because of symptomatic fibroids. By the time a woman has a hysterectomy for fibroids, she has usually endured several years of worsening symptoms. That's because fibroids tend to grow over time. A gynecologist can remove a fibroid uterus during either an abdominal or a vaginal hysterectomy. The choice depends on the size of the fibroids and other factors such as previous births and previous surgeries.

- **Myomectomy**. In this surgical procedure only the fibroids are removed; the uterus is repaired and left in place. This is the surgical procedure many women choose if they are not finished with childbearing. At first glance, it seems that this treatment is a middle ground between observation and hysterectomy. However, myomectomy is actually a difficult surgical procedure, more difficult than a hysterectomy. Myomectomy often causes significant blood loss, and blood transfusions may be required. In addition, some fibroids are so large, or buried so deeply within the wall of the uterus, that it is not possible to save the uterus, and a hysterectomy must be done, even though it was not planned. There are exceptions to this, however. Sometimes, fibroids grow on a stalk (pedunculated fibroids), and these are easy to remove.

- Medical treatment. Since fibroids are dependent on estrogen for their growth, medical treatments that lower estrogen levels can cause fibroids to shrink. A group of medications known as GnRH antagonists can dramatically lower estrogen levels. Women who take these medications for three to six months find that their fibroids shrink in size by 50% or more. They usually experience dramatic relief of their symptoms of heavy bleeding and pelvic pain.

Unfortunately, GnRH antagonists cause unpleasant side effects in over 90% of women. The therapy is usually used for only three months, and should not be used for more than six months because the risk of developing brittle bones (**osteoporosis**) begins to rise. Once the treatment is stopped, the fibroids begin to grow back to their original size. Within six months, most of the old symptoms return. Therefore, GnRH antagonists cannot be used as long-term solution. At the moment, treatment

KEY TERMS

Anemia—Low blood count.

GnRH antagonists—A group of medications that affect the reproductive hormones. These medications are used to treat fibroids, endometriosis, and infertility.

Hysterectomy—Removal of the uterus (with or without removal of the ovaries) by surgery. The surgery can be performed through an incision in the abdomen, or the uterus can be removed through the vagina.

Menopause—The end of the reproductive years, signaled by the end of menstrual periods. Also known as "the change."

Osteoporosis—Brittle bones commonly found in elderly women.

with GnRH antagonists is used mainly in preparation for surgery (myomectomy or hysterectomy). Shrinking the size of the fibroids makes surgery much easier, and reducing the heavy bleeding allows a woman to build up her **blood count** before surgery.

Fibroids can cause problems during pregnancy because they often grow in size. Large fibroids can cause pain and lead to premature labor. Fibroids cannot be removed during pregnancy because of the risk of injury to the uterus and hemorrhage. GnRH antagonists cannot be used during pregnancy. Treatment is limited to pain medication and medication to prevent premature labor, if necessary.

Prognosis

Many women who have fibroids have no symptoms or have only minor symptoms of heavy menstrual bleeding or pelvic pressure. However, fibroids tend to grow over time, and gradually cause more symptoms. Many women ultimately decide to have some form of treatment. Currently, hysterectomy is the most popular form of treatment.

Prevention

Uterine fibroids cannot be prevented.

Resources

BOOKS

Friedman, Andrew J. "Uterine Fibroids." In *Primary Care of Women*, ed. Karen J. Carlson and Stephanie A. Eisenstat. St. Louis: Mosby-Year Book, Inc., 1995.

Muto, Michael G., and Andrew J. Friedman. "Leiomyomas." In *Kistner's Gynecology.* 6th ed. Ed. Kenneth J. Ryan, Ross S. Berkowitz, and Robert L. Barbieri. St. Louis: Mosby, 1995.

Amy B. Tuteur, MD

Uterus x rays *see* **Hysterosalpingography**

Uveitis

Definition

Uveitis is an inflammation of the uveal tract, which lines the inside of the eye behind the cornea. Much of the uvea lies between the retina and tough, outer sclera. The uveal tract has three parts: the iris, the ciliary body, and the choroid. Uveitis is categorized according to the part of the uveal tract that is affected. Anterior uveitis is an inflammation of the front part of the uveal tract; it includes inflammation of the iris (iritis) and inflammation of the iris and the ciliary body (iridocyclitis). Posterior uveitis is an inflammation of the part of the uveal tract behind the lens of the eye. It includes inflammation of the choroid (choroiditis) and inflammation of the choroid and retina (chorioretinitis). Uveitis that affects the entire uveal tract is called panuveitis or diffuse uveitis.

Description

The uveal tract is made up of the iris, ciliary body, and choroid. The iris is the colored part of the eye. The ciliary body is inside the eye and produces a fluid called aqueous humor. Ciliary muscles aid in accommodation, the process of changing the shape of the lens in the eye to see things at various distances. The choroid lines the back of the eye and has many blood vessels. It helps nourish part of the retina. The choroid lies between the retina and outermost sclera.

Uveitis may either persist for a long time (chronic) or have a short-term duration (acute). Anterior uveitis is classified as either granulomatous or nongranulomatous. The distinction is based on the disease agents that were considered responsible for the condition. At one time, it was thought that granulomatous uveitis was caused by **tuberculosis** bacilli whereas nongranulomatous uveitis was thought to be caused by streptococci. The distinction is still used even though the causes of uveitis are now understood differently.

In most cases, uveitis affects only one eye, although posterior uveitis sometimes involves both eyes. About 60% of cases develop within the eye itself, but 40% are

associated with systemic diseases or disorders ranging from **toxoplasmosis** to **syphilis**. Many of these are diseases of childhood and adolescence. Uveitis does not appear to run in families or to be associated with lifestyle choices, occupational history, geographical location, or environmental factors.

Uveitis is a serious condition that may develop rapidly and cause lasting damage to the eye. Patients who think they may have chronic uveitis should seek evaluation and treatment by an ophthalmologist (a physician who specializes in diseases of the eye) as soon as possible. If the patient has a sudden loss of vision and the eye looks inflamed, the patient should go *immediately* to the doctor for emergency treatment.

Causes and symptoms

The causes of uveitis are not fully understood, but they can be a result of trauma, allergy, or a response to a systemic or ocular disease. Uveitis may be a type of immune-response mechanism. In people with impaired immune systems, uveitis may be due to an infection.

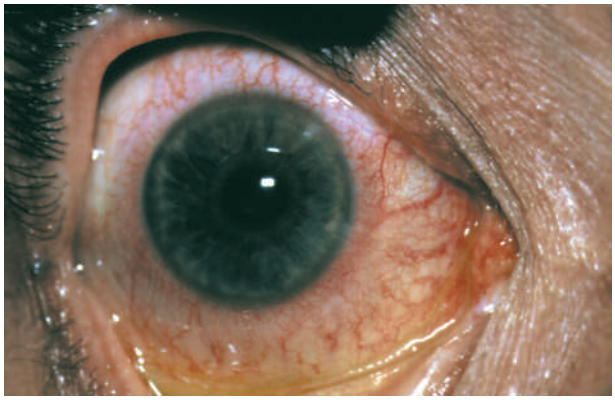
Chronic uveitis is often associated with systemic disorders (e.g., **Lyme disease**, **sarcoidosis**, or juvenile **rheumatoid arthritis**).

Anterior uveitis

The so-called classic symptoms of anterior uveitis—severe **pain**; redness, particularly around the edge of the iris; and extreme sensitivity to light (photophobia)—occur mostly in acute uveitis. In anterior uveitis, the doctor will see a so-called "flare and cell" pattern when looking into the watery fluid (aqueous humor) between the cornea and the lens of the patient's eye. The iris may adhere to the lens, thus increasing the intraocular pressure. There may be nodules on the iris. There may be tearing and the pupil may be constricted and nonreactive. In severe cases of anterior uveitis, there may be hypopyon (a small amount of pus or collection of white cells) visible when the doctor examines the eye.

GRANULOMATOUS UVEITIS. In granulomatous uveitis, there will be large yellowish-white cells visible on the back of the cornea, and possibly some small nodules on the iris. Granulomatous uveitis is usually less acute than the nongranulomatous form; the eye is only mildly inflamed and the patient's vision is somewhat blurred.

Granulomatous uveitis can be produced by syphilis, toxoplasmosis, cytomegalovirus, sarcoidosis, tuberculosis, or Vogt-Koyonagi-Harada syndrome (VKH). VKH is marked by severe uveitis associated with hair loss, **hearing loss**, loss of pigment in the eyelashes and brows, and headaches. It occurs most commonly in Asians.



This person has acute iritis, or inflammation of the iris. Symptoms include pain in the eye or forehead and reddening of the margin of the iris. Treatment requires total rest of the eye (dark glasses and atropine drops which paralyze the muscles of accommodation), accompanied by application of corticosteroids. *(Photo Researchers, Inc. Reproduced by permission.)*

NONGRANULOMATOUS UVEITIS. In nongranulomatous uveitis, the cells visible on the cornea are smaller, and there are no masses on the iris. This type of anterior uveitis is, however, more painful. The eye is red and the patient experiences both photophobia and loss of vision.

Systemic diseases that can cause nongranulomatous uveitis include **ankylosing spondylitis**, **Reiter's syndrome**, **psoriasis**, **ulcerative colitis**, **Behcet's syndrome**, Lyme disease, and **Crohn's disease**. Children—especially girls—with anterior uveitis should be screened for juvenile rheumatoid arthritis (JRA).

Posterior uveitis

The symptoms of posterior uveitis are sometimes subtle. The patient may notice blurred or hazy vision, or floating black spots before the eyes. There may be pain and photophobia. The iris may attach to the lens in the eye thus increasing intraocular pressure.

Posterior uveitis may be acute or chronic. It is more likely to involve both eyes. When the doctor examines the eye, cells may be seen in the vitreous humor, which is the normally transparent gel that fills the eyeball behind the lens. There will be yellowish or dark areas of inflammation on the choroid and the retina. The blood vessels in the retina develop a sheath or covering of inflammatory tissue. In severe cases, the vitreous humor is so cloudy that the doctor cannot see the retina at the back of the eye.

PARS PLANITIS. Pars planitis is an inflammation of the pars plana, which is a part of the ciliary body. Pars planitis usually occurs in older children or young adults, and can develop into posterior uveitis.

KEY TERMS

Choroid—The part of the uveal tract behind the ciliary body. The choroid underlies and nourishes the retina and absorbs scattered light.

Ciliary body—The part of the uveal tract between the iris and the choroid.

Cornea—The transparent front part of the eye that covers the iris and pupil.

Flare and cell—A pattern revealed by slit-lamp examination that indicates uveitis. Flare and cell resembles light filtered through smoke.

Hypopyon—A small amount of pus or collection of white cells that is visible in the front of the eye in severe cases of anterior uveitis.

Iris—The circular membrane that forms the colored portion of the eye and expands or contracts around the pupil.

Photophobia—Extreme sensitivity to light. Photophobia is a major symptom of acute uveitis.

Pupil—The opening in the center of the iris that allows light to pass through to the retina.

Retina—The innermost membrane at the back of the eyeball on which images are projected by the lens.

Slit lamp—An instrument that combines a binocular microscope with special lights. It allows an eye doctor to examine the front portion of the eye.

Uveal tract—The pigmented membrane that lines the back of the retina of the eye and extends forward to include the iris. The uveal tract is sometimes called the uvea and has three parts: the iris, the choroid, and the ciliary body.

Vitreous humor—The clear gel-like substance that fills the eyeball behind the lens.

The diseases that cause granulomatous uveitis may also cause posterior uveitis.

Diagnosis

The eye doctor will examine the patient's eyes with a slit lamp in order to rule out **conjunctivitis** and certain types of **glaucoma**. The slit lamp is an instrument that combines a binocular microscope with a special light. The slit lamp can shine a narrow beam of very bright light into the eye and allow the doctor to examine the front part of the eye in detail. The slit-lamp exam is not painful, however if the patient is sensitive to light there will be discomfort.

The absence of a discharge from the eye and the absence of infectious organisms in a laboratory smear usually rule out conjunctivitis. In addition, the size of the pupil is often small in uveitis whereas it is normal in conjunctivitis. In acute glaucoma, the patient has severe pain, the cornea of the eye is cloudy, and the pressure level of the fluid inside the eye is abnormally high; whereas in uveitis the pain is moderate, the cornea is clear, and the fluid pressure is normal or possibly lower or slightly above normal. The doctor may also use the slit lamp and another lens to examine the back of the eye to get a good look at the retina and choroid. Other instruments, such as a hand-held ophthalmoscope or a binocular indirect ophthalmoscope, can be used to examine the back of the eye. There should be no discomfort with these tests except if the patient is sensitive to the bright light.

Laboratory testing

Laboratory testing is used to rule out conjunctivitis in some patients. The doctor wipes the inside of the patient's eyelid with a swab in order to obtain a sample for testing. Although blood tests are not necessary to diagnose uveitis by itself, they are used to diagnose the cause if the doctor suspects that toxoplasmosis or another systemic disease is responsible for the uveitis.

Treatment

Uveitis is generally treated by an ophthalmologist because therapy requires topical and oral medications, however, some optometrists (O.D.) are state licensed to use therapeutic medications. Other doctors may be involved in treating the underlying disease, if the patient has one, and in monitoring the patient's responses to medications.

Anterior uveitis is treated with corticosteroid drops; in severe cases, the patient may be given steroid injections in the area of the eye or oral steroids. Atropine sulfate drops may be given to dilate the patient's pupil. Posterior uveitis is treated with systemic **corticosteroids**. It is usually not necessary to dilate the pupil.

Prolonged steroid use may increase intraocular pressure, thereby increasing the risk of glaucoma. Steroid use has also been connected to cataract formation. Patients should be monitored closely and frequently.

Prognosis

The prognosis depends upon the location of the uveitis, on whether it is chronic or acute, and on the promptness of treatment. The prognosis for untreated uveitis is poor. Untreated anterior uveitis usually pro-

gresses to posterior uveitis, resulting in **cataracts**, scar tissue, and eventual glaucoma. If treated promptly, anterior uveitis usually clears up in several days or weeks, but is likely to recur. Posterior uveitis usually results in some permanent loss or blurring of vision.

Prevention

Patients with anterior uveitis should be warned about the possibility of recurrence and instructed about its symptoms, especially inflammation of the iris. They should be advised to seek treatment at once at the first signs of recurrence.

Resources

BOOKS

Eisenbaum, Allan M. "Eye." In *Current Pediatric Diagnosis & Treatment*, ed. William W. Hay Jr., et al. Stamford: Appleton & Lange, 1997.

"Ophthalmologic Disorders: Uveal Tract; Uveitis." In *The Merck Manual of Diagnosis and Therapy.* 16th ed. Ed. Robert Berkow. Rahway, NJ: Merck Research Laboratories, 1992.

Riordan-Eva, Paul, et al. "Eye." In *Current Medical Diagnosis and Treatment, 1998*. 37th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1997.

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

"Uveitis." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

V

Vaccination

Definition

Vaccination is the use of vaccines to prevent specific diseases.

Purpose

Many diseases that once caused widespread illness, disability, and **death** now can be prevented through the use of vaccines. Vaccines are medicines that contain weakened or dead bacteria or viruses. When a person takes a vaccine, his or her immune system responds by producing antibodies—substances that weaken or destroy disease-causing organisms. When the person is later exposed to live bacteria or viruses of the same kind that were in the vaccine, the antibodies prevent those organisms from making the person sick. Vaccines usually also stimulate the so-called cellular immune system as well. In other words, the person becomes immune to the disease the organisms normally cause. The process of building up immunity by taking a vaccine is called immunization.

Vaccines are used in several ways. Some, such as the **rabies** vaccine, are given only when a person is likely to have been exposed to the virus that causes the disease—through a dog bite, for example. Others are given to travelers planning to visit countries where certain diseases are common such as **typhoid fever** or **yellow fever**. Vaccines such as the **influenza** vaccine, or "flu shot," are given mainly to specific groups of people—older adults and others who are at high risk of developing influenza or its complications. Then, there are vaccines that are given to almost everyone, such as the ones that prevent **diphtheria**, **tetanus**, **polio** and **measles**.

Children routinely have a series of vaccinations that begins at birth. Given according to a specific schedule, these vaccinations protect against **hepatitis B**, diphtheria, tetanus, pertussis (**whooping cough**), measles, **mumps**, **rubella** (German measles), varicella (**chickenpox**), polio, pneumococcus and *Haemophilus influenzae* type b (Hib disease, a major cause of spinal **meningitis**) and, in some states, **hepatitis A**. This series of vaccinations is recommended by the American Academy of Family Physicians, the American Academy of Pediatrics, and the Centers for Disease Control and Prevention and is required in all states before children can enter school. All states will make exceptions for children who have medical conditions such as **cancer** that prevent them from having vaccinations, and some states also will make exceptions for children whose parents object for religious or other reasons.

Description

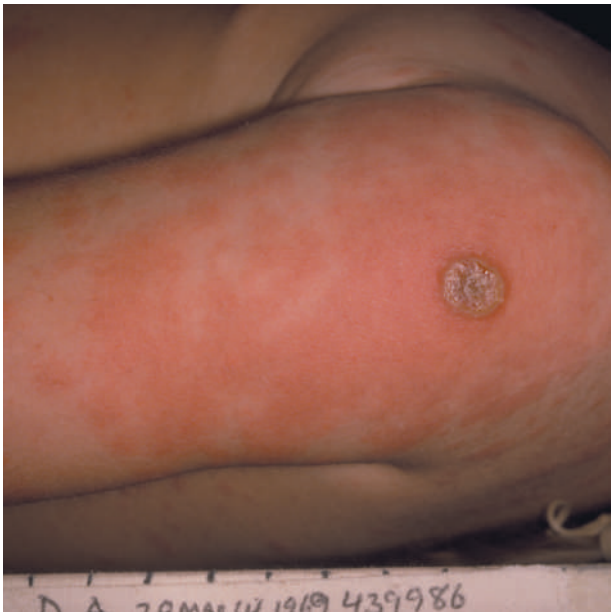
In addition to those discussed above, vaccines are available for preventing **anthrax**, **cholera**, hepatitis A, **Japanese encephalitis**, meningococcal meningitis, **plague**, pneumococcal infection (meningitis, **pneumonia**), **tuberculosis**, typhoid **fever**, and yellow fever. Most vaccines are given as injections, but a few are given by mouth.

Some vaccines are combined in one injection, such as the measles-mumps-rubella (MMR) or diphtheria-pertussis-tetanus (DPT) combinations.

Recommended dosage

The recommended dosage depends on the type of vaccine and may be different for different patients. The healthcare professional who gives the vaccine will decide on the proper dose.

A vaccination health record will help parents and health care providers keep track of a child's vaccinations. The record should be started when the child has his or her first vaccination and should be updated with each additional vaccination. While most physicians follow the recommended vaccination schedule, parents should understand that some flexibility is allowed. For example, vaccinations that are scheduled for age two months may be given anytime between six to 10 weeks. When possi-



An allergic reaction to a vaccination shot. *(Photograph by Lester V. Bergman, Corbis Images. Reproduced by permission.)*

Recommended Immunization Schedule

Age	Vaccine
0–2 months	Hepatitis B
1–4 months	Hepatitis B
2 months	DTP (diphtheria-tetanus-pertussis)
	Hib (Haemophilus influenzae type B)
	Polio
4 months	DTP
	Hib
	Polio
6 months	DTP
	Hib
6–18 months	Hepatitis B
	Polio
12–15 months	Hib
	MMR (measles-mumps-rubella)
12–18 months	Varicella (chickenpox)
15–18 months	DTP
4–6 years	DTP
	Polio
	MMR
11–12 years	Hepatitis B (if not already completed)
	MMR (if not already completed)
	Varicella (if not already completed)
11–16 years	DT (diptheria-tetanus booster shot; and then booster shot every 10 to 15 years)

ble, follow the schedule. However, slight departures will not prevent the child from developing immunity, as long as all the vaccinations are given at around the right times. The child's physician is the best person to decide when each vaccination should be given.

Anyone planning a trip to another country should check to find out what vaccinations are needed. Some vaccinations must be given as much as 12 weeks before the trip, so getting this information early is important. Many major hospitals and medical centers have travel clinics that can provide this information. The Traveler's Health Section of the Centers for Disease Control and Prevention also has information on vaccination requirements.

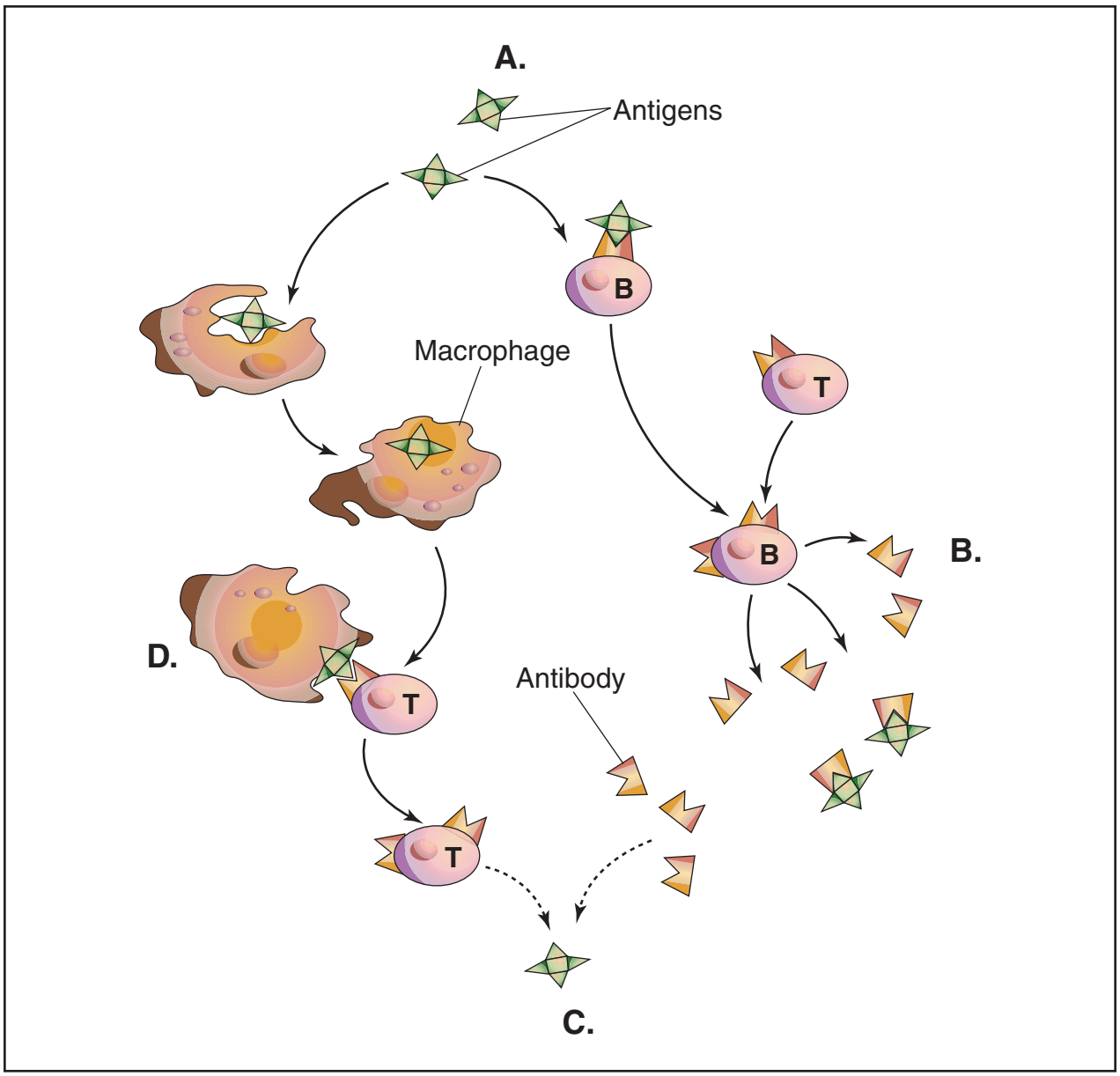
Precautions

Vaccines are not always effective, and there is no way to predict whether a vaccine will "take" in any particular person. To be most effective, vaccination programs depend on whole communities participating. The more people who are vaccinated, the lower everyone's risk of being exposed to a disease. Even people who do not develop immunity through vaccination are safer when their friends, neighbors, children, and coworkers are immunized.

Like most medical procedures, vaccination has risks as well as substantial benefits. Anyone who takes a vaccine should make that sure he or she is fully informed about both the benefits and the risks. Any questions or concerns should be discussed with a physician or other health care provider. The Centers for Disease Control and Prevention, located in Atlanta, Georgia, also is a good source of information.

Vaccines may cause problems for people with certain **allergies**. For example, people who are allergic to the **antibiotics** neomycin or polymyxin B should not take rubella vaccine, measles vaccine, mumps vaccine or the combined measles-mumps-rubella (MMR) vaccine. Anyone who has had a severe allergic reaction to baker's yeast should not take the hepatitis B vaccine. Patients who are allergic to antibiotics such as gentamicin sulfate, streptomycin sulfate or other **aminoglycosides** should check with their physicians before taking influenza vaccine, as some influenza vaccines contain small amounts of these drugs. Also, some vaccines, including those for influenza, measles and mumps, are grown in the fluids of chick embryos and should not be taken by people who are allergic to eggs. In general, anyone who has had an unusual reactions to a vaccine in the past should let his or her physician know before taking the same kind of vaccine again. The physician also should be told about any allergies to foods, medicines, preservatives, or other substances.

People with certain other medical conditions should be cautious about taking vaccines. Influenza vaccine, for example, may reactivate **Guillain-Barré syndrome** (GBS) in people who have had it before. This vaccine



How vaccines work: A. Vaccines contain antigens (weakened or dead viruses, bacteria, and fungi that cause disease and infection). When introduced into the body, the antigens stimulate the immune system response by instructing B cells to produce antibodies, with assistance from T-cells. B. The antibodies are produced to fight the weakened or dead viruses in the vaccine. C. The antibodies "practice" on the weakened viruses, preparing the immune system to destroy real and stronger viruses in the future. D. When new antigens enter the body, white blood cells called macrophages engulf them, process the information contained in the antigens, and send it to the T-cells so that an immune system response can be mobilized. *(Illustration by Electronic Illustrators Group.)*

also may worsen illnesses that involve the lungs, such as **bronchitis** or pneumonia. Vaccines that cause fever as a side effect may trigger seizures in people who have a history of seizures caused by fever.

Certain vaccines are not recommended for use during **pregnancy**, but some may be given to women at especially high risk of getting a specific disease such as polio. Vaccines also may be given to pregnant women to prevent medical problems in their babies. For example, vaccinating a pregnant woman with tetanus toxoid can prevent her baby from getting tetanus at birth.

Women should avoid becoming pregnant for three months after taking rubella vaccine, measles vaccine, mumps vaccine or the combined measles-mumps-rubella

KEY TERMS

Anthrax—An infectious disease caused by a type of bacterium. The disease can be passed from animals to people and usually is fatal. Symptoms include sores on the skin.

Antibody—A type of protein produced in the blood or in the body tissues that helps the body fight infection.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Cholera—An infection of the small intestine caused by a type of bacterium. The disease is spread by drinking water or eating seafood or other foods that have been contaminated with the feces of infected people. It occurs in parts of Asia, Africa, Latin America, India, and the Middle East. Symptoms include watery diarrhea and exhaustion.

Encephalitis—Inflammation of the brain, usually caused by a virus. The inflammation may interfere with normal brain function and may cause seizures, sleepiness, confusion, personality changes, weakness in one or more parts of the body, and even coma.

Feces—(Also called stool.) The solid waste that is left after food is digested. Feces form in the intestines and pass out of the body through the anus.

Guillain-Barré syndrome (GBS)—A disease of the nerves with symptoms that include sudden numbness and weakness in the arms and legs, sometimes leading to paralysis. The disease is serious and requires medical treatment, but most people recover completely.

Immune system—The body's natural defenses against disease and infection.

Immunization—A process or procedure that protects the body against an infectious disease. A vaccination is a type of immunization.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Meningitis—Inflammation of tissues that surround the brain and spinal cord.

Microorganism—An organism that is too small to be seen with the naked eye.

Organism—An individual of some type of life form, such as a plant, an animal, or a microorganism.

Plague—A highly infectious disease that can be fatal if not treated promptly. The bacteria that cause plague mainly infect rats, mice, squirrels, and other wild rodents. The disease is passed to people through fleas. Infected people can then spread the disease to other people.

Seizure—A sudden attack, spasm, or convulsion.

Tuberculosis—An infectious disease that usually affects the lungs, but may also affect other parts of the body. Symptoms include fever, weight loss, and coughing up blood.

Typhoid fever—An infectious disease caused by a type of bacterium. People with this disease have a lingering fever and feel depressed and exhausted. Diarrhea and rose-colored spots on the chest and abdomen are other symptoms. The disease is spread through poor sanitation.

Virus—A tiny, disease-causing particle that can reproduce only in living cells.

Yellow fever—An infectious disease caused by a virus. The disease, which is spread by mosquitoes, is most common in Central and South America and Central Africa. Symptoms include high fever, jaundice (yellow eyes and skin) and dark-colored vomit, a sign of internal bleeding. Yellow fever can be fatal.

(MMR) as these vaccines could cause problems in the unborn baby.

Women who are breastfeeding should check with their physicians before taking any vaccine.

Side effects

Most side effects from vaccines are minor and easily treated. The most common are **pain**, redness, and swelling at the site of the injection. Some people may also develop a fever or a rash. In rare cases, vaccines may cause severe allergic reactions, swelling of the brain, or seizures. Anyone who has an unusual reaction after receiving a vaccine should get in touch with a physician right away.

Interactions

Vaccines may interact with other medicines and medical treatments. When this happens, the effects of the vaccine or the other medicine may change or the risk of side

effects may be greater. For example, **radiation therapy** and cancer drugs may reduce the effectiveness of many vaccines or may increase the chance of side effects. Anyone who takes a vaccine should let the physician know all other medicines he or she is taking and should ask whether the possible interactions could interfere with the effects of the vaccine or the other medicines.

Resources

PERIODICALS

Doheny, Kathleen. "Vaccinations Are for Big People Too: Adults Should Consider Asking Their Doctors about Hepatitis B and Other Ailments." *Vibrant Life* 11 (September-October 1995): 15.

Gindler, Jacqueline, et al. "Immunization—Effective at All Ages." *Patient Care* 29 (May 15, 1995): 119.

McCall, Timothy. "Should You Get a Flu Shot?" *American Health* 15 (September 1996): 23.

OTHER

Centers for Disease Control National Immunization Program. <http://www.cdc.gov/nip>.

National Immunization Information Hotline. Centers for Disease Control and Prevention. (800) 232-2522.

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Vaccines *see* **Vaccination**

Vaginal pain

Definition

Pain in the vaginal canal is usually associated with an underlying medical and/or psychological condition.

Description

Vaginal pain is experienced usually during vaginal manipulation or sexual intercourse. Approximately 50–85% of the causes are due to organic (medical) conditions. However, it is typical for the medical condition to be compounded by psychological issues such as depression and problems associated with sexual identity. The primary entity concerns dyspareunia, a vaginal pain experienced during sexual intercourse. The vagina has three physiological functions: an outflow duct for menstrual discharge, to receive the penis during sexual intercourse, and as the birthing canal. The overall prevalence for dyspareunia is 20% (15% of women and 57% of men). A significant percentage of **breast cancer** and **hysterectomy** patients demonstrated **sexual dysfunction**.

KEY TERMS

Laproscopic surgery— A surgical procedure to correct or diagnose an underlying disease.

Causes and symptoms

The causes can be categorized as organic, due to a medical condition and/or psychological difficulties. Medical conditions can include chronic diseases, minor ailments, breast **cancer**, and medications. Psychological cause can be related to physical or sexual **abuse**. **Pregnancy** and hormonal changes (decreased estrogen) have significant negative impact on sexual activity, desire, and satisfaction. Dyspareunia can be divided into three types of pain: superficial, vaginal, and deep. Superficial pain is associated with attempted penetration. This is usually caused by changes in anatomy, irritative condition, or vaginismus. Vaginal pain is associated with friction, indicating a problem with lubrication and /or arousal disorders. Deep pain is related to thrusting and is indicative of pelvic disease or an inability for **pelvic relaxation**.

Diagnosis

The diagnosis must be pursued with diligence and in a comprehensive manner. A careful history and **physical examination** is essential. Procedures that can be used include surgical investigation (**laparoscopy**) and treatment of the underlying cause(s).

Treatment

Treatment is directed at diagnosing the underlying condition, which can be medical and/or psychological cause(s). Treatment can include surgery, hormonal therapy (replacements), psychotherapy, and pain control protocols.

Prognosis

The prognosis depends on the primary cause. If treatment is aggressively pursued and patient compliance is satisfactory the overall outcome is favorable.

Prevention

There are no precise preventive measures since the condition can result from normal **aging** and/or progressively worsening psychological disease.

Resources

BOOKS

Ryan, Kenneth J., et al, eds. *Kistner's Gynecology & Women's Health.* 7th ed. Mosby, Inc., 1999.

Goroll, Allan H., et al. *Primary Care Medicine*. 4th ed. Lippincott, Williams & Wilkins, 2000.
Tasman, Allan, et al eds. *Psychiatry.* 1st ed. W. B. Saunders Company, 1997.

ORGANIZATION

The American College of Obstetricians and Gynecologists. 409 12th St., S.W., PO Box 96920, Washington, D.C., 20090-6920.

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Vaginal warts *see* **Genital warts**
Vaginitis *see* **Vulvovaginitis**

Vagotomy

Definition

Vagotomy is the surgical cutting of the vagus nerve to reduce acid secretion in the stomach.

Purpose

The vagus nerve splits into branches that go to different parts of the stomach. Stimulation from these branches causes the stomach to produce acid. Too much stomach acid leads to ulcers that may eventually bleed and create an emergency situation.

Vagotomy is performed when acid production in the stomach can not be reduced by other means. It is used when ulcers in the stomach and duodenum do not respond to medication and changes in diet. It is an appropriate surgery when there are ulcer complications, such as obstruction of digestive flow, bleeding, or perforation. The frequency with which elective vagotomy is performed has decreased in the past 20 years as drugs have become increasingly effective in treating ulcers. However, the number of vagotomies performed in emergency situations has remained about the same.

Vagotomy is often performed in conjunction with other gastrointestinal surgery, such as partial removal of the stomach (antrectomy or subtotal **gastrectomy**). There are several types of vagotomies. Truncal vagotomy severs the trunk of the vagus nerve as it enters the abdomen. Parietal cell or proximal gastric vagotomy leaves the trunk intact, but severs the branches that go to different parts of the stomach.

Precautions

Patients who receive vagotomies are most often seen in emergency situations where bleeding and perforated ulcers make it necessary to act immediately. As with any major surgery, people who use alcohol excessively, smoke, are obese, and are very young or very old are at higher risks for complications.

Description

Vagotomy is performed under general anesthesia by a surgeon in a hospital. The surgeon makes an incision in the abdomen and locates the vagus nerve. Either the trunk or the branches leading to the stomach are cut. Then the abdominal muscles are sewn back together, and the skin is closed with sutures.

Often, other gastrointestinal surgery is performed at the same time as the vagotomy. Part of the stomach may be removed, for instance. Vagotomy causes a decrease in peristalsis and a change in the emptying patterns of the stomach. To ease this, a **pyloroplasty** is often performed. This procedure widens the outlet from the stomach to the small intestine.

Preparation

A gastroscopy and x rays of the gastrointestinal system are performed as diagnostic procedures to determine the position and condition of the ulcer. Standard preoperative blood and urine tests are done. The patient should discuss with the anesthesiologist any medications or conditions that might affect the administration of anesthesia.

Aftercare

Patients who have had a vagotomy stay in the hospital for about seven days. For the first three or four days, nasogastric suctioning is required. A tube is inserted through the nose and into the stomach. The stomach contents are then suctioned out. Patients eat a clear liquid diet until the gastrointestinal tract is functioning again. When patients return to a regular diet, spicy and acidic food should be avoided.

It takes about six weeks to fully recover from the surgery. The sutures that close the skin can be removed in seven to ten days. Patients are encouraged to move around soon after the operation to prevent the formation of deep vein blood clots. **Pain** medication, stool softeners, and **antibiotics** may be prescribed following the operation.

Risks

As with all surgery, excessive bleeding and infection are possible complications. In addition, the emptying patterns of the stomach are changed. This can lead to dumping syndrome and **diarrhea**. Dumping syndrome is a condition where shortly after eating, the patient experi-

ences **palpitations**, sweating, nausea, cramps, vomiting, and diarrhea.

Normal results

Normal recovery is expected for most patients. In about 10% of those who have vagotomy without stomach removal, ulcers recur. Two to three percent of patients who have some portion of their stomach removed also have recurrent ulcers.

Resources

BOOKS

"Stomach and Duodenum." In *Current Surgical Diagnosis and Treatment*. 10th ed. Ed. Lawrence W. Way. Stamford: Appleton & Lange, 1994.

Tish Davidson

Valacyclovir *see* **Antiviral drugs**

Valley fever *see* **Coccidioidomycosis**

Valsalva maneuver

Definition

The Valsalva maneuver is performed by attempting to forcibly exhale while keeping the mouth and nose closed. It is used as a diagnostic tool to evaluate the condition of the heart and is sometimes done as a treatment to correct abnormal heart rhythms or relieve chest **pain**.

Purpose

The Valsalva maneuver is used with patients who have suspected heart abnormalities, often in conjunction with **echocardiography**. The maneuver is based on the fact that when a patient forcibly exhales against a closed nose and mouth while bearing down, as if having a bowel movement, specific changes occur in blood pressure and the rate and volume of blood returning to the heart.

Comparing the changes in a diseased heart to those expected in a normal heart gives clues to the type and location of heart damage. In addition, when a doctor listens to the chest with a stethoscope during the Valsalva maneuver, characteristic heart sounds are heard. Variations in these sounds can indicate the type of abnormality present in the heart.

The Valsalva maneuver also corrects some rapid heartbeats originating in the atria. When the maneuver is done correctly, blood pressure rises. This forces the heart to respond by correcting its rhythm and beating more slowly. On rare occasions, the Valsalva maneuver can be used to diminish chest pain in patients with mild coronary disease.

Unrelated to any evaluation of the heart, the Valsalva maneuver is also taught to patients with **multiple sclerosis** who are unable to fully empty the bladder (flaccid bladder). It is sometimes used in sexual therapy to help men avoid **premature ejaculation**.

KEY TERMS

Atria—The heart has four chambers. The right and left atria are at the top of the heart and receive returning blood from the veins. The right and left ventricles are at the bottom of the heart and act as the body's main pumps.

Echocardiography—An ultrasound test that shows the size, shape, and movement of the heart.

Precautions

The Valsalva maneuver should not be performed on patients who have severe **coronary artery disease**, have experienced recent **heart attack**, or where there is a moderate to severe reduction in blood volume.

Description

When performed formally, the patient is asked to blow against an aneroid pressure measuring device (manometer) and maintain a pressure of 40 millimeters of mercury (mm Hg) for 30 seconds. Or, less formally, the patient may be asked to bear down, as if having a bowel movement. During this 30 second period, a recording is made of the changes in blood pressure and murmurs of the heart.

Preparation

The patient may be connected to a heart monitor and echocardiograph or the physician may simply use a stethoscope to monitor the heart. Sometimes an indwelling needle is inserted for accurate pressure measurements, depending on whether the procedure is being done for corrective or diagnostic purposes.

Aftercare

When this procedure is done to regulate irregular heart rhythms, the patient usually remains on a heart monitor to evaluate heartbeat.

Risks

The patient may feel dizzy or faint during the procedure, but serious consequences are rare. There is a risk that the Valsalva maneuver can cause blood clots to detach, bleeding, and abnormal rhythms originating in the ventricle. It can also cause cardiac arrest. Consequently, the procedure is usually performed in a setting where emergency equipment is accessible.

Normal results

There are four characteristic changes or phases in a normal heart's response to the Valsalva maneuver. An abnormality in any of these phases indicates a cardiovascular abnormality.

Resources

BOOKS

Braunwald, Eugene, ed. *Heart Disease: A Textbook of Cardiovascular Medicine.* Philadelphia: W. B. Saunders Co., 1997.

"Valsalva's Maneuver." In *Everything You Need to Know About Medical Treatments.* Springhouse, PA: Springhouse Corp., 1996.

Tish Davidson

Valvular heart disease

Definition

Valvular heart disease refers to several disorders and diseases of the heart valves, which are the tissue flaps that regulate the flow of blood through the four chambers of the heart.

Description

The human heart consists of four chambers—two upper chambers (the atria) and two lower chambers (the ventricles)—that are responsible for pumping blood. The heart valves are like one-way doors, which open and close with each beat of the heart, controlling the blood flow from one chamber to the next. Each of these valves is made up of a few thin folds of tissue. When functioning correctly, they keep blood from flowing backwards into a chamber when closed.

The four valves function in the following manner:

- The mitral valve is located between the left atrium and the left ventricle. It is the only valve with two flaps, or cusps.
- The tricuspid valve is located on the right side of the heart, between the right atrium and right ventricle. It is made up of three cusps, each a different size.
- The aortic valve is located on the left side of the heart and opens to allow blood to leave the heart from the left ventricle into the aorta, which is the main artery of the body. It closes to prevent blood from flowing back into the left ventricle.
- The pulmonary valve is situated on the right side of the heart, between the right ventricle and pulmonary artery. It allows blood to exit the heart and enter the lungs via the pulmonary artery. It closes to prevent blood from flowing back into the right ventricle.

Patients with valvular heart disease have a malfunction of one or more of these valves. There are several types of valvular heart diseases with distinct symptoms and treatments. These are:

- mitral valve prolapse (displacement)
- mitral valve insufficiency (regurgitation)
- mitral valve stenosis (narrowing)
- aortic valve insufficiency
- aortic valve stenosis
- tricuspid valve insufficiency
- tricuspid valve stenosis
- pulmonic stenosis
- pulmonic insufficiency

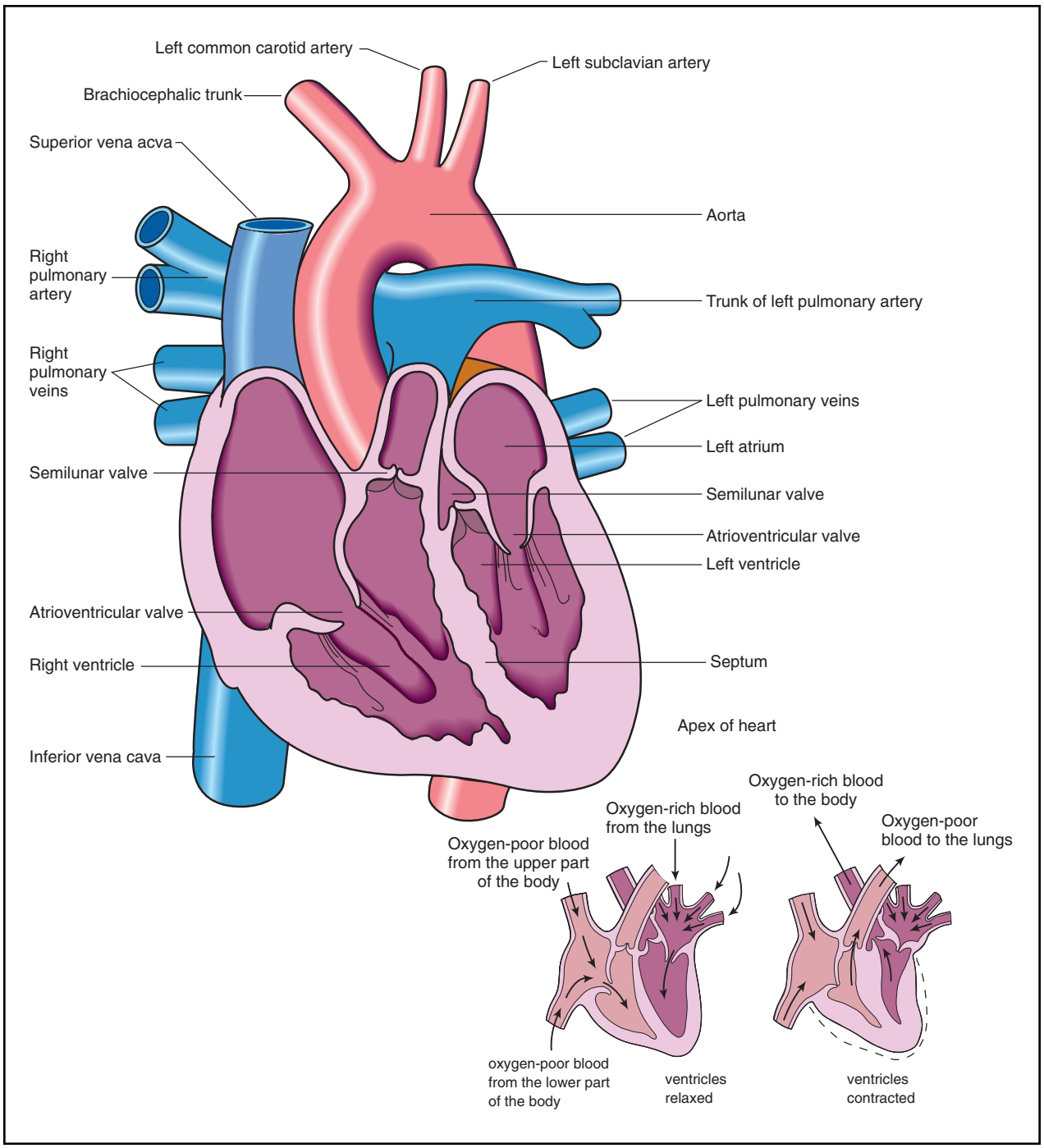
Certain types of heart disease can lead to one of the specific conditions listed above. These include **rheumatic fever** and infective inflammation of the heart (**endocarditis**). Multivalvular heart disease refers to a condition involving more than one of the heart valves.

Causes and symptoms

Problems with heart valves may occur as a result of infection, degeneration, or congenital abnormality. The most common infections are rheumatic **fever** and infective endocarditis.

Rheumatic fever

Rheumatic fever is a condition that results from the body's immune response to certain types of streptococcal bacteria. It occurs rarely. When it does occur, it is most often in children who have had **strep throat** that was not completely treated. The symptoms of rheumatic fever include heart inflammation, uncontrolled movement of limbs and face, arthritis that moves from joint to joint, **shortness of breath**, weakness, and either lumps under the skin or raised red patches on the skin. The most common valvular heart diseases to result from rheumatic fever



Anatomy of the human heart. The illustration at the bottom right shows how the right and left ventricles contract and relax when blood is pumped through the heart. *(Illustration by Hans & Cassady, Inc.)*

are mitral stenosis, tricuspid stenosis, aortic insufficiency, aortic stenosis, multivalvular involvement, and less commonly, pulmonic stenosis. Chronic rheumatic heart disease can result from one occurrence or from repeated attacks. It is not as common as it once was in the United States, but still occurs frequently in developing countries.

Infective endocarditis

Infective endocarditis is an infection and inflammation of the inner layer, or membrane, of heart tissue (endocardium). Most people with a healthy, normal heart are not at significant risk for contracting infective endocarditis. However, people who have had rheumatic fever, with its

resulting scarring, or a congenital cause of heart malformation, may contract this disease when certain bacteria enter the bloodstream and become lodged in the heart. In particular, dental surgery or any surgery involving the mouth, bladder, prostate, or female pelvic organs increases risk for this infection. The disease may also occur in drug addicts who inject their veins using unsterilized needles, even if they have normal heart valves. Symptoms of infective endocarditis include fever, a new or changing heart murmur, and abnormal loss of appetite or **fatigue**.

The use of appetite suppressants

In 1997 and early 1998, research was underway to determine if fen-phen, the abbreviation for a combination of the two weight-loss drugs fenfluramine and phentermine, caused heart valve problems in some patients. Physicians were concerned that this drug combination could affect the heart valves because the drugs alter metabolism of serotonin in the body. Serotonin is a natural substance found in the brain and intestines that can affect blood vessels. Until the issue could be studied more, physicians recommended that patients taper off the drugs, finally stopping them altogether. The drug's manufacturer removed fenfluramine from the market until further study was conducted.

Other valvular heart disease

The mitral and aortic valves may also be affected by deposits of calcium in the heart that occurs with **aging**. This can lead to thickening and leakage of heart valves. Heart attacks can also damage the mitral valve structures. Additionally, certain connective tissue disorders can adversely affect the heart valves, for example, Marfan's syndrome and myxomatous degeneration.

Diagnosis

Specific types of valvular heart disease are diagnosed using **electrocardiography** (EKG), **echocardiography**, certain x-ray studies, and/or **cardiac catheterization**. An EKG provides a record of electrical changes in the heart muscle during the heartbeat. Echocardiography uses sound waves to make images of the heart. These images can show if there are any abnormalities of the heart valves. Cardiac catheterization is a procedure in which a small tube (called a catheter) is inserted into an artery and passed into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart.

Rheumatic fever

Rheumatic fever may be suspected when a recent throat infection has occurred and other major or minor symptoms appear, such as joint ache, abnormal EKG, or a blood test indicating heart inflammation. **Heart murmurs** may be detected from routine examination.

Infective endocarditis

A diagnosis of infective endocarditis can be obtained through patient history, EKG, ultrasound, or cardiac catheterization. Patients who have developed the disease rapidly may report fever, fatigue, night sweats, chills, and joint inflammation. Those whose disease has developed more slowly will show signs of rapid heart rate, an enlarged spleen, various skin colors or spots, and heart murmur. The physician may order blood tests to determine what is causing the infection.

Appetite suppressants

People with a history of using appetite suppressants may be sent for EKGs or further testing if any of the symptoms of valvular heart disease, such as swelling, considerable fatigue, or shortness of breath occur.

Treatment

The treatment of specific valvular heart diseases will vary, depending on the valve involved and the extent of damage or malfunction. Some patients will not require treatment and many will be treated with medication. Sometimes, patients need surgery. If multivalvular disease is suspected or involved, different valves may be evaluated during surgery on one of the affected valves.

Rheumatic fever

Patients with rheumatic fever will be treated with **antibiotics** to eliminate streptococcal organisms that may still remain in the heart. Patients may receive antibiotics to prevent further infection, and inflammation may be treated with **aspirin** or cortisone-like drugs.

Infective endocarditis

Physicians will use the appropriate antibiotic or some combination of antibiotics to treat infective endocarditis, depending on the type of bacterium that caused the disease. Severe cases of this disease may be corrected by valve replacement surgery.

Appetite suppressants

The role of appetite suppressants (fen-phen) in valvular heart disease has been under study. As of 1998, these drugs were voluntarily removed from the market.

Prognosis

The prognosis for patients with valvular heart disease varies depending on the underlying cause, age and

health of the patient, and the degree of valvular damage or involvement.

Rheumatic fever

Patients with rheumatic heart disease face a lifetime of caution over contact with the same bacterium that caused the disease. Since it can cause inflammation of one or more organs or joints, complications can occur. The inflammation of the heart may subside without side effects. Permanent scarring of one or more heart valves is a possibility and may require surgery to repair or replace damaged valves. In severe cases, rheumatic fever can lead to **death** from **heart failure**.

Infective endocarditis

The prognosis for patients with infective endocarditis depends on the underlying heart disease and resulting complications. If the disease further damages heart valves, symptoms may occur for years after initial treatment. Sometimes, endocarditis can result in heart or renal failure. If untreated, it can be fatal.

Appetite suppressants

As of early 1998, prognosis for patients with valvular heart disease resulting from the use of certain appetite suppressants was still under study. Since it is believed that different valves may be affected, treatment would most likely follow a similar course as that for the specific valvular disease.

Prevention

Certain measures can be taken to prevent some valvular disease. However, once valvular heart disease that results from congenital abnormality occurs, it may not be prevented. Steps can be taken to prevent further complications.

Rheumatic fever

The best prevention for rheumatic fever is prompt and thorough treatment of any suspected streptococcal infection, particularly strep throat in children. A physician should check any **sore throat** with fever that persists for more than 24 hours. The physician will probably order a **throat culture**. Completion of the antibiotic treatment even after symptoms diminish is important to be certain the infection is eliminated.

Infective endocarditis

Anyone who was born with a defective hart valve, those with artificial (prosthetic) valves, or those who have had a valve scarred by rheumatic fever, should use prescribed antibiotics by mouth before and after a dental procedure. These patients may also need to receive injected antibiotics prior to procedures involving the bladder, prostate, and pelvic organs.

KEY TERMS

Congenital—Used to describe a condition or defect present at birth.

Stenosis—An abnormal valve condition which is characterized by tightening or narrowing of the opening.

Streptococcal (*Streptococcus*)—*Streptococcus* is a bacterium that causes infection in people. Its most commonly known strain causes the infection strep throat.

Throat culture—A test for strep throat that involves swabbing the back of the throat and sending the swab to a laboratory, which will determine whether bacteria is present.

Appetite suppressants

The drug associated with valvular heart disease, fenfluramine, was not available on the market as of mid-1998.

Resources

BOOKS

Current Medical Diagnosis and Treatment, 1996. 35th ed. Ed. Stephen McPhee, et al. Stamford: Appleton & Lange, 1995.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

OTHER

Mayo Clinic Online. 5 Mar. 1998 <http://www.mayohealth.org>.

Teresa Norris, RN

Valvuloplasty *see* **Heart valve repair**

Varicella *see* **Chickenpox**

Varicocele removal *see* **Testicular surgery**

Varicose veins

Definition

Varicose veins are dilated, tortuous, elongated superficial veins that are usually seen in the legs.

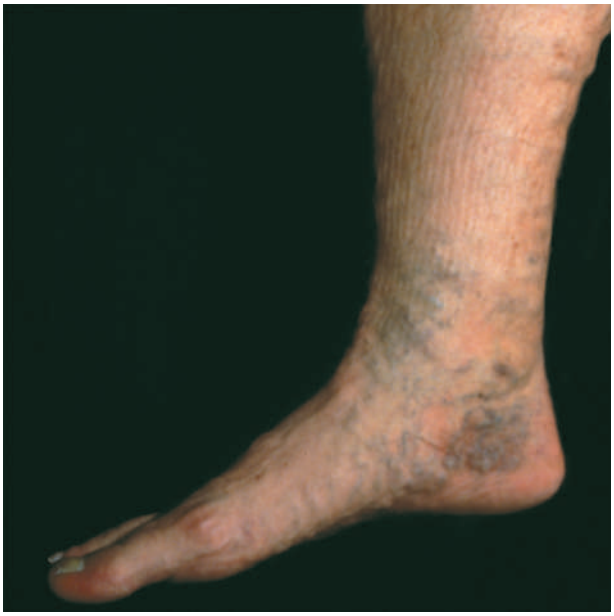
Description

Varicose veins, also called varicosities, are seen most often in the legs, although they can be found in other parts of the body. Most often, they appear as lumpy, winding vessels just below the surface of the skin. There are three types of veins, superficial veins that are just beneath the surface of the skin, deep veins that are large blood vessels found deep inside muscles, and perforator veins that connect the superficial veins to the deep veins. The superficial veins are the blood vessels most often affected by varicose veins and are the veins seen by eye when the varicose condition has developed.

The inside wall of veins have valves that open and close in response to the blood flow. When the left ventricle of the heart pushes blood out into the aorta, it produces the high pressure pulse of the heartbeat and pushes blood throughout the body. Between heartbeats, there is a period of low blood pressure. During the low pressure period, blood in the veins is affected by gravity and wants to flow downward. The valves in the veins prevent this from happening. Varicose veins start when one or more valves fail to close. The blood pressure in that section of vein increases, causing additional valves to fail. This allows blood to pool and stretch the veins, further weakening the walls of the veins. The walls of the affected veins lose their elasticity in response to increased blood pressure. As the vessels weaken, more and more valves are unable to close properly. The veins become larger and wider over time and begin to appear as lumpy, winding chains underneath the skin. Varicose veins can develop in the deep veins also. Varicose veins in the superficial veins are called primary varicosities, while varicose veins in the deep veins are called secondary varicosities.

Causes and symptoms

The predisposing causes of varicose veins are multiple, and lifestyle and hormonal factors play a role. Some families seem to have a higher incidence of varicose veins, indicating that there may be a genetic component to this disease. Varicose veins are progressive; as one section of the veins weakens, it causes increased pressure on adjacent sections of veins. These sections often develop varicosities. Varicose veins can appear following **pregnancy**, **thrombophlebitis**, congenital blood vessel weakness, or **obesity**, but is not limited to these conditions. **Edema** of the surrounding tissue, ankles, and calves, is not usually a complication of primary (superficial) varicose veins and, when seen, usually indicates that the deep veins may have varicosities or clots.

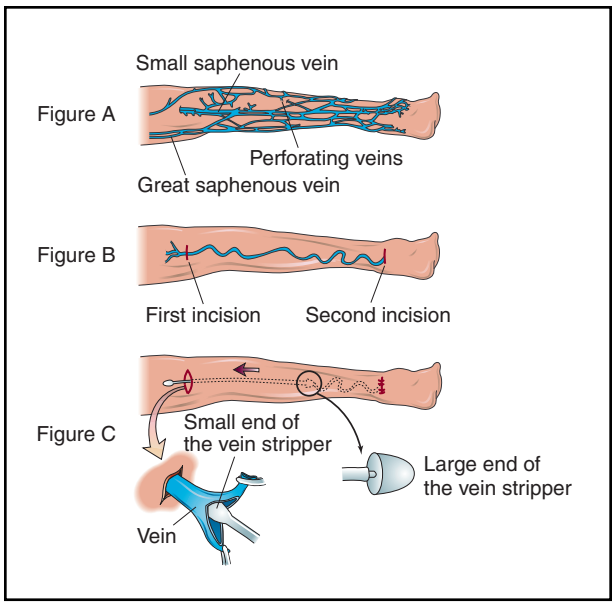


Varicose veins on a man's leg. *(Custom Medical Stock Photo. Reproduced by permission.)*

Varicose veins are a common problem; approximately 15% of the adult population in the United States have varicose veins. Women have a much higher incidence of this disease than men. The symptoms can include aching, **pain**, itchiness, or burning sensations, especially when standing. In some cases, with chronically bad veins, there may be a brownish discoloration of the skin or ulcers (open sores) near the ankles. A condition that is frequently associated with varicose veins is spider-burst veins. Spider-burst veins are very small veins that are enlarged. They may be caused by back-pressure from varicose veins, but can be caused by other factors. They are frequently associated with pregnancy and there may be hormonal factors associated with their development. They are primarily of cosmetic concern and do not present any medical concerns.

Diagnosis

Varicose veins can usually be seen. In cases where varicose veins are suspected, but can not be seen, a physician may frequently detect them by palpation (pressing with the fingers). X rays or ultrasound tests can detect varicose veins in the deep and perforator veins and rule out blood clots in the deep veins.



Varicose veins may be surgically removed from the body when they are causing pain and when hemorrhaging or recurrent thrombosis appear. Surgery involves making an incision through the skin at both ends of the section of vein being removed (figure B). A flexible wire is inserted through one end and extended to the other. The wire is then withdrawn, pulling the vein out with it (figure C). *(Illustration by Electronic Illustrators Group.)*

KEY TERMS

Congenital—Existing at or before birth; a condition that developed while the fetus was in utero or as a consequence of the birth process.

Edema—Swelling caused by a collection of fluid in a tissue or body cavity.

Hemorrhage—Bleeding from blood vessels.

Palpation—The process of examining a patient by touch.

Treatment

There is no cure for varicose veins. Treatment falls into two classes; relief of symptoms and removal of the affected veins. Symptom relief includes such measures as wearing support stockings, which compress the veins and hold them in place. This keeps the veins from stretching and limits pain. Other measures are sitting down, using a footstool when sitting, avoiding standing for long periods of time, and raising the legs whenever possible. These measures work by reducing the blood pressure in leg veins. Prolonged standing allows the blood to collect under high pressure in the varicose veins. **Exercise** such as walking, biking, and swimming, is beneficial. When the legs are active, the leg muscles help pump the blood in the veins. This limits the amount of blood that collects in the varicose veins and reduces some of the symptoms. These measures reduce symptoms, but do not stop the disease.

Surgery is used to remove varicose veins from the body. It is recommended for varicose veins that are causing pain or are very unsightly, and when hemorrhaging or recurrent thrombosis appear. Surgery involves making an incision through the skin at both ends of the section of vein being removed. A flexible wire is inserted through one end and extended to the other. The wire is then withdrawn, pulling the vein out with it. This is called "stripping" and is the most common method to remove superficial varicose veins. As long as the deeper veins are still functioning properly, a person can live without some of the superficial veins. Because of this, stripped varicose veins are not replaced.

Injection therapy is an alternate therapy used to seal varicose veins. This prevents blood from entering the sealed sections of the vein. The veins remain in the body, but no longer carry blood. This procedure can be performed on an out-patient basis and does not require anesthesia. It is frequently used if people develop more varicose veins after surgery to remove the larger varicose veins and to seal spider-burst veins for people concerned about cosmetic appearance. Injection therapy is also called sclerotherapy. At one time, a method of injection therapy was used that did not have a good success rate. Veins did not seal properly and blood clots formed. Modern injection therapy is improved and has a much higher success rate.

Prognosis

Untreated varicose veins become increasingly large and more obvious with time. Surgical stripping of varicose veins is successful for most patients. Most do not develop new, large varicose veins following surgery. Surgery does not decrease a person's tendency to develop varicose veins. Varicose veins may develop in other locations after stripping.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York: McGraw-Hill 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

Larsen, D. E., ed. *Mayo Clinic Family Health Book.* New York: William Morrow and Co., Inc. 1996.

John T. Lohr, PhD

Variola *see* **Smallpox**

Vascular headache *see* **Migraine headache**

Vasculitis

Definition

Vasculitis refers to a varied group of disorders which all share a common underlying problem of inflammation of a blood vessel or blood vessels. The inflammation may affect any size blood vessel, anywhere in the body. It may affect either arteries and/or veins. The inflammation may be focal, meaning that it affects a single location within a vessel; or it may be widespread, with areas of inflammation scattered throughout a particular organ or tissue, or even affecting more than one organ system in the body.

Description

Inflammation is a process which occurs when the immune system of the body responds to either an injury or a foreign invader (virus, bacteria, or fungi). The immune system response involves sending a variety of cells and chemicals to the area in question. Inflammation causes blood vessels in the area to leak, causing swelling. The inflamed area becomes red, hot to the touch, and tender.

Antibodies are immune cells which recognize and bind to specific markers (called antigens) on other cells (including bacteria and viruses). These antibody-antigen complexes can then stimulate the immune system to send a variety of other cells and chemicals involved in inflammation to their specific location.

Some researchers believe that the damaging process of vasculitis is kicked off by such antibody-antigen complexes. These complexes are deposited along the walls of the blood vessels. The resulting inflow of immune cells and chemicals causes inflammation within the blood vessels.

The type of disease caused by vasculitis varies depending on a number of factors:

- the organ system or tissue in which the vasculitis occurs
- the specific type of inflammatory response provoked
- whether the affected vessels are veins (which bring blood to the heart) or arteries (which carry blood and oxygen from the heart to the organs and tissues)
- the degree to which blood flow within the affected vessel is reduced

Causes and symptoms

Some types of vasculitis appear to be due to a type of allergic response to a specific substance (for example, a drug). Other types of vasculitis have no identifiable initiating event. Furthermore, researchers have not been able to consistently identify antibody-antigen complexes in all of the types of diseases caused by vasculitis. The types of antigens responsible for the initial immune response have often gone unidentified as well. Furthermore, not all people with such complexes deposited along the blood vessels go on to develop vasculitis. Some researchers believe that, in addition to the presence of immune complexes, an individual must have some other characteristics which make him or her susceptible to vasculitis. Many questions have yet to be answered to totally explain the development these diseases.

Symptoms

Symptoms of vasculitis depend on the severity of the inflammation and the organ system or systems affected. Some types of vasculitis are so mild that the only symptoms noted are small reddish-purple dots (called petechiae) on the skin due to tiny amounts of blood seeping out of leaky blood vessels. In more widespread types of vasculitis, the patient may have general symptoms of illness, including **fever**, achy muscles and joints, decreased appetite, weight loss, and loss of energy. The organ systems affected by vasculitis may include:

- The skin. **Rashes**, bumps under the skin, petechiae, larger reddish-purple circles (purpura), or bruising (ecchymoses) may appear. Areas of skin totally deprived of blood flow, and therefore of oxygen, may die, resulting in blackened areas of gangrene.
- The joints. In addition to joint **pain**, the joints themselves may become inflamed, resulting in arthritis.
- Brain and nervous system. Inflammation of the blood vessels in the brain can cause headaches, changes in personality, confusion, and seizures. If an area of the brain becomes totally deprived of oxygen, a **stroke** occurs. A stroke means that an area of brain tissue is either severely injured or completely dead from lack of oxygen. This may leave the individual with a permanent disability. If the vessels that lead to the eyes are affected, vision may become seriously disturbed. Nerves in the arms and legs may result in painful tingling sensations, loss of feeling, and weakness.
- Gastrointestinal system. Patients may have significant abdominal pain, vomiting, and **diarrhea**. If blood flow

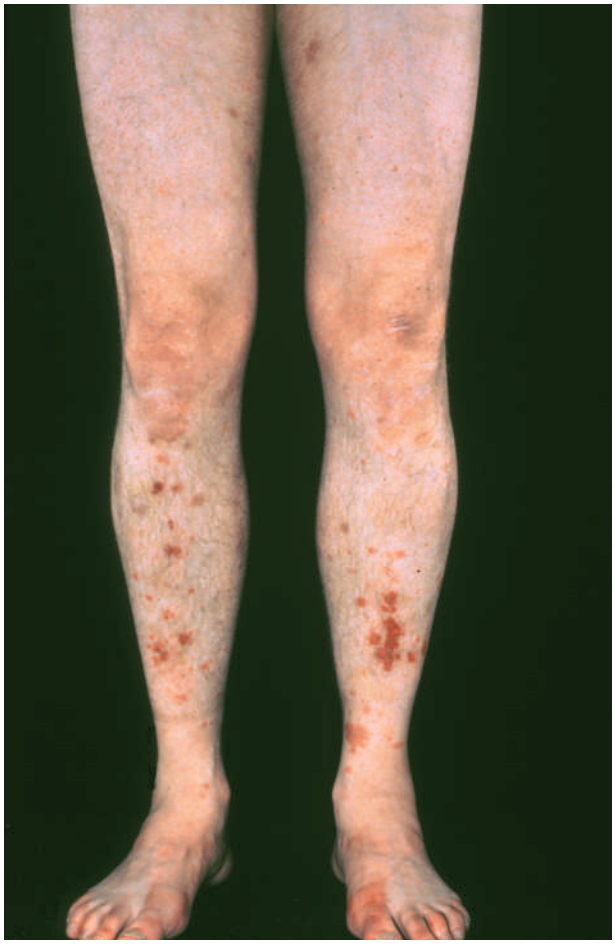
is completely cut off to an area of intestine, that part of the intestine will die off. The liver may be affected.

- Heart. This is an extremely serious type of vasculitis. The arteries of the heart (coronary arteries) may develop weakened areas, called aneurysms. The heart muscle itself may become inflamed and enlarged. With oxygen deprivation of the heart muscle, the individual may suffer a heart attack.
- Lungs. The patient may experience **shortness of breath** with chest pain, and may **cough** up blood. There may be **wheezing**.
- Kidney. Changes in the arteries of the kidney may result in high blood pressure. The kidneys may become increasingly unable to appropriately filter the blood, and kidney failure may occur.

Specific diseases

Multiple types of disease are associated with vasculitis. Many autoimmune diseases have vasculitis as one of their complications. These include **systemic lupus erythematosus**, **rheumatoid arthritis**, **scleroderma**, and **polymyositis**. Other types of diseases which have vasculitis as their major manifestations include:

- Polyarteritis nodosa. This is an extremely serious, systemic (affecting systems throughout the body) form of vasculitis. Small and medium arteries are involved, and the inflammation is so severe that the walls of the arteries may be destroyed. Any organ system, or multiple organ systems, may be affected. The most serious effects include kidney failure, complications involving the heart, gastrointestinal problems, and high blood pressure.
- Kawasaki's disease is an acute disease which primarily strikes young children. Fever and skin manifestations occur in all patients. While most patients recover completely, a few patients suffer from vasculitis in the heart. This is frequently fatal.
- Henoch-Schonlein purpura. While this frequently occurs in children, adults may also be affected. This disease tends to affect the skin, joints, gastrointestinal tract, and kidneys.
- **Serum sickness** occurs when an individual reacts to a component of a drug, for example penicillin. Symptoms of this are often confined to the skin, although fevers, joint pain, and swelling of lymph nodes may also occur.
- **Temporal arteritis** (also called giant cell arteritis) tends to involve arteries which branch off the major artery that leads to the head, called the carotid. An artery which feeds tissues in the area of the temple (the temporal artery) is often affected. Severe headaches are the most classic symptom. Other symptoms include **fatigue**, loss of appetite and then weight, fever, heavy sweating, joint pain, and pain in the muscles of the neck, shoulders, and back. If the vasculitis includes arteries which supply the eye, serious visual disturbance or even blindness may result.
- Takayasu's arteritis affects the aorta (the very large main artery that exits the heart and receives all of the blood to be delivered throughout the body), and arteries which branch off of the aorta. Initial symptoms include fatigue, fever, sweating at night, joint pain, and loss of appetite and weight. Every organ may be affected by this disease. A common sign of this disease is the inability to feel the pulse in any of the usual locations (the pulse is the regular, rhythmic sensation one can feel with a finger over an artery, for example in the wrist, which represents the beating of the heart and the regular flow of blood).



This person's legs are afflicted with leukocytoblastic vasculitis, a condition in which a blood or lymph vessel becomes inflamed. *(Custom Medical Stock Photo. Reproduced by permission.)*

KEY TERMS

Aneurysm—A weakened area in the wall of a blood vessel which causes an outpouching or bulge. Aneurysms may be fatal if these weak areas burst, resulting in uncontrollable bleeding.

Antibody—Specialized cells of the immune system which can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Antigen—A special, identifying marker on the outside of cells.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system therefore attacks and causes damage to these tissues.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Inflammation—The body's response to tissue damage. Includes hotness, swelling, redness, and pain in the affected part.

Petechia—A tiny, purplish-red spot on the skin. Caused by the leakage of a bit of blood out of a vessel and under the skin.

Purpura—A large, purplish-red circle on the skin. Caused by the leakage of blood out of a vessel and under the skin.

- **Wegener's granulomatosis**: This disease exerts its most serious effects on the respiratory tract. The vasculitis produced by this disease includes the formation of fibrous, scarring nodules called granulomas. Symptoms include nose bleeds, ear infections, cough, shortness of breath, and chest pain. There may be bleeding in the lungs, and a patient may cough up blood. The kidneys, eyes, and skin are also frequently involved.

Diagnosis

Diagnosis of any type of vasculitis involves demonstrating the presence of a strong inflammatory process. Tests which reveal inflammation throughout the body include **erythrocyte sedimentation rate**, blood tests which may reveal anemia and increased white blood cells, and tests to demonstrate the presence of immune complexes and/or antibodies circulating in the blood. An x-ray procedure, called **angiography**, involves injecting dye into a major artery, and then taking x-ray pictures to examine the blood vessels, in order to demonstrate the presence of inflammation of the vessel walls. Tissue samples (biopsies) may be taken from affected organs to demonstrate inflammation.

Treatment

Even though there are many different types of vasculitis, with many different symptoms based on the organ system affected, treatments are essentially the same. They all involve trying to decrease the activity of the immune system. Steroid medications (like prednisone) are usually the first types of drugs used. Steroids work by interfering with the chemicals involved in the inflammatory process. More potent drugs for severe cases of vasculitis have more serious side effects. These include drugs like cyclophosphamide. Cyclophosphamide works by actually killing cells of the patient's immune system.

Prognosis

The prognosis for vasculitis is quite variable. Some mild forms of vasculitis, such as those brought on by reactions to medications, may resolve totally on their own and not even require treatment. Temporal arteritis, serum sickness, Henoch-Schonlein purpura, and Kawasaki's disease usually have excellent prognoses, although when Kawasaki's affects the heart, there is a high **death** rate. Other types of vasculitis were always fatal, prior to the availability of prednisone and cyclophosphamide, and continue to have high rates of fatal complications. These include polyarteritis nodosa and Wegener's granulomatosis.

Prevention

Because so little is known about what causes a particular individual to develop vasculitis, there are no known ways to prevent it.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

"Vasculitides." In *Cecil Essentials of Medicine*, ed. Thomas E. Andreoli, et al. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Bush, Thomas M. "Systemic Vasculitis: Diagnostic Clues to this Confusing Array of Diseases." *Postgraduate Medicine* 103, no. 2 (Feb. 1998): 68+.

Jennette, J. Charles. "Small-Cell Vasculitis." *The New England Journal of Medicine* 337, no. 21 (20 Nov. 1997): 1512+.

Ledford, Dennis K. "Immunologic aspects of Vasculitis and Cardiovascular Disease." *The Journal of the American Medical Association* 278, no. 22 (10 Dec. 1997): 1962+.
Watts, R. A., and D. G. I. Scott. "Rashes and Vasculitis." *British Medical Journal* 310, no. 6987 (29 Apr. 1995): 1128+.

ORGANIZATIONS

Lupus Foundation of America. 1300 Piccard Dr., Suite 200, Rockville, MD 20850. (800) 558-0121. <http://www.lupus.org>.
Wegener's Foundation, Inc. 3705 South George Mason Drive, Suite 1813 South, Falls Church, VA 22041. (703) 931-5852.

Rosalyn Carson-DeWitt, MD

Vasectomy

Definition

A vasectomy is a surgical procedure performed on males in which the vas deferens (tubes that carry sperm from the testicles to the seminal vesicles) are cut, tied, cauterized (burned or seared) or otherwise interrupted. The semen no longer contains sperm after the tubes are cut, so conception cannot occur. The testicles continue to produce sperm, but they die and are absorbed by the body.

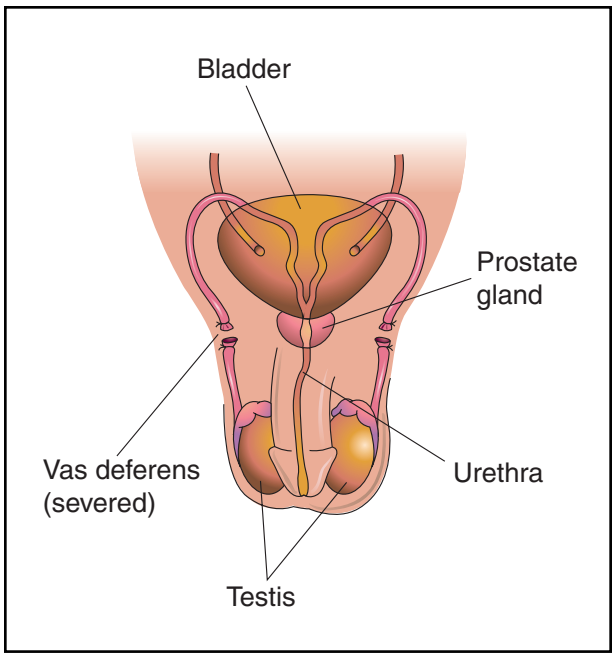
Purpose

The purpose of this operation is to provide reliable **contraception**. Research indicates that the level of effectiveness is 99.6%. Vasectomy is the most reliable method of contraception.

Description

Vasectomies are often performed in the doctor's office using a local anesthesia. The patient's scrotum area will be shaved and cleaned with an antiseptic solution to reduce the chance of infection. A small incision is made into the scrotum (the sac containing the testicles that produce the sperm). Each of the vas deferens (one from each testicle) is tied in two places with nonabsorbable (permanent) sutures and the tube is severed between the ties. The ends may be cauterized (burned or seared) to decrease the chance that they will leak or grow back together.

Sterility does not occur immediately after the procedure is finished. Men must use other methods of contraception until two consecutive semen analyses confirm that there are no sperm present in the semen. This will take four to six weeks or 15-20 ejaculations to clear all of the sperm from the tubes.



Vasectomy is a surgical procedure performed on males in which the vas deferens (tubes that conduct sperm from the testicles to the penis) are cut, tied, cauterized, or otherwise interrupted. Although the testicles still produce sperm, the sperm die and are absorbed by the body. Men who have had vasectomies may continue to ejaculate the same amount of semen as before the procedure. *(Illustration by Electronic Illustrators Group.)*

"No scalpel" vasectomies are gaining popularity. Instead of an incision, a small puncture is made into the scrotum. The vas deferens are cut and sealed in a manner similar to that described above. No stitches are necessary and the patient has less **pain**. Other advantages include less damage to the tissues, less bleeding, less risk of infection, and less discomfort after the procedure.

In some, cases vasectomies may be reversed. However, this procedure should be considered permanent as there is no guarantee of successful reversal.

Preparation

No special physical preparation is required. The physician will first assess the patient's general health in order to identify any potential problems that could occur. The doctor will then explain possible risks and side effects. The patient is asked to sign a consent form which indicates that he understands the information he has received, and gives the doctor permission to perform the operation.

Aftercare

Following the surgery, ice packs are often applied to scrotum to decrease pain and swelling. A dressing

KEY TERMS

Ejaculation—The act of expelling the sperm through the penis during orgasm.

Epididymitis—Inflammation of the small tube that rests on top of the testicle and is part of the system that carries sperm from the testicle to the penis. The condition can be successfully treated with antibiotics if necessary.

Scrotum—The sac which contains the testicles.

Sperm granuloma—A collection of fluid that leaks from an improperly sealed or tied vas deferens. They usually disappear on their own, but can be drained if necessary.

Testicles—The two egg-shaped organs found in the scrotum that produce sperm.

Tubal ligation—A surgical procedure in which the fallopian tubes are tied in two places and cut between. This prevents eggs from moving from the ovary to the uterus.

(or athletic supporter) which supports the scrotum can also reduce pain. Mild over-the-counter pain medication such as **aspirin** or **acetaminophen** (Tylenol) should be able to control any discomfort. Activities may be restricted for one to two days, and sexual intercourse for three to four days.

Risks

There are very few risks associated with vasectomy other than infection, bruising, **epididymitis** (inflammation of the tube that carries the sperm from the testicle to the penis), and sperm granulomas (collection of fluid that leaks from a poorly sealed or tied vas deferens). These are easily treated if they do occur. Patients do not experience difficulty achieving an erection, maintaining an erection, or ejaculating. There is no decrease in the production of the male hormone (testosterone), and sex drive and ability are not altered. Vasectomy is safer and less expensive than **tubal ligation** (sterilization of a female by cutting the fallopian tube to prevent conception).

Normal results

Normally, vasectomies are 99% successful in preventing conception. As such, it is one of the most effective methods available to consumers.

Resources

BOOKS

Nichols, Francine H., and Elaine Zwelling. *Maternal-Newborn Nursing: Theory and Practice.* Philadelpia.: W. B.Saunders Co., 1997.

Olds, Sally B., Marcia L. London, and Patricia Wieland Ladewig. *Maternal-Newborn Nursing: A Family Centered Approach.* Menlo Park, CA.: Addison-Wesley, 1996.

ORGANIZATIONS

Planned Parenthood League of Massachusetts. (800) 258-4448. <http://www.pplm.org>.

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Vasodilators

Definition

Vasodilators are medicines that act directly on muscles in blood vessel walls to make blood vessels widen (dilate).

Purpose

Vasodilators are used to treat high blood pressure (**hypertension**). By widening the arteries, these drugs allow blood to flow through more easily, reducing blood pressure. Controlling high blood pressure is important because the condition puts a burden on the heart and the arteries, which can lead to permanent damage over time. If untreated, high blood pressure increases the risk of heart attacks, **heart failure**, **stroke**, or kidney failure. Vasodilators usually are prescribed with other types of blood pressure drugs and rarely are used alone.

Description

Examples of vasodilators are hydralazine (Apresoline) and **minoxidil** (Loniten). The vasodilator hydralazine also may be used to control high blood pressure in pregnant women or to bring down extremely high blood pressure in emergency situations. In the forms used for treating high blood pressure (tablets or injections), these drugs are available only with a physician's prescription. A liquid form of minoxidil, used to promote hair growth in people with certain kinds of baldness and is applied directly to the scalp, is sold without a prescription.

Recommended dosage

The recommended dosage depends on the type of vasodilator. Check with the physician who prescribed the

drug or the pharmacist who filled the prescription for the correct dosage, and use the medicine only as directed.

Physicians usually prescribe vasodilators along with other blood pressure medicines. Taking each drug at the correct time is extremely important. Health care providers can offer suggestions of ways to remember when to take each drug.

Precautions

Seeing a physician regularly while taking a vasodilator is important, especially during the first few months. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. People who have high blood pressure often feel fine. But even when they feel well, patients should keep seeing their physicians and taking their medicine.

Vasodilators will not cure high blood pressure, but will help control the condition. To avoid the serious health problems that high blood pressure can cause, patients may have to take medicine for the rest of their lives. Furthermore, medicine alone may not be enough. People with high blood pressure may also need to avoid certain foods and keep their weight under control. The health care professional who is treating the condition can offer advice on what measures may be necessary.

Some people feel dizzy or have headaches while using this medicine. These problems are especially likely to occur in older people, who are more sensitive than younger people to the medicine's effects. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they know how the drugs affect them.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take vasodilators. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had an unusual reaction to a vasodilator in the past should let his or her physician know before taking this type of drug again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Several problems—from excess hair growth to blood abnormalities—have been reported in babies whose mothers take this vasodilators during **pregnancy**. In studies of laboratory animals, hydralazine causes **birth defects** in mice and rabbits, but not in rats. The effects of taking vasodilators during pregnancy have not been specifically studied in humans. Women who are pregnant or who may become pregnant should check with their physicians before using this medicine. Women who become pregnant while taking a vasodilator should tell their physicians right away.

BREASTFEEDING. Women who are breastfeeding their babies or who plan to breastfeed should check with their physicians before using this medicine.

OTHER MEDICAL CONDITIONS. Using a vasodilator to lower blood pressure may worsen the problems that result from heart disease, blood vessel disease, or a recent **heart attack** or stroke. This medicine may also make **angina** (chest **pain**) worse. And in people with **pheochromocytoma** (tumor of the adrenal medulla), vasodilators may make the tumor more active. Before using a vasodilator, people with any of these medical problems should make sure their physicians are aware of their conditions.

People with kidney disease should also check with their physicians before using a vasodilator. Side effects may be greater in these people because their kidneys are slow to clear the medicine from the body.

USE OF CERTAIN MEDICINES. Taking vasodilators with certain other drugs may affect the way the drugs work or may increase the chance of side effects. Do not take any other prescription or nonprescription (over-the-counter) medicine with a vasodilator unless it has been discussed with the physician who prescribed the vasodilator.

Side effects

Some side effects of vasodilators go away as the body adjusts to the drug and do not need medical attention unless they continue or they interfere with normal activities. These include:

- headache
- nausea or vomiting
- diarrhea
- loss of appetite

In addition, minoxidil may cause a temporary increase in hair growth, especially on the face, arms, and back. Patients who are bothered by this should check with their physicians.

Other side effects of vasodilators should have medical attention. Check with a physician immediately if a fast or irregular heartbeat occurs. And if any of the following problems occur, check with a physician as soon as possible:

- chest pain
- muscle pain

KEY TERMS

Adrenal gland—One of a pair of organs located next to the kidneys. The adrenal glands produce hormones that control many body functions.

Adrenal medulla—The inner part of the adrenal gland. The adrenal medulla produces the hormones epinephrine (adrenaline), which stimulates the heart, tightens blood vessels, and relaxes some smooth muscles; and norepinephrine, which has similar effects.

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

- joint pain
- pain, numbness, tingling or weakness in the hands or feet
- swollen feet or lower legs
- swollen lymph nodes
- bloating
- **fever** and **sore throat**
- general discomfort or feeling of illness
- weakness
- blisters on skin; skin rash or **itching**; flushing or redness of the skin

Additional side effects are possible. Anyone who has unusual symptoms while taking a vasodilator should get in touch with his or her physician.

Interactions

Vasodilators may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the chance of side effects may be greater. In addition, many prescription and nonprescription (over-the-counter) drugs may affect blood pressure. *Do not take any other medicine without the approval of the physician who prescribed the vasodilator.* In particular, avoid using over-the-counter medicines for appetite control, colds, **cough**, sinus problems, **asthma**, hay fever and other allergies, as these may increase blood pressure. At the other extreme, dangerously low blood pressure may result when drugs such as the blood pressure medicine guanethidine (Ismelin) or nitrates, used to treat chest pain, are combined with vasodilators.

Nancy Ross-Flanigan

Vasodilatory *see* **Shock**

Vasopressin test *see* **Antidiuretic hormone (ADH) test**

Vasovagal faint *see* **Fainting**

Vegetarianism

Definition

Vegetarianism is the voluntary abstinence from eating meat. Vegetarians refrain from eating meat for various reasons, including religious, health, and ethical ones. Lacto-ovo vegetarians supplement their diet with dairy (lactose) products and eggs (ovo). Vegans (pronounced vee-guns) do not eat any animal-derived products at all.

Purpose

Vegetarianism is recommended as a dietary therapy for a variety of conditions, including heart disease, **high cholesterol**, diabetes, and **stroke**. Vegetarianism is a major dietary therapy in the alternative treatment of **cancer**. Other conditions treated with a dietary therapy of vegetarianism include **obesity**, **osteoporosis**, arthritis, **allergies**, **asthma**, environmental illness, **hypertension**, **gout**, **gallstones**, **hemorrhoids**, **kidney stones**, ulcers, colitis, **premenstrual syndrome**, **anxiety**, and depression. Vegetarians often report higher energy levels, better digestion, and mental clarity. Vegetarianism is an economical and easily implemented preventative practice as well.

Description

The term vegetarian was coined in 1847 by the founders of the Vegetarian Society of Great Britain, but vegetarianism has been around as long as people have created **diets**. Some of the world's oldest cultures advocate a vegetarian diet for health and religious purposes. In India, millions of Hindus are vegetarians because of their religious beliefs. One of the ancient mythological works of Hinduism, the *Mahabharata*, states that, "Those who desire to possess good memory, beauty, long life with perfect health, and physical, moral and spiritual strength, should abstain from animal foods." The **yoga** system of living and health is vegetarian, because its dietary practices are based on the belief that healthy food contains *prana*. Prana is the universal life energy, which yoga experts believe is abundant in fresh fruits, grains, nuts and vegetables, but absent in meat because meat has been killed. Yogis also believe that spiritual health is influenced by the

DR. JOHN HARVEY KELLOGG (1852–1943)

(AP/Wide World Photos. Reproduced by permission.)

John Harvey Kellogg is known as the father of modern breakfast cereal. He was born in Tyrone Township, Michigan, on February 26, 1852, into a Seventh Day Adventist family. At age 12, he became an apprentice at the Review and Herald Press, a publishing company run by the church. He attended school in Battle Creek, Michigan. He attended Bellevue Hospital Medical College in New York where he received his medical degree in 1875. In 1876, at the age of 24, Kellogg became an abdominal surgeon and superintendent of the Western Health Reform Institute, which he renamed the Battle Creek Sanitarium. There, he began applying his theories about natural living to his medical practice. Himself a vegetarian, he first advocated a diet high in whole grains, fruits, nuts, and legumes. He later included all types of vegetables in the diet. His controversial health regimen included morning calisthenics, open-air sleeping, cleansing enemas, chewing food hundreds of times before swallowing, and drinking plenty of water.

In the 1890s, Kellogg established a laboratory at the sanitarium to develop more nutritious foods. His brother, Will Keith Kellogg, joined in his research. In 1895 they developed a breakfast cereal of wheat flakes called Granose. The cereal quickly grew in popularity and was soon sold by mail order. This was followed by rice flakes and corn flakes. The brothers established the Sanitas Food Company. But philosophical differences led them to split into two companies. Will founded the W. K. Kellogg Company, which retained the rights to the cereal products. John set up the Battle Creek Food Company, which produced coffee substitutes and soymilk. John Kellogg also edited *Good Health Magazine*, which promoted vegetarianism, for 60 years. In 1904, he published a book, *The Miricle of Life*. He continued to promote his version of healthy living and radical techniques until his death in 1943.

practice of *ahimsa*, or not harming living beings. The principle of *ahimsa* (non-violence) appears in the Upanishads (Vedic literature) from c. 600–300 B.C. Taking of animal life or human life under any circumstances is sinful and results in rebirth as a lower organism. It became a fundamental element of Jainism, another religion of India. Some Buddhists in Japan and China are also vegetarian because of spiritual beliefs. In the Christian tradition, the Trappist Monks of the Catholic Church are vegetarian, and some vegetarians argue that there is evidence that Jesus and his early followers were vegetarian. Other traditional cultures, such as those in the Middle East and the Mediterranean regions, have evolved diets that frequently consist of vegetarian foods. The Mediterranean diet, which a Harvard study declared to be one of the world's healthiest, is primarily, although not strictly, vegetarian.

The list of famous vegetarians forms an illustrious group. The ancient Greek philosophers, including Socrates, Plato, and Pythagoras, advocated vegetarianism. In modern times, the word to describe someone who likes to feast on food and wine is "epicure," but it is little known that Epicurus, the ancient philosopher, was himself a diligent vegetarian. Other famous vegetarians include Leonardo da Vinci, Sir Isaac Newton, Leo Tolstoy, Ralph Waldo Emerson, and Henry Thoreau. This century's celebrated vegetarians include Gandhi, the physician Albert Schweitzer, writer George Bernard Shaw, musician Paul McCartney, and champion triathlete Dave Scott. Albert Einstein, although not a strict vegetarian himself, stated that a vegetarian diet would be an evolutionary step for the human race.

Vegetarianism in America received a lot of interest during the last half of the nineteenth century and the beginning of the twentieth century, during periods of experimentation with diets and health practices. Vegetarianism has also been a religious practice for some Americans, including the Seventh-day Adventists, whose lacto-ovo vegetarian diets have been studied for their health benefits. Vegetarianism has been steadily gaining acceptance as an alterna-

tive to the meat-and-potatoes bias of the traditional American diet. In 1997, Vegetarian Resource Group performed a Roper poll that showed that 13 million Americans, or 5% of the population, identified themselves as vegetarians.

Several factors contribute to the interest in vegetarianism in America. Outbreaks of **food poisoning** from meat products, as well as increased concern over the additives in meat such as hormones and **antibiotics**, have led some people and professionals to question meat's safety. There is also an increased awareness of the questionable treatment of farm animals in factory farming. But the growing health consciousness of Americans is probably the major reason for the surge in interest in vegetarianism. **Nutrition** experts have built up convincing evidence that there are major problems with the conventional American diet, which is centered around meat products that are high in cholesterol and saturated fat and low in fiber. Heart disease, cancer, and diabetes, which cause 68% of all deaths in America, are all believed to be influenced by this diet. Nutritionists have repeatedly shown in studies that a healthy diet consists of plenty of fresh vegetables and fruits, complex carbohydrates such as whole grains, and foods that are high in fiber and low in cholesterol and saturated fat. Vegetarianism, a diet that fulfills all these criteria, has become part of many healthy lifestyles. In alternative medicine, vegetarianism is a cornerstone dietary therapy, used in **Ayurvedic medicine**, **detoxification** treatments, macrobiotics, the Ornish diet for heart disease, and in therapies for many chronic conditions.

Preparations

Some people, particularly those with severe or chronic conditions such as heart disease or cancer, may be advised by a health practitioner to become vegetarian suddenly. For most people, nutritionists recommend that a vegetarian diet be adopted gradually, to allow people's bodies and lifestyles time to adjust to new eating habits and food intake.

Some nutritionists have designed transition diets to help people become vegetarian in stages. Many Americans eat meat products at nearly every meal, and the first stage of a transition diet is to substitute just a few meals a week with wholly vegetarian foods. Then, particular meat products can be slowly reduced and eliminated from the diet and replaced with vegetarian foods. Red meat can be reduced and then eliminated, followed by pork, poultry, and fish. For those wishing to become pure vegetarians or vegans, the final step would be to substitute eggs and dairy products with other nutrient-rich foods. Individuals should be willing to experiment with transition diets, and should have patience when learning how combine vegetarianism with social activities such as dining out.

The transition to vegetarianism can be smoother for those who make informed choices with dietary practices. Sound nutritional guidelines include decreasing the intake of fat, increasing fiber, and emphasizing fresh fruits, vegetables, legumes, and whole grains in the diet while avoiding processed foods and sugar. Everyone can improve their health by becoming familiar with recommended dietary and nutritional practices, such as reading labels and understanding basic nutritional concepts such as daily requirements for calories, protein, fat, and nutrients. Would-be vegetarians can experiment with meat substitutes, foods that are high in protein and essential nutrients. Thanks to the growing interest in vegetarianism, many meat substitutes are now readily available. Tofu and tempeh are products made from soybeans that are high in protein, calcium, and other nutrients. There are "veggie-burgers" that can be grilled like hamburgers, and vegetarian substitutes for turkey and sausage with surprisingly authentic textures and taste. There are many vegetarian cookbooks on the market as well.

Precautions

In general, a well-planned vegetarian diet is healthy and safe. However, vegetarians, and particularly vegans who eat no animal products, need to be aware of particular nutrients that may be lacking in non-animal diets. These are amino acids, vitamin B_{12}, vitamin D, calcium, iron, zinc, and essential fatty acids. Furthermore, pregnant women, growing children, and those with health conditions have higher requirements for these nutrients.

Vegetarians should be aware of getting *complete protein* in their diets. A complete protein contains all of the essential amino acids, which are the building blocks for protein essential to the diet because the body cannot make them. Meat and dairy products generally contain complete proteins, but most vegetarian foods such as grains and legumes contain incomplete proteins, lacking one or more of the essential amino acids. However, vegetarians can easily overcome this by combining particular foods in order to create complete proteins. For instance, beans are high in the amino acid lysine but low in tryptophan and methionine, but rice is low in lysine and high in tryptophan and methionine. Thus, combining rice and beans makes a complete protein. In general, combining legumes such as soy, lentils, beans, and peas with grains like rice, wheat, or oats forms complete proteins. Eating dairy products or nuts with grains also makes proteins complete. Oatmeal with milk on it is complete, as is peanut butter on whole wheat bread. Proteins do not necessarily need to be combined in the same meal, but generally within four hours.

Getting enough vitamin B_{12} may be an issue for some vegetarians, particularly vegans, because meat and dairy products are the main sources. Vitamin supplements that contain vitamin B_{12} are recommended. Spirulina, a nutritional supplement made from algae, is also a vegetarian source, as are fortified soy products and nutritional yeast.

Vitamin D can be obtained by **vitamins**, fortified foods, and sunshine. Calcium can be obtained in enriched tofu, seeds, nuts, legumes, dairy products, and dark green vegetables including broccoli, kale, spinach, and collard greens. Iron is found in raisins, figs, legumes, tofu, whole grains (particularly whole wheat), potatoes, and dark green leafy vegetables. Iron is absorbed more efficiently by the body when iron-containing foods are eaten with foods that contain vitamin C, such as fruits, tomatoes, and green vegetables. Zinc is abundant in nuts, pumpkin seeds, legumes, whole grains, and tofu. For vegetarians who don't eat fish, getting enough omega-3 essential fatty acids may be an issue, and supplements such as flaxseed oil should be considered, as well as eating walnuts and canola oil.

Vegetarians do not necessarily have healthier diets. Some studies have shown that some vegetarians consume large amounts of cholesterol and saturated fat. Eggs and dairy products contain cholesterol and saturated fat, while nuts, oils, and avocados are vegetable sources of saturated fat. To reap the full benefits of a vegetarian diet, vegetarians should be conscious of cholesterol and saturated fat intake. Vegetarians may also consider buying organic foods, which are grown without the use of synthetic chemicals, as another health precaution.

Research and general acceptance

A vegetarian diet has many well-documented health benefits. It has been shown that vegetarians have a higher life expectancy, as much as several years, than those who eat a meat-centered diet. The U.S. Food and Drug Administration (FDA) has stated that data has shown vegetarians to have a strong or significant probability against contracting obesity, heart disease, lung cancer, **colon cancer**, **alcoholism**, hypertension, diabetes, gallstones, gout, kidney stones, and ulcers. However, the FDA also points out that vegetarians tend to have healthy lifestyle habits, so other factors may contribute to their increased health besides diet alone.

A vegetarian diet, as prescribed by Dr. Dean Ornish, has been shown to improve heart disease and reverse the effects of **atherosclerosis**, or hardening of the arteries. It should be noted that Dr. Ornish's diet was used in conjunction with **exercise**, **stress reduction**, and other holistic methods. The Ornish diet is lacto-ovo vegetarian, because it allows the use of egg whites and non-fat dairy products.

Vegetarians have a resource of statistics in their favor when it comes to presenting persuasive arguments in favor of their eating habits. Vegetarians claim that a vegetarian diet is a major step in improving the health of citizens and the environment. Americans eat over 200 lbs (91 kg) of meat per person per year. The incidence of heart disease, cancer diabetes, and other diseases has increased along with a dramatic increase in meat consumption during the past century. Many statistics show significantly smaller risks for vegetarians contracting certain conditions. The risks of women getting **breast cancer** and men contracting prostrate cancer are nearly four times as high for frequent meat eaters as for those who eat meat sparingly or not at all. For heart attacks, American men have a 50% risk of having one, but the risk drops down to 15% for lacto-ovo vegetarians and to only 4% for vegans. For cancer, studies of populations around the world have implied that plant-based diets have lower associated risks for certain types of cancer.

Vegetarians claim other reasons for adopting a meat-free diet. One major concern is the amount of pesticides and synthetic additives such as hormones that show up in meat products. Chemicals tend to accumulate in the tissue of animals that are higher in the food chain, a process called *bioaccumulation*. Vegetarians, by not eating meat, can avoid the exposure to these accumulated toxins, many of which are known to influence the development of cancer. One study showed that DDT, a cancer-causing pesticide, was present in significant levels in mother's milk for 99% of American women, but only 8% of vegetarian women had significant levels of the pesticide. Women who eat meat had 35 times higher levels of particular pesticides than vegetarian women. The synthetic hormones and antibiotics added to American cattle has led some European countries to ban American beef altogether. The widespread use of antibiotics in livestock has made many infectious agents more resistant to them, making some diseases harder to treat.

Vegetarians resort to ethical and environmental arguments as well when supporting their food choices. Much of U.S. agriculture is dedicated to producing meat, which is an expensive and resource-depleting practice. It has been estimated that 1.3 billion people could be fed with the grain that America uses to feed livestock, and **starvation** is a major problem in world health. Producing meat places a heavy burden on natural resources, as compared to growing grain and vegetables. One acre of land can grow approximately 40,000 lbs (18,000 kg) of potatoes or 250 lbs (113 kg) of beef, and it takes 50,000 gal (200,000 l) of water to produce 1 lb (0.45 kg) of California beef but only 25 gal (100 l) of water to produce 1 lb (0.45 kg) of wheat. Half of all water used in America is for livestock production. Vegetarians argue that the

KEY TERMS

Cholesterol—A steroid fat found in animal foods that is also produced in the body from saturated fat for several important functions. Excess cholesterol intake is linked to many diseases.

Complex carbohydrates—Complex carbohydrates are broken down by the body into simple sugars for energy, are found in grains, fruits and vegetables. They are generally recommended in the diet over refined sugar and honey, because they are a more steady source of energy and often contain fiber and nutrients as well.

Legume—Group of plant foods including beans, peas, and lentils, which are high in protein, fiber, and other nutrients.

Organic food—Food grown without the use of synthetic pesticides and fertilizers.

Saturated fat—Fat that is usually solid at room temperature, found mainly in meat and dairy products but also in vegetable sources such as some nuts, seeds, and avocados.

Unsaturated fat—Fat found in plant foods that is typically liquid (oil) at room temperature. They can be monounsaturated or polyunsaturated, depending on the chemical structure. Unsaturated fats are the most recommended dietary fats.

American consumption of beef may also be contributing to global warming, by the large amounts of fossil fuels used in its production. The South American rainforest is being cleared to support American's beef consumption, as the United States yearly imports 300 million lbs (136 million kg) of meat from Central and South America. The production of meat has been estimated as causing up to 85% of the loss of topsoil of America's farmlands.

Despite the favorable statistics, vegetarianism does have its opponents. The meat industry in America is a powerful organization that has spent millions of dollars over decades advertising the benefits of eating meat. Vegetarians point out that life-long eating habits are difficult to change for many people, despite research showing that vegetarian diets can provide the same nutrients as meat-centered diets.

Resources

BOOKS

Akers, Keith. *A Vegetarian Sourcebook*. New York: Putnam, 1993.

Null, Gary. *The Vegetarian Handbook*. New York: St. Martins, 1987.

Robbins, John. *Diet for a New America*. Walpole, New Hampshire: Stillpoint, 1987.

PERIODICALS

Vegetarian Journal. Vegetarian Resource Group (VRG). PO Box 1463, Baltimore, MD 21203.

Vegetarian Times. 4 High Ridge Park, Stamford, CT 06905. (877) 321-1796.

Vegetarian Nutrition and Health Letter. 1707 Nichol Hall, Loma Linda, CA 92350. (888) 558-8703.

ORGANIZATIONS

North American Vegetarian Society (NAVS). PO Box 72, Dolgeville, NY 13329. (518) 568-7970.

Douglas Dupler

Vegetative state

Definition

A coma-like state characterized by open eyes and the appearance of wakefulness is defined as vegetative.

Description

The vegetative state is a chronic or long-term condition. This condition differs from a persistent vegetative state (PVS, a state of **coma** that lacks both awareness and wakefulness) since patients have awakened from coma, but still have not regained awareness. In the vegetative state patients can open their eyelids occasionally and demonstrate sleep-wake cycles. They also completely lack cognitive function. The vegetative state is also called coma vigil.

Causes and symptoms

The vegetative state can be caused by:

- cardiac arrest
- prolonged and profound **hypoglycemia** (an abnormal and severe decrease in blood sugar)
- carbon monoxide poisoning
- head injury
- brain hemorrhage
- compression of the brainstem
- tumors
- bilateral hemispheric demyelination (a loss of nerve cells)

- injury of the brain following infections (**meningitis** or encephalitis)
- neurodegenerative diseases
- anencephaly (an abnormality of the brain and skull)
- diffuse nerve cell injury

Patients in a vegetative state apparently have functioning of a special area in the brain called the reticular activating system (RAS) responsible for sleep-wake cycles. The connections that integrate more complex abilities such as awareness are interrupted. Patients in the vegetative state can open and close eyes spontaneously. They may appear to track or follow objects with their eyes. Patients may chew and swallow food placed in the mouth. The vegetative patient does not respond to sound, hunger, or **pain**. Patients cannot obey verbal commands and lack local motor responses. Additionally these patients cannot talk in comprehendible terms and they may become noisy, restless, and hypermobility. These patients are in a state or arousal but completely lack awareness.

Diagnosis

Diagnosis of vegetative state depends on the primary cause of brain dysfunction. A comprehensive history and neurological examination, neuroimaging studies, and chemical analysis of the blood are essential. Additionally, special tests such as cerebrospinal fluid (CSF, is the fluid that bathes and nourishes the brain and spinal cord) analysis and electroencephalographic (EEG analyzes the electrical activity within the brain) may be indicated to establish a diagnosis.

Treatment

Treatment is directed to presenting symptoms and patient needs. Patients require constant monitoring and assistance with feeding, hydration hygiene, assisted movement (to help prevent ulcers and blood clots in the legs), and elimination of waste products.

Alternative treatment

There is no known alternative treatment for vegetative patients.

Prognosis

The prognosis is generally poor and the condition can persist chronically.

Prevention

There is no known prevention since this state can occur as a result of unavoidable situations such as an accident, tumor, and bleeding or genetic abnormality.

KEY TERMS

Cognitive— The ability (or lack of) to think, learn, and memorize.

Hypermobility— Increased movement of joints.

Resources

BOOKS

Goetz, Christopher G., et al, eds. *Textbook of Clinical Neurology.* 1st ed. W. B. Saunders Company, 1999.

Goldman, Lee, et al. *Cecil Textbook of Medicine*. 21st ed. W. B. Saunders Company, 2000.

Miller, Ronald D., et al, eds. *Anesthesia*. 5th ed. Churchill Livingstone, Inc., 2000.

Rosen, Peter. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Tear Book, Inc., 1998.

Laith Farid Gulli, M.D.

Velopharyngeal insufficiency

Definition

Velopharyngeal insufficiency is the improper closing of the velopharyngeal sphincter (soft palate muscle) during speech characterized by an acute nasal quality of the voice.

Description

At the back of the mouth is a circle of structures that include the tonsils, the tongue, and the palate. During speech, this apparatus must close off the nose for proper articulation of the explosive consonants “p,” “b,” “g,” “t,” and “d.” If it does not close, there is a snort sound produced through the nose. Improper function of this structure also produces a nasal tone to the voice.

Causes and symptoms

There are three main causes for this defect:

- Cleft palate is a congenital condition, producing a defect in the palate that allows air to escape upward during speech.
- If tonsil and adenoid surgery is done improperly, velopharyngeal insufficiency may result. The occurrence rate is approximately one in every 2,000-3,000 tonsillectomies.

KEY TERMS

Adenoids—Lymph glands just above the tonsils and the palate.

Cleft palate—Congenital defect marked by a split in the roof of the mouth.

Nasopharyngoscopy—A diagnostic procedure that examines the nasal passageways and pharynx with an instrument outfitted with an optical system.

Pharynx—A canal located between the mouth cavity and the esophagus.

Tonsillectomy—Surgical removal of the tonsils.

Tonsils—Lymph glands in the throat, just behind the back teeth.

- Nerve or muscle disease may paralyze the muscles that operate the velopharyngeal sphincter.

The primary symptom is the speech impediment. Some people develop a change in their speaking pattern or a series of facial grimaces to try to overcome the difficulty. If the condition is acute, regurgitation through the nose may occur.

Diagnosis

Examination of the velopharyngeal sphincter through ultrasound scans, fiber-optic nasopharyngoscopy, and videofluoroscopy will reveal the extent of velopharyngeal insufficiency. Speech and velopharyngeal sphincter movement are compared to make the diagnosis.

Treatment

Velopharyngeal insufficiency is treated with a combination of surgery and speech therapy. There are several surgical procedures that can be performed to correct the physical malfunction. They include:

- Pharyngeal flap procedure that moves the skin flap from the pharynx to the soft palate.
- Palatal push-back that separates the hard and soft palate in order to lengthen the soft palate.
- Pharyngoplasty that lengthens the soft palate by turning the pharyngeal skin flaps.
- Augmentation pharyngoplasty that inserts an implant into the pharyngeal wall to enlarge it, thus narrowing the velopharyngeal opening.
- Velopharyngeal sphincter reconstruction.

Prognosis

The combination of surgery to correct the insufficiency and speech therapy to retrain the voice successfully alleviate velopharyngeal insufficiency.

Resources

BOOKS

English, Gerald M. *Otolaryngology.* Philadelphia: J. B. Lippencott Co., 1990.

PERIODICALS

Conley, S. F., et al. "Identification and Assessment of Velopharyngeal Inadequacy." *American Journal of Otolaryngology* 18 (Jan./Feb. 1997): 38-46.

Eufinger, H., et al. "Speech Results and Velopharyngeal Morphology Following 151 Cranially Based Velopharyngoplasties." *Folia Phoniatrica et Logopedica* 47 (1995): 193-198.

Huang M. H., S. T. Lee, and K. Rajendran. "Anatomic Basis of Cleft Palate and Velopharyngeal Surgery: Implications from a Fresh Cadaveric Study." *Plastic & Reconstructive Surgery* 101 (Mar. 1998): 613-627.

Morris, H. L., et al. "Clinical Results of Pharyngeal Flap Surgery: the Iowa Experience." *Plastic & Reconstructive Surgery* 95 (Apr. 1995): 652-662.

Ren, Y. F., A. Isberg, and G. Henningsson. "Velopharyngeal Incompetence and Persistent Hypernasality after Adenoidectomy in Children without Palatal Defect." *Cleft Palate-Craniofacial Journal* 32 (Nov. 1995): 476-482.

Sell, D., and L. Ma. "A Model of Practice for the Management of Velopharyngeal Dysfunction." *British Journal of Oral & Maxillofacial Surgery* 34 (Oct. 1996): 357-363.

J. Ricker Polsdorfer, MD

Vena cava filter

Definition

A vena cava filter is a device inserted into a major vein to prevent a blood clot from entering the lungs.

Purpose

The purpose of a vena cava filter is to prevent a blood clot from potentially traveling to the lungs. A thrombus clot traveling to the lungs is called a **pulmonary embolism** (PE). A thrombus in the deep venous system (the part of the circulation that brings blood back to the heart) represents a disorder of normal hemostasis (the normal clotting of blood).

Insertion of a vena cava filter is indicated for patients who:

- cannot receive medications that can dissolve the clot (anticoagulation therapy)
- have a thrombus in a deeply situated vein
- experiance complication of anticoagulation therapy such as bleeding
- experiance failure of anticoagulation therapy to prevent pulmonary **embolism**
- have an embolus in the lungs (pulmonary embolectomy) removed
- have a recurrent embolism while receiving adequate medications
- have significant bleeding complications during anticoagulation

Precautions

There no significant precautions concerning insertion of a vena cava filter. The devices are usually effective and short-term complications are unusual

Description

Vena cava filters are usually inserted in to prevent PE caused by a thrombosis in a deep vein (DVT). Approximately 60% of patients who die in a hospital have evidence of PE during **autopsy**. The incidence (number of new cases) of DVT is highest for patients undergoing surgical repair of a fractured hip. However, DVT is common in both surgical and medical patients. DVT is found in 29–33% of patients in medical intensive care units (MICU) and in 27–40% of patients with a **heart attack** (myocardial infarction). Vena cava filters are placed to prevent thrombi from entering the lungs. There is currently a new type of filter called the Kim-Ray-Greenfield filter.

Preparation

Insertion of a vena cava filter is an invasive procedure. The patient is prepared for this procedure using standard surgical protocols. The VCF is commonly implanted in the jugular vein in the neck or the femoral vein in the groin. The procedure is generally well tolerated.

Aftercare

This depends on the patient's health status and recommendation's for continued care.

Risks

Many patients have died from PE even with a vena cava implantation. Use of a VCF is primarily indicated if there are contraindications for anticoagulation therapy. VCF can increase a patient's susceptibility for developing recurrent DVT.

KEY TERMS

Embolus— An embolus (or emboli the plural form) is a blood clot that has detached from its site of origin and travels to the lungs (pulmonary artery), where it can rupture the artery, causing death.

Pulmonary embolism— A traveling thrombus that has lodged in the pulmonary artery.

Thrombus— A thrombus (or thrombi the plural form) is a blood clot that can form in a deeply situated vein.

Normal results

Patient progresses well and prevention of large emboli that can cause a PE is successful.

Abnormal results

The desired effect is not accomplished and the patient develops a PE resulting in **death**.

Resources

BOOKS

Bone, Roger C. *Pulmonary & Critical Care Medicine*. Mosby-Year Book, Inc., 2000.

Braunwald, Eugene, et al, eds. *Heart Disease: A Textbook of Cardiovascular Medicine*. 6th ed. W. B. Saunders Company, 2001.

Goldman, Lee, et al, eds. *Cecil Textbook of Medicine*. 21st ed. W. B. Saunders Company, 2000.

Rakel, Robert E., et al, eds. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Year Book, Inc., 1998.

Rakel, Robert E., et al, eds. *Conn's Current Therapy*. 53rd ed. W. B. Saunders Company, 2001.

Townsend, Courtney M. *Sabiston Textbook of Surgery*. 16th ed. W. B. Saunders Company, 2001.

PERIODICALS

Isnard, R., and M. Komajda. "Thromboembolism in Heart Failure, Old Ideas and New Challenges." *European Journal of Heart Fail* (June 2001).

ORGANIZATIONS

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Venereal diseases *see* **Sexually transmitted diseases**

Venography

Definition

Venography is an x-ray test that provides an image of the leg veins after a contrast dye is injected into a vein in the patient's foot.

Purpose

Venography is primarily performed to diagnose **deep vein thrombosis** (a condition that can lead to **pulmonary embolism**). It is the standard procedure used to detect this type of disorder. Venography can also be used to distinguish blood clots from obstructions in the veins, to evaluate congenital vein problems, to see how the deep leg vein valves are working, and to identify a vein for arterial bypass grafting.

Precautions

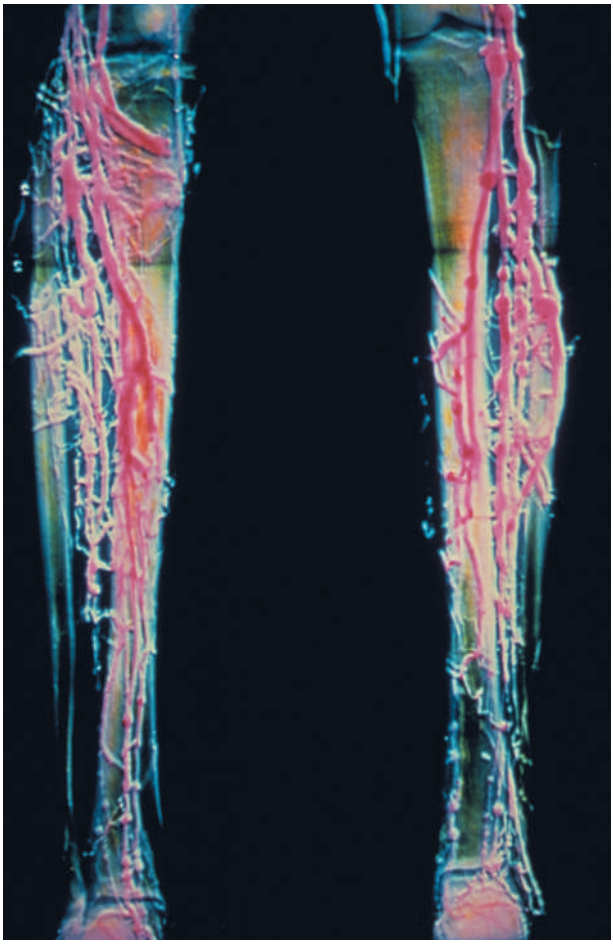
Venography is usually not performed in patients with kidney (renal) problems.

Description

Venography (also called phlebography, ascending contrast phlebography, or contrast venography) is an invasive diagnostic test that provides a constant image of leg veins on a fluoroscope screen. Venography identifies the location, extent, and degree of attachment of the blood clots, and enables the condition of the deep leg veins to be assessed. It is especially useful when there is a strong suspicion of deep vein thrombosis, but non-invasive tests have failed to identify the disease.

Venography is the most accurate test for detecting deep vein thrombosis. It is nearly 100% sensitive and specific in making this diagnosis (pulmonary **embolism** is diagnosed in other ways). Accuracy is crucial since deep vein thrombosis can lead to pulmonary embolism, a condition that can be fatal.

Venography is not used often, however, because it is painful, expensive, exposes the patient to a fairly high dose of radiation, and can cause complications. In about 5% of cases, there are technical problems in conducting the test. In addition, the test is less accurate in diagnosing problems below the knee. Venography takes between 30-45 minutes and can be done in a physician's office, a laboratory, or a hospital.



A venographic image of a patient's legs with varicose veins. *(Custom Medical Stock Photo. Reproduced by permission.)*

During the procedure, the patient lies on a tilting x-ray table. The area where the catheter will be inserted will be shaved, if necessary, and cleaned. Sometimes a local anesthetic is injected to numb the skin at the site of the insertion. Sometimes a small incision is required to make a point for insertion. The catheter is inserted and the contrast solution (or dye) is slowly injected. Injection of the dye causes a warm, flushing feeling in the leg that may spread through the body. The contrast solution may also cause slight nausea. About 18% of patients experience discomfort from the contrast solution.

In order to fill the deep venous system with dye, a tight band (or tourniquet) may be tied around the ankle of the foot the dye is injected into, or the lower extremities may be tilted. The patient is asked to keep the leg still. The doctor also observes the movement of the solution through the vein with a fluoroscope. At the same time, a series of x rays are taken. When the test is finished, fluid is injected to clear the dye from the veins, the catheter is

removed, and a bandage is applied over the site of the injection.

Preparation

Fasting or drinking only clear liquids is necessary for four hours before the test. However, sometimes the test done in an emergency even if the patient has eaten. The contrast solution contains iodine, to which some people are allergic. Patients who have **allergies** or hay **fever**, or have had a bad reaction to a contrast solution, should tell their doctor. A sedative, such as diazepam (Valium), may be prescribed to help the patient relax.

Aftercare

Patients should drink large amounts of fluids to flush the remaining contrast solution from their bodies. The area around the incision will be sore for a few days. If there is swelling, redness, **pain**, or fever, the doctor should be notified. Pain medication may be needed. In most cases, the patient can resume normal activities the next day.

Risks

Venography can also cause complications such as phlebitis, tissue damage, and the formation of deep vein thrombosis in a healthy leg. A rare side effect in up to 8% of cases is a severe allergic reaction to the dye. This usually happens within 30 minutes after injection of the dye and requires medical attention.

Normal results

Normal venography results show proper blood flow through the leg veins.

Abnormal results

Abnormal venography results show well-defined filling defects in veins. Findings include:

- blood clots
- consistent filling defects
- an abrupt end of a test dye column
- major deep veins that are unfilled
- dye flow that is diverted

These results confirm a diagnosis of deep vein thrombosis

Resources

BOOKS

DeBakey, Michael E., and Antonio M. Gotto Jr. "Invasive Diagnostic Procedures." In *The New Living Heart*. Holbrook, MA: Adams Media Corporation, 1997.

Texas Heart Institute. "Diseases of the Peripheral Arteries and Veins." In *Texas Heart Institute Heart Owner's Handbook*. New York: Wiley & Sons, 1996.

"Venography." In *Mayo Clinic Practice of Cardiology*. 3rd ed. St. Louis: Mosby, 1996.

"Venous Imaging." In *Diagnostic Nuclear Medicine*. 3rd ed. Vol. 1. Baltimore: Williams & Wilkins, 1996.

PERIODICALS

Barloon T. J., G. R. Bergus, and J. E. Seabold. "Diagnostic Imaging of Lower Limb Deep Venous Thrombosis." *American Family Physician* 56 (1 Sept. 1997): 791-801.

Tapson, Victor F. "Pulmonary Embolism - New Diagnostic Approaches." *New England Journal of Medicine* 336 (15 May 1997).

OTHER

"Venography Helps Patients Avoid Hospital Readmission." *American Academy of Orthopaedic Surgeons Page*. 24 Feb. 1996. 4 Mar. 1998 <http://www.aaos.org>.

"Catching Deep Vein Thrombosis in Time: Diagnostic Tests at a Glance." *SpringNet*. 11 Aug. 1997. 4 Mar. 1998 <http://www.springnet.com/ce/p507bs4.htm>.

Lori De Milto

KEY TERMS

Contrast solution—A liquid dye injected into the body that allows veins to be seen by x rays. Without the dye, the veins could not be seen on x rays.

Deep vein thrombosis—The development or presence of a blood clot in a vein deep within the leg. Deep vein thrombosis can lead to pulmonary embolism.

Invasive —A diagnostic test that invades healthy tissue; in the case of venography, through an incision in a healthy vein.

Pulmonary embolism —An obstruction of a blood vessel in the lungs, usually due to a blood clot, that blocks a pulmonary artery. Pulmonary embolism can be very serious and in some cases is fatal.

Venous access

Definition

Venous access introduces a needle into a vein, usually for the purpose of withdrawing blood or administering medication.

Purpose

Venous access is necessary for fluid administration, medication administration, and obtaining blood for chemical analysis. Sites for access include veins located in the peripheral arms or legs, scalp, neck, and bone.

Venous access in children may pose special problems since finding appropriate veins and **immobilization** may be difficult but essential. For complicated procedures **sedation** may be indicated. Venous access can be performed during emergency situations, for outpatients, inpatients, and those who require long term **chemotherapy**.

Precautions

There are no major precautions for access during emergency procedures. The main concern during an emergency would be to secure a portal of entry to infuse potentially life saving medications and fluids. For all methods of access the main precautionary measures include attention to accurate procedures. Proper procedures are necessary to minimize the possibility of infection, **embolism**, phlebitis, or destruction of neighboring tissue.

Description

For peripheral venipuncture the common site is usually a vein in the arm (the anticubital fossa located on the opposite side of the elbow) or on the flat bony area of the hand (dorsum of the hand). Scalp veins are accessible in infants under one year of age. The selected vein should be long and straight for needle accommodation. It should be identified by straightness, lack of pulsation (characteristic of an artery), and filling with blood form above (arteries fill from below). Internal jugular catheterization is performed in the neck using special bone and muscle landmarks. The external jugular vein can be cannulized by immobilizing tilted and rotating the head. The subclavian approach is a complicated procedure and emergency access can be performed if attempts for access a vein in other areas have failed. Intraosseous venous access is usually accomplished through a leg bone. Catheters implanted in the front of the chest (anterior chest wall) can accomplish long-term venous access. A large leg vein is preferably used and isolated by dissection. A catheter is inserted into the vein and they are tied together.

Preparation

For peripheral vein access in the arm, a tourniquet is applied a few inches over the puncture site. The skin over the puncture site is sterilized with an alcohol pad. The needle is inserted and either blood is drawn and the needle is removed, or a catheter is inserted to place an intravenous line. Scalp veins can be accessible by immobilizing the head, shaving the area from hair, and using a rubber band as a tourniquet. Internal jugular vein catheterization is accomplished by extending the patient's head over the edge of a table or cart and rotating away from the intended puncture site. Immobilizing the head and extending it 15–20 degrees over the edge of a bed or cart and rotating away from the puncture site can cannalize the external jugular vein. The subclavian vein access is a complicated procedure and requires sedation and special positioning (Trendelenburg). A towel should be place in the back of the area. The skin should be cleansed and the puncture site is anesthetized. For the femoral approach the leg is externally rotated. The artery should be felt and along with specific anatomical landmarks the vein can be localized. The skin should be cleaned and anesthetized. During venous cutdown a large vein near the anklebone is careful dissected away from underlying tissues. The area must be properly cleaned and anaesthetize prior to making an incision. A catheter is inserted and secured in place with sutures.

Aftercare

For simple procedures such as peripheral venous access, applying simple pressure (to stop bleeding) and a bandage may be sufficient. For more complicated procedures, the primary cause for access should be treated as well as care to avoid or treat potential complications that may arise from access.

Risks

For access into a peripheral vein, care must be taken not to puncture both sides of the vein. After removal of the needle or catheter, a piece of cotton and pressure should be applied over the puncture site to prevent unwanted bleeding. Access with a scalp vein should be preformed with care to avoid hematoma formation (localized blood clot), accidental puncture of an artery, or infection. Access into the internal jugular vein in the neck can cause laceration of an artery or nerve. This procedure can also cause hematoma (blood clot) formation; damage to local nerves within the area, **pneumothorax**, or misplaced catheterization. Venous access into the external jugular vein can cause hematoma or placement outside the thorax. Subclavian vein access can cause air to enter a vein (resulting in an air embolus) or pneumothorax. Cannulation of the femoral vein in the groin area can cause infection or **thrombophlebitis**. Intraosseous venous access commonly performed in a leg bone can cause hematomas, infection or damage to bone marrow. This procedure should not be performed if the attempts in one leg is unsuccessful, the skin over the legs is diseased

KEY TERMS

Cannula— Insertion of a tube.

Catheterization— The process of inserting a tubular instrument into a body cavity to permit passage of fluid.

Phlebitis— Inflammation of a vein.

Pneumothorax-— The presence of air in the cavity that surrounds the lungs.

(from a burn or infection), or there is a broken leg bone or bone disease. Venous cutdown can cause infection, loss of the catheter in the vein, phlebitis, or nerve damage.

Resources

BOOKS

Pfenninger, John L., et al, eds. *Procedures for Primary Care Physicians.* 1st ed. Mosby-Year Book, Inc., 1994.

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Venous insufficiency

Definition

Venous insufficiency is described as abnormal blood flow through veins that can cause local damage, damage to affected legs, or **death**.

Description

Syndromes related to venous insufficiency are caused by valve incompetence. Venous insufficiency is a chronic (long term) condition. The number of new and existing cases is dependent on age and gender. Some patients may have a positive family history. Usually older persons and females are more commonly affected. Deep situated and superficial veins can be affected. **Cancer** obstructing veins in the pelvis area can cause superficial venous insufficiency. Deep venous insufficiency is commonly caused by **thrombophlebitis**, causing obstruction of valves that regulate blood flow in veins. Small veins that have been occluded by a thrombosis may re-canalize (opening up new channels to re-direct blood flow). These re-canalized veins are inadequate and cannot correct the impairment of flow. However, larger veins may still remain occluded. When a thrombosis occurs the valves that regulate venous blood flow become thickened and incompetent, rendering them incapable of regulating back flow of blood. This valvular incompetence will cause an increase in the presence within veins (venous **hypertension**). Venous hypertension is responsible for most of the symptoms associated with venous disease. Superficial veins can become dilated causing **varicose veins** (veins that bulge and seem tortuous). Leg ulcers can be severe and are responsible for 100,000 cases of disability in the United States alone.

Causes and symptoms

The symptoms of chronic venous insufficiency can be subjective and objective. Subjective symptoms include throbbing, cramping, burning sensations, and leg **fatigue**. Patients can also develop chronic leg ulcers that may not heal. Varicose veins in the legs can bleed (since veins are delicate structures with thin walls) and cause death. Patients often develop fluid retention (**edema**) in the affected limb. Skin changes can occur and affected areas can become thin, shiny, discolored (blue-purple), and atrophic. The skin usually becomes thick and tough.

Diagnosis

There are several techniques used to diagnose venous disease. Electrical impedance plethysmography (IPG) provides a functional evaluation for outflow obstruction ultrasound (a machine that transmits sound waves) studies can visualize the venous system in certain areas. Another technique called duplex scanning can measure velocity within a vein.

Treatment

Periodic elevation of legs and bed rest can help with leg swelling. Patients are advised to avoid prolonged periods of standing or sitting. Wearing compression stockings can also reduce swelling of the leg. Mild skin infections can be treated with compresses, steroids, and, if infection is present, with **antibiotics**. Ulceration's can be treated with compresses, possible surgery, special ointments, and a semi-rigid boot that helps improve blood flow. Varicose veins can be treated with elastic stockings. About 15–20% of patients require surgery, but only after careful evaluation and specialized testing confirms a beneficial value.

Prognosis

The prognosis is variable and depends on the progression of disease, extent of damage, and the presence

KEY TERMS

Atrophic— A wasting of cells and tissues.

Thrombophlebitis— Venous inflammation with formation of a thrombus.

Thrombus— A clot in the cardiovascular system (the system that circulates blood throughout the body).

of other diseases, which may affect the cardiovascular system.

Prevention

Persons who have a strong family history, evidence of disease, and/or those who stand on their legs many hours daily should discuss the option of elastic stocking with their primary clinician.

Resources

BOOKS

Goroll, Alan H., et al. *Primary Care Medicine.* 4th ed. Lippincott, Williams & Wilkins, 2000.

Pfenninger, John L., et al, eds. *Procedures for Primary Care Physicians.* 1st ed. Mosby-Year Book, Inc., 1994.

Rakel, Robert E., et al, eds. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. Mosby-Year Book, Inc., 1998.

Townsend, Courtney M. *Sabiston Textbook of Surgery.* 16th ed. W. B. Saunders Company, 2001.

ORGANIZATION

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Ventricular aneurysm

Definition

Ventricular aneurysm is a complication of a **heart attack** (myocardial infarction). It is a ballooning of a section of a blood vessel in the heart that first appears several days or weeks after an acute myocardial infarction.

Description

A myocardial infarction occurs when a section of the heart wall is deprived of blood and dies (undergoes necrosis, or tissue **death**, and scarring). The heart wall is mainly muscle. It has two ventricles, the right and left ventricles, which pump blood to and from the lungs, and to the body. When part of the heart muscle dies, pumping power from that part of the wall is lost. After a myocardial infarction, the part of the heart wall that did not die must continue pumping blood and compensate for the dead muscle.

Ventricular aneurysm is one of the complications that follow a myocardial infarction.

An aneurysm is the outward swelling, or ballooning, of a blood vessel at a weak spot in the wall of the blood vessel. In the case of ventricular aneurysm, the aneurysm occurs in the wall of the heart at the spot where the myocardial infarction occurred. A scar usually forms in the area of the dead muscle tissue, and may eventually calcify. Ventricular aneurysms generally do not rupture. The left ventricle is involved in most cases of ventricular aneurysm.

Causes and symptoms

The principle symptom of a ventricular aneurysm is cardiac insufficiency, a condition in which not enough blood is being pumped to the body. Ventricular aneurysm is usually found after a large infarction in the muscle wall of a ventricle. Ventricular aneurysm is seldom seen immediately after a myocardial infarction. It takes several days or weeks to several months to develop. Frequently, recurrent ventricular irregular heartbeats (**arrhythmias**) and low cardiac output result from the presence of a ventricular aneurysm. Blood clots (thrombi) may form on the inside wall of the aneurysm and produce systemic blood clots that get stuck in a blood vessel (embolisms), which could lead to **stroke** or an ischemic leg (a usually painful condition in which lack of blood circulation leads to reduced function).

Diagnosis

A number of signs may indicate ventricular aneurysm, including an abnormal precordial impulse in the heartbeat, persistent elevation of the S-T segment of an electrocardiogram, and a characteristic bulge seen on the heart when x-rayed. The bulge is typically seen when the heart contracts, driving blood to the aorta, in the systolic phase of the heartbeat. Echolocation (**echocardiography** or ultrasound) can confirm the presence of an aneurysm. **Cardiac catheterization** may be performed to determine the extent of the aneurysm and the status of the coronary arteries. Stethoscopic examination reveals abnormal heart sounds, especially those associated with a backflow of blood from the left ventricle to the left atrium in systole or contraction beat (mitral regurgitation). This heart murmur is caused by the heart muscles no longer being able to properly operate the mitral valve.

KEY TERMS

Arrhythmia—A disturbance in the beating pattern of the heart.

Myocardial infarction—Commonly known as a heart attack, a myocardial infarction occurs when a part of the heart muscle is deprived of blood and dies.

Treatment

Most cases of ventricular aneurysm are treated by close medical follow-up and limiting patient activity. Surgical removal of the aneurysm is an option when persistent left ventricular failure or arrhythmia occurs, and the aneurysm is large. **Vasodilators**, **diuretics**, and digoxin are used to treat **heart failure**. Anticoagulant drugs are used to prevent the formation of blood clots. **Antiarrhythmic drugs** are used to treat heart arrhythmias.

Prognosis

Ventricular aneurysm occurs more frequently than is commonly thought. Based on postmortem examination, ventricular aneurysm occurs in as many as 15% of myocardial infarction cases. Patients with a large ventricular aneurysm in the left ventricle have a reduced survival rate. Many patients have mild symptoms which are not life-threatening. The survival rate is dependent on the function of the left ventricle.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart*. 9th ed. New York: McGraw-Hill, 1998.

Gibler, W. B., and T. P. Aufderheide. *Emergency Cardiac Care*. St. Louis: Mosby, 1994.

Giuliani, E. R., et al. *Mayo Clinic Practice of Cardiology*. 3rd ed. St. Louis: Mosby, 1996.

John T. Lohr, PhD

Ventricular assist device

Definition

A ventricular assist device (VAD) is a mechanical pump used for temporary blood circulation support. It decreases the workload of the heart while maintaining adequate flow and blood pressure.

Purpose

A VAD is a temporary life-sustaining device. VADs can replace the left ventricle (LVAD), the right ventricle (RVAD), or both ventricles (BIVAD). They are used when the heart muscle is damaged and needs to rest in order to heal or when blood flow from the heart is inadequate. VADs can also be used as a bridge in patients awaiting **heart transplantation** or in patients who have rejected a transplanted heart.

Examples of patients who might be candidates for a VAD are those who:

- have suffered a massive heart attack
- cannot be weaned from heart-lung bypass after treatment with intravenous fluids, medications, and insertion of a balloon pump in the aorta
- have an infection in the heart wall that does not respond to conventional treatment
- are awaiting a heart transplant and are unresponsive to drug therapy and intravenous fluids
- are undergoing high-risk procedures to clear the blockages in a coronary artery

Although one in five people suffer left side ventricular failure, only a minority are candidates for VADs. To be considered for a VAD, patients must meet specific criteria concerning blood flow, blood pressure, and general health.

Precautions

Poor candidates for a VAD include those with:

- irreversible renal failure
- severe disease of the vascular system of the brain
- cancer that has spread (metastasized)
- severe liver disease
- blood clotting disorders
- severe lung disease
- infections that do not respond to antibiotics
- extreme youth or age

Description

There are four types of VADs, each appropriate for a different condition. Surgery to install a VAD is performed under general anesthesia in a hospital operating room. An incision is made in the chest, then catheters are inserted into the heart and the correct artery. The surgeon

KEY TERMS

Coronary blood vessels—The arteries and veins that supply blood to the heart muscle.

Diaphragm—The muscle that separates the chest cavity from the abdominal cavity.

Ventricle—The heart has four chambers. The right and left ventricles are at the bottom of the heart and act as the body's main pumps.

sutures the catheters in place, then attaches tubing to connect the catheters to the pump. The pump stays outside the body. Once it is turned on, blood flows out of the diseased ventricle and into the pump, then is returned to the correct blood vessel leaving the heart.

Preparation

Before the operation the patient meets with an anesthesiologist to determine any special conditions that will affect the administration of anesthesia. Standard preoperative blood and urine studies are performed, and the heart is monitored both before and during the operation with an electrocardiograph.

Aftercare

The patient is monitored in intensive care, with follow-up blood, urine, and neurological studies. Blood thinning medications are given to prevent blood clotting.

Except for those patients awaiting a heart transplant, patients are slowly and gradually weaned from the VAD. Even when patients no longer need the VAD, they will require supportive drug therapy and/or a balloon pump inserted in the aorta.

Risks

VAD insertion carries risks of severe complications. Bleeding from surgery is common and occurs in as many as 30-50% of patients. Other complications include the development of blood clots, partial **paralysis** of the diaphragm, **respiratory failure**, kidney failure, failure of the VAD, damage to the coronary blood vessels, **stroke**, and infection.

Sometimes when the left ventricle is supported, the right ventricle begins to need assistance. If VADs are inserted in both ventricles, the heart may become so dependent on their support that they cannot be removed.

Normal results

Because conditions for which VADs are used vary widely and because of the high risks associated with VAD insertion, the outcome of surgery cannot be predicted.

Resources

BOOKS

"Ventricular Assist Device." In *The Patient's Guide to Medical Tests*, ed. Barry L. Zaret, et al. Boston: Houghton Mifflin, 1997.

OTHER

"Ventricular Assist Devices." Department of Biological and Agricultural Engineering. New York State University <http://www.bae.ncsu.edu>.

Tish Davidson

Ventricular ectopic beats

Definition

A ventricular ectopic beat (VEB) is an extra heartbeat originating in the lower chamber of the heart. This beat, also called a premature ventricular contraction (PVC), occurs before the beat triggered by the heart's normal function.

Description

Ventricular ectopic beats are common and do not indicate a problem in people without heart disease. However, if a person has aortic stenosis, **heart failure**, or a previous **heart attack**, VEBs may be followed by **ventricular tachycardia** and fibrillation, which can lead to sudden **death**.

Causes and symptoms

Although the origin of a VEB is well documented, the exact cause or causes are not well understood. Some physicians believe the beat is caused by a trigger of specific origin, while other physicians believe the beat is random. Occasional ventricular ectopic beats occur in healthy people. If there is no evidence of heart disease, there is little or no danger to the individual.

A single ventricular ectopic beat has very little effect on the pumping ability of the heart and usually does not cause any symptoms. If a symptom is felt, it is the feeling of a strong or skipped beat, often described as a thump, kick, or flip-flop. Sometimes, the sensation is referred to as a fullness in the neck.

KEY TERMS

Angioplasty—A surgical procedure which dilates a narrowed or blocked part of an artery.

Aortic stenosis—A stiffening of the artery which carries blood from the heart to the body.

Beta-blockers—A class of medication used to block the cellular response to chemicals normally present in the body.

Coronary artery—The vessel which brings blood to the muscle of the heart.

Fibrillation—Rapid, uncoordinated quivering of the heart.

Heart failure—A term used when the heart is unable to pump enough blood to supply the needs of the body.

Diagnosis

Ventricular ectopic beats are easily seen on an electrocardiogram.

Treatment

If a person is otherwise healthy, the only treatment needed is to decrease **stress** and limit the use of alcohol and **caffeine**. Cold medicines, available without prescription, sometimes contain drugs (e.g., **decongestants**) that stimulate the heart and should be used with caution.

If symptoms are uncomfortable, or the pattern of VEBs indicates a problem, the physician may prescribe drug therapy. Beta-blockers are quite safe and are usually tried first.

A person who has a history of heart attack or heart disease, and is experiencing frequent or complex VEBs, is at greater risk of sudden death. Drug therapy with beta-blockers will be recommended. In addition, **angioplasty** or coronary artery bypass surgery may relieve any underlying coronary artery blockage and reduce the danger of sudden death.

Treatment with **antiarrhythmic drugs** can suppress VEBs, but they can also increase the risk of a fatal abnormal rhythm. Often, extensive electrophysiologic testing and risk evaluation will be done before this method of treatment is prescribed.

Prognosis

In healthy people, VEBs are inconsequential. If the person with heart disease is able to find an effective means of controlling ventricular ectopic beats, the outlook is good.

Prevention

Occasional ventricular ectopic beats in healthy people do not need to be prevented. People with a history of heart disease can usually control VEBs with medication.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Ventricular failure *see* **Heart failure**

Ventricular fibrillation

Definition

Ventricular fibrillation is a very rapid, uncoordinated, ineffective series of contractions throughout the lower chambers of the heart. Unless stopped, these chaotic impulses are fatal.

Description

When the ventricles begin to quiver, and do not employ coordinated contractions, the heart is said to be fibrillating. In this condition the ventricles cannot pump blood from the heart. Ventricular fibrillation (V-fib) is the worst kind of abnormal heart rhythm, and is a form of cardiac arrest. It involves the pumping of the lower chambers of the heart, while atrial fibrillation involves the upper chambers.

Causes and symptoms

Ventricular fibrillation is often associated with acute ischemic events (**ischemia** involves the deprivation of oxygenated blood to an area of tissue), and with chronic ischemic heart disease. It is frequently seen immediately following a **heart attack**. It may also develop during hypoxia, atrial fibrillation, or improper grounding of electrical devices. An extremely low level of potassium in the blood can also cause ventricular fibrillation.

KEY TERMS

Atrial fibrillation—A condition in which the upper chambers of the heart quiver instead of contracting effectively

Cardiopulmonary resuscitation (CPR)—Using rescue breathing and chest compressions to help a person whose breathing and heartbeat have stopped

Cardioversion—A electrical shock delivered to the heart to restore a normal rhythm

Electrocardiogram—A visual representation of the heart beat

Heart failure—A term used when the heart is unable to pump enough blood to supply the needs of the body

Hypoxia—Insufficient oxygen in the cells of the body

Ischemic—Insufficient blood reaching the tissues

The first, and usually the only, symptom of V-fib is sudden unconsciousness.

Diagnosis

When an individual suddenly collapses, the possibility of ventricular fibrillation should be considered immediately. A quick assessment usually shows no pulse or heartbeat. The diagnosis of ventricular fibrillation is confirmed with an electrocardiogram.

Treatment

Basic **life support** with standard **cardiopulmonary resuscitation** (**CPR**) must be started within a few minutes, followed as soon as possible with **cardioversion**. Cardioversion is an electric shock delivered to the heart to stop the fibrillating. Early **defibrillation** is the key to survival. If left untreated, irreversible brain damage, due to lack of oxygen to the brain, occurs after about five minutes. After the heart resumes its normal rhythm, medications are given to help maintain the rhythm.

Prognosis

Early and effective CPR may provide the time necessary for medical personnel to arrive with a defibrillator. If a defibrillator is able to promptly restore a normal rhythm, up to 25% of victims are able to leave the hospital without evidence of brain damage.

If ventricular fibrillation occurs in the hospital in conjunction with a heart attack, defibrillation has a 95% success rate. If shock and **heart failure** are present at the time, even with immediate defibrillation, only about 30% of those stricken are successfully restore to a normal heart rate.

Prevention

A healthy lifestyle to reduce the risk of heart diseases which lead to ventricular fibrillation is the best prevention. For people who have experienced an episode of V-fib, an internal cardioverter-defibrillator may prevent further episodes.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

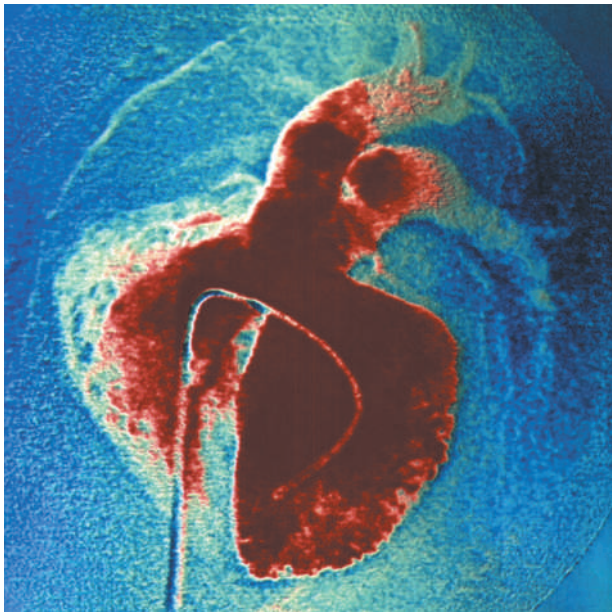
Ventricular septal defect

Definition

A ventricular septal defect is a hole in the wall of the heart (septum) that separates the left lower chamber (left ventricle) from the right lower chamber (right ventricle). The hole allows blood to flow from the left ventricle to the right ventricle instead of entering the aorta for distribution throughout the body. Ventricular septal defect is one of a group of heart problems found in newborn babies that are collectively called **congenital heart disease**.

Description

The heart has four chambers. The two lower chambers are called ventricles and are responsible for pumping blood. The right ventricle pumps blood to the lungs and the left ventricle pumps blood throughout the body. If there is a hole in the septum that separates the two ventricles, blood from the left ventricle can enter the right ventricle. This blood recycles through the lungs before returning to the left ventricle. This results in less oxygenated blood reaching the body. If the hole is sufficiently large, the lack of oxygen being delivered to the body



An angiogram of a ventricular septal defect. This is a hole in the ventricular septum causing blood to flow from the left ventricle (right of image) to the right ventricle and to the lungs. The bent catheter at the center, which is used to take the angiogram, passes through the hole between the ventricles. *(Photograph by Simon Fraser, Photo Researchers, Inc. Reproduced by permission.)*

KEY TERMS

Echocardiogram—An image of the heart produced by an instrument that uses sound waves to create image the heart.

Electrocardiogram—A graph of the heart's beating action.

Endocarditis—An inflammation of the interior lining of the heart that is frequently caused by infectious agents.

can cause severe problems, including **heart failure** and breathlessness. Approximately 0.7% of all babies have a congenital heart defect. Of these, 20% have a ventricular septal defect.

Causes and symptoms

Congenital heart defects are errors in the development of the heart structure. They occur early in the life of the embryo. There is no known cause of congenital heart defects. They can be associated with several diseases, such as German **measles** (**rubella**) and **Down syndrome**. Genetics does not seem to play a role in ventricular septal defect. People with a heart defect do not have an increased chance of passing it on to their children.

Symptoms result from a reduced amount of oxygen going to the body. Symptoms are proportional to the size of the defect. They may appear at any time in the life of the child. In cases where the hole in the septum is very small, few or no symptoms may appear and the child may develop normally. In cases where the ventricular septal defect is large, the newborn will shows signs of heavy breathing, sweating, and feeding difficulties. Children with this defect tire easily. Ventricular septal defect can also result in stunted growth resulting from insufficient oxygen being delivered to the growing body. Children with ventricular septal defect tend to suffer more frequent colds and **pneumonia**, and have a higher rate of inflammation and infection of the heart (**endocarditis**).

Diagnosis

The condition is first suspected based on observation of the child. The physician will listen to the heart with a stethoscope (auscultation) to detect a heart murmur. X rays, electrocardiogram (ECG), and **echocardiography** can all be used to evaluate ventricular septal defect.

Treatment

Most small holes close without treatment. Often, as the child grows, the hole closes or becomes smaller. If the hole is large or fails to close, the child is usually treated with drugs. Holes that persist and are causing problems in development are corrected by open heart surgery. Usually, surgery is performed after one year of age, but before the child enters school. This allows time for a trial of drug therapy, which could potentially eliminate the need for surgery. The operation is generally safe.

Prognosis

Children with small septal defects tend to develop normally and without any effect on their ability to participate in physical activities. Surgery allows children with larger defects to live nearly normal lives.

Resources

BOOKS

Alexander, R. W., R. C. Schlant, and V. Fuster, eds. *The Heart.* 9th ed. New York: McGraw-Hill, 1998.

Berkow, Robert, ed. *Merck Manual of Medical Information.* Whitehouse Station, NJ: Merck Research Laboratories, 1997.

OTHER

"Ventricular Septal Defect." *The Merck Page*. 13 Apr. 1998 <http://www.merck.com>.

John T. Lohr, PhD

Ventricular shunt

Definition

Ventricular shunt is a surgical procedure in which a tube is placed in one of the fluid-filled chambers inside the brain (ventricles). The fluid around the brain and the spinal column is called the cerebrospinal fluid. When infection or disease causes an excess of this cerebrospinal fluid in the ventricles, the shunt is placed to drain it and thereby relieve excess pressure.

KEY TERMS

Cerebrospinal fluid—Fluid bathing the brain and spinal cord.

Computed tomography (CT) scan—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Dementia—Progressive loss of mental abilities.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Purpose

Ventricular shunt relieves **hydrocephalus**, a condition in which the ventricles are enlarged. In hydrocephalus, pressure from the cerebrospinal fluid usually increases. It may be caused by tumor of the brain or of the membranes covering the brain (meninges), infection of or bleeding into the cerebrospinal fluid, or inborn malformations of the brain. Symptoms of hydrocephalus may include **headache**, personality disturbances and loss of intellectual abilities (**dementia**), problems in walking, irritability, vomiting, abnormal eye movements, or a low level of consciousness.

Normal pressure hydrocephalus is associated with progressive dementia, problems in walking, and loss of bladder control (**urinary incontinence**). Even though the cerebrospinal fluid is not thought to be under increased pressure in this condition, it may also be treated by ventricular shunting.

Precautions

As with any surgical procedure, the surgeon must know about any medications or health problems that may increase the patient's risk. Because infections are both common and serious complications, **antibiotics** are often given before and after surgery.

Description

The ventricular shunt tube is placed to drain fluid from the ventricular system in the brain to the cavity of the abdomen or to the large vein in the neck (jugular vein). Therefore, surgical procedures must be done both in the brain and at the drainage site. The tubing contains valves to insure that fluid can only flow out of the brain and not back into it. The valve can be set at a desired pressure to allow cerebrospinal fluid to escape whenever the pressure level is exceeded.

A small reservoir may be attached to the tubing and placed under the scalp. This reservoir allows samples of cerebrospinal fluid to be removed with a syringe to check the pressure. Fluid from the reservoir can also be examined for bacteria, **cancer** cells, blood, or protein, depending on the cause of hydrocephalus. The reservoir may also be used to inject antibiotics for cerebrospinal fluid infection or **chemotherapy** medication for meningeal tumors.

Preparation

The diagnosis of hydrocephalus should be confirmed by diagnostic techniques that make images of the brain, such as computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI), before the shunting procedure is performed. These techniques will also show any associated brain abnormalities. Cerebrospinal fluid should be examined if infection or tumor of the meninges is suspected. Patients with dementia or **mental retardation** should undergo neuropsychological testing to establish a baseline psychological profile before the shunting procedure.

Patients with normal pressure hydrocephalus may experience a temporary improvement in walking and mental abilities upon removal of a moderate amount of cerebrospinal fluid. This improvement may be an indication that shunting will improve their condition. However, patients who do not improve after temporary cerebrospinal fluid drainage may still benefit from ventricular shunt. When a case is in doubt, continuous monitor-

ing of cerebrospinal fluid pressure (which in itself requires a surgical procedure) may indicate whether shunting is likely to be helpful.

Aftercare

To avoid infections at the shunt site, the area should be kept clean. Cerebrospinal fluid should be checked periodically by the doctor to be sure there is no infection or bleeding into the shunt. Cerebrospinal fluid pressure should be checked to be sure the shunt is operating properly. The eyes should be examined regularly because shunt failure may damage the nerve to the eyes (optic nerve). If not treated promptly, damage to the optic nerve causes irreversible loss of vision. Patients or caregivers should understand the life-threatening nature of shunt problems. All symptoms and signs of potential shunt failure or infection must be taken seriously.

Risks

Complications of shunting occur in 30% of cases, but only 5% are serious. Serious and long-term complications are bleeding under the outermost covering of the brain (**subdural hematoma**), infection, **stroke**, and shunt failure. Infection at the shunt site may cause a loss of intelligence. When shunts drain to the abdomen (ventriculoperitoneal shunts), fluid may accumulate in the abdomen or abdominal organs may be injured. If cerebrospinal fluid pressure is lowered too much, patients may have severe headaches, often with **nausea and vomiting**, whenever they sit up or stand.

Normal results

Of patients with normal pressure hydrocephalus who are treated with shunting, 25-80% experience long-term improvement. Normal pressure hydrocephalus is more likely to improve when it is caused by infection of or bleeding into the cerebrospinal fluid than when it occurs without an underlying cause. Walking difficulties and bladder control are more likely to improve than dementia is.

After shunting, the ventricles get smaller within three or four days. This shrinkage occurs even when hydrocephalus has been present for a year or more. Clinically detectable signs of improvement occur within a few weeks. The cause of hydrocephalus, duration of hydrocephalus before shunting, and associated brain abnormalities affect the outcome.

Resources

BOOKS

Black, P. M. "The Normal Pressure Hydrocephalus Syndrome." In *Concepts in Neurosurgery: Hydrocephalus*, ed. R. M. Scott. Baltimore: William & Wilkins, 1990.

PERIODICALS

McLone, D. G., and K. E. Aronyk. "An Approach to the Management of Arrested and Compensated Hydrocephalus. (Review)." *Pediatric Neurosurgery* 19, no. 2 (1993): 101-103.

Raftopoulos, C., et al. "Prospective Analysis by Computed Tomography and Long-Term Outcome of 23 Adult Patients with Chronic Idiopathic Hydrocephalus." *Neurosurgery* 38 (1996): 51-59.

Vanneste, J., et al. "Shunting Normal-Pressure Hydrocephalus: Do the Benefits Outweigh the Risk? A Multicenter Study and Literature Review." *Neurology* 42 (1992): 54-59.

ORGANIZATIONS

American Academy of Neurology. 1080 Montreal Ave., St. Paul, MN 55116. (612) 695-1940. <http://www.aan.com>.

Laurie Barclay, MD

Ventricular tachycardia

Definition

Ventricular tachycardia (V-tach) is a rapid heart beat that originates in one of the lower chambers (the ventricles) of the heart. To be classified as tachycardia, the heart rate is usually at least 100 beats per minute.

Description

A rapid heart rate can originate in either the left or right ventricle. Ventricular tachycardia which lasts more than 30 seconds is referred to as sustained ventricular tachycardia. A period of three to five rapid beats is called a salvo, and six beats or more lasting less than 30 seconds is called nonsustained ventricular tachycardia. Rapid ventricular rhythms are more serious than rapid atrial rhythms because they make the heart extremely inefficient. They also tend to cause more severe symptoms, and have a much greater tendency to result in **death**.

Although generally considered to be among the life-threatening abnormal rhythms, harmless forms of sustained V-tach do exist. These occur in people without any structural heart disease.

Causes and symptoms

Most ventricular tachycardias are associated with serious heart disease such as coronary artery blockage, cardiomyopathy, or **valvular heart disease**. V-tach is often triggered by an extra beat originating in either the right or left ventricle. It also occurs frequently in connection with a **heart attack**. V-tach commonly occurs within 24 hours of the start of the attack. It must be treated

KEY TERMS

Atrial—Having to do with the upper chambers of the heart.

Cardiomyopathy—A disease of the heart muscle.

Cardioversion—A electrical shock delivered to the heart to restore a normal rhythm.

Coronary artery—The artery that supplies blood to the heart muscle itself.

Electrocardiogram—A visual representation of the heart beat.

Fibrillation—Rapid, uncoordinated, quivering of the heart.

Palpitations—Uncomfortable feeling of the heart beat in the chest.

Valvular—Having to do with the valves inside the heart.

quickly to prevent fibrillation. After 48 to 72 hours of the heart attack, the risk of ventricular tachycardia is small. However, people who have suffered severe damage to the larger anterior wall of the heart have a second danger period, because V-tach often occurs during convalescence from this type of heart attack.

Sustained ventricular tachycardia prevents the ventricles from filling adequately so the heart can not pump normally. This results in loss of blood pressure, and can lead to a loss of consciousness and to **heart failure**.

The individual with V-tach almost always experiences palpitation, though some episodes cause no symptoms at all.

Diagnosis

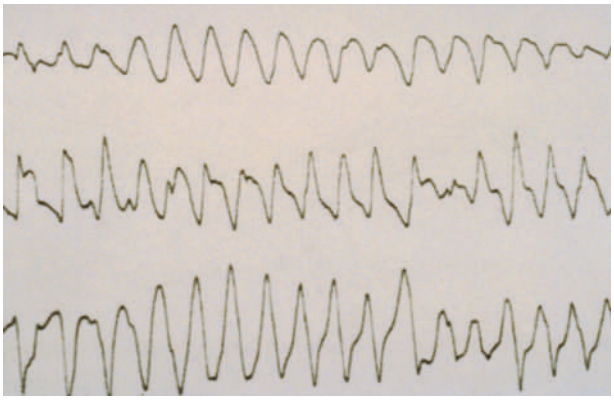
Diagnosis is easily made with an electrocardiogram.

Treatment

Any episode of ventricular tachycardia that causes symptoms needs to be treated. An episode that lasts more than 30 seconds, even without symptoms, also needs to be treated. Drug therapy can be given intravenously to suppress episodes of V-tach. If blood pressure falls below normal, a person will need electric **cardioversion** ("shock") immediately.

Prognosis

With appropriate drug or surgical treatment, ventricular tachycardia can be controlled in most people.



An electrocardiographic image indicating a rapid heart beat. *(Custom Medical Stock Photo. Reproduced by permission.)*

Prevention

A person susceptible to sustained ventricular tachycardia often has a small abnormal area in the ventricles that is the source of the trigger event. This area can sometimes be surgically removed. If surgery is not an option, and drug therapy is not effective, a device called an automatic cardioverter-defibrillator may be implanted.

Resources

BOOKS

McGoon, Michael D., ed. *Mayo Clinic Heart Book: The Ultimate Guide to Heart Health*. New York: William Morrow and Co., Inc., 1993.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

Dorothy Elinor Stonely

Verrucae *see* **Warts**

Vertigo *see* **Dizziness**

Vesicle *see* **Skin lesions**

Vesicoureteral reflux

Definition

Vesicoureteral reflux (VUR) refers to a condition in which urine flows from the bladder, back up the ureter, and back into the kidneys.

Description

The normal flow of urine begins in the collecting system of each kidney. Urine then flows out of each kidney and into a tube called the ureter. Each ureter leads into the bladder, where the urine collects until it is passed out of the body. Normally, urine should flow only in this direction. In vesicoureteral reflux, however, urine that has already collected in the bladder is able to flow backwards from the bladder, up the ureter, and back into the collecting system of the kidney. VUR may be present in either one or both ureters.

Vesicoureteral reflux causes damage to the kidneys in two ways:

- The kidney is not designed to withstand very much pressure. When VUR is present, backpressure of the urine on the kidney is significant. This can damage the kidney.
- The kidney is usually sterile, meaning that no bacteria are normally present within it. In VUR, bacteria that enter through the urinary tract may be carried back up the ureter with the urine. These bacteria can enter the kidney, causing severe infection.

Causes and symptoms

Most cases of VUR are due to a defect in the way the ureter is implanted into the bladder. The angle may be wrong, or the valve (which should allow urine only one-way entrance into the bladder) may be weak. Structural defects of the urinary system may also cause VUR. These include a situation in which two ureters leave a kidney, instead of the usual one (duplicated ureters), and in which the ureter is greatly enlarged at the end leading into the bladder (ureterocele).

VUR alone does not usually cause symptoms. Symptoms develop when an infection has set in. The usual symptoms of infection include frequent need to urinate, **pain** or burning with urination, and blood or pus in the urine. Occasionally, VUR is suspected when a child has a difficult time becoming toilet trained. In these cases, the bladder may become irritable and spasm, because it is never totally empty of urine. When the kidneys have been damaged, high blood pressure may develop.

Diagnosis

VUR is diagnosed by taking a series of x-ray pictures. These are taken after putting a small tube (catheter) into the bladder. The bladder is then filled with a dye solution which lights up on the x-ray picture. Pictures are taken immediately, followed by x rays taken while the patient is urinating. This will allow reflux to be demonstrated, and will reveal whether the level of reflux increases when pressure increases during urination. Reflux is then graded based on the height and effects of the VUR:

- Grade I. VUR enters just the portion of the ureter closest to the bladder. The ureter appears normal in size.
- Grade II. VUR enters the entire ureter, and goes up into the collecting system of the kidney. The ureter and the collecting system appear normal in size and structure.
- Grade III. VUR enters the entire ureter and kidney collecting system. Either the ureter or the collecting system are abnormal in size or shape.
- Grade IV. Similar to Grade III, but the ureter is greatly enlarged.
- Grade V. Similar to Grade IV, but the ureter is also abnormally twisted/curved, and the collecting system is greatly enlarged, with absence of the usual structural details.

Treatment

Treatment depends on the grade that is diagnosed. In grades I and II, the usual treatment involves long-term use of a small daily dose of **antibiotics** to prevent the development of infections. The urine is tested regularly to make sure that no infection occurs. The kidneys are evaluated regularly to make sure that they are growing normally and that no new scarring has occurred. Grade III VUR can be treated with antibiotics and careful monitoring. New infections, scarring, or stunting of kidney growth may result in a need for surgery. Grades IV and V are extremely likely to require surgery.

Surgery for VUR consists of reimplanting the ureters into the bladder at a more normal angle. This usually improves the functioning of the valve leading into the bladder. When structural defects of the urinary system are present, surgery will almost always be required to repair these defects.

Prognosis

Prognosis is dependent on the grade of VUR. About 80% of children with grades I and II VUR simply grow out of the problem. As they grow, the ureter lengthens, changing its angle of entry into the bladder. About 50% of children with grade III VUR will require surgery. Nearly all children with grades IV and V VUR will require surgery. In these cases, it is usually best to perform surgery at a relatively young age, in order to avoid damage and scarring to the kidneys.

Prevention

While there is no known method of preventing VUR, it is important to note that a high number of the siblings of

KEY TERMS

Bladder—The muscular sac which receives urine from the kidneys, stores it, and ultimately works to remove it from the body during urination.

Reflux—A condition in which flow is backwards from normal.

Ureter—A muscular tube leading from the kidney to the bladder, down which the urine flows.

children with VUR will also have VUR. Many of these siblings (about 36%) will have no symptoms, but will be discovered through routine examinations prompted by their brother's or sister's problems. It is important to identify these children, so that antibiotic treatment can be used to prevent the development of infection and kidney damage.

Resources

BOOKS

Francoeur, D., et al. "Urologic Problems." In *Pediatric and Adolescent Gynecology*, ed. J. S. Sanfilippo, et al. Philadelphia: W. B. Saunders Co., 1994.

Gonzalez, Richard. "Vesicoureteral Reflux." In *Nelson Textbook of Pediatrics*, ed. Richard E. Behrman. Philadelphia: W. B. Saunders Co., 1996.

PERIODICALS

Connolly, L. P., et al "Vesicoureteral Reflux in Children: Incidence and Severity in Siblings." *Journal of Urology* 157, no. 6 (June 1997): 2287+.

Greenfield, S. P., et al. "Experience with Vesicoureteral Reflux in Children: Clinical Characteristics." *Journal of Urology* 158, no. 2 (Aug. 1997): 574+.

Manzoni, G., and E. Merlini. "Vesico-Ureteral Reflux in 1996." *Paediatric Urology* 6, no. 6 (Nov. 1996): 301+.

ORGANIZATIONS

American Foundation for Urologic Disease. 300 West Pratt St., Suite 401, Baltimore, MD 21201. (800) 242-2383.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580. (800) 891-5388. <http://www.niddk.nih.gov/health/urolog/pubs/kuorg/kuorg.htm>.

Rosalyn Carson-DeWitt, MD

Vestibulitis *see* **Labyrinthitis**

Viagra *see* **Sildenafil citrate**

Vibrio cholera infection *see* **Cholera**

Vibrio parahemolyticus infection *see* **Vibriosis**

Vibriosis

Definition

Vibriosis is a disease caused by an infection with bacteria of the *Vibrio* genus, most commonly *Vibrio parahemolyticus* or *Vibrio vulnificus*. *Vibrio* bacteria cause **diarrhea**, skin infections, and/or blood infections. The diarrhea-causing *Vibrio parahemolyticus* is a relatively harmless infection, but *Vibrio vulnificus* infection, though rare, can lead to blood **poisoning** and **death** in many cases.

Description

Vibriosis is a general term referring to an infection by any member of the large group of *Vibrio* bacteria. The bacteria that causes **cholera** is in this group. Alternate names include non-cholera *Vibrio* infection, *Vibrio parahemolyticus* infection, and *Vibrio vulnificus* infection.

Vibrio parahemolyticus and *Vibrio vulnificus* are found in salt water. Infection with either of these two bacteria primarily occurs through eating contaminated raw seafood. Raw oysters are the usual source, although other seafood can carry the bacteria.

Vibrio parahemolyticus causes severe diarrhea. *Vibrio vulnificus* may cause diarrhea, but in persons with an underlying disease it may cause severe blood infections (septicemia or blood poisoning). Contact of a wound with seawater or contaminated seafood can lead to a *Vibrio vulnificus* skin infection.

Vibriosis is not very common in the United States. Most cases occur in coastal states between June and October. Between 1988 and 1991, there were only 21 reported cases of *Vibrio parahemolyticus* infection in the United States. Between 1988 and 1995, there were over 300 reports of *Vibrio vulnificus* infection in the United States.

Causes and symptoms

Vibriosis is caused by eating seafood contaminated with *Vibrio parahemolyticus* or *Vibrio vulnificus*. These bacteria damage the inner wall of the intestine, which causes diarrhea and related symptoms. *Vibrio vulnificus* can get through the intestinal wall and into the bloodstream.

Persons at risk for severe, often fatal vibriosis include those with liver disease (**cirrhosis**), excess iron (**hemochromatosis**), **thalassemia** (a blood disorder), **AIDS**, diabetes, or those who are immunosuppressed.

Symptoms of intestinal infection occur within two days of eating contaminated seafood. Symptoms last for

two to 10 days and include watery diarrhea, abdominal cramps, nausea, vomiting, **headache**, and possibly **fever**. Symptoms of a blood infection develop one to two days after eating contaminated seafood, and include fever, chills, low blood pressure, and large fluid-filled blisters on the arms or legs. Similar blisters can also be produced by a *Vibrio vulnificus* skin infection.

Diagnosis

Vibriosis can be diagnosed and treated by an infectious disease specialist. It is diagnosed when *Vibrio* bacteria are grown from samples of stool, blood, or blister fluid. The symptoms and a recent history of eating raw seafood are very important clues for diagnosis.

Treatment

To counteract the fluid loss resulting from diarrhea, the patient will receive fluids either by mouth or intravenously. **Antibiotics** are not helpful in treating *Vibrio parahemolyticus* diarrhea.

However, *Vibrio vulnificus* infections are treated with antibiotics such as tetracycline (Sumycin, Achromycin V), or doxycycline (Monodox) plus ceftazidime (Ceftaz, Fortraz, Tazicef). One out of five patients with vibriosis requires hospitalization.

Prognosis

Most healthy persons completely recover from diarrhea caused by *Vibrio* bacteria. *Vibrio vulnificus* blood infection affects persons with underlying illness and is fatal in half of those cases. *Vibrio vulnificus* wound infections are fatal in one quarter of the cases.

Prevention

Contamination with *Vibrio* bacteria does not change the look, smell, or taste of the seafood. Vibriosis can be prevented by avoiding raw or undercooked shellfish, keeping raw shellfish and its juices away from cooked foods, and avoiding contact of wounded skin with seawater or raw seafood.

Resources

BOOKS

Sack, David A. "Cholera and Related Illnesses Caused by Vibrio Species and Aeromonas." In *Infectious Diseases*, ed. Sherwood L. Gorbach, et al. Philadelphia: W. B. Saunders Co., 1998.

PERIODICALS

Kumamoto, Kenneth S., and David J. Vukich. "Clinical Infections of Vibrio vulnificus: A Case Report and Review of the Literature." *The Journal of Emergency Medicine* 16, no. 1 (1998): 61-66.

OTHER

Center for Food Safety and Applied Nutrition. <http://vm.cfsan.fda.gov>.

Belinda Rowland, PhD

Viral diarrhea *see* **Rotavirus infections**

Viral meningitis *see* **Meningitis**

Visceral l *see* **Roundworm infections**

Vision training

Definition

Vision training, also known as vision therapy or orthoptics, consists of a variety of programs to enhance visual performance. It includes treatments for focusing, binocularity, and eye movement problems. Vision training is generally provided by an optometrist (O.D.).

Purpose

While visual acuity refers to how clearly each eye can see, vision training addresses how well the two eyes work together as a team. When looking at an object, the eyes must focus on the object (e.g., focusing for near or far objects). This involves the lens system of the eyes. The eyes must also work as a team and point at the same object so that the person does not see double. Aiming precisely at the same object will aid in depth perception (stereopsis) and seeing objects in three-dimensions (3D).

Although crossed eyes (**strabismus**) is an obvious condition, many defects in the coordination of eye movement are far less apparent. Even so, they can cause problems in reading, driving vehicles, and other complex tasks that require the integrated function of eyes and body. It is the goal of vision therapy to improve these subtle interactions using carefully devised exercises and devices.

The discipline, called "behavioral optometry," involves a careful evaluation of visual function, concentrating on complex skills such as rapid reading, distance perception, peripheral field awareness, accommodative facility, and the coordinated movement of each eye in relationship to the other. From that assessment the doctor goes on to design a course of exercises to correct the problems discovered. Like any other type of training, success requires practice and persistence until habits and reflexes can be retrained.

There are a number of different techniques and instruments used in vision therapy; the field is evolving rapidly in many directions. Some computerized exercises are being developed that promise better patient motivation. A device called the Dynavision apparatus, has produced positive results in retraining **stroke** victims to operate motor vehicles. And traditional forms of vision therapy have increased reading efficiency in an older age group (62 to 75 years).

Because the goal of vision training is to improve visual efficiency and visual processing, people having problems reading should consider a vision training evaluation. Children rubbing their eyes while reading, avoiding reading, or getting headaches while reading should be evaluated. Problems with sustaining focusing (accommodative insufficiency) or problems keeping words single (convergence or divergence problems) may be present. A full eye-health evaluation and vision training workup may reveal a problem. Vision training is also appropriate for people learning how to coordinate the eyes after surgery for strabismus. Vision training can also be used in lazy eye (**amblyopia**) and includes patching the eye and doing various exercises.

Dyslexia is a problem with following the flow of words when reading. Often the order of letters or words is reversed. It is a complex problem involving the way the brain processes the stream of information coming in from the eyes. While vision therapy is not a treatment for dyslexia or learning disabilities, there may be an underlying visual processing problem that may be present. Vision therapy can be part of a multidisciplinary approach to treating learning disabilities.

Sports vision deals with visual performance in sport-related activities. Protective eyewear is also a large consideration when participating in sports. Basketball, baseball, racquetball, and swimming (and other sports as well) can all cause injury to the eyes. Batting helmets with face shields, protective goggles with polycarbonate lenses, or something as simple as ultraviolet (UV) coatings on glasses to protect the eyes from the sun in outdoor sports such as golf can protect the eyes. Hitting a baseball or throwing a basketball into a hoop requires accurate fixation. Golfers need to see clearly and judge distance. Bifocals may need to be adjusted to allow for putting, driving, and reading the score card. While many of these issues (e.g., UV coatings) can be addressed at a regular eye exam, sports vision may be able to help with more specific, individual problems.

Precautions

Behavioral optometry is a relatively new field of study. Results are mixed. Newer techniques, more refined evaluation methods, and newer pieces of apparatus are continuously being appraised. More study results are needed to define the scope and benefits of this discipline.

Description

Vision therapy is individually tailored to the subject and the discovered problems. It can be a lengthy process with many variations that requires repetition until eye muscles, coordination, reflexes, habits, and the way the brain handles visual input are all retrained. Each program will be individualized. The patient should be aware of the time involved for treatment. Treatment can be from several weeks to several months depending upon the condition. Some insurance plans may cover vision training.

Preparation

If vision therapy is recommended, the optometrist will discuss thoroughly what is expected and necessary for success. The patient must be prepared to perform some eye exercises at home.

Aftercare

Even after the treatment is successful, it may be necessary to continue the exercises to maintain the benefits. It may be necessary to repeat treatment in the future.

Risks

No risk is involved. The treatment is safe.

Normal results

A carefully and individually tailored program of vision therapy should result in a gradual improvement in whatever complex visual function is being addressed. This progress ought to be measurable by using the same tests that were used to diagnose it. If the patient had symptoms, such as headaches or double vision while reading, it should be alleviated.

Abnormal results

Because the treatment is safe, the only abnormal result is failure. At the start of treatment, the optometrist should provide a reasonable estimate of what improvement to expect and how long it will take. Should this prove incorrect, either the treatment needs to be modified or the problem deemed untreatable by that method.

Resources

PERIODICALS

Birnbaum, M. H. "Behavioral Optometry: A Historical Perspective." *Journal of the American Optometric Association* 65, no. 4 (Apr. 1994): 255-64.

KEY TERMS

Accommodation—The focusing of the lens of the eye.

Binocular—Both eyes accurately pointing to the same object.

Stereopsis—The visual perception of depth, or the ability to see three-dimensionally. For this to occur, the person must be binocular.

Gallaway, M., and M. Schieman. "The Efficacy of Vision Therapy for Convergence Excess." *Journal of the American Optometric Association* 68, no. 2 (Feb. 1997): 81-6.

Garriott, R. S., C. L. Heyman, and M. W. Rouse. "Role of Optometric Vision Therapy for Surgically Treated Strabismus Patients." *Optometry & Vision Science* 74, no. 4 (Apr. 1997): 179-84.

Groffman, S. "Motivational Factors in Vision Therapy: Comparison of Computerized vs. Manipulative Techniques." *Journal of the American Optometric Association* 67, no. 6 (June 1996): 344-9.

Klavora, P., et al. "The Effects of Dynavision Rehabilitation on Behind-the-Wheel Driving Ability and Selected Psychomotor Abilities of Persons After Stroke." *American Journal of Occupational Therapy* 49, no.6 (June 1995): 534-542.

Klavora, P., and M. Warren. "Rehabilitation of Visuomotor Skills in Poststroke Patients Using the Dynavision Apparatus." *Perceptual and Motor Skills* 86, no. 1 (Feb. 1998): 23-30.

Kulp, M. T., and P. P. Schmidt. "Effect of Oculomotor and Other Visual Skills on Reading Performance: A Literature Review." *Optometry & Vision Science* 73, no. 4 (Apr. 1996): 283-92.

Russell, G. E., and B.Wick. "A Prospective Study of Treatment of Accommodative Insufficiency." *Optometry & Vision Science* 70, no. 2 (Feb. 1993): 131-5.

Solan, H. A., J. Feldman, and L. Tujak. "Developing Visual and Reading Efficiency in Older Adults." *Optometry & Vision Science* 72, no. 2 (Feb. 1995): 139-45.

Wood, J. M., and B. Abernethy. "An Assessment of the Efficacy of Sports Vision Training Programs." *Optometry & Vision Science* 74, no. 8 (Aug. 1997): 646-59.

ORGANIZATIONS

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. <http://www.aoanet.org>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

J. Ricker Polsdorfer, MD

Visual evoked potential study *see* **Evoked potential studies**

Visual impairment

Definition

Total blindness is the inability to tell light from dark, or the total inability to see. Visual impairment or low vision is a severe reduction in vision that can't be corrected with standard glasses or contact lenses and reduces a person's ability to function at certain or all tasks. Legal blindness (which is actually a severe visual impairment) refers to a best-corrected central vision of 20/200 or worse in the better eye or a visual acuity of better than 20/200 but with a visual field no greater than 20° (e.g., side vision that is so reduced that it appears as if the person is looking through a tunnel).

Description

Vision is normally measured using a Snellen chart. A Snellen chart has letters of different sizes that are read, one eye at a time, from a distance of 20 ft. People with normal vision are able to read the 20 ft line at 20 ft—20/20 vision—or the 40 ft line at 40 ft, the 100 ft line at 100 ft, and so forth. If at 20 ft the smallest readable letter is larger, vision is designated as the distance from the chart over the size of the smallest letter that can be read.

Eye care professionals measure vision in many ways. Clarity (sharpness) of vision indicates how well a person's central visual status is. The diopter is the unit of measure for refractive errors such as nearsightedness, farsightedness, and **astigmatism** and indicates the strength of corrective lenses needed. People do not just see straight ahead; the entire area of vision is called the visual field. Some people have good vision (e.g., see clearly) but have areas of reduced or no vision (blind spots) in parts of their visual field. Others have good vision in the center but poor vision around the edges (peripheral visual field). People with very poor vision may be able only to count fingers at a given distance from their eyes. This distance becomes the measure of their ability to see.

The World Health Organization (WHO) defines impaired vision in five categories:

- Low vision 1 is a best corrected visual acuity of 20/70.
- Low vision 2 starts at 20/200.
- Blindness 3 is below 20/400.
- Blindness 4 is worse than 5/300

- Blindness 5 is no light perception at all.
- A visual field between 5° and 10° (compared with a normal visual field of about 120°) goes into category 3; less than 5° into category 4, even if the tiny spot of central vision is perfect.

Color blindness is the reduced ability to perceive certain colors, usually red and green. It is a hereditary defect and affects very few tasks. Contrast sensitivity describes the ability to distinguish one object from another. A person with reduced contrast sensitivity may have problems seeing things in the fog because of the decrease in contrast between the object and the fog.

According to the WHO there are over forty million people worldwide whose vision is category 3 or worse, 80% of whom live in developing countries. Half of the blind population in the United States is over 65 years of age.

Causes and symptoms

The leading causes of blindness include:

- **macular degeneration**
- **glaucoma**
- **cataracts**
- diabetes mellitus

Other possible causes include infections, injury, or **nutrition**.

Infections

Most infectious eye diseases have been eliminated in the industrialized nations by sanitation, medication, and public health measures. Viral infections are the main exception to this statement. Some infections that may lead to visual impairment include:

- Herpes simplex **keratitis**. A viral infection of the cornea. Repeated occurrences may lead to corneal scarring.
- **Trachoma**. This disease is responsible for six to nine million cases of blindness around the world, of the third of a billion who have the disease. Trachoma is caused by an incomplete bacterium, *Chlamydia trachomatis*, that is easily treated with standard **antibiotics**. It is transmitted directly from eye to eye, mostly by flies. The chlamydia gradually destroy the cornea.
- Leprosy (Hansen's disease). This is another bacterial disease that has a high affinity for the eyes. It, too, can be effectively treated with medicines.
- River blindness. Much of the tropics of the Eastern Hemisphere are infested with *Onchocerca volvulus*, a worm that causes "river blindness." This worm is transmitted by fly bites and can be treated with a drug called ivermectin. Nevertheless, twenty-eight million people have the disease, and 40% of them are blind from it.

Other causes

Exposure of a pregnant woman to certain diseases (e.g., **rubella** or **toxoplasmosis**) can cause congenital eye problems. Injuries to the eyes can result in blindness. Very little blindness is due to disease in the brain or the optic nerves. **Multiple sclerosis** and similar nervous system diseases, brain tumors, diseases of the eye sockets, and head injuries are rare causes of blindness.

Nutrition

Vitamin A deficiency is a widespread cause of corneal degeneration in children in developing nations. As many as five million children develop xerophthalmia from this deficiency each year. Five percent end up blind.

Diagnosis

A low vision exam is slightly different from a general exam. While a case history, visual status, and eye health evaluation are common to both exams, some things do differ. Eye charts other than a Snellen eye chart will be used. Testing distance will vary. A trial frame worn by the patient is usually used instead of the instrument containing the lenses the patient sits behind (phoropter). Because the low vision exam is slightly more goal oriented than a general exam, for example, what specifically is the patient having trouble with (reading, seeing street signs, etc.) different optical and nonoptical aids will generally be tried. Eye health is the last thing to be checked so that the lights necessary to examine the eyes won't interfere with the rest of the testing.

Treatment

There are many options for patients with visual impairment. There are optical and nonoptical aids. Optical aids include:

- Telescopes. May be used to read street signs.
- Hand magnifiers. May be used to read labels on things at the store.
- Stand magnifiers. May be used to read.
- Prisms. May be used to move the image onto a healthy part of the retina in some eye diseases.
- Closed circuit television (CCTV). For large magnification (e.g., for reading).

Nonoptical aids can include large print books and magazines, check-writing guides, large print dials on the telephone, and more.

For those who are blind, there are enormous resources available to improve the quality of life. For the legally blind, financial assistance for help may be possible. Braille and audio books are increasingly available. Guide dogs provide well-trained eyes and independence. Orientation and mobility training is available. There are special schools for blind children and access to disability support through Social Security and private institutions.

Prognosis

The prognosis generally relates to the severity of the impairment and the ability of the aids to correct it. A good low vision exam is important to be aware of the latest low vision aids.

Prevention

Regular eye exams are important to detect silent eye problems (e.g., glaucoma). Left untreated, glaucoma can result in blindness.

Corneal infections can be treated with effective antibiotics. When a cornea has become opaque beyond recovery it must be transplanted. Good hygiene (e.g., washing hands frequently) to prevent infection, proper use of contact lenses, and not sharing makeup are just some ways to guard against corneal infections.

Cataracts should be removed when they interfere with a person's quality of life.

Primary prevention addresses the causes before they ever begin. Fly control can be accomplished by simple sanitation methods. Public health measures can reduce the incidence of many infectious diseases. Vitamin A supplementation (when appropriate) will eliminate xerophthalmia completely. It is possible that protecting the eyes against ultraviolet (UV) light will reduce the incidence of cataracts, macular degeneration, and some other eye diseases. UV coatings can be placed on regular glasses, sunglasses, and ski goggles. Patients should ask their eye care professional about UV coatings. Protective goggles should also be worn in certain situations (e.g., certain jobs, sports, even mowing the lawn).

Secondary prevention addresses treating established diseases before they cause irreversible eye damage. Having general physical checkups can also detect systemic diseases such as diabetes or high blood pressure. Control of diabetes is very important in preserving sight.

Resources

BOOKS

Bennett, J. Claude, and Fred Plum, eds. *Cecil Textbook of Medicine*. Philadelphia: W. B. Saunders Co., 1996.

Riordan-Eva, Paul. "Blindness." In *General Ophthalmology.* 13th ed. Ed. Daniel Vaughan. Stamford: Appleton & Lange, 1993.

Sardegna, Jill Otis, and T. Paul, *The Encyclopedia of Blindness and Vision Impairment*. New York: Facts on File, Inc., 1990.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

American Foundation for the Blind. 11 Penn Plaza, Suite 300, New York, NY 10001. (800) 232-5463.

Guide Dogs for the Blind. P.O. Box 1200, San Rafael, CA 94915. (415) 499-4000.

International Eye Foundation. 7801 Norfolk Ave., Bethesda, MD 20814. (301) 986-1830.

The Lighthouse National Center for Education. 111 E. 59th Street. New York, NY 10022. (800) 334-5497.

National Association for the Visually Handicapped. 22 West 21st St., New York, NY 10010. (212) 889-3141.

National Center For Sight. (800) 221-3004.

National Children's Eye Care Foundation. One Clinic Center, A3-108, Cleveland, OH 44195. (216) 444-0488.

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892-3655. (301) 496-5248. <http://www.nei.nih.gov>.

National Federation of the Blind. 1800 Johnson St., Baltimore, MD 21230. (301) 569-9314.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331-2020. <http://www.preventblindness.org>.

Research to Prevent Blindness. 598 Madison Ave., New York, NY 10022. (212) 363-3911.

KEY TERMS

Cornea—The clear dome-shaped structure that's part of the front of the eye. It lies in front of the colored part of the eye (iris).

Diabetic retinopathy—Retinal disease caused by the damage diabetes does to small blood vessels.

Phoropter—The instrument used to measure refractive status of the eyes. It contains many lenses which are then changed in front of the eyes while the patient is looking at an eye chart. This is when the doctor usually asks, "Which is better, one or two?"

Xerophthalmia—A drying of the cornea and conjunctiva.

J. Ricker Polsdorfer, MD

Visualization *see* **Guided imagery**

Vitamin A deficiency

Definition

Vitamin A deficiency exists when the chronic failure to eat sufficient amounts of vitamin A or beta-carotene results in levels of blood-serum vitamin A that are below a defined range. Beta-carotene is a form of pre-vitamin A, which is readily converted to vitamin A in the body. Night blindness is the first symptom of vitamin A deficiency. Prolonged and severe vitamin A deficiency can produce total and irreversible blindness.

Description

Vitamin A (called retinol in mammals) is a fat-soluble vitamin. The recommended dietary allowance (RDA) for vitamin A is 1.0 mg/day for the adult man and 0.8 mg/day for the adult woman. Since beta-carotene is converted to vitamin A in the body, the body's requirement for vitamin A can be supplied entirely by beta-carotene. Six mg of beta-carotene are considered to be the equivalent of 1 mg of vitamin A. The best sources of vitamin A are eggs, milk, butter, liver, and fish, such as herring, sardines, and tuna. Beef is a poor source of vitamin A. Plants do not contain vitamin A, but they do contain beta-carotene and other carotenoids. The best sources of beta-carotene are dark-green, orange, and yellow vegetables; spinach, carrots, oranges, and sweet potatoes are excellent examples. Cereals are poor sources of beta-carotene.

Vitamin A is used for two functions in the body. Used in the eye, it is a component of the eye's light-sensitive parts, containing rods and cones, that allow for night-vision or for seeing in dim-light circumstances. Vitamin A (retinol) occurs in the rods. Another form of Vitamin A, retinoic acid, is used in the body for regulating the development of various tissues, such as the cells of the skin, and the lining of the lungs and intestines. Vitamin A is important during embryological development, since, without vitamin A, the fertilized egg cannot develop into a fetus.

Causes and symptoms

Vitamin A deficiency occurs with the chronic consumption of **diets** that are deficient in both vitamin A and beta-carotene. When vitamin A deficiency exists in the developed world, it tends to happen in alcoholics or in people with diseases that affect the intestine's ability to absorb fat. Examples of such diseases are **celiac disease** (chronic nutritional disorder), **cystic fibrosis**, and **cholestasis** (bile-flow failure or interference). Vitamin A deficiency occurred in infants during the early 1900s in Denmark. The deficiency resulted when milk fat was made into butter for export, leaving the by-product (skimmed milk) for infant feeding. Vitamin A deficiency has taken place in infants in impoverished populations in India, where the only foods fed to the infants were low in beta-carotene. Vitamin A deficiency is also common in areas like Southeast Asia, where polished rice, which lacks the vitamin, is a major part of the diet.

The earliest symptom of vitamin A deficiency is night blindness. Prolonged deficiency results in drying of the conjunctiva (the mucous membrane that lines the inner surface of the eyelids and extends over the forepart of the eyeball). With continued vitamin A deficiency, the drying extends to the cornea (xerophthalamia). The cornea eventually shrivels up and becomes ulcerated (keratinomalacia). Superficial, foamy gray triangular spots may appear in the white of the eye (Bitot's spots). Finally, inflammation and infection occur in the interior of the eye, resulting in total and irreversible blindness.

Diagnosis

Vitamin A status is measured by tests for retinol. Blood-serum retinol concentrations of 30-60 mg/dl are considered in the normal range. Levels that fall below this range indicate vitamin A deficiency. Night blindness is measured by a technique called electroretinography. Xerophthalamia, keratinomalacia, and Bitot's spots are diagnosed visually by trained medical personnel.

Treatment

Vitamin A deficiency can be prevented or treated by taking vitamin supplements or by getting injections of the vitamin. The specific doses given are oral retinyl palmitate (110 mg), retinyl acetate (66 mg), or injected retinyl palmitate (55 mg) administered on each of two successive days, and once a few weeks later if symptoms are not relieved.

Prognosis

The prognosis for correcting night blindness is excellent. Xerophthalamia can be corrected with vitamin A therapy. Ulcerations, tissue **death**, and total blindness, caused by severe vitamin A deficiency, cannot be treated with vitamin A.

Prevention

Vitamin A deficiency can be prevented by including foods rich in vitamin A or beta-carotene as a regular component of the diet; liver, meat, eggs, milk, and dairy products are examples. Foods rich in beta-carotene include red

KEY TERMS

Bitot's spots—Bitot's spots are superficial, foamy gray, triangular spots on the white of the eyeball.

Carotenoids—Carotenoids are yellow to deep-red pigments.

Conjunctiva—The conjunctiva is a clear layer of cells that covers the eye and directly contacts the atmosphere. The conjunctiva is about five-cells thick.

Cornea—The cornea is a clear layer of cells that covers the eye, just under the conjunctiva. The cornea is about 50-cells thick.

Fat-soluble vitamin—Fat-soluble vitamins can be dissolved in oil or in melted fat. Water-soluble vitamins can be dissolved in water or juice.

Keratinomalacia—Keratinomalacia is ulceration of the cornea.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences, and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Xerophthalmia—Xerophthalmia is a dry, thickened, lusterless condition of the eyeball resulting from vitamin A deficiency.

peppers, carrots, pumpkins, as well as those just mentioned. Margarine is rich in beta-carotene, because this chemical is used as a coloring agent in margarine production. In Africa, Indonesia, and the Philippines, vitamin A deficiency is prevented by public health programs that supply children with injections of the vitamin.

Resources

BOOKS

Brody, T. *Nutritional Biochemistry.* San Diego: Academic Press, Inc., 1998.

Combs, G. *The Vitamins.* San Diego: Academic Press, Inc., 1992.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

Filteau, S. M., and A. M. Tomkins."Vitamin A Supplementation in Developing Countries." *Archives of Disease in Childhood* 72 (1995): 106-109.

Tom Brody, PhD

Vitamin B_1 *see* **Beriberi**

Vitamin B_2 deficiency *see* **Riboflavin deficiency**

Vitamin B_6 deficiency

Definition

Vitamin B_6 is used by the body as a catalyst in reactions that involve amino acids. Vitamin B_6 deficiency is rare, since most foods eaten contain the vitamin.

Description

Vitamin B_6 is a water-soluble vitamin. The recommended dietary allowance (RDA) for vitamin B_6 is 2.0 mg/day for the adult man and 1.6 mg/day for the adult woman. Vitamin B_6 in the diet generally occurs as a form called pyridoxal phosphate. In this form, it cannot be absorbed by the body. During the process of digestion, the phosphate group is removed, and pyridoxal is produced. However, the body readily absorbs pyridoxal, and converts it back to the active form of the vitamin (pyridoxal phosphate).

Poultry, fish, liver, and eggs are good sources of vitamin B_6, comprising about 3-4 mg vitamin/kg food; meat and milk contain lesser amounts of the vitamin. The vitamin also occurs, at about half this level, in a variety of plant foods, including beans, broccoli, cabbage, and peas. Vitamin B_6 tends to be destroyed with prolonged cooking, with storage, or with exposure to light.

As mentioned, vitamin B_6 takes various forms. One of these forms, called pyridoxine, is relatively stable. For this reason, pyridoxine is the form of vitamin B_6 that is used in vitamin supplements, or when foods are fortified. Apples and other fruits are poor sources of the vitamin, containing only 0.2-0.6 mg vitamin/kg food.

Vitamin B_6, used mainly in the body for the processing of amino acids, performs this task along with certain enzymes. The enzyme that participates in this type of complex is aminotransferase. Several types of aminotransferase exist. With vitamin B_6 deficiency, while aminotransferase continues to occur in the various organs of the body,

KEY TERMS

Amino acid—Amino acids are small molecules that are used as building blocks for all proteins. Some amino acids are also used in the body for the manufacture of hormones. There are about 20 nutritionally important amino acids, including glutamic acid, glycine, methionine, lysine, tryptophan, serine, and glycine.

Fat-soluble vitamins—Fat-soluble vitamins can be dissolved in oil or in melted fat.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences, and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Water-soluble vitamins—Water-soluble vitamins can be dissolved in water or juice.

there is an abnormally low level of the active vitamin B_6/aminotransferase complex present. Thus, this vitamin deficiency results in the impairment of a variety of activities in the body. With supplement correction of the vitamin B_6 deficiency, the aminotransferase then readily forms the active complex, and normal metabolism is restored.

Vitamin B_6 converts certain amino acids (glutamic acid, aspartic acid, glycine) to energy. This allows the body to process all dietary protein, even when the dietary protein is in excess of the body's needs. Vitamin B_6 also allows the body to synthesize certain amino acids. For example, if the diet is deficient or low in certain amino acids, such as glycine or serine, vitamin B_6 enables the body to make them from sugar. Vitamin B_6 is used also for the synthesis of certain hormones, such as adrenaline.

Causes and symptoms

Vitamin B_6 deficiency occurs rarely. When it does, it is usually associated with poor absorption of nutrients in the gastrointestinal tract (as in **alcoholism**, or with chronic **diarrhea**), the taking of certain drugs (as isoniazid, hydrolazine, penicillamine) that inactivate the vitamin, with genetic disorders that inhibit metabolism of the vitamin, or in cases of **starvation**.

The symptoms of vitamin B_6 deficiency in adults are only vaguely defined. These include nervousness, irritability, **insomnia**, muscle weakness, and difficulty in walking. Vitamin B_6 deficiency may produce fissures and cracking at the corners of the mouth. The deficiency occurred in infants fed early versions of commercial canned infant formula, when the vitamin had been inadvertently omitted from the formula. This error resulted in infants failing to grow, in irritability, and in seizures.

Diagnosis

Vitamin B_6 status is measured by the transaminase stimulation test. This test requires extraction of red blood cells, and placement of the cells in two test tubes. Special chemicals (reagents) are added to both test tubes to allow for measurement of aminotransferase. This enzyme requires pyridoxal phosphate. A known quantity of pure pyridoxal phosphate is added to one of the test tubes. The activity level of the enzyme is measured, and compared, in both test tubes. If the added pyridoxal phosphate did not stimulate activity, the patient is considered not to be deficient in vitamin B_6. Neither is the patient considered deficient if only slight stimulation occurred. But if a stimulation of four-fold or more occurred, a vitamin B_6 deficiency is present.

Treatment

Vitamin B_6 deficiency can be prevented or treated with consumption of the recommended dietary allowance, as supplied by food or by vitamin supplements.

Prognosis

The prognosis for correcting vitamin B_6 deficiency is excellent.

Prevention

Vitamin B_6 deficiency is not a major concern for most people. The deficiency can be prevented with consumption of a mixed diet that includes poultry, fish, eggs, meat, vegetables, and grains.

Resources

BOOKS

Brody, T. *Nutritional Biochemistry.* San Diego: Academic Press, Inc., 1998.

Combs, G. *The Vitamins.* San Diego: Academic Press, Inc., 1992.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

"Intakes of B Vitamins from Diet and Supplements." *Nutrition Research Newletter* (Apr. 1997): 46.

Tom Brody, PhD

Vitamin B_{12} deficiency anemia *see* **Pernicious anemia**

Vitamin C deficiency *see* **Scurvy**

Vitamin D deficiency

Definition

Vitamin D deficiency exists when the concentration of 25-hydroxy-vitamin D (25-OH-D) in the blood serum occurs at 12 ng/ml (nanograms/milliliter), or less. The normal concentration of 25-hydroxy-vitamin D in the blood serum is 25-50 ng/ml. When vitamin D deficiency continues for many months in growing children, the disease commonly referred to as rickets will occur. A prolonged deficiency of the vitamin in adults results in osteomalacia. Both diseases involve defects in bones.

Description

Vitamin D is a fat-soluble vitamin, meaning it is able to be dissolved in fat. While some vitamin D is supplied by the diet, most of it is made in the body. To make vitamin D, cholesterol, a sterol that is widely distributed in animal tissues and occurs in the yolk of eggs, as well as in various oils and fats, is necessary. Once cholesterol is available in the body, a slight alteration in the cholesterol molecule occurs, with one change taking place in the skin. This alteration requires the energy of sunlight (or ultraviolet light). Vitamin D deficiency, as well as rickets and osteomalacia, tends to occur in persons who do not get enough sunlight and who fail to eat foods that are rich in vitamin D.

Once consumed, or made in the body, vitamin D is further altered to produce a hormone called 1,25-dihydroxy-vitamin D (1,25-diOH-D). The conversion of vitamin D to 1,25-diOH-D does not occur in the skin, but in the liver and kidney. First, vitamin D is converted to 25-OH-D in the liver; it then enters the bloodstream, where it is taken-up by the kidneys. At this point, it is converted to 1,25-diOH-D. Therefore, the manufacture of 1,25-diOH-D requires the participation of various organs of the body—the liver, kidney, and skin.

The purpose of 1,25-diOH-D in the body is to keep the concentration of calcium at a constant level in the bloodstream. The maintenance of calcium at a constant level is absolutely required for human life to exist, since dissolved calcium is required for nerves and muscles to work. One of the ways in which 1,25-diOH-D accomplishes this mission is by stimulating the absorption of dietary calcium by the intestines.

The sequence of events that can lead to vitamin D deficiency, then to bone disease, is as follows: a lack of vitamin D in the body creates an inability to manufacture 1,25-diOH-D, which results in decreased absorption of dietary calcium and increased loss of calcium in the feces. When this happens, the bones are affected. Vitamin D deficiency results in a lack of bone mineralization (calcification) in growing persons, or in an increased demineralization (decalcification) of bone in adults.

Causes and symptoms

Vitamin D deficiency can be caused by conditions that result in little exposure to sunlight. These conditions include: living in northern countries; having dark skin; being elderly or an infant, and having little chance to go outside; and covering one's face and body, such as for religious reasons. Many Arab women cover the entire body with black cloth, and wear a veil and black gloves when they go outside. These women may acquire vitamin D deficiency, even though they live in a sunny climate.

Most foods contain little or no vitamin D. As a result, sunshine is often a deciding factor in whether vitamin D deficiency occurs. Although fortified milk and fortified infant formula contain high levels of vitamin D, human breast milk is rather low in the vitamin. The term fortified means that **vitamins** are added to the food by the manufacturer.

To say that a food is high or low in vitamin D means how much of that food needs to be eaten in order to prevent vitamin deficiency and maintain good health. An exact meaning can be provided by comparing the Recommended Dietary Allowance of vitamin D with the amount of vitamin D supplied by a particular food per day. The Recommended Dietary Allowance, also referred to as RDA, is a recommendation based on data derived from different population groups and ages. The RDA for vitamin D for adults is 200 International Units (IU) per day, and can be supplied by eating approximately 1.5 kg of beef, 2.0 kg of corn oil, or 100 kg of cabbage. Few people, though, would want to eat a kilogram of beef in one day, and no human being is capable of eating 100 kg of cabbage in a day; therefore, these foods are poor sources of vitamin D. However, saltwater fish such as salmon, herring, and sardines are rich in vitamin D, supplied from the oils produced by these fish. The RDA can also be supplied by eating roughly 50 g of salmon or 2.0 g of cod liver oil,

and since fortified milk contains 400 IU per quart, half a quart of milk provides the RDA. For comparison, human breast milk contains only 4 to 60 IU per quart.

No harm is likely to result from vitamin D deficiency that occurs for only a few days a year. If the deficiency occurs for a period of many months or years, however, rickets or osteomalacia may develop. The symptoms of rickets include bowed legs and bowed arms. The bowed appearance is due to the softening of bones, and their bending if the bones are weight-bearing. Bone growth occurs through the creation of new cartilage, a soft substance at the ends of bones. When the mineral calcium phosphate is deposited onto the cartilage, a hard structure is created. In vitamin D deficiency, though, calcium is not available to create hardened bone, and the result is soft bone. Other symptoms of rickets include particular bony bumps on the ribs called rachitic rosary (beadlike prominences at the junction of the ribs with their cartilages) and knock-knees. Seizures may also occasionally occur in a child with rickets, because of reduced levels of dissolved calcium in the bloodstream.

Although osteomalacia is rare in the United States, symptoms of this disease include reduced bone strength, an increase in bone **fractures**, and sometimes bone **pain**, muscle weakness, and a waddling walk.

Diagnosis

Vitamin D deficiency is diagnosed by measuring the level of 25-hydroxy-vitamin D in the blood serum. The normal level or concentration of this form of the vitamin ranges from 25-50 ng/ml. Deficiency occurs when this level decreases to about 12 ng/ml or less. As mentioned previously, 25-OH-D is not the active form of the vitamin. It must be converted to 1,25-diOH-D in order to cause responses in various organs of the body. However, the levels of vitamin D, or of 1,25-dihydroxy-vitamin D in the blood, do not give a reliable picture of whether a person is deficient in the vitamin. For this reason, they are not measured when testing for vitamin D deficiency.

Rickets is diagnosed by x-ray examination of leg bones. A distinct pattern of irregularities, abnormalities, and a coarse appearance can be clearly seen with rickets. Osteomalacia is also diagnosed with x-ray examination. Measurements of blood plasma 25-OH-D, blood plasma calcium, and blood plasma parathyroid hormone must also be obtained for the diagnosis of these diseases. Parathyroid hormone and 1,25-diOH-D work together in the body to regulate the levels of calcium in the blood.

Treatment

Rickets heals promptly with 4,000 IU of oral vitamin D per day administered for approximately one month. During this treatment, the doctor should monitor the levels of 25-OH-D in the plasma to make certain they are raised to a normal value. The bone abnormalities (visible by x ray) generally disappear gradually over a period of 3-9 months. Parents are instructed to take their infants outdoors for approximately 20 minutes per day with their faces exposed. Children should also be encouraged to play outside. Foods that are good sources of vitamin D include cod liver oil, egg yolks, butter, and oily fish. Some foods, including milk and breakfast cereals, are also fortified with synthetic vitamin D.

Osteomalacia is treated by eating 2,500 IU per day of vitamin D for about three months. Measurements of 25-OH-D, calcium, and parathyroid hormone should be obtained after the treatment period to make sure the therapy did, in fact, result in normal blood values.

Care must be taken in treating vitamin D deficiency, since high doses of vitamin D are toxic and can result in the permanent deposit of **minerals** in the heart, lungs, and kidneys. Symptoms of toxicity are nausea, vomiting, pain in joints, and lack of interest in eating food. In adults, vitamin D toxicity occurs with eating 50,000 IU or more per day. In infants, toxicity occurs with 1,000 IU per day. The continued intake of toxic doses results in **death**.

Rickets and osteomalacia are almost always treated with oral supplements of vitamin D, with the recommendation to acquire daily exposure to direct sunlight. An alternative to sunlight is the use of an ultraviolet (UV) lamp. When using UV lamps, the eyes must be covered to protect them against damage. Many types of sunglasses allow UV light to pass through, so only those that are opaque to UV light should be used. Attempts to acquire sunlight through glass windows fail to help the body make vitamin D. This is because UV light does not pass through window glass.

Rickets may also occur with calcium deficiency, even when a child is regularly exposed to sunshine. This type of rickets has been found in various parts of Africa. The bone deformities are similar to, or are the same as, those that occur in typical rickets; however, calcium deficiency rickets is treated by increasing the amount of calcium in the diet. No amount of vitamin D can cure the rickets of a child with a diet that is extremely low in calcium. For this reason, it is recommended that calcium be given in conjunction with vitamin D supplementation.

Prognosis

The prognoses for correcting vitamin D deficiency, rickets, and osteomalacia are excellent. Vitamin D treatment results in the return of bone mineralization to a normal rate, the correction of low plasma calcium levels, the prevention of seizures, and a recovery from bone pain.

KEY TERMS

25-hydroxy-vitamin D—This is the form of vitamin D that is measured in order to assess vitamin D deficiency.

Cholesterol—A fat-soluble steroid alcohol (sterol) found in animal fats and oils, and in egg yolks. The human body needs cholesterol to produce vitamin D.

Fat-soluble vitamin—A vitamin that dissolves easily in fat or oil, but not in water. The fat-soluble vitamins are vitamins D, E, A, and K.

International unit (IU)—A measurement of biological activity in which one IU is equal to one mg (milligram).

Osteomalacia—Osteomalacia is a bone disease that occurs in adults and is caused by a prolonged period of vitamin D deficiency.

Rachitic rosary—Beadlike bumps present at the junction of the ribs with their cartilages—often seen in children with rickets.

Recommended Dietary Allowance (RDA)—The amount of nutrients, including vitamins, that should be supplied by foods on a daily basis to maintain normal health. Recommendations are based on data obtained from different population groups and ages.

Rickets—Rickets is a bone disease that occurs in infants and growing children and is caused by a prolonged period of vitamin D deficiency.

On the other hand, deformities such as bowed legs and the rachitic rosary persist throughout adult life.

Prevention

Food fortification has almost completely eliminated rickets in the United States. Vitamin D deficiency can be prevented by acquiring the RDA through drinking fortified milk and eating fortified cereals. For those who cannot drink milk, supplements of pills might be considered. In some older people, a 400 IU supplement may not be enough to result in the normal absorption of calcium; therefore, daily doses of 10,000 IU per day may be needed. For infants who are fed only breast milk (and rarely exposed to sunshine), a daily supplement of 200-300 IU is recommended.

Rickets continues to be a problem in Africans and Asian Indians who migrate to Canada or Great Britain, especially where these immigrants do not drink fortified milk. Prevention of rickets in these populations is attempted through educational programs sponsored by the government.

Resources

BOOKS

Brody, Tom. "Vitamin D." In *Nutritional Biochemistry.* San Diego: Academic Press, 1994.

Collins, E. D., and Anthony Norman. "Vitamin D." In *Handbook of Vitamins*, ed. Lawrence Machlin. New York: Marcel Dekker, Inc., 1991.

Feldman, D. *Vitamin D*. San Diego: Academic Press, 1997.

Food and Nutrition Board. "Vitamin D." In *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

Binet, A., and S.W. Kooh. "Persistence of Vitamin D-Deficiency Rickets in Toronto in the 1990s." *Cancer Journal of Public Health* (July/Aug. 1996): 227-230.

El-Sonbaty, M. R., and N. Abdul-Ghaffar."Vitamin D Deficiency in Veiled Kuwaiti Women." *European Journal of Clinical Nutrition* 50 (1996): 315-318.

Kinyamu, H., et al. "Serum Vitamin D Metabolites and Calcium Absorption in Normal Young and Elderly Free-Living Women and in Women Living in Nursing Homes." *American Journal of Clinical Nutrition* 65 (1997): 790-797.

Tom Brody, PhD

Vitamin E deficiency

Definition

Vitamin E deficiency is a very rare problem that results in damage to nerves. When vitamin E deficiency does occur, it strikes people with diseases that prevent the absorption of dietary fats and fat-soluble nutrients. Since vitamin E is a fat-soluble vitamin, it has some of the properties of fat.

Description

The recommended dietary allowance (RDA) for vitamin E is 10 mg/day for the adult man, 8 mg/day for the adult woman, and 3 mg/day for the infant. Vitamin E occurs in foods in a variety of related forms. The most potent and useful form of vitamin E is called alpha-tocopherol. The best sources of vitamin E are vegetable oils, such as corn oil, soy oil, and peanut oil. Animal fats, such as butter and lard, contain lower levels of the vitamin. Corn oil contains about 16 mg of alpha-tocopherol per 100

KEY TERMS

Fat-soluble vitamin—Fat-soluble vitamins can be dissolved in oil or in melted fat.

Recommended Dietary Allowance—The Recommended Dietary Allowances (RDAs) are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences, and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Toxic oxygen—Oxygen is required for life, as it is needed for energy production. When oxygen is used by the body, most of it is converted to water. However, a small fraction of the oxygen breathed is converted to toxic oxygen. The body uses several different processes for preventing and repairing toxic-oxygen damage. One of these processes involves vitamin E.

Water-soluble vitamins—Water-soluble vitamins can be dissolved in water or juice.

g oil. Wheat-germ oil contains 120 mg alpha-tocopherol per 100 g oil. Fish, eggs, and beef contain relatively low levels of the vitamin, with about 1 mg per 100 g food.

Vitamin E seems to have only one function in the body: the prevention of the natural and continual process of deterioration of all body tissues. This deterioration is provoked by a number of causes; one of these is toxic oxygen. During the body's metabolism of atmospheric oxygen, toxic oxygen is produced continuously in the body by the formation of by-products. These toxic by-products include hydrogen peroxide, superoxide, and hypochlorite.

Hypochlorite is a natural product, produced by cells of the immune system. It is also the active component of bleach. Once formed, toxic oxygen can damage various parts of the body, such as the membranes which form the boundaries of every cell. Vitamin E serves the body in protecting membranes from toxic oxygen damage. In contrast, vitamin C serves to protect the aqueous, or watery, regions of the cell from toxic oxygen damage. The membranes that are most sensitive to toxic oxygen damage are the membranes of nerves; therefore, the main symptom of vitamin E deficiency is damage to the nervous system.

Causes and symptoms

As mentioned, when vitamin E deficiency occurs, it strikes people with diseases that prevent the absorption of dietary fats and fat-soluble nutrients. These diseases include **cystic fibrosis**, **pancreatitis**, and **cholestasis** (bile-flow obstruction). Bile salts, produced in the liver, are required for the absorption of fats. Cholestasis causes a decrease in the formation of bile salts and the consequent failure of the body to absorb dietary fats. For this reason, this disease may result in vitamin E deficiency. Premature infants may be at risk for vitamin E deficiency because they may be born with low tissue levels of the vitamin, and because they have a poorly developed capacity for absorbing dietary fats. Infants suffering from fat-malabsorption diseases can develop symptoms of vitamin E deficiency by age two. In adults, the onset of a fat-malabsorption disease can provoke vitamin E deficiency after a longer period, as an example, ten years.

Vitamin E deficiency in humans results in ataxia (poor muscle coordination with shaky movements), decreased sensation to vibration, lack of reflexes, and **paralysis** of eye muscles. One particularly severe symptom of vitamin E deficiency is the inability to walk.

Diagnosis

Vitamin E status is measured by assessment of the content of alpha-tocopherol in the blood plasma, using a method called high-pressure liquid chromatography. Blood plasma levels of alpha-tocopherol that are 5.0 mg/l, or above, indicate normal vitamin E status; levels below 5.0 mg/l indicate vitamin E deficiency.

Treatment

Vitamin E deficiency that occurs with cholestatic liver disease, or other malabsorption syndromes, can be treated with weekly injections of 100 mg alpha-tocopherol that may continue for six months.Vitamin E deficiency in premature infants may require treatment for only a few weeks.

Prognosis

The prognosis for correcting the neurological symptoms of vitamin E deficiency is fair to excellent.

Prevention

The prevention of vitamin E deficiency should not be a concern for most people, since the vitamin is found in a wide variety of foods. Attention has been given to the theory that vitamin E serves to protect against **cancer** and **atherosclerosis**. The evidence that normal levels of

vitamin E protect against atherosclerosis is fairly convincing. However, there is little or no proof that vitamin E intake, above and beyond the recommended daily allowance (RDA), can prevent cancer or atherosclerosis.

Resources

BOOKS

Brody, T. *Nutritional Biochemistry.* San Diego: Academic Press, Inc., 1998.

Combs, G. *The Vitamins.* San Diego: Academic Press, Inc., 1992.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

Tanyel, Mary C. Mahlon, and Louis D. Mancano. "Neurologic findings in vitamin E deficiency." *American Family Physician* (Jan. 1997): 197+.

"Vitamin E deficiency and progressive ataxia." *Nutrition Research Newsletter* (Mar. 1994): 30.

Tom Brody, PhD

Vitamin K deficiency

Definition

Vitamin K deficiency exists when chronic failure to eat sufficient amounts of vitamin K results in a tendency for spontaneous bleeding or in prolonged and excessive bleeding with trauma or injury. Vitamin K deficiency occurs also in newborn infants, as well as in people treated with certain **antibiotics**. The protein in the body most affected by vitamin K deficiency is a blood-clotting protein called prothrombin.

Description

Vitamin K is a fat-soluble vitamin. The recommended dietary allowance (RDA) for vitamin K is 80 mg/day for the adult man, 65 mg/day for the adult woman, and 5 mg/day for the newborn infant. The vitamin K present in plant foods is called phylloquinone; while the form of the vitamin present in animal foods is called menaquinone. Both of these **vitamins** are absorbed from the diet and converted to an active form called dihydrovitamin K.

Spinach, lettuce, broccoli, brussels sprouts, and cabbage are good sources of vitamin K, containing about 8 mg vitamin K/kg food. Cow milk is also a good source of the vitamin.

A portion of the body's vitamin K is supplied by bacteria living in the intestine rather than by dietary sources.

Vitamin K plays an important role in blood clotting. Without the vitamin, even a small cut would cause continuous bleeding in the body, and **death**. Blood clotting is a process that begins automatically when any injury produces a tear in a blood vessel. The process of blood clotting involves a collection of molecules, which circulate continuously through the bloodstream. When an injury occurs, these molecules rapidly assemble and form the blood clot. The clotting factors are proteins, and include proteins called Factor II, Factor VII, Factor IX, and Factor X. Factor II is also called prothrombin. These proteins require vitamin K for their synthesis in the body. The blood-clotting process also requires a dozen other proteins that do not need vitamin K for their synthesis.

Causes and symptoms

Newborns are especially prone to vitamin K deficiency. A nursing-mother's milk is low in the vitamin; breast milk can supply only about 20% of the infant's requirement. Infants are born with low levels of vitamin K in their body; they do not have any vitamin K-producing bacteria in their intestines. Their digestive tracts are sterile. As a result, a form of vitamin K deficiency, called hemorrhagic disease of the newborn, may develop. This disease involves spontaneous bleeding beneath the skin or elsewhere in the infant's body, and occurs in about 1% of all infants. In rare cases, it causes death due to spontaneous bleeding in the brain.

Vitamin K deficiency in adults is rare. When it occurs, it is found in people with diseases that prevent the absorption of fat. These diseases include **cystic fibrosis**, **celiac disease**, and **cholestasis**. Vitamin K deficiency can exist in adults treated with antibiotics that kill the bacteria that normally live in the digestive tract. As mentioned, the intestine-bacteria supply part of our daily requirement of vitamin K. Vitamin K deficiency can result in bleeding gums, and in skin that is easily bruised.

Diagnosis

Vitamin K status is measured by the **prothrombin time** test. The normal prothrombin time is about 13 seconds. With vitamin K deficiency, the prothrombin time can be several minutes. The test involves taking a sample of blood, placing it in a machine called a fibrometer, and measuring the time it takes for blood-clot formation. Blood-clotting problems can also be caused by a rare genetic disease called **hemophilia**. Hemophilia is not related to vitamin K deficiency. Once vitamin K deficiency is suspected, further tests must be used to distinguish it from possible hemophilia. Where a bleeding dis-

KEY TERMS

Fat-soluble vitamin—Fat-soluble vitamins can be dissolved in oil or in melted fat.

Hemorrhage—Bleeding that continues for an abnormally long period of time.

Prothrombin—Prothrombin is a blood-clotting protein. Injury to a blood vessel produces a signal which triggers the conversion of prothrombin to thrombin. Thrombin is a protein which plays a central role in provoking the assembly of other proteins to form the blood clot.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences, and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Water-soluble vitamins—Water-soluble vitamins can be dissolved in water or juice.

order can be corrected by vitamin K treatment, the diagnosis of vitamin K deficiency is proven to be correct.

Treatment

Vitamin K deficiency in newborn infants is treated and prevented with a single injection of phylloquinone (5 mg). Adults with vitamin K deficiency are treated with daily oral doses of 10 mg phylloquinone for one week.

Prognosis

The prognosis for correcting vitamin K deficiency, and associated blood-clotting problems, is excellent.

Prevention

Aside from newborns and young infants, vitamin K deficiency is not a concern for the general population. Vitamin K deficiency can be prevented by assuring that the diet contains foods such as spinach, cabbage, brussels sprouts, and eggs. Soybean oil, canola oil, and olive oil are good sources of the vitamin, while corn oil and peanut oil are very poor sources.

Resources

BOOKS

Brody, T. *Nutritional Biochemistry.* San Diego: Academic Press, Inc., 1998.

Combs, G. *The Vitamins.* San Diego: Academic Press, Inc., 1992.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

Suttie, J. W. "The importance of menaquinones in human nutrition." *Annual Review of Nutrition* 15 (1995): 399-417.

Tom Brody, PhD

Vitamin poisoning *see* **Vitamin toxicity**

Vitamin tests

Definition

Vitamin tests measure the levels of certain **vitamins** in an individual's blood. They are generally used to aid in the diagnosis of vitamin deficiencies or in detecting toxic amounts of a vitamin in a patient's system.

Purpose

Vitamins are components of food that are needed for growth, reproduction, and maintaining good health. The vitamins include vitamin D, vitamin E, vitamin A, and vitamin K, which are the fat-soluble vitamins, and folate, vitamin B_{12}, biotin, vitamin B_6, niacin, thiamin, riboflavin, pantothenic acid, and ascorbic acid, which are the water-soluble vitamins. Vitamins are required in the diet in only tiny amounts, in contrast to the energy components of the diet, such as sugars, starches, and fats. However, not receiving sufficient quantities of a certain vitamin can be devastating, resulting in vitamin deficiency diseases such as **scurvy**, **pellagra**, or rickets. Conversely, consuming too much of a certain vitamin can be toxic to a person's system. Vitamin tests are used to assess the level of certain vitamins in an individual's blood so that doctors can more accurately diagnose vitamin deficiency diseases or vitamin overdoses and devise effective therapy. The vitamins that are most commonly measured by doctors are folate, vitamin B_{12}, vitamin K, vitamin D, and vitamin A.

Description

Most of the vitamin tests are conducted by acquiring a sample of blood, and then preparing plasma or serum

from the blood sample. Each vitamin occurs at extremely small concentrations when compared to levels of most other molecules in the blood. Blood contains a great number of chemicals and molecules, and many of these tend to interfere with the vitamin tests. For this reason, a procedure that separates the vitamin from contaminating substances is usually performed immediately prior to conducting the actual test. Most laboratories use high pressure liquid chromatography (HPLC), also called high performance liquid chromatography, as this purification step. In HPLC, the sample is pumped at high pressure through a tube lined with an absorbent material, to which the different molecules cling at different rates. Following separation or purification by HPLC, the vitamin is detected by a color reaction or fluorescence reaction. In these reactions, the amount of color or fluorescence that is formed is proportional to the amount of vitamin in the sample, allowing the analyst to calculate the amount of vitamin present in the original sample. In the case of some vitamins, the purified vitamin is reacted with a special chemical (reagent) prior to detection.

Levels of some vitamins may be measured indirectly by a biological test that mimics the actual function of the vitamin in the body. Riboflavin status is often measured by a test in which the rate by which a certain enzyme converts one molecule into another indicates how much Vitamin B_2 is present in a person's blood. Vitamin K is often measured by a test that times how long it takes for a spontaneous blood clot to form in a prepared sample. Vitamin E status is often measured by placing the red blood cells in a test tube, adding hydrogen peroxide, and the assessing the resulting breakdown of the red blood cells. When a **vitamin E deficiency** exists, the red blood cells have a greater tendency to break.

Preparation

Most vitamin tests require no preparation; however, some may require that the patient fast for at least eight hours before giving a blood sample, or stop using some medications.

Normal results

The values that are considered to be normal for each vitamin can vary slightly. This variability can arise from different testing machines or from different types of chemistry that are used in conducting the vitamin assays. In interpreting data on plasma vitamin levels, it should also be noted that different normal ranges may exist for different age groups and genders. For example, the normal range for plasma vitamin B_6 for males is 7-52 nanograms per milliliter (ng/mL) for males and 2-26 ng/mL for females.

The normal ranges for levels of certain vitamins are as follows. Please note that, by convention, the units referring to the levels of each of the vitamins may differ from each other. The units picogram/milliliter (pg/mL), nanogram/milliliter (ng/mL), and micrograms per deciliter (micrograms/dL) refer to the weight of vitamin in the specified volume. The units nanomoles/liter (nmol/L) and micromoles/liter (M/L) refer to the concentration of vitamin in the specified volume.

- folate (**folic acid**). 3.1-18.0 ng/mL
- vitamin B_{12}. 200-1100 pg/mL
- thiamin. 9-44 nmol/L
- riboflavin. 6.2-39 nmol/L
- vitamin B_6. 7-52 ng/mL
- vitamin C (asorbic acid). 28-84 M/L
- vitamin A. 28-94 micrograms/dL
- vitamin D. (25-hydroxy-vitamin D). 25-50 ng/mL
- vitamin K. 80-1160 pg/mL

Abnormal results

In all cases, abnormal results fall below or above the normal concentration range. However, as noted above, values that are considered to be borderline or severely abnormal can differ according to the discretion of the medical laboratory or physician.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Combs, Gerald. *The Vitamins.* San Diego: Academic Press, 1992.

Nollet, L. *Handbook of Food Analysis*. New York: Marcel Dekker, Inc., 1996.

Tom Brody, PhD

Vitamin toxicity

Definition

Vitamin toxicity is a condition in which a person develops symptoms as side effects from taking massive doses of **vitamins**. Vitamins vary in the amounts that are required to cause toxicity and in the specific symptoms that result. Vitamin toxicity, which is also called hypervitaminosis or vitamin **poisoning**, is becoming more common in developed countries because of the popularity of

vitamin supplements. Many people treat themselves for minor illnesses with large doses (megadoses) of vitamins.

Description

Overview

Vitamins are organic molecules in food that are needed in small amounts for growth, reproduction, and the maintenance of good health. Some vitamins can be dissolved in oil or melted fat. These fat-soluble vitamins include vitamin D, vitamin E, vitamin A (retinol), and vitamin K. Other vitamins can be dissolved in water. These water-soluble vitamins include folate (**folic acid**), vitamin B_{12}, biotin, vitamin B_6, niacin, thiamin, riboflavin, pantothenic acid, and vitamin C (ascorbic acid). Taking too much of any vitamin can produce a toxic effect. Vitamin A and vitamin D are the most likely to produce hypervitaminosis in large doses, while riboflavin, pantothenic acid, biotin, and vitamin C appear to be the least likely to cause problems.

Vitamins in medical treatment

Vitamin supplements are used for the treatment of various diseases or for reducing the risk of certain diseases. For example, moderate supplements of folic acid appear to reduce the risk for certain **birth defects** (neural tube defects), and possibly reduce the risk of **cancer**. Therapy for diseases brings with it the risk for irreversible vitamin toxicity only in the case of vitamin D. This vitamin is toxic at levels which are only moderately greater than the recommended dietary allowance (RDA). Niacin is commonly used as a drug for the treatment of heart disease. Niacin is far less toxic than vitamin D. Vitamin toxicity is not a risk with medically supervised therapy using any of the other vitamins.

Vitamin megadoses

With the exception of folic acid supplements, the practice of taking vitamin supplements by healthy individuals has little or no relation to good health. Most adults in the United States can obtain enough vitamins by eating a well-balanced diet. It has, however, become increasingly common for people to take vitamins at levels far greater than the RDA. These high levels are sometimes called vitamin megadoses. Megadoses are harmless for most vitamins. But in the cases of a few of the vitamins—specifically vitamin D, vitamin A, and vitamin B_6—megadoses can be harmful or fatal. Researchers have also started to look more closely at megadoses of vitamin C and of vitamin E, since indirect evidence suggests that these two vitamins may reduce the risks of cancer, heart disease, and **aging**. It is not yet clear whether megadoses of either of these vitamins has any influence on health. Some experts think that megadoses of vitamin C may protect people from cancer. On the other hand, other researchers have gathered indirect evidence that vitamin C megadoses may cause cancer.

Causes and symptoms

Fat-soluble vitamins

VITAMIN D. Vitamin D and vitamin A are the most toxic of the fat-soluble vitamins. The symptoms of vitamin D toxicity are nausea, vomiting, **pain** in the joints, and loss of appetite. The patient may experience **constipation** alternating with **diarrhea**, or have tingling sensations in the mouth. The toxic dose of vitamin D depends on its frequency. In infants, a single dose of 15 mg or greater may be toxic, but it is also the case that daily doses of 1.0 mg over a prolonged period may be toxic. In adults, a daily dose of 1.0-2.0 mg of vitamin D is toxic when consumed for a prolonged period. A single dose of about 50 mg or greater is toxic for adults. The immediate effect of an overdose of vitamin D is abdominal cramps, **nausea and vomiting**. Toxic doses of vitamin D taken over a prolonged period of time result in irreversible deposits of calcium crystals in the soft tissues of the body that may damage the heart, lungs, and kidneys.

VITAMIN A. Vitamin A toxicity can occur with long-term consumption of 20 mg of retinol or more per day. The symptoms of vitamin A overdosing include accumulation of water in the brain (**hydrocephalus**), vomiting, tiredness, constipation, bone pain, and severe headaches. The skin may acquire a rough and dry appearance, with hair loss and brittle nails. Vitamin A toxicity is a special issue during **pregnancy**. Expectant mothers who take 10 mg vitamin A or more on a daily basis may have an infant with birth defects. These birth defects include abnormalities of the face, nervous system, heart, and thymus gland. It is possible to take in toxic levels of vitamin A by eating large quantities of certain foods. For example, about 30 grams of beef liver, 500 grams of eggs, or 2,500 grams of mackerel would supply 10 mg of retinol. The livers of polar bears and other arctic animals may contain especially high levels of vitamin A.

VITAMIN E. Megadoses of vitamin E may produce headaches, tiredness, double vision, and diarrhea in humans. Studies with animals fed large doses of vitamin E have revealed that this vitamin may interfere with the absorption of other fat-soluble vitamins. The term absorption means the transfer of the vitamin from the gut into the bloodstream. Thus, large doses of vitamin E consumed over many weeks or months might result in deficiencies of vitamin D, vitamin A, and vitamin K.

VITAMIN K. Prolonged consumption of megadoses of vitamin K (menadione) results in anemia, which is a

reduced level of red blood cells in the bloodstream. When large doses of menadione are given to infants, they result in the deposit of pigments in the brain, nerve damage, the destruction of red blood cells (hemolysis), and **death**. A daily injection of 10 mg of menadione into an infant for three days can kill the child. This tragic fact was discovered during the early days of vitamin research, when newborn infants were injected with menadione to prevent a disease known as hemorrhagic disease of the newborn. Today a different form of vitamin K is used to protect infants against this disease.

Water-soluble vitamins

FOLATE. Folate occurs in various forms in food. There are over a dozen related forms of folate. The folate in oral vitamin supplements occurs in only one form, however—folic acid. Large doses of folic acid (20 grams/day) can result in eventual kidney damage. Folate is considered, however, to be relatively nontoxic, except in cases where folate supplementation can lead to **pernicious anemia**.

VITAMIN B_{12}. Vitamin B_{12} is important in the treatment of pernicious anemia. Pernicious anemia is more common among middle-aged and older adults; it is usually detected in patients between the ages of 40 and 80. The disease affects about 0.1% of all persons in the general population in the United States, and about 3% of the elderly population. Pernicious anemia is treated with large doses of vitamin B_{12}. Typically, 0.1 mg of the vitamin is injected each week until the symptoms of pernicious anemia disappear. The patient then takes oral doses of vitamin B_{12} for the rest of his or her life. Although vitamin B_{12} toxicity is not an issue for patients being treated for pernicious anemia, treatment of these patients with folic acid may cause problems. Specifically, pernicious anemia is often first detected because the patient feels weak or tired. If the anemia is not treated, the patient may suffer irreversible nerve damage. The problem with folic acid supplements is that the folic acid treatment prevents the anemia from developing, but allows the eventual nerve damage to occur.

VITAMIN B_6. Vitamin B_6 is clearly toxic at doses about 1000 times the RDA. Daily doses of 2-5 grams of one specific form of this vitamin can produce difficulty in walking and tingling sensations in the legs and soles of the feet. Continued megadoses of vitamin B_6 result in further unsteadiness, difficulty in handling small objects, and numbness in the hands. When the high doses are stopped, recovery begins after two months. Complete recovery may take two to three years.

VITAMIN C. The RDA for vitamin C in adults is 60 mg per day. Large doses of vitamin C are considered to be toxic in persons with a family history of or tendency to form **kidney stones** or gallbladder stones. Kidney and gallbladder stones usually consist of calcium oxalate. Oxalate occurs in high concentrations in foods such as cocoa, chocolate, rhubarb, and spinach. A fraction of the vitamin C in the body is normally broken down in the body to produce oxalate. A daily supplement of 3.0 grams of vitamin C has been found to double the level of oxalate that passes through the kidneys and is excreted into the urine.

NIACIN. The RDA for niacin is 15-19 mg per day in adults. Niacin comes in two forms, nicotinic acid and nicotinamide. Either form can satisfy the adult requirement for this vitamin. Nicotinic acid, however, is toxic at levels of 100 times the RDA. It can cause flushing of the skin, nausea, diarrhea, and liver damage. Flushing is an increase in blood passing through the veins in the skin, due to the dilation of arteries passing through deeper parts of the face or other parts of the body. In spite of the side effects, however, large doses of nicotinic acid are often used to lower blood cholesterol in order to prevent heart disease. Nicotinic acid results in a lowering of LDL-cholesterol ("bad cholesterol"), an increase in HDL-cholesterol ("good cholesterol"), and a decrease in plasma triglycerides. Treatment involves daily doses of 1.5-4.0 grams of nicotinic acid per day. Flushing of the skin occurs as a side effect when nicotinic acid therapy is started, but may disappear with continued therapy.

Diagnosis

The diagnosis of vitamin toxicity is usually made on the basis of the patient's dietary or medical history. Questioning the patient about the use of vitamin supplements may shed light on some of his or her physical symptoms. With some vitamins, the doctor can confirm the diagnosis by ordering blood or urine tests for specific vitamins. When large amounts of the water-soluble vitamins are consumed, a large fraction of the vitamin is absorbed into the bloodstream and promptly excreted into the urine. The fat-soluble vitamins are more likely to be absorbed into the bloodstream and deposited in the fat and other tissues. In the cases of both water-soluble and fat-soluble vitamins, any vitamin not absorbed by the intestines is excreted in the feces. Megadoses of many of the vitamins produce diarrhea, because the non-absorbed nutrient draws water out of the body and into the gut, resulting in the loss of this water from the body.

Treatment

In all cases, treatment of vitamin toxicity requires discontinuing vitamin supplements. Vitamin D toxicity needs additional action to reduce the calcium levels in the bloodstream because it can cause abnormally high levels of

KEY TERMS

Absorption—The transfer of a vitamin from the digestive tract to the bloodstream.

Ascorbic acid—Another name for vitamin C.

Hypercalcemia—Hypercalcemia is a condition marked by abnormally high levels of calcium in the blood. It is an issue during vitamin D toxicity.

Hypervitaminosis—Another name for vitamin toxicity.

Megadose—A very large dose of a vitamin, taken by some people as a form of self-medication.

Menadione—A synthetic form of vitamin K. It is sometimes called vitamin K_3.

Recommended Dietary Allowance (RDA)—The recommended dietary allowances (RDAs) are the quantities of nutrients in the diet that are needed for good health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years.

Retinol—Another name for vitamin A.

plasma calcium (**hypercalcemia**). Severe hypercalcemia is a medical emergency and may be treated by infusing a solution of 0.9% sodium chloride into the patient's bloodstream. The infusion consists of two to three liters of salt water given over a period of one to two days.

Prognosis

The prognosis for reversing vitamin toxicity is excellent for most patients. Side effects usually go away as soon as overdoses are stopped. The exceptions are severe vitamin D toxicity, severe vitamin A toxicity, and severe vitamin B_6 toxicity. Too much vitamin D leads to deposits of calcium salts in the soft tissue of the body, which cannot be reversed. Birth defects due to vitamin A toxicity cannot be reversed. Damage to the nervous system caused by megadoses of vitamin B_6 can be reversed, but complete reversal may require a recovery period of over a year.

Prevention

Vitamin toxicity can be prevented by minimizing the use of vitamin supplements. If vitamin D supplements are being used on a doctor's orders, vitamin toxicity can be prevented by monitoring the levels of plasma calcium. The development of hypercalcemia with vitamin D treatment indicates that the patient is at risk for vitamin D toxicity.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Combs, Gerald. *The Vitamins.* San Diego: Academic Press, Inc., 1992.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

PERIODICALS

Markestad, T., et al. "Intermittent Digh-dose Vitamin D Prophylaxis During Infancy: Effect on Vitamin D Metabolites, Calcium, and Phosphorus." *American Journal of Clinical Nutrition* 46 (1987): 652-658.

Tzimas, G., et al. "Embryotoxic Doses of Vitamin A to Rabbits Result in Low Plasma but High Embryonic Concentrations of All-trans-retinoic Acid: Risk of Vitamin A Exposure in Humans." *Journal of Nutrition* 126 (1996): 2159-2171.

Tom Brody, PhD

Vitamins

Definition

Vitamins are organic components in food that are needed in very small amounts for growth and for maintaining good health. The vitamins include vitamin D, vitamin E, vitamin A, and vitamin K, or the fat-soluble vitamins, and folate (**folic acid**), vitamin B_{12}, biotin, vitamin B_6, niacin, thiamin, riboflavin, pantothenic acid, and vitamin C (ascorbic acid), or the water-soluble vitamins. Vitamins are required in the diet in only tiny amounts, in contrast to the energy components of the diet. The energy components of the diet are sugars, starches, fats, and oils, and these occur in relatively large amounts in the diet.

Most of the vitamins are closely associated with a corresponding vitamin deficiency disease. **Vitamin D deficiency** causes rickets, a disease of the bones. **Vitamin E deficiency** occurs only very rarely, and causes nerve damage. **Vitamin A deficiency** is common throughout the poorer parts of the world, and causes night blindness. Severe vitamin A deficiency can result in xerophthalamia, a disease which, if left untreated, results in total blindness. **Vitamin K deficiency** results in spontaneous bleeding. Mild or moderate folate deficiency is common throughout the world, and can result from the failure to eat green, leafy vegetables or fruits and fruit juices. Folate deficiency causes megaloblastic anemia, which is characterized by the presence of large abnormal cells called megaloblasts in the circulating blood. The symptoms of megaloblastic anemia are tiredness and weakness. Vitamin B_{12} deficiency occurs with

Essential Vitamins

Vitamin	What It Does For The Body
Vitamin A (Beta Carotene)	Promotes growth and repair of body tissues; reduces susceptibility to infections; aids in bone and teeth formation; maintains smooth skin
Vitamin B-1 (Thiamin)	Promotes growth and muscle tone; aids in the proper functioning of the muscles, heart, and nervous system; assists in digestion of carbohydrates
Vitamin B-2 (Riboflavin)	Maintains good vision and healthy skin, hair, and nails; assists in formation of antibodies and red blood cells; aids in carbohydrate, fat, and protein metabolism
Vitamin B-3 (Niacinamide)	Reduces cholesterol levels in the blood; maintains healthy skin, tongue, and digestive system; improves blood circulation; increases energy
Vitamin B-5	Fortifies white blood cells; helps the body's resistance to stress; builds cells
Vitamin B-6 (Pyridoxine)	Aids in the synthesis and breakdown of amino acids and the metabolism of fats and carbohydrates; supports the central nervous system; maintains healthy skin
Vitamin B-12 (Cobalamin)	Promotes growth in children; prevents anemia by regenerating red blood cells; aids in the metabolism of carbohydrates, fats, and proteins; maintains healthy nervous system
Biotin	Aids in the metabolism of proteins and fats; promotes healthy skin
Choline	Helps the liver eliminate toxins
Folic Acid (Folate, Folacin)	Promotes the growth and reproduction of body cells; aids in the formation of red blood cells and bone marrow
Vitamin C (Ascorbic Acid)	One of the major antioxidants; essential for healthy teeth, gums, and bones; helps to heal wounds, fractures, and scar tissue; builds resistance to infections; assists in the prevention and treatment of the common cold; prevents scurvy
Vitamin D	Improves the absorption of calcium and phosphorous (essential in the formation of healthy bones and teeth) maintains nervous system
Vitamin E	A major antioxidant; supplies oxygen to blood; provides nourishment to cells; prevents blood clots; slows cellular aging
Vitamin K (Menadione)	Prevents internal bleeding; reduces heavy menstrual flow

the failure to consume meat, milk or other dairy products. Vitamin B_{12} deficiency causes megaloblastic anemia and, if severe enough, can result in irreversible nerve damage. Niacin deficiency results in **pellagra**. Pellagra involves skin **rashes** and scabs, **diarrhea**, and mental depression. Thiamin deficiency results in **beriberi**, a disease resulting in atrophy, weakness of the legs, nerve damage, and **heart failure**. Vitamin C deficiency results in **scurvy**, a disease that involves bleeding. Specific diseases uniquely associated with deficiencies in vitamin B_6, riboflavin, or pantothenic acid have not been found in the humans, though persons who have been starving, or consuming poor **diets** for several months, might be expected to be deficient in most of the nutrients, including vitamin B_6, riboflavin, and pantothenic acid.

Some of the vitamins serve only one function in the body, while other vitamins serve a variety of unrelated functions. Hence, some vitamin deficiencies tend to result in one type of defect, while other deficiencies result in a variety of problems.

Purpose

People are treated with vitamins for three reasons. The primary reason is to relieve a vitamin deficiency, when one has been detected. Chemical tests suitable for the detection of all vitamin deficiencies are available. The diagnosis of vitamin deficiency is often aided by visual tests, such as the examination of blood cells with a microscope, the x ray examination of bones, or a visual examination of the eyes or skin.

A second reason for vitamin treatment is to prevent the development of an expected deficiency. Here, vitamins are administered even with no test for possible deficiency. One example is vitamin K treatment of newborn infants to prevent bleeding. Food supplementation is another form of vitamin treatment. The vitamin D added to foods serves the purpose of preventing the deficiency from occurring in persons who may not be exposed much to sunlight and who fail to consume foods that are fortified with vitamin D, such as milk. Niacin supplementation prevents pellagra, a disease that occurs in people who rely heavily on corn as the main source of food, and who do not eat much meat or milk. In general, the American food supply is fortified with niacin.

A third reason for vitamin treatment is to reduce the risk for diseases that may occur even when vitamin deficiency cannot be detected by chemical tests. One example is folate deficiency. The risk for cardiovascular disease can be slightly reduced for a large fraction of the population by folic acid supplements. And the risk for certain **birth defects** can be sharply reduced in certain women by folic acid supplements.

Vitamin treatment is important during specific diseases where the body's normal processing of a vitamin is impaired. In these cases, high doses of the needed vitamin can force the body to process or utilize it in the normal manner. One example is **pernicious anemia**, a disease that tends to occur in middle age or old age, and impairs the absorption of vitamin B_{12}. Surveys have revealed that about 0.1% of the general population, and 2-3% of the elderly, may have the disease. If left untreat-

KEY TERMS

Genetic disease—A genetic disease is a disease that is passed from one generation to the next, but does not necessarily appear in each generation. An example of genetic disease is Down's syndrome.

Plasma—Blood consists of red and white cells, as well as other components, that float in a liquid. This liquid is called plasma.

Recommended dietary allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients of the diet that are required to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain health in the greatest number of people.

Serum—Serum is blood plasma with the blood clotting proteins removed. Serum is prepared by removing blood from the subject, allowing the blood naturally to form a blood clot, and then using a centrifuge to remove the red blood cells and the blood clot. The blood clot takes the form of an indistinct clump.

Vitamin status—Vitamin status refers to the state of vitamin sufficiency or deficiency of any person. For example, a test may reveal that a patient's folate status is sufficient, borderline, or severely inadequate.

ed, pernicous anemia leads to nervous system damage. The disease can easily be treated with large oral daily doses of vitamin B_{12} (hydroxocobalamin) or with monthly injections of the vitamin.

Vitamin supplements are widely available as over-the-counter products. But whether they work to prevent or curtail certain illnesses, particularly in people with a balanced diet, is a matter of debate and ongoing research. For example, vitamin C is not proven to prevent the **common cold**. Yet, millions of people take it for that reason. Ask a physician or pharmacist for more information on the appropriate use of multivitamin supplements.

Precautions

Vitamin A and vitamin D can be toxic in high doses. Side effects range from **dizziness** to kidney failure. Ask a physician or pharmacist about the correct use of a multivitamin supplement that contains these vitamins.

Description

Vitamin treatment is usually done in three ways: by replacing a poor diet with one that supplies the recommended dietary allowance, by consuming oral supplements, or by injections. Injections are useful for persons with diseases that prevent absorption of fat-soluble vitamins. Oral vitamin supplements are especially useful for persons who otherwise cannot or will not consume food that is a good vitamin source, such as meat, milk or other dairy products. For example, a vegetarian who will not consume meat may be encouraged to consume oral supplements of vitamin B_{12}.

Treatment of genetic diseases which impair the absorption or utilization of specific vitamins may require megadoses of the vitamin throughout one's lifetime. Megadose means a level of about 10-1,000 times greater than the RDA. Pernicious anemia, homocystinuria, and biotinidase deficiency are three examples of genetic diseases which are treated with megadoses of vitamins.

Preparation

The diagnosis of a vitamin deficiency usually involves a blood test. An overnight fast is usually recommended as preparation prior to withdrawal of the blood test so that vitamin-fortified foods do not affect the test results.

Aftercare

The response to vitamin treatment can be monitored by chemical tests, by an examination of red blood cells or white blood cells, or by physiological tests, depending on the exact vitamin deficiency.

Risks

Few risks are associated with vitamin treatment. Any possible risks depend on the vitamin and the reason why it was prescribed. Ask a physician or pharmacist about how and when to take vitamin supplements, particularly those that have not been prescribed by a physician.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry.* San Diego: Academic Press, 1998.

Combs, Gerald. *The Vitamins.* San Diego: Academic Press, 1992.

Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington, DC: National Academy Press, 1989.

Tom Brody, PhD

Vitiligo

Definition

Vitiligo is a condition in which a loss of cells that give color to the skin (melanocytes) results in smooth, white patches in the midst of normally pigmented skin.

Description

Vitiligo is a common, often inherited disorder characterized by areas of well-defined, milky white skin. People with vitiligo may have eye abnormalities and also have a higher incidence of thyroid disease, **diabetes mellitus**, and **pernicious anemia**. Vitiligo affects about 1-2% of the world's population. It is more easily observed in sun-exposed areas of the body and in darker skin types, but it affects any area of the body and all races. Vitiligo seems to affect men and women equally, although women more frequently seek treatment for the disorder.

Vitiligo may appear as one or two well-defined white patches or it may appear over large portions of the body. Typical sites for generalized vitiligo are areas surrounding body openings, bony areas, fingers, and toes. It can begin at any age but about 50% of the time it starts before the age of 20.

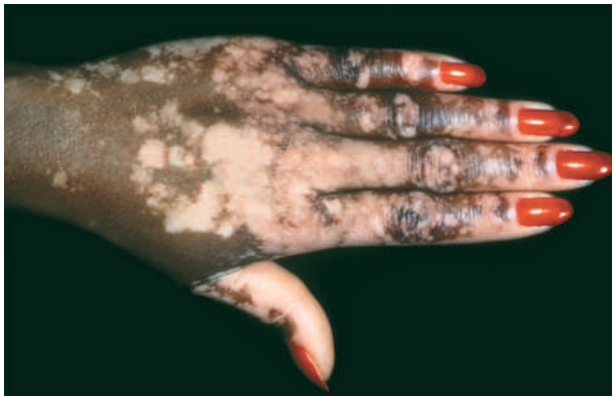
Causes and symptoms

Vitiligo is a disorder with complex causes. People with vitiligo seem to inherit a genetic predisposition for the disorder, and the appearance of disorder can be brought on by a variety of precipitating causes. Many people report that their vitiligo first appeared following a traumatic or stressful event, such as an accident, job loss, **death** of a family member, severe **sunburn**, or serious illness. There are at least three theories about the underlying mechanism of vitiligo. One theory says nerve endings in the skin release a chemical that is toxic to the melanocytes. A second theory states that the melanocytes simply self-destruct. The third explanation is that vitiligo is a type of autoimmune disease in which the immune system targets the body's own cells and tissues.

The primary symptom of vitiligo is the loss of skin color. Hair growing from the affected skin areas also lacks color. In addition, people with vitiligo may have pigment abnormalities of the retina or iris of the eyes. A minority of patients also may have inflammation of the retina or iris, but vision is not usually impaired.

Diagnosis

The diagnosis of vitiligo is usually made by observation. Progressive, white areas found at typical sites point to a diagnosis of vitiligo. If the diagnosis is not certain, the doctor will test for other conditions which can mimic vitiligo, such as chemical leukoderma or **systemic lupus erythematosus**. If the tests rule out other conditions, vitiligo is confirmed.



Loss of pigmentation is one characteristic of vitiligo, as seen on this woman's hand. *(Custom Medical Stock Photo. Reproduced by permission.)*

Treatment

Vitiligo cannot be cured, but it can be managed. Cosmetics can be used to improve the appearance of the white areas not covered by clothing. **Sunscreens** prevent burning of the affected areas and also prevent the normal skin around the patches from becoming darker. Skin creams and oral medications are available for severe cases, but they have side effects that may make them undesirable. Autologous transplantation of skin is an option for those who are severely affected. Bleaching or depigmentation of the normal skin is another option.

In addition to treating the skin, attention should be paid to the psychological well-being of the individual. Extreme cases of vitiligo can be unattractive and may affect a person's outlook and social interactions.

Prognosis

The condition is usually gradually progressive. Sometimes the patches grow rapidly over a short period, and then the condition remains stable for many years.

Prevention

No measures are currently known to prevent vitiligo.

Resources

BOOKS

Fitzpatrick, Thomas B., et al., eds. *Dermatology in General Medicine*. New York: McGraw-Hill, 1993.

KEY TERMS

Autoimmune disease—A condition in which something triggers the immune system to react against and attack the body's own tissues.

Autologous transplantation—A procedure wherein the person donates blood or tissue to themselves.

Iris—The colored part of the eye.

Pernicious anemia—A disease in which red blood cells are abnormally formed due to the body's inability to absorb vitamin B_{12}.

Retina—The innermost layer of the eye, it contains the rods and cones, specialized light-sensitive cells.

Professional Guide to Diseases. 5th ed. Springhouse, PA: Springhouse Corporation, 1995.

ORGANIZATIONS

Frontier's International Vitiligo Foundation. 4 Rozina Court, Owings Mills, MD 21117. (301) 594-0958.

National Foundation for Vitiligo and Pigment Disorders. 9032 South Normandy Drive, Centerville, OH 45459. (513) 885-5739.

National Vitiligo Foundation. P.O. Box 6337, Tyler, TX 75703. (903) 531-9767. 73071.33@compuserve.com.

Dorothy Elinor Stonely

Vitrectomy

Definition

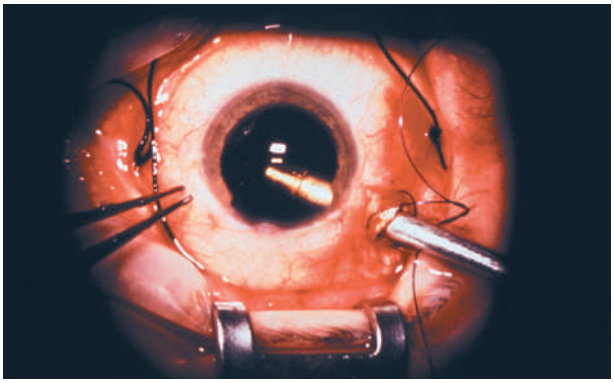
Vitrectomy is the surgical removal of the vitreous (transparent gel that fills the eye from the iris to the retina).

Purpose

The bulk of the contents of the eyeball is a clear jelly-like substance that is susceptible to several afflictions that impair vision by damaging its transparency.

- infections
- injuries
- bleeding, particularly from diabetic retinopathy.
- blood vessels growing into the vitreous, again due to diabetes

The retina is the light-sensitive membrane that receives images and transmits them to the brain. It covers the inside of the back of the eye. On occasion the retina will fall into the vitreous, a condition called **retinal detachment**. This may be due to disease in the vitreous that pulls the retina inward, small tears in the retina that allow liquid to seep behind it and push it forward, or injury to the eye that simply breaks the retina loose. It may be necessary to remove the vitreous in order to replace the retina and restore vision.



Vitrectomy is a surgical procedure in which the vitreous, the transparent gel that fills the eye from the iris to the retina, is removed. During this procedure, the surgeon penetrates the eyeball with a tiny instrument (shown above), which liquefies the vitreous and suctions it out of the eye. *(Photo Researchers, Inc. Reproduced by permission.)*

Description

Using instruments suited for microscopic surgery, the ophthalmologist (eye surgeon) penetrates the eyeball, aspirates the vitreous, and replaces it with saline. The saline replaces the vitreous at a constant pressure in order to keep the eye from collapsing. Once the saline is in place, both eyes are patched. The procedure takes two to three hours to complete.

Preparation

Because this is a major operation on the eye, the surgeon will perform a very extensive evaluation of both eyes. After looking inside with a variety of lenses, a CT, MRI, or ultrasound study may be needed. Immediately prior to the vitrectomy, the pupils will be dilated.

Aftercare

Eye drops and **antibiotics** are administered, and eye rest is advised until healing is completed.

Risks

Risks associated with vitrectomy are retinal detachment, bleeding, iatrogenic (medically caused) **cataracts**, and endophthalmitis (inflammation of the eyeball).

KEY TERMS

Computed tomography (CT scan)—Computerized method of creating images of internal organs using x rays.

Diabetic retinopathy—Disease that damages the blood vessels in the back of the eye caused by diabetes mellitus.

Endophthalmitis—Inflammation of the eyeball.

Iatrogenic—Inadvertently caused by medical treatment.

Magnetic resonance imaging (MRI)—Computerized method of creating images of internal organs using magnetic fields.

Saline—A salt solution equivalent to that in the body—0.9% salt in water.

Normal results

Vision is restored to useful levels in two-thirds of patients.

Resources

BOOKS

O'Malley, Conor. "Vitreous." In *General Ophthalmology.* 13th ed. Ed. Daniel Vaughan. Stamford: Appleton & Lange, 1993.

Sardegna, Jill, and T. Paul Otis. *The Encyclopedia of Blindness and Vision Impairment*. New York: Facts on File, Inc., 1990.

J. Ricker Polsdorfer, MD

Vivax malaria *see* **Malaria**

Vocal cord nodules and polyps

KEY TERMS

Laryngitis—Inflammation of the larynx (voice box).

Lesion—A wound or injury.

Otorhinolaryngologist—A physician specializing in ear, nose, and throat diseases. Also known as otolaryngologist.

Definition

Vocal cord nodules and polyps are noncancerous growths on the vocal cords that affect the voice.

Description

The vocal cords, located in the voice box in the middle of the neck, are two tough, fibrous bands that vibrate to produce sound. They are covered with a layer of tissue that is similar to skin. With use, this layer thickens. With heavy use, the thickening may localize, producing a nodule. Unlike skin, heavy usage over a short time may also produce polyps. A polyp is a soft, smooth lump containing mostly blood and blood vessels. A nodule is similar to a polyp, but tends to be firmer.

Causes and symptoms

Chronic infections caused by **allergies** and inhalation of irritants, such as cigarette smoke, may produce these lesions, but extensive use of the voice is the most common cause of vocal nodules and polyps. Nodules and polyps are more common in male children, female adolescents, and female adults. This may be due in part to the faster speed at which the cords vibrate to produce higher-pitched voices.

Voice alterations are most apparent in singers, who may notice the higher registers are the first to change. Hoarseness causes others to seek medical attention.

Diagnosis

The head and neck surgeon (otorhinolaryngologist) must see the vocal cords to diagnose these lesions. It is also important to confirm that there are not other problems instead of or in addition to these benign lumps. Other causes of hoarseness include throat cancers, **vocal cord paralysis**, and simple **laryngitis**. The cords can usually be seen using a mirror placed at the back of the tongue. More elaborate scopes, including a videostroboscope, allow better views while the cords are producing sounds.

A biopsy of a nodule or polyp will ensure they are not cancerous.

Treatment

Voice rest is the first choice treatment for polyps. Polyps that appeared suddenly will resolve with a few days of complete silence. Nodules do not disappear with rest. Lesions that have been there longer may be slower to disappear and require voice training by a speech therapist.

Nodules and polyps may be surgically removed, using either conventional techniques or lasers.

Prognosis

Continued overuse of the voice will cause these lesions to regrow.

Prevention

Careful use of the voice will prevent most vocal cord nodules and polyps. Avoiding inhaled irritants, may also prevent nodules and polyps from forming.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of the Nose, Throat, Ear, Head, and Neck*. Philadelphia: Lea & Febiger, 1991.

J. Ricker Polsdorfer, MD

Vocal cord paralysis

Definition

Vocal cord **paralysis** is the inability to move the vocal cords and the resulting loss of vocal cord function.

Description

The vocal cords are a pair of tough, fibrous bands that lie across the air column in the middle of the voice box. They assist three functions: breathing, swallowing, and speaking. When vocal cords vibrate, they produce sound, allowing us to speak. Vocal cords temporarily stop breathing to aid coughing and for expelling **foreign objects**. During swallowing, the vocal cords shut the airway so that food is not inhaled. When vocal cords are paralyzed, all three functions are affected.

The relaxed position of the vocal cords is halfway open. There is one set of muscles that closes them all the way and one set that opens them. Each set of muscles is controlled by a different nerve. Each nerve comes from a different direction—one from above and one from below (the recurrent laryngeal nerve). Vocal cords can either be partially paralyzed on one side or completely paralyzed on both sides.

Causes and symptoms

Vocal cord paralysis can result from injury, tumors, or surgery in the neck and upper chest. Brain tumors and **stroke** can also affect the nerves. Infectious diseases that damage nerves—like **whooping cough**, **tetanus** and polio—can also cause vocal cord paralysis. Vocal cord paralysis can also appear as a congenital defect. If congenital, the most frequent cause is a brain defect, which can often be effectively treated.

KEY TERMS

Computed tomography (CT scan)—Computerized use of x rays to create images of internal organs.

Laryngoscope—A diagnostic instrument that is used to examine the interior of the larynx.

Magnetic resonance imaging (MRI)—Computerized use of magnetic fields and radio-frequency signals to create images of internal organs.

Recurrent laryngeal nerve—One of two offshoots of the vagus nerve that connect to the larynx. It is located below the larynx.

Stridor—A raspy sound that occurs during respiration when the airways are blocked.

Tracheostomy—Surgical opening in the neck to the trachea to aid respiration.

Voice box—The larynx.

The most dangerous form of vocal cord paralysis is one that affects the opening function, controlled by the recurrent laryngeal nerve. If both vocal cords are paralyzed, breathing stops or becomes very labored. Fortunately, injury during trauma or surgery often involves only one side, but the congenital causes can damage both sides.

Vocal cord paralysis produces several symptoms.

- The voice is always affected; at best it is breathy and weak. At worst, it is not there at all. In infants, the cry can be weak. Older children will suppress laughing and coughing because it is hard to do.
- Swallowing may be hindered so that food ends up in the airway, causing violent coughing and often leading to pneumonia.
- Breathing is obstructed on inspiration, producing a condition known as **stridor**. Closing the airway while breathing in produces creaking noises in the throat and changes the shape of the chest. The breast bone is drawn inward, much more visibly in the flexible chest of a small child.

Diagnosis

The voice box must be observed during breathing to characterize the problem. A viewing instrument called a laryngoscope, either flexible or rigid, is passed through the nose or throat until the cords becomes visible. The motion of each cord can then be seen, and other problems in the area identified.

X rays, CT, or MRI scans of the skull may be done if a brain disorder is suspected.

Treatment

An adequate airway is immediately necessary, usually secured with an endotracheal tube in the windpipe. If a cure cannot be achieved, a permanent breathing hole (tracheostomy) is cut in the neck. Brain problems that are relieved within 24 hours usually allow the cords to regain their function. Care must be taken to assure that swallowing takes place normally.

Alternative treatment

Vocal cord paralysis can be addressed with constitutional **homeopathy**. This will work with the whole person, not just the symptoms, to help bring about healing. Botanical medicine and deep tissue massage to the area can also bring some resolution, although it may not be long term.

Resources

BOOKS

Ballenger, John Jacob. *Disorders of the Nose, Throat, Ear, Head, and Neck*. Philadelphia: Lea & Febiger, 1991.

J. Ricker Polsdorfer, MD

Vocal cord polyps *see* **Vocal cord nodules and polyps**

Voiding cystourethrography *see* **Retrograde urethrography**

Volvulus *see* **Intestinal obstructions**

Vomiting *see* **Nausea and vomiting; Cyclic vomiting syndrome; Hyperemesis gravidarum**

Von Gierke's disease *see* **Glycogen storage diseases**

Von Recklinghausen disease *see* **Neurofibromatosis**

von Willebrand disease

Definition

Von Willebrand disease is caused by a deficiency or an abnormality in a protein called von Willebrand factor and is characterized by prolonged bleeding.

Description

The Finnish physician Erik von Willebrand was the first to describe von Willebrand disease (VWD). In 1926 Dr. von Willebrand noticed that many male and female members of a large family from the Aland Islands had increased bruising (bleeding into the skin) and prolonged episodes of bleeding. The severity of the bleeding varied between family members and ranged from mild to severe and typically involved the mouth, nose, genital and urinary tracts, and occasionally the intestinal tract. Excessive bleeding during the menstrual period was also experience by some of the women in this family. What differentiated this bleeding disorder from classical **hemophilia** was that it appeared not to be associated with muscle and joint bleeding and affected women and men rather than just men. Dr. von Willebrand named this disorder *hereditary pseudohemophilia*.

Pseudohemophilia, or von Willebrand disease (VWD) as it is now called, is caused when the body does not produce enough of a protein called von Willebrand factor(vWF) or produces abnormal vWF. vWF is involved in the process of blood clotting (coagulation). Blood clotting is necessary to heal an injury to a blood vessel. When a blood vessel is injured, vWF enables blood cells called platelets to bind to the injured area and form a temporary plug to seal the hole and stop the bleeding. vWF is secreted by platelets and by the cells that line the inner wall of the blood vessels (endothelial cells). The platelets release other chemicals, called factors, in response to a blood vessel injury, which are involved in forming a strong permanent clot. vWF binds to and stabilizes factor VIII, one of the factors involved in forming the permanent clot.

A deficiency or abnormality in vWF can interfere with the formation of the temporary platelet plug and also affect the normal survival of factor VIII, which can indirectly interfere with the production of the permanent clot. Individuals with VWD, therefore, have difficulty in forming blood clots and as a result they may bleed for longer periods of time. In most cases the bleeding is due to an obvious injury, although it can sometimes occur spontaneously.

VWD is classified into three basic types: type 1, 2, and 3 based on the amount and type of vWF that is produced. Type 1 is the most common and mildest form and results when the body produces slightly decreased amounts of typically normal vWF. Type 2 can be classified into five subtypes (A,B,M,N) and results when the body produces an abnormal type of vWF. Type 3 is the rarest and most severe form and results when the body does not produce any detectable vWF.

Approximately one out of 100 people are affected with VWD, making it the most common inherited bleed-

ing disorder (hemophilia). VWD affects people of all ethnic backgrounds. Approximately 70–80% of people with VWD have type 1 and close to 20–30% have type 2. Type 3 is very rare and occurs in less than one percent of people with VWD.

Causes and symptoms

The genetics of VWD are complex and involve a gene that produces vWF and is found on chromosome 12. Since we inherit two of each type of chromosome we inherit two vWF genes. There are different types of changes in the vWF gene that can affect the production of vWF. Some types of changes can cause the vWF gene to produce decreased amounts of normal vWF, while other changes can cause the gene to produce abnormal vWF. Most of the gene changes are significant enough that a change in only one vWF gene is sufficient to cause VWD. Some gene changes only cause VWD if both genes are changed, which often leads to more severe symptoms. Type 1 VWD is called an autosomal dominant condition since it is caused by a change in only one vWF gene. Since type 1 VWD results in only a slight decrease in the amount of vWF produced, the symptoms are often mild and even non-existent in some patients. Most cases of Type 2 VWD are autosomal dominant since they are caused by a change in only one vWF gene that results in the production of an abnormal protein. An autosomal dominant form of VWD can be inherited from either parent or can occur spontaneously in the embryo that is formed when the egg and sperm cells come together during fertilization.

Some cases of type 2 VWD and all cases of type 3 VWD are autosomal recessive since they are caused by changes in both vWF genes. A person with an autosomal recessive form of VWD has inherited a changed gene from his or her mother and a changed gene from his or her father. Parents who have a child with an autosomal recessive form of VWD are called carriers, since they each possess one changed vWF gene and one unchanged vWF gene. Many carriers for the autosomal recessive forms of type 2 VWD and type 3 VWD do not have any symptoms, although some people with type 3 VWD are born to parents who have type 1 VWD and may have symptoms. Each child born to parents who are both carriers for VWD has a 25% chance of having VWD, a 50% chance of being a carrier, and a 25% chance of being neither a carrier nor affected with VWD disease. A person with an autosomal dominant form of VWD has a 50% chance of passing the changed gene on to his or her children who may or may not have symptoms.

VWD is usually a relatively mild disorder characterized by easy bruising, recurrent nosebleeds, heavy menstrual periods, and extended bleeding after surgeries and invasive dental work. There is a great deal of variability in the severity of symptoms, which can range from clinically insignificant to life threatening. Even people within the same family who are affected with the same type of VWD may exhibit different symptoms. An individual with VWD may exhibit a range of symptoms over the course of his or her lifetime and may experience an improvement in symptoms with age. The severity of the disease is partially related to the amount and type of vWF that the body produces, but is also influenced by other genetic and non-genetic factors.

Type 1

Type 1, the mildest form of VWD, is usually associated with easy bruising, recurrent nosebleeds, heavy menstrual periods, and prolonged bleeding after surgeries and invasive work. Many people with type 1 VWD do not have any noticeable symptoms or only have prolonged bleeding after surgery or significant trauma. The amount of vWF produced by the body increases during **pregnancy**, so prolonged bleeding during delivery is uncommon in people with type 1 VWD.

Type 2

People with type 2 VWD usually have symptoms from early childhood and symptoms may even be present at birth. They usually experience prolonged bleeding from cuts, easy bruising, nose bleeds, skin hematomas, and prolonged bleeding from the gums following teeth extraction and minor trauma. More than 50% of women with type 2 VWD experience heavy periods that may require a blood **transfusion**. Gastrointestinal bleeding is rare but can be life-threatening. Some women with type 2 VWD exhibit prolonged bleeding during delivery.

Type 3

Type 3 VWD can be quite severe and is associated with bruising and bleeding from the mouth, nose, intestinal, genital and urinary tracts. Type 3 is also associated with spontaneous bleeding into the muscles and joints, which can result in joint deformities. Some women with type 3 VWD experience prolonged bleeding during delivery.

Diagnosis

Diagnostic testing

Many people with VWD have mild symptoms or symptoms that can be confused with other bleeding disorders making it difficult to diagnose VWD on the basis of clinical symptoms. VWD should be suspected in any person with a normal number of platelets in their blood

and bleeding from the mucous membranes such as the nose, gums and gastrointestinal tract. Testing for an individual with suspected VWD often includes the measurement of:

- how long it takes for the bleeding to stop after a tiny cut is made in the skin (the **bleeding time**)
- the amount of vWF (vWF antigen measurement)
- the activity of vWF (ristocetin co-factor activity)
- the amount of factor VIII (factor VIII antigen measurement)
- activity of factor VIII

People with type 1 VWD usually have an increased bleeding time but they may have an intermittently normal bleeding time. They also have a decreased amount of vWF, and decreased vWF activity and usually have slightly decreased factor VIII levels and activity. People with type 2 VWD have a prolonged bleeding time, decreased activity of vWF and may have decreased amounts of vWF and factor VIII, and may have decreased factor VIII activity. Type 3 individuals have undetectable amounts of vWF, negligible vWF activity, factor VIII levels of less than 5–10%, and significantly reduced factor VIII activity. The activity of vWF is reduced for all types of VWD, making it the most sensitive means of identifying all three types of VWD. Patients with borderline results should be tested two to three times over a three month period.

Once a patient is diagnosed with VWD, further testing such as vWF multimer analysis and ristocetin-induced platelet aggregation (RIPA) may need to be performed to determine the subtype. Multimer analysis evaluates the structure of the vWF, and RIPA measures how much ristocetin is required to cause the clumping of platelets in a blood sample. The vWF multimer analysis is able to differentiate people with a structurally normal vWF (type 1) from people with a structurally abnormal vWF (type 2) and is often able to identify the subtype of patients with type 2 VWD. People with type 1 VWD usually have normal to decreased RIPA concentrations. Depending on the subtype, patients with type 2 VWD either have increased or decreased RIPA. RIPA is usually absent and the multimer analysis shows undetectable vWF in people with type 3 VWD.

In some cases DNA testing can be a valuable adjunct to biochemical testing. The detection of gene alteration(s) can confirm a diagnosis and can determine the type and subtype of VWD. It can also help to facilitate prenatal testing and testing of other family members. Unfortunately, as of 2001, many people with VWD possess DNA changes that are not detectable through DNA testing. A person who has a mother, father, or sibling diagnosed with VWD should undergo biochemical testing for VWD. If the relative with VWD possesses a detectable gene change, then DNA testing should also be considered.

Prenatal testing

If one parent has been diagnosed with an autosomal dominant form of VWD or both parents are carriers for an autosomal recessive form of VWD, then prenatal testing can be considered. If the parent with an autosomal dominant form of VWD possesses a detectable gene change or both parents who are carriers for an autosomal recessive form of VWD possess detectable mutations, then DNA testing of their fetus would be available. DNA testing can be performed through **amniocentesis** or **chorionic villus sampling**. If the DNA change in the parent(s) is unknown then prenatal testing can sometimes be performed through biochemical testing of blood obtained from the fetal umbilical cord, which is less accurate and is associated with a higher risk of pregnancy loss.

Treatment

VWD is most commonly treated by replacement of vWF through the administration of blood products that contain vWF or through treatment with desmopressin (DDAVP, 1-deamino-8-D-arginine vasopressin). DDAVP functions by increasing the amount of factor VIII and vWF in the bloodstream. Treatment with blood products or DDAVP may be started in response to uncontrollable bleeding or may be administered prior to procedures such as surgeries or dental work. The type of treatment chosen depends on the type of VWD and a patient's response to a preliminary treatment trial.

Treatment with desmopressin

DDAVP is the most common treatment for people with type 1 VWD. About 80% of people with type 1 VWD respond to DDAVP therapy. Treatment with DDAVP can also be used to treat some people with type 2 VWD. Patients with Type 2B VWD should not be treated with this medication since DDAVP can induce dangerous platelet clumping. Type 3 VWD should not be treated with DDAVP since this medication does not increase the level of vWF in type 3 patients. DDAVP should only be used in people who have been shown to be responsive through a pre-treatment trial transfusion with this medication.

DDAVP can be administered intravenously or through a nasal inhaler. DDAVP has relatively few side effects although some people may experience facial flushing, tingling sensations, and headaches after treatment with this medication. Often treatment with this

KEY TERMS

Amniocentesis—A procedure performed at 16-18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Autosomal dominant—A pattern of genetic inheritance where only one abnormal gene is needed to display the trait or disease.

Autosomal recessive—A pattern of genetic inheritance where two abnormal genes are needed to display the trait or disease.

Biochemical testing—Measuring the amount or activity of a particular enzyme or protein in a sample of blood or urine or other tissue from the body.

Carrier—A person who possesses a gene for an abnormal trait without showing signs of the disorder. The person may pass the abnormal gene on to offspring.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10-12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Desmopressin (DDAVP)—A drug used in the treatment of von Willebrand's disease.

Diagnostic testing—Testing performed to determine if someone is affected with a particular disease.

DNA testing—Analysis of DNA (the genetic component of cells) in order to determine changes in genes that may indicate a specific disorder.

Endothelial cells—The cells lining the inner walls of the blood vessels.

Factor VIII—A protein involved in blood clotting that requires vWF for stability and long-term survival in the bloodstream.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Platelets—Small disc-shaped structures that circulate in the blood stream and participate in blood clotting.

Prenatal testing—Testing for a disease such as a genetic condition in an unborn baby.

Protein—Important building blocks of the body, composed of amino acids, involved in the formation of body structures and controlling the basic functions of the human body.

Skin hematoma—Blood from a broken blood vessel that has accumulated under the skin.

von Willebrand factor (vWF)—A protein found in the blood that is involved in the process of blood clotting.

medication is only required prior to invasive surgeries or dental procedures.

Treatment with blood products

Patients who are unable to tolerate or are unresponsive to drug-based treatments are treated with concentrated factor VIII obtained from blood products. Not all factor VIII concentrates can be used since some do not contain enough vWF. The concentrate is treated to kill most viruses, although caution should be used since not all types of viruses are destroyed. If the factor VIII concentrates are unable to manage a severe bleeding episode, then blood products called cryoprecipitates, which con-

tain concentrated amounts of vWF, or platelet concentrates should be considered. Caution should be used when treating with these blood products since they are not treated to kill viruses.

Other treatments and precautions

Medications called fibrinolytic inhibitors can be helpful in the control of intestinal, mouth, and nose bleeding. Estrogens such as are found in **oral contraceptives** increase the synthesis of vWF and can sometimes be used in the long-term treatment of women with mild to moderate VWD. Estrogens are also sometimes used prior to surgery in women with type 1 VWD. Some topical agents are available to treat nose and mouth bleeds. Patients with VWD should avoid taking **aspirin**, which can increase their susceptibility to bleeding and people with severe forms of VWD should avoid activities that increase their risk of injury such as contact sports.

Prognosis

The prognosis for VWD disease is generally fairly good and most individuals have a normal lifespan. The prognosis can depend, however on accurate diagnosis and appropriate medical treatment.

Resources

BOOKS

Handin, Robert I. "Disorders of the Platelet and Vessel Wall." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Sadler, J.E. "Von Willebrand Disease." In *The Metabolic and Molecular Basis of Inherited Disease,* edited by C.R. Scriver, et al. New York: McGraw Hill, 1995.

PERIODICALS

Ginsburg, David. "Molecular Genetics of von Willebrand Disease." *Thrombosis and Haemostasis* 82, no. 2 (1999): 585–591.

Nichols, William C., and David Ginsburg. "Von Willebrand's Disease." *Medicine* 76 (Jan. 1997): 1.

Voelker, Rebecca. "New Focus on von Willebrand's Disease." *Journal of the American Medical Association* 278 (October 8, 1997): 1137.

ORGANIZATIONS

Canadian Hemophilia Society. 625 President Kennedy, Suite 1210, Montreal, QUE H3A 1K2. Canada (514) 848-0503. Fax: (514) 848-9661. chs@hemophilia.ca. <http://www.hemophilia.ca/english/index.html>.

Haemophelia Society—Von Willebrand Support Services. Chesterfield House, 385 Euston Road, London, NW1 3AU. UK 0171 380 0600. Fax: 0171 387 8220. melissa@haemophilia-soc.demon.co.uk. <http://www.haemophilia-soc.demon.co.uk/vwd%20services1.html>.

National Hemophilia Foundation. Soho Building, 110 Greene Street, Suite 406, New York, NY 10012. (212) 219-8180. <http://www.hemophilia.org/home.htm>.

OTHER

Mannucci, Pier "Desmopressin (DDAVP) in the Treatment of Bleeding Disorders: The First Twenty Years." The Treatment of Hemophilia Monograph Series. No. 11 (1998). <http://www.wfh.org/InformationAboutHemophilia/Publications/Monographs/Treatment_Series/TOH_PDF/TOH11_DDAVP.pdf>.

Paper, Renee. "Gynecological Complications in Women with Bleeding Disorders." The Treatment of Hemophilia Monograph Series. No. 5 (1996). <http://www.wfh.org/InformationAboutHemophilia/Publications/Monographs/Treatment_Series/TOH_PDF/TOH5_VWD.pdf>.

World Federation of Hemophilia. "Protocols for the Treatment of Hemophilia and von Willebrand Disease." No. 14 (1998). <http://www.wfh.org/InformationAboutHemophilia/Publications/Monographs/Treatment_Series/TOH_PDF/TOH14_Protocols_Treatment.pdf>.

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VSD *see* **Ventricular septal defect**

Vulvar cancer

Definition

Vulvar **cancer** refers to an abnormal, cancerous growth in the external female genitalia.

Description

Vulvar cancer is a rare disease that occurs mainly in elderly women. The vulva refers to the external female genitalia, which includes the labia, the opening of the vagina, the clitoris, and the space between the vagina and anus (perineum). There are two pairs of labia (a Latin term meaning lips). The labia meet to protect the openings of the vagina and the tube that connects to the bladder (urethra). The outer, most prominent folds of skin are called labia majora, and the smaller, inner skin folds are called labia minora. Vulvar cancer can affect any part of the female genitalia, but usually affects the labia.

Approximately 70% of vulvar cancers involve the labia (usually the labia majora), 15% to 20% involve the clitoris, and 15% to 20% involve the perineum. For approximately 5% of the cases, the cancer is present at more than one location. For approximately 10% of the cases, so much of the vulva is affected by cancer that the original location cannot be determined. Vulvar cancer

can spread to nearby structures including the anus, vagina, and urethra.

Most vulvar cancers are squamous cell carcinomas. Squamous cells are the main cell type of the skin. Squamous cell carcinoma often begins at the edges of the labia majora or labia minora or the area around the vagina. This type of cancer is usually slow-growing and may begin with a precancerous condition referred to as vulvar intraepithelial neoplasia (VIN), or dysplasia. This means that precancerous cells are present in the surface layer of skin.

Other, less common types of vulvar cancer are melanoma, basal cell carcinoma, adenocarcinomas, Paget's disease of the vulva, and tumors of the connective tissue under the skin. Melanoma, a cancer that develops from the cells that produce the pigment that determines the skin's color, can occur anywhere on the skin, including the vulva. Melanoma is the second most common type of vulvar cancer, and accounts for 5% to 10% of the cases. Half of all vulvar melanomas involve the labia majora. Basal cell carcinoma, which is the most common type of cancer that occurs on parts of the skin exposed to the sun, very rarely occurs on the vulva. Adenocarcinomas develop from glands, including the glands at the opening of the vagina (Bartholin's glands) that produce a mucus-like lubricating fluid.

Vulvar cancer is most common in women over 50 years of age. The median age at diagnosis is 65 to 70 years old. Additional risk factors for vulvar cancer include having multiple sexual partners, **cervical cancer**, and the presence of chronic vaginal and vulvar inflammations. This type of cancer is often associated with **sexually transmitted diseases**.

Vulvar cancer is most common in women who are between the ages of 65 and 75 years. In the United States there are approximately 3,000 new cases of vulvar cancer diagnosed each year. Vulvar cancer accounts for only 1% of all cancers in women. Approximately 5% of all gynecologic cancers occur on the vulva. For unknown reasons, the incidence of vulvar cancer seems to be rising.

Causes and symptoms

Cancer is caused when the normal mechanisms that control cell growth become disturbed, causing the cells to continually grow without stopping. This is usually the result of damage to the DNA in the cell. Although the cause of vulvar cancer is unknown, studies have identified several risk factors for vulvar cancer. These include:

- Vulvar intraepithelial neoplasia (VIN). This abnormal growth of the surface cells of the vulva can sometimes progress to cancer.
- Infection with human papillomavirus (HPV). This virus is sexually transmitted and can cause **genital warts**. Although HPV DNA can be detected in most cases of vulvar intraepithelial neoplasia, it is detected in fewer than half of all cases of vulvar cancer. Therefore, the link between HPV infection and vulvar cancer is unclear. As of 2001, it is theorized that two classes of vulvar cancer exist: one that is associated with HPV infection and one that is not.
- Herpes simplex virus 2 (HSV2). This sexually transmitted virus is also associated with increased risk for vulvar cancer.
- Cigarette **smoking**. Smoking in combination with infection by HPV or HSV2 was found to be a particularly strong risk factor for vulvar cancer.
- Infection with human **immunodeficiency** virus (HIV). This virus, which causes **AIDS**, decreases the body's immune ability, leaving it vulnerable to a variety of diseases, including vulvar cancer.
- Chronic vulvar inflammation. Long term irritation and inflammation of the vulva and vagina, which may be caused by poor hygiene, can increase the risk of vulvar cancer.
- Abnormal Pap smears. Women who have had abnormal Pap smears are at an increased risk of developing vulvar cancer.
- Chronic immunosuppression. Women who have had long-term suppression of their immune system caused by disease (such as certain cancers) or medication (such as those taken after organ transplantation) have an increased risk of developing vulvar cancer.

The hallmark symptom of vulvar cancer is **itching** (pruritus), which is experienced by 90% of the women afflicted by this cancer. The cancerous lesion is readily visible. Unfortunately, because of embarrassment or denial, it is not uncommon for women to delay medical assessment of vulvar abnormalities. Any abnormalities should be reported to a gynecologist.

If squamous cell vulvar cancer is present, it may appear as a raised red, pink, or white bump (nodule). It is often accompanied by **pain**, bleeding, vaginal discharge, and painful urination. **Malignant melanoma** of the vulva usually appears as a pigmented, ulcerated growth. Other types of vulvar cancer may appear as a distinct mass of tissue, sore and scaly areas, or cauliflower-like growths that look like **warts**.

Diagnosis

A gynecological examination will be used to observe the suspected area. During this examination, the

physician may use a special magnifying instrument called a colposcope to view the area better. Additionally, the area may be treated with a dilute solution of acetic acid, which causes some abnormal areas to turn white, making them easier to see. During this examination, if any area is suspected of being abnormal, a tissue sample (biopsy) will be taken. The biopsy can be performed in the doctor's office with the use of local anesthetic. A wedge-shaped piece of tissue, which contains the suspect lesion with some surrounding normal skin and the underlying skin layers and connective tissue, will be removed. Small lesions will be removed in their entirety (excisional biopsy). The diagnosis of cancer depends on a microscopic analysis of this tissue by a pathologist.

The diagnosis for vulvar cancer will determine how advanced the cancer is and how much it has spread. This is determined by the size of the tumor and how deep it has invaded the surrounding tissue and organs, such as the lymph nodes. It will also be determined if the cancer has metastasized, or spread to other organs. Tests used to determine the extent of the cancer include x ray and computed tomography scan (CT scan). Endoscopic examination of the bladder (**cystoscopy**) and/or rectum (proctoscopy) may be performed if it is suspected that the cancer has spread to these organs.

Treatment

Clinical staging

The International Federation of Gynecology and Obstetrics (FIGO) has adopted a surgical staging system for vulvar cancer. The stage of cancer is determined after surgery. The previous clinical staging system for vulvar cancer is no longer used. Vulvar cancer is categorized into five stages (0, I, II, III, and IV) which may be further subdivided (A and B) based on the depth or spread of cancerous tissue. The FIGO stages for vulvar cancer are:

- Stage 0. Vulvar intraepithelial neoplasia.
- Stage I. Cancer is confined to the vulva and perineum. The lesion is less than 2 cm (about 0.8 in) in size.
- Stage II. Cancer is confined to the vulva and perineum. The lesion is larger than 2 cm (larger than 0.8 in) in size.
- Stage III. Cancer has spread to the vagina, urethra, anus, and/or the lymph nodes in the groin (inguinofemoral).
- Stage IV. Cancer has spread to the bladder, bowel, pelvic bone, pelvic lymph nodes, and/or other parts of the body.

Treatments

Treatment for vulvar cancer will depend on its stage and the patient's general state of health. Surgery is the mainstay of treatment for most cases of vulvar cancer.

SURGERY. The primary treatment for stage I and stage II vulvar cancer is surgery to remove the cancerous lesion and possibly the inguinofemoral lymph nodes. Removal of the lesion may be done by laser, to burn off a minimal amount of tissue, or by scalpel (local excision), to remove more of the tissue. The choice will depend on the severity of the cancer. If a large area of the vulva is removed, it is called a vulvectomy. Radical vulvectomy removes the entire vulva. A vulvectomy may require skin grafts from other areas of the body to cover the wound and make an artificial vulva. Because of the significant morbidity and the psychosexual consequences of radical vulvectomy, there is a trend toward minimizing the extent of cancer excision. The specific inguinofemoral lymph node that would receive lymph fluid from the cancerous lesion, known as the sentinel node, may be exposed for examination (lymph node dissection) or removed (lymphadenectomy), especially in cases in which the cancerous lesion has invaded to a depth of more than 1 mm. Surgery may also be followed by **chemotherapy** and/or **radiation therapy** to kill additional cancer cells.

Surgical treatment of stage III and stage IV vulvar cancer is much more complex. Extensive surgery would be necessary to completely remove the cancerous tissue. Surgery would involve excision of pelvic organs (pelvic exenteration), radical vulvectomy, and lymphadenectomy. Because this extensive surgery comes with a substantial risk of complications, it may be possible to treat advanced vulvar cancer with minimal surgery by using radiation therapy and/or chemotherapy as additional treatment (adjuvant therapy).

An intraoperative technique that is used to identify the sentinel node in **breast cancer** and melanoma is being applied to vulvar cancer. This technique, called lymphoscintigraphy, is performed during surgical treatment of vulvar cancer and allows the surgeon to immediately identify the sentinel node. A radioactive compound (technetium 99m sulfur colloid) is injected into the cancerous lesion approximately two hours prior to surgery. This injection causes little discomfort, so local anesthesia is not required. During surgery, a radioactivity detector is used to locate the sentinel node and any other nodes to which cancer has spread. Though still in the experimental stage, vulvar lymphoscintigraphy shows promise in reducing morbidity and hospital length of stay.

The most common complication of vulvectomy is the development of a tumor-like collection of clear liquid (wound seroma). Other surgical complications include urinary tract infection, wound infection, temporary nerve injury, fluid accumulation (**edema**) in the legs, **urinary incontinence**, falling or sinking of the genitals (genital prolapse), and blood clots (thrombus).

KEY TERMS

Adjuvant therapy—A treatment that is intended to aid primary treatment. Adjuvant treatments for vulvar cancer are radiation therapy and chemotherapy.

Biopsy—Removal of a small piece of tissue for microscopic examination. This is done under local anesthesia and removed by either using a scalpel or a punch, which removes a small cylindrical portion of tissue.

Colposcope—An instrument used for examination of the vagina and cervix. Part of the instrument includes a magnifying lens for better visualization.

Metastasis—The movement of cancer cells from one area of the body to another. This occurs through the blood vessels or the lymph vessels.

Pelvic exenteration—Surgical removal of the organs of the true pelvis which includes the uterus, vagina, and cervix.

Sentinel lymph node—The first lymph node to receive lymph fluid from a tumor. If the sentinel node is cancer-free, then it is likely that the cancerous cells have not metastasized.

RADIATION THERAPY. Radiation therapy uses high-energy radiation from x rays and gamma rays to kill the cancer cells. The skin in the treated area may become red and dry and may take as long as a year to return to normal. **Fatigue**, upset stomach, **diarrhea**, and nausea are also common complaints of women having radiation therapy. Radiation therapy in the pelvic area may cause the vagina to become narrow as scar tissue forms. This phenomenon, known as vaginal stenosis, makes intercourse painful.

CHEMOTHERAPY. Chemotherapy uses **anticancer drugs** to kill the cancer cells. The drugs are given by mouth (orally) or intravenously. They enter the bloodstream and can travel to all parts of the body to kill cancer cells. Generally, a combination of drugs is given because it is more effective than a single drug in treating cancer. The side effects of chemotherapy are significant and include stomach upset, vomiting, appetite loss, hair loss, mouth or vaginal sores, fatigue, menstrual cycle changes, and **premature menopause**. There is also an increased chance of infections.

Alternative treatment

Although alternative and complementary therapies are used by many cancer patients, very few controlled studies on the effectiveness of such therapies exist. Mind-body techniques such as prayer, **biofeedback**, visualization, **meditation**, and **yoga** have not shown any effect in reducing cancer but can reduce **stress** and lessen some of the side effects of cancer treatments. Clinical studies of hydrazine sulfate found that it had no effect on cancer and even worsened the health and well- being of the study subjects. One clinical study of the drug amygdalin (Laetrile) found that it had no effect on cancer. Laetrile can be toxic and has caused **death**. Shark cartilage, although highly touted as an effective cancer treatment, is an improbable therapy that has not been the subject of clinical study.

The American Cancer Society has found that the "metabolic diets" pose serious risk to the patient. The effectiveness of the macrobiotic, Gerson, and Kelley **diets** and the Manner metabolic therapy has not been scientifically proven. The FDA was unable to substantiate the anticancer claims made about the popular Cancell treatment.

There is no evidence for the effectiveness of most over-the-counter herbal cancer remedies. However, some herbals have shown an anticancer effect. As shown in clinical studies, Polysaccharide krestin, from the mushroom *Coriolus versicolor*, has significant effectiveness against cancer. In a small study, the green alga *Chlorella pyrenoidosa* has been shown to have anticancer activity. In a few small studies, evening primrose oil has shown some benefit in the treatment of cancer.

Prognosis

Factors that are correlated with disease outcome include the diameter and depth of the cancerous lesion, involvement of local lymph nodes, cell type, HPV status, and age of the patient. Vulvar cancers that are HPV positive have a better prognosis than those that are HPV negative. The 5-year survival rate is 98% for stage I vulvar cancer and 87% for stage II vulvar cancer. The survival rate drops steadily as the number of affected lymph nodes increases. The survival rate is 75% for patients with one or two, 36% for those with three or four, and 24% for those with five or six involved lymph nodes. The previous statistics were obtained from studies of patients who received surgical treatment only and cannot be used to determine survival rates when adjuvant therapy is employed.

Vulvar cancer can spread locally to encompass the anus, vagina, and urethra. Because of the anatomy of the vulva, it is not uncommon for the cancer to spread to the local lymph nodes. Advanced stages of vulvar cancer can affect the pelvic bone. The lungs are the most common site for vulvar cancer metastasis. Metastasis through the blood (hematogenous spread) is uncommon.

Prevention

The risk of vulvar cancer can be decreased by avoiding risk factors, most of which involve lifestyle choices. Specifically, to reduce the risk of vulvar cancer, women should not smoke and should refrain from engaging in unsafe sexual behavior. Good hygiene of the genital area to prevent infection and inflammation may also reduce the risk of vulvar cancer.

Because vulvar cancer is highly curable in its early stages, women should consult a physician as soon as a vulvar abnormality is detected. Regular gynecological examinations are necessary to detect precancerous conditions that can be treated before the cancer becomes invasive. Because some vulvar cancer is a type of skin cancer, the American Cancer Society also recommends self-examination of the vulva using a mirror. If **moles** are present in the genital area, women should employ the ABCD rule:

- Asymmetry. A cancerous mole may have two halves of unequal size.
- Border irregularity. A cancerous mole may have ragged or notched edges.
- Color. A cancerous mole may have variations in color.
- Diameter. A cancerous mole may have a diameter wider than 6 mm (1/4 in).

Resources

BOOKS

American Cancer Society's Guide to Complementary and Alternative Cancer Methods. Bruss, Katherine, Christina Salter, and Esmeralda Galan, eds. Atlanta: American Cancer Society, 2000.

Eifel, Patricia, Jonathan Berrek, and James Thigpen. "Cancer of the Cervix, Vagina, and Vulva." In *Cancer: Principles & Practice of Oncology.* DeVita, Vincent, Samuel Hellman, and Steven Rosenberg, eds. Philadelphia: Lippincott Williams & Wilkins, 2001.

Garcia, Agustin, and J. Tate Thigpen. "Tumors of the Vulva and Vagina." In *Textbook of Uncommon Cancer.* Raghavan, D., M. Brecher, D. Johnson, N. Meropol, P. Moots, and J. Thigpen, eds. Chichester: John Wiley & Sons, 1999.

Primack, Aron. "Complementary/Alternative Therapies in the Prevention and Treatment of Cancer." In *Complementary/ Alternative Medicine: An Evidence- Based Approach.* Spencer, John, and Joseph Jacobs. St. Louis: Mosby, 1999.

PERIODICALS

Grendys, Edward, and James Fiorica. "Innovations in the Management of Vulvar Carcinoma." *Current Opinion in Obstetrics and Gynecology* 12 (February 2000): 15-20.

ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329. (800) ACS-2345. <http://www.cancer.org>.

Cancer Research Institute, National Headquarters. 681 Fifth Ave., New York, NY 10022. (800) 992-2623. <http://www.cancerresearch.org>.

Gynecologic Cancer Foundation. 401 N. Michigan Ave., Chicago, IL 60611. (800) 444-4441 or (312) 644-6610. <http://www.wcn.org/gcf>.

National Institutes of Health. National Cancer Institute. 9000 Rockville Pike, Bethesda, MD 20982. (800) 4-CANCER. <http://cancernet.nci.nih.gov>.

OTHER

Cancer Care News. 3 July 2001 <http://www.cancercare.org>.

Quackwatch, Questionable Cancer Therapies. 3 July 2001 <http://www.quackwatch.com>.

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Vulvitis *see* **Vulvovaginitis**

Vulvovaginitis

Definition

Inflammation of the vagina and vulva most often caused by a bacterial, fungal, or parasitic infection.

Description

Vulvovaginitis, vulvitis, and vaginitis are general terms that refer to the inflammation of the vagina and/or vulva (the external genital organs of a woman).These conditions can be caused by bacterial, fungal, or parasitic infections. Also, vulvovaginitis can be caused by low estrogen levels (called "atrophic vaginitis") or any type of allergic or irritation response from things such as spermicidal products, condoms, soaps, and bubble bath.

In general, vulvovaginitis causes vaginal discharge, irritation, and **itching**. One of the most common reasons why women visit their doctor is because of a change in vaginal discharge. It is completely normal for a woman to have a vaginal discharge, the amount and consistency of which varies during the course of the menstrual cycle. Each of the three most common types of vulvovaginitis will be described separately.

Bacterial vaginosis

Bacterial vaginosis is the most common cause of vaginitis during the childbearing years. Forty percent to 50% of vaginitis cases are caused by bacterial vaginosis. The occurrence of bacterial vaginosis is difficult to determine but studies have proposed that 10% to 41% of

women have had it at least once. The occurrence of bacterial vaginosis in the United States is highest among African-American women and women who have had multiple sexual partners and lowest among Asian women and women with no history of sexual contact with men. Bacterial vaginosis is not considered a sexually transmitted disease although it can be acquired by sexual intercourse.

Bacterial vaginosis is not caused by a particular organism but is a change in the balance of normal vaginal bacteria. Ninety percent of the bacteria found in a healthy vagina belong to the *Lactobacillus* family. For unknown reasons, there is a shift in the bacterial population that results in overgrowth of other bacteria. Patients suffering from bacterial vaginosis have very high numbers of bacteria such as *Gardnerella vaginalis*, *Mycoplasmahominis*, *Bacteroides* species, and *Mobiluncus* species. These bacteria can be found at numbers 100 to 1000 times greater than found in the healthy vagina. In contrast, *Lactobacillus* bacteria are in very low numbers or completely absent from the vagina of women with bacterial vaginosis.

Candida vulvovaginitis

Candida vulvovaginitis also has been called "vulvovaginal candidiasis," "candidal vaginitis," "monilial infection," or "vaginal yeast infection." Twenty to 25% of the vaginitis cases are candida vulvovaginitis. It has been estimated that about 75% of all women get a vaginal yeast infection at least once. In 80-90% of the cases, candida vulvovaginitis is caused by an overgrowth of the yeast *Candida albicans*. The remaining cases are caused by other species of *Candida*. It is not known what causes the yeast overgrowth. However, **antibiotics** can inadvertently kill normal bacteria in the vagina and cause an overgrowth of *Candida*.

Candida vulvovaginitis is not considered a sexually transmitted disease because *Candida* species are commonly found in the healthy vagina. It is a rare disease in girls before **puberty** and celibate women. Vaginal yeast infections tend to occur more frequently in women who are pregnant, diabetic and not controlling their disease, taking birth control pills, or taking antibiotics. Some women have four or more attacks per year which is called "recurrent vaginal candidiasis."

Trichomoniasis

Trichomoniasis, which is sometimes called "trich," accounts for 15-20% of the cases of vaginitis. It is estimated that two million to three million American women get trichomoniasis each year. Unlike the previous two causes of vulvovaginitis, trichomoniasis is a sexually transmitted disease. This means that the disease is passed from person-to-person only by sexual contact. Trichomoniasis occurs in both men and women and is caused by an infection with the single-celled parasite *Trichomonas vaginalis*. Infection with *Trichomonas vaginalis* is frequently associated with other **sexually transmitted diseases** and assists the spread of the **AIDS** virus.

Causes and symptoms

Vulvovaginitis is most often caused by a bacterial, fungal, or parasitic infection as described above. Other microorganisms may cause vulvovaginitis, or it may be caused by allergic reaction, irritation, injury, low estrogen levels, and certain diseases. Risk factors for bacterial vaginosis include using an intrauterine device (**IUD**), nonwhite race, prior **pregnancy**, first sexual activity at an early age, having multiple sexual partners, and having a history of sexually transmitted diseases. Persons at an increased risk for candida vulvovaginitis include those who have had previous candida infections, frequent sexual intercourse, use birth control pills, have AIDS, are pregnant, are taking antibiotics or **corticosteroids**, are diabetic, use douches, use perfumed feminine hygiene sprays, wear tight clothing, or use vaginal sponges or an IUD.

The typical symptoms of vulvovaginitis are: vaginal discharge, itching, and irritation. Women may have few or no symptoms, while others may have pronounced symptoms. The main symptom of bacterial vaginosis is a fishy-smelling, thin, milky-white or gray vaginal discharge but itching and burning may also be present. The fishy smell is stronger after sexual intercourse. The symptoms of candida vulvovaginitis are itching, soreness, painful sexual intercourse, and a thick, curdy, white (like cottage cheese) vaginal discharge. Trichomoniasis symptoms are: painful urination, painful sexual intercourse, and a yellow-green to gray, foul smelling, sometimes frothy, vaginal discharge.

Diagnosis

Vulvovaginitis can be diagnosed and treated by a nurse practitioner or physician. Most insurance companies cover the costs of diagnosis and treatment. To diagnose vulvovaginitis, the doctor will examine the vagina (using a speculum to keep the vagina open) and take a sample of the vaginal discharge for tests and microscopic analysis. Laboratory culture results should be available in two to three days but the microscopic examination of the vaginal discharge may be immediately performed in the doctor's office. Diagnosis may be difficult because there are many different causes of vulvovaginitis. Women who think that they have vulvovaginitis should always visit their doctor to get an accurate diagnosis. Many women assume that they have a yeast infection and

take over-the-counter medicines without first consulting their doctors.

There are four signs that indicate that a woman has bacterial vaginosis. These signs (called "Amsel's criteria") are: a thin, milky white discharge that clings to the walls of the vagina, presence of a fishy odor, a vaginal pH of greater than 4.5, and the presence of "clue cells" in the vagina. Clue cells are vaginal cells that are covered with small bacteria. A diagnosis of candida vulvovaginitis is made after finding a normal vaginal pH (4 to 4.5) and the presence of many yeast cells in the sample of vaginal discharge or growth of yeast on laboratory media. A trichomoniasis diagnosis is made when the parasites are found in the vaginal discharge either by microscopic examination or in laboratory cultures.

Treatment

Both bacterial vaginosis and trichomoniasis require prescription medication for treatment. Candida vulvovaginitis may be treated with either prescription or over-the-counter medicines. It is not advisable to take over-the-counter vaginal yeast infection medicines if one does not have a yeast infection. An Institute of Epidemiological Research survey of 390 gynecologists found that 44% of the women who were diagnosed with bacterial vaginosis had first treated themselves with over-the-counter yeast infection medications.

Bacterial vaginosis should be treated daily for one week with the antibiotics metronidazole (Flagyl, Protostat) or clindamycin (Cleocin) either as pills taken orally or in a gel or cream form put into the vagina. Trichomoniasis is treated with either a large, single dose of metronidazole or with a smaller dose taken twice daily for one week. Male sexual partners of women with trichomoniasis also must be treated.

Candida vulvovaginitis is most often treated by the application of medicated gels, creams, or suppositories applied directly to the vagina. The antifungal drugs used to treat candida vulvovaginitis include oral fluconazole (Diflucan), butoconazole (Femstat), clotrimazole (Gynelotrimin, Mycelex), miconazole (Monistat), and ticonazole (Vagistat). Most require only one or a few days of therapy to be effective. Women who have recurrent candida infections may receive treatment for several weeks and then some form of a long-term preventative treatment.

Alternative treatment

One of the primary focuses of alternative treatment for vaginal conditions including vulvovaginitis is rebalancing the normal vaginal flora. To assist with this rebalancing, *Lactobacillus acidophilus* and *L. bifidus* are recommended, either taken internally or introduced directly into the vagina. Garlic (*Allium sativum*), both taken internally and inserted into the vagina (a peeled whole clove wrapped in gauze), may be helpful due to its antibacterial and antifungal actions. A variety of other herbs can be used as douches or in suppository form to help treat acute flare-ups of vaginal symptoms. For example a douche made by steeping 1–2 tsp. of calendula (*Calendula officinalis*) in boiling water (let the water cool before using) may help reduce inflammation. A boric acid douche can help to acidify the vaginal pH so that unwanted bacteria cannot survive and multiply. For atrophic vaginitis, especially in menopausal women, topical application of progesterone cream can help with the thinning of the tissue so that symptoms can abate.

Dietary modification and nutritional supplementation may also be helpful in the treatment of vulvovaginitis. Antioxidant **vitamins**, including A, C, and E, as well as B complex vitamins, and vitamin D, are recommended. Foods to avoid include cheese, alcohol, chocolate, soy sauce, sugar, vinegar, fruits, and any fermented foods. Wearing cotton underwear and loose fitting clothes and avoiding panty hose can help keep the vagina cool and dry, thus helping to prevent some forms of vulvovaginitis. Cases of chronic vulvovaginitis should be addressed on systemic level by an alternative practitioner.

KEY TERMS

Parasite—An animal or plant that can only survive by living inside or upon another animal or plant.

Vulva—The external genital organs of a woman, including the outer and inner lips, clitoris, and opening of the vagina.

Prognosis

Vulvovaginitis is a disease with minor symptoms and most women respond well to medications. It is believed that certain vaginal infections, if left untreated, can lead to more serious conditions such as **pelvic inflammatory disease**, endometritis, postsurgical infections, and spread of the AIDS virus.

Prevention

Vaginal infections may be prevented by following these suggestions:

- Over-the-counter yeast infection treatments should not be taken unless the woman had been diagnosed with **candidiasis** before and recognizes the symptoms.

- Douching should be avoided because it may disturb the balance of organisms in the vagina and may spread them higher into the reproductive system.
- Thoroughly dry oneself after bathing and remove a wet bathing suit promptly.
- Avoid wearing tight clothing and wear cotton underwear.
- Clean diaphragms, cervical caps, and spermicide applicators after use. Use condoms to avoid sexually transmitted disease.
- After a bowel movement, wipe from front to back to avoid spreading intestinal bacteria to the vagina.

Resources

PERIODICALS

Sobel, Jack D. "Vaginitis." *The New England Journal of Medicine* 337 (Dec. 1997): 1896-1903.

ORGANIZATIONS

National Vaginitis Association. 117 South Cook St., Suite 315, Barrington, IL 60010. (800) 909-8745. <VagAssoc@aol.com>. <http://www.vaginalinfections. org>.

OTHER

"Women's Health STD Information Center." *JAMA*. <http://pubs.ama-assn.org>.

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W

Waldenström disease *see* **Waldenström's macroglobulinemia**

Waldenström's macroglobulinemia

Definition

Waldenström's macroglobulinemia is a rare, chronic **cancer** of the immune system that is characterized by hyperviscosity, or thickening, of the blood.

Description

Waldenström's (Waldenstrom, Waldenstroem's) macroglobulinemia (WM) is a lymphoma, or cancer of the lymphatic system. It was first identified in 1944, by the Swedish physician Jan Gosta Waldenström, in patients who had a thickening of the serum, or liquid part, of the blood. Their blood serum contained a great deal of a very large molecule called a globulin. Thus, the disorder is called macroglobulinemia.

Lymphomas are cancers that originate in tissues of the lymphatic system. All lymphomas other than **Hodgkin's disease**, including WM, are known collectively as non-Hodgkin's lymphomas. There are 13 major types of non-Hodgkin's lymphomas, and others that are very rare. Other names that are sometimes used for WM include: lymphoplasmacytic lymphoma, lymphoplasmacytic leukemia, macroglobulinemia of Waldenström, primary macroglobulinemia, Waldenström's syndrome, Waldenström's purpura, or hyperglobulinemic purpura. Purpura refers to purple spots on the skin, resulting from the frequent bleeding and bruising that can be a symptom of WM.

WM is classified as a low-grade or indolent form of lymphoma because it is a slow-growing cancer that produces fewer symptoms than other types of lymphomas. WM most often affects males over the age of 65. Frequently, this disease produces no symptoms and does not require treatment. It has not been studied as extensively as other types of lymphoma.

The lymphatic system

The lymphatic system is part of the body's immune system, for fighting disease, and part of the blood-producing system. It includes the lymph vessels and nodes, and the spleen, bone marrow, and thymus. The narrow lymphatic vessels carry lymphatic fluid from throughout the body. The lymph nodes are small, pea-shaped organs that filter the lymphatic fluid and trap foreign substances, including viruses, bacteria, and cancer cells. The spleen, in the upper left abdomen, removes old cells and debris from the blood. The bone marrow, the spongy tissue inside the bones, produces new blood cells.

B lymphocytes or B cells are white blood cells that recognize disease-causing organisms. They circulate throughout the body in the blood and lymphatic fluid. Each B lymphocyte recognizes a specific foreign substance, or antigen. When it encounters its specific antigen, the B cell begins to divide and multiply, producing large numbers of identical (monoclonal), mature plasma cells. These plasma cells produce large amounts of antibody that are specific for the antigen. Antibodies are large proteins called immunoglobulins (Igs) that bind to and remove the specific antigen.

A type of Ig, called IgM, is part of the early immune response. The IgM molecules form clusters in the bloodstream. When these IgM clusters encounter their specific antigen, usually a bacterium, they cover it so that it can be destroyed by other immune system cells.

Plasma cell neoplasm

WM is a type of plasma cell neoplasm or B-cell lymphoma. These are lymphomas in which certain plasma cells become abnormal, or cancerous, and begin to grow uncontrollably. In WM, the cancerous plasma cells

overproduce large amounts of identical (monoclonal) IgM antibody. This IgM also is called M protein, for monoclonal or myeloma protein.

Macroglobulinemia refers to the accumulation of this M protein in the serum of the blood. This large amount of M protein can cause the blood to thicken, causing hyperviscosity. The malignant plasma cells of some WM patients also produce and secrete partial immunoglobulins called light chains, or Bence-Jones proteins. The malignant plasma cells can invade various tissues, including the bone marrow, lymph nodes, and spleen, causing these tissues to swell.

WM accounts for about 1-2% of non-Hodgkin's lymphomas. It is estimated that it may affect about five out of every 100,000 people. It usually affects people over the age of 50, and most often develops after age 65. It is more common in men than in women. In the United States, WM is more common among Caucasians than among African Americans. The disease can run in families.

Causes and symptoms

The cause of WM is not known.

Many individuals with WM have no symptoms of the disease. This is known as asymptomatic macroglobulinemia. When symptoms of WM are present, they may vary greatly from one individual to the next.

Hyperviscosity syndrome

At least 50% of individuals with WM have hyperviscosity syndrome, an increased viscosity or thickening of the blood caused by the accumulation of IgM in the serum. Hyperviscosity can cause a slowing in the circulation through small blood vessels. This condition can lead to a variety of symptoms:

- **fatigue**
- weakness
- rash
- bruising
- nose bleeds
- gastrointestinal bleeding
- weight loss
- night sweats
- increased and recurrent infections
- poor blood circulation in the extremities

Poor blood circulation, or Raynaud's phenomenon, can affect any part of the body, but particularly the fingers, toes, nose, and ears.

Cold weather can cause additional circulatory problems, by further thickening the blood and slowing down circulation. In some cases, the excess blood protein may precipitate out of the blood in the cold, creating particles that can block small blood vessels. This is called cryoglobulinemia. The extremities may turn white, or a patchy red and white. The hands, feet, fingers, toes, ears, and nose may feel cold, numb, or painful.

Hyperviscosity may affect the brain and nervous system, leading to additional symptoms. These symptoms include:

- peripheral neuropathy, caused by changes in the nerves, leading to **pain** or numbness in the extremities
- dizziness
- headaches
- vision problems or loss of vision
- mental confusion
- poor coordination
- temporary paralysis
- mental changes

Hyperviscosity can clog the tubules that form the filtering system of the kidneys, leading to kidney damage or kidney failure. Existing heart conditions can be aggravated by WM. In extreme cases, WM may result in **heart failure**. Late-stage WM also may lead to mental changes that can progress to **coma**.

Anemia

The accumulation of IgM in the blood causes an increase in the volume of the blood plasma. This effectively dilutes out the red blood cells and other blood components. The lowered concentration of red blood cells can lead to anemia and cause serious fatigue. Likewise, a deficiency in platelets (**thrombocytopenia**), which cause the blood to clot, can result in easy bleeding and bruising. As the cancer progresses, there may be abnormal bleeding from the gums, nose, mouth, and intestinal tract. There may be bluish discoloration of the skin. In the later stages of the disease, leukopenia, a deficiency in white blood cells, also can develop.

Organ involvement

In 5-10% of WM cases, the IgM may be deposited in tissues. Thus, some individuals with WM have enlargement of the lymph nodes, the spleen, and/or the liver.

If Bence-Jones proteins are produced by the malignant plasma cells, they may be deposited in the kidneys. There they can plug up the tiny tubules that form the filtering system of the kidneys. This can lead to kidney damage and kidney failure.

KEY TERMS

Anemia—Any condition in which the red blood cell count is below normal.

Antibody—Immunoglobulin produced by immune system cells that recognizes and binds to a specific foreign substance (antigen).

Antigen—Foreign substance that is recognized by a specific antibody.

Autosomal dominant—Genetic trait that is expressed when present on only one of a pair of non-sex-linked chromosomes.

B cell (B lymphocyte)—Type of white blood cell that produces antibodies.

Bence-Jones protein—Light chain of an immunoglobulin that may be overproduced in Waldenstrom's macroglobulinemia; it is excreted in the urine.

Biopsy—Removal of a small sample of tissue for examination under a microscope; used in the diagnosis of cancer.

Cryoglobulinemia—Condition in which protein in the blood forms particles in the cold, blocking blood vessels and leading to pain and numbness of the extremities.

Hyperviscosity—Thick, viscous blood, caused by the accumulation of large proteins, such as immunoglobulins, in the serum.

Immunoelectrophoresis—Use of an electrical field to separate proteins in a mixture (such as blood or urine), on the basis of the size and electrical charge of the proteins; followed by the detection of an antigen (such as IgM), using a specific antibody.

Immunoglobulin (Ig)—Antibody such as IgM; large protein produced by B cells that recognizes and binds to a specific antigen.

Interferon alpha—Potent immune-defense protein; used as an anti-cancer drug.

Lymphatic system—The vessels, lymph nodes, and organs, including the bone marrow, spleen, and thymus, that produce and carry white blood cells to fight disease.

Lymphoma—Cancer that originates in lymphatic tissue.

M protein—Monoclonal or myeloma protein; IgM that is overproduced in Waldenstrom's macroglobulinemia and accumulates in the blood and urine.

Monoclonal—Identical cells or proteins; cells (clones) derived from a single, genetically-distinct cell, or proteins produced by these cells.

Plasma cell—Type of white blood cell that produces antibodies; derived from an antigen-specific B cell.

Plasmapheresis—Plasma exchange transfusion; the separation of serum from blood cells to treat hyperviscosity of the blood.

Platelet—Cell that is involved in blood clotting.

Stem cell—Undifferentiated cell that retains the ability to develop into any one of numerous cell types.

Diagnosis

Since many individuals with WM have no symptoms, the initial diagnosis may result from blood tests that are performed for some other purpose. Blood cell counts may reveal low red blood cell and platelet levels. A **physical examination** may indicate enlargement of the lymph nodes, spleen, and/or liver. A retinal **eye examination** with an ophthalmoscope may show retinal veins that are enlarged or bleeding.

Blood and urine tests

Serum **protein electrophoresis** is used to measure proteins in the blood. In this laboratory procedure, serum proteins are separated in an electrical field, based on the size and electrical charge of the proteins. Serum **immunoelectrophoresis** uses a second antibody that reacts with IgM. A spike in the Ig fraction indicates a large amount of identical or monoclonal IgM in individuals with WM.

Normal serum contains 0.7-1.6 gm per deciliter (g/dl) of Ig, with no monoclonal Ig present. At serum IgM concentrations of 3-5 g/dl, symptoms of hyperviscosity often are present. However some individuals remain asymptomatic with IgM levels as high as 9 g/dl.

Urinalysis may indicate protein in the urine. A urine Bence-Jones protein test may indicate the presence of these small, partial Igs.

Bone marrow

Abnormal blood tests usually are followed by a bone marrow biopsy. In this procedure, a needle is inserted into a bone and a small amount of marrow is removed. Microscopic examination of the marrow may reveal elevated levels of lymphocytes and plasma cells. However, less than 5% of patients with WM have lytic bone lesions, caused by cancerous plasma cells in the bone marrow that are destroying healthy cells. Bone lesions can be detected with x rays.

Treatment

Clinical staging, to define how far a cancer has spread through the body, is the common method for choosing a cancer treatment. However, there is no generally-accepted staging system for WM.

There also is no generally-accepted course of treatment for WM. Treatment may not be necessary for asymptomatic macroglobulinemia. However, if IgM serum levels are very high, treatment may be initiated even in the absence of symptoms. If symptoms are present, treatment is directed at relieving symptoms and retarding the disease's development. Of major concern is the prevention or alleviation of blood hyperviscosity. Therefore, the initial treatment depends on the viscosity of the blood at diagnosis.

Hyperviscosity

Plasmapheresis, or plasma exchange **transfusion**, is a procedure for thinning the blood. In this treatment, blood is removed and passed through a cell separator that removes the plasma, containing the IgM, from the red and white blood cells and platelets. The blood cells are transfused back into the patient, along with a plasma substitute or donated plasma. Plasmapheresis relieves many of the acute symptoms of WM. Individuals with WM may be given fluid to counter the effects of hyperviscous blood.

Low blood cell counts

Treatments for low blood cell levels include:

- the drug Procrit to treat anemia
- transfusions with packed red blood cells to treat anemia in later stages of the disease
- antibiotics to treat infections caused by a deficiency in white blood cells
- transfusions with blood platelets

Chemotherapy

Chemotherapy, the use of anti-cancer drugs, helps to slow the abnormal development of plasma cells, but does not cure WM. It can reduce the amount of IgM in the bone marrow. In particular, chemotherapy is used to treat severe hyperviscosity and anemia that are caused by WM.

Chlorambucil (Leukeran), possibly in combination with prednisone, is the typical chemotherapy choice for WM. This treatment is effective in 57% of cases. These drugs are taken by mouth. Prednisone is a corticosteroid that affects many body systems. It has anti-cancer and anti-inflammatory effects and is an immune system suppressant. Other drug combinations that are used to treat WM include cyclophosphamide (Cytoxan), vincristine, and prednisone, with or without doxorubicin. Fludaribine, 2-chlorodeoxyadenosine, and **corticosteroids** also may be used.

side effects of chemotherapy may include:

- mouth sores
- nausea and indigestion
- hair loss
- increased appetite
- nervousness
- insomnia

These side effects disappear after the chemotherapy is discontinued.

The long-term management of WM usually is accomplished through a combination of plasmapheresis and chemotherapy.

Alternative treatment

Biological therapy or immunotherapy, with the potent, immune system protein interferon alpha, is used to relieve the symptoms of WM. Interferon alpha works by boosting the body's immune response. Interferon can cause flu-like symptoms, such as **fever**, chills, and fatigue. It also can cause digestive problems and may affect blood pressure.

The drug rituximab, an antibody that is active against antibody-producing cells, is effective in about 30% of individuals with WM. Rituximab is a monoclonal antibody produced in the laboratory. Monoclonal antibody treatment may cause a an allergic reaction in some people.

Prognosis

There is no cure for WM. In general, patients go into partial or complete remission following initial treatments. However the disease is not cured and follow-up treatment may be necessary.

The prognosis for this cancer depends on an individual's age, general health, and genetic (hereditary) make-

up. Males, individuals over age 60, and those with severe anemia have the lowest survival rates. The Revised European American Lymphoma (REAL) classification system gives WM a good prognosis following treatment, with an average five-year survival rate of 50-70%. However, many people with WM live much longer, some without developing any symptoms of the disease. About 16-23% of individuals with WM die of unrelated causes.

Prevention

There is no known prevention for WM.

Resources

BOOKS

Drum, David. *Making the Chemotherapy Decision*. 2nd ed. Los Angeles: Lowell House, 1996.

Kyle, Robert A. "Plasma Cell Disorders". In *Cecil Textbook of Medicine,* edited by J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders, 1996.

Longo, Dan. L. "Plasma Cell Disorders". In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. New York: McGraw-Hill, 1998.

Sutcliffe, Simon B., ed. *Lymphoma and You: A Guide for Patients Living with Hodgkin's Disease and Non-Hodgkin's Lymphoma*. Toronto: The Medicine Group Ltd., 1998.

ORGANIZATIONS

Cure for Lymphoma Foundation. 215 Lexington Ave., New York, NY 10016. (212) 213-9595. (800)-CFL-6848. infocfl@cfl.org. <http://www.cfl.org/home.html>. An advocacy organization; education and support programs, research grants, information on clinical trials for Hodgkin's and non-Hodgkin's lymphomas.

International Waldenstrom's Macroglobulinemia Foundation. 2300 Bee Ridge Road, Sarasota, FL 34239-6226. (941) 927-IWMF. <http://www.iwmf.com>. Information, educational programs, support for patients and families, research support.

The Leukemia and Lymphoma Society. 600 Third Ave., New York, NY 10016. (800) 955-4572. (914) 949-5213. <http://www.leukemia-lymphoma.org>. Information, support, and guidance for patients and health care professionals.

The Lymphoma Research Foundation of America, Inc. 8800 Venice Boulevard, Suite 207, Los Angeles, CA 90034. (310) 204-7040). <http://www.lymphoma.org>. Research into treatments for lymphoma; educational and emotional support programs for patients and families.

OTHER

Complementary and Alternative Therapies for Leukemia, Lymphoma, Hodgkin's Disease and Myeloma. The Leukemia and Lymphoma Society. 27 Mar. 2001. 28 June 2001. <http://www.leukemia-lymphoma.org>.

"Macroglobulinemia of Waldenstrom." WebMD. 1999. 14 Apr. 2001. 28 June 2001. <http://my.webmd.com/content/asset/adam_disease_macroglobulinemia-primary>.

McKusick, Victor A. "Macroglobulinemia, Waldenstrom; WM." *Online Mendelian Inheritance in Man*. John Hopkins University. 28 Dec. 1999. 28 June 2001. <http://www.ncbi.nlm.nih.gov:80/entrez/dispomim.cgi?id=153600>.

"Multiple Myeloma and Other Plasma CellNeoplasms." CancerNet. National Cancer Institute. Mar. 2001. 28 June 2001. <http://cancernet.nci.nih.gov>.

"Non-Hodgkin's Lymphoma." Cancer Resource Center. American Cancer Society. 20 Dec 1998. 28 June 2001. <http://www3.cancer.org/cancerinfo/load_cont.asp?ct=32&st=wi>.

Waldenstroms.com. International Waldenstrom's Macroglobulinemia Foundation. 28 June 2001. <http://www.iwmf.com>.

J. Ricker Polsdorfer
Margaret Alic, Ph.D.

Walleye *see* **Strabismus**

Warts

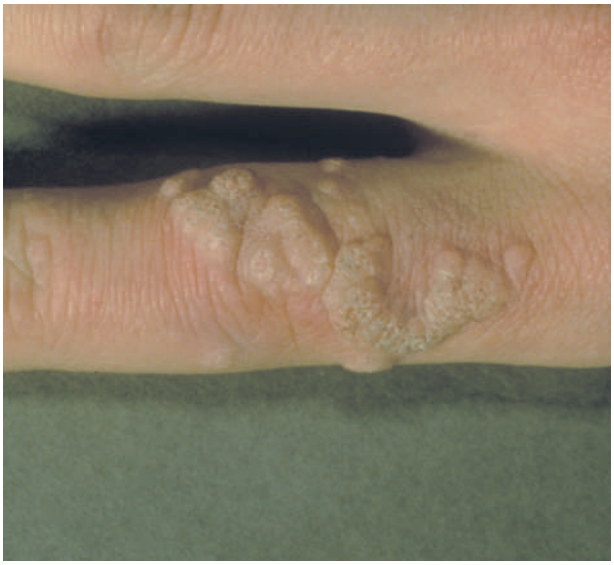
Definition

Warts are small, benign growths caused by a viral infection of the skin or mucous membrane. The virus infects the surface layer. The viruses that cause warts are members of the human papilloma virus (HPV) family. Warts are not cancerous but some strains of HPV, usually not associated with warts, have been linked with **cancer** formation. Warts are contagious from person to person and from one area of the body to another on the same person.

Description

Particularly common among children, young adults, and women, warts are a problem for 7-10% of the population. There are close to 60 types of HPV that cause warts, each preferring a specific skin location. For instance, some types of HPV cause warts to grow on the skin, others cause them to grow inside the mouth, while still others cause them to grow on the genital and rectal areas. However, most can be active anywhere on the body. The virus enters through the skin and produces new warts after an incubation period of one to eight months. Warts are usually skin-colored and feel rough to the touch, but they also can be dark, flat, and smooth.

Warts are passed from person to person, directly and indirectly. Some people are continually susceptible to warts, while others are more resistant to HPV and seldom get them. The virus takes hold more readily when



Cluster of warts on finger. *(Custom Medical Stock Photo. Reproduced by permission.)*

the skin has been damaged in some way, which may explain why children who bite their nails tend to have warts located on their fingers. People who take a medication to suppress their immune system or are on long-term steroid use are also prone to a wart virus infection. This same is true for patients with **AIDS**.

Causes and symptoms

The more common types of warts include:

- common hand warts
- foot warts
- flat warts
- **genital warts**

Hand warts

Common hand warts grow around the nails, on the fingers, and on the backs of hands. They appear more frequently where skin is broken, such as in areas where fingernails are bitten or hangnails picked.

Foot warts

Foot warts are called plantar warts because the word plantar is the medical term for the sole of the foot, the area where the wart usually appears as a single lesion or as a cluster. Plantar warts, however, do not stick up above the surface like common warts. The ball of the foot, the heel and the plantar part of the toes are the most likely locations for the warts because the skin in those areas is subject to the most weight, pressure and irritation, making a small break or crack more likely.

Plantar warts are familiar to all ages groups, appearing frequently in children between the ages of 12-16. Adolescents often come into contact with a wart virus in a locker room, swimming pool area, or by walking barefooted on dirty surfaces. The blood vessels feeding them are the black dots that are visible on the wart. If left untreated, these warts can grow to an inch or more in circumference and spread into clusters of several warts. They are known to be very painful at times, the **pain** usually compared to the feeling of a permanent stone in the shoe particularly if the wart is on a pressure point of the foot. People with **diabetes mellitus** are prone to complications from plantar warts related to the development of sores or ulceration and the poor healing potential associated with diabetes.

Flat warts

Flat warts tend to grow in great numbers and are smaller and smoother than other warts. They can erupt anywhere, appearing more frequently on the legs of women, the faces of children, and on the areas of the face that are shaved by young adult males.

Genital warts

Genital warts, also called condyloma acuminata or venereal warts, are one of the most common causes of sexually transmitted disease (STD) in this country. According to the *Journal of the American Medical Association's* STD Information Center, they are contracted by sexual contact with an infected person who carries HPV and are more contagious than other warts. It is estimated that two-thirds of the people who have sexual contact with a partner with genital warts will develop the disease within three months of contact. As a result, about one million new cases of genital warts are diagnosed in the United States each year.

Genital warts tend to be small flat bumps or they may be thin and tall. They are usually soft and not scaly like other warts. In women, genital warts appear on the genitalia, within the vagina, on the cervix, and around the anus or within the rectum. In men, genital warts usually appear on the tip of the penis but may also be found on the scrotum or around the anus. Genital warts can also develop in the mouth of a person who has had oral sexual contact with an infected person.

Diagnosis

Patients who notice warts in their genital area should see a doctor. The doctor may be able to diagnose the warts with a simple examination. If the warts are small, the doctor may put a vinegar-like liquid on the skin, which makes the warts turn white and easier to see, and then use a magnifying glass to look for them.

Treatment

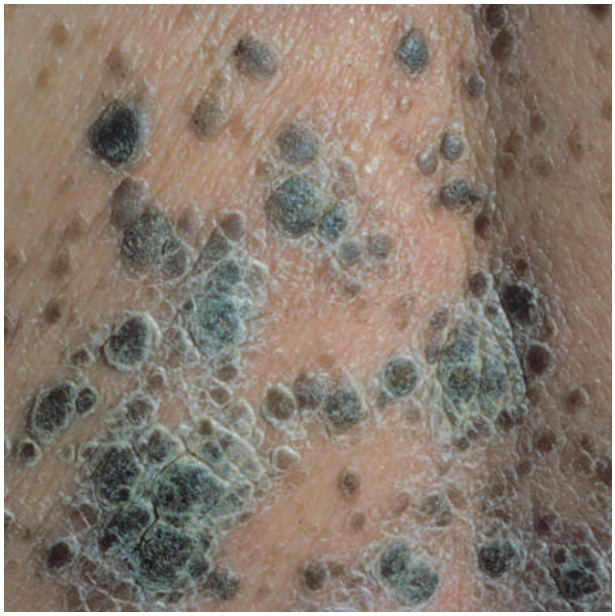
Home/self treatment

Many of the nonprescription wart remedies available at drug stores will remove simple warts from hands and fingers. These medications may be lotions, ointments, or plasters and work by chemically removing the skin that was affected by the wart virus. The chemicals are strong, however, and should be used with care since they can remove healthy as well as infected skin. These solutions should be avoided by diabetics and those with cardiovascular or other circulatory disorders whose skin may be insensitive and not appreciate irritation.

Flat warts are best treated with topical retinoides (retinoic acid) or a gel containing salicylic acid. The acid doesn't actually kill the wart virus, but waterlogs the skin so that the surface layer, with the virus, peels off. These products can take up to three months of treatment depending on the size and depth of the wart. Patches are also good to use. Rather than applying drops, a small pad is placed on the wart and left for 48 hours and then replaced with a new one. The patch usually contains a higher concentration of salicylic acid and may irritate the surrounding skin. If this occurs, patients should switch to a gel or stop medication for a period. To help the healing process for flat facial warts, men should shave with an electric shaver or temporarily grow a beard. Women with flat warts on areas that are shaved should use other methods to remove hair such as depilatory cream or wax.

Professional treatment

Physicians should be consulted if there are no signs of progress after a month of self treatment. Doctors have many ways of removing warts, including using stronger topically applied chemicals than those available in drugstores. Some of these solutions include podofilox, topical podophyllum, and trichloracetic acid (TCA). Some burning and discomfort for one or more days following treatment can be expected. Although these chemicals are effective, they may not destroy all warts completely. A second method of removal is freezing or cryosurgery on the wart using liquid nitrogen. **Cryotherapy** is relatively inexpensive, does not require anesthesia, and usually does not result in scarring. Although temporarily uncomfortable, it provides an effective and safe way to deliver freezing temperatures to a particular area on the skin, and healing is usually quick. Physicians may also choose to burn the wart with liquid nitrogen or numb the skin and then scrape off the wart. Another removal process is electrocautery (electric burning), destroying the wart by burning it with an electric needle. **Laser surgery** is also becoming a more common option for removing warts.



Seborrhoeic warts appearing on this patient's back. *(Custom Medical Stock Photo. Reproduced by permission.)*

Genital warts are the most difficult to treat. They can be removed, but the viral infection itself cannot be cured. Often, because the warts are so small, more than one treatment may be needed. The virus continues to live in the deeper skin, which is why warts often return after they have been removed. Strong chemicals may be applied as well as surgical excision with or without electrocautery. This therapy requires a small operative procedure and a local anesthetic. Laser therapy, although more expensive, is often used for treating venereal warts that are more extensive. The use of lasers which vaporize the lesion can theoretically transmit the HPV. It is not at all clear, however, if this occurs.

There is no one recommended method for eliminating plantar warts. If detected early, cryotherapy is usually enough. However, they can be very resilient, requiring treatment over several months. Treatment ranges from the conservative approach of applying chemical solutions to the more aggressive option of surgery. Patients with diabetes or vascular disease are usually treated with the more conservative methods.

Alternative treatment

There are a variety of alternative approaches to the treatment of warts. The suggestions described below apply to common warts and plantar warts, not to genital or cervical warts. Since genital and cervial warts are transmitted sexually, they should be treated by a physician

KEY TERMS

Condyloma acuminata—Another term for genital warts.

Cryotherapy—Freezing with liquid nitrogen for removal.

Endometritis—Inflammation of the endometrium or mucous membrane of the uterus.

Epidermis—The outer layer of human skin.

Human papilloma virus (HPV)—A family of viruses that causes hand warts, foot warts, flat warts and genital warts.

Retinoic acid—Vitamin A_1 acid which is used topically to treat acne.

Salicylic acid—An agent prescribed in the treatment of hyperkeratotic skin conditions and fungal infections.

For the treatment of common or plantar warts, alternative practitioners may recommend these remedies.

- Apply a paste made of vitamin C powder to the wart for one to two weeks.
- Place a crushed or sliced garlic clove over the wart for seven consecutive nights while sleeping.
- Soak the wart in water, put cross-hatches over it with a sterile needle, and apply drops of thuja (*Thuja occidentalis*) tincture onto the wart. Repeat the cross-hatching and tincture application until the wart is saturated with the tincture. Repeat several times each day for one to two weeks. (A tincture is an herbal extract made with alcohol.)
- Tape a piece of banana peel, latex side down, over the wart and leave it on overnight. Repeat nightly for one to two weeks.

Because warts are caused by a virus, general immune system support can be effective in helping to keep warts from coming back after treatment or to keep them from multiplying or growing. Eating a well balanced diet high in sources of **vitamins** A, C, and E can help strengthen the immune system. Avoiding **stress**, which is believed to compromise the immune system, is also helpful.

Prognosis

Even though genital warts may be removed, the virus itself continues to live. The HPV can cause tissue changes in the cervix of women with cervical infection. The general recommendation for women who have a history of genital warts is to see their doctors every six months for Pap smears to monitor any changes that may occur.

For plantar warts, the treatment goal is to destroy the wart and its virus without causing much damage to healthy skin. It is not unusual for treatment to cause pain until the foot heals because of the weight put on the foot.

Prevention

Genital warts can be prevented by using condoms and avoiding unprotected sex. Barrier protection will not, however, prevent the spread of wart-causing HPV to uncovered areas such as the pubis and upper thighs. Plantar warts can be prevented by wearing shoes, changing shoes daily, keeping feet clean and dry, and not ignoring skin growths and changes in the skin.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

Moyer, Susan M., and Donna B. Fedus. *The All New Medical Book of Remedies for People Over 50*. Publications International, Ltd., 1995.

Renner, John H. *The Home Remedies Handbook*. Publications International, Ltd., 1994.

Stupik, Ramona. *AMA Complete Guide to Women's Health*. New York: Random House, 1996.

PERIODICALS

Siwek, J. "Warts on the Hands." *Washington Post*, 19 Apr. 1995, 15

Smith, Trevor. "Runners Focus on Your Feet." *Running & FitNews*, June 1997, 4-5.

"Warts." *Mayo Clinic Health Letter* (July 1993): 5.

"What to do about Warts." *Consumer Reports on Health* (July 1997): 81-82.

ORGANIZATIONS

American Academy of Dermatology. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-0230. <http://www.aad.org>.

American Academy of Family Physicians. 8880 Ward Parkway, Kansas City, MO 64114. (816) 333-9700. <http://www.aafp.org>.

American Podiatric Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814-1698. (301) 571-9200. <http://www.apma.org>.

Dermatology College of Medicine, The University of Iowa, 200 Hawkins Dr., Iowa City, IO 52242. (319) 356-2274. <http://tray.dermatology.uiowa.edu>.

Ruthan Brodsky

Water pills *see* **Diuretics**

Water therapy *see* **Hydrotherapy**

Waterhouse-Friderichsen syndrome *see* **Meningococcemia**

Weber test *see* **Hearing tests with a tuning fork**

Wechsler intelligence test

Definition

The Wechsler Intelligence Scales are a series of standardized tests used to evaluate cognitive abilities and intellectual abilities in children and adults.

Purpose

The Wechsler Intelligence Scales for Children (regular, revised, and third edition) and Wechsler Preschool and Primary Scale of Intelligence are used as tools in school placement, in determining the presence of a learning disability or a developmental delay, in identifying giftedness, and in tracking intellectual development.

The Wechsler Adult Intelligence Scales (regular and revised) are used to determine vocational ability, to assess adult intellectual ability in the classroom, and to determine organic deficits. Both adult and children's Wechsler scales are often included in neuropsychological testing to assess the brain function of individuals with neurological impairments.

Precautions

Intelligence testing requires a clinically trained examiner. The Wechsler scales should be administered, scored, and interpreted by a trained professional, preferably a psychologist or psychiatrist.

Description

All of the Wechsler scales are divided into six verbal and five performance subtests. The complete test takes 60-90 minutes to administer. Verbal and Performance IQs are scored based on the results of the testing, and then a composite Full Scale IQ score is computed. Although earlier editions of some of the Wechsler Scales are still available, the latest revisions are described below:

Wechsler Adult Intelligence Scale-Revised (WAIS-R)

The WAIS-R, the 1981 revision of the original Wechsler Adult Intelligence Scale, is designed for adults, age 16-74. The 11 subtests of the WAIS-R include information, digit span, vocabulary, arithmetic, comprehension, similarities, picture completion, picture arrangement, block design, object assembly, and digit symbol. An example of questions on the subtest of similarities might be: "Describe how the following pair of words are alike or the same—hamburger and pizza." A correct response would be "Both are things to eat."

Wechsler Intelligence Scale for Children, Third Edition (WISC-III)

The WISC-III subtests includes many of the same categories of subtests as the WAIS-R. In addition, there are two optional performance subtests: symbol search and mazes.

Wechsler Preschool and Primary Scale of Intelligence (WPPSI)

The WPPSI is designed for children age 4-6½ years. The test is divided into six verbal and five performance subtests. The eleven subtests are presented in the following order: information, animal house and animal house retest, vocabulary, picture completion, arithmetic, mazes, geometric design, similarities, block design, comprehension, and sentences.

The 1997 Medicare reimbursement rate for psychological and neuropsychological testing, including intelligence testing, is $58.35 an hour. Billing time typically includes test administration, scoring and interpretation, and reporting. Many insurance plans cover all or a portion of diagnostic psychological testing.

Normal results

The Wechsler Intelligence Scales are standardized tests, meaning that as part of the test design, they were administered to a large representative sample of the target population, and norms were determined from the results. The scales have a mean, or average, standard score of 100 and a standard deviation of 15. The standard deviation indicates how far above or below the norm the subject's score is. For example, a ten-year-old is assessed with the WISC-III scale and achieves a full-scale IQ score of 85. The mean score of 100 is the average level at which all 10-year-olds in the representative sample performed. This child's score would be one standard deviation below that norm.

While the full-scale IQ scores provide a reference point for evaluation, they are only an average of a variety of skill areas. A trained psychologist will evaluate and interpret an individual's performance on the scale's subtests to discover their strengths and weaknesses and offer recommendations based upon these findings.

KEY TERMS

Norms—Normative or mean score for a particular age group.

Representative sample—A random sample of people that adequately represents the test-taking population in age, gender, race, and socioeconomic standing.

Standard deviation—A measure of the distribution of scores around the average (mean). In a normal distribution, two standard deviations above and below the mean includes about 95% of all samples.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

Resources

BOOKS

Maddox, Taddy. *Tests: A Comprehensive Reference for Assessments in Psychology, Education, and Business*. 4th ed. Austin: Pro-ed, 1997.

Shore, Milton F., Patrick J. Brice, and Barbara G. Love. *When Your Child Needs Testing*. New York: Crossroad Publishing, 1992.

Wodrich, David L. *Children's Psychological Testing: A Guide for Nonpsychologists*. Baltimore: Paul H. Brookes Publishing, 1997.

PERIODICALS

Czubaj, Camilla Anne. "The Wechsler Adult Intelligence Scale—Revised, Revisited." *Education* 117, no. 3 (Winter 1997): 271-3.

Slate, John R., and Craig H. Jones. "WISC-III IQ Scores and Special Education Diagnosis." *The Journal of Psychology* 131, no. 1 (Jan. 1997): 119-120.

ORGANIZATIONS

American Psychological Association (APA). 750 First St. NE, Washington, DC 20002-4242. (202) 336-5700. <ttp://www.apa.org>.

The Catholic University of America. Washington, DC 20064. (800) 464-3742. <http://www.ericae.net>.

Paula Anne Ford-Martin

Wegener's granulomatosis

Definition

Wegener's granulomatosis is a very rare disease that affects many different organs and systems of the body. It mainly attacks the respiratory system (sinuses, nose, windpipe, and the lungs) and the kidneys. One of the main features of the disease is an inflammation of the blood vessels (**vasculitis**). The inflammation narrows the blood vessels and reduces the blood flow to the affected organs. This destroys tissues and damages vital organs.

Description

Wegener's granulomatosis (WG) is not a contagious disease, and there is no evidence to suggest that it is hereditary either. It is a very rare disease, affecting only 1 in every 30,000-50,000 people. About 500 new cases are diagnosed each year. The disease can occur at any age, however, it mostly affects individuals in their 30s and 40s. It affects males and females equally. Ninety seven percent of all patients are Caucasian, 2% are Black and 1% are of another race.

Causes and symptoms

No viral, bacterial, or other causative agent has yet been identified for WG. It is thought to be an autoimmune disease, meaning that the body's immune system attacks "itself," that is, the body's own tissues.

Whenever there is an infection in the body, proteins called antibodies, which are capable of attacking the infectious agent, are formed in the blood. In WG, the antibodies that are formed are directed against the white blood cells of the immune system. They are therefore called "auto-antibodies" (antibodies against one's own body cells). These auto-antibodies bind to the blood cells and forms clumps known as immune complexes. The complexes accumulate in the tissues and the blood vessels, leading to a tumor-like (granulomatous) inflammation of the blood vessels. This slows down the blood flow to the different organs and tissues, causing damage and resulting in the many symptoms of WG.

The symptoms of WG, and the severity of the symptoms, vary from patient to patient. One of the most common features is a chronic runny nose and other cold-like symptoms that do not respond to standard treatment. The cold symptoms gradually worsen and could lead to **sinusitis** (inflammation of the sinuses), middle ear infection (**otitis media**), **cough**, coughing of blood, and inflammation of the lung (pleuritis and **pneumonia**). Other symptoms include **fever**, **fatigue**, loss of appetite, weight loss, joint **pain**, night sweats, change in urine color, and weakness.

Kidney (renal) disease is the most serious development of WG. Patients who do not have renal disease are said to have "Limited Wegener's."

Diagnosis

Early diagnosis is critical for the most effective treatment of the disease. However, there are no specific laboratory tests for WG. Blood tests are used to rule out other causes of the symptoms and to determine which organs are affected. The blood tests often show anemia (low red cell count) and high white blood cell counts. If the kidneys are involved, red blood cells are seen in the urine when viewed under a microscope. Also, blood tests aimed at measuring kidney function may show abnormalities.

Chest x rays are used to determine if the lungs are involved. **Computed tomography scans** (CT scans) of sinuses and lungs, and **kidney biopsy**, are also important tools used in diagnosing WG.

A specific type of antibody called anti-neutrophil cytoplasmic antibody (ANCA) is seen in the blood of about 90% of the patients with WG. The ANCA are a group of antibodies directed against the individual's own white blood cells (namely, the neutrophils). These anti-neutrophil cytoplasmic antibodies are also found in other inflammatory conditions and diseases (such as HIV infection). Though the ANCA test is useful, it cannot be used by itself to make a diagnosis of WG. However, the amount of ANCA in the blood can be measured and correlates well with the progression of the disease. When there is a relapse or a flare-up, the ANCA levels go up. Levels decrease when the disease is controlled by appropriate treatment.

Since there are no definitive laboratory tests for WG, and the initial symptoms of the disease are not very specific, it takes five to 15 months, on an average, to make a diagnosis of WG.

Treatment

Cyclophosphamide (Cytoxan) which is an anti-cancer drug, and **corticosteroids**, such as prednisone, are used to treat WG. These are powerful drugs that suppress the immune system. However, they are also very toxic and can have serious side effects. The patient has to be watched carefully by the doctors and the dosage of the drugs has to be adjusted, if needed.

Since the patient's immune system is suppressed while on these drugs, he or she is at an increased risk for contracting infections. Vaccinations for flu and pneumonia are recommended.

Prognosis

In the past, approximately 80% of the patients with untreated WG died within a year of contracting the disease and 90% died within two years. Today, however, the prognosis has been dramatically improved. With appropriate treatment, patients can survive for much longer periods and lead relatively normal lives.

Approximately 50% of the patients with WG will have a relapse of the disease. This generally happens within two years of stopping the medication, but can occur at any point either during treatment or after stopping treatment. Therefore, it is extremely important that patients continue to see their doctors regularly even after stopping the medications.

KEY TERMS

Auto-antibodies—An antibody that is produced in, and reacts with, an antigen in the same person or animal.

Autoimmune disease—Any disease which causes tissue injury due to an immunological reaction of antibodies against the patient's own tissues.

Granulomatous—Resembling a tumor made of granular material.

Immune complexes—Clusters or aggregates of antigen and antibody bound together.

Vasculitis—Inflammation of the walls of the blood vessels.

Prevention

At present, there are no preventive measures known for Wegener's granulomatosis.

Resources

BOOKS

Harrison's Principles of Internal Medicine. Ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Merck Manual of Diagnosis and Therapy. 17th ed. Ed. Robert Berkow, et al. Rahway, NJ: Merck Research Laboratories, 1997.

ORGANIZATIONS

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Wegener's Foundation, Inc. 3705 South George Mason Drive, Suite 1813 South, Falls Church, VA 22041. (703) 931-5852.

Wegener's Granulomatosis Support Group, Inc. P.O. Box 28660, Kansas City, MO 64188-8660. (800) 277-9474. <http://www.wgsg.org/wgsg>.

Lata Cherath, PhD

Weil's disease *see* **Leptospirosis**

Wermer's syndrome *see* **Multiple endocrine neoplasia syndromes**

Wernicke-Korsakoff disease *see* **Alcohol-related neurologic disease**

Western equine encephalitis *see* **Arbovirus encephalitis**

Western herbalism *see* **Herbalism, western**

Wheezing

Definition

Wheezing is a high-pitched whistling sound associated with labored breathing.

Description

Wheezing occurs when a child or adult tries to breathe deeply through air passages that are narrowed or filled with mucus as a result of:

- allergy
- infection
- illness
- irritation

Wheezing is most common when exhaling. It is sometimes accompanied by a mild sensation of tightness in the chest. **Anxiety** about not being able to breathe easily can cause muscle tension that makes matters worse.

Causes and symptoms

Wheezing is the symptom most associated with **asthma**. It can be caused by:

- exposure to allergens (food, pollen, and other substances, that cause a person to have an allergic reaction)
- fumes
- ice-cold drinks, or very cold air
- medication
- strenuous **exercise**
- weather changes.
- foreign objects trapped in the airway
- cystic fibrosis, and other genetic disorders
- respiratory illnesses like **pneumonia**, **bronchitis**, congestive **heart failure**, and **emphysema**

Diagnosis

A family physician, allergist, or pulmonary specialist takes a medical history that includes questions about **allergies**, or unexplained symptoms that may be the result of allergic reactions. If the pattern of the patient's symptoms suggests the presence of allergy, skin and blood tests are performed to identify the precise nature of the problem.

A **pulmonary function test** may be ordered to measure the amount of air moving through the patient's breathing passages. X rays are sometimes indicated for patients whose wheezing seems to be caused by chronic bronchitis or emphysema.

Treatment

Mild wheezing may be relieved by drinking plenty of juice, water, weak tea, and broth. Ice-cold drinks should be avoided.

A vaporizer can help clear air passages. A steam tent, created by lowering the face toward a sink filled with hot water, placing a towel over the head and sink, and inhaling the steam, can do likewise.

Bronchodilators (medications that help widen narrowed airways) may be prescribed for patients whose wheezing is the result of asthma.

Antibiotics are generally used to cure acute bronchitis and other respiratory infections. **Expectorants** cough-producing medications) or bronchodilators are prescribed to remove excess mucus from the breathing passages.

If wheezing is caused by an allergic reaction, **antihistamines** will probably be prescribed to neutralize body chemicals that react to the allergen.

Medical emergencies

Breathing problems can be life-threatening. Immediate medical attention is required whenever an individual:

- turns blue or gray and stops breathing
- becomes extremely short of breath, and is unable to speak
- coughs up bubbly-pink or white phlegm
- seems to be suffocating
- develops a **fever** of 101°F (38.3°C) or higher
- wheezes most of the time, and coughs up gray or greenish phlegm

Alternative treatment

Certain **yoga** positions (Bridge, Cobra, Pigeon, and Sphinx) may relieve wheezing by improving breathing

control and reducing **stress**. Patients whose wheezing is related to asthma, chronic bronchitis, emphysema, or a severe allergic reaction may benefit from these techniques, but must continue to have their condition monitored by a conventional physician.

Prognosis

Mild wheezing caused by infection or acute illness usually disappears when the underlying cause is eliminated.

Some doctors believe that childhood respiratory infections may activate parts of the immune system that prevent asthma from developing.

Prevention

Stopping **smoking** can eliminate wheezing. So can reducing or preventing exposure to other substances that cause the problem.

Resources

BOOKS

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

OTHER

"Kids in Daycare Three Times as Likely to Have Wheezing Illnesses." Americal Lung Assiciation Page. 16 May 1998 <http://www.lungusa.org>.

"Wheezing." University of Michigan Health System Page. 7 May 1998 <http://www.mcare2.org/healthtips/homecare/wheezing.htm>.

"Wheezing." WebMD. 17 May 1998 <http://my.webmd.com/index>.

Maureen Haggerty

Whiplash

Definition

Whiplash is a sudden, moderate-to-severe strain affecting the bones, discs, muscles, nerves, or tendons of the neck.

Description

The neck is composed of seven small bones. Known as the cervical spine, these bones:

- support the head
- help maintain an unobstructed enclosure for the spinal cord
- influence the shape and structure of the spine
- affect posture and balance

About 1,000,000 whiplash injuries occur in the United States every year. Most are the result of motor vehicle accidents or collisions involving contact sports. When unexpected force jerks the head back, then forward the bones of the neck snap out of position and irritated nerves can interfere with flow of blood and transmission of nerve impulses. Pinched nerves can damage or destroy the function of body parts whose actions they govern.

Risk factors

Osteoarthritis of the spine increases the risk of whiplash injury. So do poor driving habits, driving in bad weather, or driving when tired, tense, or under the influence of alcohol or other drugs.

Causes and symptoms

Tension shortens and tightens muscles. **Fatigue** relaxes them. Either condition increases the likelihood that whiplash will occur and the probability that the injury will be severe.

Sometimes symptoms of whiplash appear right away. Sometimes they do not develop until hours, days, or weeks after the injury occurs. Symptoms of whiplash include:

- **pain** or stiffness in the neck, jaw, shoulders, or arms
- dizziness
- headache
- loss of feeling in an arm or hand
- nausea and vomiting

Depression and vision problems are rare symptoms of this condition.

Diagnosis

Whiplash is difficult to diagnose because x rays and other imaging studies do not always reveal changes in bone structure. Organs affected by nerve damage or reduced blood supply may generate symptoms not clearly related to whiplash.

Diagnosis is based on observation of the patient's symptoms, medical history, **physical examination**, and neurological studies to determine whether the spine has been injured.

Treatment

Medication, physical therapy, and supportive measures are used to treat whiplash. Chiropractors gently realign the spine to relax pinched nerves or improve blood flow. A patient whose symptoms are severe may

wear a soft, padded collar (Thomas collar or cervical collar) until the pain diminishes.

When pressure on the root of the nerve causes loss of strength or sensation in a hand or arm, a cervical **traction** apparatus may be recommended.

Self-care

Inflammation and cramping can be alleviated by wrapping ice or an ice pack in a thin towel and applying it to the injured area for 10-20 minutes every hour. After the first 24 hours, painful muscle spasms can be prevented by alternating cold packs with **heat treatments**. Letting a warm shower run on the neck and shoulders for 10-20 minutes twice a day is recommended. Between showers, warm towels or a heat lamp should be used to warm and soothe the neck for 10-15 minutes several times a day.

Improving posture is important, and gentle massage can be beneficial. Sleeping without a pillow promotes healing, and a cervical collar or small rolled towel pinned under the chin can provide support and prevent muscle fatigue.

Alcohol should be avoided. A chiropractor, primary care physician, or orthopedic specialist should be notified whenever a painful neck injury occurs. Another situation requiring attention is if the face or arm weaken or become painful or numb following a neck injury.

Prognosis

With treatment, whiplash can usually be cured in one week to three months after injury occurs. If nerve roots are damaged, numbness and weakness may last until recovery is complete.

Prevention

Chiropractors can recommend diet and **exercise** techniques to reduce **stress** and tension. Careful, defensive driving, wearing seatbelts, and using padded automobile headrests can lessen the likelihood of whiplash.

Resources

PERIODICALS

Sturzenegger, M., et al. "Presenting Symptoms and Signs after Whiplash Injury: The Influence of Accident Mechanisms." *Neurology* 44 (1994): 688.

OTHER

"Whiplash." ThriveOnline. 6 June 1995 <http://thriveonline.oxygen.com>.

"Whiplash." Loyola University Health System. 6 June 1998 <http://www.luhs.org>.

Haggerty, Maureen. "Whiplash." A Healthy Me Page. 7 June 1998 <http://www.ahealthyme.com/topic/topic100587681>.

Maureen Haggerty

Whipple's disease *see* **Malabsorption syndrome**

White blood cell count and differential

Definition

The white blood cell count and differential determine the number of white blood cells and the percentage of each type of white blood cell in a person's blood. These tests are included in general health examinations and help investigate a variety of illnesses, including infection, allergy, and leukemia.

Purpose

The white blood cell count provides a clue to the presence of illness. White cells protect the body by fighting infection and attacking foreign material. When extra white cells are needed, the bone marrow increases production.

There are five types of white cells, each with different functions: neutrophils, lymphocytes, monocytes, eosinophils, and basophils. The differential reveals if these cells are present in a normal distribution, or if one cell type is increased or decreased. This information helps diagnose specific types of illness.

Conditions or medications that weaken the immune system, such as **AIDS** or **chemotherapy**, cause a decrease in white cells. The white cell count detects dangerously low numbers of white cells.

Recovery from illness can be monitored by the white cell count. Counts continuing to rise or fall to abnormal levels indicate a worsening condition; counts returning to normal indicate improvement.

Description

Neutrophils increase in response to bacterial infection. They destroy bacteria by enveloping and digesting them, a process called phagocytosis. When many neutrophils are needed, they are released from the bone marrow as immature cells, called bands or stab cells.

Lymphocytes fight viral infections and some bacterial infections. Certain lymphocytes directly attack invading microorganisms; others produce antibodies that attack and destroy microorganisms and other foreign material. Large lymphocytes, called atypical lympho-

cytes, are seen during **infectious mononucleosis** and other illnesses.

Monocytes increase during severe infections, and other conditions. They remove debris and microorganisms by phagocytosis. Eosinophils and basophils increase in response to allergic reactions and parasitic infection.

White cell counts are usually done on an automated instrument. A sample of blood is mixed with a chemical to burst the red blood cells. The remaining white cells are counted by the instrument.

The differential is done by spreading a drop of blood on a microscope slide. The slide is stained with a special stain and examined under a microscope. One-hundred white cells are counted and identified as either neutrophils, bands, lymphocytes, monocytes, eosinophils or basophils. Any atypical or immature cells also are counted. Cells are identified by the shape and appearance of the nucleus, the color of cytoplasm (the background of the cell), and the presence and color of granules. The percentage of each cell type is reported. At the same time, red cells and platelets are examined for abnormalities in appearance. Some instruments perform an automated differential.

Both the white blood cell count (also called white count or leukocyte count) and the differential (also called diff) are covered by insurance. Results are available the same day.

Preparation

This test requires 7 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site. Pressure to the puncture site until the bleeding stops reduces bruising; warm packs relieve discomfort. The person may feel dizzy or faint.

Normal results

Total white cell count 5,000-10,000/µL. Neutrophils 50-60%. Lymphocytes 20-40%. Monocytes 2-6%. Eosinophils 1-4%. Basophils 0.5-1%. Bands 0-3%.

Abnormal results

The white cell count and differential are interpreted according to a person's clinical condition and medical history. **Leukocytosis** (a white count increased to over 10,000/µL) is seen in bacterial infections, inflammation, leukemia, trauma, and **stress**. Leukopenia (a white count decreased to less than 4,000/µL) is seen in some viral infections or severe bacterial infections, and conditions that affect the bone marrow such as dietary deficiencies, chemotherapy, **radiation therapy**, and autoimmune diseases.

KEY TERMS

Band—Immature neutrophil.

Basophil—White blood cell that increases in response to parasitic infections and allergic reactions.

Differential—Blood test that determines the percentage of each type of white blood cell in a person's blood.

Eosinophil—White blood cell that increases in response to parasitic infections and allergic reactions.

Leukocytosis—A white count increased to over 10,000/μL.

Leukopenia—A white count decreased to less than 4,000/μL.

Lymphocyte—White blood cell that fights viral and some bacterial infections by direct attack or the production of antibodies.

Monocyte—White blood cell that increases during a variety of conditions including severe infections. It removes debris and microorganisms by phagocytosis.

Neutrophil—White blood cell that increases in response to bacterial infection. It removes and kills bacteria through phagocytosis.

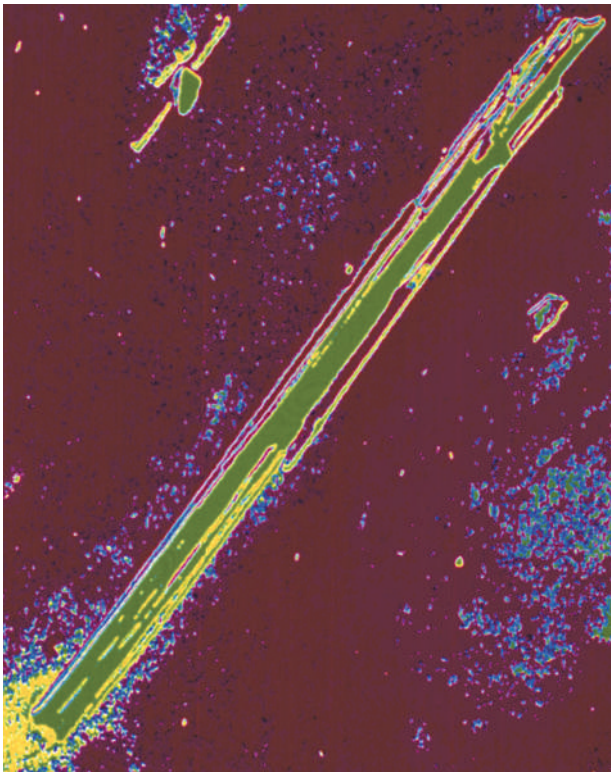
Phagocytosis—A process by which a white blood cell envelopes and digests debris and microorganisms to remove them from the blood.

Nancy J. Nordenson

Whooping cough

Definition

Whooping **cough**, also known as pertussis, is a highly contagious disease which causes classic spasms



A magnified image of a pertussis toxin crystal that causes whooping cough. *(National Institutes of Health/Custom Medical Stock Photo. Reproduced by permission.)*

(paroxysms) of uncontrollable coughing, followed by a sharp, high-pitched intake of air which creates the characteristic "whoop" of the disease's name.

Description

Whooping cough is caused by a bacteria called *Bordatella pertussis*. *B. pertussis* causes its most severe symptoms by attaching itself to those cells in the respiratory tract which have cilia. Cilia are small, hair-like projections that beat continuously, and serve to constantly sweep the respiratory tract clean of such debris as mucus, bacteria, viruses, and dead cells. When *B. pertussis* interferes with this normal, janitorial function, mucus and cellular debris accumulate and cause constant irritation to the respiratory tract, triggering coughing and increasing further mucus production.

Whooping cough is a disease which exists throughout the world. While people of any age can contract whooping cough, children under the age of two are at the highest risk for both the disease and for serious complications and **death**. Apparently, exposure to *B. pertussis* bacteria earlier in life gives a person some immunity against infection with it later on. Subsequent infections resemble the **common cold**.

Causes and symptoms

Whooping cough has four somewhat overlapping stages: incubation, catarrhal stage, paroxysmal stage, and convalescent stage.

An individual usually acquires *B. pertussis* by inhaling droplets infected with the bacteria coughed into the air by someone already suffering with the infection. Incubation is the symptomless period of seven to 14 days after breathing in the *B. pertussis* bacteria, and during which the bacteria multiply and penetrate the lining tissues of the entire respiratory tract.

The catarrhal stage is often mistaken for an exceedingly heavy cold. The patient has teary eyes, sneezing, **fatigue**, poor appetite, and an extremely runny nose (rhinorrhea). This stage lasts about 10-14 days.

The paroxysmal stage, lasting two to four weeks, begins with the development of the characteristic whooping cough. Spasms of uncontrollable coughing, the "whooping" sound of the sharp inspiration of air, and vomiting are all hallmarks of this stage. The whoop is believed to occur due to inflammation and mucous which narrow the breathing tubes, causing the patient to struggle to get air into his/her lungs; the effort results in intense exhaustion. The paroxysms (spasms) can be induced by over activity, feeding, crying, or even overhearing someone else cough.

The mucus which is produced during the paroxysmal stage is thicker and more difficult to clear than the more watery mucus of the catarrhal stage, and the patient becomes increasingly exhausted attempting to clear the respiratory tract through coughing. Severely ill children may have great difficult maintaining the normal level of oxygen in their systems, and may appear somewhat blue after a paroxysm of coughing, due to the low oxygen content of their blood. Such children may also suffer from swelling and degeneration of the brain (encephalopathy), which is believed to be caused both by lack of oxygen to the brain during paroxysms, and also by bleeding into the brain caused by increased pressure during coughing. Seizures may result from decreased oxygen to the brain. Some children have such greatly increased abdominal pressure during coughing that hernias result (hernias are the abnormal protrusion of a loop of intestine through a weak area of muscle). Another complicating factor during this phase is the development of **pneumonia** from infection with another bacterial agent; the bacteria takes hold due to the patient's already-weakened condition.

If the patient survives the paroxysmal stage, recovery occurs gradually during the convalescent stage, usually taking about three to four weeks. However, spasms of coughing may continue to occur over a period of months, especially when a patient contracts a cold, or other respiratory infection.

Diagnosis

Diagnosis based just on the patient's symptoms is not particularly accurate, as the catarrhal stage may appear to be a heavy cold, a case of the flu, or a simple **bronchitis**. Other viruses and **tuberculosis** infections can cause symptoms similar to those found during the paroxysmal stage. The presence of a pertussis-like cough along with an increase of certain specific white blood cells (lymphocytes) is suggestive of pertussis (whooping cough). However, cough can occur from other pertussis-like viruses. The most accurate method of diagnosis is to culture (grow on a laboratory plate) the organisms obtained from swabbing mucus out of the nasopharynx (the breathing tube continuous with the nose). *B. pertussis* can then be identified by examining the culture under a microscope.

Treatment

Treatment with the antibiotic erythromycin is helpful only at very early stages of whooping cough, during incubation and early in the catarrhal stage. After the cilia and the cells bearing those cilia, are damaged, the process cannot be reversed. Such a patient will experience the full progression of whooping cough symptoms; symptoms will only improve when the old, damaged lining cells of the respiratory tract are replaced over time with new, healthy, cilia-bearing cells. However, treatment with erythromycin is still recommended, to decrease the likelihood of *B. pertussis* spreading. In fact, all members of the household where a patient with whooping cough lives should be treated with erythromycin to prevent the spread of *B. pertussis* throughout the community. The only other treatment is supportive, and involves careful monitoring of fluids to prevent **dehydration**, rest in a quiet, dark room to decrease paroxysms, and suctioning of mucus.

Prognosis

Just under 1% of all cases of whooping cough cause death. Children who die of whooping cough usually have one or more of the following three conditions present:

- severe pneumonia, perhaps with accompanying encephalopathy
- extreme weight loss, weakness, and metabolic abnormalities due to persistent vomiting during paroxysms of coughing
- other pre-existing conditions, so that the patient is already in a relatively weak, vulnerable state (such conditions may include low birth weight babies, poor **nutrition**, infection with the **measles** virus, presence of other respiratory or gastrointestinal infections or diseases)

KEY TERMS

Cilia—Tiny, hair-like projections from a cell. In the respiratory tract, cilia beat constantly in order to move mucus and debris up and out of the respiratory tree, in order to protect the lung from infection or irritation by foreign bodies.

Encephalopathy—Swelling and degeneration of the brain.

Prevention

The mainstay of prevention lies in programs similar to the mass immunization program in the United States which begins immunization inoculations when infants are two months old. The pertussis vaccine, most often given as one immunization together with **diphtheria** and **tetanus**, has greatly reduced the incidence of whooping cough. Unfortunately, there has been some concern about serious neurologic side effects from the vaccine itself. This concern led huge numbers of parents in England, Japan, and Sweden to avoid immunizing their children, which in turn has led to major epidemics of disease in those countries. However, several carefully constructed research studies have disproved the idea that the pertussis vaccine is the cause of neurologic damage. Furthermore, a newer formulation of the pertussis vaccine is available. Unlike the old whole cell pertussis vaccine, which is composed of the entire bacterial cell which has been deactivated (and therefore unable to cause infection), the newer acellular pertussis vaccine does not use a whole cell of the bacteria, but is made up of (between two and five) chemical components of the *B. pertussis* bacteria. The acellular pertussis vaccine appears to greatly reduce the risk of unpleasant reactions to the vaccine, including high **fever** and discomfort following **vaccination**.

Resources

BOOKS

"Pertussis." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Jenkinson, Douglas. "Natural Course of 500 Consecutive Cases of Whooping Cough: A General Practice Population Study." *British Medical Journal* 310, no. 6975 (4 Feb. 1995): 299+.

Rosalyn Carson-DeWitt, MD

Wilderness medicine

Definition

Wilderness medicine encompasses the prevention, diagnosis, and treatment of injuries and medical conditions that may occur during activities in remote territories.

Purpose

Activities that may require wilderness medicine include backpacking, cross-country skiing, mountaineering, white water rafting, scuba diving, and exploration in undeveloped regions such as deserts or jungles. Wilderness medicine has evolved to deal with situations in which definitive medical care is hours or days away, and in which patients may require quick or extended attention. Wilderness medicine utilizes first aid techniques, but requires additional skills that take into account demanding environments, uncommon threats to health, hazardous or lengthy travel to medical facilities, and difficulties in obtaining food, water, and shelter.

Wilderness medicine uses techniques to assess and treat a variety of conditions and injuries, including:

- **wounds** and **burns**
- external and internal bleeding
- cardiac arrest
- head injuries
- spinal cord injuries
- **fractures** and dislocations
- **altitude sickness**
- problems from cold and heat
- allergic and anaphylactic reactions
- lightning strikes
- near drowning
- insect, reptile and animal bites
- poisoning
- emergency child birth

Precautions

In wilderness situations caregivers should follow the maxim of *first, do no harm*. Uninjured members of groups should not attempt rescues that place themselves in danger. People administering first aid or wilderness medicine should remain calm and organized at all times. Only those with experience should administer medications and medical procedures. Injured people should not be moved until they are fully evaluated, or unless environmental conditions are threatening and require immediate shelter.

People with certain medical conditions should avoid travel in the wilderness, which can make existing conditions worse. These conditions include metastatic **cancer**, peptic ulcers, **coronary artery disease**, chronic obstructive pulmonary disease, clotting or bleeding disorders, high-altitude sickness, chronic **rheumatoid arthritis**, chronic severe back **pain**, and chronic knee and hip joint disease.

Description

The first stage of wilderness medicine begins with an assessment of the injury or condition. Primary assessment is used to quickly determine if a patient is in a life-threatening situation and to provide immediate emergency care. Secondary assessment is the thorough evaluation of a patient after life-threatening circumstances are relieved.

Primary assessment

A rule of thumb for the first steps of primary assessment, recommended by the Wilderness Medicine Institute, is the ABCDE procedure. It stands for Airway, Breathing, Circulation, Disability, and Exposure assessment. First, a patient's airway should be checked by close observation of whether or not air can move in and out and any obstructions to breathing should be alleviated. In unconscious people the tongue can often fall to the back of the throat and block breathing and the head should be tilted back and the lower jaw raised to alleviate the obstruction. If neck or spinal cord injuries are suspected, the head must be handled with extreme care to avoid further injury to the delicate spinal cord. In these cases, the lower jaw can be pulled forward to open the airway. If the neck is severely out of alignment due to an injury or fall, it may be gently realigned to free the airway.

After the airway is cleared and breathing is ensured, a patient's circulation is checked by noting the pulse of the carotid artery, on the neck, the pulse of the femoral artery in the front groin, and by listening to the heartbeat. If pulse is lacking, **cardiopulmonary resuscitation** (**CPR**) may be required, which requires chest compression and mouth-to-mouth breathing. Circulation checks include surveying a patient for bleeding. If severe bleeding is present, it should be stopped by direct pressure to the injured area, and by elevating the wound level to the heart if possible.

Disability assessment means checking for damage to the spinal cord, particularly in the cervical region of the neck. Assessment of exposure determines if environmental conditions, such as heat or cold, are immediate threats to a patient's life, which may require actions such as seeking shelter or covering the patient with protective clothing.

Secondary assessment

During this stage, a thorough **physical examination** of the patient is made from head to toe to determine the extent of injuries or problems. Caretakers performing the assessment should write detailed notes in order to inform physicians or emergency workers later. Patients are thoroughly interviewed to determine the scope of problems and any previous medical issues that might be related. Patients should be spoken to calmly to determine their mental states and how well they respond to stimuli. Vital signs such as heart rate and respiration rate should be noted and monitored. The skin should be carefully observed for injuries, **boils**, **rashes**, and discoloration. Red or flushed skin may indicate **fever** or heat-related conditions, while pale or blotchy skin can point to **shock** or **hypothermia**. A bluish tint to the skin may mean a lack of oxygen. Contact lenses should be removed from patients in cold conditions, as they can freeze to the eyes. During secondary assessment the patient should be closely monitored over time until improvement is noted or further treatment decisions are made. At all times in wilderness injuries, shock must be watched for and immediately treated.

Shock

In wilderness situations shock should be suspected after traumatic injuries, significant loss of blood due to internal or external bleeding, extreme loss of fluids from vomiting or **diarrhea**, heart attacks, and spinal cord injuries. Shock is easiest to alleviate when it is treated early; when not treated properly, it can progress to unconsciousness and **death**. When the likelihood of shock occurs, patients should be continually monitored and supported.

Symptoms of shock begin with **anxiety** and restlessness, with increased heart rates and labored, shallow breathing. Shock victims tend to sweat profusely with cool and clammy skin. Thirst and nausea are also symptoms.

Shock is treated in the wilderness by maintaining an open airway for the patient to breathe, by treating any injuries such as bleeding wounds, by reducing pain if possible, and by replenishing fluids. Patients should be kept calm and warm and their feet should be elevated if possible to increase blood flow to the organs. If shock symptoms progress, plans should be quickly made to get help or evacuate the patient.

Evacuation

Evacuation of a patient may be a crucial decision in the wilderness, depending upon the severity of an injury or condition, the difficulty of moving the patient, the time considerations involved, and the availability of outside help. In general if a patient with severe symptoms is not improving despite care then evacuation becomes necessary. The Wilderness Medical Society lists symptoms that require postponing travel or evacuating patients:

- progressive deterioration with symptoms of **dizziness**, **fainting**, abnormally slow (bradycardia) or fast (tachycardia) heart rate, labored breathing, poor mental status, progressive weakness, constant vomiting or diarrhea, intolerance of oral fluids, or recurrent loss of consciousness due to head injuries
- debilitating pain
- inability to sustain pace due to medical problems
- passage of blood by mouth or rectum
- symptoms of serious high-altitude illness
- infections that get worse despite treatment
- chest pain that is not musculoskeletal in origin
- psychological status threatening the individual or group

If a patient cannot be moved without risk of further injury, then other members of a party, preferably two or more, should be sent to get outside help. When requesting outside assistance, the safety of incoming rescuers and time constraints should be weighed. Requests for outside help should be made in writing, and include an assessment of the patient and situation as well as a detailed location of the incident. In some regions, helicopter evacuation may be an option, and should be used if an injury is life-threatening.

During evacuation patients must be handled with extreme care, as well as insulated from heat, cold and further injuries. Larger wilderness expeditions may have special devices available for transporting injured members, while smaller parties may have to improvise transporting devices by using backpacks, ropes and other available materials.

Wounds and burns

In wilderness situations wound management strives to stop bleeding, prevent infection, and speed healing. Bleeding from wounds should be controlled by direct pressure. Wounds and burns should be cleaned gently and thoroughly, treated with antibiotic ointment, and covered with bandages to avoid infections. Wounds that have high risks of infections, such as large cuts, open fractures, and animal bites, should be watched closely.

External and internal bleeding

External bleeding should be stopped by direct pressure, such as firmly applying a clean bandage or compress

to an open wound. Secondary pressure may be applied to pressure points, such as the large arteries in the upper arm or groin, to slow bleeding. Tourniquets are recommended only in life-threatening situations, as they can cause complications and infections. Symptoms of internal bleeding include dizziness, fainting, rapid heartbeat, weak pulse, **shortness of breath**, thirst, loss of color, vomiting blood, blood in the feces or urine, and severe pain or swelling in the abdomen. If internal bleeding is suspected, medical help should be sought immediately. With all cases of significant blood loss, shock must be carefully considered.

Cardiac arrest

Cardiac arrest in the wilderness may require CPR, although CPR is less effective in remote regions that lack access to the **life support** technology that ambulances quickly supply. CPR should be administered to patients who have suffered near drowning, hypothermia, lightning strikes, and drug overdoses. CPR generally should not be administered in the wilderness if it endangers the rescuers, if the time of the cardiac arrest is unknown, if the patient appears to be dead or rigor mortis has set in, or if cardiac arrest was caused by severe trauma or lethal injuries.

Head injuries

Head injuries that do not cause loss of consciousness in the victim are rarely dangerous. Short-term loss of consciousness following head injuries is known as **concussion**, and these patients should be closely monitored for 24 hours, including waking them every three hours during sleep to check for mental alertness. For head injuries that cause prolonged unconsciousness, the airway and cervical spine must be protected. Severe brain injury is indicated by relapses into unconsciousness, bad headaches, bleeding from the ears, clear fluid draining from the nose, vomiting, persistent disorientation, personality changes, seizures, irregular heartbeat and breathing, and unequal or unreactive pupils. Severe head injuries must be treated by seeking immediate medical help or evacuation.

Spinal cord injuries

If spinal cord injuries are suspected, patients must be immobilized. Some expeditions or rescue teams may carry special splints or vests in their medical kits. If no such equipment is available, *spineboards* may be fashioned from available materials such as backpacks, poles, or ice axes to prevent unnecessary movement of the injured backbone.

Fractures and dislocations

Wilderness care for fractures recommends **immobilization** by using splints and slings. If manufactured splints and slings are not available in the medicine kit, they can be improvised by using natural materials, ski poles, ice axes, clothing, or parts of backpacks. In the case of dislocations, standard wilderness procedure is to splint, tape and stabilize the injury in the current position. However, if circulation or nerve function is impaired, or if the injured person is in extreme pain, relocation may be necessary by realigning the injured area. Relocation is most effective if it is done immediately following the injury, before stiffness or muscle spasms set in.

Altitude sickness

Symptoms of altitude sickness include **headache**, nausea, **fatigue**, vomiting, and bluish skin. Ataxia, or loss of muscular control and balance indicates more severe altitude sickness. Altitude sickness can occur at altitudes above 8,000 feet. The best prevention of the condition is allowing plenty of time for acclimatization at high altitudes, drinking plenty of fluids, and eating a diet rich in carbohydrates. **Aspirin** or **acetaminophen** may be taken, while the drug acetazolamide (Diamox) can relieve symptoms of mild acute mountain sickness (AMS). Other related conditions, which can cause death, are high altitude cerebral **edema** (HACE), which causes fluid accumulation on the brain, and high altitude **pulmonary edema** (HAPE), which causes fluid in the lungs. The main treatment for acute mountain sickness is to rapidly descend to lower altitudes. In some cases oxygen may be available to ease symptoms.

Problems from cold and heat

Frostbite is localized tissue damage from exposure to cold, and is remedied by the slow warming of exposed parts, preferably in heated water. Hypothermia is the condition resulting from lowered body core temperature, and is a common affliction in wilderness medicine. Mild hypothermia occurs when the body's core temperature (measured rectally) falls from normal to 95°F (35°C) Fahrenheit. Moderate hypothermia gives temperatures between 90-95°F (32.2-35°C), while severe hypothermia occurs when a body's core temperature falls below 90°F (32.2°C). Symptoms include severe shivering, confusion, apathy, drowsiness, slurred speech, and impaired reflexes, and progresses to the point of unconsciousness.

Even cases of the mildest hypothermia must be cared for closely. Patients in whom hypothermia is suspected should be immediately warmed by gently removing wet clothing and providing dry clothing, blankets and shelter. They should be monitored for body temperature changes. Severe hypothermia cannot be remedied in the wilderness; victims must be immediately and gently evacuated. Warming severe hypothermia victims too

quickly is dangerous. Cardiopulmonary resuscitation (CPR) may be initiated on victims of severe hypothermia who have cardiac arrest. In cases of near drowning, hypothermia must always be suspected.

Illness from heat includes heat exhaustion and the more severe heat **stroke**. Symptoms include confusion, rapid weak pulse, cramps, dizziness, nausea, diarrhea, headache, and high measured temperatures. Sweating may or may not occur, and the skin may be clammy and blotched. The principle treatment for heat illness in the wilderness is immediate cooling of the patient, by providing shade, fanning, sponging and immersion in cold water. Heat exhaustion will correct itself with enough rest and water. Heat stroke is life threatening and requires immediate cooling and rehydration with fluids, preferably intravenous ones. Prevention of heat illness includes proper conditioning, protective clothing, and avoiding **dehydration**.

Insect, reptile, and animal bites

Wilderness medicine must deal with an array of **bites and stings**, from bears, snakes, reptiles, spiders, scorpions, bees, fish and ticks. Prevention includes knowledge of the threats in the region being explored, as well as packing appropriate supplies such as bee sting kits for anaphylactic shock and snakebite kits for venomous attacks. The goal of treatment is to stop bleeding, prevent infection, and alleviate envenomation, or exposure to poison. The Sawyer Extractor is a suction tool used to remove snake venom, while the Epipen and Anakit are available by prescription for anaphylactic shock due to stings and severe allergic reactions.

Preparation

Knowledge and sound planning can be the difference between success and disaster in the backcountry. Members of extended wilderness outings should undergo thorough examinations by their physicians and dentists prior to undertaking expeditions. People going on wilderness outings should begin in a state of sound physical fitness by undertaking appropriate conditioning programs, as well as becoming acclimatized to special conditions such as altitude or extreme temperatures. Those with medications should be aware of potential side effects and complications, and inform other members of their group. At least two, and preferably all, members of wilderness expeditions should be familiar with first aid, wilderness medicine and rescue procedures. All members of wilderness outings should carry appropriate clothing, equipment, food, water, and first aid supplies. Trip itineraries should be recorded with park rangers or other official services. Means of communication with rescue facilities should be considered in advance in case emergencies arise.

Carrying adequate medical supplies is a crucial preparation for wilderness outings. These supplies will vary depending on the length of the trip and the region. Medical kits should contain basic first aid supplies such as bandages, dressings, pain relievers, water purification tablets, sunscreen, **antiseptics**, and ointments. Additional medical supplies include **antibiotics**, medications for gastrointestinal problems, **antihistamines** and emergency kits for **asthma** or allergic reactions, snake and insect bite kits, splints, and basic surgical supplies. Extended expeditions or those facing extreme conditions might include intravenous fluids, oxygen bottles for altitude problems, rescue gear and evacuation equipment, and specific medications for regional diseases and infections, such as **malaria**.

Immunizations are a very important preparation for those entering wilderness areas, particularly in Third World countries. Immunizations should be planned as far in advance as possible, as some take several weeks to become effective and others cannot be given together. Some immunizations that may be required, depending on the region, include **tetanus**, poliovirus, **measles**, **mumps**, **rubella**, **cholera**, **yellow fever**, meningococcus, hepatitis, bubonic **plague**, **typhoid fever** and **rabies**. See Resources below for sources of specific immunization information.

Several organizations provide training and certification for various levels of wilderness medicine. The most basic levels of preparation are first aid and first responder certifications, followed by outdoor emergency care (OEC) training. More rigorous training provides the wilderness first responder (WFR), the wilderness emergency medical technician (WEMC), or the wilderness prehospital emergency care (WPHEC) certifications. The most advanced level of wilderness medical certification is search and rescue (SAR) emergency care, which provides expertise in a sophisticated array of rescue techniques and equipment.

Resources

BOOKS

Auerbach, Paul, MD. *Medicine for the Outdoors*. New York: The Lyons Press, 1999.

Bowman, Warren, MD. *Outdoor Emergency Care*. Lakewood, CO: National Ski Patrol, 1998.

Forgey, William, MD. *Wilderness Medical Society Practice Guidelines for Wilderness Emergency Care*. Merrillville, IN: ICS Books, 1995.

Tilton, Buck, and Frank Hubbell, DO. *Medicine for the Backcountry*. Old Saybrook, CT: Globe Pequot, 1994.

Wilkerson, James. *Medicine for Mountaineering and Other Wilderness Activities*. Seattle: The Mountaineers, 1992.

KEY TERMS

Anaphylactic shock—Severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

Cardiac arrest—Heart failure or heart attack.

Dislocation—Displacement of bones at a joint.

Envenomation—Exposure to venom by bites or stings from insects, reptiles, and fish.

Wilderness—Large backcountry areas lacking roads, communication and other modern infrastructure.

ORGANIZATIONS

International Association for Medical Assistance to Travelers (IAMAT). 417 Center St., Lewistown, NY 14092. (716) 754-4883.

U.S. Centers for Disease Control. 1600 Clifton Road NE, Atlanta, GA 30333. (404) 639-1610. <http://www.cdc.gov>. Publishes *Health Information for International Travel.*

Wilderness Medical Society. PO Box 2463, Indianapolis, IN 46204. (317) 631-1745.

Wilderness Medicine Institute. PO Box 9, 413 Main Street, Pitkin, CO 81241. (970) 641-3572. <http://www.wildernessmed.com>.

Douglas Dupler

Wilms' tumor

Definition

Wilms' tumor is a cancerous tumor of the kidney that usually occurs in young children.

Description

When an unborn baby is developing, the kidneys are formed from primitive cells. Over time, these cells become more specialized. The cells mature and organize into the normal kidney structure. Sometimes, clumps of these cells remain in their original, primitive form. If these cells begin to multiply after birth, they may ultimately form a large mass of abnormal cells. This is known as a Wilms' tumor.

Wilms' tumor is a type of malignant tumor. This means that it is made up of cells that are significantly immature and abnormal. These cells are also capable of invading nearby structures within the kidney and traveling out of the kidney into other structures. Malignant cells can even travel through the body to invade other organ systems, most commonly the lungs and brain. These features of Wilms' tumor make it a type of **cancer** that, without treatment, would eventually cause **death**. However, advances in medicine during the last 20 years have made Wilms' tumor a very treatable form of cancer.

Wilms' tumor occurs almost exclusively in young children. The average patient is about three years old. Females are only slightly more likely than males to develop Wilms' tumors. In the United States, Wilms' tumor occurs in 8.3 individuals per million in white children under the age of 15 years. The rate is higher among African-Americans and lower among Asian-Americans. Wilms' tumors are found more commonly in patients with other types of **birth defects**. These defects include:

- absence of the colored part (the iris) of the eye (aniridia)
- enlargement of one arm, one leg, or half of the face (hemihypertrophy)
- certain birth defects of the urinary system or genitals
- certain genetic syndromes (WAGR syndrome, Denys-Drash syndrome, and Beckwith-Wiedemann syndrome)

Causes and symptoms

The cause of Wilms' tumor is not completely understood. Because 15% of all patients with this type of tumor have other heritable defects, it seems clear that at least some cases of Wilms' tumor may be due to an herited alteration. It appears that the tendency to develop a Wilms' tumor can run in families. In fact, about 1.5% of all children with a Wilms' tumor have family members who have also had a Wilms' tumor. The genetic mechanisms associated with the disease are unusually complex.

Some patients with Wilms' tumor experience abdominal **pain**, nausea, vomiting, high blood pressure, or blood in the urine. However, the parents of many children with this type of tumor are the first to notice a firm, rounded mass in their child's abdomen. This discovery is often made while bathing or dressing the child and frequently occurs before any other symptoms appear. Rarely, a Wilms' tumor is diagnosed after there has been bleeding into the tumor, resulting in sudden swelling of the abdomen and a low red blood cell count (anemia).

About 5% of Wilms' tumor cases involve both kidneys during the initial evaluation. The tumor appears on either side equally. When pathologists look at these tumor cells under the microscope, they see great diversity in the types of cells. Some types of cells are associated

with a more favorable outcome in the patient than others. In about 15% of cases, physicians find some degree of cancer spread (metastasis). The most common sites in the body where metastasis occurs are the liver and lungs.

Researchers have found evidence that certain types of lesions occur before the development of the Wilms' tumor. These lesions usually appear in the form of stromal, tubule, or blastemal cells.

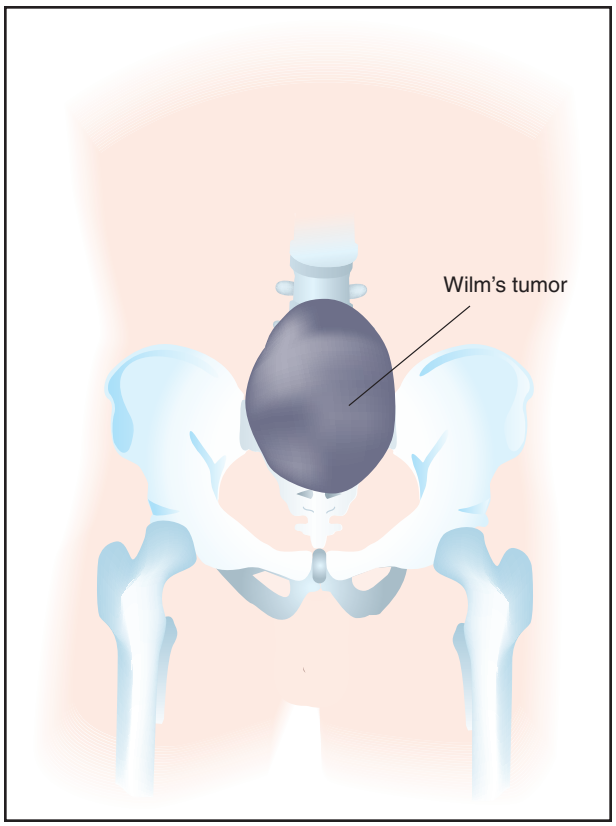
Diagnosis

Children with Wilms' tumor generally first present to physicians with a swollen abdomen or with an obvious abdominal mass. The physician may also find that the child has **fever**, bloody urine, or abdominal pain. The physician will order a variety of tests before imaging is performed. These tests mostly involve blood analysis in the form of a white blood cell count, complete **blood count**, **platelet count**, and serum calcium evaluation. Liver and kidney function testing will also be performed as well as a **urinalysis**.

Initial diagnosis of Wilms' tumor is made by looking at the tumor using various imaging techniques. Ultrasound and **computed tomography scans** (CT scans) are helpful in diagnosing Wilms' tumor. Intravenous pyelography, where a dye injected into a vein helps show the structures of the kidney, can also be used in diagnosing this type of tumor. Final diagnosis, however, depends on obtaining a tissue sample from the mass (biopsy), and examining it under a microscope in order to verify that it has the characteristics of a Wilms' tumor. This biopsy is usually done during surgery to remove or decrease the size of the tumor. Other studies (chest x rays, CT scan of the lungs, bone marrow biopsy) may also be done in order to see if the tumor has spread to other locations.

Treatment

Treatment for Wilms' tumor almost always begins with surgery to remove or decrease the size of the kidney tumor. Except in patients who have tumors in both kidneys, this surgery usually will require complete removal of the affected kidney. During surgery, the surrounding lymph nodes, the area around the kidneys, and the entire abdomen will also be examined. While the tumor can spread to these surrounding areas, it is less likely to do so compared to other types of cancer. In cases where the tumor affects both kidneys, surgeons will try to preserve the kidney with the smaller tumor by removing only a portion of the kidney, if possible. Additional biopsies of these areas may be done to see if the cancer has spread. The next treatment steps depend on whether/where the cancer has spread. Samples of the tumor are also examined under a microscope to determine particular characteristics of the cells making up the tumor.



Wilm's tumor. *(Illustration by Argosy, Inc.)*

Information about the tumor cell type and the spread of the tumor is used to decide the best kind of treatment for a particular patient. Treatment is usually a combination of surgery, medications used to kill cancer cells (**chemotherapy**), and x rays or other high-energy rays used to kill cancer cells (**radiation therapy**). These therapies are called adjuvant therapies, and this type of combination therapy has been shown to substantially improve outcome in patients with Wilms' tumor. It has long been known that Wilms' tumors respond to radiation therapy. Likewise, some types of chemotherapy have been found to be effective in treating Wilms' tumor. These effective drugs include dactinomycin, doxorubicin, vincristine, and cyclophosphamide. In rare cases, **bone marrow transplantation** may be used.

The National Wilms' Tumor Study Group has developed a staging system to describe Wilms' tumors. All of the stages assume that surgical removal of the tumor has occurred. Stage I involves "favorable" Wilms' tumor cells and is usually treated successfully with combination chemotherapy involving dactinomycin and vincristine and without abdominal radiation therapy. Stage II tumors

KEY TERMS

Biopsy—A procedure in which a small sample of tissue is removed, prepared, and examined with a microscope to determine the characteristics of the tissue's cells.

Blastemal—An immature material from which cells and tissues develop.

Cancer—A process where abnormal cells within the body begin to grow out of control, acquire the ability to invade nearby structures, and travel through the bloodstream in order to invade distant structures.

Malignant—Refers to cancer or cancer cells.

Sarcoma—A type of cancer that originates from connective tissue such as bone or muscle.

Stromal—A type of tissue that is associated with the support of an organ.

Tubule—Tissues and cells associated with the structures that connect the renal pelvis to the glomeruli.

involving a favorable histology (cell characteristics) are usually treated with the same therapy as Stage I. Stage III tumors with favorable histology are usually treated with a combination chemotherapy with doxorubicin, dactinomycin, and vincristine along with radiation therapy to the abdomen. Stage IV disease with a favorable histology is generally treated with combination chemotherapy with dactinomycin, doxorubicin, and vincristine. These patients usually receive abdominal radiation therapy and lung radiation therapy if the tumor has spread to the lungs.

In the case of Stage II through IV tumors with unfavorable, or anaplastic, cells, then the previously-mentioned combination chemotherapy is used along with the drug cyclophosphamide. These patients also receive lung radiation therapy if the tumor has spread to the lungs. Another type of tumor cell can be present in Stages I through IV. This cell type is called clear cell sarcoma of the kidney. If this type of cell is present, then patients receive combination therapy with vincristine, doxorubicin, and dactinomycin. All of these patients receive abdominal radiation therapy and lung radiation therapy if the tumor has spread to the lungs.

Prognosis

The prognosis for patients with Wilms' tumor is quite good, compared to the prognosis for most types of cancer. The patients who have the best prognosis are usually those who have a small-sized tumor, a favorable cell type, are young (especially under two years old), and have an early stage of cancer that has not spread. Modern treatments have been especially effective in the treatment of this cancer. Patients with the favorable type of cell have a long-term survival rate of 93%, whereas those with anaplasia have a long-term survival rate of 43% and those with the sarcoma form have a survival rate of 36%.

Prevention

There are no known ways to prevent a Wilms' tumor, although it is important that children with birth defects associated with Wilms' tumor be carefully monitored.

Resources

BOOKS

Black, Timothy L. "Wilms' Tumor." In *Dambro: Griffith's 5-Minute Clinical Consult.* Philadelphia: J.B. Lippincott, 1999.

"Wilms' Tumor." In *Cancer: Principles and Practice of Oncology.* DeVita, Vincent Jr., et al, eds. Philadelphia: J. B. Lippincott Company, 2001.

Cecil Textbook of Medicine. Goldman, Lee, et al, eds. Philadelphia: W.B. Saunders Company, 2000.

PERIODICALS

Coppes, Max J., and Kathy Pritchard-Jones. "Principles of Wilms' Tumor Biology." *Urologic Clinics of North America* 27 (August 2000).

Neville, Holly L., and Michael L. Ritchey. "Wilms' Tumor." *Urologic Clinics of North America* 27 (August 2000).

ORGANIZATIONS

American Cancer Society. 1515 Clifton Rd. NE, Atlanta, GA 30329. (800) 227-2345. <http://www.cancer.org>.

March of Dimes Birth Defects Foundation, National Office. 1275 Mamaroneck Ave., White Plains, NY 10605. <http://www.modimes.org>.

Mark A. Mitchell, M.D.

Wilson disease

Definition

Wilson disease is a rare, inherited disorder that causes excess copper to accumulate in the body. Steadily increasing amounts of copper circulating in the blood are deposited primarily in the brain, liver, kidneys, and the cornea of the eyes.

Description

Under normal conditions, copper that finds its way into the body through the diet is processed within the

liver. This processed form of copper is then passed into the gallbladder, along with the other components of bile (a fluid produced by the liver, which enters the small intestine in order to help in digestive processes). When the gallbladder empties its contents into the first part of the small intestine (duodenum), the copper in the bile enters and passes through the intestine with the waste products of digestion. In healthy individuals, copper is then passed out of the body in stool.

In Wilson disease, copper does not pass from the liver into the bile, but rather begins to accumulate within the liver. As copper levels rise in the liver, the damaged organ begins to allow copper to flow into the bloodstream, where it circulates. Copper is then deposited throughout the body, building up primarily in the kidneys, the brain and nervous system, and the eyes. Wilson disease, then, is a disorder of copper **poisoning** occurring from birth.

Wilson disease affects approximately one in 30,000 to one in 100,000 individuals and can affect people from many different populations. Approximately one in 90 individuals are carriers of the gene for Wilson disease.

Causes and symptoms

Wilson disease is inherited in an autosomal recessive manner. Autosomal recessive refers to the pattern of inheritance where each parent carries a gene for the disease on one of his or her chromosome pairs. When each parent passes on the chromosome with the gene for Wilson disease, the child will be affected with the disease. Both males and females can be affected with Wilson disease. If an individual is a carrier of the Wilson disease gene they do not have any symptoms of this disease. In order to be affected, an individual must inherit two copies of the gene, one from each parent. Many cases of Wilson disease may not be inherited but occur as a spontaneous mutation in the gene.

The gene for Wilson disease is located on chromosome number 13. The name of the gene is called ATP7B and is thought to be involved in transporting copper. As of 2001, over 70 different mutations of this gene have been identified, making diagnosis by **genetic testing** difficult.

Symptoms typically present between the ages of three and 60 with age 17 considered to be the average age a diagnosis is made. About half of all patients experience their first symptoms in the liver. The illness causes swelling and tenderness of the liver, sometimes with **fever**, mimicking more common disorders, such as viral hepatitis and **infectious mononucleosis**. Abnormal levels of circulating liver enzymes reveal that the liver is being seriously damaged. This form of damage is referred to as "fatty degeneration." Without medical intervention, the liver damage will progress to actual **cirrhosis**. An often-fatal manifestation of liver disease is called fulminant hepatitis. This extremely severe inflammation of the liver (hepatitis) results in **jaundice**, fluid leaking into the abdomen, low protein circulating in the blood, abnormalities of the blood clotting system, swelling of the brain, and anemia due to the abnormal destruction of red blood cells.

Neurological symptoms are the first to occur in half of all patients due to copper accumulation in the brain and nervous system. The average age of onset for neurological symptoms is 21. These symptoms include **tremors** of the hands, uncontrollable movements of the limbs, stiffness, drooling, difficulty swallowing, difficulty talking, and **headache**. There is no change in patient's intelligence.

About one third of all patients with Wilson disease have a variety of psychiatric symptoms as the first signs of the disease. These symptoms include inability to cope, depression, irritability, increased anger, and inappropriate behavior. Often times patients have trouble completing tasks at work or in school.

Other symptoms that can affect patients with Wilson disease, and may occur before or after a diagnosis has been made include joint disorders, symptoms of arthritis and skeletal problems such as **osteoporosis**. Patients have occasionally been affected with **kidney stones**, abnormal handling of glucose in their body and women have menstrual cycle irregularities including stopping their regular cycle temporarily.

Diagnosis

The diagnosis of Wilson disease can be performed relatively easily through several different tests however because Wilson disease is so rare, diagnosis is often unfortunately delayed. The tests used to diagnose Wilson disease can be performed on patients who have and who have not already shown symptoms of the disease. It is extremely important to make a diagnosis as soon as possible since liver damage can occur before there are any signs of the disease.

An easy way to diagnose Wilson disease is to measure the amount of a glycoprotein found in the blood called ceruloplasmin. Low levels of ceruloplasmin can diagnose the disease in about 80% of affected patients. This procedure is not as effective for women taking birth control pills, pregnant women, or infants less than six months of age.

A second test involving an **eye examination** to detect a characteristic ring of copper deposited in a membrane of the cornea (referred to as Kayser-Fleischer rings)is very easy to perform and is very useful in diag-

KEY TERMS

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Bile—A substance produced by the liver, and concentrated and stored in the gallbladder. Bile contains a number of different substances, including bile salts, cholesterol, and bilirubin.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Cell—The smallest living units of the body which group together to form tissues and help the body perform specific functions.

Ceruloplasmin—A protein circulating in the bloodstream that binds with copper and transports it.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Cirrhosis—A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Gallbladder—A small, pear-shaped organ in the upper right hand corner of the abdomen. It is connected by a series of ducts (tube-like channels) to the liver, pancreas, and duodenum (first part of the small intestine). The gallbladder receives bile from the liver, and concentrates and stores it. After a meal, bile is squeezed out of the gallbladder into the intestine, where it aids in digestion of food.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Glucose—One of the two simple sugars, together with galactose, that makes up the protein, lactose, found in milk. Glucose is the form of sugar that is usable by the body to generate energy.

Hepatitis—A viral disease characterized by inflammation of the liver cells (hepatocytes). People infected with hepatitis B or hepatitis C virus are at an increased risk for developing liver cancer.

Jaundice—Yellowing of the skin or eyes due to excess of bilirubin in the blood.

Toxic—Poisoinous.

nosing patients who have already exhibited symptoms. This test is not as effective in persons without symptoms. This diagnostic test cannot be used by itself to make a diagnosis because some patients with liver disease but not Wilson disease will test positive.

A third test for diagnosing Wilson disease involves measuring the amount of copper in the liver. This can be accomplished by sampling a portion of the liver, called a biopsy. This is one of the most effective ways in which to diagnose Wilson disease, however the procedure itself is more difficult to perform than the others.

Other tests are also useful, for example measuring the amount of copper passed into the urine daily (high in Wilson disease). Another lab test measures the ability of a patient's ceruloplasmin to bind with a form of copper (decreased in Wilson disease). And finally, as discussed under genetic profile, some patients can be diagnosed through a DNA test to determine whether or not they carry two genes for Wilson disease. This test does not always provide to be useful in certain patients and is of most use when used to test the brothers and sisters of affected patients.

Treatment

Treatment involves life-long administration of either D-penicillamine or trientine hydrochloride. Both of these drugs remove copper deposits throughout the body by binding to the copper which is removed through the body in urine. Zinc acetate and a low copper diet are other ways in which to treat Wilson disease.

Penicillamine has a number of serious side effects:

- joint pain
- neurological problems
- systemic lupus erythematosus
- decreased production of all blood elements

• interference with clotting

• allergic reactions

Careful monitoring is necessary. When patients have side effects from penicillamine, the dose can sometimes be lowered to an effective level that causes fewer difficulties. Alternatively, steroid medications may be required to reduce certain sensitivity reactions. Trientine has fewer potential side effects, but must still be carefully monitored.

Treatment with zinc is also an effective way to remove excess copper from the body. Zinc is a metal that works to block copper absorption and bind copper in the intestinal cells until it is all released into the stool approximately one week later. The benefit of treatment with zinc is there are no toxic side effects however the zinc is a slower acting agent than the other drugs. It takes four to eight months for the zinc to be effective in reducing the overall amount of copper in the body.

Finally, patients with Wilson disease are encouraged to follow a diet low in copper, with an average copper intake of 1.0 mg/day. Foods to be avoided for the high levels of copper include liver and shellfish. Patients are also instructed to monitor their drinking water for excess levels of copper and drink distilled water instead.

Prognosis

Without treatment, Wilson disease is always fatal. With treatment, symptoms may continue to worsen for the first six to eight weeks. After this time, definite improvement should begin to be seen. However, it may take several years (two to five) of treatment to reach maximal benefit to the brain and liver. Even then, many patients are not returned to their original level of functioning. Patients with Wilson disease need to maintain some sort of anticopper treatment for the rest of their lives in order to prevent copper levels from rising in the body. Interruptions in treatment can result in a relapse of the disease which is not reversible, and can ultimately lead to **death**.

Resources

BOOKS

Scheinberg, I. Herbert. "Wilson's Disease." In *Harrison's Principles of Internal Medicine,* edited by Anthony S. Fauci, et al. 14th ed. New York: McGraw-Hill, 1998.

PERIODICALS

Gow, P.J., et al. "Diagnosis of Wilson's Disease: An Experience Over Three Decades." *Gut* 46(March 2000): 415-419.

Hariharan, Ramesh, and L. Fred Herbert. "Wilson's Disease." *Hospital Practice* 31(August 15, 1996)556+.

Robertson, W.M. "Wilson's Disease." *Archives of Neurology* 57, no. 2 (February 2000): 276-7.

ORGANIZATIONS

American Liver Foundation. 75 Maiden Lane, Suite 603, New York, NY 10038. (800) 465-4837 or (888) 443-7222. <http://www.liverfoundation.org>.

National Organization for Rare Disorders (NORD). PO Box 8923, New Fairfield, CT 06812-8923. (203) 746-6518 or (800) 999-6673. Fax: (203) 746-6481. <http://www.rarediseases.org>.

Wilson's Disease Association. 4 Navaho Dr., Brookfield, CT 06804. (800) 399-0266.

OTHER

Wilson's Disease Association. <http://www.medhelp.org/wda/wil.htm>.

Katherine S. Hunt

Wiskott-Aldrich syndrome

Definition

Wiskott-Aldrich syndrome (WAS) is a rare inherited disorder marked by a low level of blood platelets, eczema, recurrent infections, and a high risk of leukemia or lymph node tumors.

Description

WAS was named for the two physicians who first reported the disorder. In 1937, Dr. A. Wiskott, a physician working in Munich, described two affected boys of German ancestry who had repeated infections, a skin rash, and poor blood-clotting ability. Nearly twenty years later, Dr. R.A. Aldrich reported similar symptoms in members of an American family of Dutch ancestry.

WAS is inherited as an X-linked genetic disorder and will therefore only affect males. The gene responsible for WAS is located on the short arm of the X chromosome. Since males have only one X chromosome they only have one copy of the gene. If that copy carries the abnormal gene, they will have WAS. In contrast, females have two X chromosomes. They will have a normal copy of the gene on one chromosome even if an abnormal gene is on the other because the abnormal gene is very rare. The normal copy on one X chromosome is usually sufficient to prevent females from having WAS. However, women who have one abnormal copy of the WAS gene are designated as carriers. While they will not have WAS, they have a 50% risk of passing the gene to each of their sons who will have WAS. Carrier females also have a 50% risk of passing the defective copy of the gene to their daughters who also become carriers."

Researchers identified the gene for WAS in 1994 and pinpointed its location on the short arm of the X chromosome. As of 2000, over 100 different mutations have been found in the gene among WAS patients. The fact that there are many mutations many explain some of the variability of symptoms among boys with WAS. However, even within the same family, affected individuals with the identical WAS gene mutation may have different degrees of severity of the disease. The mild form, X-linked **thrombocytopenia**, is also caused by mutations in this same gene.

The WAS syndrome affects one in every 250,000 male children and occurs worldwide. In the year 2000, scientists estimated that about 500 Americans have WAS.

Causes and symptoms

The syndrome is caused by a defect (mutation) in a specific gene called the WAS gene that normally codes for the protein named Wiskott-Aldrich Syndrome Protein (WASP). This vital protein is a component of cells that are important in the body's defense against infection (lymphocytes). The same protein also functions in the cells that help prevent bleeding (platelets). A less severe form of the disease, X-linked thrombocytopenia affects mainly the platelets.

Increased susceptibility to infections, eczema, and excessive bleeding are the hallmarks of WAS, although the symptoms can vary signficantly from one patient to another. The immune system of patients with WAS produces too few B and T cells. B cells are the cells in the body that make antibodies. There are many types of T cells. Both B and T cells are needed to defend the body against infection. Because both types of cells are affected, WAS patients are subject to repeated infections from bacteria, fungi, and viruses. Ear infections, **meningitis**, and **pneumonia** are common in boys with WAS.

WAS patients also have thrombocytopenia, a decreased number of platelets. Platelets are the specialized blood cells that help to form blood clots and prevent uncontrolled bleeding. The platelets may also be smaller than normal. Some of the earliest symptoms of the syndrome are hemorrhage from **circumcision**, bloody **diarrhea**, and a tendency to bruise very easily.

Anemia and an enlarged spleen (splenomegaly) are seen in some patients. About 10% of patients develop malignancies, usually leukemia or tumors in the lymph nodes (non-Hodgkin's lymphoma).

Diagnosis

The diagnosis of WAS is usually suspected in male infants who have excessive bleeding, eczema, and frequent bacterial or viral infections. Special blood tests can then be ordered to confirm WAS. The blood of Wiskott-Aldrich patients will show a low **platelet count** and a weak immune (antibody) response. It is also possible to confirm the diagnosis by obtaining a small sample of the patient's blood and analyzing the DNA for a mutation in the WAS gene. Knowledge of the exact mutation combined with information about how much WAS protein the defective gene can produce may help predict how severe a form of the disease an individual will have.

Carrier Testing

If the specific WAS gene mutation is identified in an affected child, that child's mother can then be tested to confirm that she carries the gene. Other members of the mother's family may also want to consider testing to find out if they carry the same gene mutation. The first step in studying other family members is for a geneticist or genetic counselor to obtain a detailed family history and construct a pedigree (family tree) to determine which family members should be offered testing.

Prenatal Diagnosis

In families where there has been one child born with WAS, prenatal testing should be offered in subsequent pregnancies. There 50% chance with each subsequent **pregnancy** that the mother, who is a carrier, will transmit the abnormal copy of the gene to her baby. The key is to first identify the particular WAS gene mutation in the child with WAS. Then, early in a pregnancy, cells can be obtained from the developing fetus by **chorionic villus sampling** or **amniocentesis**, and checked for the same mutation. Women who carry the abnormal WAS gene and are considering prenatal diagnosis should discuss the risks and benefits of this type of testing with a geneticist or genetic counselor.

Treatment

Standard treatments for individuals with WAS include **antibiotics** for infections and platelet transfusions to limit bleeding. Immune globulin is given to strengthen the individual's immune system. Eczema can be treated with corticosteroid creams applied directly to the skin. The spleen is sometimes removed to reduce the risk of bleeding. In individuals with WAS, however, removal of the spleen also increases the risk of infection unless antibiotics are given to prevent infections. About 50% of individuals with WAS are helped by treatment with transfer factor, which is a substance derived from the T cells of a healthy person. Transfer factor is given to improve both blood clotting and immune functions. **Bone marrow transplantation** has been successful in a

KEY TERMS

Amniocentesis—A procedure performed at 16-18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Chorionic villus biopsy—A procedure used for prenatal diagnosis at 10-12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Eczema—Inflammation of the skin with redness and other variable signs such as crusts, watery discharge, itching.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Immune system—A major system of the body that produces specialized cells and substances that interact with and destroy foreign antigens that invade the body.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Platelets—Small disc-shaped structures that circulate in the blood stream and participate in blood clotting.

Prenatal diagnosis—The determination of whether a fetus possesses a disease or disorder while it is still in the womb.

Syndrome—A group of signs and symptoms that collectively characterize a disease or disorder.

Thrombocytopenia—A persistent decrease in the number of blood platelets usually associated with hemorrhaging.

X-linked—Located on the X chromosome, one of the sex chromosomes. X-linked genes follow a characteristic pattern of inheritance from one generation to the next.

number of cases. It has been most successful in boys under five years of age where the donor is a sibling whose tissue type closely matches that of the individual with WAS. As of 2000, attempts were also being made to treat individuals with WAS with umbilical cord blood from unrelated newborns in cases where the individual diagnosed with WAS has no matched sibling donor.

Prognosis

The prognosis for males diagnosed with Wiskott-Adrich syndrome is poor. The average individual lives about four years; those who survive into adolescence often develop **cancer**. **Death** usually occurs from severe bleeding or overwhelming infection in the first few years of life.

Resources

BOOKS

Belmont, J. W., and J. M. Puck. "T Cell and Combined Immunodeficiency Disorders." In *The Metabolic & Molecular Bases of Inherited Disease*, edited by C. R. Scriver, et al. New York: McGraw-Hill, 2001.

PERIODICALS

Kuska, B. "Wiskott-Aldrich Syndrome: Molecular Pieces Slide Into Place." *Journal of the National Cancer Institute* 92 (January 5, 2000): 9-11.

ORGANIZATIONS

Immune Deficiency Foundation. 40 W. Chesapeake Ave., Suite 308, Towson, MD 21204. (800) 296-4433. Fax: (410) 321-9165. <http://www.primaryimmune.org/inside.htm>.

OTHER

NORD—National Organization for Rare Disorders, Inc. <http://www.rarediseases.org>.

"Entry 301000: Wiskott-Aldrich Syndrome." *OMIM—Online Mendelian Inheritance in Man*. <http://www.ncbi.nlm.nih.gov/entrez/dispomim.cgi?id=301000>.

Sallie Boineau Freeman, PhD

Withdrawal syndromes

Definition

Withdrawal syndrome occurs in drug and alcohol addicted individuals who discontinue or reduce the use of their drug of choice. This process of eliminating drugs and alcohol from the body is known as **detoxification**. **Anxiety**, **insomnia**, nausea, perspiration, body aches, and **tremors** are just a few of the physical and psychological symptoms of drug and alcohol withdrawal that may occur during detoxification.

Description

Drugs and alcohol affect mood by altering brain chemistry, specifically the production of neurotransmitters. Neurotransmitters are chemicals in the central nervous system that enable nerve impulses to travel through the central nervous system and regulate thought processes, behavior, and emotion. Drugs that temporarily elevate neurotransmitter levels are called stimulants. Drugs that decrease neurotransmitter levels and depress the central nervous system are called depressants; they include opiates and sedative-hypnotic drugs such as alcohol and **barbiturates**. (There are exceptions: Benzodiazepine elevates the level of an inhibitory neurotransmitter, GABA, therefore it serves as a tranquilizer)

When drug or alcohol consumption becomes chronic, the body adjusts to the constant presence of the substance by changing its normal production of neurotransmitters. If drug and alcohol use suddenly stops, the body and central nervous system react to the absence of the substance with an array of symptoms known collectively as withdrawal syndrome.

Causes and symptoms

Acute withdrawal syndrome begins within hours of abstinence, and includes a full range of physical and psychological symptoms. More long-term, or subacute, withdrawal symptoms, such as intense drug craving, may occur weeks or months after detoxification has taken place.

Alcohol withdrawal

Alcohol withdrawal syndrome occurs in alcohol-dependent individuals who suddenly stop or dramatically reduce their alcohol intake. The onset of the syndrome is likely to occur within a week, but usually occurs within 24 hours of the individual's last drink, and is triggered when the central nervous system attempts to adjust to the sudden absence of ethyl alcohol in the body. Symptoms may include extreme anxiety, disorientation, **hallucinations**, **sleep disorders**, hand tremors, nausea, sweating, seizures, and racing pulse. **Delirium** tremens (DTs) are an extreme example of withdrawal. In the worst cases, untreated alcohol withdrawal syndrome can result in **death**.

Barbiturate withdrawal

Barbiturates are prescribed as anticonvulsants, sedatives, and general anesthetics. They can also mimic some of the characteristics of alcohol intoxication (including euphoria, elation, and uninhibited behavior), which make them candidates for abuse. Commonly abused barbiturates include amobarbital (Amytal), pentobarbital (Nembutal), and secobarbital (Seconal). These drugs depress the respiratory and nervous system functions; and, because abusers rapidly build up a tolerance to the effects of the drug, fatal overdose or **coma** can easily occur. Symptoms of withdrawal syndrome appear 12-20 hours after the last dose; they include anxiety, irritability, elevated heart and respiration rate, muscle **pain**, nausea, tremors, hallucinations, confusion, and seizures. Death is a possibility if the condition is left untreated. Because barbiturates decrease REM sleep (rapid eye movement sleep, during which dreaming takes place), withdrawal often results in sleep disruptions such as nightmares, insomnia, or vivid dreaming.

Opiate withdrawal

Opiates are powerfully addictive analgesic drugs that deaden nerve pathways related to pain. Abusers of propoxyphene (Darvon), meperidine (Demerol), percocet (Oxycodone), heroin, morphine, and other powerfully addictive opiates quickly build up a tolerance to the drugs and need progressively larger doses to achieve the desired effect. Stopping or reducing the intake of the drug can cause severe withdrawal symptoms, which begin six to eight hours after the last dosage. Symptoms are flu-like, and include gastrointestinal distress, anxiety, nausea, insomnia, muscle pain, fevers, sweating, and runny nose and eyes.

Stimulant withdrawal

Use of stimulants, such as **cocaine**, crack, amphetamines, and methamphetamines, cause an increase in neurotransmitters in the central nervous system and produce feelings of alertness and increased energy. This initial "rush" is followed by a longer period of neurotransmitter loss, characterized by depression, lethargy, and a craving for more stimulants—sometimes called a rebound effect. When a stimulant-dependent individual abstains from stimulant use, withdrawal symptoms, including depression, **fatigue**, insomnia, and loss of appetite, reflect this drop in neurotransmitter levels. Withdrawal typically takes one to two weeks.

Diagnosis

A detailed history of the patient's drug or alcohol use taken before detoxification can be helpful in predicting the severity of withdrawal symptoms. Standardized clinical tests, such as the Clinical Institute Withdrawal Assessment for Alcohol, revised, (CIWA-Ar), are used to evaluate the severity of withdrawal symptoms throughout the detoxification procedure.

Treatment

Pharmacologic and medical management is often recommended for withdrawal syndrome. The physical condition of the patient is closely monitored throughout the detoxification procedure.

Alcohol withdrawal

Alcohol withdrawal syndrome can be treated at home or in a hospital or treatment setting. Inpatient treatment is recommended for patients who are at risk for serious withdrawal symptoms or re-intoxication if treated as an outpatient. Withdrawal symptoms are minimized through the administration of cross-tolerant sedatives. Long-acting **benzodiazepines**, such as diazepam (Valium), chlordiazepoxide (Librium), and lorazepam (Ativan), are the pharmacologic treatment of choice in managing the symptoms of alcohol withdrawal. Drug dosage is adjusted to offset the discomfort of withdrawal, without causing a euphoric effect, and is then gradually decreased as withdrawal symptoms lessen.

Barbiturate withdrawal

Because the risk for seizures and other severe complications is high, barbiturate withdrawal should be monitored in a hospital setting. Patients are given low doses of phenobarbital at a regular interval until mild intoxication is achieved. The dosage amount and frequency is then gradually decreased until withdrawal is complete.

Opiate withdrawal

Two basic treatment approaches are used for managing opiate withdrawal. The first involves treating the symptoms of the withdrawal with appropriate medication. Clondine, an antihypertensive drug, is commonly prescribed to reduce muscle pain and cramping. Other symptom-specific drugs are administered on an as-needed basis.

The second treatment option is to replace the patient's drug of choice with **methadone**, a long-acting, cross-tolerant opiate that does not normally produce a "high." Doses of methadone are administered every four to six hours. The patient's reaction is closely observed, and dosages are slowly decreased until withdrawal symptoms have disappeared, and dosages are then discontinued. Methadone withdrawal can be completed within three weeks. It is important to note that methadone withdrawal treatment differs from a methadone maintenance program, in which patients who are unwilling to give up opiates are prescribed methadone as a legal, long-term substitute for their drug of choice.

Rapid opiate detoxification (ROD) is an emerging treatment option for opiate withdrawal. The ROD method is reported to be faster and to cause less physical discomfort than traditional forms of opiate detoxification. The treatment is typically performed in a hospital or private clinic setting. Naltrexone, an opiate antagonistic that blocks opiate receptors and reverses the effects of opiates, is administered to trigger the withdrawal response. Clonidine is given simultaneously to ease the symptoms of withdrawal. The patient is anesthetized throughout the three to four hour procedure, and withdrawal occurs while the patient sleeps. Vital signs are monitored closely and a ventilator may be employed.

Stimulant withdrawal

Because of the depression and dysphoria (feeling of a psychological low) related to stimulant withdrawal,

KEY TERMS

Analgesics—Pain killing drugs that depress respiratory function. Opiates are analgesics.

Antagonist—A substance that tends to nullify the action of another.

Benzodiazepines—Sedatives used to treat anxiety, epilepsy, and alcohol withdrawal syndrome. Diazepam (Valium), alprazolam (Xanax), and chlordiazepoxide (Librium) are all benzodiazepines.

Cross-tolerant—A drug that has the same pharmacological effect as another is considered cross-tolerant. Cross-tolerant drugs are often used in treating withdrawal syndromes.

Detoxification—The process of physically eliminating drugs and/or alcohol from the system of a substance-dependent individual.

Dysphoria—A depressed and anxious mood state.

Neurotransmitters—Chemicals in the brain that affect the nervous system and alter thinking patterns.

Opiates—Analgesic, pain killing drugs, such as heroin and morphine that depress the central nervous system.

psychological and/or medical management is critical. Treatment may include a regimen of drugs that increase neurotransmitter production.

Prognosis

A closely observed, medically managed detoxification typically results in a safe and tolerable withdrawal experience for the patient. Detoxification is only a short-term solution for obtaining abstinence. An **addiction** treatment and long-term recovery program is necessary to achieve long-term sobriety. Without such a treatment program, the likelihood of recurrence of abuse and, therefore, the recurrence of withdrawal syndrome is high.

Prevention

After detoxification, alcohol and drug dependent individuals are encouraged to maintain their abstinence through participation in substance abuse treatment or a twelve-step recovery program.

Resources

BOOKS

Landry, Mim J. *Understanding Drugs of Abuse: The Processes of Addiction, Treatment, and Recovery.* Washington, DC: American Psychiatric Press, 1994.

Schuckit, Marc A. *Drug and Alcohol Use: A Clinical Guide to Diagnosis and Treatment.* 4th ed. New York: Plenum, 1995.

PERIODICALS

Barttner, Thaddeus, and Lance Gooberman. "Rapid Opiate Detoxification." *American Journal of Drug and Alcohol Abuse* 22, no. 4 (Nov. 1996): 489-95.

Hall, Wayne, and Deborah Zador. "The Alcohol Withdrawal Syndrome." *The Lancet* 349, no. 9069 (June 1997): 1897-900.

ORGANIZATIONS

Alcoholics Anonymous (A.A). General Service Office. 475 Riverside Drive, New York, NY 10015. (212) 870-3400. <http://www.alcoholics-anonymous.org>.

National Clearinghouse for Alcohol and Drug Information. Center for Substance Abuse Prevention. P.O. Box 2345, Rockville, MD 20847-2345. (800) 729-6686. <http://www.health.org>.

National Council on Alcoholism and Drug Dependence. 12 West 21st St., New York, NY 10010. (800) 622-2255. <http://www.ncadd.org>.

National Institute on Alcohol Abuse and Alcoholism (NIAAA). 6000 Executive Boulevard, Willco Building, Bethesda, Maryland 20892-7003. <http://www.niaaa.nih.gov>.

Paula Anne Ford-Martin

Wolff-Parkinson-White syndrome

Definition

Wolff-Parkinson-White syndrome is an abnormality in the electrical functioning of the heart which may cause rapid heart rates. The abnormality affects the electrical signal between the atria and ventricles.

Description

Blood is circulated through the heart and body by a muscular pump and valve system involving the atria and ventricles. The right atrium receives oxygen-lacking blood returning to the heart from the body. The blood is passed from the right atrium into the right ventricle, which contracts and sends blood out to the pulmonary artery. The pulmonary artery sends the blood into the lungs, where carbon dioxide is removed, and fresh oxygen is added. The left atrium receives blood with oxygen from the lungs and passes this arterial blood to the left ventricle, where it is emptied into the aorta, the main artery of the heart.

These functions are directed by electrical signals within the heart. In patients afflicted with Wolff-Parkinson-White syndrome, an abnormal pathway exists that causes additional electrical signals to pass between the atria and ventricles, possibly causing rapid heart rate.

Causes and symptoms

Congenital heart disease may contribute to this and other **arrhythmias**. Ebstein's anomaly, a congenital heart defect that involves displacement of the tricuspid valve, located on the right side of the heart, is one known cause of Wolff-Parkinson-White syndrome. This anomaly allows blood to flow via the small hole to the other side of the heart. Often, there is no known cause for Wolff-Parkinson-White syndrome. Many people with the syndrome have no symptoms. On the other hand, some people experience temporary rapid heartbeat due to certain drugs, **smoking**, and **anxiety**.

Diagnosis

Electrocardiography (ECG) is used to diagnose Wolff-Parkinson-White syndrome, and other cardiac arrhythmias. A trained physician, normally a cardiologist, can recognize patterns of electrical conduction. With this syndrome, the extra pathway will show a pattern different from those of normal conduction. If no irregular patterns show on the ECG, the patient may be

sent home with a 24-hour heart monitor, called a Holter monitor, which will help detect intermittent occurrences. Other studies, such as the cardiac electrophysiologic study (EPS), may be ordered to pinpoint the location of the accessory pathway, and to determine a course of treatment.

Treatment

Various drugs may be used to treat Wolff-Parkinson-White syndrome, as well as other cardiac arrhythmias. The purpose of these drugs is to slow the electrical signals and excitation of heart muscles. As some of these drugs may have side effects, including the rare production of new or more frequent arrhythmias, the patient should be carefully observed. Ablative therapies may be accomplished with radiofrequency or cardiac catheters to cut through the tissue which is causing the abnormal electrical signals.

At one time, only open heart surgery was used, but the procedure can be done now with local anesthesia in a special cardiac laboratory. In some cases, surgery may still be recommended to treat Wolff-Parkinson-White syndrome.Young people with this syndrome may be treated more successfully with surgery, rather than enduring a lifetime of drug treatments, or the possible threat of **sudden cardiac death**.

Alternative treatment

A provider may teach patients methods to help control heart rate. Relaxation techniques, **acupuncture**, botanical medicine, and **homeopathy** can all be helpful supportive therapies.

Prognosis

Most patients with this syndrome can lead normal lives, even with episodes of tachycardia. In many cases, the syndrome is secondary to the underlying congenital heart defect. However, Wolff-Parkinson-White syndrome can cause sudden cardiac arrest in certain instances.

Prevention

If the syndrome is not due to congenital heart disease, the patient may try avoiding behaviors which lead to arrhythmia, such as elimination of **caffeine**, alcohol, **cocaine**, and smoking.

Resources

BOOKS

Current Diagnosis. Vol. 9. Ed. Rex B. Conn, et al. Philadelphia: W. B. Saunders Co., 1997.

KEY TERMS

Ablative—Used to describe a procedure involving removal of a tissue or body part, or destruction of its funtion.

Arrhythmia—Irregular heart beat.

Electrocardiograph (ECG)—A test of a patient's heartbeat that involves placing leads, or detectors, on the patient's chest to record electrical impulses in the heart. The test will produce a strip, or picture record of the heart's electrical function.

Tachycardia—Rapid heart rate, defined as more than 100 beats per minute.

ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373-6300. <http://www.americanheart.org>.

National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-1222. <http://www.nhlbi.nih.gov>.

Teresa Norris, RN

Women's health

Definition

Women's health is the effect of gender on disease and health that encompasses a broad range of biological and psychosocial issues.

Description

Women's health is the concept that examines gender differences in health and disease states. The average life expectancy has almost doubled for women (79 years for women and 73 years for men), when compared with averages during the turn of the century. Because of the gender gap in lifespan, women comprise approximately two thirds of the population older than 65 and three fourths of the population aged 85 years and older. Currently the fastest growing group in the United States is persons aged 85 years and older. Because of gender life expectancy differences, it is estimated that at the beginning of the twenty-first century, women will outnumber men in the 85 years and older category by 3:1. The reasons for this variance are primarily due to physiological differences among men and women.

During different phases of a women's life cycle there are complex interactions that exist between sex hormones, physiological changes, and emotional issues. Physiological changes occur as early as embryonic development when hormones program structural differences between male and female brains. During reproductive years, sex hormones profoundly influence reproduction and development, which creates a spectrum of gender specific health issues. With advancing age and onset of **menopause**, women's risk factors for disease is comparably similar to men's. Although the same disease may affect women as men, it is thought that biological mechanisms and psychosocial differences influence the clinical course of the disease (natural history) differently in women. The number of women working has doubled within the past 50 years. The effect of work **stress**, new environmental exposures and multiple roles is expected to have health and social impact.

The leading causes of **death** among women are cardiovascular disease, malignant **cancer**, cerebrovascular disease, chronic lung disease, pneumonia/influenza, and diabetes. Additionally, women can be prone to **osteoporosis**, alcohol abuse, psychological disorders, human **immunodeficiency** virus infection, and violence.

Heart Disease accounts for approximately a third of all deaths in women. About 250,000 women die annually of coronary heart disease or a one in three chance after age 40 years. The incidence of heart disease occurs about 10 years later in women than in men, since estrogens in premenopausal women has a protective effect. African American women are more prone to die from heart disease up to age 75. Beyond 75 years of age the propensity is reversed. Native American and Hispanic women have lower death rates from heart disease.

Malignant cancers are the most common cause of premature death among women. **Breast cancer** is the second leading cause of death in women and the most commonly diagnosed cancer. Lung cancer, secondary to cigarette **smoking** is the leading cause of cancer death among women.

Cerebrovascular disease, or stroked related deaths account for approximately 6% of all deaths in women and it is the third leading cause of mortality. The least common form of **stroke**, **subarachnoid hemorrhage**, is the more common cause in women.

The prevalence of cigarette smoking has increased greatly in women and this is correlated with pulmonary disease. Death rates for pulmonary disease including cancer and infectious causes of death are expected to rise for women.

Diabetes, a leading cause of death in women is more prevalent among Hispanic, African American, and Native American women. Past age 45, diabetes affects about one in six women.

Women can also develop:

- osteoporosis, or loss of the quantity of bone, common in postmenopausal women who have estrogen changes.
- alcohol abuse, characterized by repeated usage of alcohol despite negative consequences. These women frequently do not seek treatment because of fear of consequences (i.e., loss of child custody). This disease can also have adverse affects on fertility and in the developing fetus if the mother continues to consume alcohol (fetal alcohol syndrome).
- psychological disorders, such as depression and eating disorders.
- acquired immunodeficiency syndrome (**AIDS**), which represents the highest percent increase in death rates.
- violence, a leading cause of death, primarily caused by a perpetrator who is or was a partner.

Causes and symptoms

Cardiovascular disease can be caused by blockage of a blood vessel, high blood pressure, or a secondary complication to another disease. There may be an abnormal heart rhythm or cell death. Patients may complain of a broad spectrum of symptoms that may include **pain** chest discomfort, high blood pressure, or strain during physical exertion.

When attempting to define the cause and symptoms of cancer, it is important to assess the type of cancer and location. Additionally, if the tumor is localized (benign) or has spread to other areas (malignant), is vital for treatment planning and overall prognosis. In cases of breast cancer there mat be a lump discovered during self-examination or **mammography** (special breast x rays).

Cerebrovascular disease may cause **tremors** (shaking), loss of balance and coordination, or functional and sensation loss of some parts of the body. Patients may have sudden transient strokes that could result in temporary loss of consciousness and **amnesia** of the incident. Patients may also develop chronic neurological states that causing memory loss and behavioral changes (**Alzheimer's disease**).

Patients with pulmonary (lung) cancer may develop **shortness of breath**, **fatigue**, weight loss, worsening **cough**, and coughing up bright red blood with sputum. Lung infections such as **pneumonia** may present with high **fever**, weakness, difficulty breathing, and abnormal breathe sounds heard with a stethoscope during **physical examination**.

Diabetes is a syndrome with disordered metabolism and high blood sugar due to an abnormality in the chemical that regulates sugar levels. It is characterized by an increased thirst, urination, and chronic skin infections.

Osteoporosis may cause the bones to be brittle and weak. It is usually not detected until bones start to break.

The alcohol abuser will continue to drink despite negative repercussions. The person may not seek treatment to evade legal and/or child custody problems. The patient may hide alcohol, or confine drinking to specific times. The disease progresses to where there may be permanent liver damage, memory blackouts and **malnutrition**.

Depression may manifest a loss of interest and desire. Patients may have difficulty getting out of bed. They may lack motivation to work or tend to daily activities.

Patients with AIDS may not have symptoms for years. When active disease occurs, patients will typically develop recurrent infections that are the usual cause of death.

Domestic violence is usually associated with a perpetrator who is in a relationship with the affected person. Abuse can be manifested by physical violence and/or homicide.

Diagnosis

Diagnosis can be accomplished with a history, physical examination, and specialized tests or procedures. For cardiovascular disease an electrocardiogram can determine the activity of the heart. Additional tests may include **echocardiography** (ultrasonic waves that generate an image), stress testing, and studies that require placing a catheter with a probe to examine the damage to heart tissue. Special tests with dyes may also be injected to enhance visualization. Cancer may be detected using specialized test called tumor makers and imaging studies such as MRI and CAT scans. Cerebrovascular disease can be detected with a complete neurological examination and specialized imaging technology. Diabetes is usually detected by a careful history presence of risk factors (**obesity**) and blood analysis of glucose levels. Osteoporosis can be evaluated with specialized bone densitometry. Alcohol abuse can be established by a biopsycho-social assessment and standardized tests which screen for this disorder. Psychological evaluation (such as the **Minnesota Multiphasic Personality Inventory**, MMPI) can usually detect depression or eating disorders. AIDS can be established by a careful history, belonging to high-risk groups and Western blot analysis (examination of blood to detect the protein of human immunodeficiency virus). Violence can be established by physical signs of beating, such as cuts and **bruises**.

Treatment

Treatment depends on the extent of disease and the present health status of the patient. Additionally, in some cases treatment may stopped at sometime, or it may altogether be refused. Treatment for cardiovascular disease may include surgical intervention and/or conservative medical treatment with medications. Diet, **exercise**, and weight reduction are important parameters for treatment planning. Appropriate referrals, counseling, and follow up are usually indicated. Treatment for cancer may include a combination of surgery, **chemotherapy** or **radiation therapy**. These treatment modalities may be given singly or in combination or at different times during disease progression. Cerebrovascular disease can be treated surgically and/or with medications that thin the blood. Symptomatic care may be indicated in addition to close monitoring if the patient develops disability and/or cognitive impairment. Diabetes can be treated by dietary modifications and medications, which treat abnormal levels of blood glucose (sugar). Osteoporosis can be treatment with estrogen replacement and regular vitamin/mineral intake. Alcohol abuse may require long-term therapy, inpatient treatment and medications. Community centered support group meeting are also recommended as a form of treatment maintenance. To date there is no treatment for AIDS, other than medications, that offer symptomatic relief. Alcohol abuse, psychological disorders and violence require therapy, possible medication, and community centered support group meetings.

Alternative treatment

There are numerous studies which support intake od coenzyme Q10 for cardiovascular health. Studies have shown that beta-carotene and vitamin E and C have no effect for cancer. Some studies indicate positive results for reproductive health using **acupuncture**. Some advocates proposed certain herbs may be beneficial during menopause. According to most medical literature, further research using scientific method is vital for general acceptance.

Prognosis

The prognosis depends on the extent of disease and the physical and emotional status of the patient. Prognosis is also related to tolerance of treatment, adverse drug effects, and complication during or after surgery, disease resurgence and patient compliance with treatment recommendations.

Prevention

One of the most reliable measures of prevention is education and training. The Council on Graduate Medical

KEY TERMS

Electrocardiogram— An instrument that monitors heart rate and rhythm.

Education has provided funding for numerous centers to research women health issues. On more individual level preventive and personal habits are vital for good health. Most physicians believe that a baseline physical examination is a reliable comparative tool. Women should receive counseling for special issues concerning cigarette smoking, exercise, diet, primary disease prevention, safe sexual practices, alcohol abuse, psychological disorders, and violence. Additionally, knowledge of family history is important since many diseases have a strong propensity among first-degree relatives. Blood pressure should normally be measured every other year. Screening tests for breast, cervical, and colorectal cancer is recommended. Pap smears taken during routine pelvic examinations can screen for disease processes in the reproductive tract. Serum cholesterol monitoring and reduction are advised. Patients may require postmenopausal estrogen replacement therapy and vitamin/mineral supplements.

Resources

BOOKS

Duthie, Edmund H., et al, eds. *Practice of Geriatrics.* 3rd ed. W. B. Saunders Company, 1998.

Ryan, Kenneth J., et al, eds. *Kistner's Gynecology & Women's Health.* 7th ed. Mosby, Inc., 1999.

PERIODICALS

Lautenbach, G. L., and M. Petri. "Women's Health: General Medical Care of the Patient with Rheumatic Disease." *Rheumatic Diseases Clinics of North America* 25 (Aug. 1999).

ORGANIZATION

U.S. Department of Health & Human Services. 200 Independence Ave SW, Washington DC 20201. (877) 696-6775. <http://www.hhs.gov>.

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Wound culture

Definition

A wound culture is a laboratory test in which microorganisms from a wound are grown in a special growth medium. It is done to find and identify the microorganism causing an infection in a wound or an **abscess**. If a microorganism is found, more testing is done to determine the **antibiotics** that will be effective in treating the infection.

Purpose

Wounds are injuries to body tissues caused by disease processes or events such as **burns**, punctures, and human or animal bites. Wounds or abscesses also occur within body tissues as a result of surgery or dental procedures. Wounds become infected when microorganisms from the outside environment, or from within the person's body, enter the open wound and multiply. A wound that is red, painful, swollen, and draining pus is probably infected. A **fever** following surgery indicates an infection at the site of surgery.

To enable healing and prevent the spread of infection to other body tissues, the infecting microorganisms must be killed. A wound culture discovers which type of microorganism is causing the infection and the best antibiotic with which to kill it.

Description

A sample of material, such as pus or a portion of tissue, is taken from the wound, placed in a sterile container, and sent to the laboratory. In the laboratory, this material is spread over the surface of several different types of culture plates and placed in an incubator at body temperature for one to two days.

A Gram stain is done by staining the slide with purple and red stains, then examining it under a microscope. If many white blood cells and bacteria are seen, it is an early confirmation of infection. The color of stain retained by the bacteria (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to their identity, and help the physician predict which antibiotics might work best even before the entire test is completed. Bacteria that stain purple are called gram-positive; those that stain red are called gram-negative.

Bacteria can be grouped into two categories: aerobes and anaerobes. Aerobes are bacteria that need oxygen to live; anaerobes live only where there is no oxygen. Deep wounds, closed-off from oxygen, are an ideal environment for an anaerobic infection to develop. Foul-smelling odor, gas, or **gangrene** at the infection site are signs of an infection caused by an anaerobic bacteria. Routine cultures typically only look for aerobic bacteria. If the physician tells the laboratory to include a culture for anaerobes, a portion of the wound sample will be put

on culture plates, or in a tube of culture broth, and incubated in a special chamber without oxygen.

Bacteria present in the wound sample will multiply and appear as visible colonies on the plates, or as cloudiness in the tube of broth. They are identified by the appearance of their colonies, the results of biochemical tests, and information from Gram staining part of the bacterial colony.

A sensitivity test, also called an antibiotic susceptibility test, is also done. The bacteria are tested against different antibiotics to determine which will treat the infection by killing the bacteria.

If the physician thinks the wound may be infected with a mold or yeast, a fungal culture is also done. The wound sample is spread on special culture plates that are treated to encourage the growth of mold and yeast. Different biochemical tests and stains are used to identify molds and yeast.

Other more unusual microorganisms, such as *Mycobacterium leprae*, may be the cause of a wound infection. The physician must notify the laboratory to culture specifically for these more unusual microorganisms.

The initial Gram stain result is available the same day, or in less than an hour if requested by the physician. An early report, known as a preliminary report, is usually available after one day. This report will tell if any microorganisms have yet been found, and, if so, their Gram stain appearance. For example, they may have the appearance of a gram-negative rod, or a gram-positive cocci (spherical shape). The final report, usually available in one to three days, includes complete identification, an estimate of the quantity of the microorganisms, plus a list of the antibiotics to which they are sensitive. Cultures for fungi and anaerobic bacteria may take two to three weeks.

Wound culture is also called soft tissue culture, abscess culture, or wound culture and sensitivity.

Preparation

A piece of the infected tissue is the best specimen. If this is not possible, the next best specimen is pus from the wound. Because many microorganisms normally live on skin and mucous membrane, the specimen must not be allowed to touch the area surrounding the wound.

The physician first cleans the surface of the wound using alcohol. Using a syringe, the physician suctions out (aspirates) as much pus as possible from the wound. Next, this is sent to the laboratory in a sterile container. If it is impossible to aspirate the pus, pus from within the wound can be collected on a swab.

KEY TERMS

Aerobe—Bacteria that require oxygen to live.

Anaerobe—Bacteria that live only where there is no oxygen.

Normal flora—The mixture of bacteria normally found at specific body sites.

The physician may choose to start the person on an antibiotic before the culture and sensitivity tests are completed. However, the specimen for culture should be collected before antibiotics are begun. Antibiotics in the person's system may prevent microorganisms present in the wound from growing in culture, and thus not be identifiable.

Normal results

A normal culture may be contaminated by a mixture of microorganisms normally found on a person's skin (normal flora).

It is not uncommon for the microorganism causing a wound infection to not grow in culture. This is particularly true if the specimen was collected with a swab rather than an aspirate or tissue biopsy.

Abnormal results

Streptococcus Group A, ***Escherichia coli***, *Proteus*, *Klebsiella*, *Pseudomonas*, *Enterobacter*, Enterococci, *Staphylococcus aureus*, *Bacterioides*, and *Clostridium*, are common causes of wound infections. More than one microorganism may be the cause of the infection.

Resources

BOOKS

Isada, Carlos M., et al. *Infectious Diseases Handbook.* Hudson, OH: Lexi-Comp Inc., 1995.

Koneman, Elmer W., et al. *Color Atlas and Textbook of Diagnostic Microbiology.* 4th ed. Philadelphia: J. B. Lippincott Co., 1992.

Pagana, Kathleen Deska. *Mosby's Manual of Diagnostic and Laboratory Tests.* St. Louis: Mosby, Inc., 1998.

Shulman, Standford T., et al., eds. *The Biologic and Clinical Basis of Infectious Diseases.* 5th ed. Philadelphia: W. B. Saunders Co., 1997.

PERIODICALS

Robson, Martin C. "Wound Infection. A Failure of Wound Healing Caused by an Imbalance of Bacteria." *Surgical Clinics of North America* (June 1997): 637-650.

ORGANIZATIONS

The Wound Healing Society. 1550 South Coast Highway, Suite 201, Laguna Beach, CA 92651. (888) 434-4234. <http://wizard.pharm.wayne.edu/woundsoc/WHS.HTM>.

Nancy J. Nordenson

KEY TERMS

Antiseptic—Chemicals applied to the skin to destroy bacteria and prevent infection.

Wound flushing

Definition

Wound flushing is a method of cleaning a wound by applying pressurized water or antiseptic solutions to the tissues.

Purpose

Wound flushing is used to help flush debris from a wound, lessening the risk of infection or treating an infection that already exists. If the wound is flushed with an antiseptic, it is more likely to heal correctly; flushing the wound can help prevent the surface from healing over a possibly infected area underneath.

Description

Wound flushing is usually done in a hospital, though if it is performed at home, there is less chance of infection because of the higher risk of bacterial contamination in the hospital environment. Wound flushing is especially helpful in treating people with bites, lacerations, or crush injuries, which often become infected due to the presence of dead tissue and foreign debris, such as splinters or dirt. In a non-surgical situation, the procedure is usually performed by a nurse. An acute injury, such as a crushing wound or knife cut, the wound is flushed right before the injury is stitched closed. For people with chronic **wounds**, such as bed sores or abscesses, the wound may be flushed periodically to treat or prevent infection. During an operation, a surgeon uses an antibacterial solution to flush the surgical site just before stitching the wound closed. After surgery, the wounds may be flushed to treat or prevent infection.

Preparation

The nurse or doctor may inject the site with a local anesthetic before flushing the wound.

Aftercare

After the wound is flushed, the health care provider cleans the area around the wound to guard against infection. Packing to absorb excess fluids may be placed into the wound, followed by a sterile bandage.

Risks

Complications rarely occur, especially if the solution used to flush the wound is chosen carefully so as to avoid skin irritation. Patients should call the doctor immediately if there is any sign of infection, such as **fever**, pus, or swelling.

Normal results

The wound will heal correctly, from the inside out, without infection.

Resources

BOOKS

Smeltzer, Suzanne C., and Brenda Bare. *Brunner and Suddarth's Textbook of Medical/Surgical Nursing*. Philadelphia: J. B. Lippincott Co., 1992.

Wounds

Definition

A wound occurs when the integrity of any tissue is compromised (e.g. skin breaks, muscle tears, **burns**, or bone **fractures**). A wound may be caused by an act, such as a gunshot, fall, or surgical procedure; by an infectious disease; or by an underlying condition.

Description

Types and causes of wounds are wide ranging, and health care professionals have several different ways of classifying them. They may be chronic, such as the skin ulcers caused by **diabetes mellitus**, or acute, such as a gunshot wound or animal bite. Wounds may also be referred to as open, in which the skin has been compromised and underlying tissues are exposed, or closed, in which the skin has not been compromised, but trauma to underlying structures has occurred (e.g. a bruised rib or

cerebral contusion). Emergency personnel and first-aid workers generally place acute wounds in one of eight categories:

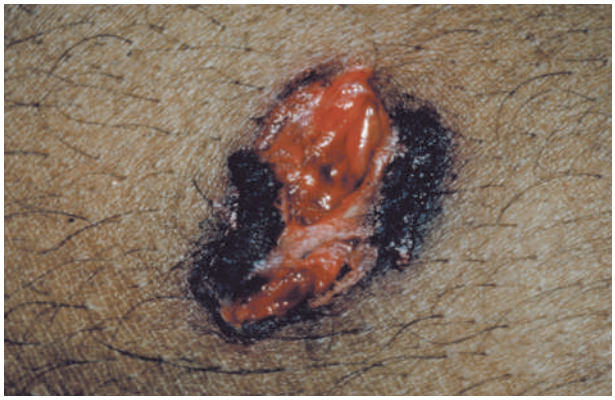
- Abrasions. Also called scrapes, they occur when the skin is rubbed away by friction against another rough surface (e.g. rope burns and skinned knees).
- Avulsions. Occur when an entire structure or part of it is forcibly pulled away, such as the loss of a permanent tooth or an ear lobe. Explosions, gunshots, and animal bites may cause avulsions.
- Contusions. Also called **bruises**, these are the result of a forceful trauma that injures an internal structure without breaking the skin. Blows to the chest, abdomen, or head with a blunt instrument (e.g. a football or a fist) can cause contusions.
- Crush wounds. Occur when a heavy object falls onto a person, splitting the skin and shattering or tearing underlying structures.
- Cuts. Slicing wounds made with a sharp instrument, leaving even edges. They may be as minimal as a paper cut or as significant as a surgical incision.
- Lacerations. Also called tears, these are separating wounds that produce ragged edges. They are produced by a tremendous force against the body, either from an internal source as in **childbirth**, or from an external source like a punch.
- Missile wounds. Also called velocity wounds, they are caused by an object entering the body at a high speed, typically a bullet.
- Punctures. Deep, narrow wounds produced by sharp objects such as nails, knives, and broken glass.

Causes and symptoms

Acute wounds have a wide range of causes. Often, they are the unintentional results of motor vehicle accidents, falls, mishandling of sharp objects, or sports-related injury. Wounds may also be an intentional result of violence involving assault with weapons, including fists, knives, or guns.

The general symptoms of a wound are localized **pain** and bleeding. Specific symptoms include:

- An abrasion usually appears as lines of scraped skin with tiny spots of bleeding.
- An avulsion has heavy, rapid bleeding and a noticeable absence of tissue.
- A contusion may appear as a bruise beneath the skin or may appear only on imaging tests; an internal wound may also generate symptoms such as weakness, perspiration, and pain.



A close-up of a hard-contact gunshot wound with accompanying burn marks on the left and right sides of the wound. *(Custom Medical Stock Photo. Reproduced by permission.)*

- A crush wound may have irregular margins like a laceration; however, the wound will be deeper and trauma to muscle and bone may be apparent.
- A cut may have little or profuse bleeding depending on its depth and length; its even edges readily line up.
- A laceration too may have little or profuse bleeding; the tissue damage is generally greater and the wound's ragged edges do not readily line up.
- A missile entry wound may be accompanied by an exit wound, and bleeding may be profuse, depending on the nature of the injury.
- A puncture wound will be greater than its length, therefore there is usually little bleeding around the outside of the wound and more bleeding inside, causing discoloration.

Diagnosis

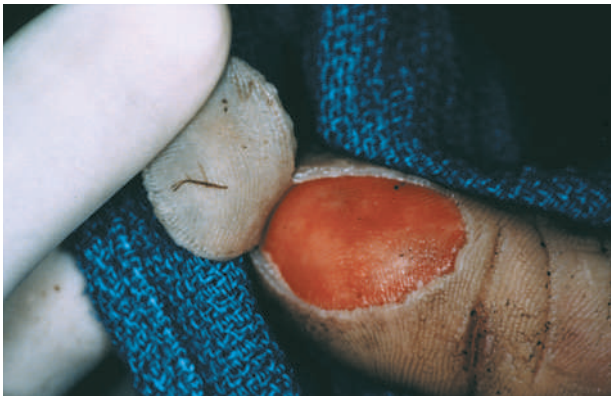
A diagnosis is made by visual examination and may be confirmed by a report of the causal events. Medical personnel will also assess the extent of the wound and what effect it has had on the patient's well being (e.g. profound blood loss, damage to the nervous system or skeletal system).

Treatment

Treatment of wounds involves stopping any bleeding, then cleaning and dressing the wound to prevent infection. Additional medical attention may be required if the effects of the wound have compromised the body's ability to function effectively.

Stopping the bleeding

Most bleeding may be stopped by direct pressure. Direct pressure is applied by placing a clean cloth or



A defensive hand wound from a knife attack. *(Photograph by D. Willoughby, Custom Medical Stock Photo. Reproduced by permission.)*

dressing over the wound and pressing the palm of the hand over the entire area. This limits local bleeding without disrupting a significant portion of the circulation. The cloth absorbs blood and allows clot formation; the clot should not be disturbed, so if blood soaks through the cloth, another cloth should be placed directly on top rather than replacing the original cloth.

If the wound is on an arm or leg that does not appear to have a broken bone, the wound should be elevated to a height above the person's heart while direct pressure is applied. Elevating the wound allows gravity to slow down the flow of blood to that area.

If severe bleeding cannot be stopped by direct pressure or with elevation, the next step is to apply pressure to the major artery supplying blood to the area of the wound. In the arm, pressure would be applied to the brachial artery by pressing the inside of the upper arm against the bone. In the leg, pressure would be applied to the femoral artery by pressing on the inner crease of the groin against the pelvic bone.

If the bleeding from an arm or leg is so extreme as to be life-threatening and if it cannot be stopped by any other means, a tourniquet may be required. However, in the process of limiting further blood loss, the tourniquet also drastically deprives the limb tissues of oxygen. As a result, the patient may live but the limb may die.

Dressing the wound

Once the bleeding has been stopped, cleaning and dressing the wound is important for preventing infection. Although the flowing blood flushes debris from the wound, running water should also be used to rinse away dirt. Embedded particles such as wood slivers and glass splinters, if not too deep, may be removed with a needle or pair of tweezers that has been sterilized in rubbing alcohol or in the heat of a flame. Once the wound has been cleared of foreign material and washed, it should be gently blotted dry, with care not to disturb the blood clot. An antibiotic ointment may be applied. The wound should then be covered with a clean dressing and bandaged to hold the dressing in place.

Getting medical assistance

A person who has become impaled on a fixed object, such as a fence post or a stake in the ground, should only be moved by emergency medical personnel. **Foreign objects** embedded in the eye should only be removed by a doctor. Larger penetrating objects, such as a fishhook or an arrow, should only be removed by a doctor to prevent further damage as they exit.

KEY TERMS

Abrasion—Also called a scrape. The rubbing away of the skin surface by friction against another rough surface.

Avulsion—The forcible separation of a piece from the entire structure.

Butterfly bandage—A narrow strip of adhesive with wider flaring ends (shaped like butterfly wings) used to hold the edges of a wound together while it heals.

Cut—Separation of skin or other tissue made by a sharp edge, producing regular edges.

Laceration—Also called a tear. Separation of skin or other tissue by a tremendous force, producing irregular edges.

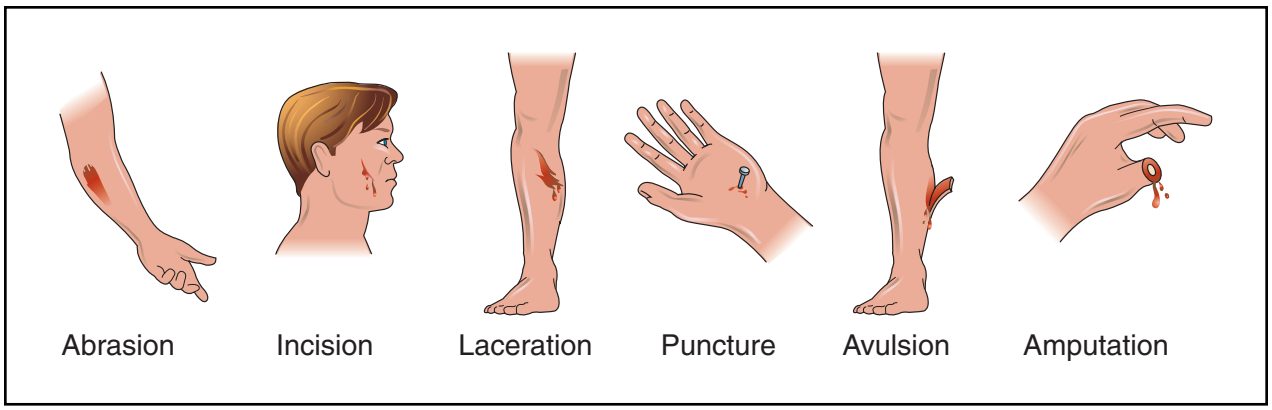
Plasma—The straw-colored fluid component of blood, without the other blood cells.

Puncture—An injury caused by a sharp, narrow object deeply penetrating the skin.

Tourniquet—A device used to control bleeding, consisting of a constricting band applied tightly around a limb above the wound. It should only be used if the bleeding in life-threatening and can not be controlled by other means.

Traumatic shock—A condition of depressed body functions as a reaction to injury with loss of body fluids or lack of oxygen. Signs of traumatic shock include weak and rapid pulse, shallow and rapid breathing, and pale, cool, clammy skin.

Whole blood—Blood which contains red blood cells, white blood cells, and platelets in plasma.



Examples of open wounds. *(Illustration by Electronic Illustrators Group.)*

Additional medical attention is necessary in several instances. Wounds which penetrate the muscle beneath the skin should be cleaned and treated by a doctor. Such a wound may require stitches to keep it closed during healing. Some deep wounds which do not extend to the underlying muscle may only require butterfly bandages to keep them closed during healing. Wounds to the face and neck, even small ones, should always be examined and treated by a doctor to preserve sensory function and minimize scarring. Deep wounds to the hands and wrists should be examined for nerve and tendon damage. Puncture wounds may require a **tetanus** shot to prevent serious infection. Animal bites should always be examined and the possibility of **rabies** infection determined.

Infection

Wounds which develop signs of infection should also be brought to a doctor's attention. Signs of infection are swelling, redness, tenderness, throbbing pain, localized warmth, **fever**, swollen lymph glands, the presence of pus either in the wound or draining from it, and red streaks spreading away from the wound.

Emergency treatment

With even as little as one quart of blood lost, a person may lose consciousness and go into traumatic **shock**. Because this is life-threatening, emergency medical assistance should be called immediately. If the person stops breathing, artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered. In the absence of a pulse, **cardiopulmonary resuscitation** (**CPR**) must be performed. Once the person is breathing unassisted, the bleeding may be attended to.

In cases of severe blood loss, medical treatment may include the intravenous replacement of body fluids. This may be infusion with saline or plasma, or a **transfusion** of whole blood.

Alternative treatment

In addition to the conventional treatments described above, there are alternative therapies that may help support the injured person. **Homeopathy** can be very effective in acute wound situations. *Ledum* (*Ledum palustre*) is recommended for puncture wounds (taken internally). Calendula (*Calendula officinalis*) is the primary homeopathic remedy for wounds. An antiseptic, it is used topically as a succus (juice), tea, or salve. Another naturally occurring antiseptic is tea tree oil (*Melaleuca* spp.), which can be mixed with water for cleaning wounds. Aloe (*Aloe barbadensis*) can be applied topically to soothe skin during healing. When wounds affect the nerves, especially in the arms and legs, St.-John's-wort (*Hypericum perforatum*) can be helpful when taken internally or applied topically. **Acupuncture** can help support the healing process by restoring the energy flow in the meridians that have been affected by the wound. In some cases, vitamin E taken orally or applied topically can speed healing and prevent scarring.

Prognosis

Without the complication of infection, most wounds heal well with time. Depending on the depth and size of the wound, it may or may not leave a visible scar.

Prevention

Most actions that result in wounds are preventable. Injuries from motor vehicle accidents may be reduced by wearing seat belts and placing children in size-appropriate car seats in the back seat. Sharp, jagged, or pointed objects or machinery parts should be used according to

the manufacturer's instructions and only for their intended purpose. Firearms and explosives should be used only by adults with explicit training; they should also be kept locked and away from children. Persons engaging in sports, games, and recreational activities should wear all proper protective equipment and follow safety rules.

Resources

BOOKS

American Red Cross Staff. *Standard First Aid*. St. Louis: Mosby Yearbook, 1992.

The Editors of Time-Life Books. *The Medical Advisor: The Complete Guide to Alternative and Conventional Treatments*. Alexandria, VA: Time Life, Inc., 1996.

ORGANIZATIONS

American Red Cross. P.O. Box 37243, Washington, D.C. 20013. <http://www.redcross.org>.

Bethany Thivierge
Carol A. Turkington

Wryneck *see* **Torticollis**

X

X-linked agammaglobulinemia

Definition

X-linked agammaglobulinemia (XLA) or Bruton's agammaglobulinemia is present at birth (congenital) and is characterized by low or completely absent levels of immunoglobulins in the bloodstream. Immunoglobulins are protein molecules in blood serum that function like antibodies. Without them, the body lacks a fully functioning immune system. Persons with XLA are vulnerable to repeated, potentially fatal bacterial infections.

Description

XLA occurs in one in 50,000 to one in 100,000 newborns. Almost all persons with the disorder are males. Although persons with XLA carry the genes to produce immunoglobulins, a genetic defect on the X chromosome prevents their formation. This defect is not associated with the immunoglobulins themselves, but rather with the B cells in the bloodstream that ordinarily secrete the immunoglobulins.

B cells are a type of white blood cell. They are the sole producers of immunoglobulins in the body. B cells are produced in the bone marrow and carried to the spleen, lymph nodes, and other organs as they mature. The maturation process depends on an enzyme called Bruton's agammaglobulinemia tyrosine kinase (Btk). If Btk is missing or defective, the B cells cannot mature and cannot produce immunoglobulins.

The gene for Btk is on the X chromosome. Certain changes (mutations) in this gene result in defective Btk. Since the gene is carried on the X chromosome, XLA individuals are almost always male. Females have two X chromosomes, which means they have two copies of the Btk gene, one of which is normal. Males have only one X chromosome.

Causes and symptoms

XLA is caused by a defect in the gene that codes for Btk. This defect leads to blocked maturation of B cells, the cells that produce immunoglobulins. Because other portions of the immune system are functional, people with XLA can fight off some types of infection, such as fungal and most viral infections. Immunoglobulins, however, are vital to combat bacterial infections. Infants with XLA usually do not show symptoms during the first six months of life because immunoglobulins from their mothers are circulating in their bloodstreams. As the mother's supply decreases, the baby becomes increasingly vulnerable to bacterial infections.

Common symptoms of immunoglobulin deficiency appear after the infant is six months old. They include frequent ear and sinus infections, **pneumonia**, and **gastroenteritis**. Certain viruses, such as hepatitis and **polio** viruses, can also pose a threat. Children with XLA grow slowly, have small tonsils and lymph nodes, and may develop chronic skin infections. Approximately 20% of these children develop arthritis, possibly as a result of joint infections.

Diagnosis

Frequent bacterial infections, a lack of mature B cells, and low-to-nonexistent levels of immunoglobulins point to a diagnosis of XLA. A sample of the infant's blood serum can be analyzed for the presence of immunoglobulins by a technique called **immunoelectrophoresis**. To make a definitive diagnosis, the child's X chromosome is analyzed for defects in the Btk gene. Similar analysis can be used for prenatal diagnosis or to detect carriers of the defective gene.

Treatment

Treatment of XLA consists of regular intravenous doses of commercially prepared gamma globulin (sold under the trade names Gamimune or Gammagard) to

KEY TERMS

Antibody—A molecule that is produced by the immune system in response to a protein, called an antigen, that is not recognized as belonging in the body.

B cell—A type of lymphocyte, or white blood cell, that is a key component of the body's immune system. Mature B cells produce immunoglobulins.

Bruton's agammaglobulinemia tyrosine kinase (Btk)—An enzyme vital for the maturation of B cells.

Carrier—A person who has a genetic defect but does not develop any symptoms or signs of the defect. The carrier's offspring may inherit the defect and develop the associated disorder.

Enzyme—A protein molecule that prompts rapid biochemical reactions.

Immunoglobulin—A protein molecule formed by mature B cells in response to foreign proteins in the body. There are five types of immunoglobulins, but the major one is gamma globulin or immunoglobulin G.

Mutation—A change in a gene that alters the function or other characteristics of the gene's product.

X chromosome—One of the two sex chromosomes (the other is Y) that determine a person's gender. Normal males have both an X and a Y chromosome, and normal females have two X chromosomes.

ward off infections. **Antibiotics** are used to treat infections as they occur. Children with XLA must be treated promptly for even minor cuts and scrapes, and taught to avoid crowds and people with active infections.

Prognosis

Prior to the era of gamma globulin and antibiotic treatment, approximately 90% of XLA individuals died before age 8. Early diagnosis and current therapy allows most individuals with XLA to reach adulthood and lead relatively normal lives. Infants who develop polio or persistent viral infections, however, have a poorer prognosis.

Prevention

Parents of a child with XLA should consider **genetic counseling** if they are planning to have more children.

Resources

BOOKS

Barrett, Douglas J., et al. "Antibody Deficiency Diseases." In *The Metabolic and Molecular Bases of Inherited Disease*. 7th ed. Ed. Charles R. Scriver, et al. New York: McGraw-Hill, Inc., 1995.

Physicians' Guide to Rare Diseases. Ed. Jess G. Thoene. Montvale, NJ: Dowden Publishing Co., Inc., 1995.

"X-Linked Infantile Hypogammaglobulinemia." In *Professional Guide to Diseases*, ed. Stanley Loeb, et al. Springhouse, PA: Springhouse Corporation, 1991.

PERIODICALS

Ochs, Hans D., and C. I. Edvard Smith. "X-Linked Agammaglobulinemia: A Clinical and Molecular Analysis." *Medicine* 75 (1996): 287.

Sideras, Paschalis, and C. I. Edvard Smith. "Molecular and Cellular Aspects of X-Linked Agammaglobulinemia." *Advances in Immunology* 59 (1995): 135.

ORGANIZATIONS

Immune Deficiency Foundation. 25 W. Chesapeake Ave., Suite 206, Towson, MD 21204. (800) 296-4433. <http://www.primaryimmune.org>.

National Organization for Rare Disorders. P.O. Box 8923, New Fairfield, CT 06812-8923. (800) 999-6673. <http://www.rarediseases.org>.

Julia Barrett

X rays of the eye's orbit *see* **X rays of the orbit**

X rays of the orbit

Definition

Orbital x rays are studies of the area and structures containing the eye. The orbit is the circle of thin bones that houses and protects the eye, even extending behind the eye and nearly wrapping around it. The orbit includes the eyebrow, the bridge of the nose and the cheekbone. X rays are a form of radiation (like light) that can penetrate body tissues.

Purpose

Orbital x ray, or orbital radiography, is often used to detect problems resulting from injury or trauma to the eye. The exam may also detect changes to the structure of the eye, which may indicate various diseases. An ophthalmologist may also order an orbital x ray if there is concern that foreign bodies may be present in the eye that cannot be detected with an instrument called an ophthalmoscope.

Precautions

Pregnant women and women who could possibly be pregnant should only receive orbital x rays when absolutely necessary. If the patient is in severe **pain** due to injury or trauma, a painkiller may be given to help ease discomfort during positioning of the head throughout the exam. No other precautions are necessary for orbital x rays.

Description

Each orbit is composed of a floor, a roof, a medial (in the center plane) and lateral (sides of the plane) walls. The orbital x ray involves several different views in order for the physician to clearly see various parts of the eye without obstruction. In orbital x rays, images of the unaffected eye may also be taken to compare its shapes and structures to those of the affected eye. Views may include side view (lateral), back to front (posteroanterior), base view, views from both sides, and an image from the center to one outside edge (half-axial projection). Projections of the optical canal will also be included. For all of these views, the patient may be seated upright or asked to lie on a table in the x ray room.

The orbital x ray procedure should take about 15 minutes to complete. Following the procedure, the patient will usually be asked to wait until the films are developed to ensure they are high enough quality and that repeat x rays are not necessary. A physician may perform the x ray exam in his or her office, or refer the patient to an outpatient radiology facility or hospital radiology department. In the case of emergency, the exam may be performed in the emergency room or a nearby radiology area of the hospital.

Preparation

There are no special dietary preparations needed prior to an orbital x ray. As with any radiography procedure, the patient should remove any jewelry or metal objects, which may interfere with a clear image.

Aftercare

No aftercare is required following this diagnostic test.

Risks

Radiation exposure is low for this procedure and all certified radiology facilities follow strict personnel and equipment guidelines for radiation protection. Women of child bearing age and children should be offered protective shielding (lead aprons) to cover the genital and/or abdominal areas.

KEY TERMS

Blowout fracture—A fracture or break in the orbit that is caused by sudden and violent impact to the area.

Malignancy—A malignancy is a tumor that is cancerous and growing.

Medial wall—The middle bone, or wall of the eye's orbit. It is generally thicker than the roof and floor walls.

Ophthalmologist—A physician who specializes in the workings, structures and care of the eyes.

Ophthalmoscope—An instrument routinely used by ophthalmologists to examine the interior of the eye. It consists of a small light, a mirror, and lenses of differing powers that magnify.

Radiography—Examination of any part of the body through the use of x rays. The process produces an image of shadows and contrasts on film.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

Normal results

Normal findings will show the bones of the orbit intact, and will show similarity between the orbit that is being studied and the unaffected orbit.

Abnormal results

Positive findings from an orbital x ray may show that there has been injury to the eye. Certains signs may indicate some disease that is affecting the orbital structures. Tiny **fractures** in the orbital bones can usually be detected on the radiograph. The floor bone, the medial wall and the ethmoid bone, which is a spongy bone that forms the upper part of the nasal cavity, are the most likely to break. In a blowout fracture (one involving the orbital floor), radiographic findings may include disruption to the orbital floor, an opaque look to the sinuses on the same side as the affected orbit (due to hemorrhage) or signs of sinus problems from the orbital root's interference. These indications can be seen in most typical orbital x ray views.

Since the physician examines both orbits side by side, indications of differences in size and shape of the various structures in the orbit may be apparent. The orbit may be enlarged, indicating irritation from an injury or

foreign body. A number of growing tumors within the eye or brain area may also cause orbital enlargement. Destruction of the walls of the orbit may indicate a nearby infection or malignancy. Changes in density of the tiny orbit bones may also be a sign of bone disease or **cancer** spread to bone.

Children's orbits are more likely to be enlarged by a fast growing lesion, since their orbital bones have not fully developed.

Resources

BOOKS

Illustrated Guide to Diagnostic Tests. Ed. J. A. Lewis. Springhouse, PA: Springhouse Corp. 1994.

ORGANIZATIONS

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892-3655. (301) 496-5248. <http://www.nei.nih.gov>.

American Academy of Ophthalmology. 655 Beach Street, P.O. Box 7424, San Francisco, CA 94120-7424. <http://www.eyenet.org>.

OTHER

Scgeue Eye Institute. University of Pennsylvania Health System <http://www.med.upenn.edu/ophth>.

Teresa Norris, RN

Xerophthalmia *see* **Vitamin A deficiency**

Xerostomia *see* **Dry mouth**

XLA *see* **X-linked agammaglobulinemia**

Y

Yaws

Definition

Yaws is a chronic illness which first affects the skin, and then affects the bones.

Description

Yaws tends to strike children, particularly between the ages of two and five. It is common in areas where poverty and overcrowding interfere with good hygiene practices. The most common locations are in rural areas throughout Africa, Southeast Asia, and in locations bordering the equator in the Americas.

Causes and symptoms

Yaws is caused by a spiral-shaped bacterium (spirochete) called *Treponema pertenue*. This bacterium belongs to the same family as the bacterium that causes **syphilis**.

Yaws is passed among people by direct skin contact. It requires some kind of a scratched or insect bitten area in order for the bacteria to actually settle in and cause infection. An injured spot on the leg is the most common part of the body through which the bacteria enter. Young children, who are constantly bumping themselves in play, who wear little clothing, who do not wash their hands often, and who may frequently put their hands in their mouths, are particularly susceptible.

The first symptom of yaws occurs three to four weeks after acquiring the bacteria. The area where the bacteria originally entered the skin becomes a noticeable bump (papule). The papule grows larger and develops a punched-out center (ulcer), covered with a yellow crust. Lymph nodes in the area may become swollen and tender. This first papule may take as long as six months to heal. Secondary soft, gummy growths then appear on the face, arms and legs, and buttocks. These soft, tumor-like masses may grow on the soles of the feet, causing the patient to walk in an odd and characteristic fashion on the sides of his or her feet (nicknamed "crab yaws"). More destructive tumors may then disrupt the bones of the face, the jaw, and the lower leg. Ulcers around the nose and on the face may be very mutilating.

Diagnosis

Samples taken from the first papules may be examined using a technique called dark-field microscopy. This often allows the spirochetes to be identified. They may also be identified in fluid withdrawn from swollen lymph nodes. Various tests can also be run on blood samples to determine if an individual is producing antibodies (special immune cells) which are specifically made in response to the presence of these spirochetes.

Treatment

A single penicillin injection in a muscle is sufficient to completely end the disease.

Prognosis

Without treatment, yaws is a terribly disfiguring chronic illness. With appropriate treatment, the progression of the disease can be completely halted.

Prevention

For a time, the World Health Organization (WHO) was working to totally eradicate yaws, just as **smallpox** was successfully eradicated. This has not occurred, however. WHO continues to work to identify and respond to outbreaks quickly, in an effort to at least slow the spread of yaws.

Resources

BOOKS

Perine, Peter L. "Endemic Treponematoses." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

KEY TERMS

Papule—A raised bump on the skin.

Ulcer—A punched-out, irritated pit on the skin.

Sherris, John C., and James J. Plorde. "Spirochetes." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases.* 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Yellow fever

Definition

Yellow **fever** is a severe infectious disease, caused by a virus called a "flavivirus." This flavivirus can cause outbreaks of epidemic proportions throughout Africa and tropical America. The first written evidence of such an epidemic occurred in the Yucatan in 1648. Since that time, much has been learned about the interesting transmission patterns of this devastating illness.

Description

In order to understand how yellow fever is passed, several terms need to be defined. The word "host" refers to an animal that can be infected with a particular disease. The term "vector" refers to an organism which can carry a particular disease-causing agent (such as a virus or bacteria) without actually developing the disease. The vector can then pass the virus or bacteria on to a new host.

Many of the common illnesses in the United States (including the **common cold**, many viral causes of **diarrhea**, and **influenza** or "flu") are spread via direct passage of the causative virus between human beings. Yellow fever, however, cannot be passed directly from one infected human being to another. Instead, the virus responsible for yellow fever requires an intermediate vector, a mosquito, which carries the virus from one host to another.

The hosts of yellow fever include both humans and monkeys. The cycle of yellow fever transmission occurs as follows: an infected monkey is bitten by a tree-hole breeding mosquito. This mosquito acquires the virus, and can pass the virus on to any number of other monkeys that it may bite. When a human is bitten by such a mosquito, the human may acquire the virus. In the case of South American yellow fever, the infected human may return to the city, where an urban mosquito (*Aedes aegypti*) serves as a viral vector, spreading the infection rapidly by biting humans.

Symptoms

Once a mosquito has passed the yellow fever virus to a human, the chance of disease developing is about 5-20%. Infection may be fought off by the host's immune system, or may be so mild that it is never identified.

In human hosts who develop the disease yellow fever, there are five distinct stages through which the infection evolves. These have been termed the periods of incubation, invasion, remission, intoxication, and convalescence.

Yellow fever's incubation period (the amount of time between the introduction of the virus into the host and the development of symptoms) is three to six days. During this time, there are generally no symptoms identifiable to the host.

The period of invasion lasts two to five days, and begins with an abrupt onset of symptoms, including fever and chills, intense **headache** and lower backache, muscle aches, nausea, and extreme exhaustion. The patient's tongue shows a characteristic white, furry coating in the center, surrounded by a swollen, reddened margin. While most other infections that cause a high fever also cause an increased heart rate, yellow fever results in an unusual finding, called Faget's sign. This is the simultaneous occurrence of a high fever with a slowed heart rate. Throughout the period of invasion, there are still live viruses circulating in the patient's blood stream. Therefore, a mosquito can bite the ill patient, acquire the virus, and continue passing it on to others.

The next phase is called the period of remission. The fever falls, and symptoms decrease in severity for several hours to several days. In some patients, this signals the end of the disease; in other patients, this proves only to be the calm before the storm.

The period of intoxication represents the most severe and potentially fatal phase of the illness. During this time, lasting three to nine days, a type of degeneration of the internal organs (specifically the kidneys, liver, and heart) occurs. This fatty degeneration results in what is considered the classic triad of yellow fever symptoms: **jaundice**, black vomit, and the dumping of protein into the urine. Jaundice causes the whites of the patient's eyes

and the patient's skin to take on a distinctive yellow color. This is due to liver damage, and the accumulation of a substance called bilirubin, which is normally processed by a healthy liver. The liver damage also results in a tendency toward bleeding; the patient's vomit appears black due to the presence of blood. Protein, which is normally kept out of the urine by healthy, intact kidneys, appears in the urine due to disruption of the kidney's healthy functioning.

Patients who survive the period of intoxication enter into a relatively short period of convalescence. They recover with no long term effects related to the yellow fever infection. Further, infection with the yellow fever virus results in lifelong immunity against repeated infection with the virus.

Diagnosis

Diagnosis of yellow fever depends on the examination of blood by various techniques in order to demonstrate either yellow fever viral antigens (the part of the virus that stimulates the patient's immune system to respond) or specific antibodies (specific cells produced by the patient's immune system which are directed against the yellow fever virus). The diagnosis can be strongly suspected when Faget's sign is present. When the classic triad of symptoms is noted yellow fever is strongly suspected.

Treatment

There are no current anti-viral treatments available to combat the yellow fever virus. The only treatment of yellow fever involves attempts to relieve its symptoms. Fevers and **pain** should be relieved with **acetaminophen**, not **aspirin** or ibuprofen, both of which could increase the already-present risk of bleeding. **Dehydration** (due to fluid loss both from fever and bleeding) needs to be carefully avoided. This can be accomplished by increasing fluids. The risk of bleeding into the stomach can be decreased through the administration of **antacids** and other medications. Hemorrhage may require blood transfusions. Kidney failure may require dialysis (a process that allows the work of the kidneys in clearing the blood of potentially toxic substances to be taken over by a machine, outside of the body).

Prognosis

Five to ten percent of all diagnosed cases of yellow fever are fatal. Jaundice occurring during a yellow fever infection is an extremely grave predictor. Twenty to fifty percent of these patients die of the infection. **Death** may occur due to massive bleeding (hemorrhage), often following a lapse into a comatose state.

KEY TERMS

Epidemic—A situation in which a particular disease spreads rapidly through a population of people in a relatively short period of time.

Faget's sign—The simultaneous occurrence of a high fever with a slowed heart rate.

Host—The organism (such as a monkey or human) in which another organism (such as a virus or bacteria) is living.

Vector—A carrier organism (such as a fly or mosquito) which serves to deliver a virus (or other agent of infection) to a host.

Prevention

A very safe, very effective yellow fever vaccine exists. About 95% of vaccine recipients acquire long-term immunity to the yellow fever virus. Careful measures to decrease mosquito populations in both urban areas and jungle areas in which humans are working, along with programs to vaccinate all people living in such areas, are necessary to avoid massive yellow fever outbreaks.

Resources

BOOKS

Ray, C. George. "Arthropod-Borne and Other Zoonotic Viruses." In *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. 3rd ed. Ed. Kenneth J. Ryan. Norwalk, CT: Appleton & Lange, 1994.

Shope, Robert E. "Yellow Fever." In *Cecil Textbook of Medicine*, ed. J. Claude Bennett and Fred Plum. Philadelphia: W. B. Saunders Co., 1996.

Stoffman, Phyllis. *The Family Guide to Preventing and Treating 100 Infectious Diseases*. New York: John Wiley & Sons, 1995.

PERIODICALS

Farley, Dixie. "Treating Tropical Diseases." *FDA Consumer* (Jan./Feb. 1997): 26+.

Robertson, Susan E., et al. "Yellow Fever: A Decade of Reemergence." *Journal of the American Medical Association* (9 Oct. 1996): 1157+.

ORGANIZATIONS

Centers for Disease Control and Prevention. 1600 Clifton Rd., NE, Atlanta, GA 30333. (800) 311-3435, (404) 639-3311. <http://www.cdc.gov>.

Rosalyn Carson-DeWitt, MD

Yersinia enterocolitica infection *see* **Yersinosis**

Yersinia pestis *see* **Plague**

Yersinia pseudotuberculosis infection *see* **Yersinosis**

Yersinosis

Definition

Yersinosis refers to infection by a genus of bacteria known as *Yersinia*. The two sub-types that are responsible for yersinosis are *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. The diseases produced by these organisms are called "zoonoses," because the bacteria is passed to humans from animal sources.

The name *Yersinia* comes from Dr. Alexandre Yersin, who was the first person to grow a much more deadly type of *Yersinia* known as *Yersinia pestis*, the bacteria responsible for what is now known as bubonic **plague**. This article, however, will deal with the more common forms of *Yersinia*, namely *Y. enterocolitica* and *Y. pseudotuberculosis*.

Description

Yersinia are classified as gram-negative bacteria (bacteria that do not accept the color of a stain in a Gram stain test, which indicates the general chemical nature of the cell wall of the bacteria); they have a variety of appearances, and are therefore called pleomorphic. They belong to Enterobacteriacae, the large group of organisms that inhabit the intestinal tract. There are many different subtypes of *Yersinia*.

They are found worldwide and have been isolated from soil, fresh water, contaminated foods, and many wild and domestic animals. For reasons not entirely clear, disease caused by these organisms occurs more frequently in areas of northern Europe, especially Scandinavia. Infection, particularly in children ages one through four years, is quite common, though often these infections produce few symptoms. Studies have shown that infection with these bacteria is almost as common as that with *Shigella* or *Campylobacter*.

Causes and symptoms

Animals are the most important sources of bacterial infection for humans. Whether from pets or undercooked meat (especially pork), these bacteria almost always enter the human body through the mouth (oral transmission). An incubation period of one to eleven days passes before signs of disease develop. Rare cases have been transmitted by way of contaminated blood transfusions.

Yersinia produces several different types of disease. The most common form is a short-lived inflammation of the intestine known as enterocolitis. Most often the very end of the small intestine is involved, an area known as the terminal ileum. The result is **gastroenteritis**, with cramping abdominal **pain**, **fever**, and **diarrhea**. Diarrhea generally continues for two weeks or so, but can go on for many months. Up to 40% of patients also experience **nausea and vomiting**; and in one-third, inflammation of the intestine leads to bleeding.

In other patients, the same area of the intestine is involved, but instead of causing diarrhea, a syndrome resembling **appendicitis** occurs. In this syndrome, the lymph nodes surrounding the intestine are especially involved; this has lead to the term mesenteric adenitis. Although this syndrome resolves without serious consequences, it is often difficult to differentiate from appendicitis, and leads to surgery in some instances. Ultrasound exam may be able to demonstrate a normal appendix and avoid surgery. Why some patients develop symptoms of gastroenteritis, and others only inflammation, pain, and fever, is unknown.

In some patients, *Yersinia* produces infection of areas other than the intestinal tract. These include:

- Inflammation of the throat (pharyngitis) and **tonsillitis**; this can be quite severe and even lead to **death**, particularly in adults.
- Septicemia, or infection of the blood stream, with spreading of infection to other organs such as bone, meninges, kidneys, and others. Individuals with decreased immunity due to liver disease, diabetes, **cancer**, and other diseases are at increased risk for this complication.

Different parts of the body may be affected (such as joints, eyes, and urinary system) by changes in the immune system caused by *Yersinia* infection. Arthritis, which is especially frequent in Scandinavia, occurs in up to 10% of *Yersinia* infections. About one week after typical intestinal symptoms, swelling and pain in multiple joints occurs. The knees and ankles are most often involved, and become inflamed over a period of two weeks. In two-thirds of those affected, symptoms gradually resolve over one to three months without need for treatment. Rarely does chronic joint disease develop.

Inflammation of the heart muscle, called **myocarditis**, sometimes occurs together with the arthritis. In about

15-20% of patients, the skin develops a red, raised area, usually located on the shins, called **erythema nodosum**. This appears within a few weeks of the intestinal symptoms and disappears over a month or so.

Diagnosis

Identifying *Yersinia* as the cause of all or any of these symptoms is not an easy task. It is possible to grow the organism from stool cultures, but this is difficult to do unless special methods are used.

A change in antibody levels can also be used to determine the presence of infection. To be accurate, levels must be initially examined early in the illness. Therefore, it is most important for the possible diagnosis and examination to be thought of early.

Treatment

Since most of the symptoms caused by *Yersinia* are self limiting, specific antibiotic treatment is generally not needed. Patients with **dehydration** from gastroenteritis are given supportive therapy, including treatment aimed at replacing fluids.

Antibiotics are indicated, however, for those patients who develop more severe infections, such as invasion of the bloodstream (septicemia), or who develop infections at specific sites, such as bone. A variety of antibiotics have been used, but it is not clear which produces the best results.

No specific treatment is indicated for the joint, ocular, skin, or urinary symptoms that result from infection. As stated, these are not due to direct invasion by the bacteria, but are related to changes in immune reactions produced by the infection. However, treatment of those experiencing severe arthritic symptoms with NSAIDS (**nonsteroidal anti-inflammatory drugs**) or steroid injection at inflamed joints is used in selected cases.

Prognosis

As noted above, most of the time, *Yersinia* infection has an excellent outlook. However, when these bacteria invade the bloodstream or produce disease beyond the gastrointestinal tract, the outlook is less positive. This may be because more severe infections occur in those with decreased immunity. Death rate from septicemia has been reported to be as high as 50%.

Prevention

Safe food handling procedures and food-preparation practices are by far the best means of avoiding infection.

KEY TERMS

Mesenteric adenitis—Inflammation of the lymph nodes which serve the small intestine. Has symptoms similar to appendicitis.

Septicemia—Systemic disease associated with the presence of microorganisms or their toxins in the blood; blood poisoning.

Undercooked food, especially pork or other animal products, should not be eaten.

Resources

BOOKS

Campbell, Grant L., and David T. Dennis. "Other Yersinia Infections." In *Harrison's Principles of Internal Medicine*, ed. Anthony S. Fauci, et al. New York: McGraw-Hill, 1997.

Hamer, Davidson H., and Sherwood L. Gorbach. "Yersinia." In *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, ed. Mark Feldman, et al. Philadelphia: W. B. Saunders Co., 1997.

OTHER

"Bad Bug Book." Center for Food Safety and Applied Nutrition. <http://vm.cfsan.fda.gov/~mow/intro.html>.

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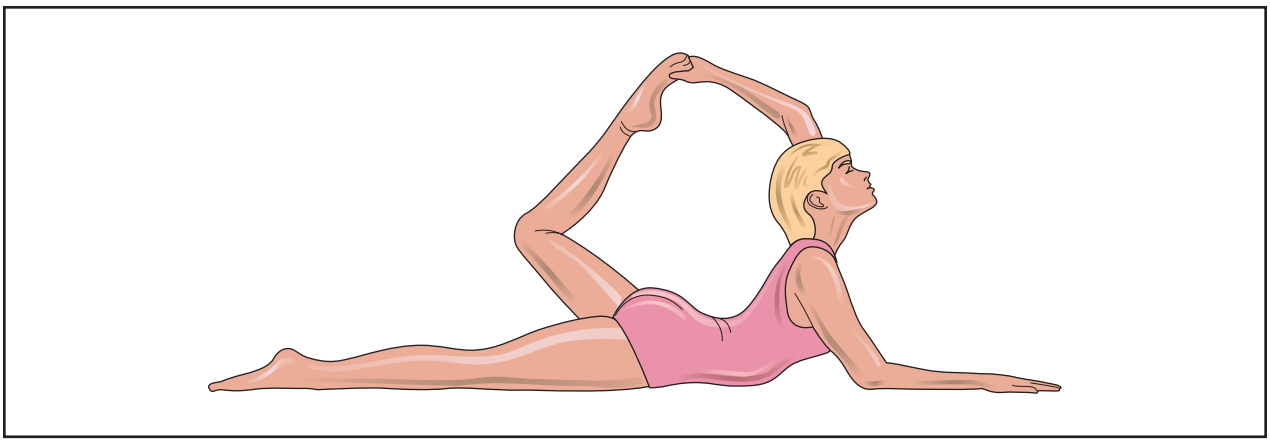
Yoga

Definition

The term *yoga* comes from a Sanskrit word which means yoke or union. Traditionally, yoga is a method joining the individual self with the Divine, Universal Spirit, or Cosmic Consciousness. Physical and mental exercises are designed to help achieve this goal, also called self-transcendence or enlightenment. On the physical level, yoga postures, called *asanas*, are designed to tone, strengthen, and align the body. These postures are performed to make the spine supple and healthy and to promote blood flow to all the organs, glands, and tissues, keeping all the bodily systems healthy. On the mental level, yoga uses breathing techniques (*pranayama*) and **meditation** (*dyana*) to quiet, clarify, and discipline the mind. However, experts are quick to point out that yoga



Yoga is a system that benefits the body, mind, and spirit by teaching self-control through a series of postures and exercises as well as through breathing, relaxation, and meditation techniques. *(Illustration by Electronic Illustrators Group.)*

is not a religion, but a way of living with health and peace of mind as its aims.

Purpose

Yoga has been used to alleviate problems associated with high blood pressure, **high cholesterol**, migraine headaches, **asthma**, shallow breathing, backaches, **constipation**, diabetes, **menopause**, **multiple sclerosis**, **varicose veins**, **carpal tunnel syndrome** and many chronic illnesses. It also has been studied and approved for its ability to promote relaxation and reduce **stress**.

Yoga can also provide the same benefits as any well-designed **exercise** program, increasing general health and stamina, reducing stress, and improving those conditions brought about by sedentary lifestyles. Yoga has the added advantage of being a low-impact activity that uses only gravity as resistance, which makes it an excellent physical therapy routine; certain yoga postures can be safely used to strengthen and balance all parts of the body.

Meditation has been much studied and approved for its benefits in reducing stress-related conditions. The landmark book,*The Relaxation Response*, by Harvard cardiologist Herbert Benson, showed that meditation and breathing techniques for relaxation could have the opposite effect of stress, reducing blood pressure and other indicators. Since then, much research has reiterated the benefits of meditation for **stress reduction** and general health. Currently, the American Medical Association recommends meditation techniques as a first step before medication for borderline **hypertension** cases.

Modern psychological studies have shown that even slight facial expressions can cause changes in the involuntary nervous system; yoga utilizes the mind/body connection. That is, yoga practice contains the central ideas that physical posture and alignment can influence a person's mood and self-esteem, and also that the mind can be used to shape and heal the body. Yoga practitioners claim that the strengthening of mind/body awareness can bring eventual improvements in all facets of a person's life.

Description

Origins

Yoga originated in ancient India and is one of the longest surviving philosophical systems in the world. Some scholars have estimated that yoga is as old as 5,000 years; artifacts detailing yoga postures have been found in India from over 3000 B.C. Yoga masters (*yogis*) claim that it is a highly developed science of healthy living that has been tested and perfected for all these years. Yoga was first brought to America in the late 1800s when Swami Vivekananda, an Indian teacher and yogi, presented a lecture on meditation in Chicago. Yoga slowly began gaining followers, and flourished during the 1960s when there was a surge of interest in Eastern philosophy. There has since been a vast exchange of yoga knowledge in America, with many students going to India to study and many Indian experts coming here to teach, resulting in the establishment of a wide variety schools. Today, yoga is thriving, and it has become easy to find teachers and practitioners throughout America. A recent Roper poll, commissioned by*Yoga Journal*, found that 11 million Americans do yoga at least occasionally and 6 million perform it regularly. Yoga stretches are used by physical therapists and professional sports teams, and the benefits of yoga are being touted by movie stars and Fortune 500 executives. Many prestigious schools of medicine have studied and introduced yoga techniques as proven therapies for illness and stress. Some medical schools, like UCLA, even offer yoga classes as part of their physician training program.

Classical yoga is separated into eight limbs, each a part of the complete system for mental, physical and spiritual well-being. Four of the limbs deal with mental and physical exercises designed to bring the mind in tune with the body. The other four deal with different stages of meditation. There are six major types of yoga, all with the same goals of health and harmony but with varying techniques: hatha, raja, karma, bhakti, jnana, and tantra yoga. **Hatha yoga** is the most commonly practiced branch of yoga in America, and it is a highly developed system of nearly 200 physical postures, movements and breathing techniques designed to tune the body to its optimal health. The yoga philosophy believes the breath to be the most important facet of health, as the breath is the largest source of *prana*, or life force, and hatha yoga utilizes *pranayama*, which literally means the science or control of breathing. Hatha yoga was originally developed as a system to make the body strong and healthy enough to enable mental awareness and spiritual enlightenment.

There are several different schools of hatha yoga in America; the two most prevalent ones are Iyengar and ashtanga yoga. Iyengar yoga was founded by B.K.S. Iyengar, who is widely considered as one of the great living innovators of yoga. Iyengar yoga puts strict emphasis on form and alignment, and uses traditional hatha yoga techniques in new manners and sequences. Iyengar yoga can be good for physical therapy because it allows the use of props like straps and blocks to make it easier for some people to get into the yoga postures. Ashtanga yoga can be a more vigorous routine, using a flowing and dance-like sequence of hatha postures to generate body heat, which purifies the body through sweating and deep breathing.

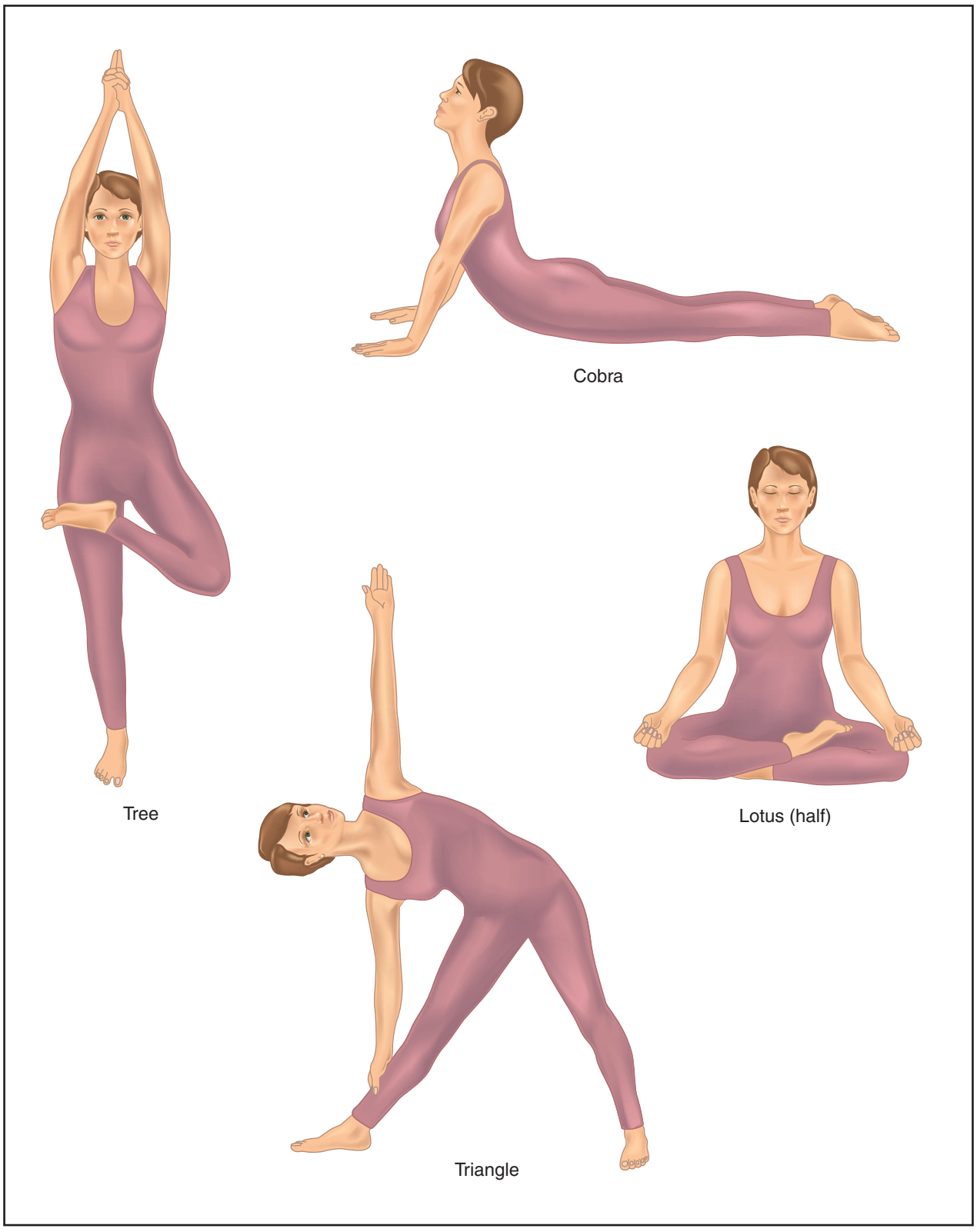
The other types of yoga show some of the remaining ideas which permeate yoga. Raja yoga strives to bring about mental clarity and discipline through meditation, simplicity, and non-attachment to worldly things and desires. Karma yoga emphasizes charity, service to others, non-aggression and non-harming as means to awareness and peace. Bhakti yoga is the path of devotion and love of God, or Universal Spirit. Jnana yoga is the practice and development of knowledge and wisdom. Finally, tantra yoga is the path of self-awareness through religious rituals, including awareness of sexuality as sacred and vital.

A typical hatha yoga routine consists of a sequence of physical poses, or asanas, and the sequence is designed to work all parts of the body, with particular emphasis on making the spine supple and healthy and increasing circulation. Hatha yoga asanas utilize three basic movements: forward bends, backward bends, and twisting motions. Each asana is named for a common thing it resembles, like the sun salutation, cobra, locust, plough, bow, eagle, tree, and the head to knee pose, to name a few. Each pose has steps for entering and exiting it, and each posture requires proper form and alignment. A pose is held for some time, depending on its level of difficulty and one's strength and stamina, and the practitioner is also usually aware of when to inhale and exhale at certain points in each posture, as breathing properly is another fundamental aspect of yoga. Breathing should be deep and through the nose. Mental concentration in each position is also very important, which improves awareness, poise and posture. During a yoga routine there is often a position in which to perform meditation, if deep relaxation is one of the goals of the sequence.

Yoga routines can take anywhere from 20 minutes to two or more hours, with one hour being a good time investment to perform a sequence of postures and a meditation. Some yoga routines, depending on the teacher and school, can be as strenuous as the most difficult workout, and some routines merely stretch and align the body while the breath and heart rate are kept slow and steady. Yoga achieves its best results when it is practiced as a daily discipline, and yoga can be a life-long exercise routine, offering deeper and more challenging positions as a practitioner becomes more adept. The basic positions can increase a person's strength, flexibility and sense of well-being almost immediately, but it can take years to perfect and deepen them, which is an appealing and stimulating aspect of yoga for many.

PATANJALI

There is little historical information available on Patanjali, who is credited with developing yoga, one of the six systems of Hindu philosophy. Several scholars suggest several persons may have developed yoga under the pseudonym of Patanjali. In any case, Patanjali existed around 150 B.C. in India. He developed yoga based on a loose set of doctrines and practices from the Upanishads, themselves a set of mystical writings. The Upanishads are part of the Aranyakas, philosophical concepts that are part of the Veda, the most ancient body of literature of Hinduism. Patanjali gave these combined philosophical and esoteric writings a common foundation in his *Yoga Sutra*, a set of 196 concise aphorisms (wise sayings) that form the principles of yoga. He also drew upon Samkhya, the oldest classic system of Hindu philosophy. Patanjali's yoga accepted Samkhya metaphysics and the concept of a supreme soul. He established an eight-stage discipline of self-control and meditation. The individual sutras (verses) lay out the entire tradition of meditation. They also describe the moral and physical disciplines needed for the soul to attain absolute freedom from the body and self.



Demonstrations of the tree, triangle, cobra, and lotus poses. The tree and triangle are good for balance and coordination. Cobra stretches the pelvic and strengthens the back. Lotus is a meditative pose. *(Illustration by Electronic Illustrators Group.)*

Yoga is usually best learned from a yoga teacher or physical therapist, but yoga is simple enough that one can learn the basics from good books on the subject, which are plentiful. Yoga classes are generally inexpensive, averaging around 10 dollars per class, and students can learn basic postures in just a few classes. Many YMCAs, colleges, and community health organizations offer beginning yoga classes as well, often for nominal fees. If yoga is part of a physical therapy program, it can be reimbursed by insurance.

Preparations

Yoga can be performed by those of any age and condition, although not all poses should be attempted by everyone. Yoga is also a very accessible form of exercise; all that is needed is a flat floor surface large enough to stretch out on, a mat or towel, and enough overhead space to fully raise the arms. It is a good activity for those who can't go to gyms, who don't like other forms of exercise, or have very busy schedules. Yoga should be done on an empty stomach, and teachers recommend waiting three or more hours after meals. Loose and comfortable clothing should be worn.

Precautions

People with injuries, medical conditions, or spinal problems should consult a doctor before beginning yoga. Those with medical conditions should find a yoga teacher who is familiar with their type of problem and who is willing to give them individual attention. Pregnant women can benefit from yoga, but should always be guided by an experienced teacher. Certain yoga positions should not be performed with a **fever**, or during menstruation.

Beginners should exercise care and concentration when performing yoga postures, and not try to stretch too much too quickly, as injury could result. Some advanced yoga postures, like the headstand and full lotus position, can be difficult and require strength, flexibility, and gradual preparation, so beginners should get the help of a teacher before attempting them.

Yoga is not a competive sport; it does not matter how a person does in comparison with others, but how aware and disciplined one becomes with one's own body and limitations. Proper form and alignment should always be maintained during a stretch or posture, and the stretch or posture should be stopped when there is **pain**, **dizziness**, or **fatigue**. The mental component of yoga is just as important as the physical postures. Concentration and awareness of breath should not be neglected. Yoga should be done with an open, gentle, and non-critical mind; when one stretches into a yoga position, it can be thought of accepting and working on one's limits. Impatience, self-criticism and comparing oneself to others will not help in this process of self-knowledge. While performing the yoga of breathing (pranayama) and meditation (dyana), it is best to have an experienced teacher, as these powerful techniques can cause dizziness and discomfort when done improperly.

KEY TERMS

Asana—A position or stance in yoga.

Dyana—The yoga term for meditation.

Hatha yoga—Form of yoga using postures, breathing methods and meditation.

Meditation—Technique of concentration for relaxing the mind and body.

Pranayama—Yoga breathing techniques.

Yogi—A trained yoga expert.

Side effects

Some people have reported injuries by performing yoga postures without proper form or concentration, or by attempting difficult positions without working up to them gradually or having appropriate supervision. Beginners sometimes report muscle soreness and fatigue after performing yoga, but these side effects diminish with practice.

Research and general acceptance

Although yoga originated in a culture very different from modern America, it has been accepted and its practice has spread relatively quickly. Many yogis are amazed at how rapidly yoga's popularity has spread in America, considering the legend that it was passed down secretly by handfuls of adherents for many centuries.

There can still be found some resistance to yoga, for active and busy Americans sometimes find it hard to believe that an exercise program that requires them to slow down, concentrate, and breathe deeply can be more effective than lifting weights or running. However, ongoing research in top medical schools is showing yoga's effectiveness for overall health and for specific problems, making it an increasingly acceptable health practice.

Resources

BOOKS

Ansari, Mark, and Lark, Liz. *Yoga for Beginners.* New York: Harper, 1999.

Bodian, Stephan, and Feuerstein, Georg. *Living Yoga*. New York: Putnam, 1993.
Carrico, Mara. *Yoga Journal's Yoga Basics*. New York: Henry Holt, 1997.
Iyengar, B.K.S. *Light on Yoga*. New York: Schocken, 1975.

PERIODICALS

Yoga Journal. P.O. Box 469088, Escondido, CA 92046. <http://www.yogajournal.com>.
Yoga International Magazine. R.R. 1 Box 407, Honesdale, PA 18431. <http://www.yimag.com>.

ORGANIZATIONS

International Association of Yoga Therapists (IAYT), 4150 Tivoli Ave., Los Angeles, CA 90066.

OTHER

<http://www.yogadirectory.com>.
<http://www.yogafinder.com>.

Douglas Dupler

"Yuppie flu" *see* **Chronic fatigue syndrome**

Z

Zenker's diverticulum *see* **Esophageal pouches**

Zidovudine *see* **Antiretroviral drugs**

Zinc deficiency *see* **Mineral deficiency**

Zinc excess *see* **Mineral toxicity**

Zolpidem *see* **Anti-insomnia drugs**

Zoonosis

Definition

Zoonosis, also called *zoonotic disease* refers to diseases that can be passed from animals, whether wild or domesticated, to humans.

Description

Although many diseases are species specific, meaning that they can only occur in one animal species, many other diseases can be spread between different animal species. These are infectious diseases, caused by bacteria, viruses, or other disease causing organisms that can live as well in humans as in other animals.

There are different methods of transmission for different diseases. In some cases, zoonotic diseases are transferred by direct contact with infected animals, much as being near an infected human can cause the spread of an infectious disease. Other diseases are spread by drinking water that contains the eggs of parasites. The eggs enter the water supply from the feces of infected animals. Still others are spread by eating the flesh of infected animals. Tapeworms are spread this way. Other diseases are spread by insect vectors. An insect, such as a flea or tick, feeds on an infected animal, then feeds on a human. In the process, the insect transfer the infecting organism.

Some zoonotic diseases are well known, such as rats (**plague**), deer tick (**Lyme disease**). Others are not as well known. For example, elephants may develop **tuberculosis**, and spread it to humans.

Causes and symptoms

The following is a partial list of animals and the diseases that they may carry. Not all animal carriers are listed, nor are all the diseases that the various species may carry.

- Bats are important **rabies** carriers, and also carry several other viral diseases that can affect humans.
- Cats may carry the causative organisms for plague, **anthrax**, cowpox, tapeworm, and many bacterial infections.
- Dogs may carry plague, tapeworm, rabies, **Rocky Mountain Spotted Fever**, and Lyme disease.
- Horses may carry anthrax, rabies, and *Salmonella* infections.
- Cattle may carry the organisms that cause anthrax, European tick-borne **encephalitis**, rabies, tapeworm, *Salmonella* infections and many bacterial and viral diseases.
- Pigs are best known for carrying tapeworm, but may also carry a large number of other infections including anthrax, **influenza**, and rabies.
- Sheep and goats may carry rabies, European tick-borne encephalitis, *Salmonella* infections, and many bacterial and viral diseases.
- Rabbits may carry plague and Q-Fever.
- Birds may carry *Campylobacteriosis* , *Chlamydia psittaci*, *Pasteurella multocida, Histoplasma capsulatum, Salmonellosis*, and others.

Zoonotic diseases may be spread in different ways. Tapeworms care often spread to humans when they eat the infected meat of fish, cattle, and swine. Other diseases are transferred by insect vectors, often blood-feeding insects that carry the cause of the disease from one animal to another.

KEY TERMS

Anthrax—A diease of wam blooded animals, particularly cattle and sheep, transmissable to humans. The disease causes severe skin and lung damage.

Bovine spongiform encephalopathy—A progressive, fatal disease of the nervous system of domestic animals. It is transmitted by eating infected food.

Lyme disease—An acute disease which is usually marked by skin rash, fever, fatigue and chills. Left untreated, it may cause heart and nervous system damage.

Q-Fever—A disease that is marked by high fever, chills and muscle pain. It is seen in North America, Europe, and parts of Africa. It may be spread by drinking raw milk, or by tick bites.

Zoonotic—A disease which can be sreap from animals to humans.

Diagnosis

Diagnosis of the disease is made in the usual manner, by identifying the infecting organism. Each disease has established symptoms and tests. Identifying the carrier may be easy, or may be more difficult when the cause is a fairly common infection. For example, tapeworms are usually species specific. Cattle, pigs, and fish all carry different species of tapeworms, although all can be transmitted to humans who eat undercooked meat containing live tapeworm eggs. Once the tapeworm has been identified, it is easy to tell which species the tapeworm came from.

Other zoonotic infections may be harder to identify. Sometimes the infection is fairly common among both humans and animals, and it is impossible to tell. Snakes may carry the bacteria ***Escherichia coli*** and *Proteus vulgaris*, but since these bacteria are already common among humans, it would be difficult to trace infections back to snakes.

Because of increased trade between nations, and changes in animal habitats, there are often new zoonotic diseases. These may be found in animals transported from one nation to another, bringing with them new diseases. In some cases, changes in the environment lead to changes in the migratory habits of animal species, bringing new infections.

Treatment

Treatment is the established treatment for the specific infection.

Prevention

Prevention of zoonotic infections may take different forms, depending on the nature of the carrier and the infection.

Some zoonotic infections can be avoided by immunizing the animals that carry the disease. Pets and other domestic animals should have rabies vaccinations, and wild animals are immunized with an oral vaccine that is encased in a suitable bait. In some places, the bait is dropped by airplane over the range of the potential rabies carrier. When the animal eats the bait, they also ingest the oral vaccine, thereby protecting them from rabies, and reducing the risk of spread of the disease. This method has been used to protect foxes, coyotes, and other wild animals.

Many zoonotic diseases that are passed by eating the meat of infected animals can be prevented by proper cooking of the infected meat. Tapeworm infestations can be prevented by cooking, and *Salmonella* infections from chickens and eggs can be prevented by being sure that both the meat and the eggs are fully cooked.

For other zoonotic diseases, programs are in place to eliminate the host, or the vector that spreads the disease. Plague is prevented by elimination of the rats—a common source of the infection—and of fleas that carry the disease from rats to humans. Efforts to control bovine spongiform encephalitis, better known as Mad Cow disease, have focused on the destruction of infected cattle to prevent spread of the disease.

Other means of prevention simply rely on care. People living in areas where Lyme disease is common are warned to take precautions against the bite of the deer tick, which transfers the disease. These precautions include not walking in tall grass, not walking bare legged, and wearing light-colored clothing so that the presence of the dark ticks can be readily seen.

Resources

PERIODICALS

"CDC improves monitoring of outbreaks." *American Medical News* (January 24, 2000).

"When man's best friend isn't." *Mother Earth News* (June/July 2000).

"The zoonotic threat: Curbing pet-to-people infections." *Dog World* (October 1999).

"Zoonoses." *Agricultural Research* (February 2000).

ORGANIZATIONS

American Association of Zoo Keepers (AAZK). Topeka Zoological Park 3601 SW 29th St., Ste. 133 Topeka, KS 66614-2054.

National Animal Disease Center Zoonotic Research Unit. 2300 Dayton Ave. PO Box 70 Ames, IA 50010.

Samuel Uretsky, PharmD

ORGANIZATIONS

The following is an alphabetical compilation of organizations listed in the *Resources* section of the main body entries. Although the list is comprehensive, it is by no means exhaustive. It is a starting point for further information, as well as other online and print sources. Many of the organizations listed provide information for multiple disorders and have links to additional related websites. E-mail addresses and web addresses listed were provided by the associations; Gale Group is not responsible for the accuracy of the addresses or the contents of the websites.

A

Academy of General Dentistry
Ste. 1200, 211 East Chicago Ave.
Chicago, IL 60611
(312) 440-4300
<http://wwwagd.org>

Academy for Guided Imagery
PO Box 2070
Mill Valley, CA 94942
(800) 726-2070

Achromatopsia Network
C/O Frances Futterman
PO Box 214
Berkeley, CA 94701-0214
<http://wwwachromat.org/how_to_join.html>

Acid Maltase Deficiency Association
PO Box 700248
San Antonio, TX 78270-0248
(210) 494-6144
<http://www.amda-pompe.org>

Acoustic Neuroma Association of Canada
Box 369 Edmonton, AB T5J 2J6
(800) 561-ANAC(2622)
(780) 428-3384
anac@compusmartab.ca
<http://www.anac.ca>

Action Against Allergy (AAA)
PO Box 278
Twickenham Middlesex, Greater London TW1 4QQ
United Kingdom

Acupressure Institute
1533 Shattuck Ave
Berkeley, CA 94709

Advancement of Women's Health Research
1828 L St NW, Ste. 625
Washington, DC 20036
(202) 223-8224
<http://www.womens-health.org>

Aerospace Medical Association
320 S Henry St
Alexandria, VA 22314-3579
(703) 739-2240
<http://www.asma.org>

Agoraphobics Building Independent Lives
3805 Cutshaw Ave, Ste. 415, Dept W
Richmond, VA 23230
(804) 353-3964
<http://www.anxietysupport.org>

Agoraphobic Foundation of Canada
PO Box 132
Chomedey, Laval, Quebec H7W 4K2
Canada

Agoraphobics In Motion
605 W 11 Mile Rd
Royal Oak, MI 48067
(248) 547-0400

Al-Anon, Al-anon Family Group, Inc
PO Box 862, Midtown Station
New York, NY 10018-0862
(800)356-9996
<http://www.recovery.org/aa>

Albert Ellis Institute
45 East 65th St
New York, NY 10021
(800) 323-4738
<http://www.rebt.org>

Alcoholics Anonymous (AA)
General Service Office
475 Riverside Dr
New York, NY 10015
(212) 870-3400
<http://www.alcoholics-anonymous.org>

Alexander Graham Bell Association for the Deaf
3417 Volta Place NW
Washington, DC 20007
(202) 337-5220
<http://www.agbell.org>

Alexander Technique International
1692 Massachusetts Ave, 3rd Floor
Cambridge, MA 02138
(888) 321-0856
Fax: (617) 497-2615
ati@ati-netcom
<http://www.ati-net.com>

Alliance of Genetic Support Groups
4301 Connecticut Ave NW, Ste. 404
Washington, DC 20008
(202)966-5557
<http://www.geneticalliance.org>

Alliance for Lung Cancer Advocacy, Support and Education
PO Box 849
Vancouver, WA 98666
(800) 298-2436
<http://www.alcase.org>

Alzheimer's Association
919 North Michigan Ave, Ste. 1000
Chicago, IL 60611
(800) 272-3900
<http://www.alz.org>

Ambiguous Genitalia Support Network
PO Box 313
Clements, CA 95227
(209) 727-0313

American Academy of Allergy Asthma and Immunology
611 East Wells St
Milwaukee, WI 53202
(800) 822-2762
<http://www.aaaai.org>

American Academy of Audiology
8201 Greensboro Dr, Ste. 300
McLean, VA 22102
(703) 610-9022
<http://audiology.org>

American Academy of Child and Adolescent Psychiatry (AACAP)
3615 Wisconsin Ave NW
Washington, DC 20016
(202) 966-7300
<http://www.aacap.org>

American Academy of Clinical Sexologists
1929 18th St NW, Ste. 1166
Washington, DC 20009
(202) 462-2122

American Academy of Cosmetic Surgery
401 N Michigan Ave
Chicago, IL 60611-4267
(313) 527-6713
<http://www.cosmeticsurgeryonline.com>

American Academy of Dermatology
930 N Meacham Road
PO Box 4014
Schaumburg, IL 60168-4014
(847) 330-0230
<http://www.aad.org>

American Academy of Emergency Medicine
611 East Wells St
Milwaukee, WI 53202
(800) 884-2236
Fax: (414) 276-3349
<http://www.aaem.org/>

American Academy of Environmental Medicine
PO Box CN 1001-8001
New Hope, PA 18938
(215) 862-4544

American Academy of Facial, Plastic, and Reconstructive Surgery
1110 Vermont Ave NW, Ste. 220
Washington, DC 20005
(800) 332-3223

American Academy of Family Physicians
11400 Tomahawk Creek Parkway
Leawood, KS 66211-2672
(913) 906-6000
<http://www.aafp.org>

American Academy of Husband-Coached Childbirth
PO Box 5224
Sherman Oaks, CA 91413
(800) 423-2397
(800) 422-4784 (in California)

American Academy of Medical Acupuncture
2520 Milvia St
Berkeley, CA 94704
(415) 841-3220

American Academy of Neurology
1080 Montreal Ave
St Paul, MN 55116
(612) 695-1940
<http://www.aan.com>

American Academy of Ophthalmology
655 Beach St
PO Box 7424
San Francisco, CA 94120-7424
<http://www.eyenet.org>

American Academy of Orthopaedic Surgeons
6300 N River Road
Rosemont, IL 60018
(847) 823-7186
<http://www.aaos.org>

American Academy of Otolaryngology-Head and Neck Surgery, Inc
One Prince St
Alexandria, VA 22314-3357
(703) 836-4444
<http://www.entnet.org>

American Academy of Pediatric Dentistry
211 East Chicago Ave, Ste. 700
Chicago, IL 60611-2616
(312) 337-2169
<http://www.aapd.org>

American Academy of Pediatrics
141 Northwest Point Blvd
Elk Grove Village, IL 60007-1098
(847) 434-4000
Fax: (847) 434-8000
<http://www.aaporg/visit/contact.htm>

American Academy of Wound Management
1255 23rd St NW
Washington, DC 20037
(202) 521-0368
<http://www.aawm.org>

American Allergy Association (AAA)
3104 E Camelback, Ste. 459
Phoenix, AZ 85016

American Amputation Foundation Inc
PO Box 250218
Hillcrest Station
Little Rock, AR 72225
(501) 666-2523

American Anorexia/Bulimia Association Inc
293 Central Park West, Ste. IR
New York, NY 10024
(212) 501-8351

American Art Therapy Association
1202 Allanson Rd
Mundelein, IL 60060-3808
(888) 290-0878
(847) 949-6064
Fax: (847)566-4580
arttherapy@ntrnet
<http://www.arttherapy.org>

American Association of Acupuncture & Oriental Medicine
4101 Lake Boone Trail, Ste. 201
Raleigh, NC 27607
(919) 787-5181

American Association of Blood Banks
8101 Glenbrook Road
Bethesda, MD 20814
(301) 907-6977
<http://www.aabb.org>

American Association of Colleges of Osteopathic Medicine
5550 Friendship Blvd, Ste. 310
Chevy Chase, MD 20815-7231
(301) 968-4100
<http://www.aacom.org>

American Association for Chronic Fatigue Syndrome
7 Van Buren St
Albany, NY 12206
(518) 435-1765
<http://weberuwashington.edu/~dedra/aacfs1.html>

American Association of the Deaf-Blind
814 Thayer Ave, Ste. 302
Silver Spring, MD 20910
(301) 588-6545

American Association of Endodontists
211 East Chicago Ave, Ste. 1100
Chicago, IL 60611-2691
(800) 872-3636
<http://www.aae.org>

American Association of Kidney Patients (AAKP)
100 S Ashley Dr, Ste. 280
Tampa, FL 33602
(800) 749-2257
<http://www.aakp.org>

American Association of Nutritional Consultants
810 S Buffalo St
Warsaw, IN 46580
(888) 828-2262

American Association for Marriage and Family Therapy
1133 15th St NW, Ste. 300
Washington, DC 20005-2710
(202) 452-0109
<http://www.aamft.org>

American Association on Mental Retardation (AAMR)
444 North Capitol St NW, Ste. 846
Washington, DC 20001-1512
(800) 424-3688
<http://www.aamr.org>

American Association of Naturopathic Physicians
601, Valley St, Ste. 105
Seattle, WA 98109
(206) 298-0126
<http://www.naturopathic.org>

American Association of Oral & Maxillofacial Surgeons
9700 W Bryn Mawr Ave
Rosemont, IL 60018
(847) 678-6200

American Association of Oriental Medicine
433 Front St
Catasququa, PA 18032
(888) 500-7999
<http://www.aaom.org>

American Association of Orthodontists
401 North Lindbergh Blvd
St Louis, MO 63141-7816
(314) 993-1700
<http://www.aaortho.org>

American Association for Respiratory Care
11030 Ables Lane
Dallas, TX 75229
(972) 243-2272
<http://www.aarc.org>

American Association of Sex Educators Counselors and Therapists
PO Box 5488
Richmond, VA 23220
<http://www.aasect.org>

American Association of Tissue Banks
1350 Beverly Road, Ste. 220-A
McLean, VA 22101
(703) 827-9582

American Behcet's Disease Association
PO Box 280240
Memphis, TN 38168-0240
<http://www.behcets.com>

American Board of Hypnotherapy
16842 Von Karman Ave, Ste. 476
Irvine, CA 92714
<http://www.hypnosis.com/>

American Botanical Council
PO Box 201660
Austin, TX 78720-1660

American Brain Tumor Association
2720 River Road, Ste. 146
Des Plaines, IL 60018-4110
(800) 886-2282
<http://www.abta.org>

American Burn Association
625 N Michigan Ave, Ste. 1530
Chicago, IL 60611
(800) 548-2876
<http://www.ameriburn.org>

American Cancer Society (National Headquarters)
1599 Clifton Road NE
Atlanta, GA 30329
(800) 227-2345
<http://www.cancer.org>

American Celiac Society
58 Musano Court
West Orange, NJ 07052
(201) 325-8837

American Chiropractic Association
1701 Clarendon Blvd
Arlington, VA 22209
(800)986-4636
<http://www.amerchiro.org/>

American Chronic Pain Association
PO Box 850
Rocklin, CA 95677-0850
(916) 632-0922
<http://memberstripod.com/~widdy/ACPA.html>

American College of Allergy Asthma & Immunology
85 West Algonquin Road, Ste. 550
Arlington Heights, IL 60005
(847) 427-1200

American College of Angiology
295 Northern Blvd, Ste. 104
Great Neck, NY 11021-4701

American College of Emergency Physicians
PO Box 619911
Dallas, TX 75261-9911
(800) 798-1822
(972) 550-0911
Fax: (972) 580-2816
info@acep.org
<http://www.acep.org/>

American College of Gastroenterology
4900 B South 31st St
Arlington, VA 22206
(703) 820-7400
<http://www.acggi.org/ct_.html>

American College of Hyperbaric Medicine
PO Box 25914-130
Houston, TX 77265
(713) 528-0657
<http://www.hyperbaricmedicine.org>

American College of Nuclear Medicine
PO Box 175
Landisville, PA 31906
(717) 898-6006

American College of Nutrition
722 Robert E Lee Dr
Wilmington, NC 20412-0927
(919) 152-1222

American College of Obstetricians and Gynecologists
409 12th St SW
PO Box 96920
Washington, DC 20090-6920
<http://www.acog.org>

American College of Osteopathic Emergency Physicians
142 E Ontario St, Ste. 550
Chicago, IL 60611
(312) 587-3709
(800) 521-3709
Fax: (312) 587-9951
<http://www.acoep.org>

American College of Radiology
1891 Preston White Dr
Reston, VA 22091
(800) 227-5463
<http://www.acr.org>

American College of Rheumatology
1800 Century Place, Ste. 250
Atlanta, GA 30345
(404) 633-3777
<http://www.rheumatology.org>

American College of Sports Medicine
401 W Michigan St
Indianapolis, IN 46202-3233
(317) 637-9200
Fax: (317) 634-7817
mkeckhaver@acsmorg
<http://www.acsm.org/>

American College of Surgeons
633 North St Clair St
Chicago, IL 60611-32311
(312) 202-5000
Fax: (312) 202-5001
postmaster@facsorg
<http://www.facs.org/>

American Council for Headache Education (ACHE)
19 Mantua Road
Mt Royal, NJ 08061
(800) 255-2243
<http://www.achenet.org>

American Council on Transplantation
PO Box 1709
Alexandria, VA 22313
(800) ACT-GIVE

American Dental Association
211 E Chicago Ave
Chicago, IL 60611
(312) 440-2500
<http://www.ada.org>

American Dental Hygienists' Association
444 North Michigan Ave
Chicago, IL 60611
(800) 847-6718

American Diabetes Association
1701 North Beauregard St
Alexandria, VA 22311
(800) 342-2383
<http://www.diabetes.org>

American Dietetic Association
216 W Jackson Blvd
Chicago, IL 60606-6995
(800) 745-0775
<http://www.eatright.org/cdr.html>

American Epilepsy Society
342 North Main St
West Hartford, CT 06117-2507
(860) 586-7505
<http://www.aesnet.org>

American Foundation for the Blind
11 Penn Plaza, Ste. 300
New York, NY 10001
(800) 232-5463

American Foundation for Homeopathy
1508 S Garfield
Alhambra, CA 91801

American Foundation for the Prevention of Venereal Disease Inc
799 Broadway, Ste. 638
New York, NY 10003
(212) 759-2069

American Foundation for Urologic Disease
1128 N Charles St
Baltimore, MD 21201
(401) 468-1800
<http://www.afud.org>

American Gastroenterological Association (AGA)
7910 Woodmont Ave 7th Floor
Bethesda, MD 20814
(310) 654-2055
aga001@aol.com
<http://www.gastro.org/index.html>

American Hair Loss Council
30 Grassy Plain Road
Bethel, CT 06801
(888) 873-9719
<http://www.ahlc.org/>

American Hearing Research Foundation
55 E Washington St, Ste. 2022
Chicago, IL 60602
(312) 726-9670
<http://www.american-hearing.org/>

American Heart Association
7272 Greenville Ave
Dallas, TX 75231-4596
(214) 373-6300
(800) 242-8721
inquire@heartorg
<http://www.americanheart.org>

American Hemochromatosis Society Inc
777 E Atlantic Ave PMB Z-363
Delray Beach, FL 33483-5352
(561) 266-9037
(888) 655-4766
ahs@eminet
<http://www.americanhs.org>

American Holistic Medical Association
4101 Lake Boone Trail, Ste. 201
Raleigh, NC 27607

American Humane Association Children's Division
63 Inverness Dr East
Englewood, CO 80112-5117
(800) 227-4645
<http://www.americanhumane.org>

American Institute for Cancer Research (AICR)
1759 R St NW
Washington, DC 20009
(800) 843-8114
<http://www.aicr.org>

American Institute of Nutrition
9650 Rockville Pike
Bethesda, MD 20814-3990
(301) 530-7050

American Institute of Stress
124 Park Ave
Yonkers, NY 10703
(914) 963-1200
<http://www.stress.org>

American Institute of Ultrasound in Medicine
14750 Sweitzer Lane, Ste. 100
Laurel, MD 20707-5906
(800) 638-5352
<http://www.aium.org>

American Institute of Vedic Studies
PO Box 8357
Santa Fe NM 87504
(505) 983-9385

American Kidney Foundation
6110 Executive Blvd #1010
Rockville, MD 20852
(800) 638-8299

American Kidney Fund (AKF)
Ste. 1010 6110 Executive Blvd
Rockville, MD 20852
(800) 638-8299
<http://www.arboncom/kidney>

American Leprosy Missions
1 ALM Way
Greenville SC 29601
(800)LEPROSY

American Liver Foundation
1425 Pompton Ave
Cedar Grove, NJ 07009
(800) 223-0179
<http://www.liverfoundation.org>

American Lung Association
1740 Broadway
New York, NY 10019
(800) 586-4872
(212) 315-8700
<http://www.lungusa.org>

American Lyme Disease Foundation Inc
Mill Pond Offices
293 Route 100, Ste. 204
Somers, NY 10589
(800) 876-LYME
<http://www.w2com/docs2/d5/lyme.html>

American Medical Association
515 N State St
Chicago, IL 60610
(312) 464-5000
<http://www.ama-assn.org/>

American Optometric Association
243 North Lindbergh Blvd
St Louis, MO 63141
(314) 991-4100
<http://www.aoanet.org>

American Oriental Bodywork Therapy Association
50 Maple Place
Manhassett, NY 11030

American Orthopedic Foot and Ankle Society
222 South Prospect
Park Ridge, IL 60068

American Orthopaedic Society for Sports Medicine
6300 N River Road, Ste. 200
Rosemont, IL 60018
(847) 292-4900
<http://www.sportsmed.org>

American Pain Society
4700 W Lake Ave
Glenview, IL 60025
(847) 375-4715
<http://www.ampainsoc.org>

American Parkinson Disease Association
60 Bay St, Ste. 401
Staten Island, NY 10301
(800) 223-2732
<http://www.apdaparkinson.org>

American Podiatric Medical Association
9312 Old Georgetown Road
Bethesda, MD 20814-1698
(301) 571-9200
<http://www.apma.org>

American Podiatry Association
20 Chevy Chase Circle NW
Washington, DC 20015

American Polarity Therapy Association
PO Box 19858
Boulder, CO 80308
(303) 545-2080
Fax: (303) 545-2161

American Physical Therapy Association
1111 North Fairfax St
Alexandria, VA 22314
(800) 999-2782
<https://www.apta.org>

American Porphyria Foundation
PO Box 22712
Houston, TX 77227
(713) 266-9617
<http://www.enterprise.net/apf/>

American Pseudo-Obstruction & Hirschsprung's Society
158 Pleasant St
North Andover, MA 01845
(978)685-4477

American Psychiatric Association
1400 K St NW
Washington, DC 20005
(888) 357-7924
<http://www.psych.org>

American Psychological Association (APA)
750 First St NE
Washington, DC 20002-4242
(202) 336-5700
<http://www.apa.org>

American Psychotherapy & Medical Hypnosis Association
210 S Sierra
Reno, NV 89501
<http://membersxoom.com/Hypnosis/>

American Red Cross
PO Box 37243
Washington, DC 20013
<http://www.redcross.org>

American Skin Association Inc
150 E 58th St, 3rd floor
New York, NY 10155-0002
(212) 688-6547

American Sleep Apnea Association
1424 K St NW, Ste. 302
Washington, DC 20005
(202) 293-3650
<http://www.sleepapnea.org>

American Sleep Disorders Association
1610 14th St NW, Ste. 300
Rochester, MN 55901
(507) 287-6006
<http://www.asda.org>

American Social Health Association
PO Box 13827 Research
Triangle Park, NC 27709
(800) 227-8922
<http://www.ashastd.org>

American Society of Addiction Medicine
4601 North Park Ave Arcade, Ste. 101
Chevy Chase, MD 20815
(301) 656-3920
<http://www.asam.org>

American Society of Cataract and Refractive Surgery
4000 Legato Road, Ste. 850
Fairfax, VA 22033-4055
(703) 591-2220
<http://www.ascrs.org>

American Society of Clinical Hypnosis
200 E Devon Ave
Des Plaines, IL 60018

American Society of Clinical Oncology
225 Reinekers Lane, Ste. 650
Alexandria, VA 22314
(703) 299-0150
<http://www.asco.org>

American Society of Clinical Pathologists
2100 West Harrison St
Chicago, IL 60612
(312) 738-1336
<http://www.ascp.org/index.asp>

American Society of Colon and Rectal Surgeons
85 W Algonquin Road, Ste. 550
Arlington Heights, IL 60005
(847)290-9184

American Society for Colposcopy and Cervical Pathology
20 W Washington St, Ste. #1
Hagerstown, MD 21740
(800) 787-7227
<http://www.asccp.org>

American Society for Dermatologic Surgery
930 N Meacham Road
PO Box 4014
Schaumburg, IL 60168-4014
(847) 330-9830
<http://www.asds-net.org>

American Society of Extra-Corporeal Technology
11480 Sunset Hills Rd, Ste. 210E
Reston, VA 20190
(703) 435-8556
<http://www.amsect.org>

American Society for Gastrointestinal Endoscopy
13 Elm St Manchester, MA 01944
(508) 526-8330
<http://www.asgeorg/doc/201>

American Society of Hematology
1200 19th St NW, Ste. 300
Washington, DC 20036-2422
(202) 857-1118
<http://www.hematology.org>

American Society of Human Genetics
9650 Rockville Pike
Bethesda, MD 20814-3998
(301) 571-1825
<http://www.faseb.org/genetics/ashg/ashgmenu.htm>

American Society of Hypertension
515 Madison Ave, Ste. 1212
New York, NY 10022
(212) 644-0650
<http://www.ash-us.org>

American Society for Laser Medicine and Surgery
2404, Ste.wart Square
Wausau, WI 54401
(715) 845-9283
<http://www.aslms.org>

American Society of Microbiology
1752 N St NW
Washington, DC 20036
(202) 737-3600
<http://www.asmusa.org>

American Society of Nuclear Cardiology
9111 Old Georgetown Road
Bethesda, MD 20814-1699
(301) 493-2360
Fax: (301) 493-2376
admin@asnc.org
<http://www.asnc.org/>

American Society of Ophthalmic Plastic and Reconstructive Surgery
1133 West Morse Blvd #201
Winter Park, FL 32789
(407) 647-8839
<http://www.asoprs.org>

American Society of Plastic and Reconstructive Surgeons
44 E Algonquin Rd
Arlington Heights, IL 60005
(847) 228-9900
<http://www.plasticsurgery.org>

American Society for Prophylaxis in Obstetrics/LAMAZE (ASPO /LAMAZE)
1840 Wilson Blvd, Ste. 204
Arlington, VA 22201
(800) 368-4404

American Society of Radiologic Technologists
15000 Central Ave SE
Albuquerque NM 87123-3917
(505) 298-4500
<http://www.asrt.org>

American Society for Reproductive Medicine
1209 Montgomery Highway
Birmingham, AL 35216-2809
(205) 978-5000
<asrm@asrm.com>
<http://www.asrm.com>

American Society for Surgery of the Hand
6300 N River Rd, Ste. 600
Rosemont, IL 60018
<http://www.hand-surg.org>

American Speech-Language-Hearing Association
10801 Rockville Pike
Rockville, MD 20852
(800) 638-8255
<http://www.asha.org>

American Thoracic Society
1740 Broadway
New York, NY 10019
(212) 315-8700
<http://www.thoracic.org>

American Thyroid Association Inc
Montefiore Medical Center
111 E 210th St
Bronx, NY 10467
<http://www.thyroid.org>

American Tinnitus Association
PO Box 5
Portland, OR 97207
(503) 248-9985
tinnitus@ata.org

American Trauma Society
8903 Presidential Pkwy, Ste. 512
Upper Marlboro, MD 20227
(800) 556-7890
<http://www.amtrauma.org>

American Urological Association
1120 North Charles St
Baltimore, MD 21201-5559
(410) 727-1100
<http://www.auanet.org/index_hicfm>

Amputee Coalition of America
PO Box 2528
Knoxville, TN 37901-2528
(888) 267-5669
<http://www.amputee-coalition.org>

Amyloidosis Network International
7118 Cole Creek Dr
Houston, TX 77092-1421
(888) 1AMYLOID
<http://www.health.gov/nhic/Scripts/Entrycfm?HRCode=HR2397>

Anorexia Nervosa and Related Eating Disorders Inc
PO Box 5102
Eugene, OR 97405
(541) 344-1144

Anxiety Disorders Association of America
11900 Park Lawn Dr, Ste. 100
Rockville, MD 20852
(800) 545-7367
<http://www.adaa.org>

Aplastic Anemia Foundation of America
PO Box 613
Annapolis, MD 21404
(800)747-2820
<http://www.aplastic.org>

The Arc
900 Varnum St NE
Washington, DC 20017
(202) 636-2950
<http://thearc.org>

Arc of the United States (formerly Association for Retarded Citizens of the US)
500 East Border St, Ste. 300
Arlington, TX 76010
(817) 261-6003
<http://thearc.org>

Arteriovenous Malformation Support Group
168 Six Mile Canyon Road
Dayton, NV 89403
(702) 246-0682

Arthritis Foundation
1300 W Peachtree St
Atlanta, GA 30309
(800) 283-7800
<http://www.arthritis.org>

Association for the Advancement of Gestalt Therapy
400 East 58th St
New York, NY 10022
(212) 486-1581
<http://www.aagt.org>

Association for Applied Psychotherapy and Biofeedback
10200 W 44th Ave, Ste. 304
Wheat Ridge, CO 80033-2840
(303) 422-8436
<http://www.aapb.org>

Association of Birth Defect Children
3526 Emerywood Lane
Orlando, FL 32806
(305) 859-2821

Association for the Bladder Exstrophy Community
PO Box 1472
Wake Forest, NC 27588-1472
(919) 624-9447
<http://www.bladderexstrophycom/support.htm>

Association for the Care of Children's Health (ACCH)
7910 Woodmont Ave, Ste. 300
Bethesda, MD 20814
(800) 808-2224

Association for the Cure of Cancer of the Prostate (CaPCure)
1250 Fourth St, Ste. 360
Santa Monica, CA 90401
(800) 757-CURE
<http://www.capcure.org>

Association for Glycogen Storage Disease
PO Box 896
Durant, IA 52747-9769
(319) 785-6038

Association for Neuro-Metabolic Disorders
5223 Brookfield Lane
Sylvania, OH 43560-1809
(419) 885-1497

Association of SIDS and Infant Mortality Programs
Minnesota SID Center Children's Hospitals and Clinics
2525 Chicago Ave S
Minneapolis, MN 55404
(612) 813-6285
<http://www.asip1.org>

Association for Spina Bifida and Hydrocephalus
42 Park Rd
Peterborough PE1 2UQ
United Kingdom
0173 355 5988
Fax: 017 3355 5985
postmaster@asbahorg
<http://www.asbahdemon.co.uk>

Asthma and Allergy Foundation of America
1233 20th St NW, Ste. 402
Washington, DC 20036
(800) 727-8462
<http://www.aafa.org>

Aston Training Center
P O Box 3568
Incline Village, NV 89450
(775) 831-8228
Astonpat@aolcom
<http://www.aston-patterning.com>

Audiology Awareness Campaign
3008 Millwood Ave

Columbia SC 29205
(800) 445-8629

Auditory-Verbal International
2121 Eisenhower Ave, Ste. 402
Alexandria, VA 22314
(703) 739-1049
<avi@auditory-verbal.org>
<http://www.auditory-verbal.org/contact.htm>

Autism Research Institute
4182 Adams Ave
San Diego, CA 92116
(619) 281-7165

Autism Society of America
7910 Woodmont Ave, Ste. 300
Bethesda, MD 20814-3067
(800) 328-8476
<http://www.autism-society.org>

Autism Network International
PO Box 448
Syracuse, NY 13210

Ayurveda Holistic Center
Bayville
Long Island, NY
(516)759-7731
mail@Ayurvedahccom
<http://www.Ayurvedahc.com>

Ayurvedic Institute
11311 Menaul NE
Albuquerque, NM 87112
(505)291-9698
info@Ayurveda.com
<http://www.Ayurveda.com>

Ayurvedic and Naturopathic Medical Clinic
10025 NE 4th St
Bellevue, WA 98004
(206)453-8022

B

Bastyr University of Natural Health Sciences
144 NE 54th St
Seattle, WA 98105
(206) 523-9585

Baylor College of Medicine
1 Baylor Plaza
Houston, TX 77030
(713) 798-4951
<http://publicbcmtmc.edu>

Beck Institute
GSB Building City Line and Belmont Aves, Ste. 700
Bala Cynwyd, PA 19004-1610
(610) 664-3020
<http://www.beckinstitute.org>

Behcet's Organization Worldwide Head Office
PO Box 27
Watchet Somerset TA23 OYJ
United Kingdom
<http://www.behcets.org>

Bell's Palsy Research Foundation
9121 E Tanque Verde, Ste. 105-286
Tucson, AZ 85749
(520) 749-4614

Beryllium Support Group
PO Box 2021
Broomfield, CO 80038-2021
(303) 412-7065
<http://www.dimensional.com/~mhj>

Better Hearing Institute
515 King St, Ste. 420
Alexandria, VA 22314
(703) 684-3391

Biofeedback Certification Institute of America
10200 W 44th Ave, Ste. 310
Wheat Ridge, CO 80033
(303) 420-2902

Bladder Health Council American Foundation for Urologic Disease
300 West Pratt St, Ste. 401
Baltimore, MD 21201
(800) 242-2383
(410) 727-2908

Brain Aneurysm Foundation Inc
66 Canal St
Boston, MA 02114
(617) 723-3870
<http://neurosurgerymghharvard.edu/baf>

Brain Injury Association of America
105 North Alfred St
Alexandria, VA 22314
(800) 444-6443
<http://www.biausa.org>

Brain Tumor Information Services
Box 405, Room J341
University of Chicago Hospitals
5841 S Maryland Ave
Chicago, IL 60637
(312) 684-1400

British Leprosy Relief Association LEPRA
Fairfax House
Causton Road
Colchester Essex CO1 1PU
United Kingdom

British Coalition of Heritable Disorders of Connective Tissue
Rochester House
5 Aldershot Road
Fleet Hampshire GU13 9NG
United Kingdom
(012) 52-810472

C

California Colon Hygienist Society
333 Miller Ave, Ste. 1
Mill, Valley, CA 94941
(415) 383-7224

Canadian Society for Mucopolysaccharide and Related Diseases
PO Box 64714
Unionville ONT L3R-OM9
Canada
(905) 479-8701
(800) 667-1846
<http://www.mpssociety.ca>

Canadian HIV/AIDS Clearinghouse
1565 Carling Ave, Ste. 400
Ottawa ON K1Z 8R1
Canada
(877) 999-7740
<http://www.clearinghousecpha.ca/clearinghouse_e.htm>

Canadian MEN Society
PO Box 100
Meola Saskatchewan SOM 1XO
Canada
(306) 892-2080

Canadian 22q Group
320 Cote St Antoine West
Montreal Quebec H3Y 2J4
Canada

Cancer Care Inc
275 Seventh Ave
New York, NY 10001
(800) 813-HOPE
<http://www.cancercare.org>

Cancer Group Institute
1814 NE Miami Gardens Dr
North Miami Beach, FL 33179
(305) 651-5070
<http://www.cancergroup.com/em19.html>

Cancer Research Institute (National Headquarters)
681 Fifth Ave
New York, NY 10022
(800) 992-2623
<http://www.cancerresearch.org>

Cancer Prevention Coalition
2121 West Taylor St
Chicago, IL 60612
(312) 996-2297
<http:\\www.preventcancer.com>

Cancer Group Institute
17620 9th Ave NE

North Miami Beach, FL 33162
(305) 493-1980
<http://www.cancergroup.com>

Cancer Hope Network
Ste. A Two North Rd
Chester, NJ 07930
(877) HOPENET
<http://www.cancerhopenetwork.org>

Cancer Information Service National Cancer Institute
Building 31, Room 10A19
9000 Rockville Pike
Bethesda, MD 20892
(800)4-CANCER
<http://www.nci.nih.gov/cancerinfo/index.html>

CancerNet
National Cancer Institute 9000 Rockville Pike
Bldg 31, Rm 10A16
Bethesda, MD 20892
(800) 422-6237
<http://www.icicncinih.gov>

Carcinoid Cancer Foundation Inc
1751 York Ave
New York, NY 10128
(212) 722-3132
<http://www.carcinoid.org>

Cardiac Arrhythmia Research and Education Foundation (CARE)
2082 Michelson Dr #301
Irvine, CA 92612
(800) 404-9500
<http://www.longqt.com>

Celiac Disease Foundation
13251 Ventura Blvd, Ste. 1
Studio City, CA 91604-1838
(818) 990-2354
<http://www.cdf@celiac.org>

Celiac Sprue Association/United State of America (CSA/USA)
PO Box 31700
Omaha, NE 68131-0700
(402) 558-0600

Center for Cell and Gene Therapy
Baylor College of Medicine
1102 Bates St, Ste. 1100
Houston, TX 77030-2399
(713) 770-4663
<http://www.bcmtmc.edu/genetherapy>

Center for Devices and Radiological Health
United States Food and Drug Administration
1901 Chapman Ave
Rockville, MD 20857
(301) 443-4109
<http://www.fda.gov/cdrh>

Center for Fertility and In Vitro Fertilization Loma Linda University
11370 Anderson St
Loma Linda, CA 92354
(909) 796-4851
<http://www.llu.edu/llumc/fertility>

Center for Holistic Urology
161 Fort Washington Ave
New York, NY 10032
(212) 305-0347
<http://www.holisticurology.com>

Center for Mind/Body Medicine
PO Box 1048
La Jolla, CA 92038
(619)794-2425

Center for Mindfulness
University of Massachusetts Medical Center
55 Lake Ave North
Worcester, MA 01655
(508) 856-2656
<http://www.umassmed.edu/cfm>

Center for Occupational and Environmental Medicine
7510 Northforest Dr
North Charleston, SC 29420
(843) 572-1600
<http:\\www.coem.com>

Center for the Study of Anorexia and Bulimia
1 W 91st St
New York, NY 10024
(212) 595-3449

Center for Taste and Smell Disorders
University of Colorado Health Sciences Center
4200 E Ninth Ave
Denver, CO 80262
(303) 315-5660
<http://www.hsccolorado.edu>

Centers for Disease Control and Prevention
1600 Clifton Rd NE
Atlanta, GA 30333
(800) 311-3435
(404) 639-3311
<http://www.cdc.gov>

Central Institute for the Deaf
Washington University
St Louis MO
<http://cidmacwustl.edu>

Chalice of Repose Project at St Patrick Hospital
312 East Pine St
Missoula, MT 59802
(406) 329-2810
Fax: (406) 329-5614
<http://www.saintpatrick.org/chalice/>

Charcot Marie Tooth Association (CMTA)
2700 Chestnut Parkway
Chester, PA 19013
(610) 499-9264
(800) 606-CMTA
Fax: (610) 499-9267
cmtassoc@aol.com
<www.charcot-marie-tooth.org>

Child Abuse Prevention Center of Utah
2955 Harrison Blvd #102
Ogden UT 84403
(888) 273-0071

Childbirth Education Foundation
PO Box 5
Richboro, PA 18954
(215) 357-2792

Children Living with Inherited Metabolic Diseases
The Quadrangle Crewe Hall Weston Rd
Crewe Cheshire CW1-6UR
United Kingdom
127 025 0221
Fax: 0870-7700-327
<http://www.climb.org.uk>

Children's Gaucher Research Fund
PO Box 2123
Granite Bay, CA 95746-2123
(916) 797-3700
Fax: (916) 797-3707
<http://www.childrensgaucher.org>

Children's Blood Foundation
333 East 38th St Room 830
New York, NY 10016-2745
(212) 297-4336
cfg@nyhmedcornell.edu

Children's Brittle Bone Foundation
7701 95th St
Pleasant Prairie, WI 53158
(847) 433-498
<http://www.cbbf.org>

Children's Health Information Network
1561 Clark Dr
Yardley, PA 19067
(215) 493-3068
<http://www.tchin.org>

Children's Organ Transplant Association Inc
2501 COTA Dr
Bloomington, IN 47403
(800) 366-2682
<http://www.cota.org>

Children's PKU Network (CPN)
3790 Via De La, VA lle, Ste. 120
Del Mar, CA 92014
(800) 377-6677
<http://www.pkunetwork.org/>

Chinese National Chi Kung Institute
PO Box 31578
San Francisco, CA 94131
(800) 824-2433

Chromosome Deletion Outreach Inc
PO Box 724
Boca Raton, FL 33429-0724
(888) 236-6680

Chromosome 18 Registry & Research Society
6302 Fox Head
San Antonio, TX 78247
(210) 657-4968
<http://www.chromosome18.org>

Chronic Granulomatous Disease Association
2616 Monterey Road
San Marino, CA 91108-1646
(818) 441-4118

Chronic Pain Outreach
822 Wycliff Ct
Manassas, VA 22110
(703) 368-7357

CMT International
1 Springbank Dr
St Catherine's ONT L2S2K1
Canada
(905) 687-3630
<http://www.cmtint.org>

Cocaine Anonymous
6125 Washington Blvd, Ste. 202
Culver City, CA 90232
(800) 347-8998

Cochlear Implant Club International
5335 Wisconsin Ave NW, Ste. 440
Washington, DC 20015-2052
(202) 895-2781
<http://www.cici.org>

College of American Pathologists
325 Waukegan Road
Northfield, IL 60093
(800) 323-4040
<http://www.cap.org>

College of Maharishi Ayur-Ved Maharishi International University
1000 4th St
Fairfield, IA 52557
(515) 472-7000

Coma Recovery Association Inc
570 Elmont Rd, Ste. 104
Elmont, NY 11003
(516) 355-0951

Compassionate Friends
PO Box 3696
Oak Brook, IL 60522
(877) 969-0010
<http:www./compassionatefriends.org>

Congenital Heart Anomalies Support Education and Resources (CHASER)
2112 North Wilkins Rd
Swanton, OH 43558
(419) 825-5575
<http://www.csun.edu/~hfmth006/chaser>

Congenital Heart Disease Information and Resources
1561 Clark Dr
Yardley, PA 19067
<http://www.tchin.org>

Congenital Nevus Support Group
1400 South Joyce St
Number C-1201
Arlington, VA 22202
(703) 920-3249

Cooley's Anemia Foundation Inc
129-09 26th Ave #203
Flushing, NY 11354
(800) 522-7222
(718) 321-2873
<http://www.thalassemia.org>

Council for Homeopathic Certification
PO Box 157
Corte Madera, CA 94976

Cri du Chat Society
Dept of Human Genetics
Box 33, MCV Station
Richmond, VA 23298
(804) 786-9632

Crohn's and Colitis Foundation of America Inc
386 Park Ave South
17th Floor
New York, NY 10016-8804
(800) 932-2423

Cystic Fibrosis Foundation
6931 Arlington Road
Bethesda, MD 20814
(800) 344-4823
<http://www.cff.org>

Cystinuria Support Network
21001 NE 36th St
Redmond, WA 98053
(425) 868-2996
<http://www.cystinuria.com>

D

Deafness Research Foundation
1225 I St NW
No 500
Washington, DC 20005

Depression After Delivery (DAD)
PO Box 1282
Morrisville, PA 19067
(800) 944-4773

Dermatology College of Medicine
University of Iowa
200 Hawkins Dr
Iowa City, IA 52242
(319) 356-2274
<http://traydermatologyuiowa.edu>

Dermatomyositis and Polymyositis Support Group
146 Newtown Road
Southampton SO2 9HR
United Kingdom

Digestive Disease National Coalition
507 Capitol Court NE, Ste. 200
Washington, DC 20003
(202) 544-7497
<http://www.ddnc.org>

Digestive Health Initiative
7910 Woodmont Ave #914
Bethesda, MD 20814
(800) 668-5237
<http://www.gastro.org/dhi.html>

Divers Alert Network
The Peter B Bennett Center
6 West Colony Place
Durham, NC 27705
(800) 446-2671
<http://www.diversalertnetwork.org>

E

Ear Foundation
1817 Patterson St
Nashville, TN 37203
(800) 545-4327
<http://www.earfoundation.org>

Eating Disorder Awareness & Prevention Inc
603, Stewart St, Ste. 803
Seattle, WA 98101
(206) 382-3587

Edward Bach Centre
Mount Vernon Bakers Lane
Sotwell Oxon OX10 OPX
United Kingdom
centre@bachcentre.com
<http://www.bachcentre.com>

Elhers-Danlos National Foundation
6399 Wilshire Blvd, Ste. 203
Los Angeles, CA 90048
(323) 651-3038
Fax: (323) 651-1366
<http://www.ednf.org>

Ehlers-Danlos Support Group - UK
PO Box 335
Farnham Surrey GU10 1XJ

United Kingdom
01252 690 940
<http://www.atvndirect.co.uk>

Emphysema Anonymous Inc
PO Box 3224
Seminole, FL 34642
(813)391-9977

Endocrine Society
4350 East West Highway, Ste. 500
Bethesda, MD 20814-4410
(301) 941-0200
Fax: (301) 941-0259
endostaff@endo-society.org

Endometriosis Association International Headquarters
8585 North 76th Place
Milwaukee, WI 53223
(800) 992-3636
<http://EndometriosisAssn.org>

Environmental Health Center
1025 Connecticut Ave NW
Washington, DC 20036
(202) 293-2270

Epilepsy Concern International Service Group
1282 Wynnewood Dr
West Palm Beach, FL 33417
(407) 683-0044

Epilepsy Foundation of America
4351 Garden City Dr, Ste. 406
Landover, MD 20785-2267
(301) 459-3700
(800) 332-1000
<http://www.epilepsyfoundation.org>

ERIC Clearinghouse on Assessment and Evaluation
1131 Shriver Laboratory
Bldg 075
University of Maryland
College Park, MD 20742
(800) 464-3742
<http://www.ericae.net>

Extracorporeal Life Support Organization
1327 Jones Dr, Ste. 101
Ann Arbor MI 48105
(734) 998-6600
<http://www.elsomedumich.edu>

EyesOnThePrizeOrg
446 S Anaheim Hills Road #108
Anaheim Hills, CA 92807
<http://www.eyesontheprize.org>

F

Familial Polyposis Registry
Department of Colorectal Surgery
Cleveland Clinic Foundation
9500 Euclid Ave
Cleveland, OH 44195-5001
(216) 444-6470

Family Caregiver Alliance
425 Bush St, Ste. 500
San Francisco, CA 94108
(800) 445-8106
<http://www.caregiver.org>

Fasting Center International
32 West Anapurna St #360
Santa Barbara, CA 93101
<http://www.fasting.com>

Federal Drug Administration
5600 Fishers Lane
Rockville, MD 20857
(800) 532-4440
<http://www.fda.gov>

Federation for Children With Special Needs
1135 Tremont St, Ste. 420
Boston, MA 02120
(617) 236-7210
<http://www.fcsn.org>

Federation of Feminist Women's Health Centers
1469 Humboldt Rd, Ste. 200
Chico, CA 96928
(530) 891-1911

Feldenkrais Guild of North America
3611 SW Hood Ave, Ste. 100
Portland, OR 97201
(800) 775-2118
(503) 221-6612
Fax: (503) 221-6616
<http://www.feldenkrais.com/>

Female Sexual Medicine Center
UCLA Medical Center
924 Westwood Blvd, Ste. 520
Los Angeles, CA 90024
(310) 825-0025
<http://www.newshe.com>

Fetal Alcohol Syndrome Family Resource Institute
PO Box 2525
Lynnwood, WA 98036
(253) 531-2878
(800) 999-3429
<http://www.fetalalcoholsyndrome.org>

5p- Society
7108 Katella Ave. #502
Stanton,, CA 90680
(888) 970-0777
<http://www.fivepminus.org>

Florida Institute of Psychophysical Integration: Quantum Balance
5837 Mariner Dr
Tampa, FL 33609-3411
(813) 186-2273
Fax: (813) 287-2870
DrJoy@JohnsonMail.com

Flower Essence Society
PO Box 459
Nevada City, CA 95959
(800) 736-9222 (US & Canada)
Fax: (530) 265-0584
mail@flowersociety.org
<http://www.flowersociety.org>

Food and Drug Administration
Office of Inquiry and Consumer Information
5600 Fisher Lane
Room 12-A-40
Rockville, MD 20857
(301) 827-4420
<http://www.fda.gov/fdahomepage.html>

Food and Nutrition Information Center
10301 Baltimore Blvd
Room 304
Beltsville, MD 20705-2351
<http://www.nalusda.gov/fnic>

Foundation Fighting Blindness
Executive Plaza I, Ste. 800
11350 McCormick Road
Hunt, Valley, MD 21031-1014
(888) 394-3937
<http://www.blindness.org>

Foundation for Ichthyosis and Related Skin Types
650 N Cannon Ave, Ste. 17
Landsdale, PA 19446
(215) 631-1411
(800) 545-3286
Fax: (215) 631-1413
<http://www.scalyskin.org>

Frontier's International Vitiligo Foundation
4 Rozina Court
Owings Mills, MD 21117
(301) 594-0958

G

Gamblers Anonymous International Service Office
PO Box 17173
Los Angeles, CA 90017
(213) 386-8789
Fax: (213) 386-0030
<http://www.gamblersanonymous.org/>

Gay and Lesbian Medical Association
459 Fulton St, Ste. 107
San Francisco, CA 94102
(415) 225-4547
<http://www.glma.org>

Gluten Intolerance Group
PO Box 23053
Seattle, WA 98102-0353
(206) 325-6980

GriefNet
PO Box 3272
Ann Arbor MI 48106
<http://rivendell.org>

Guide Dogs for the Blind
PO Box 1200
San Rafael, CA 94915
(415) 499-4000

Guillain-Barré Syndrome Foundation International
PO Box 262
Wynnewood, PA 19096
(610) 667-0131
(610) 667-0131
<http://www.webmast.com/gbs>

Gynecologic Cancer Foundation
401 North Michigan Ave
Chicago, IL 60611
(800) 444-4441
<http://www.wcn.org>

H

Hairy Cell Leukemia Research Foundation
2345 County Farm Lane
Schaumburg, IL 60194
(800) 693-6173

HCF Nutrition Research Foundation Inc
PO Box 22124
Lexington, KY 40522
(606) 276-3119

Head Injury Hotline
PO Box 84151
Seattle, WA 98124
(206) 621- 8558
<http://www.headinjury.com>

Head Trauma Support Project Inc
2500 Marconi Ave, Ste. 203
Sacramento, CA 95821
(916) 482-5770

Health Services and Resources Administration
Division of Organ Transplantation
Room 11A-22
5600 Fishers Lane
Rockville, MD 20857

Hear Now
9745 E Hampden Ave, Ste. 300
Denver, CO 80231
(800) 648-HEAR
(202) 651-5258

Hearing Industries Association
1800 M St NW
Washington, DC 20036
(202) 651-5258

Hearing Loss Link
2600 W Peterson Ave, Ste. 202
Chicago, IL 60659
(312) 743-1032
(312) 743-1007 (TDD)

Heimlich Institute
PO Box 8858
Cincinnati, OH 45208
heimlich@iglou.com
<http://www.heimlichinstitute.org/index.htm>

Hellerwork
406 Berry St
Mt Shasta, CA 96067
(530) 926-2500
<http://www.hellerwork.com>

Hemochromatosis Foundation Inc
PO Box 8569
Albany, NY 12208-0569
(518) 489-0972
skleiner@shivahuntercuny.edu
<http://www.hemochromatosis.org>

Hepatitis B Foundation
101 Greenwood Ave, Ste. 570
Jenkintown, PA 19046
(215) 884-8786
info@hepb.org

Herb Research Foundation
1007 Pearl St, Ste. 200
Boulder, CO 80302
(303) 449-2265
<http://www.herbs.org>

Hermansky-Pudlak Syndrome Network Inc
One South Road
Oyster Bay, NY 11771-1905
(800) 789-9477
appell@theonramp.net

Hirshberg Foundation for Pancreatic Cancer Research
375 Homewood Rd
Los Angeles, CA 90049
(310) 472-6310
<http://www.pancreatic.org>

Histiocytosis Association of America
302 North Broadway
Pitman, NJ 08071
(800) 548-2758 (USA and Canada)
<http://www.histio.org>

Homeopathic Educational Services
2124B Kittredge St
Berkeley, CA 94704
(510) 649-0294
Fax: (510) 649-1955

Hospice Foundation of America
2001 S St NW, Ste. 300
Washington, DC 20009
(800) 854-3402
<http://www.hospicefoundation.org>

Hospicelink
Hospice Education Institute
190 Westbrook Rd
Essex, CT 06426-1510
(800) 331-1620
<http://www.hospiceworld.com>

Human Growth Foundation
997 Glen Cove Ave
Glen Head, NY 11545
(800) 451-6434
<http://www.hgfound.org>

Hydrocephalus Foundation Inc
(HyFI) 910 Rear Broadway
Saugus, MA 01906
(781) 942-1161
HyFI1@netscape.net
<http://www.hydrocephalus.org>

Hypoglycemia Association Inc
18008 New Hampshire Ave
PO Box 165
Ashton, MD 20861-0165

Hypospadias Association of America
4950 S Yosemite St
Box F2-156
Greenwood Village, CO 80111
hypospadiasassn@yahoo.com
<http://www.hypospadias.net>

I

IgA Nephropathy Support Network
964 Brown Ave
Huntington, Valley, PA 19006
(215) 663-0536

Immune Deficiency Foundation
25 W Chesapeake Ave, Ste. 206
Towson, MD 21204
(800) 296-4433
<http://www.primaryimmune.org>

Impotence Institute of America Impotents Anonymous
10400 Little Patuxent Parkway, Ste. 485
Columbia, MD 21044-3502
(800) 669-1603

INFOLEP Leprosy Information Services
Postbus 950051090 HA
Amsterdam Netherlands
Infolep@antenna.nl

Inherited High Cholesterol Foundation
410 Chipeta Way

Room 167
Salt Lake City UT 84104
(888) 244-2465

Insight Meditation Society
1230 Pleasant St
Barre, MA 01005
(978) 355-4378
Fax: (978) 355-6398
<http://www.dharma.org>

Institute for Families with Blind Children
PO Box 54700, Mail Stop 111
Los Angeles, CA 90054-0700
(213) 669-4649

Institute for Preventative Sports Medicine
PO Box 7032
Ann Arbor, MI 48107
(313) 434-3390
<http://www.ipsm.org>

International Association of Enterstomal Therapy
27241 La Paz Road, Ste. 121
Laguna Niguel, CA 92656
(714) 476-0268

International Association of Infant Massage
PO Box 1045
Oak View, CA 93022

International Association of Laryngectomees (IAL)
7440 North Shadeland Ave, Ste. 100
Indianapolis, IN 46250
<http://www.larynxlink.com/>

International Association for Medical Assistance to Travelers (IAMAT)
417 Center St
Lewistown, NY 14092
(716) 754-4883

International Association of Parents and Professionals for Safe Alternatives in Childbirth
Rte 1, Box 646
Marble Hill, MO 63764
(314) 238-2010

International Association of Reiki Professionals
PO Box 481
Winchester, MA 01890
<http://www.iarp.org>

International Association of Yoga Therapists (IAYT)
4150 Tivoli Ave
Los Angeles, CA 90066

International Bio-Oxidative Medicine Foundation (IBOMF)
PO Box 891954
Oklahoma City OK 73109
(405) 634-7855
Fax: (405) 634-7320

International Childbirth Education Association
PO Box 20048
Minneapolis, MN 55420
(612) 854-8660

International Chi Kung/Qi Gong Directory
2730 29th St
Boulder, CO 80301
(303) 442-3131

International Cesarean Awareness Network
1304 Kingsdale Ave
Redondo Beach, CA 90278
(310) 542-6400

International Council for the Control of Iodine Deficiency Disorders
43 Circuit Road
Chester Hill, MA 02167
(207) 335-2221
<http://www.tulane.edu/~icec/iccidd home.htm>

International College of Applied Kinesiology
PO Box 905
Lawrence KS 66044-9005
(913) 542-1801

International Colour Vision Society: Forschungsstelle fuer Experimentelle Ophthalmologie
Roentgenweg 11
Tuebingen D-72076
Germany
<http://orlaboptomunsw.edu.au/ICVS>

International Council for Medical and Clinical Therapists
7361 McWhorter Place, Ste. 300
Annandale, VA 22003-5469
<http://www.ultradepth.com/ICMCT. htm>

International DiGeorge/VCF Support Network
c/o Family Voices of New York
46 1/2 Clinton Ave
Cortland, NY 13045
(607) 753-1250

International Eye Foundation
7801 Norfolk Ave
Bethesda, MD 20814
(301) 986-1830

International Foundation for Functional Gastrointestinal Disorders
PO Box 17864
Milwaukee, WI 53217
(888) 964-2001
<http://www.iffgd.org>

International Foundation for Homeopathy
2366 Eastlake Ave East
#301
Seattle, WA 98102
(425)776-4147

International Institute of Infant Massage
605 Bledsoe Rd NW
Albuquerque, NM 87107
(505) 341-9381
Fax: (505) 341-9386
<http://www.infantmassage.com>

International Institute of Reflexology
PO Box 12642
St Petersburg, FL 33733-2642
(727) 343-4811
Fax: (727) 381-2807
fteflex@concentric.net

International Lactation Consultants Association
201 Brown Ave
Evanston, IL 60202
(708) 260-8874

International Lesch-Nyhan Disease Association
114 Winchester Way
Shamong, NJ 08088-9398
(215) 677-4206

International Medical and Dental Hypnotherapy Association
4110 Edgeland, Ste. 800
Royal Oak MI 48073-2285
<http://www.infinityinst.com>

International Myopia Prevention Association
RD No 5, Box 171
Ligonier, PA 15658
(412) 238-2101

International NLP Trainers Association Ltd
Coombe House Mill Road
Fareham Hampshire PO16 0TN
United Kingdom
(044) 01489 571171

International Ozone Association Ind Pan American Group
31 Strawberry Hill Ave
Stamford, CT 06902
(203) 348-3542
Fax: (203) 967-4845

International Polio Network
4207 Lindell Blvd, Ste. 110
St Louis, MO 63108-2915
(314) 534-0475

International Rett Syndrome Association
9121 Piscataway Road, Ste. 2B

Clinton, MD 20735
(800) 818-7388
<http://www.rettsyndrome.org>

International School of Shiatsu
10 South Clinton St
Doylestown, PA 18901

International Tremor Foundation
7046 West 105th St
Overland Park KS 66212
(913) 341-3880

Intersex Society
PO Box 31791
San Francisco, CA 94131

Intestinal Health Institute
4427 East Fifth St
Tucson, AZ 85711
(520) 325-9686
info@sheilas.com
<http://www.sheilas.com>

Irish Raynaud's and Scleroderma Society
PO Box 2958
Foxrock Dublin 18
Ireland
(01) 235 0900
irss@indigo.ie

Iron Disorders Institute Inc
PO Box 3021
Greenville SC 29602
(864) 241-0111
irondis@aol.com
<http://www.irondisorders.org>

Iron Overload Diseases Association Inc
433 Westwind Dr North
Palm Beach, FL 33408
(561) 840-8512
iod@ironoverload.org

J

Juvenile Diabetes Foundation
120 Wall St 19th Floor
New York, NY 10005
(800) 533-2873
<http://www.jdf.org>

K

Kids with Heart
1578 Careful Dr
Green Bay, WI 54304
(800) 538-5390
<http://www.execpc.com/~kdswhrt>

Klinefelter Syndrome and Associates Inc
PO Box 119
Roseville, CA 95678-0119
(916) 773-2999
(888) 999-9428
Fax: (916) 773-1449
ksinfo@geneticorg
<http://www.genetic.org/ks>

Klinefelter's Organization
PO Box 60
Orpington BR68ZQ
United Kingdom
<http://hometownaol.com/KSCUK/index.htm>

Komen Foundation
5005 LBJ Freeway, Ste. 250
Dallas, TX 75244
(972) 855-1600
<http://www.komen.org>

L

LaLeche League International
1400 N Meacham Rd
Schaumburg, IL 60173-4048
(800) 525-3243
<http://www.lalecheleague.org>

Late Onset Tay-Sachs Foundation
1303 Paper Mill Road
Erdenheim, PA 19038
(800)672-2022

League for the Hard of Hearing
71 West 23rd St
New York, NY 10010-4162
(212) 741-7650
<http://www.lhh.org>

Learning Disabilities Association of America
4156 Library Road
Pittsburg, PA 15234
(412) 341-1515
<http://www.ldanatl.org>

Lesch-Nyhan Syndrome Registry
New York University School of Medicine
Department of Psychiatry
550 First Ave
New York, NY 10012
(212) 263-6458

Leukaemia Research Fund
43 Great Ormond St
London WC1N 3JJ
United Kingdom
(020) 7405-0101
<http://dspacedialpipex.com/lrf-//>

Leukemia Society of America Inc
600 Third Ave
New York, NY 10016
(800) 955 4572
<http://www.leukemia.org>

Lighthouse National Center for Education
111 E 59th St
New York, NY 10022
(800) 334-5497
<http://www.lighthouse.org>

Lighthouse National Center for Vision and Aging
111 E 59th St
New York, NY 10022
(800) 334-5497
<http://www.lighthouse.org>

Little People of America Inc
National Headquarters
PO Box 745
Lubbock, TX 79408
(806) 737-8186
(888) LPA-2001
lpadatabase@juno.com
<http://www.lpaonline.org>

Lupus Foundation of America
1300 Piccard Dr, Ste. 200
Rockville, MD 20850
(800) 558-0121
<http://www.lupus.org>

Lyme Disease Network of New Jersey Inc
43 Winton Road
East Brunswick, NJ 08816
<http://www.lymenet.org>

Lymphoma Research Foundation
8800 Venice Blvd, Ste. 207
Los Angeles, CA 90034
(310) 204 7040

M

March of Dimes Birth Defects Foundation
1275 Mamaroneck Ave
White Plains, NY 10605
(888) 663-4637
resourcecenter@modimes.org
<http://www.modimes.org>

Massachusetts College of Emergency Physicians (MACEP)
P O Box 296
Swansea, MA 02777
(508) 643-0117
Fax: (508) 643-0141

Massachusetts General Hospital
Functional and, Ste.reotactic Neurosurgery Cingulotomy Unit
Fruit St
Boston, MA 02114
(617) 726-2000
<http://neurosurgerymghharvard.edu/cingulot.htm>

Méniére's Network
1817 Patterson St
Nashville, TN 37203
(800) 545-4327
<http://www.earfoundation.org>

Meningitis Foundation of America
7155 Shadeland Station, Ste. 190
Indianapolis, IN 46256-3922
(800) 668-1129
<http://www.musa.org/welcome.htm>

Metabolic Information Network
PO Box 670847
Dallas, TX 75367-0847
(214) 696-2188
(800) 945-2188

Micronutrient Initiative
(c/o International Development Research Centre)
250 Albert St Ottawa Ontario
Canada K1G 3H9
(613) 236-6163, ext 2050
<http://www.idrc.ca/mi/index.htm>

Midlife Women's Network
5129 Logan Ave S
Minneapolis, MN 55419
(800) 886-4354

Midwest Heart Specialists
Physician Office Building
3825 Highland Ave
Tower 2, Ste. 400
Downers Grove, IL 60515
(630) 719-4799
<http://www.midwestheart.com>

Milne Institute Inc
PO Box 2716
Monterey, CA 93942-2716
(831) 649-1825
Fax: (831) 649-1826
<http://www.milneinstitute.com>
milneinst@aol.com

Mind-Body Medical Institute
Beth Israel Deaconess Medical Center
One Deaconess Road
Boston, MA 02215
(617) 632-9525
<http://www.mindbodyharvard.edu>

Mine Safety and Health Administration
4015 Wilson Blvd
Arlington, VA 22203
(703) 235-1910
<http://www.msha.gov>

Mommies Enduring Neonatal Death (MEND)
PO Box 1007
Coppell, TX 75067
(972) 459-2396
(888) 695-6363
<http://www.mend.org/home_index.asp>

Multiple Myeloma Research Foundation
11 Forest St
New Canaan, CT 06840
(203) 972-1250
<http://www.multiplemyeloma.org>

Muscular Dystrophy Association
3300 East Sunrise Dr
Tucson, AZ 85718
(520) 529-2000
(800) 572-1717
<http://www.mdausa.org>

Myasthenia Gravis Foundation of America
222 S Riverside Plaza, Ste. 1540
Chicago, IL 60606
(800) 541-5454
<http://www.medunc.edu>

Myelin Project Headquarters
2001 Pennsylvania Ave NW, Ste. 225
Washington, DC 20006-1850
(202) 452-8994
<http://www.myelin.org>

Myelodysplastic Syndromes Foundation
464 Main St
PO Box 477
Crosswicks, NJ 08515
(800) MDS-0839
<http://www.mds-foundation.org>

Myopia International Research Foundation
1265 Broadway
Room 608
New York, NY 10001
(212) 684-2777

Myositis Association of America
600-D University Blvd
Harrisonburg, VA 22801
(540) 433-7686
<http://www.myositis.org>

N

Nar-Anon Family Group Headquarters Inc
PO Box 2562
Palos Verdes Peninsula, CA 90274
(310) 547-5800

Narcolepsy Network
PO Box 42460
Cincinnati, OH 45242
(973) 276-0115

National Adrenal Disease Foundation
505 Northern Blvd, Ste. 200
Great Neck, NY 11021
(516) 487-4992

National AIDS Treatment Advocacy Project
580 Broadway, Ste. 403
New York, NY 10012
(888) 266-2827
<http://www.natap.org>

National Alliance on Alcoholism and Drug Dependence Inc
12 West 21st St
New York, NY 10010
(212) 206-6770

National Alliance of Breast Cancer Organizations
9 East 37th St
10th Floor
New York, NY 10016
(888) 806-2226
Fax: 212-689-1213
<http://www.nabco.org/>

National Alliance for Breastfeeding Advocacy
254 Conant Rd
Weston, MA 02193
(617) 893-3553

National Alliance of Methadone Advocates (NAMA)
435 Second Ave
New York, NY 10010
(212) 595-6262
<http://www.methadone.org/>

National Alliance for the Mentally Ill (NAMI)
Colonial Place Three
2107 Wilson Blvd, Ste. 300
Arlington, VA 22201-3042
(800) 950-6264
<http://www.nami.org>

National Alliance for Research on Schizophrenia and Depression
60 Cutter Mill Road, Ste. 200
Great Neck, NY 11021
(516) 829-0091
<http://www.mhsource.com>

National Animal Disease Center
Zoonotic Research Unit
2300 Dayton Ave
PO Box 70
Ames, IA 50010

National Anxiety Foundation
3135 Custer Dr
Lexington, KY 40517
(606) 272-7166
<http://www.lexington-on-line.com/naf.html>

National Aphasia Association
156 5th Ave, Ste. 707
New York, NY 10010
(800) 922-4622
<http://www.aphasia.org>

National Association of Anorexia Nervosa and Associated Disorders
Box 7
Highland Park, IL 60035
(708) 831-3438

National Association of Cognitive-Behavioral Therapists
PO Box 2195
Weirton WV 26062
(800) 853-1135
<http://www.nacbt.org>

National Association for Continence
PO Box 8310
Spartanburg, SC 29305-8310
(800) 252-3337
<http://www.nafc.org>

National Association for the Deaf
814 Thayer Ave
Silver Spring, MD 20910
(301) 587-1788
(301) 587-1789 (TDD)
<http://www.nad.org>

National Association of Holistic Aromatherapy
836 Hanley Industrial Court
St Louis, MO 63144
(888) ASK-NAHA
<http://www.naha.org>

National Association for Proton Therapy
7910 Woodmont Ave, Ste. 1303
Bethesda, MD 20814
(301) 913-9360
<http://www.proton-therapy.org/Default.htm>

National Association for Premenstrual Syndrome
7 Swift's Court High St
Seal Kent TN15 0EG
United Kingdom
+44 (0) 1732 760011
<http://www.PMDD.org.uk>

National Association for Pseudoxanthoma Elasticum
3500 East 12th Ave
Denver, CO 80206
(303) 355-3866
Fax: (303) 355-3859
Pxenape@eStcom
<http://www.napxe.org>

National Association for the Visually Handicapped
22 West 21st St
New York, NY 10010
(212) 889-3141

National Athletic Trainers' Association
2952, Stemmons Freeway
Dallas, TX 75247-6916
(800) 879-6282
(214) 637-6282
Fax: (214) 637-2206
<http://www.nata.org/>

National Attention Deficit Disorder Association (ADDA)
9930 Johnnycake Ridge Road, Ste. 3E
Mentor, OH 44060
(800) 487-2282
<http://www.add.org>

National Autism Hotline
c/o Autism Services Center
PO Box 507
605 Ninth St
Huntington, WV 25710
(304) 525-8014

National Birth Defects Prevention Network
Atlanta, GA
(770) 488-3550
<http://www.nbdpn.org>

National Board for Hypnotherapy and Hypnotic Anaesthesiology
7841 West Ludlow Dr, Ste. A
Peoria, AZ 85381
<http://www.nbha-medicine.com/index.html>

National Breast Cancer Coalition
1707 L St NW, Ste. 1060
Washington, DC 20036
(800) 622-2838
Fax: 202-265-6854
<http://www.natlbcc.org/>

National Cancer Institute
Building 31, Room 10A31
31 Center Dr
MSC 2580
Bethesda, MD 20892-2580
(800) 422-6237
<http://www.nci.nih.gov>

National Center for Complementary and Alternative Medicine (National Institutes of Health)
PO Box 8218
Silver Spring, MD 20907-8218
(888) 644-6226
<http://nccam.nih.gov>

National Center for Homeopathy
801 North Fairfax St, Ste. 306
Alexandria, VA 22134
(703) 548-7790

National Center for Learning Disabilities (NCLD)
381 Park Ave South, Ste. 1401
New York, NY 10016
(410) 296-0232
<http://www.ncld.org>

National Center for Nutrition and Dietetics
American Dietetic Association
216 West Jackson Blvd, Ste. 800
Chicago, IL 60606-6995
(800) 366-1655

National Center for the Preservation of Medicinal Herbs
3350 Beech Grove Road
Rutland, OH 45775
(740) 742-4401

National Center on Shaken Baby Syndrome
2955 Harrison Blvd #102
Ogden, UT 84403
(801) 627-3399
<http://www.dontshake.com>

National Center on Sleep Disorders Research
Two Rockledge Centre
6701 Rockledge Dr
Bethesda, MD 20892
(301) 435-0199

National Certification Board for Therapeutic Massage and Bodywork
8201 Greensboro Dr, Ste. 300
McLean, VA 22102

National Children's Eye Care Foundation
One Clinic Center A3-108
Cleveland, OH 44195
(216) 444-0488

National Cholesterol Education Program
NHLBI Information Center
PO Box 30105
Bethesda, MD 20824-0105
<http://www.nhlbi.nih.gov>

National Chronic Pain Outreach Association Inc
PO Box 274
Millboro, VA 24460
(540) 997-5004

National Clearinghouse for Alcohol and Drug Information
11426-28 Rockville Pike, Ste. 200
Rockville, MD 20852
(800) 729-6686
<http://www.health.org/>

National Clearinghouse on Child Abuse and Neglect Information
PO Box 1182
Washington, DC 20013-1182
(800) 394-3366
<http://www.calib.com/nccanch>

National Coalition for Cancer Survivorship
1010 Wayne Ave 7th Floor
Silver Spring, MD 20910-5600
(301) 650-9127
(877) NCCS-YES
<http://www.cansearch.org>

National Committee to Prevent Child Abuse
200 S Michigan Ave 17th Floor
Chicago, IL 60604
(312) 663-3520
<http://www.childabuse.org>

National Congenital Port Wine Stain Foundation
123 East 63rd St
New York, NY 10021
(516) 867-5137

National Council on Alcoholism and Drug Dependence
12 West 21st St
New York, NY 10010
(800) 622-2255
<http://www.ncadd.org>

National Depressive and Manic-Depressive Association (NDMDA)
730 N Franklin St, Ste. 501
Chicago, IL 60610
(800) 826-3632
<http://www.ndmda.org>

National Digestive Diseases Information Clearinghouse
2 Information Way
Bethesda, MD 20892-3570
nddic@aeriecom
<http://www.niddk.nih.gov/Brochures/NDDIC.htm>

National Easter Seal Society
230 W Monroe St, Ste. 1800
Chicago, IL 60606-4802
(312) 726-6200
(800) 221-6827
<http://www.easter-seals.org>

National Eating Disorders Organization (NEDO)
6655 South Yale Ave
Tulsa OK 74136
(918) 481-4044

National Enuresis Society
7777 Forest Lane, Ste. C-737
Dallas, TX 75230-2518
(800) 697-8080
<http://www.pedsumn.edu/Centers/NES>

National Eye Institute
2020 Vision Place
Bethesda, MD 20892-3655
(301) 496-5248
<http://www.nei.nih.gov>

National Familial Pancreas Tumor Registry
The Johns Hopkins Hospital
600 North Wolfe St
Baltimore, MD 21287-6417
(410) 377-7450

National Federation of the Blind
1800 Johnson St
Baltimore, MD 21230
(301) 569-9314

National Foundation for Vitiligo and Pigment Disorders
9032 South Normandy Dr
Centerville, OH 45459
(513) 885-5739

National Fragile X Foundation
PO Box 190488
San Francisco, CA 94119-0988
(800) 688-8765
(510) 763-6030
Fax: (510) 763-6223
natlfx@sprintmailcom
<http://nfxf.org>

National Gaucher Foundation
11140 Rockville Pike, Ste. 350
Rockville, MD 20852-3106
(800) 925-8885
<http://www.gaucherdisease.org>

National Guild of Hypnotists
PO Box 308
Merrimack NH
<http://www.ngh.net>

National Head Injury Foundation
333 Turnpike Rd
Southboro, MA 01722
(617) 485-9950

National Headache Foundation
428 W St James Place
Chicago, IL 60614
(800) 843-2256
<http://www.headaches.org>

National Hearing Aid Society
20361 Middlebelt
Livonia MI 48152
(800) 521-5247
(313) 478-2610

National Heart Lung and Blood Institute
PO Box 30105
Bethesda, MD 20824-0105
(301) 251-1222
<http://www.nhlbi.nih.gov>

National Hemophilia Foundation
116 West 32nd St
11th Floor
New York, NY 10001
(800) 42-HANDI
<http://www.info@hemophilia.org>

National Human Genome Research Institute
The National Institutes of Health
9000 Rockville Pike
Bethesda, MD 20892
(301) 496-2433
<http://www.nhgri.nih.gov>

National Hypoglycemia Association Inc
PO Box 120
Ridgewood, NJ 07451
(201) 670-1189

National Institute on Alcohol Abuse and Alcoholism (NIAAA)
6000 Executive Blvd
Bethesda Maryland 20892-7003
<http://www.niaaa.nih.gov>

National Institute of Allergy and Infectious Disease
Building 31 Room 7A-50
31 Center Dr
MSC 2520
Bethesda, MD 20892-2520
(301) 496-5717
<http://www.niaid.nih.gov/default.htm>

National Institute of Arthritis and Musculoskeletal and Skin Diseases
9000 Rockville Pike
Bldg 31, Rm 9A04
Bethesda, MD 20892

National Institute of Child Health and Human Development
Bldg 31, Room 2A32 MSC 2425
31 Center Dr
Bethesda, MD 20892-2425
(800) 505-2742
<http://www.nichd.nih.gov/sids/sids.htm>

National Institute on Deafness and Other Communication Disorders
National Institutes of Health
31 Center Dr
MSC 2320
Bethesda, MD 20892-2320
<http://www.nidcd.nih.gov>

National Institute of Dental Research
31 Center Dr
MSC 2190
Building 31, Room 5B49
Bethesda, MD 20892-2190

National Institute of Diabetes and Digestive and Kidney Diseases
31 Center Dr
USC2560 Building 31, Room 9A-04
Bethesda, MD 20892-2560
(301) 496-3583
<http://www.Niddk.nih.gov>

National Institute on Drug Abuse
PO Box 30652

Bethesda, MD 20824-0652
(888) 644-6432
<http:\\www.drugabuse.gov>

National Institute of General Medical Sciences
Division of Pharmacology Physiology and Biological Chemistry
45 Center Dr
MSC 6200
Bethesda, MD 20892-6200

National Institute of Mental Health
Mental Health Public Inquiries
5600 Fishers Lane
Room 15C-05
Rockville, MD 20857
(888) 826-9438
<http://www.nimh.nih.gov>

National Institute of Mental Health Panic Campaign
Rm 15C-05
5600 Fishers Lane
Rockville, MD 20857
(800) 647-2642
<http://www.nimh.nih.gov>

National Institute of Neurological Disorders and Stroke
PO Box 5801
Bethesda, MD 20824
(800) 352-9424
<http://www.ninds.nih.gov/index.htm>

National Jewish Center for Immunology and Respiratory Medicine
1400 Jackson St
Denver, CO 80206
(800) 222-5864
<http://www.nationaljewish.org/main.html>

National Kidney Foundation
30 East 33rd St
New York, NY 10016
(800) 622-9010
<http://www.kidney.org>

National Kidney and Urologic Diseases Information Clearinghouse
3 Information Way
Bethesda, MD 20892
(800) 891-5390
<http://www.niddk.nih.gov/health/kidney/nkudic.htm>

National Lead Information Center National Safety Council
1025 Connecticut Ave NW, Ste. 1200
Washington, DC 20036
(800) 532-3394
<http://www.nsc.org/ehc/lead.htm>

National Lymphedema Network (NLN)
2211 Post St, Ste. 404
San Francisco, CA 94115
(800) 541-3259
<http://www.hooked.net>

National Mental Health Association
1021 Prince St
Alexandria, VA 22314
(703) 684-7722
<http://www.nmha.org>

National MPS Society
102 Aspen Dr
Downingtown, PA 19335
(610) 942-0100
Fax: (610) 942-7188
info@mpssocietyorg
<http://www.mpssociety.org>

National Necrotizing Fascitis Foundation
PO Box 145
Niantic, CT 06357
(616) 261-2538
<http://www.nnff.org/>

National Organization for Albinism and Hypopigmentation (NOAH)
1530 Locust St #29
Philadelphia, PA 19102-4415
(800) 473-2310
<http://www.albinism.org>

National Organization for Rare Disorders (NORD)
PO Box 8923
New Fairfield, CT 06812-8923
(203) 746-6518
(800) 999-6673
Fax: (203)746-6481
<http://www.rarediseases.org>

National Osteoporosis Foundation
1150 17th St NW, Ste. 500
Washington, DC 20036-4603
<http://www.nof.org>

National Pancreas Foundation
PO Box 935
Wexford, PA 15090-0935
<http://www.pancreasfoundation.org>

National Parkinson Foundation
1501 NW Ninth Ave
Bob Hope Road
Miami, FL 33136
<http://www.parkinson.org>

National Prostate Cancer Coalition
1156 15th St NW
Washington, DC 20005
(202) 463-9455
<http://www.4npcc.org>

National Psoriasis Foundation
6600 SW 92nd Ave, Ste. 300
Portland, OR 97223
(800) 723-9166
<http://www.psoriasis.org>

National Respiratory Distress Syndrome Foundation
PO Box 723
Montgomeryville, PA 18936

National Safe Kids Campaign
1301 Pennsylvania Ave, Ste. 1000
Washington, DC 20004-1707
<http://pedsccmwustledu/All-Net/english/neurpage/protect/drown.htm>

National Sleep Foundation
1522 K St NW, Ste. 500
Washington, DC 20005
<http://www.sleepfoundation.org>

National Society of Genetic Counselors
233 Canterbury Dr
Wallingford, PA 19086-6617
(610) 872-1192
<http://www.nsgc.org/GeneticCounselingYou.asp>

National Society to Prevent Blindness
500 East Remington Rd
Schaumburg, IL 60173
(708) 843-2020
(800) 331-2020
<http://www.preventblindness.org>

National Stroke Association
9707 E Easter Lane
Englewood, CO 80112
(800) 787-6537
<http://www.stroke.org>

National Tay-Sachs and Allied Diseases Association
2001 Beacon St, Ste. 204
Brookline, MA 02146
(800) 906-8723
<http://www.ntsad.org>

National Tourette Syndrome Association Inc
42-40 Bell Blvd
Bayside, NY 11361-2820
(718) 224-2999
Fax: (718) 279-9596
tourette@ixnetcom.com

National, Vaginitis Association
117 South Cook St, Ste. 315
Barrington, IL 60010
(800) 909-8745
VagAssoc@aol.com
<http://www.vaginalinfections.org>

National Vitiligo Foundation
PO Box 6337
Tyler, TX 75703
(903) 531-9767
7307133@compuserve.com

National Women's Health Resource Center
120 Albany St, Ste. 820
New Brunswick, NJ 08901
(877) 986-9472
<http://www.healthywomen.org>

Neuropathy Association
60 E 42nd St, Ste. 942
New York, NY 10165
(212) 692-0662
<http://www.neuropathy.org>

North American Society of Homeopaths
10700 Old County Rd 15 #350
Minneapolis, MN 55441
(612) 593-9458

North American Vegetarian Society (NAVS)
PO Box 72
Dolgeville, NY 13329
(518) 568-7970

Northeastern T'ai Chi Chuan Association
163 West 23rd St 5th Floor
New York, NY 10011
(212) 741-1922

Northwest Center for Environmental Medicine
177 NE 102nd St
Portland, OR 97220
(503) 561-0966

O

Obsessive-Compulsive Anonymous
PO Box 215
New Hyde Park, NY 11040
(516) 741-4901
west24th@aol.com
<http://members@aol.com/west24th/index.html>

Office on Smoking and Health
Centers for Disease Control and Prevention
Mailstop K-50
4770 Buford Highway NE
Atlanta, GA 30341-3724
(800) 232-1311
<http://www.cdc.gov/tobacco/>

Office of the Special Assistant for Gulf War Illnesses
5113 Leesburg Pike, Ste. 901
Falls Church, VA 22041
(703) 578-8518
<http://www.gulflink.osd.mil>

Optician Association of America
7023 Little River Turnpike, Ste. 207
Annandale, VA 22003
(703) 916-8856
<http://www.opticians.org>

Oral Health Education Foundation Inc
5865 Colonist Dr
PO Box 396
Fairburn, GA 30213
(770) 969-7400

Osteoporosis and Related Bone Diseases-National Resource Center
1150 17th S NW, Ste. 500
Washington, DC 20036
(800) 624-2663

Overeaters Anonymous World Service Office
6075 Zenith, CT NE
Rio Rancho NM 87124
(505) 891-2664
<http://www.overeatersanonymous.org>

P

Paget Foundation
200, VA rick St, Ste. 1004
New York, NY 10014-4810
(800)23-PAGET

Parents Families and Friends of Lesbians and Gays
1726 M St NW, Ste. 400
Washington, DC 20036
(202) 467-8180
<http://www.pflag.org>

Pediatric/Adolescent Gastroesophageal Reflux Association Inc
PO Box 1153
Germantown, MD 20875-1153
(301) 601-9541
<http://www.reflux.org>

Periodic Paralysis Association
5225 Canyon Crest Dr #71-351
Riverside, CA 92507
(909) 781-4401
<http://www.periodicparalysis.org>

Phoenix Project/Head Injury Hotline
Box 84151
Seattle, WA 98124
(206)621-8558
<http://www.headinjury.com>

Pilates Studio
2121 Broadway, Ste. 201
New York, NY 10023-1786
(800)474-5283
(888) 474-5283
(212)875-0189
Fax: (212) 769-2368
<http:\\www.pilates-studio.com>

Planned Parenthood Federation of America Inc
810 Seventh Ave
New York, NY 10019
(800) 669-0156
<http://www.plannedparenthood.org>

Polycystic Kidney Disease Foundation
4901 Main St
Kansas City, MO 64112-2634
(800) PKD-CURE
<http://www.pkdcure.org/home.htm>

Polycystic Ovarian Syndrome Association
PO Box 80517
Portland, OR 97280
(877) 775-7267
info@pcossupport.org
<http://www.pcosupport.org/>

Postpartum Support International
927 North Kellog Ave
Santa Barbara, CA 93111
(805) 967-7636

Prader-Willi Foundation
223 Main St
Port Washington, NY 11050
(800)253-7993
<http://www.prader-willi.org>

Prader-Willi Syndrome Association(USA)
5700 Midnight Pass Rd
Sarasota, FL 34242
(800) 926-4797
<http://www.pwsusa.org>

Pregnancy and Infant Loss Support (SHARE)
St Joseph Health Center
300 First Capitol Dr
St Charles, MO 63301
(800) 821-6819
<http://www.nationalshareoffice.com/index.html>

Prevent Blindness America
500 East Remington Road
Schaumburg, IL 60173
(800) 331-2020
<http://www.prevent-blindness.org>

Project Inform
205 13th St #2001
San Francisco, CA 94103
(800) 822-7422
<http://www.projinf.org>

Prostate Health Council
American Foundation for Urologic Disease
1128 N Charles St
Baltimore, MD 21201-5559
(800) 828-7866
<http://www.afud.org>

Prostatitis Foundation Information Distribution Center
2029 Ireland Grove Park
Bloomington, IL 61704
(309) 664-6222
<http://www.prostate.org>

Pulmonary Fibrosis Foundation
1075 Santa Fe Dr
Denver, CO 80204
(720) 932-7850
<http://pulmonaryfibrosis.org>

Pulmonary Hypertension Association
PO Box 24733
Speedway, IN 46224-0733
(800) 748-7274
<http://www.phassociation.org>

PXE International Inc
23 Mountain St
Sharon, MA 02067
(781) 784-3817
Fax: (781) 784-6672
PXEInter@aol.com
<http://www.pxe.org/>

Q

Qigong Human Life Research Foundation
PO Box 5327
Cleveland, OH 44101
(216) 475-4712

R

Radiological Society of North America
820 Jorie Blvd
Oak Brook, IL 60523-2251
(630) 571-2670
<http://www.rsna.org>

Rainbows Down Under—A Trisomy 18 and Trisomy 13 Resource
SOFT Australia 198 Oak Rd
Kirrawee NSW 2232
Australia
02-9521-6039
<http://membersoptushomecom.au./karens>

Rape Abuse and Incest National Network
635-B Pennsylvania Ave SE
Washington, DC 20003
(800) 656-HOPE

Raynaud's & Scleroderma Association (UK)
112 Crewe Road
Alsager Cheshire ST7 2JA
United Kingdom
(44) (0) 1270 872776
webmaster@raynaudsdemon.co.uk
<http://www.raynaudsdemon.co.uk>

Reflexology Association of America
4012 Rainbow St
KPMB#585
Las Vegas, NV 89103-2059

Rehabilitation International
25 East 21st St
New York, NY 10010
(212) 420-1500

Resolve
1310 Broadway
Somerville, MA 02144-1731
(617) 623-0744
<http://www.resolve.org>

Restless Legs Syndrome Foundation
1904 Banbury Road
Raleigh, NC 27608-4428
(919) 781-4428
<http://www.rls.org>

Retinoblastoma International
4650 Sunset Blvd
Mail Stop #88
Los Angeles, CA 90027
(323) 669-2299
info@retinoblastoma.net
<http://www.retinoblastoma.net/rbi/index_rbi.htm>

Retinoblastoma Society
Saint Bartholomew's Hospital
London EC1A 7BE
United Kingdom
020 7600 3309
Fax: 020 7600 8579
<http://dsdialpipex.com/rbinfo>

Rocky Mountain Institute of Yoga and Ayurveda
PO Box 1091
Boulder, CO 80306
(303)443-6923

Rolf Institute of Structural Integration
209 Canyon Blvd
PO Box 1868
Boulder, CO 80306-1868
(303) 449-5903
(800) 530-8875
<http://www.rolf.org/>

S

Schizophrenics Anonymous
15920 W Twelve Mile
Southfield MI 48076
(248) 477-1983

Scleroderma Foundation
12 Kent Way, Ste. 101
Byfield, MA 01922
(978) 463-5843
(800) 722-HOPE
Fax: (978) 463-5809
<http://www.scleroderma.org>

Second Wind Lung Transplant Association Inc
9030 West Lakeview Court
Crystal River, FL 34428
(888) 222-2690
<http://www.arthouse.com/secondwind>

Self Help for Hard of Hearing People Inc
7800 Wisconsin Ave
Bethesda, MD 20814
(301) 657-2248
<http://www.shhh.org>

Sensory Integration International/The Ayres Clinic
1514 Cabrillo Ave
Torrance, CA 90501-2817

Sexuality Information and Education Council of the United States
130 W 42nd St, Ste. 350
New York, NY 10036
(212) 819-9770
<http://www.siecus.org>

Shriners Hospitals for Children
International Shrine Headquarters
2900 Rocky Point Dr
Tampa, FL 33607-1460
(813) 281-0300
<http://www.shrinershq.org>

Shy-Drager Syndrome Support Group
2004 Howard Lane
Austin, TX 78728
(800) 288-5582
<http://www.shy-drager.com>

Sickle Cell Disease Association of America Inc
200 Corporate Point, Ste. 495
Culver City, CA 90230-8727
(800) 421-8453
Scdaa@sicklecelldisease.org
<http://sicklecelldisease.org/>

Society for Light Treatment and Biological Rhythms
PO Box 591687
174 Cook St
San Francisco, CA 94159-1687
<http://www.websciences.org/sltbr>

Society for Progressive Supranuclear Palsy Inc
Ste. #5065
Johns Hopkins Outpatient Center
601 N Caroline St

Baltimore, MD 21287
(800) 457-4777
<http://www.psp.org>

Society of Neuro-Lingustic Programming
PO Box 424
Hopatcong, NJ 07843
(201) 770-3600

Society for Mucopolysaccharide Diseases
46 Woodside Rd
Amersham Buckinghamshire HP6 6AJ
United Kingdom
+44 (01494) 434156
<http://www.mpssociety.co.uk>

Society of Nuclear Medicine
1850 Samuel Morse Dr
Reston, VA 10016
(703) 708-9000
<http://www.snm.org>

Spina Bifida Association of America
4590 MacArthur Blvd NW, Ste. 250
Washington, DC 20007-4226
(800) 621-3141
(202) 944-3285
Fax: (202) 944-3295

Spine Center
1911 Arch St
Philadelphia, PA 19103
(215) 665-8300
<http://www.thespinecenter.com>

SPOHNC Support for People with Oral and Head and Neck Cancer
PO Box 53
Locust, Valley, NY 11560-0053
(800) 377-0928
<http://www.spohnc.org>

Sudden Arrhythimia Death Syndromes Foundation
540 Arapeen Dr, Ste. 207
Salt Lake City UT 84108
(800) STOP SAD
<http://www.sads.org>
<http://www.ihc.com/research/longqt.html>

Sudden Infant Death Syndrome Alliance
1314 Bedford Ave, Ste. 210
Baltimore, MD 21208
(800) 221-7437
<http://www.sidsalliance.org>

Support Organization for Trisomy 18 13 and Related Disorders (SOFT)
2982 South Union St
Rochester, NY 14624
(800) 716-7638
<http://www.trisomy.org>

T

Tardive Dyskinesia/Tardive Dystonia National Association
PO Box 45732
Seattle, WA 98145-0732
(206) 522-3166

Texas Heart Institute Heart Information Service
PO Box 20345
Houston, TX 77225-0345
(800) 292-2221
<http://www.tmc.edu/thi/his.html>

Thyroid Foundation of America Inc
Ruth Sleeper Hall RSL350
40 Parkman St
Boston, MA 02114-2698
(800) 832-8321
<http://www.tfaeweb.org/pub/tfa>

Thyroid Society for Education and Research
7515 South Main St, Ste. 545
Houston, TX 77030
(800) 849-7643
<http:the-thyroid-society.org/thyroid.html>

Tourette Syndrome Foundation of Canada
194 Jarvis St #206
Toronto ONT M5B 2B7
Canada
(800) 361-3120
tsfcorg@sympatico.ca
<http://www.tourette.ca>

Trager Institute
21 Locust Ave
Mill, Valley, CA 94941-2806
(415) 388-2688
Fax: (415) 399-2710
admin@trager.com
<http://www.trager.com>

Trans-Hyperboreau Institute of Science
PO Box 2344
Sausalito, CA 94966
(415) 331-0230
(800) 485-8095
Fax: (415) 331-0231

Transverse Myelitis Association
1787 Sutter Parkway
Powell, OH 43065-8806
(614) 766-1806
<http://www.myelitis.org>

Trichotillomania Learning Center Inc
1215 Mission St, Ste. 2
Santa Cruz, CA 95060
(831) 457-1004
Fax: (831) 426-4383
<http://www.trich.org>

Trigeminal Neuralgia/Tic Douloureux Association
PO Box 340
Barnegat Light, NJ 08006
(609) 361-1014

Turner Syndrome Society of England
2 Mayfield Ave
London W41PW
United Kingdom
44 (0)181-994 7625
Fax: 44 (0)181-995 9075
<http://www.exnet.com/staff/sys4/ts.html
<http://www.tss.org.uk>

U

Undersea and Hyperbaric Medical Society
10531 Metropolitan Ave
Kensington, MD 20895
(301) 942-2980
<http://www.uhms.org>

United Cerebral Palsy Association Inc (UCP)
1660 L St NW, Ste. 700
Washington, DC 20036-5602
(202)776-0406
(800)872-5827
<http://www.ucpa.org>

United Network for Organ Sharing
1100 Boulders Parkway, Ste. 500
PO Box 13770
Richmond, VA 23225-8770
(804) 330-8500
<http://www.unos.org>

United Ostomy Association Inc (UOA)
19772 MacArthur Blvd, Ste. 200
Irvine, CA 92612-2405
(800) 826-0826
<http://www.uoa.org>

United Plant Savers
PO Box 98
East Barre VT 05649
(802)479-9825
<http://www.plantsavers.org>

United States Department of Health and Human Services
200 Independence Ave SW
Washington, DC 20201
(877) 696-6775
<http://www.hhs.gov>

United States Department of Justice Drug Enforcement Administration
2401 Jefferson Davis Highway
Alexandria, VA 22301
(888) 644-6432
<http:\\www.usdoj.gov/dea>

United States Department of Justice Office for Victims of Crime
810 7th St NW
Washington, DC 20531

United States Food and Drug Administration (FDA) Center for Drug Evaluation and Research
Viagra Information
<http://www.fda.gov/cder/consumerinfo/viagra/default.htm>

United States National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894
(888) 346-3656
<http://www.nlm.nih.gov>

United States Renal Data System (USRDS)
The University of Michigan
315 W Huron, Ste. 240
Ann Arbor MI 48103
(734) 998-6611
<http://www.medumichedu/usrds>

University of California Los Angeles
Harbor-UCLA Medical Center Research and Education Institute
1124 W Carson St B-4
South Torrance, CA 90502

University of Illinois Center for Narcolepsy Research
845 S Damen Ave
Chicago, IL 60612
(312) 996-5176

Upledger Institute
11211 Prosperity Farms Rd
Palm Beach Gardens, FL 33410
(800) 233-5880
Fax: (561) 622-4771
<http://www.upledger.com>

V

Vestibular Disorders Association
PO Box 4467
Portland, OR 97208-4467
(503) 229-7705
<http://www.teleport.com/~veda>

Veterans Administration
Persian Gulf Medical Information Helpline
400 South 18th St
St Louis, MO 63103-2271
(800)749-8387

W

Wegener's Foundation Inc
3705 South George Mason Dr, Ste. 1813
South Falls Church, VA 22041
(703) 931-5852

Wegener's Granulomatosis Support Group Inc
PO Box 28660
Kansas City, MO 64188-8660
(800) 277-9474
<http://www.wgsg.org/wgsg>

Weight-Control Information Network
1 Win Way
Bethesda, MD 20896-3665
(301) 951-1120
<http://www.navigatortufts.edu/special/win.html>

Wellness Community
35 E Seventh St, Ste. 412
Cincinnati, OH 45202
(888) 793-9355
<http://www.wellness-community.org>

Wilderness Medical Society
PO Box 2463
Indianapolis, IN 46204
(317) 631-1745

Wilderness Medicine Institute
PO Box 9
413 Main St
Pitkin, CO 81241
(970) 641-3572
<http://www.wildernessmed.com>

Wilson's Disease Association
4 Navaho Dr
Brookfield, CT 06804
(800) 399-0266

Women's Cancer Network
c/o Gynecologic Cancer Foundation
401 N Michigan Ave
Chicago, IL 60611
(312) 644-6610
<http://www.wcn.org>

World Hypnosis Organization Inc
2521 W Montrose Ave
Chicago, IL 60618
<http://www.worldhypnosis.org/about.html>

Worldwide Education and Awareness for Movement Disorders
One Gustave L Levy Place
Box 1052
New York, NY 10029
(800) 437-6683
<http://www.wemove.org>

Wound Care Institute
1100 NE 163rd St, Ste. #101
North Miami Beach, FL 33162
(305) 919-9192
<http://woundcare.org>

Wound Healing Society
1550 South Coast Highway, Ste. 201
Laguna Beach, CA 92651
(888) 434-4234
<http://wizardpharmwayne.edu/woundsoc/WHS.htm>

Wright State University Aerospace Medicine Program
PO Box 92
Dayton, OH 45401-0927
(937) 276-8338
<http://www.medwright.edu>

Y

Y-ME National Organization for Breast Cancer Information and Support
18220 Harwood Ave
Homewood, IL 60430
(800) 221-2141
(708) 799-8228

Z

Zain Hansen MPS Foundation
23400 Henderson Rd
Covelo, CA 95420
(800) 767-3121

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